On the Threshold Sea Surface Temperature for Onset of Convection

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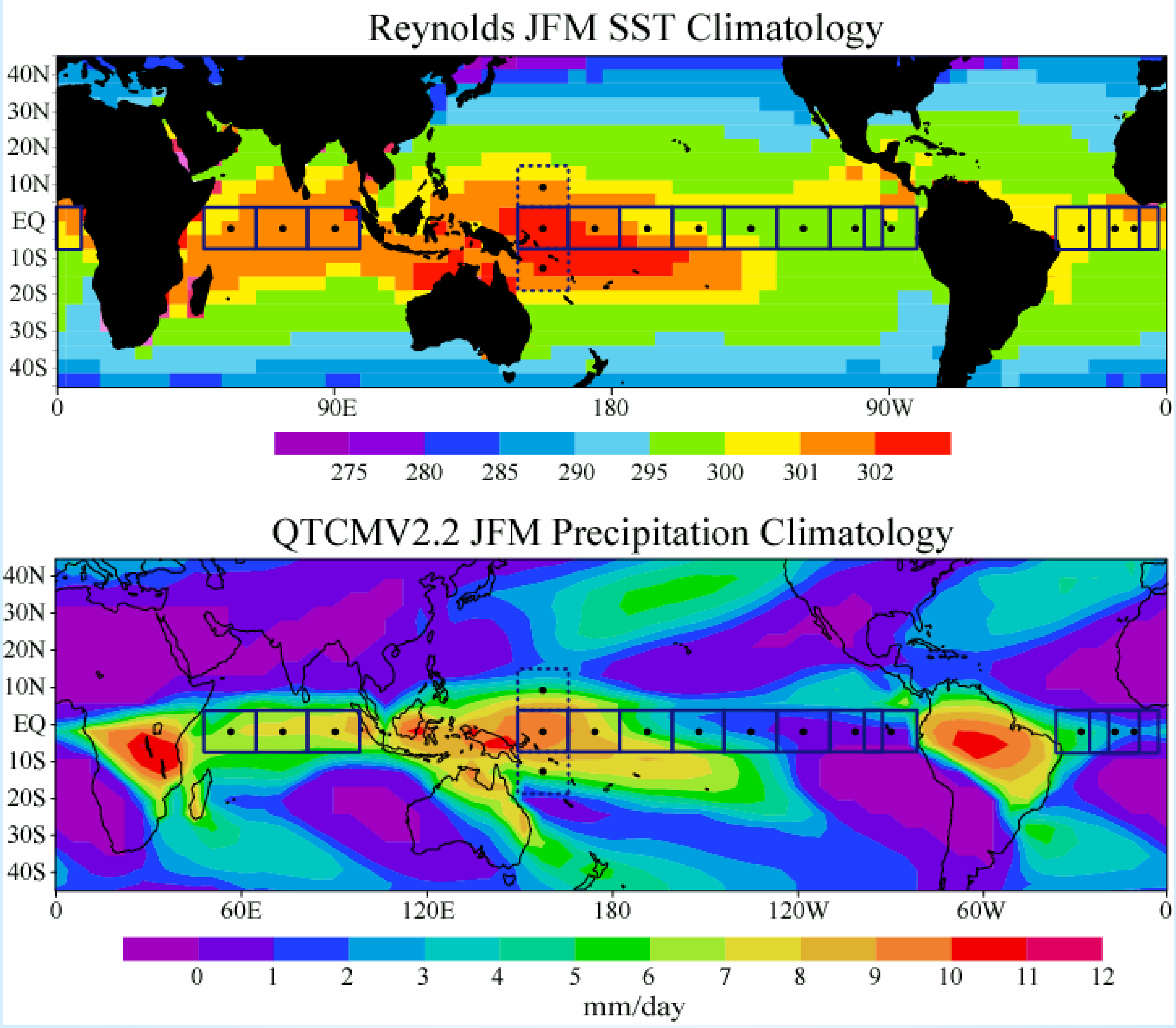
- Notion of threshold SST based on strong deep convection zones for $SST \geq 27.5$ C (Graham & Barnett,1987)
- Threshold is relative. Pattern ≈ same if add 2C everywhere (Randall et al 2001)
- Can we make concept more precise?
- Spatial dependence?
- Add local –/+ SST anomaly until convection stops/starts
- Experiments in QTCM: Quasi-equilibrium Tropical Circulation Model (> 500 ensemble experiments)

Example of regions for which local threshold will be determined



Precipitation vs SST for various regions for DJF

Defining the threshold:

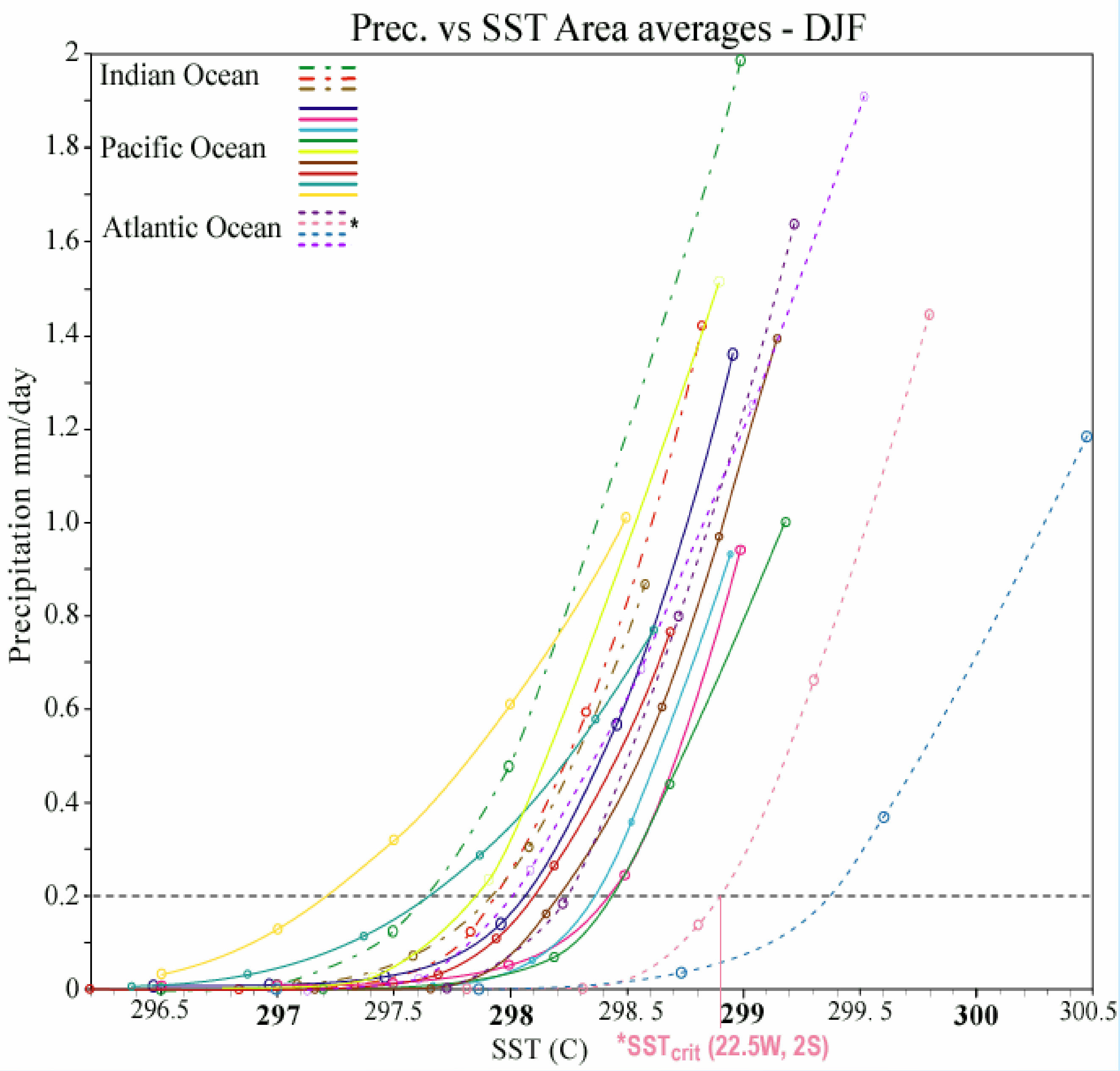
Use 0.2 mm/day for onset of convection in ensemble avg.

(defining threshold between medium and large convection more arbitrary)

Threshold values: 297.2 to 299.4

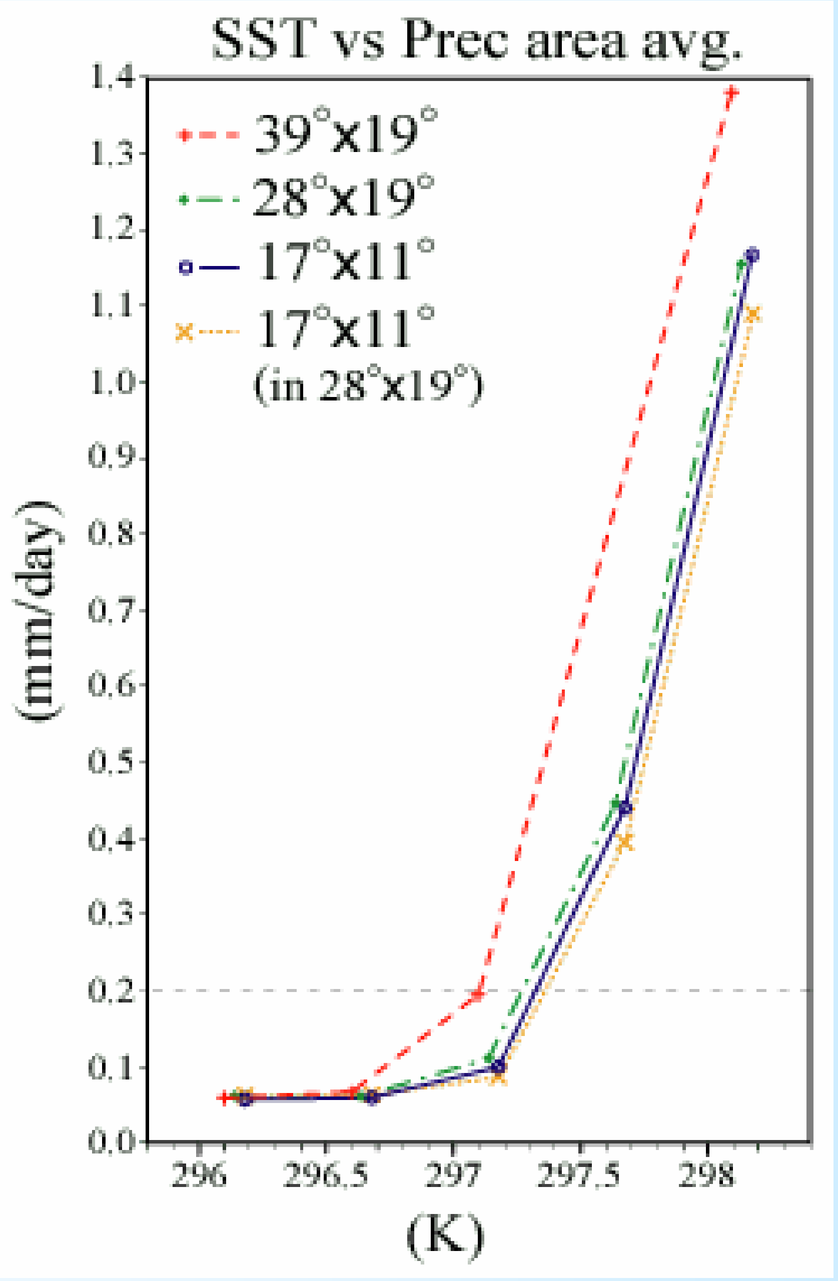
Realistic case:

- **SST = observed clim. + local anomaly**
- **Land temperature is modeled**



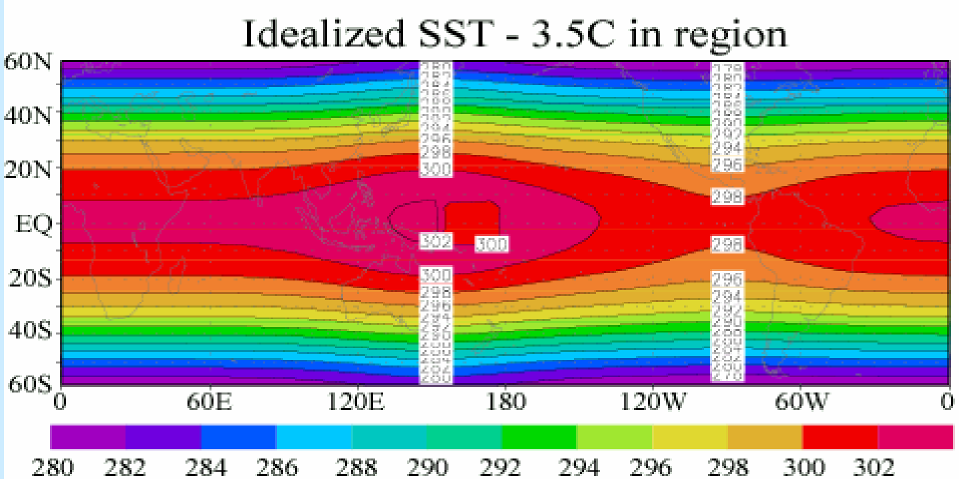
Effect of box size

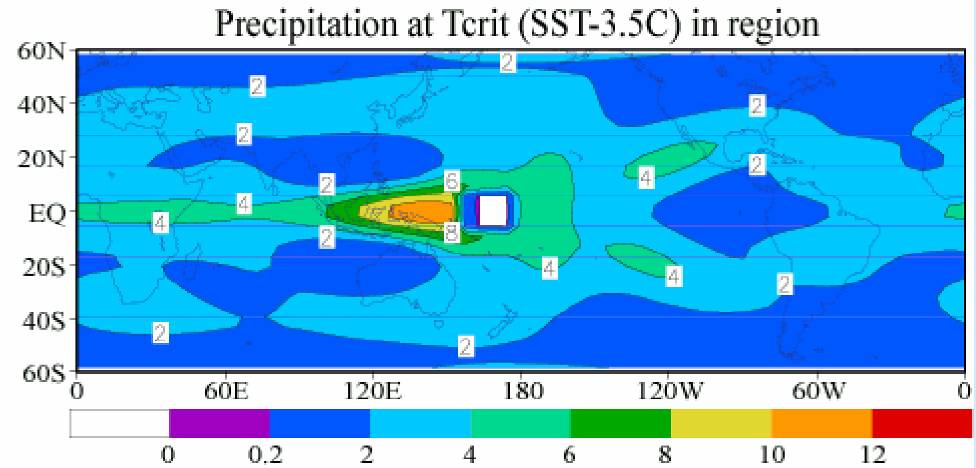
- Western Pacific warm pool, all centered at (169E, 2S)
- Region where SST is lowered is 39°x19°, 28°x19°, 17°x1°1 and a 17°x11° in a 28°x19° area, respectively
- SST_{crit} not very sensitive within this range

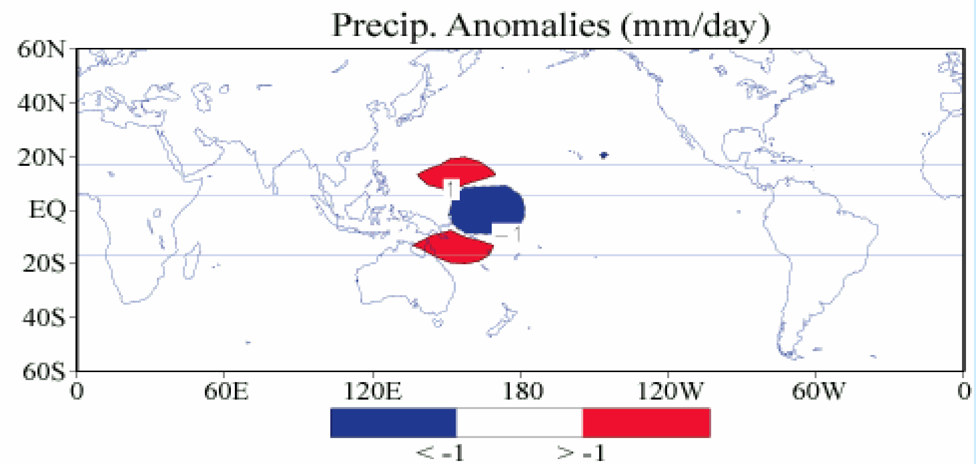


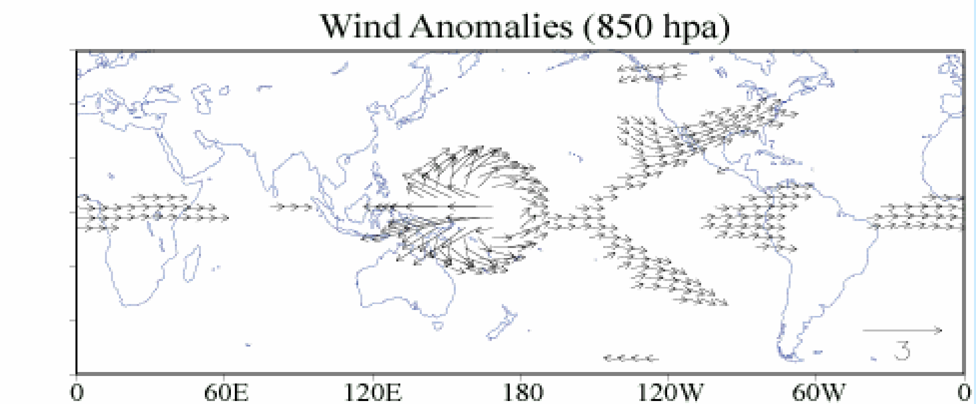
Precip. & Winds (850mb) at SST_{crit}

- **Idealized SST climatology case**
- **SST region bounded by 157.5E - 147.375 X 5.625S - 5.625N**
- **SST_{crit} = temp at which prec = 0.2mm/day**



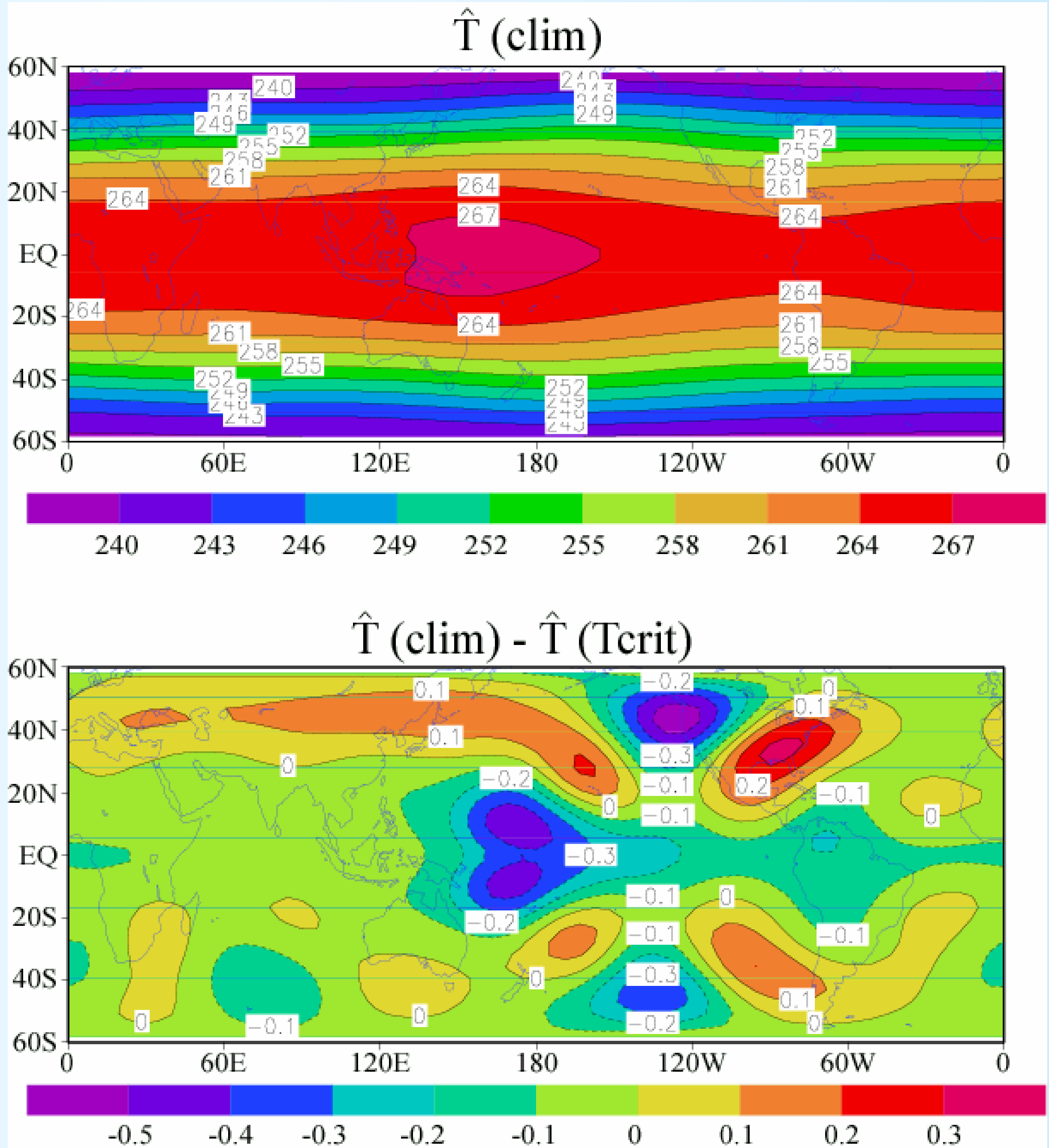






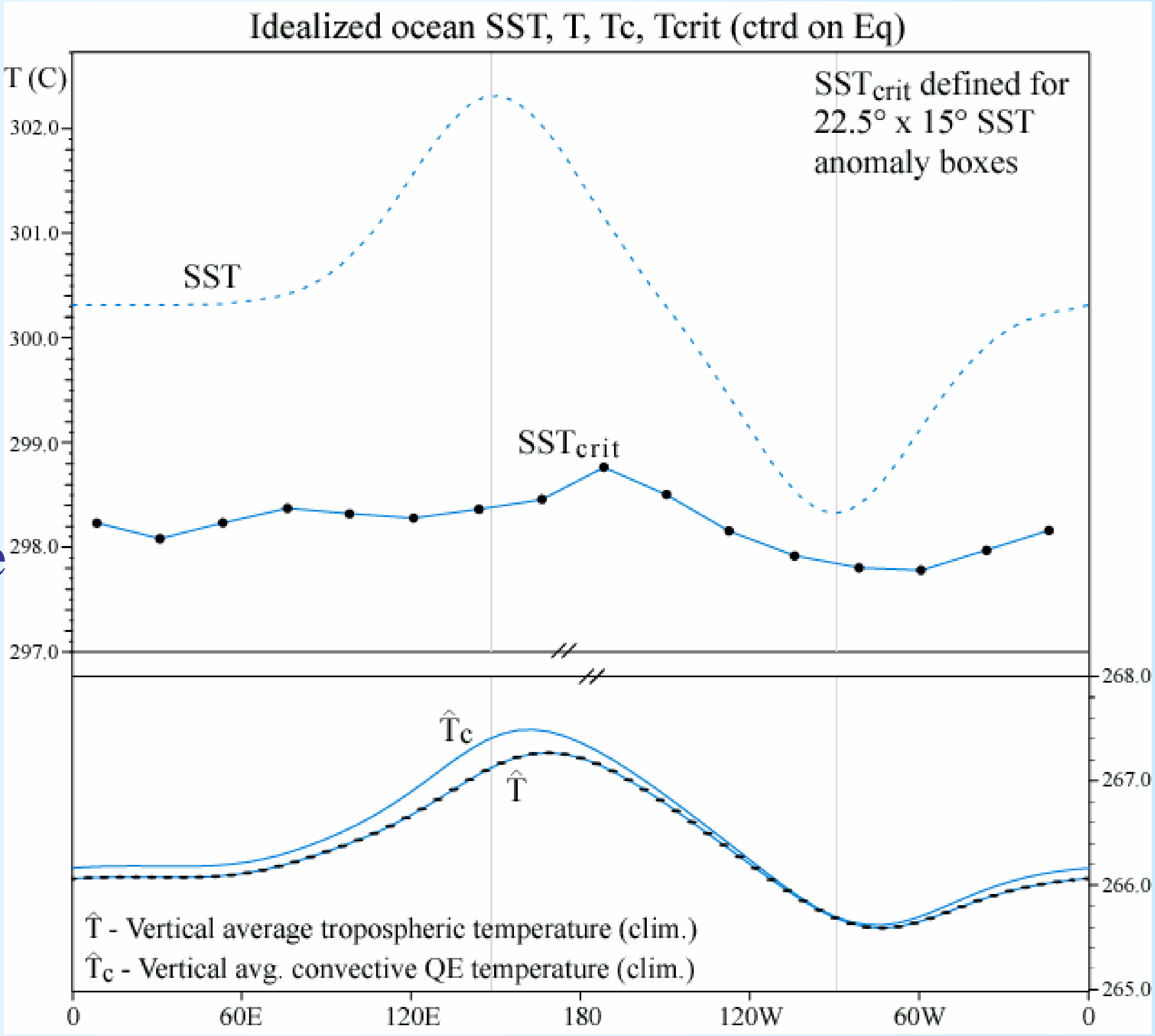
$\hat{T}$ Climatology and Anomaly

- Idealized SST climatology case
- Anomaly box area bounded by 157.5E - 147.375E x 5.625S - 5.625N
- $\hat{T}$ denotes tropospheric vertical average
- $\hat{T}$ anomaly amplitude relatively small



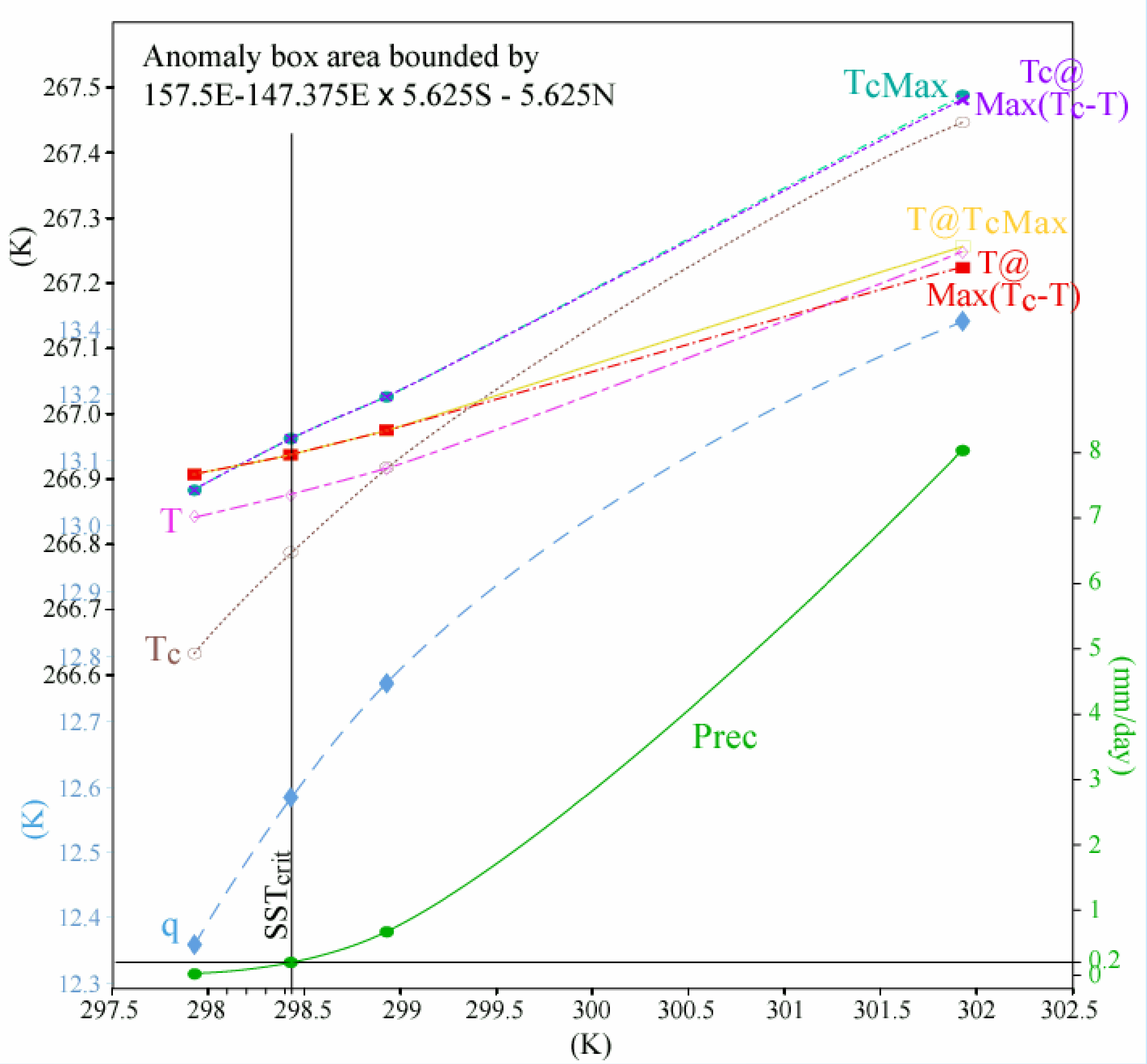
Idealized SST climatology case - SST, SST_{crit}, $\hat{T}$, $\hat{T}_c$

- There is regional variation of SST_{crit}
- SST_{crit} amplitude smaller than SST variations in clim
- SST_{crit} eastward shift relative to SST
- $\hat{T}$ shifted east relative to SST due to wave dynamics
- $\hat{T}_c$ Affected by SST
- Convection for $\hat{T}_c - \hat{T} > 0$ (CAPE)



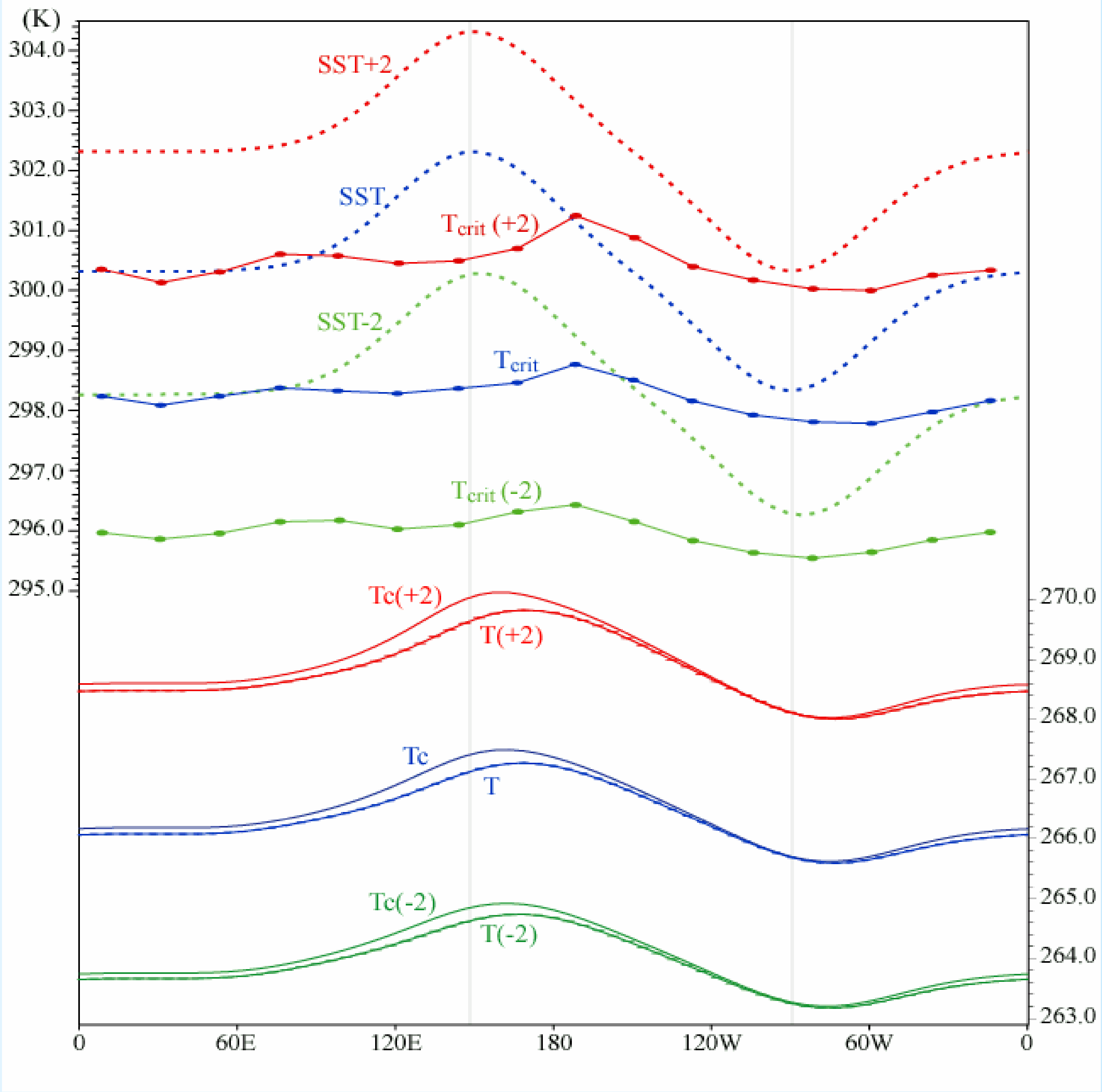
Box area avg. SST vs. $\hat{T}$, $\hat{T}_c$ Prec, $\hat{q}$

- Idealized SST clim
- Specific humidity q tends to drop with local SST
- $\hat{T}_c$ drops with q
- $\hat{T}$ drops more slowly
- CAPE ~ $\hat{T}_c$ - $\hat{T}$
- Precip drops with CAPE
- But variations within box so point with max CAPE controls onset



Idealized SST +/-2C - SST, SST_{crit}, $\hat{T}$, $\hat{T}_c$

- SST_{crit} is relative to surrounding regions
- Adding ±2C to all SST just shifts the entire pattern (approximately)



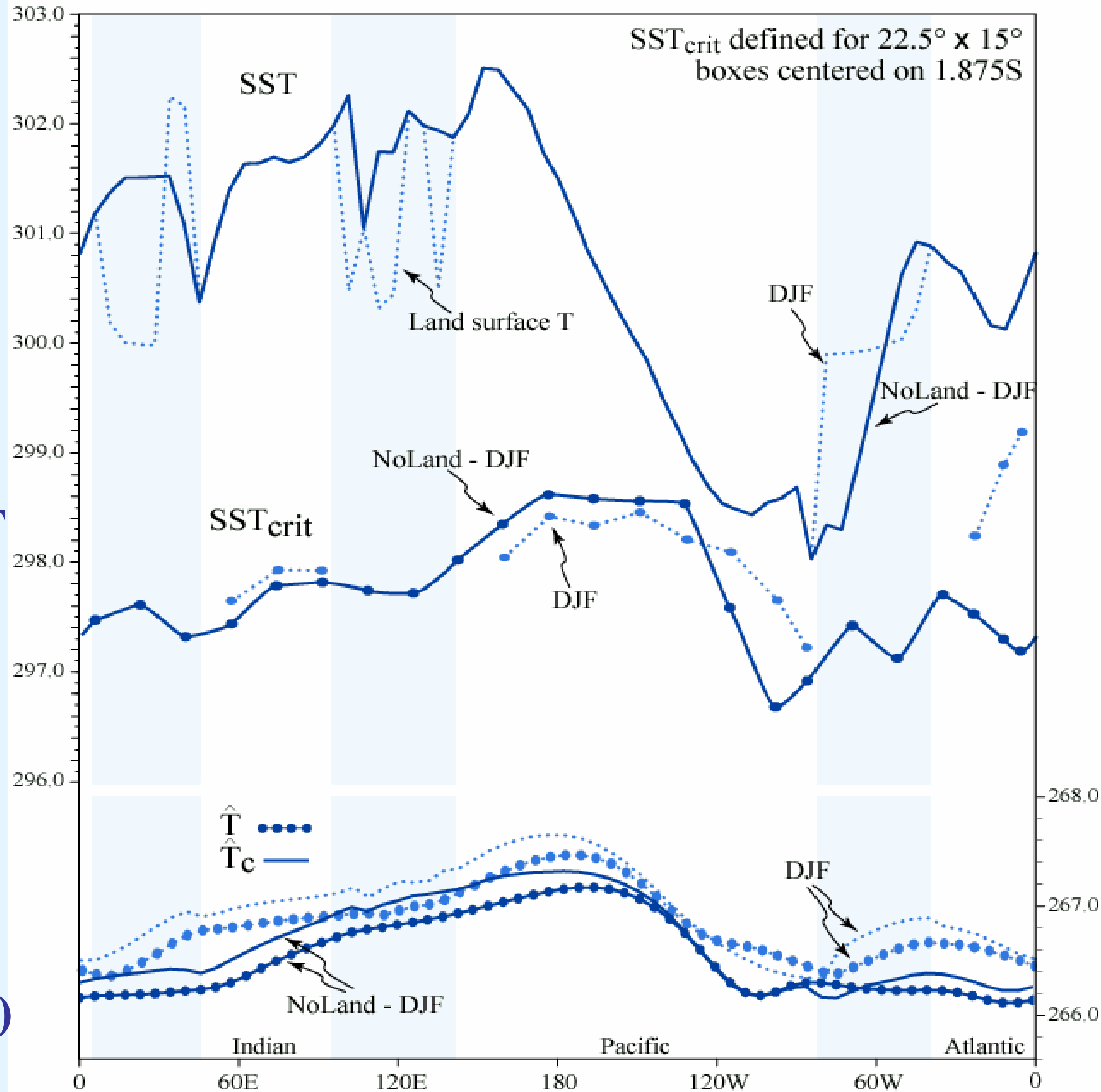
NoLand-DJF & DJF (realistic case)
SST, SST_{crit}, $\hat{T}$, $\hat{T}_c$

NoLand case:

- SST_{crit} differs by > 1C between central Pacific and Atlantic or Indian (2C to E. Pac.)
- $\hat{T}$ smoother and shifted eastward rel. to clim SST
- SST_{crit} tends to follow $\hat{T}$
- Approx. consistent with $\hat{T}$
- Postulate $\hat{T}_c$ drawn toward local SST, $\hat{T}$ strongly affected by large-scale wave dynamics

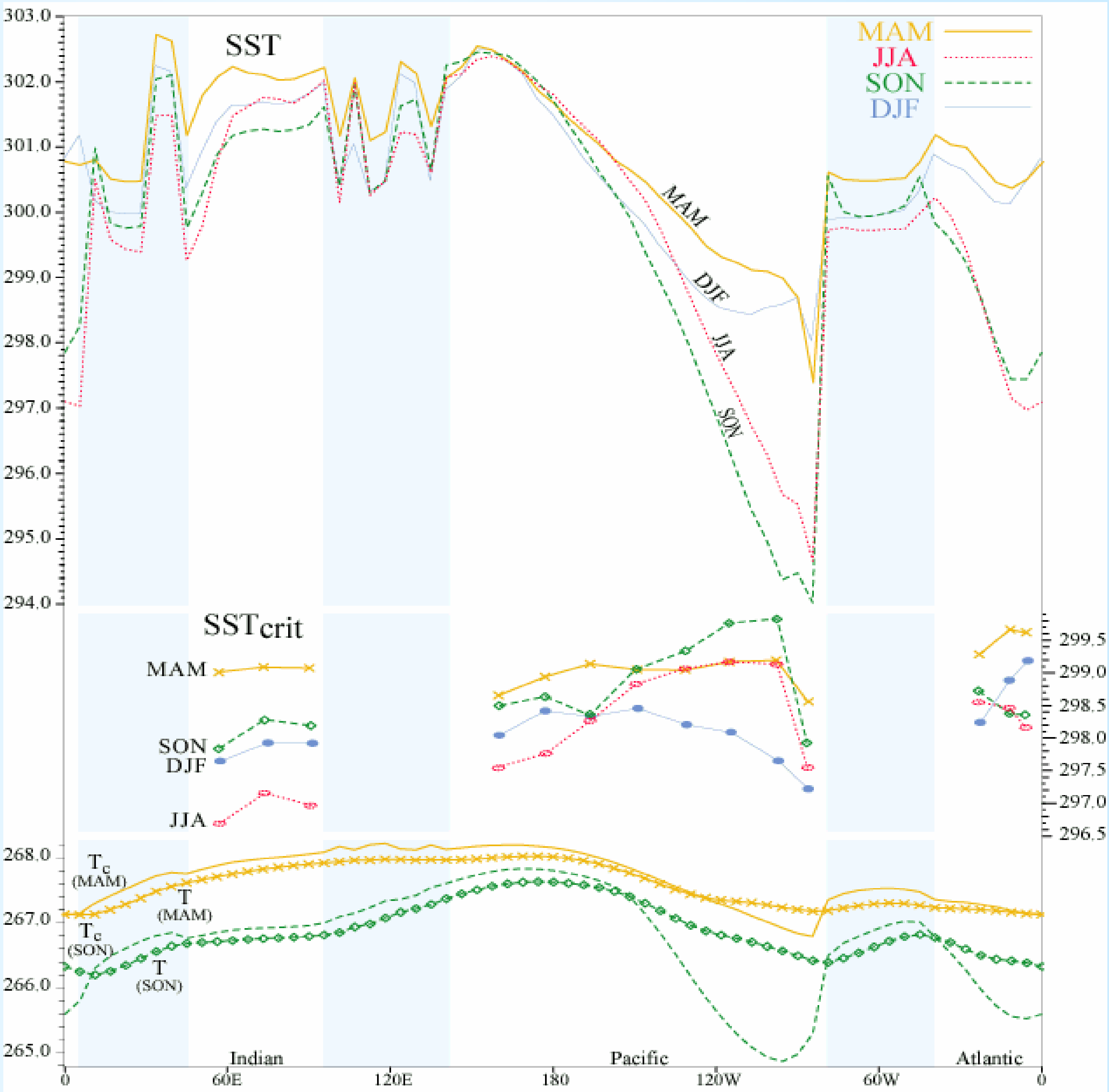
Realistic case:

- Similar but with exceptions ? (e.g., Atlantic)



Realistic case - DJF, MAM, JJA, SON - SST, SST_{crit}, T, & T_c

- SST_{crit} changes with season as well as region
- Hard to find simple rule for SST_{crit} relation to clim. SST
- Regional and land effects changing with seasonal climatology



Summary

- **Defining SST_{crit} by local SST anomaly experiments and low onset threshold works in deep tropics**
- **SST_{crit} is relative (to other regions): a very large scale SST change has completely different effects (e.g., little effect on precipitation pattern) than regional SST anomalies**
- **SST_{crit} has substantial spatial and seasonal variations (smaller than range of SST climatology)**
- **For idealized SST climatology or No-Land case (with observed/interpolated SST) the relation of SST_{crit} to SST can be understood by two effects on CAPE: wave dynamics on $\hat{T}$ and local SST on q**
- **For realistic case the local effects involve advection, relation to neighboring land regions etc. $\Rightarrow$ SST_{crit} bears complex relation to SST climatology**

Title Page

TropTemp

End show