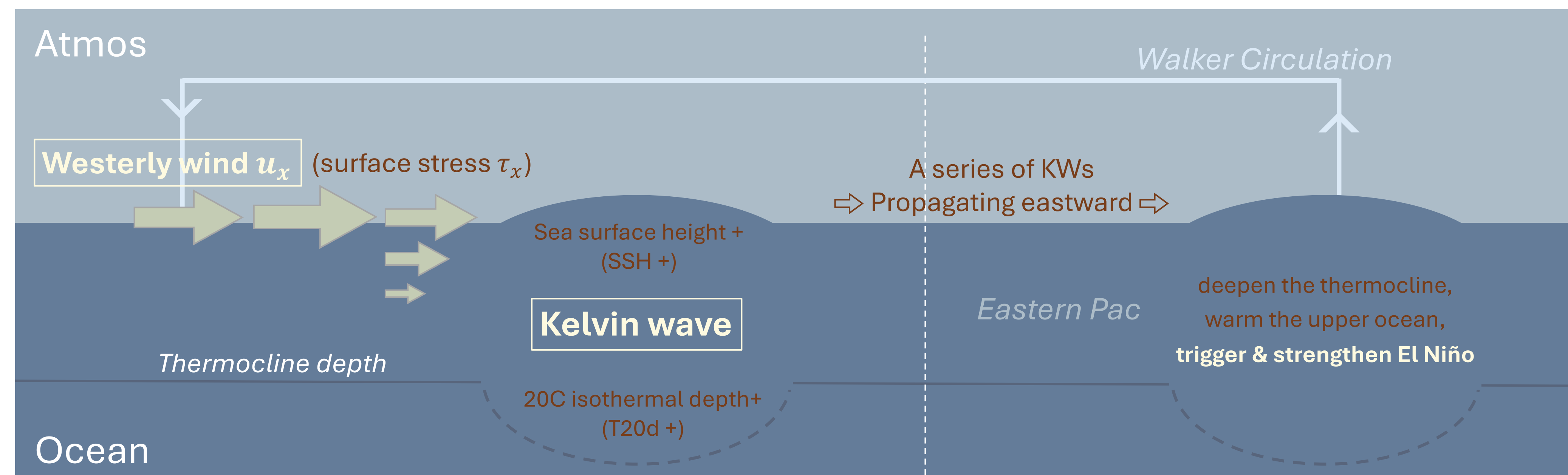




Diagnostics of Westerly Wind Events (WWEs) and Oceanic Kelvin Wave (KW) Responses in the equatorial Pacific in CMIP6 models

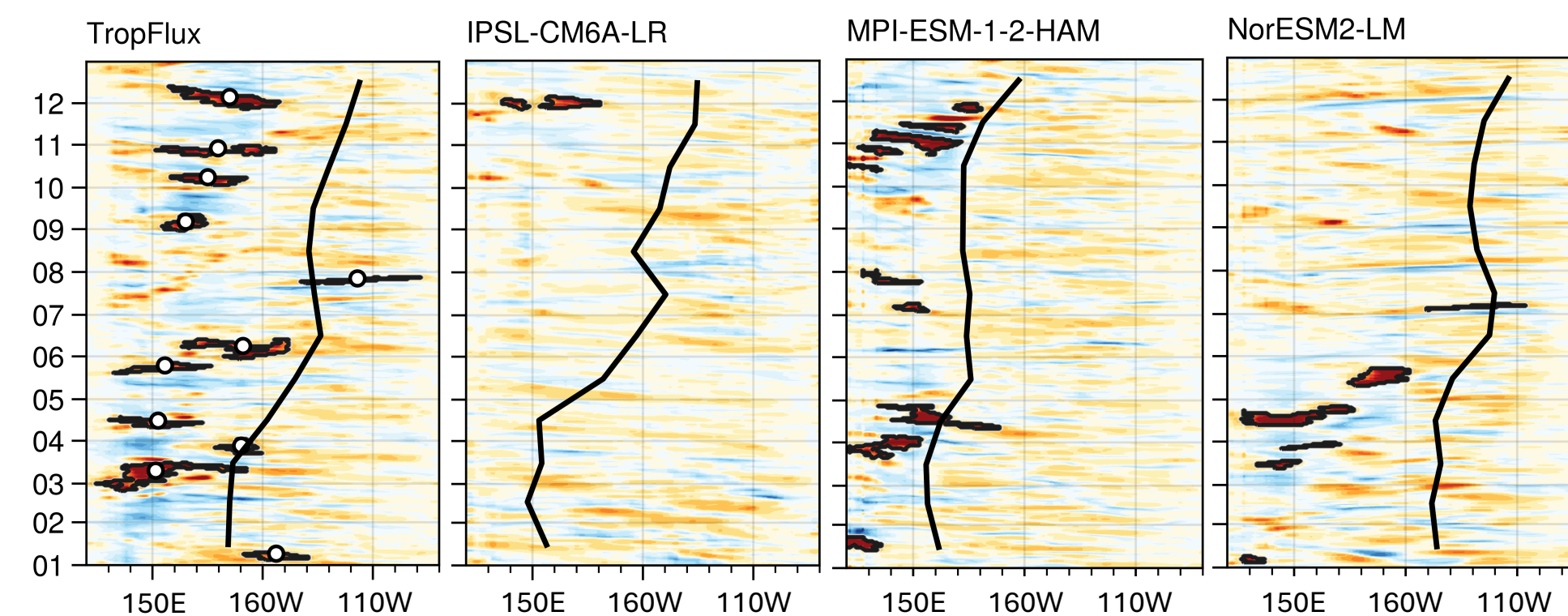
Jingxuan Cui, Emily Riley Dellaripa, Charlotte DeMott, and Eric Maloney (Department of Atmospheric Science, Colorado State University)

1 Why important



- **WWEs** are anomalously strong westerlies, associated with **intraseasonal variations** (e.g., the **MJO**)
- Strong WWEs → **intraseasonal oceanic KWs** → El Niño events.
- El Niño events, in turn, modulate background conditions that affect **the MJOs** and thus **WWEs**.
- **Faithful representations of WWEs and KWs are fundamental in simulations of tropical subseasonal to seasonal variations in climate and forecast models.**

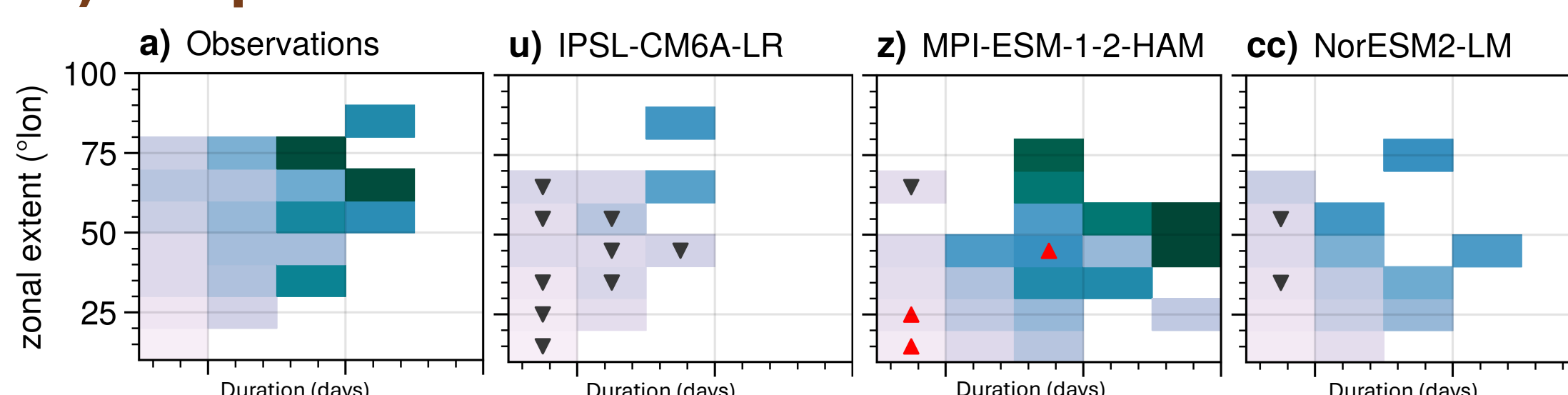
2 Westerly Wind Events in CMIP6 models



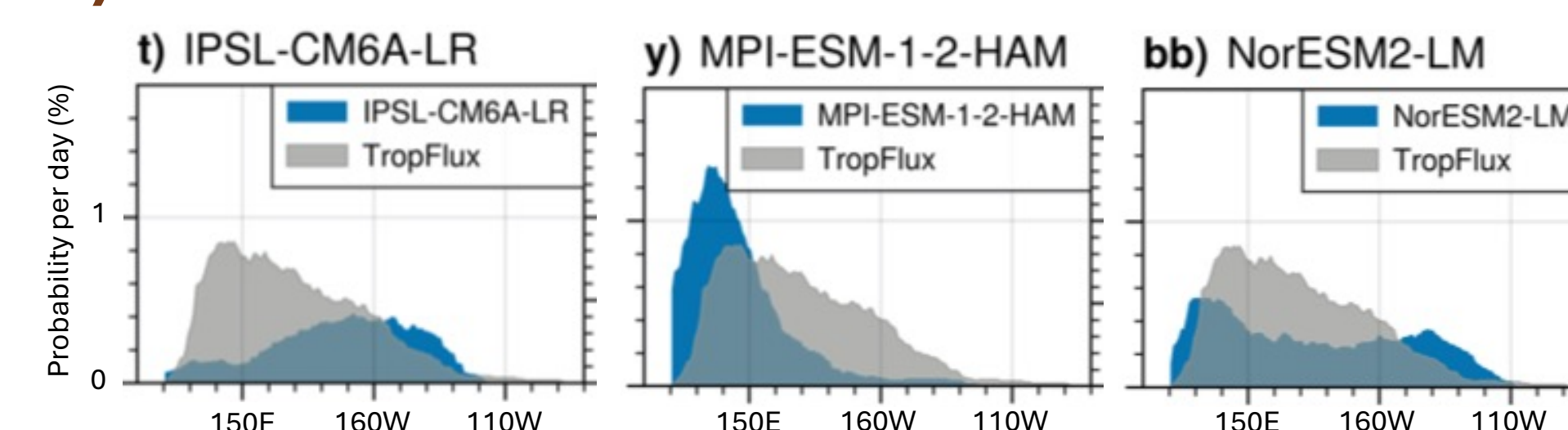
WWE (adapted from Puy et al. 2016):

- 120-day high-pass filtered $\tau_x \geq 0.04 \text{ Nm}^{-2}$ ($\sim 2\sigma$)
- last ≥ 5 days
- zonal extent $\geq 10^\circ$ longitude

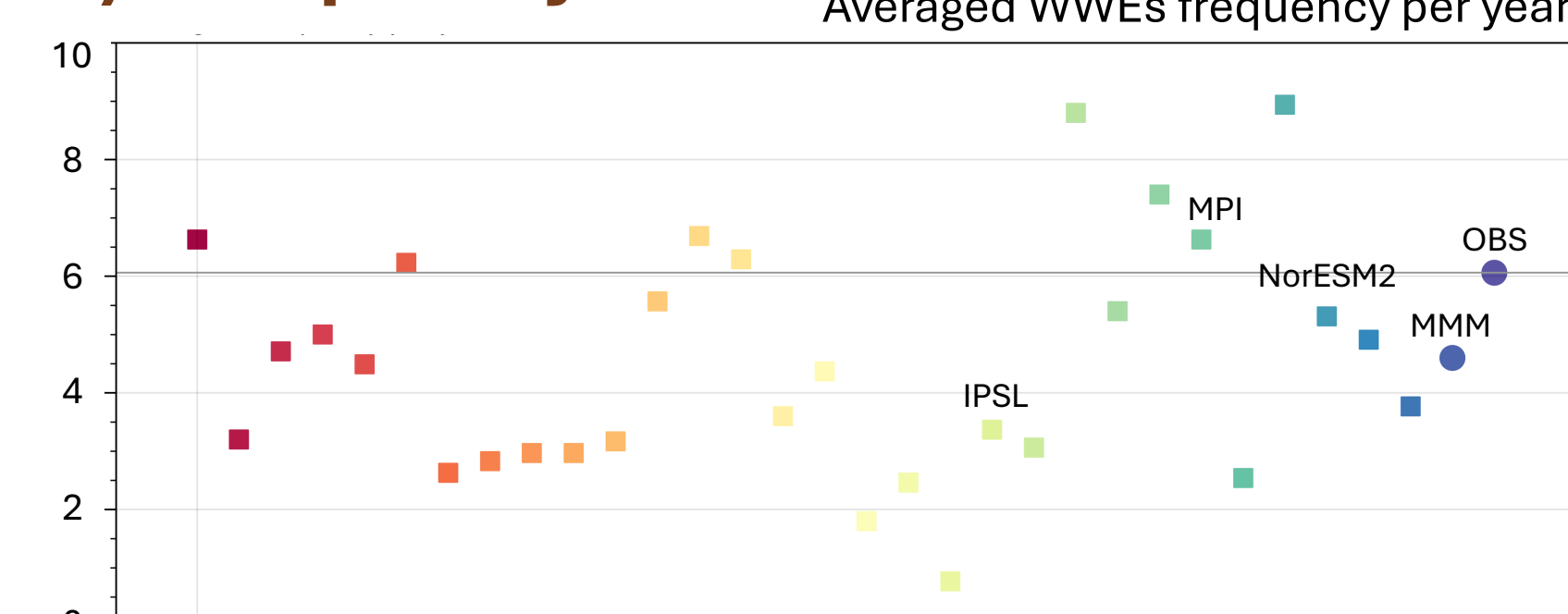
2) Amplitude



3) Zonal distribution



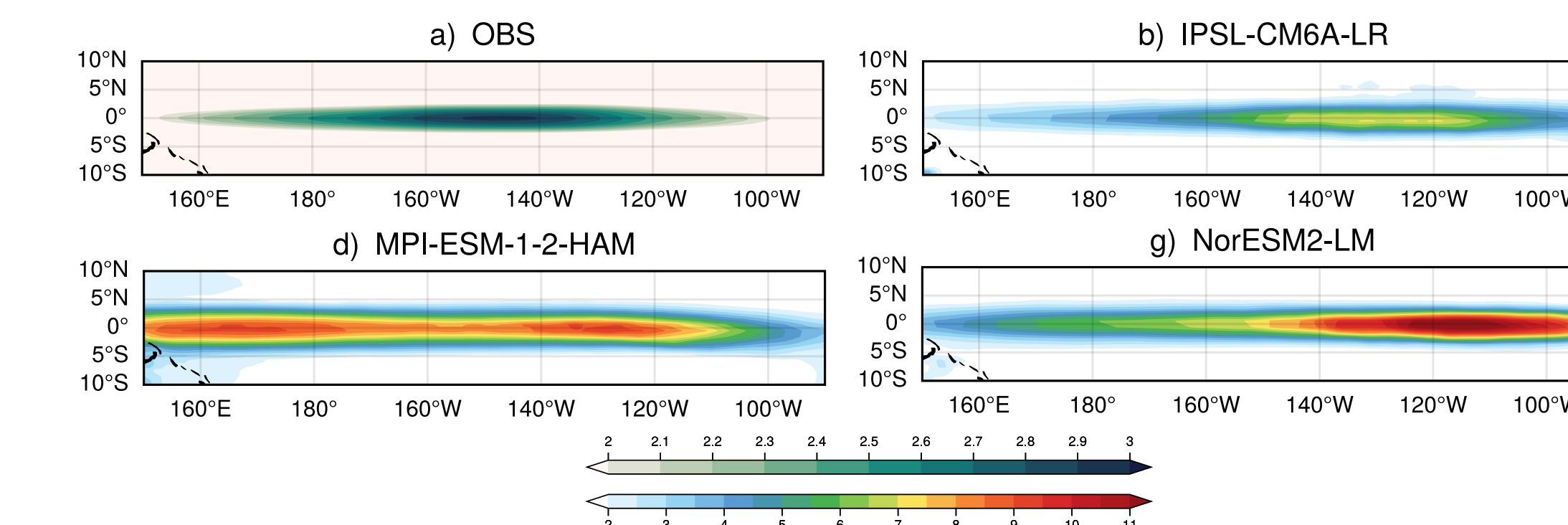
1) Frequency



- Most models underestimate the WWE frequency
- Model WWEs tend to be weaker than the OBS
- Most models underestimate the occurrence in WP; some models show bi-model structure

3 Kelvin wave responses

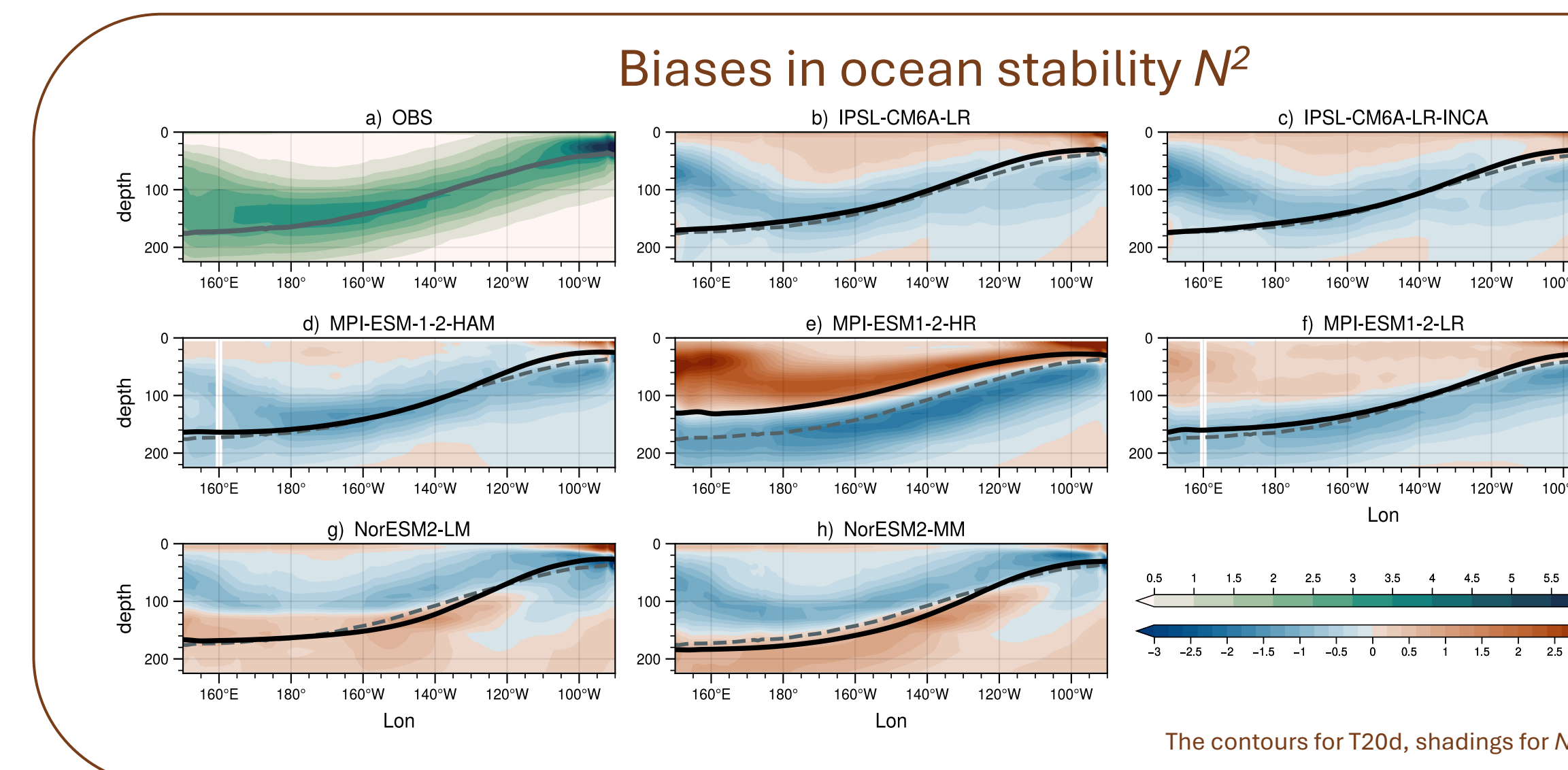
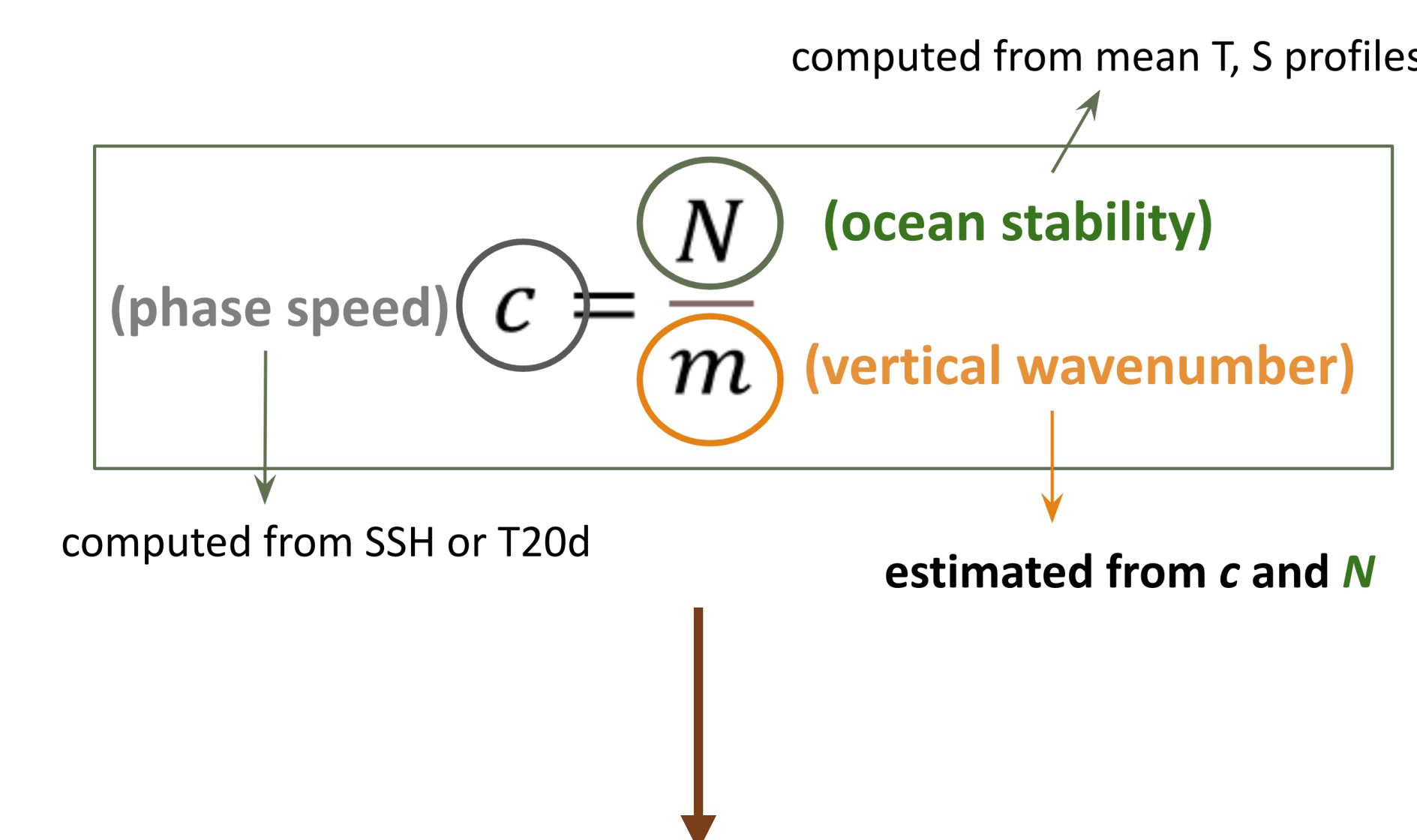
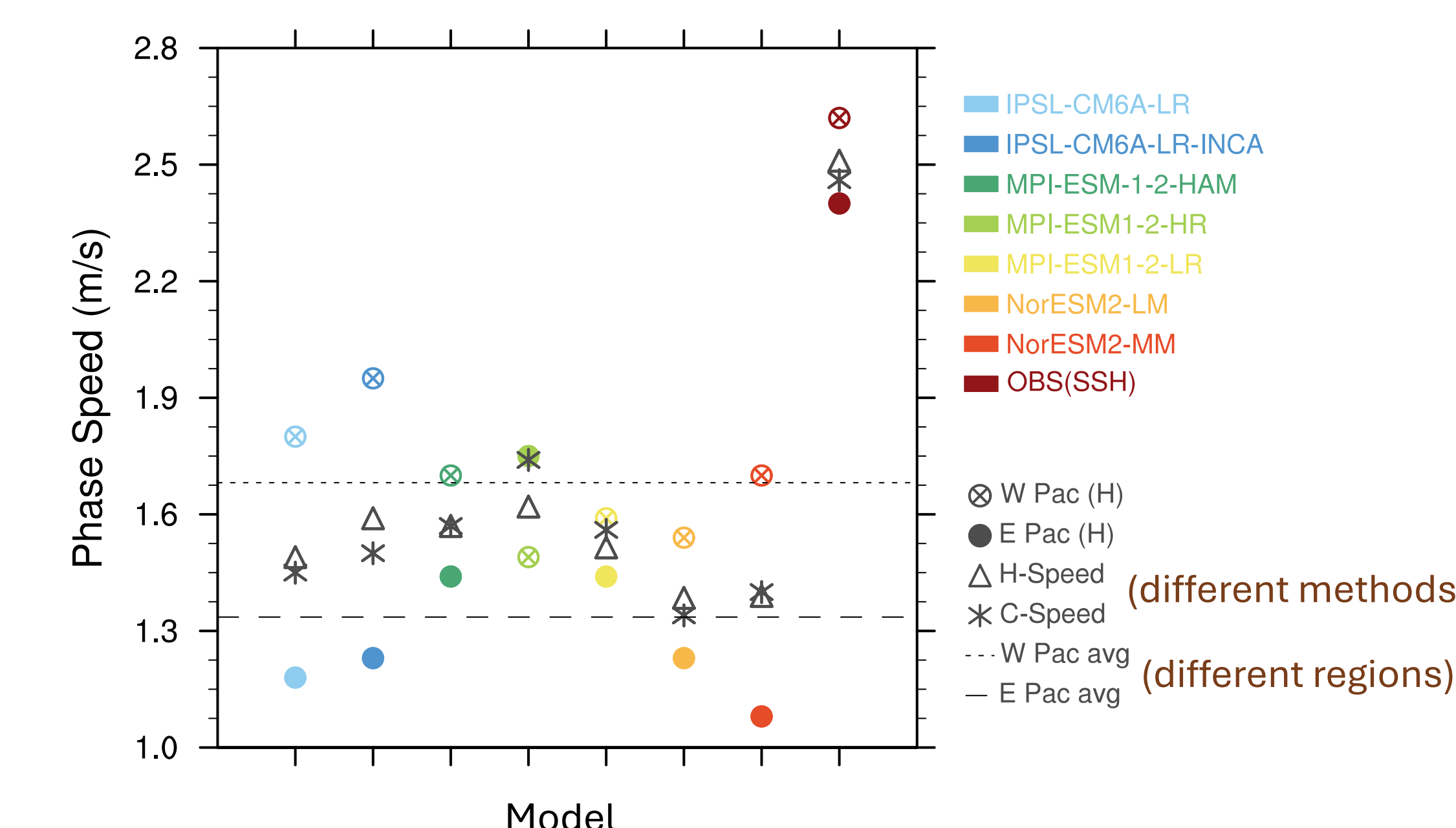
1) Zonal distribution: variation of 30-120d SSH/T20d anomalies



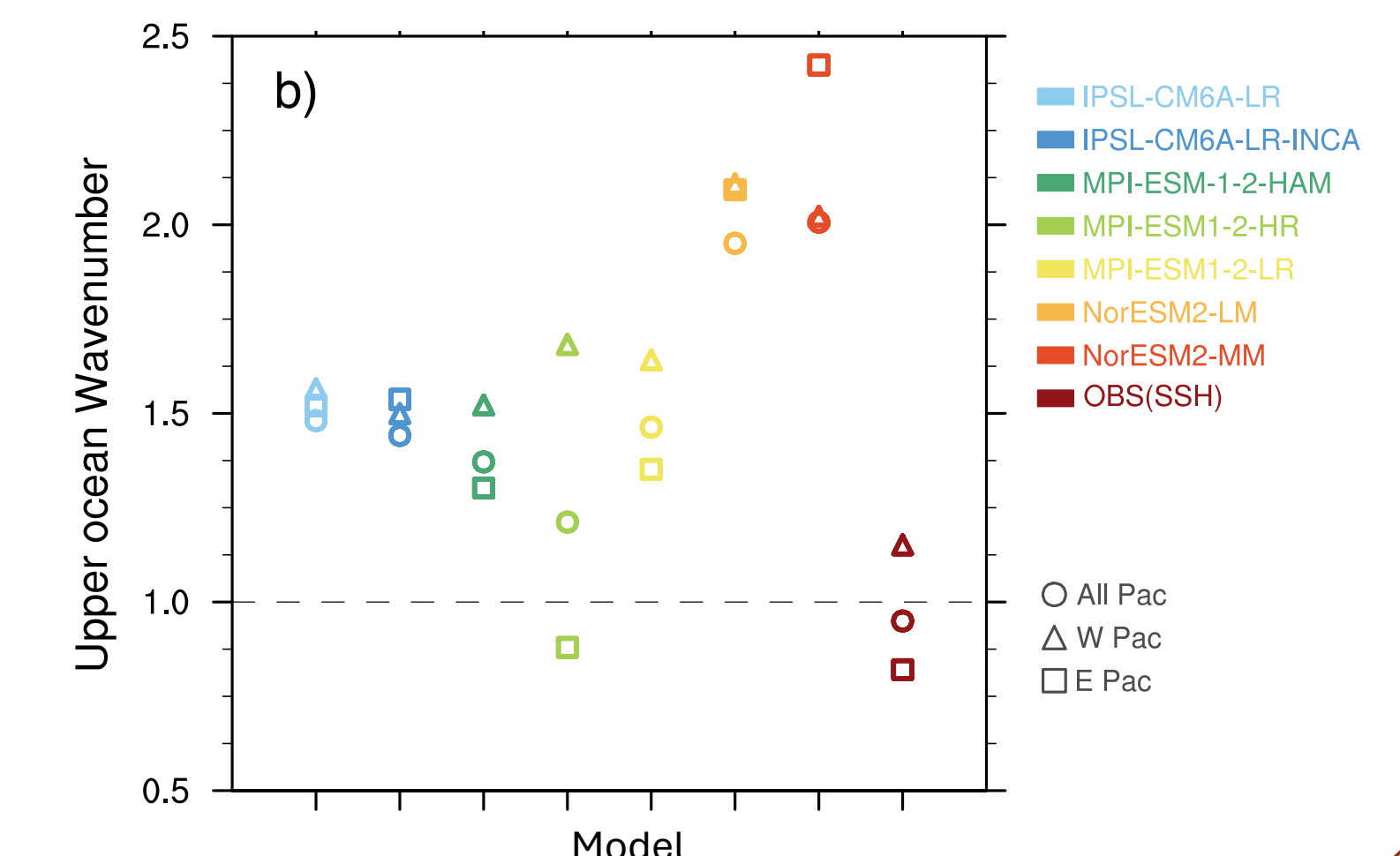
The first time daily T20d (20°C isothermal depth, a common proxy for thermocline depth) output is available in CMIP archive!
However, only seven models provide it.

- Sea surface height (SSH) and T20d anomalies are highly correlated, both can represent KWs
- KW features are well aligned with the WWE zonal distributions and amplitudes among models

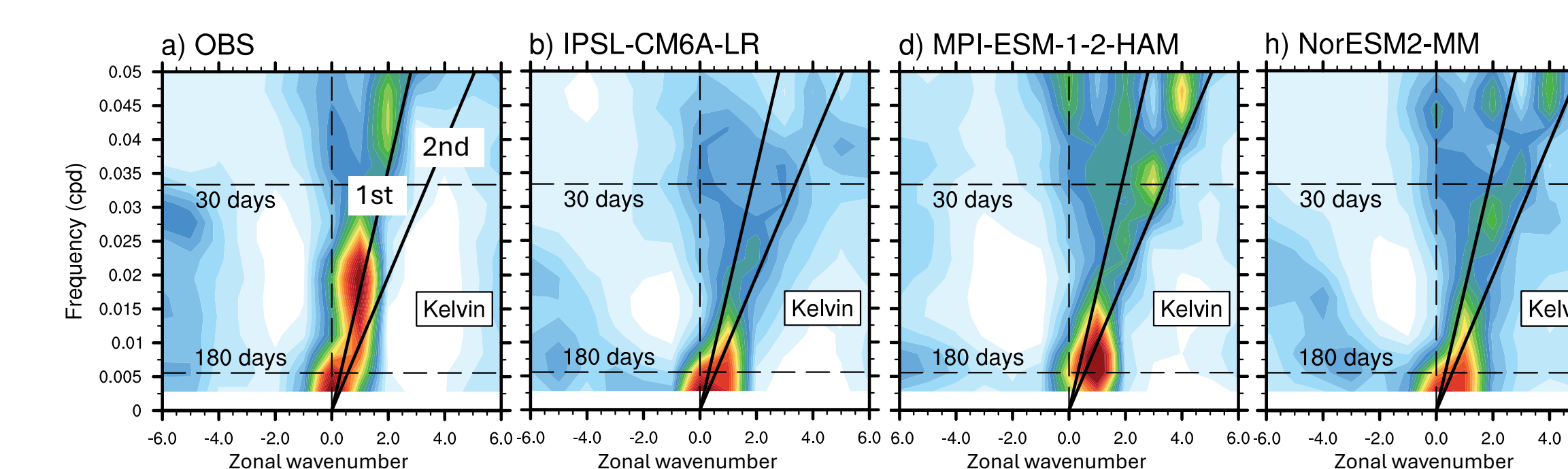
2) Propagation speed:



Biases in estimated wavenumber m



- The observed KWs show the 1st baroclinic mode feature
- The model KWs are a mixture of the 1st and higher order baroclinic modes
- Biased ocean stability is not the main cause



(Wavenumber-frequency Spectrum of SSH/T20 anomalies)

The Diagnostics

Westerly Wind Events (WWEs)

Frequency: underestimated

Amplitude: weaker

Zonal distribution: under/overpredicted in the WP or EP

Underpredicted MJO & CRW variances

Biased mix of higher order baroclinic modes

Propagation speed: much slower

Zonal distribution

Kelvin Waves (KWs)

How to adapt the diagnostics developed for climate simulations to forecast model output?

Check out Charlotte DeMott's talk tomorrow (Sep 5) at 3:30 pm in the Auditorium!

1. Riley Dellaripa et al., 2024: Evaluation of intraseasonal westerly wind events in the Pacific Ocean in CMIP6 models. J. Climate. Accepted.
2. Cui et al., 2024: Process-based evaluation of intraseasonal oceanic Kelvin waves in the Pacific Ocean in CMIP6 models. J. Climate. In revision.