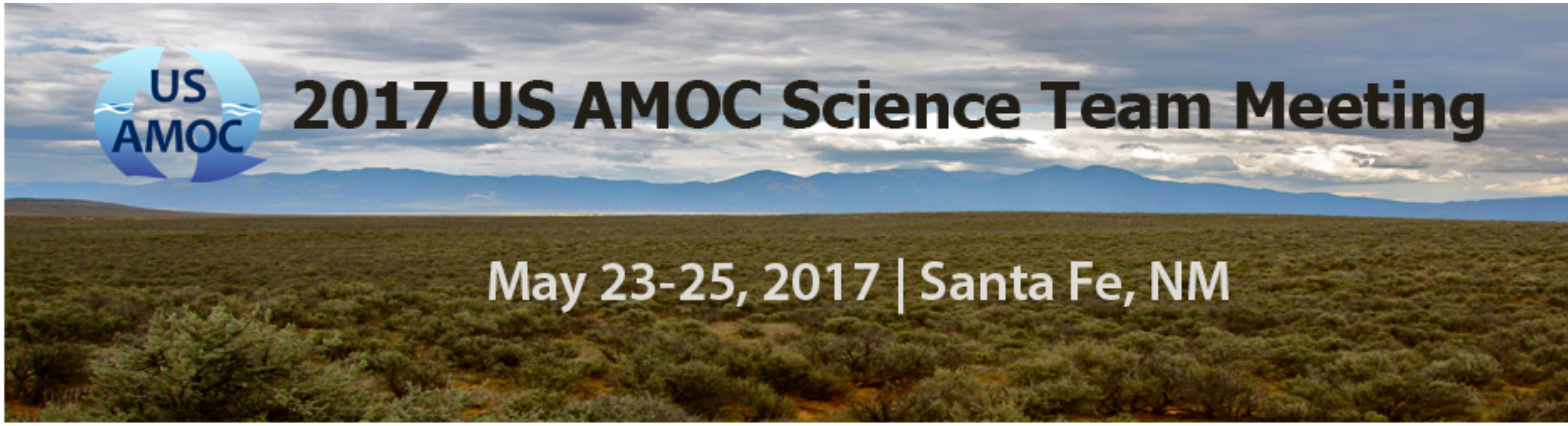



## Organizing Committee

Wilbert Weijer, DOE LANL (chair)

Gokhan Danabasoglu, NCAR; Femke de Jong, Duke University;

Matthias Lankhorst, SIO; Mike Patterson, US CLIVAR;

Jill Reisdorf, UCAR; Kristan Uhlenbrock, US CLIVAR; Rong Zhang, NOAA GFDL

## Primary goals for the meeting include:

- Providing updates on progress within the community,
- Identifying emerging research gaps and questions,
- Discussing future opportunities and legacy activities as the Science Team plans to wrap-up in 2020,
- Enhancing collaborations among the Science Team members.

## Meeting format

- 4 oral and poster sessions based on the Task Team Structure + discussions
- 2 Special Science Sessions: AMOC stability metrics and drivers of Atlantic Multi-decadal Variability (AMV)
- Breakout sessions
- General discussion

# AMOC Review / Synthesis Papers

As the Science Team sunsets in 2020, we would like to produce a collection of review / synthesis articles that highlight the advancements in AMOC-related science made during the existence of the US AMOC Science Team as well as the UK RAPID Program.

Joint effort between the US AMOC Science Team and the UK RAPID Program with authors drawn from both communities and their collaborators.

Virtual Special Issue

Feeds into both the UK RAPID Program Review in 2018 – 2019 time frame and the Ocean Obs '19.

## Preliminary list of potential paper themes which can be combined and/or expanded:

1. Characterizing the mean state of AMOC, and heat and salt transport by AMOC, over the whole Atlantic basin,
2. Characterizing the annual fluctuations of AMOC and the importance of winds vs. buoyancy forcing,
3. Inter-annual, decadal, centennial, etc. variations of AMOC and the mechanisms that drive them (including trends),
4. Impacts of AMOC on SST (e.g., AMV), SSH, sea-ice, weather, climate, ecosystems, ... (including paleo-climate linkages),
5. AMOC fingerprints and proxies (somewhat related to #4),
6. Impacts of eddies/mesoscale variability on AMOC characteristics,
7. AMOC and climate prediction on various time scales,
8. AMOC (stability) thresholds,
9. AMOC coherency,
10. ......

## A charge for the Breakout / Task Team groups:

Discuss review / synthesis paper topics (new topics?), taking into account what has been already published and in progress.

Suggest one to two topics that you think would address a gap with possible volunteers to lead the effort.

**Lead Authorships:** Volunteers and reached out

**Journals:** AGU; Current Climate Change Reports (a review journal); ....

**Tentative timeline:**

June 2017: Draft list of topics and lead authors in collaboration with UK RAPID Program

July 2017: Confirm / finalize topics and authorships

January - February 2018: Submission deadline

- Timeline for the next US AMOC Report (March 2018)
- Timeline for the EC rotations (October 2018)
- 2018 International Meeting: Joint with UK RAPID, July 2018, USA

# US AMOC / UK RAPID International Science Meeting

24-27 July 2018

Mayfair Hotel on Biscayne Bay in Coconut Grove,
Miami, FL, USA

Next Step: Forming a Scientific Organizing Committee
(3 US AMOC + 3 UK RAPID)

## AMOC observing system implementation and evaluation

- What is the observed AMOC variability and what are the underlying mechanisms driving variability?
- What is the meridional coherence of the observed AMOC?
- What technological advances and novel combinations of existing technologies can be used to make AMOC observations sustainable into the future?

## AMOC state, variability, and change

- Which AMOC signals have been consistently identified in both observations and simulations, and which have not?
- What AMOC fingerprints show up coherently across multiple observing systems?
- What ideas drive us to consensus in data-assimilating models on current and past states of AMOC?

## AMOC variability mechanisms and predictability

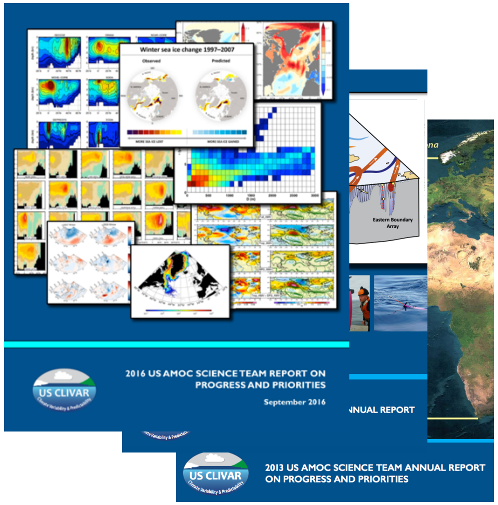
- How do exchanges of buoyancy and momentum between the ocean and the atmosphere/cryosphere, and between the Atlantic and adjoining basins, drive AMOC variability across a broad range of timescales, from monthly to millennial (i.e., quasi steady-state)?
- What are the magnitude, location, and physical mechanisms associated with interior diapycnal mixing in the ocean that are relevant to the diabatic AMOC? How are these processes represented in ocean GCMs?
- How can we use eddy-resolving models more effectively to i) test the robustness of AMOC variability mechanisms identified in coarser GCMs or idealized models; ii) address the origins of persistent model bias in the North Atlantic region (e.g., Gulf Stream separation and the North Atlantic Current path); and iii) assess the role of ocean turbulence in AMOC variability.
- What are the predictability properties of AMOC in idealized and comprehensive models, and which mechanisms affect these properties?

## Role of AMOC in global climate and ecosystems

- What is the role of low-frequency AMOC variability in the Atlantic Multi-decadal Variability (AMV) and its associated climate impacts?
- What are the interactions between AMOC/Atlantic heat transport and the cryosphere, such as Arctic sea ice and the Greenland ice sheet?
- What are the AMOC impacts on biogeochemical cycles and marine ecosystems?

# ----AMOC Metrics Project: Bringing Models and Data into a Common Framework for Evaluating the State, Circulation, and Impacts of the Atlantic Ocean

Alicia Karspeck and Gokhan Danabasoglu
National Center for Atmospheric Research



# Need for a dedicated effort to facilitate the joint analysis of models and observations

- Comparing model simulations with observations of the natural world is essential for assessing the quality of our models and advancing their fidelity.
- This has been widely acknowledged within the AMOC community and the concept of a common framework into which both observations and models can be mapped and subsequently analyzed has emerged under the term "AMOC Metrics."
- The need for a metrics activity has been highlighted in the last four US AMOC Science Team Reports (US CLIVAR Office 2013; Danabasoglu et al. 2014; 2015; 2016;).
- The concept has also emerged as a priority from the US CLIVAR sponsored meeting "Connecting Paleo and Modern Oceanographic Data to Understand AMOC Over Decades to Centuries" (Kilbourne 2017).

# Need for a dedicated effort to facilitate the joint analysis of models and observations

Comparison of model-simulated data with observations can be prohibitively difficult for individual researchers due to:

- Data format and infrastructure barriers: In general, simulated and observed data are not made available in consistent data formats or through well-publicized common public archives.
- Incommensurability: In general, models do not simulate the same quantity that observations measure and there tend not to be explicitly outlined, reproducible protocols to achieve a consistent mapping between "model space" and "observation space."
- Social/scientific barriers: Observationalists and modelers typically operate within separate disciplinary spheres, reducing the opportunity for nuanced discussions of the most consistent methods for comparing model output and data.

# The goals and expected outcomes of AMOC Metrics Project

The AMOC Metrics Project is a *service-activity* that will

- Promote the use of metrics in intercomparison projects that are relevant to advancing understanding of the Atlantic Ocean state, circulation, and influence,
- Reflect the science advances being driven by the AMOC community,
- Facilitate the joint interpretation of models and data,
- Promote objectivity in model-intercomparisons.

# The goals and expected outcomes of AMOC Metrics Project

One of the key work-tasks of this project will be the coordinated-selection, curation, and prototype-use of an *initial* collection of scientifically-relevant, observationally based AMOC Metrics that meet the following criteria:

- Can be expressed as a single-variable time series,
- Can be used to characterize historical aspects of the Atlantic basin tracer-state, circulation, or impact,
- Are relevant for monitoring the ocean state and/or are relevant to current scientific discourse on Atlantic Ocean variability and prediction,
- Can be calculated from both observational data sources and global climate models.

# Partnerships and natural synergies

The AMOC Metrics concept is not an intercomparison project nor is it a project aimed at the scientific task of developing new metrics. Instead, it will promote the existing and emerging body of modeling and observational work on Atlantic Ocean science that has been funded by multiple agencies.

Natural partnerships:

- US AMOC Science Team (RAPID, OSNAP, SAMOC, etc.),
- CLIVAR Ocean Model Development Panel (OMDP) – Ocean Model Intercomparison Project (OMIP),
- CLIVAR Global Synthesis and Observations Panel (GSOP) − Ocean Reanalysis Intercomparison Project (ORA-IP) organized by the CLIVAR Global Synthesis and Observation Panel (GSOP),
- NCAR Climate Variability Diagnostics Package (CVDP),
- CMIP connection via DOE LLNL PCMDI Metrics Packages (PMP).

We will collaborate with PCMDI (Gleckler) to integrate our AMOC Metrics into the PMP. This will ensure that AMOC Metrics are applied to all new community simulations and that the data needed for our AMOC Metrics are included in obs4MIPs.

# Work scope of pilot project

Initial phase of the project will focus on identifying a set of 5-10 AMOC Metrics that each reflect a different aspect of the Atlantic basin variability and are relevant to current scientific discourse. Priority will be given to datasets that are at least 10 years in length and have a reasonably straightforward mapping from climate model fields/grids to the space of observations.

A listing of the available AMOC-relevant observational datasets compiled by the US AMOC Task Team 1 will be used to guide the initial short-list for candidate datasets.

As each target metric is worked on, we will identify the most appropriate, expert observational contact person, acquire the base-observational data, document the data provenance, and begin the process of developing detailed recipes for how a commensurate time series can be generated from gridded model output.

A project website will be developed to serve as a central hub for disseminating information on the metrics, recipes, giving progress updates to the community, collecting feedback, and sharing results.

# Example Metrics

Western Subpolar gyre
Upper Ocean Heat Content 0-700m(1955-present)
Upper ocean Salinity(?)
Contact: {?}

- *Original source*: NOAA/NODC and EN4 data bases
- *Prepared by:* [TBD]
- *Download metric*: [insert link here]
- *Indications:* Changes in the water column density may be associated with changes in the strength of the gyre circulatio
- *List of related publ*
  Hakkinen
- *Instructions for co*
  [insert tex

Western subpolar gyre (Labrador Sea) SSH (1992-present)
Contact: {possibly Sirpa Hakkinen?}

- *Original source*: AVISO [insert reference here]
- *Prepared by:* [TBD]
- *Download metric*: [insert link here]
- *Indications:*
  SSH changes in the subpolar gyre have been used to indicate changes in the water column density and associated changes in the strength of the gyre circulation
- *List of related publications*:
  Hakkinen et al (2004;2013) , [insert more citations here]
- *Instructions for computing metric from gridded model:*
  [insert text here]

Florida Current @ 27N (1982-present)
Contact: Molly Baringer

- *Original source*: NOAA AOML (www.aoml.noaa.gov/phod/wbts/data.php)
- *Prepared by:* [Christopher.Meinen@noaa.gov)
- *Download metric*: [insert link here]
- *Indications:* Transport estimated of the Florida Current from the submarine cable voltage calibration cruise
- *Related publications*:
  e.g. [insert more citations here]
- *Instructions for computing metric from gridded model:*
  [AK note: For models, do we need to define this over a boundary of northward flow (e.g. between Florida coast and the end of northward transport), or Florida to EightMileRock (at 76W), or Florida to the continental shelf at about 81 W)