

ITSC20
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A physically-based observation error covariance matrix for IASI

**Hyung-Wook Chun¹, Reima Eresmaa², Anthony P. McNally²,
Niels Bormann², and Marco Matricardi²**

¹ Korea Institute of Atmospheric Prediction Systems (KIAPS)

² European Centre for Medium Range Weather Forecasts (ECMWF)

hw.chun@kiaps.org,
chunhw@gmail.com,

**Thanks to Cristina Lupu for providing
background error covariance of
ECMWF**

How can we get observation errors?

(NWP SAF Training Course 2015, Observation errors from Niels)

● Diagnostics based on output from DA systems, e.g.:

- [Hollingsworth/Lönnberg](#)
- [Desroziers et al., 2006](#)

Bormann et al., 2015, Weston et al., 2014, Stewart et al., 2013

ITSC20 presentations related to hyperspectral IR observation error

- 5.01 Collard @ NCEP
- 5.02 Campbell @ NRL
- 5.03 Bormann @ ECMWF
- 5p.01 Smith @ Met Office
- 5p.05 Garand @ Environment Canada

● Error inventory (physical method):

- [Based on considering all contributions to the error/uncertainty](#)

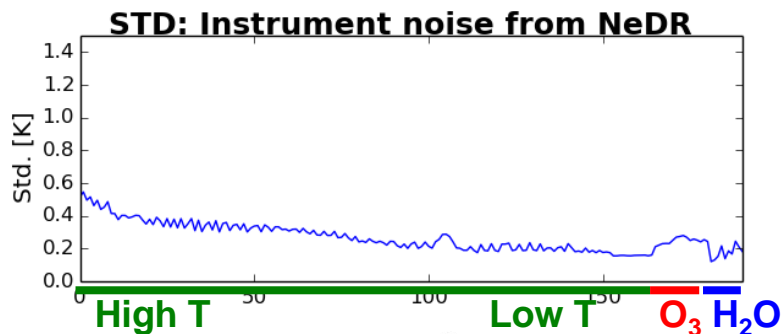
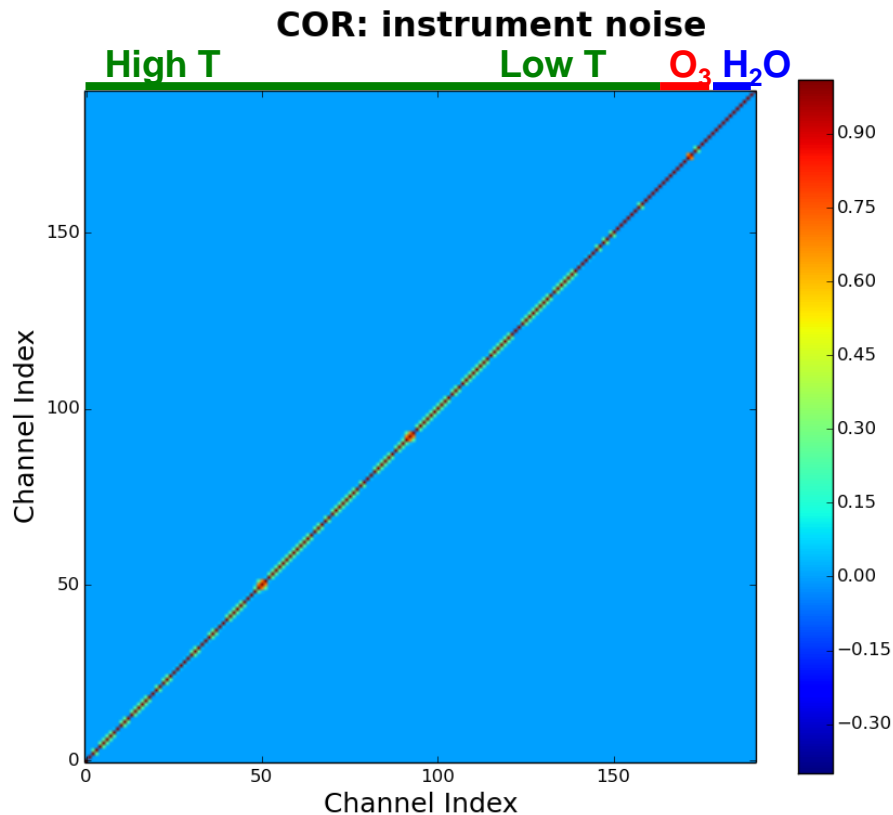


Contribution to observation error

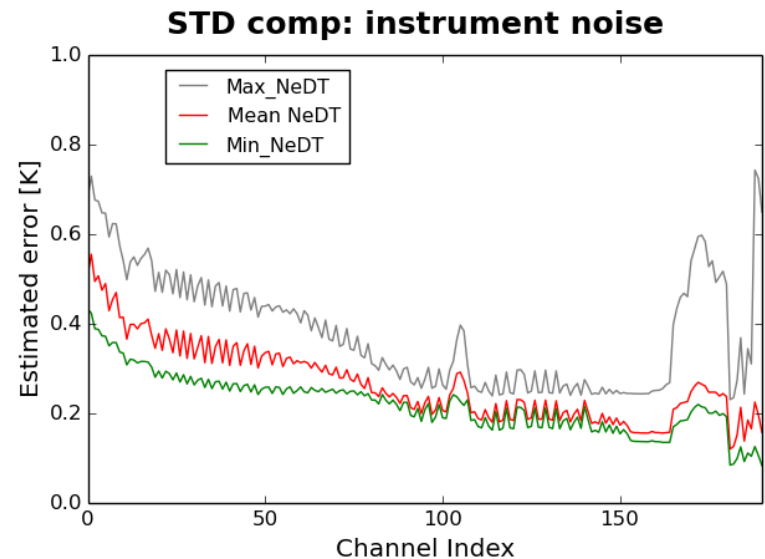
- Measurement error
: instrument noise
- Quality control error
: error due to the cloud detection scheme missing some clouds in clear-sky radiance assimilation
- Forward model error
: RTTOV and LBL error
- Representativeness error
: observation point vs model representation

(NWP SAF Training Course 2015, Observation errors from Niels)

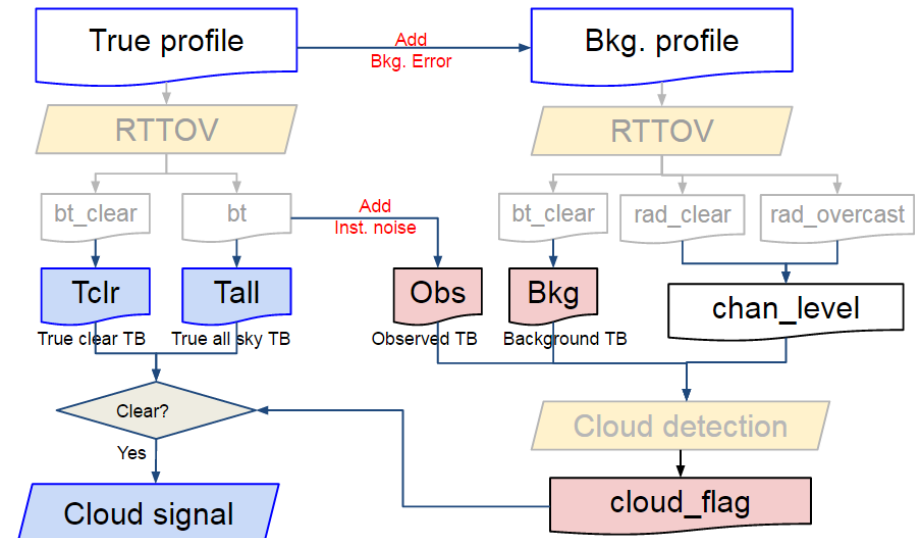
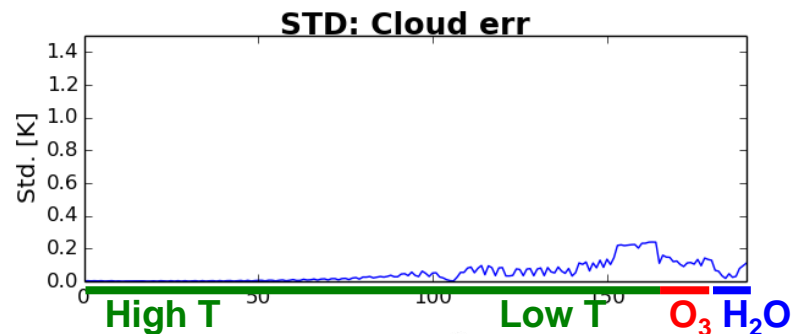
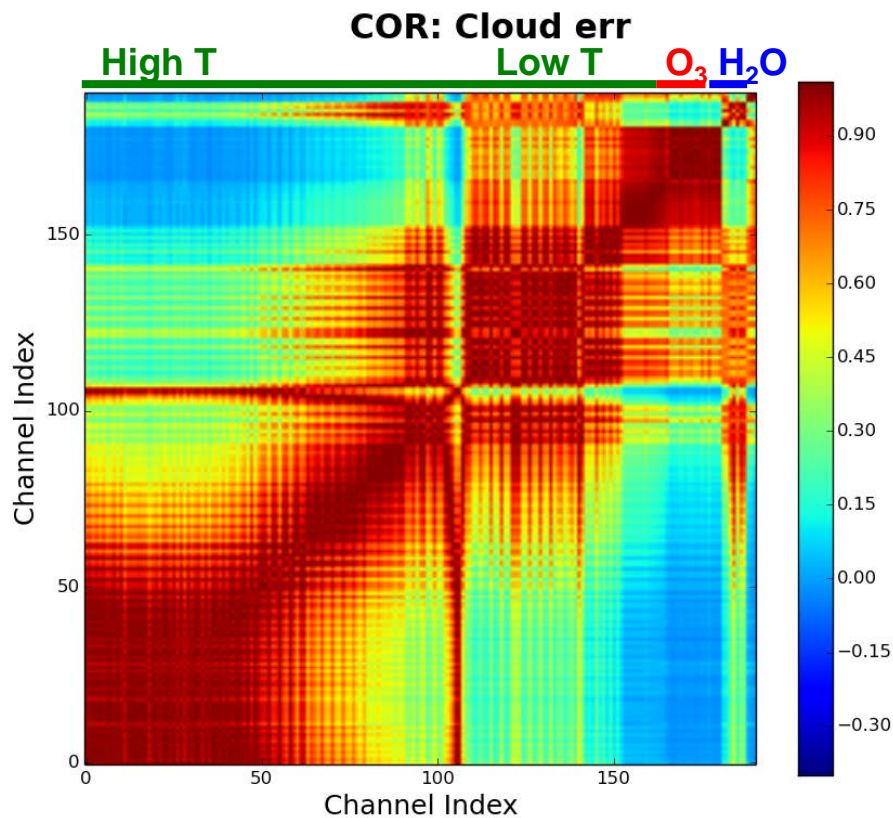
Instrument noise (from CNES)



- NeDR
 - Noise equivalent differential radiance
 - provided by CNES
 - Constant
- NeDT
 - Noise equivalent differential temperature
 - scene dependent



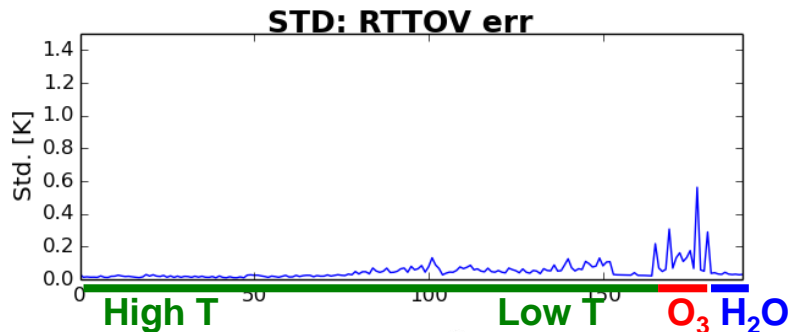
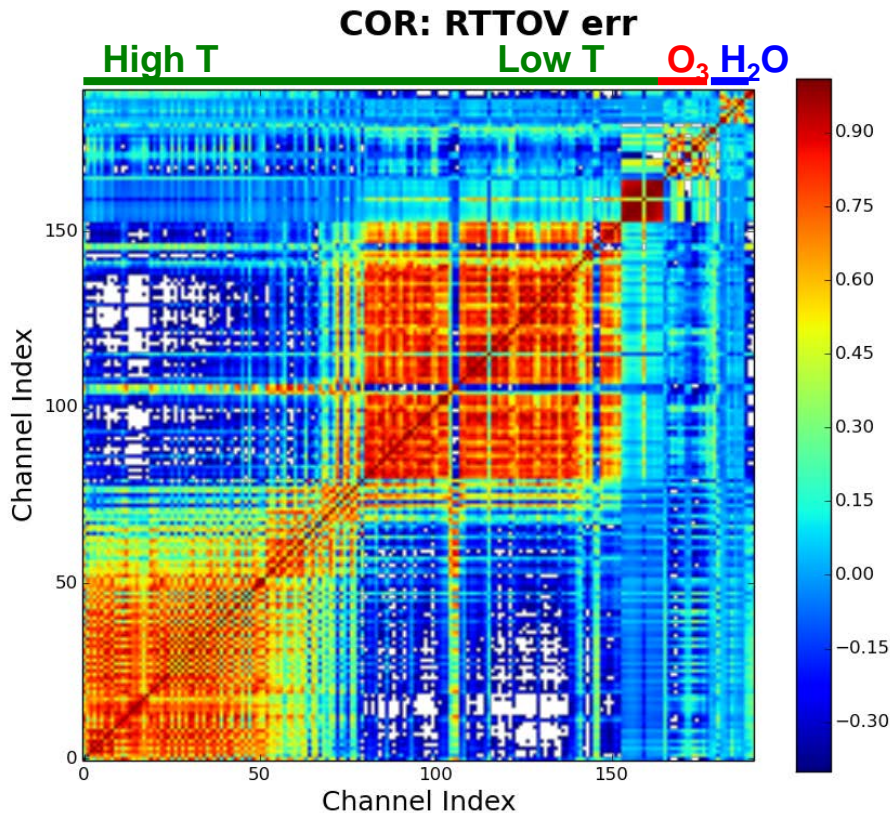
Cloud error due to cloud detection algorithm missing cloud



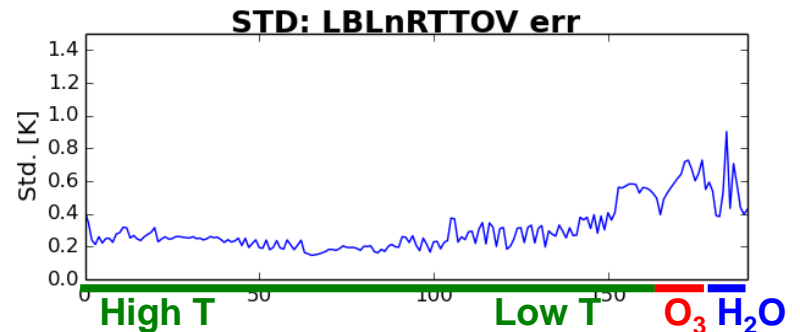
- True profile: NWP SAF data set (Eresmaa and McNally, 2014)
- Cloud detection algorithm: (McNally and Watts, 2003)
- Cloud error when cloud_flag for window channel is clear
- Cloud errors can be retrieved with respect to clear channel reference.
- **Caution: Cloud error is dependent on background error**

Forward model error

(From Dr. Matricardi)

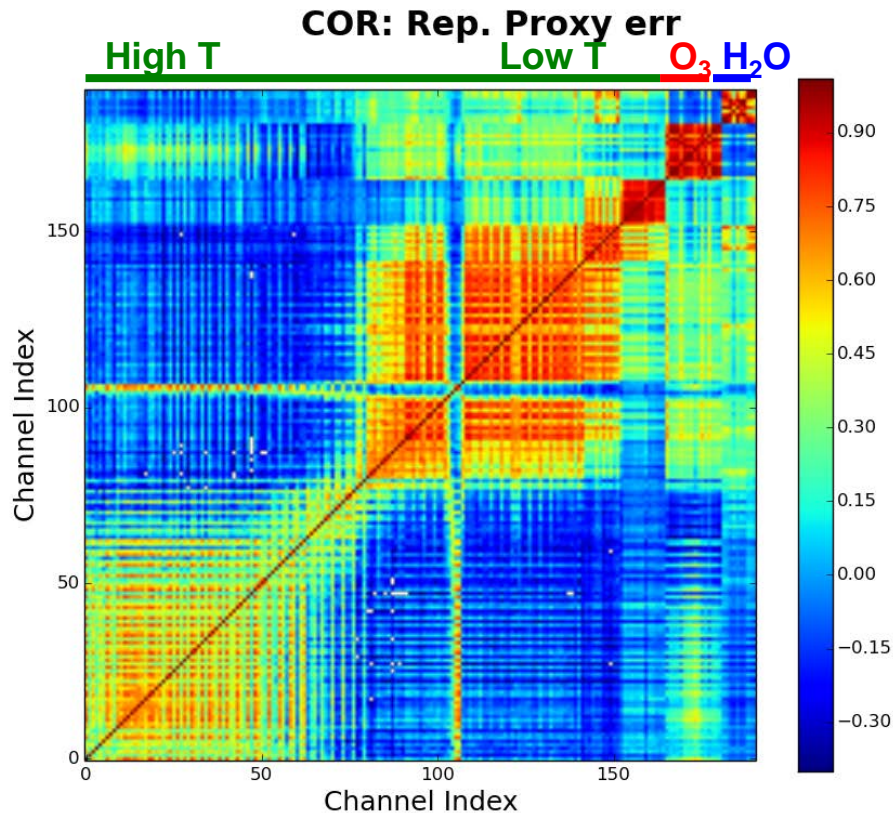


- RTTOV error
 - Regression error during calculation of RT coefficients over a set of 5160 profiles
- LBLnRTTOV
 - standard deviation of the difference between observed IASI and simulated IASI with GRUAN profile (Manus Island, during 2011-2013, 27 samples)
 - While IASI instrument noise has been removed from the standard deviation, small sample and radiosonde error have not been considered.

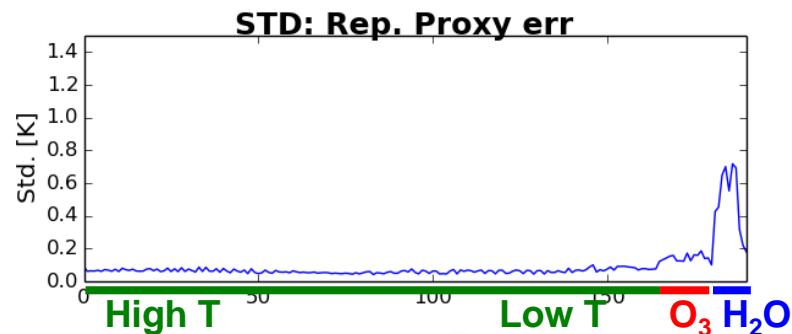


Representativeness error

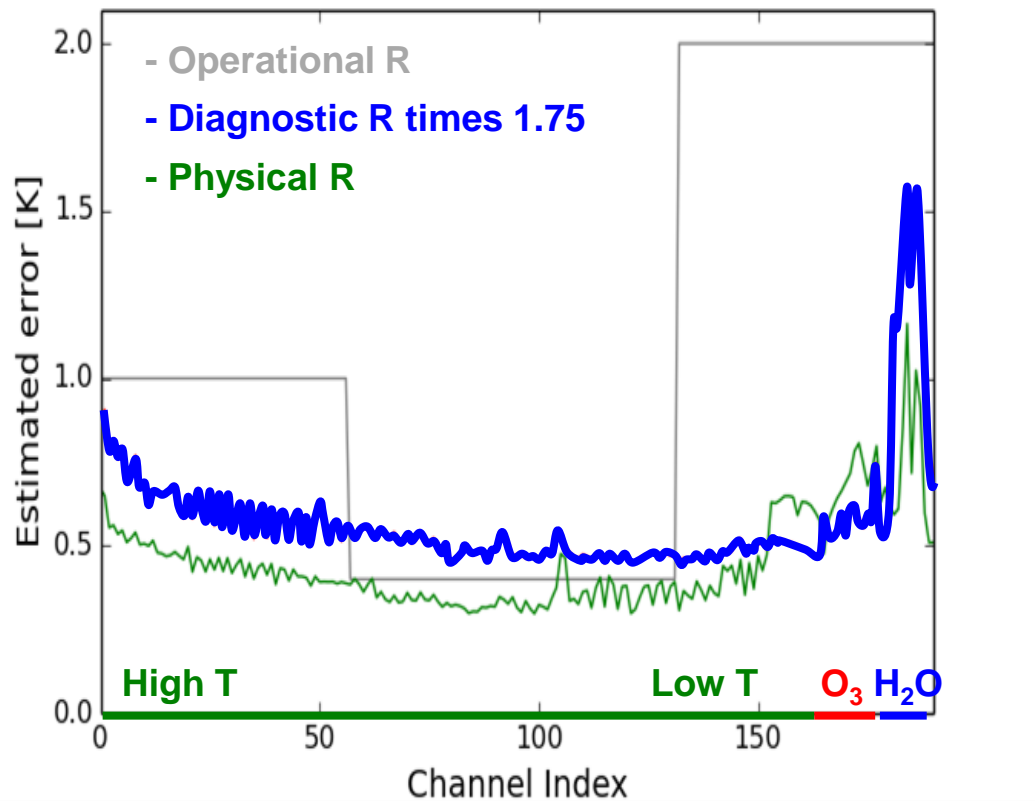
(From Dr. Bormann)



- Rep_Proxy come from the background departure difference between T1270 and T159 with re-setting for positive definite matrix.
- The Rep_Proxy only gives an idea which channels are affected by representativeness errors.



Comparison of standard dev. : physical R vs diagnostic R



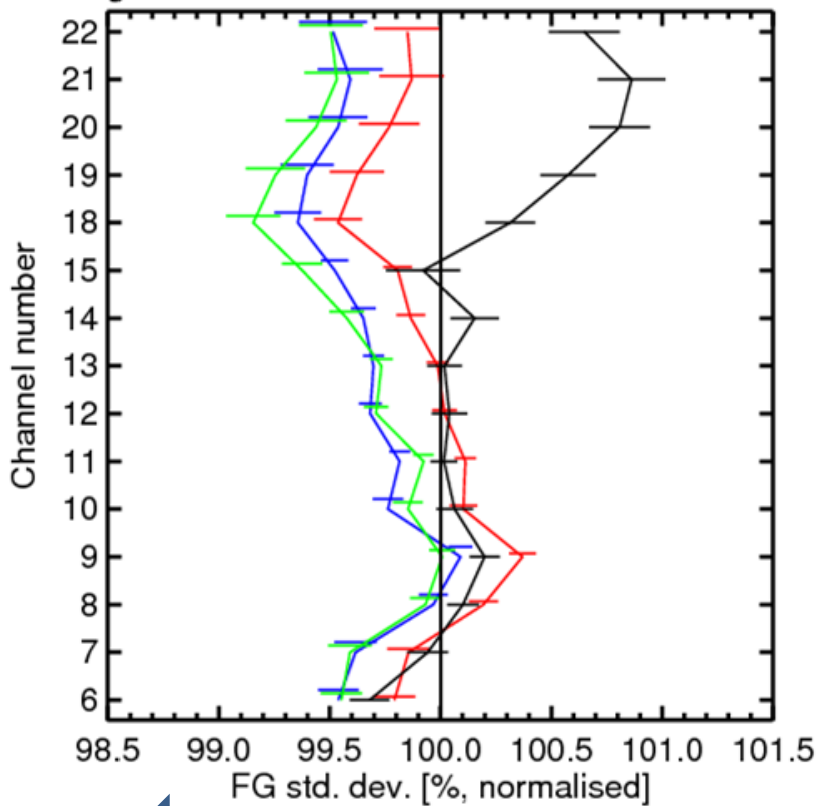
191 IASI radiances are assimilated for ECMWF IFS system : CY41, T639, 137 vertical levels during 3 months (Jan-Mar 2015)

with different kinds of IASI observation error covariance (R)

- Control: Operational R (without inter-channel correlation)
- Diagnostic R in Bormann et al. (2015)
- Physical R in this study
- Denial IASI radiances

Normalised STD of background departure w.r.t operational setting

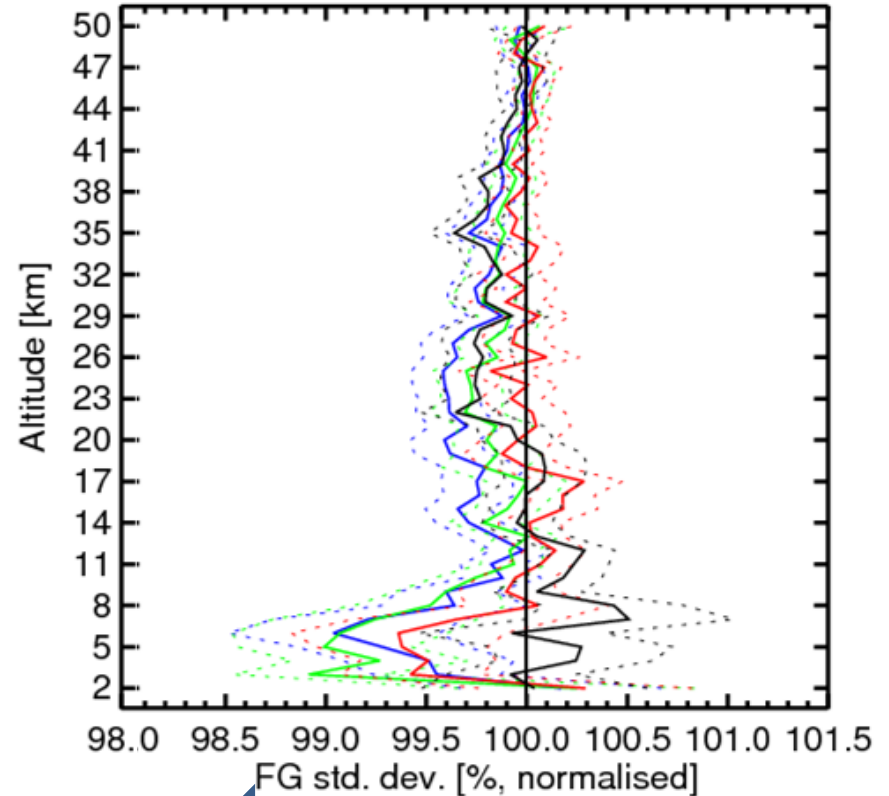
ATMS



← Improved



GPSRO

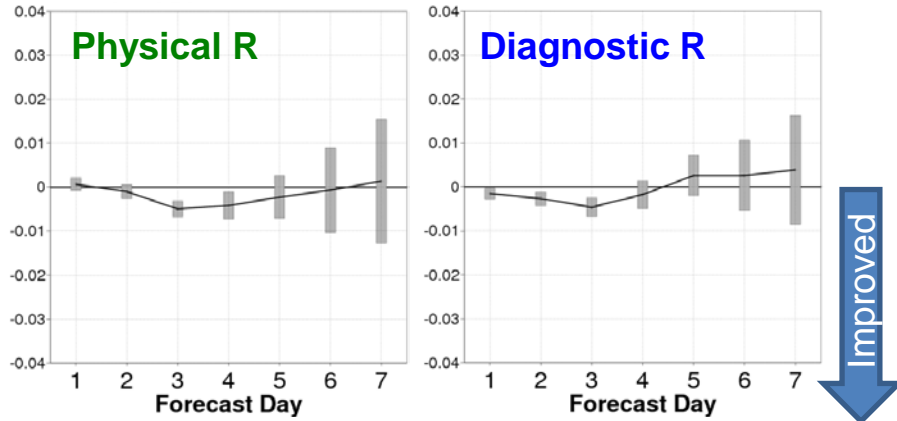


← Improved

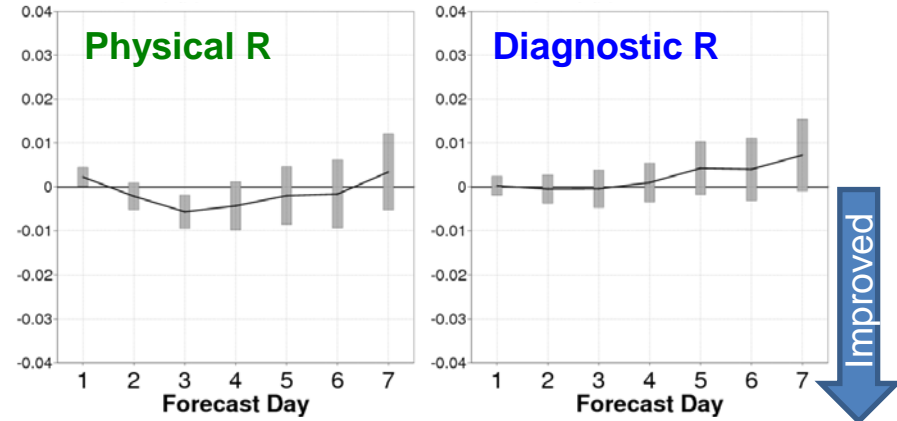
- Denial IASI
- Physical R (diagonal LBL)
- Physical R (full LBL)
- Diagnostic R times 1.75 from Bormann (2015)

Control-normalized forecast error standard deviation for wind, RH, and T

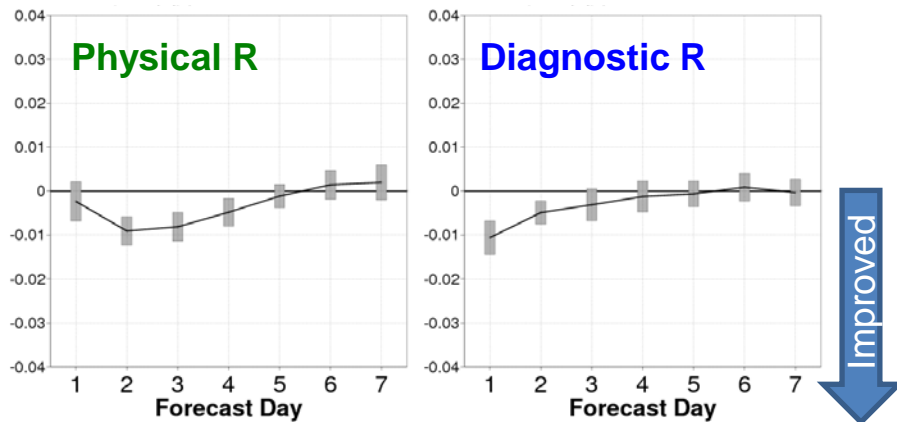
WV_{50hPa} in (20N,90N)



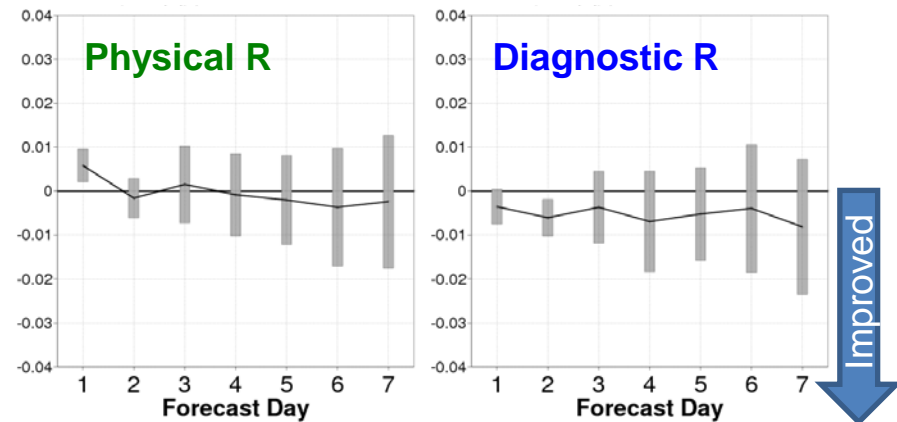
WV_{700hPa} in (20N,90N)



RH_{850hPa} in (20S,20N)



T_{100hPa} in (20S,90S)



Summary and further studies

- Building up a physically-based observation error covariance matrix for IASI radiance assimilation from a knowledge of individual sources of error.

source	dominant channels
instrument noise	All, especially T sounding ch.
cloud error	Window ch.
radiative transfer error	All, especially O ₃ and WV ch.
representativeness error	WV ch.

- The combination of these produces a covariance with stronger inter-channel correlations than those diagnosed from innovations.
- The physically based error estimate performs well in assimilation tests, comparable to that of an empirically tuned covariance based on innovation diagnosis.
- Further studies
 - Refine LBLnRTTOV error estimate
 - Evaluate scene dependence of physical R

**Thanks for
your attentions**

