



# Evaluation of FY2E Reprocessed AMVs IN GRAPES

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**NWP/CMA**

IWW13, June 2016

# Outline

- **FY2E reprocessed AMVs**
- **Observation Error and Number**
- **Experiments in GRAPES global forecast system**
- **Conclusion and discussion**

# Reprocessed FY2E AMVs: algorithm changes

- A new calibration system

Calibration of Inner Blackbody corrected by Lunar  
Emission (CIBLE)



- Preprocess of satellite image

- Eliminate the influence of abnormal
- Remove noise in the satellite image

- Second tracking algorithm

the slow biases are reduced

1<sup>st</sup>: 32 X 32

2<sup>nd</sup>: 16 X 16

- Height assignment

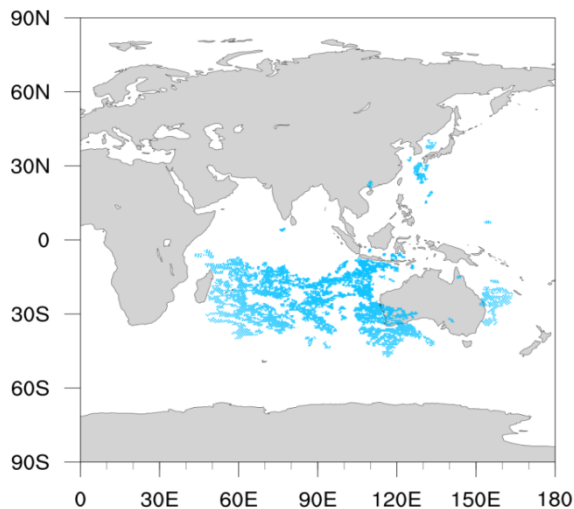
- inversion layer
- target box full of cloud

Zhang Xiaohu et al.,2014: Status of operational AMVs from FY-2 satellites since the 11th winds workshop, IWW12.

# 1000-700hPa

**FY2E/AMV\_IR Coverage(NEW)**  
**1000hPa-700hPa,QI\_GE\_80 DATA**

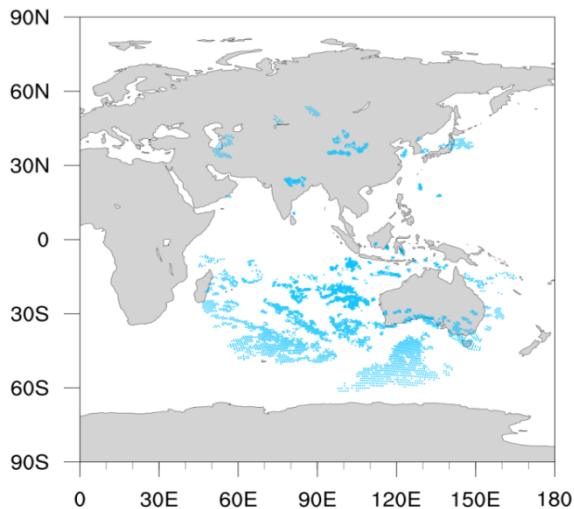
2013/08/01 UTC total station of obs =5478



# 700-400hPa

**FY2E/AMV\_IR Coverage(NEW)**  
**700hPa-400hPa,QI\_GE\_80 DATA**

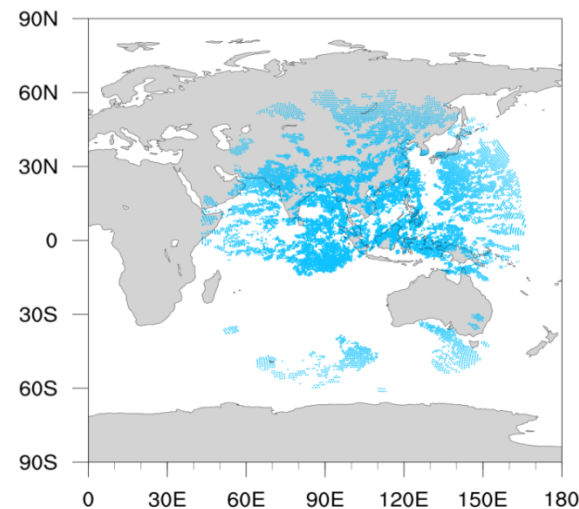
2013/08/01 UTC total station of obs =4607



# 400-100hPa

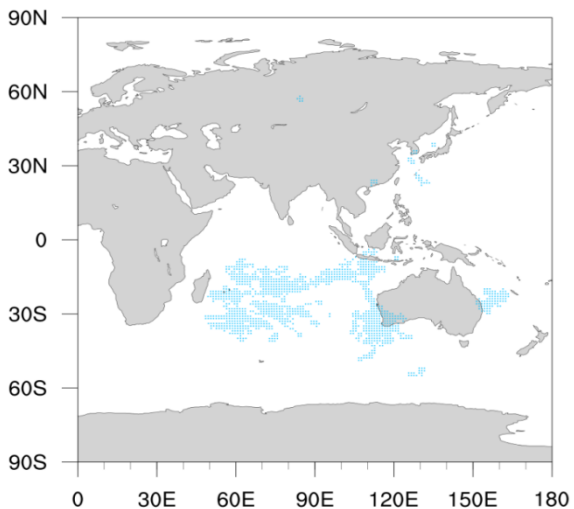
**FY2E/AMV\_IR Coverage(NEW)**  
**400hPa-100hPa,QI\_GE\_80 DATA**

2013/08/01 UTC total station of obs =15805



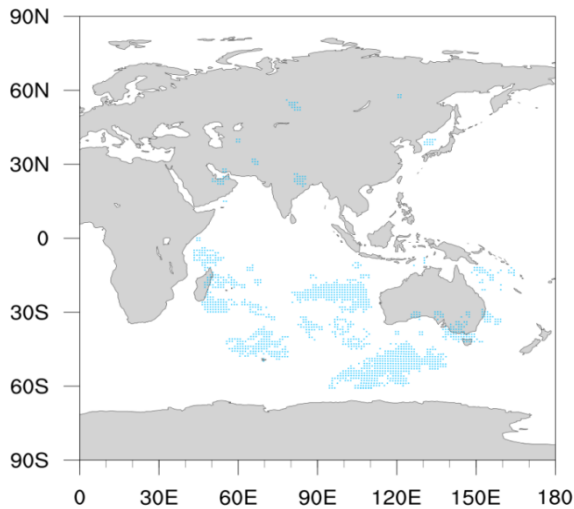
**FY2E/AMV\_IR Coverage(OLD)**  
**1000hPa-700hPa,QI\_GE\_80 DATA**

2013/08/01 UTC total station of obs =1243



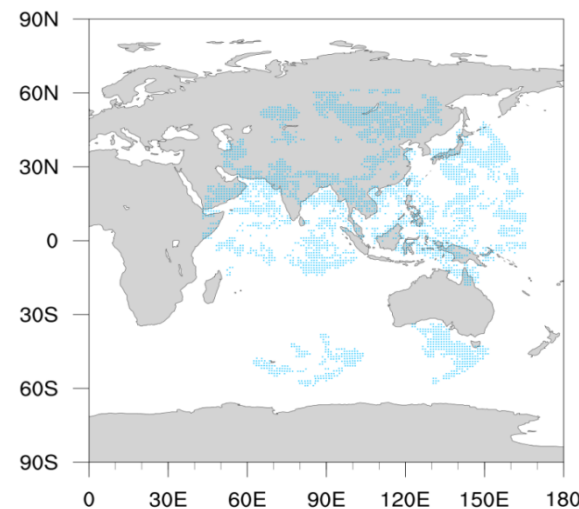
**FY2E/AMV\_IR Coverage(OLD)**  
**700hPa-400hPa,QI\_GE\_80 DATA**

2013/08/01 UTC total station of obs =1397

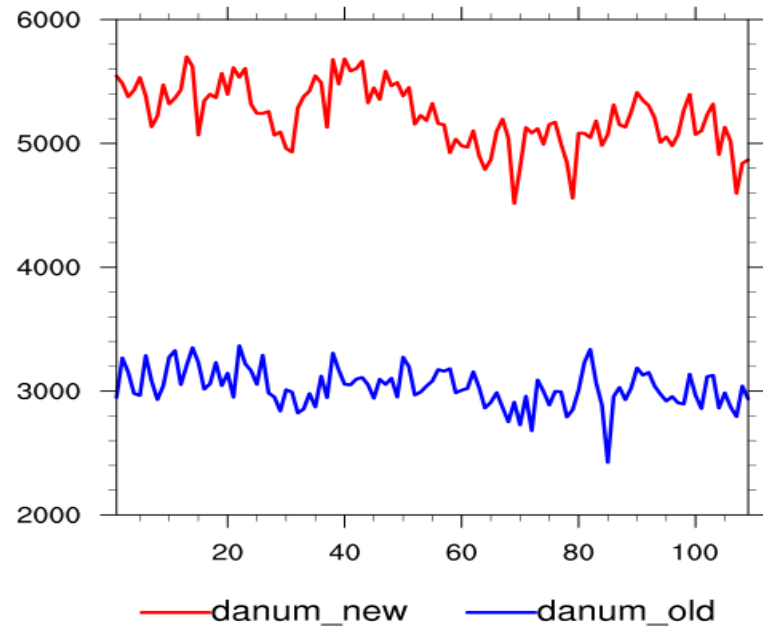
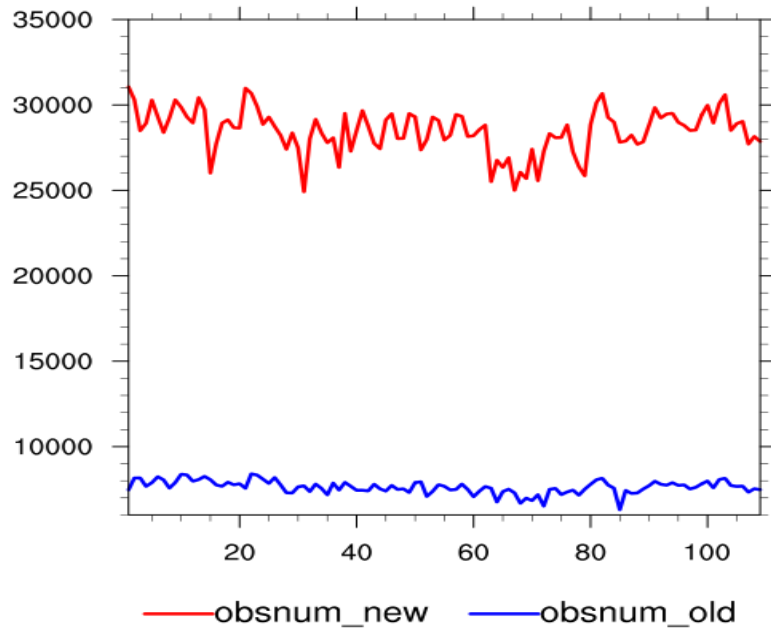
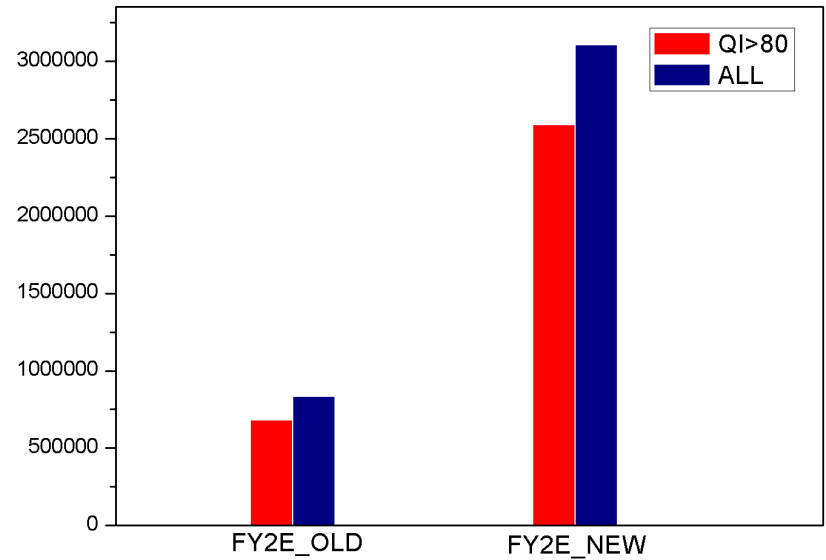


**FY2E/AMV\_IR Coverage(OLD)**  
**400hPa-100hPa,QI\_GE\_80 DATA**

2013/08/01 UTC total station of obs =3584

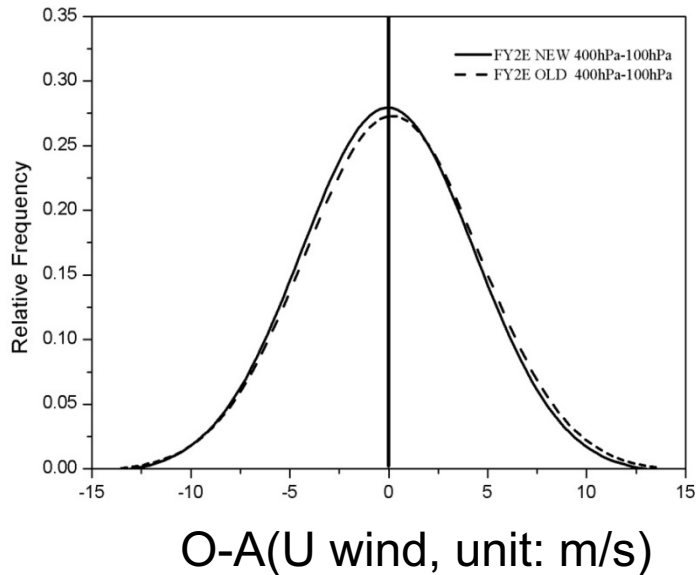


# 201308: IR winds

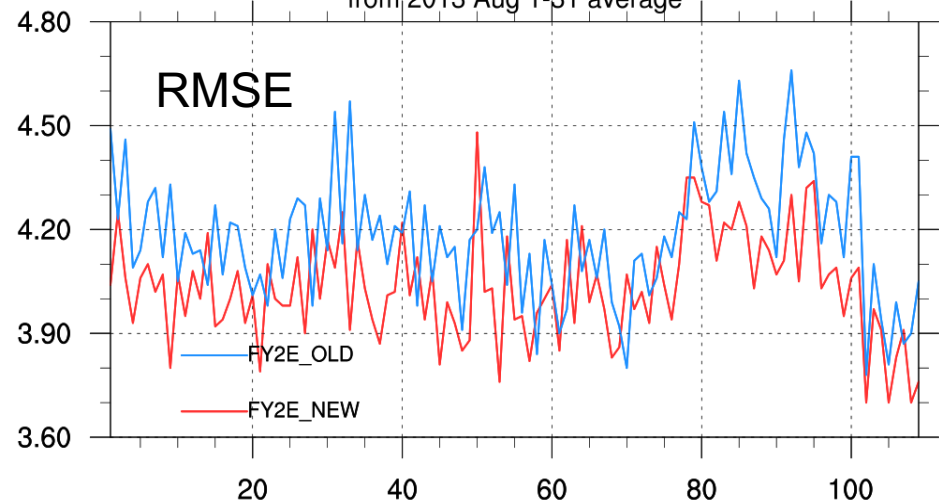


# O-A(ERA\_INTERIM)

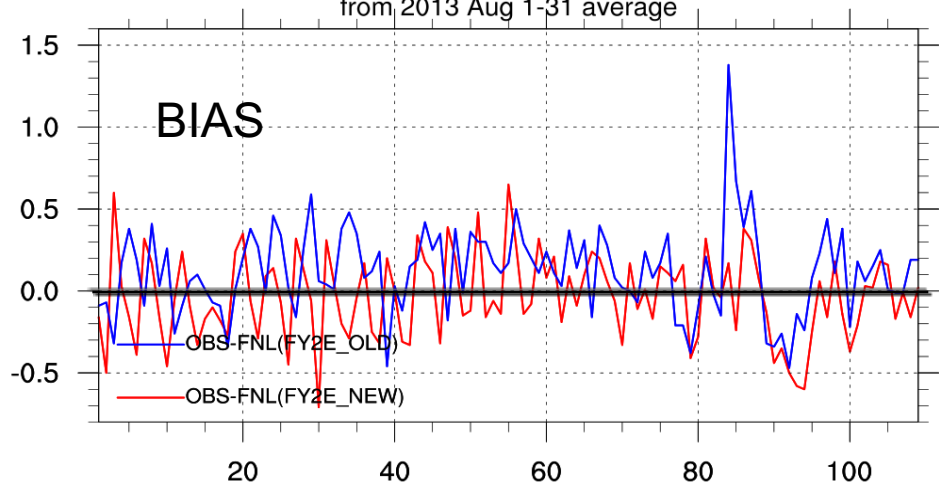
● 20130801~20130831

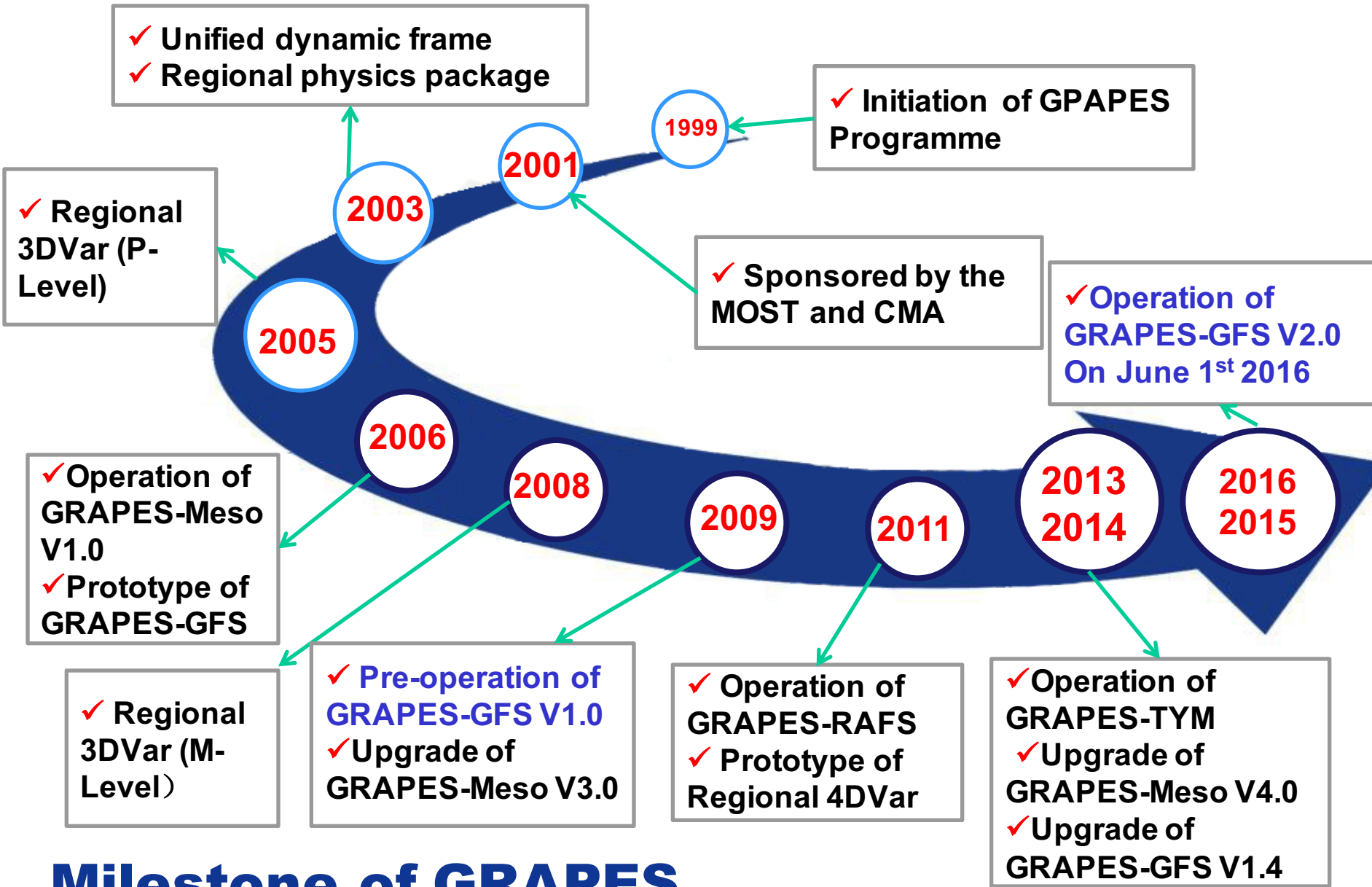


RMSE for U wind from FY-2E/AMV\_IR  
Area:lon\_w=0.0,lon\_e=360.0,lat\_s=-90.0,lat\_n=90.0  
400hPa-100hPa,QI\_GE\_80 DATA  
from 2013 Aug 1-31 average



Statistics for U wind from FY-2E/AMV\_IR  
Area:lon\_w=0.0,lon\_e=360.0,lat\_s=-90.0,lat\_n=90.0  
400hPa-100hPa,QI\_GE\_80 DATA  
from 2013 Aug 1-31 average





# Milestone of GRAPES

# GRAPES global forecast system: performance

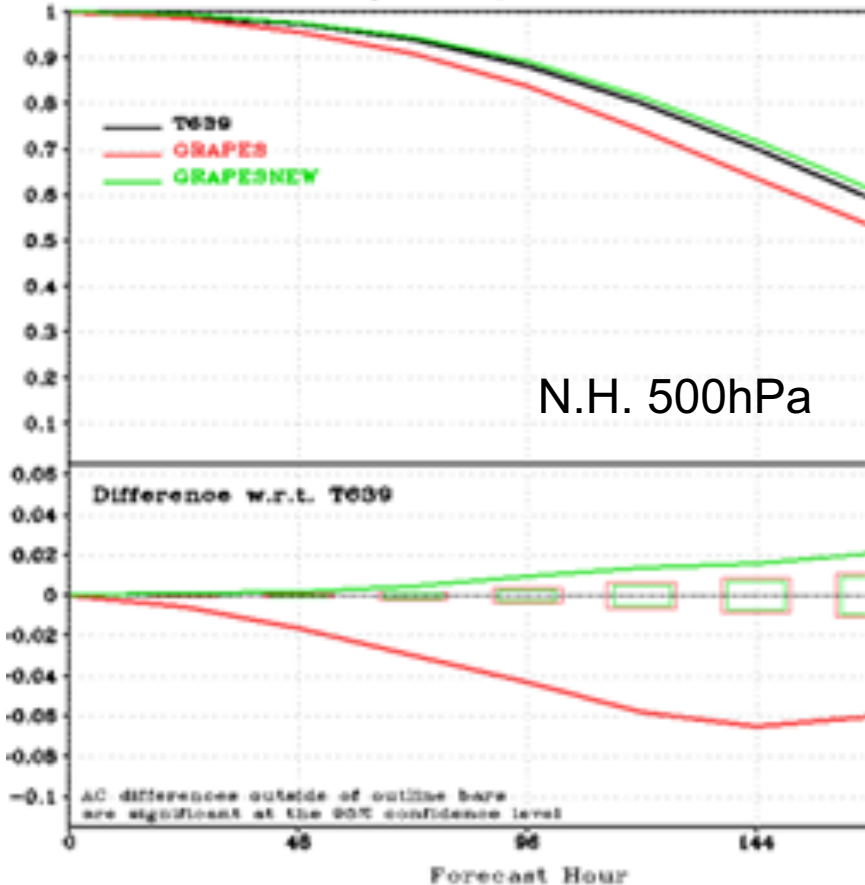
T639: CMA operational global system

GRAPES V1.4 (2013)

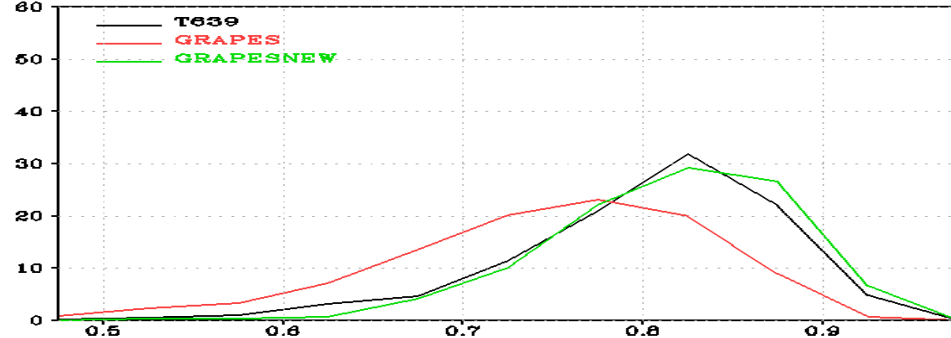
GRAPES V2.0 (2015)

20130501-20150801

AC: HGT P500 G2/NHX 12Z, 20130901-20150831

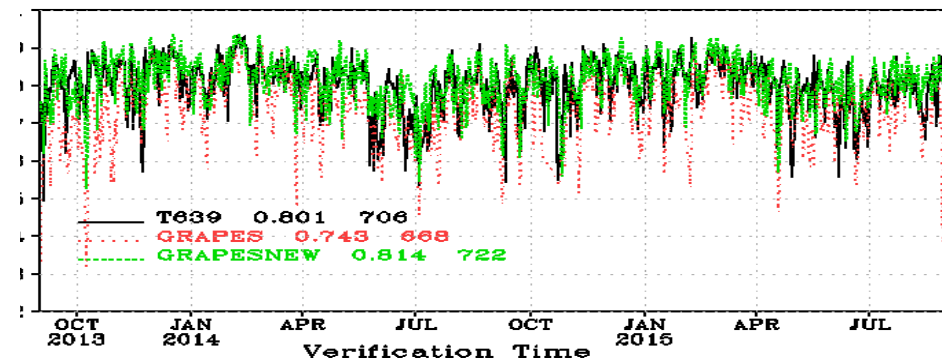


AC Freq: HGT P500 G2/NHX 12Z, Day 5



## N.H. Day-5 ACC at 500hPa timeseries

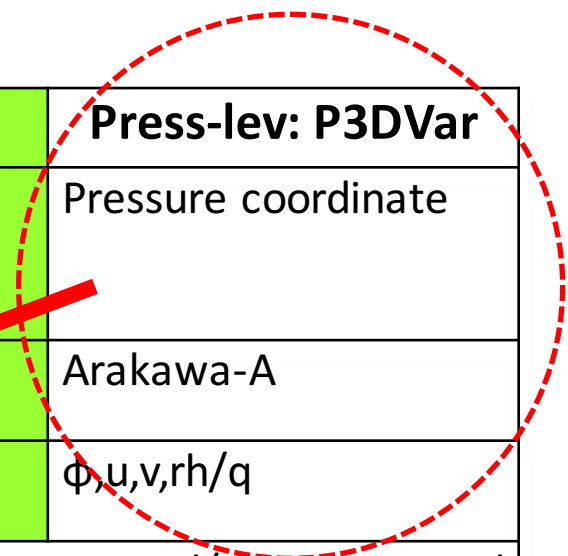
Anomaly Correl: HGT P500 G2/NHX 12Z, Day 5





# Main features of GRAPES 3DVar

GRAPES 3DVar	Model-level: M3DVar	Press-lev: P3DVar
Vertical coordinate	Height-based terrain following coordinate & Charney-Phillips staggered grid	Pressure coordinate
Horizontal grid	Arakawa-C	Arakawa-A
Analysis variable	$\pi, u, v, q / rh / rh^* / \text{normalized } rh^*$	$\phi, u, v, rh / q$
Background error covariance	Horizontal and vertical correlation separated/non-separated, NCEP(NMC) method for error co-variances	
Control variable transformation	Horizontal filter and vertical EOF transformation	
Balance constraint	Linear balanced + pressure-wind balance statistic regression	
Spatial interpolation	Bi-linear interpolation (horizontal), linear or 3 <sup>rd</sup> spline interpolation (vertical)	
Minimization	Limited memory BFGS method	
Program design	Modular and parallel design	



# Data Assimilation Experiments in GRAPES

- **GRAPES global forecast system**

- LAT/LON grids, Terrain-following Height
- 3D-Var, 0.25\*0.25degree, L60(model top=3hPa)
- Sonde, Synop, GPS\_RO, AMSU-A, IASI , AIRS, MWHS2(FY3C)
- **Become operational on June 1<sup>st</sup> 2016**

- **Experiments(0.5\*0.5 degree)**

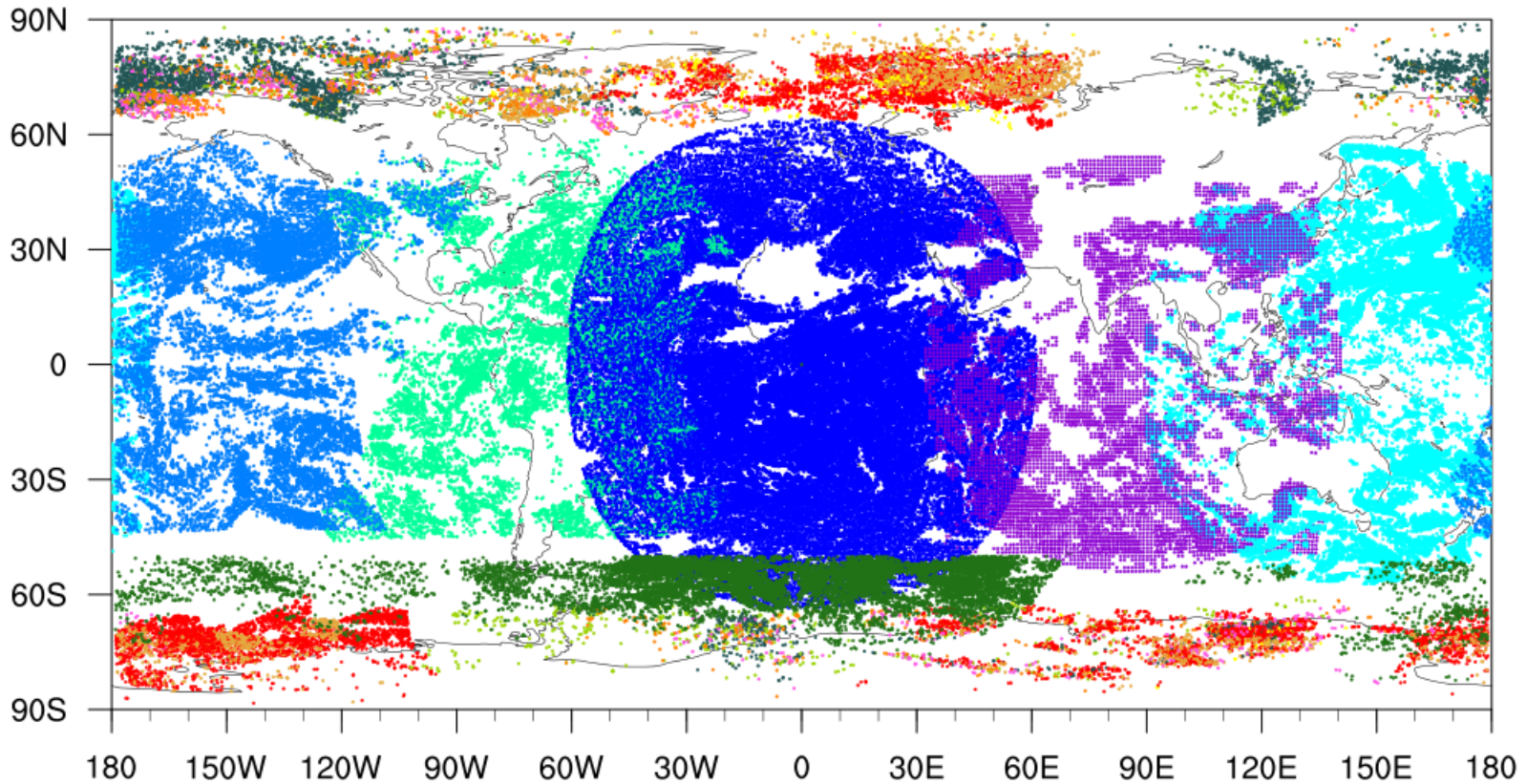
- CNTL: All+FY2E AMVs(old)
- EXP: All+FY2E AMVs(new)

## GEO+LEO+GEO\_LEO winds

### GRAPES Data Coverage(All obs DA)-AMV IR

2014/2/28 18 UTC

total number of obs =171581



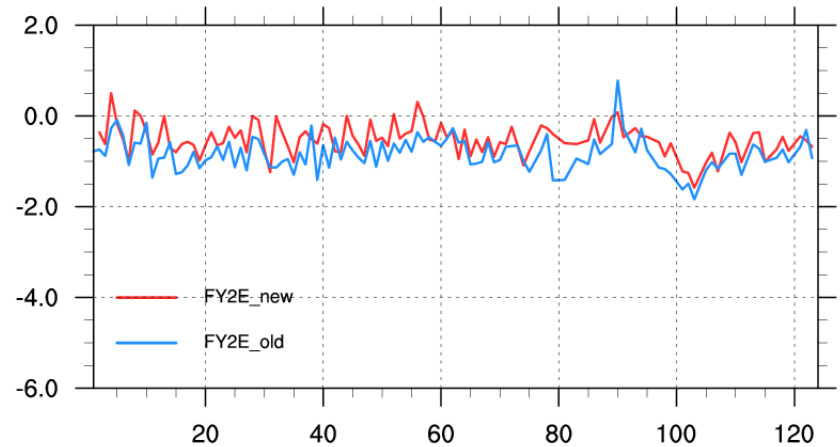
- |                   |                  |                |                |              |              |
|-------------------|------------------|----------------|----------------|--------------|--------------|
| ● METOP-2 8393    | ● MET8 0         | ● MET10 69276  | ● MTSAT 29229  | ● NOAA15 965 | ● NOAA16 515 |
| ● NOAA18 1180     | ● LANDSAT8 1265  | ● GOES13 15625 | ● GOES15 15570 | ● FY-2D 7934 | ● FY-2E 0    |
| ● MODIS-TERRA3064 | ● MODIS-AQUA3927 | ● LEO-GEO14638 |                |              |              |

for providing Leo\_Geo Winds

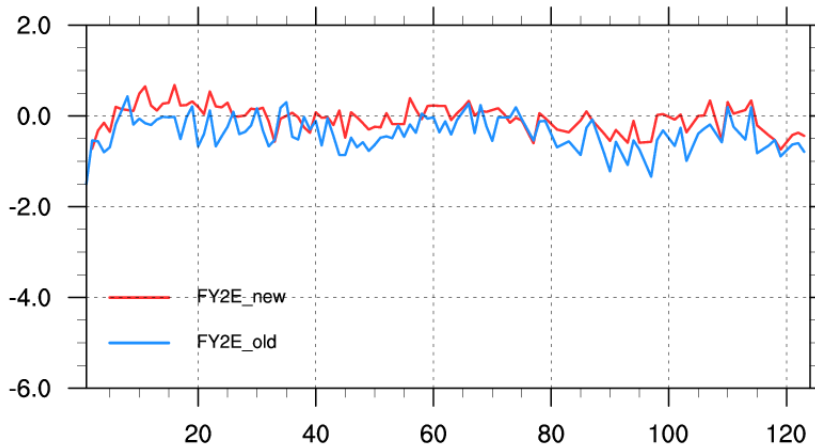
Thanks Dr. Matthew A. Lazzara, Dr. David Santek ,Dr. Brett Hoover at SSEC!

# Bias(O-B) time series

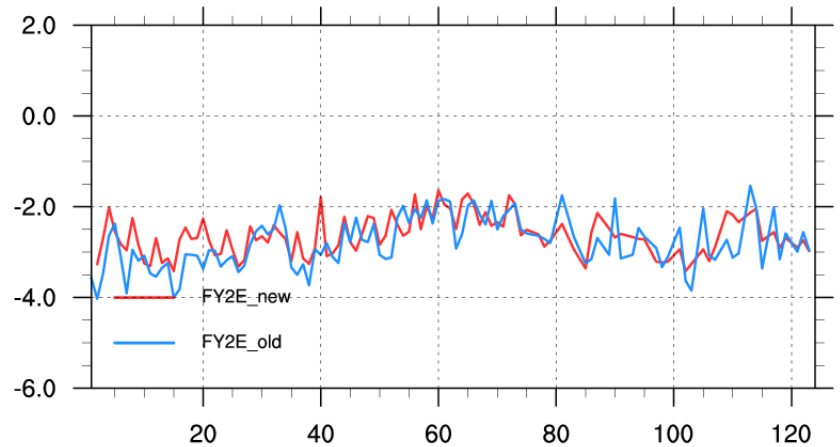
BIAS for U wind innovation from FY2E/AMV\_IR  
Area:lon\_w=0.0,lon\_e=360.0,lat\_s=-90.0,lat\_n=90.0  
Level 400hPa-100hPa from 2013 Aug 1-31 average



BIAS for U wind innovation from FY2E/AMV\_IR  
Area:lon\_w=0.0,lon\_e=360.0,lat\_s=-90.0,lat\_n=90.0  
Level 1000hPa-700hPa from 2013 Aug 1-31 average



BIAS for U wind innovation from FY2E/AMV\_IR  
Area:lon\_w=0.0,lon\_e=360.0,lat\_s=-90.0,lat\_n=90.0  
Level 700hPa-400hPa from 2013 Aug 1-31 average



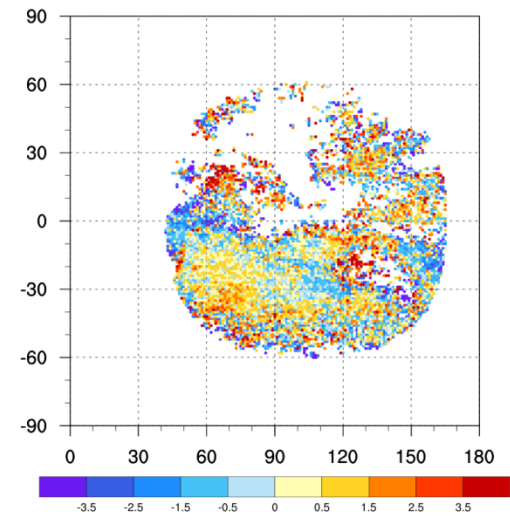
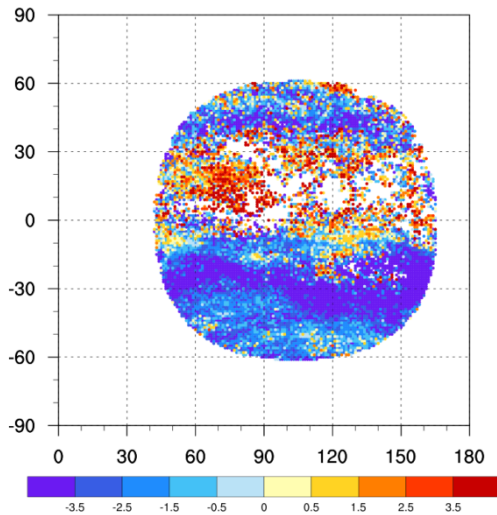
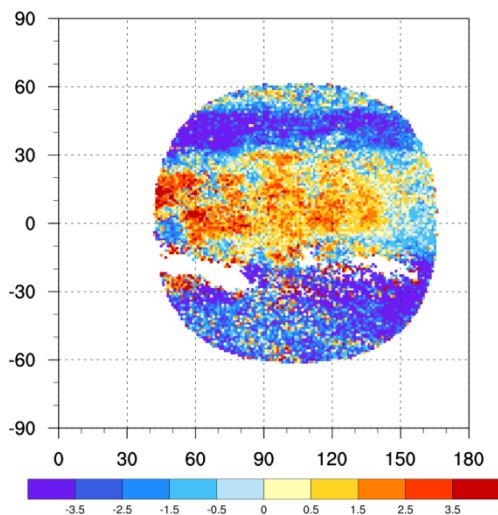
# <O-B> of FY2E old and new AMVs(IR), 201308

400hPa-100hPa

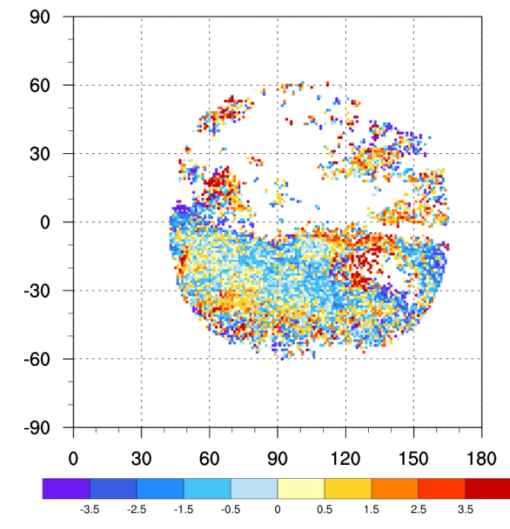
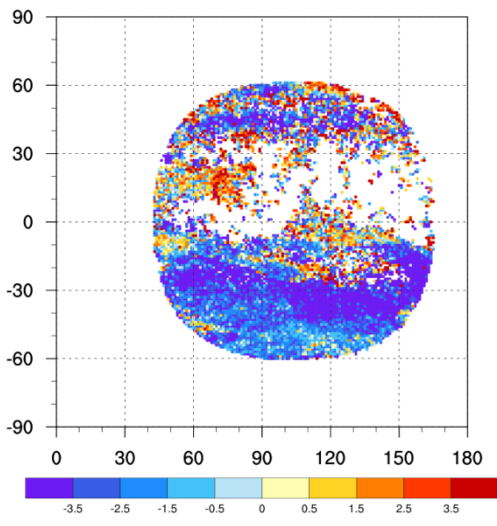
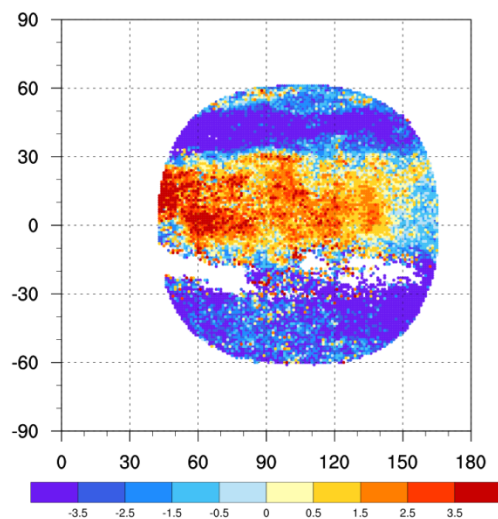
700hPa-400hPa

1000hPa-700hPa

FY2E  
NEW



FY2E  
OLD



# Geometrical interpretation of analysis

## ● Practical Implementation

- Multi. Variable and Obs.

- QC  $(\sigma^o)^2 = d_a^o d_b^o > 0$

## ● Monitoring of Obs. Error

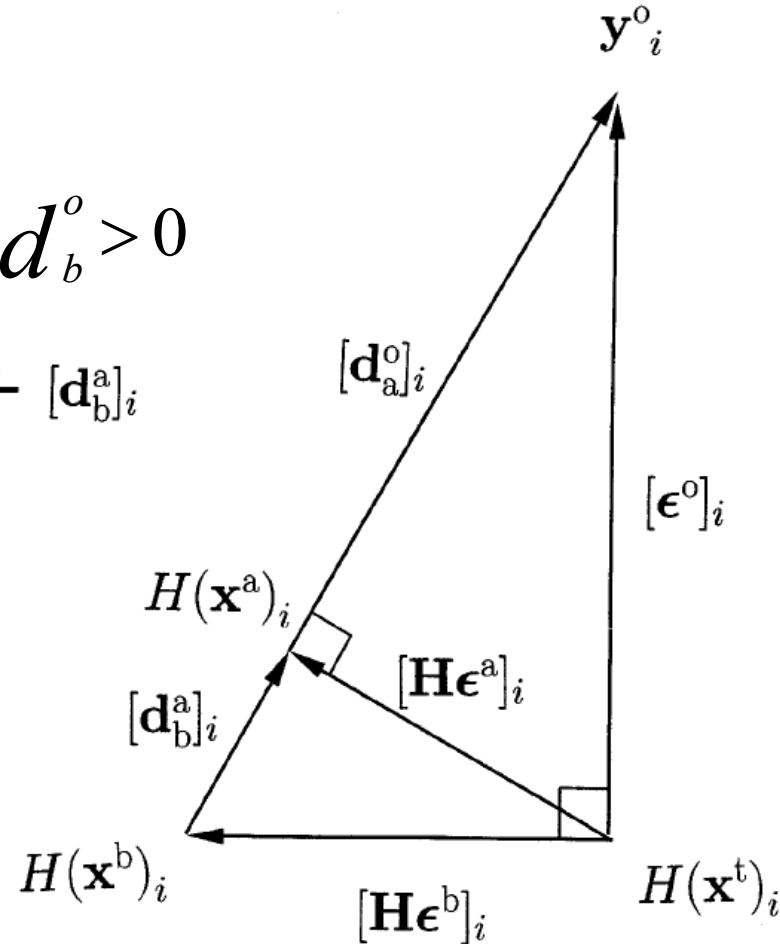
- based on O-B and O-A

- Easy to use

$$E[d_a^o (d_b^o)^T] = R$$

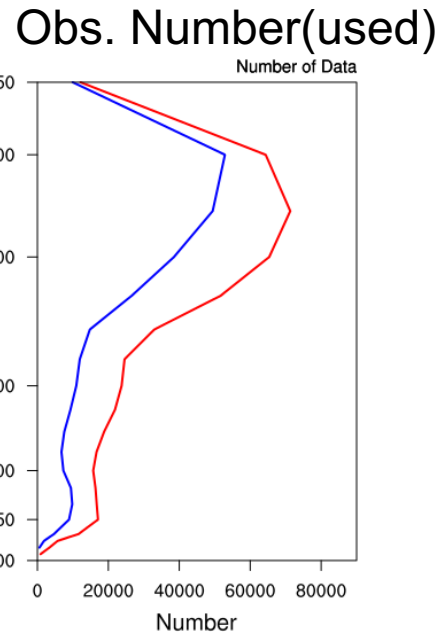
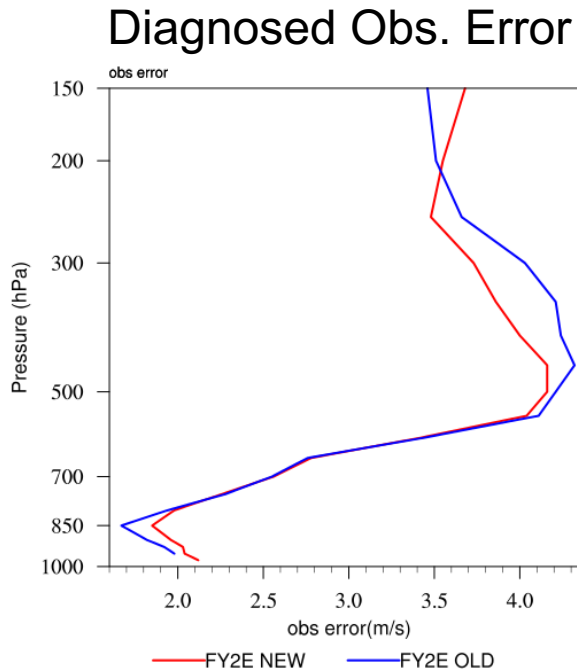
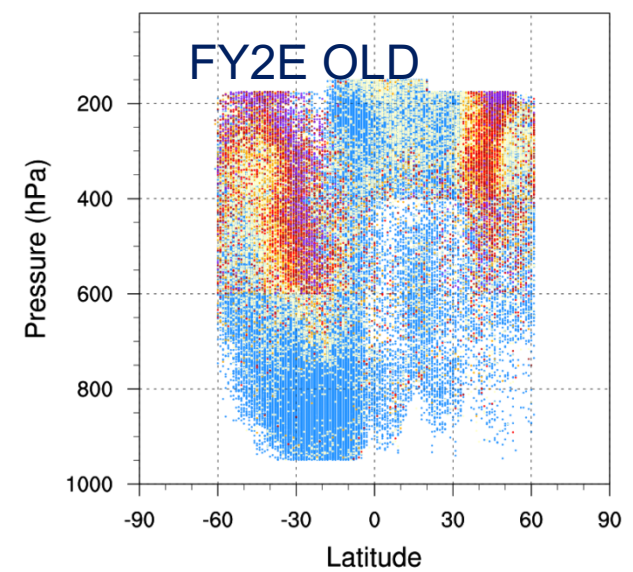
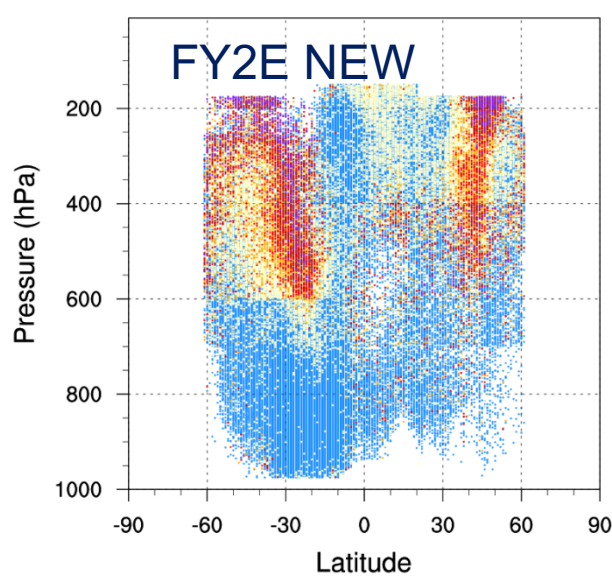
$$(\sigma^o)^2 = d_a^o d_b^o$$

The diag. of R:





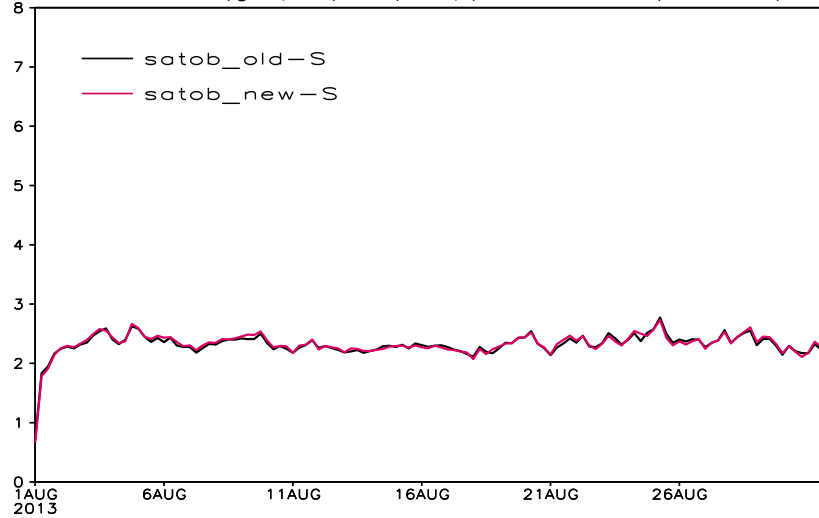
# Observation Error Estimation using Desroziers's method



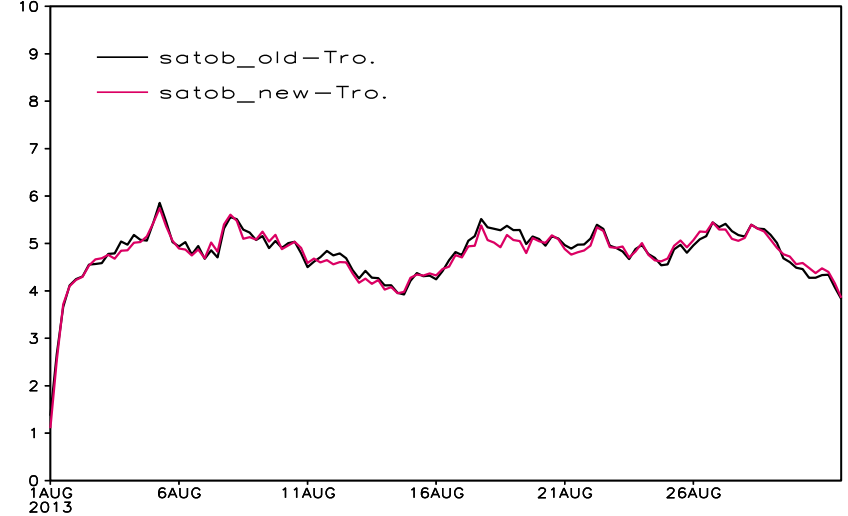
# Verification of wind analyses against NCEP

## global analysis: RMSE time series at 150hPa

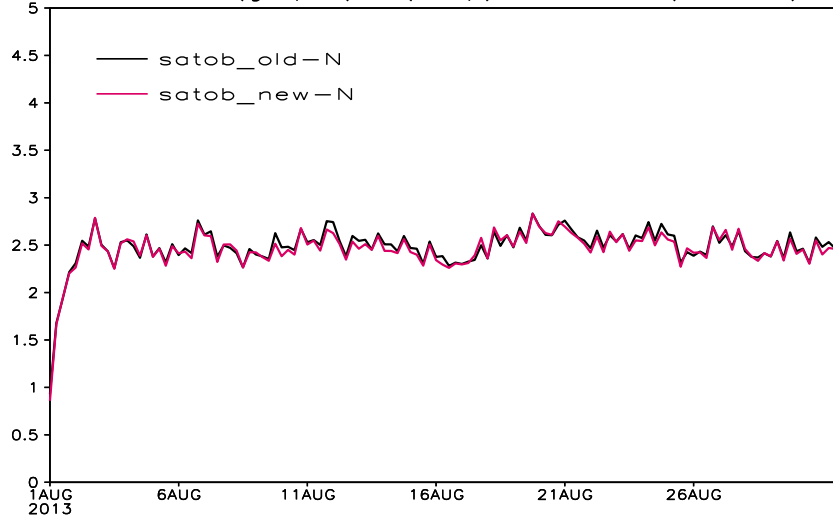
RMS of  $U(\text{grapes}) - U(\text{ncep})$  S. Hemis (150hPa)



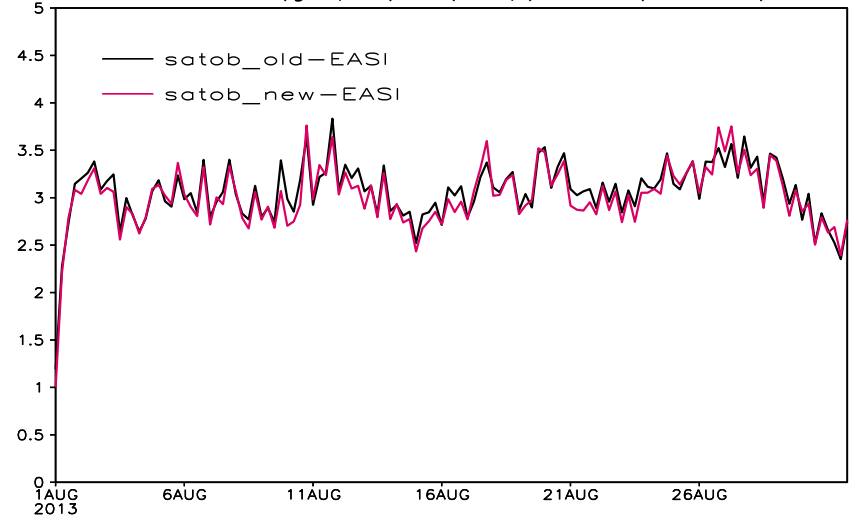
RMS of  $U(\text{grapes}) - U(\text{ncep})$  Tropics (150hPa)



RMS of  $U(\text{grapes}) - U(\text{ncep})$  N. Hemis (150hPa)



RMS of  $U(\text{grapes}) - U(\text{ncep})$  EASI (150hPa)

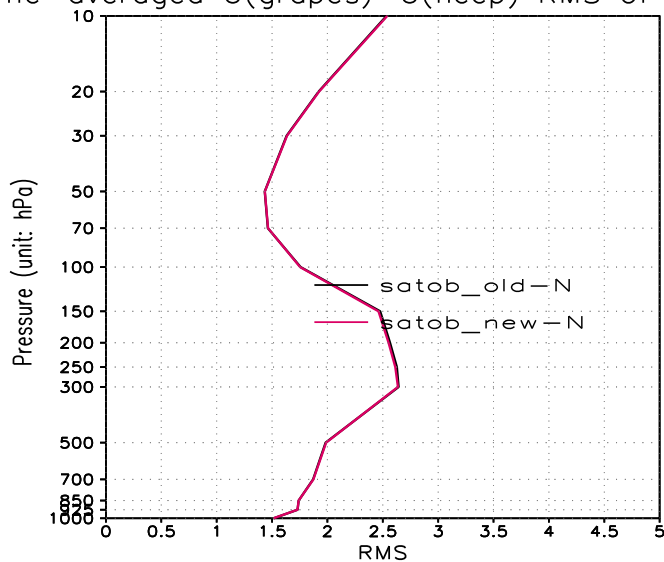




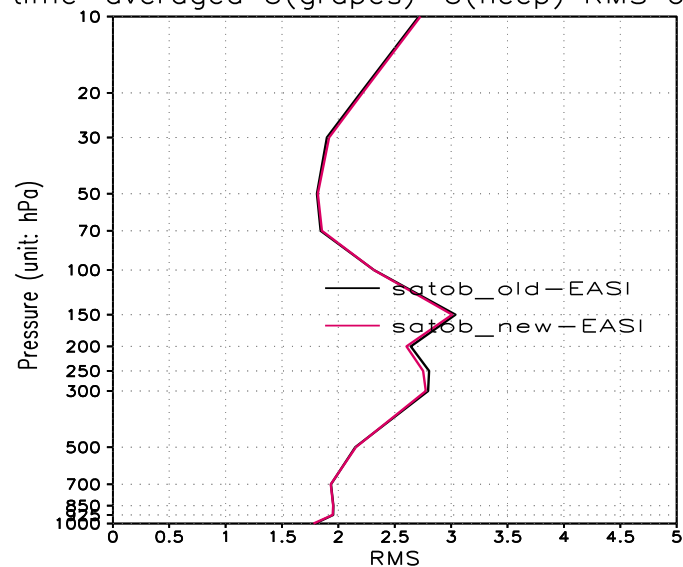
# Verification of wind analyses against NCEP

## global analysis: RMSE vertical profile

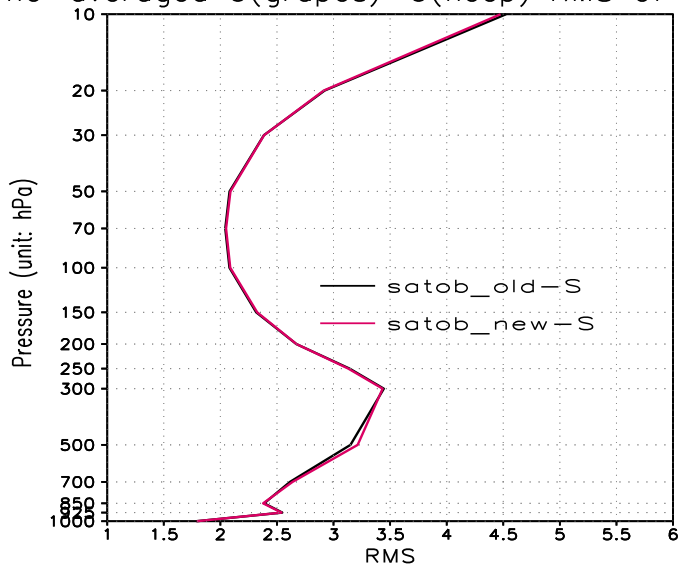
time-averaged  $U(\text{grapes}) - U(\text{ncep})$  RMS of N.Hemis



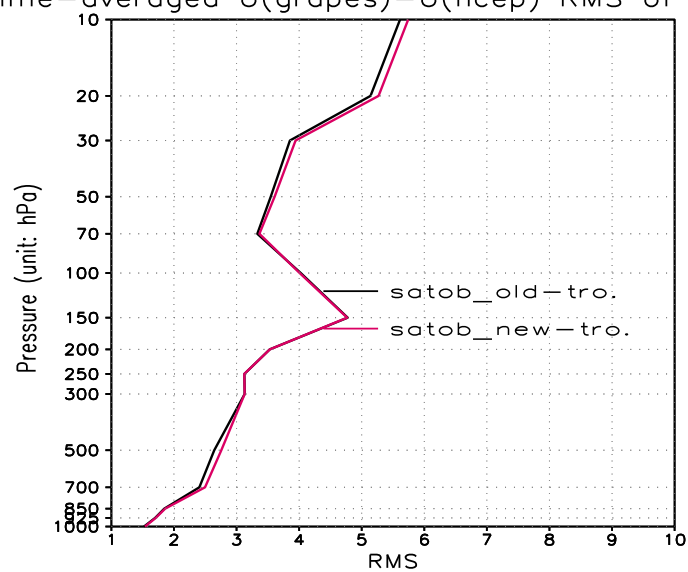
time-averaged  $U(\text{grapes}) - U(\text{ncep})$  RMS of EASI



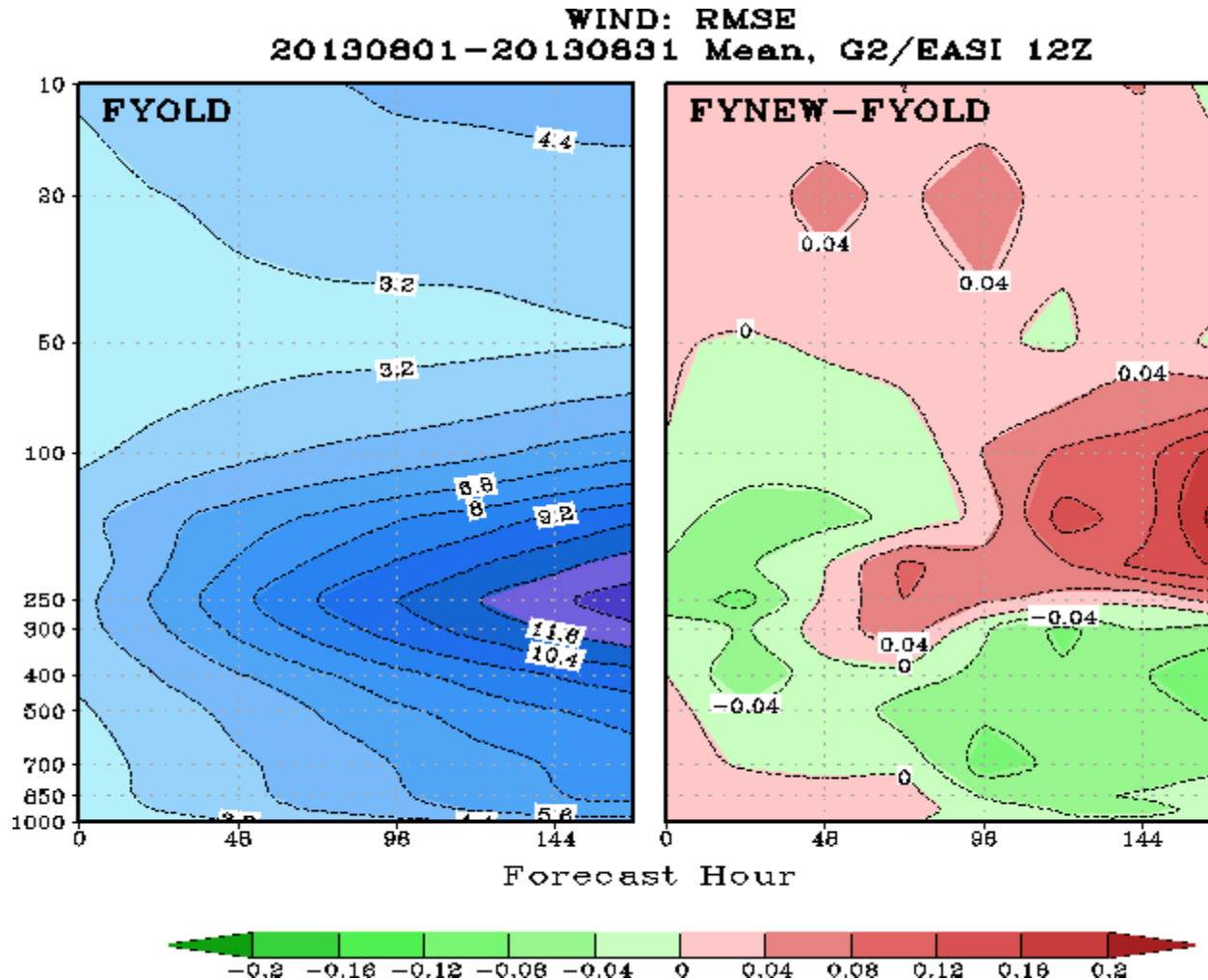
time-averaged  $U(\text{grapes}) - U(\text{ncep})$  RMS of S.Hemis



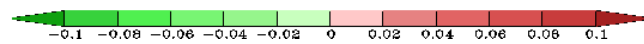
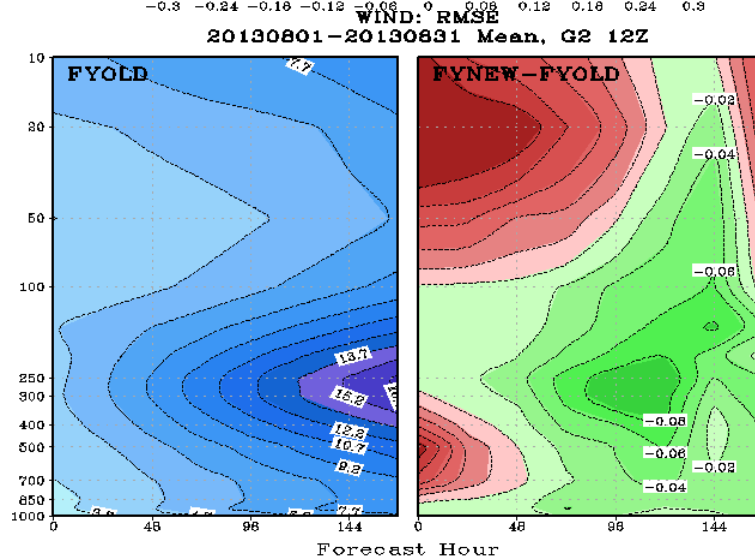
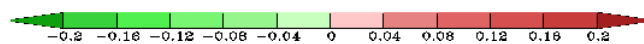
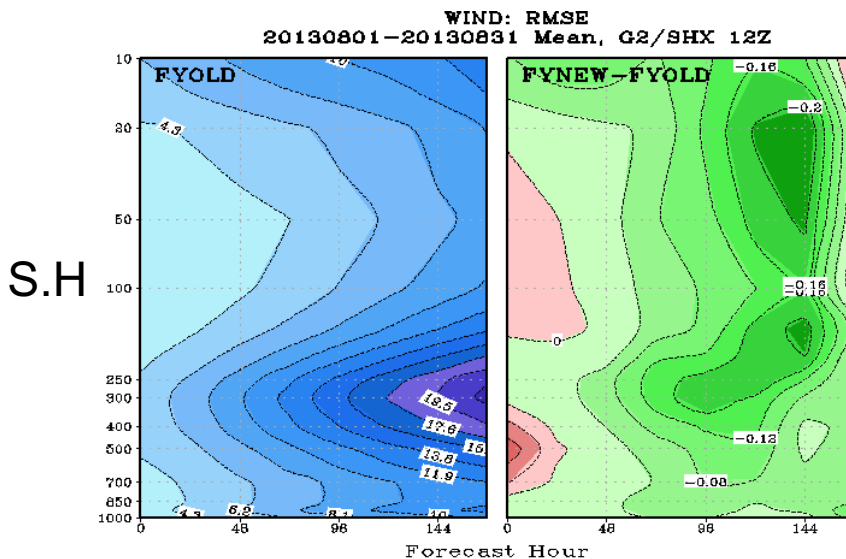
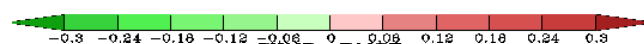
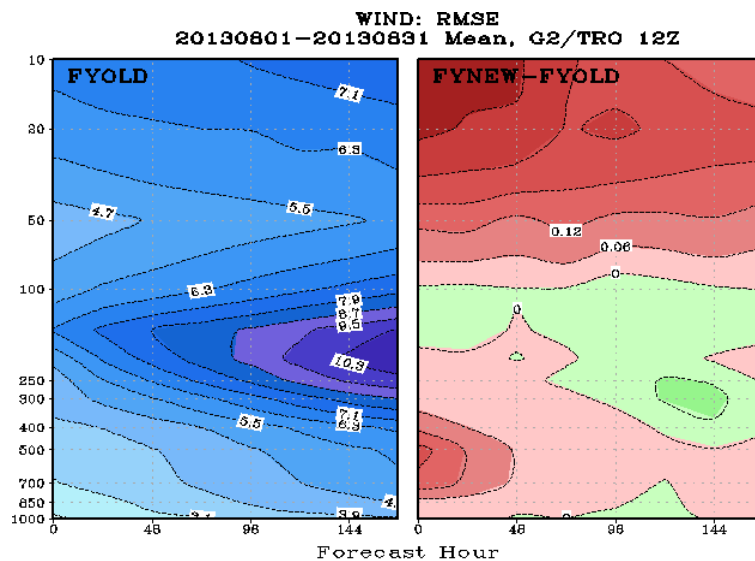
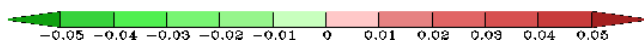
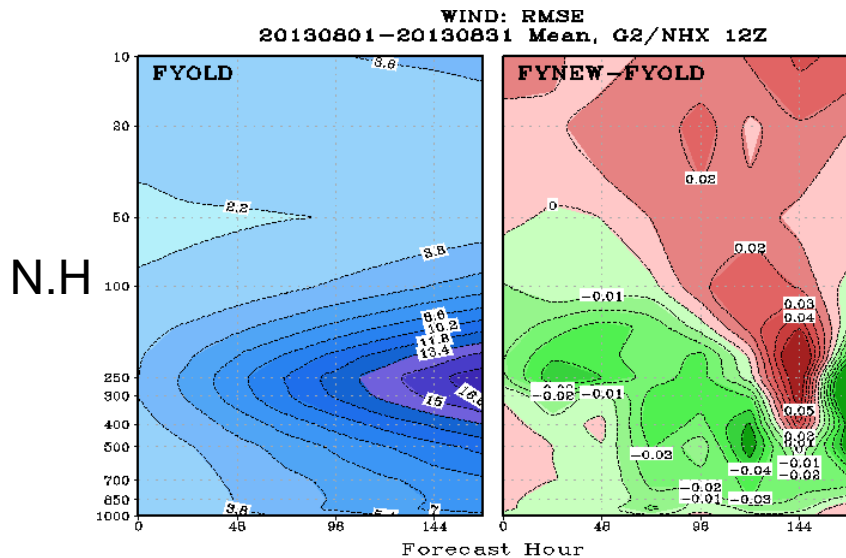
time-averaged  $U(\text{grapes}) - U(\text{ncep})$  RMS of Tropics



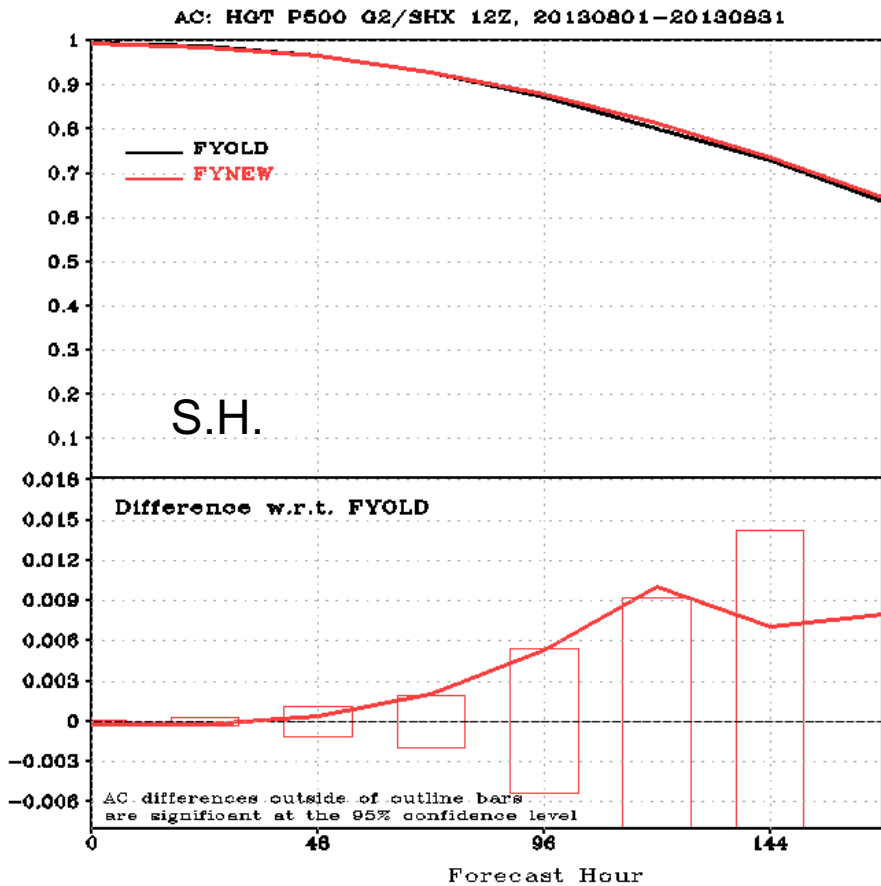
# Impact on Wind forecasts in East Asia



# Impact on Wind forecasts



# Impact on forecasts



Score Card for fynew against fyold

Domain	Parameter	Level	Anomaly Correlation				RMS Error			
EASI	UWND	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		850	█	█	█	█	█	█	█	█
	VWND	250	▲	█	█	█	▲	█	█	█
		500	▲	█	█	█	▲	█	█	█
		850	█	█	█	█	█	█	█	█
	TEMP	250	█	▼	█	█	█	▼	█	█
		500	█	█	█	█	█	█	█	█
		850	█	█	█	█	█	█	█	█
	HGT	250	█	█	█	█	▲	█	█	█
		500	█	█	█	█	█	█	█	█
		700	█	▼	▲	▲	█	█	█	█
NH	UWND	250	▲	█	█	█	▲	█	█	█
		500	█	█	█	█	█	█	█	█
		850	█	█	█	█	█	█	█	█
	VWND	250	▲	█	█	█	▲	█	█	█
		500	▲	█	█	█	█	█	█	█
		850	▲	█	█	█	█	█	█	█
	TEMP	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		850	█	█	█	█	█	█	█	█
	HGT	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		700	█	█	█	█	█	█	█	█
SH	UWND	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		850	█	█	█	█	█	█	█	█
	VWND	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		850	█	█	█	█	█	█	█	█
	TEMP	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		850	█	█	█	█	█	█	█	█
	HGT	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		700	█	█	█	█	█	█	█	█
TRO	UWND	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		850	█	█	█	█	█	█	█	█
	VWND	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		850	█	█	█	█	█	█	█	█
	TEMP	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		850	█	█	█	█	█	█	█	█
	HGT	250	█	█	█	█	█	█	█	█
		500	█	█	█	█	█	█	█	█
		700	█	█	█	█	█	█	█	█

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

# Conclusions and Discussions

- **The reprocessed FY2E IR AMVs**

- **Observation number Increased (about 3 times )**
- **The mean biases are reduced**
- **The diagnosed observation error reduced**
- **The impact on GRAPES analyses and forecasts is Positive**

- **Ongoing work**

- **Tuning of the observation error of the AMVs**
- **Height adjustment of AMVs in DA**
- **Assimilation of Hourly AMVs in GRAPES Global 4D-Var**
- **Use of the reprocessed FY2 AMVs in China Reanalysis**