Nonlinear Surface and Local Dynamics in Wind-Driven OSCAR Currents Over Three Decades of Observations

Kathleen Dohan, Earth & Space Research, Seattle, WA, USA

This poster outlines a newly funded IOVWST project.

Motivation: Ocean surface currents are an essential climate variable. It is vital to understand the link between the surface winds and ocean surface currents as a coupled dynamic system. This coupling occurs at the interaction between the ocean's surface boundary layer and the atmospheric lower planetary boundary layer. This study emphasizes the upper ocean boundary layer, a dynamic space dominated by surface wind stress, the associated mixing, wave processes, and momentum transfer that generates the surface currents.

OSCAR is a satellite-derived global surface current product provided in near-real time based on wind-driven Ekman currents, quasi-steady geostrophy, and thermal wind adjustment (www.esr.org/research/oscar). OSCAR products are hosted by the NASA PO.DAAC. OSCAR performs very well in many parts of the ocean, but there remain some areas that need more model development, which we will address in this project.

This study will consist of **three main objectives**

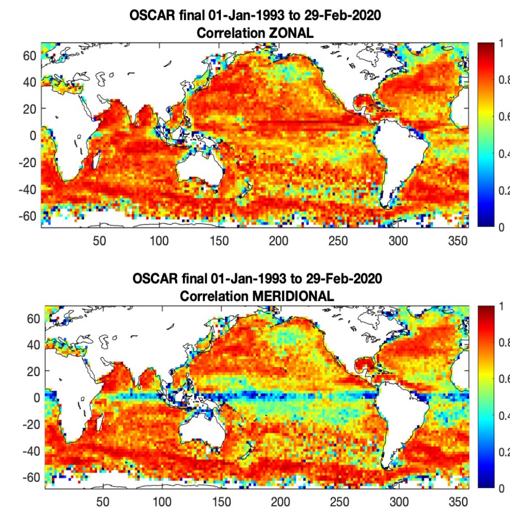
1) Increase the fidelity of the OSCAR model by adding surface wave effects and vertical variation
2) Assess the need for small-scale wind data within the context of different scatterometer constellations
3) Use the advantage of three decades of concurrent wind and current data to investigate the climate scale changes of ocean circulation and the winds that drive them.

The **key scientific questions** are:

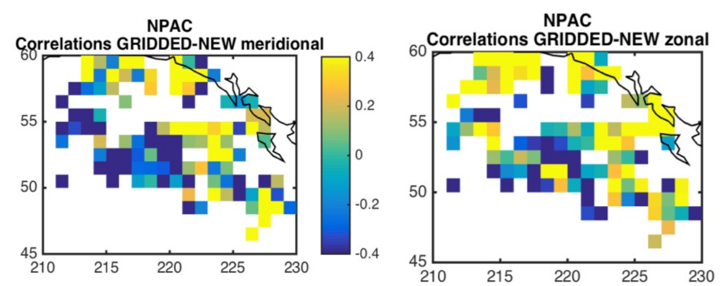
- Where does Ekman theory break down in the global ocean and why?
- How much do wind-driven currents depend on the scales of the satellite wind measurements?
- How can we connect top surface current data to mixed layer currents in a simple global model?
- How are currents responding to any long-term changes in winds?

These will be answered through several **main tasks**:

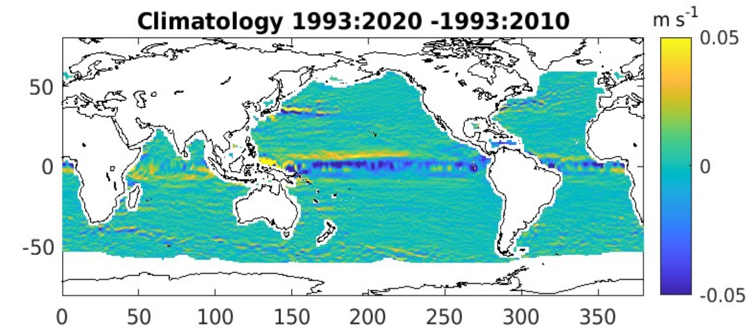
- Systematic match-up between all available global ocean vector wind datasets with *in situ* data together with a statistical analysis.
- Calculation of small-scale currents using swath data from all available scatterometers to diagnose where Ekman theory works
- Co-analyses of long-term wind and current trends
- Model development:
    - Development of a Stokes-Coriolis term within the OSCAR model
    - Assessment and possible inclusion of Langmuir turbulence in OSCAR
    - Investigation of vertical variation through the generalized Ekman model



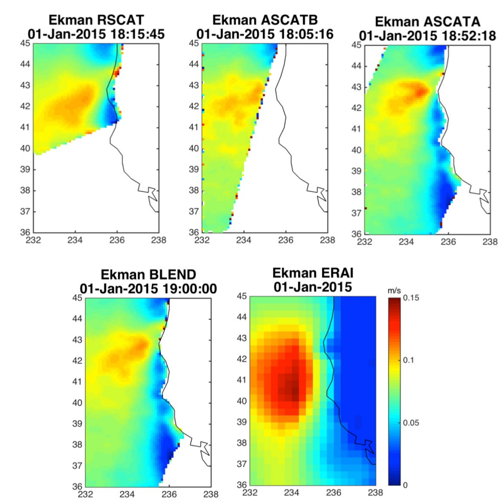
Problematic areas of OSCAR: Correlation of OSCAR v2.0 final with drifters, from 1993:2020. Drifter velocities and locations are daily binned. OSCAR velocities are interpolated to the drifter locations, and correlations are made between zonal and meridional components. Left: zonal correlation coefficient using 20 years of data, binned to 2° boxes. Right: Meridional correlation coefficients.



Regridding to get close to coasts: Sample OSCAR results in the North Pacific region comparing correlations with drifters from the OSCAR 0.25° product ('NEW') and a blended gridded ASCAT A, B, and RapidSCAT product. Calculating Ekman currents from level 2 data is promising closer to the coasts.



Shifting circulation patterns observed over decades of satellite data: OSCAR zonal velocity climatology from 1993:2020 – climatology from 1993:2010. Meridional shifts of currents are the most noticeable, seen as the banded blue/yellow lines.



Importance of small scales and the vector wind constellation: Demonstration of difference in Ekman current calculated from differently measured and sampled winds. Shown are example griddings and Ekman calculation from RapidSCAT, ASCAT A, ASCAT B, the 3 blended, and the same using ERA Interim model winds. Although the small scale Ekman currents are promising, validation is difficult.