

# Assimilation of AIRS and IASI radiances at JMA global NWP system

Akira Okagaki and Hidehiko Murata(\*)

Numerical Prediction Division, Japan Meteorological Agency (NPD/JMA)  
 (\*) Meteorological Satellite Center, Japan Meteorological Agency (MSC/JMA)  
[a-okagaki@met.kishou.go.jp](mailto:a-okagaki@met.kishou.go.jp)



- In this study, clear-sky radiances from AIRS and IASI in the temperature sensitive-channels are assimilated aiming to the operational use.
- Channel selection and cloud QC schemes are described below. Assimilating these data in JMA global NWP system, experiments showed positive impacts on both analysis and forecast accuracy.
- Effects of upgrades of JMA global NWP system (increase of vertical resolution (60 to 100), extension of model top (0.1hPa to 0.01hPa)) in the hyper spectral infrared sounders assimilation are also presented.

## 1. Channel selection

- JMA obtains AIRS,IASI data from NOAA/NESDIS. Each data consist of 324, 616 channels, respectively.
- In this study, we aim to assimilate CO2 absorbing band channels, which lay around 15μm wavelength.
- Some channels sensitive to model-top or above are eliminated.
- After these selection steps, AIRS 85 channels and IASI 69 channels are assimilated in this study.

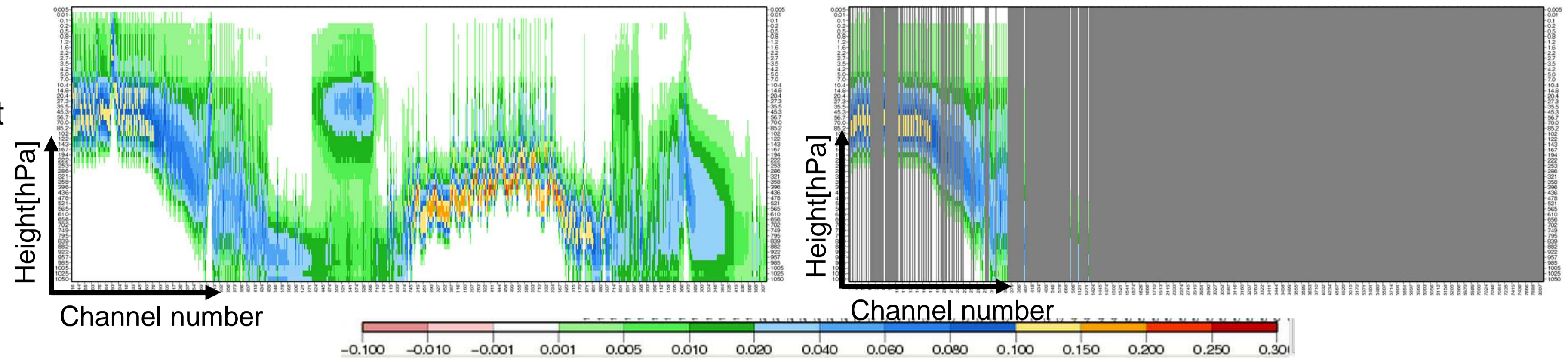


Fig 1. Weighting functions(color) of IASI channels. Left) 616 channels, obtained from NOAA/NESDIS, Right) same as left, but no use channels are gray-masked.

## 2. Cloud QC to assimilate only clear radiances

- For tropospheric peaking channels, we applied cloud QC as follows:
  1. Check difference of observed BTs (10.2μm – 11.8μm). If the difference is larger than a threshold, the FOV is flagged as “cirrus”. All tropospheric channels are rejected in “cirrus”.(Fig 2.1 right)
  2. When a FOV is not “cirrus”, check first-guess departure in window channel (~10.2μm, AIRS:ch950, IASI:ch1338). The model equivalents are calculated by clear sky RT. When the departure is smaller than a threshold, the FOV is flagged as “clear”. All channels are passed in “clear”.(Fig 2.1 center)
  3. When a FOV is neither “cirrus” nor “clear”, the cloud top height is estimated by Minimum Residual Method (Eyre and Menzel 1989) with two channels (13.4μm, 10.8μm, AIRS:ch333&797, IASI:ch405&1098) (Fig 2.2). Channels sensitive to levels below the estimated cloud top height are rejected.

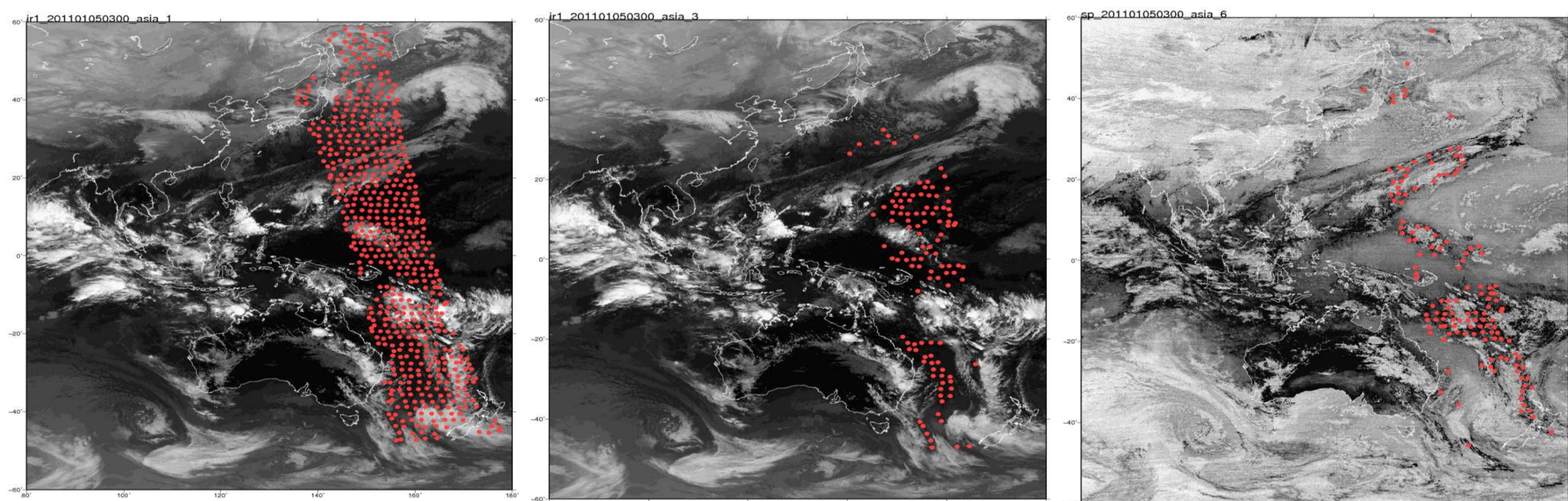


Fig 2.1: (Left)AIRS one granule and MTSAT infrared image at the same time; (center) “clear” data; (right) “cirrus” data and MTSAT split image. Dark color in split image indicates thin ice cloud.

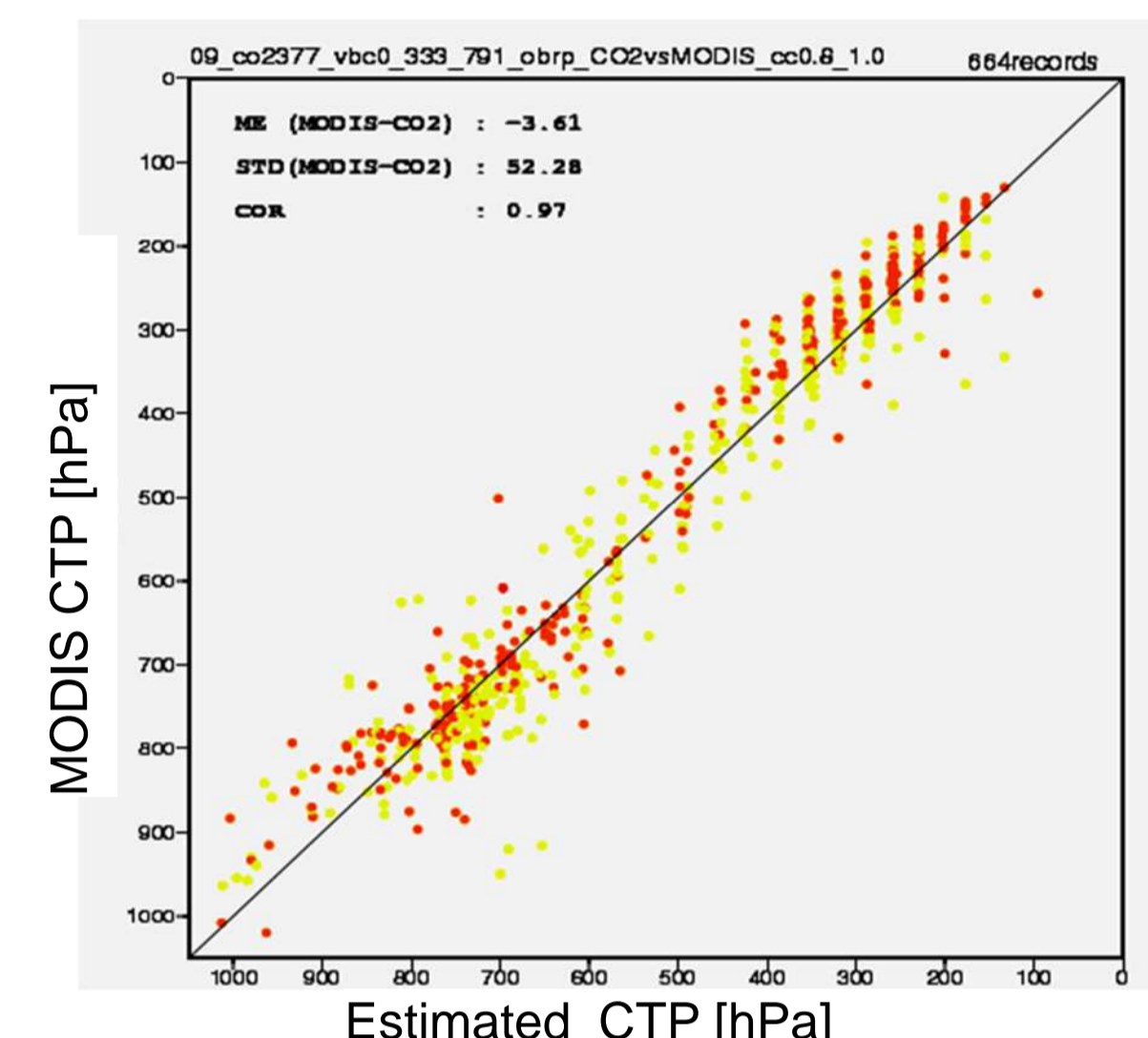


Fig 2.2: Comparison of cloud top pressure estimated by Minimum Residual (MR) Method and co-located MODIS products. Only cloud fraction  $\geq 0.8$  locations are plotted. Red circles correspond to cloud fraction  $\geq 0.9$ .

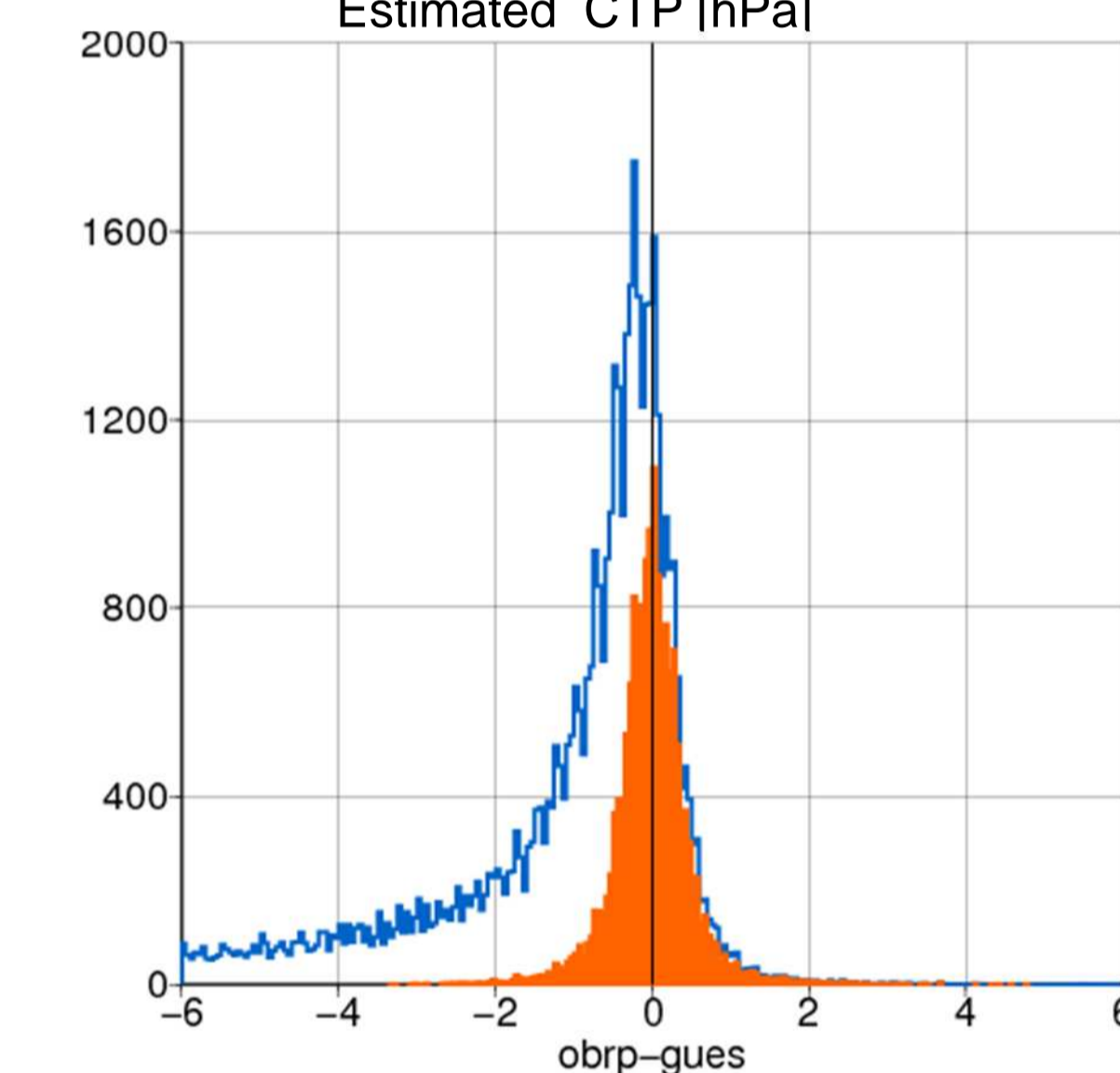


Fig 2.3: Histograms of first guess departure for MetopB/IASI lower tropospheric channels, at 2013/09/01. Blue: before cloud QC; Red: after cloud QC. Departures for clear radiances showed gaussian distribution as we expect.

## 3. Assimilation Experiments

- OSEs to test the impacts of Aqua/AIRS and Metop-A,B/IASI have been run for Aug to Oct 2013 period.
- First guess fitting to other observation were confirmed. The improvement was clear especially in radiance data. (Fig 3.1).
- Forecast error were reduced in short range(up to 48hours). It is consistent with the improvement of first guess field (Fig 3.2)

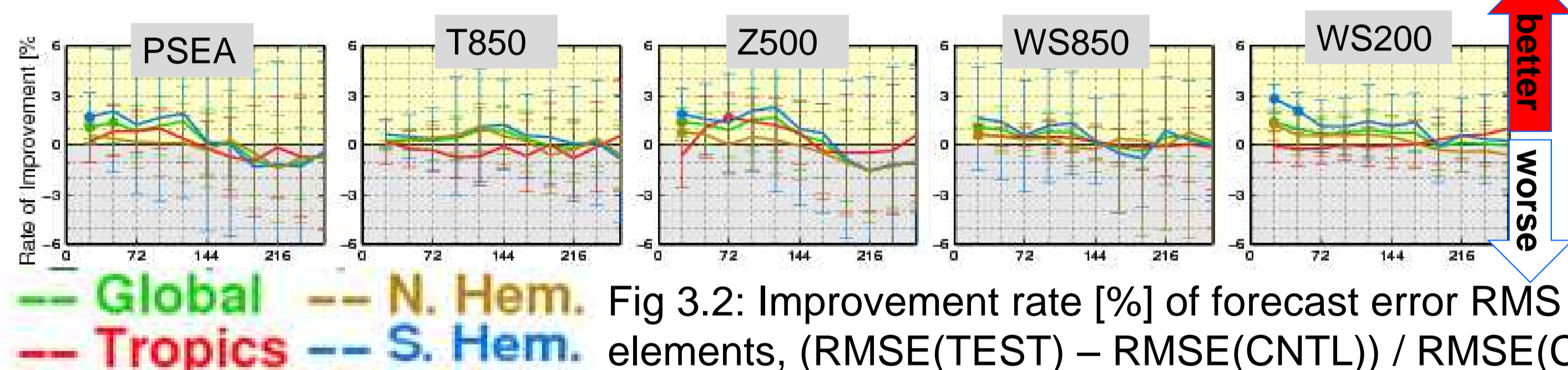


Fig 3.2: Improvement rate [%] of forecast error RMS for five elements,  $(RMSE(TEST) - RMSE(CNTL)) / RMSE(CNTL)$ . Solid circles indicate statistically significant difference.

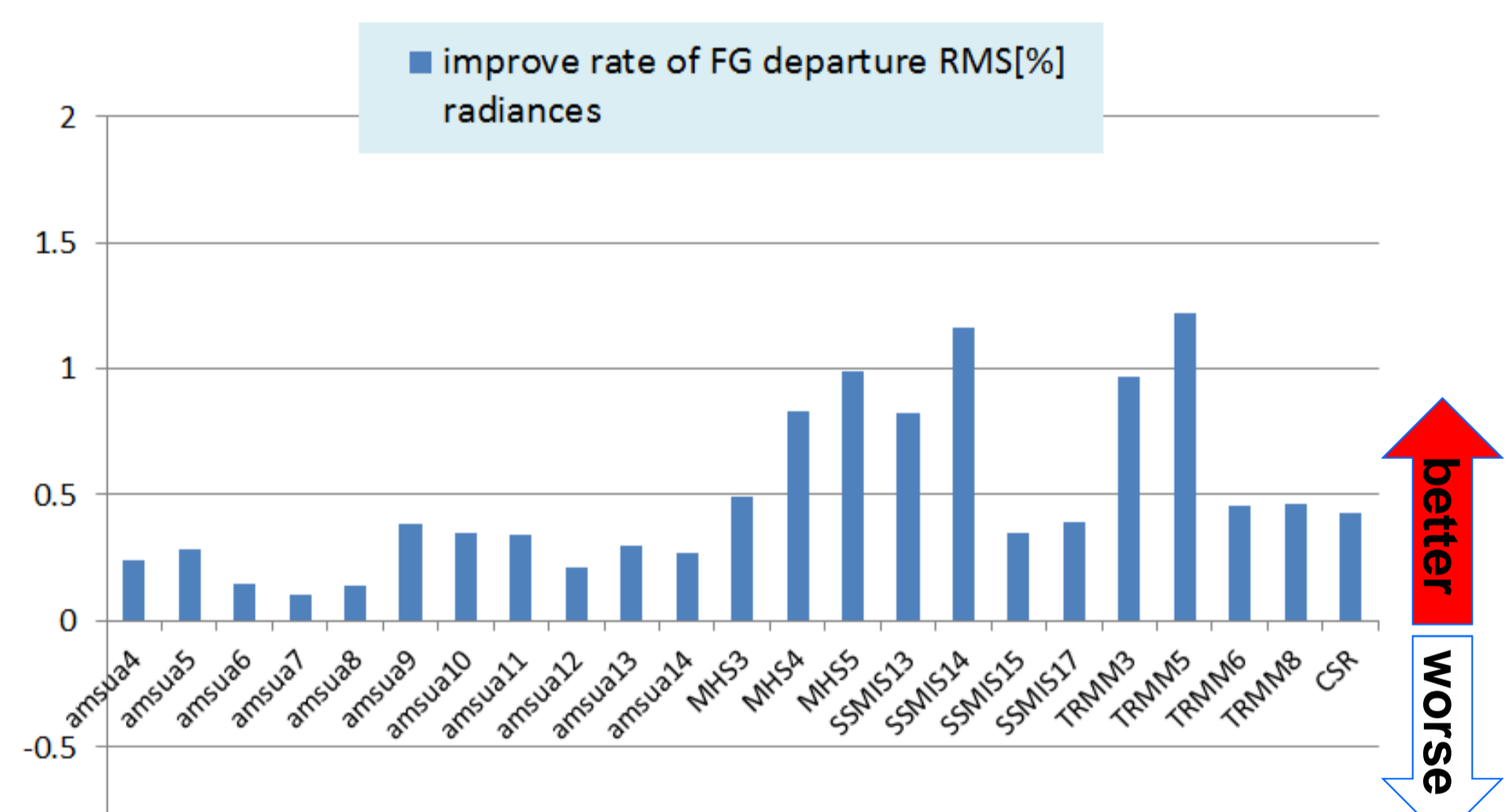


Fig 3.1: Comparison of first guess departure between “CNTL” without Metop-A,B/IASI, Aqua/AIRS, “TEST” with Metop-A,B/IASI, Aqua/AIRS, for other satellite radiances data. Improve rates[%] are defined as  $(CNTL - TEST) / CNTL$ , here CNTL and TEST indicate first guess departure STDV for CNTL and TEST, respectively.

## 4. Comparison with new GSM&GA and hyper-spectral IR observations

- JMA has extended model top of GSM&GA from 0.1hPa to 0.01hPa in Mar 2014, as increasing number of vertical levels from 60 to 100. (Fig 4.1)
- The FG-departures of AIRS&IASI based on 100 levels model (L100) were compared with those based on previous operational model (L60).
  - Mean errors (ME) of selected channels for assimilation were reduced. ME of more upper air sensitive channels, e.g. Q-branch, were reduced more clearly (Fig 4.2).
  - By the contrast of IASI neighboring channels, the accuracy of first guess of L100 model were improved especially in upper-stratosphere (Fig 4.3).

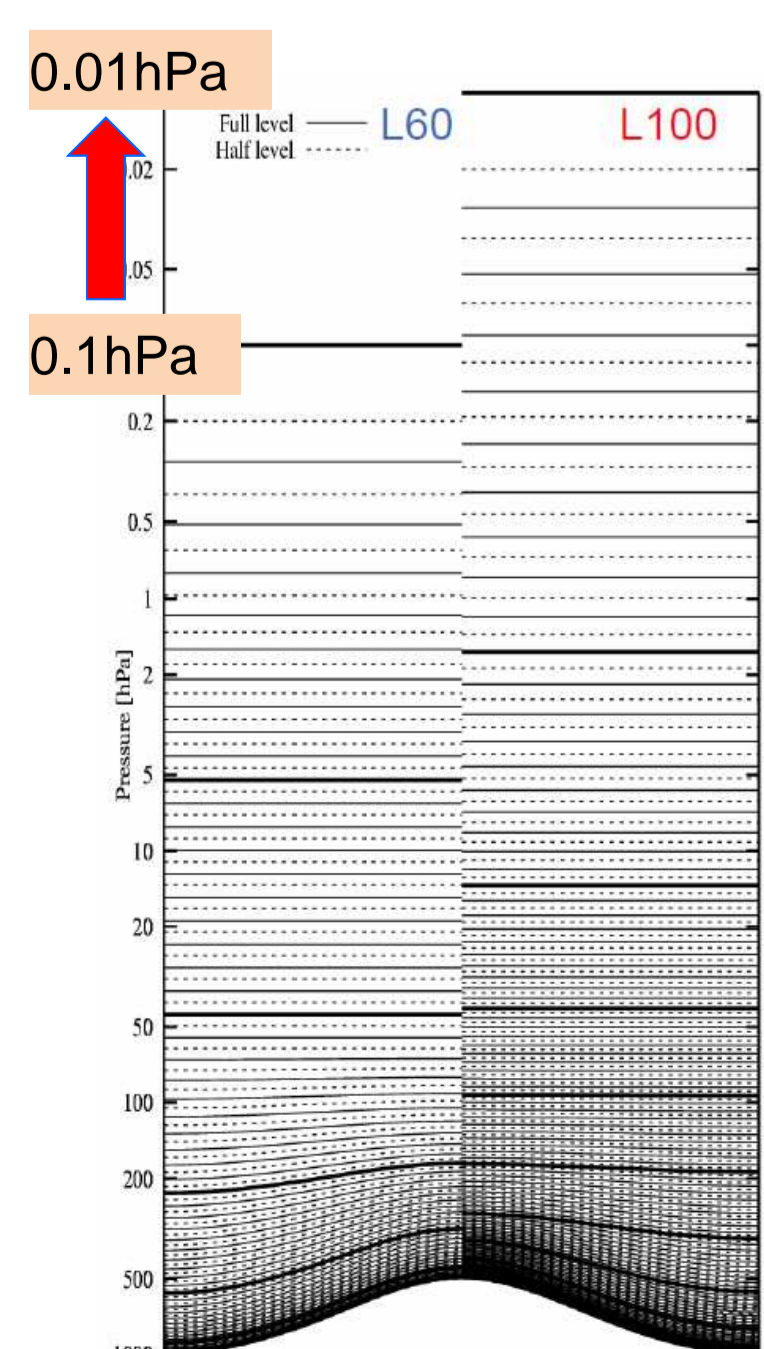


Fig4.1 : Distributions of vertical levels in current / developing GSM&GA.

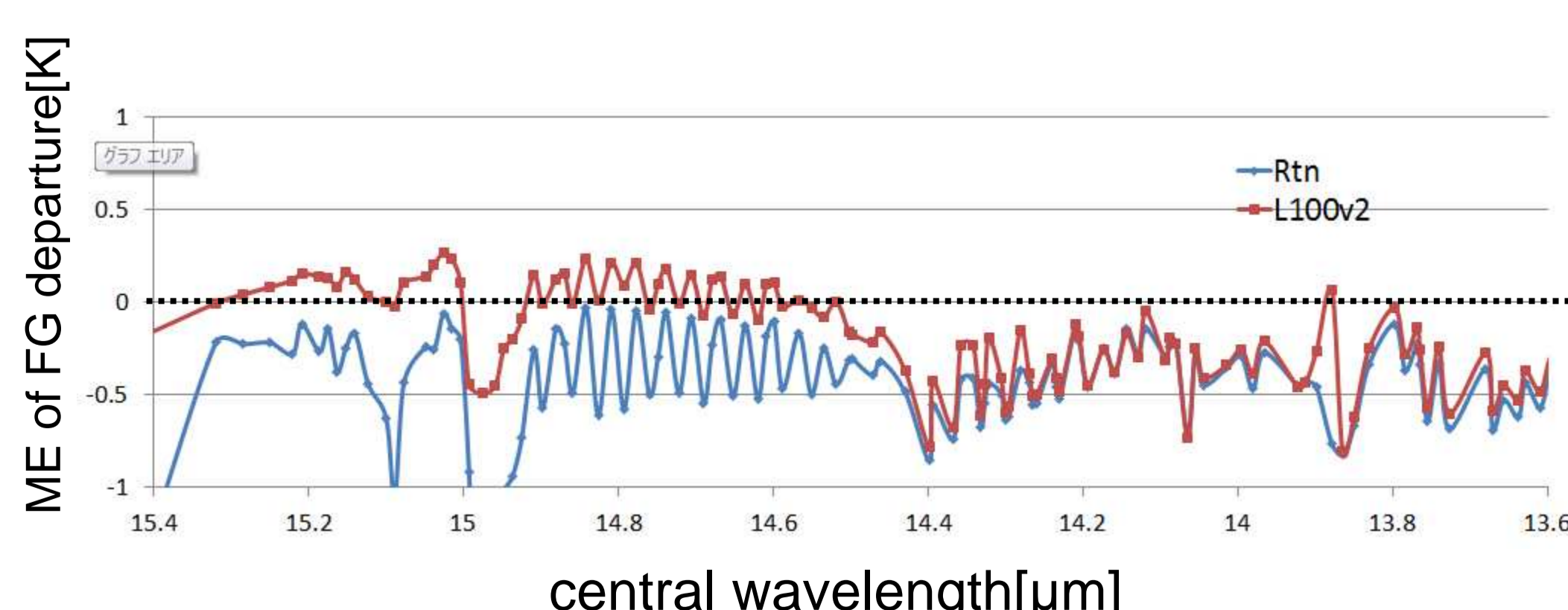


Fig4.2 : Averaged FG-departures with IASI CO2 band channels from 19 July to 28 July 2012. Blue; L60, Red; L100.

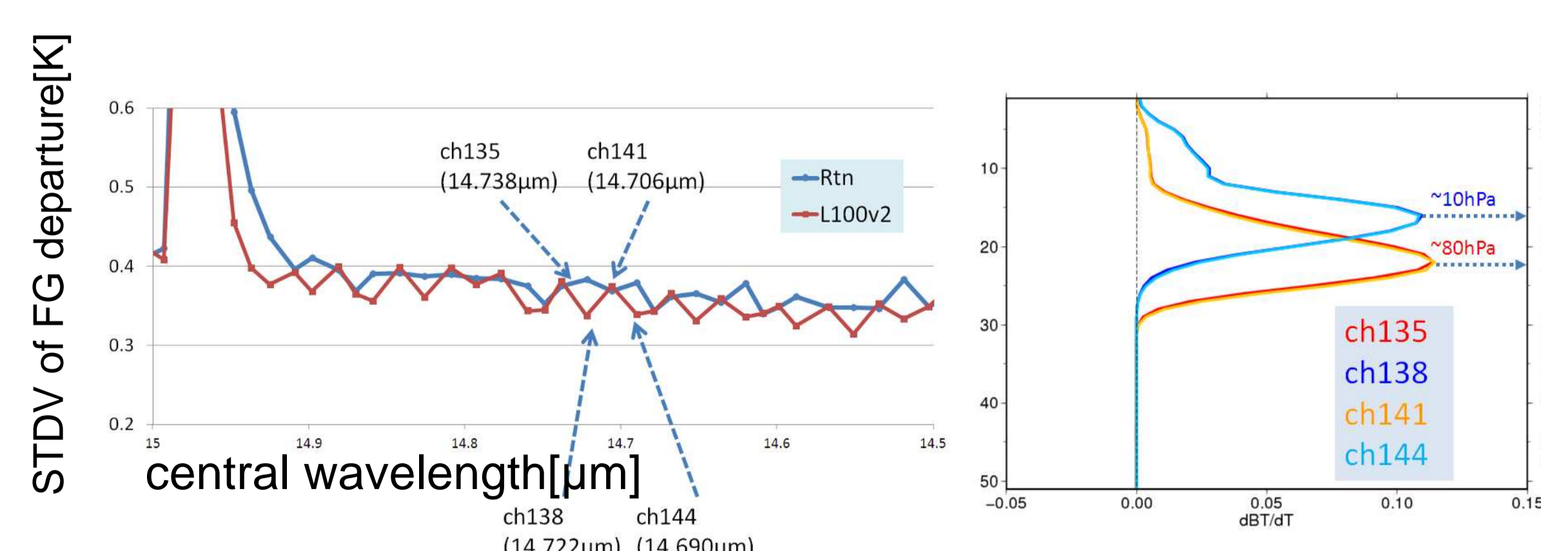


Fig4.3 : (left) As of Fig 4.2, but for standard deviation (STDV), for IASI. Improvements of STDVs are clear at ch138 and ch144, but not at ch135 and ch141. (right) T-Jacobians of ch135, 138, 141, 144. (ch135 and ch141, ch138 and ch144 are almost overlapped.) The sensitivity height of ch138 and ch144 are  $\sim 10$ hPa. So, improvements of L100 first guess field are more significant around 10hPa height than 80hPa height.