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WALES Quicklook Overview and Comparison of H_2O Measurements with IFS and DS

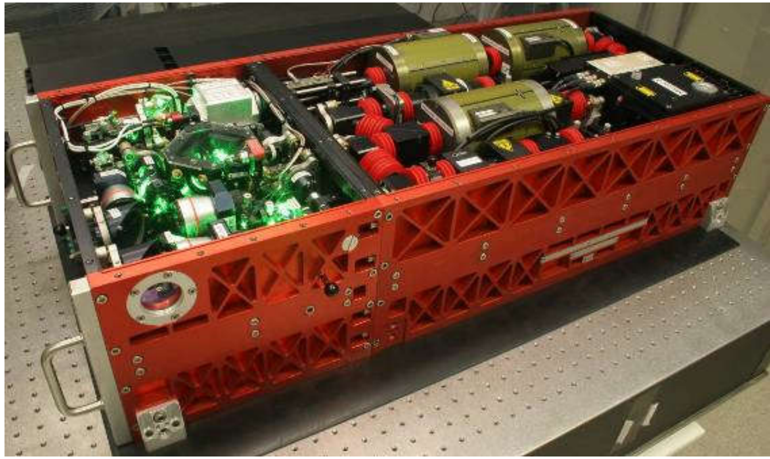
Martin Wirth, Silke Groß, Georgios Dekoutsidis, Manuel Gutleben
German Aerospace Center (DLR), Institute of Atmospheric Physics, Wessling, Germany

Contents

DLR WALES Products

Aerosol/Clouds

- Backscatter coefficient at 532 nm and 1064 nm
  - Color ratio (532 nm / 1064 nm) of backscatter
- Particle depolarization at 532 nm
- Assumption free extinction correction at 532 nm (J_2-HSRL)
- Geometrical mapping with a spatial resolution of:
  15 m vertical / 200 m horizontal (7.5 m / 40 m raw data)
- Cloud geometry (top height/length statistics)
- Aerosol/Cloud classification
- Lidar/Radar synergistic products (see talk of F. Ewald)



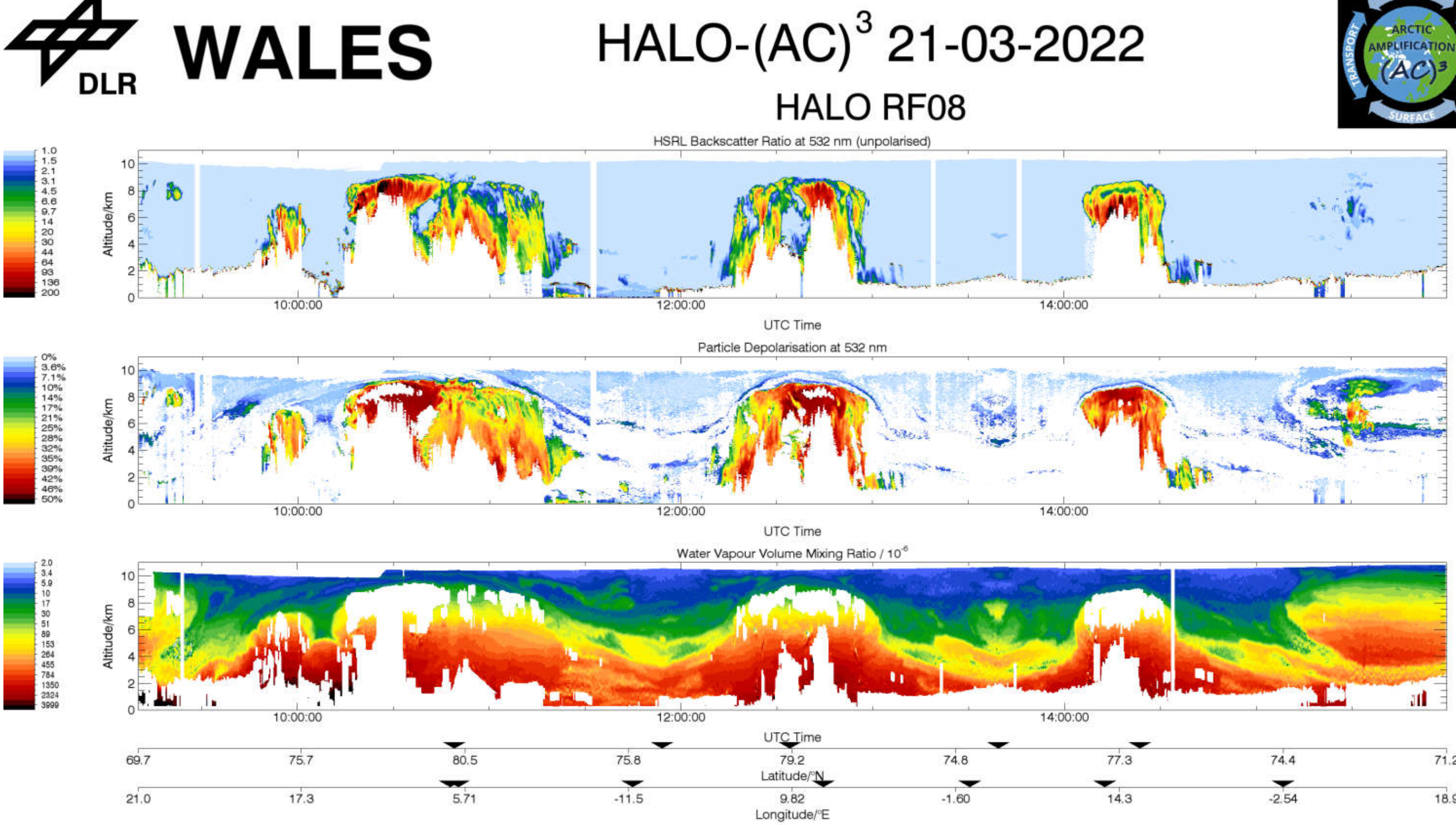
DLR WALES Products

Water Vapor

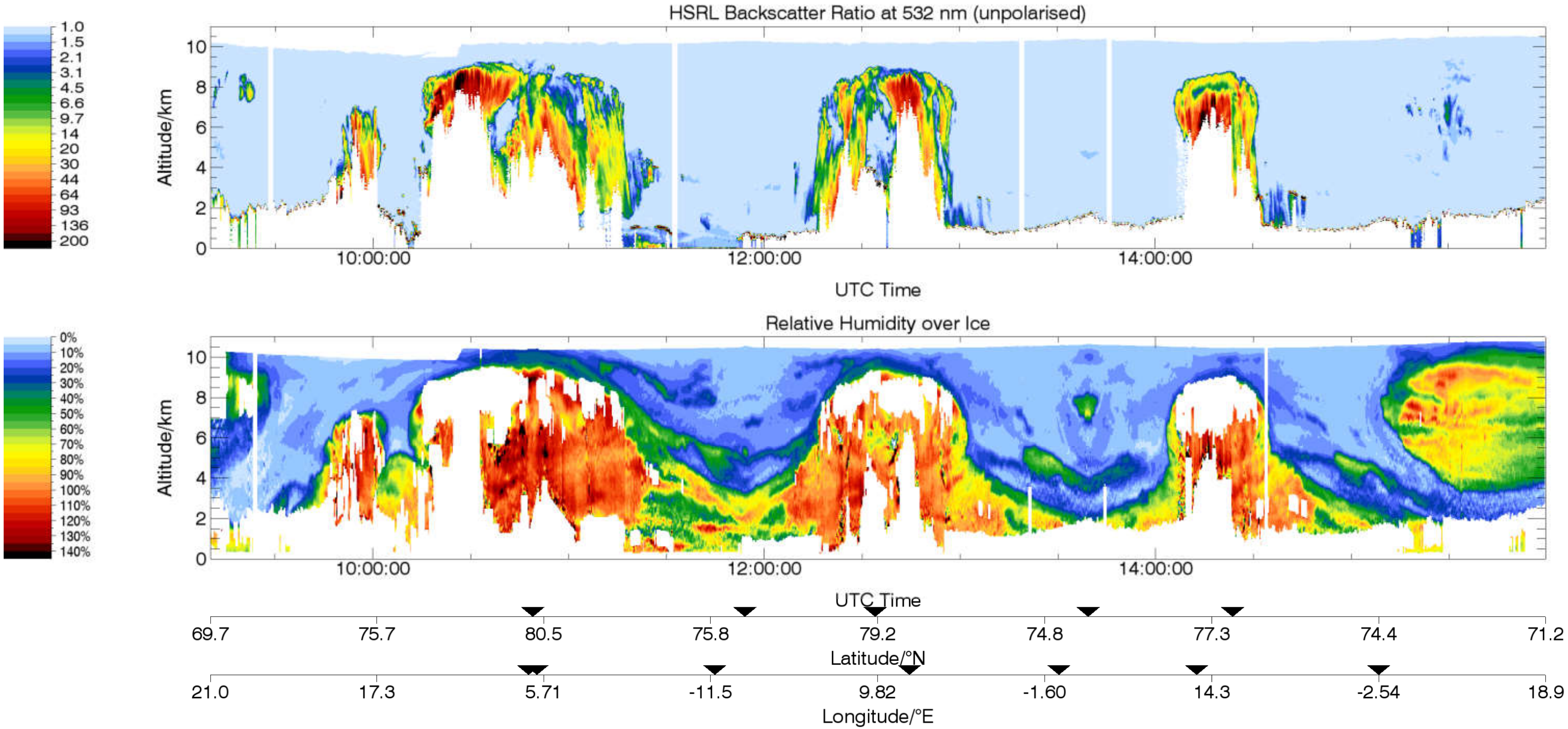
- H_2O mixing ratio profile covering whole troposphere
  (typical resolution for HALO-(AC)³:
  200 m vertical / 2.5 km horizontal)
- Relative humidity in combination with external temperature data (e.g. ECMWF)
- Systematic error sources (no radiometric calibration necessary)
  - Absorption cross section: 2%-3%
  - Density profile: 1%
  - Wavelength calibration: 1%
- Statistical error
  - dependent on vertical/horizontal resolution, H_2O-profile and ambient light: generally in the order of 5% (1σ)
    Statistical Error is calculated and tabulated with every profile

Number of channels for H_2O measurement	4
Number of channels for aerosol measurement	5
Transmitted optical power	48 W
Telescope diameter	48 cm
Total weight	495 kg
Dimensions L x W x H	1.7 m x 1.1 m x 1.2 m
Power consumption of laser system	1500 W
Power consumption total	2000 W

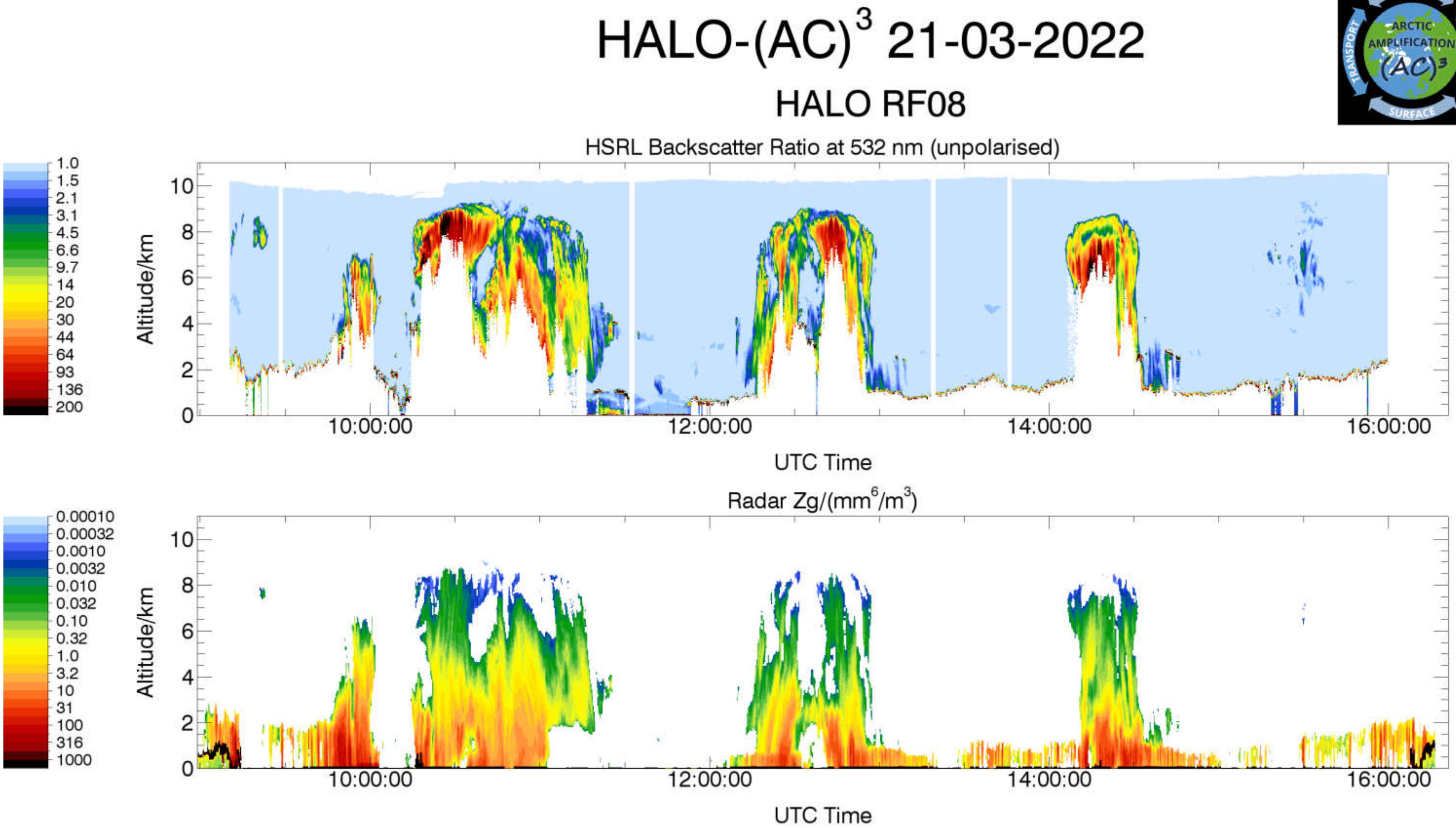
RF08 21-03-2022: Cold Air Outbreak – Standard Products



RF08 21-03-2022: Cold Air Outbreak – Relative Humidity using IFS Temperature



RF08 21-03-2022: Cold Air Outbreak – Lidar vs. Radar



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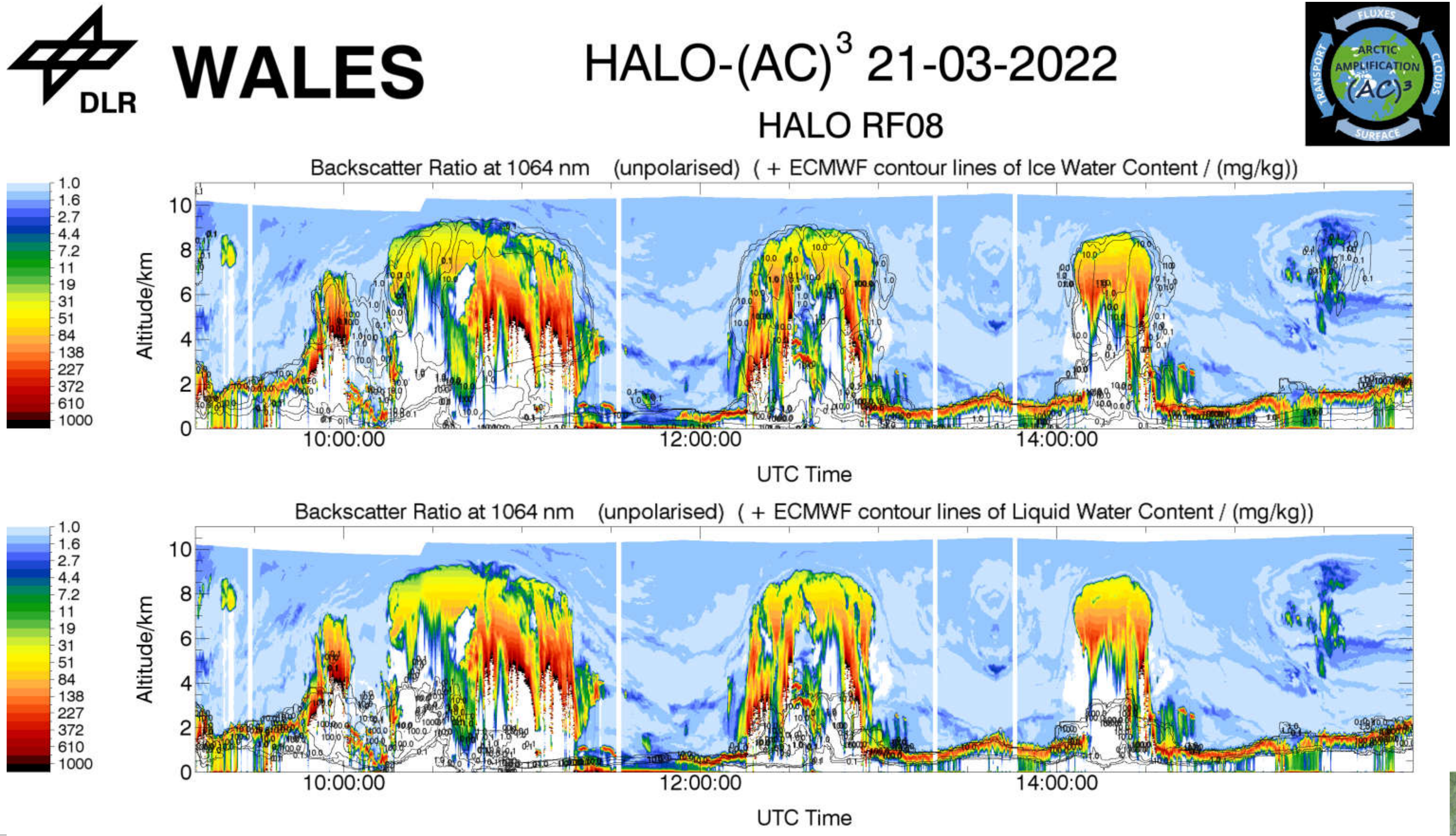
RF08 21-03-2022: Cold Air Outbreak – Cloud Representation in IFS

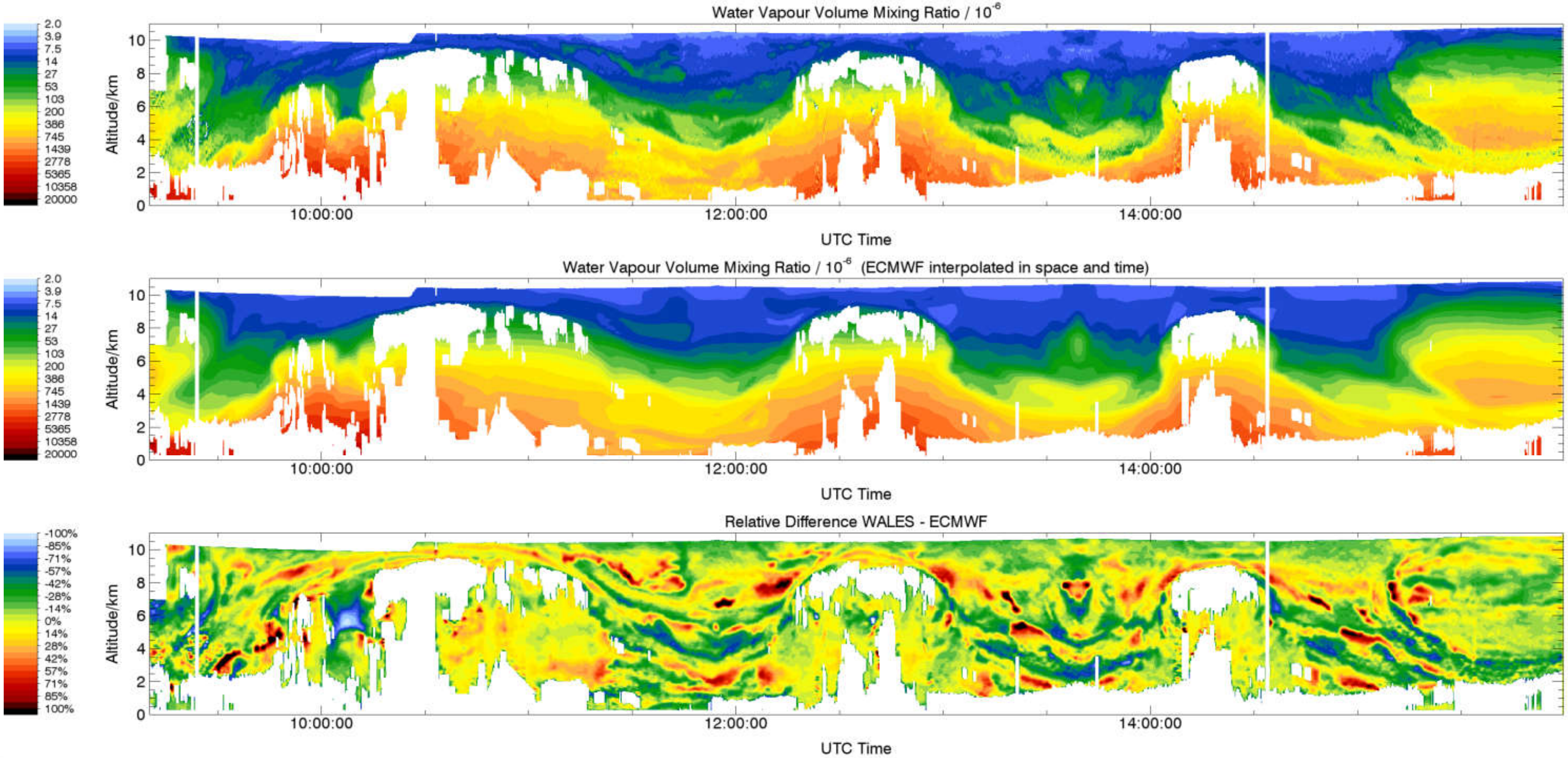


RF08 21-03-2022: Cold Air Outbreak – Humidity Representation in IFS

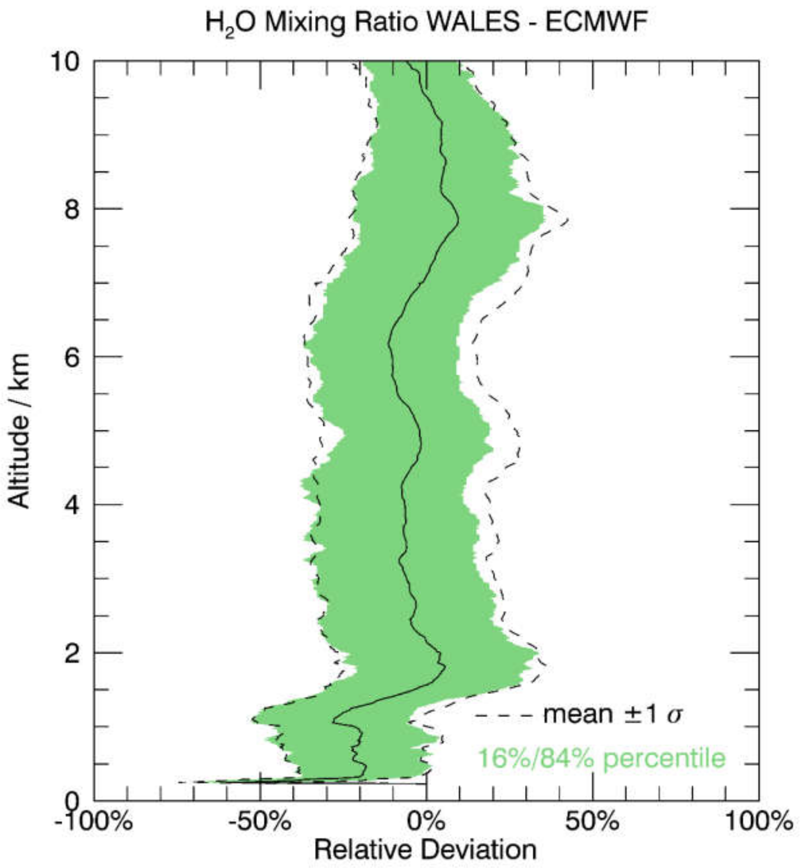
WALES

HALO-(AC)³ 21-03-2022

HALO RF08



RF08 21-03-2022: Cold Air Outbreak – Humidity Representation in IFS

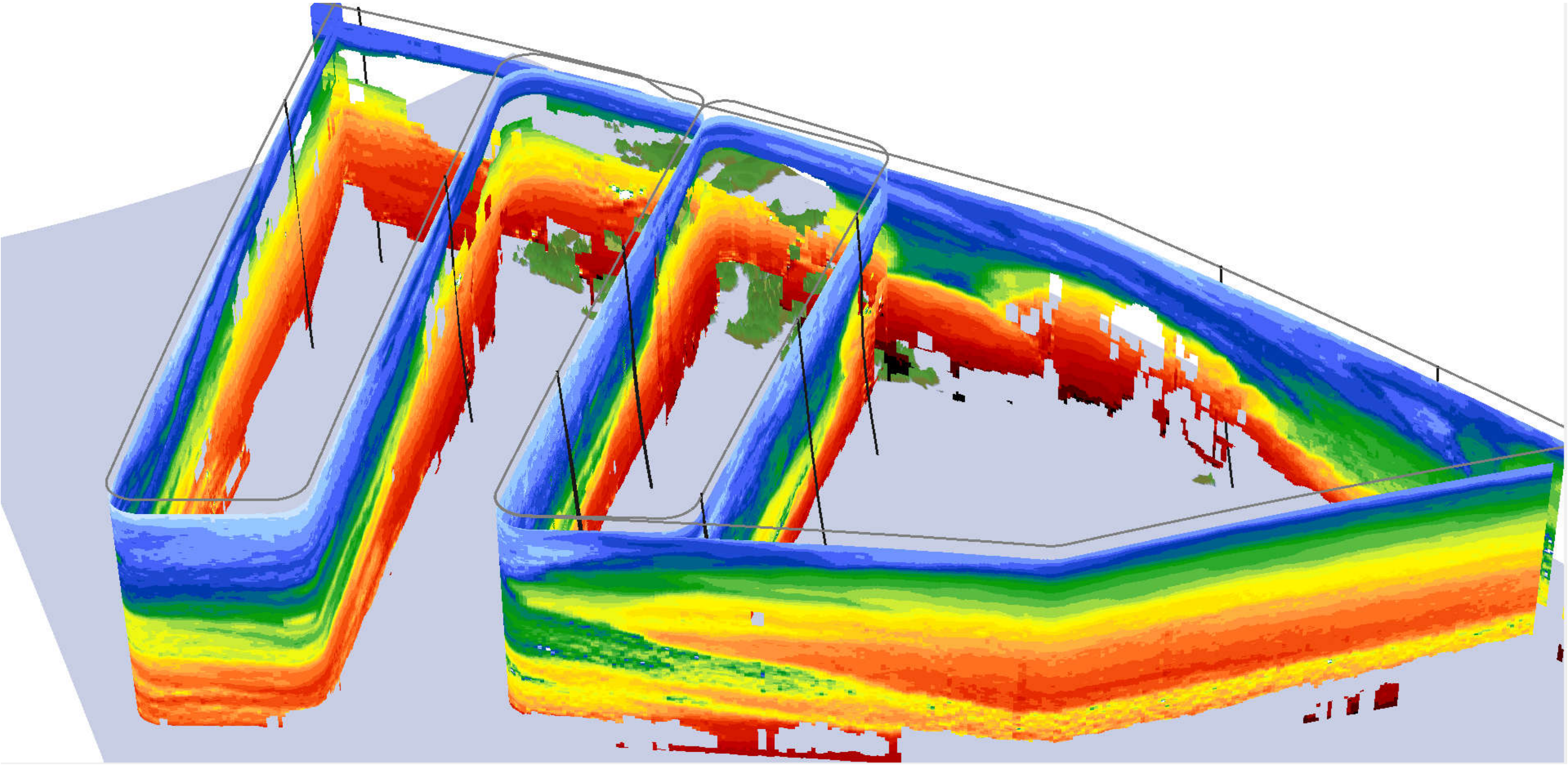


Mean bias (0.2 - 10 km): -4.5%   Mean bias (2 - 10 km): -2.4%

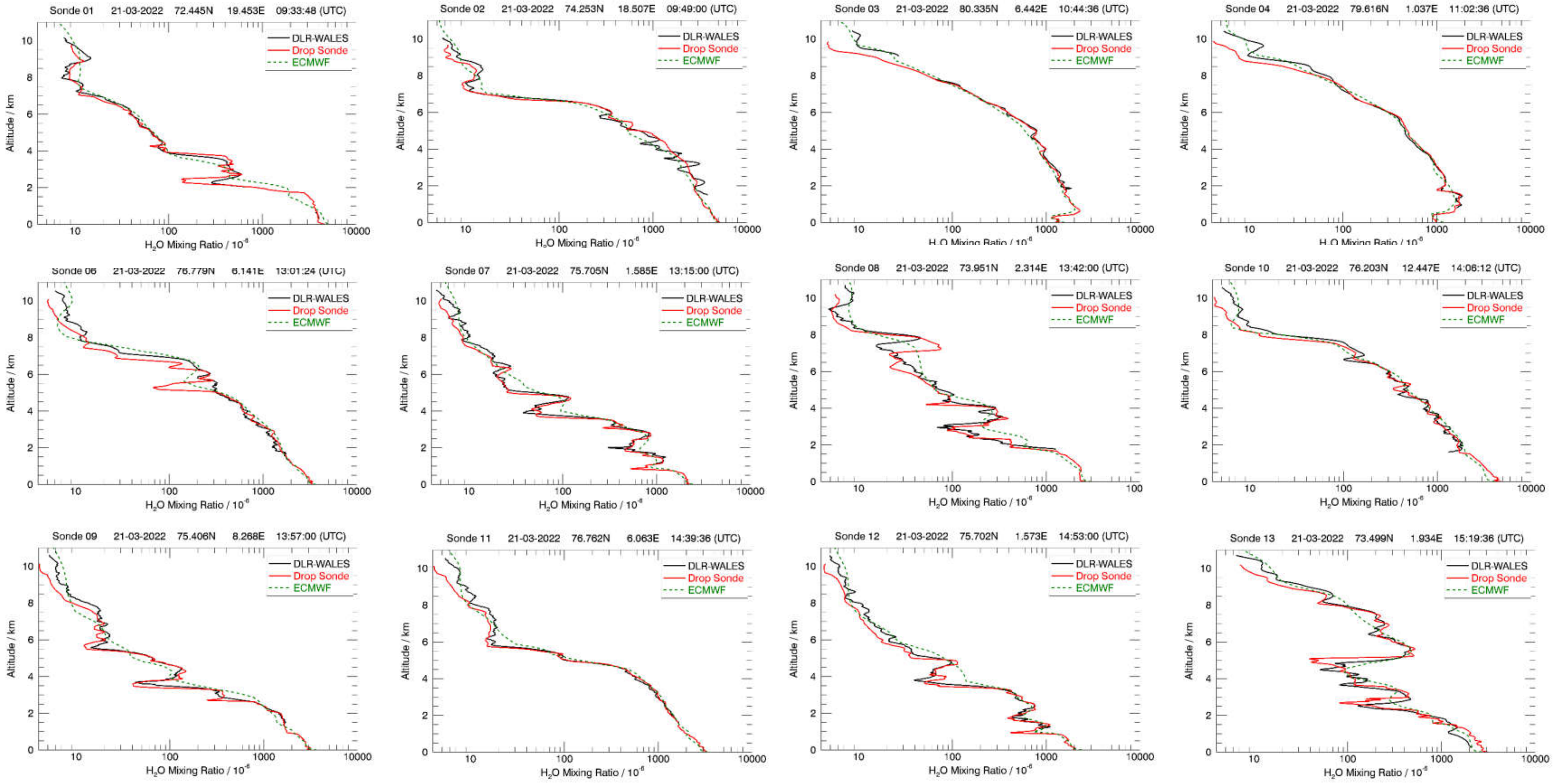
- Total column values show quite low bias
- Standard deviation very close to percentiles for a Gaussian Distribution. No signs that statistics is dominated by outliers or second modes.
- Humidity below 1 km: WALES measurements only from a few cloud gaps. IFS shows no gaps at these places which may explain the higher VW in the model.

Result may be biased by HALO drop sondes which have been assimilated, TBC

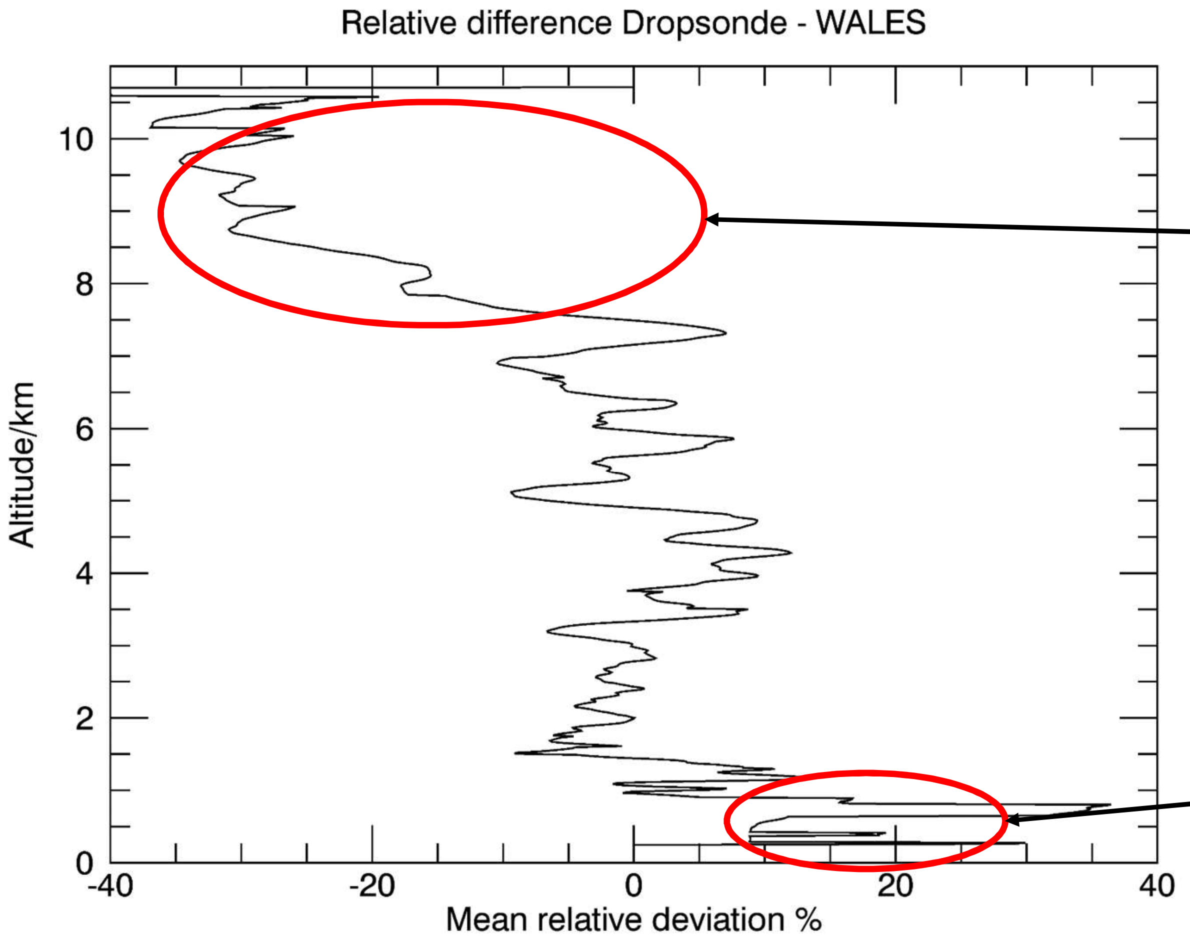
RF08 21-03-2022: Cold Air Outbreak – Humidity WALES vs DS



RF08 21-03-2022: Cold Air Outbreak – Humidity WALES vs DS



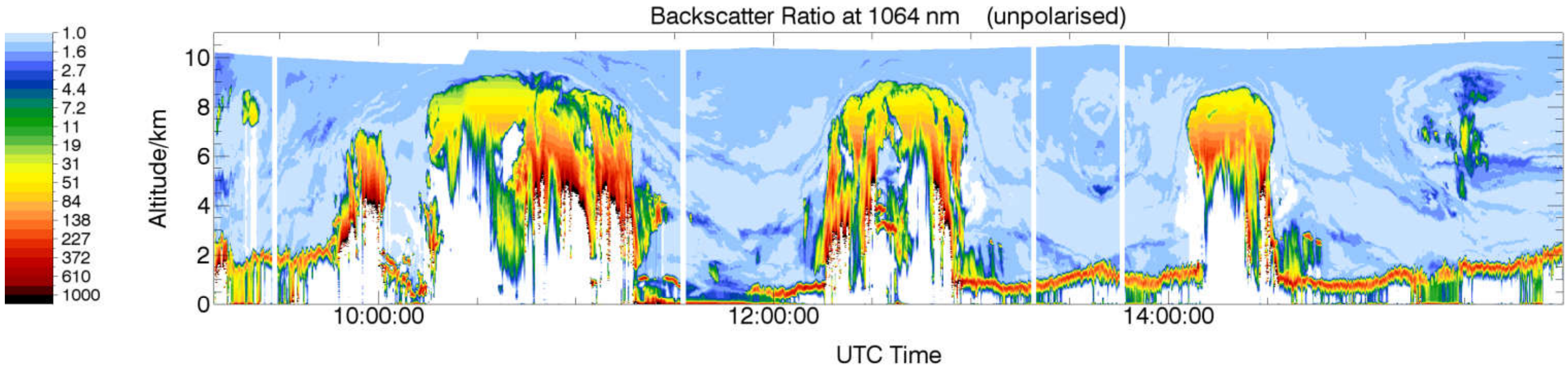
RF08 21-03-2022: Cold Air Outbreak – Humidity WALES vs DS

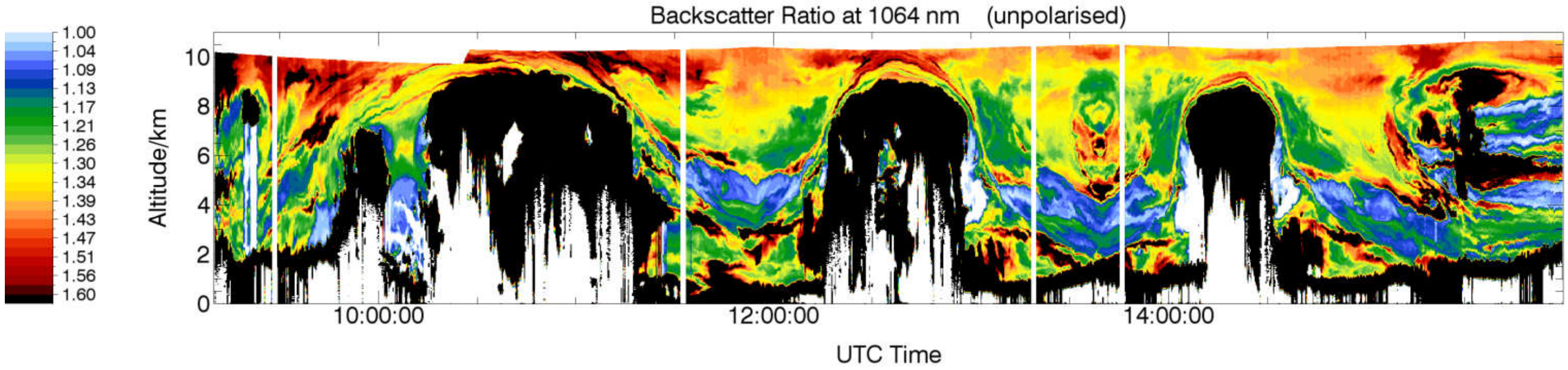


- Good agreement between 1 km and 7 km altitude
- Drop Sonde dry bias around tropopause (mixing ratios below 100 ppm)
- Comparison limited to no and thin cloud regions
- Statistics to a large part dominated by atmospheric variability. (Sondes drift away from the lidar curtain by 10 km or more)

Bad statistics due to low cloud deck (only 1 sonde)

RF08 21-03-2022: Cold Air Outbreak – Aerosol Distribution





Background aerosol distribution clearly shows the different airmasses

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First general Observations

Cirrus Clouds

- Cirrus tops show extreme high backscatter much more often than mid-latitude cirrus: points to a higher number of smaller particles
- Depolarization ratios in cirrus are typically lower than 50% - which is also in contrast to mid-latitude cirrus and consistent with the assumption of smaller particles
- Cirrus regions often appear to be slightly supersaturated, again in contrast to mid altitude summer

Model Comparisons

- Cirrus covered regions analyzed quite well in IFS most of the time
- Low differences in water vapor distribution between IFS and WALES in the mean. But errors of ±100% in certain regions mostly due to low model resolution. No high model wet bias in the UTLS like observed in mid latitude summer

Drop Sonde Comparisons

- Drop sondes compare well at mixing ratios above 100 ppm. DS show dry bias of about 30% at a humidity below this value.

Aerosol

- High aerosol concentrations at and above tropopause.
- Low concentrations in the middle troposphere, besides distinct layers

Applications to HALO-(AC)³

- Properties of Arctic Clouds
  - Cloud macrophysics
  - Ice cloud microphysics / radiative properties
- Classification of Arctic aerosol
  - Assessment of Optical properties
  - Attribution to source regions (transported vs. intrinsic aerosol)
  - Modifications of optical properties by long range transport to the Arctic
- Aerosol/Cloud interactions
- Characterization of humidity biases in the Arctic
  - Comparison to NWP-analyses
  - Validation of Satellite products
- EarthCARE pre-validation
  - establishment of dataset for algorithm development and testing