SPITFIRE Southampton Partnership for Innovative Training of Future Investigators Researching the Environment

UNIVERSITY OF Southampton

Simplifying the Dynamics of the Atlantic Meridional Overturning Circulation at 26°N

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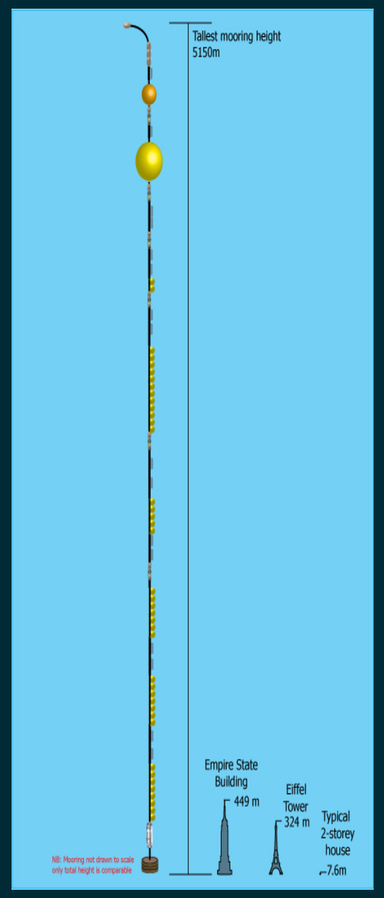
Outline

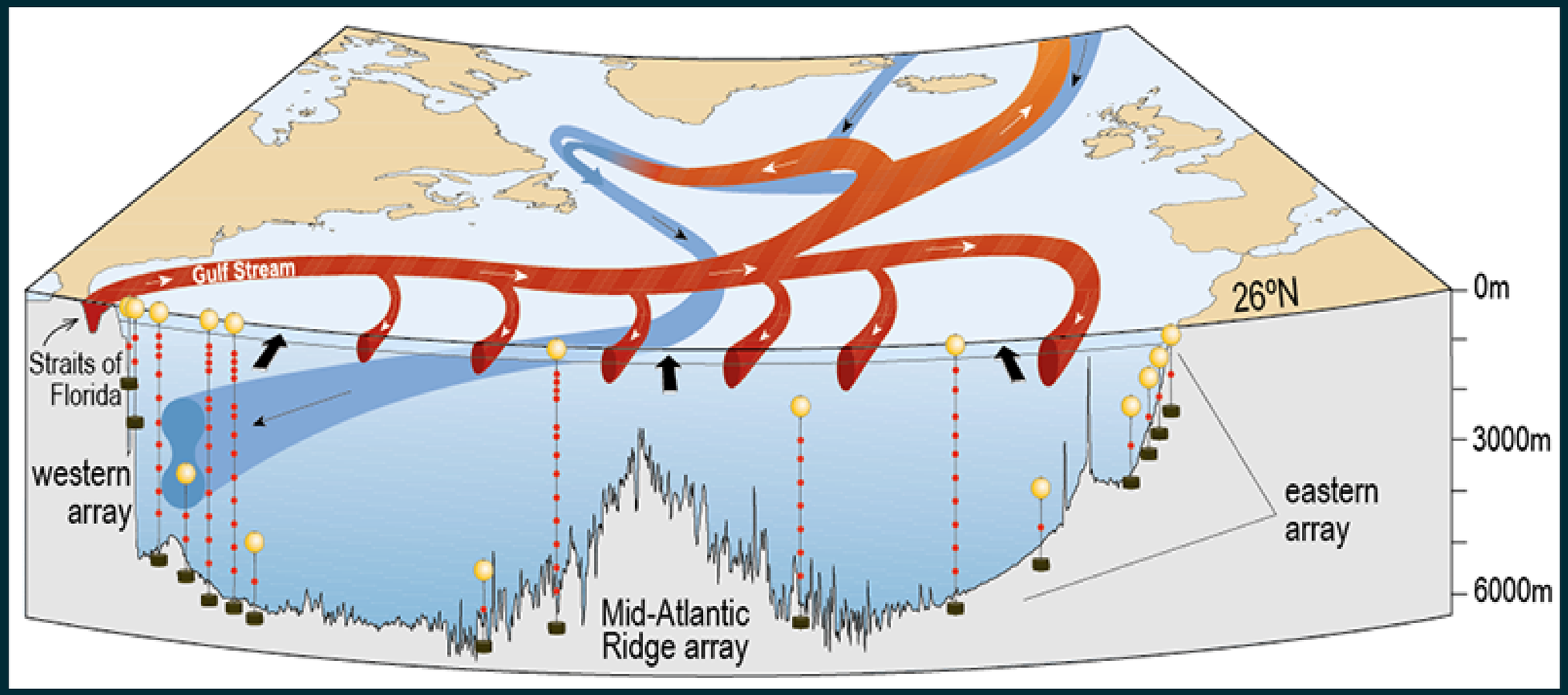
- What is the Atlantic Meridional Overturning Circulation?
- Why do we want to simplify its dynamics?
- How: linear regression models

What is the Atlantic Meridional Overturning Circulation?

(AMOC)

RAPID mooring array at 26°N

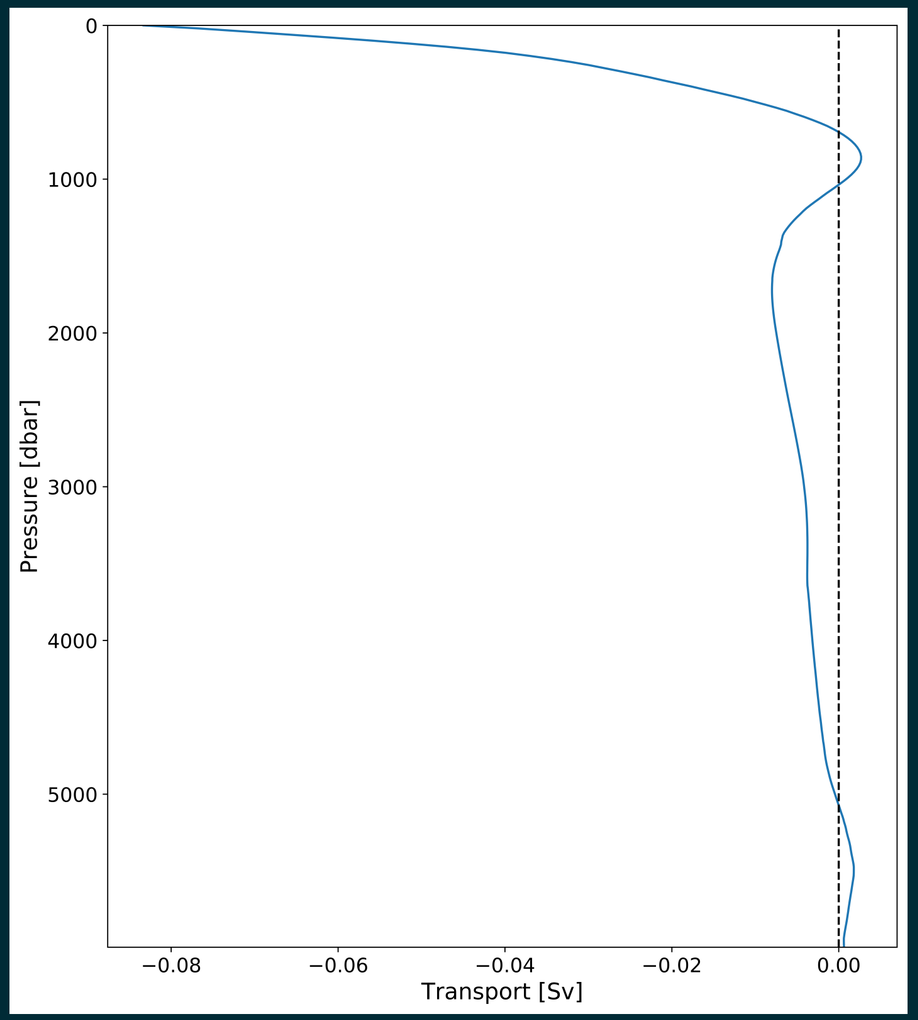




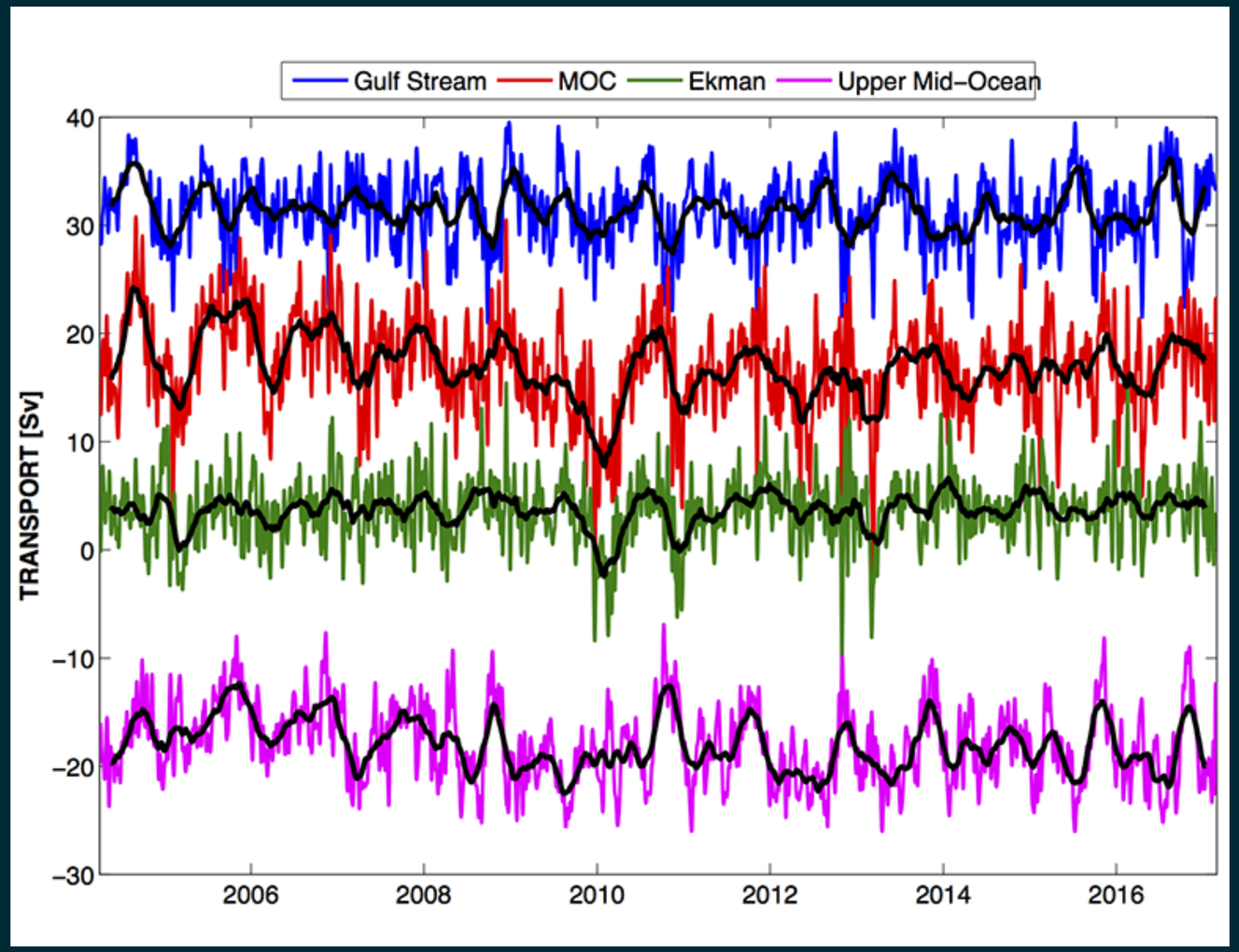
(from www.rapid.ac.uk)

Instruments on the moorings measure temperature, salinity, pressure and current velocity

Mid-ocean transport profile



RAPID AMOC timeseries



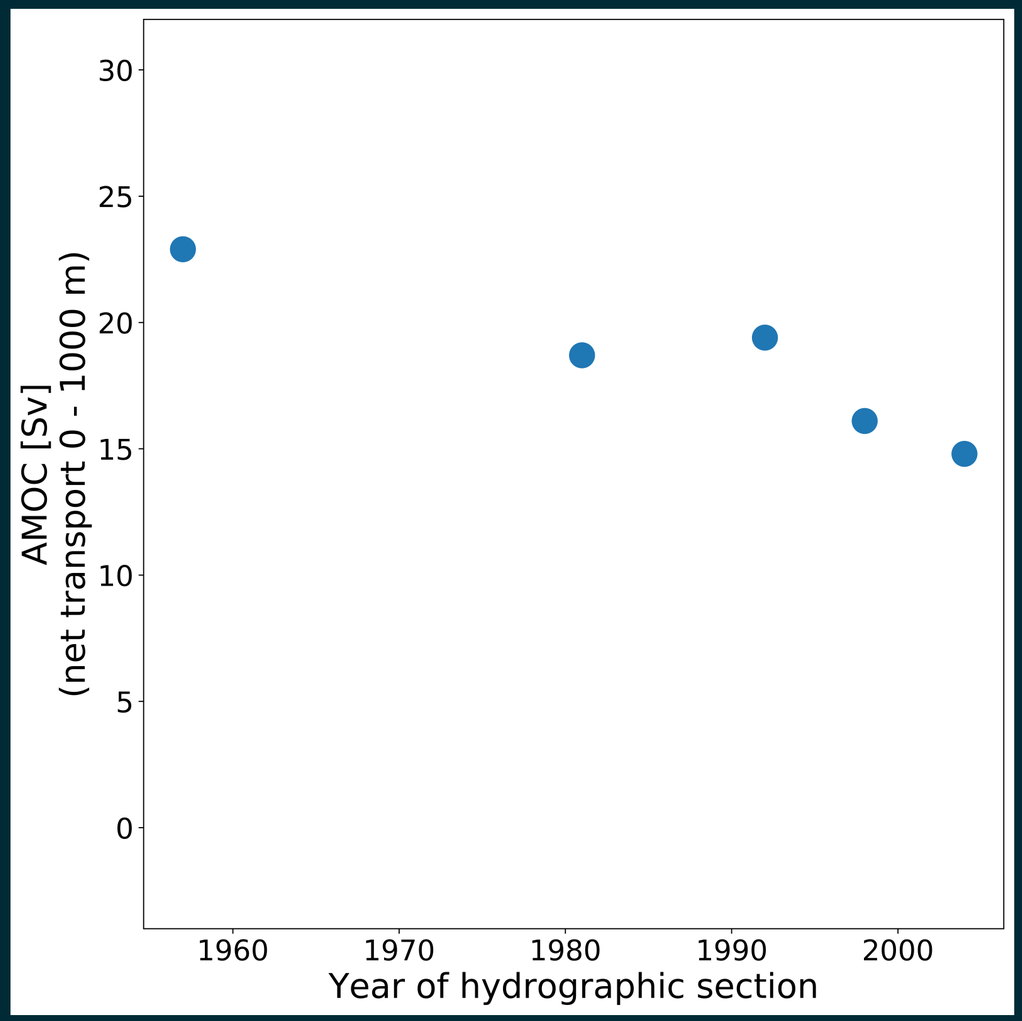
Transport = flux through a cross-sectional area (e.g., Atlantic Ocean at 26°N)

UMO = Upper Mid-Ocean transport, integrated down to deepest northward transport

Why do we want to simplify the dynamics?

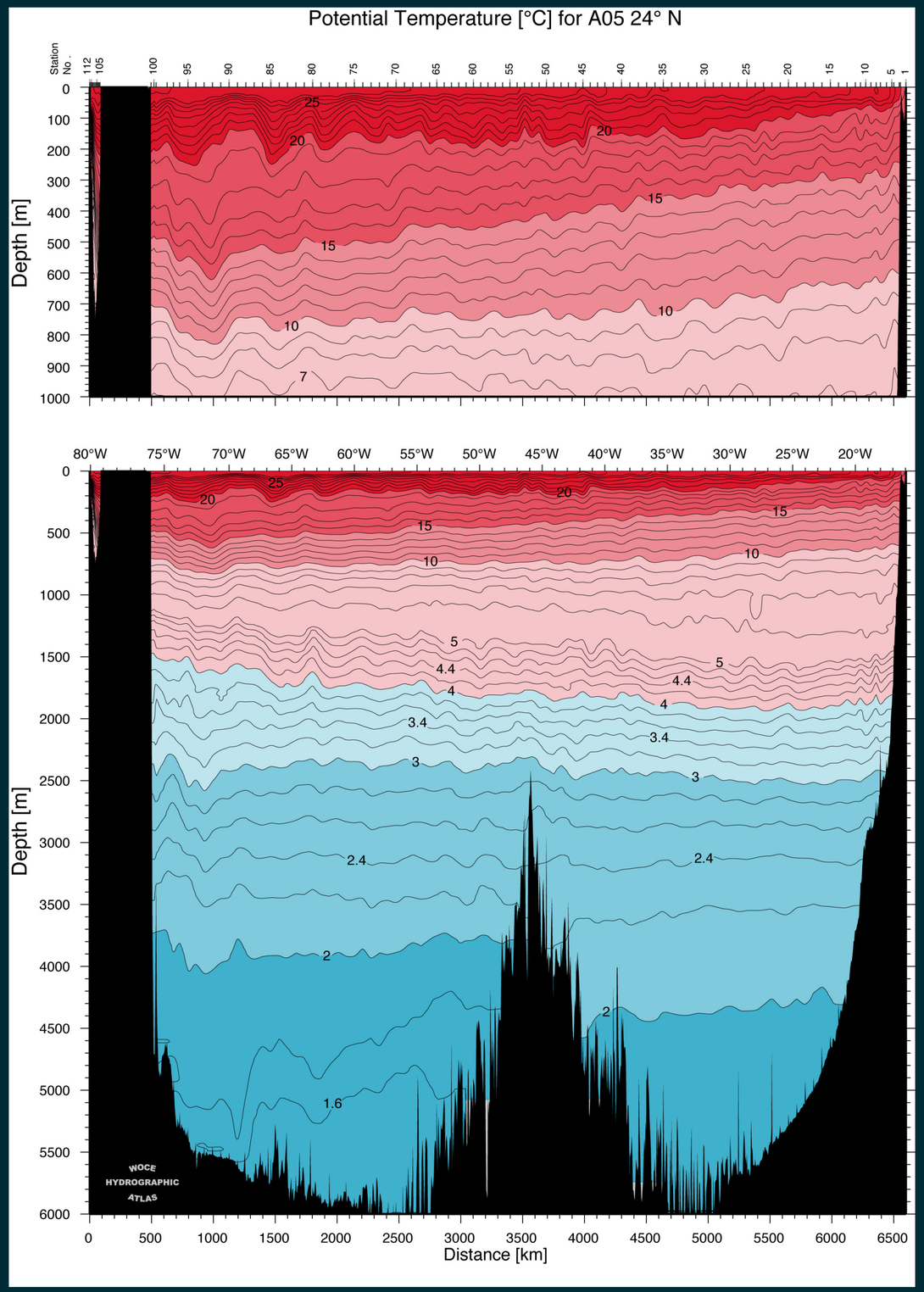
Before 2004, measurements were taken by research ships crossing the Atlantic

RRS Discovery II leaving Woods Hole Oceanographic Institute in 1957



(Data from Bryden et al., (2005))

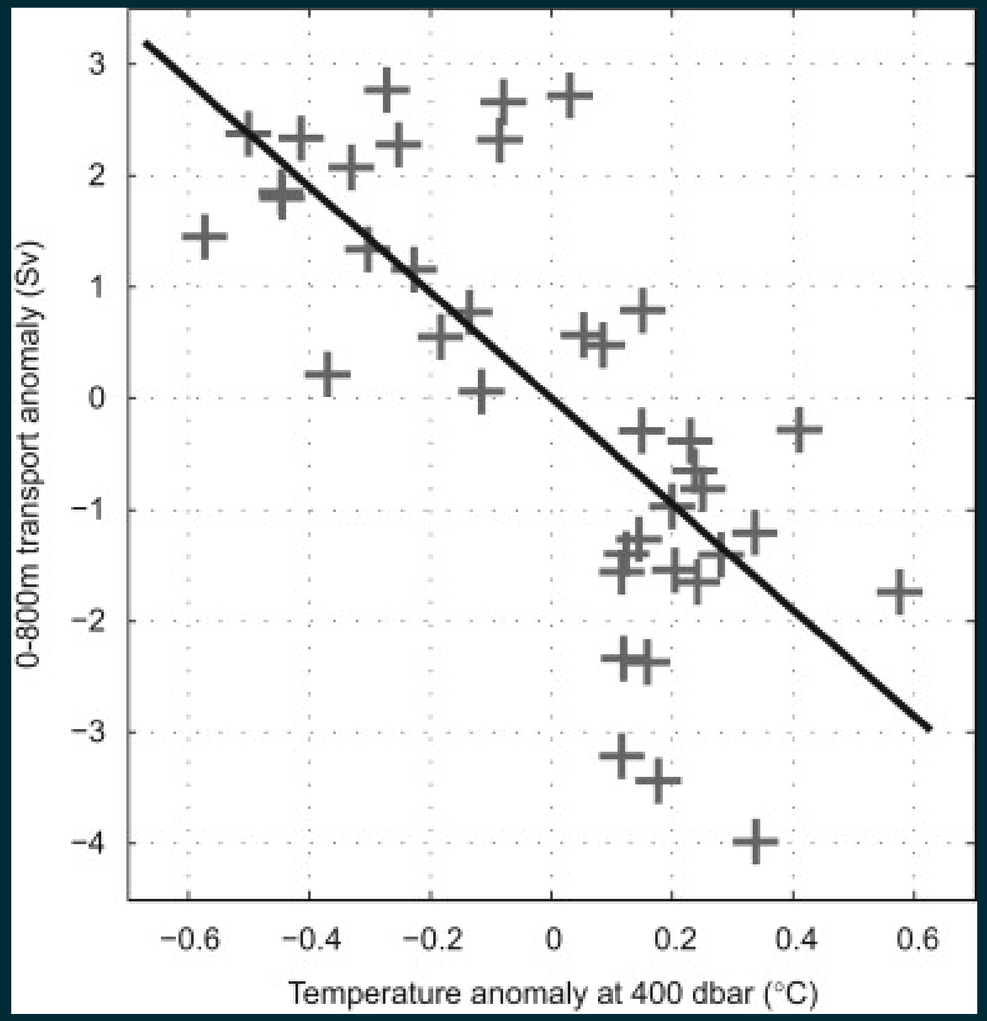
A simple linear regression



Atlantic Ocean potential temperature section at 24°N

World Ocean Circulation Experiment (1990 - 1997)

Simple linear regression



Longworth et al. (2011)

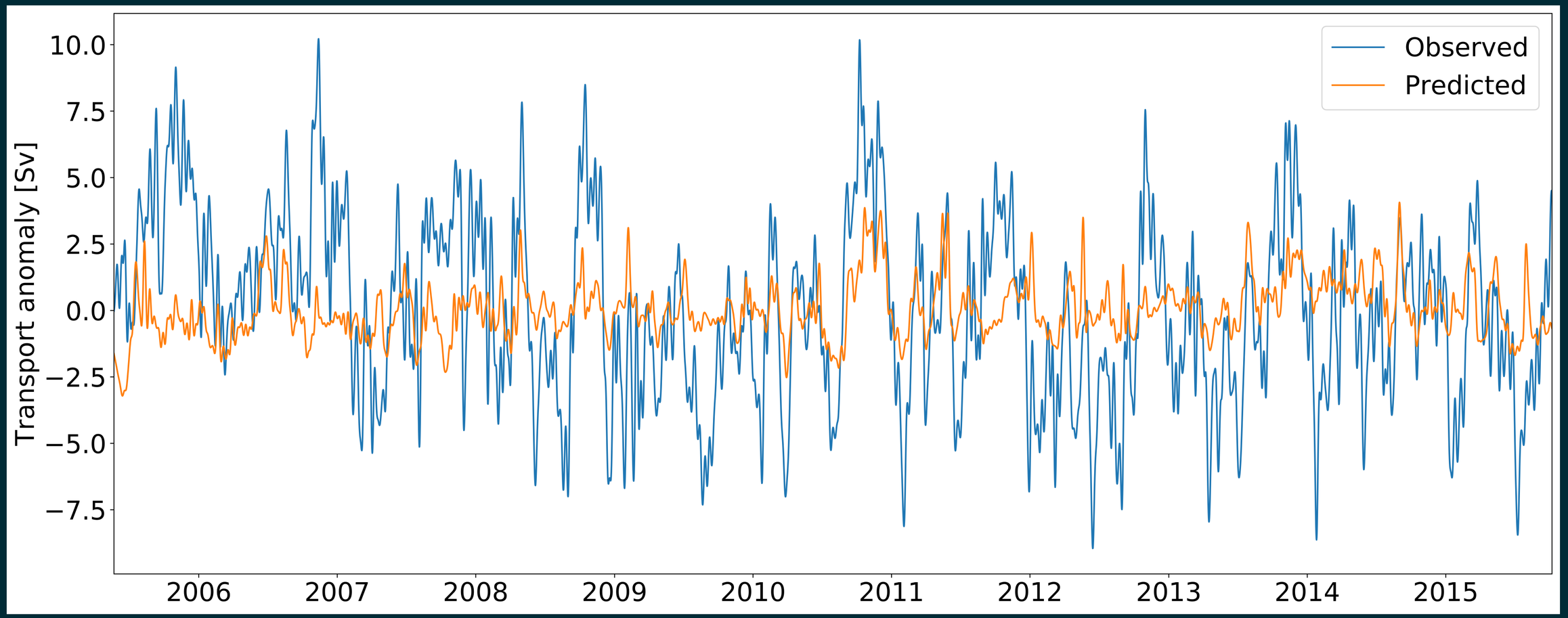
Data from 39 CTD casts taken between 1981 and 2005

$$\Delta T_{upper} = A \cdot temp_{400} + B$$

Regression explains 53% of variance

Simple linear regression using RAPID data

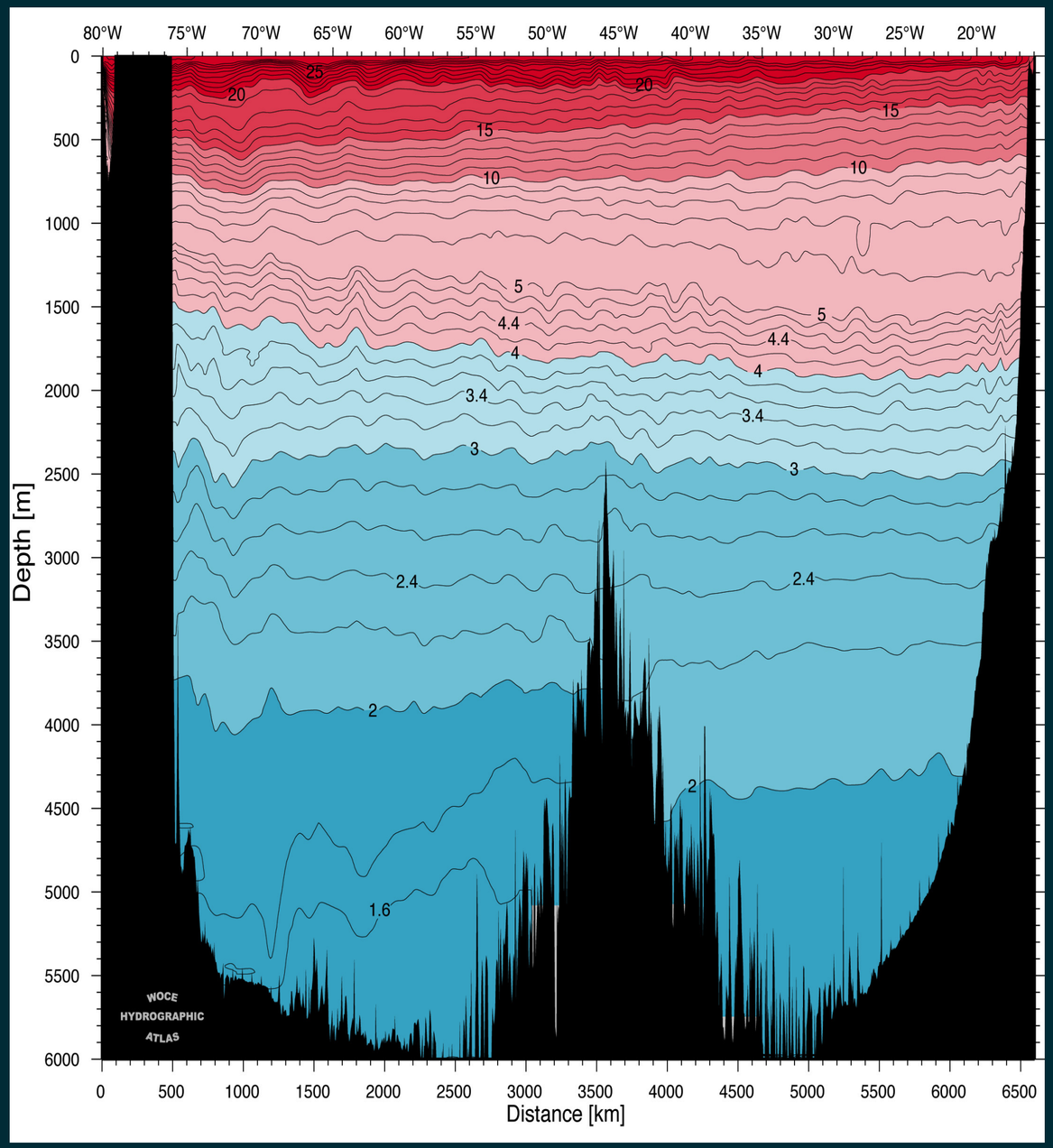
Thermocline (0 - 800m) transport predicted by western boundary temperature at 400 dbar

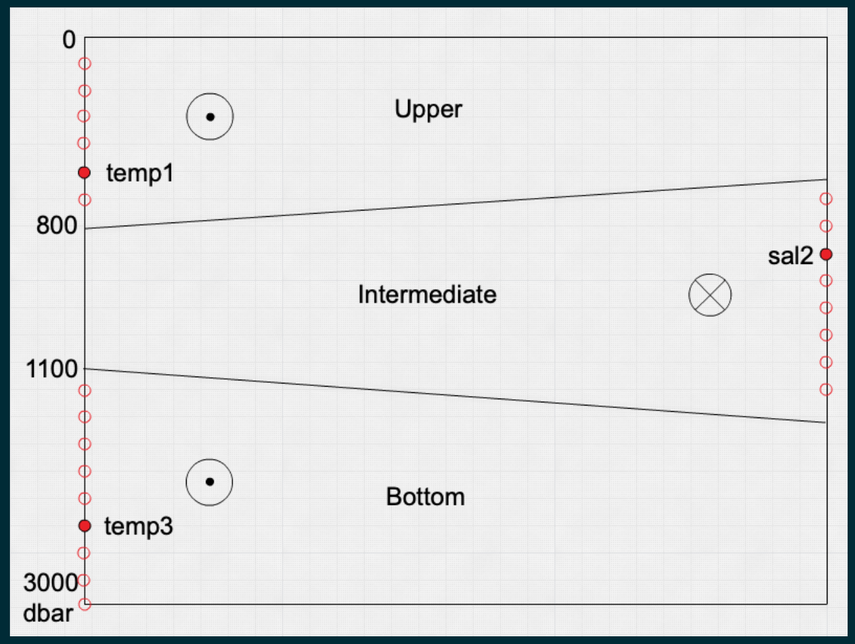


Only 9% of thermocline transport variance explained by regression

A slightly more complicated linear regression

Multiple linear regression



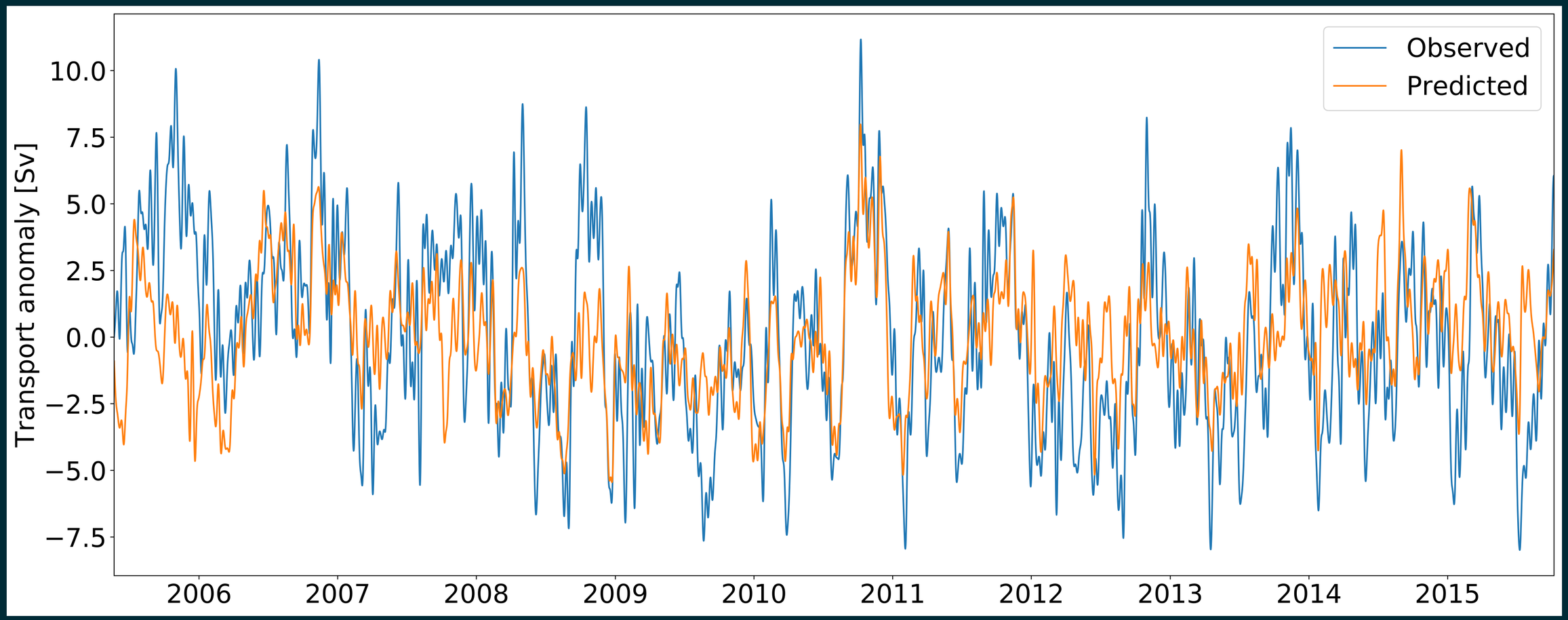


$$\Delta T = A \cdot temp_1 + B \cdot sal_2 + C \cdot temp_3 + D$$

Find the depth at which each variable gives the highest variance explained by the regression

Multiple linear regression using temperature and salinity anomalies

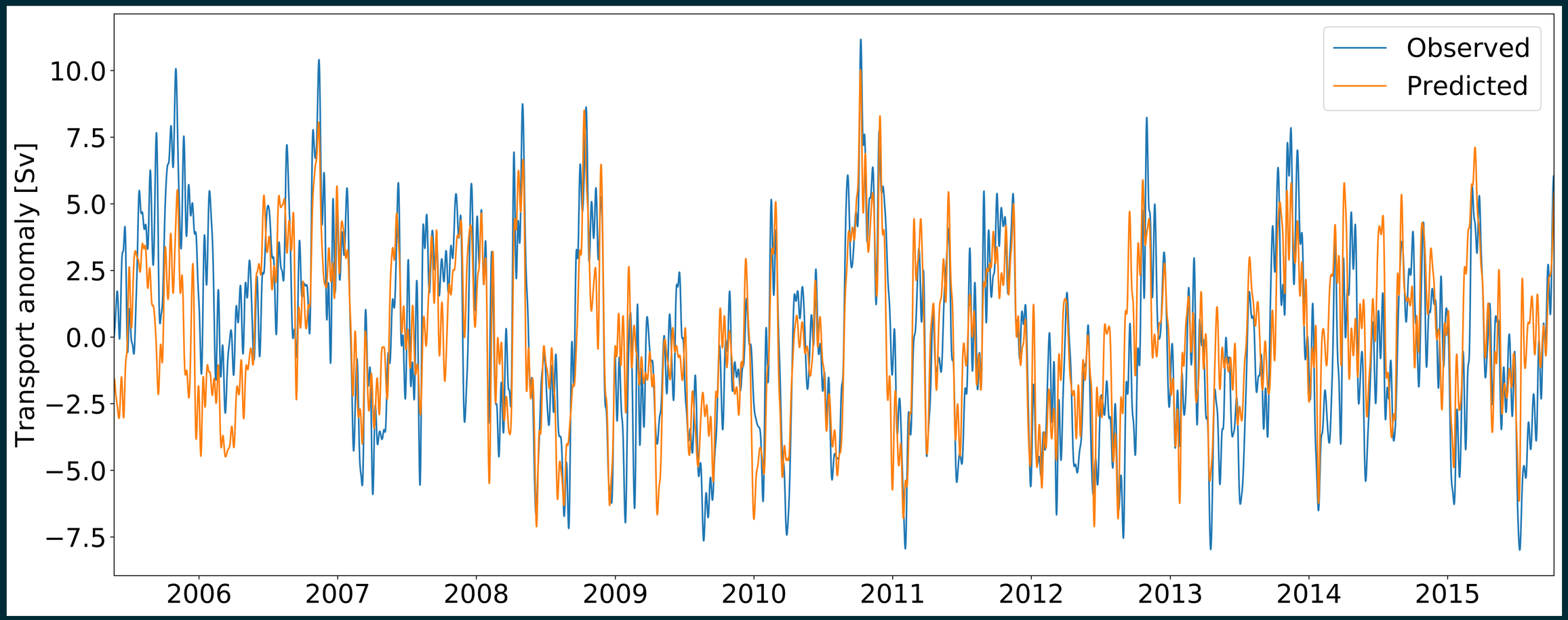
$$\Delta T = A \cdot temp_{780} + B \cdot sal_{1020} + C \cdot temp_{2840} + D$$



Now 39% of mid-ocean transport variance explained by regression

Multiple linear regression using density anomalies

$$\Delta T = A \cdot \rho_{740} + B \cdot \rho_{940} + C \cdot \rho_{2840} + D$$



67% of mid-ocean transport variance explained by regression

Summary

- A three-layer regression captures nearly 70% of the variance of an AMOC component
- Using temperature and salinity doesn't capture dynamics as well as density
- Applying the regression to historical temperature and salinity data should extend our understanding of past AMOC states (within a level of uncertainty)

Thank you!

Any questions?

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