FengYun 2C and Its Application

Celebration of CIMSS’s Silver Anniversary

- Review of over 25 years’ bilateral cooperation
- Products from FY2C Meteorological Satellite

P. Zhang on behalf of Xu Jianmin
Visitors from NSMC to CIMSS

- **1980s: Fengxian Zhou, Xia-Lin Ma, Zonghao Wang, Yanni Qu**
  - McIDAS was introduced and used on NSMC
  - ITPP PC version was generated and distributed

- **1990s: Jun Li, Wenjian Zhang**
  - ITPP improved version was generated and distributed
  - IAPP was generated and distributed

- **2000s: Zhongdong Yang, Xuebao Wu, Peng Zhang, Feng Lu**
  - IMAPP algorithm and software development
  - GOES calibration
Other short visitors

- Academician: Jianmin Xu
- Academician: Bolin Zhao
- Former NSMC director: Chaohua Dong
- Prof. Yuanjing Zhu

Staff here from NSMC

- Xuanji Wang
- Hong Zhang
CIMSS visitors to NSMC

Tom Achtor,
Chris Velden,
Hank Revercomb,
Jun Li,
Allen Huang,
Paul Menzel,
Liam Gumley,
Hal Woolf,
Steve Ackerman ……
**WMO - OMM**

**NSMC and NESDIS/ORA**

* Working together on WMO Expert Team that is influencing vision of Global Observing System of 2015

* Sharing DB Processing Packages for FY2 plus MODIS & AIRS

* Conducting remote sensing seminars in real and virtual labs

---

**GOS**

**X-band Antenna**

**Classroom in China**
Dr Jun Li of NESDIS/CIMSS awarded title “guest chief scientist” by NSMC in March 2003

Dear Paul, Hank, Steve, and Tom,

I am pleased to inform you that Dr. Jun Li, a scientist at your center, has been awarded the title of "guest chief scientist" on satellite atmospheric sounding by National Satellite Meteorological Center (NSMC) of China in March. He is the first scientist out of NSMC who has received this title. A certificate (Chinese version) has been given to him. From our point of view, Dr. Jun Li's research work, talent, and publications on atmospheric remote sounding during the past 10 years are highly recognized at NSMC. In addition, he has not only made great achievements in research, but also made great contribution in promoting the cooperative research work between NSMC and CIMSS on processing and applying data from both U.S. and Chinese weather satellites. .......

Sincerely,

Wenjian Zhang
Director General National Satellite Meteorological Center(NSMC) of China
MODIS identifies cloud Classes

By Zhongdong Yang
Sensitivity Study for Land Surface Emissivity by Xuebao Wu

PhD work with Prof Zhu Yuanjing with guidance from Paul Menzel (NESDIS) and Zhang Wenjian (NSMC)
Dust Storm Remote Sensing with 3 TIR channels

By Peng Zhang
EE Effects on GOES-R HES Simulated from MAS data

By Peng Zhang

Original MAS fold BT image

Radiance clear 12.00 7.1592 0.5653 0.1135 0.0503 0.027 0.0176 0.0121

Radiance cloudy 12.00 6.9406 0.5472 0.1098 0.0487 0.0261 0.017 0.0117

Radiance clear 13.83 3.3778 0.266 0.0537 0.0238 0.0128 0.0084 0.0057

Radiance cloudy 13.83 3.423 0.2696 0.0544 0.0241 0.0129 0.0085 0.0058

FOV 1st nbr 2nd nbr 3rd nbr 4th nbr 5th nbr others

clear 12.00 7.1592 0.5653 0.1135 0.0503 0.027 0.0176 0.0121
clear 13.83 3.3778 0.266 0.0537 0.0238 0.0128 0.0084 0.0057
cloudy 12.00 6.9406 0.5472 0.1098 0.0487 0.0261 0.017 0.0117
cloudy 13.83 3.423 0.2696 0.0544 0.0241 0.0129 0.0085 0.0058
MODIS direct reception software developed at NESDIS/CIMSS and implemented at NSMC added generation of cloud mask & level 2 cloud and clear sky products.
MODIS sees fires in China
FY1C sees clouds over CONUS
Continuing Collaboration on Cal/Val on Remote Sensing Instruments using instrumented ground sites

MODIS Band 2 Reflectance Histogram
Samples Location: QinHai Lake Water Surface, CHINA

 Calibration accuracy of MODIS Band 2 is found to be within 1.5% of Qin Hai Lake in situ measurements.

Zhongdong Yang

Calibration of NOAA 17 AVHRR ch1 pre and post launch comparison
ZhangYuxiang, Rongzhiguo, HuXiuqing, Zhanglijun, Qiukangmu, Xu Jiamin and students
Intercalibration of geostationary FY2B and polar orbiting NOAA AVHRR & HIRS demonstrated.

It remains to be done routinely.
Impact of Cooperation between CIMSS and NSMC

- **Benefit to CIMSS**
  - Visitors helps to finish CIMSS projects
  - Visitors help to develop software packages for communities
    - ITPP, IAPP, IMAPP
- **Benefit to NSMC**
  - Satellite data processing software was used for processing FY data
  - The first DB ground station for EOS data in China by Paul and Liam
  - Visitors play key role in China (e.g.)
    - Wenjian Zhang: Director of NSMC
    - Zhongdong Yang: Chief Engineer of NSMC
    - ......
As far as the overarching issue of the importance of the **U.S.-PRC Atmosphere Protocol**, there are a number of issues of note:

- **Data Access**: China currently has a free and open data access policy and plans to continue this policy in the future.

- **Future Satellite Coordination**: NSMC has indicated a willingness to fly their next generation polar satellites to enhance the NPOESS-Metop constellation by filling potential gaps with its AMSU-like instrument as well as its future ocean color instruments.

- **Added Expertise**: Bilateral cooperation has opened doors for several Chinese scientists to work in NOAA labs and to contribute to the research programs and to return to China with added expertise for Chinese utilization of the Global Observing System.

- **Virtual Lab**: US-PRC cooperation has generated interrogation tools for the web based Virtual Lab, which is used for international training exercises by the WMO.

- **DB Data and Software**: Cooperation with China has enabled reception of DB data from FY1B and 1C at several NOAA offices, most notably at the Fairbanks NWS Field Office.

- **RAMSDIS**: While serving as a visiting scientist to CIRA, NSMC’s General Director Yang Jun’s expertise was critical to the development of RAMSDIS. RAMSDIS proved a big asset to NOAA/ NWS. Also, RAMSDIS made possible the virtual laboratory for satellite data utilization.
Products from FY2C Meteorological Satellite

Leading Scientist: Xu Jianmin
FY2C Data Processing Team

Content

• General introduction to FY2C
• FY2C image registration, navigation, calibration status
• Products from FY2C
FY2
Meteorological Satellite
## FY-2C 5 Channel Radiometer

<table>
<thead>
<tr>
<th>Channel</th>
<th>Wavelength (µm)</th>
<th>Quantification Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIS</td>
<td>0.55 0.90</td>
<td>6 bits</td>
</tr>
<tr>
<td>IR1</td>
<td>10.3 11.3</td>
<td>10 bits</td>
</tr>
<tr>
<td>IR2</td>
<td>11.5 12.5</td>
<td>10 bits</td>
</tr>
<tr>
<td>IR3</td>
<td>6.3  7.6</td>
<td>10 bits</td>
</tr>
<tr>
<td>IR4</td>
<td>3.5  4.0</td>
<td>10 bits</td>
</tr>
</tbody>
</table>
PREPROCESSING

Status on Image Registration
Navigation and Calibration
Image Registration

- Inter-channel
- Channel
- Inter-detector for Visible channel

For FY2C Satellite, multi channel observation is such realized:

- Sensors of different channels are located at difference places of the focus plane.
- Image registration is performed at ground.
Inter-Channel Registration

Before registration

After registration in line direction

IR1,IR2 VIS IR3,IR4

4 Line Bias
Channel Registration
Visible Channel Multi-detectors Registration
Image Navigation

**Speciality:** We developed the unique technique to navigate the FY2C image. It doesn’t use landmark but full disk image center for the Image Navigation.

- Time series of the past full disk image center and the satellite position are known data for the model.
- FY2C image navigation grid is gained by the solution of a mathematical model.
- 13 parameters for image navigation are gained. 12 of them can be treated as constant in 24 hours.
- All navigation process is done automatically. No any landmark registration or manual operation is performed.
- Except 1 or 2 days after orbital and attitude control, the accuracy of prediction grid is IR pixel level.
Time series of the past full disk image center
Full disk image center is predictable

sin fitter of image center line position

point: real position
blue point: point used by sinfitter
Time series of the past full disk image center, notice the vertical movement of the image.
Put Earth center at the origin, there is a tendency of turning motion.
Three components of misalignment

Pitch, Yaw, Roll

GOES-7 and before did not define the roll misalignment
FY-2B Animation

Calibration with NOAA

- FY-2C IR1 and NOAA-17 ch4 spectral response
- FY-2C IR1 and NOAA-17 ch4 spectral response
- Spectral response of FY-2C and NOAA-17
- Himawari-12 and FY-2C water band response
Geographic registration
FY-2C IR measurements and BT compared with NOAA
PRODUCT PROCESSING
Layer 05  800hPa
Atmosphere Reduction
Example

Layer 05  800hPa  Incident
Radiation

IR Atmosphere Reduction
FY2C Image Broadcasted by TV
# Products from FY2C

<table>
<thead>
<tr>
<th>Name of Product</th>
<th>Coverage</th>
<th>Time/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>50°N-50°S 55°E-155°E</td>
<td>4</td>
</tr>
<tr>
<td>SST</td>
<td>60°N-60°S 45°E-165°E</td>
<td>8</td>
</tr>
<tr>
<td>Upper Troposphere Humidity</td>
<td>60°N-60°S 45°E-165°E</td>
<td>8</td>
</tr>
<tr>
<td>ISCCP Data set</td>
<td>60°N-60°S 45°E-165°E</td>
<td>8</td>
</tr>
<tr>
<td>Precipitation Index</td>
<td>60°N-60°S 45°E-165°E</td>
<td>8</td>
</tr>
<tr>
<td>Precipitation Estimation</td>
<td>60°N-60°S 45°E-165°E</td>
<td>4</td>
</tr>
<tr>
<td>Cloud Classification</td>
<td>60°N-60°S 45°E-165°E</td>
<td>8</td>
</tr>
<tr>
<td>Cloud Amount</td>
<td>60°N-60°S 45°E-165°E</td>
<td>8</td>
</tr>
<tr>
<td>Humidity Profile from Cloud</td>
<td>50°N-50°S 55°E-155°E</td>
<td>8</td>
</tr>
<tr>
<td>Perceptible Water in Clear Sky Region</td>
<td>60°N-60°S 45°E-165°E</td>
<td>8</td>
</tr>
<tr>
<td>Outgoing Long wave Radiation</td>
<td>60°N-60°S 45°E-165°E</td>
<td>8</td>
</tr>
<tr>
<td>Solar Irradiance</td>
<td>60°N-60°S 45°E-165°E</td>
<td>1</td>
</tr>
<tr>
<td>Snow Cover</td>
<td>60°N-60°S 45°E-165°E</td>
<td>1</td>
</tr>
<tr>
<td>Sea Ice</td>
<td>60°N-60°S 45°E-165°E</td>
<td>1</td>
</tr>
<tr>
<td>Flood Monitoring</td>
<td>China</td>
<td>1</td>
</tr>
<tr>
<td>Soil Moisture</td>
<td>60°N-60°S 45°E-165°E</td>
<td>1</td>
</tr>
<tr>
<td>Fire Monitoring</td>
<td>China</td>
<td>24</td>
</tr>
<tr>
<td>Tropical Cyclone Position and Intensity</td>
<td>Western Pacific and India Ocean</td>
<td>24</td>
</tr>
<tr>
<td>Sand Storm Monitoring</td>
<td>China and Mongolia</td>
<td>8</td>
</tr>
<tr>
<td>Fog</td>
<td>China</td>
<td>24</td>
</tr>
<tr>
<td>TBB</td>
<td>60°N-60°S 45°E-165°E</td>
<td>8</td>
</tr>
</tbody>
</table>
Cloud is defined with topography so that the cloud detection can work for Tibetan Plateau.
IR image and cloud classification
FY2C Fog
Atmospheric motion vectors
Motion vectors is comparable with sonde data
Precipitation Estimation

6 hourly precipitation  2005.04.22.18  04.23.00
FY2C total precipitable water

FY2C_TPW_MLT_NOM_2 0050507_0600_a.bmp

FY2C_TPW_MLT_NOM_2 0050508_0600_a.bmp
FY2C/NOAA OLR comparison

FY-2C 实时 OLR 产品等值线图（2005年4月29日04时56分
局部，单位：瓦/米**2）

NOAA-16 实时 OLR 产品等值线图（2005年4月29日04时44分
，单位：瓦/米**2）
FY-2C 沙尘暴监测产品
Solar irradiance for China region at 24 April 2005/06Z

Solar irradiance VIS image
FY2C fire monitoring

Comparative with NOAA-16

FY2C fire monitoring
2005/03/21/05 26z

NOAA-16 fire monitoring
2005/03/21/05 26Z
FY2C fire monitoring in south east Asia  March 21 2005 0529Z
FY2C Flood Monitoring
Soil moisture estimated with ground temperature tendency
FY2C
snow cover

Snowy days in the month
FY2C Sea Ice
Regional Sea Ice
Sea ice compared with NOAA

NOAA-16 Sea ice
2005/04/04/04 31Z

FY2C Sea ice
2005/04/04/04 00Z
Regional Sea Ice  Antarctic
Tropical Cyclone
Tropical Cyclone position compared with QUIKSCAT
With the bilateral Cooperation

- More CIMSS experts’ research can be applied to FY2C data processing to bloom the FY2C’s application;
- FY2C data can be easy to access for CIMSS’s Experts;
- Experience in FY2C data processing can be shared with CIMSS’s experts to improve the US. Geostationary satellite;
- Celebrating CIMSS’s silver anniversary and cheers for 25 years’ relationship between CIMSS and NSMC
Stop Here

Thank you.