

## Supplementary Materials for

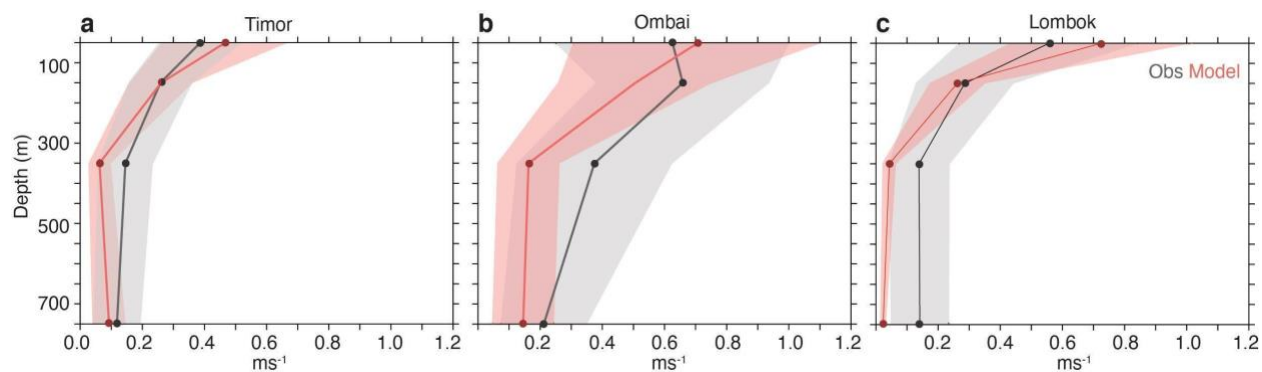
### **Madden-Julian Oscillation winds excite an intraseasonal see-saw of ocean mass that affects Earth's polar motion**

M. Afroosa<sup>1,2†</sup>, B. Rohith<sup>1†</sup>, Arya Paul<sup>1\*</sup>, Fabien Durand<sup>3,4</sup>, Romain Bourdallé-Badie<sup>5</sup>, P.V. Sreedevi<sup>1,6</sup>, Olivier de Viron<sup>7</sup>, Valérie Ballu<sup>7</sup>, S.S.C. Shenoi<sup>1</sup>

Correspondence to: [aryapaul@incois.gov.in](mailto:aryapaul@incois.gov.in).

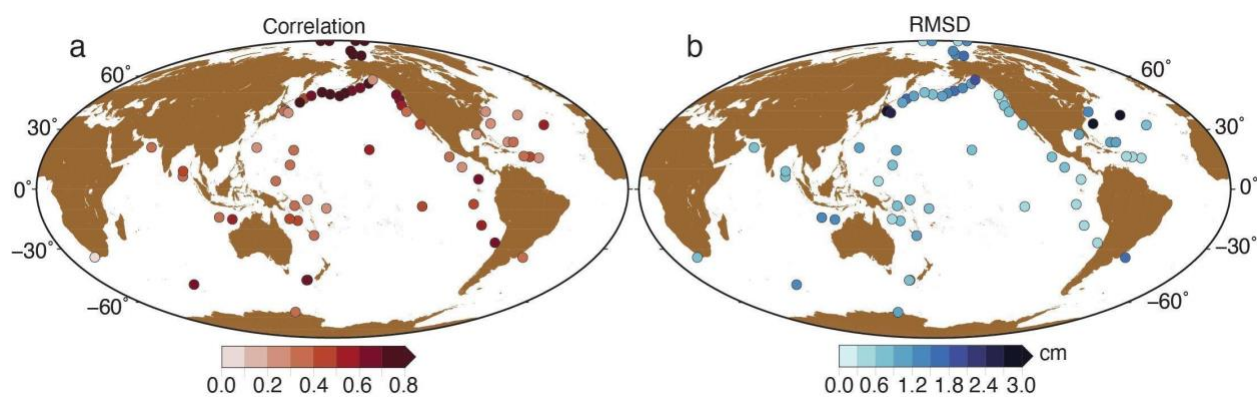
**This PDF file includes:**

**Supplementary Figures 1 to 6.**



**Supplementary Figure 1.**

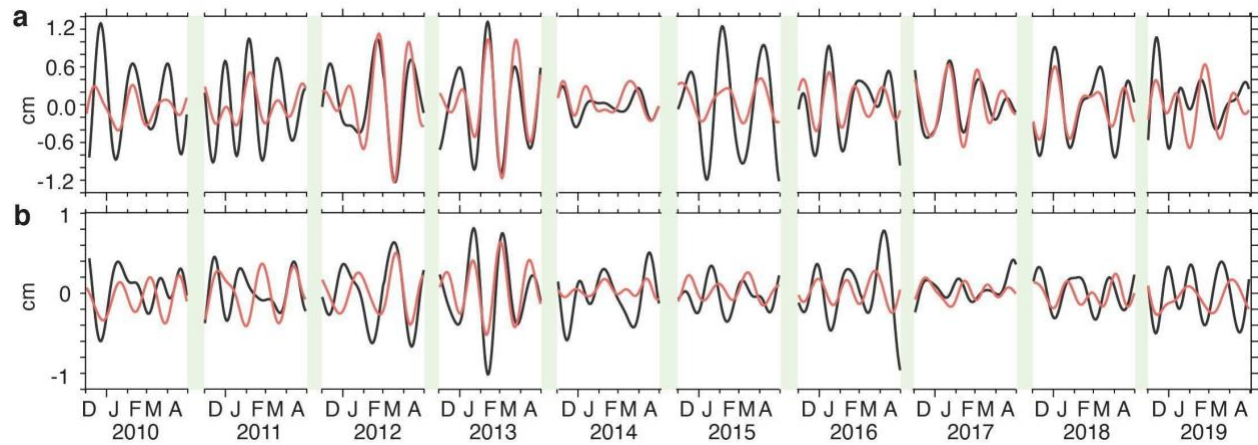
**Model validation of Indonesian Throughflow speeds.** Plot of mean speed (solid lines) and its standard deviation (shaded) through (a) Timor ( $122.95^{\circ}\text{E}$ ,  $11.36^{\circ}\text{S}$ ) (b) Ombai ( $125^{\circ}\text{E}$ ,  $8.53^{\circ}\text{S}$ ) (c) Lombok strait ( $115.89^{\circ}\text{E}$ ,  $8.4^{\circ}\text{S}$ ) from the control run (red, 2009-19) and INSTANT mooring observations (black, 2004-2006).



**Supplementary Figure 2.**

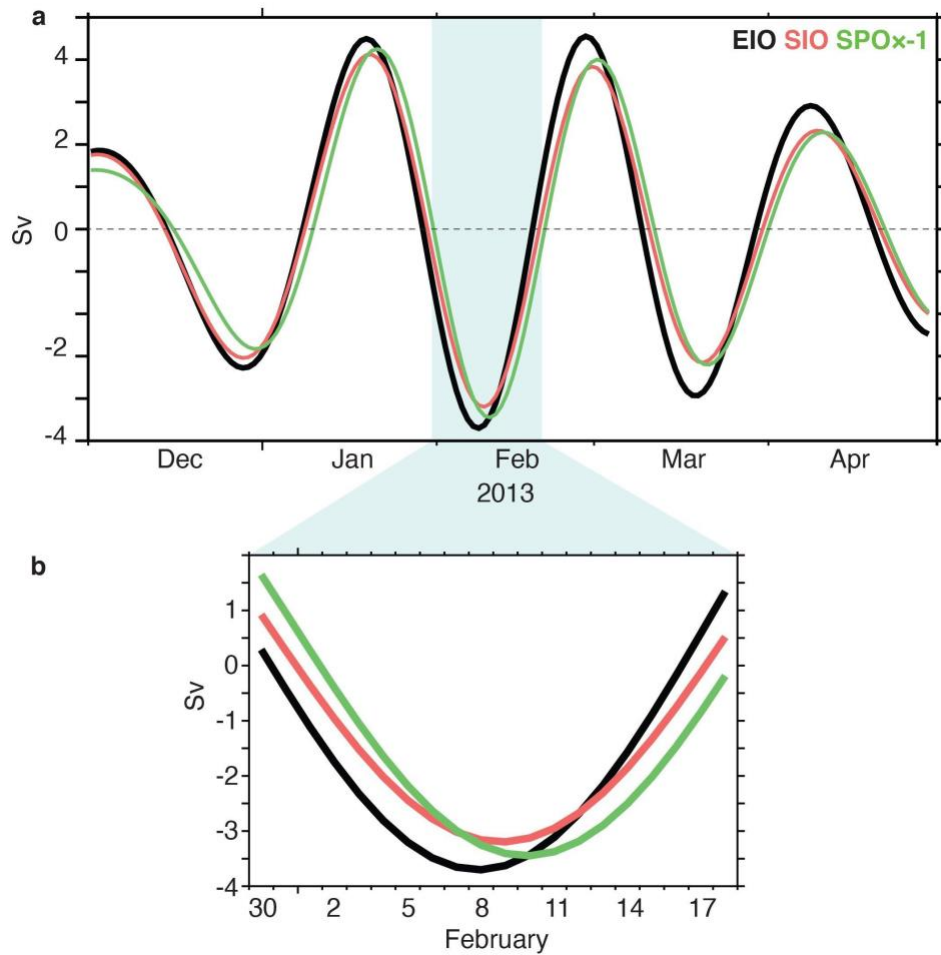
**Model validation of anomaly in equivalent water depth.** (a) Correlation (>90% significance) and (b) Root Mean Squared Deviation (RMSD) between intraseasonal equivalent water depth

from bottom pressure recorders (>90% significance) and the control run at respective bottom pressure recorder locations during 2009-2019.



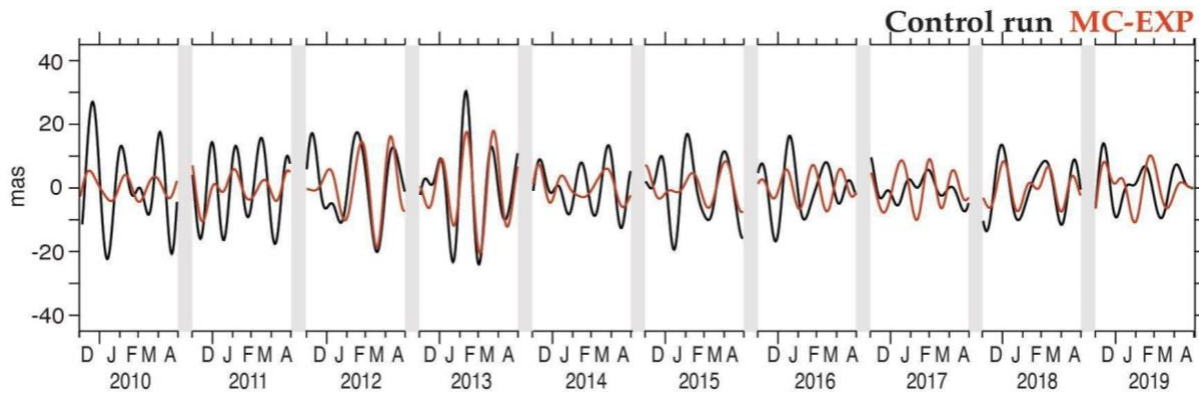
### Supplementary Figure 3.

**Basin-wide averaged anomaly in equivalent water depth.** Plot of spatially averaged of anomaly in equivalent water depth computed over (a) the Indian basin (red shaded region in Fig.2d) and (b) the Pacific basin (blue shaded region in Fig.2d) during December-April of 2009-2019 from the control run (black) and MC-EXP (red).



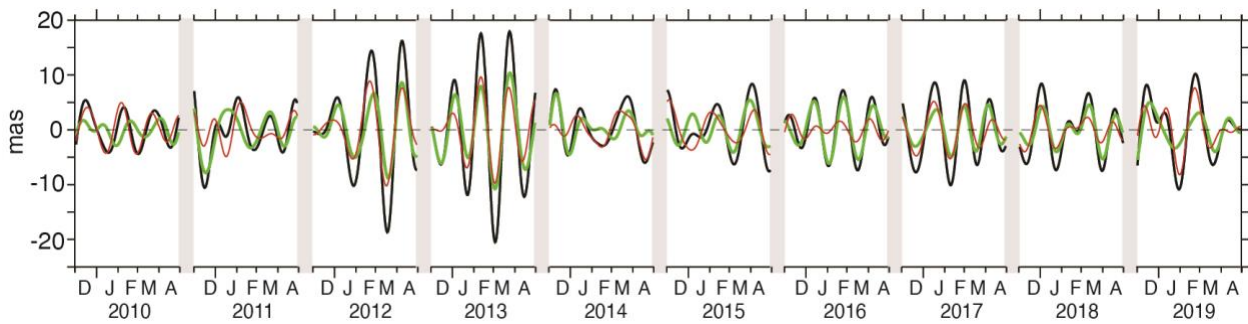
#### Supplementary Figure 4.

**Volume transport :** (a) Time series of intraseasonal volume transport (in Sv) across the control sections shown on Fig.2d, namely Eastern Indian Ocean (EIO, black curve), Southern Indian Ocean (SIO, red curve) and Southern Pacific Ocean (SPO, green curve, multiplied by -1 to illustrate the delay in phase) during December to April of 2012-13. (b) Inset of (a) for one peak event in February 2013.



**Supplementary Figure 5.**

**Time series of the intraseasonal ocean angular momentum excitation function about the y-axis of the Earth ( $\chi_2$ ).** Plot of the time evolution of intraseasonal  $\chi_2$  estimated from control run (black) and MC-EXP (red) during each December-April of 2009-2019.



**Supplementary Figure 6.**

**Time series of the current and mass term of intraseasonal ocean angular momentum excitation function about the y-axis of the Earth ( $\chi_2$ ).** Plot of the time evolution of intraseasonal  $\chi_2$  estimated from MC-EXP ; current + mass (black), current (red) and mass (green) during each December-April of 2009-2019.