

A NEW REMOTE SENSING RESOURCE FROM CHINESE FY-3A SATELLITE

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ABSTRACT: The National Satellite Meteorological Center (NSMC) was established within the China Meteorological Administration (CMA) in 1970. The responsibility of NSMC is to operate, manage, and improve the nation's meteorological satellite system; to make requirements for new satellite; to archive and disseminate satellite data/products to meet the need of public and private users, assist decision making, and scientific research programs.

Since 1988, China has Launched nine meteorological satellites, five of them are sun-synchronous, four of them are geo-stationary satellite, and will continue the two types meteorological satellite programs. At present FY-1D, FY-2C and FY-2D satellites are providing observation data to users in real time.

FY-3A was launched successfully in Taiyuan launching Center of China on May 27, 2008, and now is in check out stage. This satellite will be operational by the end of this year. FY-3 is a new series of Chinese polar-orbiting meteorological satellites. It is not only for meteorology use, but also provide widely use for environment application.

1. INTRODUCTION

Meteorological satellites have become an irreplaceable weather, ocean and land observing tool in China. These satellites are monitoring nature disasters and improving the efficiency of many sectors of our national economy. It is impossible to ignore the space derived data in the fields of meteorology, hydrology, agriculture as well as disaster monitoring in China, such a big agricultural country. For this reason, China is making her unremitting efforts on building up the meteorological system and data application system.

As a new-generation of polar-orbiting meteorological satellite, FY-3 series is made up of 2 experimental and at least 4 operational satellites. FY-3 series is expected a service life till 2020. FY-3 series is more powerful than FY-1(the Chinese first generation) since it has sounding capabilities and truth collar image with higher spatial resolution of 250m. Equipped with 11 instruments, the FY-3A satellite is able to acquire global data in an all-weather, multi-spectra band, 3 dimension, and quantitative manner. This paper will focus on FY-3A satellite systems including the platform, payloads, products and application capabilities. FY-3A data and products are open to all users in the world.

2. FY-3A SPECIFICATIONS

FY-3A is a sun-synchronous polar-orbiting environmental satellite. The satellite in general is a hexahedron of $4.4 \times 2.0 \times 2.0$ meters. The total weight is about 2300 kg.

The one solar panel is mounted on one side of the satellite main body which makes the span length of the satellite 10 meters in flight. The attitude control of the satellite is three-axis stabilized with a measuring precision of 50 meters with the measurement of the star sensor onboard the satellite. The altitude of FY-3A is 831 km. Orbital period (minutes) is about 102 minutes. Onboard data storage is 144 GB. Design life is three years.

3. FY-3A PAYLOADS

FY-3A is equipped with 11 instruments, It carries 11 instruments which are Visible and InfraRed Radiometer (VIRR), MEdium Resolution Spectral Imager (MERSI) MicroWave Radiation Imager (MWRI), Total Ozone mapping Unit (TOU), InfraRed Atmospheric Sounder (IRAS), MicroWave atmospheric Temperature Sounder (MWTS), MicroWave atmospheric Humidity Sounder (MWHs), Solar Backscatter Ultraviolet Sounder (SBUV), Solar Irradiation Monitor (SIM), Earth Radiation Measuror (ERM) and Space Environment Monitorr (SEM). Figure 1 is a diagram of FY-3A with the all instruments.

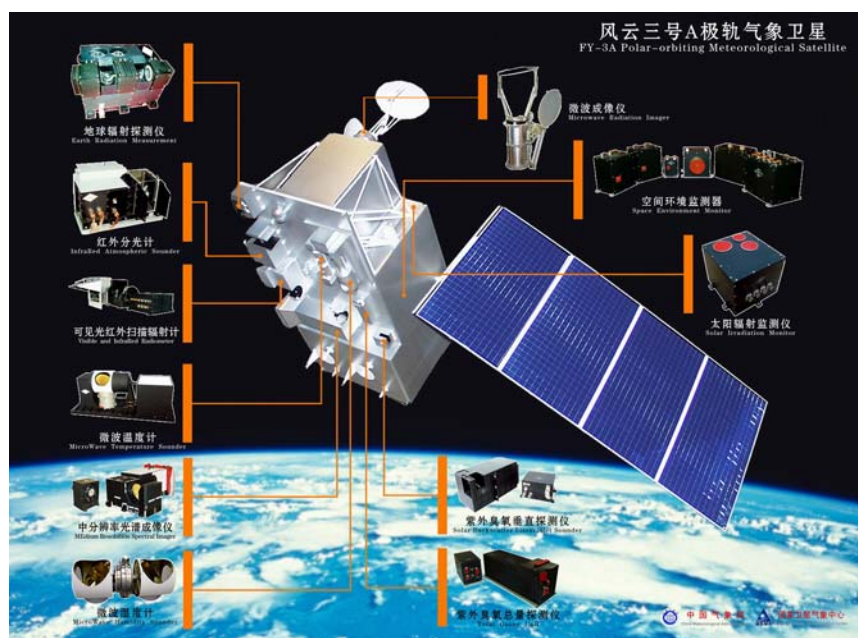


Figure1 FY3-A Diagram

Potential Applications from the FY-3A observations are in weather forecaster, climate research, environment monitoring, natural calamities monitoring, space weather monitoring. The major remote sensing instruments are allistrated on table 1.

Table 1 FY-3A major remote sensing instruments

Instrument name	Major characteristics	Primary use
Imaging Mission		
VIRR	Spectral range: 0.44~12.5 μ m Channel numbers: 10 Cross track scanning: ±55.4° Spatial resolution: 1.1 KM	Cloud, vegetation, snow and ice, SST, LST, water vapour, aerosol, ocean colour , etc.
MERSI	Spectral range: 0.41~12.5 μ m Channel numbers: 20 Cross track scanning: ±55.4°	True colour imagery, cloud, vegetation, snow and ice, ocean colour, aerosol, rapid response

	Spatial resolution: 0.25~1KM	products(fires, flooding, etc.
MWRI	Frequency range: 10.65~89GHz Channel numbers: 10 (5 frequencies with H,V polarization) Conical scanning: 110.8° Spatial resolution: 15-80 KM	Rainfall, soil moisture, cloud liquid water, sea surface parameters
TOU	Spectral range: 309~361nm Channel numbers: 6 Cross track scanning: $\pm 56.0^\circ$ Spatial resolution: 50 KM	Total ozone distribution
Sounding Mission		
IRAS	Spectral range: 0.69~15.5 μ m Channel numbers: 26 Cross track scanning: $\pm 49.5^\circ$ Spatial resolution: 17.0 KM	Atmospheric temperature profile, atmospheric humidity profile, total ozone content, cirrus, aerosol, etc
MWTS	Frequency range: 50~57GHz Channel numbers: 4 Cross track scanning: $\pm 48.6^\circ$ Spatial resolution : 50~75 KM	Atmospheric temperature profile, rainfall, cloud liquid water, surface parameters, etc.
MWHS	Frequency range: 150~183GHz Channel numbers: 5 Cross track scanning: $\pm 48.95^\circ$ Spatial resolution (SSP): 15 KM	Atmospheric humidity profile, water vapour, rainfall, cloud liquid water, etc.
SBUS	Spectral range: 252~340nm Channel numbers: 12 Cross track scanning: $\pm 56.0^\circ$ Spatial resolution : 200 KM	Ozone profile, Total ozone amount.

* All the spatial resolutions indicated in the above table is for sub-satellite point

4. FY-3A DATA FORMAT AND DATA TRANSMISSION

The FY-3A interface formats are consistent with the requirement of the Consultative Committee for Space Data Systems (CCSDS) standards. This document is structured to identify FY-3A selected options and requirements. The spacecraft communications links are S-band, L-band and X-band. Commands are via S-band only. Command and Telemetry links is active simultaneously. The S-band section of the Communications Subsystem provides primary telemetry and command (T&C) service to and from FY-3A ground stations. The L-band and X-band section of the Communication Subsystem provides the science and engineering data downlink for the FY-3A common spacecraft. Three modes of operation are provided: (1) Delayed Picture Transmission (DPT) data format. All the global stored science and engineering data is transmitted in high data rate at 93 Mbps, to the NSMC national ground playback stations (Beijing, Guangzhou, Urumuqi and Jamusi) and the oversee station in Kirruna of Sweden when the satellite flies over the acquisition range of these stations. The DPT transmission band frequency is within 8025 - 8400 MHz. (2) Mission Picture Transmission (MPT) data format. MPT is in the X-band Direct Broadcast (DB) mode. The main function of this data format is for

real-time broadcasting of the science and engineering data of MERIS, with the data rate of 18.7 Mbps, to any receiving station with line of sight view. The broadcasting band frequency is between 7750-7850 MHz. (3) HRPT data format. HRPT transmission band frequency is within 1698-1710 MHz at the data rate of 4.2 Mbps. The data is in real time global broadcasting.

5. GROUND SEGMENT

5.1 Data Receiving Network

A completely new ground system is developed for data receiving, processing, storage and dissemination of FY-3A data and products. FY-3A products are derived by using scientifically algorithms with satellites observations.

FY-3A global data receiving network (say in Fig. 2) is made up of four China's domestic ground stations, and an overseas high-latitude station. The network is designed to cover the global data collected by FY-3A satellite. The data error rate for all modes required is better than 1×10^{-6} .

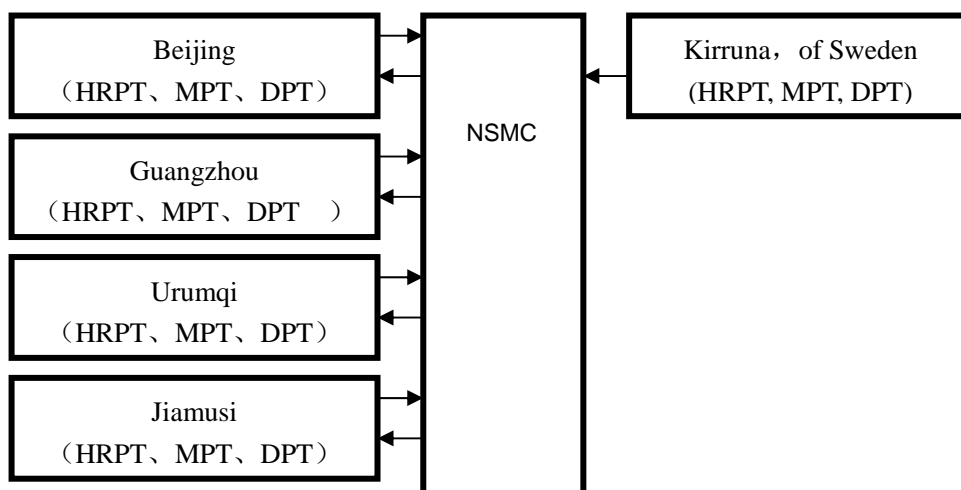


Figure 2 FY-3A receiving network

5.2 Products

Products for atmosphere and cloud are as follows:

Cloud mask, cloud top temperature, cloud top height, cloud type cloud cover; outgoing long-wave radiation at TOA, aerosol over ocean, fog detection, total perceptible water, Precipitation Rate at the ground; atmospheric temperature and humidity profile; atmospheric stability index; total ozone, ozone profile; flux at TOA.

Products for Land and Sea Surface are as follows:

Vegetation index, land cover (vegetation type), snow cover; land surface reflectivity and temperature; flooding index; global fire area; sea surface temperature, ocean color/chlorophyll, sea-ice cover.

Products for Space Weather are as follows:

Solar proton, solar ion, solar electron, potential, radiant dose, single event.

Two products are given as examples in Figures 3-4.

5.3 Data and Products Distribution

All users over the world can receive FY-3A HRPT and MPT data directly since these two type data are directly broadcasted by FY-3A while the satellite is observing earth. NSMC/CMA will update FENGYUNcast which is broadcasting current satellite data and

products based on the DVB-S technique. DVB-S is a digital video broadcast by satellite system used to distribute satellite data. Figure 5 gives FENGYUNcast coverage. Users in the coverage can get the data and products.

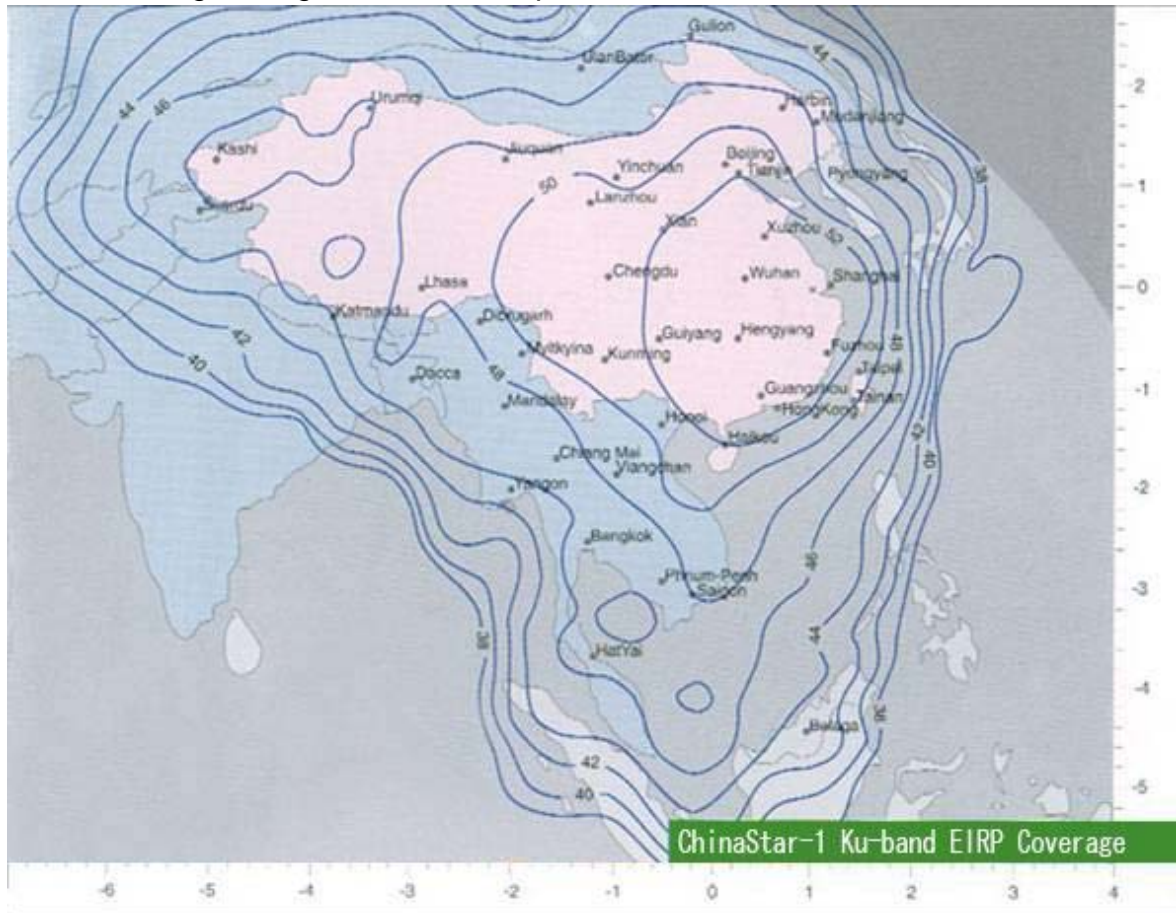


Figure 5 ChinaStar-1 Ku-band EIRP Coverage

6. FORWARD LOOK

There are two phases for FY-3 series which are experimental and operational. The first two satellites (FY-3A/B) are experimental satellites. The purposes of FY-3A/B are risk reduction in engineering, products development and validation, utilization demonstration in some areas. The satellites constellation for operational phase (FY-3C/D...) is planned with expanded sounding and imaging capabilities. Two polar satellites in operation (one in the AM and one in the PM orbit, payload will be different for AM/PM satellites, time slots could be coordinated though WMO). One low inclination orbit satellite is planning, mainly for precipitation measurement (mainly Radar, Passive Microwave measurement). Details are still in discussion. China will continue her effort to develop two types (LEO and GEO) of meteorological and environmental satellites to meet national requirements and modernizing the meteorological service of China and world meteorological community. Chinese meteorological satellite program is one of the components of space-based Global Observing System (GOS) of WMO. It is believed that the Chinese satellites are not only benefit the nation of China, but also a valuable contribution to the international meteorological, hydrological and environmental community.

REFERENCES

The FY-3 ground segment engineering design, National Satellite Meteorological Center of China Meteorological Administration, January 2007 (in Chinese)
The planning on Chinese Meteorological Satellite: from 1998-2010, China Meteorological Administration, April 1998 (in Chinese)

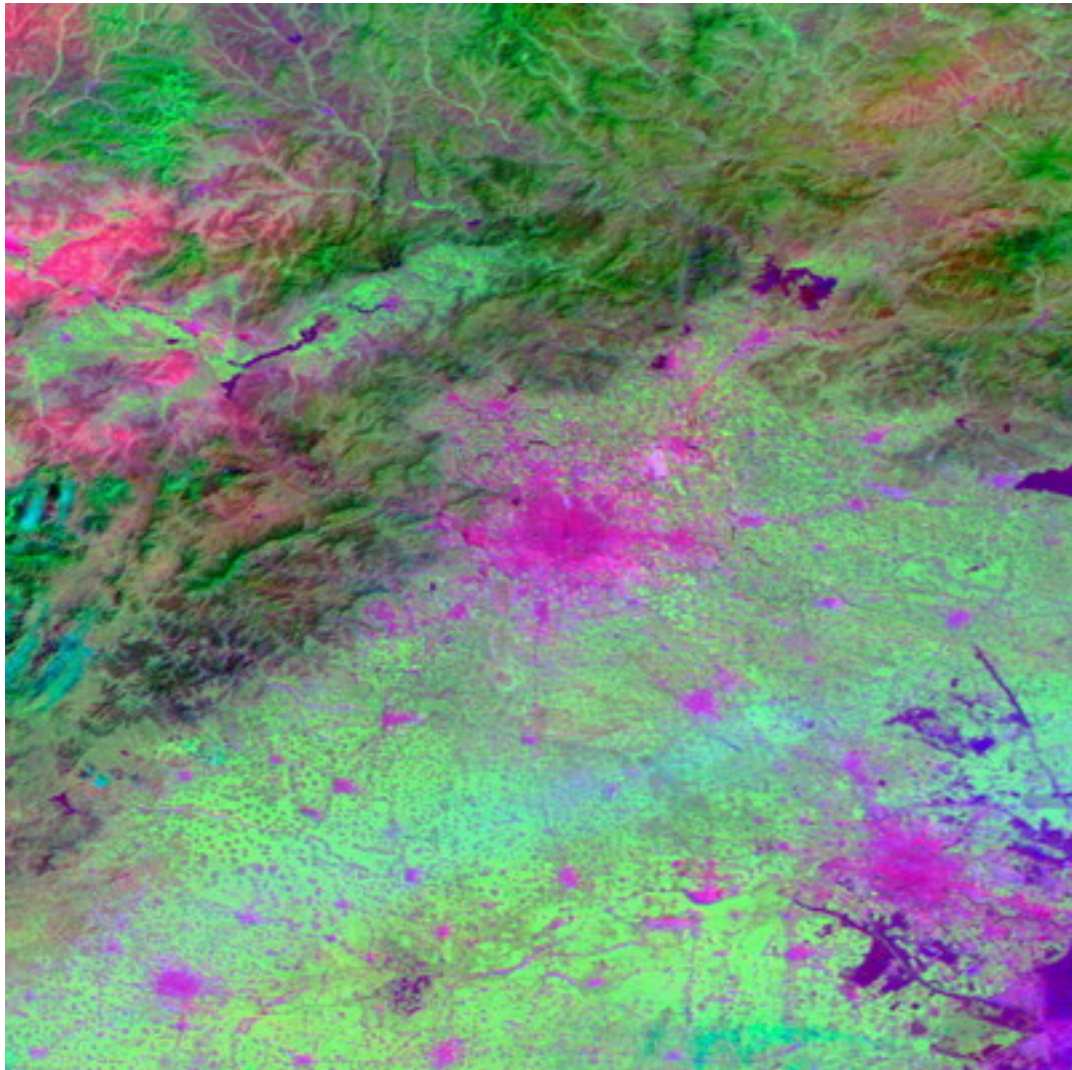


Figure 3 City hot environment monitoring (pink colour)

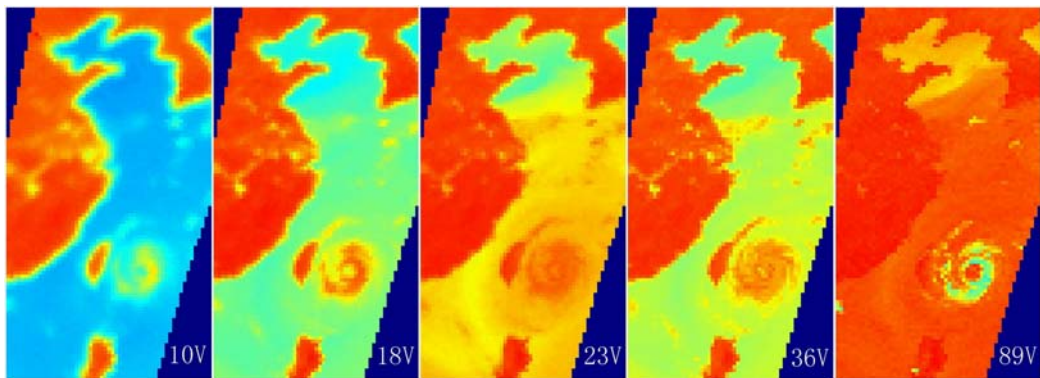


Figure 4 MWRI SINLAKU Typhoon monitoring (12/9/2008)