Persistence of Tropical SSTs in Climate Models

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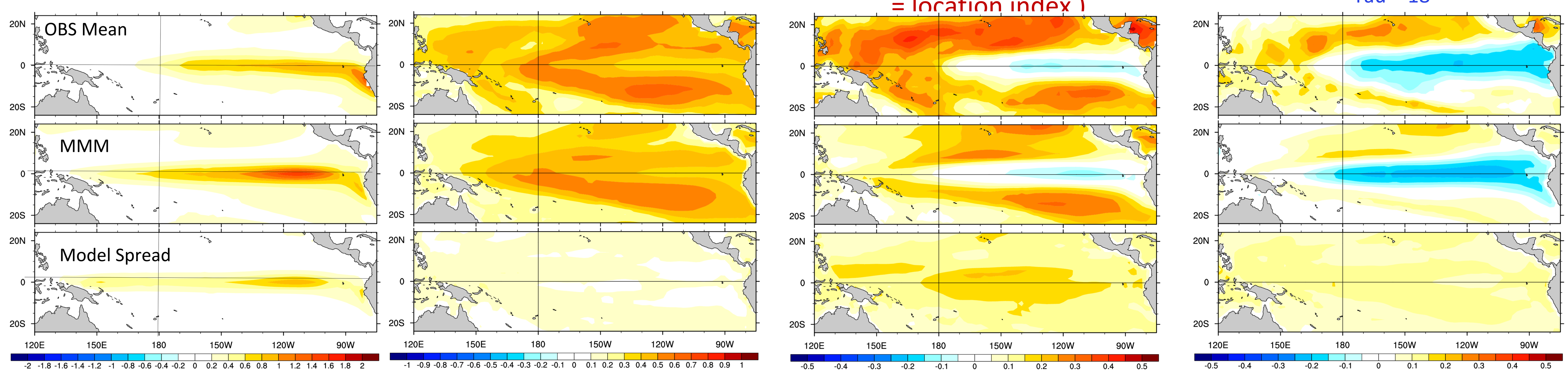
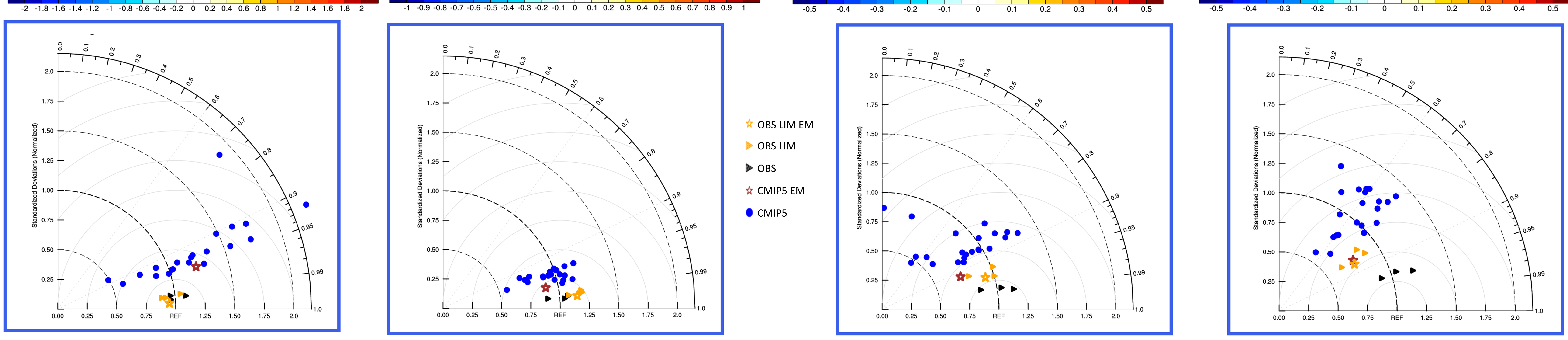
Dynamically meaningful metrics should capture the *evolving* nature of ENSO, not just static variance.
Lag-covariances provide both spatial pattern and temporal evolution, which are the expression of the system dynamics.

SST variance

SST autocorrelation = Covariance/Variance $\rho_i(\tau) = C_{ii}(\tau) / C_{ii}(0)$ (i = location index)

Tau = 0 | Tau = 6 | Tau = 12 | Tau = 18

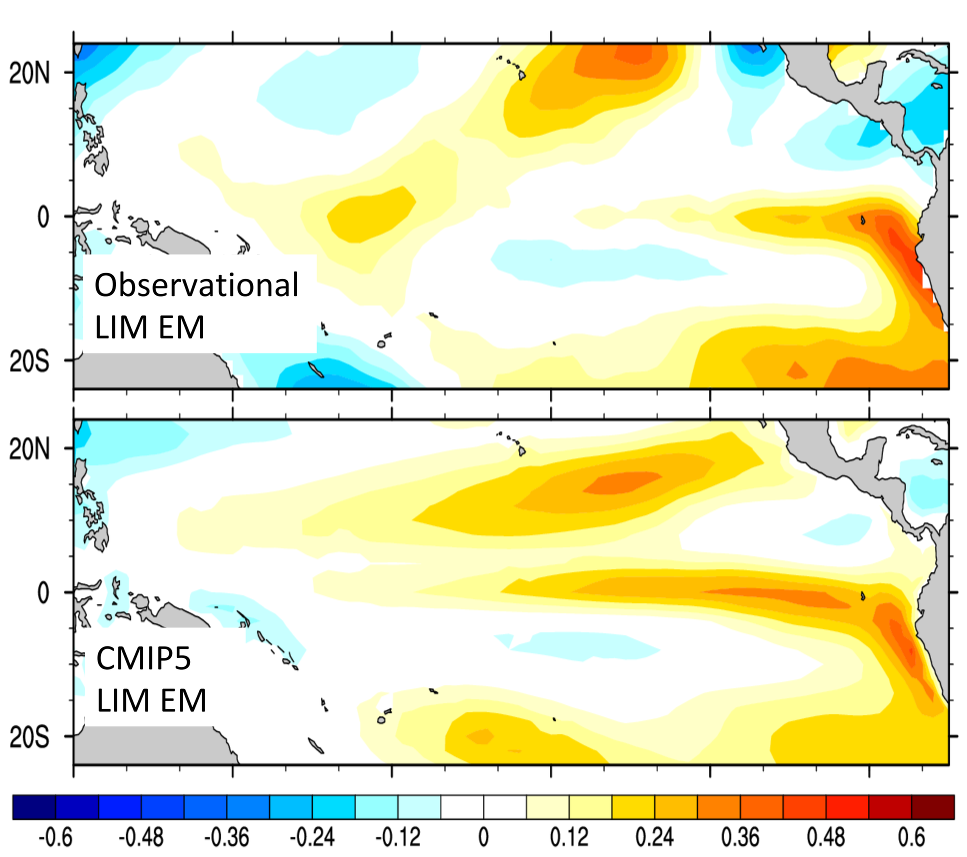


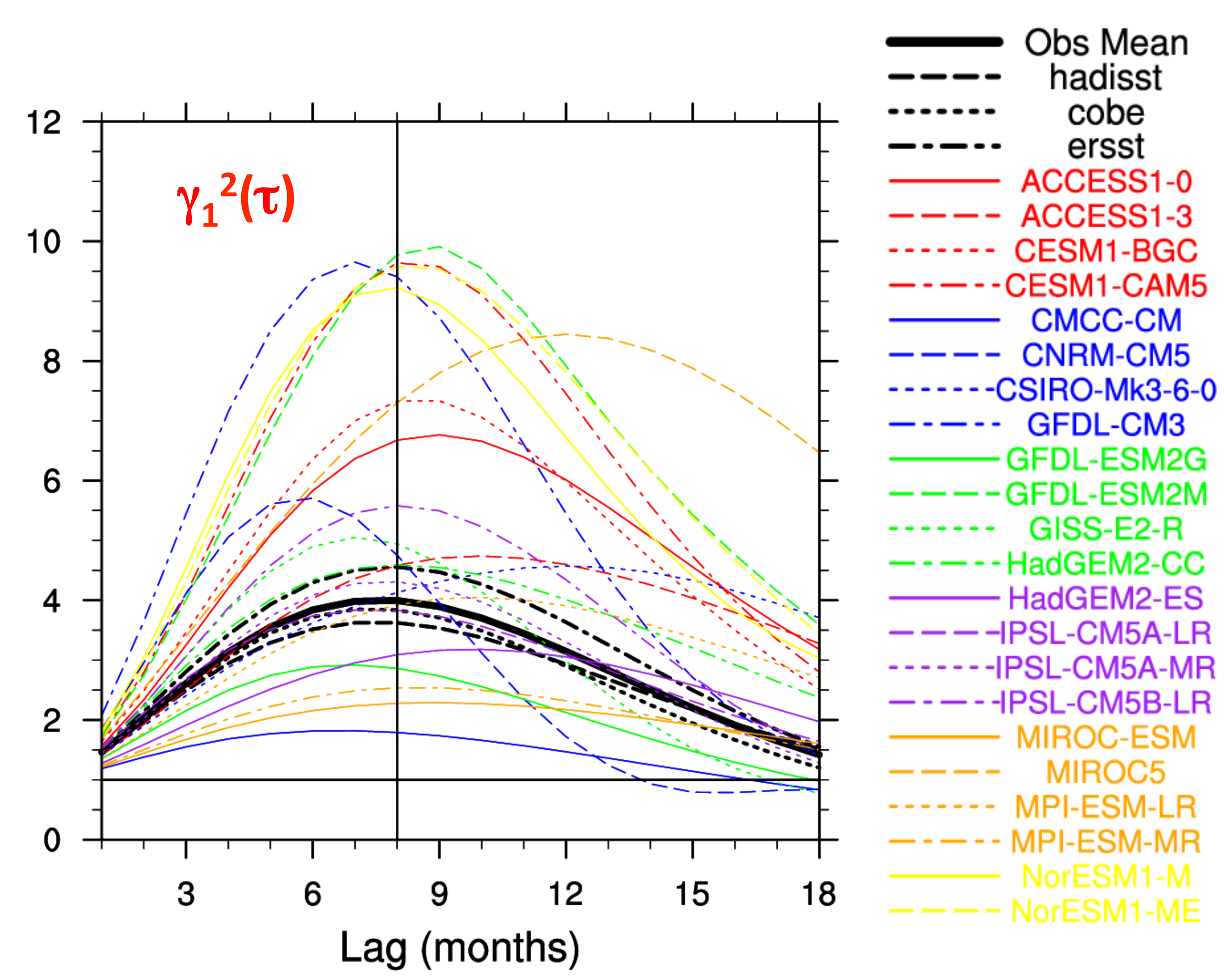


Observational and model monthly SST anomalies have been detrended, and a 3-month running average has been applied prior to the analysis.
Taylor diagrams use observational ensemble mean (EM) as reference point and are uncentered (include spatial means).

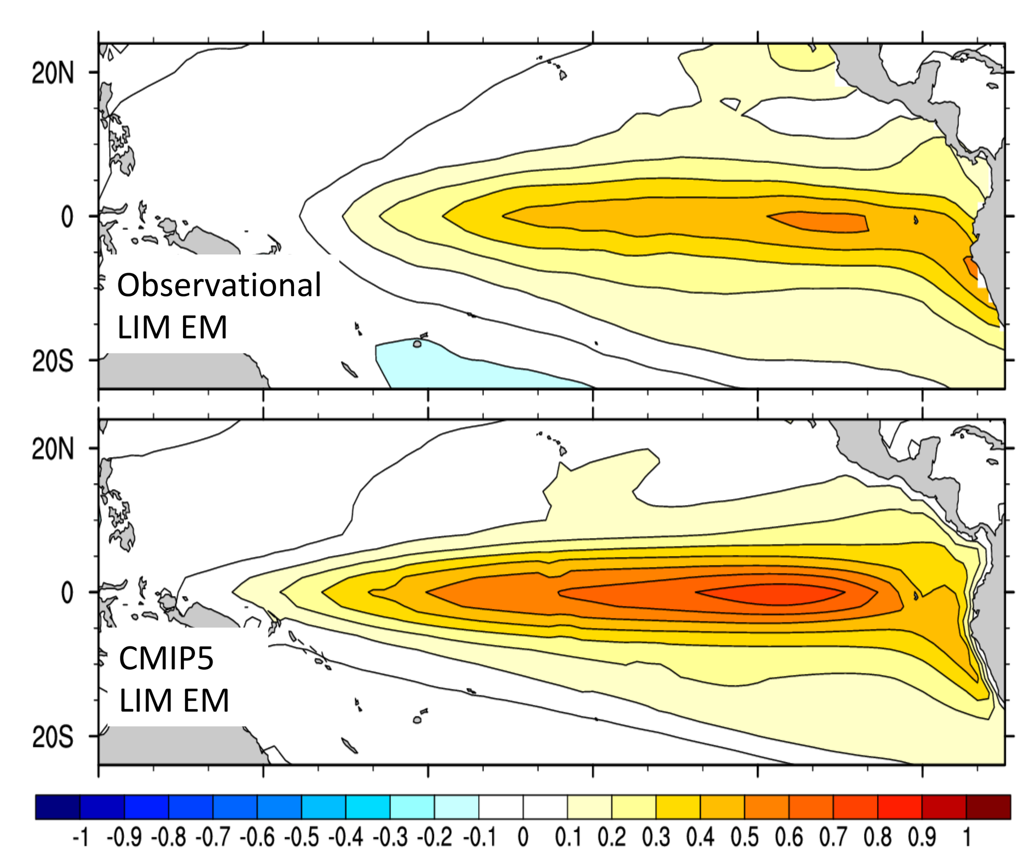
Linear Inverse Modeling (LIM) captures the system dynamics

Optimal Initial Lag 8 months

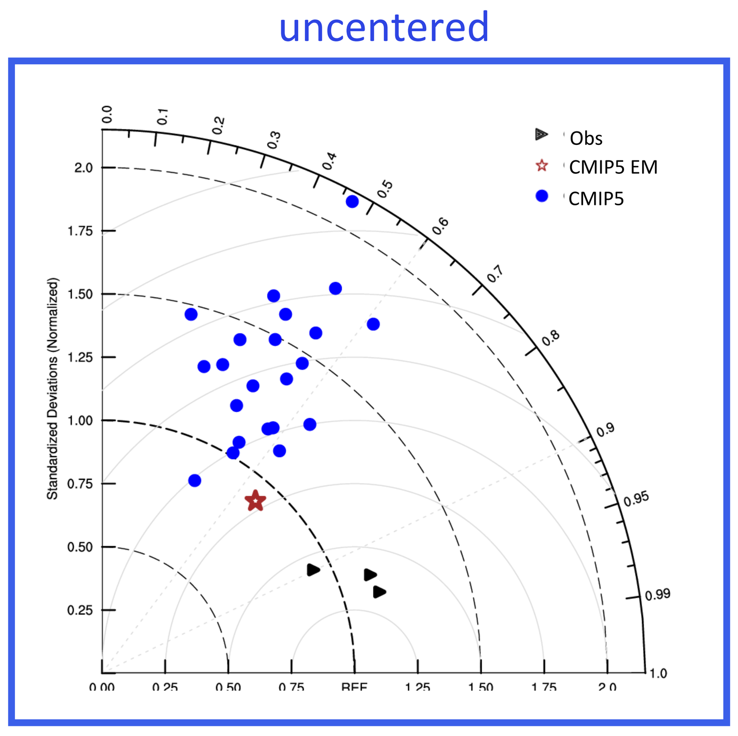




Optimal Final Lag 8 months



CMIP5 optimal initial referenced to Obs. EM uncentered



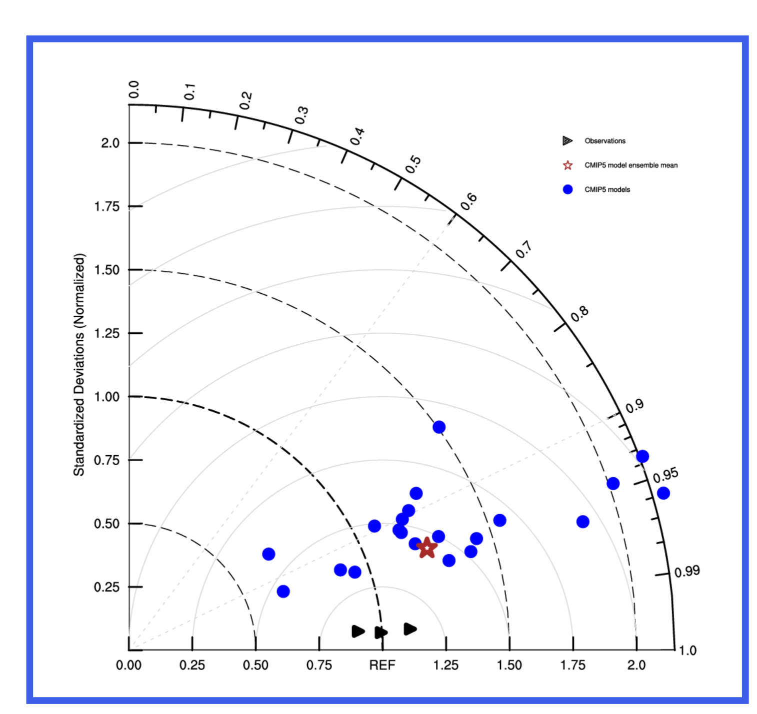
Local autocorrelation: $\rho_i(\tau) = C_{ii}(\tau) / C_{ii}(0)$

Define $\mathbf{G}(\tau) = \mathbf{C}(\tau)\,\mathbf{C}(0)^{-1}$ *Note!* $G_{ii}(\tau) \neq \rho_i(\tau)$

LIM: $\mathbf{G}(\tau) = [\mathbf{G}(1)]^{\tau}$

Maximum anomaly growth over time interval τ is achieved for initial state $\mathbf{v}_1$, which evolves into $\gamma_1 \mathbf{u}_1$ (using SVD of $\mathbf{G}(\tau) = \mathbf{u}\gamma\mathbf{v}^T$), so that domain variance increases by a factor of γ_1^2

CMIP5 optimal final referenced to Obs. EM uncentered



Models show a large spread in the optimal initial states, as well as in the γ_1^2, representing differences in their dynamics. Analyses of current and projected climate variability need to account for errors in model dynamics.