

Toward Regional Validation and Potential Enhancements to VIIRS SST Products

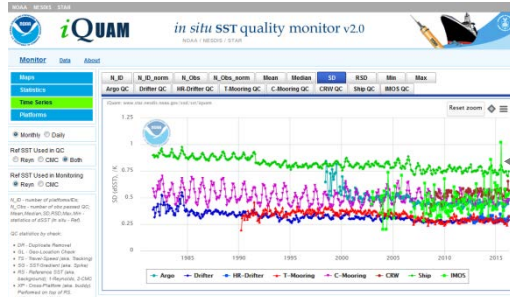
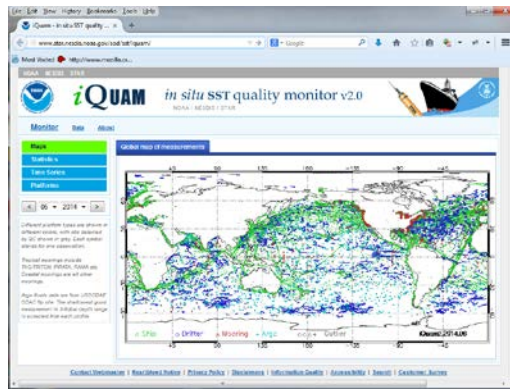
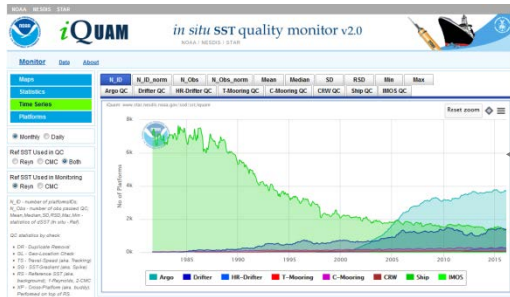
Yanni Ding^{1,2}, Alexander Ignatov¹, Michael Grossberg³,
Irina Gladkova^{1,3}, Calvin Chu³

¹*STAR, NOAA Center for Weather and Climate Prediction (NCWCP), USA*

²*CIRA, Colorado State University (CSU), USA*

³*City College of New York, USA*

Global SST Monitoring well established at NOAA



Monitoring in iQuam

NOAA L2
NOAA L3
NOAA L4

NOAA NESDIS STAR

iQuam in situ SST quality monitor v2.0

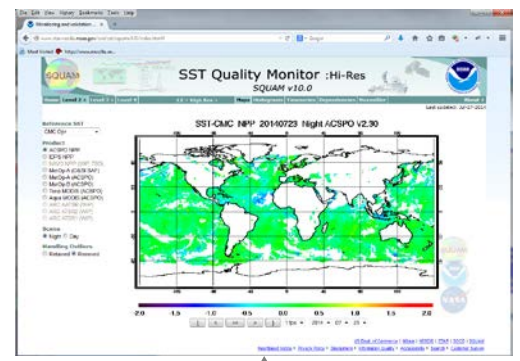
NOAA NESDIS STAR

File Name	Update Time	Data Source
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-05-30 11:02	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-05-01 11:26	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-02-01 11:24	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-02-01 11:08	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-02-03 17:26	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-02-04 15:17	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-12-31 14:00	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-17 19:26	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-19 19:22	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-20 29:11	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-20 29:03	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-19 15:56	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-17 18:22	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-17 18:16	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-17 18:36	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-18 18:47	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-19 20:06	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-19 18:22	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-19 18:16	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-17 18:26	GTS_ANG0 float HR-Drifter; MODS; CRW
201505_31M0_L2_08R531.531_Arghm_V2.00_v1.0_M05.3.6C	2015-11-17 18:26	GTS_ANG0 float HR-Drifter; MODS; CRW

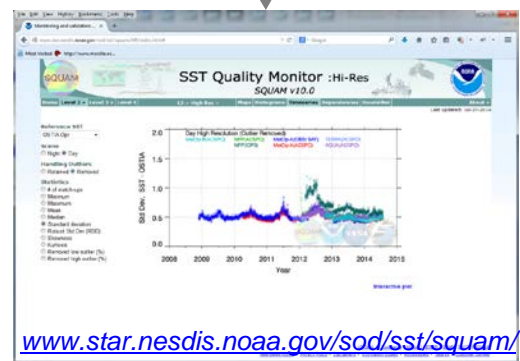
iQuam Data

www.star.nesdis.noaa.gov/sod/sst/iquam/

GHRSS T L2
GHRSS T L3
GHRSS T L4



Satellite-iQuam-L4 Match-Ups



www.star.nesdis.noaa.gov/sod/sst/squam/

Monitoring in SQUAM

New ACSPO Regional Monitor for SST (ARMS)

Good global metrics does not guarantee uniform regional performance

Complementing global validation with regional was recommended by JPSS Program Office

New ACSPO Regional Monitor for SST (ARMS) has been established

www.star.nesdis.noaa.gov/sod/sst/arms/

Current ARMS Goals and Capabilities

1. Focus on challenging areas
 - Coastal / Internal waters
 - High-latitudes
 - Cloudy regions
 - Dynamic areas
2. Monitor performance of the current SST and cloud algorithms
3. Check different ACSPO polar SST products for inter-consistency
4. Compare polar vs. geo SST (Himawari-8 AHI and future GOES-R ABI)
5. Compare to high-resolution L4 (MUR)

ARMS Interface: Region Selection, Data Download

- ✓ Monitored are: SSTs and Δ SSTs=SST-Ref. SST (CMC L4), Clear-sky and All-sky
- ✓ Currently, includes 20 special regions (can be changed/expanded based on users needs)



ACSPO Regional Monitor of SST

20 special regions

Chesapeake Bay

--- Atlantic ---

- Chesapeake Bay
- Mid-Atlantic Coast, US
- Greenland & Norwegian Seas
- South-East Coast, US
- Gulf of Mexico, US
- Puerto Rico
- Brazil Current
- Drake Passage
- Pacific ---
- Humboldt Current
- Baja California
- Monterey Bay
- North-West Coast, US
- Aleutian Islands
- Bering Strait
- Kuroshio Current
- Korea Strait
- South China Sea
- Agulhas Current

2016 04 25

Night Day/Night
 Day

Show Source Images

hdf

hdf file download

Missing Cloudy Land Sea Ice

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Data courtesy of:
NOAA/NESDIS/STAR

Satellite:
NPP
Sensor:
VIIRS-L2P
Date:
2016/04/25 JD 116
Time:
06:20:01 UTC
01:20:01 -0500
Scene time:
NIGHT
Projection type:
MAPPED
Map projection:
1 km/pixel
MERCATOR
Latitude bounds:
35 N -> 41 N
Longitude bounds:
76 W -> 72 W

SEA SURFACE TEMPERATURE (kelvin)

298
296
294
292
290
288
286
284

ARMS Interface: Product Selection



ACSPO Regional Monitor of SST

Product Selection

Agulhas Current ▾

Clear Sky All Sky

SST SST-Ref

S-NPP-L2P S-NPP-L3U

AQUA TERRA

NOAA-18 METOP-A

NOAA-19 METOP-B

Compare to L4/Geo

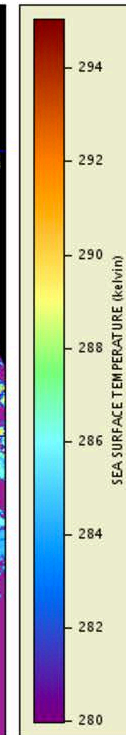
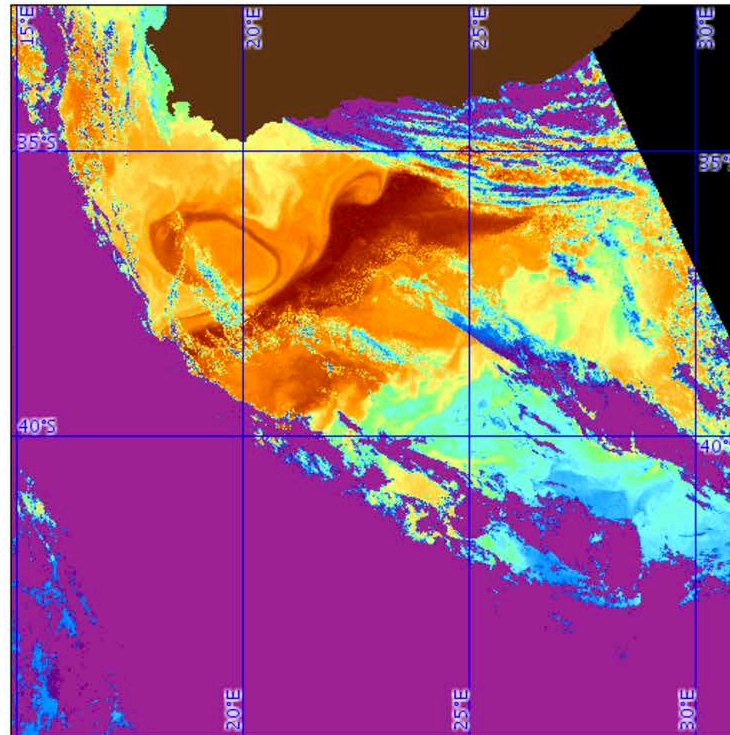
MUR

2016 ▾ 08 ▾ 02 ▾

Night Day/Night

Day

Show Source Images

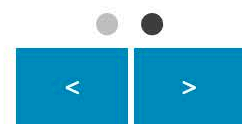


NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Data courtesy of:
NOAA/NESDIS/STAR

Satellite:
NPP
Sensor:
VIIRS-L2P
Date:
2016/08/02 JD 215
Time:
13:00:02 UTC
15:00:02 +0200
Scene time:
DAY
Projection type:
MAPPED
Map projection:
3.52 km/pixel
MERCATOR
Latitude bounds:
46 S -> 31 S
Longitude bounds:
14 E -> 32 E

↓ hdf

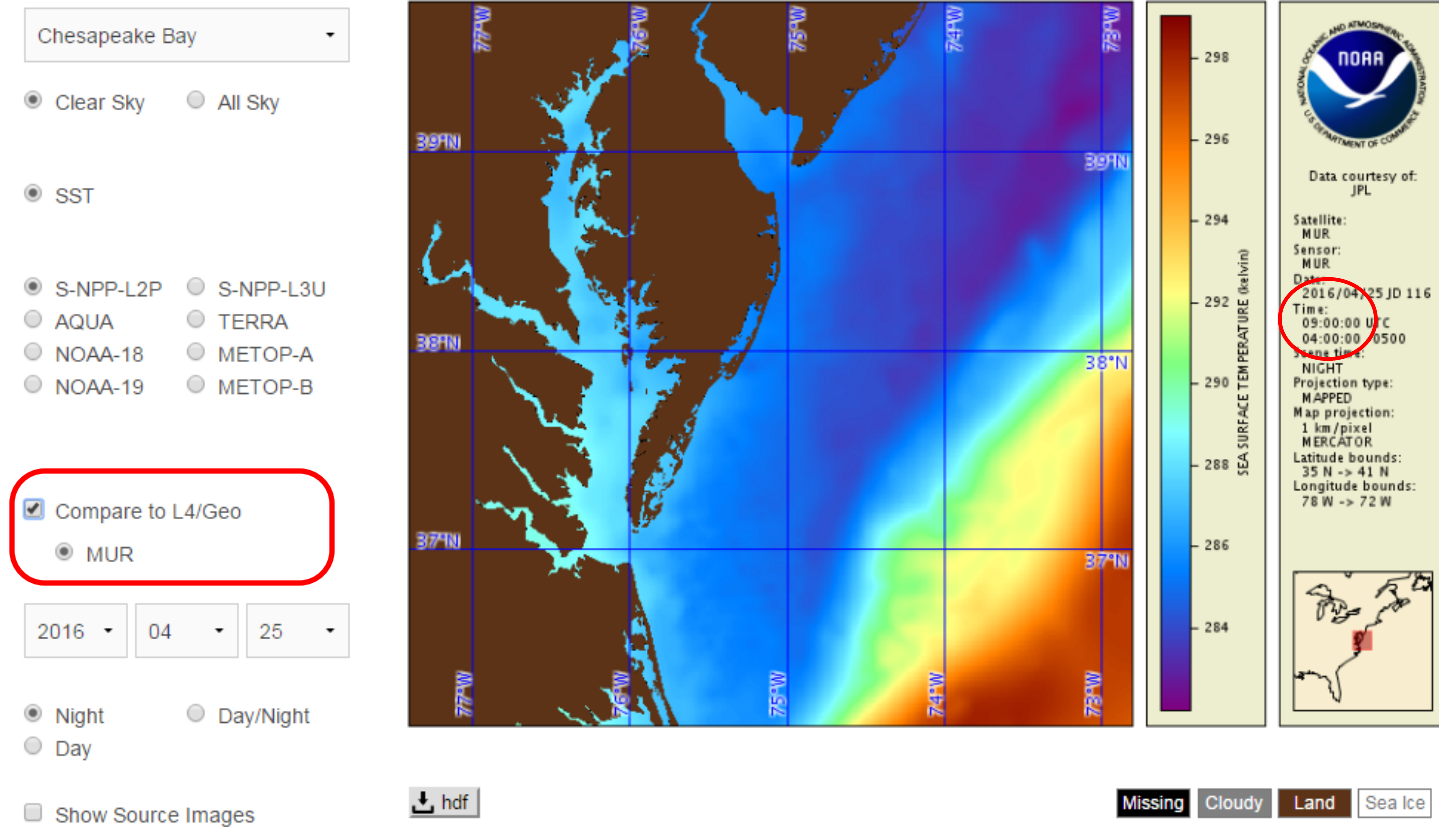


Missing Cloudy Land Sea Ice

Comparison to L4 SST (MUR)



ACSPO Regional Monitor of SST



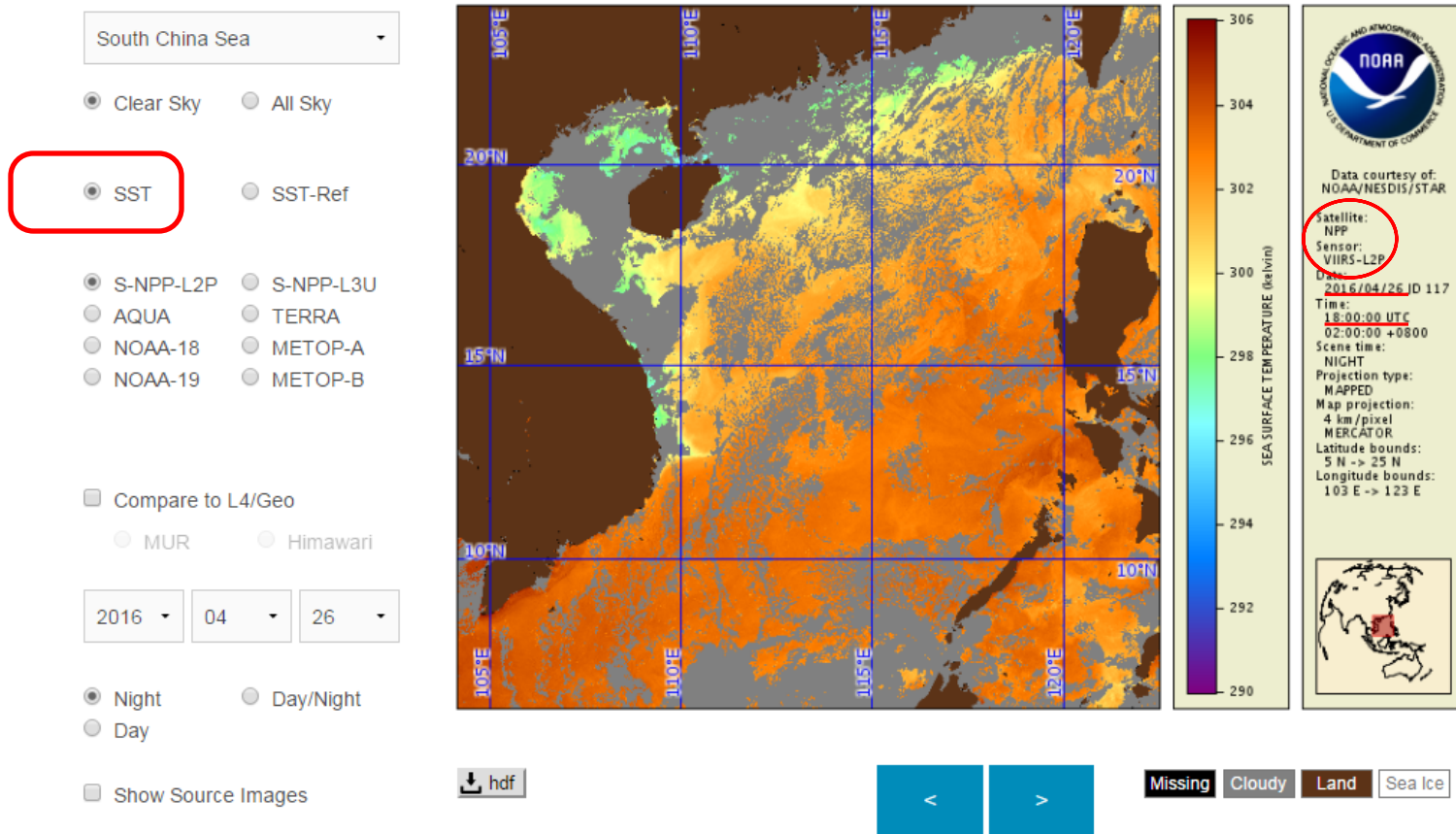
© 2015 NOAA. All rights reserved.

Select Polar Product to compare to geo

- ✓ Three regions: Kuroshio Current (KU), Korea Strait (KJ), South China Sea (SC)



ACSPO Regional Monitor of SST



Compare to geo (Himawari-8)

✓ Show geo SST with corresponding time to monitored polar satellites



ACSPO Regional Monitor of SST

South China Sea

- Clear Sky All Sky
- SST SST-Ref
- S-NPP-L2P S-NPP-L3U
TERRA
METOP-A
METOP-B

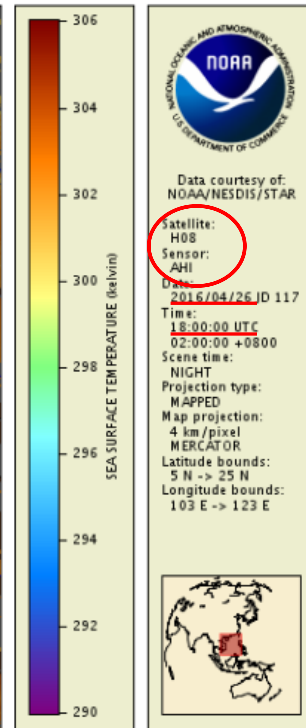
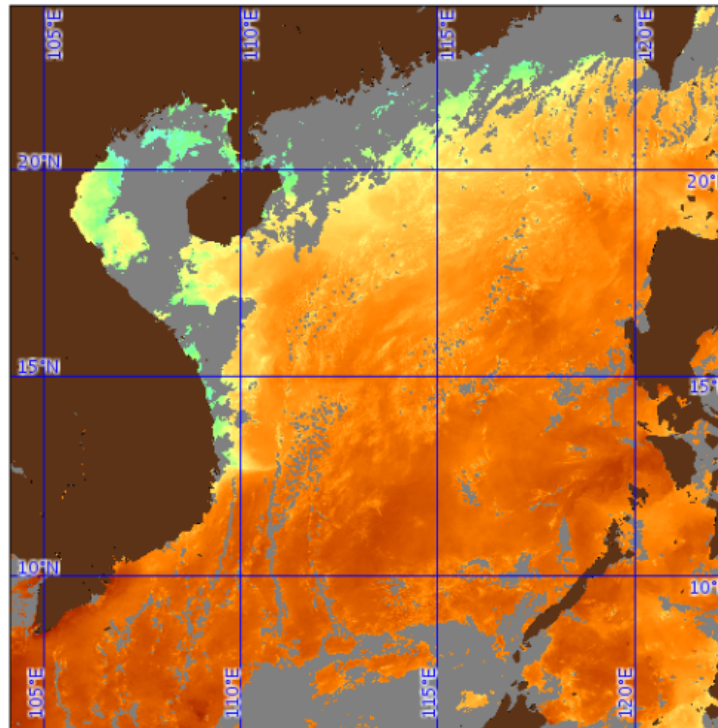
Closest in time geo

- Compare to L4/Geo
- MUR Himawari

2016 04 26

- Night Day/Night
 Day

Show Source Images



↓ hdf

Missing Cloudy Land Sea Ice

Demos of ARMS Capabilities

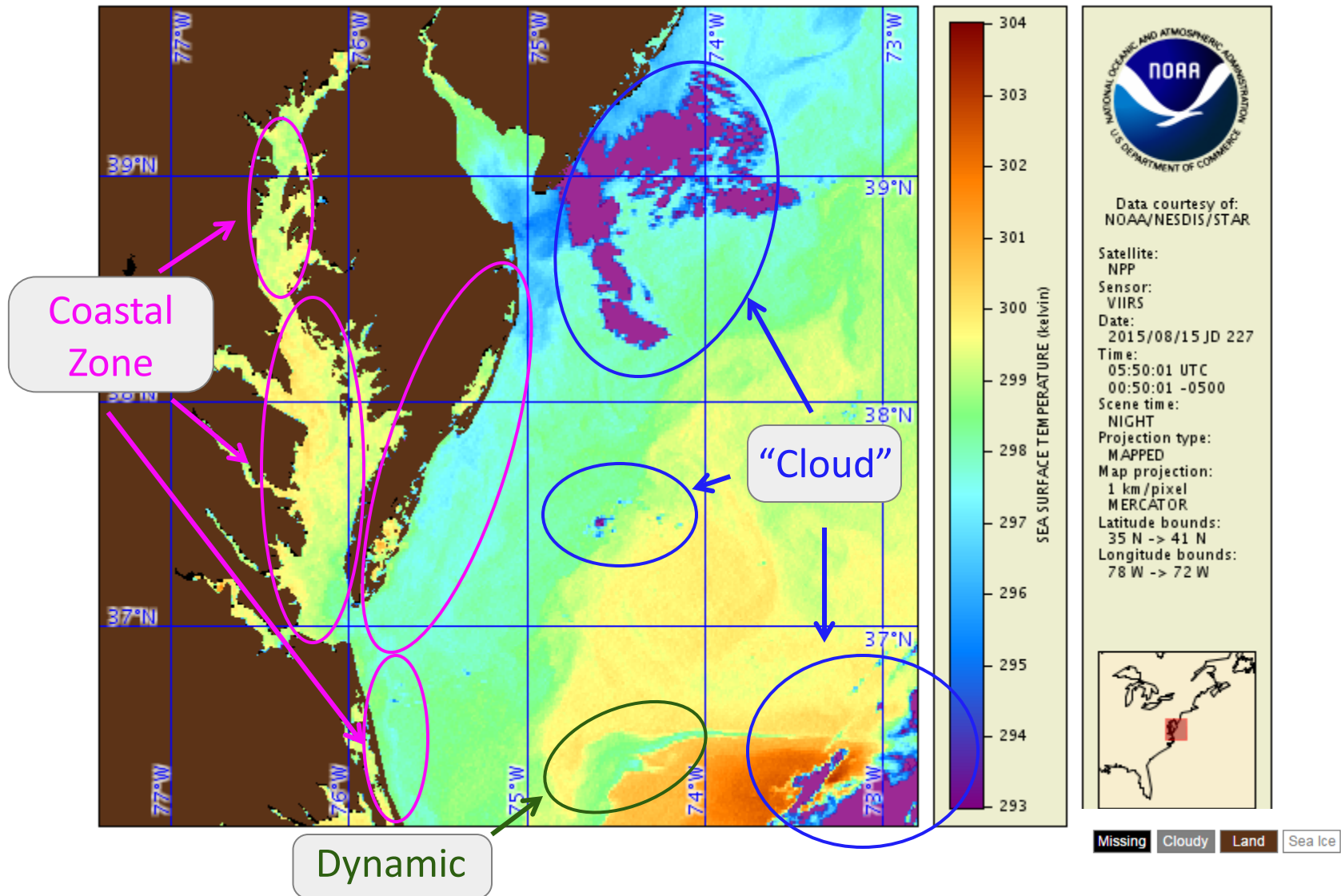
Validate Clear-Sky Domain

Validate SST for day/night consistency

Check the (external) sea-ice mask

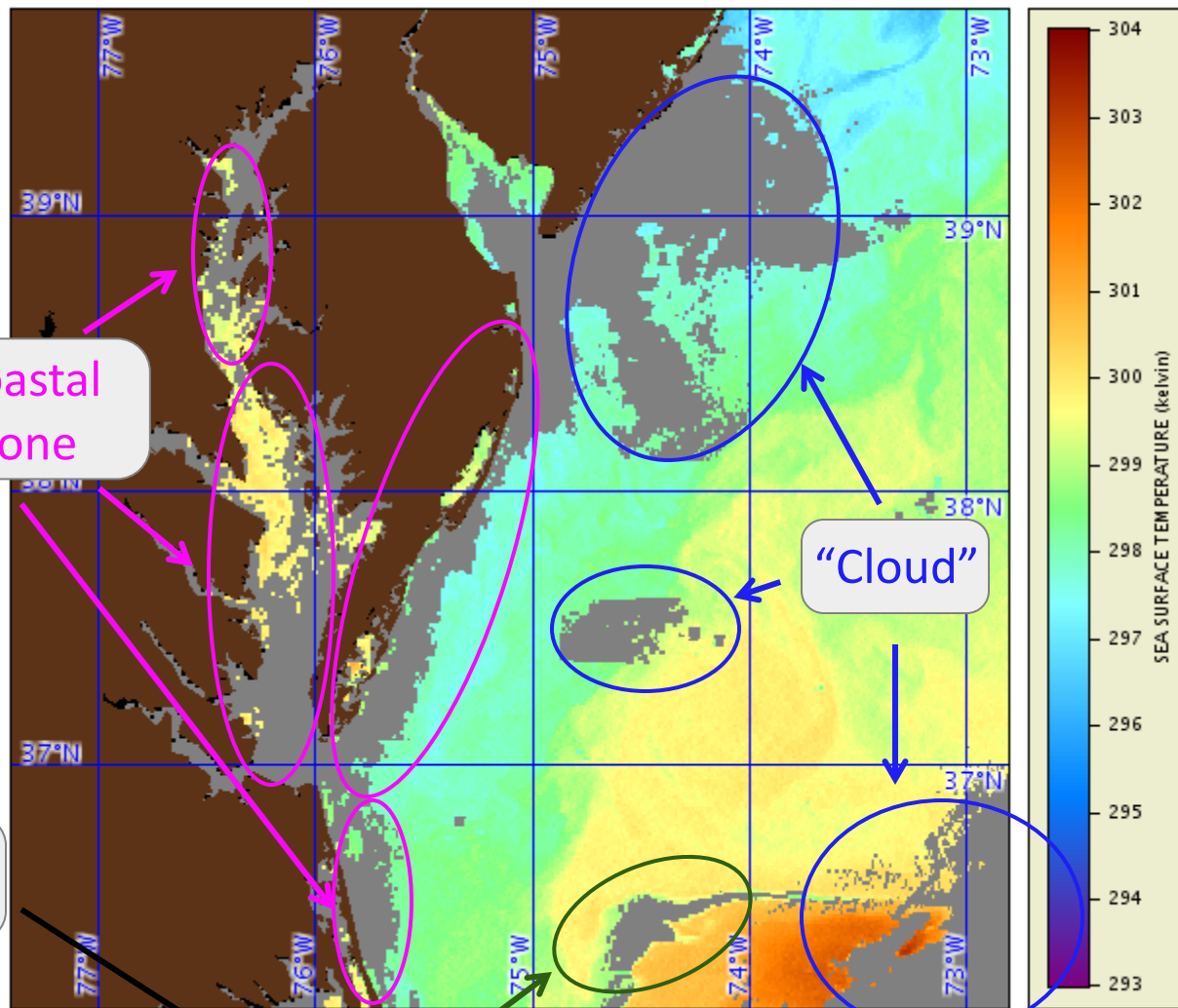
Identify areas of improvement


Example #1: Conservative clear-sky mask In coastal/dynamic region (Chesapeake Bay)




Example #1: Conservative clear-sky mask in coastal/dynamic region (Chesapeake Bay)

- ✓ The cold regions (coastal and dynamic areas) may be identified as “cloud” by ACSPO



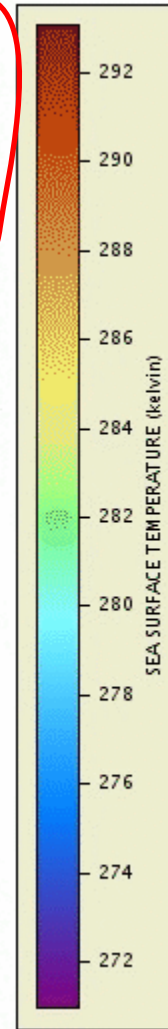
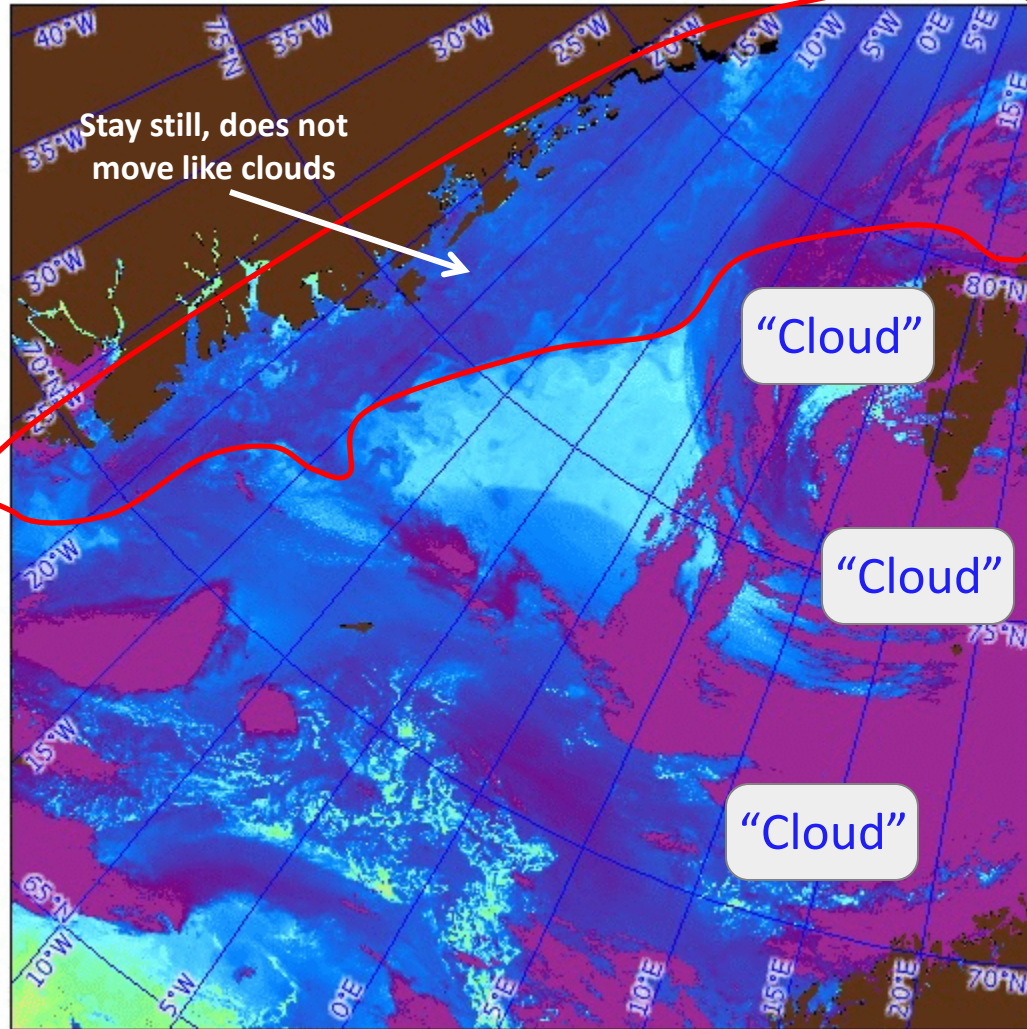

Data courtesy of:
NOAA/NESDIS/STAR

Satellite:
NPP
Sensor:
VIIRS
Date:
2015/08/15 JD 227
Time:
05:50:01 UTC
00:50:01 -0500
Scene time:
NIGHT
Projection type:
MAPPED
Map projection:
1 km/pixel
MERCATOR
Latitude bounds:
35 N -> 41 N
Longitude bounds:
78 W -> 72 W



Missing Cloudy Land Sea Ice

Example #2: current ice mask in high-latitudes (Greenland/Norwegian Seas)



Data courtesy of:
NOAA/NESDIS/STAR

Satellite:
NPP

Sensor:
VIIRS

Date:
2015/07/16 JD 197

Time:
03:20:02 UTC
03:20:02 +0000

Scene time:
DAY

Projection type:
MAPPED

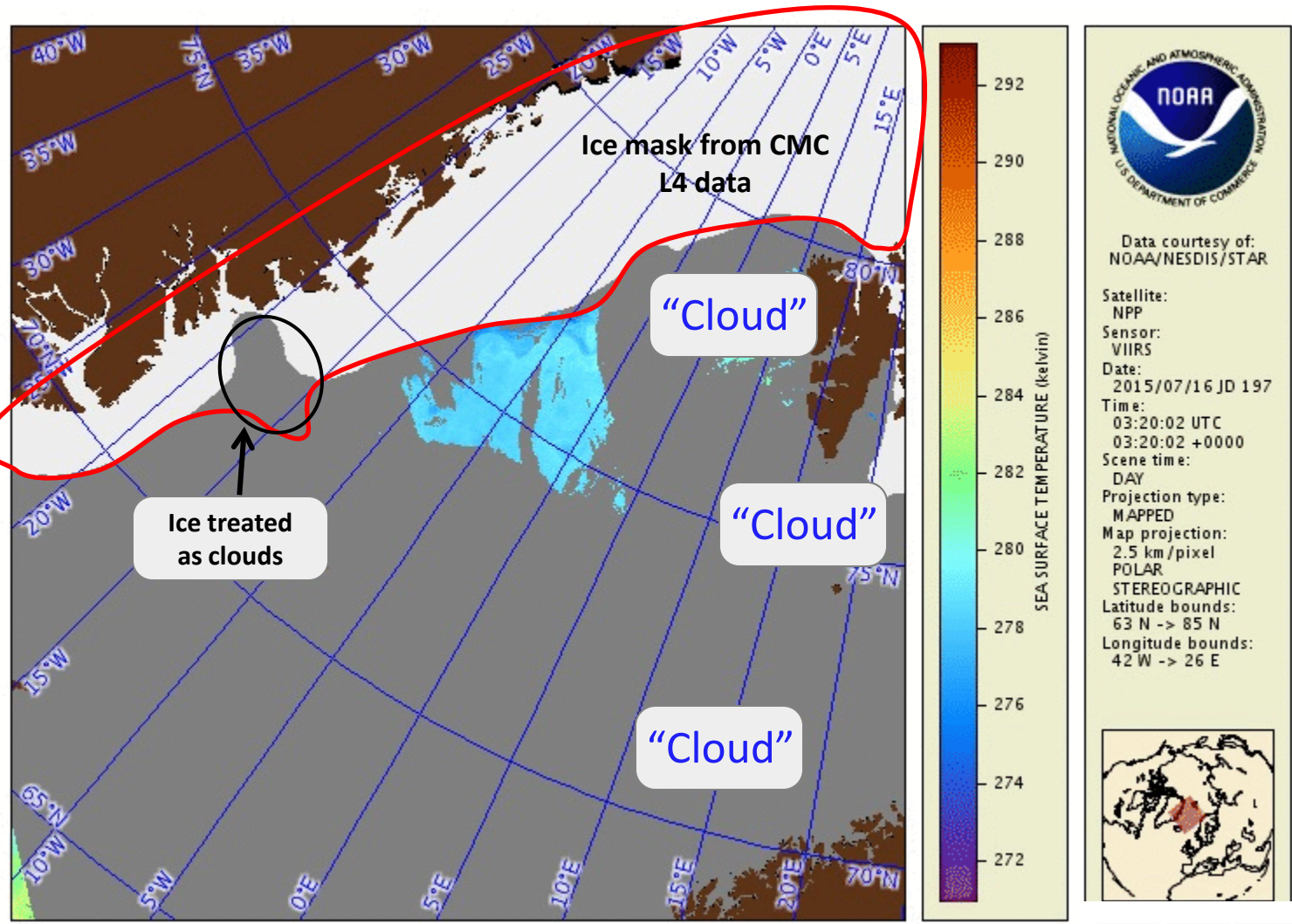
Map projection:
2.5 km/pixel
POLAR
STEREOGRAPHIC

Latitude bounds:
63 N -> 85 N

Longitude bounds:
42 W -> 26 E

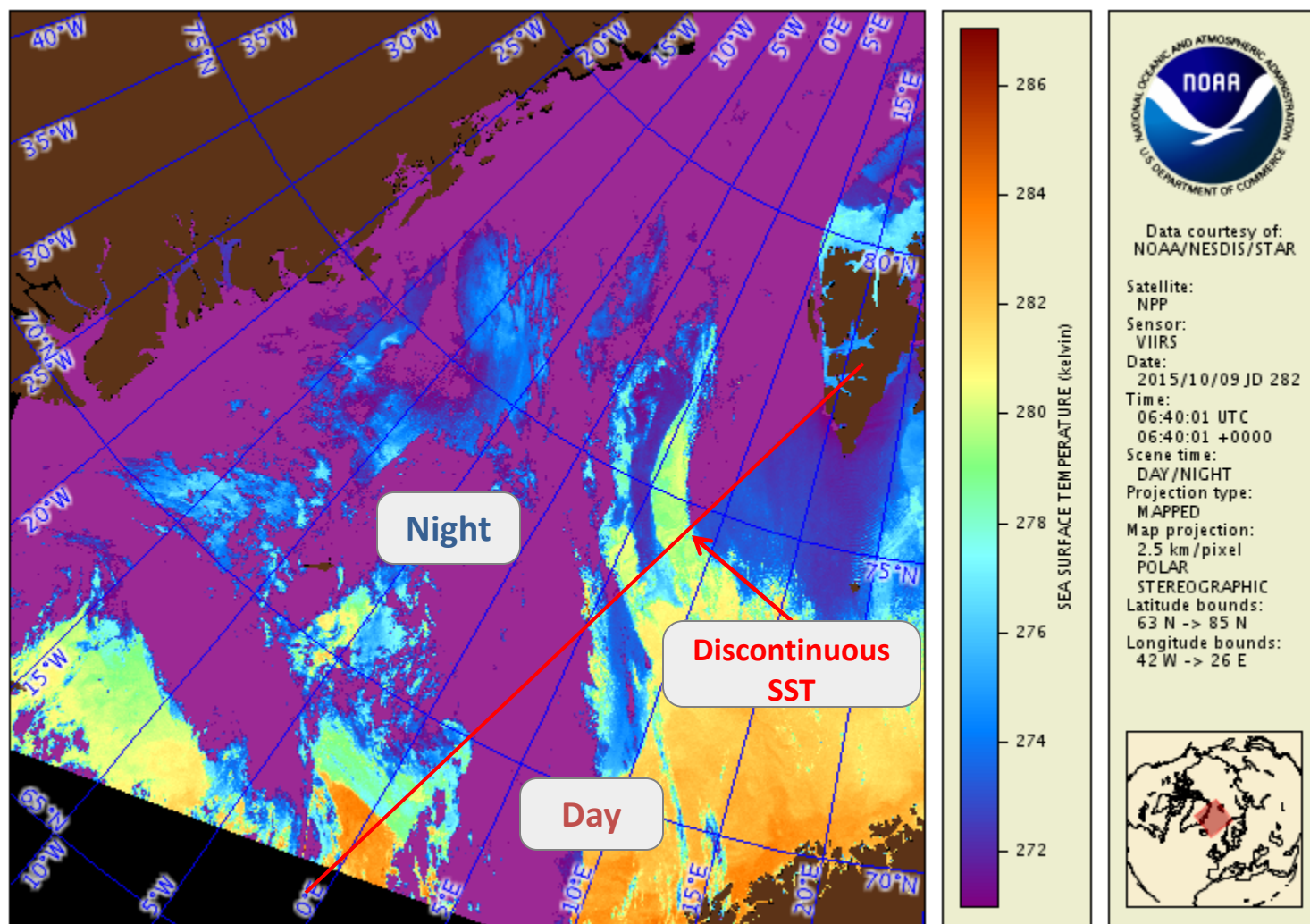
Missing Cloudy Land Sea Ice

Example #2: current ice mask in high-latitudes (Greenland/Norwegian Seas)



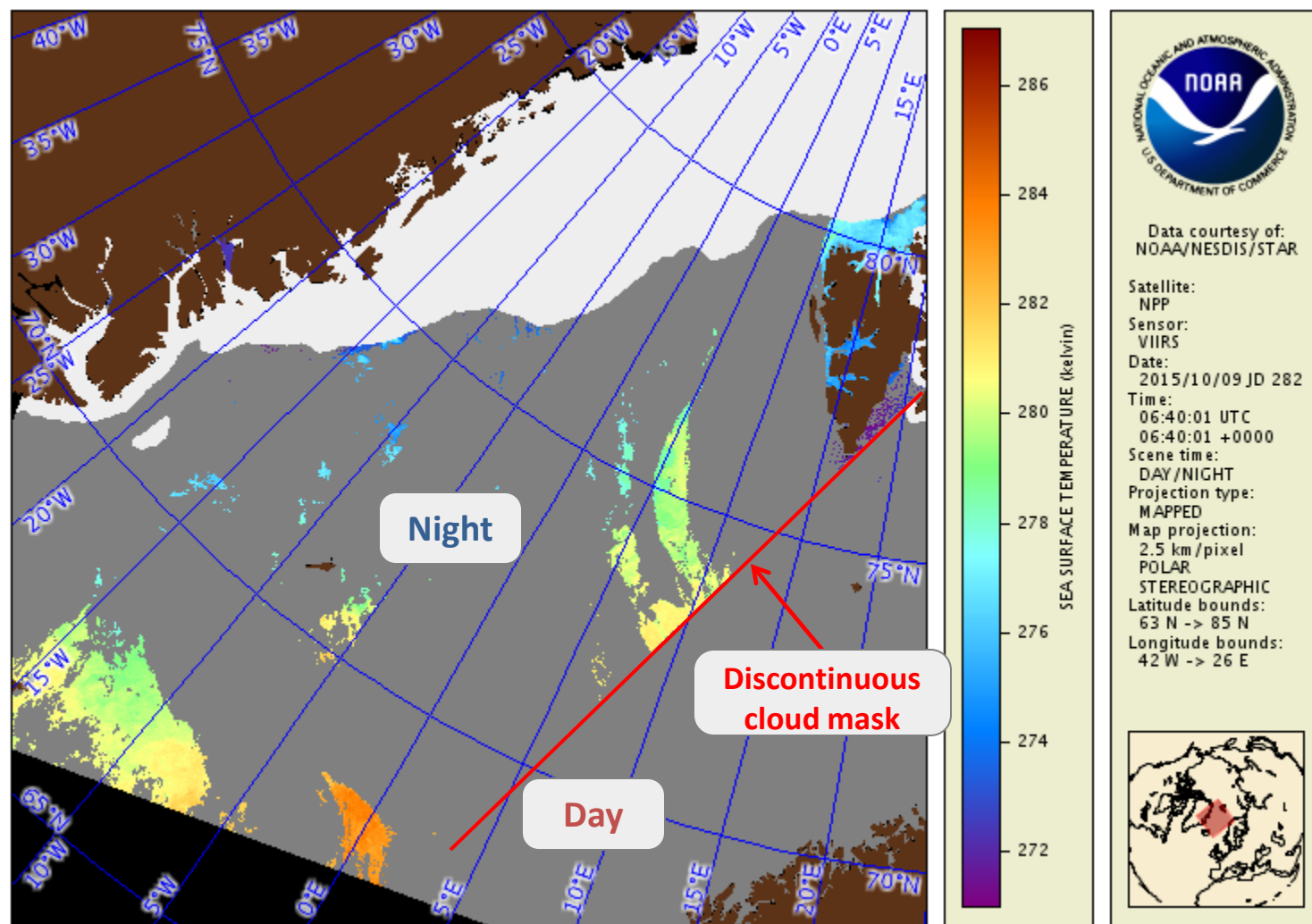
Sea ice and cold water may be identified as “cloud” by ACSPO

Example #3: Discontinuity problem in day/night transition zone



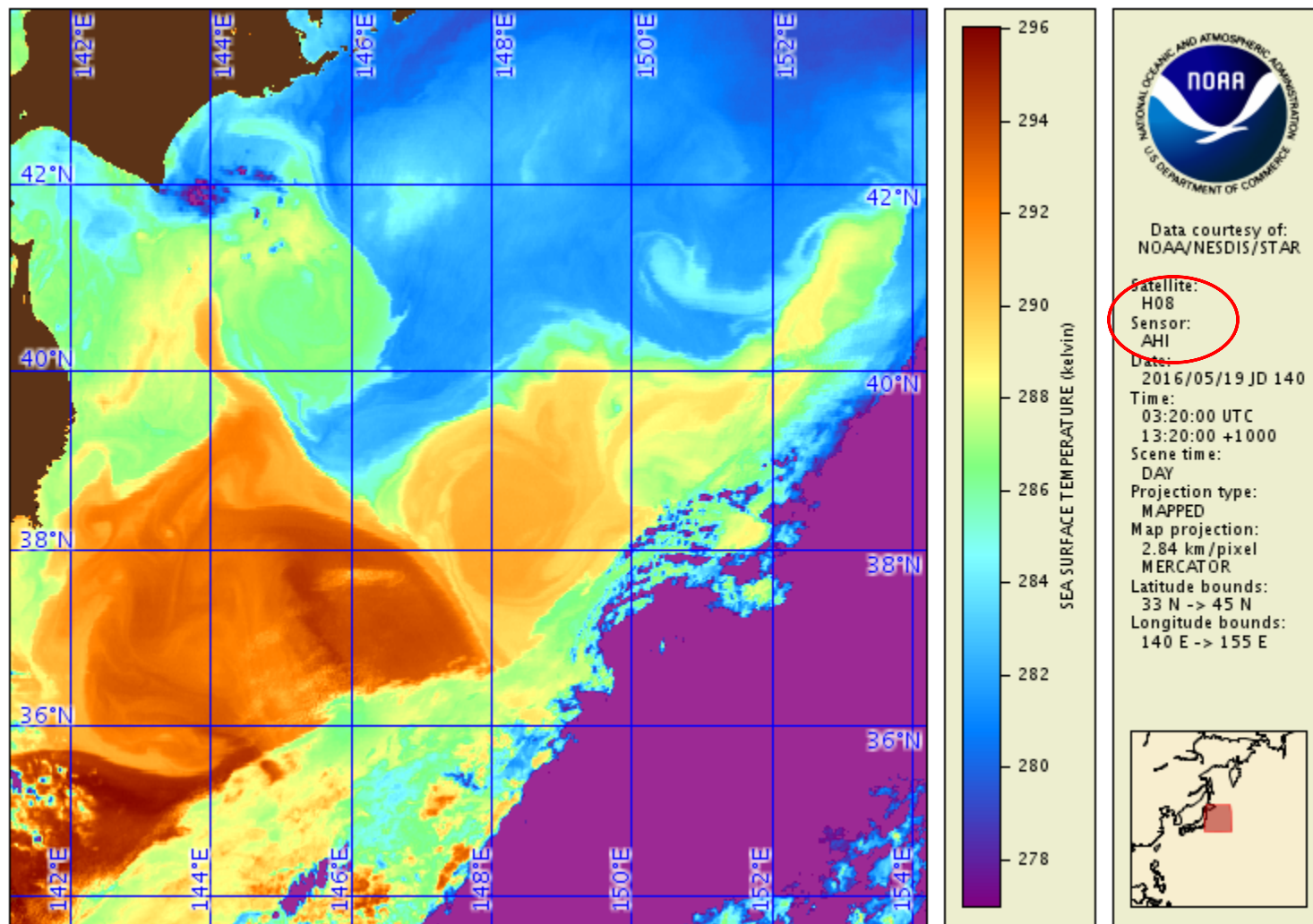
SST algorithm is different in daytime and nighttime, which causes discontinuity

Example #3: Discontinuity problem in day/night transition zone



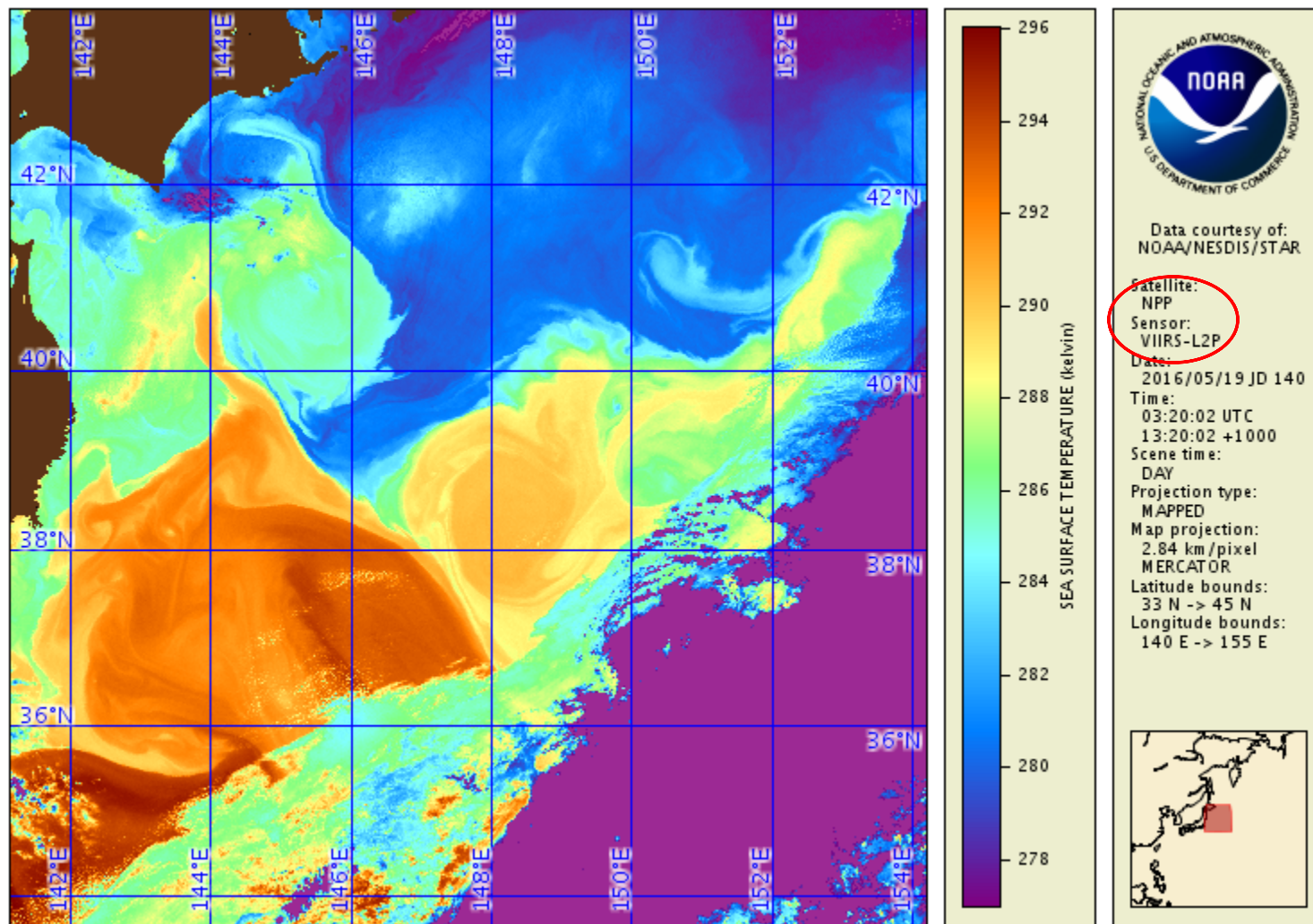
Use of gross filter **RGCT** instead of ratio filter **RRCT** causes cloud mask discontinuity

Example #4: Warm bias in AHI (comparing to VIIRS)



The warm bias seems smaller in next ACSP0 version

Example #4: Warm bias in AHI (compared to VIIRS)



Conclusion

- Identified potential improvements of ACSPO SST using ARMS
 - Conservative clear-sky mask in coastal zones, dynamic areas, and high-latitudes in some cases
 - Room to improve the current ice mask used in ACSPO (based on CMC)
 - Discontinuity problem in both SST algorithm and cloud mask in day/night transition zone
 - Warm bias in AHI compared to VIIRS
 - Study how to fuse data of different overpasses together, and step forward to new L3C (collated from the same satellite) and L3S (super-collated from different platforms) SST products
- Next step:

Work on those problems, improve the performance of ACSPO SST