SST Operation at CMA

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Outline

1. **Introduction**
2. **SST products**
3. **SST validation**
4. **CMA SST specification crosscheck with GDS2.0**
5. **Summary**

Introduction-CMA FY SST products

- ❑ **VIsible and Infrared Radiometer (VIRR)**
  - **FY3(01) FY3A/B**
  - **FY3(02) FY3C**
- ❑ **MEdium Resolution Spectral Imager(MERSI) II**
  - **FY3(02) FY3D**

LEO IR SST

- ❑ **Visible and Infrared Spin Scan Radiometer(VISSR)**
  - **FY2(02) FY2C/D/E**
  - **FY2(03) FY2F/G**
- ❑ **Advanced Geostationary Radiation Imager(AGRI)**
  - **FY4A**

GEO IR SST

- ❑ **MicroWave Radiation Imager(MWRI)**
  - **FY3(02) FY3C**
  - **FY3(02) FY3D**

LEO MW SST

- ➢ **red: end of service**
- ➢ **blue :postponed**
- ➢ **purple: in post launch test**

FY: Fengyun, ‘Feng’ in Chinese means Wind and ‘yun’ means Cloud.

http://www.nsmc.org.cn/en/NSMC/Channels/outline.html

CMA FY SST products

❑LEO IR SST

- FY3C VIRR SST

❑LEO MW SST

- FY3C MWRI SST

❑GEO IR SST

- FY2G VISSR SST
- FY4A AGRI SST

❑Blend SST

- FY3C+FY4A

CMA LEO IR SST Specification(Current)

❑FY3A/B VIRR_SST (daytime only)

- **5-Minute granule:**
  - Spatial Resolution: ~1.1km
  - Array Size: 2048*1800
  - Files Number: ~144 granules per day
- **Global regular lat/lon :**
  - Spatial Resolution: 1km
  - Array Size: 1000*1000
  - Files Number: 648 blocks per day

❑FY3C VIRR_SST

- **5-Minute granule :**
  - Spatial Resolution: ~1.1km
  - Array Size: 2048*1800,
  - Files Number: ~288 granules per day
- **Global regular lat/lon :**
  - Spatial Resolution: 5km
  - Array Size: 7200*3600
  - Files Number: 2 files per day, day and night are stored separately

CMA LEO IR SST Specification(Future)

❑FY3D MERSI_SST

- **5-Minute granule :**
  - ➢ Spatial Resolution: ~1.1km
  - ➢ Array Size: 2048*2000
  - ➢ **Spatial Resolution: ~250m**
  - ➢ Array Size: 8192*8000
- **Global regular lat/lon :**
  - ➢ Spatial Resolution: 5km
  - ➢ Array Size: 7200*3600
  - ➢ Files Number: 2 files , day and night will be stored separately
- **Regional regular lat/lon :**
  - ➢ Spatial Resolution: 1km
  - ➢ Array Size: 9000*5000
  - ➢ Files Number: 2 files , day and night will be stored separately

CMA LEO MV SST Specification(Research)

❑FY3C/D MWRI_SST

- **5-Minute granule:**
  - ➢ Spatial Resolution: ~25km
  - ➢ Array Size: 254*1725
  - ➢ Files Number: ~28 files per day, ascending and descending are stored separately
- **Global regular lat/lon:**
  - ➢ Spatial Resolution: 25km
  - ➢ Array Size: 1440*720
  - ➢ File Number: 1 file per day include Ascending and Descending

CMA GEO IR SST Specification(current)

❑FY2 VISSR_SST

- **Nominal : FULL DISK**
  - **Spatial Resolution: ~5km**
  - Array Size: 2288*2288
  - **Files Number: 24 files per day**
- **regular lat/lon :**
  - Spatial Resolution: 50km
  - Array Size: 512*512
  - Files Number:24 files per day

CMA GEO IR SST Specification(Future)

❑FY4A AGRI SST

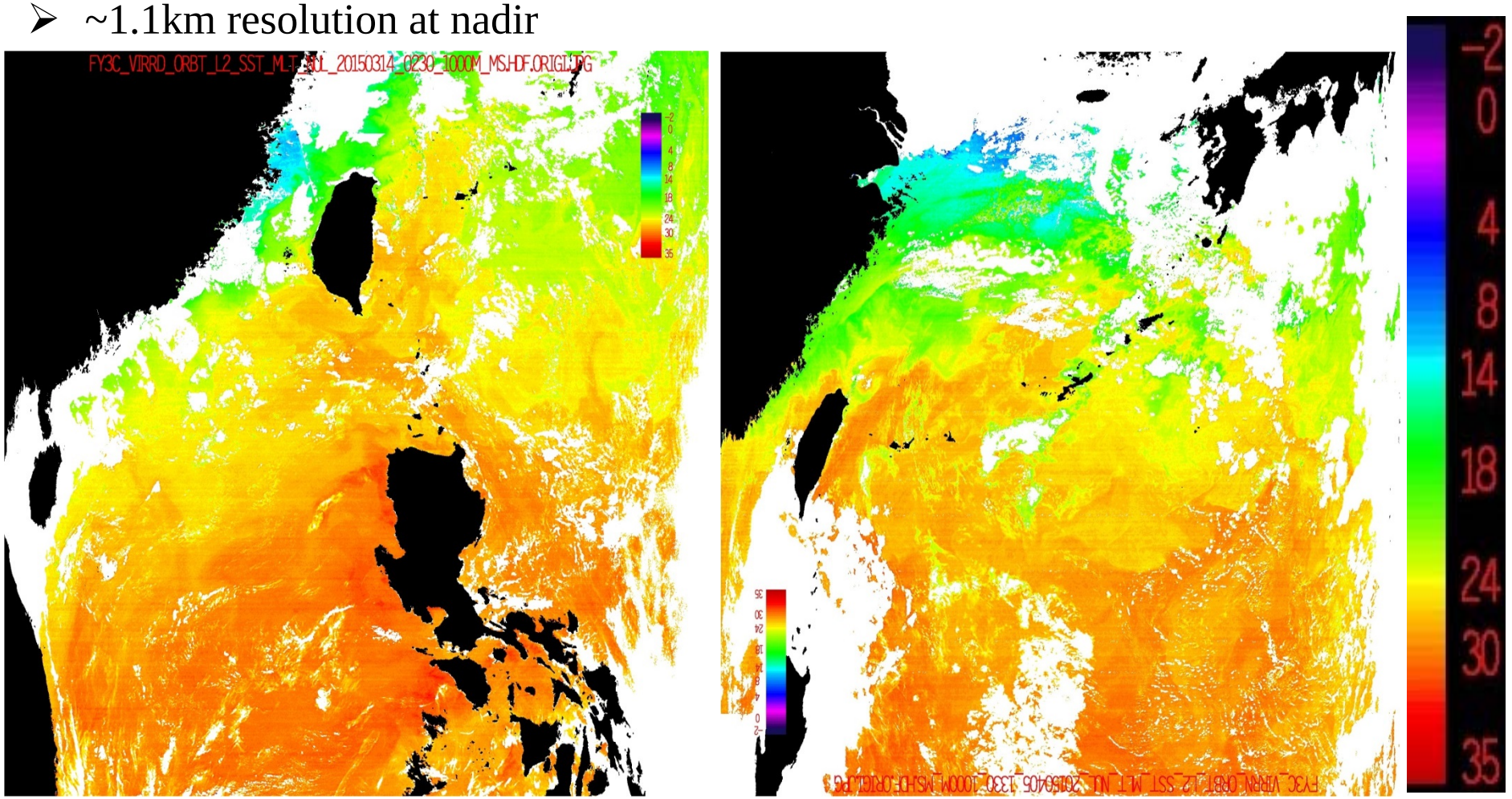
- **Nominal : FULL DISK**
  - ➢ Spatial Resolution: ~4km
  - ➢ Array Size: 2748*2748
  - ➢ **Files Number:96 files per day**
- **regular lat/lon**
  - ➢ Spatial Resolution: 4km
  - ➢ Files Number:96 files per day

LEO IR SST- FY3 SST status

- FY-3 Satellite data is processed by data preprocessing system (DPPS) and product generation system (PGS) of FY-3 ground segment.
- FY-3 L1B data from DPPS and cloud mask product from PGS are used for SST retrieval .
- Granule SST is derived from the split-window MCSST algorithm and stored in 5-minute granule (2048×1800 pixels) .
- Based on the granule SST product, the 5km lat/lon grid daily, 10-day and monthly SST products were also derived, stored by daytime and nighttime separately.
- The Coefs are Calculated directly by Bulk SST, so FY3C/VIRR SST reflects variations in skin SST, but on average represents bulk SST.

LEO IR SST- FY3C/VIRR 5-minute granule SST

- 5-minute granule MCSST: $T_s = a_0 + a_1 T_{11} + a_2 (T_{11} - T_{12}) + a_3 (T_{11} - T_{12})(\sec\theta - 1)$
- ~1.1km resolution at nadir



20150314 02:30（UTC） granule SST

20150405 13:30（UTC） granule SST

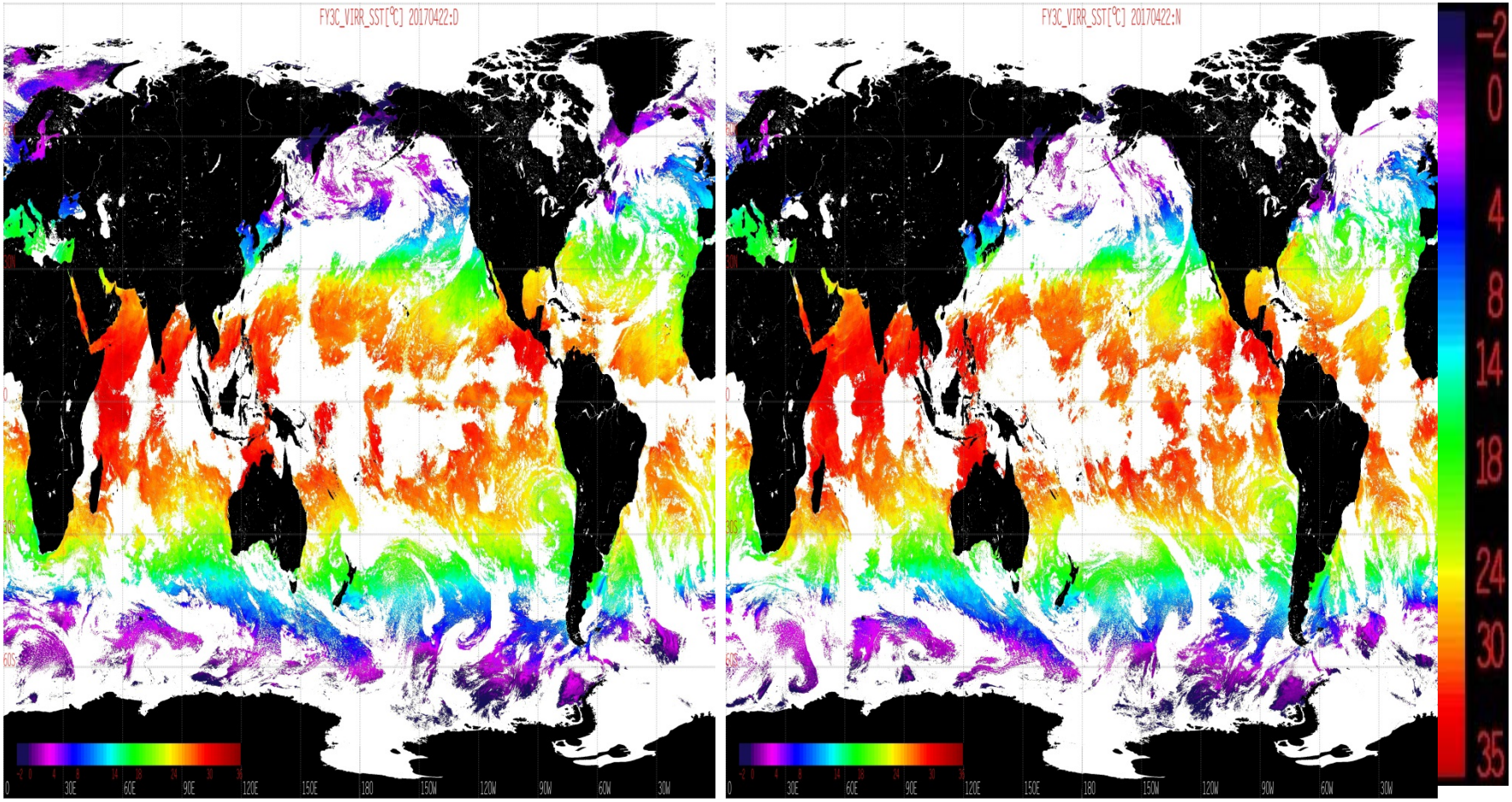
Daytime

2017.4.22 Daily

Nighttime

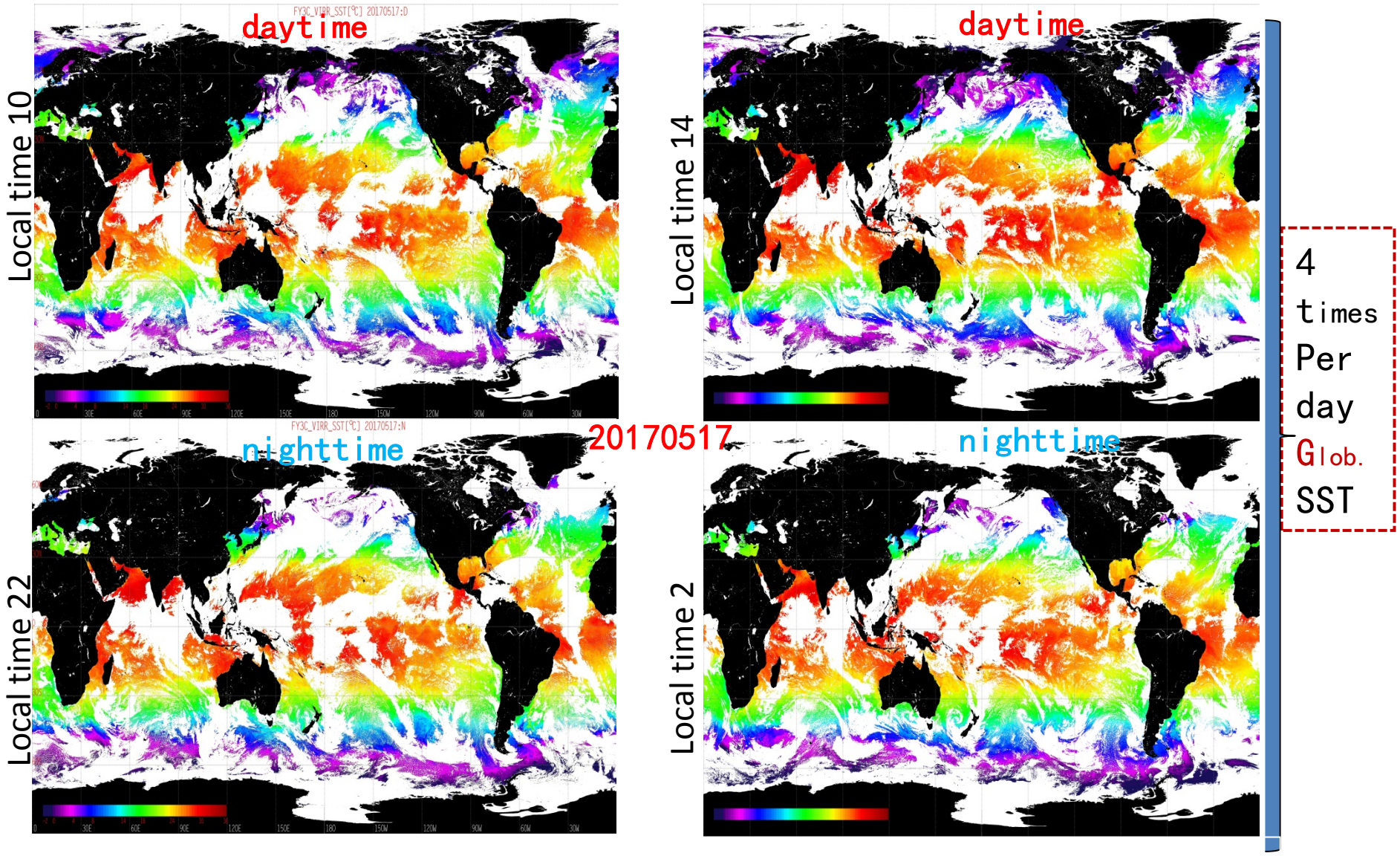
LEO IR SST- FY3C/VIRR daily SST

- derived from 5-minute granule SST
- 5km regular lat/lon grid



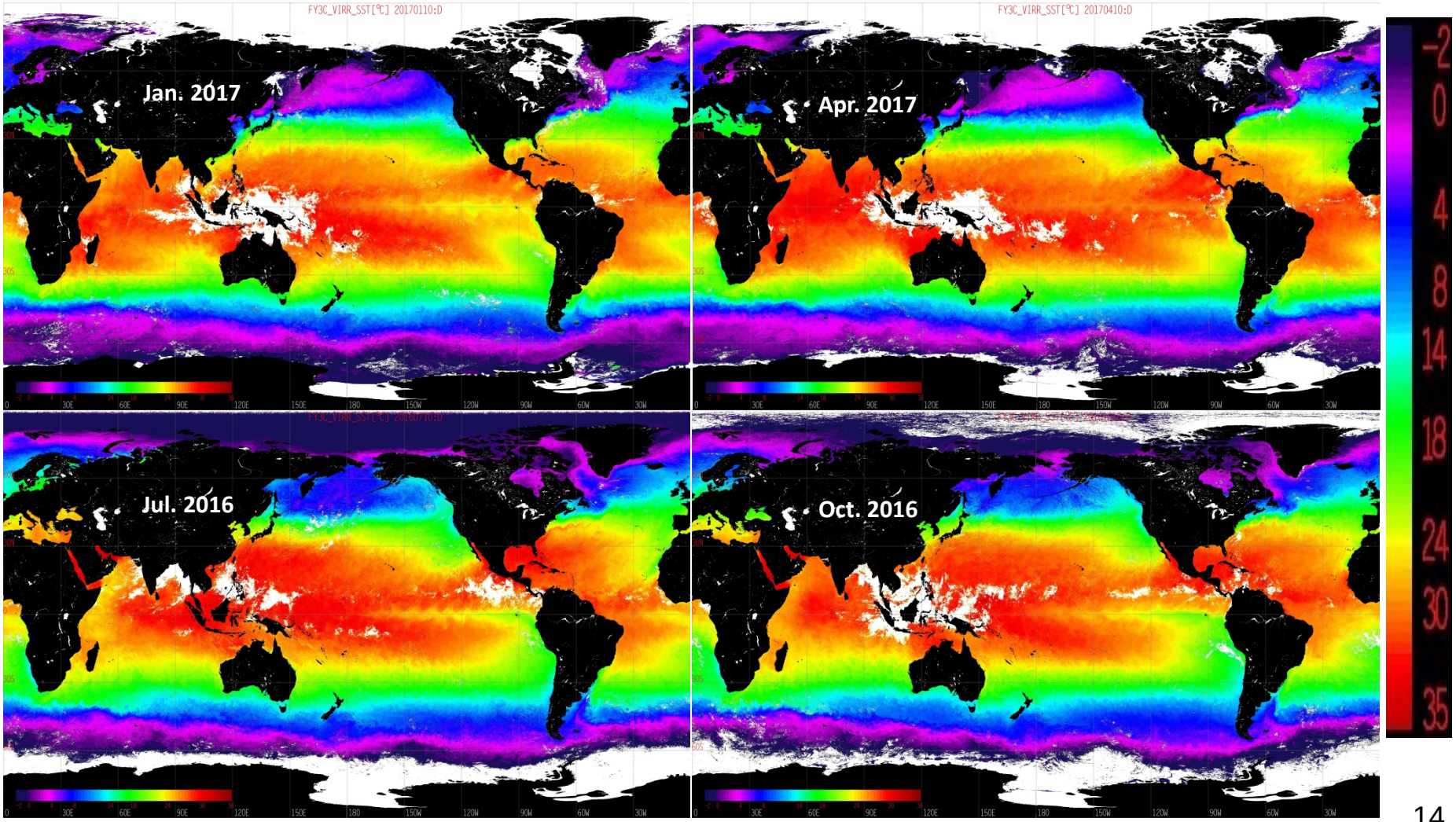
Daytime 2017.4.22 Daily Nighttime

LEO IR SST- FY3/VIRR daily SST(FY-3 AM+PM)



LEO IR SST- FY3C/VIRR 10-day SST

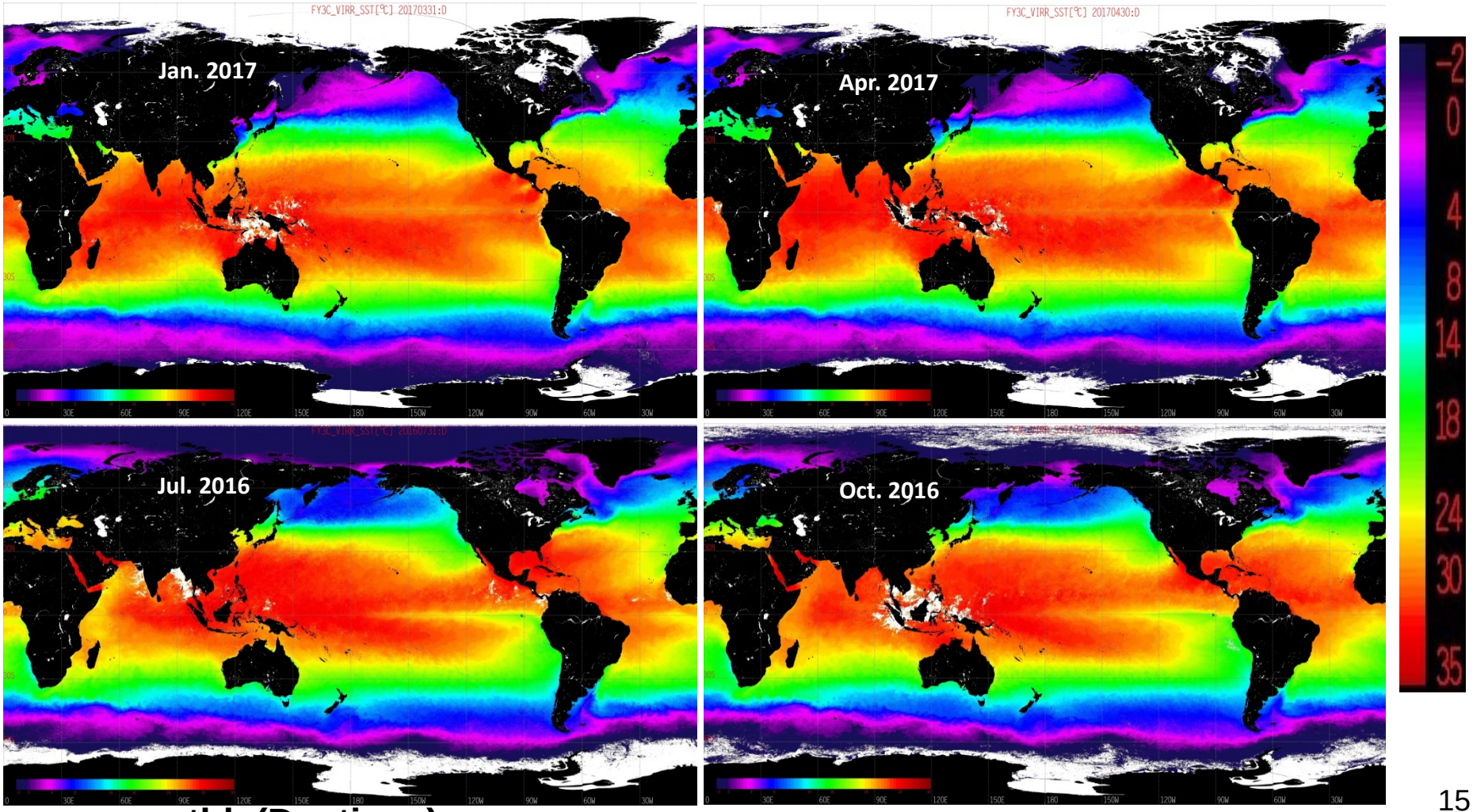
- derived from 5km daily SST
- 5km regular lat/lon grid



10-day(Daytime)

LEO IR SST- FY3C/VIRR monthly SST

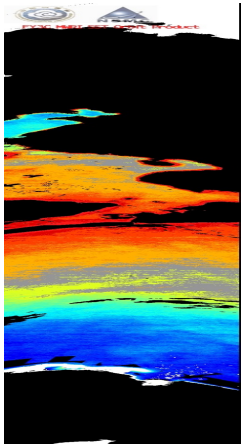
- derived from 5km 10-day SST
- 5km regular lat/lon grid

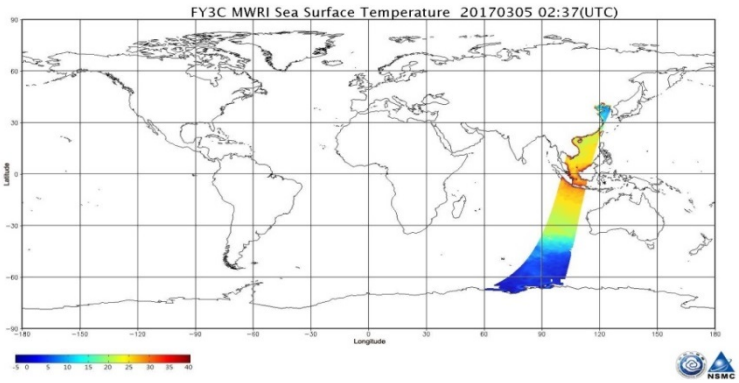


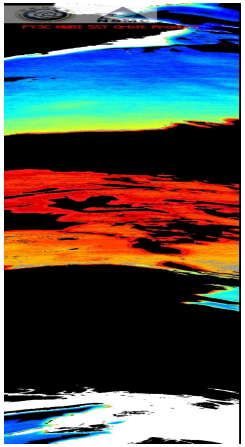
monthly(Daytime)

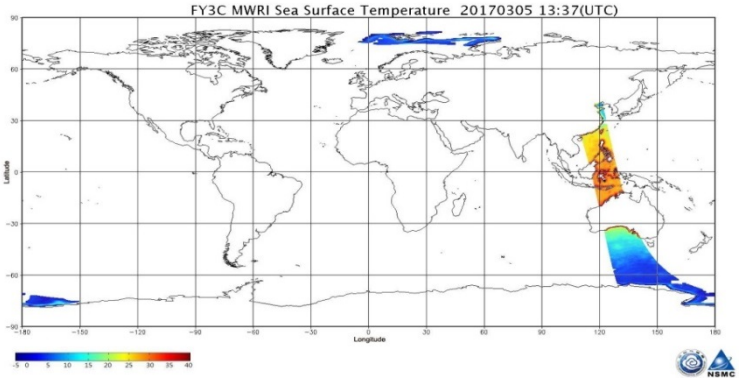
LEO WM SST- FY3C/MWRI orbit SST(research)

- orbit SST
- ~25km resolution at nadir





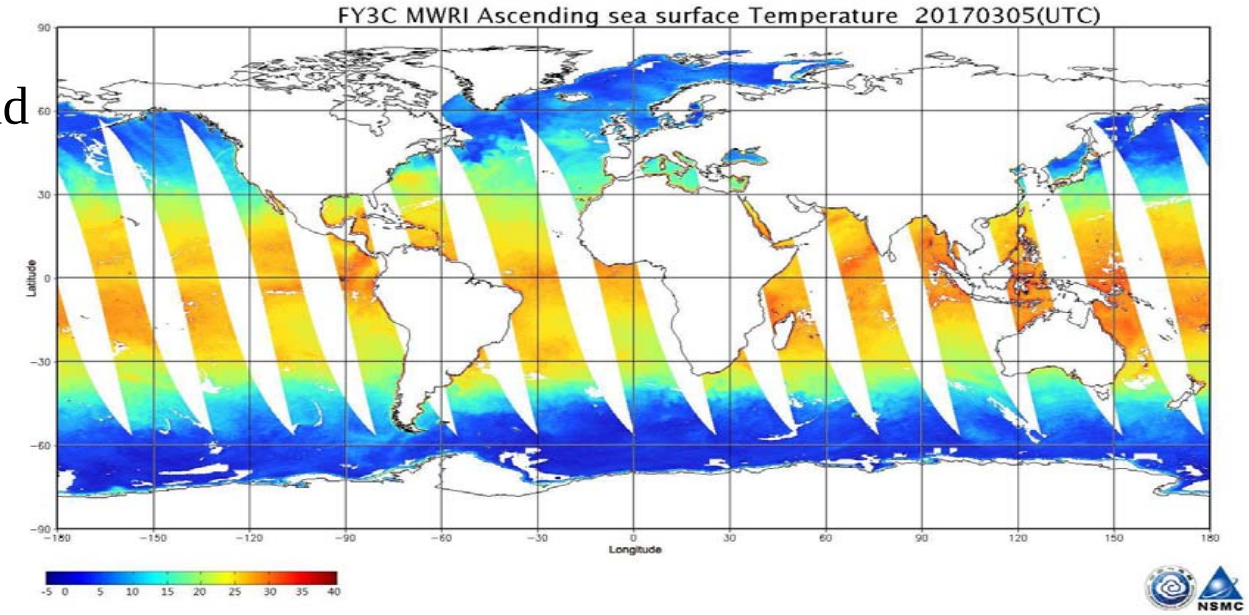


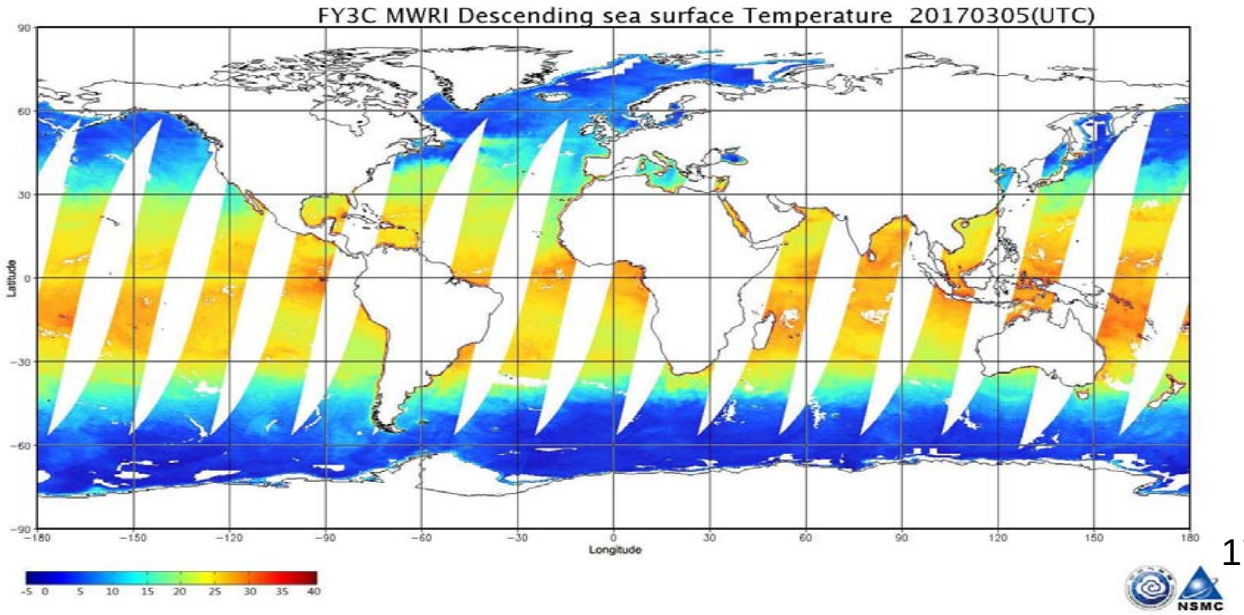


$$sst = const + aT_{B10v} + bT_{B10h} + c\ln(290 - T_{B18v}) + d\ln(290 - T_{B18h}) + e\ln(290 - T_{B23v}) + f\ln(290 - T_{B23h}) + g\ln(290 - T_{B37v}) + h\ln(290 - T_{B37h})$$

LEO MW SST- FY3C/MWRI daily SST(research)

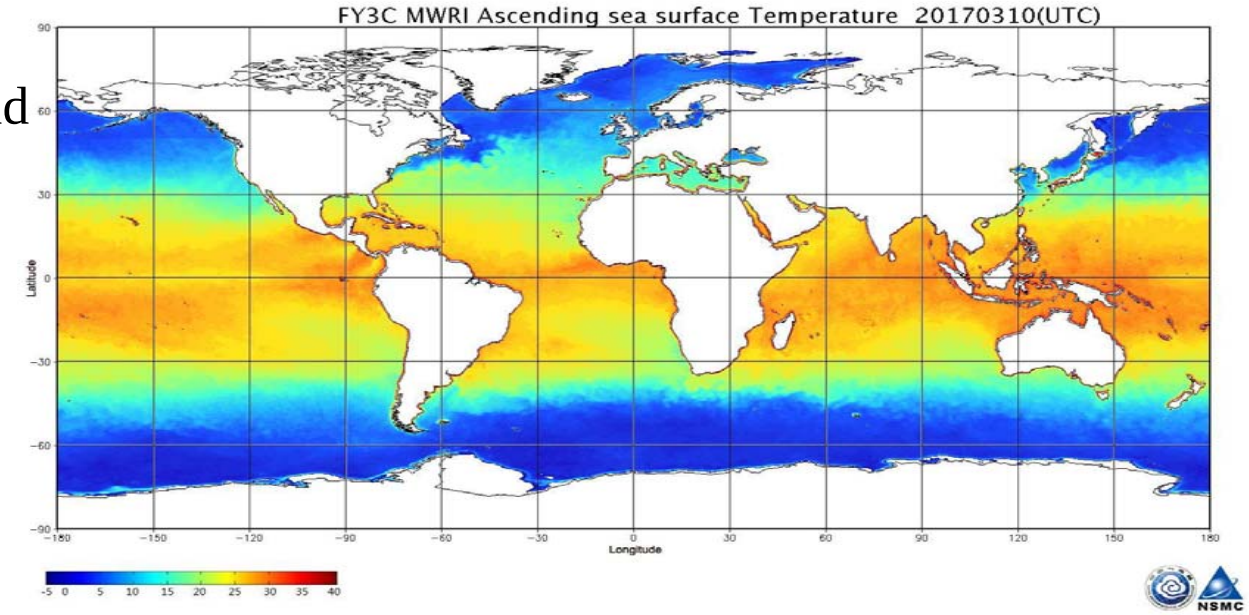
- derived from orbit SST
- 25km regular lat/lon grid

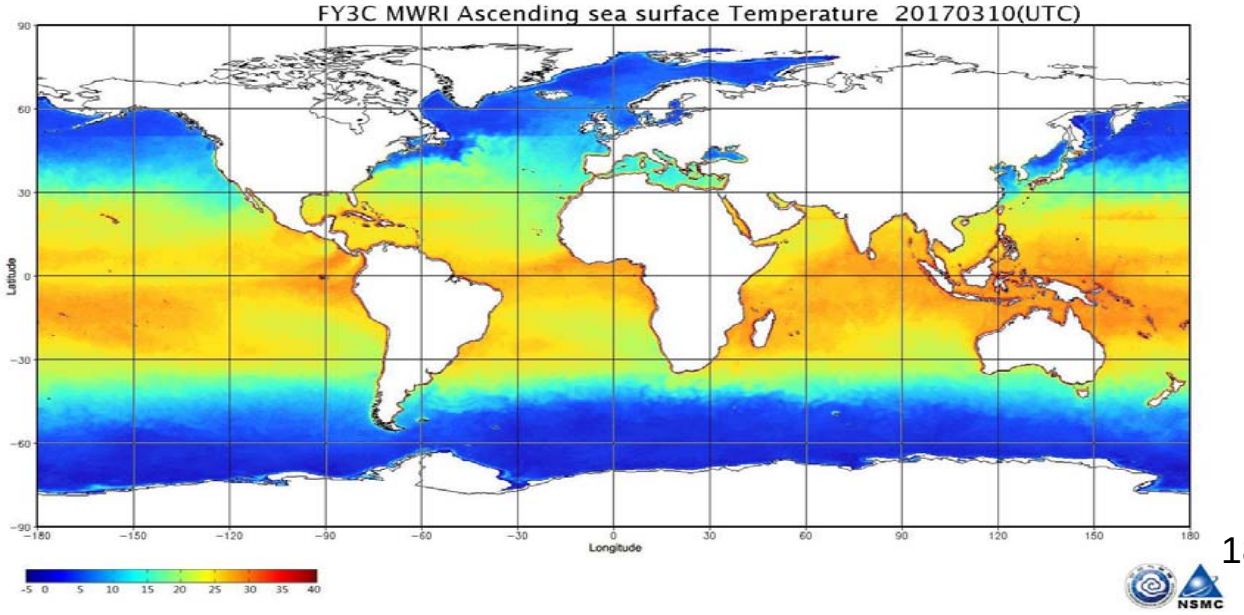




LEO MV SST- FY3C/MWRI 10-day SST(research)

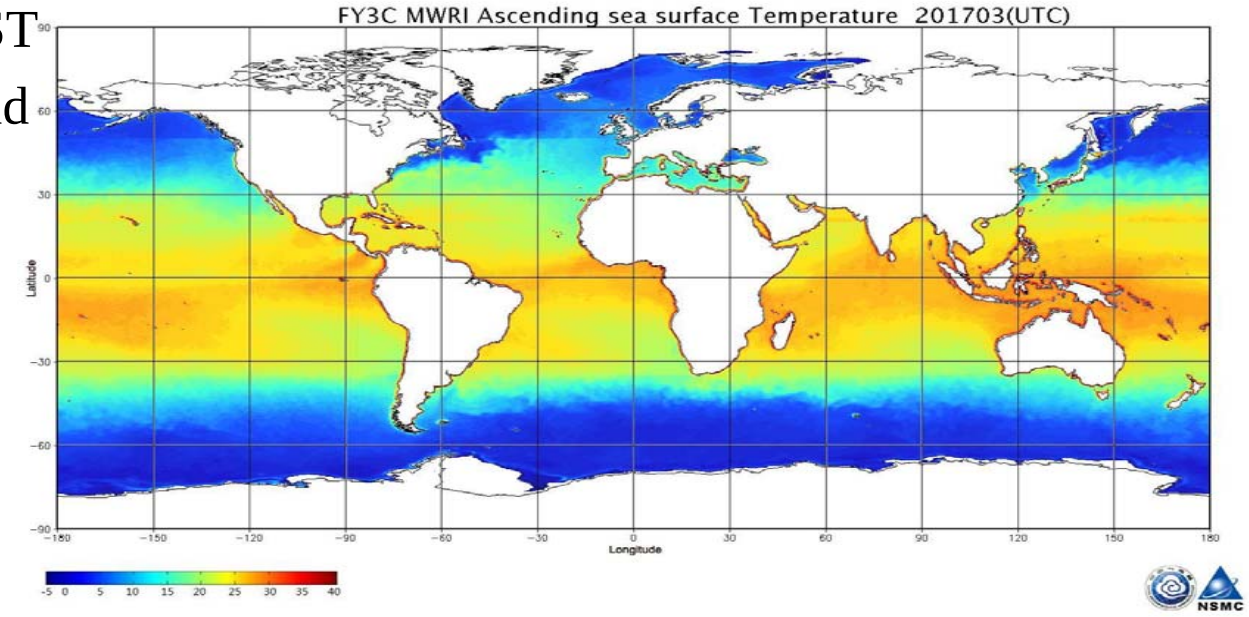
- derived from daily SST
- 25km regular lat/lon grid

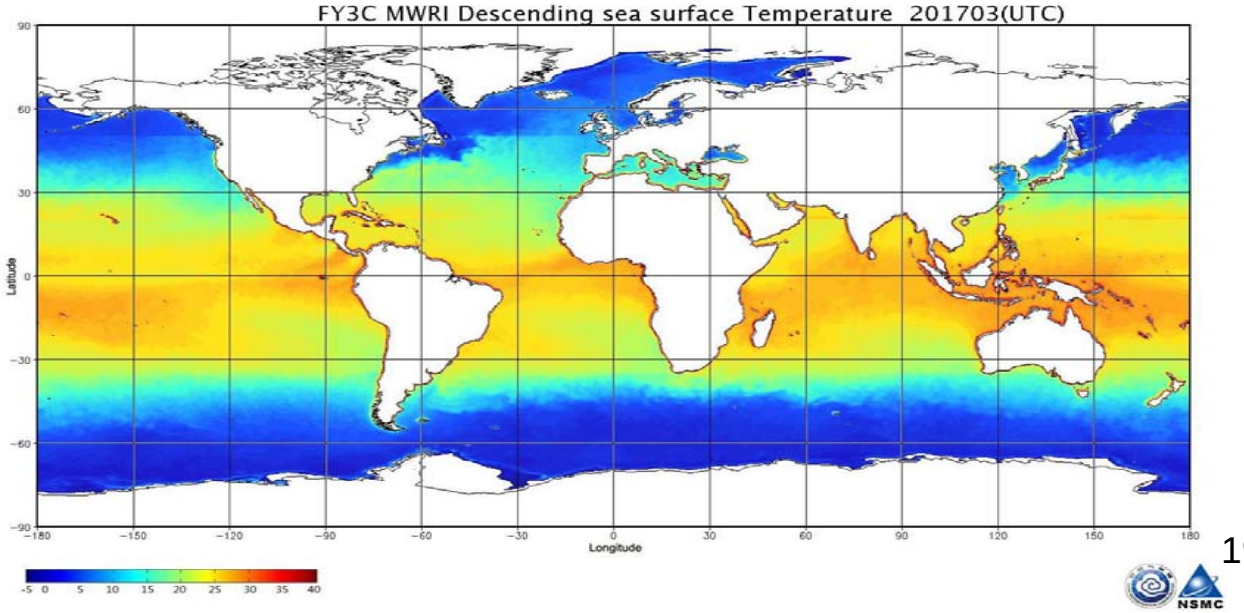




LEO IR SST- FY3C/MWRI monthly SST(research)

- derived from 10-day SST
- 25km regular lat/lon grid





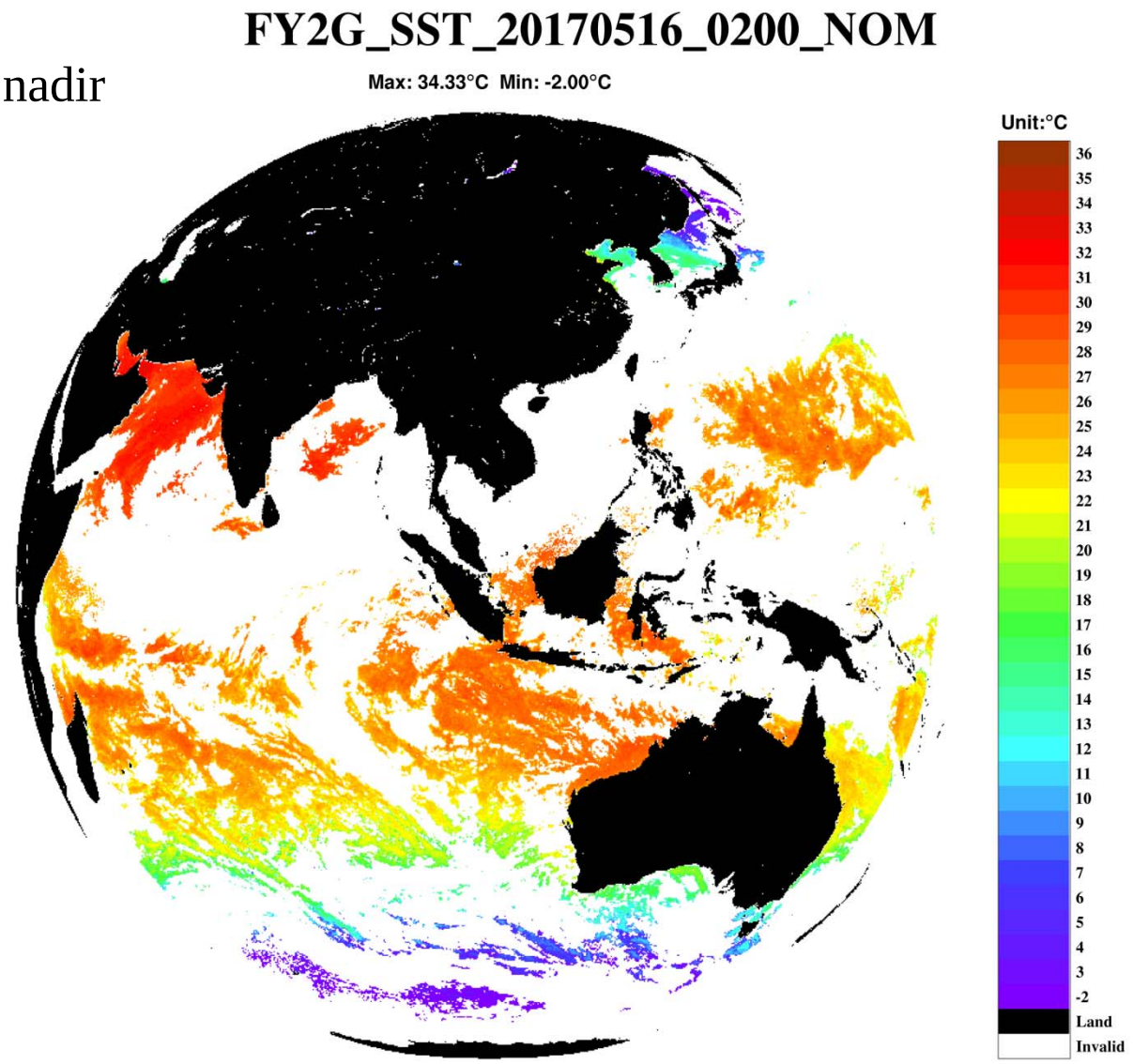
GEO IR SST- FY2 SST status

- FY-2 Satellite data is processed by data processing center (DPC) of FY-2 ground segment.
- FY-2 NOM* data and cloud mask product from DPC are used for SST retrieval .
- FY-2 hourly SST is derived from the split-window QuaDratic term MCSST(QDSST) algorithm and stored in FY-2 NOM format(2288×2288 pixels).
- Based on the FY-2 hourly SST product, the 3-hour, daily, 10-day and monthly SST products are also derived.
- The Coefs are Calculated directly by Bulk SST, so FY2 SST reflects variations in skin SST, but on average represents bulk SST.

NOM * : Nominal projection , non-regular lat/lon grid

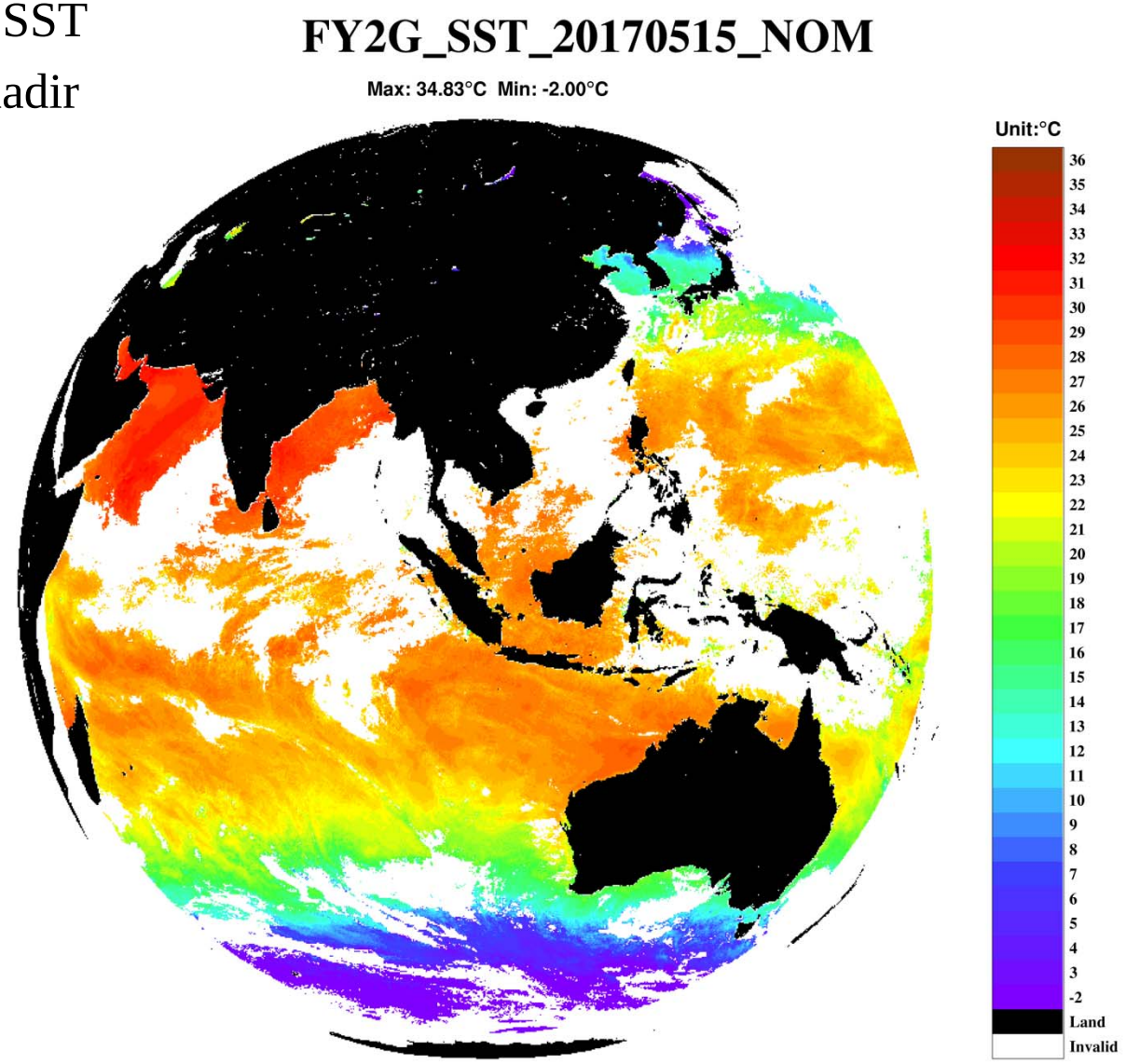
GEO IR SST- FY2G VISSR hourly SST

- hourly NOM SST
- ~5km resolution at nadir



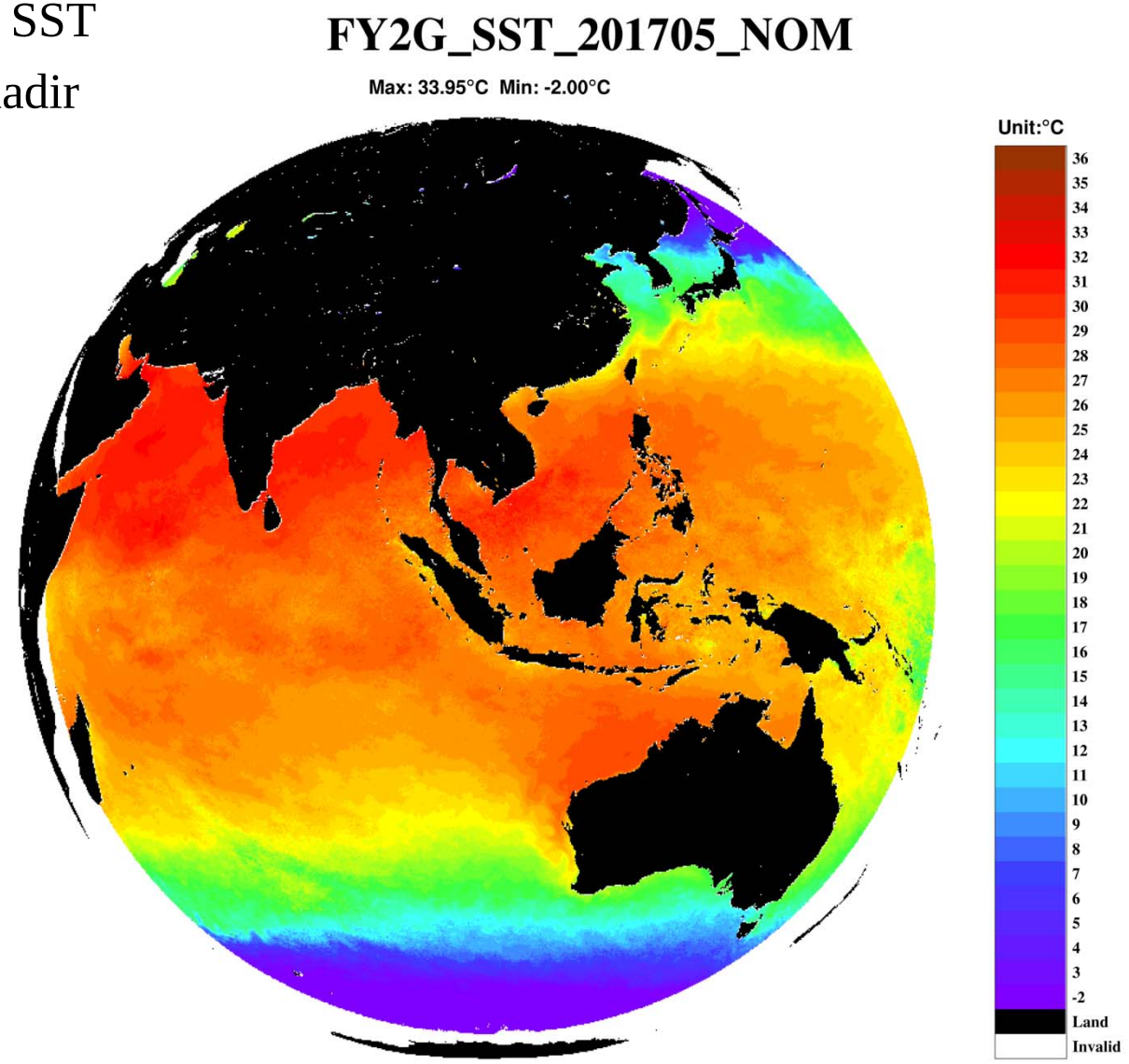
GEO IR SST- FY2G VISSR daily SST

- derived from hourly SST
- ~5km resolution at nadir



GEO IR SST- FY2G VISSR monthly SST

- derived from 10-day SST
- ~5km resolution at nadir



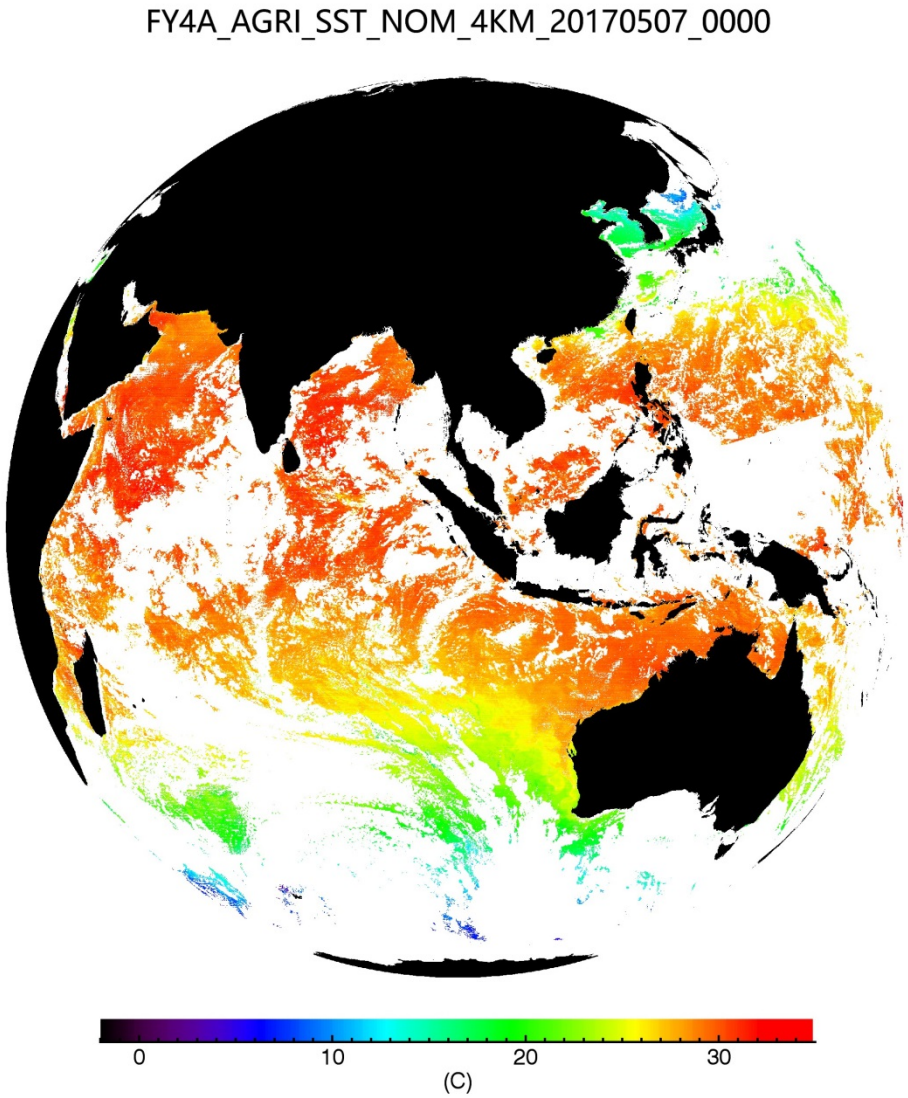
GEO IR SST- FY4 SST status

- FY-4 Satellite data is processed by navigation and registration system (NRS) and product generation system (PGS) of FY-4 ground segment.
- FY-4 NOM* data from NRS and cloud mask product from PGS are used for SST retrieval .
- FY-4 15-minute SST is derived from the split-window nonlinear SST(NLSST) algorithm and stored in FY-4 NOM format(2748×2748 pixels).
- Based on the 15-minute FY-4 SST product, the hourly, daily, 10-day and monthly SST products are also derived.
- The Coefs are Calculated directly by Bulk SST, so FY4 SST reflects variations in skin SST, but on average represents bulk SST.

NOM * : Nominal projection , non-regular lat/lon grid

GEO IR SST- FY4A AGRI 15-minute SST

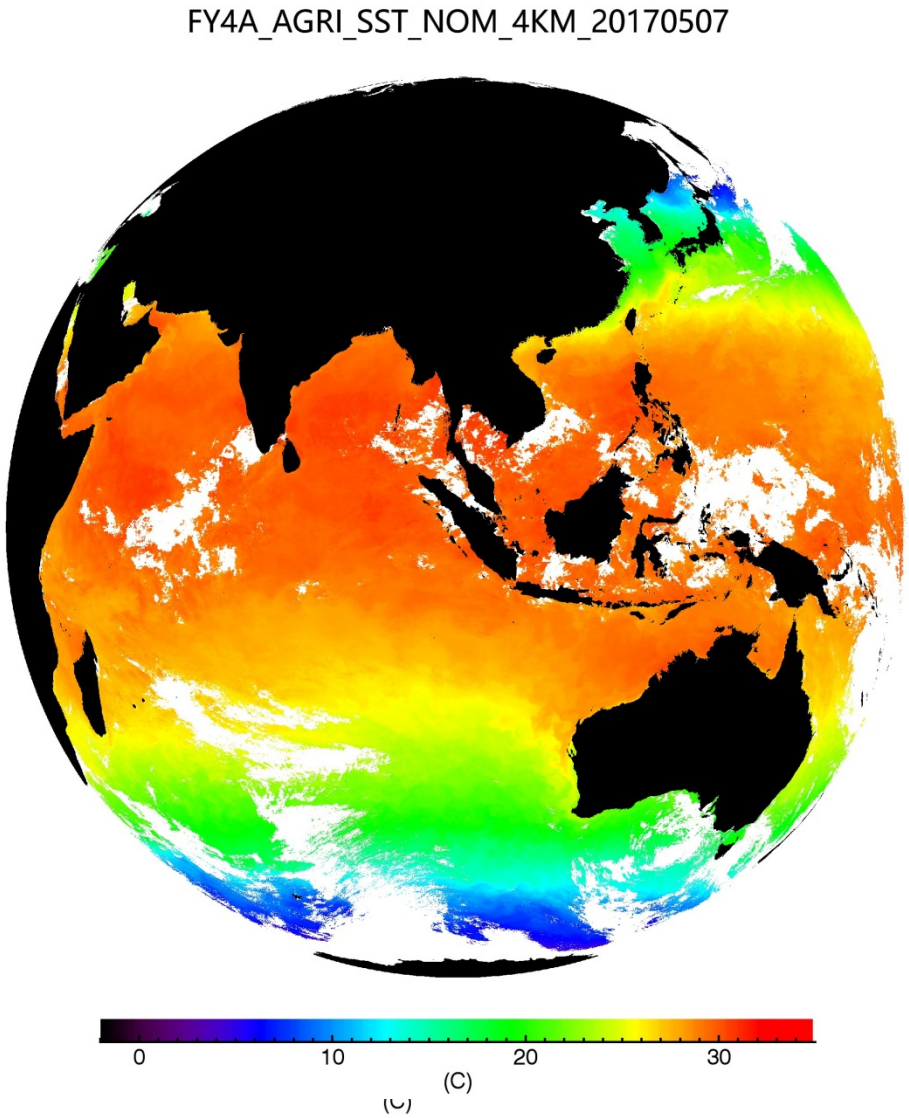
- 15-minute NOM SST
- ~4km resolution at nadir



NLSST: $T_s = a_0 + a_1 T_{11} + a_2 T_{FG}(T_{11} - T_{12}) + a_3 (T_{11} - T_{12})(\sec\theta - 1)$

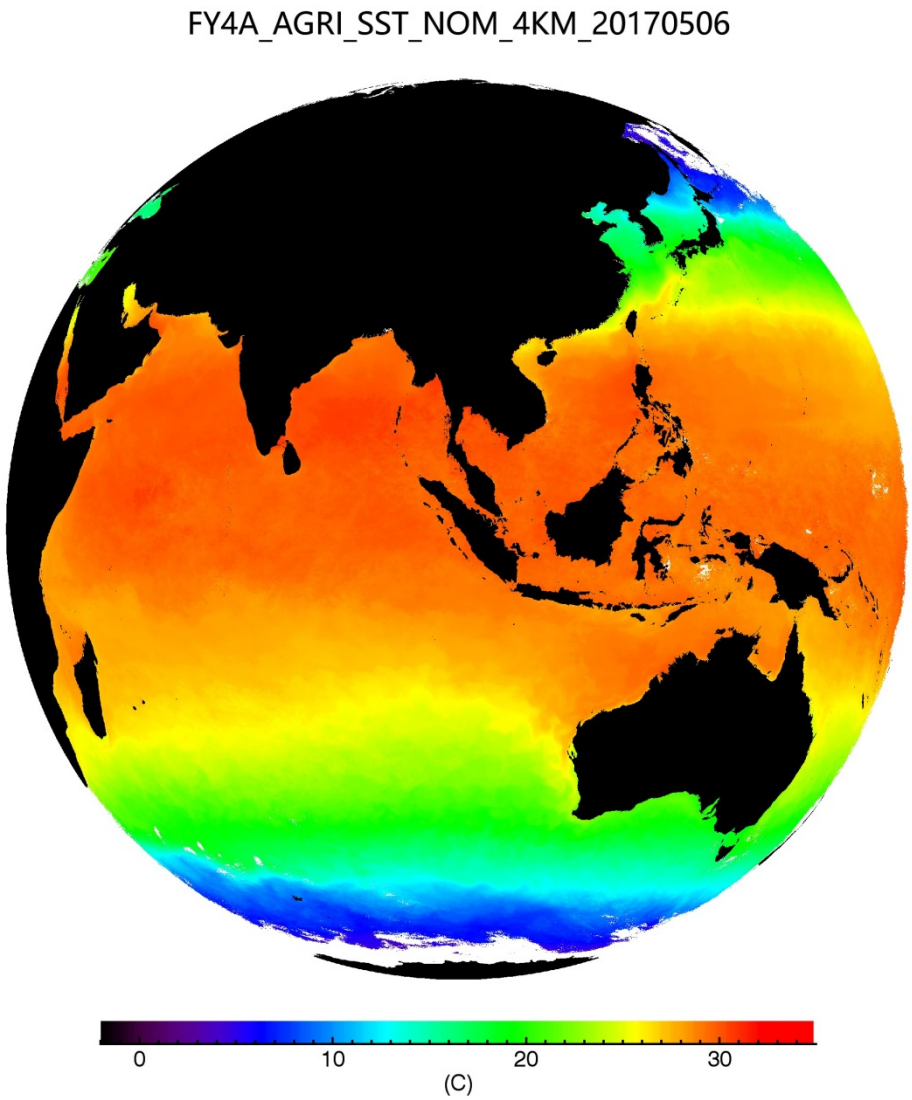
GEO IR SST- FY4A AGRI daily SST

- derived from hourly SST
- ~4km resolution at nadir

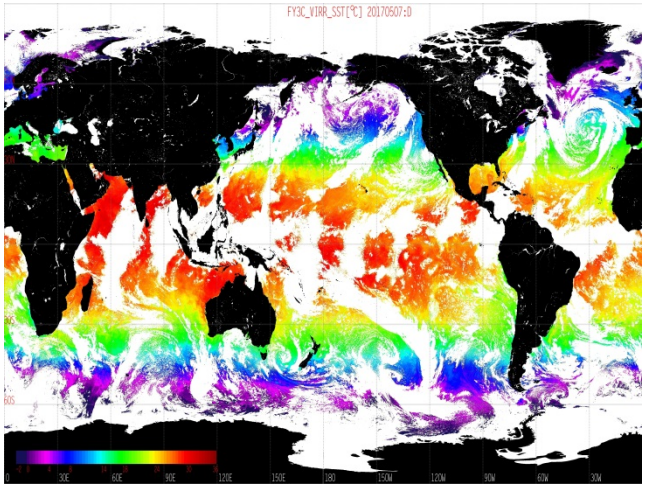


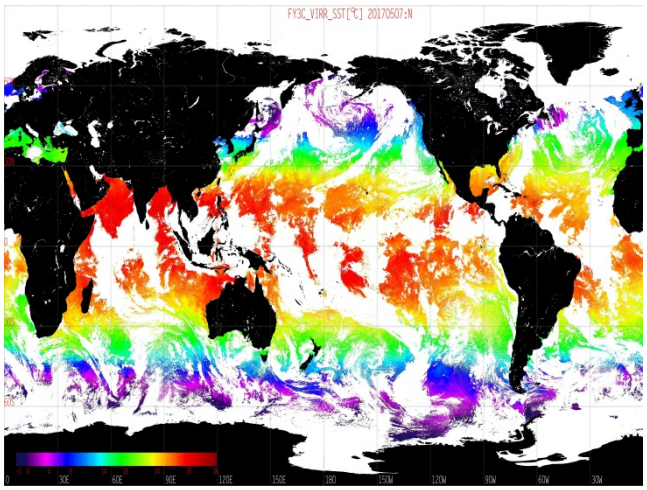
GEO IR SST- FY4A AGRI 10-day SST

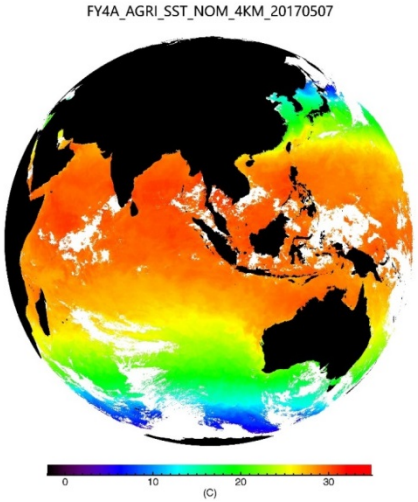
- derived from daily SST
- ~4km resolution at nadir

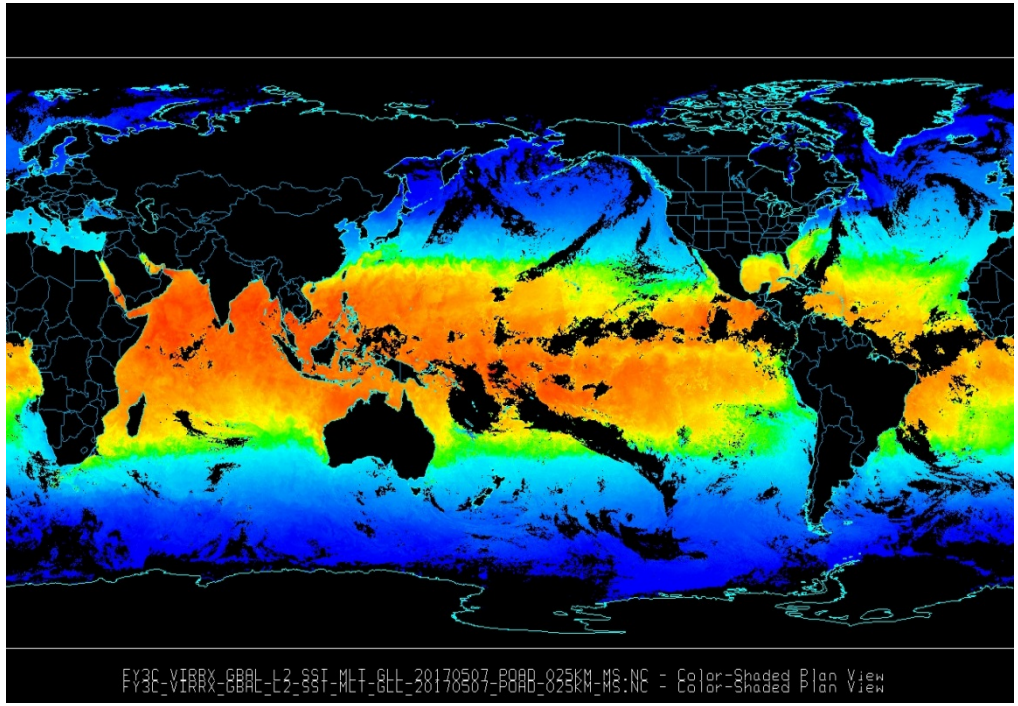


Fengyun Satellite SST Blending experiment- FY LeoGeo









Date： 7 May 2017
Projection: regular lat/lon grid
Resolution： 25KM

	Obs_num	coverage
FY3C/VIRR daily	440727	63.8%
FY3C/VIRR & FY4A	460396	66.6%

FYSST validation

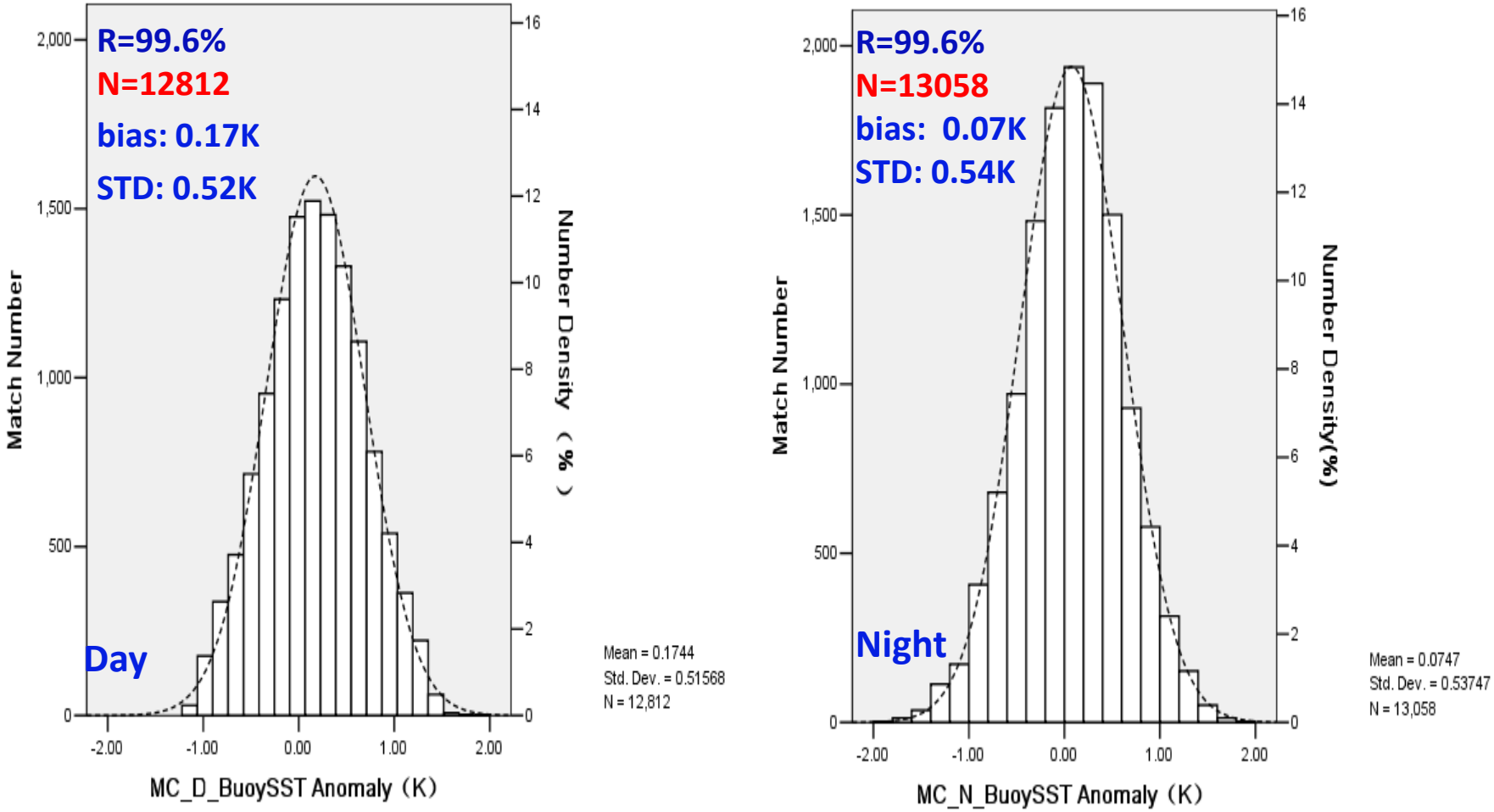
- **Validate SST against in situ data (matchup analyses)**
  - matchup window：within 1hour and 1 IR pixel
  - FY3SST-BuoySST(satellite SST minus buoy SST)

- **Compare SST against Global gridded L4 SST : OISST**
  - matchup window： within 1 Day and 1 IR pixel
  - OISST is bilinearly interpolated to sensor's pixels
  - FYSST-OISST
  - Statistics are generated according to quality flag

Reynolds OI v2 daily 0.25° SST(hereafter OISST) was chosen as reference SST for FYSST anomaly analyses.

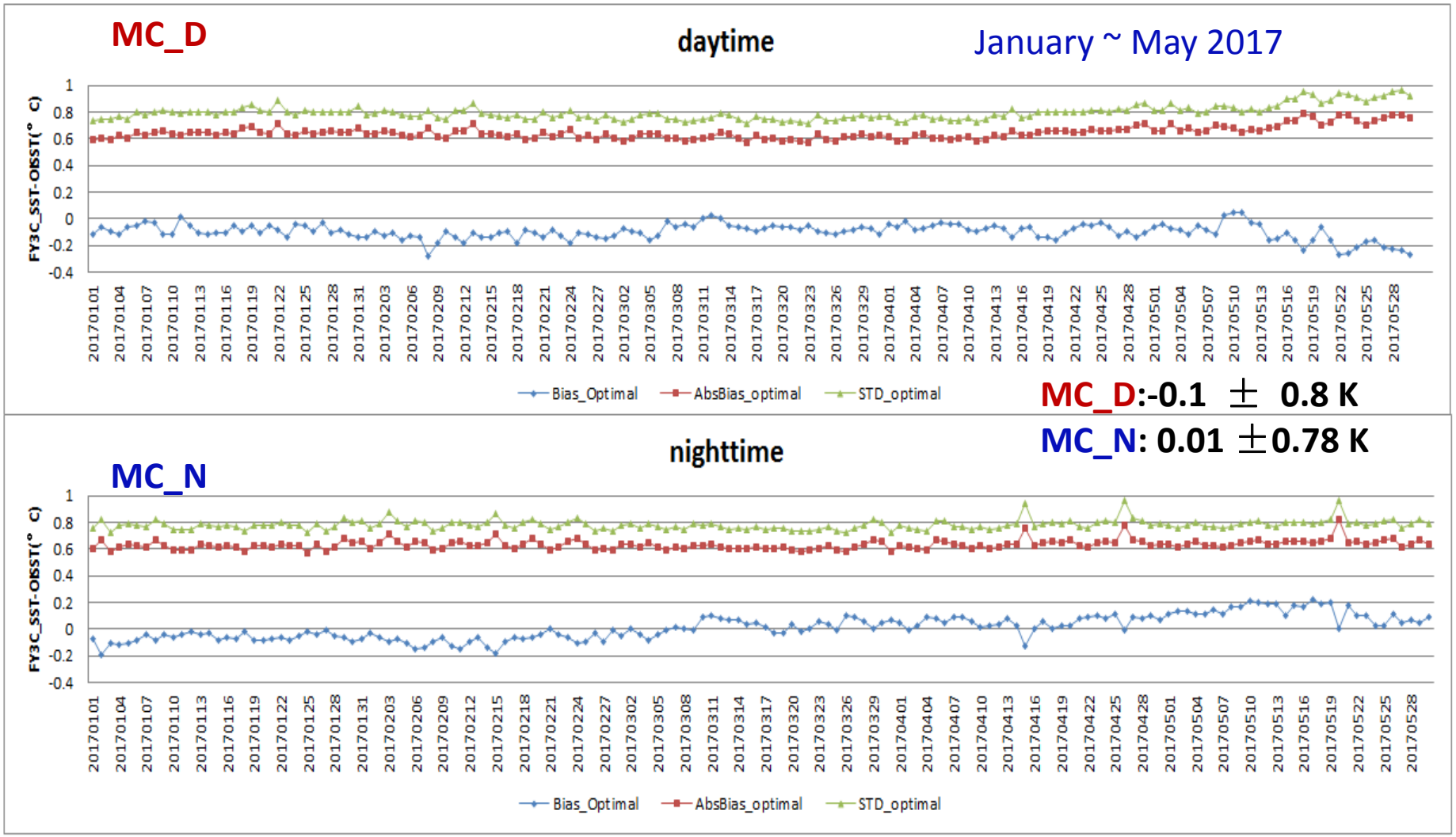
Validate FY-3C/VIRR SST against in situ data

(matchup analyses 2016.11~2017.1)



The coefficients are derived from October to December 2015 MDB, an independent MDB from November 2016 to January 2017 was used to assess the FY-3C/VIRR SST accuracy.

Compare FY-3C/VIRR operational SST against Daily OISST

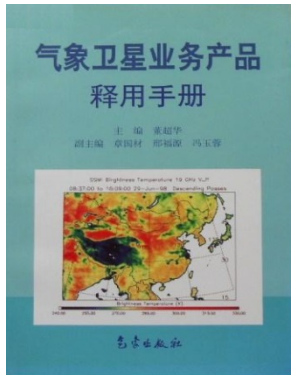


The daily time series of anomaly statistics of FY-3C/VIRR operational SST from January to May 2017 for the quality flag with optimal(0)。

Books for FY data and product specification

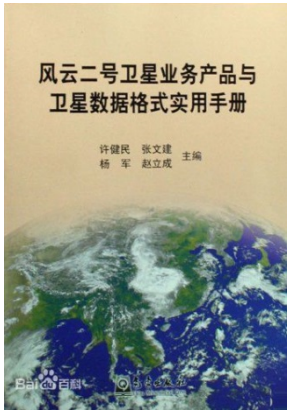
❑ **Reference Manual of Meteorological Satellite Operational Products(in Chinese)**

- Chaohua Dong. etc. Beijing: China Meteorological Press,1999.4
- **AWX1.0**: **A**dvanced **W**eather satellite e**X**change format （CMA internal format）



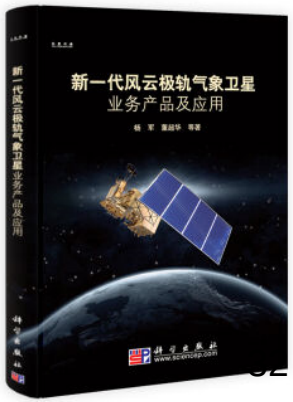
❑ **Reference Manual of FY2 Geo-Meteorological Satellite Operational Products and Data Format (in Chinese)**

- Jianmin Xu. etc. Beijing: China Meteorological Press,2008.12
- **AWX2.0**
- HDF5.0/BUFR/GRIB



❑ **New Generation FY Leo-Meteorological Satellite Operational Products and Applications (in Chinese)**

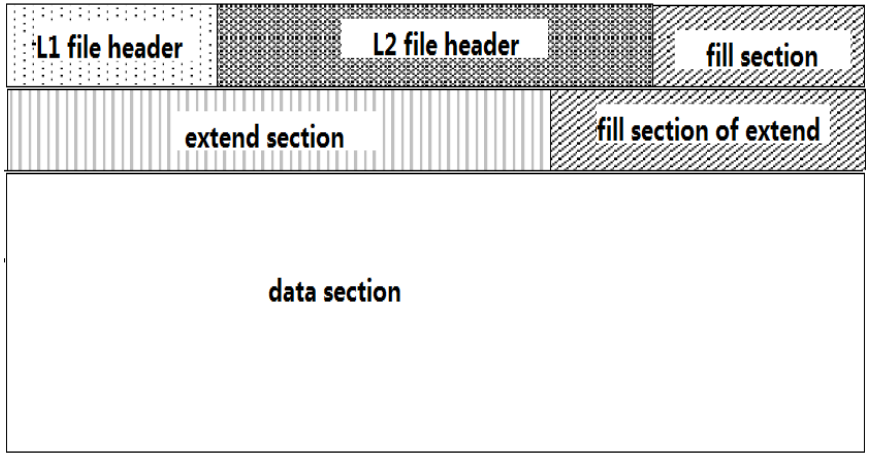
- Jun Yang. etc. Beijing: China Science Press,2010.10
- HDF5.0



CMA satellite data exchange format

❑ **AWX2.1:** AWX File Format Specification Version 2.1.pdf

- **SAT1996 filename:** T_1T_2DMYYGg.AWX
  - ➢ TTPMYYGg for polar-obitting SST
  - ➢ TTGMYYGg for geostationary SST
- **SAT2004 filename :** <SatId>_<ProdId>_<ChannelFlag>_<ProjID>_<startData>_<startTime>.AWX
  - ➢ FY2C_SST_MLT_OTG_YYYYMMDD_HHMM.AWX
- **Data format:**
  - ➢ Level 1 File Header
  - ➢ Level 2 File Header
  - ➢ Fill Section
  - ➢ Extend Section
  - ➢ Fill Section of Extend Section
  - ➢ Data Section



- After 2004, meteorological satellite data and products used for CMA's domestic meteorological information communication system were archived in AWX2.1 format.
- The English version document of AWX2.1 file format specification can be found on : http://www.nsmc.org.cn/en/NSMC/Contents/DocumentsDetails01.html

CMA satellite data exchange format

AWX File Format Specification Version 2.1

Source: Author: IssuedDate:

1. Contents of distributed meteorological satellite products
1.1 Concept of distributed meteorological satellite products
1.2 Standard formats of distributed meteorological satellite products
1.2.1 Imagery products
1.2.2 Grid field quantitative products
1.2.3 Discrete field products
1.2.4 Graphical analysis products
2. Standard file names of distributed meteorological satellite products
2.1 SAT96 format and file naming
2.2 SAT2004 format and file naming
2.2.1 Characters that can be used in file naming
2.2.2 Composition of file naming

download

AWX: Advanced Weather satellite eXchange format

CMA SST specification crosscheck with GDS2.0(LEO)

	CMA FY3 SST	GDS2.0
Processing Level	L2 (orbit)	L2P
	L2 (regular lat/lon grid) Daily	L3U
		L3C
	L3 (regular lat/lon grid) 10-day / monthly	
	None	L3S
	None	L4
SST Type	SSTskin* SSTsubskin	SSTint SSTskin SSTsubskin SSTdepth SSTfnd SSTblend
File Type	HDF5	netCDF or XML

The coefficients for regression were calculated from matchups of BTs and in situ bulk SSTs. As a result, SSTskin* reflects variations in skin SST, but on average represents bulk SST.

CMA SST specification crosscheck with GDS2.0(GEO)

	CMA FY2/4 SST	GDS2.0
Processing Level	L2 (NOM)	L2P
	L2 (NOM) 3-hour / daily L2 (regular lat/lon grid) 3-hour / daily	L3U
	L3 (NOM) 10-day / monthly L3 (regular lat/lon grid) 10-day / monthly	L3C
	None	L3S
	None	L4
SST Type	SSTskin*	SSTint SSTskin SSTsubskin SSTdepth SSTfnd SSTblend
File Type	HDF5(for FY2 NOM) netCDF(for FY4 NOM) AWX2.0(for regular lat/lon grid)	netCDF or XML

- NOM: Nominal projection, non-regular lat/lon grid
- SSTskin* reflects variations in skin SST, but on average represents bulk SST.

CMA SST specification crosscheck with GDS2.0

GDS2.0 L2P dataset	FY2 VISSR	FY3A/B VIRR	FY3C VIRR	FY3D MERSI	FY3C/D MWRI	FY4A AGRI
Global Attributes	√	√	√	√	√	√
Geolocation Data	①	②	②	②	√	①
sea_surface_temperature	√	√	√	√	√	√
sst_dtime			②	②	√	
sses_bias						
sses_standard_deviation						
l2p_flags			√	√		√
quality_level					√	
dt_analysis			√	√		√
wind_speed						
sea_ice_fraction			√	√	√	
aerosol_dyanmamc_indicator			√	√		

As a multi-satellite, huge data and products processing and archiving center, storage saving is more concerned by NSMC/CMA.

① static geolocation data in nominal projection, shared by all NOM L1 data and L2/3 products.

② dynamic geolocation and time data stored in a separate file, shared by all L1 data and L2 products of VIRR and MERSI respectively.

Summary

- **GHRSST GDS2.0**

- GDS instructed on how to process satellite data streams, defined the format and content of the data and metadata, and documented the basic approaches to providing uncertainty estimates and auxiliary data sets.

- **FY-SST**

- FY-SST of different satellite series has different format.

- The accuracy of FY-SST is still need to be improved, especially for FY-3 MICROWAVE SST.

- CMA would like to have more cooperation with GHRSST in SST operational product validation and data blending.

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Thank you!