DopplerScatt Instrument Concept for Simultaneous Measurements of Ocean Surface Vector Winds and Currents – First results of surface current and wind retrievals

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Why Measure Ocean Currents?

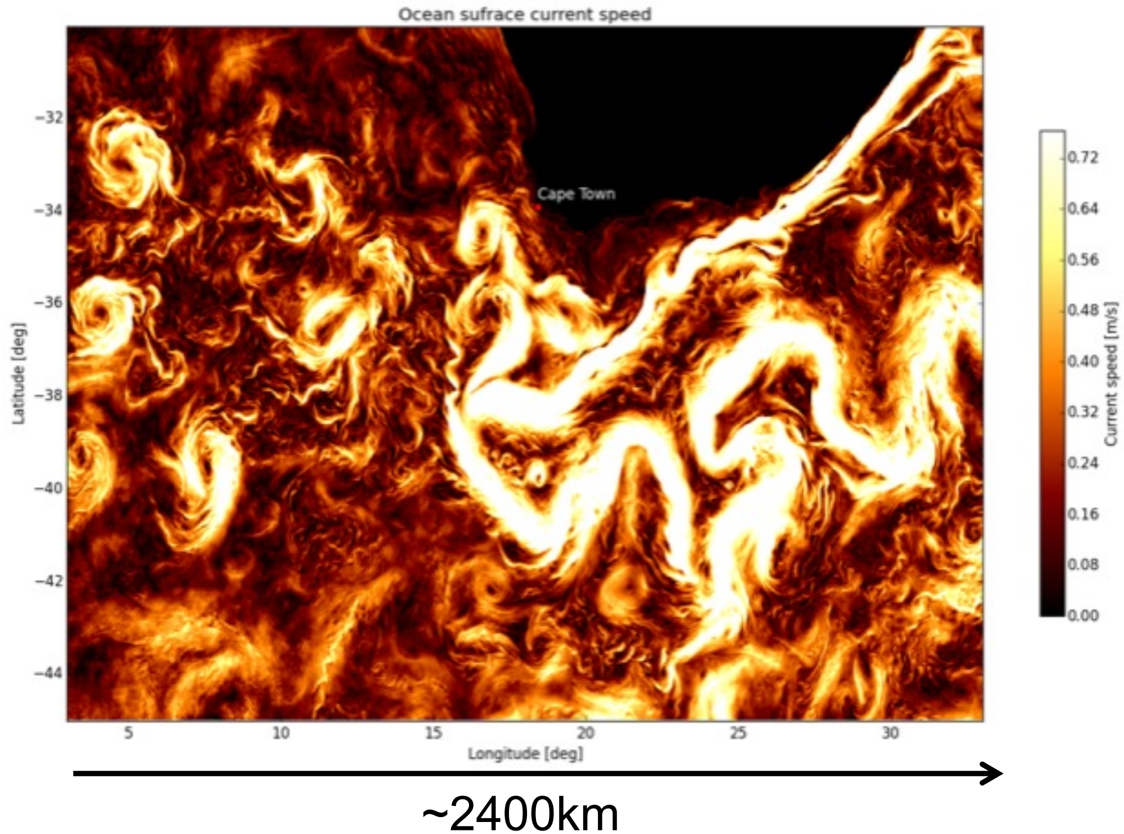


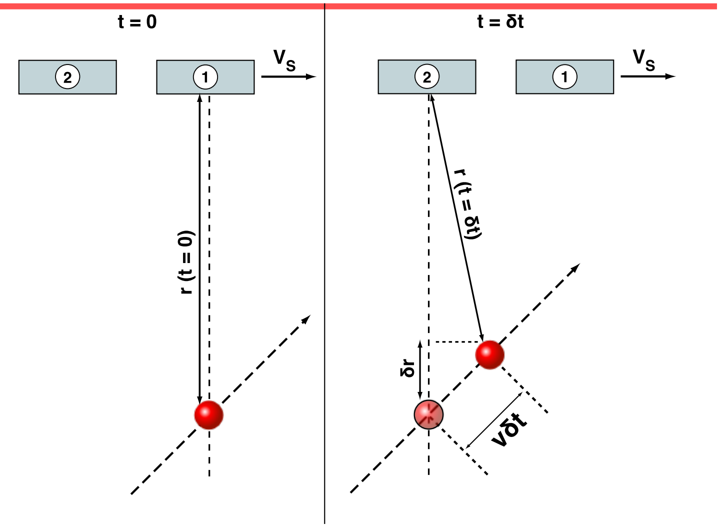
Image of modeled ocean surface currents from the high resolution ECCO2 model.

Currently, we have no way to validate these results at high resolution.

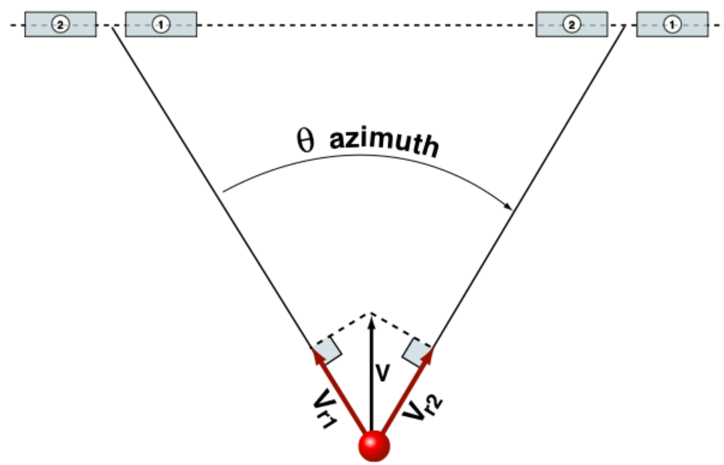
- Ocean surface currents are an essential climate variable
- Knowledge of ocean surface currents will improve our knowledge of energy transfer between the atmosphere and the ocean and our understanding of the advection of heat, nutrients, and pollutants in the ocean.
- Ocean surface currents are a unique complement to the geostrophic currents measured by the forthcoming SWOT mission.

The DopplerScatt Concept

- Coherent radars can measure radial velocities by measuring Doppler shifts.
- The use of Doppler for one component of the surface current velocity has been demonstrated from space using SAR's.
  - Since SAR only looks in one direction, only one component of the velocity is retrieved.
  - Swath width and data rate limitations make SAR's impractical for global coverage
- Rodríguez (2012, 2014) has extended the concept to be able to measure ***both*** components by using a pencil-beam scanning scatterometer.
  - A wide swath coverage would enable global coverage in one day
  - The same instrument would also measure high resolution winds
- The DopplerScatt IIP will demonstrate the feasibility and accuracy of this concept using an airborne instrument and the results will be applicable to future spaceborne missions.



Doppler Phase Difference: $\Delta\Phi = 2k\Delta r = f_D\delta t$
Radial velocity component: $v_r = \Delta r/\delta t = \Delta\Phi/(2k\delta t)$



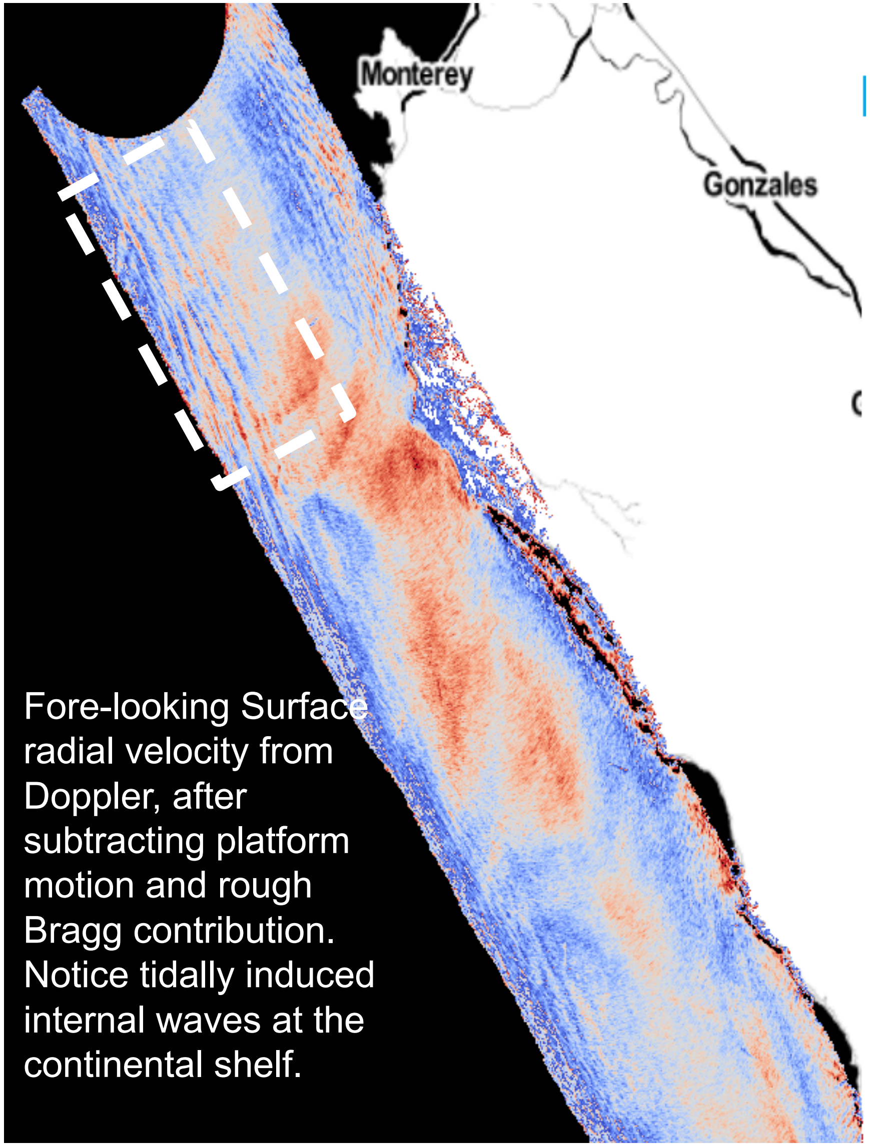
DopplerScatt During Deployment

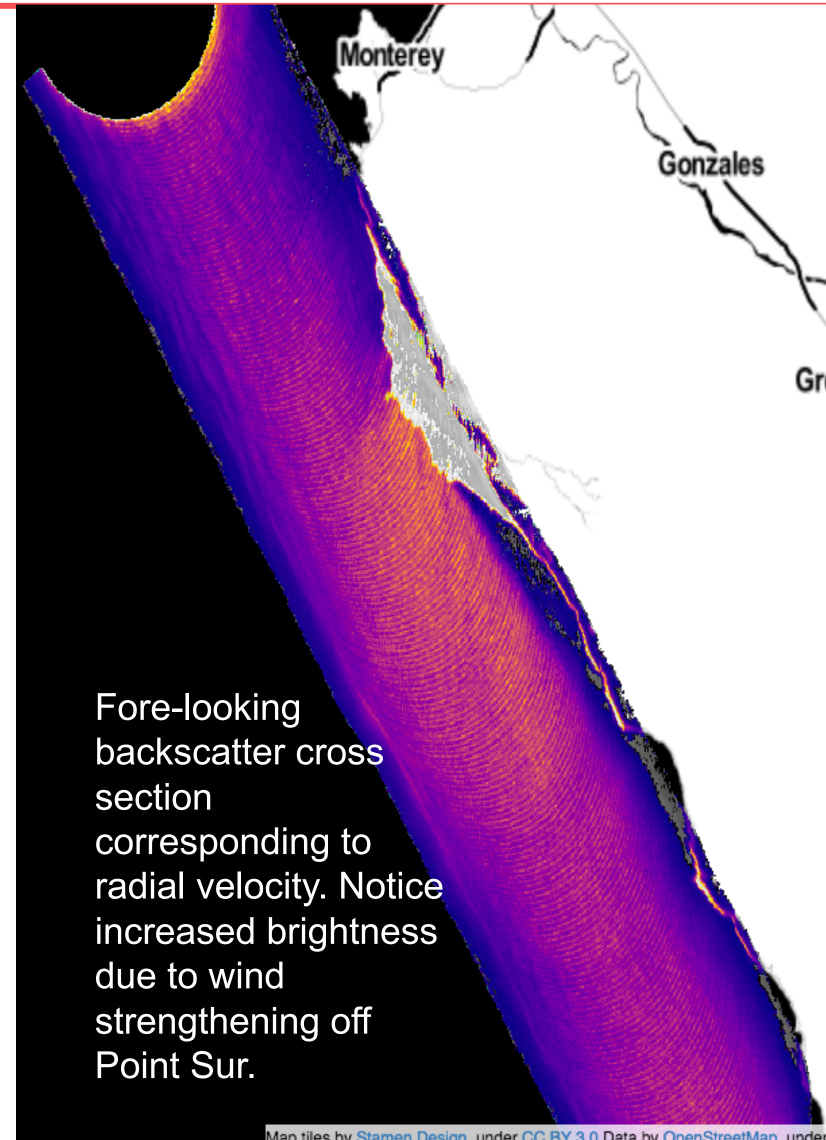
Outside of the aircraft

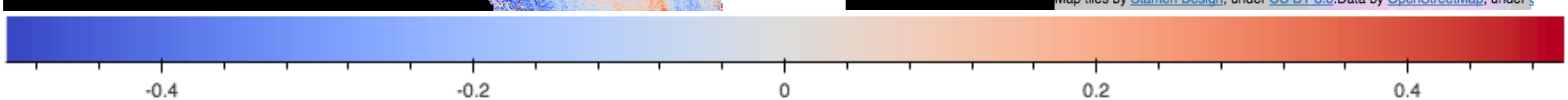
Inside the cabin

- Engineering flights:
  - Rosamond Lake, Palmdale (June 2016)
  - Monterey Bay, CA
- First science flights:
  - Portland, OR (September 2016)
- Calibration Validation flights:
  - New Orleans, LA – SPLASH (April 2017)
  - Monterey Bay, CA – KISS (May 2017)
- **Over 70 hours of data collection** (and lots of flying for the team)

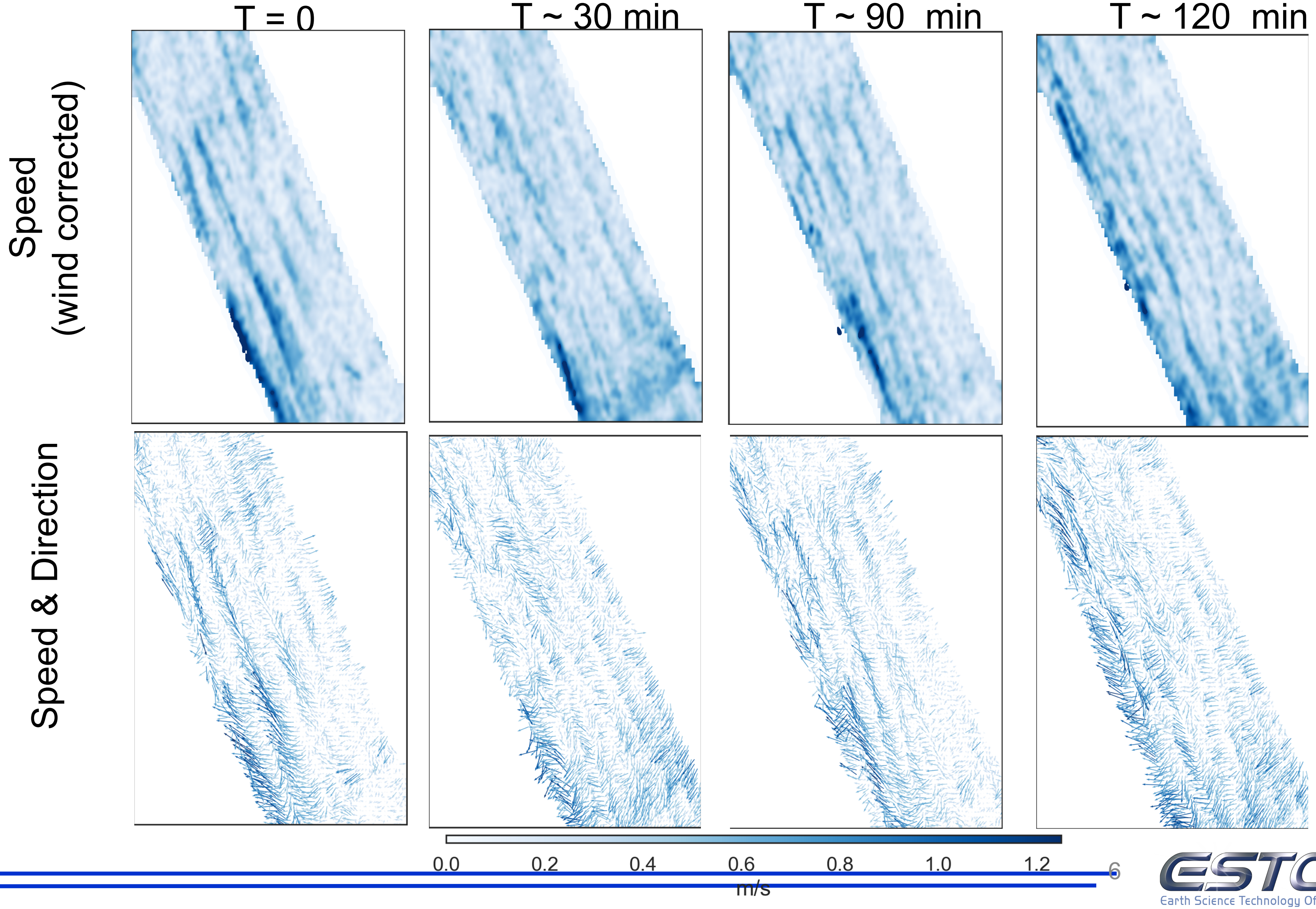
DopplerScatt physical measurements– Engineering Flight June 22nd 2016



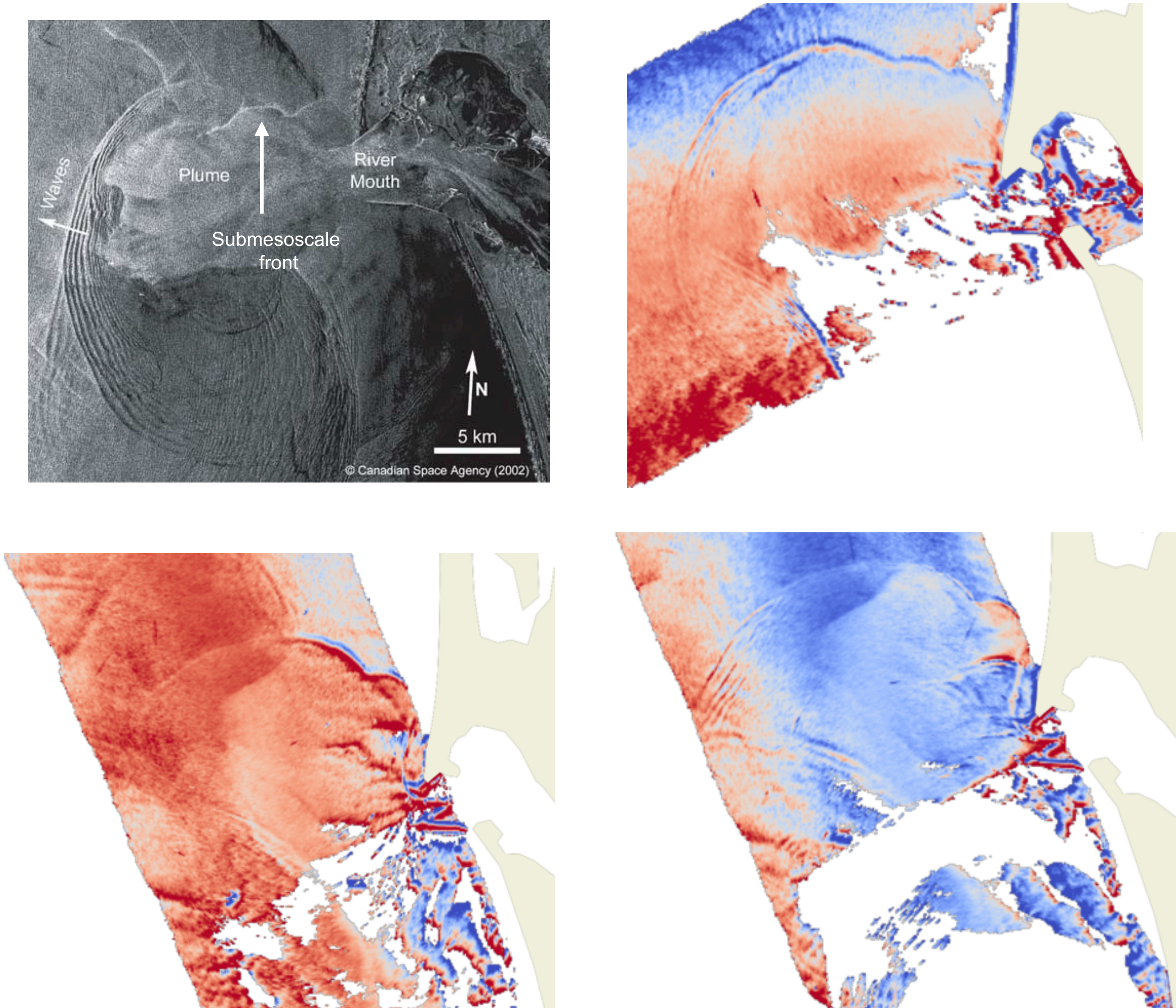




Preliminary Retrievals with Wind Correction
Internal Wave Changes



Columbia River Internal Wave Tidal Bore



Clockwise from top left:

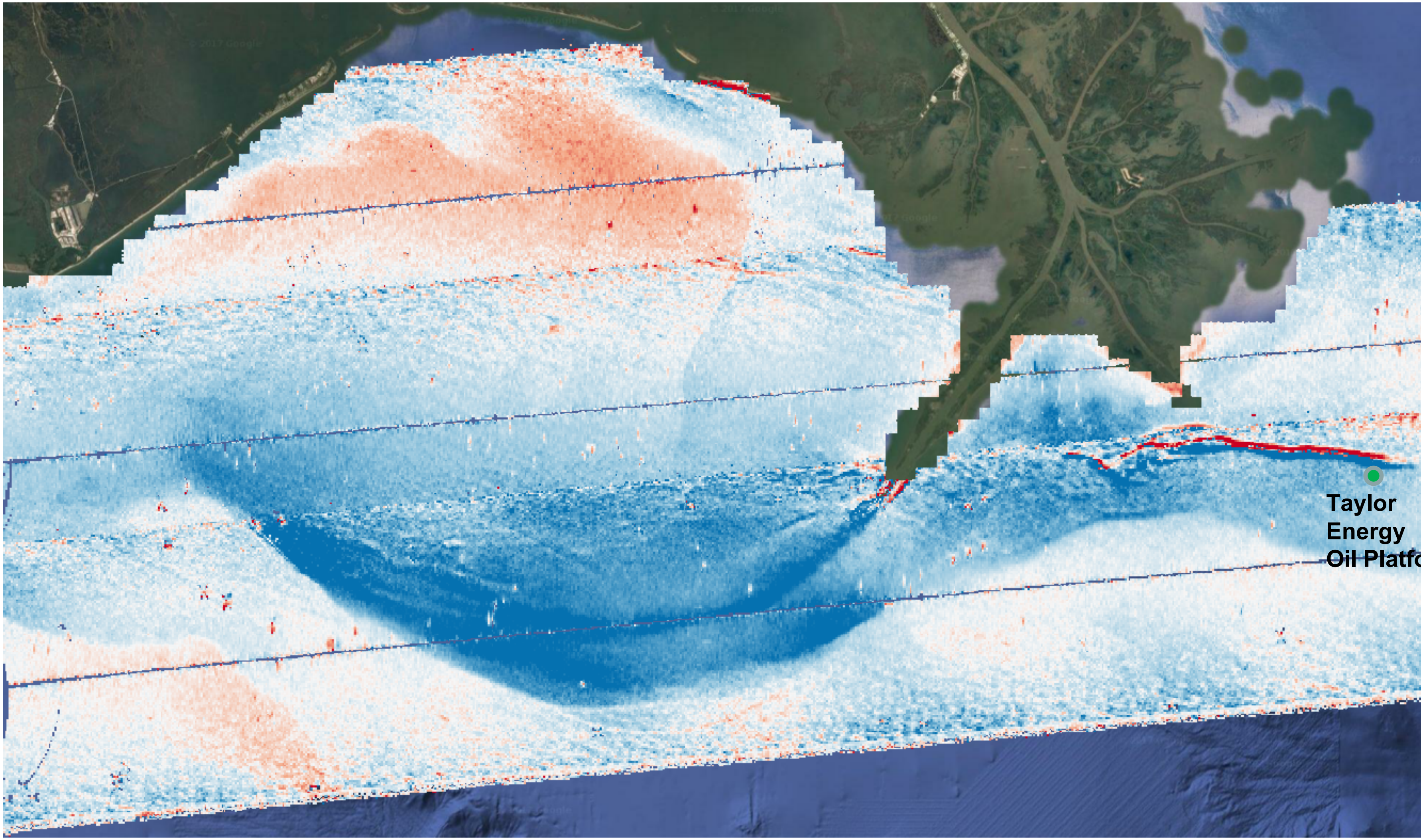
1. Satellite SAR image of the Columbia river plume from Aug 9th 2002, Nash & Moum, Nature, 2005 showing internal waves generated by the plume. Another feature has been conjectured to be a submesoscale front (Akan et al, JGR submitted. J. McWilliams, personal communication)

2. DopplerScatt September 13th Track 1 fore-looking radial velocity

3. DopplerScatt September 13th Plume track fore-looking radial velocity

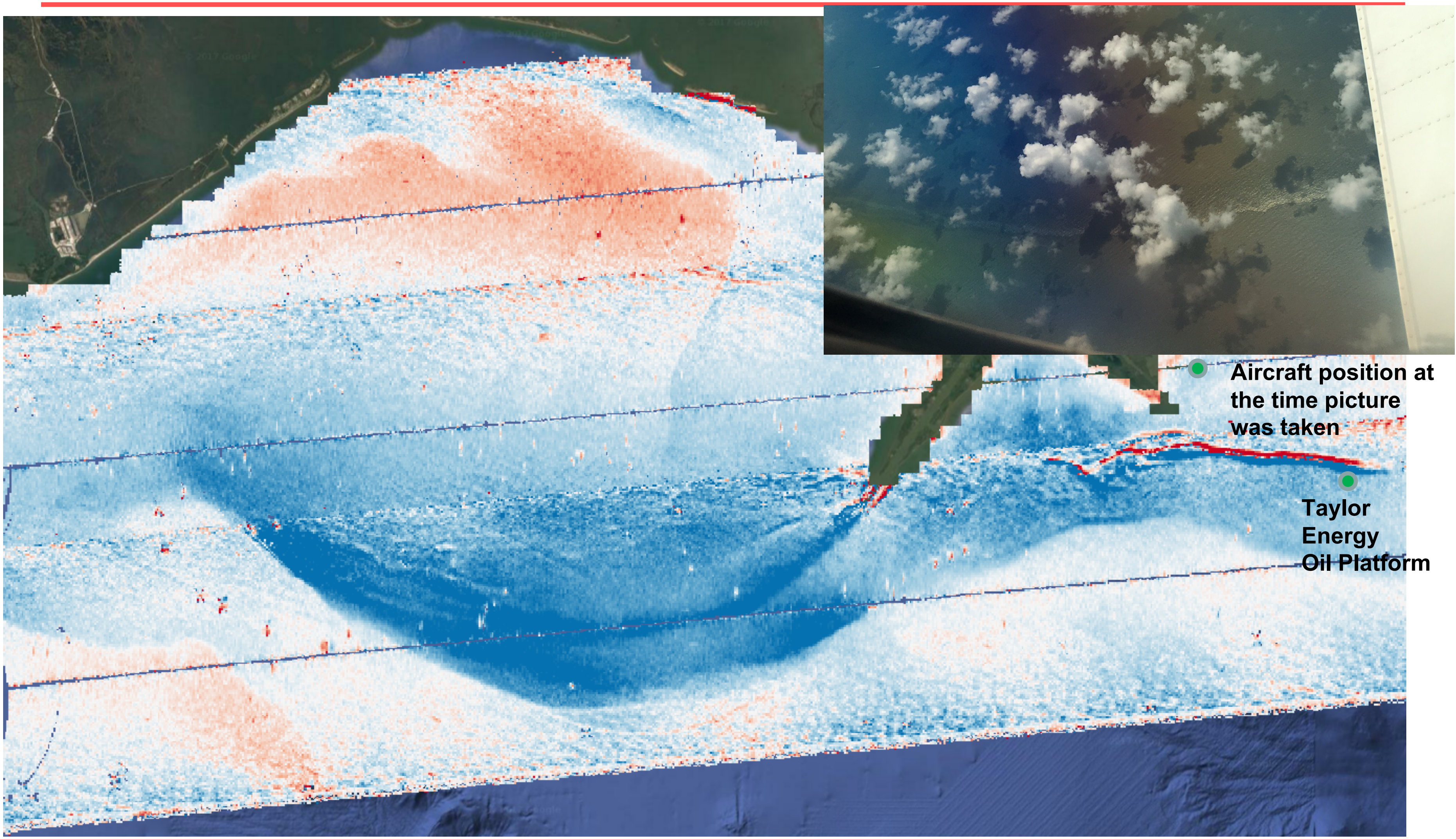
4. DopplerScatt September 13th Plume track aft-looking radial velocity

DopplerScatt U Surface Velocity Component 20170418



U component = East/West component of the current
Red – moving East, Blue – moving West

DopplerScatt U Surface Velocity Component 20170418



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ESTO Earth Science Technology Office

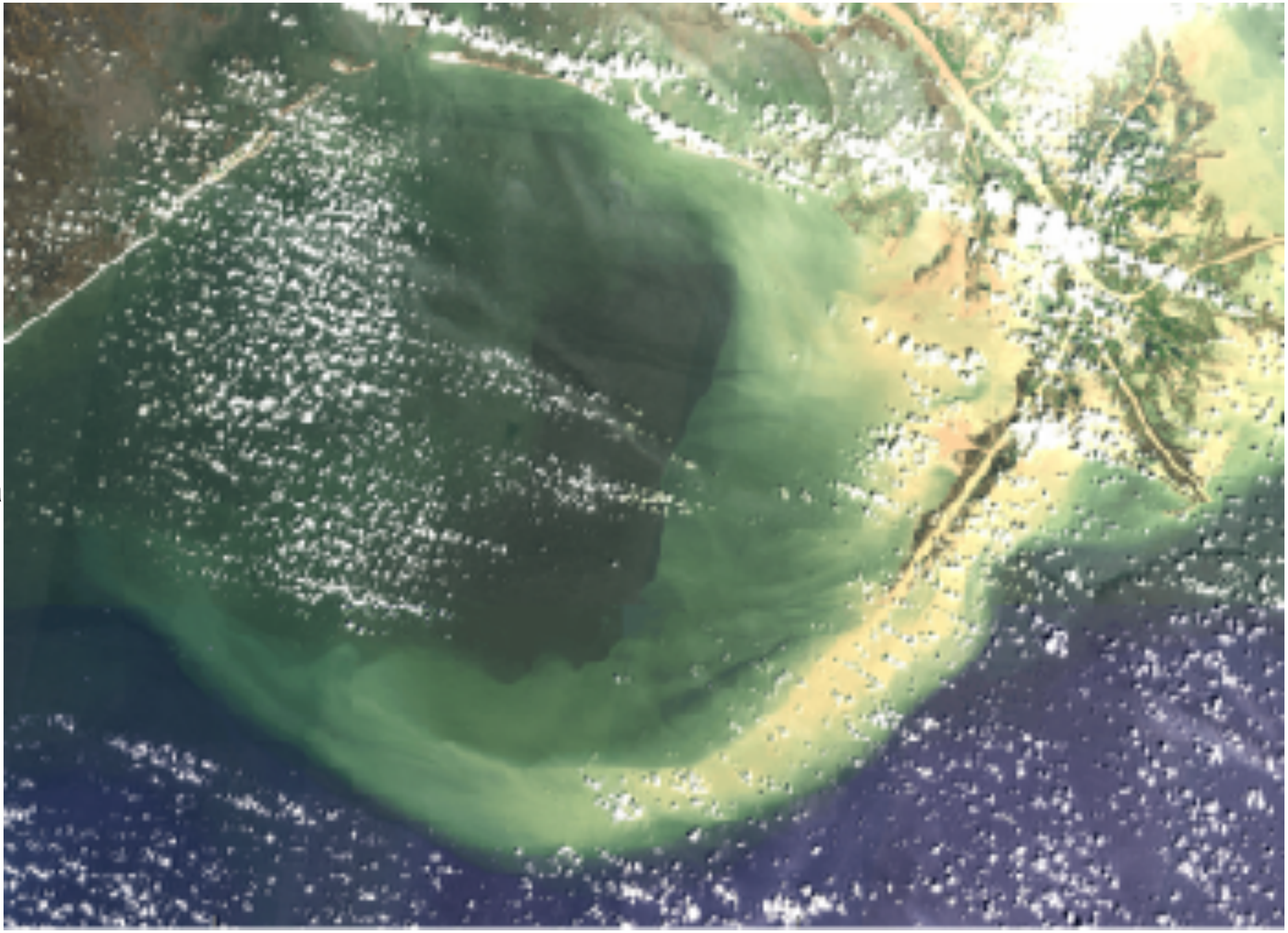
Sentinel 3 Image on 2017-04-18

Optical image by the ESA Sentinel-3 satellite mission's OLCI (Ocean and Land Colour Instrument)

The green/yellow colors indicate sediment and chlorophyll being carried by the plume of the Mississippi River and mixed with the Gulf of Mexico waters in Barataria Bay

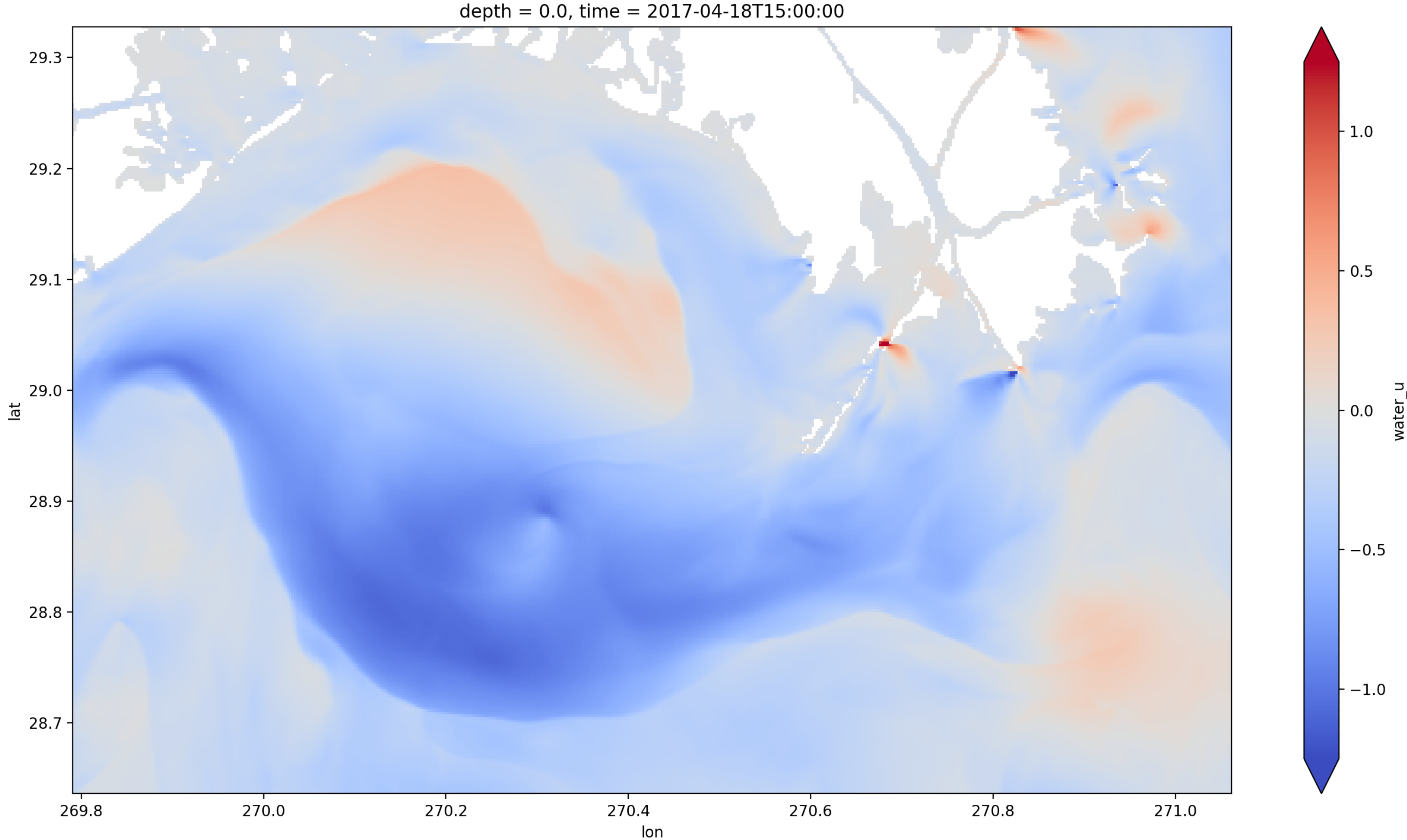
The sediments that are being carried by the currents follow closely the currents and fronts observed by DopplerScatt

The convergence feature emanating from the Taylor Energy platform is visible in the image as a dark streak



Courtesy of J. Molemaker & SPLASH team

NCOM U Surface Velocity



NCOM run at 250m resolution with special tuning for river inputs.
Data courtesy of G. Jacobs & NRL NCOM team

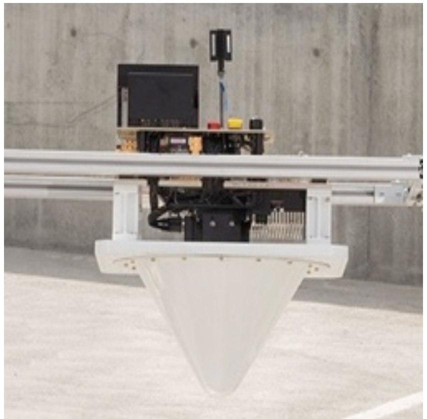
Summary

DopplerScatt - Scanning Doppler radar developed under NASA's IIP program becoming operational under NASA AITT program

Data Products:

- Vector ocean surface currents
- Vector ocean surface winds
- Radar brightness maps (sensitive to surfactants such as oil films)

Mapping capabilities: 25 km swath (from 8.5 km altitude); maps 200km x 100km area in about 4 hrs; 200m data product resolution; ~5-10cm/s radial velocity precision.



DopplerScatt instrument. It has been deployed on a DOE King Air and will transition to an operational instrument in the NASA King Air B200.

DopplerScatt SPLASH deployment

Potential Scientific Uses

- Observation of mesoscale to submesoscale transition in surface current circulation with associated wind drivers.
- Observation of internal waves and evolution over synoptic scales
- Improved understanding of air-sea interaction by simultaneous measurements of surface currents, wind stress, and SST (separate sensor that can be accommodated in NASA King Air platform).
- Improved understanding of mechanisms leading to upwelling
- Understanding of interactions of river plumes and ocean circulation, including mixing

Potential for Operational Use

- High resolution characterization of circulation in coastal shipping areas
- Tracking of surface surfactants (e.g., oil) with simultaneous measurements of surface currents and winds to aid models in prediction of dispersal
- Understanding beach erosion
- Planning for oil platform siting and safety