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Response to Convective Enhancement of Surface Fluxes in CAM

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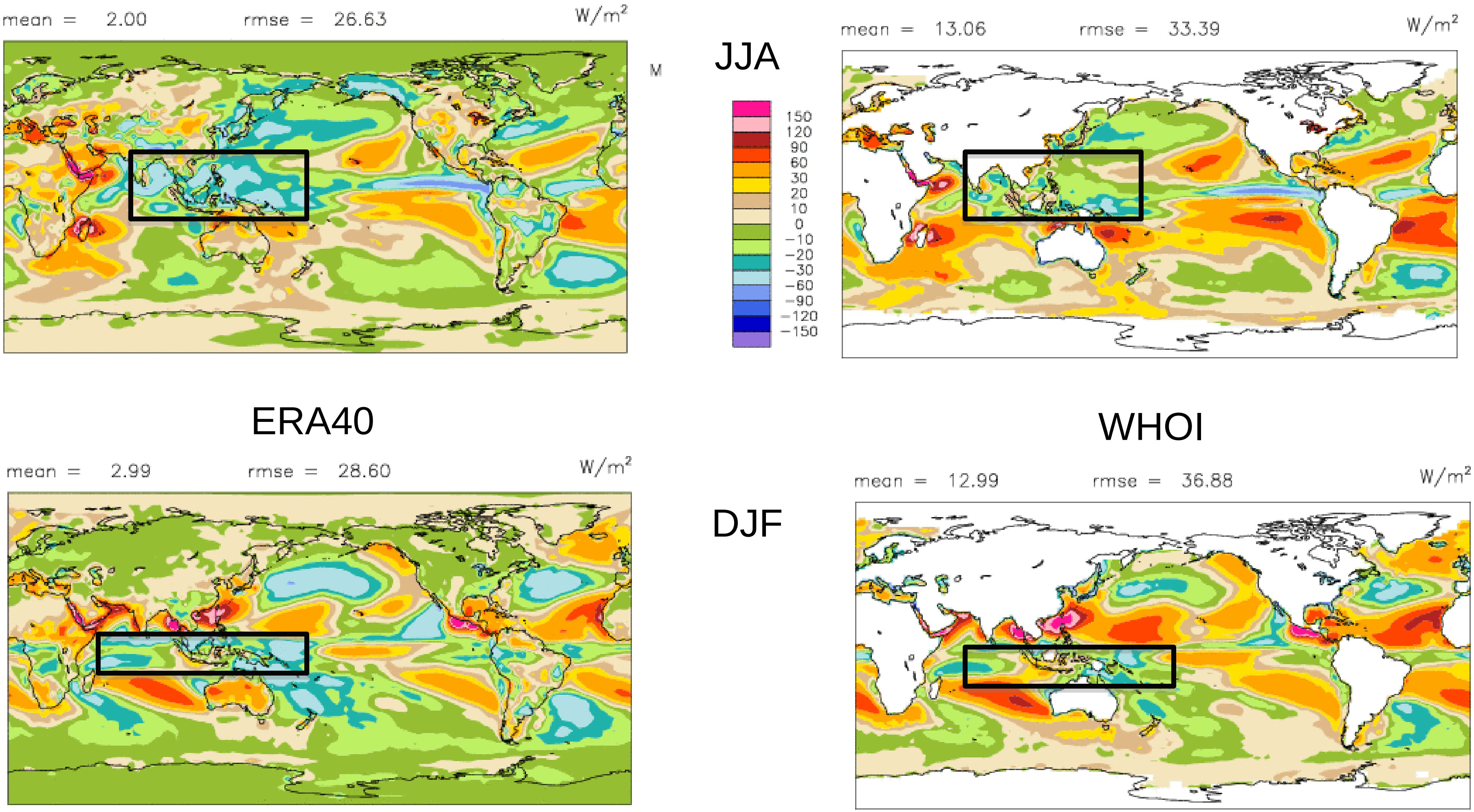
Motivation

- Latent heat fluxes are too low in the deep tropics
- Even if grid mean surface winds are correct, no guarantee grid mean fluxes (<= sub-grid winds) will be correct
- Free convection limit already included in surface flux formulation
- Precipitating convection gustiness not included
- Follow Redelsperger et al. (2000) to determine surface flux enhancement based on
  - Precipitation
  - Updraft mass flux
  - Downdraft mass flux

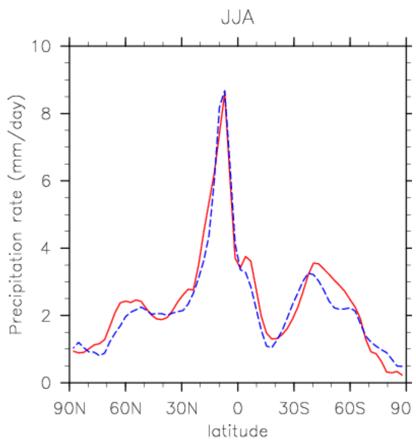
Low latent heat flux in the convecting deep tropics

LHFLX Error – CAM3.6

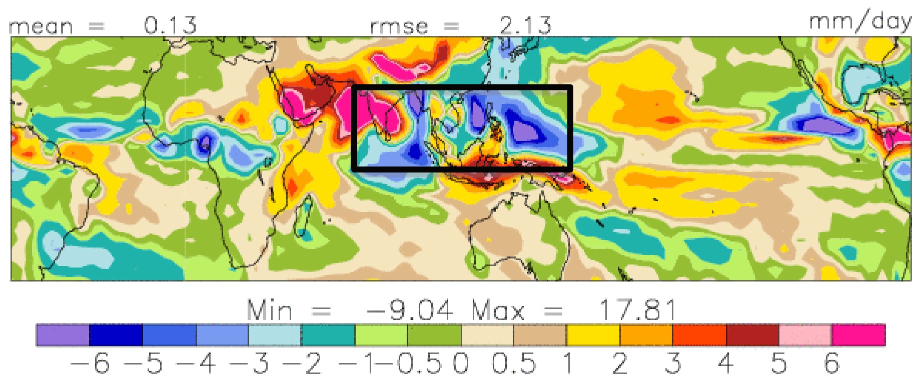


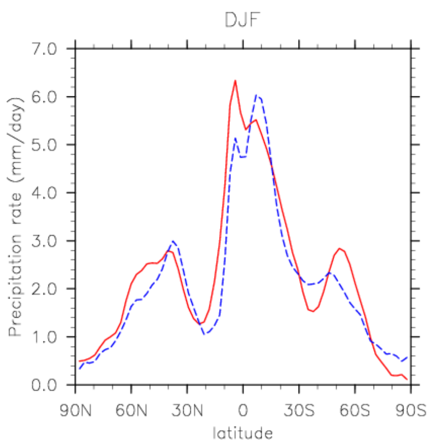
Rainfall Halo

Dry regions coincide with low latent heat flux regions

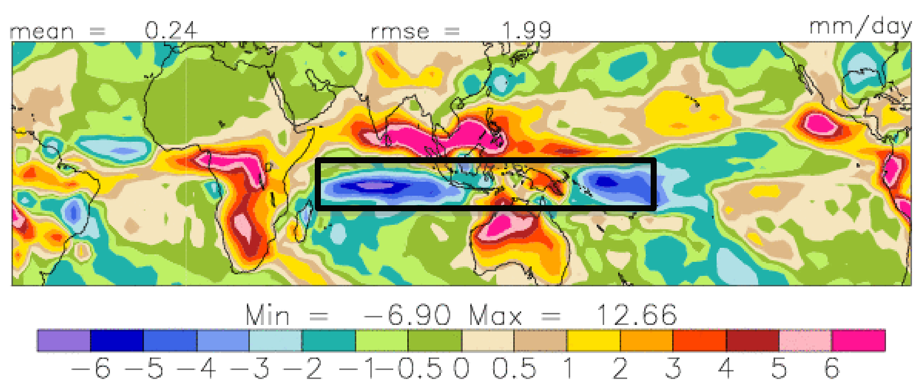


JJA





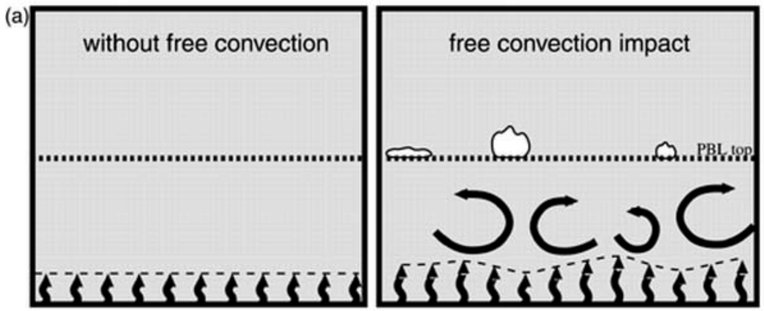
DJF



CMAP
(Weaker –ve
signal in GPCP)

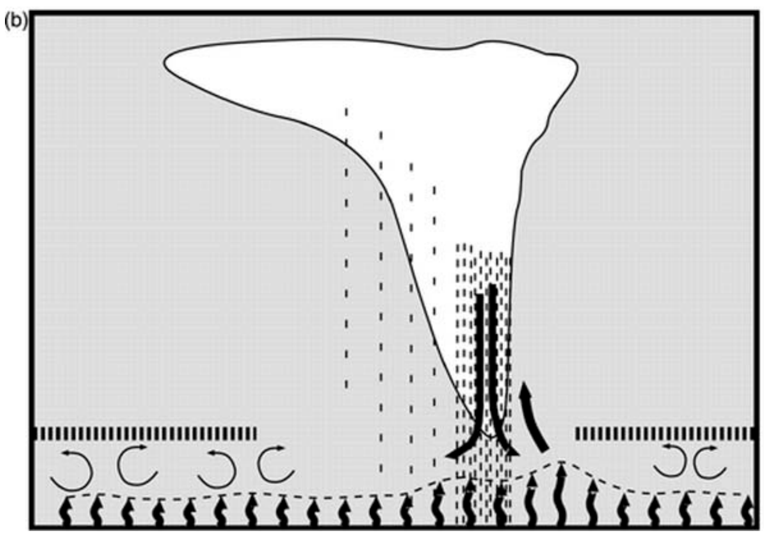
Surface fluxes in low wind conditions

ENHANCEMENT OF SURFACE FLUXES FOR UNDISTURBED PBL



- Parameterizing surface fluxes in low wind conditions can be problematic
- Model assumes free convection regimes give enhanced surface fluxes

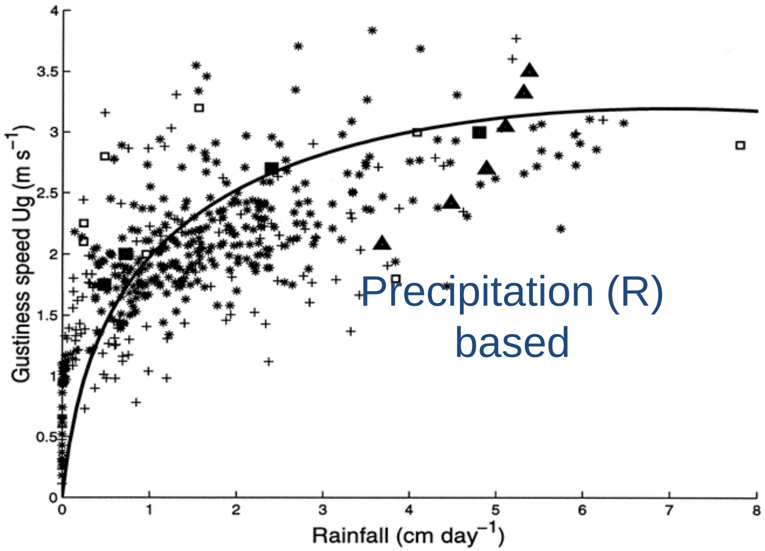
ENHANCEMENT OF SURFACE FLUXES FOR DISTURBED PBL



- Lowest mean surface winds are seen in the deep tropics
- Region of strongest deep convection
- Significant multidirectional wind gusts that average to near zero

Convective gustiness relationships

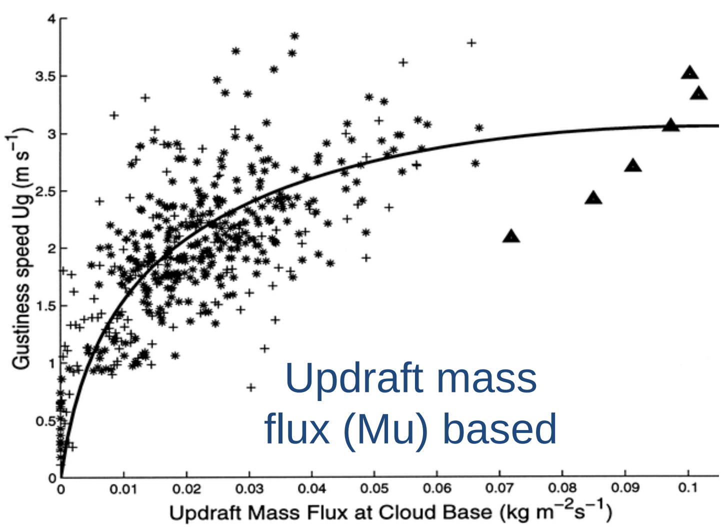
Based on CRM simulations of TOGA-COARE periods



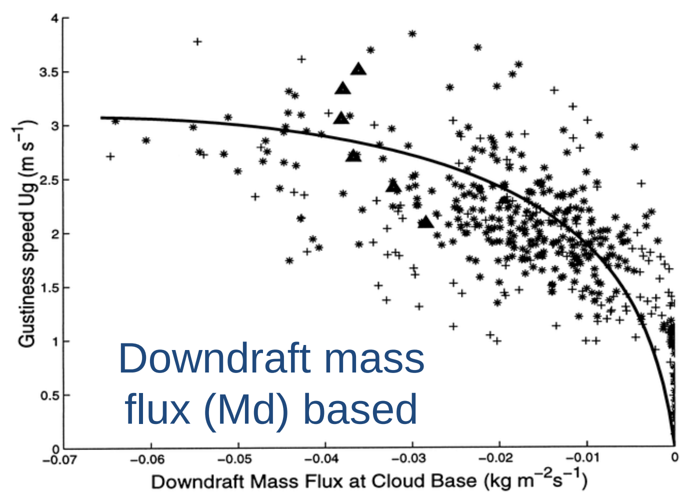
Add wind gust for purposes of surface latent heat flux only

$$U^2 = U_0^2 + U_g^2$$

$$Ug = \log(1.0 + 6.69R - 0.476R^2)$$



$$U_g = \log(1.0 + 386.6M_u - 1850.0M_u^2)$$

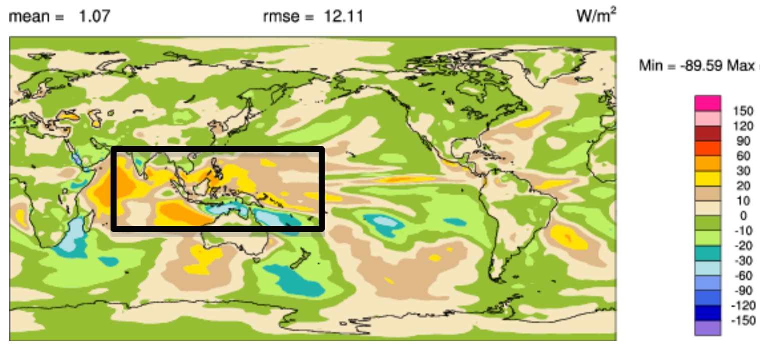


$$U_g = \log(1.0 - 600.4M_d - 4375.0M_d^2),$$

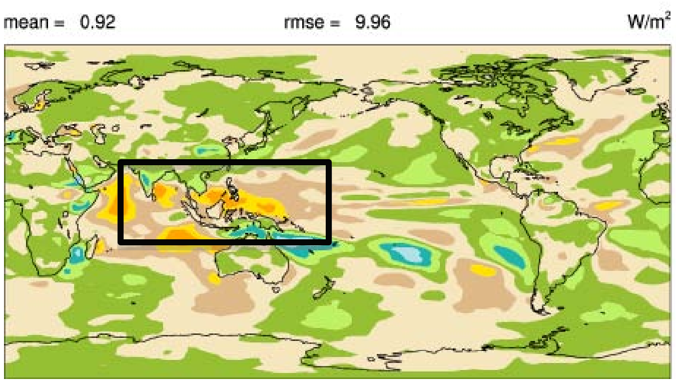
JJA Latent Heat Flux Changes

Differences with convective enhancement of surface fluxes (5-yr runs)

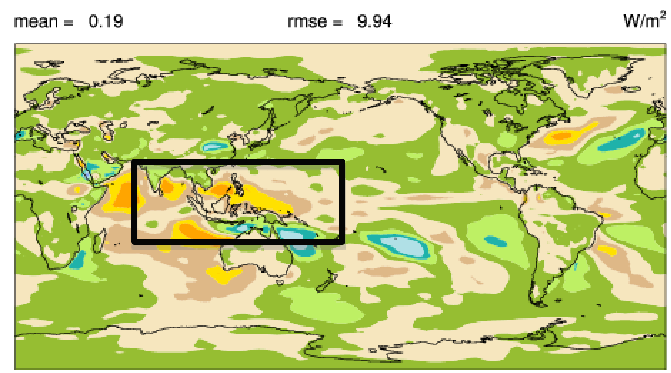
Precipitation based



Updraft based



Downdraft based



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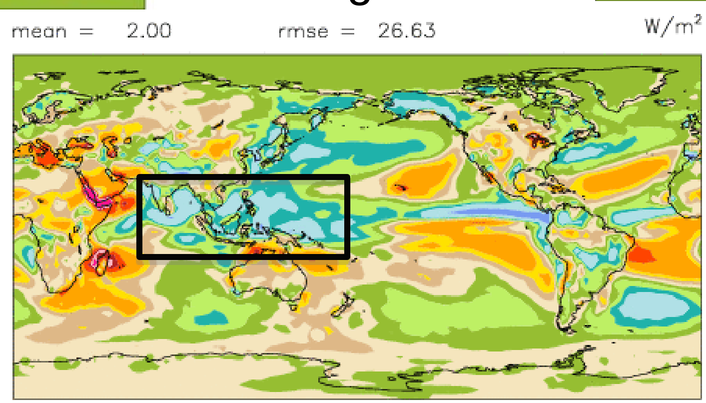
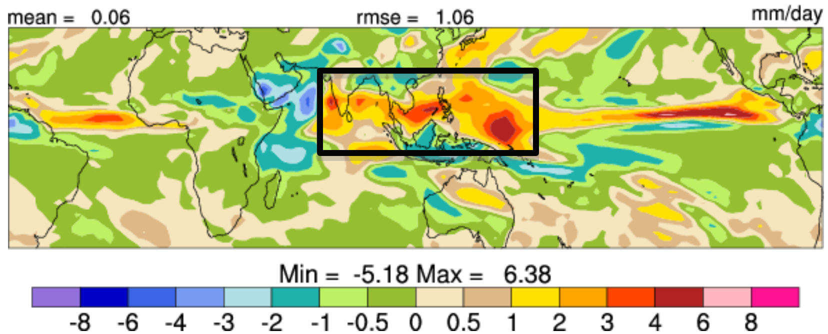


JJA Rainfall

Differences with convective enhancement of surface fluxes (5-yr runs)

Precipitation based



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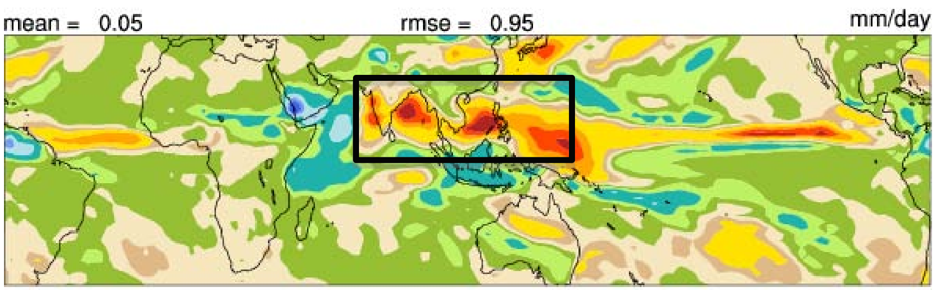
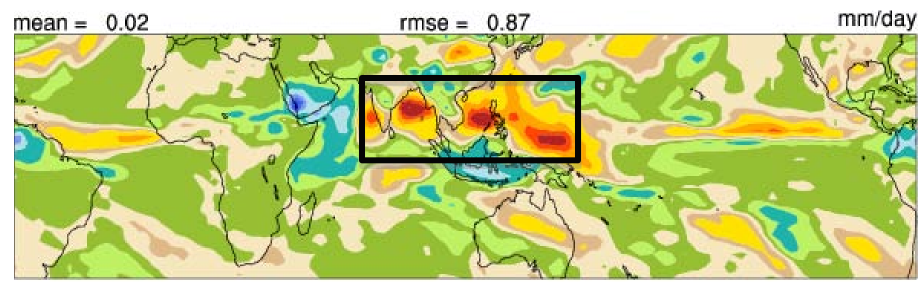


Downdraft based



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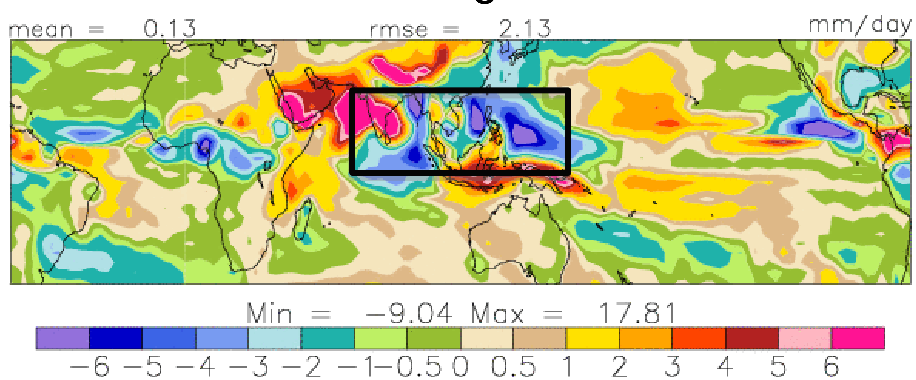
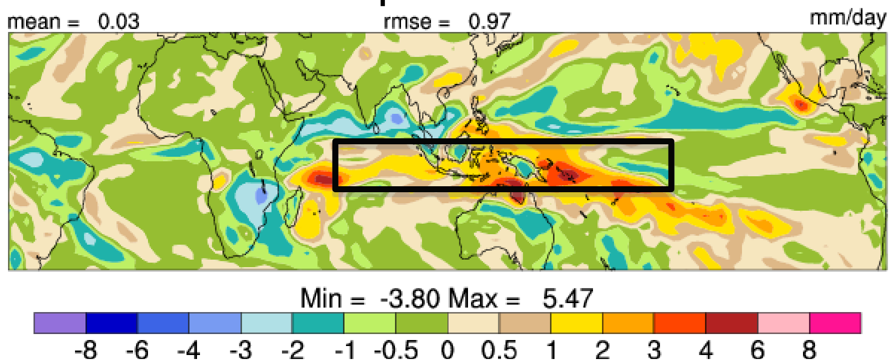


DJF Rainfall

Differences with convective enhancement of surface fluxes (5-yr runs)

Precipitation based



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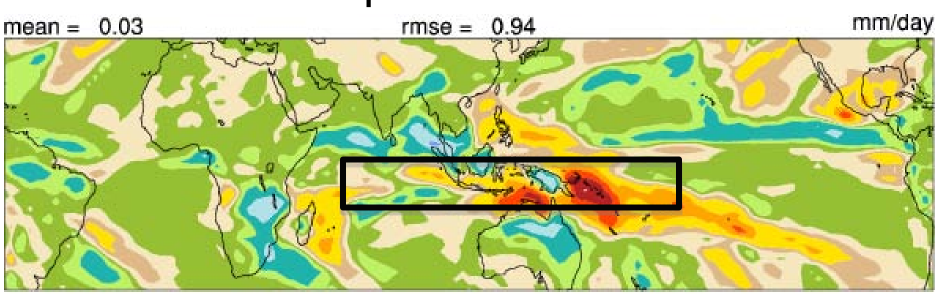

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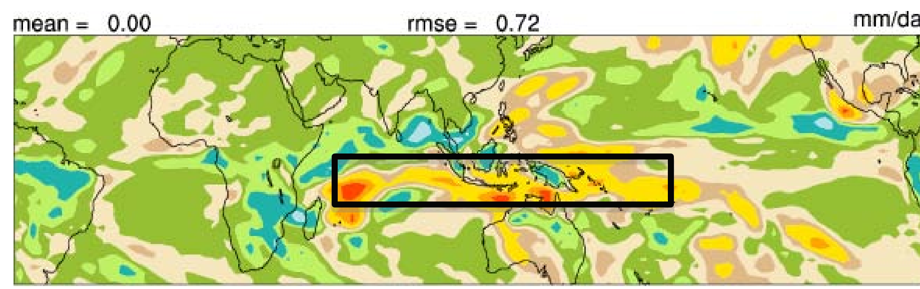

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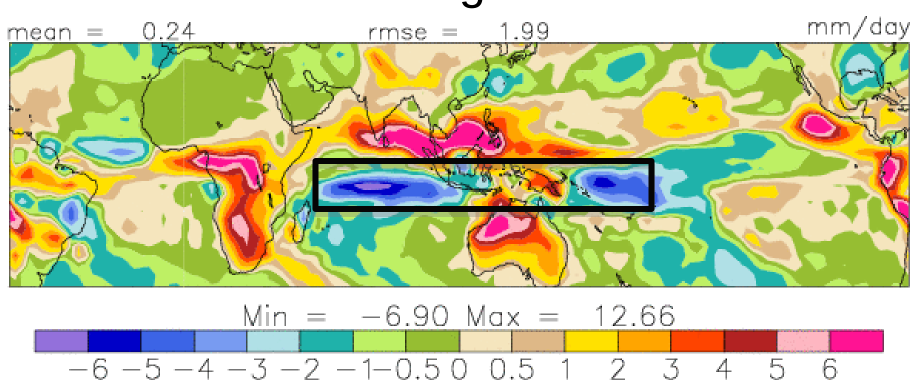
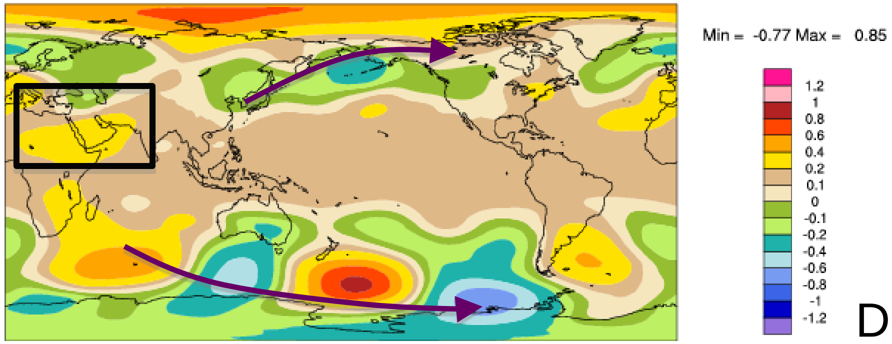


JJA Circulation/Teleconnection Changes

Differences with convective enhancement of surface fluxes (5-yr runs)

Precipitation based



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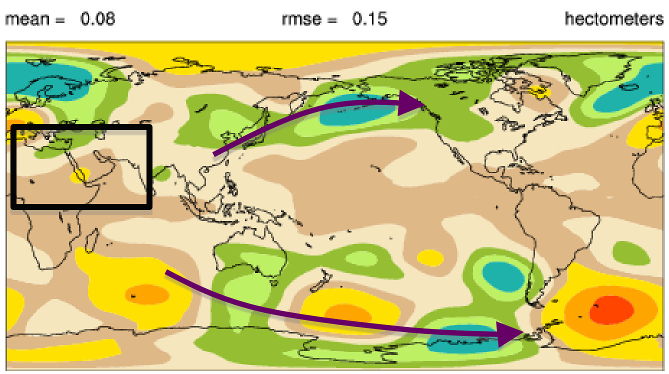

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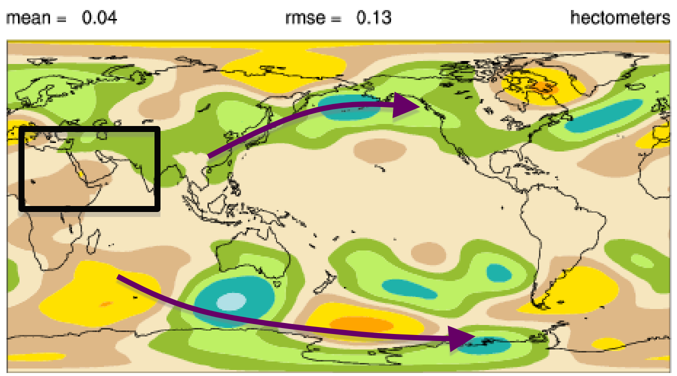

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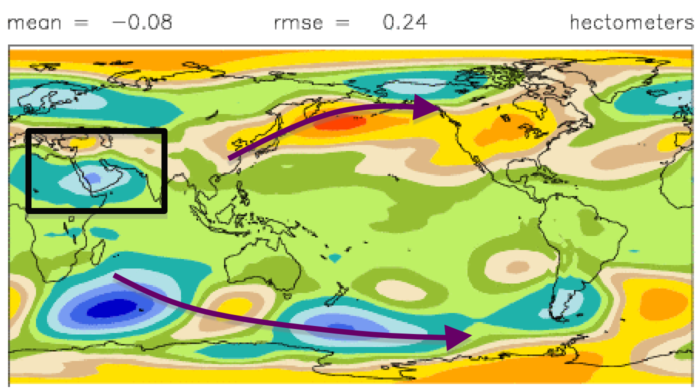
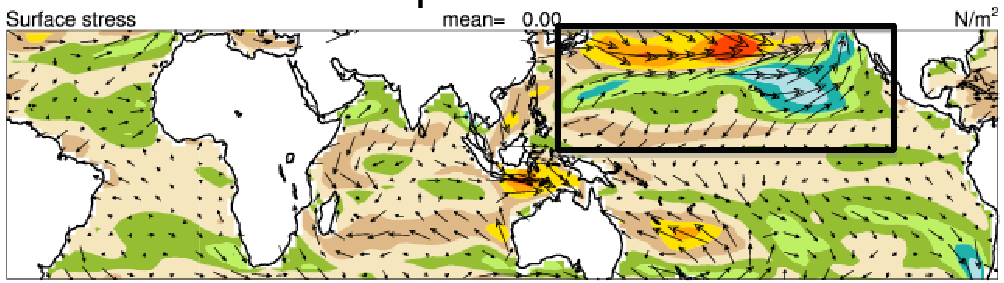


Equally coherent teleconnections in DJF

DJF Surface Stresses

Differences with convective enhancement of surface fluxes (5-yr runs)

Precipitation based



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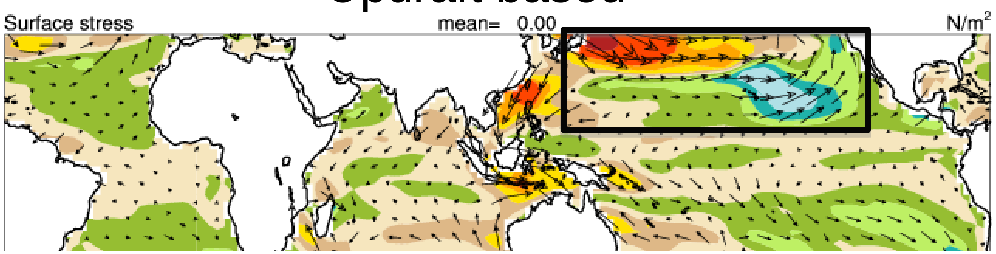

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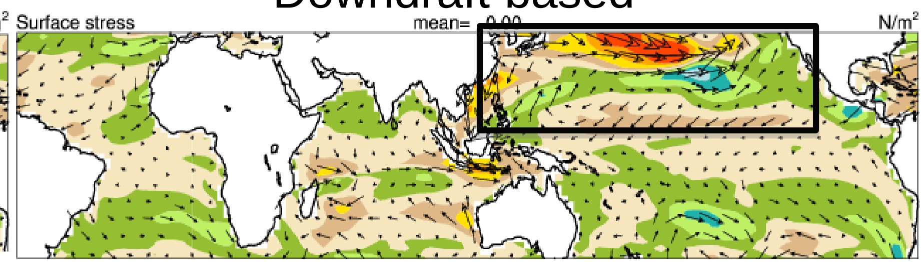

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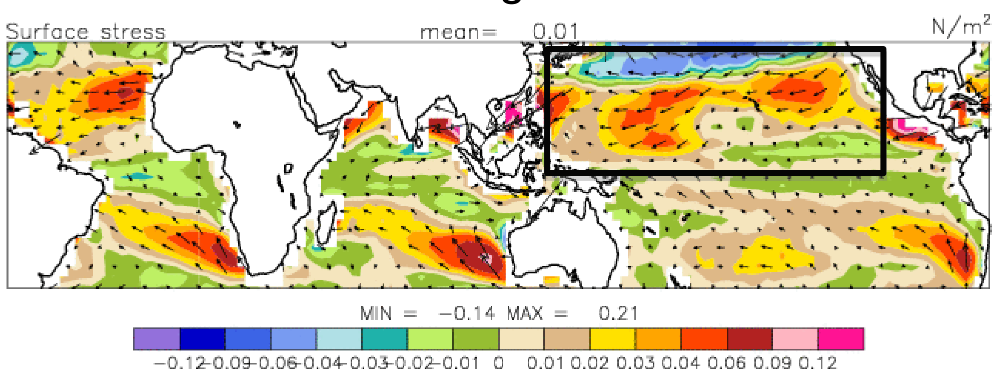
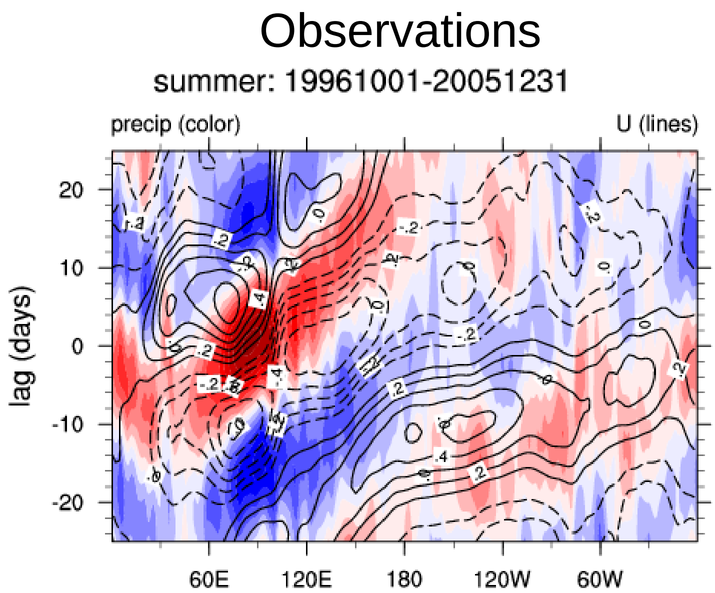
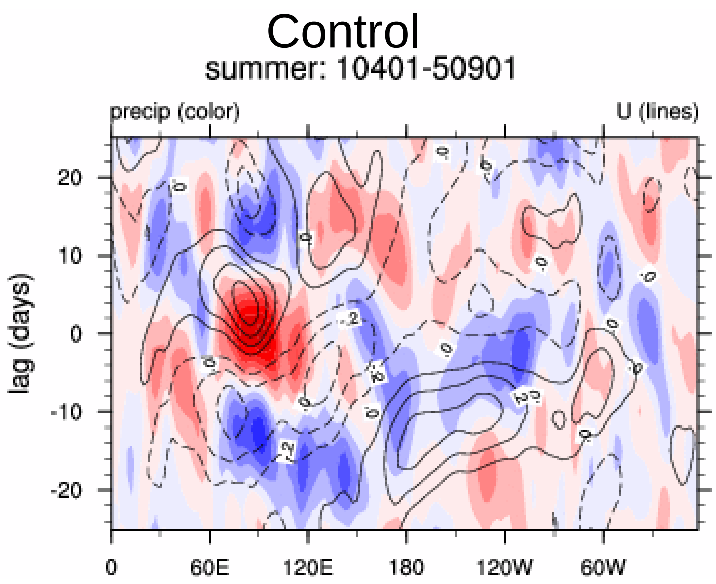
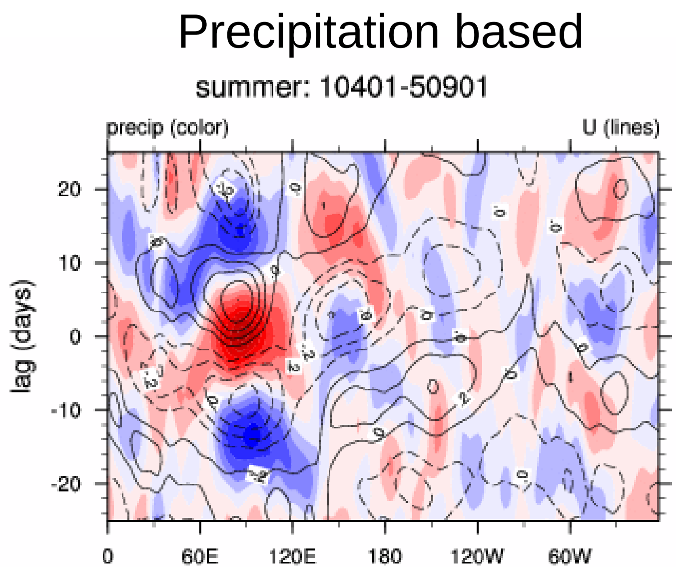


JJA ISV lag correlation (precip,U850, contours)

Less westward propagation in the Indian Ocean? - Maybe







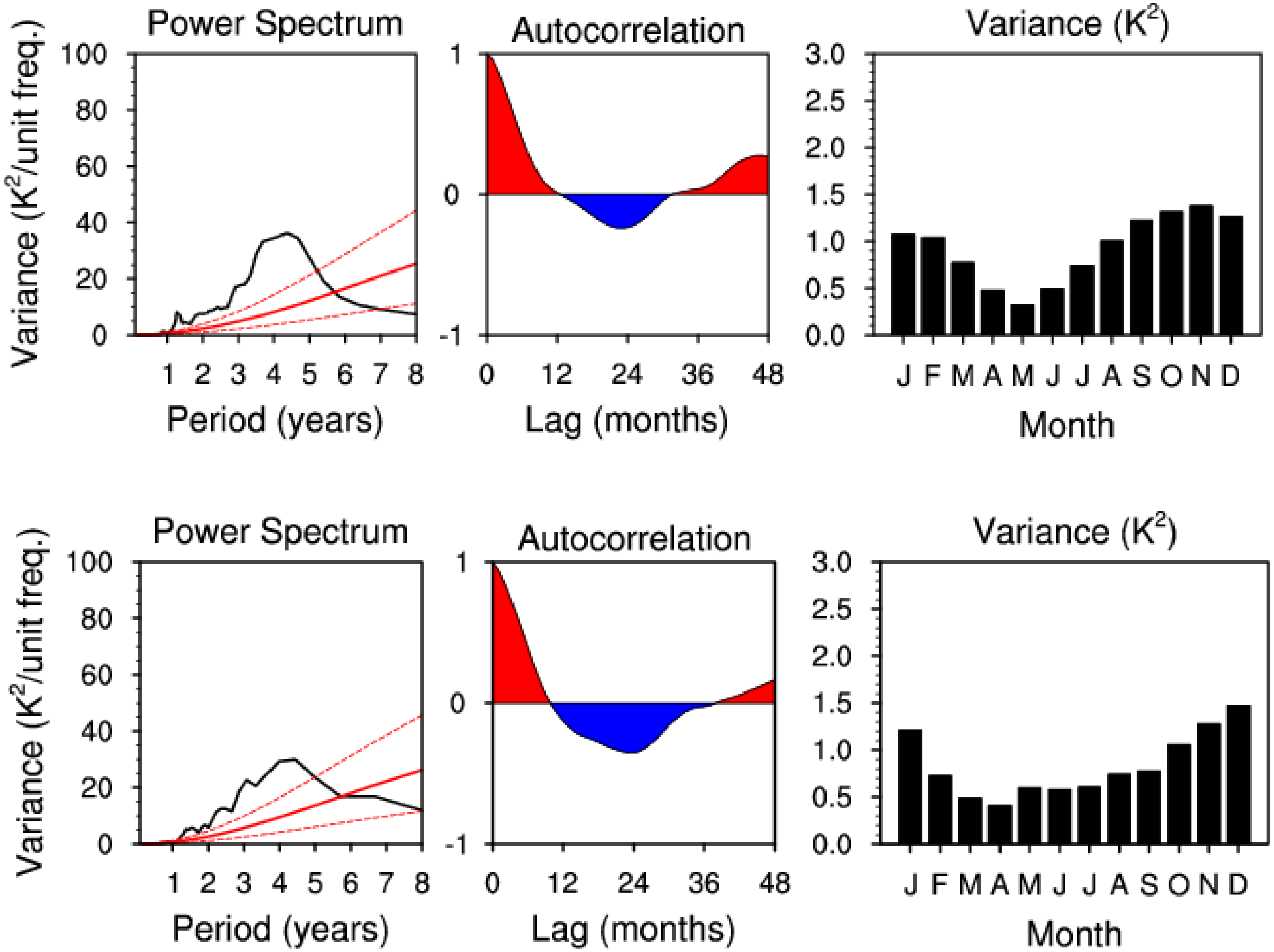
Summary

- Identified deep convection regions with low surface latent heat flux
- Included analytical relationships to specify a gust velocity based on convective rainfall, updraft mass flux, downdraft mass flux
- Order of strength of effect rain, UD, DD

- Local effects include
    - Enhanced surface LH flux in low wind regions
    - Increased precipitation
    - Increased mid-tropospheric temperature (good)
    - Increased mid-trop humidity (bad, but a global problem)

- Remote effects
    - Reduced tropical rainfall ‘halo’
    - Summer monsoon shift eastwards
    - Stationary wave propagation correction

- Some impacts on intraseasonal activity (tbd - Dani)
- Further investigation (changes coupling fluxes – eek!)



Power Spectrum
Variance (K^2/unit freq.)
100
80
60
40
20
0
1 2 3 4 5 6 7 8
Period (years)
Autocorrelation
1
0
-1
0 12 24 36 48
Lag (months)
Variance (K^2)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
J F M A M J J A S O N D
Month
Power Spectrum
Variance (K^2/unit freq.)
100
80
60
40
20
0
1 2 3 4 5 6 7 8
Period (years)
Autocorrelation
1
0
-1
0 12 24 36 48
Lag (months)
Variance (K^2)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
J F M A M J J A S O N D
Month