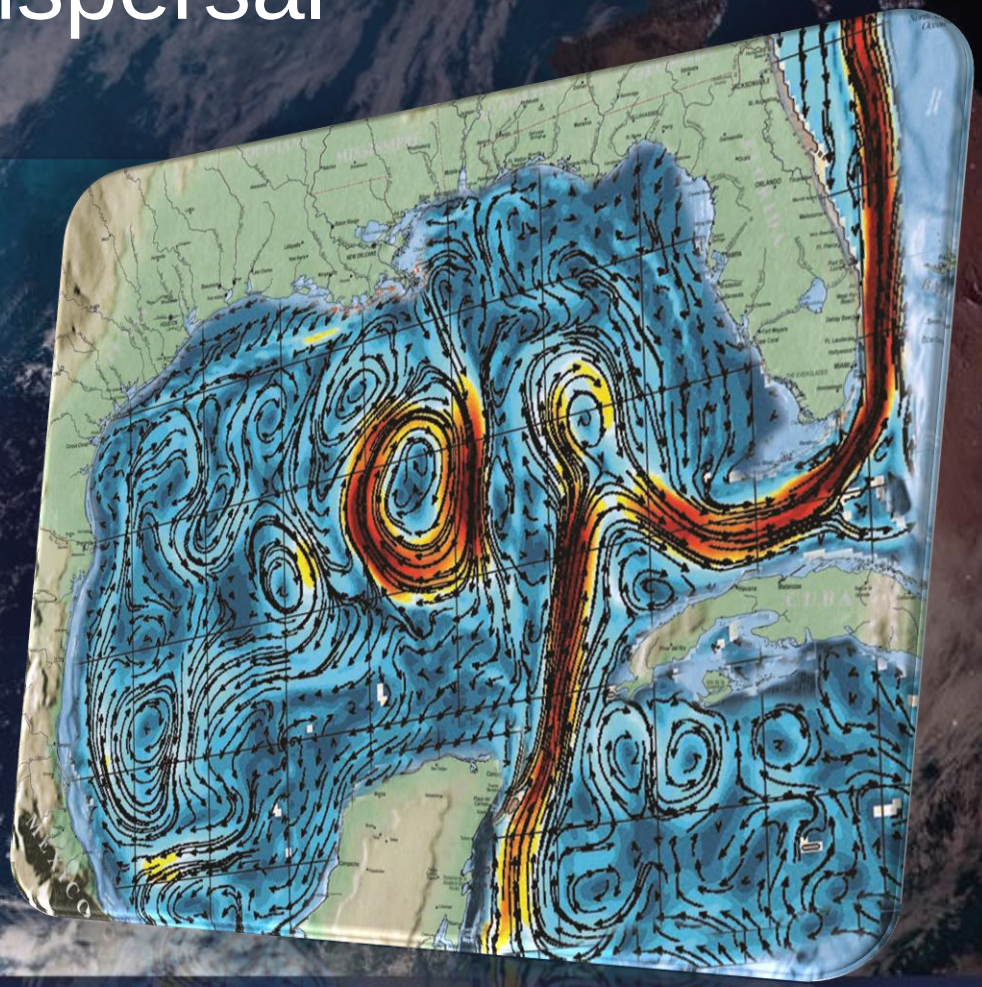
National Aeronautics and Space Administration

# Gulf of Mexico Loop Current Monitoring and Marine Debris Dispersal



NASA Stennis Space Center

March 24, 2011

# Community Concerns

- **Ecotourism is the fastest growing segment of the Texas Gulf Coast's tourism-based economy.**
- **Within the Coastal Bend Area of Texas, Ecotourism employs 8,748 citizens and provides $233.5 M in household earnings.**
- **Padre Island National Seashore (PINS) is a critical part of the Central Flyway, a major migratory route for 380 species of migratory birds (13 threatened or endangered). Marine debris threatens this vital avian habitat.**
- **Marine debris also threatens habitat of the highly endangered Kemp's Ridley Sea Turtle. PINS is one of the two global nesting sites for this species. In 1994 to 2010, PINS' Kemp's Ridley nests grew from 1 to 74 confirmed nests.**

*Falco peregrinus*

*Lepiochelys kempii*

# Partners / Collaborators

- NOAA Marine Debris Division
- National Park Service
- University of Colorado – Center for Astrodynamics Research
- Padre Island National Seashore (PINS)

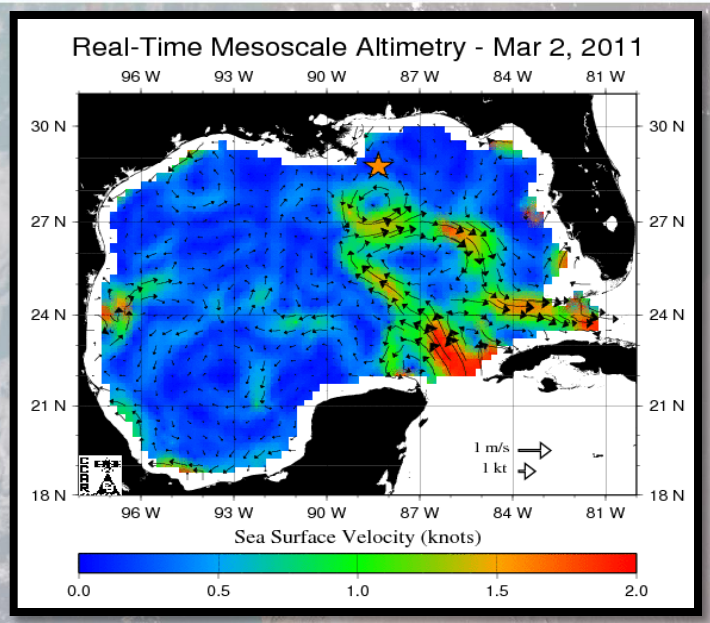
| Science Advisors |
| --- |
| Joe Spruce<br>CSC, Stennis Space Center |
| Dr. Robert Leben<br>University of Colorado<br>Center for Astrodynamics Research |

| Collaborators |
| --- |
| Neal Parry<br>GoM Regional Coordinator<br>NOAA Marine Debris Program |
| William Botts<br>Education Coordinator - PINS |

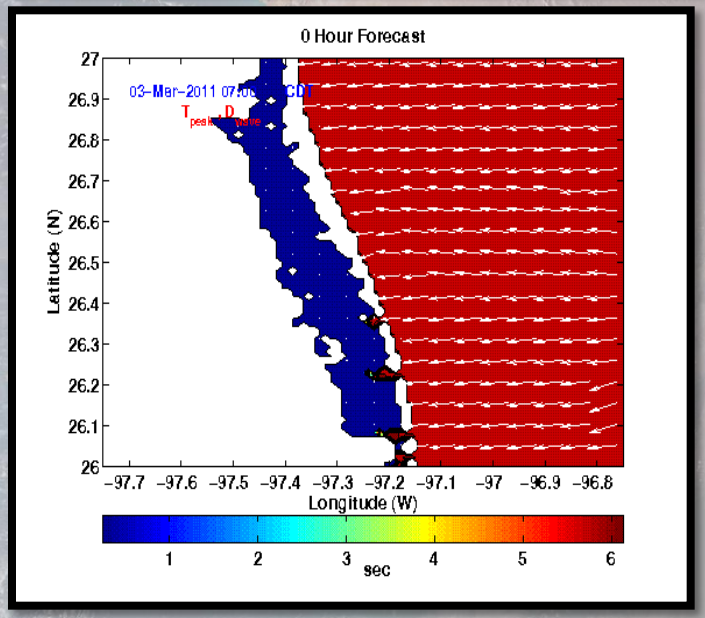
# Partner Needs

- **Visual geospatial animations to convey sources and mechanisms of dispersal to enhance marine debris regulation, enforcement and education**
- **An improved method to monitor the Gulf of Mexico Loop Current and marine debris trajectories as well as predict debris particle transport paths**

Loop Current Altimetry




MASE Wave Model




## National Applications Addressed:

Public Health

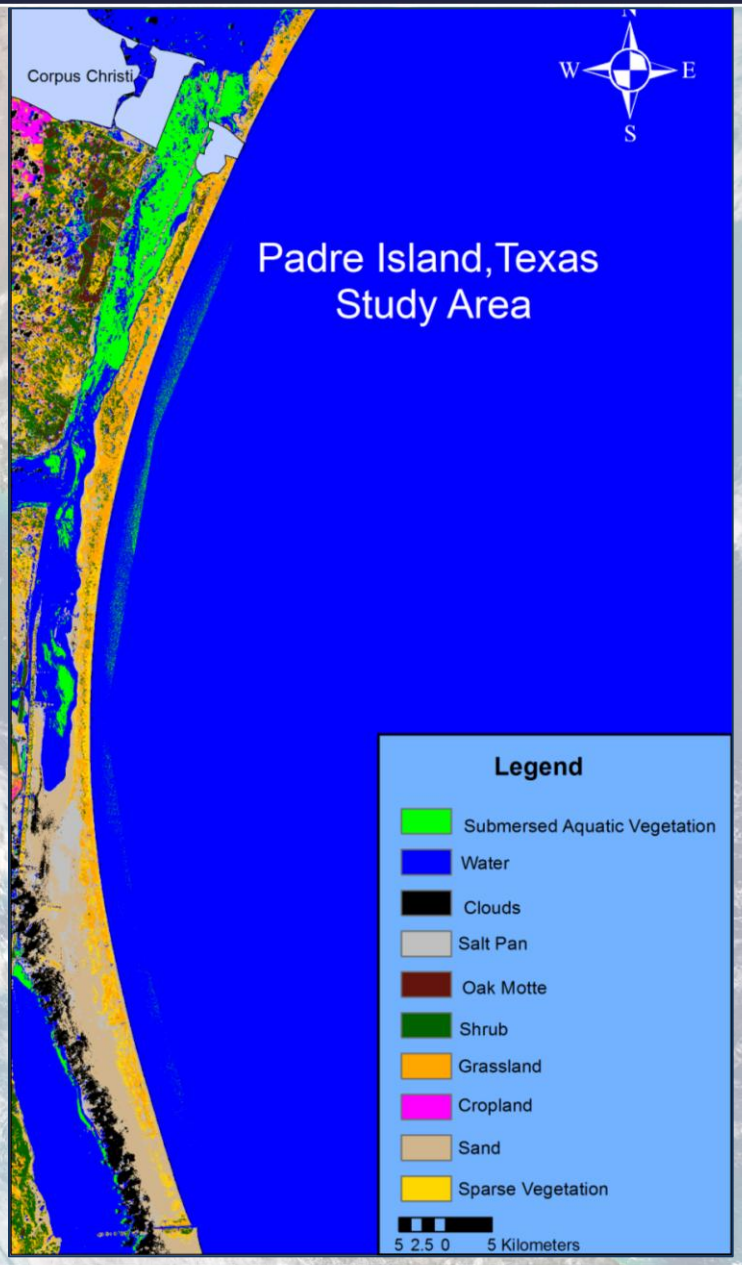
Ecological Forecasting

Water Resources

# Study Area

- **Study Area – Gulf of Mexico & Padre Island, Texas**

# Study Area Ecosystem



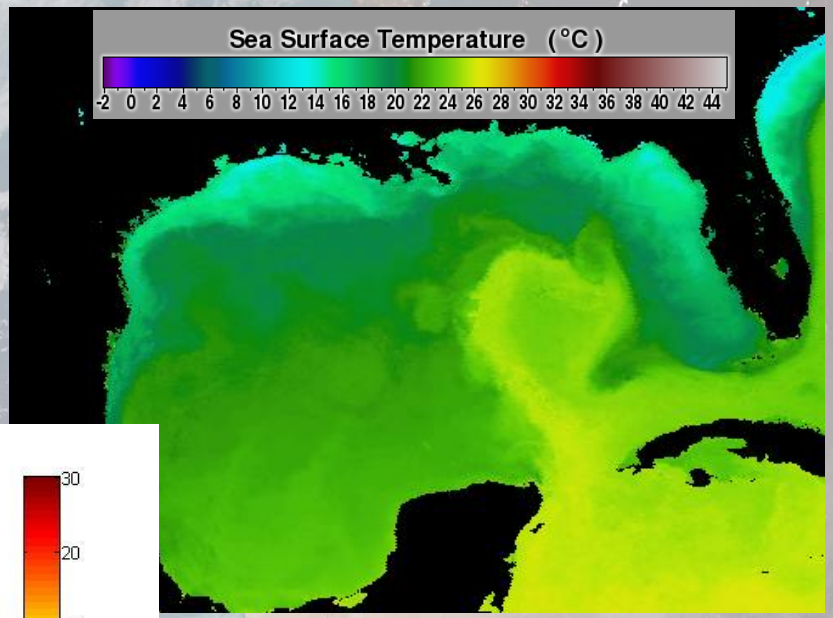

Map of Padre Island General Land Cover
Produced from June 10, 2010 Landsat Imagery

Padre Island National Seashore
Image Credit: National Park Service

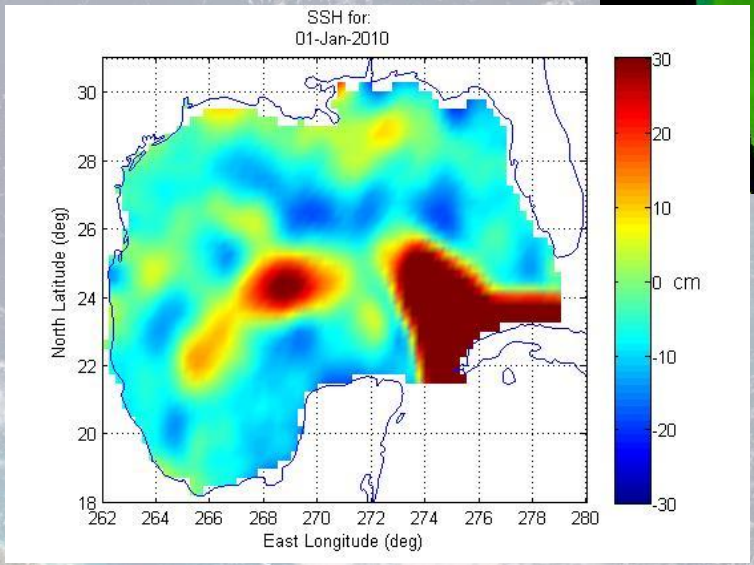
# Project Methodology

- **Sea Surface Temperature sensors utilized:**
  - MODIS onboard *Aqua* and *Terra*
  - Subset and converted from HDF format in ERDAS Imagine
- **Altimeter sensors utilized:**

  **Used by Colorado Center for Astrodynamics Research to Calculate Daily Sea Surface Height**
  - Jason 1
  - Jason 2
  - TOPEX/Poseidon
  - ERS 1
  - ERS 2
  - Envisat



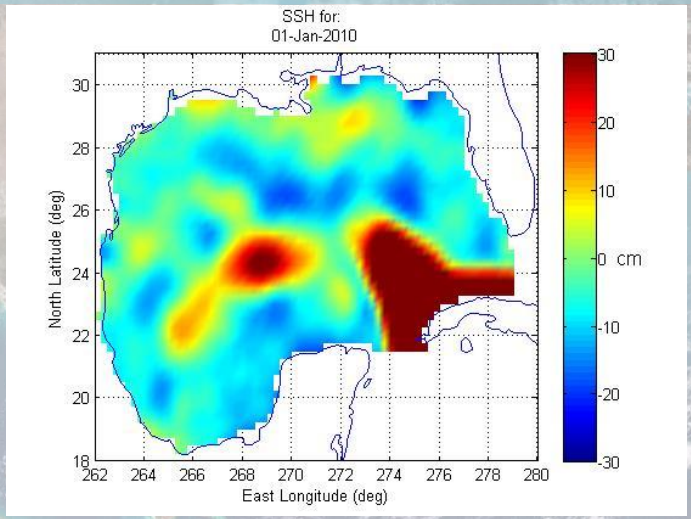

**MODIS Feb. 10-17, 2011**




**Sea Surface Height from Blended Altimeter Data**

# Project Methodology

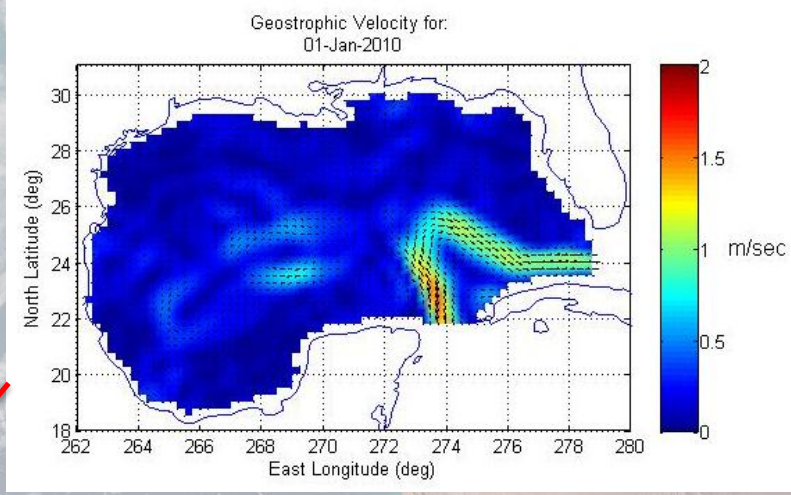
Data acquired from the Colorado Center for Astrodynamics Research



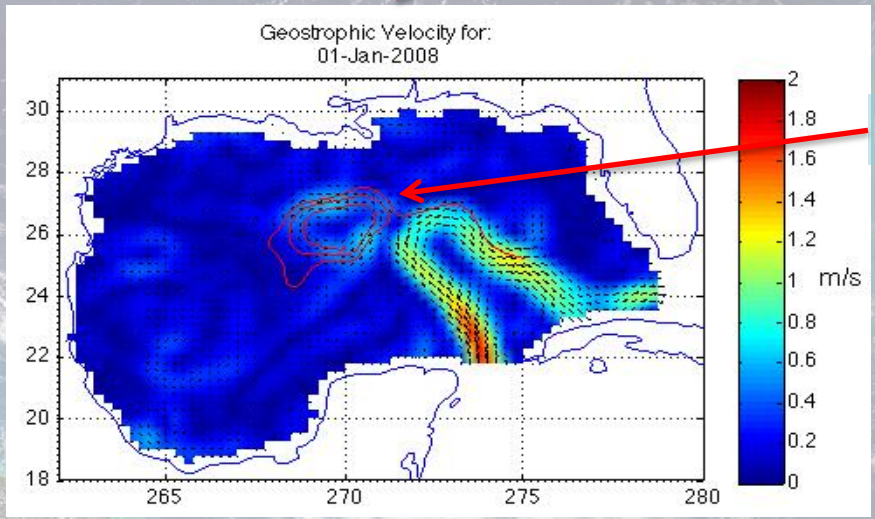

**SSH Calculated Using Blended Satellite Altimeter Data**

**Altimeter Data Processing Completed in Matlab**

Geostrophic Velocity




**Calculated as a Balance of the Horizontal Pressure Gradient and the Coriolis Force**

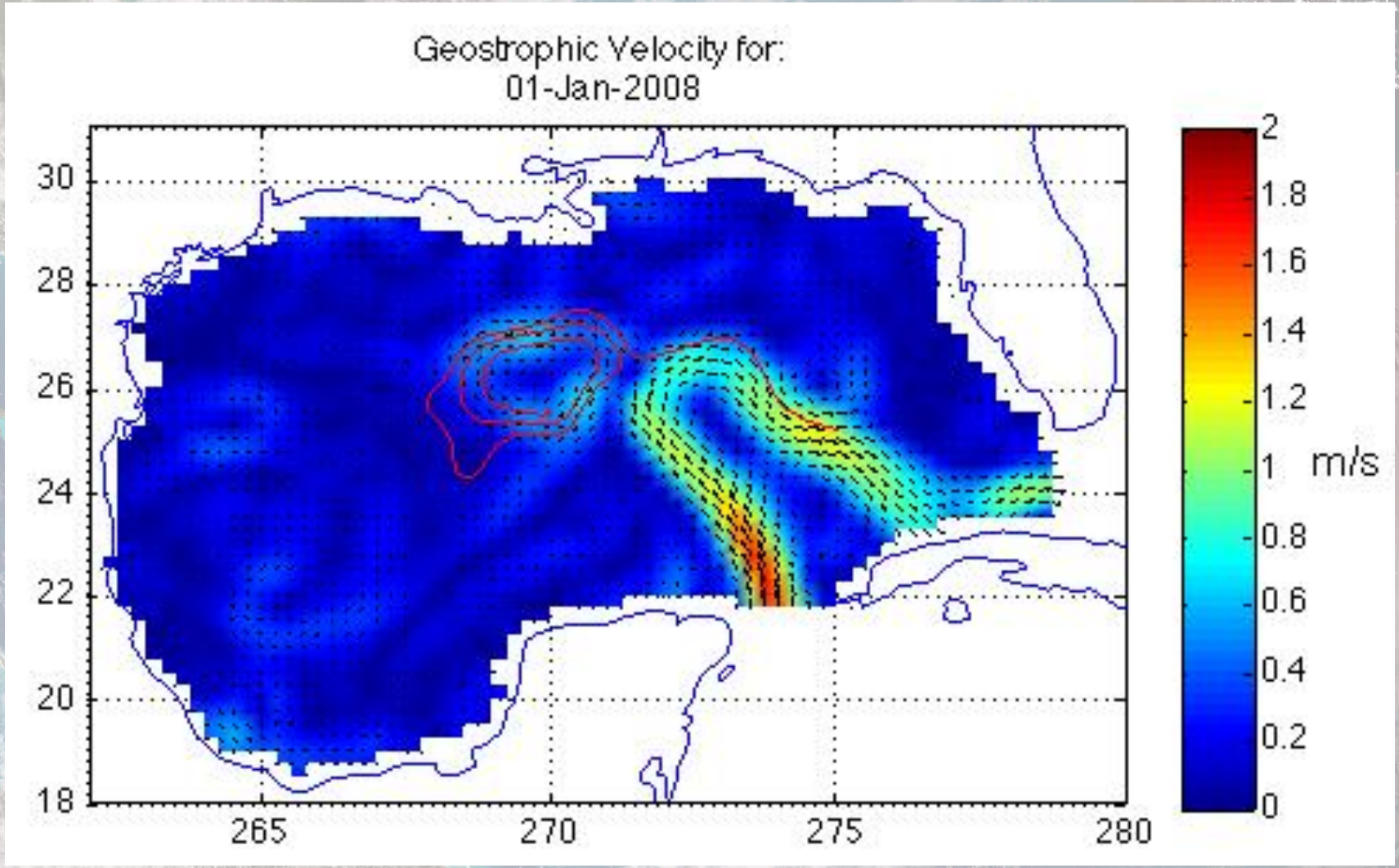



Particle Paths

**Particle Path Calculated by Integrating Over Time and Space Using the Euler Numerical Integration Method**

# Results

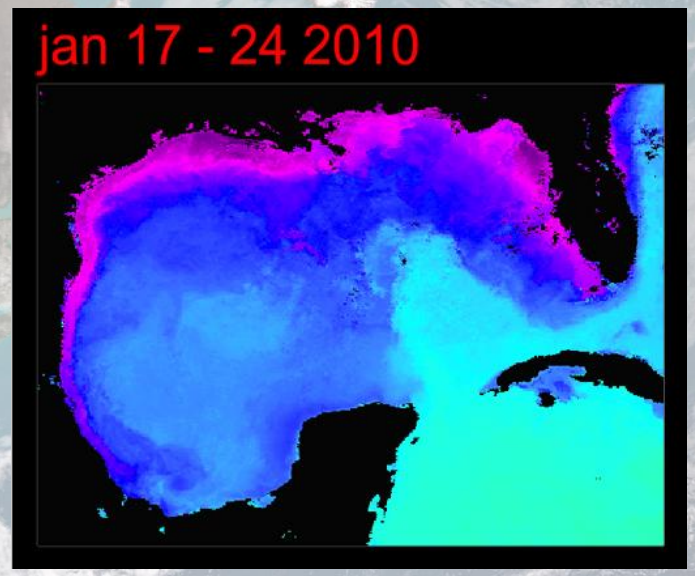
## Particle Path Calculated Using Geostrophic Velocity Measurements from Blended Satellite Altimeter Data and Euler's Integration Method

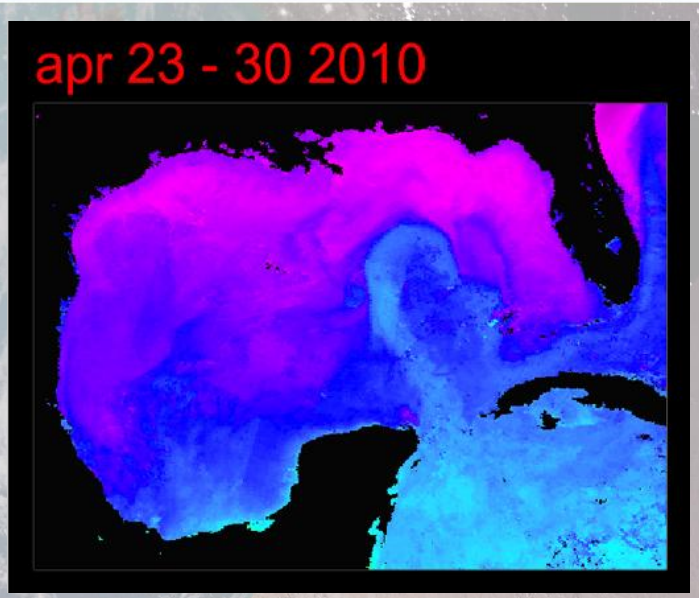


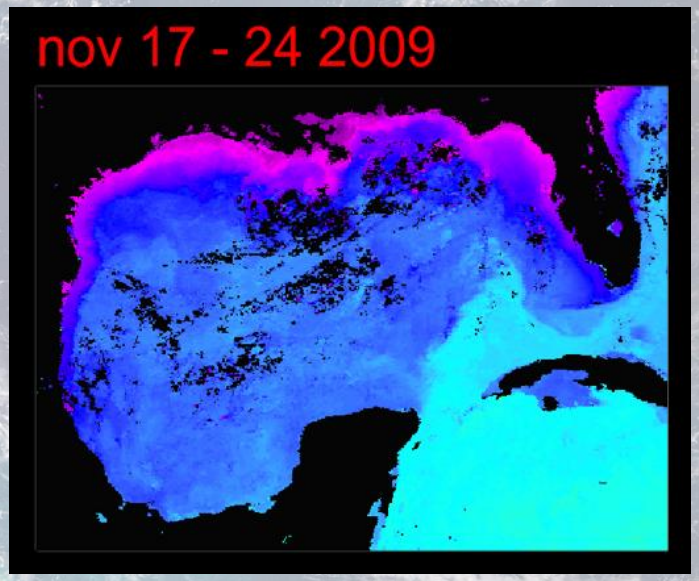
# Results

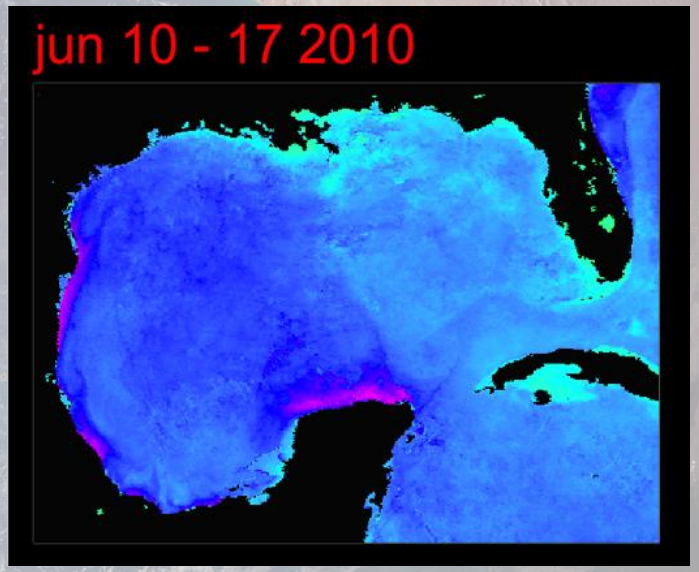
- Because of the warmer loop current temperature, the current can be monitored using MODIS Sea Surface Temperature data.

- However, because sea surface temperature is warmer over the entire Gulf in summer months, this method is not useful in those months.




Cooler temperatures shown in purple, warmer in shades of blue

# Results Summary

- **Visualization and time series of MODIS SST data**
- **Updated altimeter data processing methodology**
- **Maps and time series showing Sea Surface Height for the Gulf of Mexico**
- **Maps of geostrophic velocities and particle path predictions**

# Discussion

## Conclusions:

- **Satellite altimeter data is very useful for calculating Sea Surface Height, calculating geostrophic velocity, and predicting Particle Paths.**
- **Euler's numerical integration method is a less complex method for calculating particle paths. According to partners at University of Colorado, using the Runge-Kutta method would improve accuracy.**
- **MODIS Sea Surface Temperature data can be used to monitor the loop current in cooler months but is not useful in the warmer summer months.**

## Limitations:

- **The loop current is not the only force distributing debris throughout the Gulf; prevailing wind patterns and long shore transport influence debris dispersal as well.**

# Future Work

**Work on this project will be continued during the Summer 2011 term. The team will complete the following tasks:**

- **Collect and analyze data showing marine debris accumulation along Gulf of Mexico coastlines**
- **Attempt to identify point sources of marine debris in the Gulf of Mexico by incorporating the 1994 MMS study**
- **Use Runge-Kutta numerical integration method to calculate particle paths to improve accuracy**
- **Analyze marine debris accumulation patterns that result from the Gulf of Mexico Loop Current using methodology developed during the Spring 2011 term**
- **Provide enhanced maps, visualizations, and methodology to partners in order to aid in decision making processes and outreach and community education programs**

# Acknowledgments


- **Joe Spruce - Stennis Space Center**
- **Dr. Robert Leben - University of Colorado**
- **Neal  Parry – NOAA Marine Debris Division**
- **William Botts – Education Coordinator, PINS**
- **Gabriel  LoDolce – University of Colorado**
- **Cheri Miller – DEVELOP Southeast Region Coordinator**
- **Brandie Mitchell – DEVELOP Stennis Student Director**
- **Jason Jones – DEVELOP National Program**

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