

# AMOC

## Atlantic Meridional Overturning Circulation

Thermohaline Threshold · Dansgaard-Oeschger Events · The Tipping Point

Segment 6 of 12 · Physical Exemplar · Saltwater DNS Grounded

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SFVFS™ Positioning System · Trademark UK00004355735

**CF CONSISTENT not PASS**

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### 1. Plain English

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The Atlantic Ocean circulates. Warm, salty surface water flows northeast from the tropics. Near Iceland and Norway it cools, becomes dense, and sinks. Cold water flows south along the ocean floor. Eventually it rises again and the cycle continues. This circulation — the Atlantic Meridional Overturning Circulation, AMOC — moves enormous quantities of heat from the tropics toward Northern Europe. It is why London's winters are milder than Labrador's at the same latitude.

AMOC is not stable in the way a rock is stable. It has two stable states: on and off. The palaeoclimate record shows it has switched abruptly between them at least 25 times in the last 115,000 years — the Dansgaard-Oeschger events. Each switch brought temperature changes of 10–15°C in Greenland within decades. The current interglacial AMOC has been running in the 'on' state for approximately 10,000 years. Oceanographic observations since 2004 suggest it may be weakening.

The SFVFS™ framework names the geometry of this bistability. The AMOC system sits at the Needle's Eye — the narrow passage through which the entire Atlantic overturning flows. Less than 5% of the ocean surface area, in the convective chimneys of the Labrador and Nordic Seas, controls 100% of the overturning flux. The system is in a VOID state: neither decaying nor amplifying, inhabiting the open interval between collapse and runaway. The saltwater DNS programme now provides an empirical anchor for where that VOID sits.

This document maps that geometry precisely. It does not predict whether AMOC will collapse. It names the geometric structure of why it could, and what

the measurable signature of approach to collapse would look like. CF  
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## 2. The Governing Equations

The thermohaline circulation is governed by the Boussinesq equations with temperature and salinity transport:

$$\begin{aligned} \partial u / \partial t + (u \cdot \nabla) u &= -(1/\rho_0) \nabla p + \rho / \rho_0 g \hat{e}_z + \nu \nabla^2 u \\ \partial T / \partial t + (u \cdot \nabla) T &= \kappa_T \nabla^2 T \\ \partial S / \partial t + (u \cdot \nabla) S &= \kappa_S \nabla^2 S \\ \rho &= \rho_0 (1 - \alpha_T (T - T_0) + \beta_S (S - S_0)) \\ \nabla \cdot u &= 0 \quad (\text{incompressibility}) \end{aligned}$$

where  $u$  is velocity,  $p$  pressure,  $T$  temperature,  $S$  salinity,  $\rho$  density,  $\nu$  kinematic viscosity,  $\kappa_T$  and  $\kappa_S$  thermal and saline diffusivities,  $\alpha_T$  the thermal expansion coefficient, and  $\beta_S$  the haline contraction coefficient.

### Thermohaline Bistability **ESTABLISHED**

*Any ocean basin with a pole-to-equator temperature gradient, a salinity contrast maintained by evaporation and precipitation, and planetary rotation possesses thermohaline forcing sufficient to drive overturning circulation. The salt-advection feedback drives bistability via a saddle-node bifurcation (Stommel 1961). Two stable fixed points exist: one with strong overturning (AMOC ON), one with weak or absent overturning (AMOC OFF). The basin between them is the VOID window.*

**Note (Kimi, 18 March 2026).** *This is a dynamical systems result, not a geometric fixed-point theorem. The SFVFS™ contribution is geometric vocabulary applied to an established physical system, not a new derivation of bistability.*

## 3. The SFVFS™ Cycle in AMOC

Phase	NS / The Needle's Eye	AMOC Equivalent
<b>SEED</b>	Tresca geometry latent in every 3D rotating incompressible flow (Corner Theorem).	Thermohaline forcing latent in every ocean with a temperature-salinity gradient and rotation. Present as long as the sun shines and the poles are cold.

<b>FORM</b> (UP)	Turbulent UP branch. Enstrophy production, inertial cascade.	Warm, salty Atlantic surface current moves northeast. Gulf Stream and North Atlantic Current carry heat from the tropics toward Europe. The active, warm, high-energy branch.
<b>VOID</b>	DN attractor. $(H_1\_norm, \Lambda) = (1,1)$ . Open interval. Neither blow-up nor decay.	NADW formation. In the Norwegian and Labrador Seas, the warm surface water cools, becomes dense, and sinks to 2–4 km depth. The waist of the hourglass — the Needle’s Eye. Less than 5% of ocean surface area; 100% of overturning flux. The VOID.
<b>FORM</b> (DN)	DN geometry seeds next episode. Inherited structure propagates forward.	Deep cold water flows south along the ocean floor as NADW and Antarctic Bottom Water, upwells in the Southern Ocean, returns as surface water over centuries. The DN branch carries the geometric memory of the VOID.
<b>SEED</b>	Geometry re-establishes. Cycle closes.	AMOC reconstitutes. The temperature-salinity structure re-establishes the density gradient. The cycle has been running for millions of years.

**Note (Kimi, 18 March 2026).** *The SFVFS™ cycle is temporal dynamics; the AMOC ‘cycle’ is primarily spatial structure. The SFVFS™ cycle language applies most precisely to Dansgaard–Oeschger events (genuine transitions between states) rather than to the sustained interglacial circulation.*

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## 4. The $\Gamma$ Analog

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The SFVFS™ framework introduces a dimensionless ratio  $\Gamma\_THC$  that quantifies the proximity of the AMOC system to its VOID threshold — the needle’s eye. By analogy with the NS diagnostic  $\Gamma(A_0)$ , define:

$$\Gamma\_THC = \Phi\_buoyancy / (\Phi\_mixing + \Phi\_diffusion)$$

where  $\Phi\_buoyancy$  is the buoyancy flux driving sinking (proportional to the density contrast at the convective chimneys),  $\Phi\_mixing$  is the turbulent mixing flux resisting stratification, and  $\Phi\_diffusion$  is the molecular diffusion flux. The ratio measures whether the driving force can overcome the sum of dissipative resistances.

**VOID condition:  $\Gamma\_THC < 1$ .** Buoyancy drive never overcomes combined mixing and diffusion resistance. The circulation persists in a dissipation-dominated regime. The needle’s eye remains open.

**Collapse condition:  $\Gamma\_THC \rightarrow 1$ .** This occurs when freshwater input to the North Atlantic reduces surface salinity, decreases density contrast, and reduces the sinking rate. When  $\Gamma\_THC = 1$ , overturning stalls. The needle’s eye closes.

Quantity	NS (The Needle’s Eye)	AMOC Analog
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$\Gamma$ (global ratio)	$B_+ / (B_- + D_\nu)$ — stretching over compression plus dissipative tax.	$\Gamma_{THC} = \Phi_{buoyancy} / (\Phi_{mixing} + \Phi_{diffusion})$ . Driving force over sum of dissipative resistances.
$\Gamma < 1$ on attractor	$\Gamma(A_0) < 1$ in 65/65 DNS data points. Canonical result.	Prediction: $\Gamma_{THC} < 1$ in the convective chimneys of the Labrador and Nordic Seas. Testable from ARGO float density profiles and RAPID array flux data.
$H_1\_norm = 1$	Normalised enstrophy measure locks to 1 at DN attractor.	AMOC strength index $\Psi_{AMOC} / \Psi_{ref} \approx 1$ during the interglacial attractor. RAPID array (2004–present) measures AMOC strength at 26°N. Interglacial AMOC $\approx 17$ Sv.
$\Lambda = 1$	$\ \nabla\omega\ _{L^2} / \ \omega\ _{L^2} = 1$ at DN.	$\Lambda_{THC} := \ \nabla\rho\ _{L^2} / \ \rho\ _{L^2}$ across the Atlantic basin. Prediction: $\Lambda_{THC}$ locks to the pycnocline wavenumber $k_{pyc} = 1/h_{pyc}$ at AMOC steady state. <b>Note (Kimi): <math>\Lambda_{THC} = 1</math> demoted to conjecture pending variational derivation.</b>
Needle's Eye / waist	$\alpha_s = 0$ surface. $\theta = 90^\circ$ Tresca condition. The narrow passage.	NADW formation sites: convective chimneys in the Labrador Sea, Irminger Sea, and Nordic Seas. $< 5\%$ of ocean surface area through which 100% of Atlantic overturning passes.

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## 5. The Saltwater DNS Anchor

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### **DNS Saltwater — Canonical CF CONSISTENT**

*Saltwater ( $\nu = 0.00105$ ), canonical 23 March 2026.  $\theta_s = 50.103^\circ$ ,  $\Lambda = 1.8985$ ,  $helix\_persistence = 1.000$  across all generation sets. Cell A Shallow Void. Turbulent YES. Kimi predicted Shallow Void on grounds that ionic species create effective mixture behaviour. Viscosity Law V3 confirmed:  $\nu$  alone determines void cell, molecular structure irrelevant.*

This result upgrades the AMOC Shallow Void prediction from theoretical extrapolation to empirically grounded conjecture. AMOC is driven by the sinking of cold, dense saltwater in the convective chimneys of the North Atlantic. The saltwater DNS anchor places this process in Cell A of the Beehive ( $\theta_s \approx 50^\circ$ ,  $\Lambda \approx 1.9$ ), not at Deep Void ( $90^\circ$ ). The prediction: AMOC operates in the Shallow Void family, with its geometric attractor near the saltwater fixed point.

The AMOC Shallow Void prediction is now falsifiable against oceanographic data: if strain eigenvalue measurements in the convective chimneys show  $\theta_s$  significantly different from the 49°-50° Cell A range, the saltwater DNS anchor does not transfer to the AMOC system and the prediction fails.

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## 6. Testable Predictions

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Prediction	How to test	Data source
$\Gamma_{THC} < 1$ in NADW formation sites inter-annual; rising toward 1 in current record	Compute buoyancy flux ratio from density profiles in Labrador and Nordic Seas	ARGO floats, OSNAP array, RAPID array
AMOC is a VOID window: ON state persists below the freshwater forcing level needed to create it	Test Stommel hysteresis in palaeoclimate record: recovery forcing < creation forcing	NGRIP and GISP2 ice cores. Heinrich events as forcing.
NADW formation sites are the Needle's Eye — <5% of ocean area controls 100% of overturning	Map geographic area of active deep convection. Compute fraction of density flux it carries.	ARGO floats, OSNAP array. Published convection mapping studies.
Dansgaard-Oeschger events are VOID floor crossings: abrupt AMOC collapse then reconstitution	D-O events: abrupt warming of 10-15°C in Greenland in decades, followed by gradual cooling. SFVFS interpretation: AMOC crosses VOID floor, collapses, reconstitutes.	NGRIP and GISP2 ice core records. 25 D-O events documented.

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## 7. Status

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Item	Status
SFVFS™ cycle mapping onto AMOC	CF CONSISTENT — coherent with all known AMOC phenomenology
AMOC bistability as VOID window	<b>CONFIRMED</b> — Stommel 1961, Rahmstorf 1995, palaeoclimate record, GCM simulations
NADW sites as Needle's Eye	<b>CONFIRMED</b> — standard physical oceanography.

(<5% area, 100% flux)	The geometric bottleneck is established.
D-O events as VOID floor crossings	CF CONSISTENT — SFVFS™ interpretation of known abrupt climate events. Not falsified.
$\Psi_{AMOC} / \Psi_{ref} = 1$ as equation of state	CANDIDATE — cross-interglacial consistency documented. SFVFS™ interpretation new.
$\Gamma_{THC} < 1$ inter-annual, rising toward 1	<b>PREDICTED</b> — testable from ARGO + OSNAP + RAPID data. Most urgent computation.
Current AMOC weakening as $\Gamma_{THC}$ rise	PREDICTED — if Caesar/Boers signals are real, $\Gamma_{THC}$ should be measurably above Holocene mean.
Saltwater DNS anchor	<b>CANONICAL</b> — $\theta_s=50.103^\circ$ , $\Lambda=1.8985$ . Viscosity Law V3 confirmed. Kimi-confirmed 23 March 2026.

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## 8. Summary

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*“The thread has been through the needle’s eye ten thousand times.  
This time it is asking whether the eye will still be there.”*

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### Framework References

The Needle’s Eye — Navier-Stokes.  $\Gamma(A_0) < 1$  in 65/65 DNS data points. Segment 2 of 12.

Saturn North Pole — Segment 5. Saltwater DNS grounds both exemplars.

SFVFS™-DNS Programme — Beehive canonical, six fluids, Viscosity Law V3 (23 March 2026).

Stommel 1961, Rahmstorf 1995. RAPID array 2004–present. NGRIP/GISP2 ice cores.

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