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FEBRUARY 2, 2026

Characteristics of sub-seasonal variability in CAM7 and CESM3

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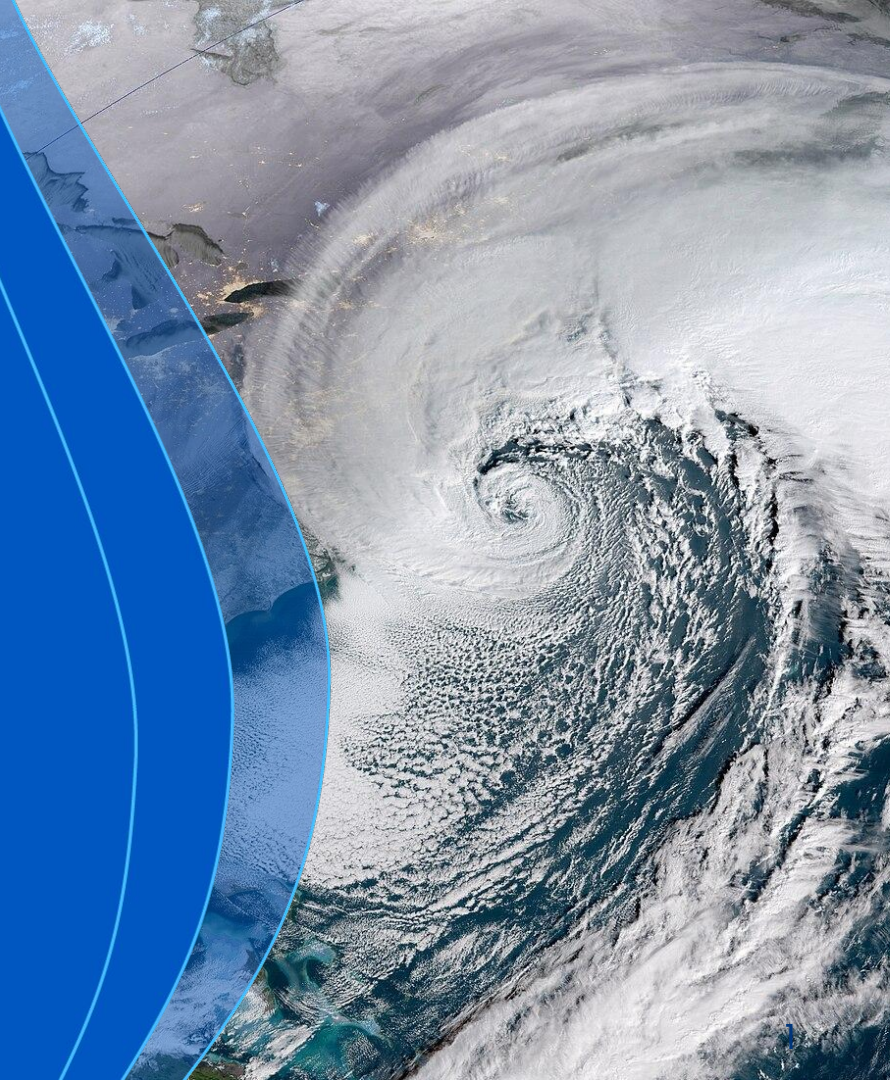
Climate Variability and Change (CVCWG)

THANKS: Cecile Hannay, Julio Bacmeister, Adam Herrington, Isla Simpson, Peter Lauritzen, +++



This material is based upon work supported by the NSF National Center for Atmospheric Research, a major facility sponsored by the U.S. National Science Foundation and managed by the University Corporation for Atmospheric Research. Any opinions, findings and conclusions or recommendations expressed in this material do not necessarily reflect the views of NSF.

Simulations

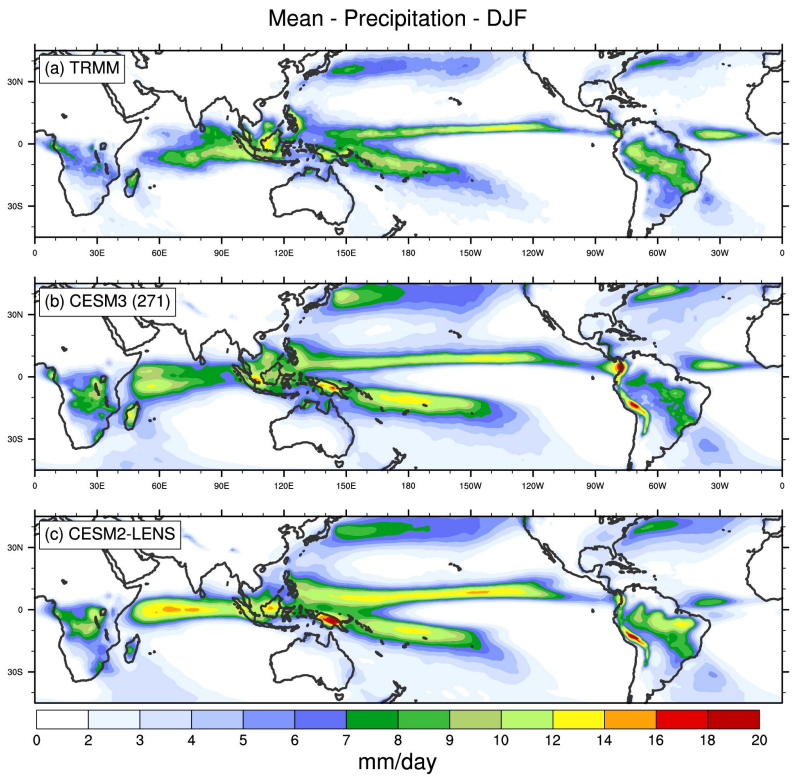
Model	Simulations	Years	Notes
CESM3	B1850C_LTso	40-69	#271 (#276)
CESM3	BHISTC_LTso	1979-2005	#271 (#276)
CESM2	BHIST (LENS2)	1850-1869, 1979-2005	10/20 ens.
CESM1	BHIST (LENS1)	1850-1869, 1979-2005	10/20 ens.
CAM7	FLTHIST	1979-2005	
CAM6	FHIST	1979-2005	
CESM3 (2025)	BLT1850		#121

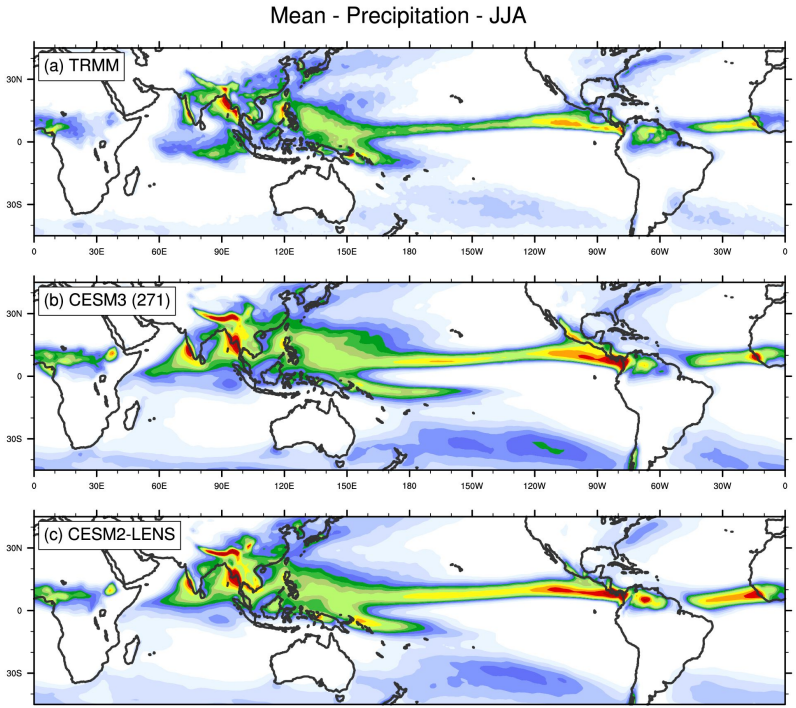
Observations

Reanalyses
ERA5, ERAI, MERRA
Precipitation
TRMM, GPCP
OLR
NOAA

Daily averages
3-hrly averages
(monthly)

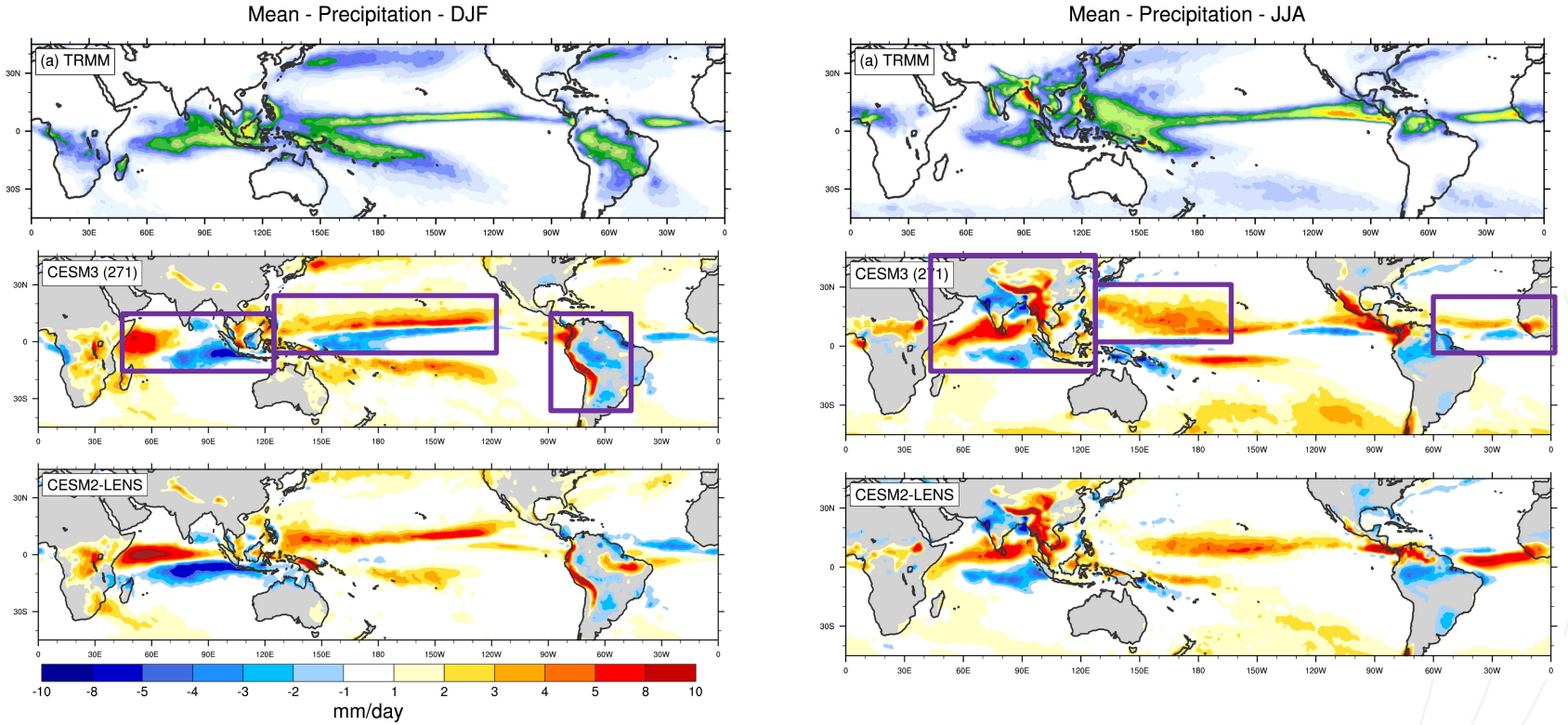
Unorganized variability





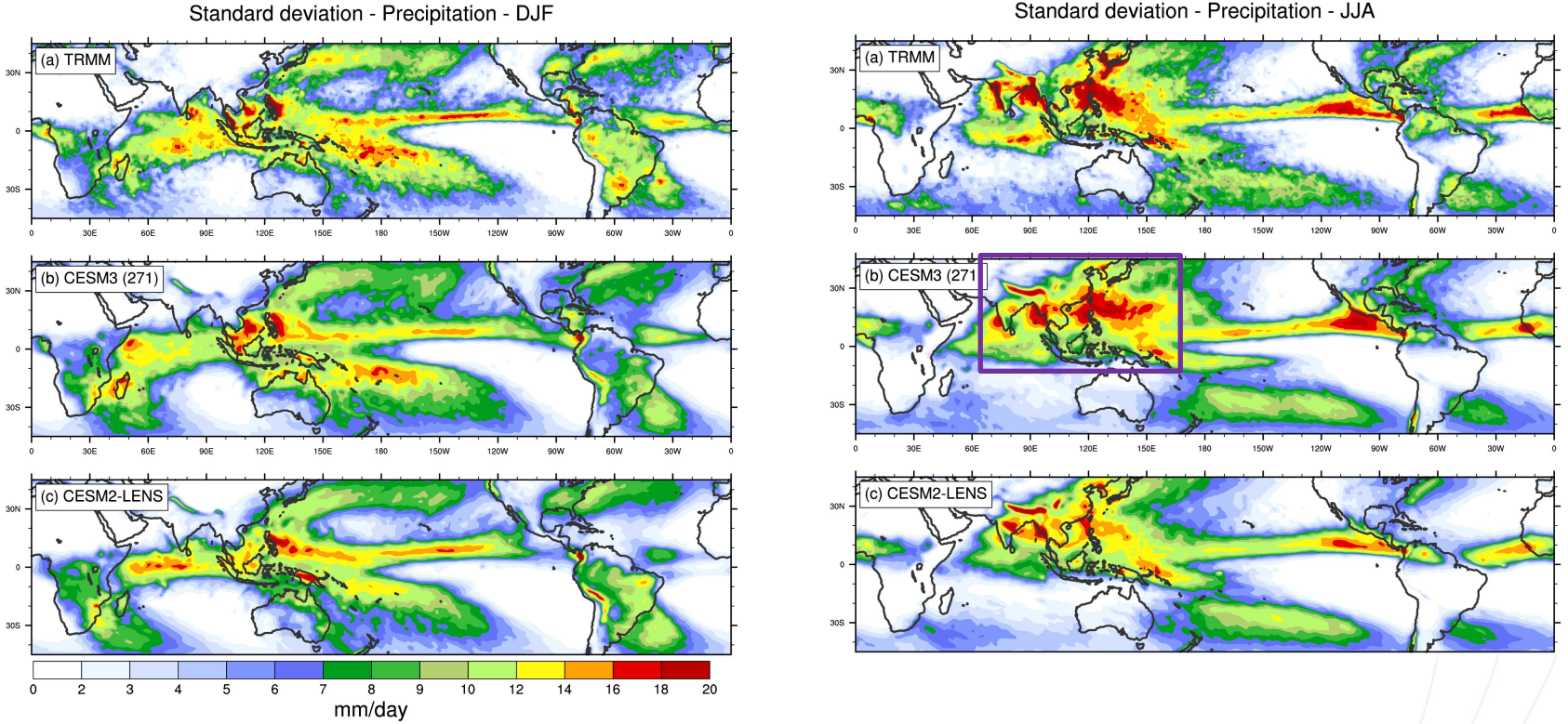
Mean Precipitation (2000-2009,1979-2005)

Unorganized variability



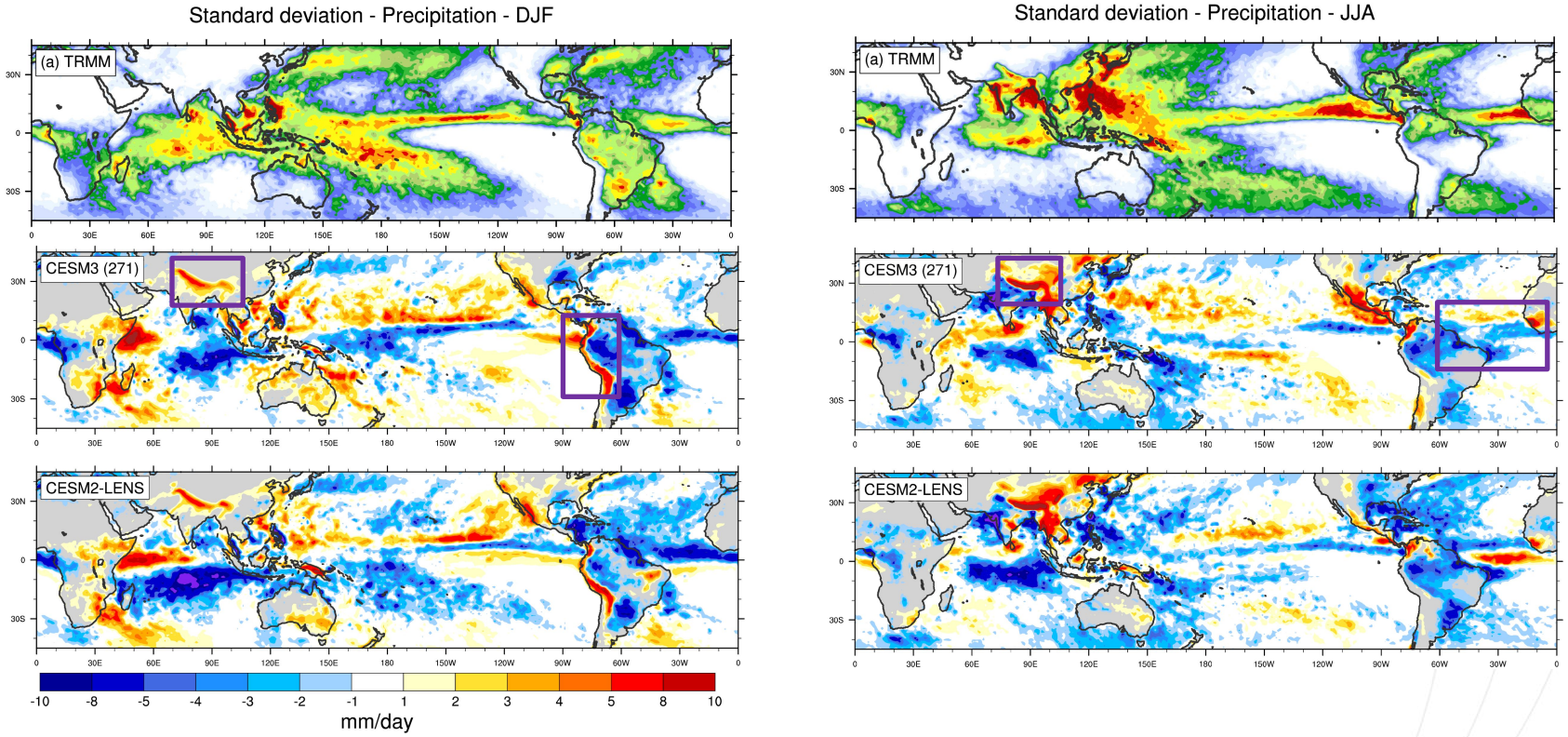
Mean Precipitation Bias (1979-2005)

Unorganized variability



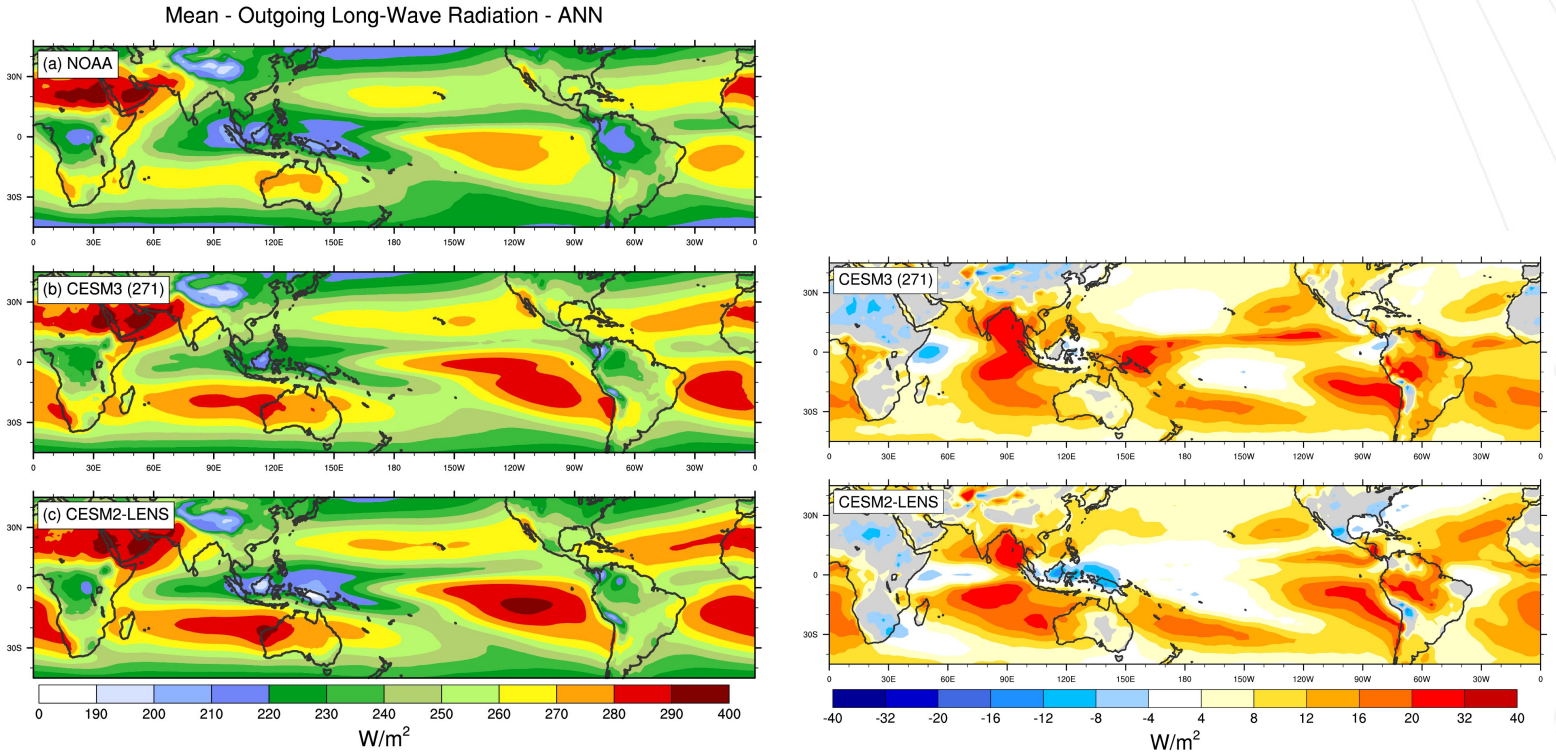
Precipitation Std dev. (2000-2009,1979-2005)

Unorganized variability



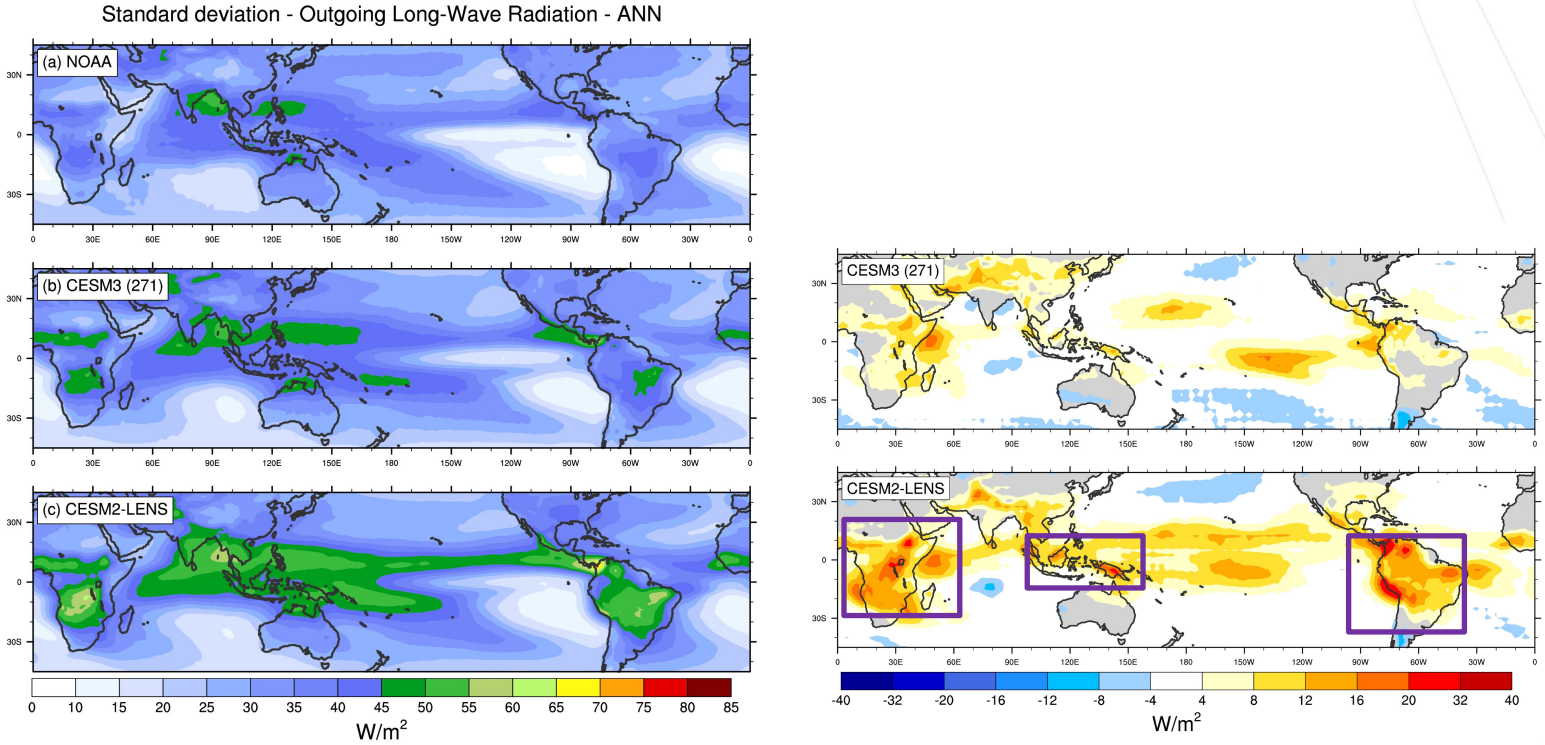
Precipitation Std dev. (2000-2009,1979-2005)

Unorganized variability



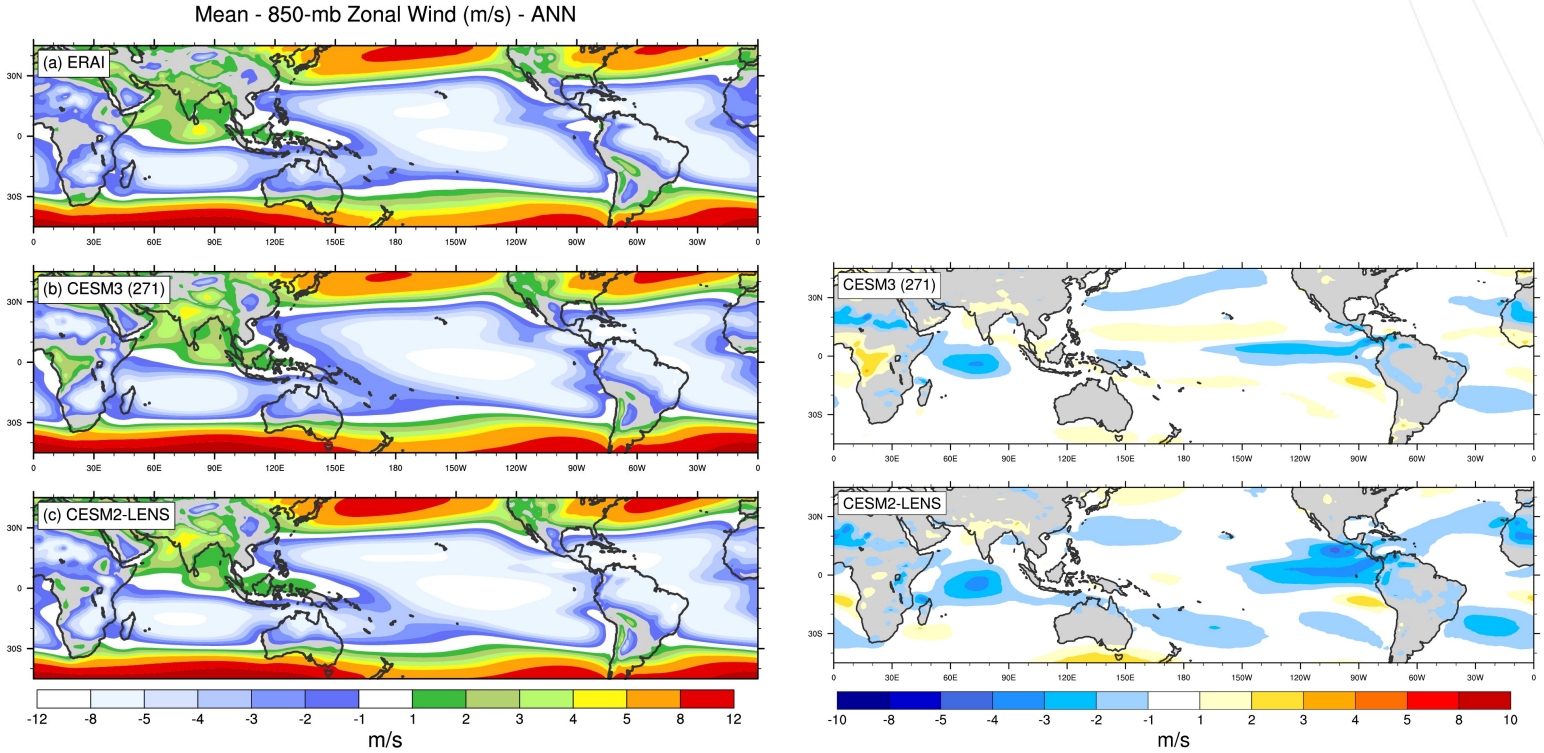
Outgoing Longwave Radiation Mean (2000-2009,1979-2005)

Unorganized variability



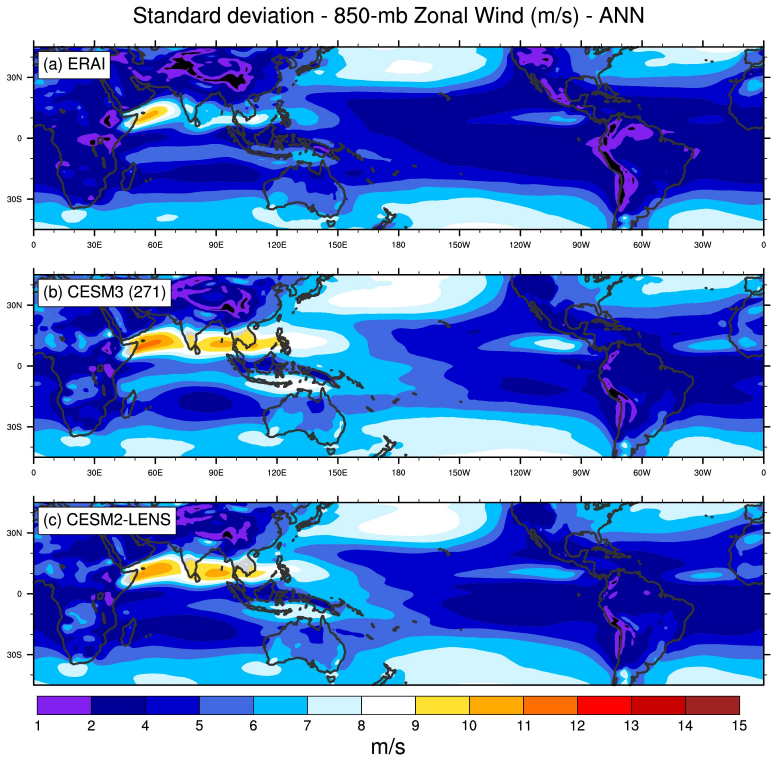
Outgoing Longwave Radiation Std. Dev. (2000-2009,1979-2005)

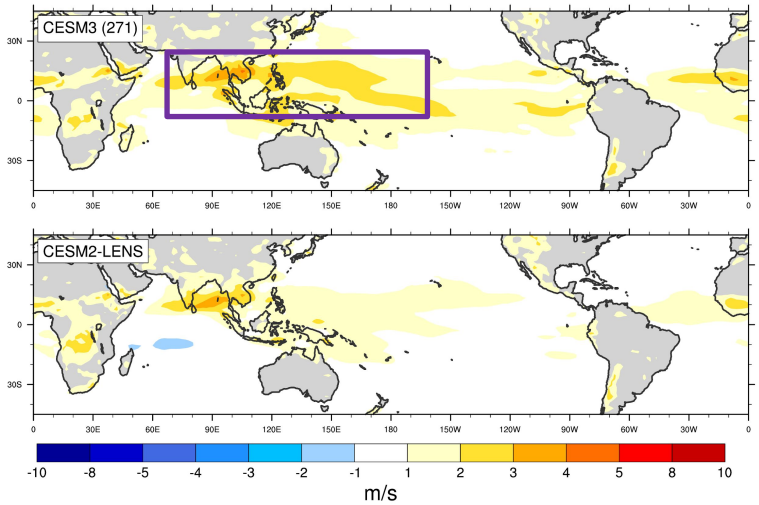
Unorganized variability



Outgoing Longwave Radiation Mean (2000-2009,1979-2005)

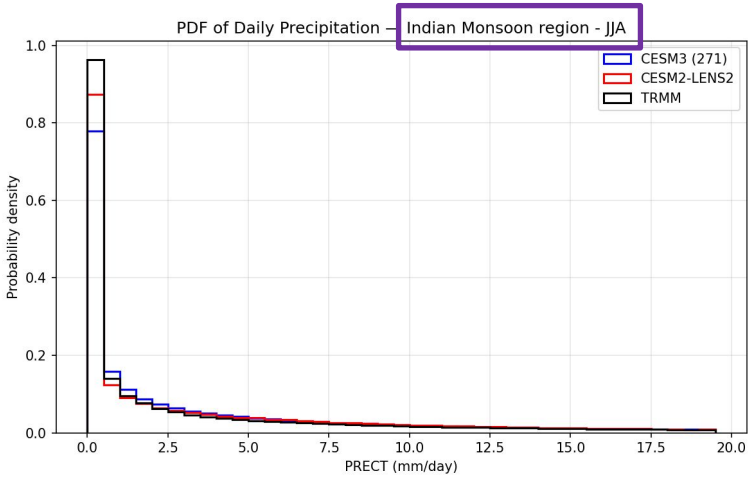
Unorganized variability

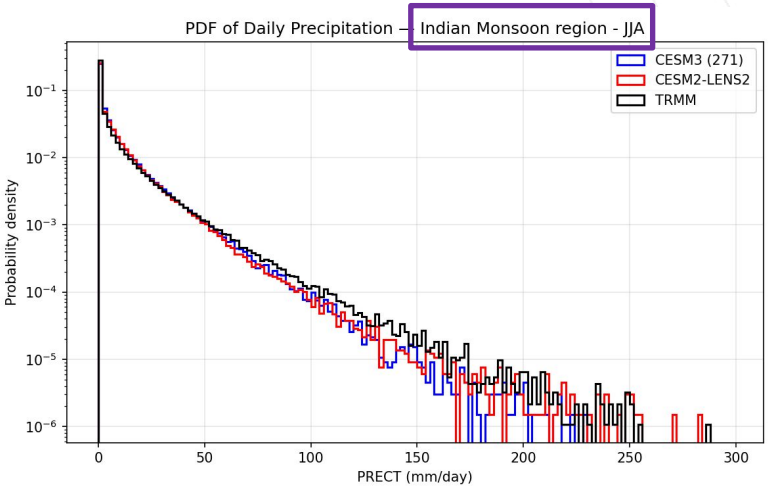




Outgoing Longwave Radiation Std. Dev. (2000-2009,1979-2005)

Precipitation Daily PDF

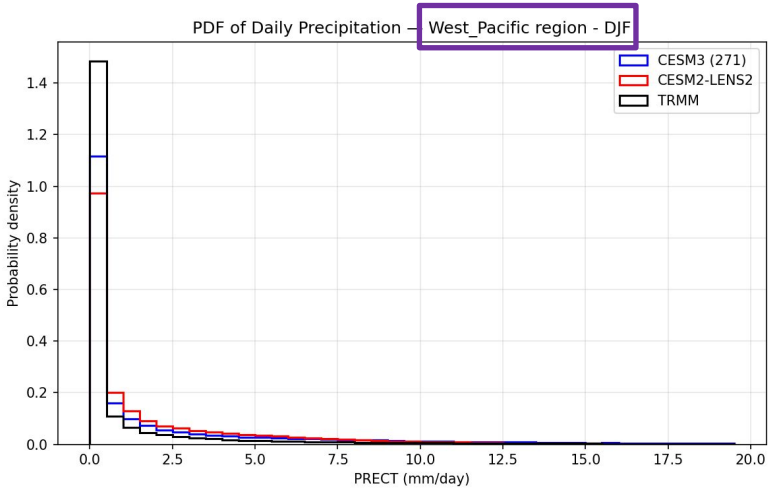


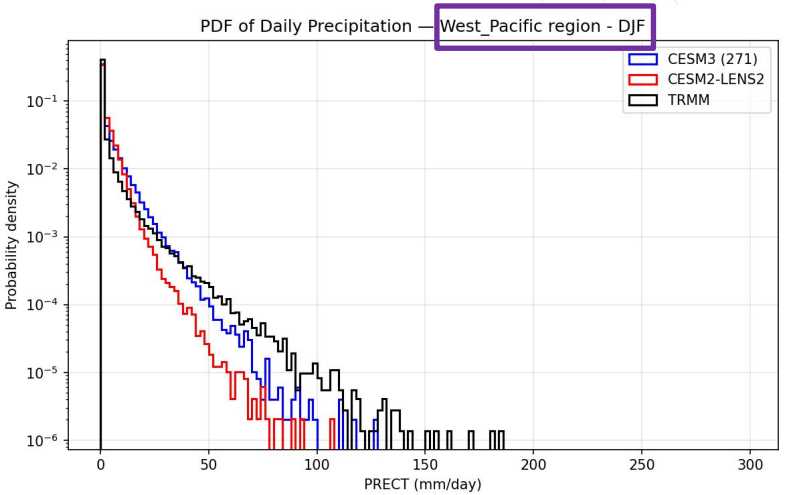


- CESM3 +ve bias in weak events (-ve bias in CESM2)

Total Precipitation (2000-2009) [all at 1 deg]

Precipitation Daily PDF

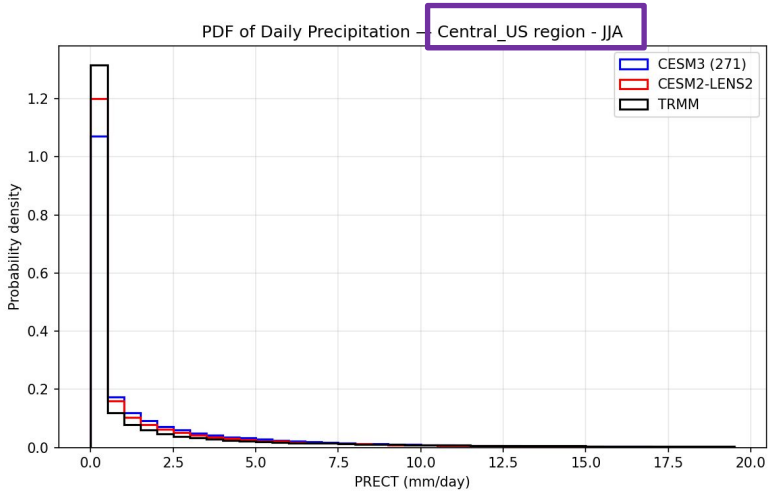


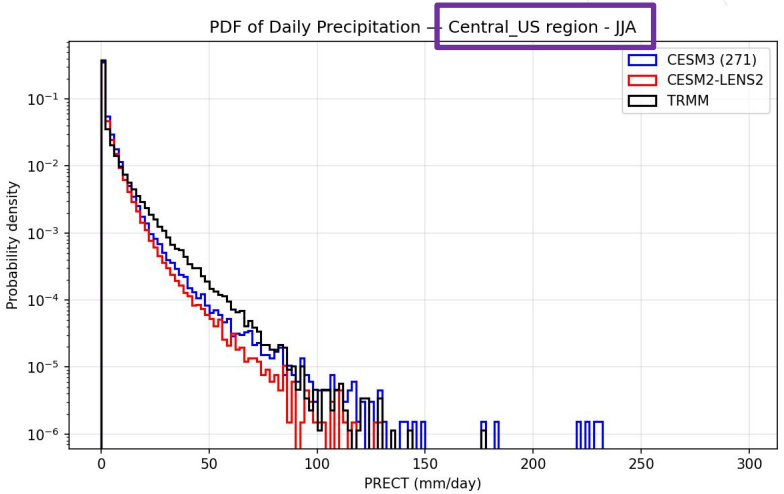


- CESM3 clear improvement
- Still too much 10 mm/day ‘ZM drizzle’, but less in CESM3
- Much improved tail beyond 20 mm/day

Daily Mean Precipitation (1991-2000, 2000-2009)

Precipitation Daily PDF

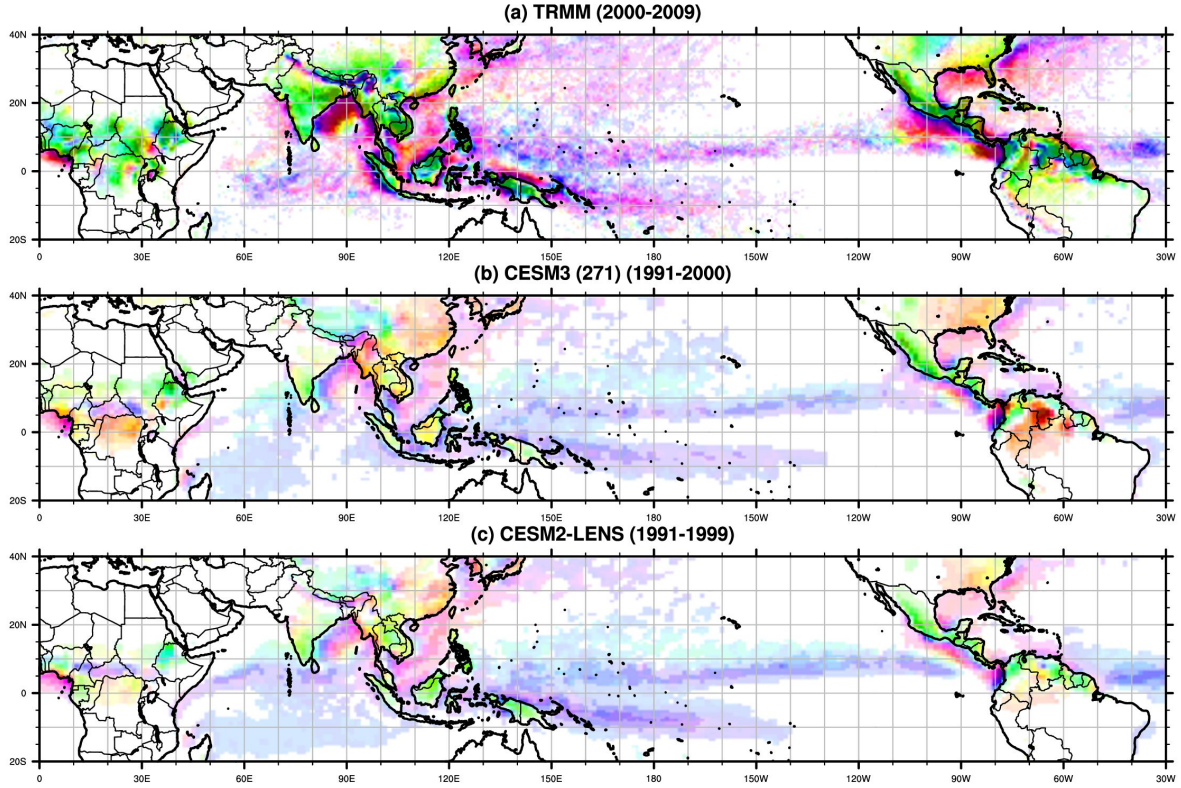




- Moderate->strong events 50% too low
- Weak events to prevalent
- Coller coupled versus AMIP?

Daily Mean Precipitation (1991-2000, 2000-2009)

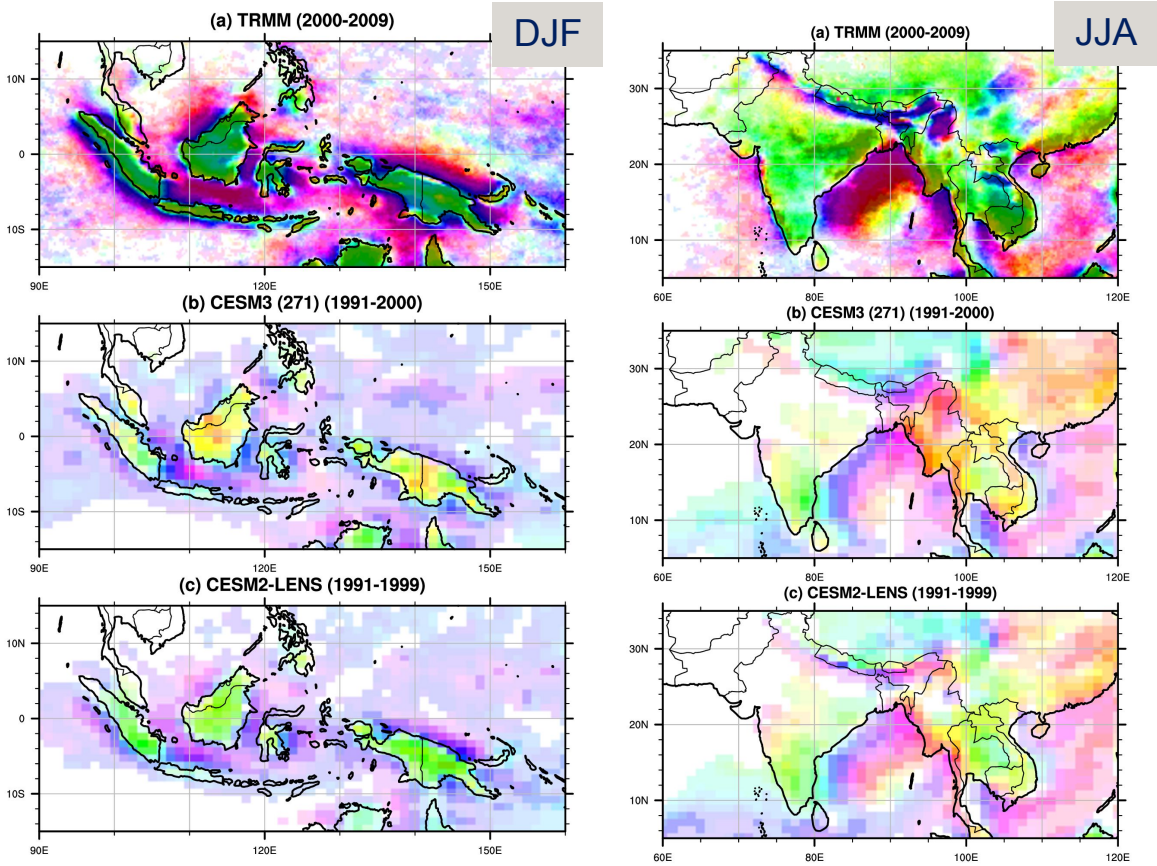
Diurnal Cycle



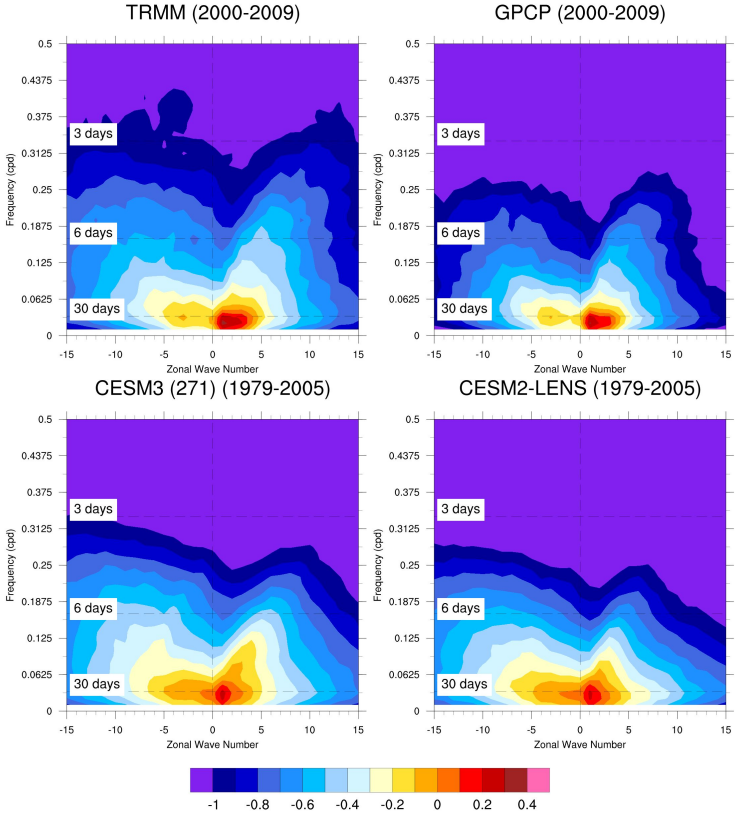
- Too early in CESM2/3 especially over land
- Earlier timing in CESM3
- Too weak amplitude over ocean
- More accurate phase over significant orography

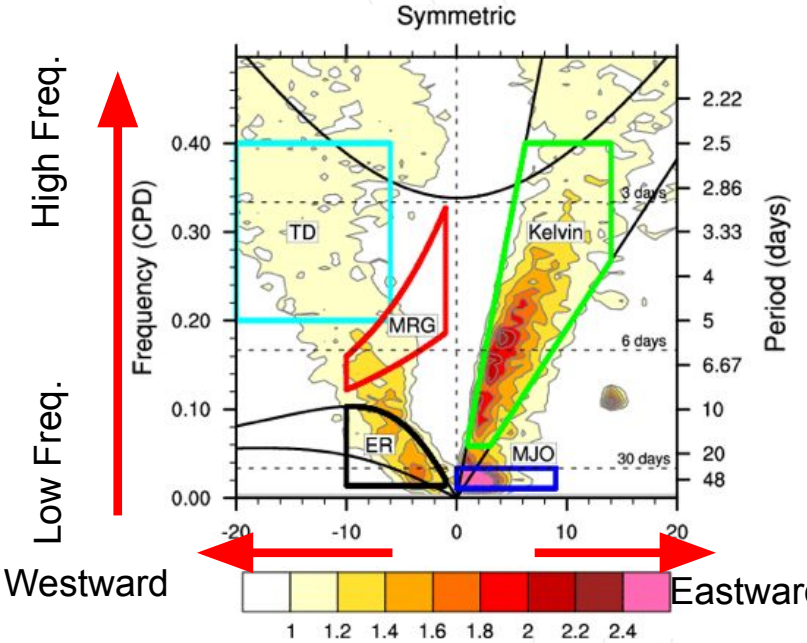
JJA Phase and Amplitude of Mean Diurnal Cycle

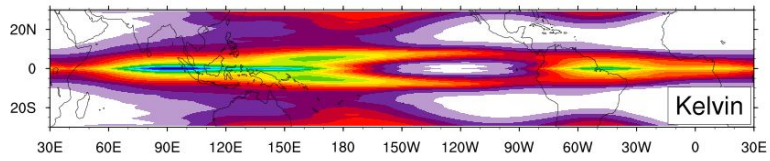
Diurnal Cycle



Equatorial Wave Variability

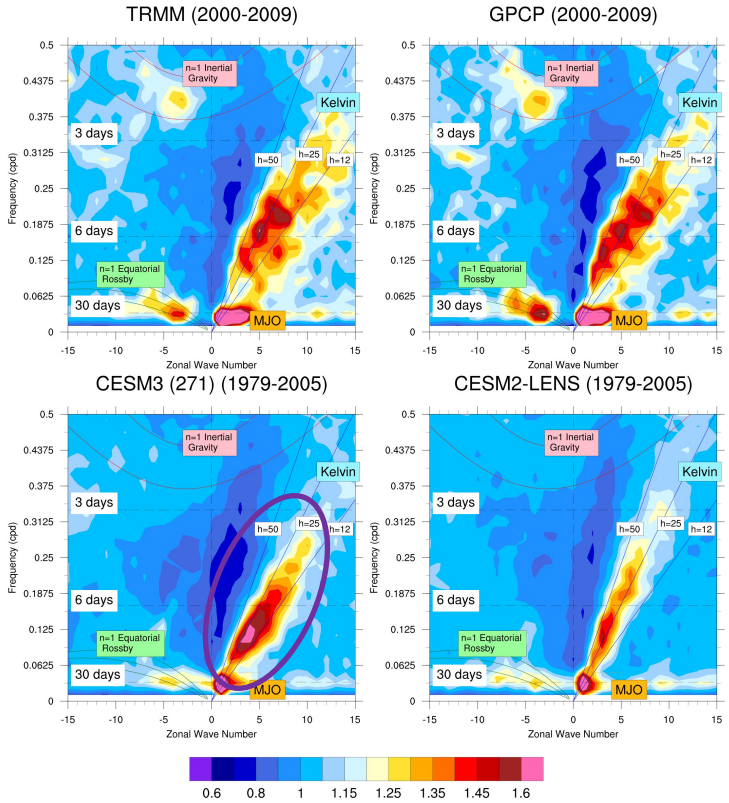




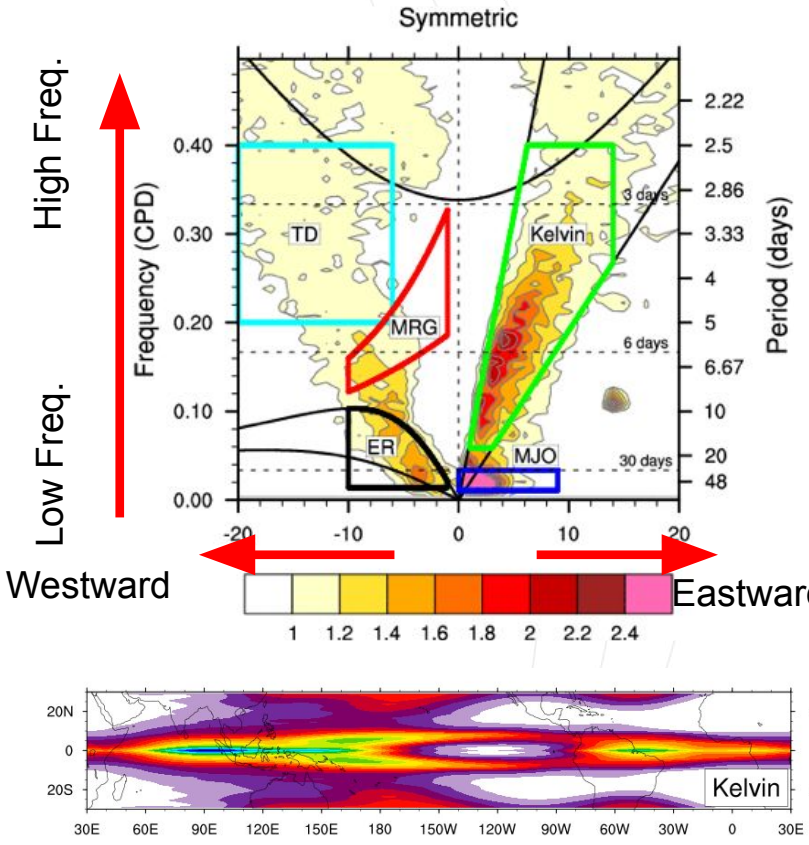


Daily Mean Precipitation [all at 1 deg]

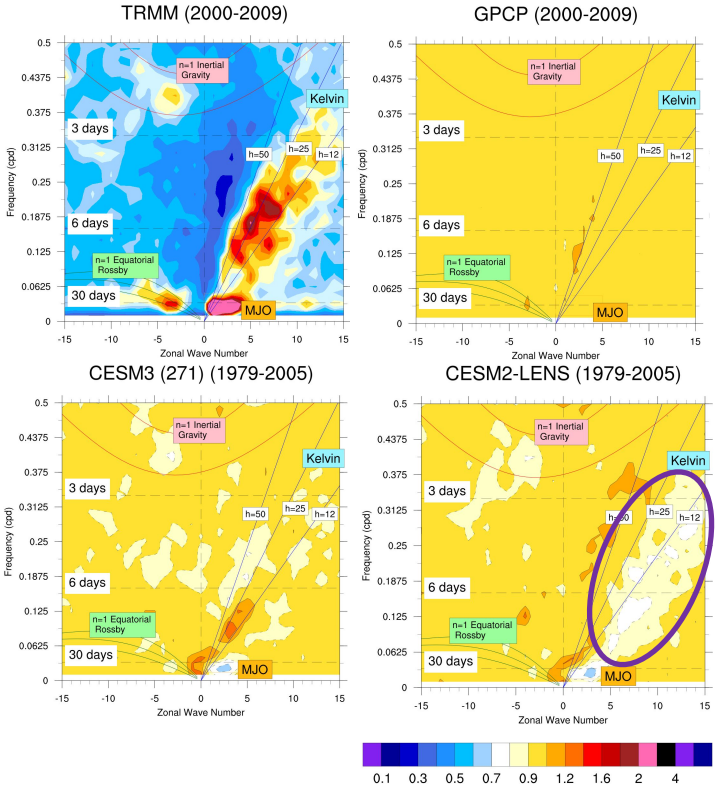
Equatorial Wave Variability

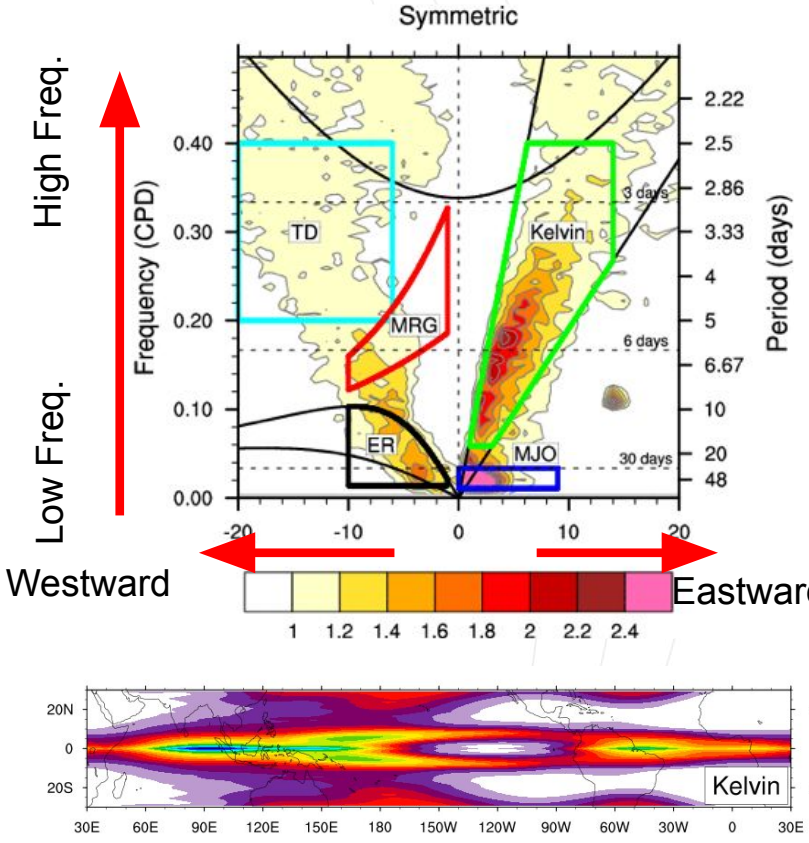


Daily Mean Precipitation



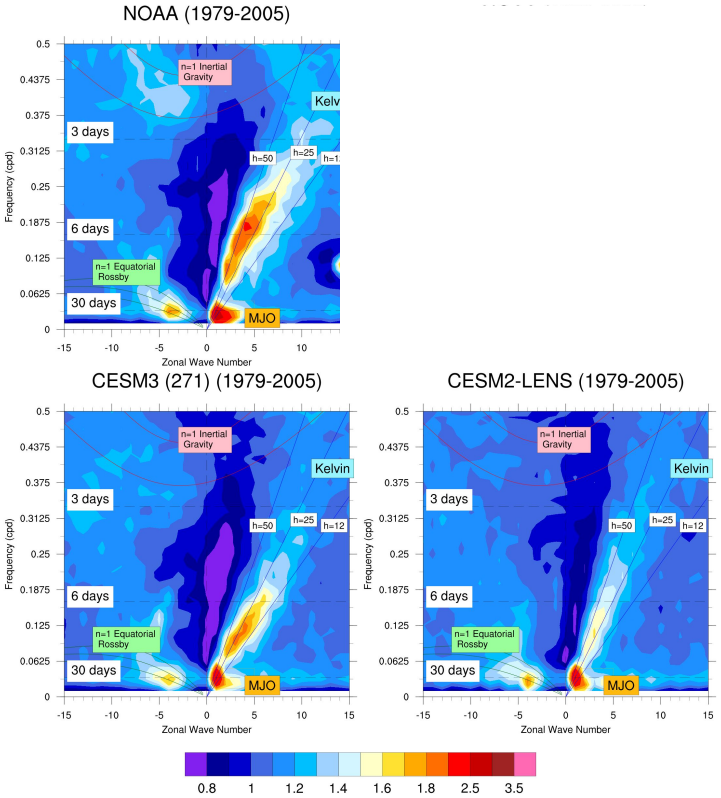
Equatorial Wave Variability



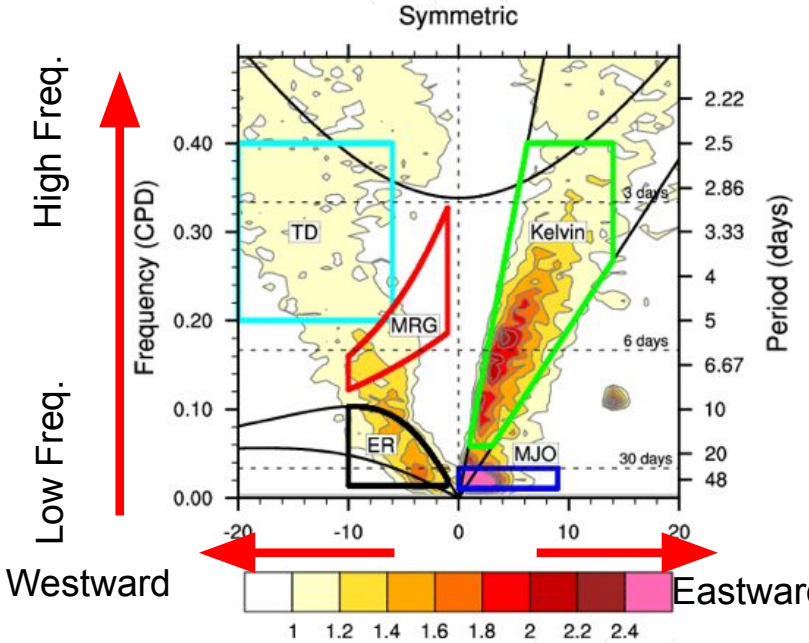


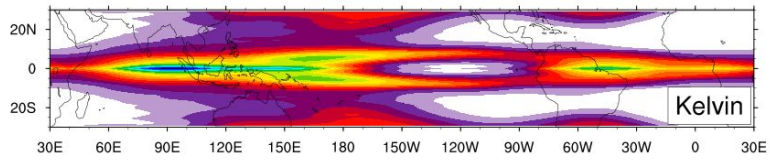
Daily Mean Precipitation

Equatorial Wave Variability

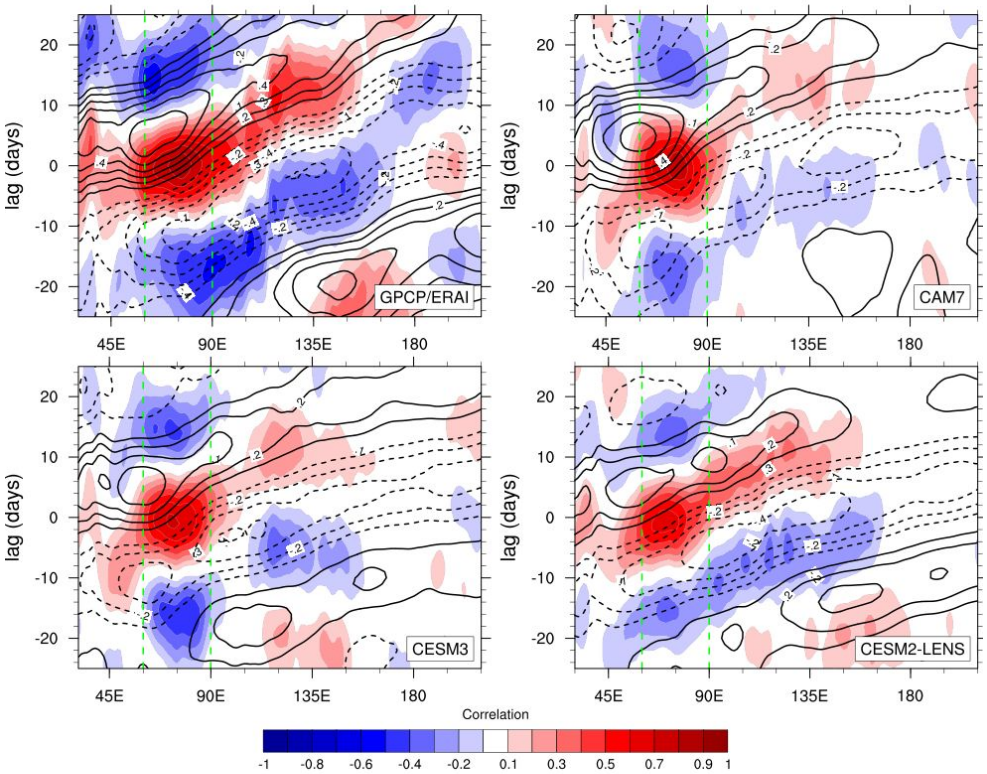


Daily Mean OLR





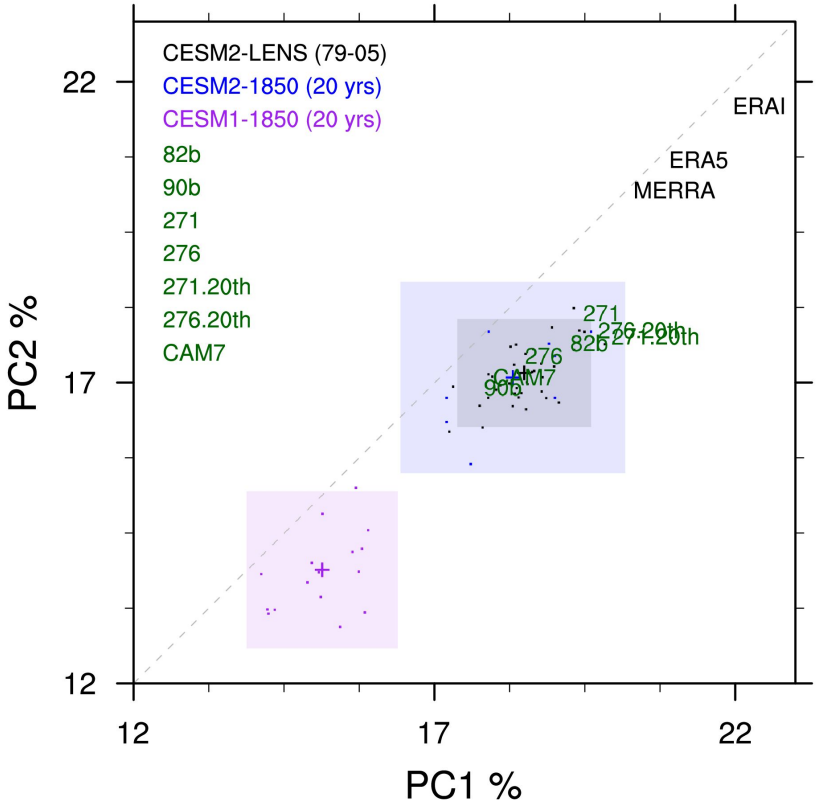
Madden Julian Oscillation (MJO)



- CESM3 generally less coherent that CESM2
- Decoupling in the West Pacific leads to speed up
- CAM7 is more coherent than CAM6 (but a lot of sensitivity)
- *MJO improved with Multiscale Coherent Structure Parameterization (MCSP) - included in CESM3 release*

Daily Mean Precipitation (red/blue) and 850-mb zonal wind (contours) lag correlations Indian Ocn.

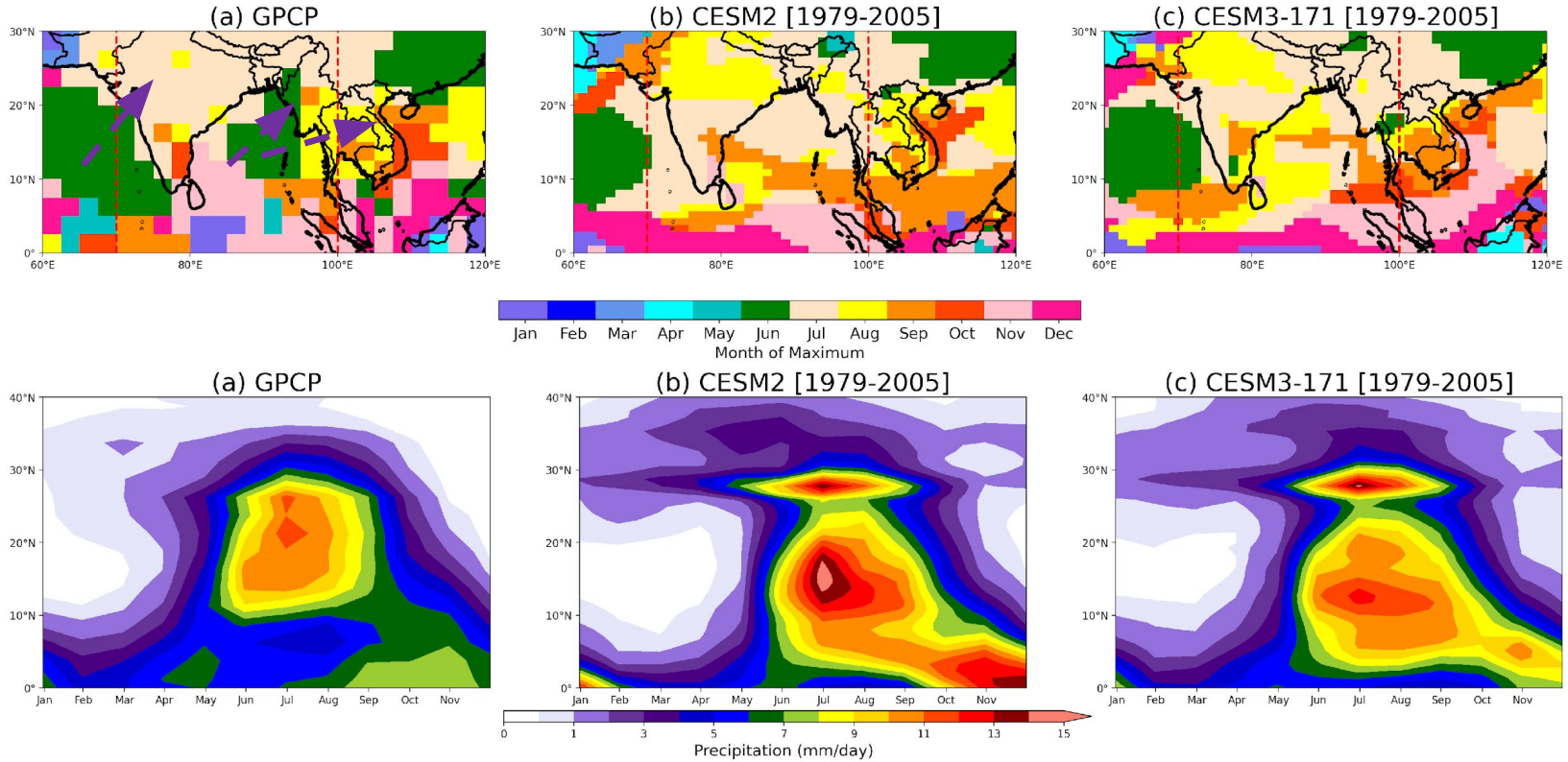
Madden Julian Oscillation (MJO)



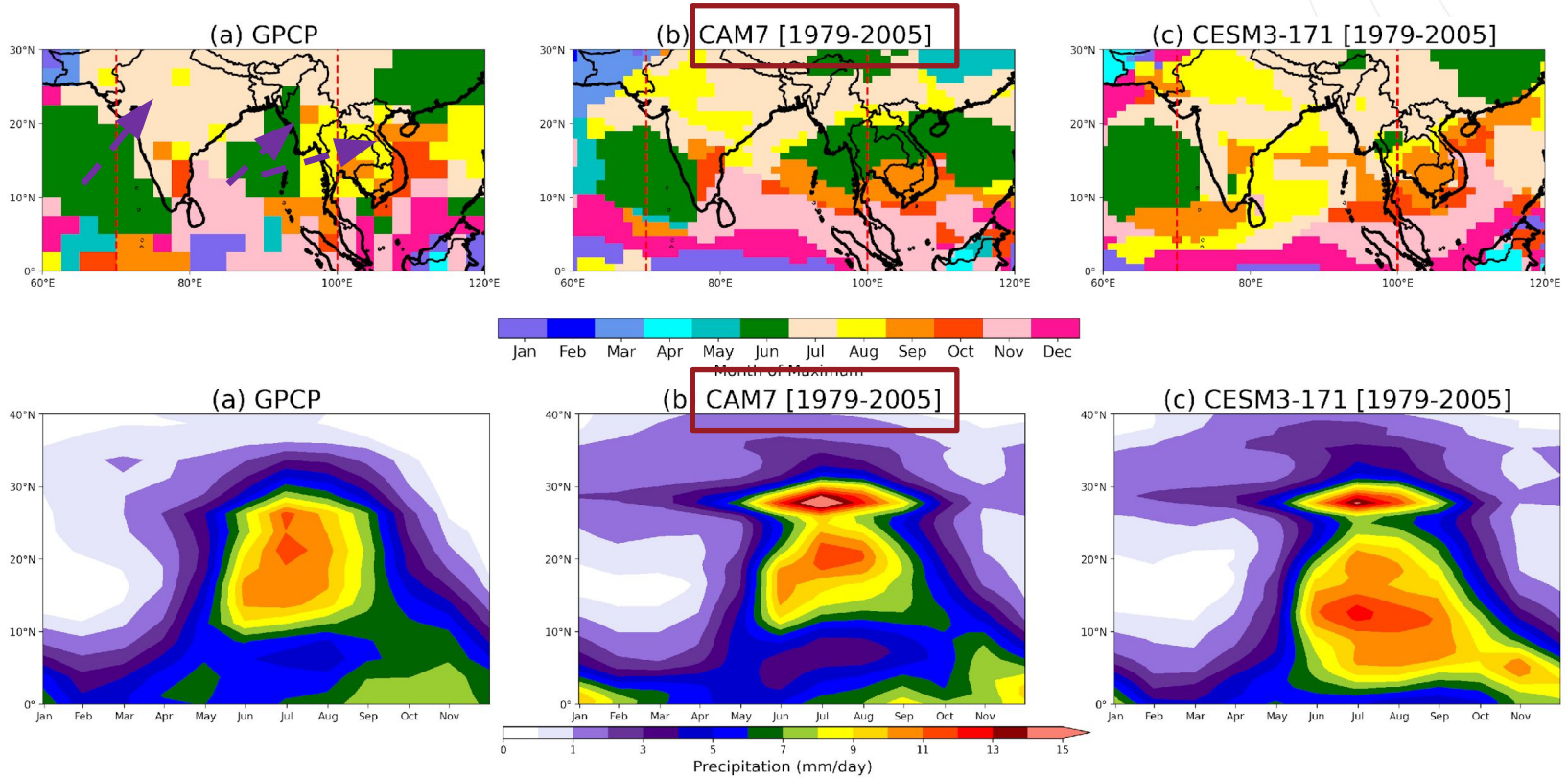
- CESM3 mostly within the CESM2 LENS spread
- Clearly better than CESM spread
- Better than previous CESM3 incarnations (82b/90b)?
- 20th cent CESM3 stronger PC1?

First principal components of U200/U850/OLR intraseasonal filtered (% explained)

Indian Monsoon

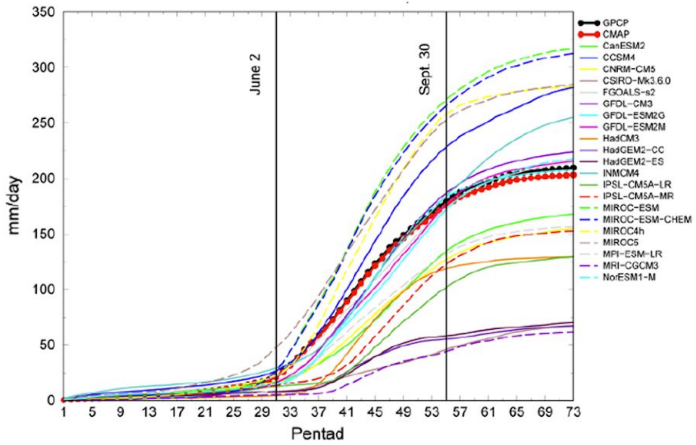


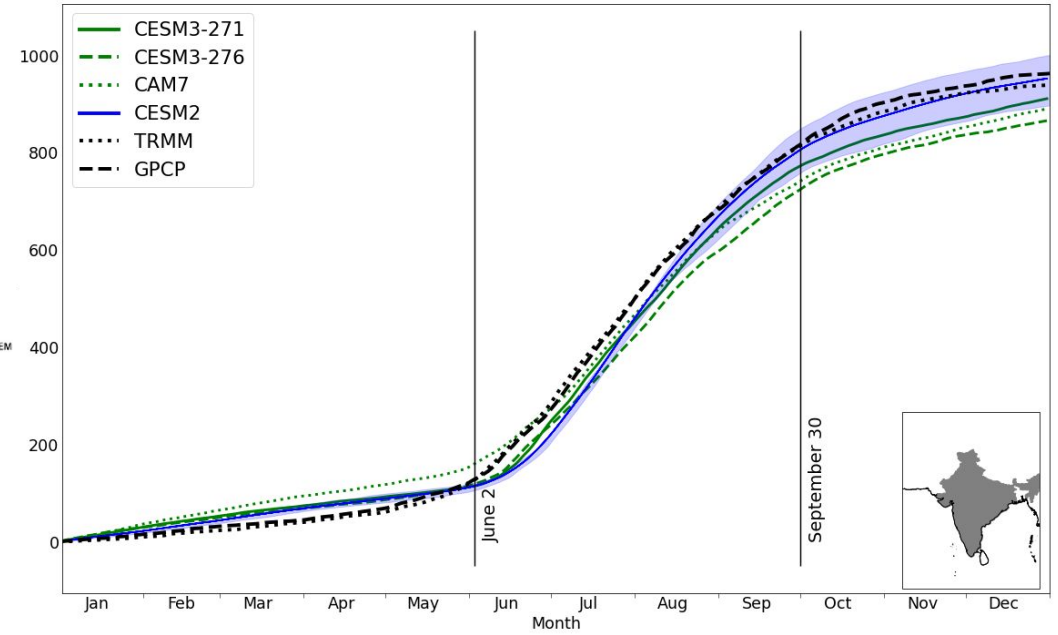
Indian Monsoon



Global Monsoons

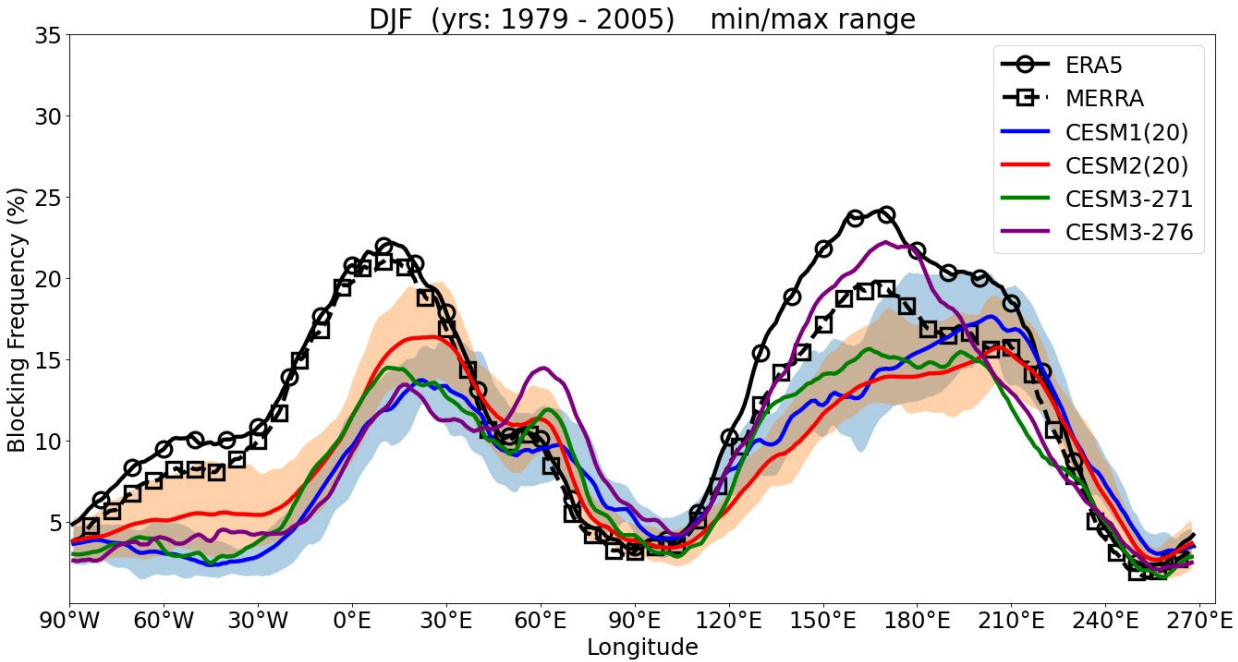
CMIP5 models





Cumulative Distribution Function (PRECT - daily)

Blocking (1D)

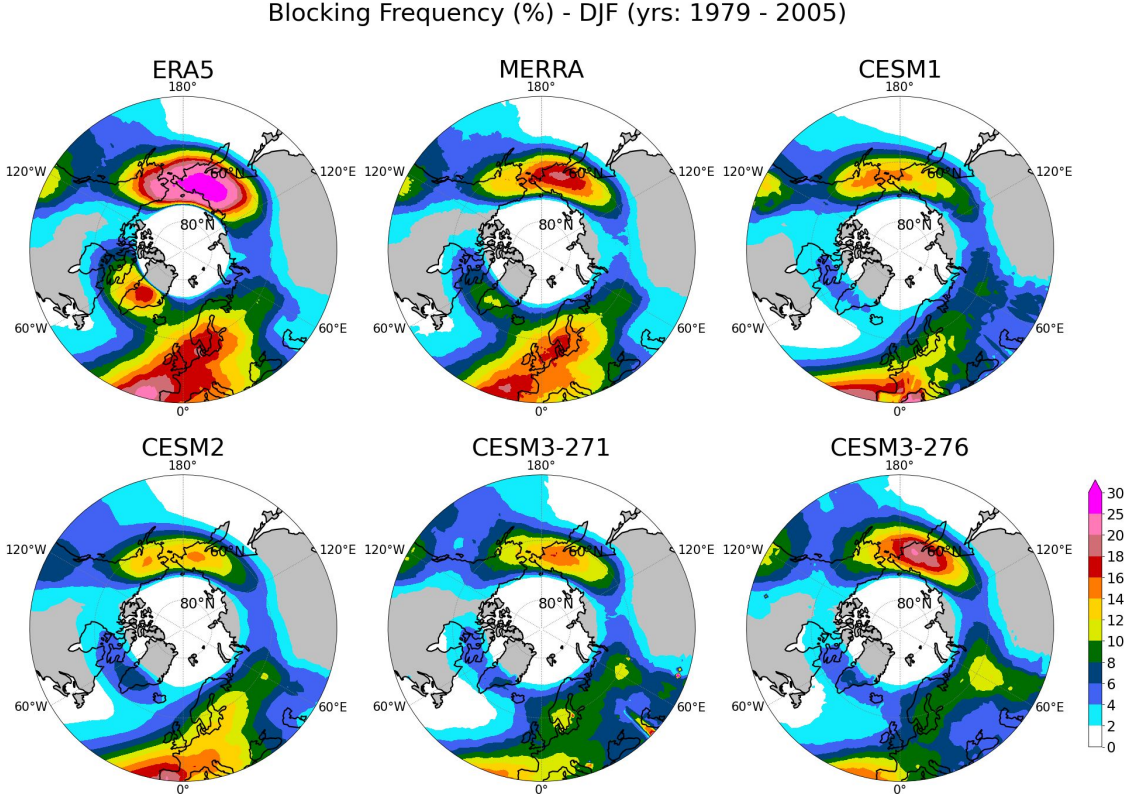


- Persistent DJF Euro/Atlantic bias
- Pacific likely still underestimated, but large internal variability

Daily 500-mb geopotential (50N) height based diagnostic (latitude gradient threshold)

Tibaldi and Molteni (1990)

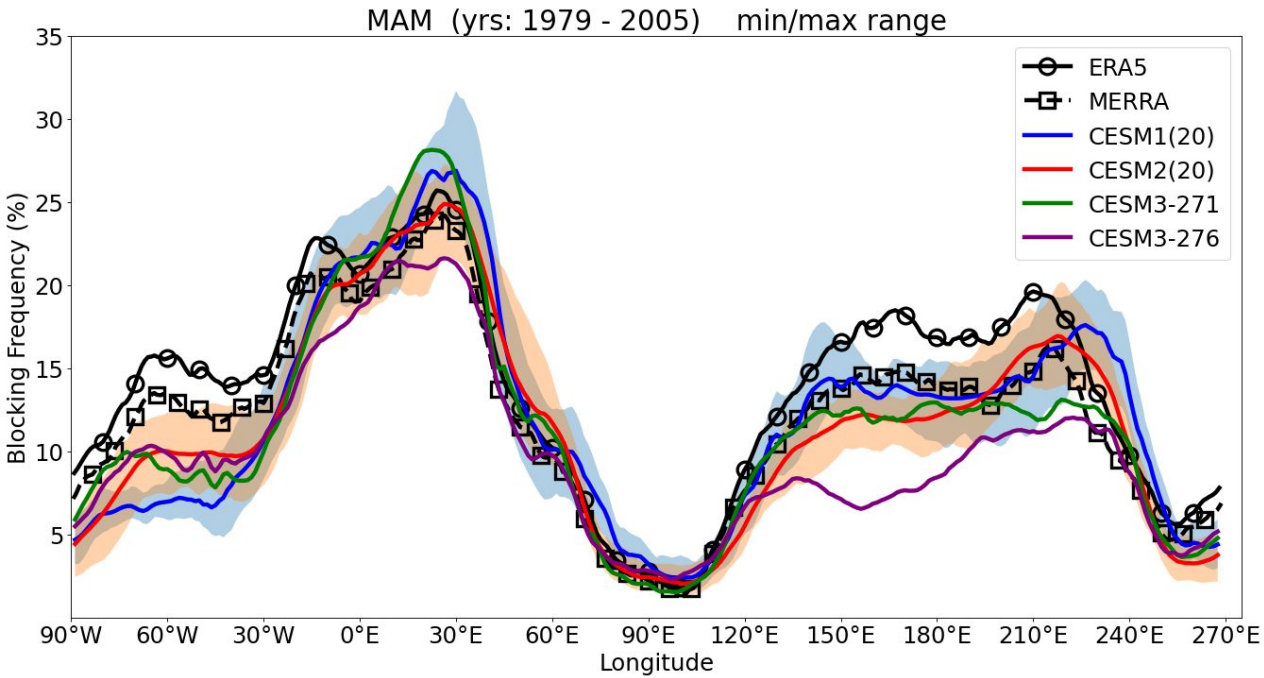
Blocking (2D)



- Persistent DJF Euro/Atlantic bias
- Pacific likely still underestimated, but large internal variability
- Pacific 2D with string maximum in CESM3
- CESM2 ensemble mean here

2-D lat/lon gradient thresholds *Davini et al. (2012)*

Blocking (1D)



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- Persistent DJF Euro/Atlantic bias
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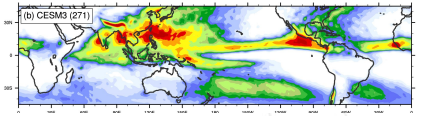
- Pacific 2D with string maximum in CESM3
- CESM2 ensemble mean here

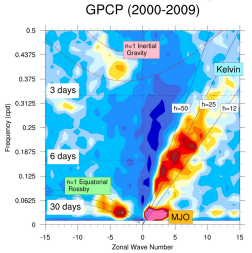
- MAM more skillful in Euro-Atlantic
- Still misses Greenland local maximum
- Significant variability in with CESM3 in the Pacific??

Summary (distinct improvements of CESM3)

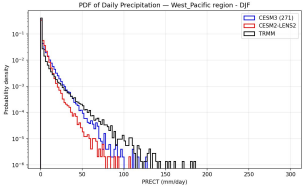
- Unorganized variance is improved (increased for precipitation)



- Wave number frequency strength within observations (full + wave modes)



- Precipitation PDFs, capture center and tails of distributions better BUT may be a background state dependency



- *Degradations? Slightly in MJO and Monsoon onset, maybe blocking*
- *What is the role of physics, vs vertical resolution (L32 vs L58)?*

Summary

	2025	2026
Sub-seasonal variability		
Atmospheric Blocking		
Monsoons		
Tropical Waves		
Madden Julian Oscillation (MJO)		
Diurnal Cycle		
Precipitation Distributions/Extremes		
	#121	*#271, #276*

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Thanks!

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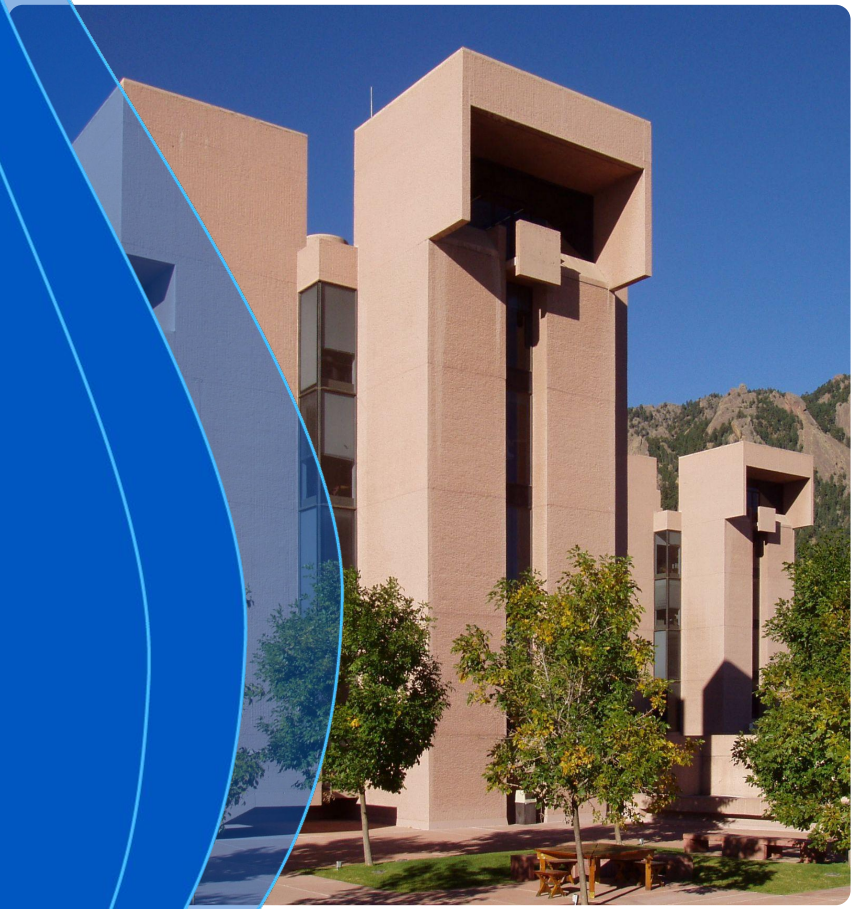

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