# The Impact of Geostationary Interferometric Infrared Sounder (GIIRS) Cloud Cleared Radiances on Typhoon forecasts: Maria (2018)

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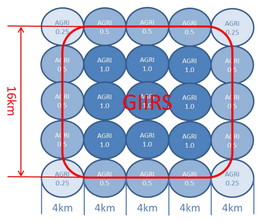
**Abstract:** Hyperspectral infrared (IR) sounder could provide detailed atmospheric temperature and moisture information with high vertical resolution that is essential for improving the forecast skills of numerical weather prediction. Generally, only clear sky radiances are used in model, because the observations from IR sounder are sensitive to clouds. A cloud-clearing (CC) method, which could remove cloud effect from IR cloudy field of view (FOV) and derive the cloud-cleared radiances (CCRs) or clear sky equivalent radiances, can be an alternative and effective technique to make full use of thermal information of FOV with partial cloud cover in data assimilation. Previous researchers have applied this technique to polar orbiting weather satellites (such as CrIS) and showed good results. This study focuses on Geostationary Interferometric Infrared Sounder (GIIRS) CCRs calculated from Advanced Geosynchronous Radiation Imager (AGRI) onboard FengYun-4A. The differences between the observation and simulation brightness temperature (O-B) indicate that CC method can effectively obtain the GIIRS CCRs for cloudy FOV, because it has consistent O-B with that from clear sky. To compare the impacts from assimilation of GIIRS original radiances and CCRs, three experiments are carried out on Typhoon Maria (2018) case using Global/Regional Assimilation and PrEdiction System (GRAPES) 4D-Var. In the assimilation window, more GIIRS observations are used by assimilating GIIRS CCRs than by assimilating GIIRS original radiances. The typhoon track forecast also shows that the assimilation effect of GIIRS CCRs is improved compared with the original observations.

## 1. Intercomparison between GIIRS and AGRI

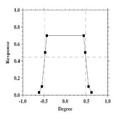
① The mean radiation of the matched AGRI pixel is calculated based on the spatial spread function of the GIIRS's FOV.

$$Rad\_AGRI\_mean = \frac{\sum Rad(ipixel) * weights(ipixel)}{\sum weights(ipixel)}$$




$$Radclr\_AGRI = \frac{\sum Rad(ipixel\_clr) * weights(ipixel\_clr)}{\sum weights(ipixel\_clr)}$$

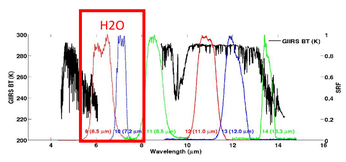
$$BT = anti\_Plank(radiance, EquivMid\_wn)$$



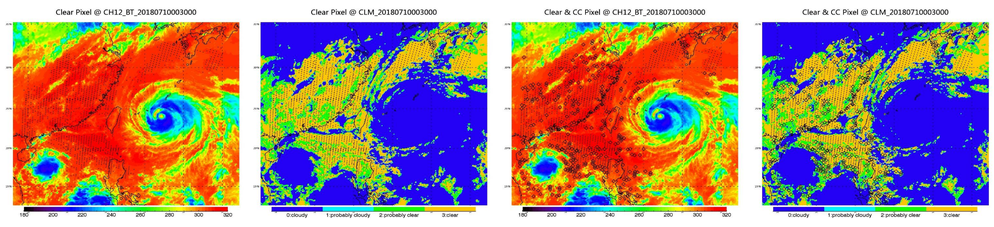
② The equivalent radiation convolution of each channel of GIIRS is calculated based on the spectral response function (SRF) of the AGRI after hamming apodization of GIIRS radiation.

$$Rad\_GIIRS\_conv = \frac{\int RAD(v) \times SRF(v) dv}{\int SRF(v)\, dv}$$

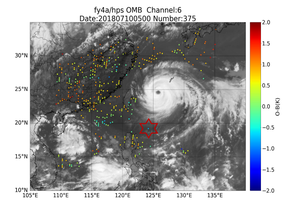
$$BT = anti\_Plank(radiance, EquivMid\_wn)$$



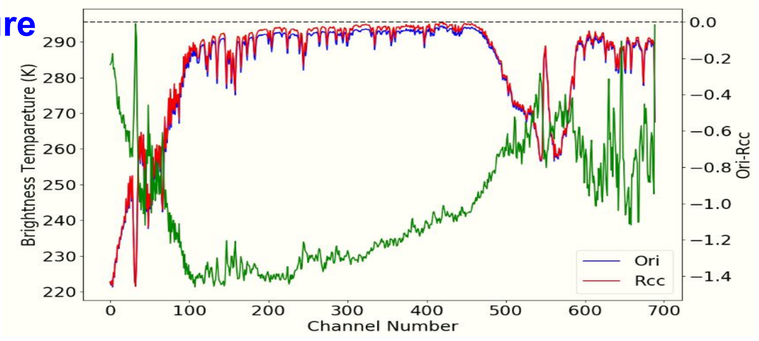

③ Intercomparison result



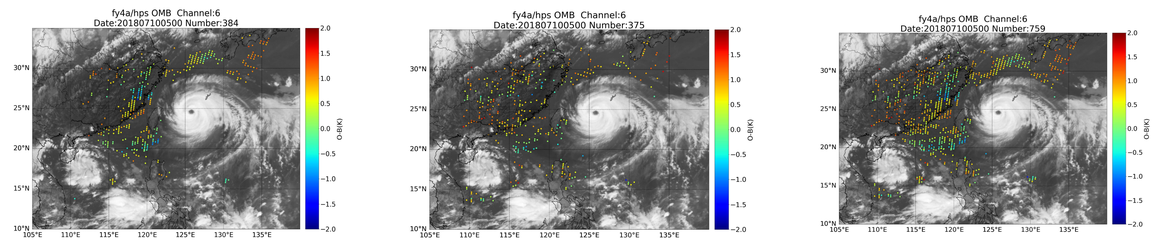

## 2. Brightness temperature



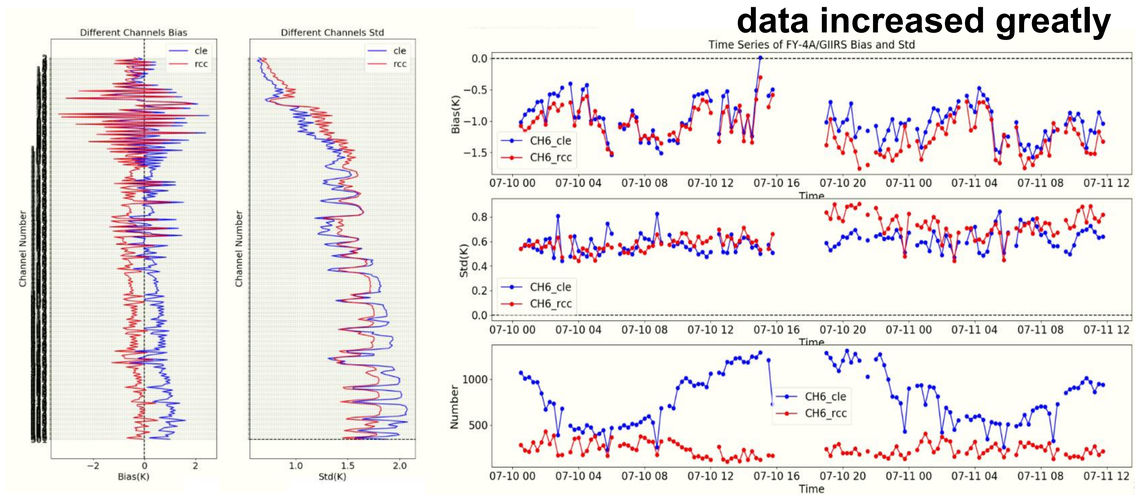

CCRs



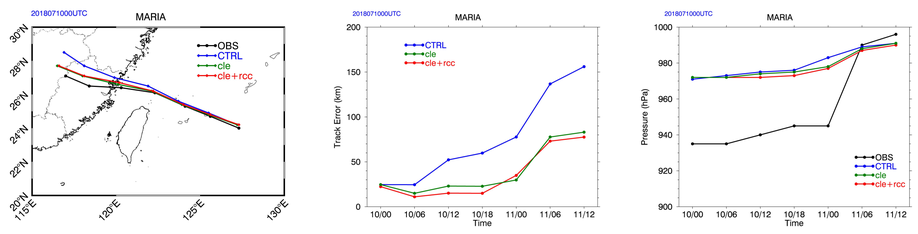

## 3. CCRs data impacts on O-B




original clear radiances + CCRs → **The number of assimilated data increased greatly**




## 4. Impacts on Track forecasts




| Track error | (GIIR-CTRL)/CTRL (%) | | | | | | | mean |
|---|---|---|---|---|---|---|---|---|
| Ori | 0 | 39.09 | 56 | 61.9 | 61.68 | 43.22 | 46.78 | **44.1** |
| Ori+RCCs | 9.23 | 55.1 | 71.11 | 75.02 | 55.12 | 46.58 | 50.30 | **51.78** |

The **positive impact** from GIIRS CCRs on Typhoon Maria (2018) forecasts.

## 5. Summary

① GIIRS CCRs can substantially increase the number of GIIRS radiance observations in assimilation system.

② GIIRS CCRs have larger influence on O-B for channels with weighting functions peaking at low levels.

③ Assimilating GIIRS CCRs improve the Maria's forecast results.

**Reference**

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