ACSPO v2.50
&
upcoming improvements in v2.60

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[2]*City College of New York, USA*
[3]*Global Science and Technology, Inc., USA*

Two ACSPO Releases Underway

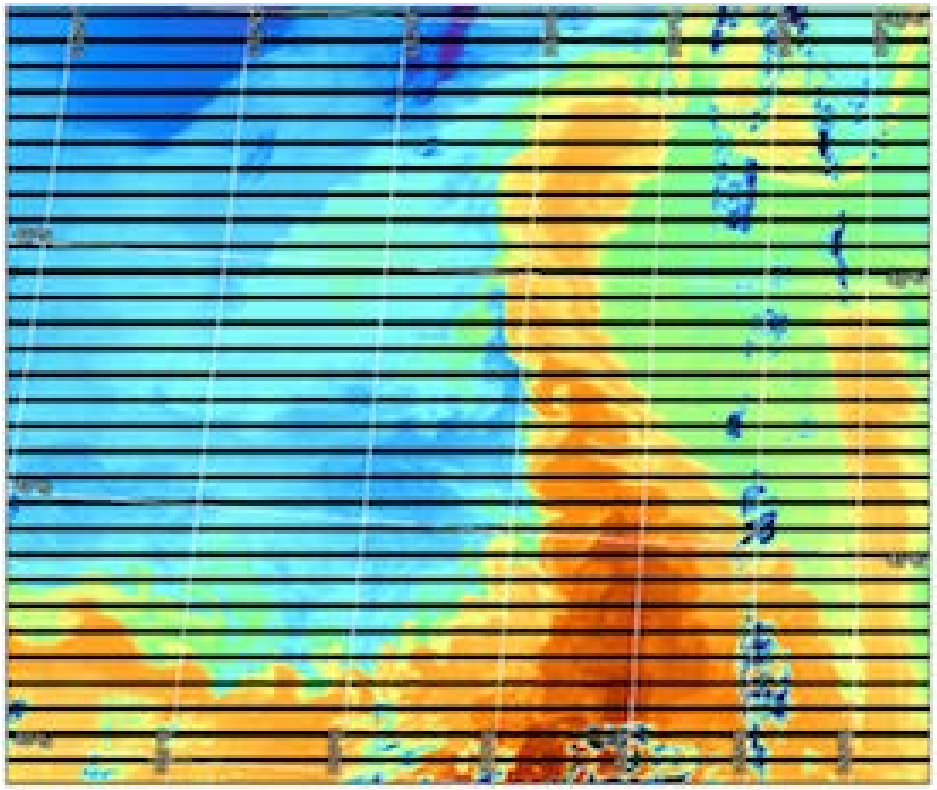
ACSPO 2.5:

- Improve brightness temperature (BT) and SST imagery in the full VIIRS swath, using special resampling algorithms to minimize geometrical distortions and fill in the bow-tie deleted pixels
- Revisit SST algorithms to provide improved sensitivity, and potentially utilize optional SST bands (e.g. 8.6 μm)

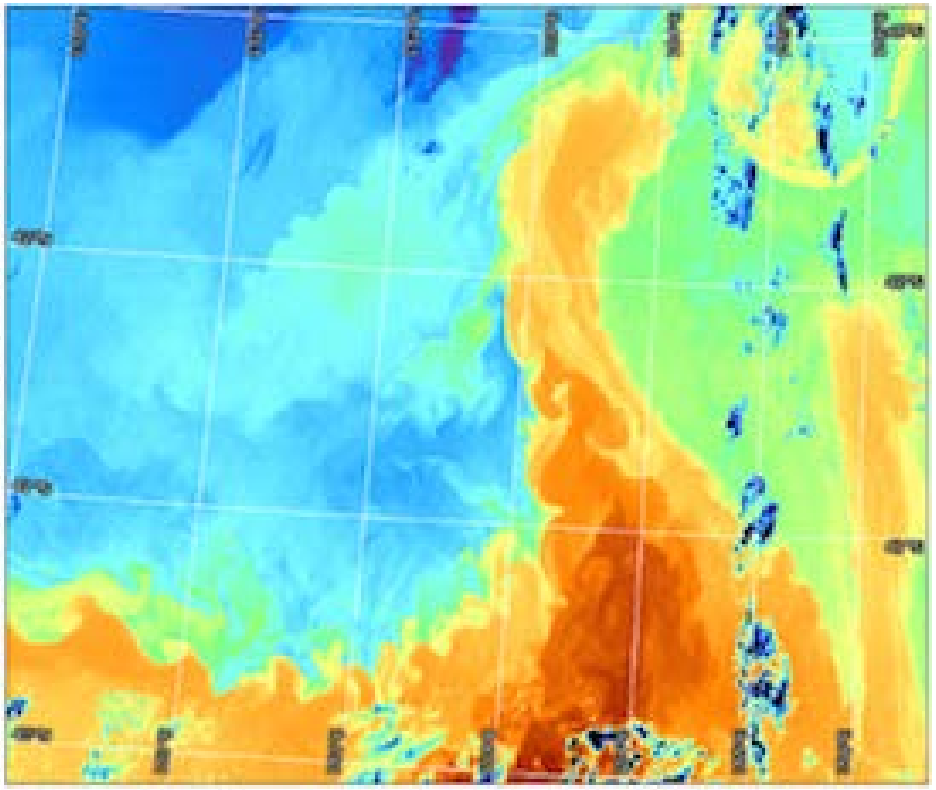
ACSPO 2.6:

- Improve clear sky identification in dynamic, coastal, and high-latitude areas of the ocean
- Derive Ocean Fronts and save in L2 and L3U ACSPO SST products

ACSPO 2.5 Imagery Improvement



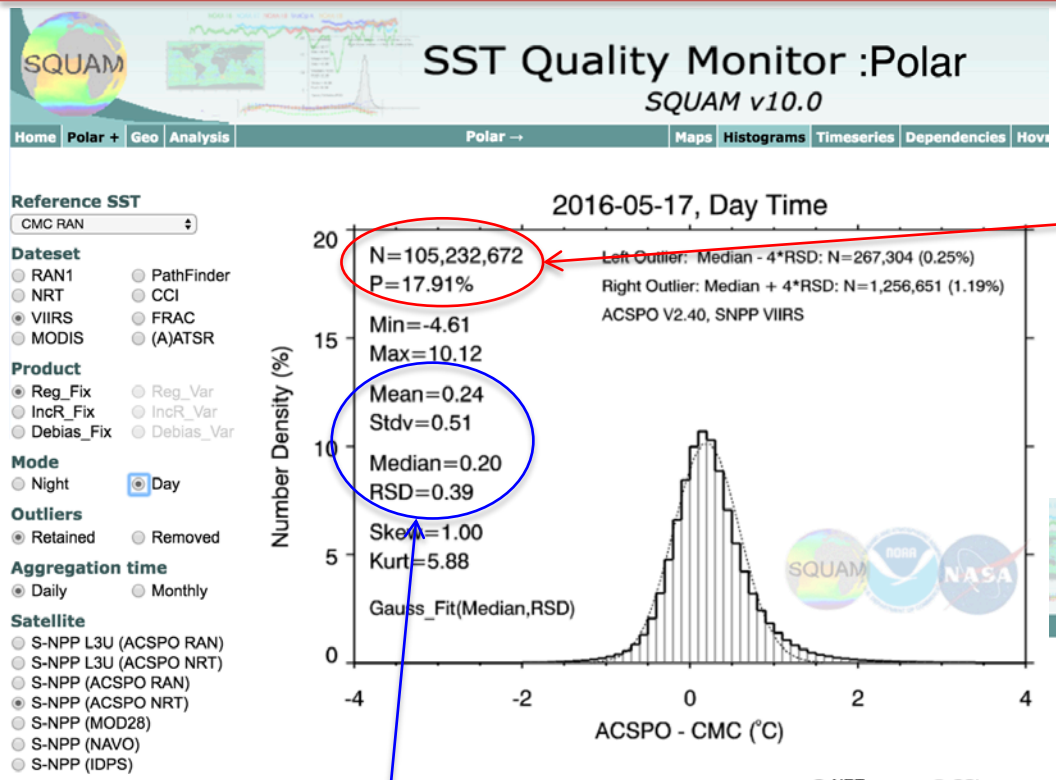
Original VIIRS SST in swath projection



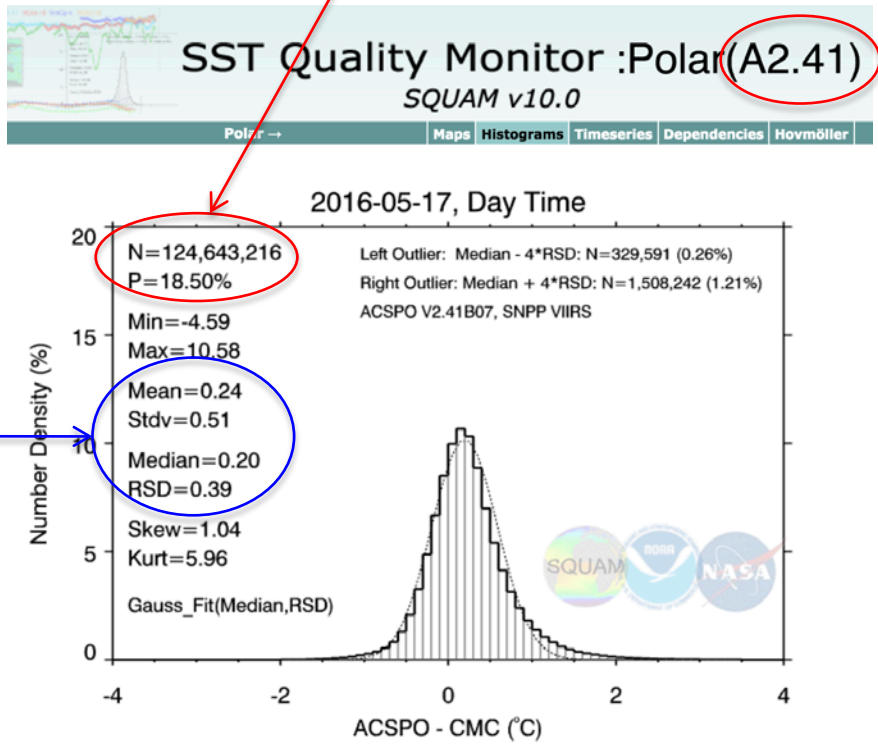
Resampled VIIRS SST

Left: Example of bow-tie deletions when the Visible Infrared Imaging Radiometer Suite (VIIRS) sea surface temperature (SST) image is displayed in the original swath projection. Right: Corresponding resampled SST ACSPO v2.5 imagery

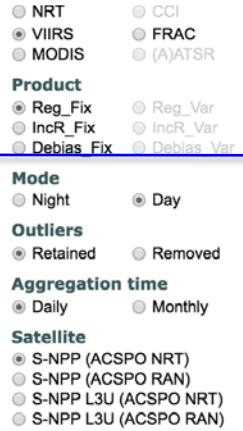
Preliminary tested in SQUAM

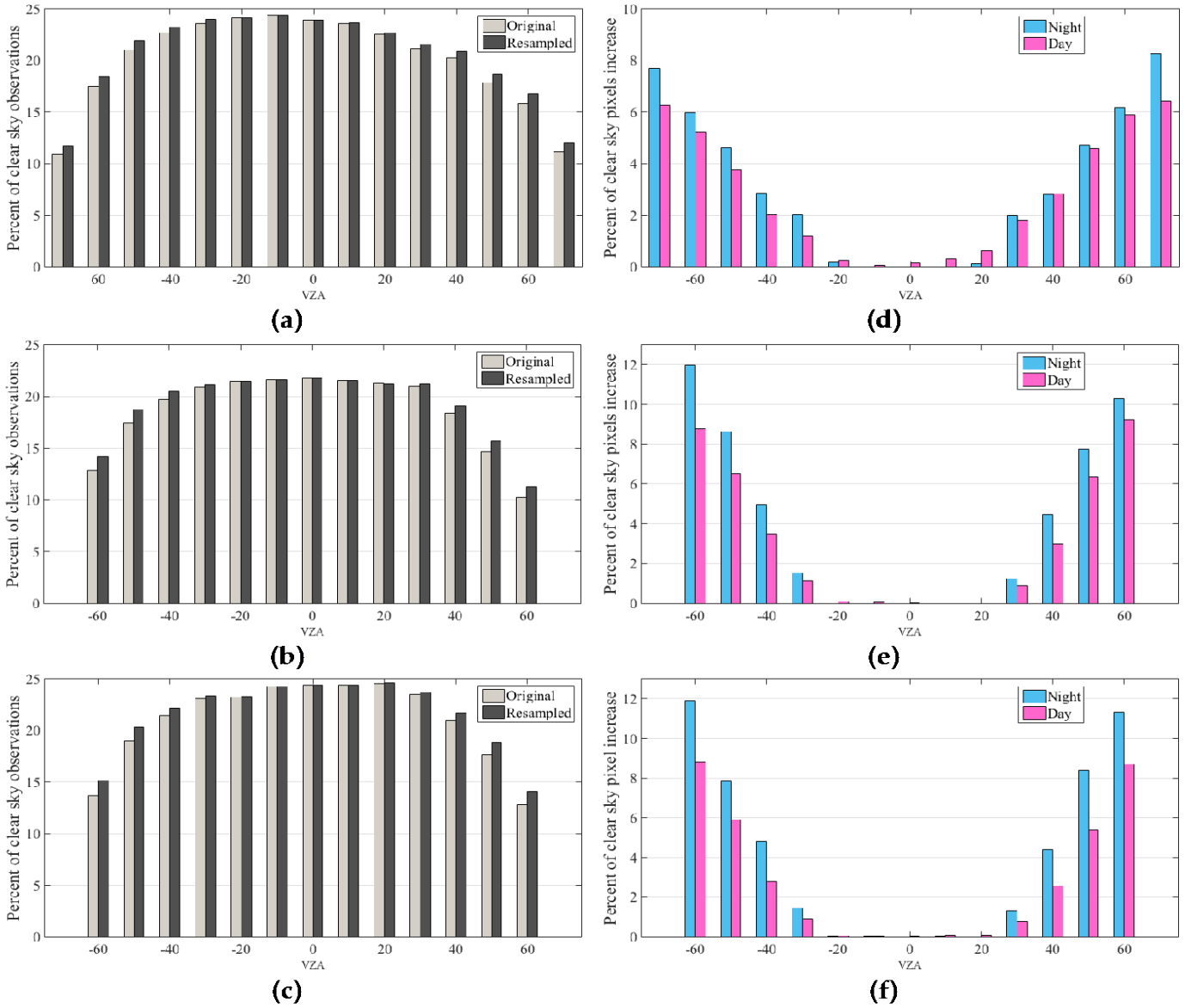


Increased number of observations



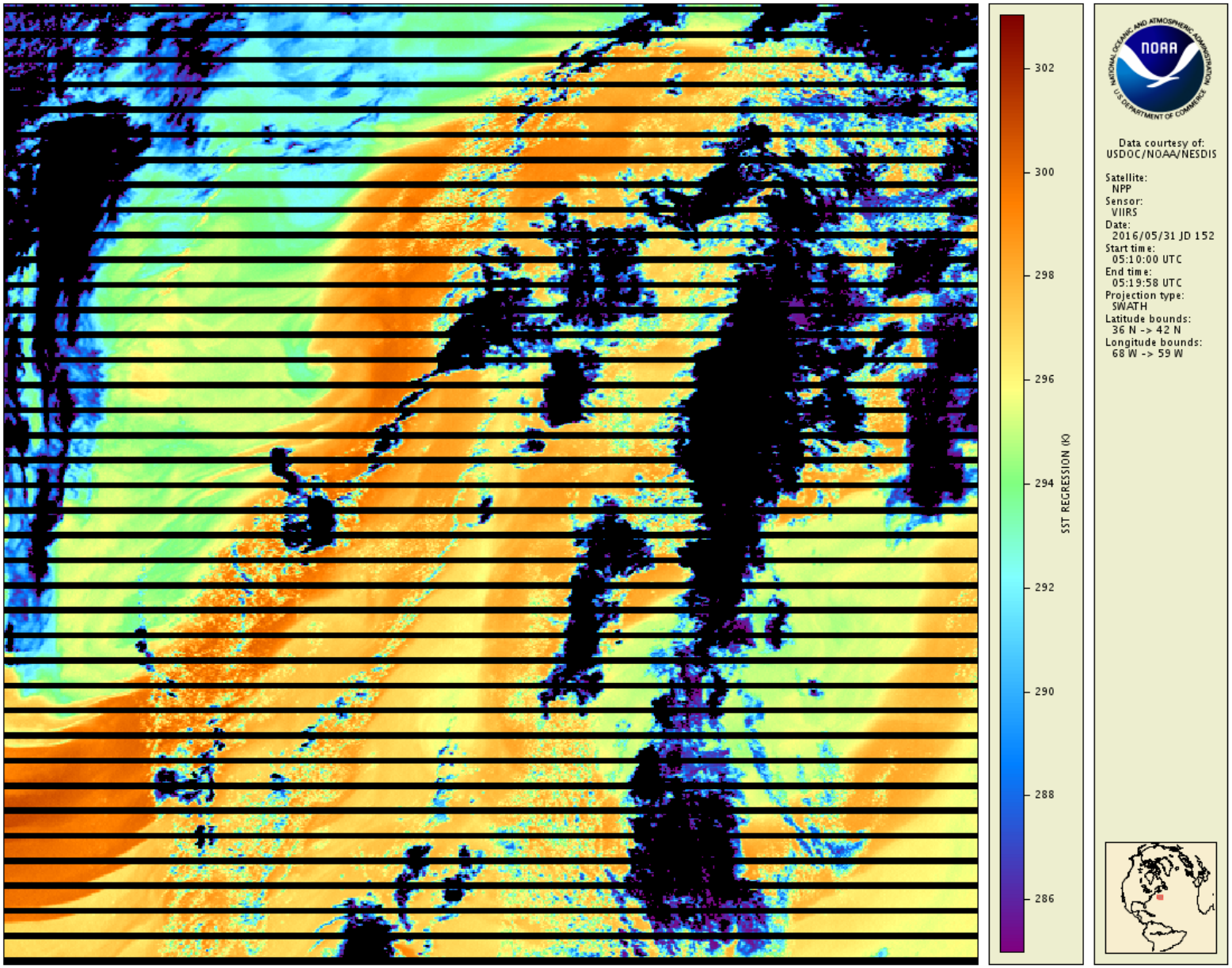
Similar performance statistics



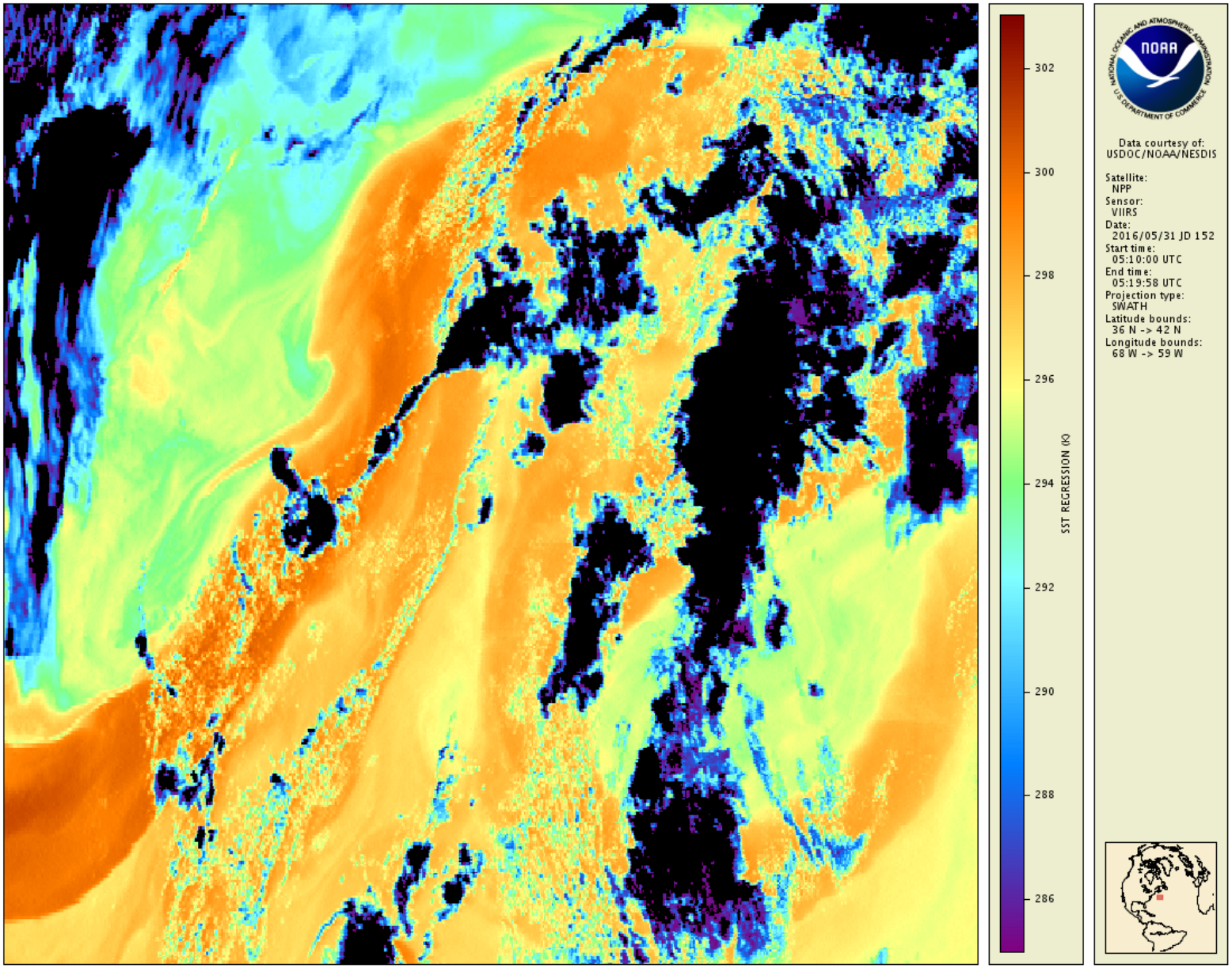


Number of clear sky observations for one day (18 October 2015) of global ACSPO SST data as a function of view zenith angle (VZA) for (**a**) S-NPP VIIRS; (**b**) Aqua MODIS; (**c**) Terra MODIS. Original data are shown in light gray and resampled in dark gray. Day and night data are combined together.
Corresponding percent increase for (**d**) S-NPP VIIRS; (**e**) Aqua MODIS and (**f**) Terra MODIS (separated by night and day).

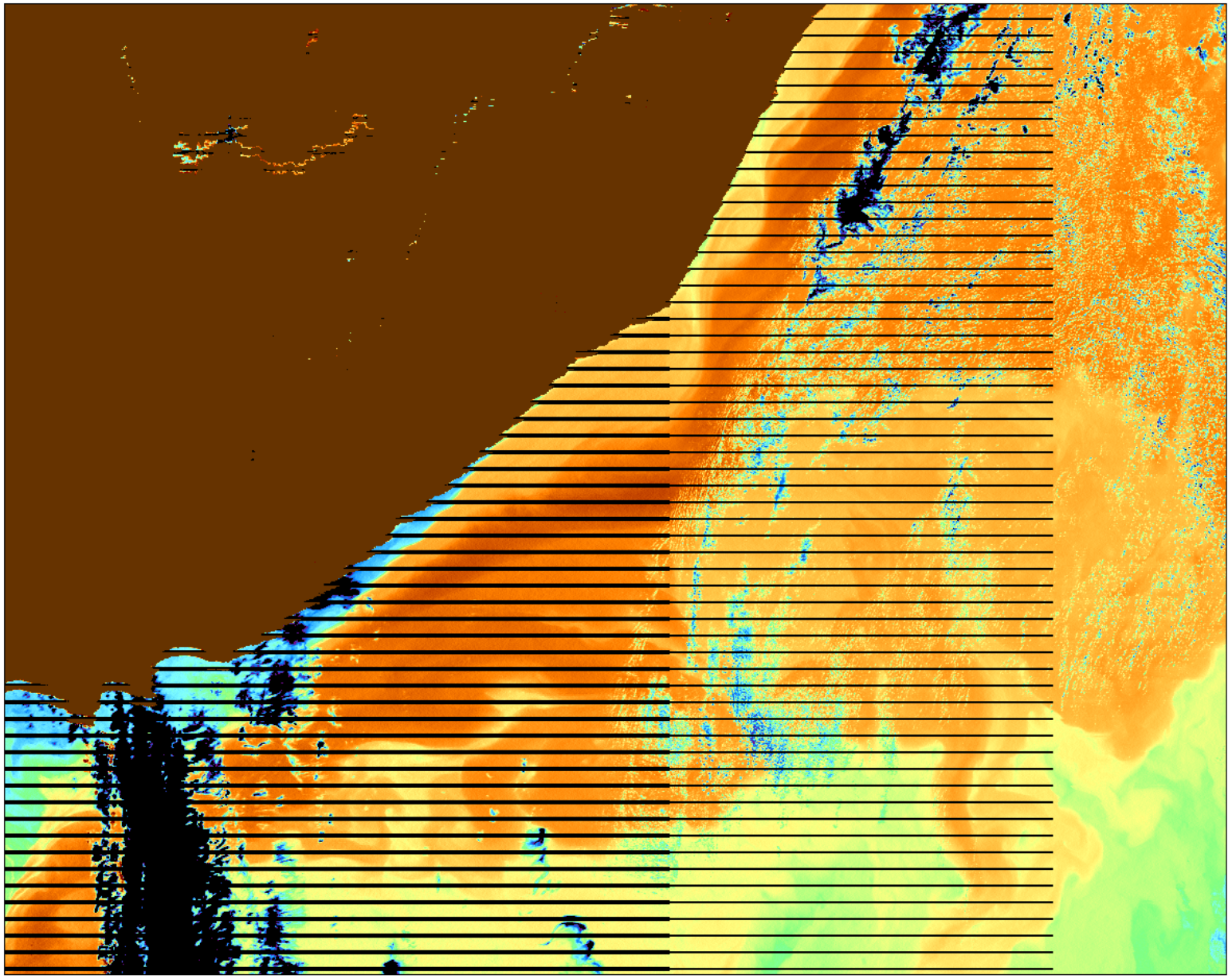
Original (with onboard deletions)

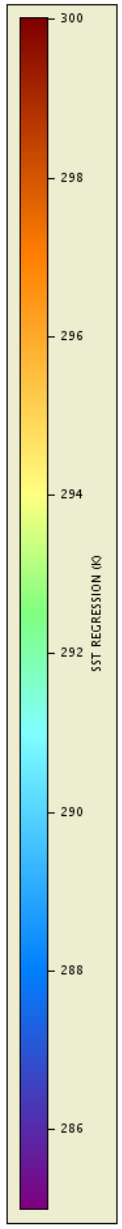


Resampled


302
300
298
296
294
292
290
288
286
SST REGRESSION (K)
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2016/05/31 JD 152
Start time:
05:10:00 UTC
End time:
05:19:58 UTC
Projection type:
SWATH
Latitude bounds:
36 N -> 42 N
Longitude bounds:
68 W -> 59 W

Original (with onboard deletions)

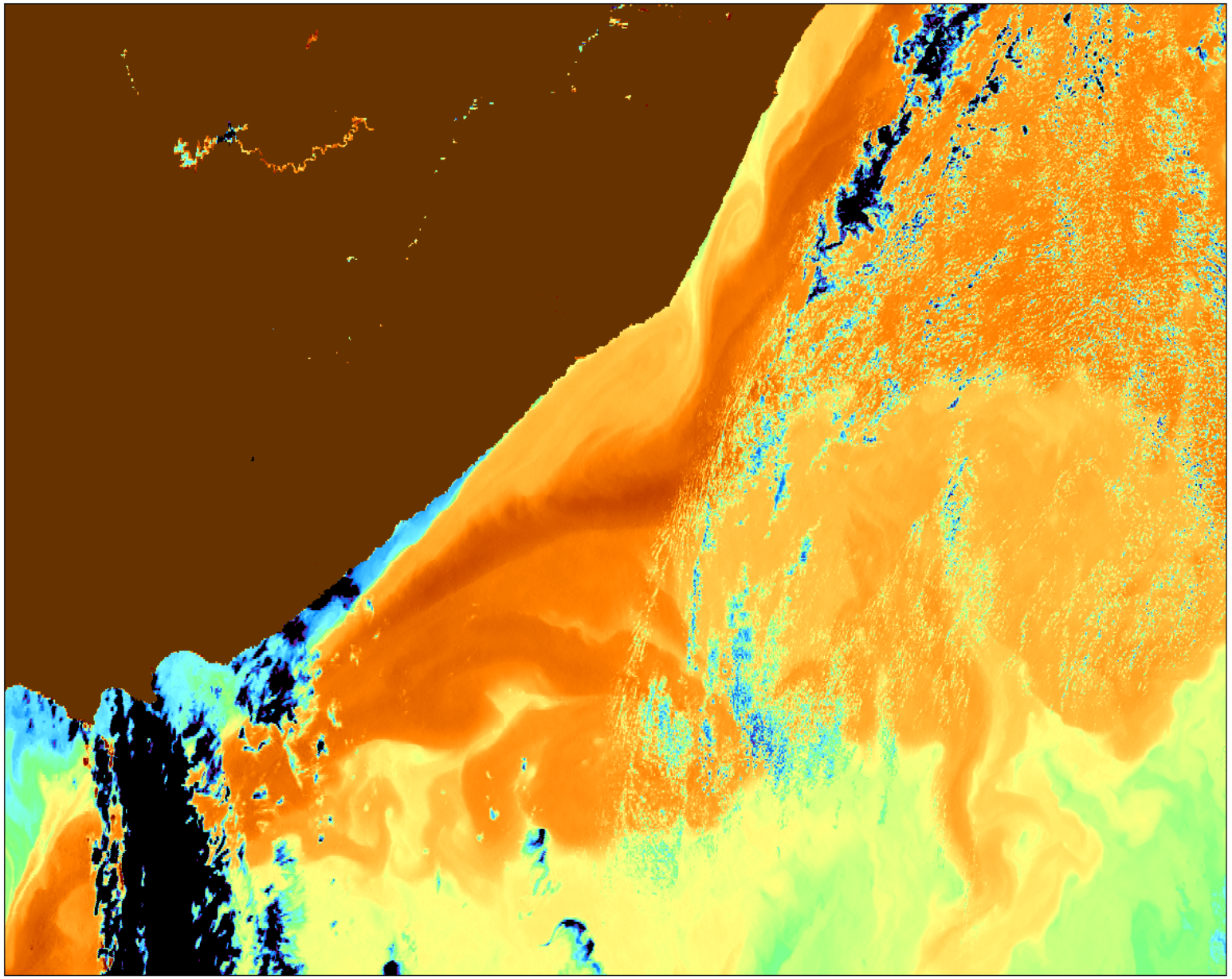


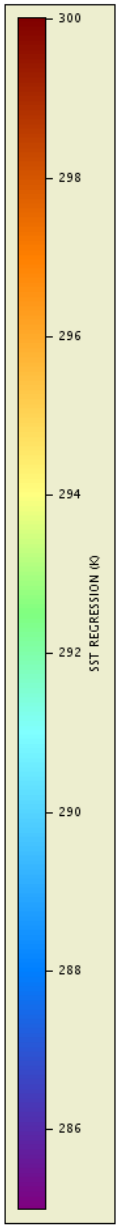


Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP
Sensor:
VIIRS
Date:
2016/05/31 JD 152
Start time:
11:00:01 UTC
End time:
11:09:59 UTC
Projection type:
SWATH
Latitude bounds:
37 S -> 28 S
Longitude bounds:
22 E -> 38 E

Resampled

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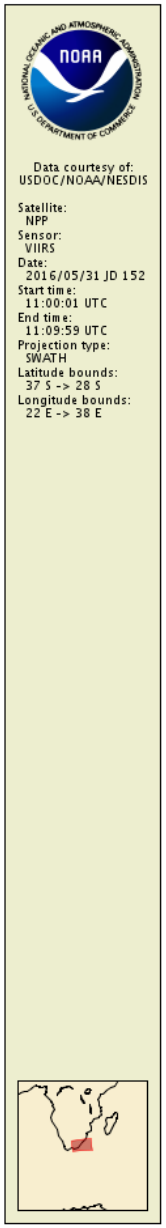
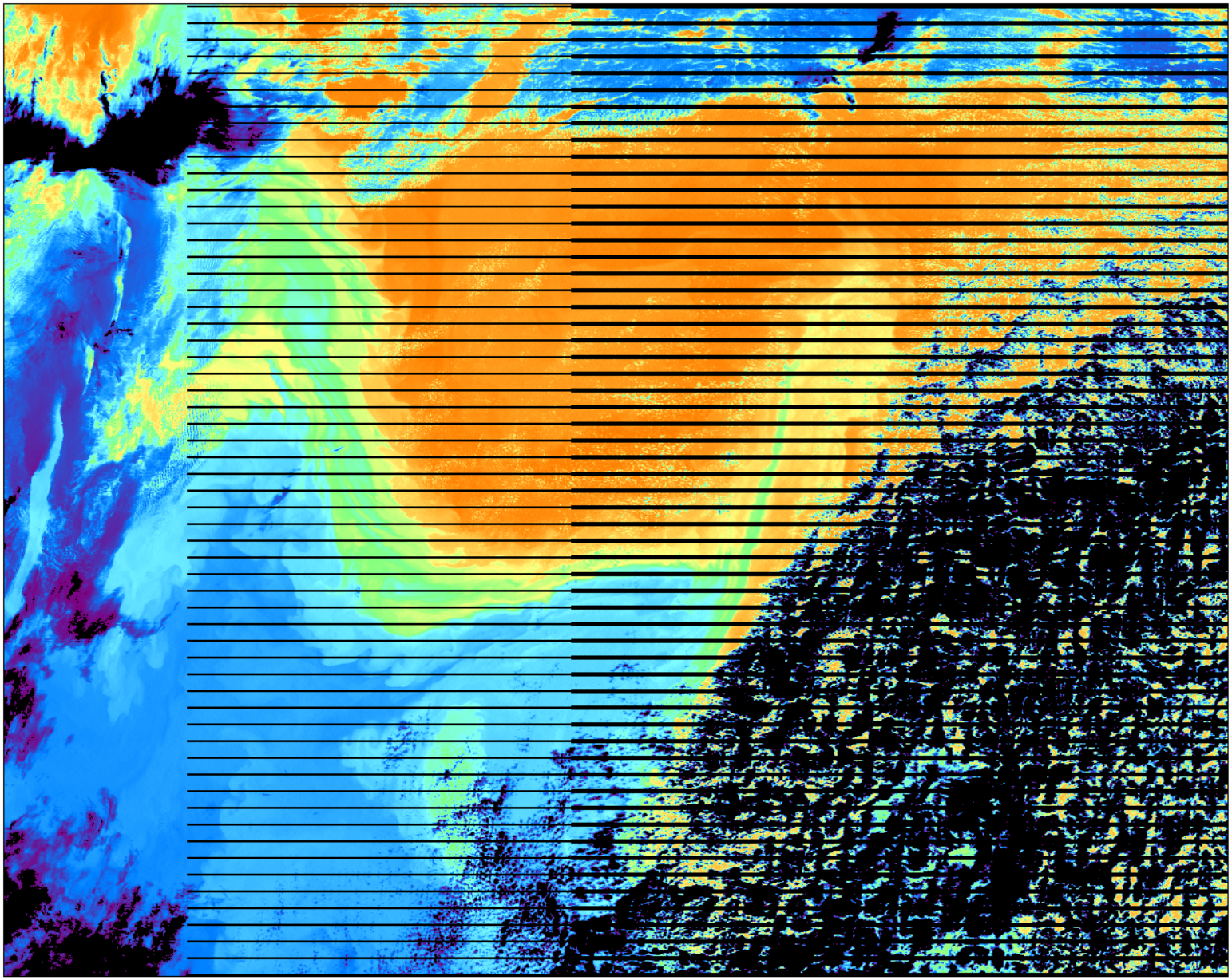
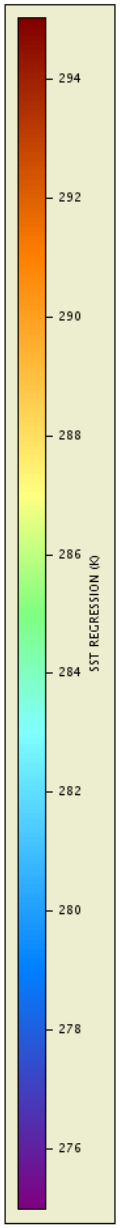
SST REGRESSION (K)


Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2016/05/31 JD 152
Start time:
11:00:01 UTC
End time:
11:09:59 UTC
Projection type:
SWATH
Latitude bounds:
37 S -> 28 S
Longitude bounds:
22 E -> 38 E

Original (with onboard deletions)

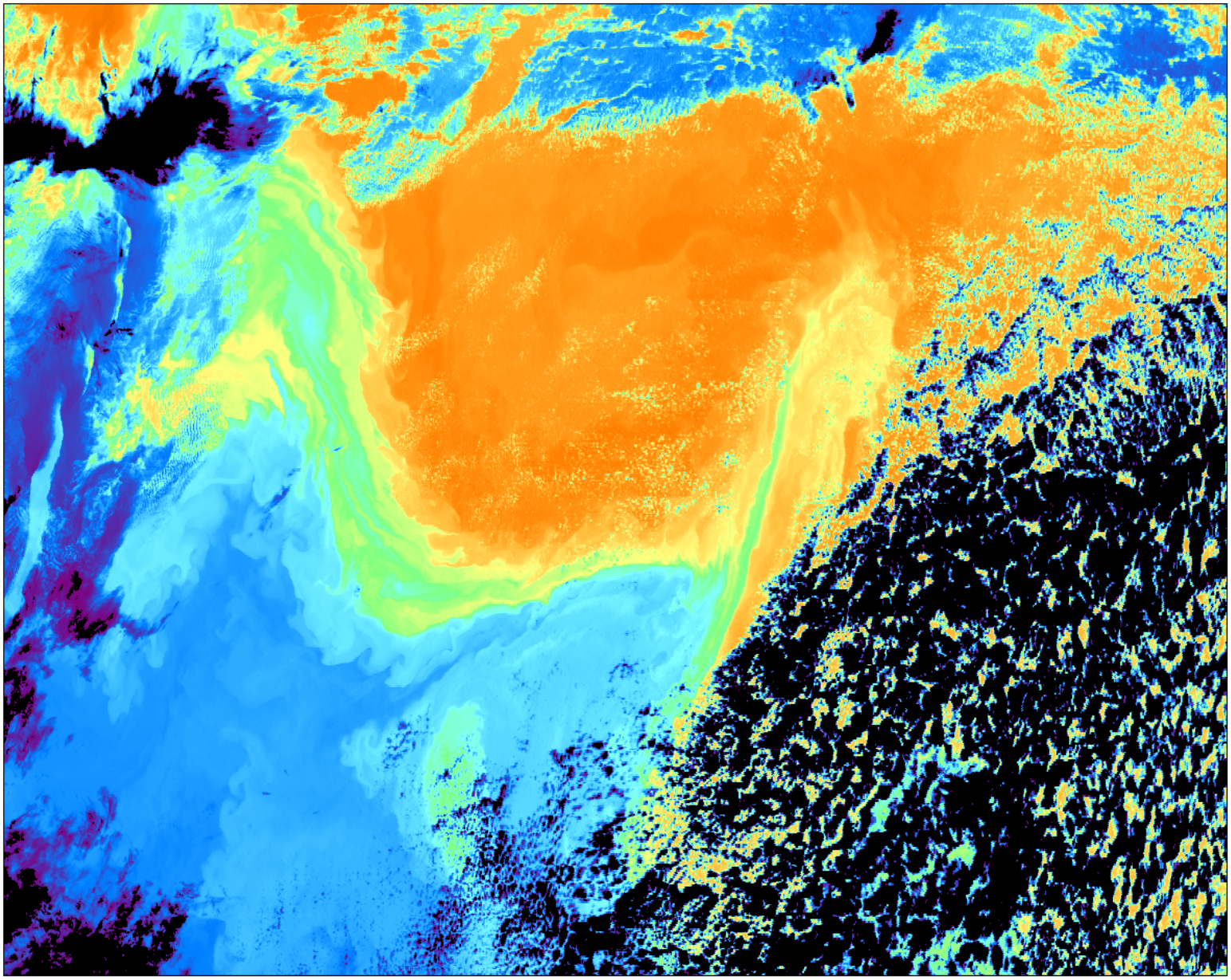


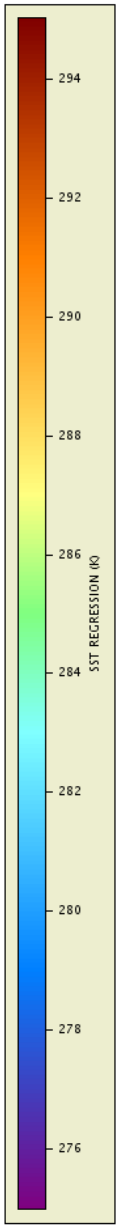


Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP
Sensor:
VIIRS
Date:
2016/05/31 JD 152
Start time:
11:00:01 UTC
End time:
11:09:59 UTC
Projection type:
SWATH
Latitude bounds:
46 S -> 35 S
Longitude bounds:
46 E -> 64 E

Resampled

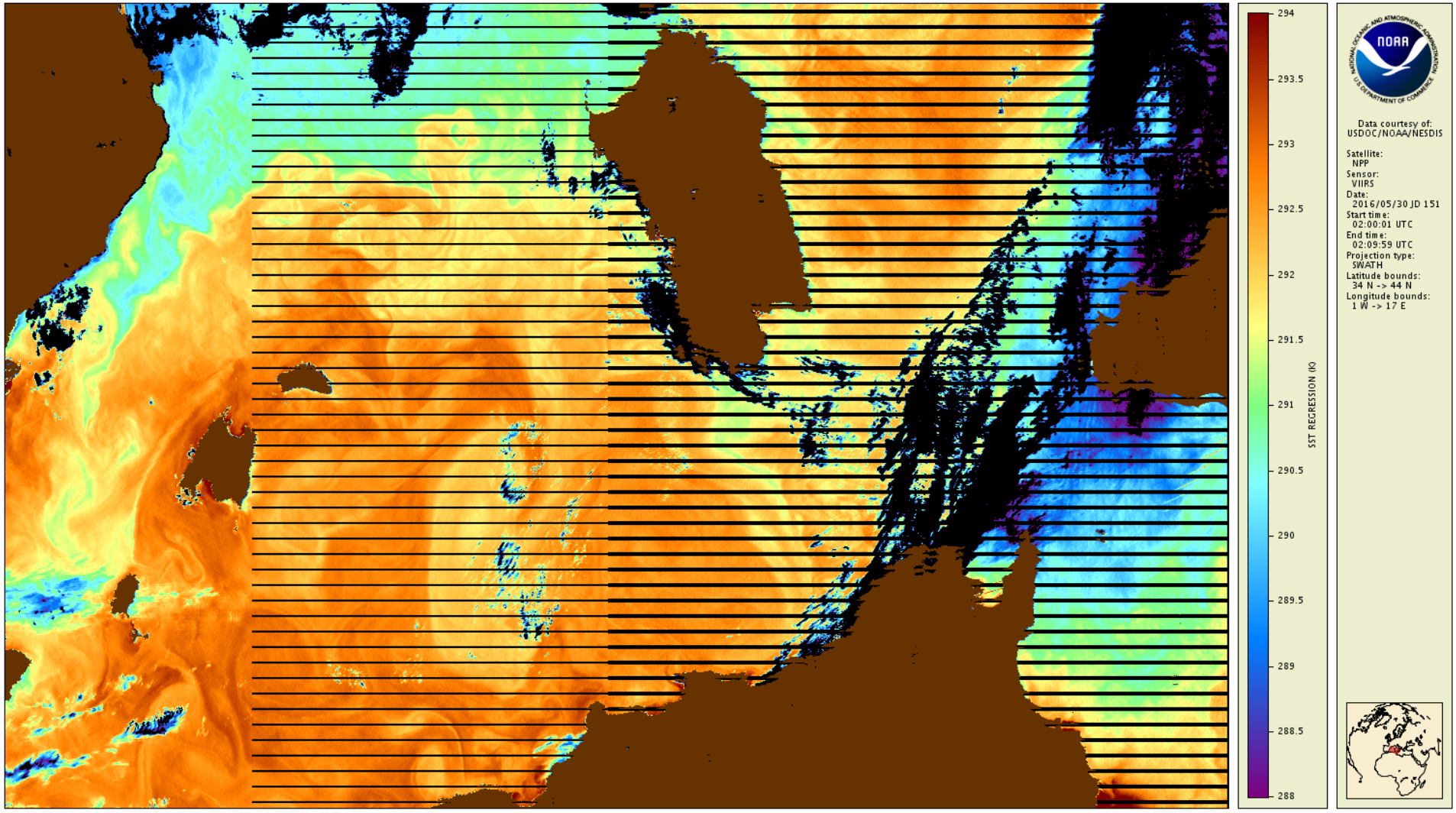




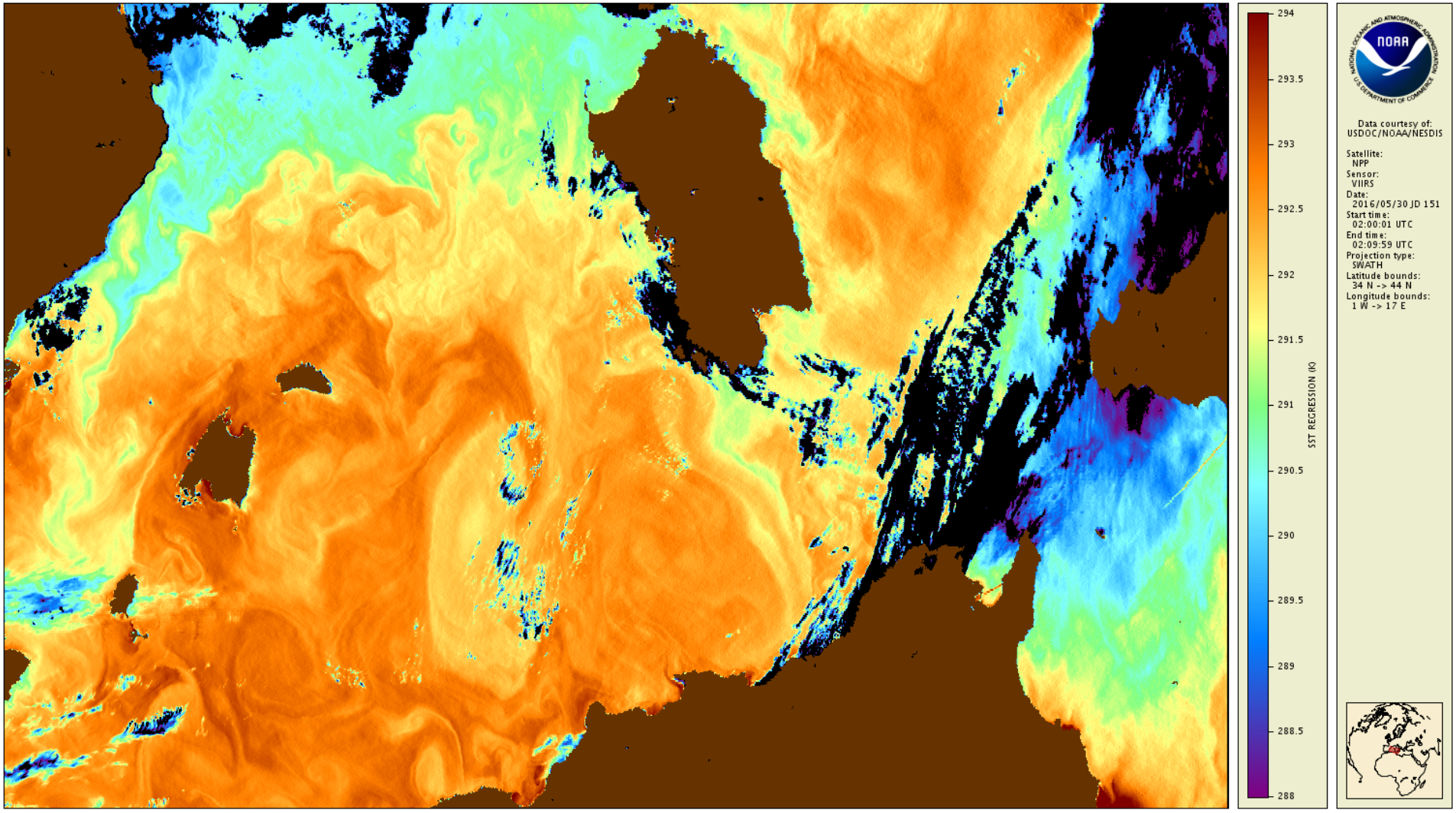
Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP
Sensor:
VIIRS
Date:
2016/05/31 JD 152
Start time:
11:00:01 UTC
End time:
11:09:59 UTC
Projection type:
SWATH
Latitude bounds:
46 S -> 35 S
Longitude bounds:
46 E -> 64 E

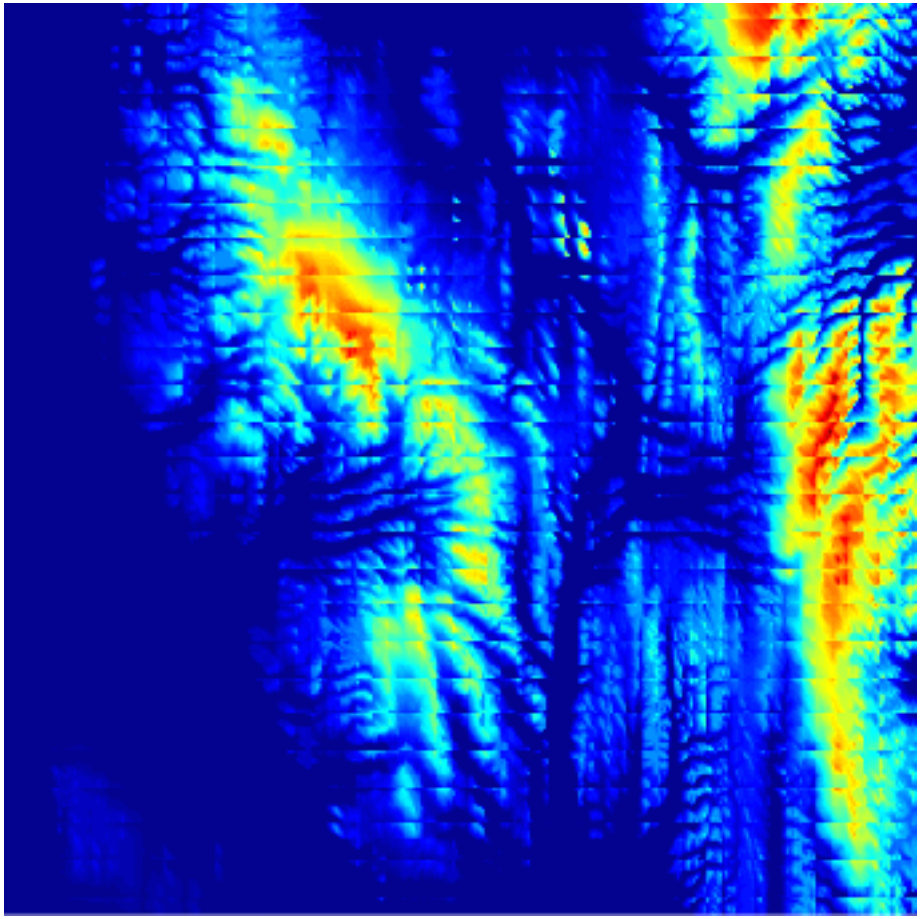
Original (with onboard deletions)

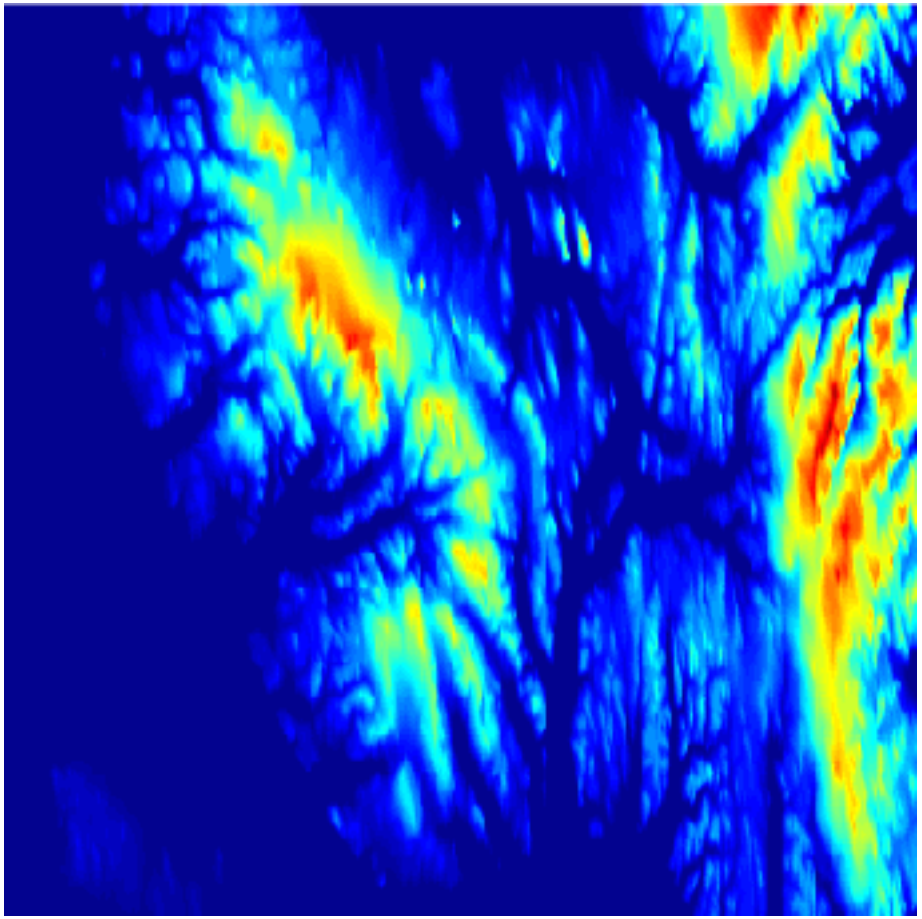


Resampled


294
293.5
293
292.5
292
291.5
291
290.5
290
289.5
289
288.5
288
SST REGRESSION (K)
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2016/05/30 JD 151
Start time:
02:00:01 UTC
End time:
02:09:59 UTC
Projection type:
SWATH
Latitude bounds:
34 N -> 44 N
Longitude bounds:
1 W -> 17 E

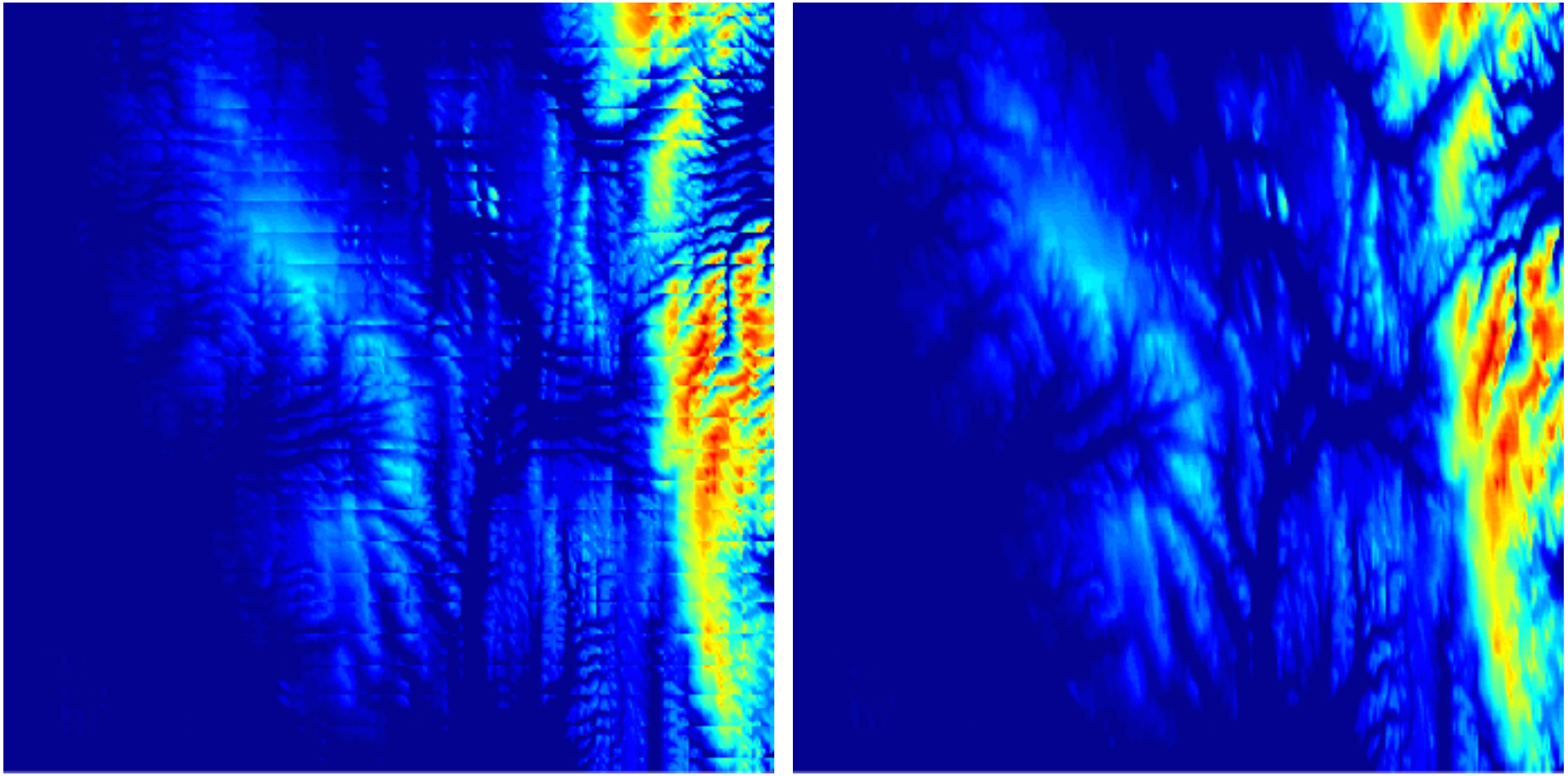
Resampled Geo: Longitude





Left: Difference between terrain-corrected and ellipsoid longitudes in the original scan order (from GMTCO and GMODO VIIRS geo files);
Right: De-bowtized longitude difference after re-sampling.

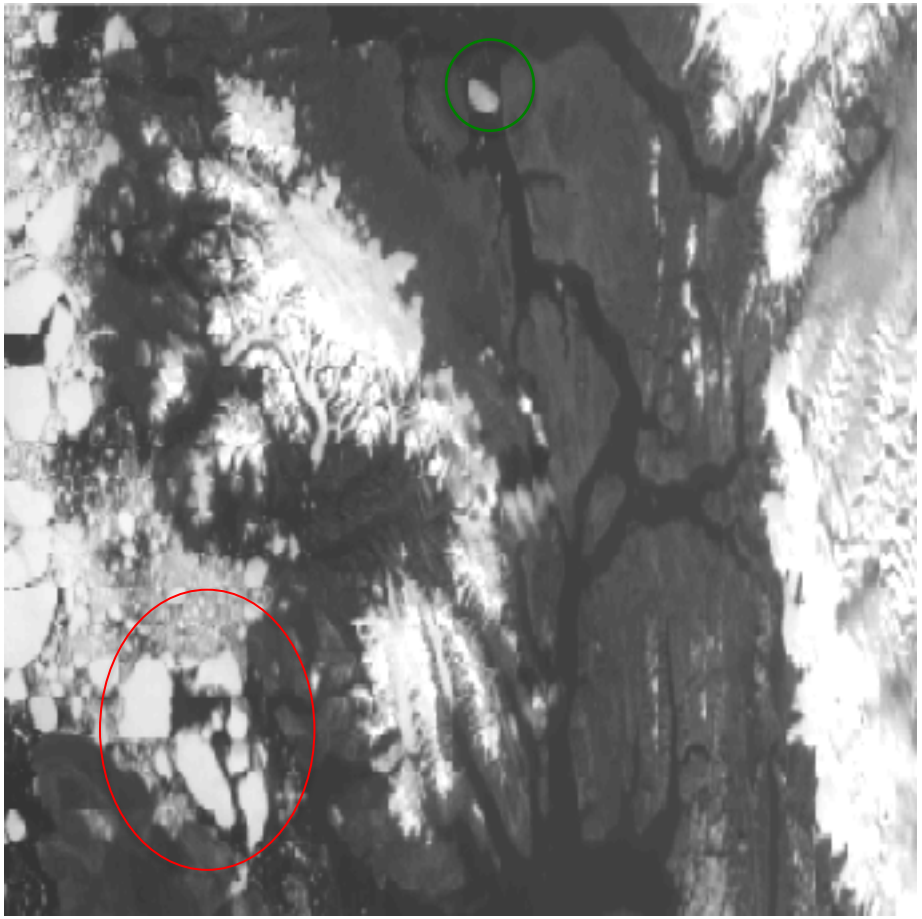
Resampled Geo: Latitude



Left: Difference between terrain-corrected and ellipsoid latitudes in the original scan order (from GMTCO and GMODO VIIRS geo files);
Right: De-bowtized latitude difference after re-sampling.

Resampling for non-SST VIIRS bands

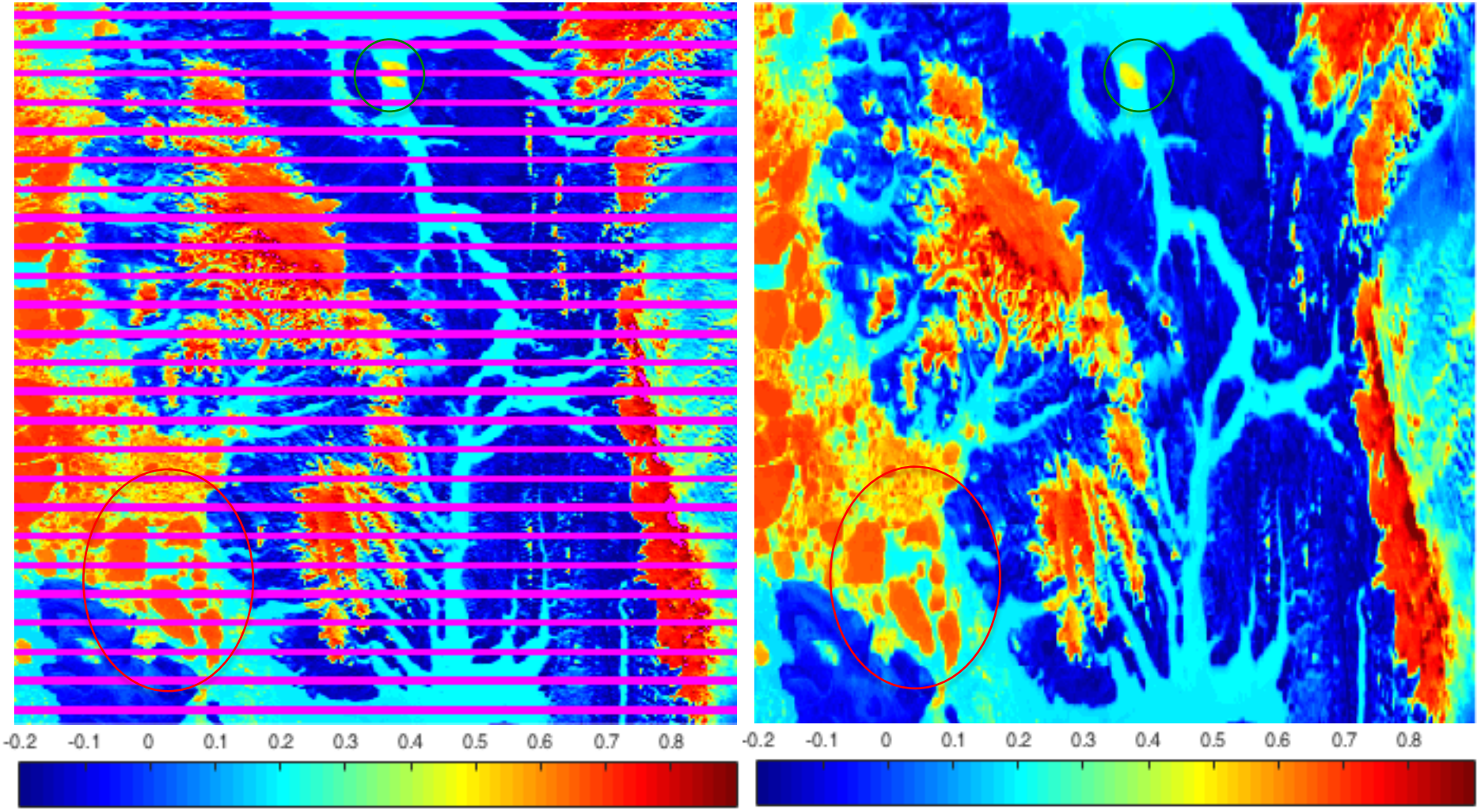
Original VIIRS band M4



Resampled band M4

400 by 400 crop taken from the end of the VIIRS swath for the 20:29:08.1 UTC pass on Sept 1, 2015 over Arctic Ocean. The crop includes Qikiqtaaluk Region (Nunavut, CA) showing part of the Northwestern with mountainous and glaciated terrain.

Resampling for non-SST VIIRS bands



Difference between VIIRS M4 (0.55 µm) and M10 (1.6 µm): Original (left), Resampled (right).

The fine-scale details captured by VIIRS instrument are preserved during proposed resampling procedure.

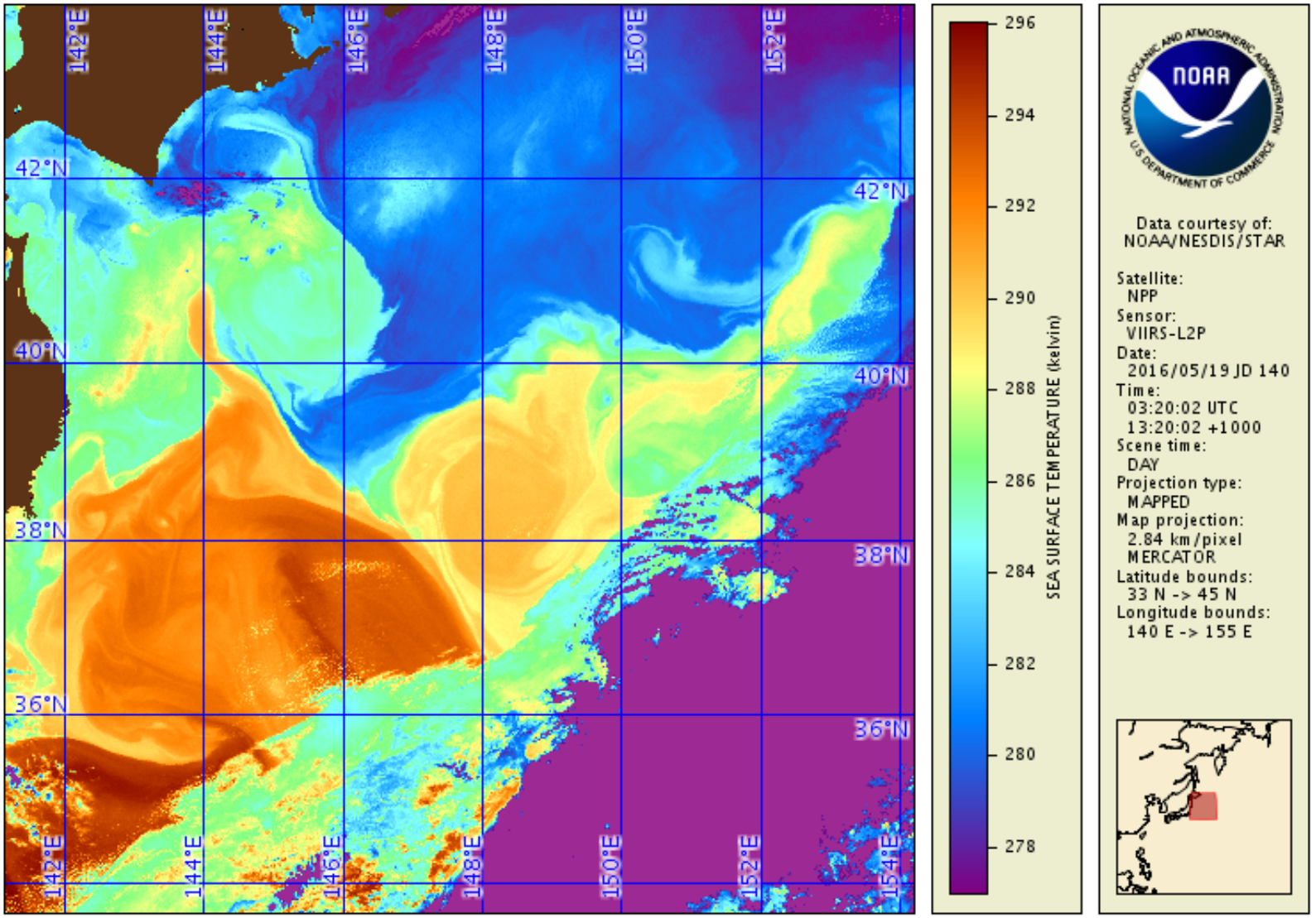
ACSPO 2.6

Planned Improvements in 2.6:

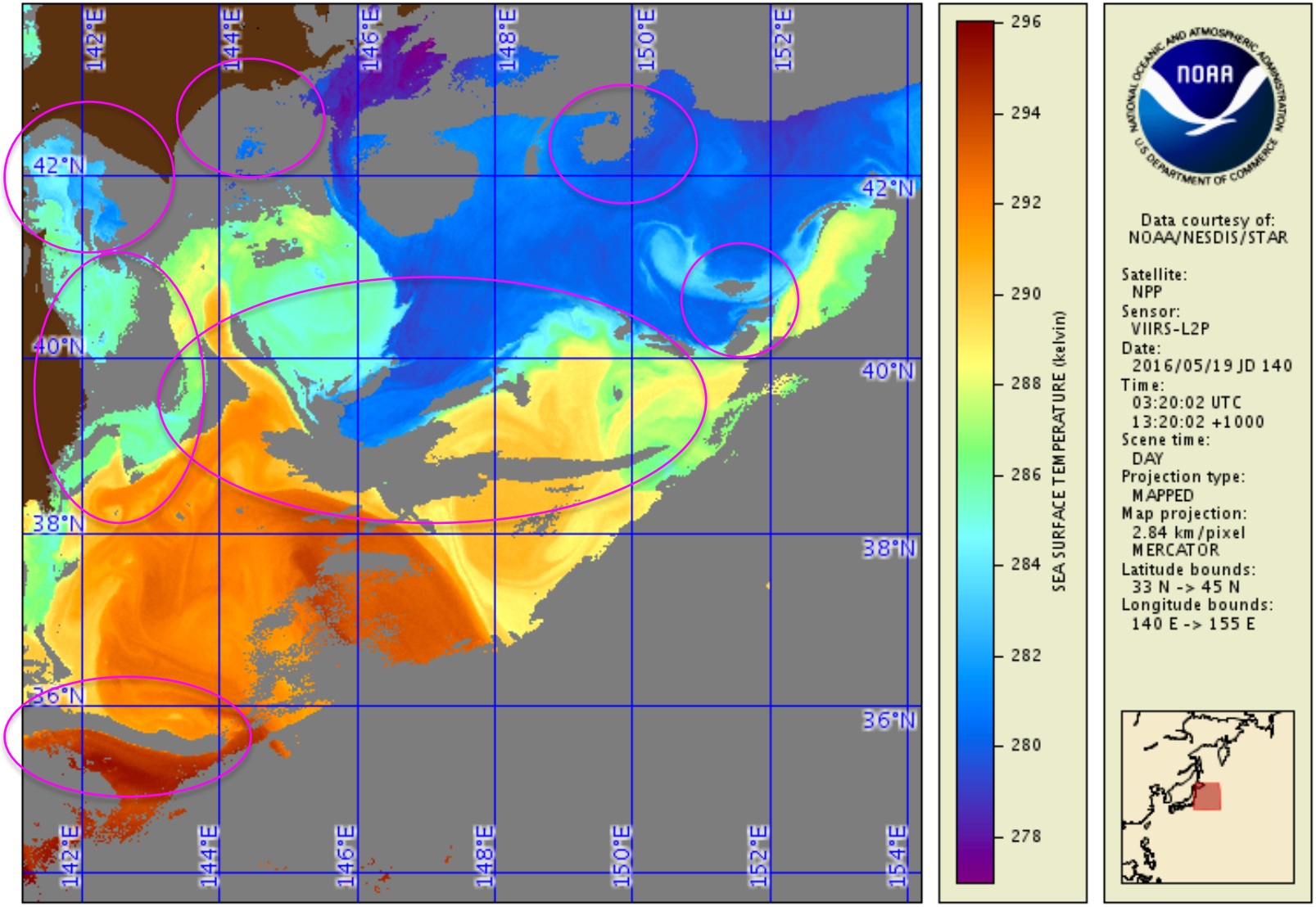
- Improve clear sky identification in dynamic, coastal, and high-latitude areas of the ocean (to facilitate L3 and L4 improvements in these challenging regions, which are often missing in satellite data)

- Derive Ocean Fronts and save in L2 and L3U ACSPO SST products

Example of misclassifications in dynamic regions (no cloud mask)



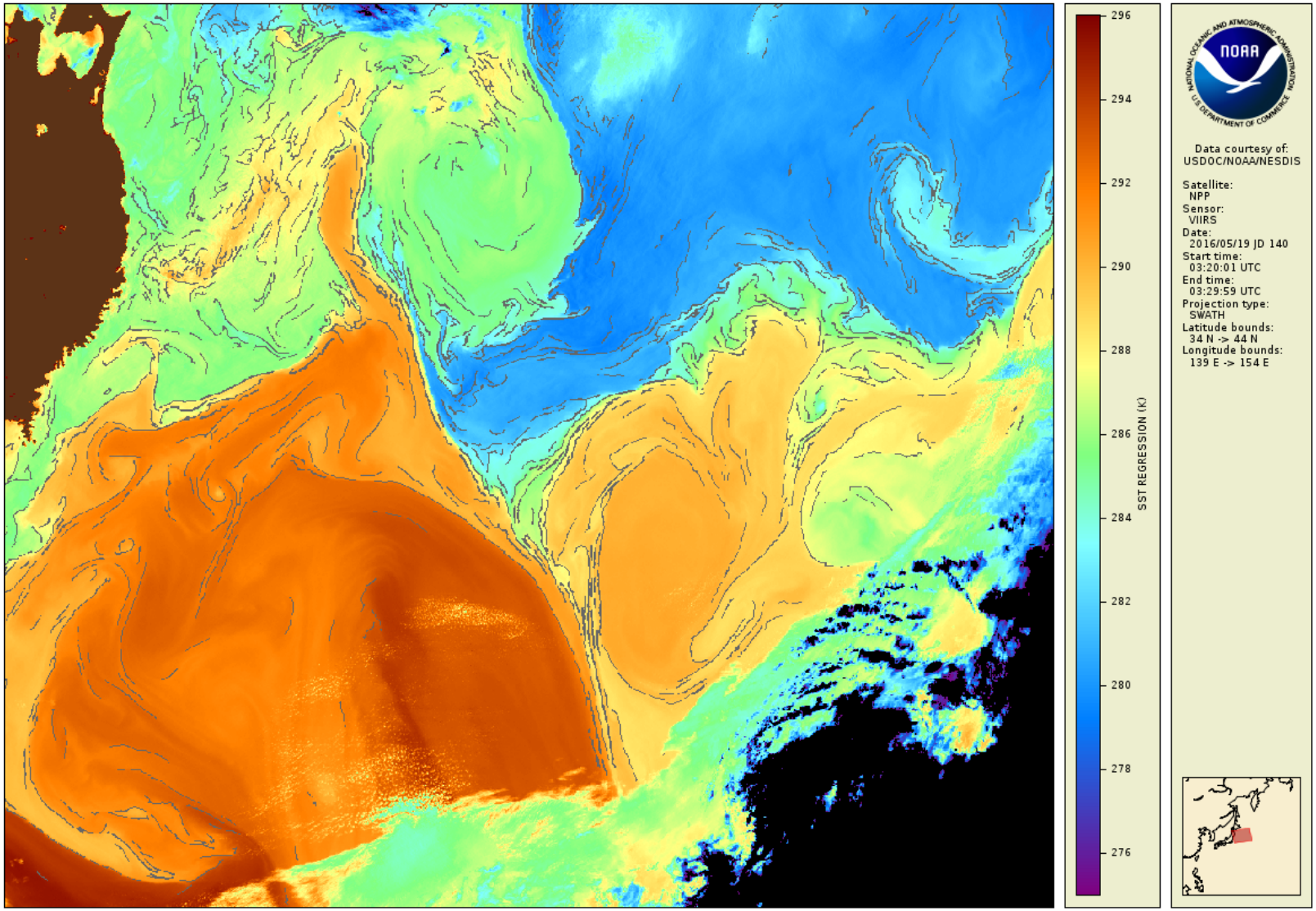
With current cloud mask (rendered in gray)



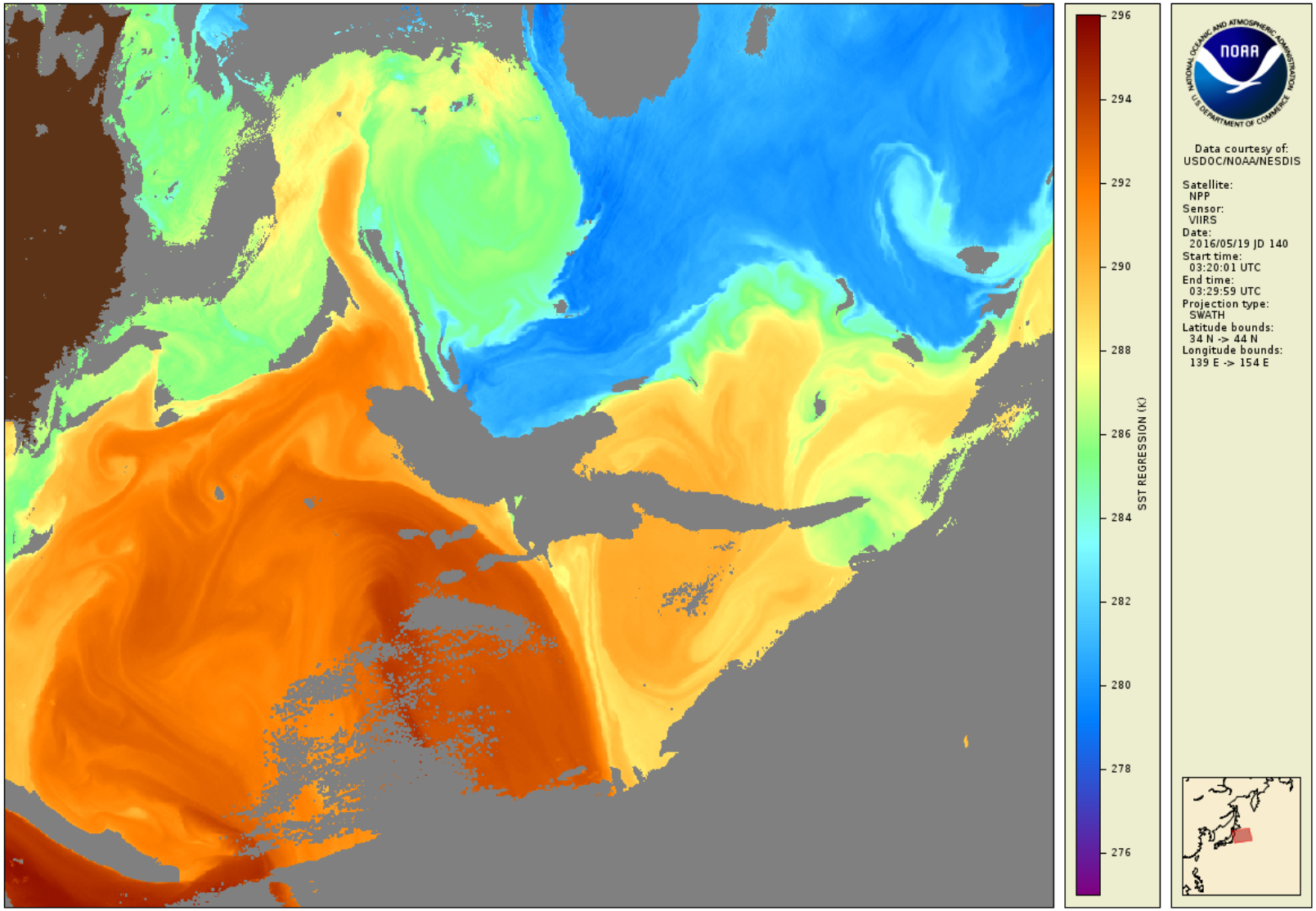
Current Practice and Limitations

- **External cloud masks are subject to 2 types of misclassifications: “false alarms” and “cloud leakages”**
- **False alarms mostly occur in dynamic areas (currents, eddies, upwellings), costal zones, and sea-ice transitions**
- **Misclassifications are often persistent from one overpass to another**
- **Results in loss of data in interesting areas and day/night inconsistency**
- **Cloud leakages can lead to false front detection**
- **Traditional front detection algorithms assume availability of external cloud mask**

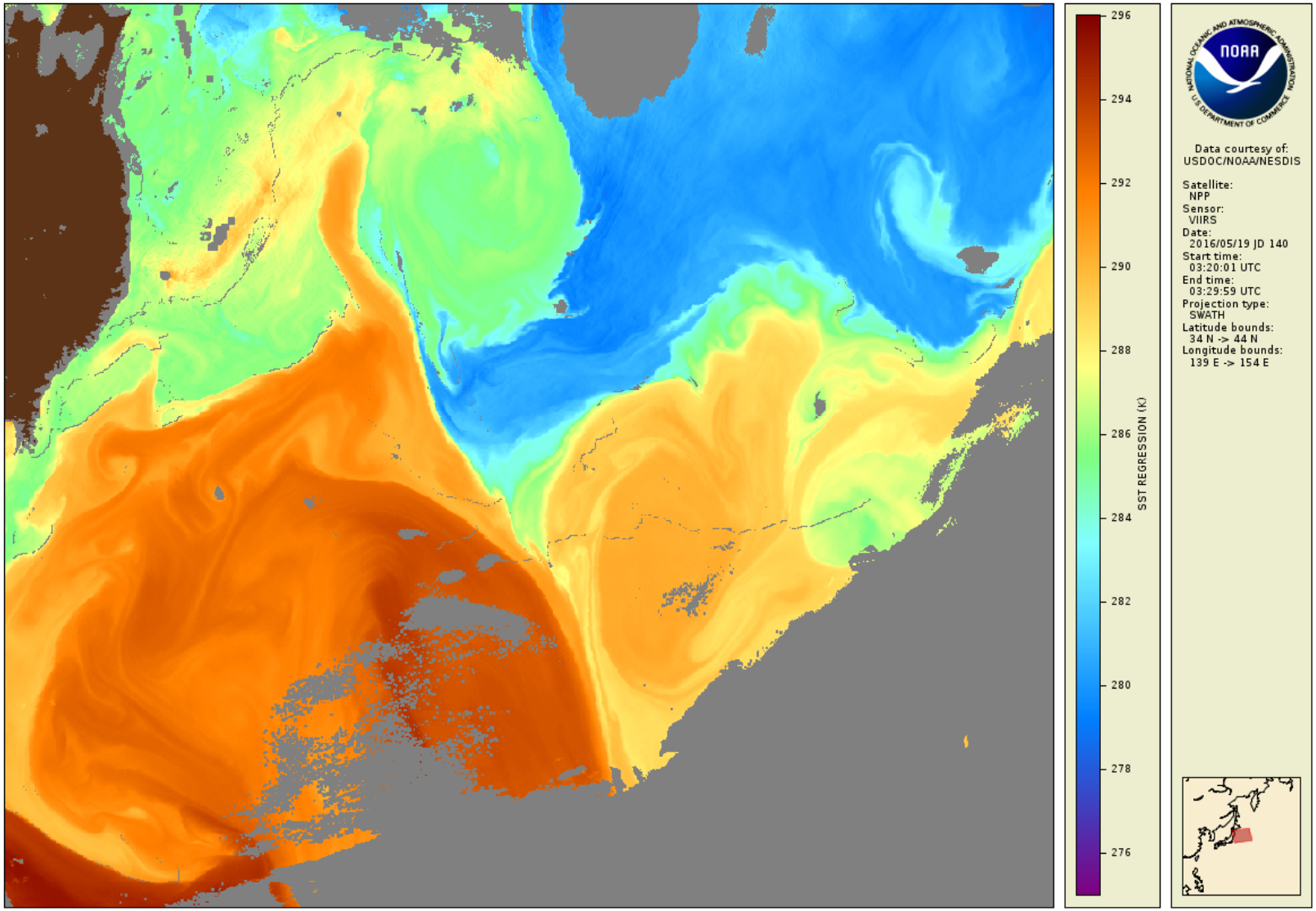
SST with thermal fronts overlaid



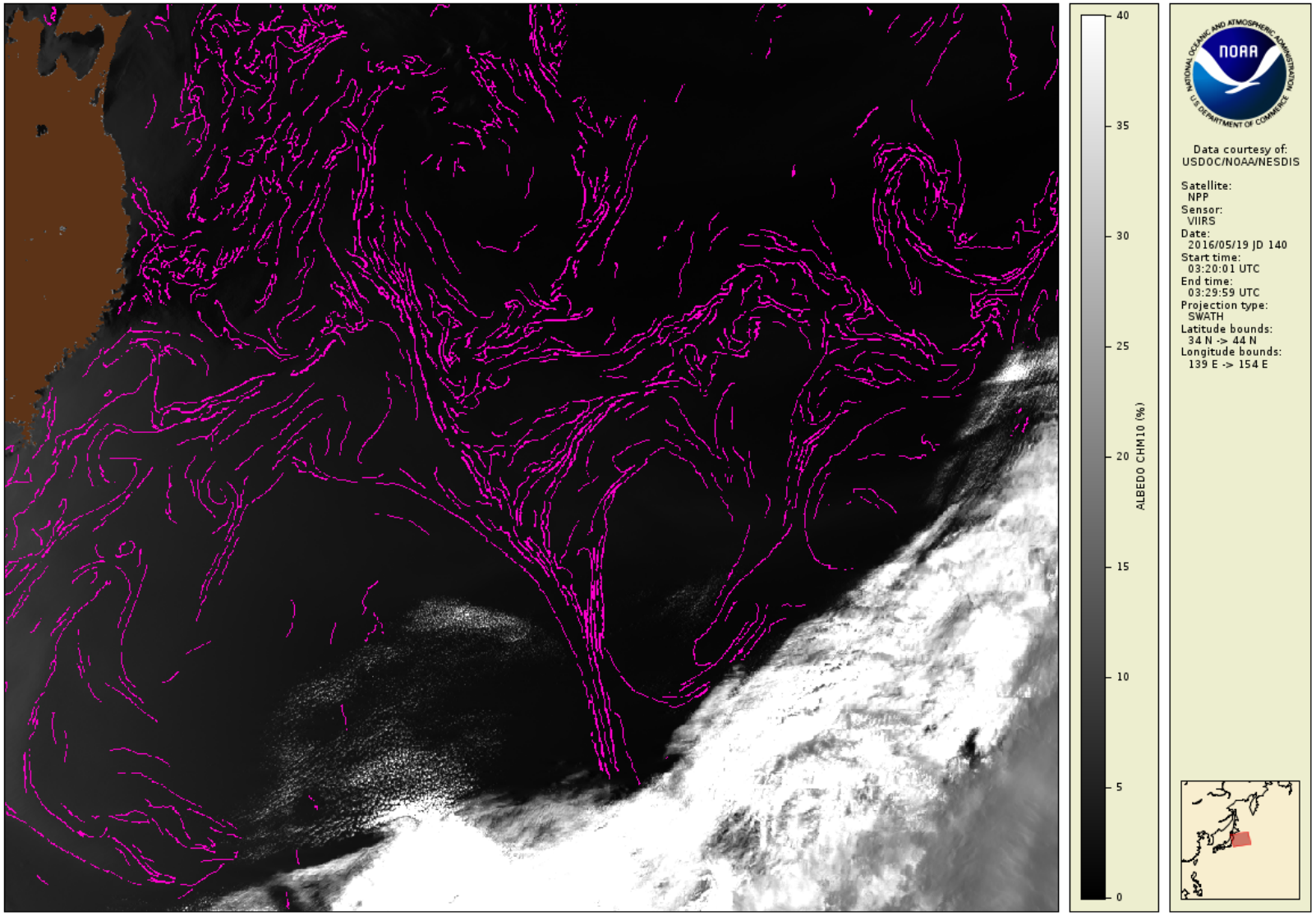
SST with current cloud mask



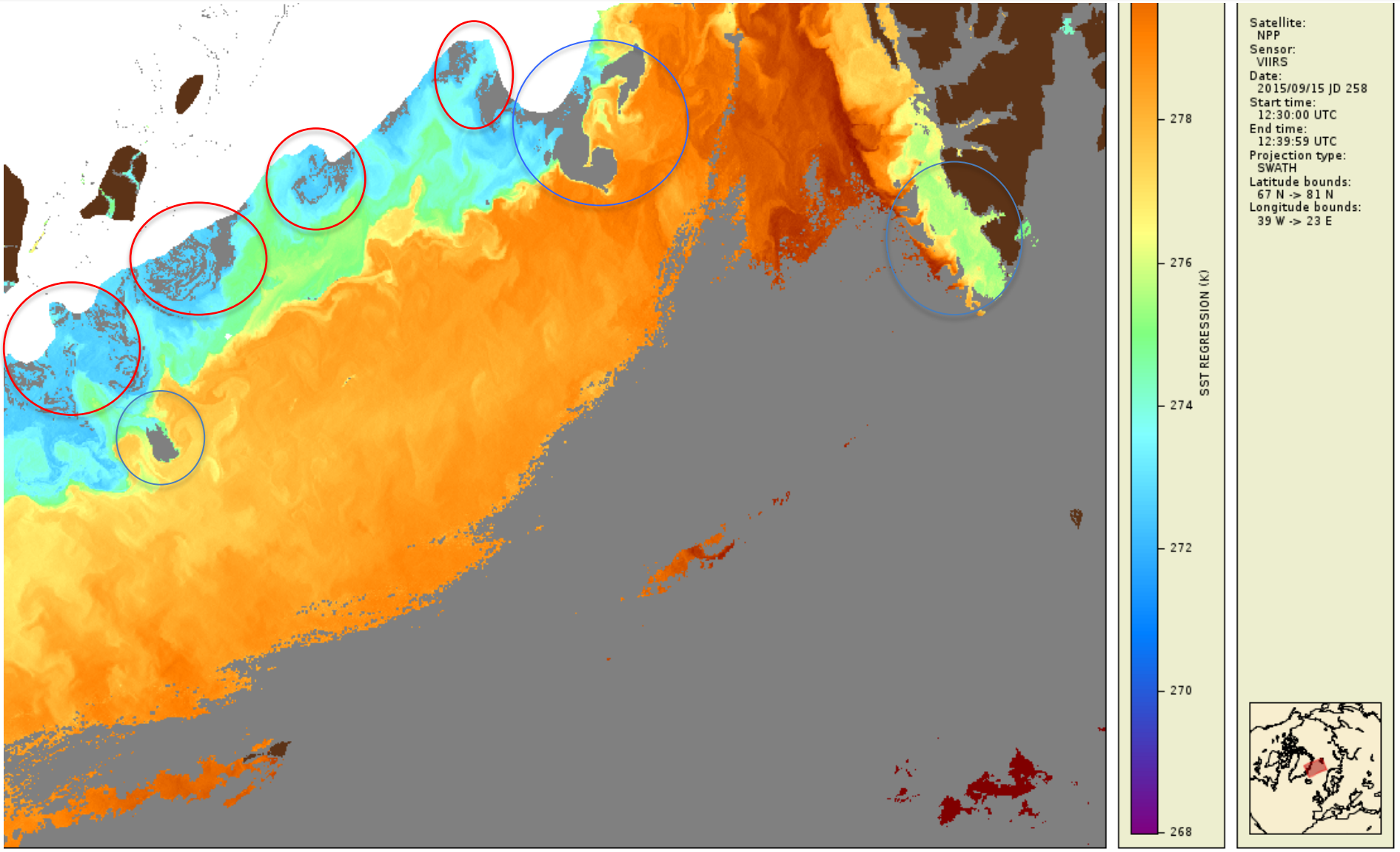
SST with corrected cloud mask



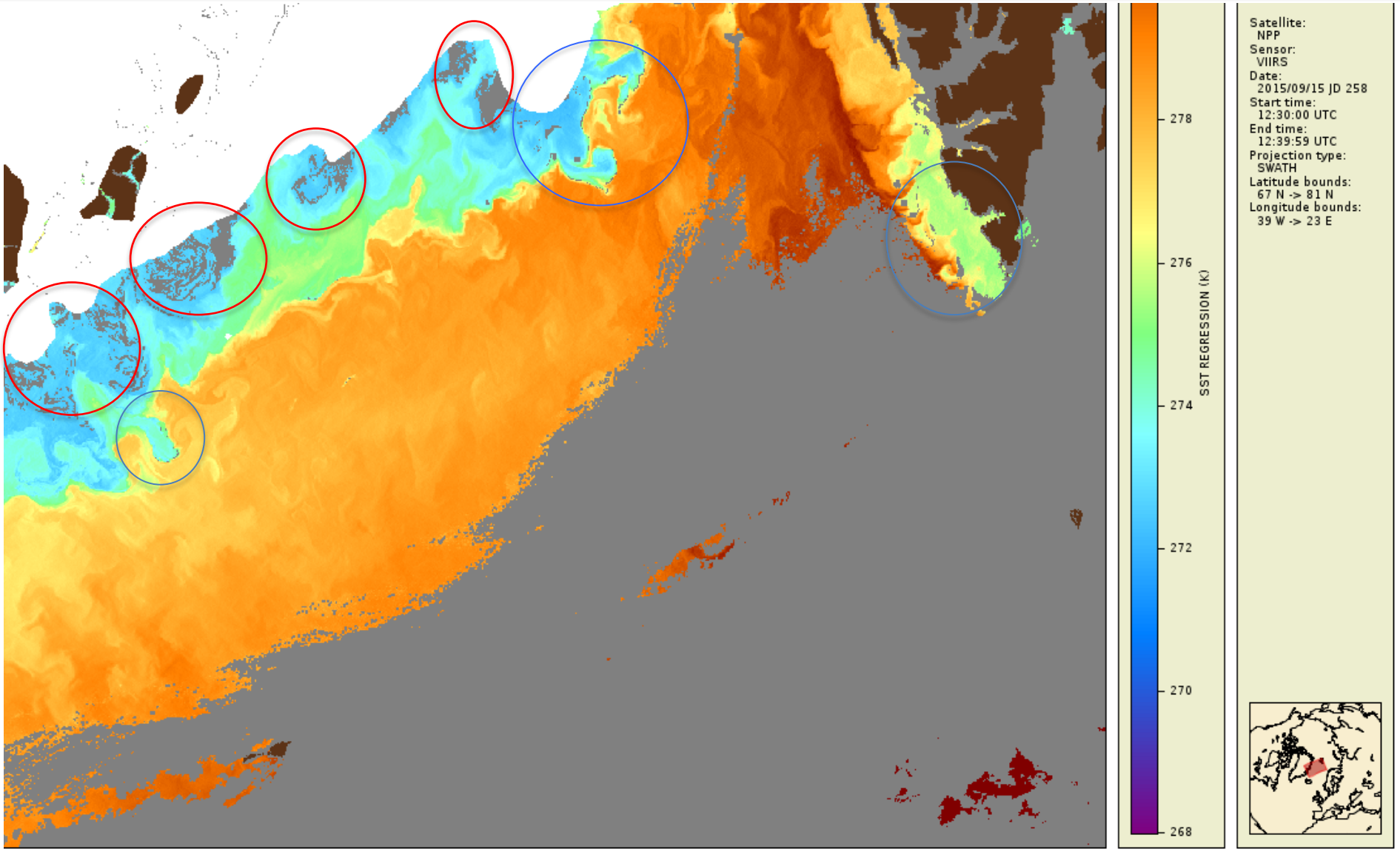
Albedo with thermal fronts overlaid



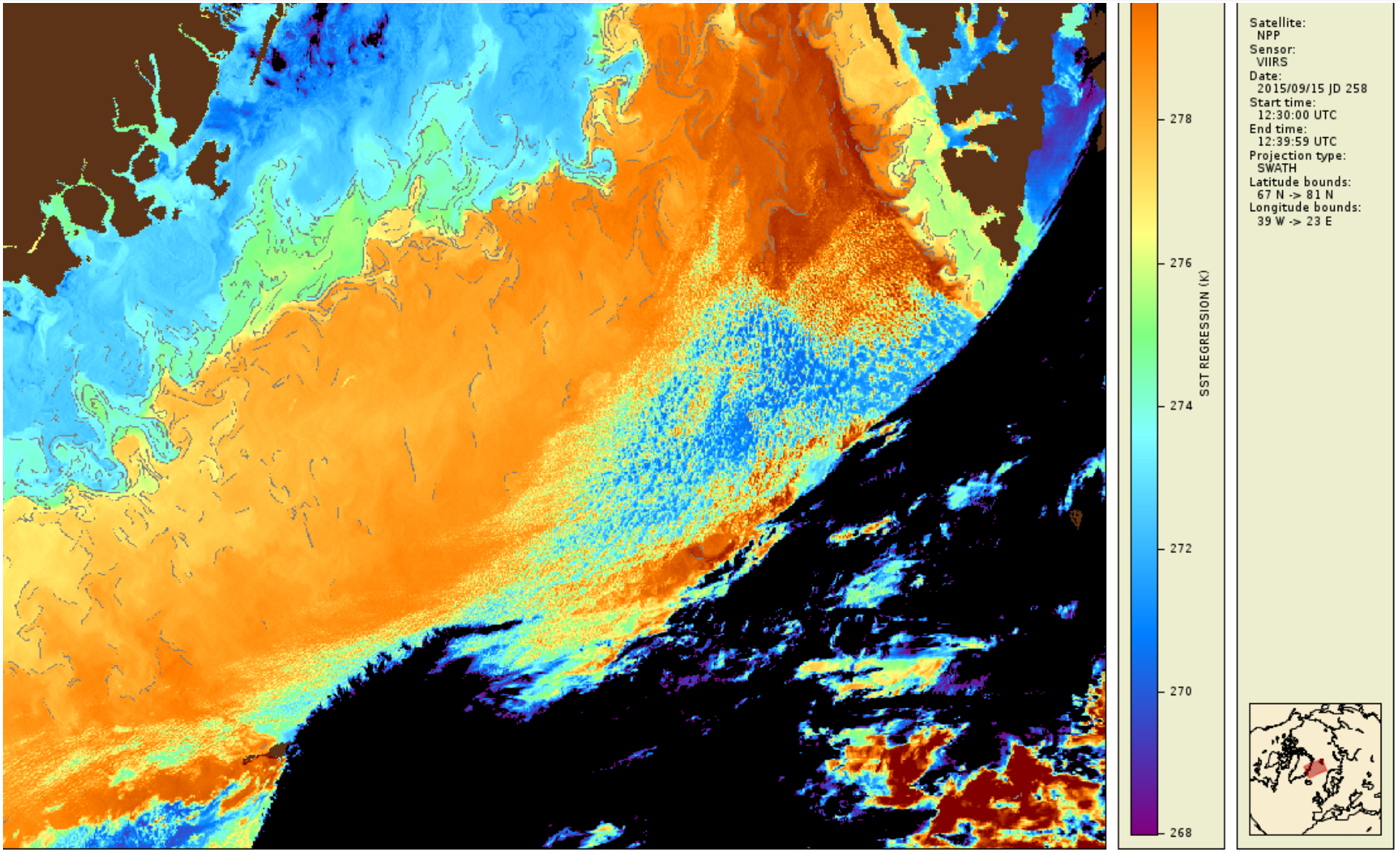
How reliable is sea ice mask?



SST with corrected cloud mask



SST with thermal fronts overlaid



Publications

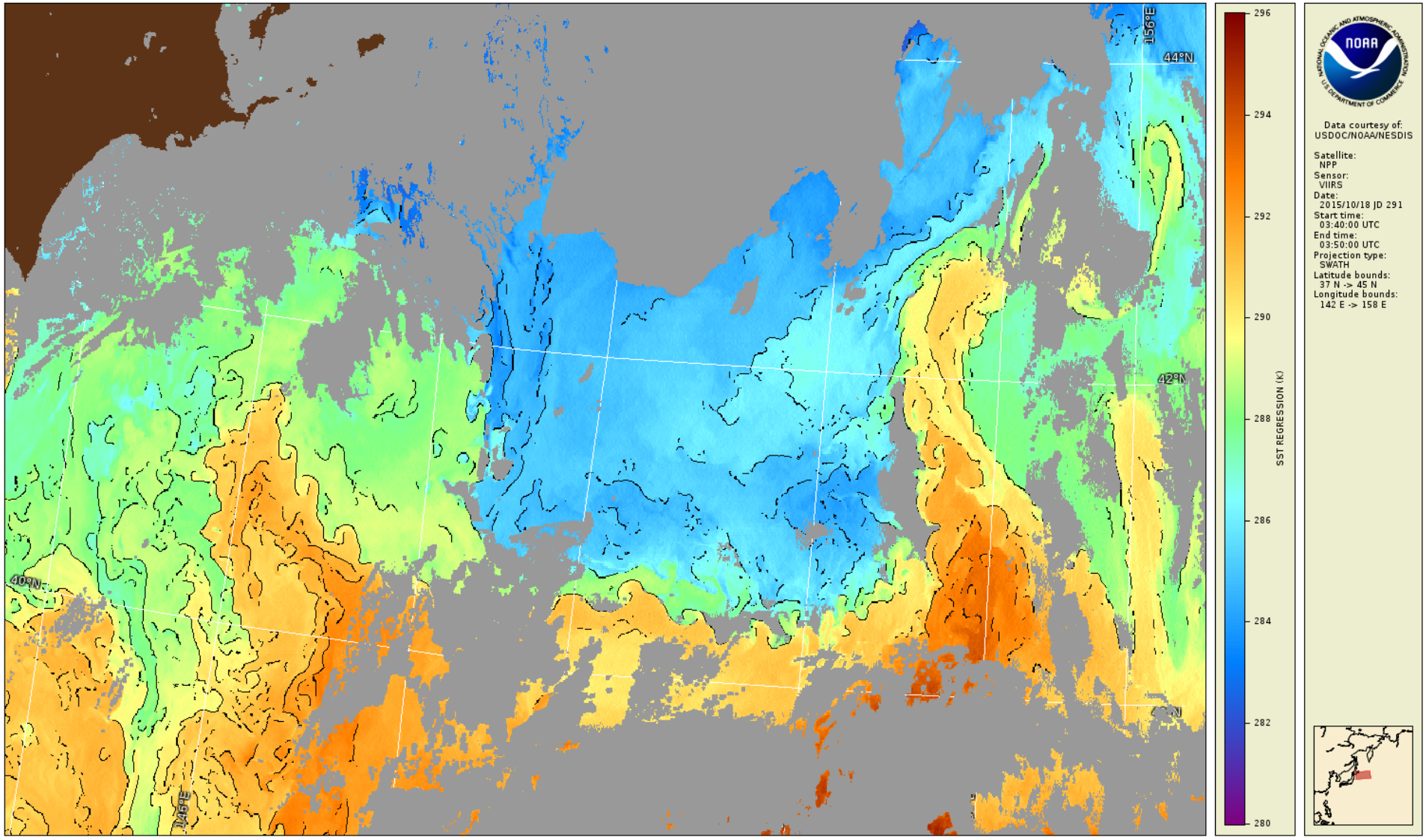
- Gladkova, I., Y. Kihai, A. Ignatov, F. Shahriar, B. Petrenko, 2015: SST Pattern Test in ACSPO clear-sky mask for VIIRS. Remote Sens. Env., 160, 87-98.

- Gladkova, I., A. Ignatov, F. Shahriar, Y. Kihai, D. Hillger, B. Petrenko, 2016: Improved VIIRS and MODIS SST Imagery, Remote Sens., 8(1), 79

Future Work

- **Pending implementation of the bow-tie deletion & correction algorithms with VIIRS and MODIS (ACSPO v2.50), finalize the Ocean Fronts Algorithm and document**
- **Comprehensively test/evaluate the improved ACSPO clear-sky mask**
- **Implement pattern recognition and thermal front detection algorithms in ACSPO v2.60**
- **Work with L4, fisheries, marine biologists and other users to evaluate the effect on their analyses**

Backup Slides


156°E
44°N
42°N
40°N
146°E
296
294
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284
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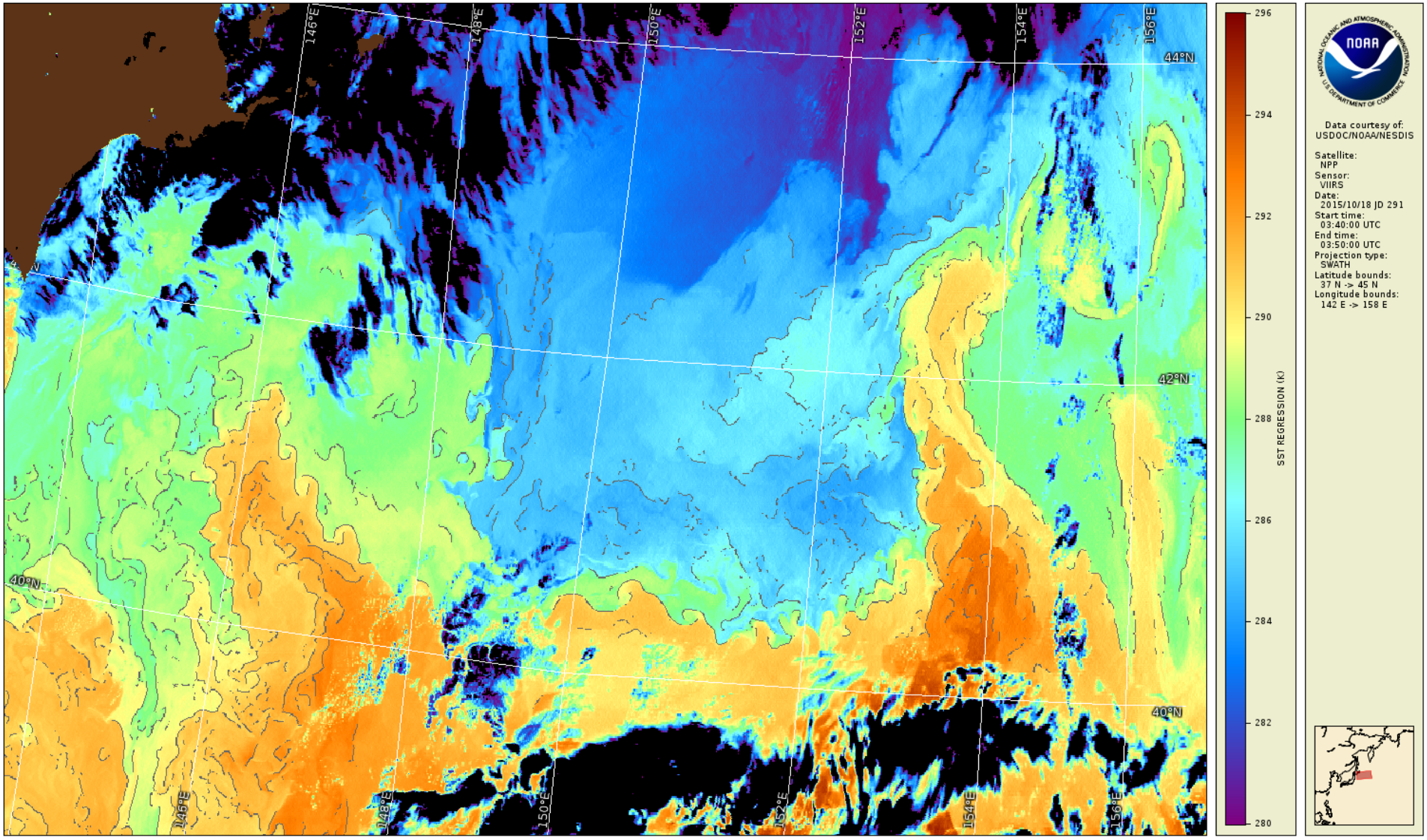
280
SST REGRESSION (K)
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2015/10/18 JD 291
Start time:
03:40:00 UTC
End time:
03:50:00 UTC
Projection type:
SWATH
Latitude bounds:
37 N -> 45 N
Longitude bounds:
142 E -> 158 E


146°E
148°E
150°E
152°E
154°E
156°E
44°N
42°N
40°N
296
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288
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284
282
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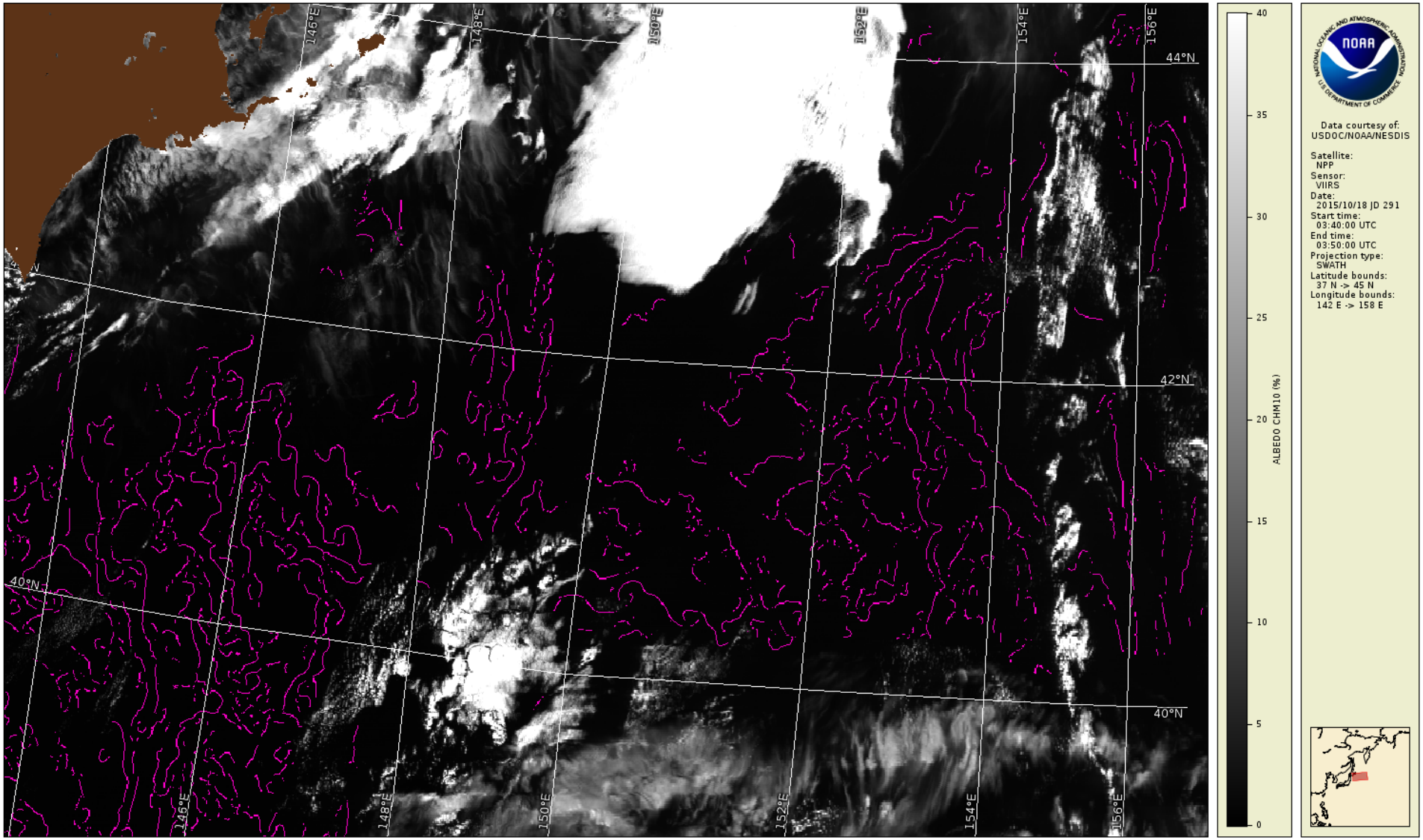
SST REGRESSION (K)
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2015/10/18 JD 291
Start time:
03:40:00 UTC
End time:
03:50:00 UTC
Projection type:
SWATH
Latitude bounds:
37 N -> 45 N
Longitude bounds:
142 E -> 158 E


146°E
148°E
150°E
152°E
154°E
156°E
44°N
42°N
40°N
ALBEDO CHM10 (%)
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25
30
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Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2015/10/18 JD 291
Start time:
03:40:00 UTC
End time:
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Projection type:
SWATH
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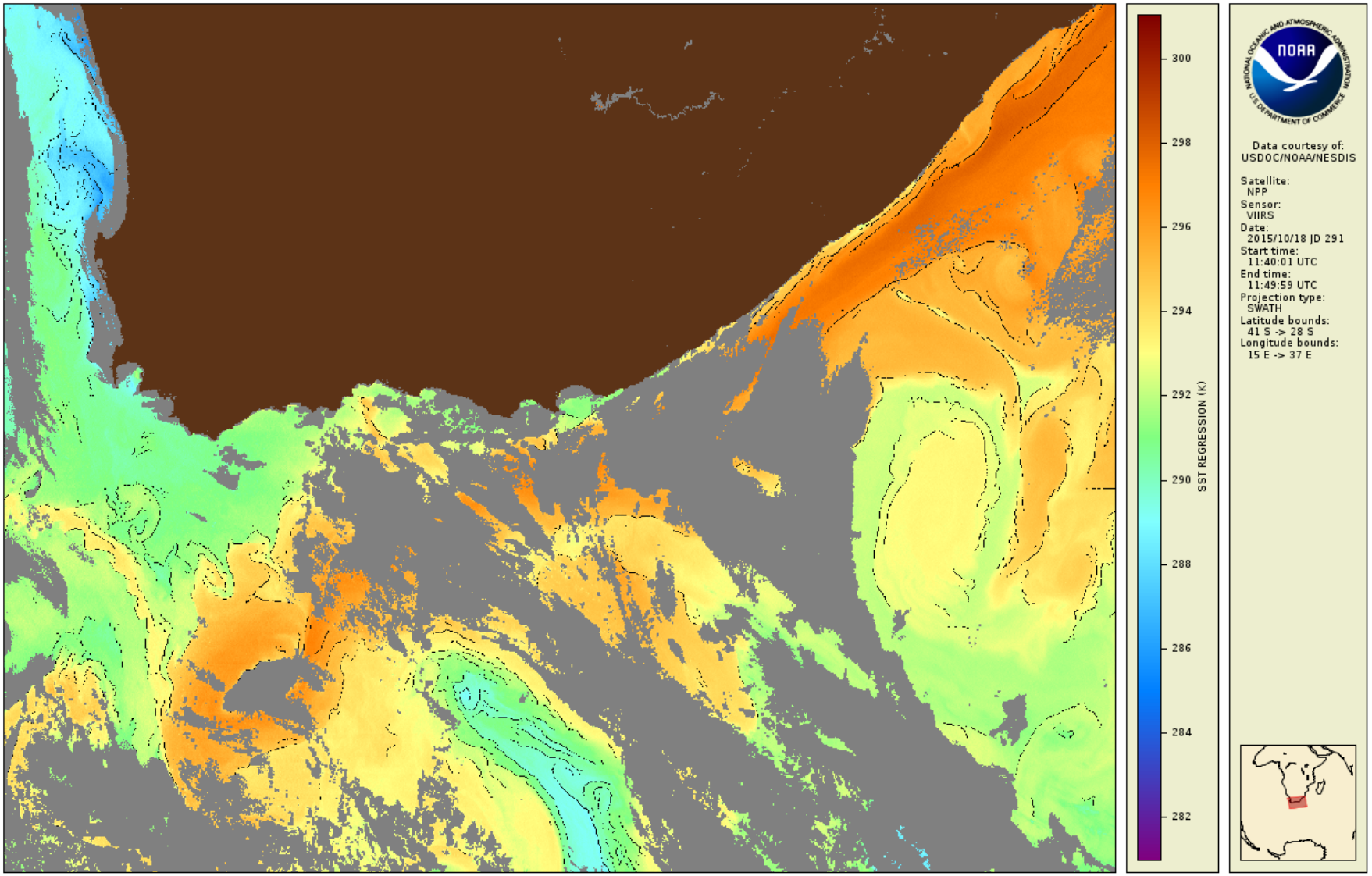
Longitude bounds:
142 E -> 158 E


300
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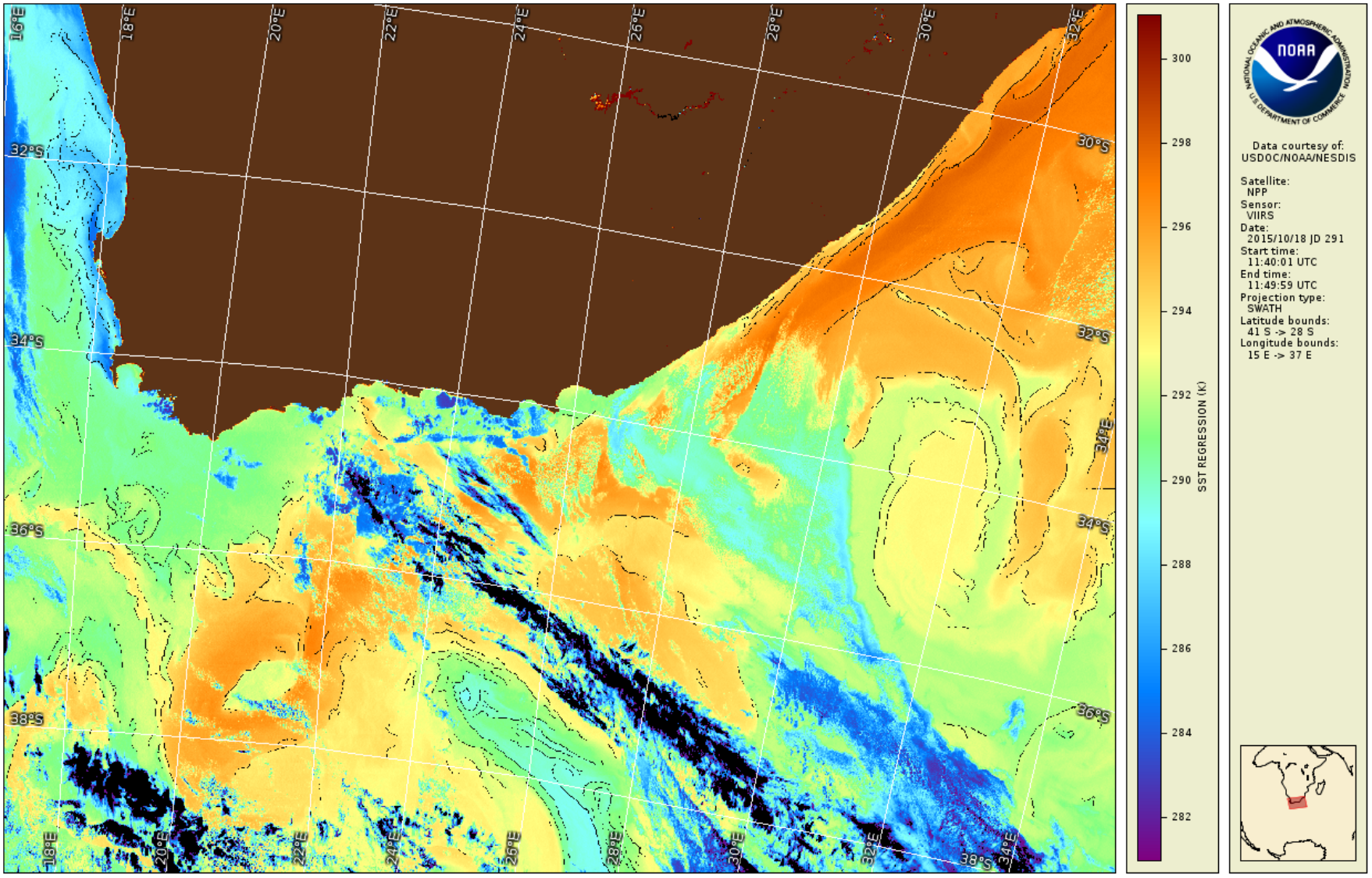
282
SST REGRESSION (K)
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2015/10/18 JD 291
Start time:
11:40:01 UTC
End time:
11:49:59 UTC
Projection type:
SWATH
Latitude bounds:
41 S -> 28 S
Longitude bounds:
15 E -> 37 E


16°E
18°E
20°E
22°E
24°E
26°E
28°E
30°E
32°E
32°S
34°S
36°S
38°S
30°S
32°S
34°S
36°S
38°S
34°E
SST REGRESSION (K)
300
298
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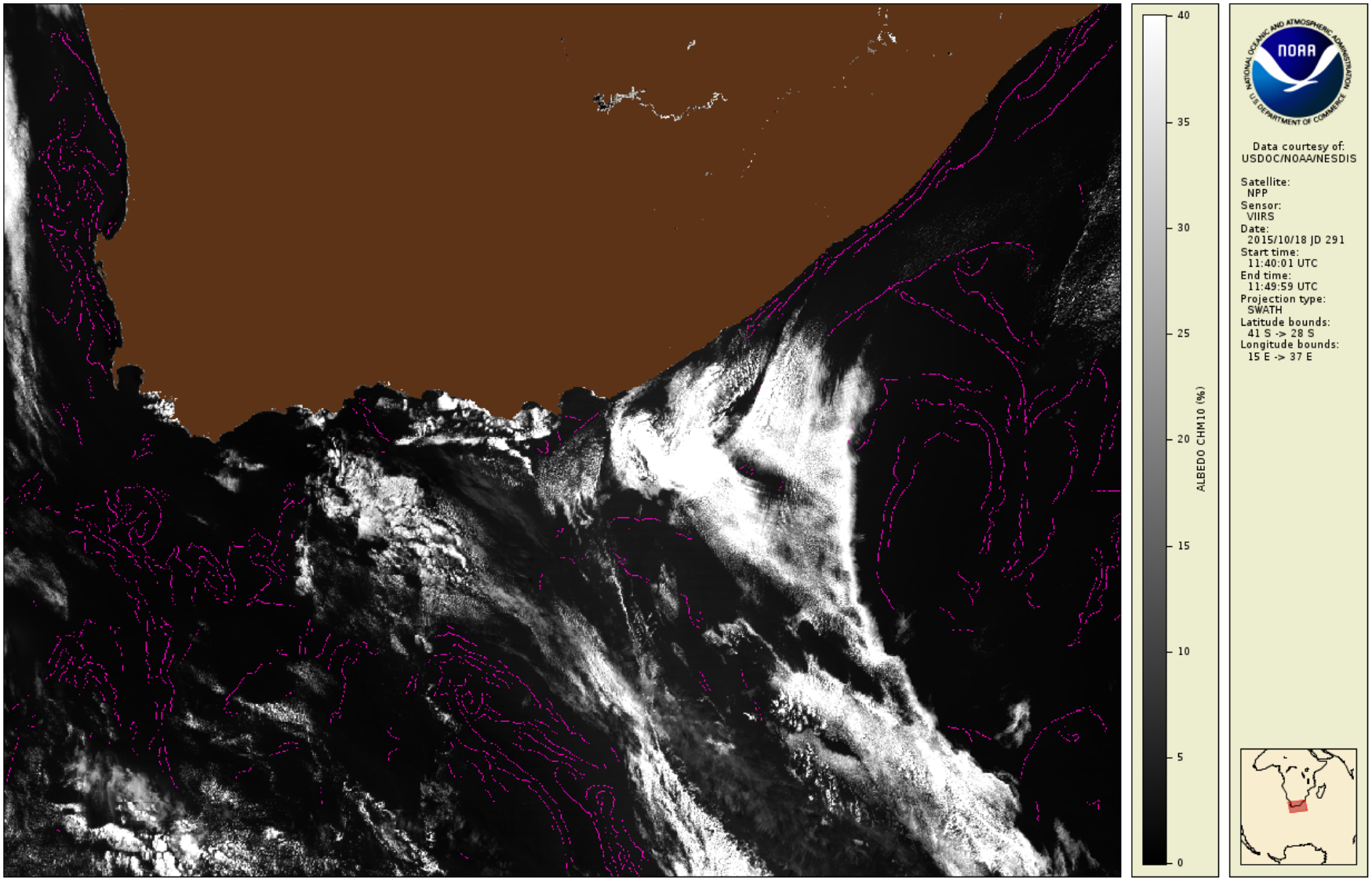
284
282
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2015/10/18 JD 291
Start time:
11:40:01 UTC
End time:
11:49:59 UTC
Projection type:
SWATH
Latitude bounds:
41 S -> 28 S
Longitude bounds:
15 E -> 37 E


40
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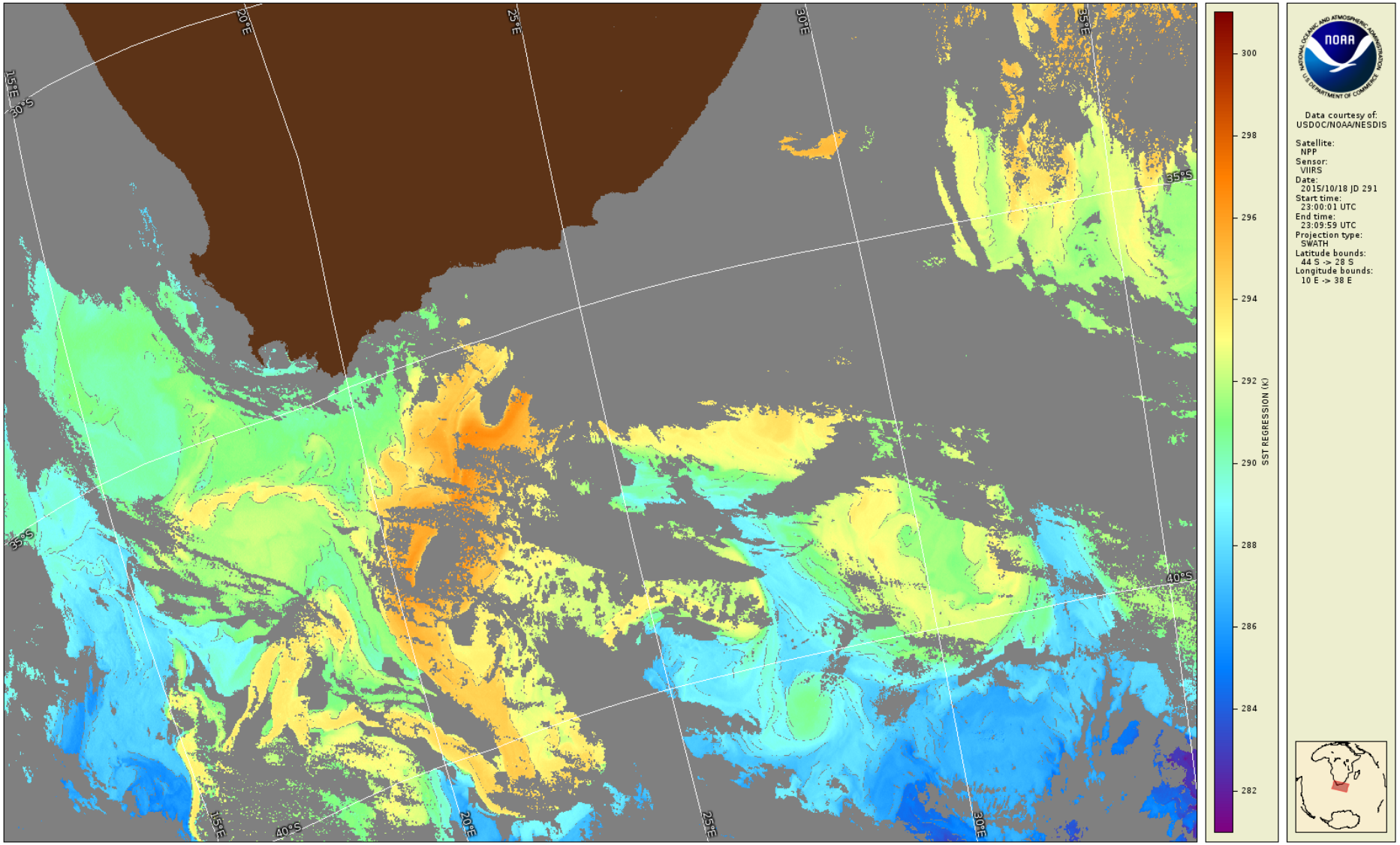
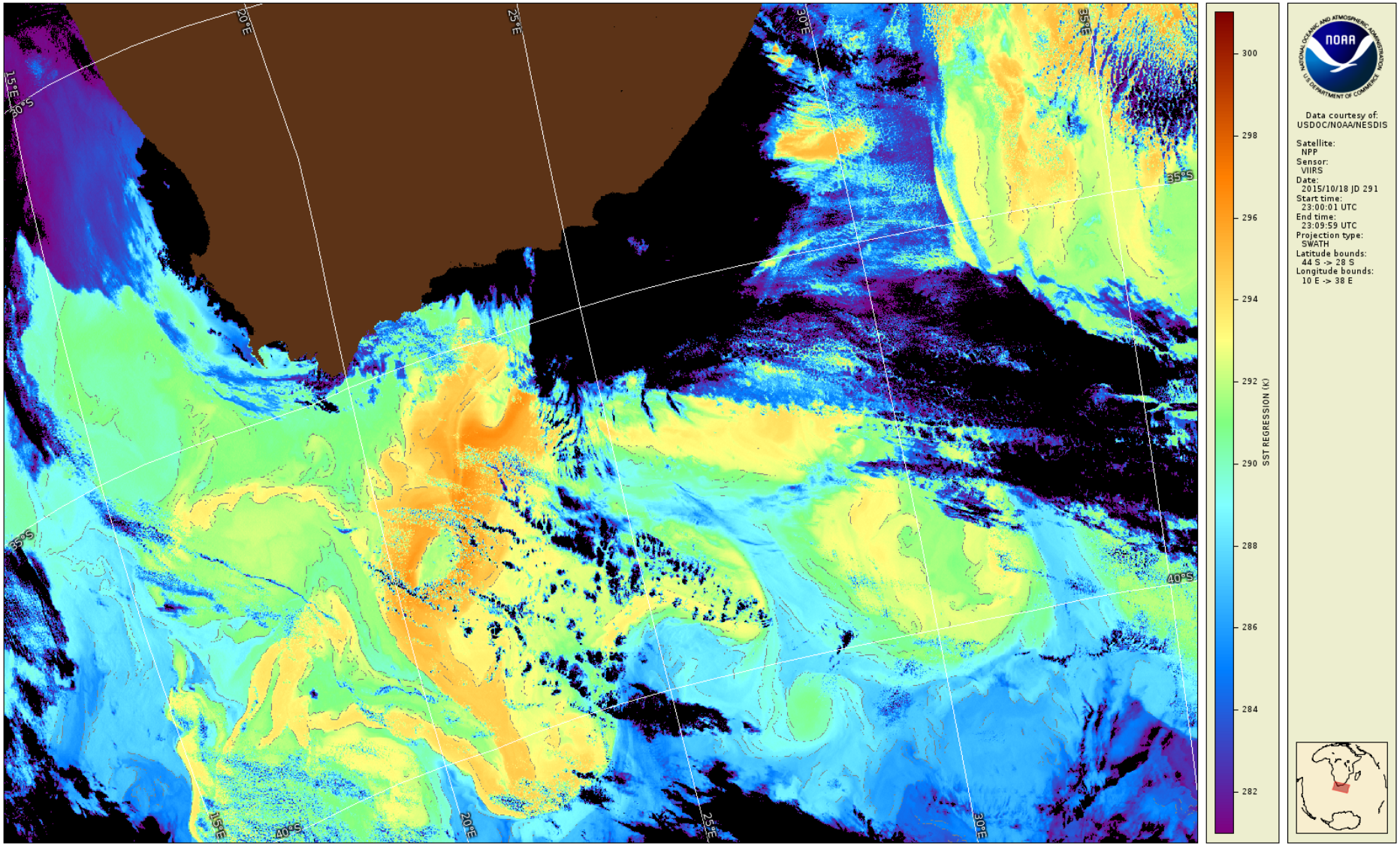
25
20
15
10
5
0
ALBEDO CHM10 (%)
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2015/10/18 JD 291
Start time:
11:40:01 UTC
End time:
11:49:59 UTC
Projection type:
SWATH
Latitude bounds:
41 S -> 28 S
Longitude bounds:
15 E -> 37 E


15°E
20°E
25°E
30°E
35°E
30°S
35°S
40°S
SST REGRESSION (K)
300
298
296
294
292
290
288
286
284
282
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2015/10/18 JD 291
Start time:
23:00:01 UTC
End time:
23:09:59 UTC
Projection type:
SWATH
Latitude bounds:
44 S -> 28 S
Longitude bounds:
10 E -> 38 E


20°E
25°E
30°E
35°E
15°E
30°S
35°S
40°S
SST REGRESSION (K)
300
298
296
294
292
290
288
286
284
282
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2015/10/18 JD 291
Start time:
23:00:01 UTC
End time:
23:09:59 UTC
Projection type:
SWATH
Latitude bounds:
44 S -> 28 S
Longitude bounds:
10 E -> 38 E

Next question is:
How reliable is sea ice mask?