STATUS OF AMVS FROM FENGYUN SATELLITES

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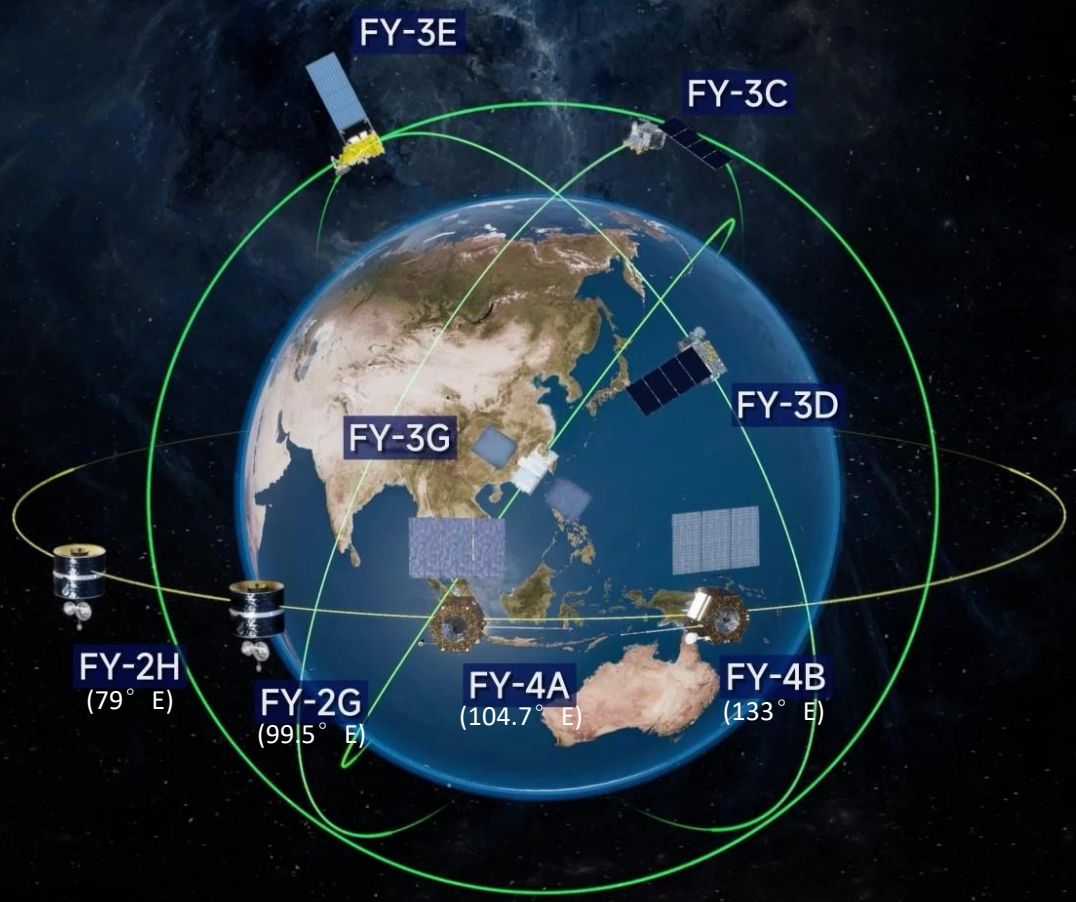
Contents

- Status of FENGYUN Satellites
- Operational AMV System and Products
- Satellite Product Distribution and Access
- Future work

- **Since IWW15, CMA's FengYun satellite status has been updated as follows:**
  - **3 Recruit: FY-4B, FY-3E and FY-3G**
  - **2 Retired: FY-3B and FY-2F**

8 FengYun Satellites in orbit



GEO

FY-2G, -2H
FY-2G (99.5° E) and FY-2H (79° E)
Full disk every 30 min
FY-2H, last flight unit of FY-2 series.

FY-4A, -4B
China's second generation GEO meteorological satellites.

FY-4A (104.7° E) , Full disk every 15 min.

FY-4B (133° E), Full disk every 15 min, partial areas rapid scanning at 1 min.
Operational

FY-3C
Mid-morning orbit
Operational with degraded performance

FY-3D
Afternoon orbit, ECT 13:45 local time
10 EO instruments

FY-3E
Early-morning orbit, ECT 5:41 LT
11 EO instruments
Operational

FY-3G
Drifting orbit,
6 EO instruments
Pre-operational

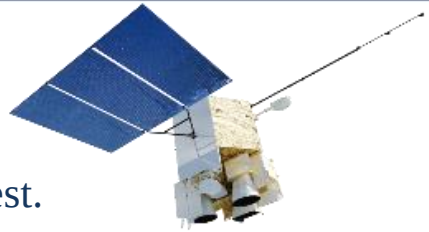
Current FENGYUN GEO Satellites

Sector	Satellites currently in Orbit	Location	Lunch date	Status	Instrument Capacity
West-Pacific (108° E-180° E)	FY-4B	133° E	3 Jun. 2021	Primary operation for full disk scan	AGRI,GIIRS, GFI,SEP
Indian Ocean (36° E-108° E)	FY-2G	99.5° E	31 Dec. 2014	Primary operation for full disk scan	S-VISSR, SEM
	FY-4A	104.7° E	11 Dec. 2016	Primary operation for full disk scan	AGRI,GIIRS, LMI,SEP
	FY-2H	79° E	5 Jun. 2018	Primary operation for full disk scan since 1, Jan. 2019	S-VISSR, SEM

Mission objectives:

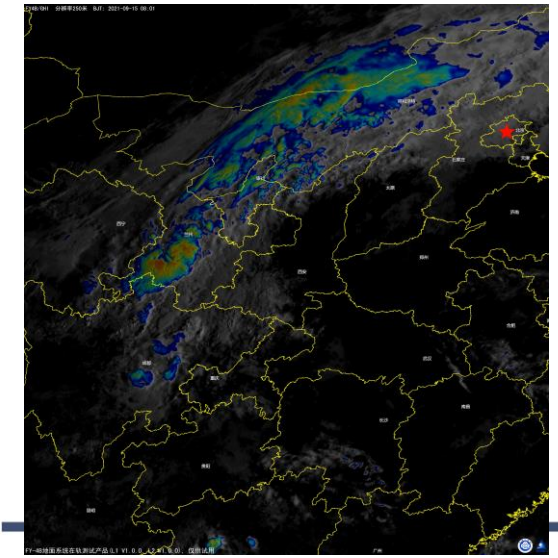
- Support nowcasting and severe weather warning.
- Support NWP (numerical weather prediction), regional and global.
- Support climate applications.
- Support environment and disaster monitoring.

FY-4B status

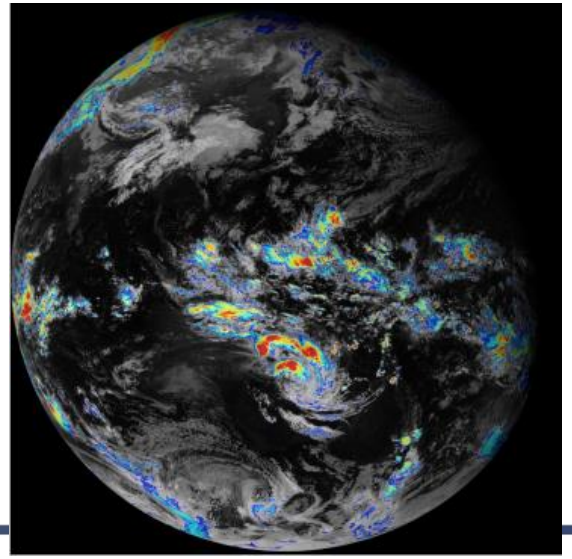


- Launched on Jun. 3rd, 2021. Located at 133ºE now.
- Satellites with 4 instruments onboard have passed the post-launch test.
- Satellite data is available on NSMC website for trial application since June 1, 2022.
- 52 baseline products(L2) have been developed.
- Key Improvement :
  - GHI: High-speed imager, 1miniute interval;
  - GIIRS: Improved calibration;
  - SEP/FGM: Wide-range energetic and multi-direction particles, high-time resolution magnetic field.

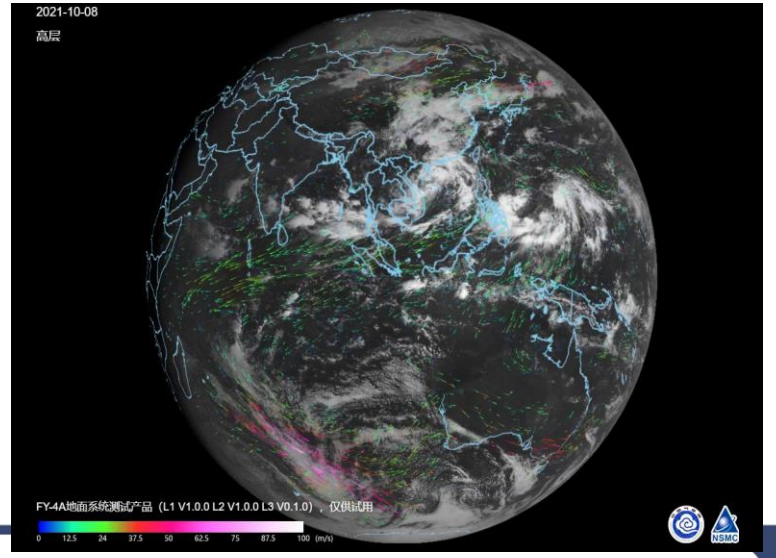
GHI 1 Minute Interval Cloud Animation



Fusion convection (Sandwich) image



Atmosphere Motion Vectors（High level）



	Instruments
1	Advanced Geostationary Radiation Imager(AGRI)
2	Geostationary Interferometric Infrared Sounder(GIIRS)
3	Geostationary High Speed Imager(GHI)
4	Space Environment Package(SEP)

Current FENGYUN LEO Satellites

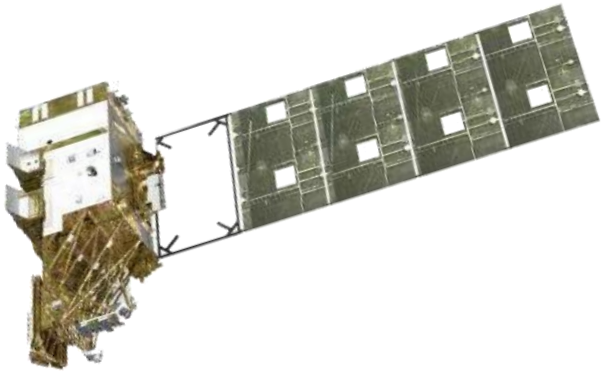
Orbit Type (equatorial crossing times)	Satellites currently in Orbit	Equatorial crossing Time(design specifications)	Lunch date	Status	Main Instrument
“morning” Orbit (07:00-12:00) (19:00-24:00)	FY-3C	10:00	23 Sept. 2013	Primary operation	VIRR(O), MERSI(S), IRAS(S), MWRI(S), MWTS-2(S), MWHS-2(O),TOU(O), SIM(S), ERM(O), GNOS(O),SEM(S)
“afternoon” Orbit (12:00-17:00) (00:00-05:00)	FY-3D	14:00	15 Nov. 2017	Primary operation	MERSI-II(O), HIRAS(O),MWTS-II(O), MWHS-II(O), MWRI(O), GAS(O),GNOS(O), WAI(O), IPM(O), SEM(O)
“early morning” Orbit (05:00-07:00) (17:00-19:00)	FY-3E	05:30	5 Jul. 2021	Primary operation	MERSI, MWTS, MWHS, GNOS, WindRad, HIRAS, SIM, SSIM, SEM, IPM, XEUVI
Low inclination satellite	FY-3G		16 Apr. 2023	Pre-operational	MERSI, MWRI, GNOS, PMR

(O) means the instruments working operationally
(S) Means the instruments are suspended

Main mission:

- operational meteorology.
- Substantial contribution to ocean and ice monitoring, climate monitoring.
- Significant contribution to atmospheric chemistry and space weather.

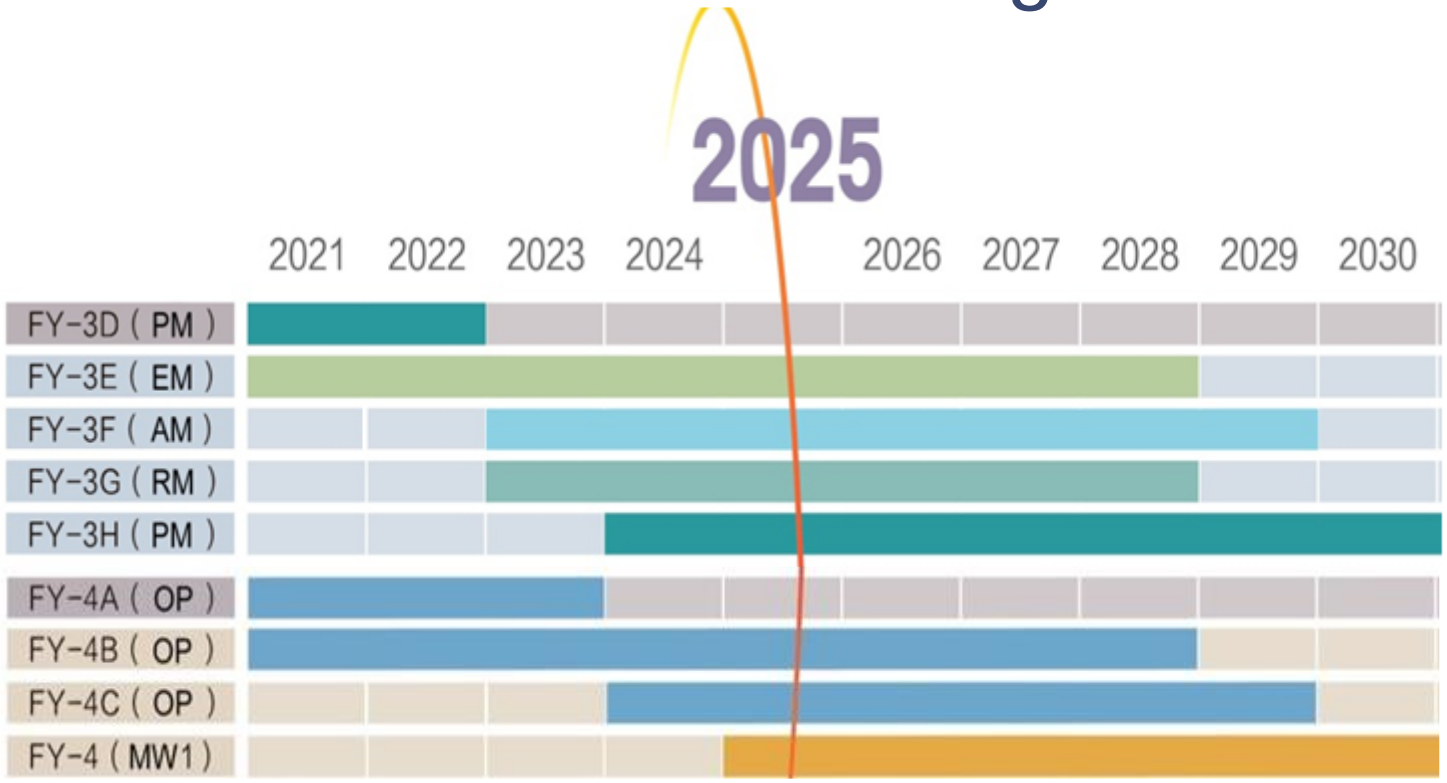
FY-3E status



- Launched on July 5th,2021, local Equator Crossing Time: 5:40 desc.
- First operational meteorological satellite in EM orbit for civil use.
- Satellite data is available on NSMC website for trial application since June 1, 2022.
- FY-3E provides an optimal temporal distribution with the mid-morning and afternoon satellites. NWP communities will significantly benefit.
- 46 baseline products(L2) have been developed.

NO.	Instruments	Status
1	WindRad (Wind radar)	**new**
2	SSIM (Solar Spectral Irradiance Monitor)	**new**
3	XEUVI (Solar X-ray and Extreme Ultraviolet Imager)	**new**
4	MERSI-LL (medium resolution spectral imager),	**improved**
5	MWTS-III (Micro-Wave Temperature Sounder),	**improved**
6	HIRAS-II (hyper-spectral infrared atmospheric sounder),	**improved**
7	GNOS-II (GNSS Occultation Sounder)	**improved**
8	SIM-II (Solar Irradiance Monitor),	**improved**
9	SEM (Space Environment Monitor),	**improved**
10	Tri-IPM (Triple-angle Ionospheric PhotoMeter)	**improved**
11	MWHS-II (Micro-Wave Humidity Sounder),,,	inherited

FENGYUN Satellites Programs



- 2 FY-3 polar-orbiting satellites to be launched, which will be arranged by the layout of three solar synchronous polar-orbiting satellites in early-morning, mid-morning and afternoon, and one precipitation measurement satellite in inclination orbit by 2025.
- 1 FY-4 GEO optical satellites to be launched.
- 1 FY-4 GEO microwave satellite to be launched.

Future FENGYUN Satellites

Future additional satellite	Scheduled launch	Planned Location	Instruments
FY-3F	2023	“morning” Orbit	MERSI-III, MWTS-III, MWHS-II, MWRI-II, HIRAS-II, OMS-N, OMS-L, ERM-II, SIM-II, GNOS-II
FY-3H	2024	“afternoon” Orbit	MERSI-III, MWTS-III, MWHS-II, MWRI-II, HIRAS-II, IPM, GAS, WAI-II, GNOS-II
FY-4C	2024	TBD	AGRI,GIIRS,LMI, SEP,MUSI,SUVI
FY-4(MW1)	2024	TBD	TBD

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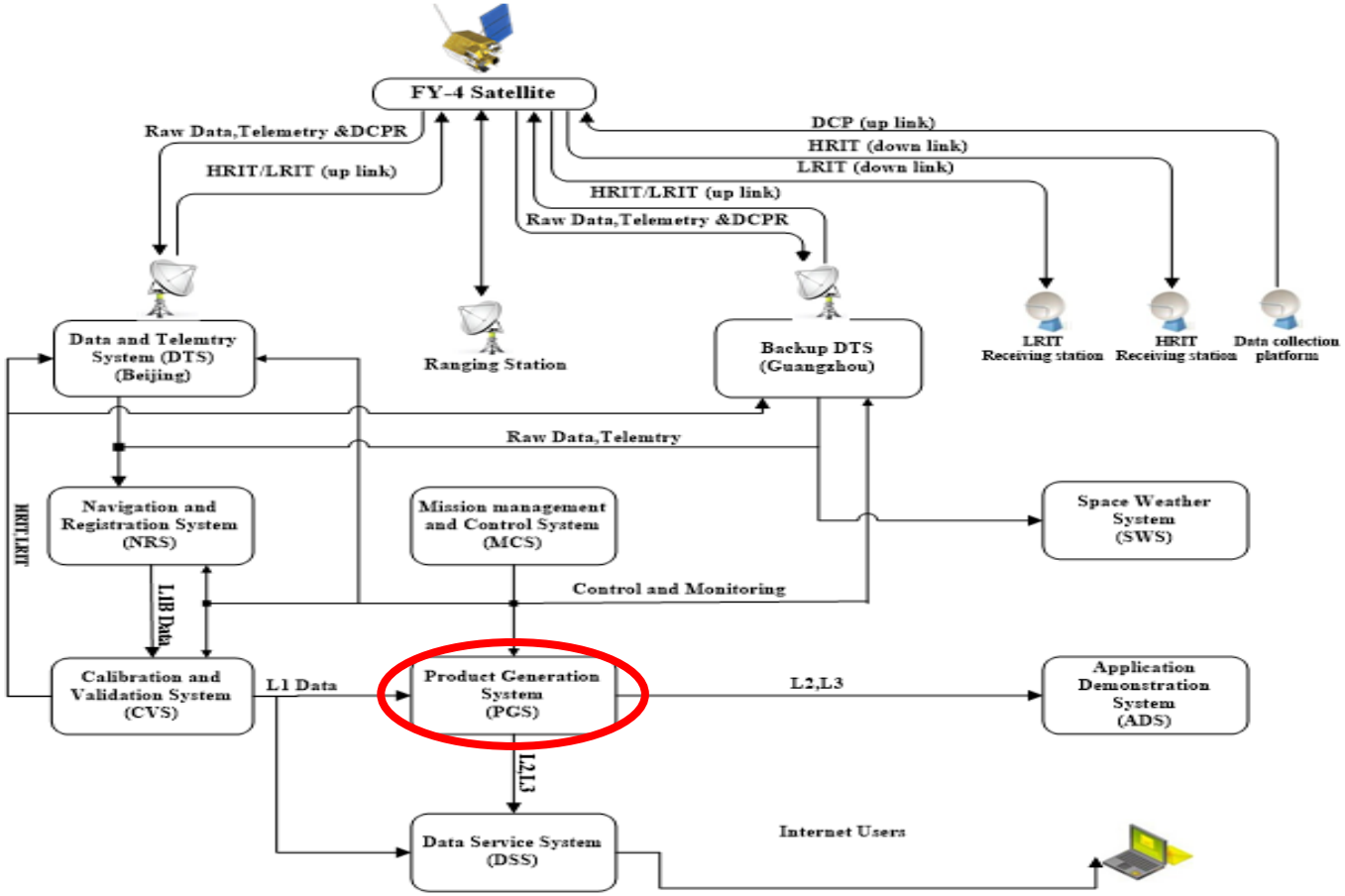
Operational AMV Systems

- Legacy FY-2 and FY-4 AMV System
  - Continue to generate FY-2G, FY-2H, FY-4A and FY-4B AMV products
  - Heritage Winds algorithm

FY-4 AMV System

- FY-4 AMV System is a subsystem of PGS



Current status of FY-2&FY-4 winds

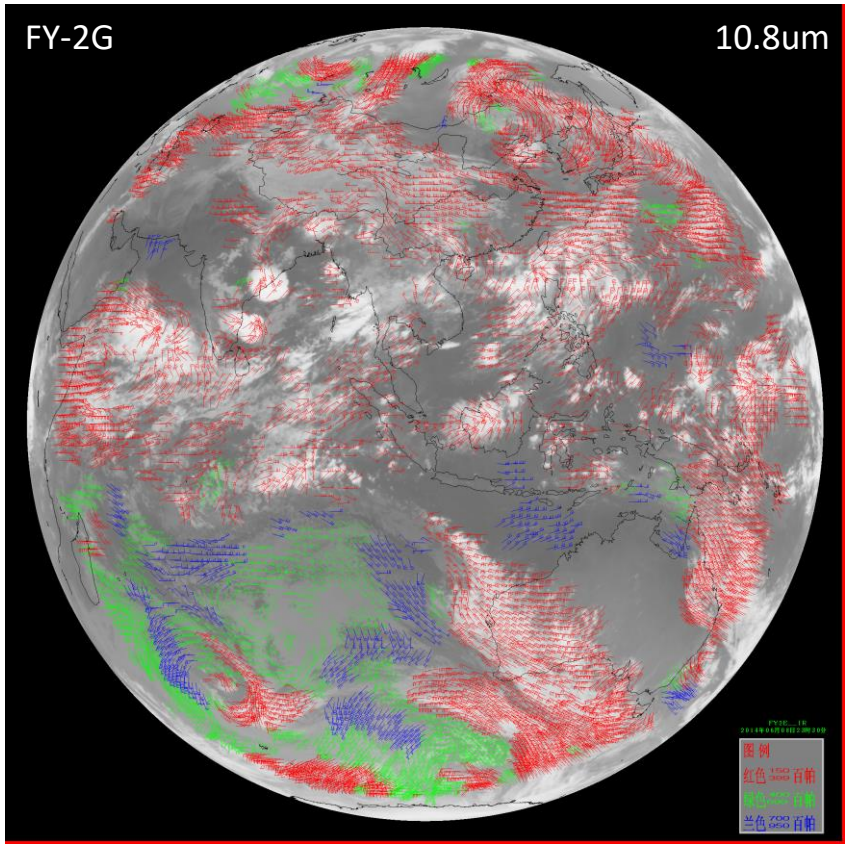
Satellite	AMV Products	Frequency	Image Sectors	Image Interval (min)	Format
FY-2G	Infrared (10. 8um)	6 hours	FULL DISK	30	Native & BUFR
	Water Vapor (6.7um)	6 hours	FULL DISK	30	Native & BUFR
FY-2H	Infrared (10. 8um)	6 hours	FULL DISK	30	Native
	Water Vapor (6.7um)	6 hours	FULL DISK	30	Native
	Infrared (10. 8um)	30 minutes	NORTHERN DISK	30	Native
	Water Vapor (6.7um)	30 minutes	NORTHERN DISK	30	Native
FY-4A	Infrared (10. 8um)	3 hours	FULL DISK	15	NETCDF4
	Water Vapor (6.25um)	3 hours	FULL DISK	15	NETCDF4
	Water Vapor (7.10um)	3 hours	FULL DISK	15	NETCDF4
FY-4B	Infrared (10. 8um)	15 minutes	FULL DISK	15	NETCDF4
	Water Vapor (6.25um)	15 minutes	FULL DISK	15	NETCDF4
	Water Vapor (6.95um)	15 minutes	FULL DISK	15	NETCDF4
	Water Vapor (7.42um)	15 minutes	FULL DISK	15	NETCDF4

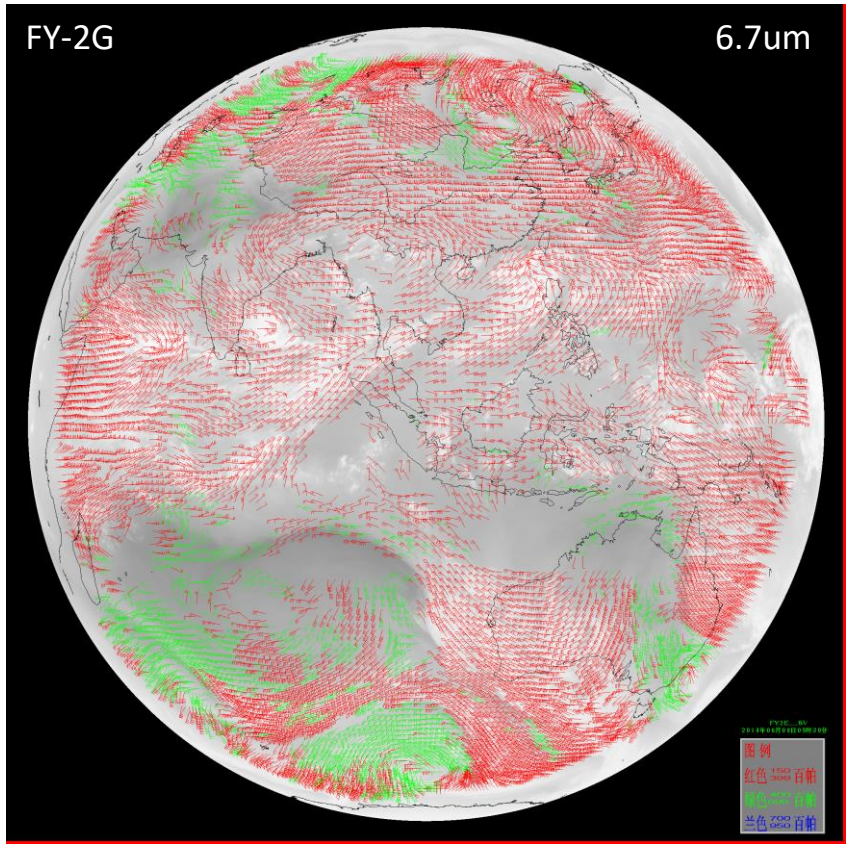
Enhancements:

- FY-4B AMV 15-minute in FULL DISK

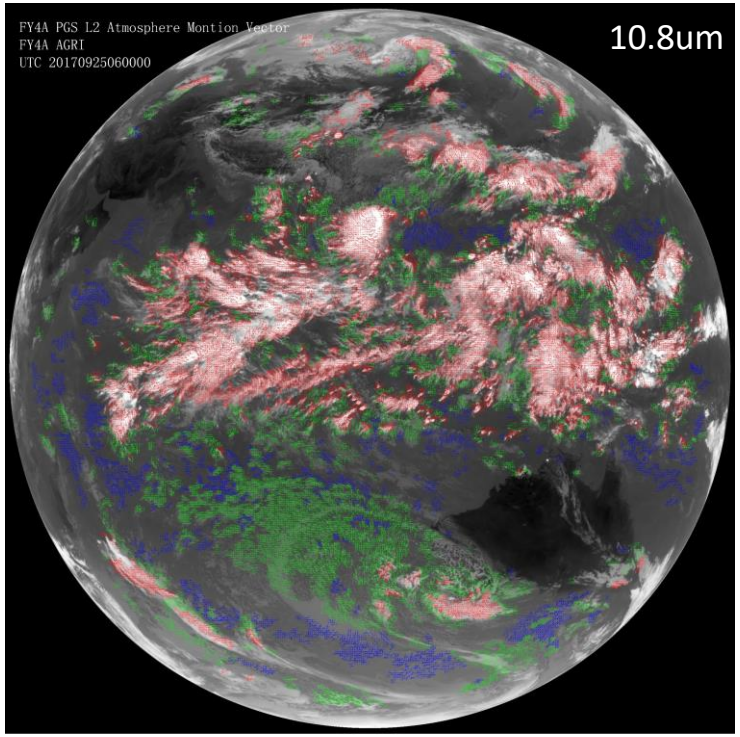
FY2 AMV products in operation

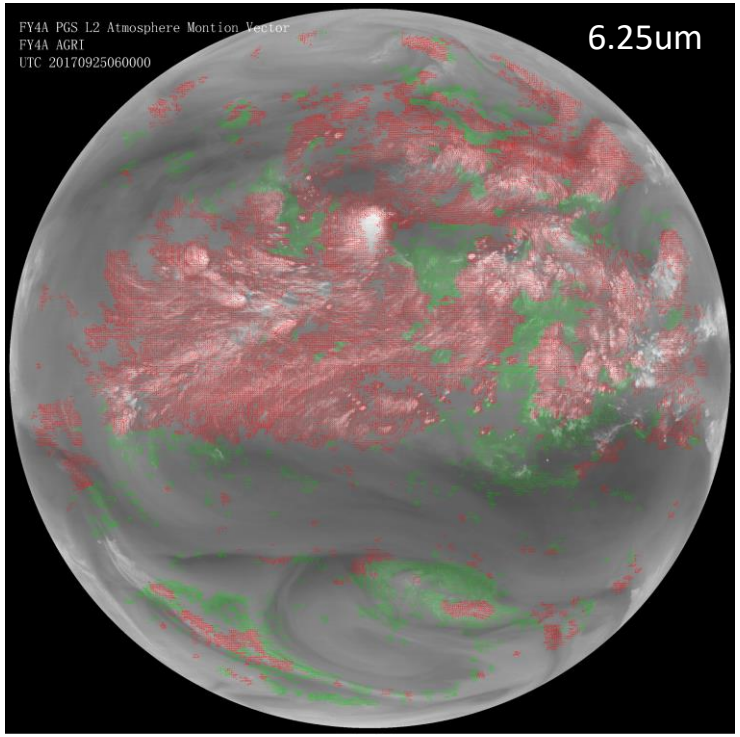
- FY-2G, FY2H Winds

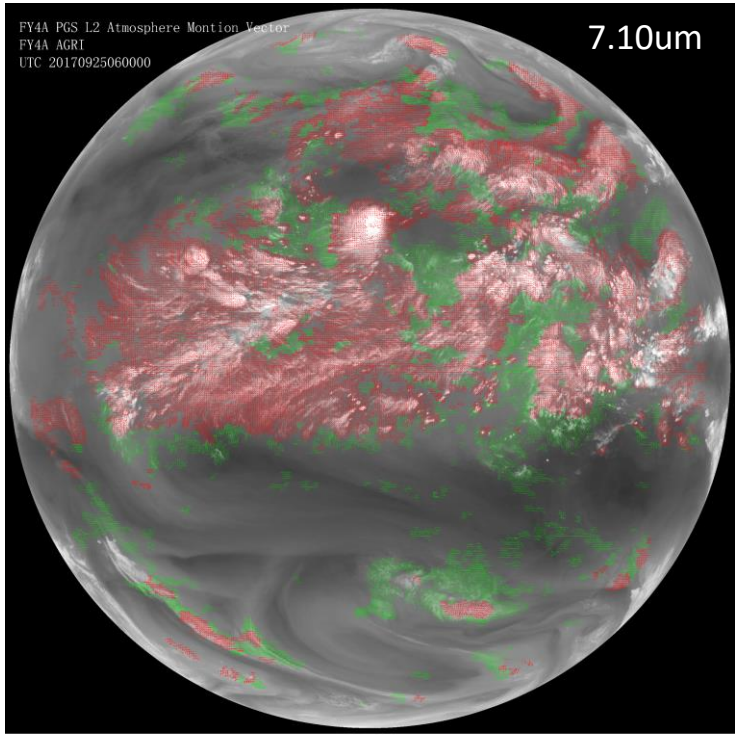




FY-4A AMV products in operation

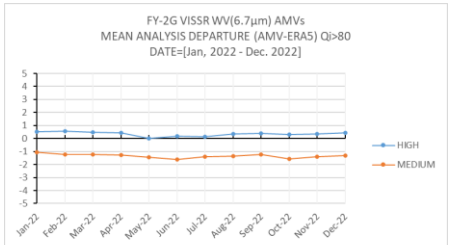


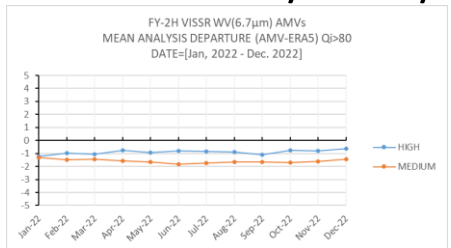


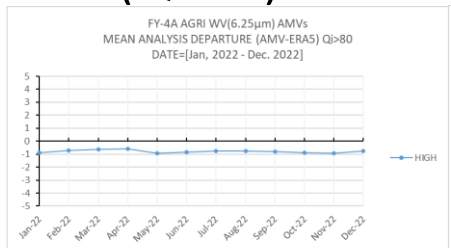


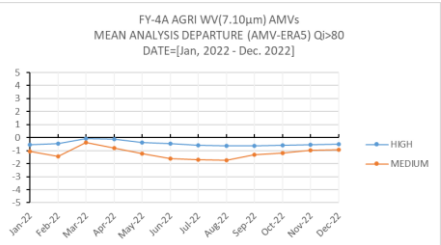
Quality Monitoring (2022)

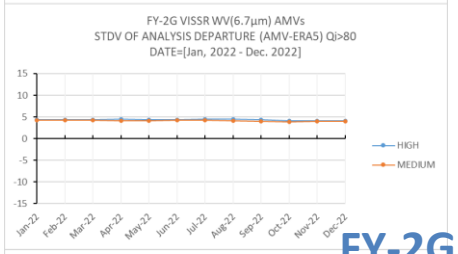
monthly statistics for speed from AMV departure (AMV-ERA5)
FY2G /FY2H/FY4A AMV (QI>80)



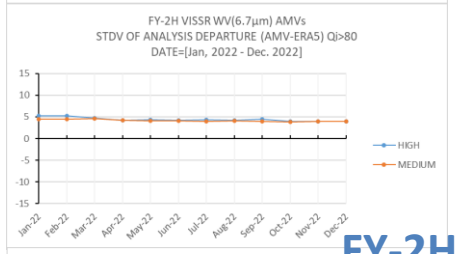




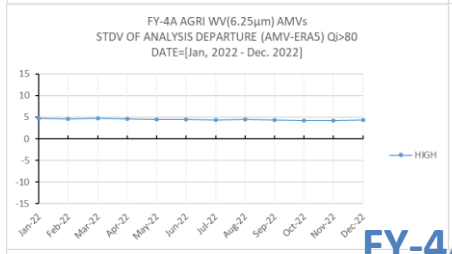


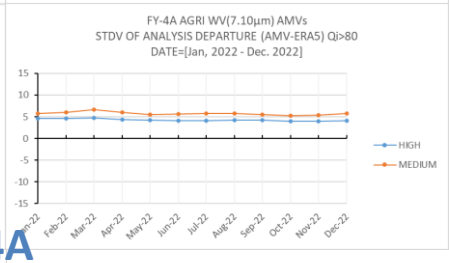


FY-2G

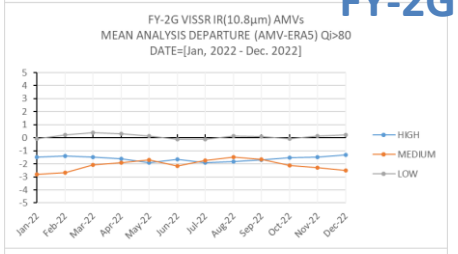


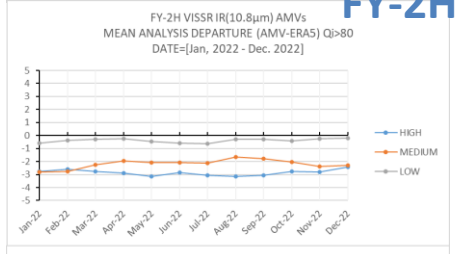
FY-2H

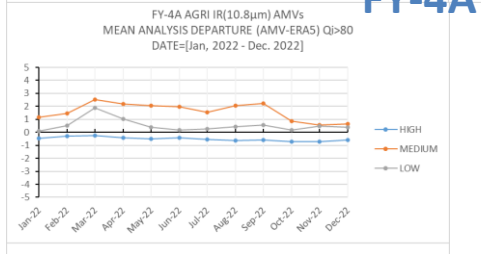


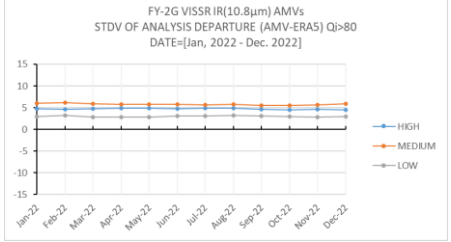


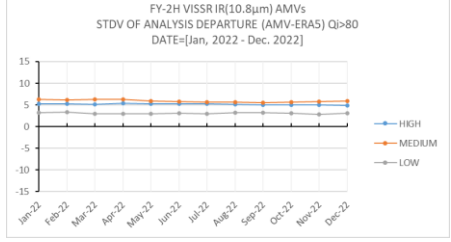
FY-4A

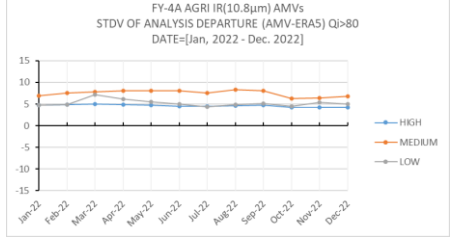












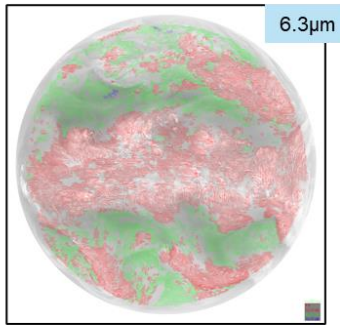
- The quality of AMVs from FY2G/FY2H is relatively stable
- The quality of AMVs from FY4A has some fluctuations.

FY-4B AMVs

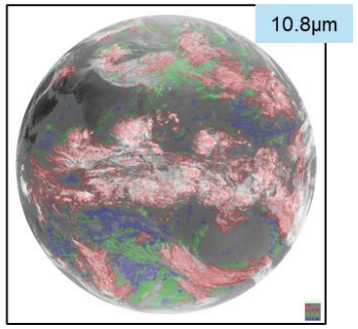
FY-2G AMVs 4/day

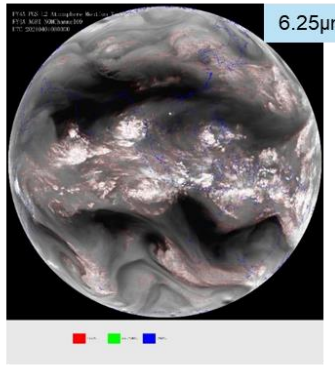
FY-4A AMVs 8/day

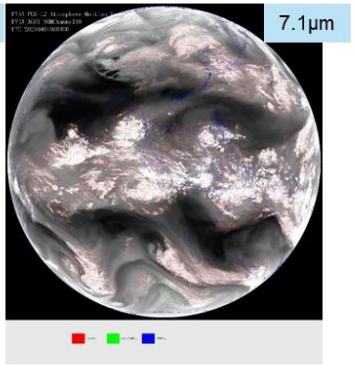
FY-4B AMVs 96/day

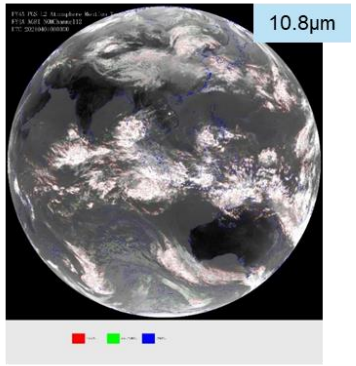


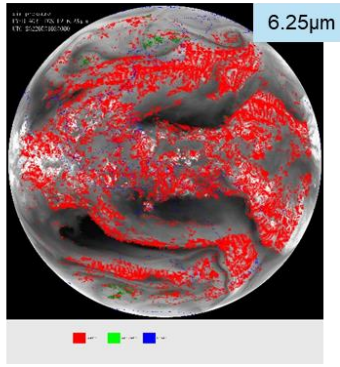
Temporal resolution increased !
More channel AMVs !

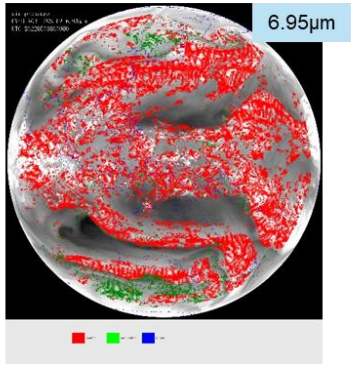


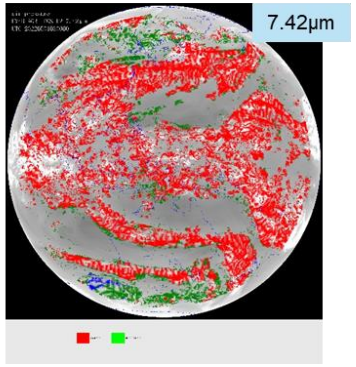


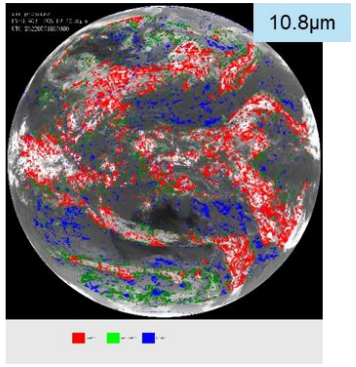






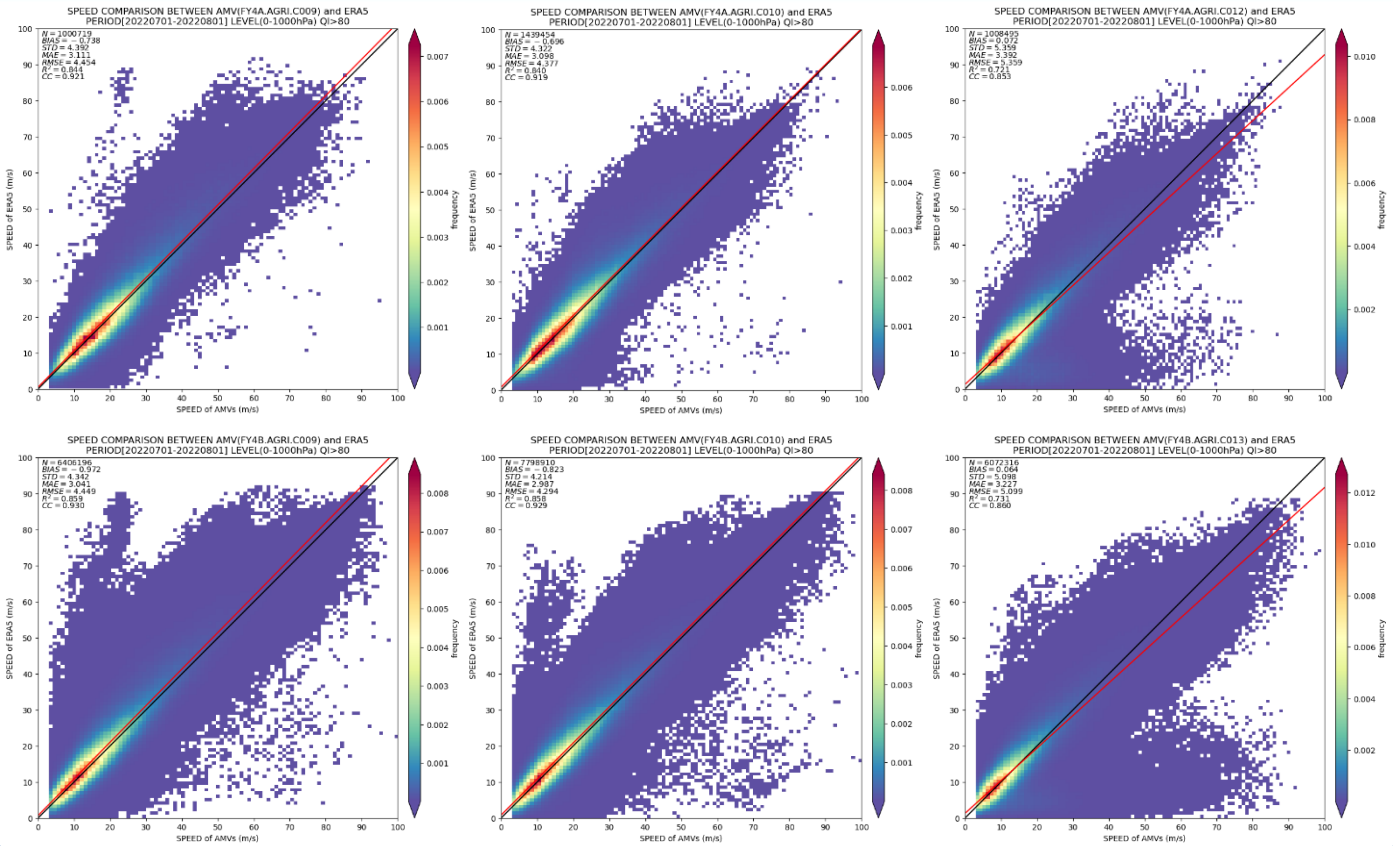






The FY-4B has 3 water vapor channel products with increased time resolution to 15 minutes

FY-4B AMVs



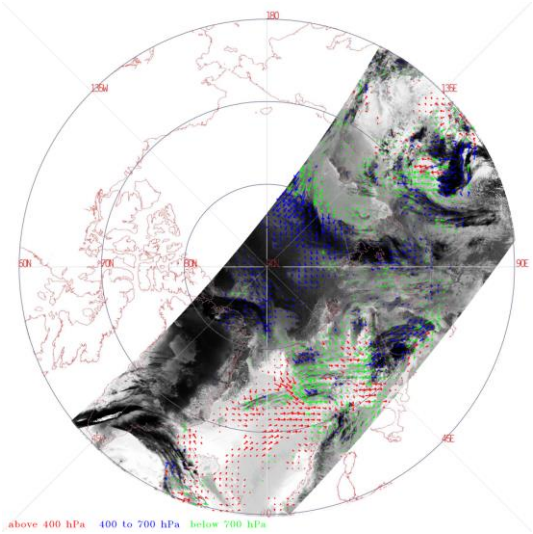
Comparing the AMV products of the three corresponding channels of FY-4A and FY-4B operations in July 2022 with ERA5 wind speed, the analysis results show that: FY-4B AMVs have better quality than FY-4A.

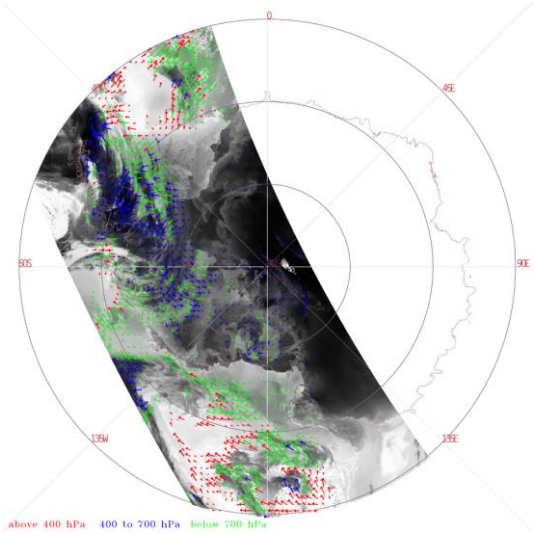
Comparison of AMV speed with ERA5 wind speed（0-1000hPa, QI>80）

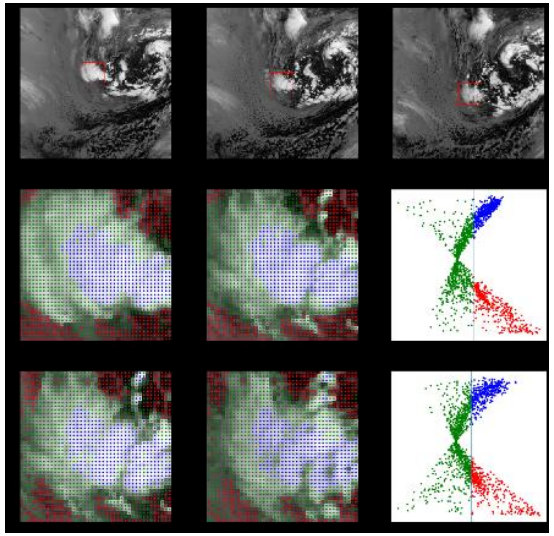
	WV(6.25μm)			WV(6.95μm)			IR(10.8μm)		
	N	MAE	RMSE	N	MAE	RMSE	N	MAE	RMSE
FY-4A	1000719	3.11	4.45	2163977	3.30	4.76	1008495	3.39	5.36
FY-4B	6406196	3.04	4.45	7798910	2.99	4.29	6072316	3.23	5.10

FY-3E AMVs

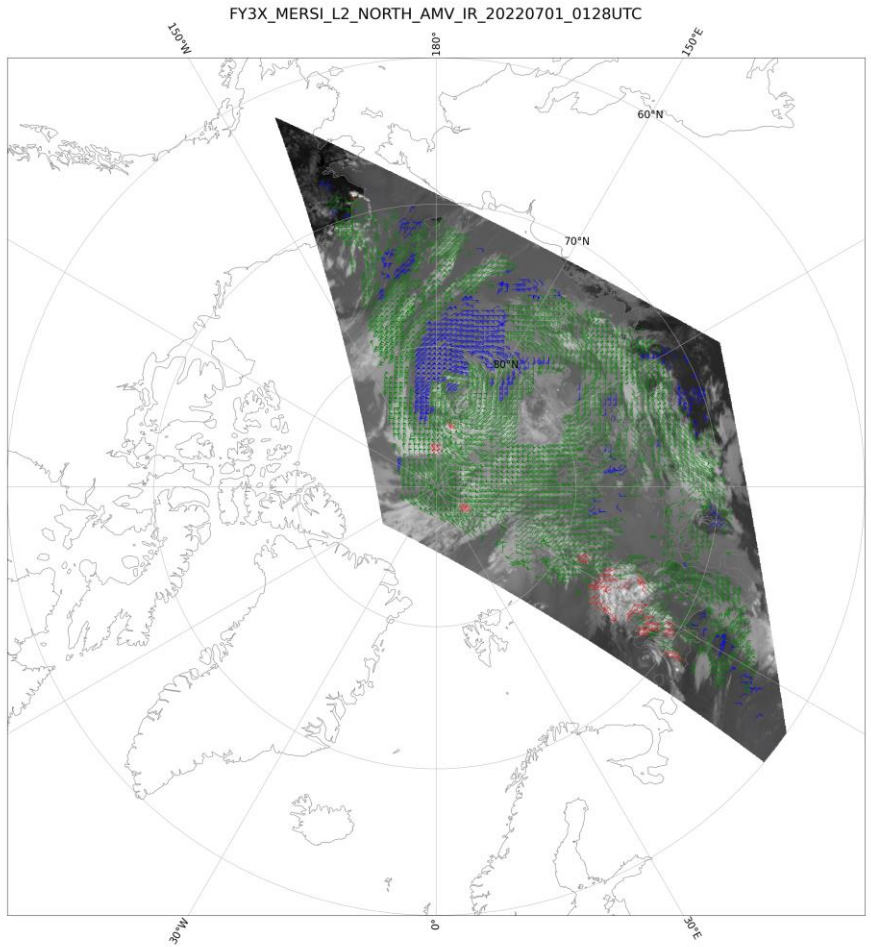
- FY-3E AMVs uses the infrared (10.8μm) and water vapor (7.2μm) channel data of the Medium Resolution Spectral Imager-2 (MERSI-II) instrument of FY-3E and uses cross correlation method for tracking and CCC method in height assignment.
- FY-3E polar wind products are in trial operation and are expected to be operation in this year.







FY-3E AMVs



This is an animation of an FY-3E north polar AMV product, and from the animation, you can clearly see the movement of the Arctic polar vortex.

The quality of FY-3E AMVs

Quality analysis was conducted using ERA5 as the verification source for the FY-3E AMVs from July 1 to July 15, 2022. The results are shown in the table below.

Quality of north polar area FY-3E IR AMV

	LEVEL	N	BIAS (m/s)	STD (m/s)	MAE (m/s)	RMSE (m/s)
QI=ALL	ALL	260189	1.23	6.80	5.29	6.91
	<400hPa	22601	1.43	9.43	7.81	9.53
	400-700hPa	194714	1.34	6.69	5.26	6.83
	>700hPa	42874	0.62	5.48	4.07	5.52
QI>60	ALL	**83760**	**-0.60**	**3.86**	**3.01**	**3.91**
	<400hPa	**5645**	**-0.23**	**6.63**	**5.27**	**6.63**
	400-700hPa	**64479**	**-0.56**	**3.71**	**2.95**	**3.75**
	>700hPa	**13636**	**-0.98**	**2.82**	**2.34**	**2.99**

Quality of south polar area FY-3E IR AMV

	LEVEL	N	BIAS (m/s)	STD (m/s)	MAE (m/s)	RMSE (m/s)
QI=ALL	ALL	334148	-1.23	7.82	6.14	7.92
	<400hPa	140725	-2.65	8.36	6.89	8.77
	400-700hPa	165059	-0.21	7.34	5.69	7.35
	>700hPa	28364	-0.11	6.56	5.04	6.56
QI>60	ALL	**67613**	**-0.73**	**4.95**	**3.83**	**5.00**
	<400hPa	**24533**	**-0.92**	**5.70**	**4.39**	**5.77**
	400-700hPa	**35043**	**-0.56**	**4.61**	**3.61**	**4.64**
	>700hPa	**8037**	**-0.86**	**3.78**	**3.10**	**3.87**

Quality of north polar area FY-3E WV AMV

	LEVEL	N	BIAS (m/s)	STD (m/s)	MAE (m/s)	RMSE (m/s)
QI=ALL	ALL	221132	0.92	8.13	6.44	8.18
	<400hPa	86446	0.91	8.77	7.09	8.82
	400-700hPa	134686	0.93	7.69	6.03	7.74
QI>60	ALL	**62696**	**-0.76**	**4.73**	**3.68**	**4.79**
	<400hPa	**23162**	**-1.11**	**5.70**	**4.51**	**5.80**
	400-700hPa	**39534**	**-0.56**	**4.05**	**3.19**	**4.09**

Quality of south polar area FY-3E WV AMV

	LEVEL	N	BIAS (m/s)	STD (m/s)	MAE (m/s)	RMSE (m/s)
QI=ALL	全层次	331486	-0.34	8.19	6.42	8.20
	<400hPa	139645	-1.39	8.73	7.02	8.84
	400-700hPa	190675	0.44	7.67	5.98	7.68
QI>60	ALL	**63239**	**-0.44**	**5.18**	**3.97**	**5.20**
	<400hPa	**27207**	**-0.32**	**5.93**	**4.55**	**5.94**
	400-700hPa	**35847**	**-0.54**	**4.53**	**3.53**	**4.56**

Contents

- Status of FENGYUN Satellites
- Operational AMV System and Products
- Satellite Product Distribution and Access
- Future work

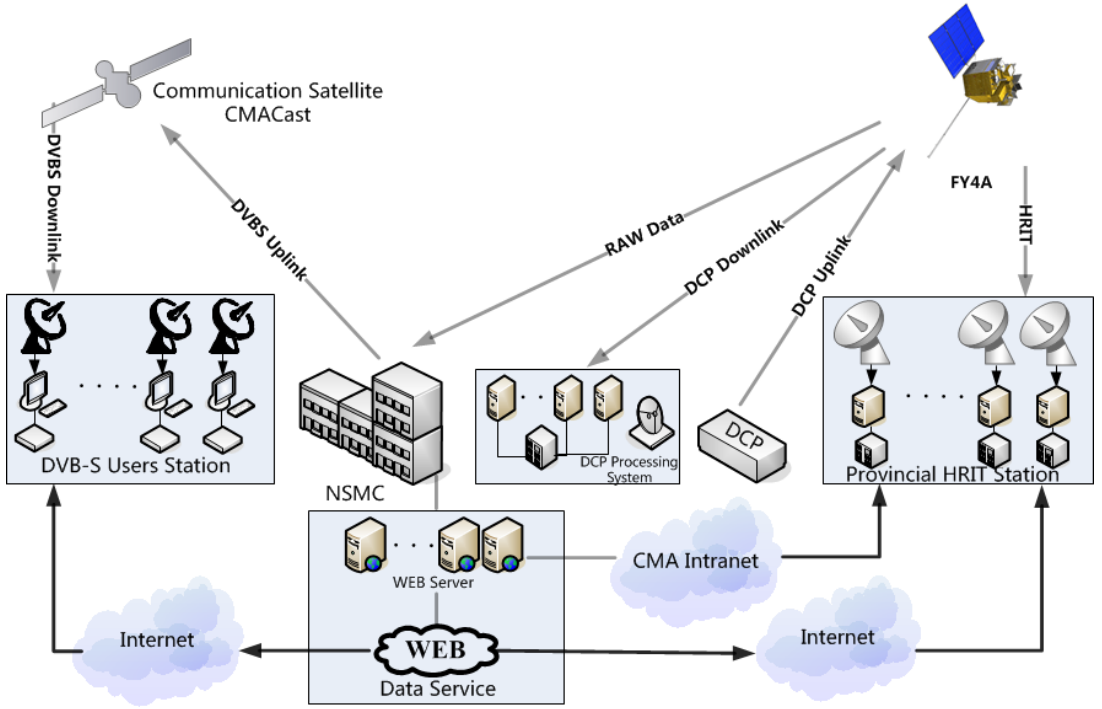
AMV Products Distribution

- FY-2G, FY-2H, FY-4A and FY-4B AMV products are in operation and distributed via FTP server or network share disk for intranet users and via CMACast or website for international users.
- FY-2G AMV products are also distributed via GTS.

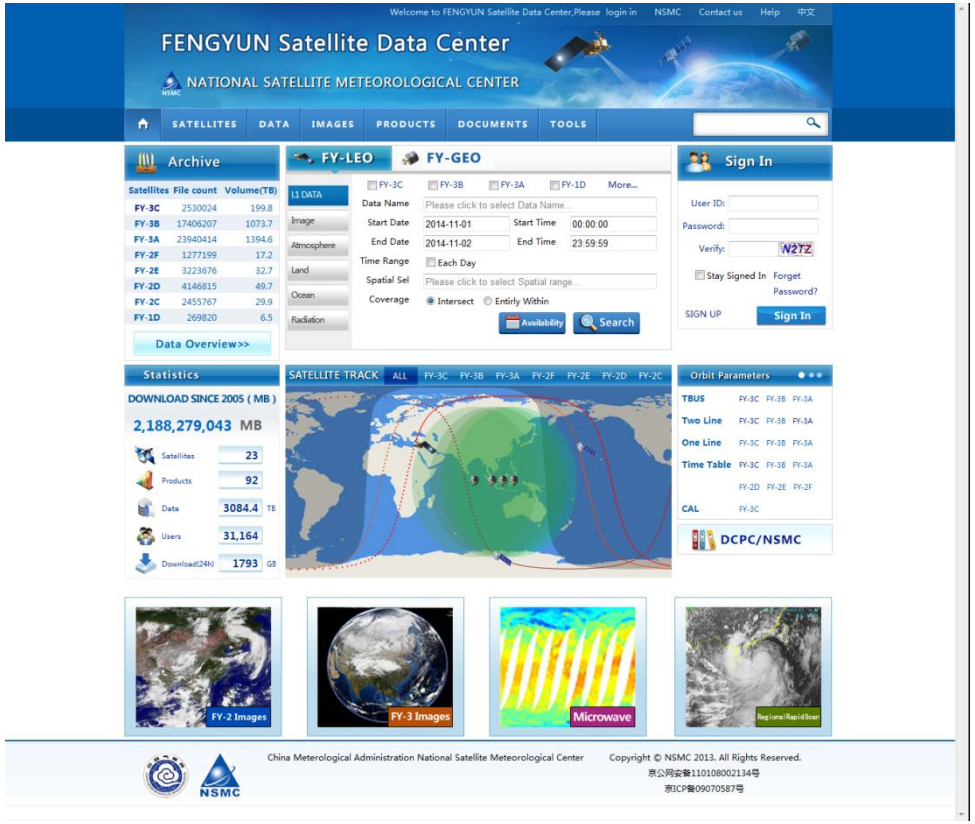
Data Service

- Integrated Space/Ground Based Data Service System

  - ❖ Real time Data:
    - DB (L1)
    - CMACast (L2)
  - ❖ Non Real Time
    - Website
    - Manual Service
  - ❖ In addition:
    - Cloud Service



Data Service Web Portal



http://satellite.nsmc.org.cn

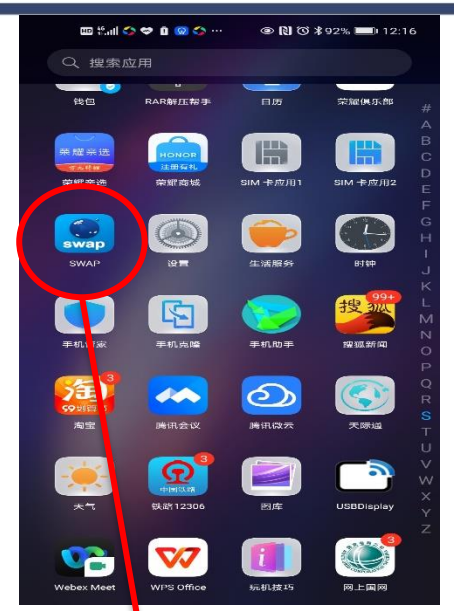
- All 8PB archived data (real time)
- Satellites' information
- Satellite images browse
- Documents and tools

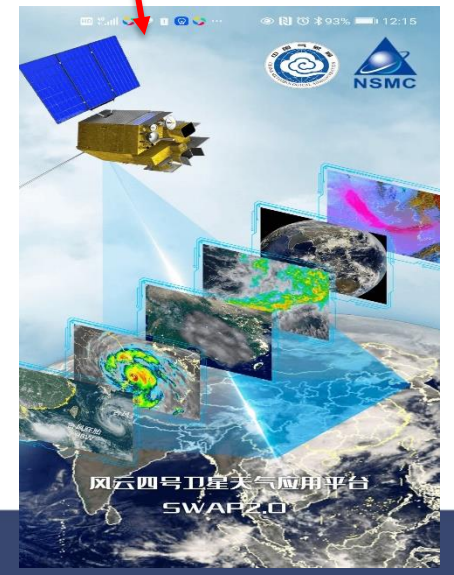
User： freely register, update need authorize

- ❖ Normal: 500MB/day
- ❖ Junior: 3GB/day
- ❖ Senior: 10GB/day

Progress in satellite application

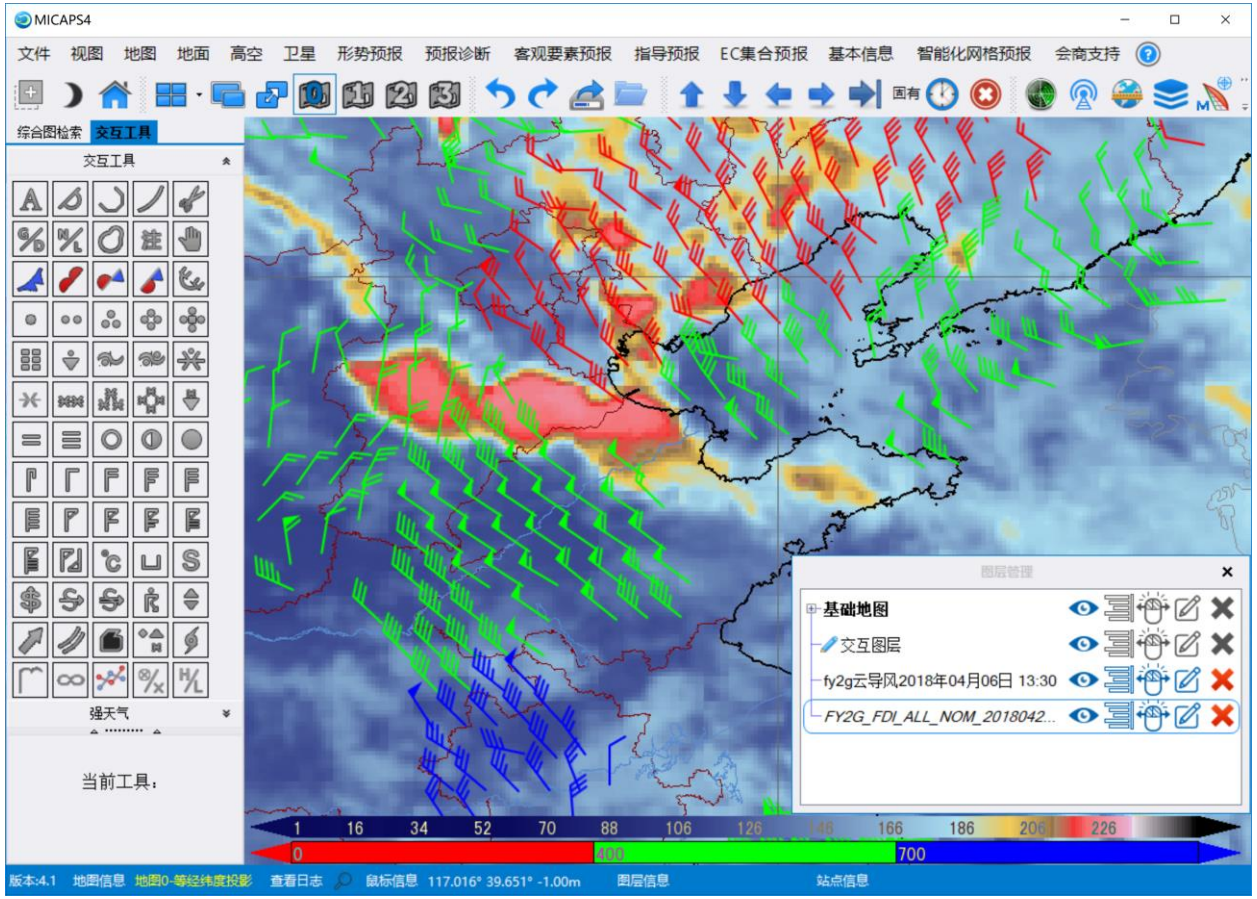
At the same time, in order to facilitate users to obtain and use satellite data, CMA also developed many application systems or mobile phone applets, some of which are available in multiple languages for international users.





Day to Day Uses of AMV at MICAPS

MICAPS (Meteorology Information Comprehensive Analysis Process System)



- MICAPS gives the field forecasters access to a multitude of digital data to help them in daily forecast preparation
- MICAPS display software allows for easy integration of AMVs with a multitude of other data sources like model analyses/forecasts, observations from other observation systems

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Future work

- To improve AMV products quality
  - Especially in the middle and low level AMVs from FY-4A
- FY-3E polar winds
  - FY-3E polar wind products are expected to start operation in this year
- Development of BUFR codes for FY-2H, FY-4A, FY-4B and FY-3E AMV products

Thanks for your attention

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