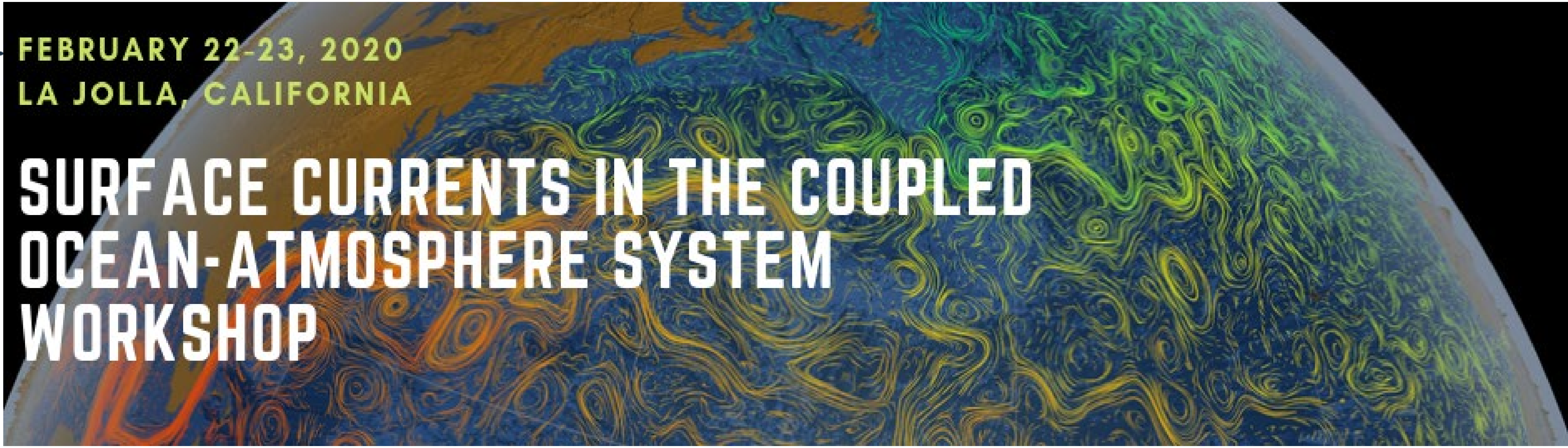
Welcome to the Workshop!



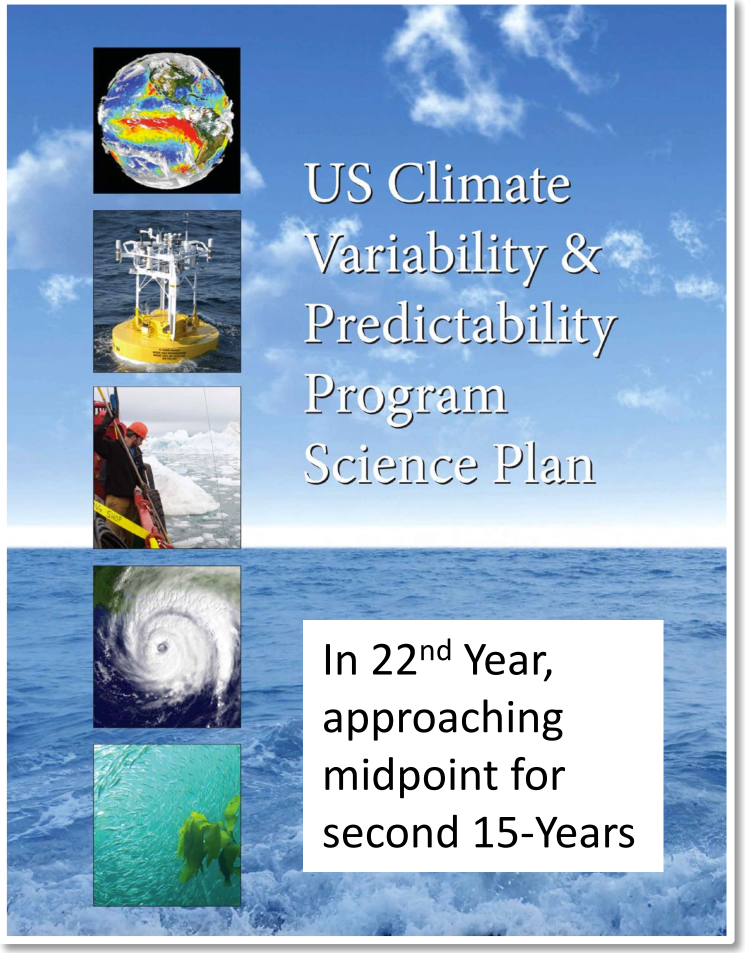
- Thank you to our sponsors: NASA, NOAA and NSF
- Thank you to the US CLIVAR office for supporting the workshop and helping organize it
    - Particularly Jennie Zhu and Mike Patterson
- Thank Sarah Gille for what ended up being a lot more work than expected to make the meeting happen in La Jolla

US Climate Variability & Predictability (CLIVAR)
An Earth System Science Community Program

To foster **understanding and prediction of climate variability and change** on intraseasonal-to-centennial timescales, through observations and modeling

with emphasis on the **role of the ocean and its interaction** with other elements of the Earth system, and to serve the climate community and society

through the **coordination and facilitation** of research on outstanding climate questions.



In 22nd Year, approaching midpoint for second 15-Years

→ US contribution to International CLIVAR

→ Ocean's role component of US Global Change Research Program (USGCRP)

US CLIVAR Goals

1) Understand the **role of the oceans** in climate variability on different time scales.

2) Understand the **processes** that contribute to climate change and variability in the past, present, and future.

3) Better **quantify uncertainties** in the observations, simulations, predictions and projections of climate variability and change.

4) Improve the **development and evaluation of climate simulations and predictions.**

5) **Collaborate with research and operational communities** that develop and use climate information.

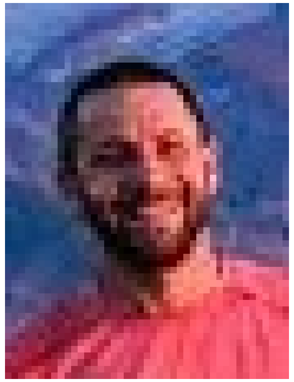
US CLIVAR Research Challenges

Decadal Variability & Predictability	Climate & Extreme Events	Polar Climate Changes	Climate & Carbon/Biogeochemistry
• Decadal modes of variability • Overturning circulation • Warming hiatus • Expanding tropics • Initialized predictions • Large ensembles	• Tropical cyclones & hurricanes • Sea level variability, change, & extremes/coastal inundation • Heat waves/cold outbreaks • Drought • Heavy precip & floods	• Arctic-subpolar gyre exchanges • Southern Ocean stratification & transport • Ocean-ice sheet & ocean-sea ice interactions • Arctic-midlatitude atmos. connections	• Carbon cycle sensitivity • Coupled physical & biogeochemical processes • Marine ecosystem and fisheries response to climate variability & change
• Multi-year predictability • Stratosphere influences	• East Coast sea level • S2S predictability of severe storms	• Arctic Ocean & Sub-Arctic Seas circulation • Sea ice prediction	• West Coast marine prediction

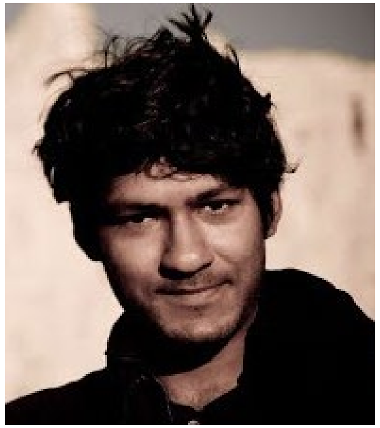
2020 Surface Currents Workshop Scientific Steering Committee

Mark Bourassa, Florida State University (co-chair)
Kyla Drushka, University of Washington (co-chair)
Shane Elipot, University of Miami
Tom Farrar, Woods Hole Oceanographic Institution
Peter Gaube, University of Washington
Sarah Gille, University of California - San Diego
Hyodae Seo, Woods Hole Oceanographic Institution
Mike Stukel, Florida State University
Aneesh Subramanian, University of Colorado





Workshop Motivation

Ocean surface currents have a profound influence on human life in two major ways:

- They are critical in horizontal transport and dispersal of pollutants and physical, biological, and chemical properties, and
- They are an important factor in air-sea exchange of properties like heat and energy.

These factors underscore a broader need for better air-sea fluxes to improve subseasonal-to-seasonal prediction.

Surface currents have been poorly observed, particularly within the upper meter of the ocean, but new aircraft- and space-based platforms to measure surface currents are on the horizon.

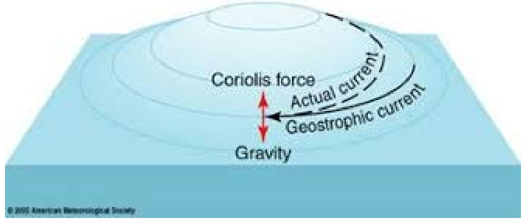
- We will identify what is needed for surface currents and gaps in these needs, and paths (solutions) to observe and use surface currents

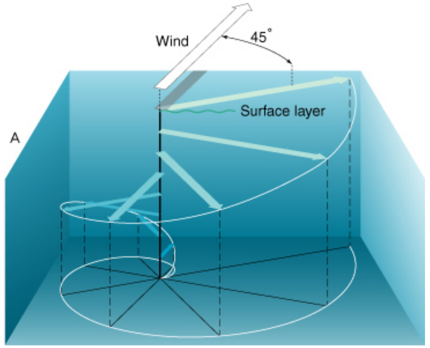
Recent developments in the field of upper ocean currents

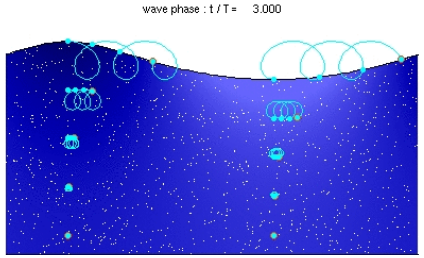
- Coupled modeling is much more appreciated
  - Currents (and gradients in currents) are more important to coupling as resolution increases.
  - Strong surface current features are found everywhere
- Satellite missions to measure surface currents have been developed, and in one case competed for funding (more on this later)
- In situ observations
  - Ageostrophic currents have vastly more impact on vertical motion than geostrophic currents
  - New drifters have been developed
  - Measurements of current profiles near the surface

What is “Surface Current” (from attendee applications)

- Daily averaged current at the top of the ocean
- Average current in the top layer of an ocean model
- Daily average geostrophic current from altimetry
- Currents at 15 m depth (or 3 to 10 m depth, or near the surface)
- Hourly gridded currents corresponding to a 1 m depth
- The Lagrangian mean velocity of the air-sea interface... hence it contains the Stokes drift
- Not well defined
- A frame of reference for ripples, or the current needed for flux calculations
- Average velocity of the mixed layer



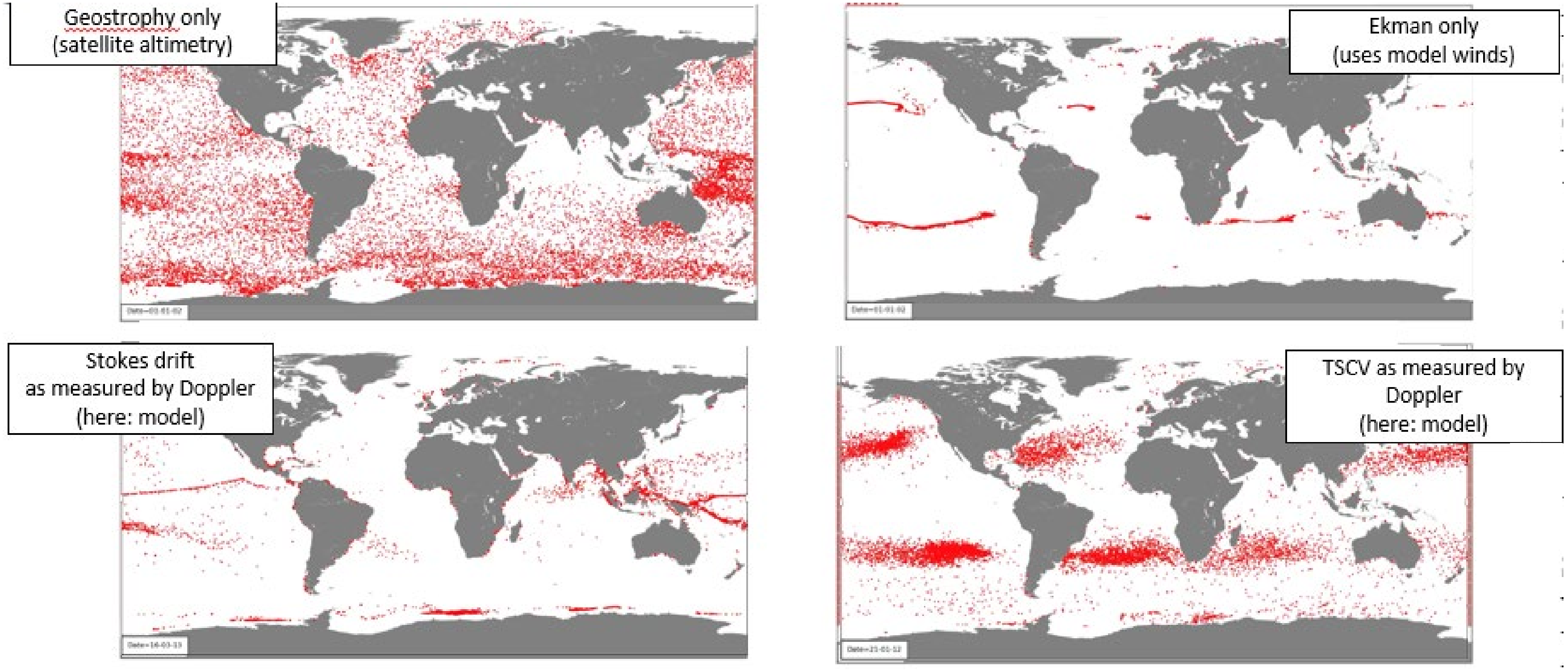




These different answers emphasize the prior conclusion that we need to understand the profile of near surface currents well enough to translate between these definitions.

Example: Surface Transport (biology, debris)

(Onink et al, 2019 JGR-Oceans)

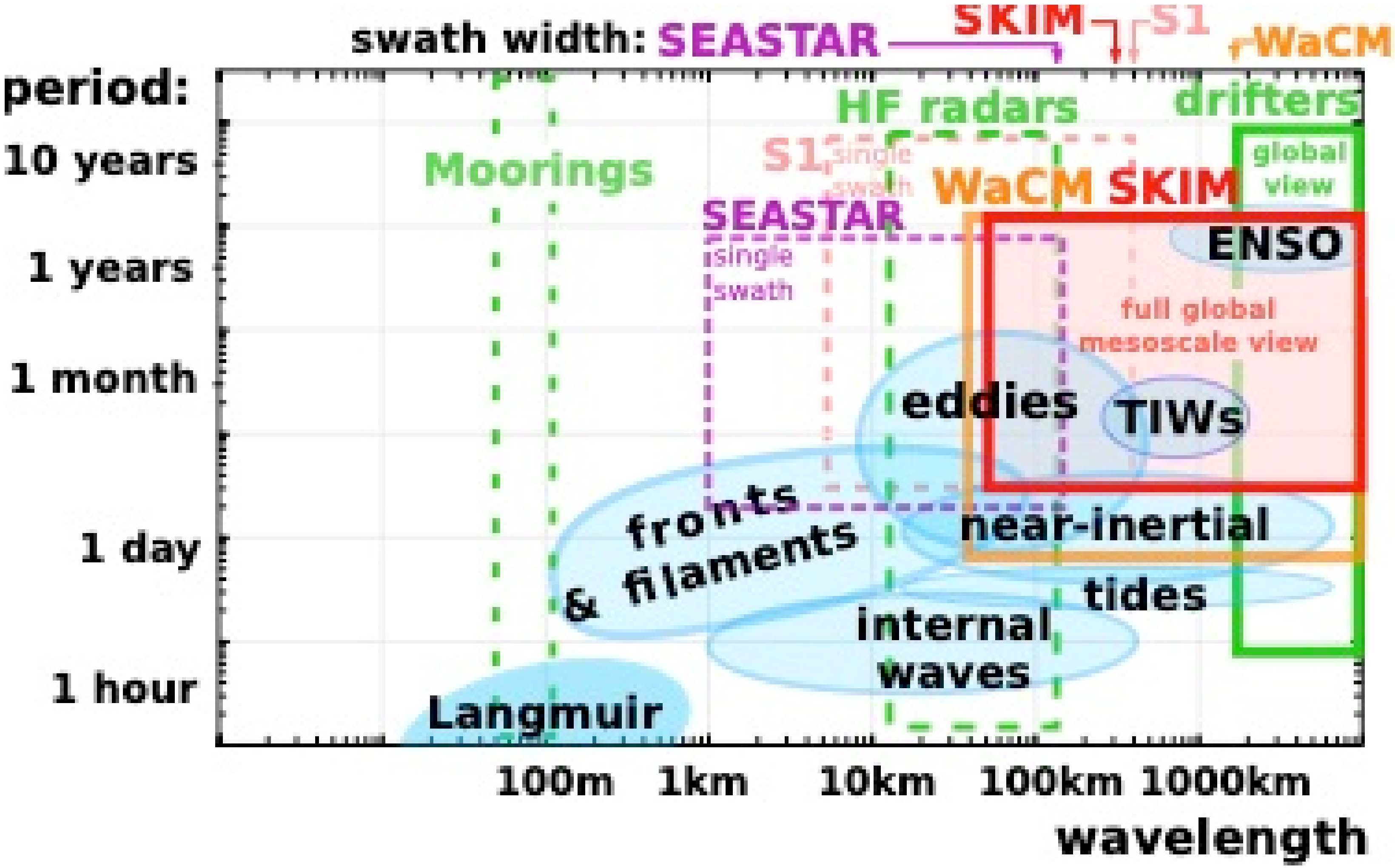


- The dispersal of biological and human made particles near the surface is an important scientific and social problem.
- Dispersal of surface tracers depends on total surface Eulerian currents, Stokes drift, and windage.
- Stokes drift estimates can be obtained from wave spectra or correlation to winds, obtained using Doppler scatterometry.
- Total Surface Currents from Doppler scatterometry.

Existing Missions and Mission Concepts

- **S-MODE** (2019-2024):
  - Ongoing NASA Earth Ventures Suborbital-3 Mission to map ocean ***submesoscales*** (1 km – 20 km) and air-sea interaction using airborne and *in situ* current, wind, wave and hyperspectral measurements. (T. Farrar, WHOI, PI)
- **SKIM**:
  - ESA Earth Explorer 9 candidate to map global ***surface currents and waves*** using near-nadir Doppler scatterometry. (Ardhuin et al., FMS, OceanObs, 2019)
  - 4-day global coverage, ~30 km swath spatial resolution
- **WaCM:**
  - ***Surface currents and winds*** concept responding to NRC Decadal Review observational requirements. (Rodríguez et al., FMS, OceanObs, 2019)
  - 1-day global coverage, 5 km winds swath resolution, ~5-30 km currents swath resolution.
- **SEASTAR:**
  - ***Submesoscale dynamics imager*** *(surface current and wind vectors, wave spectra),* candidate for ESA Earth Explorer 10 & 11. Uses squinted ATI SAR. (Gommenginger et al., FMS, OceanObs, 2019)
  - Polar, shelf and coastal seas (1-2 day or 7-30 day revisit), 1 km spatial swath resolution.

Space-Time Sampling of Ocean Features



Ardhuin, Fabrice, et al. "Satellite Doppler observations for the motions of the oceans." Bulletin of the American Meteorological Society 2019 (2019).

Workshop Goals

- **Bring together** members of the "physics" and "applications" communities in the field of ocean surface currents. The overarching aims of the workshop are to:
  - Develop a **practical definition** for "surface current", including the measurement and model depths and accuracies needed for different applications;
  - Summarize the ways in which surface currents modify air-sea coupling and how they respond to air-sea coupling, and the extent to which this coupling can affect processes and applications; and
  - Quantify uncertainties in estimates of transport of pollutants, particles, sea ice, etc. resulting from misrepresentation of surface currents in models and observations, the impacts on climate prediction resulting from these uncertainties, and how new measurement strategies (e.g., from satellites) can help in this.
- **Develop plans for improved modelling and observations of surface currents** with the goal of understanding different processes. A second objective is to improve the interdisciplinary collaboration between the physical oceanography, atmospheric science, and biological and chemical oceanography communities, as well as the surface currents "applications" communities.

This is an inclusive workshop

- The goal of the workshop is to exchange ideas in an open way
- We encourage the participation of all attendees, regardless of career stage or expertise
  - Feel free to ask questions
  - Please contribute to the breakout sessions
- We will not tolerate bullying or disrespect – please reach out to any of the SOC members or the US CLIVAR team (Jennie and Mike) if you have concerns

Workshop Organization

A two day workshop with posters, short presentations, and guided discussion (breakout sessions) will be hosted to achieve workshop objectives and community building.

- **Day 1 AM**: Plenary - Current state of knowledge about the role of currents in air-sea coupling; breakout session
- **Day 1 PM**: Plenary - Vertical structure of near-surface velocity (and impact on applications); breakout session.

Day 1 will end with a poster session and reception.

- **Day 2 AM**: Plenary - Wind-wave-current interaction (and impact on applications); breakout session
- **Day 2 PM**: Plenary - Applications; breakout session. Day 2 will end with report from the four breakout sessions.

Lunch will be provided to encourage discussion