All-sky infrared radiances assimilation of selected humidity sensitive IASI channels at NCEP/EMC

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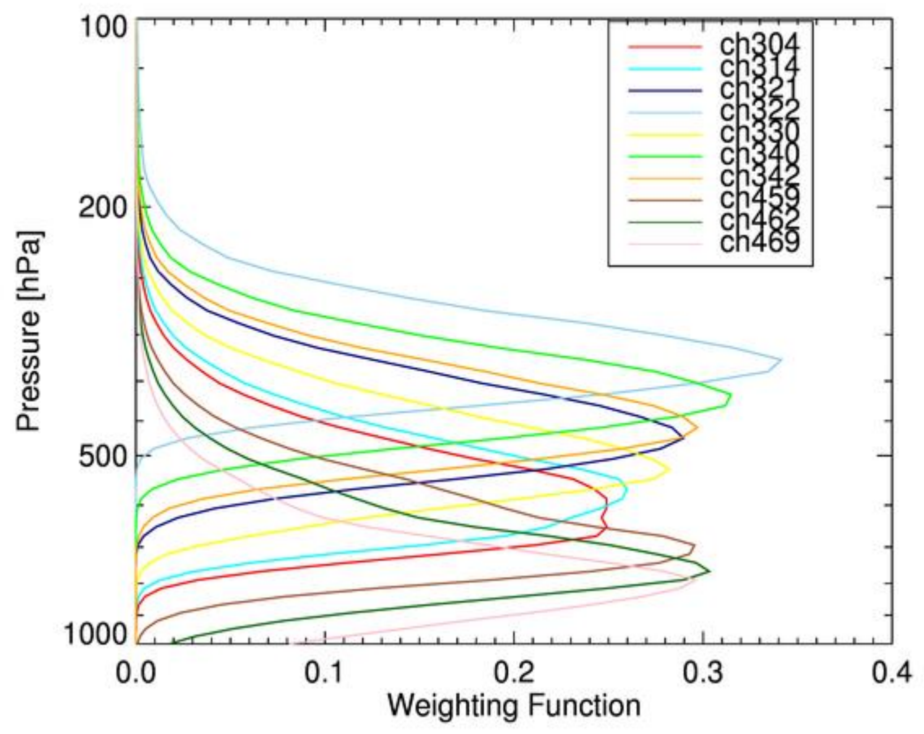
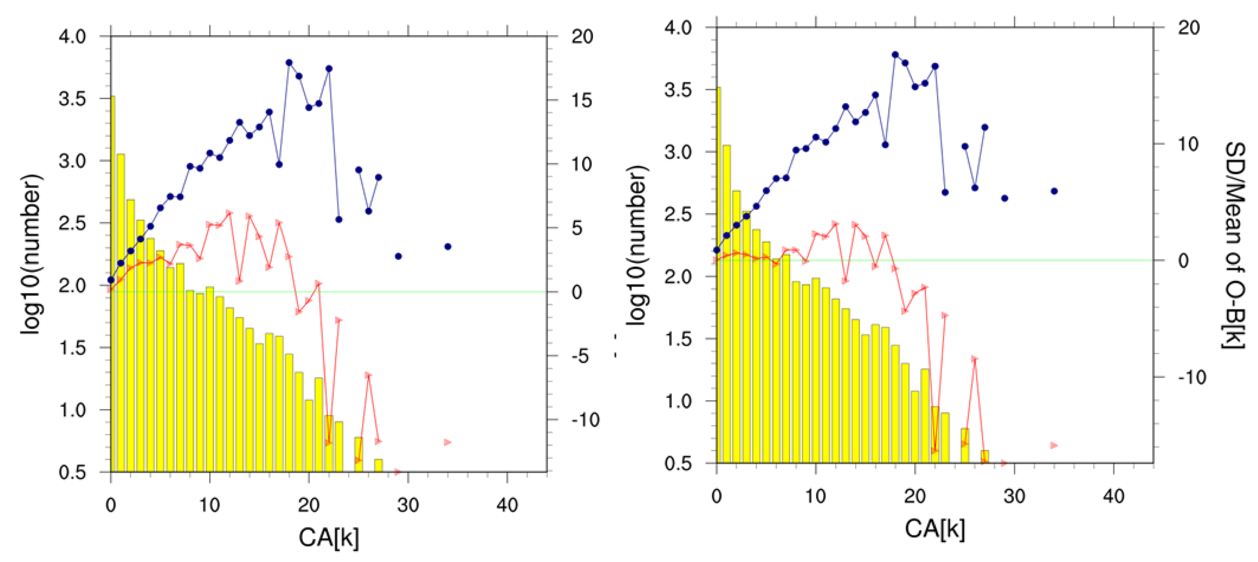
Introduction

This work focuses on the assimilation of all-sky infrared radiances of selected Infrared Atmospheric Sounding Interferometer (IASI) channels using NCEP GFS model. Radiances simulation are implemented using Community Radiative Transfer Model (CRTM) that includes profiles for liquid-water content and ice-water content. The new released CRTM which includes cloud over computation is used in this study. Four overlap schemes are available for selection: weighted average overlap assumption (Geer et al,.2009), maximum, random. and maximum/random overlap assumptions (Morcrette and Jakob,2000). One season parallel experiment was performed from 2015052500 to 2015072400 for this IR all sky assimilation work. Statistical analysis that over the ocean of observation minus background departure O-B as well as are evaluated for selected humidity sensitive channels. The observation screening procedure was developed to improve the cloudy scenes selection. Cloud-dependent quality controls and observation error are evaluated in this study. The goal for this preliminary work is to extend the microwave (MW) all sky radiances assimilation at NCEP/EMC to infrared (IR) all sky assimilation for the channel that are suited in all sky conditions.



Channel number	Wave number (cm⁻¹)	Channel index
2889	1367	304
2958	1384.25	314
2993	1393	321
3002	1395.25	322
3049	1407	330
3105	1421	340
3110	1422.25	342
5381	1990	459
5399	1994.5	462
5480	2014.75	469

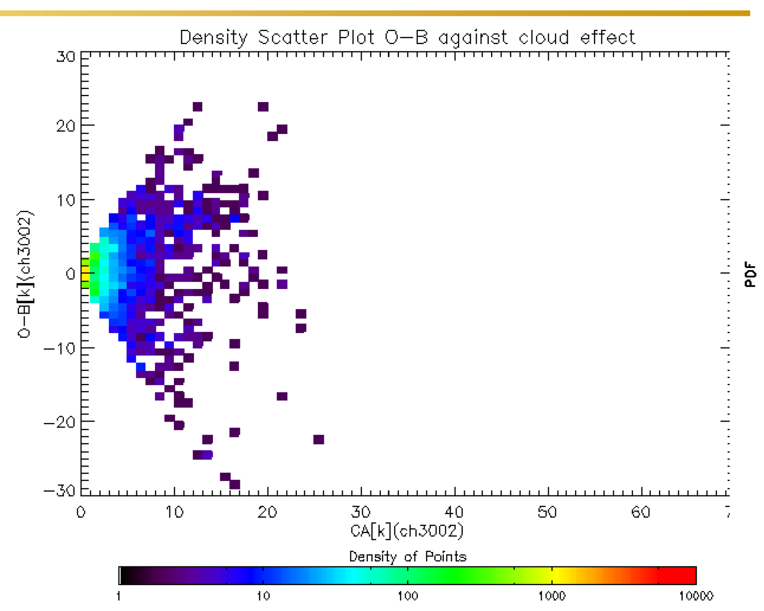
Prediction of O-B variability using the cloud effect parameter (IASI Ch3002)



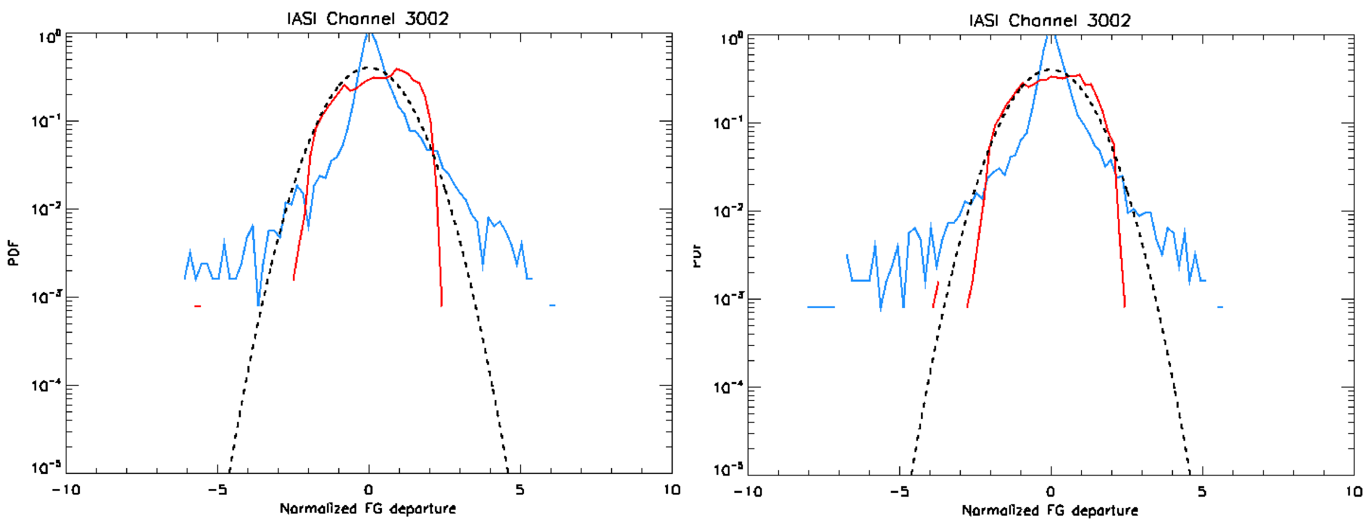
O-B assuming overcast — O-B using model's cloud fraction

$$Rad_{allsky} = (1\text{-}TCC)*Rad_{clear} + TCC*Rad_{cloudy}$$

-- Calculate the total cloud cover (TCC) using the four overlap schemes from the cloud fraction profile
-- Select all points from cloudy and clear simulation for humidity sensitive channels from the table.
-- Default overlap scheme is average overlap assumption.
--Apply computed TCC to calculate the all sky radiances:
- --Include all the points (no QC)
- --In radiance space
- --Over the ocean

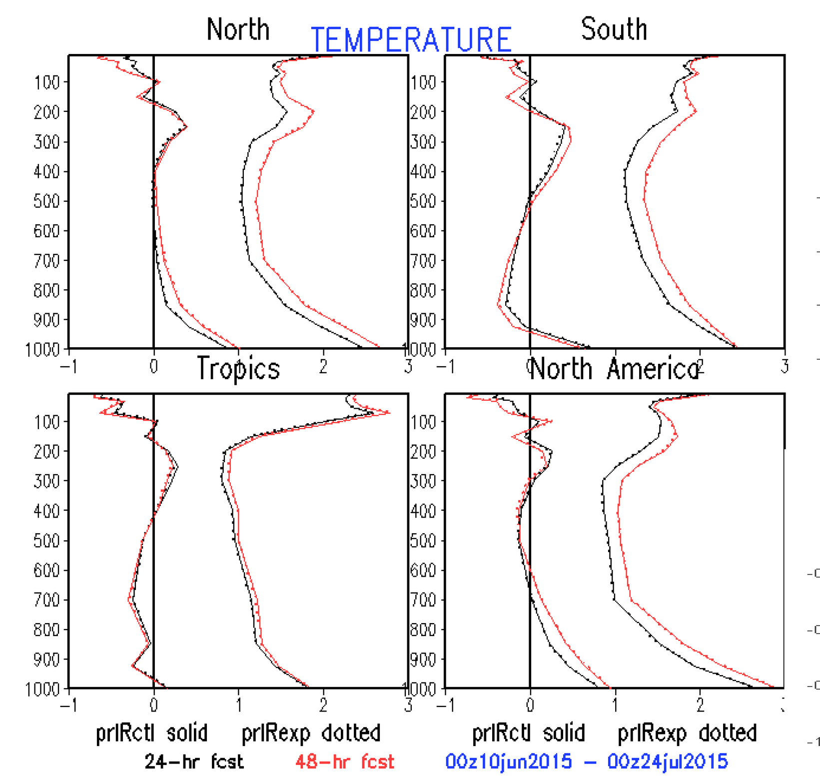


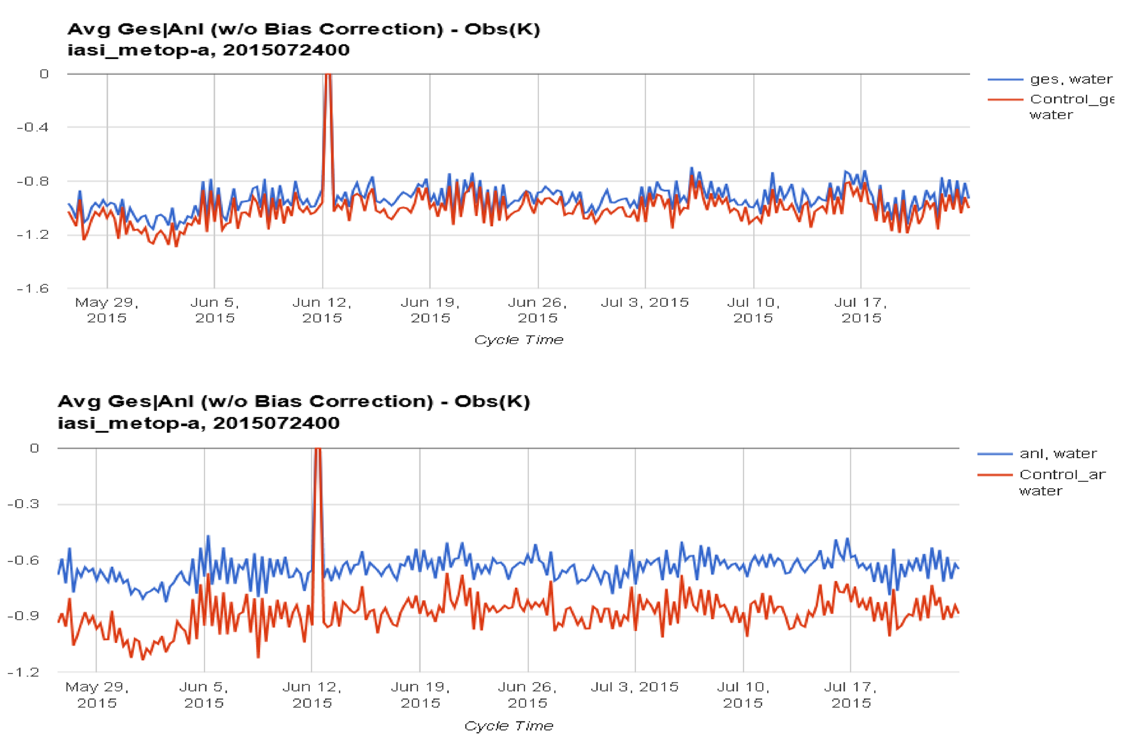
PDFs of O-B normalized by O-B SD (function of CA)

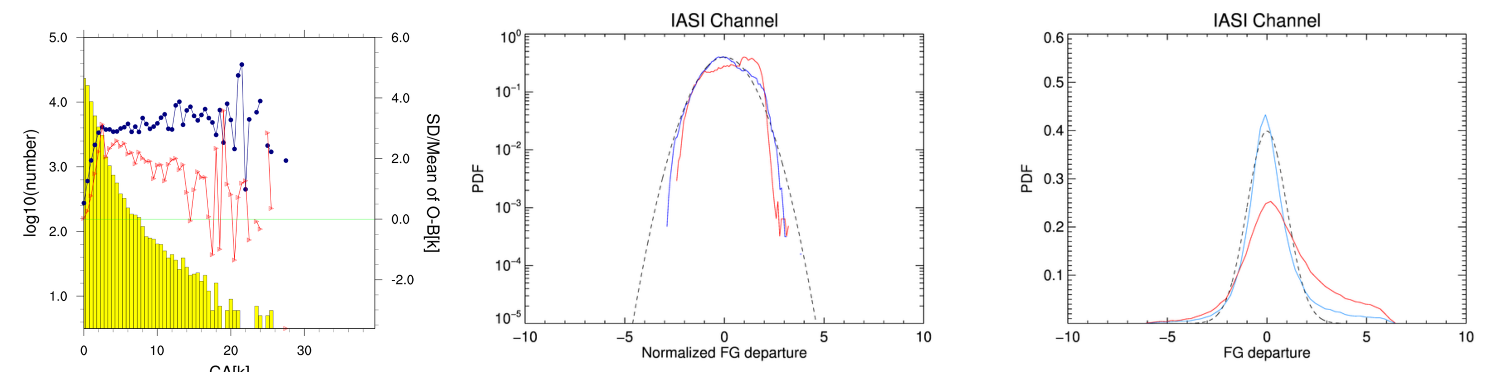


O-B assuming overcast — O-B using model's cloud fraction

Results from parallel experiment : 2015052500-2015072400

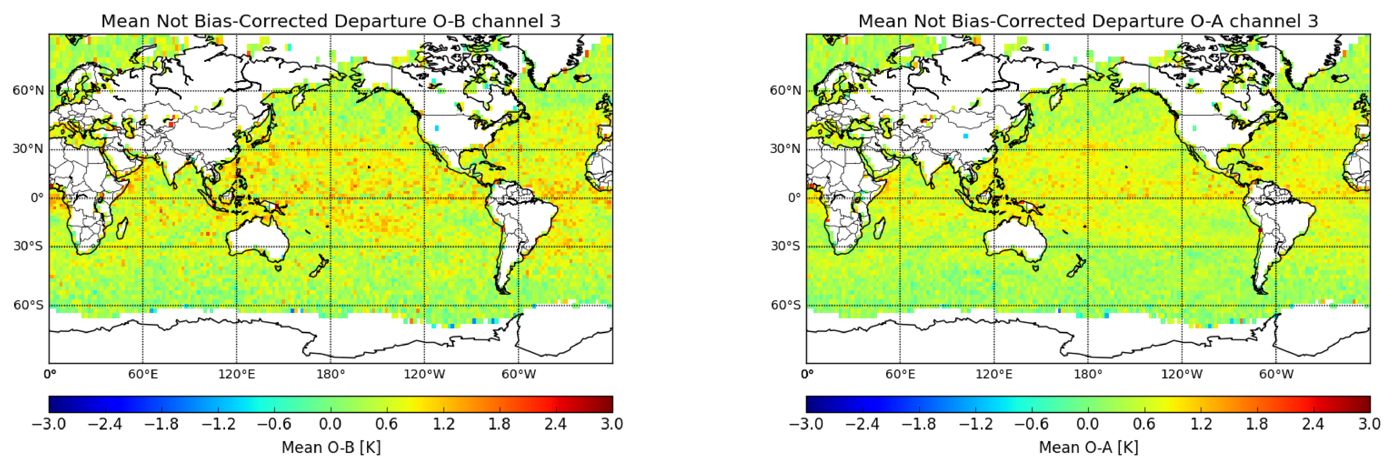




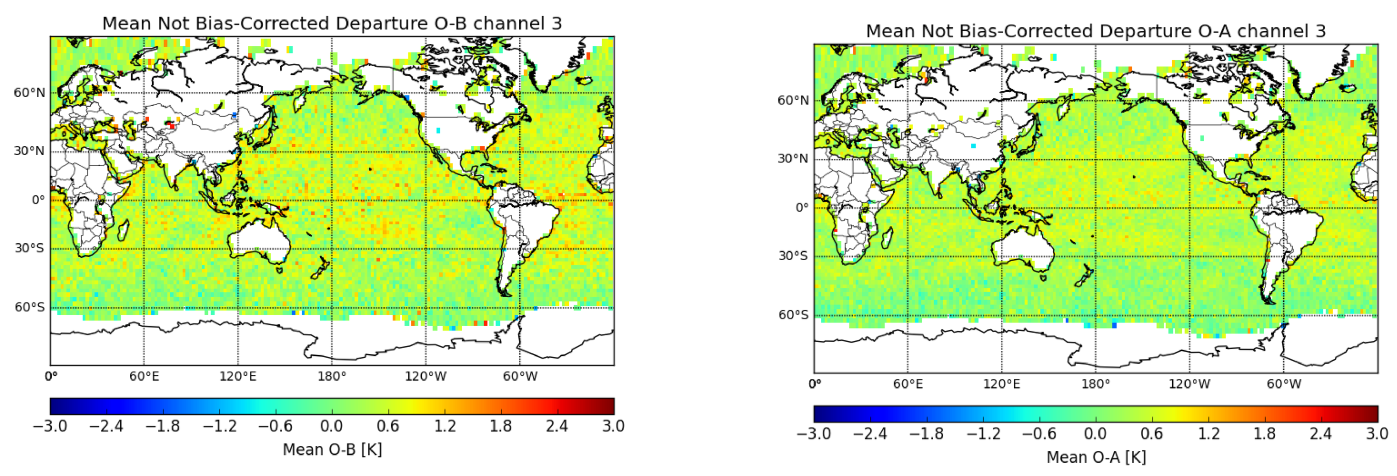


Analysis PDFs response well by including cloud effect and model;s cloud fraction

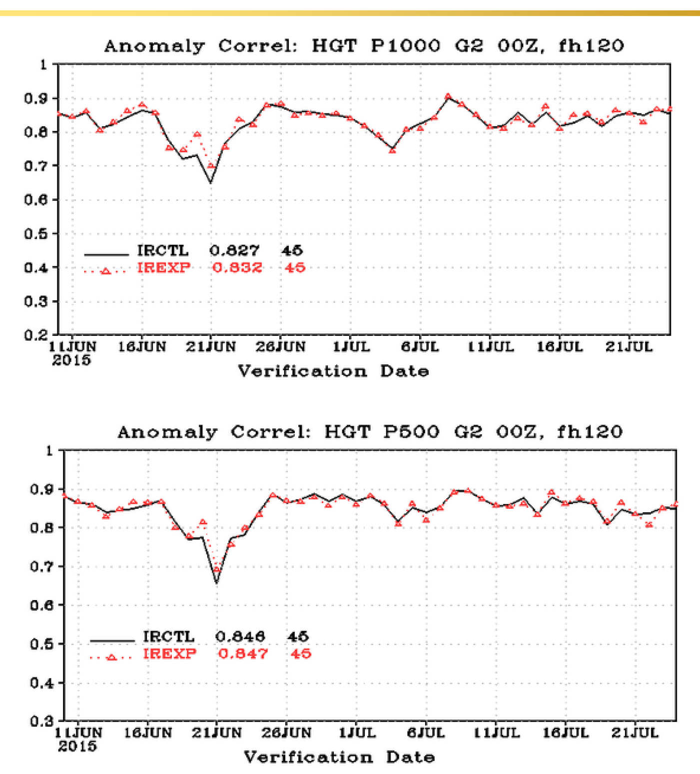
MHS channel 3 unbias corrected mean O-B/O-A from control

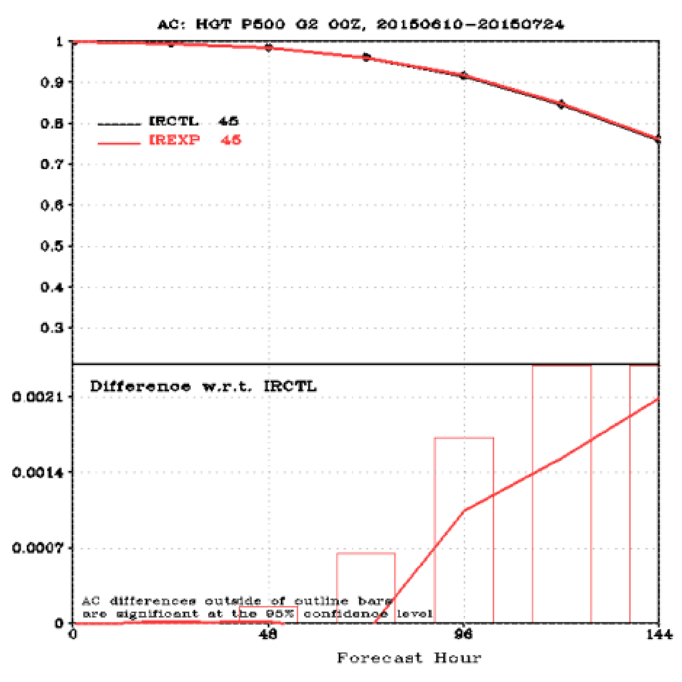


MHS channel 3 unbias corrected mean O-B/O-A from experiment

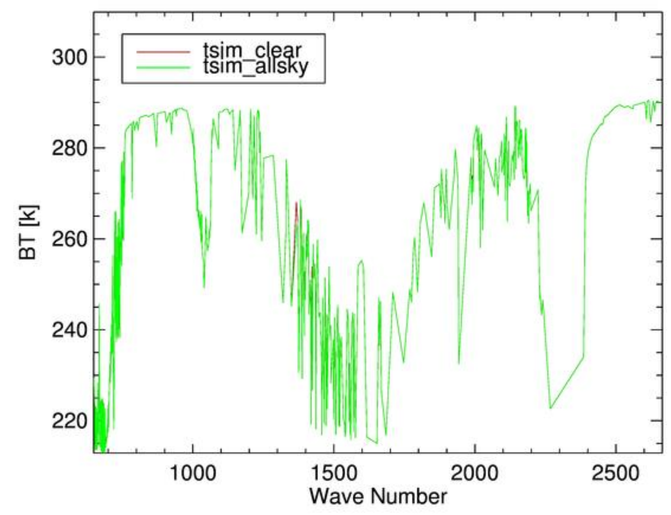


Analysis PDFs response well by including cloud effect and model;s cloud fraction

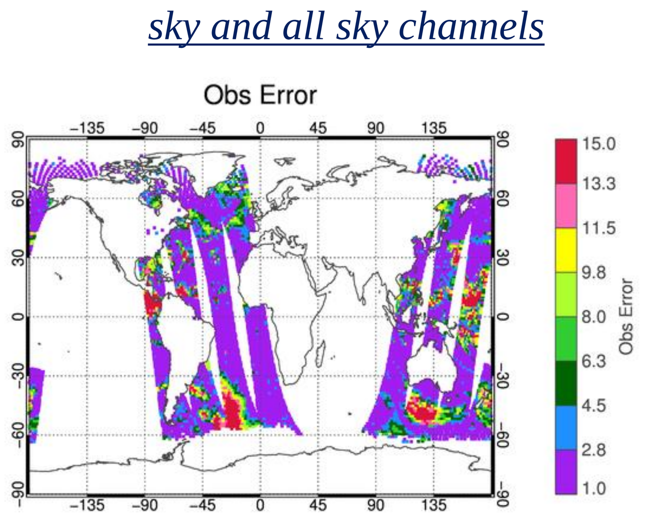




Cloud parameter for IR radiances



Mixed channels: separate observation errors for clear sky and all sky channels



- Symmetric cloud parameter for IR radiances
  - $CA_i = (|OB_i\text{-}FG_{clr,i}|+|FG_i\text{-}FG_{clr,i}|)/2$
    FG_{clr}: clear-sky FG, i: channel
  - $CA_i = (|C_O|+|C_M|)/2$

The concept of a symmetric cloud effect parameter is introduced by Geer and Bauer (2011) for the microwave, and Okamato et *al*. (2014) for the infrared. We applied the development of the symmetric cloud parameter for IR radiances to this study to express the cloud effect on variability in O-B.
The density scatter plot of O-B against the cloud effect average is shown for channel 3002. The standard deviation of O-B for the same channel as a function of CA is shown to explain the prediction of O-B variability using the cloud effect parameter.

Summary and Path forward

- Assimilating IASI water vapor sensitive channels in all sky condition show slight positive/neutral impact.
- Four CRTM cloud cover schemes were tested in this study and the average overlap scheme was selected.
- IASI all sky radiances assimilation reduced the bias of other satellite instrument.
- The next step is prepare for operational implementation.

Reference

- Geer AJ, Bauer P. 2011: Observation errors in all-sky data assimilation. *Q. J. R. Meteorol. Soc.* **137**: 2024–2037, doi: 10.1002/qj.830.
- J.-J. Morcrette and C.Jakob. 2000: The response of the ECMWF model to changes in the cloud overlap assumption. *Mon. Wea.Rev.*, 128(6):1707-1732.
- Okamoto K, McNally A.P., and Bell W. 2014: Pregress towards the assimilation of all-sky infrared radiances: an evaluation of cloud effects. *Q. J. R.Meteorol. Soc.* **140**: 1603–1614, doi: 10.1002/qj.2242.