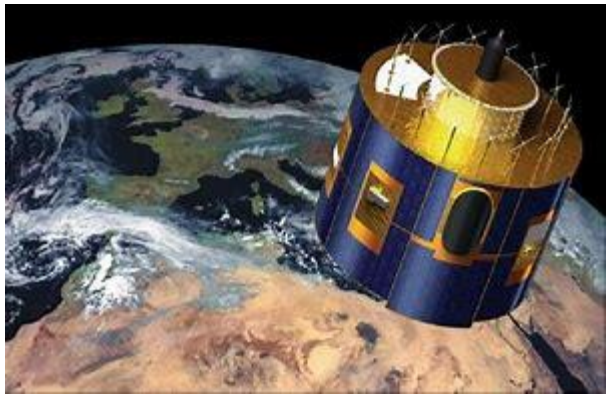
Allsky Assimilation of SEVIRI-WV channels in ICON-D2

- status September 2021-

Annika Schomburg

*and many many others (Liselotte Bach, Christina Stumpf, Christoph Schraff, Roland Potthast, Robin Faulwetter, Christina Köpken-Watts, Thorsten Steinert, Hendrik Reich, Thomas Deppisch, Felix Fundel, etc **etc**….)*



COSMO – GM 2021

Outline

- Characteristics of SEVIRI WV channels
- First guess statistics
- Localization and height assignment
- Assimilation settings
- Results
  - Baseline experiment
  - Experiment without vertical localization
  - Experiment with transmission for height assignment
- Observation error modeling
  - Approach
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- Summary, open issues and next steps

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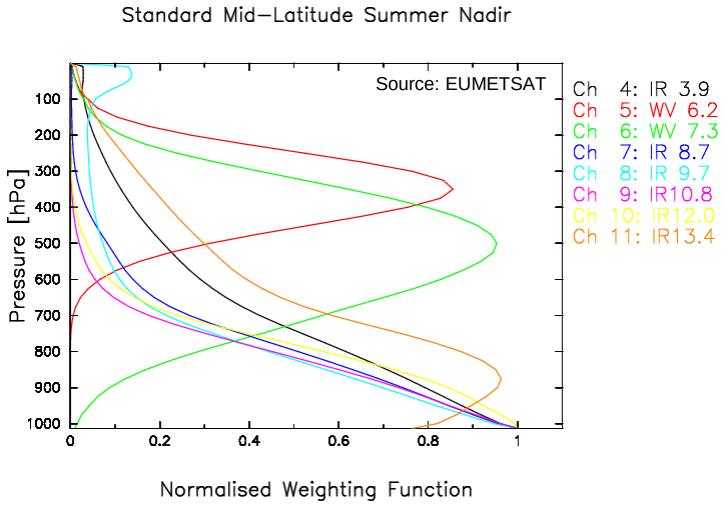
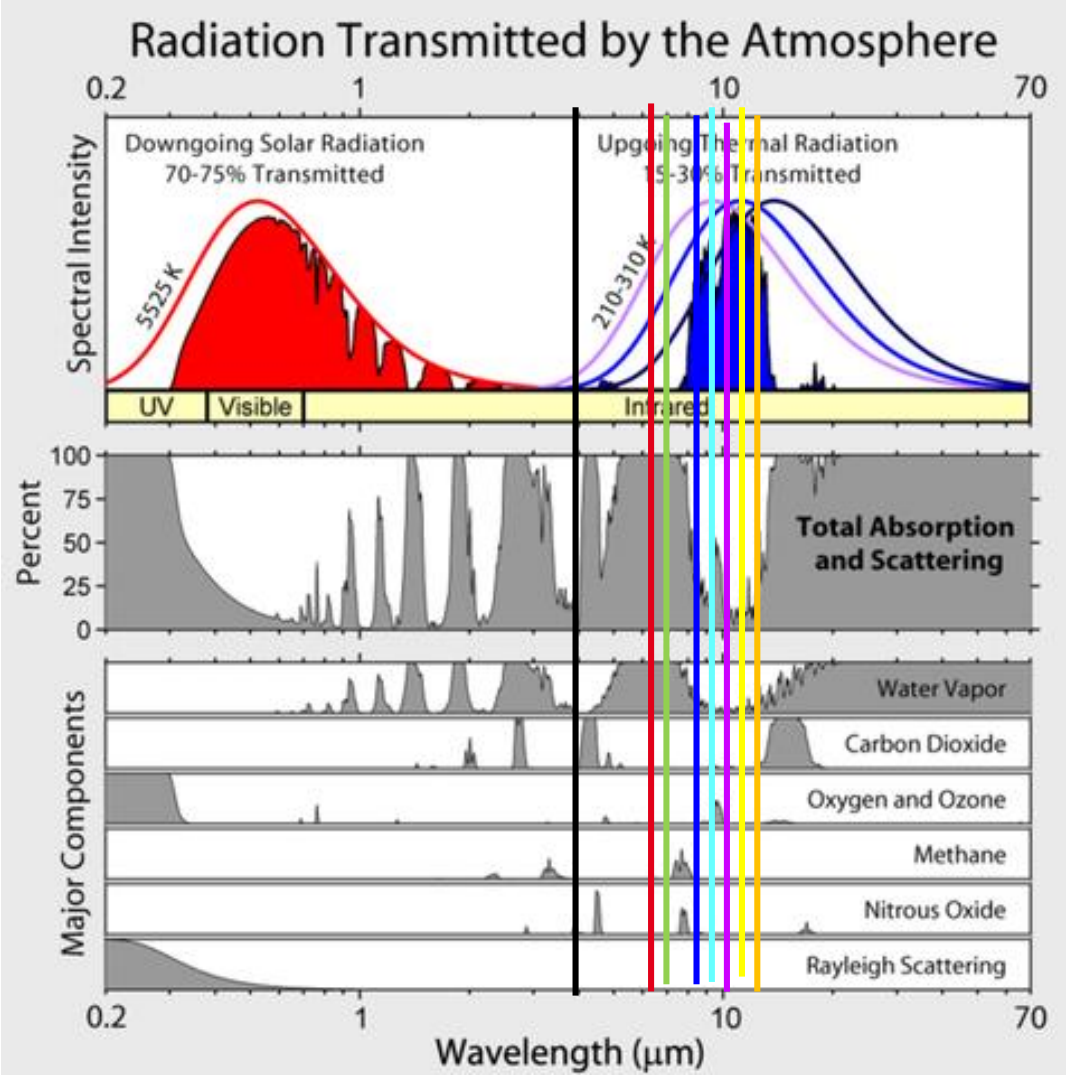
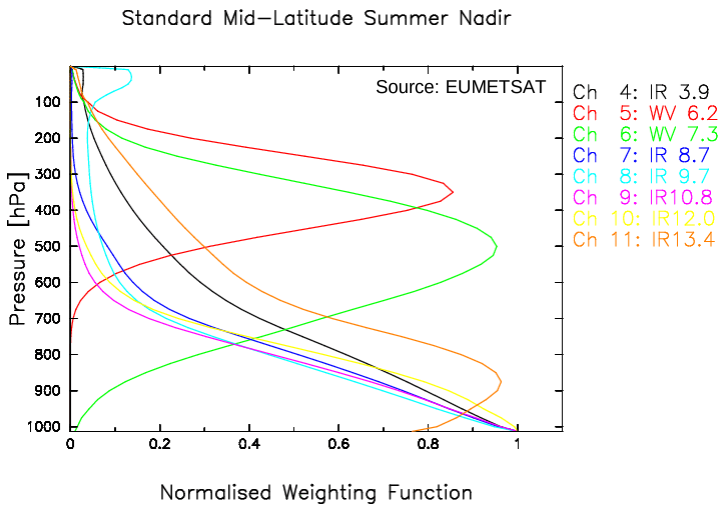
Sensitivities of SEVIRI channels

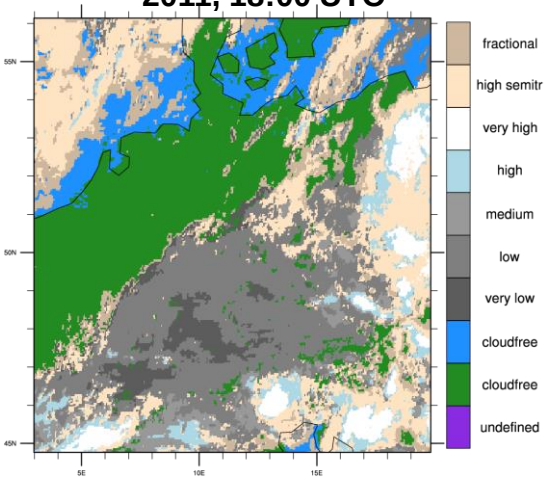




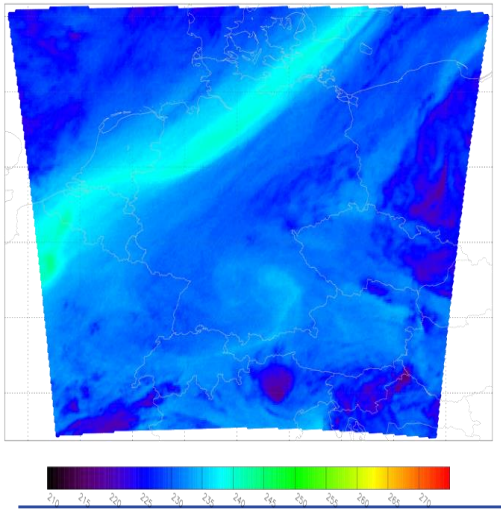
Sensitivities of SEVIRI IR channels



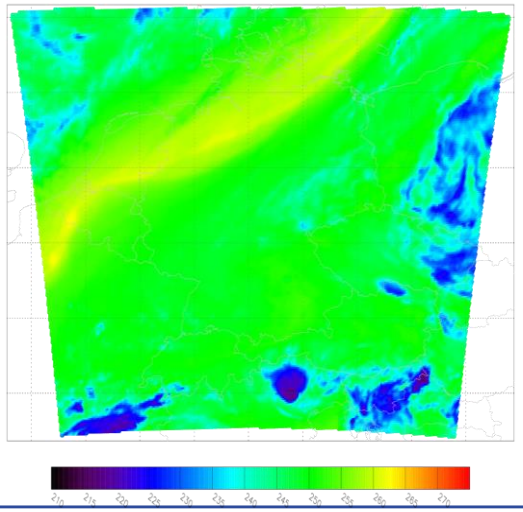
Cloud classification at 1 June 2011, 18:00 UTC



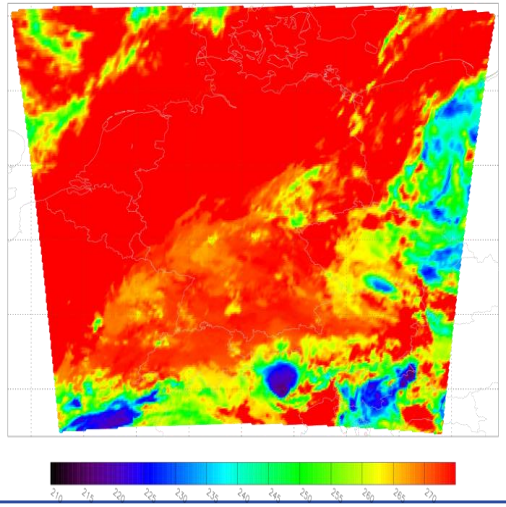
WV6.2



WV7.3



IR10.8



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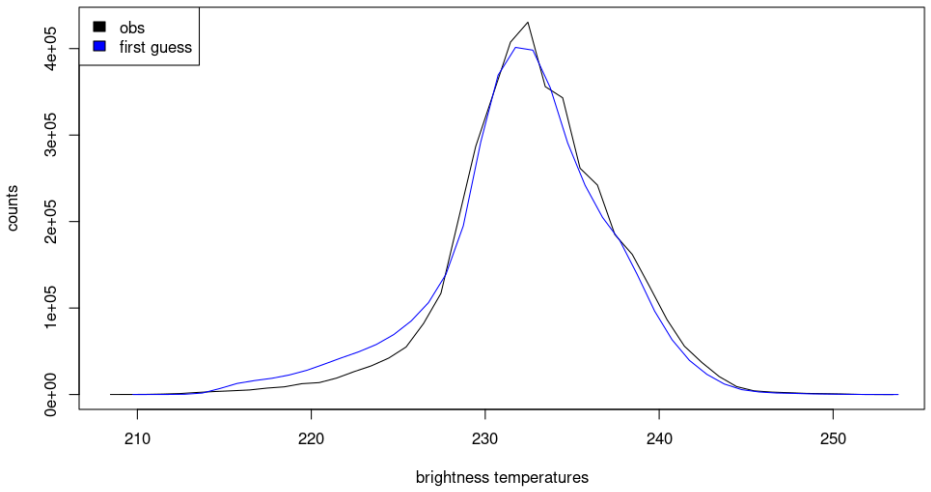
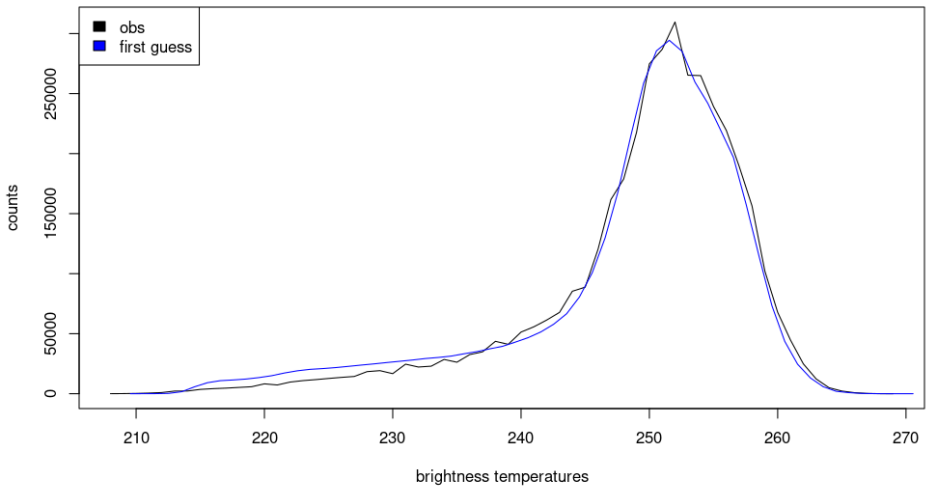
TB distribution (23 days in August 2020)

WV6.2**µm**



WV7.3**µm**



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Localization and height assignment

- Horizontal localization radius: 35km
- Vertical localization: satellite radiances are integral measurements over the whole vertical column → Two options:
  - **Do not localize vertically**, assign the same weight in the LETKF for the whole vertical column of the members
  - Assign a height where the satellite **radiance is most sensitive**, localize around this height.
    - Based on the Jacobians (output of RTTOV-k-Module, but expensive!)

$$w(l) = \frac{\frac{\partial H}{\partial T}(l) \cdot STD(T) + abs(\frac{\partial H}{\partial q}(l) \cdot STD(q))}{p_{thick}(l)}$$

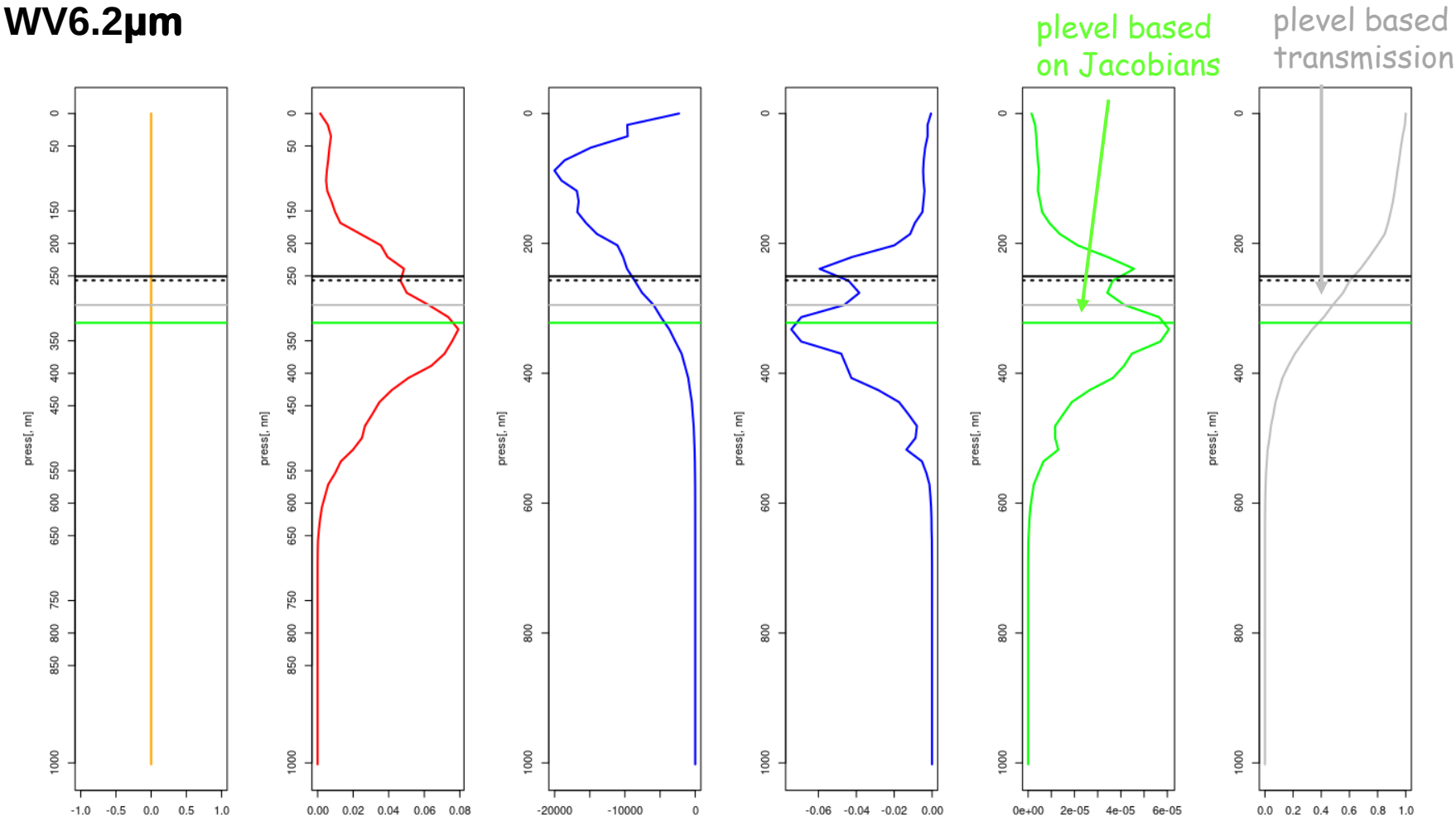
$$plev = \frac{\sum w(l) \cdot p(l)}{\sum w(l)}$$

    - Based on the transmission (output of RTTOV): $t(s_1, s_2) = \exp(-\tau(s_1, s_2))$
      - Assign to height where the transmission as seen by the satellite has dropped to 0.5

Optical depth

Vertical height assignment: Example for cloud-free column

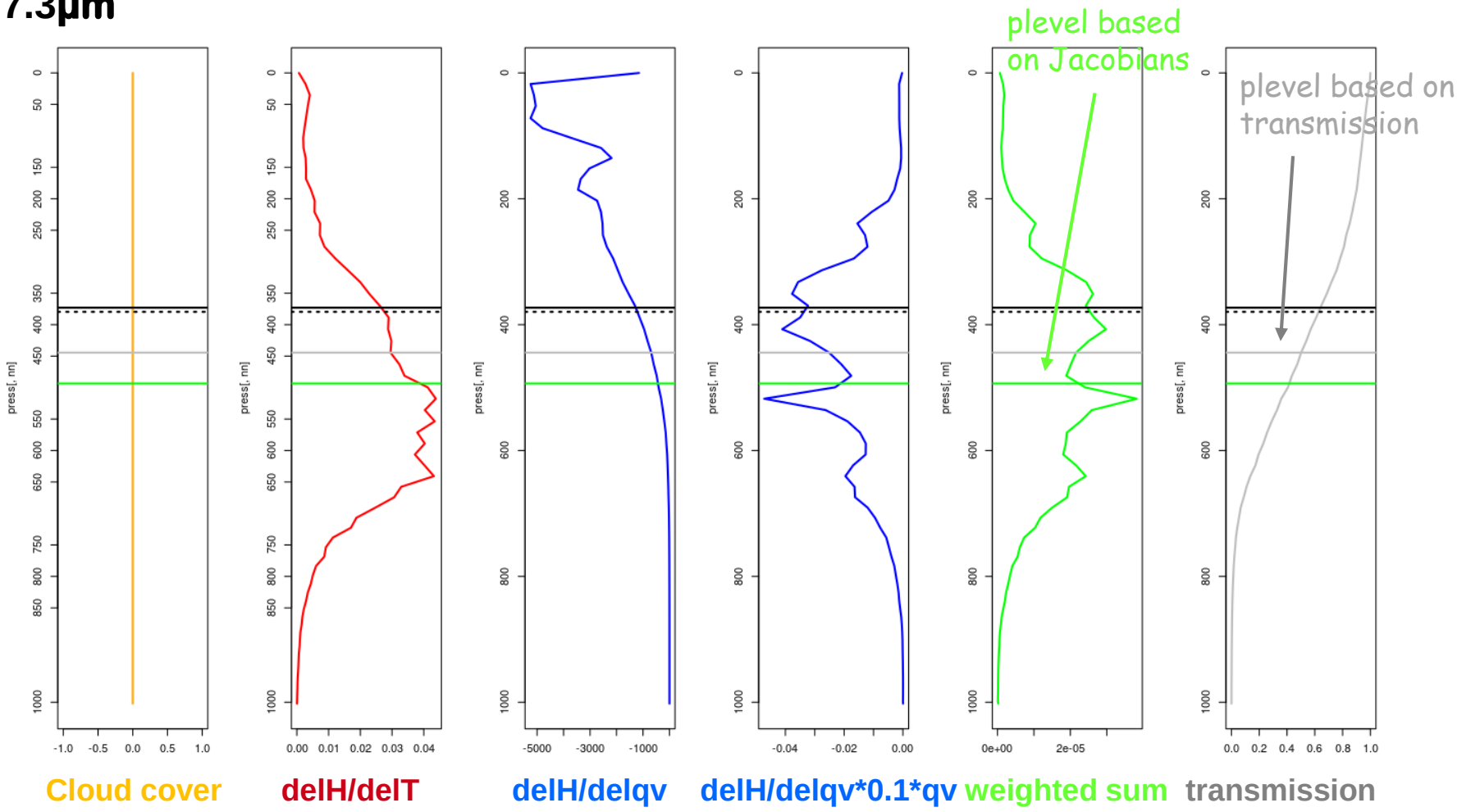
WV6.2µm



Vertical height assignment: Example for cloud-free column

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

WV7.3µm



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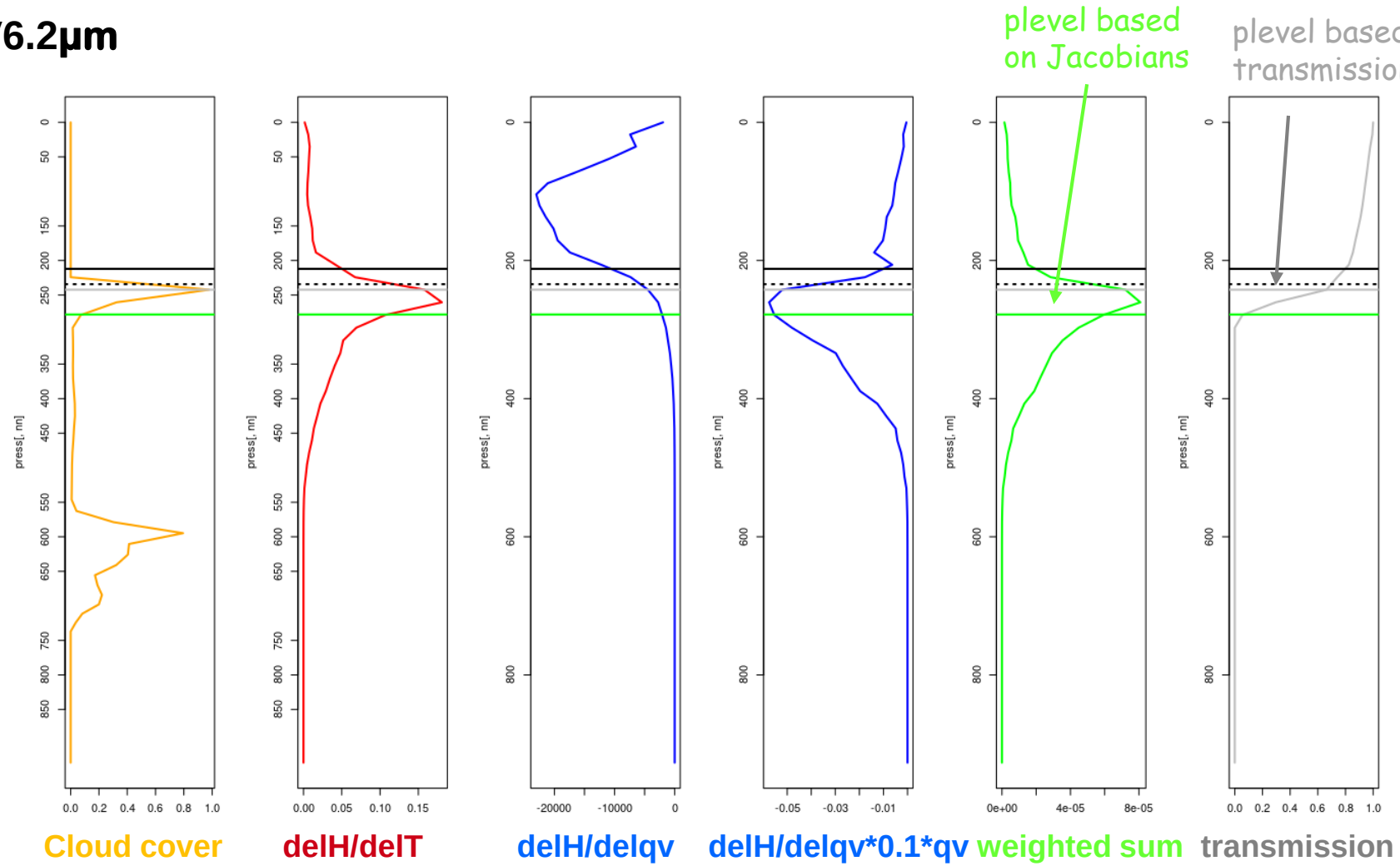
WV6.2µm



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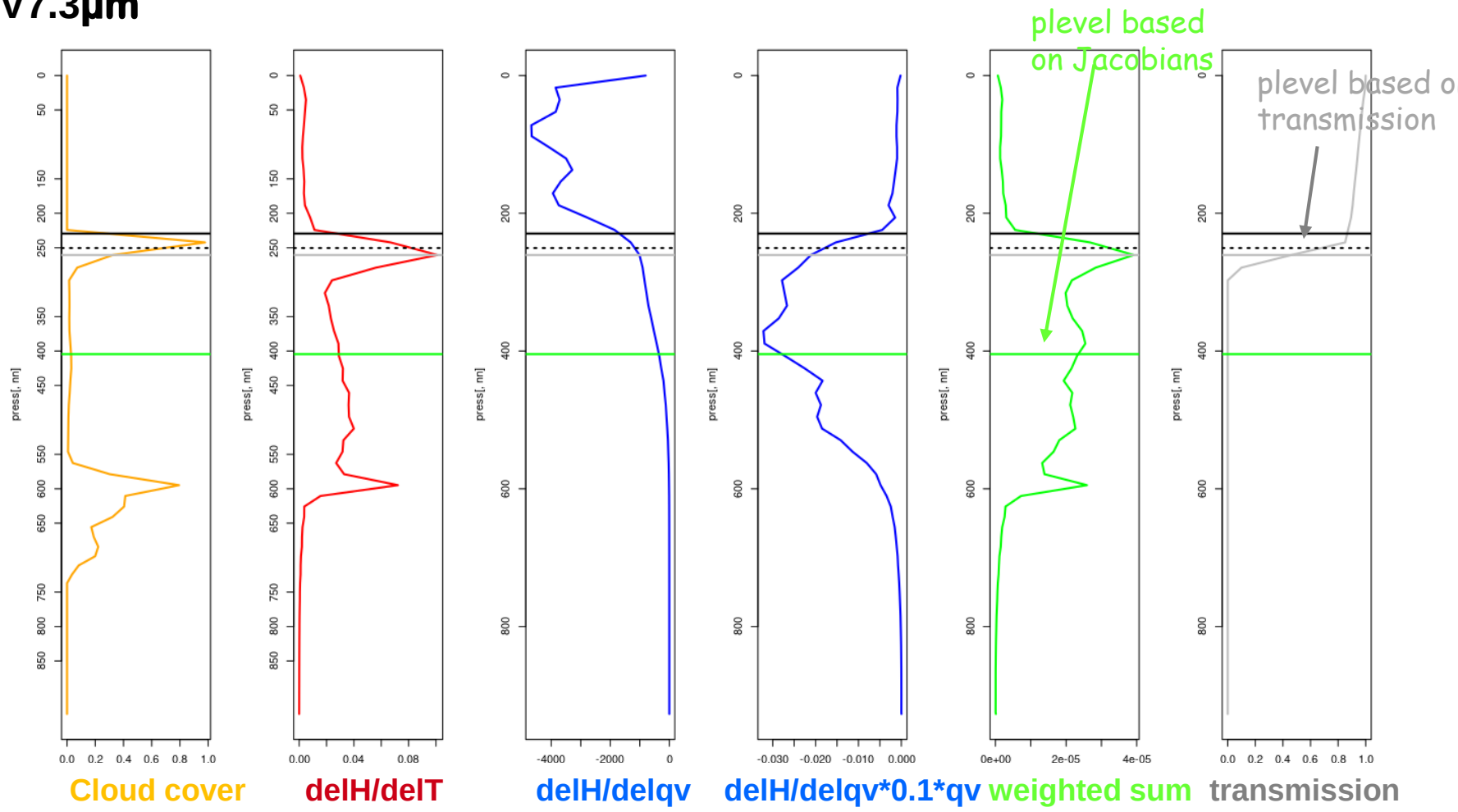

- By these approaches one gets **a different height for each member…**

  → Within the LETKF **the highest plevel of all members** is chosen

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Baseline experiment: Settings

- Assimilated data: **Conventional data, 2mT&RH, 3D Radar radial winds and reflectivity, Latent Heat Nudging, SEVIRI WV channels**
- **Reference experiment: Identical but no SEVIRI**
- Period: **23days**: 3 - 25 August 2020
- Observation operator RTTOV13
  - Via MEC-light (datool)
- Allsky
- No bias correction
- Observation error: **constant error of 6K for both channels**
- Thinning: take every 4th pixel (in both directions)
- **Height assignment dependent on Jacobians**, vertical localization radius 0.25-0.35 in ln(p), horizontal localization 35km

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Forecast verification: upper air (TEMPS)

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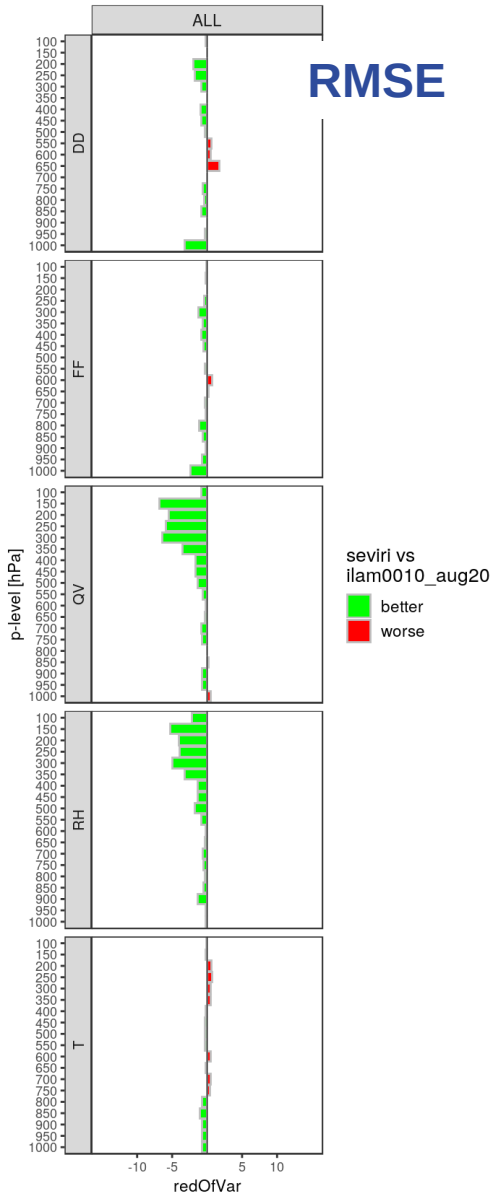
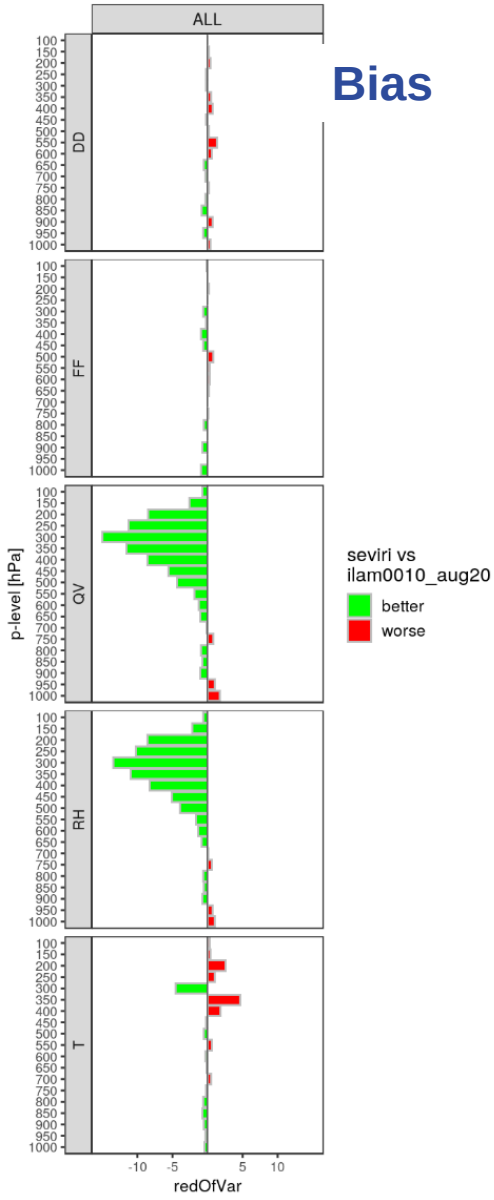
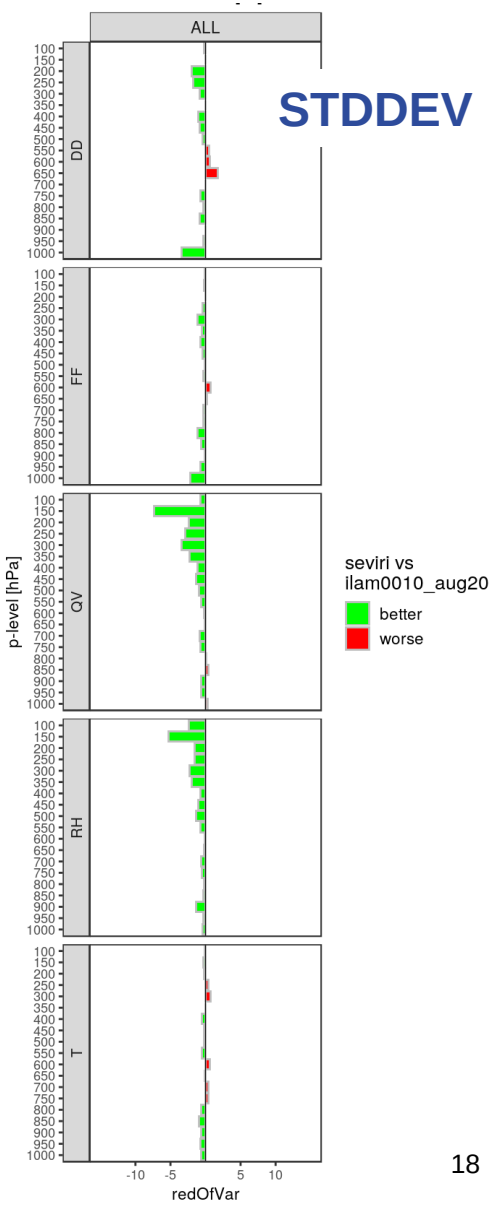
RMSE



Bias



STDDEV



Forecast verification: Surface

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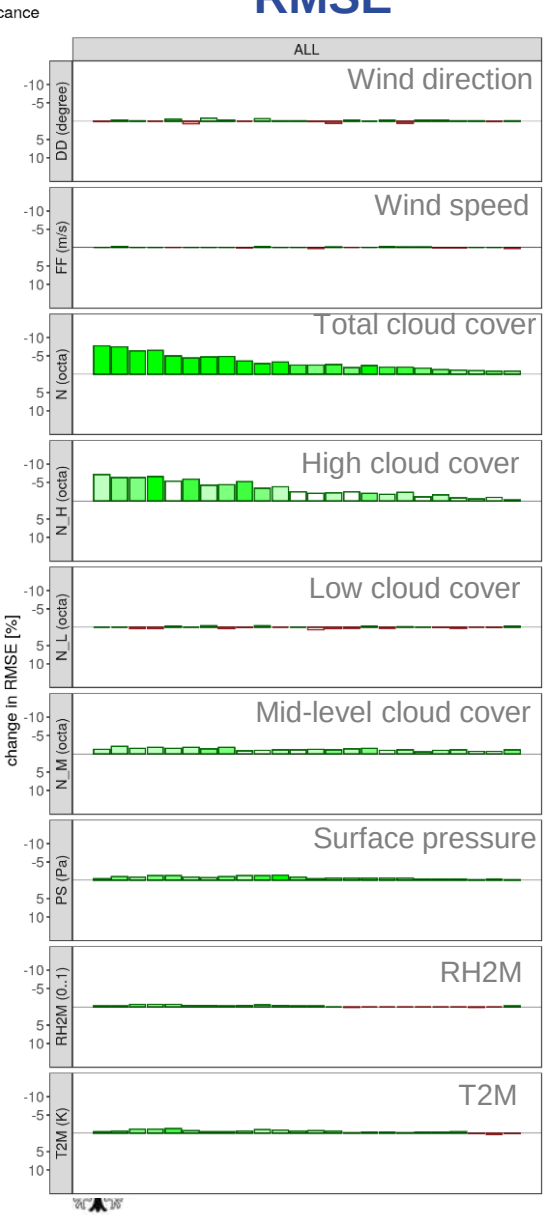
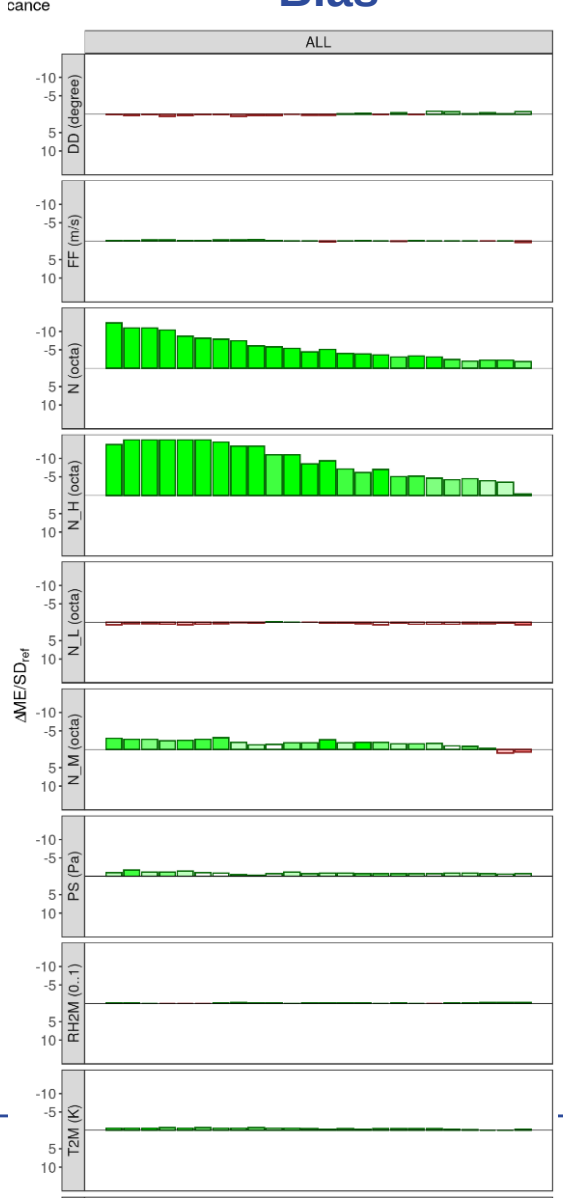
RMSE



Bias



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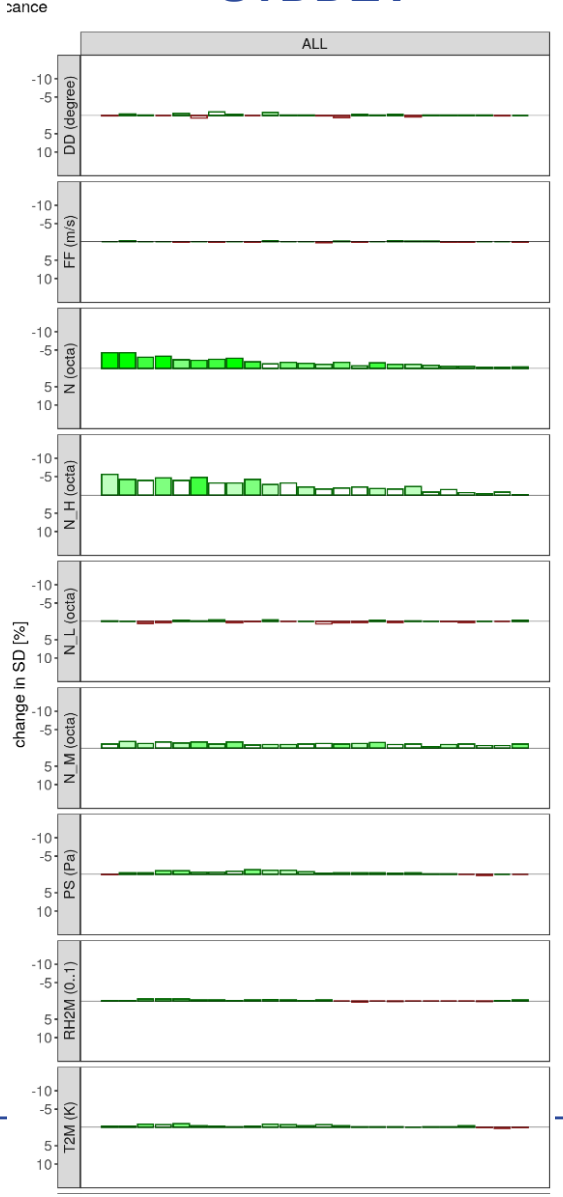
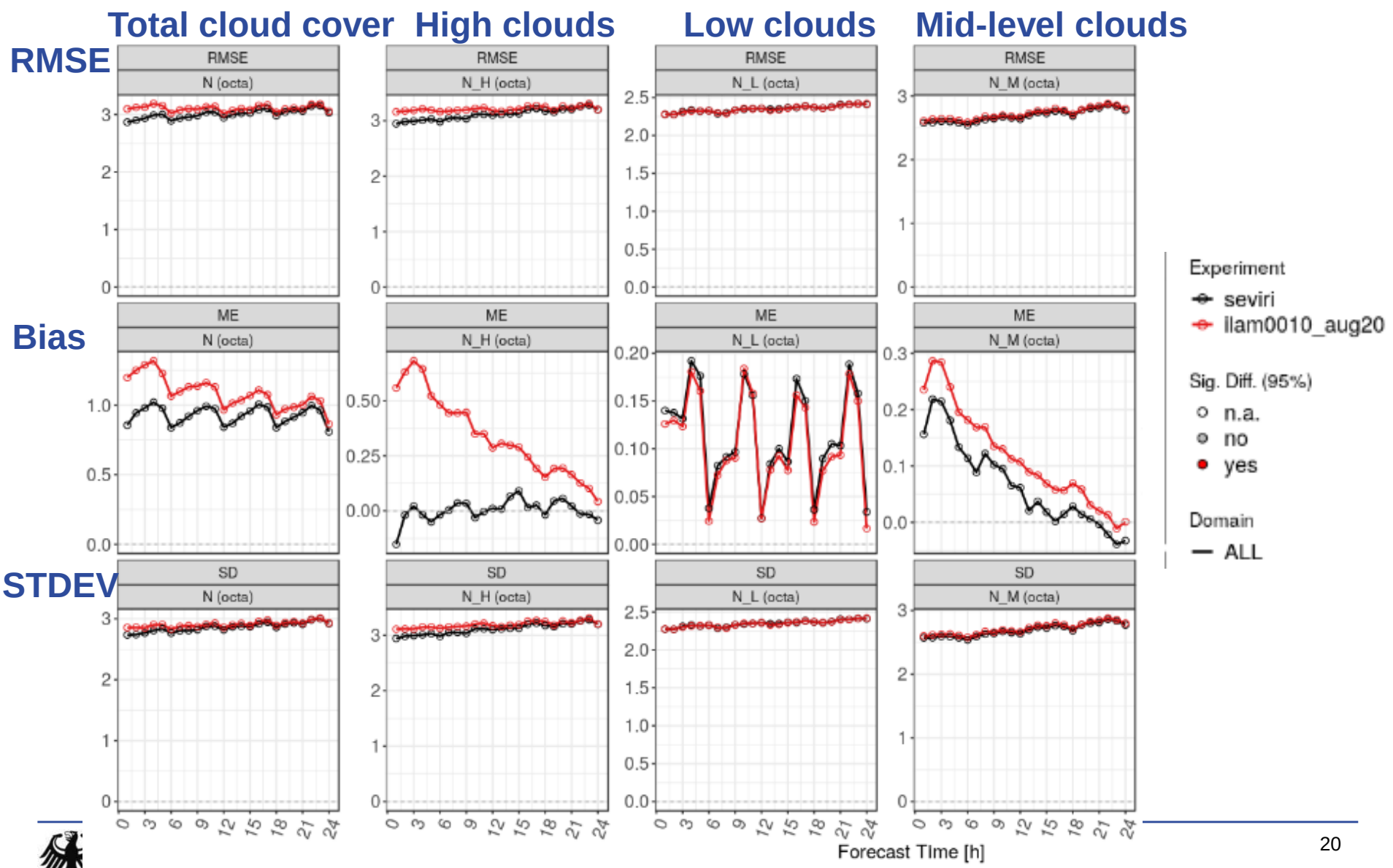
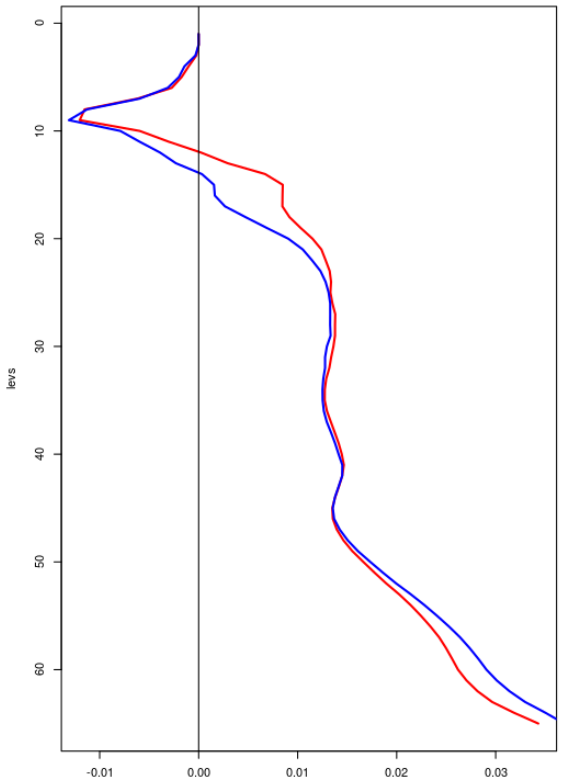


Surface verification (leadtime plots)

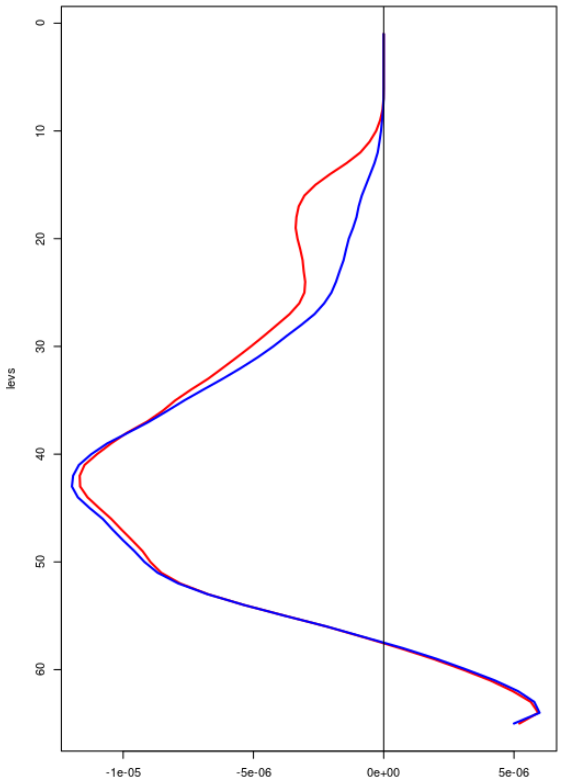


Analysis increments (Temporal and spatial average)

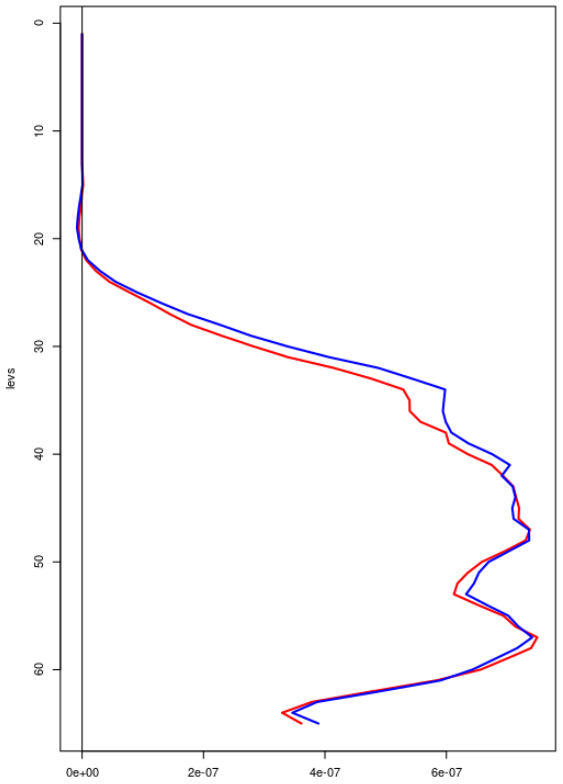
SEVIRI
Ref



T inc

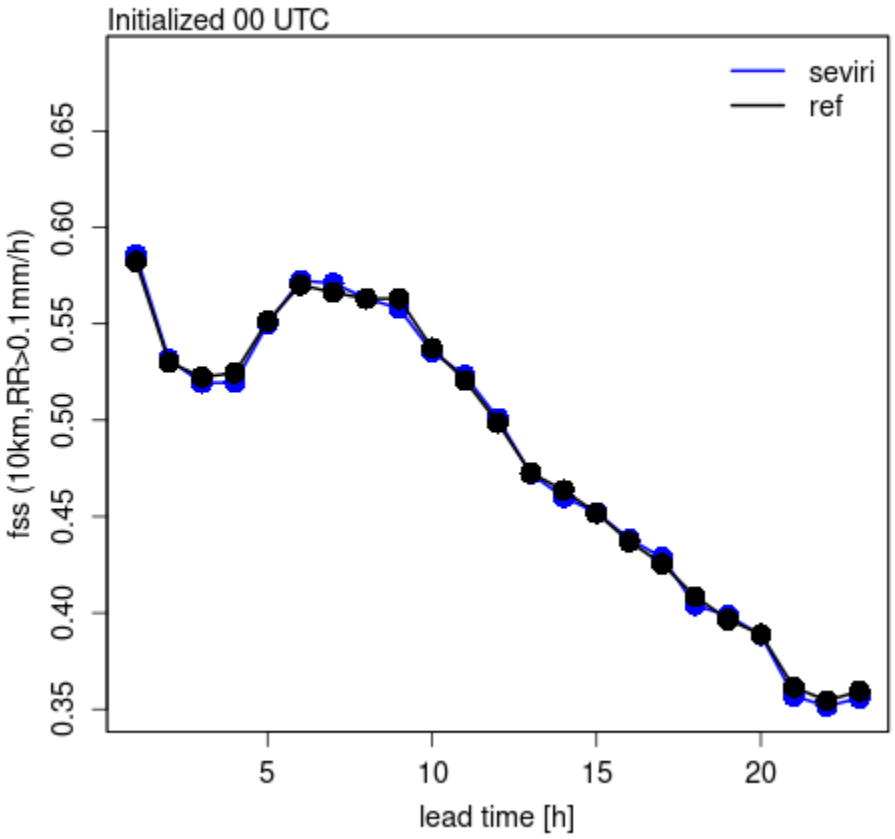


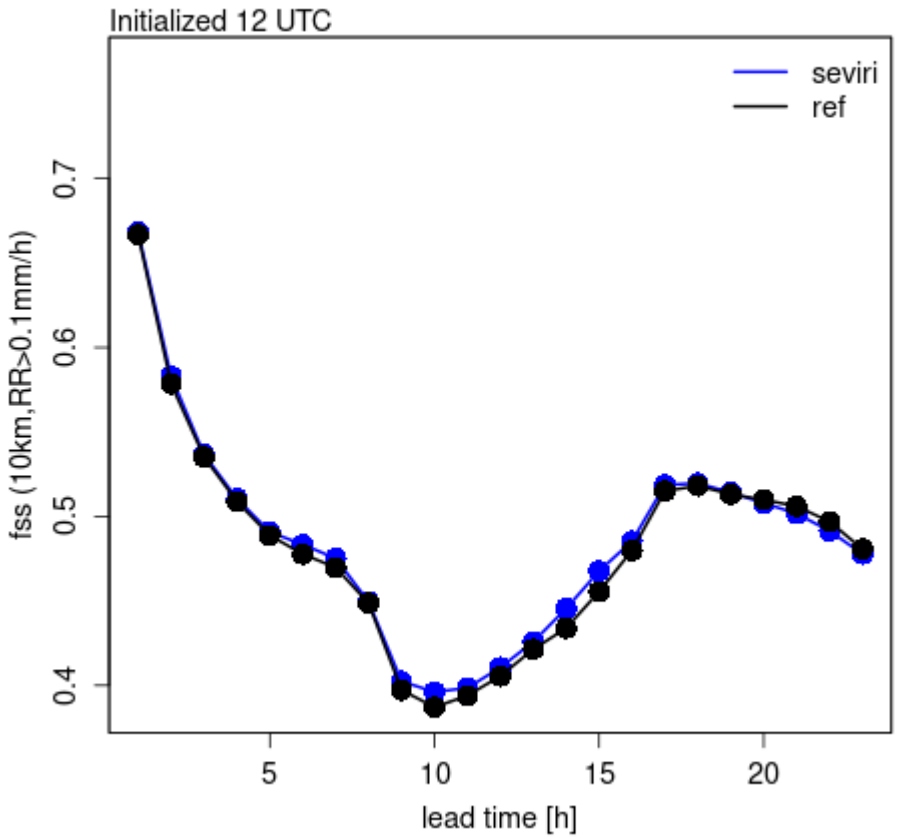
QV inc



QC inc

Precipitation verification





Fractional skill score for 10km area and RR>0.1mm

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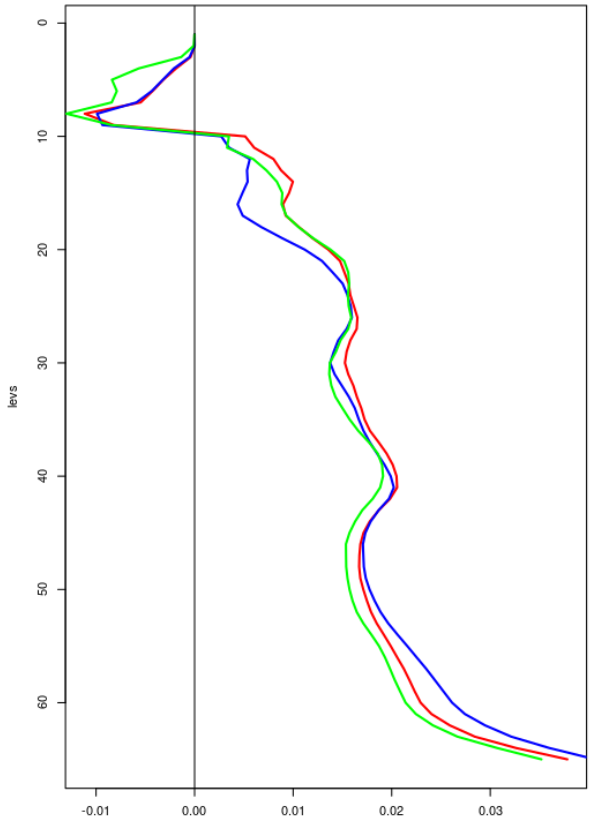
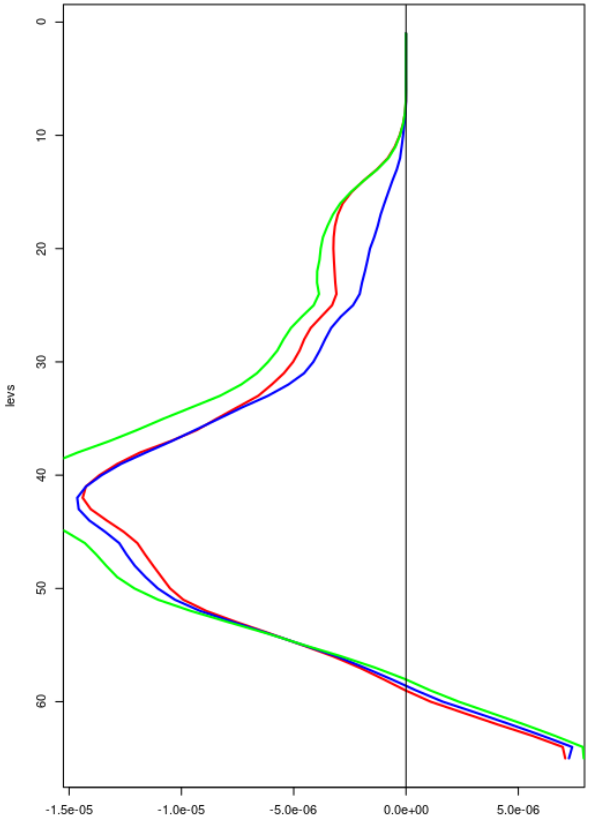
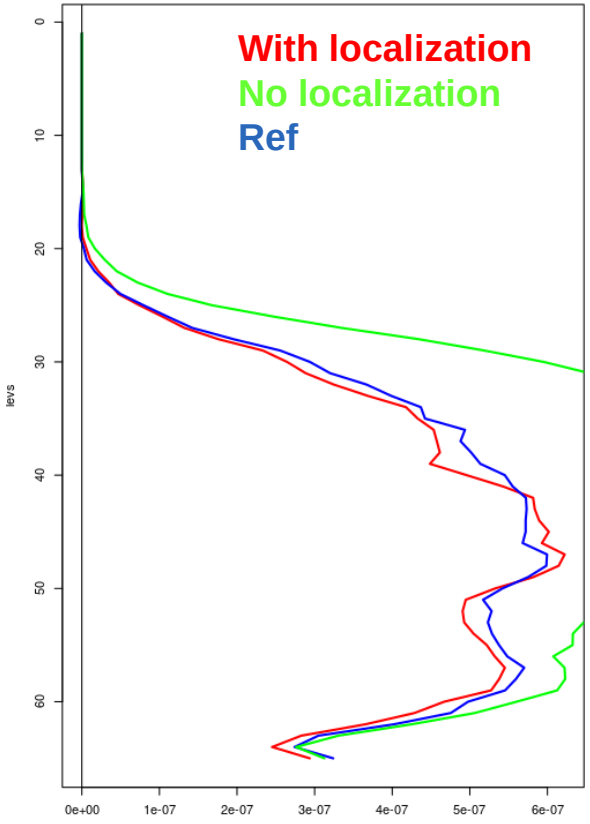
Experiment without vertical localization: Increments



T inc



QV inc



QC inc

Experiment without vertical localization: Analysis and first guess verification

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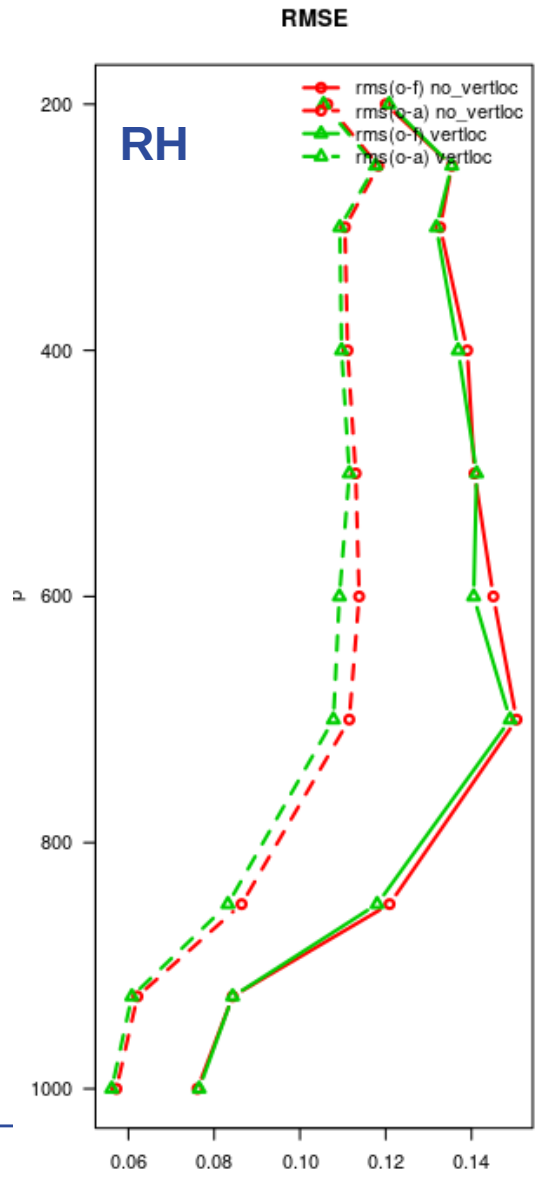

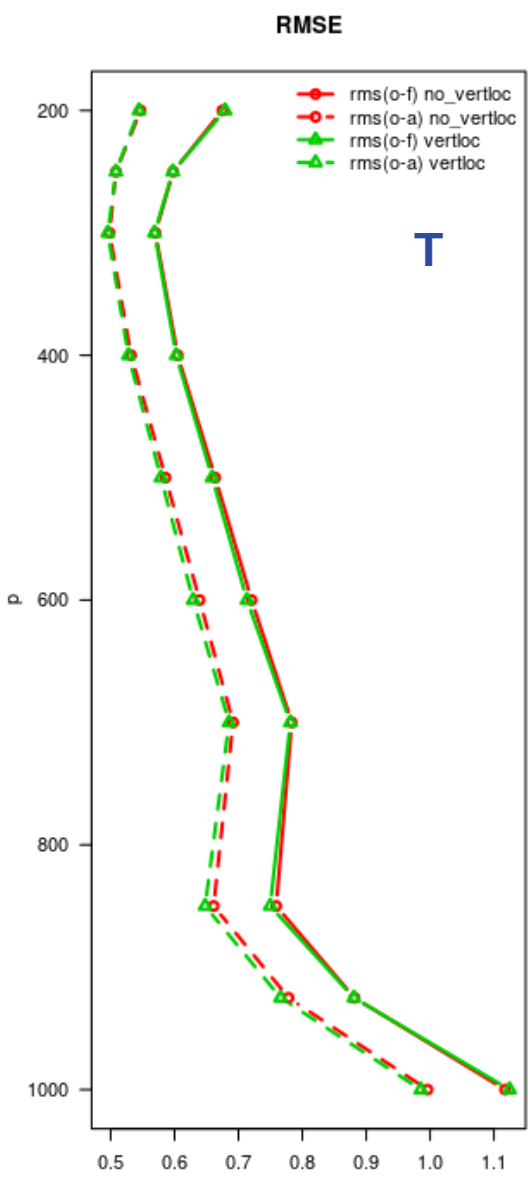

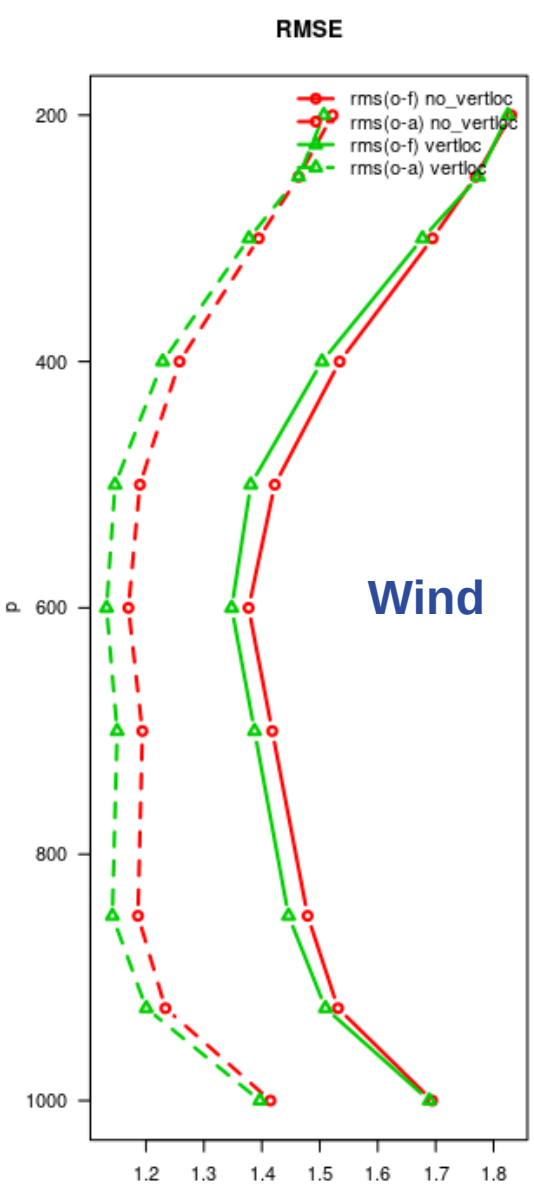

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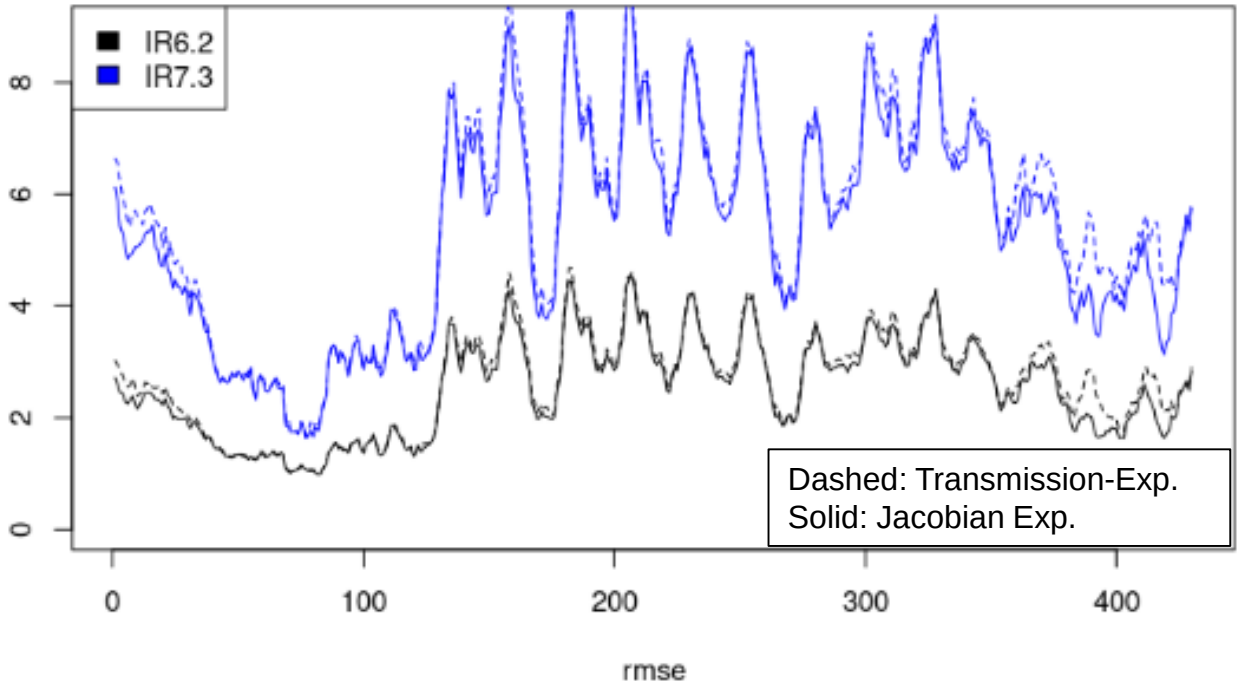
Experiment based on transmission for height assignment

- Gave mostly neutral impact, but sometimes negative impact
  - Reason: Many observations were set to passive because their plevel was now higher than 200 hPa (KENDA does not assimilate observations that high, due to upper boundary relaxation zone to ICON-EU)



Why bad performance of transmission-based height assignment experiment?

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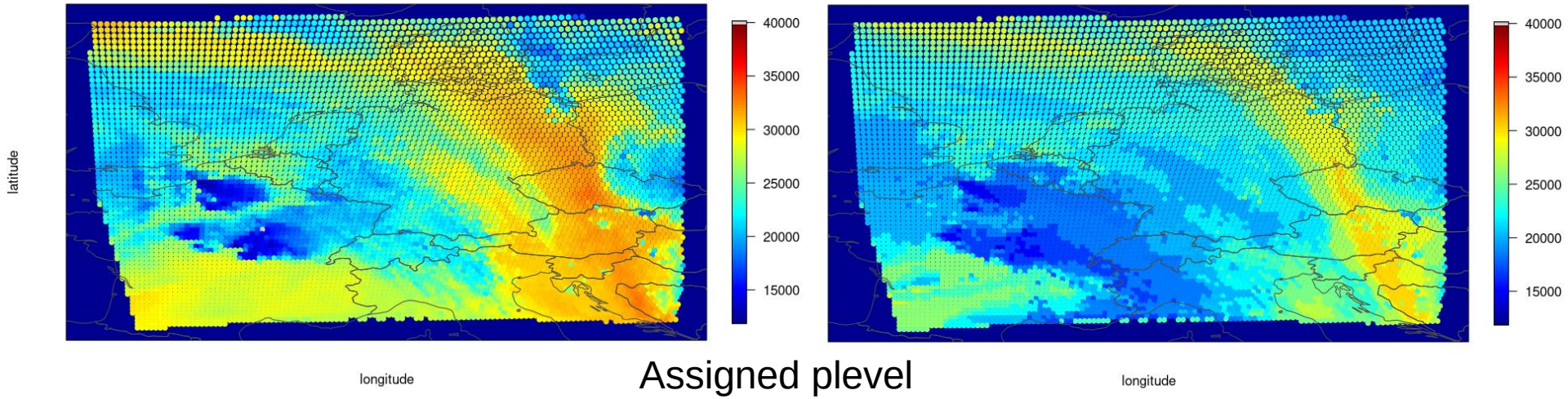
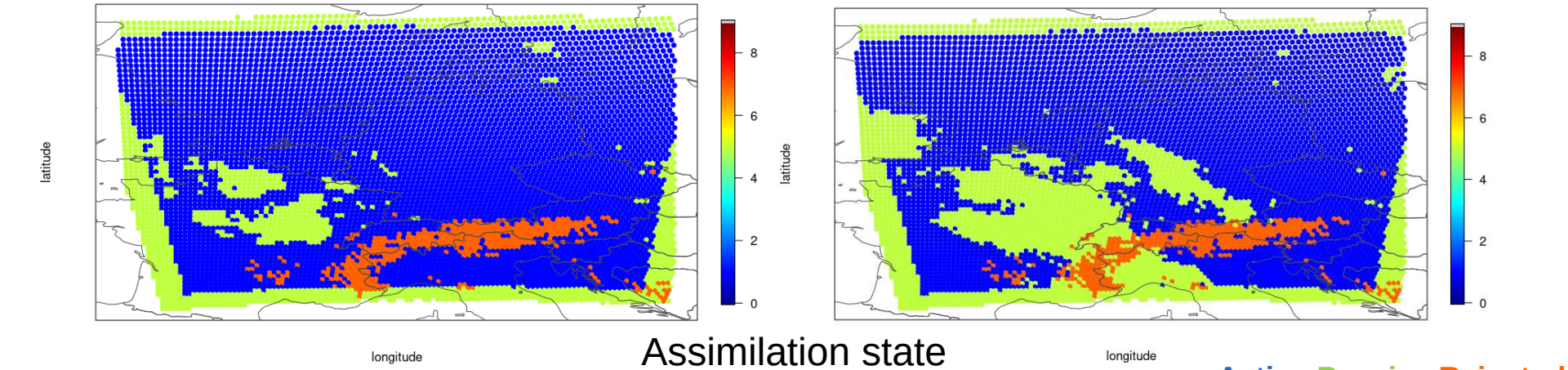
DWD

Jacobian-based height assignment

Transmission-based height assignment



Assigned plevel



Assimilation state

Active Passive Rejected

→ *Next test: set plevel to 201hPa if between 150 and 200 hPa*

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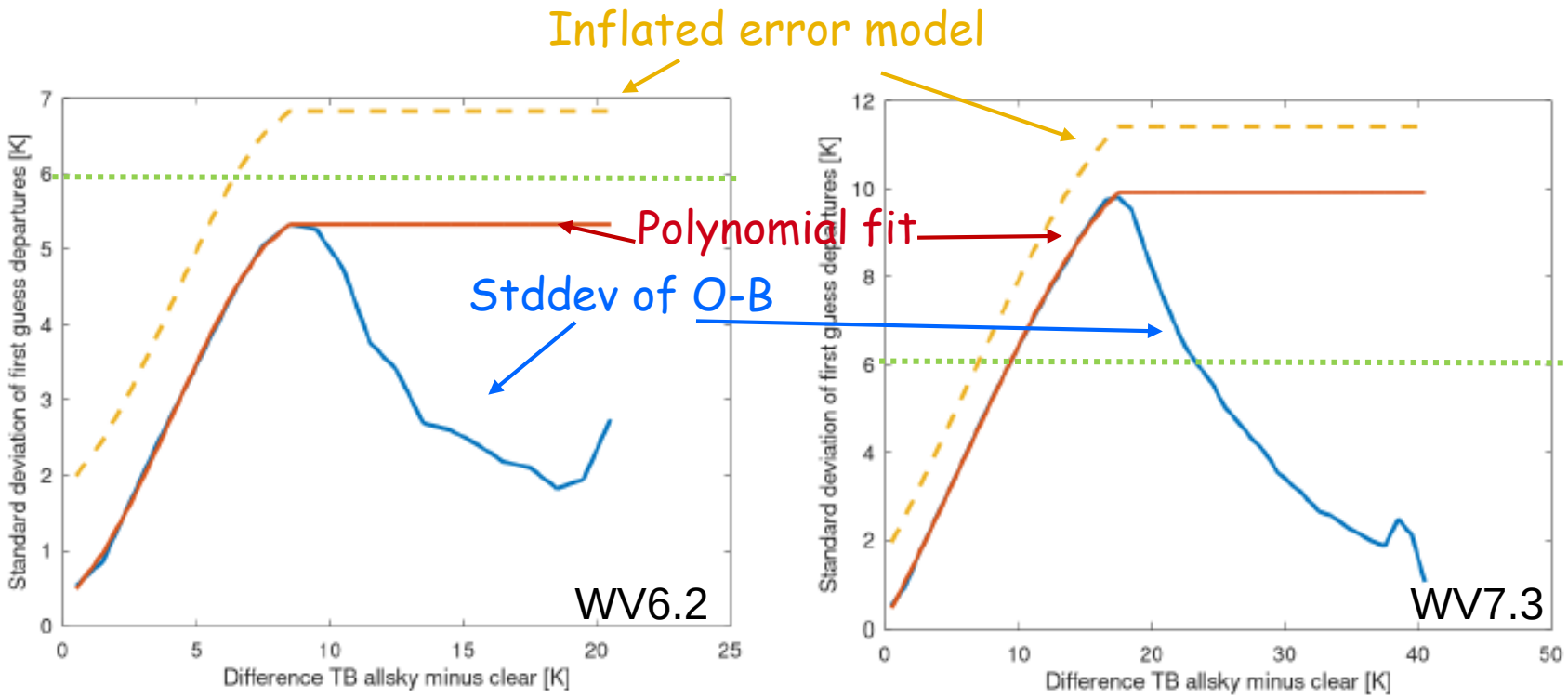
Inflated error model



- Error model based on symmetric cloud impact (fit to standard deviation of first guess departure), see Okamoto et al.(2014)

$$\Delta TB_{sym} = \frac{(|TB^{sim}_{allsky} - TB^{sim}_{clearsky}|) + (|TB^{obs} - TB^{sim}_{clearsky}|)}{2}$$

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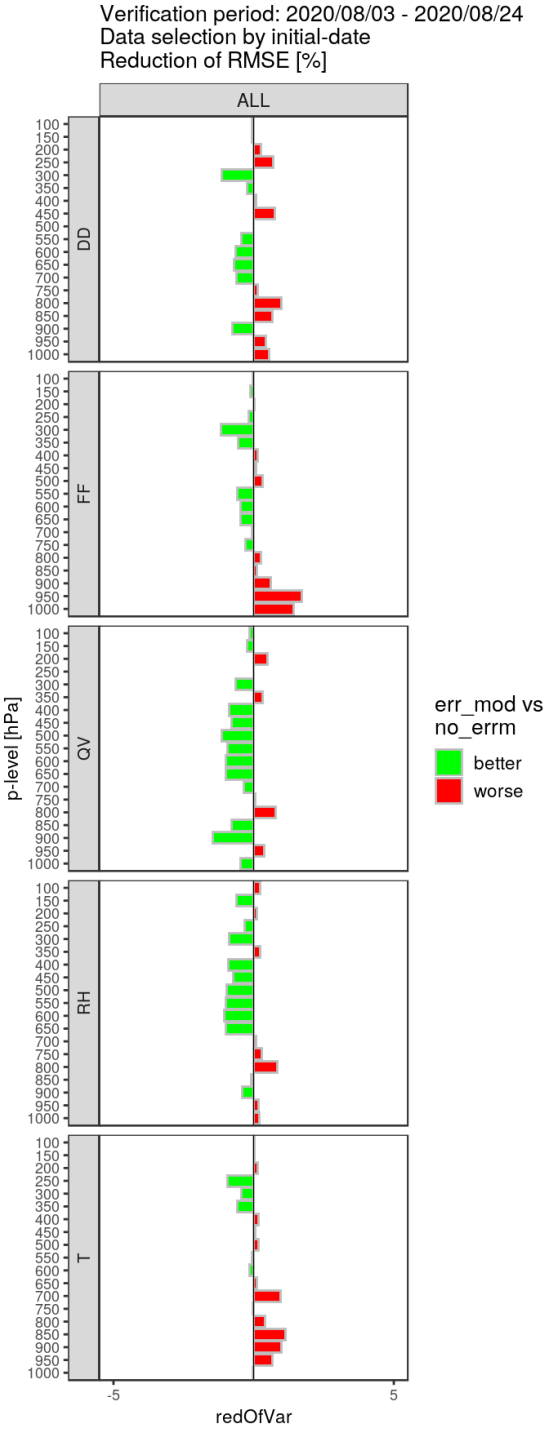

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Summary

- The allsky assimilation of SEVIRI WV channels in ICON-D2 gives good results, esp. for upper air humidity
  - Mostly because of a systematic high-cloud overestimation in first forecast hours, which is corrected by SEVIRI radiances

Next steps and open issues

- Run more periods
- Bias correction
- Combined experiment with SEVIRI VIS
  - Technical adapations necessary to set localization and superobbing options channel dependent
- Slant path
- Super“m“odding
- Test in Online System

Thank you for your attention!