Investigation of AIRS and AMSU Sounding Products in Regional Numerical Weather Prediction

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1. Objective

- Regional numerical weather prediction (NWP) model can do high resolution forecast. Forecast performance is effected by initial and boundary value.
- Data assimilation (DA) can improve initial condition by observations.
- A new AIRS single Field-of-View (SFOV) product retrieved by 1D-Var have higher spatial resolution than AMSU standard retrieval product.
- Use AMSU and AIRS SFOV soundings to evaluate the performance for introducing these two different data sets.

2. AMSU v.s. AIRS SFOV Retrievals

Table1. Deference between AMSU and AIRS SFOV.

	AMSU	AIRS SFOV
Instrument	AMSU (MW) and AIRS (IR)	AIRS (IR) only
Horizontal resolution	45 km @ nadir	13.5 km @ nadir
Vertical resolution	T=28 levels; Q=15 levels	T/Q =101 levels
Cloud limit	0% ~ 80%	0% ~ 1%

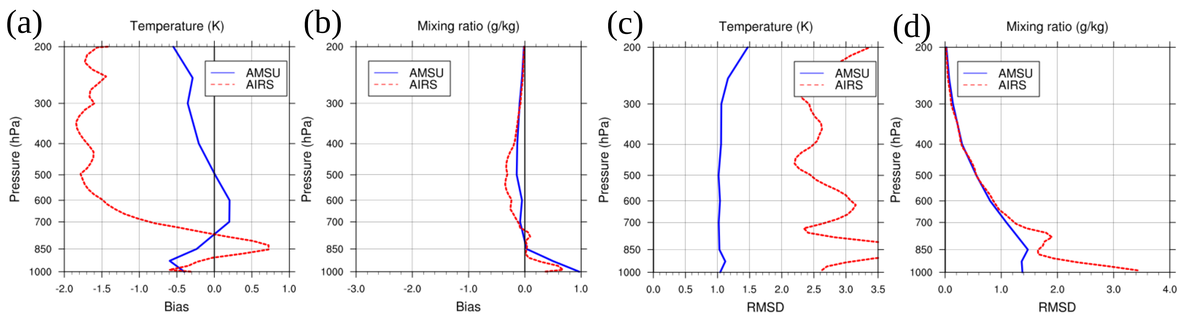

Figure 1. AMSU (AIRS SFOV) temperature (moisture) retrieval product's bias and RMSD in May 2012. ECMWF-interim reanalysis (0.25°x0.25°) data set is selected as reference.

3. Model and Experiment

Weather Research and Forecasting Model V3.1.1

Initial time: 2012/06/08~13 (6 days) 0000 UTC
Initial: NCEP GFS ANL
Lateral boundary: ANL (DA) and FCST (FCST)
Domain: 3 one-way nested domains
Resolution: vertical 31 levels, horizontal 45/15/5 km

WRF Data Assimilation v3.1.1

3D-Var
Assimilation interval: 6 h
Time windows: ±3 hr
Cycling period: 2 days

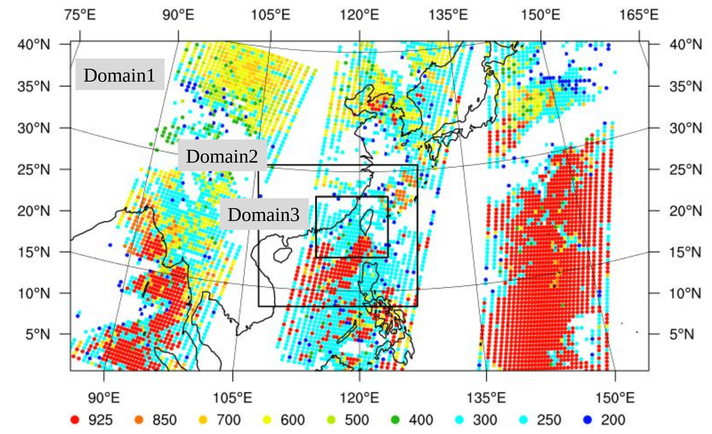

Figure2. Domain and satellite observation. Point is a representative level from AMSU/AIRS data, all data above (include) this level have best quality.

Table 2. Physics schemes in the model.

Physics scheme	
Microphysics	WSM 5-class
Longwave radiation	rrtm
Shortwave radiation	Dudhia
Boundary layer	Yonsei University
Cumulus	new Kain-Fritsch

Table 3. Control and Experiments.

Experiment	Data Assimilated
CTRL	GTS
E_AMSU	GTS + AMSU
E_AIRS	GTS + AIRS SFOV

4. Preliminary Result

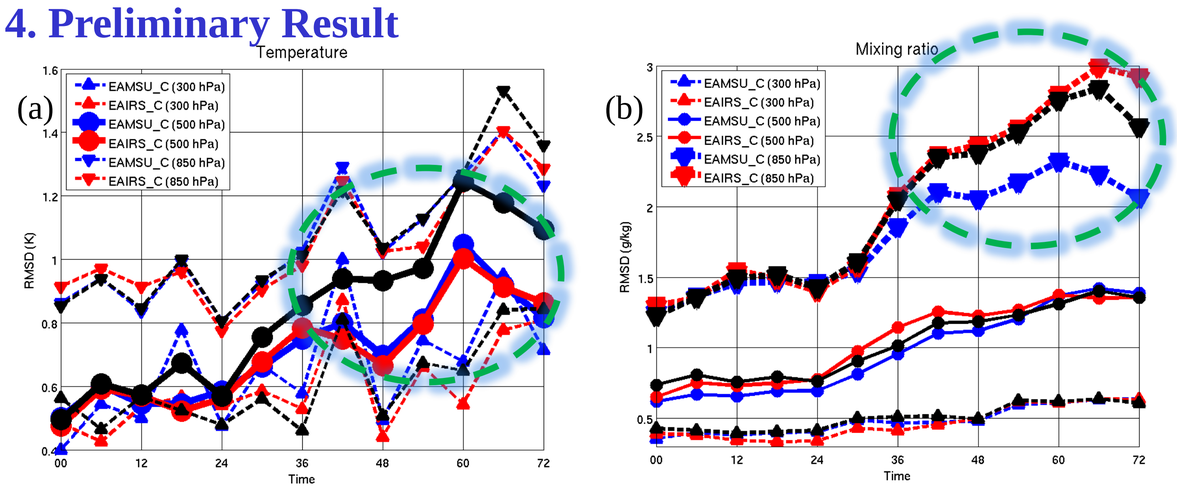

Figure 3. Control and Experiment run's forecast RMSD verification. (a) is Temperature and (b) is mixing ratio. Black lines are CTRL. A-axis is forecast time averaged by 6 runs in each experiment. ECMWF-interim reanalysis data set is selected as reference. Green circle represent lager difference, it will discussed in chapter 6.

- E_AMSU better than E_AIRS.
- There are many difference between AMSU and AIRS (ex. coverage, resolution, accuracy and observation/retrieval characteristic)
- Desiring new experiment to investigation the impact from these two retrieval product.

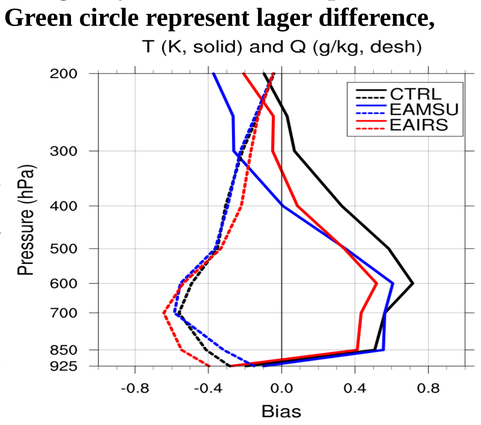

Figure 4. Mean bias form 0-72 forecast.

5. Data Spatial Quality Control-Collocation

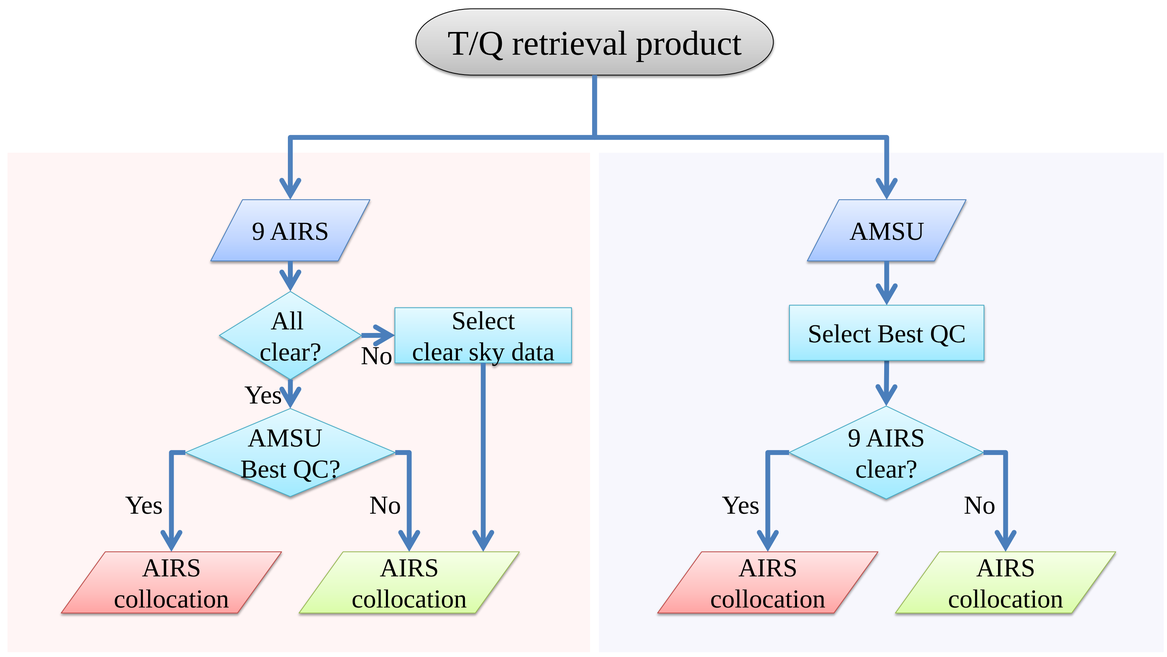

Figure 5. Collocation flow chart. AMSU's QC is base on TAirStd_QC and H2OMMRLevStd_QC provided from AMSU data set.

6. Sensitive Experiment

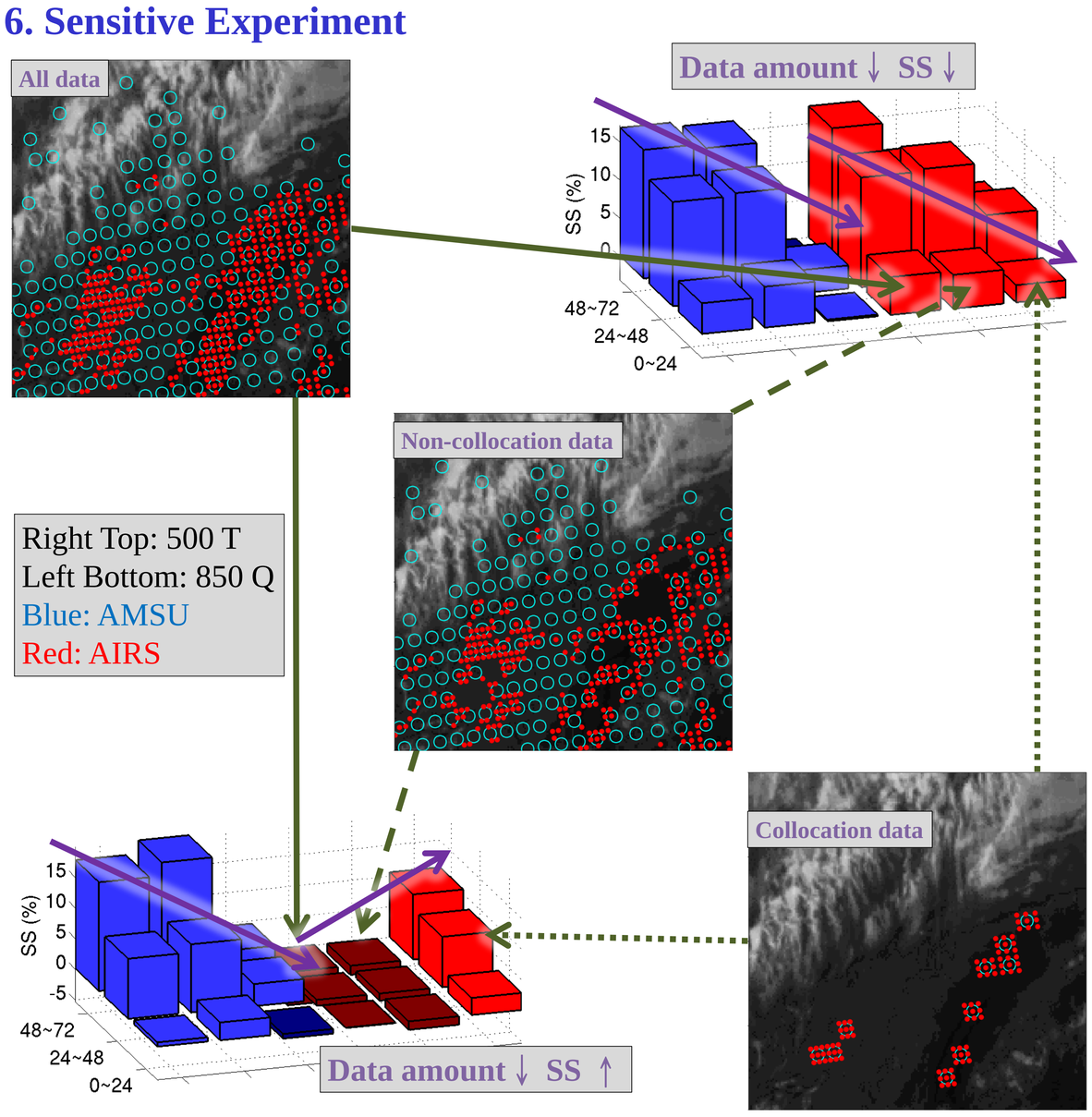

Figure 6. 500 hPa Temperature and 850 hPa mixing ratio's Skill Score in each experiment. Light: SS>0; dark: SS<0. SS represent improvement compared with CTRL.

$$Skill\ Score(SS) = \left(\frac{RMSD_{CTRL} - RMSD_{EXP}}{RMSD_{CTRL}}\right) * 100\%$$

- AMSU experiment: AMSU provide a stable retrieval product because it's observation/retrieval characteristic. It may cause this linear feature in SS/data.
- AIRS experiment: Mixing ratio have better performance than the other two. It may due to non-collocation data (green point shown in Fig.6). Data assimilation system may destroy existing system by taken and transmitted these non-cloud feature to entire region from non-collocation data.

7. Summary and Future Work

- If there have same data coverage between AIRS and AMSU, AIRS will have better positive impact in NWP forecast system than AMSU.
- Might be able to improve AIRS SFOV non-collocation problem in data assimilation system by using AIRS SFOV cloud retrieval product.
- Reducing observation influence radius or using another data assimilation method which can transmitting data information better may improve high resolution satellite retrieval product application in NWP forecast.

References

Liu, C.-Y.*, G.-R. Liu, T.-H. Lin, C.-C. Liu, H. Ren, and C.-C. Young (2014), Using Surface Stations to Improve Sounding Retrievals from Hyperspectral Infrared Instruments, *IEEE TRANS. ON GEOSCIENCE AND REMOTE SENSING* (accepted).

Liu, C.-Y.*, J. Li, P. Zhang, T. J. Schmit (2012), Applications of Full Spatial Resolution Space-Based Advanced Infrared Soundings in the Preconvection Environment, *WEATHER AND FORECASTING*, **27**, 515-524, doi:10.1175/WAF-D-10-05057.1.