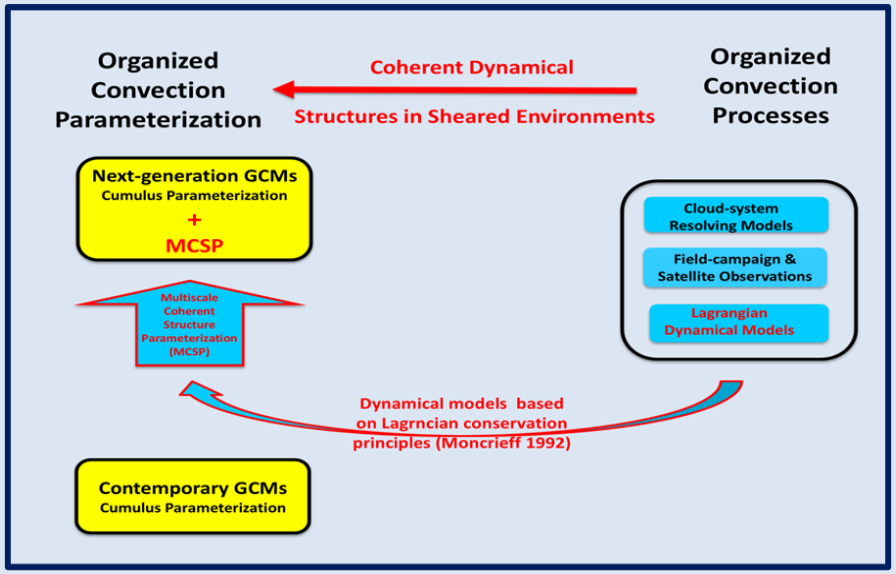
Organized Convection *a la* El Nino Onset

Mitch Moncrieff, CGD

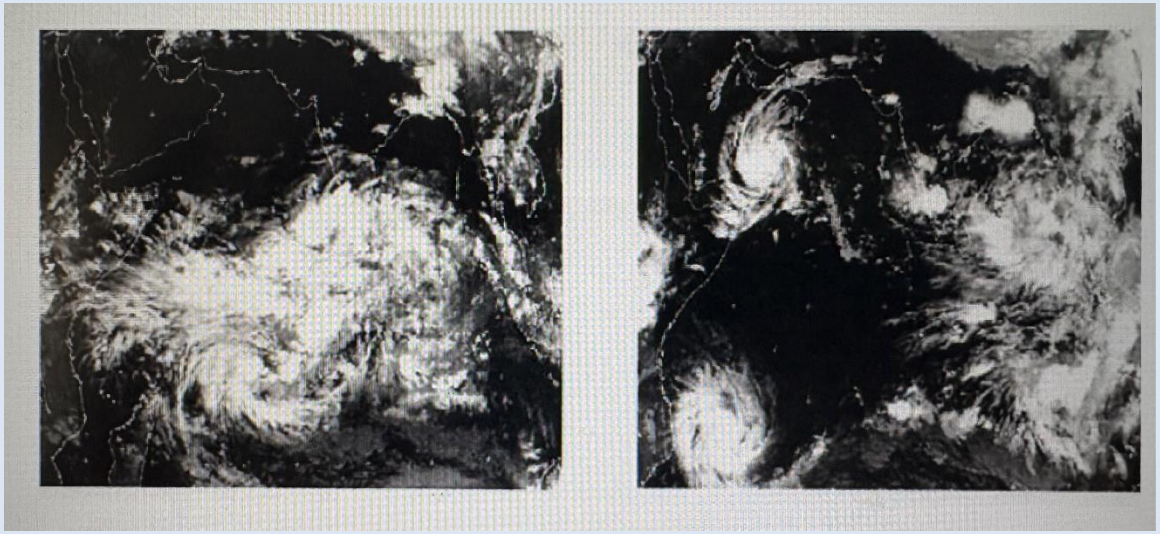
- **Modern treatment of organized convection in GCMs by Multiscale Coherent Structure Parameterization (MCSP) was inaugurated by Moncrieff et al. (2017)**



- **Moncrieff et al. (2017), Chen et al. (2021), Zhang et al. (2025), and Terai (2025) implementation of MCSP in NCAR CAM/CESM, DOE E3SM, and UK UM climate models showed MCSP significantly improves the Madden-Julian Oscillation (MJO), among other key features**

- **Application of MCSP in GCMs is presently mostly focused on thermodynamic parameterization and convective momentum transport and broader aspects require attention (Moncrieff 2010, Moncrieff 2019, Moncrieff 2022, Yang et al. 2018) sets the scene herein.**

Westerly Wind-bursts

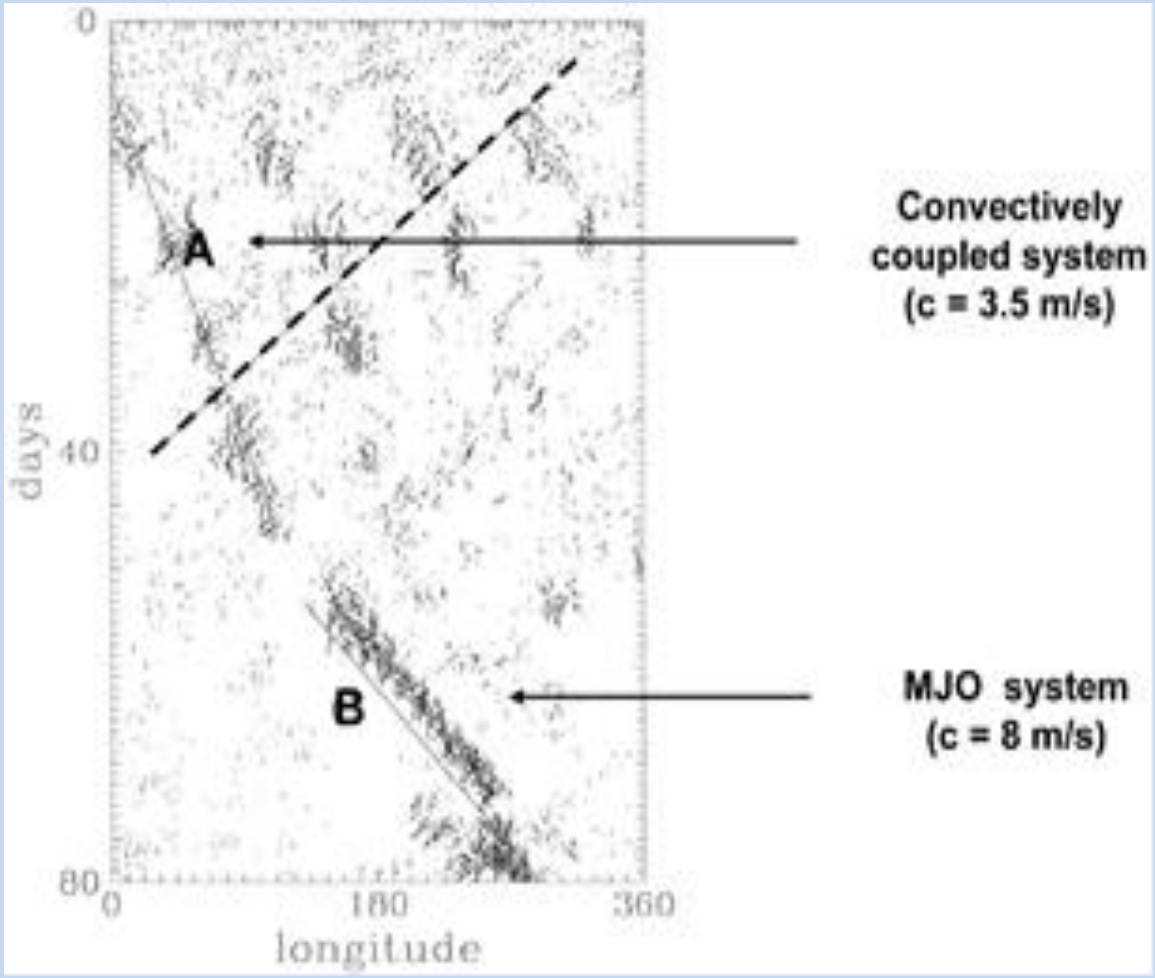


- **Tropical westerly wind-bursts call attention to parameterization of momentum transport by organized convection, and is salient for El Nino onset**

- **Two key dynamical features:**
  i) Vertical momentum transport within the MJO (left image, available in MCSP)
  ii) Horizonal momentum transport by twin tropical cyclones in MJO wake (right)

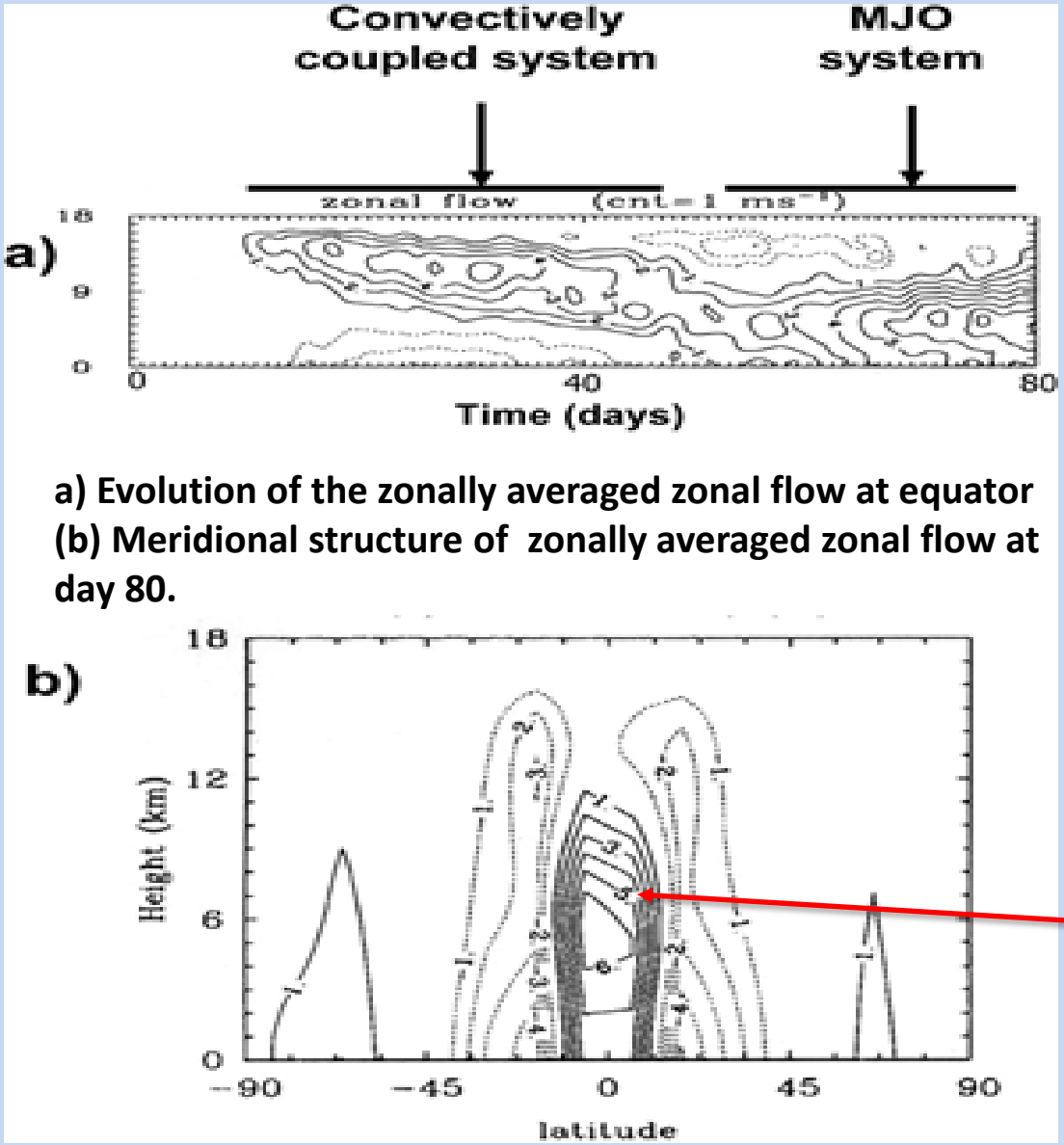
- **Grabowski (2001) super-parameterized numerical simulations and Moncrieff (2004) dynamical analysis of the large-scale organization of tropical convection provide salient information for item ii.**

Simulated large scale distribution of precipitation



Grabowski (2001)

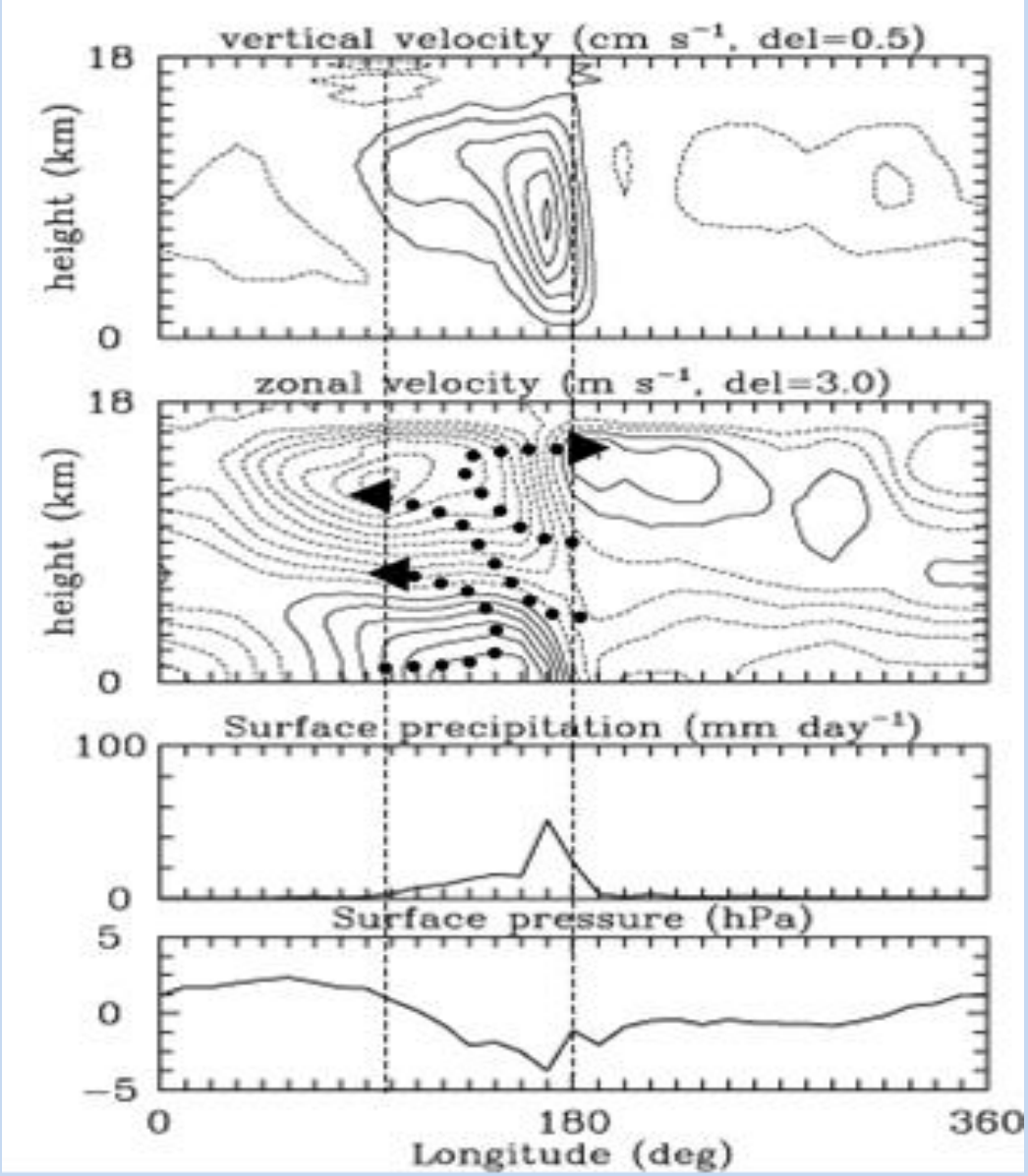
Zonally Averaged Flow



a) Evolution of the zonally averaged zonal flow at equator (b) Meridional structure of zonally averaged zonal flow at day 80.

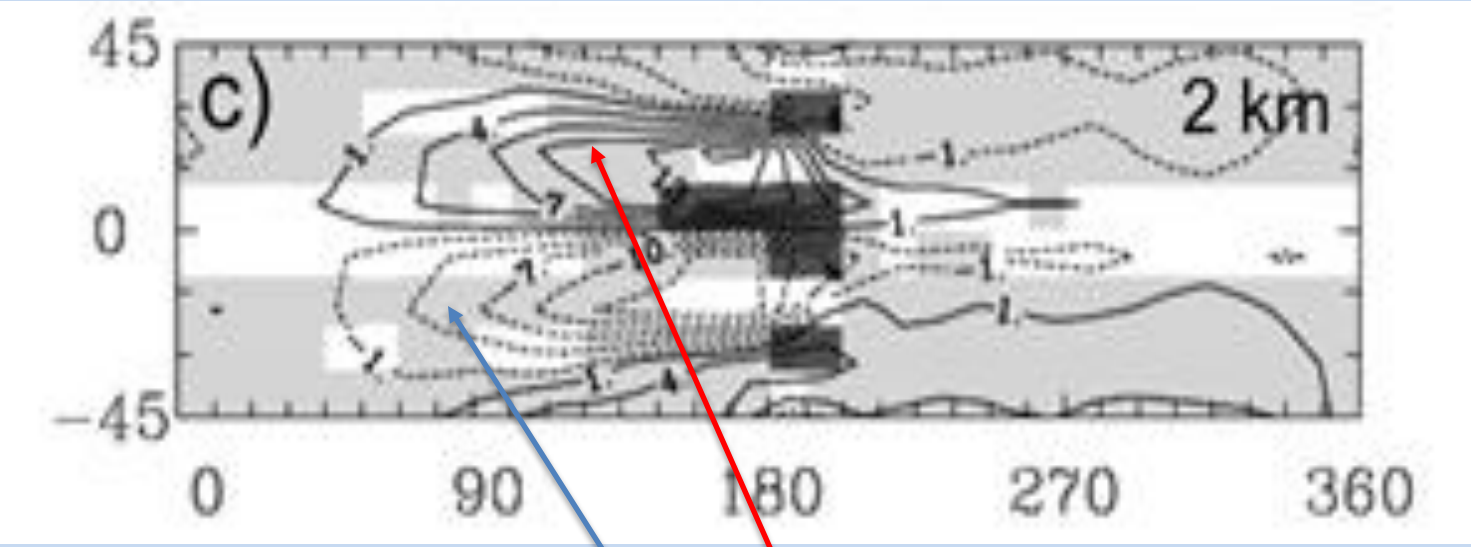
Moncrieff (2004)

20-day averaged fields above equator for the MJO system



Moncrieff (2004)

Vertical Vorticity

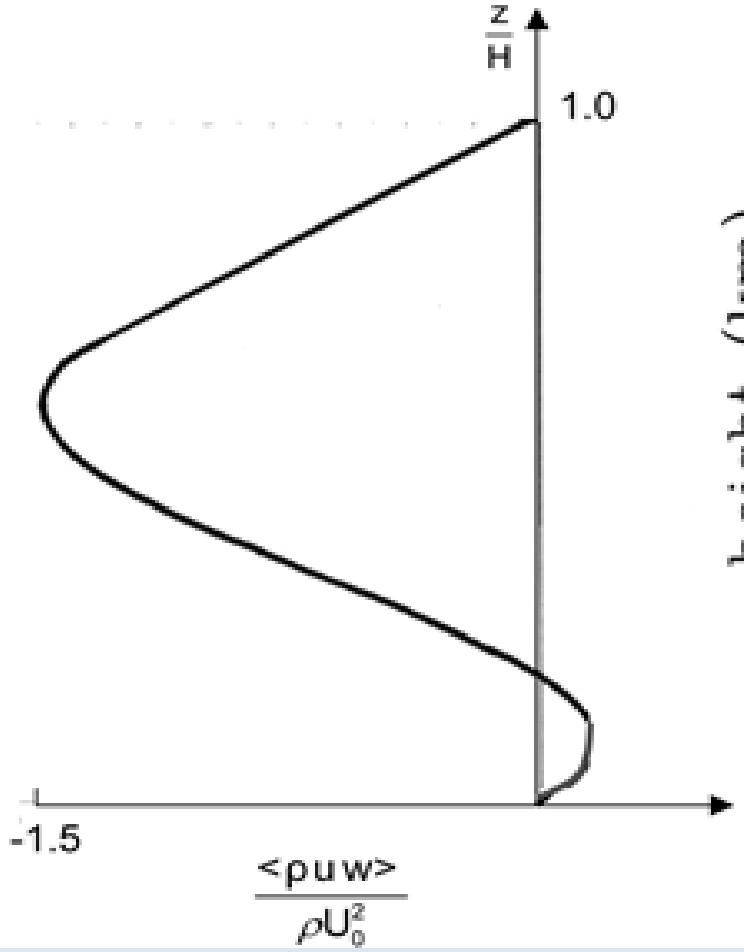


Moncrieff (2004)

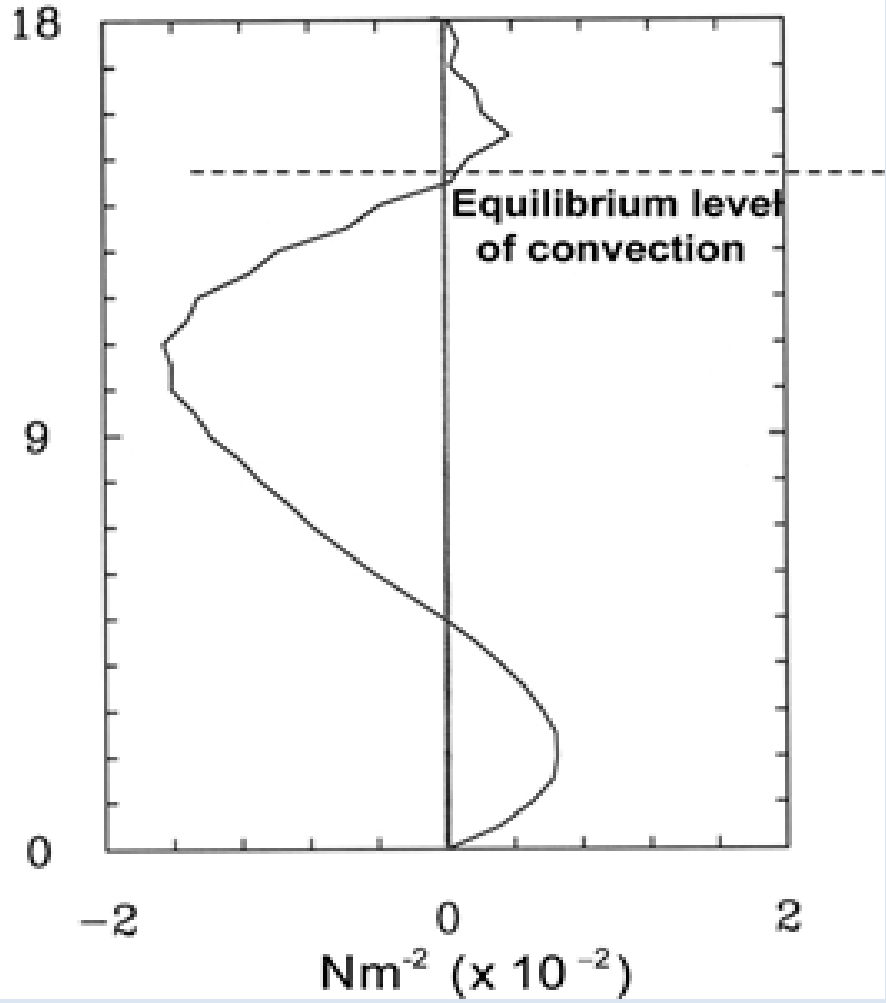
Rossby-gravity gyres

Vertical Momentum Flux Contribution by the MJO

Analytic Model



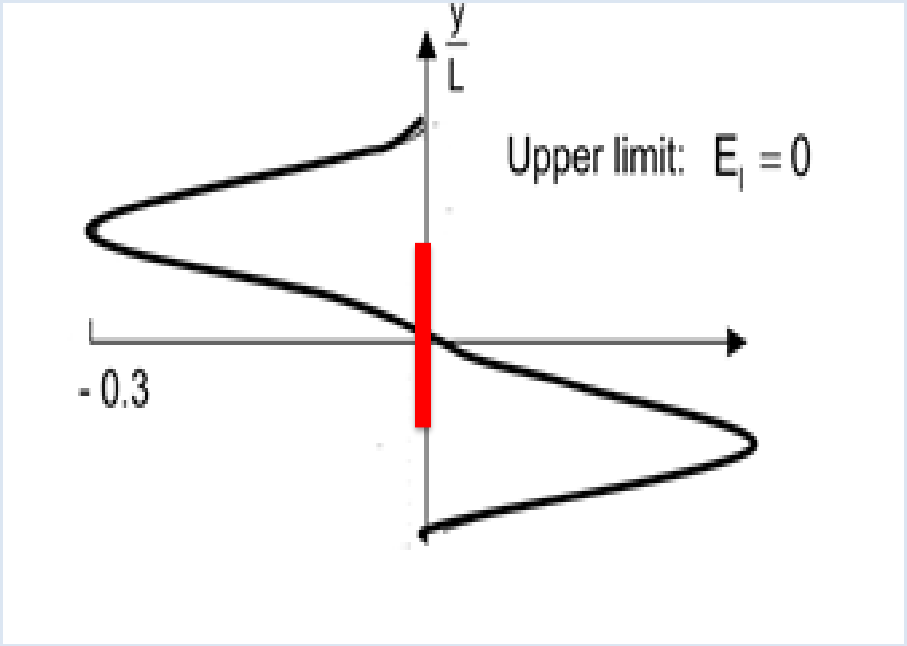
Numerical Simulation



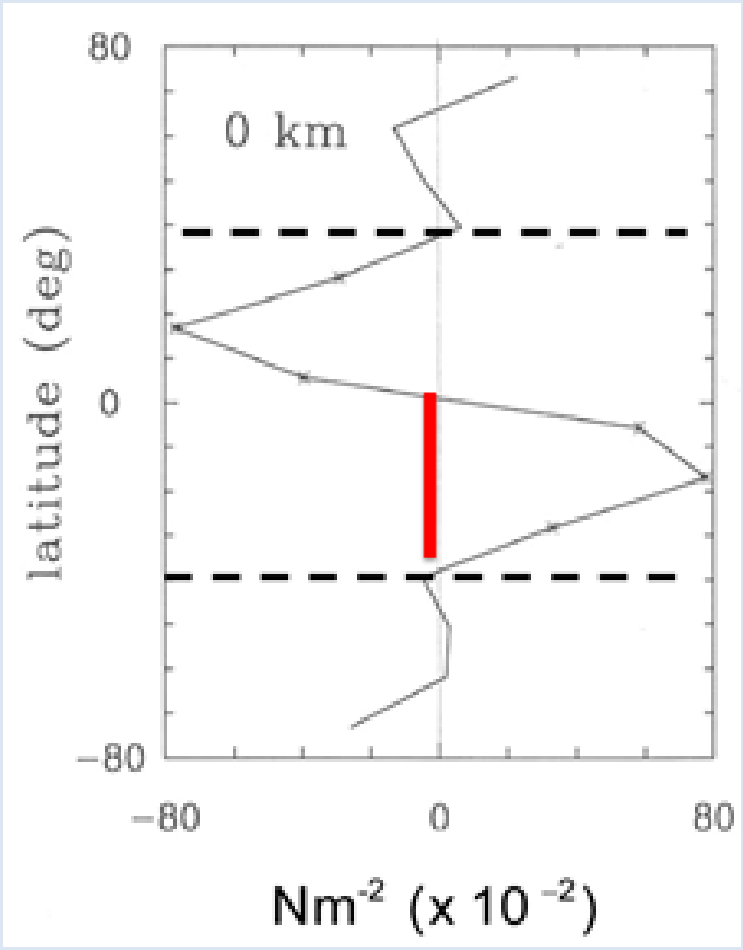
The negative of vertical derivative of momentum flux contributes to the westerly burst

Meridional Momentum Flux by the Rossby-gravity Gyres

Analytic Model

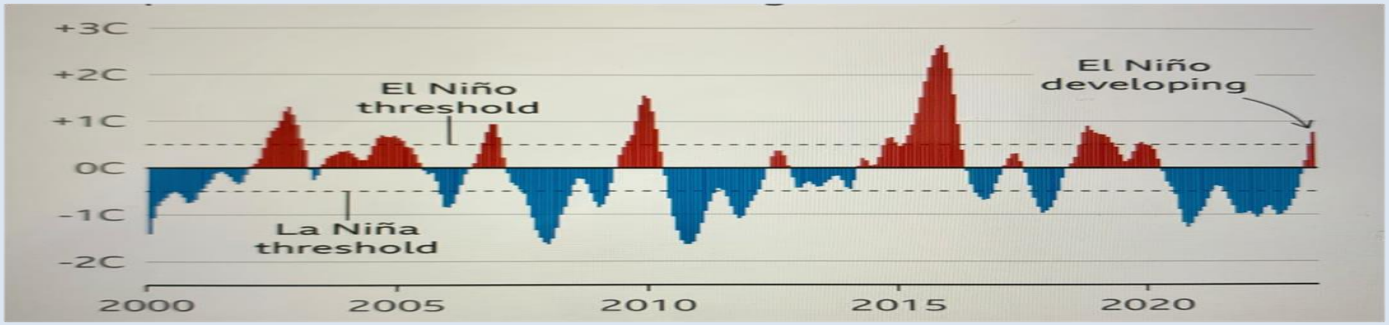


Numerical Simulation



The negative of meridional momentum flux in the red zones contributes to the westerly burst

Take-away comments



- **Analytic model momentum fluxes agree excellently with numerical simulation results showing that the MCSP paradigm is valid**
- **MCSP directly overcomes key "Gray Zone" issues facing contemporary GCMs wherei organized convection is neither treated by traditional parameterizations nor adequately resolved**
- **Convective momentum transport by MJO & Rossby-gyres in GCMs is a key El Nino onset issue and salient to the QBO (i.e., Kai Huang's talk)**
- **Contribution of Rossby-gyres to westerly wind-bursts exceeds (by an order of magnitude) the contribution by MJOs**
- **This may explain the variability of El Nino events in the above diagram**

References

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