Small-scale and High-frequency SSH Variability Inferred from In-situ Measurements in Support of AirSWOT

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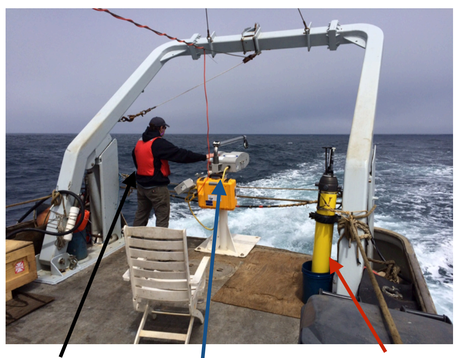
Abstract

In April 2015 a small army of investigators was mobilized to aid in site selection and in-situ data collection for an AirSWOT validation campaign in the coastal ocean off Monterey Bay, California. We report here on measurements of dynamic height and velocity collected by profiling floats (EM-APEX), under-way CTD (UCTD), surface drifters, and shore-based HF Radar, and their relationship to satellite sea-surface height (SSH) from AltiKa, sea-surface temperature (SST) imagery, and coastal ROMS forecasts.

While the height comparisons among the various platforms are encouraging, the spatial resolution of the ROMS model limits its ability to capture submesoscale eddy and frontal features. In addition, temporal sampling by the EM-APEX floats reveals substantial SSH variability from the internal tide in certain locations. Velocity comparisons are more problematic, with HF Radar and ROMS (assimilating HF Radar data) showing substantially reduced speeds relative to the surface drifters and profiling floats.

Subsurface structures sampled in space and time by the UCTD and EM-APEX, along with high-resolution SST imagery, illustrate the complexity and rapidly-evolving state of the submesoscale field off Monterey and clarify the challenges of observing these types of features from AirSWOT and SWOT.

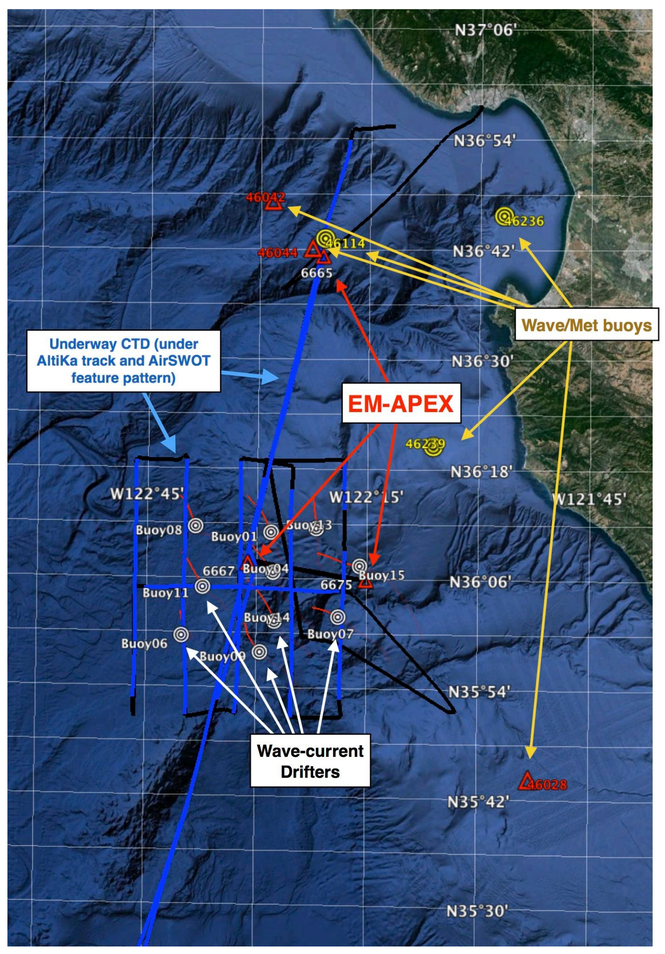
April 2015 Field Survey off Monterey from R/V *Shana Rae*



Operator

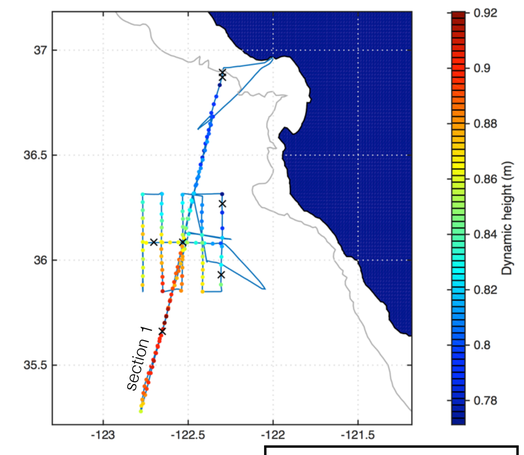
Underway CTD (UCTD) winch and spooler

EM-APEX (ElectroMagnetic Profiling EXplorer) Profiling Float

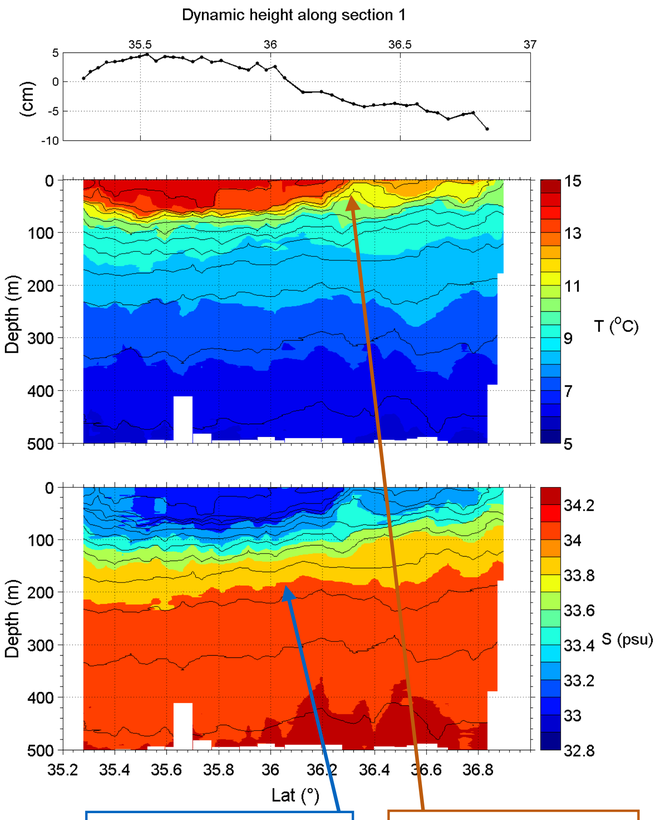


Summary of field assets in the April 2015 experiment. The two principal AirSWOT patterns were a long line following an AltiKa track and a 2-D 40x40 km survey box.

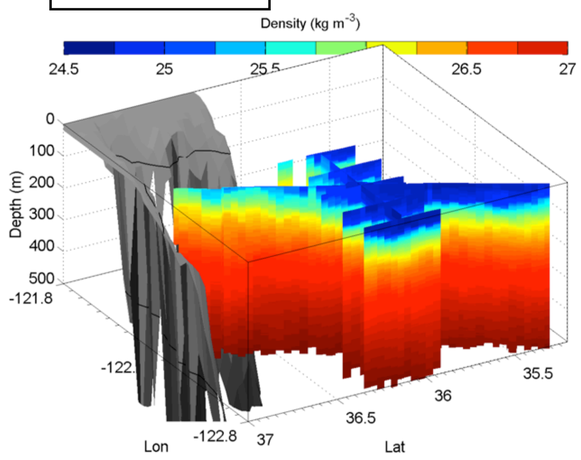
Spatial Variability from Underway CTD



UCTD Survey track, April 17-21, 2015

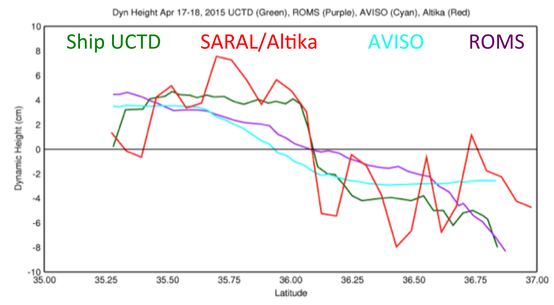


3D view looking southeast

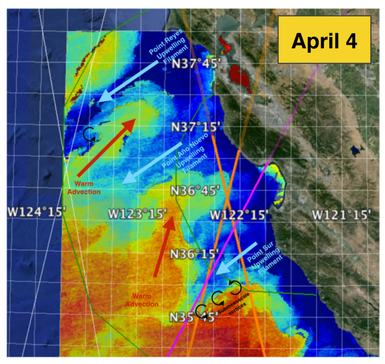


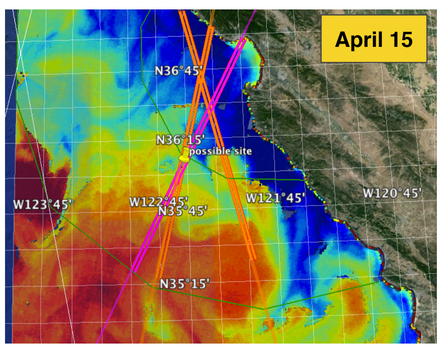
Deep baroclinic signal produces largest SSH signature

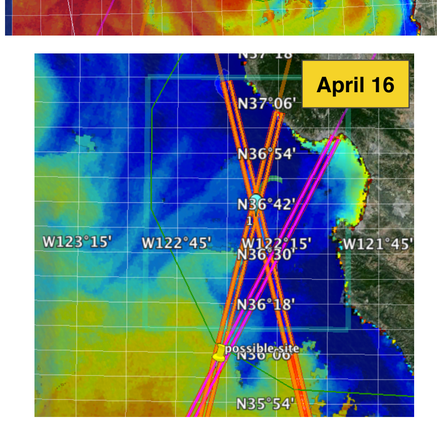
Shallow SST signal is considerably weaker in SSH



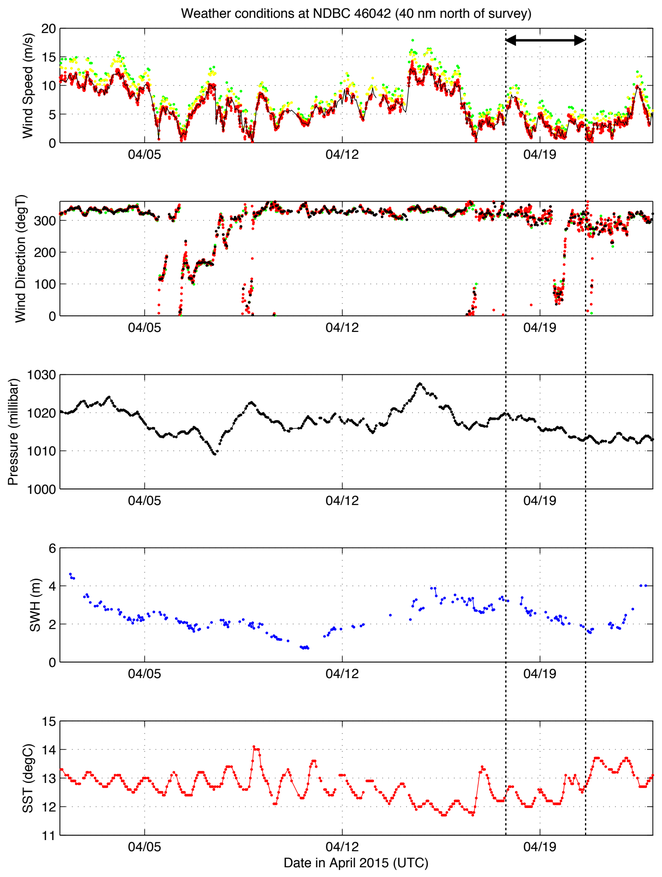
Setting: Mesoscale, Winds, Internal Tide

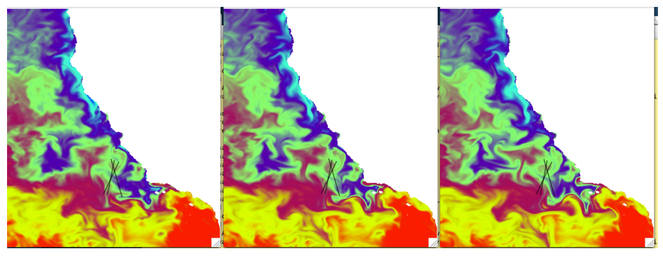






SST Imagery (MODIS and METOPO-A)



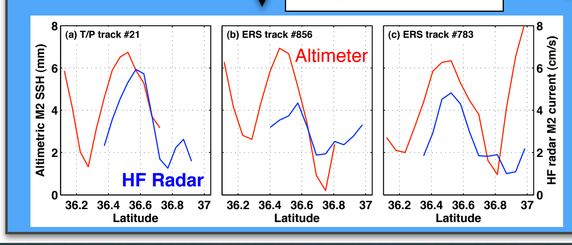


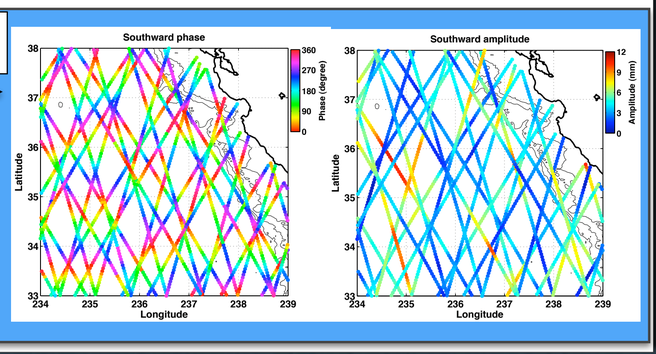
ROMS SST Forecasts, made on April 16 for April 16, 17, 18 (Note growing and evolving features in coastal upwelling pattern)

Internal Tides from Satellite Altimetry and HF Radar

multi-satellite southbound wave fits

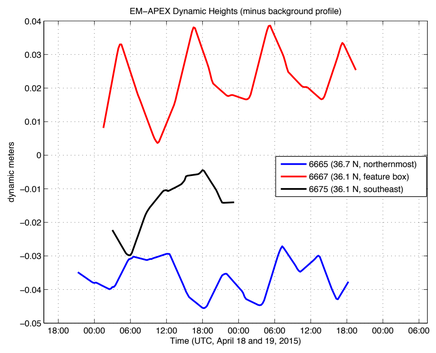
along-track comparison

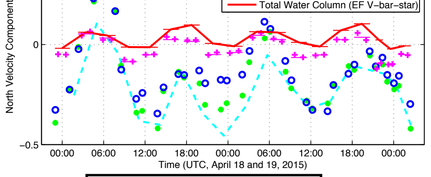


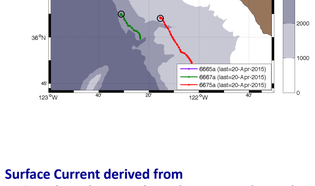


Temporal Variability from EM-APEX Floats

Dynamic height (surface relative to 500m) timeseries



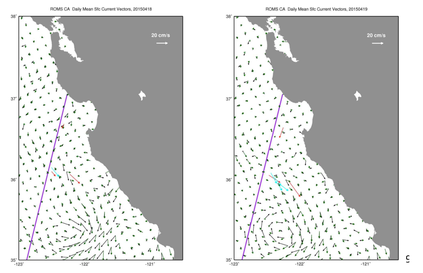


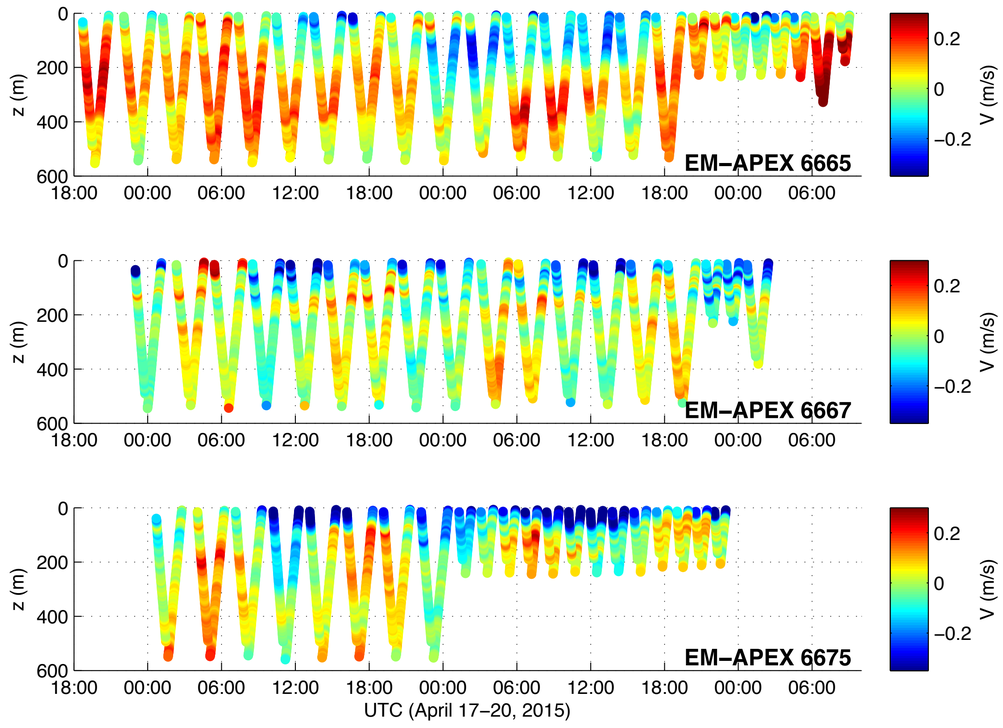


Meridional velocity at center of survey box (surface, upper ocean, and total)

Velocity comparison between floats, surface drifters, HF-RADAR, and ROMS

Surface Current derived from EMA Floats (Red), Drifters (Cyan), ROMS (Black), HF Radar (Green)





Depth–time sampling by EM-APEX (meridional velocity, showing tidal and near-inertial internal wave signals)

Conclusions

- Mesoscale and sub-mesoscale oceanic structures off California make an effective signal for validating SSH measurements in the range of interest for SWOT (10-200 km) and AirSWOT (0.1-100 km).
- Internal wave signals, including tidal and near-inertial, contribute significant “noise” to snapshot profiles of slowly-evolving structures.
- Dynamic height computed from subsurface density is an effective measure of spatial and temporal SSH variability in locations of strong stratification and surface-intensified dynamics.
- The complex mixture of space and time in a rapidly-evolving submesoscale field challenging to interpret from measurements with limited spatial coverage and temporal resolution.

Acknowledgments

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