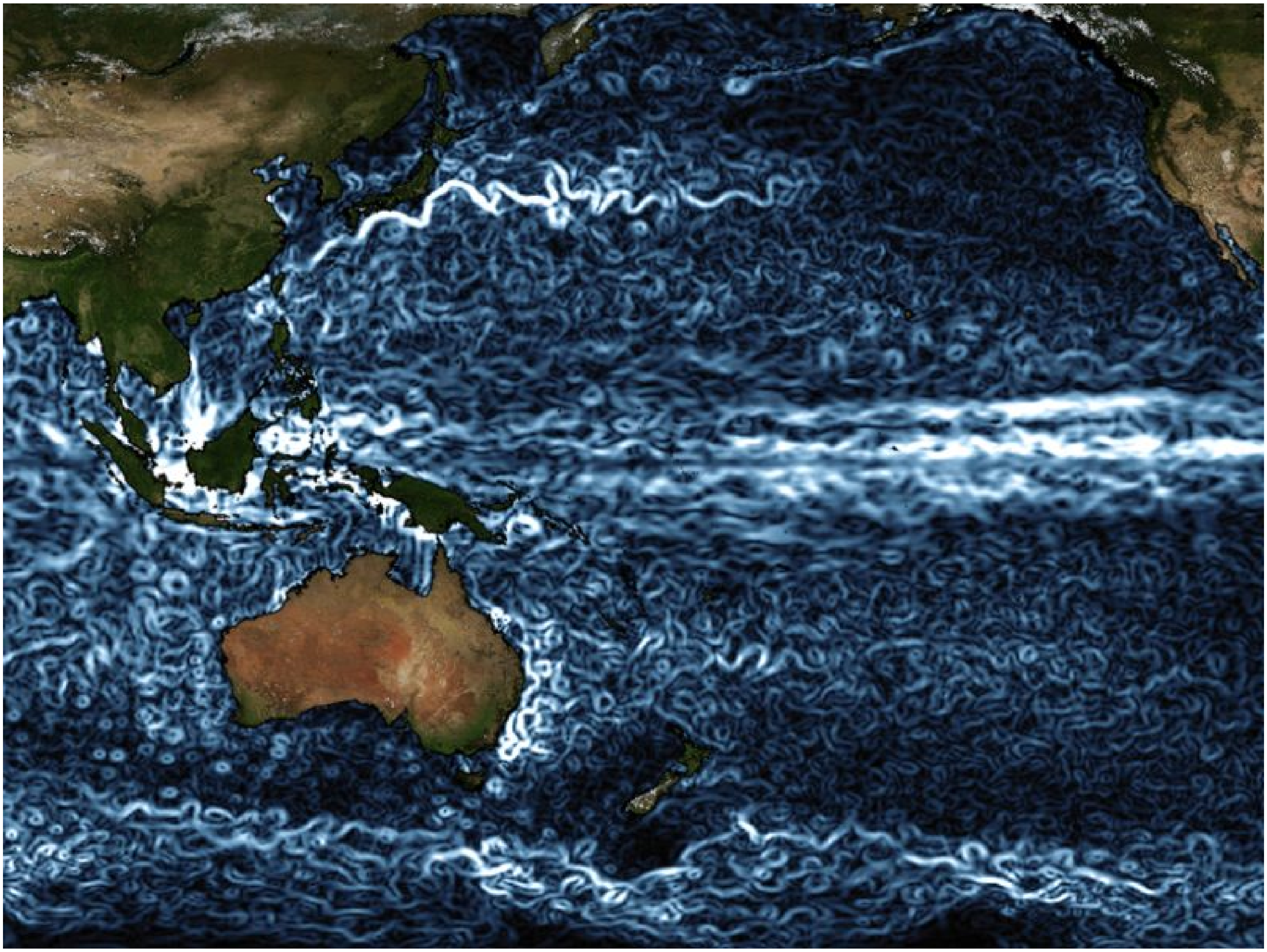
Exploring the Interplay Between Ocean Eddies and the Atmosphere

Ocean Mesoscale Eddy Interactions with the Atmosphere: A CLIVAR Workshop; Portland, Oregon, 17–18 February 2018



A snapshot of ocean surface velocity intensity in the Indian and Pacific oceans on 31 December 2013, estimated from the global Map of Absolute Dynamic Topography derived from satellite altimetry. Stronger currents are indicated by lighter colors, with white representing about 0.75 meter per second. Participants at a workshop earlier this year outlined several specific actions necessary to improve our understanding of how ocean eddies affect the atmosphere and vice versa. Credit: CLS/CNES

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Mesoscale eddies, circling currents a few hundred kilometers across, are omnipresent in the ocean. Ever-improving observations—from satellites, moorings, and autonomous floats—show that eddies differ from their surroundings and can transport oceanic heat and salt over large distances. The imprint of eddies on sea surface temperature (https://eos.org/articles/scientists-predict-active-hurricane-season) affects the overlying atmosphere, and these interactions feed back to affect the eddies themselves. With rapid advances in numerical modeling, climate models, for the first time, have sufficient resolution to capture these eddies (https://www.gfdl.noaa.gov/ocean-mesoscale-eddies/) and their interactions with the atmosphere.

As we learn more about the rich dynamics of these ubiquitous features, three questions emerge: How can we use direct measurements to better assess eddy interactions with the atmosphere? How do such interactions affect ocean dynamics? Can eddies, despite their small size, influence weather and climate?

A U.S. Climate Variability (CLIVAR (https://usclivar.org)) and Predictability Program workshop (https://usclivar.org/meetings/ocean-mesoscale-eddy-workshop) earlier this year addressed just these questions. More than 50 oceanographers and atmospheric scientists from 10 nations met to assess the state of knowledge about ocean eddy–atmosphere interactions and to plan research.

Presentations described observations showing that the temperatures associated with the eddies influence winds in the atmospheric boundary layer (https://www.metoffice.gov.uk/research/foundation/parametrizations/boundary-layer) by modulating atmospheric pressures and vertical mixing. Winds, in turn, affect how hard the atmosphere pushes on the ocean surface, as do the eddy currents themselves, with consequent effects on eddy energies and the ocean circulation.

New model results suggest that the atmosphere, at weather scales or larger, responds to cumulative effects of the much smaller ocean eddies.

Participants agreed that we need a better understanding of how the wind stress (https://eos.org/research-spotlights/swirling-eddies-in-the-antarctic-may-have-global-impacts) and air-sea fluxes (https://eos.org/meeting-reports/new-approaches-for-air-sea-fluxes-in-the-southern-ocean) of heat and moisture are controlled—these are represented by empirical formulas containing uncertain parameters. When models treat the ocean independently from the atmosphere, how should feedbacks from the atmosphere be represented?

Finally, intriguing new model results presented at the workshop suggested that the atmosphere, at weather scales or larger, responds to cumulative effects of the much smaller ocean eddies. Such a response would require a “rectification” of local effects, but how this may happen in nature is not yet understood.

Participants decided on several actions to advance the science:

developing plans for modeling experiments with ocean-only and atmosphere-only models
exploring different representations in each of the fluids not simulated within these models
developing protocols for diagnosing interactions within coupled models
developing new approaches to analyzing the increasing number of available data sets
making the case for new observations in field campaigns and from satellites

The consensus among workshop participants is that eddy-atmosphere interactions are important for the ocean and the atmosphere at space scales and timescales much larger and longer than those of an individual eddy. We are on the cusp of new modeling and observational results that will show us how all this works.

More information on the workshop is available at the workshop's website (https://www.gfdl.noaa.gov/ocean-mesoscale-eddies/).

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