

# US CLIVAR Working Group on Air–Sea Interaction Overview

*Mesoscale and Frontal–Scale Ocean–Atmosphere  
Interactions and Influence on Large–Scale Climate*

## Co–Chairs

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## US Members

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US CLIVAR Whither the Gulf Stream Workshop  
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# Working Group Objectives

**Overarching goal:** Formulate and coordinate observational and modeling efforts to quantify oceanic mesoscale and frontal-scale air-sea coupled processes and evaluate their integrated impacts on Earth's climate and hydrological cycle

- ▶ Produce a review paper synthesizing current understanding and open questions, and demonstrate influence of this air-sea coupling on a wide variety of high-level processes in Earth's climate system
  - Large-scale atmospheric circulation, hydrologic cycle, and ocean dynamics and biogeochemistry, among others
- ▶ Develop diagnostic frameworks and analyze models and observations using a set of robust metrics
- ▶ Identify consensus on uncertainties and directions forward for observing and modeling
  - Guide in situ and satellite observations for optimum sampling strategies
  - Motivate coordinated process-oriented modeling and observationally-based diagnostic studies
  - Broker community efforts following the previous US CLIVAR Workshops on related topics

# Mesoscale air–sea coupling addresses aspects of core CLIVAR research challenges:



Also: Hydrological cycle (distribution of precipitation and aspects of terrestrial drought); Marine heat waves (coastal and open ocean); ocean ecology (species proliferation and distribution)

# Recent WG activities

- ▶ Submitted review paper to the Journal of Climate
  - ▶ Bi-monthly research seminars to the working group
  - ▶ Assist planning of US CLIVAR Gulf Stream workshop
  - ▶ Hosting a session at the 2022 Fall AGU meeting
  - ▶ Planning a community workshop for winter/spring 2023
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# Bi-monthly science seminars

- ▶ **Jackie May** (NRL): *“Impact of currents and submesoscale ocean resolution on the air–sea interface in a coupled model”*
- ▶ **Lucas Laurindo** (NCAR): *“Role of ocean and atmosphere variability in scale–dependent thermodynamic air–sea interactions”*
- ▶ **Eduardo Moreno–Chamarro** (Barcelona Supercomputing Center): *“Can we trust future projections of European winter precipitation?”*
- ▶ **Justin Small** (NCAR): *“Convergence over the Gulf Stream on Hourly to Annual Timescales: the Role of SST Revisited”*
- ▶ **Jim Edson** (WHOI): *“A Global Array of Surface Flux, Currents and Waves Measurements and the Evolution of the COARE Algorithm”*
- ▶ **Qing Wang** (NPS): *“Air–Sea Interaction and Electromagnetic (EM) and Electro–optical (EO) Wave Propagation – The CAPSER Project”*

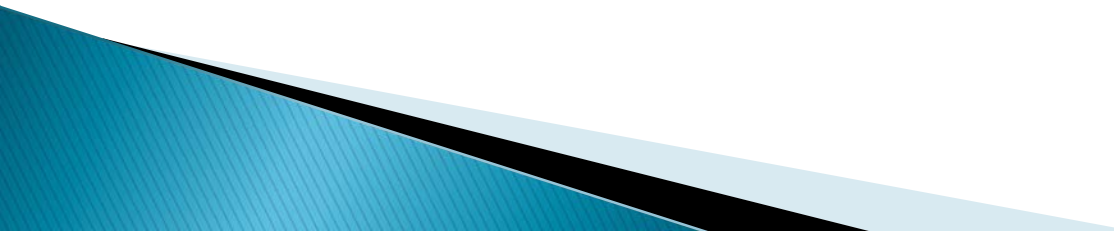
# Review paper

- ▶ “Ocean Mesoscale and Frontal-scale Ocean–Atmosphere Interactions and Influence on Large-scale Climate: A Review” Submitted to the Journal of Climate in Dec 2021
- ▶ Reviewed recent advances in many aspects of the role air–sea coupling on Earth’s large-scale climate
  - Focused on coupling processes on scales of 10–1000km and weather to climate timescales
  - This is a frontier of observational and modeling and tests the limits of spatial resolution and temporal sampling of observations and models

# Review paper key synthesis points: Some lessons learned

- 1) **Impacts of air–sea coupling touch on many key aspects of our climate system, including the hydrological cycle, ocean biogeochemical cycles, and climate change**
- 2) **Importance of sustained global observations of the oceanic mesoscale from in situ and remote sensing**
  - Lack of measurements hampers improvements in weather and climate model predictions
- 3) **Improving surface heat, momentum, and gas flux observations**
  - Emerging evidence indicates that surface current measurements are a critical missing piece of the current flux observing system
- 4) **Oceanic submesoscale is being recognized as important for air–sea coupling and large–scale climate**
  - Lack of studies (modeling and observations) due to challenges specific to submesoscale
- 5) **Diagnostics for comparing air–sea coupling between models and observations are crucial for improving coupled climate models and understanding key physical processes of air–sea coupling**
  - These diagnostics require long observational data records

# Activities of working group members

- ▶ S-MODE
  - ▶ US CLIVAR-sponsored workshops on:
    - Gulf Stream in Weather and Climate Workshop
    - Tropical Pacific Observing Needs
  - ▶ HighResMIP2, PRIMAVERA
  - ▶ OASIS
  - ▶ DYAMOND
  - ▶ WaCM winds/surface currents satellite
  - ▶ Butterfly satellite mission concept
  - ▶ DOE wind projects
  - ▶ HOTSPOT-2
  - ▶ CASPER-extension
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# Future Activities

- ▶ Community workshop (Spring 2023)
- ▶ Continued bi-monthly webinars
- ▶ Data repository and evaluation of diagnostic metrics which assess aspects of air-sea coupling in observations and models
- ▶ Focus on topics related to:
  - Impacts of surface currents on air-sea fluxes and climate
  - Non-local impacts of air-sea coupling on climate, including representation in climate model projections, Earth's hydrologic cycle (especially impacts on precipitation, terrestrial drought, etc)
  - Air-sea coupling as a source of predictability for mid-latitude weather and climate
  - Links to marine heat waves
- ▶ Anticipate that these activities will lead to a second review-type paper or feed into a white paper
- ▶ Continue involvement in current community activities, such as planning of satellite missions (e.g., Odysea) and workshops (e.g., the Gulf Stream workshop)