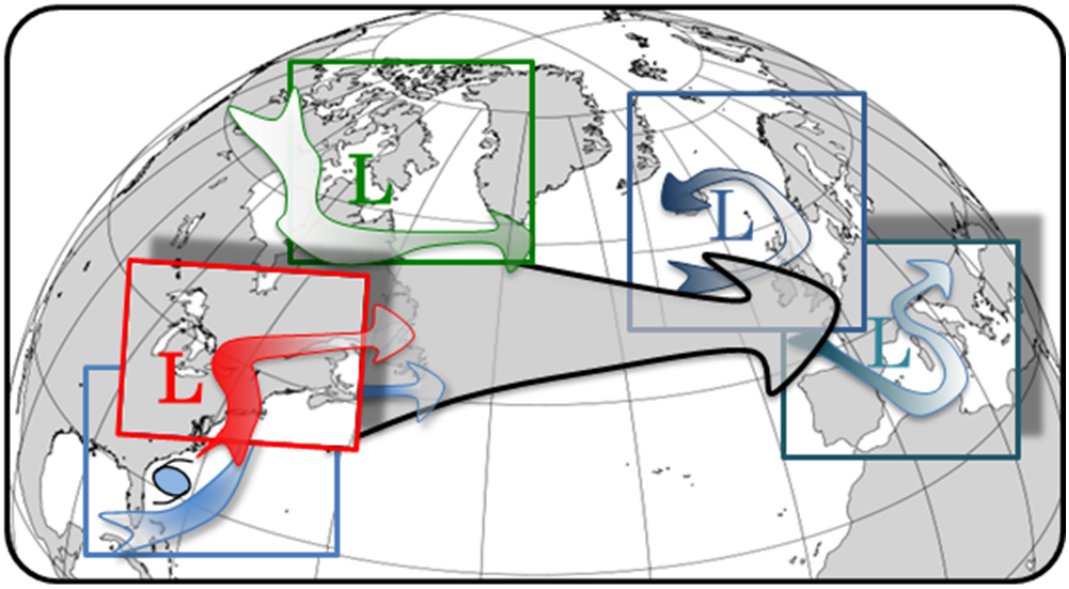
Campaign Reports of

NAWDEX



North Atlantic Waveguide

and Downstream Impact Experiment

--- Weather Summaries ---

--- Flight Planning Summaries ---

	Reports		Presentations	
	Weather Summary	Planning Summary	Planning Meeting	Weather Discussion
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08.10.	DOWN DAY			
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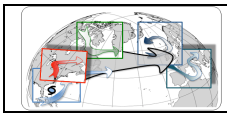
	**NAWDEX 2015** **Planning summary**	**Date: Sept. 19, 2016** **Author: G. Craig, L. Bierdel**

NAWDEX 2015 - Planning summary

The next mission is planned for Wednesday, September 21st. There will be coordinated flights of HALO and FALCON to measure the diabatic outflow of a WCB directly over and South of Iceland.
FALCON: Box pattern with flights parallel to Jetstream (current position: slightly North/ North-West of Iceland), three parallel legs capturing stratospheric and tropospheric air as well as the jet stream. Due to forecast uncertainty an adaption to the weather situation will be needed for the determination of the exact location of the tracks.
HALO: Measurement of WCB ascent region South of Iceland, one leg will be coordinated with FALCON, a triangle South of Iceland will be flown where 13 dropsondes will be released.
An early estimate for the take-off time is mid-afternoon.

The responsible persons for this mission are

- Scientific Manager: George Craig
- Chief Forecaster: Christian Grams
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: Ben Harvey
- Mission Scientists: Florian Pantillon (HALO), Oliver Reitebuch (FALCON), Julian Quinting (Ground support)

The schedule for the current day is a flight planning meeting with mission scientists and pilots at 12 UTC and a weather discussion at 16 UTC. The weather discussion will continue to be held at 16 UTC in future.

The main topic of the General meeting were the coordinated FALCON/HALO flights planned for Wednesday, September 21st as well as an outlook to a possible mission on Friday/Saturday September 23rd and 24th. The main discussion was about the following points:

Feedback from transfer flight:

- A radar calibration circle should be included in a future mission (not successful during transfer flight)
- The 2-micron lidar didn't work as expected during the transfer flight. Future planning should take into account that the lidar only works stably after about 1 hour of the flight.
- Flight planning should consider satellite tracks for possible underflights. M. Mech will provide the GPM tracks to the forecasting team.
- During the transfer flight a dropsonde did not work as expected and a new one had to be launched. Upcoming flights should be equipped with spare dropsondes.

Wednesday mission:

- M. Bramberger requested for the HALO flight that the flight level be lowered in order to capture more turbulent activity. This might conflict with the minimum height HALO can fly on while staying over the cloud top. Vertical cloud cross-sections for the planned flight track will be provided in the upcoming Planning meeting.

- The initially planned descent and ascent of the FALCON (capture of vertical temperature profile) is not possible due to operational constraints. Flights can be performed on different levels which will be discussed in the 12 UTC meeting with the pilots.
- The exact flight planning can potentially be synchronized with Satellite overpasses: A-Train (around 14:30 UTC) and GPM (14:40 UTC and 16 UTC)
- specMACS requires daylight at take-off for calibration purposes. The timing of the mission should account for this limitation.

Friday/Saturday mission:

- On Friday/Saturday (September 24th/25th) there is the chance for another flight. The WCB inflow will be far enough North that it can be captured which might be a unique opportunity during the campaign given the range of the aircraft.
- On Friday HALO is planned to fly South (less than 61 degree North) to capture the WCB ascent regions on low levels. To that end, HALO will fly below the NAT tracks (flight level 260-280) and the associated planning procedure requires an announcement of the flight track on Wednesday, September 21st.
- This flight might be coordinated with FAAM.
- The mission PI of the mission on Friday will be L. Bierdel.
- For Saturday, a coordinated flight of HALO and FALCON is planned to capture the WCB outflow which will be located between Iceland and Norway.
- The basic concept of the plans for Friday/Saturday was found to be reasonable by flight facility (F. Probst) and should be refined by Wednesday.

	NAWDEX 2015 Planning summary	Date: Sept. 20, 2016 Author: G. Craig, L. Bierdel

NAWDEX 2015 - Planning summary

The flight plans made yesterday were confirmed with small adjustments to the current weather situation. The center time for the mission was set to 15 UTC.
FALCON: The flight pattern has been slightly rotated to adjust to the location of the PV gradient in the updated forecast.
HALO: The flight track has been adjusted (moved further North) so that the core of the low pressure system will be overflown. Leg 1-2-3 will be synchronized with the overpass of GPM, leg 4-5-6 will be coordinated with FALCON.
The responsible persons for this mission are

- Scientific Manager: George Craig
- Chief Forecaster: Christian Grams
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: Ben Harvey
- Mission Scientists: Florian Pantillon (HALO), Oliver Reitebuch (FALCON), Julian Quinting (Ground support)

The schedule for the current day is a flight planning meeting with mission scientists and pilots at 12 UTC and a weather discussion at 16 UTC.

The main topics of the General meeting were the coordinated FALCON/HALO flights planned for Wednesday, September 21st, the concept for a possible coordinated HALO/FAAM mission to take place on Friday September 23rd, as well as possible options for the upcoming week. The following points were raised in the discussion:
Wednesday mission:

- The instrument scientists onboard the FALCON and HALO will be:
  FALCON: Oliver Reitebuch, Christian Lemmerz
  HALO: Axel Amedieck, Friedhelm Jansen, Mario Mech, Florian Pantillon, Kevin Wolf, Hans Grob
- M. Mech suggested launching at least one dropsonde during the GPM overpass (waypoint 1, HALO)
- Whether or not dropsondes can be released during the mission tomorrow between waypoints 7 and 8 by HALO depends on the location of the NAT-tracks. So far NAT-track forecasts are available.
- Waypoint 7 of HALO might be shifted further East to capture more tropospheric air masses
- The following radiosondes have been requested for the mission:
  Iceland: Keflavik (15, 18, 21 UTC), Egilsstadir (12 UTC)
  Greenland East Coast: Ittoqqortoormiit (15,18,21 UTC)
- A. Minikin again clarified the procedure before take-off for FALCON and HALO. 30 mins. before

roll-out there will be a short briefing with all on-board scientists .

Friday mission:

- On Friday there will be the opportunity to perform a quasi-Lagrangian measurement of WCB ascent. HALO will fly south to the region of low-level WCB inflow, then proceed North towards Ireland, and finally return to Iceland. During the flight at the location of the mid-level ascent a zig-zag flight pattern is planned to capture the ascending air masses. The release of drop-sondes is planned for the overflight of low-level WCB inflow as well as ascending air masses.
- FALCON will not participate in this mission (range of aircraft insufficient).
- There is an opportunity for the Friday mission to be coordinated with the UK FAAM BAE 145 aircraft. The FAAM aircraft will start from its base at East Midlands airport, and after a possible refuelling stop at Shannon Airport, cross the mid-level ascending air masses before returning to base. Communication with Geraint Vaughan is ongoing to clarify details. It has already been noted that the FAAM aircraft has limitations concerning the timing of the mission (latest back at East midlands by 19UTC).
- The transect through the ascending air performed by FAAM could be synchronized with HALO. It is intended that HALO flies above cloud top (lidar and radar measurements) and FAAM flies through low/mid-level clouds for microphysical measurements (release of dropsondes is also intended).
- The HALO flight will be in the NAT-track region where special flying requests are required. A detailed track has to be announced by tonight to F. Probst. It will then be clarified by tomorrow in what NOTAM region the release of dropsondes will be possible.
- In order to fly in the NAT-track region, HALO has to stay under flight level 280.
- There is the possibility to capture regions of intense clear-air turbulence. This is of special interest for M. Bramberger.

Saturday and next week:

- On Saturday the upper-level outflow of the WCB inflow captured on Friday will be located North of Iceland between Norway and Greenland. Capturing this outflow is of great interest since the associated low-level inflow has been measured on Friday. There is some uncertainty related to timing of the outflow and diffusion of air parcels. This flight will be coordinated between HALO and FALCON.
- F. Probst mentioned that the duty time of the pilots might become an issue. The mission planned for Friday involves a long flight and for operators, staff and pilots there are limitations concerning the duty time (14h duty time has to be followed by 14h off-time). This has to be taken into account for the planning for the mission on Saturday.

Next week:

- On Sunday there is the possibility of a day off.
- The next potential mission would be Monday, September 26. Ex-TC Karl and a

downstream cyclone will consecutively propagate towards Iceland. The Jetstream is expected to be very strong.

NAWDEX 2016 - Planning summary

Falcon and HALO are flying today. One small adjustment has been made to the HALO flight plan.
FALCON: Flight pattern as decided yesterday.
HALO: Easternmost point (P4) moved toward the north to keep leg P4-P5 in inflow region.

The responsible persons for this mission are

- Scientific Manager: George Craig
- Chief Forecaster: Christian Grams
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: Ben Harvey
- Mission Scientists: Florian Pantillon (HALO), Oliver Reitebuch (FALCON), Julian Quinting (Ground support)

The schedule for the current day is a weather discussion at 16 UTC.

The main topic of the General meeting was the HALO flight planned for Friday, September 23st, coordinated with FAAM . The following points were raised in the discussion:

Friday mission:

- A HALO flight is planned to explore the ascent region of the strong WCB and associated ridge building to the North- East of the British Isles. The earlier part of the flight will be at lower flight levels (FL280) to allow dropsondes under the NA-Tracks, then ascending to higher altitudes (FL450) for coordination with FAAM and to sample the outflow region during the return to Keflavik. Coordination with FAAM will occur on the leg P4-P5. The long flight to the south that was presented yesterday has been changed since forecasts show that the inflow region is too far south to be observed.
- Martin Hagen commented that FL450 might be too high for radar measurements to reach to the surface (depending on pitch) and suggests FL430 might be preferable.
- Frank Probst does not expect the length of the flight to be a problem, even with the long distance at FL280.
- The shape of the NOTAM box was discussed, and a good solution could be an L-shape to include the legs P1-P2-P3.

The responsible persons for this mission are

- Scientific Manager: Heini Wernli

- Chief Forecaster: Hanin Binder
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: Ben Harvey
- Mission Scientists: Lotte Bierdel (HALO), Oliver Reitebuch (FALCON), Marlene Baumgart (Ground support)

Saturday and next week:

Options to be considered in the weather discussion this afternoon are:

1. Flights on Saturday with Falcon and/or HALO to sample the upper-level outflow of the WCB inflow captured on Friday. Capturing this outflow is of great interest since the associated low-level inflow has been measured on Friday.
2. Flights on Monday to measure the outflow of the cyclone downstream of TC Karl. This is a very strong ascent, but may not be in range of the aircraft.

Further points from the discussion:

- At the moment the weather forecast is very uncertain.
- Depending on these plans, a rest day may be announced for either Saturday or Sunday.

	NAWDEX 2016 Planning summary	Date: Sept. 22, 2016 Author: H. Wernli, M. Bramberger

NAWDEX 2016 - Planning summary

Today there are no flights. The next mission (IOP3) is planned for tomorrow, Friday 23 September, with both HALO and Falcon, and with a coordinated flight with the UK FAAM aircraft.

The schedule for today is a **weather discussion** at 16 UTC and a first **quicklook meeting** at 1630 UTC.

The main topic of the General Meeting was the coordination of the HALO, Falcon and FAAM flights on Friday 23 September.

IOP2 on Wed 21 September
Research flights yesterday with HALO and Falcon were successful and no major incident on the instruments' side occurred. Only the shutter of the dropsonde system did not work very well and therefore it will be checked today on the ground and during the check flight performed today in the afternoon.

IOP3 on Fri 23 Sept

- A HALO flight is planned to explore the ascent region of the strong WCB and associated ridge building to the North-East of the British Isles. The earlier part of the flight will be at lower flight levels (FL280) to allow dropsondes beneath the NA-Tracks, then ascending to higher altitudes (FL430) for coordination with FAAM to the west of Scotland, and to sample the outflow region during the return to Keflavik. Coordination with FAAM will occur on the leg P4-P5 from 8W to 13W at 55.3N. The FAAM will fly at FL100 to FL230 and take microphysical measurements in the WCB ascent region.
- As discussed in the weather discussion meeting yesterday afternoon, we decided to also fly with Falcon, in order to capture the cyclonic shear side to the east of Iceland. The plan is to do one transect towards the SE coordinated with HALO to drop sondes. The detailed location and intensity of this jet (and the associated WCB outflow) is still somehow uncertain but it seems that a strong jet streak is close to Iceland in the morning. We therefore adjusted the HALO flight track such that the first leg after take off will go towards the SE together with the Falcon. Then HALO will go back to the originally planned leg towards the South.
- Frank Probst mentions that he is optimistic that we will get the NOTAM box as designed yesterday between about 9 and 11 UTC.
- In summary, the new flight plan includes coordinated legs in the morning with Falcon and in the afternoon with FAAM. The timing for the NOTAM box can remain unchanged (otherwise we risk to loose permission to release dropsondes). The scientific objectives of these flights are: jet stream, WCB ascent and outflow, cloud microphysics, and embedded convection in WCBs.

The responsible persons for this mission are

- Scientific Manager: Heini Wernli
- Chief Forecaster: Hanin Binder
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: Ben Harvey
- Mission Scientists: Lotte Bierdel (HALO), Oliver Reitebuch (FALCON), Marlene Baumgart (Ground support)

Day Off on Saturday
A 2nd day off was announced for Sat 24 September.

	NAWDEX 2016 Planning summary	Date: Sept. 22, 2016 Author: H. Wernli, M. Bramberger

Outlook for Monday and the days beyond

Early next week the key weather systems are (according to the latest forecast):
An extratropical cyclone generated over Newfoundland and developing towards the central North Atlantic; with a potentially strong WCB outflow towards Iceland
TC Karl, which will recurve and is likely to propagate rapidly towards Europe (as a diabatic Rossby wave?). TC Karl has been sampled with dropsondes from the US SHOUT experiment.
TC Lisa to the SE of TC Karl.
Forecasts show different evolutions of these weather systems, but very intense WCB activity over the North Atlantic is very likely. Plans should be developed for a potential flight on Monday (preliminary plans on Friday, detailed plan on Sunday).

The responsible persons for a potential mission on Monday are

- Scientific Manager: Jim Doyle
- Chief Forecaster: Julian Quinting
- Instrument Manager: N.N:
- Coordinator Ground-Based Observations: N.N.
- Mission Scientists: George Craig (HALO), Oliver Reitebuch (FALCON), Volkmar Wirth (Ground support)

Further points from the discussion:

- At the moment the weather forecast is very uncertain from Monday onward.
- Oliver Reitebuch makes us aware that next week a calibration flight with Falcon over cloud-free Greenland is necessary for the lidars. The Chief Forecasters will check cloud conditions over Greenland.

	NAWDEX 2016 Planning summary	Date: Sept. 23, 2016 Author: H. Wernli, M. Bramberger

NAWDEX 2016 - Planning summary

IOP3 is ongoing today with flights of HALO, Falcon and FAAM. Planning is starting for IOP4, most likely with a southbound HALO flight on the afternoon of Monday 26 September.

The schedule for today is a **weather discussion** at 16 UTC.

The main topic of the General Meeting was the outlook with different scenarios for Monday 26 September.

IOP3 on Fri 23 Sept

- Both HALO and Falcon took off early this morning. The Falcon is already back and reported excellent conditions for the wind lidars. HALO is currently on its southernmost leg crossing the WCB and dropping sondes. The coordinated flight leg with FAAM north of Ireland is planned at 1215 UTC. The cyclone sampled today has now a name, its "Vladiana".

The responsible persons for this mission are

- Scientific Manager: Heini Wernli
- Chief Forecaster: Hanin Binder
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: Ben Harvey
- Mission Scientists: Lotte Bierdel (HALO), Oliver Reitebuch (FALCON), Marlene Baumgart (Ground support)

Day Off on Saturday

A 2nd day off was announced for Sat 24 September.

Weather outlook over the weekend

- Sat: Vladiana replaces Ursula near Iceland, new cyclone forms over Newfoundland (we refer to this cyclone as the downstream or DS cyclone); TC Karl is in the Subtropics.
- Sun: Vladiana is still near Iceland, the DS cyclone moves south of Greenland, TC Karl is recurving and TC Lisa enters the game

HALO flight options on Mon 26 Sept

As presented yesterday, several key weather systems are present in the different forecast scenarios for Monday:

- The DS cyclone developing towards the central North Atlantic; with a potentially strong WCB outflow towards Iceland
- TC Karl, which will recurve and is likely to propagate rapidly towards Europe. There are different scenarios of what TC Karl will do whilst moving into the extratropics: diabatic Rossby wave propagation towards Europe with and without intensification; merging with the DS cyclone – in all situations there is strong WCB outflow associated with TC Karl.
- TC Lisa to the SE of TC Karl.

George and Volkmar, and Hanin and Julian developed 3 possible flight scenarios for Monday afternoon, based on different meteorological scenarios. The 1st scenario focuses on crossing of the strong jet and flying into the center of the DS cyclones (with an intense PV tower), and the 2nd includes legs beneath the very high tropopause region south of the jet in the region with very strong horizontal water vapour transport. This region is cloud-free at mid-to-high levels and would allow for measurements in the moist boundary layer. The 3rd scenario is a variant of the 2nd. The scenarios are briefly discussed. The critical aspect of all 3 flight tracks is that they are mainly in the NAT region and that dropping sondes would be essential for this mission. Therefore a large NOTAM area would be required. The NOTAM issue will be discussed with Frank after the General Meeting.

	NAWDEX 2016 Planning summary	Date: Sept. 23, 2016 Author: H. Wernli, M. Bramberger

The responsible persons for a potential HALO mission on Monday are

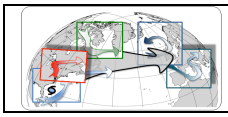
- Scientific Manager: Jim Doyle
- Chief Forecaster: Julian Quinting
- Instrument Manager: N.N:
- Coordinator Ground-Based Observations: Leo Saffin
- Mission Scientists: George Craig (HALO), Volkmar Wirth (Ground support)

Falcon flight options on Mon/Tue 26/27 September

We only briefly discussed options for Falcon flights early next week. One option would be to fly late on Monday south of Iceland (if the ridgebuilding associated with the DS cyclone will be strong), and the other option early on Tuesday to the east of Iceland if the WCB outflow rather heads towards Scandinavia. Both scenarios can be planned in detail on Sunday.

Further points from the discussion:

- The Global Hawk (SHOUT campaign) is able to drop sondes today in and around TC Karl, which might lead to reducing the uncertainty level of the forecasts.
- Information from John Methven: The FAAM aircraft plans a coordinated flight with HALO (HAMP instrument) in the 4th week of NAWDEX. At that time, the FAAM will still be in the UK. After NAWDEX, on 17 Oct, the FAAM will come to Iceland for research flights on volcanic emissions.
- The French Falcon will arrive on Wed 28 September.

	**NAWDEX 2016** **Planning summary**	**Date: September 25, 2016** **Author: F. Baur, H. Wernli**

NAWDEX 2016 - Planning summary

Today there are no flights. The next missions are planned for tomorrow, Monday 26 September (IOP4) with Halo and Tuesday 27 September with Falcon, FAAM and HALO.

The schedule for today is the detailed planning of the HALO flight that will take place on Monday 26 September. At 16UTC there will be a weather discussion with a 10 Minutes quicklook session at the beginning with 1 slide per instrument. In addition there will be science meetings on days with less flight planning activities.

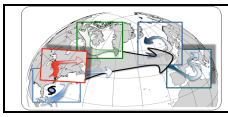
IOP3 on Friday 23 September

Research flights on Friday with HALO, Falcon and FAAM were successful. All instruments worked well and the measurements were successful. The Falcon could measure winds in the cirrus clouds above the jet exit very well in a coordinated flight leg with HALO in the morning. The ascent region of the WCB was crossed 3 times by HALO and 21 dropsondes were released in total. The FAAM arrived at the meeting point RUBEX later than planned. However, a request to Shannon airspace administration, HALO was allowed to fly an extra circle in order to start the coordinated flight leg with FAAM about as planned.

IOP4 on Monday 26 September

- On Monday a HALO flight addresses the structure of ex-TC Karl, which was explored during the last 2 days by the Global Hawk as part of the SHOUT mission. Until Monday 12 UTC, ex-TC Karl will merge with a cyclone evolving from Newfoundland, and this merged system will be associated with a very pronounced tropopause fold. The HALO flight is planned with several transects across this fold and the strong WCB further east.
- The first part of the flight will be at high levels (FL410) to measure the water vapour structure near the dry intrusion. Further south, at FL280, sondes will be dropped ahead of the dry intrusion and across the tropopause fold.
- The current flight plan might be too long. These issues will be discussed with the pilots in the meeting at 12UTC when the flight track will be planned in detail.

- Scientific Manager: Heinli Wernli (today), Jim Doyle (Mon 26 Sept)
- Chief Forecaster: Julian Quinting
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: Leo Shaffin
- Mission Scientist: George Craig (HALO), Oliver Reitebuch (Falcon), Volkmar Wirth (Ground support)

	**NAWDEX 2016** **Planning summary**	**Date: September 25, 2016** **Author: F. Baur, H. Wernli**

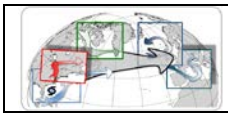
IOP5 on Tuesday 27 September

- Ex-TC Karl will be captured in its mature state.
- A mission coordinated between Falcon and FAAM is planned between the Faroe Islands until northern Scotland, crossing the PV streamer and the strong jet stream.
- The meeting point with the British FAAM will be near the Faroe Islands at 10:40 UTC.
- FAAM is operating at lower altitudes to make measurements in warm and ice clouds. The Falcon is flying at FL360 to take wind measurements in the tropospheric and stratospheric air and near the surface. In between the relative humidity might be too low.
- A HALO flight is trying to catch the breakup of the PV streamer into a PV cutoff. This cutoff determines the future evolution of ex-TC Karl towards Norway.
- The flight plans for Falcon and HALO will be further discussed with the pilots at 12 UTC.

  - Scientific Manager: Heini Wernli, Jim Doyle (Mon/Tue 26/27 Sept)
  - Chief Forecaster: Julian Quinting
  - Instrument Manager: Manuel Gutleben
  - Coordinator Ground-Based Observations: Leo Shaffin
  - Mission Scientist: Hanin Binder (HALO), Oliver Reitebuch (Falcon), Andreas Schäfler and Christian Keil (Ground Support)

Further points from discussion:

Radiosondes will be launched by Martina Bramberger between Tuesday and Wednesday 26/27 Sept to capture gravity waves possibly excited by the strongly anticyclonically curved jet stream approaching Iceland. A possible measurement flight with Falcon on Wednesday will be discussed tomorrow.

	**NAWDEX 2016** **Planning summary**	**Date: 26 September 2016** **Author: Florian Baur, Jim Doyle**

NAWDEX 2016 - Planning summary

Today, the Halo is flying to measure the intensification of the post-Karl cyclone. Tomorrow, Tuesday 27.09. a coordinated flight with Falcon and FAAM as well as a flight with Halo is planned.

The schedule for today is the detailed planning of the flights (coordinated flight with Falcon and FAAM + flight with Halo) that will take place tomorrow, Tuesday 27. September. At 16UTC there will be a weather discussion.

IOP5 on Tuesday 27 September

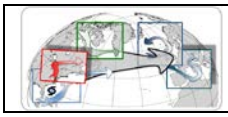
- The Falcon will sample an upper-level cutoff and the BAE146 will measure a cold front downstream of Ex-Karl. The Halo will sample a region of strong moisture flux partially associated with the former tropical storm Lisa.

Falcon & FAAM BAE146:

- Falcon is flying from Keflavik to Faroe Islands to meet the FAAM at 1040 UTC for a coordinated flight leg with a southbound leg near Scotland.
- Due to predicted high wind speeds, FAAM will fly directly to the meeting point on a leg shifted slightly eastward.
- FAAM will drop approximately 20 dropsondes on the south-bound coordinated flight leg at FL280.
- Falcon will cross the wind maximum of the jet stream 2 times at FL360.
- Communication will take place between the Falcon and FAAM pilots including the details of the meeting point.
- Take-off time of Falcon: 0920UTC

Halo flight:

- The Halo will sample the cutoff process of the PV-streamer in southward direction to reach the region of moisture inflow in a developing warm conveyor belt
- A zig-zag pattern will be flown along the moist inflow region to capture the low level moisture which will ascend in the following days. Flight level will be FL280 for deployment of the dropsondes (~20) in the region of strong moisture flux.
- Entrance of Irish airspace and will rise to FL410
- On the transit north, the cutoff region will be crossed a second time
- Detailed flight panning with pilots will take place at 12UTC today
  - Scientific Manager: Jim Doyle
  - Chief Forecaster: Julian Quinting
  - Instrument Manager: Manuel Gutleben
  - Coordinator Ground-Based Observations: Leo Shaffin
  - HALO Mission Scientists: Hannin Binder (Halo), Oliver Reitebuch (Falcon), Andreas Schäfler and Christian Keil (Ground Support)

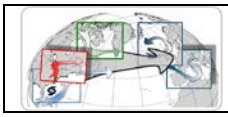
	**NAWDEX 2016** **Planning summary**	**Date: 26 September 2016** **Author: Florian Baur, Jim Doyle**

Radiosonde IOP on Tuesday and Wednesday (27 and 28. September)

- Additional Radiosondes will be launched from Keflavik at 00UTC and 06UTC
- Strong curvature in the upper-level jet and diffluence may be forcing the gravity waves
- Data will be sent on the GTS

Further points from discussion:

- The next flight opportunity will be on Fri/Sat when a rapidly developing cyclone is forecast to occur
- The clear sky conditions on Wednesday will allow for a calibration flight with Falcon above Icelandic glaciers on Wednesday (further discussion tomorrow)
- No flight planned for Halo on Wed. or Thu.

	**NAWDEX 2016** **Planning summary**	**Date:27 September 2016** **Author: Jim Doyle, Florian Baur**

NAWDEX 2016 - Planning summary

- **No research flights are planned until Saturday, 1 October.**
- **Tomorrow (Wednesday), 28. September, there will be a calibration flight with Falcon.**
- **Tomorrow (Wednesday), 28. September will be a down day for the NAWDEX forecast and flight planning teams and for the HALO crew. Thursday 29 September will be a down day for the Falcon staff.**

The schedule for today:

- weather discussion at 16:00 UTC

HALO mission yesterday went very well. The dry intrusion was sampled using the LIDAR system and dropsondes were deployed in this region. The last flight leg had to be slightly adjusted to capture the dry intrusion which was moving a little bit faster than forecasted.

A short quicklook session from the Monday and Tuesday missions will take place on Thursday 16UTC at the beginning of the weather discussion.

Falcon flight today (Tuesday), 27. September:

- LIDAR issues with the instrument were worked out before take-off
- There was some confusion about the coordinated flight plan with the FAAM BAE146. The waypoint 1 location was changed shortly before take-off for unknown reasons. It is recommended that we establish a single contact person for the FAAM missions so that better communication can take place for NAWDEX coordinated missions.
- The aircraft meeting point at 10:30 UTC at WP1 near the Faroe Islands was successful

HALO flight today (Tuesday), 27. September:

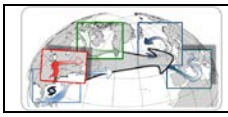
- aircraft take off time was 11:30 UTC
- all instruments are functioning fine

Falcon Lidar calibration flight tomorrow (Wednesday), 28. September:

- there will be clear skies during the morning until the early afternoon
- calibration flights will be performed above an Icelandic glacier south-east of Reykjavik
- Take-off time: 9:00 UTC
- NOTAM-Box between 10:00 UTC and 12:00 UTC

Radiosonde IOP for Gravity Waves (Tuesday-Wednesday)

- Enhanced radiosonde launches by NAWDEX scientists at Keflavik are taking place today and tomorrow to sample possible non-orographic gravity wave activity.

	**NAWDEX 2016** **Planning summary**	**Date:27 September 2016** **Author: Jim Doyle, Florian Baur**

Radiosonde observations between Thursday (29 September) through Saturday (1st October)

- Additional radiosondes will be launched over central Europe to document where possible the evolution of the moist inflow region following the HALO flights and to obtain verification measurements in regions of high-impact weather further downstream where the moist atmospheric river arrives above central Europe.

Schedule for the next days:

- Tomorrow, Wednesday 28 September:
  - Scheduled down-Day for HALO crew and forecasting team
  - No general and weather forecast meetings
- Thursday, 29 September:
  - Scheduled down-Day for Falcon crew
  - Plan is for flight planning for possible missions on Saturday, 1st October with HALO and on Sunday, 2nd October with Falcon and HALO to sample a rapidly developing cyclone and warm conveyor belt, which will be south of Iceland by the weekend.

Further comments based on the discussion:

- Two consecutive flights with 9-h or longer flight duration are too long for the pilots and crew. It is recommended to conduct one shorter and one longer flight in such situation. This will be taken into account when planning for future missions.
- We need to identify the key point of contact for collaboration with British FAAM BAE146
- We need to improve the coordination when a new person is running the dropsonde system on the HALO to make sure: i) the person is fully trained, and ii) the person is aware ahead of time of their role.

NAWDEX 2016 - Planning summary

There are no flights planned today. This is a down day for the Falcon crew. The next missions are planned for Sunday, 1st October (HALO) and under consdieration for Sunday, 2nd October (French and German Falcon and HALO).

Today's schedule:

- Weather discussion with a short introduction the French team, a short Quicklook session of the Monday and Tuesday mission at 16:00 UTC
- There will be a midterm party at 19:30 UTC. Please bring some finger food! Beverages are provided.

Report HALO mission on Tuesday (27 September):

- Everything worked out as planned
- one additional sonde was dropped (in total: 20)
- inflow region with strong dust layer and high moisture signals could be sampled

Report from coordinated Falcon – FAAM BAE146 mission on Tuesday (27 September):

- some coordination issues appeared but could be solved
- successful coordinated N-S directed flight leg
- FAAM BAE146 dropped 23 sondes

Report of Falcon calibration flight on Wednesday (28 September):

- calibration flight above Vatnajökull glacier was successful

Report of Radiosonde IOP:

- 5 Radiosondes were launched
- observations up to 42km altitude

Status of the aircraft:

- Falcon: OK. A brake had to be replaced before Wednesday's flight
- HALO: OK. One position light will be replaced tomorrow

Status of instruments:

- All OK.

IOP6 on Saturday 1st October:

- Evolving cyclone is located south of Iceland and is moving towards Iceland while intensifying
- targets of the measurements are the temperature structure in the strong PV anomaly in the

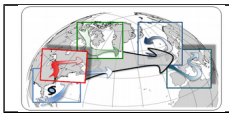
centre, the moisture structure at tropopause level and the high wind speeds near the tropopause fault

- Take off is planned for 8:30 UTC
- Satellite overpass at 15:01 UTC
- Who were the responsible persons:
    - Scientific Manager: George Craig
    - Chief Forecaster: Julian Quinting
    - Instrument Manager: Manuel Gutleben
    - Coordinator Ground-Based Observations: Jacob Maddison
    - Mission Scientists: Andreas Schäfler (HALO), Pila Bossman and Florian Baur (Ground Support)

- **Discussion**
    - No major problems were noted with the flight plan which will remain at high levels in Gander and Shanwick airspace.
    - The vertical resolution of both the cloud radar and water vapor lidar are sufficient to resolve sub-kilometre structures near the tropopause.
    - Look for ships located near cyclone where additional radiosondes could be launched.

Further announcements:

- Another mission (IOP7) will be proposed for Sunday (2nd October)
    - Coordinated mission with HALO, Falcon (French and German)
    - Further planning and discussion at the synoptic meeting at 16:00UTC and presentation of the draft tomorrow in the general meeting (11 UTC)

	**NAWDEX 2016** **Planning summary**	**Date: 30 September 2016** **Author: George Craig, Florian Baur**

NAWDEX 2016 - Planning summary

There are no flights planned today. The next missions are planned for tomorrow, Saturday 1st October, with HALO and Sunday, 2nd October, with HALO, DLR Falcon and French Safire Falcon.

Today's schedule:

- There will be a weather discussion at 16:00 UTC including a discussion about a possible mission on Monday, 3rd October, with Falcon and about a possible day off next week.

IOP6, tomorrow 1st October:

- plan from yesterday remained unchanged

Safire Falcon test flight tomorrow 1st October:

- There will be a test & calibration flight east of Iceland

IOP7 on Sunday 2nd October:

- A coordinated flight leg with HALO, DLR Falcon and Safire Falcon is planned to observe the tropopause fold near Greenland
- after this coordinated flight leg, the two Falcons will fly a box pattern to measure winds in order to compute the divergent wind in this area (FL360)
- HALO will drop around 10 sondes in the area of the tropopause fold where high winds are expected (near the turning point) (FL410)
- HALO will fly in south-eastern direction towards Irelandic airspace to descend below the NAT-tracks (FL280)
- the jet stream will be crossed a third time in westward direction until the centre of the cyclone (and hence the driest point) where HALO turns northward to return towards Reykjavik
- in the last 2 flight legs another 15 sondes will be dropped
- take off: DLR Falcon: 08:20 UTC
  Safire Falcon: 08:30 UTC
  HALO: 08:40 UTC
  - Scientific Manager: Heini Wernli
  - Chief Forecaster: Christian Grams
  - Instrument Manager: Manuel Gutleben
  - Coordinator Ground-Based Observations: Jacob Maddison
  - Dropsond operator: Martin Hagen
  - Mission Scientists: Christian Keil (HALO), Oliver Reitebuch (Falcon), Jim Doyle (Ground Support)

Safire Falcon flight on Sunday afternoon:

- Take off at 13:00 UTC to have a Satellite underpass with the A-Train at 14:00 UTC
- afterwards, the jet stream will be crossed 2 times south of Iceland

→ wind conditions for landing on Sunday should be checked

Further announcements:

- additional Radiosondes will be requested for the east coast of Greenland and from ships around the southern tip of Greenland on Sunday
- instruments of the Safire Falcon will be added to the Wiki
- it is very important to **keep the kitchen clean** and leave the chairs in the Lobby
- please provide slides to the chief forecaster 30 Minutes before the meeting

	NAWDEX 2016 Planning summary	Date: Oct. 01, 2016 Author: H. Wernli, M. Bramberger

NAWDEX 2016 - Planning summary

IOP6 was planned for today, but unfortunately HALO had to return one hour after takeoff because of a technical problem. For tomorrow, Sun 02 Oct, coordinated flights are planned with FALCON and SAFIRE between Iceland and Greenland.

The schedule for today is a **weather discussion** at 16 UTC.

The main topics of the General Meeting were the situation of HALO, the flights on Sun 02 Oct, and the outlook to the first half of next week.

IOP6 on Sat 01 Oct

- HALO took off early this morning as planned, heading towards an intense cyclone near 35W/50N, but due to technical problems had to return after about one hour.

The Mission Scientists for this flight were: Florian Baur (flying), Pila Bussmann, Andreas Schäfler, Julian Quinting (Ground support).

IOP7 on Sun 02 Oct

- As we heard just after the General Meeting, HALO cannot fly on Sunday.
- The morning flights of FALCON and SAFIRE are scheduled as planned yesterday (coordinated flights near the Greenland east coast), with takeoff at about 8:30 UTC. SAFIRE will drop sondes (that originally were planned for HALO).
- In the afternoon, SAFIRE will do a second flight with an A-Train overpass.

Weather forecast for the next days

- Sat 01 Oct: Intense cyclone near 35W/50N with a interesting structure in the WV satellite imagery (strong dry slot and also “dark eye” in the cyclone center due to very intense upper-level PV anomaly; weaker lee cyclone developing near Greenland
- Sun 02 Oct: Strong ridge amplification due to the cyclone, which further intensifies and approaches Iceland; in the evening strong surface winds near Iceland; downstream trough formation over Europe
- Mon 03 Oct: Still very strong surface winds near Iceland (>20 m/s); heavy precipitation over Europe due to upper-level trough / cutoff system; over the central North Atlantic a strong jet forms with a weak frontal wave developing at 45N
- Tue 04 Oct: The frontal wave shows a rapid development (maybe with a DRW-like behavior) with a very intense WCB
- Wed 05 Oct: The frontal wave undergoes rapid deepening SW of Iceland, again leading to very intense surface winds near Iceland: a new subtropical cyclone forms in the western North Atlantic; over Europe the cutoff splits and leads to potentially intense precipitation (the EFI is high on Wed and Thu in several places in central and eastern Europe and in Iceland)
- Thu 06 Oct: TC Matthew approaches the US East Coast; its track is still uncertain but it likely recurves; east of Iceland a very strong jet evolves with an intense WCB

Flight options from Mon 03 Oct onwards

- No flights are planned on Mon 03, also because of the predicted strong surface winds near Iceland
- Flight plans for potential flights with HALO and FALCON on Tue, Wed and Thu are developed today and tomorrow
- Flights on Wed might be hampered by very strong surface winds

	NAWDEX 2016 Planning summary	Date: Oct. 01, 2016 Author: H. Wernli, M. Bramberger

Radiosonde Task Team (RTT)

- For alerting additional radiosoundings (EUMETNET), an RTT is suggested, such that the plans are developed in a more coordinated way between the different partners.
- The current members of the RTT are Andreas Schäfler, Carolyn Reynolds, Jacob Maddison, Gwendal Rivière and Michael Riemer – of course this team is open to input from all others
- The RTT is asked to briefly meet with the Chief Forecast in the early afternoon for coordination with flight plans; at the 16 UTC meeting, the RTT will present their plans
- The RTT should alert some stations well in advance (up to 3 days)

Radiosonde IOP in Keflavik

- Martina Bramberger plans a second radiosonde mission on Sun/Mon with launches at 12 and 18 UTC 02 Oct, and 06, 12 and 18 UTC 03 Oct
- Christian Euler and potentially 3 colleagues from ETH/Uni Bern will help with the launches

	NAWDEX 2016 Planning summary	Date: 2. October 2016 Author: Heini Wernli, Florian Baur

NAWDEX 2016 - Planning summary

Today, the DLR FALCON and French SAFIRE are in the air to capture the tropopause fold near the Greenland east coast. Tomorrow, there will be no research flight due to high winds expected in the Keflavik region. Next missions are currently planned for Tuesday - Thursday (04-06 October 2016).

Today's schedule:

- There will be a weather discussion at 16:00 UTC today.

Coordinated flights of FALCON & SAFIRE today (IOP7 02 October 2016):

- the coordinated flight was successful so far
- there are little problems with a lidar on FALCON
- SAFIRE dropped 9 sondes (6 are already in the GTS)
- FALCON is closing the box off the coast of Greenland and SAFIRE is directly heading back to Keflavik

Weather evolution until Thursday 06 October

- Sun 02 Oct: The "Saturday cyclone approaches Iceland, intensifies and merges with the Greenland cyclone. The downstream ridge intensifies and further downstream a PV cutoff forms over Benelux.
- Mon 03 Oct: The "Saturday cyclone" is located between Greenland and Iceland and strong surface winds prevail near Keflavik. A new frontal wave forms south of Newfoundland.
- Tue 04 Oct: The frontal wave propagates rapidly as a diabatic Rossby wave; there is a last burst of WCB ascent associated with the "Saturday cyclone"; a new WCB and ridgebuilding start upstream due to the intensifying frontal wave.
- Wed 05 Oct: The frontal wave is located west of Iceland, again very strong surface winds and heavy rain is expected for Iceland. Two cutoffs are located over Europe, associated with heavy precipitation (position still uncertain).
- Thu 06 Oct: The cyclone is still west of Iceland, with a strong poleward moisture flux towards Svalbard and beneath a very strong meridional jet to the Arctic.

Potential IOP 8 on Tuesday 04 October

Flights have been proposed for all three aircraft:

- **HALO:** On the way south towards about 35W/50N, the outflow region of the WCB will be crossed; the centre of the cyclone will be crossed in zonal direction and the poleward moisture transport will be measured east of the cyclone in the ascent region of the WCB; after crossing the centre of the surface low pressure system the track leads to 61N to be able to climb from FL280 to FL430; dropsondes are planned at the lower altitude (FL280) in the first part of the flight in the vicinity of the cyclone; the higher leg will again fly over the centre of the system.
- **SAFIRE:** The plan is to meet with HALO on the flight leg back to Keflavik to have a coordinated flight leg above the WCB outflow region during about 1 hour.
- **FALCON**: The plan is to fly a west-east flight leg north of Keflavik to measure the jet stream and tropopause fold; it will probably fly eastward at FL360 and back at FL370.

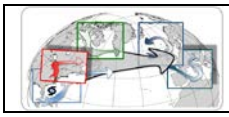
Responsible persons:

- Scientific Manager today: Heini Wernli
- Chief Forecaster today: Christian Grams
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: Jacob Maddison
- Mission Scientists for Tue 04 Oct: Maxi Böttcher & Christian Keil (HALO); Jim Doyle & Pila Bussmann (FALCON)

	NAWDEX 2016 Planning summary	Date: 2. October 2016 Author: Heini Wernli, Florian Baur

Further announcements:

- If the repairing of the HALO can be finished today, there will be a down day for HALO tomorrow (03 Oct 2016)
- Changes of the HALO flight plan on Tuesday have to be announced **at latest** 5 hours before take off (no changes during the flight possible)
- Frank Probst will be replaced by Stefan Hempe
- Andreas Minikin will be replaced by Katrin Witte

	**NAWDEX 2016** **Planning summary**	**Date: 3. October 2016** **Author: Jim Doyle, Florian Baur**

NAWDEX 2016 - Planning summary

Today, there are no research flights. Next flights are planned for tomorrow (4. October) with Halo, DLR Falcon and Safire, Wednesday (5. October) with Halo and Safire and on Thursday (6. October) with Halo and DLR Falcon.

Today's schedule:

- planning of the Tuesday flights with pilots at 12:00 UTC
- planning of the Wednesday flights with pilots at 13:00 UTC
- weather discussion at 16:00 UTC

Instruments report:

- **HALO**: instruments are fine
- **DLR Falcon**: maintenance for the 2 Micron Lidar
- **Safire**: instruments are fine

Weather evolution:

- Tue 04 Oct: The frontal wave propagates rapidly as a diabatic Rossby wave; there is a last burst of WCB ascent associated with the "Saturday cyclone"; a new WCB and ridge building starting upstream due to the intensifying frontal wave.
- Wed 05 Oct: The frontal wave is located west of Iceland, again very strong surface winds and heavy rain is expected for Iceland. Two cutoffs are located over Europe, associated with heavy precipitation (forecast position still uncertain).
- Thu 06 Oct: The cyclone is still west of Iceland, with a strong poleward moisture flux towards Svalbard and beneath a very strong meridional jet to the Arctic.

<u>IOP 8 on Tuesday 04. October 2016:</u>

HALO:

- sampling of cyclone south of Iceland evolved from a diabatic Rossby wave
- first fly at a lower FL to be able to drop sondes in the vicinity of the cyclone (**18**)
- cross the cyclone centre 2 times to sample the structure of the centre and the moisture structure in the region of maximum moisture transport east of the centre
- traverse northward along the WCB until 61N to climb from FL280 to FL410
- traverse again southward and
- capture the WCB outflow and the structure of the centre and tropopause region from above
- take off: 11:00 UTC
- **Safire:** there will be a coordinated flight leg at the end of the flight track to capture the WCB outflow region. It will be discussed if Safire will drop sondes during this coordinated leg.

Falcon:

- The jet stream will pass by Iceland very close
- Falcon will head north to cross the jet stream twice
- as it is expected to be clear to the surface over northern Iceland, Falcon will fly two short legs above Iceland for the calibration of the Lidar

IOP 10 on Wednesday 05. October 2016:

- HALO will enter the jet stream south of Iceland and fly along it in northward direction to measure clear air turbulence
- north of Iceland, Halo will exit the jet stream to orient along a Satellite overpass with Callypso
- possible coordinated flight leg with Safire during Satellite underpass. (under discussion)

IOP 11 on Thursday 06. October 2016:

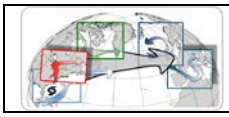
- The first part of the mission will be coordinated with Safire and DLR Falcon. During these legs the tropopause fold will be crossed twice.
- HALO will then head towards Greenland to capture the moisture flux and tropopause structure
- possible Satellite overpasses will be explored
- Planned FL: 410

Responsible Persons:

- Scientific Manager: Jim Doyle
- Chief Forecaster: Andreas Schäfler
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: Jacob Maddison
- Mission Scientists for Tue 04 Oct: Christian Keil (HALO), Maxi Böttcher (Ground Support); Jim Doyle & Pila Bossmann (Falcon)
- Mission Scientists for Wed 05 Oct: Martina Bramberger (HALO), Julian Quinting (Ground Support)

Further announcments:

- Down-day for Falcon has to be by Friday, 07. October
- Hangar doors cannot be opened at wind speeds above approximately 20 m/s (wind direction approximately SE)
- repairing of HALO should be finished; last test tomorrow (4. Oct) before takeoff (roll out 2 hours before take off).

	**NAWDEX 2016** **Planning summary**	**Date: 04 October 2016** **Author: Jim Doyle, Florian Baur**

NAWDEX 2016 - Planning summary

Today's mission with HALO has been cancelled due to ongoing technical problems. A HALO flight for Wednesday looks unlikely due to the ongoing technical issue. Falcon took off this morning with a 15 minute delay and will take off for a second mission after refuelling at 13:10 UTC (IOP 8). The next possible missions are planned for tomorrow (05 Oct) with HALO and Safire and Thursday (05 Oct) with Halo and Safire.

Today's schedule:

- There will be a weather discussion at 16:00UTC

Weather evolution:

- **Wed, 05 Oct:** The former diabatic Rossby Wave is located at the southern tip of Greenland. The system's WCB outflow is building up the ridge over Scandinavia and moisture is still being advected to the Icelandic region.
- **Thu, 06 Oct:** The leading edge of the trough is located over Iceland and will force orographic precipitation on the windward side of Iceland and Greenland

IOP 9 on Wednesday 05 October:

HALO: (Status unknown)

- sampling of a cyclone south of Iceland evolved from a diabatic Rossby wave
- first fly at a lower FL to be able to drop sondes in the vicinity of the cyclone (18)
- cross the cyclone centre 2 times to sample the structure of the centre and the moisture structure in the region of maximum moisture transport east of the centre
- traverse northward along the WCB until 61N to climb from FL280 to FL410 traverse again southward and capture the WCB outflow and the structure of the centre and tropopause region from above take off: 11:00 UTC
- **Safire**: there will be a coordinated flight leg at the end of the flight track to capture the WCB outflow region. It will be discussed if Safire will drop sondes during this coordinated leg

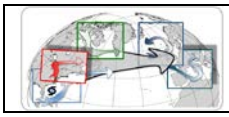
The high wind conditions forecasted for tomorrow (Wed) may be problematic for the door and aircraft

The HALO status is unknown and considered unlikely to be available due to the technical issue.

IOP 10 on Thursday 06 October:

HALO

- sample structure of mixed phase clouds and orographic precipitation at the windward eastern coast of Greenland

	**NAWDEX 2016** **Planning summary**	**Date: 04 October 2016** **Author: Jim Doyle, Florian Baur**

- potential coordinated flight leg with Safire on the way back to Iceland while Satellite underpass
- sample orographic precipitation at the windward side of Iceland

- Who were the responsible persons:
  - Scientific Manager: Jim Doyle
  - Chief Forecaster: Andreas Schäfler
  - Instrument Manager: Manuel Gutleben
  - Coordinator Ground-Based Observations: Jacob Maddison
  - Mission Scientists: **Tue 4. Oct**: Christian Keil (HALO), Maxi Böttcher (Ground Support) HALO cancelled
    Wed 5. Oct: Martina Bramberger (HALO), Julian Quinting (Ground Support) HALO status unknown
    Thu 6. Oct: Martina Bramberger (HALO), Julian Quinting (Ground Support)

Further announcements:

- Today's mission with HALO had to be cancelled due to technical problems
- Tomorrow's mission with HALO is in question (appears unlikely)
- The status and availability of HALO beyond today is unknown at this time.
- Wednesday is a down day for Falcon

	NAWDEX 2016 Planning summary	Date: 05 October 2016 Author:

NAWDEX 2016 - Planning summary

The repair work and tests at HALO could be successfully completed and the aircraft is ready again for the next IOPs. SAFIRE could fly today despite the very strong surface winds in Keflavik. Further flights are planned for tomorrow (06 Oct) with HALO and on Friday (07 Oct) with HALO, FALCON and SAFIRE.

Synoptic evolution

- **Thu 06 Oct**: A Tropopause Polar Vortex (TPV) potentially formed by radiative processes in the Arctic moves along the waveguide and is located between Greenland and Newfoundland
- **Fri 07 Oct**: The mature TPV is located southeast of Greenland in a broad trough, which shows some WCB activity between Iceland and Greenland.

Flights on Wednesday 05 October

FALCON has a day off today. SAFIRE will fly in the afternoon. The potential HALO flight in the afternoon into the WCB ascent region is cancelled due to the high surface winds in Keflavik and because of the interesting flight options for Thu and Fri.

IOP9 on Thursday 06 October

Two options for HALO flights were presented and the discussion at the General Meeting led to the following decision:

- Sampling of TPV anomaly with several transects at two altitudes (climb to higher FL in Newfoundland airspace)
- Main aim of this mission is to measure the horizontal and vertical moisture structure in the region of the TPV and downstream

IOP10 on Friday 07 October

Coordinated flights are planned with all three aircraft in the afternoon

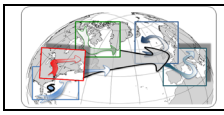
- SAFIRE aims to measure an atmospheric river structure near Iceland
- FALCON will measure winds between Iceland and the trough further west with the now mature TPV
- HALO will first do a coordinated leg with SAFIRE in the region of strong moisture transport west of Iceland, then an A-Train underpass towards Greenland in a region with weak WCB ascent, and then fly to the centre of the upper-level through where HALO will meet FALCON for a common flight leg back to Iceland (with dropsondes).

Further announcements:

- tomorrow: maintenance work at the FALCON; down day for SAFIRE

Who were the responsible persons:

- Scientific Manager: Heini Wernli
- Technical Manager: Katrin Witte
- Chief Forecaster: Andreas Schäfler / Jacopo Ripoldi
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: John Methven
- Mission scientists for HALO on Thu: Martina Bramberger (mission scientist), Julian Quinting (Ground Support)

	**NAWDEX 2016** **Planning summary**	**Date: 06.10.2016** **Author: J. Methven, J. Mack**

NAWDEX 2016 - Planning summary

- **Today:**
  - **FALCON:** no flight, maintenance on aircraft
  - **HALO**: in the air (take-off at 7.00 UTC, landing at 15.30 UTC)
  - **Instrument status:** All instruments working on HALO and DLR-FALCON

- **Responsibilities:**
  - Scientific Manager: John Methven
  - Technical Manager: Andreas Schäfler
  - Chief Forecaster: Bas Crezee
  - Instrument Manager: Manuel Gutleben
  - Coordinator Ground-Based Observations: Lucas Höppler
  - Mission Scientists HALO on Thursday: Martina Bramberger (PI), Julian Quinting
  - Mission Scientists HALO on Friday: Christian Keil (PI), Roman Attinger

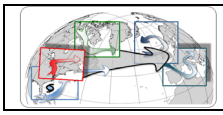
- **Schedule of the day:** Flight planning meeting with mission scientists and pilots at 12 UTC and a weather discussion at 16 UTC.

- **Summary of the General Meeting:**
  - **Topics**
    - Weather discussion
    - Coordinated flight of HALO, DLR-FALCON and SAFIRE tomorrow, 07.10.2016
    - Outlook for Sunday and Monday (Radiometer Intercomparison with HALO, FAAM and SAFIRE)
  - **Weather discussion**
    - Analysis: Deep trough east of Iceland, continued WCB outflow north Iceland and the TPV propagates along southern edge of the trough
    - Forecast:
      On Friday, the TPV will propagate first towards the tip of Greenland, where it becomes more disturbed, and then continues to the south of Iceland where it wraps cyclonically around the trough; connected to the cyclone strong winds are expected at Keflavik (potential problem for planned flights). The uncertainty for the following days is still high but cyclone Matthew is moving in and smaller cyclones form on the jet stream with potential WCB activity.
  - **Friday 07.10.2016**
    - HALO:
      - Only small adjustments to flight plan from yesterday 05.10.2016, due to way-point changes for FALCON flight
      - Goals:

Sample mixed phase clouds in WCB ascent region
Lagrangian tracking of EX-TPV structure (already investigated by HALO today)
CALIPSO satellite overpass
Coordinated flight legs with 11 dropsondes with DLR-FALCON ("PV-ometer" to measure PV divergence) and SAFIRE (atmospheric river measurements with dropsondes on coordinated leg)

- FALCON:
  - Slight adjustments to avoid cirrus clouds
  - Flight level 290 requested in order to be above cloud border (not yet confirmed)
  - PV measurements in coordination with HALO
- SAFIRE:
  - Only minor changes to yesterdays flight planning
  - Most recent ECWMF forecasts still show merging of two distinct moisture features but still distinct in MET office forecast
  - Six dropsondes on the coordinated leg with HALO
- High winds are a potential problem for the south-facing hangar door; rearrangement of aircraft to use north door would be desirable (communication with NASA team necessary)

- **Saturday, 8.10.**
  - No flights of HALO, DLR-FALCON and SAFIRE
- **Sunday, 9.10.**
  - Potential HALO flight to measure structure of PV streamer and its interaction with a precipitation band ahead (connected to the surface low south of the streamer)
  - Problem: still high uncertainty in the forecasts
- **Monday, 10.10.**
  - Possible Radiometer intercomparison flight of SAFIRE, HALO, and FAAM close to Scotland
  - Constraints for measurements: air-crafts should be outside and above clouds
  - Tuesday looking less likely as the forecast does not show enough clouds
  - Possible WCB flight in connection with the intercomparison flight

	**NAWDEX 2016** **Planning summary**	**Date: 07.10.2016** **Author: J. Methven, J. Mack**

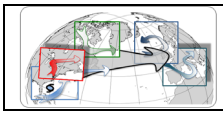
NAWDEX 2016 - Planning summary

- **Today:**
  - **FALCON, HALO:** flights cancelled due to too high wind speeds at Keflavik
  - **SAFIRE**: in the air (take-off at 11.30 UTC)
  - **Instrument status:** All instruments working on HALO and DLR-FALCON

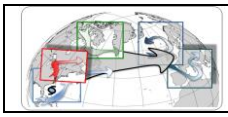
- **Responsibilities:**
  - Scientific Manager: John Methven
  - Chief Forecaster: Bas Crezee
  - Instrument Manager: Florian Ewald
  - Coordinator Ground-Based Observations: Lucas Höppler

- **Schedule of the day:** Flight planning meeting with mission scientists and pilots at 12 UTC and a weather discussion at 16 UTC.

- **Summary of the General Meeting:**
  - **Topics**
    - Wind constraints
    - Day off on Saturday for DLR team (HALO, DLR-FALCON)
    - Weather discussion
    - Plan for coordinated flight of HALO, DLR-FALCON, SAFIRE on Sunday, 09.10.
    - Plan for coordinated flight of HALO, DLR-FALCON on Monday, 10.10.
    - Radiometer Intercomparison Flight on Tuesday/Wednesday
  - **Wind constraints**
    - Gusts above 20 m/s are expected (TAF 28 knots (gusting 37 knots)) but from 15-18 UTC 37 knots (gusting 47 knots), decrease expected after midnight
    - HALO and DLR-FALCON cancelled as wind speeds are expected to be too high at landing
    - Later flight no option as fuel already on board
  - **Weather discussion**
    - Analysis: Deep trough west of Iceland, former TPV interacts with cyclone south-east of Greenland
    - Forecast: In the following days the same trough is deformed into a PV streamer with a surface low baroclinic development east of the streamer. During Sunday the PV streamer will break into two upper-level cut-offs.
      Blocking over Scandinavia remains.
      Tropical cyclones Matthew and Nicole stay out of reach.
  - **Saturday, 8.10.**
    - Day off for HALO and DLR-FALCON

	**NAWDEX 2016** **Planning summary**	**Date: 07.10.2016** **Author: J. Methven, J. Mack**

- **Sunday, 9.10. (IOP 11)**
  - **HALO**
    - **Goals**: structure of PV-Streamer; vortex roll-up process; measuring two distinct moist air streams ahead of trough, (1) stems from WCB ascent in developing cyclone "turning anticyclonically", (2) poleward ascending air ahead of PV filament running into Iceland; Calipso underpass in this airmass (update: not attempted any longer)
    - measuring the structure of the PV-streamer in a long southward flight leg
    - exit the PV-streamer at 53N to fly SE towards the WCB ascent region
    - cross the PV-streamer in E-W direction and head northwards in the upstream ridge
    - cross PV-streamer in W-E direction and fly into the WCB outflow region
    - heading northward for the Satellite overpass and to meet with SAFIRE
    - estimated take off time: 10:05; estimated meeting time with SAFIRE and DLR-FALCON at 17:45 UTC at 61N 13W
    - no dropsondes are planned; FL430
  - **FALCON**:
    - **Goals**: jet structure south of Iceland; moist air-stream (2)
    - flight along jet stream from south to north
    - crossing the jet stream in east west direction
    - Planned FL360 climbing up to FL380, take-off 15:20 UTC
    - Comment from Heini Wernli: flight planning needs to check that most interesting features are reached after LIDAR has warmed up (45 min)
  - **SAFIRE:**
    - plan to fly slightly further south compared to yesterday's flight track to reach cirrus shield south of Iceland
    - a coordinated leg with HALO will be discussed
- **Monday, 10.10.**
  - no Radiometre intercomparison with British FAAM BAE146 (possibly shifted to Tue or Wed)
  - possible follow-up mission with HALO
- **Outlook for Tuesday/Wednesday**
  - Potential Radiometer Intercomparison with FAAM
  - Location: In between Scotland and Faroe Islands
  - Time: Around midday
  - For team in Iceland: discuss Tuesday plan on Sunday
  - Monday 09:00 UTC teleconference for intercomparison

	**NAWDEX 2016** **Planning summary**	**Date: 09.10.2016** **Author: J. Methven**

NAWDEX 2016 - Planning summary

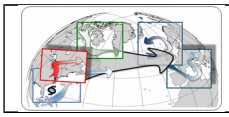
- **Today:**
  - **SAFIRE**: take-off at 09:55 UTC to rendezvous with HALO for Calipso overpass ~10:30
  - **HALO:** take-off 10:05 UTC (note: typo on slide in forecast meeting [10:50] almost caused error) for long flight starting with satellite overpass in moist poleward moving air stream ahead of a very long PV streamer extending southwards from Iceland towards the Azores. Flight along PV streamer and then several sections across upper level vortex formed by streamer roll-up and baroclinic growth of surface cyclone below. Returning to moist air stream near Iceland for comparison leg with both SAFIRE and DLR-FALCON. Aiming for dropsondes on comparison leg (flying last in line) if possible with ATC.
  - **DLR-Falcon:** 15:20 UTC take-off flying eastwards (north of Iceland) across poleward moist air stream and then rendezvous at 1745 UTC (61N, 13W) at FL380.
  - **SAFIRE II:** second flight take-off 1630 UTC, going directly to the rendezvous, comparison leg and then turning to NNE across moist air stream before returning.
  - **Instrument status:** All instruments working on HALO and DLR-FALCON

- **Responsibilities:**
  - Scientific Manager: John Methven
  - Chief Forecaster: Julian Quinting
  - Instrument Manager: Florian Ewald
  - Coordinator Ground-Based Observations: Lucas Höppler

- **Schedule of the day:** Flight planning meeting with mission scientists and pilots at 12 UTC and a weather discussion at 16 UTC. Ground mission scientists for 3 aircraft (Tobi, Philippe & Matthias) to sit together in ops room for comparison leg.

- **Summary of the General Meeting:**
  - **Topics**
    - Weather discussion
    - Plan for HALO flight on Monday
    - Plan for radiometer comparison flight of FAAM, SAFIRE, HALO on Tuesday, 11/10.
    - Or plan B for coordinated flight of SAFIRE & DLR-FALCON on Tuesday, 11/10.
  - **Weather discussion**
    - Analysis: Deep trough to SW of Iceland has been deformed into long PV filament stretching southwards and predicted roll-up with 3 vortex centres: one to the north of Iceland, one at 45N and one nearer the Azores.
    - Forecast: In the following day the roll-up continues with the central vortex resulting in the baroclinic development of surface cyclone “Sanchez”.
    - Tuesday – northwards oriented portion of the jet stream between Greenland

and Iceland with strong ascending moist air stream.
    - Wednesday – similar situation and Sanchez reaching Spain
    - Thursday – high impact weather (winds and precip) ahead of Sanchez across the western Mediterranean.
    - Tropical cyclone Matthew strained out near Newfoundland and Nicole stays out of reach.
- **Monday, 10.10.**
    - **HALO:** take-off 12:00 UTC for flight southwards at FL430 along PV filament to a point to the SW of Sanchez. Then cross-section with radar/lidar across upper level PV cut-off to Irish air space, enabling a descent to FL280 for return along almost same path with dropsondes. 15 dropsondes on section to SW corner and then 5 northwards from there – the last one in clear air for calibration.
    - **DLR-Falcon & SAFIRE:** no plans
    - Monday 09:00 UTC teleconference for intercomparison
- **Tuesday, 11.10.2016**
    - **Plan A – FAAM, SAFIRE, HALO:** radiometer comparison in the afternoon along 61.5N if it is possible to reach 15W. Region west of Ireland is too far for SAFIRE. Key issue is altitude of cirrus (up to FL390) and little cloud below.
    - **Plan B –** SAFIRE & DLR-Falcon: take-off proposed 10:15 flying together from Keflavik (DLR-Falcon ahead) to (62N, 38W) then (61N, 34W) and back focusing on crossing northwards jet stream and associated moisture flux.
- **Wednesday, 12.10.2016**
    - Similar situation forecast to Tuesday with strong northwards flow between Iceland and Greenland. Flights to WSW of Iceland would be interesting. Risk of strong winds at Keflavik (especially in morning).
- **Outlook for Tuesday/Wednesday**
    - Potential Radiometer Intercomparison with FAAM: Weds, clouds are too far west and again high. Thurs – perhaps possible but very uncertain forecast.
- **Radiosonde requests**
    - Sunday: Two ships mid Atlantic anticipated to be near PV streamer + Tasiilaq and Keflavik for northwards moist atmospheric river
    - Monday: Azores and ship mid-Atlantic plus Aberystwyth and Brest to capture WCB ouflow from Sunday HALO flight. Also Keflavik and Jan Mayen for atmospheric river.
    - Tuesday: Aberystwyth, Brest & Paris for WCB outflow. Azores and ship for Sanchez cyclone. Lisbon for Sanchez approach.
    - Tuesday & Wednesday: Keflavik & Tasiilaq for atmospheric river.
    - Wednesday & Thursday: Paris, Bordeaux, Lisbon, Sardinia & Rome for HIW ahead of Sanchez system.

	**NAWDEX 2016** **Planning summary**	**Date: 10.10.2016** **Author: F. Baur, T. Selz**

NAWDEX 2016 - Planning summary

Today:

- HALO took off at 12:00 UTC to sample the WCB ascent region and tropopause structure in the cyclone “Sanchez”. Plans had to be changed as the planned flight track was too long
- SAFIRE took off to measure the WCB branch east of Iceland
- There will be a weather discussion at 16:00 UTC.

Responsibilities:

- Scientific Manager: Andreas Schäfler
- Chief Forecaster: Matthias
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: Lucas Höppler

Weather evolution:

- **Today**, cot-off Sanchez is moving approximately in eastward direction towards the English Channel.
- In the following days, Ex-TC Matthew is moving northward and the outflow is building up a ridge downstream of the cyclone. A second ridge forming further downstream may lead to WCB ascent above Iceland on Thursday.

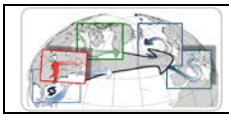
Possible flights during the next days:

Tuesday, 11. Oct.:

- Option A:
  - Radiometre intercomparison between HALO and British FAAM BAE146
  - Meeting (at 14:00 UTC) between Iceland and Scotland to measure ice clouds in a coordinated flight leg
  - Take off at 13:00 UTC
- Option B:
  - jet crossing SW of Iceland with DLR Falcon
  - this is a region of enhanced sensitivity concerning precipitation over Iceland on the following day
  - T/O: 10:30 UTC

Wednesday, 12. Oct:

- WCB is expected to be located between Iceland and Greenland.
- HALO:
  - several crossings of PV gradient of the evolving ridge with HALO
  - coordination with SAFIRE and Satellite at 14:45 UTC
  - coordinated flight leg with Falcon on the way back to KEF while crossing the jet
  - possible: LIDAR calibration in cloudless region

	**NAWDEX 2016** **Planning summary**	**Date: 2016-10-11** **Author: A. Schäfler**

NAWDEX 2016 - Planning summary

Decisions of today
Today no flights were conducted. We kept open to fly a coordinated mission with the French Falcon and the FAAM BAE southeast of Iceland. However, the British Colleagues had to cancelled the flight due to missing fire support at Iceland.

Plans for Wednesday, 12 October.

Based on the plans from yesterday we updated the flight plan for a HALO flight south of Iceland in the WCB inflow/ascent/outflow. The flight is planned with a coordinated flight leg under the A-TRAIN overpass at ~14:45 UTC with the French Falcon. Additionally we planned a Falcon flight in the approaching jetstream where the return leg is coordinated with HALO. From yesterday's plan we saw quite a difference so that we shifted the plan to a later take-off time. The uncertainty are the winds at Iceland that may influence the landing at late times

Plans for Thursday, 13 October
A ridge builds over the norther North Atlantic that provides a great possibility to observe the moisture structure in the WCB outflow. Therfore we planned a flight on Thursday between Iceland, eastern Greenland, Spitzbergen, Norway. However surface winds should increase until Thursday

Plans for Friday, 14 October
This is the last chance for a coordination with FAAM

	NAWDEX 2016 Planning summary	Date: 12 October 2016 Author:

NAWDEX 2016 - Planning summary

Today's surface winds in Keflavik are again very strong and do not allow flights with HALO and FALCON. Rainfall is very intense since yesterday evening and the Icelandic Met Office issued a flood warning. Despite this, we are planning a long HALO flight into the evolving upper-level ridge tomorrow (Thu 13 Oct), including coordinated legs with FALCON and SAFIRE, an overpass at Andoya research station, and a relatively low-level leg over Iceland to capture gravity waves.

Synoptic evolution

- **Wed 12 Oct**: The "downstream cyclone of TC Matthew" is rapidly moving towards Iceland and strongly intensifying until midnight. Strong moisture fluxes lead to heavy precipitation along the south coast of Iceland (predicted to last until early Friday). Very strong winds prevail all over Iceland.
- **Thu 13 Oct**: The cyclone becomes mature between Greenland and Iceland and weakens rapidly. North of Iceland a strong ridge forms and rapidly expands into the Arctic. High-impact weather occurs over Iceland and in Southern France.

Flights on Wednesday 12 October

Surface gusts in Keflavik exceed 40 kts and therefore the planned flights for HALO and FALCON had to be cancelled at 11 UTC. The afternoon flight with SAFIRE is still planned.

IOP12 on Thursday 13 October

Flights are planned with all aircraft:

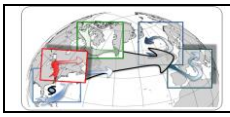
- HALO will do a long flight (take off time 8 UTC, duration 9 hours) along the edge of the upper-level ridge to almost 80N, then east to Andoya (overpass of research station), then across the ridge back to Iceland where several special legs are planned: (i) common leg with FALCON across the jet west of Iceland, (ii) common leg with SAFIRE over Iceland, (iii) leg at FL300 to observe orographic gravity waves over Iceland. Most of the ridge appears to be covered by cirrus clouds, with WCB outflow at its western and northern edge. The additional aim of a satellite overpass has been cancelled because it would have required an earlier take off time when winds are potentially still too high.
- Two flights are planned with FALCON: (1) box pattern across the jet west of Iceland (take off 12:35 UTC, duration 3 hours); and (2) back and forth across two jets west of Iceland (take off 17:30 UTC, duration 3.5 hours).
- SAFIRE will fly two legs with HALO and one leg with both HALO and FALCON near Iceland.

Friday 14 October

This will be the last option to do the ISMAR radiometer intercomparison flight of FAAM, SAFIRE and HALO. According to the forecasts, the cloud scene along 61N, between about 8-15W, looks favorable (cirrus clouds of various thickness, not too high such that all aircraft could fly above). Discussions will continue during the day to then take a common decision about this flight. The meeting point near 61N/15W would be at 9:30 UTC. HALO could combine this flight with an A-Train overpass at 12:53 UTC.

Responsibilties:

- Scientific Manager: Heini Wernli
- Technical Manager: Katrin Witte
- Chief Forecaster: Paolo Ghinassi / Matthias Röthlisberger
- Instrument Manager: Manuel Gutleben
- Coordinator Ground-Based Observations: John Methven / Lucas Höppler
- Mission scientists for HALO on Thu: Florian Ewald (mission scientist), Julia Mack, Tobias Selz, Maxi Böttcher (Ground Support)

	**NAWDEX 2016** **Planning summary**	**Date: 13.10.2016** **Author: J. Methven**

NAWDEX 2016 - Planning summary

- **Today:**
  - **HALO:** take-off 07:58 UTC towards north, following the poleward edge of extending ridge "Thor" along the curve indicated as WCB outflow in the ETH forecasts. Arc around almost half a circle passing above eastern Greenland, then south of Svalbard to fly over Andoya MST radar. Return to north of Iceland crossing centre of ridge dome.
  - Passing Iceland into moist air stream on NW for intended comparison leg with both SAFIRE and DLR-FALCON flying towards the east and then south. Aiming for 6 dropsondes on comparison leg (flying last in line) if possible with ATC.
  - **DLR-Falcon flight I:** 12:30 UTC take-off flying westwards (after climb to parallel to wind) across poleward jet stream along stratospheric side and then rendezvous at 1400 UTC at FL380. Comparison leg crossing jet stream and into the WCB on its eastern side – a PV-meter flight with the HALO dropsondes. Only doing eastward comparison leg, then returning to SW of Iceland to close loop at FL380 for integral divergence estimate.
  - **DLR-Falcon flight II:** 17:30 UTC take-off aiming to cross the PV filament between Iceland and Greenland – crossing the jet stream on its eastern and western flank. Changing heading to SW near Greenland to cross strongly curved jet on western flank and predicted GW activity there. Idea of two different A2D scan patterns out and back.
  - **SAFIRE:** take-off 12:30 UTC, following DLR Falcon track to the rendezvous at 1400, comparison leg to east and then south across Iceland with HALO through predicted orographic gravity waves.
  - **Aircraft status:** At last minute announcement that a fuel leak has been detected on DLR-Falcon and *both DLR Falcon flights have been cancelled*.
  - **Instrument status:** All instruments working on HALO and SAFIRE with the exception of the 183 GHz channel on HAMP which has an intermittent fault. Will try to fix after HALO flight today.

- **Responsibilities:**
  - Scientific Manager: John Methven
  - Chief Forecaster: Paolo Ghinassi
  - Instrument Manager: Florian Ewald
  - Coordinator Ground-Based Observations: Lucas Höppler

- **Schedule of the day:** Flight planning meeting with mission scientists and pilots at 12 UTC and a weather discussion at 16 UTC. Ground mission scientists for 3 aircraft (Tobi, Philippe & Matthias) to sit together in ops room for comparison legs.

- **Summary of the General Meeting:**
  - **Topics**

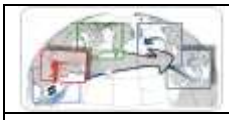
- Weather discussion
- Plan for radiometer comparison flight of FAAM, SAFIRE, HALO on Friday, 14/10.
- Plan for HALO flight into TPV near Canada on Saturday 15/10.
- Two plans for DLR-Falcon on Saturday.
- Possibility for aerosol flight with two falcons on Sunday.

- **Weather discussion**
  - Analysis: Wind decrease at Keflavik started at 0000 UTC last night with shift of cold front to the east. Will shift back west in the afternoon. PV cut-off Sanchez/Brigitte has stretched meridionally, more like a narrow trough, and is incident on northern Spain and southern France.
  - Forecast: Precip ahead of Sanchez is forecast to be very heavy over S France and S Alps.
  - Friday – Heavy rain on S Alps continues. Frontal cyclone developing on the long trailing cold front extended southwards from Iceland is forecast to move in slowly towards southern Ireland, England and NW France.
  - Saturday – Meanwhile a tropopause polar vortex (TPV) is forecast to move from Canadian Arctic out over sea to the SE of Baffin Island. Steve Cavallo first alerted us to this coherent TPV on Monday and the possibility that it would move within range. TC Nicole interacts with narrow trough on jet stream and develops a narrow warm sector heralding extratropical transition.
  - Sunday – TPV introduces lower predictability to tropopause position locally and the development of the associated trough and lee cyclone forming to the east of Greenland.
  - Nicole stays out of reach.
- **Friday, 14.10.2016**
  - **FAAM, SAFIRE, HALO:** radiometer comparison. 0730 UT take-off from East Midlands (UK) required for FAAM aircraft in order to return from double flight in time. Fixes ETA at meeting point 61N, 10W at 0930 UT (later in day revised to 61N, 9W at 0915 UT). Requires SAFIRE, followed by HALO, to take-off at 0800 UT. Planned comparison levels: HALO FL410, SAFIRE FL370, FAAM FL330. Forecast cloud situation is good especially between point B (59.5N, 6.5W) and C (56.5N, 6.5W) with max cloud tops predicted at FL310 (below all aircraft) and also some mid and low-level cloud above weak occluded front between surface high and low.
  - **SAFIRE and HALO:** Also A-train overpass has been identified at 12:50 UT to the east of Scotland (56.8N, 0.3E) and joint leg is proposed from there towards the NNW (63.2N, 4.0W). This requires SAFIRE to refuel at Inverness and HALO to devise a two hour flight plan to fill the interval between the FAAM comparison and A-train rendezvous. Plans to be made together immediately.
- **Saturday, 15.10.2016**
  - **HALO:** Flight to target TPV as it crosses over Labrador Sea from Baffin Island.

Originally proposed late flight as best (crossing feature 1800-2100) but crew constraint following today's long flight and need for HALO down day on Sunday means latest landing is 1830 UTC. However, TPV is forecast to move very slowly during Saturday so earlier flight plan needs to be designed.

- **DLR-Falcon – flight I:** A2D lidar scan patterns proposed by Christian over northern Iceland in clear sky but RH=50-70% (ideal). Requires 3 passes in box with two different scan patterns and straight leg return. FL360.
- **DLR-Falcon – flight II:** lidar calibration flight in clear air above the Iceland glacier, as done on 28/9/16. Requires circles drifting with the ambient wind. FL360. Christian to be MS on both flights.
- **SAFIRE:** Down day.

- **Need to file plans for HALO on Friday and 3 Saturday flights now.**
- **Radiosonde requests**
  - Thursday/Friday: Sondes have already been requested spanning the northern Atlantic up to Svalbard. Federico Grazzini communicated via chat that additional 12 UTC radiosondes have been instructed from station 16144 in the Po Valley (Thurs, Fri and Sat) in high impact weather.
  - Saturday: additional sondes are requested from S Greenland (Tasiilaq and Narsarsuaq) for 15 and 18 UT to tie in with HALO flight.

	**NAWDEX 2016** **Weather summary**	**Date: 19 September 2016** **Author: H.Binder, C.Grams**

Synoptic Analysis: Monday 19 September 2016

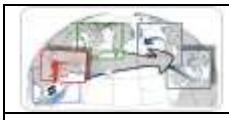
- Stationary trough centered over Greenland and Iceland, zonally oriented upper-level jet at its southern boundary.
- Surface cyclone located between the southern tip of Greenland and south of Iceland.
- Confluence or warm subtropical air from Gulf of Mexico and Caribbean and cold polar air masses from the Labrador Sea -> formation of a surface front below the upper-level jet extending from the east of Newfoundland to the central North Atlantic, intense precipitation along front.
- Formation of a frontal wave and later an associated WCB east of Newfoundland. We aim to measure outflow of this WCB 2 days later.

Forecast Tuesday 20 September 2016

- Trough and surface cyclone remain stationary near Iceland.
- Surface front strengthens, frontal wave propagates eastward, and associated WCB inflow region moves to the south of Iceland, continuous ascent to the northeast of inflow.

Forecast Wednesday 21 September 2016

- Explosive intensification of frontal wave cyclone to the south of Iceland at about 55°N between Tuesday and Wednesday (SLP deepening by >25 hPa between valid time (VT) 20/12 UTC and VT 21/12 UTC).
- Pronounced warm sector and strong WCB ascent directly to the south of Iceland, WCB outflow over Iceland; WCB outflow associated with a cyclonic (slightly lower) and an anticyclonic branch. Ensemble shows high probabilities (80-100%) for WCB ascent and outflow locations at VT21/12 UTC.
- Strong diabatic ridge amplification by WCB outflow over Iceland, strong negative PV advection by divergent wind (strongest at 315K at valid time VT 21/18 UTC)
- Overall robust scenario. Detailed model consistency:
    - Ridge building for forecast base time (BT) 19/00 UTC is about 3-6 hours earlier compared to BT 18/00 UTC, and cyclone is 10 hPa deeper (975 hPa for BT 19/00 UTC)
    - WCB outflow reaches 325K for BT 18/00 UTC over Iceland at VT 21/18 UTC. Outflow height for BT 18/12 run the is much lower (still pronounced ridgebuilding at 315K). BT 19/00 UTC again closer to BT 18/00 UTC. WCB outflow probability over Iceland increases from 60-80% for BT 18/00 UTC to 80-100% for BT 19/00 UTC.
    - Frontal wave reaches minimum SLP at about 22/00 UTC for all three base times (18/00, 18/12 and 19/00 UTC). For BT 19/00 UTC ensemble member converge towards a very intense SLP minimum of about 980 hPa.

	**NAWDEX 2016** **Weather summary**	**Date: 19 September 2016** **Author: H.Binder, C.Grams**

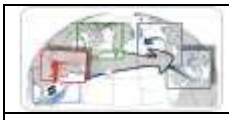
Forecast Outlook

- Thursday, 22 Sep: Second cyclogenesis north of Newfoundland; again injection of tropical warm air masses in newly forming warm sector.
- Friday, 23 Sep: Strong WCB formation south and east of Iceland, WCB outflow of same system north and east of Iceland on Saturday, 24 Sep. Potential for Lagrangian measurements with HALO and Falcon aircrafts (UK FAAM Bae146).
- Model consistency: robust signature of WCB ascent in region extending from Iceland southward to 45°N on Friday, 23 Sep. BT 18/12 UTC featured slight eastward shift. Robust signature of WCB outflow north of Iceland stretching from the coast of Greenland to Scotland and Norway on Saturday, 24 Sep.
- Potential extratropical transition (ET) and midlatitude impact of TC Karl Sunday-Wednesday: Strong downstream cyclone (and a strong WCB) reaching Iceland on Monday for BT 19/00Z. ET Karl reaches Iceland on Wednesday for BT 19/00Z. Track of these cyclonic systems seems relatively certain, still high uncertainty in terms of intensity and timing.

NAWDEX Flight Planning Matrix: 19 September 2016	Moisture Structure in BL	Mixed phase clouds	Diabatic effects on cyclonic systems	Impacts of tropopause waveguide uncertainty on HIW events	Moisture and cloud structure 'at the tropopause	Initial Condition Sensitivity and Predictability	EarthCare related observations	ADM related observations
Wed 21 Sept 2016 (D+2)								
Thu 22 Sept 2016 (D+3)								
Fri 23 Sept 2016 (D+4)								
Sat 24 Sept 2016 (D+5)								
Sun 26 Sept 2016(D+6)								

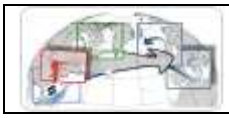
Scientific discussion

- Three to four missions are on the horizon in next 10 days
- Wednesday flight:
  - Exact positioning of box flight pattern for Falcon, measuring divergence vs. divergent wind. Signal of gravity waves.
  - Location and timing of additional radiosoundings
  - Jet crossing with HALO and Falcon, position of dropsondes.
  - Sensitivity regions for WCB ascent at 61N.
- Friday: coordination with UK-FAAM Bae146 aircraft for inflow measurements, activation of

	**NAWDEX 2016** **Weather summary**	**Date: 19 September 2016** **Author: H.Binder, C.Grams**

NOTAM box needed on Wednesday.

- Uncertainty for track of ET Karl and downstream cyclone, Coordination with SHOUT for ET Karl. Strong divergence and negative PV advection by irrotational wind from convection linked to atmospheric river downstream of ET Karl.
- Priorities for the many options during the next 10 days? When to take day off? Wednesday high priority, as WCB outflow is over Iceland. Friday/Saturday high priority, as it features possibility for Lagrangian measurements.
- Organisation of flight planning for ET Karl and downstream cyclone. Tentative flight plan on Friday for Monday? Day off Sunday? Skip downstream cyclone? But downstream cyclone appears more intense, and having more midlatitude impact …

	**NAWDEX 2016** **Weather summary**	**Date: 20. September 2016** **Author: C. Grams/H. Binder**

Synoptic Analysis: Tuesday 20 September 2016

- A large-scale trough remains stationary over Greenland and Iceland, with an associated stationary mature surface cyclone centred southwest of Iceland.
- Continuing confluence of warm subtropical and cold polar air masses has strengthened the frontal zone that extends now from Newfoundland to Iceland and further poleward to Svalbard.
- A frontal wave developed at the frontal zone (55N, 20W) and features incipient strong WCB activity, with ascending air along the leading edge of the upper-level trough.

Forecast Day 1 Wednesday 21 September 2016: planned mission

- The frontal wave strongly intensifies between 20 and 21 September while moving towards the south of Iceland.
- In the afternoon WCB outflow is located directly over Iceland, ascent just to the South of Iceland, maybe even some inflow to the Southeast of Iceland.
- Diabatic WCB outflow erodes the trough over Iceland and forms a marked tropopause step just to the Northwest of Iceland.
- Model consistency: Outflow height varies with different forecast initialisation times (BT), with the latest forecasts consistently predicting PV erosion up to 315K and strongest negative PV advection by irrotational wind at 315K. Region of PV erosion is consistently predicted over Iceland. Position of surface cyclone, warm sector, and WCB ascent region continuously predicted closer to Iceland in BT 18/12Z to BT 20/00Z. BT20/12Z again features a slightly more southward position of the cyclone centre. Still the impact of this shift on the upper-level PV erosion and ridgebuilding is marginal.

Forecast Day 2-3 Thurday 22, Friday 23 September 2016

- The former frontal wave becomes a mature quasi-stationary cyclone with its centre over and slightly south of Iceland on Thursday, 22 September.
- Over the Atlantic ongoing advection of warm-subtropical air feeds into another incipient cyclogenesis north of Newfoundland (52N, 50W). This cyclone propagates along the persistent baroclinic zone towards Iceland and strongly intensifies on Friday before reaching Iceland.
- Along with the cyclone, a strong WCB forms in the eastern North Atlantic with a pronounced inflow and ascent region west of the British Isles and Ireland, and later just to the Southeast of Iceland. WCB outflow is more anticyclonic into central Norway.
- Model consistency: The cyclogenesis of the Friday cyclone is consistent for BT 18/12Z to 20/12Z, the inflow and ascent region of the WCB shift only marginally. However, the WCB outflow region remains uncertain, with latest forecast initialisation times favouring a more anticyclone WCB outflow branch.

Forecast Outlook

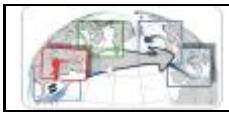
- On Saturday and Sunday 24-25 September the Friday cyclone becomes again stationary South of and over Iceland replacing the former Wednesday cyclone. In the wake of the cyclone strong

atmospheric river type moisture transport occurs, and impinges on the British Isles and Northern Europe, with the potential for heavy precipitation and strong winds.

- In the subtropical Atlantic (30N, 58W) tropical storm Karl intensifies initially as a tropical system and starts propagating into the midlatitudes. At the same time another Newfoundland cyclone forms ("downstream cyclone") and interacts with moisture of sub-tropical origin that is transported poleward downstream of TC Karl. The subsequent evolution is very uncertain, with either and/or both of the systems having the potential to strongly deepen and to reach Iceland during Tuesday-Thursday 27-29 September. Both systems are embedded in a strong atmospheric river, that might cause again heavy precipitation in Europe later next week.
- Very strong WCB activity is associated with Ex-TC Karl and the "downstream cyclone". Although the individual evolution of these systems is not clear, yet, strong ridgebuilding is consistently predicted South of Iceland, reaching high isentropic levels (340K).
- Along with this evolution very strong negative PV advection at upperlevels strongly enhance the tropopause PV gradient. This is most likely due to very intense diabatic outflow of ascending air in the region where tropical and polar air masses merge at lower levels. Consequently an extremely intense zonally-aligned upper-level jet stream evolves over the North Atlantic with maximum wind speeds potentially exceeding 90 m s^{-1} at 300hPa.

Scientific discussion

- New planning tool: Forward trajectories from curtain below flight track. (Heini Wernli).
- Flight Wednesday 21. September:
  - Jim Doyle: Strong sensitivities in COAMPS moist adjoint model for Wednesday cyclones, at 850hPa in cyclone area, at 250hPa at tropopause region. HALO and Falcon will sample these regions.
  - Do both Halo and Falcon missions, even if the forecast shifts.
- Flights Friday/Saturday 23/24 September:
  - Details of the HALO flight on Friday. Aim to capture WCB (inflow) ascent west of Ireland below the NAT tracks. HALO flight already very long, use Falcon to measure outflow? Cloud cover problematic, so that we might only have cloud radar, and drop sondes into ascent region. Optimal flight level for HALO?
  - We might not be able to start next HALO early enough on Saturday in order to measure WCB outflow in a truly Lagrangian sense (recapture air, observed on Friday). Falcon mission to measure WCB outflow close to Iceland in the night from Friday to Saturday and HALO later on Saturday to Norway to catch WCB outflow, or skip Saturday flight because of a more promising situation on Monday?
  - How to coordinate location and timing with FAAM aircraft (measurement of microphysical cloud properties at low-levels)?

	**NAWDEX 2016** **Weather summary**	**Date: 21. September 2016** **Author: C. Grams/H. Binder**

Synoptic Analysis: Wednesday 21 September 2016: mission

- As during the last days, a large-scale trough remains stationary over Greenland and Iceland, and a frontal zone extends from Newfoundland to Iceland and further poleward to Svalbard.
- A frontal wave cyclone, in the morning located at about 55N/20W, strongly intensifies while moving towards the south of Iceland.
- The cyclone is associated with strong WCB activity, with ascending air along the leading edge of the upper-level trough. In the afternoon the WCB outflow is centered over Iceland and the ascent just to the south of Iceland. The low PV in the WCB outflow erodes the trough over Iceland.
- Mission in the afternoon: Falcon measures the tropopause structure and flies along and across the jet. HALO has a coordinated leg with Falcon, and additionally measures the WCB ascent in the warm sector south of Iceland.

Forecast Day 1-2 Thurday 22, Friday 23 September 2016

- On Thursday, 22 September the icelandic cyclone reaches its mature stage and becomes quasi-stationary near Iceland.
- North of Newfoundland (52N, 50W) another frontal wave cyclone develops, and continuous warm-air advection from the subtropics maintains the strong frontal zone. The new Newfoundland cyclone subsequently propagates eastward and toward Iceland along the persistent baroclinic zone and strongly intensifies on Friday.
- The cyclone is associated with strong WCB activity. On Friday the WCB inflow is located west of Portugal and the Bay of Biscay, the WCB ascent west of the British Isles and Ireland, and the WCB outflow between Iceland and Norway.
- Model consistency: The cyclogenesis of the Friday cyclone is consistent for BT 18/12Z to 21/00Z, the inflow and ascent region of the WCB shift only marginally. However, the WCB outflow region remains uncertain, but there is a tendency that a strong anticyclonic WCB outflow branch is favored.

Forecast Outlook

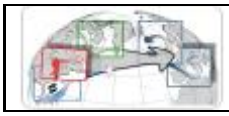
- On Saturday and Sunday 24-25 September the Friday cyclone becomes again stationary near Iceland and replaces the former Wednesday cyclone. Strong moisture transport in the wake of the cyclone affects the British Isles and Northern Europe, with the potential for heavy precipitation and strong winds.
- Another cyclone forms on the continuously strong baroclinic zone near Newfoundland ("downstream cyclone") and propagates eastward. In the subtropical Atlantic (30N, 58W) tropical storm Karl intensifies initially as a tropical system, recurves and also moves into the midlatitudes.
- Very strong WCB activity is associated with Ex-TC Karl and the "downstream cyclone". Strong ridge amplification, and strengthening of the wave guide is consistently predicted south of Iceland, reaching high isentropic levels (340K). This is most likely due to the strong outflow of the WCB ascending in the region where tropical and polar air masses merge at lower levels, resulting in very pronounced negative PV advection at upper levels and a strong enhancement

of the tropopause PV gradient.

- Consequently, an extremely strong jet with 300-hPa winds potentially exceeding 90 m s^{-1} develops over the Atlantic on Monday.
- Downstream of the diabatically amplified upper-level trough, an elongated PV streamer over western Europe leads to strong moisture transport along its leading edge and heavy precipitation in the Alpine region on Monday.
- The subsequent evolution of the downstream cyclone and Karl are very uncertain, with either and/or both of the systems having the potential to strongly deepen and to reach Iceland during Tuesday-Thursday 27-29 September. Today a third scenario emerged, with Karl reaching the British Isles as a relatively weak system, but explosively intensifying over the North Sea and becoming a severe winter storm, that affects the North Sea and Baltic Sea region.

Scientific discussion

- Flights Friday/Saturday 23/24 September:
    - Detailed (but preliminary) flight plan for HALO: Measure WCB ascent (coordinated leg with FAAM aircraft) and some outflow between Iceland and the British Isles. Additionally, it was decided to plan a mission with Falcon during the evening to measure WCB outflow.
    - Fly on Saturday to capture WCB outflow in a Lagrangian sense (recapture the same air observed during the WCB ascent on Friday)? One-day forward trajectory calculations from the HALO track show that some Lagrangian matches are possible, but overall the flow situation is not ideal to do this from Iceland. Or skip Saturday flight because the situation looks more promising on Monday, and it is easier for flight planning (day off can be set to Saturday)? A lot of support for option to skip Saturday flight.

	**NAWDEX 2016** **Weather summary**	**Date: 22. September 2016** **Author: H. Binder/H. Wernli**

Synoptic Analysis: Thursday 22 September 2016

- A large-scale upper-level trough persists over Greenland and Iceland.
- Below the upper-level trough cyclone "Ursula" has reached its mature stage and became quasi-stationary, with its center over Iceland.
- A new frontal wave develops north of Newfoundland, fed by ongoing warm-air advection from the subtropics.

Forecast Day 1 for Friday 23 September 2016: planned mission

- The Newfoundland cyclone rapidly intensifies while moving eastward along the baroclinic zone. At noon it is located west of the UK, and minimum SLP amounts to about 980 hPa.
- A strong WCB is associated with the cyclone, with the inflow west of Portugal and the Bay of Biscay, a pronounced ascent region west of the UK, and the outflow centered to the south of Iceland.
- Planned mission: With HALO measure WCB ascent (coordinated leg with FAAM aircraft) west of the UK, and with HALO and Falcon the WCB outflow between Iceland and the UK.

Forecast Outlook

- On Saturday and Sunday 24-25 September the cyclone observed on Friday becomes again stationary near Iceland and replaces cyclone "Ursula". Strong moisture transport in the wake of the cyclone results in heavy precipitation over the UK and Northern Europe between Saturday and Monday.
- A new cyclone forms near Newfoundland ("downstream cyclone") on the continuously strong baroclinic zone and propagates eastward. In the subtropical North Atlantic tropical storm Karl intensifies, recurves and starts moving toward the midlatitudes. Between the two systems, an extremely strong jet with 300-hPa winds potentially exceeding 90 m s^{-1} is predicted to develop on Monday.
- The evolution of Karl and the downstream cyclone, and the large-scale flow they are embedded in, are very uncertain, with different scenarios:
    - (i) BT21/00 UTC: On Monday 26 September the DS cyclone is associated with an LC2-type upper-level wave (due to a strong cyclonic branch of the WCB outflow), and further downstream an elongated PV streamer over western Europe leads to heavy precipitation in the Alpine region. Subsequently the DS cyclone and Karl both intensify and move toward Iceland/Norway.
    - (ii) BT21/12 UTC: On Monday 26 September the flow associated with the DS cyclone is more zonal, Karl slower, and the PV streamer over western Europe less pronounced. TC Karl later merges with another tropical system, TC Lisa, propagates relatively slowly over the North Atlantic, explosively intensifies over the North Sea and becomes a severe winter storm that affects the North Sea and Baltic Sea region on Wednesday, 28 September.
    - (iii) BT22/00 UTC: On Monday 26 September the flow over the western and central North Atlantic is even more zonal than in the BT21/12 run, Karl weaker, and the PV streamer over western Europe even less pronounced. Karl subsequently overtakes Lisa

and rapidly propagates northeastward along the straight jet as a diabatic Rossby Wave. It explosively intensifies over the Norwegian Sea and becomes a severe winter storm that affects Norway on Tuesday-Wednesday 27-28 September.

- Although the synoptic evolution next week is uncertain, both TC Karl and the downstream cyclone are associated with a pronounced WCB, with strong diabatic ridge amplification by the WCB outflow consistently predicted south of Iceland, reaching high isentropic levels (340 K).

Scientific discussion

- Today the meeting was short due to a quicklook meeting starting at 16.30 UTC.

	**NAWDEX 2016** **Weather summary**	**Date: 23. September 2016** **Author: H. Binder/J. Quinting**

Synoptic Analysis: Friday 23 September 2016

- A large-scale upper-level trough remains quasi-stationary over Greenland and Iceland. At low levels the mature cyclone "Ursula" is still located near Iceland.
- A new cyclone, "Vladiana", which formed on Thursday 22 September near Newfoundland as a frontal wave, has rapidly intensified between Thursday and Friday, 22/23 September, while moving eastward along the baroclinic zone. At Friday noon the cyclone is located at about 25°W/57°N, and minimum SLP is less than 984 hPa. The cyclone is associated with a strong WCB, with the inflow and ascent region located west of Portugal and the UK, and the outflow centered south of Iceland.
- Today's mission: HALO and Falcon first flew coordinated and captured the WCB outflow between Iceland and the UK, and then HALO captured the WCB ascent (one coordinated leg with FAAM aircraft) west of the UK.

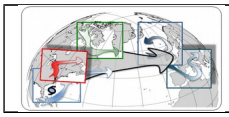
Forecast Outlook

- On Saturday and Sunday 24-25 September, cyclone "Vladiana" becomes stationary near Iceland and replaces cyclone "Ursula". The trailing cold front associated with "Vladiana" moves over Western Europe, leading to heavy precipitation over the UK and Northern Europe on Saturday 24 September, over the Pyrenees on Sunday 25 September, and over the Alps on Monday, 26 September.
- Near Newfoundland another cyclone forms ("downstream cyclone"), fed continuously by moist subtropical air masses, and subsequently moves eastward. In the subtropical North Atlantic tropical storm Karl intensifies, recurves and also starts to move northeastward. An extremely strong jet develops between the two systems, with 300-hPa winds potentially exceeding 90 m s^{-1} on Monday.
- As during the previous days, the evolution of Karl and the downstream cyclone, and the large-scale flow they are embedded in, remains very uncertain, and every model run features a different scenario. In today's ECMWF run with base time 23/00 UTC, Karl merges with the DS cyclone on Monday. The merging is associated with an LC2 type wave breaking. A downstream PV streamer (which is, however, less pronounced than in the BT21/00 UTC run) leads to heavy precipitation over the Alpine region. The DS cyclone moves toward Iceland/Norway on Tuesday, and a new cyclone develops over the subtropical North Atlantic which moves toward Iceland on Wednesday.

Scientific discussion

- The synoptic evolution is very uncertain, which renders a detailed flight planning difficult. Despite the uncertainties, Monday 26 September looks promising for a mission, and different scenarios for HALO and Falcon flights have been discussed in today's meeting. Detailed flight plans will be discussed on Sunday 25 September.

	**NAWDEX 2016** **Weather summary**	**Date: 23. September 2016** **Author: H. Binder/J. Quinting**

	**NAWDEX 2016** **Weather summary**	**Date: 25/09/2016** **Author: J. Quinting, H. Binder**

Synoptic Analysis

A deep trough over eastern North America, a zonal flow over the North Atlantic, and a high amplitude ridge over Scandinavia characterize the large-scale flow on 25 September 2016. Ahead of the upper-level trough over eastern North America, upper-level forcing leads to the formation of a weak low-pressure system ("downstream cyclone") east of Newfoundland. At the same time, TC Karl undergoes extratropical transition and moves toward the midlatitude jet. The outflow of TC Karl contributes to the formation of an intense upper-level anticyclone that starts breaking anticyclonically over the eastern subtropical Atlantic. Extratropical cyclone "Vladinia", which was target of IOP 3, has weakened considerably and is located above Iceland.

Forecast Day 1 (tomorrow)

Ahead of the trough over eastern North America and in a southwesterly flow, TC Karl moves toward the intensifying midlatitude jet and starts merging with the initially weak "downstream cyclone". During the merging process, former TC Karl is predicted to intensify rapidly as an extratropical cyclone to a mean sea level pressure minimum of less than 970 hPa at 18 UTC. At the same time, the jet stream will potentially intensify to wind speed of more than 85 m/s at 300 hPa.

On the eastern flank of the intensifying cyclone, warm moist air masses are transported toward the midlatitude baroclinic zone. The rapidly ascending air masses form an intense WCB that lifts the tropopause north of the cyclone centre. The cyclonically ascending branch of the WCB contributes to the formation of an upper-level PV hook and an LC2-type breaking of the upstream trough. The stratospheric branch of the LC2 wave breaking and the subtropical ridge to the south, form a remarkable tropopause fold that reaches down to the boundary layer. This tropopause will be one target of NAWDEX IOP4.

Forecast Day 2 (day after tomorrow)

The LC2-type wave breaking continues on Tuesday. An east-west elongated tropospheric PV streamer extends from the Faroe Islands to the southern tip of Greenland. Likewise, a stratospheric PV streamer extends from the central North Atlantic to North Scotland. This stratospheric PV streamer is predicted to break apart. The breaking process will likely result in a west-east elongated upper-level cutoff to the south of Iceland. This upper-level cut-off and its associated low-pressure system (ex-TC Karl) will propagate toward Norway until Wednesday. The cut-off process is likely related to upper-level diabatic outflow associated with a baroclinic wave that develops ahead of an upper-level trough over the central North Atlantic. Though this baroclinic wave develops in a relatively moist environment, it does not intensify significantly. At upper levels, a weak downstream ridge amplifies. This ridge and its associated jet streak will be located to the south of Iceland on Wednesday.

Forecast Outlook

After several consecutive days of high cyclone activity, the synoptic activity will likely cease at the end of the week. Some forecast scenarios indicate a next cyclone development for next weekend.

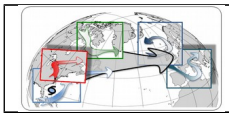
Scientific discussion

The scientific discussion focused mainly on three flights on Monday and Tuesday.

- On Monday, HALO will capture the rapid extratropical intensification of ex-Karl, its associated WCB, and

the structure of the remarkable tropopause fold.

- On Tuesday, the DLR-Falcon and the UK FAAM BAE 146 will perform coordinated flights into the region of the upper-level cut-off. DLR-Falcon will sample the upper-level winds, whereas the UK FAAM BAE 146 will focus on the properties of a bent-back warm front to the south of the cut-off system.
- On Tuesday afternoon, HALO will most likely investigate the tropopause structure during the cut-off process, low-level moisture transport over the Atlantic, as well as the tropopause structure of the cut-off system itself.
- All Monday and Tuesday activities will be supported by additional radiosoundings from the Azores, Iceland, Norway and the Shetland Islands.
- A gravity wave IOP is planned for Tuesday and Wednesday. Additional radiosoundings will be launched from Keflavik. Possible flights associated with this IOP will be discussed on Monday.

	**NAWDEX 2016** **Weather summary**	**Date: 26/09/2016** **Author: J. Quinting**

Synoptic Analysis

Ahead of a deep, upper-level trough, the former tropical cyclone Karl merges with an extratropical low pressure system over the central North Atlantic. This merging of the two systems results in an explosively deepening midlatitude cyclone (referred to as “ex-Karl”). Intense warm conveyor belt (WCB) ascent on the eastern flank of ex-Karl lifts the tropopause north of the cyclone centre. The cyclonically ascending branch of the WCB contributes to the formation of an upper-level PV hook and an LC2-type breaking of the upstream trough. The stratospheric branch of the LC2 wave breaking and the subtropical ridge to the south form a remarkable tropopause fold that reaches down to the boundary layer. The HALO aircraft documented the structure of ex-Karl and of its surrounding air masses during NAWDEX IOP 4.
The flow in downstream regions is characterized by a trough that extends from Iceland to the Mediterranean and a high amplitude ridge over Scandinavia.

Forecast Day 1 (Tuesday, 27/09/2016)

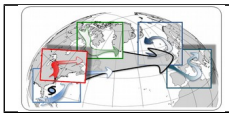
The LC2-type wave breaking associated with ex-Karl continues on Tuesday. An east-west elongated tropospheric PV streamer extends from the Faroe Islands to the southern tip of Greenland. Likewise, a stratospheric PV streamer extends from the central North Atlantic to North Scotland. This stratospheric PV streamer is predicted to break apart. The breaking process will likely result in a west-east elongated upper-level cut-off to the south of Iceland. On the eastern flank of this upper-level cut-off and downstream of ex-Karl, a relatively small low pressure system develops north of Scotland. This low pressure system intensifies to less than 990 hPa and is located between Iceland and Norway on the following day.
The cut-off process to the south of Iceland is likely related to upper-level diabatic outflow associated with a baroclinic wave that develops ahead of an upper-level trough over the central North Atlantic. Though this baroclinic wave develops in a relatively moist environment, it does not intensify significantly. At upper levels, a weak downstream ridge amplifies. This ridge and its associated jet streak will be located to the south of Iceland on Wednesday.

Forecast Day 2 (Wednesday, 28/09/2016)

The baroclinic wave that started to develop on the previous day, intensifies weakly over the central North Atlantic ahead of an upper-level trough. On its southern flank and in the warm sector of this baroclinic wave, moist air masses are transported eastward. This moisture transport is potentially enhanced through moisture injection from the former tropical cyclone Lisa. Until Thursday, the region of strongest moisture transport reaches the Norwegian coast. Here, the lifting of air masses will result in heavy precipitation.

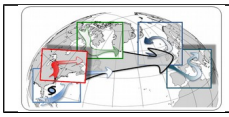
Forecast Outlook

After several consecutive days of high cyclone activity, the synoptic activity will likely cease over the central and eastern North Atlantic on Thursday and Friday. However, several forecast scenarios predict the develop of a new midlatitude low pressure system over the western North Atlantic at the end of this week. This system is expected to intensify rapidly on Saturday and Sunday over the central North Atlantic. Warm-conveyor belt outflow of this system will likely be located in the Icelandic region on Sunday/Monday.

	**NAWDEX 2016** **Weather summary**	**Date: 26/09/2016** **Author: J. Quinting**

Scientific discussion

- On Tuesday, the DLR-Falcon and the UK FAAM BAE 146 will perform coordinated flights into the region of the upper-level cut-off. DLR-Falcon will sample the upper-level winds, whereas the UK FAAM BAE 146 will focus on the properties of a bent-back warm front to the south of the cut-off system.
- On Tuesday afternoon, HALO will investigate the tropopause structure during the cut-off process, low-level moisture transport over the Atlantic, as well as the tropopause structure of the cut-off system itself. In particular, the low-level moisture transport is of big interest as this is a sensitive region for the heavy precipitation over Northern Europe in the following days.
- All activities will be supported by additional radiosoundings from the Azores, the UK, Norway and Sweden. Radiosondes will be launched 6-hourly from regions with high moisture flux.
- A gravity wave IOP is planned for Tuesday and Wednesday. Additional radiosoundings will be launched from Keflavik.
- The DLR-Falcon will perform Lidar calibration flights over Iceland on Wednesday.

	**NAWDEX 2016** **Weather summary**	**Date: 27/09/2016** **Author: J. Quinting**

Synoptic Analysis

A deep trough over the western North Atlantic and a corresponding ridge downstream dominate the large-scale synoptic situation. A weak low-level disturbance has formed in the southwesterly flow ahead of the trough. Warm, moist air masses are being transport eastward in the warm sector of this disturbance. This moisture transport is presumably fed by the former tropical cyclone Lisa which is located to the south of the midlatitude disturbance.

Ex-Karl and the associated upper-level PV anomaly are located to the south of Iceland. The upper-level positive PV anomaly is stretched zonally and eventually breaks apart. Below the eastern edge of this west-east elongated PV anomaly, a new low-pressure system develops. This low pressure system moves northeast toward the Norwegian coastline. The low pressure system and its associated frontal systems bring strong winds and precipitation to southern Norway.

Forecast Day 1 (Wednesday, 28/09/2016)

The low-level disturbance that started to develop on the previous day, intensifies to less than 985 hPa over the central North Atlantic ahead of an upper-level trough. On its southern flank and in the warm sector of this baroclinic wave, moist air masses are transported eastward. This moisture transport is potentially enhanced through moisture injection from the former tropical cyclone Lisa. Until Thursday, the region of strongest moisture transport reaches the Norwegian coast. Here, the lifting of air masses will result in heavy precipitation.

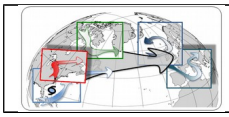
Forecast Day 2 (Thursday, 29/09/2016)

The low-level disturbance over the eastern North Atlantic is propagating north-eastward and will most likely reach the Norwegian coast during the day. The moist air masses in the warm sector of this system will be lifted over the Norwegian coast. This will potentially result in heavy precipitation and strong winds in southern Norway. In addition, a relatively strong pressure gradient on the southern flank of the system will bring strong winds over the North Sea and Baltic Sea. Upper-level outflow of strongly ascending air masses is presumably contributing to ridge building in downstream regions.

Over the western North Atlantic, the break-up of a PV streamer will result in two upper-level cut-off systems. The eastern cut-off is associated with the development of a weak surface pressure anomaly in the Newfoundland region.

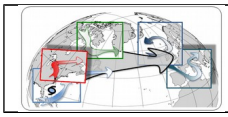
Forecast Outlook

The low pressure system over Newfoundland is predicted to propagate eastward in the following days. In a moist environment and ahead of an upper-level trough, this system is expected to intensify rapidly over the central North Atlantic. Current forecast agree well concerning the location of the low pressure system during the next days. However, high uncertainties exist concerning the intensity of this system. Upper-level outflow associated with WCB activity on the eastern flank of the low pressure system will contribute to a strong ridge building over Iceland during the weekend. The evolution of the low pressure system itself as well as the development of the upper-level ridge are certainly a target for further NAWDEX flights.

	**NAWDEX 2016** **Weather summary**	**Date: 27/09/2016** **Author: J. Quinting**

Scientific discussion

- The DLR-Falcon will perform Lidar calibration flights over Iceland on Wednesday.
- Flights on Saturday and Sunday will be planned in detail from Thursday onwards.

	**NAWDEX 2016** **Weather summary**	**Date: 29/09/2016** **Author: J. Quinting**

Synoptic Analysis

A deep trough over the central North Atlantic and downstream ridge characterize the large-scale flow. An elongated PV streamer extends westward from the southern tip of the trough. This PV streamer starts breaking apart into two cut-off systems over North America. The eastern most cut-off system is expected to be involved in a cyclogenesis event over the Atlantic in the following days.
Cyclone “Walpurga” that developed earlier ahead of the upper-level trough is located to the north of Scotland. This low pressure system is associated with strong winds of more than 100 km/h over Scotland and Norway.

Forecast Day 1 (Friday, 30/09/2016)

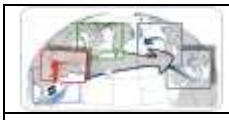
The PV streamer over eastern North America will break apart into two cut-off systems. One of these cut-offs will be located over Newfoundland. To the south of this cut-off, the mean sea level pressure field indicates the development of a new low pressure system. On its eastern flank, warm moist air masses – most likely of subtropical origin - are being transported toward a low-level baroclinic zone. The air masses ascend along the baroclinic zone and form an intense warm conveyor belt. Cross-isentropic ascent within this warm conveyor belt reduces upper-level PV and thus contributes to a ridge building in downstream regions. The low-pressure system itself will likely deepen to less than 1000 hPa during the day.

Forecast Day 2 (Saturday, 01/10/2016)

On forecast day 2, an upper-level trough will approach the developing low pressure system from upstream regions. This trough provides upper-level forcing for a further deepening of the cyclone. The warm conveyor belt activity continues on the eastern flank of the cyclone. This results in erosion of upper-level PV and a ridge building to the north of the cyclone center. In addition, upper-level irrotational winds impinge on the remarkably strong PV gradient and thus contribute to a westward extension of the ridge.

Forecast Outlook

The intensification of the low pressure system will continue during the next day. Ensemble forecast suggest that the system will deepen to a central pressure minimum between 950 to 970 hPa. The upper-level PV structure indicates a LC2-type wave breaking above the cyclone center. The ridge amplification downstream is expected to continue due to persistent warm-conveyor belt activity.
Current forecast scenarios indicate a further cyclogenesis during Tuesday/Wednesday next week. This cyclone is predicted to move toward Iceland and thus will be followed intensively during the next days.

	**NAWDEX 2016** **Weather summary**	**Date: 30 September 2016** **Author: B. Crezee, C. Grams**

Synoptic Analysis Friday, 30 September 2016

At Friday, 20 September the upper-level flow in the North Atlantic region is characterised by a broad upper-level trough extending from Iceland into Scandinavia. In the western North Atlantic between Newfoundland and Greenland the earlier day's cut-off process resulted in a complicated flow structure characterised by a split jet. A very small upper-level PV cut-off (exceeding 10 PVU at 300 hPa) becomes collocated with a surface frontal wave like cyclone over Newfoundland, that evolved at the tip of a region of enhanced subtropical warm-air. The superposition results in an explosive deepening of this cyclone, which we call "Saturday cyclone". The cyclone has developed a pronounced warm sector to the west; its center is characterised by very dry air mass. At its eastern flanks an intense WCB evolves, which will have its outflow over the entire North Atlantic region from Greenland over Iceland to Norway in the following days.
In the eastern Atlantic region cyclone "Walpurga" whose WCB inflow was measured during IOP5 is located over Scandinavia and merged into "Ex-Karl". The precipitation due to WCB and AR activity at the Norwegian Coast exceeded locally 160mm in the past 48 hours, which is a severe but not an unusual event.

Forecast Day 1 (tomorrow) Saturday, 1 October 2016
On Saturday 1 October, the large-scale upper-level trough extends southwards from Greenland and approaches the Saturday cyclone, supporting its further intensification. Air parcels rise in the warm sector of the cyclone forming a very intense WCB and instigating strong ridgebuilding to the South of Iceland. At the same time a lee cyclone develops to the east of the southern tip of Greenland, associated with the northern branch of the split jet. The flight planning for Saturday did not change.

Forecast Day 2 (day after tomorrow) Sunday, 2 October 2016
On Sunday 2 October the "Saturday cyclone" reaches its mature stage with a minimum central pressure between to 955-965 hPa, while gradually moving towards Iceland. Winds in Keflavik will start increasing on Sunday afternoon, with peak winds expected Sunday night until Monday noon. Also WCB (inflow) activity continues on the western flank of the cyclone. The WCB outflow continues strongly amplifying the ridge, which now expands from Greenland over Iceland to Scotland. On the downstream flank the ridge itself leads to a further southward protrusion of the trough now located over southern Sweden and Denmark. The adjoint model sensitivities highlight uncertainties for the evolution of the Saturday forecast, which are related to moisture transport in the south eastern quadrant of the cyclone at Saturday. The flight planning for Sunday did not change.

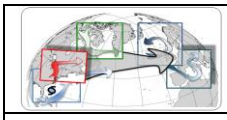
Forecast Outlook
On Monday 3 October, there is still strong WCB outflow into the downstream ridge. Now the trough-ridge couplet starts to break cyclonically and wraps up in the region between Iceland and Greenland. The cyclone has merged with the lee becomes stationary close to the southern tip of Greenland. The cyclone has consumed most of the moist and warm air. The marked baroclinic zone between Iceland

and Norway has been eroded. The EFI indicates very strong winds over the Keflavik area.
On Tuesday 4 October the Saturday cyclone remains stationary at the Southern tip of Greenland. Although the western part of the ridge was eroded by cyclonic wave breaking, ongoing WCB outflow continues amplifying the ridge to the East, which now propagates eastward. At the surface high pressure) builds up over Scandinavia. The downstream trough cuts off into the Balkans region. There is high uncertainty related to the exact position of this cut-off. However, it is very likely that it will cause heavy precipitation in some regions of Central and Eastern Europe.
Over the western North Atlantic new moisture transport emerges from subtropical regions and re-establishs a strong baroclinic zone, extending from the Halifax region to the Azores. On this baroclinic zone a new frontal wave cyclone formed which is located at about 40W, 45N at 12 UTC associated with an initial WCB.
On Wednesday 5 October, the frontal wave cyclone tracks along the baroclinic zone straight towards Iceland and strongly intensifies. A very intense WCB forms along with the strong warm air and moisture advection and ascends towards the Iceland area. The cut-off over the Balkans splits up in two parts and initiates northerly flow towards the Eastern Alps, potentially leads to heavy precipitation over the wider eastern Alpine region. The exact timing and regions affected by this HIW are still very uncertain, due to uncertainty in the position of the upper-level cut-off.
On Thursday 6 October the frontal wave cyclone has become mature and is located just west of Iceland. Still WCB ascent continues directly over Iceland. There is indication that the upstream trough cuts off into the Azores region. Hurricane Matthew might undergo extratropical transition and track into the North Atlantic region.

The entire period Sunday 2 October to Friday 7 October is characterised by warm-moist air advection towards Iceland in a strong southerly flow. This results in a mulit-day period of heavy precipitation in southern Iceland.

Scientific discussion

- The nature of the “Saturday cyclone” has been discussed intensively. The small size of the upper-level cut off and its strong intensification from 00UTC to 15UTC Friday 30 Sep is surprising. The WV sat imagery shows very dry air in its centre. At the same time it is located in a complicated split jet structure and might experience upper-level forcing associated with different jet streaks. Finally the cyclone is located in a region of subtropical warm-moist air.
- The WCB associated with the “Saturday cyclone” is very intense and reaches up to 340K. It triggers ridgebuilding and the elongation of a downstream trough that cuts off early next week over Scandinavia into eastern Europe. Discussion if and how the cut-off process could be observed with extra radio sounding in Scandinavia and Central Europe.
- Downstream high impact weather associated with the Central European cut-off mid of next week.
- Uncertainty in frontal wave evolution Tue-Thu next week.

	**NAWDEX 2016** **Weather summary**	**Date: 01 October 2016** **Author: C. Grams, B. Crezee**

Synoptic Analysis Saturday, 1 October 2016

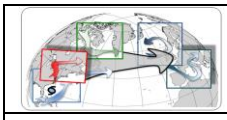
On Saturday at 12 UTC, the "Saturday cyclone" is located south of Iceland at about 35W, 50N. During the last 24h it strongly intensified when a the tiny upper-level cut-off became collocated with the low-level frontal wave over Newfoundland. Very dry stratospheric air is still located in the centre of the cyclone and in its cold sector. Enhanced transport of a subtropical warm air mass occurs in a narrow atmospheric river type band ahead of a strong baroclinic zone that extends from the US East Coast into the central North Atlantic. This air mass also forms the warm sector of the cyclone and reaches close to its centre. At upper-levels a pronounced zonal jet streak is located over northern Québéc and Newfoundland. Further to the East the jet splits into a strong southern branch and a weaker northern branch. Along with the northern branch and tropospheric-deep westerly flow a lee cyclogenesis occurred between the southern tip of Greenland and Iceland. The small cut-off associated with the "Saturday cyclone" is located in between these jet streaks. Strong WCB activity emerged along with the intensifying cyclone and build a ridge towards Greenland and Iceland. Downstream a trough amplifies equatorward and is centred over the British Isles on Saturday.

Forecast Day 1 (tomorrow) Sunday, 2 October 2016

On Sunday, the "Saturday cyclone formerly known as Xun" merges with the Greenland lee cyclone, further intensifies, and approaches Iceland. It now expands over the entire North Atlantic region from Newfoundland, towards Iceland and the British Isles. The subtropical air mass reaches Iceland . At upper-levels very strong ridgebuilding continues, in particular in the western half of the ridge, where low-PV air starts to wrap up cyclonically into the cyclone center and a step tropopause step formed over the Greenland coast at about 70N. Likewise strong WCB activity continuous. The wrapping up of the western side of the ridge helps amplifying the upstream trough that starts extending equatorward to about 45N. At the same time anticyclonic WCB outflow help amplifying the downstream trough over the British Isles, that starts cutting off over the Netherlands.
As the surface cyclone approaches Iceland strong surface winds and precipitation are expected, in particular in south(western) Iceland.

Forecast Day 2 (day after tomorrow) Monday, 3 October 2016

On Monday, the "Saturday cyclone" is located just southwest of Iceland and the strongest wind field affects KEF. We expect sustained wind speeds of 15-20 m s^{-1} in southwestern Iceland. WCB activity still continues. The entire Rossby wave pattern (upstream trough, ridge, downstream trough) further amplifies and slightly shifts eastward. A marked cut-off cyclone forms downstream and becomes located over eastern Germany and Poland. Although tropospheric-deep southerly flow prevails from Ireland to Iceland, most of the subtropical air has been mixed up in the cyclonic system. However, in the subtropical western North Atlantic another episode of strong advection of warm moist air begins reinforcing the baroclinic zone east of Newfoundland, and an initial frontal wave is evident in surface pressure.

	**NAWDEX 2016** **Weather summary**	**Date: 01 October 2016** **Author: C. Grams, B. Crezee**

Forecast Outlook

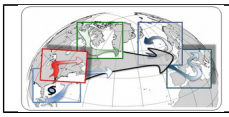
During Tuesday 4 October, the baroclinic zone strengthens and the frontal wave propagates fast eastward into the central North Atlantic. Whereas the track of this new frontal wave cyclone is quite certain amongst the last 3 initialisation times and within the ensemble, the exact timing and position feature high uncertainty. Still incipient WCB activitiy is evident with the frontal wave cyclone and helps amplifying the upstream trough of the "Saturday cyclone". Very strong moisture flux occurs in the wake of the forming frontal wave cyclone.

The "Saturday cyclone" became mature south of Greenland. The upstream trough amplification initiates a final episode of WCB activity with the Saturday cyclone. The associated WCB outflow enhances a strong jet streak just to the east of Iceland and helps maintaining the ridge, that now becomes centred and blocked over Scancinavia along with a very strong surface anticyclone. The European cut-off propagated into the Balkans and triggers heavy precipitation in that region. The exact location of the cut-off and associated HIW is still uncertain.

During Wednesday to Thursday, 5-6 October, the frontal wave cyclone strongly intensifies and will be the main feature of interest. It most likely affects Iceland with heavy precipitation and very strong winds (>20m/s) on Wednesday. Along with this cyclone very intense WCB activity occurs on Tue-Thursday. To the end of the week, Hurricane Matthew most likely tracks along the US East coast. Strong moisture and warm air transport ahead of it produces a favourable environment for (sub-) tropical cyclogenesis in the sub-tropical western North Atlantic. Some model runs feature several cyclogeneses in this air mass to the Northeast of recurving Matthew. These cyclones feature strong outflows, and together with Matthew will affect predictability downstream over Iceland.

Scientific discussion

- The main feature of interest is the frontal wave cyclone developing from Tue-Thu and featuring very strong WCB activity.
- At the same time the frontal wave cyclone triggers intense moisture transport towards Iceland and further poleward.
- The cut-off forming downstream over Europe due to the strong WCB outflow and associated ridgebuilding might trigger heavy precipitation. This potential NAWDEX European HIW period is of interest.
- As cyclones affect Iceland surface weather in KEF is monitored. In particular wind on Monday and Wednesday are critical for flight operations.

	**NAWDEX 2016** **Weather summary**	**Date: 02/10/2016** **Author: J. Quinting**

Synoptic Analysis

An intense cyclone (core pressure of less than 965 hPa), the “Saturday cyclone”, is located over the central Atlantic and ahead of an upper-level trough. This trough starts breaking cyclonically during the day. Warm conveyor belt ascent in the warm sector of the cyclone and its associated outflow contribute to a downstream ridge building. In response to the ridge building, a PV streamer forms over Scandinavia and central Europe. This PV streamer breaks apart until the end of the day and a stratospheric cut-off forms over Germany and Benelux.

Forecast Day 1 (Monday, 03/10/2016)

The cyclonic wave breaking over the central North Atlantic and the downstream ridge building are expected to continue. The low pressure system associated with the breaking trough will be located south west of Iceland. A southerly flow on its eastern flank will bring strong winds and rain to the Keflavik area. Warm conveyor belt activity in the warm sector of the cyclone continues. These strongly ascending air masses are predicted to have their outflow two days later between Greenland and Scandinavia.

The cut-off that formed further downstream on the previous day will be located over central Europe. It is associated with warm conveyor belt ascent on its eastern flank. These rapidly ascending air masses are predicted to bring intense rainfall to central Europe during the course of the week.

Over the western North Atlantic, a dip in mean sea level pressure indicates the development of a new cyclone southeast of Newfoundland. In a strong upper-level westerly flow this diabatic Rossby wave starts to intensify. A massive warm conveyor belt leads to ridge building downstream that is expected to continue during the next day.

Forecast Day 2 (Tuesday, 04/10/2016)

According to the ECMWF IFS forecast of 02 October 0000 UTC, the diabatic Rossby wave will undergo a rapid intensification. An approaching upper-level trough provides forcing such that the cyclone will deepen from 1000 to 960 hPa in 24 hours. This rapid intensification is associated with the formation of a remarkable warm conveyor belt. Cross-isentropic transport of low-PV air within this rapidly ascending air masses contributes to a renewing of the high amplitude ridge over Scandinavia that was initially built by the warm conveyor belt associated with the “Saturday cyclone”.

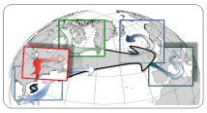
Forecast Outlook

The diabatic Rossby wave itself will be located between Greenland and Iceland. Moisture transport and a strong pressure gradient will lead to heavy precpitation and strong winds around Iceland. Warm conveyor belt activity is expected to continue during the following days. Likewise, the ridge downstream of the diabatic Rossby wave will experience further amplification. Until 06 October, the northern edge of the ridge will reach about 80N.

A stratospheric cut-off system to the south of the ridge will likely bring considerably amounts of rain to central and eastern Europe.

Scientific Discussion

A Halo flight is scheduled for Tuesday 04/10. The objectives for this flight will be measuring the structure of the diabatic Rossby wave, the structure of its outflow, and the strong WCB ascent associated with the system. Tentative flight plans were presented for (coordinated) missions on 05/06 October. Plans for these flights have to be refined in the following days.

	**NAWDEX 2016** **Weather summary**	**Date: 03 October 2016** **Author: A. Schaefler, B. Crezee, J.Riboldi**

Synoptic analysis (Monday 3 Oct)

After having brought strong winds (gusts >25m/s) over Keflavik on Sunday 02 and Monday 03 October, the occluded "Saturday cyclone" is gradually weakening and is centered at 12Z southwest of Iceland, around 37 W, 61 N. WCB activity and meridional moisture transport are still present just W of the British Isles, associated with a broad PV streamer extending southward until 40N. The ridge enhanced by the multiple WCBs of the cyclone extends in the North Atlantic up to 75N: the circulation associated with it promotes the downstream elongation of a narrow PV streamer over central Europe and its subsequent breaking. This latest system leads during the forecast period to heavy precipitations in a broad region between Germany, Poland and the Carpathians.

A new frontal wave is developing off the coast of Newfoundland around 55W, 40N in a region which is very rich in subtropical moisture. It exhibits a weak 1005 hPa surface low, has a low level PV signature and it is not directly linked to upper level PV structures: the peculiar structure of this storm identifies it as a so-called "Diabatic Rossby Wave" (DRW). The explosive and rapid evolution of this weather system and the transport of the moisture associated with it will be become objects of investigation in the incoming days.

Forecast Day 1 (Tuesday 4 Oct)

During the evening and the night on Tuesday the "frontal wave cyclone" undergoes explosive intensification: the ECMWF model predicts its central pressure to be already 975hPa at 12UTC and 965hPa in the evening. The storm develops also a strong PV tower at its center, with low level values of PV higher than 3pvu. This very rapid intensification coincides with a northward acceleration of the system, that rapidly approaches 60N during the day and starts to affect Iceland. The motion of the cyclone carries high values of subtropical moisture at its eastern flank and this very moist air mass, advected northward, is expected to produce heavy rain over Iceland between Wednesday and Thursday. The remainants of the "Saturday cyclone" merge with this new system during the day. A very rapid ridgebuilding, associated with a WCB, occurs downstream of the cyclone: the ridge reaches Iceland in the evening. The sudden ridgebuilding promotes also the erosion of the pre-existing PV streamer over the Atlantic, which evolves into a PV cut-off over the Bay of Biscay.

Forecast Day 2 (Wednesday 5 Oct)

The "frontal wave cyclone" deepens again slightly during the night to 960hPa, then gradually starts to weaken during the day. It is centered near the southern tip of Greenland, around 35W,60N and remains almost stationary. The cyclone is now embedded in a PV streamer over western Atlantic: it is bounded at the eastern flank by a meridionally aligned jet streak, which brings the very broad WCB

outflow directly above Iceland. Moisture transport at low levels continues under the jet from South to North and is associated to heavy rain and strong winds (>15m/s) over West Iceland. The ridgebuilding initiated in the previous day also is ongoing and brings temperate air masses up to 75N: this massive ridge originated from the diabatic outflow of the cyclone occupies now the whole North Atlantic, west of Iceland, and almost all scandinavian countries, and translates itself into a strong blocking anticyclone over Scandinavia (>1045hPa) that persists during the whole forecast period.

Forecast Day 3 (Thursday 6 Oct)

The situation depicted at Day 2 does not vary significantly on Thursday: the “frontal wave” cyclone remains stationary and keeps weakening near Greenland, the jet remains stationary just west of Iceland and keeps a straight S-N orientation, moisture transport continues along the same direction and brings again rain to the South of Iceland. WCB outflows are still present in the morning over the North Atlantic, but no further WCB activity associated to the cyclone develops.

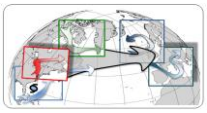
The cut-off originally located over the Bay of Biscay moves into the Mediterranean Sea during the morning and leads to cyclogenesis and heavy rain over Southern France and, during the day, Northern Italy. The interplay of this system with the cut-off over Central Europe brings precipitations over a broad area encompassing France, Italy, the Balkans and the Alpine region.

Forecast Outlook

The situation over Iceland and the North Atlantic remains similar during the following days, with the development of another weaker frontal wave cyclone between 40 and 50N that remains out of reach. Iceland is always located at the edge of the PV streamer and the flow over Europe is blocked and constrained by the big blocking anticyclone over Scandinavia. Persistence of the circulation pattern can lead to heavy precipitation events over various regions of Europe.

Scientific discussion

- The cyclone developing over the North Atlantic on Tuesday is associated with severe weather, strong diabatic outflow and moisture transport to Iceland. It moves rapidly northward to the southern coast of Greenland.
- The strong diabatic outflow promotes a ridgebuilding that merges with a pre-existing ridge over Scandinavia: this contributes to the creation of a very broad blocking anticyclone and has consequences for the weather over Europe.

	**NAWDEX 2016** **Weather summary**	**Date: 04 October 2016** **Author: A. Schaefler, B. Crezee, J.Riboldi**

Synoptic analysis

A frontal wave exhibiting Diabatic Rossby Wave (DRW) characteristics develops explosively off the coast of Newfoundland and moves very rapidly from 55W, 40N to 30W, 60N during the day of Tuesday 04 October. The system promotes a meridional export of subtropical moisture to Iceland and the North Atlantic, which occurs also in the form of a very broad WCB. Very rapid ridgebuilding, associated with divergent diabatic outflow, occurs downstream of the cyclone in the direction of Scandinavia, where a broad blocking anticyclone is established.

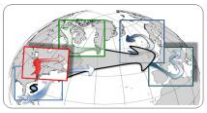
The flow pattern over Europe evolves during the next days to a typical “Rex blocking” configuration: a broad anticyclone over Scandinavia and the North Atlantic, supported by a very strong negative PV anomaly, and a low pressure system over central Europe, supported by two PV cut-off at upper levels over the Carpathians and the Pyrenees.

Forecast Day 1 (Wednesday 5 Oct)

At 00 UTC the frontal wave cyclone has reached its minimum MSLP at 960hPa and starts gradually to fill. It is located during this time to the East of Greenland, at 35W, 60N: the strong pressure gradient between this low and the 1045hPa anticyclone centred over Norway leads to gale winds over Keflavik, especially during the morning and the afternoon. Moisture transport is very strong and an associated WCB brings heavy precipitations to Keflavik. A pronounced jet streak, almost perfectly meridionally aligned on 25W, sits above Iceland with wind speeds > 60 m/s and drives the WCB outflow to cover almost totally the latitudinal band between 60 and 70N over the Atlantic.
Ridgebuilding by the frontal wave cyclone reaches by the end of the day very high latitudes, above 75N, and joins with the pre-existing ridge above Scandinavia to cover the whole North Atlantic region.

Forecast Day 2 (Thursday 6 Oct)
The “frontal wave cyclone” keeps weakening while it remains stationary near the East coast of Greenland. The cyclone is at this time embedded in a broad PV streamer over Greenland, that extends further south. Early on Wednesday a Tropopause Polar Vortex (TPV), originated from a broad PV filament stretching from the pole towards Canada, moves from Hudson bay towards the southern tip of Greenland, at the rear flank of the aforementioned streamer. The TPV, a minimum in 2 PVU at the cold side of the jet, is accompanied by a weak maximum of theta at 2 PVU on the warm side of the jet. Meridional moisture transport is still significant but weakens during the day, as well as WCB activity on the eastern flank of the PV streamer. Conditions in Keflavik remain still windy and rainy.

Forecast Day 3 (Friday 7 Oct)

	**NAWDEX 2016** **Weather summary**	**Date: 04 October 2016** **Author: A. Schaefler, B. Crezee, J.Riboldi**

The deterministic ECMWF forecast shows the “frontal wave” cyclone becoming a weak low with minimum central pressure > 1000 hPa at this time. The PV streamer, now with the embedded TPV cited above, is associated with a region of ascent and to a weak divergent outflow at 320K, although very few ascending trajectories meet the standard for the definition of a WCB (ascent of more than 600hPa in 48 hours). However, many members of the ECMWF Ensemble show the possibility of a stronger low and the prosecution of a stronger WCB activity at the eastern flank of the PV streamer. This situation may be relevant for potential future investigations with the NAWDEX aircrafts.

The interplay of the cut-off low over the Pyrenees, moving towards the Mediterranean, and the cut-off over Central Europe leads to heavy rain over a broad area encompassing France, Italy, the Balkans and the Alpine region. This merging is promoted by the Scandinavian blocking anticyclone, that induces a strong easterly flow over Central Europe and advects the cut-off low westward.

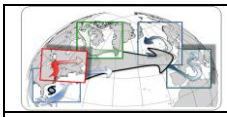
Forecast Outlook

The situation over Iceland and the North Atlantic remains similar during the following days, with the development of another frontal wave cyclone between 40 and 50N The flow over Europe is blocked and constrained by the big blocking anticyclone over Scandinavia. Persistence of the circulation pattern can lead to heavy precipitation events over various regions of Europe.

Hurricane Matthew, a cat. 4 tropical cyclone, impacts the Caribbeans on Tuesday and moves northward during the following days. The deterministic run sees it moving parallel to the East Coast and eventually interacting with an upper-level PV streamer east of Newfoundland on Sunday 10th October. This evolution would lead to very strong WCB activity and ridgebuilding in the direction of Iceland and to a sudden increase in forecast uncertainty, highlighted by the Ensembles. The system can potentially become object of study during the following week and remains monitored.

Scientific discussion

- The intensification of the “DRW-frontal wave” cyclone in the Atlantic is associated with strong latent heat release, significant divergent outflow and meridional moisture transport and is therefore interesting for the objectives of the campaign.
- Iceland remains under the influence of a PV streamer located at the west, that promotes continuous southerly flow rich in subtropical moisture. Forcing for ascent over the North Atlantic is present but relatively weak.
- The synoptic situation over Europe evolves towards a blocking pattern until the end of the forecast period. Significant uncertainty is anyway present due to the presence of a TPV and, on the long range, on the potential impact of the extratopical transition of hurricane Matthew. The situation remains also conductive to high impact weather over various regions of Europe.

	**NAWDEX 2016** **Weather summary**	**Date: 05 October 2016** **Author: B. Crezee, J.Riboldi**

Synoptic analysis

After having reached its maximum strength, the “frontal wave cyclone” developed on Thursday starts gradually to fill, but it is still able to bring winds above 25m/s and heavy rain to western Iceland. The region sits under a pronounced jet streak, that drives a very broad WCB outflow above Iceland. Ridgebuilding associated with this cyclone joins a pre-existing ridge above Scandinavia and generates a “Rex blocking” configuration, with a broad anticyclone over Scandinavia and the North Atlantic, that persists until the end of the forecast period.

A broad PV cut-off embedded in a strong antizonal flow drives the weather over Central Europe and the Mediterranean, and leads to lower-than-average temperatures and heavy rain.

Forecast Day 1 (Thursday 6 Oct)

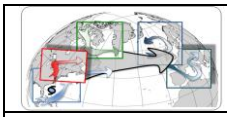
The “frontal wave cyclone” keeps weakening while it remains stationary near the southern tip of Greenland. The cyclone is at this time embedded in a broad PV streamer over Greenland, linked to the aforementioned jet streak, that brings a moist southerly flow over Iceland. After the gale of Wednesday, the wind remains weaker (<10 m/s) during the day in Keflavik. Moderate warm conveyor belt (WCB) activity brings precipitation to the south east coast of Iceland.

A tropopause polar vortex (TPV) moves from Hudson Bay towards Greenland and becomes embedded in the PV streamer to the west of Iceland. It is located at 12Z right under the southern tip of Greenland and at 18Z close to 40W, 55N. The system stands out in the weather charts as a small closed contour of high PV values (>8 pvu at 320K) and low moisture. The balanced wind component of this system enhances weak ridgebuilding along the waveguide and promotes the elongation of a small PV streamer in the direction of the Bay of Biscay.

Forecast Day 2 (Friday 7 Oct)

The large scale pattern does not show substantial variations during Friday: the flow over Iceland remains south-easterly and moist. The development of a surface low pressure centre, related to the action of the TPV, in the central Atlantic excites a weak WCB activity at the eastern flank of the PV streamer. This leads again to some precipitation and strong winds (15-20m/s) over Keflavik. Outflow of the WCB is directed towards Greenland and promotes a cyclonic wrap-up of the cited PV streamer.

The cut-off low over the Pyrenees, generated on Tuesday by the sudden ridgebuilding of the “frontal wave cyclone” moves to the Mediterranean and merges with the the cut-off over Central Europe. This merging is promoted by the Scandinavian blocking anticyclone, that induces a strong easterly flow over Central Europe and advects the cut-off low westward. Heavy rain is therefore forecasted over the Balkans and southern Italy, also associated with a WCB rising from the Mediterranean.

	**NAWDEX 2016** **Weather summary**	**Date: 05 October 2016** **Author: B. Crezee, J.Riboldi**

Forecast Day 3 (Saturday 8 Oct)

The synoptic pattern is blocked by a large anticyclone over Scandinavia, which is well structured at upper (broad region with PV < 0.2pvu) and lower (MSLP > 1040hPa) levels. Some PV filaments coming from the cut-off over Europe slowly re-circulate inside the ridge. The PV streamer moves eastward and reaches the west coast of Iceland, shifting also the jet core together with it. WCB activity is absent.

A new surface low, associated with significant diabatic outflow and WCB activity, forms at 40W, 40N. It is linked to the PV streamer now over Iceland by a small filament of high PV, that provides upper level forcing for deepening to 1000 hPa. The outflow of the system extends until 50N in the Central Atlantic. The system is however much weaker than the one shown by the ECMWF model in the run of yesterday, 04 October, at 00UTC.

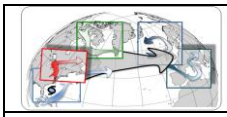
Forecast Outlook

As already said, the flow over Europe is blocked and constrained by the big blocking anticyclone over Scandinavia. The large scale flow pattern shows a perturbed area to the west of Iceland and remains conductive for moderate bursts of WCB activity over Iceland. The deterministic run predicts one of such bursts to occur on Monday.

Two tropical system are moving in the North Atlantic. On Friday TC Matthew moves very close to the East Coast of the United States and is forecasted to recurve back to the Ocean south of Cape Hatteras, after having hit Florida and the Carolinas as a strong Cat.3 hurricane. The newly developed Tropical Storm Nicole remains South of Bermuda. Both the systems are obviously associated with strong diabatic outflow. Ensemble forecast guidance for Europe from the ECMWF model suggests two possible scenarios, depending on the fact that Matthew is able to undergo ET in the North Atlantic or not (and therefore decaying at lower latitudes in the Central Atlantic).

Scientific discussion

- Iceland remains under the influence of a PV streamer located at the west, that promotes continuous southerly flow rich in subtropical moisture.
- A TPV drifts quickly between Thursday and Friday from Canada to Greenland and wraps up cyclonically in a PV streamer located to the west of Iceland. An associated surface low in the vicinity leads to a weak WCB on Friday, with ascent just to the west of Iceland.
- The synoptic situation over Europe evolves towards a blocking pattern. The potential impact of the extratropical transition of hurricane Matthew and of Tropical Storm Nicole makes forecast for next week uncertain.

	**NAWDEX 2016** **Weather summary**	**Date: 06 October 2016** **Author: B. Crezee, J.Riboldi**

Synoptic analysis

A broad upper-level trough approaches Iceland from the west. Embedded within this trough is a TPV, of which the structure has been observed today. The ridge downstream of the trough, lies over Scandinavia and is characterized by a strong high pressure area at the surface of over 1045 hPa. A cut-off sits over central Europe, bringing heavy rain and strong winds to the Baltic states and eastern Europe.

Forecast Day 1 (Friday 7 Oct)

The TPV gets absorbed into the broad trough and merges its coherent core into the PV streamer west of Iceland. The PV streamer tends to wrap up cyclonically during the day, together with some weak WCB activity. In front of the trough rather strong northward moisture transport occurs. The strong anticyclone to the west of Iceland leads to strong winds from SE winds over Keflavik, with gusts possibly exceeding 20 m/s.

Forecast Day 2 (Saturday 8 Oct)

The blocking anticyclone persists over Scandinavia. The upper-level trough with embedded ex-TPV is being stretched southward by the confluence between westerly flow and the easterly flow related to the Scandinavian anticyclone. To the south of the upper-level trough (at 320K) at around 40N there exists a weak surface low, in a warm and moist environment. This low interacts during the day with the cited PV streamer, deepens to 1005hPa and spawns a broad WCB in the direction of Europe.

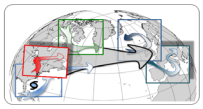
Forecast Outlook

On Sunday the upper-level trough is further stretched, and the southern part becomes a PV filament. Rather strong precipitation occurs surrounding the surface low at 40N extending further northwards along the PV filament. There is a high probability of WCB ascent in this region.

On Monday the outflow of this WCB activity is probably located to the west of Ireland. A larger outflow region is located further south, and is related to a WCB having its inflow close to the surface low. To the west of these systems a high pressure ridge is building, in the outflow of hurricane Matthew and tropical cyclone Nicole. A potential ET of Matthew has become less likely.

Scientific discussion

- The strong anticyclone over Scandinavia promotes a blocked situation over Europe, with fair weather over the North Europe and persisting bad weather and precipitations over the South and the East of Europe.
- A PV streamer to the west of Iceland maintains a strong southerly moist flow, embedded in a region with weak forcing for ascent. The stretching of this structure to the south, in regions where more moisture is present, leads to occasional WCB bursts over Europe and the North Atlantic.
- The evolution of the tropical systems over the North Atlantic is monitored.

	**NAWDEX 2016** **Weather summary**	**Date: 07 October 2016** **Author: B. Crezee, J.Riboldi, P. Ghinassi**

Synoptic analysis

A broad upper-level trough lies to the west of Iceland and brings strong winds to the Keflavik area. The ridge downstream of the trough, lies over Scandinavia and is characterized by a strong high pressure area at the surface of over 1045 hPa.

Forecast Day 1 (Saturday 8 Oct)

A broad PV streamer is found southwest of Iceland for all the day, moving to the east until reaching the western part of Iceland. Over Scandinavia the blocking conditions (associated with a broad area of low PV) persist, while a cut-off of high PV is located over central Europe. This blocking structure (Rex blocking) stays almost stationary during the whole day. At the surface an area of low pressure (associated with the PV streamer in the upper levels) is found to the south west of Iceland, with two extratropical cyclones in the North Atlantic, one located west to Iceland and another one more to the south. The latter presents a Warm Conveyor Belt with the inflow and ascent region located in the middle of the Atlantic Ocean (at around 40 N) with its outflow predicted to impinge on the anticyclonic structure over Scandinavia. The wind at the surface will still blow from the south (although it will be weaken than today, definitely below 20 m/s) continuing to transport moisture northward.

Forecast Day 2 (Sunday 9 Oct)

The synoptic pattern is similar to saturday. The PV streamer in the mid-Atlantic becomes more and more narrow during the day and wraps cyclonically around the low pressure system at 30W, 45N, which deepens to 995hPa. The large amount of moisture associated with this system promotes a WCB to the East of the streamer and the diabatic outflow acts to further erode the streamer, which becomes a cut-off at 320K by the end of the day. WCB trajectories associated with this system reach the Mediterranean. Iceland is still is reached by the outflow of the weak WCB that started on Saturday ahead of the PV streamer.

Forecast Outlook

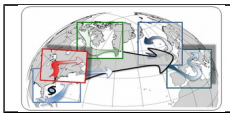
On monday the PV streamer has broken into two small cutoffs, the northern one associated with the surface cyclone. Two regions of WCB outflow can be identified, one in between Ireland and Iceland, and another region further to the south, reaching the Iberian peninsula.

On tuesday the low is predicted to slightly deepen. In the west of the basin, close to Newfoundland, an upper-level ridge overruns a strong low-level baroclinic zone, leading to explosive cyclogenesis in some model runs, though ensemble shows high uncertainty regarding this scenario. On the long term (wed-sat) predictability decreases rapidly, though most likely the Scandinavian blocking moves slowly

westwards to arrive south of Iceland. Diabatic activity (ascent regions) are probably located quite far to the west and/or south, though diabatic outflow might very well reach Iceland.

Scientific discussion

- The PV streamer and associated moisture transport and WCBs brings together many of the campaign aims on sunday/monday.

	**NAWDEX 2016** **Weather summary**	**Date: 09/10/2016** **Author: J. Quinting**

Synoptic Analysis

The tropical cyclones “Matthew” and “Nicole”, a high pressure system over the western North Atlantic, a potential vorticity (PV) streamer over the central North Atlantic, and a blocking high pressure system over Scandinavia determine the large-scale flow in the NAWDEX region. The PV streamer over the central North Atlantic is associated with a cyclogenesis event. On 09 October 12 UTC, the forming low pressure centre at 45N/30W exhibits an intensity of less than 995 hPa. Low-level moisture transport on the eastern flank of this low pressure system is co-located with a warm conveyor belt (WCB) inflow region. The WCB trajectories that ascend about 12-24 hours later have their outflow in two different regions. The WCBs that have their inflow close to the low pressure centre ascend rapidly and turn anticyclonically toward the Mediterranean. The WCB trajectories that have their inflow further east, ascend northward and are predicted to reach Iceland on 11 October. Both WCBs contribute to ridge formation in downstream regions. The northward ascending WCB potentially supports the maintenance of the blocking high pressure system over Scandinavia.

Forecast Day 1 (Monday, 10/10/2016)

ECMWF forecast suggest a strong interaction between the remnants of TC Matthew and an upstream PV streamer on Monday 10 October. Remarkably strong moisture transport on the eastern flank of Matthew feeds WCB ascent over the western North Atlantic. The WCB outflow results in negative PV advection by the irrotational wind on the eastern flank of the upstream PV streamer. This negative PV advection indicates ridge amplification as well as a deceleration of the eastward propagation of the upstream PV streamer.

The PV streamer over the central North Atlantic is expected to break apart into two cut-off systems. The northerly cut-off system is vertically aligned with the low pressure system that formed during the previous day. On 10 October 12 UTC, the upper-level cut-off and its associated low pressure system are located at 45N/25W. A WCB on the eastern flank of these two systems contributes to downstream ridge amplification. This ridge will likely reach Iceland on Tuesday, 04 October.

Forecast Day 2 (Tuesday, 11/10/2016)

The interaction between a PV streamer and the remnants of TC Matthew will likely continue on Tuesday 11 October. Low-level moisture transport is still feeding strong ascent over the western North Atlantic. The resulting upper-level divergent outflow continues to impinge on the midlatitude wave guide. A stratospheric positive PV anomaly counteracts this divergent outflow so that a downstream ridge amplification does not occur. On the southern flank of the positive PV anomaly, a closed isobar in mean sea level pressure indicates the formation of a new low pressure system – the “downstream cyclone”.

The stratospheric cut-off that formed during the previous day over the central North Atlantic will likely rejoin the stratospheric PV reservoir. In its centre, the upper-level PV values exceed 10 PVU at the 325 K isentropic surface. WCB ascent on its eastern flank results in upper-level divergent winds that impinge on the wave guide.

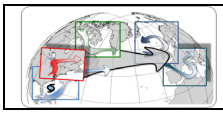
Forecast Outlook

Forecasts for forecast day 3 and beyond are highly uncertain. Ensemble forecast suggest that this uncertainty is due to the interaction between the remnants of TC Matthew and an upstream PV streamer. This uncertainty is reflected by a bifurcation in the track forecast for Matthew. The uncertainty intensifies and propagates into downstream regions. On Wednesday, various forecast scenarios exist for the central North Atlantic. Some forecasts show a ridge building south of Greenland whereas others show a trough in the same region. This phase shift of 180° in the Rossby wave pattern makes forecasts for further flights in the Icelandic region

extremely difficult.

Scientific Discussion

The structure of the cut-off system over the central to eastern North Atlantic is target of a HALO flight on 10 October. A further promising situation is predicted to evolve on Wednesday. However, due to forecast uncertainties a decision on further flight plans is postponed to the next day.

	**NAWDEX 2016** **Weather summary**	**Date: 10 October 2016** **Author: M. Röthlisberger**

Synoptic Analysis of Monday, 10 October

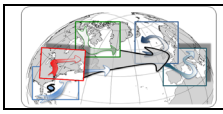
Ex tropical cyclone Matthew, a PV streamer approaching Matthew from the west, a cyclone developing downstream of Matthew ("downstream cyclone"), a strengthening ridge over the central North Pacific, a blocking anticyclone over the Scandinavia and the remnants of the former Sunday PV streamer (including cut-off "Sanchez") are the key flow features on 10 Oct 2016. Ex TC Matthew interacts with the approaching PV streamer to form the downstream cyclone. The intensification of the downstream cyclone feeds on the remnant moisture of TC Matthew and is associated with very strong upper-level divergence and negative PV advection by the irrotational wind, particularly at 340K, and a strong WCB occurring on the eastern side of the deepening downstream cyclone. At 21 UTC, the approximate central pressure of the downstream cyclone is 996hPa. It is further noteworthy that the exact evolution of this ex TC - streamer interaction has changed substantially from the BT09/12Z forecast to the BT10/00Z forecast, which affects the further flow evolution over the central and northern North Atlantic. The cut-off "Sanchez" has broken off from the former Sunday streamer. WCB activity to the northeast of Sanchez initiates ridge building over the eastern North Atlantic, downstream of the most northerly remnant of the former Sunday PV streamer.

Forecast Day 1 (Tuesday, 11 Oct)

On Tuesday, 11 October, the downstream cyclone moves eastward, towards the central North Atlantic, while its minimum central pressure remains roughly constant. While moving eastward, warm and moist air is advected on the southeastern flank of the downstream cyclone and at upper-levels ridge amplification continues. Cut-off Sanchez re-intensifies to reach more than 10PVU on 325K in its center, and moves towards the Iberian Peninsula. The most northerly cyclone remaining from the Sunday PV Streamer starts to decay, however, ridge building over the eastern North Atlantic continues.
For Tuesday, a combined FAAM, Safire Falcon and HALO flight is planned and should allow for a radiometer intercomparison on these three aircrafts. However, due to uncertain cloud forecasts as well as a possible HALO flight on Wednesday it is still uncertain whether or not the intercomparison flights will take place. The decision will be made tomorrow (11 October) before 10UTC.
Compared to previous ECMWF forecast runs (i.e., BT09/00Z and BT09/12Z) the ECMWF ensemble prediction systems now converges towards a Tuesday (11 October) solution with strong ridge building over the western North Atlantic.

Forecast Day 2 (Wednesday, 12 October)

Wednesday 12 October sees a second pulse of ridge building associated with the downstream cyclone, this time just southwest of Iceland. This ridge building is associated with WCB ascent between Iceland and Greenland and substantial negative PV advection by the irrotational wind, however, this time the advection is stronger on 310-315K. The downstream cyclone is now associated with a pronounced trough over the western Atlantic. At 12 Oct, 18UTC this trough starts to wrap up cyclonically (LC2-type wave breaking), however, the degree to which this wrap up occurs is uncertain as the different ECMWF ensemble members differ with regard to this wrap up. The ECMWF ensemble prediction system indicates that the uncertainty in this LC2-type wave breaking results from uncertainties regarding the strength of the downstream cyclone during Wednesday. Cut-off Sanchez is now located over the Iberian Peninsula.

	**NAWDEX 2016** **Weather summary**	**Date: 10 October 2016** **Author: M. Röthlisberger**

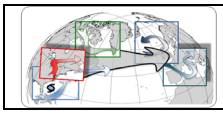
Forecast Outlook

The uncertainty associated with the cyclonic wrap up (LC2-type wave breaking) grows and propagates towards the north on Thursday, 13 October. This leads to very different model realizations of the upper-level flow over the North Atlantic, in the region of Iceland. However, many ensemble members produce a re-intensification of the blocking anticyclone over Scandinavia. Meanwhile, cut-off Sanchez re-attaches to the stratospheric body of high-PV air on 325K over Spain and triggers intense precipitation over Southern France.

Forecasts are uncertain in the North Atlantic region from Thursday onwards. However, different model runs as well as most ECMWF ensemble members agree on the position of the former cut-off Sanchez over the Mediterranean coast of Spain. Therefore, EFI forecasts of precipitation in Southern France and on the Alpine south side remain high. Moreover, the blocking anticyclone over Scandinavia is likely to persist at least into the weekend.

Scientific discussion

Key aspects of todays scientific discussions include the radiometer intercomparison flights of FAAM, Safire and Halo as well as plans for Wednesday flights for all aircrafts. It has been highlighted by the forecasting team that Wednesday is a great opportunity to address key NAWDEX objectives such as diabatic processes occurring in WCB ascent, blocking re-intensification due to WCBs as well as FC uncertainties related to diabatic processes. The major concern is that the cloud forecast for the radiometer intercomparison is not ideal on Tuesday. Moreover, a HALO flight on Tuesday makes a long HALO-flight on Wednesday impossible. On the other hand, Tuesday currently seems to be the most promising day for the radiometer intercomparison. This is because on Wednesday the cloud cover will likely be far from ideal and on Thursday, the forecast are still too uncertain to plan the intercomparison.

	**NAWDEX 2016** **Weather summary**	**Date: 11 October 2016** **Author: M. Röthlisberger**

Synoptic Analysis of Tuesday, 11 October

The downstream cyclone of ex TC Matthew ("downstream cyclone"), a strengthening ridge over the central North Pacific, the blocking anticyclone Peter over the Scandinavia and cut-off "Brigitte", formerly known as "Sanchez", are the key flow features on 11 Oct 2016. The downstream cyclone is associated with a first WCB, which enhances ridge building over the western North Pacific. Also, the downstream cyclone advects moist and warm air on its south-eastern flank towards the central North Atlantic, where the inflow region of a second warm conveyor belt associated with the downstream cyclone is located. The minimum central pressure of the downstream cyclone on 11 Oct at 06UTC is 995hPa and the system slightly weakens during the day. Cut-off Brigitte moves towards the Iberian Peninsula.

The FAAM/SAFIRE/HALO radiometer intercomparison has been cancelled due to lack of clouds as well as logistic problems.

Forecast Day 1 (Wednesday, 12 Oct)

On Wednesday a ridge-trough couplet forms over eastern North America and the western North Atlantic, with the trough being located upstream of the downstream cyclone. The downstream cyclone is now approaching Iceland, ahead of that deepening trough over the western North Atlantic. This movement is accompanied by a second WCB with its ascent between Greenland an Iceland and its outflow north of Iceland. The BT11/00Z forecast agrees with the BT10/00Z forecast in terms of the large-scale flow pattern over the North Atlantic, however, the two runs differ quite strongly with regard to the strength of the downstream cyclone. The BT11/00Z forecast predicts a weaker cyclone, with a weaker WCB and less cyclonic wrap up of the upper-level trough (LC2-type wave breaking). The weaker WCB leads to a weaker PV gradient to the west of Iceland compared to the BT10/00Z forecast. For Wednesday, flights for all aircraft are planned, which aim at sampling the WCB ascent and outflow to the west of Iceland. Cut-off Brigitte reaches the Iberian Peninsula during the day.

Forecast Day 2 (Thursday, 13 October)

On Thursday, 13 October, ridge building due to the WCB west of Iceland continues and the northern edge of the ridge is approaching Spitsbergen. There is a considerable change from the BT10/00Z to the BT11/00Z forecast regarding the position and strength of the downstream cyclone on Thursday 13 Oct. The BT11/00Z produces a much weaker downstream cyclone, which is, located closer to Iceland than in the BT10/00Z run. Therefore, even though the cyclone is weaker in the later run, the SLP gradients in the Icelandic region remain similar between the two runs and winds above 12m/s are expected on Thursday in KEF. Thus, the possibility of no flights on Thursday due to too high winds remains. Cut-off Brigitte is now located over the Spanish Mediterranean cost and is associated with high precipitation in Southern France and the Alpine south side. Also, along the trailing cold front of the downstream cyclone, two frontal waves develop. The more southerly of the two intensifies and forms a cut-off over the eastern North Atlantic (termed 'new cyclone' in the slides). Moreover, over the western North Atlantic the large-scale but weak (in terms of PV) ridge builds up further.

Thursday plans for HALO aim to sample the ridge north of Iceland in a triangular shape between

Keflavik, central Greenland and Andoya (Norway). A first plan for a SAFIRE flight between Iceland and Greenland on Thursday has been proposed.

Forecast Outlook

On Friday the ridge north of Iceland develops into a tropospheric cut-off and moves towards Scandinavia. The "new cyclone" deepens and is likely to become an important flow feature during the weekend. Generally, the meridional PV and temperature gradients over the North Atlantic region are very week and make precise and reliable forecasting difficult.

Scientific discussion

Key aspects of today's scientific discussions include Wednesday’s flights of all aircraft as well as plans for Thursday HALO and SAFIRE flights. The flow situation on Wednesday and Thursday allows addressing key aims of NAWDEX regarding the PV evolution in a forming ridge, WCB ascent and outflow as well as predictability aspects of diabatic processes in WCBs. Also, the possibility of a radiometer intercomparison of FAAM/HALO/SAFIRE has been discussed for Friday.

NAWDEX – Weather summary
Wed 12th October
Author: Paolo Ghinassi

Synoptic Analysis – Wed 12 Oct

In the upper levels a trough is located over Greenland extending to the south, while a ridge (associated with a broad area of low Potential Vorticity) is still present over Scandinavia from the previous days. Over the rest of Europe and the Mediterranean persists a cyclonic circulation pattern due to an upper level trough over central/eastern Europe and a cut-off located in the Atlantic ocean just west to France (named “Brigitte”). The cyclone at the surface associated with the trough over Greenland (named “Downstream cyclone”) is approaching Iceland during the day (passing to the west, between Iceland and Greenland, with Iceland just in the middle of the warm conveyor belt) and it turned out to be stronger than how was predicted in yesterday's forecast, causing winds above the threshold for flying.

Forecast Day 1 – Thu 13 Oct

In the upper levels there are no substantial changes in the large scale pattern. At the surface, the Downstream cyclone is predicted to move further to the north, with the associated cold front reaching the western coast of Iceland. After the transit of such front (expected in the morning) the wind is predicted to decrease consistently. However, despite the short range, there is still uncertainty on the wind speed, due to the difficulties in predicting the exact position of the front. The WCB outflow of the Downstream cyclone is contributing to the diabatic production of low potential vorticity, with a new ridge building (named Thor/Peter in today's presentation) north of Iceland. This results in the broadening of the low PV area in the upper troposphere above the North Atlantic. Over the Mediterranean the cyclonic circulation is predicted to intensify, with the possibilitiy of extreme precipitations over southern France.

Forecast Day 2 – Fri 14 Oct

In the upper level the ridge Thor/Peter is predicted to move further to the North, evolving in a cut-off. The upper level trough formerly over Greenland (PV streamer) is moving towards the middle of the Atlantic, with an associated frontal wave at the surface. This structure is predicted to trigger a new cyclogenesis west of Ireland (named “Frontal cyclone”). By the end of the day this PV streamer will move towards the high PV area located over Europe. Over the western Mediteranean the cyclone is moving slowly to the east, with severe precipitations reaching northern Italy.

Forecast Outlook - Sat 15/Dom 16

On Saturday the PV streamer formerly over Greenland is predicted to wrap around and merge with the high PV located over Europe in a single cut-off. The low PV cut-off (Ex ridge Thor/Peter) persists to the north of Iceland.
It is worth to mention that this dipole structure (low PV to the North, high PV to the south) above the North Atlantic has a very weak PV gradient (particularly evident on the 330K isentrope) and therefore there is some uncertainty about

its precise structure and location. This area of very weak PV gradient will persist also on Sunday.
At the surface, during these days, the “Frontal cyclone” is predicted to stay quite stationary west of the British Isles. By Sunday the hurricane Nicole is predicted to interact with a very narrow PV filament located in the North Atlantic south of Greenland and east of Canada. Although not predicted from today's deterministic forecast, its extratropical transition might be a possible evolution.

Key aspects of today's scientific discussions:
Thursday HALO fight's aim will be to analyse the PV evolution in a forming ridge, WCB ascent and outflow as well as predictability aspects of diabatic processes in WCBs. FALCON instead will focus more on wind speed measurements in the jet streak. For Friday it is planned a radiometer intercomparison during a leg of coordinated flight of the UK FAAM/HALO/SAFIRE aircrafts.

NAWDEX 2016
Weather summary

Date: 14/10/2016
Author: Paolo Ghinassi

Synoptic Analysis – (Thursday, 13/10/2016)

The upper level large scale pattern is characterized by a ridge over Scandinavia (named Thor/Peter) flanked by two troughs, one above Greenland and one over western Europe (ex cut-off Brigitte). At the surface, the Downstream cyclone is passing offshore of the western coast of Iceland, which will be for all the day on the edge of the cold front associated with such cyclone. The WCB outflow of the Downstream cyclone is contributing to the intensification of the ridge Thor/Peter, that will also expand to the west. Over the Mediterranean the cyclone Brigitte is bringing high amounts of precipitations over southern France.

Forecast Day 1 – (Friday, 14/10/2016)

In the upper levels the ridge Thor/Peter is predicted to move further to the North, evolving in a cut-off. The PV streamer formerly over Greenland is predicted to move towards the middle of the Atlantic, wrapping around and merging with the high PV over Europe in a single cut-off. The associated frontal wave in the lower levels will create a baroclinic region in the middle of the Atlantic that will lead to a new cyclogenesis west of Ireland (named “Frontal cyclone”). Over the western Mediteranean the cyclone Brigitte is moving slowly to the east, with severe precipitations reaching northern Italy, enhanced by the alpine and appenninic orography.

Forecast Day 2 – (Saturday, 15/10/2016)

The upper level pattern in the dowstream region of the North Atlantic will maintain similar, with the low PV cut-off Thor/Peter stationary over Scandinavia and an high PV cut-off west of the British Isles. In the upstream region there is a ridge which is building over Greenland and a trough behind it, over northeastern Canada. This trough also shows a blob of very low temperature at the tropopause (Tropopause Polar Vortex), which is propagating following the trough towards Greenland. Despite the PV gradient remains quite weak in the upper levels (330 K) above the North Atlantic the predictability of the large scale flow has increased compared to the previous days, as the ensembles of 2PVU on isentropic surfaces show.

Forecast Outlook – (Sunday, 16/10/2016)

Over the downstream region no significant changes on the large scale flow are predicted. In the upstream region the ridge over Greenland will continue to build up and will move to the east, with the trough (associated with a PV streamer) formerly over Canada just behind it. The latter will develop a cyclogenesys in the lower levels, on the leeward side of Greenland. The tropical cyclone Nicole is also predicted to interact with the tail of this PV streamer, with the latest forecast showing its extratropical transition later on during next

week.

Key aspects of today's scientific discussion:

Tomorrow's flights aim will be related to a radiometer intercomparison with a coordinated flight of the UK FAAM, HALO and SAFIRE. Unfortunately the FALCON flights which were related to measiring wind in jet streak regions are cancelled due to a technical problem. Saturday HALO's flight objective will be to analyse the TPV predicted between Canada and Greenland.