Global and Regional OSEs at JMA

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  - AMSU-A over coast, MHS over land, (related to S7SatLand)
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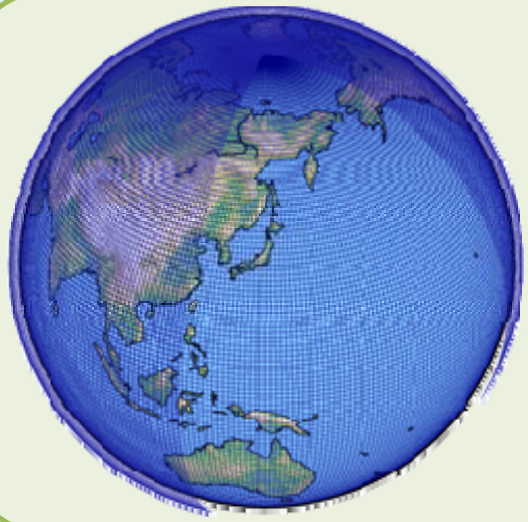
- Regional OSEs
  - Radar reflectivity (related to S5Radar)
  - Satellite radiance
- Additional OSEs
  - SHIP & BUOY (related to S1MarinePs and S10Thinning)

JMA NWP SYSTEM

Operational NWP models at JMA/NPD

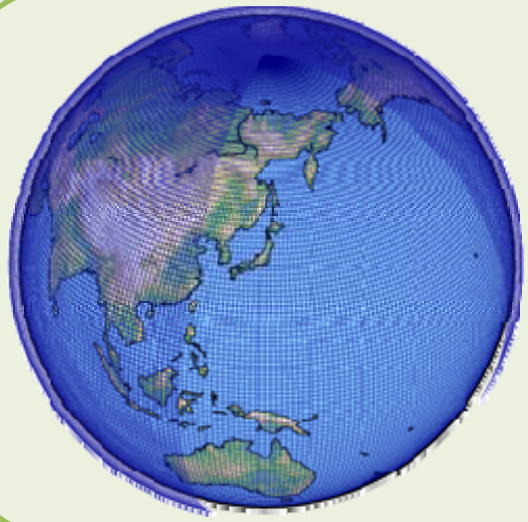
deterministic models only



GSM: Global Spectral Model
- Forecast domain: whole the Globe
- Purpose: short- and medium-range forecast
- Horizontal resolution: TL959 (0.1875deg.)
- Vertical layers: 60 Layers up to 0.1hPa
- Forecast Hours:
  - up to 84-hours at 00, 06, 18UTC,
  - up to 216-hours at 12UTC

MSM: Meso-Scale Model
- Forecast domain: Japan and its surroundings
- Purpose: Disaster reduction, short-range forecast
- Horizontal resolution: 5km
- Vertical layers: 50 Layers up to 22km
- Forecast Hours
  - up to 15-hours at 00,06,12,18UTC,
  - up to 33-hours at 03,09,15,21UTC

Operational DA systems at JMA/NPD



GA: Global Analysis (4DVAR)
- Model resolution:
  - Outer: TL959 (0.1875deg.)
  - Inner: TL319 (0.5625deg.)
- Data cut off time
  - for Early Analysis: +2h20m
  - for Cycle Analysis: +11h35m(00,12)/5h35m(06,18)
- Assimilation Window: -3h to +3h

MA: Meso-scale Analysis (4DVAR)
- Model resolution:
  - Outer: 5km
  - Inner: 15km
- Data cut off time: +50min.
- Assimilation Window: -3h to Analysis time

Summary of assimilated observations

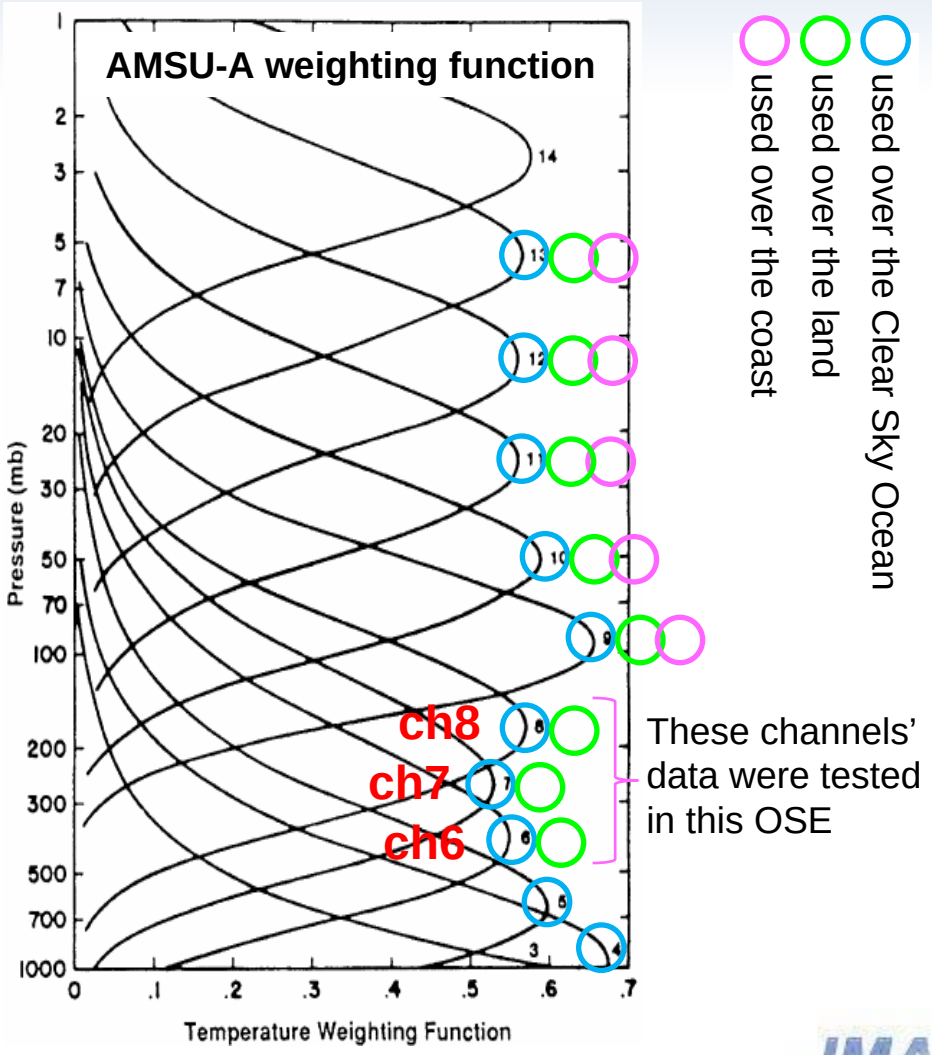
	Kind	P	T	UV	RH	IPW	RR	Doppeler Velocity	Radiance	Refractivity
Direct Observations	Land Surface Observations	**GM**								
	Sea Surface Observations	**GM**	**GM**							
	Aviation		**GM**	**GM**						
	Upper Air Sounding	**GM**	**GM**	**GM**	**GM**					
	Upper Air Wind Profiles	**GM**		**GM**						
Remote Sensing	Wind Profiler			**GM**						
	Doppler Radar							**M**		
	Radar/Raingauge-Analyzed Precipitation						**M**			
	Radar Reflectivity				**M**					
	Ground-Based GPS					**M**				
Bogus	Typhoon Bogus	**GM**		**GM**						
GEO Satellite	Atmospheric Motion Vector (AMV)			**GM**						
	Clear Sky Radiance (CSR)								**GM**	
LEO Satellite	Polar AMV			**G**						
	Microwave Sounder								**GM**	
	Microwave Imager						**M**		**GM**	
	Scatterometer			**G**						
	GPS Radio Occultation									**G**

G: Global / M: Meso


GLOBAL OSE

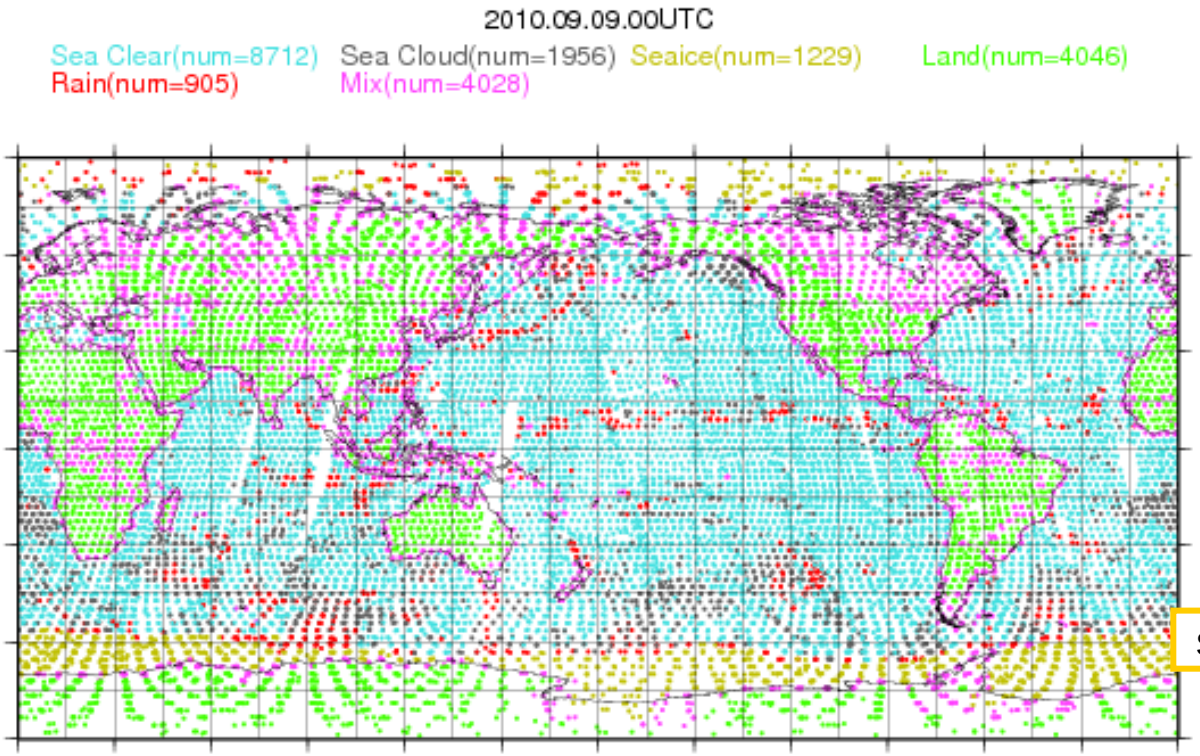
AMSU-A over coast

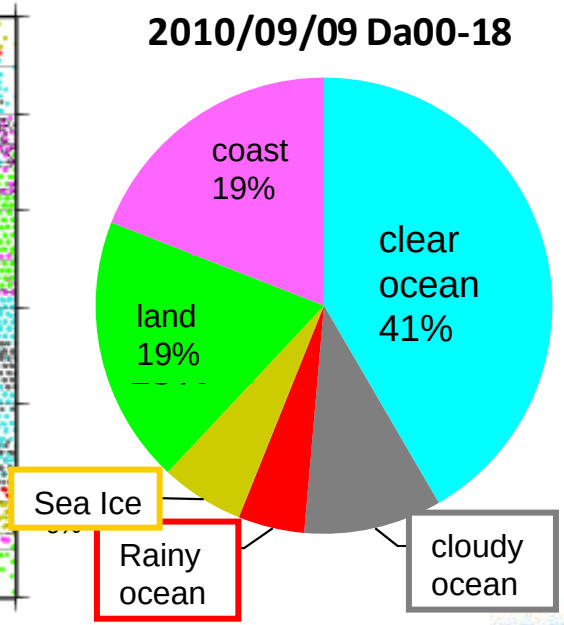
- JMA had not used ch.6-8 data of AMSU-A over coast, while the data was used over land area.
  - To avoid complicated emissivity issue
- A question had been emerged whether this treatment was proper or not.
- So that OSEs to use these channels' data over coast were conducted in 2010.



“Coast” data distribution

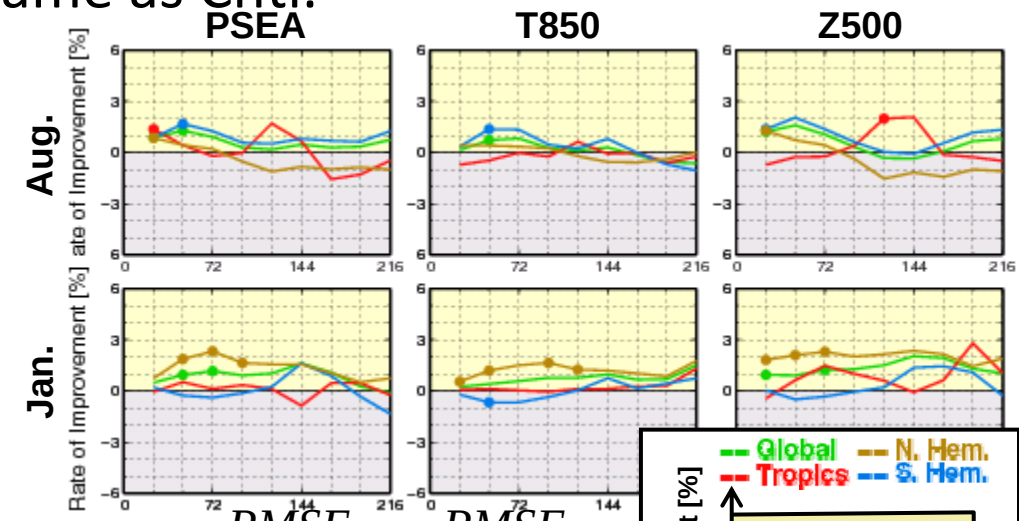
- The data numbers over “land” and “coast” are almost same, because there are many islands and inland lakes in the world.





OSE and the results

- Settings
  - Low res. DA(T106) and forecast (TL319) system
  - Test periods: Jan. and Aug. 2010
    - The test used AMSU-A ch.6-8 data over coast and the other settings were same as Cntl.
  - Results
    - show the positive impact mostly
    - The more homogeneous data usage provides the better forecast

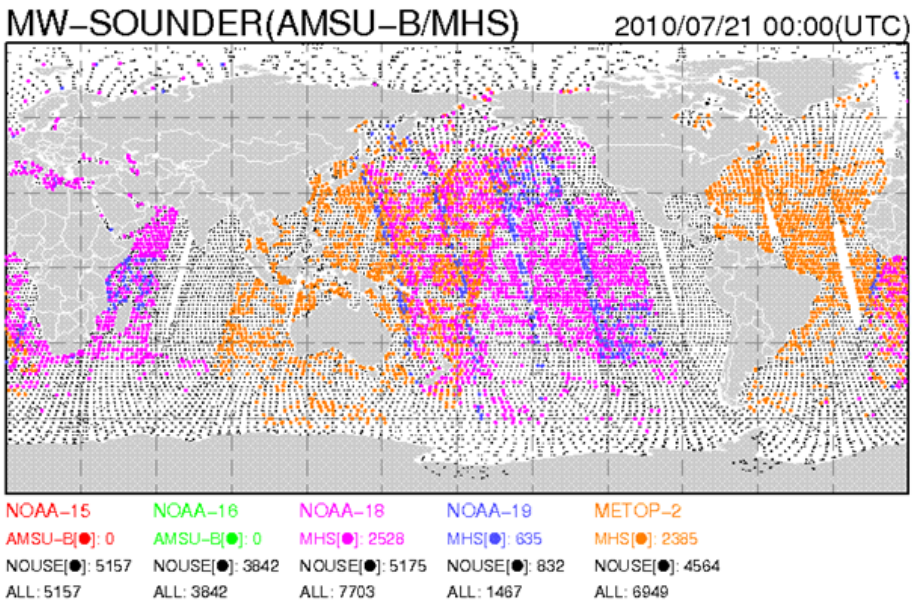


$$RoI = \frac{RMSE_{cntl} - RMSE_{test}}{RMSE_{cntl}}$$

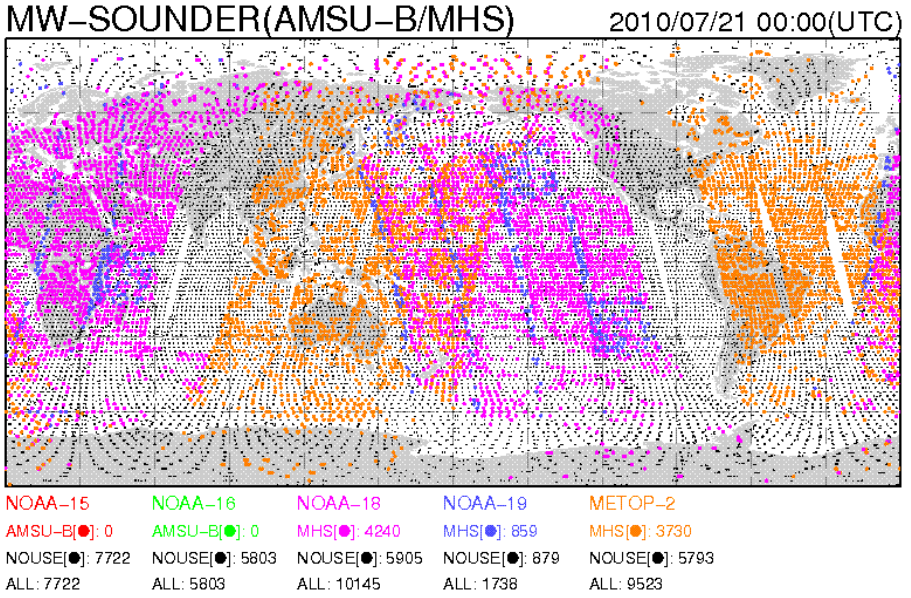
MHS over the land area

- JMA is not using MHS data over land area and is testing to use the data with replacing the RTM RTTOV v9.3 by v10 (with the emissivity ATLAS).

CNTL

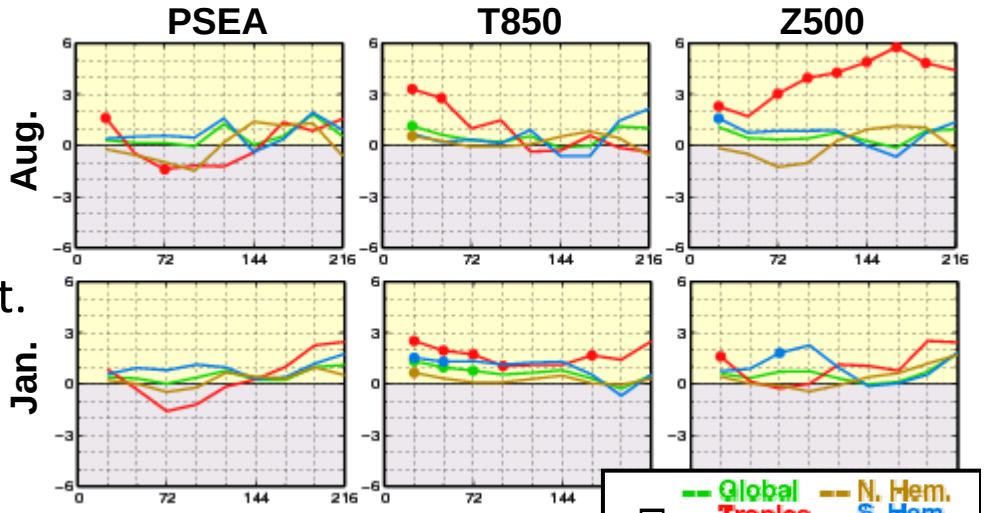


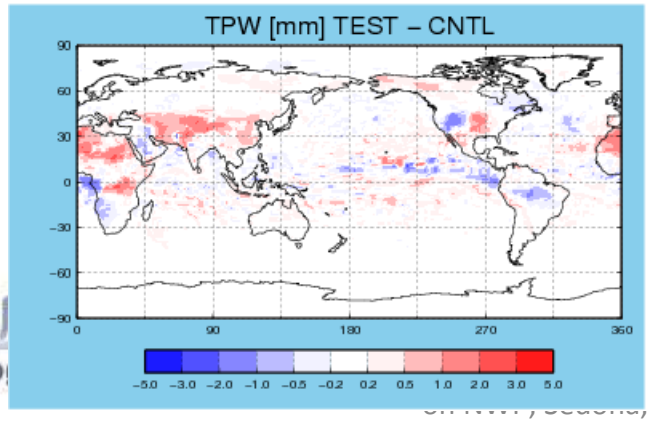
TEST



OSE and the results

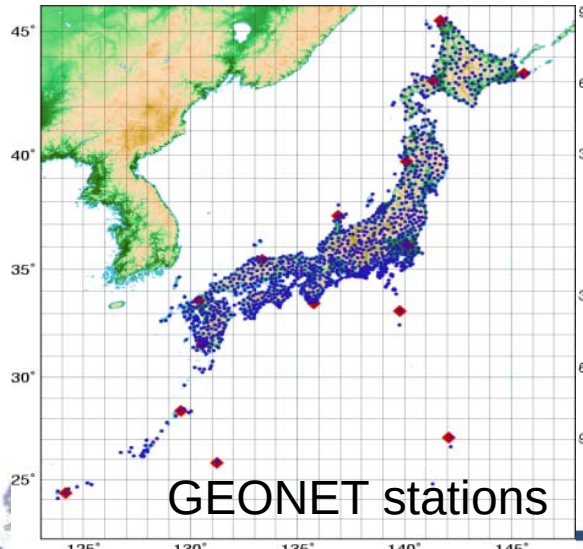
- Settings
  - Low res. DA(T106) and forecast (TL319) system
  - Test periods: Jan. 2011 and Aug. 2010
    - The test used MHS over the land area with RTTOV v10
  - Results:
    - the data humidifies the analysis field over land and showed the positive impact.

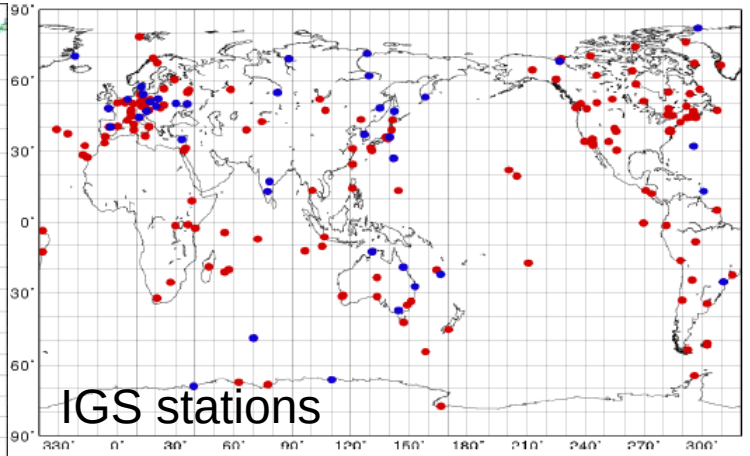


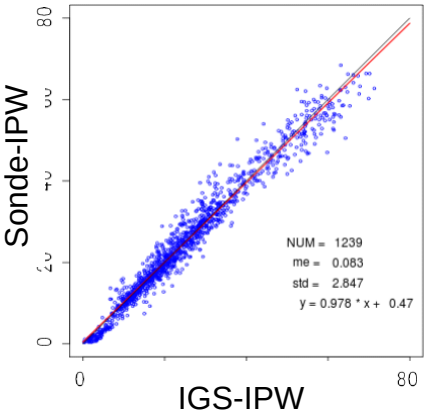


Ground based GNSS data

- In Japan, GEONET (operated by The Geospatial Information Authority of Japan) data is being used for integrated precipitable water (IPW) retrievals.
  - And the IPW data are assimilated in the Meso-scale NWP system.
  - But it was not assimilated in the Global NWP system
- IGS (International GNSS Service) data are investigated for the global NWP system.



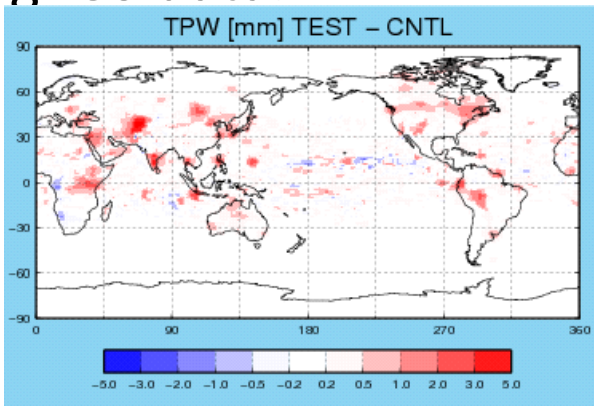




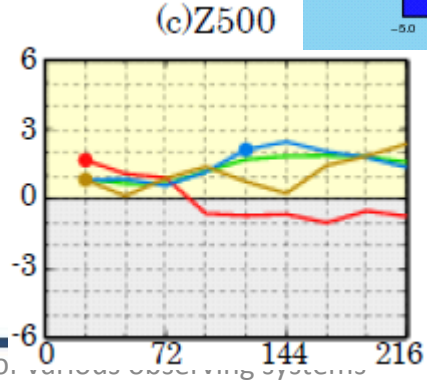
GIPSY/OASIS-II software provided by NASA/JPL is used for IPW retrievals.

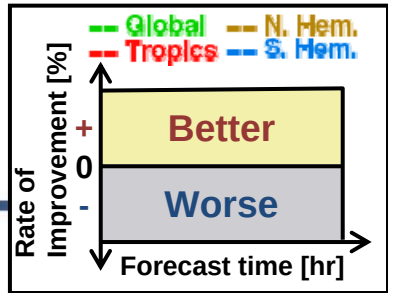
OSE and the results

- Settings
  - Low res. DA(T106) and forecast (TL319) system
  - Test period: Aug. 2010
    - Test used GNSS-IPW retrieved by using IGS data.
  - Result:
    - The data humidifies the analysis field
    - This result is consistent with the MHS OSE.
    - Positive impact was found on the forecast



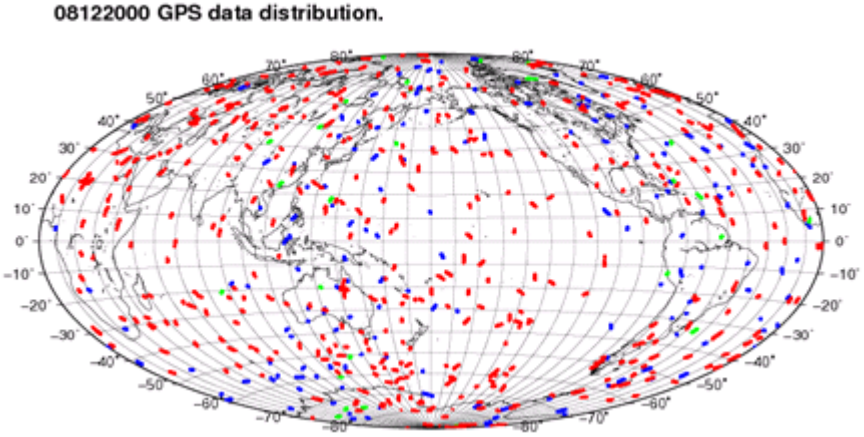
International exchange of the ground-based GNSS data is desired.

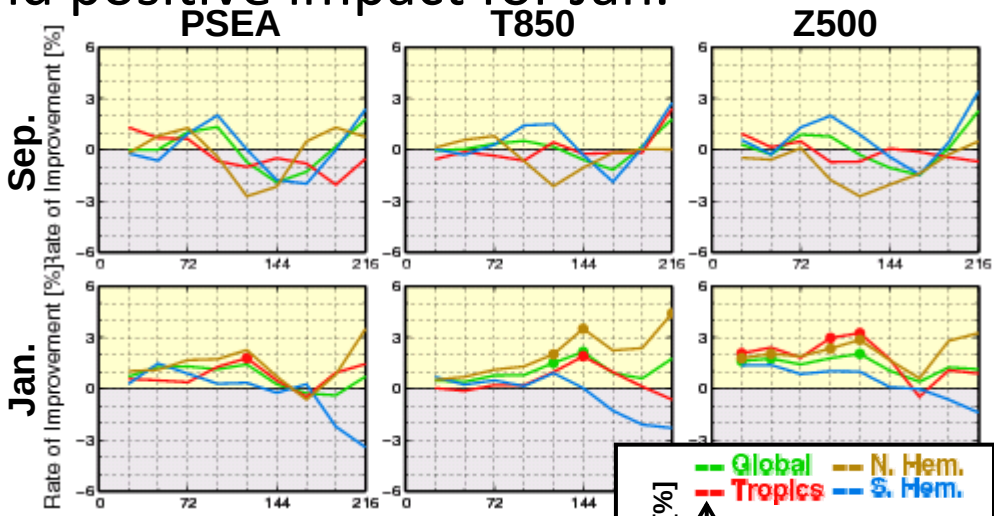




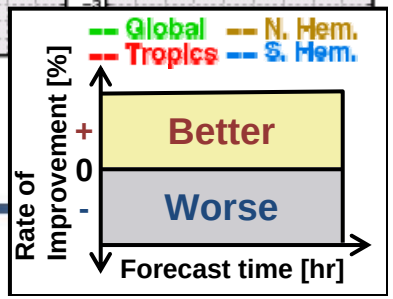
COSMIC GNSS-RO data

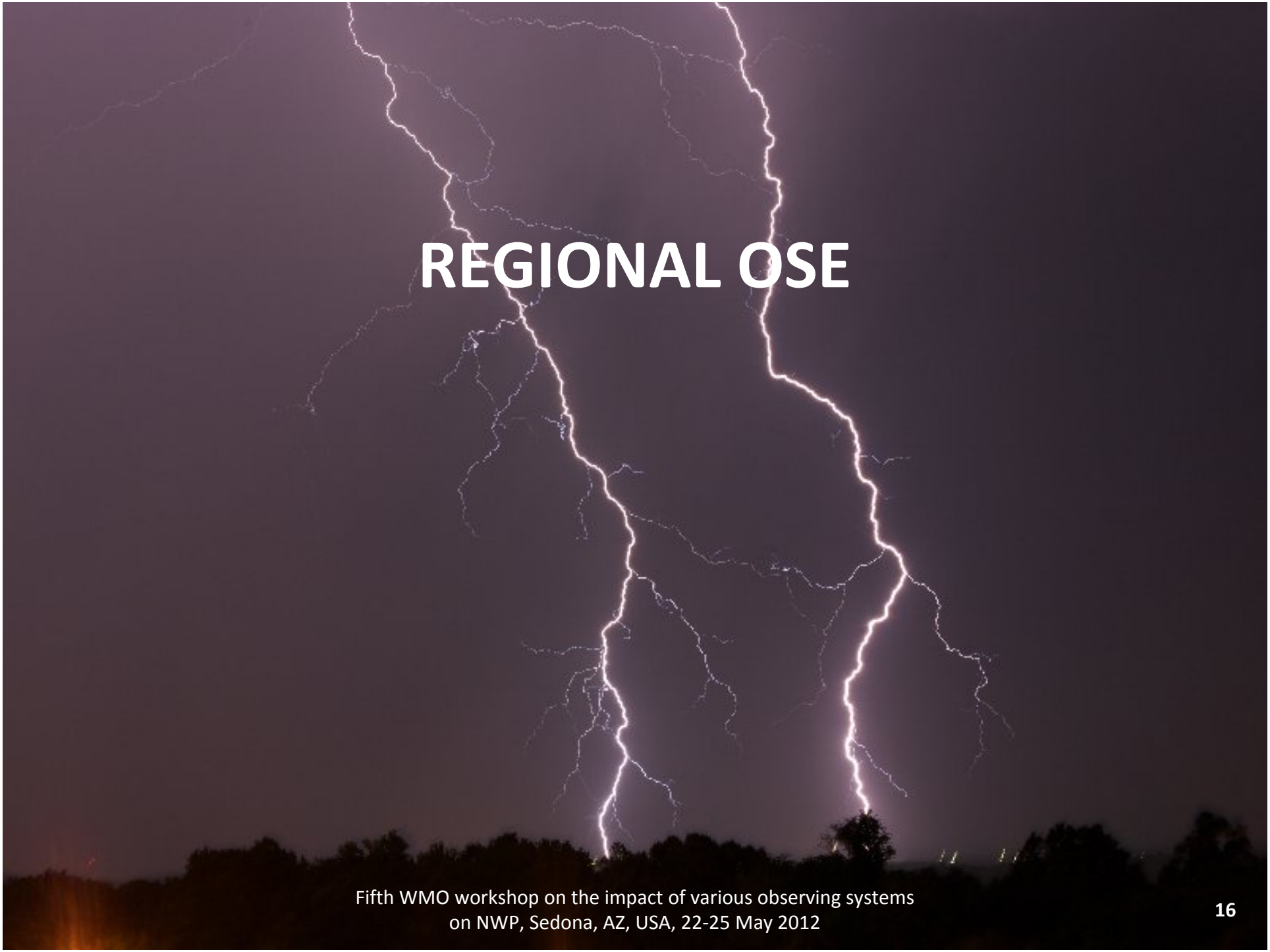
- COSMIC GNSS-RO data assimilation was started on 2010 in JMA. The pre-operational test (OSE) were conducted before the operation.
- The test periods: Sep. 2009 and Jan. 2009
  - neutral impact for Sep. and positive impact for Jan.





Looking at the Jan. OSE, the impact was increased along the forecast time for T850

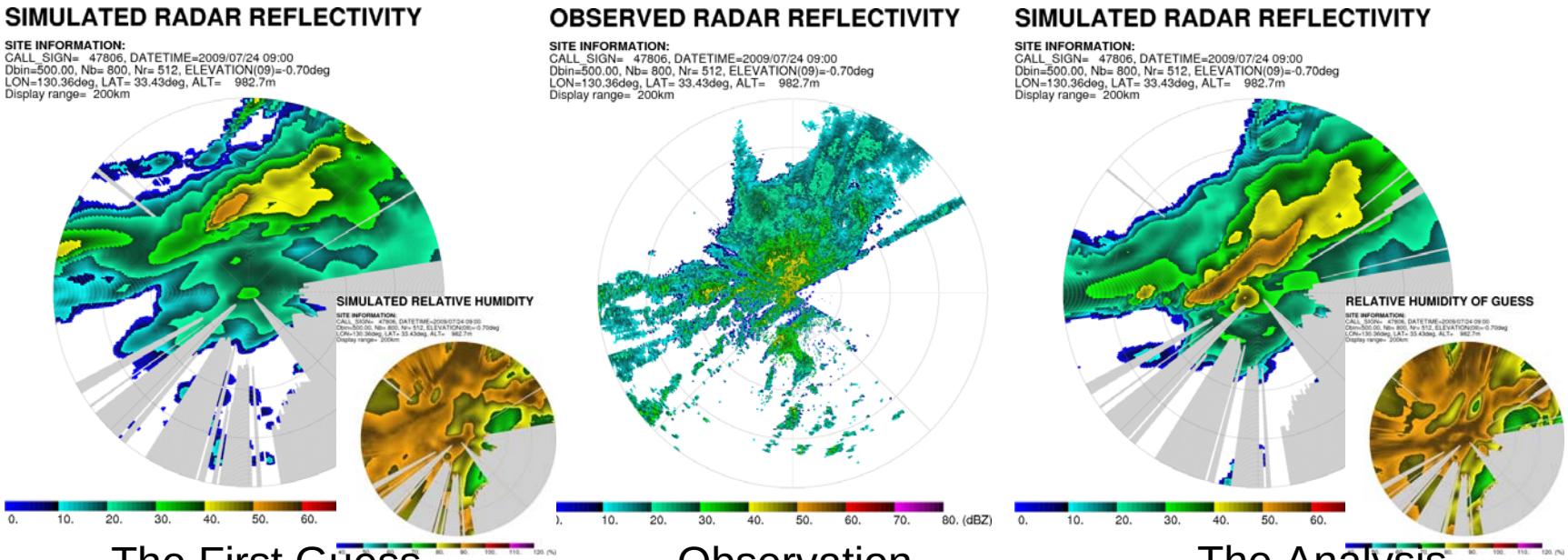




REGIONAL OSE

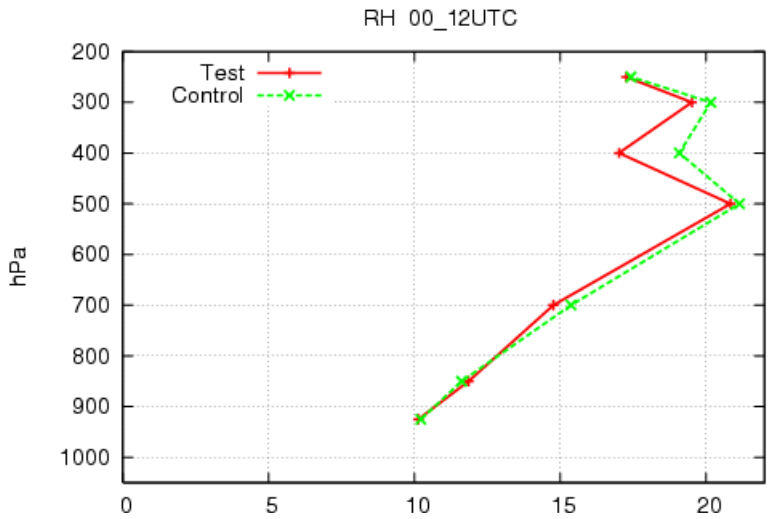
Radar Reflectivity

- JMA started assimilation of the pseudo-RH data retrieved from 3D radar reflectivity by Bayesian method.

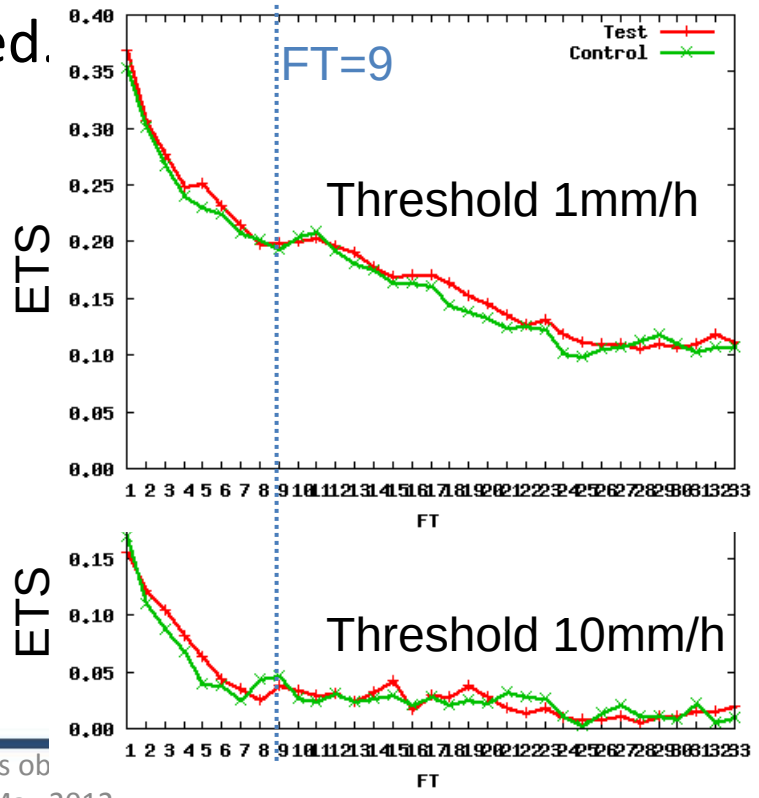


Regional OSE for radar reflectivity

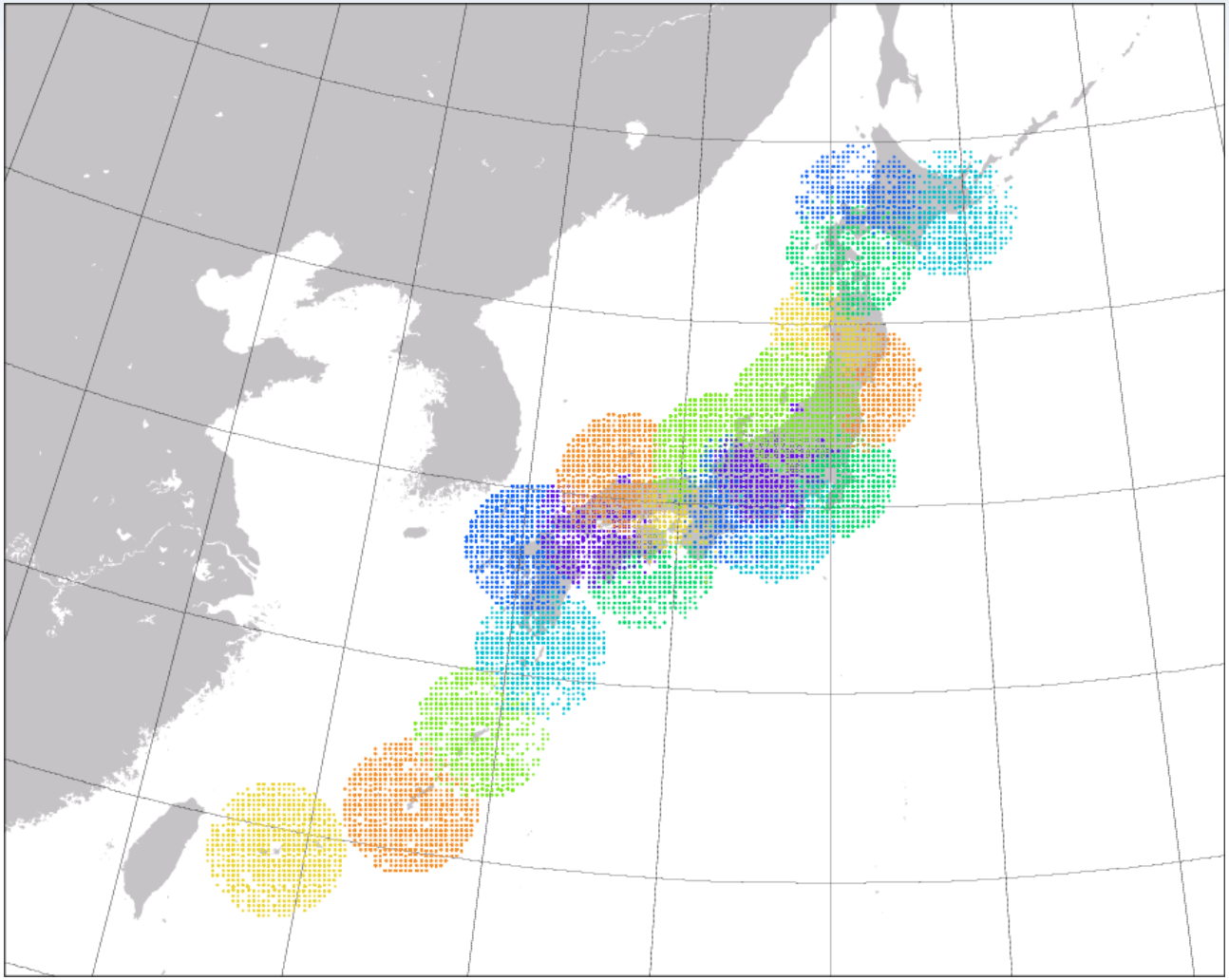
- Several rainfall events were tested.
  - The results show the improvement of the water vapor profile of initial conditions and reduction of displacement errors in the precipitation system.
  - The more upstream data is desired.



RH forecast RMSE at FT=3, evaluated against radiosonde data

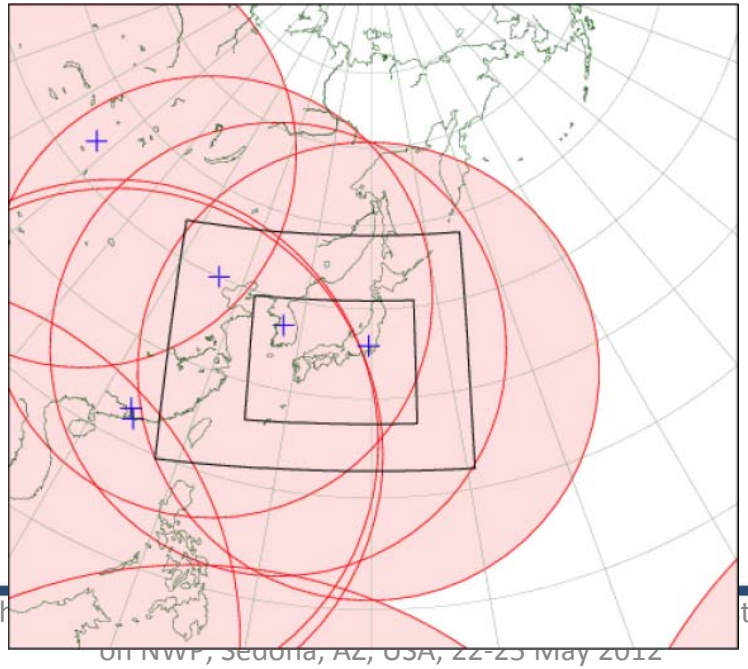


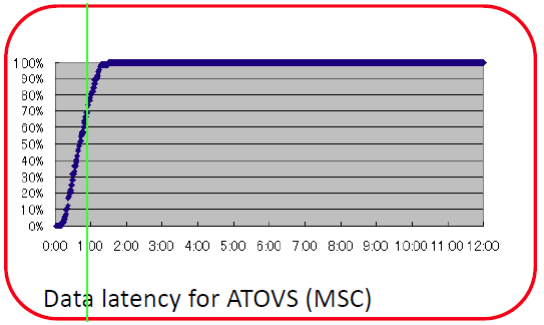
Assimilated radar data coverage

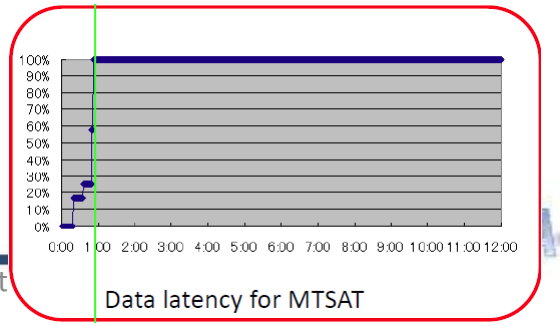


Radiance

- Satellite data assimilation in Meso NWP system
  - JMA had been assimilated T and PW retrievals from ATOVS and MWRs with Meso NWP system. And It was replaced by radiance assimilation on Dec. 2010.
  - For this implementation, RARS (Regional ATOVS Retransmission Service) data is important for the real time operation.







Comparison of available data

as of 2010

	Satellite/Sonsor	Retrievals (Old System)	Radiances (New System)	Global Analysis
Microwave Imager	Aqua/AMSR-E	PW RR	TB RR	TB
	DMSP-F16/SSMIS	N/A	TB RR	TB
	DMSP F17/SSMIS	N/A	TB RR	TB
	TRMM/TMI	PW RR	TB RR	TB
Microwave Temperature Sounder	DMSP-F16/SSMIS	N/A	TB	TB
	NOAA15/AMSU-A	T(NESDIS)	TB	TB
	NOAA16/AMSU-A	N/A	TB	TB
	NOAA18/AMSU-A	T(NESDIS)	TB	TB
	NOAA19/AMSU-A	T(NESDIS)	TB	TB
	Metop/AMSU-A	T(NESDIS)	TB	TB
	Aqua/AMSU-A	N/A	TB	TB
Microwave Humidity Sounder	NOAA15/AMSU-B	N/A	TB	TB
	NOAA16/AMSU-B	N/A	TB	TB
	NOAA17/AMSU-B	N/A	TB	TB
	NOAA18/MHS	N/A	TB	TB
	NOAA19/MHS	N/A	TB	TB
	Metop/MHS	N/A	TB	TB
Infrared Sounder	NOAA17/HIRS	T(MSC)	N/A	N/A
	Aqua/AIRS	N/A	N/A	N/A
	Metop/IASI	N/A	N/A	N/A
Infrared Imager	MTSAT-1R/Imager	N/A	CSR	CSR

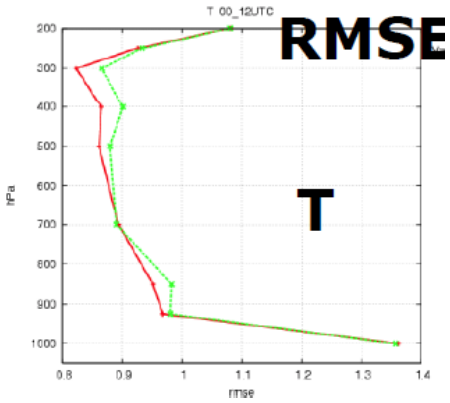
PW: Precipitable Water
RR: Rain Rate
T(NESDIS): Temperature retrieved by NESDIS
T(MSC): Temperature retrieved by MSC
TB: Brightness Temperature
CSR: Clear Sky Radiance

Note:
RR retrieval assimilation is continued since radiance assimilation is only available at clear sky area, currently.

Note:
DMSP-F16/SSMIS data is not used in the current operation because of the degrade of the quality.

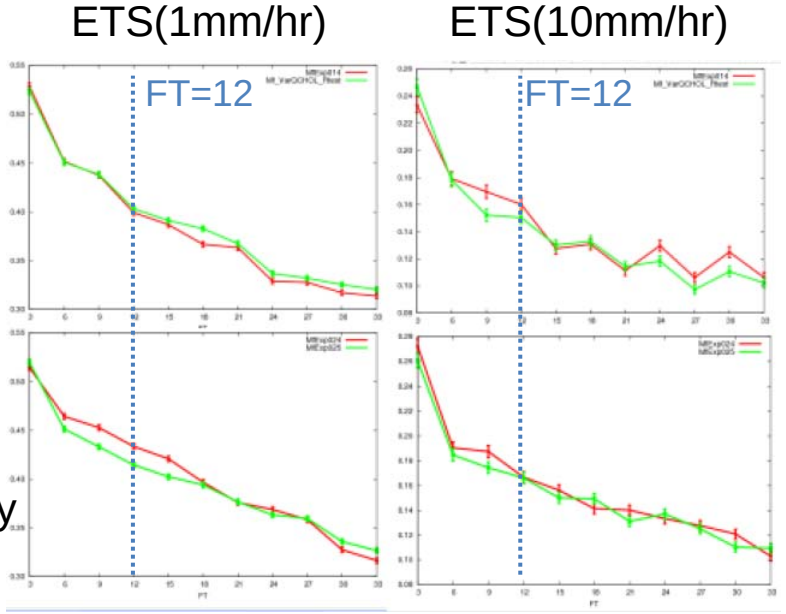
Regional OSE for radiance

- OSEs were conducted before operation.
  - The result show the smaller RMSE of temperature forecast against radiosonde data, and the better skill for the rainfall forecast.



Case 1
12 days in summer 2009

Case 2
13 days in summer 2010, including heavy rain case




ADDITIONAL OSE

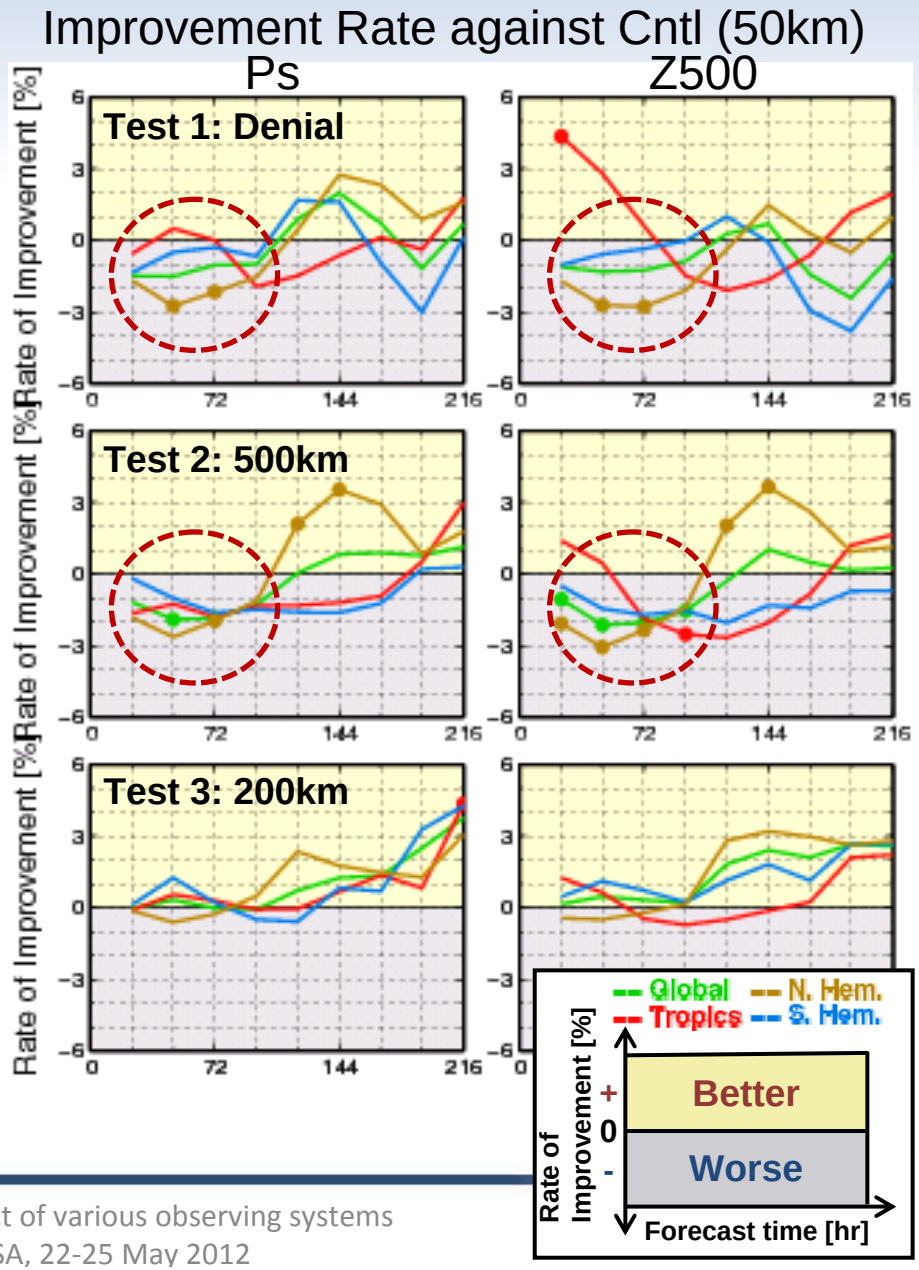
SHIP & BUOY OSEs

- Introduction
  - JMA has been using SHIP & BUOY Ps data for long time and the thinning distance is 50km. But, Is this optimum?
- Settings for this preliminary study
  - Used low res. system (TL319 forecast with TL159 4D-Var)
  - DA cycle period: 20 Oct. 2011 – 19 Nov. 2011 (very short!)
  - Forecast cases : 12UTC on 1 – 10 Nov. 2011 (very short!)
- OSEs:
  - Cntl: 50km thinning; Test1: SHIP & BUOY Ps data denial;
  - Test2: 500km thinning; Test3: 200km thinning;

Note: ASCAT data is assimilated with 50km thinning in all the test

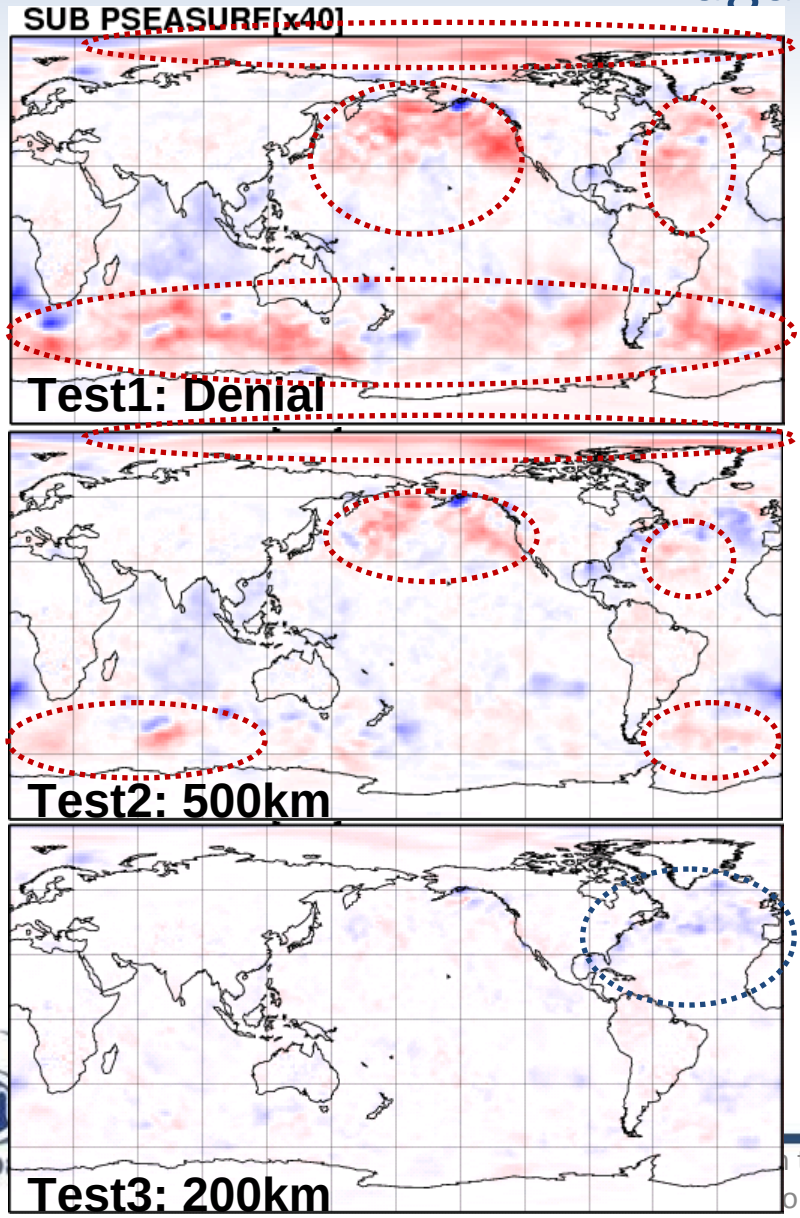
The OSE result

- Test 1 and 2 showed the clear degradation of the forecast skill, especially on the short range (~FT96) forecast.
- Test3 showed the better forecast skill than Cntl mostly.
  - Statistical study showed the observation error correlation length are about 200km
- Comment for this result
  - These results suggested that the current JMA NWP systems need the marine Ps data with the density of one per around 200x200km^{2,}
  - at least on the low res. system.



Mean Absolute Innovation Difference

against CNTL



In the test 1 and 2, the larger mean absolute innovations of P_{MSL} are found around mid-ocean. It suggests 6-hours forecast error is larger in this test over there.

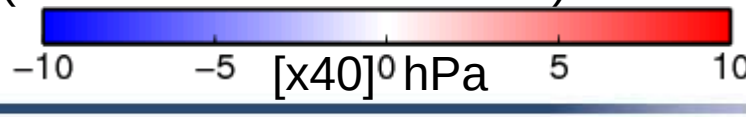
➔Degradation of the forecast quality

In the test 3, the larger mean absolute innovations of P_{MSL} are hardly found.

➔No Degradation of the forecast quality

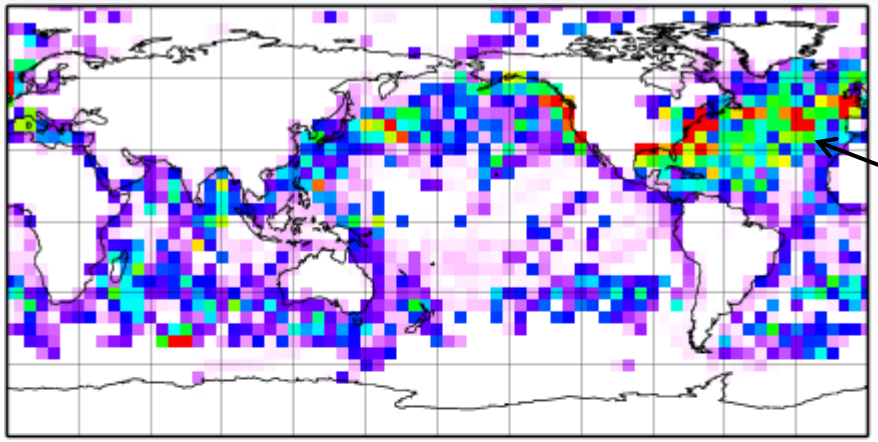
The smaller mean absolute innovations are found around the North America and northern part of Atlantic Ocean. The reason must be the longer thinning distance.

(i.e. fewer assimilated site).



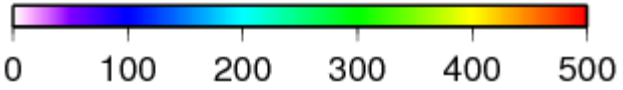
Total assimilated SHIP & BUOY data

Cntl: 50km

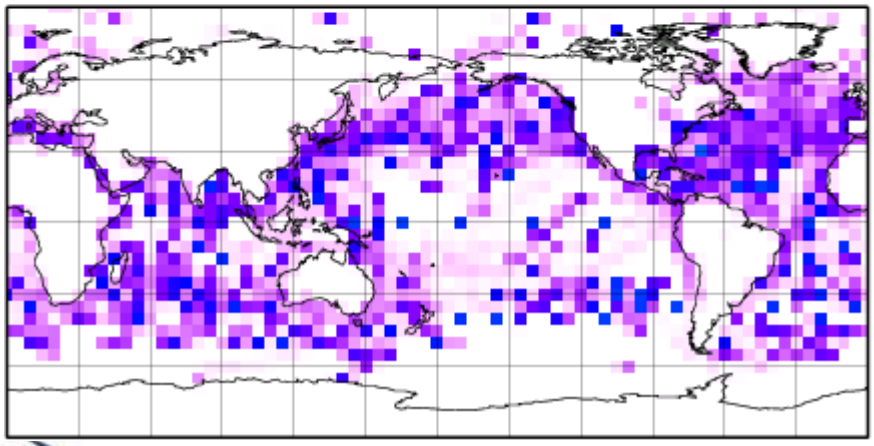


Strong inhomogeneity

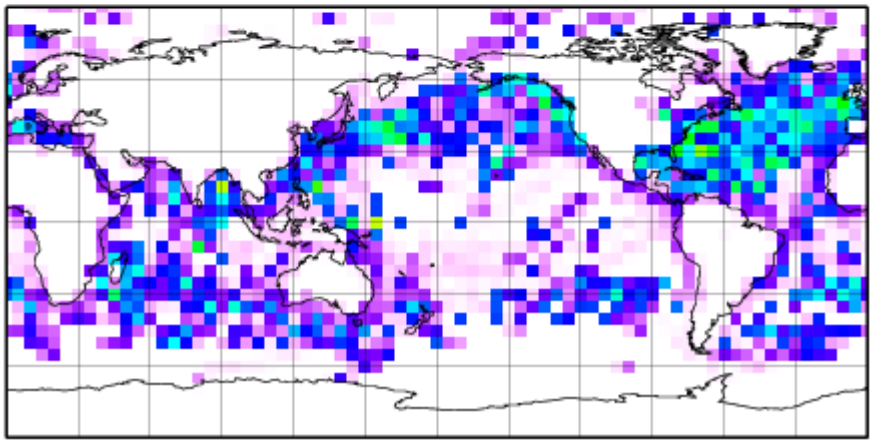
Total on 5deg. grid box.

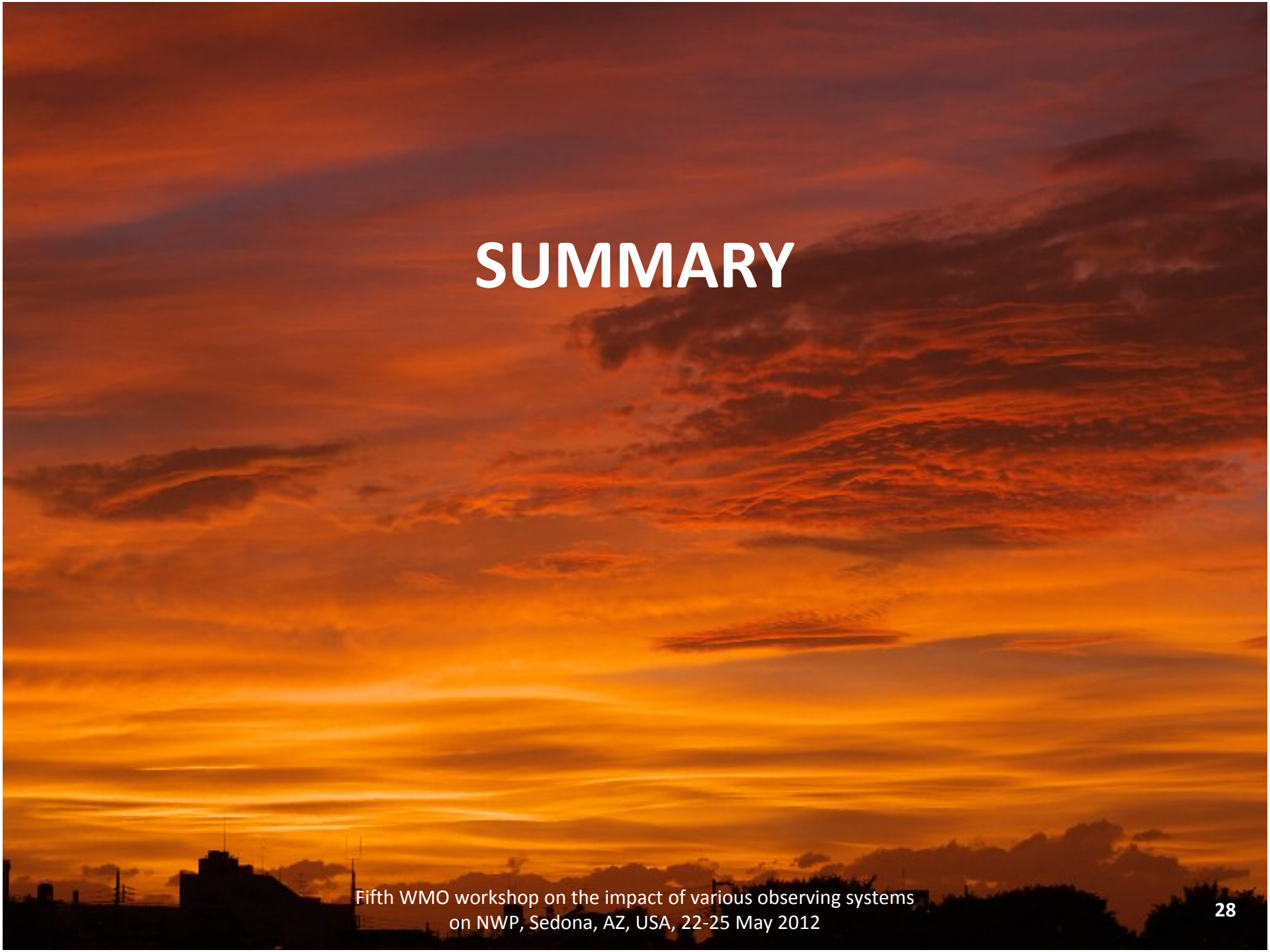


Test2: 500km



Test3: 200km




SUMMARY

Summary

- JMA conducted a variety of OSEs to improve the skill of the operational NWP system.
  - Global OSEs show (1) the more homogeneous use of radiance data is important, (2) MHS assimilation and GNSS-IPW assimilation showed the consistent results and such humidity data over land area is important (3) the impact of the GNSS-RO were found in some days forecast.
  - Regional OSEs showed the improvement of the forecast skill by using the more remotely sensed data, but it looks the impacts were hardly confirmed over 10hours forecast.
- Preliminary OSEs for SHIP & BUOY
  - The OSEs showed the JMA system needs the data with the density of one per 200x200km^2 (at least, on the low res. system) .

Thanks for your attention

Backup

assimilated Doppler data coverage