# Ocean Modeling for Improvement of Hurricane Forecasts


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# Ocean Model for TC prediction

## Accurate prediction of storm intensification requires…

*3D Ocean model coupling*

*"(tropical) cyclone models to **incorporate ocean subsurface dynamics**, as well as buoy **data to represent these dynamics**. If any one of these components is missing, prediction accuracy is compromised."*

*Data Assimilation*

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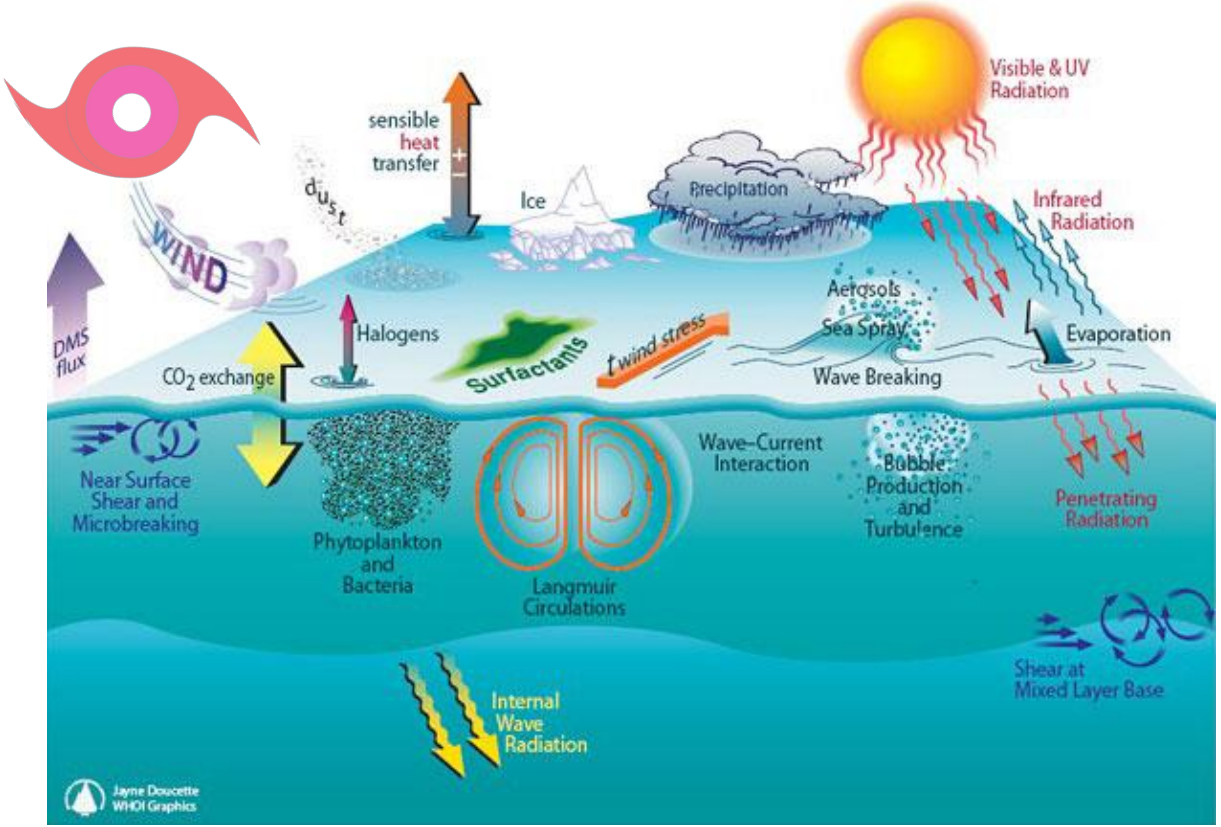
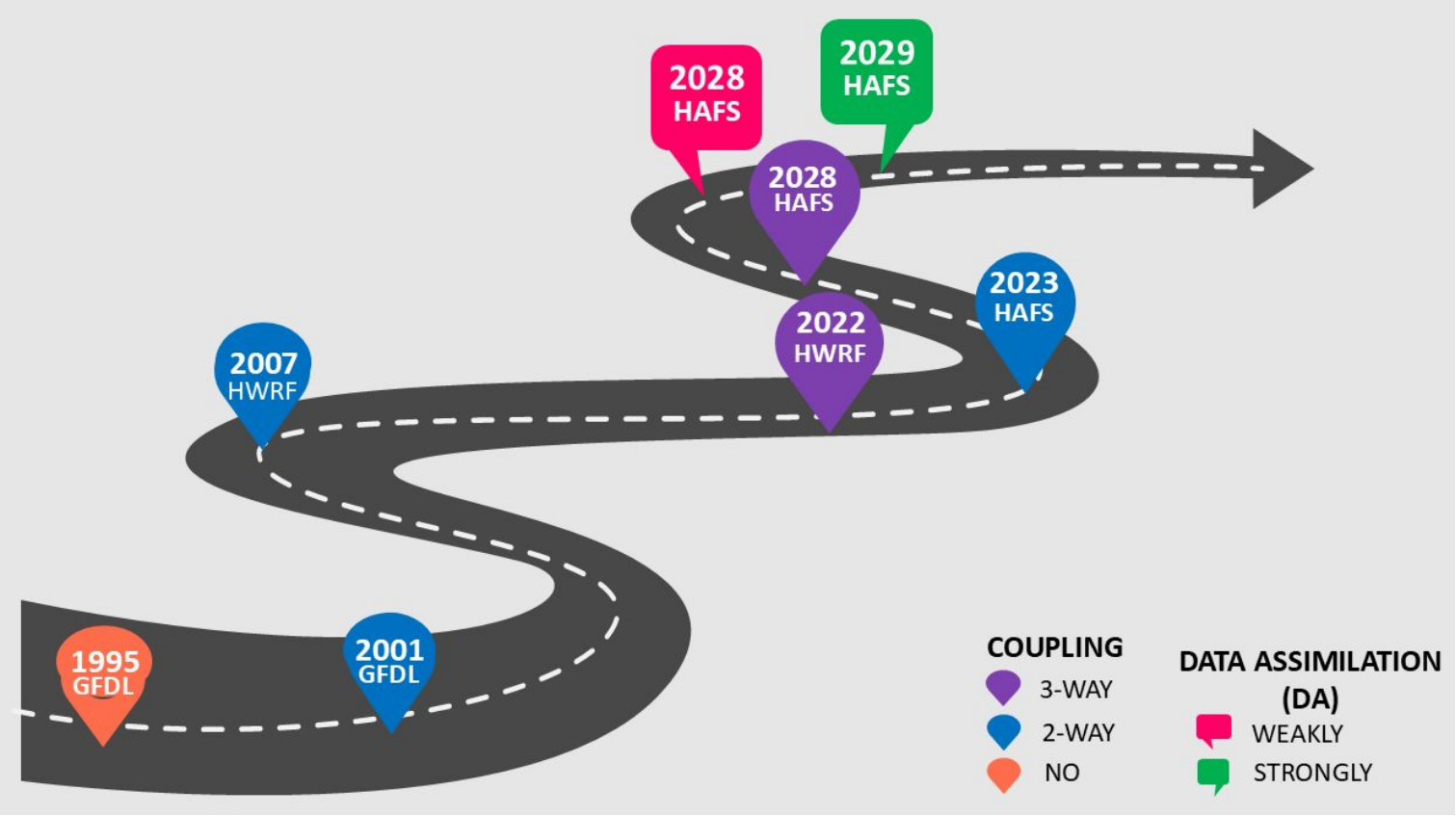
# Earth System Modeling




…

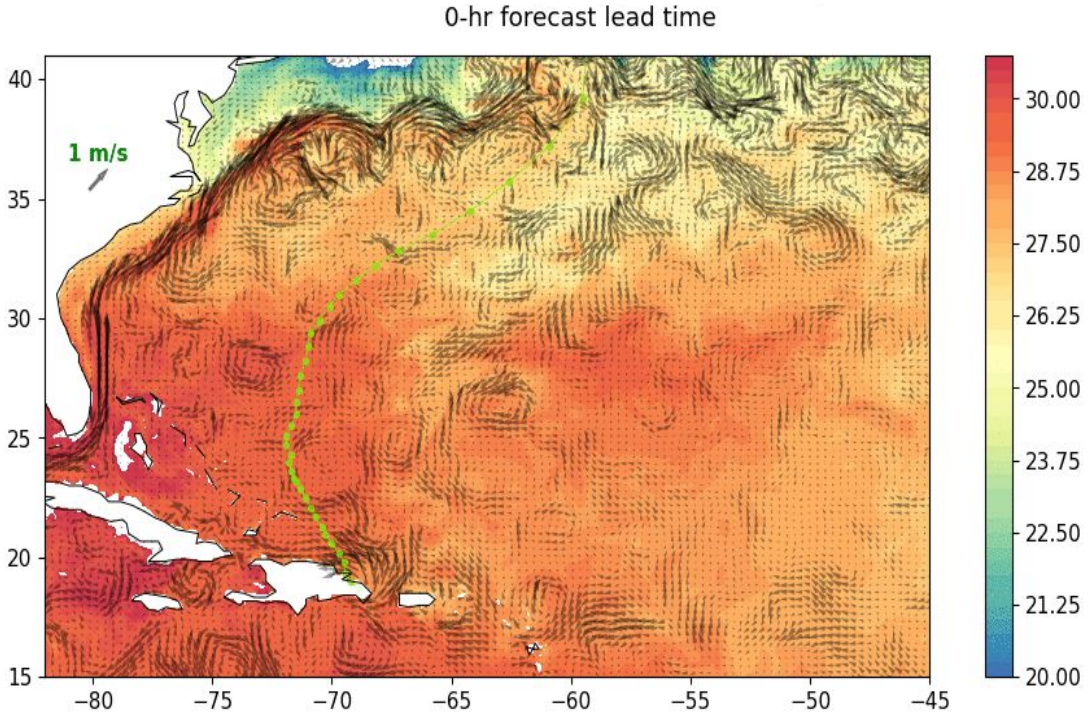
***Technology and science still trailing behind !***

# Tropical Cyclone Modeling Roadmap:
## *Waves and Coupled DA Are Missing!*



# Next-Gen Ocean Model (MOM6): Hurricane Fiona

## Sea Surface Temperature, Currents, Predicted TC track




**Relevant phenomena for TCs:**

- SST cooling
- Storm-induced currents
- Cold Wake
- Storm-induced upwelling
- Storm-induced inertial waves

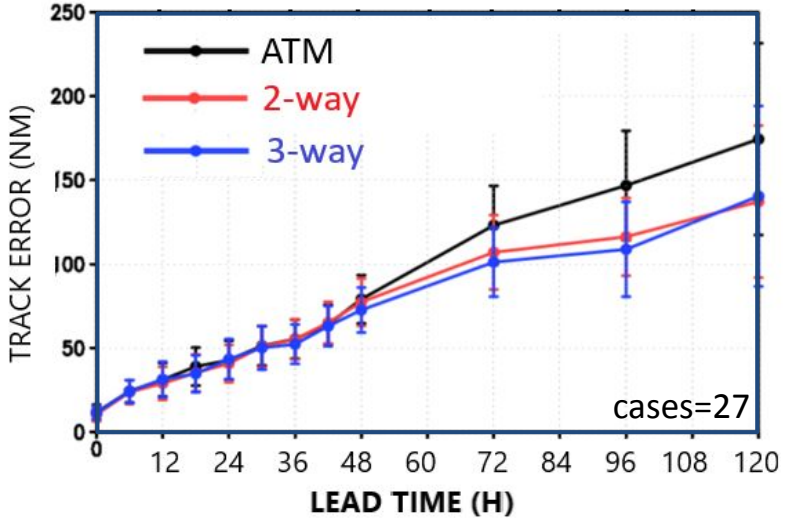
**Why do they matter?**

- ~4 hours - flux modulation
- ~18 hours - intensity modulation

# 3-Way Coupling Improves TC forecasts

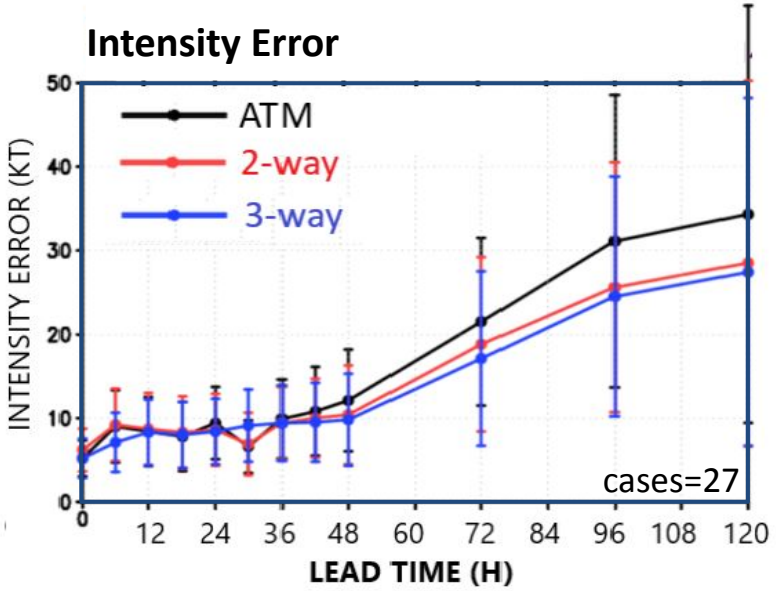
## Hurricane Laura (2020)

### Track Error




**IMPROVEMENT!**
6-27%

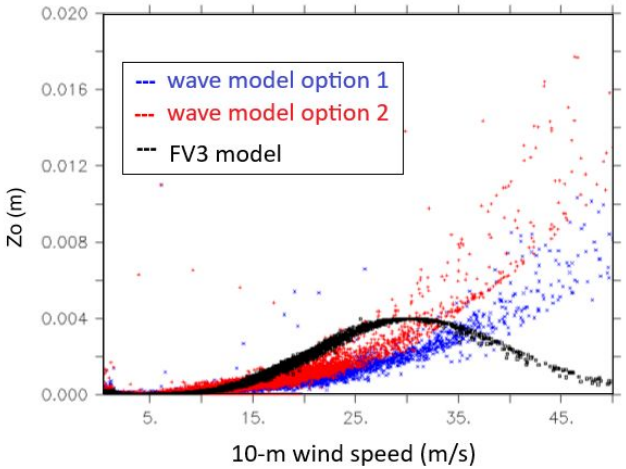
### Intensity Error



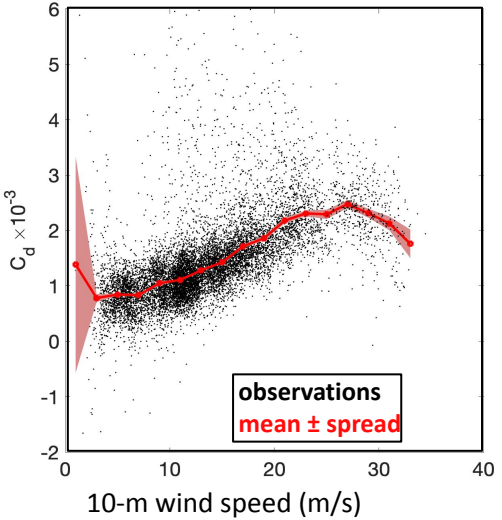

**IMPROVEMENT!**
5-17%

# Using Observations to Improve Modeling

**Surface Roughness (Model)**

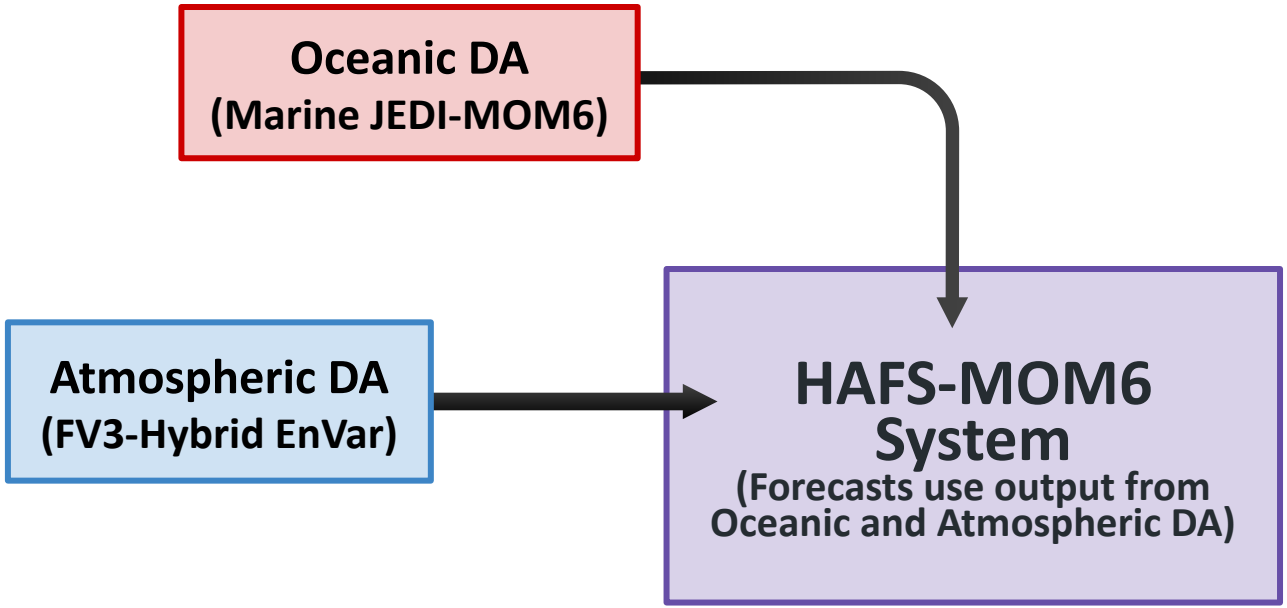



**Drag Coefficient (Saildrone)**




- Momentum exchange depends on sea state & varies by TC quadrant
- Saildrone observations are helpful for verification

# Advancing HAFS with MOM6 and Oceanic DA



# Our Path Forward

| Milestone | 2025 | 2026 | 2027 | 2028 | 2029 |
|---|---|---|---|---|---|
| Deliverables | | | | | |
| **COUPLING** | | | | | |
| 3-way | | | | | |
| 3-way + sea spray | | | | | |
| **DATA ASSIMILATION** | | | | | |
| weakly coupled 3DVar | | | | | |
| weakly coupled hybrid | | | | | |
| strongly coupled | | | | | |

Lighter shade - ***R***esearch/***D***evelopment/***A***dvancement
Darker shade - potential ***T***ransition

# Closing Summary

## Key Takeaways

- Marriage between Research and Operations among the NOAA LOs
- Build high-fidelity Earth-system model with coupled data assimilation

## Future Outlook

- 3-way coupling and 3-way coupling + sea spray
- Weakly coupled and strongly coupled DA