# AMOC: The Atlantic's Critical Climate Engine

## Understanding the Atlantic Meridional Overturning Circulation and Its Climate Implications

Climate Science Briefing • 2024

## WHAT IS AMOC?

The Atlantic Meridional Overturning Circulation (AMOC) is a massive ocean current system that transports warm water northward and cold water southward, regulating global climate patterns.

## CONTEXT

This oceanic conveyor belt moves approximately 15 million cubic meters of water per second—equivalent to 15 times the flow of all the world's rivers combined.

# How AMOC Works

- Warm surface waters flow northward from the tropics
- Waters cool and become denser in the North Atlantic
- Dense water sinks to deep ocean layers near Greenland

- Cold deep water flows southward along the ocean floor
- System driven by temperature and salinity differences
- Connects surface and deep ocean circulation globally

## The Atlantic Conveyor Belt

Simplified view of AMOC circulation showing warm surface currents (red) and cold deep currents (blue)

## AMOC Monitoring Timeline

**2004**

DIRECT MEASUREMENTS BEGAN

**baseline**

**1000+**

YEARS OF STABILITY

**historical**

**15%**

WEAKENING SINCE 1950S

**declining**

## Historical Temperature Anomalies

| Period | Temperature Anomaly | Context |
|---|---|---|
| 1866-05 | -0.350°C | Pre-industrial baseline |
| 1893-02 | -0.578°C | Coldest recorded month |
| 1893-05 | -0.404°C | Spring cooling period |
| 1903-05 | -0.478°C | Early 20th century |

Berkeley Earth land+ocean monthly temperature anomalies showing historical variability

# Regional Climate Effects

- Moderates European temperatures by 5-10°C
- Influences Atlantic hurricane formation patterns
- Affects monsoon systems in Africa and Asia

- Controls Arctic sea ice extent variations
- Regulates Sahel rainfall and drought cycles
- Impacts North American winter weather patterns

## AMOC Scenarios Through 2100

### Stable AMOC

Continued current strength

- Gradual warming continues
- Regional patterns maintained
- Predictable climate shifts

### Weakened AMOC

30-50% reduction in strength

- Accelerated Arctic warming
- European cooling
- Shifted precipitation patterns

### AMOC Collapse

Near-complete shutdown

- Dramatic regional cooling
- Severe weather disruption
- Irreversible tipping point

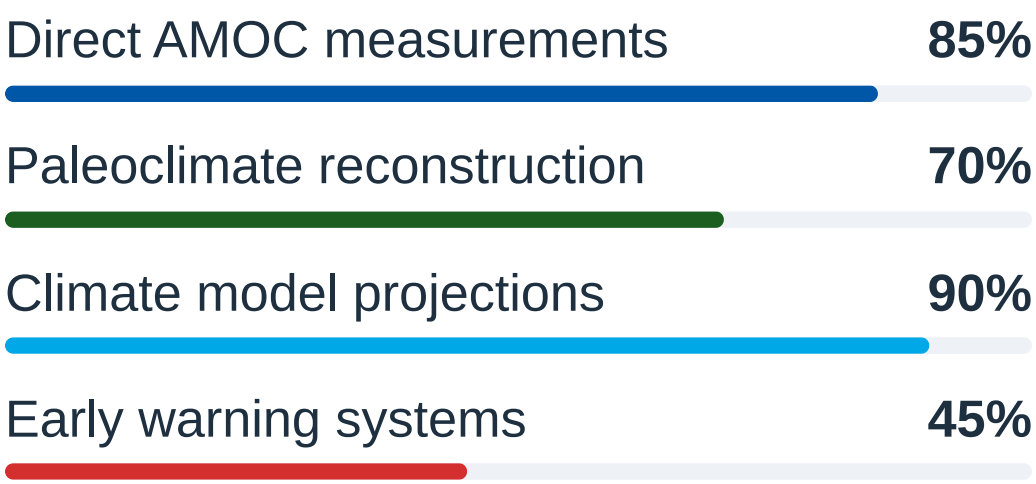
## AMOC TIPPING POINT RISK

AMOC weakening threatens major climate disruptions. Although activation does not mean immediate collapse, it marks the beginning of potentially irreversible changes to global climate systems.

## EXPERT ASSESSMENT

> *“Breach of +1.5°C reference mark correlates with severe compound event escalation. Spatial, temporal, and testimonial evidence compound to narrow the safe operating space.”*
>
> — IPCC AR6 Working Group II Assessment

## Monitoring Capabilities



## THE PRECAUTIONARY APPROACH

Given the potential for irreversible climate system changes, continuous monitoring and risk assessment of AMOC stability is essential for climate adaptation planning.

## CONTEXT

The precautionary principle requires measuring post-tipping point consequences to overall climate system development following any activation date.

## Sources

- Berkeley Earth Temperature Data Archive
- IPCC Sixth Assessment Report Working Group II
- Prof. Stefan Rahmstorf - AMOC Research
- RAPID-MOCHA AMOC Monitoring Array
- Climate Model Intercomparison Project (CMIP6)
- Atlantic Meridional Overturning Circulation Observations