



Forecasting Rapid Intensification of Hurricanes

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ABSTRACT

Hurricanes are a major weather threat to coastal communities every summer from May through November. On average, 7 hurricanes form each year in the Atlantic and 3 of these become major storms rated at Category 3 or above with winds exceeding 110mph.

Storm activity and associated costs are on the rise in recent years with over \$600 billion in property damage from 24 major hurricanes since 2017. Tragically, hurricanes have resulted in over 4,500 fatalities during this period with most of these deaths occurring during more severe major hurricanes.

Forecasting of hurricane paths and severity has significantly improved over time, but recent major storms have demonstrated rapid intensification just prior to making landfall. This sudden increase in severity can be difficult to manage as evacuation orders need to be specific and timely to minimize loss of life and allow time for property defense and adequate mobilization of emergency response personnel.

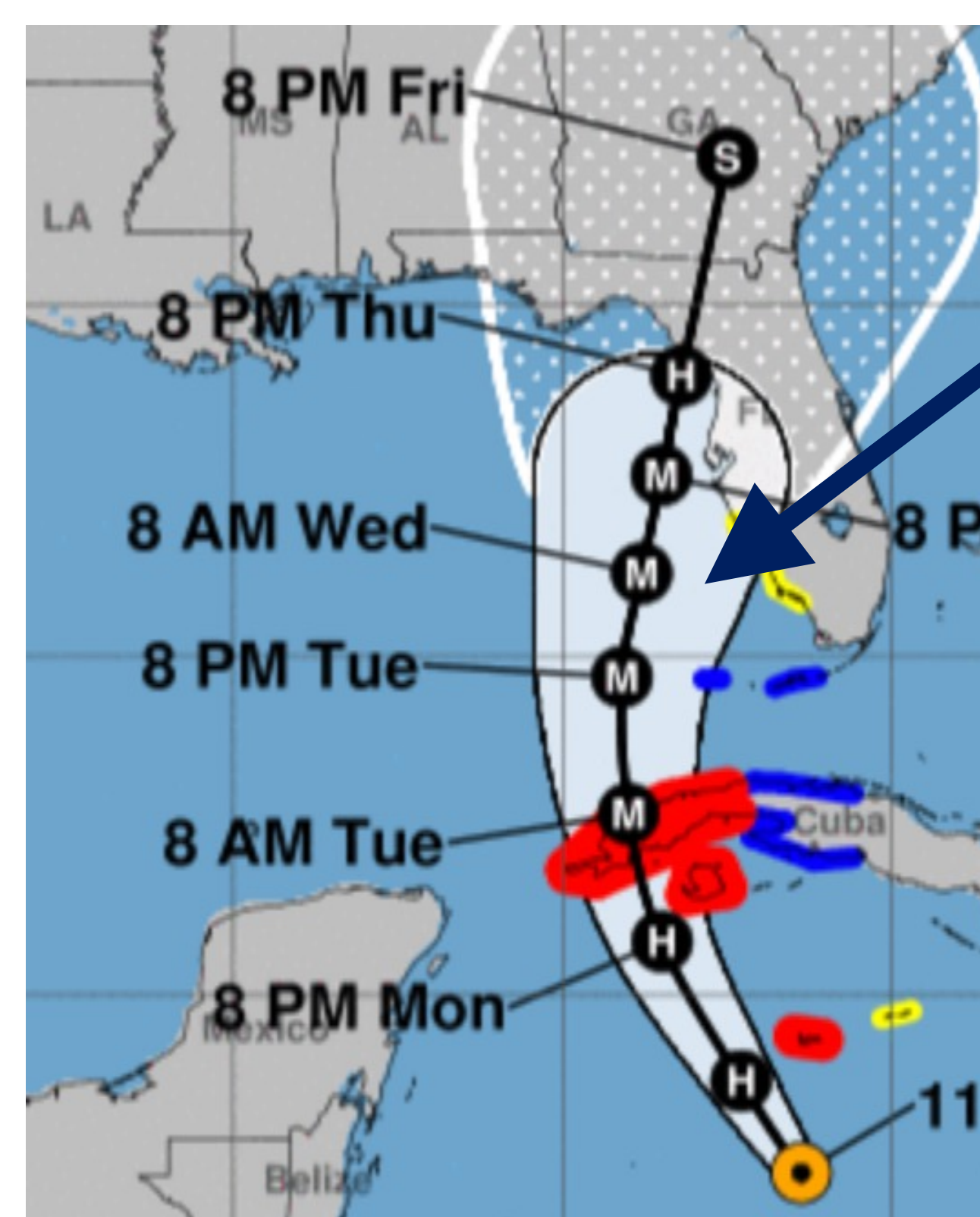
Rapid intensification is becoming more common due to favorable climate conditions for hurricanes, such as warmer sea surface temperatures due to global warming. Using these temperatures which are visible on satellite imagery to forecast rapid intensification can provide critical lead time for hurricane management, thus saving lives and limiting losses with improved timeliness and preparedness.

RESEARCH QUESTION AND METHODS

Can infrared sea surface temperature imagery along forecasted hurricane paths provide a strong indicator of rapid intensification (RI)?

- Used VIIRS module on the JPSS satellite for daily high-resolution sea surface temperature information
 - >Source allows for timely data collection during hurricane forecast periods
- Collected imaging data for all 15 hurricanes (reaching at least Category 1 status) during 2020-2022 seasons.

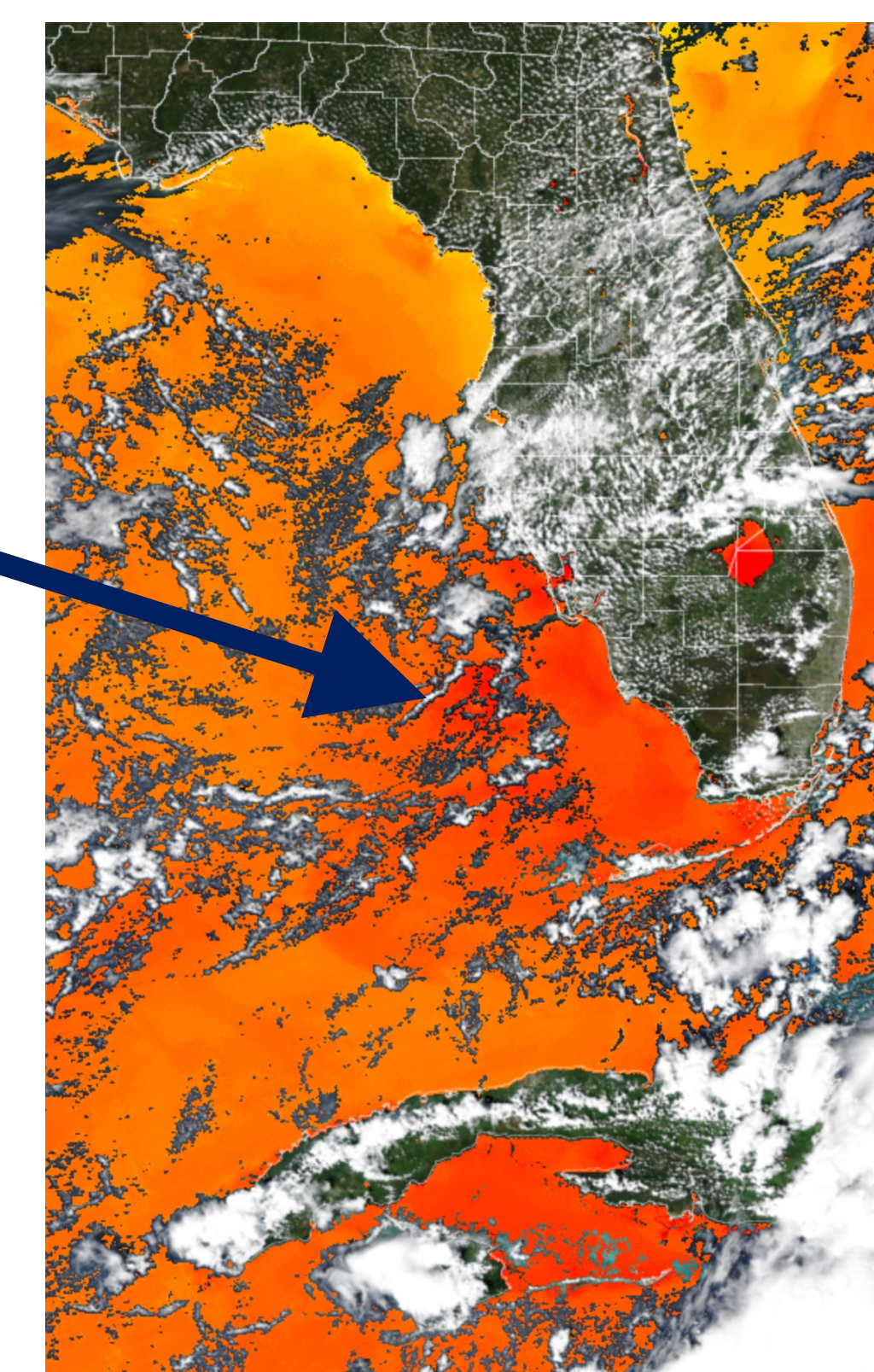
ANALYSIS: PROJECTED HURRICANE PATH AND SEA SURFACE TEMPERATURE IMAGERY



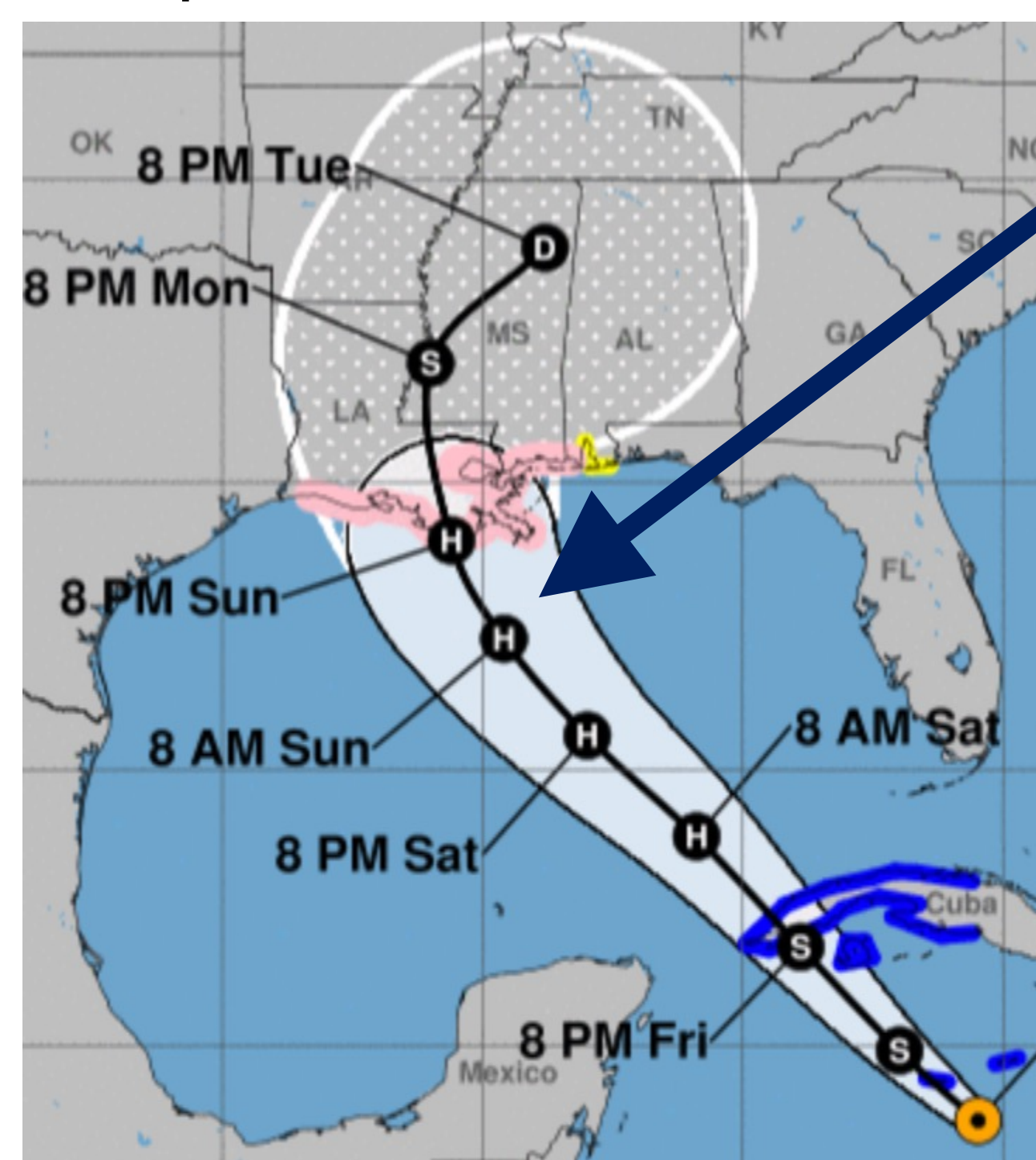
National Hurricane Center Hurricane Ian Path Forecast Sept 25, 2022

Ian forecast to pass over very hot water (>90°F)

Ian strengthened from weak tropical storm to Cat 4 hurricane



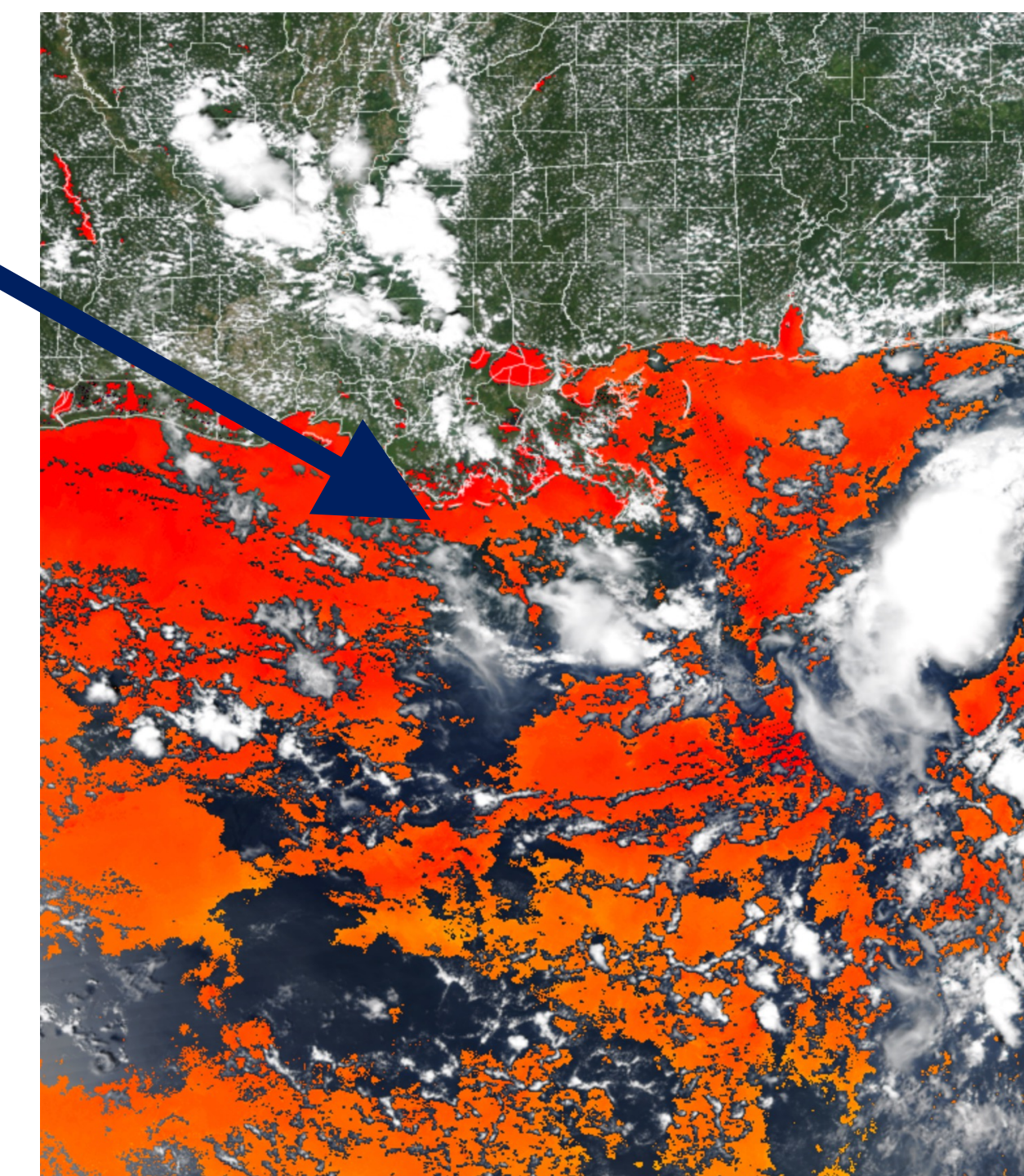
VIIRS Sea Surface Temperature Sept 25, 2022



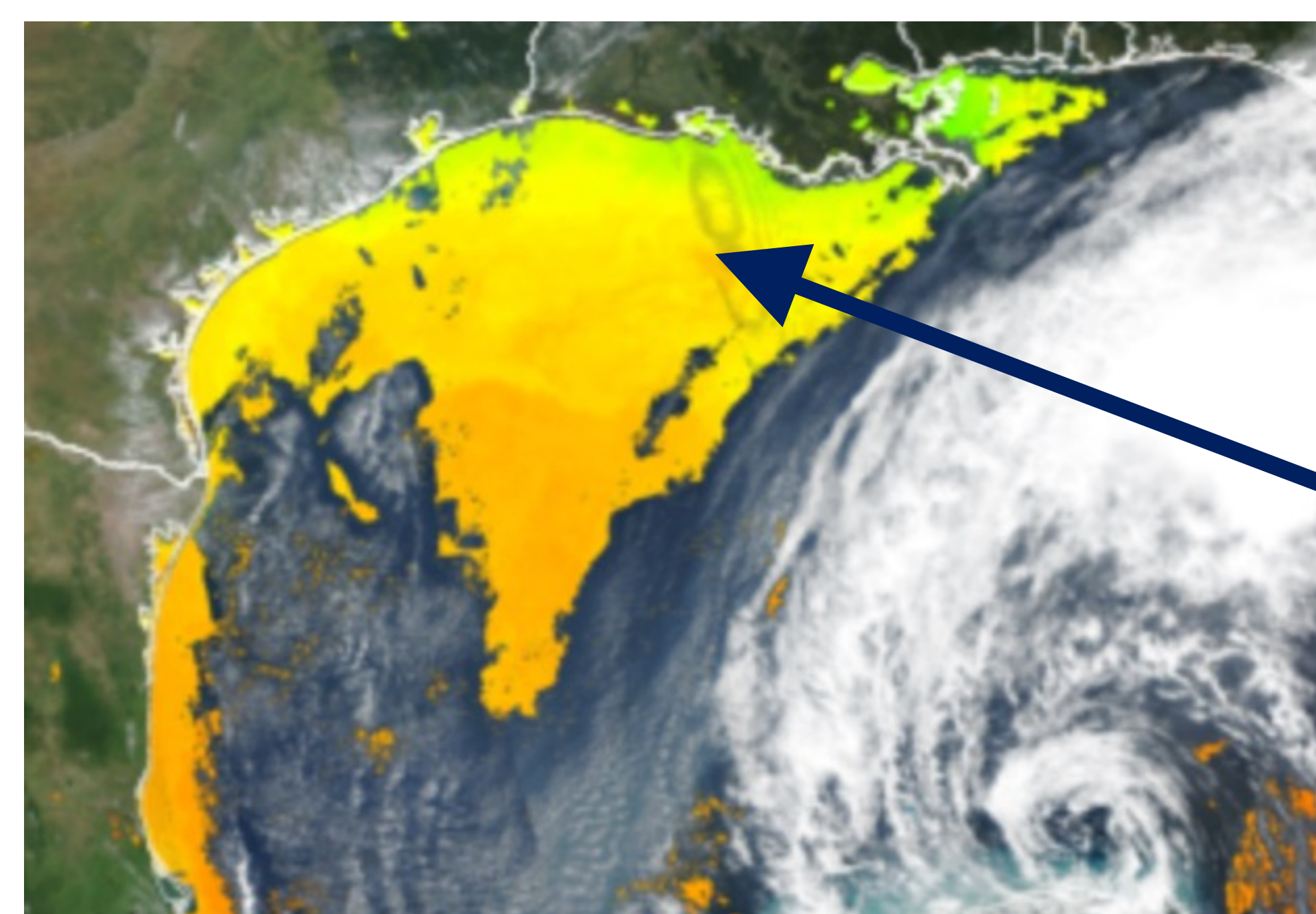
National Hurricane Center Hurricane Ida Path Forecast Aug 26, 2021

Ida forecast to pass over very hot water (>90°F)

Ida strengthened from tropical depression to Cat 4 hurricane



VIIRS Sea Surface Temperature Aug 24, 2021



VIIRS Sea Surface Temperature Oct 5, 2020

Cat 4 Hurricane Delta weakened to Cat 2 over cold water (<80°F)

RESULTS and CONCLUSIONS

Analysis shows high sea surface temperature is predictive indicator of rapid intensification of hurricanes

- 100% (3 of 3) of the hurricanes passing over hot water > 90°F had rapid intensification and reached Category 4 strength
- 0% (0 of 12) of the hurricanes passing over cooler water < 90°F had rapid intensification
- None of the storms passing over cooler water achieved major hurricane strength (>=Cat 3) at landfall

Sea Surface Temperature	% w/ Rapid Intensification	Average Category at Landfall
90°F < T	100%	4
82°F < T < 90°F	0%	1
T < 82°F	0%	1

- Daily VIIRS sea surface temperature imagery was critical for collection of data along the path of the 15 hurricanes
- VIIRS sea surface temperature imagery could be used to improve and enhance hurricane forecast techniques to more accurately predict RI
- Improved forecasting could help save lives and increase preparedness in advance of the most severe storms

REFERENCES

- National Hurricane Center <https://www.nhc.noaa.gov/climo/>
- NOAA Office for Coastal Management <https://coast.noaa.gov/states/fast-facts/hurricane-costs.html>
- Weather Underground Hurricane Archive <https://www.wunderground.com/hurricane/archive>
- Nature: Potential Explanation for Increase in Rapid Intensification <https://www.nature.com/articles/s41467-022-34321-6>
- NOAA JSTAR Image Mapper <https://www.star.nesdis.noaa.gov/jps/mapper/>