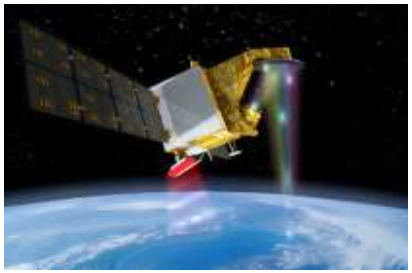
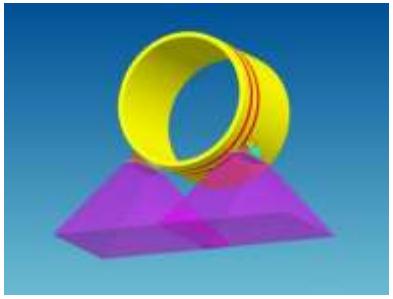
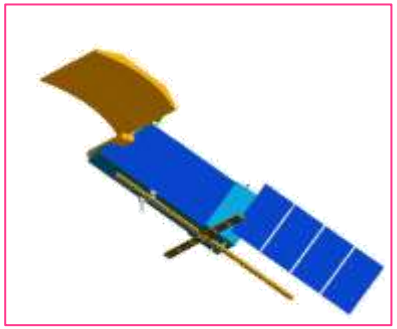
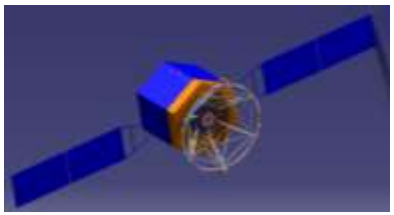
NSSC Update of EO Missions and CAL/VAL









Xiaolong DONG
National Space Science Center
Chinese Academy of Sciences
(NSSC,CAS)

Contributors:
Qifeng LU, NSMC/CMA
Qitao SONG, Wu ZHOU, NSOAS/SOA

CEOS WGCV-41
Tokyo, Japan
September 5-7, 2016

NSSC,CAS

National Space Science Center
Chinese Academy of Sciences

Planning, Development, Management & Operation of Space Science Missions (2011~)

Research & Development of Space Science and Applications （1958~)

NSSC: Snapshot of History

- 1958, Established to start 1st Satellite of China
- 1975, started microwave remote sensing development in China
- 1992-2003, science, applications and payloads for Chinese manned space flight program
- 2003-, payloads for Chinese lunar missions
- 2011-, Space science missions
- 2015-, payloads for Chinese Martian mission






Nssc

Science and Technology： Space Science & Applications

Dept of Space Science | **Dept of Space Technology** | **Dept of Space Environment** | **Dept of Microwave Remote Sensing**

SKL of Space Weather

CSKL of Complex Space Systems

CS Center of Space Environment

CSKL of Microwave Remote Sensing

Space Science Study Center

Mission Management Center

Mission Operation Center

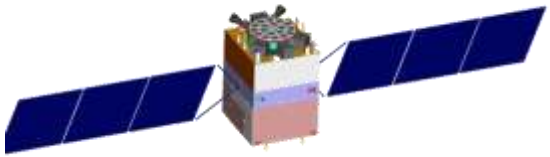
Assurance and Test Center

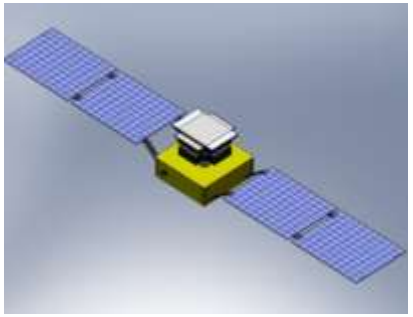
Space Science Mission: Planning, Management and Operations

MIRS

Update of NSSC: Space Science Missions

Objective	Mission
Black Hole	HXMT (2016. ~12)
Microgravity / Life Science	SJ-10 (2016.4)
Quantum Experiment	QUESS (2016.8)
Dark Matter Particle Exploration	DAMPE (2015.12)





Update of NSSC:

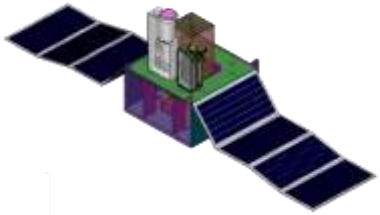
Space Science Missions planned for 2016~2020

Solar wind, Magnetosphere, Ionosphere Link Explorer

SMILE (CAS-ESA)

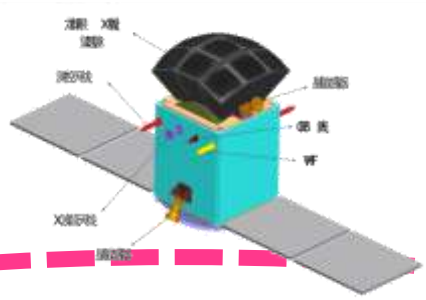
Space-based Solar Observatory for the Origin of Space Weather

ASO-S



Exploring the dynamic X-ray Universe

EP (Einstein Probe)

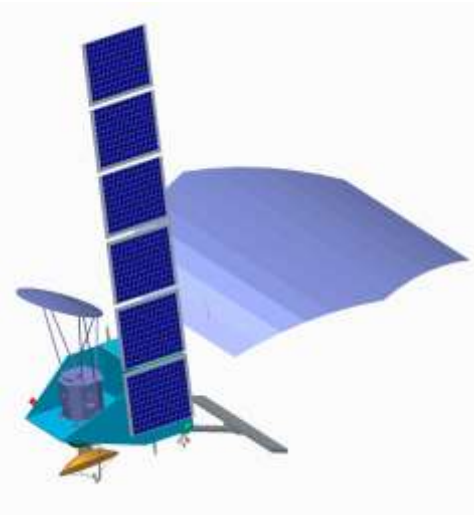


Synergetic Observations of Global Water Cycle

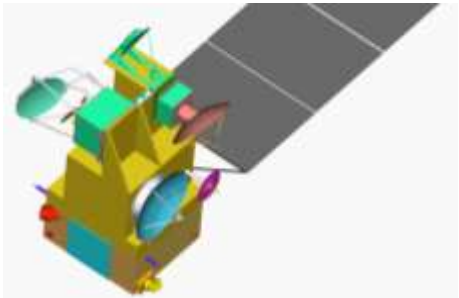
WCOM

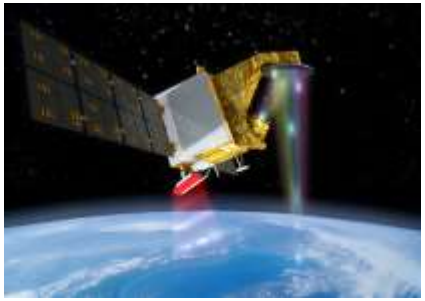
NSSC: Contributions to EO Satellites

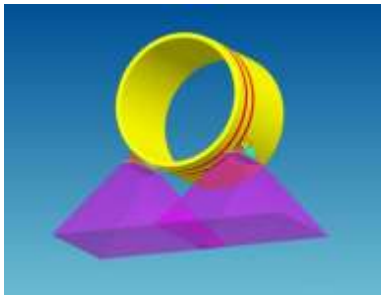
- **Oceanography and Meteorology**
  - **HY-2 (A, B, C and Follow-on): ALT+ACMR**
  - **COSM: MICAP**
  - **FY-3 and follow-on: MWHS/MWHTS(MWHS-II), GNOS space environment package**
  - **CFOSAT: radar scatterometer**
  - **FY-4 (optical and microwave): Microwave imager, space environment package**



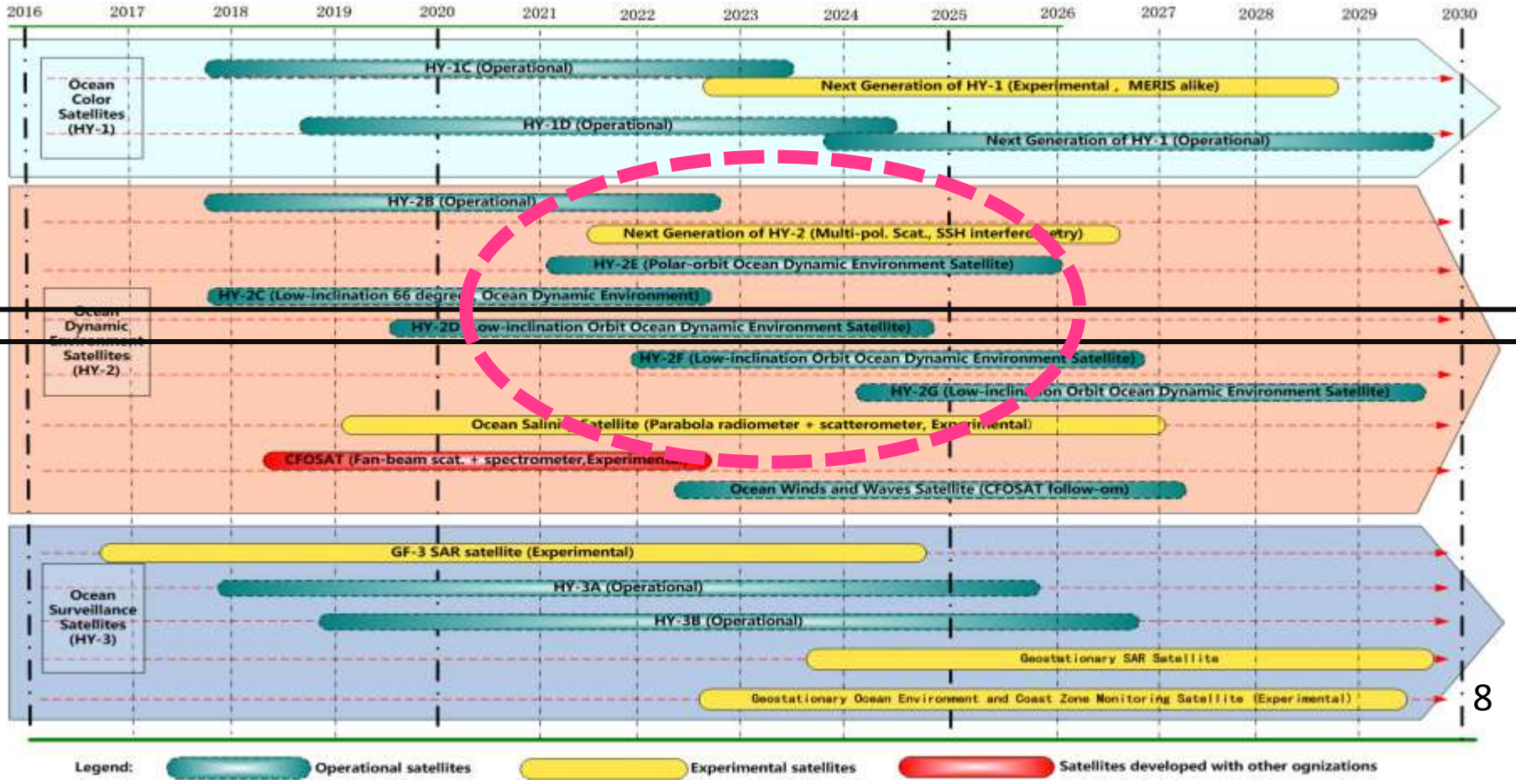
- **Space Science & Opportunity Missions**
  - **WCOM: IMI+DPS+PMI**
  - **WSRA: to be launched 2016**







Oceanographic Satellite of China 2016~ (by Q.Song, NSOAS/SOA)



HY-2 update

- HY-2A : in orbit >5yrs (2011.08.16)
  - New version of ALT data
- HY-2B/C : start satellite and payload
  - DFRA: dual frequency radar altimeter : Ku (13.58GHz) & C (5.25GHz)
  - ACMR: atmospheric correction microwave radiometer: 18.7 , 23.8 , 37GHz
  - SCAT: radar scatterometer: Ku-band (RF switch network & receiver
  - MWRA: microwave imager (6.6-37GHz): L1 data production
- HY-2 follow-on
  - ALT➔SAR AlT+WSRA
  - SCAT➔C/Ku Pol-SCAT
  - RAD➔ Polarimetric RAD
  - Start technology-demonstration 2016

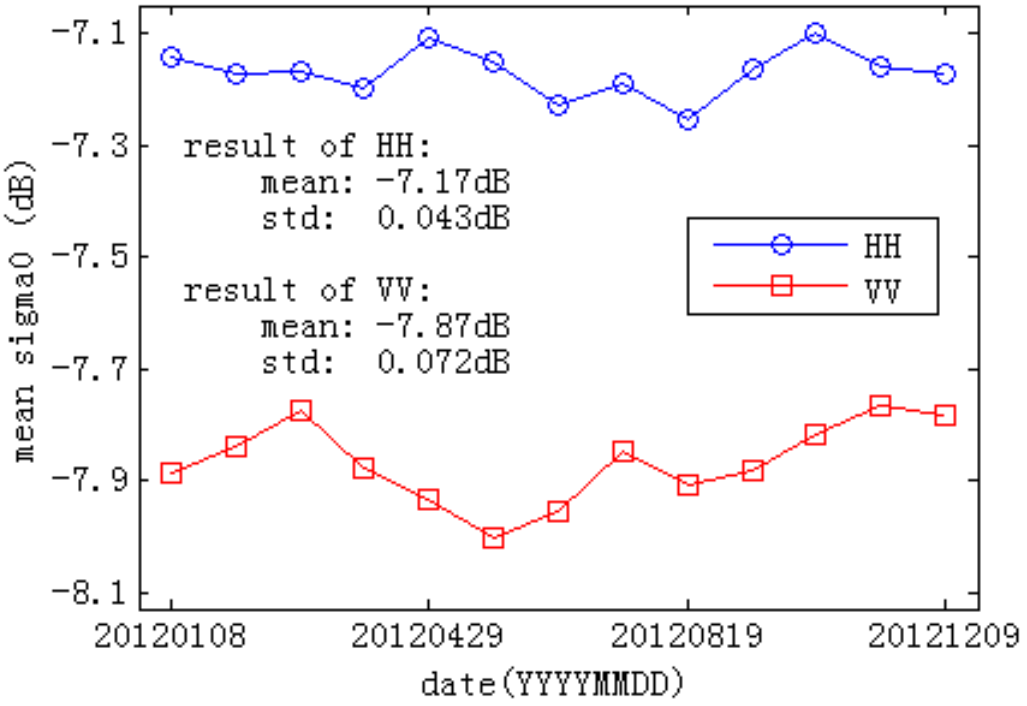
HY-2A Scatterometer:
in-orbit calibration and validation (by W. ZHOU)

- Absolute Calibration using transponders.
- Validation and monitoring of L1B backscatter using measurements over natural targets (Amazon rainforest).
- Relative Calibration using ocean calibration method.
- Validation of the wind vectors using wind measurements by global buoys (NDBC, TAO, et al), satellite scatterometer (ASCAT, WindSAT, et al), NWP outputs (ECMWF, NCEP), et al.

HY-2A Scatterometer Transponder

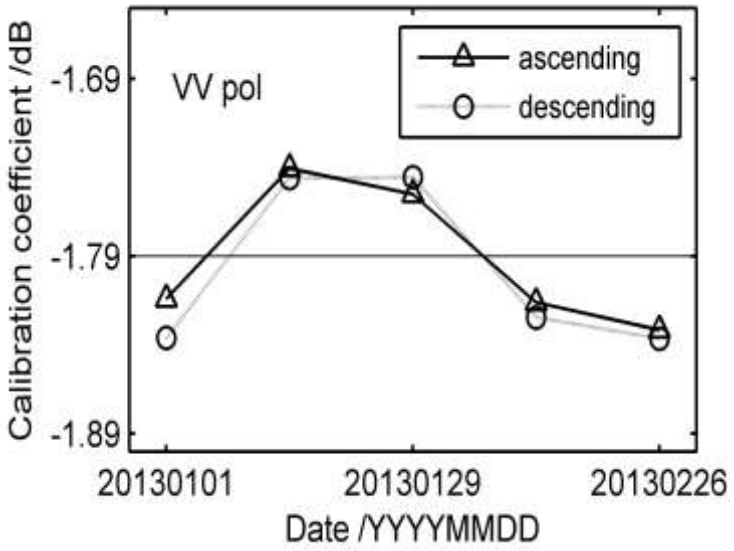
Fig.1 The HY-2A scatterometer transponder

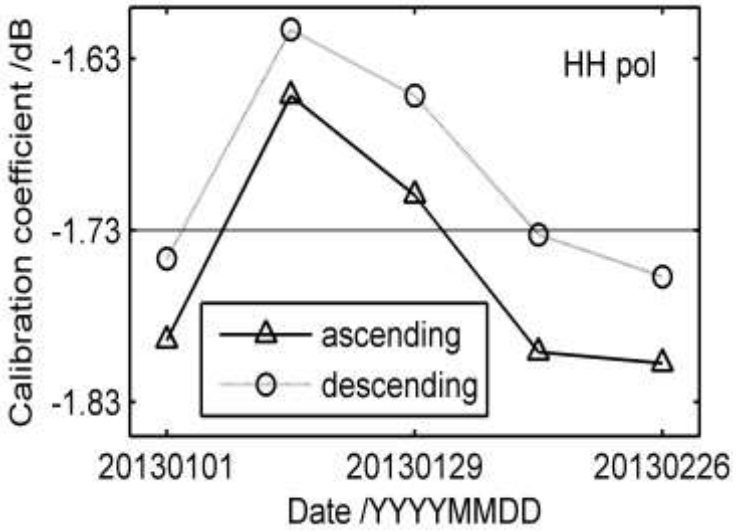
Natural targets (Amazon Rainforest)



The seasonal variation of the backscatter coefficients measured by HY-2A scatterometer in selected validation zone in Amazon Rainforest

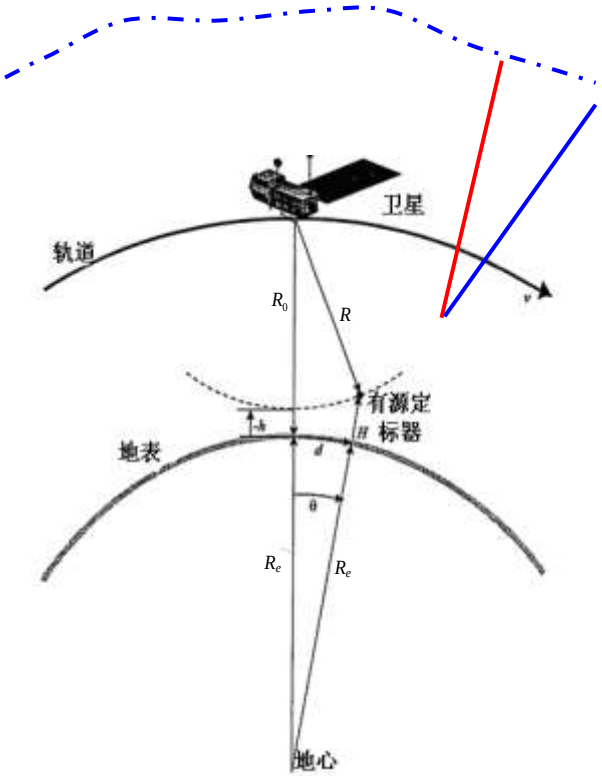
Ocean Calibration

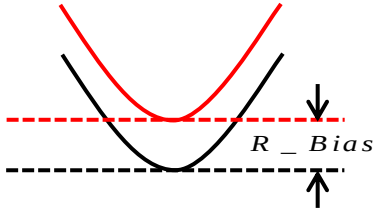




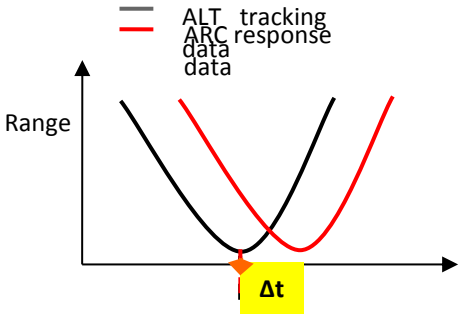
The calibration coefficients of HY-2A scatterometer using the NSCAT-2 model function by ocean calibration method: Left is for VV polarization, right is for HH polarization

HY-2A Altimeter:
Calibration/correction with transponder-calibrator



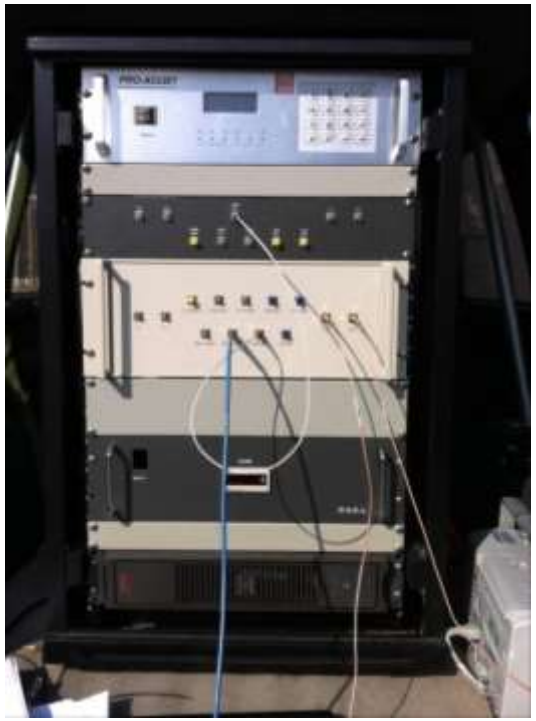


System bias due to internal transmission path

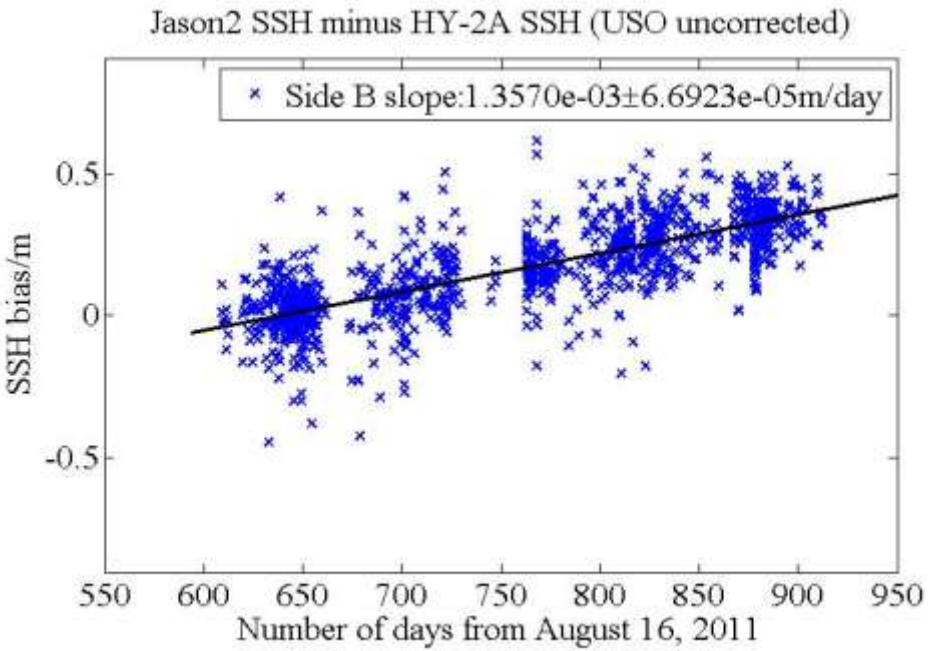


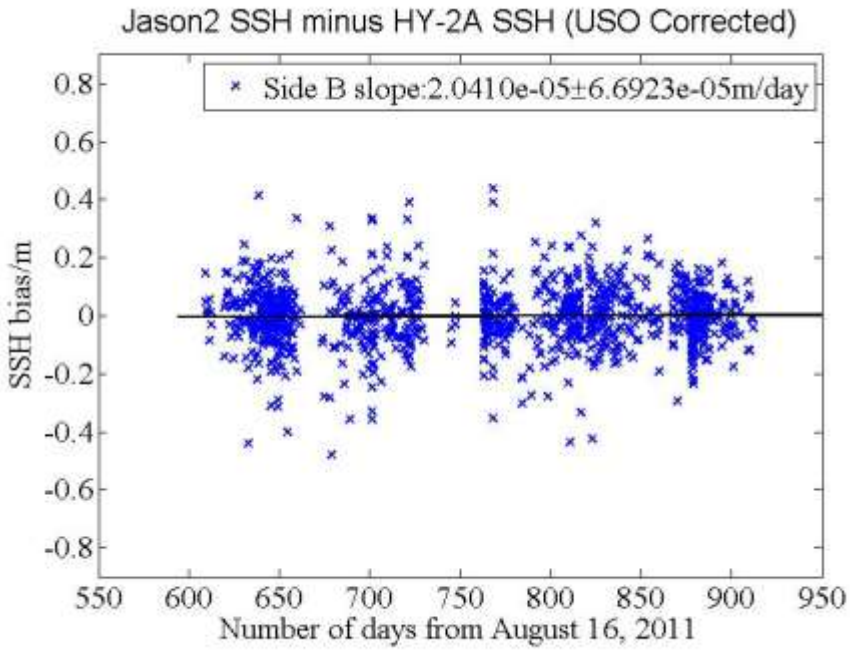
Clock frequency-shift

Calibration with reconstructive ground-transponder



Corrections of frequency-shift of USO upgrade to atomic clock for HY2B/C (correction to ~1cm)



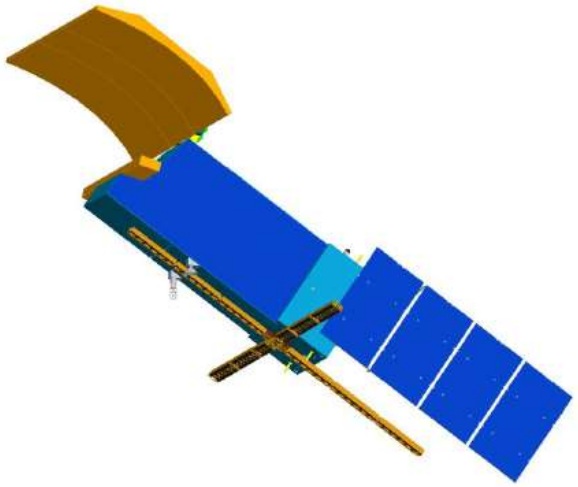


CFOSAT update

- **Payloads:**
  - **SWIM: multiple beam radar for ocean surface wave spectrum (Ku band, by CNES)**
  - **SCAT: rotating fan-beam scatterometer of ocean surface wind vector (ku band, by NSSC)**
- **Schedule**
  - **CDR: Nov 2015, after 2 year delay**
  - **kick of SCAT flight model: 2016.07.23**
  - **delivery of flight model: 2017.04**
  - **Launch: 2018**

COSM update

Chinese Ocean Salinity Mission



- Mission requirements:
  - 0.1psu, 200km, monthly
  - With Simultaneous observation of ocean surface roughness and SST
- Schedule
  - 2011~2014:grounddemonstration on different payload technology
  - 2015: mission definition, preliminary design, risk mitigation
  - 2016: preparation and submission of mission proposal for approval
  - Estimated launching: 2019

2 payloads:

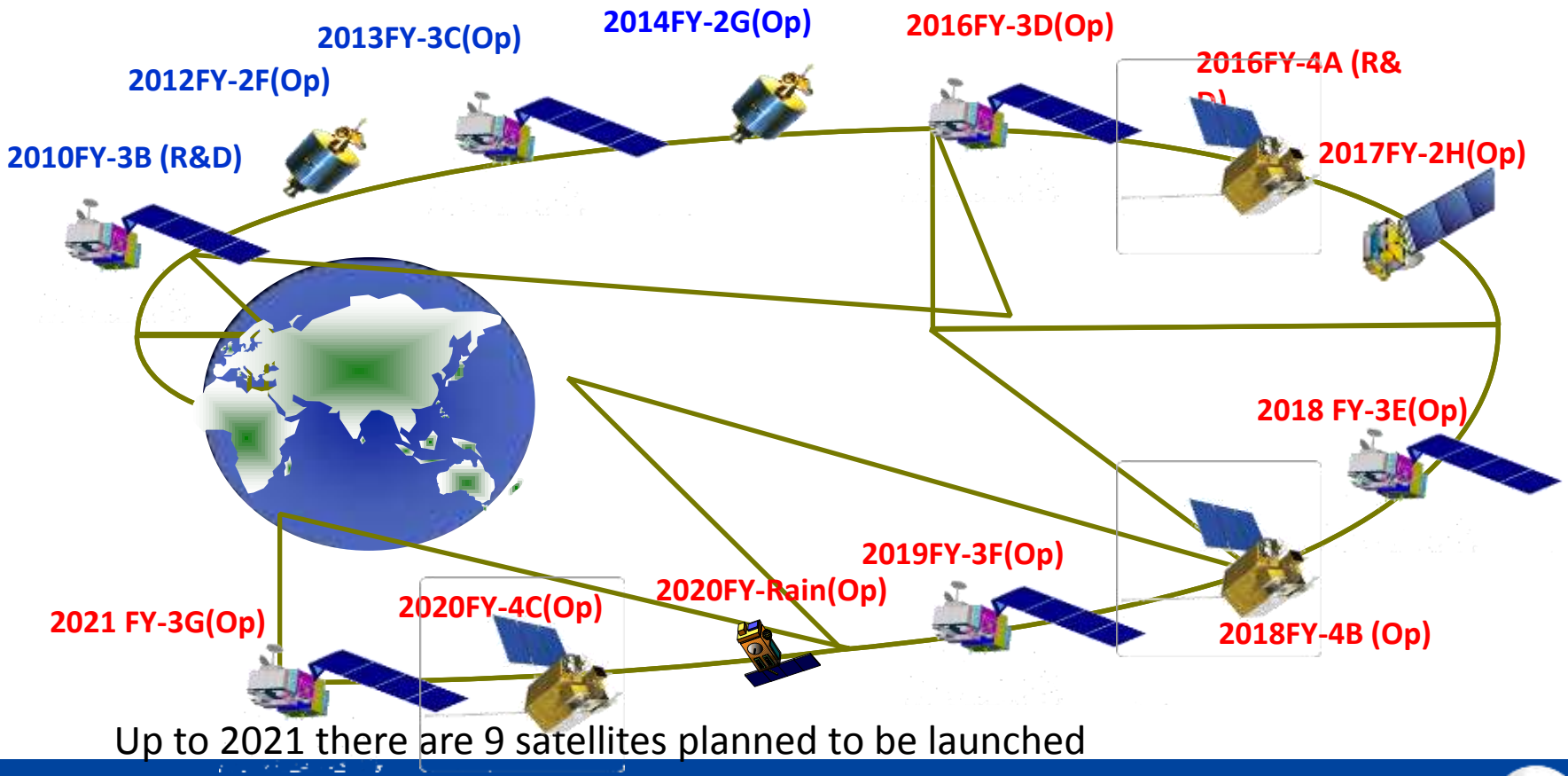
- **MICAP: microwave imager combined active passive (L, C, X, K band) (NSSC)**
- **MiR2D: microwave 2-D interferometric imager (CAST-Xian)**

Oceanographic Satellite of China 2016~

(by Q. Lu, NSMC/CMA)

National Program for Fengyun Meteorological Satellite from 2016-2021

LEO: AM+PM+Dawn Dusk; GEO: optical+microwave (under development)



Up to 2021 there are 9 satellites planned to be launched

The FY-3A/B/C/D Instrument Suite

Infrared Atmospheric Sounder (IRAS)
20 channels
(~HIRS/3)

Microwave Temperature Sounder (MWTS)
4 channel (~MSU)
13 channels

Microwave Humidity Sounder (MWHS)
5 channel (~MHS)
15channels with channels at 118 GHz

Microwave Radiation Imager
10 channels
(~AMSR-E)

GNSS Radio-Occultation Sounder (GNOS)
(~GPS)

N0.	Sensor Siute	Satellite / Sensor	FY-3E（05）EM Satellite	FY-3F（06）AM Satellite	FY-3G（07）PM Satellite	FY-3R（08）Rainfall Satellite
		Scheduled Launch Date	2018	2019	2021	2020
1	Optical Imagers	MERSI	√（III-Low Light）	√（III）	√（III）	√（III-Simplified）
2	Passive Microwave Sensors	MWTS	√	√	√	√
		MWHS	√	√	√	√
		MWRI		√	√	√
3	Occultation Sounder	GNOS	√	√	√	√
4	Active Microwave Sensors	WindRAD	√	√		
		Rainfall RAD				√
5	Hyperspectral Sounding Sensors	HIRAS	√	√	√	
		GAS (Greenhouse Gases Absorption Spectrometer)			√	
		OMS (Ozone Mapping Spectrometer)		√		
6	Radiance Observation Sensor Suite	ERM		√		
		SIM	√	√		
		SSIM (Solar Spectral Irradiation Monitor)	√			
7	Space Weather Sensor Suite	SEM		√	√	
		Wide Angle Aurora Imager		√	√	
		Ionosphere photometer	√(Multi-angle)	√	√	
		Solar X-EUV Imager	√			

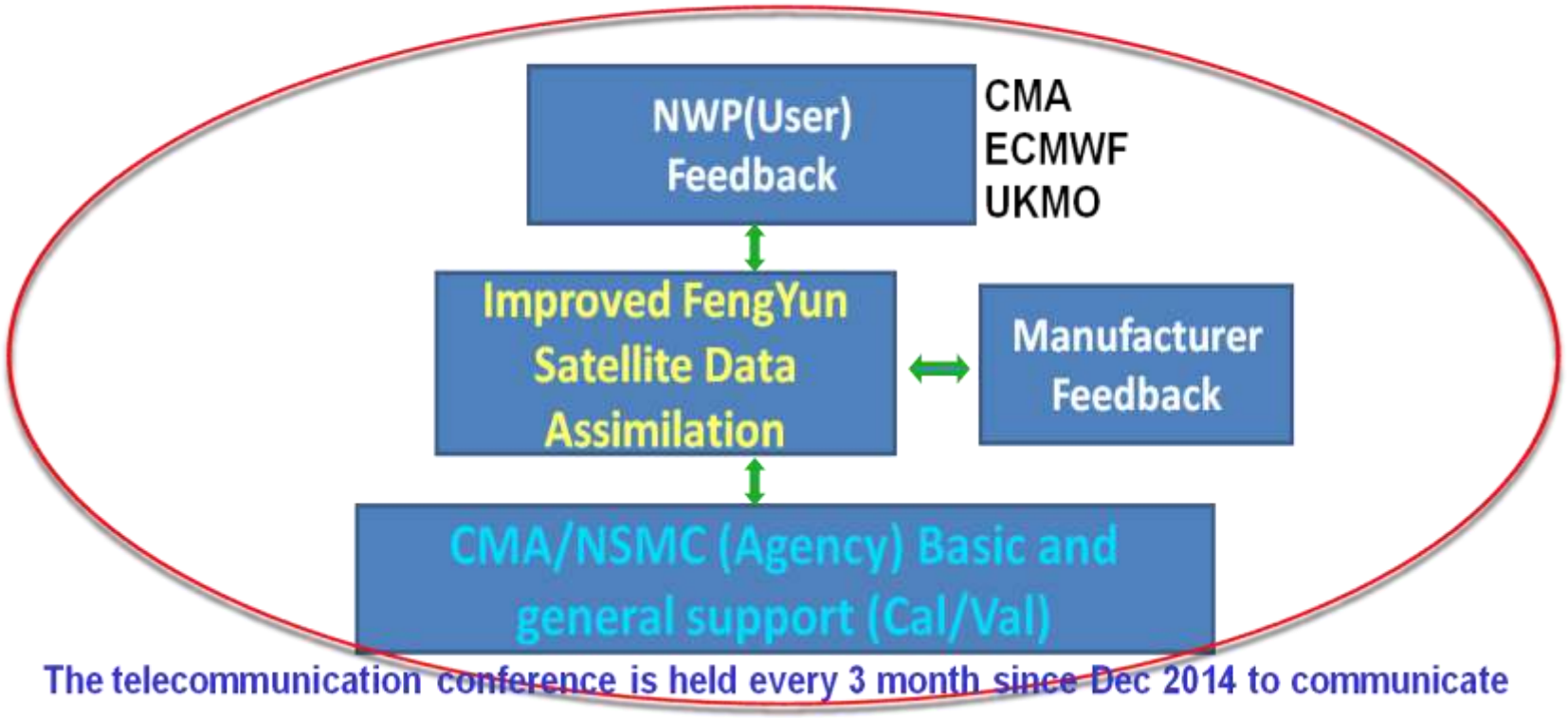
- Improved Medium Resolution Spectrum Imager (MERSI II) in FY-3D, 3E, 3F
- Greenhouse Gases Absorption Spectrometer (GAS) in FY-3D,3F
- Hyper-Spectral Infrared Sounder (HIRAS) will take replace of current IRAS in FY-3D,F
- Sea Surface Wind Radar (WindRAD) in FY-3E

Payloads Configuration for FY-3E/F/G/R and Precipitation Mission

Closer collaborations among NWP user, agency and manufacturer

--improve the misunderstanding and fill the gap from requirements

Share; early evaluation; preparation before launch



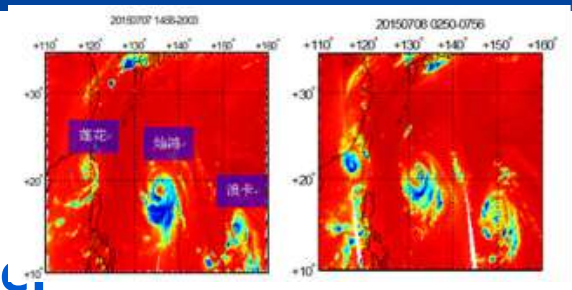
The telecommunication conference is held every 3 month since Dec 2014 to communicate the progress on evaluating, improving and assimilating FY-3C data in NWP models

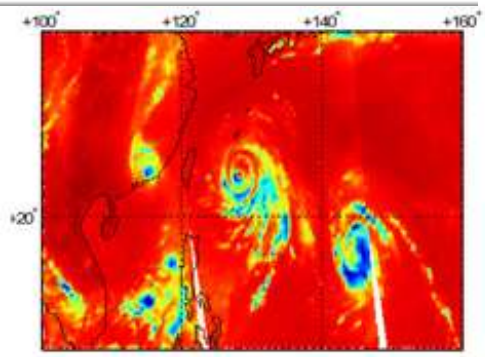
FY-3 update

- **FY-3A/B**
  - **MWHS: Microwave humidity Sounder**

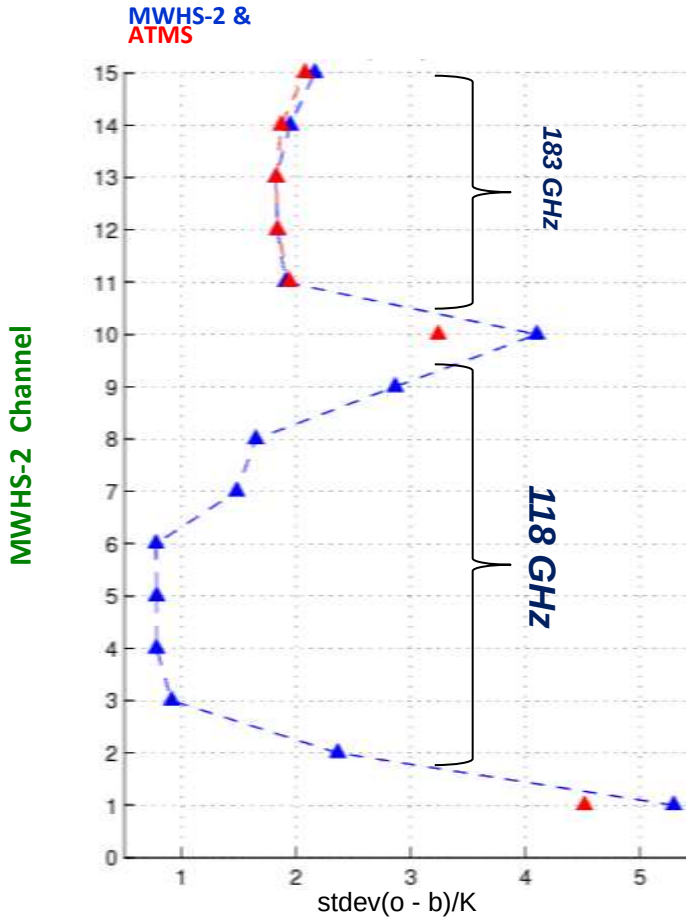
  5 Channels: 150GHz: H, V-pol; 183GHz: 3channels for vapor
  - **FY-3A ended (launched 2008)**
  - **FY-3B in good status (from 2010)**
- **FY-3C/D**
  - **MWHTS: Microwave Humidity and Temperature Sounders**

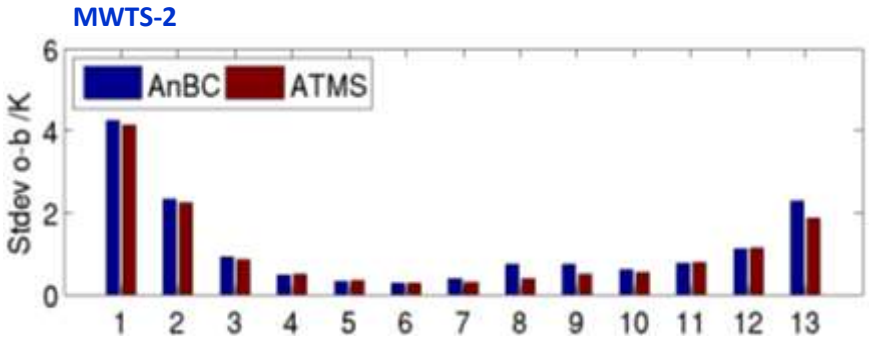
  15Channels: 90GHz, 150GHz, 118GHz, 183GHz
  - **FY-3C: MWHTS in good status since 2013**
  - **FY-3D: to be launched in 2016**

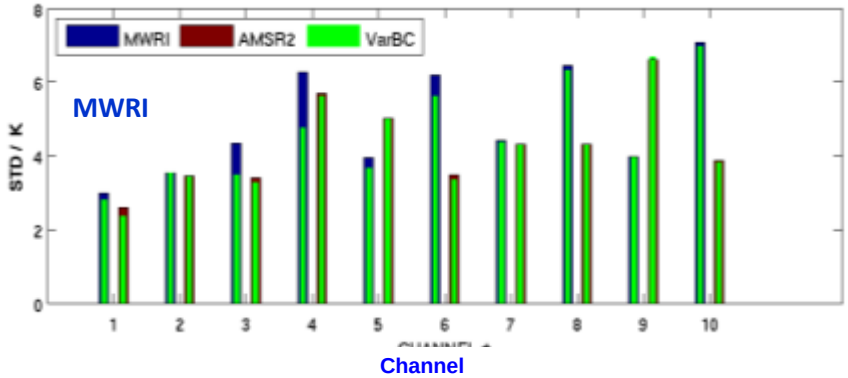




The comparable data quality of FY-3C sounding instruments to its international counterparts







The plan and status of FY-3C in NWP model from three centers..

ECMWF			
	2014	2015	2016
FY-3B MWHS	Op DA	Op DA	Op DA
FY-3C MWTS2	Evaluation	Evaluation (Now dead)	Evaluation (Now dead)
FY-3C MWHS2	Evaluation	Monitoring	Op DA
FY-3C MWRI	Evaluation	Evaluation	To be Moni
FY-3C IRAS	Evaluation	Evaluation	Monitoring
FY-3C GNOS	Sample data	Sample data	Evaluation

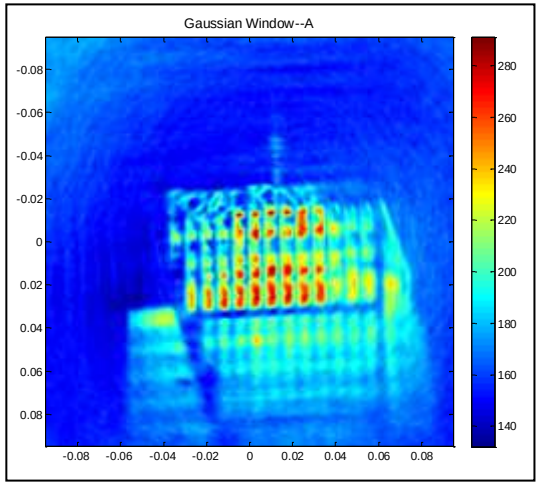
UKMO			
	2014	2015	2016
FY-3B MWHS	Evaluation	Monitoring	To be Op DA
FY-3C MWTS2	Evaluation	Evaluation (Now dead)	Evaluation (Now dead)
FY-3C MWHS2	Evaluation	Monitoring	Op DA
FY-3C MWRI	Evaluation		To be Moni
FY-3C IRAS			
FY-3C GNOS	Evaluation	Evaluation	Evaluation

CMA NWPC			
	2014	2015	2016
FY-3B MWHS	Evaluation	Evaluation	To be Moni
FY-3C MWTS2	Evaluation	Evaluation (Now dead)	Evaluation (Now dead)
FY-3C MWHS2	Evaluation	To be Op Da	Op DA
FY-3C MWRI	Evaluation		To be Moni
FY-3C IRAS			
FY-3C GNOS	Evaluation	To be Op Da	Op DA

- **FY3C MWHS-2 has been operationally assimilated and monitored in the Met Office global model on 15 March 2016, and in ECMWF IFS system on 4 April 2016 .**
- **Operational assimilation of MWHS-2 with 183 GHz channels globally and GNOS in CMA/GRAPES have been activated in April 2016.**

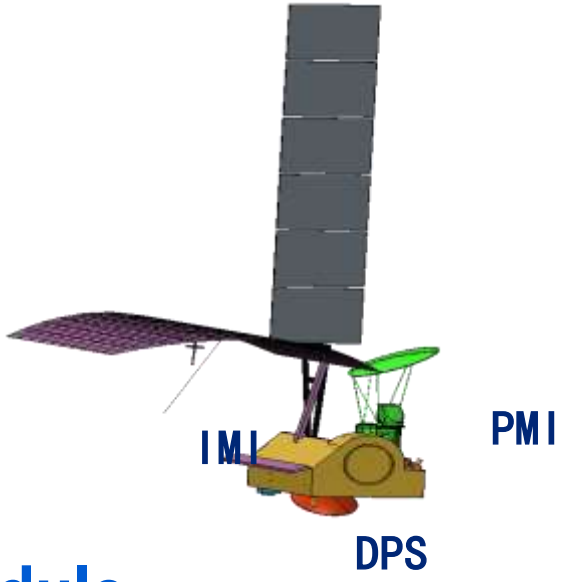
FY-4 update

- Optical and microwave version
- FY-4A Optical:
  - to be launched in 2016
- FY-4 microwave
  - Satellite-level intensive study to be started 2016
- Payload development in NSSC
  - GIMS: geostationary Interferometric Microwave Sounder (NSSC+ESA)
    - 50-60GHz: Temperature channels: NSSC
    - 183GHz: vapor channels: ESA
  - DMGMS: dual-mode geostationary microwave sounder (NSSC+CAST-Xi'an)
    - 50-60GHz: interferometric imaging sounder
    - 90, 118, 167, 183GHz: real aperture reflector antenna
  - Schedule:
    - 2016-2018: intensive study
    - 2019-2021: qualification and flight model development
    - Estimated launch year ~2022

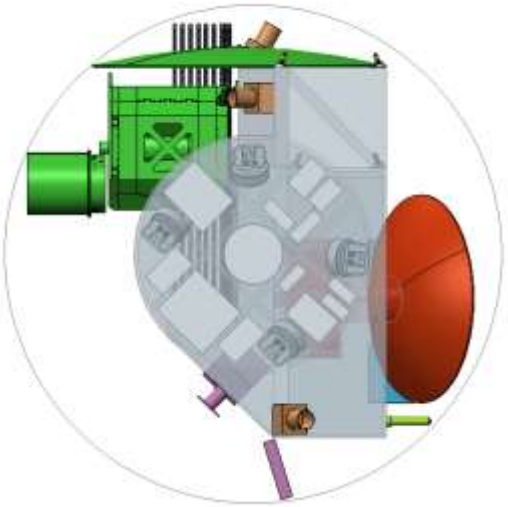


WCOM: water cycle observation mission

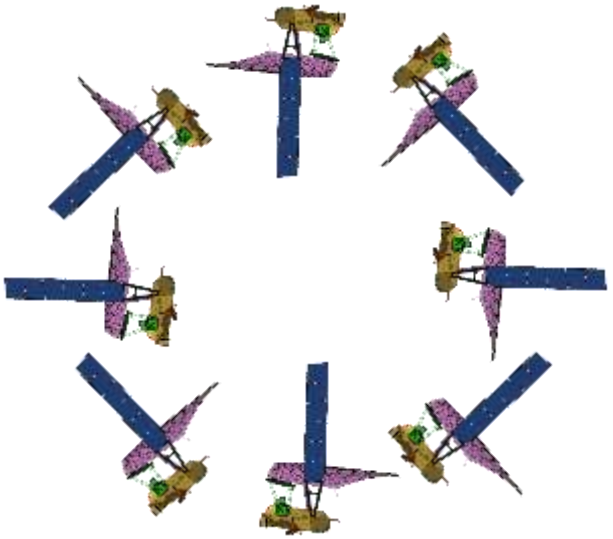
- SSO 6:00am 600km
- 3 payloads
  - IMI: L-S-C interferometic microwave imager
  - DPS: dual-frequency polarized scatterometer (X, Ku)
  - PMI: Polarimetric microwave imager (7.2-90GHz)
- Objective parameters
  - Soil moisture, ocean salinity, snow water equivalent, frozen-thaw, ocean surface evapotranspiration (wind and temperature)



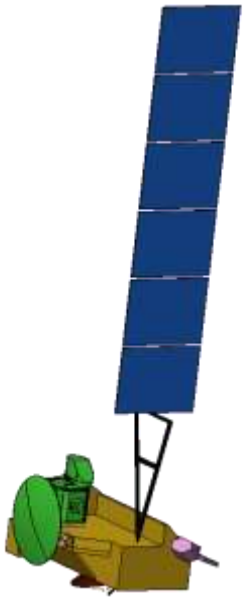
- Schedule
  - Intensive study: 2014-2015
  - Mission proposal submitted for CAS approval: 2016.05
  - Qualification and flight model development: 2017-2019
  - Estimated launch: 2020



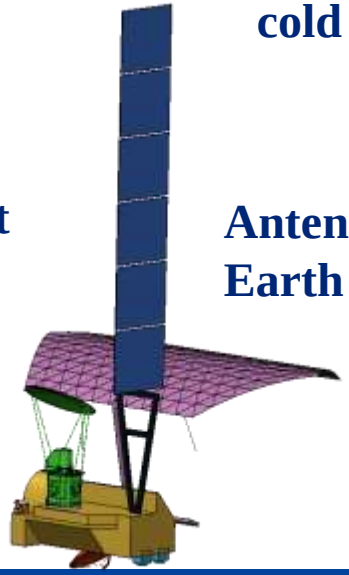
launch



Maneuver for
cold sky calibration



Solar wing
deployment



Antenna deployment
Earth Observation