



Dynamical Filtering of Tropical Subseasonal Variability in Observations and Forecast Models

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Introduction

The tropics contain phenomena that vary on many different timescales. On intra-seasonal scales, tropical variability is dominated by the MJO, and indices used to identify it contain other processes with different limits of predictability and downstream impacts. In this work, we introduce a way of dynamically filtering tropical variability that is based on a linear inverse model (LIM). In particular, we compare the forecast model representation of tropical intraseasonal modes to those in observations.

Linear Inverse Model (LIM)

$$\frac{d\vec{x}}{dt} = L\vec{x} + \vec{\xi}$$

Stochastic forcing

Linear operator

State vector

$$L = \tau_0^{-1} \ln \left[\langle \vec{x}(t + \tau_0) \vec{x}(t)^T \rangle (\langle \vec{x}(t) \vec{x}(t)^T \rangle)^{-1} \right]$$

τ_0 : time lag
 $\langle * \rangle$: expectation operator
 \ln : matrix natural logarithm

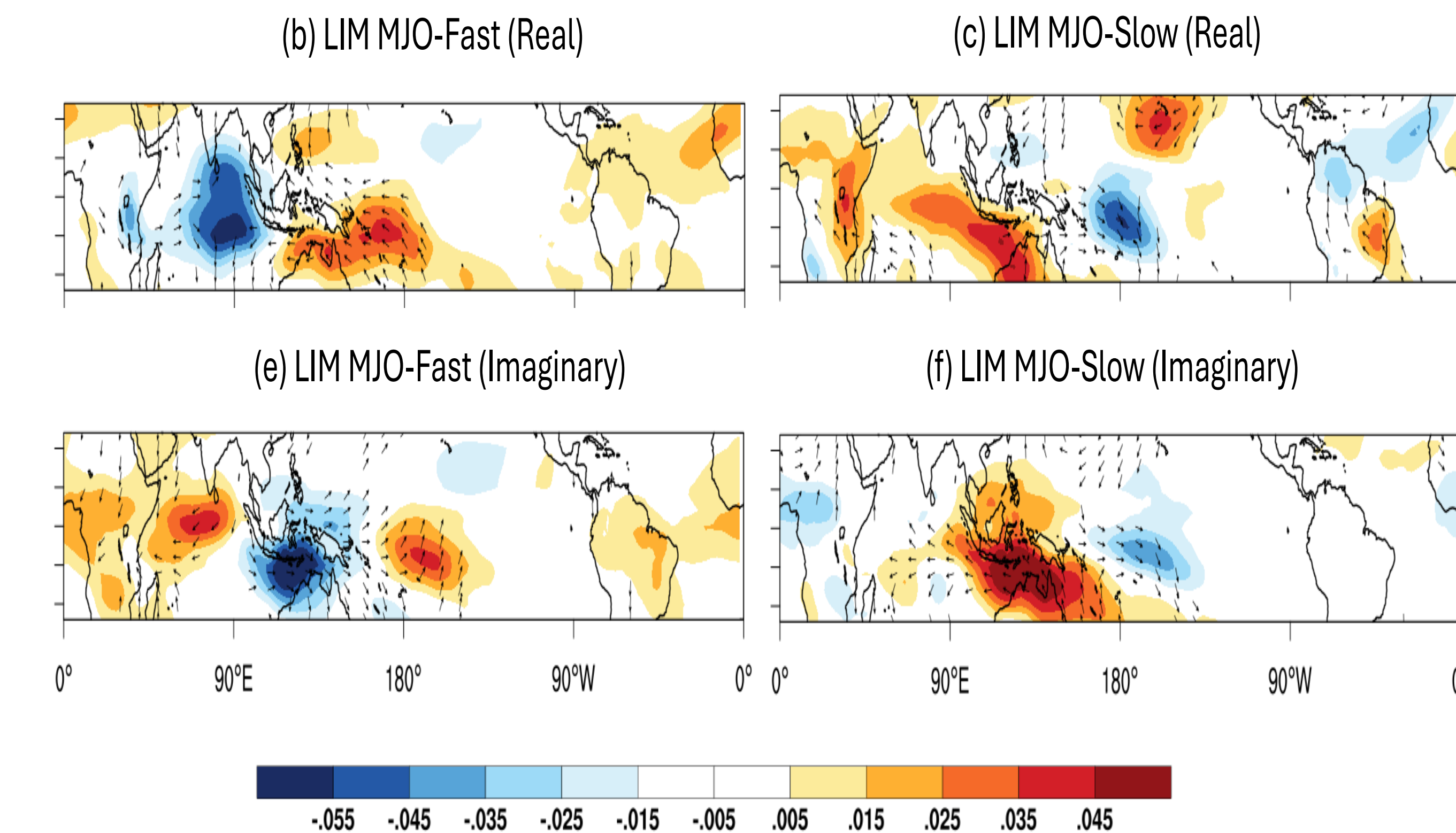
Eigenvectors/eigenvalues yield space-time structure of deterministic dynamics:

- 1) Eigenvectors correspond to spatial patterns
- 2) Real component of eigenvalue: e-folding time
- 3) Complex component of eigenvalue: frequency

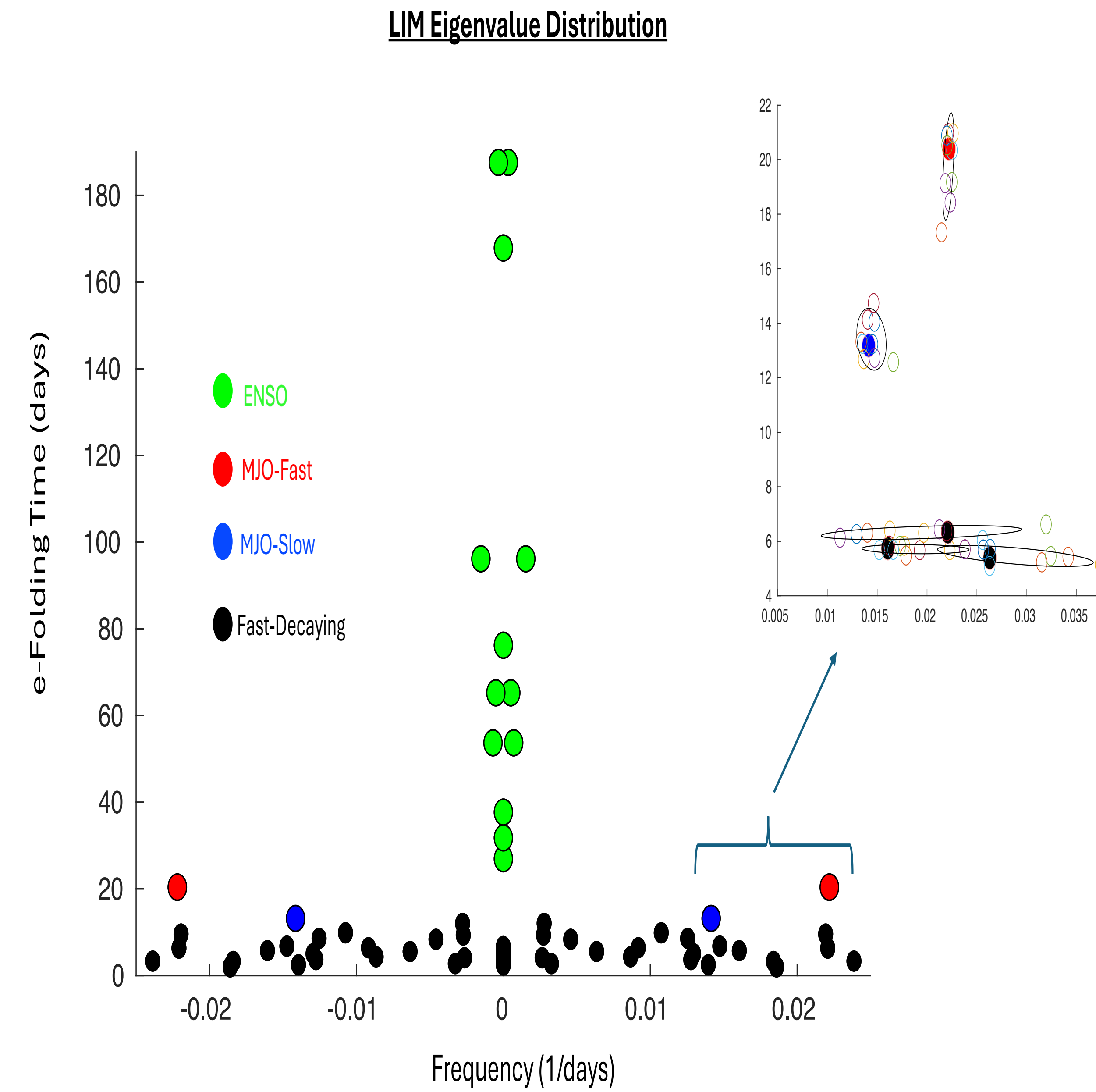
Data and LIM Construction

- LIM trained on 5-day lag covariances of 5-day running mean anomalies of winter (Nov 1st – May 1st, 1979-2021) ERA5 data on a 2-degree grid
- Variables are 200-hPa and 850-hPa zonal and meridional winds, SST, and OLR (24° S-24° N)
- Anomalies are projected onto leading EOFs (82 in total):
 - 1 Combined wind ($u_{200}, v_{200}, u_{850}, v_{850}$) (28 EOFs, 48% of total variance)
 - 2 SST (14 EOFs, 66% of total variance)
 - 3 OLR (40 EOFs 62% of total variance)

Intraseasonal Modes

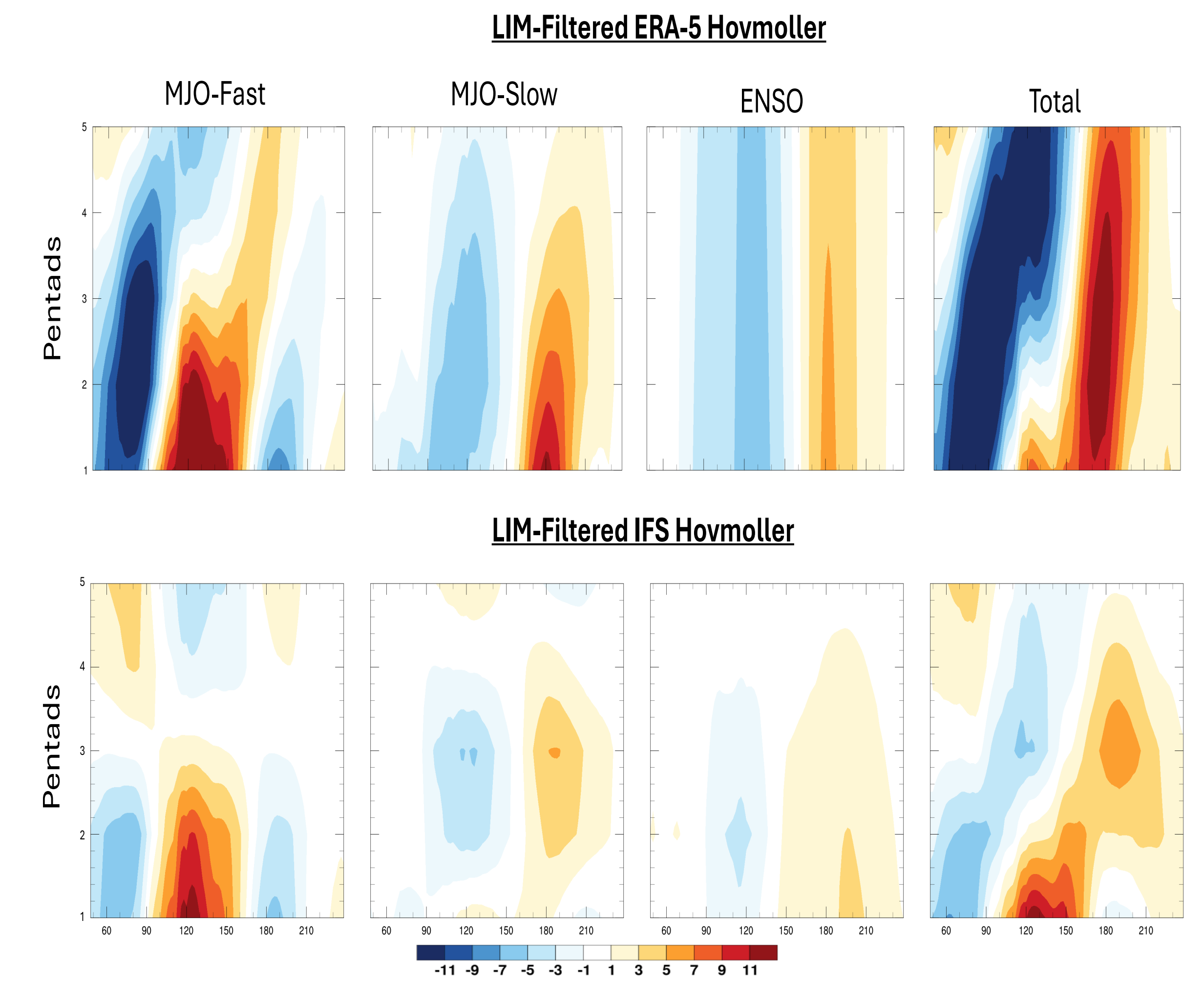


LIM Filter

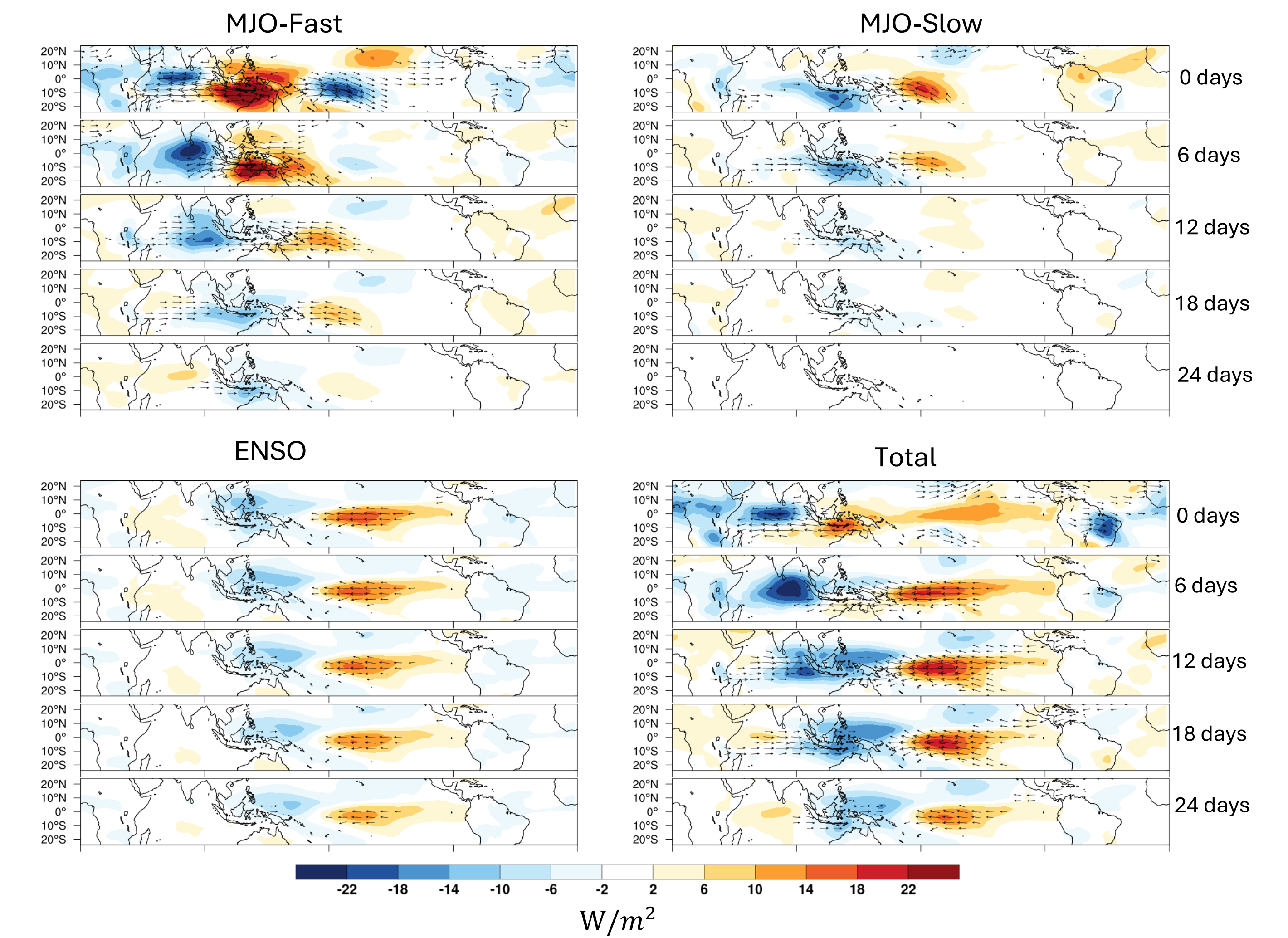


Filtering RMM in ERA-5 and the IFS

- We filter the optimal initial structures associated with the MJO



ERA5 Filtered Lagged Composites



Conclusion

We have presented a method for filtering tropical variability using the eigenmodes of a linear inverse model. This method can be applied to both observational and model data, and can be used to determine how well modes of tropical variability are represented in forecast models.

LIM-Filtered RMM Composites

