

Land Surface Feedbacks Related to Atlantic Variability

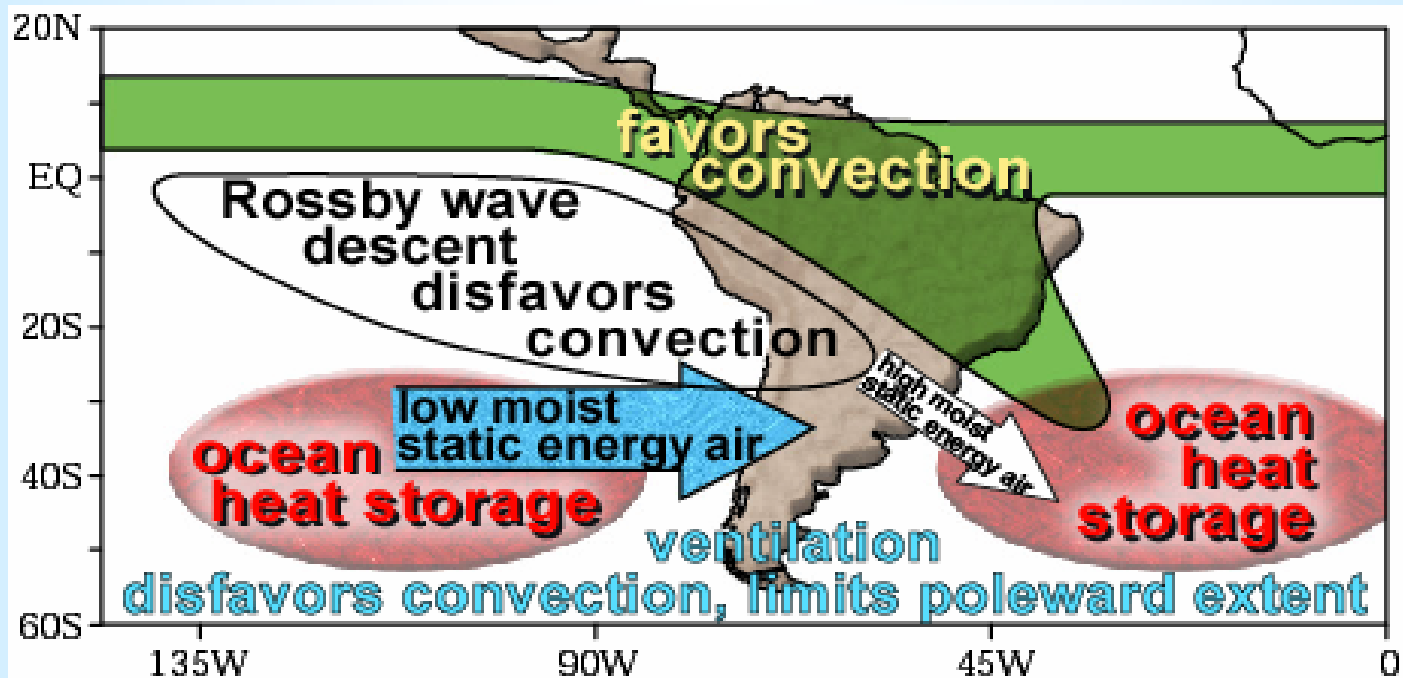
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Collaborators: Ning Zeng, U. Maryland; Chia Chou, Academia Sinica, Taiwan; Hui Su, UCLA

- Dynamical vs. land surface factors in summer monsoons**
- Land surface feedbacks in teleconnection**
- Vegetation feedbacks in teleconnected variability**

Factors in summer monsoon extent

- **Dynamic:**
 - “ventilation mechanism”
 - $v \cdot \nabla(q + T)$ importing low moist static energy air
 - wave dynamics
 - Kelvinoid
 - Rossby-related “interactive Rodwell-Hoskins” mechanism
- **Thermodynamic:**
 - positive net flux (Rad + SH + Latent) into atmospheric column = TOA over land
- **Land-Surface processes:**
 - Albedo
 - Soil wetness/ evapotranspiration

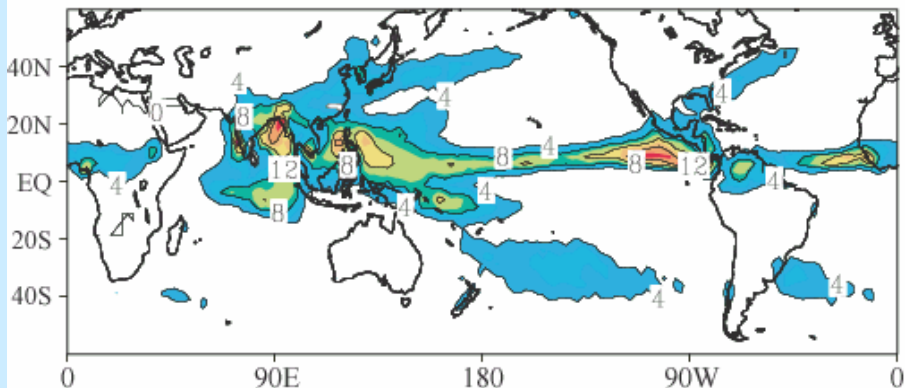


Factors in summer monsoons

Observed climatology July

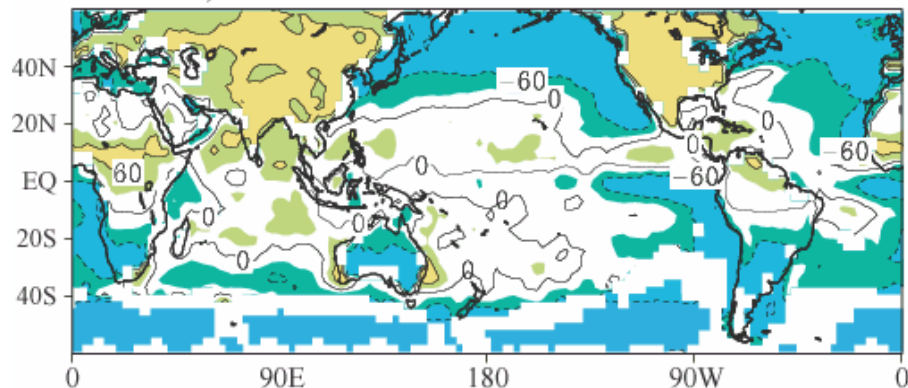
Precipitation

Xie - Arkin



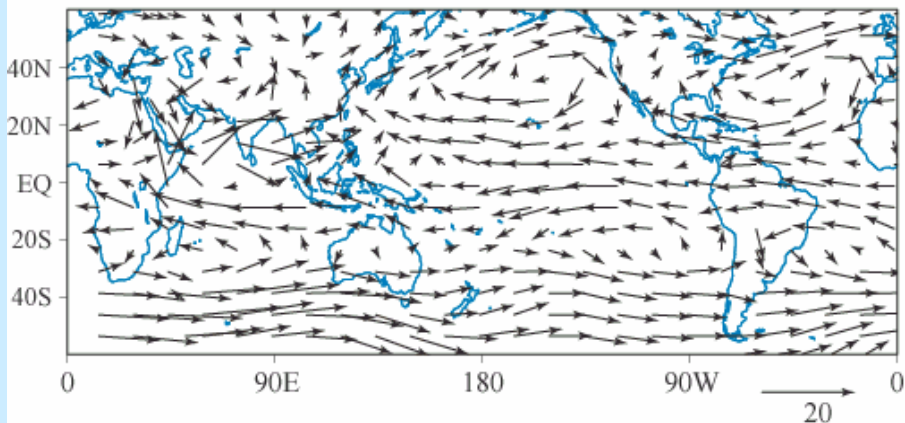
Net flux into atmosphere

COADS, ERBE and Darnell et al.



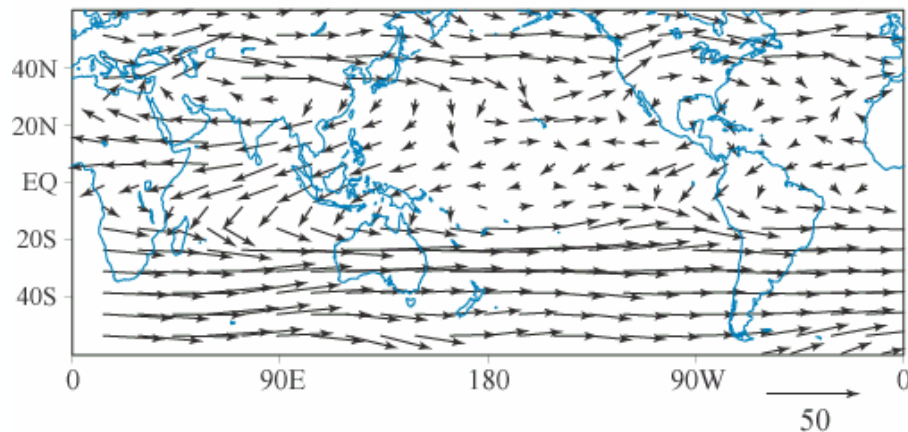
Low-level wind

wind at 850mb: NCEP



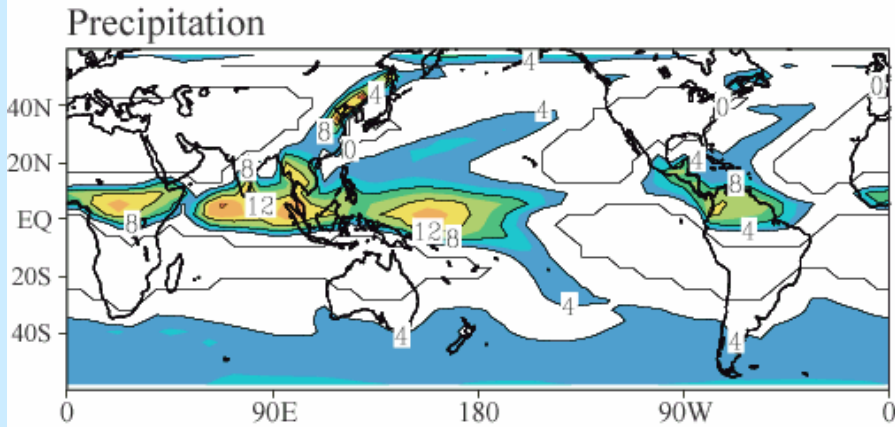
Upper-level wind

wind at 200mb: NCEP

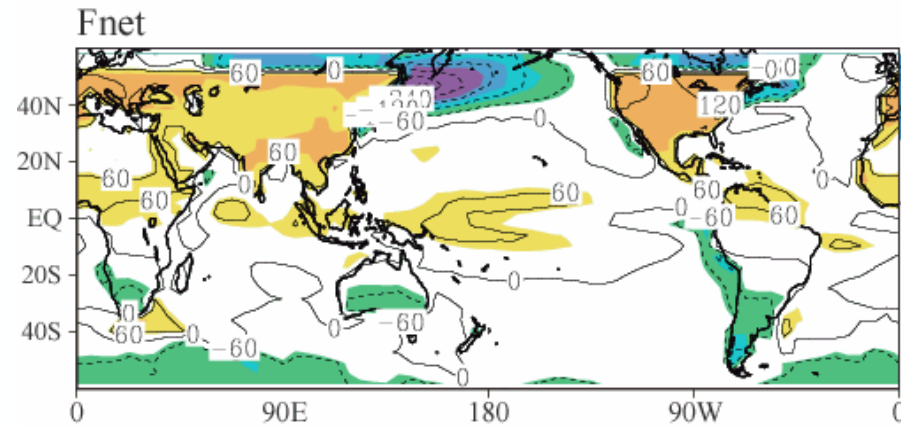


QTCM climatology July (coupled to a mixed-layer ocean)

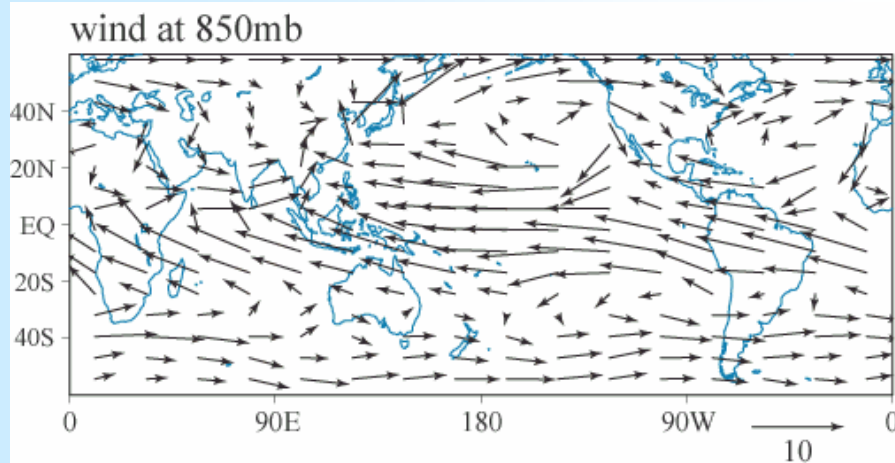
Precipitation



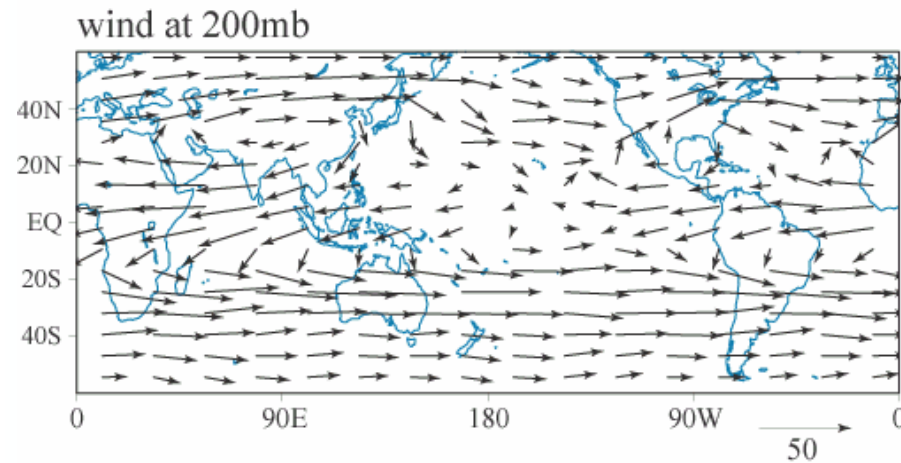
Net flux into atmosphere



Low-level wind



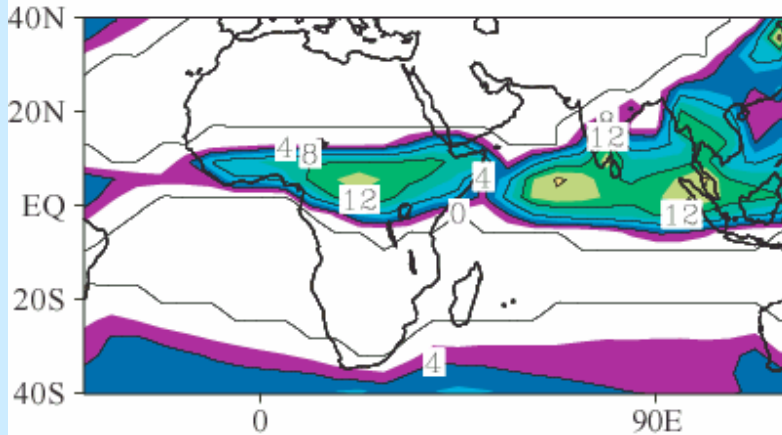
Upper-level wind



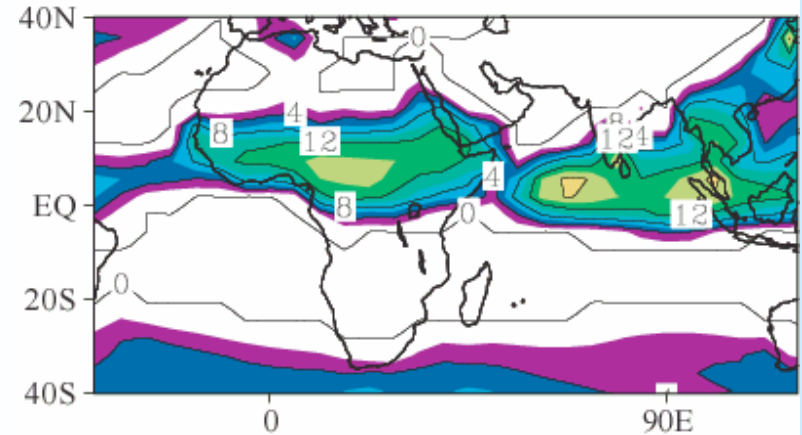
African region case (observed albedo) July

Precipitation

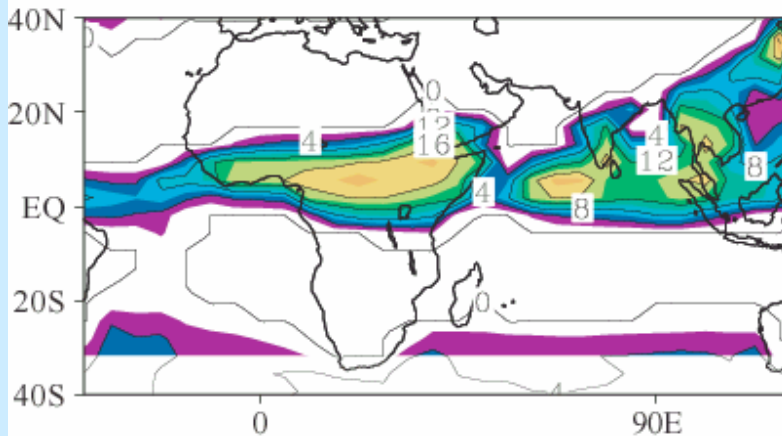
Control



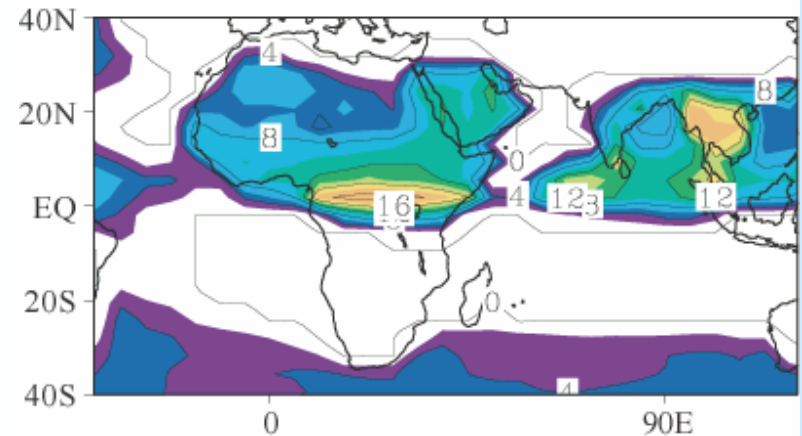
Saturated soil moisture over African region



No ventilation: $v \cdot \nabla q$, $v \cdot \nabla T$ set to zero over African region

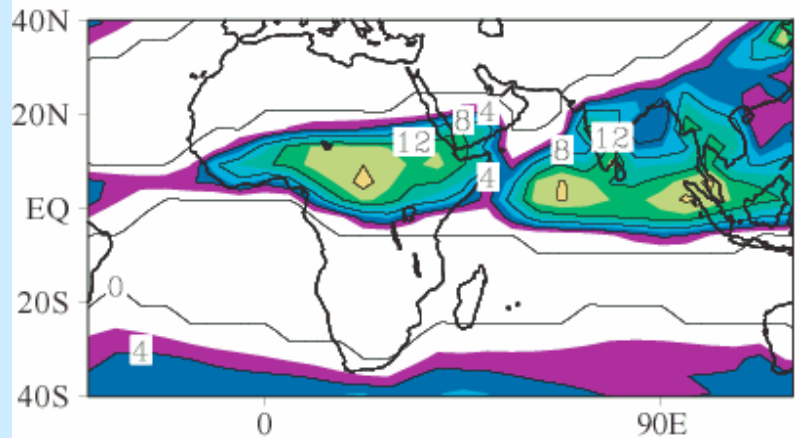


No ventilation and no β -effect: $f = \text{constant}$ in African region (0 - 50N)

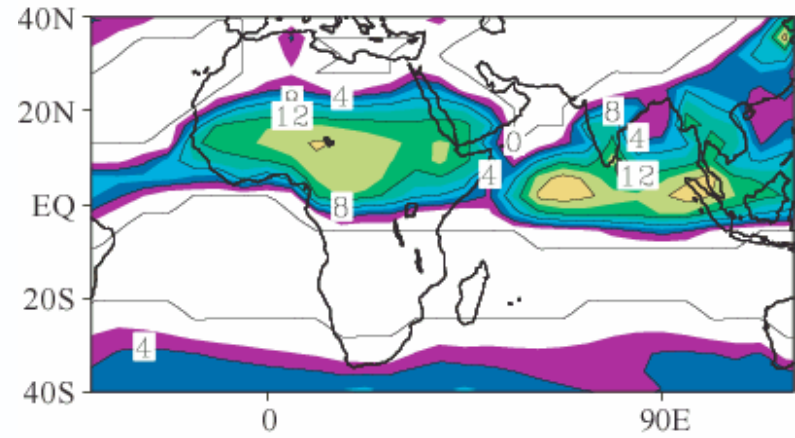


African region case (albedo set to 0.2 over land) July

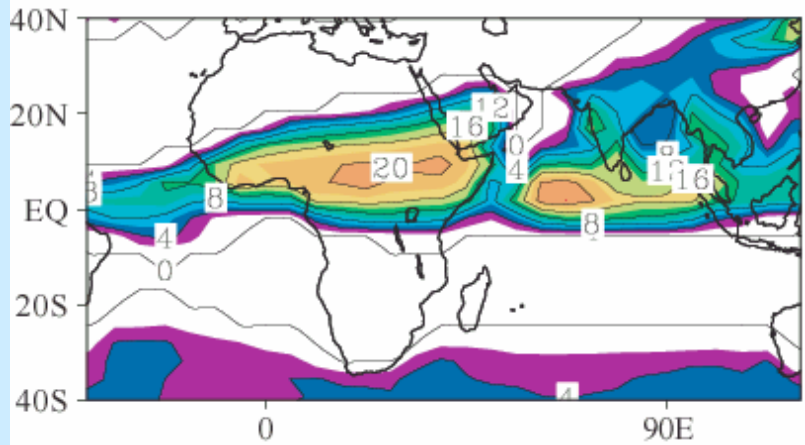
Precipitation
Control



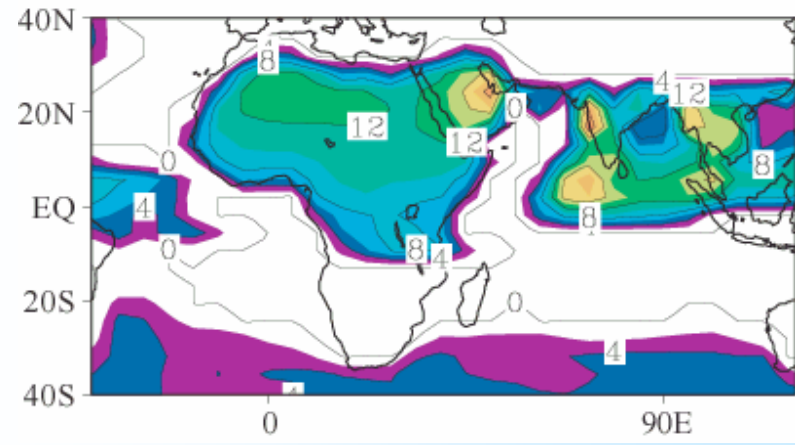
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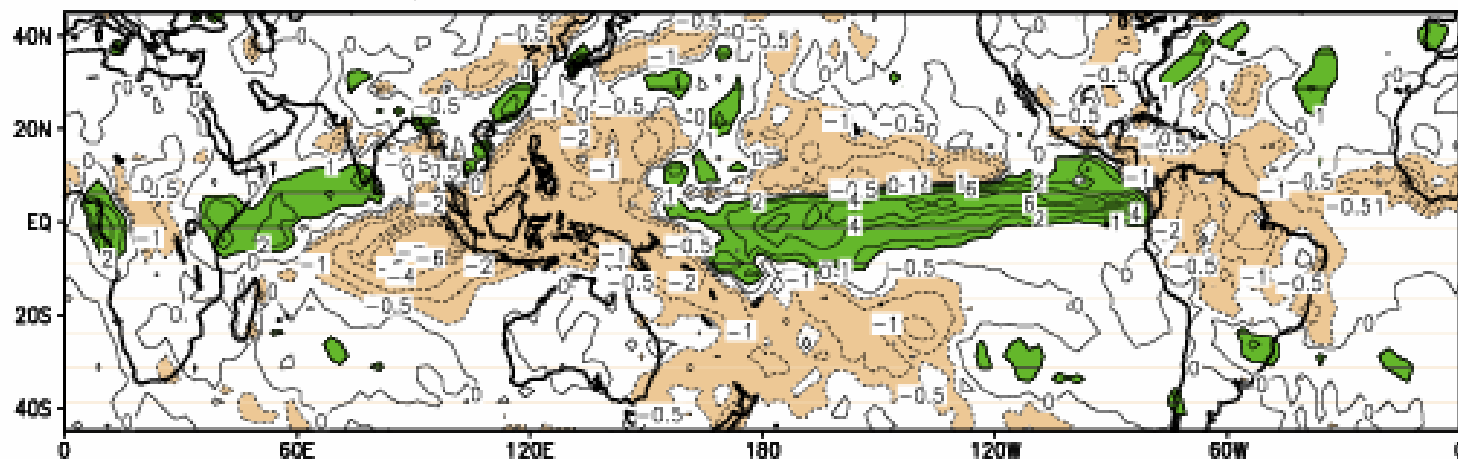


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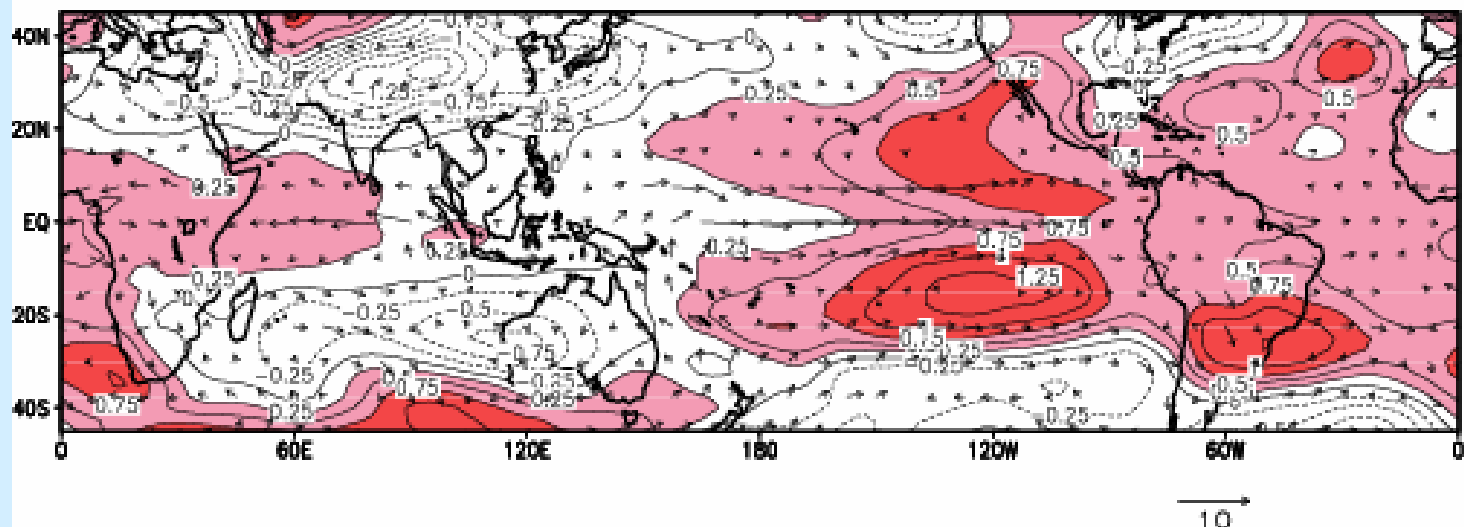


July - Nov. 1997 observed prec. and temp. anom.

Precip. Anomalies JASON 1997 Xie-Arkin

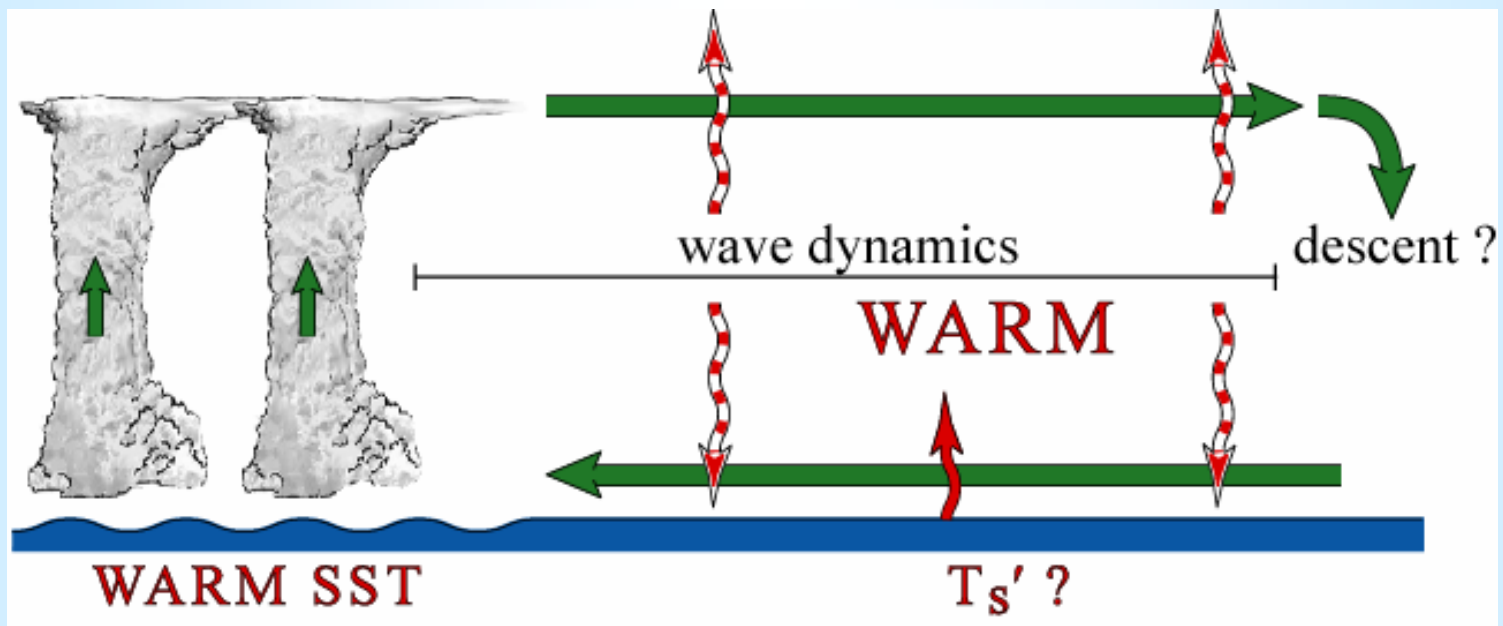


Temp. (850-200 hpa) and Wind (850 hpa) Anom.
JASON 1997 NCEP



Teleconnections to land regions

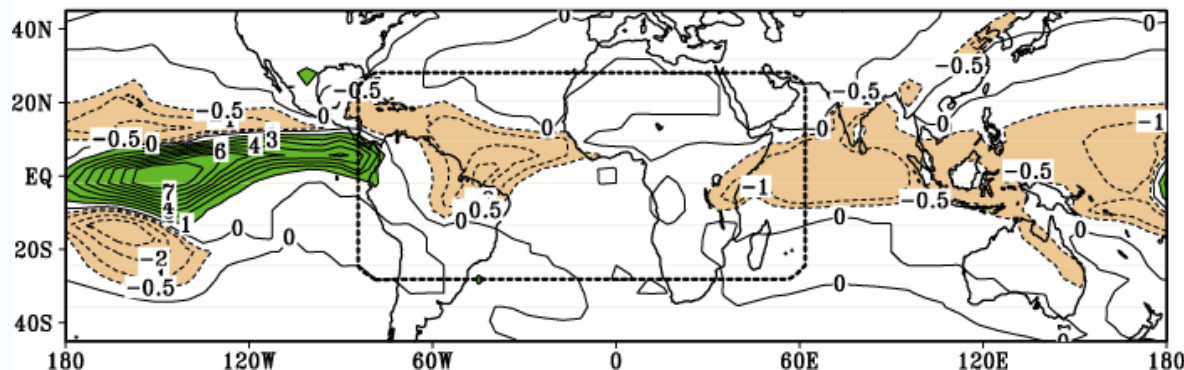
- Increased convective heating over warm SST
- Warming spread by wave dynamics
- But longwave cooling due to T' is small; descent anomalies driven by ...?



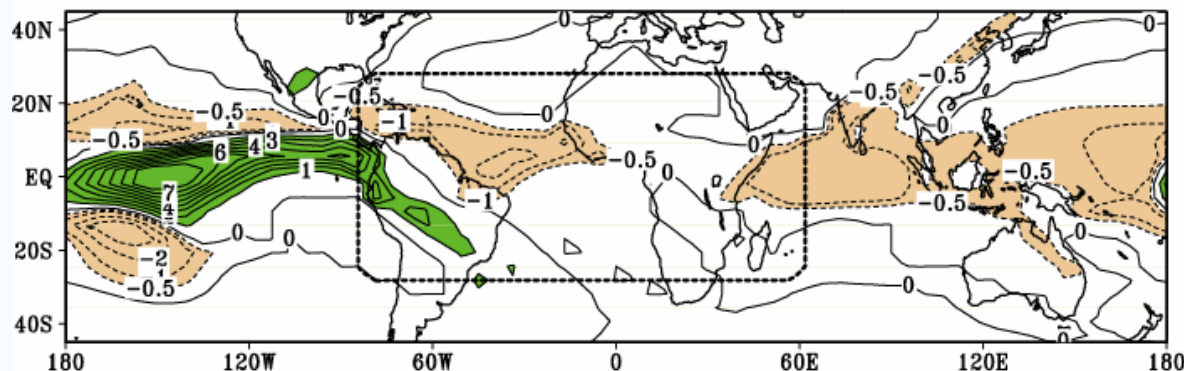
QTCM Experiments suppressing potential mechanisms for descent anomalies

Anomaly ()' term
 suppressed in region:
T' radiative effects

(a) Precip. JASON 1997 POSPAC_CLIMRADT-CLIM

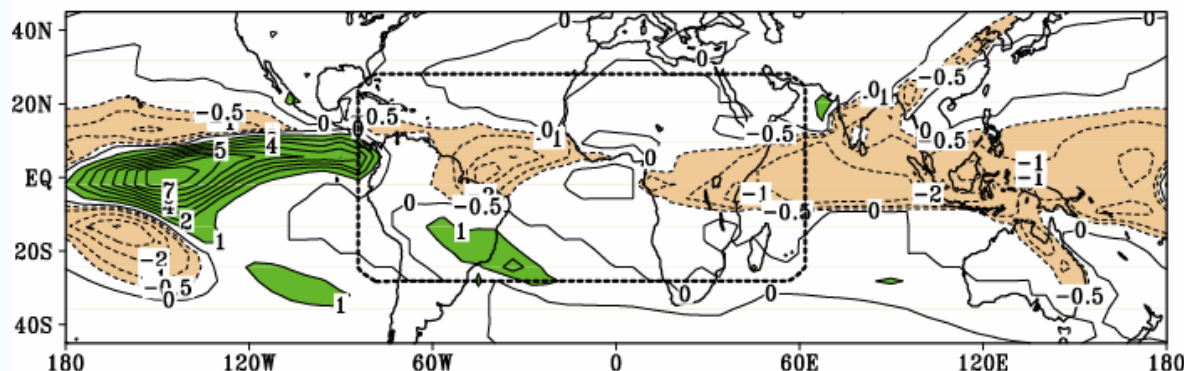


Precip. JASON 1997 POSPAC_CLIMGRDQ-CLIM



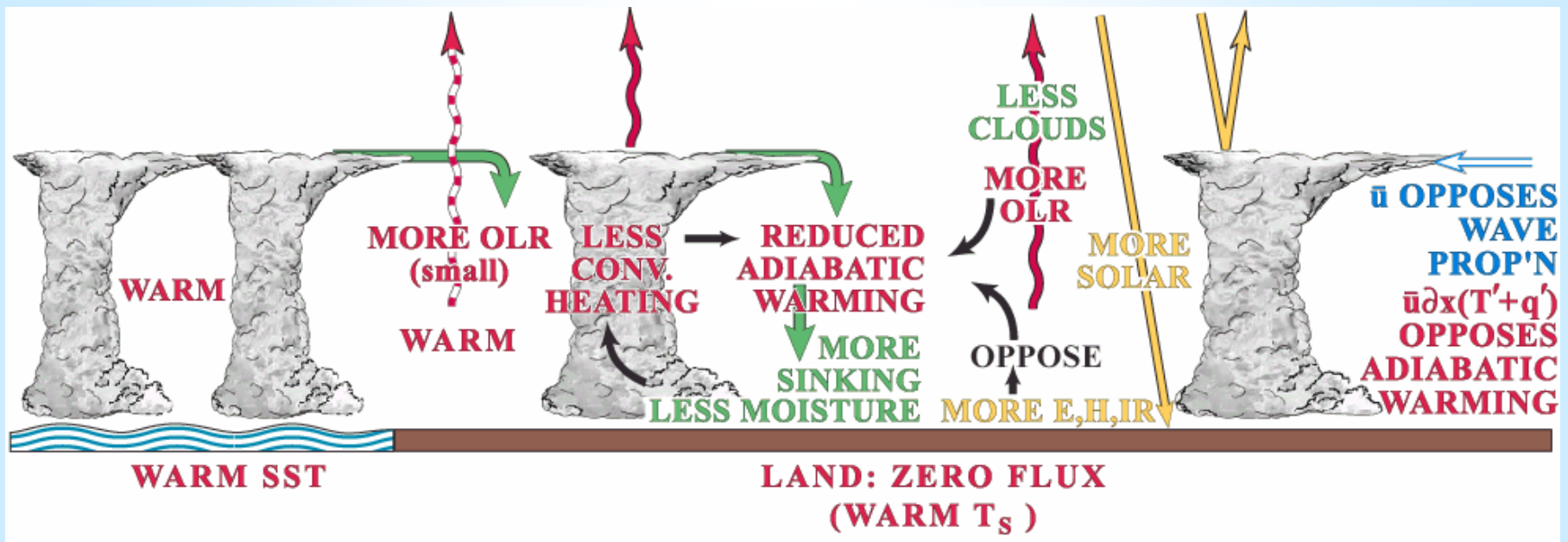
$(v \cdot \nabla q)'$

(a) Precip. JASON 1997 POSPAC_CLIMDRAG-CLIM



$(\text{surface stress})'$

Some processes in tropical teleconnections



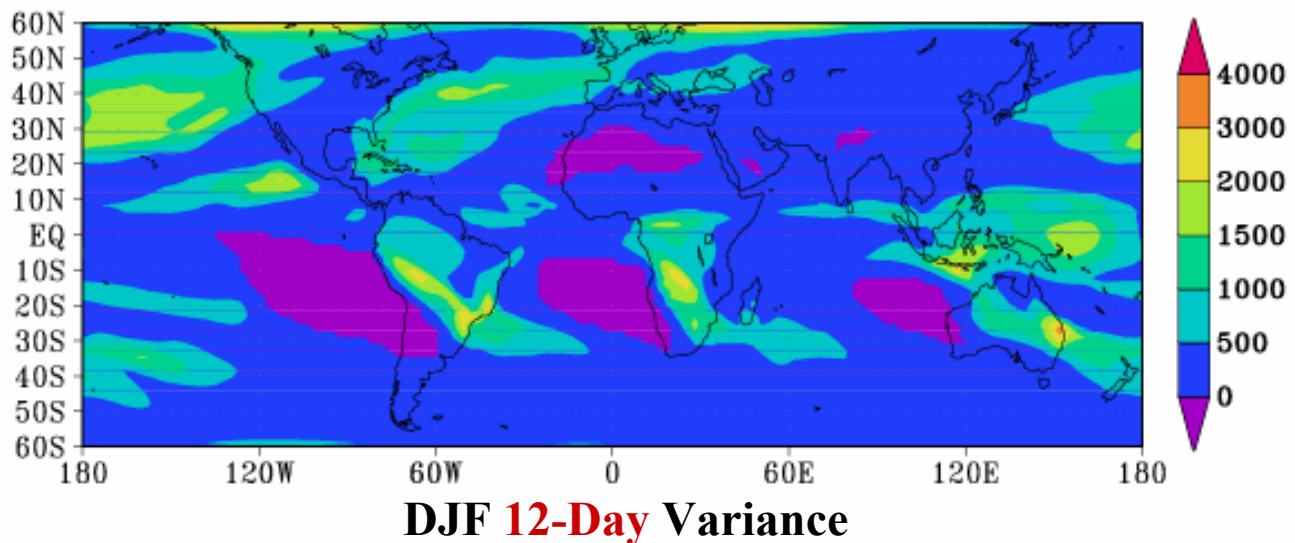
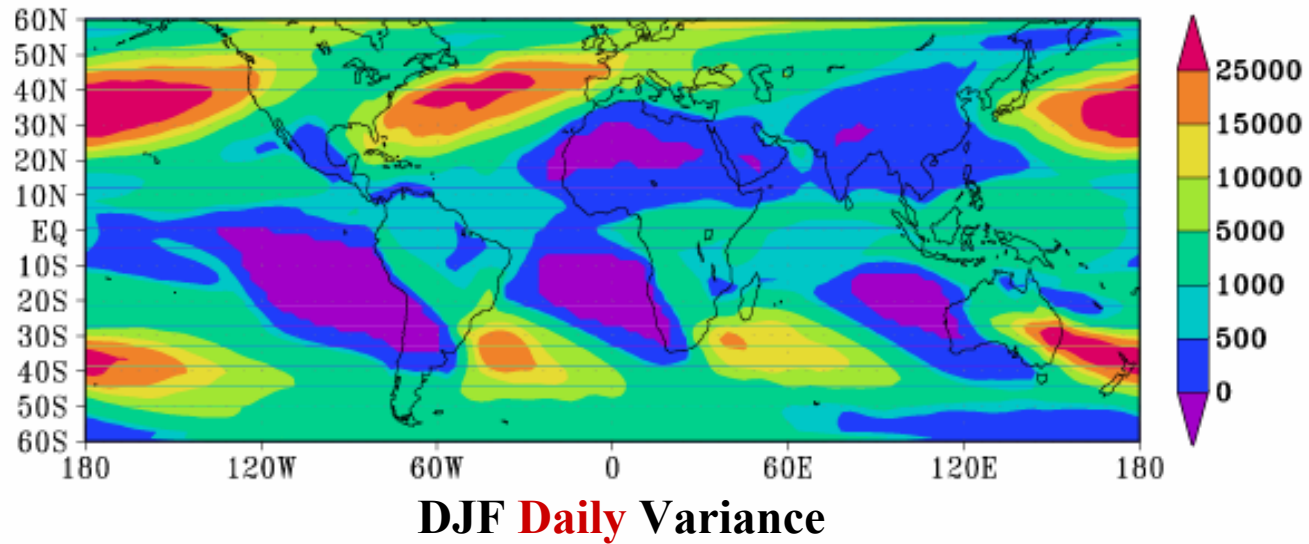
- Convection & I.R. Cloud-Rad. Feedbacks
 - Reduce effective static stability
 - Reduce length scale over which descent occurs
 - Tendency to increase descent anomalies
- Land-Surface Feedback Returns Flux Anomalies to Atm.
- Combined with Shortwave Cloud-Radiation Feedbacks
 - Increase effective static stability
 - Increase length scale over which descent occurs
 - Tendency to reduce descent anomalies

SACZ variability

Possibly rel. to SACZ variability of Liebmann et al 1999,
Robertson & Mechoso 2000

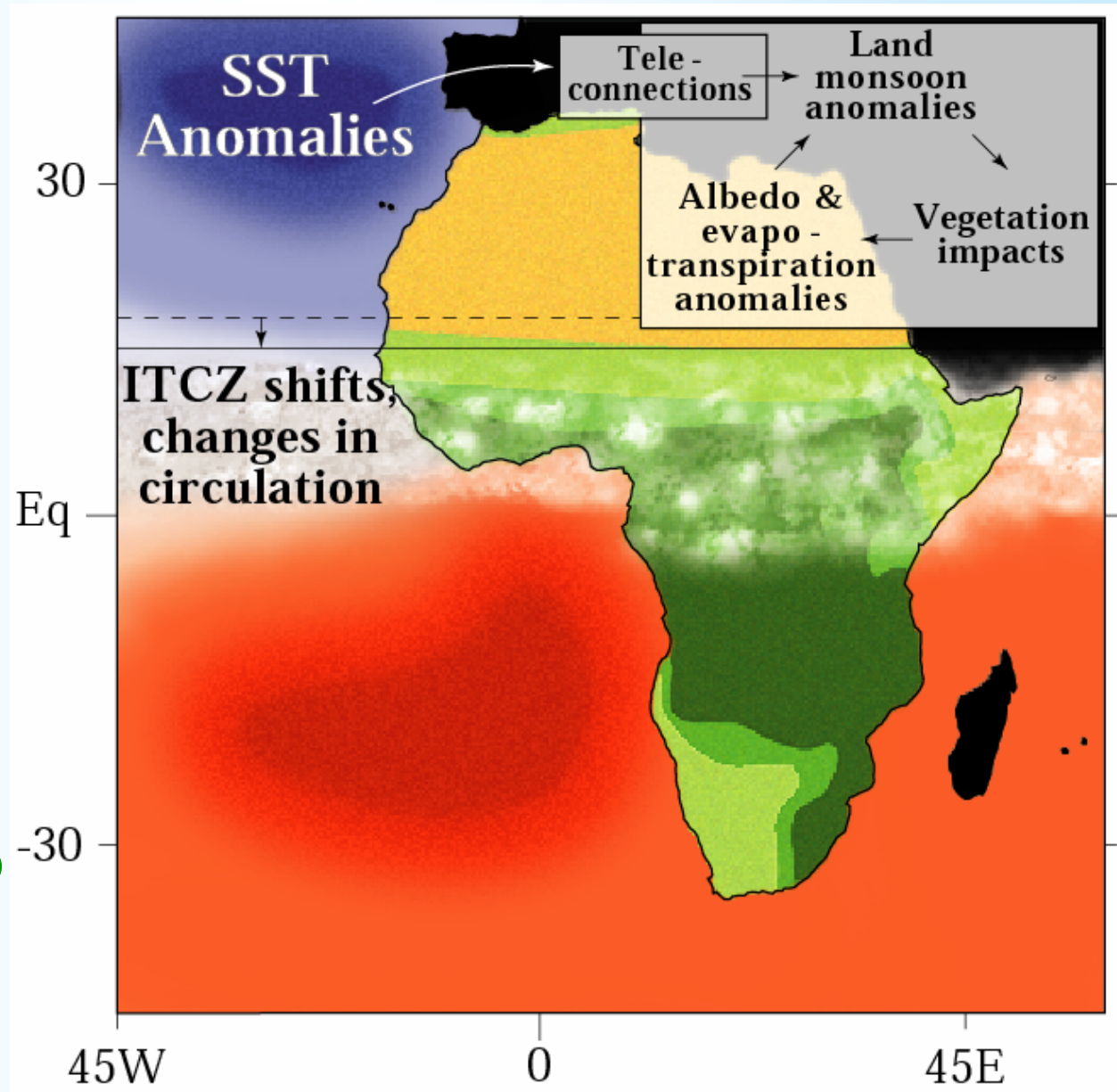
QTCM with
seasonal SST
forcing

Precipitation
variance for DJF



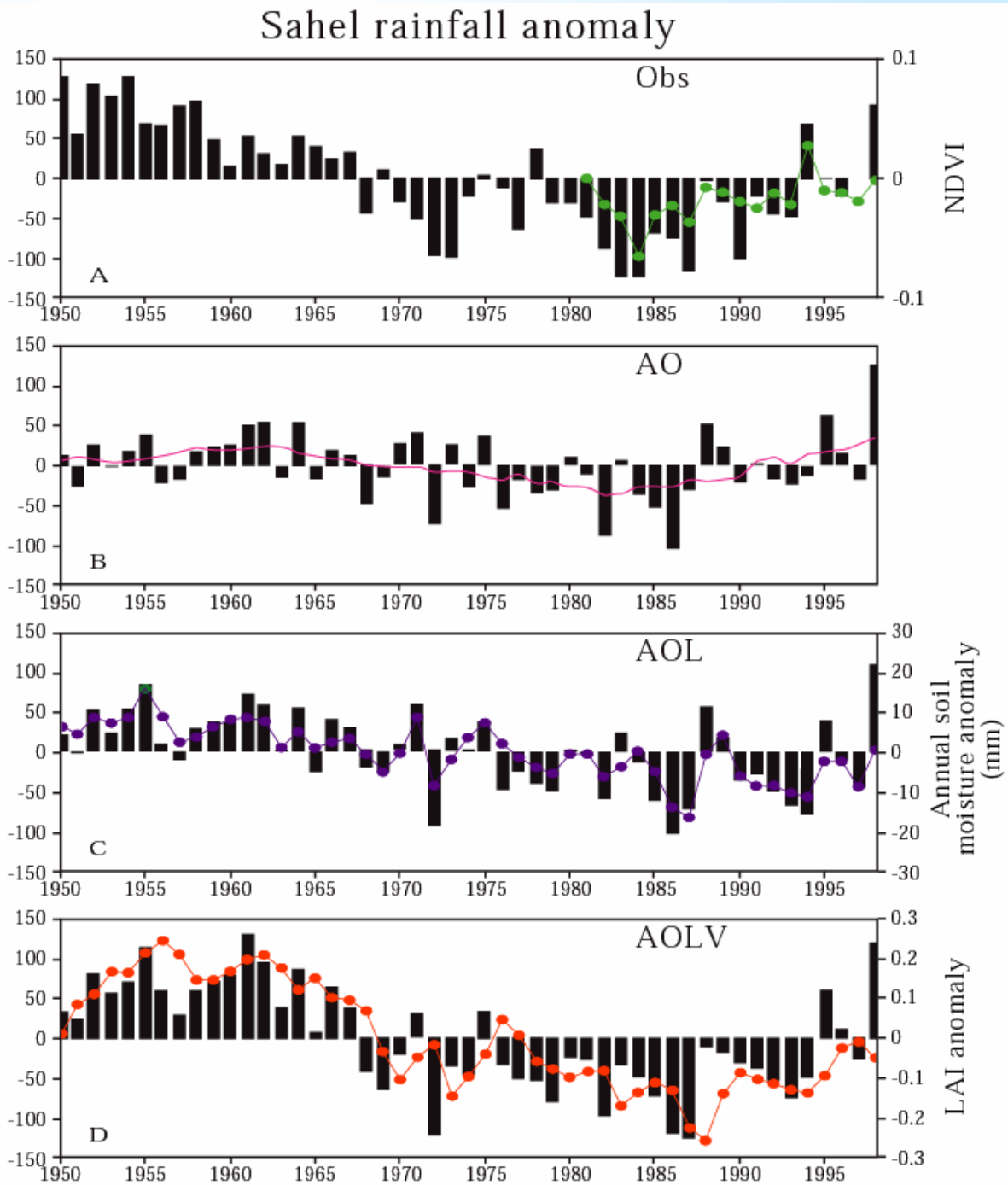
Land-surface feedbacks in teleconnected SST impacts

- Charney 1975
- Folland et al 1986
- Xue and Shukla 1993
- Claussen et al 1999
- Joussaume et al 1999
- Zeng et al 1999



Drying trend in the Sahel 1950s -1980s

- (A) Observed
- (B) Forced by SST
- (C) Amplified by soil moisture and
- (D) vegetation



Summary

- **Interplay of land-surface, oceanic and atmospheric dynamical processes in monsoon circulations**
- **Tropical teleconnections:**
 - atmospheric moist convective & wave dynamics
 - land-surface feedbacks include effects of $F_{s^{net}}=0$, soil moisture and drag
 - can modify teleconnections both locally and between ocean basins (e.g. Pacific to Atlantic)
- **Vegetation feedbacks:**
 - albedo feedbacks larger in low veg. regions, evapotranspiration effects larger in high veg. regions
 - veg. feedbacks can slightly amplify teleconnected effects from ocean (e.g. Sahel)
 - time scale of vegetation feedbacks can lead to distinct effects on interdecadal and shorter time scales