Evaluation of SST products from HY satellites

Lei Guan, Mingkun Liu, Cong Men, Kailin Zhang

Ocean Remote Sensing Institute
Department of Marine Technology
College of Information Science and Engineering
Ocean University of China
Qingdao, China

Outline

- Introduction
- SST from HY-1B COCTS
- SST from HY-2 Scanning Microwave Radiometer
- Summary

Introduction

Sea surface temperature products are operationally produced from Haiyang satellites and Fengyun satellites observations in China

- Haiyang (HY) Series Satellite

National Ocean Satellite Application Center (NSOAS) of the State Oceanic Administration of China (SOA) is responsible for development of ocean satellite series and satellite ocean applications. (http://www.nsoas.gov.cn)

- Fengyun (FY) Series Satellite

National Satellite Meteorological Center (NSMC) of China Meteorological Administration (CMA) is responsible for development of meteorological satellite series and satellite meteorological applications. (http://www.nsmc.cma.gov.cn)

- HY-1 Series Satellites
  Chinese Ocean Color and Temperature Scanner (COCTS)
  - HY-1A, May 2002
  - HY-1B, Apr. 2007

- HY-2 Series Satellites
  Scanning Microwave Radiometer
  - HY-2, Aug. 2011

- FY-3 Series Satellites
  Visible infrared scanning radiometer (VIRR)
  - FY-3A, May 2008
  - FY-3B, Nov. 2010
  - FY-3C, Nov. 2013

- FY-2 Series Satellites
  Stretched - Visible and Infrared Spin-Scan Radiometer(S-VISSR)
  - FY-2C, Oct. 2004
  - FY-2D, Dec. 2006
  - FY-2E, Dec. 2008
  - FY-2F, Jan. 2012

HY-1 Chinese Ocean Color and Temperature Scanner (COCTS)

Table 2: Specification of the COCTS instrument

Spectral range (μm)	SNR	Dynamic range (%)	Observation objective
0.402 - 0.422	440	40	Yellow substance, water pollution
0.433 - 0.453	600	35	Absorption of chlorophyll
0.480 - 0.500	590	30	Chlorophyll, sea water optics sea ice Pollutants, shallow sea topography
0.510 - 0.530	560	28	Chlorophyll, water depth, Sediment of low concentration
0.555 - 0.575	525	25	Chlorophyll, sediment of low concentration
0.660 - 0.680	390	20	Peak of fluorescence, sediment of high concentration, pollution, atmospheric correction, aerosols
0.730 - 0.770	400	15	Sediment of high concentration, atmospheric correction
0.845 - 0.885	415	15	Atmospheric correction, water vapor
10.30 - 11.40 (TIR)	NEΔT = 0.2 K (at 300 K)		SST (Sea Surface Temperature), sea ice, temperature of cloud top
11.40 - 12.50 (TIR)	NEΔT = 0.2 K (at 300 K)		SST, sea ice, temperature of cloud top

✧ HY-2 Series Satellites
Scanning Microwave Radiometer

Center frequency (GHz)	6.6	10.7	18.7	23.8	37
RF bandwidth (MHz)	350	250	250	400	1000
Polarization	V,H	V,H	V,H	V	V,H
Brightness temperature sensitivity (K)	0.5	0.5	0.5	0.5	0.8
Calibration precision	1 K @ 180~320 K				
Swath width	1600 km				
Ground resolution (km)	100	62	36	30	18
Dynamic range (K)	3~350				
Receiver linearity	> 0.999				
Main beam coefficient	> 95%				
Scanning mode	Conical scanning				

✧ FY-3 Series Satellites
Visible infrared scanning radiometer (VIRR)

Channel	Spectral range (μm)	Noise Equivalent Reflectance (%) or NEΔT (at 300 K)	Dynamic range (% or K)
1	0.58-0.68	0.1%	0-100%
2	0.84-0.89	0.1%	0-100%
3	3.55-3.95	0.3 K	180-350 K
4	10.3-11.3	0.2 K	180-330 K
5	11.5-12.5	0.2 K	180-330 K
6	1.58-1.64	0.15%	0-90%
7	0.43-0.48	0.05%	0-50%
8	0.48-0.53	0.05%	0-50%
9	0.53-0.58	0.05%	0-50%
10	1.325-1.395	0.19%	0-90%

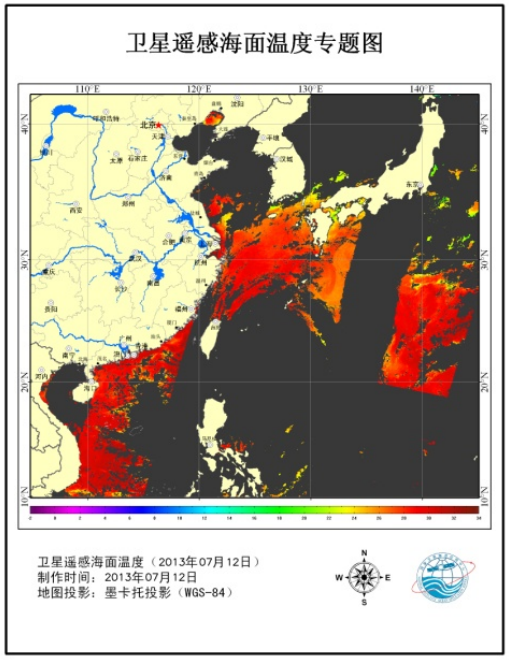
✧ FY-2 Series Satellites

Stretched - Visible and Infrared Spin-Scan Radiometer(S-VISSR)

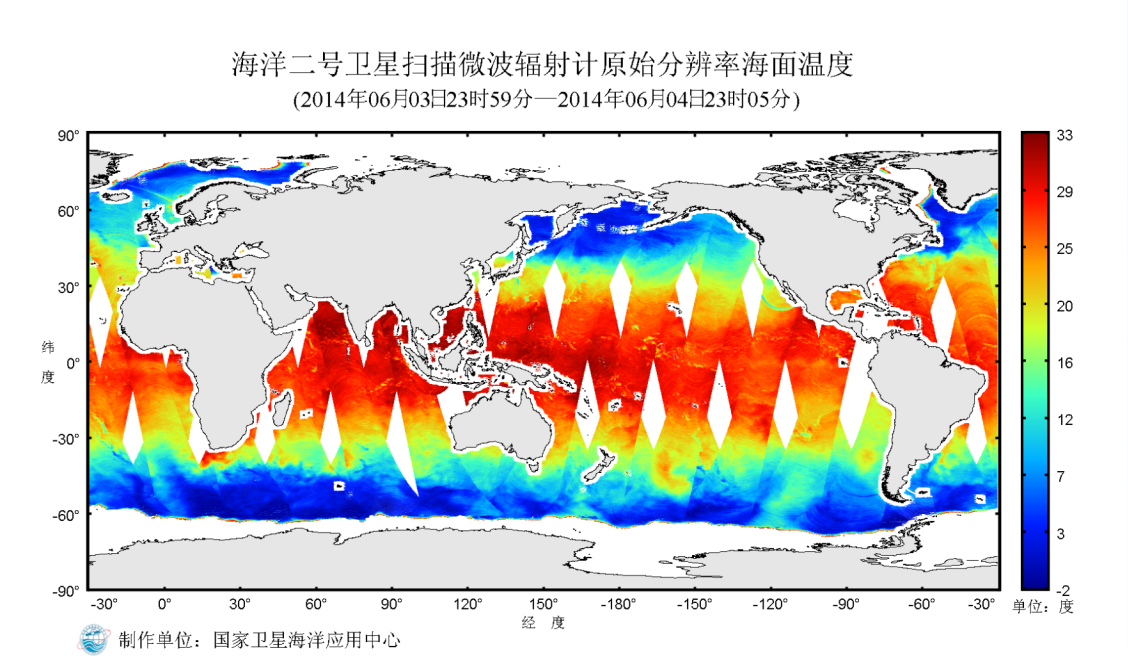
Channel	**FY-2, A, B**	**FY-2, C, D, E**
VIS (Visible)	0.50 - 1.05 μm	0.50 - 0.99 μm
IR1 (Infrared 1)	10.5 - 12.5 μm	10.3 - 11.3 μm
IR2		11.5 - 12.5 μm
IR3		3.5 - 4.0 μm
WV (Water Vapor)	6.3 - 7.6 μm	6.3 - 7.6 μm

NSOAS HY satellite SST products

HY-1B Products



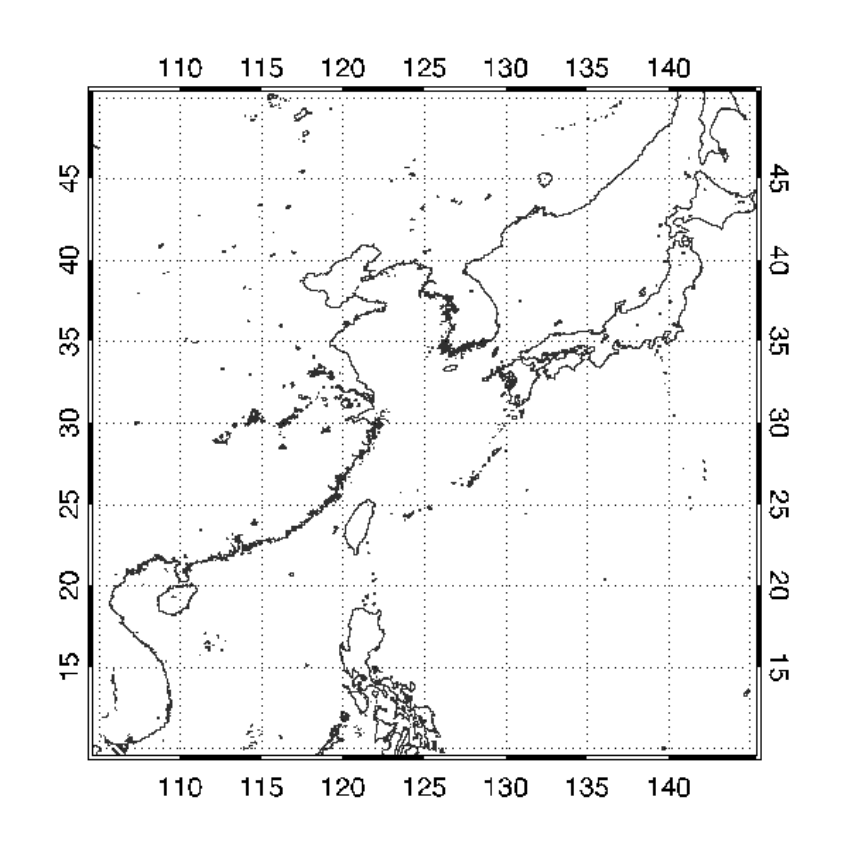
HY-2 Products



NSMC FY satellite SST products

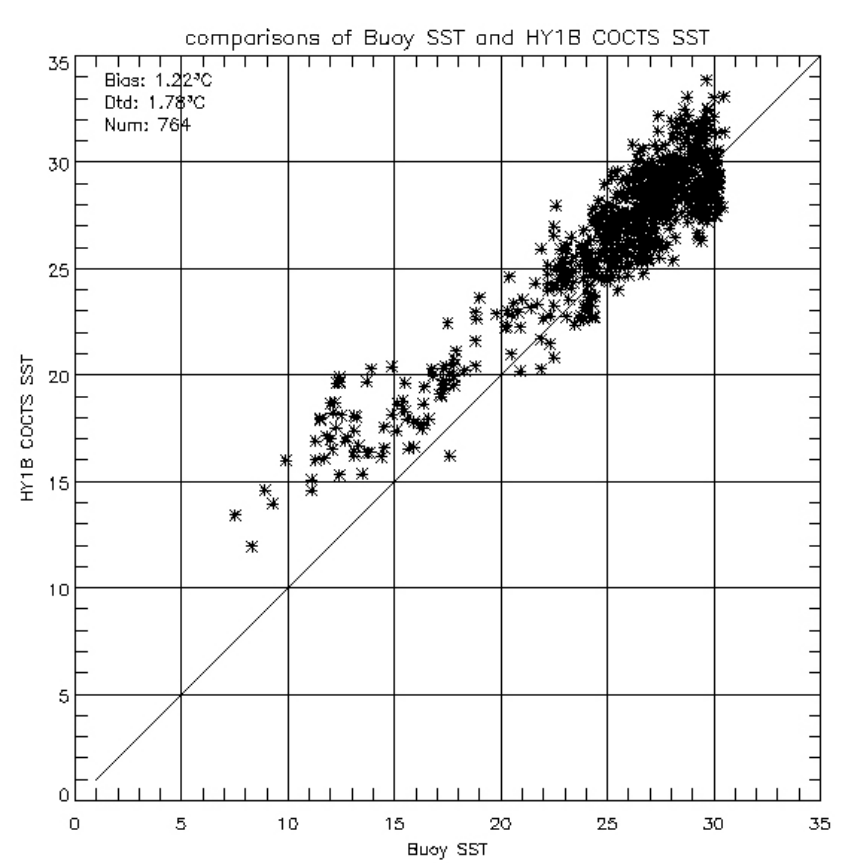
http://satellite.cma.gov.cn

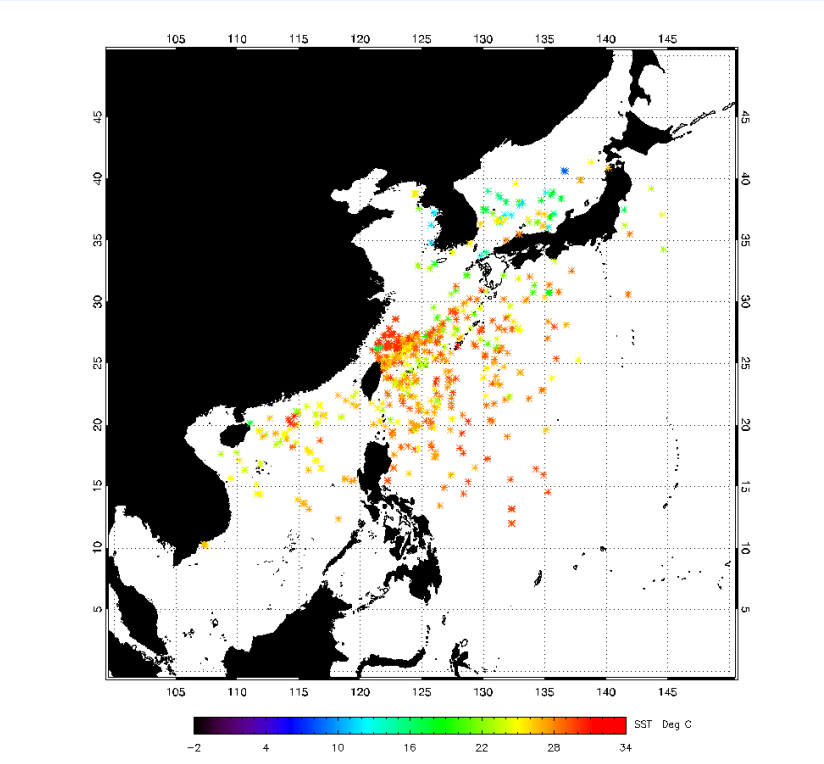
Preliminary results on HY-1B COCTS SST retrieval and validation



HY-1B L2B SST products in Feb., May. , Aug. Nov. during 2008-2011
430 products

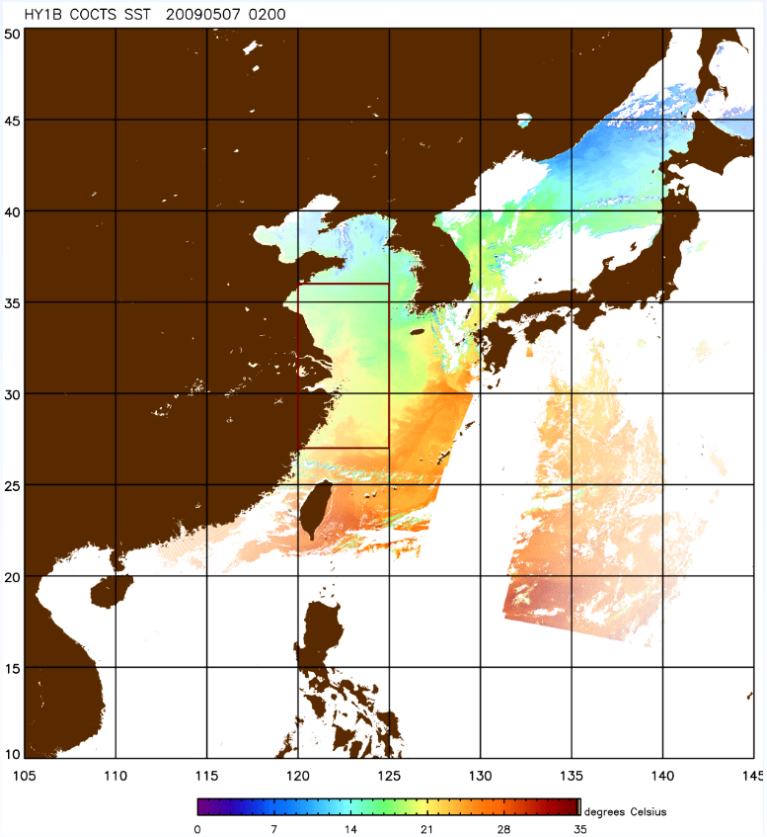
Buoy data from NEAR-GOOS Database

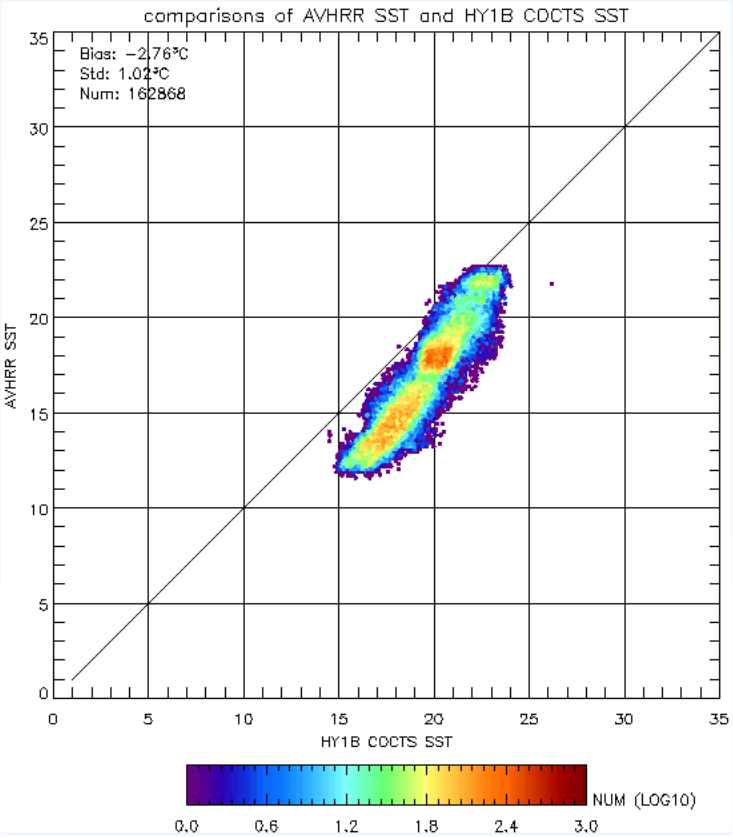




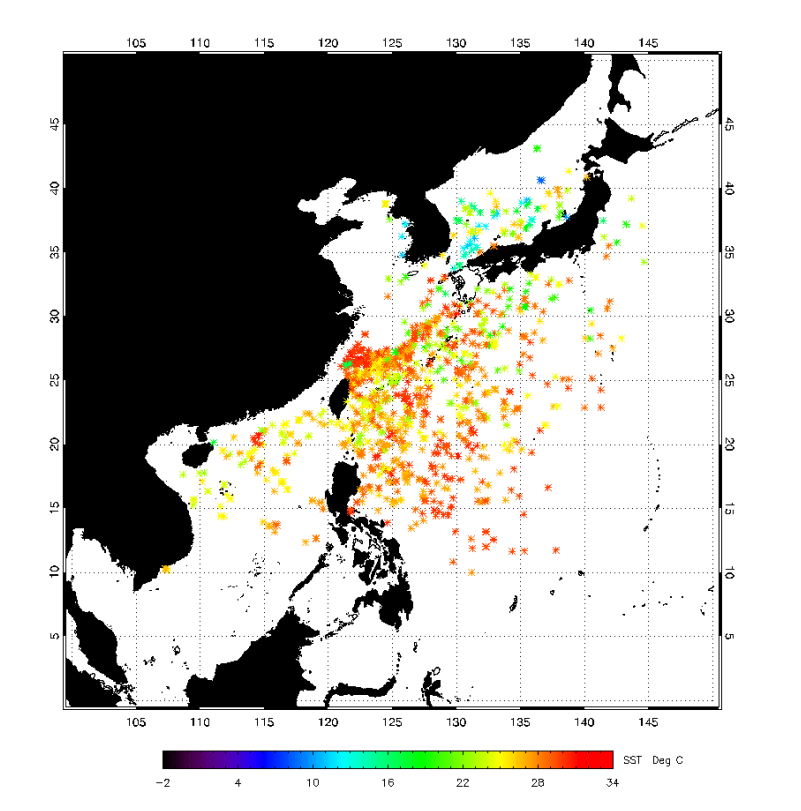
Temporal window: 1 hour
Spatial window: 0.01°
No. of Matchup: 764
Bias: 1.22 °C , Std. Dev.: 1.78 °C

Comparisons of HY-1B COCTS L2B SST products and buoy SST data





Comparison of COCTS SST with AVHRR SST



HY-1B L1B products
in Feb., May. , Aug. Nov. during
2008-2011

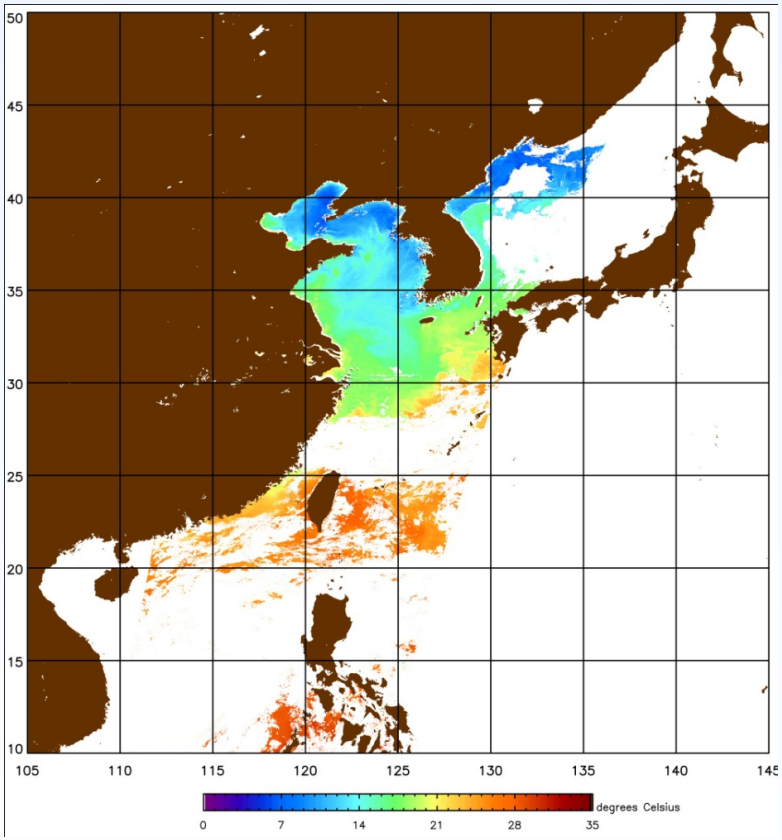
Temporal window: 1 hour
Spatial window: 0.01°

No. of Matchup: 1565 - Total
1044 - Regression
521 - Validation

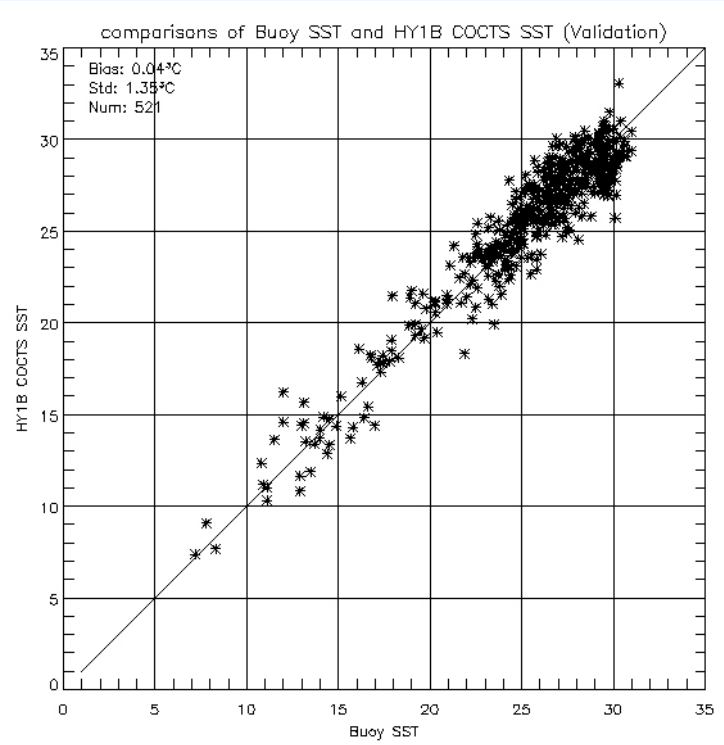
$$NLSST = \alpha_0 + a_1 \times T_9 + a_2 \times T_{sfc} \times (T_9 - T_{10}) + a_3 \times (T_9 - T_{10}) \times (\sec\theta_{saz} - 1)$$

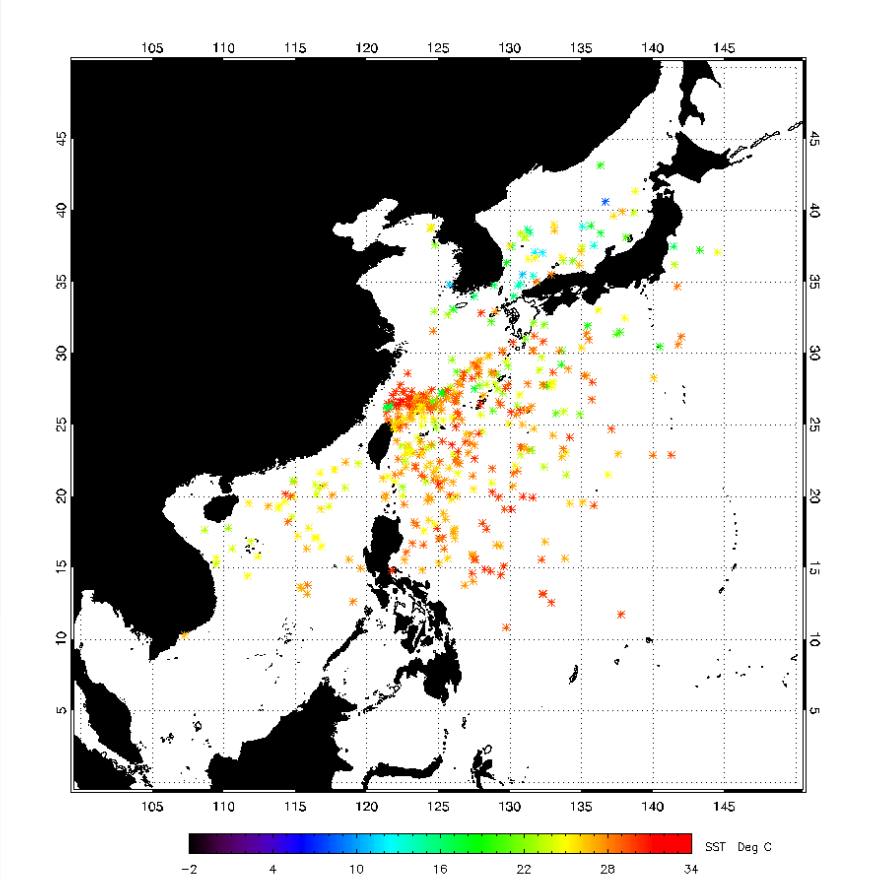
$$MCSST = b_0 + b_1 \times T_9 + b_2 \times (T_9 - T_{10}) + b_3 \times (T_9 - T_{10}) \times (\sec\theta_{saz} - 1)$$

Generation of the new SST retrieval coefficients



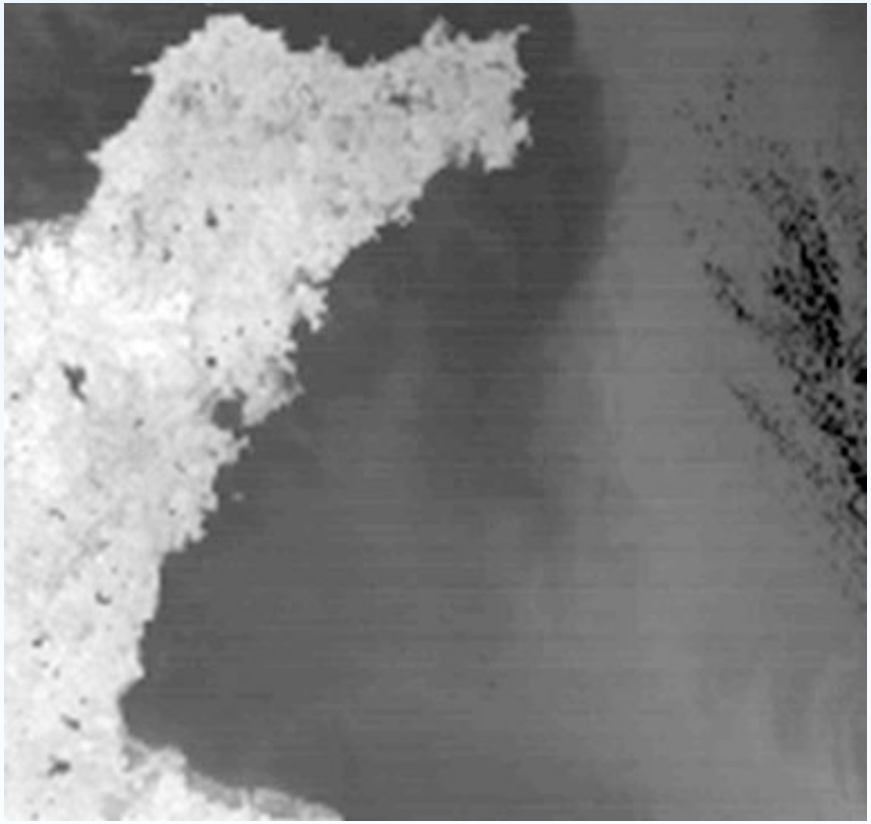
COCTS SST on 6 May 2009

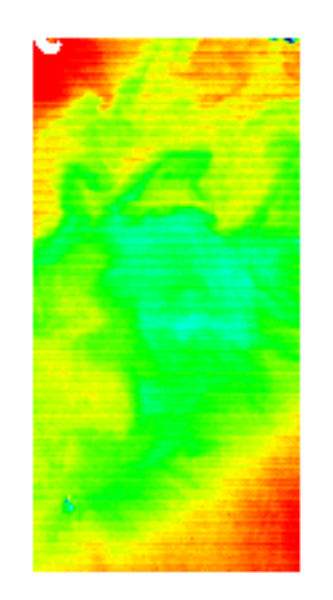


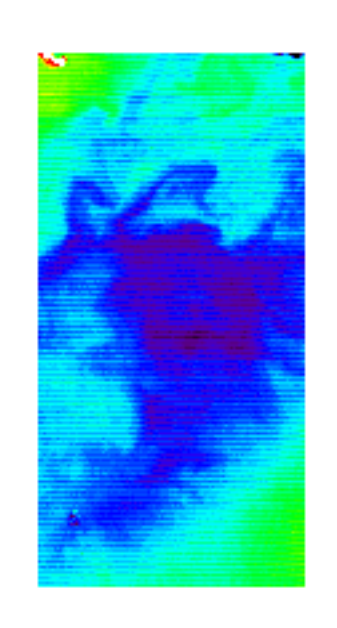


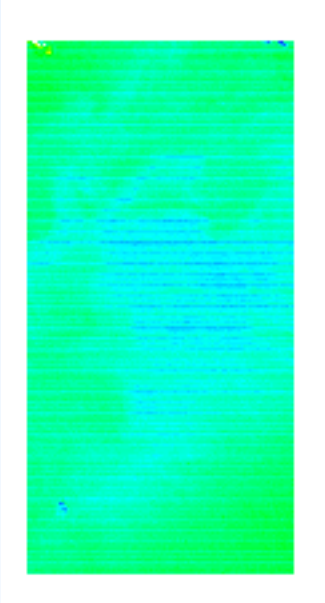
Bias: 0.04 °C , Std. Dev.: 1.35 °C

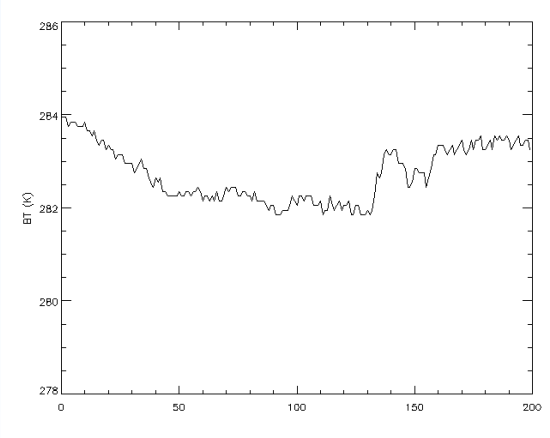
Evaluation of the new SST retrieval coefficients

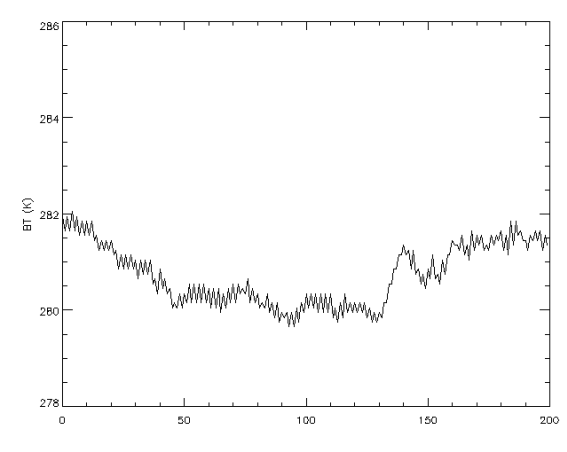


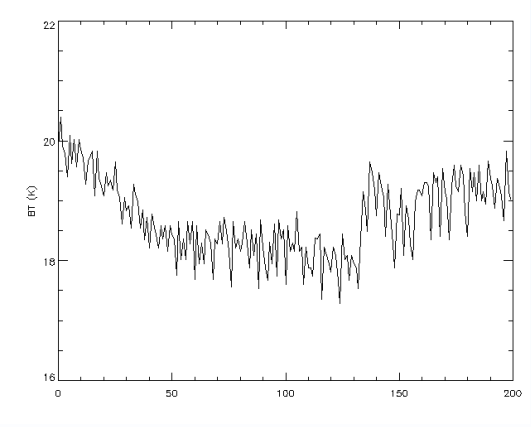




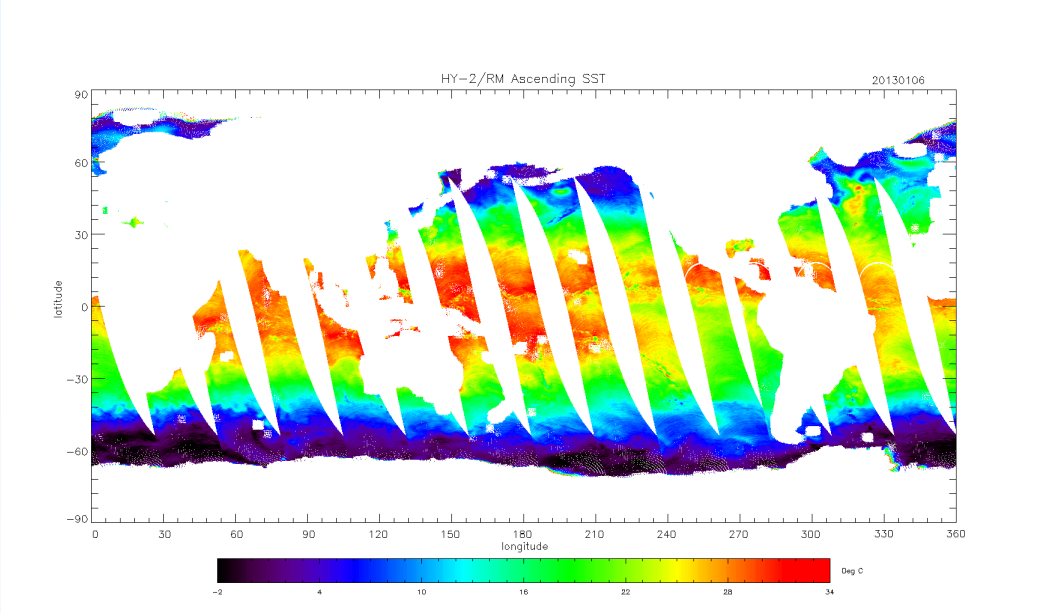


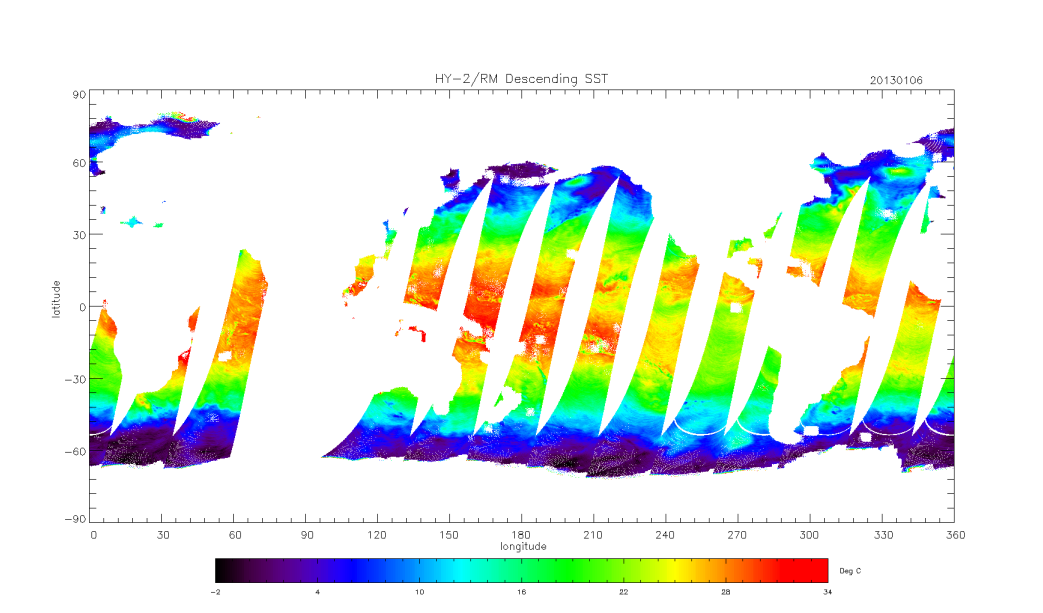

286
284
282
280
278
BT (K)
0
50
100
150
200


286
284
282
280
278
BT (K)
0
50
100
150
200


22
20
18
16
BT (K)
0
50
100
150
200

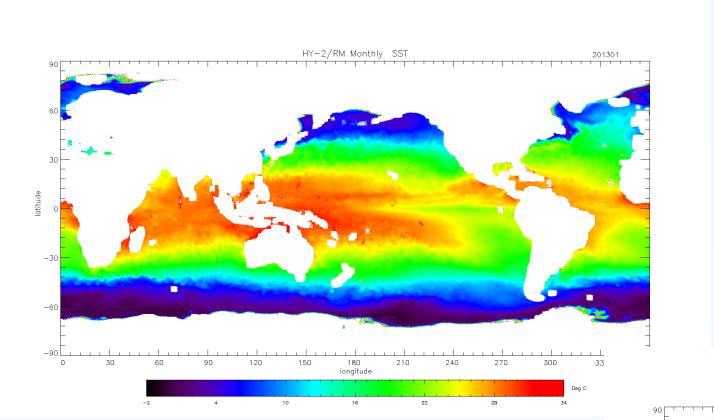
Evaluation of SST products from HY-2 Scanning Microwave Radiometer (RM)

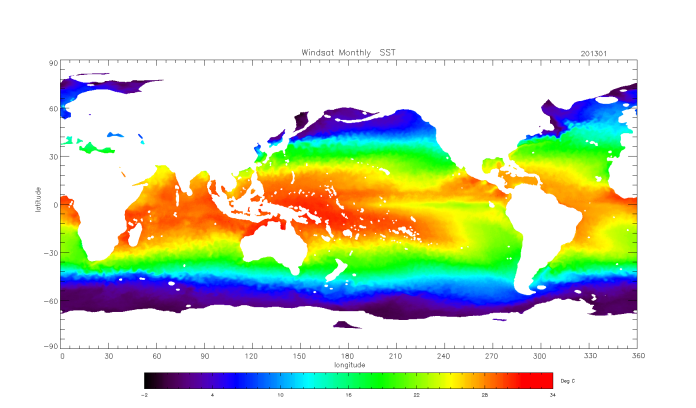

HY-2/RM Ascending SST
20130106
latitude
longitude
Deg C

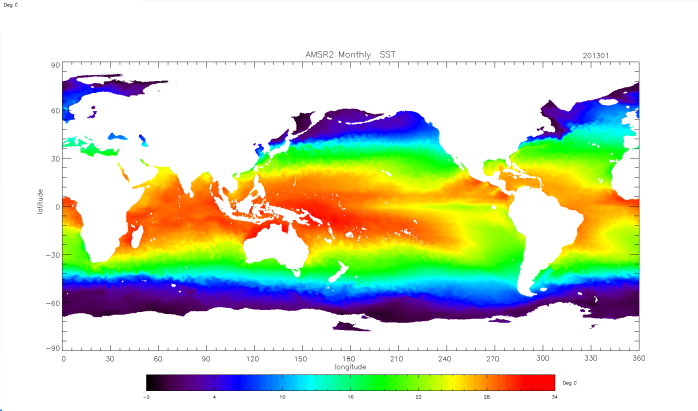

HY-2/RM Descending SST
20130106
latitude
longitude
Deg C

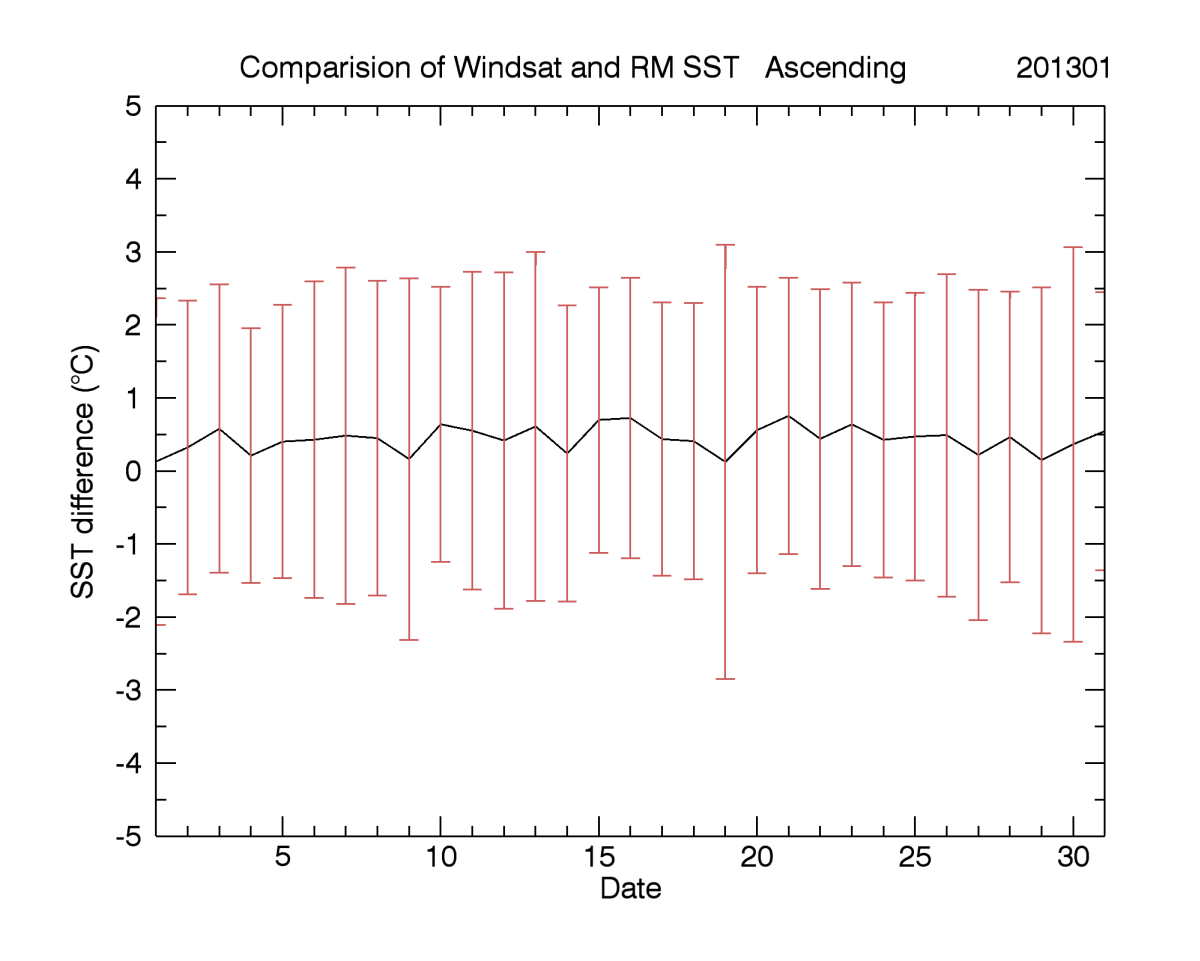
Comparison of HY RM SST with Windsat, AMSR2 SST

Aug. 2012 – Mar. 2014



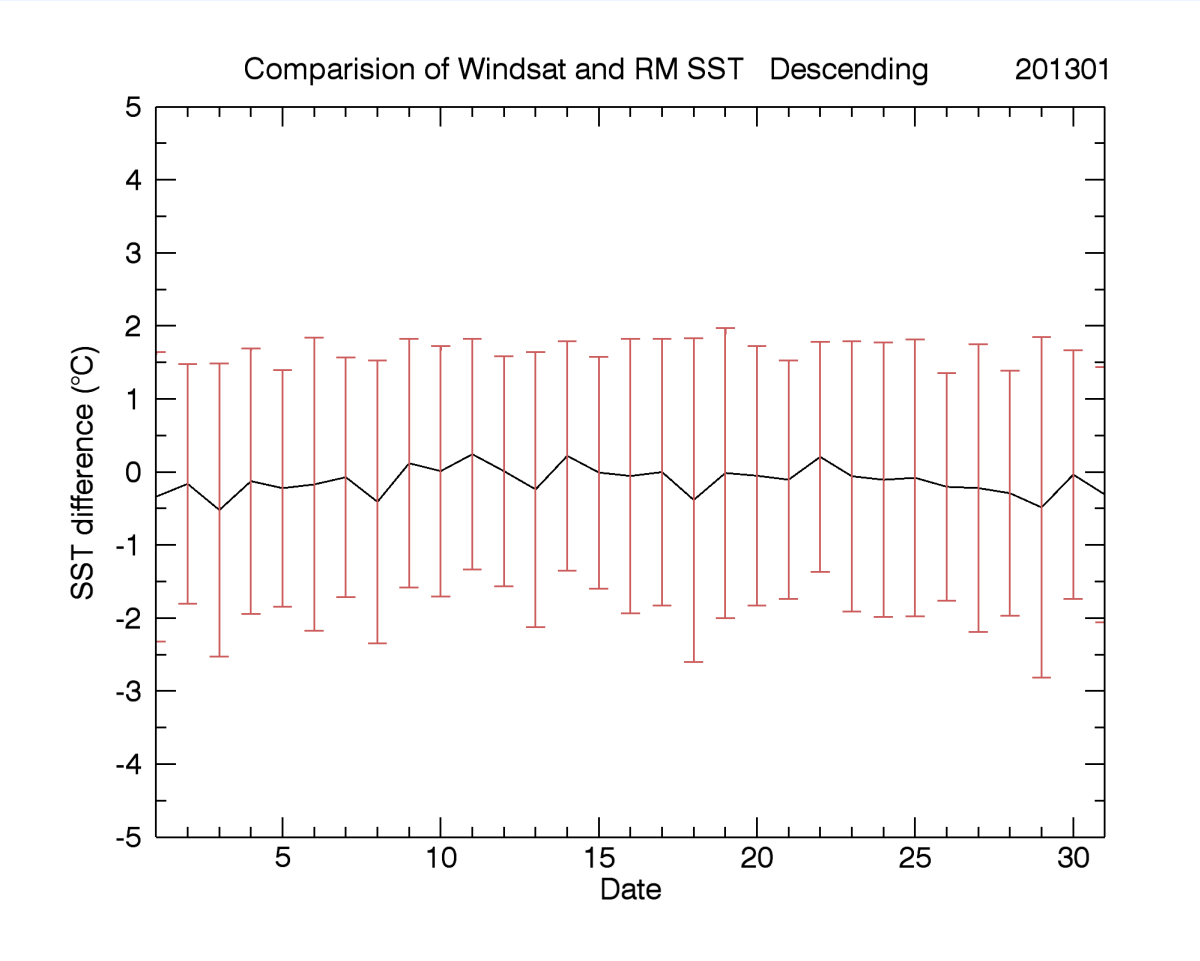






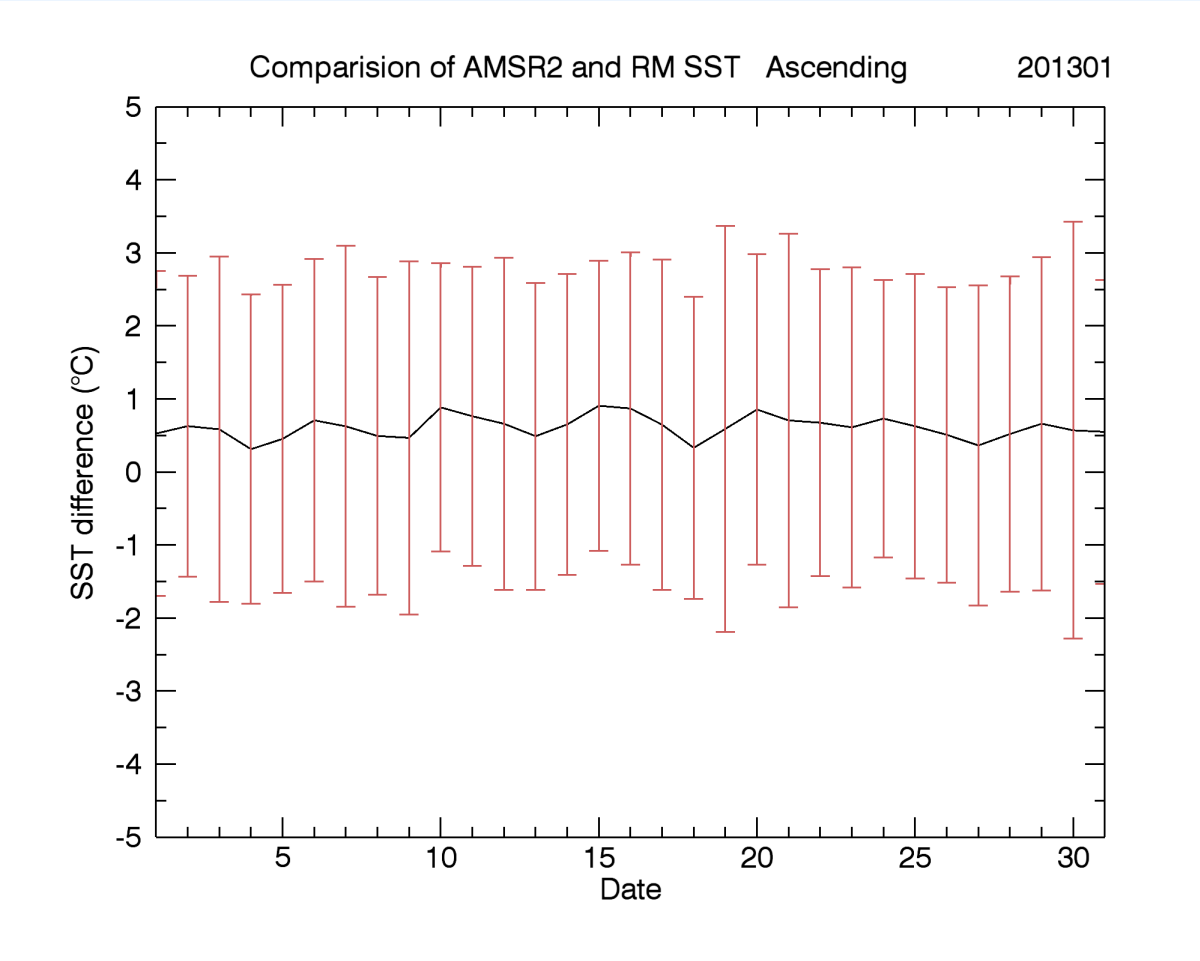
Bias: 0.12°C-0.75°C , mean: 0.44°C

Std. Dev.: 1.90°C-2.85°C mean: 2.11 °C



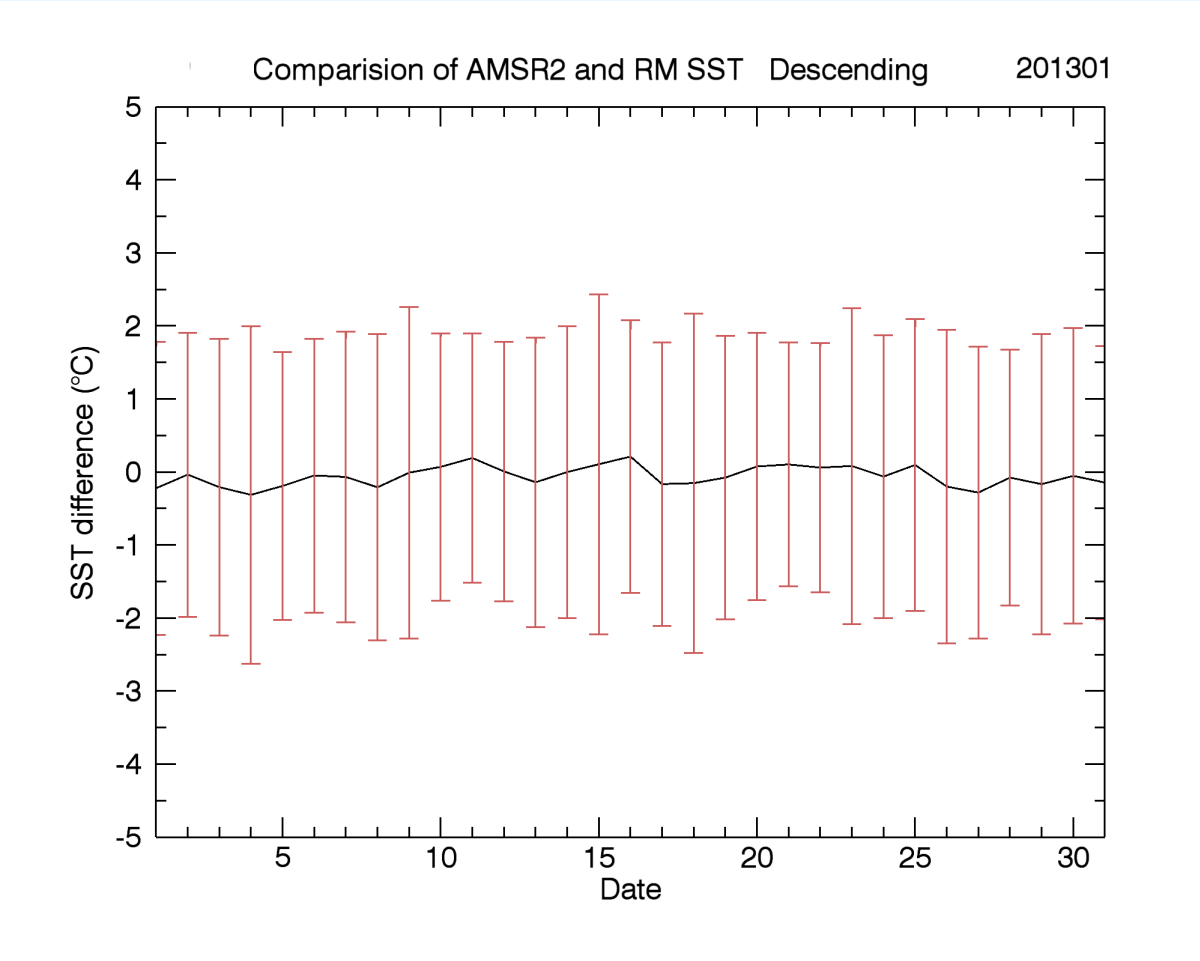
Bias: -0.52°C-0.24°C , mean: -0.13°C

Std. Dev.: 1.56°C-2.33° C mean: 1.80°C



Bias: 0.31°C-0.91°C, mean: 0.61°C

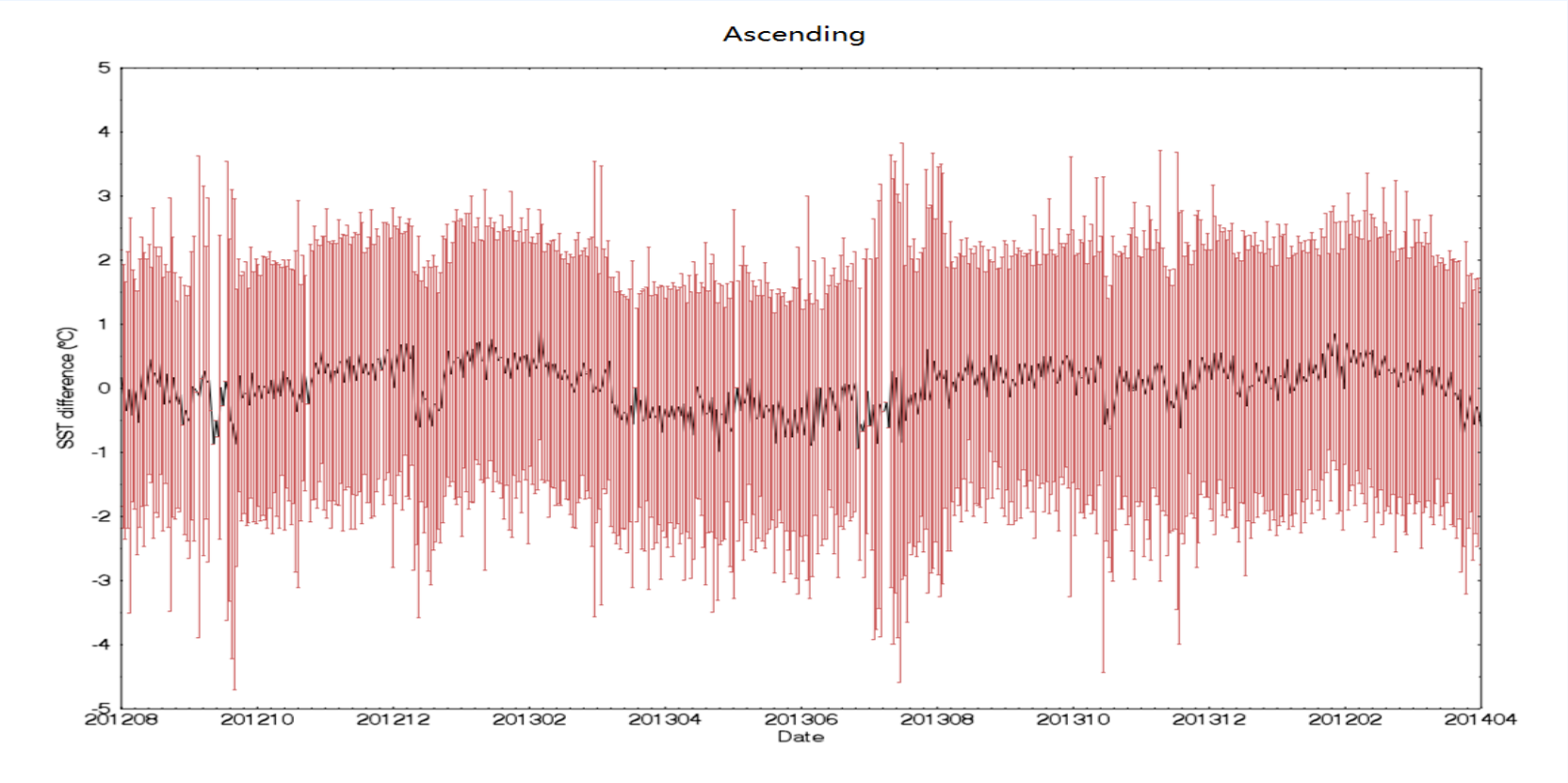
Std. Dev.: 1.90°C-2.85°C mean: 2.21 °C



Bias: -0.31°C-0.21°C , mean: -0.06°C

Std. Dev.: 1.67°C-2.33°C mean: 1.97°C

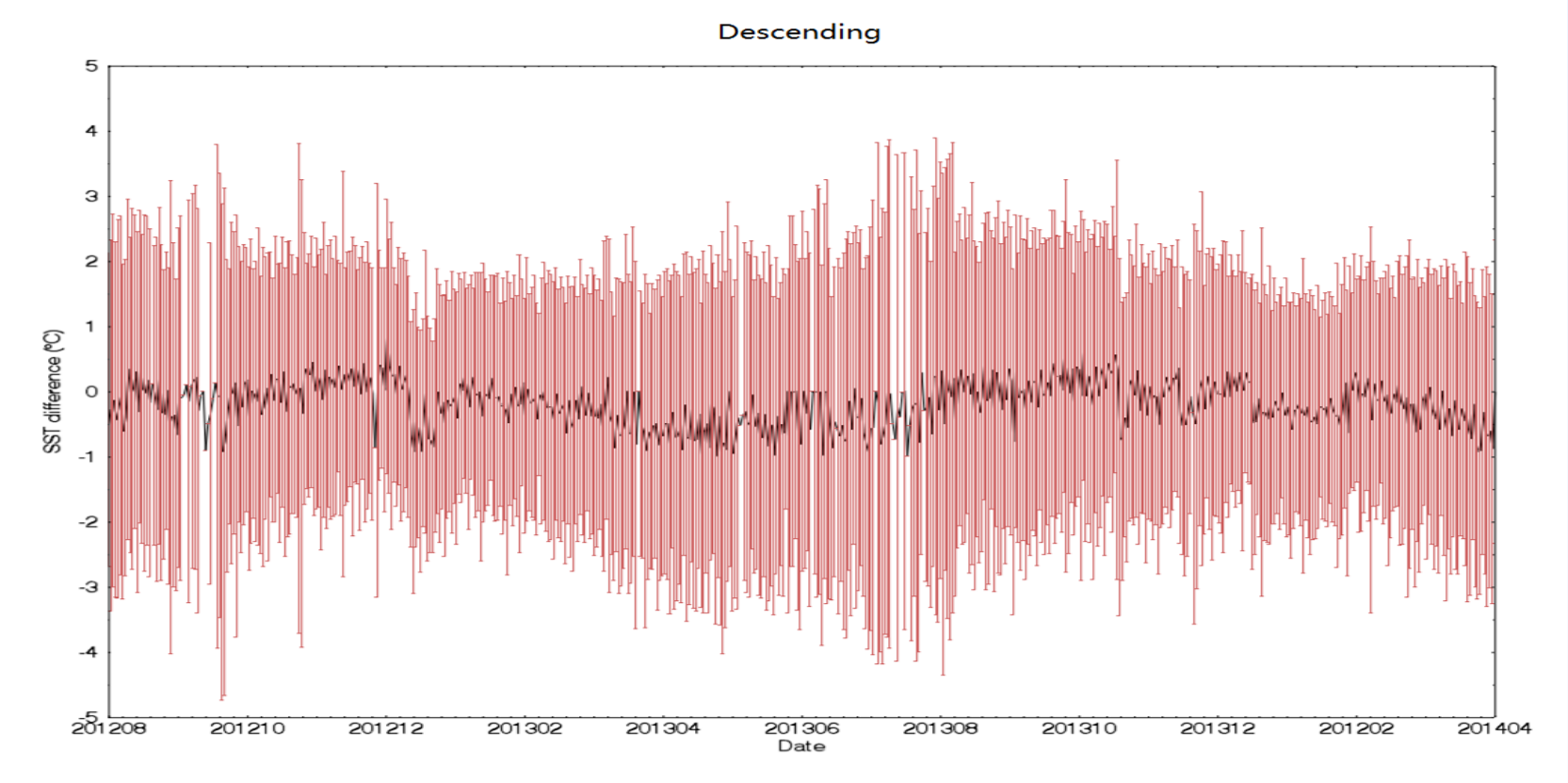
Comparison of Windsat and RM SST, Aug. 2012 – Mar. 2014



Bias: -1.17°C -1.63°C, mean: 0.04°C

Std. Dev.: 1.37°C-3.86°C mean: 2.14°C

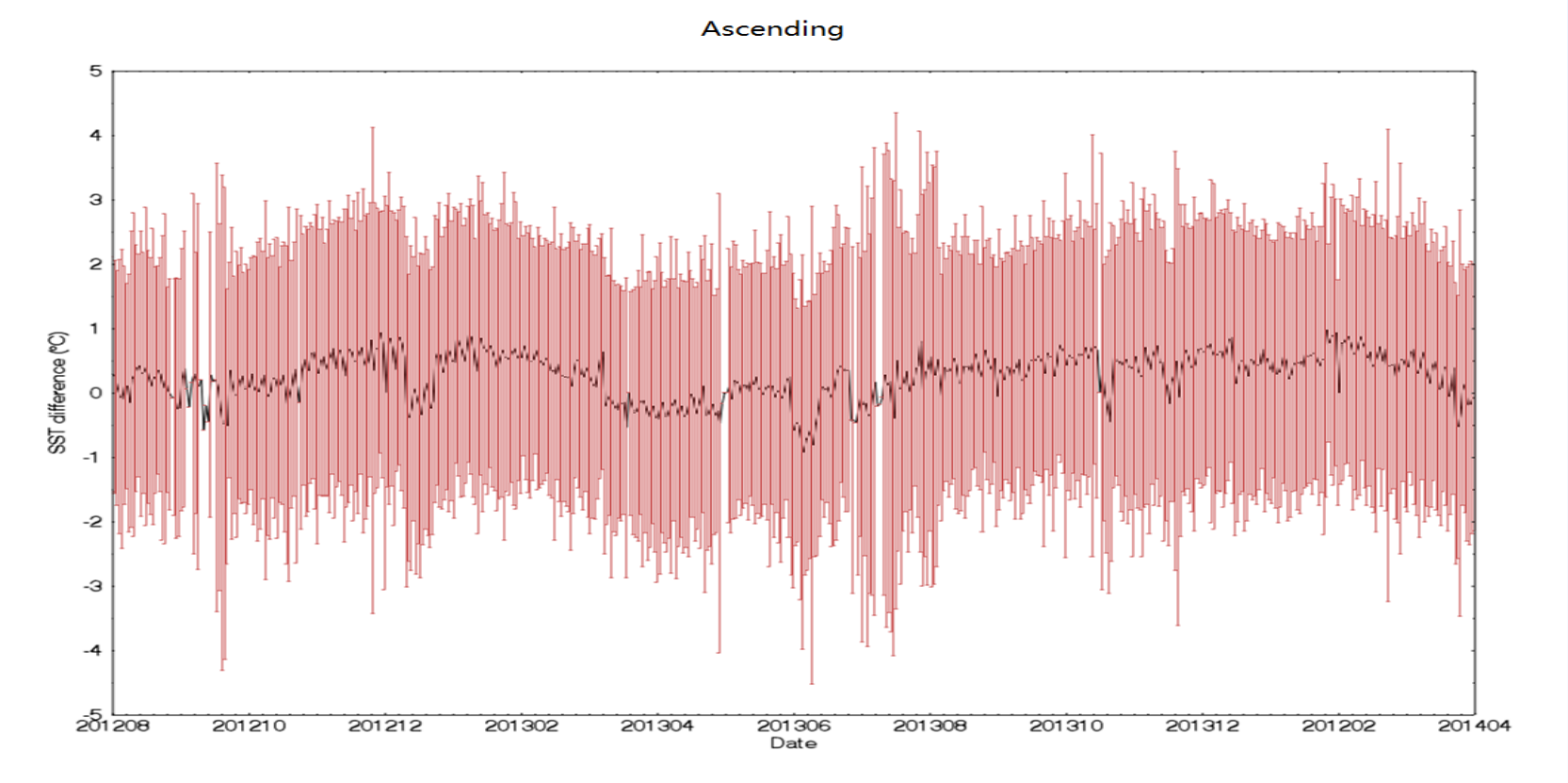
Comparison of Windsat and RM SST, Aug. 2012 – Mar. 2014



Bias: -1.75°C-0.84°C , mean: -0.23°C

Std. Dev.: 1.25°C-4.00°C mean: 2.27°C

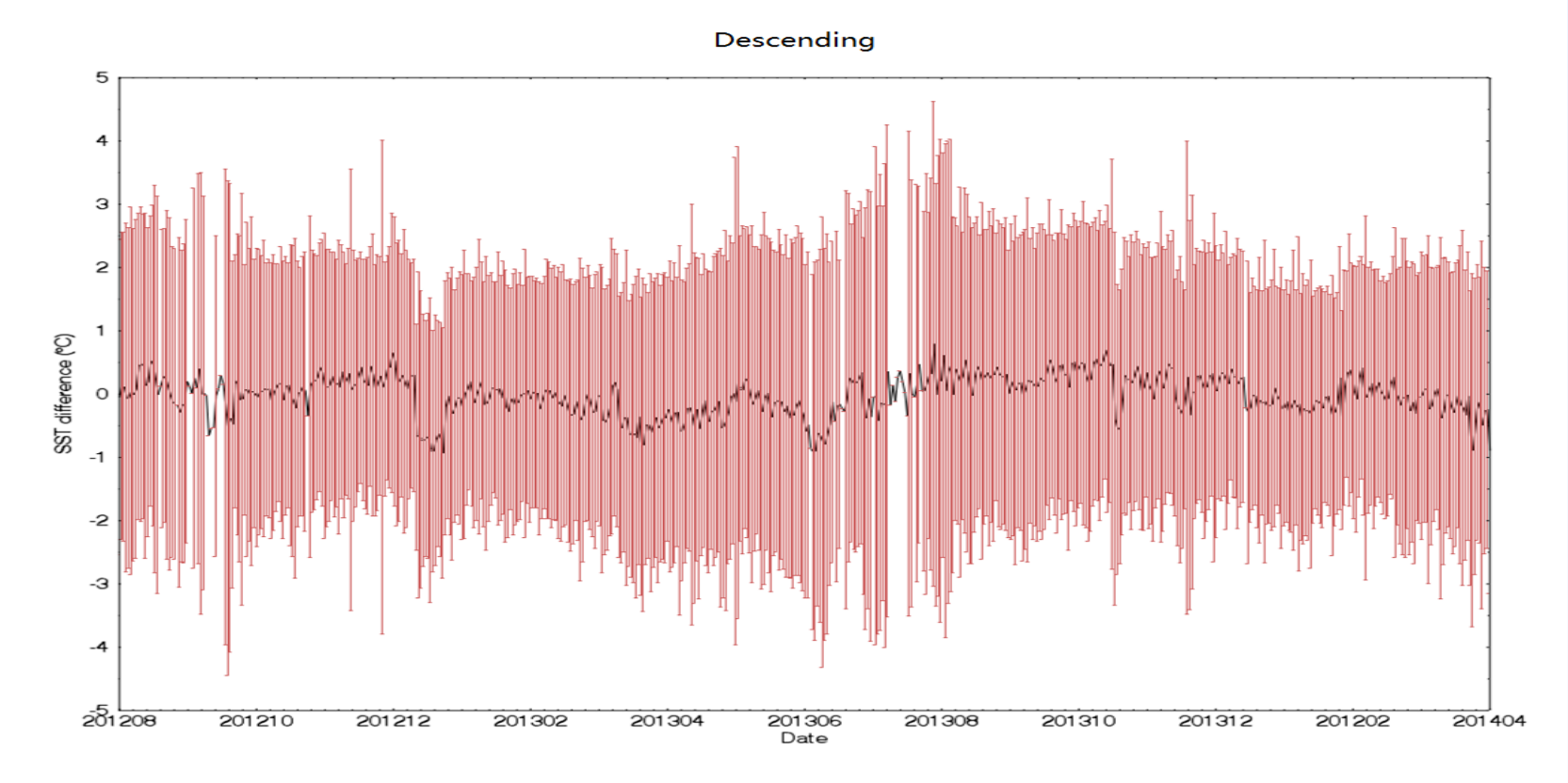
Comparison of AMSR2 and RM SST, Aug. 2012 – Mar. 2014



Bias: -0.92°C-1.44°C , mean: 0.28°C

Std. Dev.: 1.53°C-3.85°C mean: 2.20°C

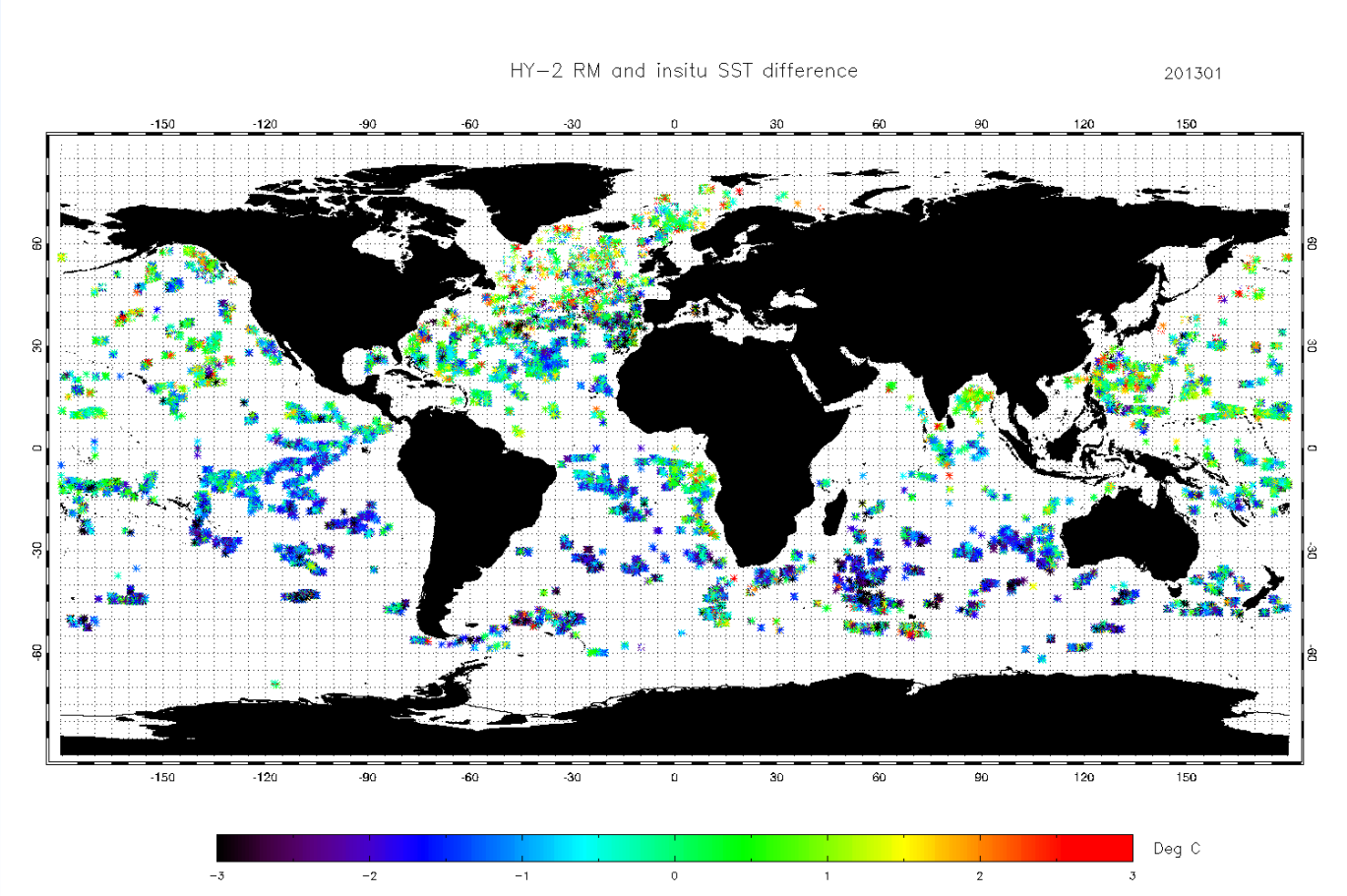
Comparison of AMSR2 and RM SST, Aug. 2012 – Mar. 2014

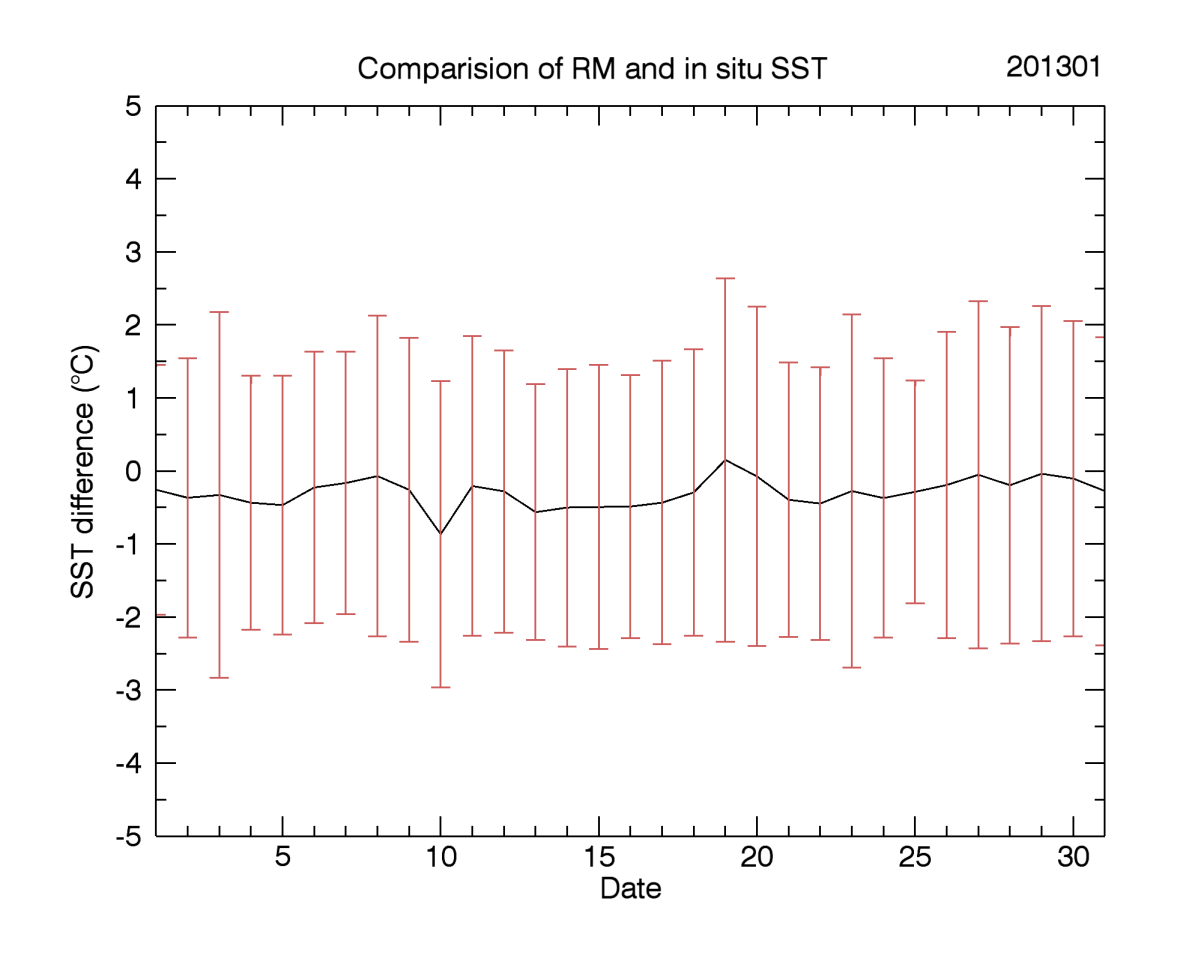


Bias: -1.35°C-0.79°C , mean: -0.04°C

Std. Dev.: 1.63°C-3.94°C mean: 2.23°C

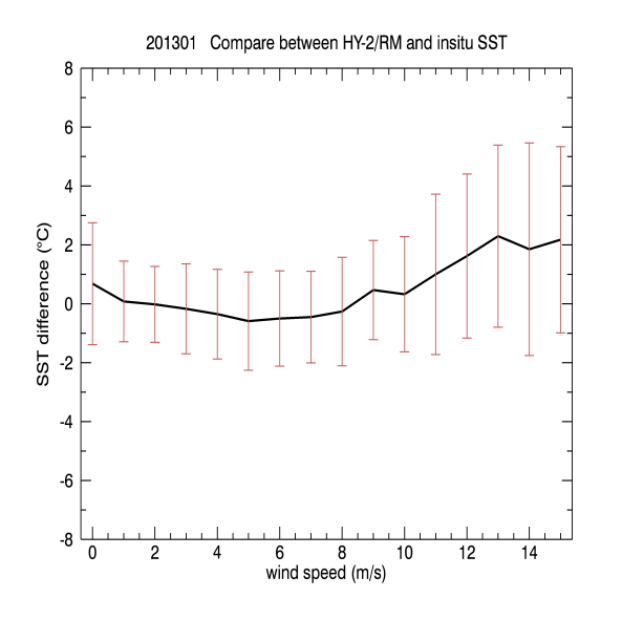
Comparison of HY RM with iQuam data

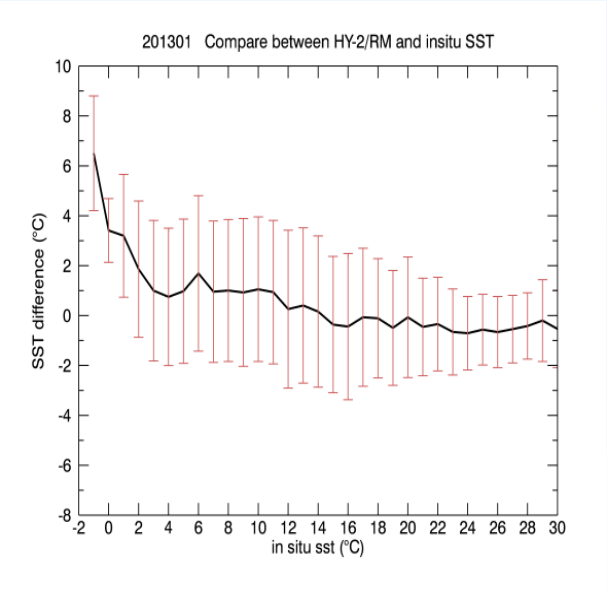




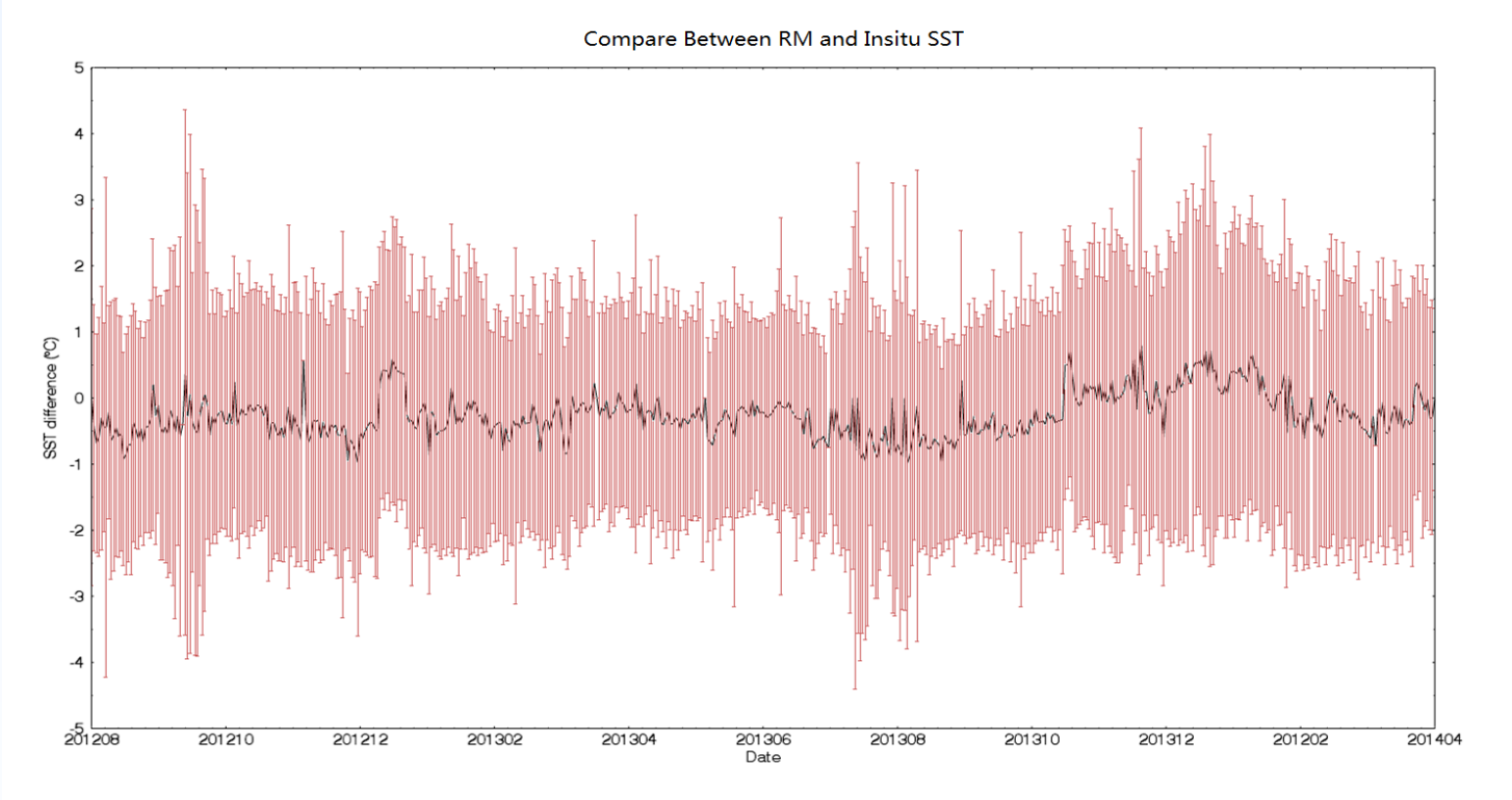
Bias: -0.87°C-0.15°C , mean: -0.30°C

Std. Dev.: 1.53°C-2.50°C mean: 2.02°C


201301 Compare between HY-2/RM and insitu SST
SST difference (°C)
wind speed (m/s)
8
6
4
2
0
-2
-4
-6
-8
0
2
4
6
8
10
12
14


201301 Compare between HY-2/RM and insitu SST
SST difference (°C)
in situ sst (°C)
10
8
6
4
2
0
-2
-4
-6
-8
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30

Comparison of RM SST and in situ SST, Aug. 2012 – Mar. 2014



Bias: -1.45°C-0.79°C , mean: -0.27°C

Std. Dev.: 1.30°C-3.98°C mean: 1.97°C

Sumary

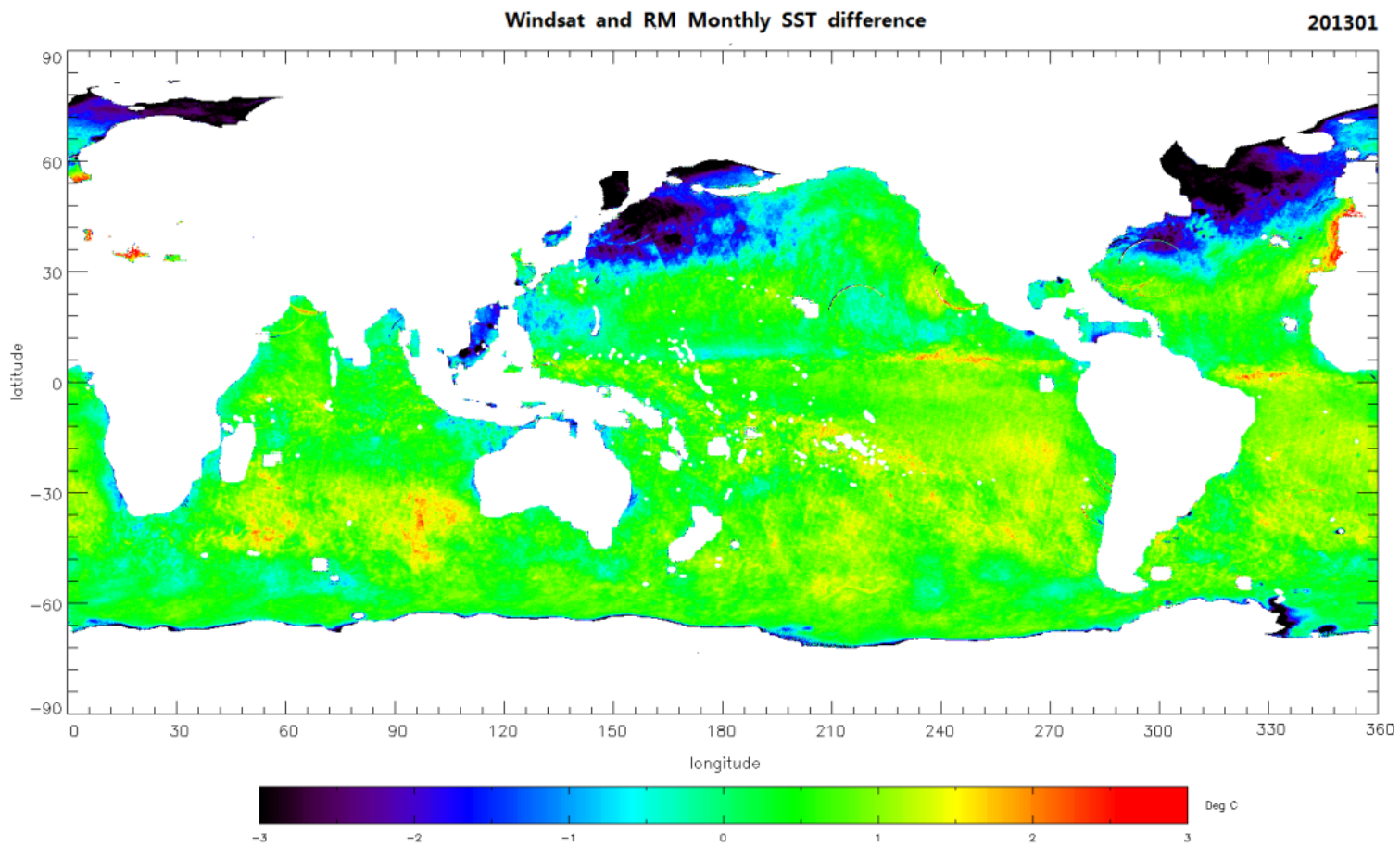
- ✧ HY-1B
  - ✧ Investigate calibration issue
  - ✧ Reduce stripe noise
  - ✧ Refine the retrieval coefficients with more matchups

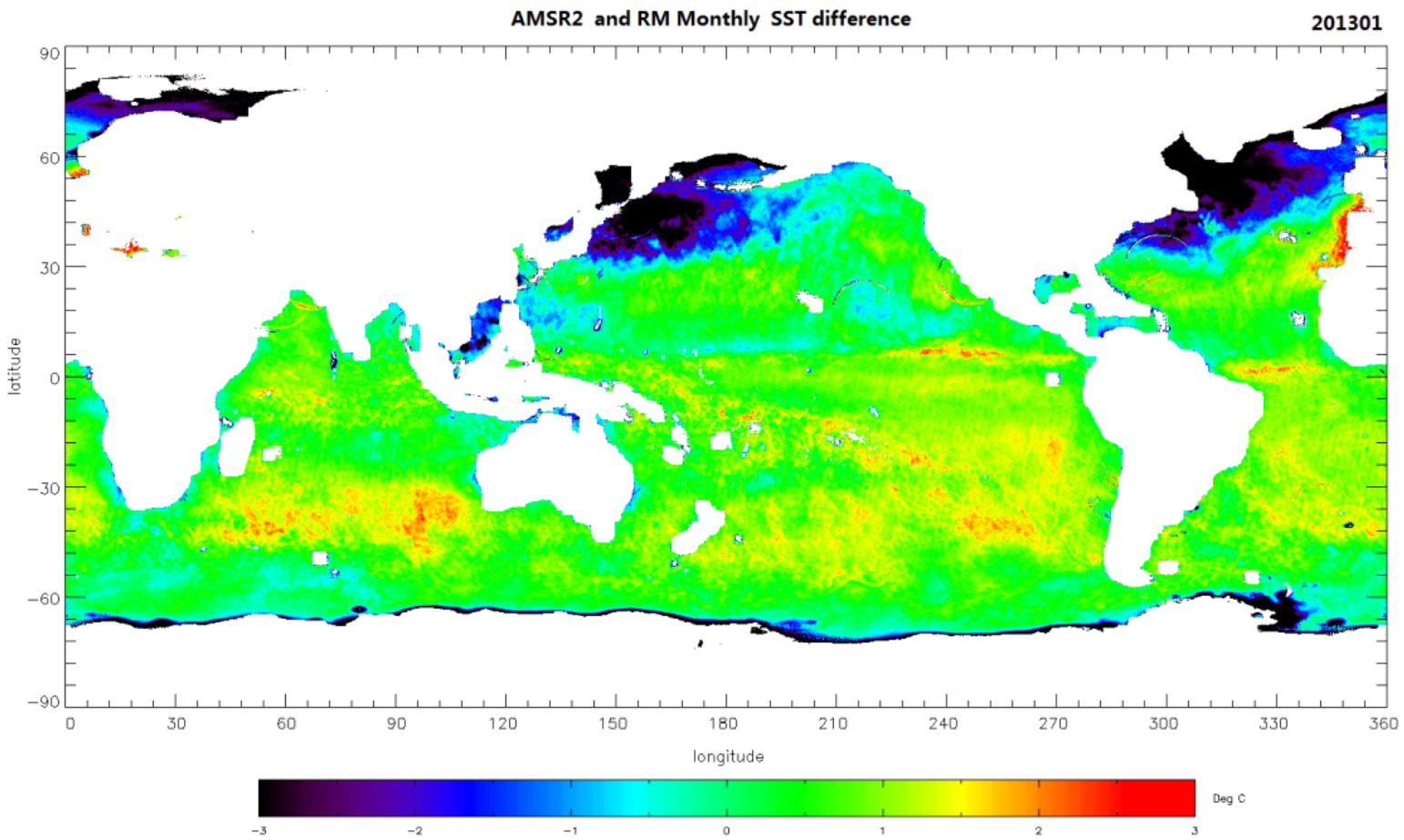
- ✧ HY-2
  - ✧ Investigate calibration issue
  - ✧ Quality control
  - ✧ Algorithm

www.qdta.gov.cn

u!

Backup


Windsat and RM Monthly SST difference
201301
latitude
longitude
90
60
30
0
−30
−60
−90
0
30
60
90
120
150
180
210
240
270
300
330
360
Deg C
−3
−2
−1
0
1
2
3


AMSR2 and RM Monthly SST difference
201301
latitude
longitude
90
60
30
0
−30
−60
−90
0
30
60
90
120
150
180
210
240
270
300
330
360
−3
−2
−1
0
1
2
3
Deg C