

A Consortium for COnvection-scale modelling  
Research and Development

## Advances in the use of observations in ACCORD

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work of numerous contributors from ACCORD DA teams

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News on evolution of assimilation approaches for various atmospheric observations:

- Conventional datasets
- Mode-S aircraft observations
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- Radar reflectivity
- Satellite datasets:
  - lightning data
  - clear-sky and all-sky microwave sounders
  - towards assimilation for IR sounders
- Conclusions

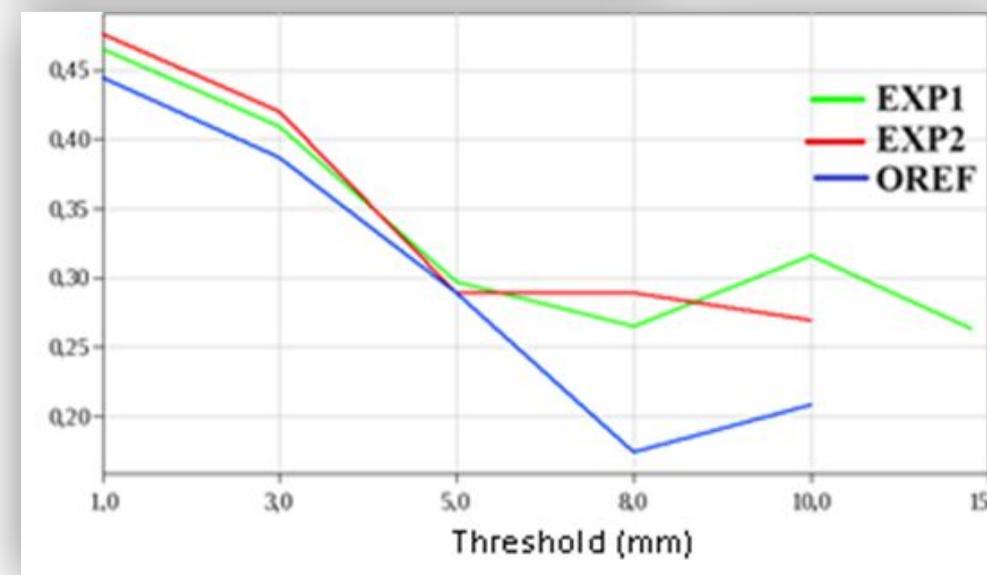
# Impact of denser surface observations

## In AROME/HU:

- Enhanced exchange of AWS within RC LACE
- Test of impact of additional surface data using:
  - default thinning of 80 km
  - reduced thinning of 40 km
- Runs with denser data clearly outperform the reference (May and November 2023) for precipitation

EDS of 3-hour afternoon precipitation in May 2023.

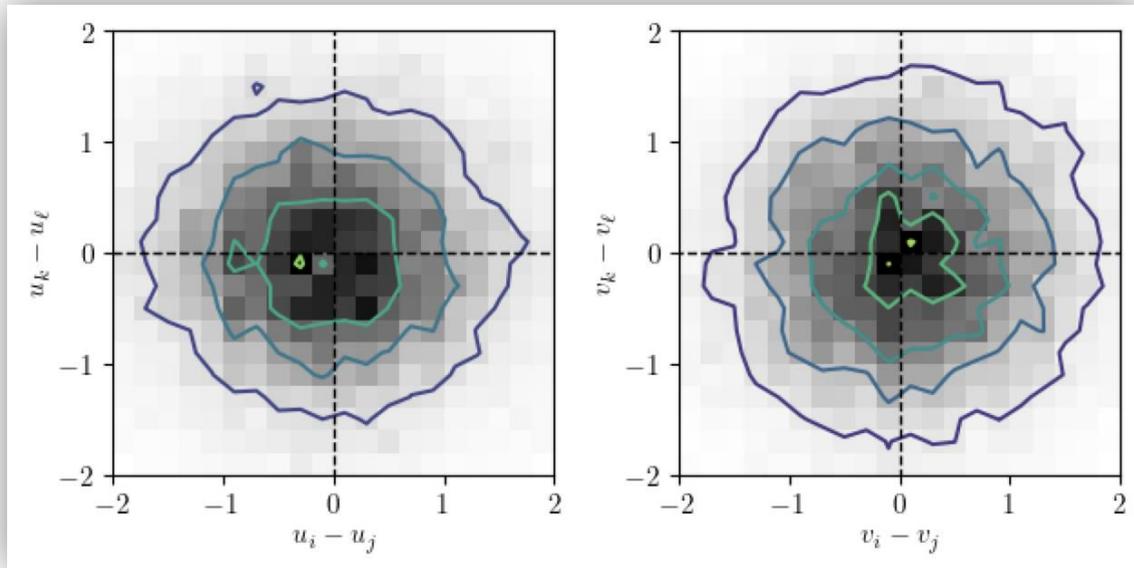
SYNOP



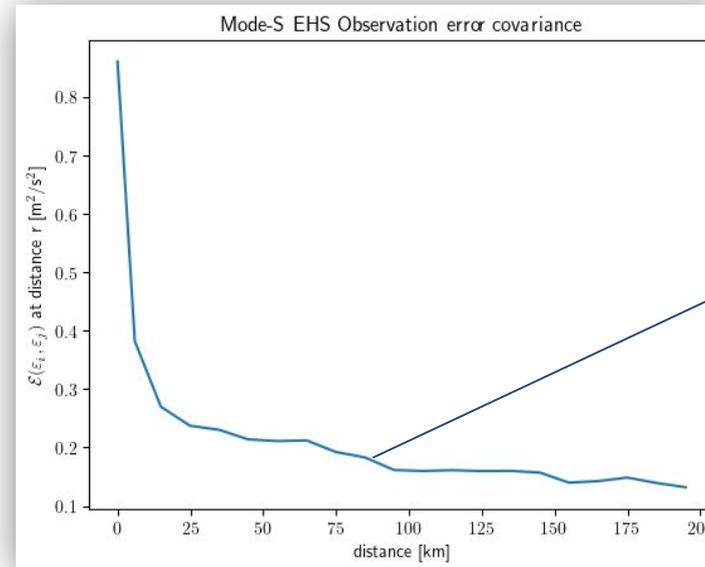
SNOP +  
LACE  
exchange

# Mode-S EHS: observation error characteristics

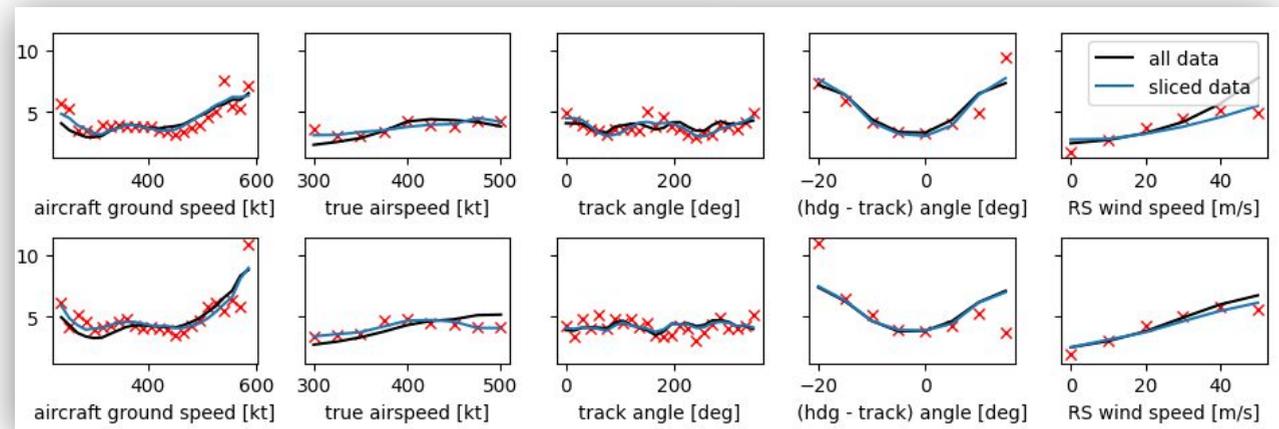
A recent study by KNMI based on 4D cube data analysis and collocation with radiosondes.



Double difference analysis: observation errors from different aircraft are not correlated.



auto-covariance around 0.1 – 0.2 [m<sup>2</sup>/s<sup>2</sup>] beyond 25 km due to heading correction errors

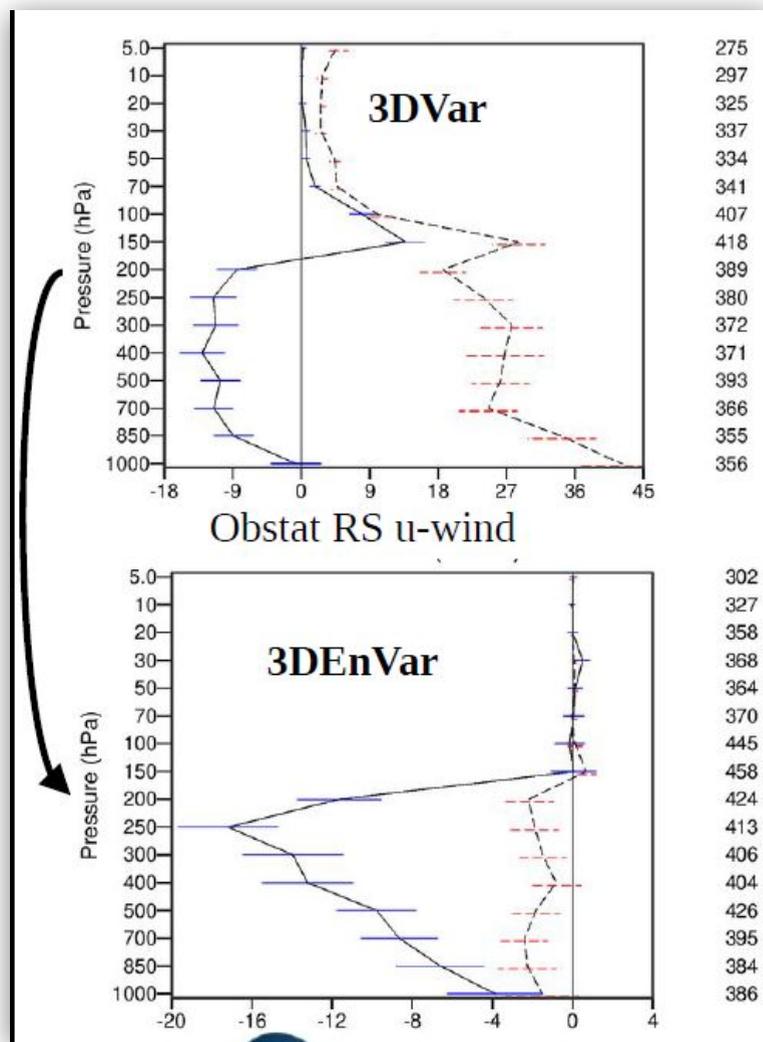
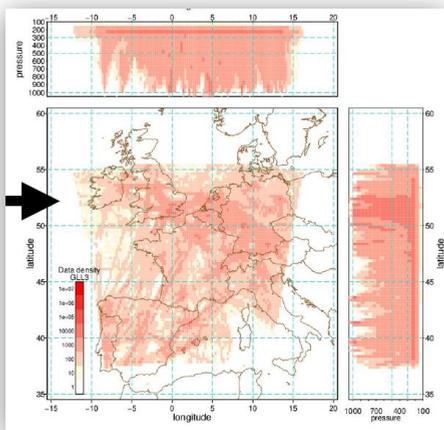


Obs. errors depend on the state variables of the aircraft.

# Impact of EMADDC Mode-S in 3DEnVar

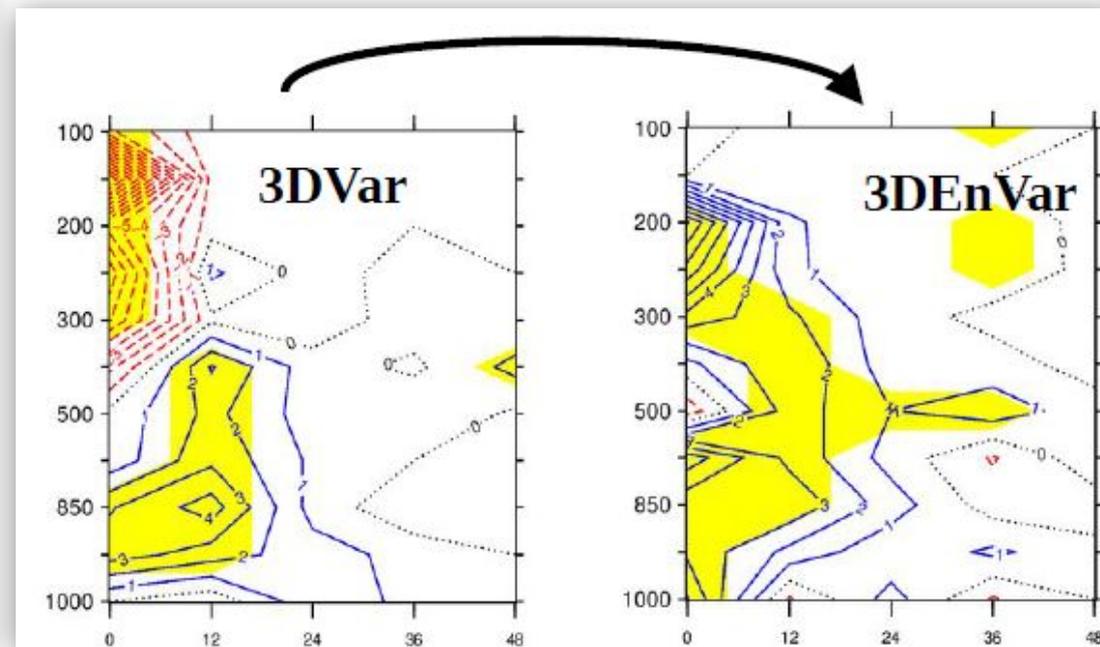
## In AROME-France 3DEnVar:

- Mode-S EHS from EMADDC, after **whitelisting**
- Globally positive impact for wind and temperature, and mid-level humidity, up to 24-30h.



In observation departure statistics...

.. and forecast scores.



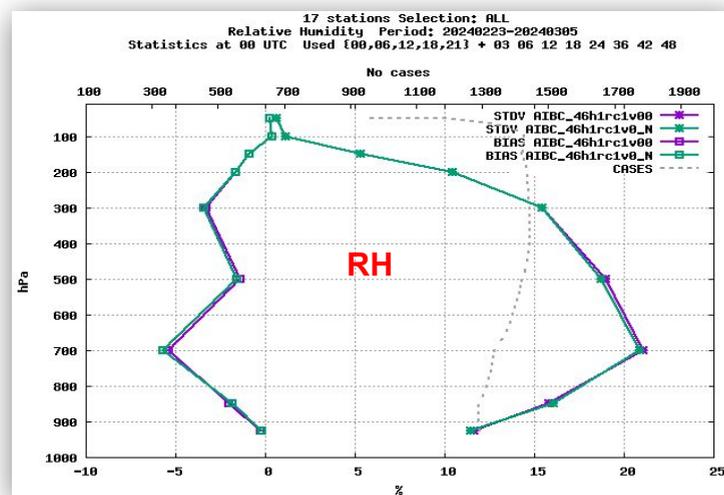
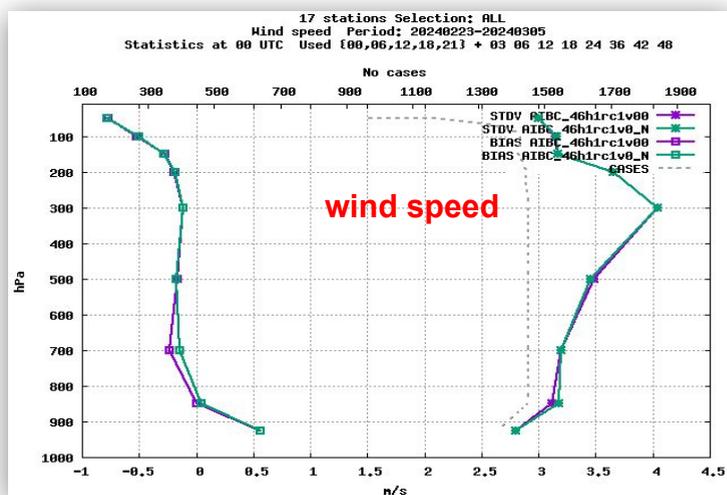
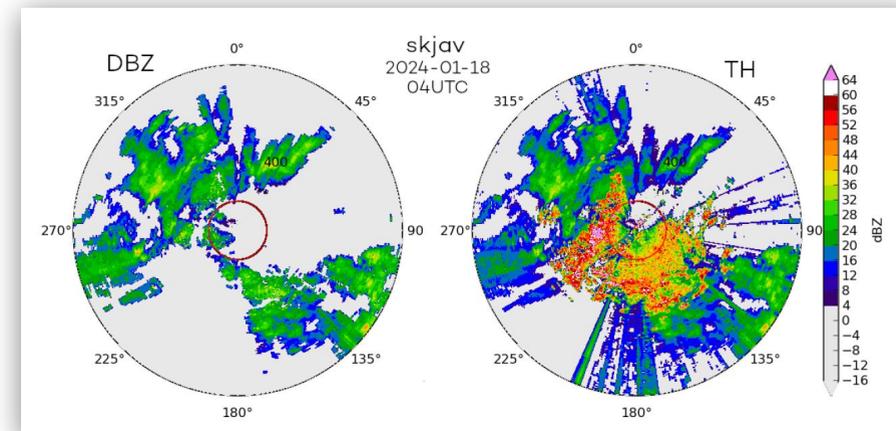
# Evaluation of new OPERA NIMBUS service for radar volumes

NIMBUS service provides quality-controlled volume radar tailored for assimilation in NWP models.

## In HARMONIE-AROME

NIMBUS radar data evaluated for three domains:

- Model runs with NIMBUS data show a neutral impact.
- Opportunity to increase amount of radar data in MetCoOp - crucial impact in certain weather regimes.



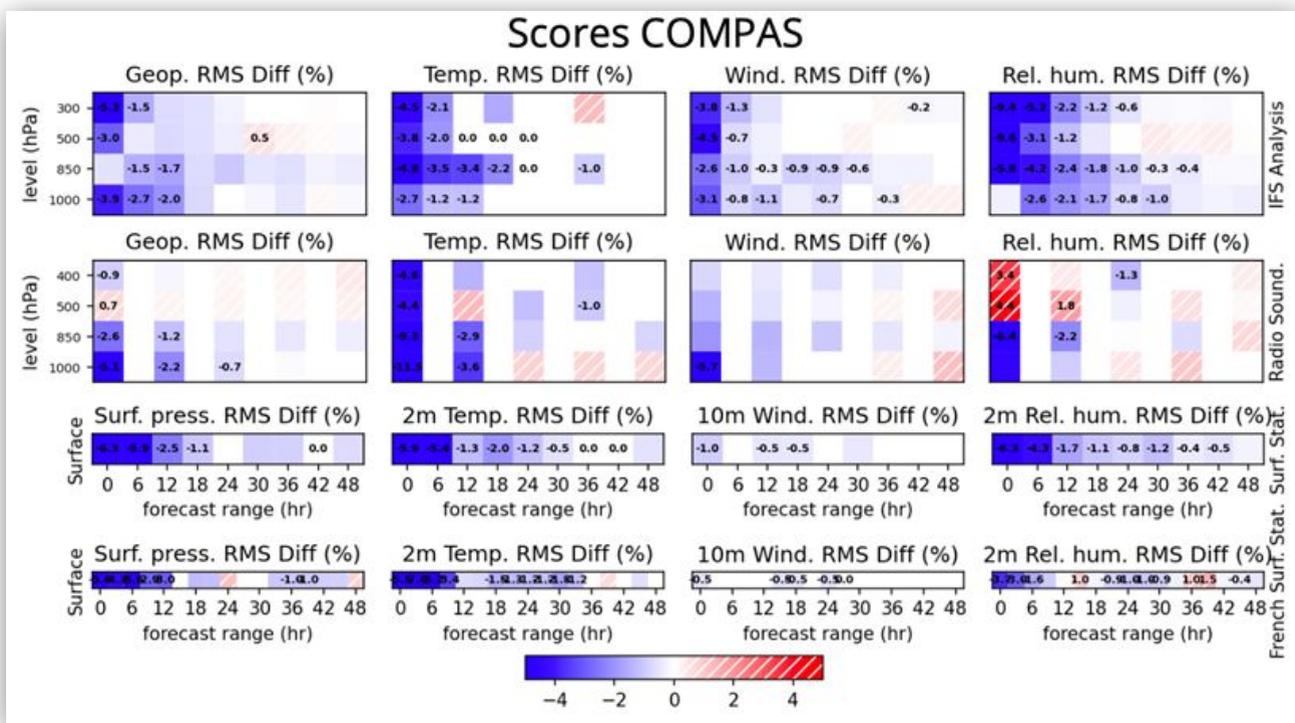
## In RC LACE systems

- Identification of differences between NIMBUS/OIFS production lines
- Check for availability, metadata, structural similarity

# Towards improved radar assimilation

## In AROME-France

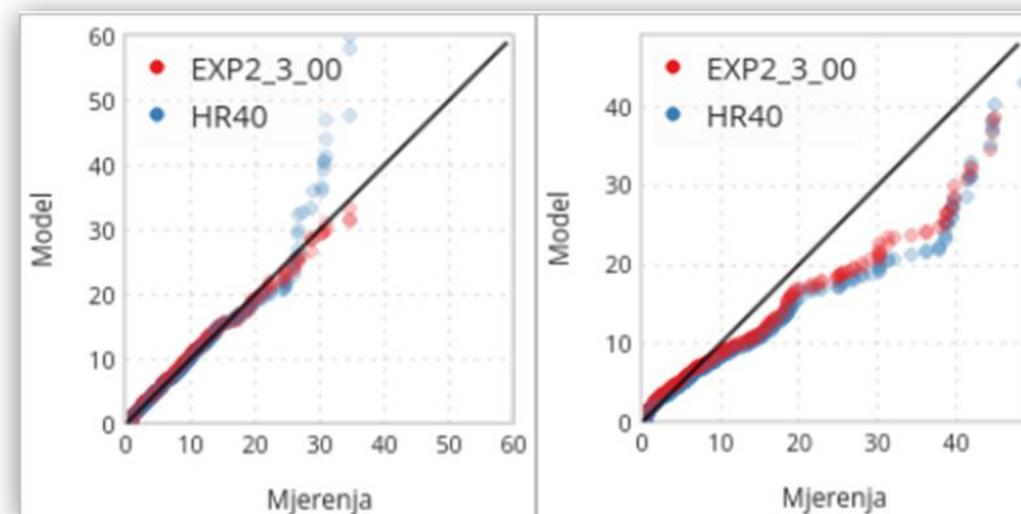
Refining the settings of the **new direct assimilation** stream for ground **radar reflectivities**, leading to major improvements of the forecasts.



## In ALARO-Croatia

Continental stations

Coastal stations



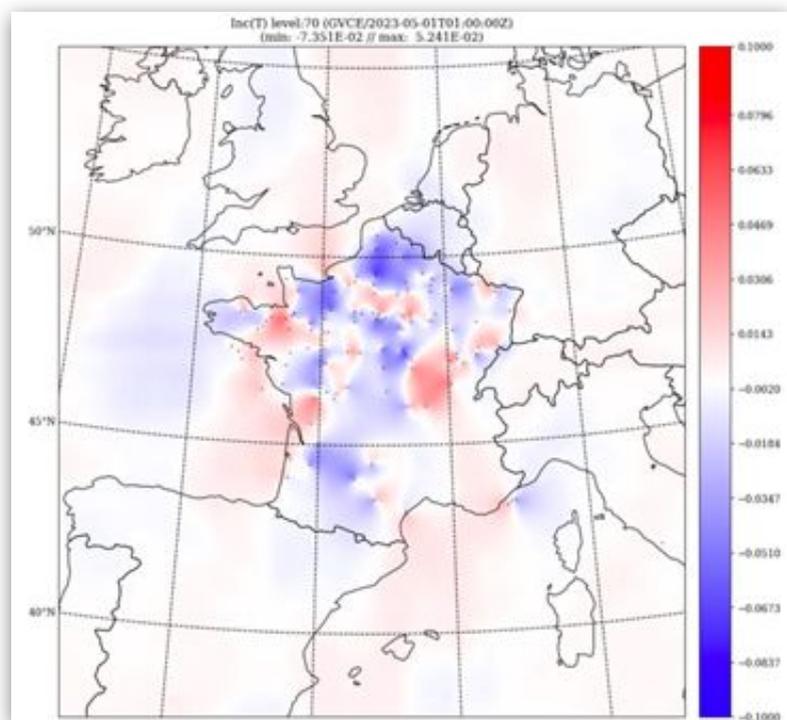
Without radar reflectivity DA  
With radar reflectivity DA

Several adaptations for Bayesian inversion implemented to **suppress dry bias** on clouds and enable **positive impact on precipitation** in ALARO-based systems.

# Progress with GNSS-derived observations

## In AROME-France

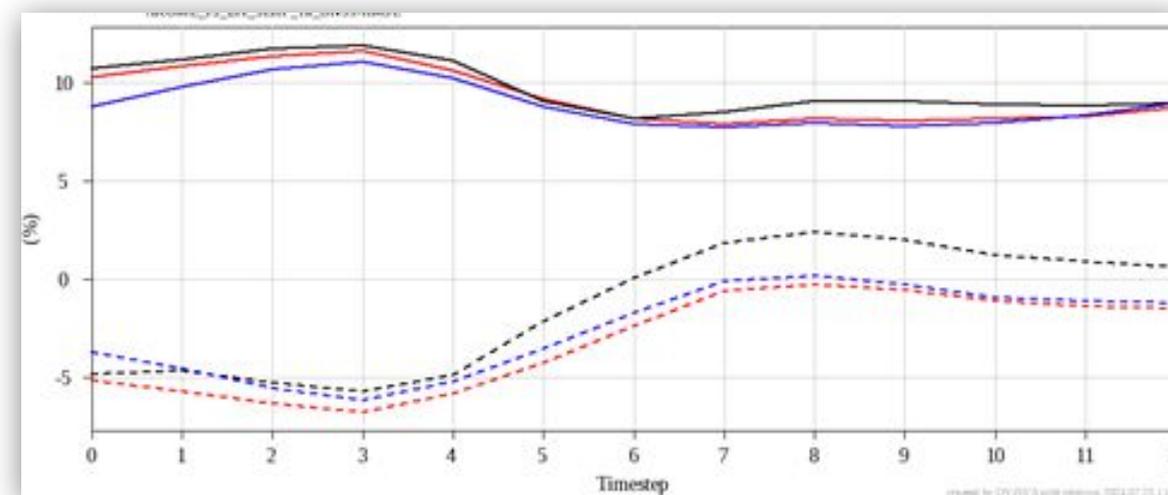
Construction of the data stream to assimilate **tropospheric gradients** in addition to zenith delays.



Increment map from ground GNSS tropospheric gradients.

## In AROME-Hungary

Positive impact on scores in RUC after **revising the whitelist** for ZTD (with more assimilated observations).

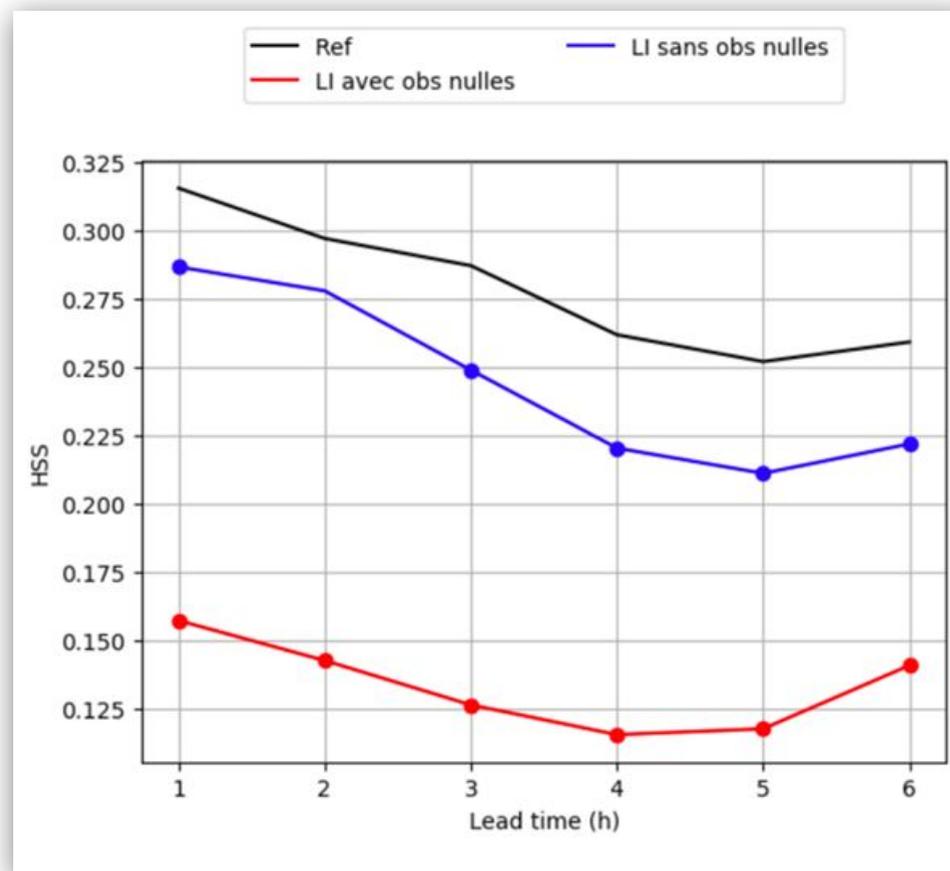


RUC with GNSS ZTD - new whitelist  
RUC with GNSS ZTD with old whitelist  
2.5 km AROME

# First assimilation trials with MTG lightning imager data

## In AROME-France

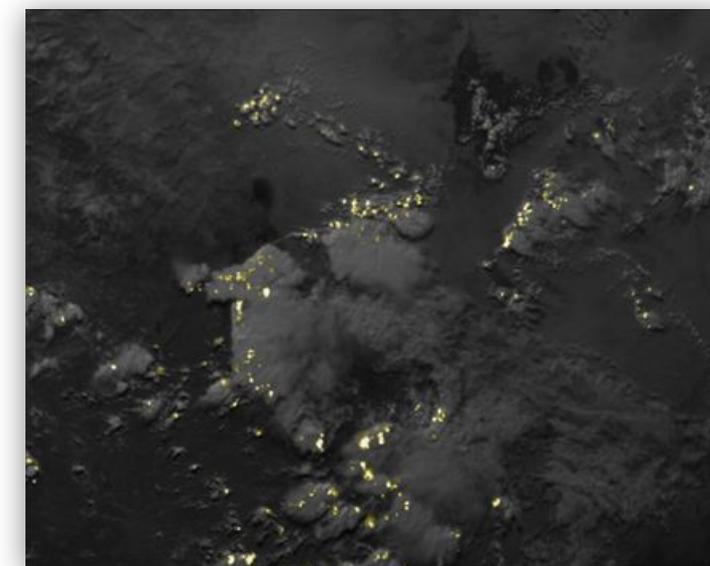
- First assimilation experiments of the pre-operational MTG/LI data within the 3DVar with hydrometeors in the control vector.
- Work on the quality control of MTG/LI data (assimilation or not assimilation of non-lightning data)



Assim. LI without no-lightning data

Assim. LI with no-lightning data

Reference (no LI assimilation)



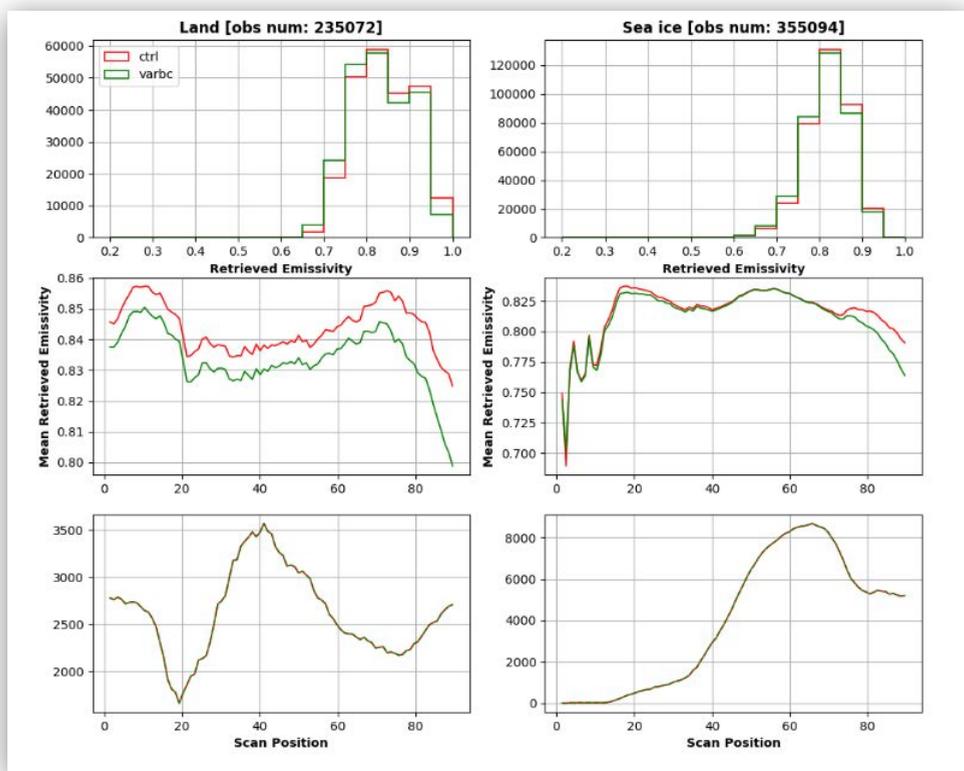
MTG

Lightning imager data

# Refined assimilation of clear-sky microwave radiances

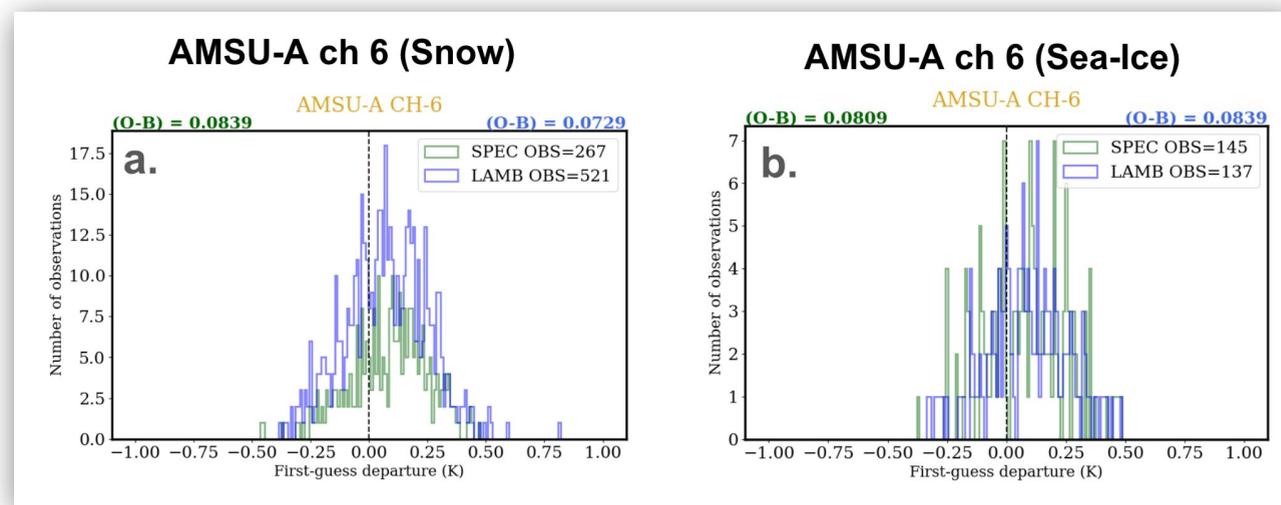
## In AROME-Arctic

Dynamic surface emissivity estimation for microwave sensors - apply VarBC to Ch. 1 (and 2 over sea ice) to actively assimilate Chs. 2,3,4.



## In MetCoOp Harmonie-AROME:

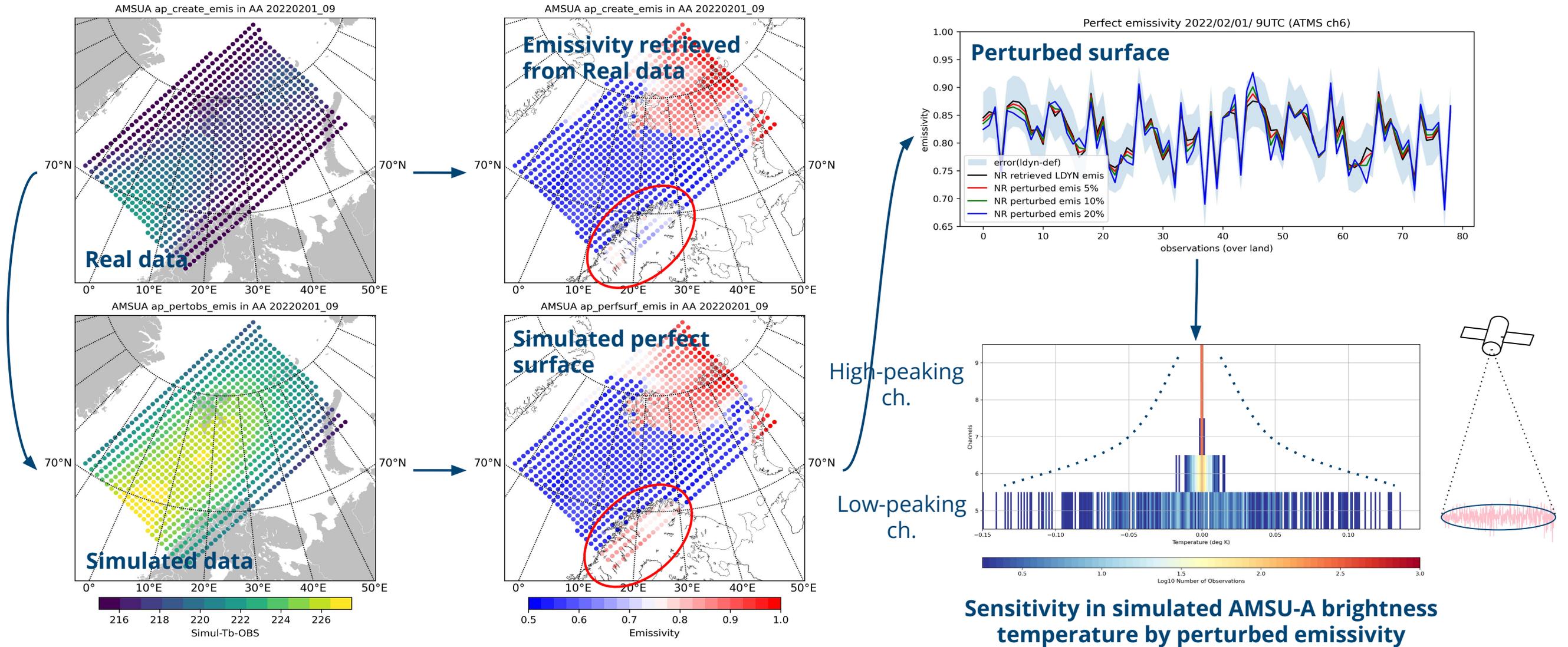
Evaluation of Lambertian vs. specular reflection for surface-sensitive MHS channels over snow and ice. The choice causes noticeable differences in 12h forecast.



First guess departure differences over snow and sea-ice.

Developments to be applied on data from AWS; a cloud detection scheme using 325 GHz data is planned.

# Arctic Observing System Simulation Experiment - sensitivity of emissivity retrieval

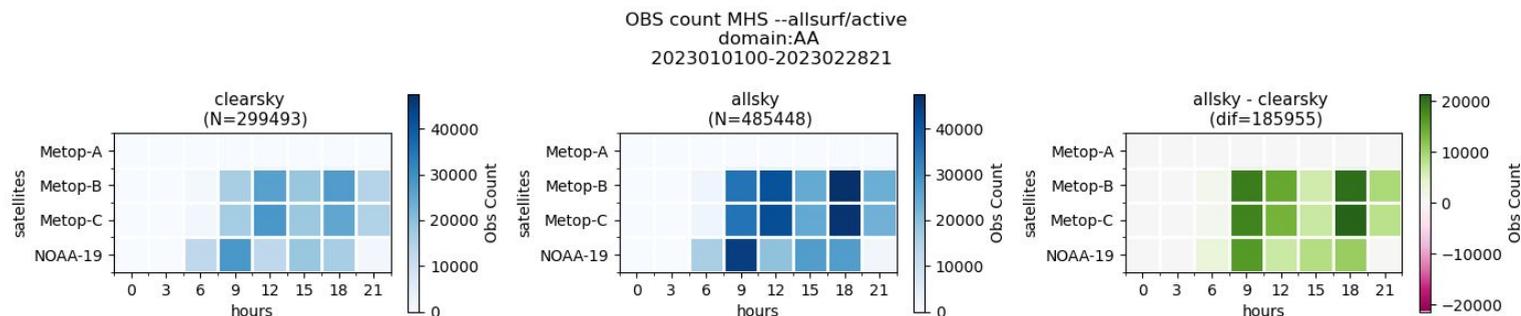


# Assimilation of microwave radiances in all-sky mode

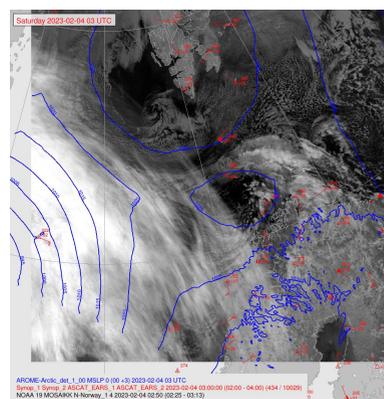
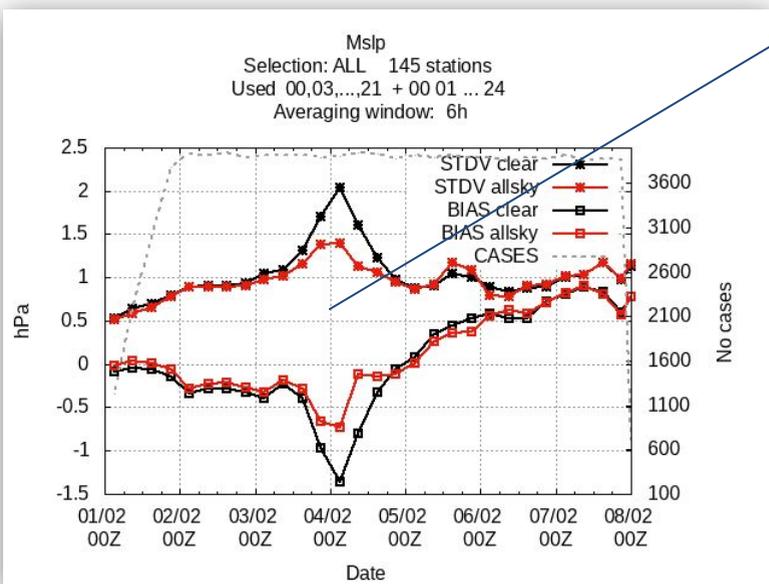
## In AROME-Arctic

Assimilation of 183 GHz humidity channels from MHS together with other instruments over the Arctic.

Much more observations (around +60%) of MHS can be actively used.

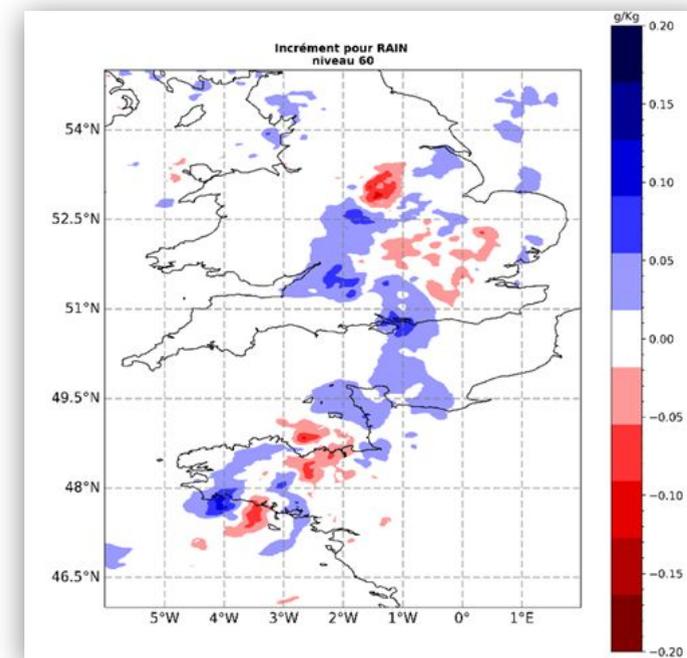


Improved **mslp forecast** in all-sky MHS assim. for a small polar low.



## In AROME-France

- All-sky assimilation of MHS, MWHS2, GMI and AMSR-2 in 3D-EnVar with hydrometeors.
- Improvements of the thinning in the all-sky route.

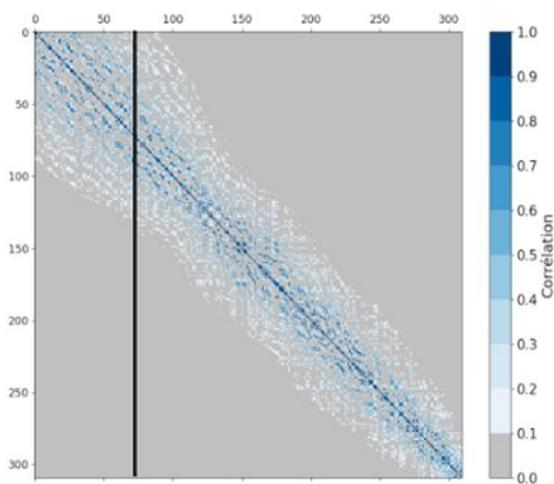


Increments on **rain** from GMI.

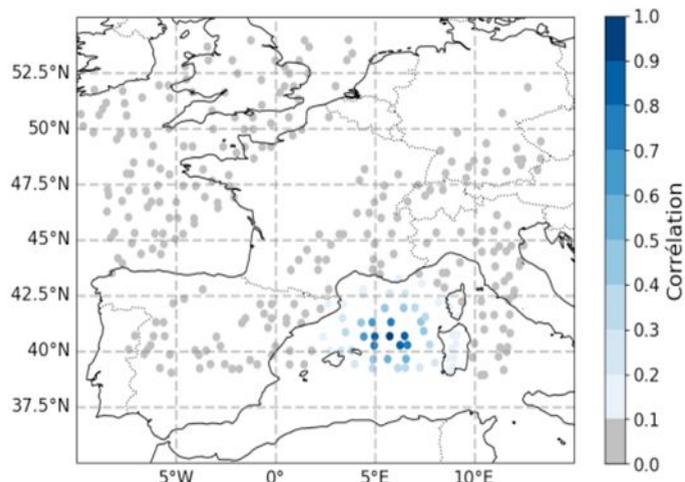
# Towards assimilation of IR (and VIS) data in all-sky mode

## In AROME-France:

Horizontally-correlated observation errors  
(for SEVIRI, IASI and MTG).



Matrice de corrélation  
SEVIRI canal 4



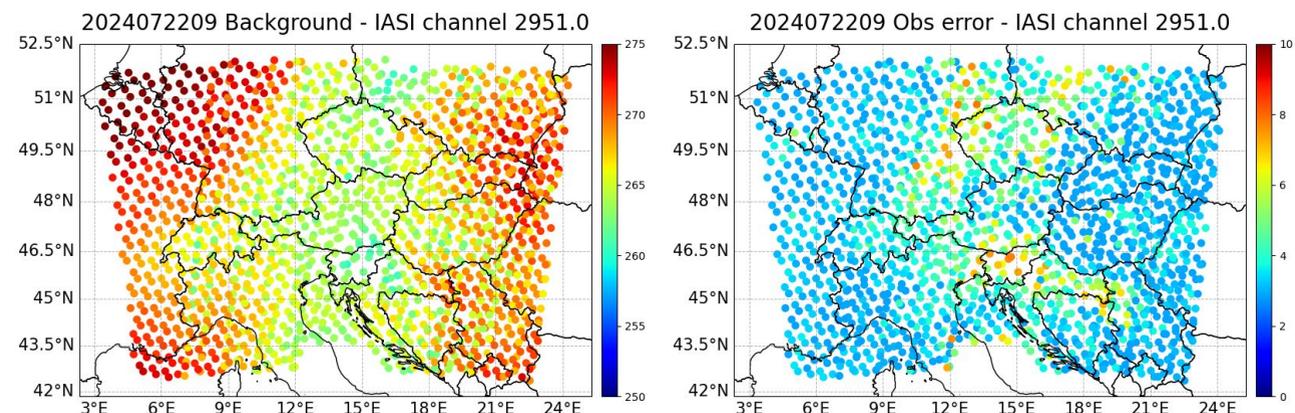
68<sup>ème</sup> colonne de la matrice  
de corrélation - SEVIRI canal 4

R matrix for SEVIRI  
Channel 4

68<sup>th</sup> column of the R matrix  
– SEVIRI Channel 4

## In C-LAEF1k:

- All-sky assimilation of IASI using observation error scaled by cloud contamination.
- Tests with IR and VIS channels from MSG SEVIRI.
- 3DEnVar with hydrometeors.



IASI Ch. 2951 brightness temperature and  
observation error scaled with **cloud contamination**.

# Conclusions

- Various developments and ongoing obs. studies (with increased cooperation between ACCORD members).
- Notable improvements from observations when assimilated with 3DEnVar:
  - more realistic cross-correlations (Mode-S)
  - feedback projected to hydrometeors (radar reflectivity, microwave radiances, ...)
- Refined radiance assimilation approaches (for northern Europe and the Arctic).
- Ongoing studies to optimally apply all-sky assimilation (using more data, improved modelling of obs. errors).
- Ongoing studies to prepare assimilation of new datasets from MTG/EPS-SG (lightning data, IR sounding capabilities).

**Thank you for your attention!**

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