Recent upgrades of satellite radiance data assimilation at JMA

Norio Kamekawa, Masahiro Kazumori, Yoichi Hirahara, Yasutaka Murakami, Yasutaka Ikuta
Numerical Prediction Division, Japan Meteorological Agency (JMA)

Outline of NWP systems at JMA

Table 1 shows specifications of JMA's forecast model and data assimilation systems. Details are available on the http://www.jma.go.jp/jma/en/Activities/nwp.html .

Table 1: Specifications of JMA's NWP models

Model	Global Model & Analysis (GSM,GA)	Global Ensemble Model (GEPS)	Meso-scale Model &Analysis (MSM,MA)	Local Forecast Model &Analysis (LFM, LA)
Horizontal / vertical res.	TL959 / L100 (up to 0.01hPa)	TL479 / L100 (up to 0.01hPa)	5 km / L76 (up to 22 km)	2 km / L58 (up to 20 km)
Forecast range (Initial time)	84h (00,06,18UTC) 264h (12UTC)	5.5 days (06,18UTC) 11 days (00,12UTC)	39h (3 hourly)	9h (1 hourly)
Data Assimilation (inner loop horizontal res.)	4D-Var (TL319)		4D-Var (15 km)	3D-Var (5 km)
Assimilation window	6h (-3 ~ +3 hours)		3h (-3 ~ 0 hours)	1 hourly update cycle for 3h (-3 ~ 0 hours)
RTM for Radiance assimilation	RTTOV 10.2			
Cut off time	Early Analysis: 2h20m Cycle Analysis: 11h50m (00, 12UTC), 7h50m (06, 18UTC)		50m	30m

List of Upgrades

Below are the main updates of observation data assimilation from ITSC-20.

- ASCAT (MA, Dec. 2015) (Moriya 2016)
- GPM/DPR (MA, Mar. 2016) (Y. Ikuta 2016)
- GPM/GMI (GA, MA, Mar. 2016) (M. Kazumori 2016)
- Hiwawari-8 AMV (GA, MA, LA, Mar. 2016) (K.Yamashita 2016)
- Hiwawari-8 CSR (GA, MA, Mar. 2016) (M. Kazumori 2016)
- GNSS RO (MA, Mar. 2016) (Hirahara et al. 2017)
- Radiance and soil moisture content (LA, Jan. 2017) (Y. Ikuta 2017)
- Suomi-NPP/ATMS (GA, Mar. 2017) (Hirahara et al. 2017)
- Suomi-NPP/CrIS (GA, Mar. 2017) (N. Kamekawa and M. Kazumori 2017)
- SSMIS/ch9-11(GA, Mar. 2017) (Y. Murakami and M. Kazumori 2017)
- Improvement of GNSS RO utilization (GA, Jul. 2017)

Assimilation of satellite data in Local Analysis

Soil moisture content and clear sky radiances have been assimilated operationally in the JMA local analysis system since January 2017 (Ikuta 2017). The water vapor profiles on upper troposphere, precipitation, surface temperature and humidity were improved.

Impact of Early Analysis data delivered from DBNet

DBNet (Direct Broadcast Network) is expanding the RARS (Regional ATOVS Retransmission Services) concept to other data types in support of a wider range of applications. Fig 1 shows coverage map of DBNet stations. AMSU-A and MHS radiances from the Asia-Pacific Regional ATOVS Retransmission Service (A-P RARS) have been operationally assimilated into global NWP system run by the JMA since Feb. 2007.

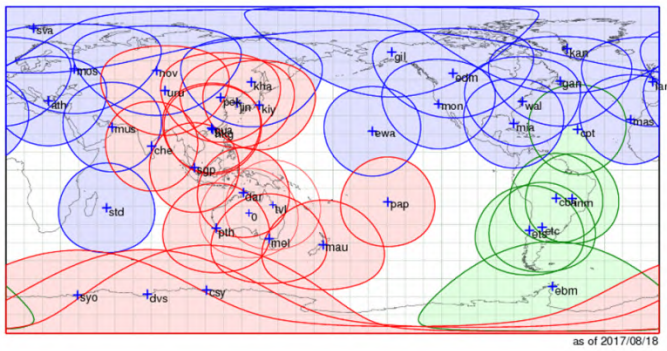

Fig 1: Coverage map of DBNet stations. Blue, Red and Green areas show respectively EARS, AP-RARS and SA-RARS stations.

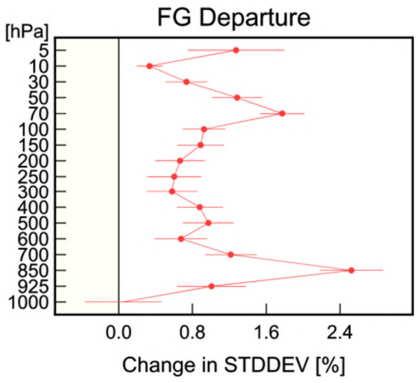

Fig 2: Normalized changes in the standard deviation of first-guess departures from temperature of radiosonde. Negative values represent first-guess field improvement. Error bars represent a 95% confidence interval, and red dots represent statistically significant values.

In order to confirm the usefulness of DBNet data in numerical weather forecasts, DBNet data denial experiments to be used for early analysis (data cut-off time 2h20m) were conducted. Assimilation experiments for global ATOVS data without DBNet data for summer 2016 showed statistically significant negative impacts on forecast lead time against initial fields. The amount of available data is reduced by 11%. It can be founded that DBNet data greatly contributes to improvement in the accuracy of numerical weather prediction, because negative values correspond to increased RMSE without ATOVS data delivered from DBNet assimilation.

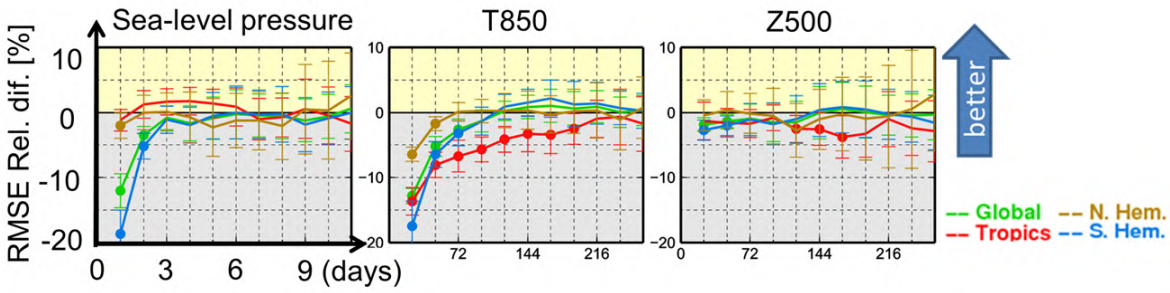

Fig 3: Normalized differences of RMSE [%] in forecast errors for sea-level pressure, 850hPa temperature, and 500hPa geopotential height verified against initial fields as a function of forecast range [days]. Negative values correspond to increased RMSE without ATOVS data delivered from DBNet assimilation.

Future Plans

The future development items are shown below.

- Development of an all-sky assimilation of microwave imager and sounder radiances
- Development of an all-sky assimilation of infrared radiances of Himawari-8
- Optimization of observation error
- Introduction of inter-channel and spatial error correlations
- Use of Suomi-NPP/ATMS in MA
- Use of Hyperspectral IR sounder in MA
- Use of stratospheric channels (ch10-15) of Suomi-NPP/ATMS in GA
- Use of Humidity channels of Hyperspectral IR sounder in GA

References

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