Advances And Opportunities For Predicting And Understanding Gulf Stream Impacts On Weather And Climate
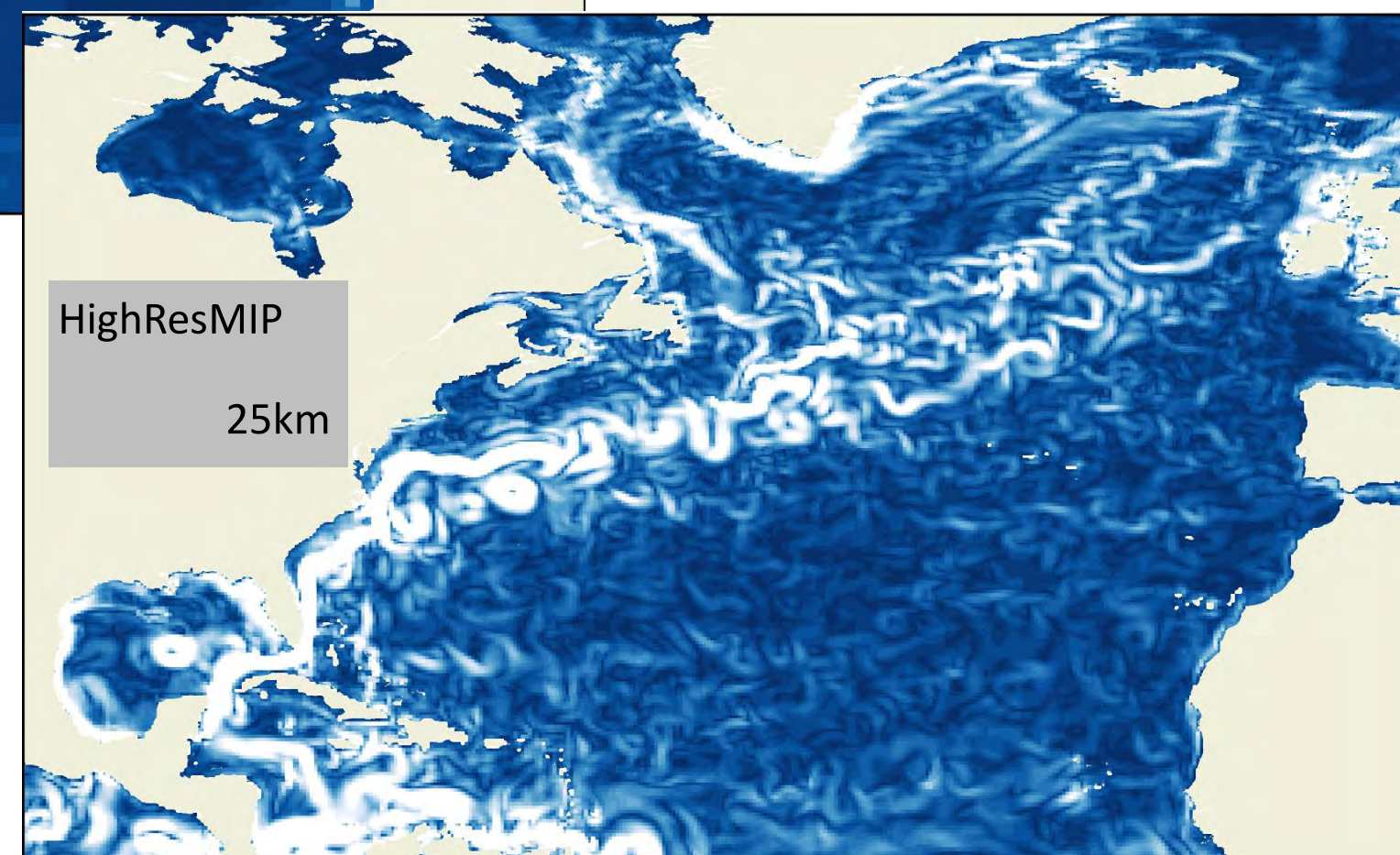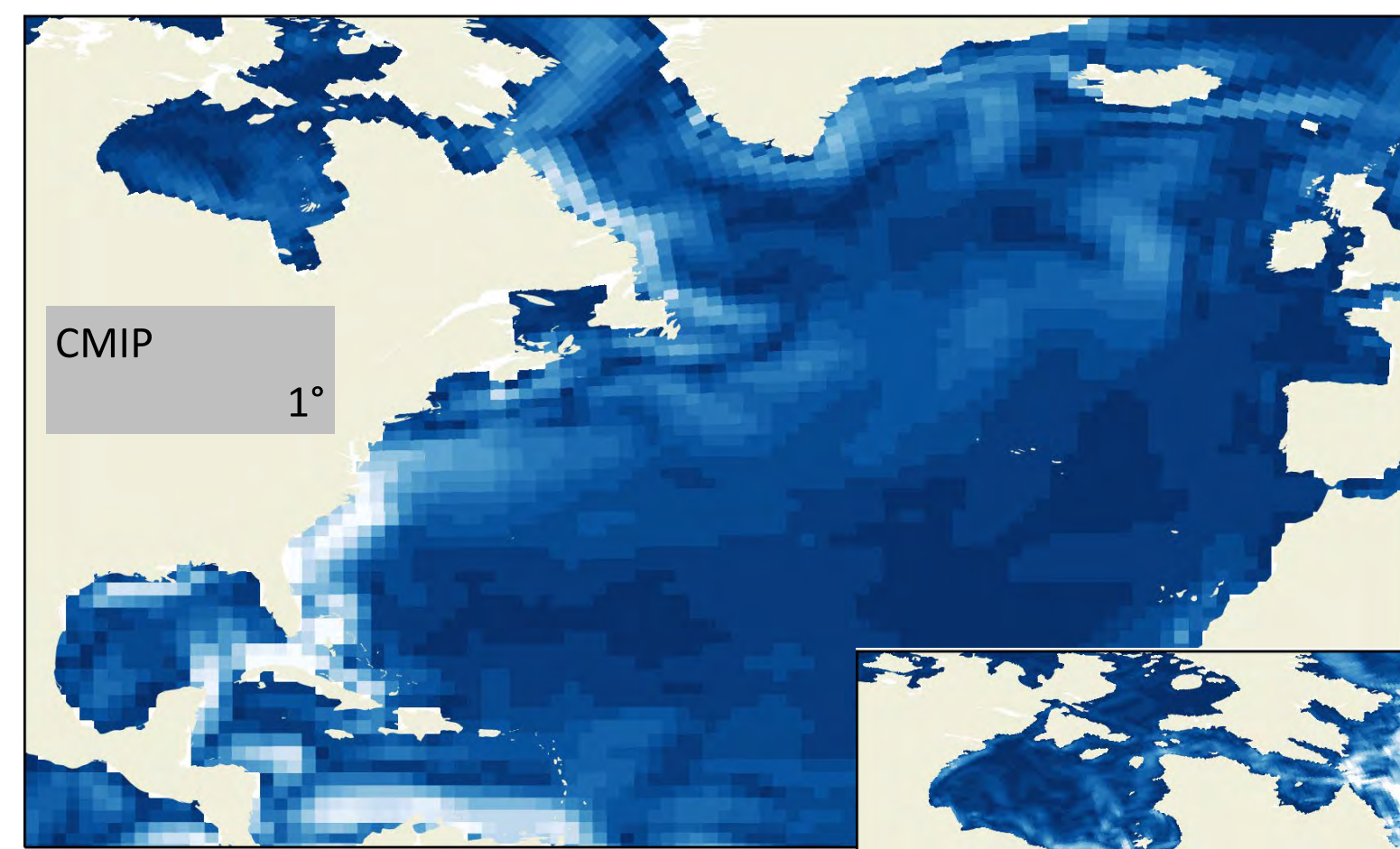
Carol Anne Clayson, Nathan Laxague, James Booth, Dujuan Kang, Larry O'Neill, Malcolm Roberts, Justin Small, Roger Samelson, & Elizabeth Thompson

2022 CLIVAR Workshop Report
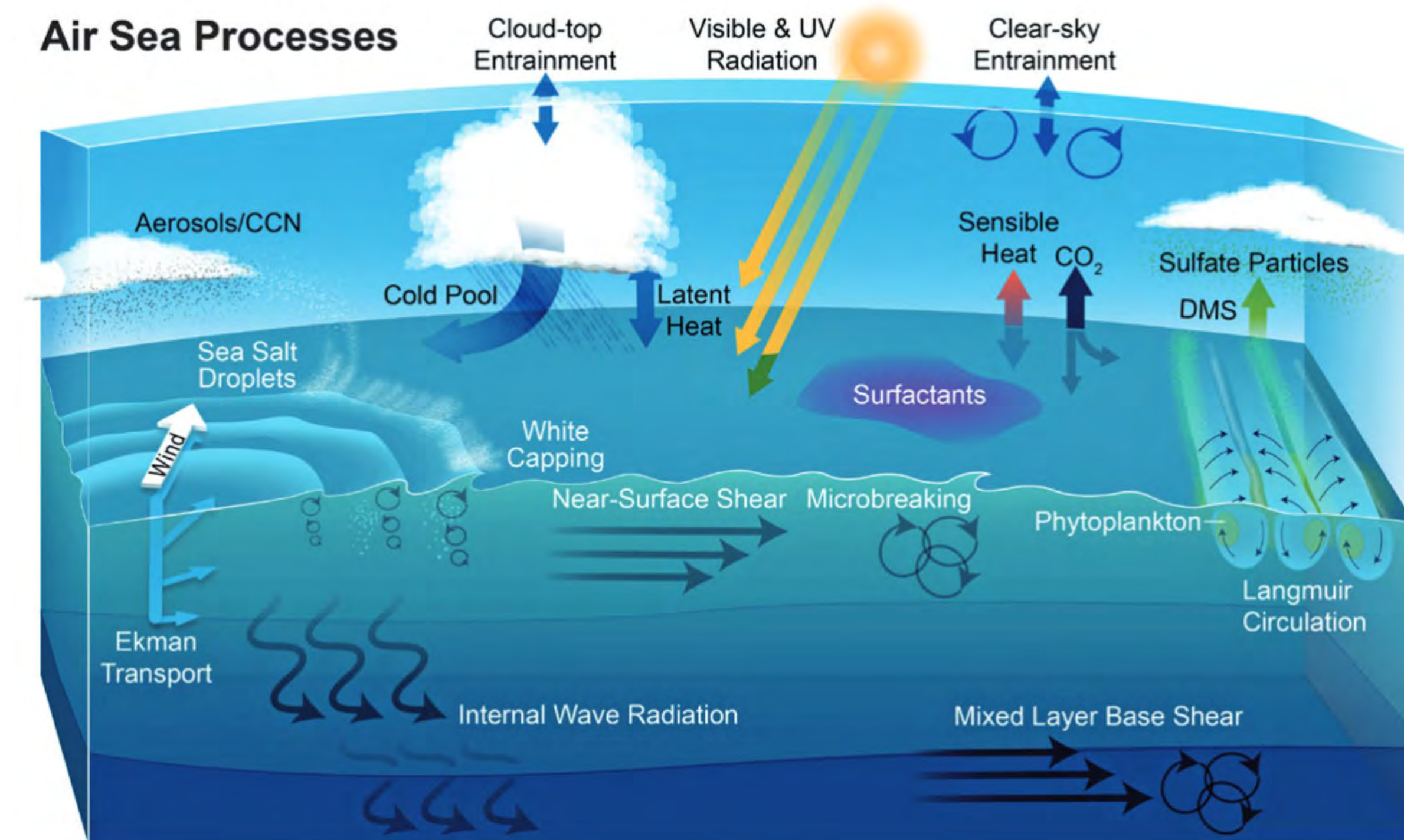
The Nature of the Problem

- The Gulf Stream is characterized by atmospheric and oceanic processes occurring over many scales in space and time.
- Air-sea coupling depends on both the local and the non-local variability.
- Local-scale processes can feed back into large-scale effects.

Malcolm Roberts, UK Met Office

CMIP 1°

HighResMIP 25km

Current speed (ms⁻¹): 0.00 0.09 0.18 0.27 0.36 0.45 0.54 0.63

Cronin et al. [2019], *Frontiers in Marine Science*

Ideas and Future Possibilities

- Hybrid observational campaigns:
  - Long-term monitoring
  - Process-focused analysis of specific phenomena
  - Vast range in resolved spatial and temporal scales
- Campaigns designed and run in tandem with models
- Current and future satellite monitoring must be involved with the *in situ* observations.

Air Sea Processes

Cloud-top Entrainment — Visible & UV Radiation — Clear-sky Entrainment

Aerosols/CCN — Cold Pool — Latent Heat — Sensible Heat — CO_2 — Sulfate Particles — DMS

Sea Salt Droplets — White Capping — Surfactants — Near-Surface Shear — Microbreaking — Phytoplankton — Langmuir Circulation — Wind

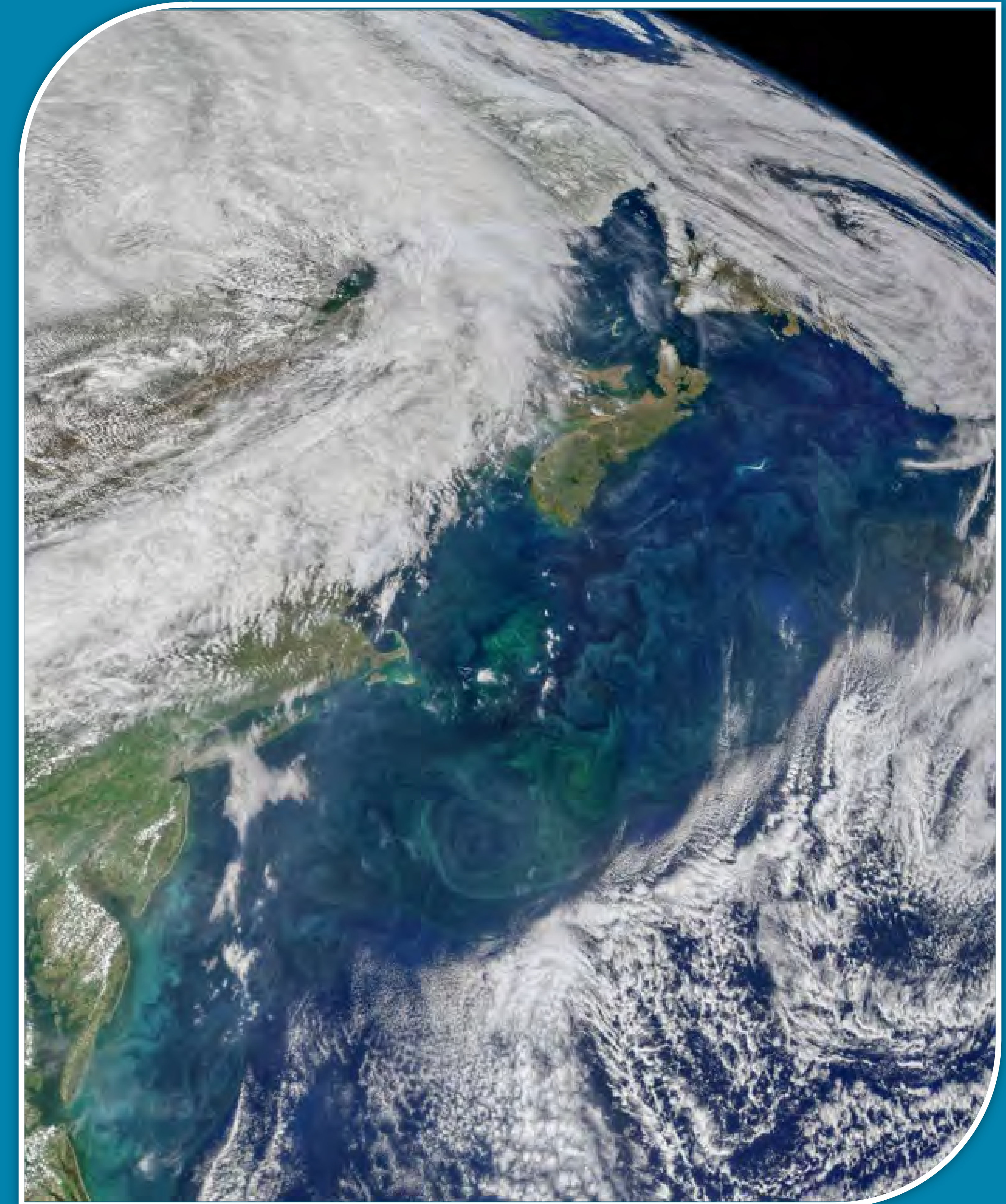Ekman Transport — Internal Wave Radiation — Mixed Layer Base Shear

Clayson et al. [2021], *Marine Technology Society Journal*

Observation & Modeling

- Observations are crucial for understanding processes and evaluating models, but are limited by:
  - Highly focused, short-time process studies
  - Long-term sampling at particular sites, with limited observables
  - Issues linking remote sensing and *in situ* measurements
- Models can give long-term, globally complete and consistent datasets at increasingly high resolution, but:
  - Have significant biases
  - Generally have weaker air-sea coupling strength than observed
  - Climate models used in future projections rarely represent mesoscale oceanic processes

Cloud-top Entrainment — **Super Site** — Clear-sky Entrainment

Latent heat — Sensible Heat — CO_2 — DMS — Wind — phytoplankton

deep ocean

Clayson et al. [2021], *Marine Technology Society Journal*

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