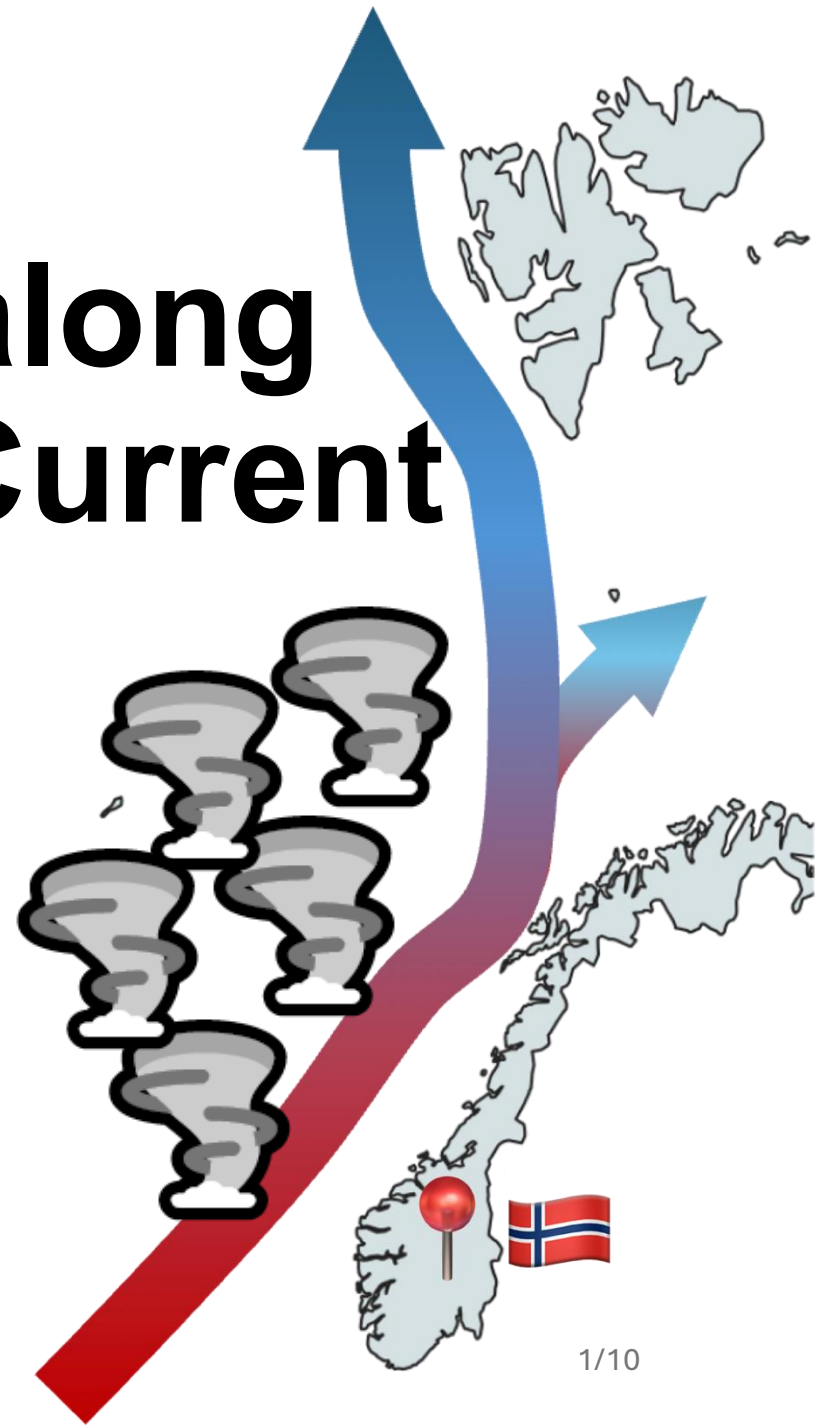


Oceanic heat transport along the Norwegian Atlantic Current and the role of eddies

Dong Jian, Xiaoming Zhai, David Stevens, Ian Renfrew

ENV colloquium, University of East Anglia

3rd July, 2025



Why oceanic heat transport?

Arctic Sea Ice

The Washington Post

Prices may vary in areas outside metropolitan Washington. Partly cloudy 57/46 • Tomorrow: Rain 64/46 CS Democracy Dies in Darkness SUNDAY, MARCH 23, 2025 • 6¢

Trump memo seen as threat to law firms

President looks to punish litigators who act against his aggressive policies

BY SHAYNA JACOBS

The White House is directing federal law enforcement officials to seek sanctions against attorneys or law firms that challenge President Donald Trump's actions in court, a move seen as an escalation of the president's attacks on those who oppose his aggressive policy changes or who have litigated against him in the past.

A White House memo issued late Friday night orders Attorney General Pam Bondi and Homeland Security Secretary Kristi L. Noem to pursue ethics challenges against lawyers who they accuse of bringing meritless cases or making arguments that are not backed up by fact, including in immigration courts.

The memo told Bondi to consider taking actions against law firm partners for perceived misconduct by junior attorneys and to review cases against the government from the past eight years to look for "misconduct that may warrant additional action."

The directive comes as the Trump administration faces more than 130 lawsuits over its efforts to dismantle agencies and diversity programs, freeze spending, fire federal workers and deport immigrants without due process.

Federal judges have issued about three dozen injunctions against the administration so far, while ruling in its favor in a little more than a dozen cases.

Friday's memo is part of a series of extraordinary executive actions in recent weeks that include punishing judges and lawyers who have taken positions against Trump. A continuing lawsuit over the deportation of alleged Venezuelan gang members based on the wartime Alien Enemies Act has been a particular sticking point, with the federal judge in the case calling the administration's actions "problematic and concerning."

Vanita Gupta, who served in top Justice Department posts in the Obama and Biden administrations, said the memo is a blatant threat to the justice system.

SEE TRUMP ON A8

As tensions rise on a melting map, Greenland's world stature grows

Danes rush to bolster the island's defenses as Trump threatens

BY WILLIAM BOOTH AND LARIS KARKLIS IN COPENHAGEN

"One way or the other," President Donald Trump has said, the United States needs to "get" Greenland. Not only to defend the homeland, but the "freedom of the world." Denmark, he says, isn't doing nearly enough to protect it. He has named two potential adversaries: China and Russia.

Its location, way out there, in a hostile ocean between North America, Western Europe and Russia, made Greenland strategically vital during the Cold War. After the Soviet Union collapsed, not so much.

But now, as tensions rise across a melting, militarizing Arctic, the world's largest island is back on the map.

Arctic sea ice typically reaches its greatest extent in March. It makes most of Greenland difficult to reach by ship.

By September, the ice contracts to its smallest extent, opening passages that can shorten shipping routes.

Greenland lies along what the old Cold Warriors dubbed the "GIUK Gap" the pinch point between Greenland, Iceland and Britain that protects the North Atlantic from Russian ships and submarines.

The island is also a waypoint for communication cables that cross the Atlantic — the kinds of cables that European defense officials say Russian "ghost ships" have been attacking by dropping and dragging their anchors across the seafloor.

Vice President JD Vance has praised Greenland's "incredible natural resources." Like Ukraine, the island possesses the critical and rare metals needed for the modern world

SEE GREENLAND ON A23

IRS on verge of migrant data deal

Agency would be lever in deportation campaign

BY JACOB BOGAGE AND JEFF STEIN

The Internal Revenue Service is nearing an agreement to allow immigration officials to use tax data to confirm the names and addresses of people suspected of being in the country illegally, according to four people familiar with the matter, culminating weeks of negotiations over using the tax system to support President Donald Trump's mass deportation campaign.

Under the agreement, Immigration and Customs Enforcement could submit names and addresses of suspected undocumented immigrants to the IRS to cross-reference with confidential taxpayer databases, said the people, who spoke on the condition of anonymity out of fear of professional reprisals.

Normally, personal tax information — even an individual's name and address — is considered confidential and closely guarded within the IRS. Unlawfully disclosing tax data carries civil and criminal penalties.

However, tax information may be shared with other federal law enforcement under certain, limited conditions — and typically with approval from a court. It would be unusual, if not unprecedented, for taxpayer privacy law exceptions to be used to justify cooperation with immigration enforcement, the people said.

The proposed agreement has alarmed career officials at the IRS, the people said, who worry that the arrangement risks abusing a narrow and seldom-used section of privacy law that's meant to help investigators build criminal cases, not enforce criminal penalties.

According to portions of a draft of the agreement obtained by The Washington Post, ICE access to tax data would be limited

SEE IRS ON A10

IRS turmoil: Tax revenue could fall by 10 percent, officials say

SEE IRS ON A11

Sea-ice area on September 24, 2024
Median sea-ice extent for September (1981-2010)
NATO member nation
Military base
U.S. Europe
Canada Russia

Source: Minimum sea ice concentration data via the Institute of Environmental Physics at the University of Bremen. Arctic military bases via The Simons Foundation Canada. Subsea cable data via TeleGeography.

Why oceanic heat transport?

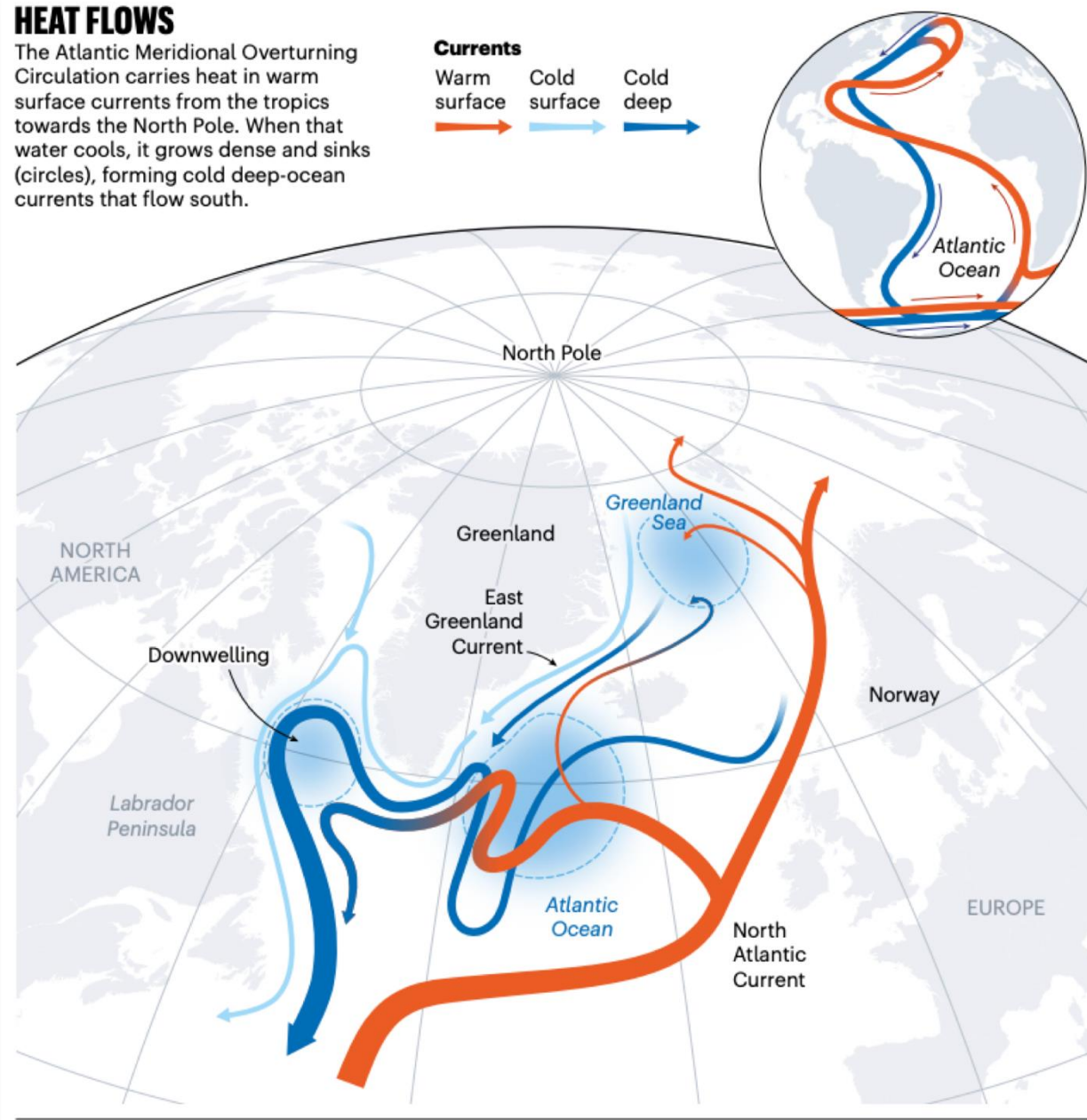
AMOC

HEAT FLOWS

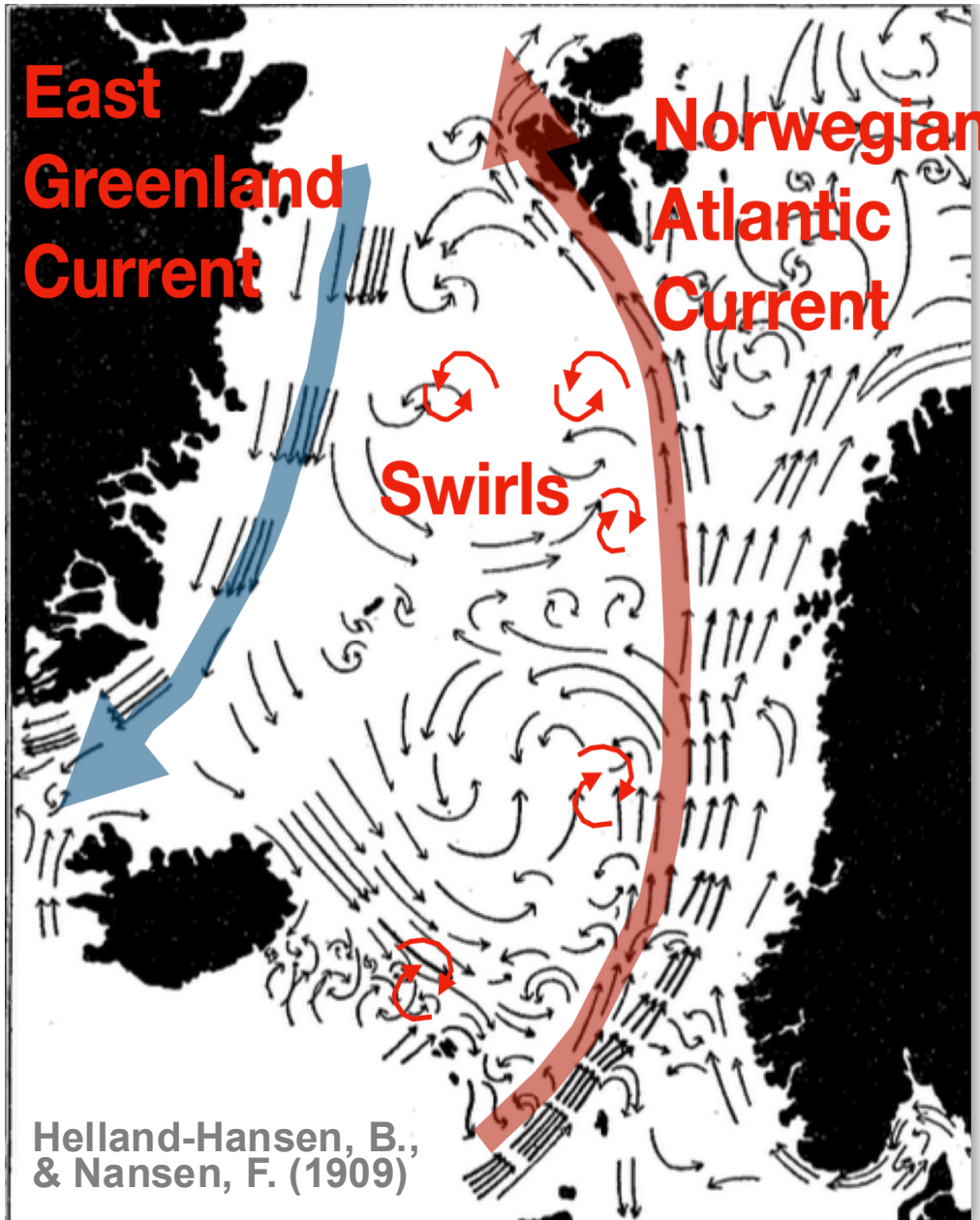
The Atlantic Meridional Overturning Circulation carries heat in warm surface currents from the tropics towards the North Pole. When that water cools, it grows dense and sinks (circles), forming cold deep-ocean currents that flow south.

Currents

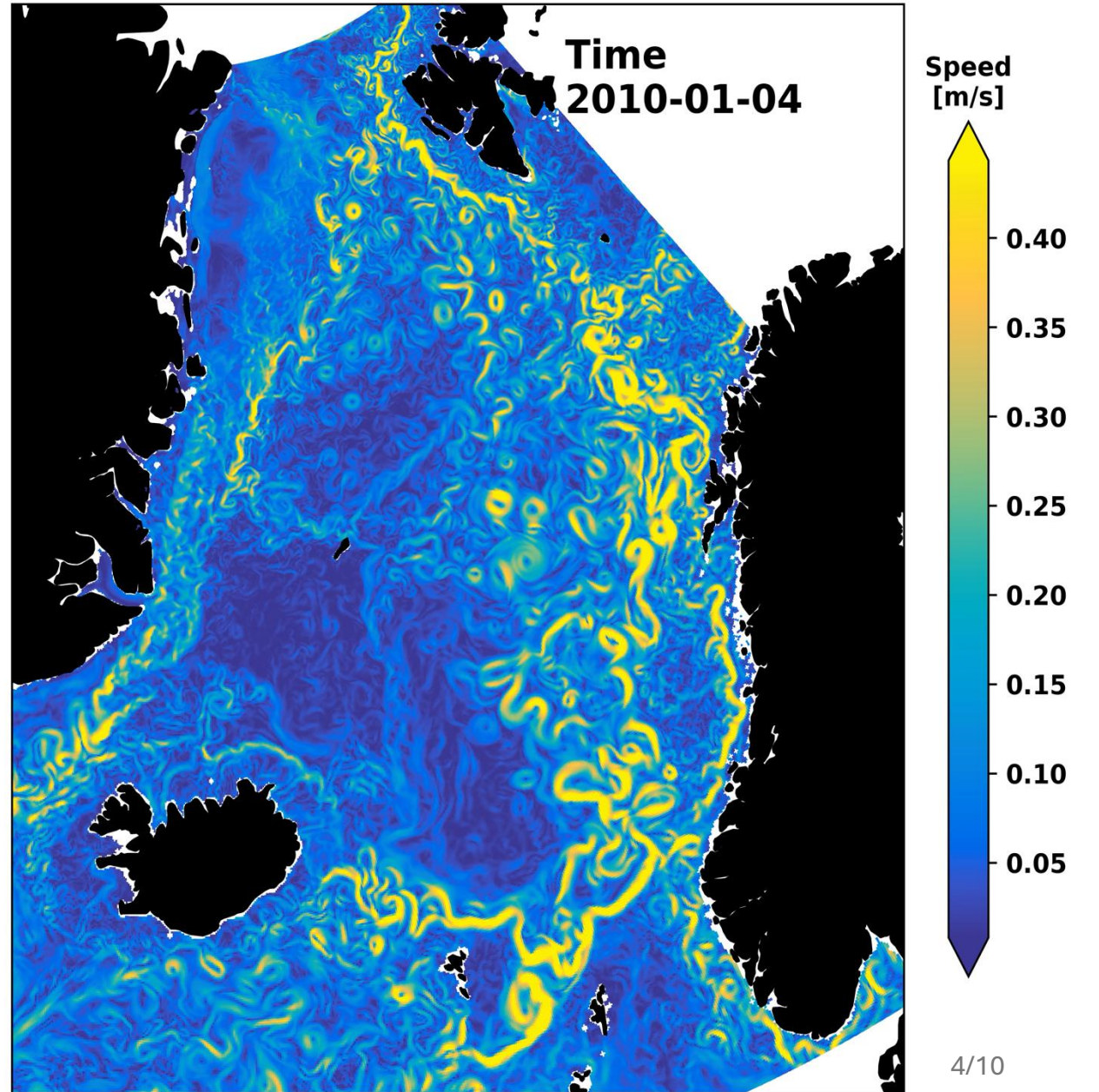
Warm surface → Cold surface → Cold deep



Map in 1909

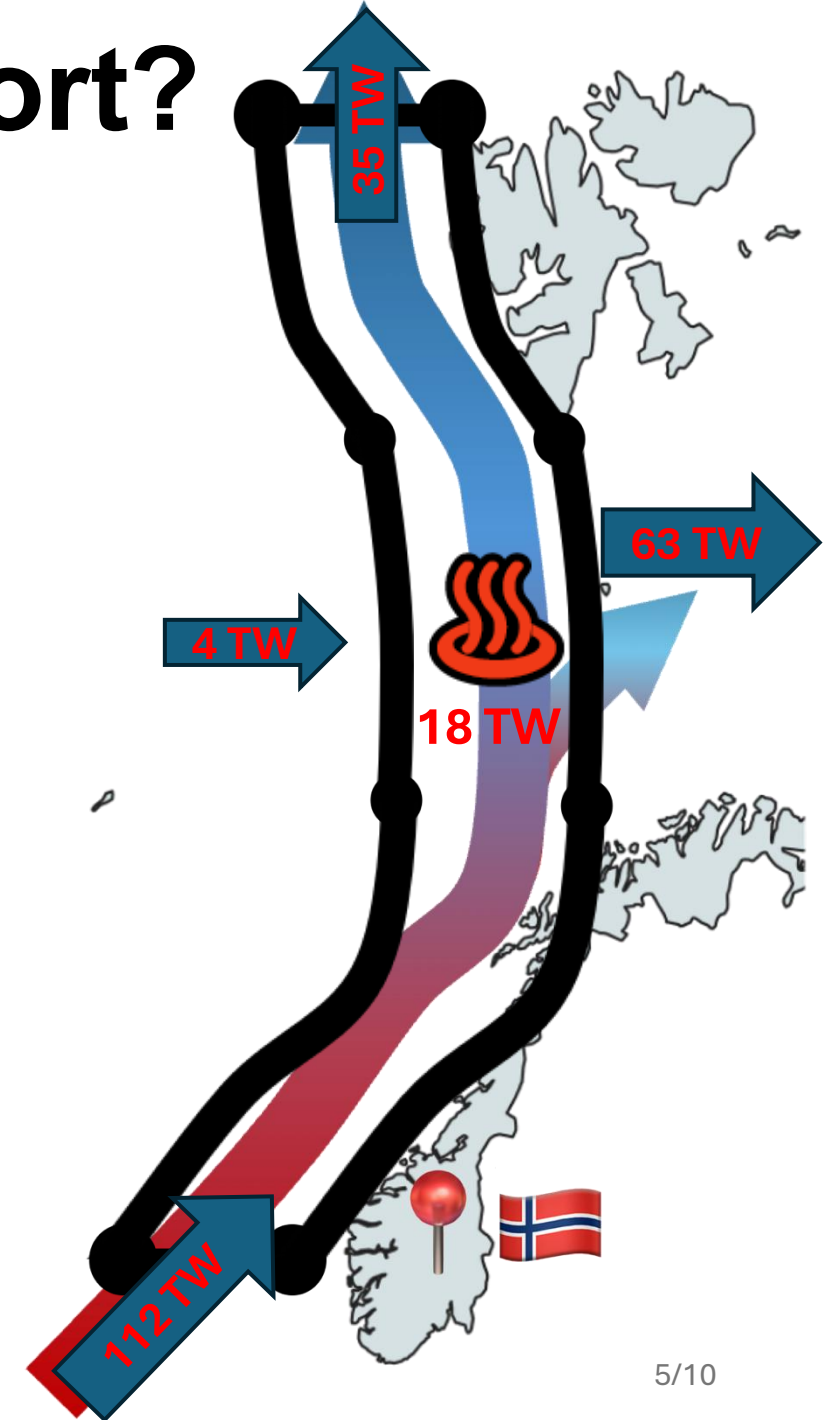
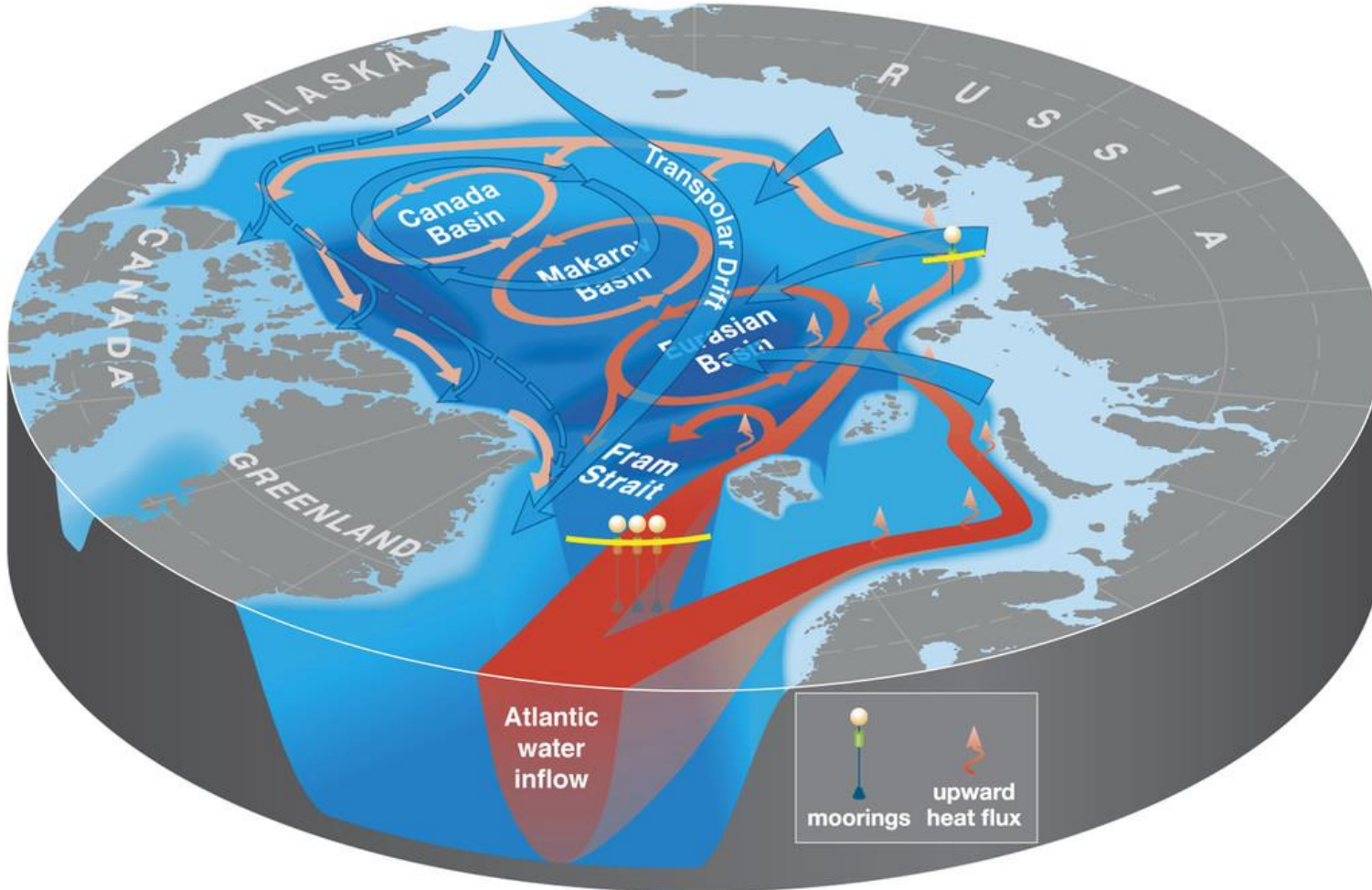


Model



What is oceanic heat transport?

$$Q = \rho C \int V \cdot T dA \quad \text{Velocity x Temperature}$$



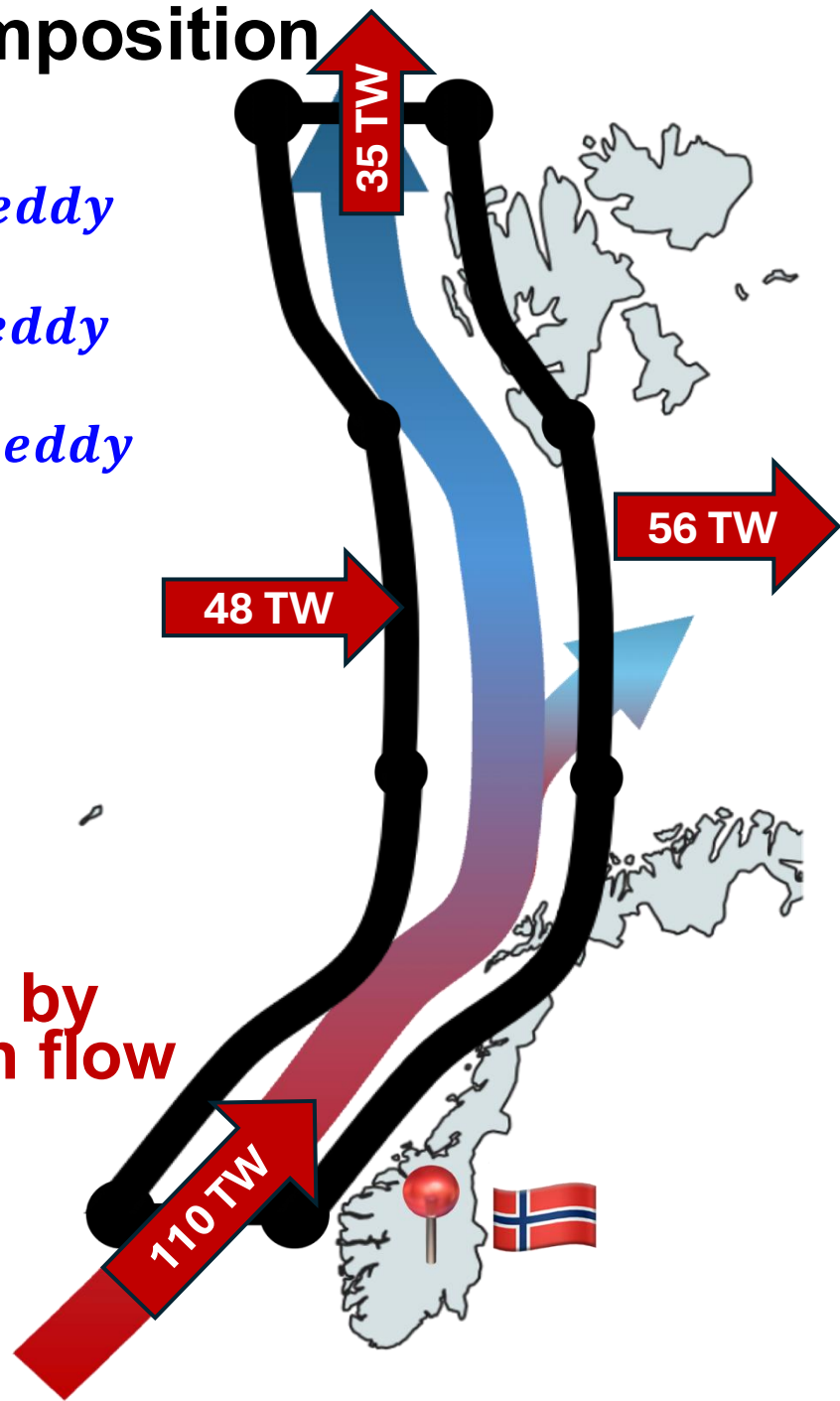
Reynolds Decomposition

$$V = \bar{V}_{Steady} + V'_{eddy}$$

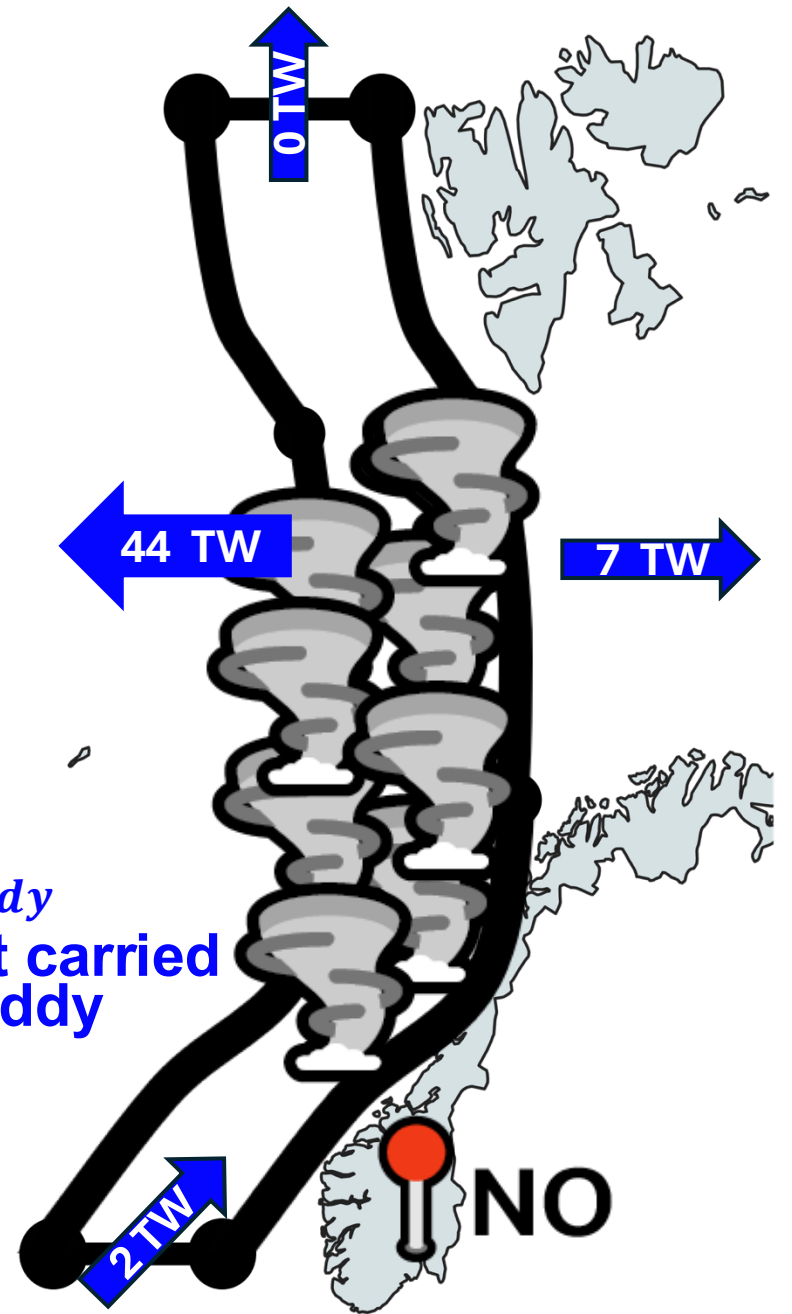
$$T = \bar{T}_{Steady} + T'_{eddy}$$

$$Q = \bar{Q}_{Steady} + Q'_{eddy}$$

\bar{Q}_{Steady}
Heat carried by
steady mean flow

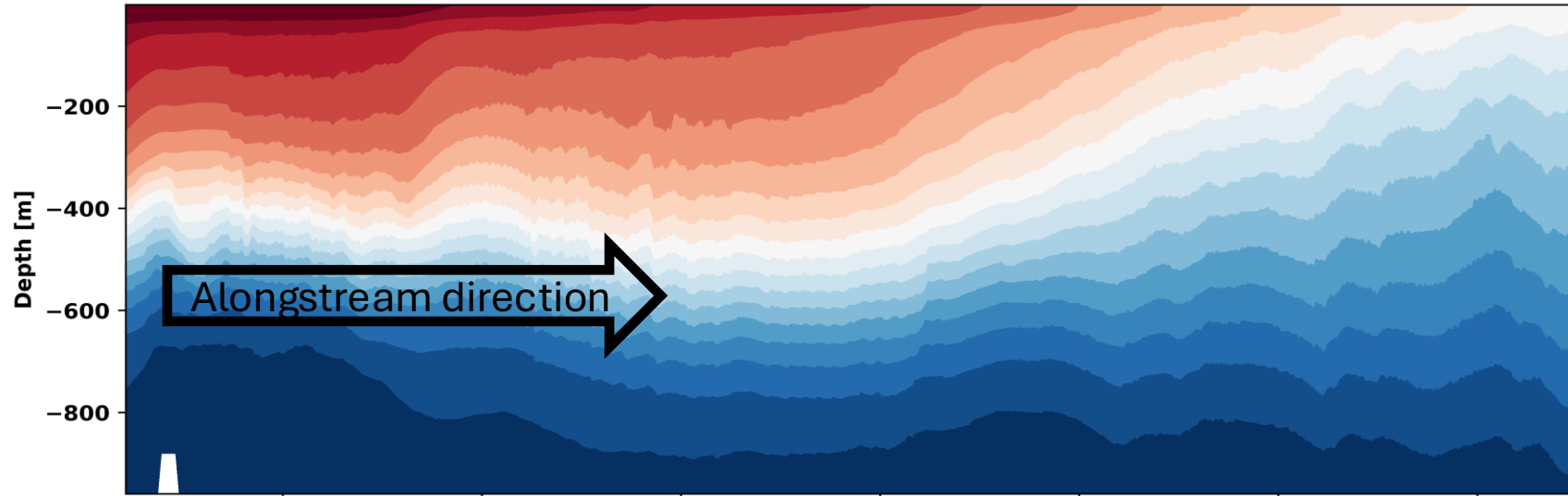


Q'_{eddy}
Heat carried
by eddy

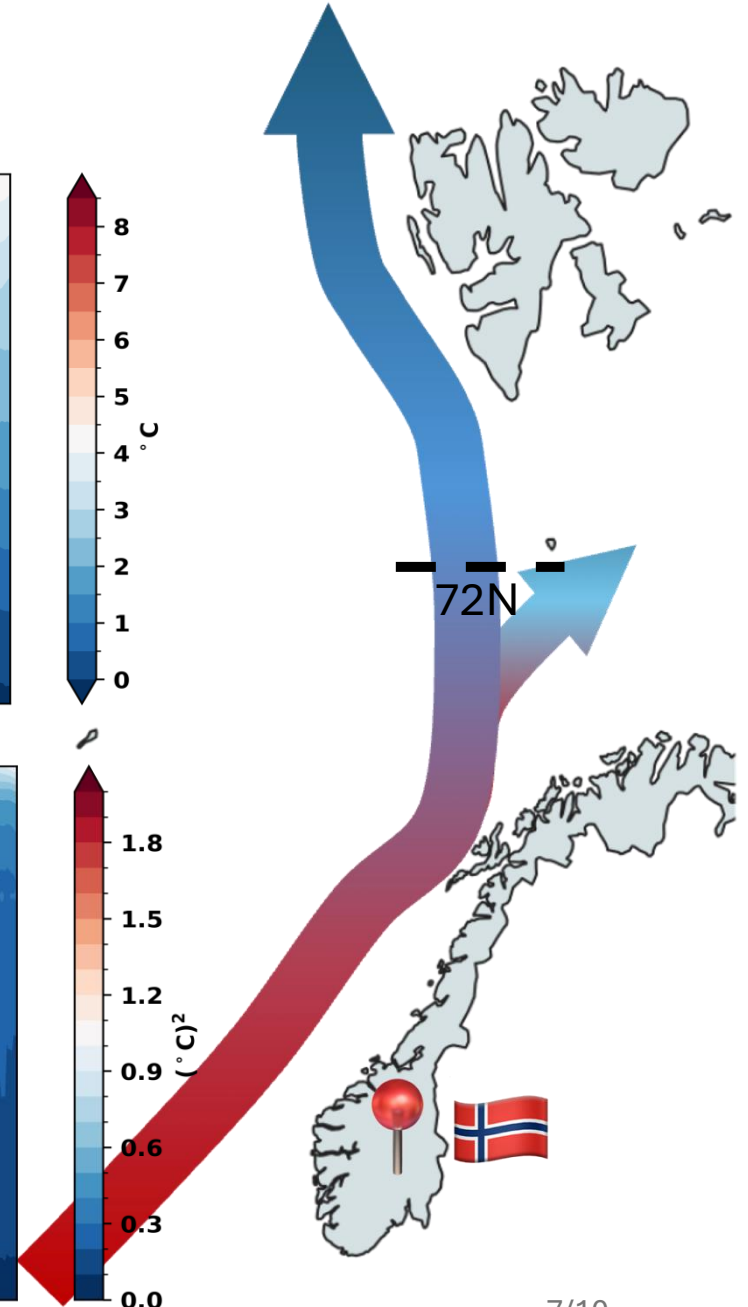
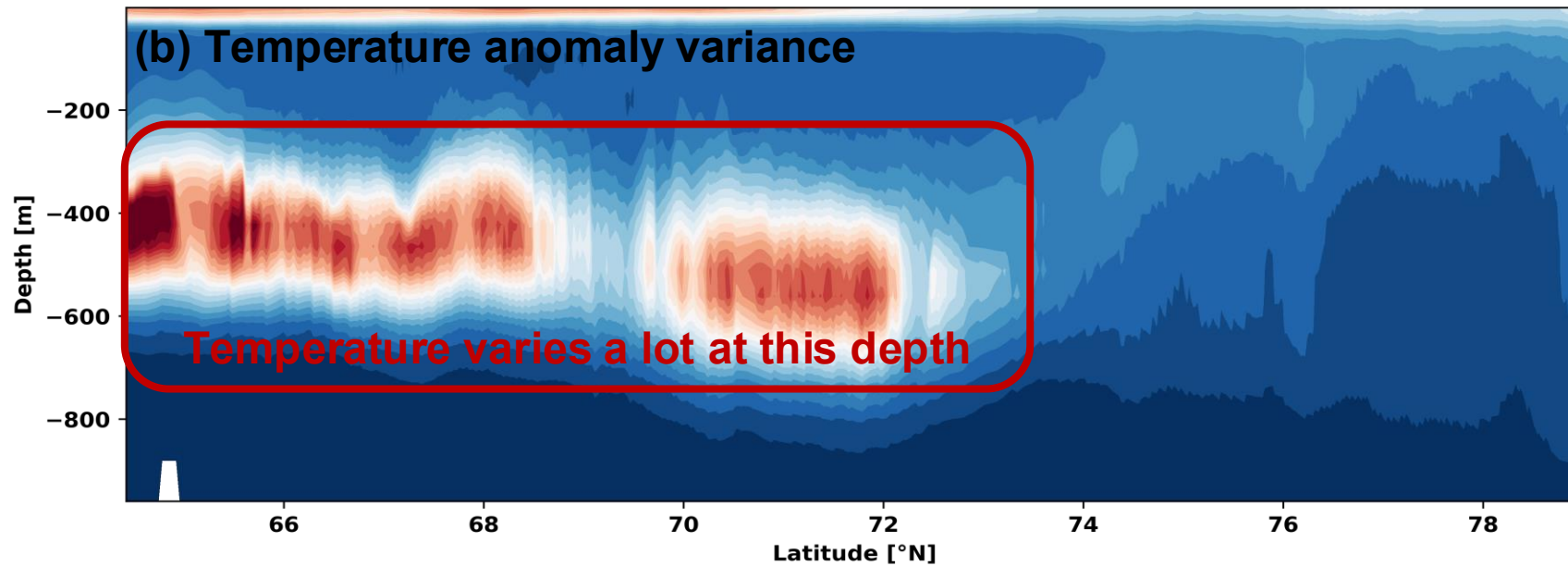


Where are eddies

(a) Time-mean Temperature profiles

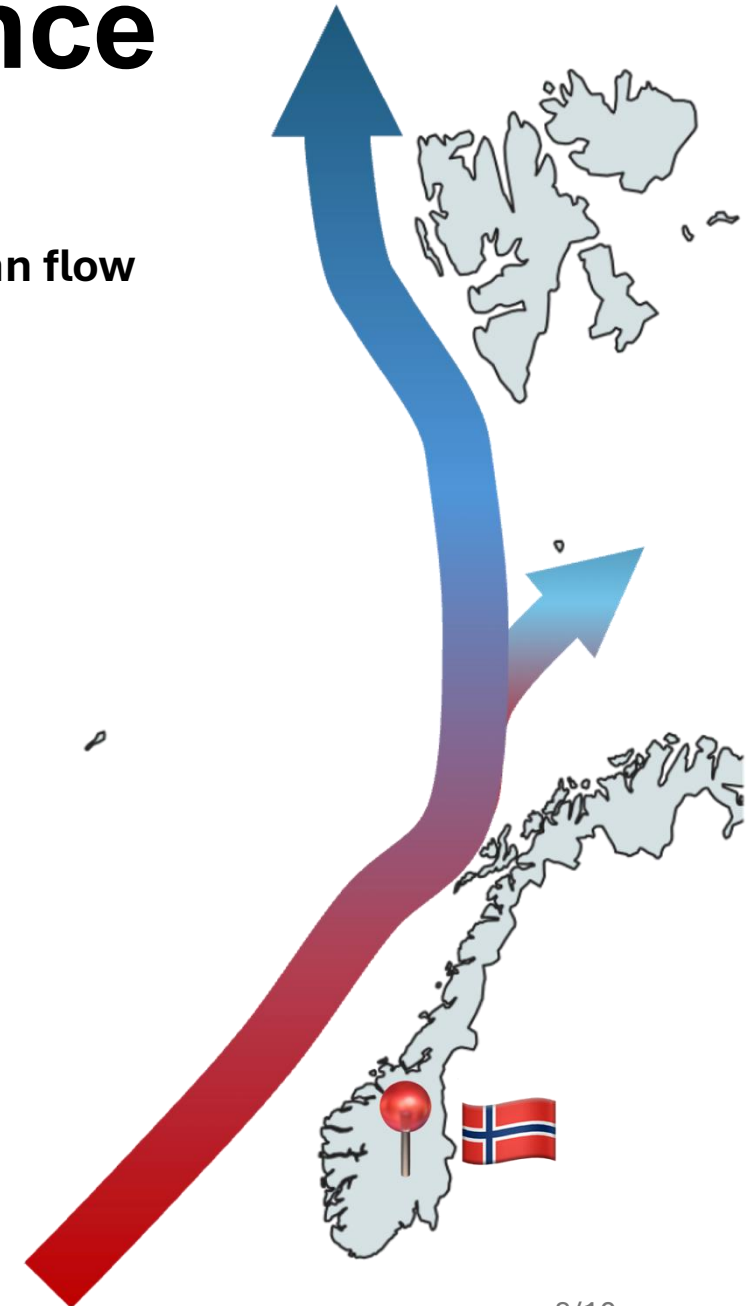
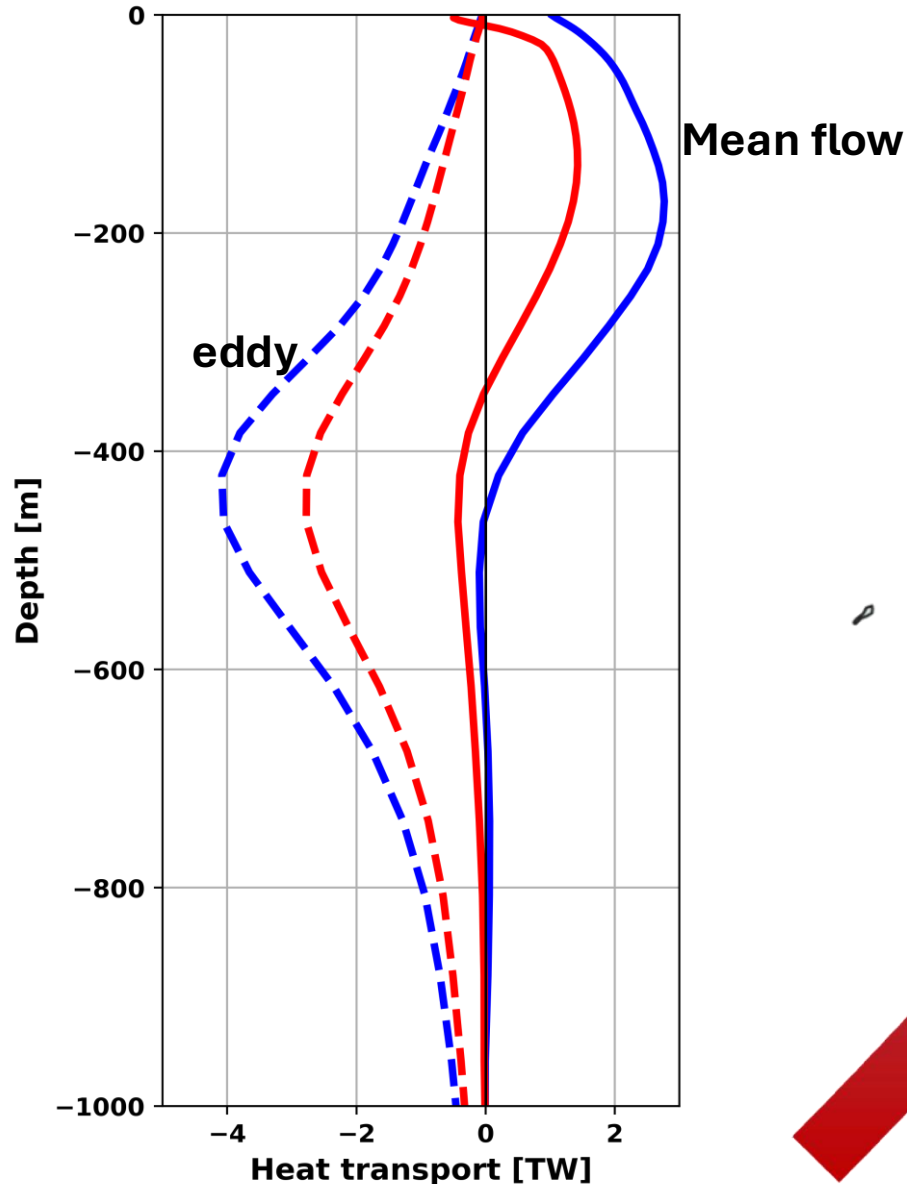


(b) Temperature anomaly variance

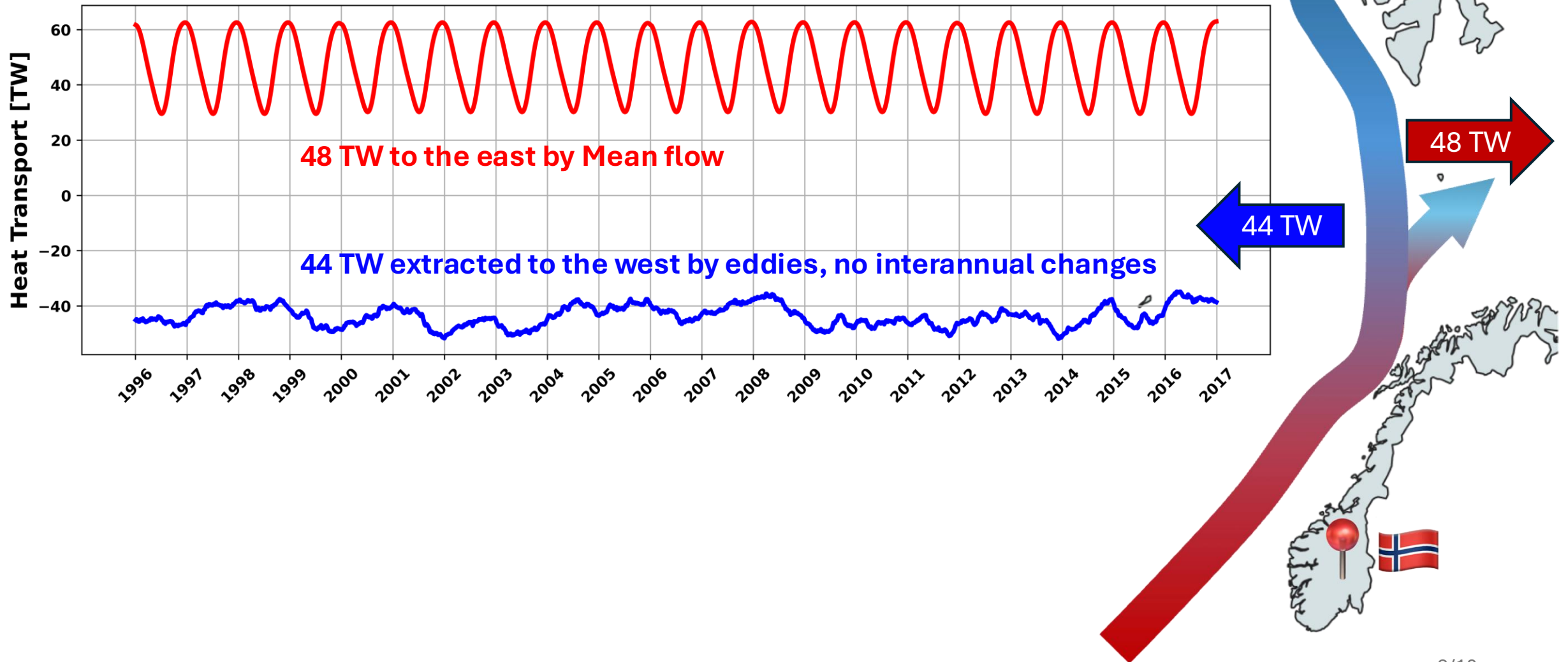


Depth and Seasonal dependence

- Heat transport in **winter (DJF, blue)** is greater than **summer (JJA, red)**
- Maximum by eddy (dashed lines) centered at ~ 450m
- Maximum by mean (solid lines) centered at ~200m



Interannual variability?



Takeaways

1. Eddies extract A LOT of heat (warm water) away from the current
2. Eddies extract more heat at depth and during winter
3. Eddies extract heat constantly year to year

