Enhancing the hyperspectral infrared radiance assimilation in the ECMWF system

Focus on: Increasing the use of IASI WV information

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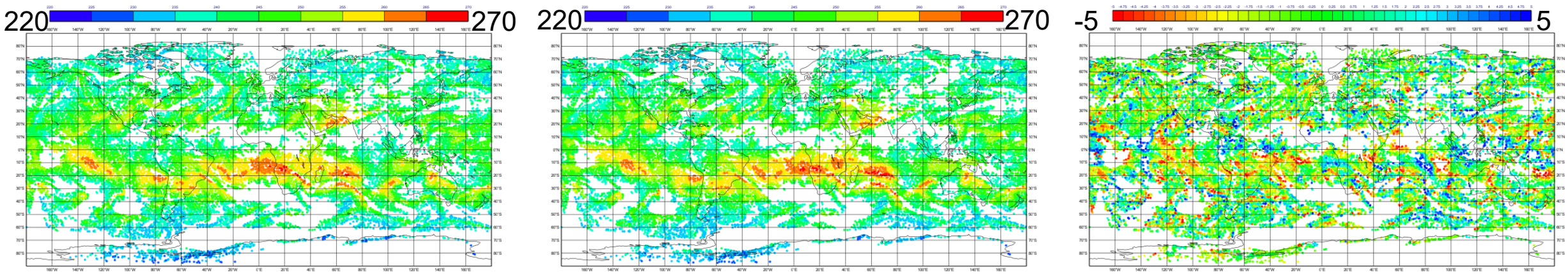
ECMWF

Radiance observations in 4D-Var, impact on wind analysis

- Adjustments in the mass field of the atmosphere.
- Assimilation system has freedom to adjust the wind field of the initial conditions directly.
- Positive impact on wind analysis/forecasts has been demonstrated with geostationary radiances and microwave instruments in the all-sky framework.

$\mathbf{x_a}$ = $\mathbf{x_b}$ + $\mathbf{K\,(y - \mathit{H}x_b)}$



$\mathbf{K = BH^T(HBH^T+R)^{-1}}$

Example: IASI channel 3002

Hyperspectral IR impact on wind

Experiments with depleted observing system

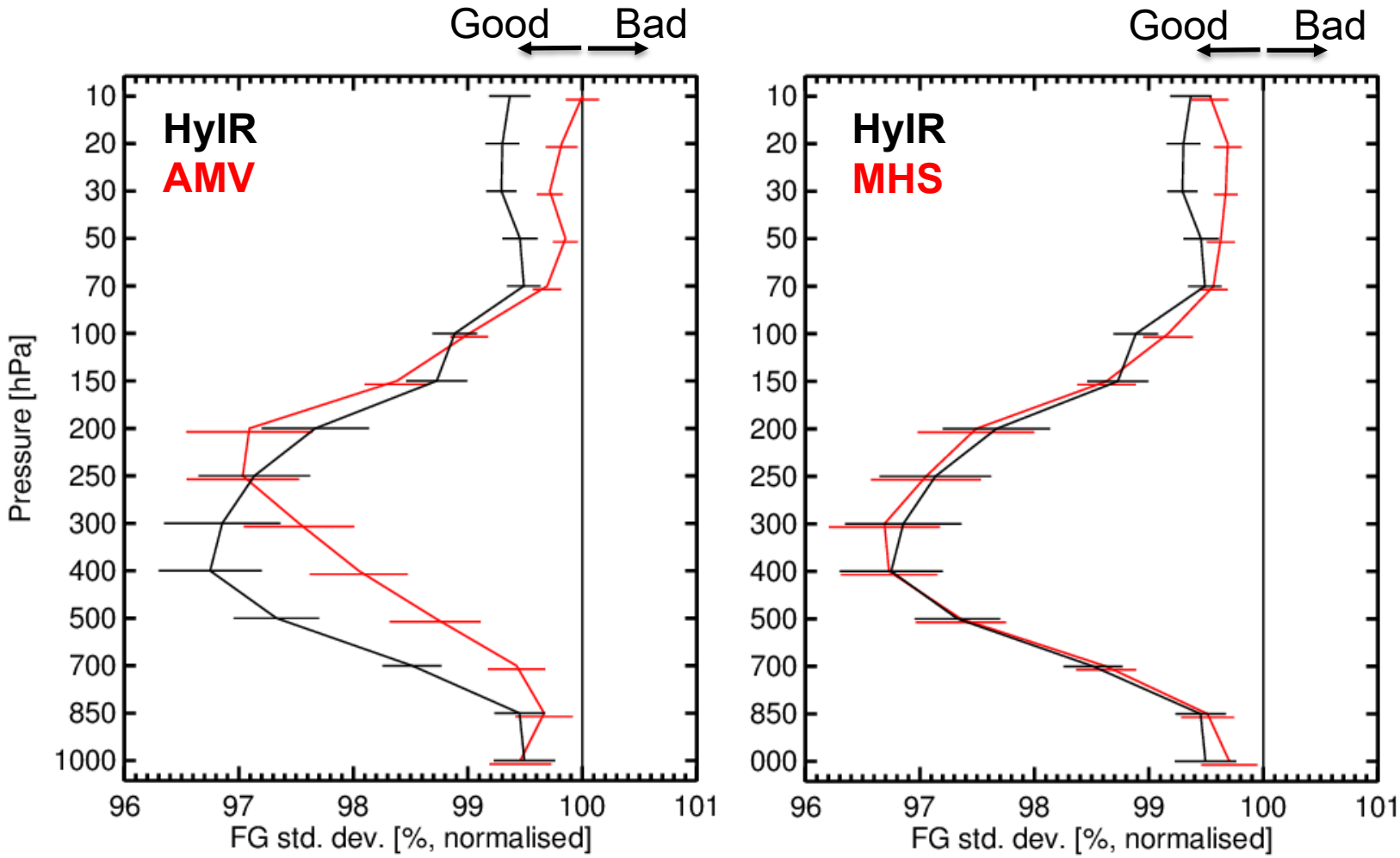
CTL (100%): Conventional + AMSU-A

HyIR: CTL + 2 IASI + CrIS + AIRS

AMV: CTL + all operationally used AMVs

MHS: CTL + MHS in all sky framework

Wind, global



Where the information is coming from

- Hyperspectral IR observations have clear positive impact on wind analysis and forecasts.
- Significant amount of the impact comes from the water vapour channels:

CTL (100%): Conventional + AMSU-A

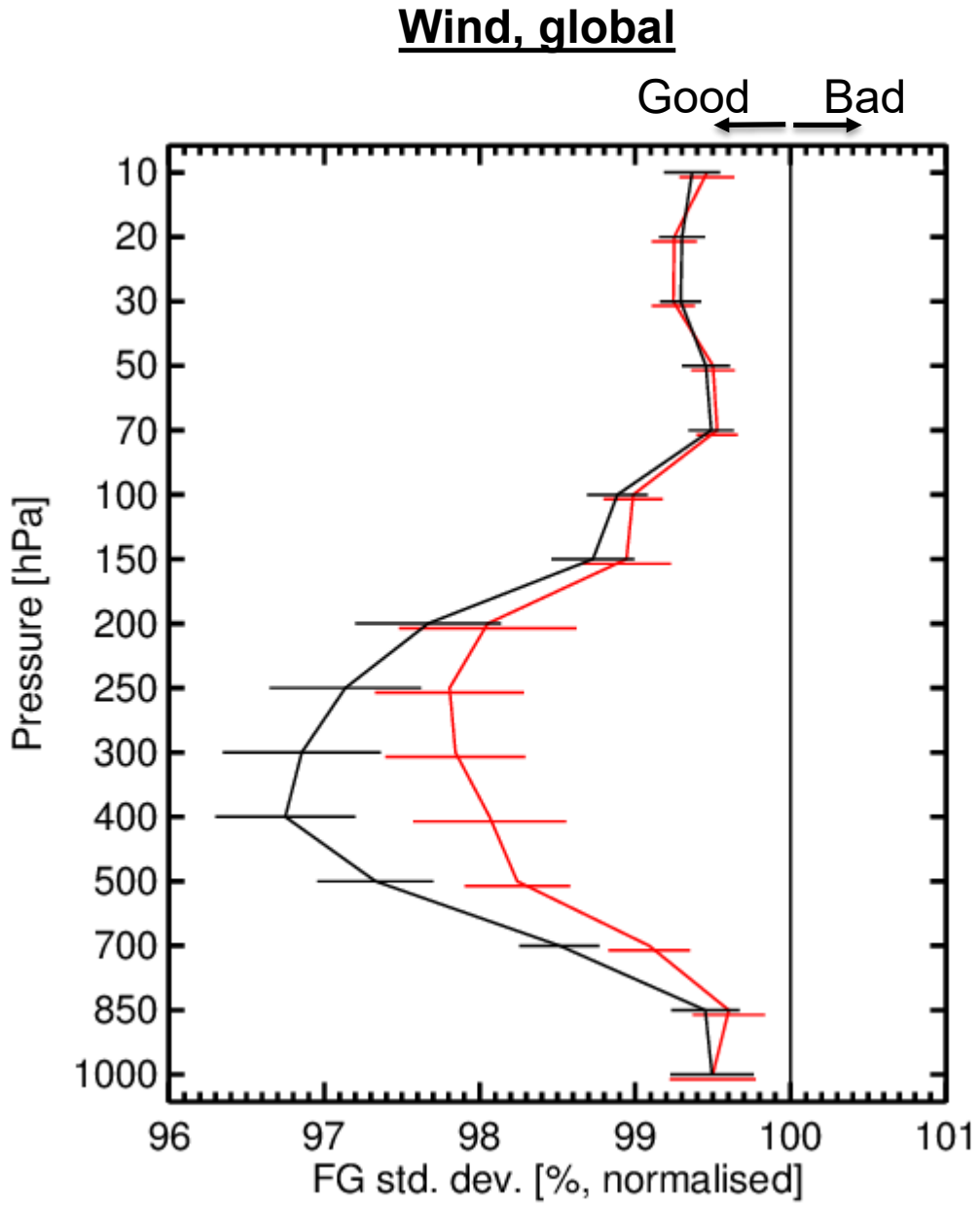
HyIR: CTL + 2 IASI + CrIS + AIRS

HyIR without WV channels

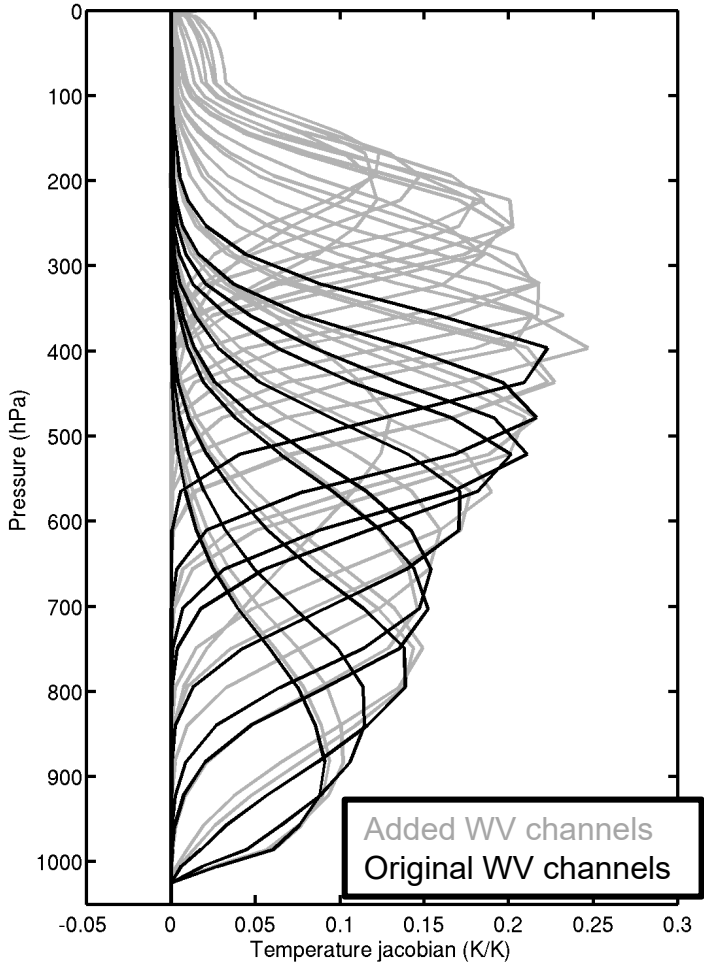
IASI: 191 channels from which 10 WV channels

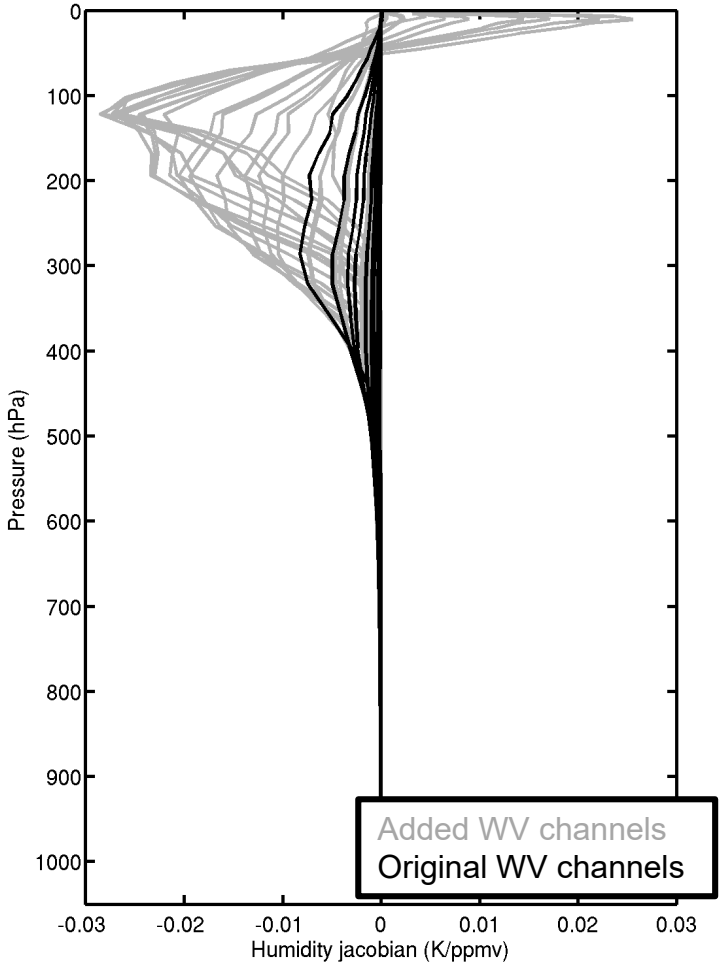
CrIS: 118 channels from which 7 WV channels

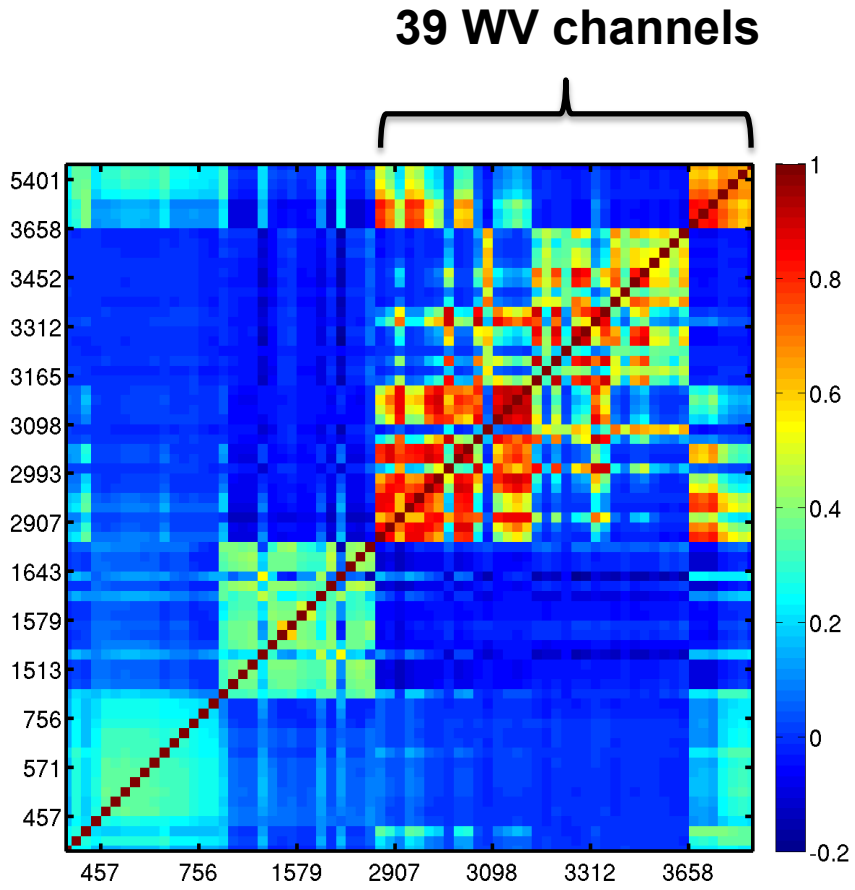
AIRS: 136 channels from which 7 WV channels



Can we enhance the wind tracing by adding more IASI WV channels?







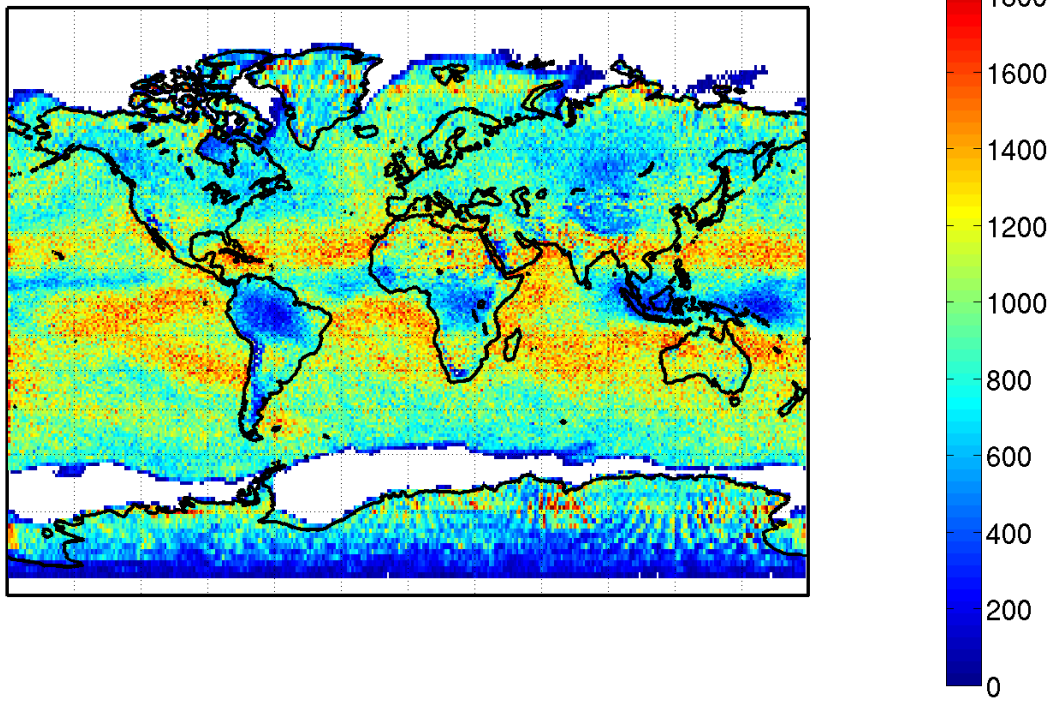
Experiment setup

- IFS cycle 46r1
  - Summer season 1.6-31.8.2018
  - Winter season 1.11.2018-28.2.2019

CTL: Full observing system including 10 WV channels for IASI

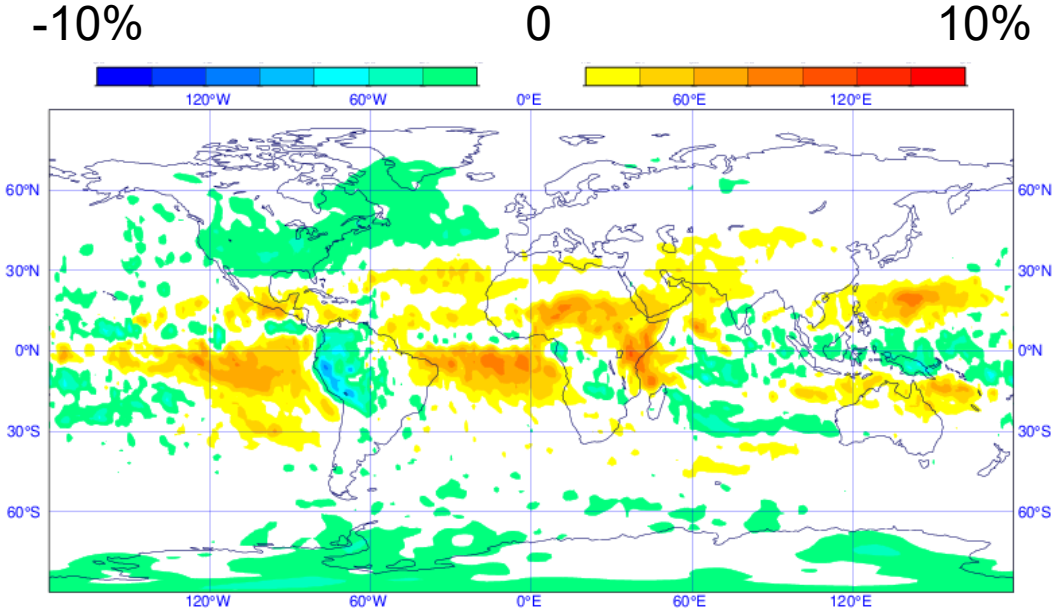
EXP: Full observing system including 39 WV channels for IASI

Number of active IASI WV radiances in EXP, November 2018

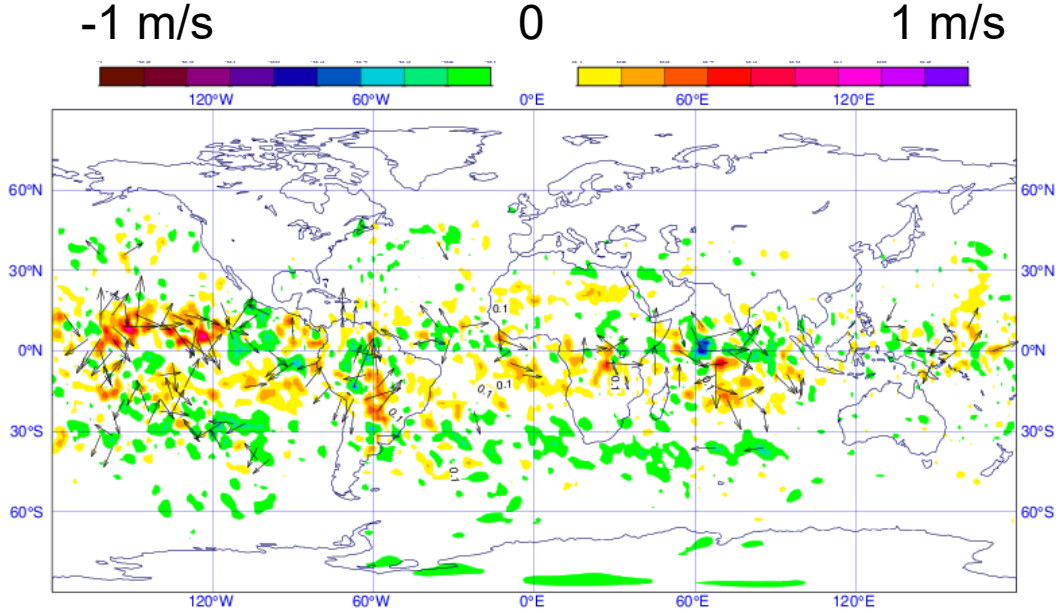


Differences in the 200 hPa level mean analyses (EXP – CTL)

Relative humidity

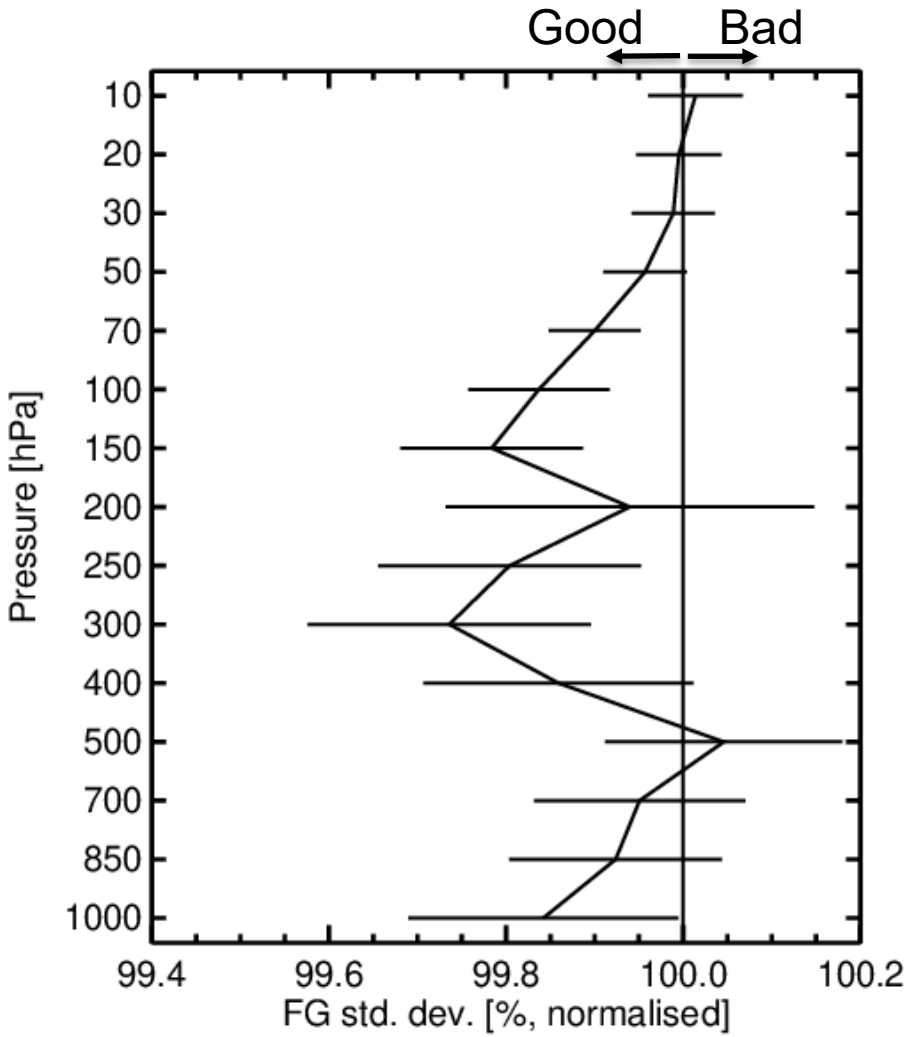


Wind

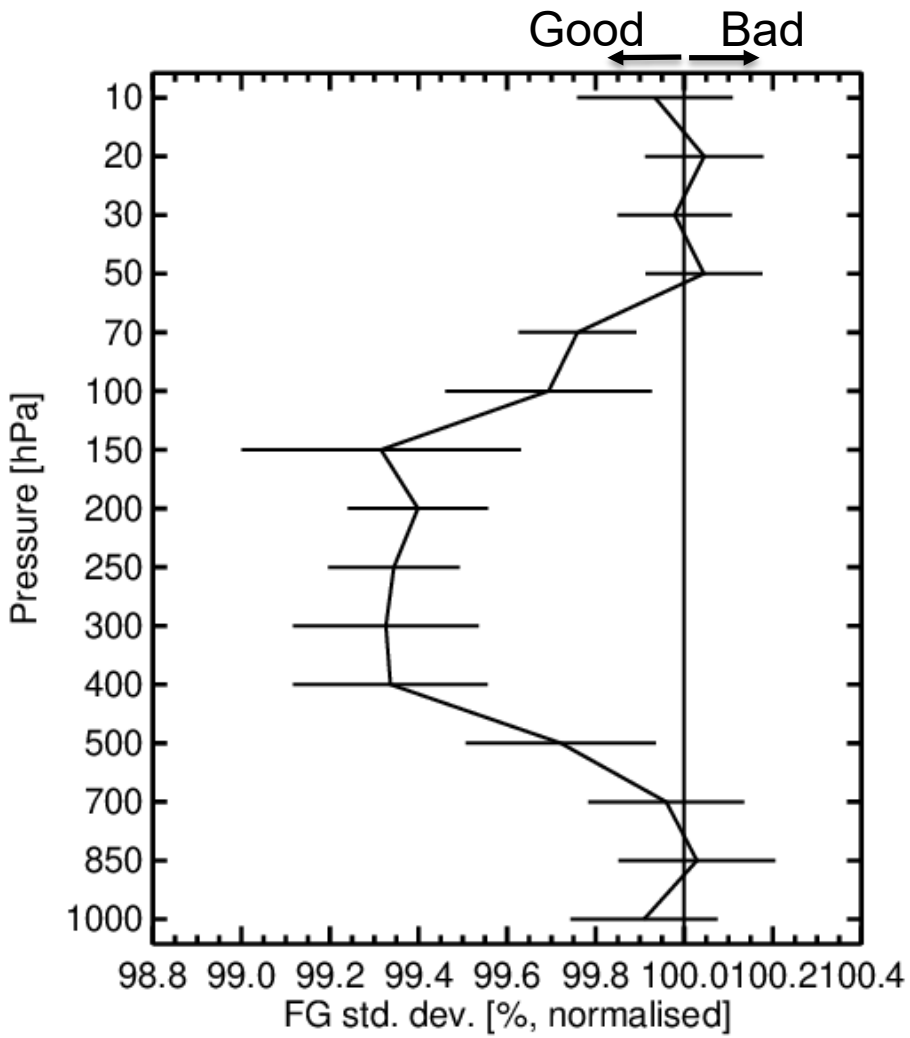


Impact on wind

Wind, global

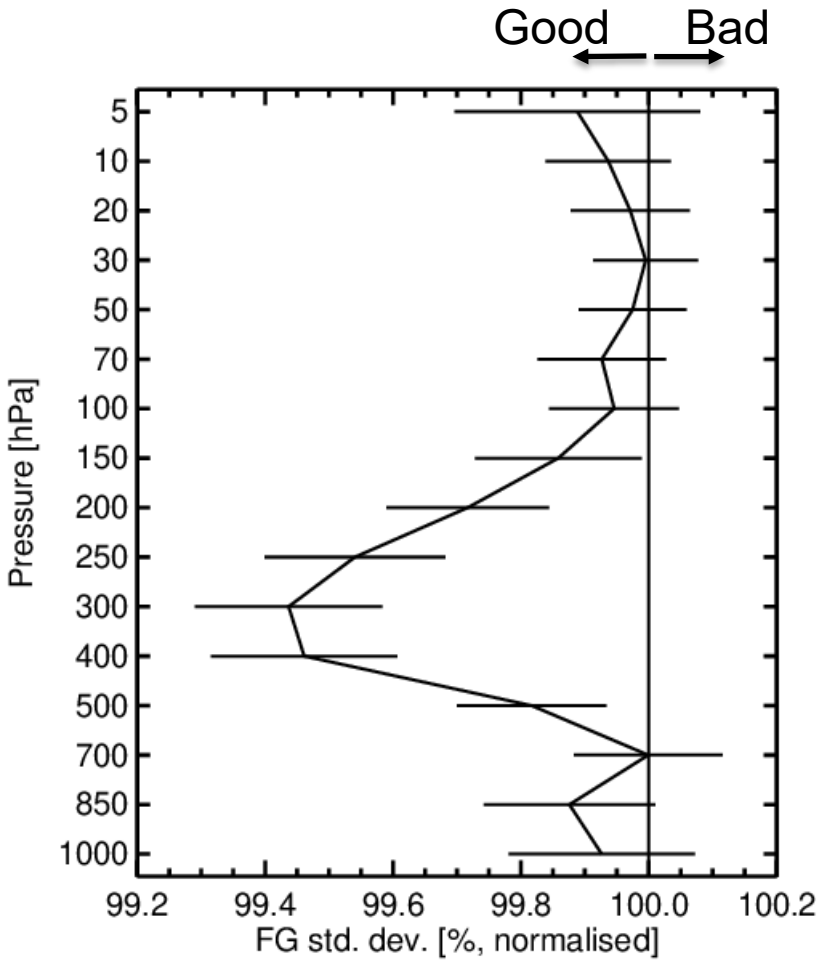


Wind, tropics

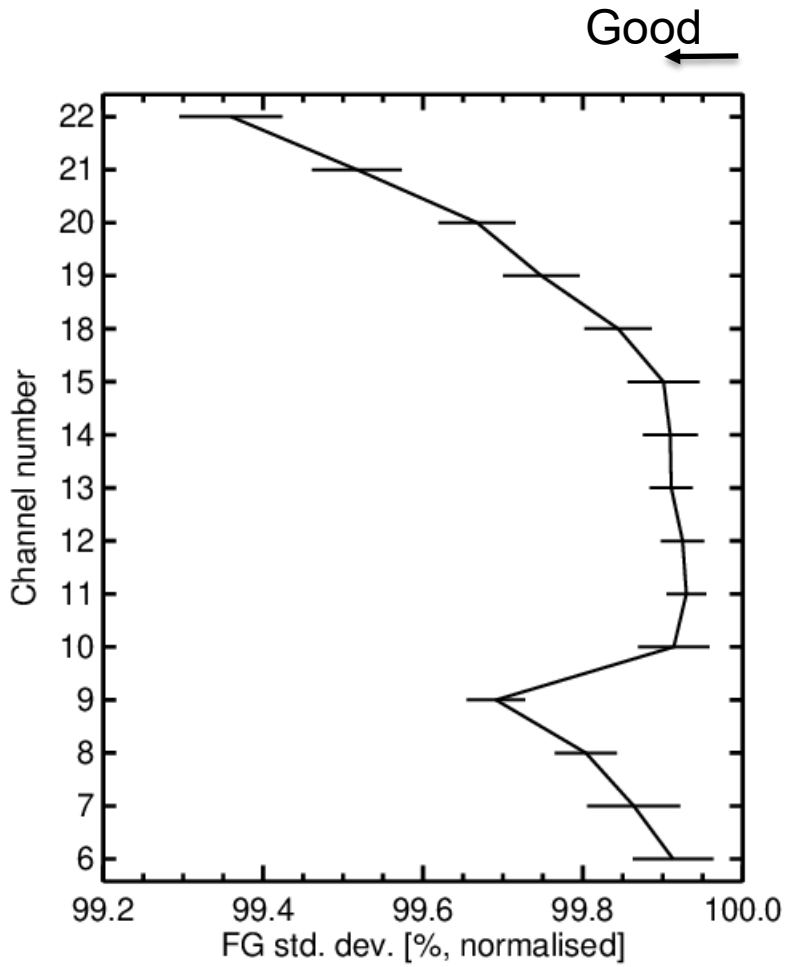


Examples of impact on other observation first guess fits

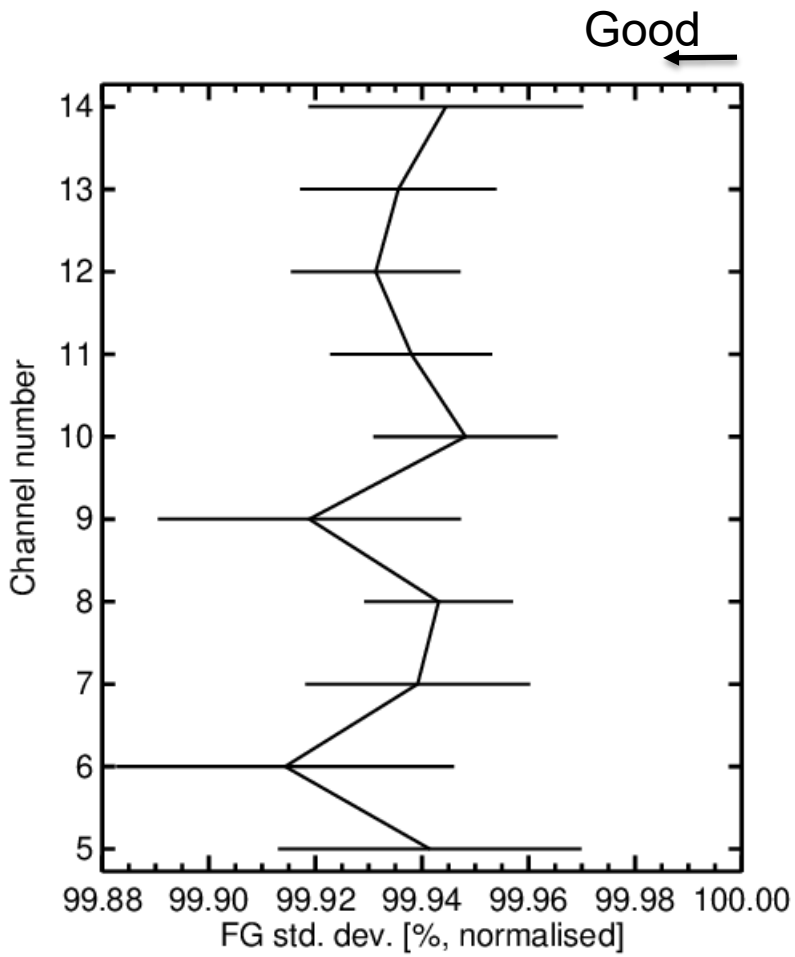
Radiosonde T, global



ATMS, global



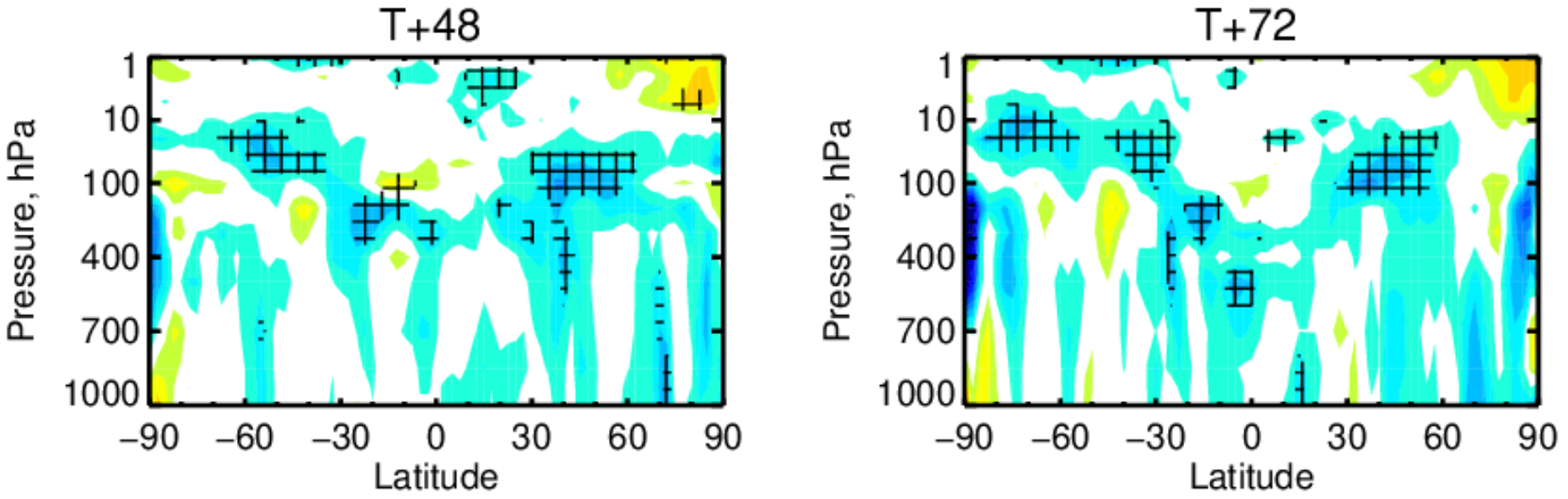
AMSU-A, global



Impact on longer range forecasts, Z

Bad

Difference in RMS error normalised by RMS error of CTL



Good

Conclusions

- Impact of hyperspectral IR data from polar orbiting instruments on wind is comparable to the impact of MHS and AMVs.
- Adding 29 IASI WV channels significantly amplifies the wind tracing and results to positive impact on wind analysis and forecasts.
- Clear positive impact is seen also for temperature and humidity observation first guess fit statistics (radiosonde, AMSU-A, GPSRO, ATMS, CrIS, MHS etc) indicating improvements in the short range forecasts.
- For longer range forecasts the impact is neutral to postitive.
- The additional IASI WV channels have been activated in operations in June 2019