

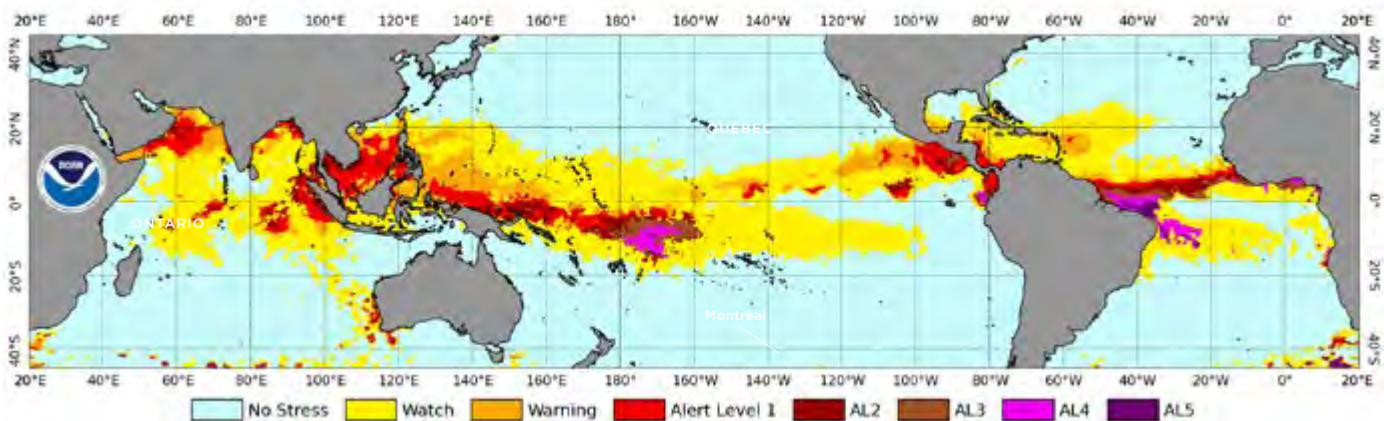
## Joint Polar Satellite System

# Where in the World is Leo DelMar: An Oceanic Mystery

National Oceanic and Atmospheric Administration (NOAA)'s Joint Polar Satellite System (JPSS) satellites help observe Earth's ocean. These observations give scientists more information about the weather, including hurricane and tropical storm forecasting. JPSS also records sea surface temperature and uses that data for coral reef bleaching forecasts. They also track ocean color, chlorophyll productivity, and harmful algal blooms which can injure fish, birds, and other marine life and may inhibit recreational use of water features.

The Visible Infrared Imaging Radiometer Suite (VIIRS) instrument aboard JPSS satellites reveals lights at night which can be used to spot illegal fishing vessels. Marine biologists use satellite imagery and climate data to study the congregation and migration patterns of the marine life they are tracking.

NOAA Coral Reef Watch Daily 5km Bleaching Alert Area 7-day Maximum (v3.1) 3 June 2024



Above is an image of NOAA's Coral Reef Watch on June 3, 2024. Coral reef bleaching occurs when extreme ocean temperatures kill the symbiotic algae that live on reefs. Bleaching can cause disease and eventually death. Rising sea surface temperatures are causing more widespread bleaching events. These images can be found at [Coral Reef Watch](https://coralreefwatch.noaa.gov). (<https://coralreefwatch.noaa.gov>)



### JOINT POLAR SATELLITE SYSTEM (JPSS)

The Joint Polar Satellite System (JPSS) is a collaborative program between the National Oceanic and Atmospheric Administration (NOAA) and its acquisition agent, the National Aeronautics and Space Administration (NASA).

[www.nesdis.noaa.gov/jpss-education](http://www.nesdis.noaa.gov/jpss-education)

[Facebook.com/JPSS.Program](https://www.facebook.com/JPSS.Program)

[@JPSSProgram](https://twitter.com/JPSSProgram)

## Objective

This activity encourages students to use JPSS maps, data, and imagery to solve the mystery of a missing person. Students will be exposed to actual satellite imagery of the ocean and test their graph reading skills.

### Materials:

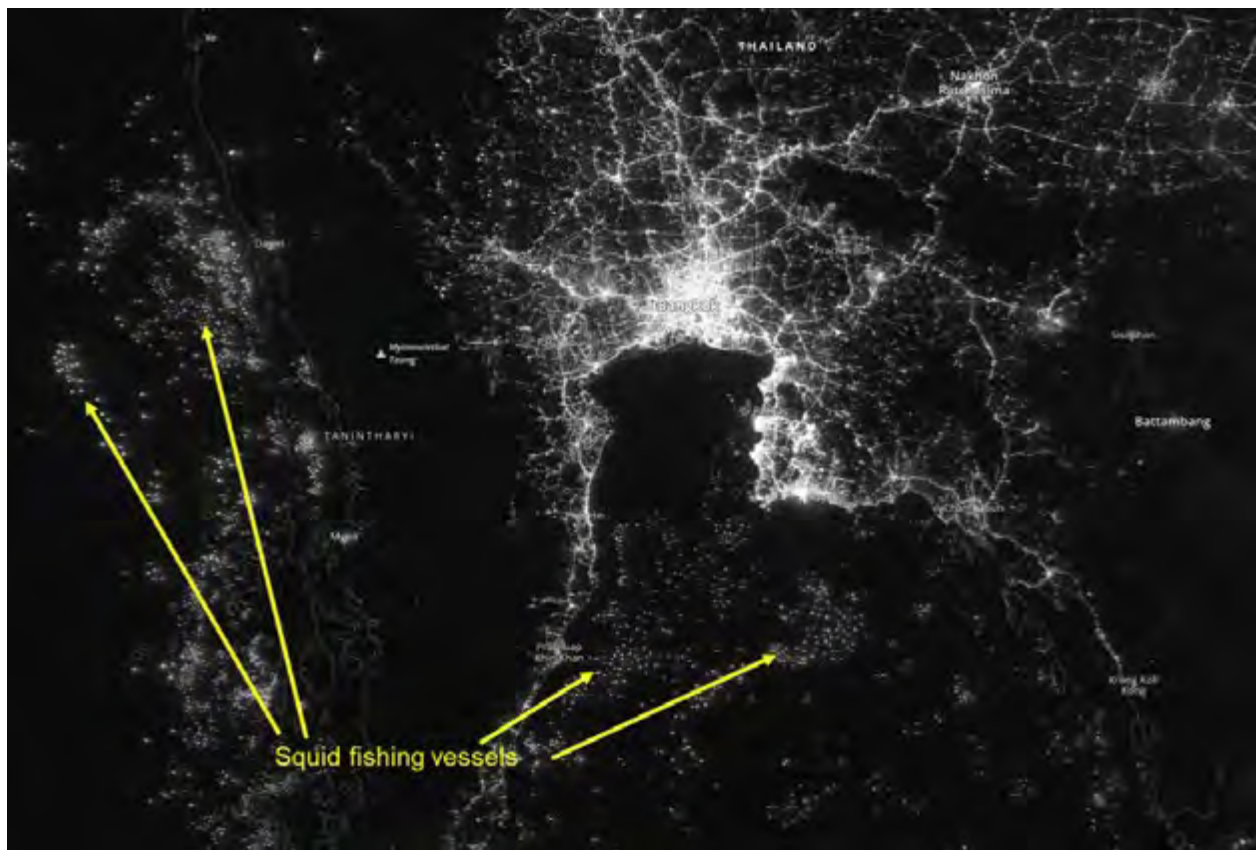
- Printed copies of the maps and clues
- Envelopes or folders to separate the clues
- Colored pencils, markers, or crayons in red, yellow, and blue

## Instructions

This activity should be done in small groups of 3-5 learners. They will use the materials to track down the location of environmentalist, Leonora “Leo” DelMar. Wait for the group to answer each question before giving them the next clue and set of maps. An optional “Bonus Clue” is provided to help narrow down the location if a group gets stuck. This mystery was designed to be solved in about 10 - 15 minutes and a timer can be used to increase the challenge.

### Answer

*Leo is on her solar and wind powered yacht investigating the Dark Fleet in **Central America**.*



Above is an example of imagery showing the “Dark Fleet.” The night-time imagery from the Visible Infrared Imaging Radiometer Suite (VIIRS) instrument aboard JPSS satellites exposes a large number of unregulated squid fishing vessels in the Indian Ocean.

# Hints, tips, and tricks

## Mission Brief

Allow the participants to read and absorb the information about the activity and answer any questions they might have before giving them the first clue. If you are using a timer, don't start the clock until after they've read and understood this card.

## Clue 1

Players will need to color in the map to reveal the three digit number. Squares with a "B" should be colored blue. Squares with an "R" should be colored red. Squares with a "Y" should be colored yellow. This will reveal the code, "351."

## Clue 2

*Participants will need to pick three of the zones on the map before you give them Clue 3.* These zones show the dark fleet of fishing vessels as indicated by red dots. They can pick any three they'd like because they will narrow down these areas in the next clue. Although most people ignore the NOAA-20 VIIRS Day-Night Band map, it actually provides an extra hint since Leo thought North America and South America were important enough to save that map in her desk. The three zones in Alaska, Florida, and Central America are the best zones to start with! Keep the zone map out for the rest of the game since they will need to refer back to it.

## Clue 3

These clues and maps help narrow down Leo's location. The clue says that Leo is going somewhere the ocean is "a toasty 32 degrees Celsius." The ocean temperature map key reveals that 32 degrees Celsius is indicated by the darkest color of red. Some participants only look at the numbers so you can choose to remind them that she could be in any dark red location even if it isn't marked. This narrows down the zones to either Florida or Central America. The voicemail message also mentions that Leo was previously planning to travel to another location but that area is experiencing some dangerous weather. The maps show that a hurricane is headed to Florida. Leo wouldn't want to be on a small boat in a hurricane so that indicates she's not in Florida. Therefore we know that Leo is in Central America.

## Bonus Clue

If students are struggling because they picked the wrong zones to investigate then you can give them this bonus clue to narrow it down further. This clue shows them that Leo is not in Alaska or Florida because those areas are experiencing harmful algal blooms. Combining this information with the ocean temperature map should lead them to choose Central America as her destination.

# Discussion Questions

After the participants have solved the mystery you can discuss some of the maps and imagery they used to see what they have learned.

1. What is the dark fleet?
2. What is sargassum? Is sargassum good or bad for the environment?
3. What is an algal bloom? Do they only form in the ocean? What can make an algal bloom "harmful?"
4. Why is the ocean warmer in the middle of the map and cooler near the edges?
5. What are some advantages of using satellite imagery to study the ocean?

# MISSION BRIEF

The intrepid environmentalist, Leonora “Leo” DelMar, has gone missing while working on an unknown project for P.O.S.E.I.D.O.N (Protecting the Oceans Space and Earth Individually by Doing Operations that are Necessary.)

All you know is that the Coast Guard suspects that she is using her solar and wind powered yacht for transportation so she’s probably somewhere in the ocean.

Leo is a big fan of using NOAA’s Joint Polar Satellite System’s data from NOAA-20 and NOAA-21.

Can you solve the clues and

**find where Leo was planning to go?**

## Clue 1

You start your investigation by checking out Leo's desk. It's unusually tidy. When you open the top drawer, it has red, yellow and blue markers, other office supplies and a **map labeled "Sargassum Density."** That's weird, some of the pixels in the map are missing their colors.

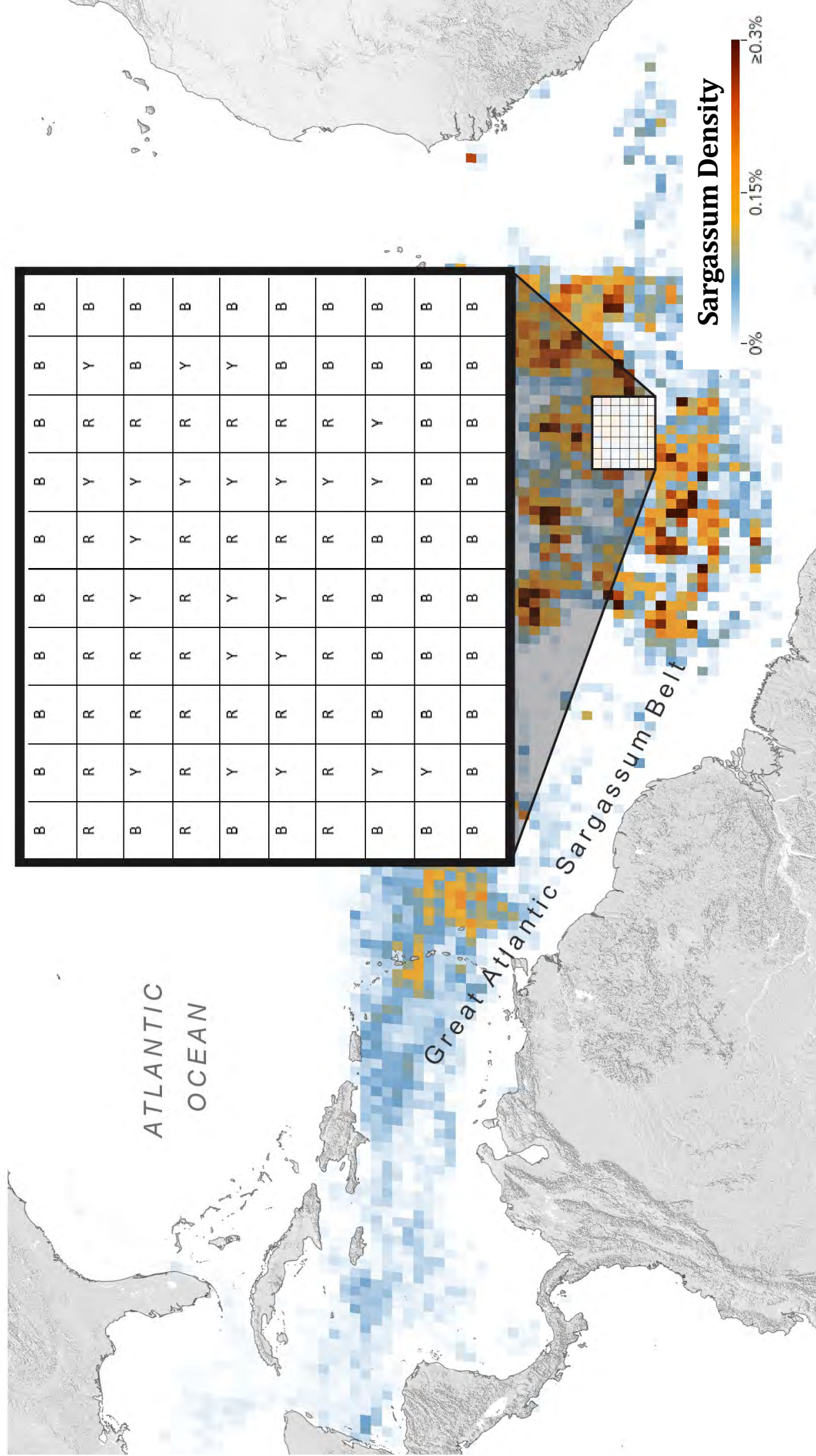
Sargassum is a type of brownish red seaweed that contributes to ocean health by providing habitat for turtles, invertebrates, fish, and birds and by producing oxygen via photosynthesis. But too much of it near the coast can make it difficult for certain marine species to move and breathe.

The second drawer has a padlock with a **three digit code**. You don't see any notes that contain the code but perhaps she left a hint?

**Crack the code to get your next clue.**



## Clue 1

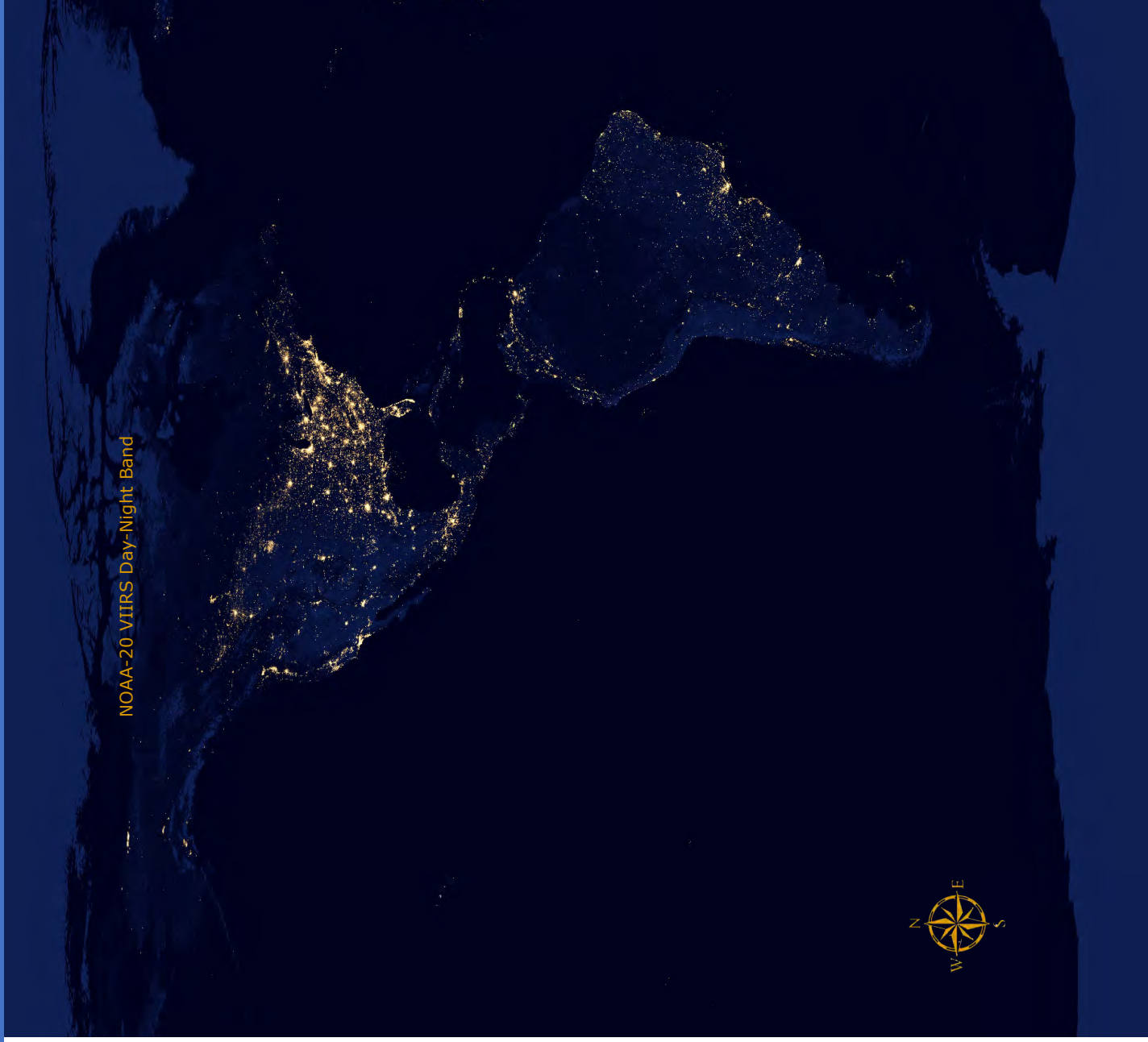


## Clue 2

You find two folders in the filing cabinet marked “Current Mission Research.” One contains NOAA-20 and NOAA-21 images showing the lights at night. It looks like Leo was keeping an eye on the “**dark fleet**” of fishing boats in the ocean. Where could she be?

**Choose three zones of fishing boats on the world map to unlock the next clue.**

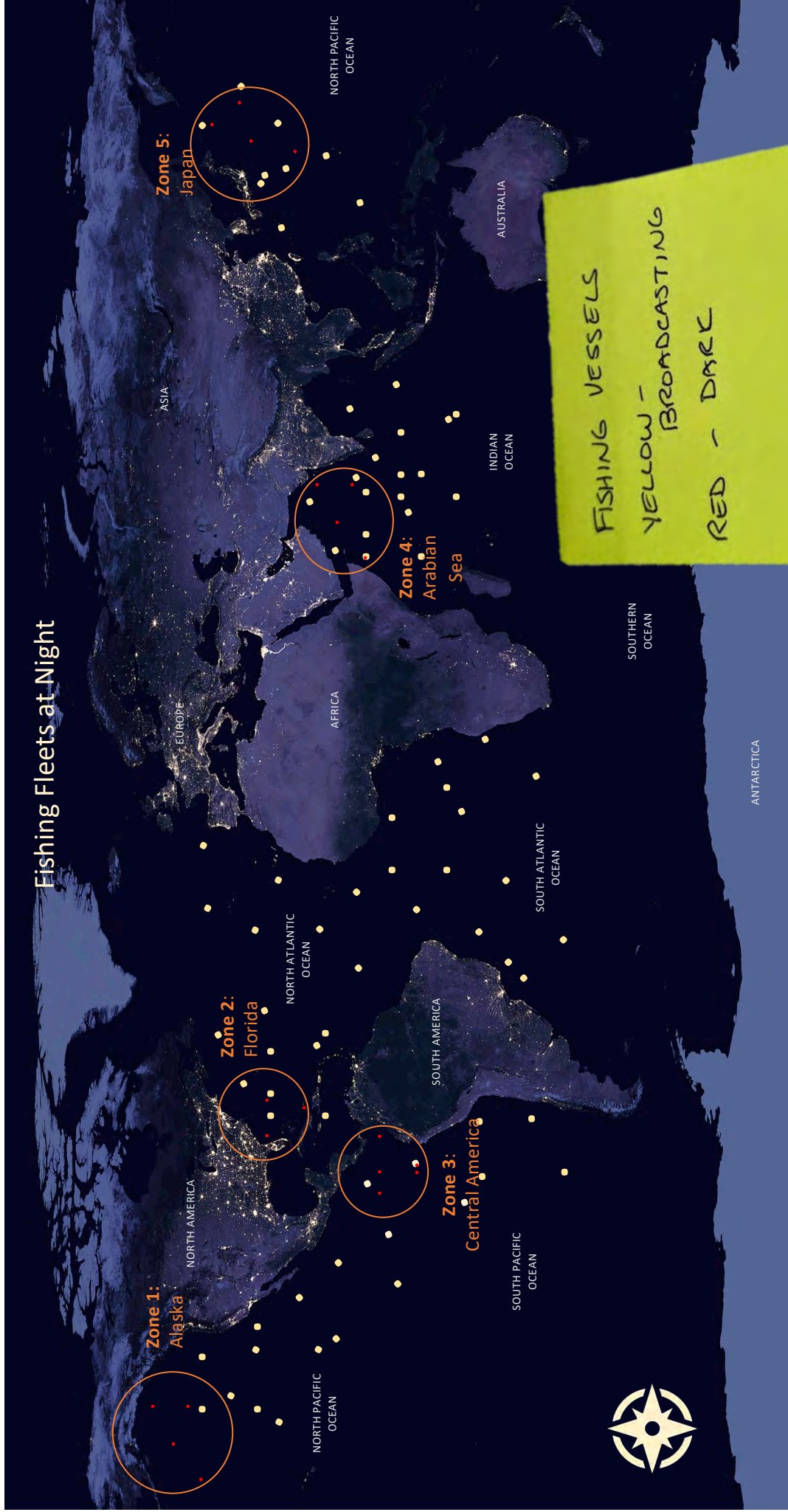
## Clue 2





# Clue 2

## Fishing Fleets at Night



FISHING VESSELS  
YELLOW - BROADCASTING  
RED - DARK

## Clue 2



THE "DARK"  
FLEET =  
ILL EGAL  
FISHING



while the VIIRS instrument on JPSS only detects heavily lit boats, lights are widely used on boats around the world to attract fish.

The ability to cross match VIIRS with Vessel Monitoring Systems (VMS) data helps detect illegal "dark vessels" in the ocean.

—GEO

## Clue 3

While you're looking at the map the red light on Leo's phone starts blinking, indicating that someone just left a voicemail message. You pick up the phone, press 9, and listen to it:

“ Hey Leo, it's Geo. I just dropped off your scuba gear at the pier. According to the Sea Surface Temperature maps the water looks like a toasty 32 degrees Celsius. Don't forget to hydrate! I'm glad we changed plans.

It looks like dangerous weather where you were originally headed.

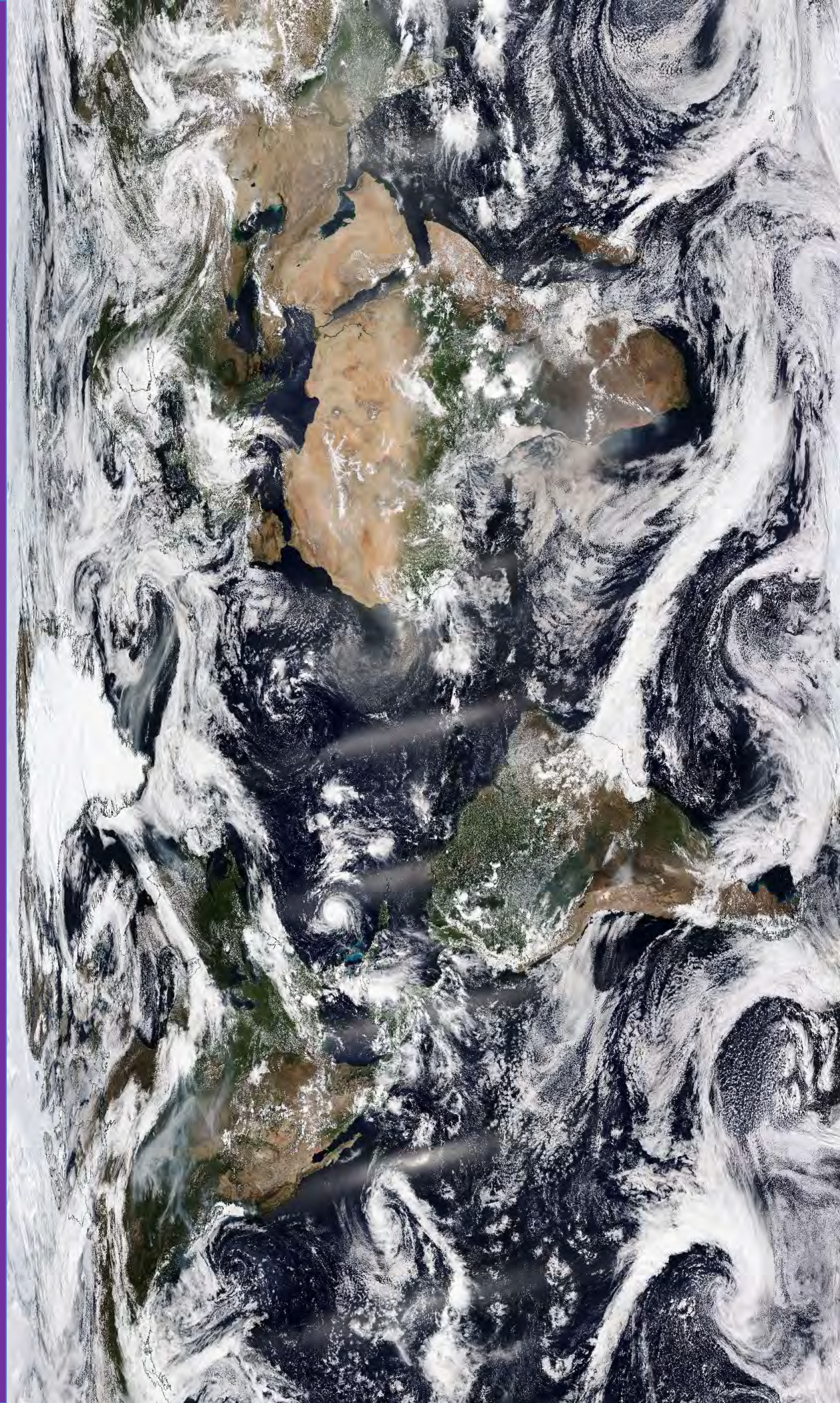
I sent you a text with some NOAA-20 imagery.”

That doesn't give you too many hints....or does it?  
You look through at the texts to see if you find any new clues and then consider your 3 suspected locations.

**Where is Leo?**

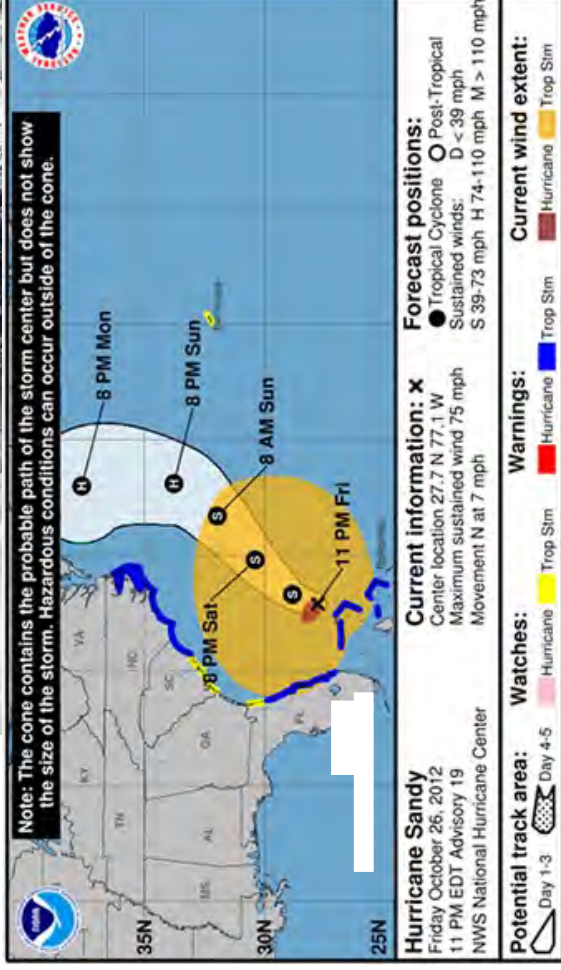
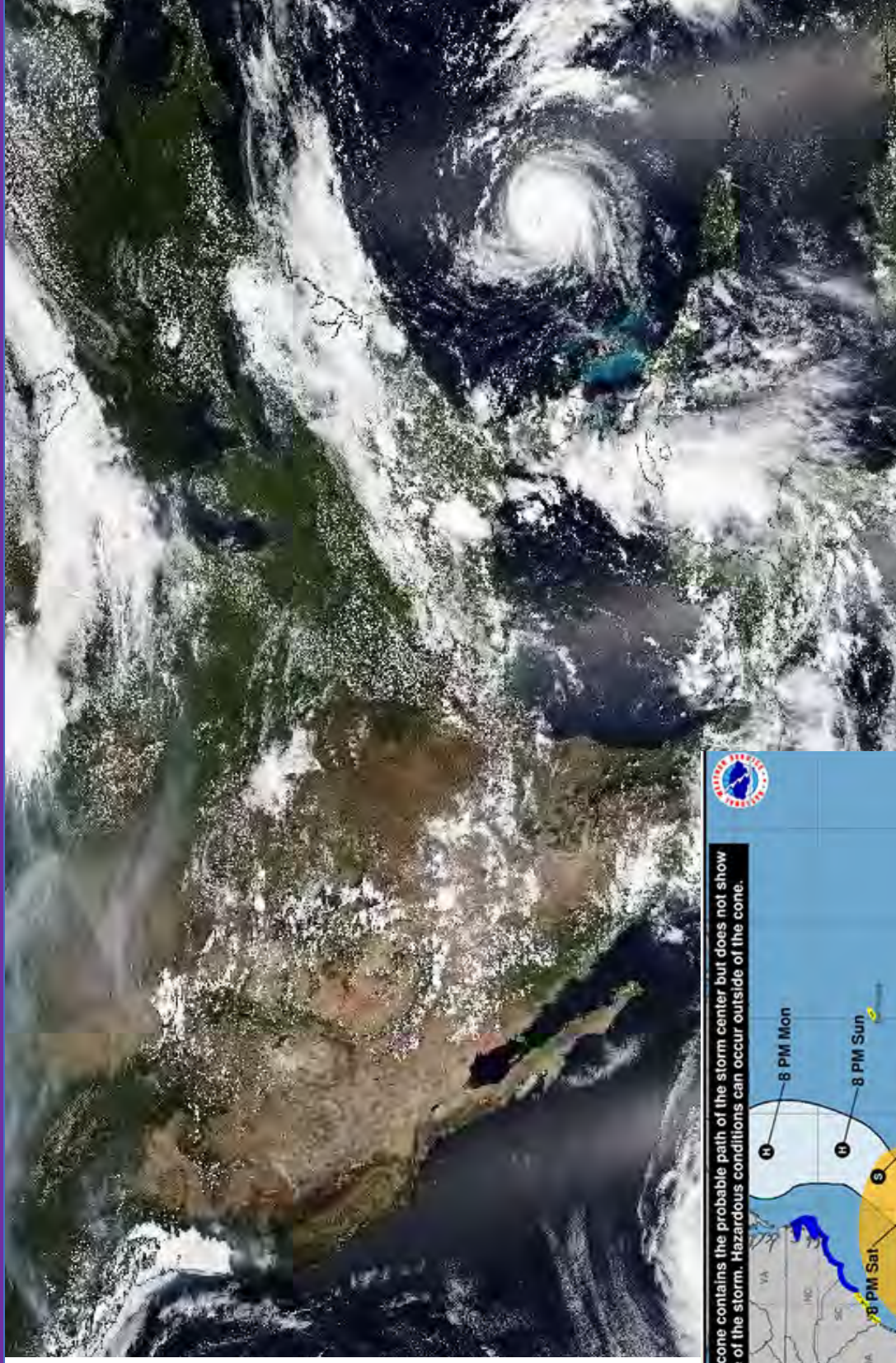


## Clue 3





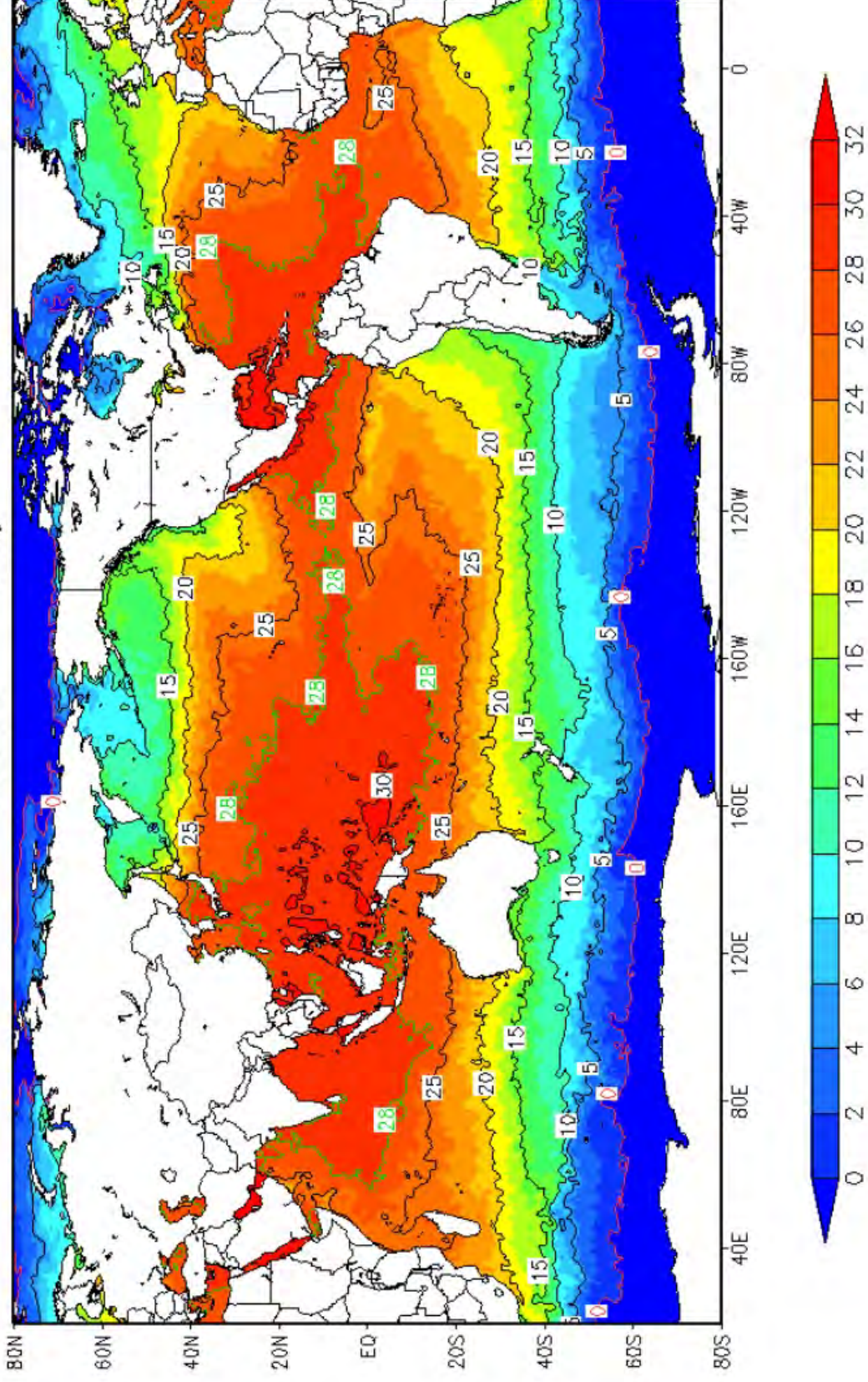
# Clue 3





## NOAA 1/4° Daily Optimum Interpolation Sea Surface Temperature

AVHRR – only



## BONUS CLUE

You've managed to intercept an email from Geo to Leo. The email seems to be a discussion they had the day before Leo disappeared. They had narrowed down the mission site to three locations but Geo was concerned about the water quality and **advised Leo to avoid two of the three proposed sites.**

**Where is Leo?**

# BONUS CLUE

**From:** "DelMar, Leonora" <leo.delmar@gmail.com>  
**To:** "Terra, Geoffrey" <geo.terra@gmail.com>  
**Subject:** Planning the Mission

G,

I totally agree. I will avoid the harmful algal blooms and head to Target 1.

--Leo

**From:** "DelMar, Leonora" <leo.delmar@gmail.com>  
**To:** "Terra, Geoffrey" <geo.terra@gmail.com>  
**Subject:** Planning the Mission

Hey Leo,

I couldn't help but notice that two of your possible target locations aren't looking great for the mission tomorrow.

I'm seeing harmful algal blooms on JPSS's NOAA-20 and NOAA-21 imagery for Target 2 and Target 3. The Visible Infrared Imaging Radiometer Suite (VIIRS) instrument aboard JPSS satellites measures ocean color, sea surface temperature, and light reflectance.

This can help predict harmful algal blooms because algae reflects light differently than phytoplankton and sediment. This unique reflectance makes it easy for VIIRS to "see" harmful algal blooms in the ocean. VIIRS measures ocean color including chlorophyll, and chlorophyll concentration can be used to estimate phytoplankton biomass, which in turn can indicate high biomass blooms. Blooms of harmful algae can turn the water color red, green or turquoise blue and can result in illness or death for humans or animals that come in contact with the water. **Fishing vessels will probably avoid those areas until the harmful algal bloom clears up so don't go to those locations.**

I've attached some helpful imagery I pulled when I was checking on the targets so you can see what you think.

Holding steady for now,

--Geo



## BONUS CLUE



Harmful algal blooms caused by nutrient runoff into the lake are common in Lake Erie. Sea Grant puts the latest research on mitigating harmful algal blooms into the hands of community water resource managers.

(Image credit: Justin Chaffin, Ohio Sea Grant)

