



Pattern Recognition Enhancements to ACSPO Clear-Sky Mask.

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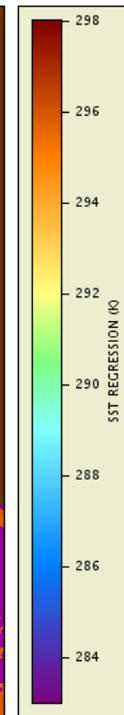
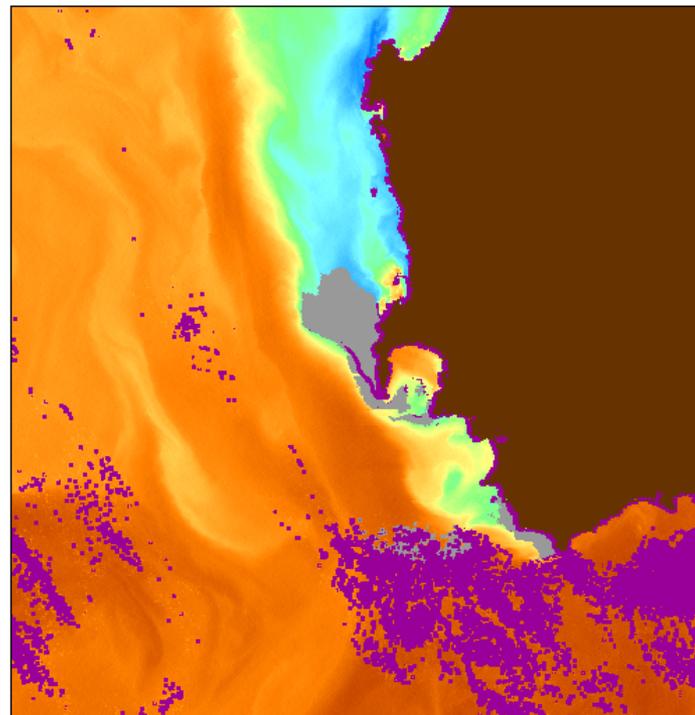
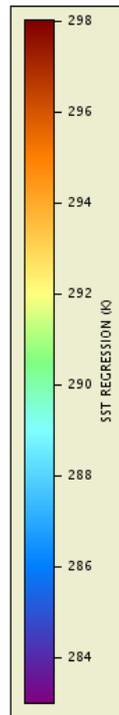
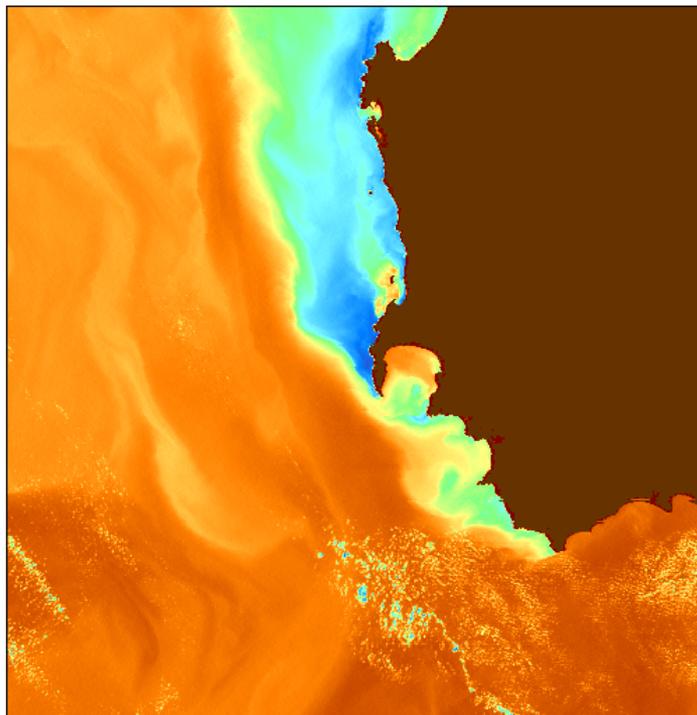
³City College of New York, NOAA/CREST,

⁴ Graduate Center of CUNY.

Motivation

- ❑ ACSPO Clear-Sky Mask (ACMS) employs comparisons of retrieved SST with L4 analyses, reflectance threshold tests and spatial uniformity tests.
- ❑ ACSM performs well on a global scale but tends to over-screen some highly dynamic areas (e.g., with strong currents, cold upwellings, eddies) as well as the coastal zones.
- ❑ These deficiencies cannot be completely eliminated by simple thresholds adjustment within ACSM without triggering massive cloud leakages.
- ❑ Visual analysis of SST field easily discriminates cloud leakages from cold SST anomalies

South Africa, 02/16/13



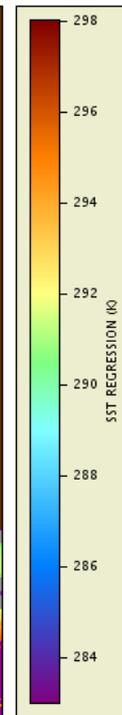
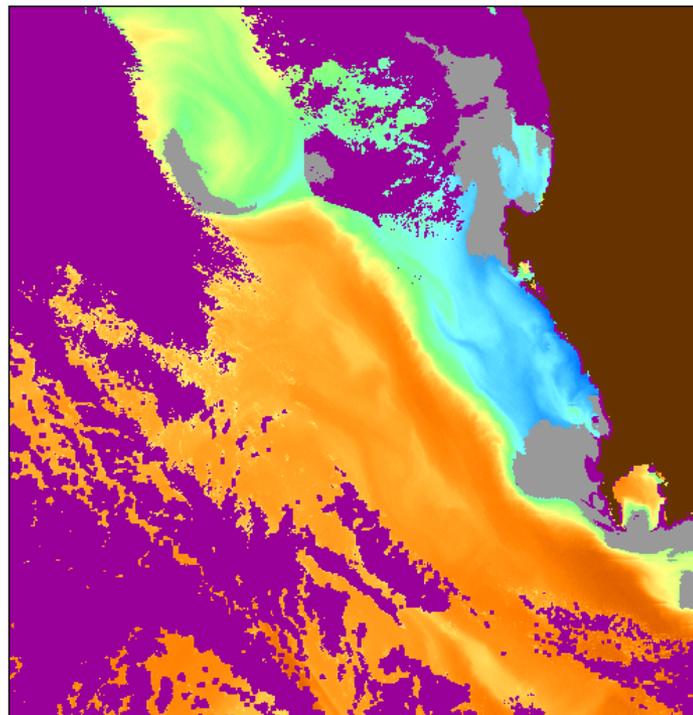
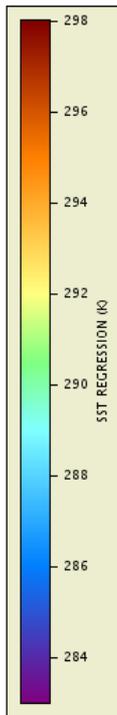
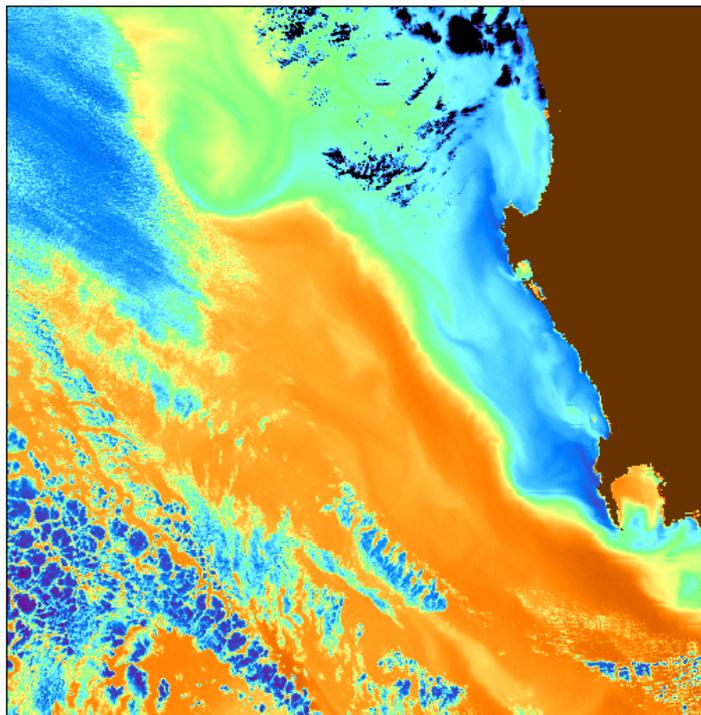

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP
Sensor:
VIIRS
Date:
2013/02/16 JD 047
Start time:
17:40:00 UTC
End time:
17:49:59 UTC
Projection type:
SWATH
Latitude bounds:
37.5 -> 31.5
Longitude bounds:
15 E -> 22 E



South Africa, 02/17/13




Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/02/17 JD 048

Start time:
05:00:01 UTC

End time:
05:09:59 UTC

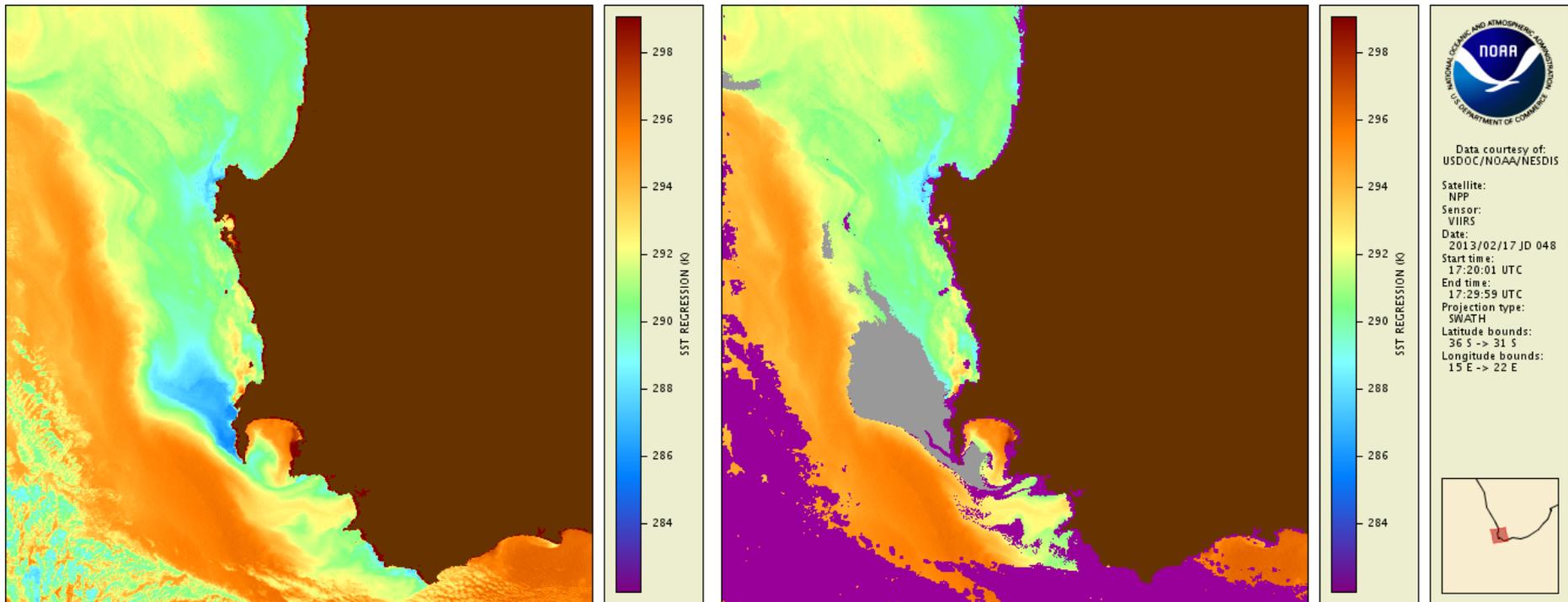
Projection type:
SWATH

Latitude bounds:
36 S -> 30 S

Longitude bounds:
15 E -> 21 E



South Africa, 02/17/13



Typical clear sky ocean regions misclassified by the ACSM :

- contiguous,
- with well-defined boundaries,
- typically located in the vicinity of ocean thermal fronts.

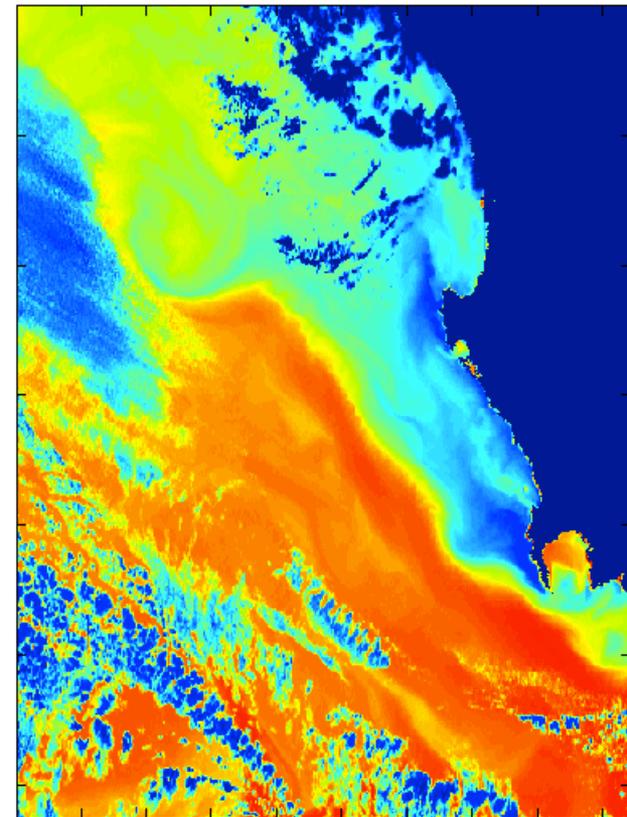
Existing image processing techniques:

- Segmentation;
- Morphological Procedures: erosion and dilation;
- Thermal Front Detection.

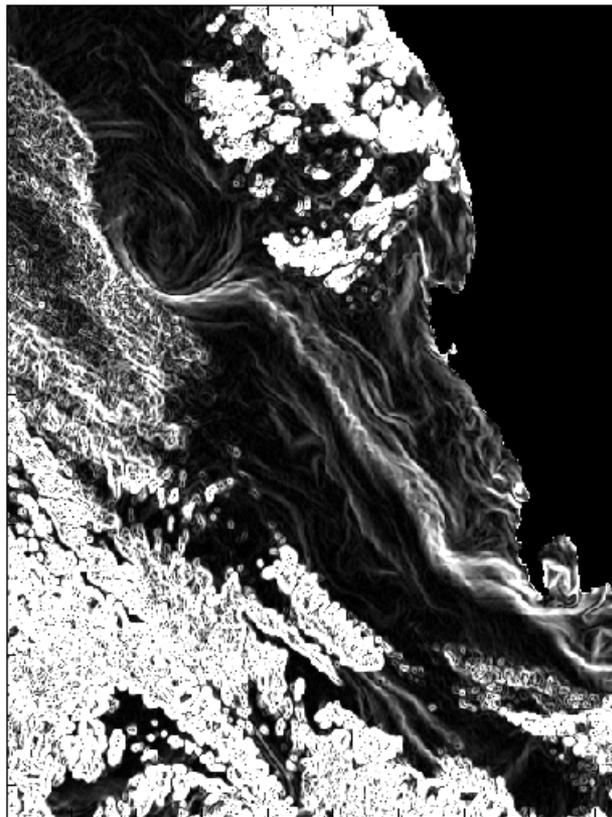
Human Perspective

- Human eye does not perceive absolute pixel values (i.e., SST values)
- It relies instead on local contrasts and ratios, which more directly correlate with gradients in an image.
- Difference between ocean and cloud patterns should be more pronounced in the SST gradient magnitude domain.

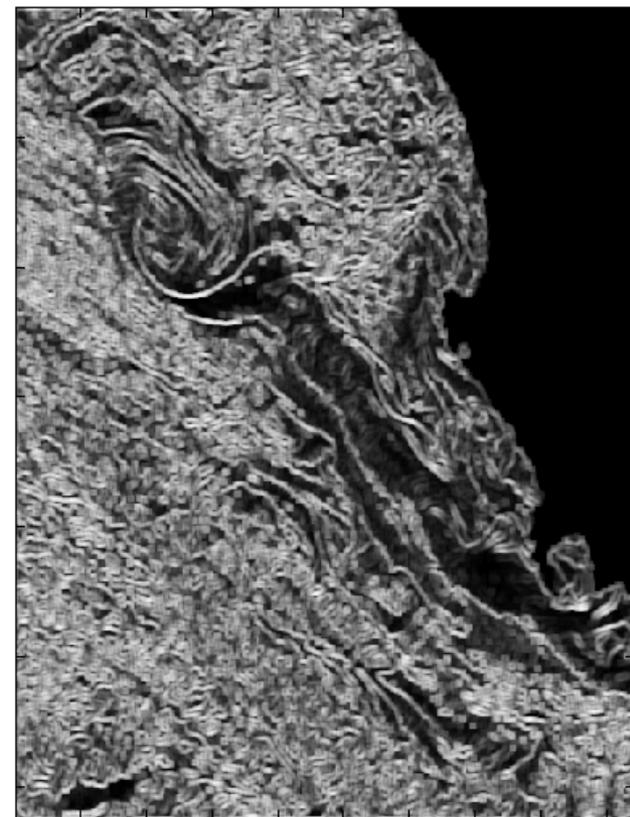
Gradient magnitude and angle



SST



Gradient magnitude



Gradient angle

Algorithm

Step 1: Identify Search Domain

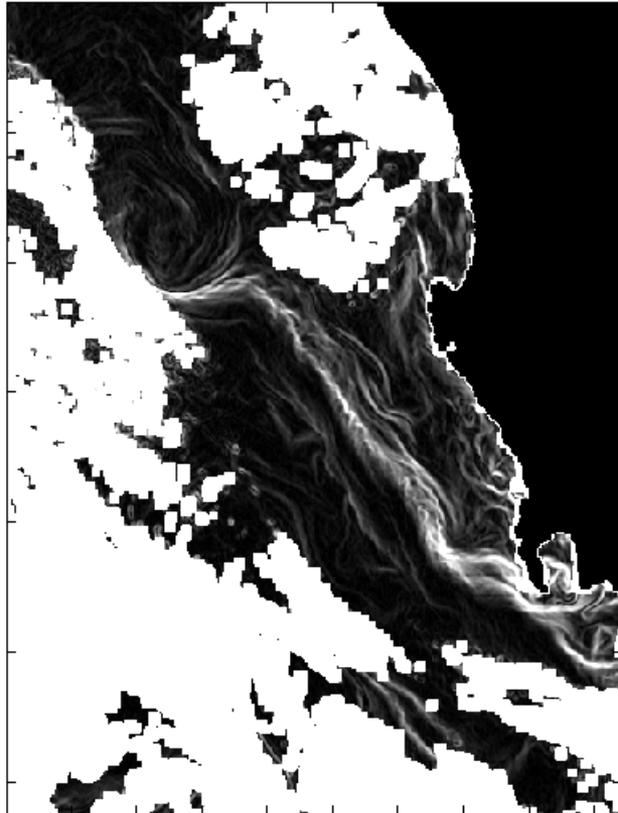
Step 2: Determine SST gradient ridges

Step 3: Determine spatially connected cold SST regions

Step 4: Discard SST segments found in Step 3 that do not border the ridges found in Step 2

Step 5: Statistical Test

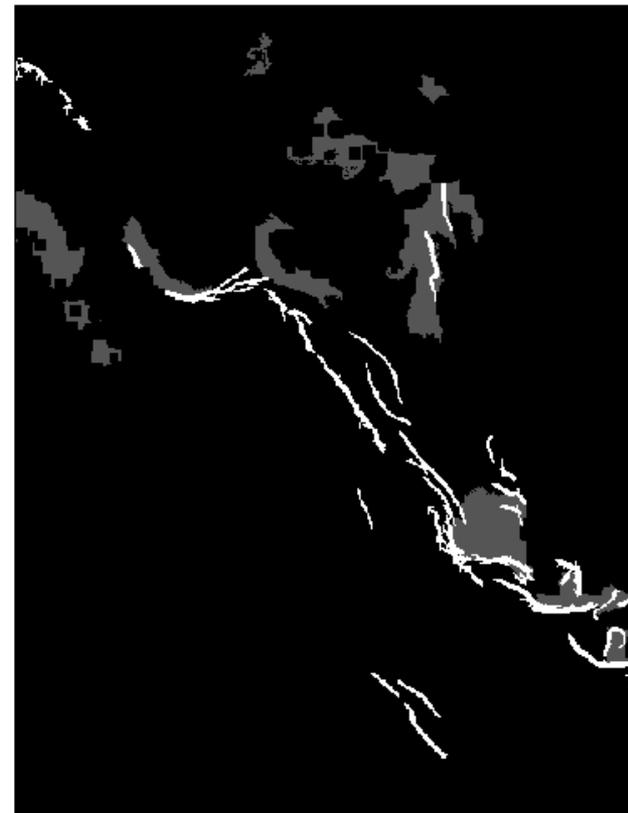
Steps



Search Space



SST Gradient Ridges



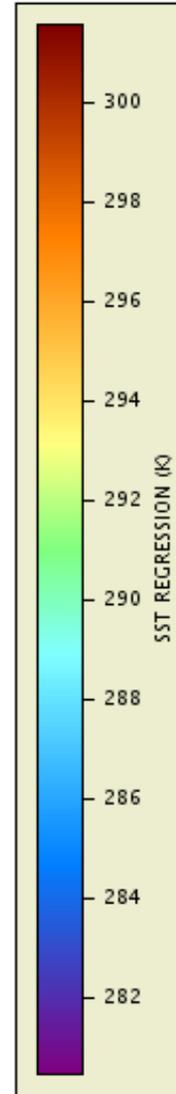
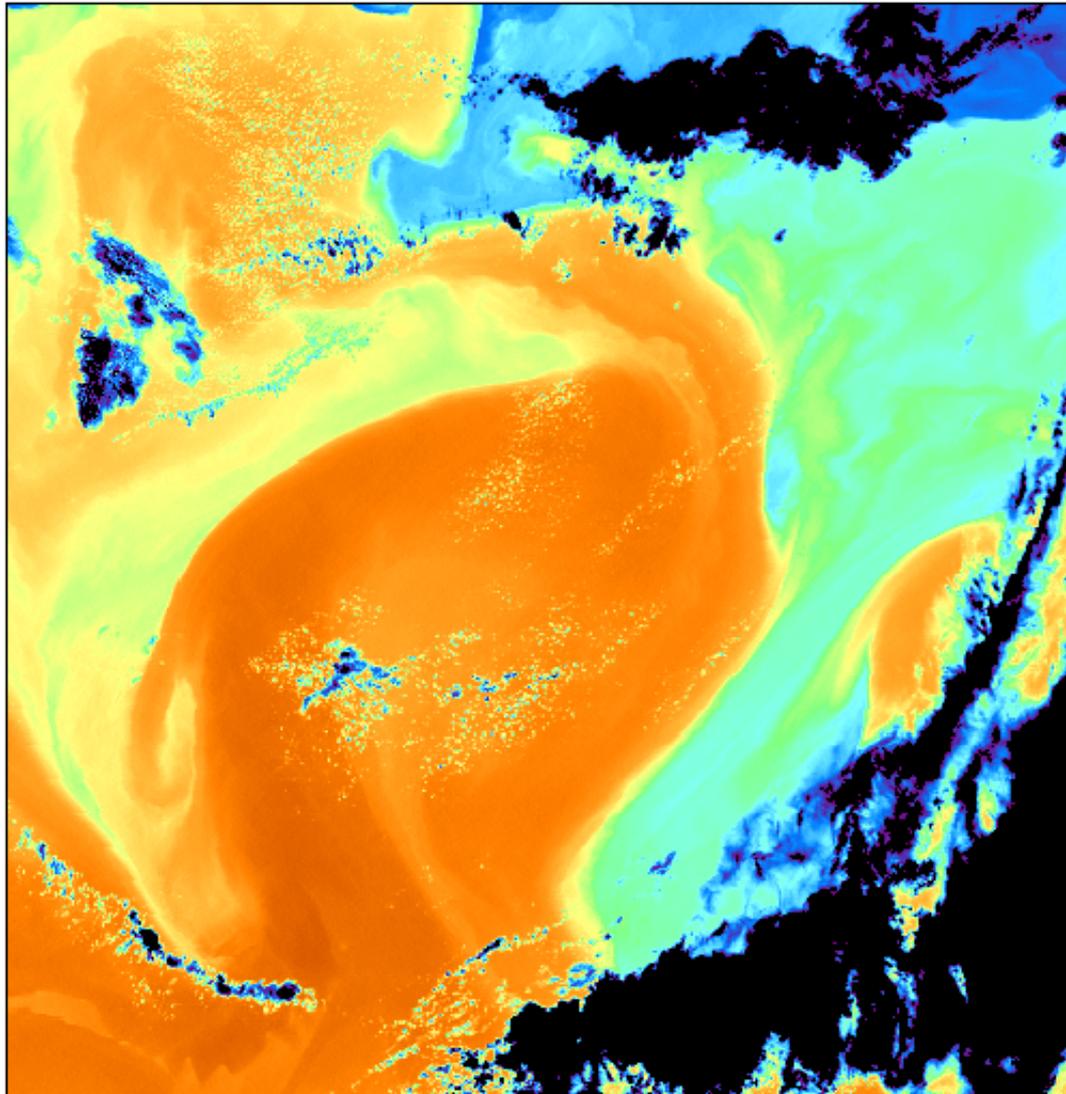
Segments bordering Ridges

Considered 2 sets of VIIRS data:

- 48 hand picked and cropped regions with typical clear sky misclassification
- 144 granules representing 1 day global observations

Results were visually inspected and analyzed;
Success rate is promising but more work is needed.

Gulf Stream, 05/10/13 (day)



Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/05/10 JD 130

Start time:
21:10:00 UTC

End time:
21:19:59 UTC

Projection type:
SWATH

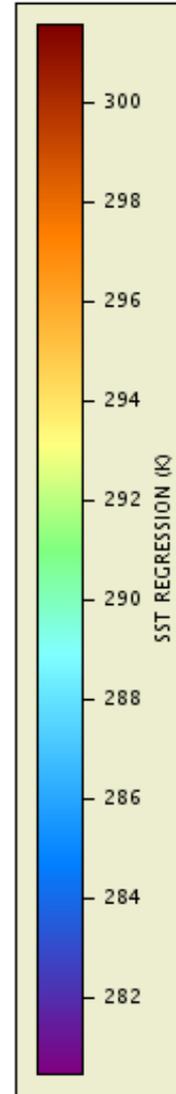
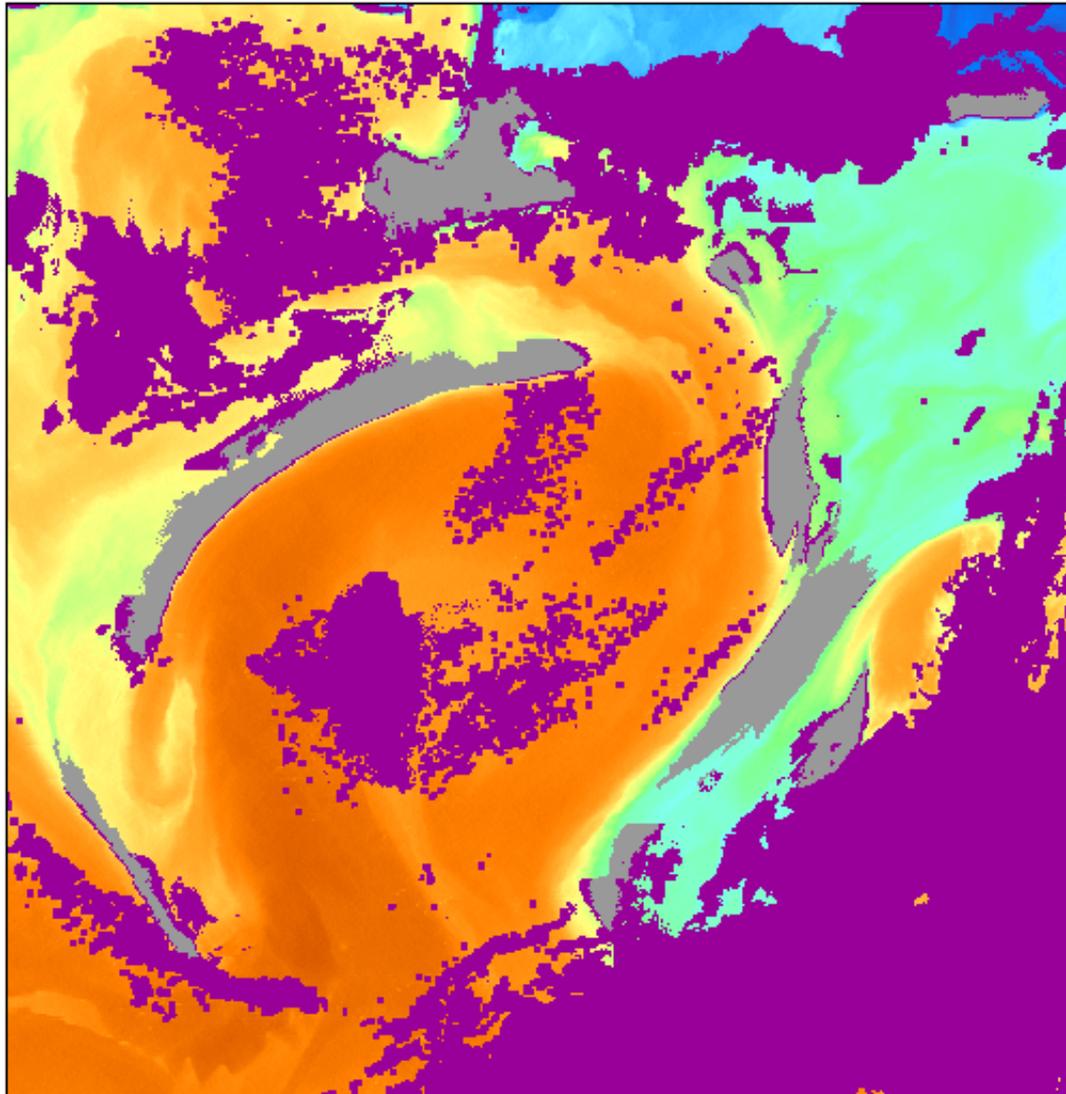
Latitude bounds:
36 N -> 42 N

Longitude bounds:
70 W -> 63 W



An inset map showing the North Atlantic Ocean region. A red square highlights the area covered by the main satellite image, located between 36°N and 42°N latitude and 70°W and 63°W longitude.

Gulf Stream, 05/10/13 (day)




Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/05/10 JD 130

Start time:
21:10:00 UTC

End time:
21:19:59 UTC

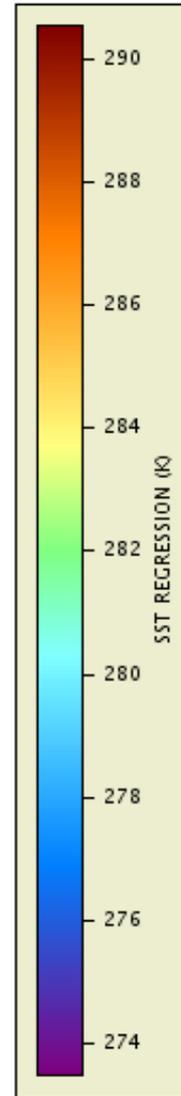
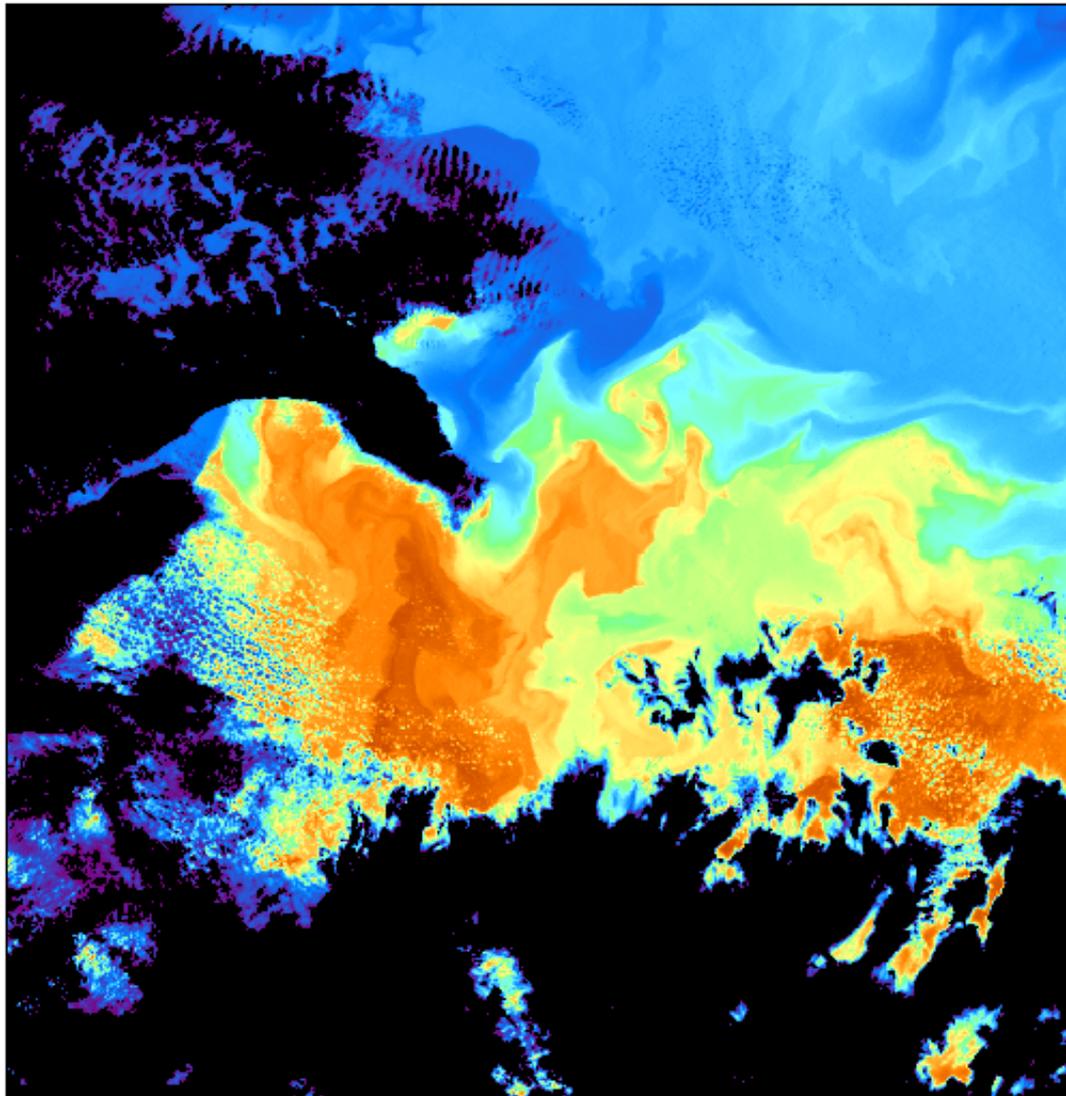
Projection type:
SWATH

Latitude bounds:
36 N -> 42 N

Longitude bounds:
70 W -> 63 W



Gulf Stream, 02/16/13




Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/02/16 JD 047

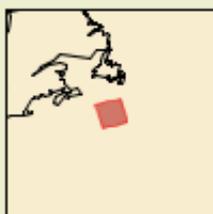
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End time:
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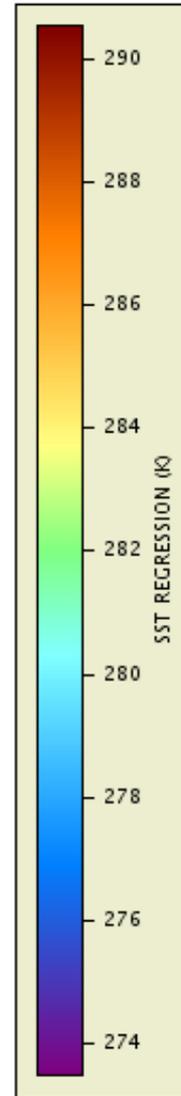
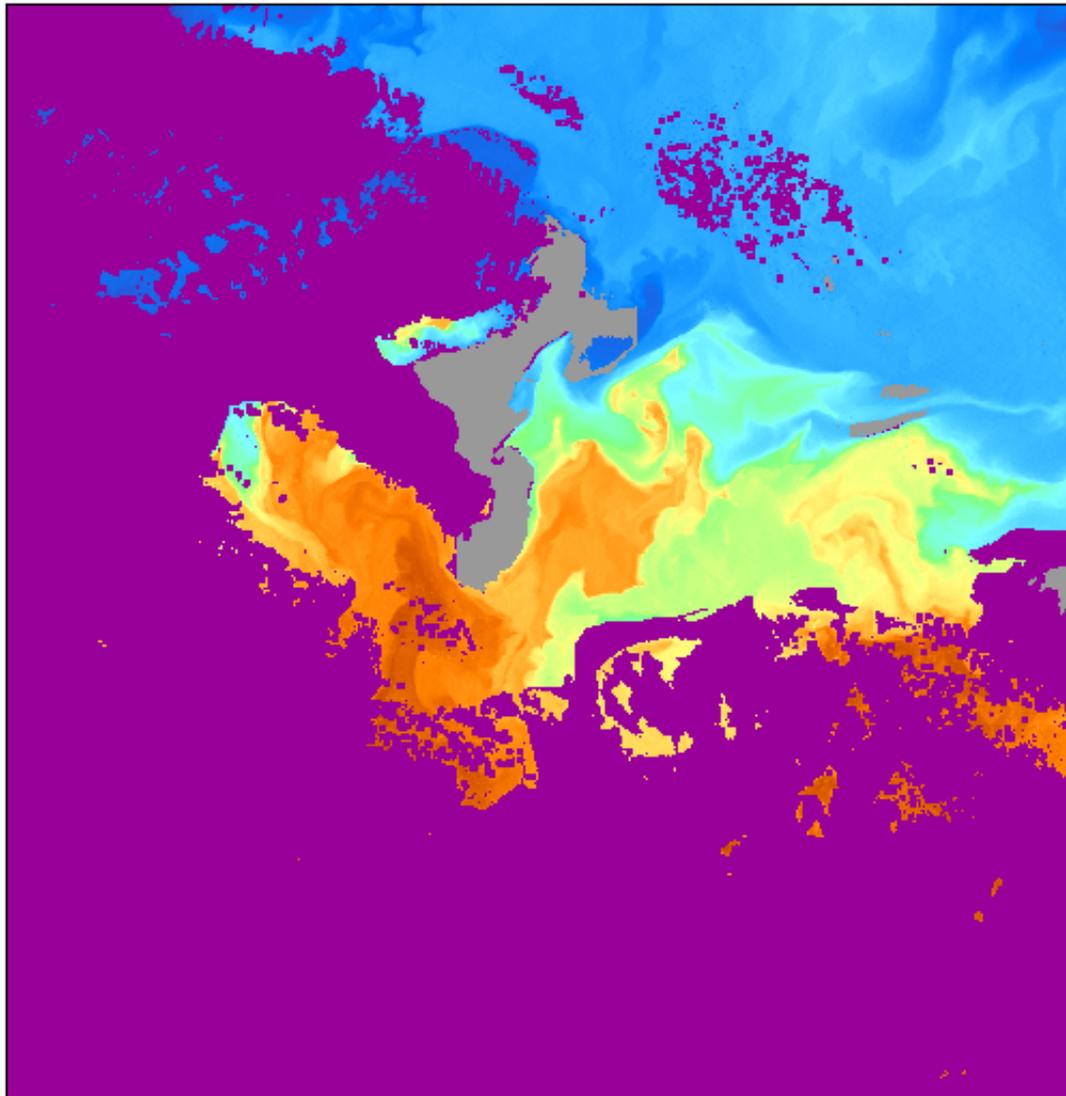
Projection type:
SWATH

Latitude bounds:
40 N -> 46 N

Longitude bounds:
59 W -> 52 W



Gulf Stream, 02/16/13



Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/02/16 JD 047

Start time:
21:30:00 UTC

End time:
21:39:59 UTC

Projection type:
SWATH

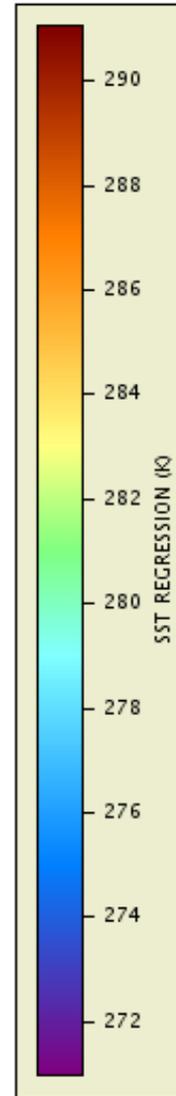
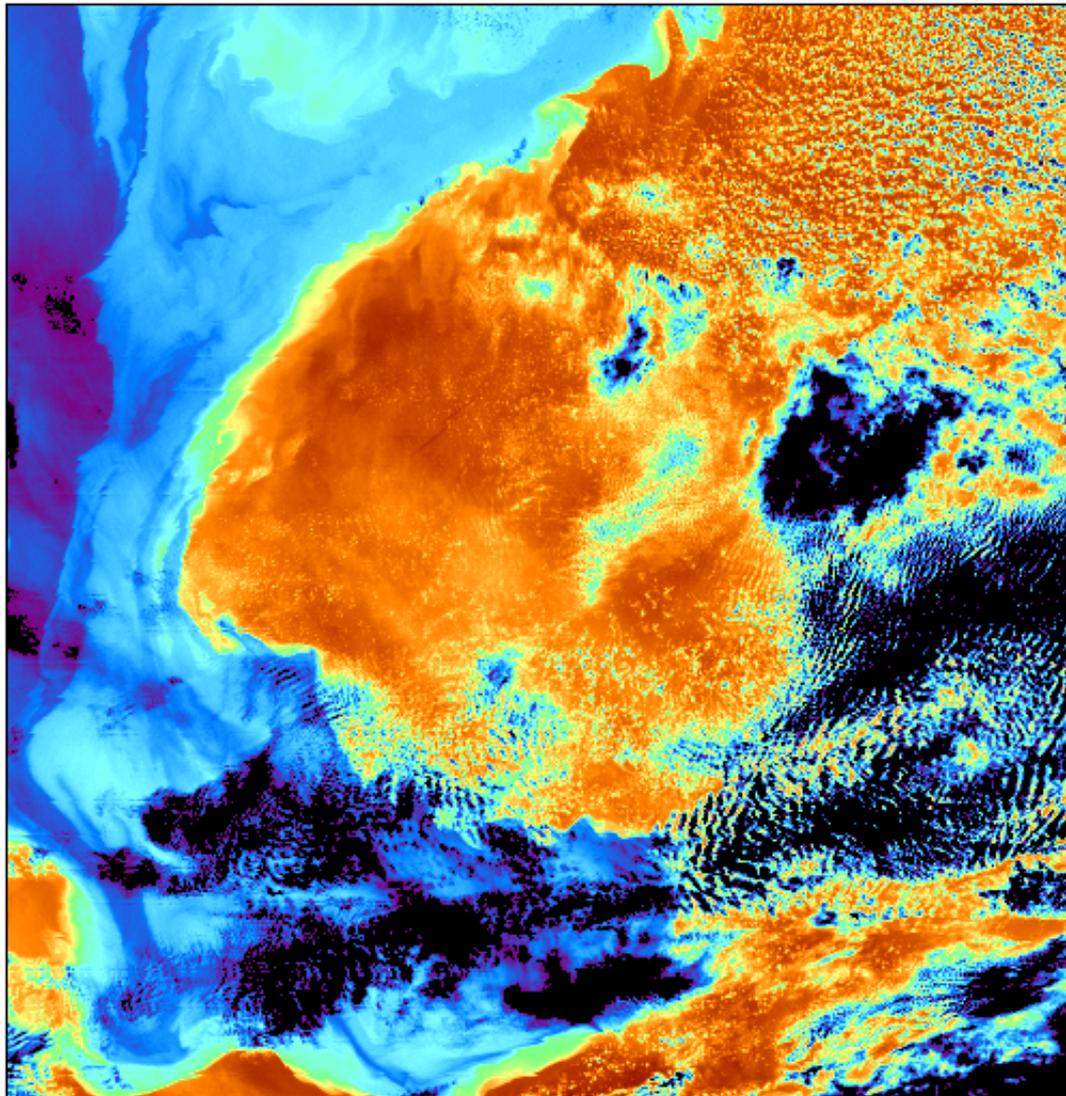
Latitude bounds:
40 N -> 46 N

Longitude bounds:
59 W -> 52 W



An inset map showing the location of the Gulf Stream region. The map shows the eastern coast of North America and the Atlantic Ocean. A red square indicates the area covered by the satellite image.

Gulf Stream, 02/17/13



Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/02/17 JD 048

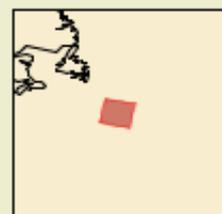
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End time:
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Projection type:
SWATH

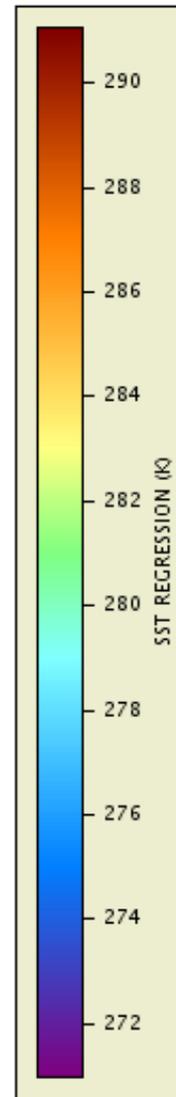
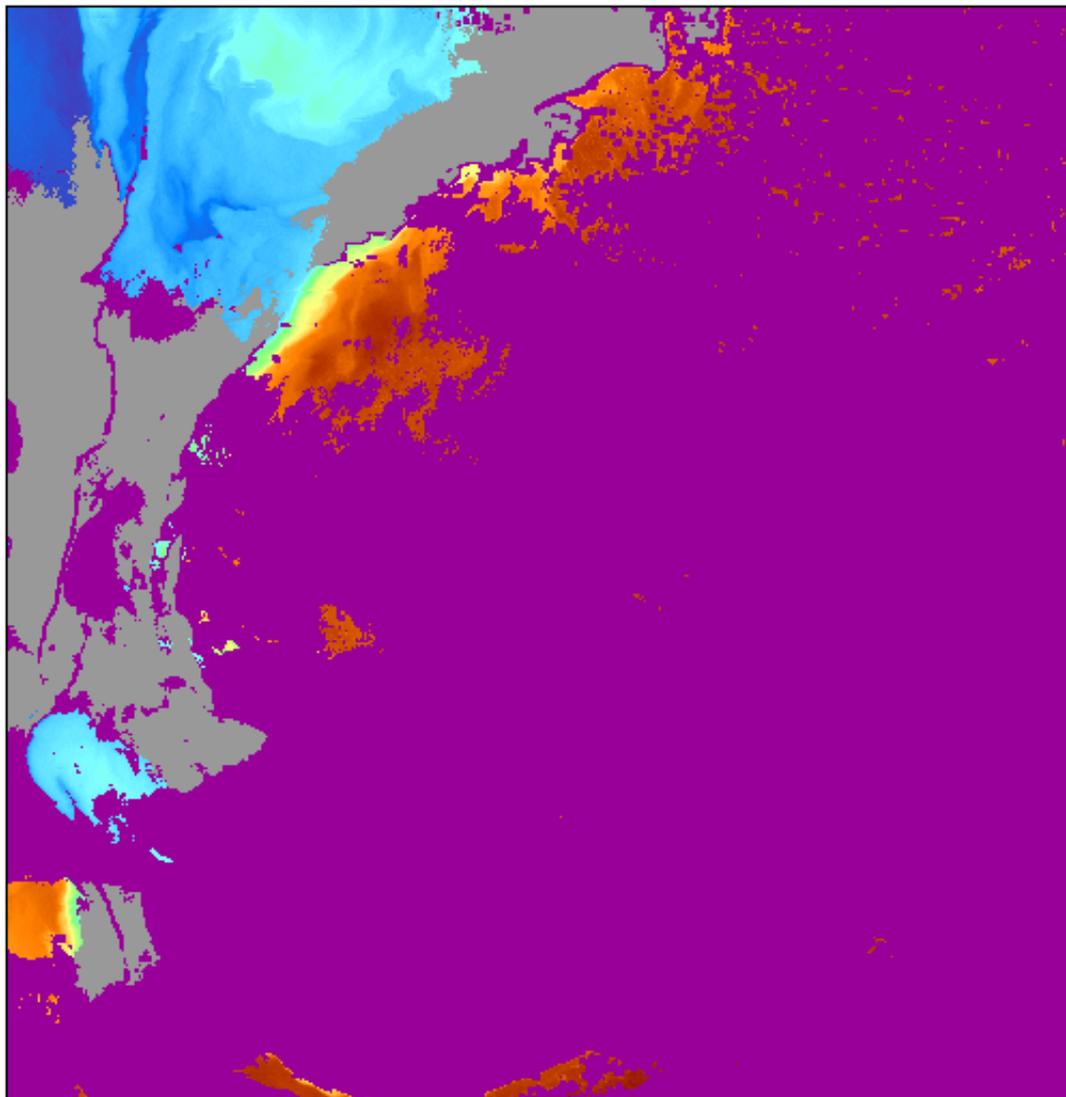
Latitude bounds:
40 N -> 45 N

Longitude bounds:
51 W -> 43 W



An inset map showing the location of the Gulf Stream region. A red square highlights the area covered by the main image, located in the western North Atlantic Ocean.

Gulf Stream, 02/17/13



Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/02/17 JD 048

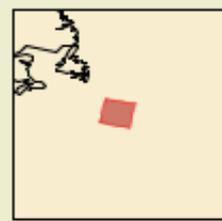
Start time:
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End time:
09:49:59 UTC

Projection type:
SWATH

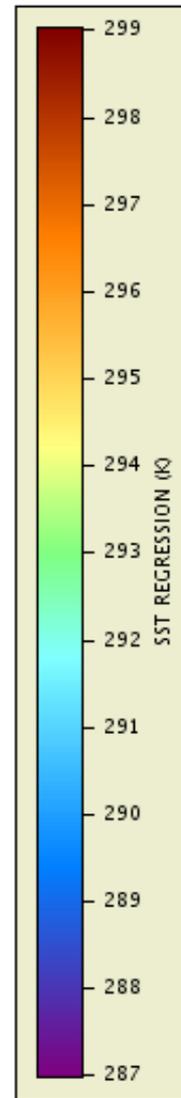
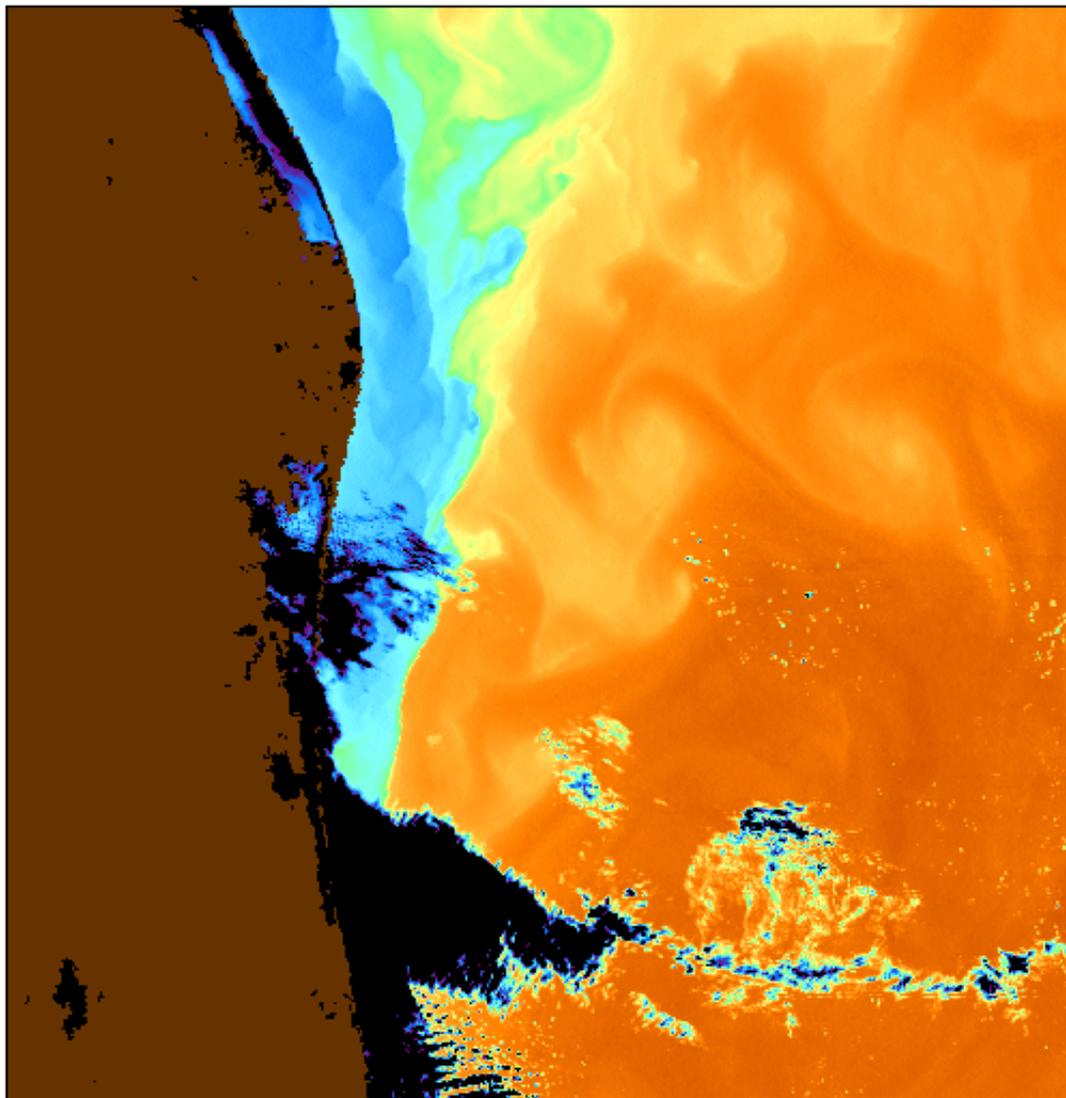
Latitude bounds:
40 N -> 45 N

Longitude bounds:
51 W -> 43 W



An inset map showing the location of the study area in the North Atlantic Ocean. A red square indicates the specific region shown in the main satellite image.

Gulf of Mexico, 02/17/13



Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/02/17 JD 048

Start time:
13:10:00 UTC

End time:
13:20:00 UTC

Projection type:
SWATH

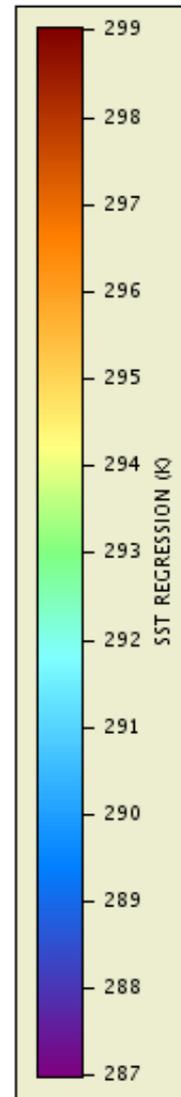
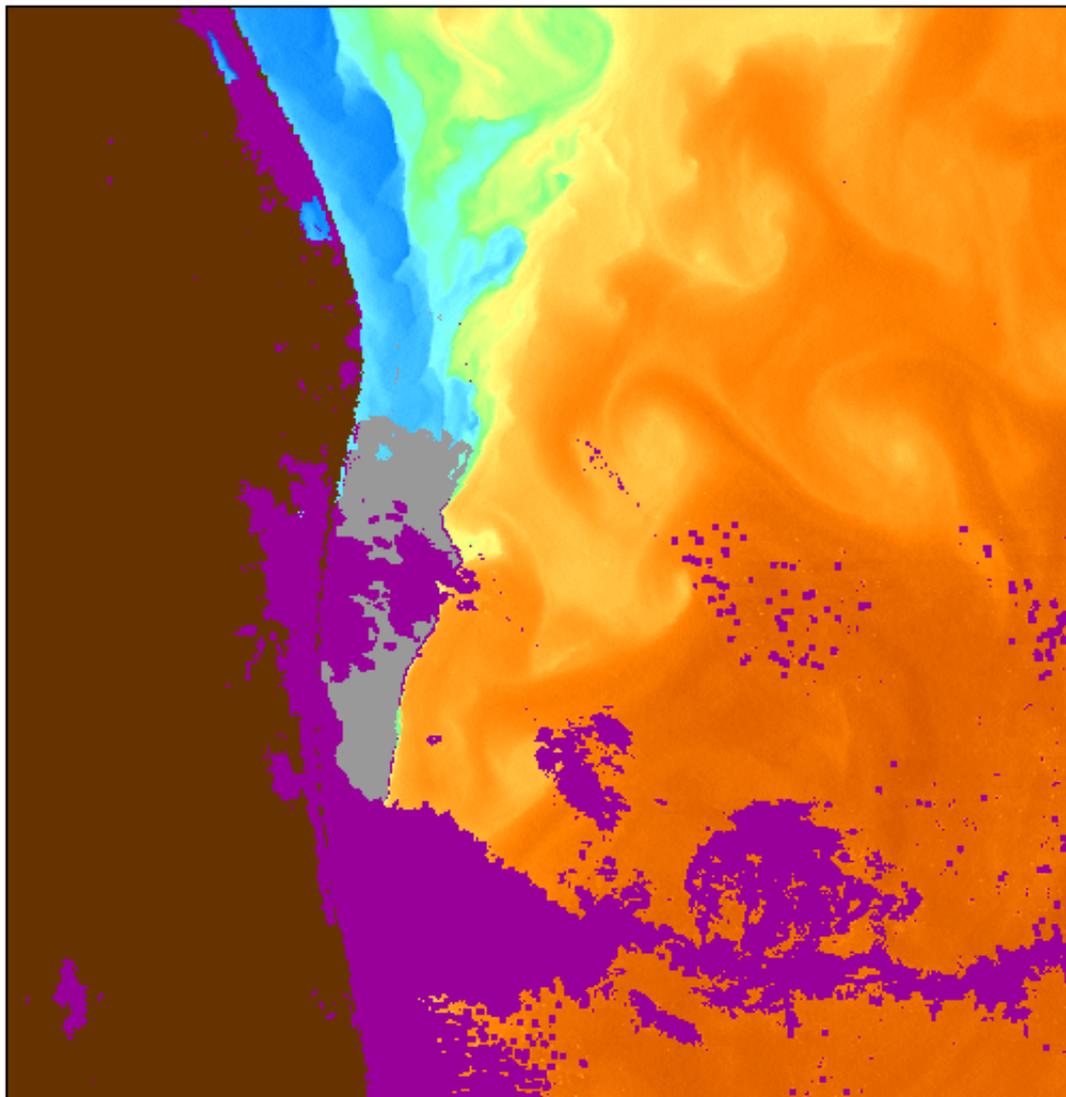
Latitude bounds:
22 N -> 28 N

Longitude bounds:
100 W -> 93 W



An inset map showing the Gulf of Mexico region, with a red box indicating the area covered by the satellite image.

Gulf of Mexico, 02/17/13



Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/02/17 JD 048

Start time:
13:10:00 UTC

End time:
13:20:00 UTC

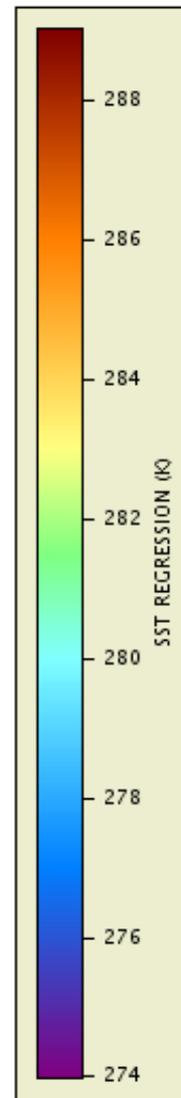
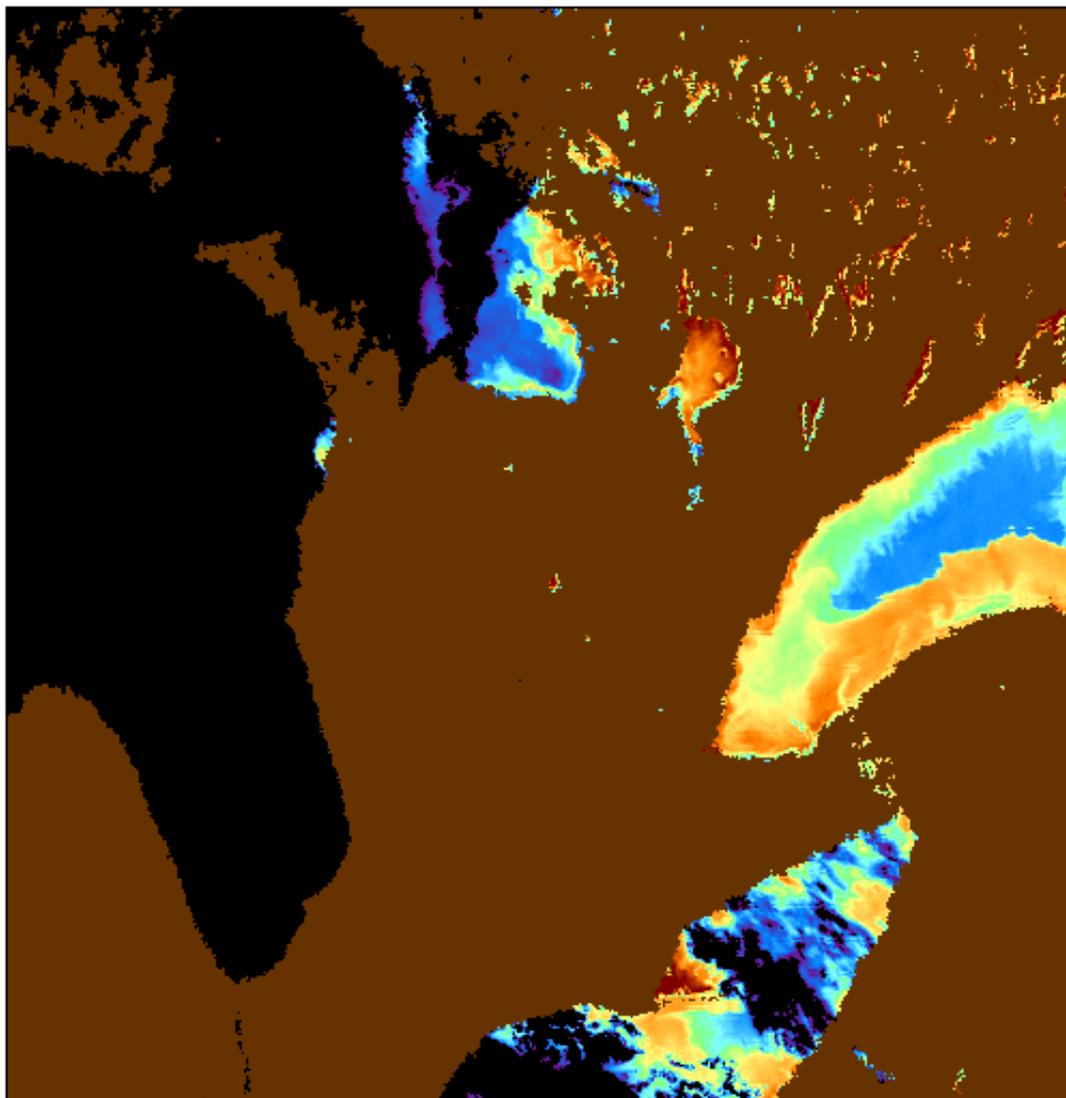
Projection type:
SWATH

Latitude bounds:
22 N -> 28 N

Longitude bounds:
100 W -> 93 W



Great Lakes, 02/17/13




Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/05/10 JD 130

Start time:
11:30:00 UTC

End time:
11:40:00 UTC

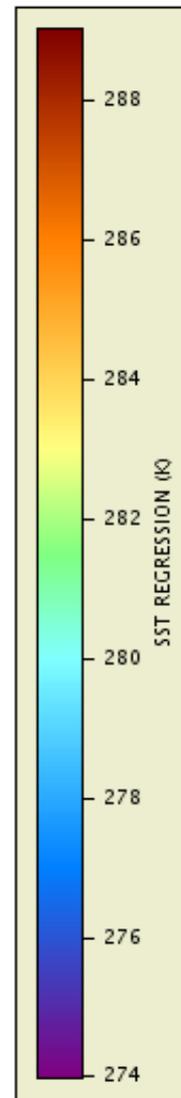
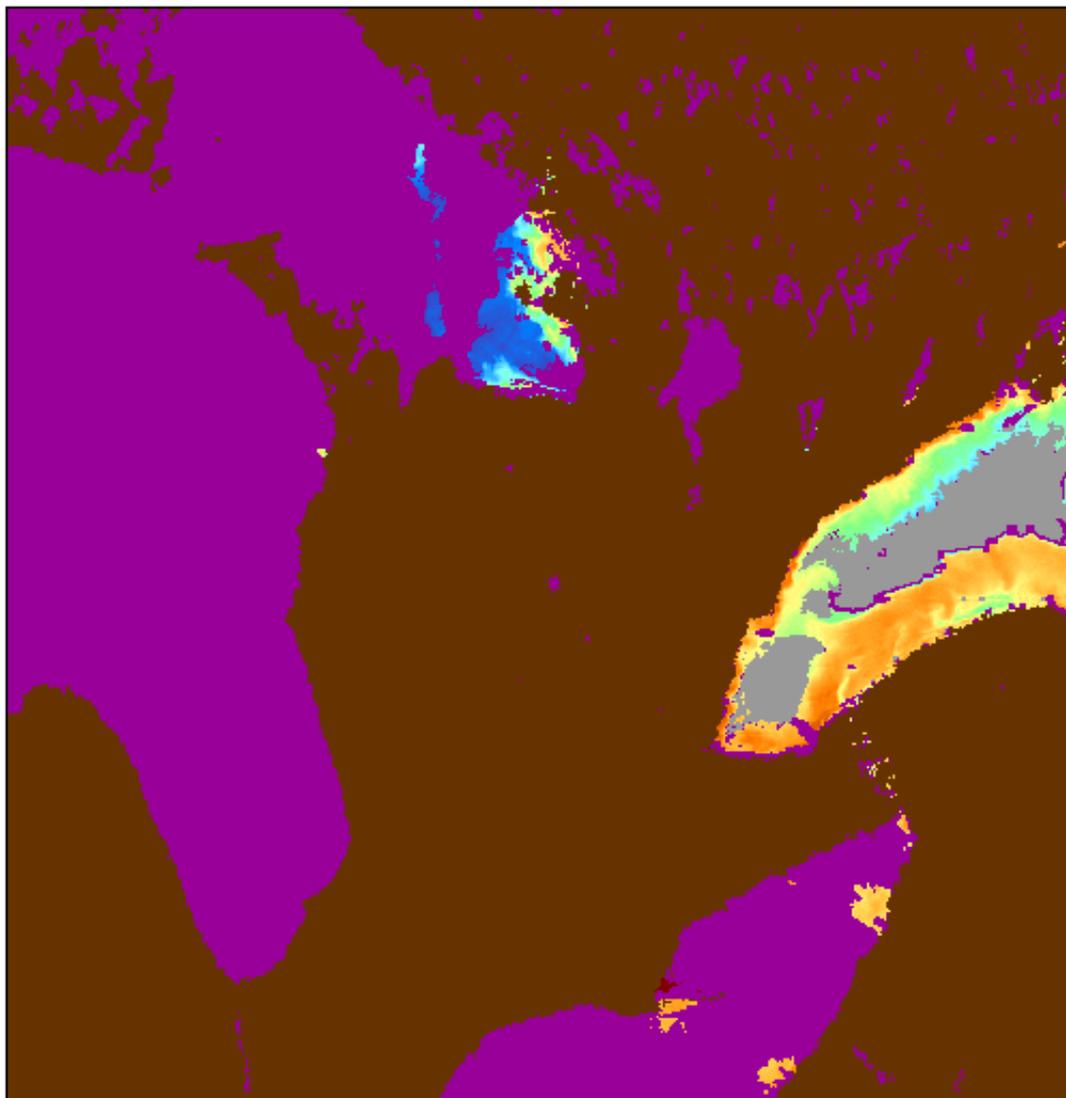
Projection type:
SWATH

Latitude bounds:
41 N -> 47 N

Longitude bounds:
84 W -> 76 W



Great Lakes, 02/17/13




Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/05/10 JD 130

Start time:
11:30:00 UTC

End time:
11:40:00 UTC

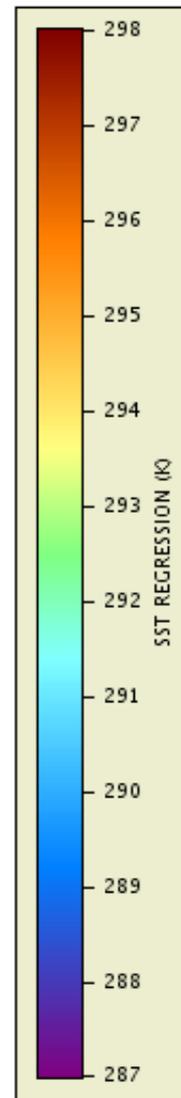
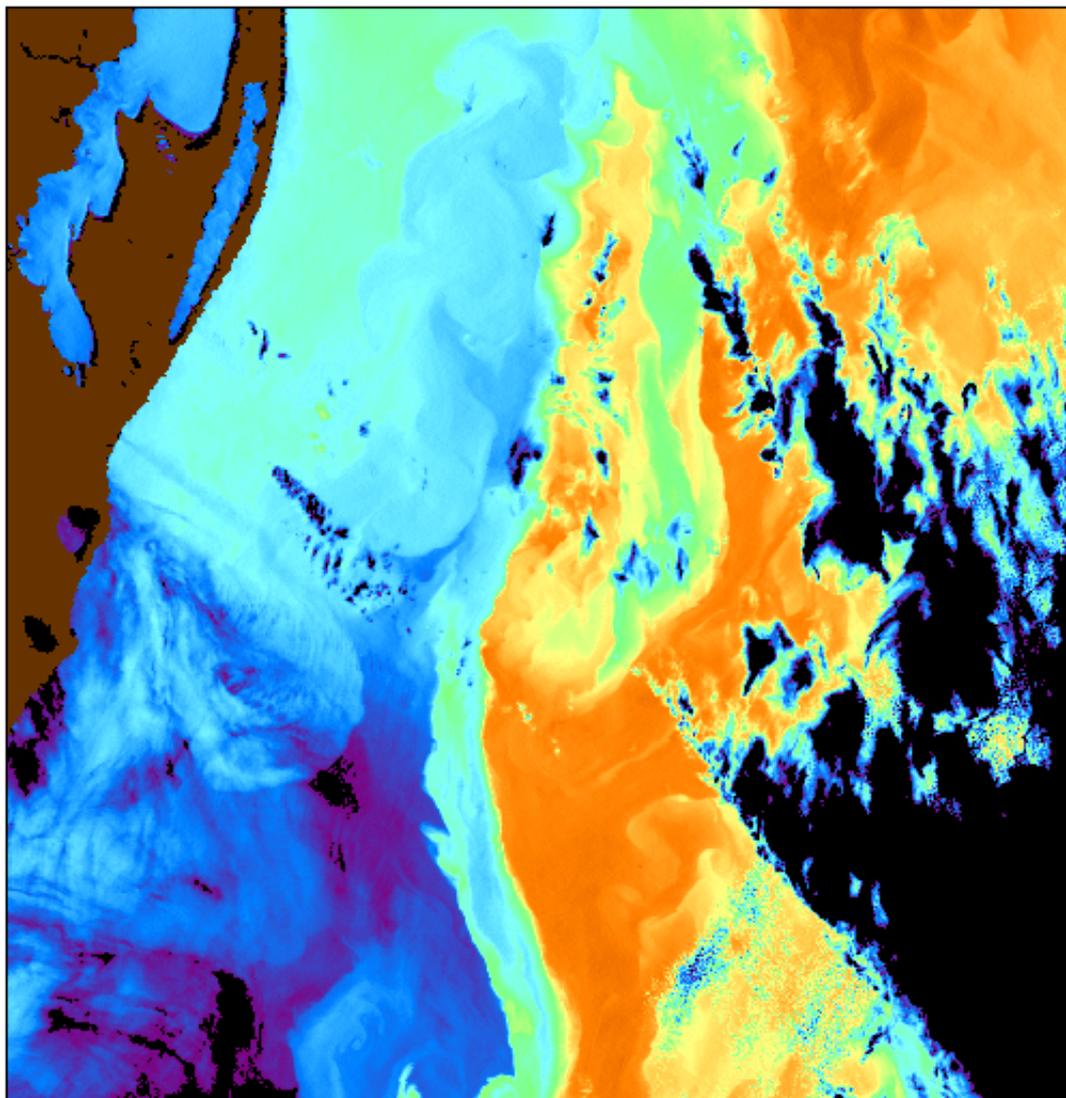
Projection type:
SWATH

Latitude bounds:
41 N -> 47 N

Longitude bounds:
84 W -> 76 W



Uruguay, 05/05/13 (night)



Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/05/10 JD 130

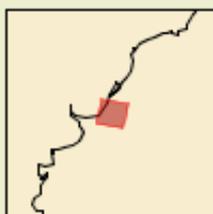
Start time:
08:30:00 UTC

End time:
08:40:00 UTC

Projection type:
SWATH

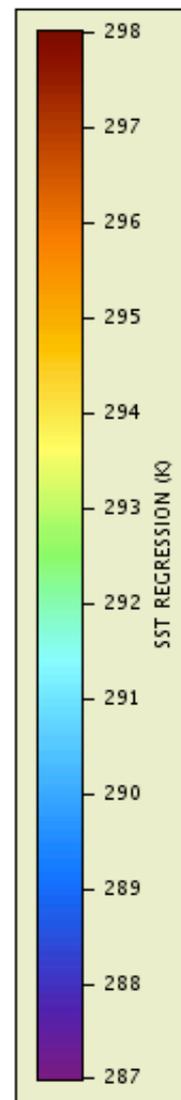
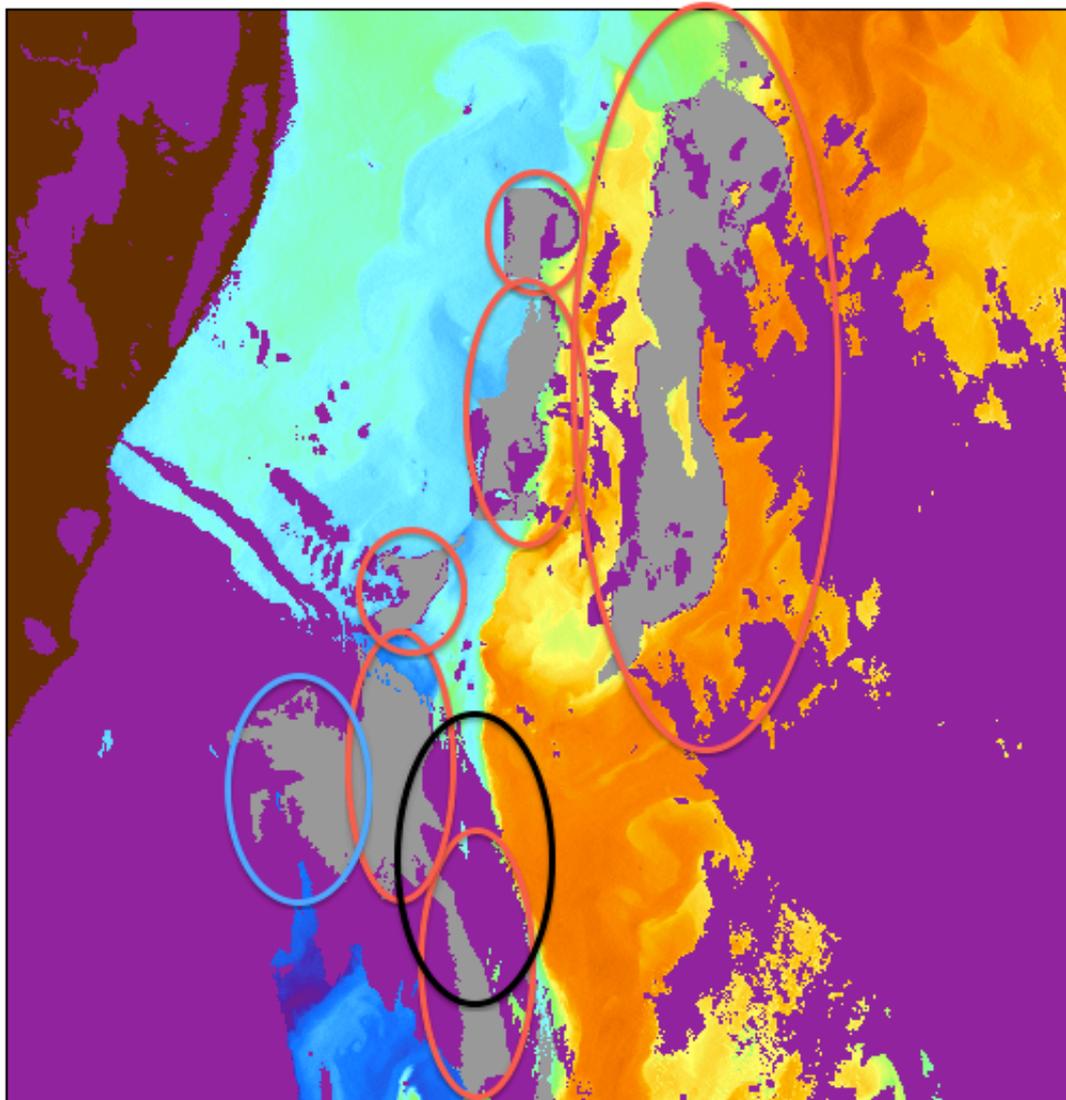
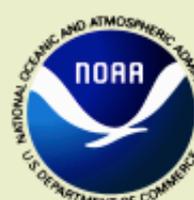
Latitude bounds:
37 S -> 32 S

Longitude bounds:
55 W -> 48 W



An inset map of Uruguay, showing the country's outline. A red square highlights the area covered by the satellite image.

Uruguay, 05/05/13 (night)

Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/05/10 JD 130

Start time:
08:30:00 UTC

End time:
08:40:00 UTC

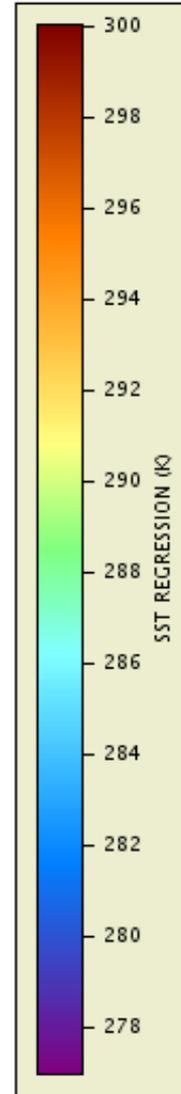
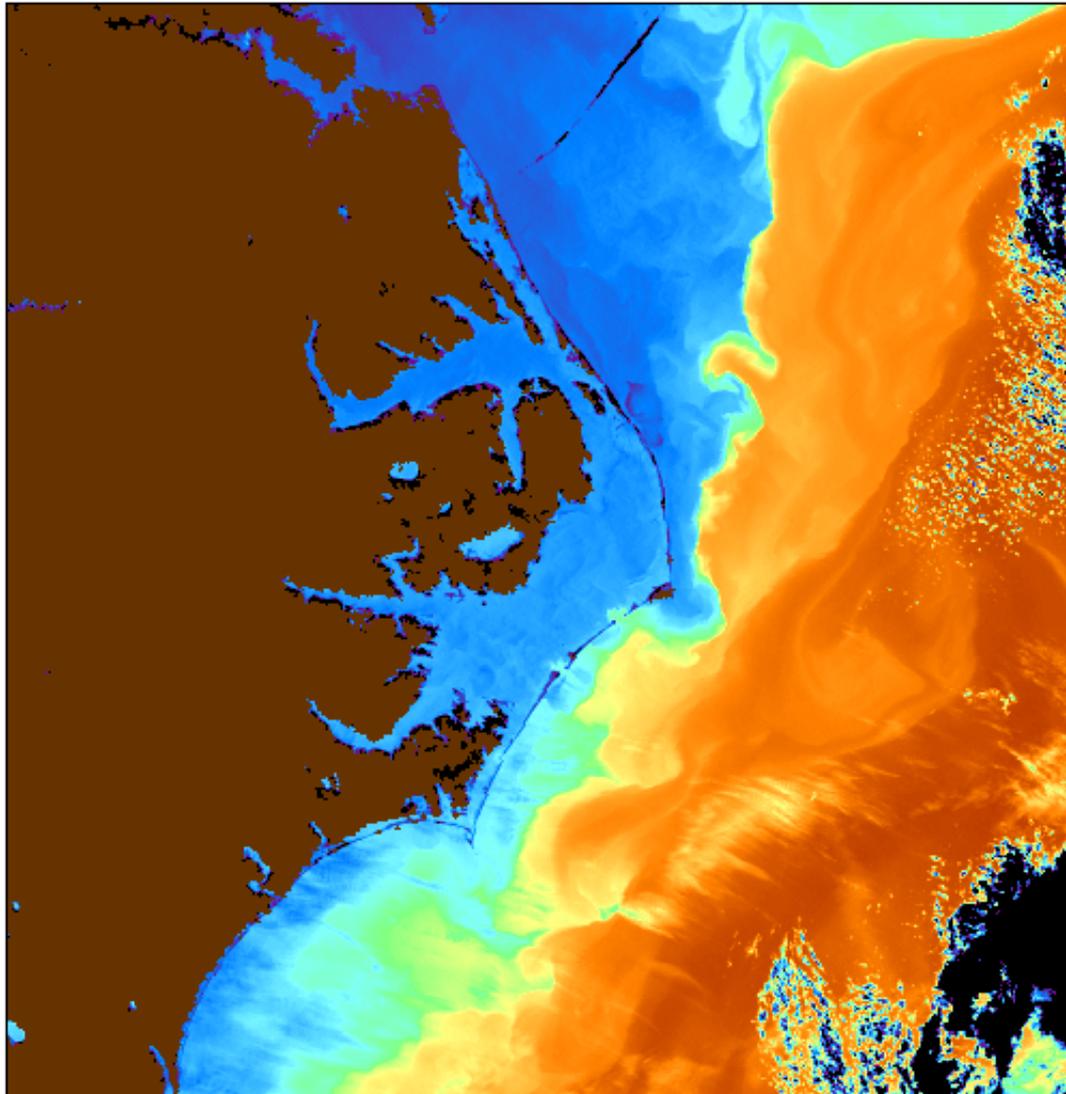
Projection type:
SWATH

Latitude bounds:
37 S -> 32 S

Longitude bounds:
55 W -> 48 W



Pamlico Sound, 02/16/13 (night)



Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/02/16 JD 047

Start time:
11:50:00 UTC

End time:
12:00:00 UTC

Projection type:
SWATH

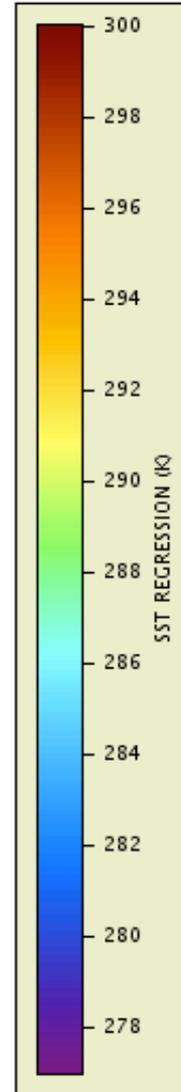
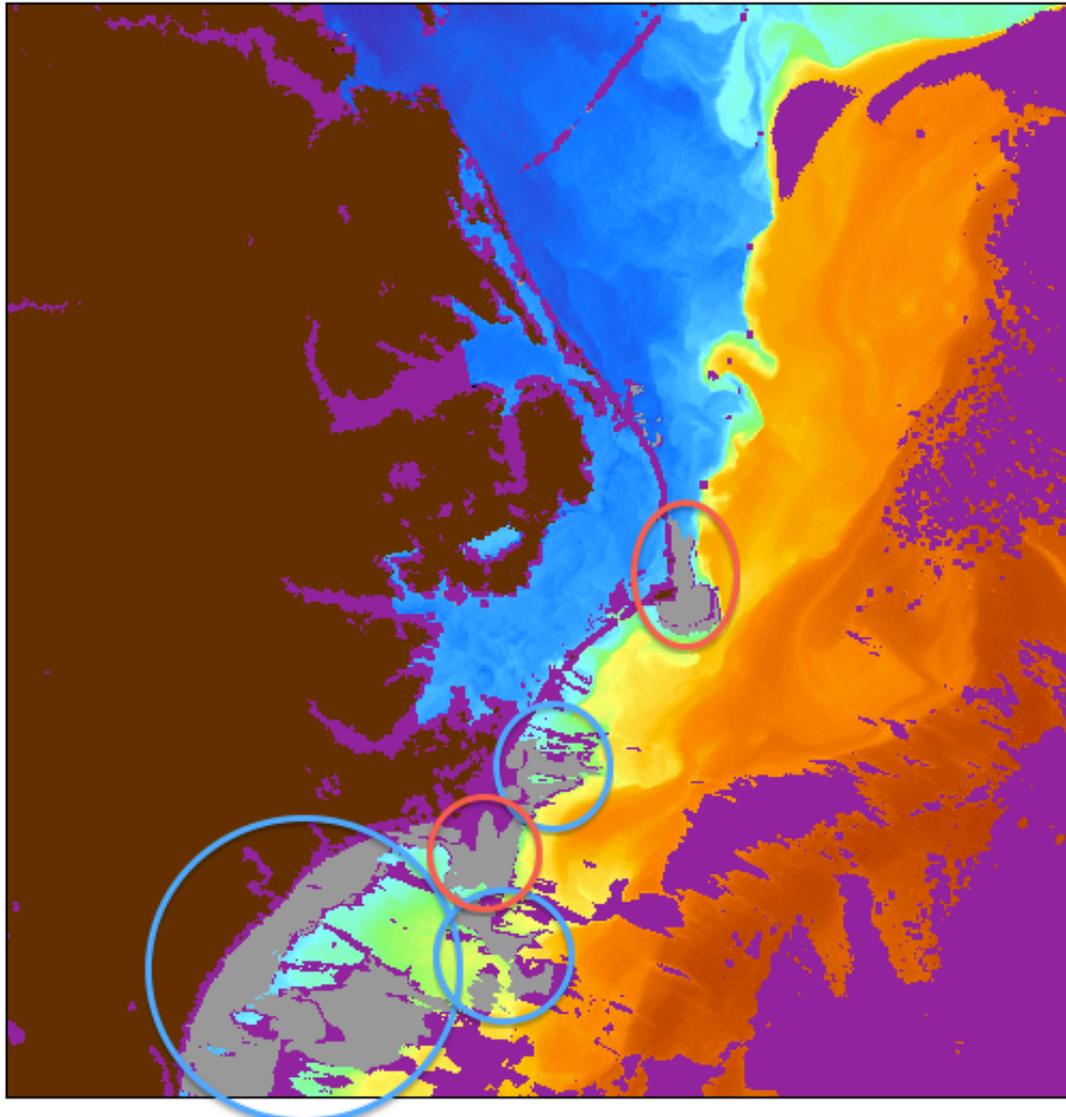
Latitude bounds:
32 N -> 38 N

Longitude bounds:
79 W -> 72 W



An inset map showing the location of the study area (Pamlico Sound) in the southeastern United States, with a red box indicating the specific region.

Pamlico Sound, 02/16/13 (night)



Data courtesy of:
USDOC/NOAA/NESDIS

Satellite:
NPP

Sensor:
VIIRS

Date:
2013/02/16 JD 047

Start time:
11:50:00 UTC

End time:
12:00:00 UTC

Projection type:
SWATH

Latitude bounds:
32 N -> 38 N

Longitude bounds:
79 W -> 72 W



Conclusion

- A supplemental algorithm to the current ACSPO Clear-Sky Mask based on pattern recognition is being explored.
- Our preliminary analyses suggest that some of the limitations inherent to the current ACSM may be alleviated and SST coverage improved.
- The improvements are mostly noticeable in the areas interesting to ACSPO users, including dynamic areas of the ocean and coastal zones.
- Future work will include tuning the algorithm, with emphasis on resolving the remaining cloud leakages.