A Systematic Relationship between Intraseasonal Variability and Mean State Bias in AGCM Simulations

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Goals

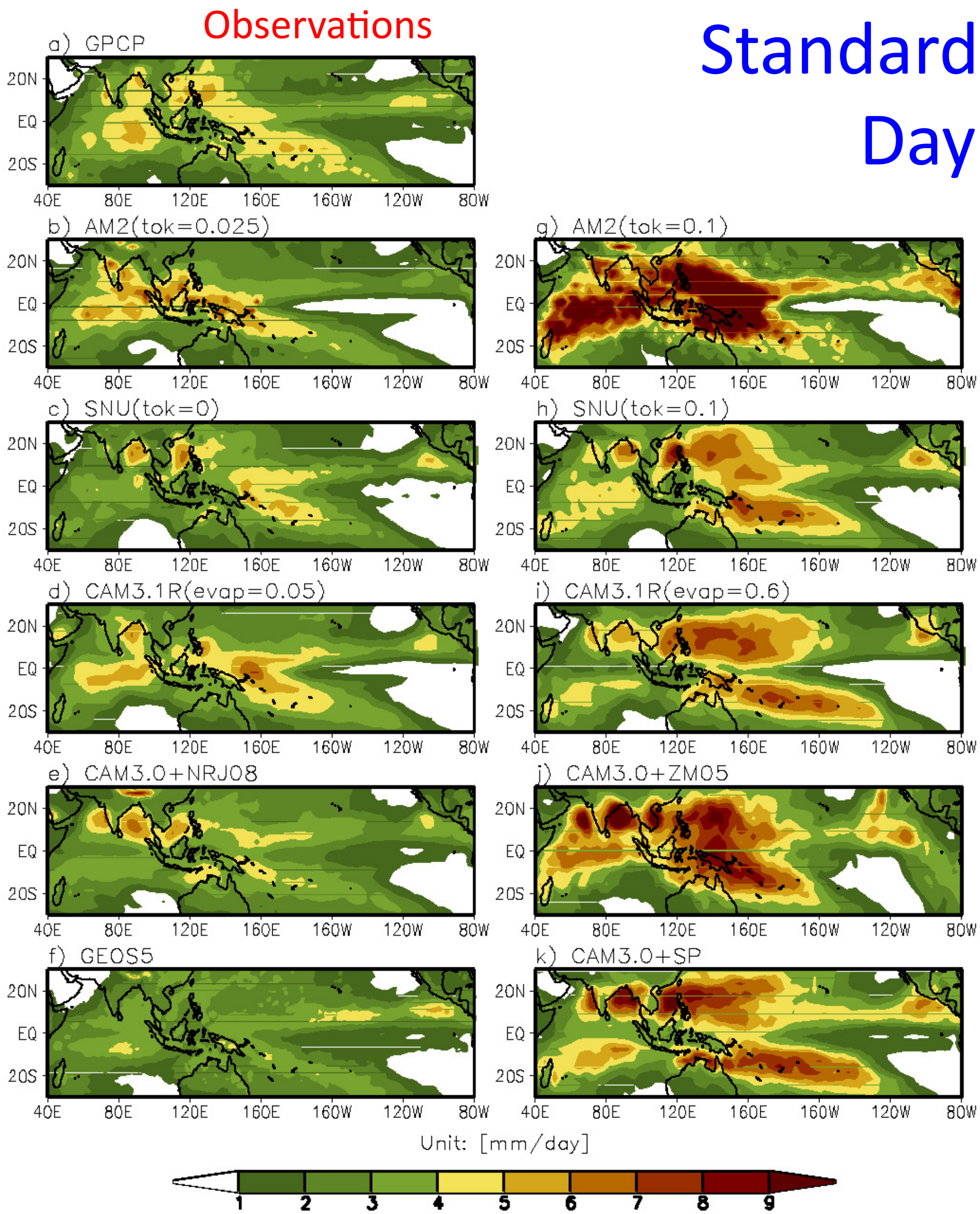
- Demonstrate a systematic relationship between the strength of intraseasonal variability and mean bias in 10 ***atmospheric*** GCM simulations.*
- Apply some proposed processed-oriented diagnostics to models to determine whether they can successfully predict simulations with high and low variability
- Possible effects of ocean coupling (e.g. Stan et al. 2010)

**known already to many modeling groups*

Models Compared

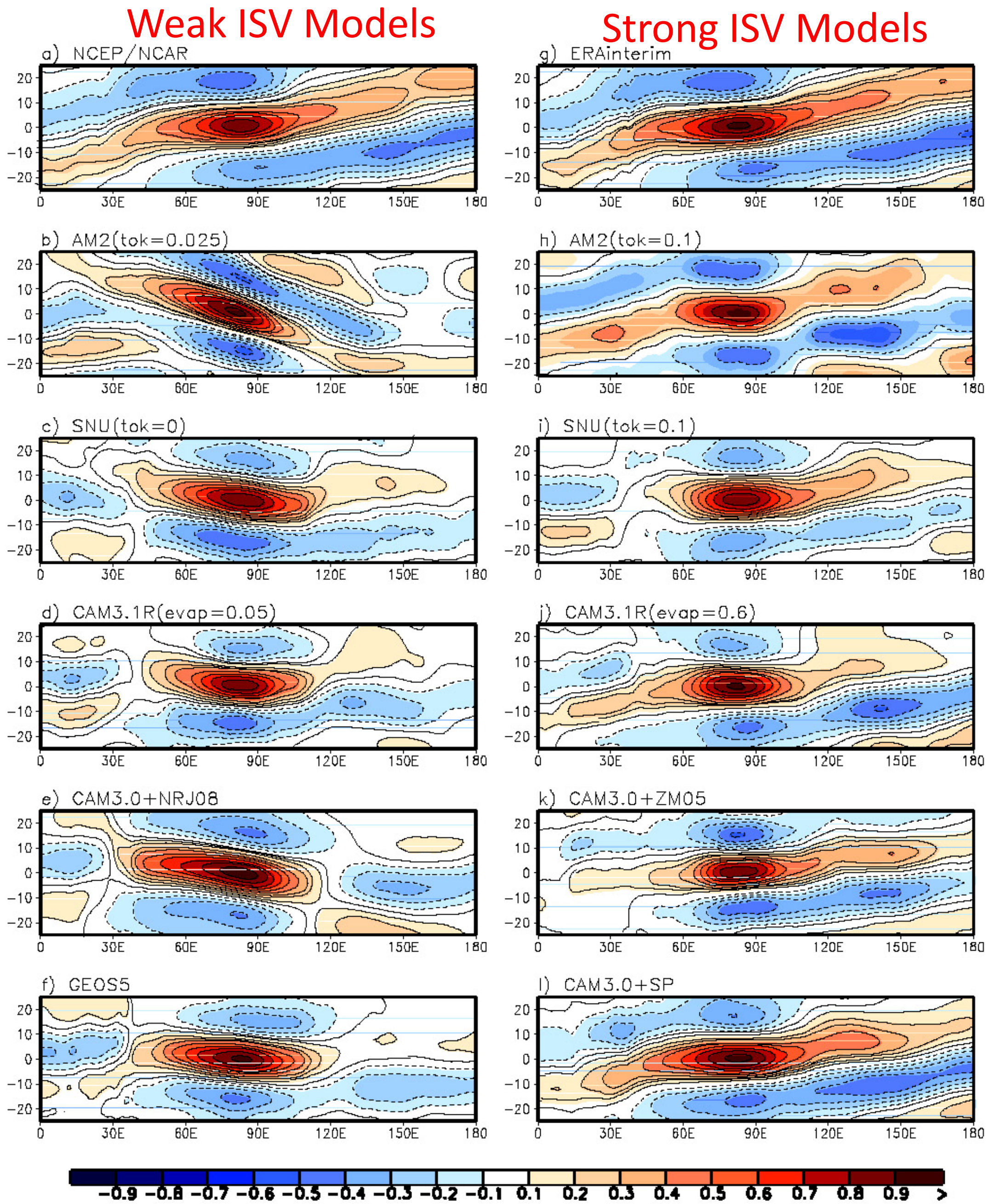
Model	Convection scheme	Version	Resolution	Period
AM2	RAS	tok=0.025 / 0.1	2.0^{o}lat x 2.0^{o}lon /L24	10yr with climatological SST
SNU	sRAS	tok=0.0 / 0.1	T42 /L20	20yr 01Jan1986-31Dec2005
CAM3.1R	RAS	evap=0.05 / 0.6	T42 /L26	10yr with climatological SST
CAM3.0	ZM	Neale et al. (2008)	1.9^{o}lat x 2.5^{o}lon /L26	20yr 01Jan1986-31Dec2005
		Zhang and Mu (2005)	T42 /L26	15yr 29Jan1980-23Jul1995
	SP	Khairoutdinov et al. (2005)	T42 /L26	19 yr 1Oct1985-25Sec2005
GEOS5	RAS	Rienecker et al. (2008) tok=0.05	1^{o}lat x 1.25^{o}lon /L72	12yr 1Dec1993-30Nov2005

Standard Deviation: 20-100 Day Precipitation



- Model versions with high ISV on right, and low ISV on left.

850 hPa Wind Lag Correlation: November-April



East-West Ratio Versus Variability

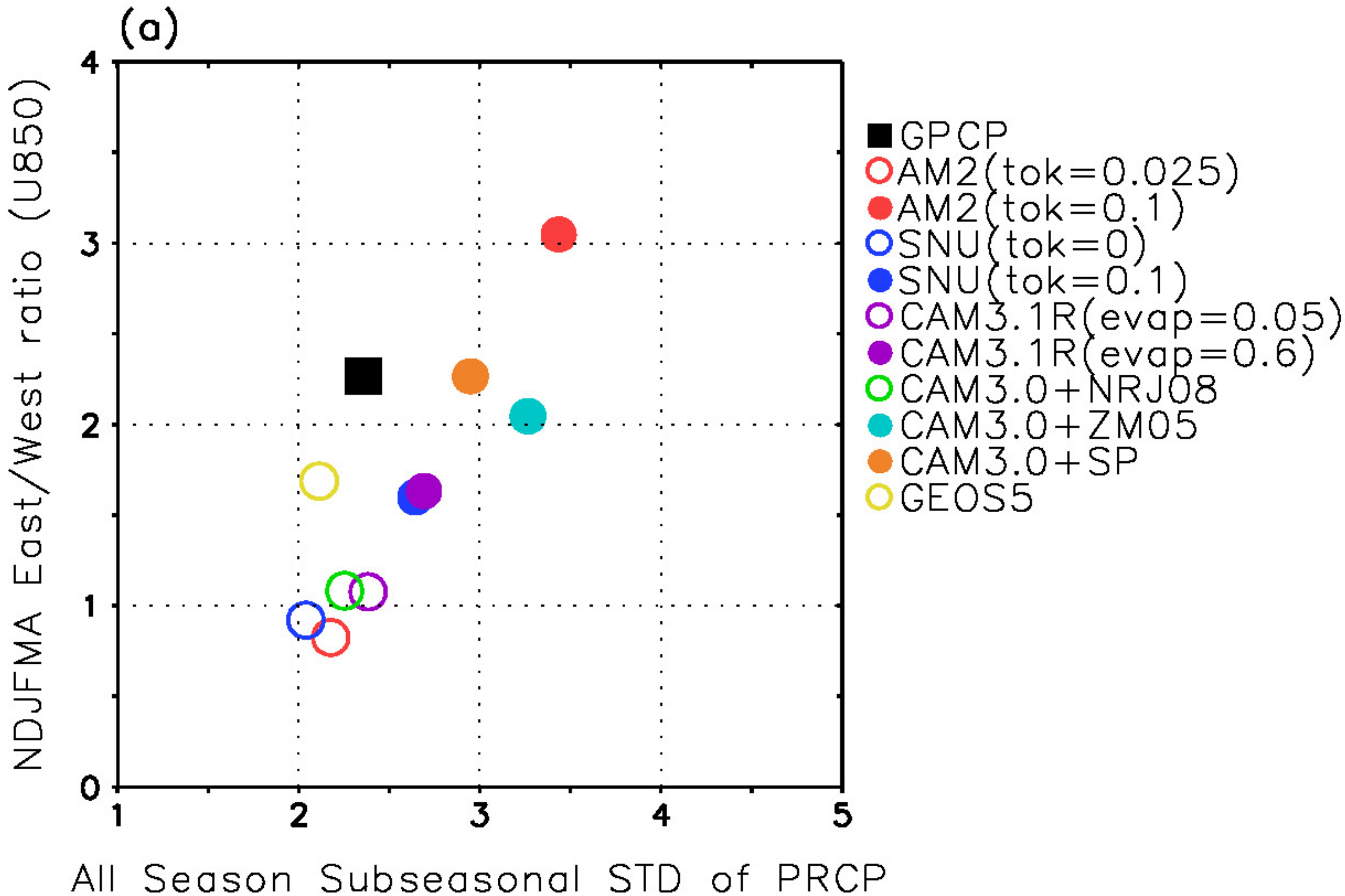
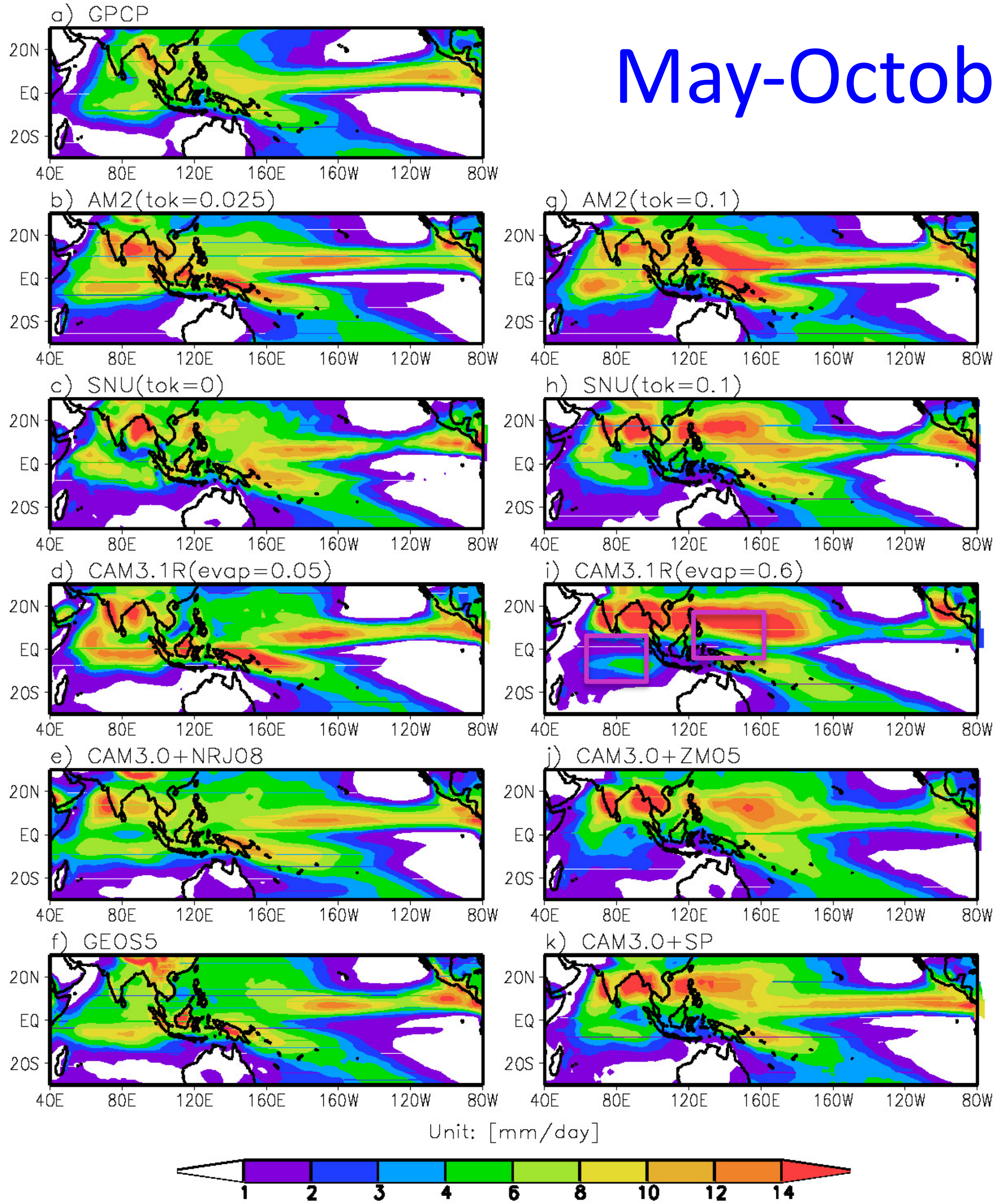


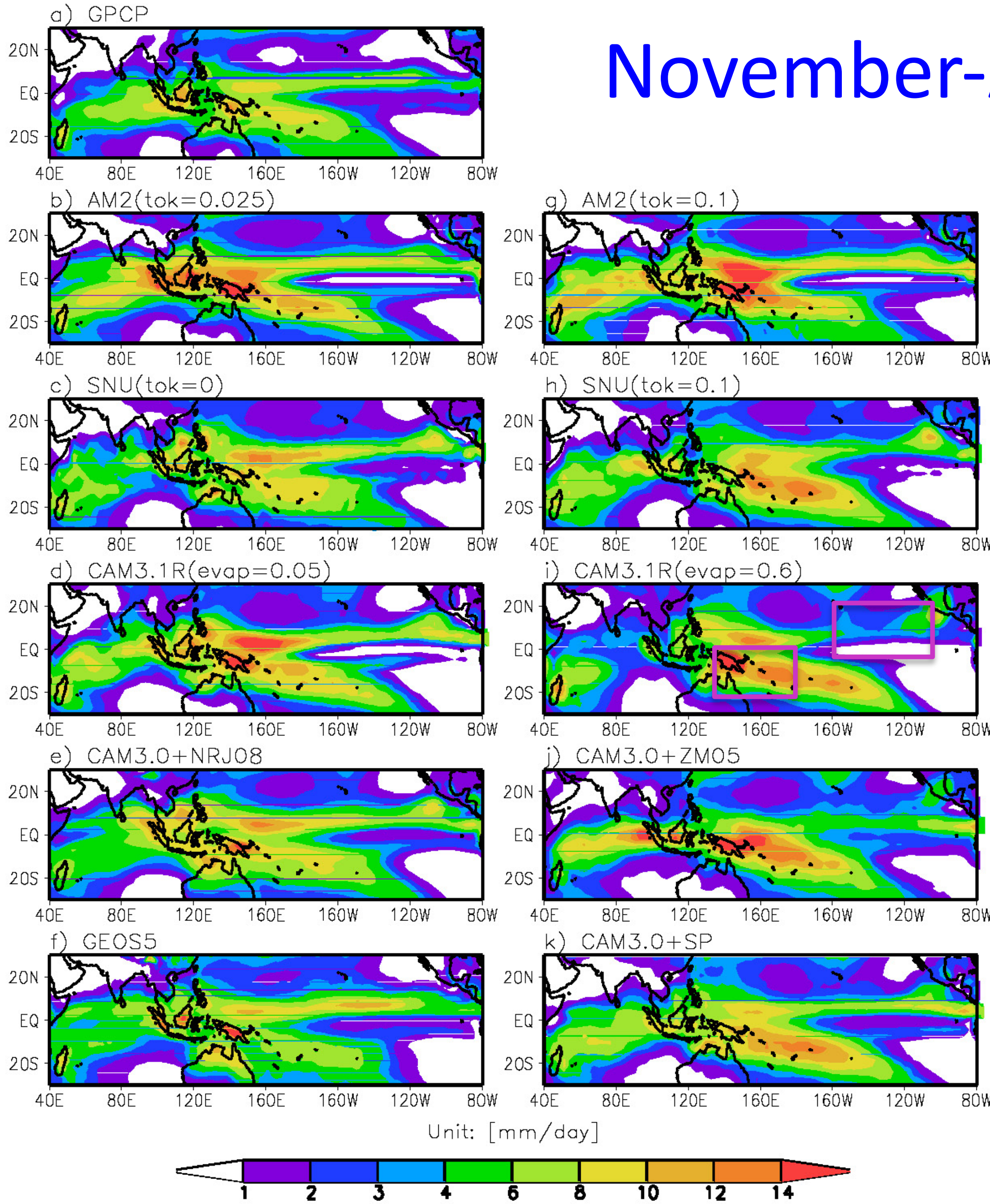
Figure 3. Scatter plot of standard deviation averaged over 0-360°E, 30°S-30°N and east/west ratio, defined as ratio of eastward propagating spectral power (summation over wavenumber 1-3, period 30-70 day) to that of westward propagating counterpart. Open (close) circle represents weak (strong) ISV model.

May-October Mean Precip.



- Model versions with high ISV on right, and low ISV on left.

November-April Mean Precip.



- Model versions with high ISV on right, and low ISV on left.

Mean State Biases Versus Variability

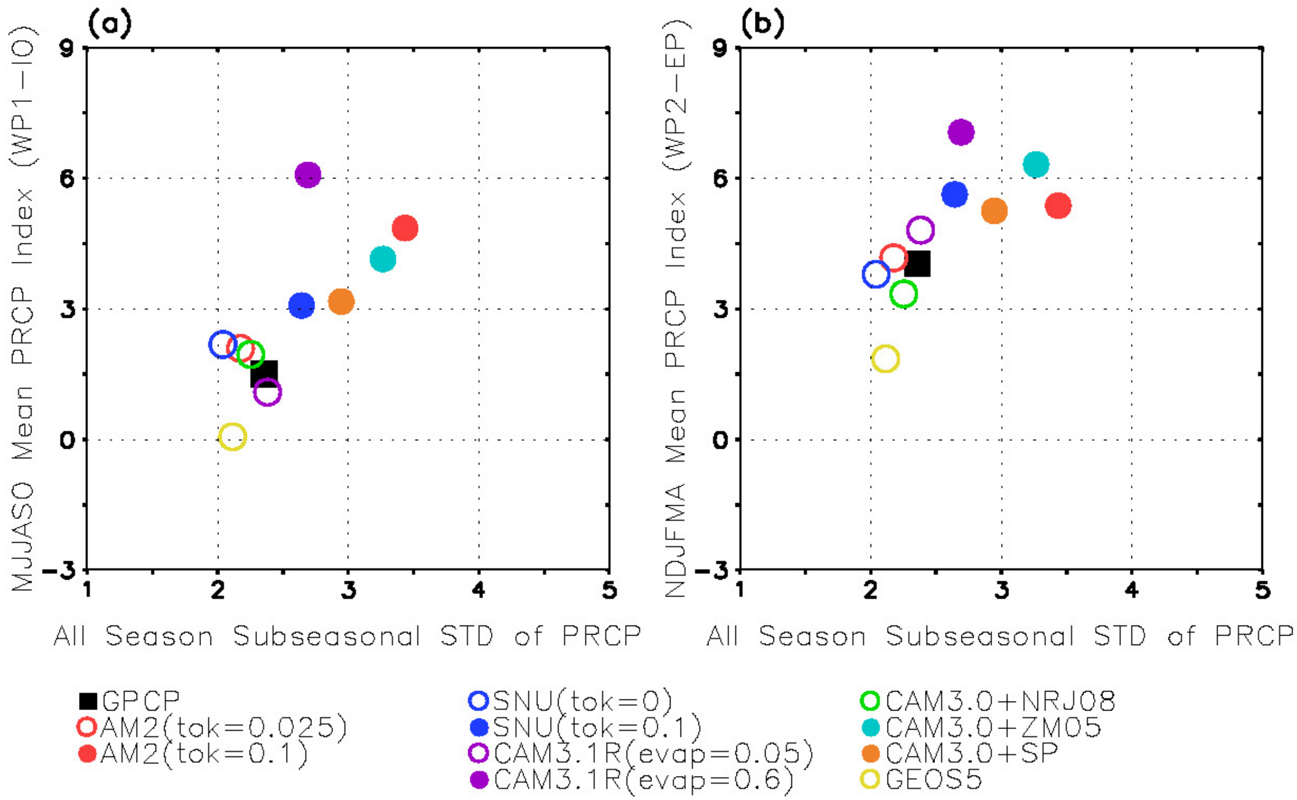


Figure 6. Scatter plots of standard deviation averaged over 0-360°E, 30°S-30°N and a) May-October mean precipitation index which is defined as averaged precipitation over WP1 (120-160°E, 5°S-20°N) minus IO (60-95°E, 15°S-5°N), and b) November-Apfil mean precipitation index defined as averaged precipitation over WP2 (140-180°E, 20°S-Eq.) minus EP (200-260°E, Eq.-10°N). Open (close) circle represents weak (strong) ISV model.

High Minus Low Variability Models

Mean Precipitation

Mean Evaporation

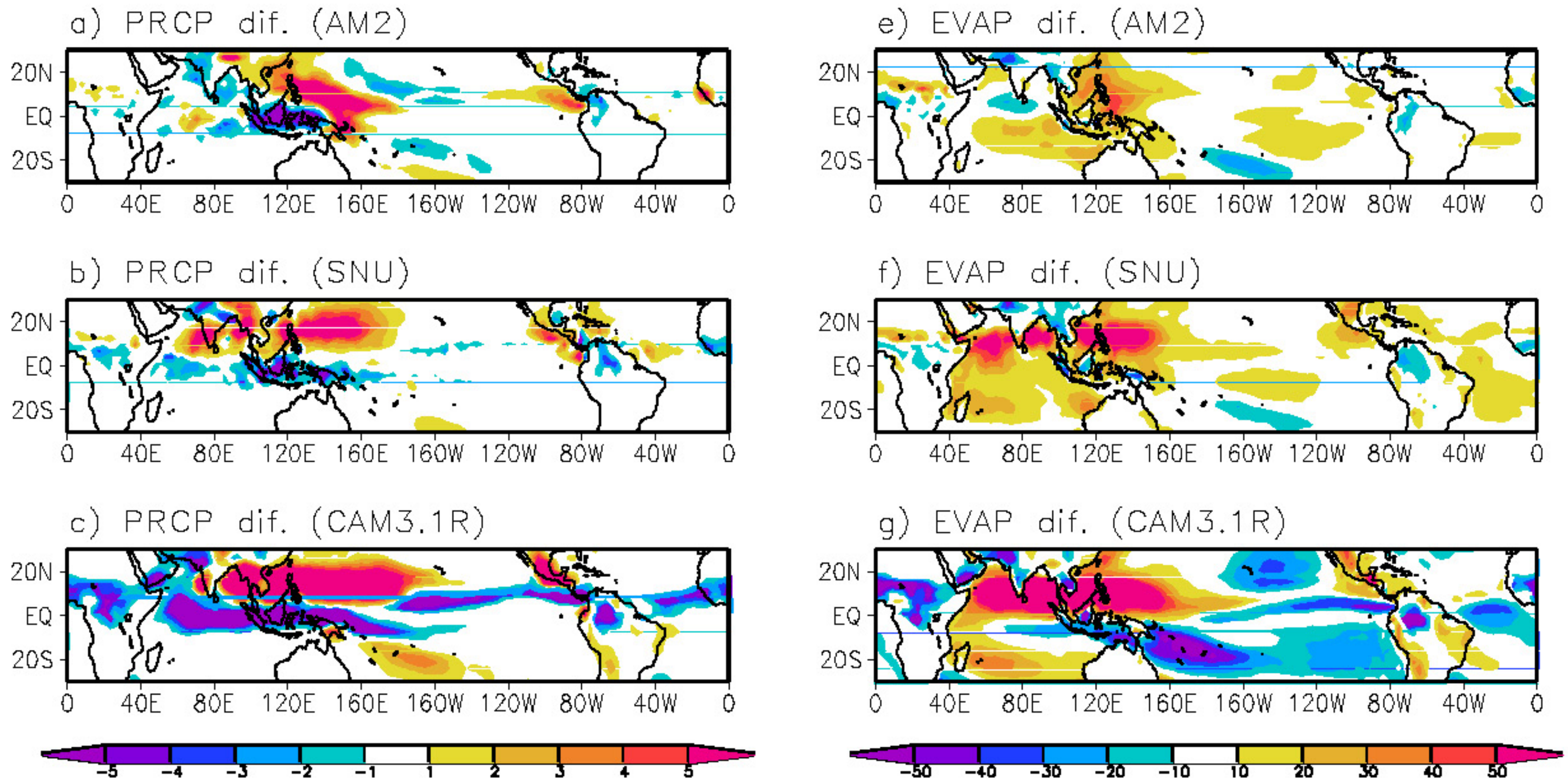


Figure 7. Difference map of May-October precipitation a) AM2, b) SNU, and c) CAM3.1R. Difference map of May-October evaporation e) AM2, f) SNU, and g) CAM3.1R.

High Minus Low Variability Models

Evaporation Standard Deviation

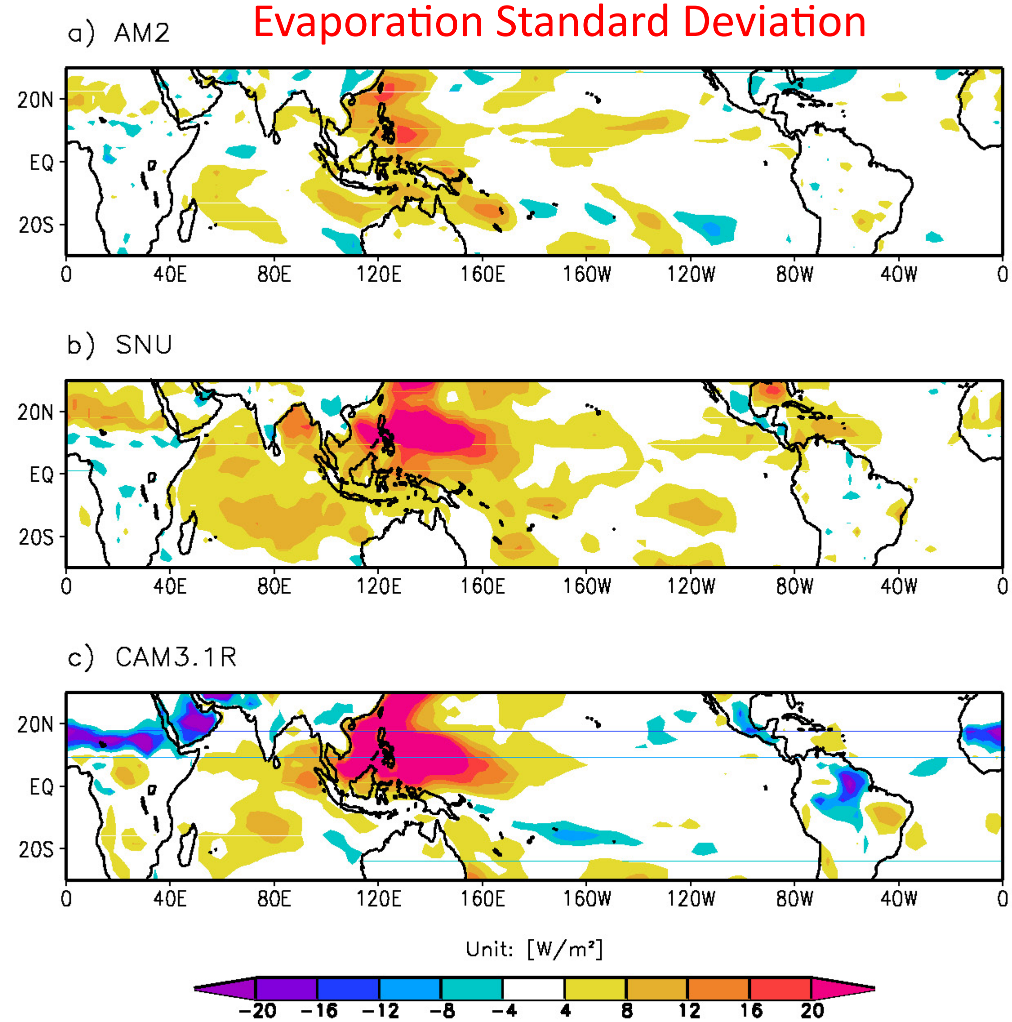
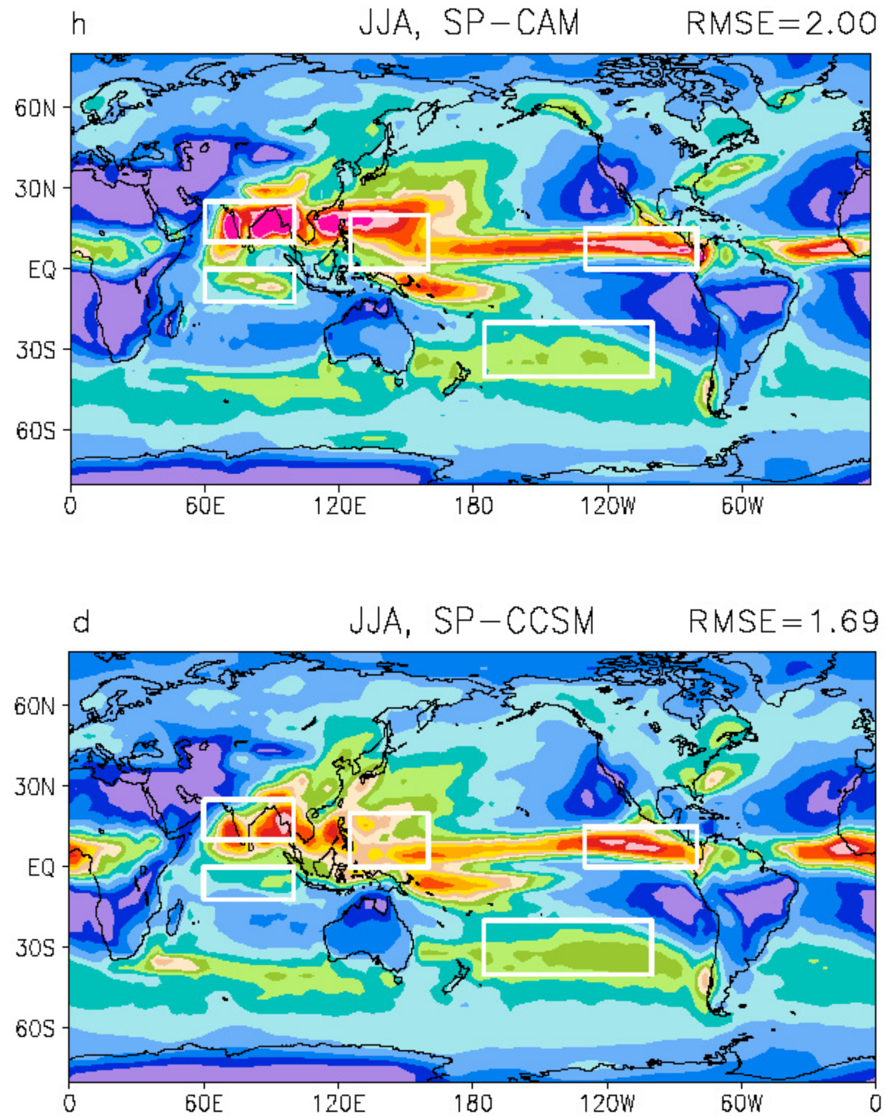


Figure 8. Difference map of May-October standard deviation of 20-100 day filtered evaporation a) AM2, b) SNU, and c) CAM3.1R

Coupling May Improve These Mean State Biases



Stan et al. 2010

High Minus Low Variability Models

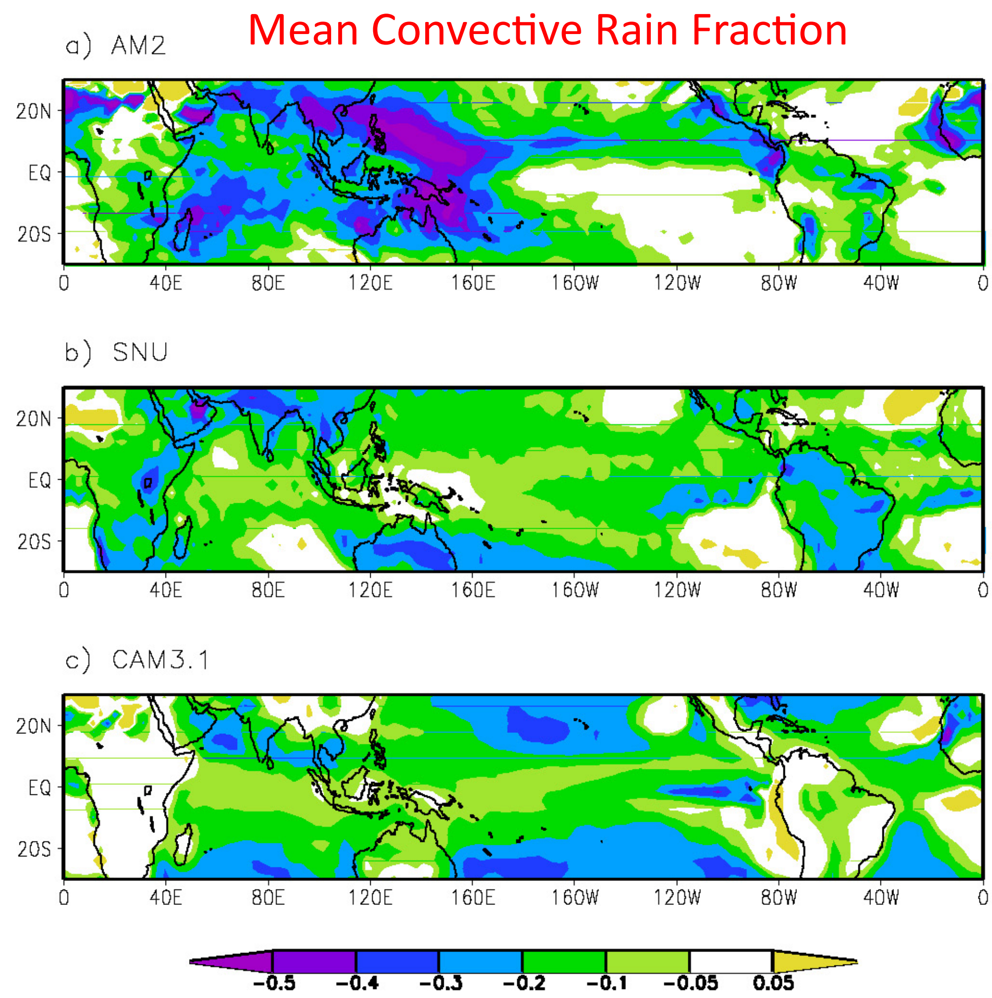
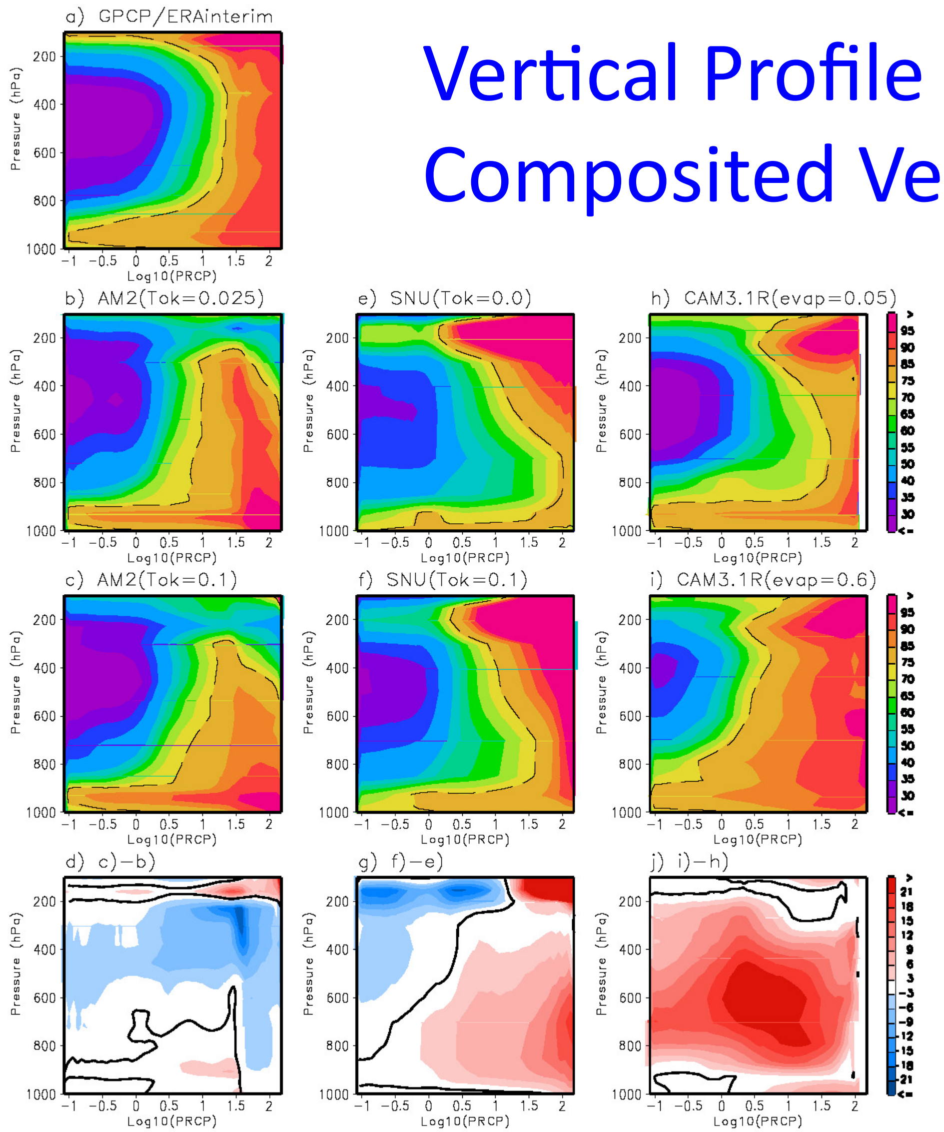


Figure 9. Difference map of annual mean convective rain fraction a) AM2, b) SNU, and c) CAM3.1R

Vertical Profile of Relative Humidity Composited Versus Precipitation



Weak ISV Models

Strong ISV Models

Figure 11. Composite vertical profile of relative humidity based on precipitation rate a) GPCP/ERAinterim, b) AM2 (Tok=0.025), c) AM2 (Tok=0.1), e) SNU (Tok=0.0), f) SNU (Tok=0.1), h) CAM3.1R (evap=0.05), and i) CAM3.1R (evap=0.6). Difference between strong- and weak-ISV models are shown in d) AM2, g) SNU, and j) CAM3.1R. The precipitation rate is plotted on a log scale with the relative humidity averaged for each bin shown on the x-axis. The data is analyzed over 40-180°E, 20°S.-20°N.

Precipitation Composited versus Saturation Fraction

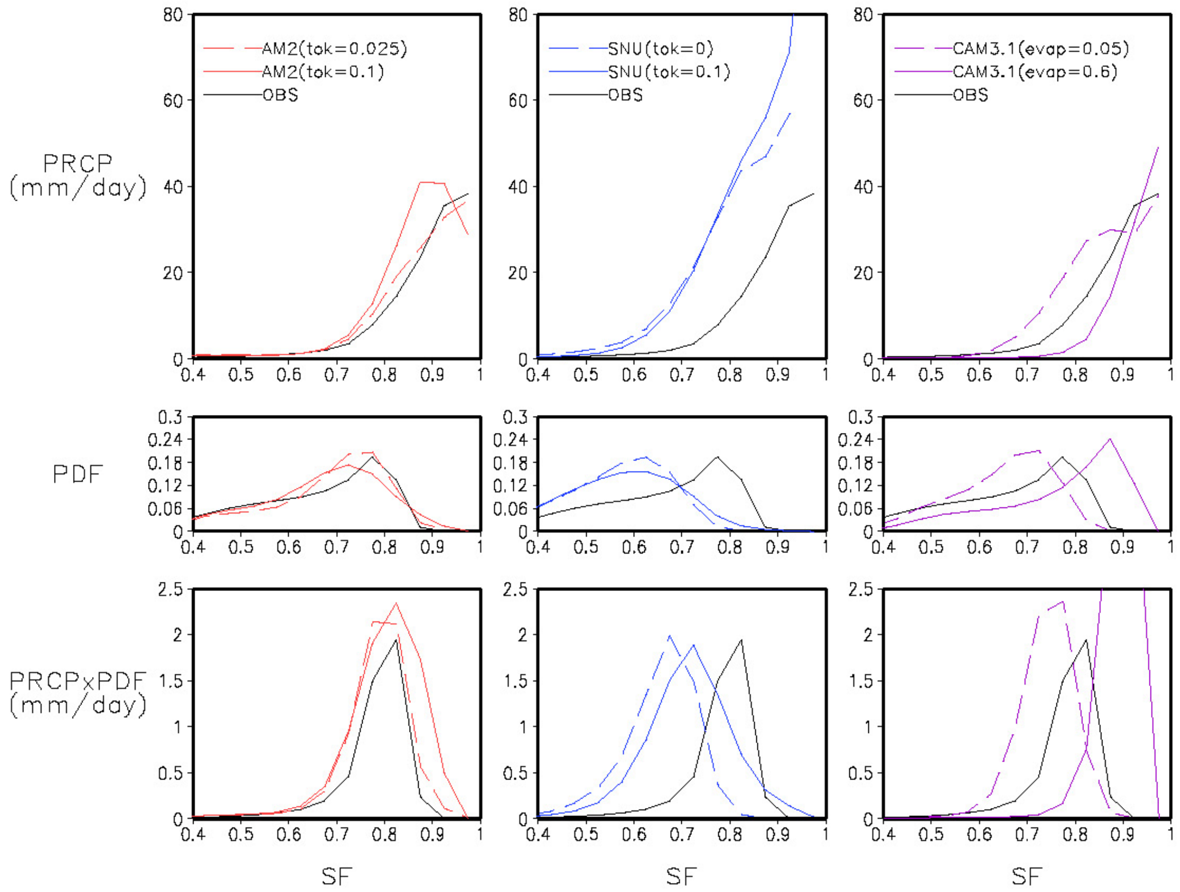


Figure 12. Upper: precipitation composite based on saturation fraction. Middle: probability density function (PDF) of saturation fraction, Lower: PDF weighted precipitation. Points over the west Pacific (130-180E, Eq.-20N) are used in calculations.

Summary

- Systematic mean biases exist in *atmospheric* general circulation models that produce strong intraseasonal variability
- An analysis of evaporative fluxes suggests that excessive wind-evaporation feedbacks may contribute to these biases
- More work is necessary to understand (via suitable process-oriented diagnostics) to assess why some models produce reasonable intraseasonal variability, and why some do not.
- Need for coupled runs (e.g. Stan et al. 2010) to assess whether similar biases for these same models hold with ocean coupling.

Extra Slides

Tropospheric Temperature versus Variability

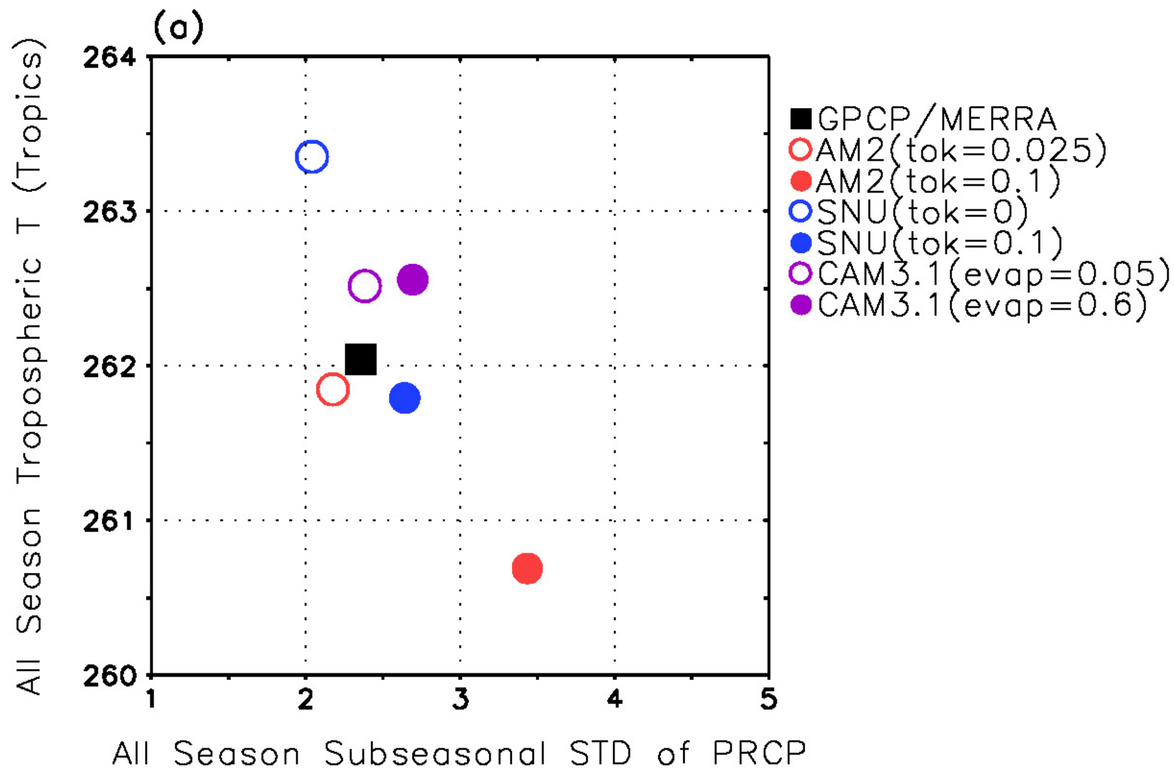


Figure 10. Scatter plots of standard deviation averaged over 0-360^{o}E, 30^{o}S-30^{o}N and mean tropospheric temperature averaged over 0-360^{o}E, 30^{o}S-30^{o}N. Open (close) circle represents weak (strong) ISV model.