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Comparison of Decadal AMOC Variability Among Climate Models

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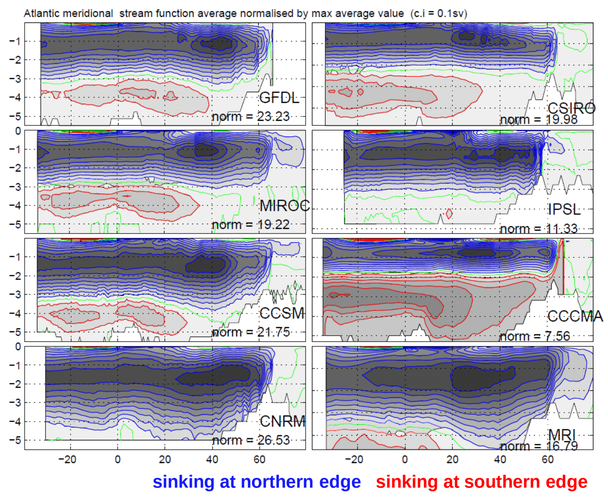
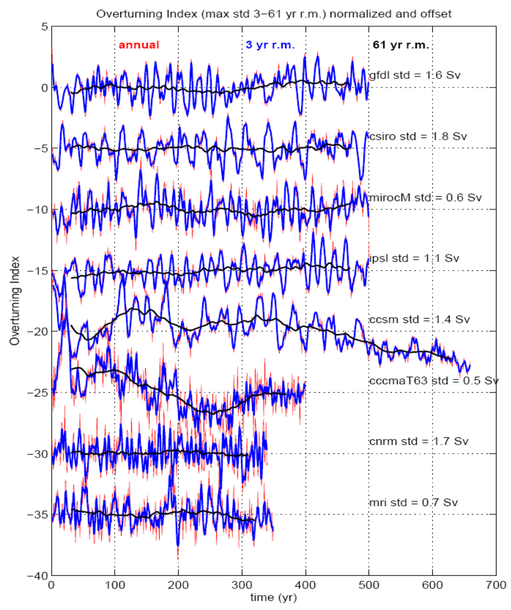
Motivation and Goal: **Numerous studies of Atlantic Meridional Overturning (AMOC) decadal variability show quantitatively and qualitatively different behavior in different models. How different is behavior when same analysis is performed on a set of CMIP3 preindustrial control runs?**

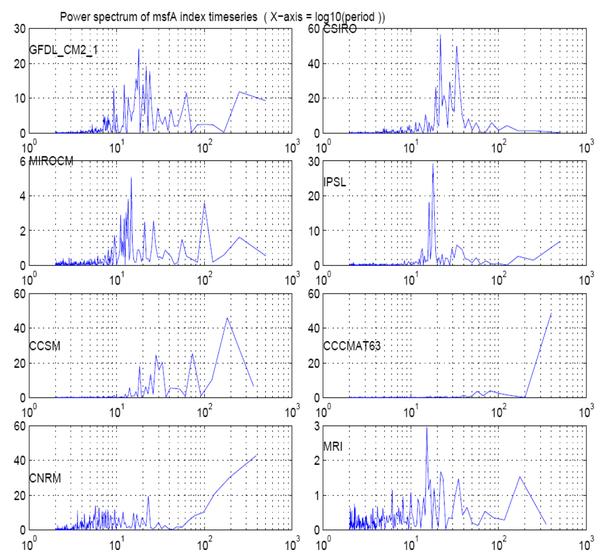
Examine 8 runs, time-mean overturning maximum ranging from 11 to 23 Sv.

Define "index" time series of decadal variability: stream function Φ anomaly at location (latitude, depth) of maximum Filtered Φ variability in 30-60N and below 300 m (filter described below).



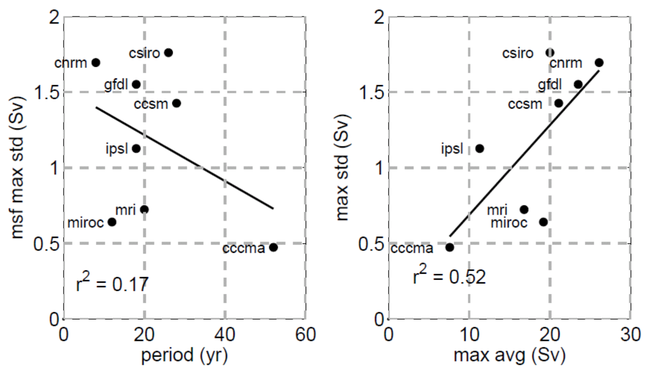
Variability is substantial for all models on decadal time scales, but relatively strong interannual for CNRM and MRI and relatively strong lower-frequency for CCSM and CCCMA.





Filter data to isolate decadal: 3 yr running mean – 61 yr running mean.

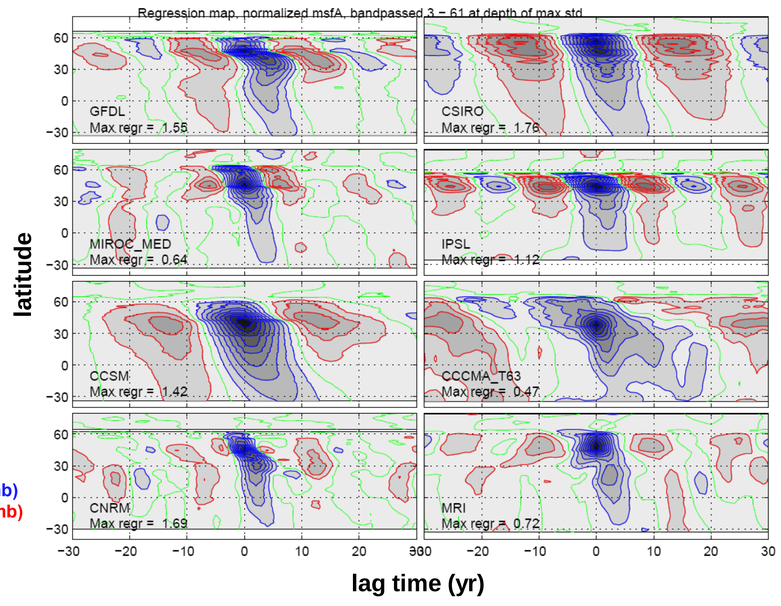
Φ index standard deviation:
.5 - 1.8 Sv
Period (between negative lobes of index autocorrelation):
10- 25 yr (+ 55 yr CCMA_T63)
(std index)/(avg max Φ):
.033 - .10



Use maps of fields regressed on to index function to portray "average" cycle.
Lat-time maps of Φ at depth of index function show:

- **peak magnitude near 45° N**
- **disturbance propagates southward**
- **reaches into southern hem**
- **propagation time O(5 yr)**

Why so long?

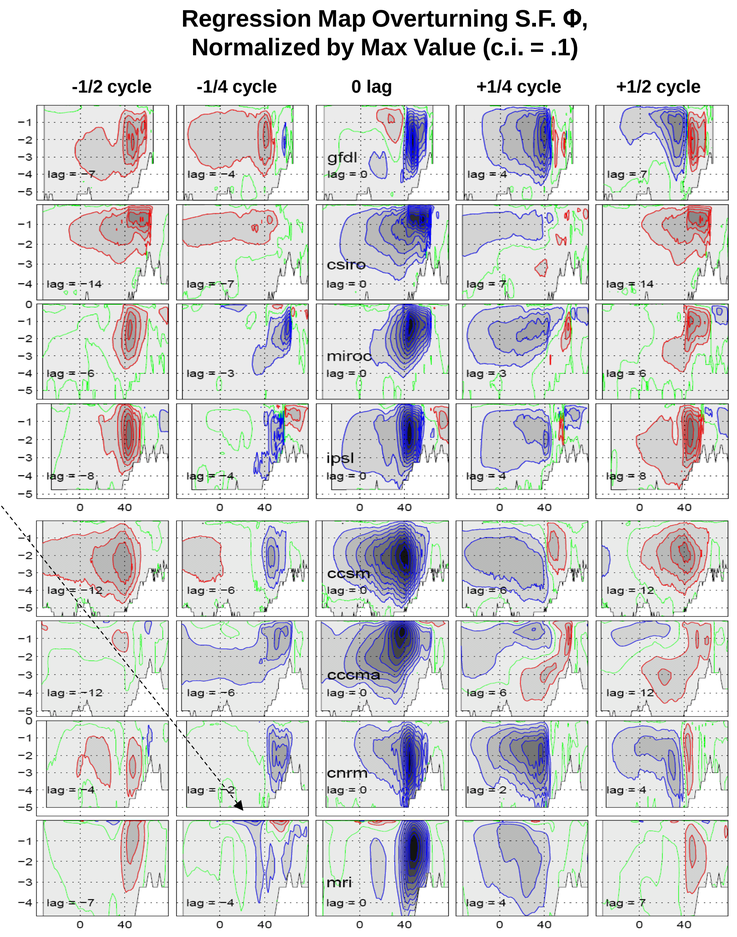


Positive correlation (N'ward transport in upper limb)
Negative correlation (S'ward transport in upper limb)

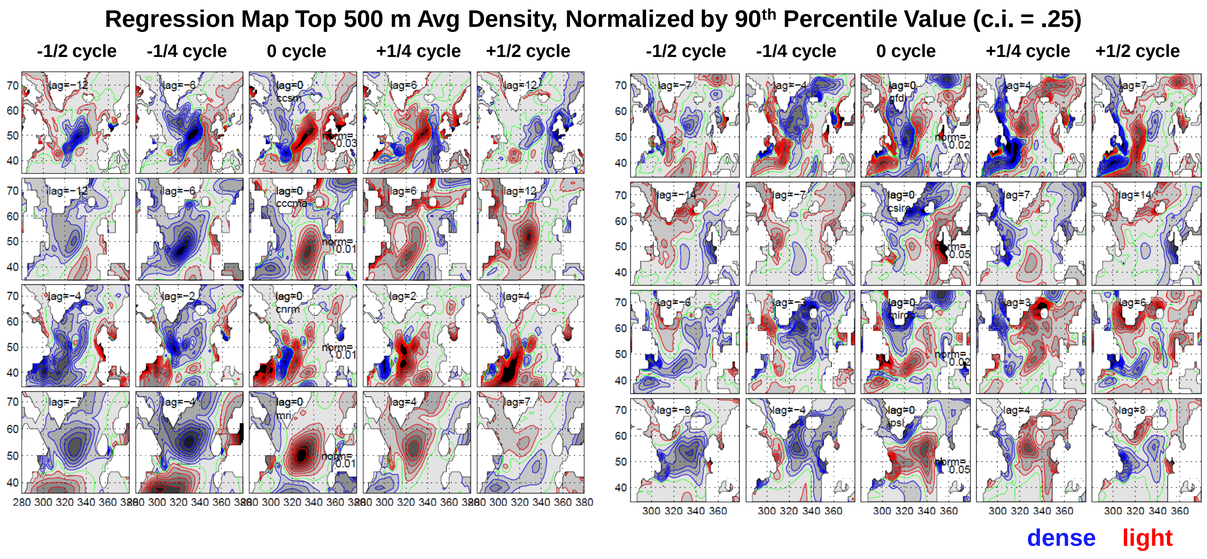
All models show deep Φ anomalies indicating thermohaline effects

But note signs of Ekman response in MRI-ECHAM5

Evolution of anomaly associated with 1st two EOFs (not shown)



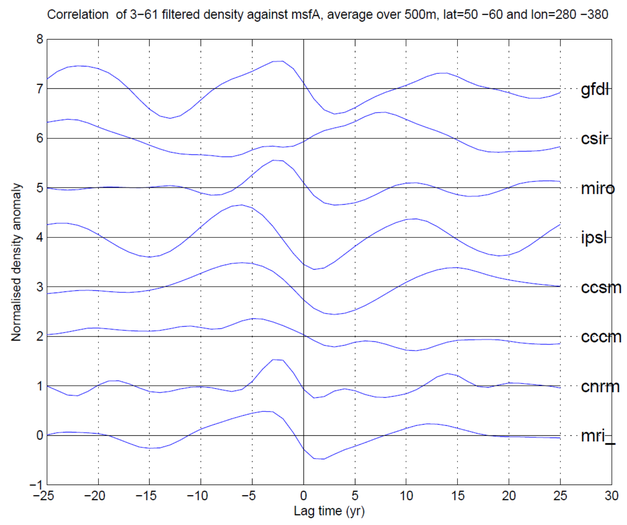
Dong and Sutton (2005, *J. Clim.*) found that top 500m of subpolar region denser than average for a few years before peak overturning anomaly in decadal variability. True for other models?



Hard to tell because
- **not single sign density anomaly in entire Deep-Water-Formation region**
- **not clear if should compare phase of index or larger-scale measure of Φ**

However…
High-latitude predominantly dense ¼ cycle before max value of Φ index for all models except CSIRO.

This could be immediate driving mechanism for Φ variability.



Conclusions: **Decadal AMOC variability (10-20 yr period, .5-2 Sv RMS) is robust feature of climate models. Overturning patterns and maybe density mechanism are common to most models.**

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