Linked Variations between the Gulf Stream, AMOC, ~~and Gyre Circulations~~

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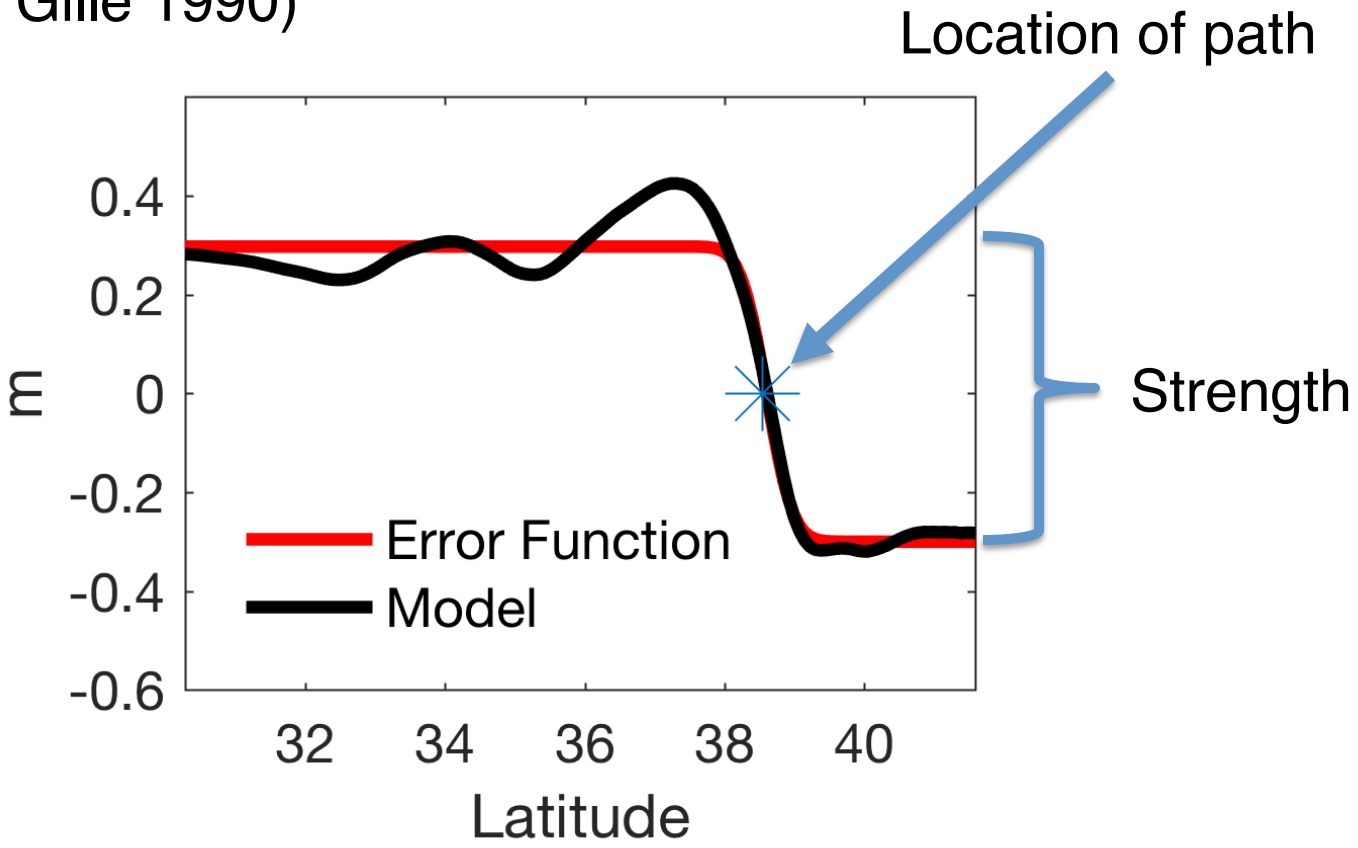
Approach: compare results from observations and a high resolution climate model

- Gulf Stream Strength (defined by amplitude of error function fit to sea surface height across the stream)
- Gulf Stream Position
  - Central position of error Function (SSH)
  - Where the 15°C crosses 200 m isobath (Temp)
- AMOC at 26°N (observations) and AMOC basin wide (models)
- Florida Current Transport

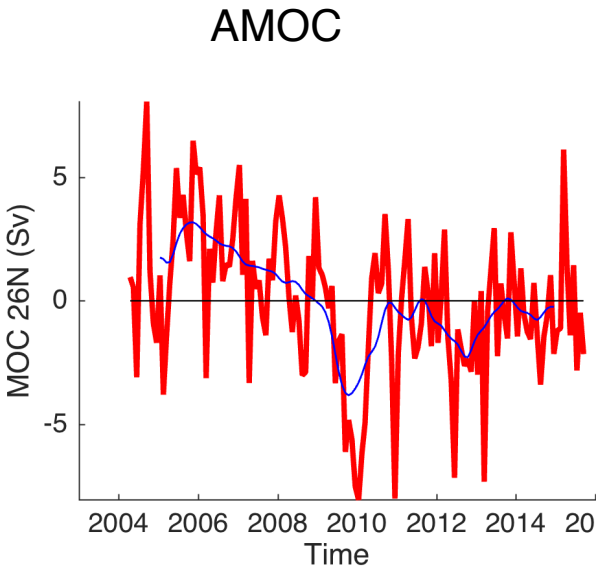
Example error function fit to across stream SSH
(Kelly and Gille 1990)

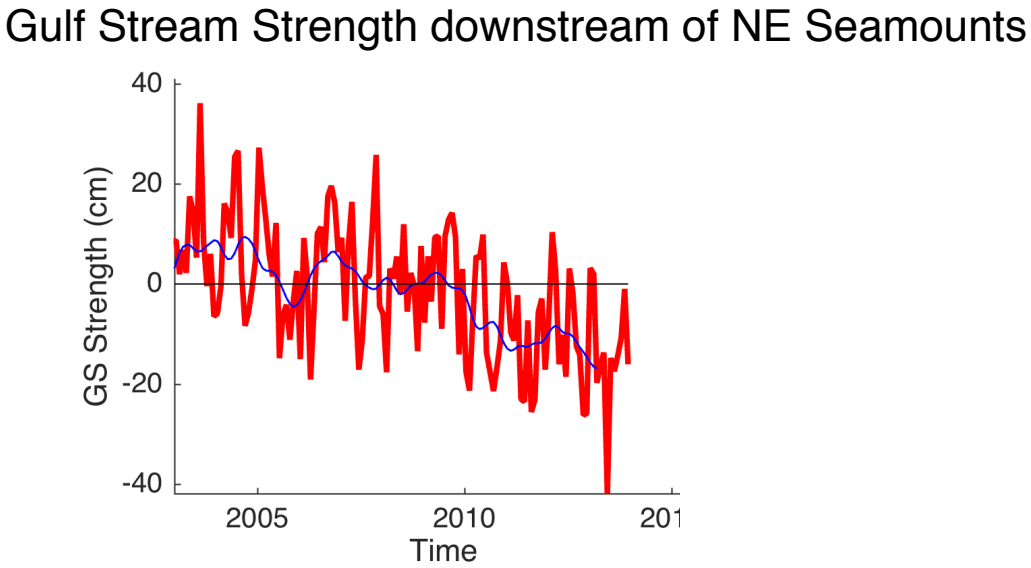


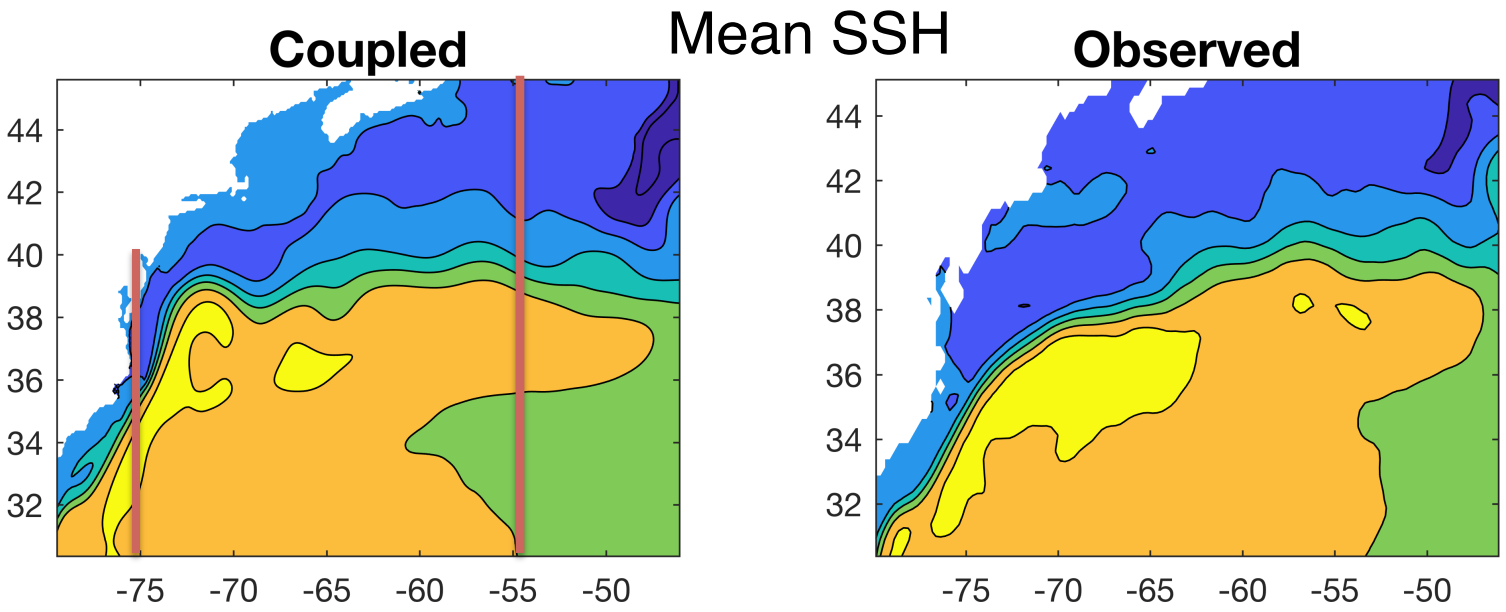
Previous analysis from observed records

- Increase in AMOC at 26°N leads increase in GS strength downstream of New England Seamounts
- Increase in AMOC at 26N leads to Northward shift near New England Seamounts
- Increase in Florida Current leads to increase in GS strength from 75W to 55W

2004-2014 trend reveals the same relationships between AMOC and Strength



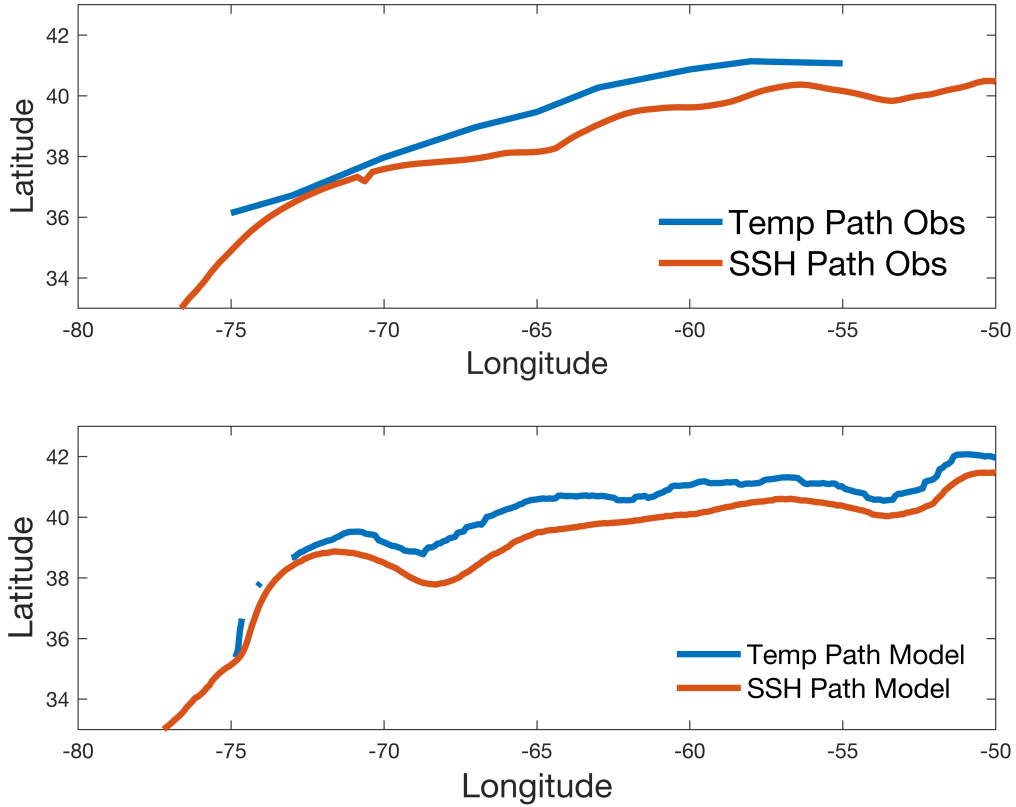




Models: POP 0.1° Ocean

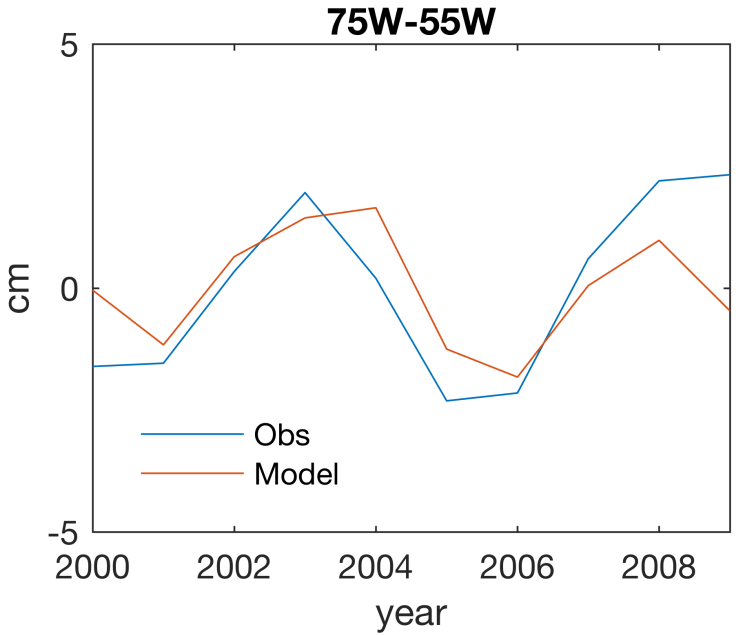
- Coupled CESM 120 year run, last 86 years used here, Small et al (2014)
- CORE forced simulation 2000-2009
- Annual Means

Mean Temp path North of SSH path
Permanent meander/overshoot in model simulations

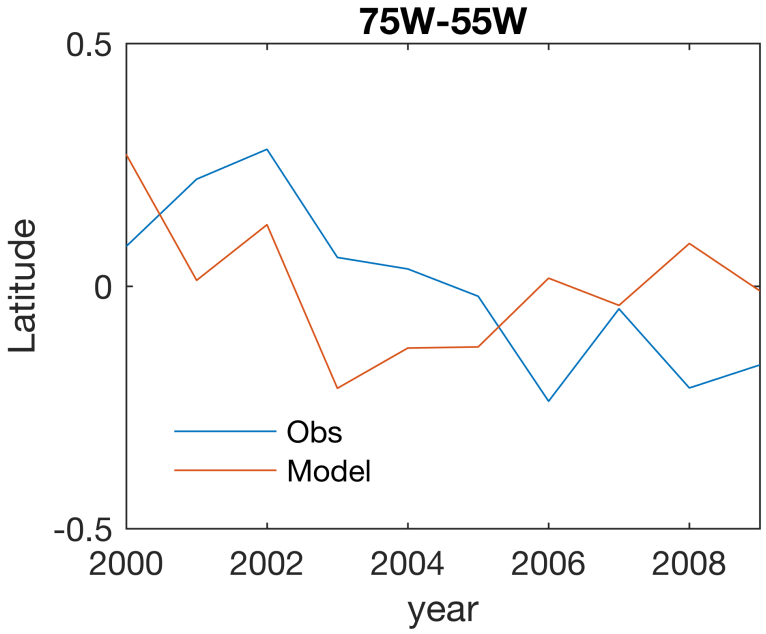


Historical simulation: 75W-55W Strength is determined by forcing

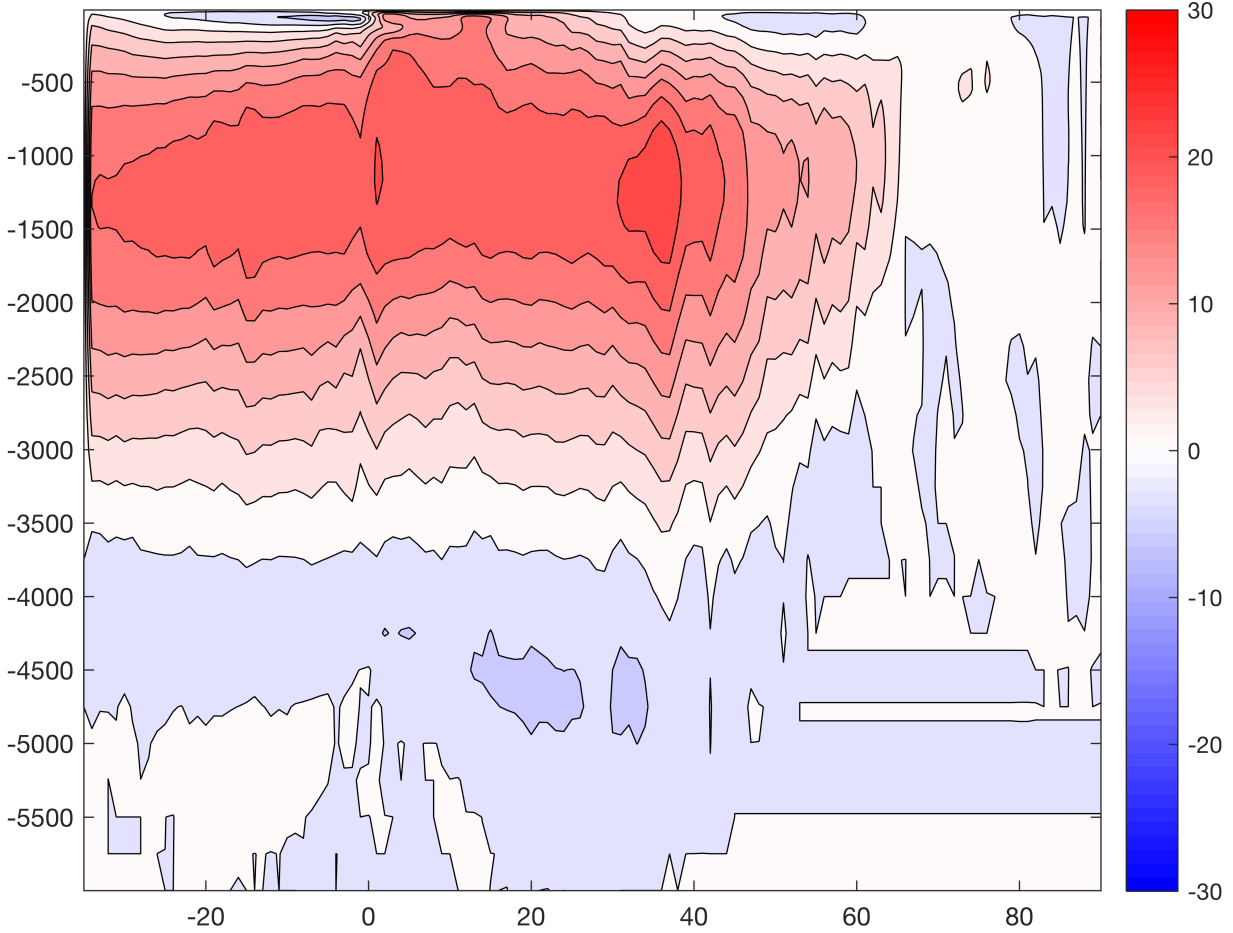
Strength



Path

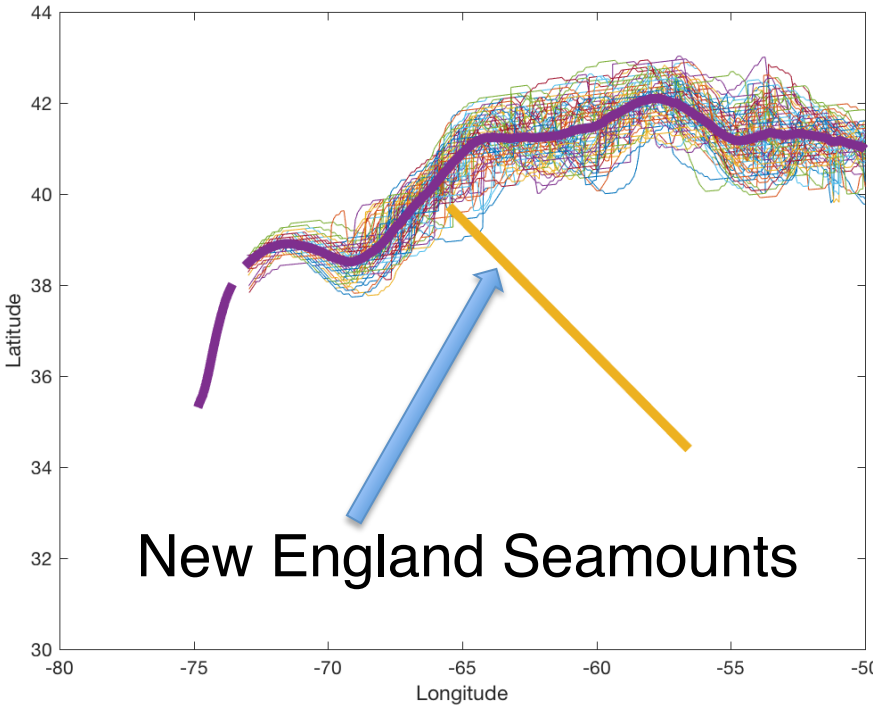


AMOC Coupled Model: Maximum at 36N 28Sv

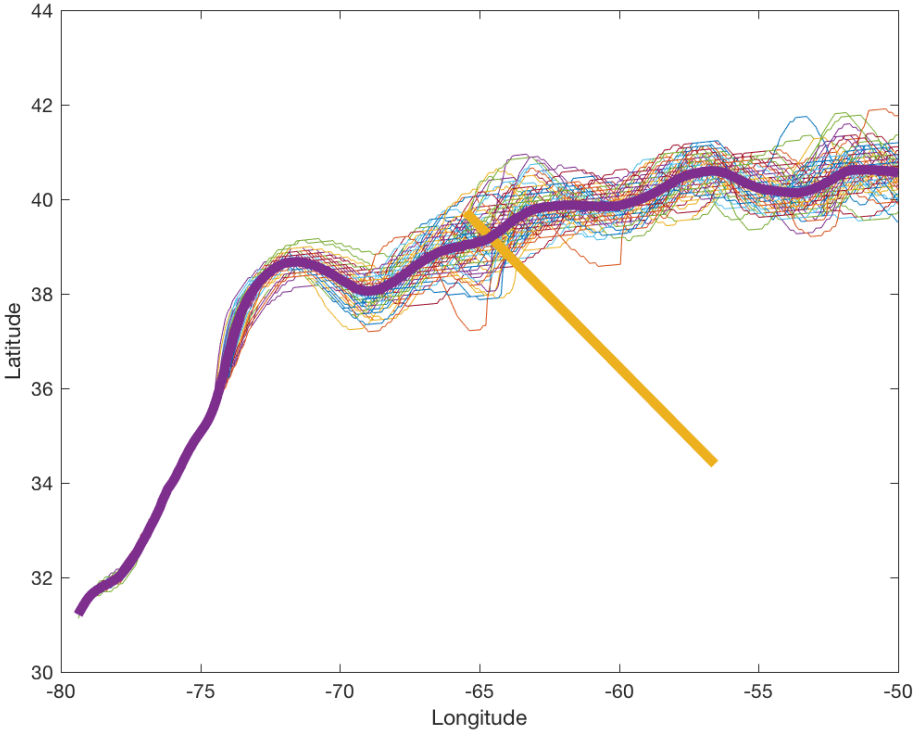


Coupled Model: SSH path more confined

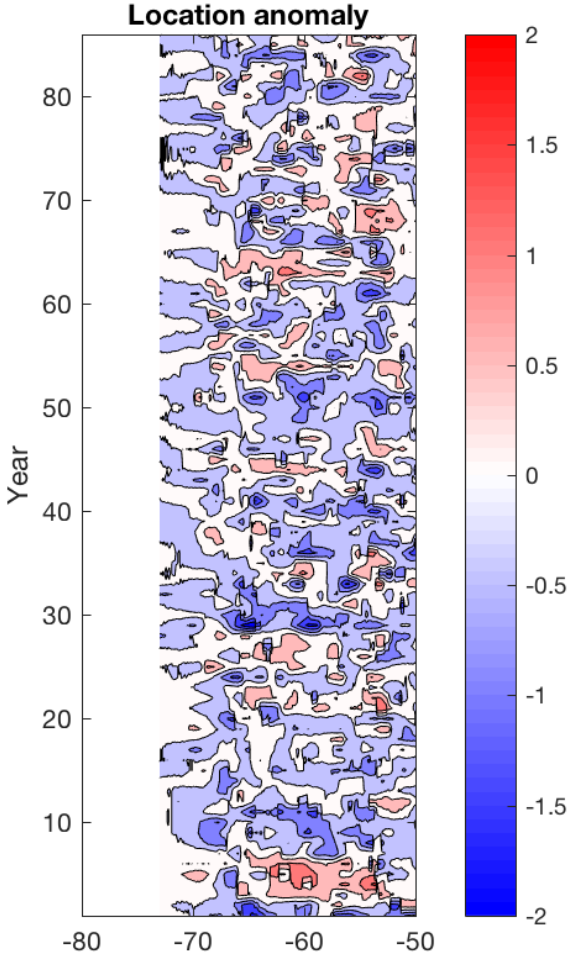
Path from Temperature



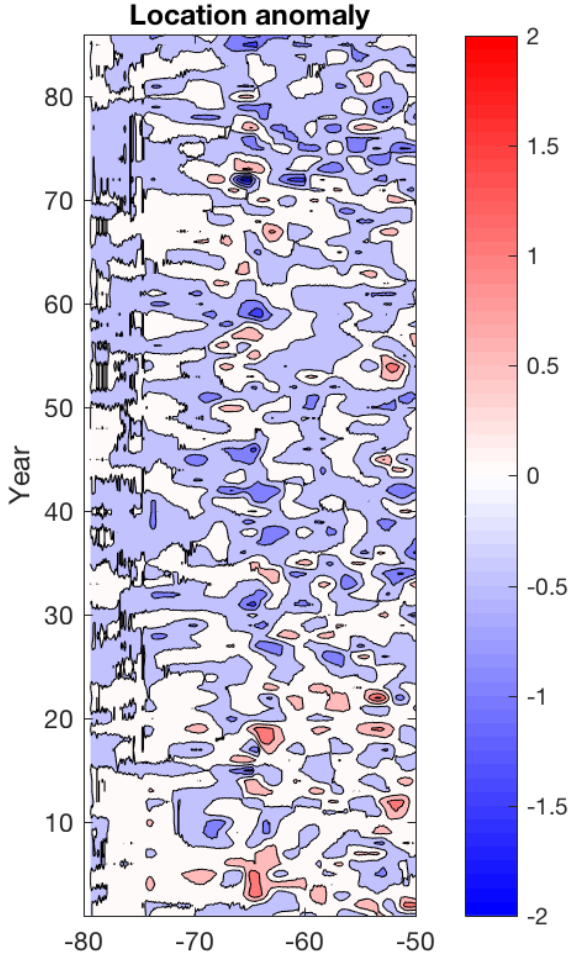
Path From SSH



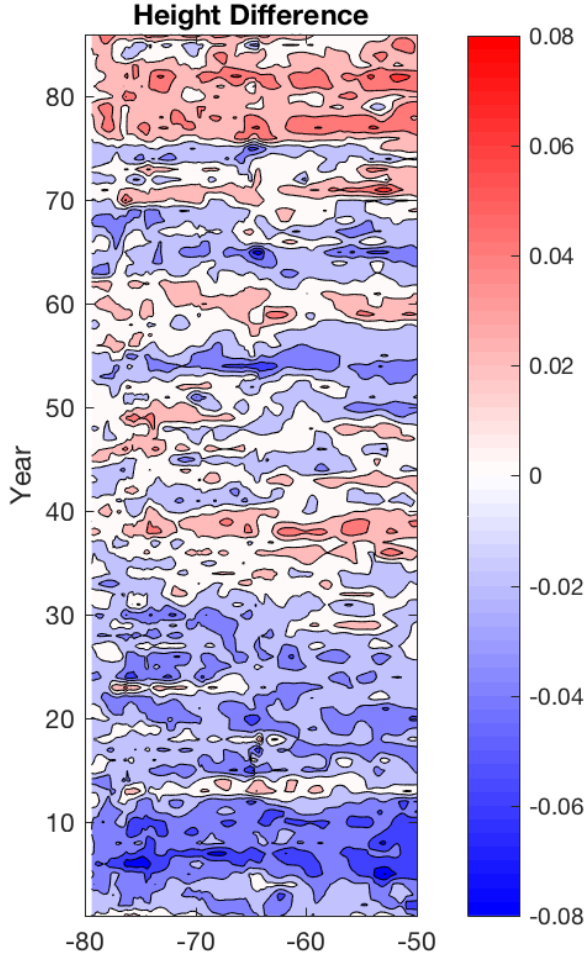
Temperature



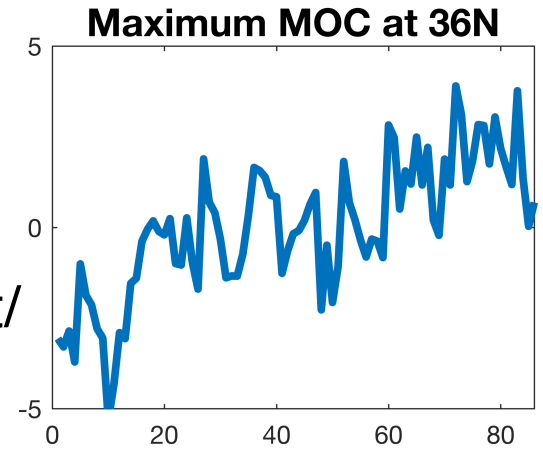
SSH location

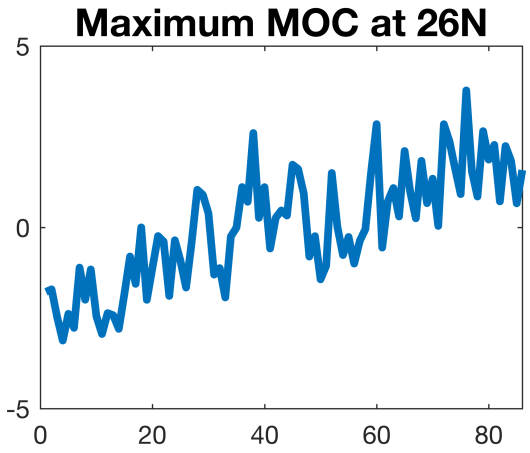


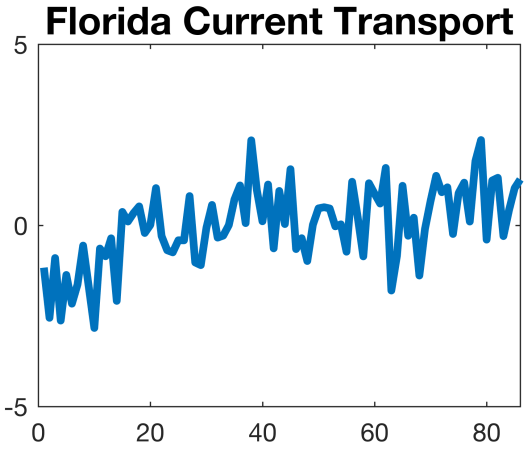
SSH Strength

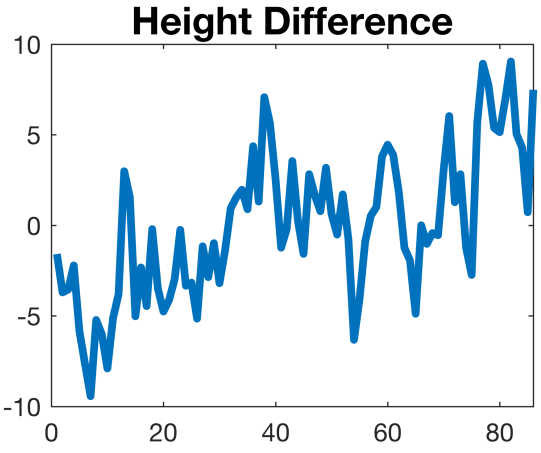


AMOC/Florida Current/
Strength all increase
over run
Height difference
averaged 75W to 55W

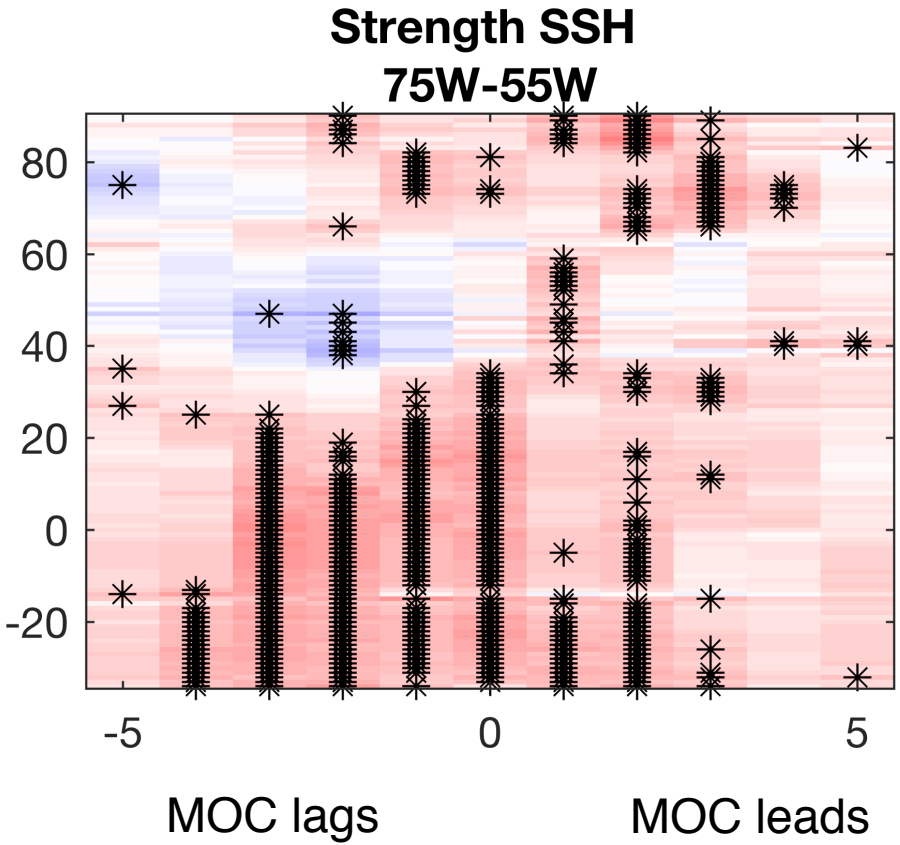




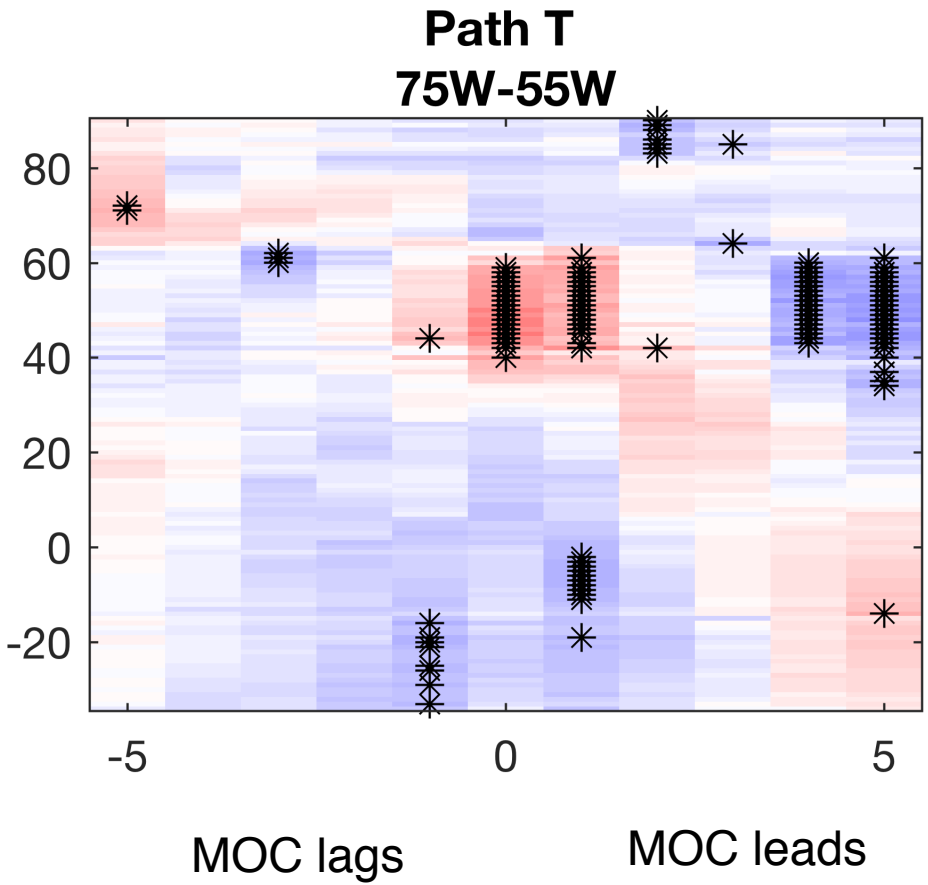




Lagged correlations: strength linked to AMOC



Temp Path linked to AMOC in SPG (but not path from SSH)

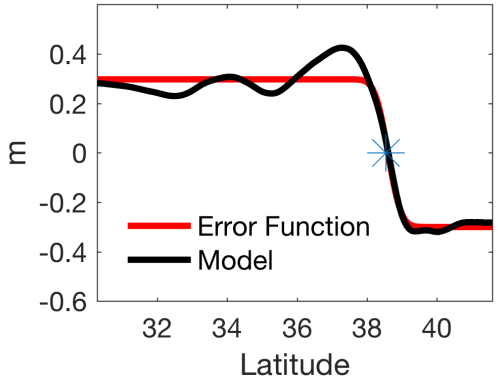


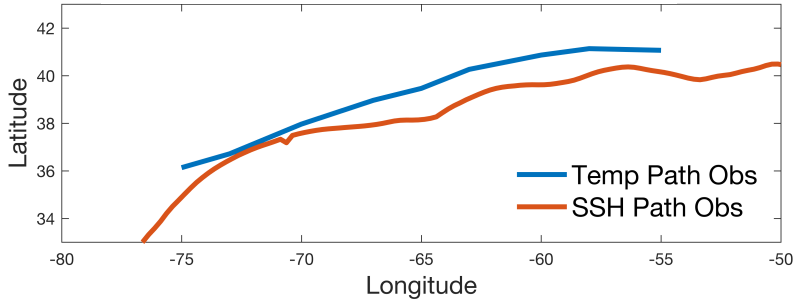
Caveats:

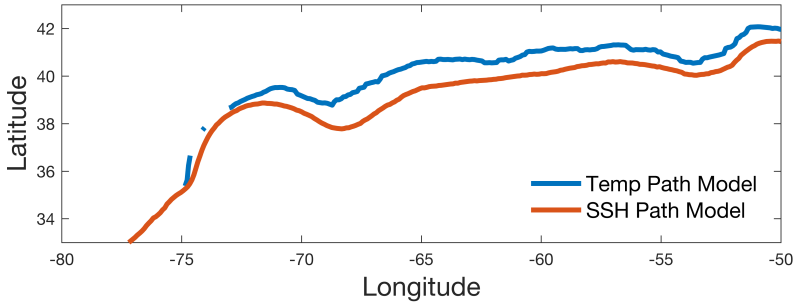
Error function fit misses the recirculation gyres

Permanent meander/ overshoot in model simulations

The Gulf Stream has complex vertical structure not well captured here







Conclusions from model analysis

- From historical run: strength but not path is driven by atmospheric forcing
- The Gulf Stream response differs upstream and downstream of New England Seamounts
- From coupled run: AMOC, Gulf Stream strength, Florida Current transport all increase over 86 year run. Model drift allows examination of long term relationships
- On interannual time scales:
  - Gulf Stream strength linked to AMOC throughout the basin
  - Path from temperature linked to changes in SPG

Further thoughts

- Both SSH and Temp paths give information about the structure of the Gulf Stream, but their connections to AMOC differ.
- SSH metric independent of regional ocean warming
- Is there a better way to quantify the role of the Gulf Stream and its role in/connections to AMOC variations?