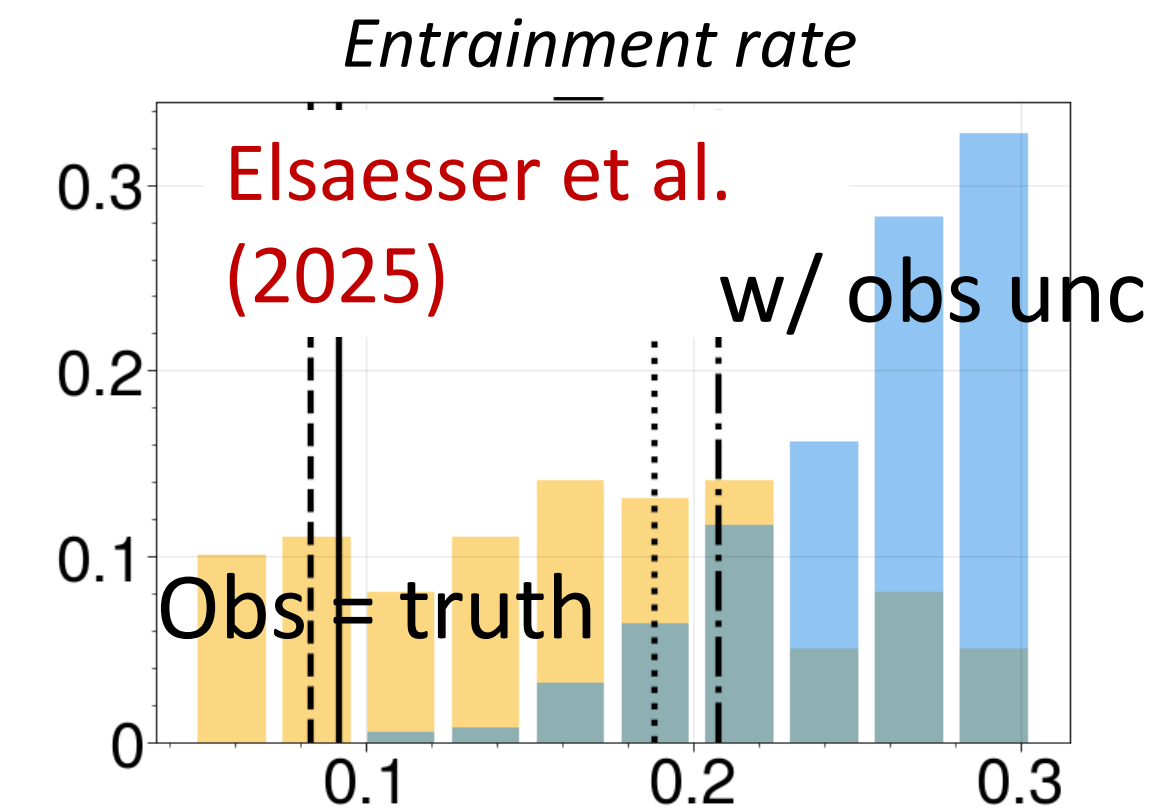
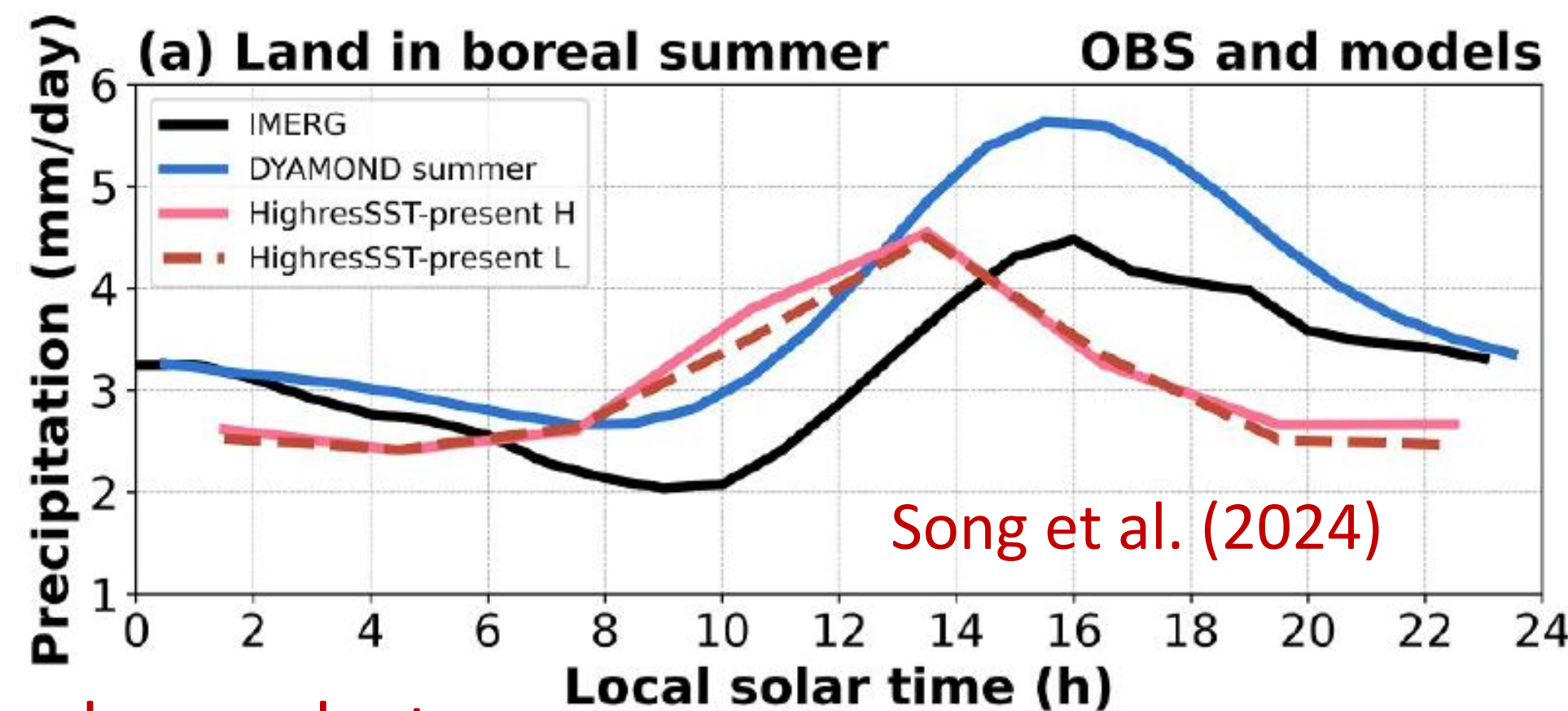
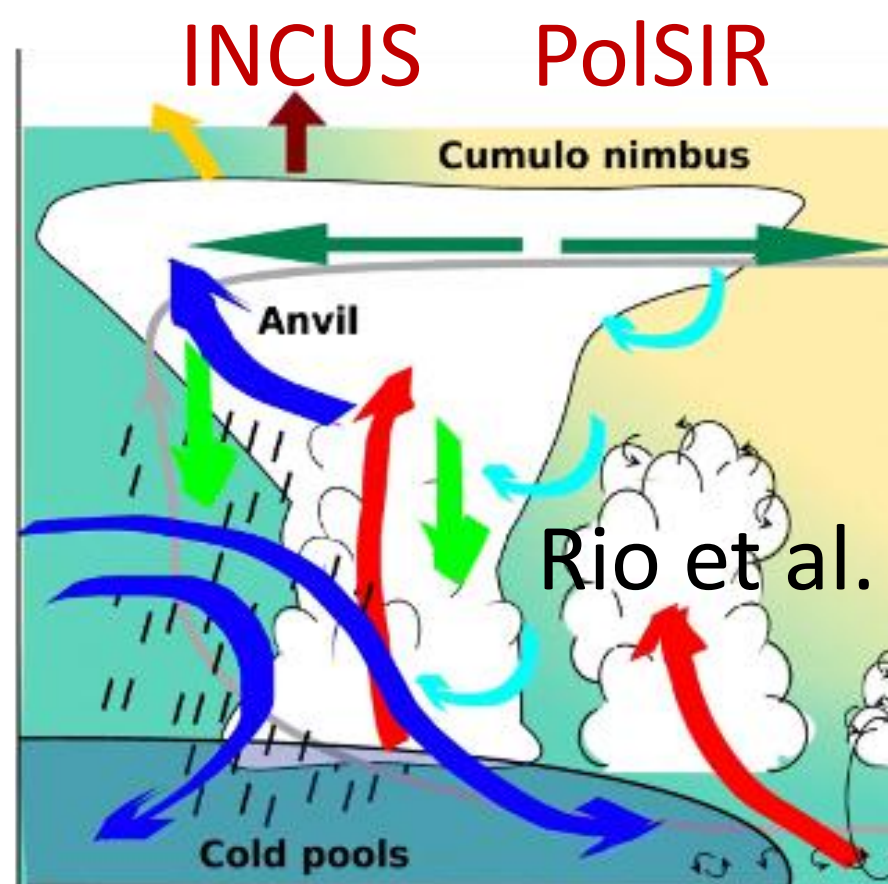


“Increasing discussion on observational uncertainty – but for Earth System Model (ESM) longer-timescale predictions, where insensitivity to initial state is a key concept – what is the relevance?” **ESM Calibrated Physics Ensemble (CPE)** Framework:

Precipitation/obs product uncertainties →
physics parameter estimation → projection spread.



Looking ahead (1): Using ESM CPE frameworks “in reverse” for **Physics OSSEs (S2S-Decadal-Climate)**. Emulators are important in all steps, & we know precip/obs product uncertainties matter, so what new/differently used obs. & uncertainty specs trace to quantified reduction in physics parameter spread?

Precip, scatterometer, sounder products

Looking ahead (2): Data fusing for ESM process constraint, requires close obs/modeler collab; Current records & future! Data are underutilized. **Top Left:** what falls out as precip. isn’t available for detrainment into anvils, and simple models (theory, ML eqn. discovery?) can be filled with fused L2 data. **Top Right:** diurnal cycle biases won’t leave. New approaches via fused Lagrangian-tracked databases (provide history)?

