Assimilation of HY-2B SMR radiance observations using CMA GFS 4DVAR system

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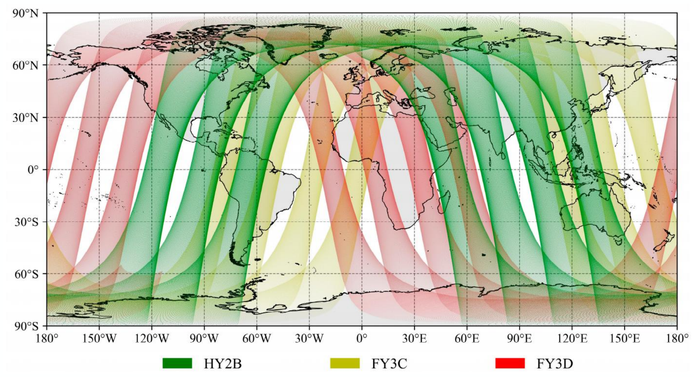
Abstract

In this study, the Haiyang-2B satellite (HY-2B) Scanning Microwave Radiometer (SMR) radiance data were assimilated into the CMA GFS four-dimensional variational (4DVar) system. Quality control procedures were developed for SMR applications by using algorithms from similar microwave instruments. A conventional bias correction approach was used to remove systematic biases before the assimilation of data. After assimilating the SMR radiance data into CMA GFS, the global low-level humidity and temperature analyses were significantly improved relative to the control experiment. Furthermore, SMR observations provide some improvements to the forecast of dynamical fields (pressure and vector wind) in the Southern Hemisphere, along with benefits to the humidity and temperature fields in the tropical lower troposphere.



Methodology

Qualitity control method:

1. An abnormal value check, which deletes observations with TB < 50 or >350 K;
2. A surface-type check. Data over land are discarded;
3. A latitude check, keeping only data between 50°N and 50°S to avoid including the pixels over sea ice;
4. Cloud detection:
   4.1 The observation is retained only if $TB_{37V} - TB_{37H} > 50$;
   4.2 Data are rejected if the CLWP values in L2C products are larger than the thresholds listed in the table below;

Frequency(GHz)	6.925	10.7	18.7	23.8	37.0
CLWP(Kg/m²)	0.35	0.35	0.3	0.25	0.1

5. A rain rate check. Rain is assumed if the data meet any of the following conditions;

$$TB_{\mathrm{V}}^{37} - 0.979TB_{\mathrm{H}}^{37} < 55\mathrm{K}, \quad (1)$$

$$1.175TB_{\mathrm{V}}^{18.7} - 30 > TB_{\mathrm{V}}^{37}, \quad (2)$$

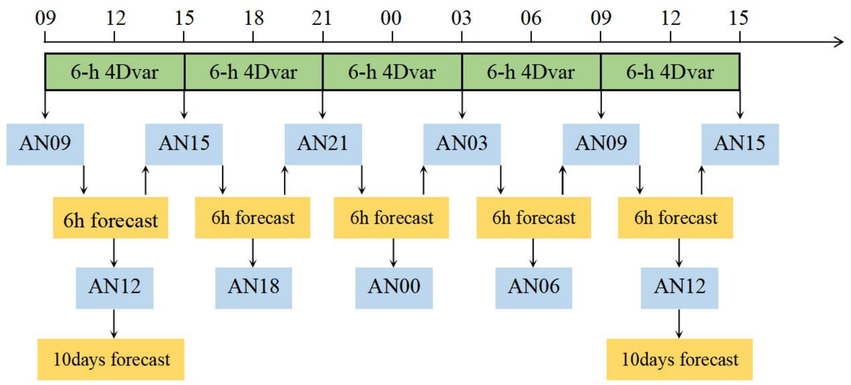
$$TB_{\mathrm{H}}^{18.7} > 170\mathrm{K}, \quad (3)$$

$$TB_{\mathrm{H}}^{37} > 210\mathrm{K}. \quad (4)$$

6. A scan position check. The first 17 pixels and the last 5 pixels for all channels of the SMR are discarded.

Experimental setup:

Experiment	Description	Period
Control	CMA GFS V3.3 (without SMR)	2021.07.10 - 2021.08.14
Test	Control plus SMR (18.7V, 23.8V, 37V)	(The first 4 days are for spin up)

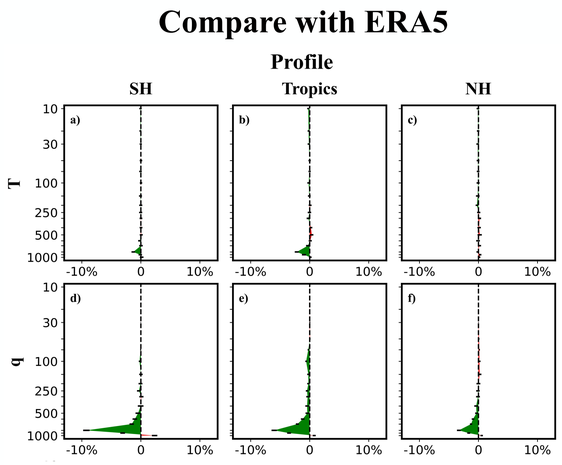


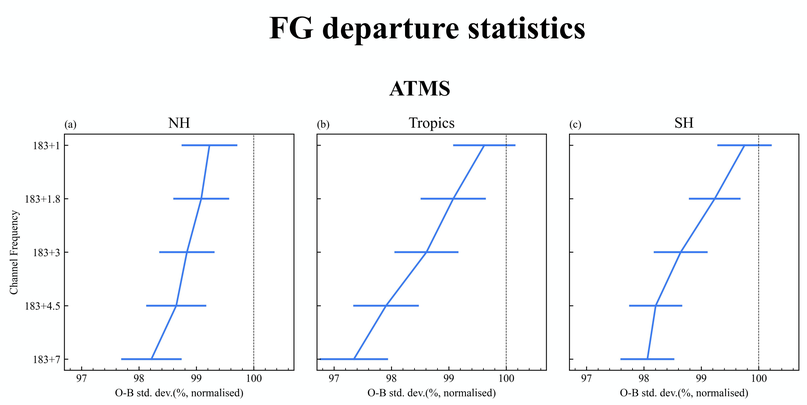
Conclusions

Optimize the analyses and forecasts of atmospheric variables

Results

Impacts on analysis fields :





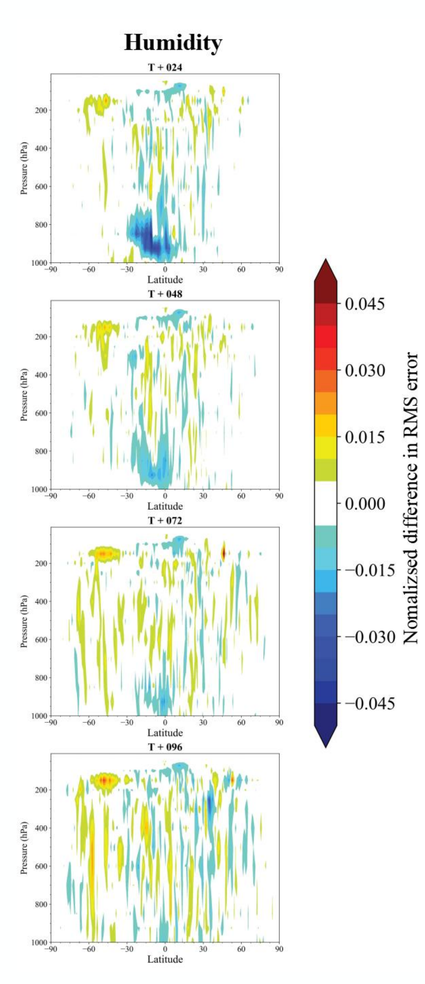
Impacts on forecast fields:

Forecast score card

Domain	Parameter	Level	Anomaly Correlation	RMS Error
SH	HGT	850	▲	▲
		500	▲	
		250		
	TEMP	850	▲	▲
		500		
		250		▲
	UWND	850	▲	▲
		500		
		250	▲	▲
	VWND	850	▲	▲
		500	▲	
		250	▲ ▲	▲ ▲
TRO	HGT	850		▲ ▲
		500	▲	▲
		250		▼ ▼ ▼ ▼ ▼ ▼
	TEMP	850	▲ ▲ ▲ ▲ ▲ ▲	▲ ▲ ▲ ▲ ▲ ▲ ▲
		500	▲	▼ ▼ ▼ ▼
		250		▼ ▼ ▼
	UWND	850	▲	▲ ▲
		500		
		250	▼ ▼	▼ ▼
	VWND	850	▲ ▲	▲ ▲ ▲
		500		
		250		

▲: Far better ▲: Better ▪: Better but not significant ▪: Equality
▼: Far worse ▼: Worse ▪: Worse but not significant

SMR observations provide some improvements to the forecast of dynamical fields (pressure and wind) in the Southern Hemisphere, along with benefits to the humidity and temperature fields in the tropical lower troposphere.



References

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