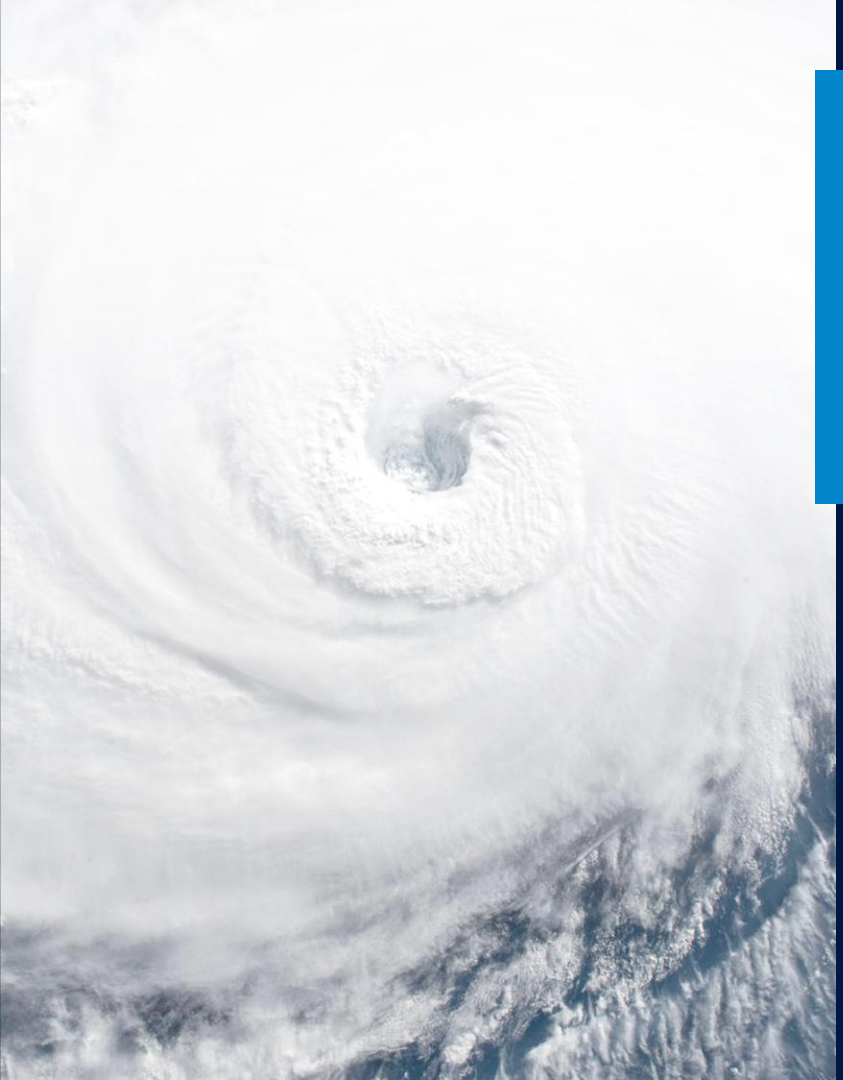


Impact of the Mississippi River plume on Hurricane Idalia (2023): a sensitivity experiment

Matthieu Le Hénaff (NOAA/AOML)

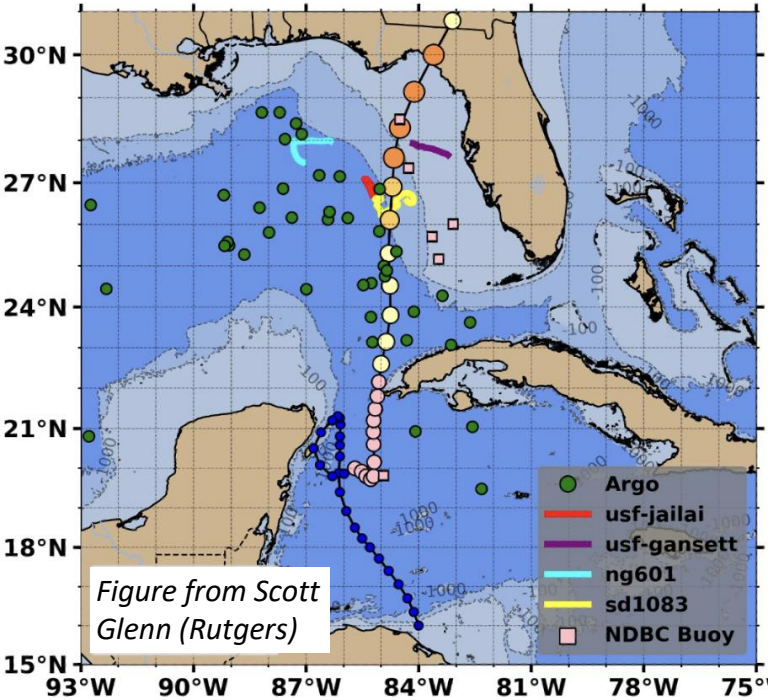
Lew Gramer (U.Miami/CIMAS-NOAA/AOML)

Atlantic Oceanographic & Meteorological Laboratory

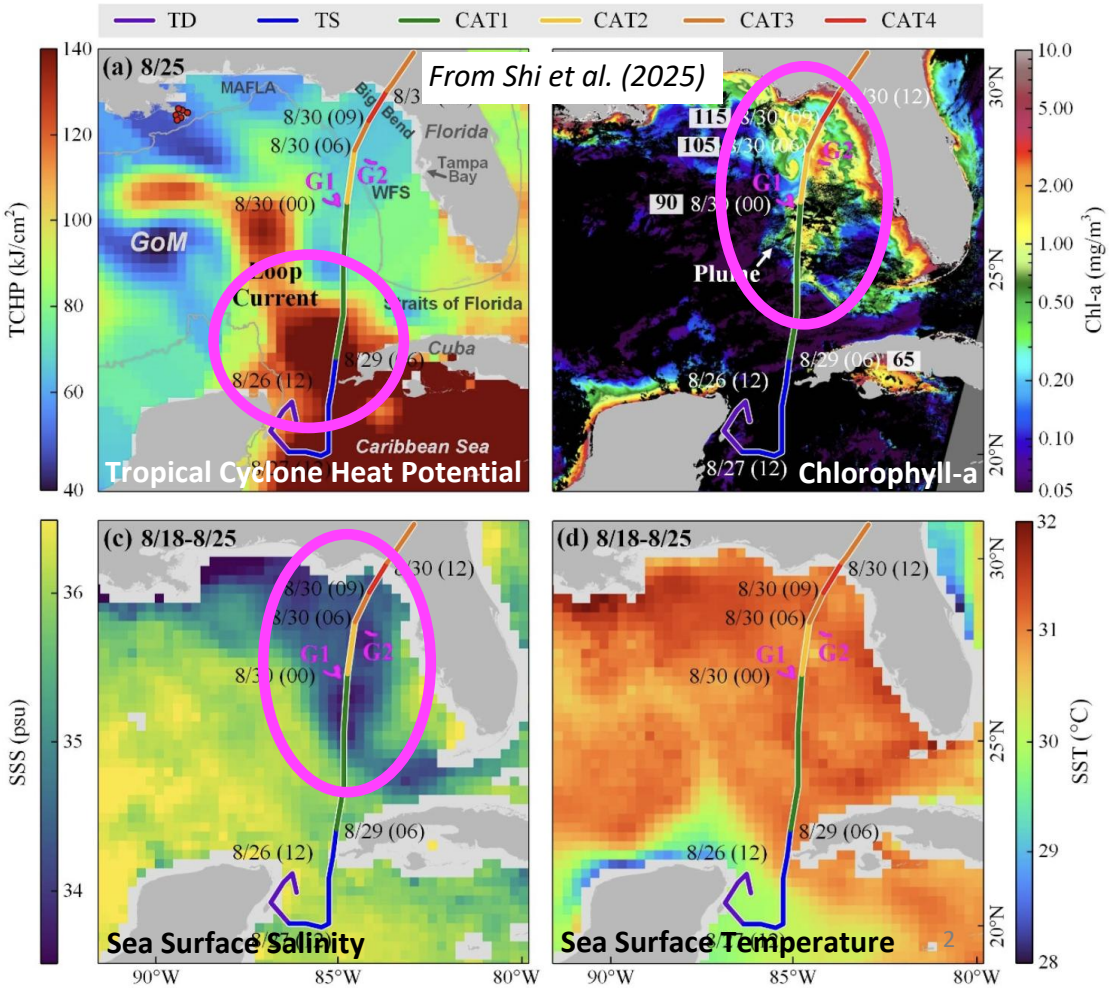
National Oceanic and Atmospheric Administration

U.S. Department of Commerce

Hurricane Idalia - Cat 1 off Cuba to Cat 3 Landfall in 2 Days



- **Formation** over the Yucatan Strait
- **Intensification** over the **Loop Current**
- **Intensification** to Cat. 2 before shelf
- **Rapid Intensification** to Cat. 3 on shelf
- **Role of Mississippi River plume?**



Sensitivity of Idalia to low-salinity plume

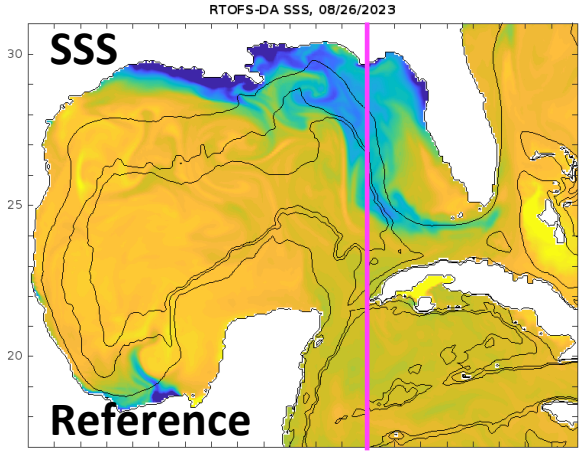
Ocean model:

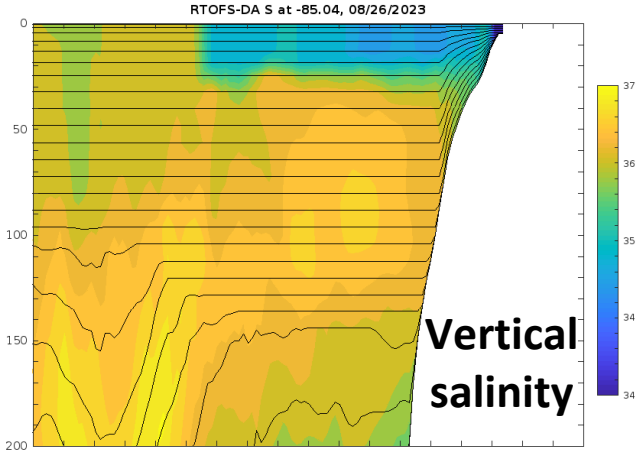
- **RTOFS-DA** (NOAA's operational global ocean prediction system)
- **HYCOM** model at 0.08^{o} resolution
- Ocean **Data Assimilation** procedure: adapted from the Navy's NCODA
- Assimilates observations (altimetry, SST, SSS, in situ profilers)
- Used to initialize HAFS hurricane forecast model

Coupled hurricane model:

- **HAFS** (NOAA's most recent hurricane forecast model, operational since 2023)
- HAFS v2.1, 2 domains of resolution 6 and 1.8 km, moving nests
- Ocean model: regional MOM6, extracted from RTOFS-DA (same resolution)
- Used to examine **the impact of ocean initial conditions** on the coupled model, while keeping the **same atmospheric component**

Sensitivity of Idalia to low-salinity plume

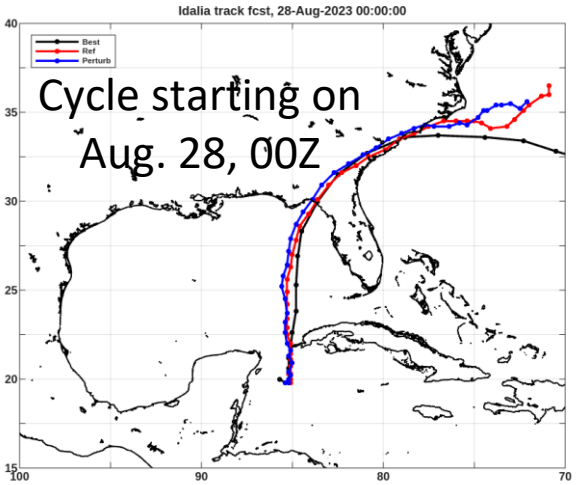


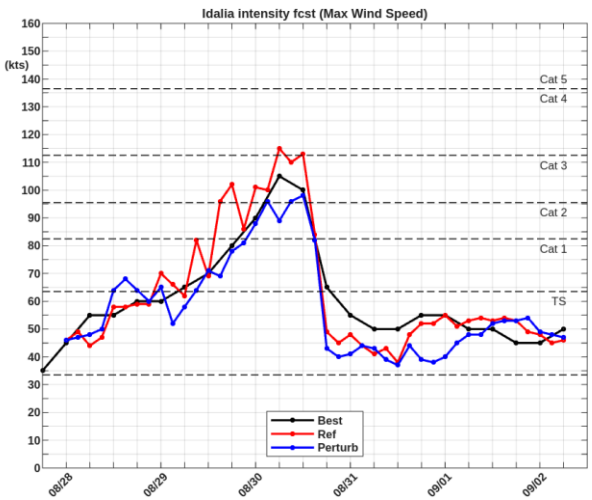


Ocean state from RTOFS:

- **Modify RTOFS** ocean estimates used for hurricane forecasting
- Upper ocean **lower salinity erased** (min. salinity=36)
- **Modified salinity**:
  - **Large scale** differences in SSS **preserved**, but **no low SSS** in Northern Gulf
  - Original **vertical structure** overall **preserved**

Sensitivity of Idalia to low-salinity plume

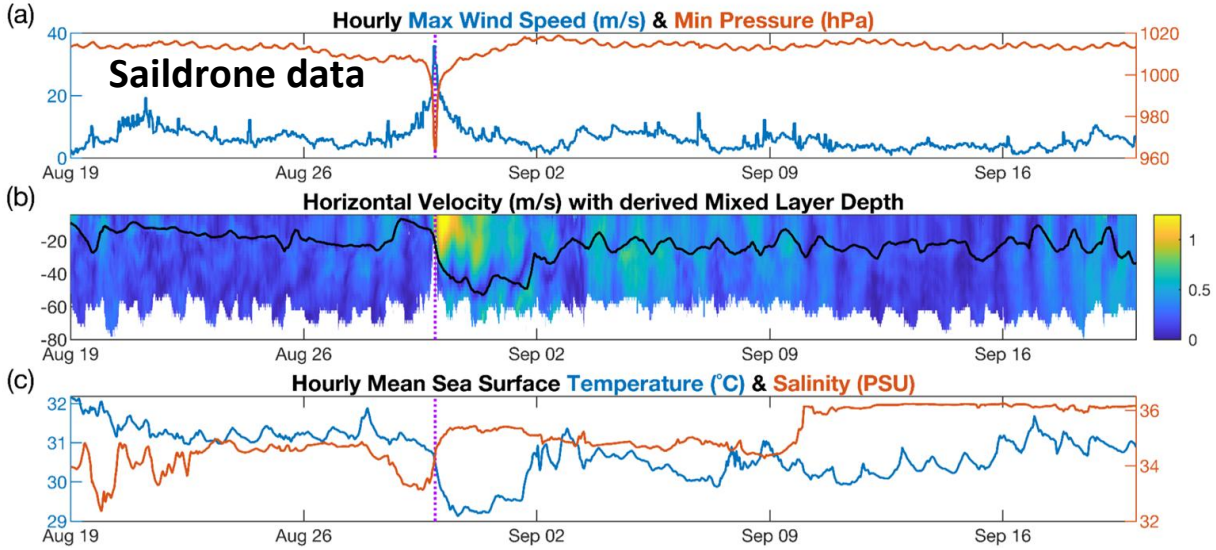


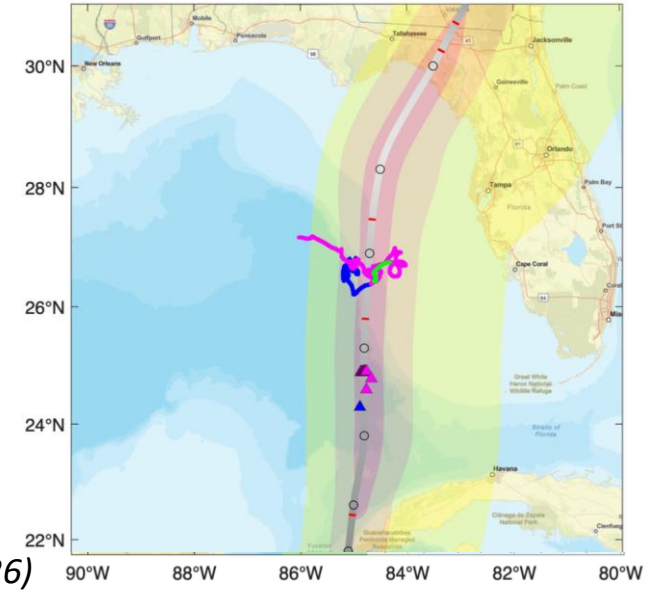


HAFS v2.1 runs:

- **2 experiments** with **2 sets of ocean initial conditions** (reference and modified salinity)
- **Trajectories close to one another**, a little west of observed
- **Intensity**: Reference case a little too intense, Modified case a little too weak
- SST difference on Sept. 1: **cooling more pronounced for the modified** case (by ~0.3C)

Sensitivity of Idalia to low-salinity plume

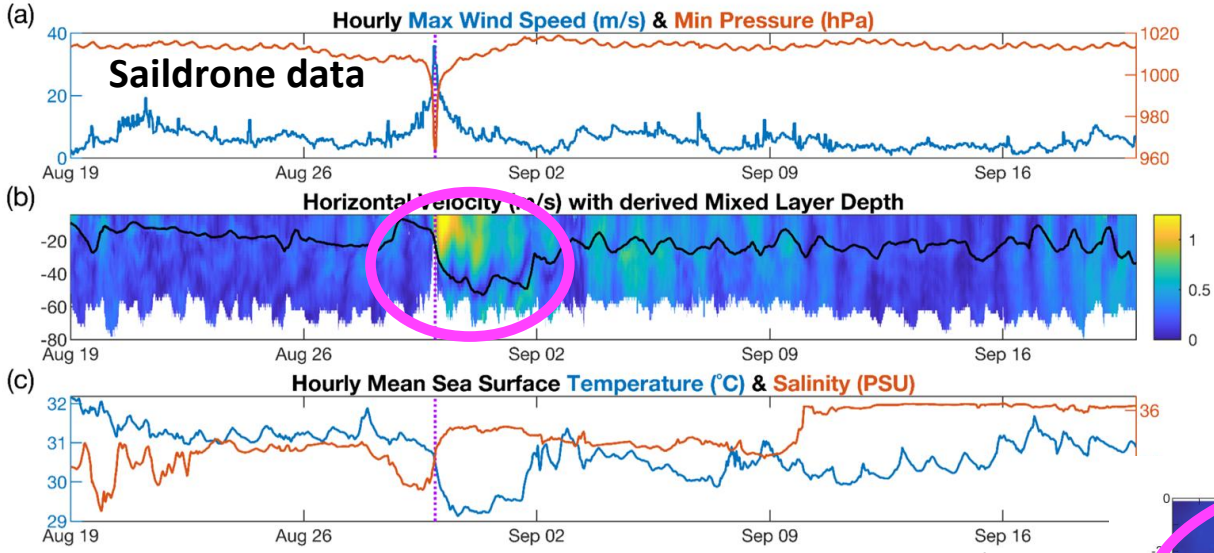




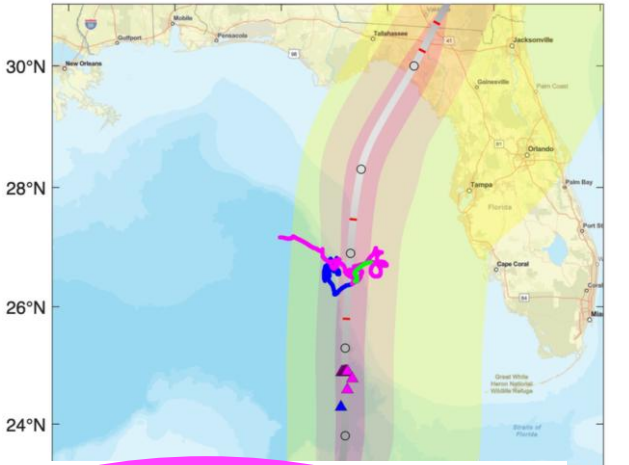
From McWhorter et al. (2026)

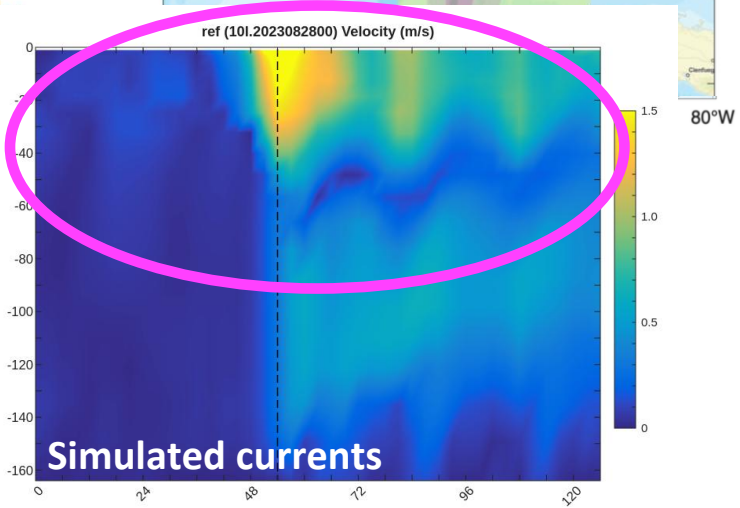
- Saildrone data available

Sensitivity of Idalia to low-salinity plume



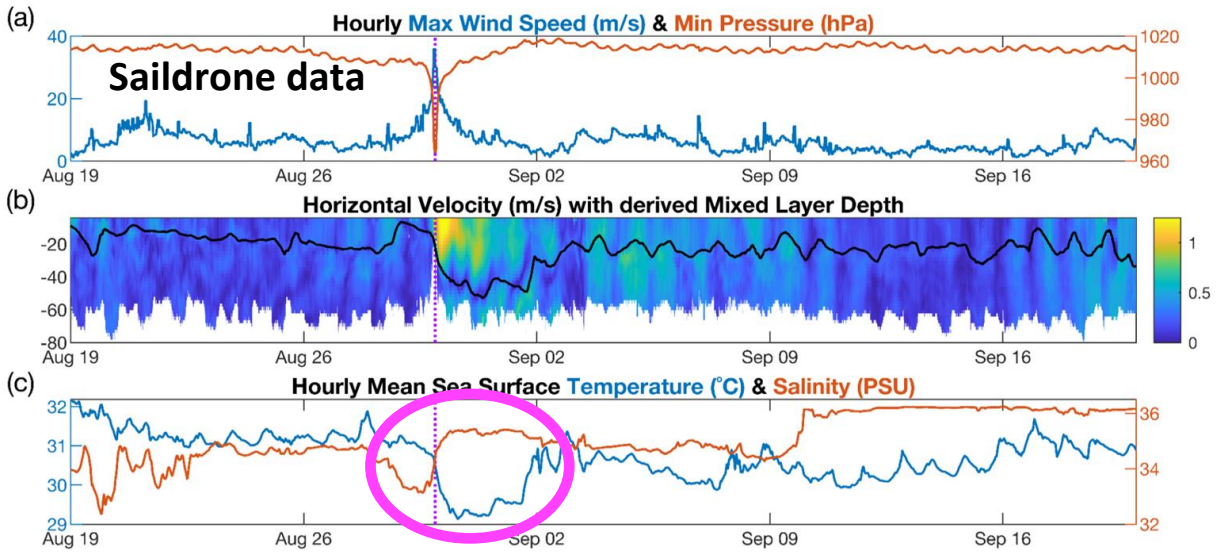
From McWhorter et

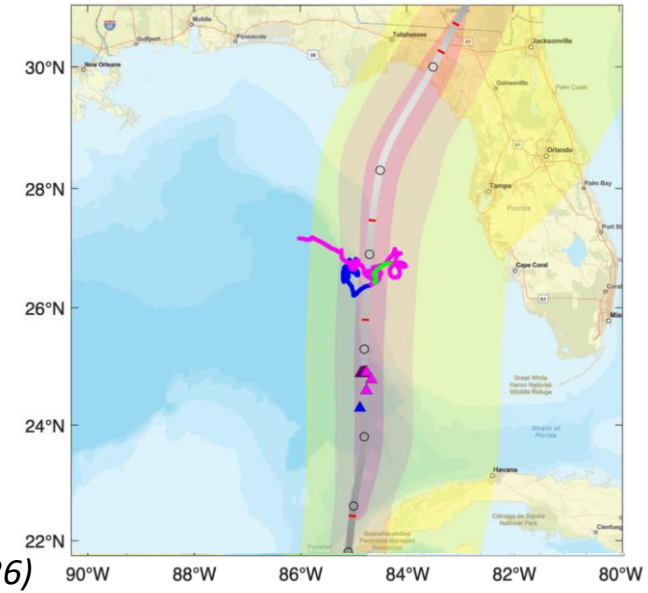




- Saildrone data available
- **Simulated upper current is very realistic**

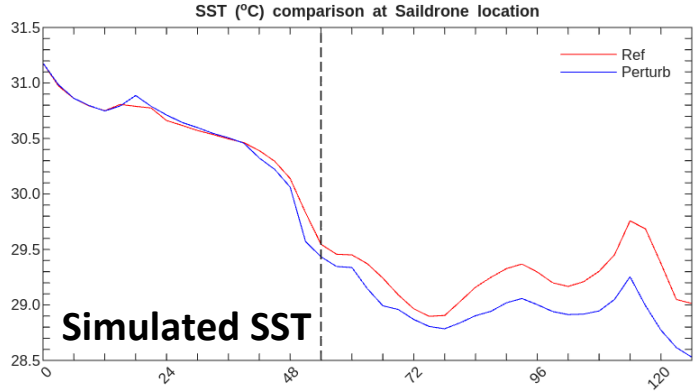
Sensitivity of Idalia to low-salinity plume



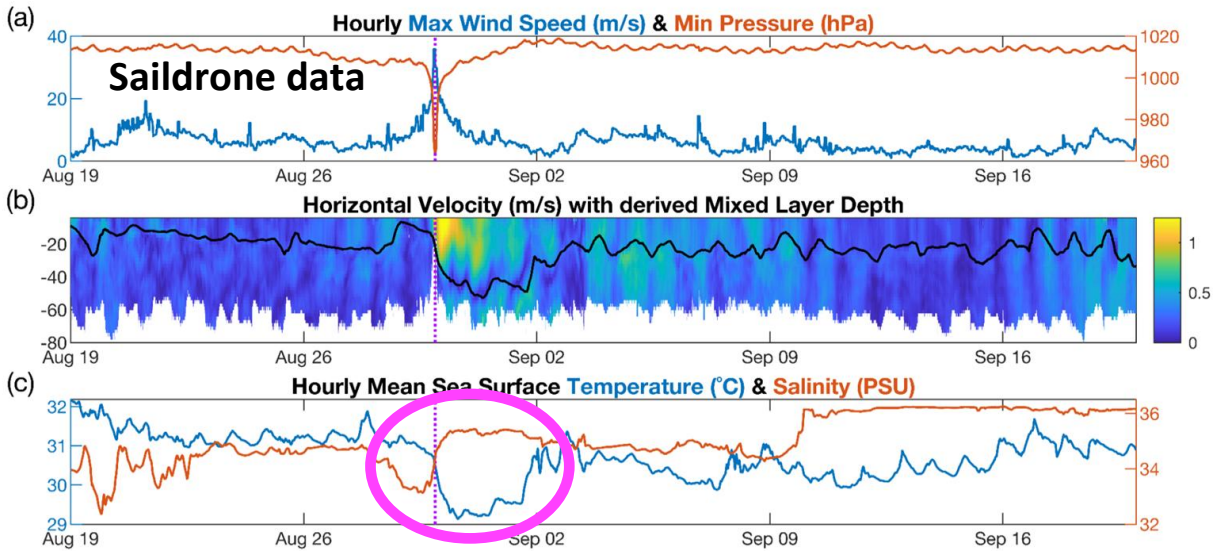


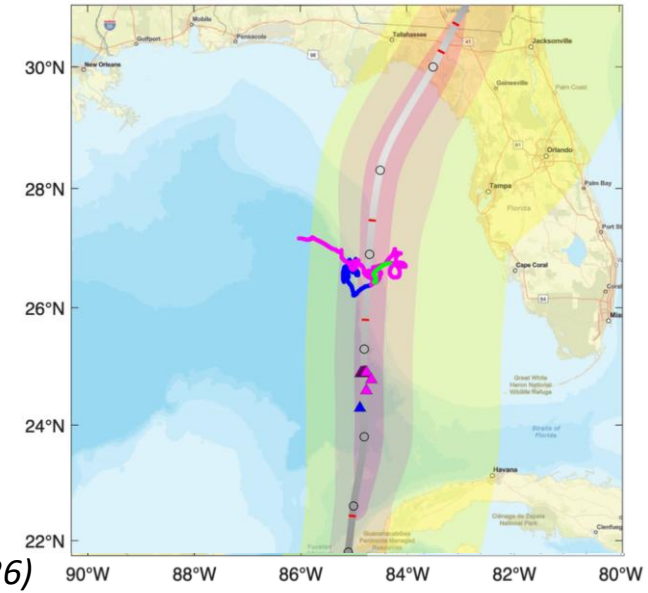
From McWhorter et al. (2026)

- **Simulated temperature realistic**
- SST of ~31°C before the storm
- Overall **cooling** of the order of **~2°C**
- **Cooling more pronounced** (by ~0.2/0.3°C) **in perturbed case** (without river plume)



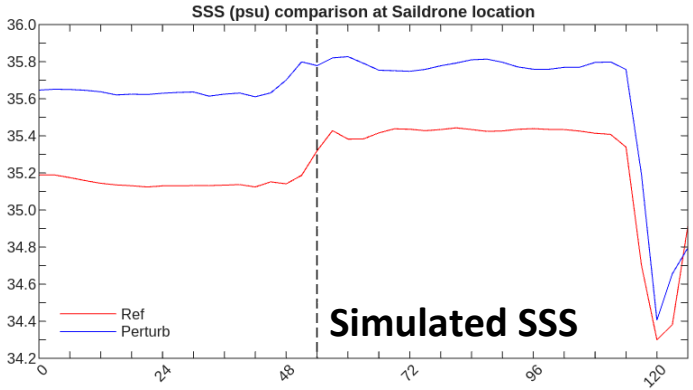
Sensitivity of Idalia to low-salinity plume





From McWhorter et al. (2026)

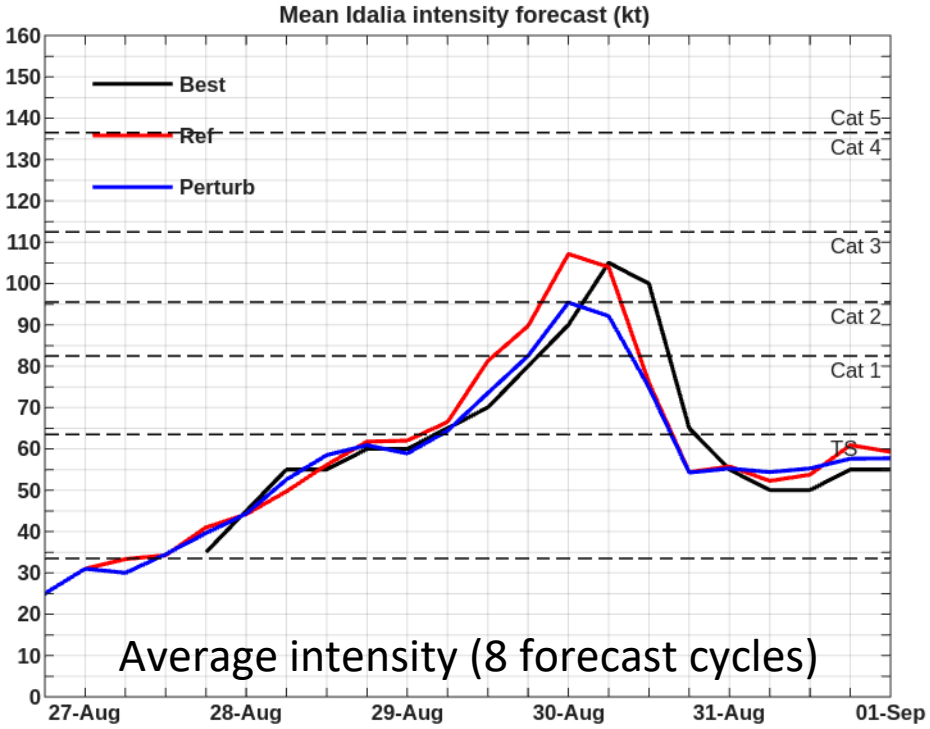
- **Simulated salinity** has smaller variability during Idalia, compared to obs
- **Reference case**: small decrease prior to the passage of the storm, followed by an increase during and after the storm, as observed
- Increase in salinity **earlier** in **perturbed case**



Sensitivity of Idalia to low-salinity plume

Impact on wind intensity prediction:

- **Both simulations**: earlier landfall by ~6 hours
- **Reference** case: **realistic intensity**
- **Perturbed case** (no river plume): **wind intensity reduced** by ~10 kts (Cat. 2 instead of Cat. 3)



Conclusions

- The **simulated ocean** in the coupled **HAFS** represents well the upper dynamics in **currents**, **SST**, and, to a lesser extent, **SSS**
- <u>When removing the river plume</u>:
  - **Cooling more pronounced** by ~0.3°C
  - Averaged **wind intensity reduced** by ~10 kts (Cat. 2 instead of Cat. 3)

⇒ This suggests that **the river plume supported the strong intensity of Hurricane Idalia**

- In addition, a BGC Argo float that was stuck under the Mississippi River plume **observed subsurface nitrate depletion** and **oxygen enrichment** during Idalia, which suggests **increased primary production** (McWhorter et al., 2026)
- Part of this work is a contribution to NASEM UGOS project

