



Joint China Australia VLab Centres of Excellence

Regional Focus Group meeting, 29th October 2021

Mr Gao Hao

Division of Remote Sensing Data Application, National Satellite Meteorological Center, China
Meteorological Administration

Mr Bodo Zeschke

Bureau of Meteorology Training Centre.

Joint Australia China VLab Centres of Excellence Regional Focus Group meeting, 29th October 2021

Contents

- **Summary of the recent achievements of the environment disaster and agriculture monitoring using FengYun satellites.**
Mr Gao Hao , Division of Remote Sensing Data Application, National Satellite Meteorological Center, China Meteorological Administration
- **Celebrating 8 years of the Australian VLab Centre of Excellence Regional Focus Group meetings, with a summary of the past two years.** Mr Bodo Zeschke, Bureau of Meteorology Training Centre.

Joint Australia China VLab Centres of Excellence Regional Focus Group meeting, 29th October 2021

Contents

- **Summary of the recent achievements of the environment disaster and agriculture monitoring using FengYun satellites.** Mr Gao Hao , Division of Remote Sensing Data Application, National Satellite Meteorological Center, China Meteorological Administration
- **Celebrating 8 years of the Australian VLab Centre of Excellence Regional Focus Group meetings, with a summary of the past two years.** Mr Bodo Zeschke, Bureau of Meteorology Training Centre.



Joint Australia China VLab Centres of Excellence Regional Focus Group meeting

Summary of the recent achievements of the environment disaster and agriculture monitoring using FengYun satellites

Gao Hao

gaohao@cma.gov.cn

National Satellite Meteorological Center (NSMC)

China Meteorological Administration (CMA)

October 29, 2021

Outline

1 Application in wildfire monitoring

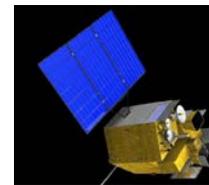
2 Application in flood monitoring

3 Application in agriculture monitoring

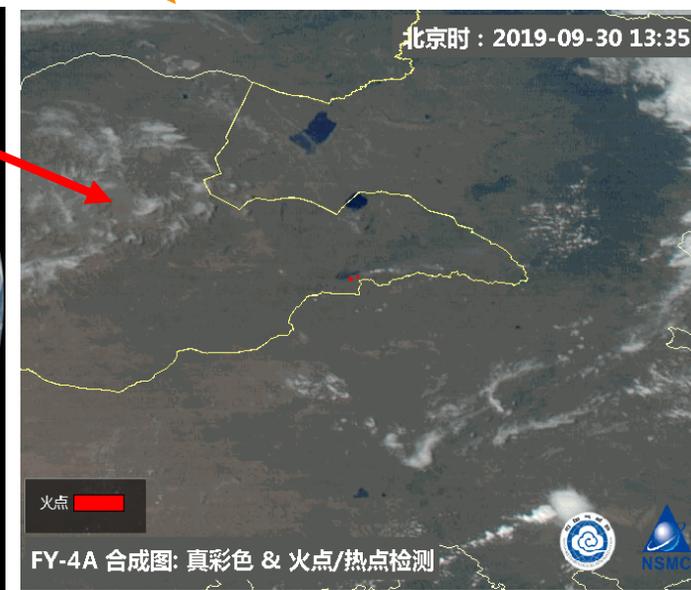
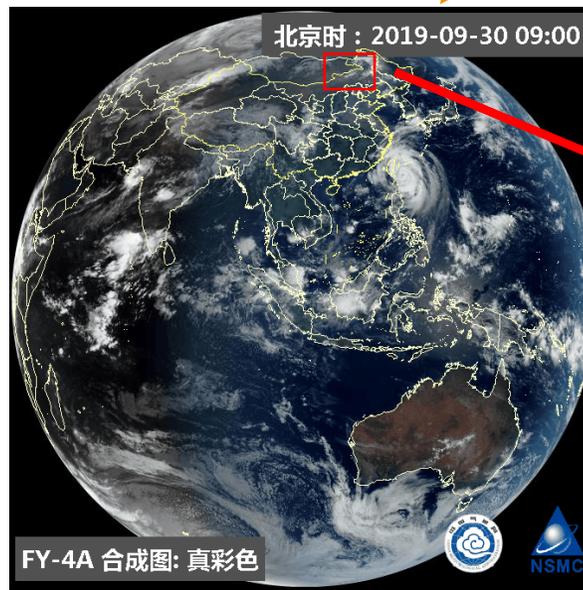
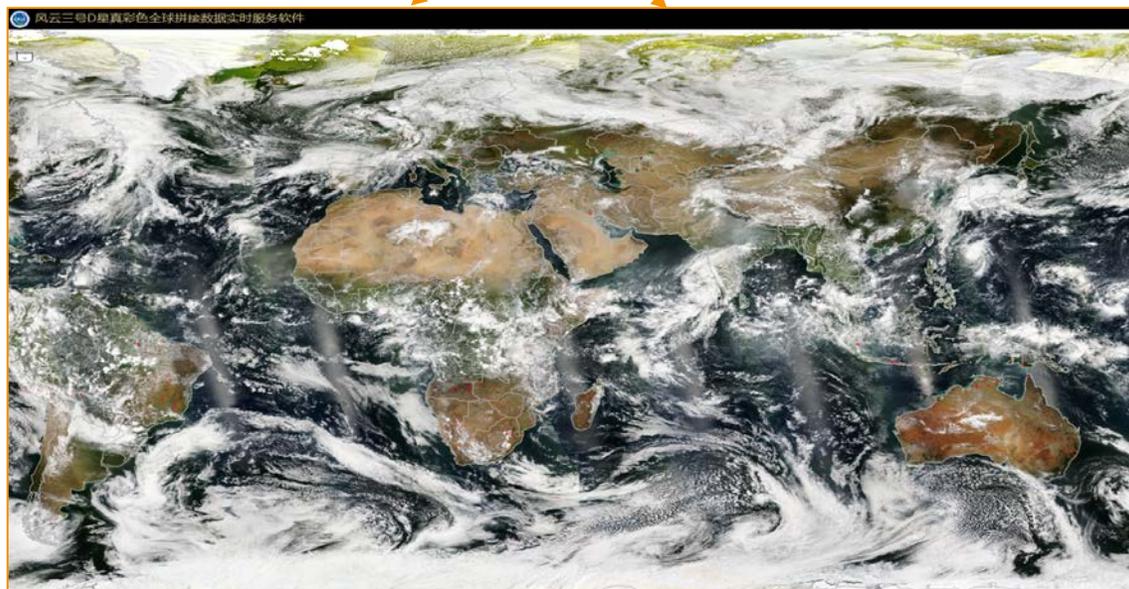
Current wildfire monitoring capability



FY-3B,C,D



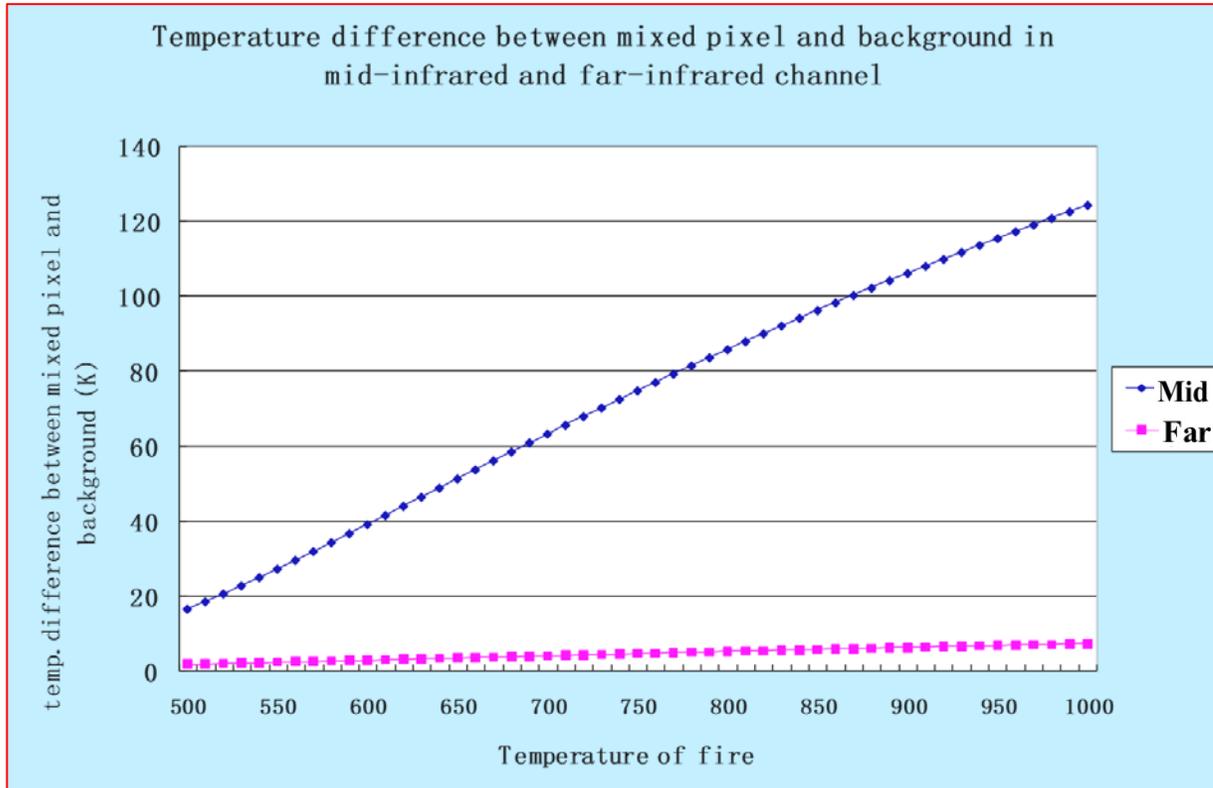
FY-4A



- FY-3 and FY-4 as the second generation of Chinese meteorological satellite, **the spatial, temporal and spectral resolution improved largely.**
- Fire monitoring capability has been enhanced greatly. More accurate and timely fire products can be generated.
- Especially in global application, FY become the most important data in NSMC.

- ✓ **High response time**
- ✓ **High positioning accuracy**
- ✓ **High monitoring frequency**

The method of wildfire detection



Find the fire position in real time!

NSMC developed the automatic wildfire detection method with higher accuracy, considering complex earth surface, different cloud conditions, and solar radiation disturbances.

1) Core algorithm

Mid-infrared channel is sensitive to fire temperature. The temperature difference between target pixel and background in mid-infrared and far-infrared are used.

$$T_{\text{MIR}} \geq (T_{\text{MIRBG}} + a \cdot \delta T_{\text{MIRBG}}) \text{ and } T_{\text{M-F}} \geq (T_{\text{M-FBG}} + a \cdot \delta T_{\text{M-FBG}})$$

2) Cloud contaminate

Different cloud conditions (cloud, thin cloud, tiny cloud, cloud edge) .

3) Sun glint

When the sun glint angle is less than 10 degrees, no fire detection.

4) Water body, desert

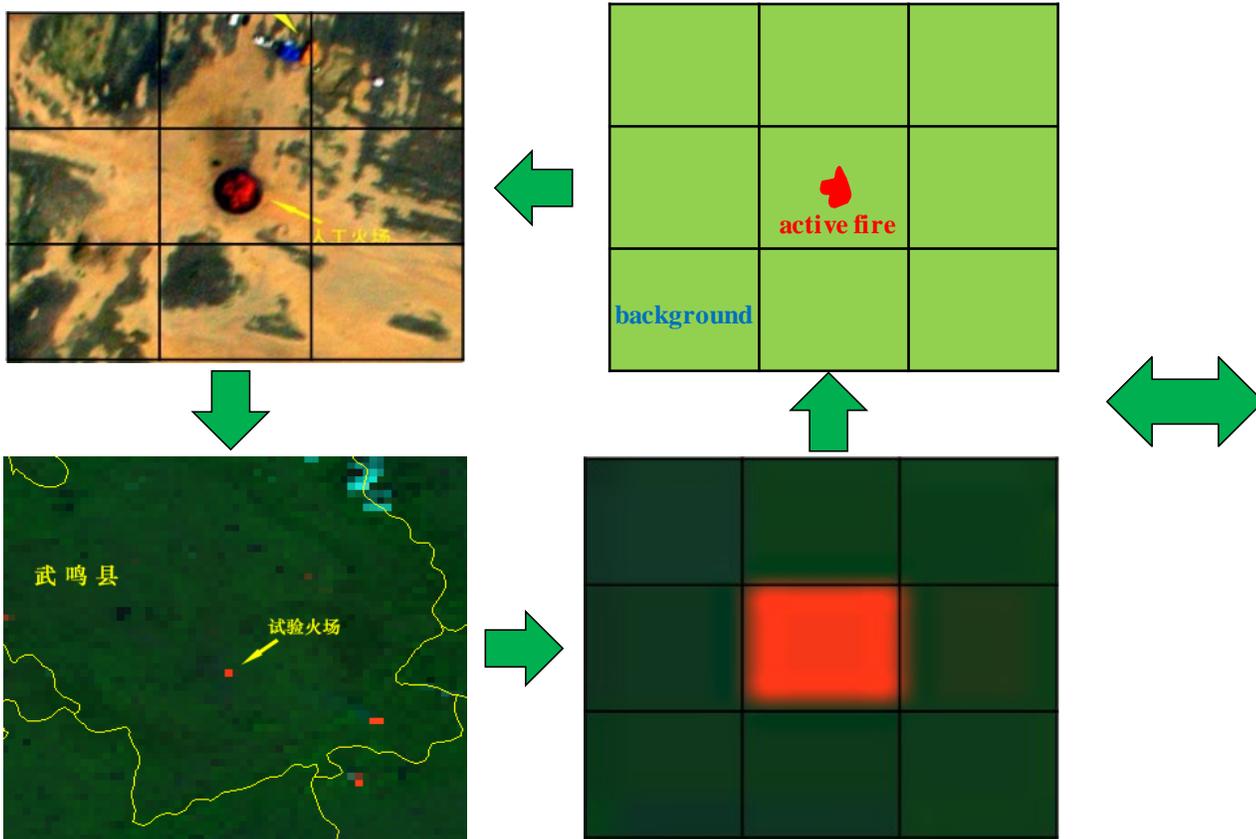
Water body and desert can be masked by land cover data.

5) Suspected fire

$$T_{\text{MIR}} > (T_{\text{MIR_AVG}} + \Delta T_{\text{MIR}}) \text{ and } T_{\text{M-F}} > (T_{\text{M-F_AVG}} + \Delta T_{\text{M-F}})$$

or $T_{\text{MIR}} > T_{\text{MIR_WM}}$

Sub-pixel wildfire information evaluation



- ✓ In daily wildfire monitoring, tens or even hundreds of fire pixels often are detected. If using pixel size as the area of active fire, it will be much larger than the actual size.
- ✓ The method to evaluate the sub-pixel size of active fire is developed, which can provide more accurate information and also be used to calculate FRP.

1) Dual channel evaluation for P, T .

Using mid-infrared and far-infrared channels to evaluate sub-pixel size and temperature of fire.

$$N_{MIR}(P, T) = P * N_{MIRt} + (1 - P) * N_{MIRbg}$$

$$N_{FIR}(P, T) = P * N_{FIRt} + (1 - P) * N_{FIRbg}$$

2) Single channel evaluation (T is set 750K)

Using single channel to evaluate sub-pixel size when the temperature (750k) of active fire is set.

$$P = (N_{MIR} - N_{MIRbg}) / (N_{MIRt} - N_{MIRbg})$$

FRP (Fire Radiation Power) evaluation

$$FRP = S_f * \sigma T^4$$

Burned area estimation

1) Two images before and after fires

$$NDVI_{\text{Before}} - NDVI_{\text{After}} > NDVI_{\text{BA_th}}$$

2) Single image after fires

$$R_{\text{Nir}} < R_{\text{Nir_th}}$$

$$NDVI = (R_{\text{Nir}} - R_{\text{Red}}) / (R_{\text{Nir}} + R_{\text{Red}})$$

$$NDVI < NDVI_{\text{th}}$$

Reflectance of burned trees and grass strongly decreased in visible and infrared channels.

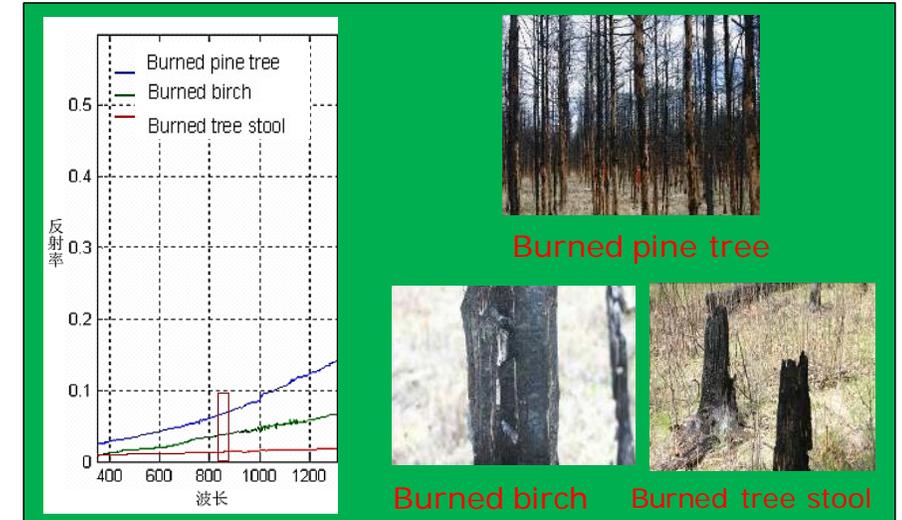
3) Multisource satellite data

$$C_G = \frac{NDVI_{\text{Mix}} - NDVI_S}{NDVI_V - NDVI_S}$$

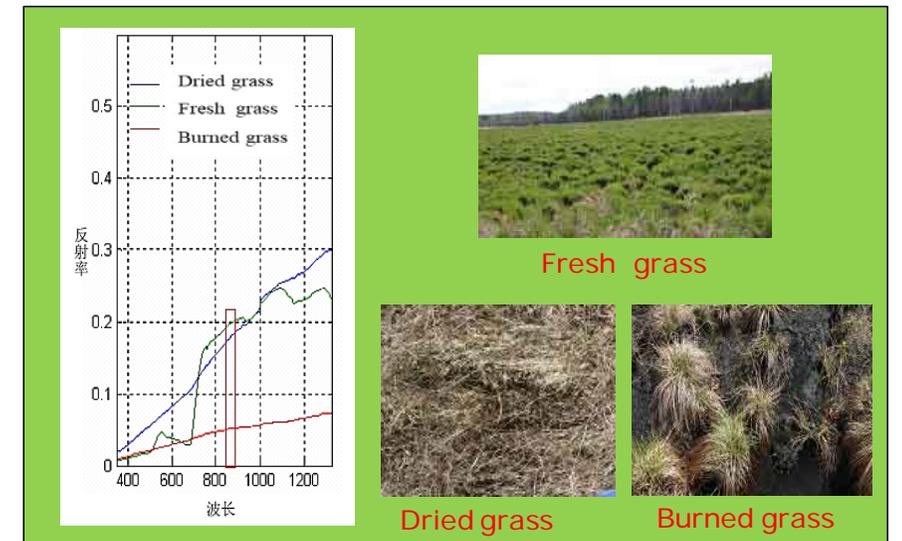
$$S = \sum_{i=1}^n S_i * C_i$$

Support for wildfire loss assessment and emission estimation

NDVI and near infrared channel data are utilized to discern burned area. Furthermore, the fusion method of FY and high spatial resolution satellite data is developed fully using the temporal and spatial resolution.



The spectrum features of burned area



Validation based on man-made fire experiment

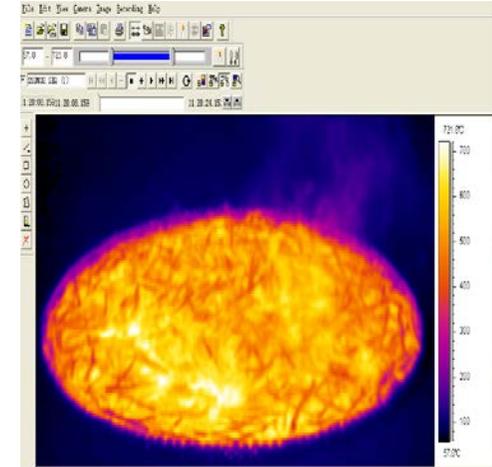


The man-made fire field in Guang Xi Province, China



Live picture of man-made fire field when satellite scans on the night

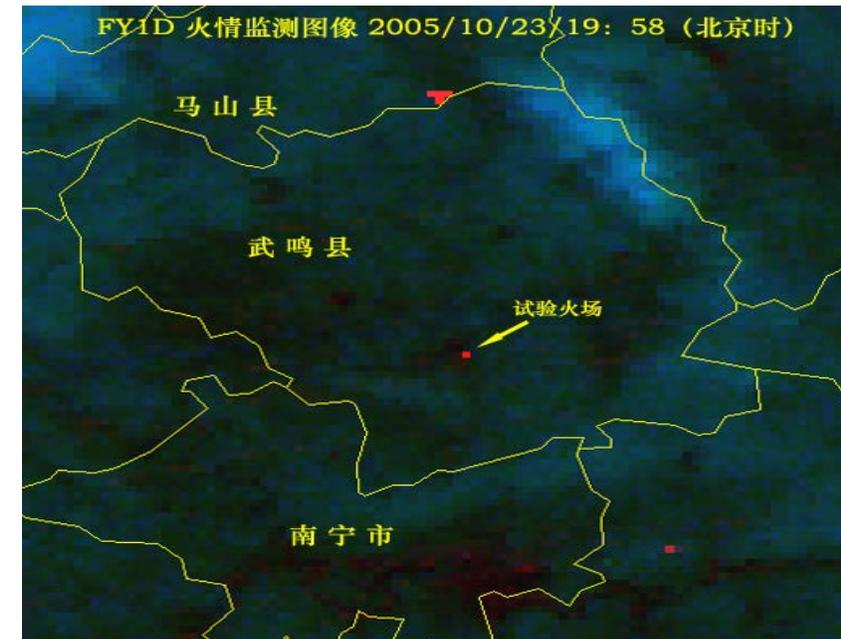
2005.10.23 19:59



Thermal Imaging System instrument

Validate the accuracy of fire monitoring

- ◆ NSMC made a man-made **fire field experiment coincident with satellite overpasses** in 2005. The man-made fire field was in circular shape, and was laid over firewood, tree branches and trunks.
- ◆ Thermal imaging system instrument was used to measure the radiance and the temperature distribution in the field.
- ◆ The experiment **indicated the methods of fire detection and sub-pixel size evaluation are effective and satisfied.**



Validation based on field investigation and experiment of wildfire

In recent years, NSMC have hold many experiments for validation of wildfire product accuracy. The accuracy of the FY-3 automatic fire monitoring algorithm is acceptable.

- ✓ In May 2007, **fire intensity evaluating** investigation in Heilongjiang using the helicopter.
- ✓ In September 2007, **active fire area evaluating** investigation in Heilongjiang using the UAV.
- ✓ In May 2013, **grassland burned area** field spectral measurement in Inner Mongolia.
- ✓ In June 2014, **farmland burned area** investigation in Henan Province.
- ✓ In July 2015, **fuel load** measurement and investigation in the northeast forest area.
- ✓ In May 2018, **crop straw active fire** field monitoring experiment.
- ✓ In July 2019, **background temperature** field measuring experiment in Heilongjiang.



The process of wildfire monitoring operation in NSMC



Satellites

- NSMC receives meteorological satellite data(e.g. FY-3, FY-4, H8...) in real time;



Products

- After data processing, multiple products of monitoring fire are produced;



Users

- The products are distributed to the users through the internet or other ways.

Products

- Long time series monitoring of fires combines with satellite images and geographic information, NSMC can produce and offer various forms of products according to the need of users.

Users

- Ministry of Emergency Management;
- CMA;
- Provincial Meteorological Office;
- International users.

**Fire Monitoring
Image**

**Fire Thematic
Map**

**Fire Distribution
and Statistics**

**Fire Information
List**

**Burned Area
Evaluation**

**Analyzing
Report**

**Fire Spread
Estimation**

**Carbon
Emission
Estimation**

...

FY-3D气象卫星监测图像
2020年09月09日(北京时间)

Fire in US, detected by FY-3D

Wildfires broke out in the western United States in late August, 2020. From September 9 to 14, a large number of fires spots along the west coast of the United States had been detected by FY-3D satellite. The smoke caused by fires spread to the Pacific ocean, and parts of the United States.



中国气象局
国家卫星气象中心

Beijing time: 2020-01-04 09:00

Fire in Australia, detected by FY-4A

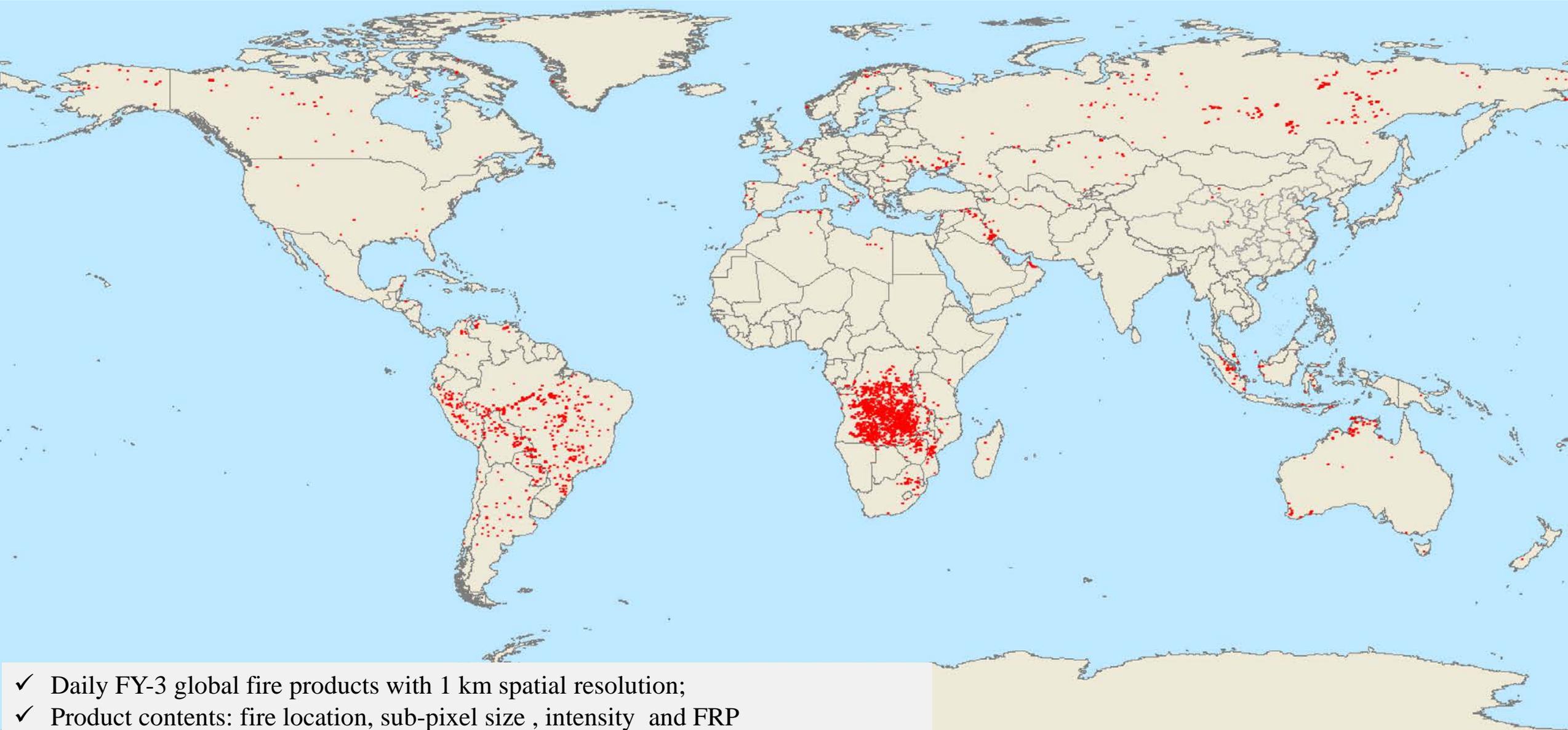
- Using FY-4A satellite, the fire spots in Australia can be detected at a higher frequency.
- The image shows the dynamic change of the fire in southeast Australia from 9:00 to 15:00 on January 4, 2020.

■ active fire/ hot spot

FY-4A: active fire/ hot spot detection

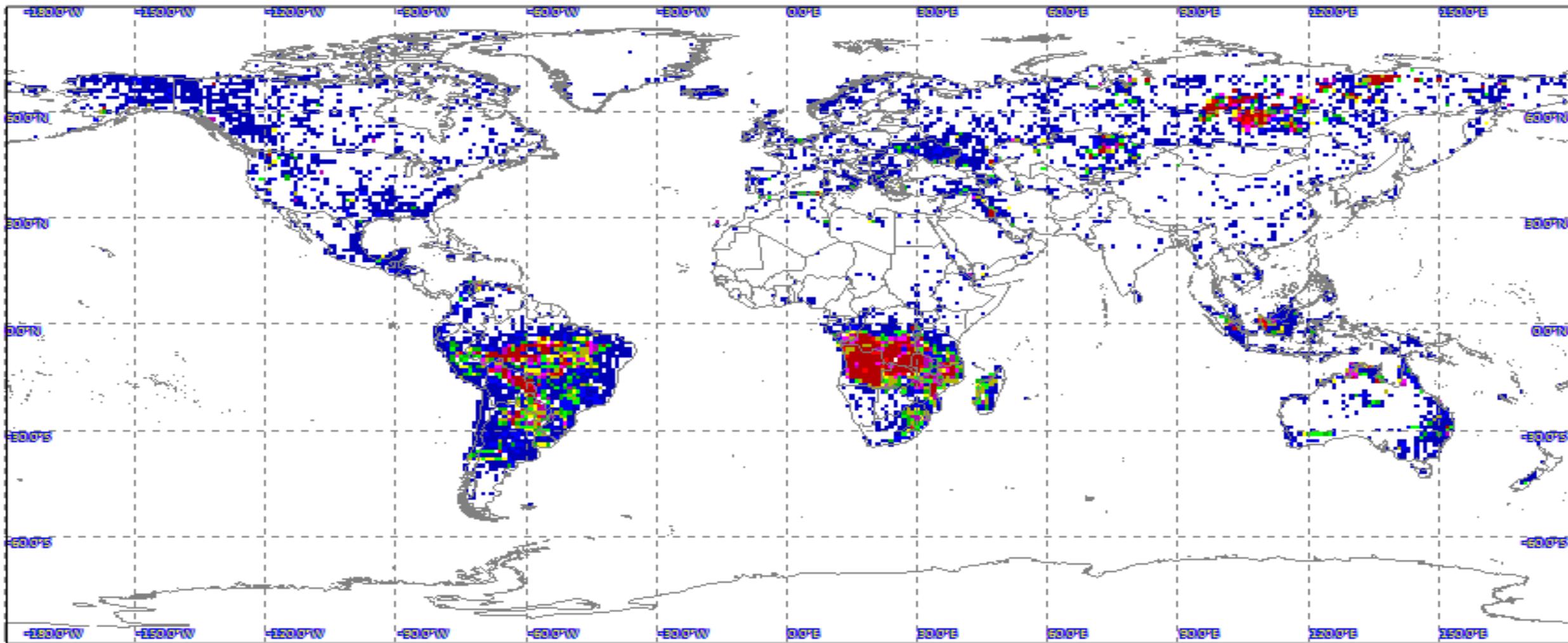


Daily global wildfire product of FY-3D (On 21 August, 2019)



- ✓ Daily FY-3 global fire products with 1 km spatial resolution;
- ✓ Product contents: fire location, sub-pixel size , intensity and FRP

Monthly global wildfire accumulation density product using FY-3D (In August,2019)



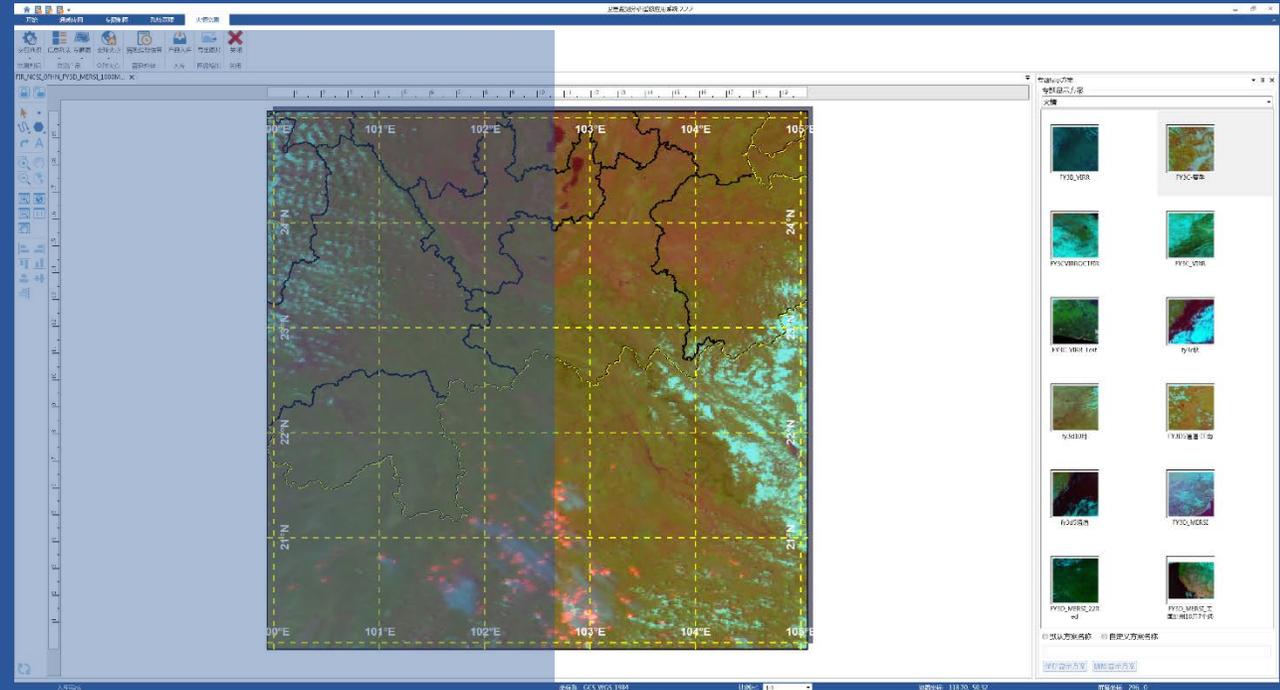
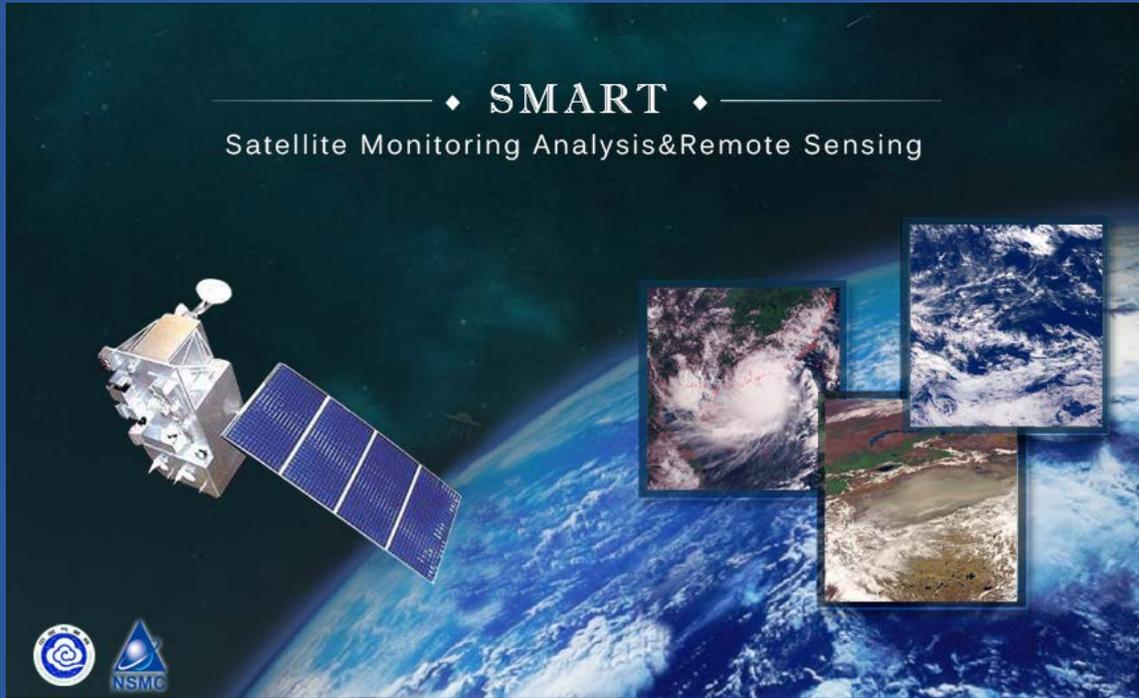
中国气象局



国家卫星气象中心

Wildfire product tools

<http://satellite.nsmc.org.cn/PortalSite/StaticContent/SoftDownload.a.spx?TypeID=16¤tculture=en-US>



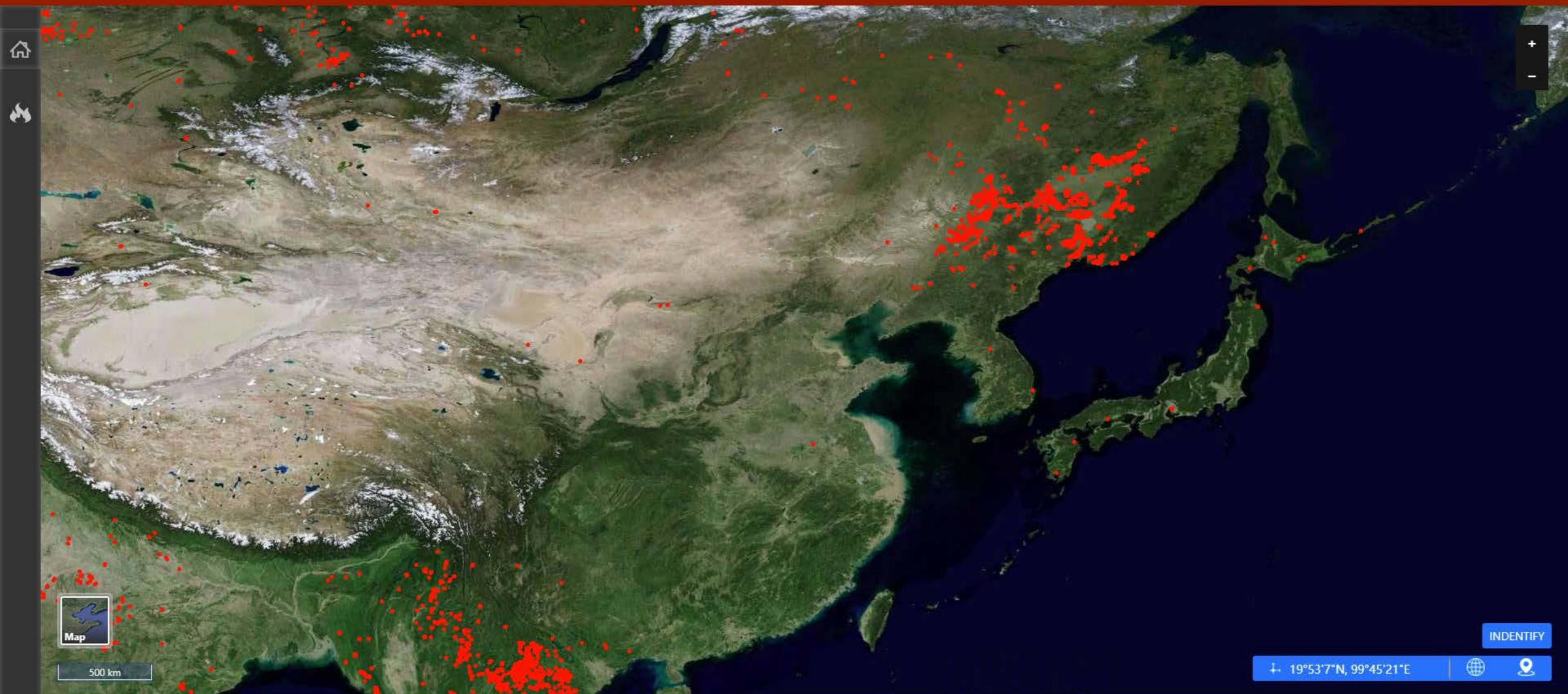
Satellite Monitoring Analysis & Remote sensing Toolkit-SMART

Software and platform of monitoring: SMART

Natural disaster and environment monitoring and analysis
---polar orbit Satellite data

With Interactive interface, SMART can be used to preprocess the FY-3 data, and its fire monitoring model can be used to detected fire spot, extracted burned area by human-machine interacting, and produced the various of fire thematic maps.

SMART is a comprehensive application platform for remote sensing monitoring and application using FY-3 and other meteorological satellite Data.



● FengYun Satellites Global Fire Product Service network has been established.

<http://fyfire.nsmc.org.cn/>



SWAP online

UTC:2019-11-09 07:00



Satellite products

<input type="checkbox"/> Lightning Frequency (One hour)	<input type="checkbox"/> Sea Surface Temperature
<input type="checkbox"/> Quantitative Precipitation Estimate	<input type="checkbox"/> Dust Storm Detection
	<input checked="" type="checkbox"/> Fire Hot Spot
<input type="checkbox"/> Upper-Level Water Vapor Atmospheric Motion Vectors	
<input type="checkbox"/> Cloud Mask	<input type="checkbox"/> Land Surface Emissivity
<input type="checkbox"/> Cloud Phase	<input type="checkbox"/> Reflected Shortwave Radiation
<input type="checkbox"/> Cloud Type	<input type="checkbox"/> Outgoing Longwave Radiation
<input type="checkbox"/> Cloud Top Height	<input type="checkbox"/> Upward Longwave Radiation
<input type="checkbox"/> Cloud Top Pressure	<input type="checkbox"/> Downward Longwave Radiation
<input type="checkbox"/> Cloud Top Temperature	
<input type="checkbox"/> Lower-Level Water Vapor Atmospheric Motion Vectors	<input type="checkbox"/> Temperature (500hPa)
<input type="checkbox"/> Infrared Atmospheric Motion Vectors	<input type="checkbox"/> Temperature (700hPa)
	<input type="checkbox"/> Temperature (850hPa)
<input type="checkbox"/> Total Precipitable Water	<input type="checkbox"/> Temperature (1000hPa)
<input type="checkbox"/> Tropopause Folding	

Software and platform of monitoring: SWAP

- **SWAP** = Satellite Weather Application Platform;
- FY-4A satellite data and its products are shown in real time on the **SWAP** website;
- The fire spot detection results detected by FY-4A are updated every 10 minutes.





<http://satellite.nsmc.org.cn/PortalSite/Default.aspx>

FENGYUN Satellite Data Center

NATIONAL SATELLITE METEOROLOGICAL CENTER

Home
>Data
>Data View

LEO
TANSAT
GEO

You have select: Land ✕ Global Fire Spot Monitoring(GFR) ✕ FY-3D ✕ Daily ✕ FY-3C ✕ FY-3B ✕

<input type="checkbox"/> Satellite	<input checked="" type="checkbox"/> FY-3D	<input checked="" type="checkbox"/> FY-3C	<input checked="" type="checkbox"/> FY-3B	<input type="checkbox"/> FY-3A
	<input type="checkbox"/> FY-1D	<input type="checkbox"/> NOAA-18	<input type="checkbox"/> NOAA-17	<input type="checkbox"/> NOAA-16 +
<input type="checkbox"/> Product	<input type="checkbox"/> L1 DATA	<input type="checkbox"/> Image	<input type="checkbox"/> Atmosphere	<input checked="" type="checkbox"/> Land
	<input type="checkbox"/> Ocean	<input type="checkbox"/> Radiation		
<input type="checkbox"/> Instrument	<input type="checkbox"/> Global Navigation Satellite System	<input type="checkbox"/> MicroWave Temperature	<input type="checkbox"/> MicroWave Humidity Sounder(MWHS)	
	<input type="checkbox"/> IPM(IPM)	<input type="checkbox"/> HIRAS(HIRAS)	<input type="checkbox"/> TSHS(TSHS) ... +	
<input type="checkbox"/> Catalog	<input checked="" type="checkbox"/> Global Fire Spot	<input type="checkbox"/> Land Surface	<input type="checkbox"/> Land Surface	<input type="checkbox"/> Vegetation Index(NVI)
	<input type="checkbox"/> Snow Cover(SNC)	<input type="checkbox"/> Snow cover Fraction(SNF)	<input type="checkbox"/> Snow Water Equivalent(SWE)	<input type="checkbox"/> Soil Moisture(VSM)
<input type="checkbox"/> Period	<input type="checkbox"/> Orbit	<input checked="" type="checkbox"/> Daily	<input type="checkbox"/> 5 Days	<input type="checkbox"/> 10 Days
	<input type="checkbox"/> Monthly			

	Product ▲	Satellite	Instrument	Period	Format	Resolution	Start Date	Last Date	File count	Volume(GB)	Availability	Operation	Quality Report
<input type="checkbox"/>	MERSI-II global fire spot monitoring	FY3D	MERSI	DAILY	HDF	1000M	2019-04-30	2019-11-09	511	0.11	View	Go	
<input type="checkbox"/>	VIRR GFR Daily	FY3B	VIRR	DAILY	HDF	1000M	2010-12-14	2019-11-08	3238	1.45	View	Go	

FY-3 daily fire products can be downloaded from FY satellite data center .

Outline



1

Application in wildfire monitoring

2

Application in flood monitoring

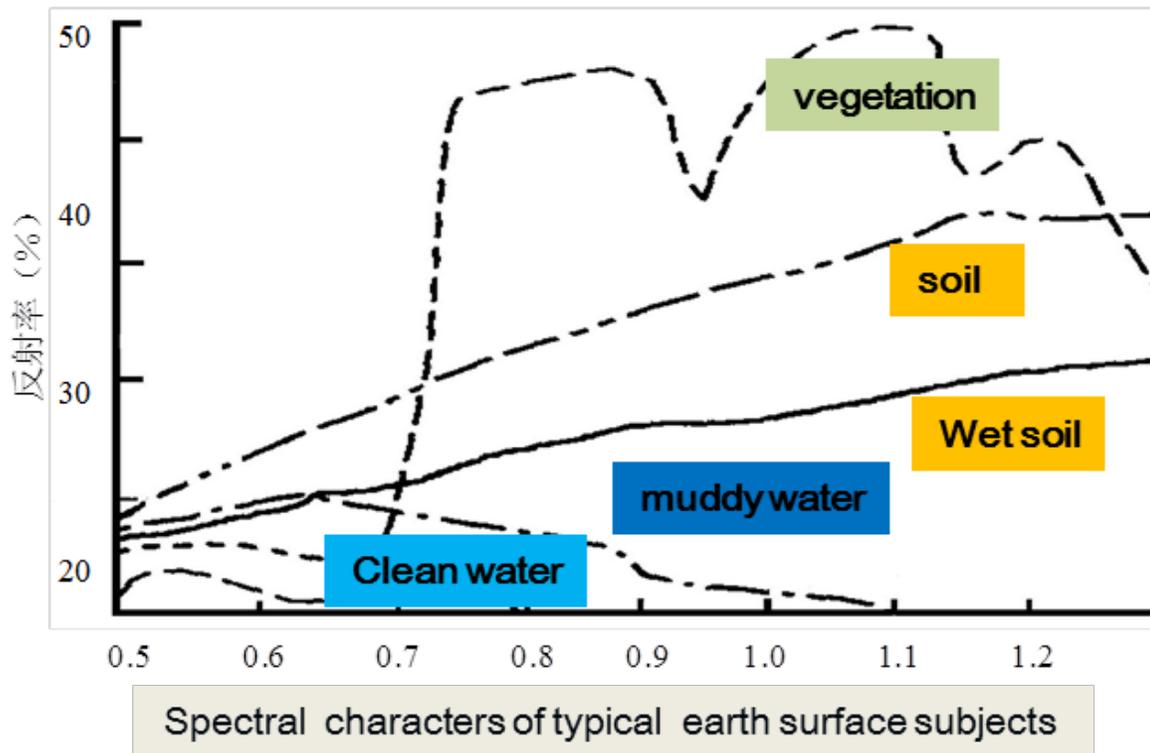
3

Application in agriculture monitoring

Theory of water Body and flood monitoring

Water body extraction by optical satellite data

- Optical remote sensing makes use of **visible and infrared sensors** to form images of the earth's surface by detecting the solar radiation reflected from targets on the ground.



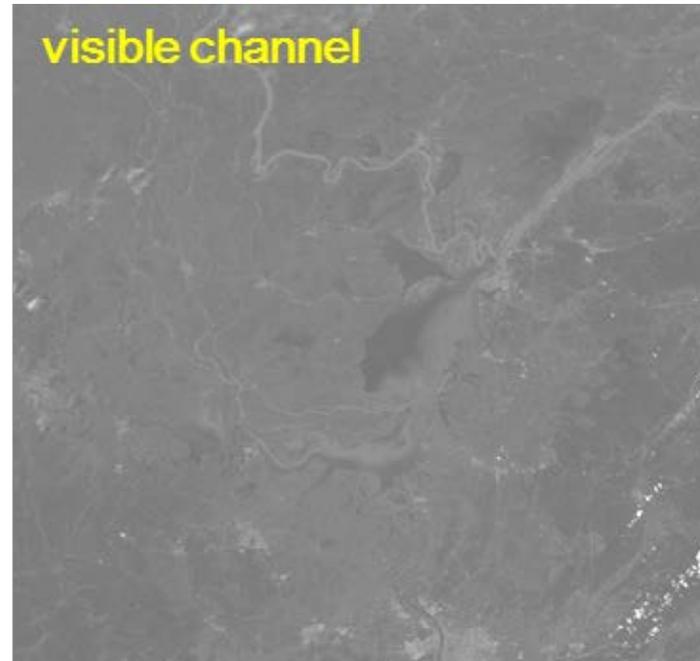
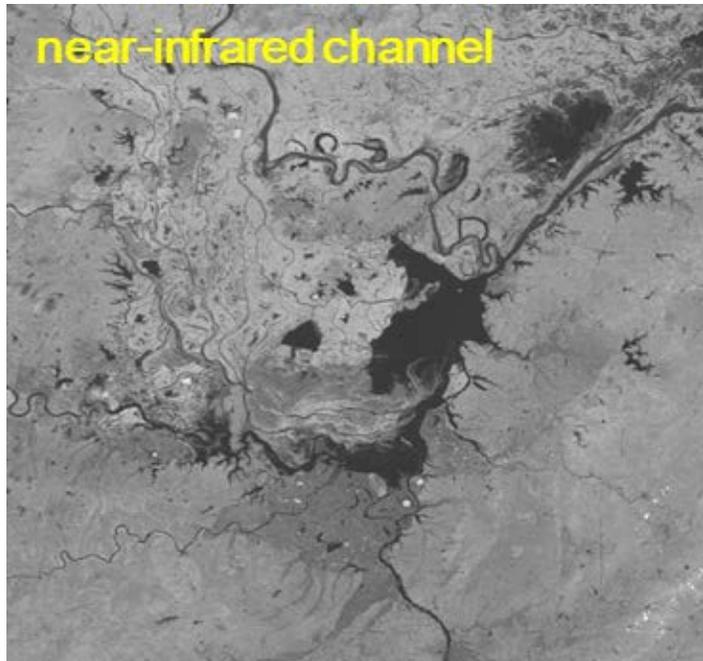
Theory: Water body has a strong absorption in near infrared channel, it leads to a very low reflectance in this channel and a lower reflectance than that in visible channel.

The reflection characteristics of vegetation and soil are just opposite to that of water.

Theory of water Body and flood monitoring

Water body extraction by optical satellite data

- The contrast of water body to ground surface (vegetation or soil) in near infrared is much higher than that in visible channel.
- The water body appeared in near infrared image is quite clear.
- So these two channels are the most effective channels for water body identification.



FY-3/MERSI, NOAA/AVHRR and
EOS/MODIS all have visible
and near infrared channels.

Water and flood monitoring method

- **(a) Water body identification under clear sky**

- In cloud free area, we can extract water body information from **near infrared channel data using the threshold.**

$$R_{nir} < R_{nir_T} \quad \text{Where } R_{nir} \text{ is the reflectance of near infrared. } R_{nir_T} \text{ is the threshold.}$$

- **(b) Water body identification under thin cloud**

- In the case of area covered by thin cloud, we can use **the ratio of near infrared channel and red channel to detect water body under thin cloud.**

$$\frac{R_{nir}}{R_{red}} < R_T \quad \text{Where } R_{nir} \text{ is the reflectance of near infrared, } R_{red} \text{ is the reflectance of red band, } R_T \text{ is the threshold.}$$

- **(c) Water body identification under the fog**

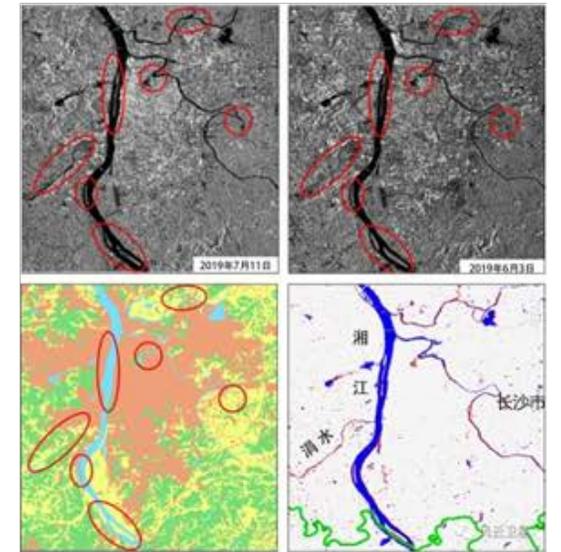
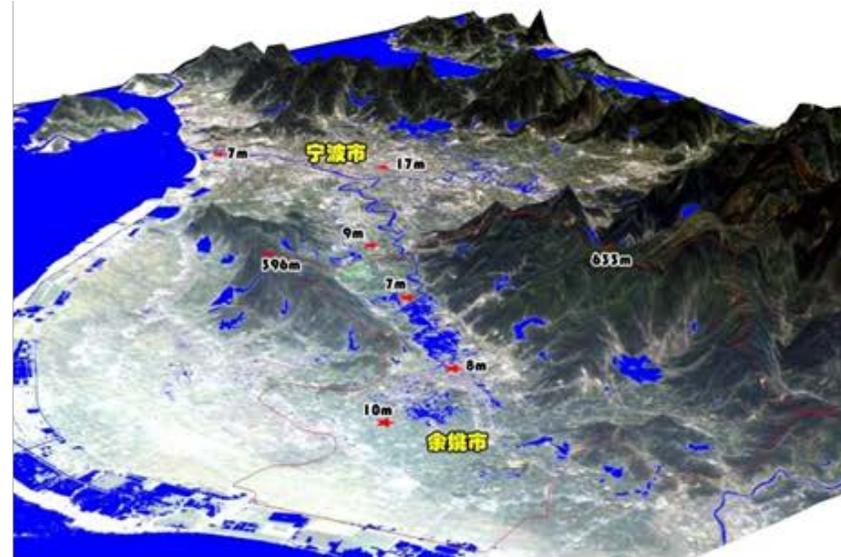
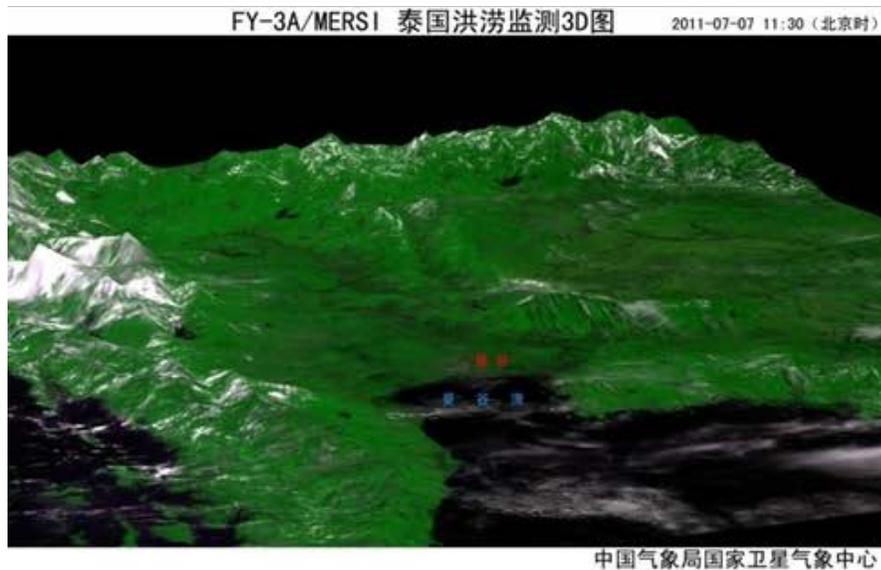
- When the water body covered by fog, **the proper temperature difference between mid-infrared and far-infrared channels are selected to identify the water.**

$$T_{mid} - T_{far} > \Delta T_L$$

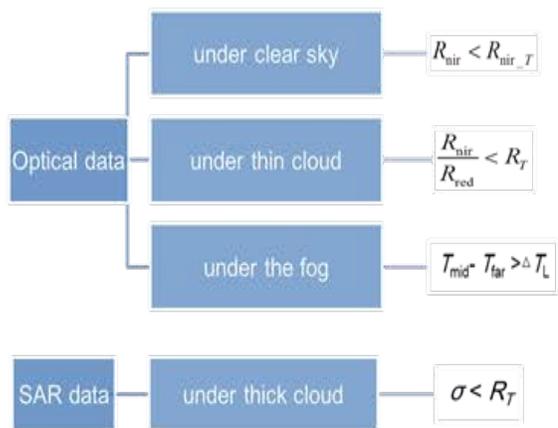
Where, ΔT_L is the difference between mid-infrared and far-infrared channels.

Flood monitoring

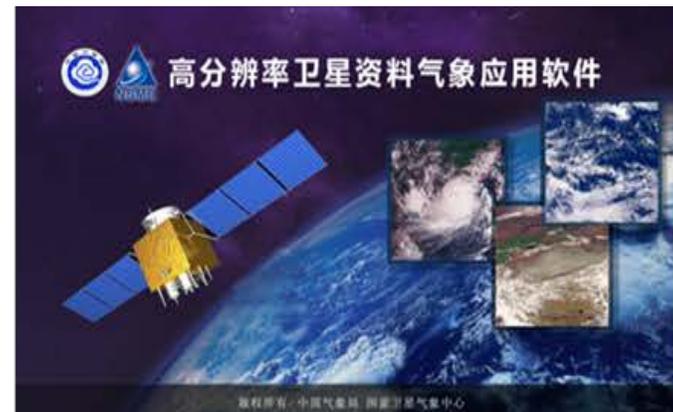
- **Flood monitoring**
- Water body identification is the base of flood monitoring.
- Usually, we classify multiple images acquired before and after the flood and then compare the classification results to identify water expansion or shrinking areas.
- Geographic Information System (GIS) technique is extensively used in quantitative analysis and thematic mapping during flood monitoring.



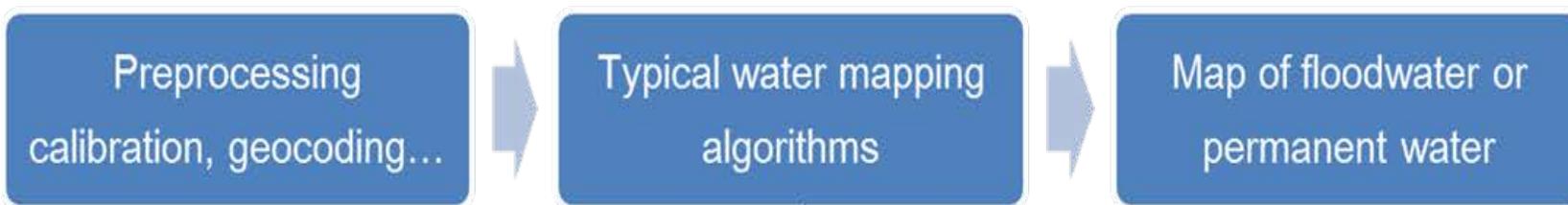
Desktop software for flood monitoring



SMART
FY satellite data



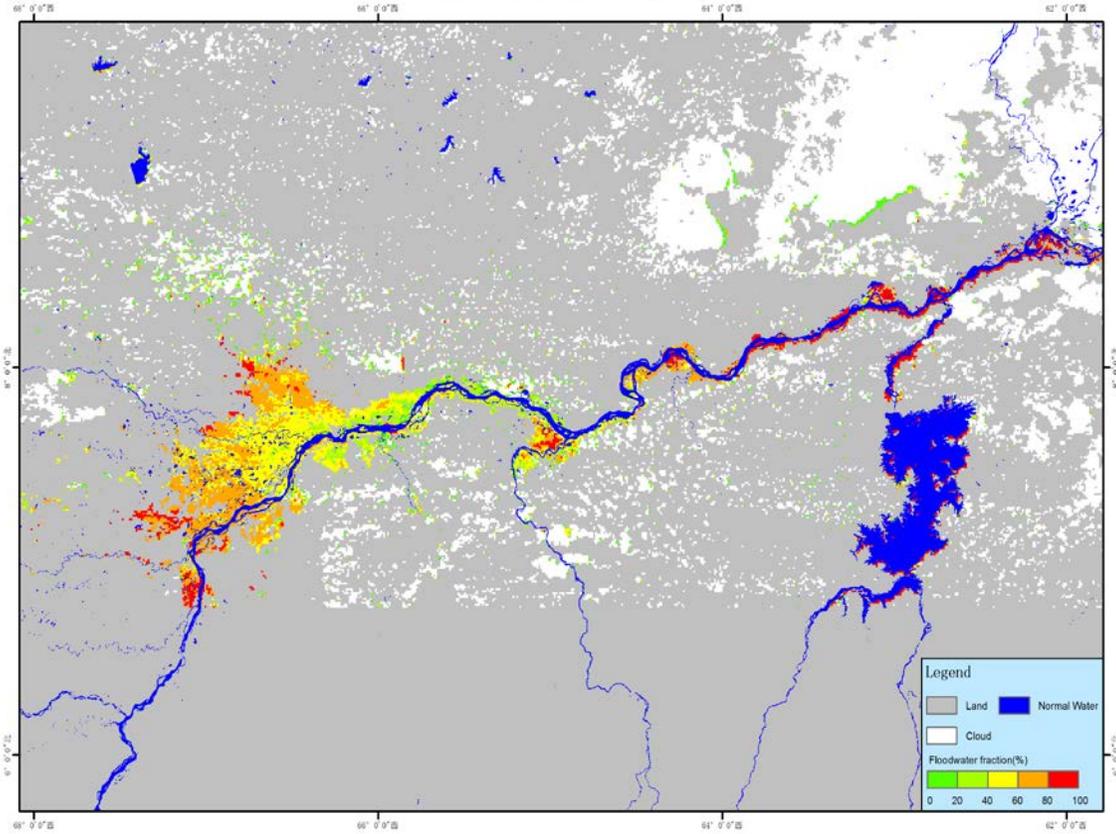
High resolution satellite data for
meteorological application software



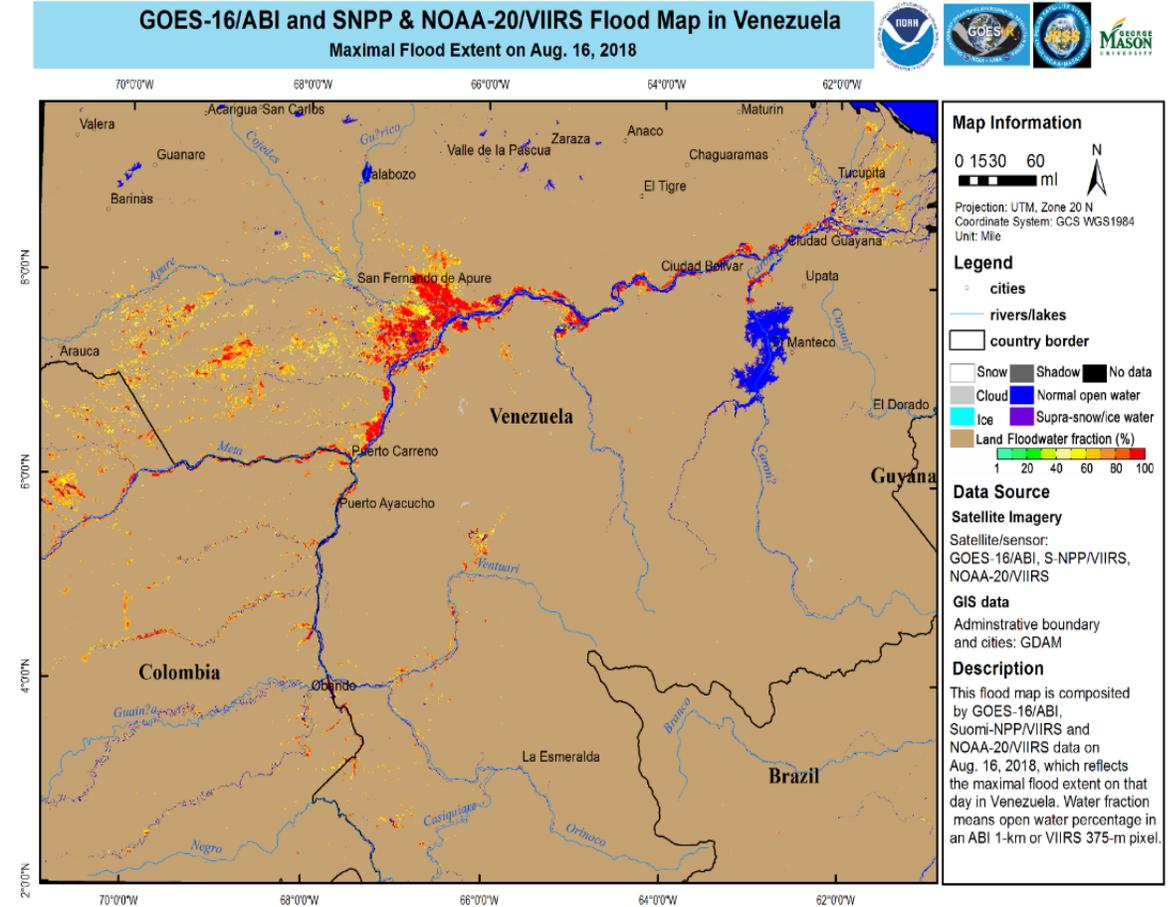


Flood monitoring in Venezuela

FengYun-3D/MERSI Flood Map in Venezuela
Maximal Flood Extent on Aug.20,2018

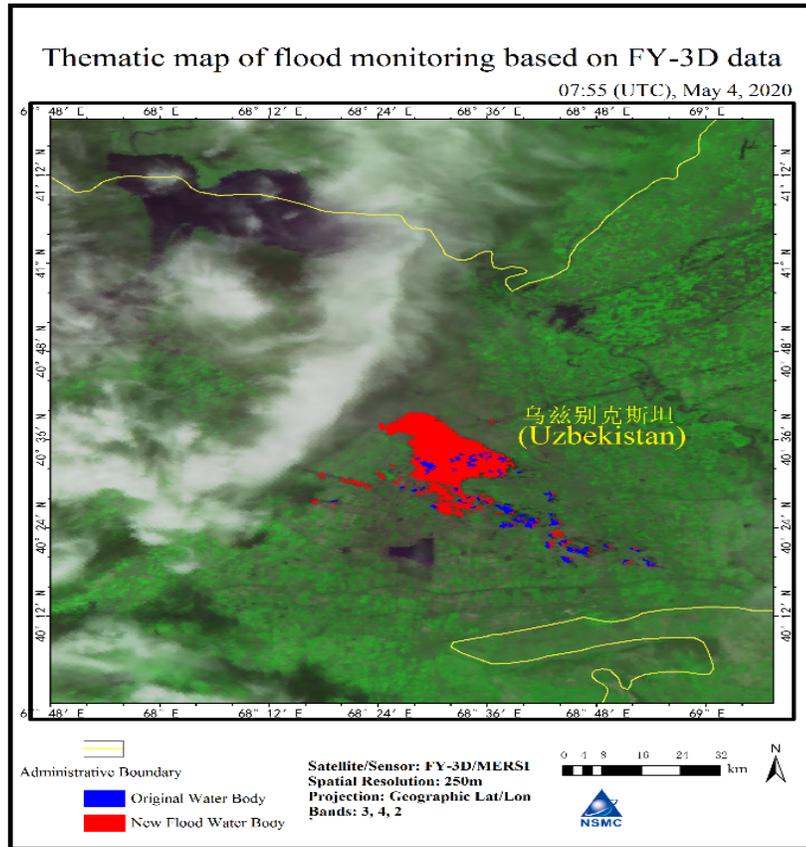


GOES-16/ABI and SNPP & NOAA-20/VIIRS Flood Map in Venezuela
Maximal Flood Extent on Aug. 16, 2018





Uzbekistan dam break monitoring



Satellite Remote-sensing Report

May 4, 2020

National Satellite Meteorological Center

Sardoba Reservoir Dam Break Monitoring in Uzbekistan

It is reported that dam break occurred in Sardoba reservoir, Syr Darya states, Uzbekistan, at 6:00 on May 1, 2020. A total of 56 people were injured, and about 70000 people were evacuated.

A large range of new flood water body was found in Syr Darya states, Uzbekistan through comparison of water body monitoring of FY-3D satellite images before (April 27 2020, Fig. 1) and after (May 2, 2020, Fig. 2) the Dam break. The flood area is about 320 square kilometers in the clear sky estimated by FY-3D satellite (Fig. 3).

There are still large range of new flood water body in Syr Darya states, Uzbekistan, monitoring through the latest FY-3D satellite images (May 4, 2020, Fig. 4). The flood area is about 220 square kilometers in the clear sky estimated by FY-3D satellite at 07:55 (UTC) on May 4 (Fig. 4), and the range of flood water body decreased relative to the results of May 2, 2020.



Outline

1

Application in wildfire monitoring

2

Application in flood monitoring

3

Application in agriculture monitoring

1. Staple Crop Area Extraction

□ Macro distribution of crops

——To serve for disaster impact assessment and crop growth monitoring

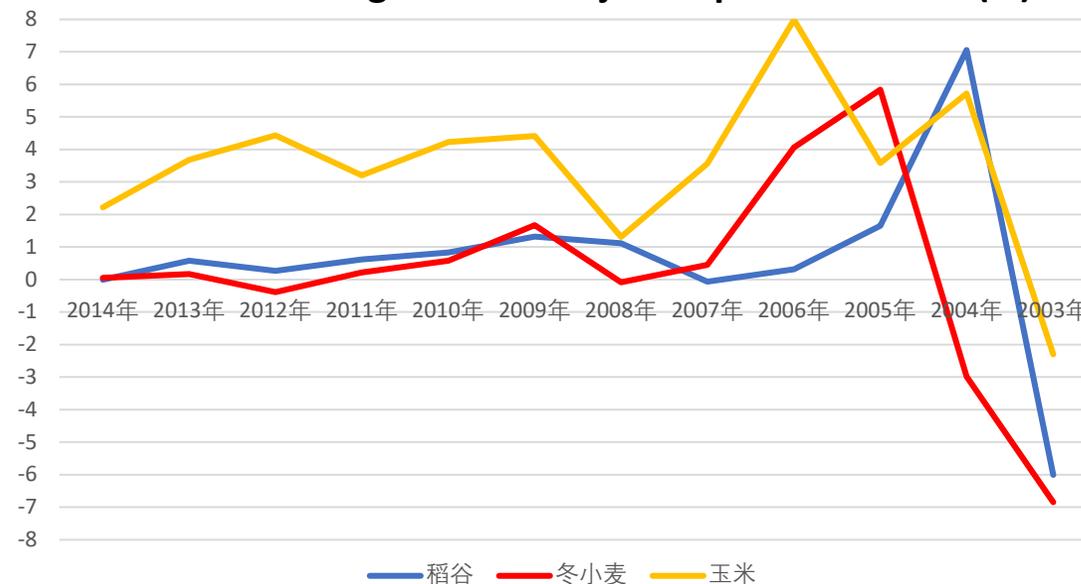
——Lower accuracy

□ Crop planting area

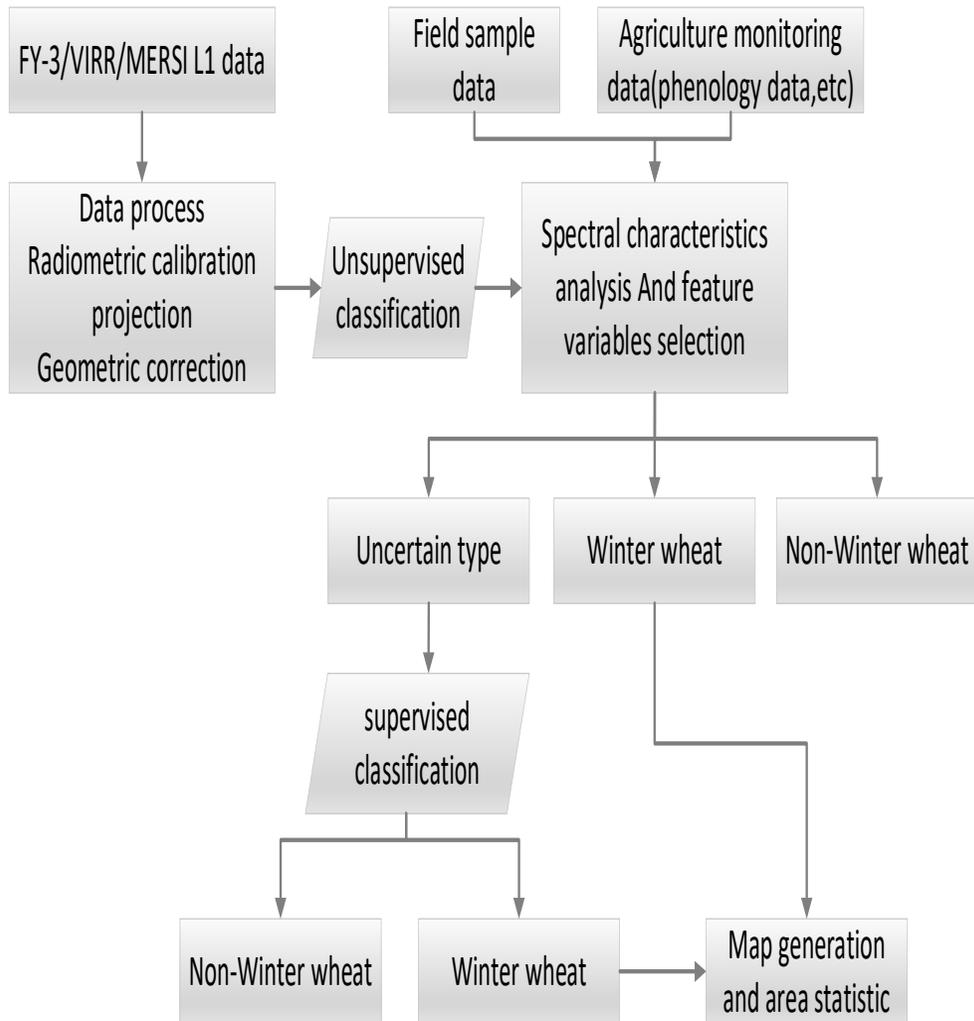
——To serve for Total crop yield forecast

——To require high accuracy

Inter-annual change rate of major crop area in China(%)



- The inter annual change rate of major crop area is small;
- It is applicable in yield estimation only that the error of remote sensing crop area is lower than 5%



□ Gather field samples and establish database

□ Select and process temporal FY-3 data based on crop phenology

- Depend on Phenology data to determine the period of remote data;
- combined phenology data with the historical crop data to predict the mixed crops, estimate the separable information of the mixed crops;
- Construct the original expectation value of the crop time spectral pattern based on Phenology data.
- Winter wheat (over-wintering period oct. –Dec., Turning Green Stage Feb.-Apr.)

□ Analyze spectral Characteristic of bands and construct feature variable of FY-3 data

- Those channels with more information, less correlation, large spectral difference and good. Further more, construct feature variables by using characteristic bands

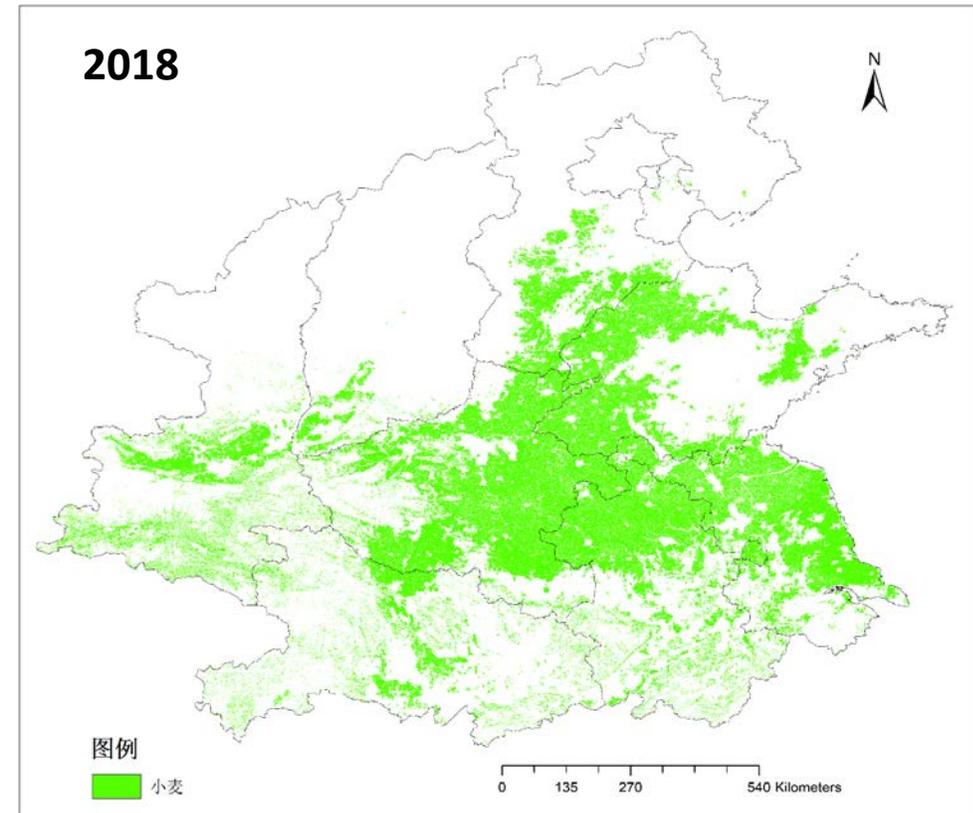
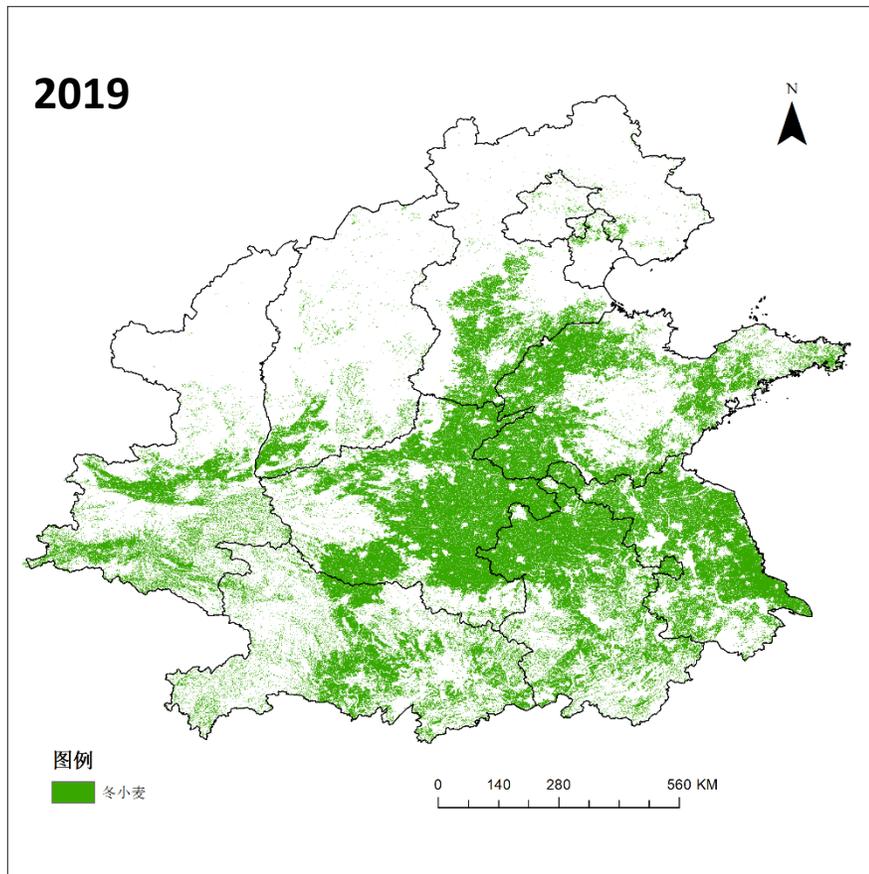
□ Extract crop area based on FY-3 data

- By analyzing the characteristics of crop TIME-SPECTRUM schema, image texture and time series, construct decision tree model. using supervised classification method for crops area extraction.

□ Validation and Mapping

Winter wheat in major producing area of North China in 2018, 2019

Using FY-3 data, we can extract several kinds of staple crops area (winter wheat, corn, rice, etc.) dynamically, which can provide the basis for crop growth monitoring.



Compared with the areas of last year, The winter wheat areas of Henan, Shandong and Hebei in 2109 are same as those in 2018. the area of Anhui and Hubei increase this year increase.

2. Phenology Monitoring

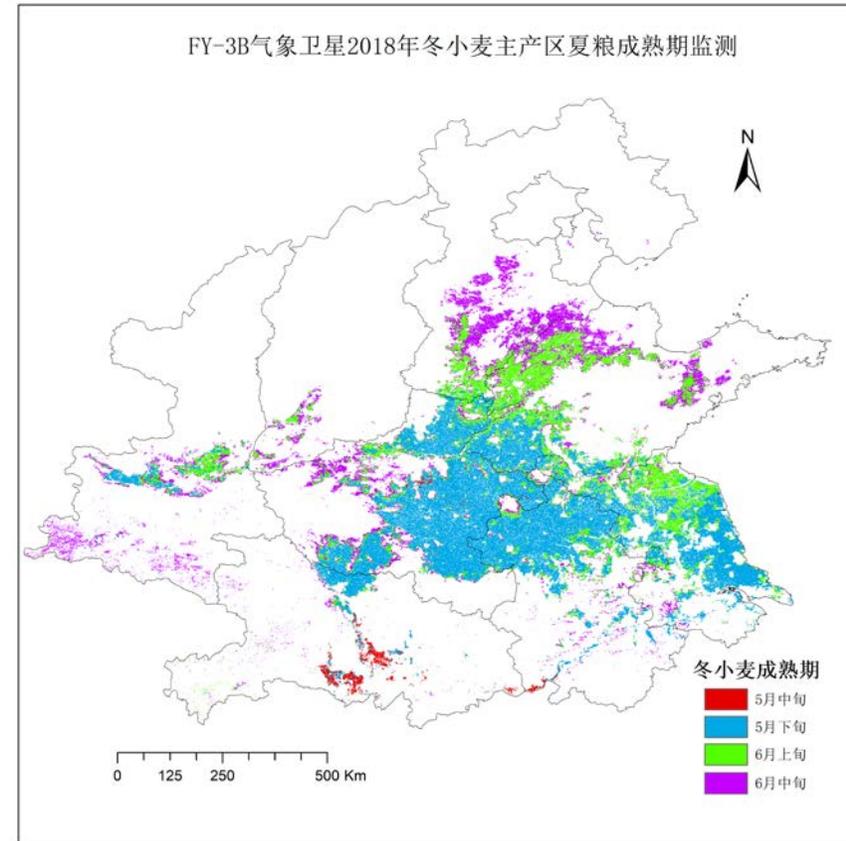
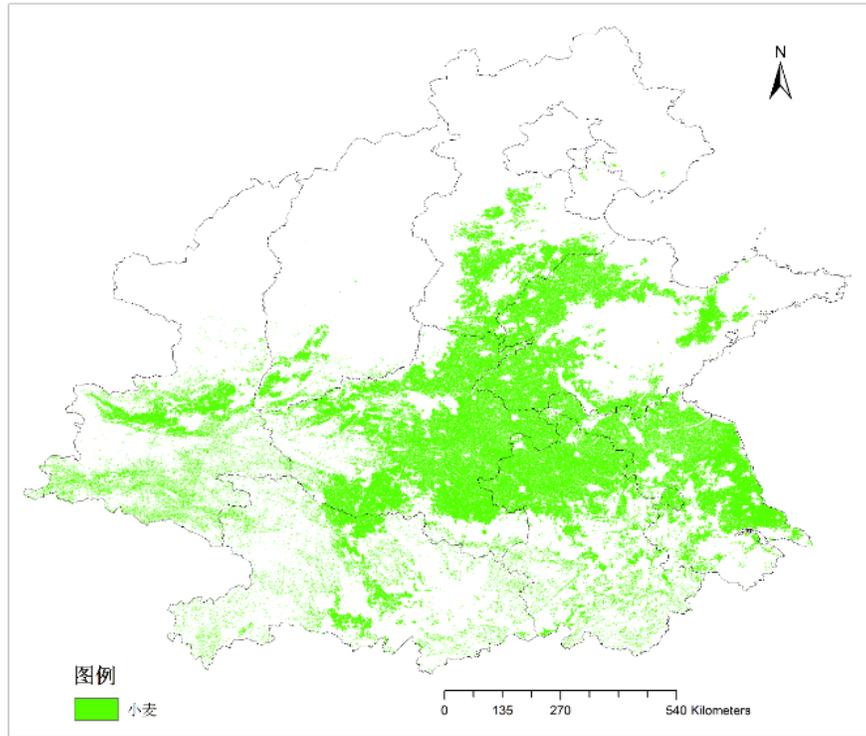
- Remote sensing of crop phenology is to find out the significant changes in crop morphology, the corresponding date and the time of plant growth cycle.
- The key of Phenology remote sensing is **to define the detection criteria of phenology using the characteristics of VI time series curve and how to extract these information from time series data.**
- Three key growth periods is to be determined for Winter wheat phenology monitoring :
 - Turning green period** -NDVI rise rapidly
 - Heading period** - NDVI maximum, transformation from vegetative Growth period to reproductive growth period),
 - Maturation period**-NDVI decline rapidly

Phenology Monitoring of Winter Wheat in Major Producing Area

Processing flow

- ❑ Establish ten-day NDVI series of FY-3(VIRR/MERSI) based on winter wheat growth phenology.
- ❑ Time series smoothing process : Adopt time series smoothing method(e.g S-G filter) to eliminate the influence of cloud and noise in order that the trend of VI time series coincide with the real vegetation growth rhythm.
- ❑ Construct crop growth curve in the pixel scale.
- ❑ Make linear regression on the VI data in the sliding time window, using the maximum slope method to determine turning green period, heading period, harvest period.

Maturation Period of Major Producing Area of Winter Wheat in 2018



In the last ten days of May, 2018, winter wheat in the northwest of Hubei, the middle and east of Henan, the southwest of Shandong, the north of Anhui and the middle of Jiangsu entered into maturation period.

3. Crop growth monitoring

Crop growth monitoring of remote sensing

Refer to the macro monitoring of crop seedling, growth and its changes, providing the basis for crop yield estimation in early stage

real-time growth monitoring

Find crop growth change by comparing the real-time VI with last year's or multi-year average, as well as a specified year. The differences can be classified and statistically displayed.

growth trend analysis

To be constructed by the time series VI data, and the crop growth state is reflected by the inter annual comparison of the growth process curve.

Real-time growth monitoring

□ Difference Index (DI)

$$DI_j = NDVI_j - NDVI_{ref}$$

Where, $NDVI_j$, $NDVI_{ref}$ are NDVI of current j and NDVI of reference year. The bigger DI, the better crop growth.

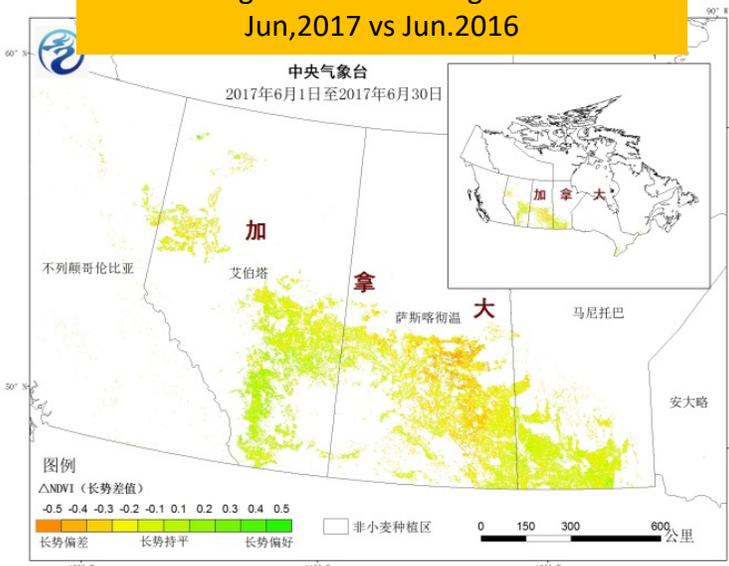
□ Vegetation Condition Index (VCI)

$$VCI_j = \frac{NDVI_j - NDVI_{min}}{NDVI_{max} - NDVI_{min}}$$

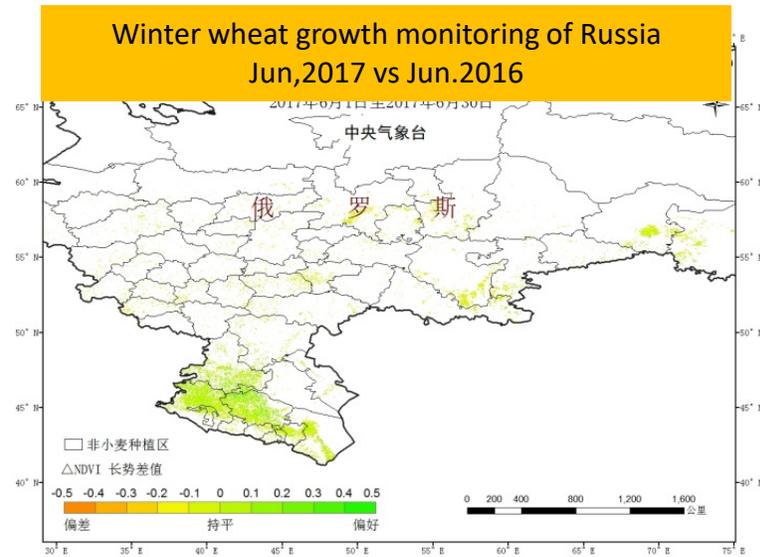
Where, VCI_j – VCI of period(time) j , $NDVI_j$ is NDVI of period(time) j , $NDVI_{max}$ is the max NDVI of the same period(time) over many years, $NDVI_{min}$ is NDVI of the same period(time) over many years. The bigger VCI, the better crop growth.

Crop growth monitoring in global major producing area

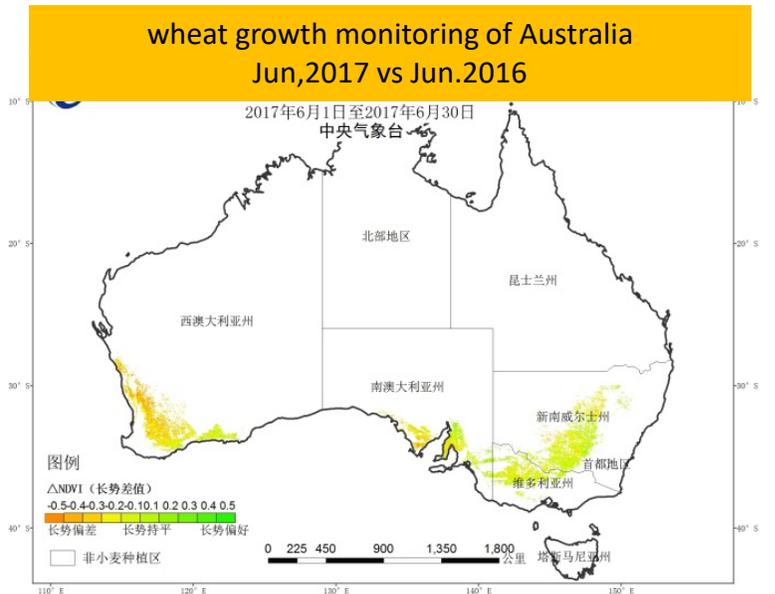
Wheat growth monitoring of Canada
Jun, 2017 vs Jun. 2016



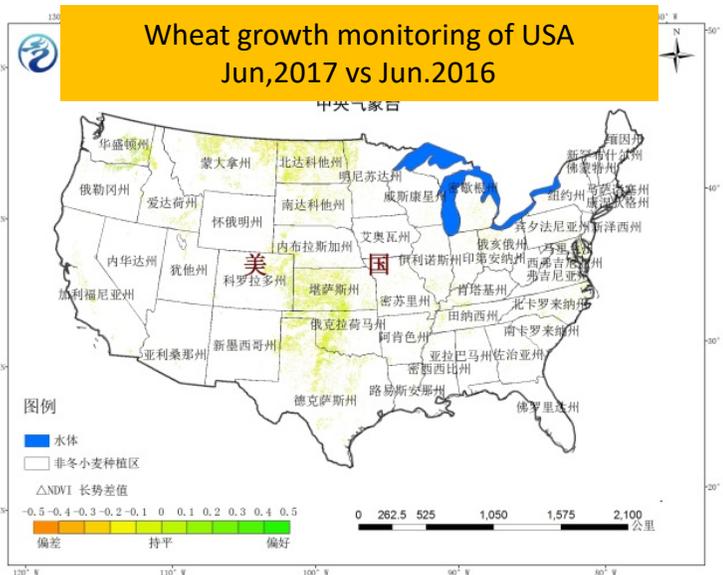
Winter wheat growth monitoring of Russia
Jun, 2017 vs Jun. 2016



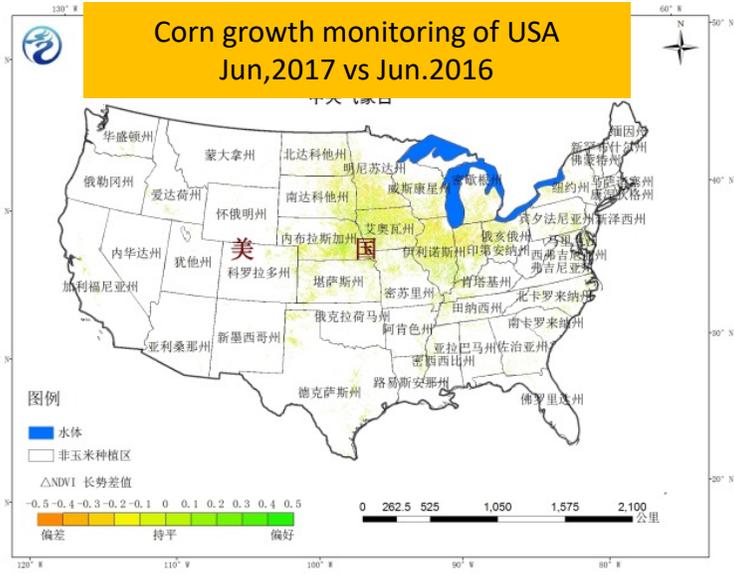
wheat growth monitoring of Australia
Jun, 2017 vs Jun. 2016



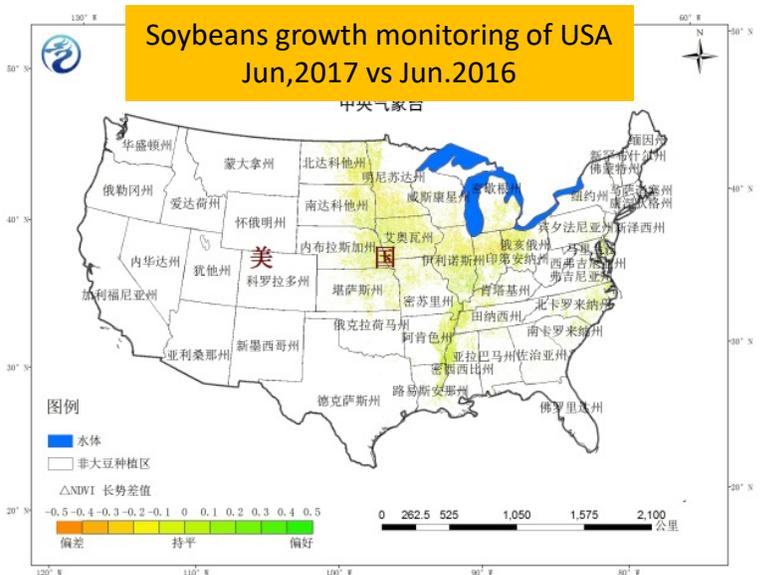
Wheat growth monitoring of USA
Jun, 2017 vs Jun. 2016



Corn growth monitoring of USA
Jun, 2017 vs Jun. 2016



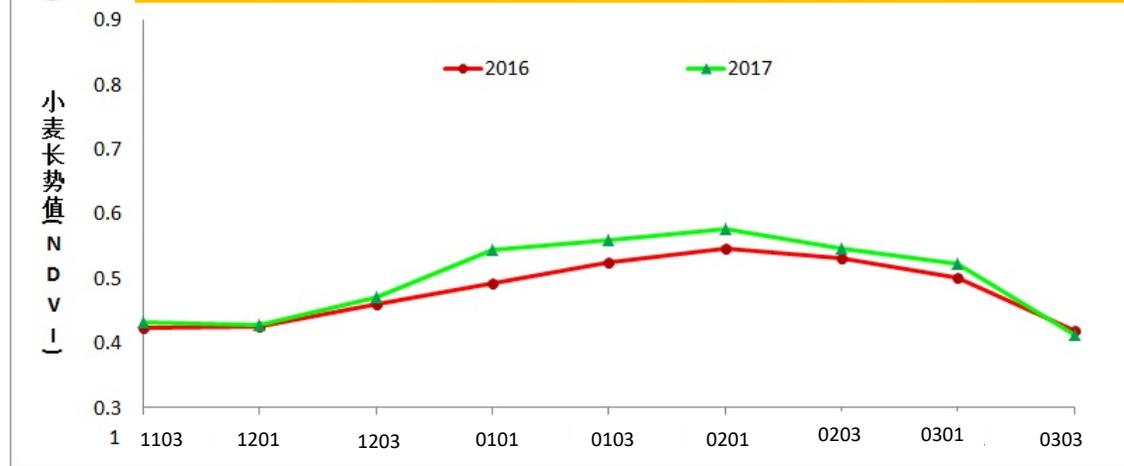
Soybeans growth monitoring of USA
Jun, 2017 vs Jun. 2016



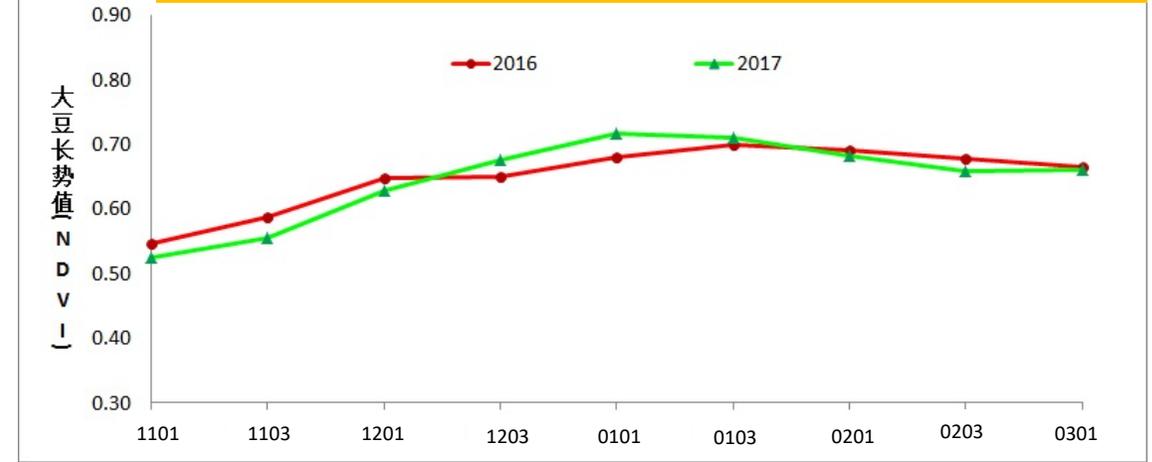
Crop growth monitoring in global major producing area—Growth trend analysis



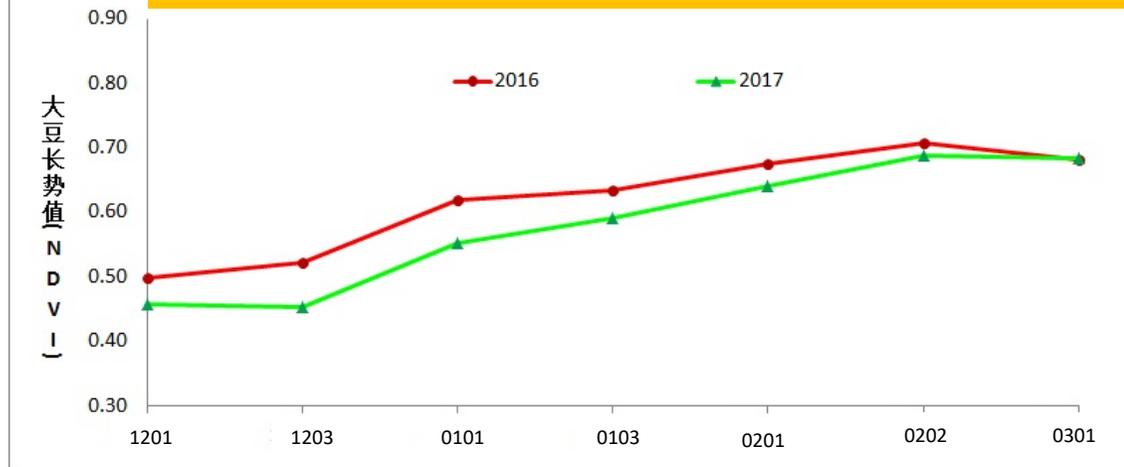
Wheat growth monitoring of India during growing season 2017 vs 2016



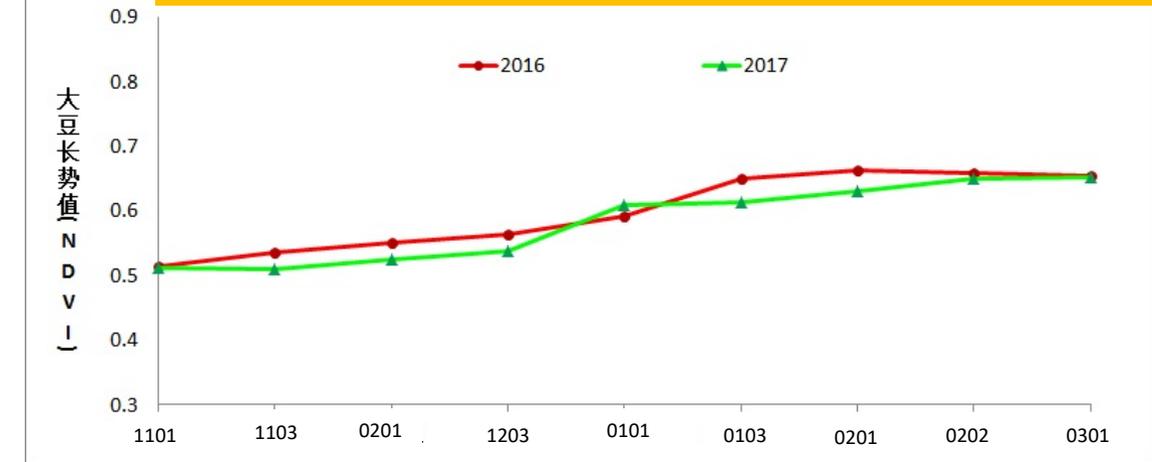
Soybeans growth monitoring of Brazil during growing season 2017 vs 2016



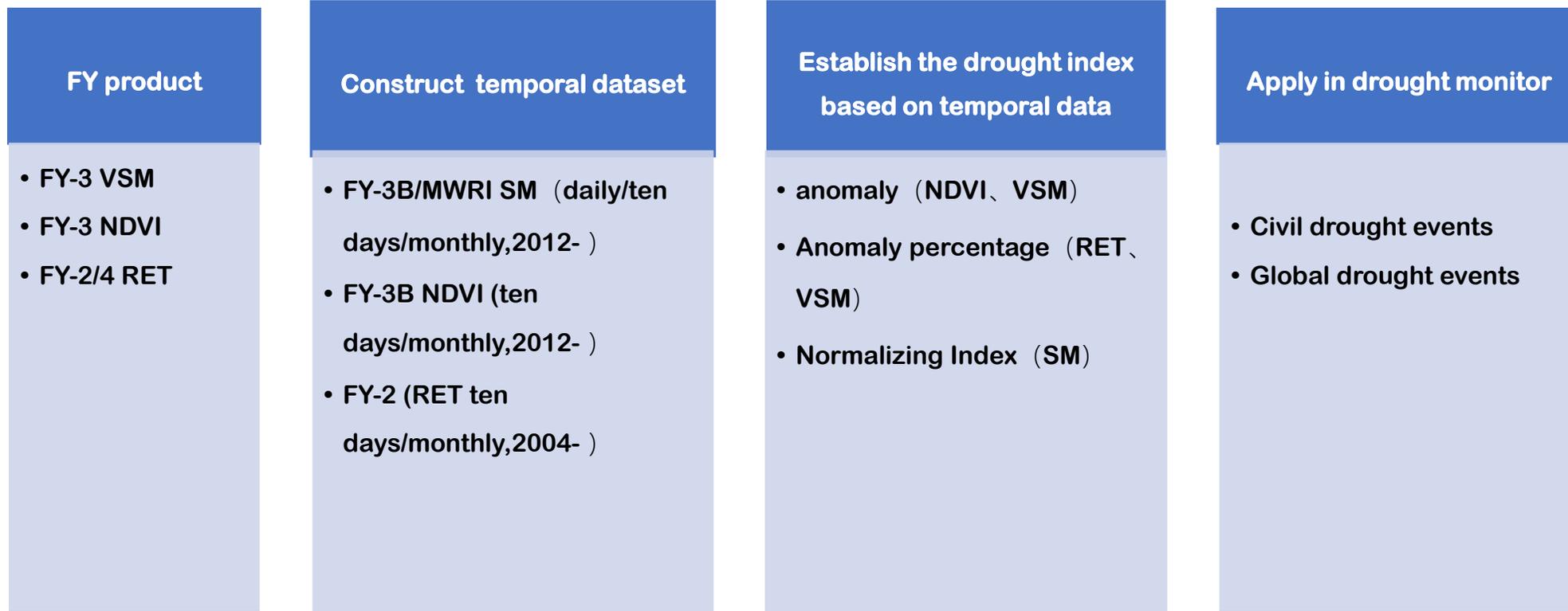
Soybeans growth monitoring of Argentina during growing season 2017 vs 2016



Soybeans growth monitoring of South America during growing season 2017 vs 2016



4. Drought Monitoring



Improvement of drought monitoring methods and indicators

Construct drought index based on FY-3/ SM

Soil moisture -- Soil volume water content (absolute value)

- Disadvantages: soil water holding capacity in different regions are different, and the same soil volume water content represents different degrees of dryness and wetness in different soil conditions.

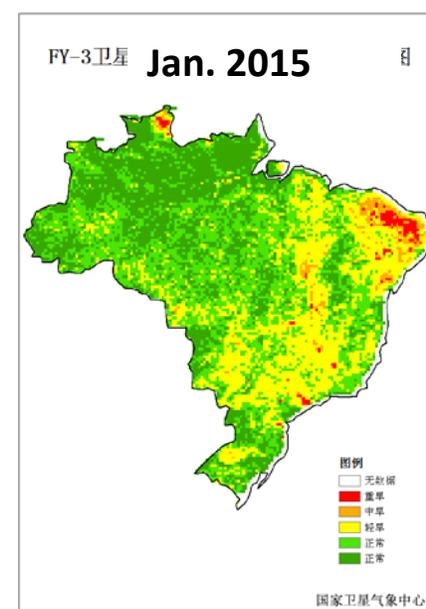
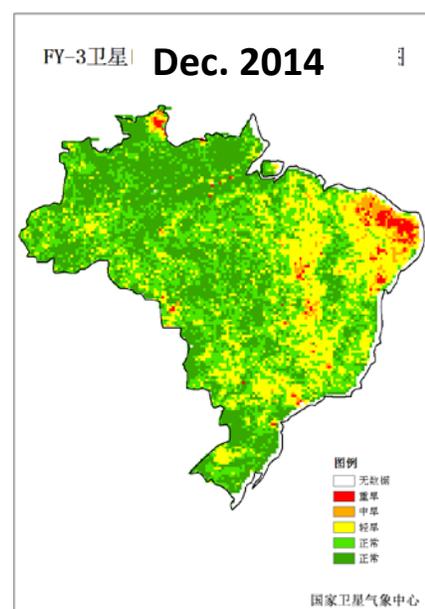
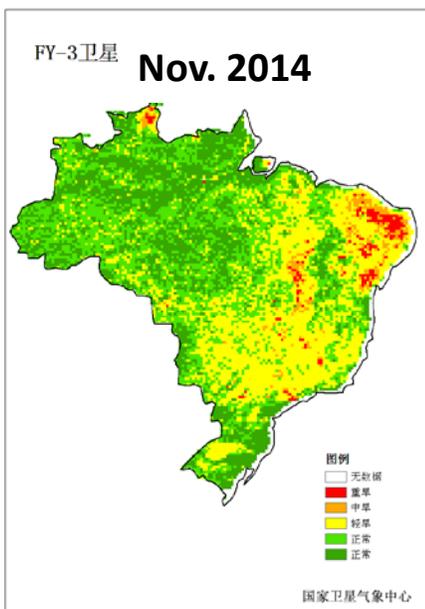
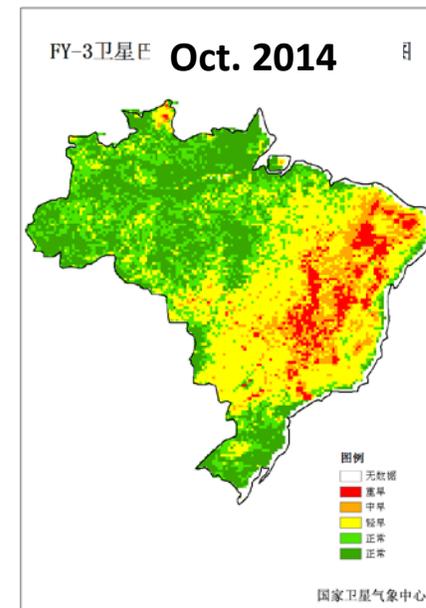
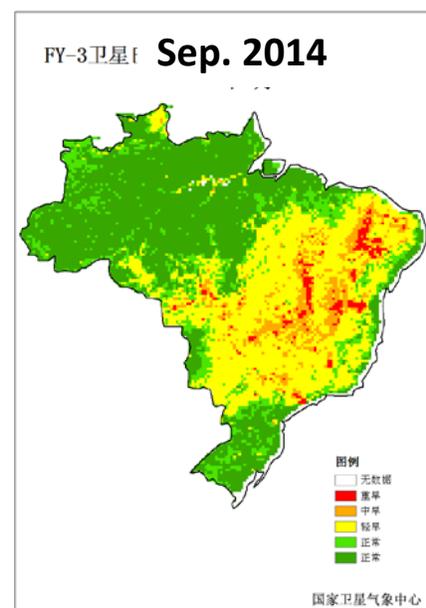
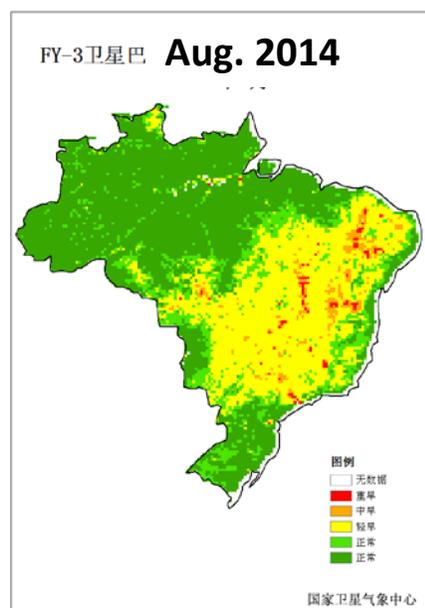
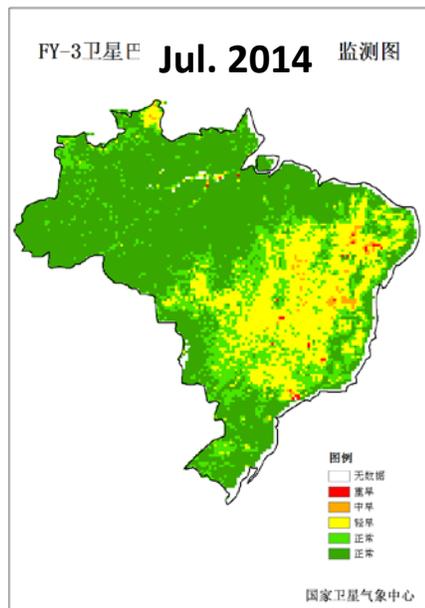
The SM difference between some time and the same period of the previous year

- Disadvantages: lack of stable reference

- **The soil moisture product of FY-3/MWRI have accumulated for 11 years** of data since the launch of FY3B (2010.10).
- **Based on the temporal series FY-3B / MWRI soil moisture data three indices are constructed:**
- **Anomaly , Anomaly percentage and normalized SM index (Nindex);**

$$Nindex = \frac{SM - SM_{min}}{SM_{max} - SM_{min}}$$

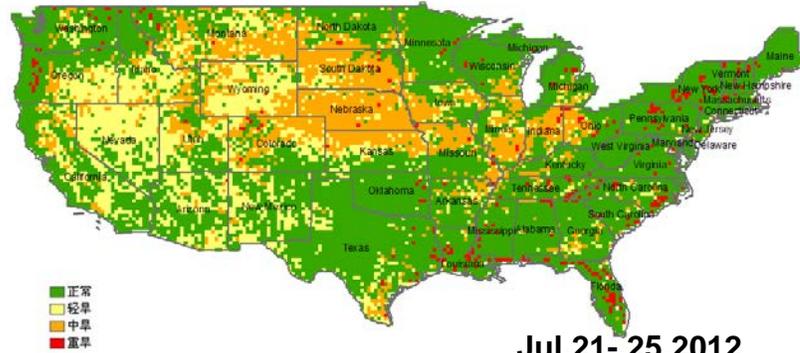
Drought monitoring of Brazil---FY-3B/MWRI soil moisture



FY-3B SM , since July 2014, there has been a large-scale drought in the eastern and south central parts of Brazil. From Sep to Oct, the drought in the eastern region has intensified, and some regions have reached a severe drought. In November, the drought has eased compared with that in October, but some regions in the northeast of Brazil still maintain a severe drought.

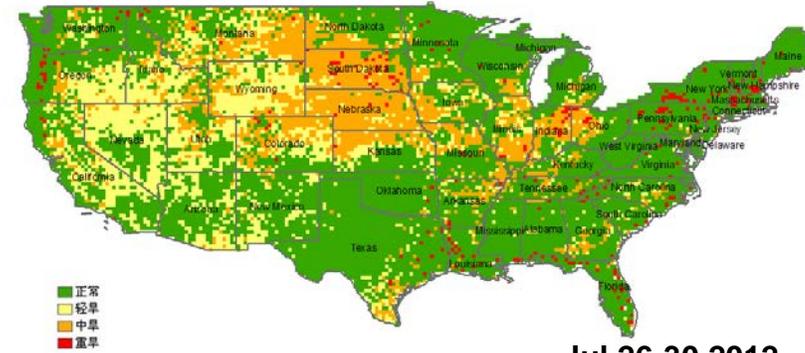
Drought monitoring of USA---soil moisture difference

FY-3B/MWR1 美国干旱监测图
2012年7月21日-7月25日



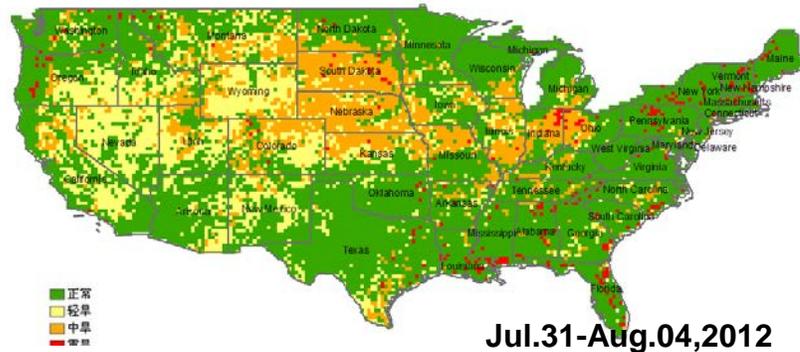
Jul.21-25,2012

FY-3B/MWR1 美国干旱监测图
2012年7月26日-7月30日



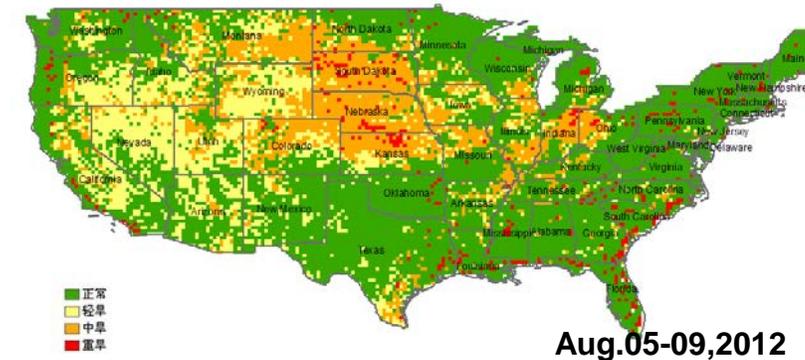
Jul.26-30,2012

FY-3B/MWR1 美国干旱监测图
2012年7月31日-8月4日



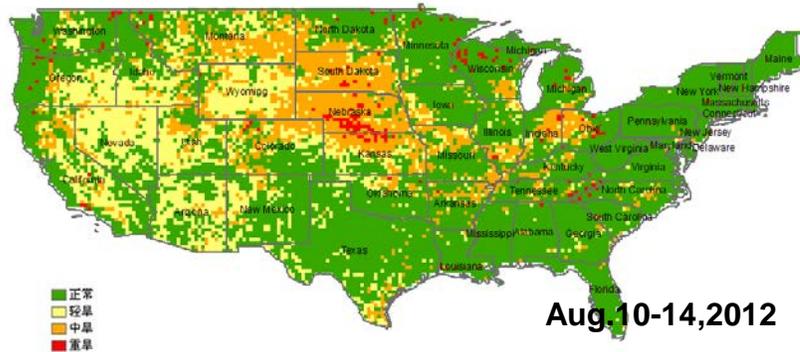
Jul.31-Aug.04,2012

FY-3B/MWR1 美国干旱监测图
2012年8月5日-8月9日



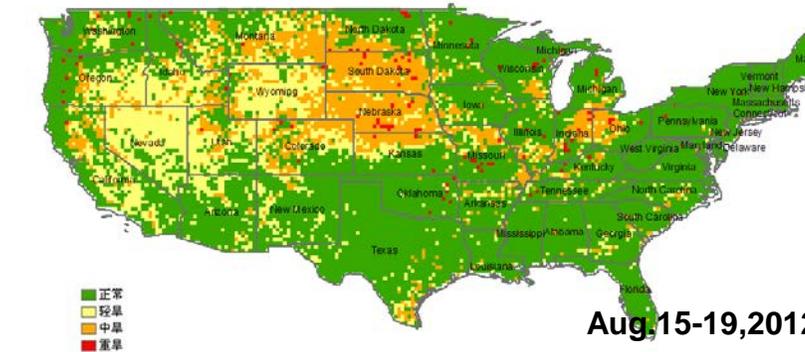
Aug.05-09,2012

FY-3B/MWR1 美国干旱监测图
2012年8月10日-8月14日



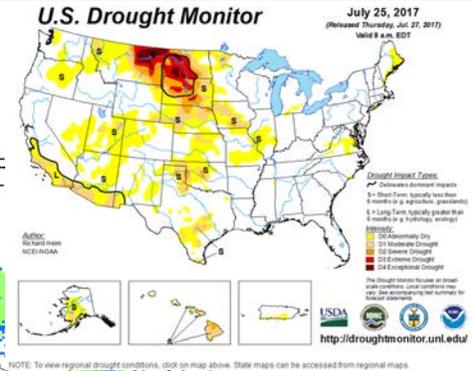
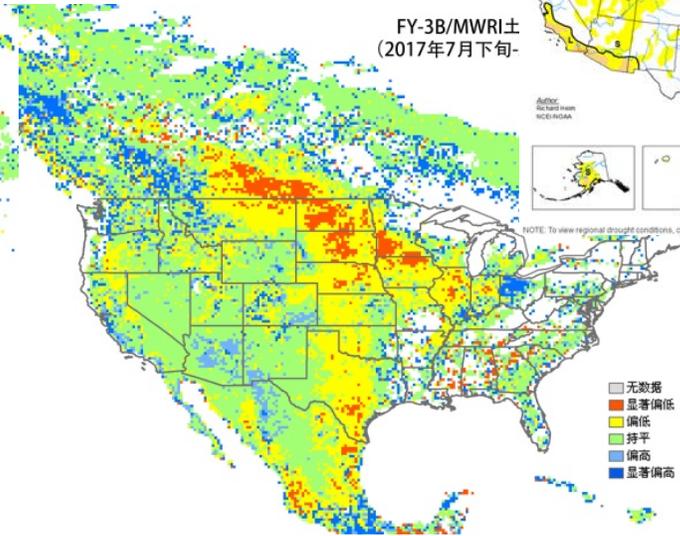
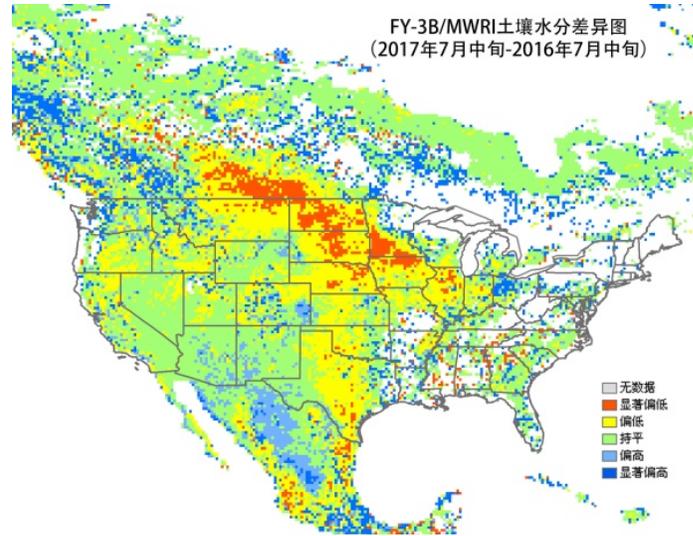
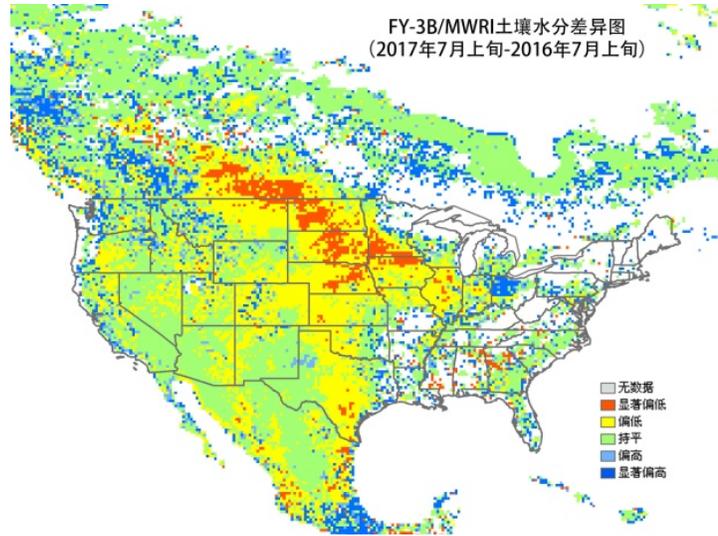
Aug.10-14,2012

FY-3B/MWR1 美国干旱监测图
2012年8月15日-8月19日

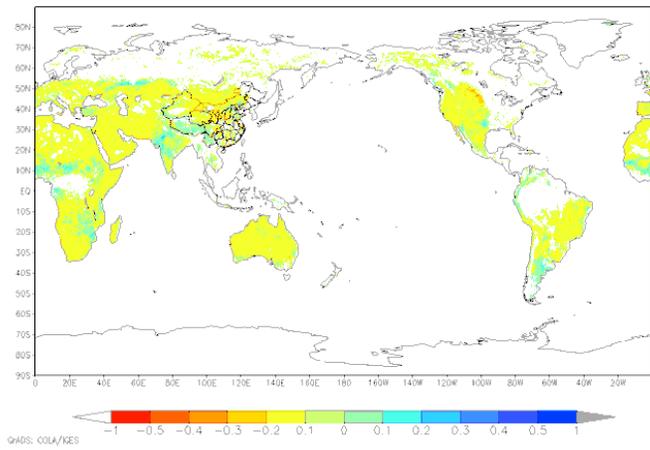


Aug.15-19,2012

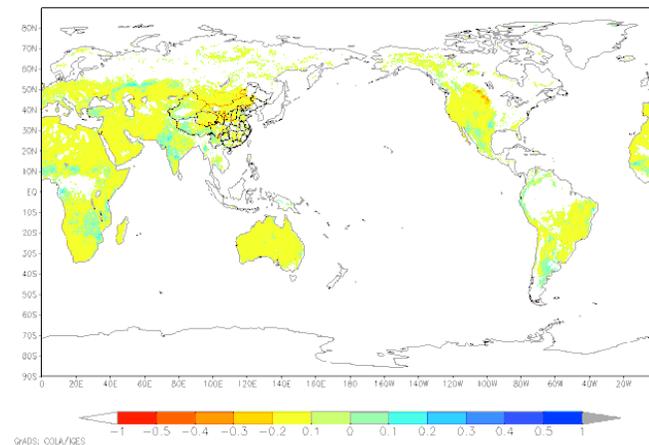
Drought monitoring of USA, in Jul. 2017



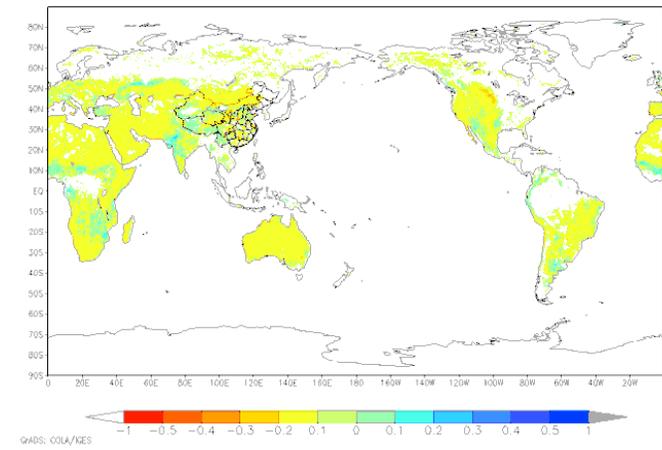
Glb_201707_1xun-anomaly



Glb_201707_2xun-anomaly



Glb_201707_3xun-anomaly





Thank you for your attention!

Email:

gaohao@cma.gov.cn

For more information, please visit the following website:

<http://rsapp.nsmc.org.cn/geofy>

http://rsapp.nsmc.org.cn/test_geofy

<http://satellite.nsmc.org.cn>

