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THE SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

# Space Industry Activity in the South Atlantic

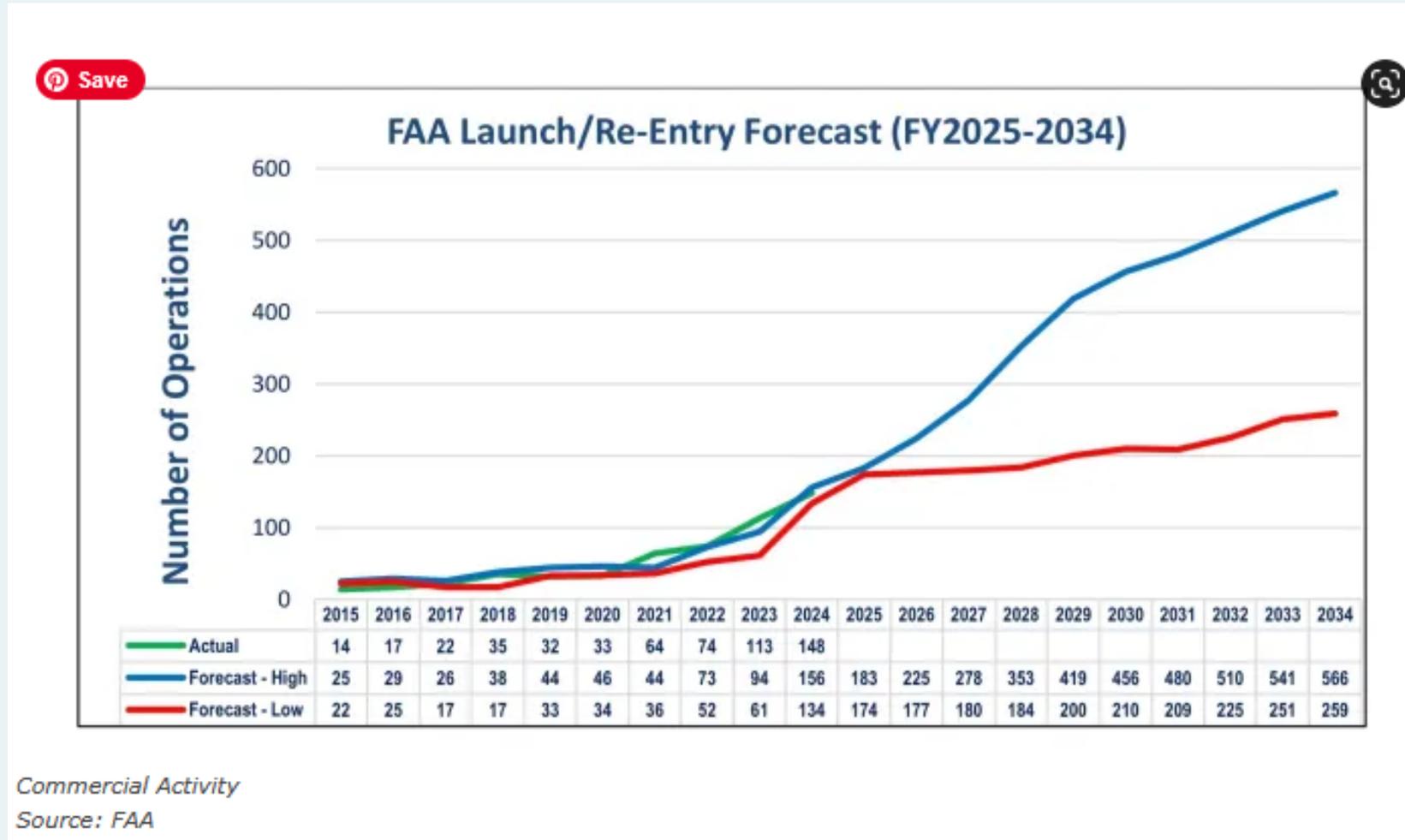


# Background

- The space industry is active in the region, mainly off Florida's east coast.
- Main big players
  - Space X – Private Corporation
  - Space Florida – Public corporation established by the state of Florida
  - NASA – Independent Government agency
  - Space Force – Air Force



# Past and projected future number of space launches as of 2024



# Background



- Since 2023:
  - Presentations to Council and HEAP from Space Florida
  - Freedom of Information Act request to USCG for information on area closures, frequency, and duration to start determining impacts to fisheries
  - Comment letters on proposed projects
- July 2025
  - HEAP made initial recommendations of possible sources of information
  - Staff contacted as many emails and phone numbers as possible



# Contacts made as of December 2025

- Fish and wildlife service: 2
- FL Fish and Wildlife Conservation Commission: 4
- FL Department of Environmental Protection: 8
- NASA: 3 (including two data requests)
- Brevard County: 2
- Indian River Lagoon Council: 1
- Reporters: 1
- Space Force: 2



# Additional Contacts

- Southern Environmental Law
- Space Force Texas
- Cumberland Island
- Port Canaveral
- Florida Atlantic University
- Wharf Study project – staff will revisit
- Numerous websites, public comments, Environmental Assessment (EA), Environmental Impact Statements (EIS)

The following slides summarize the data that has been gathered and next steps

# Point Nemo

- Point Nemo's Definition and Location

- Point Nemo is known as the *oceanic pole of inaccessibility* — the location is farthest from any land (approximately 2,688 km from the nearest landmasses).
- Its remoteness and deep waters of over 4000 meters makes it exceptionally safe for controlled re-entries of large spacecraft.

- Historical Practice

- Since the 1970s, more than 260 defunct spacecraft (including Russia's *Mir* and several Progress cargo vehicles) have been de-orbited there.
- Space agencies from the United States, Russia, Europe, and Japan have used the region for such splashdowns, and the International Space Station is slated to be de-orbited there at the end of its operational life.

- Environmental Factors

- The surrounding waters are part of the South Pacific Gyre, an area with extremely low biological productivity.
- While not entirely ecologically inert, the limited biodiversity in the region reduces concerns about impacts on marine ecosystems relative to more biologically productive zones.



# Point Nemo: Legality

- International space law (Outer Space Treaty, Liability Convention, voluntary UNOOSA debris guidelines) sets responsibilities and good practices for spacefaring States, including liability for damage caused by space objects upon re-entry and encouragement of debris mitigation.
- The marine legal framework under UNCLOS and emerging biodiversity treaties create duties to protect the marine environment, which may apply to the sinking of spacecraft, but these duties are interpreted and implemented through State practice and evolving law.
- There is no single binding international agreement that specifically authorizes or regulates spacecraft splashdowns into Point Nemo, but existing space and ocean law obligations must be considered in responsible disposal planning, reflecting broader commitments to safety and environmental protection.

# Public comments on EIS and EAs: Key Concerns



- Habitat disruption & species of concern
  - The surrounding area is a biologically rich zone with many threatened, endangered, or sensitive species
  - Launch operations, landings of boosters, and associated infrastructure can affect habitat directly (clearing land) or indirectly (disturbance, noise, light).
- Vegetation change, coastal erosion, dunes & dunes' role
  - The dunes are a crucial buffer, both for protecting infrastructure and providing nesting habitat (e.g. turtles).
  - Erosion and retreat of the shoreline threaten both the infrastructure and habitats.
  - Study of recent years (2016-2023) shows shifts in vegetation cover; these changes could be natural or because of launch activity.
- Pollutants, exhausts, and chemical exposures
  - Rocket launches emit exhaust, particulates, and sometimes acidic components into air and water
  - Solid rocket motors tend to have worse effects than liquid propellant launches, with more severe vegetation damage

<https://ntrs.nasa.gov/citations/20090007547> (1990)

<https://phys.org/news/2025-03-faa-issues-environmental-spacex-pad.html>

<https://www.usgs.gov/programs/coastal-and-marine-hazards-and-resources-program/science/cape-canaveral-dune-vulnerability>

<https://nautil.us/rockets-are-blasting-the-environment-1195186/>



# Public comments on EIS and EAs:

## Key Concerns

- Noise, lights, vibrations, and behavioral disruption
  - Loud noise and vibration from launches can disturb nesting birds, disrupt wildlife behavior, and disturb reproduction.
  - Artificial lighting and night operations (launches, landings, processing) can disorient sea turtle hatchlings, migratory birds, etc.
- Cumulative & climate-related stressors
  - Sea level rise, changing storm frequency/intensity, shoreline retreat, wetland loss
  - Fire suppression has altered some ecosystems (scrub, flatwoods) that depend on periodic burns, influencing surrounding species composition
- Regulatory constraints & biological opinions
  - Under the U.S. Endangered Species Act, “biological opinions” must be issued to assess whether proposed actions will jeopardize threatened species or damage their critical habitat.
  - Recent environmental assessments/draft EIS (Environmental Impact Statements) include mitigation, but criticisms remain about whether mitigation is sufficient.

<https://phys.org/news/2025-03-faa-issues-environmental-spacex-pad.html>

<https://www.patrick.spaceforce.mil/Portals/14/2%20Draft%20EA%20Relativity%20LC16%20Public%20Release.pdf>

<https://www.ornl.gov/publication/satellite-based-assessment-rocket-launch-and-coastal-change-impacts-cape-canaveral>

<https://newspageconomy.ca/2025/08/23/the-future-of-americas-spaceport-assessing-launch-pad-capacity-at-cape-Canaveral/>



# Trade-Offs & Mitigations

- Shoreline restoration & vegetation planting
  - NASA has done projects to rebuild dunes, replenish sand, and restore native coastal vegetation (sea oats, sea grape, railroad vine)
- Prescribed fire / fire management
  - Controlled burns are used to help preserve biodiversity and reduce risk of wildfires.
  - Yet launch operations and safety protocols can conflict with ability to burn or maintain fire regimes.
- Limiting location footprint
  - When siting new launch pads, boosters, or processing facilities, regulators are pushing to avoid critical habitat for species like the Florida scrub-jay and southeastern beach mouse.
- Limiting launch cadence / operational windows
  - Minimizing night launches, limiting booster returns, and scheduling launches during times less harmful to wildlife (non-nesting seasons)
  - Ensuring recovery operations follow environmental best practices.

<https://phys.org/news/2025-03-faa-issues-environmental-spacex-pad.html>

<https://www.ornl.gov/publication/satellite-based-assessment-rocket-launch-and-coastal-change-impacts-cape-canaveral>

<https://www.nasa.gov/centers-and-facilities/kennedy/shoreline-restoration-protects-kennedy-infrastructure-wildlife>



# **Assessment of Coastal Water Resources and Watershed Conditions In and Adjacent to Canaveral National Seashore (National Park Service, 2012)**

- Purpose: This is a baseline ecological health assessment of the Canaveral National Seashore and adjacent Mosquito Lagoon (part of the Indian River Lagoon system).
- Key Physical & Chemical Findings:
  - Water quality is generally fair to good
  - Nitrogen and phosphorus are mostly stable
  - Occasional low dissolved oxygen during summer (a stress risk)
  - Turbidity is a major concern, with suspended sediments driving light loss in the lagoon
- Biological Health:
  - Strong populations of Loggerhead and green sea turtles, Shorebirds, and Seagrasses (though some historical declines)
  - Barrier island ecosystems remain functional but vulnerable

# Assessment of Coastal Water Resources and Watershed Conditions In and Adjacent to Canaveral National Seashore (National Park Service, 2012)



- Major Threats Identified:
  - Climate change and sea-level rise
  - Storm-driven runoff
  - Eutrophication
  - Habitat loss
  - Invasive species
  - Human recreation pressure
  - Marine debris
- Important Limitation: This report does NOT directly analyze space launch pollution, but it provides critical baseline water-quality and ecosystem health data for comparison with newer rocket-impact studies.
- Main Conclusion: The Canaveral–Mosquito Lagoon system was ecologically functional in 2012, but showed clear vulnerability to additional stressors, making it highly sensitive to new pollution sources such as increased space launch activity.



# **Space Launches and Their Possible Impact on the Deterioration of the Indian River Lagoon Marine Ecosystem in Florida (Ayassamy, 2025)**

- **Purpose:** This paper examines whether rocket launches near Florida contribute to pollution and ecological stress in the Indian River Lagoon (IRL), one of the most biodiverse estuaries in North America.
- **Methods:** Systematic literature review using Scopus, Web of Science, and extensive grey literature.
  - Only 6 relevant studies were found, showing how little direct research exists on this topic.
- **Key Pollutants Identified:**
  - Trace metals: mercury, aluminum, lithium, vanadium
  - Acidifying agents: hydrochloric acid (HCl)
  - Particulates: black carbon
  - Physical debris: carbon composites, foam, rocket fragments, batteries
  - Ecological Impacts Identified:
    - Acidification of surface waters after launches
    - Metal contamination in estuarine organisms
    - Physiological stress in marine life
    - Potential links to fish kills and harmful algal blooms



# **Space Launches and Their Possible Impact on the Deterioration of the Indian River Lagoon Marine Ecosystem in Florida (Ayassamy, 2025)**

- Indian River Lagoon Findings:
  - Some spikes in acidity and trace metals align temporally with launch events
  - However, direct cause–effect remains unproven due to limited monitoring data
- Main Conclusion: Rocket launches represent a plausible but under-monitored environmental stressor for the IRL.

# Potential Negative Effects of the Brazilian Space Program on Coastal Sharks (Wosnick et al., 2023)



- Purpose: This article investigates the ecological consequences of Brazil's Alcântara Space Center, particularly after a 2003 rocket explosion, on nearby marine predators.
- Key Discovery: Extremely high levels of rubidium (Rb) were detected in shark muscle tissue near the launch site:
  - Up to 24.65 mg/kg dry weight
  - The highest concentration ever recorded in any living organism
- Why Rubidium Matters:
  - Used in rocket fuels and propulsion systems
  - Bioaccumulates and biomagnifies through food webs
  - Potential reproductive toxicity
  - Human health risks due to shark meat consumption

# Potential Negative Effects of the Brazilian Space Program on Coastal Sharks (Wosnick et al., 2023)



- Ecological Impacts:
  - Apex predator contamination indicates entire food-web exposure
  - Possible population-level impacts on sharks
  - Long-term biodiversity risk on the Brazilian Amazon coast
- Governance Failures Identified: No mandatory environmental impact studies, regular contamination monitoring, and disaster-response ecological assessments
- Main Conclusion: The authors call for urgent biomonitoring and environmental regulation as Brazil expands its commercial space operations. The Alcântara site is already showing measurable toxic contamination in wildlife.

# **Ecological Impacts of the Space Shuttle Program at John F. Kennedy Space Center, Florida (*NASA Technical Memorandum Document ID 20140012489*)**



- **Purpose and Scope:** The report evaluates the long-term (40 year) ecological effects of the Space Shuttle Program on the environment surrounding NASA's Kennedy Space Center (KSC) and the adjacent Merritt Island National Wildlife Refuge (MINWR)
- **Direct and Indirect Ecological Effects**
  - **Land use alterations:** Contributed to changes in land use and habitat modification through space program activities and associated regional development.
  - **Habitat loss and modification:** Major construction (e.g., Shuttle Landing Facility and Space Station Processing Facility) disturbed some undeveloped land; most operations occurred on previously developed or industrial areas.
  - **Water quality impacts:** Development played a role in cultural eutrophication of the Indian River Lagoon, a long-standing estuarine water quality issue.
- **Launch Emissions and Deposition**
  - **Atmospheric deposition:** Concerns about potential acid rain climate modification did not materialize measurably. Deposition of hydrogen chloride (HCl) and particulates from shuttle exhaust were assimilated, and acute effects on soils or vegetation were not evident.
  - **Metals deposition:** Shuttle emissions contained trace metals, but no acute environmental impacts were found. Research continued under regulatory monitoring (e.g., RCRA) to evaluate potential sub-lethal ecological effects.

# **Ecological Impacts of the Space Shuttle Program at John F. Kennedy Space Center, Florida (*NASA Technical Memorandum Document ID 20140012489*)**



- **Positive Environmental Contributions**
  - Environmental compliance infrastructure: Implementation of wastewater controls, hazardous waste management systems, and stormwater infrastructure minimized impacts from NASA operations.
  - Remediation and habitat restoration: Past contamination sites have been remediated; wetlands and scrub habitats have been restored in partnership with agencies like the U.S. Fish and Wildlife Service (USFWS) and the St. Johns River Water Management District (SJRWMD).
  - Protected lands: KSC remains one of the largest natural preserves on Florida's east coast due in part to NASA's ongoing stewardship.
- **Long-Term Monitoring and Future Issues**
  - Wetlands and scrub habitat health
  - Effects of emerging contaminants
  - Adaptation to climate change and projected sea level rise
  - Habitat management associated with KSC's transition to a mixed government-commercial launch facility

# Overall Takeaway Across All Three papers



Space launches introduce real chemical and debris pollution into coastal systems



Metal contamination (Hg, Rb, Li) are now documented in marine predators



Acidification and toxic deposition are plausible stressors for estuaries



Baseline health of the Indian River Lagoon is fragile

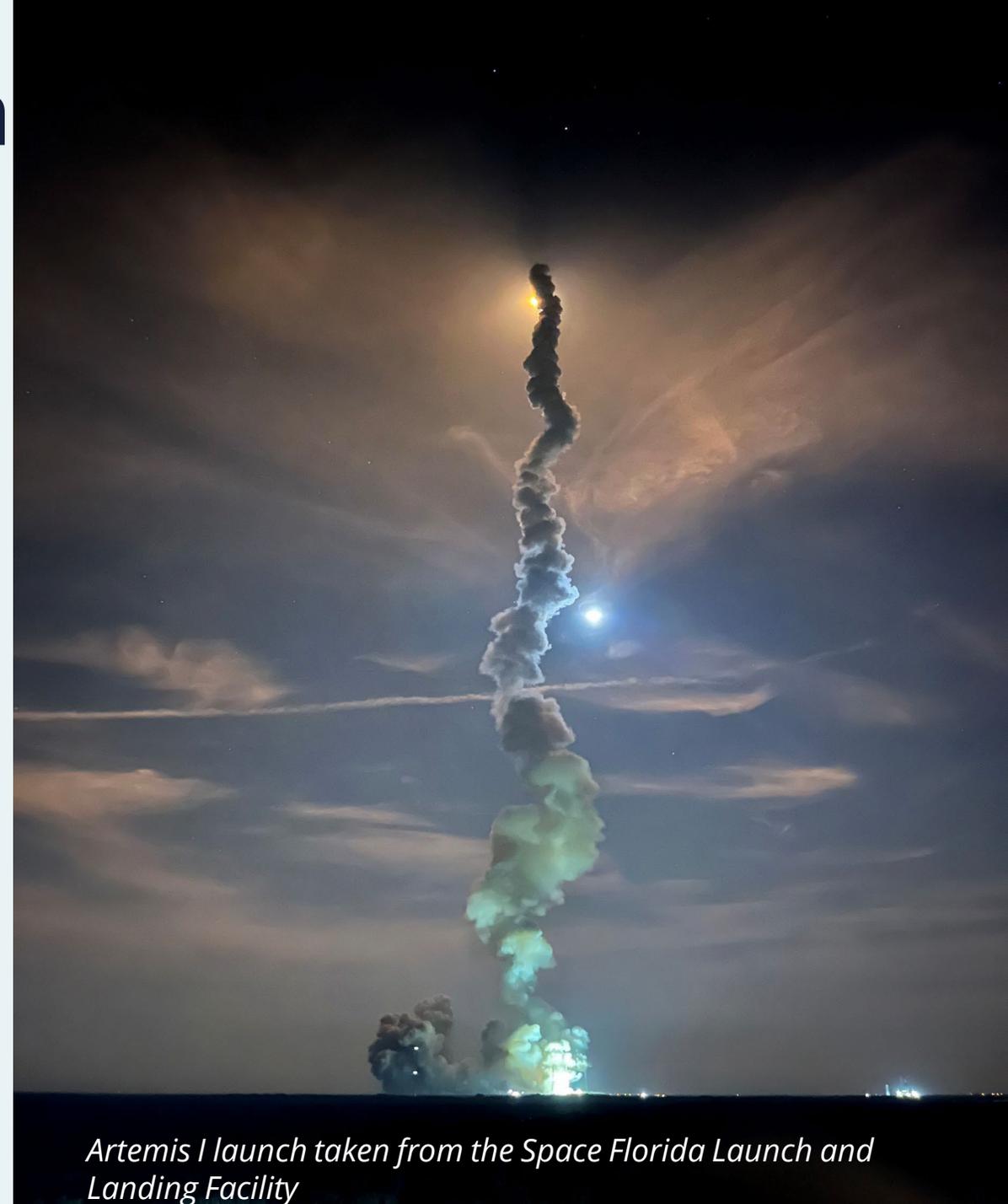


Current regulation and monitoring are inadequate for space-related pollution

# Fishermen Information

- There is plenty of anecdotal information and people who are willing to talk about space impacts
  - No one is gathering this info
- Could a Citizen Science Project be possible?

Staff will explore and report back



*Artemis I launch taken from the Space Florida Launch and Landing Facility*

# Next Contacts

- Fish Houses: Wild Ocean and Seafood Atlantic may have space debris locations
- NOAA SERO HCD Branch Chief - consults with Space Force, USAF, NASA, FAA, etc., regarding rocket launches that impact fishery resources.
- NOAA Office of Protected Resources - consults with Space Force, USAF, NASA, FAA, etc. regarding rocket launches that impact protected species.
- Air Force Center for Engineering and the Environment - conducted USAF environmental planning for space operations prior to the establishment of the US Space Force in Dec 2019.
- Anyone else?

# Questions

- Are there alternative data sources that could be tapped to allow us to evaluate the impacts of these programs?
- Is someone willing to host a data-gathering webpage?
- How can the Council further its goal of protecting EFH considering increased activity related to the space industry?

A wide-angle photograph of a sunset over the ocean. The sun is low on the horizon, partially obscured by dark clouds, creating a bright orange and yellow glow. The sky transitions from a deep blue at the top to a lighter, hazy blue near the horizon. The ocean is dark blue with gentle waves, and the sun's light reflects on the water's surface. The text "Thank you" is centered in the middle of the image in a bold, white, sans-serif font.

**Thank you**