Reykjavik Institute

AMOC Observation as Critical Infrastructure

Overview & Recommendations for Nordic Ministers

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This report examines the structural vulnerabilities facing the basin-wide AMOC observing system and the position of Nordic gateway monitoring within it. It is offered as a contribution to Nordic ministerial deliberations in 2026 and to the European institutional processes now under way through the Ocean Pact, the forthcoming Ocean Act, and the OceanEye initiative.

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Summary for Policymakers

Sustained observation is foundational to any government strategy on AMOC risk: it is what monitors the evolution of the system, on which any wider response depends. A shutdown of operations in key AMOC observation systems would most likely take years to restart, resulting not only in loss of the analytical capability the record was building, but in loss of our ability to detect weakening trends for decades to come — with direct consequences for Nordic capacity to plan, prepare, and act on AMOC risk.

A fundamental shift in mentality is required. A wait-and-see posture at this time could have drastic consequences. The current observation system was never designed for a world of AMOC security relevance, and while heroically held together by scientists over the years, it is at the brink of collapse for key components. The required shift has two elements: immediate action to secure the components already in place, and political recognition of AMOC observation as critical infrastructure to Nordic security — with an eye towards expansion to fit-for-purpose status.

Two components of the AMOC observing system are in *Critical* condition, with material exposure on an eighteen-month horizon: the RAPID array at 26.5°N (continuous since 2004, the longest transbasin record) and OSNAP in the subpolar North Atlantic. A further set of basin-wide and global components is *At risk* on a known timeline, typically 2026–2028: MOVE, SAMBA, the global Argo programme, and the GO-SHIP global hydrographic programme. RAPID and OSNAP are further exposed to Argo and GO-SHIP, on which they depend to calculate transport.

OSNAP, the most extensive basin-wide AMOC array, is a five-country (US, UK, DE, NL, CA) co-dependency in which failure of any single national contribution risks ending the observation. The United States contributes approximately half through competitive grants now exposed to FY2027 federal budget proposals. The United Kingdom contributes through National Capability funding subject to year-on-year reductions, placing UK contributions at material risk from 2027. The Netherlands contributes through moorings sustained over twelve years by a single principal investigator through consecutive open-competition grants, with post-2028 prospects highly uncertain.

Nordic gateway monitoring — across the Greenland–Scotland Ridge, the Norwegian Sea, and the Arctic gateways — sits in a different exposure category. Funding flows through institutional appropriations, but is not ring-fenced for observation and is vulnerable to fiscal compression.

The Nordic Countries together hold the most operationally significant AMOC observing assets outside the basin-wide arrays. The Greenland–Scotland Ridge monitoring currently consists of a collection of distinct national arrays rather than a coherent observing system. Closing remaining gaps and integrating these arrays would produce a trans-basin measurement, comparable in scientific weight to the RAPID and OSNAP arrays.

Iceland's government has designated AMOC collapse as a national security threat; Finland's Strategic Task 37 framework recognises AMOC collapse as a critical tipping point for national security and economic planning. The fate of the AMOC observing system — whether operated from within or outside the Nordic Countries — therefore falls within the legitimate scope of Nordic ministerial action. Two European processes in 2026 will shape how AMOC observation is embedded in European ocean-observation architecture for the coming decade: the EU Ocean Act and the OceanEye initiative, with its pledging event in September 2026.

Recommendations for Nordic Ministers

Recommendation 1. Engage directly, individually and collectively, with the governments whose decisions most determine the fate of critical AMOC observing components — principally the United Kingdom, the Netherlands and the United States.

Recommendation 2. Articulate a coordinated Nordic position on AMOC observations, and pledge existing Nordic funded contributions, within the EU Ocean Act and OceanEye processes during 2026.

Recommendation 3. Establish a standing Nordic Council of Ministers coordination group on AMOC observation with a provisional multi-year mandate, oriented toward the broader trans-Atlantic observing partnership, as the counterpart through which the recommendations below are commissioned.

Recommendation 4. Commission the standing group to prepare backstop arrangements for the 2026–2028 funding transition, covering both emergency funding mechanisms ready for ministerial activation and operational support arrangements through which Nordic ship-time and observational capacity can be contributed to externally-operated programmes.

Recommendation 5. Commission the standing group to scope a coordinated Nordic Seas AMOC observing system, including complete trans-basin measurement of overturning across the GSR, funded through a dedicated Nordic Council of Ministers line.

Recommendation 6. Pursue national critical-infrastructure designation for Nordic observing assets, in line with the framing the Intergovernmental Oceanographic Commission and the European Ocean Pact have adopted for ocean observation more broadly.

Background

In February 2026, the Nordic Council of Ministers (NCM) published *A Nordic Perspective on AMOC Tipping*[1], a synthesis of current scientific understanding of the risks a potential weakening or collapse of the Atlantic Meridional Overturning Circulation would pose to the Nordic region. Among its four suggested action points, the report called for long-term funding to sustain and operationalize key AMOC observational networks.

The NCM report framed the task as one of risk management. Its authors documented possible impacts ranging from regional climate disruption and shortened growing seasons to heightened food insecurity and dynamic sea-level rise, the latter estimated at up to approximately 50 cm along European coastlines and, unlike most other impacts, directly following AMOC slowdown in all scenarios regardless of the background warming level. Noting that existing risk management frameworks for other hazards — earthquakes, tsunamis, tropical storms, floods — rest on sustained publicly funded observing capabilities treated as critical national infrastructure, the report observed that comparable institutional arrangements would be required to support a Nordic response to AMOC risk. The recommendations were to act now to prevent a possible collapse of the AMOC, to perform a risk assessment that can be used to plan for multiple futures, and to invest in observational networks.

The present report takes up that last recommendation. It draws on the analytical work at the Royal Netherlands Institute for Sea Research (NIOZ) referenced in Section 5 of the NCM report, integrated with Nordic observing expertise, to specify what sustained operational funding of AMOC observation institutionally requires — what the current observing system consists of, how it is presently funded, what risks threaten its continuity, and what architectural features the international coalition envisioned by the NCM report would need to have.

The NCM report situates AMOC observation as the foundation of a fuller early warning capability that would couple sustained observations with model simulations, operational data integration, detection and validation, and connection to preparedness response. The present report addresses the observation foundation specifically; the further components of such a capability sit beyond its scope and will require separate development. The conversation for 2026 is securing the observation foundation on which all subsequent work depends.

The analysis is offered as a contribution to Nordic ministerial deliberations in 2026 and to the European institutional processes now under way through the Ocean Pact, the forthcoming Ocean Act, and the OceanEye initiative.

[1] https://pub.norden.org/temanord2026-504/

1. AMOC Observations are Critical Infrastructure

The call for sustained funding of AMOC observation is not a narrowly disciplinary ask. It reflects a convergence across the scientific and institutional bodies responsible for global ocean observing, which have in recent years articulated a shared view that the current funding model is insufficient and that sustained ocean observation should be recognized, and supported, as critical infrastructure.

The most explicit statement has come from the Intergovernmental Oceanographic Commission of UNESCO (IOC), the United Nations body that leads the Global Ocean Observing System (GOOS) and coordinates ocean observation globally. In its June 2024 submission to the Secretary-General's Report on Oceans and the Law of the Sea, the IOC observed that much of GOOS remains a network of the willing, primarily driven from the scientific research community and relying on short-term funding horizons, and stated that GOOS must evolve to an operational and government-supported critical observing infrastructure. The IOC State of the Ocean Report 2024 repeats the framing, identifying ocean observation as critical infrastructure to manage risk and meet future demands.

The same view is reported by the scientists directly responsible for AMOC observation. Structured interviews conducted in late 2025 and early 2026 with principal investigators of the major AMOC observing arrays, and with Nordic scientists maintaining AMOC-relevant observations in the Nordic Seas, produced a clear consensus: funding through consecutive short-term competitive science grants is inadequate to the task, and the observations should be treated as permanent operational infrastructure. The Partnership for Observation of the Global Ocean (POGO) 2025 statement *No Data, No Action* describes ocean observation as the backbone of evidence-based action on climate. The March 2026 ICARP IV Final Outcomes Report calls for the concept of critical infrastructure for international Arctic research to be formalised as a policy category.

A 2021 survey of European GOOS National Focal Points provides the corresponding empirical anchor. The survey found that only 48% of ocean health, 42% of ocean climate, and 37% of operational services observations in Europe have access to medium-term (3–5 years) or long-term (6–10 years) funding, and that no mechanism exists for long-term funding of over 63% of ocean observing activity. Where long-term funding has been secured, it has flowed through three specific routes: legal instruments requiring funding, classification as large-scale European research infrastructure, or designation as part of long-term research programmes. The critical-infrastructure category is not only what the scientific community asks for; it is the observed working route through which sustained ocean observation funding has actually been achieved in Europe.

The European Union has begun to adopt this framing. The Ocean Pact, adopted in 2025, refers to critical ocean infrastructures, data and information services as a category of European interest, placing ocean observation within the institutional vocabulary the IOC and the broader scientific community have been developing.

The category is compatible with several institutional pathways, and not all pathways produce equally durable capability. Designation achieved administratively — placement within an operational agency's budget line, as the NOAA Western Boundary Time Series component of RAPID has been — depends on the continued political and budgetary stability of the agency. The recent period has shown how quickly such designations can come under pressure. Designation anchored by a legal instrument is more durable: it creates a standing requirement that survives changes of government and administrative reorganisation, and it is the mechanism through which, as the 2021 survey found, sustained ocean observation funding has primarily been secured in European countries where it exists. Europe already has one working example applied to a specific ocean observing network: Euro-Argo ERIC, established under EU Regulation 723/2009, coordinates and sustains the European contribution to the global Argo programme through binding multi-country commitments. Euro-Argo ERIC secures one network but does not provide a general framework for ocean observation as critical infrastructure. For AMOC observation specifically, which requires trans-national coordination no single country's administrative arrangements can provide, the combination of legal anchoring and coordinated operational funding is structurally necessary to secure the observations against political volatility.

Two European processes in 2026 create the opportunity to secure this. The EU Ocean Act, expected to be adopted in the fourth quarter of 2026, is the legal instrument within reach that could provide statutory anchoring for a European Ocean Observation System in which AMOC observation is embedded. The OceanEye initiative, launched in early 2026 with a EUR 50 million allocation from Horizon Europe 2026–2027, establishes a coordinating framework for European ocean observation with the stated objective of achieving strategic autonomy in ocean observation infrastructure, data and information services. OceanEye funds the coordination layer rather than the operational observing activities; its September 2026 pledging event is the institutional moment at which national governments and other contributors can commit resources to the framework. Taken together with the Ocean Act's legislative window, the pledging event constitutes the specific near-term opportunity for Nordic countries to shape how AMOC observation is embedded within the emerging European Ocean Observation System. Section 2 describes the observing system in detail; Sections 3 and 4 develop the funding analysis and ministerial pathway.

2. Observations and Science

2.1 The AMOC as a measured system

The Atlantic Meridional Overturning Circulation is a system of interconnected ocean currents spanning the full length of the Atlantic basin and linking it to both the Arctic and Southern Oceans. The key components of this system are the northward flow of warm, saline upper-ocean water through the subtropical and subpolar North Atlantic, across the Greenland-Scotland Ridge into the Nordic seas and Arctic Ocean; the transformation of that water into cold, dense deep water through cooling and convective mixing in the Nordic Seas, the Irminger Sea, and the Labrador Sea; the overflow of dense water across the Greenland–Scotland Ridge; the southward return flow of North Atlantic Deep Water through the deep western boundary current; and the exchanges through the Arctic and Southern Ocean gateways — Fram Strait, Davis Strait, and the Barents Sea Opening to the north, and the South Atlantic gateway at approximately 34°S to the south.

Each component is measured by different assets at different latitudes using different methods. Basin-wide mooring arrays measure the integrated overturning transport across the full width of the Atlantic at their respective latitudes. Component-specific arrays and surveys — the Greenland–Scotland Ridge inflow/overflow arrays, the Svinøy section, the Barents Sea Opening, and Fram Strait observations — measure individual branches of the circulation that together constitute the Nordic arm of the AMOC. Satellite altimetry, Argo profiling floats, the ocean drifter network, and repeat hydrographic surveys provide the temperature, salinity, and sea-surface-height fields without which the moored arrays cannot calculate transport; Argo profiles and sea surface height are integral inputs to the transport calculation at each basin-wide array as well as for the branch arrays, and it is these broader observations that connect the arrays into a coherent system. The observing system is not a single instrument but a distributed network of complementary measurements, most of which are interdependent.

A summary of the principal observing components is provided in Table A. Detailed descriptions of each initiative and its funding are in Appendices A and B.

Table A. *AMOC observing system: scientific specifications. Detailed descriptions in Appendices A and B.*

Name	What it measures	Location	Series start	Continuity	Spatial	Data latency
Basin-wide AMOC arrays						
OSNAP	Transbasin AMOC: mass, heat, freshwater transport	53°–60°N	2014	Continuous	Transbasin	~2 yr (mooring cycle)
RAPID-MOC HA-WBTS	Transbasin AMOC, meridional heat + freshwater transport	26.5°N	2004	Continuous	Transbasin	2-2.5yr (mooring cycle)
SAMBA	South Atlantic AMOC at southern gateway	34.5°S	2009	Data gaps	Transbasin	TBC
Atlantic components						

MOVE	Deep western AMOC limb (NADW transport)	16°N	2000	Continuous	Western basin only	TBC
TRACOS	Tropical Atlantic circulation + AMOC since 2014	11°S	2000	Gaps	Component	TBC
NOAC	North Atlantic overturning at mid-latitudes	47°N	2013	2013–2017	Transbasin (moorings + PIES)	TBC
Greenland-Scotland Ridge: dense water return flow						
DS overflow moorings and hydrography (MFRI, UoH)	Denmark Strait Overflow		199?	Continuous	Overflow component	??
FBC overflow moorings and hydrography (FAMRI)	Faroe Bank Channel Overflow	62°N	1995	Continuous	Overflow component	~1-2 yr
Greenland-Scotland Ridge: Atlantic water inflow						
NIIC Atlantic inflow moorings and hydrography (MFRI)	Atlantic water inflow north of Iceland	Hornbanki	1994	Continuous	Inflow component	~2 yr
FC Atlantic inflow moorings and hydrography (FAMRI)	Faroe Current Atlantic water inflow north of Faroes	North of Faroes (62.5-63.5 °N; 6°W)	1993	Continuous	Inflow component	~1-2 yr
FSC Atlantic Inflow moorings (MSS) and hydrography (MD-SEDD , FAMRI)	Atlantic water inflow at the Faroe Shetland Channel	60-61°N	1994	Terminated in 2024	Inflow component	~2 yr
Arctic and sub-Arctic monitoring						
Svinøy section (IMR)	Atlantic inflow to Norwegian Sea	Svinøy–NW	1995	Continuous	Section across Norwegian Atlantic Current	~1–2 yr
Barents Sea Opening (IMR)	Atlantic inflow to Barents Sea	BSO	Long	Continuous	Component	~1–2 yr
Fram Strait (NPI)	East Greenland Current (EGC)	Fram Strait	1997	Continuous	Western Fram Strait	~2 yr
Fram Strait (AWI)	West Spitsbergen Current (WSC)	Fram Strait	1997	Continuous	Eastern Fram Strait	~1-2 yr
Davis Strait (UW)	Exchanges between Arctic/Labrador Sea and Baffin Bay	Davis Strait	2004	Continuous	Transbasin at strait	~2 yr
NO Argo programme (IMR)	T/S profiles, interior Nordic Seas	Nordic Seas	Ongoing	Continuous	Float distribution in Nordic Seas	Near-real-time (surface)
Broader observational systems (integral to AMOC analysis)						
Argo	T/S to ~2000m; integral to AMOC array calculations	Global	2000	Continuous	~3° global; gaps in polar/deep	NRT surface; delayed deep

GO-SHIP	Deep-ocean hydrography + biogeochemistry on repeat sections	Global lines	1970s	~Decadal per line	Specific lines only	Multi-year
Commercial vessel sampling	Repeat XBT/ADCP transects; currents and T structure; volume, heat, freshwater fluxes	Subpolar N. Atlantic, GSR, Gulf Stream	1999	Discontinued: Nuka Arctica 1999–2002, 2012–2016; Norröna 2009–2018	Route-specific	Delayed mode
Satellite altimetry	Sea surface height for geostrophic transport calculation	Global	1992	Continuous	Near-global	Days to weeks

2.2 The Nordic contribution

Icelandic, Faroese, and Norwegian institutions, together with international partners, operate sustained observations of AMOC components across the Nordic Seas (e.g. Svinøy section), the Arctic gateways (Fram Strait and Barent Sea opening), and over the Greenland-Scotland Ridge (GSR). These include multidecadal hydrographic surveys and mooring arrays that consist of distinct observing systems. In addition, Norway operates the Nordic Seas Argo contribution. Denmark contributes significant institutional and funding support to Faroese and Greenlandic observing activity and provides modelling capacity through DMI and palaeoceanographic reconstruction through GEUS. Swedish and Finnish contributions are primarily through modelling, theory, and limited Argo participation. Country-by-country descriptions of institutional arrangements, funding mechanisms, and pathway options are in Appendix B.

The observing arrays operating across the GSR deserve particular emphasis. The mooring and ship-based measurements at the Denmark Strait, Hornbanki, Faroe Bank Channel, Faroe Current (north of Faroes), and the Faroe–Shetland Channel together measure the greater part of the Atlantic Water inflow into the Nordic Seas and of the dense water overflowing from the Nordic Seas to the deep Atlantic. The mooring arrays at these locations were initiated in the early 1990s via the Nordic WOCE project, funded by the Nordic Council, and have subsequently been maintained through various funding sources. The Faroe–Shetland Channel mooring array maintained by Scotland's Marine Directorate (MD-SEDD) was discontinued in 2024 due to lack of funding, reducing FSC monitoring to FAMRI hydrographic transects only. Across the three inflow branches and two overflow branches, sustained mooring and ship-based observation has been maintained because these branches are fundamentally important and relatively easy to monitor.

The Nordic observations are not supplementary to the basin-wide arrays. Repeat-section analysis bracketing the subpolar North Atlantic identifies overflow water production north of the Greenland–Scotland Ridge as the primary control on overturning strength (Chafik and Rossby, 2019, *Geophysical Research Letters*) — placing the Nordic observations at what is at present understood to be the most dynamically consequential latitude in the system, and where the most dramatic impacts of a potential weakened AMOC are expected. The gaps in the present GSR observing system, and the case for a coordinated Nordic effort to close them, are addressed in Section 2.4.

2.3 What sustained observation makes possible

The value of sustained AMOC observation is most concretely demonstrated through recent scientific work that could not have been undertaken without it. The following examples illustrate how sustained observational records are producing analyses directly relevant to understanding AMOC change. Each rests on a single study and should be read as a contribution to an evolving scientific picture rather than as a settled finding.

Detecting AMOC decline. For any single observing array, high-frequency natural variability makes it difficult to distinguish a forced trend from internal fluctuations; published estimates suggest 25 to 40 years of continuous observation would be required (McCarthy et al. 2025). Xing et al. (2026, *Science Advances*) report that combining observations across multiple arrays at different latitudes may allow a meridionally consistent decline in AMOC strength to be detected on approximately 20-year records — substantially shortening the detection horizon the individual arrays would require on their own. The approach depends on each contributing array having maintained a sustained, high-quality record; had any been discontinued, the combined analysis could not have been performed.

Decision-useful AMOC projections. At present, the largest source of uncertainty about the future of the AMOC is the disagreement between climate models. Narrowing that uncertainty requires distinguishing models that reliably represent AMOC dynamics from those that do not — and that depends on observations in two ways: producing the mechanistic understanding through which model fidelity can be judged, and providing the empirical constraints through which projection spread can be reduced.

Mechanistic learning. In 2009–2010, the RAPID array at 26.5°N recorded a sharp reduction in AMOC transport that appeared consistent with the early stages of circulation collapse. Sustained observation and subsequent analysis supported an interpretation in which the event was driven in part by anomalous easterly wind patterns rather than by fundamental overturning change (Roberts et al. 2013; Zhao and Johns 2014b). The resulting mechanistic insight — that wind-driven variability can produce short-term transport anomalies comparable in magnitude to the expected forced trend — is essential for interpreting subsequent observations and for distinguishing transient variability from secular trend.

Constraining projections. Climate models disagree widely on future AMOC behaviour; unconstrained, the spread is compatible with outcomes from modest slowdown to near-collapse. Portmann et al. (2026, *Science Advances*) apply observational constraints to model projections and estimate an AMOC slowdown of 51 ± 8% by 2100, substantially larger than the unconstrained multi-model mean of 32 ± 37%. Although these numbers are not yet confirmed by other studies, they show a potential to reduce uncertainty by a factor of nearly five. The correction draws on sustained observational records suggesting systematic model biases in South Atlantic surface salinity. Without those records, projections revert to the unconstrained range — too wide to inform planning.

Model-independent threshold estimation. Ditlevsen et al. (2026, preprint) applied statistical methods to observational and proxy data to estimate a critical CO_2 concentration of approximately 715 ppm at which AMOC collapse becomes probable. The approach depends on sustained records of sufficient length for statistical signatures of approaching regime change to be identified. Extending those records would narrow the uncertainty; discontinuing them would foreclose the method.

Nordic climate dynamics and decadal predictability. Sustained observations across the Nordic gateways are revealing dynamics in the Nordic-region circulation that are directly relevant to Nordic-region climate — both in resolving the dynamical pathways through which AMOC variability connects to Scandinavian decadal predictability, and in capturing active changes in how the Atlantic and Arctic circulations interact across these gateways.

AMOC variability and Scandinavian climate through the Nordic Seas overturning. Temperature and salinity anomalies propagating northward along the Atlantic Water pathway from the midlatitudes are a primary source of decadal climate predictability for Scandinavia and the broader northern oceans. Chafik et al. (2025, *Communications Earth & Environment*) show that these anomalies do not simply pass through as passive signals but dynamically regulate the Nordic Seas overturning, controlling both the warm Atlantic inflow into the Nordic Seas and the cold dense overflows back into the North Atlantic on multi-year to decadal timescales. The strong covariability between the reconstructed Atlantic inflow and the thickness of the dense overflow layer — drawing on the sustained monitoring records at Denmark Strait and the Faroe Bank Channel — confirms the dynamical link.

Atlantification and Arctic-Atlantic interaction. Årthun et al. (2025, *Science Advances*) draw on sustained observations from the Greenland–Scotland Ridge and Arctic gateway arrays to report that Atlantification — the increasing influence of warm Atlantic water in the Arctic — appears to be driving a recent strengthening of the Arctic overturning circulation. These changes in the Nordic Seas and Arctic affect regional climate and society in the Nordic Countries and can feed back onto the Atlantic circulation. The analysis suggests that Nordic gateway observations are capturing active, large-scale changes in how the Arctic and Atlantic circulations interact.

2.4 Observational gaps

The observing system described above has revealed its own limitations. Several areas of known insufficiency bear directly on the capacity to monitor and understand AMOC change. These gaps below are identified through community-informed scientific judgement rather than derived from a unified specification. At the time of writing, no peer-reviewed work articulates what a fit-for-purpose AMOC observing system would consist of, and no such specification is expected on the timescale of the Ocean Act drafting process in late 2026. The gaps below should be read as a community-informed but non-exhaustive list.

Closing the gaps on the Greenland–Scotland Ridge (GSR). The Greenland–Scotland Ridge sits at the latitude that observation has identified as the primary control on Nordic Seas overturning strength (Section 2.2). The current GSR monitoring is a collection of distinct national arrays measuring specific components of transport rather than a uniform observational system. The arrays were initiated as early efforts to investigate key branches of Atlantic inflow into the Nordic Seas and of the overflows into the Atlantic, but significant gaps remain. In the Denmark Strait, two moorings measure transport of the densest overflow water through the narrow, deepest part of the channel, leaving the larger strait area including the Greenland shelf unobserved. The Iceland–Faroe Ridge overflow and the East Greenland Current outflow (southward flow in the upper layers) were not part of the original monitoring arrays; recent observational efforts on these branches have been complicated by intermittent funding, lack of available infrastructure, and the complex conditions on the ridge. South of Iceland, MFRI standard sections currently extend to the Icelandic shelf only and do not fully capture the overflow occurring east of Iceland. At the Faroe–Shetland Channel, the discontinuation of the MD-SEDD mooring array in 2024 has left the branch with hydrographic transects only, an immediate loss of capability that further illustrates the fragility of the current arrangement.

We now know that measuring the Atlantic-Arctic exchange, and comparing it to AMOC strength elsewhere, requires a stocktake of total net transport in all density classes. Working towards an integrated GSR observing system is a way forward in connecting the Atlantic and Arctic AMOC systems. Closing the remaining gaps will require analysis of where they are most consequential and what combination of moorings, gliders, ferry and satellite data can fill them.

Deep convection monitoring. The end of deep convection in the northern Atlantic is widely considered a likely proximate mechanism for an AMOC tipping event (Drijfhout et al. 2025). Some studies hypothesize that Subpolar Gyre convection may be a tipping element in its own right (Born et al. 2013; Born & Stocker 2014). Convection may temporarily shift to the Nordic Seas to compensate, but may eventually collapse there too (Drijfhout et al. 2025). While model analysis often focuses on the maximum convection depth in the Labrador Sea as an indicator, observations show that water mass transformation in various basins and across a range of density classes contributes to overturning and thus AMOC strength. Having concomitant measurements of convection and AMOC makes it possible to investigate these mechanisms and monitor change. Argo floats provide valuable data but may be insufficient at the resolution needed in these regions. Enhanced Argo deployment, dedicated moorings, or glider programmes in the Irminger Sea, the Iceland Basin, and the Nordic Seas should be considered a priority.

Deep ocean below 2000 metres. Standard Argo floats profile to approximately 2000 metres. The Deep Argo programme extends to 4000–6000 metres but remains in pilot phase with a limited number of floats at the time of writing; the OneArgo expansion (see Appendix A) has Deep Argo as one of its four design components, with a global target of approximately 1,200 Deep Argo floats by 2030. Since much of the AMOC return flow occurs below 2000 metres, the deep ocean remains under-observed relative to its role in the circulation, and Deep Argo scaling is the principal route to closing this gap.

South Atlantic coverage. The SAMBA array at 34.5°S has experienced data gaps. Given the significance of South Atlantic salinity for AMOC dynamics (Wijers et al. 2019), and the difficulty of climate models to correctly represent freshwater transport at the southern boundary of the Atlantic, sustained monitoring in the South Atlantic is of great scientific importance.

Data latency. AMOC transport time series from moored arrays carry a latency of approximately two years between measurement and available data. This limits the timeliness of scientific assessments and would constrain any future operational monitoring capability. The trade offs between costs and latency in a fit-for-purpose monitoring system needs to be considered. The UK's NOC led RAPID-Evolution programme is trialing data telemetry to extract data every 6 months from key moorings, to see whether a rough and ready MOC estimate is feasible on shorter timescales. Having such a system on all arrays would transform the use of AMOC information.

Coordination between Nordic and Atlantic observing communities. The Nordic monitoring programmes and the basin-wide AMOC arrays have largely developed independently. Strengthening the connection between them — in terms of coordinated and easily comparable data products, joint analytical methods, and shared scientific priorities — would increase the value of both. Scientific coordination at this level is constrained in what it can achieve: scientific bodies can identify priorities and propose standards but cannot commit national resources or direct national scientific institutions to cooperate at the scale the problem requires. Sustained coordination of the kind that could secure a Nordic–Atlantic AMOC observing system would need to operate through institutional channels with the authority to bind national commitments. Section 4 recommends the Nordic side of such coordination — a standing NCM group carrying the ministerial and scoping work — without overclaiming what Nordic-only coordination can secure on its own. The fuller Nordic–Atlantic arrangement remains a matter for development through the European and multilateral processes identified in Sections 3.4 and 4.

3. Funding Status and Fragility

3.1 How AMOC observation is funded

AMOC observing arrays, individual moorings, hydrographic surveys, and other ocean observations are ultimately funded by individual countries, research institutions, often through competitive science grants. The observations are carried out by highly trained scientific and technical personnel at sea-going oceanographic research institutes and governmental agencies. However, all these organisations ultimately depend on how much individual countries are willing to contribute to a globally coordinated effort by financing the core observations themselves.

For most AMOC observing initiatives, observations are maintained by small science groups that patch together consecutive short-term funding opportunities of two to five years. The funding sources vary from national short-term infrastructure funding to institutional allocations to proposals funded through competitive research calls. For the basin-wide arrays such as OSNAP, funding in each participating country depends heavily on funding in the other participating countries. If at some point one country cannot fund its part of an array, a domino effect may cause other countries to lose their funding as well. The vulnerability of this arrangement stands in steep contrast to the scientific importance of the observations it produces.

It is useful at this point to make explicit the distinct funding mechanisms through which AMOC observation is, or could be, supported. These are discussed in more argumentative detail in Section 1; here they are set out briefly as a framework for reading Table B and the country descriptions that follow.

Competitive short-term research grants. Proposals of two to five years, awarded on scientific excellence. The dominant current mechanism. Not designed to sustain monitoring.

Institutional allocations. Observing activity supported from a research institute's general budget, a national-capability programme, or an operational agency line — examples include MFRI, FAMRI, IMR, GEOMAR, AWI, NPI institutional budgets; UK NERC National Capability funding; and NOAA operational funding. More stable than competitive grants, but not ring-fenced for ocean observation: vulnerable to compression of the underlying budget under fiscal or political pressure.

Classification as large-scale European research infrastructure. Coordinated multi-country funding under a legal framework such as an ERIC. Euro-Argo ERIC, established under EU Regulation 723/2009, is the working example for ocean observation.

Legal instrument anchoring. Statutory recognition of observing infrastructure within binding European legislation. No current example exists for AMOC observation; the forthcoming Ocean Act is the instrument within reach.

A summary of the funding status across the observing system is provided in Table B. Detailed funding descriptions for basin-wide AMOC arrays and broader observational systems are provided in Appendix A and B.

Table B. *AMOC observing system: funding status. The funding mechanism column refers to the typology introduced in Section 3.1. Risk levels and dependency types used in this table are defined in Section 3.2.*

Name	Contributing countries	Funding mechanism	Funding horizon	Dependency	Risk status
Basin-wide AMOC arrays					
OSNAP	US, UK, NL, DE, CA	Mixed: UK via NERC NC; DE via Helmholtz (institutional); US/NL/CA via competitive grants	Most to 2028; UK to 2029 (exp. 2034), At risk from 2027;DE to 2035	Co-dependency (5-country; US ~60% + single-point (NL one PI) + UK vulnerable to cuts)	**Critical**
RAPID-MOCHA-WBTS	UK, US	UK via NERC NC; US via NOAA operational funding	UK to 2029 (exp. 2034), At risk from 2027; US to 2027	Co-dependency (cannot exist without US component, UK vulnerable to cuts)	**Critical**
SAMBA	US, ZA, AR, BR, FR	Competitive grants per country	Unknown	Co-dependency (5-country; multiple partners already in acute crisis)	**At risk**
Atlantic components					
MOVE	US	NOAA operational funding	Politically contingent	Single-point (US only; one PI)	**At risk**
TRACOS	DE	Institutional (GEOMAR/Helmholtz)	Likely to 2035	Single-point (one PI at GEOMAR)	**Vulnerable**
NOAC	DE	Institutional (GEOMAR/Helmholtz)	Discontinued 2017	Single-point (historical)	Discontinued
Greenland-Scotland Ridge: dense water return flow					
DS overflow moorings and hydrography (MFRI, UoH)	IS, DE	Institutional (MFRI, UoH)	Continuing	Institutional-budget exposure (has already produced autumn cuts)	**Vulnerable**
FBC overflow moorings and hydrography (FAMRI)	FO, DK, EU	Institutional surveys (FAMRI); mixed mooring funding (EU + DK competitive + FAMRI + philanthropy)	Surveys secure; moorings variable	Institutional-budget exposure (moorings never fully secured)	**Vulnerable**
Greenland-Scotland Ridge: Atlantic water inflow					
NIICIS Atlantic inflow moorings and hydrography (MFRI)	IS	Institutional (MFRI)	Continuing	Institutional-budget exposure (has already produced autumn cuts)	**Vulnerable**
FC Atlantic inflow moorings and hydrography (FAMRI)	FO, DK, EU	Institutional surveys (FAMRI); mixed mooring funding (EU + DK competitive + FAMRI + philanthropy)	Surveys secure; moorings variable	Institutional-budget exposure (moorings never fully secured)	**Vulnerable**
FSC Atlantic Inflow moorings (MSS) and hydrography (MD-SEDD , FAMRI)	SC, FO	Institutional (MD-SEDD); Institutional surveys (FAMRI)	Moorings discontinued in 2024		Discontinued
Arctic and sub-Arctic monitoring					
Svinøy section (IMR)	NO	Institutional (IMR) + Arctic Ocean 2050 framework	Continuing	Stable nationally	**Stable**

Barents Sea Opening (IMR)	NO	Institutional (IMR) + Arctic Ocean 2050 framework	Continuing	Stable nationally	**Stable**
Fram Strait - EGC (NPI)	NO	Institutional (NPI)	Continuing	Stable nationally	**Stable**
Fram Strait - WSC (AWI)	DE	Institutional (AWI)	Continuing	Institutional-budget exposure (project-by-project reinvestment)	**Stable**
Davis Strait	US, CA	Competitive grants (NSF, DFO)	To 2026	External-dependency (US NSF dominant)	**At risk**
NO Argo (IMR)	NO	Institutional (IMR)	To 2027 (NorArgo2 cliff	Institutional-budget exposure + known timeline cliff	**Vulnerable**
Broader observational systems					
Argo (global)	US >50%; EU ~25%	US via NOAA operational; EU via Euro-Argo ERIC (European research infrastructure)	Tight, not long-term	Single-point at scale (US >50%; OneArgo emergency declared)	**At risk**
GO-SHIP	Multiple; US ~1/3	Mixed per line (competitive grants, institutional, operational)	Always under pressure	Institutional-budget exposure + co-dependency per line	**At risk**
Satellite altimetry	EU, US	Operational agency missions (NASA, ESA, EUMETSAT)	Continuing to ~2030	Mission-continuity dependency (no successor after Sentinel-6B)	**Stable**

3.2 Where the observing system is most at risk

Of the components summarised in Table B, two have already been indefinitely discontinued due to lack of funding, two are in Critical condition: they could be materially reduced or end within eighteen months if current trajectories are not interrupted. A further set is At risk on a known timeline, typically 2026–2028. Nordic gateway monitoring sits largely in the Vulnerable category — operated under institutional budgets without acute cliffs but producing periodic reductions under ordinary fiscal pressure.

Components are classified across two dimensions: risk level (the severity and immediacy of exposure) and dependency type (the structural pattern through which exposure operates). The classifications apply throughout this section and Table B.

Risk levels

Critical — acute exposure within a multi-country co-dependency in which failure of any single contribution ends the entire observation.

At risk — material vulnerability on a known timeline (typically 2026–2028), including single-component acute exposure with no cascading partner dependency, with a plausible continuation pathway if action is taken.

Vulnerable — exposure within an institutional and political framework that remains broadly supportive, where continuation depends on routine renewal or annual budget allocation rather than on contested political commitment. Encompasses both gradual institutional compression and known cliffs with established continuation pathways.

Stable — institutionally secure under current arrangements, without identified acute exposure in the 2025–2028 window.

Discontinued — observation discontinued.

Dependency types

Single-point dependency — continuation depends on one country, one agency, or one principal investigator.

Multi-country co-dependency — continuation requires multiple countries each maintaining their contribution; failure of one risks cascading loss.

External-dependency — a nominally national programme relies on non-domestic funding or operational partnership to maintain current scope.

Institutional-budget exposure — continuation depends on an institutional budget not ring-fenced for AMOC observation, making the programme vulnerable to reprioritisation under fiscal pressure.

Mission-continuity dependency — continuation requires long-lead capital programmes and technical/operational coordination, not only budget continuation.

Critical

RAPID-MOCHA-WBTS at 26.5°N. The longest continuous transbasin AMOC record, unbroken since 2004, is sustained through complementary partnerships across NSF, NOAA, and UK NERC. Each contribution is separately exposed: NSF MOCHA terminates in June 2026 with continuation under the current US administration uncertain; NOAA WBTS faces the FY2027 budget proposal that would eliminate the Office of Oceanic and Atmospheric Research, the WBTS programme's institutional home; and UK NERC National Capability funding, which carries the array to 2029, is at risk from 2027 due to year-on-year reductions to the AtlantiS programme envelope. Failure of any single contribution would end the longest record in existence.

Country	~€M/yr	Mechanism	Horizon	Specific risk
UK	0.8	NERC NC	At risk from 2027	Annual budget reductions
US (NSF)	—	Competitive (MOCHA)	June 2026	Terminates; renewal uncertain
US (NOAA)	—	Operational (GOMO/WBTS)	2027	FY2027 proposal eliminates OAR; US political exposure

Note: The UK figure reflects the AtlantiS envelope allocation (approximately £700k per year converted at current rates) and is subject to year-on-year compression rather than a fixed multi-year commitment, with full operating costs and depreciation partly outside the envelope.

OSNAP. The most extensive basin-wide AMOC array currently in operation, OSNAP is sustained through complementary partnerships across five countries, each operating moorings that together span the array. The United States contributes approximately half of OSNAP funding through NSF competitive grants now exposed to the FY2027 budget proposal. The United Kingdom contributes through NERC National Capability funding under the AtlantiS envelope, currently funded to 2029 but at risk from 2027 due to year-on-year reductions. The Netherlands contributes the OSNAP Irminger moorings, sustained over twelve years by a single principal investigator through five consecutive grants, with no committed pathway beyond 2028. Germany and Canada contribute through institutional and DFO arrangements with their own exposures. Shutdown of the United States, United Kingdom, or Netherlands contribution would each independently end the transbasin measurement.

Country	~€M/yr	Mechanism	Horizon	Specific risk
US	3.8	Competitive grants (NSF)	To 2028	FY2027 proposal; US political exposure
UK	1.2	NERC NC	At risk from 2027	Annual budget reductions
NL	0.8	Competitive grants	To 2028	Single-PI (12 yrs, 5 grants); no post-2028 pathway yet
DE	0.6	Institutional (GEOMAR/Helmholtz)	Likely to 2035	POF-V→POF-VI transition 2027/8
CA	0.3	DFO mix	Uncertain	Depends on US NSF contribution to CA

Note: The German figure is likely an underestimate. The Netherlands figure is based on historical data; a forward estimate is closer to €1.2 million per year. The UK figure reflects the AtlantiS envelope allocation and is subject to year-on-year compression rather than a fixed multi-year commitment, with full operating costs and depreciation partly outside the envelope. The exercise as a whole is approximate, and the total annual operating cost is likely between €7 and €8 million.

At risk

SAMBA at 34.5°S. A five-country collaboration (US, Brazil, Argentina, South Africa, France) measuring AMOC at the southern boundary. The array has experienced data gaps through cascading national funding failures: the US NOAA AOML "SAM" component faces FY2026/FY2027 elimination proposals; the Brazilian SAMBAR primary term expired in 2022 with renewal uncertain; Argentine science funding under the Milei administration is in acute crisis. Per-country horizons are partly unconfirmed in public sources; the classification reflects information confidence rather than risk severity. Loss would foreclose AMOC measurement at the southern boundary entirely.

MOVE at 16°N. A 25-year record of deep western boundary current variability across the eastern Caribbean, effectively 100% US-funded through NOAA GOMO with a single PI at Scripps. The FY2027 budget proposal would eliminate NOAA OAR, GOMO's institutional home, and no replacement funder has been identified. The array's transport record has shown a significantly negative AMOC trend in recent years, which elevates the scientific cost of any interruption.

Davis Strait brackets the Arctic–Atlantic exchange together with Fram Strait. The most recent NSF Office of Polar Programs award (2019–2024, PI Craig Lee, University of Washington) covers 2019–2024 with operations continuing into 2026 only on unfunded extensions. A continuation proposal cycle is in 2024–2025 against FY2026–FY2028 NSF funding uncertainty under the proposed 55% reduction. At risk from 2026.

Argo (global). Every basin-wide AMOC array depends on this programme for the temperature and salinity fields that allow transport calculation. Total annual cost approximately USD $40M globally; the United States contributes more than half through NOAA GOMO, which faces FY2027 OAR elimination. The UK contribution is at risk from 2027 due to year-on-year reductions to the AtlantiS programme envelope. Euro-Argo ERIC issued a "OneArgo emergency" statement in 2025 under pre-existing budget pressure: the active global float count has dropped from approximately 3,900 at peak to 3,600 by mid-2025. The OneArgo expansion target of 4,700 floats by 2030 requires approximately USD $100M/year — roughly 2.5× current spending — which is not currently committed.

GO-SHIP is the global hydrographic programme essential for deep-ocean AMOC analysis below the 2,000m depth limit of Core Argo. Funded per line through a mix of competitive grants, institutional appropriations, and operational lines; some lines are chronically under-resourced. UK NERC National Capability funding (AtlantiS programme, three Atlantic sections) is at risk from 2027 due to year-on-year reductions. The US NSF cycle ends in 2026, with renewal required for 2026–2031 under FY2026 budget pressure. Rising operational costs (fuel, ship-time) are compounding pressure on per-line budgets.

Vulnerable

The Greenland–Scotland Ridge (GSR) monitoring consists of a collection of distinct national arrays rather than a uniform observational system. Observations over the ridge are jointly operated by MFRI (Iceland) and the University of Hamburg west of Iceland, and by FAMRI (Faroes) in coordination with the Scottish Government's Marine Directorate (MD-SEDD) and international partners east of Iceland. The arrays are funded through the institutional appropriations of the operating institutes; they are not ring-fenced for AMOC observation and no coordinated Nordic funding mechanism exists for the GSR system as a whole. Budget pressure at MFRI has already cut some autumn hydrographic surveys, reducing the four-survey-per-year frequency. FAMRI mooring operations are never fully secured, depending on a mixed funding base of FAMRI institutional funds, EU competitive projects, Danish recurring support, and philanthropic contributions.

The Norwegian Argo programme (NorArgo2) ends in 2027 and depends on a successful NorArgo3 proposal in the next INFRASTRUKTUR call — a material cliff given Norway is the single largest Argo contributor in the Nordic Seas. The institutional framework remains supportive: Norway is a Euro-Argo ERIC member since 2018, the Arctic Ocean 2050 programme provides a framework for sustained marine observation, and IMR's institutional commitment is stable. The exposure is operational rather than political — continuation depends on routine renewal through an established pathway rather than on contested support for the underlying programme.

TRACOS at 11°S is maintained by GEOMAR through Helmholtz Programme-Oriented Funding, with continuation depending on a single PI and the POF-V to POF-VI transition in 2027/2028. The Helmholtz framework is institutionally stable; the POF transition is a routine review cycle within a broadly supportive funding architecture. Classification reflects information confidence pending fuller GEOMAR input on POF-VI continuation.

3.3 Three patterns of vulnerability

The distribution of risk in Section 3.2 is not random. Three patterns shape it: a structural mismatch in which sustained observation is supported through funding instruments not designed for it, with single-PI or short-term-grant dependencies as the failure mode; an institutional pattern in which sustained observation is embedded in institutional or national-capability budgets but not ring-fenced, producing reductions through fiscal compression rather than through cliffs; and an acute political trajectory in the United States that propagates through the co-dependencies in Table B and converts both structural patterns into a basin-wide crisis on an eighteen-month horizon.

3.3.1 Short-term grants and single-PI dependencies

The dominant funding mechanism for sustained ocean observation across Europe and North America is short-term competitive research grants and single-investigator awards, awarded through open calls originally designed for hypothesis-testing science on three- to five-year horizons. Continuous time-series observation — a 30+ year activity when its scientific value derives from decadal signals — is being maintained through instruments not built for it. The mismatch determines the failure modes documented in Section 3.2: single-PI dependencies, grant-cycle gaps, and the absence of a committed post-grant continuation pathway.

The OSNAP Dutch contribution is the clearest instance. The Irminger moorings have been maintained for twelve years through five consecutive grants won by a single principal investigator in open competition against proposals from earth science, astronomy, chemistry, informatics, physics, and mathematics. A single unsuccessful cycle would end the observation. The same vulnerability profile recurs across the basin-wide system in different configurations — the US contributions to Davis Strait and MOCHA, the FAMRI mooring operations, the Norwegian Argo programme — each described in Section 3.2.

3.3.2 Institutional pressure and deprioritisation

A second pattern operates through institutional budgets that nominally support sustained observation but do not ring-fence it. Observation is conducted as part of an institute's operational mandate rather than as a time-limited project, which removes the grant-cycle vulnerability of the first pattern, but it does not remove the budget-cycle vulnerability. Pressure operates through periodic compression of institutional appropriations, producing reductions in observational capability that accumulate without surfacing at a single decision point.

The pattern operates at different intensities across the system. The UK case is the most acute. NERC National Capability funding administers RAPID, OSNAP, GO-SHIP, and Argo as multi-year envelopes defended on five-year review cycles, but year-on-year reductions to the AtlantiS programme envelope have placed all four UK contributions at risk from 2027 — a known compression that has already produced observable capability reductions, including the December 2020 RAPID reconfiguration and the formalisation of the reduced-cost RAPID-Evolution design as the 2027 baseline (Petit et al. 2025).

The Nordic case sits in the same pattern but at lower intensity and within a more supportive institutional framework. Gateway monitoring at MFRI, FAMRI, IMR, and NPI is funded through institutional appropriations rather than competitive short-term grants, and the activity is more deeply embedded in the operational mandates of its host institutes than UK observation is in NERC's portfolio. The exposure is real — MFRI budget pressure has produced cuts to autumn hydrographic surveys; FAMRI mooring operations are never fully secured between cycles — but it operates through routine fiscal cycles within broadly supportive political frameworks rather than through contested institutional withdrawal. Section 3.2 places UK contributions in At risk and Nordic gateway monitoring in Vulnerable to reflect the difference.

3.3.3 The US political trajectory

The two structural patterns above describe how AMOC observation can erode in ordinary times. A third pattern describes how an acute political event converts ordinary erosion into basin-wide crisis on an eighteen-month horizon.

US support for AMOC work arose from an identification of AMOC understanding as a near-term priority by the White House Joint Subcommittee on Ocean Science and Technology (SOST) in 2007. This allowed supporting agencies (NASA, NOAA, NSF and DoE) to support smaller and larger AMOC studies by US scientists and fostered international cooperation and advancement of the field. While the expertise and individual commitment is still there at the US science community level, the institutional means to support this are quickly evaporating due to de-prioritisation of climate research at the political level.

The FY2027 NOAA budget proposal, released on 3 April 2026, would eliminate funding for the Office of Oceanic and Atmospheric Research — organisational home of the WBTS programme at RAPID and of MOVE, and a principal funder of Argo and SAMBA. It is paired with a 55% reduction to the National Science Foundation, which funds MOCHA at RAPID, the US contribution to OSNAP, and the US contribution to Davis Strait. While NSF has long been supportive of these programmes, NSF stresses that competitive calls are not meant to sustain long-term monitoring, which is deemed a NOAA task. A 47% reduction to NASA science compounds the loss of satellite observational context. Congressional negotiations on FY2027 remain unresolved, but the recurrence of proposals of this scale at this frequency now constitutes a material signal about the trajectory of US support for sustained ocean observation, independent of any single budget outcome.

Propagation into the basin-wide system is direct. RAPID and OSNAP are sustained through complementary partnerships in which any single contribution failing would end the transbasin measurement; loss of the US contribution to either would do so directly. MOVE has no current partner outside the US; its loss has no current contingency. SAMBA's NOAA-AOML component is one of five exposed national contributions; Argo's US share exceeds half the programme budget.

Sustaining transbasin AMOC observation through this period will require a strengthened European contribution to a continuing trans-Atlantic observing partnership, not a European replacement of the US science community whose institutional knowledge and operational capacity remain essential. Some European capacity exists at GEOMAR and at the UK's National Oceanography Centre that could plausibly absorb a share of the operational load if funded, but this capacity has neither been scoped nor organised for that role. At the same time, the institutional pattern in Section 3.3.2 indicates that Europe's own institutional commitments are themselves under compression — UK NERC National Capability components are at risk from 2027, and Nordic gateway monitoring is exposed to ordinary fiscal cycles. The European response cannot rest on the assumption that European institutional capacity is itself secure.

3.4 What alleviating risk would require

The components at acute risk lie outside Nordic jurisdiction. They are operated by consortia in which Nordic participation is modest or absent; the funding decisions that will determine their near-term survival are being taken in Washington, Swindon, Brussels, The Hague, Kiel, and Brest. AMOC risk assessment, however, rests directly on what these systems produce. Nordic climate policy has a standing material interest in the continuation of observation that takes place elsewhere.

Three classes of Nordic action are available.

3.4.1 Direct Nordic action

The shortfall in basin-wide AMOC observation following US withdrawal is on the order of €7-10 million per year. Independent exposure from single-principal-investigator failure in the European co-dependencies — principally the OSNAP Irminger mooring maintained under rolling Dutch competitive grants through 2028 — adds a further approximately €1.2 million per year. The compression of UK NERC National Capability funding places UK contributions to RAPID, OSNAP, Argo, and GO-SHIP at risk from 2027. The combined annual budget for the UK contributions to RAPID and OSNAP alone is estimated at €2–3 million per year, though full operating costs including ship-time and capital depreciation are institutionally split and not all captured in these figures; the magnitude of any annual exposure depends on AtlantiS envelope reductions rather than a fixed shortfall. Against the national budgets of five Nordic countries, and against the climate-policy consequences of losing AMOC projection capability, these sums are modest.

No standing mechanism currently exists for channelling Nordic funds to externally-operated components, and designing a durable one is unlikely to be completed within the 2026–2028 window during which the critical components are exposed.

A Nordic multilateral emergency-funding arrangement, drawing on dedicated climate-policy allocations to backstop critical components through 2028 while durable mechanisms are scoped, could bridge the gap. Additionally, research vessels and observational capacity could be contributed directly to externally-operated programmes through bilateral arrangements at the operational level. Ship-time is a substantial and rising component of programme costs across the system, and Nordic ship-time contributions could be negotiated and put in place within months, on a timeline compatible with the 2026–2028 exposure window.

Allowing critical components to end during the design period and attempting to rebuild them subsequently would be substantially more costly and, for the longest continuous records, not reversible.

In parallel, Nordic ministries retain direct authority over the Nordic components themselves: the Greenland–Scotland Ridge arrays operated by MFRI, FAMRI and partners, the Svinøy and Barents Sea Opening sections operated by IMR, the Fram Strait operated by NPI, and the Argo contribution in Norway (NorArgo2, with NorArgo3 pending) and Finland (not currently contributing floats to the North Atlantic). Protecting and improving these is a matter of national budget decisions inside existing institutions.

3.4.2 Action through European institutions

Two European developments in the near term offer Nordic ministers concrete levers: the EU Ocean Act, drafting through late 2026, and the OceanEye initiative, with its pledging event in September 2026. The February 2026 NCM report identified the Ocean Act as a major opportunity in early 2026; OceanEye provides a parallel mechanism oriented to operational ocean observation funding. The window between now and Q4 2026 is when the institutional treatment of AMOC observation within European ocean-observation policy is being set.

The relevant ministerial action is to ensure sustained AMOC observation is explicitly recognised in both instruments: in the Ocean Act as infrastructure warranting sustained institutional commitment rather than competitive research grants, and in the OceanEye pledging architecture as a specific category under which Nordic and European contributions can be pledged. Nordic governments sit on the fora in which both instruments are shaped; coordinated Nordic positions towards Brussels, and the OceanEye processes that follow, are the principal lever for embedding AMOC observation in European architecture on a timescale compatible with the Section 3.2 risk horizon.

3.4.3 Direct diplomatic action

The European and multilateral mechanisms above do not exhaust the options. Direct bilateral engagement with the governments whose decisions most directly determine the fate of critical components — principally the United States, the United Kingdom, and the Netherlands — is available to Nordic ministers individually and collectively. The specific asks differ: a Nordic diplomatic signal to the US administration on the strategic value of NOAA observational assets; coordination with the UK on continuation of NERC National Capability support for RAPID, OSNAP, Argo and GO-SHIP, at risk from 2027; engagement with the Dutch government on continuation of the OSNAP Irminger mooring through the 2028 grant cycle.

Alternative multilateral processes are also available. The G7 and G20 climate and ocean workstreams, the IPCC process, and existing Arctic cooperation structures each offer venues in which the institutional framing of AMOC observation can be raised alongside, or in parallel to, the European and consortium-specific mechanisms. Nordic convening capacity in these fora is established; the analytical and political groundwork required to make AMOC observation a specific agenda item is modest relative to what is at stake.

Section 4 develops these three classes of action into specific proposals.

4. Recommendations for Nordic Ministers

Sustained observation is foundational to any government strategy on AMOC risk: it is what monitors the evolution of the system, on which any wider response depends. A shutdown of operations in key AMOC observation systems would most likely take years to restart, resulting not only in loss of the analytical capability the record was building, but in loss of our ability to detect weakening trends for decades to come — with direct consequences for Nordic capacity to plan, prepare, and act on AMOC risk.

A fundamental shift in mentality is required. A wait-and-see posture at this time could have drastic consequences. The current observation system was never designed for a world of AMOC security relevance, and while heroically held together by scientists over the years, it is at the brink of collapse for key components. The required shift has two elements: immediate action to secure the components already in place, and political recognition of AMOC observation as critical infrastructure to Nordic security — with an eye towards expansion to fit-for-purpose status as the system is sustained.

Three classes of action are available, set out in Section 3.4 and developed below as recommendations. Direct bilateral engagement with the governments whose decisions most determine the fate of critical components — principally the United States, the United Kingdom, and the Netherlands — is available now. Coordinated Nordic engagement with the European institutional processes shaping ocean-observation architecture for the coming decade is available through 2026. And direct Nordic action — through emergency funding for the most acute exposures, contribution of Nordic operational and ship-time capacity, coordination of the Nordic observing assets the region already operates, and national critical-infrastructure designation — runs alongside both. The three classes are complementary; none is sufficient on its own.

The policy relevance of AMOC observation to Nordic climate, fisheries, energy systems, and infrastructure is direct enough that the fate of these observing systems — whether operated from within or outside the Nordic region — falls within the legitimate scope of Nordic ministerial action. National-level recognition of AMOC risk already exists across the region, in Iceland's national security framing and Finland's Strategic Task 37 designation. Leaving the matter to the EU alone would amount to an unforced abdication of Nordic agency on an issue of direct consequence to the safety of the region.

Recommendation 1: Engage directly with the governments whose decisions most determine the fate of critical AMOC observing components.

Critical and At risk components of the basin-wide observing system are concentrated outside Nordic jurisdiction, and the funding decisions that will determine their continuity are being taken elsewhere. Nordic ministers, individually and collectively, are well placed to engage these governments directly on the strategic value of the observations at stake — as partners in a continuing trans-Atlantic observing system rather than as external observers of a foreign budget process. The specific asks differ by country. With the United Kingdom, coordination on continuation of NERC National Capability support for RAPID, OSNAP, Argo, and GO-SHIP, all at risk from 2027 due to year-on-year reductions to the AtlantiS programme envelope. With the Netherlands, engagement on continuation of the OSNAP Irminger moorings through and beyond the 2028 grant cycle. With the United States, a coordinated Nordic signal to the administration on the strategic value of NOAA and NSF observational assets, and on the continuing trans-Atlantic partnership that sustains them.

Recommendation 2: Articulate a coordinated Nordic position on AMOC observation, and pledge existing Nordic contributions, within the Ocean Act and OceanEye processes.

Although the basin-wide AMOC observing systems are not Nordic-operated, their policy relevance to the Nordic Countries is direct enough that their fate cannot reasonably be left to the EU institutional process alone. A coordinated Nordic position articulated before the content of either instrument is finalised would carry materially more weight than fragmented national input, and would place AMOC observation explicitly among the critical observational infrastructures the instruments are designed to support.

The OceanEye pledging event in September 2026 provides a specific forum at which this position can be made concrete. Nordic governments could pledge, under a common description of AMOC and overturning-circulation monitoring, the significant observational contributions they already operate — including the Greenland–Scotland Ridge inflow and overflow arrays, the Svinøy and Barents Sea Opening sections, the Fram Strait observatory, Norwegian Argo deployment in the Nordic Seas, and associated hydrographic programmes. These observations were established for purposes including regional hydrography, fisheries science, and climate monitoring; their classification as AMOC observations is itself part of the recognition this report supports. Pledging existing infrastructure under a common policy-relevant classification establishes the category within the emerging European architecture by fact rather than argument.

Recommendation 3: Establish a standing NCM coordination group on AMOC observation with a provisional multi-year mandate.

Nordic ministerial engagement with the Ocean Act, the OceanEye process, and the longer transition to a sustained European AMOC observation architecture will span multiple years and several institutional decision points. An ad hoc coordination arrangement across secretariat working groups, national ministries, and operating institutes is unlikely to sustain the coherence required. Nordic ministers could establish a standing coordination group under the Nordic Council of Ministers, with a clear analytical remit and a multi-year mandate, to carry the work between ministerial decision points and to act as the institutional counterpart through which the recommendations below are commissioned and received.

The group should be established on a provisional basis, oriented from the outset toward the broader trans-Atlantic observing partnership and with two pre-specified pathways to closure. As fit-for-purpose European or Nordic–Atlantic coordination mechanisms develop — whether through the Ocean Act's institutional provisions, through OceanEye's implementation architecture, or through other multilateral routes — the group would either transform into the Nordic counterpart within those mechanisms, or stand down where such mechanisms absorb the functions it carries. Provisional framing of this kind places the recommendation outside the category of a permanent new institution and within the category of transitional coordination appropriate to the decision horizon the next three to five years present.

Recommendation 4: Commission the standing group to prepare backstop arrangements for the 2026–2028 funding transition.

The standing group's first substantive task should be to prepare arrangements covering two elements: emergency funding mechanisms ready for ministerial activation when needed, addressing the most acute exposures in the basin-wide observing system; and operational support arrangements through which Nordic ship-time and observational capacity can be contributed to externally-operated programmes, addressing bottlenecks that ship-time costs and ship-availability create separately from programme-level funding. Both should aim for operational readiness within the second half of 2026.

Recommendation 5: Commission the standing group to scope a coordinated AMOC observing system in the Nordic Seas, funded through a dedicated Nordic Council of Ministers line.

Nordic ministers could commission the standing group (recommendation 4) to scope what a coordinated Nordic Sea AMOC observing system (building on existing observational lines) would require, across both technical and institutional dimensions. The technical dimension addresses the observational design — where the current gaps are most consequential, what combination of moorings, gliders, ferry, voluntary ship, and satellite data would close them, what spatial coverage and latency are required, and how the system connects to Argo and broader basin-wide observation. The institutional dimension addresses the coordination, governance, and financing arrangements through which such a system can be sustained, building on the existing institutional commitments at MFRI, FAMRI, IMR, NPI, GEUS, and DMI.

Priority could be given to monitoring at the Greenland-Scotland Ridge (GSR) where individual national efforts are already taking place (Appendix B), but have vulnerable funding status (Table B). The scoping should include the case for a dedicated Nordic Council of Ministers funding line for GSR monitoring, acting as the coordinating and financing instrument for the integrated system. A Nordic funding of this kind would place GSR monitoring on a sustained footing without requiring individual national reallocations, recognise the GSR observing system as a Nordic regional contribution to global AMOC observation, and provide the institutional counterpart through which Nordic GSR monitoring would be embedded into the European Ocean Observation System emerging through the Ocean Act and OceanEye.

Going forward the joint Nordic efforts could be expanded to other relevant locations and types of measurements that support AMOC monitoring. These include, but are not limited to, monitoring overturning transports across Arctic Ocean gateways (especially Fram Strait and Barents Sea Opening) and freshwater transports from Greenland and the Arctic Ocean. Methodologically, these could be built on moorings, but also include other proven means, such as ships of opportunity and gliders.

The scoping exercise should aim to report in Q4 2026 so that its findings can be submitted as Nordic input to the Ocean Act consultation process, with the technical and institutional design work it proposes running through 2027. A coordinated Nordic Seas observing system, jointly operated and financed across the Nordic Countries, would represent the most substantive Nordic contribution to global AMOC observation available within Nordic competence.

Recommendation 6: Pursue national critical-infrastructure designation for Nordic observing assets.

The sustained time series Nordic countries operate face compression along two dimensions: institutional — consecutive budget cycles, reorganisation, capacity-expansion limits — and financial — continued dependence on 3–5 year research-project funding cycles, single-investigator exposure, absence of long-term operational funding lines. Recognition of these observing systems as critical infrastructure, in line with IOC and European Ocean Pact framing, would provide a basis for governance and funding arrangements appropriate to their policy relevance on both dimensions. The principal investigators responsible for these observations, interviewed in late 2025 and early 2026, identify critical-infrastructure designation as the structural direction that would place Nordic AMOC observation on a footing compatible with its operational character.

This is primarily a matter for national ministries and legislatures, operating through the national legal and budgetary instruments available to each country. A Nordic ministerial signal that such designation is supported at the regional level would assist national processes and align them across countries.

5. References

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Appendix A — AMOC Observing Programmes

OSNAP — Overturning in the Subpolar North Atlantic Program

https://www.o-snap.org/

OSNAP is an international collaboration of scientists from five countries (United States, United Kingdom, Germany, Canada, Netherlands) providing continuous observations of volume, heat, and freshwater transport between Canada and Greenland (OSNAP West) and between Greenland and Scotland (OSNAP East). The array has produced continuous measurements since first deployment in 2014 (Lozier et al. 2019). OSNAP is the most extensive basin-wide AMOC observing array currently in operation.

Each contributing country operates moorings that together form the OSNAP array. Country participation is organised around principal investigators with institutional continuity in AMOC-relevant research, funded through a combination of national infrastructure allocations, institutional core funding, and competitive research grants. An inventory of per-country budgets assembled for the Dutch Ministry of Infrastructure and Water Management estimates total annual OSNAP operating costs at approximately €6.24 million (Groeskamp 2026). This is likely an underestimate: the five-year period on which it draws was characterised by tight funding, reduced instrumentation use, and shared ship time with the US.

United States — approximately 60% of OSNAP funding, €3.75M per year (Groeskamp 2026). Initial funding was secured in 2010–2014 through a combined call from NASA, NOAA, and NSF. NSF Phase 1 (2014–2019) was USD 32M over five years across WHOI, Duke, and the University of Miami (~USD 6.4M per year). NSF Phase 2 (March 2020) was USD 15.5M over four years across WHOI, Georgia Tech, Scripps, and the University of Miami (~USD 3.9M per year), a ~39% nominal cut and a >40% real-terms cut accounting for ship-time and instrumentation inflation. Glider deployments and mooring service frequency have been reduced between phases, consistent with the funding cut. Funding has been patched together to 2028; post-2028 continuation is uncertain under current US budget trajectories (see Section 3.3.2 and below).

United Kingdom — estimated €1.2M excluding depreciation and partial ship operational cost. OSNAP UK has been funded since 2024 through National Capability funding administered by NERC under the AtlantiS programme envelope (the same mechanism that funds RAPID; see the RAPID entry). OSNAP UK operates six moorings and continuous glider observations of the shelf edge current, funded to 2029 with a recent adjustment removing one mooring. Renewal for a further five years is subject to the next NC review. However, due to annual fiscal compression to AtlantiS, OSNAP UK is at risk from 2027. PIs: Penny Holliday (NOC) and Neil Fraser (SAMS). Earlier UK programme funding ran through NERC competitive grants (UK-OSNAP Large Grant, £3.7M 2013–2018; UK-OSNAP Decade; SNAP-DRAGON; UK-OSNAP Extension 2023–2024). Equipment funding remains uncertain.

Netherlands — estimated €1.2M per year (Groeskamp 2026). The Dutch contribution consists of the IRMINGER moorings, sustained over twelve years by a single principal investigator (Femke de Jong, NIOZ) through five consecutive grants from successive open-competition research calls. These calls are configured for "groundbreaking frontier science" and place AMOC monitoring in direct competition with proposals from earth science, astronomy, chemistry, informatics, life science, physics, and mathematics. The calls do not accommodate monitoring-specific funding for equipment, technicians, or factory instrument calibration. Ship-time is included. Dutch AMOC monitoring also depends on the national facilities equipment pool, which is not tailored to sustained monitoring and is rarely renewed. Equipment is ageing, with no strategic plan for replacement. Funding is secured to approximately 2028; post-2028 prospects are highly uncertain.

Germany — estimated €0.62M per year (Groeskamp 2026). The German contribution is coordinated by a single principal investigator at GEOMAR (Johannes Karstensen). GEOMAR is a Helmholtz institute with Programme-Oriented Funding (POF) divided internally; AMOC observations including OSNAP, TRACOS, a Labrador Sea mooring, Cape Verde moorings, and various short-term projects are supported from the remaining allocation after programme-level commitments. The POF allocation covers instruments and consumables; science, data analysis, and ship-time must be secured through additional grants (EU funds, DFG, BMBF). GEOMAR maintains a "minimum monitoring effort" contingency plan if such funds fail. The German marine science community sees the importance of OSNAP, which contributes to funding stability. The current round of funding for Helmholtz and GEOMAR ends in 2028; OSNAP participation is expected to be extended to 2035 through POF-VI.

Canada — estimated €0.25M per year (Groeskamp 2026). Canadian participation is arranged through Fisheries and Oceans Canada (DFO), which provides shiptime, and subcontracts in the US NSF grants for funds. DFO supports OSNAP for two reasons: it values being part of an international open-ocean programme, and it has a sense of ownership of the northwest Atlantic. Funding runs through a combination of fundamental-research and climate-monitoring lines. Support rests on individual scientists who actively advocate for the programme; a recent move of one scientist from DFO to Memorial University has affected DFO support. The Canadian contribution is exposed to the FY2027 US budget trajectory. Strengthened EU partner interest in OSNAP would support the Canadian case for continued participation.

The array is structurally a five-country co-dependency. Each country's contribution is scoped against the assumption that others are also participating; if one cannot fund its share, cascading exits across the others become plausible. Single-PI dependencies in multiple countries additionally expose the array to retirement, illness, or career transitions of individual scientists. Funding uncertainty after 2028, combined with multi-year lead times for research-cruise planning, makes 2026 a material decision point for the array's continuity.

Key sources:

- Lozier et al. 2019, *Science* — OSNAP first results demonstrating Irminger and Iceland basin dominance in dense water formation
- NSF press release (Phase 1): https://www.nsf.gov/news/news_summ.jsp?cntn_id=129117
- WHOI press release (Phase 2): https://www.whoi.edu/press-room/news-release/8-3m-award-to-whoi-extends-observational-record-of-critical-climate-research/
- NOC UK-OSNAP: https://noc.ac.uk/projects/uk-osnap
- Groeskamp 2026 (NIOZ report to the Dutch Ministry of Infrastructure and Water Management)

RAPID-MOCHA-WBTS at 26.5°N

https://rapid.ac.uk/

The RAPID-MOCHA-WBTS array at 26.5°N is the longest continuous transbasin AMOC observing system, with an unbroken record since 2004 — over 22 years. It is a joint programme of the United Kingdom (RAPID, NERC), the United States (MOCHA, NSF, University of Miami), and the US operational contribution (WBTS, NOAA AOML). RAPID cannot exist without the US component.

No single consolidated budget figure is published. Best estimate USD $4–6 million per year combined across UK and US components.

United Kingdom — RAPID is funded through National Capability funding administered by NERC under the AtlantiS programme envelope. NERC NC funding supports long-term infrastructure at national and decadal scale, re-evaluated on five-year review cycles and defended before a review panel at each cycle. It represents a step change from short-term competitive science grants for monitoring purposes but does not provide permanence: funding remains subject to renewal and can be reduced at any time between renewals. Review cycles have produced observable reductions in capability — see the RAPID December 2020 reduction discussed below.

The original 2024–2029 AtlantiS envelope was £41.4M, covering all UK sustained Atlantic ocean observing including RAPID and GO-SHIP sections at 26°N, 57°N, and 24°S. NERC has since reduced the envelope and signalled further reductions, with the revised total not yet publicly available. Due to this annual fiscal compression, RAPID UK is at risk from 2027. The annual UK RAPID allocation under the envelope is approximately £700k per year (approximately €0.8 million), though this figure represents the grant allocation only and excludes the full cost of ship-time and capital depreciation, which are met through other parts of the institutional cost structure. RAPID is currently funded to 2029, with renewal for a further five years subject to the next NC review. PIs: Ben Moat, David Smeed, Brian King (NOC).

A further structural development is under way through the NOC-led **RAPID-Evolution** programme, which formally transitions the 26.5°N array to a reduced-cost design from 2027 as the baseline rather than as a contingency. This represents the formal admission that the original RAPID design is unaffordable under current funding arrangements.

United States (NSF) — MOCHA component funded through NSF Award 1926008 (PI Bill Johns, University of Miami), covering January 2023 – June 2026. Predecessor award 1332978. Typical 3–4 year award value USD $2–4M total. NSF MOCHA funding terminates in June 2026, and continuation under the current US administration is uncertain.

United States (NOAA) — The WBTS component is funded by NOAA as long-term operational moorings through NOAA AOML under the Global Ocean Monitoring and Observing (GOMO) programme. PIs: Denis Volkov, Ryan Smith. WBTS includes the Florida Current submarine cable plus 26.5°N eastern moorings and hydrography. This operational-mission funding is in principle more durable than competitive research grants but is contingent on the political and budgetary stability of the funding agency. US funding terminates in 2027, with continuation under the current administration uncertain. There is a material risk that RAPID could be materially reduced or discontinued after 2027 under the current US budget trajectory (see Section 3.3.2).

The December 2020 reconfiguration. The RAPID array has operated in a reduced configuration since December 2020. Under a review aimed at producing "a lower-cost and more sustainable observing system" (Petit et al. 2025), the moorings initially deployed on each side of the Mid-Atlantic Ridge and the deep moorings along the eastern boundary (EB1 and EBHi, below 3,000m) were removed. Internal geostrophic transport is now estimated from three moorings on the western boundary (WB2, WBH2, WB3) and three on the eastern boundary (EBH1, EBH2, EBH3). Petit et al. (2025) evaluate the reduced array and find that hydrographic sections can substitute for the removed deep moorings without material loss of accuracy for the long-term AMOC trend, but that the moorings at the western boundary and in the upper 3,000m of the eastern boundary cannot be removed without unacceptable error. The reduction illustrates that sustained-but-not-permanent funding mechanisms can produce observational capability degradation even under relatively stable political conditions.

The Florida Strait cable episode. The US-operated Western Boundary Time Series (WBTS) includes a submarine cable measurement across the Florida Straits that has provided continuous Florida Current transport estimates since 1982 — the longest observational record of a boundary current in existence. The cable failed in November 2023 due to mechanical failure. As of August 2025, NOAA/AOML has reported that efforts are underway to restore the cable system but has provided no timeline for repair or resumption. An alternative method using bottom pressure gauges, satellite altimetry, and hydrographic sections has been developed (Volkov et al. 2024) and subsequently extended and validated (Volkov et al. 2025) to maintain continuity of the Florida Current transport estimates in the interim. NOAA/AOML is explicit that the alternative is a temporary substitute and that resuming cable measurements remains a priority as the most accurate and cost-effective method. A like-for-like replacement of the cable, which runs approximately 130–140 km from Jupiter, Florida to Grand Bahama, would be a multi-year capital project; no public cost estimate has been located. The episode illustrates that operational funding, although more durable than competitive grants, does not by itself guarantee continuous observation: the technical and logistical capacity to maintain and repair the observing infrastructure is also required.

Key sources:

- NERC RAPID-AMOC: https://nerc.ukri.org/research/funded/programmes/rapidamoc/
- NOAA AOML WBTS: https://www.aoml.noaa.gov/western-boundary-time-series/
- NSF Award 1926008: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1926008
- Petit et al. 2025, *JGR Oceans*: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2025JC023093
- Volkov et al. 2024, *Nature Communications*: https://www.nature.com/articles/s41467-024-51879-5
- Volkov et al. 2025, *Geophysical Research Letters*
- NOC AtlantiS: https://atlantis.ac.uk/
- NOC RAPID-Evolution: https://noc.ac.uk/projects/rapid-evolution

SAMBA — South Atlantic MOC Basin-wide Array at 34.5°S

https://www.aoml.noaa.gov/phod/SAMOC_international/

SAMBA is an international collaboration of scientists from five countries (Argentina, Brazil, France, South Africa, and the United States) that began in 2009 to monitor the AMOC at 34.5°S. The ongoing effort has experienced logistical and financial difficulties leading to data gaps. The South Atlantic is the southernmost boundary of any basin-wide AMOC observing effort and is the region where model biases in salinity most materially affect AMOC projection uncertainty.

No consolidated international budget is published. Estimate USD $2–3M/year combined across all partners.

United States — NOAA-AOML "SAM" project, funded through NOAA GOMO. PI Renellys Perez. A Bipartisan Infrastructure Law capital line (BIL/IIJA) supported the installation of ABIISS data-pod shuttle systems at the two inshore SAM sites in 2022–2024 — a positive one-off capital injection but not a sustained operating commitment. The US NOAA AOML component was proposed for elimination under the FY2026 and FY2027 administration budget proposals.

Other partners — The Brazilian SAMBAR programme (FAPESP-funded, led from USP) experienced a primary-term expiry in 2022 with renewal status not publicly confirmed. South African participation operates through NRF and ship-time grants supporting the eastern tall-mooring array. Argentine participation through CONICET and SHN is exposed to the broader compression of Argentine science funding under the current administration. French participation contributes a CPIES array deployed off Cape Town in collaboration with South African partners. Per-country horizons and current funding allocations are not separately verified in this report.

Kersalé et al. (2024, *Frontiers in Marine Science*) present the sustained record while explicitly noting the operational fragility of the array.

Key sources:

- NOAA AOML SAMOC: https://www.aoml.noaa.gov/phod/SAMOC_international/samoc_background4.php
- FAPESP 2017/09659-6: https://bv.fapesp.br/en/auxilios/98525/
- Kersalé et al. 2024: https://www.frontiersin.org/articles/10.3389/fmars.2024.1375771
- Portmann et al. 2026, *Science Advances* (South Atlantic salinity and AMOC projection)

MOVE — Meridional Overturning Variability Experiment at 16°N

https://mooring.ucsd.edu/move/

MOVE measures a component of the AMOC at 16°N across the deep western boundary current, providing approximately a 25-year record of deep flow variability. The array consists of three mooring sites between Guadeloupe and the Mid-Atlantic Ridge. MOVE originated under German funding circa 1999, and operations have subsequently transitioned to Scripps Institution of Oceanography, currently funded primarily through NOAA GOMO as part of the OceanSITES programme. Annual operating budget is not publicly disclosed.

MOVE is effectively 100% US-funded in its current operating phase, which places the most-cited single-latitude AMOC deep-transport record on a single-PI, single-agency footing. The array's transport record has shown a significantly negative AMOC trend in recent years, which elevates the scientific cost of any interruption. No identified replacement funder exists should NOAA AOML cuts proceed under the FY2026 or FY2027 budget cycles.

Key sources:

- Scripps MOVE: https://mooring.ucsd.edu/move/
- Send et al. 2014, US CLIVAR AMOC review: https://usclivar.org/sites/default/files/amoc/2015/SendAMOC2014.pdf

TRACOS at 11°S

https://www.geomar.de/en/fb1/physical-oceanography/long-term-observations/tracos-11s

TRACOS measures a component of the AMOC at 11°S in the tropical Atlantic. The array has produced records since 2000 and was reconfigured for full AMOC-relevant measurement in 2013. TRACOS is maintained by GEOMAR Helmholtz Centre for Ocean Research Kiel through Helmholtz Programme-Oriented Funding (POF), supplemented by project grants. No single TRACOS budget line is published.

Funding for TRACOS depends on the Helmholtz POF-V to POF-VI transition (2027/2028).

Key sources:

- GEOMAR TRACOS: https://www.geomar.de/en/fb1/physical-oceanography/long-term-observations/tracos-11s
- Zenodo dataset 7774572 (TRACOS array description and data): https://zenodo.org/records/7774572

NOAC — North Atlantic Changes at 47°N

NOAC (North Atlantic Changes) measured overturning at mid-latitudes using moorings and pressure inverted echosounders (PIES) between 2013 and 2018. The array is effectively in maintenance or synthesis mode; no active full-mooring operations have been confirmed in public sources after 2018. The last published data year is 2018 (Wett, Rhein et al. 2023, *Geophysical Research Letters*).

Historical funding was provided by Germany through BMBF and partner contributions to the University of Bremen. No public funding announcements after 2018 have been located. Reactivation would require a new BMBF or Helmholtz commitment.

Key sources:

- Wett, Rhein et al. 2023, *GRL*: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2023GL103284
- Pangaea NOAC record 1993–2018: https://doi.pangaea.de/10.1594/PANGAEA.959558

Davis Strait array

The Davis Strait array monitors the exchange of water, heat, and freshwater between the Arctic Ocean (via Baffin Bay) and the North Atlantic (via the Labrador Sea), across the strait between Baffin Island and Greenland. It is one of the two principal western-side gateways through which Arctic-origin waters flow southward into the Atlantic, alongside Fram Strait on the eastern side. Davis Strait has operated continuously since 2004 — 22 years — making it one of the longest continuous Arctic gateway monitoring records in existence.

Davis Strait is operated by US, Canadian and Greenlandic institutions, with collaborators from Denmark, Switzerland, Belgium and the United Kingdom. It is geographically and scientifically integrated with the Nordic gateway system: Davis Strait and Fram Strait together bracket the Arctic–Atlantic exchange, and the loss of either would leave the other as a single-point observation for northern AMOC gateway monitoring.

The array consists of 13 moorings instrumented with conductivity-temperature-depth (CTD) sensors, acoustic Doppler current profilers (ADCPs), bottom pressure recorders and biogeochemical sensors, with 12 deployed across the strait at approximately 66–67°N and one bottom pressure recorder in central Baffin Bay. Autonomous underwater gliders have supplemented the moorings for year-round surveys, though these ceased operation in 2014 due to budgetary constraints. The observing program also included extensive chemical and biological sampling as part of the biennial expeditions that service the mooring array. No consolidated budget figure is published; indicative estimate approximately USD $0.8–1.5M/year, plus ship time costs of $1.5 - 2M every other year combined US and Canadian contributions, derived from comparable NSF Arctic Observing Network (AON) gateway mooring award sizes.

United States — Davis Strait is primarily funded by the US National Science Foundation Office of Polar Programs under the Arctic Observing Network programme. The most recent NSF Award (1902595, PI Craig Lee, Applied Physics Laboratory – University of Washington) covers the 2019–2024 period, with unfunded extensions continuing operations into 2026; a continuation proposal cycle is in 2024–2025 under FY2026–FY2028 funding uncertainty. NSF commitment has ranged between $3.5 - $4.5M over 4-5 years, plus ship time costs of $1.5 - 2M each year (dropping to every other year in 2013 and beyond. NSF covered ship costs in all years of the program except 2005, when Canada provided ship support.

Canada — The Canadian Department of Fisheries and Oceans (DFO), through the Bedford Institute of Oceanography (BIO), provides the core chemistry program, field support, supplementary mooring instrumentation and, in 2005, ship support. Canada does not fund moorings directly at the scale of the US contribution but is an essential operational partner through their leadership of the chemistry program. Ship-time on the Canadian side has been a structural challenge since the retirement of CCGS *Hudson* in 2022 — BIO's traditional North Atlantic platform. The 2026 Davis Strait expedition will be undertaken with CGC Amundsen, with support from Amundsen Science and the US National Science Foundation. No secured Canadian icebreaker or ship-time commitment exists beyond 2026 pending Canadian Coast Guard fleet renewal.

Combined with US NSF FY2026–FY2028 uncertainty and the 2027 expiry of the small UK National Capability Multicentre contribution, the array faces an acute funding cliff in the 2026–2028 window.

Key sources:

- NSF Award 1902595: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1902595
- APL-UW Davis Strait project: https://iop.apl.washington.edu/project.php?id=davis
- DFO BIO Davis Strait page: https://inter-l03.dfo-mpo.gc.ca/sites/bio/science/research-recherche/ocean/arctic-arctique/davis-en.php
- Lee et al. 2025, ASOF Barcelona presentation: https://asof.awi.de/fileadmin/user_upload/asof.awi.de/Barcelona_2025/Presentations_Thur/17_ASOF2025_Lee.pdf

Argo

https://argo.ucsd.edu/

Argo is an international programme collecting temperature and salinity profiles from inside the ocean using a fleet of almost 4,000 robotic profiling floats. Operating since 1999, Argo has revolutionised subsurface ocean observation and is fundamental for understanding ocean heat uptake and ocean carbon sequestration. Argo profiles and sea surface height are integral to the AMOC transport calculation at each moored array, and Argo provides the basin-wide temperature and salinity fields without which the moored arrays cannot contextualise their measurements.

The total annual cost of Argo is approximately USD $40M/year (Argo Steering Team Report 2024; Argo programme website). The United States funds approximately half of the global programme, with NOAA AOML reporting USD $18.5M for the US component in 2024. NOAA GOMO supports approximately half of the international programme; NSF funds additional Scripps, WHOI, and University of Washington operations. Europe contributes approximately 25% through Euro-Argo ERIC (see below). Japan (JAMSTEC and JMA), Australia (CSIRO/IMOS), Germany (BSH), Canada, China, India, Korea, and the UK contribute smaller national programmes. Due to annual fiscal compression to AtlantiS, Argo UK is at risk from 2027.

Argo's future is articulated through the **OneArgo** expansion, endorsed as a UN Ocean Decade project: a target of 4,700 floats by 2030 (2,500 Core + 1,200 Deep Argo + 1,000 BGC-Argo + 350 Polar Argo). The estimated investment required to sustain OneArgo is approximately USD $100M/year globally — roughly 2.5× current Argo spending (Wang et al. 2025, *Frontiers in Marine Science*). Euro-Argo ERIC issued an "OneArgo emergency" statement in 2025 flagging that sustained funding is not yet secured and warning that without urgent national commitments the pilot will not reach its 2030 target. The active global float count has dropped from approximately 3,900 at peak to approximately 3,600 by mid-2025 — an observable undershoot against the design target.

US administration FY2026 NOAA budget proposals called for deep cuts to climate-related lines; the Congressional minibus signed January 2026 largely held NOAA at current levels, but GOMO line items remain under internal review. The FY2027 proposal reiterated deep cuts and would eliminate the Office of Oceanic and Atmospheric Research (OAR), GOMO's institutional home. Argo is one of the programmes materially exposed to this trajectory (see Section 3.3.2).

For context on the relative scale of contributions: the US currently provides approximately 10 times more Argo floats than the Netherlands when normalised by GDP — a concrete illustration of the disproportionate US contribution to the global ocean observing ecosystem on which all participating countries, including all Nordic countries, depend.

Key sources:

- Argo programme, about: https://argo.ucsd.edu/about/
- Wang et al. 2025, *Frontiers in Marine Science* (OneArgo $100M/yr): https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2025.1593904/full
- Roemmich et al. 2019, *Frontiers* (Argo 2030 design): https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2019.00439/full
- NOAA AOML, Argo turns 25 (US $18.5M 2024): https://www.aoml.noaa.gov/argo-the-crown-jewel-of-ocean-observing-systems-turns-25/

Euro-Argo ERIC

Euro-Argo ERIC is the European Research Infrastructure Consortium that coordinates Europe's contribution to the global Argo programme. It was established in 2014 under EU Regulation 723/2009 and is hosted by Ifremer in Plouzané (Brest), France. Euro-Argo ERIC is the working European example of ocean observation under a binding, coordinated legal framework (see Section 3.1, mechanism 5 — classification as large-scale European research infrastructure).

Current membership (12 members as of June 2023): France (host), Germany (BSH), UK, Italy (OGS), Spain, Netherlands, **Norway** (since 2018), **Finland**, Greece, Ireland, Bulgaria, and Poland (joined June 2023 as the 12th member). Of the Nordic countries, only Norway and Finland are currently members. **Denmark, Sweden, and Iceland are not members.**

The Strategic Plan 2024–2033 articulates a European target of approximately 25% of the global OneArgo fleet (~1,175 floats sustained). Achieving this requires national contributions to increase substantially. Euro-Argo ERIC currently depends on time-limited Horizon Europe project funding (Euro-Argo ONE 2025–2027; AMRIT 2024–2027; GEORGE 2023–2027) rather than sustained operations — a structural vulnerability common to many European research-infrastructure programmes.

Key sources:

- ESFRI Roadmap 2024: https://ri-portfolio.esfri.eu/ri-portfolio/portfolio-editions/2024-first-edition/catalogue/euro-argo-eric/
- Euro-Argo ERIC Activity Report 2024: https://www.euro-argo.eu/News-Meetings/News/News-archives/2025/Discover-2024-Euro-Argo-ERIC-activity-report
- Euro-Argo ERIC Members: https://www.euro-argo.eu/About-us/Members/Members-list
- Euro-Argo ONE 2025–2027: https://www.euro-argo.eu/EU-Projects/Euro-Argo-ONE-2025-2027

GO-SHIP

http://www.go-ship.org/

GO-SHIP coordinates a network of globally sustained hydrographic sections as part of the global ocean and climate observing system. Ship-based hydrography is the only method for obtaining high-quality, high spatial-resolution measurements of physical, chemical, and biological parameters over the full water column — essential for deep-ocean AMOC analysis, given that the AMOC return flow occurs largely below the 2,000m depth limit of Core Argo. Global hydrographic surveys have been conducted approximately every decade since the 1970s through programmes such as GEOSECS, TTO/SAVE, WOCE/JGOFS, and CLIVAR.

No consolidated global GO-SHIP budget is published. The foundational strategy document (Hood et al. 2009, IOC Technical Series 89) estimated approximately USD $10M/year globally for currently implemented sections; this figure is acknowledged as both likely understated and now dated. Per-cruise costs are in an indicative range of USD $1.5–2M.

United States — Funded primarily through NSF and NOAA. The US share is approximately one-third to one-half of all GO-SHIP sections — the largest single contributor but not a majority. The current US NSF cycle ends in 2026; renewal is required for 2026–2031 under FY2026 budget pressure.

United Kingdom — UK GO-SHIP sections at 26°N, 57°N, and 24°S (three full-depth sections per 5-year cycle) are funded under the AtlantiS programme envelope (NOC-led) — the same envelope that funds RAPID, OSNAP, and Argo UK contributions. AtlantiS is subject to the year-on-year compression described in the RAPID-MOCHA-WBTS entry; UK GO-SHIP is at risk from 2027 on the same trajectory.

Germany — Cruises funded per expedition through national German funding mechanisms (BMBF, DFG, Helmholtz) and ship-time allocations.

Key sources:

- GO-SHIP strategy (Hood et al., IOC TS 89): http://www.go-ship.org/Docs/IOCTS89_GOSHIP.pdf
- NSF Award 2023500: https://www.nsf.gov/awardsearch/showAward?AWD_ID=2023500
- NOC AtlantiS: https://atlantis.ac.uk/
- 2019 US GO-SHIP Review (US CLIVAR / OCB): https://usclivar.org/sites/default/files/documents/2019/GO-SHIP-2019-Review-Report-OCB-US-CLIVAR.pdf

Satellite altimetry (Jason series, Sentinel-6, SWOT)

Satellite altimetry provides the sea surface height fields essential to the AMOC transport calculation at moored arrays and to basin-wide reconstruction of AMOC variability. The current operational architecture comprises the Jason series, the Sentinel-6 series, and the Surface Water and Ocean Topography (SWOT) mission. The Sentinel-6 pair is designed to deliver data through approximately 2030; no successor satellite is currently funded — a long-term cliff. The Trump administration's FY2026 NASA budget initially proposed approximately 50% cuts to NASA Earth Science; Congress's January 2026 minibus largely rejected these, but agency programmatic reviews continue.

Appendix B — Nordic Countries

B.1 Iceland

Observational footprint

MFRI, in collaboration with the University of Hamburg, operates two long-term moorings in the Denmark Strait, one of the two main AMOC overflow pathways. The moorings cover approximately 85% of the Denmark Strait overflow transport and have been operated for approximately 30 years, producing continuous time series since the mid-1990s. Two additional moorings north of Iceland, in the Hornbanki section, have been measuring Atlantic water inflow into the Nordic Seas since 1994, a 32-year record.

Additionally, MFRI coordinates a long-term programme measuring hydrographic and biogeochemical properties over the Icelandic shelf and the surrounding basins. Hydrographic surveys have been providing data from the ocean around Iceland since the 1950s, however, seasonal and spatial coverage has been significantly lower in earlier years. Extended and full year-round surveys (spring, summer, autumn, winter) have been running since 1970, one of the longest and more consistent records in the North Atlantic. Despite its contribution to marine science, the Icelandic monitoring program has not been designed to address oceanographic processes such as the AMOC stability and the transport of properties across the Greenland-Scotland Ridge, but to describe the ocean conditions around the country, which has been of significant importance for the fisheries.

Institutional base

MFRI is the national marine research institute of Iceland. Total institutional revenues were 4,824.1 million ISK in 2023 (approximately EUR 32 million). Funding comes almost entirely from the Icelandic Treasury appropriation under the Ministry of Food, Agriculture and Fisheries (Matvælaráðuneytið), supplemented by a small and growing external project revenue stream. MFRI reports to the Ministry of Food, Agriculture and Fisheries, with a secondary relationship to the Ministry of the Environment, Energy and Climate for climate-relevant work. The AMOC-relevant slice of the institute budget is not separately reported: Iceland Sea CTD lines (Selvogsbanki, Siglunes, Langanes), Denmark Strait overflow moorings, and Iceland–Faroe Ridge moorings sit within the "Marine Environment" division alongside ship-time on RV *Árni Friðriksson* and RV *Thorunn Thorthadottir*. An estimate based on comparable institutional structures suggests 400–600 million ISK per year (~8–12% of institute budget) for ocean-physics and hydrography activities.

IMO (Veðurstofa Íslands) is Iceland's national meteorological and hydrological agency, reporting to the Ministry of the Environment, Energy and Climate (Umhverfis-, orku- og loftslagsráðuneytið). IMO's contribution to AMOC-relevant work is primarily in the climate-services and adaptation-assessment domain: the institute carries the climate-impact assessment function on which Iceland's national risk and adaptation work is built.

Funding mechanisms

Moorings and survey programmes are funded through MFRI's institutional baseline appropriation. No competitive grant or EU project components sustain the core AMOC-relevant work: it is baseline-funded, which provides relative stability but limits discretionary capacity.

Supplementary external funding has emerged in 2024–2026. The Röst research fund granted 60 million ISK plus a 40 million ISK top-up in 2024 for Hvalfjörður biological work; a 560 million ISK allocation in January 2026 was split across three institutions including MFRI. These external sources do not primarily support AMOC observations but illustrate the growing relevance of climate-related external funding streams.

Recent developments and cliffs

Budget pressure has led to cancellation of some autumn hydrographic surveys in recent years, reducing the four-survey-per-year frequency to three. In addition, repeated inquiries from PIs to extend hydrographic sections to the south of Iceland in order to improve overflow monitoring have been turned down due to budget limitations.

No acute cliff is publicly flagged for 2025–2028, but ocean-physics activities have no institutional ring-fence — they are vulnerable to fisheries-advice reprioritisation within the institute budget. The fisheries-advice mandate is MFRI's statutory primary mission, which creates an ongoing tension with long-term climate-relevant monitoring during periods of fiscal pressure.

B.2 Faroes

Observational footprint

The Faroe Marine Research Institute (FAMRI, *Havstovan*) has monitored the circulation and hydrography around the Faroes since 1990 — a 36-year programme. The work comprises ship-based hydrographic surveys and multiple current meter moorings. Surveys are conducted on RV *Jákup Sverri* across fixed sections spanning the Faroe Current, the Faroe Bank Channel, the Faroe–Shetland Channel and, more recently, the Iceland–Faroe Ridge. The Faroe Bank Channel overflow is one of the two principal AMOC overflow pathways, paired with the Denmark Strait overflow monitored by Iceland. FAMRI maintains two moorings in the Faroe Bank Channel, covering the whole overflow transport through the channel. Suitable replacement of the old instrumentation has been a growing concern for FAMRI, but recently, funding was achieved for an update of one of the moorings, thereby securing fit-for-purpose instrumentation and continued observations for the flagged 2025–2028 window. The inflow across the Iceland-Faroe Ridge is focused in the Faroe

Current just north of the Faroes. Large observational efforts, mainly with moorings, have been made in this current since the mid-1990s. Combining these in-situ observations with satellite altimetry data, has enabled reliable Atlantic water transport time series based on only one mooring. Uncertainties regarding future satellite data, however, underscore the need to maintain, and preferably expand this in-situ mooring array. FAMRI also maintains hydrographic transects across the Faroe-Shetland Channel in collaboration with MD-SEDD. Originally, FAMRI also maintained moorings in the Faroese side of the channel, which were out-phased due to lack of funding. MD-SEDD has maintained moorings in the Scottish side of the channel. These were, unfortunately, discontinued in 2024 with the additional risk of cuts in hydrographic surveys in the near future. This would leave the Faroe-Shetland Channel array in a limbo, presently with no back-up plan.

The Faroese physical oceanography programme has produced some of the longest continuous records of the Iceland–Faroe–Scotland Ridge system, including the flagship Faroe Bank Channel overflow time series and the Atlantic inflow time series for the Faroe Current and the Faroe–Shetland Channel. Together with the Icelandic MFRI programme, FAMRI's monitoring covers the largest part of the dense water overflowing the Greenland–Scotland Ridge.

Institutional base

FAMRI operates under the Ministry of Foreign Affairs and Fisheries (Uttanríkis- og Fiskimálaráðið) of the Faroese Government. The Faroe Islands are an autonomous nation within the Kingdom of Denmark, with devolved authority over fisheries, marine research, and economic policy. FAMRI has 53 staff and operates RV *Jákup Sverri*.

The best available figure for total institutional operating budget, including operational costs of the research vessel, is approximately USD 7.7 million per year (~50–55 million DKK), reflecting 2024–2025 data. The AMOC-relevant slice is not separately reported in institutional accounts. Faroe Bank Channel overflow moorings and Faroe Current and Faroe-Shetland Channel inflow time series sit within the physical oceanography programme. An estimate for the combined physical oceanography activities, including ship-time on RV *Jákup Sverri*, mooring refurbishment and staff is 10–15 million DKK per year.

Funding mechanisms

FAMRI's funding is assembled from several sources:

- **Faroese Government block grant** via the Ministry of Fisheries provides the institutional baseline. It funds the hydrographic surveys (which are secure) and the core scientific staff.
- **EU projects** provide supplementary funding for moorings. FAMRI has been an AtlantOS partner, participated in Blue-Action (2016–2020), participates in follow-on Horizon Europe calls and is currently a partner in ObsSea4Clim

(https://obssea4clim.eu/) and EPOC (https://epoc-eu.org/). EU project funding is time-limited and competitive.

- **Danish funding** supplement the Faroese budget, including recurring support from the Danish National Centre for Climate Research (NCKF). Research projects have also been funded by the Danish Ministry of Climate, Energy and Utilities and "Jens Smed's Oceanografiske fond" for Faroe Bank Channel and Faroe Current branches of the observing system, and Iceland–Faroe Ridge overflow research projects.
- **Philanthropic and business association contributions** fund specific mooring and equipment elements; these are irregular and small.

The mixed funding pattern — hydrographic surveys secure via block grant, mooring operations via competitive and philanthropic sources — means that operations, consumables, and equipment renewal are never fully secured. This is among the most acute funding-insecurity cases among Nordic AMOC observational programmes.

Recent developments and cliffs

No specific cliff is publicly flagged for the 2025–2028 window, but with the recent increasing oil prices there is a risk for cuts in the schedule for the research vessel. The chronic structural vulnerability — operational funding reliant on competitive EU projects — was partly alleviated by the ObsSea4Clim project, which funded two years of Faroe Bank Channel overflow, while EPOC funded an observational experiment of Iceland-Faroe Ridge overflow, aiming at establishing a mature monitoring array in this oceanographically important and complex region. No equivalent follow-on EU consortium programme has been identified.

The small absolute scale of the Faroese block grant for FAMRI means that any single-year reduction in the Faroese block grant cascades disproportionately into discretionary observation lines. The Faroese government has signalled continued commitment to the monitoring programme, and both the Danish and Faroese governments will likely continue — and may extend — the monitoring effort.

B.3 Denmark (including Greenland)

Observational footprint

Denmark's direct AMOC observational contribution is primarily supportive rather than operational. The Danish Meteorological Institute (DMI, *Danmarks Meteorologiske Institut*) conducts modelling and reanalysis work on AMOC-relevant processes. The Geological Survey of Denmark and Greenland (GEUS, *Geologiske Undersøgelse for Danmark og Grønland*) conducts palaeoceanographic reconstructions using geological archives. The National Centre for Climate Research (NCKF, *Nationalt Center for Klimaforskning*) — jointly hosted by DMI and other institutions — coordinates Danish climate research including AMOC-related work.

Denmark's more consequential AMOC contribution is through its role within the Kingdom of Denmark: supporting the Faroese and Greenlandic institutional frameworks that operate the principal observational programmes in the region. The Danish Ministry of Climate, Energy and Utilities has provided recurring "climate support to the Arctic" funding that supports Iceland-Faroe and Faroe Bank Channel branches of the observing system. This is not publicly itemised but represents a meaningful contribution to the GSR monitoring infrastructure.

Greenland — The Greenland Institute of Natural Resources (GINR, *Pinngortitaleriffik*) operates marine ecological and fisheries research in Greenlandic waters, including in regions adjacent to the Denmark Strait. GINR is an institution of the Government of Greenland (*Naalakkersuisut*) under Greenlandic autonomous authority. Greenland's direct AMOC observational contribution is modest relative to Iceland's or the Faroes', but Greenland's geographic position along the eastern boundary of the Denmark Strait and the increasing relevance of Greenlandic meltwater to AMOC freshening make GINR an institutionally important actor. Coordination between GINR and MFRI on Denmark Strait-relevant observations is a clear opportunity.

Institutional base

- **DMI** is the Danish national meteorological and oceanographic agency, reporting to the Ministry of Climate, Energy and Utilities (*Klima-, Energi- og Forsyningsministeriet*). DMI's AMOC-related work is primarily in the modelling and reanalysis domain.
- **GEUS** is Denmark's geological survey, with marine palaeoceanographic capacity.
- **NCKF** the national climate research centre in Denmark hosted at DMI integrating expertise across institutions in Denmark, Greenland and the Faroe Islands. .
- **GINR** (Greenland) operates under the Government of Greenland with a coordination relationship to Danish institutions.

Institutional budget figures for the AMOC-relevant slices of these institutions are not separately reported.

Funding mechanisms

Danish AMOC-relevant work is funded through:

- **Institutional appropriations** to DMI, GEUS, and NCKF from their respective ministerial budgets.
- **Ministry of Climate, Energy and Utilities** recurring support for Faroese and Greenlandic branches of the observing system, including the MARiNAO programme (Marine Research in the North Atlantic Ocean), administered by the Research Council of the Faroe Islands, which funds collaborative Denmark–Faroes–Greenland projects on the Greenland–Iceland–Faroe–Scotland Ridge. The 2025 AXIS project (DKK 3.6 million, GEUS-led with Faroese and Norwegian partners) is a recent

example.
(https://eng.geus.dk/about/news/news-archive/2025/september/new-research-project-to-shed-light-on-north-atlantic-ocean-currents-and-their-impact-on-climate)

- **Danish national research foundations** including *Danmarks Frie Forskningsfond* (DFF) and *Danmarks Grundforskningsfond* (DNRF) for competitive grants.
- **EU and Nordic project funding** for specific programmes.

Public AMOC attention and the 2024 Open Letter to the Nordic Council of Ministers led GEUS to contact the Ministry of Climate, Energy and Utilities to point toward the need for longer-term observations from geological archives to improve AMOC understanding and risk assessment. A joint meeting between GEUS, NCKF, DMI, and the Ministry followed, discussing concerns about AMOC and its potential for tipping. This institutional mobilisation — across geological, atmospheric-oceanographic, and coordinating bodies — is a significant signal of Danish policy interest.

Recent developments and cliffs

No acute funding cliff has been identified for Danish AMOC-relevant work in the 2025–2028 window. The principal Danish development is the institutional mobilisation noted above — GEUS, DMI, and NCKF jointly engaging the Ministry of Climate, Energy and Utilities on AMOC — which creates a policy opening rather than a risk.

B.4 Norway

Observational footprint

Norway operates the largest Nordic national AMOC-relevant observational programme. It is coordinated across three primary institutions: the Institute of Marine Research (IMR, *Havforskningsinstituttet*), the Norwegian Polar Institute (NPI, *Norsk Polarinstitutt*), and the Norwegian Meteorological Institute (MET, *Meteorologisk Institutt*).

Svinøy section and Norwegian Sea monitoring (IMR). IMR operates the Svinøy section since the mid-1970s — 50 years. Four to five cruises per year at 17 fixed stations produce a continuous hydrographic record of Atlantic inflow to the Norwegian Sea. IMR also operates the Gimsøy section off Lofoten and the Bjørnøya section further north, alongside additional Norwegian Sea hydrography.

Barents Sea Opening monitoring (IMR). The Fugløya–Bjørnøya section (Barents Sea Opening, or BSO), covered four to six times per year, measures Atlantic water inflow to the Barents Sea, which is one of the principal northward pathways of the AMOC's Nordic extent.

Fram Strait Arctic Outflow Observatory (NPI). NPI operates 5 to 7 moorings in the western Fram Strait across the East Greenland Current, with records extending to the 1990s. NPI operates RV *Kronprins Haakon* (icebreaker capability) in support of the Fram

Strait programme. The Fram Strait Arctic Outflow Observatory measures the export of fresh Arctic waters and sea ice as well as returning Arctic Atlantic Water — critical for understanding the northern limit of the AMOC and variations therein. Independently of NPIs Arctic Outflow Observatory, the German institute AWI measures the Atlantic Water inflow in the West Spitsbergen Current in the eastern Fram Strait..

Norwegian Argo programme (IMR / NorArgo2). IMR operates approximately 30–37 active Argo floats primarily in the Nordic Seas, contributing the largest Argo footprint in the Nordic Seas. The programme covers hydrographic properties in the interior Nordic Seas that no other Argo contributor reaches.

Together, Norway operates the most geographically extensive Nordic AMOC-relevant programme, covering both the Atlantic inflow pathways (Svinøy, BSO) and the Arctic exchange (Fram Strait).

Institutional base

- **IMR** is Norway's national marine research institute, reporting to the Ministry of Trade, Industry and Fisheries (*Nærings- og fiskeridepartementet*). The total institute operating budget is estimated at approximately NOK 2.5–2.8 billion per year. IMR has roughly 1,000 staff and operates a fleet of research vessels including RV *G.O. Sars* and RV *Johan Hjort*.
- **NPI** is Norway's polar research institute, reporting to the Ministry of Climate and Environment (*Klima- og miljødepartementet*). NPI's total institutional budget is approximately NOK 250 million/year (aggregator figure, 2023–2024).
- **MET** is Norway's meteorological institute, contributing satellite data processing and modelling capacity.

The AMOC-relevant slice of the combined Norwegian institutional footprint is estimated NOK 30–50 million/year for the direct observational programmes (IMR Svinøy + BSO + Gimsøy + associated moorings ≈ 1.5–2% of IMR; plus NPI Fram Strait share ≈ NOK 25–40 million/year), plus NOK 10–15 million/year for the Norwegian Argo programme. Total AMOC-relevant direct-observation spending is on the order of NOK 70–100 million/year — making Norway likely the single largest Nordic national contributor to AMOC observation.

Funding mechanisms

Norwegian AMOC-relevant funding combines:

- **Institutional appropriations** from the respective ministries provide the baseline for IMR, NPI, and MET.
- **Research Council of Norway (RCN, *Forskningsrådet*)** provides infrastructure and project funding. Key programmes include NorArgo2 (project 269753, 2018–2027) under the INFRASTRUKTUR/FORINFRA programme; NorEMSO (project 295962) funded additional mooring capacity at Svinøy; the Nansen Legacy (2018–2024, NOK

740 million, 50/50 RCN + in-kind) funded Barents Sea process work alongside core monitoring.

- **EU project funding** supplements specific programmes (AtlantOS, Euro-Argo RISE, Horizon Europe consortia).
- **International partner contributions** include US NSF support for specific aspects of Fram Strait work and German contributions to the Fram Strait programme via AWI.

Norwegian funding for AMOC-relevant work is relatively stable compared with Dutch or German competitive-grant-dependent arrangements, reflecting the institutional model in which IMR and NPI receive baseline ministerial appropriations for monitoring work.

Recent developments and cliffs

The NorArgo2 2027 cliff. The Norwegian Argo programme (NorArgo2) ends in 2027. Continuity depends on a successful NorArgo3 proposal in the next INFRASTRUKTUR call. This is a material cliff for Nordic Seas 0–2000 m hydrography capability — Norway is the single largest Argo contributor in the Nordic Seas.

Arctic Ocean 2050 / Polhavet 2050. In August 2025, the Norwegian Prime Minister announced the Arctic Ocean 2050 programme — NOK 1 billion over 10 years (2026–2036), i.e. NOK 100 million/year. Officially launched at Arctic Frontiers in February 2026. The programme is a consortium of 18 Norwegian institutions (IMR, NPI, MET, UiB, UiT as host, NORCE, NERSC, UNIS, Akvaplan-niva, Bjerknes Centre, Fridtjof Nansen Institute, FFI, and others). Allocation structure: NOK 750 million via RCN call to the consortium over 10 years; NOK 120 million via a second RCN call (2026/2027) open to non-consortium applicants; approximately NOK 130 million residual for management, administration, and infrastructure/ship-time reimbursement.

B.5 Sweden

Observational footprint

Sweden's direct AMOC observational footprint is limited. Most Swedish ocean research is focused on Polar research as a new strategic research area (https://www.vr.se/english/applying-for-funding/decisions/2026-03-23-strategic-research-areas.html) through the Swedish Polar Research Secretariat (*Polarforskningssekretariatet*) and on Baltic Sea monitoring. Some AMOC-relevant research and data collection is possible through the new Swedish Research Vessel Infrastructure for Marine Research (SWERVE) programme, which operates Sweden's research vessel capacity (including the icebreaker *Oden*, and research vessels *Svea* and *Skagerak*).

The Swedish Meteorological and Hydrological Institute (SMHI, *Sveriges meteorologiska och hydrologiska institut*) contributes ocean reanalysis and climate modelling relevant to AMOC through its operational oceanographic programme, and participates in Copernicus Marine

Service. SMHI's oceanographic monitoring is focused on Baltic Sea and Skagerrak/Kattegat waters.

The Swedish National Space Agency (*Rymdstyrelsen*) has provided funding for satellite-based ocean observation work, including contributions to AMOC time series construction using altimetry data.

Institutional base

- **SMHI** is Sweden's meteorological and hydrological institute, reporting to the Ministry of Climate and Enterprise (*Klimat- och näringslivsdepartementet*).
- **Polar Research Secretariat** coordinates Swedish polar research capacity.
- **Swedish Research Council** is the primary national funder for environmental and climate research. (https://www.vr.se)
- **Formas** national funding agency for sustainable development (https://formas.se/en/)
- Universities with relevant capacity include the University of Gothenburg (*Göteborgs universitet*) and Stockholm University (*Stockholms universitet*), which host active physical oceanography research groups.

No AMOC-specific operational programme has been identified within Swedish institutions, though Swedish researchers participate in AMOC-related research through international consortia.

Funding mechanisms

Swedish ocean research is primarily funded through:

- **Institutional appropriations** to SMHI and the Polar Research Secretariat.
- **Swedish Research Council** competitive grants for environmental and climate research.
- **Formas** Swedish Research Council for Sustainable Development, funding research on environment, climate, and spatial planning with emphasis on societal relevance.
- **Polar research funding** via the Polar Research Secretariat for Arctic/Antarctic-focused work.
- **EU project funding** for participation in consortia.

Recent developments and cliffs

SWERVE GSR contribution. In 2025, the Swedish Research Vessel Infrastructure for Marine Research (SWERVE) provided ship-time and funding for hydrographic observations across the Faroe-Shetland Channel and the Iceland-Faroe Ridge — overflow components of the Greenland-Scotland Ridge system. The intention is to revisit these waters annually, but funding is applied for grant-by-grant with no guarantee of continuity, mirroring the structural vulnerability of consecutive short-term grant funding observed elsewhere in the Atlantic system. (https://swerve.se/)

Oden successor under government consideration. A successor to the icebreaker *Oden* is under active Swedish government consideration. A new polar-class research vessel would position Sweden as a direct contributor to sustained Arctic AMOC observation, enabling repeat hydrographic sections across Fram Strait and along the East Greenland shelf and slope, where accelerating ice-sheet discharge is injecting freshwater into the pathways of the AMOC's deep return flow. Monitoring the volume and fate of this meltwater is among the most pressing gaps in current AMOC observation, as Greenland freshwater has the potential to inhibit deep-water formation and alter the overturning on decadal timescales. (https://www.polar.se/en/research-support/icebreaker-oden/)

Swedish policy attention to AMOC. Swedish politicians are aware of the sensitivity of the AMOC system and its potential societal impact, though AMOC research has not been a priority focus area in Swedish national research prioritisation.

B.6 Finland

Observational footprint

Finland's direct AMOC observational contribution is limited. The Finnish Meteorological Institute (FMI, *Ilmatieteen laitos*) operates ocean observational capacity primarily focused on the Baltic Sea with no direct North Atlantic mooring or hydrographic programme. Finland does not currently operate a North Atlantic-capable research vessel, which structurally limits its capacity for direct AMOC observation. This is a real constraint on potential Finnish contributions to trans-basin AMOC mooring arrays.

However, Finland (FMI) contributes to Euro-Argo ERIC and has deployed floats to Nordic Seas and the Barents Sea in the 2010-2022 period, but currently the Finnish contribution is focused on the Baltic Sea only. FMI also operates shallow water gliders that are part of the EU Aquarius RI, and could, in principle, be operated in the North Atlantic.

Institutional base

- **FMI** the Finnish Meteorological Institute, focusing mainly on physical and chemical oceanography, and reporting to the Ministry of Transport and Communications (*Liikenne- ja viestintäministeriö*).
- **Syke**, the Finnish Environmental Agency, focusing mainly on biological and biogeochemical oceanography, and reporting to the Ministry of the Environment (*Ympäristöministeriö*).
- **Research Council of Finland** (*Suomen Akatemia*) is the primary national funder for research.
- **University institutions**, primarily the University of Helsinki (*Helsingin yliopisto*) host physical oceanography groups.

No AMOC-specific operational programme is currently funded in Finland.

Funding mechanisms

Finnish ocean research is primarily funded through:

- **EU project funding** including Horizon Europe participation.
- **Research Council of Finland,** national funding agency with competitive research grants.
- **Institutional appropriations** to FMI from the Ministry of Transport and Communications and to Syke from the Ministry of the Environment.
    - **Euro-Argo ERIC membership** — Finland is a member, with the membership fee covered by the governmental budget. Current float contributions are focused on the Baltic Sea and paid through FMI's institutional funding for its research infrastructure (no funding is earmarked for Argo floats).

Recent developments and cliffs

Parliamentary recognition of AMOC as a critical tipping point. The Finnish Parliament's *Strategic Task 37* framework, adopted in 2024, recognises AMOC collapse as among the most critical tipping points relevant to Finnish national security and economic planning. This parliamentary recognition creates a policy anchor for Finnish advocacy on AMOC observation.

Finnish Council Presidency of the Nordic Council of Ministers (2025) hosted the Nordic Tipping Week (Helsinki, October 2025), which produced the subsequent TemaNord 2026:504 report on Nordic AMOC tipping. This is the most substantive recent Finnish contribution to AMOC policy coordination.

Finnish government tender on AMOC impact assessment. In early 2026 the Finnish government launched a €300k tender for actionable information on the impacts of a potential AMOC collapse on Finland's climate and key economic sectors. The tender reflects governmental commitment to ensuring climate adaptation measures are fit-for-purpose in AMOC collapse futures, and motivates further contributions to AMOC observational capacity.

Finnish Argo capacity in the Nordic Seas. Finland operated Argo floats in the Nordic Seas and the Barents Sea through the 2010–2022 period via FMI's Euro-Argo ERIC participation, with the contribution subsequently refocused on the Baltic Sea. The institutional capacity at FMI and the Euro-Argo ERIC membership remain available for re-deployment to the North Atlantic, with marginal cost approximately €25–50k per float depending on specification (excluding biogeochemical capacity), plus 1–2 person-months per year (~€10–20k) for handling.

Appendix C — Abbreviations

Abbreviation	Full name
ADCP	Acoustic Doppler Current Profiler
AMOC	Atlantic Meridional Overturning Circulation
AOML	Atlantic Oceanographic and Meteorological Laboratory (NOAA)
Argo	Global array of profiling floats (named after the ship of Greek mythology)
AtlantiS	UK NERC National Capability programme for sustained Atlantic ocean observing
AWI	Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research
BMBF	German Federal Ministry of Education and Research
BSO	Barents Sea Opening
CMS	Copernicus Marine Service
CTD	Conductivity, Temperature, Depth (sensor)
DFG	German Research Foundation
DFO	Fisheries and Oceans Canada
DMI	Danish Meteorological Institute
EGC	East Greenland Current
EPOC	Explaining and Predicting the Ocean Conveyor (Horizon Europe project)
ERIC	European Research Infrastructure Consortium
EU	European Union
FAMRI	Faroe Marine Research Institute
FBC	Faroe Bank Channel
FMI	Finnish Meteorological Institute
FSC	Faroe–Shetland Channel
GCOS	Global Climate Observing System
GEOMAR	GEOMAR Helmholtz Centre for Ocean Research Kiel
GEUS	Geological Survey of Denmark and Greenland
GINR	Greenland Institute of Natural Resources
GOMO	Global Ocean Monitoring and Observing programme (NOAA)
GOOS	Global Ocean Observing System
GO-SHIP	Global Ocean Ship-based Hydrographic Investigations Program

Abbreviation	Full name
GSR	Greenland–Scotland Ridge
ICARP IV	Fourth International Conference on Arctic Research Planning
IFR	Iceland–Faroe Ridge
IMO	Icelandic Meteorological Office
IMR	Institute of Marine Research (Norway)
IOC	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
KaRIn	Ka-band Radar Interferometer (SWOT instrument)
MD-SEDD	Marine Directorate – Science, Evidence, Data and Digital (Scottish Government)
MET	Norwegian Meteorological Institute
MFRI	Marine and Freshwater Research Institute (Iceland)
MOCHA	Meridional Overturning Circulation and Heatflux Array
MOVE	Meridional Overturning Variability Experiment
NADW	North Atlantic Deep Water
NASA	National Aeronautics and Space Administration
NCKF	National Centre for Climate Research (Denmark)
NCM	Nordic Council of Ministers
NERC	Natural Environment Research Council (UK)
NIIC	North Icelandic Irminger Current
NIOZ	Royal Netherlands Institute for Sea Research
NOAA	National Oceanic and Atmospheric Administration (US)
NOAC	North Atlantic Changes
NOC	National Oceanography Centre (UK)
NorArgo	Norwegian Argo programme
NPI	Norwegian Polar Institute
NSF	National Science Foundation (US)
OAR	Office of Oceanic and Atmospheric Research (NOAA)
ObsSea4Clim	Horizon Europe project
OSNAP	Overturning in the Subpolar North Atlantic Program
PIES	Pressure Inverted Echo Sounder
POF	Programme-Oriented Funding (Helmholtz)
POGO	Partnership for Observation of the Global Ocean

Abbreviation	Full name
RAPID	Rapid Climate Change – Atlantic Meridional Overturning Circulation
RCN	Research Council of Norway
SAMBA	South Atlantic MOC Basin-wide Array
SMHI	Swedish Meteorological and Hydrological Institute
SOST	Subcommittee on Ocean Science and Technology (US)
SWERVE	Swedish Research Vessel Infrastructure for Marine Research
SWOT	Surface Water and Ocean Topography (mission)
Syke	Finnish Environment Institute
TRACOS	Tropical Atlantic Circulation and Overturning at 11°S
UNESCO	United Nations Educational, Scientific and Cultural Organization
WBTS	Western Boundary Time Series
WMO	World Meteorological Organization