Characterizing the role of diabatic processes for the modification of mid-latitude Rossby waves and Jetstream winds

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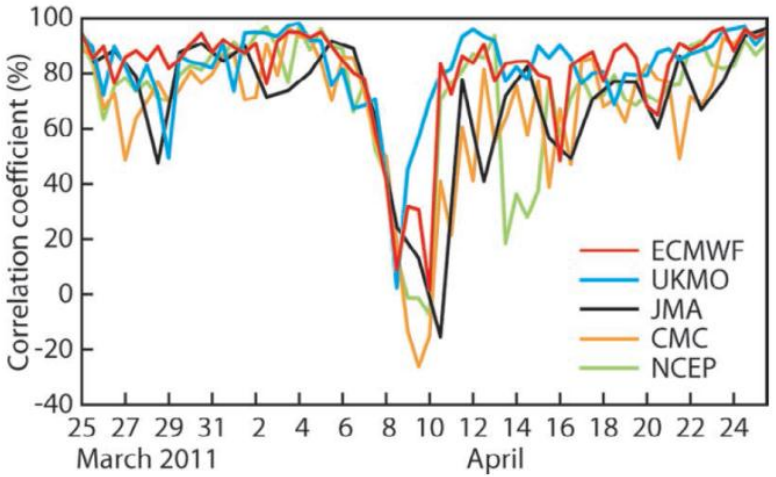
Outline

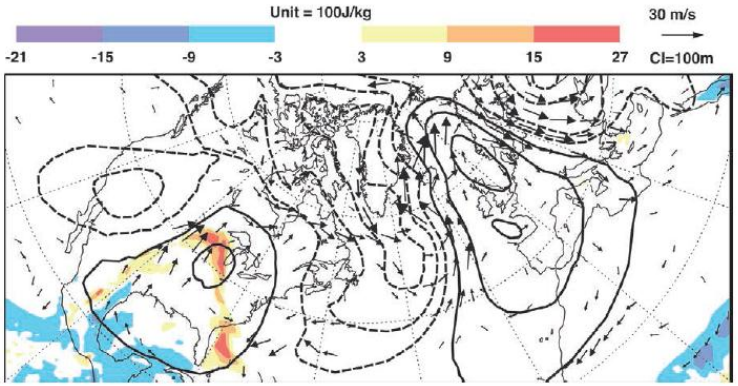
1. Why are we interested in the investigation of the **role of diabatic processes** for the weather evolution in the mid-latitudes?
2. Why are **Aeolus wind observations** interesting in this context?
3. The **North Atlantic Waveguide and Downstream Impact Experiment** – an airborne field experiment and its relation to Aeolus CAL/VAL activities

The role of diabatic processes

Day 6 FC Skill over Europe



Z500 analysis anomalies, CAPE, Wind Vectors



Rodwell et al. 2013 (BAMS)

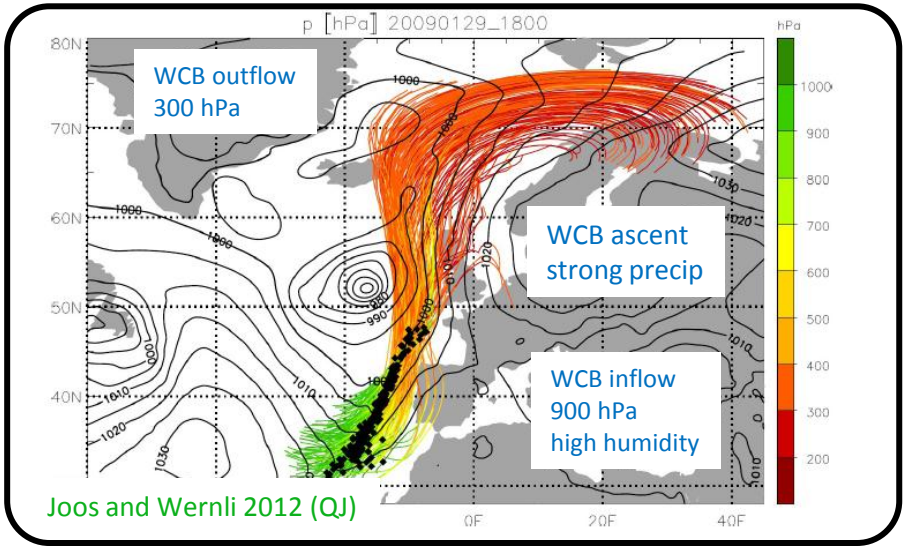
Although forecast skill improved significantly a number of forecast busts remain

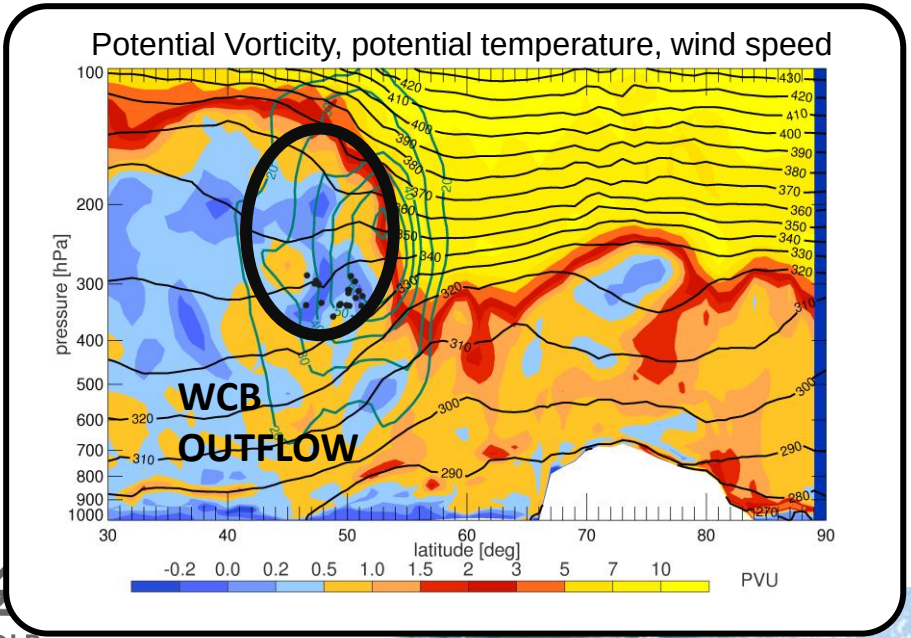
Hypothesis:

forecast errors are related to diabatic processes

Diabatic processes are associated with release of latent heat due to phase transitions of water, surface fluxes, or radiative effects

The role of diabatic processes



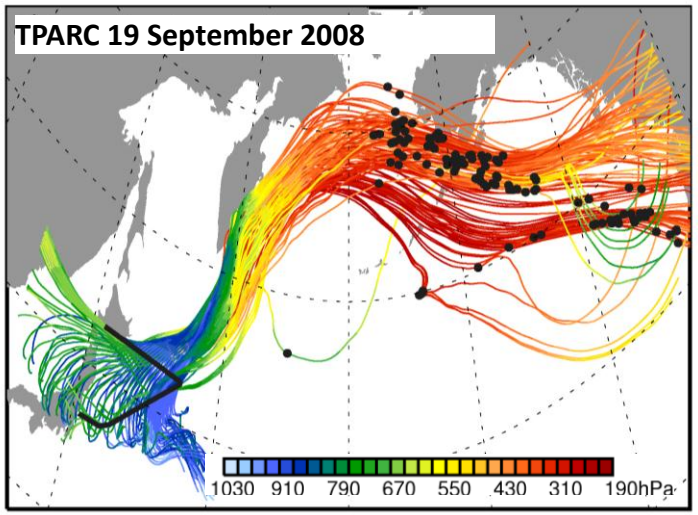


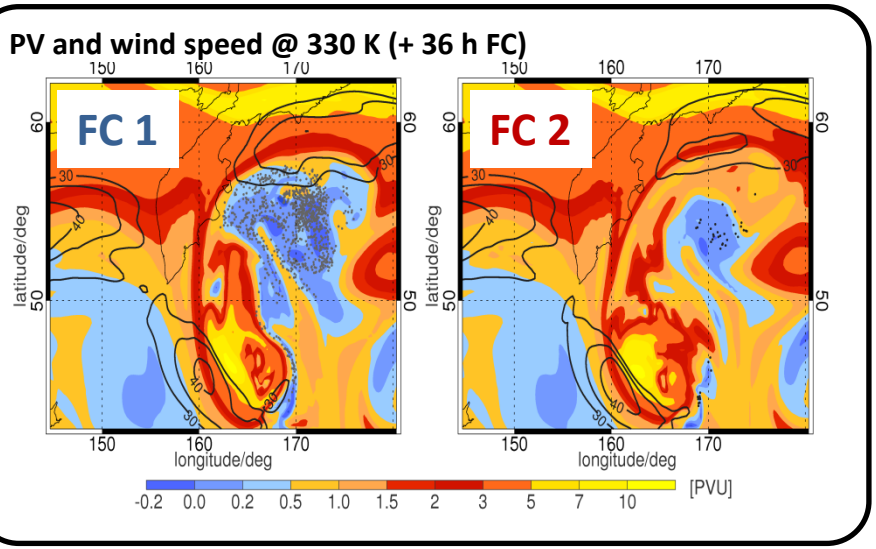
Strong diabatic processes in extratropical cyclones controlled by Warm Conveyor Belts (WCB)

- Latent heating influences the life cycle of cyclones
- WCB outflow (neg. PV anomaly) influences the downstream Rossby wave development by intensifying the upper-level ridge

Insufficiencies in the representation of WCBs (microphysical processes, inflow humidity) are expected to lead to forecast errors

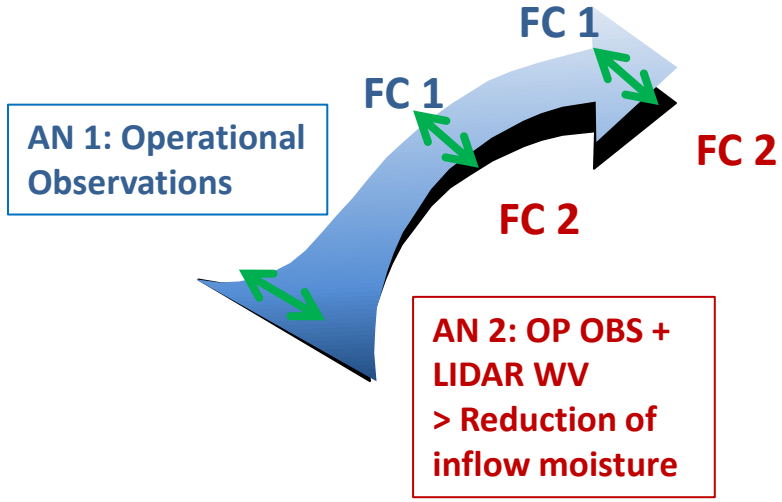
The role of diabatic processes – WCB inflow moisture





(Schäfler and Harnisch 2014, QJ)

Sensitivity of forecast accuracy to the moisture content in the inflow region of a WCB

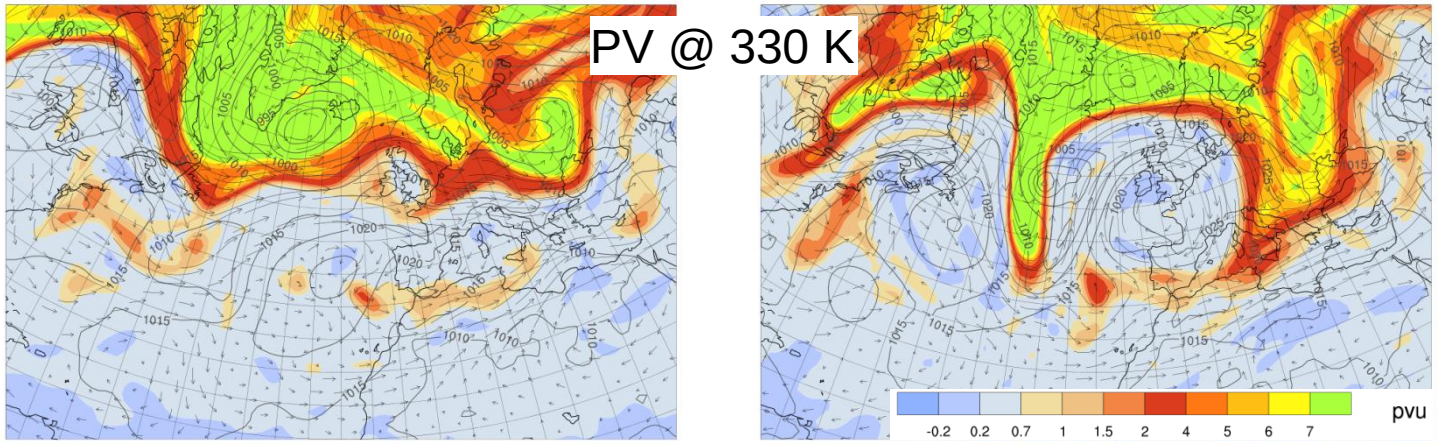


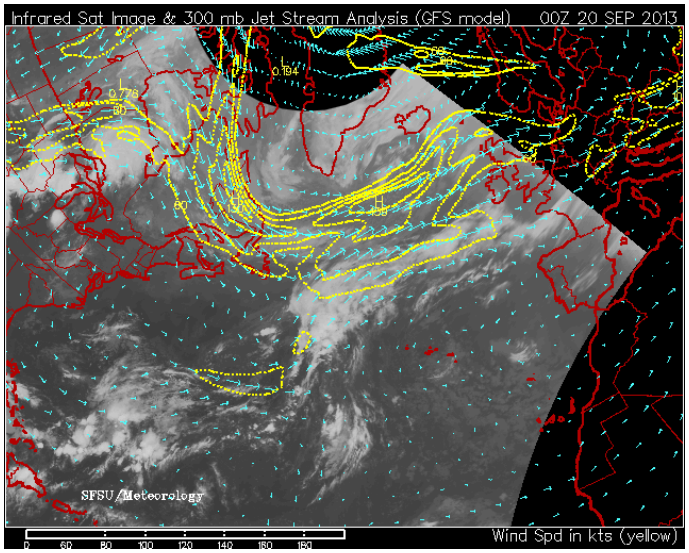
lower outflow height & reduced tropopause height caused a change in the jet-stream wind speeds

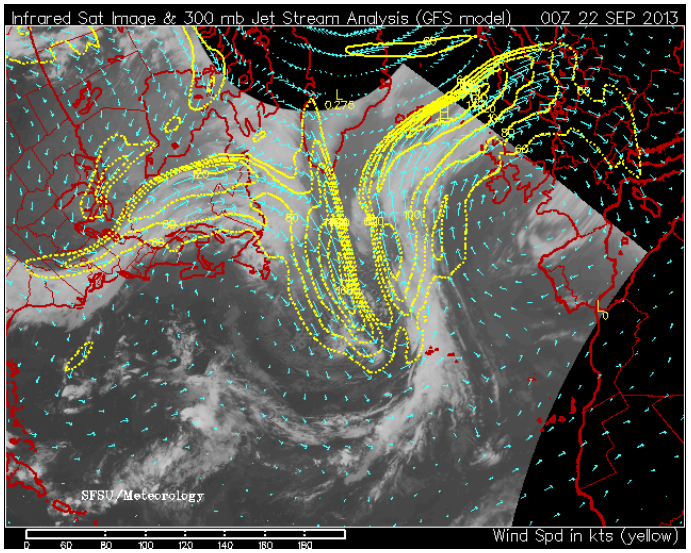
The role of diabatic processes – downstream impact

20130920 00 UTC

20130922 00 UTC







by Julian Quinting (ETH)

Why are wind observations interesting in this context?

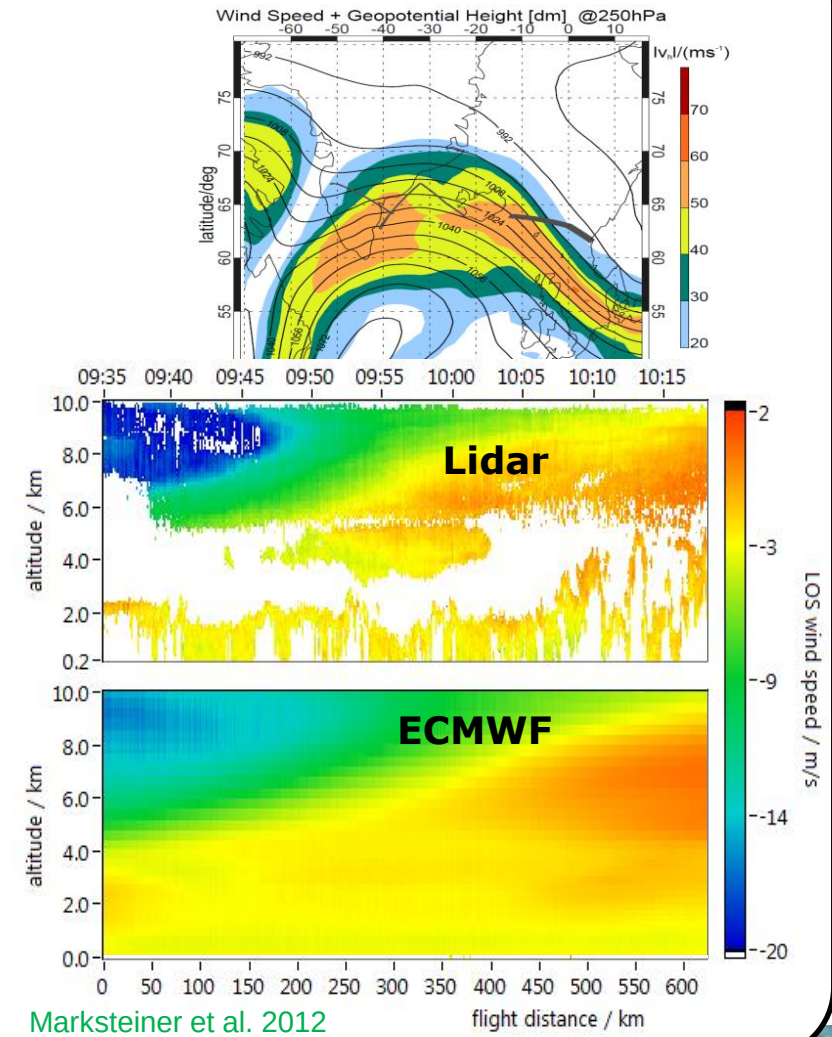
Overarching hypothesis:
There are systematic errors in model representation of waveguide perturbations that are attributable to diabatic processes

Errors are manifested as errors in PV distribution **(errors in the jet stream)**

→ forecast errors of high-impact weather downstream

→ need for wind observations in regions where diabatically modified airmasses interact with the Jetstream

Aircraft observations of jet-level winds



Marksteiner et al. 2012

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North Atlantic Waveguide and Downstream Impact Experiment

NAWDEX originally proposed by the THORPEX working group Predictability and Dynamical Processes (PDP)

→ HALO-THORPEX (2005): use HALO for a demonstration mission to investigate THORPEX relevant topics in atmospheric dynamics

2012: new initiative for an international NAWDEX program in

→ multi-aircraft international field experiment (US, Canada, UK, France, Switzerland and Germany)

→ under the auspices of the World Meteorological Organization (WMO) program High Impact Weather (HIW)

→ German/Swiss Campaign led by LMU Munich, DLR and ETH Zurich

→ first HALO campaign focusing on mid-latitude dynamics

→ initial plan: use DLR Falcon with Aeolus airborne demonstrator (A2D) for Aeolus validation flights

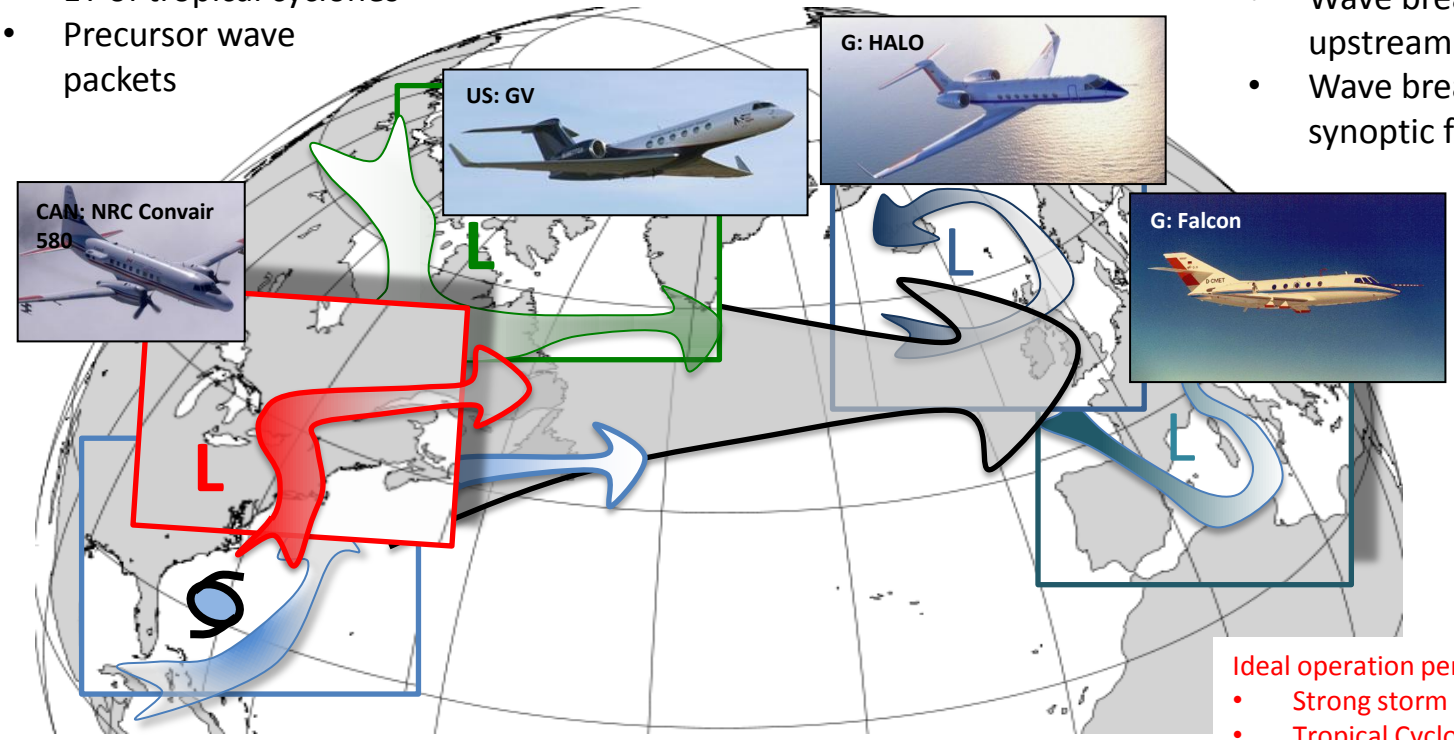
North Atlantic Waveguide and Downstream Impact Experiment

Factors modifying wave-guide disturbances

- Tropopause polar vortices (pos. PV anomalies)
- WCB outflow (neg. PV anomalies)
- ET of tropical cyclones
- Precursor wave packets

Downstream impact of diabatically modified PV anomalies

- Wave breaking sensitivity to upstream disturbances
- Wave breaking influence on synoptic features



Ideal operation period in **Sep/Oct 2016:**

- Strong storm activity
- Tropical Cyclones
- Polar Vortices
- Forecast Busts

Evolution of Rossby waves along the waveguide

- Waveguide representation
- Downstream evolution of PV anomalies
- *Local* modification of Rossby waves by pos. and neg. PV anomalies

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North Atlantic Waveguide and Downstream Impact Experiment

LMU Munich – DLR – ETH Zurich Plans

Focus on:

- Remote sensing measurements
- over the central and eastern North Atlantic
- operate from Ireland or Iceland

Primary aims:

- thermodynamic properties in outflow of WCBs and at jet level
- humidity structure of lower troposphere
- diabatic influence on upper level flow
- follow evolution of Rossby waves along the wave guide
- combined lidar/radar observations
- preparation of Aeolus mission

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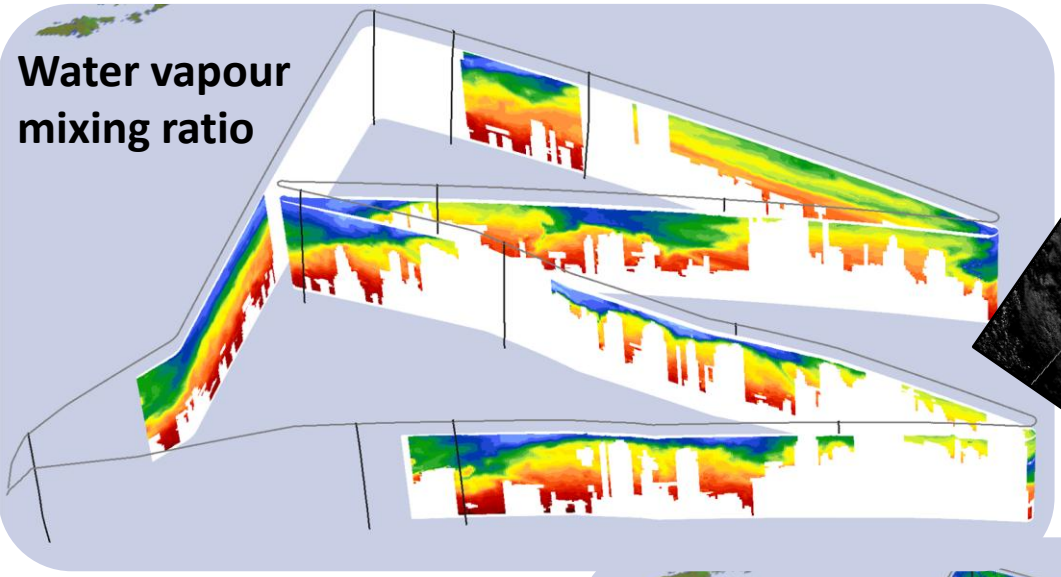
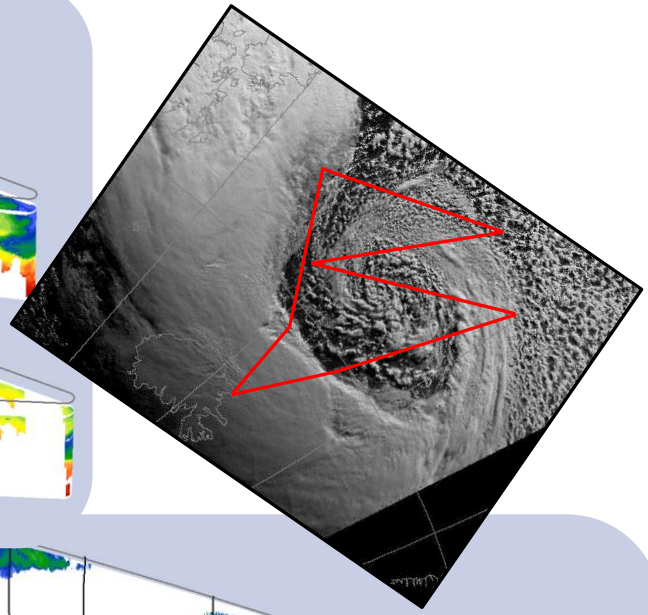
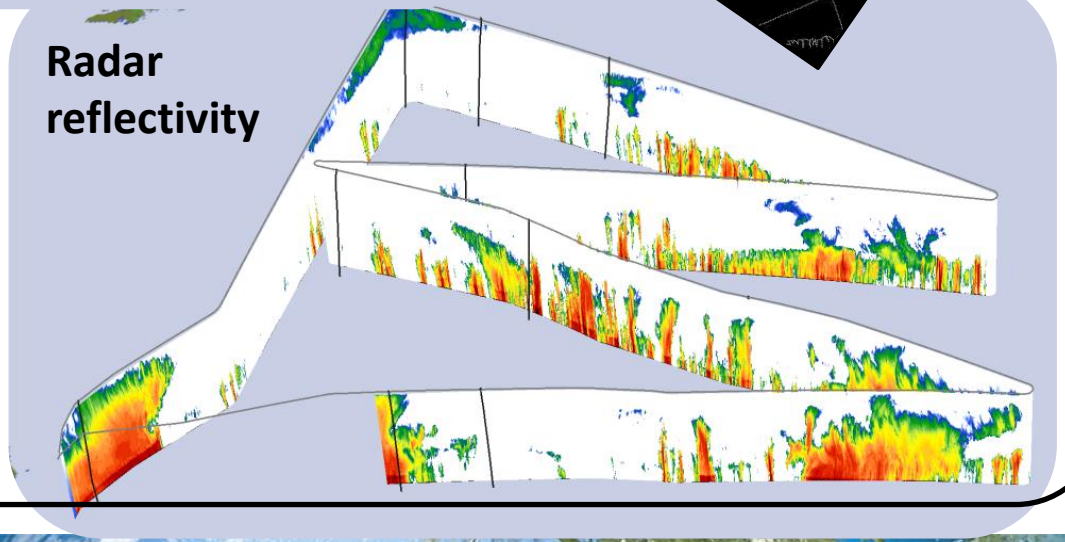
North Atlantic Waveguide and Downstream Impact Experiment







Example for HALO OBS
NARVAL IOP 2
12 January 2014

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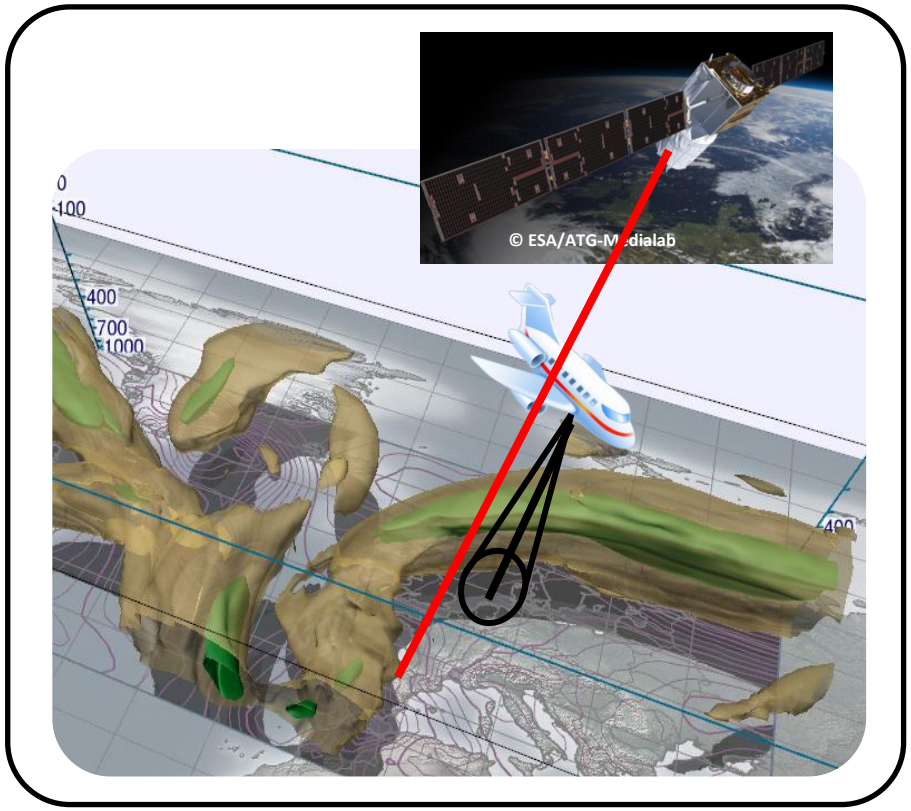
Wind observations related to Aeolus cal/val activities



NAWDEX 2016:

- wind observations in diabatically modified airmasses near the jet-stream
- A2D/2µm wind lidar for Aeolus preparatory studies related to validation, algorithms and dynamics

Future:

Aeolus/A2D observations of interest for the investigation of physical processes that impact upper level flow and the predictability in the extratropics

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