Overturning and heat transport variations in the South Atlantic in an ocean reanalysis ensemble

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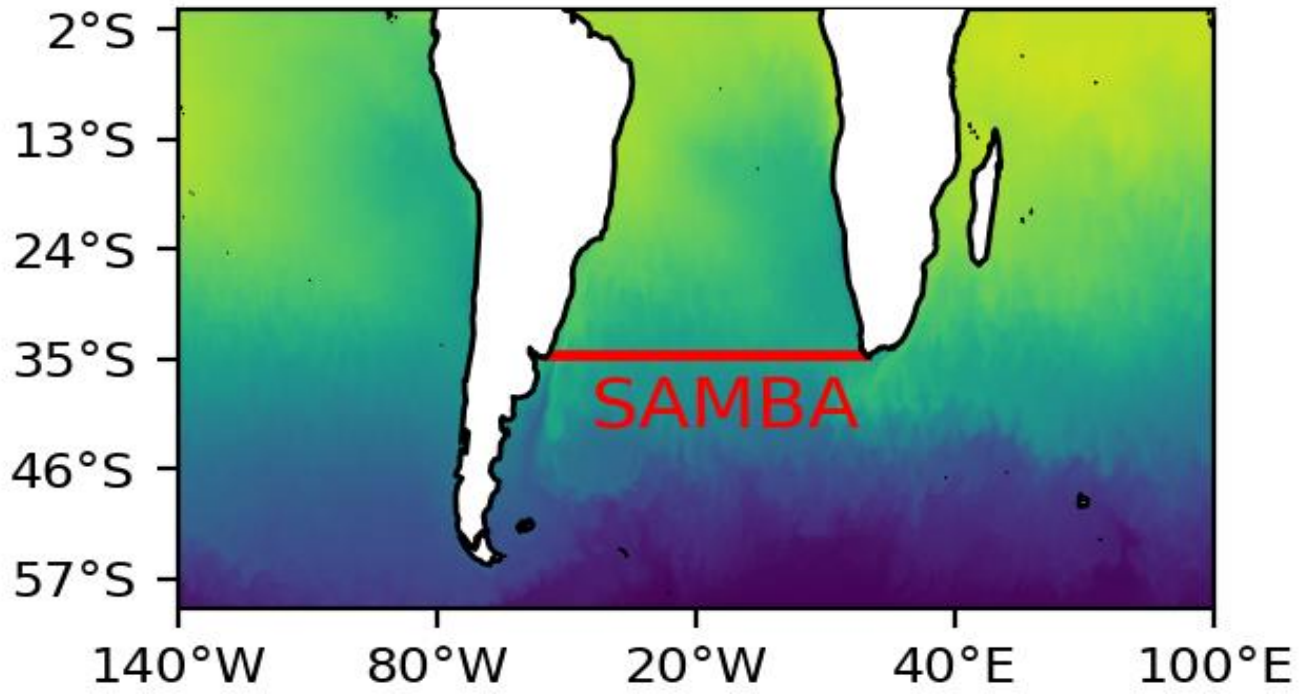
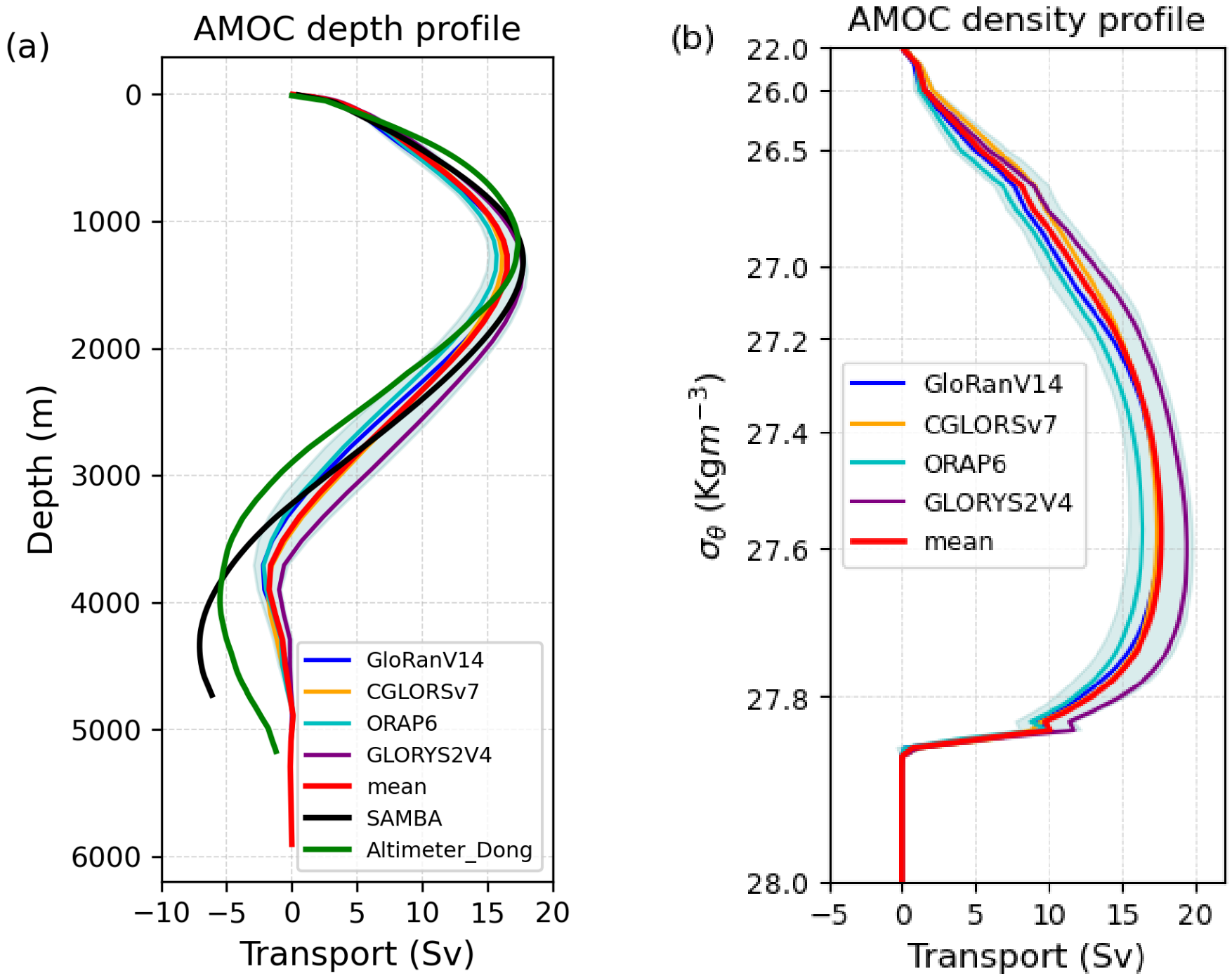


Observation and model estimates

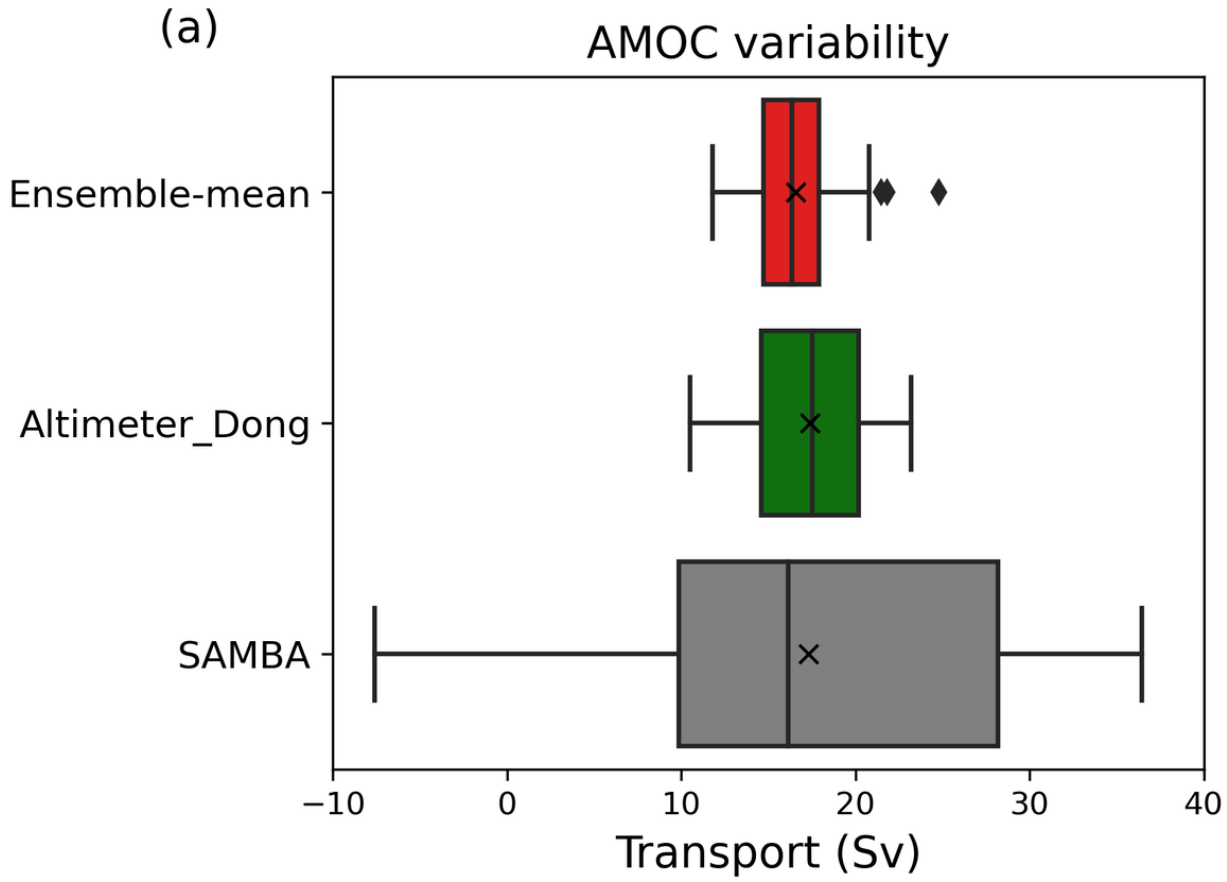
- SAMBA observations 2013-2017 (Kersalé et al., 2020, 2021)
- CMEMS ¼ degree Global ocean ensemble physics reanalysis, using C-GLORSv7, GLORYS2V4, ORAP6 and GloRanV14, 1993-2020
- CMEMS 1/12 degree Global ocean reanalysis, GLORYS12V1, 1993-2019
- NEMO ocean model but sea-ice model and DA techniques differ.
- Assimilate SST, sea level anomalies, sea-ice concentrations and in-situ temperature and salinity.
- Altimeter-based estimate 1993-2021 (Dong et al., 2021)
- Energy-budget estimates of MHT: Trenberth et al., 2019 and two estimates of Mayer et al., 2022 based on OHC tendencies from ORAS5 and ORAP6.

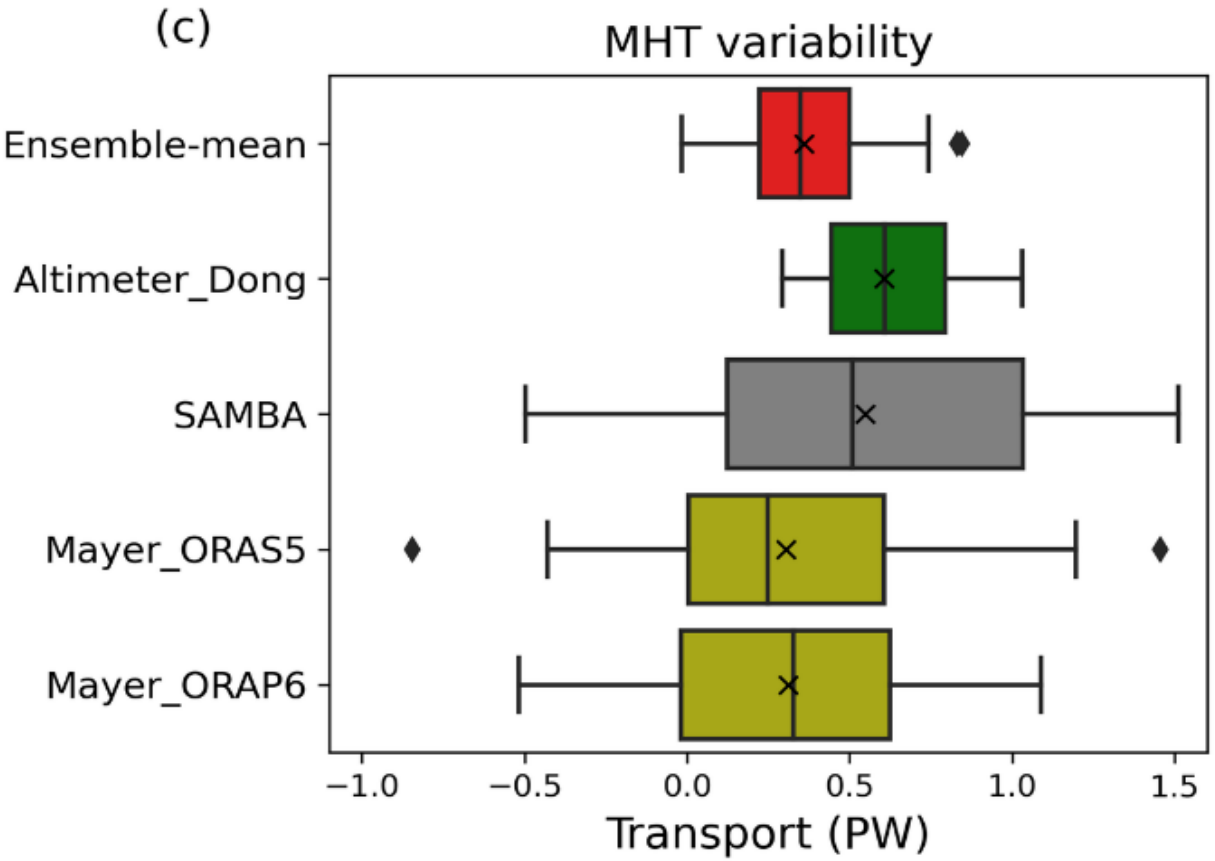
Questions

- What is the vertical structure of the overturning circulation?
- How does the time-mean and variability of transports in reanalyses compare with SAMBA and other estimates?
- What do reanalyses tell us about past changes in transports?

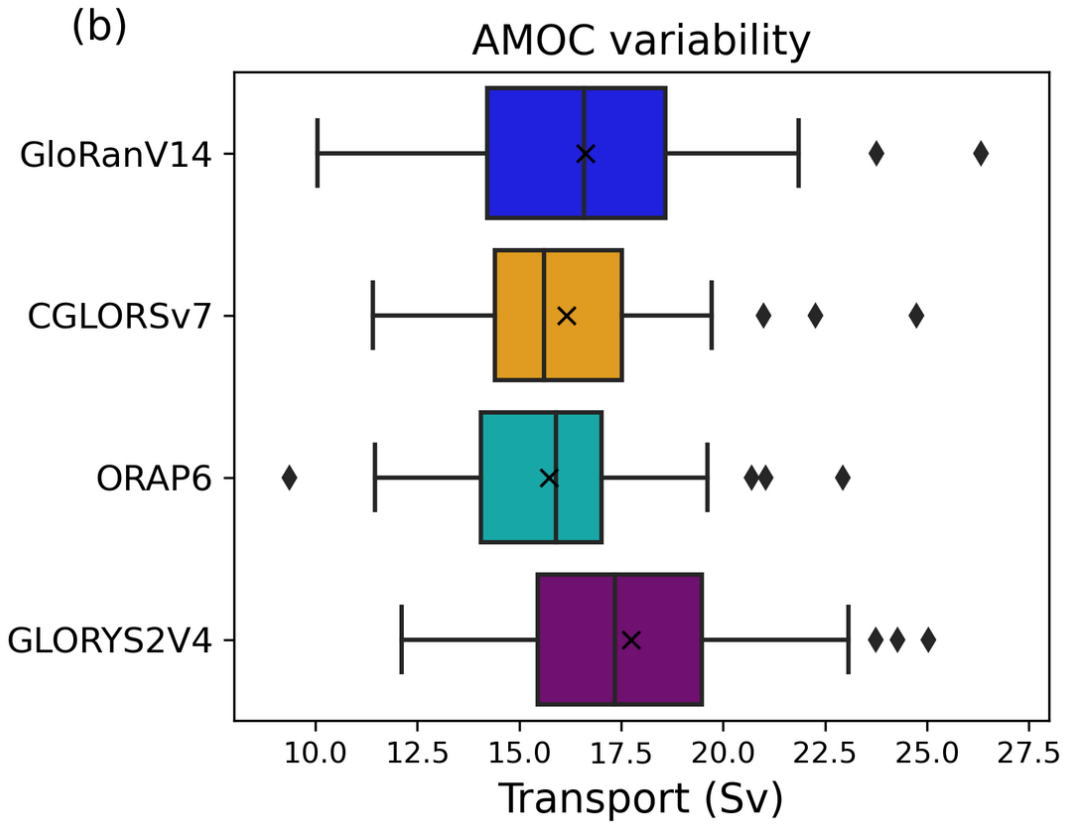

(a)
AMOC depth profile
Depth (m)
0
1000
2000
3000
4000
5000
6000
−10
−5
0
5
10
15
20
Transport (Sv)
GloRanV14
CGLORSv7
ORAP6
GLORYS2V4
mean
SAMBA
Altimeter_Dong
(b)
AMOC density profile
σ_θ (Kgm^{-3})
22.0
26.0
26.5
27.0
27.2
27.4
27.6
27.8
28.0
−5
0
5
10
15
20
Transport (Sv)
GloRanV14
CGLORSv7
ORAP6
GLORYS2V4
mean

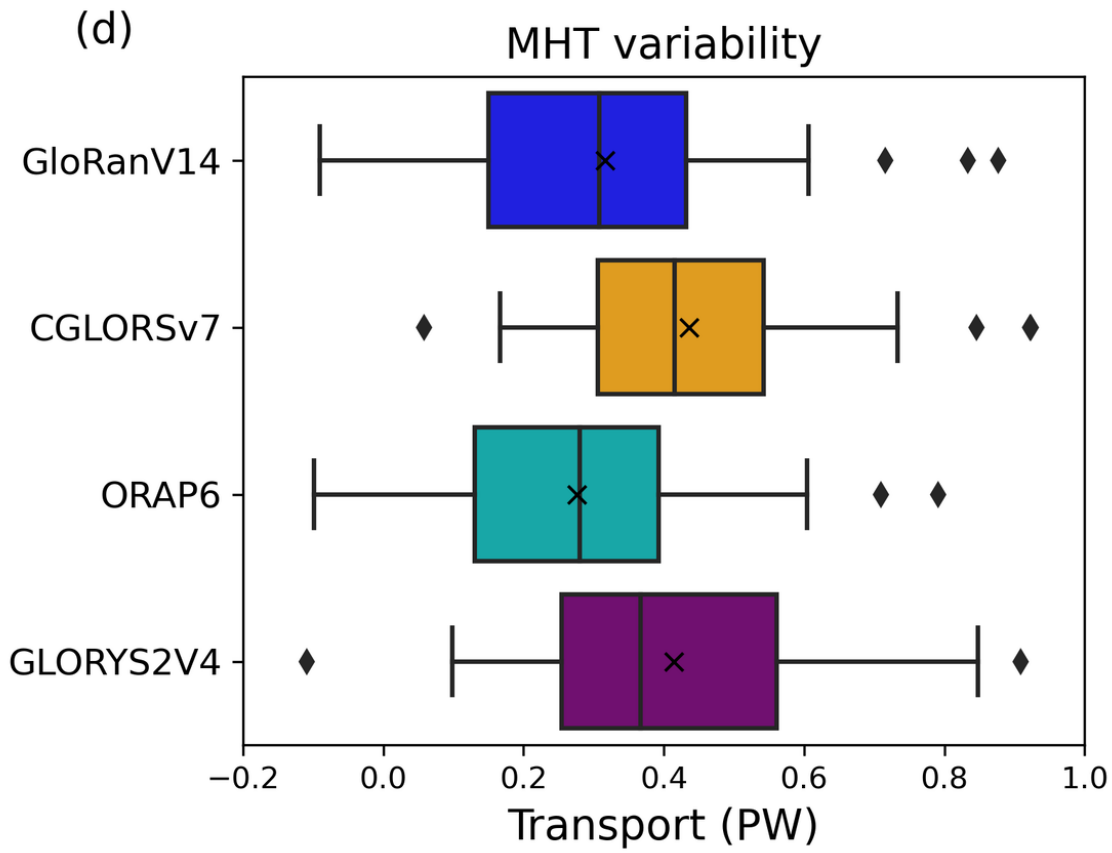
Monthly-mean variability

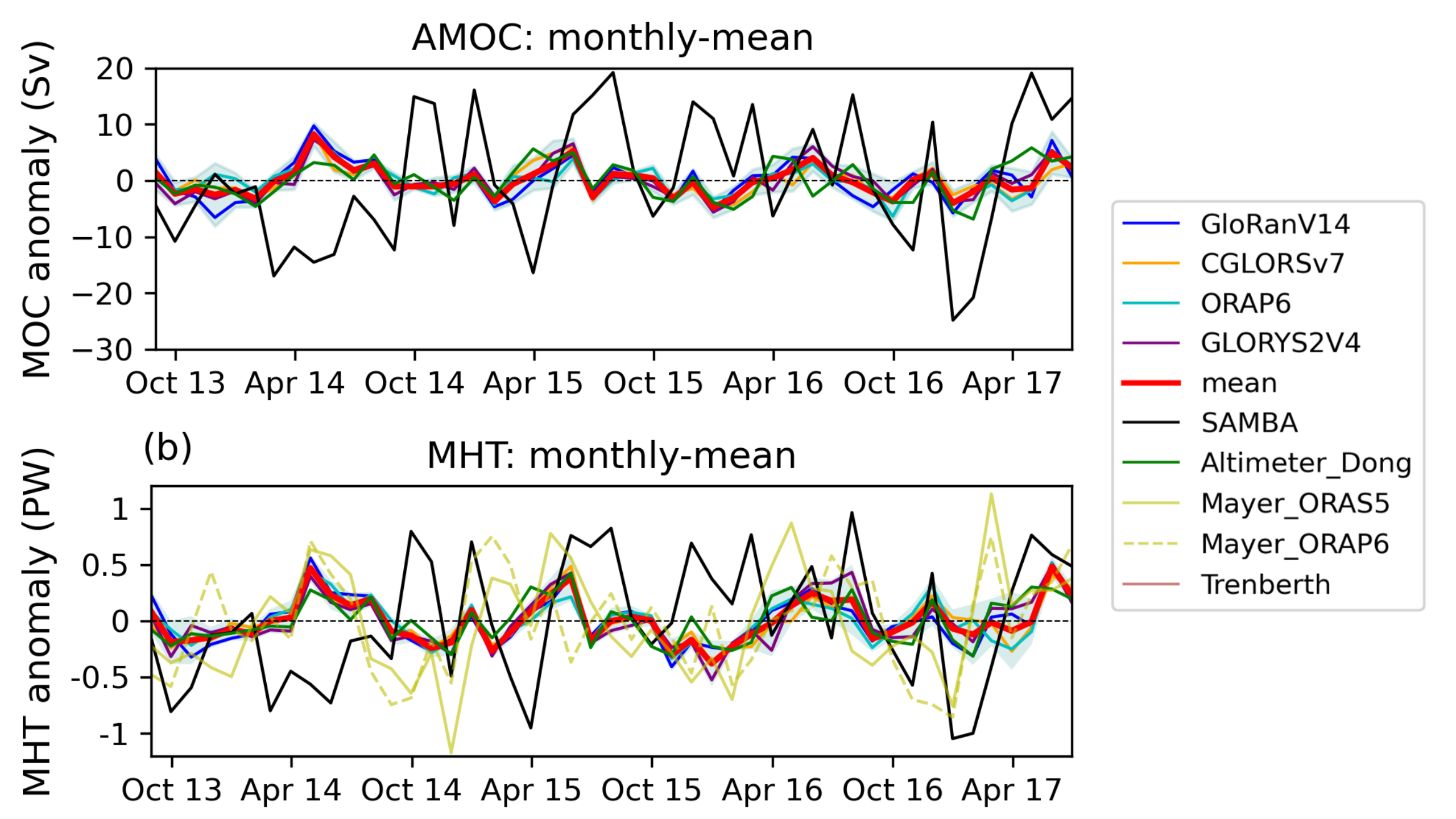


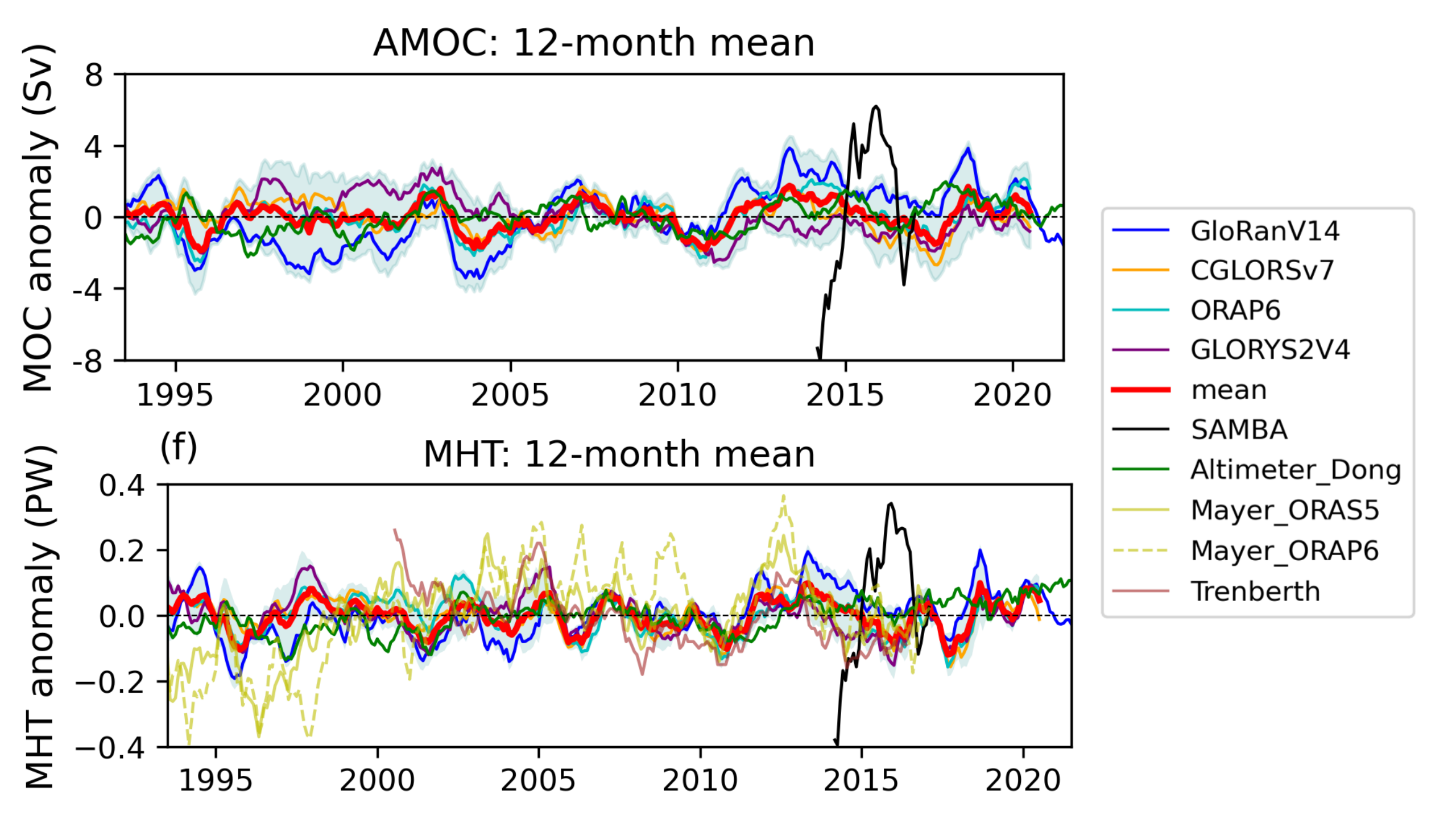


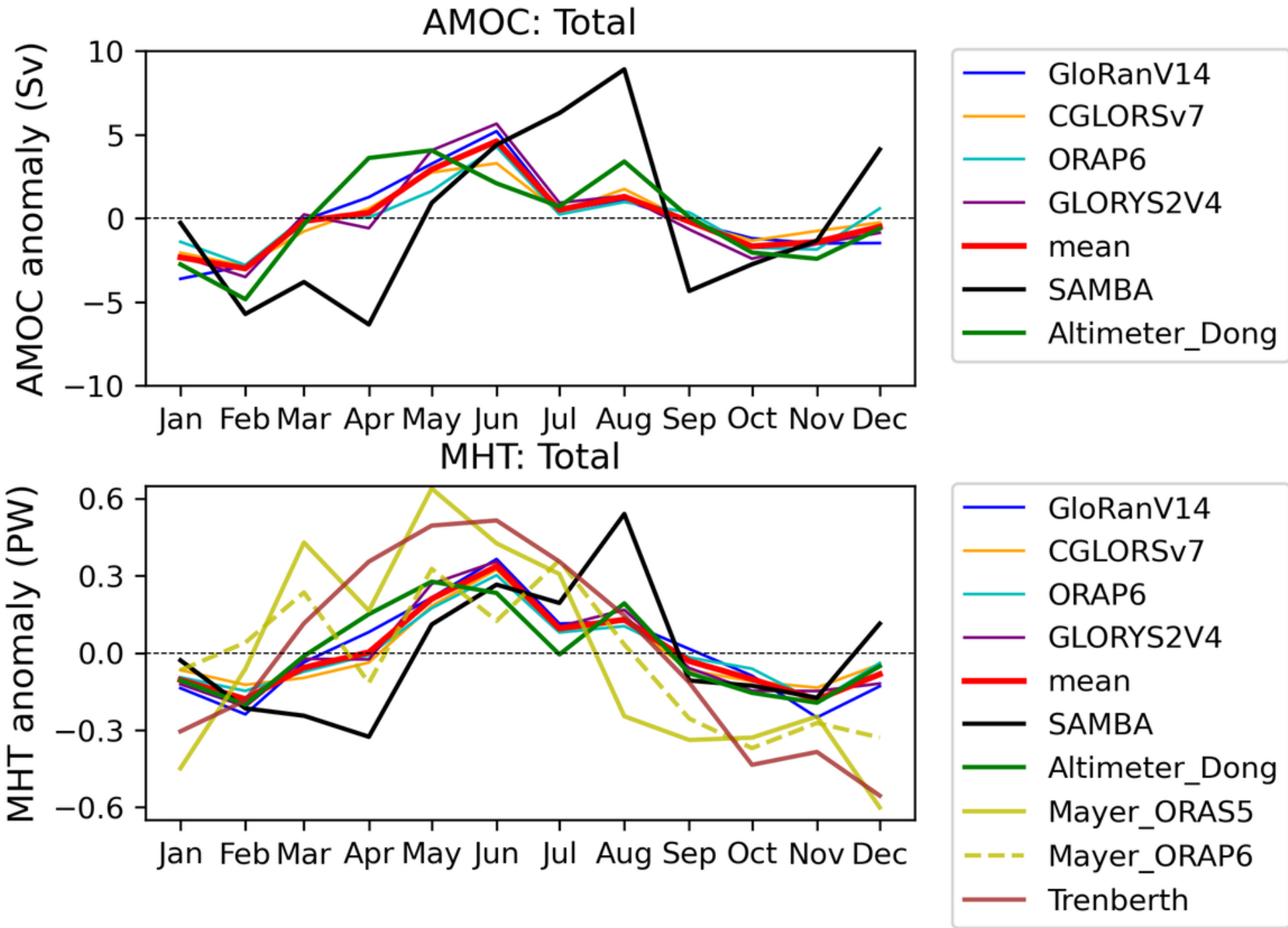
Monthly-mean variability

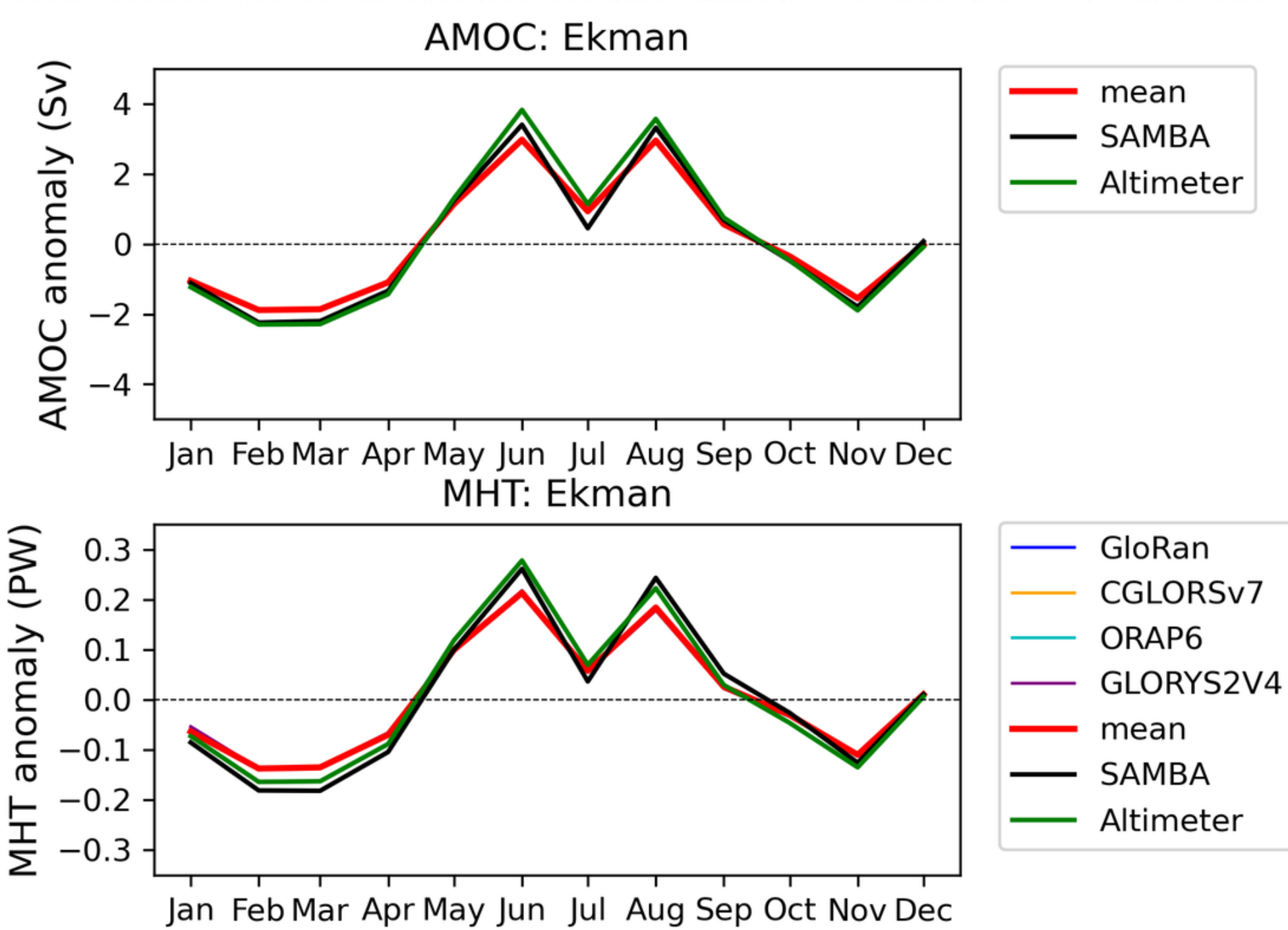


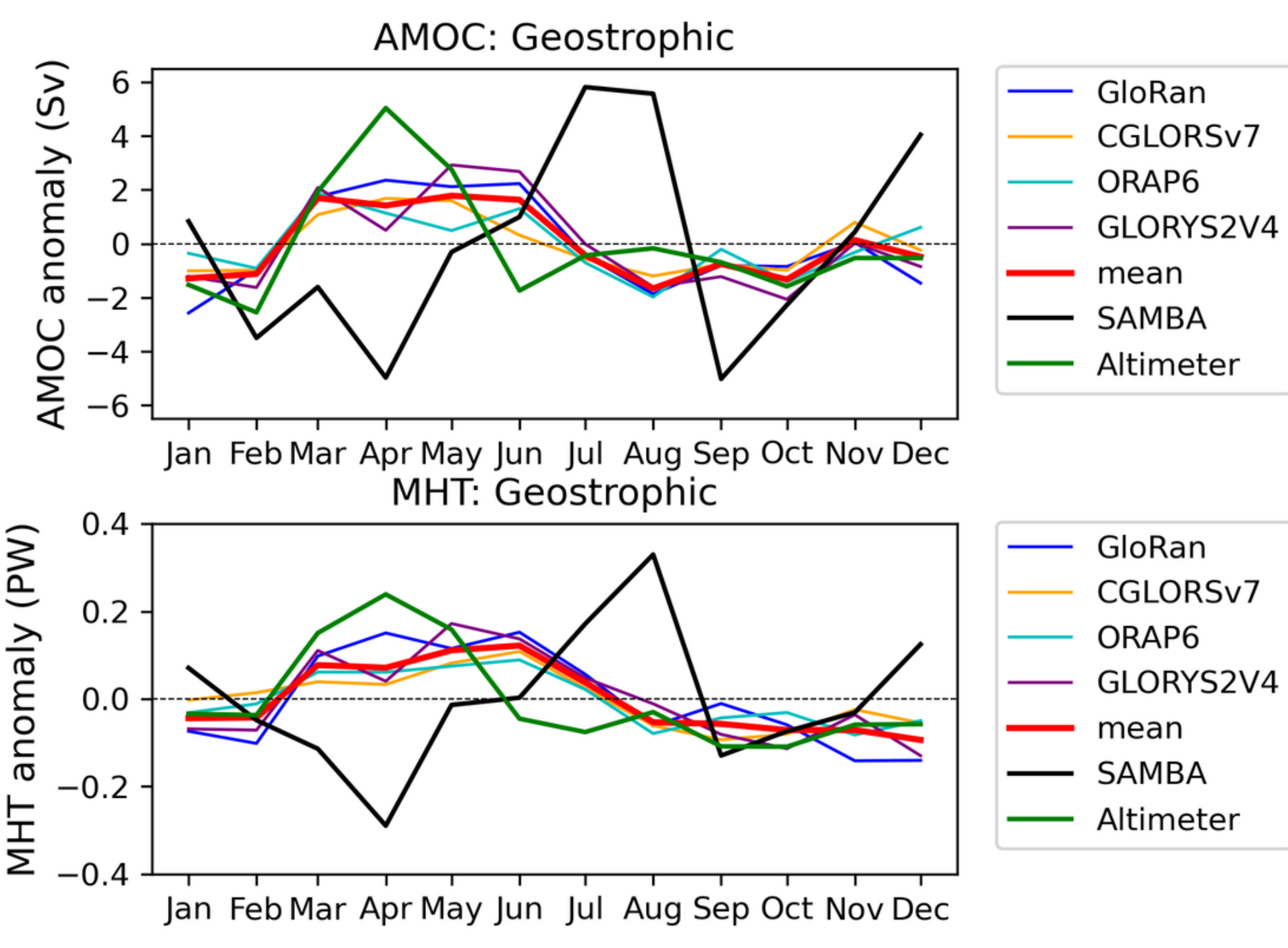



AMOC: monthly-mean
MOC anomaly (Sv)
20
10
0
−10
−20
−30
Oct 13
Apr 14
Oct 14
Apr 15
Oct 15
Apr 16
Oct 16
Apr 17
(b)
MHT: monthly-mean
MHT anomaly (PW)
1
0.5
0
-0.5
-1
Oct 13
Apr 14
Oct 14
Apr 15
Oct 15
Apr 16
Oct 16
Apr 17
GloRanV14
CGLORSv7
ORAP6
GLORYS2V4
mean
SAMBA
Altimeter_Dong
Mayer_ORAS5
Mayer_ORAP6
Trenberth


AMOC: 12-month mean
MOC anomaly (Sv)
8
4
0
-4
-8
1995
2000
2005
2010
2015
2020
(f)
MHT: 12-month mean
MHT anomaly (PW)
0.4
0.2
0.0
−0.2
−0.4
1995
2000
2005
2010
2015
2020
GloRanV14
CGLORSv7
ORAP6
GLORYS2V4
mean
SAMBA
Altimeter_Dong
Mayer_ORAS5
Mayer_ORAP6
Trenberth


AMOC: Total
AMOC anomaly (Sv)
10
5
0
−5
−10
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
GloRanV14
CGLORSv7
ORAP6
GLORYS2V4
mean
SAMBA
Altimeter_Dong
MHT: Total
MHT anomaly (PW)
0.6
0.3
0.0
−0.3
−0.6
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
GloRanV14
CGLORSv7
ORAP6
GLORYS2V4
mean
SAMBA
Altimeter_Dong
Mayer_ORAS5
Mayer_ORAP6
Trenberth


AMOC: Ekman
AMOC anomaly (Sv)
4
2
0
−2
−4
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
mean
SAMBA
Altimeter
MHT: Ekman
MHT anomaly (PW)
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
GloRan
CGLORSv7
ORAP6
GLORYS2V4
mean
SAMBA
Altimeter


AMOC: Geostrophic
AMOC anomaly (Sv)
6
4
2
0
−2
−4
−6
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
GloRan
CGLORSv7
ORAP6
GLORYS2V4
mean
SAMBA
Altimeter
MHT: Geostrophic
MHT anomaly (PW)
0.4
0.2
0.0
−0.2
−0.4
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
GloRan
CGLORSv7
ORAP6
GLORYS2V4
mean
SAMBA
Altimeter

Conclusions

- Ensemble of reanalyses provides useful estimate of South Atlantic overturning and heat transport
- Similar to monthly variability of altimeter-based estimate
- Large differences with SAMBA observations and energy-budget estimates
- Large differences in time-mean heat transport but time-mean overturning similar
- Differences due to the Geostrophic component
- Reanalyses could help understand differences

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