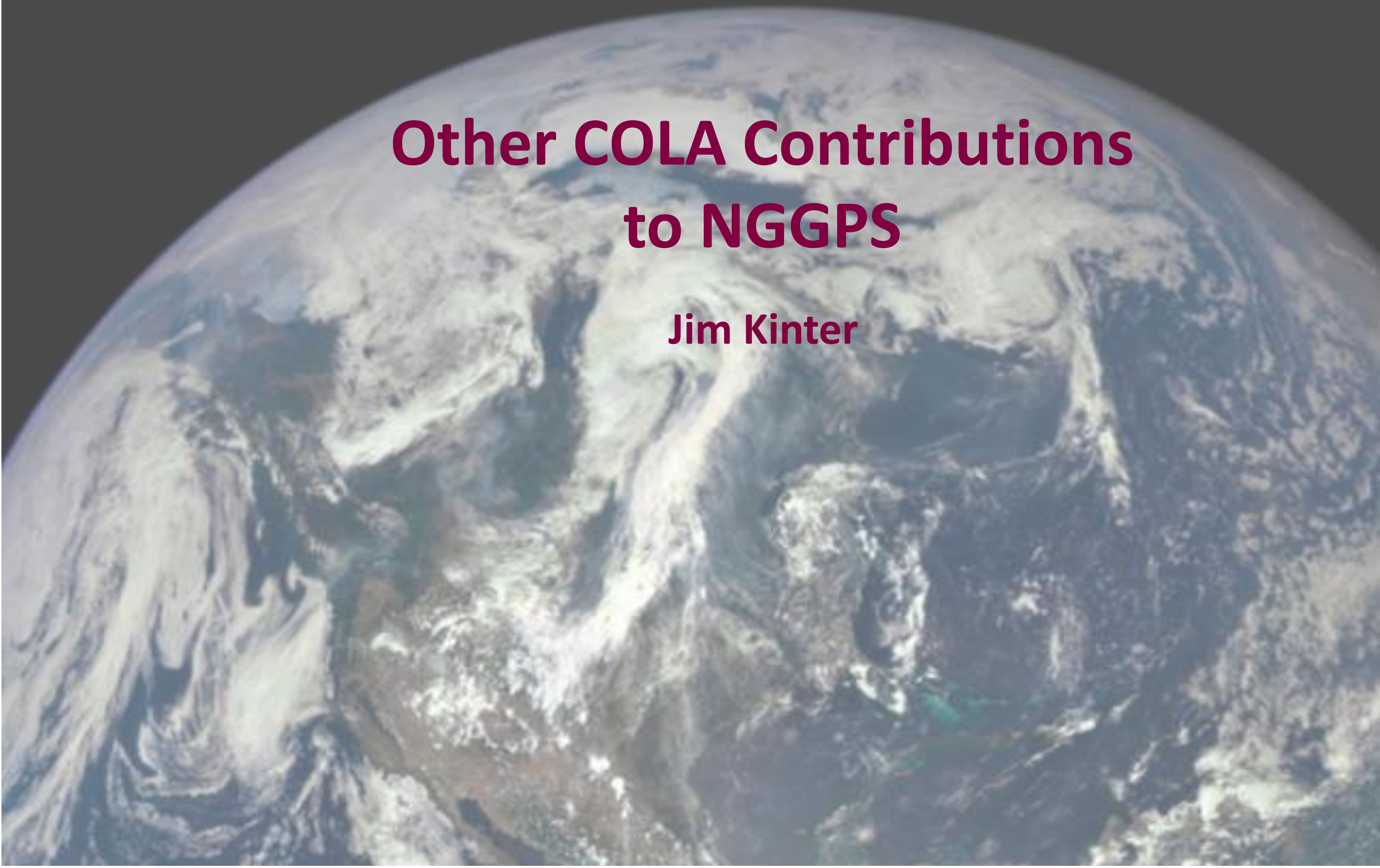


# Other COLA Contributions to NGGPS

**Jim Kinter**

*Next Generation Global Prediction System (NGGPS)*
*Modeling, Analysis, Predictions and Projections Program (MAPP)*
*PI Meeting*
*NCWCP -- 2 August 2017*

# Overview

- *Hypothesis*: Model bias is inhibiting accurate predictions at 3-4 weeks lead time of relevant processes (organized convection) and phenomena (MJO)
- Weeks 3 and 4 are beyond the deterministic limit of instantaneous NWP → must produce ensembles of forecasts from many initial states that are equi-probable and equally consistent with obs at $t_0$
- Can methods of seasonal prediction be applied to weeks 3 and 4, e.g.:
  1. Employ models of the coupled O-A-L system
  2. Verify space and time averages (weekly/biweekly means)
- Requirements?
  - Resolution: Synoptic (meso?) scales in the atmosphere? Ocean eddies?
  - Components: (Inter)active sea ice, ocean waves and/or aerosols?
  - Analysis and initialization fidelity
  - Ensemble size
  - Processes: Clouds and convection
  - Phenomena: MJO, MISO, NAO, PNA, …

# NGGPS Weeks 3-4 Prediction Research at COLA

- Baseline model: CFSv2*
  - Modifications to correct air-sea flux error, sea ice albedo setting
- Rigorous re-forecast testing designed to:
  1. Correct systematic biases, esp. deep convection in the tropics
  2. Quantify predictability and skill of weather forecasts for weeks 3-4, with special attention to diagnosing sensitivity to spatial resolution, predictability factors in the initial condition (e.g., state of the MJO, blocking conditions, etc.), and coupling between atmosphere and ocean
- Use statistical optimization methods to comprehensively evaluate the predictability and skill at weeks 3-4

* Original proposal: use UGCS; however, code not ready

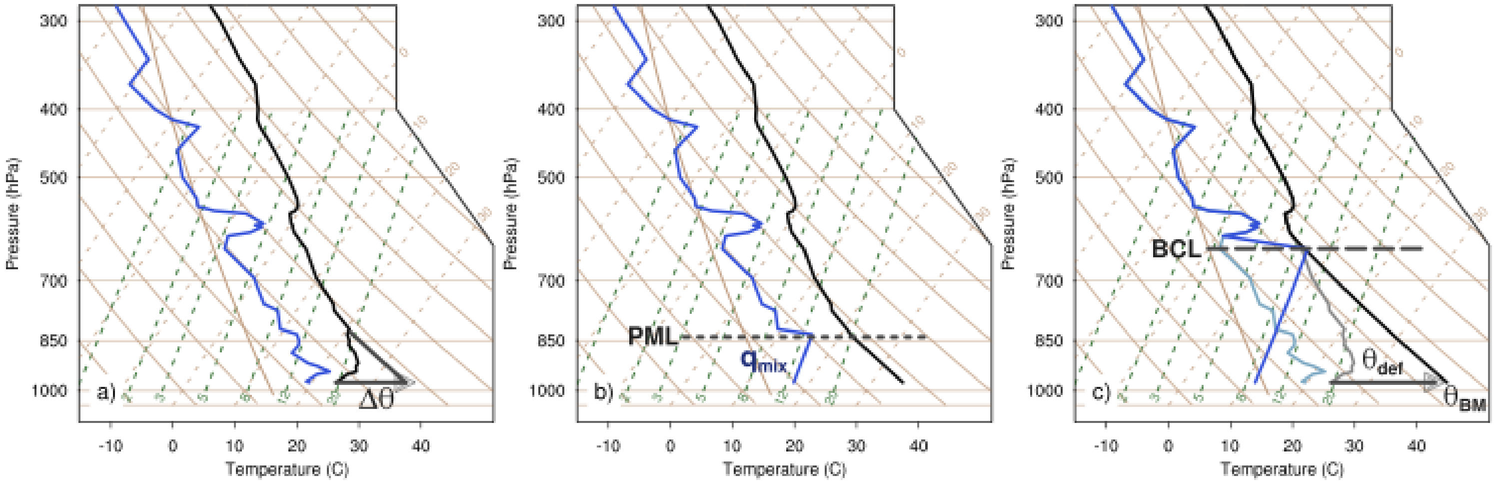
# Forecasts Improvement

- Errors in representing fast model processes, particularly convection, rapidly introduce forecast errors
- Convection errors continually introduce new errors throughout the forecast, degrading the contribution of accurate slowly varying components of the system (SST, soil moisture, snow, etc.)
- Example: convection occurs too regularly and too soon → improve the convection trigger
  - Heated Condensation Framework (Tawfik and Dirmeyer)
  - Eddy Diffusion – Mass Flux (Teixeira et al.)
  - Super-parameterization (Khairoutdinov et al.; Stan et al.)

# The Heated Condensation Framework (HCF)

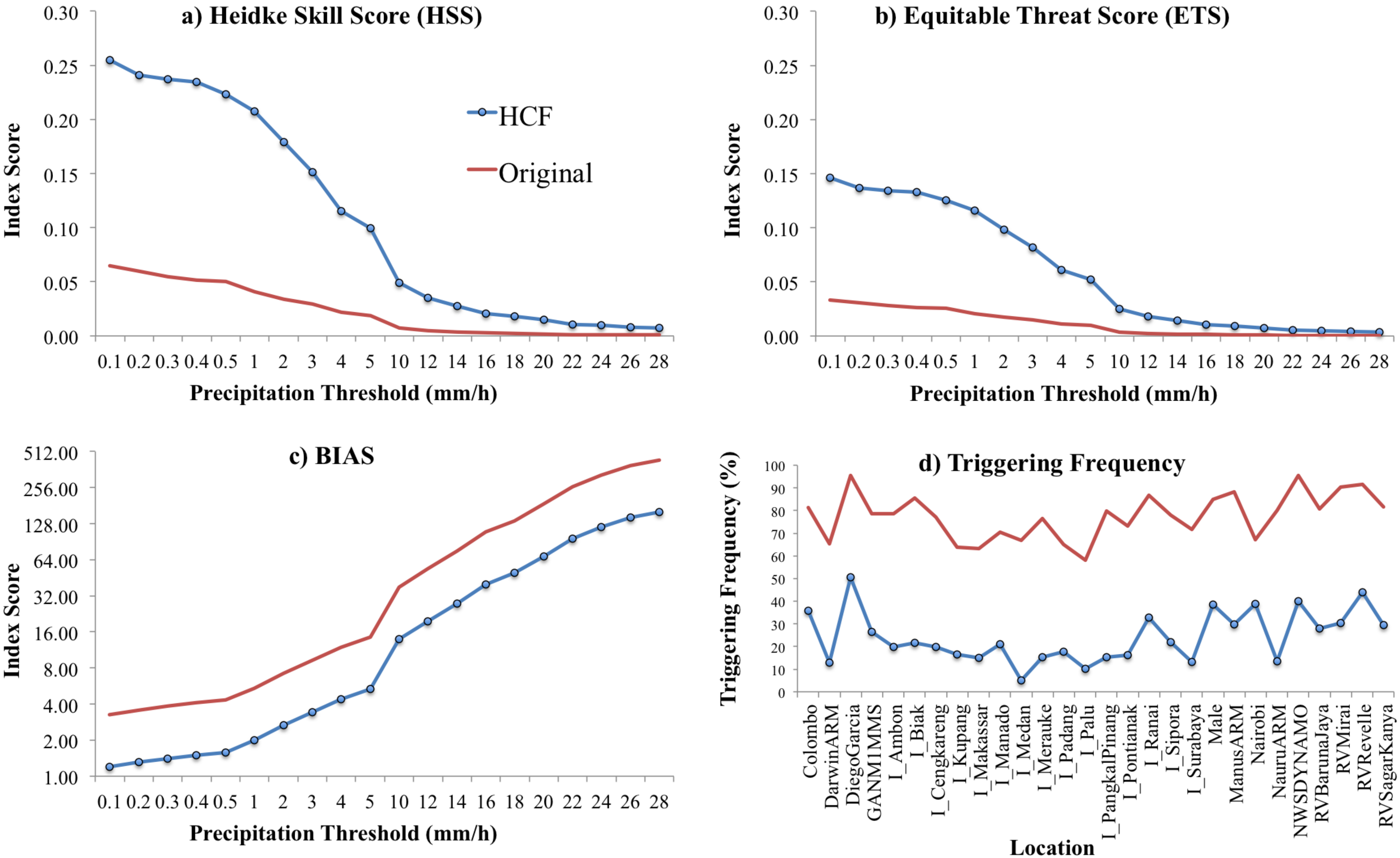
The HCF was designed to represent the atmospheric background state with respect to convection using standard profiles of temperature and specific humidity.

SkewT-LogP diagram of **temperature (black)** and **dew point (blue)** illustrating the steps to calculating the conditions for triggering convection.




**Tawfik and Dirmeyer (2014)**

# Verification w.r.t. DYNAMO Soundings



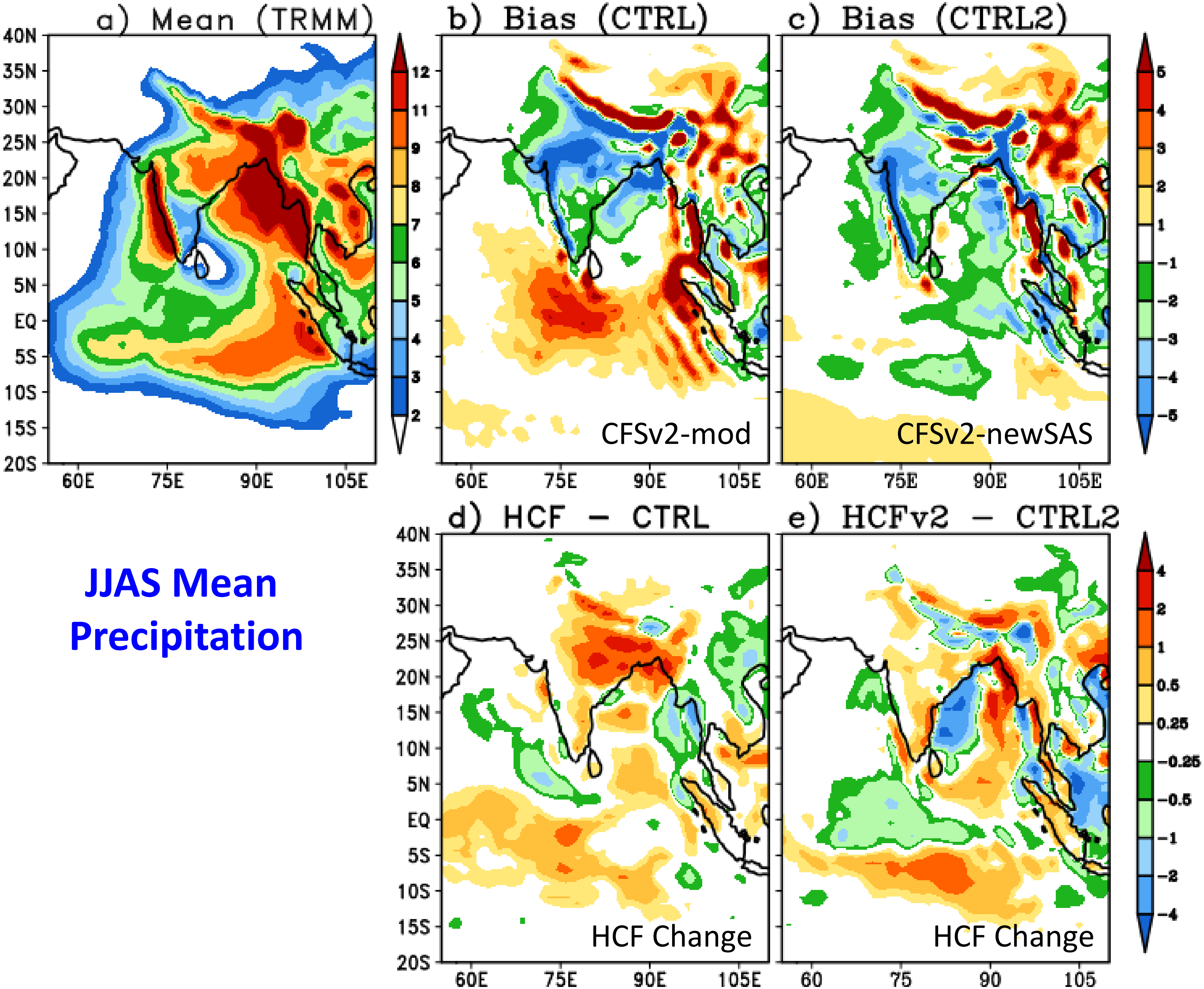
# Experiments

| Exp. | Length | Number of Years/Events | Range of Years | Number of Members per Year/Event | Initialization Date | Spatial Resolution | | Sampling Interval | Model Physics |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ATM/LS | OCN/Sea ice | | |
| CTRL | 7 months | 13 | 1998 - 2010 | 4 | April 1,2,3,4 | T126/L64 | 0.5-degL40 | Daily | Operational |
| HCF | 7 months | 13 | 1998 - 2010 | 4 | April 1,2,3,4 | T126/L64 | 0.5-degL40 | Daily | **Oper. + HCF trigger** |
| CTRL2 | 7 months | 13 | 1998 - 2010 | 4 | April 1,2,3,4 | T126/L64 | 0.5-degL40 | Daily | **New SAS + Shallow** |
| HCFv2 | 7 months | 13 | 1998 - 2010 | 4 | April 1,2,3,4 | T126/L64 | 0.5-degL40 | Daily | New SAS + Shallow **+ HCF trigger** |
| CTRL2 | 1 month | 24 | - | 7 | [Landfall, -1, …, -6] | **T382/L64** | 0.5-degL40 | 6-hourly | New SAS + Shallow Cu |
| HCFv2 | 1 month | 24 | - | 7 | [Landfall, -1, …, -6] | **T382/L64** | 0.5-degL40 | 6-hourly | New SAS + Shallow Cu **+ HCF trigger** |
| SP-CFSv2 | 1 week | 4 | Selected cases | 1 | Various | **T126 :: 4 km** | 0.5-degL40 | 6-hourly | **Super-parameterization** |

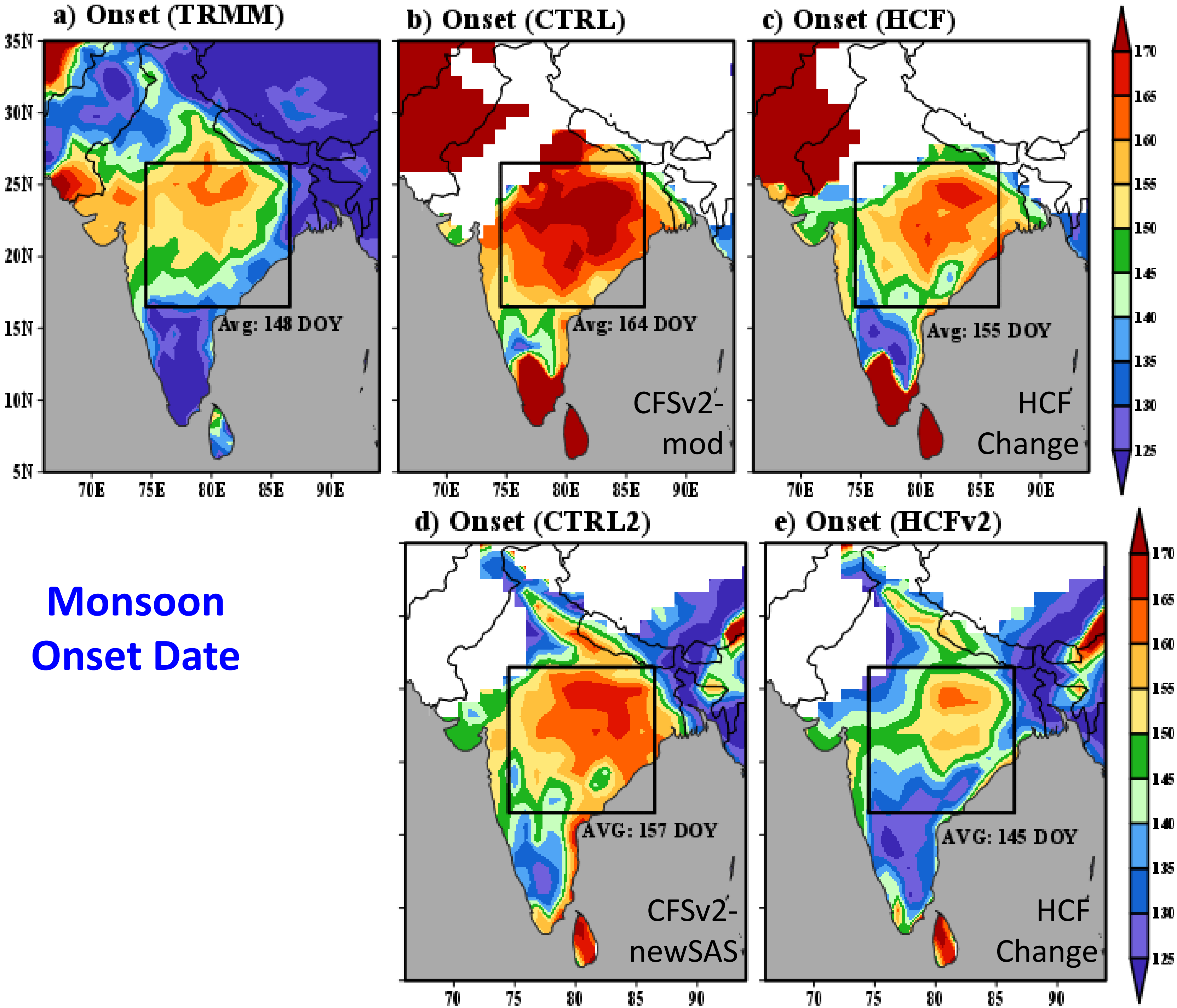
Bombardi et al. 2015
(Trigger criteria relaxed)

Bombardi et al. 2016
(Trigger criteria restricted)

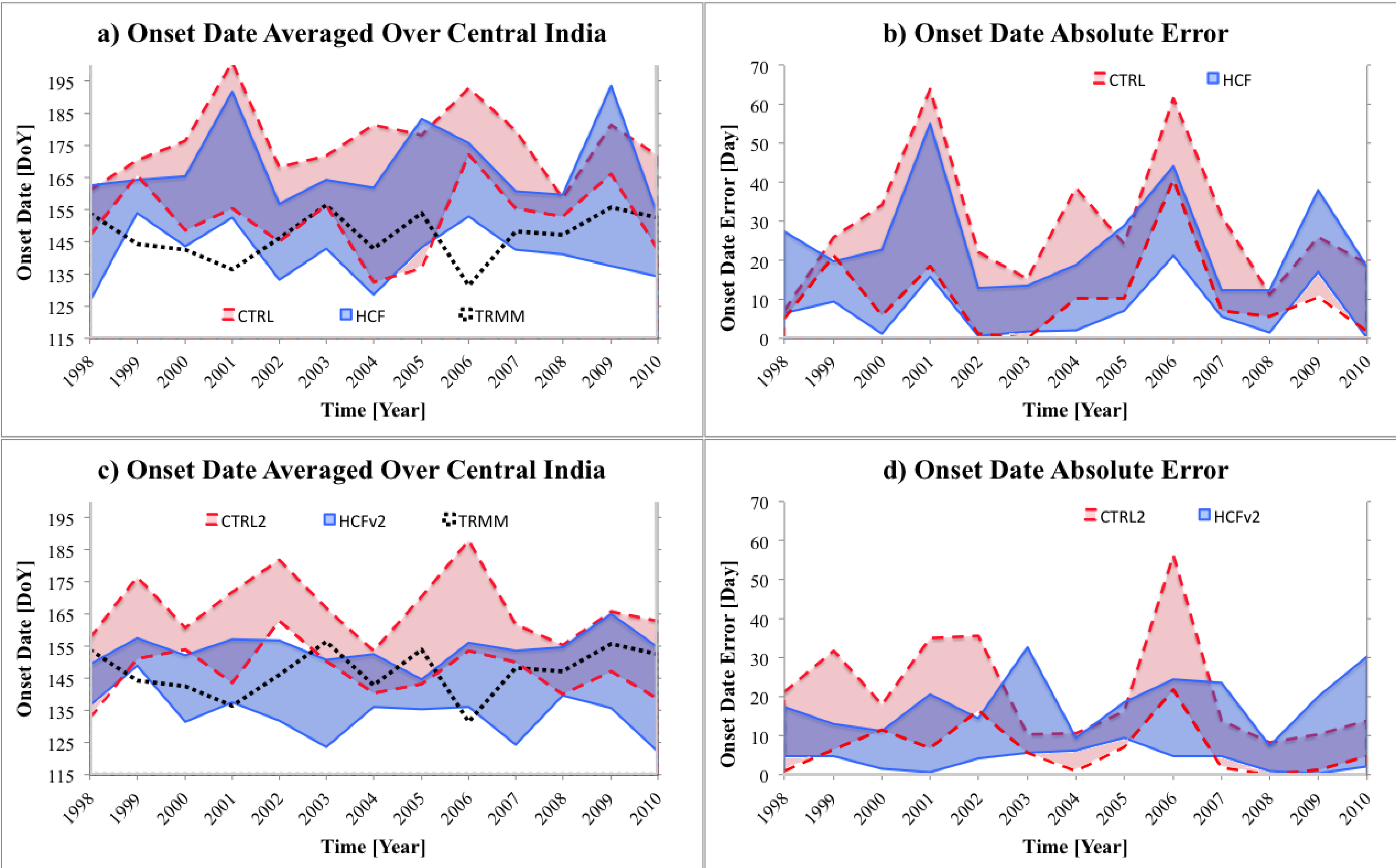
# JJAS Mean Precipitation



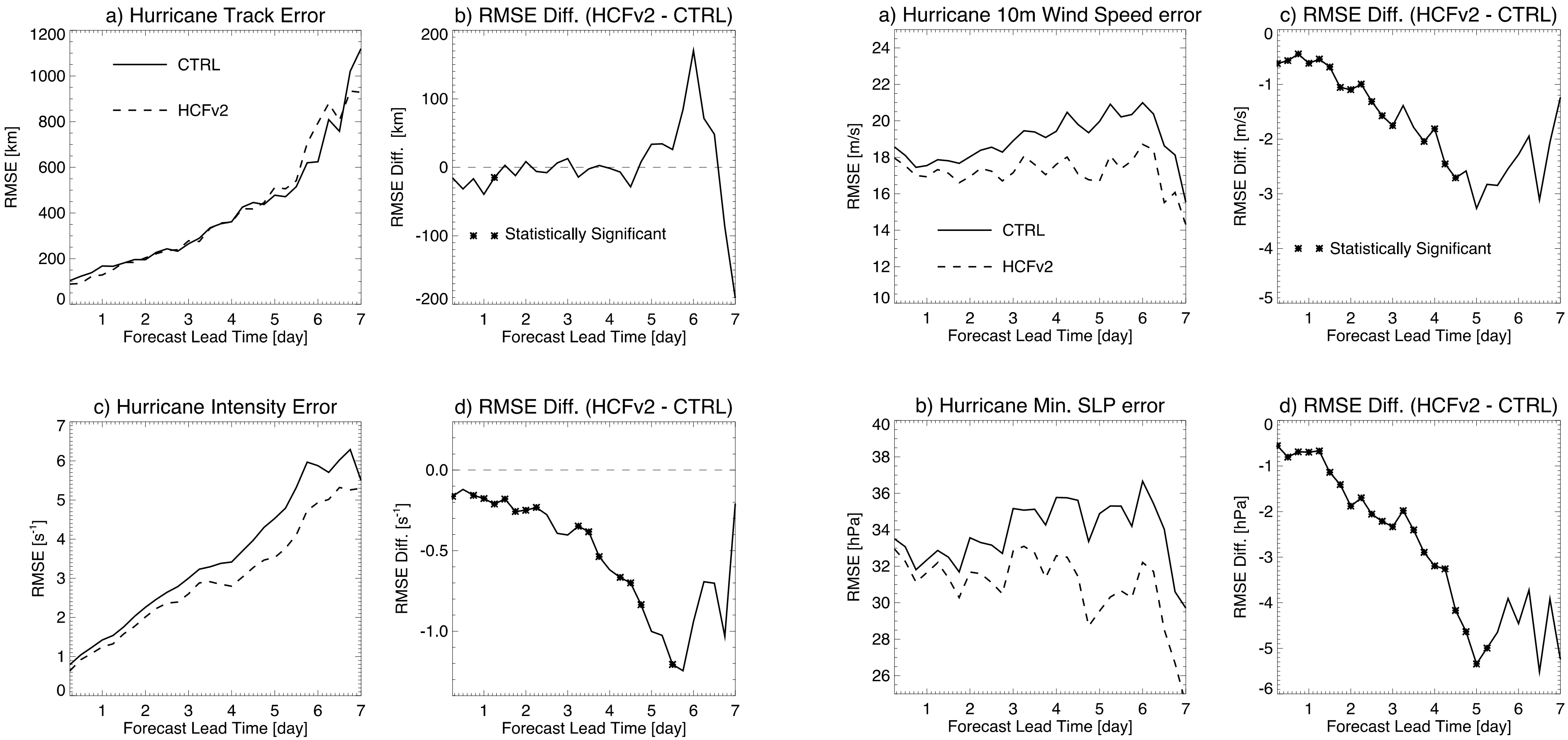
# Monsoon Onset Date



# Onset Date Variability

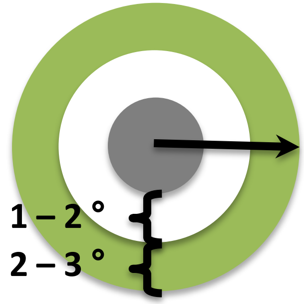


# Simulating Hurricanes at T382 (~ 38km)




**Stars = statistically significant at 5% level (24 cases; 7 members)**

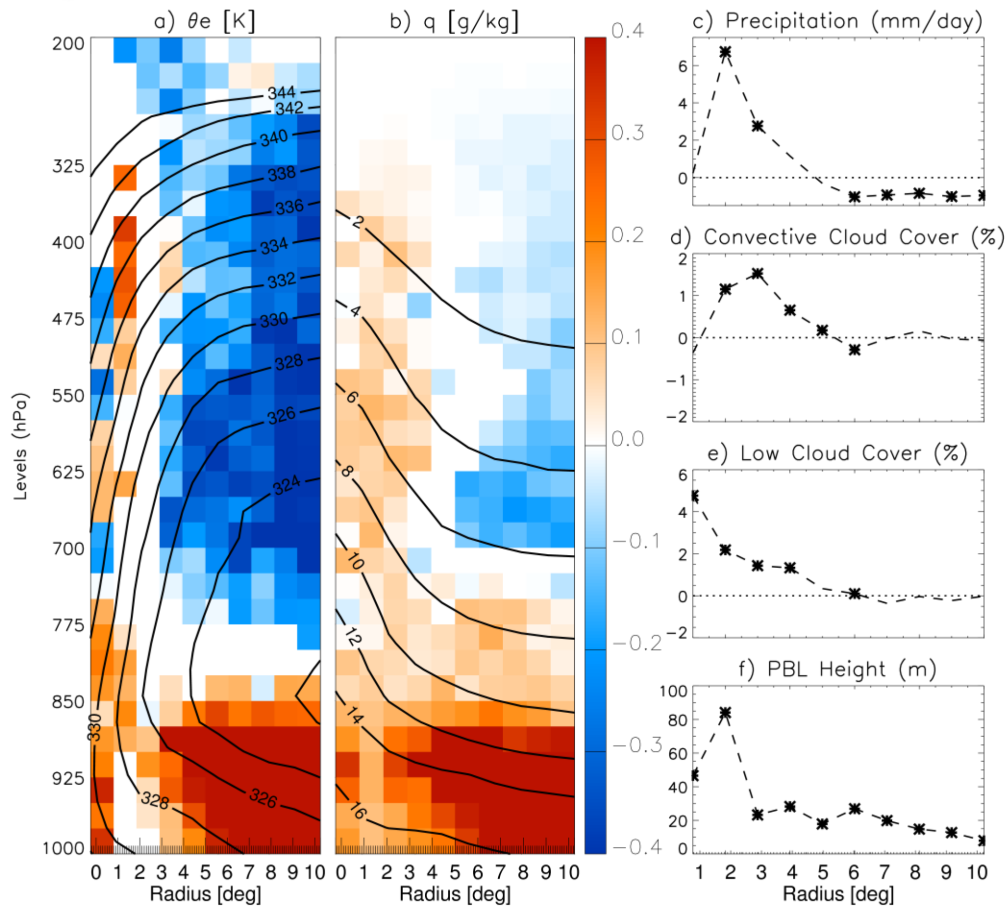
# Mechanisms




Averaged over 1 degree bins
Averaged from 24h to 72h
Median Differences

The HCF trigger activates the convective schemes less frequently:

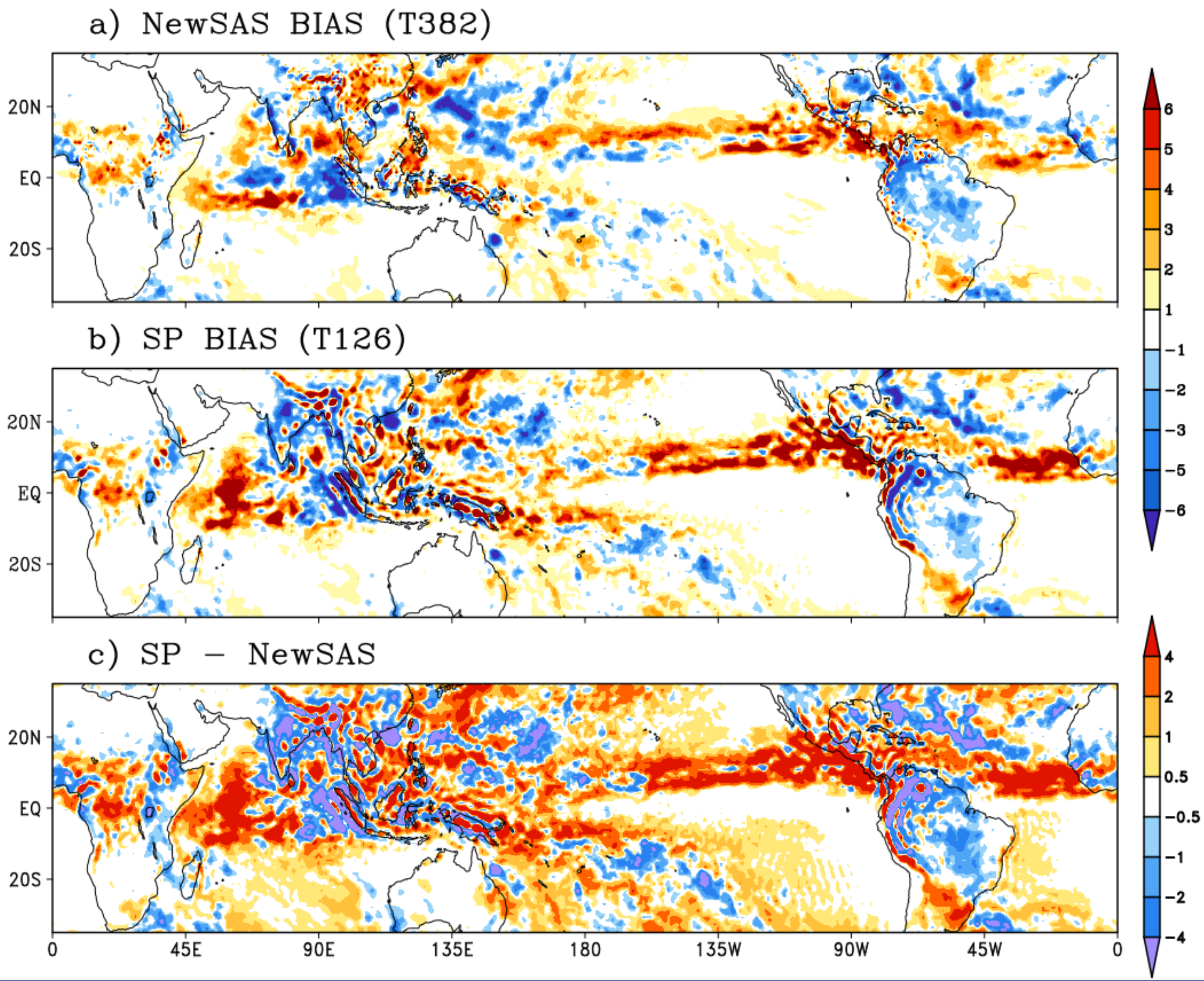
- increases convective instability
- allows PBL to moisten and grow higher
- increases precipitation, low and convective clouds
- releases latent heat, intensifying hurricanes




Bombardi et al. (2016)

**Shading or stars = statistically significant at 5% level**

# Super-Parameterization in CFSv2




Week 1
(limited set of cases)

# Discussion

- Delaying the triggering of convection (HCF, shallow convection, NewSAS) has the desired effect of allowing the PBL to grow, increasing the injection of moisture into the lower troposphere that condenses, generating more low and convective clouds and also releasing more latent heat
- Positive impacts on:
  - Seasonal total rainfall in monsoon regions
  - Onset date of rainy season
  - Tropical cyclone intensity
- No (or slightly negative) impact on SST bias
- Superparameterization tested in very limited number of cases: no significant impact on short-range forecast skill