Recent work using Satellite winds at the Deutscher Wetterdienst (DWD)

Alexander Cress
Deutscher Wetterdienst, Frankfurter Strasse 135, 63067 Offenbach am Main, Germany
alexander.cress@dwd.de

- Introduction
- Recent changes in satellite wind usage
- New products (IASI AMVs, Dual Sentinal-3 AMVs)
- Operational use of Aeolus HLOS wind data
- Use of scatterometer data
- Summary

The *deterministic* NWP-System of DWD

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Global-Modell ICON

grid size: 13 km
vertical levels: 130
Grid area: 173 km^2

Hybrid DA

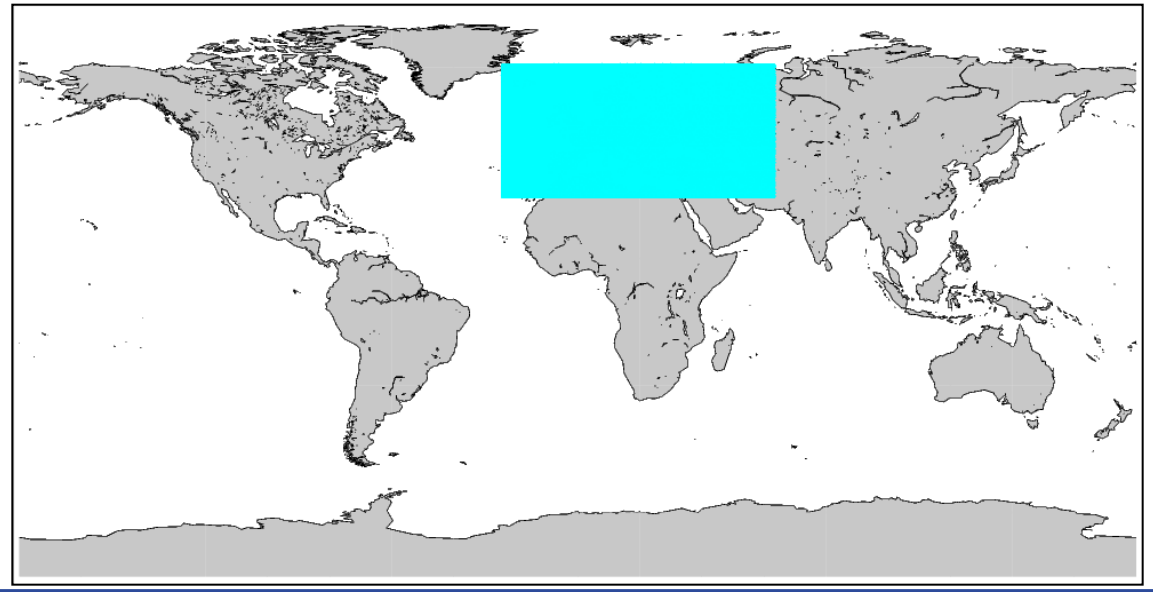
- **13km** **V**arEnKF
- Flow dependent B:
  $B_{VarEnKF} = \alpha B_{LETKF} + (\alpha\text{-}1)B_{3DVAR}$
- Incremental analysis update
- SST, SMA and snow ana

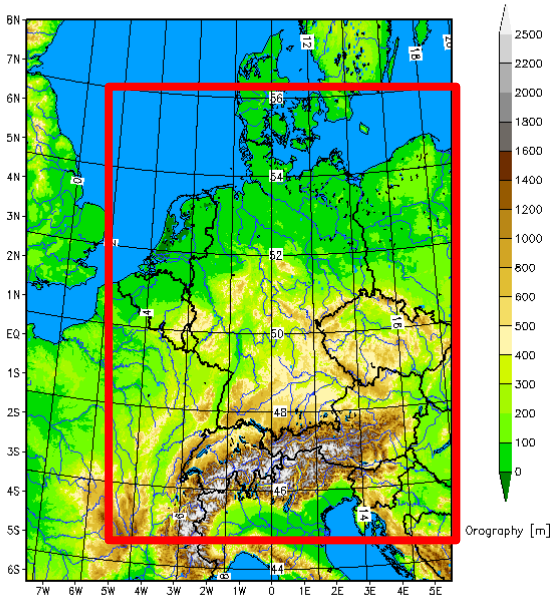
ICON-EU Nest over Europe

grid size: 6.5 km
Vertical levels: 90
forecasts:
Grid area: 43 km^2

COSMO-DE (convection resolving)

grid size: 2.2 km
vertical levels: 60
forecasts: 3-hourly
Girid area: 8 km^2
Det LETKF replaced nudging





The *probabilistic* NWP-System of DWD

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

ICON-EPS; M40

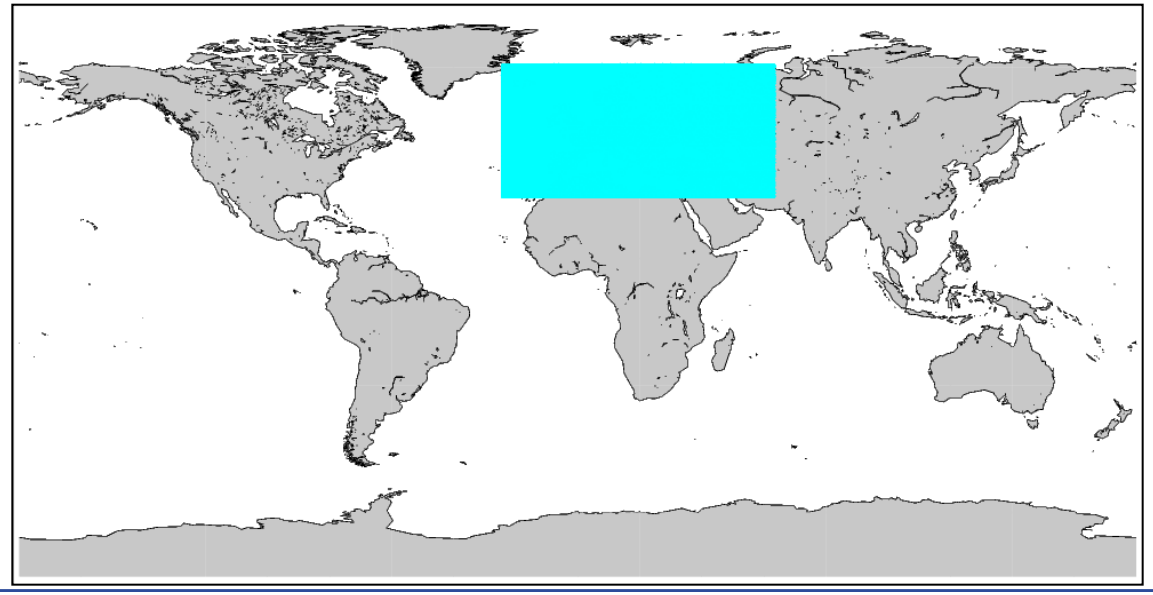
grid size: 26 km
vertical levels: 130
grid area: 1638 km^2

Ensemble DA

- 40 member 40km LETKF.
- Horizontal localization radius 300km.
- Relaxation to prior perturbations (0.75).
- Adaptive inflation (0.9 - 1.5).
- SST perturbations Soil moisture perturbations (experimental)

ICON-EU Nest over Europe

grid size: 13 km
vertical levels: 90
forecasts:
grid area: 407 km^2

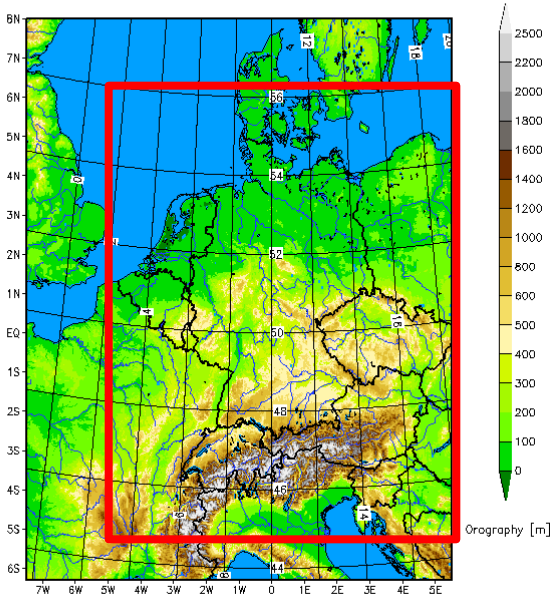


COSMO-DE-EPS; M20

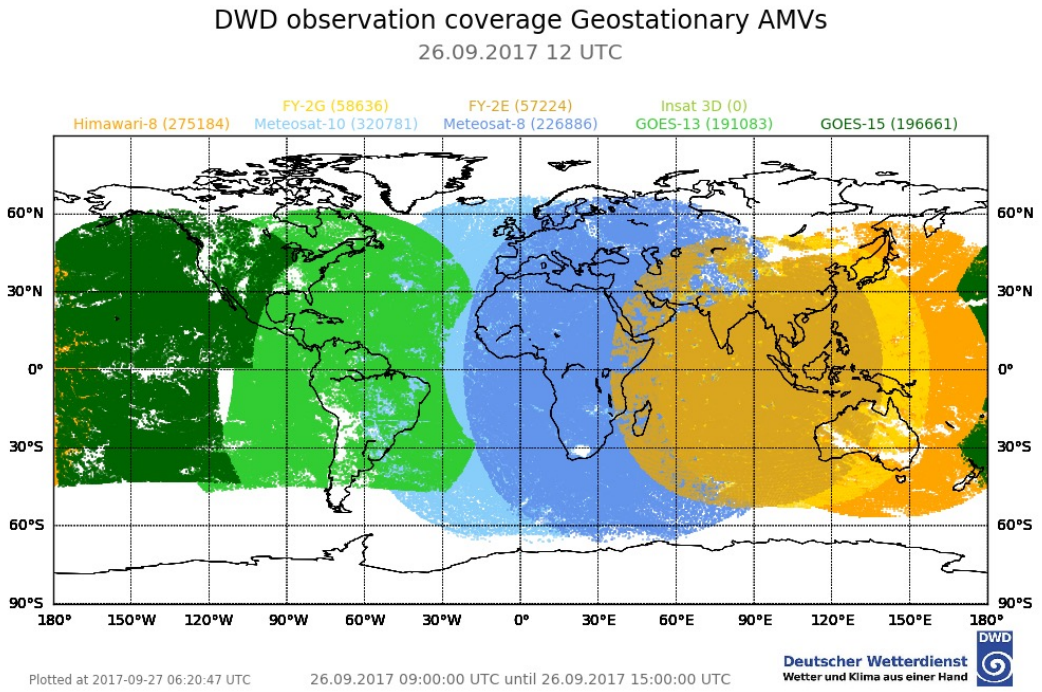
grid size: 2.2 km
vertical levels: 60
Forecasts: 3-hourly
grid area: 8 km^2

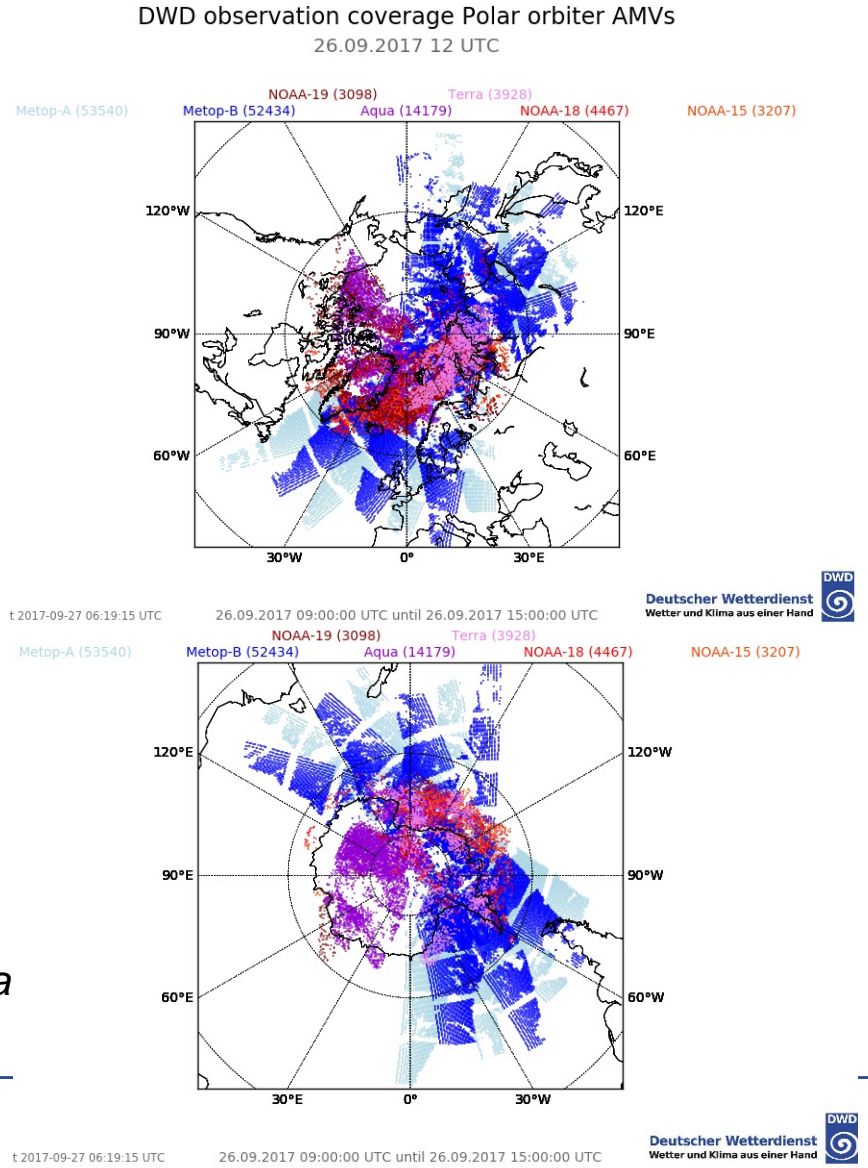
Ensemble DA

40 member 2.8 km LETKF
SST pertubations
Soil moisture pertubations



Data coverage AMVs



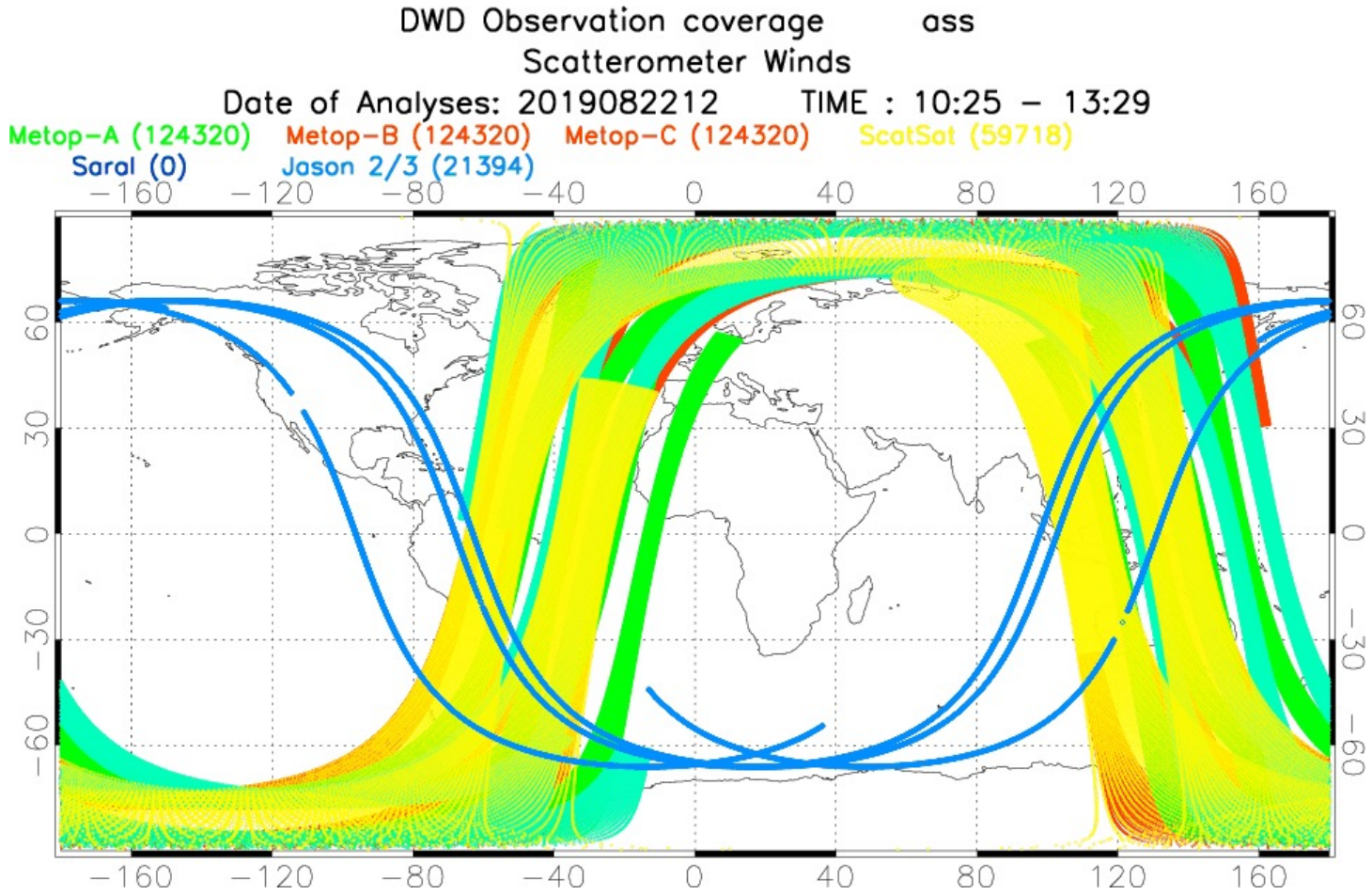


Operational

Geo: *GOES 16/18 Metop 8/10 Himarawi-9*

Polar: *AVHRR from Metop 3/5 single and dual,*
the NOAA series , MODIS from Terra and Aqua
VIIRS from NOAA 19/20, NPP

Data coverage scatterometer/altimeter



Operational scatterometer: ASCAT-METOP B/C and pre-opeational HY-2B/c
Operational altimeter: Jason 2/3 and SARAL Monitor: Sentinal A/B

Changes in operationel usage of satellite winds since the last meeting

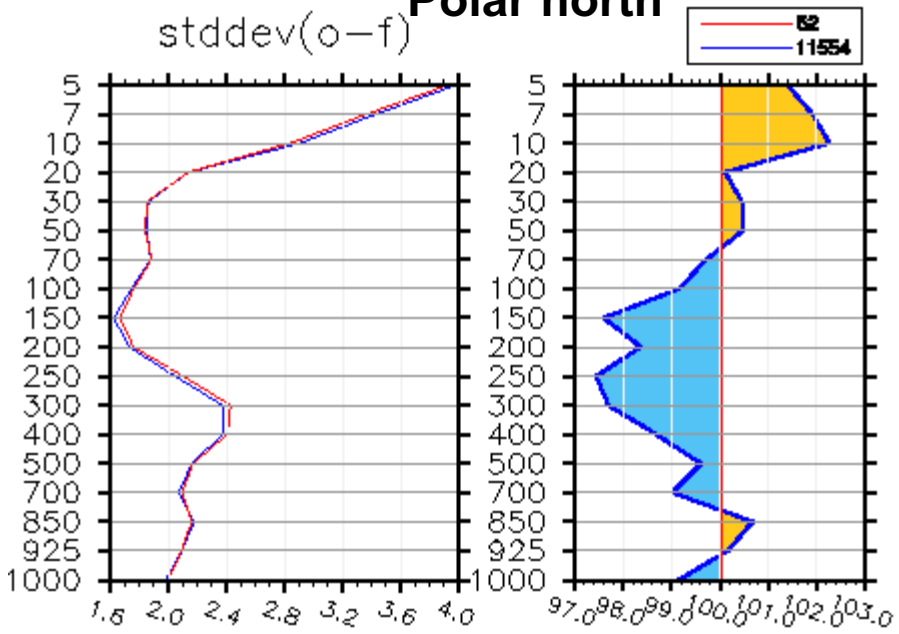
- Operational use of Himawari-9 AMVs
- Switch from GOES 17 to GOES 18 AMVs
- Switch from Meteos-11 to Meteosat-10 AMVs
- Pre-operational use of LEOGEO winds
- Pre-operational use of HY-2B/C scatterometer winds
- End-of-lifetime Aeolus wind lidar

LEOGEO AMV winds
Analysis cycle
OBS minus First Guess statistics

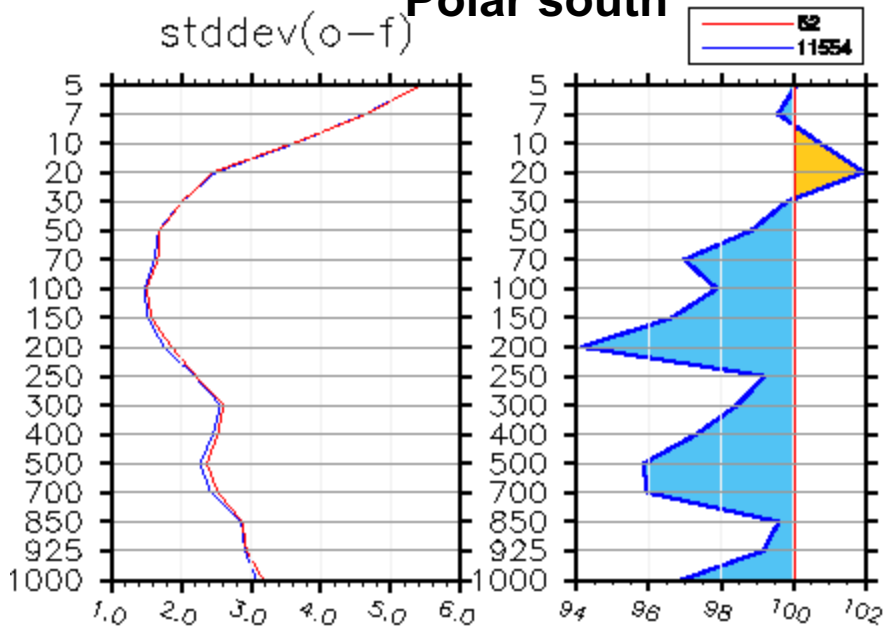
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Radiosondes

Polar north



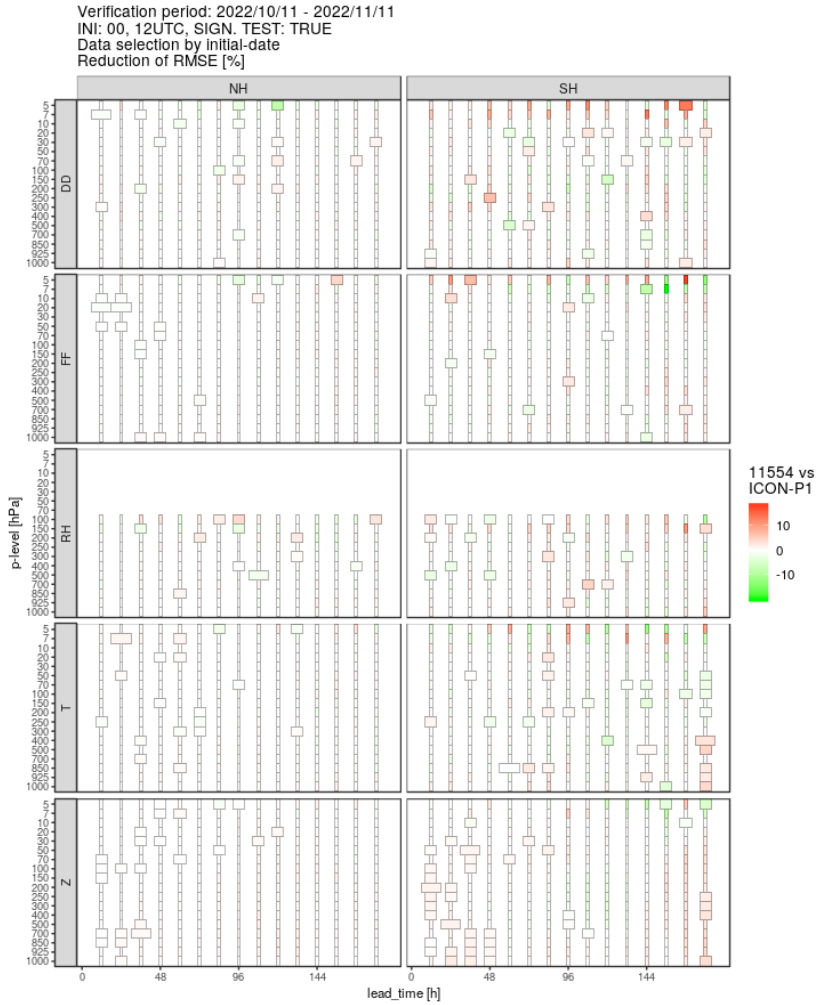
Polar south



- **In general, impact is small**
- **Largest in polar areas over water**

LEOGEO AMV winds
Foecast impact

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



- Scorecard of the relative RMS difference between the Experiments with and without LEOGEO winds
- Timeframe: 2020100100 – 2020111121
- Northern (NH) and Southern Hemisphere (SH)
- Green bars indicate improvement in forecast quality
- Red bars indicate degradation of forecast quality

- **Impact is neutral on both Hemispheres for all meteorological elements**

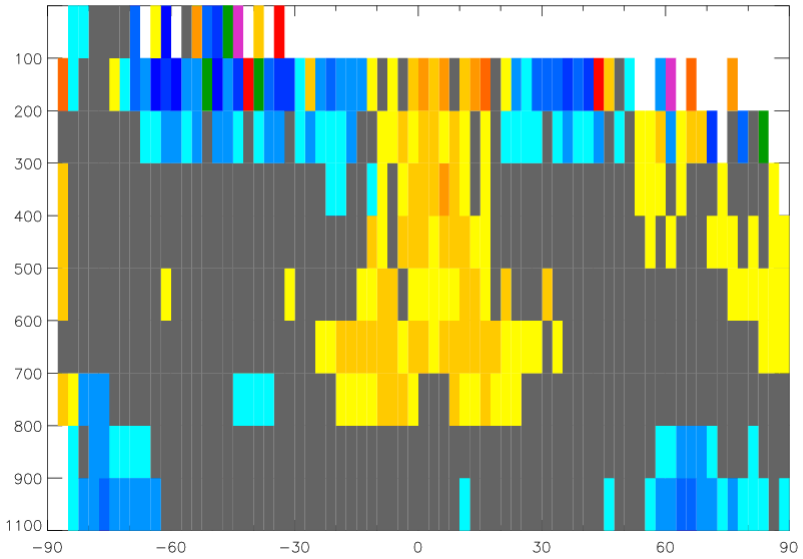
Basic description:

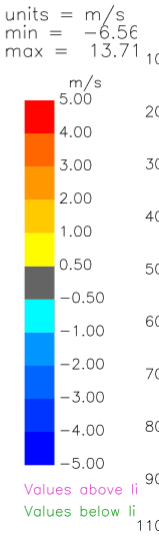
- Dual satellite AMV product derived from Sentinal-3 A/B
- Time spawn: from 10/05/2022 to 11/06/2022 and 01/12 to 31/12/2022
- Data in new AMV BUFR sequence 3-10-077
- Data stored in observation data base and assimilation code expand to use the new Sentinal-3 AMV data
- For the monitoring the Common QI without forecast was used
- FG denotes a three hourly forecast of the ICON model within the data assimilation cycle. There is a 3 hourly DA cycle

Obs minus FG statistics
Sentinal 3 AMVs

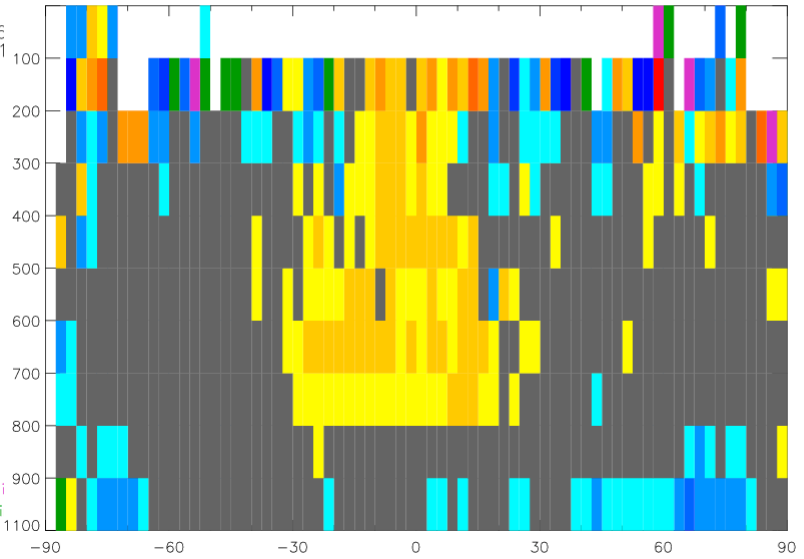
Latitude over height plot
QI > 80

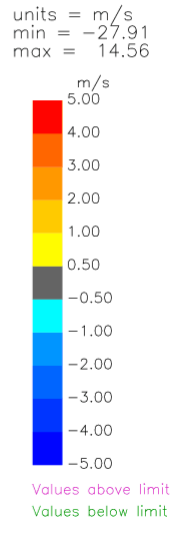
10/05/2022 – 11/06/2022





01/12/2022 – 31/12/2022



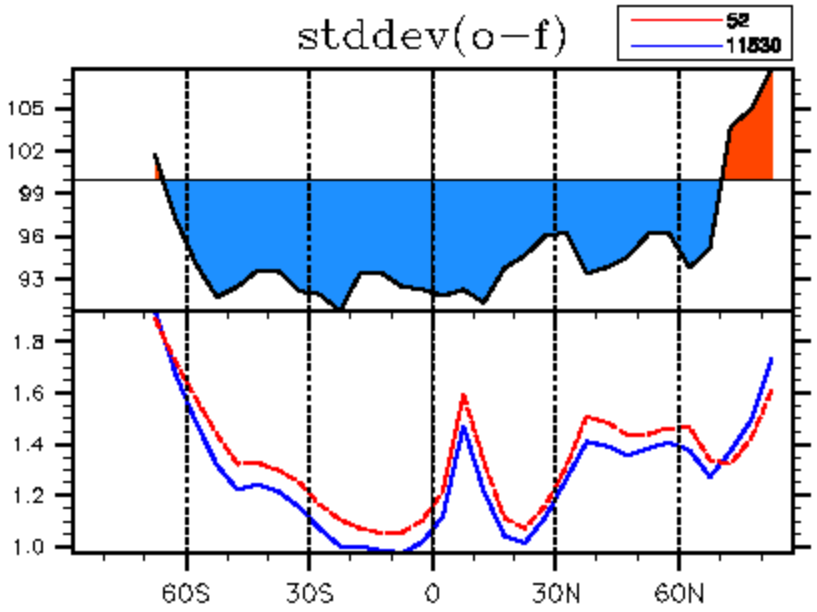


Bias largest in the tropics
Large biases above 300 hPa
Negative biases in the lower troposphere north/south of 60°N/S
Bias behavoir very consistent between summer and winter

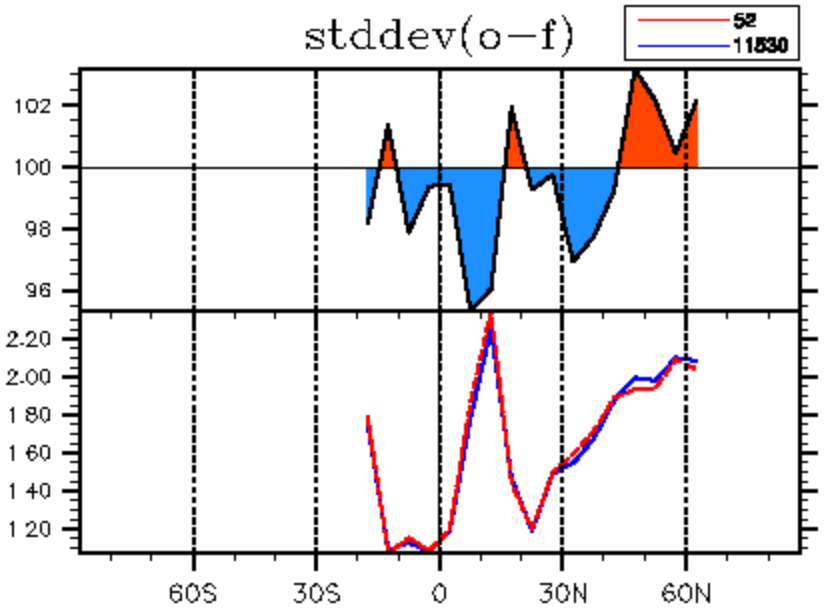
HY-2B/C scatterometer winds
OBS minus First Guess statistics

2022100100 – 2022111121
Windspeed

Metop scatterometer



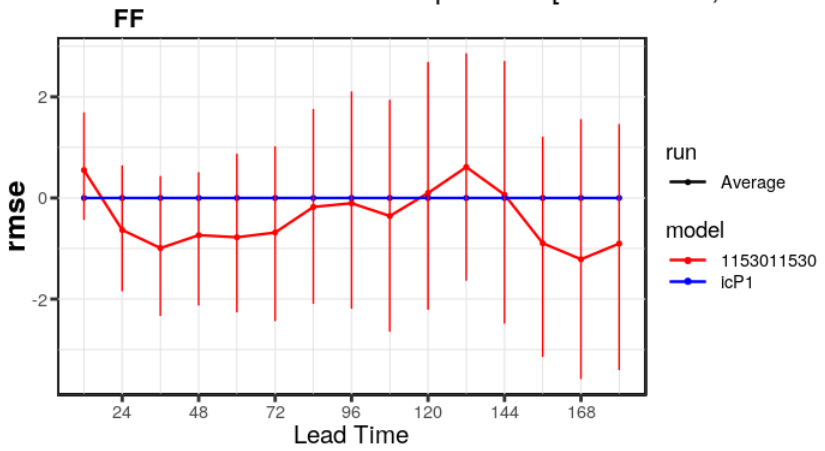
Buoys



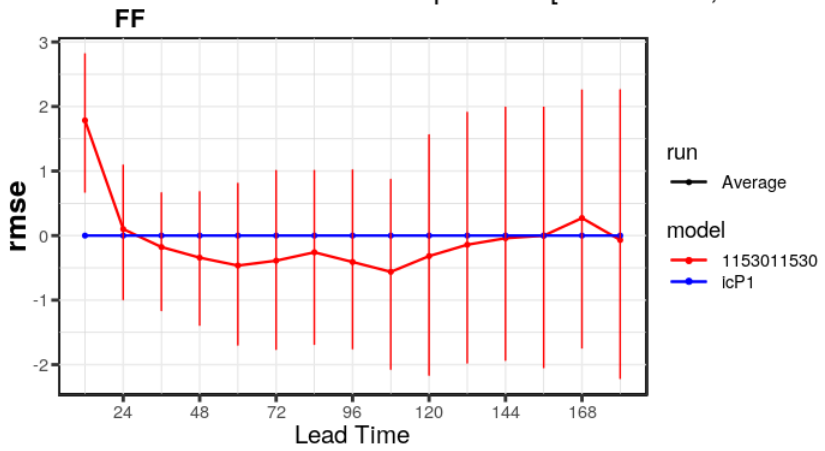
Clear positive impovement of the use of Metop scatterometer by intoducing HY-2B/C
Small positve impact of using bouy data in the tropics/subtropics

HY-2 B/C scatterometer experiment
Verification against analysis
Windspeed 1000 hPa

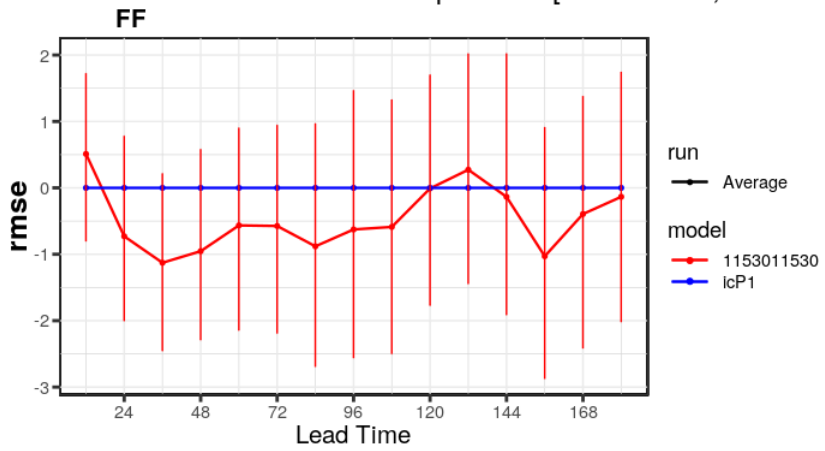
NH



TR



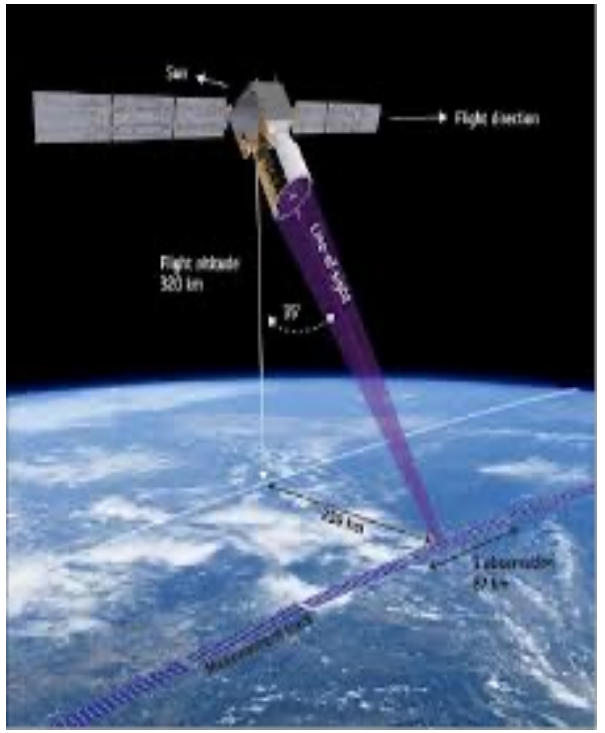
SH



- Postive impact of chinese scatterometer on forecast quality in 1000 hPa up to 5 days
- Impact larger in the Extra-tropics
- Forecast impact decreases with height

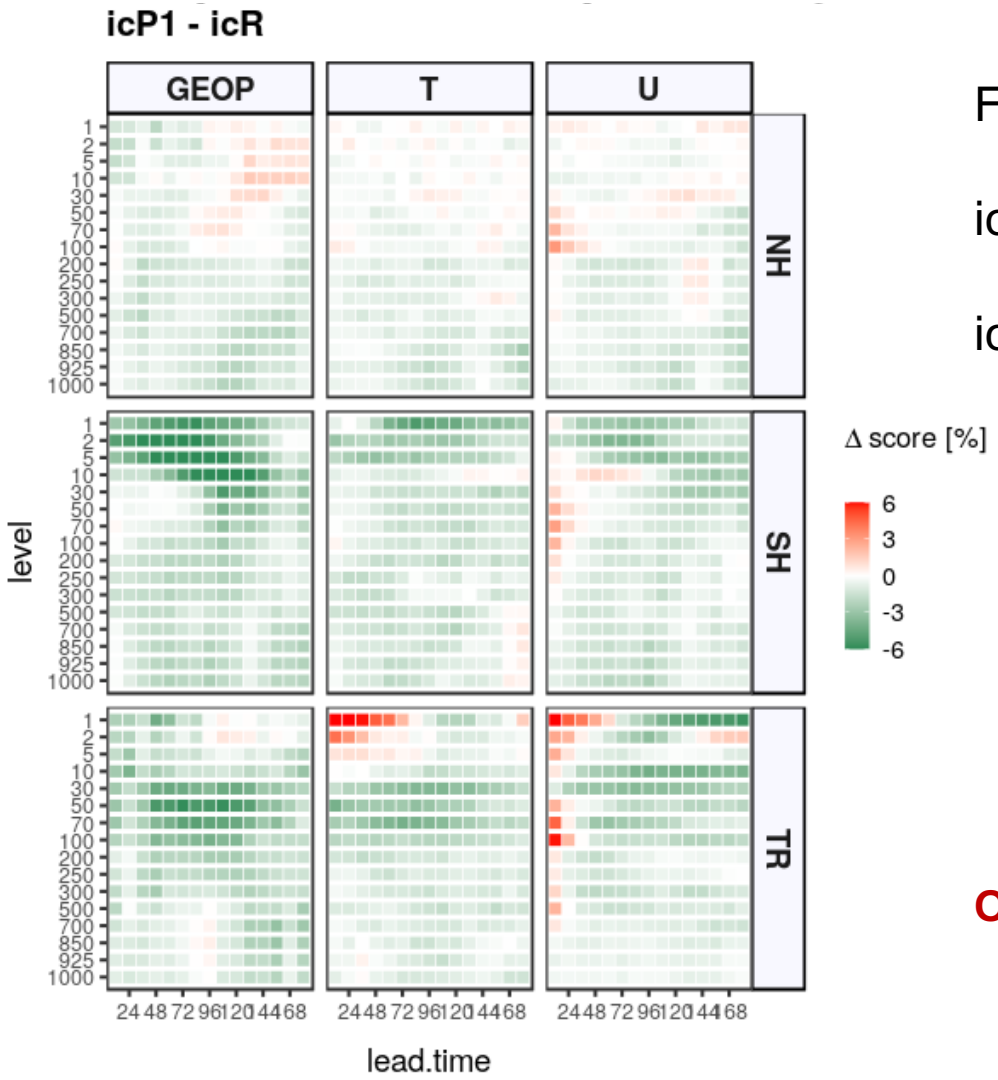
Aeolus Wind Lidar work

- *Aeolus launched in August 2018*
- *Observation variable: HLOS*
- *Level 2B Cal/Val dataset provided by ECMWF*
- *Data are provided in Bufr Format*
- *First laser operated till beginning of June 2019*
- *Second laser data available in July 2019*
- *German activities bundled in Project EVAA*
  (Experimental Validation and Assimilaton of Aeolus data)
- *Several impact experiments conducted with data from first and second laser*
- *All the activities resulted in the:*



➢ ***Operational use of Aeolus wind observations since 19th May 2020***

Score Card
Verification against own analyses
20200426 - 20200520



Final test before operational use

icP1: Experiment with operational setup including Aeolus data

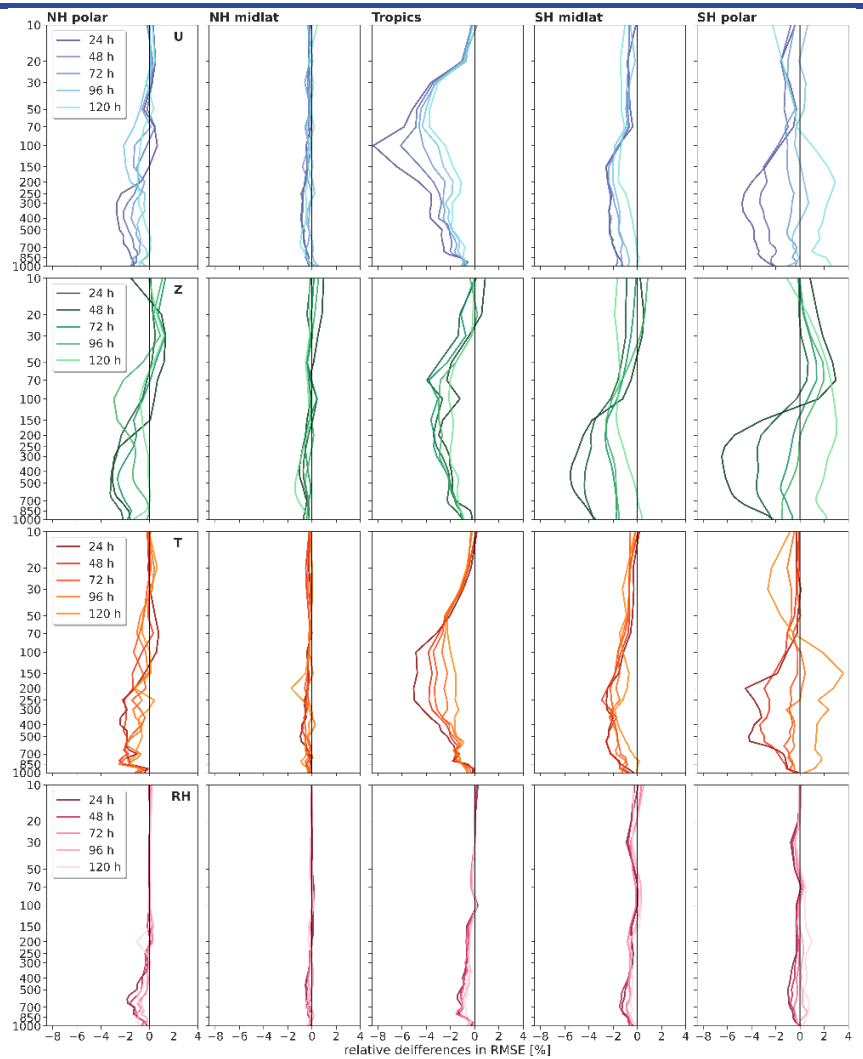
icR: Operational setting without Aeolus data

Green: positive impact of icP1
red: negative impact of icP0

Clear positive impact using Aeolus HLOS wind data

Operational use since 19th May 2020

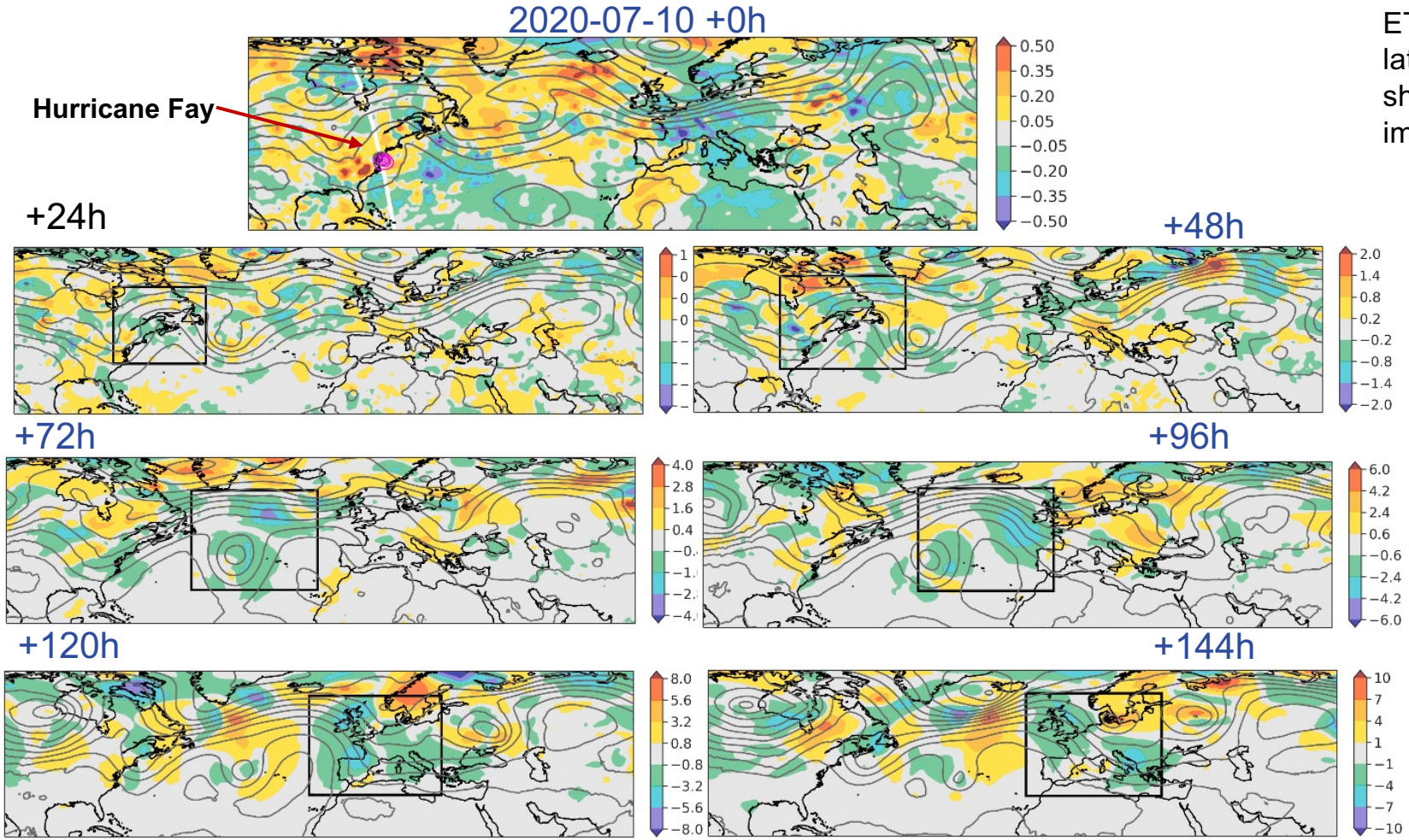
Normalized RMS reduction against ER5 analysis data



- largest positive impact occurs in tropics around the tropopause for zonal wind, geopotential and temperature
- improvements in forecast (up to 3 days) of geopotential are large in the troposphere on the SH and the polar region of the NH
- forecast of relative humidity is mainly improved in the lower troposphere in the tropics and polar region of the NH. Small improvments also on SH.
- smallest but positive impact of Aeolus winds occur in the midlatitudes of the NH for all variables

Extratropical transition (ET) of tropical cyclones – interaction with the midlatitude flow

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Difference in forecast error of experiment with/without Aeolus wind observations

ET can lead to increased forecast uncertainty of the mid-latitude waveguide by upper-level divergent, vertical wind shear and cirrus clouds leading to negative forecast impact of severe weather events over Europe.

- Aeolus track passes directly over cyclone and trough
- Large analysis differences in vacinity of trough after +48h forecast error reduction downstream of the developed trough
- A day later a substantional trough-ridge system developed over the Atlantic with a strong jet streak
- In the following strong cyclogenesis accord over the Atlantic, along with large forecast error reductions after 5/6 days largest forecast error reduction found over Europe

Improvements by Aeolos winds presumebly caused by better coverage of upper troposheric outflow and latent

- ➢ Heat release by cyclone Fay
- ➢ Beneficial capture of dry baroclinic flow dynamics

Summary

- Satellite winds are an important contribution to the global observing system
- High impact in data assimilation and forecasting system of DWD
- Integration of new satellite wind products are ongoing work
- Open for collaboration with EUMETSAT to test new poducts
  - Test of IASI AMV test data
  - Monitoring of dual Sentinal-3 AMV product
- Integration of Aeolus wind lidar observations successful
  - ➢ Large impact in the upper troposphere lower stratosphere in the tropics and on both hemispheres
  - ➢ Operational use since May 2020
- Monitoring and use of new scatterometer data like HY-2B/C

Thank you for listening