AMOC Research in Ireland: Gaps, Opportunities, and Future Directions

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SUMMARY FOR POLICYMAKERS

The Irish research community working on the Atlantic Meridional Overturning Circulation has identified key concerns, research gaps, and recommendations in response to the risk of a major ocean circulation change in the Atlantic and its consequences for weather and climate in Ireland.

KEY CONCERNS

There is growing concern that we are approaching a tipping point or a partial collapse of the Atlantic Meridional Overturning Circulation (AMOC) impacting the transfer of heat responsible for Ireland's mild climate. Even in the more likely case of a gradual AMOC decline, extreme weather events, and enhanced seasonality are likely for Ireland. In addition, changing ocean-atmospheric circulation patterns will likely disrupt nutrient distributions, air-sea carbon exchange, marine ecosystems, and human activities. The specific risks and impacts for Ireland remain uncertain but must be addressed by urgent and ambitious climate action.

RESEARCH GAPS

Despite significant advances in our understanding of AMOC we have identified key areas of research that require urgent investment.

- Comprehensive analysis of mechanisms and risks associated with a partial collapse of AMOC. This assessment must include large scale (e.g. carbon sequestration, primary productivity, meridional heat transfer) and regionally specific impacts for Ireland (e.g., sea level rise, coastal erosion, ocean acidification, extreme weather patterns, including atmospheric temperature, storminess and precipitation).
- Heat transport in warming climates: The relative roles of ocean and atmosphere need further clarification. Understanding these mechanisms is crucial for accurately modeling and predicting AMOC behavior and its influence on regional climates. For example, it remains unclear whether gyre-driven heat transport may compensate for reduced overturning in a future greenhouse climate.
- A comprehensive assessment of both marine and terrestrial ecosystem responses to partial and total AMOC convection collapse is lacking. Understanding how different species and ecosystems will be affected is crucial for developing effective adaptation and mitigation strategies for economically important ecosystems and fisheries.
- AMOC index development: Direct observations cover a relatively short timespan. Further work is needed on paleo and instrumental AMOC indices that can contextualise ongoing change, consolidate model projections & observational proxies, and support early warning indicators for AMOC change.

OPPORTUNITIES

There is an urgent call in the community to capitalize and expand on existing observational infrastructure (e.g., Irish Marine Data Buoys, OSNAP, RAPID) in a coordinated and international effort to support long-term and develop real-time observations of AMOC to facilitate communication and decision-making.

There is also strong consensus for the need to integrate paleo and modern observations with high-resolution climate modelling in order to reveal the complex spatio-temporal dimensions of the AMOC and thereby address outstanding research on both extra regional and local scales.

COMMUNICATIONS

The potential collapse of AMOC and its impact on European climate (e.g., cooling) has resulted in significant media attention which in turn has caused anxiety and confusion. While research into AMOC collapse is valuable for advancing our understanding of AMOC variability and quantifying what the impacts of a potential collapse would be, it is critical to contextualize these projections and communicate the plausibility or likelihood and timing of such events accurately to all stakeholders. We recommend a coordinated communication strategy to effectively convey AMOC science to the public and policymakers. This includes:
(1.) regular workshops and meetings,
(2.) a communication strategy that ensures information is clear, accurate, transparent, and accessible to a wide audience,
(3.) an online AMOC Hub/Webpage where new research is presented in a citizen, media, and policy friendly manner.

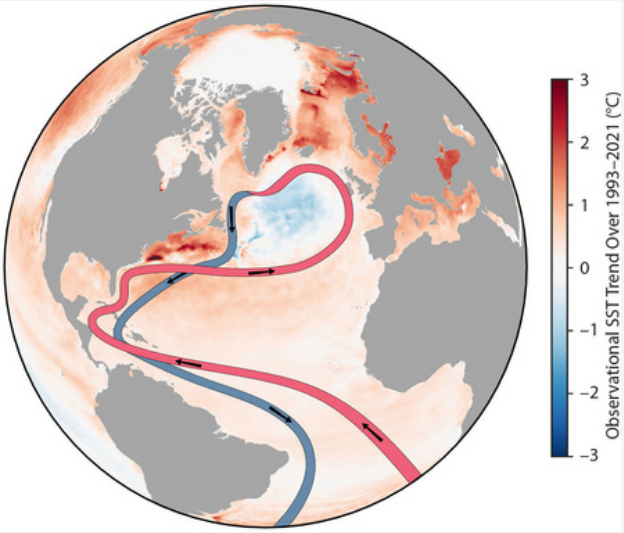
SPECIAL NOTE

Studies projecting an AMOC collapse are valuable for advancing our understanding of the risk of AMOC tipping and quantifying what the impacts of a potential collapse would be. However, it's crucial to contextualize these projections and communicate the likelihood and timing of such events accurately to all stakeholders. Some models that simulate a mid-century collapse rely on unrealistic parameters, such as an 80-fold increase in the Greenland melt rate. We recommend that emphasis should be placed on more plausible scenarios, like an AMOC slowdown of 2-3 Sv until 2050, which are supported by some modern observations, paleo-observations, and CMIP6 models. This slowdown can still have significant impacts on seasonality, extreme events, ecosystems, and socio-economic systems, and these impacts require further research.

It is also crucial to differentiate between types of AMOC collapses in model simulations when assessing mechanisms and impacts, recognizing that CMIP6 simulations often show declines due to heating and stratification rather than freshwater input. Clear communication of cooling estimates associated with an AMOC collapse is critical. In summary, it's important to clarify that (1) a complete AMOC collapse this century is unlikely using realistic climate scenarios, and (2) some simulations resulting in AMOC collapse and cooling do not include rising greenhouse gases and associated global warming.

CONCLUSION

Understanding the AMOC and its potential impacts is of paramount importance, particularly for Ireland. By addressing the research gaps and capitalizing on the opportunities outlined in this document, the Irish research community can make significant contributions to our understanding of the AMOC and its implications for the global climate system.



This graphic shows a highly simplified schematic of the Atlantic Meridional Overturning Circulation (AMOC) against a backdrop of the sea surface temperature trend since 1993 from the Copernicus Climate Change Service. *Source*: Rahmstorf, S. 2024. Is the Atlantic overturning circulation approaching a tipping point? *Oceanography* 37(3):16–29, https://doi.org/10.5670/oceanog.2024.501.

Centre/Cluster: **iCRAG**

Theme: **Marine & Coastal**

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