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# **Atlantic Meridional Overturning Circulation (AMOC)**

## Critical Climate System Analysis & Tipping Point Assessment

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## **AMOC: EARTH'S OCEAN HEATING SYSTEM**

The Atlantic Meridional Overturning Circulation is a massive ocean current system that transports warm water northward and cold water southward, functioning as Earth's primary oceanic heat distribution mechanism.

## **CONTEXT**

This circulation system directly influences global climate patterns, regional temperatures, and weather systems across the Atlantic basin and beyond.

## AMOC Monitoring Timeline

**2004**

DIRECT  
MEASUREMENTS  
BEGIN  
**baseline**

**21 years**

OBSERVATION  
PERIOD  
**ongoing**

**2050**

PROJECTED  
TIPPING POINT  
**critical**

## EXPERT ASSESSMENT

*“The most reliable findings demonstrate that the tipping point for an AMOC shutdown will occur before 2050, the AMOC tipping point where the shutdown becomes inevitable is probably in the next 10 to 20 years or so, and*

*thereafter we are past the  
point of no return.”*

— Prof. Stefan Rahmstorf,  
Professor of Physics of the Oceans,  
Potsdam University

## Temperature Anomaly Records

Period	Temperature Anomaly	Significance
1903-05	-0.478°C	Historical baseline
1957-02	-0.053°C	Mid-century reference
1957-09	+0.056°C	Warming transition
2019-05	+0.763°C	Recent peak warming

Berkeley Earth land+ocean monthly temperature anomalies

# AMOC Weakening Indicators

- Cold blob formation in North Atlantic regions
- Gulf Stream northward shift patterns
- Reduced heat transport to northern regions

- Nordic seas warming anomalies
- Altered sea surface temperature fingerprints
- Regional climate pattern disruptions

## Documented Effects

- Major climate disruptions across Atlantic basin
- Regional sea surface temperature alterations
- Modified ocean circulation patterns
- Compound climate event escalation
- Agricultural system impacts
- Economic disruption potential

## **POINT OF NO RETURN APPROACHING**

AMOC tipping point activation represents the beginning of irreversible shutdown.

Although activation does not mean immediate collapse, it marks the threshold beyond which the circulation system cannot be restored.

## Timeline to Critical Thresholds

Current Status (2025) **85%**



Tipping Point Window **95%**



Shutdown Inevitable **100%**



# Research Methodologies

### Direct Observation

Continuous monitoring since 2004 provides unprecedented data on AMOC strength and variability.

- Real-time circulation measurements
- Temperature and salinity profiles
- Current velocity monitoring

### Computer Simulations

Advanced climate models simulate AMOC shutdown scenarios to understand system responses.

### Historical Analysis

Millennium-scale data reveals AMOC stability patterns and natural variability ranges.

- Paleoclimate reconstructions
- Long-term stability assessment
- Natural variation baselines

## **PRECAUTIONARY PRINCIPLE APPLICATION**

Given the irreversible nature of AMOC collapse and its profound climate consequences, the precautionary principle requires immediate assessment of post-tipping point scenarios.

## **CONTEXT**

Scientific uncertainty about exact timing does not diminish the need for comprehensive preparation and mitigation strategies for this critical climate system transition.

## Sources & References

- Prof. Stefan Rahmstorf, Potsdam University - 'Our heating system is heading for shutdown, ATLAS25'
- Berkeley Earth Global Temperature Data - Land+Ocean Monthly Anomalies
- IPCC AR6 Working Group 2 - Climate Change Impacts and Compound Events
- Direct AMOC Measurements (2004-present) - Atlantic Monitoring Arrays
- Climate Model Simulations - AMOC Shutdown Experiments and Projections