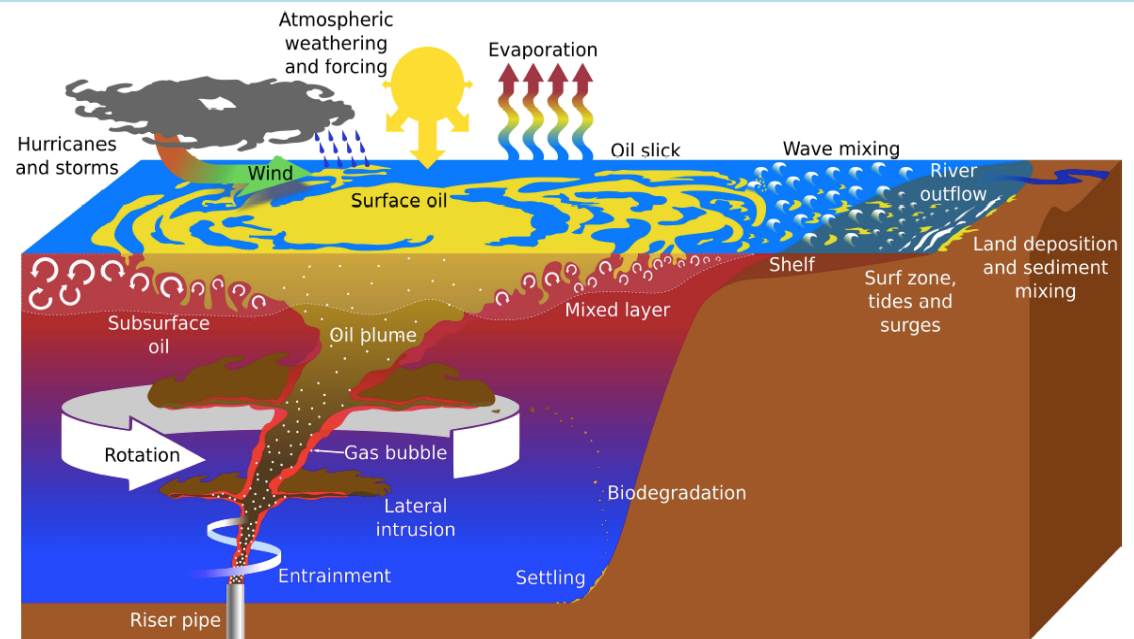
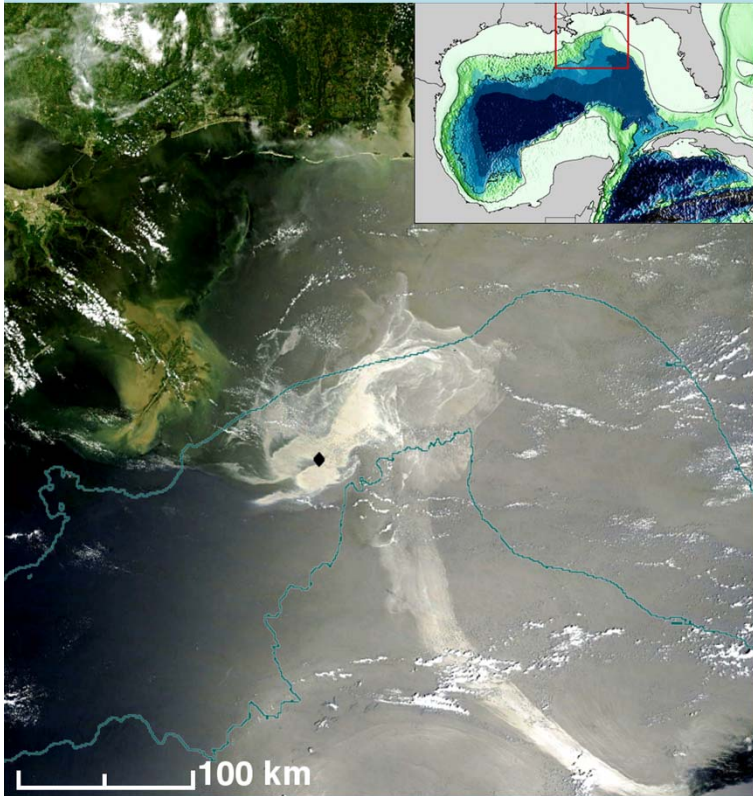


Experience from the Gulf Oil Spill:

CARTHE Program (2011-2020)
15-24 institutions, dozens of PIs
200 peer-reviewed publications

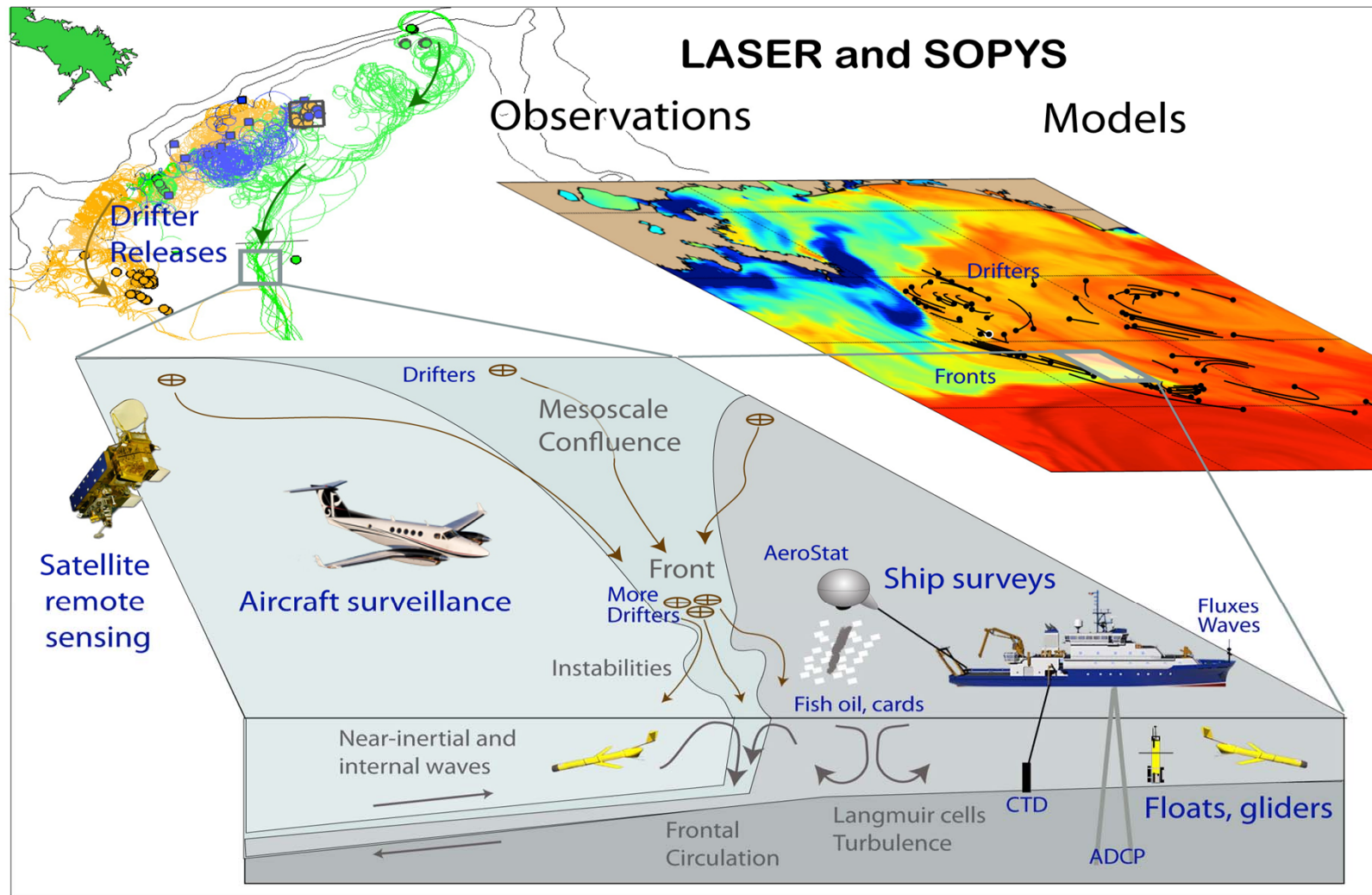


Tamay Özgökmen, NASEM Sea Level Rise Panel, 2020

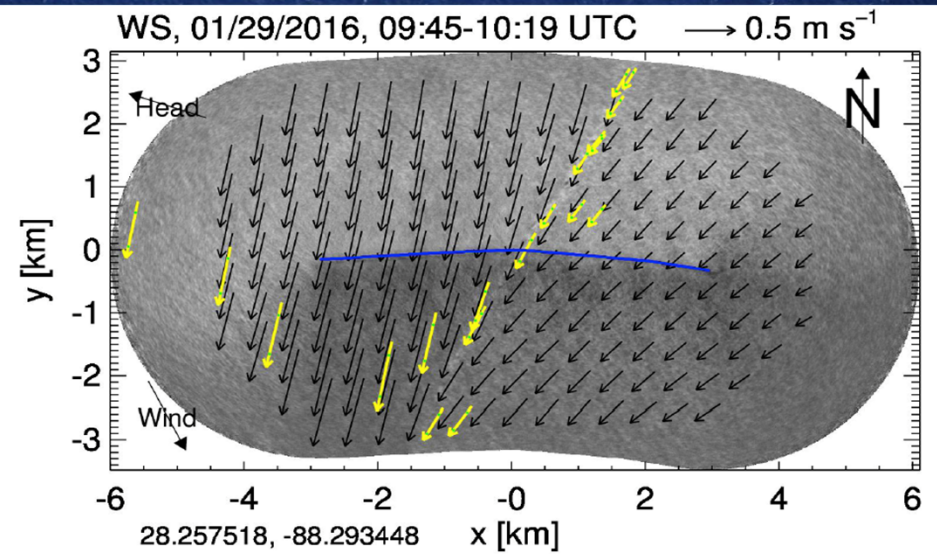
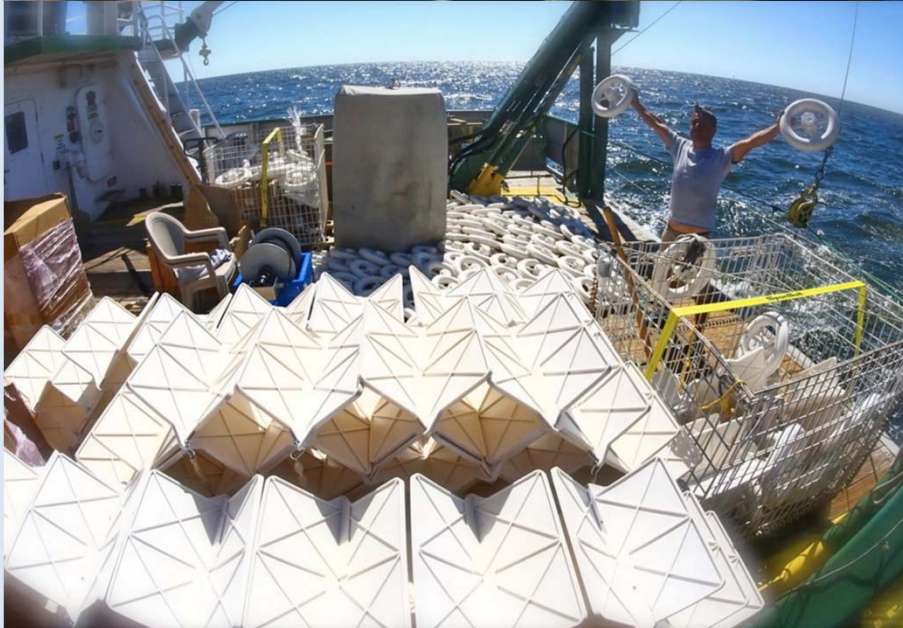
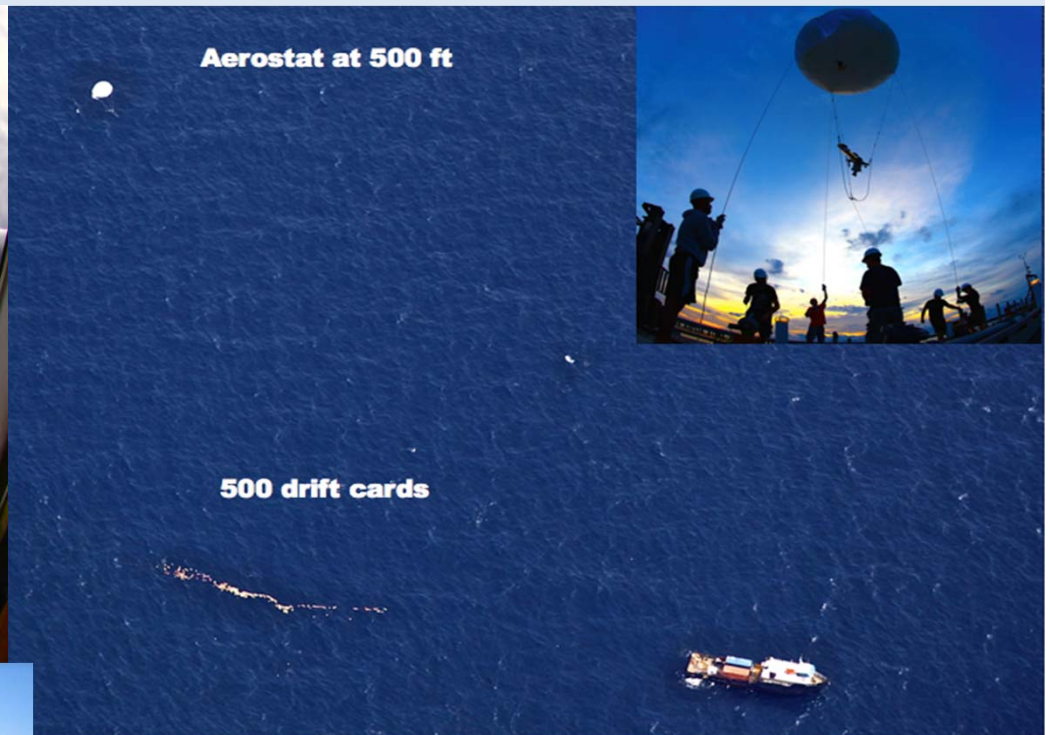
General Template for CARTHE Experiments

Basic Questions: Where will the oil go? How fast? How much?

Methods: Large air-sea expeditions with multi-sensor data over the same ocean patch guided by coupled (air-wave-ocean) modeling and satellite observations

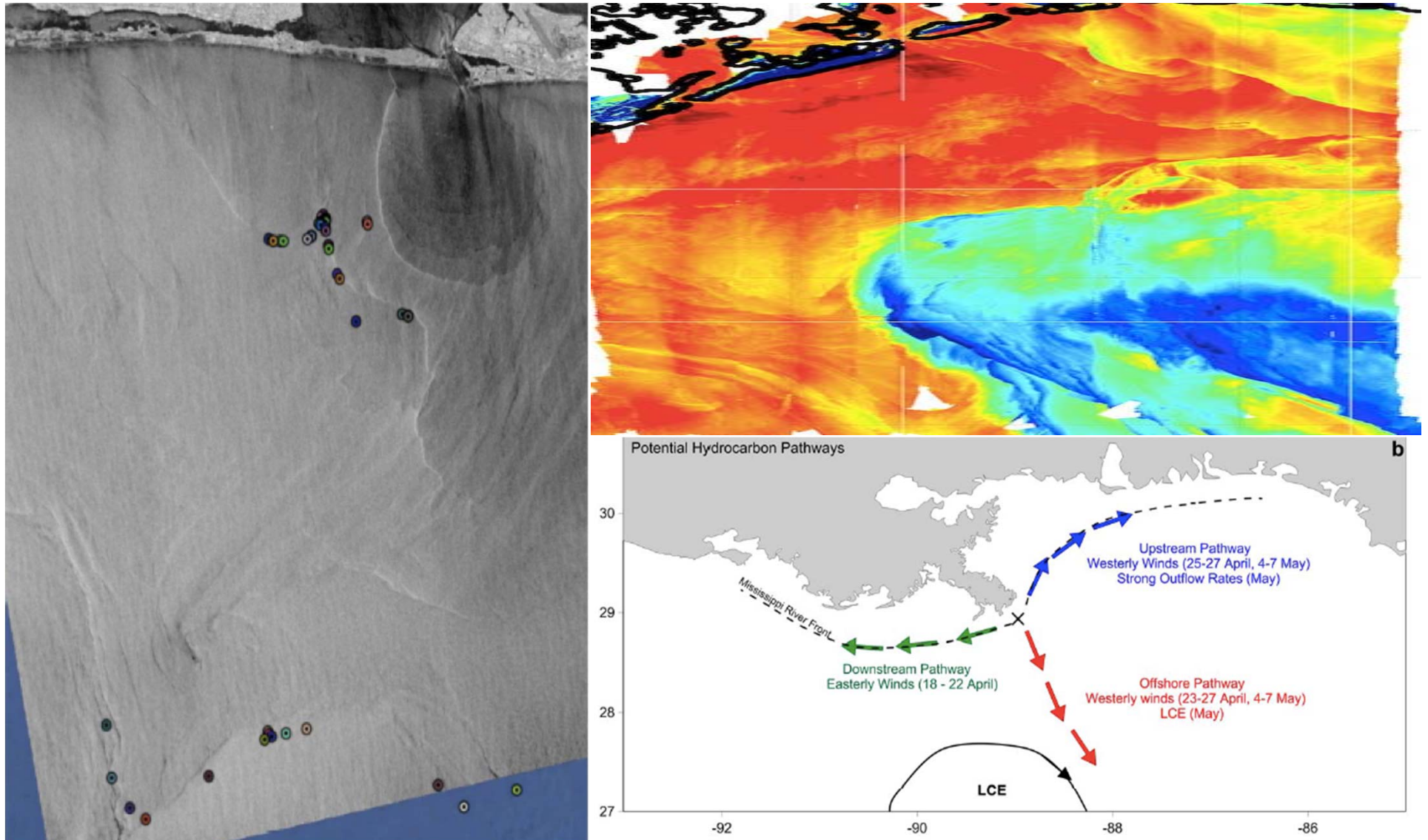


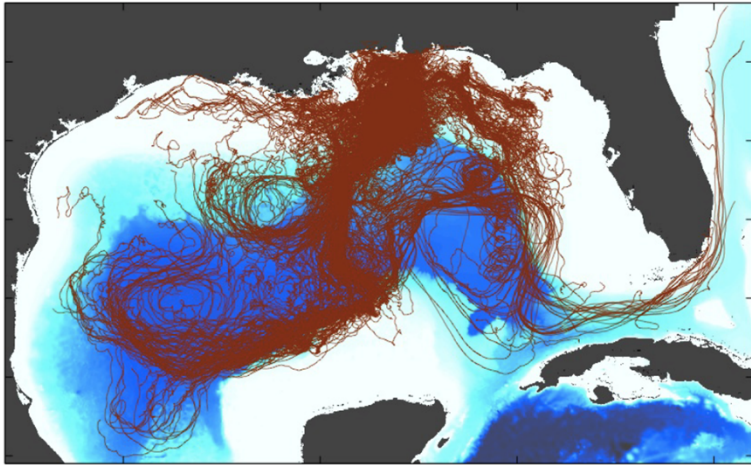
Observing Systems: biodegradable drifters; airplane 1m SST; aerostat, marine radar & drone-and aerostat-based surface current estimation



One of the main findings: Coastal zone is full of fronts controlling transport

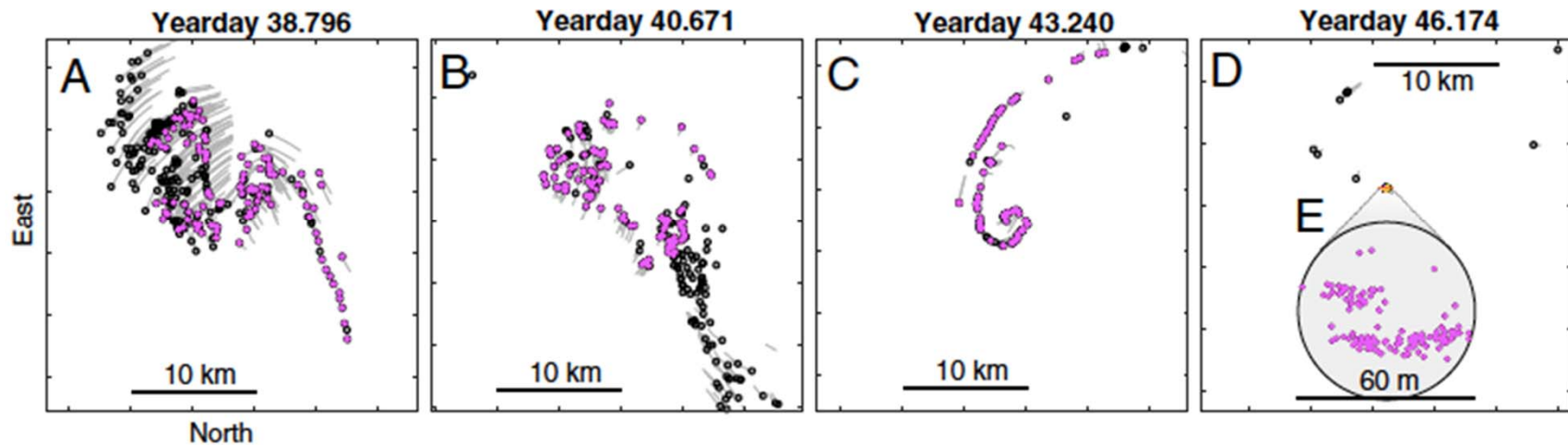
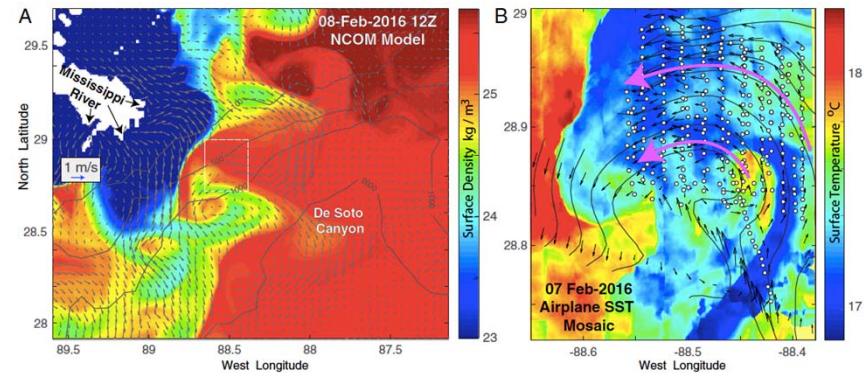
Hugueard et al., JGR Ocean, 2016; Roth et al, Cont. Shelf Res, 2017; Raschle et al., GRL, 2017; Androulidakis et al, JGR Oceans, 2018 Xia, 2020, etc





***Lagrangian Submesoscale Experiment LASER:
1000 drifters deployed around DWH site
(D'Asaro et al, Proceedings National Academy Sciences, 2018)***

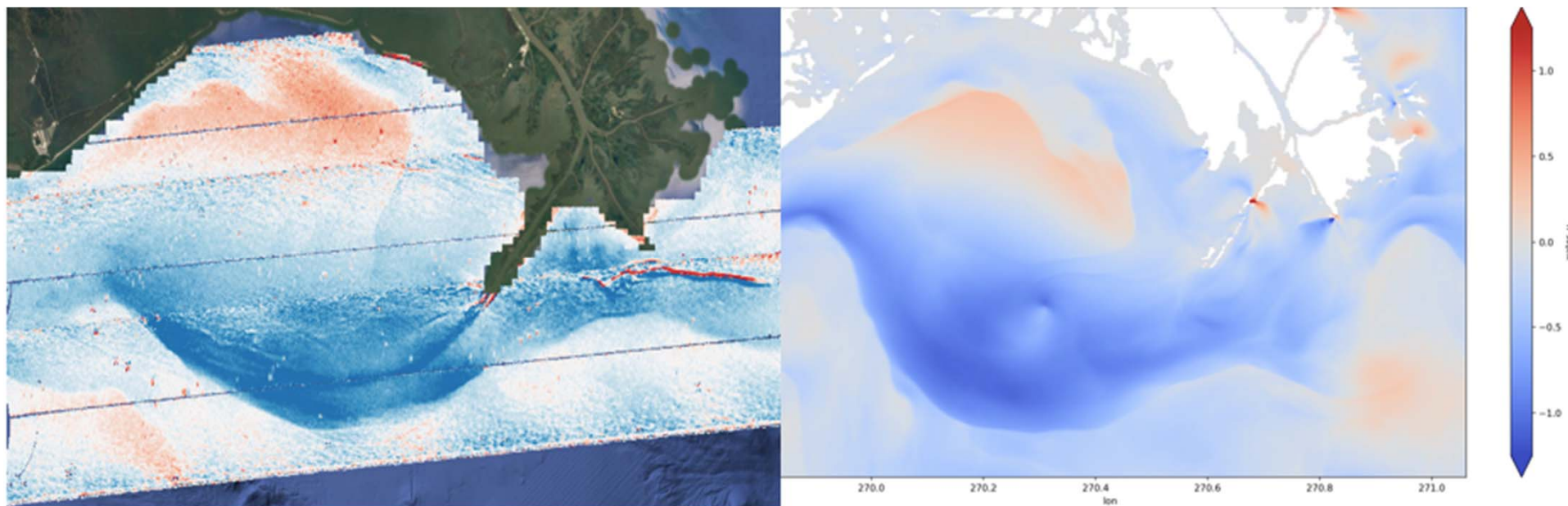
Satellite and aerial SST guided deployments:



3D transport: from the size of a city to that of a conference room; 1 million-fold area reduction!

NASA sensor calval during SPLASH (2017 Expedition)

DopplerScatt (Ernesto Rodriguez, JPL) vs NCOM (Gregg Jacobs, NRL)

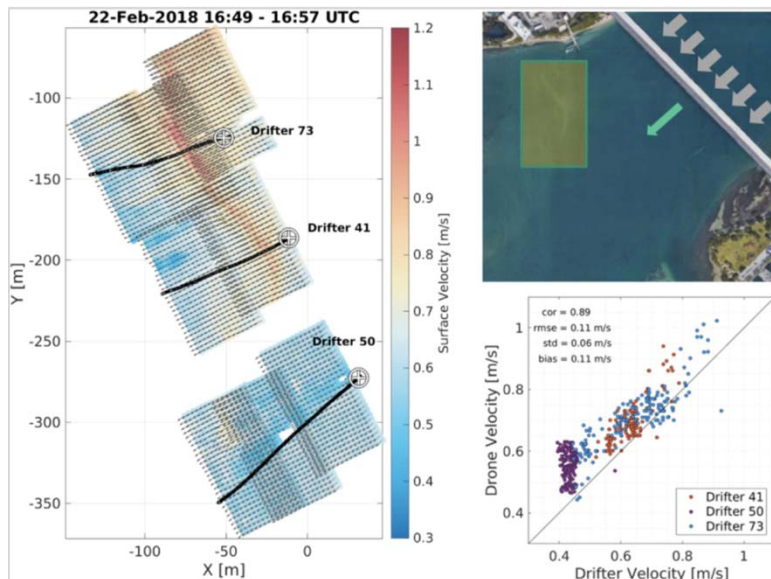


Rodriguez et al., 2018, in Remote Sensing, 10/4, 576.

Seems to have resulted in a new NASA Program: SMODE for further development

General Remarks:

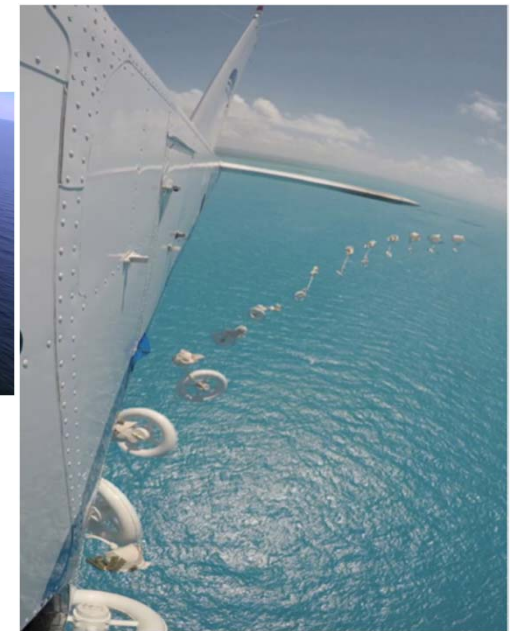
- 1) We benefitted greatly from the atmosphere-wave-ocean coupled modeling system (such as Shuyi S. Chen's, probably unique in accuracy) to develop sampling strategies before major experiments, rely on forecasts during, and to conduct analysis and produce scientific papers afterwards.
- 2) Similarly, experimental platforms should ideally contain all three components; atmospheric, wave and ocean current measurements and associated scientific community.
- 3) For coastal phenomena, driven by unique local dynamics, we think that drones provide an attractive avenue forward. Sensors and drones are developed by the global commercial market - cost effective.
- 4) Aircraft deployment of inexpensive biodegradable drifters is a good solution for coastal programs; GPS devices can measure elevation accurately. Seeding ahead of hurricanes can reveal coastal surge patterns.



Drone-based measurement of surface currents



Coastal dye release is problematic & convoluted



Aircraft deployment of drifters