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ATMOSPHERIC SCIENCE

Sensitivity of the MOC seasonal cycle to wind forcing

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GOALS: Use observations and high-resolution coupled climate and ocean-only simulations to analyze the sensitivity of the MOC seasonal cycle to wind forcing at latitudes of the RAPID/MOCHA array (26.5°N) and the developing SAMOC Basin-Wide Array (34.5°S); identify mechanisms controlling the structure of the seasonal cycle and its coherence across the Atlantic.

Observed and simulated seasonal cycles obtained from:

RAPID/MOCHA MOC data (26.5°N; 2004-2011)
AX18 XBT sections (34.5°S; 2002-2008)
Scatterometer **C**limatology of **O**cean **W**inds (1999-2009)

e.g., Cunningham et al., 2007; Dong et al., 2009; Risien and Chelton, 2008

NOAA/GFDL **CM2.5** (0.25°; yr: 21-30)
NOAA/GFDL CM2.5 **CORE** forcing (0.25°; yr: 21-30)
OGCM **F**or the **E**arth **S**imulator (0.1°; 1997-2006; NCEP)

Forced (applies to the last two entries)

e.g., Delworth et al., 2012; Masumoto et al., 2004; Sasaki et al., 2008

Observed northward volume transport by upper limb of AMOC

At 26.5°N:

$\propto -\tau_x$ $\qquad$ $\propto (\nabla \times \vec{\tau}) \cdot \hat{k}$

MOC = Gulf Stream + Ekman + Upper Midocean + Comp

e.g., Cunningham et al., 2007; Kanzow et al., 2007, 2010; Rayner et al., 2011

At 34.5°S:

MOC = Ekman + Geostrophic + Comp

e.g., Dong et al., 2009; Garzoli et al., 2013; Meinen et al., submitted

Observed seasonal cycle at 26.5°N

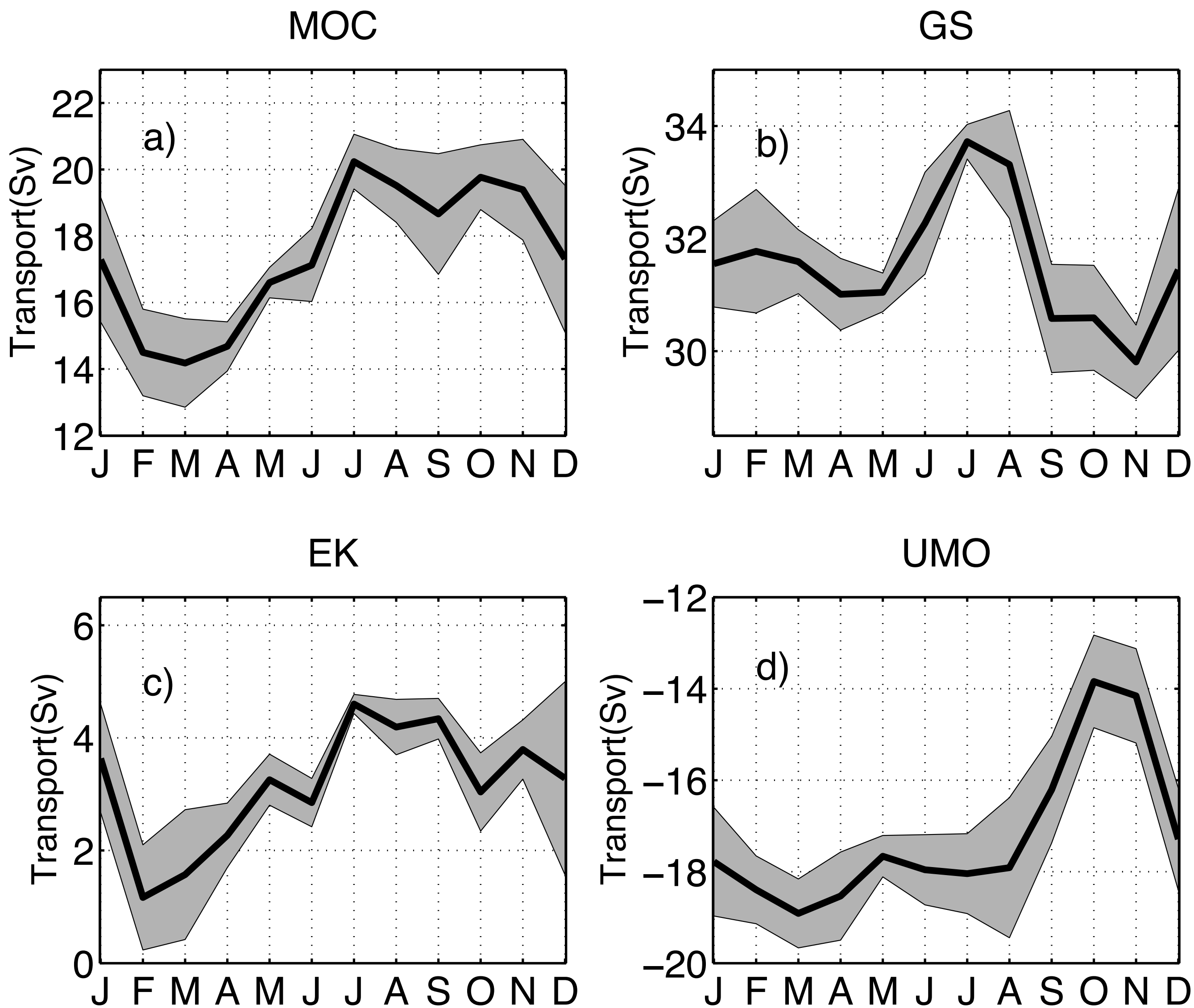
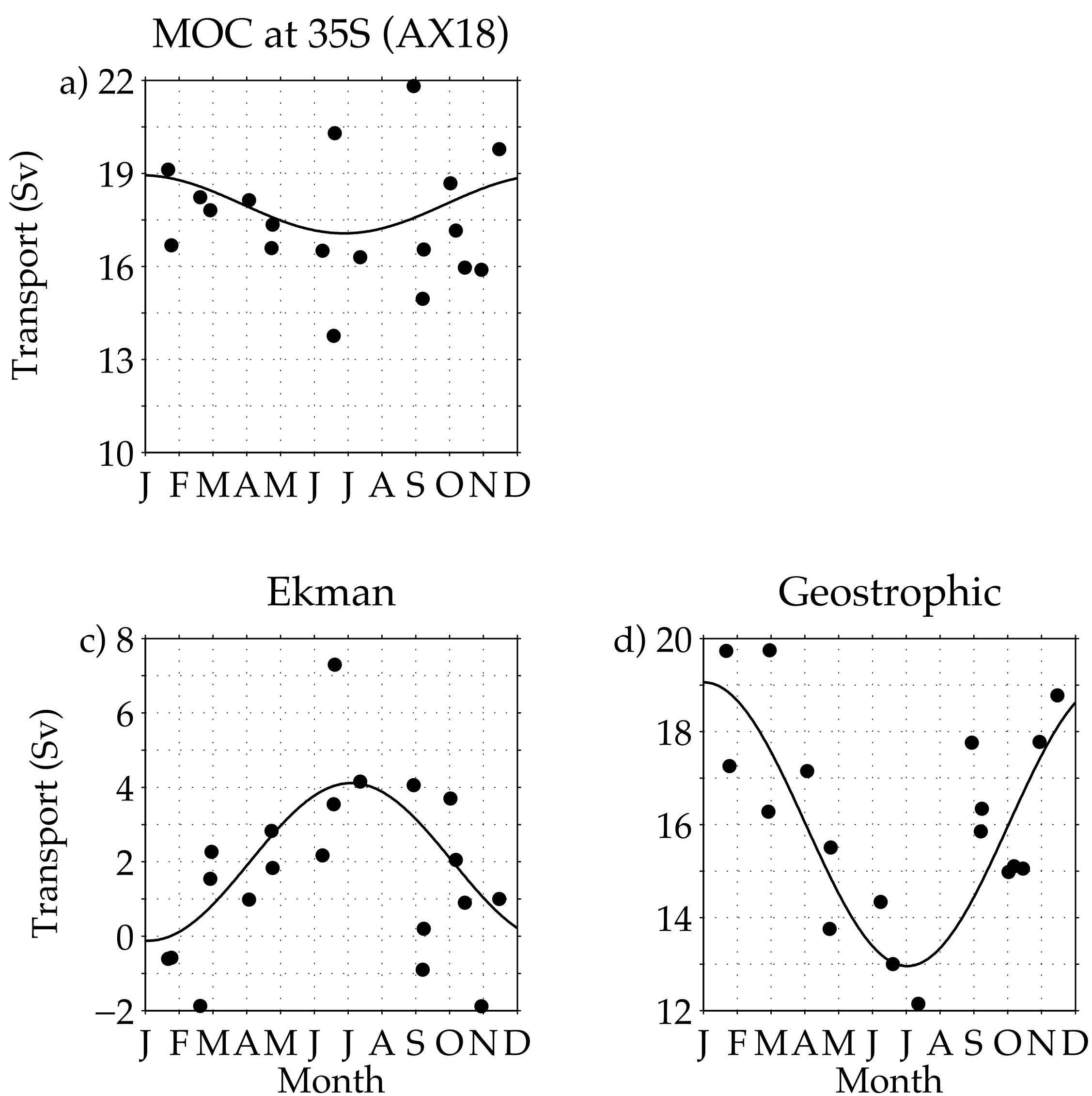


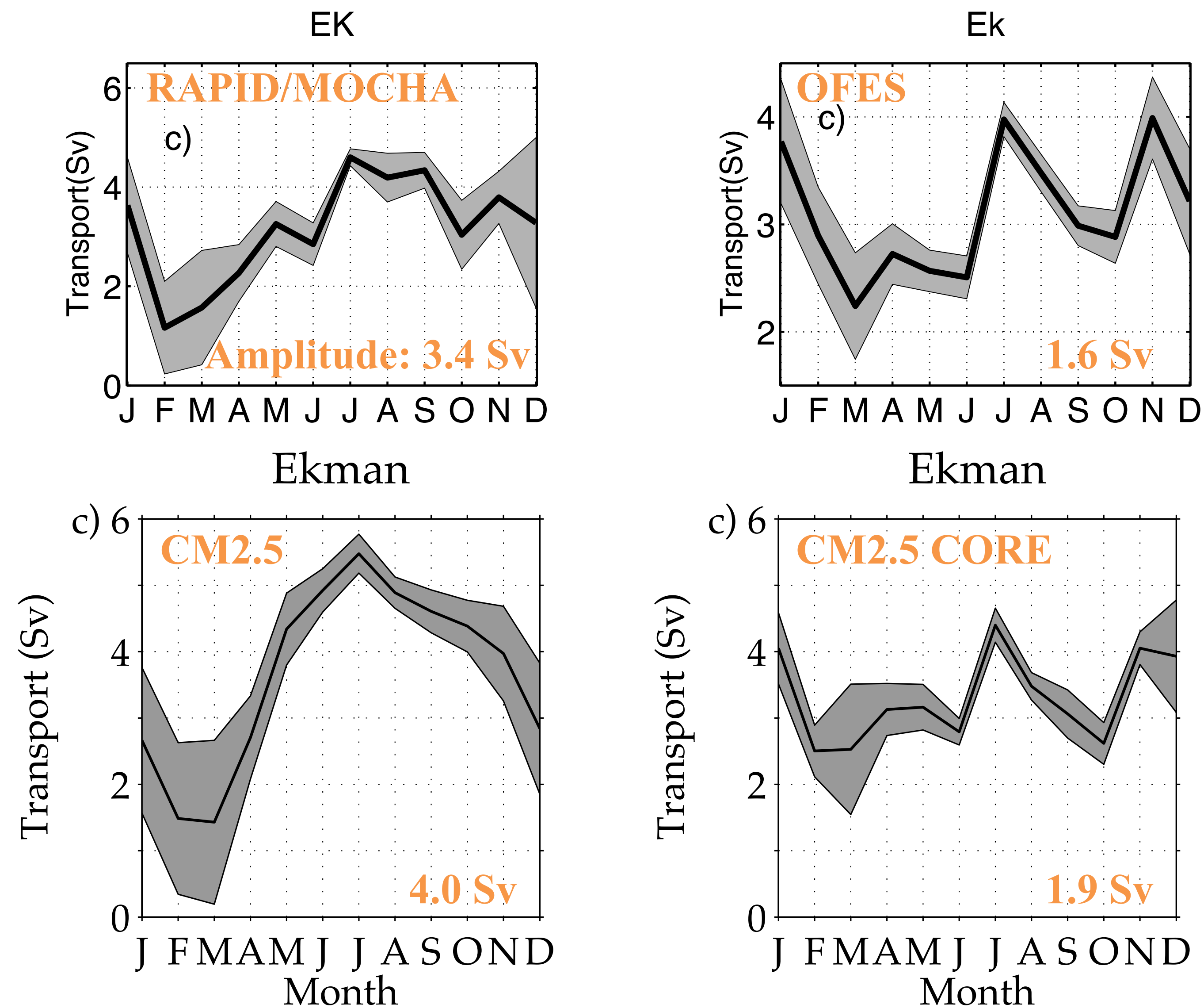
Figure 3 from Zhao and Johns, submitted

Observed seasonal cycle at 34.5°S



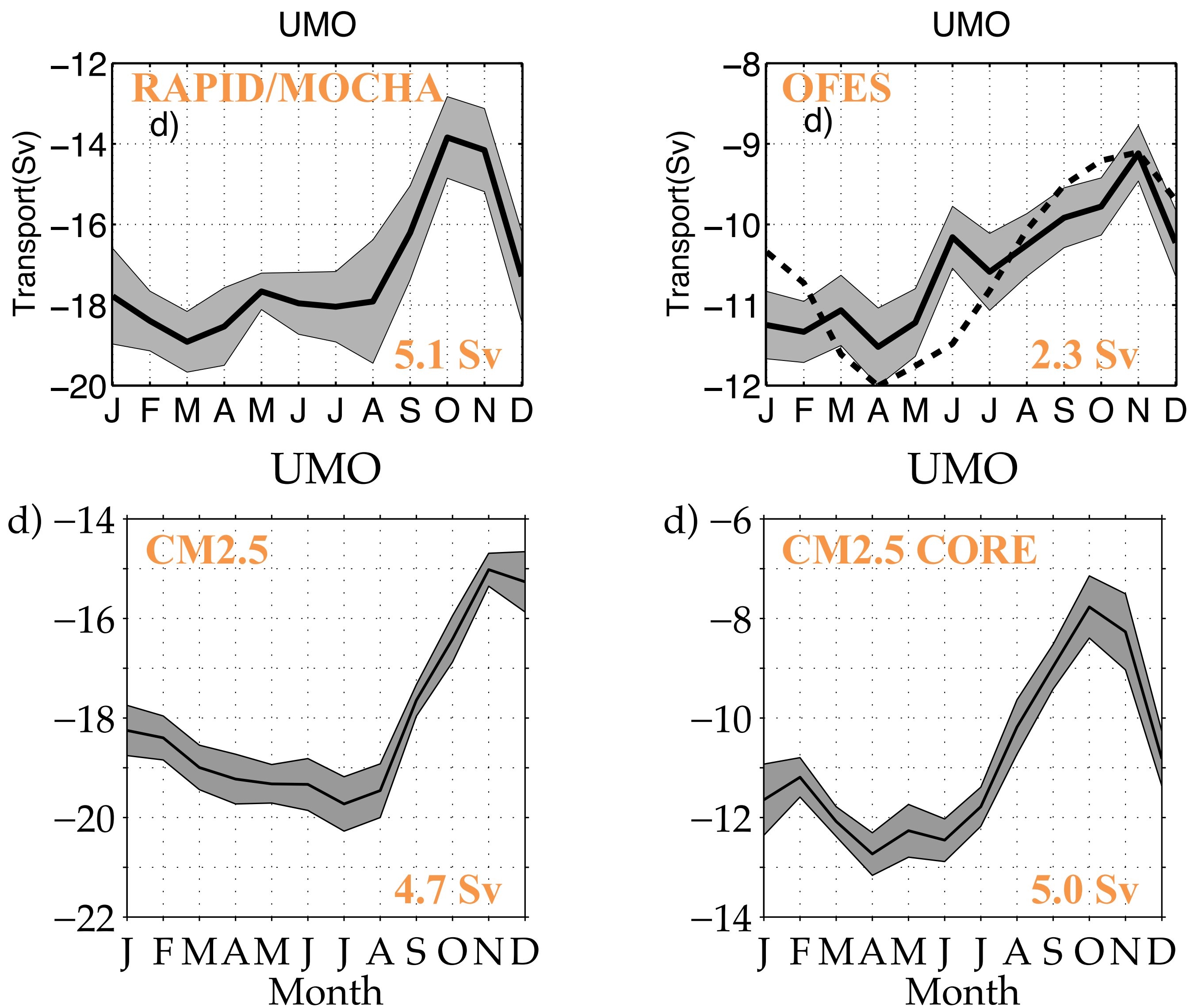
Modified from Dong et al., 2009; Garzoli et al., 2013

Ekman transport seasonal cycle at 26.5°N



Top panels: Figure 3c, 4c from Zhao and Johns, submitted

UMO transport seasonal cycle at 26.5°N



Top panels: Figure 3d, 4d from Zhao and Johns, submitted

Wind stress curl seasonal cycle and forced Rossby wave response at 26.5°N

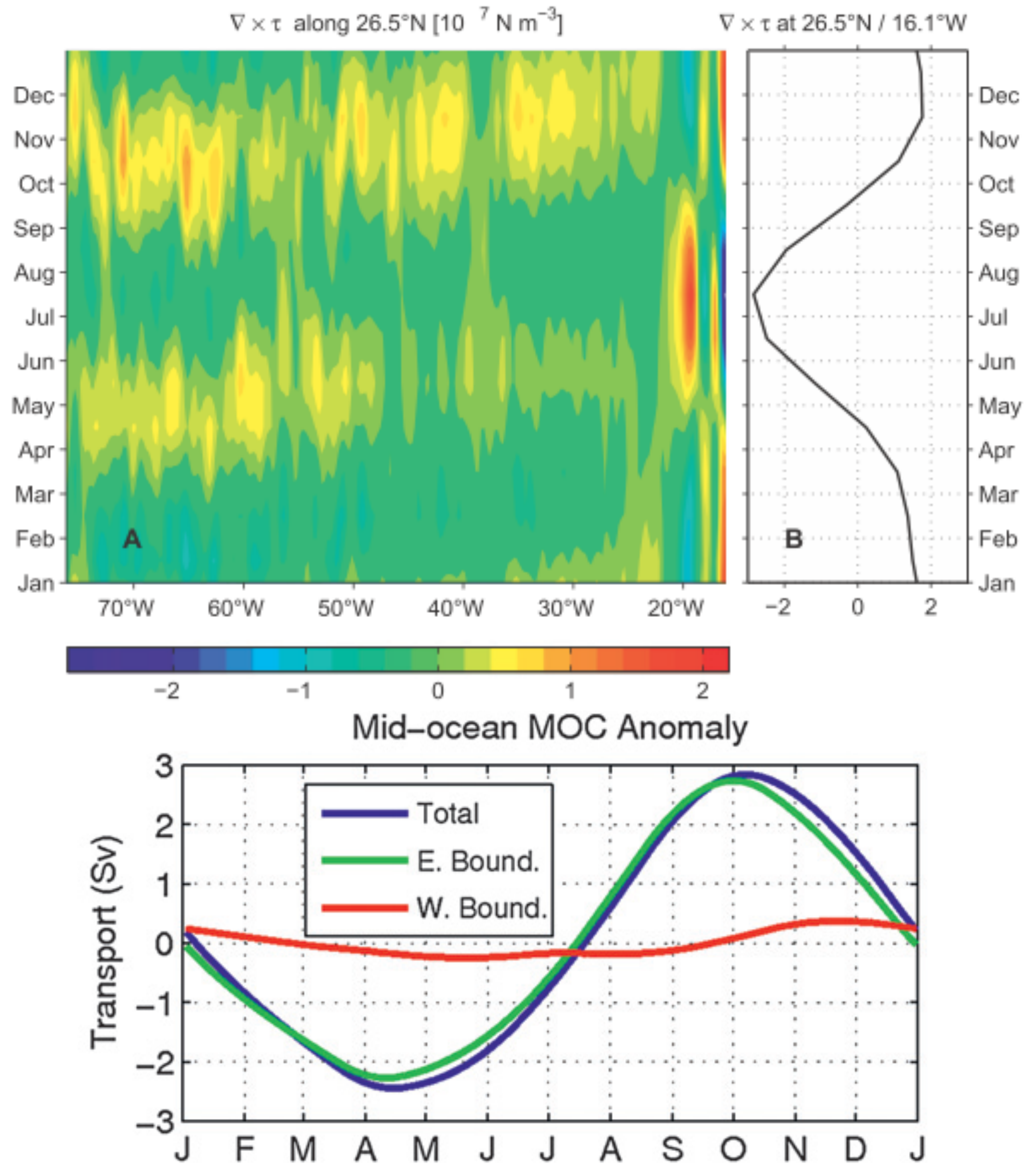
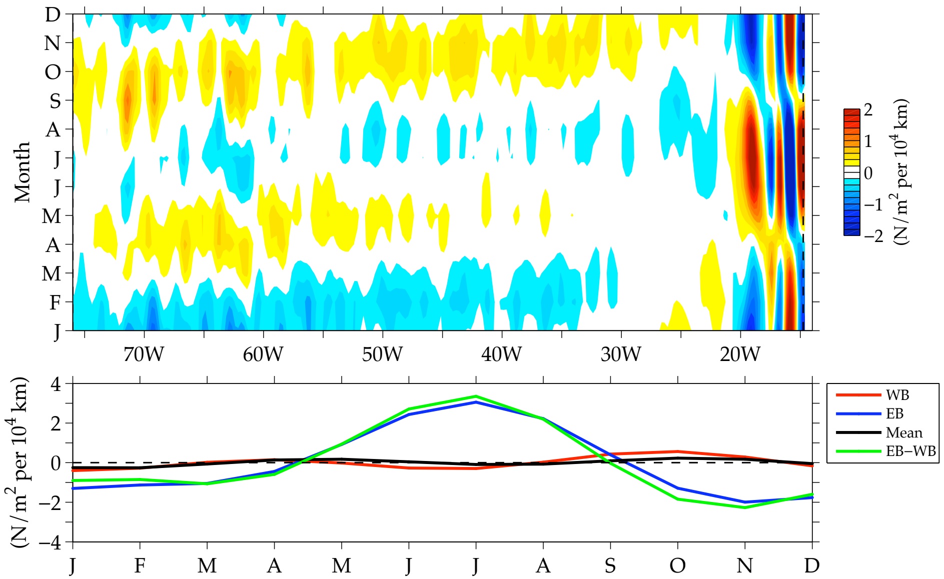


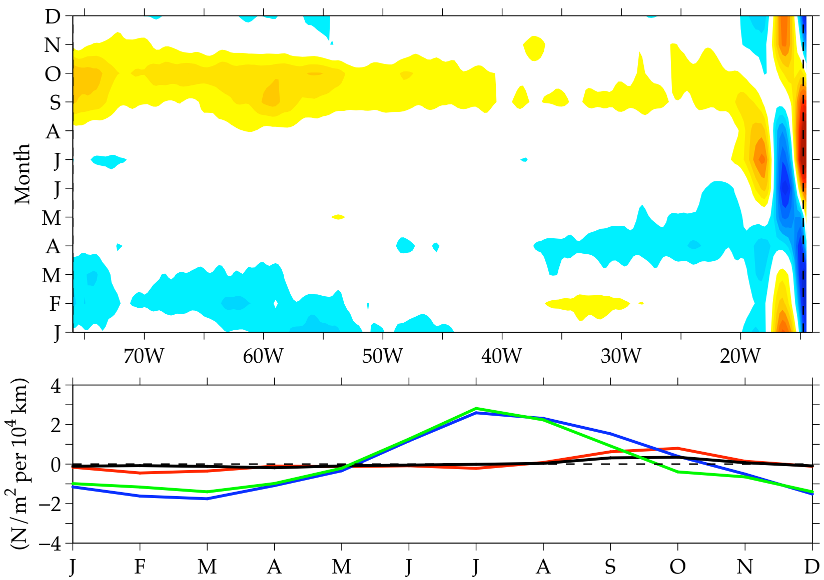
Figure 13,14a from Kanzow et al. (2010)

Wind stress curl seasonal cycle at 26.5°N

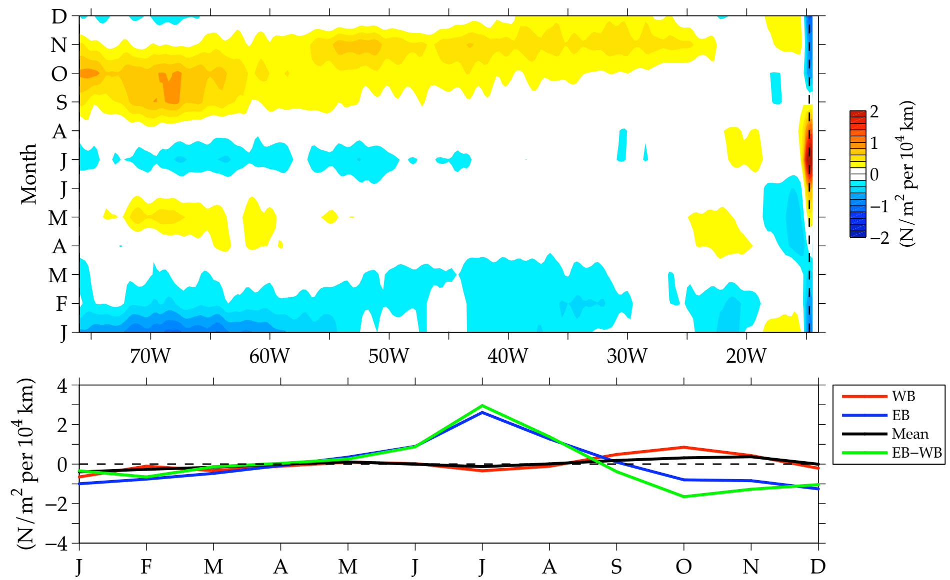
SCOW



CM2.5



CM2.5 CORE

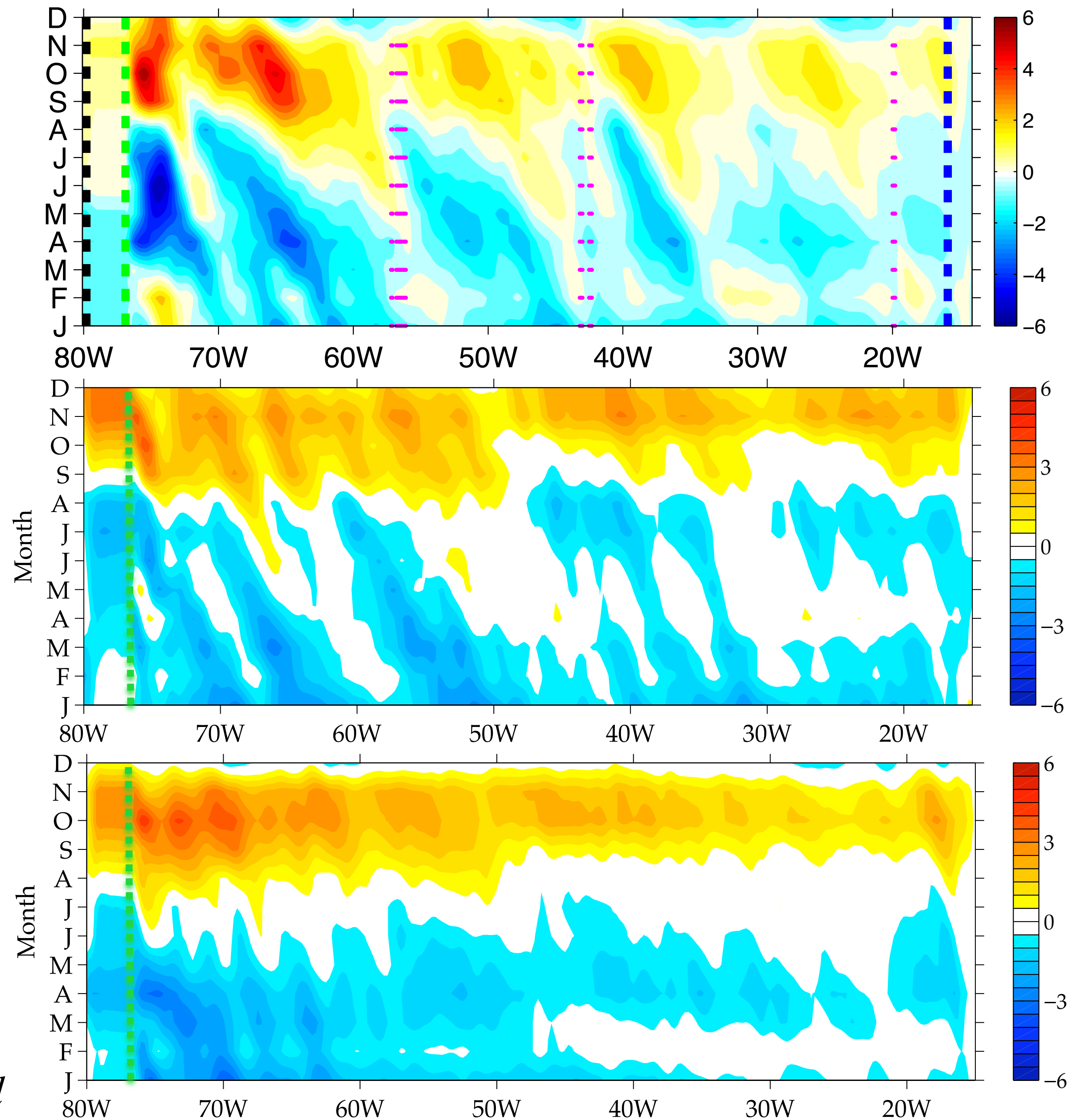


Zonally cumulative geostrophic transport seasonal cycle: 26.5°N

OFES

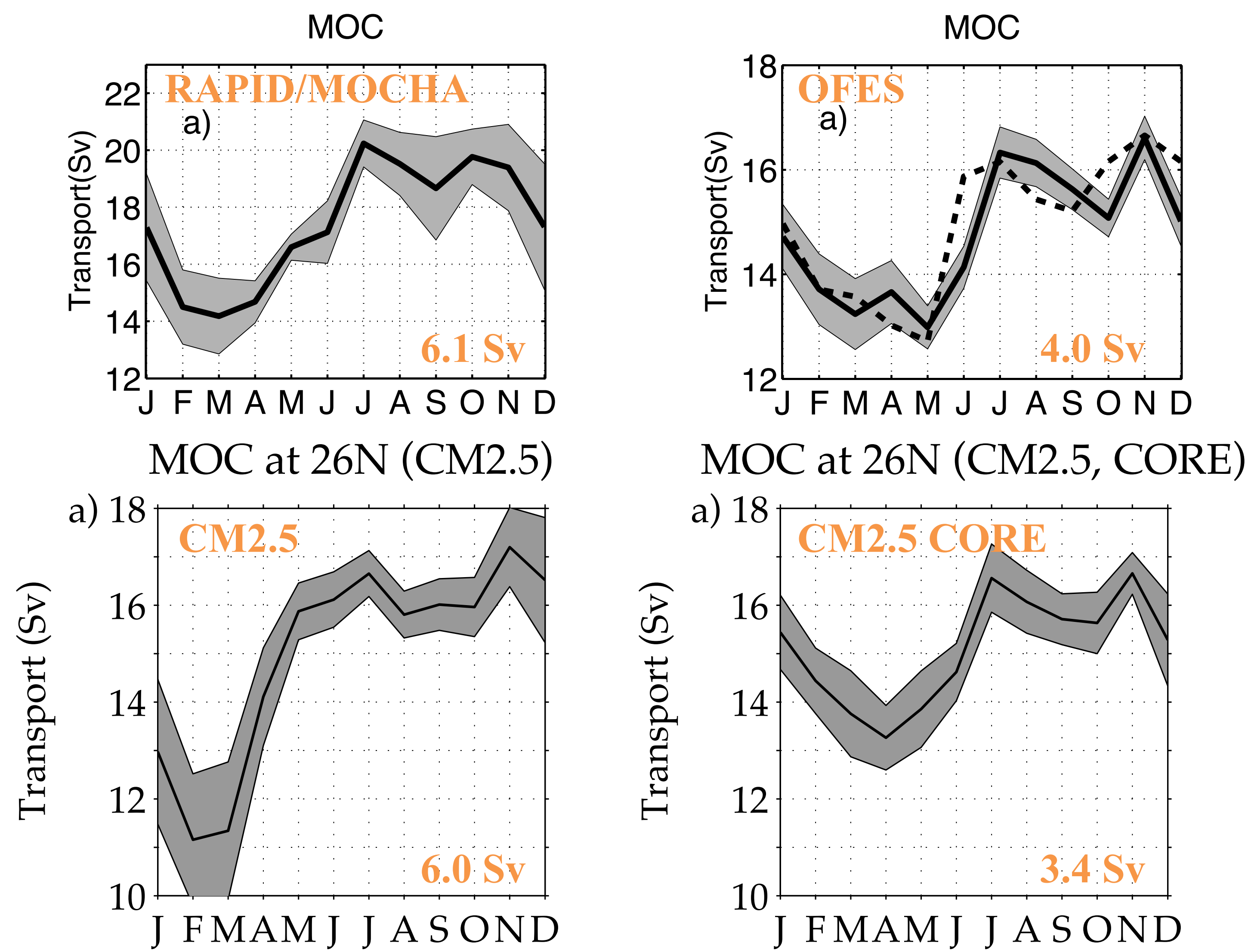
CM2.5

CM2.5 CORE



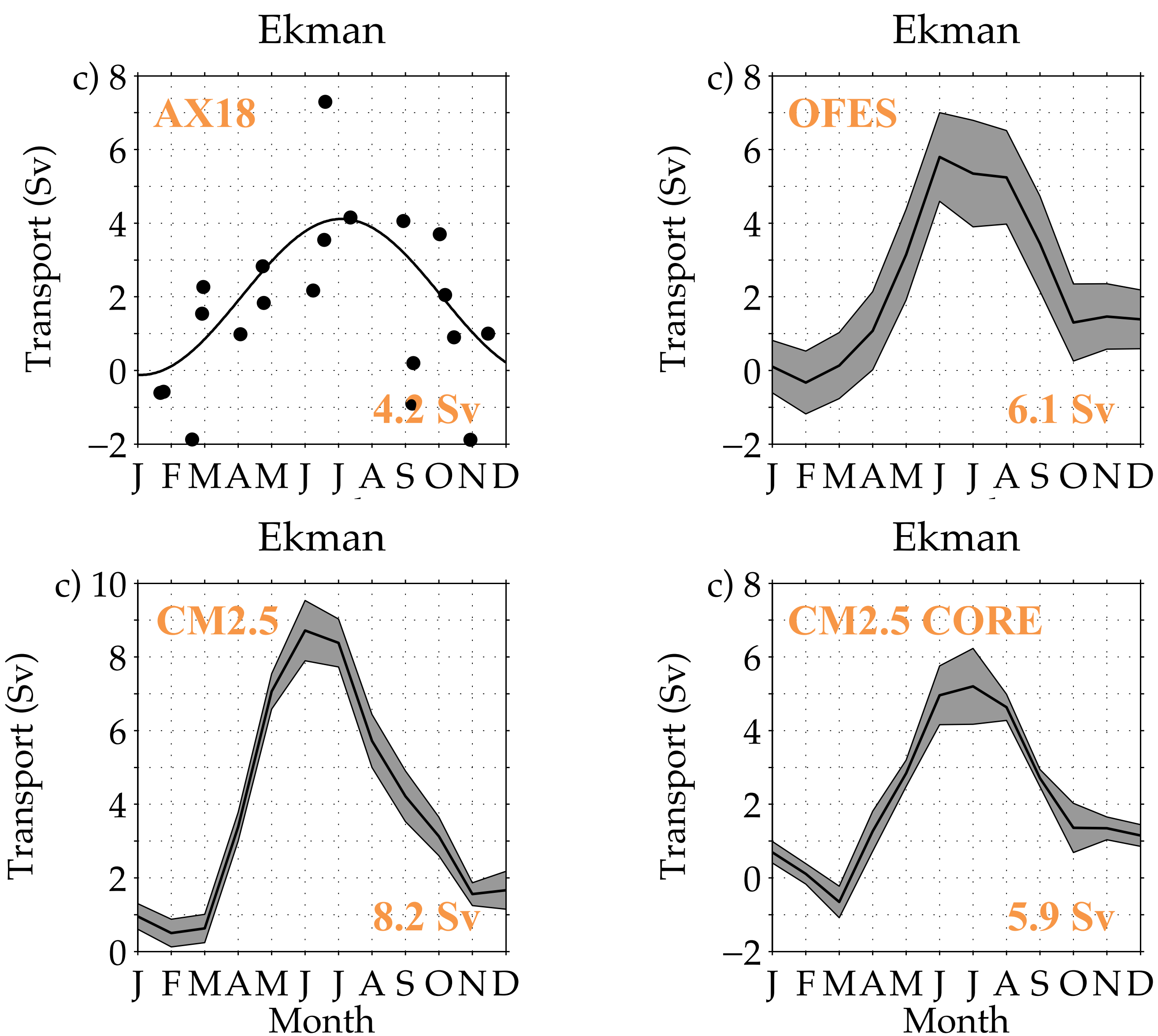
Top panel: Fig. 7a from Zhao and Johns, submitted

MOC transport seasonal cycle at 26.5°N

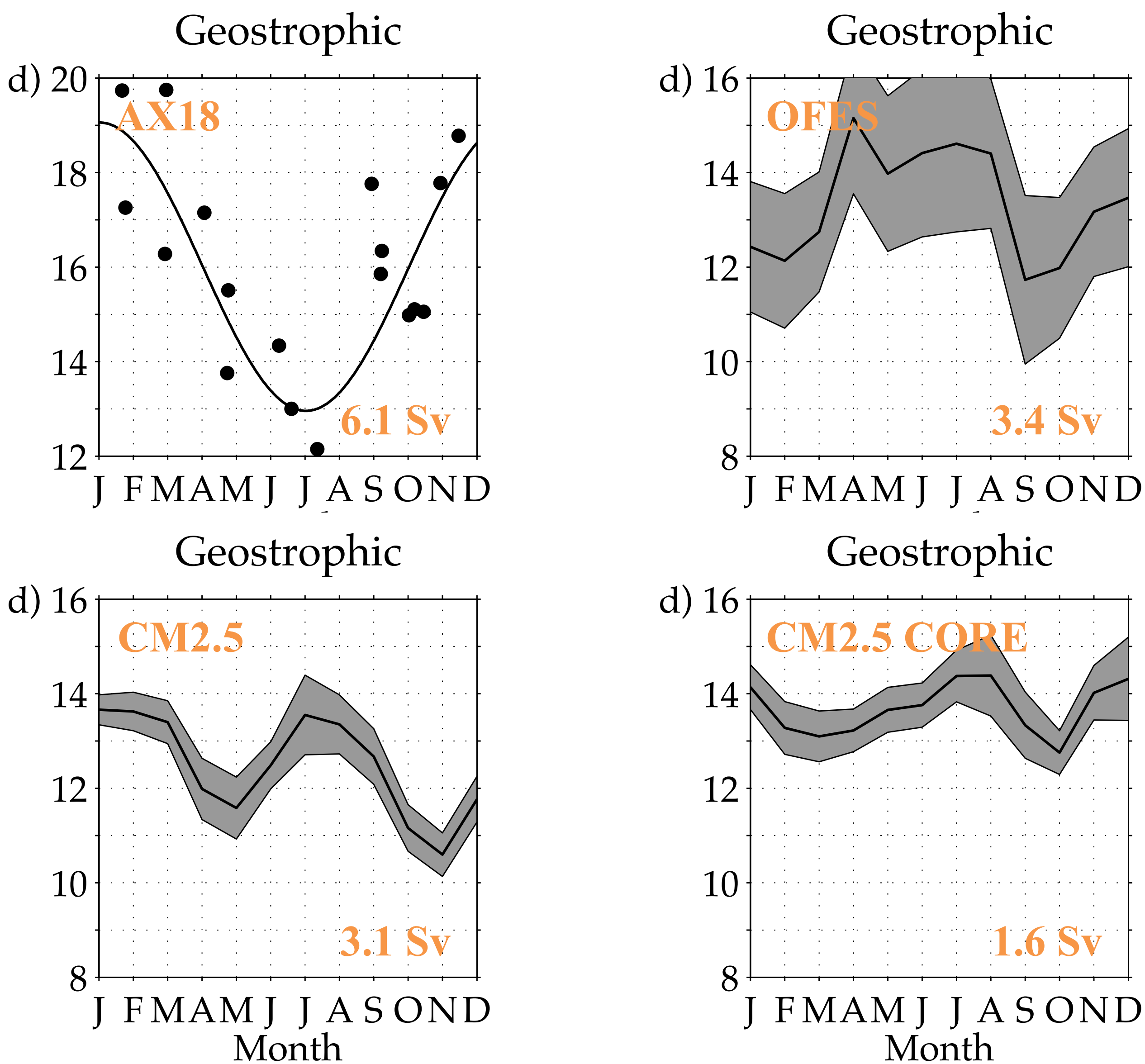


Top panels: Figure 3a, 4a from Zhao and Johns, submitted

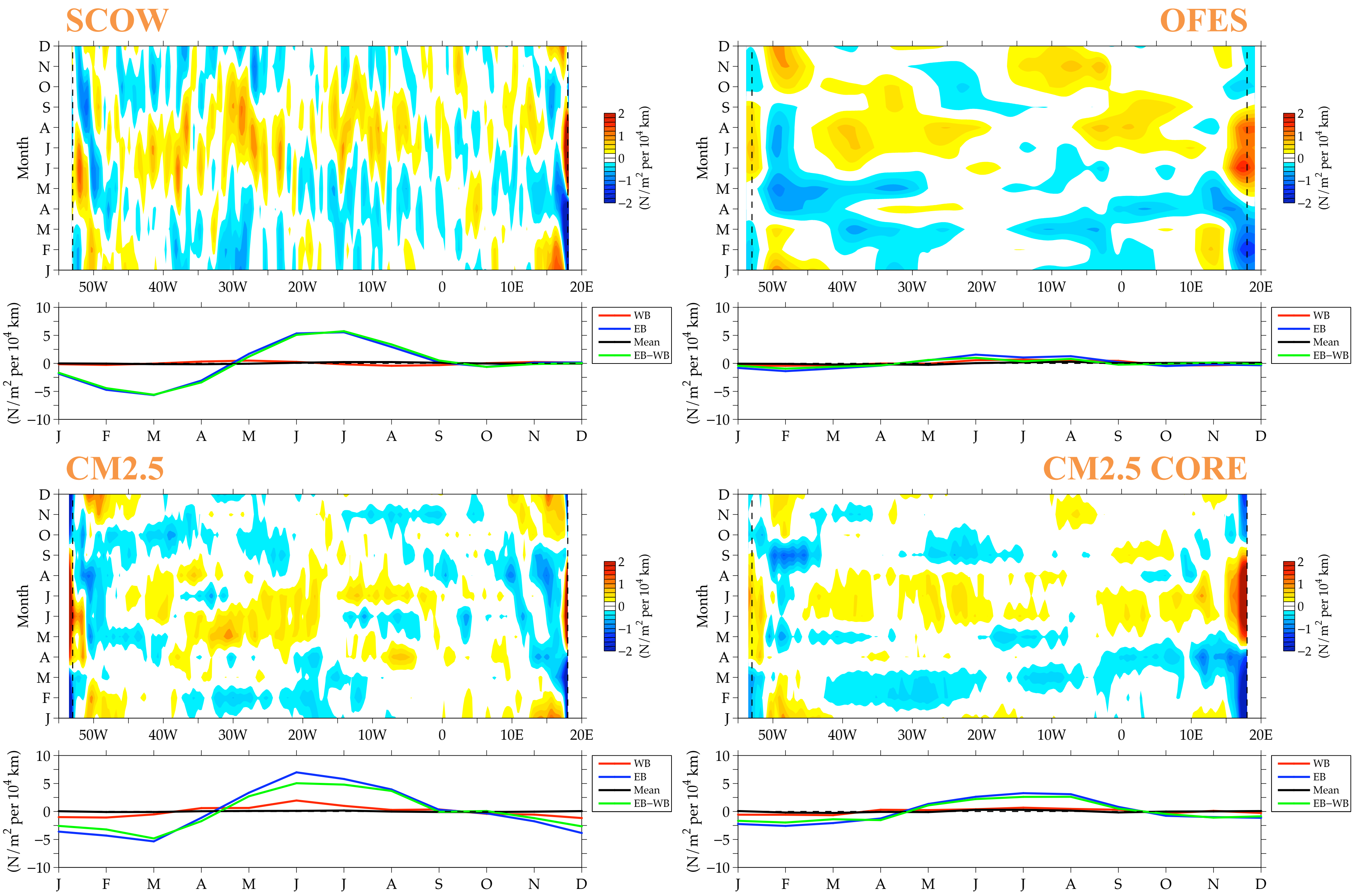
Ekman transport seasonal cycle at 34.5°S



Geostrophic transport seasonal cycle at 34.5°S



Wind stress curl seasonal cycle at 34.5°S

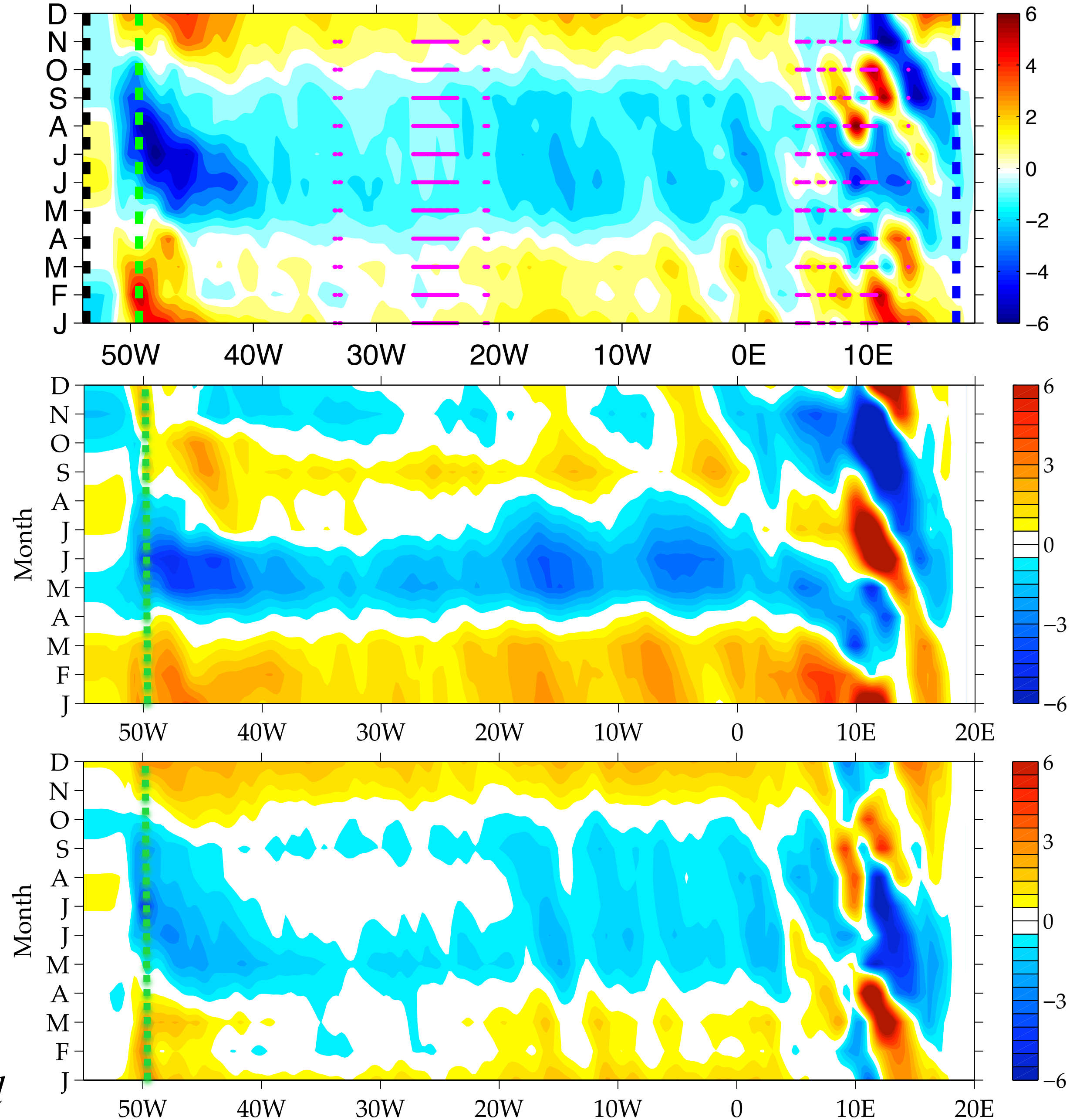


Zonally cumulative geostrophic transport seasonal cycle: 34.5°S

OFES

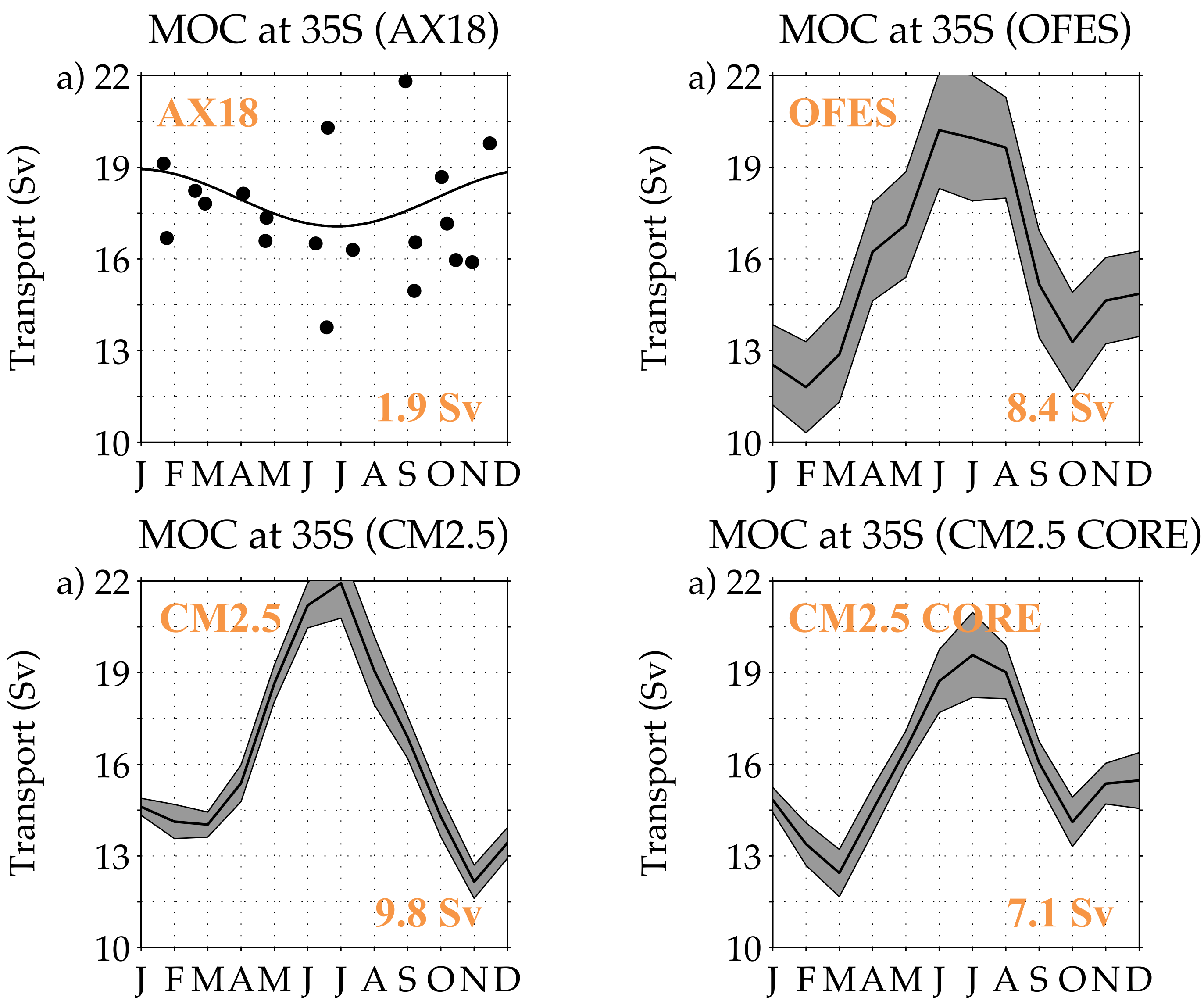
CM2.5

CM2.5 CORE



Top panel: Fig. 14a from Zhao and Johns, submitted

MOC transport seasonal cycle at 34.5°S



In summary

Simulated Ekman and UMO transport seasonal cycles are in-phase with observed seasonal cycle (and each other) at 26.5°N. **CM2.5** total MOC seasonal cycle agrees best with **RAPID/MOCHA**.

Simulated Ekman transport seasonal cycle are in-phase with observed seasonal cycle at 34.5°S (and 26.5°N), although too strong. Geostrophic transport seasonal cycles are out-of-phase with **AX18** seasonal cycle. None of simulated total MOC transport seasonal cycle agree well with **AX18**, in terms of phasing or amplitude (too strong).

Simulated winds do not represent well the complex structure of the wind stress curl seasonal cycle near the boundaries. Simulated EB – WB curl seasonal cycle curves are similar to **SCOW** at 26.5°N, but are too weak in **OFES** at 34.5°S. Future work will look at ocean sensitivity to wind stress curl structure on the boundaries.