

Abstract Understanding of the upper-ocean processes and conditions that contribute to genesis and intensification of tropical cyclones (TCs) has largely benefited from the climate-oriented ocean observing system. When the atmosphere is favorable, upper-ocean conditions have been shown to be a key factor governing air-sea enthalpy fluxes that can fuel these extreme weather events. Rapid intensification of TCs is often associated with TCs travelling over warm ocean and/or low-salinity barrier layers, which maintain warm sea surface temperatures (SSTs) near the convective center of the storm. Studies have shown that accurate TC intensity forecasts require the correct representation of these upper-ocean processes and conditions within the operational coupled ocean-atmosphere hurricane forecast models. This, in turn, requires the assimilation of sustained ocean observations from areas where these weather systems commonly travel and intensify. Increased societal/scientific interest, new technologies, pilot networks, targeted deployments of instruments, and state-of-the-art coupled numerical forecast models have enabled advances in research and forecast skills and illustrate a potential framework for future development. Here, we present examples of new technologies and pilot networks that are effectively helping assess the ocean conditions that can contribute to TC intensification, and the overall recommendations from the scientific community for such component of the global ocean observing system.

Impact of Ocean Data in Tropical Cyclone Intensity Forecasts

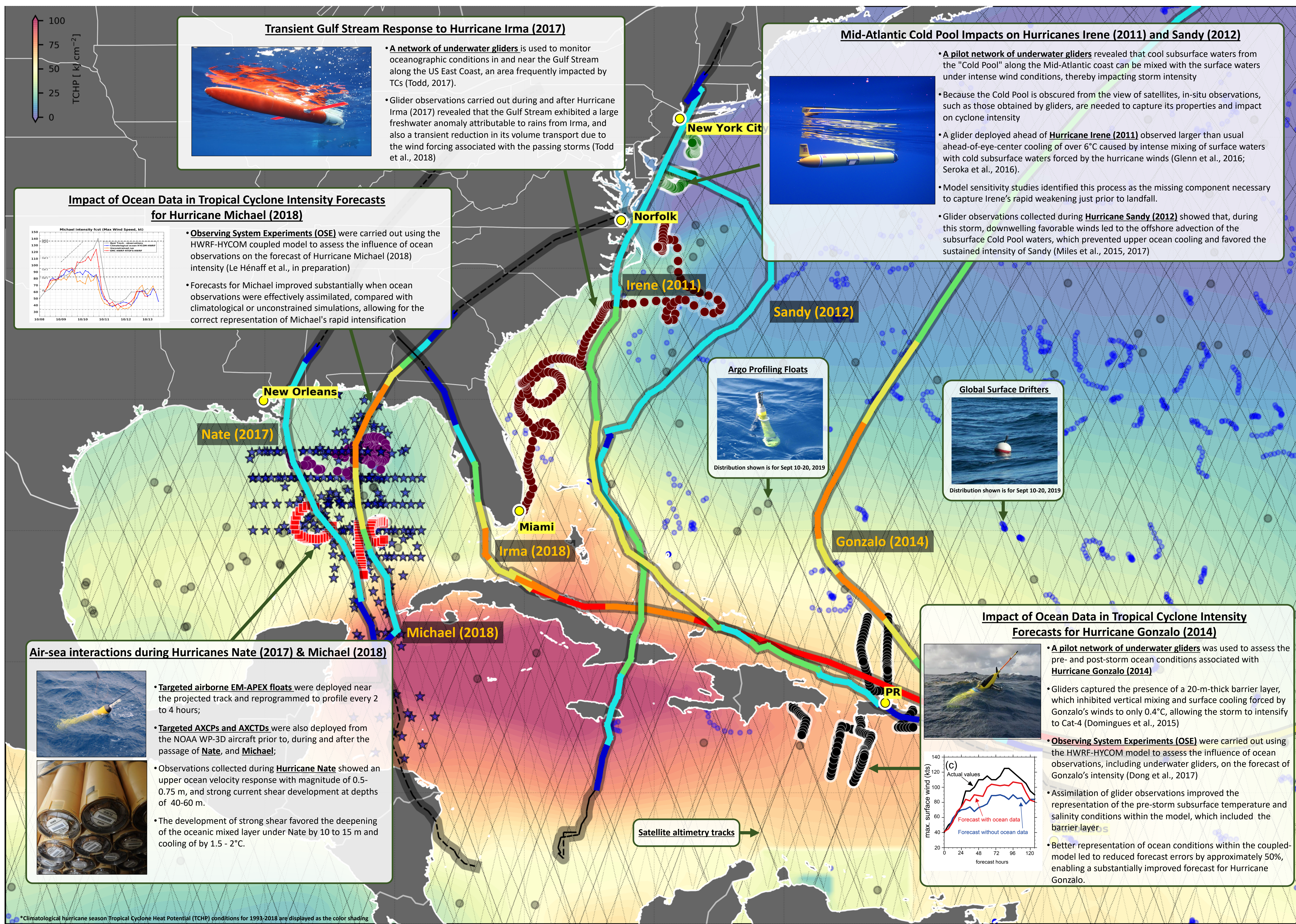
Assimilation of ocean observations is a leading-order factor in reducing initialization errors within coupled TC forecasts (Halliwell et al. 2011). Examples of overall data assimilation impacts by platform within coupled-models described here:

- **Satellite altimetry:** improved representation of oceanic mesoscale field;
- **Satellite SST:** temperature bias corrections within the mixed layer;
- **Argo profiling floats:** large-scale subsurface temperature and salinity bias corrections;
- **Underwater gliders:** improved 3D representation of sub-mesoscale and mesoscale temperature and salinity subsurface conditions and gradients, and including low-salinity barrier layers;
- **Surface drifters:** improved barometric pressure representation and satellite SST calibration;
- **Directional Wave Spectra Drifters:** improved understanding of sea-state dependent air-sea flux exchanges;

Sustained data stream in real time and longer than 3 days is required for initial data assimilation, and longer than 30 days for effective model corrections to take place.

Recommendations

- Maintain the elements of the observing system that have proven valuable for Tropical Cyclone ocean research and operational intensity forecast.
- Utilize numerical Observing System Experiments (OSEs) to quantify the impact of the current ocean observing platforms in Tropical Cyclone forecasts.
- Evaluate optimal ocean observational strategies in support of Tropical Cyclone studies and forecasts using numerical Observing System Simulation Experiments (OSSEs).
- Implement sustained and targeted ocean observations (gliders, profiling floats, drifters, etc.) dedicated to improving Tropical Cyclone intensity forecasts; and foster co-incident, co-located air-deployed profile observations (AXBTs, AXCTDs, AXCPs, floats, thermistor chains, etc.) of ocean temperature, salinity, and currents.
- Foster additional sustained measurements of sea level pressure (e.g., from drifters and moorings), and of waves, sea spray, and mixed-layer turbulence (e.g., from gliders and EM-APEX floats) to help develop, evaluate, and validate boundary layer parameterizations.
- Use upper ocean metrics (e.g., Tropical Cyclone heat potential, ocean mean temperature, mixed-layer depth, barrier layer thickness, etc.) derived from profile and satellite ocean observations in the operational evaluation and validation of numerical forecast models.
- Continue with efforts focused on improving coupled ocean-atmospheric numerical weather models, especially those relating to enhancing ocean data assimilation techniques and mixed layer parametrizations.
- Create an ocean database easily accessible to the scientific community to facilitate research in support of assessments of the role of the ocean in Tropical Cyclones studies.
- Enhance data management efforts to transmit and QA/QC data in real-time for assimilation in operational forecast models.



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