

ABSTRACT

Recent climate variability studies require the combined investigation of disparate ocean in-situ/satellite data, and numerical experiments. Ocean reanalyses, where large amounts of observations are assimilated into numerical models, provide syntheses based on both types of information.

The present study aims at describing, comparing and assessing over 1993-2001 the variability of large-scale circulation indexes (Meridional Overturning Circulation, Meridional Heat Transport, at basin scale and along the 24°N and 48°N repeated sections) obtained from six recent model integrations. These are four 50-year global ocean hindcasts from the DRAKKAR project at 2°, 1°, 1/2°, and 1/4° resolution, two global DRAKKAR reanalyses at 1° and 1/4° resolution, the 10-year MERA11 North Atlantic 1/3° reanalysis performed by Mercator-Océan, and its unconstrained counterpart.

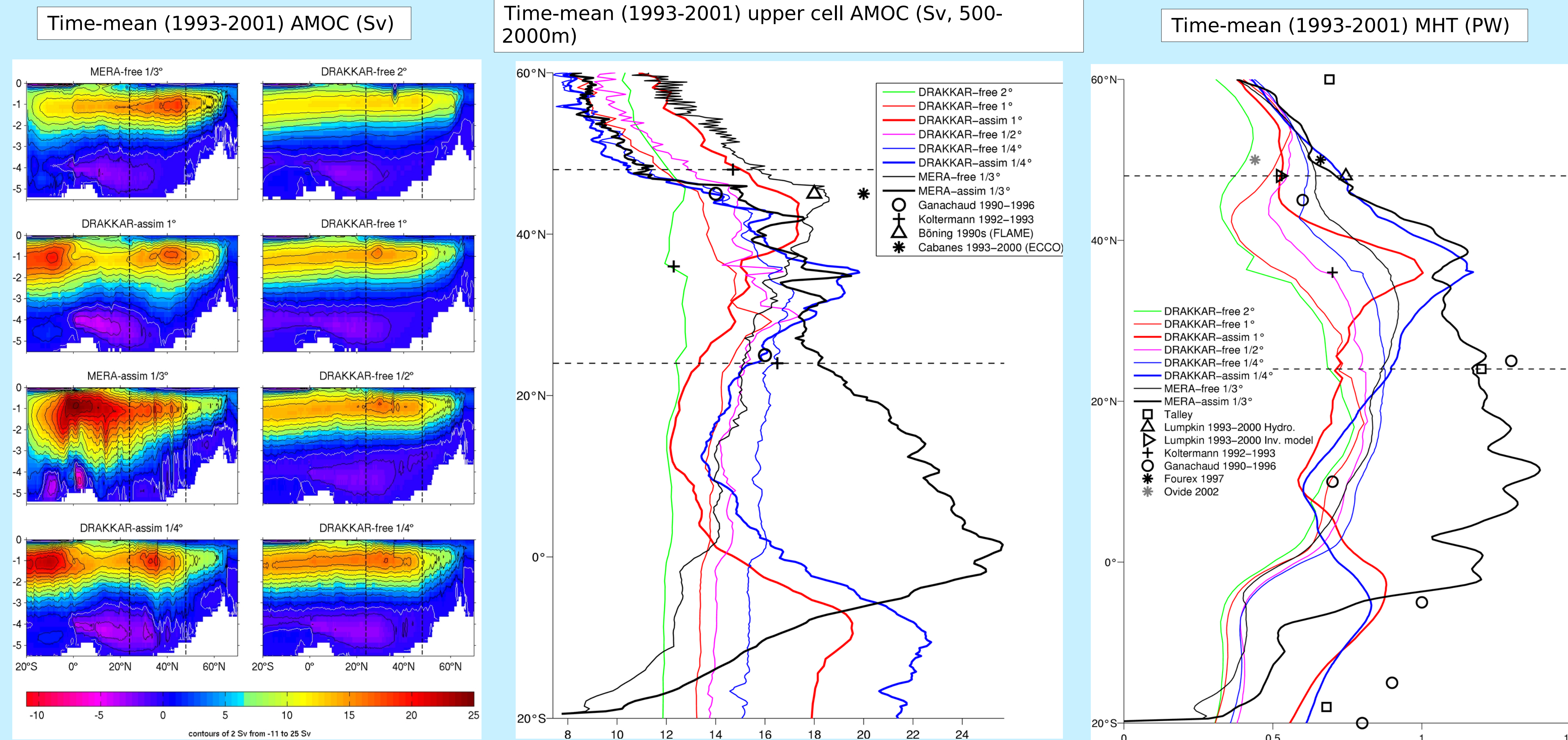
Model intercomparisons are presented. Differences reveal the impact of model resolution (among the DRAKKAR hierarchy) and sequential data assimilation (among DRAKKAR 1° and 1/4° and MERA 1/3° realisations) on the means and variabilities of these indexes, as well as on their continuity over time and space in the case of assimilation. Complementarily, common features among this 6-member hindcast ensemble exhibits robust features of the actual ocean variability, as well as their forced character.

DATASETS

Model	Resolution	Assimilation	Period	Source
MERA	1/3°	Atl. 20°S-70°N	1992-2001	Free, Mercator
MERA	1/3°	Atl. 20°S-70°N	1992-2001	Assim. - Altimetry and in situ data (T,S,surface obs.), Mercator
DRAKKAR	2°	Global	1958-2004	Free, Drakkar
DRAKKAR	1°	Global	1958-2004	Free, Drakkar
DRAKKAR	1°	Global	1958-2004	Assim. - Hydrography, Drakkar
DRAKKAR	1/2°	Global	1958-2004	Free, Drakkar
DRAKKAR	1/4°	Global	1958-2004	Free, Drakkar
DRAKKAR	1/4°	Global	1987-2004	Assim. - Hydrography, Drakkar

See Greiner et al (2006), Drakkar Group (2007) and Smith et al (2008)

TIME-MEAN STRUCTURE OF AMOC AND MHT



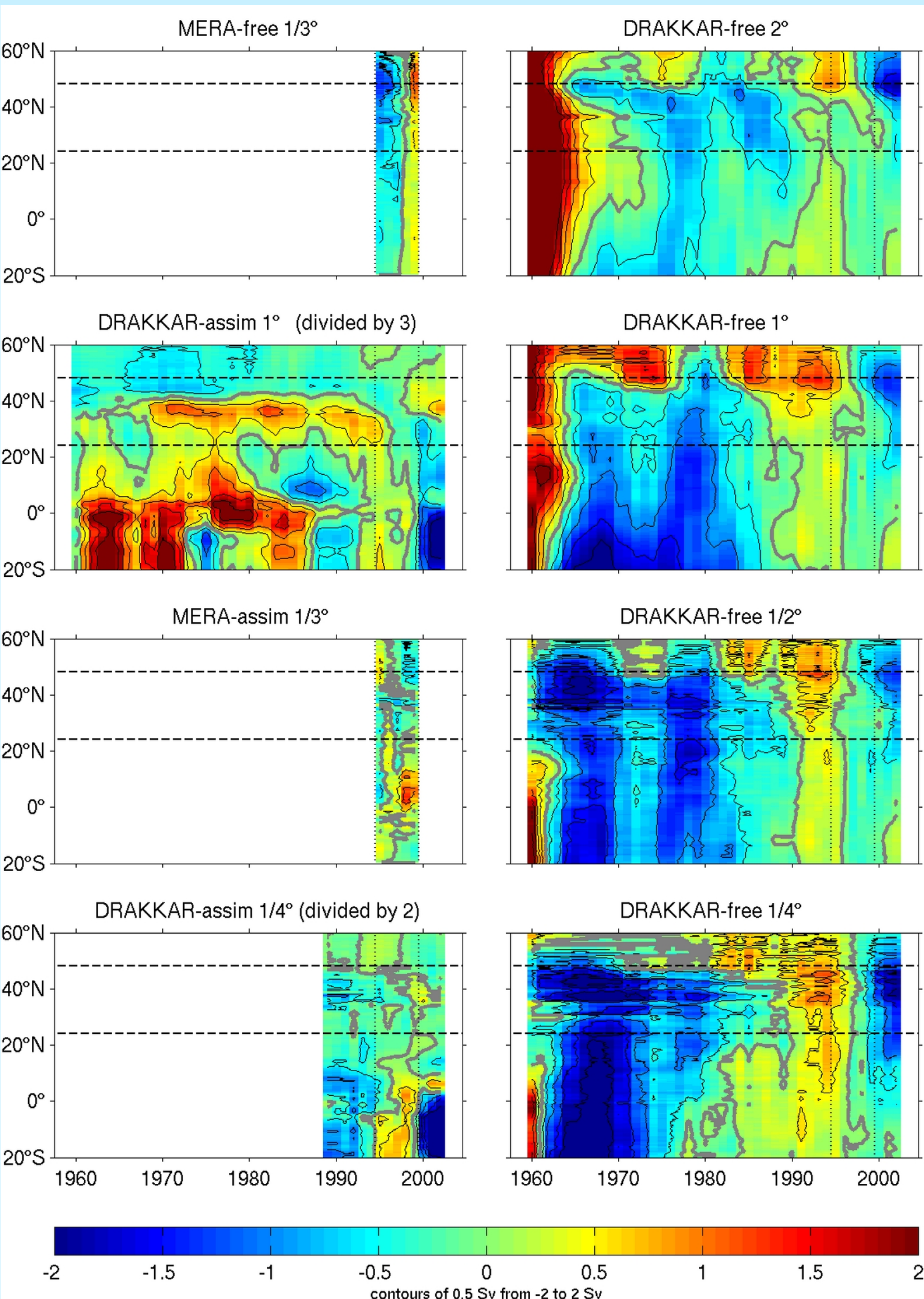
Robust:
 - Depth/latitude of North Atlantic MOC maxima.
 - Five Sv decrease of AMOC between 48°N and 60°N.
 - Meridional structure of MHT in free runs.
 - MERA-assim MHT fits best Ganachaud et al (2000) and Talley et al (2003) at 24°N.

Resolution:
 - Enhances mean AMOC from 12Sv (DRAKKAR-free 2°) to 18Sv (DRAKKAR-free 1/4°, as Talley et al 2003).
 - Enhances MHT.
 - Local MHT minima in 40°-45°N at low resolution disappear with increasing resolution (more realistic NW corner).

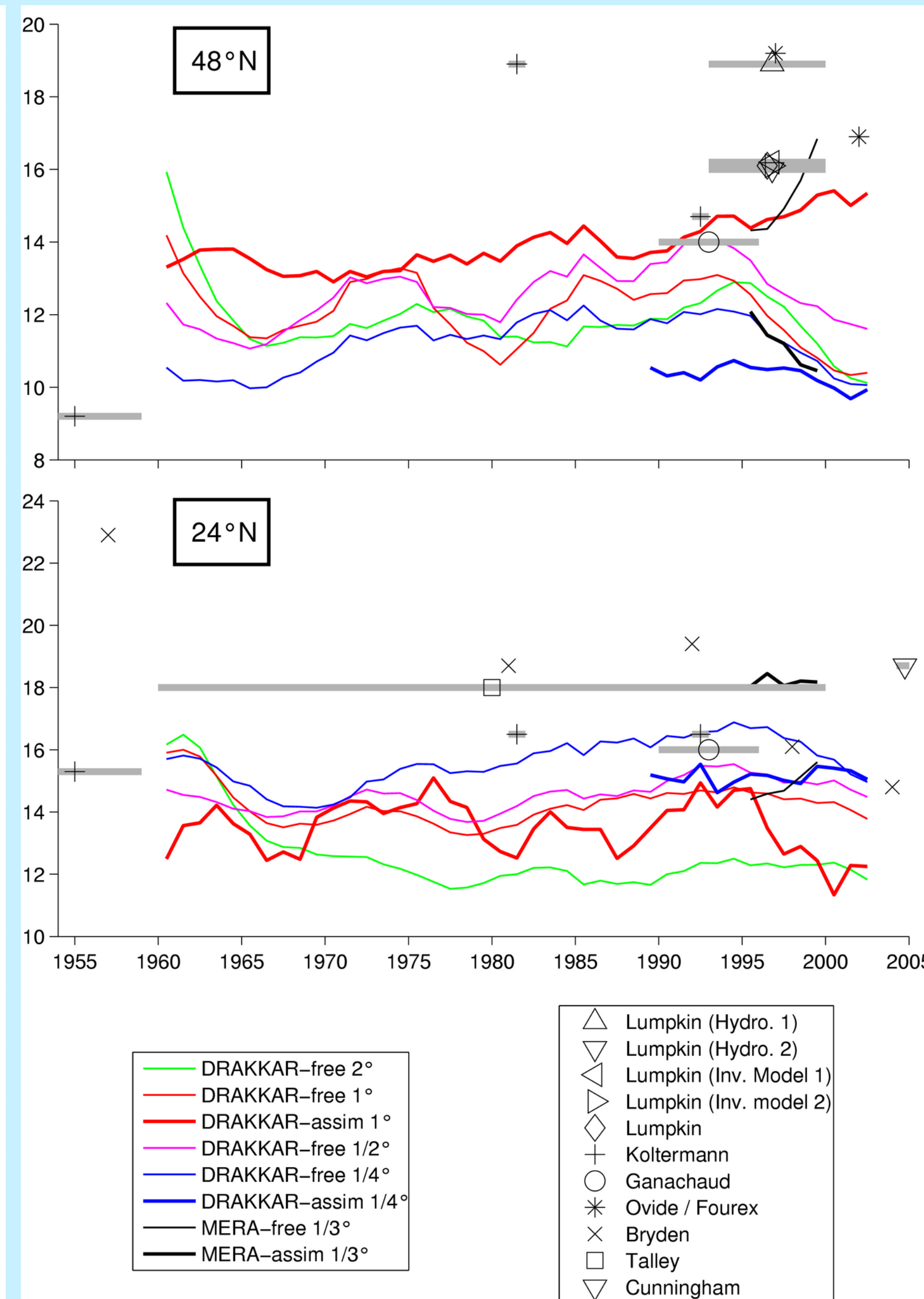
Assimilation:
 - Suspicious AMOC/MHT maxima in 20°S-5°S (DRAKKAR-assim) and 10°S-20°N (MERA-assim).
 - MERA: Overall MHT increase (but same meridional structure).
 - DRAKKAR-assim 1/4° fits MERA-assim north of 35°N.

AMOC VARIABILITY

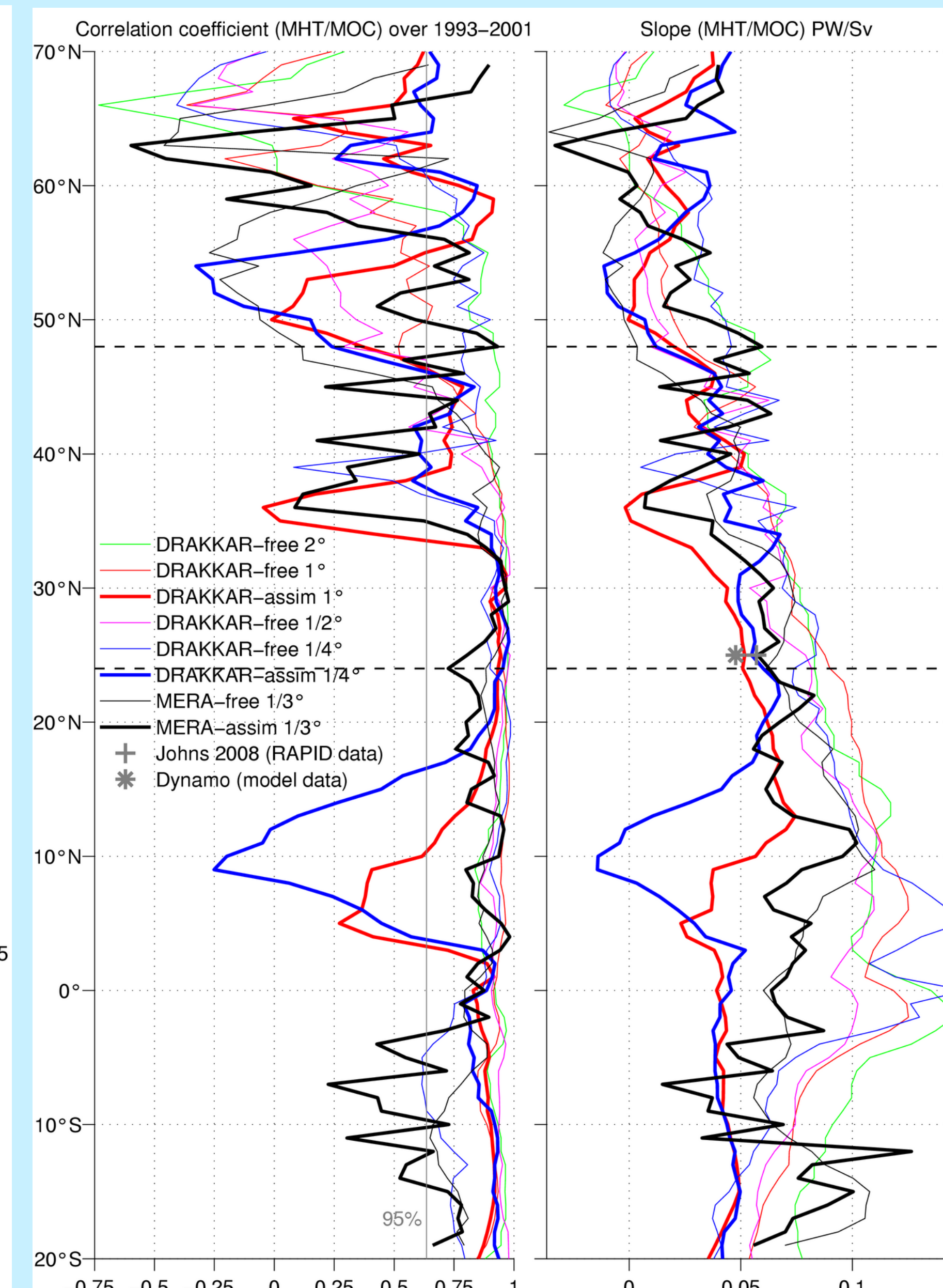
Upper cell AMOC anomaly (Sv) with respect to the common 1993-2001 period, 5-yr boxcar filtered.



Upper cell AMOC intensity (Sv) at 24°N and 48°N. 5-yr boxcar filter. Marks = obs. estimates (gray lines show the period considered).



Coefficients and slopes of the linear regression between AMOC(t) and MHT(t) at each latitude.



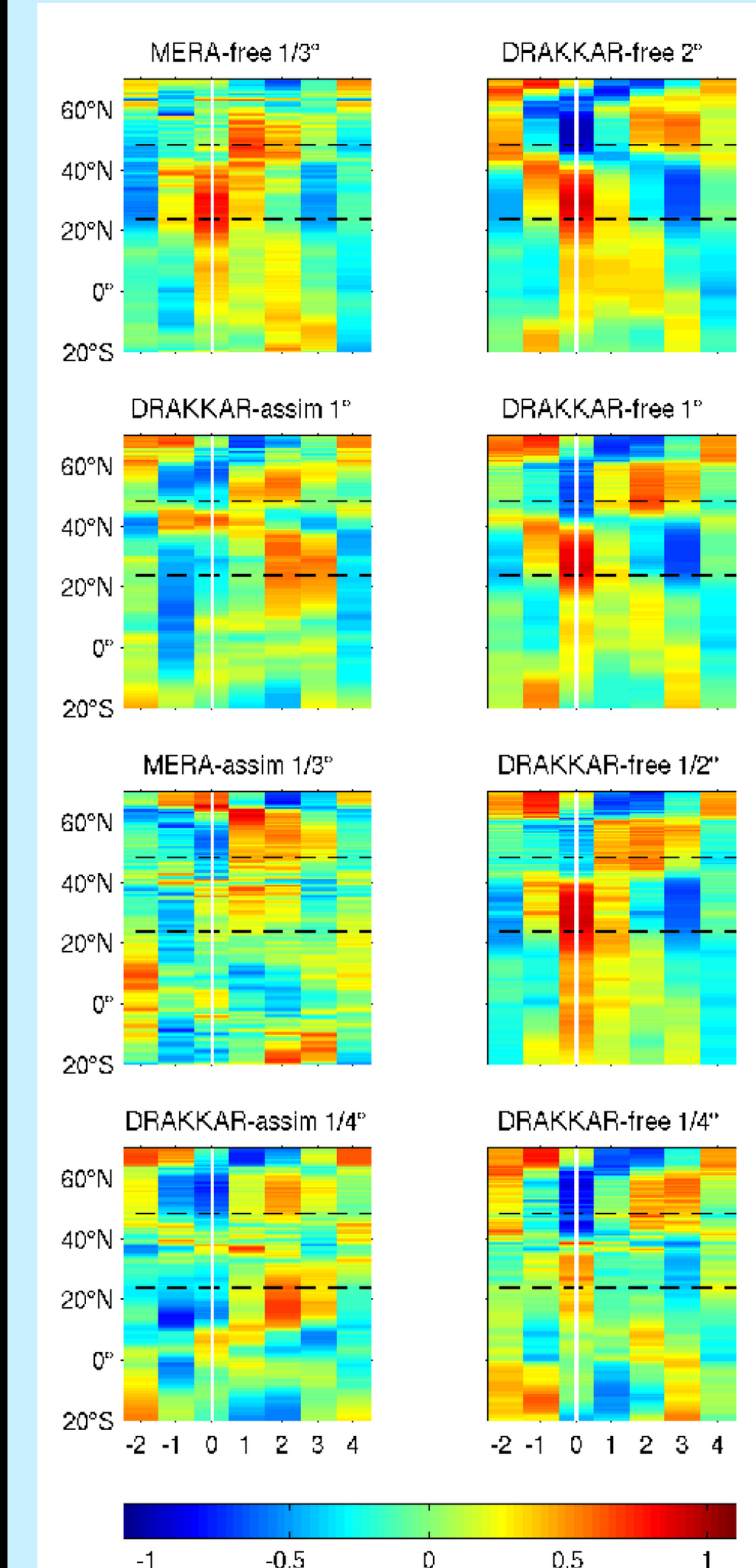
Robust:
 - Strong AMOC/MHT link at 24°N.
 - Strong AMOC/MHT link for hindcasts in 0°-30°N (realistic?).
 - Weak AMOC/MHT link for reanalyses in 5°-15°N.
 - Northward decrease of the AMOC/MHT link.

Assimilation:
 - Weakens the AMOC / MHT link.
 - Reanalyses agree with link predicted by RAPID (Johns et al 2008) and simulated by Dynamo models.

Robust:
 - AMOC increase until the 1990s, and then decrease.
Resolution:
 - Extends 1990 subpolar AMOC anomaly towards the equator.
 - Enhances MOC at 24°N.
 - 1981-1992 trend closer to Bryden et al (2005).
 - 1998-2004 AMOC and trend similar to Bryden et al (2005).
Assimilation:
 - Significantly changes AMOC variability patterns (further investigations required).

LINK WITH NAO

Lagged correlation (colors) between annual NAO(t) and AMOC(t) between 1993 and 2001, computed at each latitude (ordinate). Unfiltered yearly data. Lag in years (abscissa), NAO leads for positive lags.



Robust:
 - Subpolar response to NAO+ : AMOC decrease at lag 0. Poleward and equatorward propagation in DRAKKAR-free/assim. AMOC increase at lag 2-3.

- Subtropical response to NAO+ : AMOC increase at lag 0. AMOC decrease at lag 2-3 in FREE runs.

- wind driven at lag 0 ?
 - buoyancy driven at lag 2-3 ?

Assimilation :
 - Subtropical response to NAO becomes weak or opposite to DRAKKAR-free.

CONCLUSIONS - PERSPECTIVES

Robust:
 - Substantial inter model differences.
 - Maximum AMOC in early 1990s.

Resolution:
 - Increases time-mean AMOC / MHT through entire Atlantic.
 - More interannual "noise".

Assimilation:
 - AMOC variability quite different in reanalyses, depends on assimilation method.
 Further investigation is required to understand the impact of assimilation on AMOC / MHT mean structures and variabilities.

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