ODYSEA (Ocean Dynamics and Surface Exchange with the Atmosphere: A satellite mission concept to unravel small-scale ocean dynamics and air-sea interactions

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and the broader ODYSEA team

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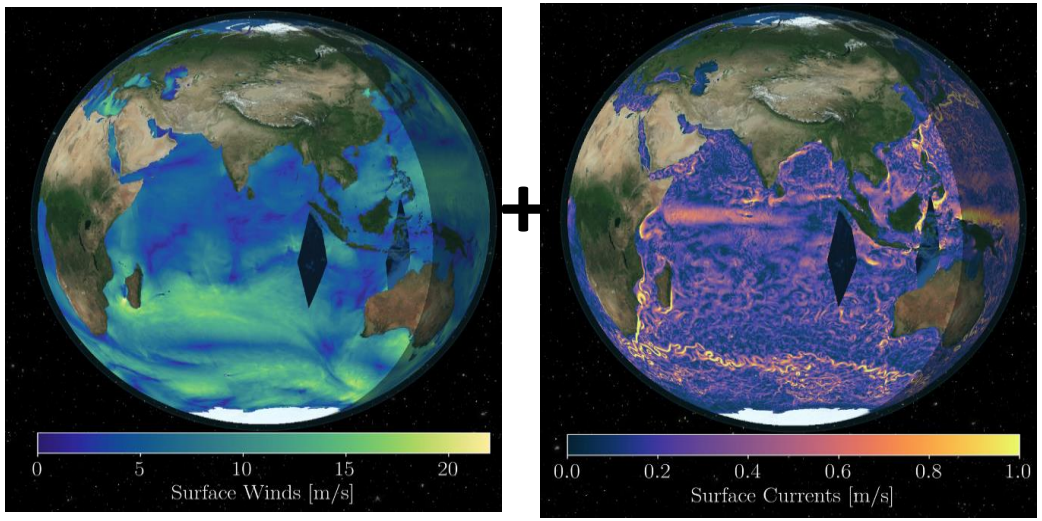
Background

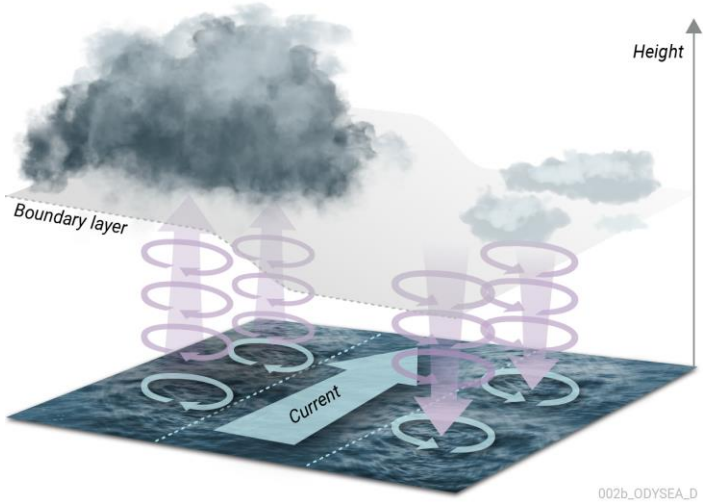
- Recent studies based on high-resolution models and field studies have underscored the importance of submesoscale and small mesoscale surface currents on air-sea interactions, ocean dynamics, marine ecosystems and biogeochemical cycles.

- There are significant capability gaps at present for observing these currents and assessing their impacts:
  - The present feature resolutions of space-based estimates of gridded surface current products are ~200 (due to gaps in altimetry ground tracks).
  - The geostrophic and Ekman theories used in deriving these current estimates breakdown near the equator.
  - These current estimates are more representative of mixed-layer currents, not necessarily the surface currents seen by the atmosphere and transporting pollutants (e.g., oil slicks).
  - The lack of simultaneous measurements of surface currents and wind stress makes it challenging for studying small-scale wind-current interaction.
  - No NRT surface current measurements over the global ocean that are needed for operational applications (e.g., ocean and ecological forecasts, Search and Rescue).
  - Present scaterometers in orbit do not meet WMO requirement (requiring at least 3 scatterometers with coordinated orbits to sample the diurnal cycle that is a fundamental building block of longer-term variability).

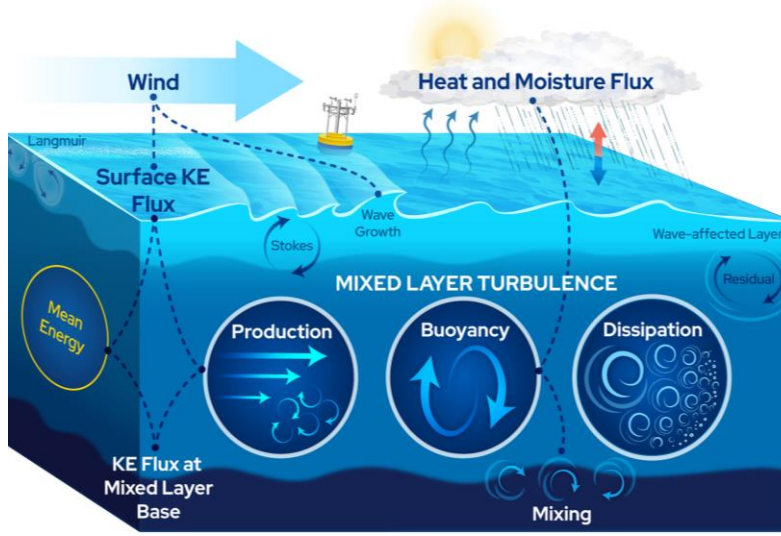
ODYSEA (**O**cean **DY**namics and **S**urface **E**xchange with the **A**tmosphere)

- A mission concept for upcoming competition under the NASA Earth System Explorers (ESE) program.
- ODYSEA fulfills a longstanding Earth Science community goal by providing the **first-ever measurements of total ocean surface current from space** and the **first global observations of ocean-surface current-wind interactions.**
- ODYSEA brings wind and current measurements up to speed to advance Earth system science and operational applications that save lives.





Small-scale wind-current interaction & effect on atmospheric BL

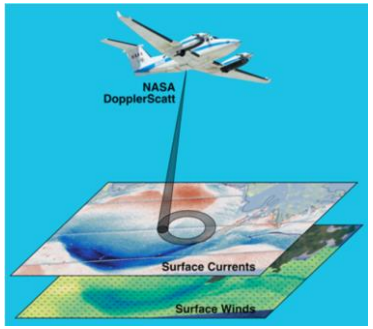


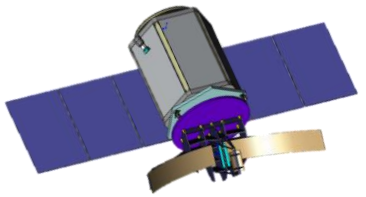
Parsing the kinetic energy budget of the ocean surface mixed layer *(Zippel et al, 2022)*

ODYSEA (Ocean DYnamics and Surface Exchange with the Atmosphere)

Instrument

- A single radar can measure vector winds and currents with 5 km posting.
- Building on NASA technological heritage of scatterometry (e.g., QuikSCAT) & DopplerScatt (mature airborne radar, being used in NASA EVS-3 Mission S-MODE).





Mission Design

Swath width: >1,500 km	Orbit: sun-sync, 600 km	~90% global coverage <1 day
NRT winds/currents (<6 hour latency)	Partner organizations: JPL, Ball Aerospace, CNES, DoD, NOAA	Science Team: US and French institutions (incl. NRL & Mercator for operational ocean forecasts)

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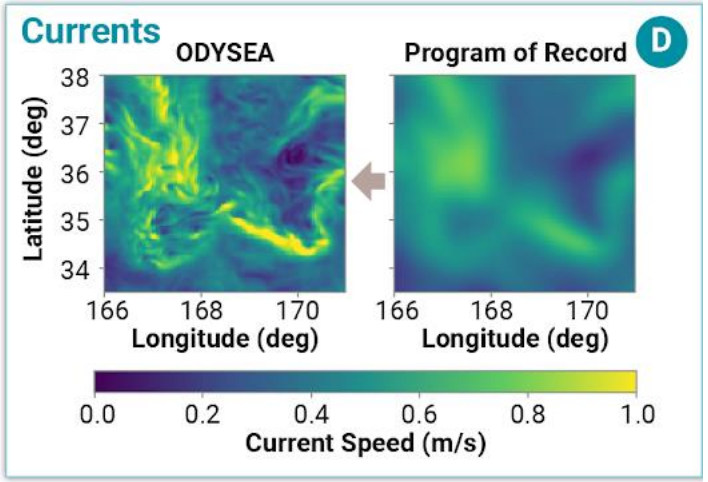
ODYSEA (vs. present) capabilities for vector winds & currents

	Resolution	Accuracy for stated resolution	Sampling	Coastal Sampling
Vector winds	5 km (~20 km)	Speed: greater of 10% or 1m/s Direction: 20 degrees	< daily (< daily)	~2 km from coast (~25 km)
Vector surface currents	5 km (>200 km)	U/V components: < 50 cm/s	< daily (~weekly)	~2 km from coast (~30 km)



ODYSEA science and applications

- How small-scale wind-current coupling affects the atmospheric boundary layer and ocean circulation.
- Variability of small-scale surface currents and their interactions with larger-scale circulation (e.g., bi-directional kinetic energy cascade).
- How surface current response to winds depend on near-surface ocean stratification, scale (submeoscale/mesoscale vs. larger scales), and region (open ocean, boundary current regimes, coastal oceans).
- Cross-shelf transport, coastal upwelling (inferred from surface current divergence).
- Assessing & constraining models, improving model parameterization & predictions.
- Operational applications (including ocean forecasts, S2S predictions, Search and Rescue)

Process and Timeline

- NASA Earth System Explorers (ESE) mission concept proposals due June 2023, addressing 7 categories of observables recommended by the US Decadal Survey in Earth Science & Applications from Space 2017 report (ESAS2017).

- ODYSEA uniquely responds to one of the 7 observable categories: “winds and Currents”.

- A two-step process: 4 concepts to be selected in Step 1; 2 concepts to be selected in Step 2 around mid-2024.

- Selected missions are to be launched around 2030.

Engagement with OceanPredict & SynObs

- The ODYSEA effort needs community wisdom, support, and advocacy.
- In particular, OSSE efforts within OceanPredict & SynObs.
- Welcome participation to the Winds and Currents webinar series since early 2022 (Tuesdays at 8 am Pacific time/5 pm CEST), including making presentations.