CMA report on highlights and issues in FY-3E and FY4B dataset and products

**Presented to CGMS-50 Working Group II session, agenda item 2 [CGMS-50-CMA-WP-09]**

**Coordination Group for Meteorological Satellites**

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LEO : 3 orbits (EM, AM, PM)
GEO: 5 positions (79°E to 133°E)

FY-4B

- The second and also **the first operational satellite** of FY-4 series, launched on June 3, 2021, located at 133°E.
- Instruments performance and L1 data testing has been basically completed, and L2 products testing is in progress.
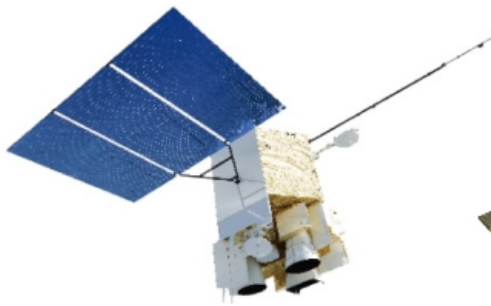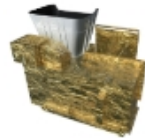
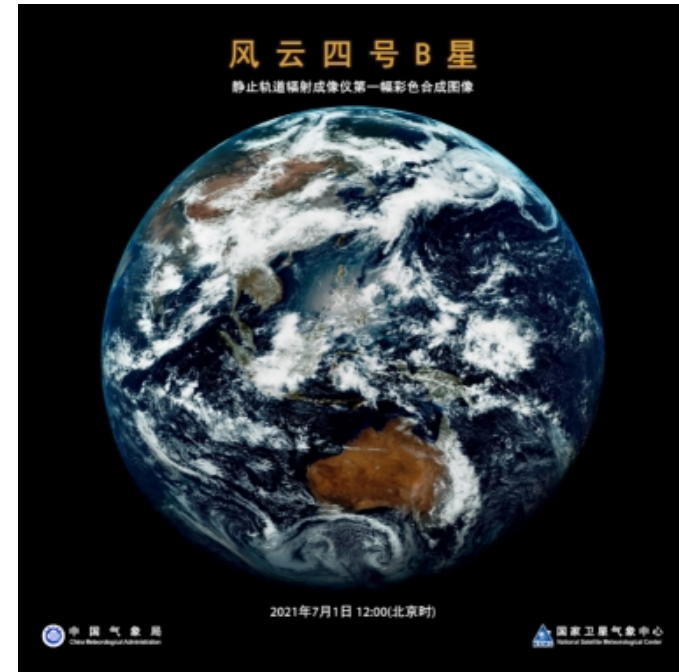Geostationary High-speed Imager (GHI)
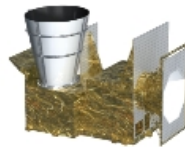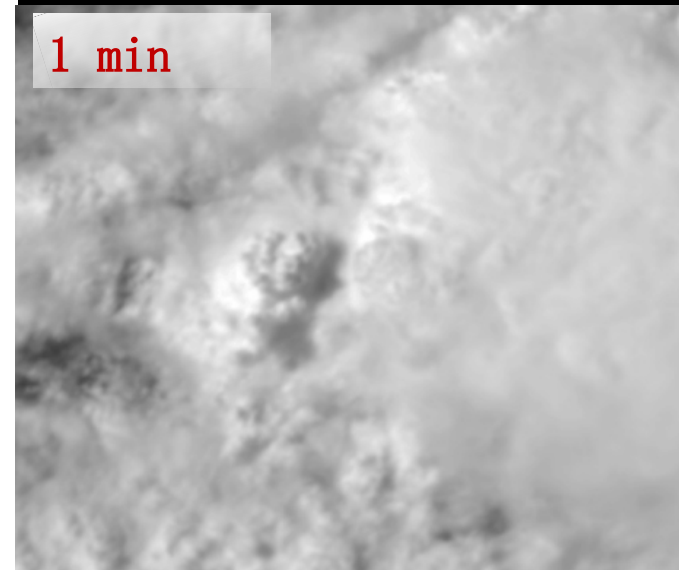
Geostationary Interferometric Infrared Sounder (GIIRS)

Advanced Geostationary Radiation Imager (AGRI)

Space Environment Monitoring Instrument Package (SEP)

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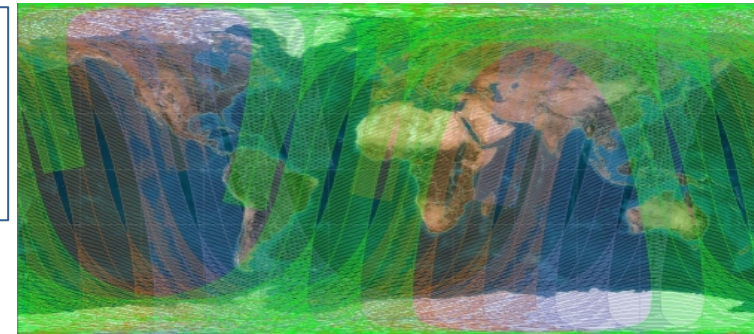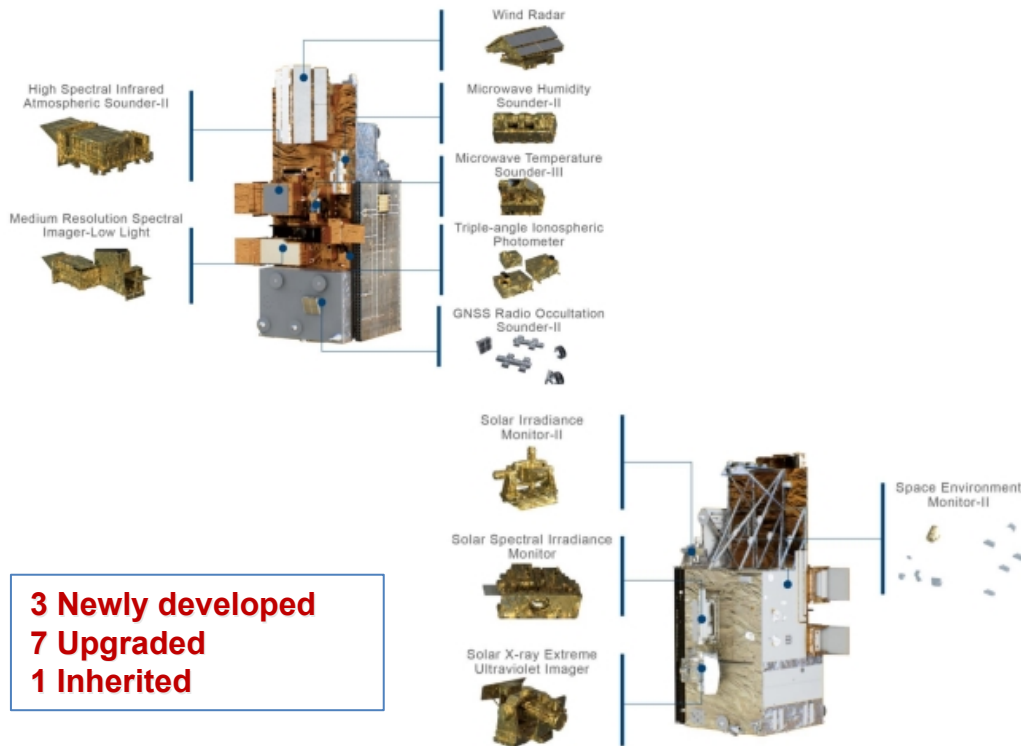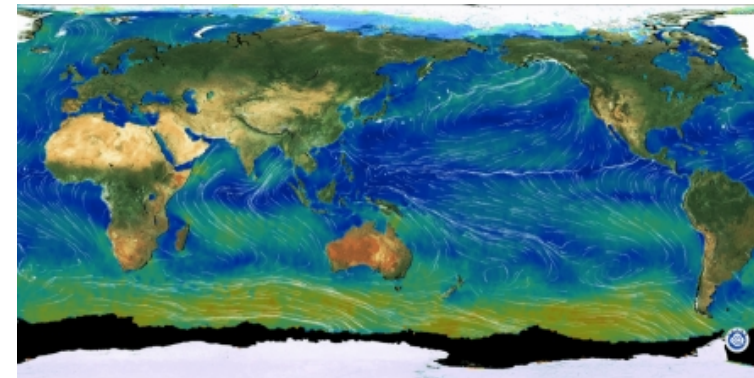

Geostationary High-speed Imager （GHI）

FY-3E

- The first civil meteorological satellite **in early morning orbit** , launched on July 5, 2021.
- Instruments performance and L1 data testing has been basically completed, and L2 products testing is in progress.

3 Newly developed
7 Upgraded
1 Inherited

FY-3 Early Morning 6:00 AM
Metop-A 9:30 AM
NPP 13:30 PM

FY-3E Monthly Mean Ocean Wind (September 2021)

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FY-3E/Wind Radar (WindRAD) instrument performence testing

- The first active remote sensing instrument of Fengyun series satellite of China.
- Detecting global sea surface wind vector, including wind speed and wind direction.
- dual-frequency: C & Ku band, both with VV & HH polarizations
- advanced rotating fan-beam
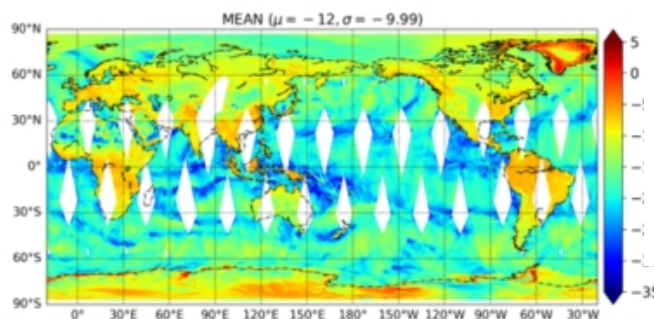
➤WindRAD has been turned on and conducted the global observation since July 9th, 2021.
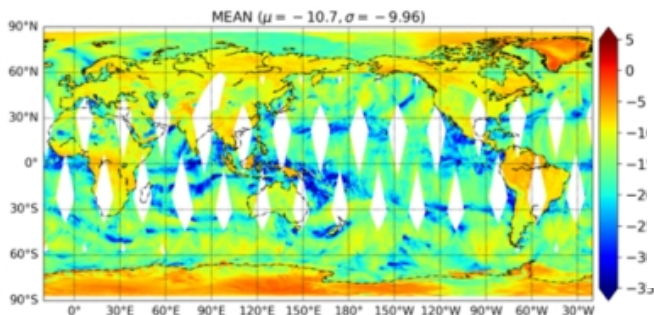
➤The status of instrument is quite stable.

➤Preliminary L1 data processing has been implemented and both of C band and Ku band data are waiting for further improvement.

Glabal backscattering coefficient of WindRAD

L1 data validation (SNO)
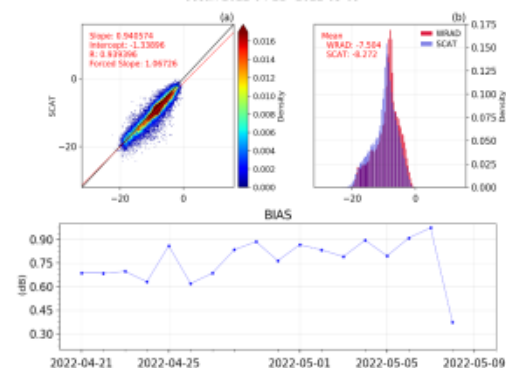
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NSMC CGMS
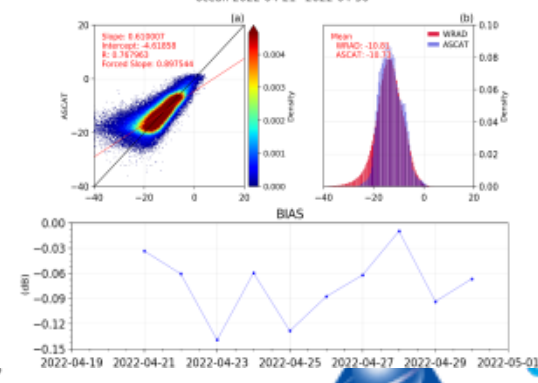
FY−3E/HIRAS−II instrument performance testing

- FY-3E/HIRAS-II is the world's first infrared hyperspectral sounder onboard the early-morning-orbit meteorological satellite for civil use.
- It measures the atmospheric upwelling infrared radiance over 650 to 2250 cm^{-1} with a spatial sampling of 14.76 km at Nadir, and a spectral sampling of 0.625 cm^{-1}.
- Preliminary performance is good
  - the NEdT@280 K is within the specification range of 0.2 K to 0.8K.
 - the spectral offsets are within 5 ppm
  - the bright temperature differences are in the level of 0.5 K ~ 1.0 K evaluated using double difference method with MetOp/IASI.


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NSMC **CGMS**
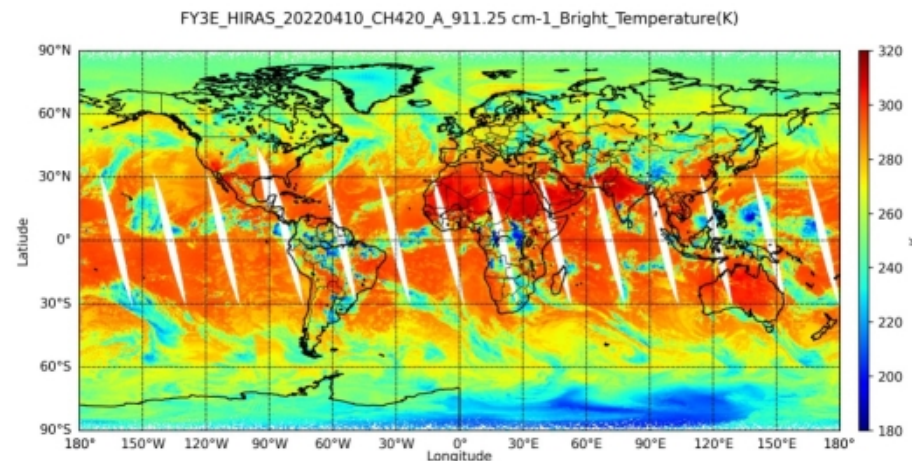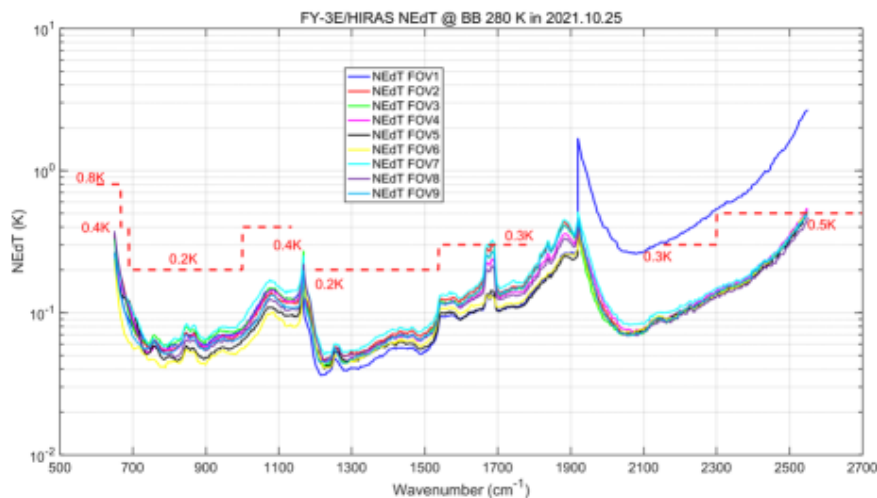
FY–4B/GIIRS instrument performence testing

- FY-4B/GIIRS is the second infrared GEO-sounder of China. This sounder is expected to be used for the NWP operational model.
- GIIRS uses two infrared detector arrays to cover the spectral bands of 680 to 1130 cm^{-1} (LWIR) and 1650 to 2250 cm^{-1} (MWIR) with a spectral sampling of 0.625 cm^{-1}. Its detector layout is 16 by 8, and a spatial sampling for a single pixel is 12 km at Nadir.
- Preliminary performance:
  - NEdR of the two bands are within the specification range of 0.1 to 0.5 $mW/(m^2 \cdot sr \cdot cm^{-1})$;
  - the spectral offsets are within 10 ppm;
  - the bright temperature differences are in the level of 1.0 K evaluated using SNO Technique with IASI.

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MC CGMS
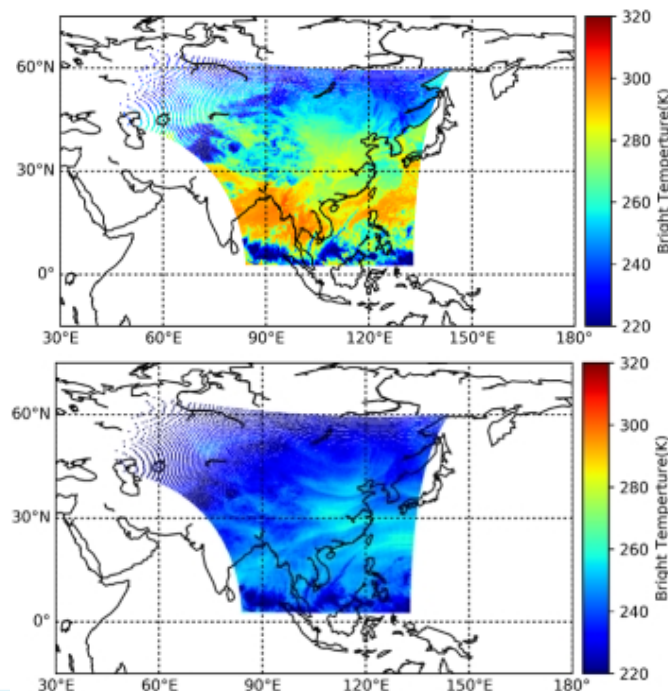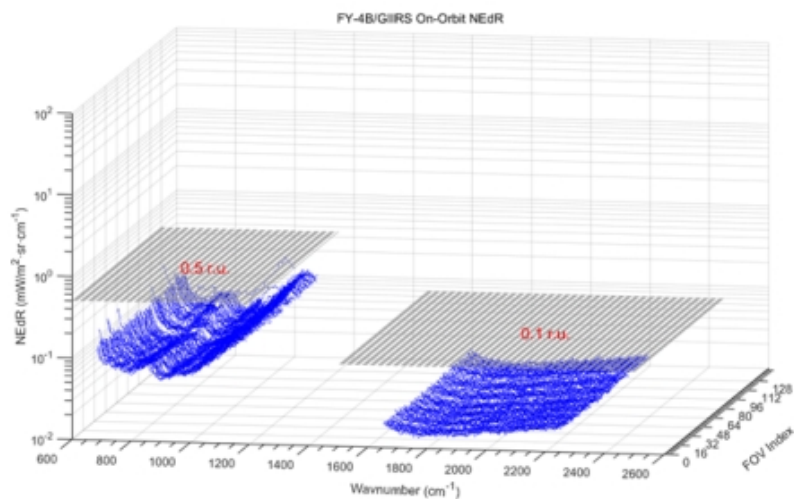
FY3E/WindRAD Ocean Vector Winds(OVWs) Product

- The ocean vector winds observed by space-borne scatterometers are the Stress-Equivalent(SE) wind at the height of 10 meters.
- Spatial resolution of **20km/C-band, 10km/Ku-band**.
- Wind speed retrieval accuracy of **1.43 m/s for C-band,** 1.36m/s for Ku-band after QC.Wind direction retrieval accuracy of 17.57 m/s for C-band, 18.91m/s for Ku-band after QC.
- Data latency of about 3 hours.
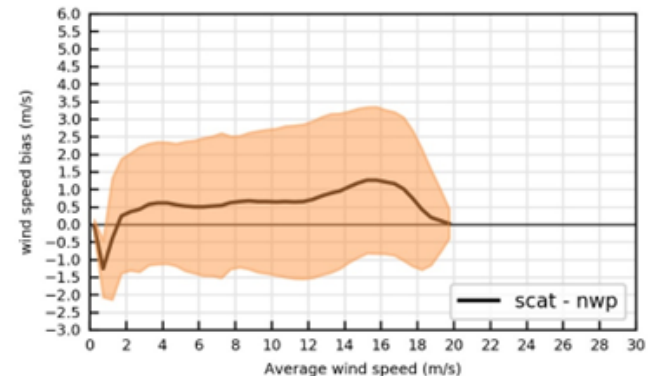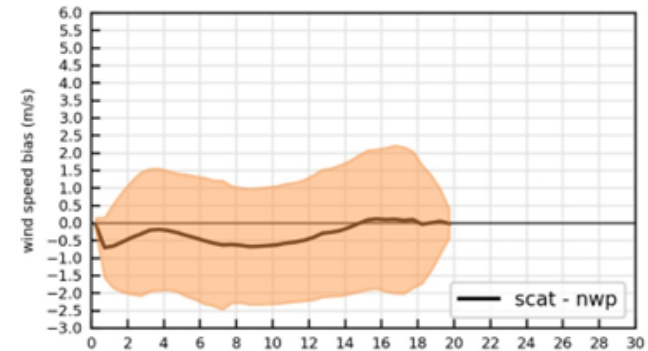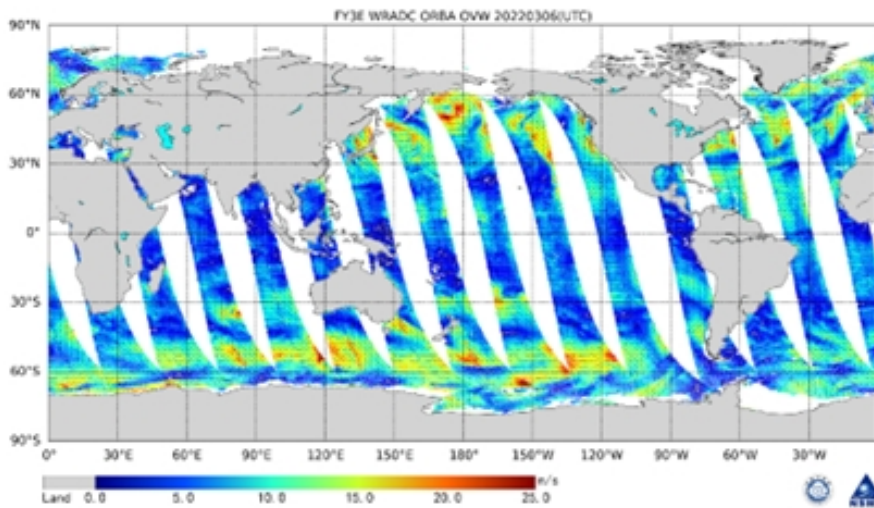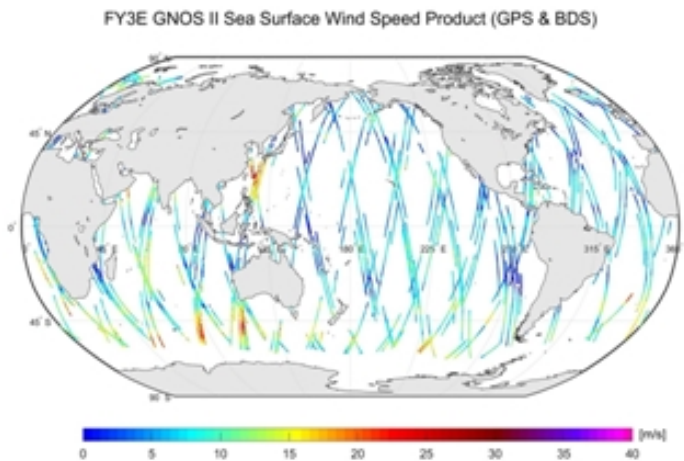
FY3E/WnidRAD Sea ice edge and type product

- ✓ **Sea ice edge product:** Classification product that distinguish between open water, open sea ice (30%-70% sea ice concentration), and closed sea ice (>70% sea ice concentration)
- ✓ **Sea ice type product:** Classification product that distinguish between first-year ice and multi-year ice
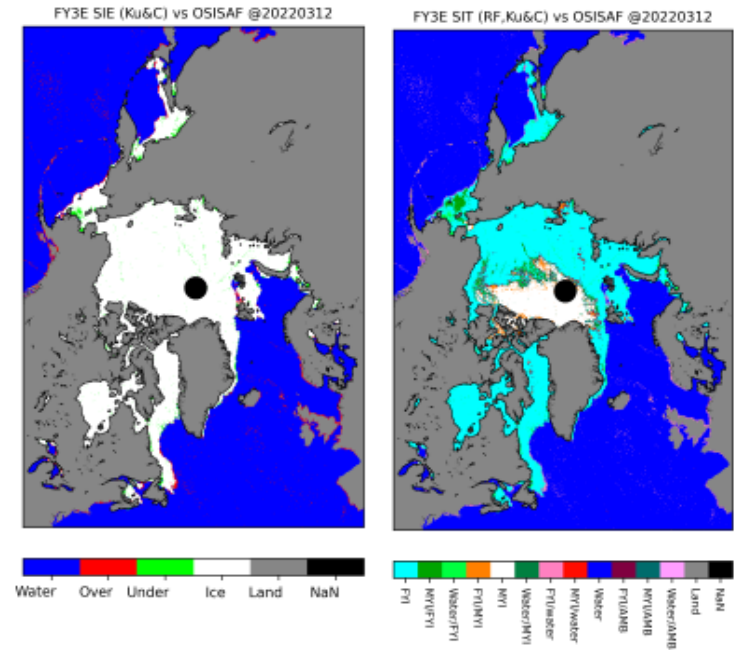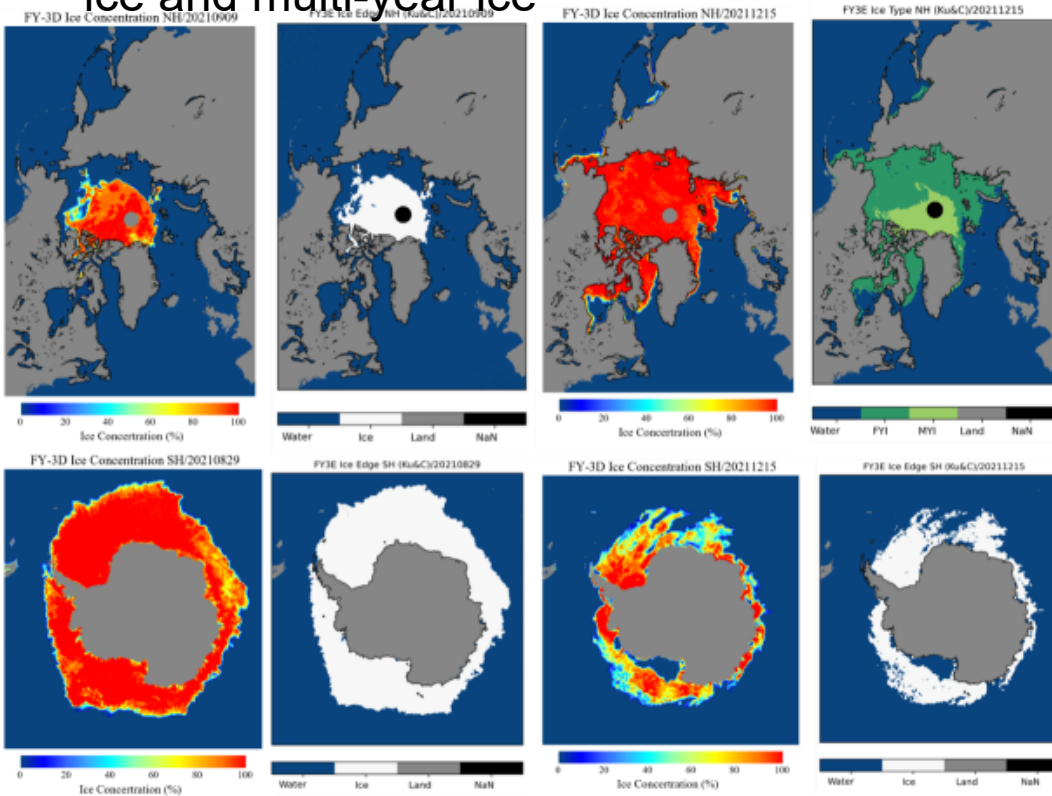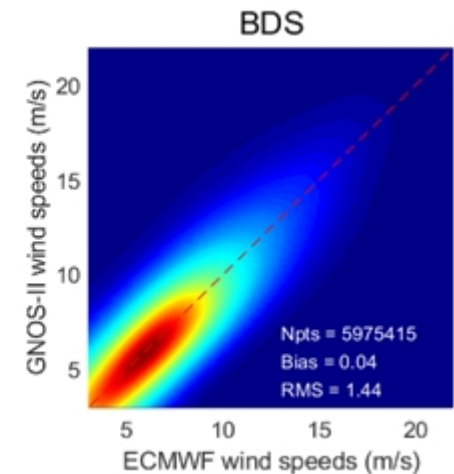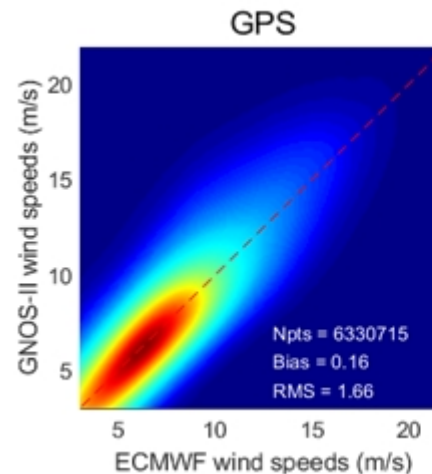

products spatial distribution comparison with OSI

FY3E/GNOS-II Reflectometry product- Sea Surface Wind Speed (SWS)

- GNOS-II's SWS data are retrieved from reflected GNSS signals (GPS and Beidou) from the ocean surface.
- Can provide global SWS of at most **8 specular points** simultaneously with 1 Hz sampling frequency.
- Spatial resolution **of 25 km,** wind retrieval accuracy of **about 1.5 m/s.**
- All-weather capability, not affected by rain attenuation.
- Data latency of about 3 hours.

FY3E GNOS II Sea Surface Wind Speed Product (GPS & BDS)

SWS product of one day

GPS

GNOS-II wind speeds (m/s)

ECMWF wind speeds (m/s)

Npts = 6330715
Bias = 0.16
RMS = 1.66

BDS

GNOS-II wind speeds (m/s)

ECMWF wind speeds (m/s)

Npts = 5975415
Bias = 0.04
RMS = 1.44

SWS Product quality

Applications:
- NWP data assimilation
- Tropical cyclone monitoring

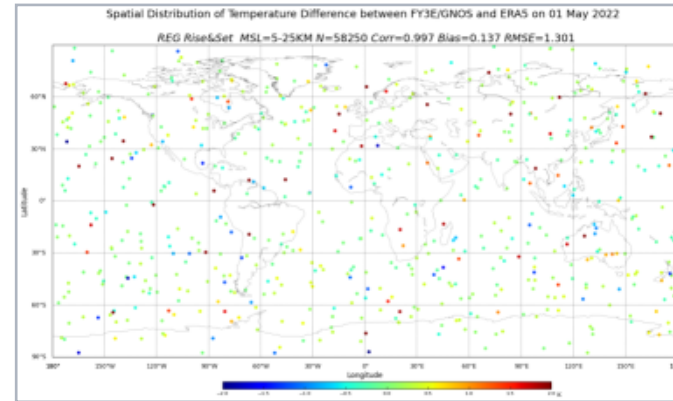**Coordination Group for Meteorological Satellites**

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FY3E/GNOS-II Radio occultation

- Including bending angle, refractivity, temperature and humidity profiles.
- GPS and BDS signals provide **1000+ daily** events.
- Near real time ~3h timeliness.
- Radio occultation profiles could be assimilated in NWP, the quality is **comparable to FY3C/FY3D**.
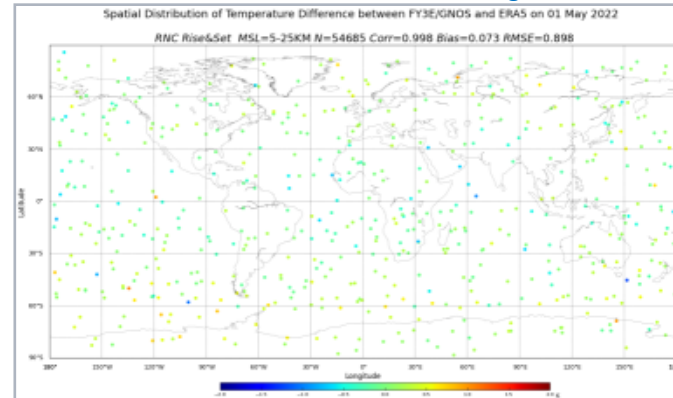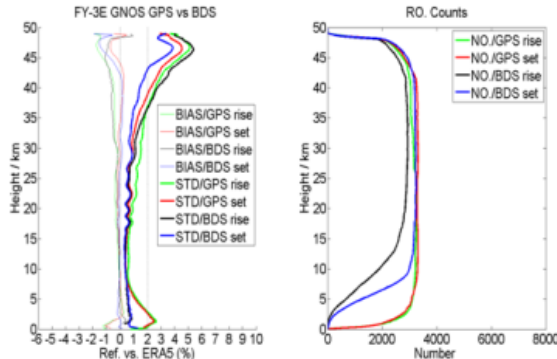- Would be **transmitted via GTS**.

GPS Bending angle p rofiles vs ERA5

GPS/BDSRefractivity profiles vs ERA5
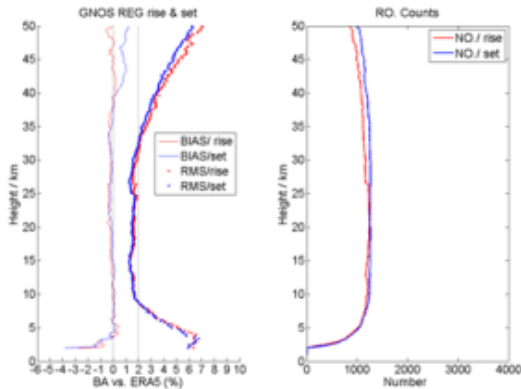
GPS T Bias at 5−25km range

BDS T Bias at 5−25km range

FY3E/VASS Atmospheric Verical Profiles

- The microwave and hyperspectral infrared sounding instruments aboard FY3E satellite have the potential to significantly improve the accuracy of weather forecasting.
- A Neural Network (NN) based machine learning method is developed to perform the temperature and humidity profile retrieval from combined MWHS, MWTS, and HIRAS observations.
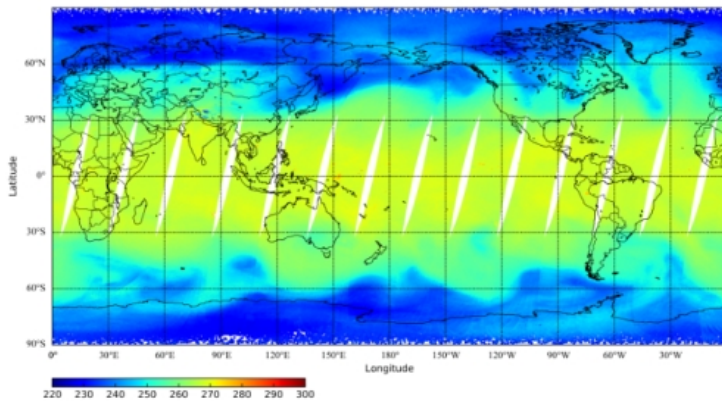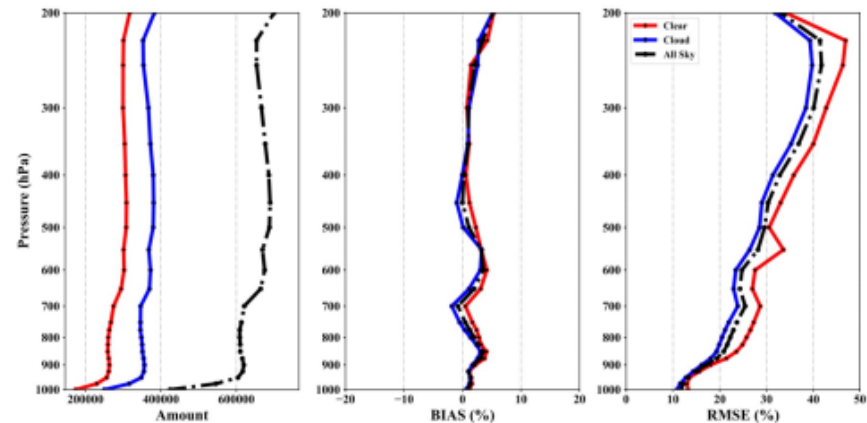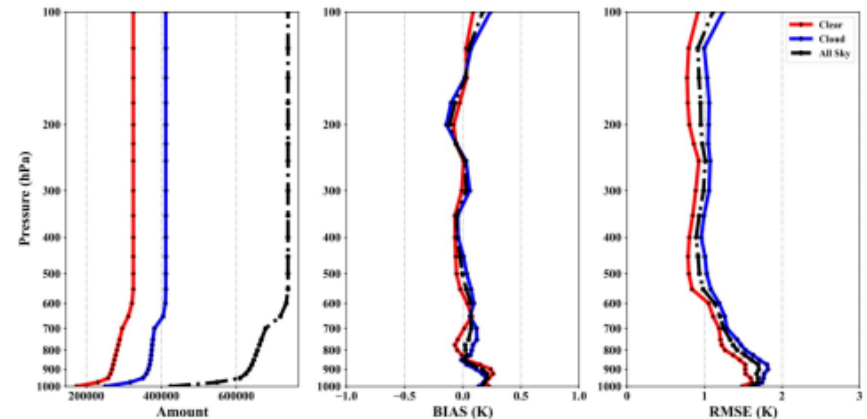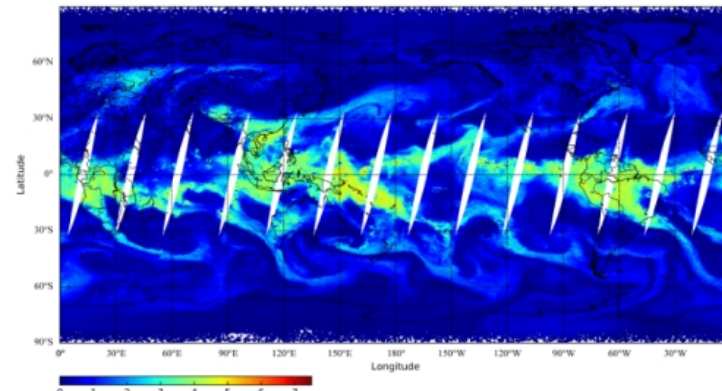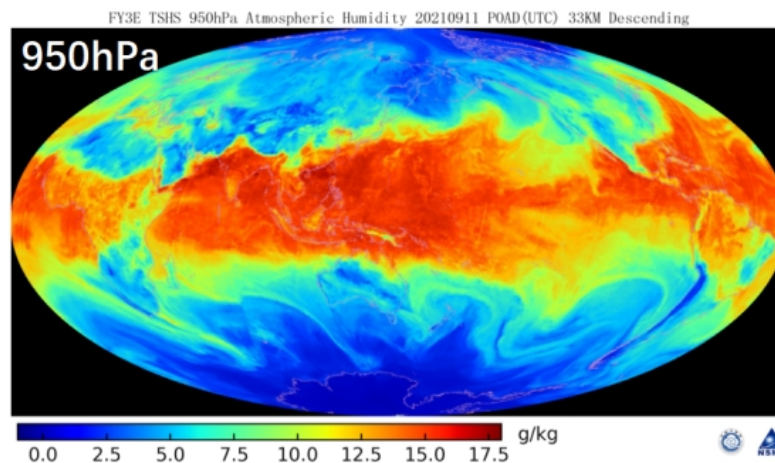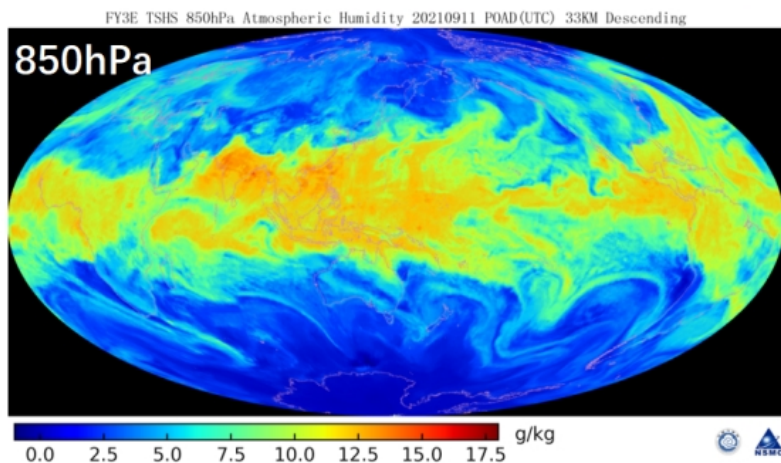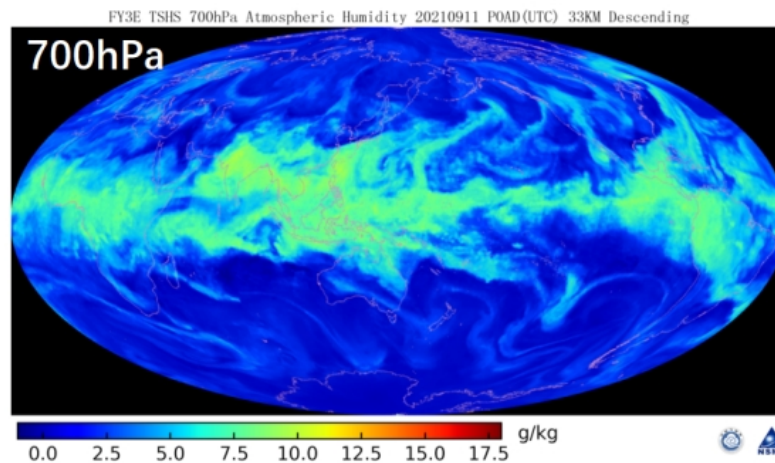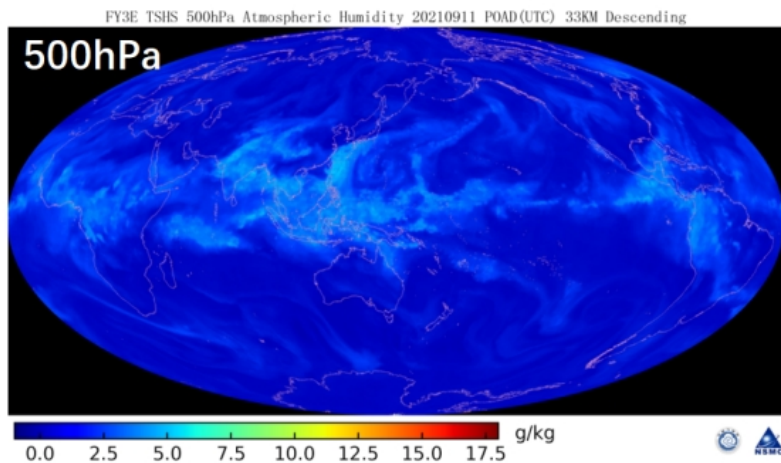
Temperature and humidity profile retrieval from combined MWHS, MWTS

FY3E/ MERSI-LL Nighttime Lights (NTL)

- Nighttime Lights (NTL) shows the nighttime visible artificial lights on land, which could characterize urban structures and indicate socioeconomic activities.
- FY-3E NTL products include monthly, seasonal and annual data with a resolution of 0.02°. The annual product is global while the monthly and seasonal products are confined to a latitudinal zone as FY-3E could only observe the nighttime lights in winter hemisphere.
- MERSI/LLB is severely contaminated by stray lights. The north hemispheric NTL data are better as the stray lights in south hemisphere are more complicated. The algorithm of NTL product is kept optimizing.
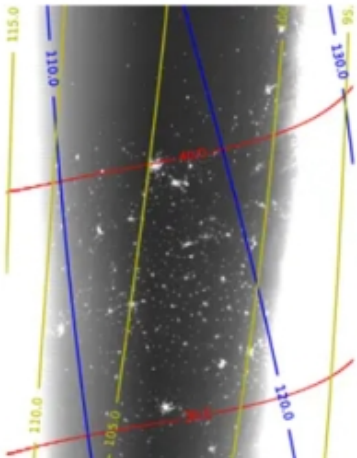
Granule L1 data → Remove stray lights → Multitemporal composition
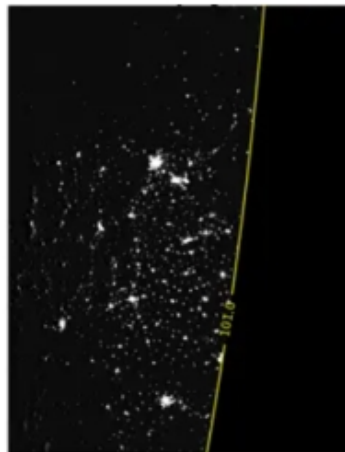
Demonstration of FY−3E China NTL in Dec,2022

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FY-3E/ MERSI-LL Polar Atmosphere Motion Vectors (AMV)

- Derived from FY-3E MERSI-LL data by tracking clouds or water vapour features in consecutive satellite images.
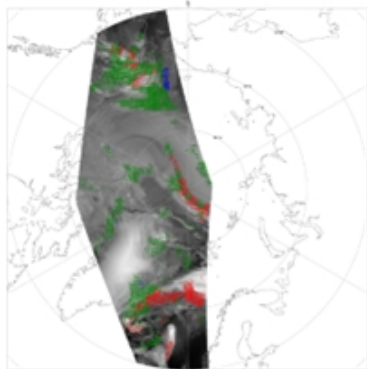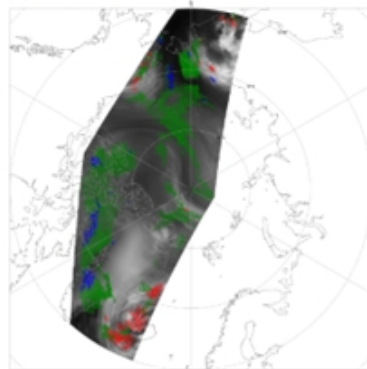- The latest derivation scheme relies on being able to define a target point based on a fixed processing grid. Only cloudy targets are used to derive the baseline products. The Cross Correlation method is used for derivation of the target displacement and EBBT method for height assignment.
- the product is still under improvement, and is expected to start trial operation next month.

IR winds from FY-3E MERSI-LL   WV winds from FY-3E MERSI-LL

High level: <400hPa   Middle level: 400~700hPa   Low level: >700hPa

prev
- dx,dy : -5, -18
- cc 0.75
next
- dx,dy : 3,19
- cc 0.73
Te = 228.45 K
H = 457 hPa
Dir = 351 degree
Spd = 13 m/s

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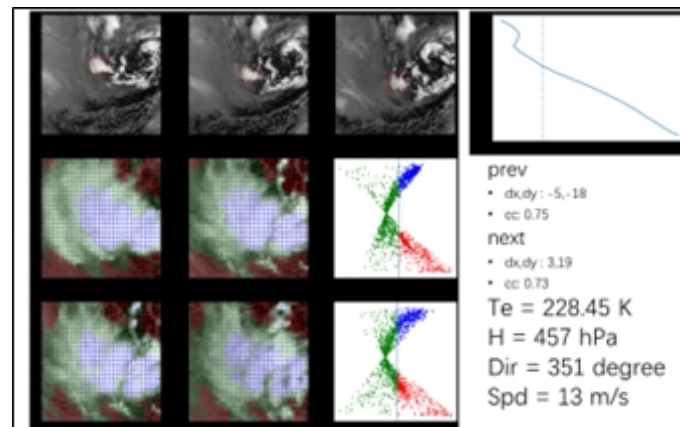
FY4B/Geocolor image and Sandwich image

Geocolor image looks approximately as it would appear when viewed with human eyes from space.

FY4B New Geocolor

1、Create Green Channel

2、Red channel compensate

3、Blue channel scattering weaken

4、Image curve enhancement
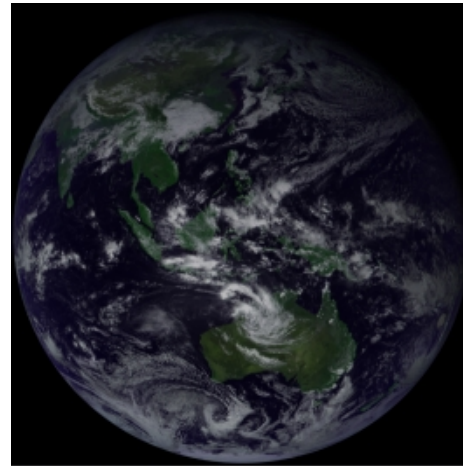
5、Fuse 3E urban lighting products

6、Compose True Color（during datetime）and Infrared product（at night）

Geocolor Image From FY4B AGRI Full Disk

Raw Image

Version I

New Version

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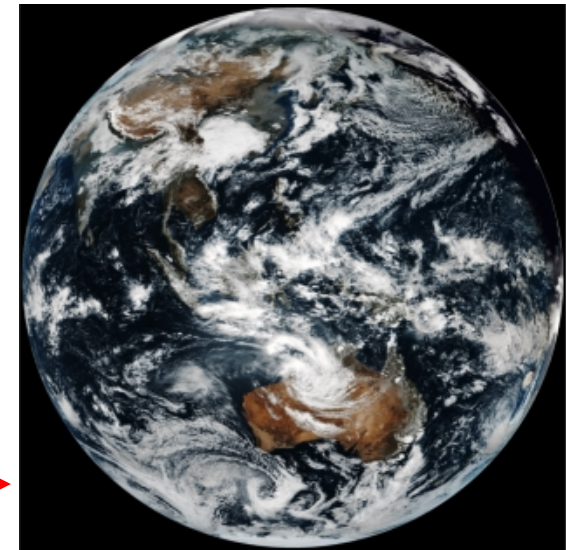
FY4B/Geocolor image and Sandwich image

Sandwich image：Advanced satellite image products for monitoring

and nowcasting of (severe) convective storms
2022-01-05 FY4B show the scale of the devastation on Tonga.

FY4B Sandwich
Use of
- Visible color **(bottom layer)**

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FY4B/Geosynchronous High-speed Image

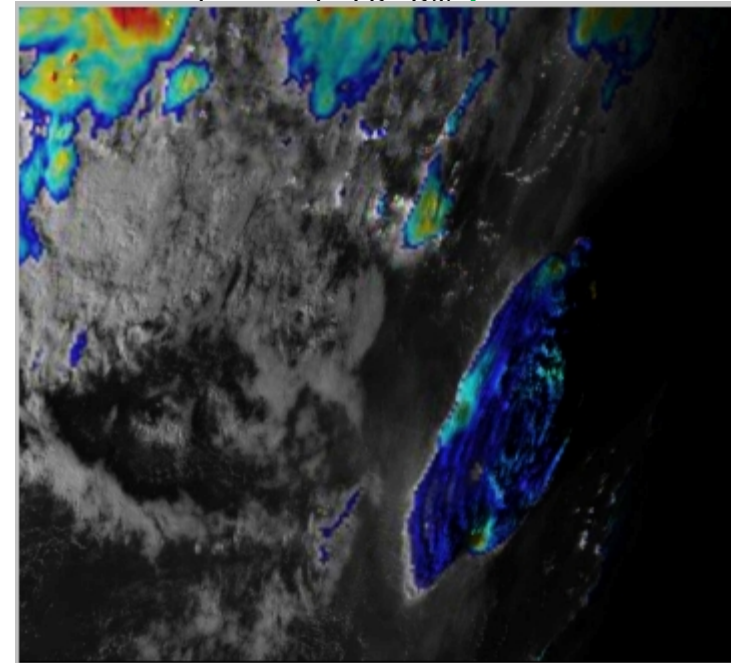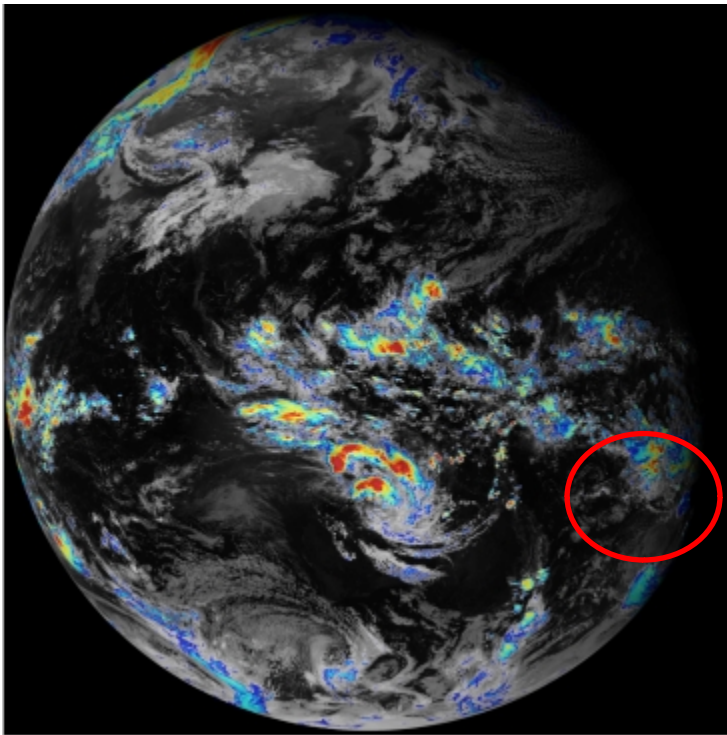- To track 2000km*2000km area with higher spatial resolution and time resolution of less than 1 minute, especially for monitoring the rapidly changing extreme weather such as typhoon and strong convection

New Service Mode: Cloud Image Livestreaming

- High compression rate Video: reduce file size **>90%**
- Parallel processing of multi resolution videos **<1min**
- Message handling-based procedure **no-waiting**
- Self-adaptive video speed control for **fluent user experience**
- Customized downloading of image/video in **original resolutions**

Geosynchronous High-speed Imager (GHI) Jul 21,2021 Henan China
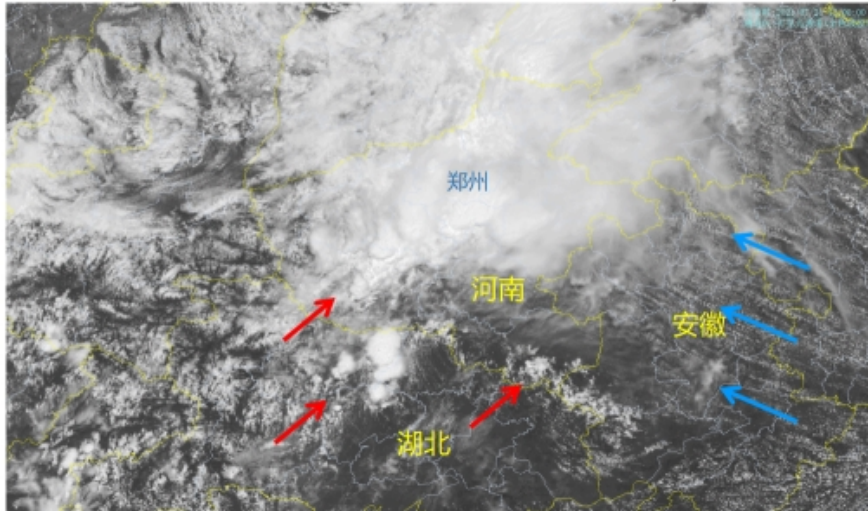
FY-4B 250m image livestreaming platform

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Executive summary of the WP

- Postlaunch cominssion test of FY-3E and FY-4B: Instruments performence and L1 data testing has been basically completed, and L2 products test is in progress.

- 35 baseline L2 products of FY-4B and 41 baseline L2 products of FY-3E have been developped and are now under validation, are expected to finish in Q2 2022.

- According to new observation capability of early morning orbit, new remote sensing products such as low-light near constant contrast and nighttime light, sea surface wind field, sea ice edge and type, etc., have been developed.

- Multiple `satellite image products` of FY-4B AGRI and GHI are developed `for monitoring and nowcasting of (severe) convective storms.`

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