STATUS OF OPERATIONAL AMVS FROM FENGYUN-2 SATELLITES

Xiaohu Zhang[1], Jianmin Xu[1], Qisong Zhang[1], Sujuan Wang[1], Wei Han[2]

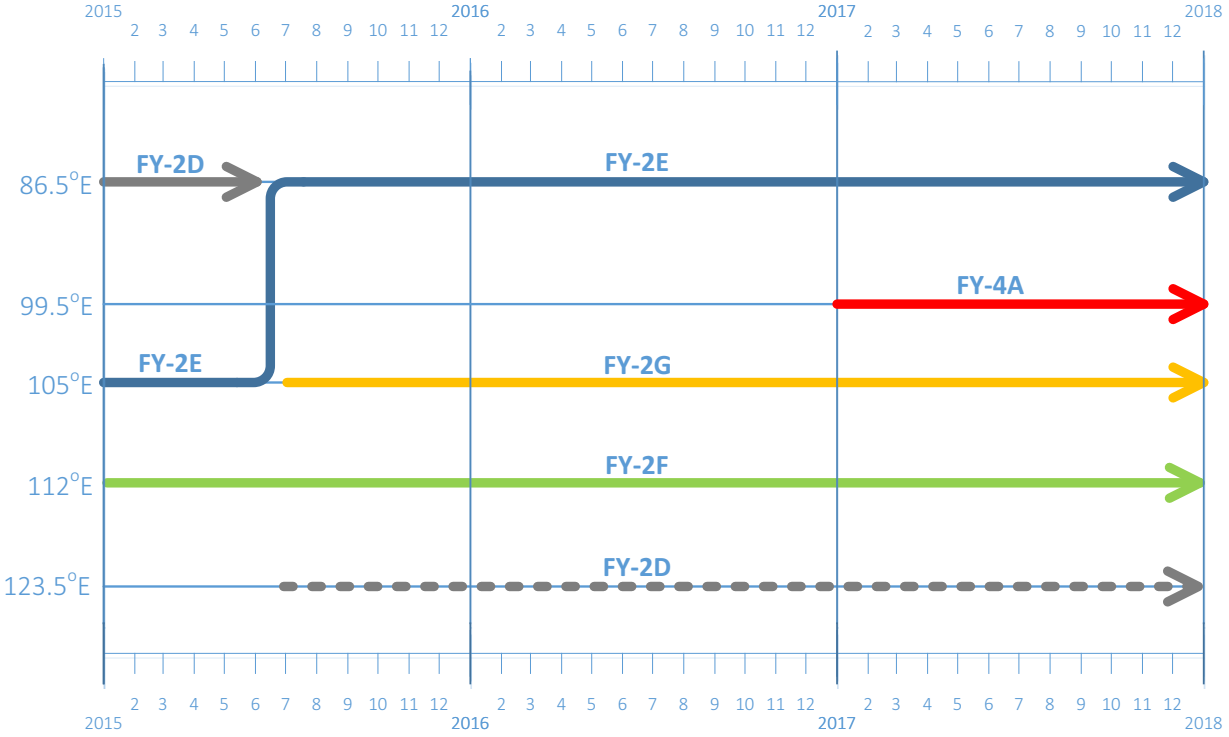
[1]NSMC/CMA, [2]NWPC/CMA

Outline

- FY-2 satellites status and plan
- Changes in operational system
- Current status of CMA winds
- Historical dataset reprocessing progress
- Future work

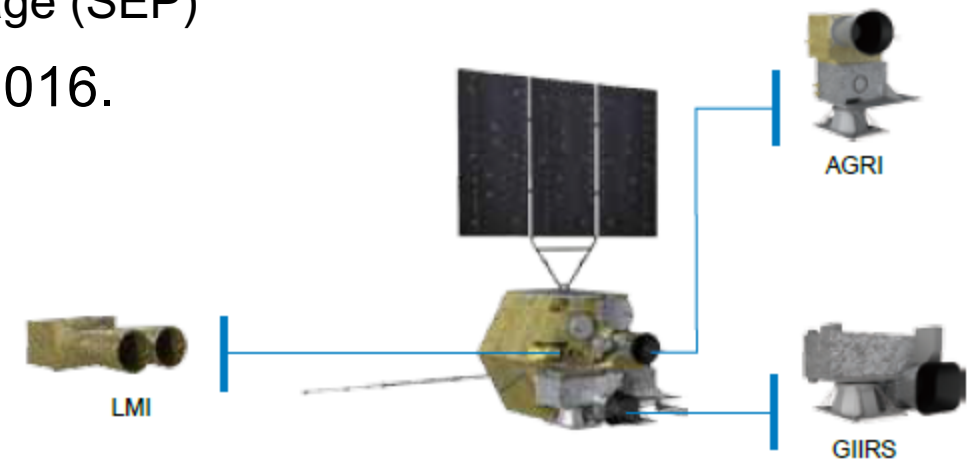
FY-2 satellites status and plan

- FY-2G replaced FY-2E at 105˚E In Jun. 2015
- FY-2E replaced FY-2D at 86.5˚E, FY-2D drifted to 123.5˚E
- FY-2F still did regional rapid scan(RRS) at 112˚E as required.
- FY-4A will be launch in Dec. 2016, located at 99.5˚E



FY-4A satellite

- FY-4 is a new geostationary meteorological satellite series planned to cover the duration of 2016~2025.
- FY-4A is the first satellite of FY-4 series, is R&D satellite.
- Four new instruments are on board the FY-4A:
  - ✓ The Advanced Geosynchronous Radiation Imager (AGRI)
  - ✓ The Geosynchronous Interferometric Infrared Sounder (GIIRS)
  - ✓ The Lightning Mapping Imager (LMI)
  - ✓ The Space Environment Package (SEP)
- FY-4A will be launch in Dec.2016.



Outline

- FY-2 satellites status and plan
- Changes in operational system
- Current status of CMA winds
- Historical dataset reprocessing progress
- Future work

Changes of CMA AMV operational system since last IWWG

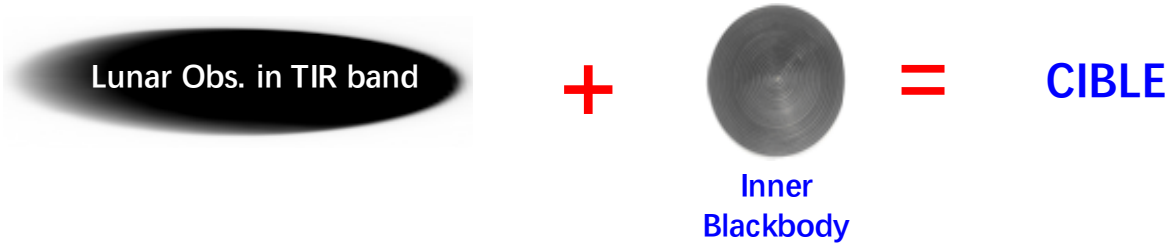
Several R&D algorithm mentioned in IWW12 has been in operation at CMA successively. The Quality of AMV in 2015 had increased.

R&D algorithm(mentioned in IWW12)	Time (in operation)
A new calibration system	Mar.2013
Eliminate the influence of abnormal satellite image	Oct.2014
Remove noise in the satellite image	Oct.2014
Second tracking algorithm	Nov.2014
Height assignment in inversion layer	Dec.2014
Height assignment in target box full of cloud	Dec.2014

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

A new calibration system was updated to operational system

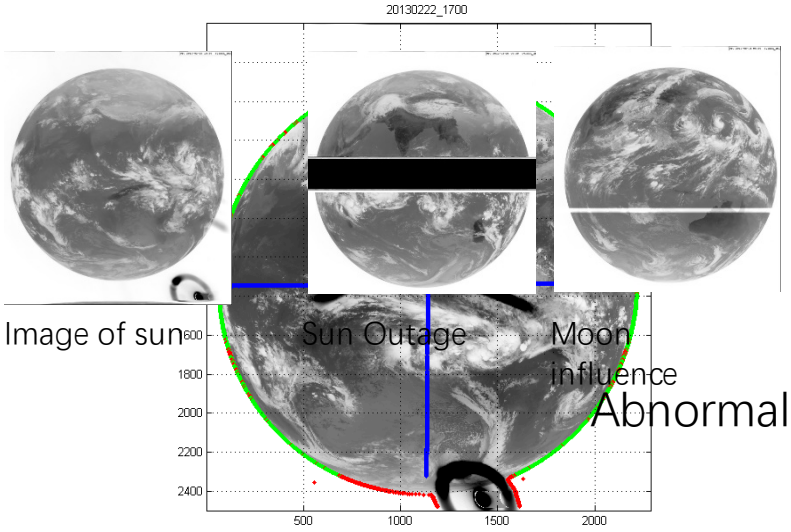
Calibration of Inner Blackbody corrected by Lunar Emission (CIBLE)

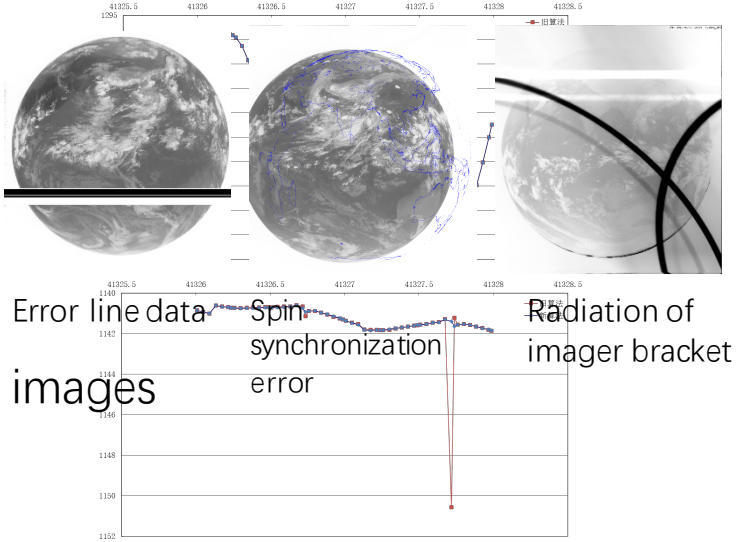


- CIBLE has been in operation for FY-2F satellite since 21 July, 2012
- CILBE has been in operation for FY-2E satellite since 27 March, 2013
- CILBE has been in operation for FY-2G satellite since Jan, 2015

Eliminate the influence of abnormal satellite image -- a new quality control algorithm performed (Oct.2014)

- ✓ The abnormal satellite image can cause bad navigation quality.
- ✓ A quality control algorithm is performed to eliminate the influence of abnormal satellite image.

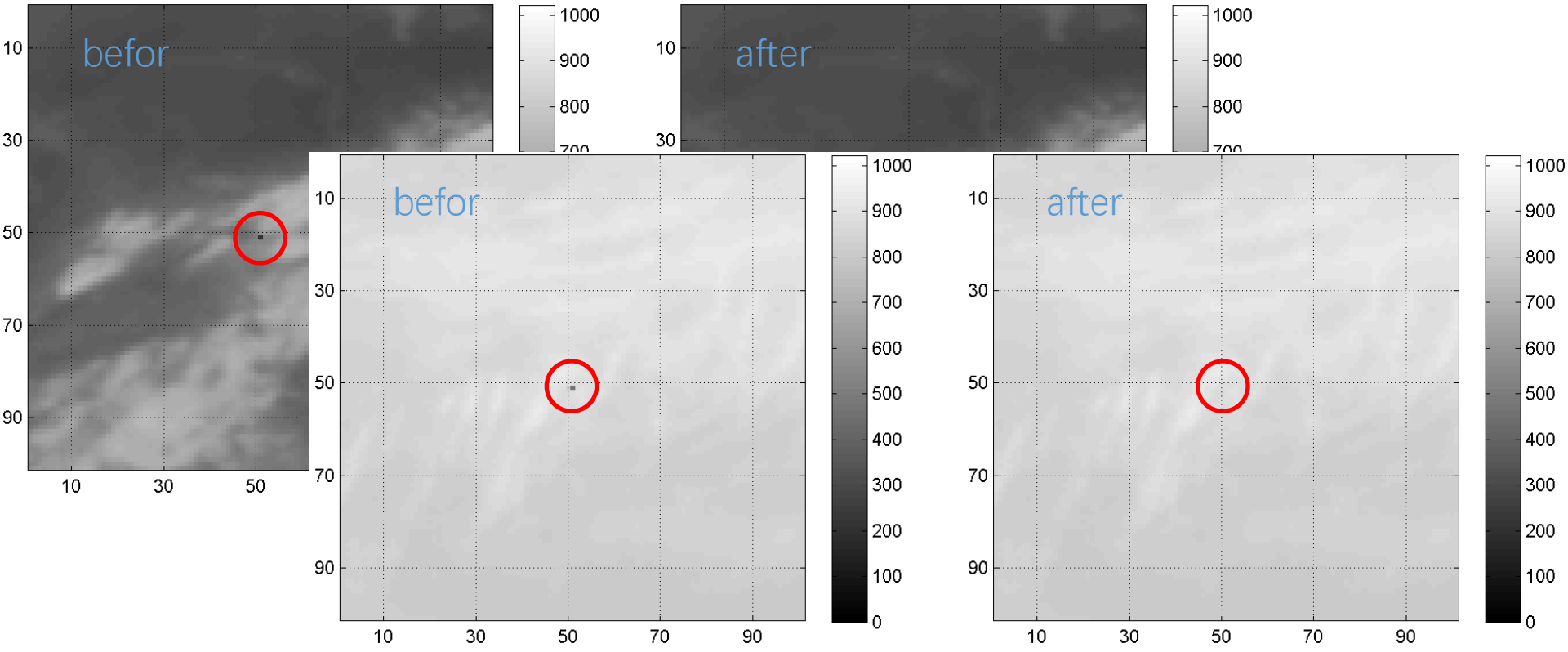




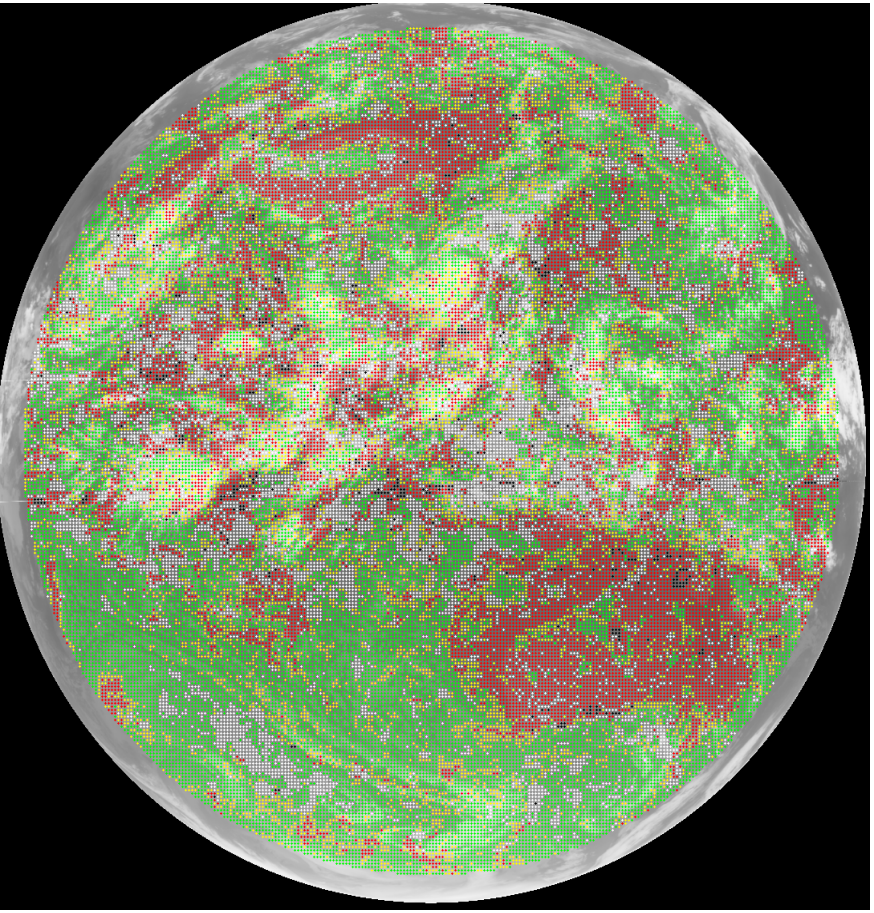
Abnormal images

Remove noise in the satellite image --Identify and eliminate the noise (Oct.2014)

- An algorithm based on median filter was performed to identify and eliminate the noise.
- The algorithm do not change the value except the noise.

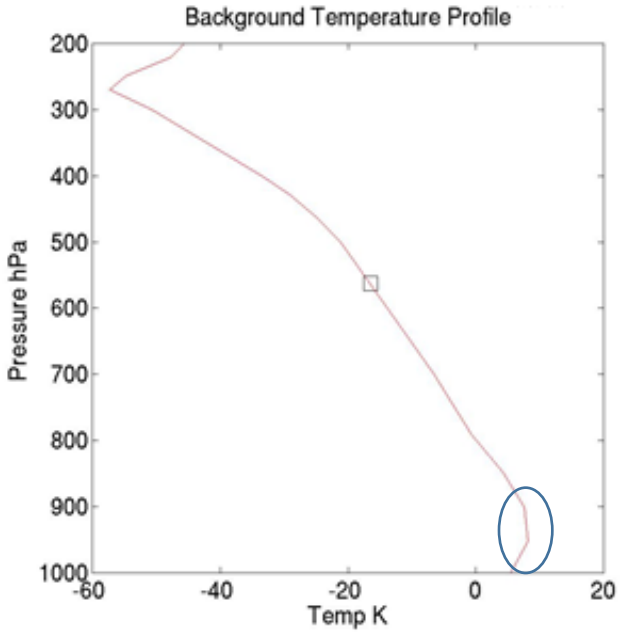


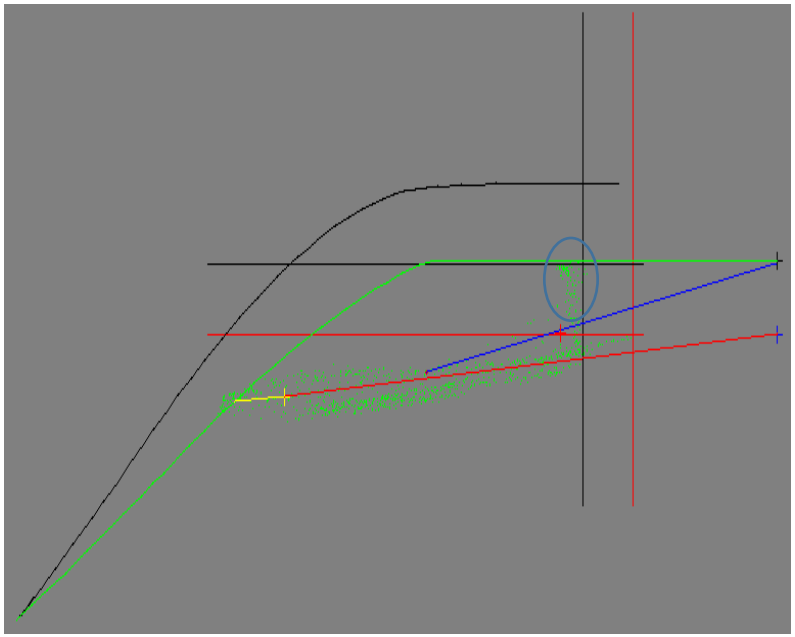
Second tracking algorithm (Nov.2014)



- If the correlation coefficent of first tracking is larger than 0.8, second tracking will be performed.
- The first tracking box is 32 X 32, and the second tracking box is 16 X 16.
- In left image:
  - ✓Green: Second tracking succeeded.
  - ✓Mean speed of First tracking: 11.01 m/s
  - ✓Mean speed of Second tracking: 13.70 m/s

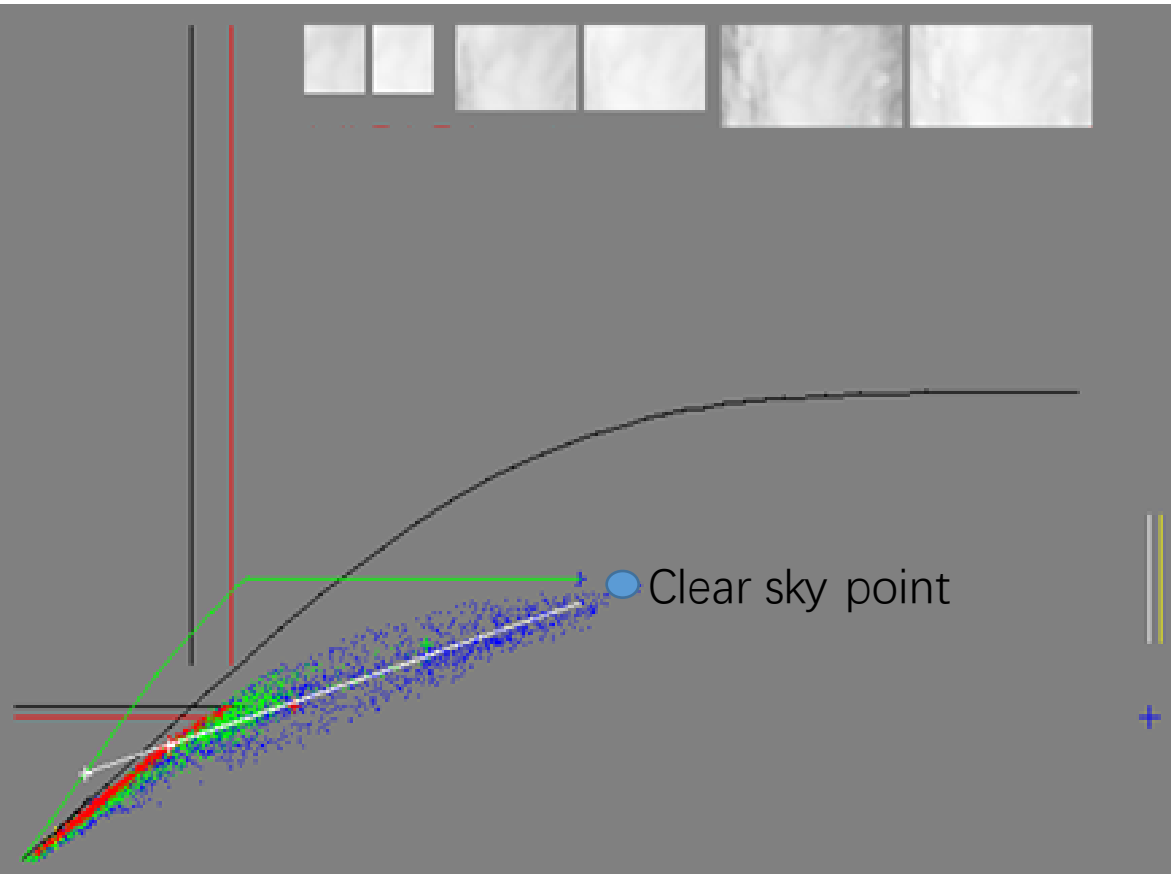
Height assignment in inversion layer (Dec.2014)





- Low-level inversions layers can produce height assignment errors for winds.
- In IR/WV relationship chart, the temperature of points in inversions layers is higher than the surface. Those points must not be used to determine the clear sky point.

Height assignment in target box full of cloud (Dec.2014)



- When the target box full of cloud, the clear sky point is difficult to be find.
- The clear sky point can be found in the expand box approximatively.

Changes in AMV BUFR data of CMA since last IWWG

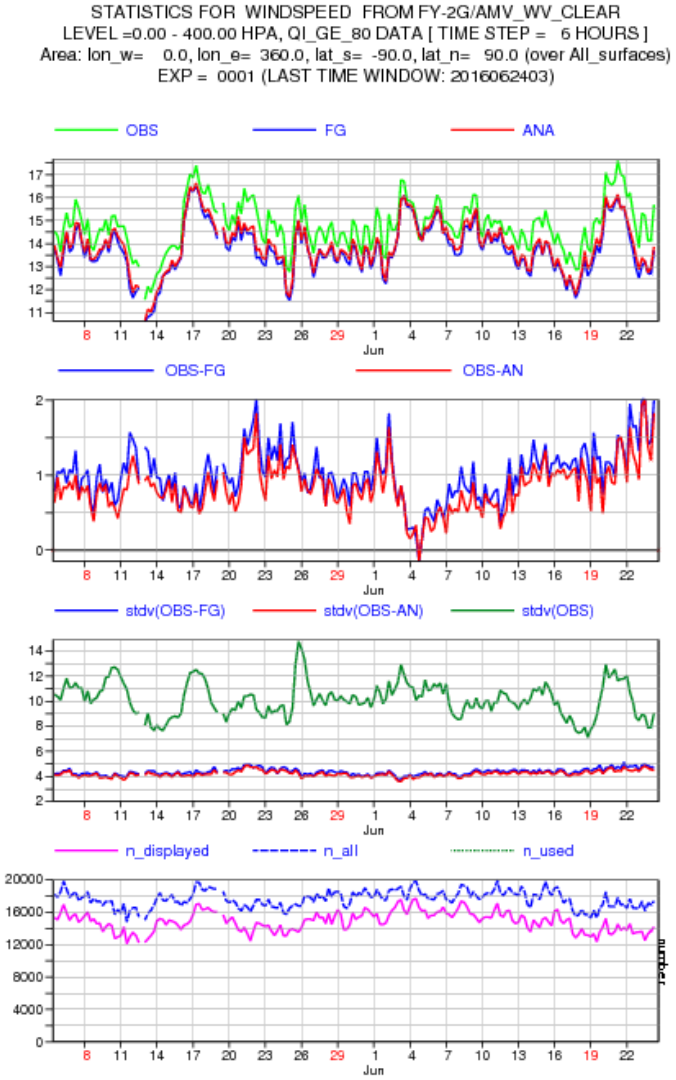
- Add QI without NWP into BUFR data

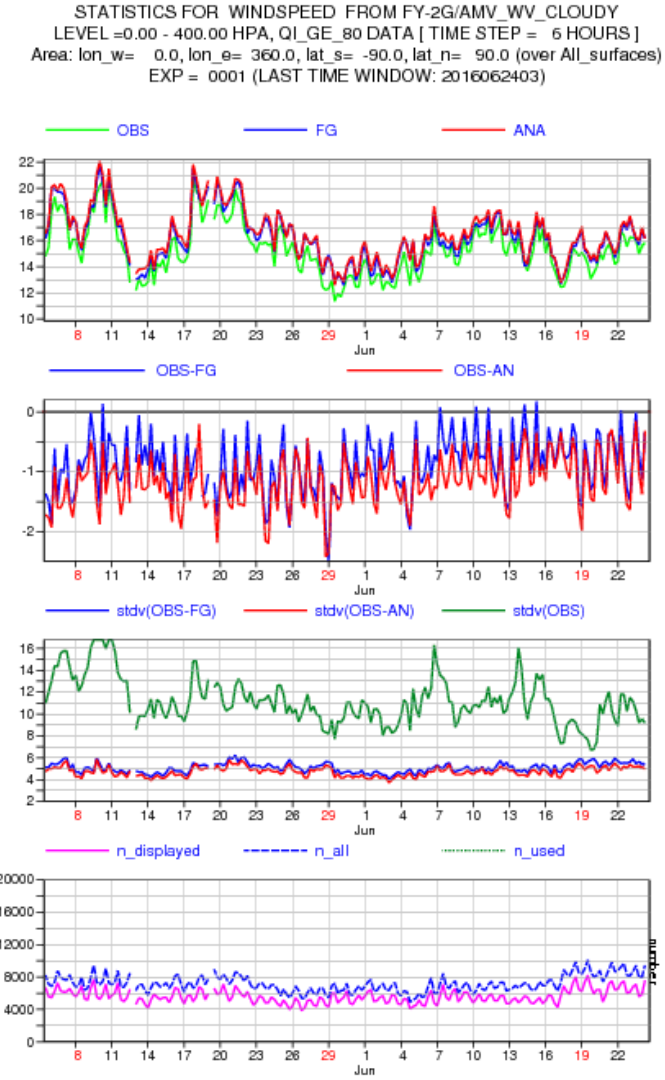
  The QI without NWP information was put in expanded data descriptor from 233 to 254 for both infrared and water vapor, and the satellite derived wind computation method (0 02 023) was put with 3 or 5 instead of 7 for water vapor wind.

- Separate cloudy winds from clear sky winds for water vapour channel

  Water vapour tracers with contribution to motion. Using clustering algorithm, If their WV BT are less than 235K and ΔIR-WV less than 15K , they are cloudy winds. Otherwise they are clear sky winds.

Cloudy and clear sky winds for water vapour channel in EC's monitoring web site





Outline

- FY-2 satellites status and plan
- Changes in operational system
- Current status of CMA winds
- Historical dataset reprocessing progress
- Future work

Current status of CMA winds

- In FY-2 AMV operational schedule, the satellite at 105˚E always generates AMV at 00,06,12,18 (UTC), and the satellite at 86.5˚E generates AMV at 03,09,15,21 (UTC)
- Since the changes of the FY-2 satellite location, AMV products are changed.

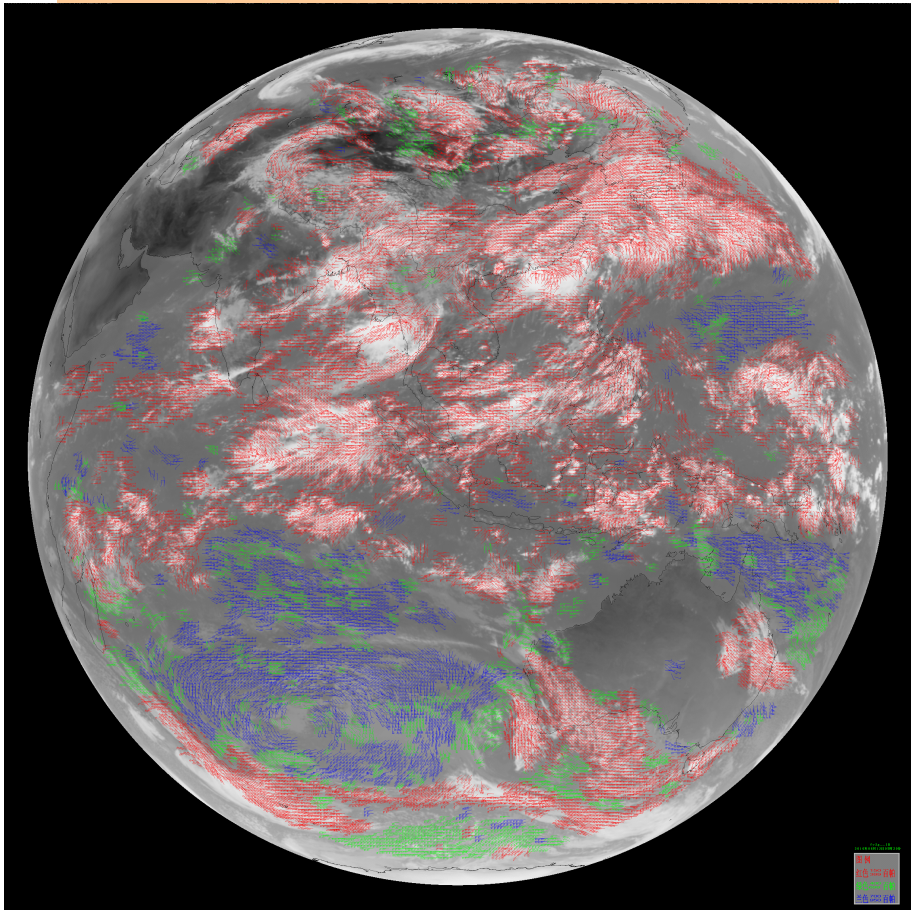
Nadir longitude	Product times	Satellite		Product
		2014.1~2015.5	2015.6~NOW	
105˚E	Every 6h 00,06,12,18 (UTC)	FY-2E	FY-2G	Infrared and Water Vapour Winds
86.5˚E	Every 6h 03,09,15,21 (UTC)	FY-2D	FY-2E	Infrared and Water Vapour Winds

Example of FY-2G AMVs

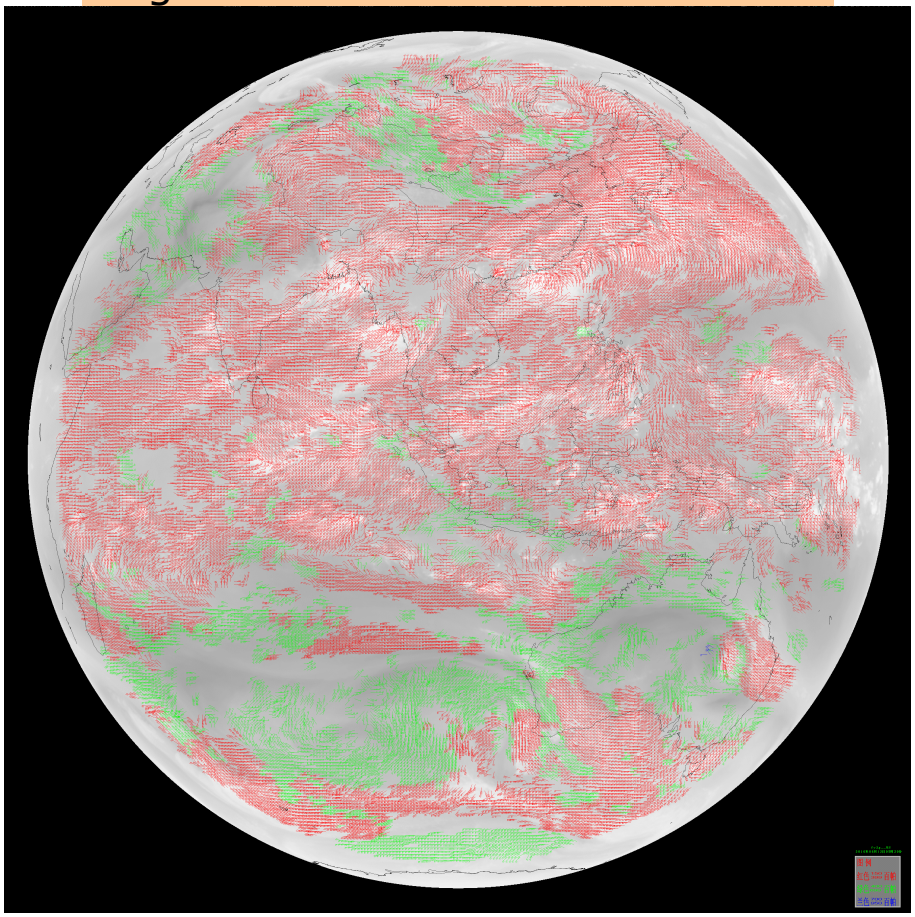
- Since the 12th wind workshop, infrared (IR) and water vapor (WV) channel AMVs derivations are performed for both FY-2G, FY2E and FY-2D.
- The AMVs passed quality control are transmitted through GTS in BURF code.

06UTC at Jun.12 2016

High-, middle- and low-level IR AMVs



High- and middle-level WV AMVs



Latest CMA AMV improvements since last IWWG

- **Mean of departures** from FY2-E/FY2G IR wind speed and those of analysis (QI>80)

	High level winds (Above 400hPa)		Middle level winds (between 400-700hPa)		Low level winds (below 700hPa)	
	2013	2015	2013	2015	2013	2013
Jan	-1.94	-1.37	-3.90	-2.54	-0.58	0.10
Feb	-1.94	-1.37	-3.06	-2.58	-0.31	-0.14
Mar	-2.21	-1.25	-2.69	-2.45	-0.36	0.07
Apr	-2.76	-1.04	-3.17	-2.16	-0.32	0.13
May	-2.61	-1.08	-2.63	-2.11	-0.08	-0.15
Jun	-2.70	-1.09	-2.50	-1.84	-0.17	0.22
Jul	-2.92	-1.15	-2.74	-2.24	-0.26	-0.21
Aug	-2.85	-1.12	-3.28	-1.99	-0.26	-0.25
Sep	-2.90	0.10	-3.10	-1.92	-0.19	-0.19
Oct	-2.46	-1.01	-2.67	-2.11	-0.35	-0.24
Nov	-2.26	0.07	-3.54	-2.04	-0.22	0.03
Dec	-2.08	0.11	-3.86	-2.28	-0.31	0.16

Latest CMA AMV improvements since last IWWG

- **Standard deviation of departures** from FY-2E/FY2G IR wind speed and those of analysis (QI>80)

	High level winds (Above 400hPa)		Middle level winds (between 400-700hPa)		Low level winds (below 700hPa)	
	2013	2015	2013	2015	2013	2015
Jan	4.64	4.61	6.04	5.14	3.02	2.64
Feb	4.72	4.36	6.01	5.06	3.12	2.76
Mar	4.81	4.61	5.81	4.65	2.74	2.45
Apr	4.91	4.39	5.79	4.43	2.70	2.35
May	4.88	4.51	5.65	4.50	2.66	2.50
Jun	4.94	4.57	5.40	4.62	2.53	2.56
Jul	5.06	4.76	5.50	4.54	2.80	2.55
Aug	5.03	4.67	5.52	4.20	2.79	2.49
Sep	4.96	4.51	5.62	4.36	2.88	2.55
Oct	4.85	4.28	5.71	4.38	2.83	2.63
Nov	4.50	4.16	5.61	4.44	2.75	2.49
Dec	4.50	4.34	5.96	4.47	3.11	3.62

Latest CMA AMV improvements since last IWWG

- Mean of departures and standard deviation of departures from FY-2E/FY-2G high level WV wind speed and those of analysis (QI>80)

	Mean of departures		STDV	
	2013	2015	2013	2015
Jan	-0.38	-0.37	4.26	4.61
Feb	-0.41	-0.37	4.28	4.36
Mar	-0.44	-0.25	3.90	4.61
Apr	-0.66	-0.04	3.95	4.39
May	-0.68	-0.08	3.95	4.51
Jun	-0.61	-0.09	4.25	4.57
Jul	-0.62	-0.15	4.62	4.76
Aug	-0.49	-0.12	4.17	4.67
Sep	-0.54	0.10	4.05	4.51
Oct	-0.36	-0.01	3.90	4.28
Nov	-0.43	0.07	3.71	4.16
Dec	-0.42	0.11	4.17	4.34

Outline

- FY-2 satellites status and plan
- Changes in operational system
- Current status of CMA winds
- Historical dataset reprocessing progress
- Future work

Historical dataset reprocessing progress

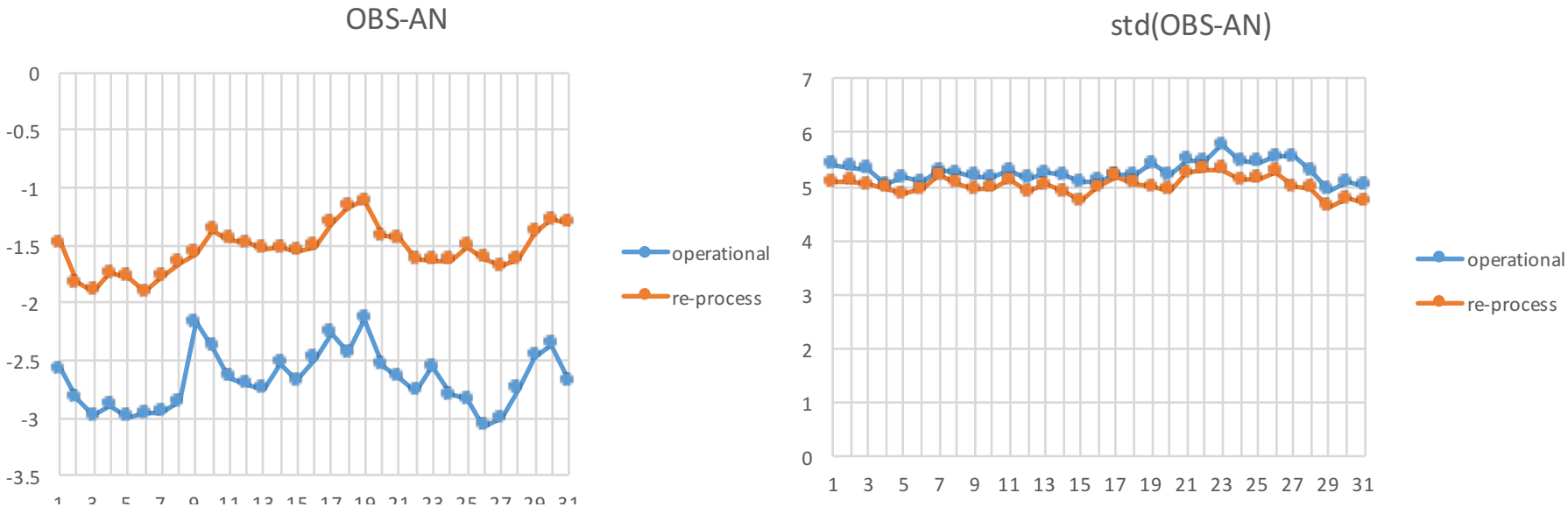
- CMA already started an project to reprocess the historical AMVs dataset in 2013.
- Reprocess all historical AMVs data with latest AMVs algorithm(CMA Version 2014)
- The project was undertaken and will be finished by the end of 2016

Historical dataset:

SATELLITE	NADIR LONGITUDE	DATE	AMVs TIME (UTC)
FY-2C	105°	Jan 1st, 2006 – Nov 24th, 2009	00/06/12/18
FY-2D	86.5°	Feb 14th, 2007 – Dec 31st, 2013	03/09/15/21
FY-2E	105°	Nov 23rd, 2009 – Dec 31st, 2013	00/06/12/18

Result of reprocessing FY-2E AMV

- The comparison of quality of reprocessed AMV and operational AMV of in August 2013. (compared with ECMWF global atmospheric reanalysis data)
- IR winds validation result:
  - ✓The bias reduce by 1.303 m/s. (-2.855 to -1.552)
  - ✓The STD reduce by 0.013 m/s. (5.031 to 5.018)



Aug.2013 FY-2E 0-400hPa (QI>80)

Impact of FY-2E Reprocessed AMVs in GRAPES

- Make a data assimilation experiments in GRAPES using reprocessed FY-2E IR AMVs of in Aug. 2013
- The reprocessed FY2E IR AMVs
  - ✓Observation number Increased (about 3 times)
  - ✓The mean biases are reduced
  - ✓The diagnosed observation error reduced
- Positive impact on GRAPES analyses and forecasts

Wei Han et al.,2016: Evaluation of FY2E Reprocessed AMVs IN GRAPES, IWW13.

Outline

- FY-2 satellites status and plan
- Changes in operational system
- Current status of CMA winds
- Historical dataset reprocessing progress
- Future work

Future work

- Continue to improve FY-2 AMV quality
  - ✓Height assignment
- FY-3 polar winds (in R&D status)
- FY-4 AMV (in system integration stage)

FY-4A AGRI and AMVs

- AGRI: 14 channels, balanced VIS, NIR, SWIR, MWIR and TIR [see detailed characteristics right]
- FY-4A AGRI AMVs:
  - ✓IR winds (IR10.8um)
  - ✓WV6.2um clear sky winds
  - ✓WV6.2um cloudy winds
  - ✓WV7.3um clear sky winds
  - ✓WV7.3um cloudy winds
  - ✓VIS winds (0.8um)

FY-4A AGRI: Advanced Geosynchronous Radiation Imager

Channel	Band	Spatial Resolution
Visible & Near-Infrared	0.45~0.49	1
	0.55~0.75	0.5~1
	0.75~0.90	1
Short-wave Infrared	1.36~1.39	2
	1.58~1.64	2
	2.1~2.35	2~4
Mid-wave Infrared	3.5~4.0(High)	2
	3.5~4.0(Low)	4
Water Vapor	5.8~6.7	4
	6.9~7.3	4
Long-wave Infrared	8.0~9.0	4
	10.3~11.3	4
	11.5~12.5	4
	13.2~13.8	4

Thank you !