
On the Correspondence between Short- and Long- Timescale Systematic Errors

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Methodology

- ***Climate models run in NWP mode for select periods of YOTC (the Year of Tropical Convection - May 2008-April 2010)***
 - ***The U.S. DOE Cloud-Associated Parameterization Testbed (CAPT) Project at LLNL***
 - ***The Transpose – AMIP Project***
- ***The goal is to better understand and yield significant insights into the cause of errors in climate models***

Examined Models

		AGCM		
CMIP5 Model		Resolutions		
	Name	Modeling Group(s)	(LonxLat, Lev)	Contact
CAPT	CAM4*	NCAR	0.9 x 1.25 (deg), L26	James Boyle
	CAM5*	NCAR	0.9 x 1.25 (deg), L30	James Boyle
Transpose-AMIP	HadGEM2-A	Met Office Hadley Centre	192x145, L38	Keith Williams
	CNRM-CM5	CNRM/ Centre Europeen de Recherche et Formation Avancees en Calcul Scientifique	256x128, L31	Michel Deque
	MIROC5	Atmosphere and Ocean Research Institute -The University of Tokyo	256x128, L40	Masahiro Watanabe

CAPT vs. Transpose-AMIP

They are essentially the same, but

Under CAPT, we run CAM4/5:

- A series of 6-day hindcasts initialized every day with the ECMWF analysis for the entire YOTC period (May 2008 – April 2010)
- a free AMIP type of run for 2008 – 2010 (weekly SST)

Under transpose AMIP, HadGEM2-A, CNRM, and MIROC5 are run:

- 4 sets of 16 5-day hindcasts initialized with the ECMWF analysis for select periods (Oct. 2008, Jan. 2009, Apr. 2009, and Jul. 2009)
- CMIP5-AMIP runs

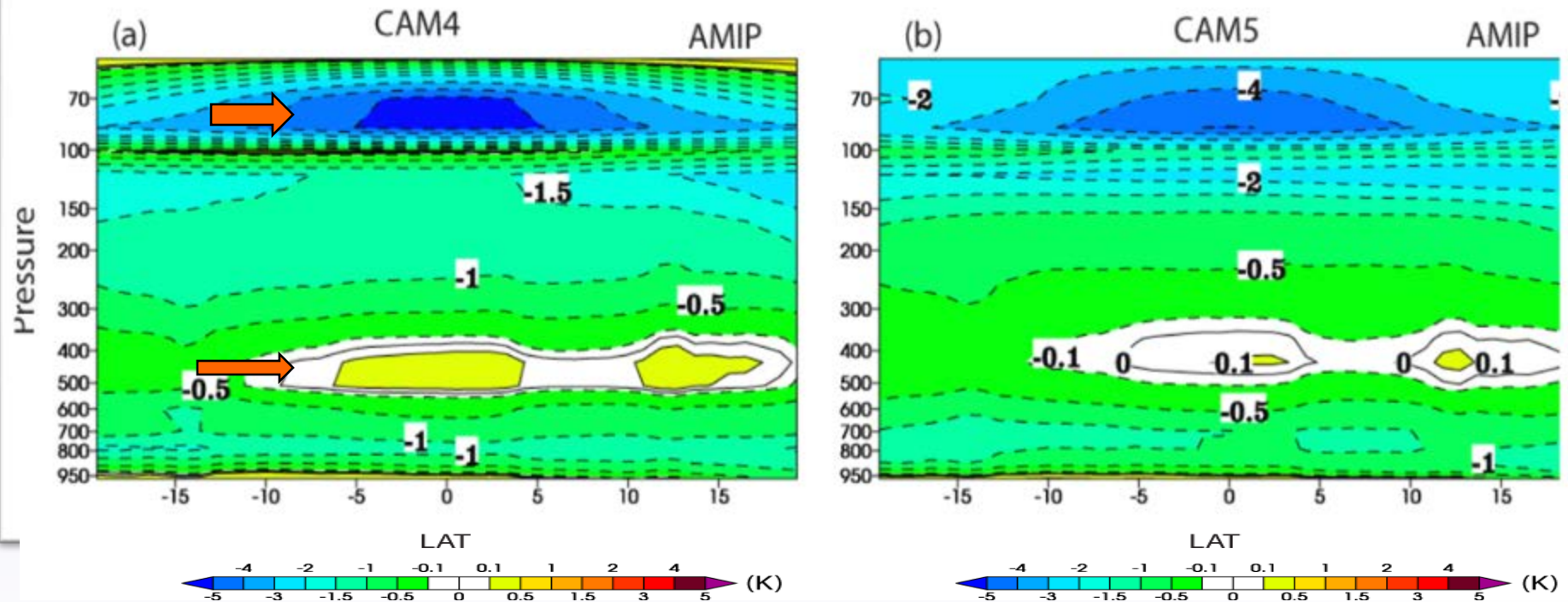
CAM4/5 have more samplings for analysis than other transpose-AMIP models

What are covered by this talk?

- ***What have been learned from CAM4/CAM5***
 - *Focus on those well-known climate biases*
- ***Initial analysis of other Transpose-AMIP models***
 - *Tropical precipitation errors*
- ***Summary and Future plan***

Tropical Temperature Error – ANN 2009

Model - ECMWF



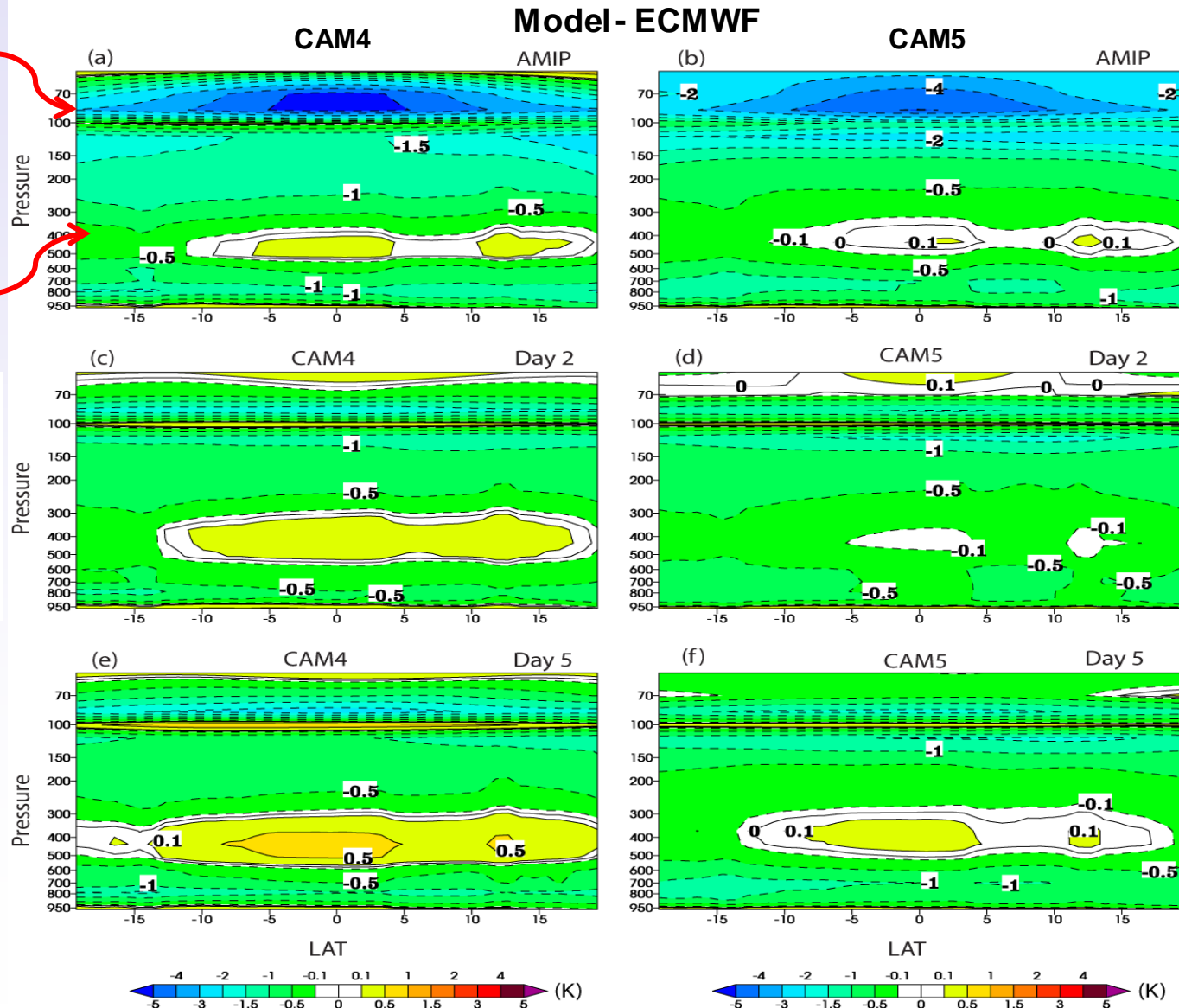
- Tropical tropopause and lower stratosphere: Large **cold bias**
- Troposphere: generally cold bias except for the middle troposphere where **warm bias** is seen.

T Errors: AMIP vs. Hindcasts

Slow processes?

fast processes?

Pressure (hPa)



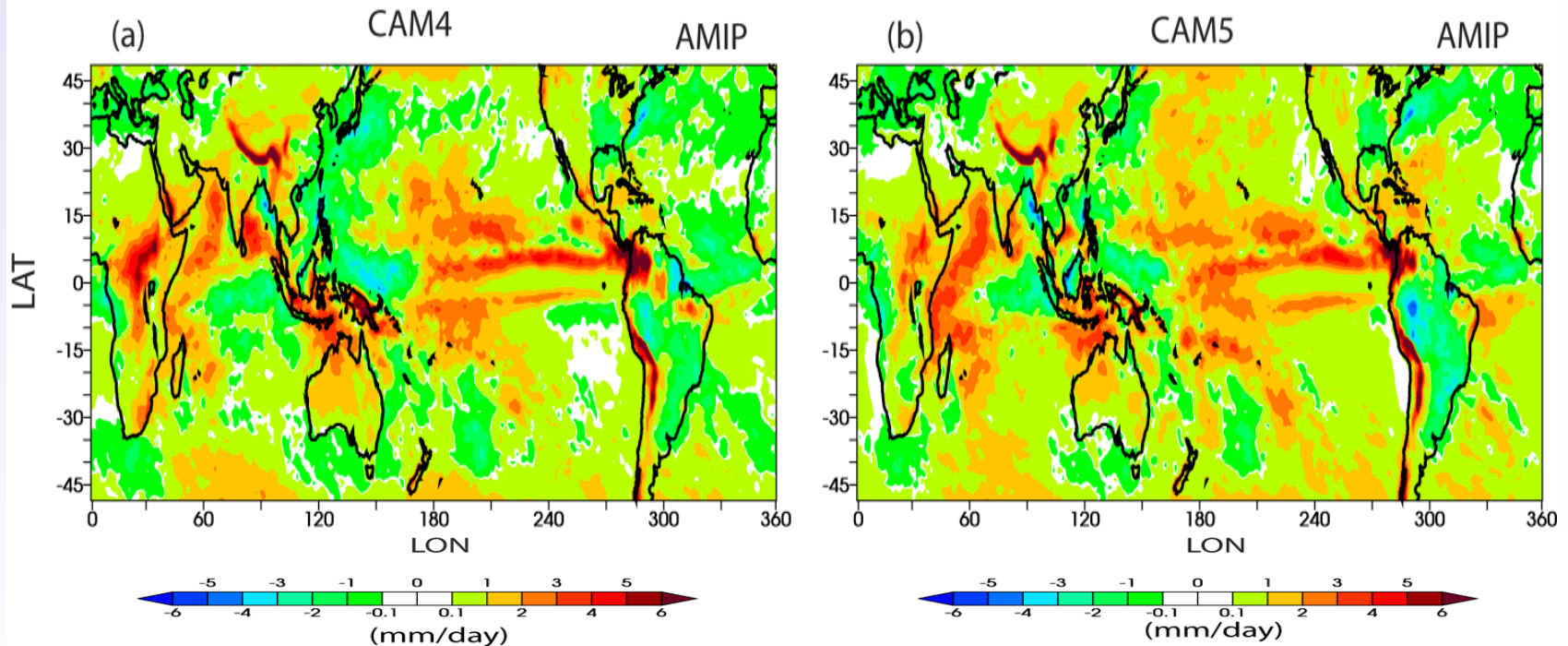
AMIP

Day 2

Day 5

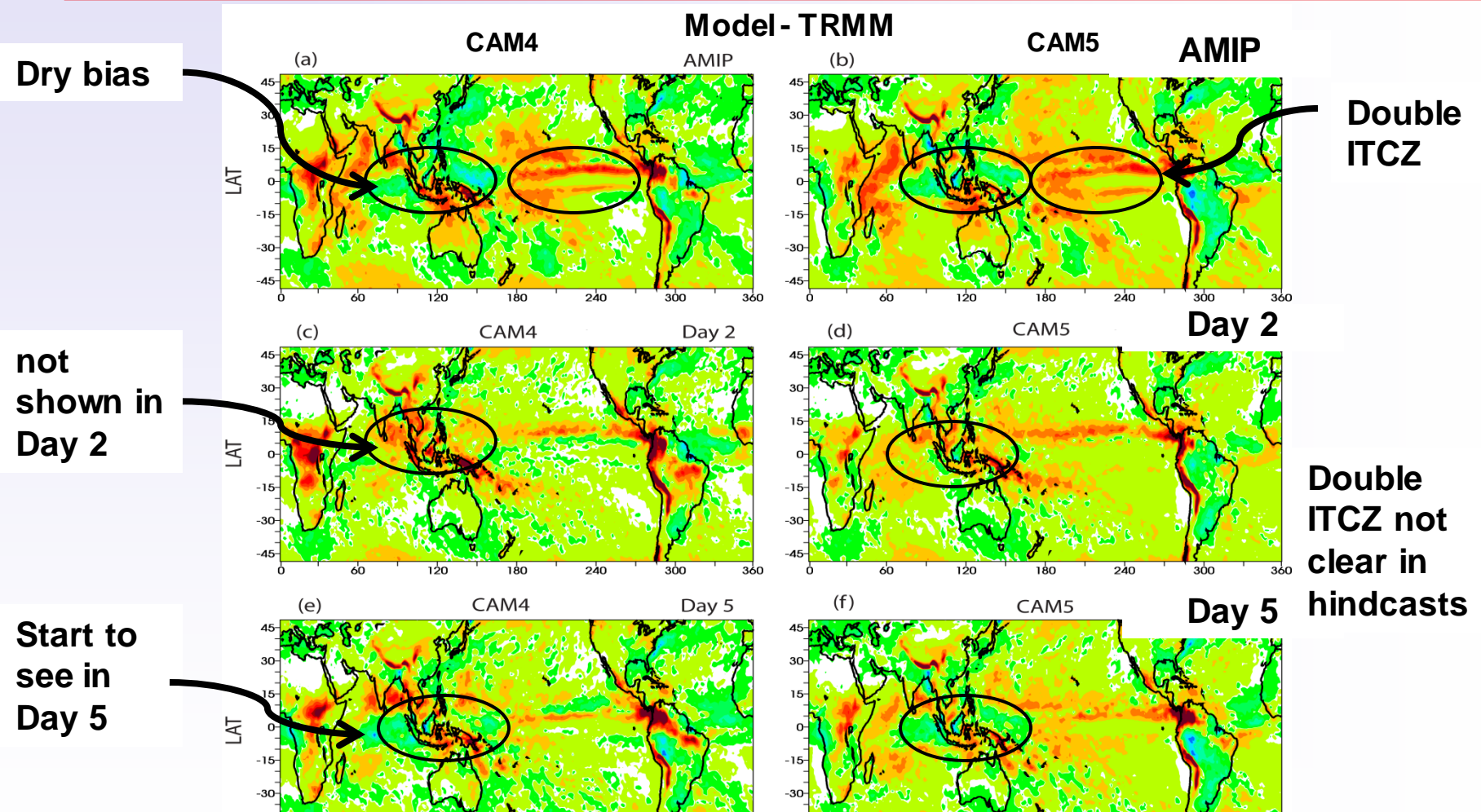
Tropical Pr errors – Strong regional features

Model - TRMM



- CAM4 vs. CAM5: remarkably similar, deep convection?
- Excessive Precip: e.g., much of the tropics, including tropical Africa, the oceans next to the Indian Peninsula, the central and eastern Pacific
- Less Precip: e.g., Maritime and the central south America
- Double ITCZ error

Tropical Pr Errors – AMIP vs. Hindcasts

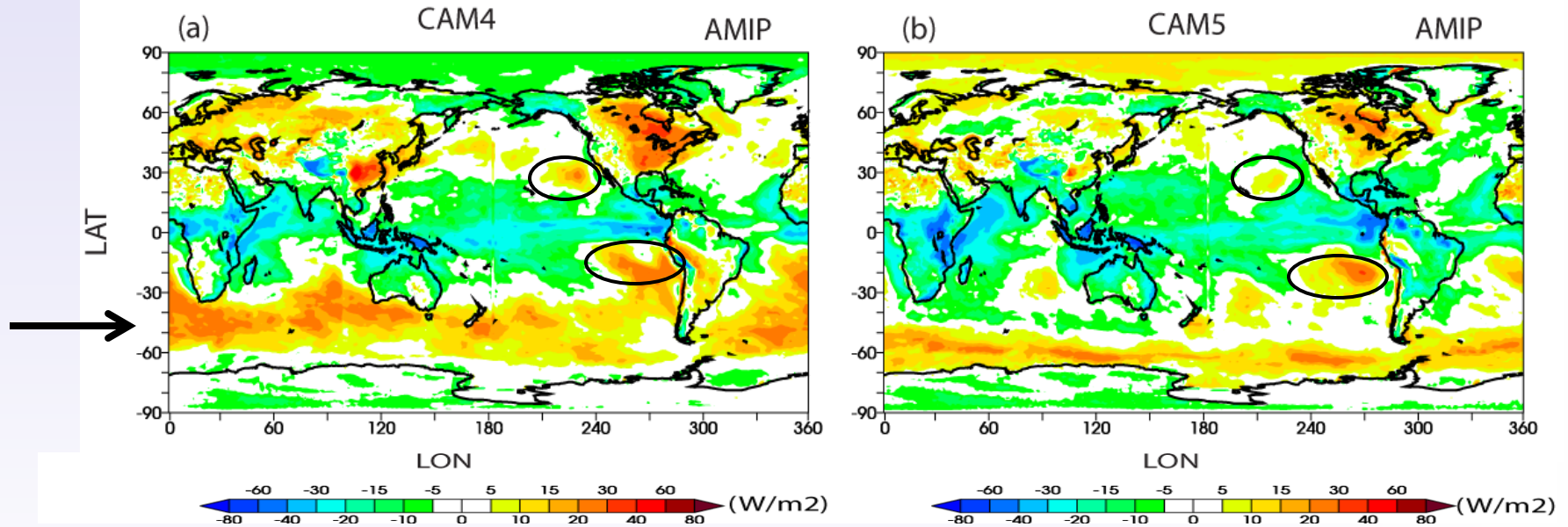


Similarity: parameterization problem

Difference: poor interaction between physics and dynamics that takes longer time to impact model precipitation

Errors in TOA SW Absorption

Model - CERES

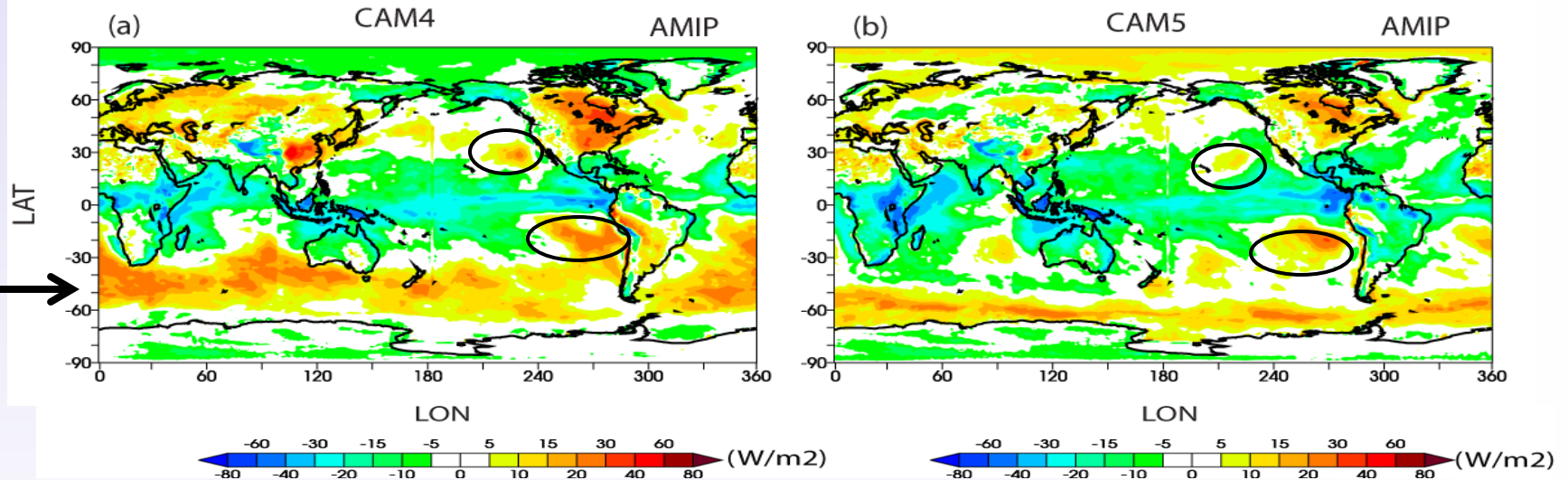


Typical errors:

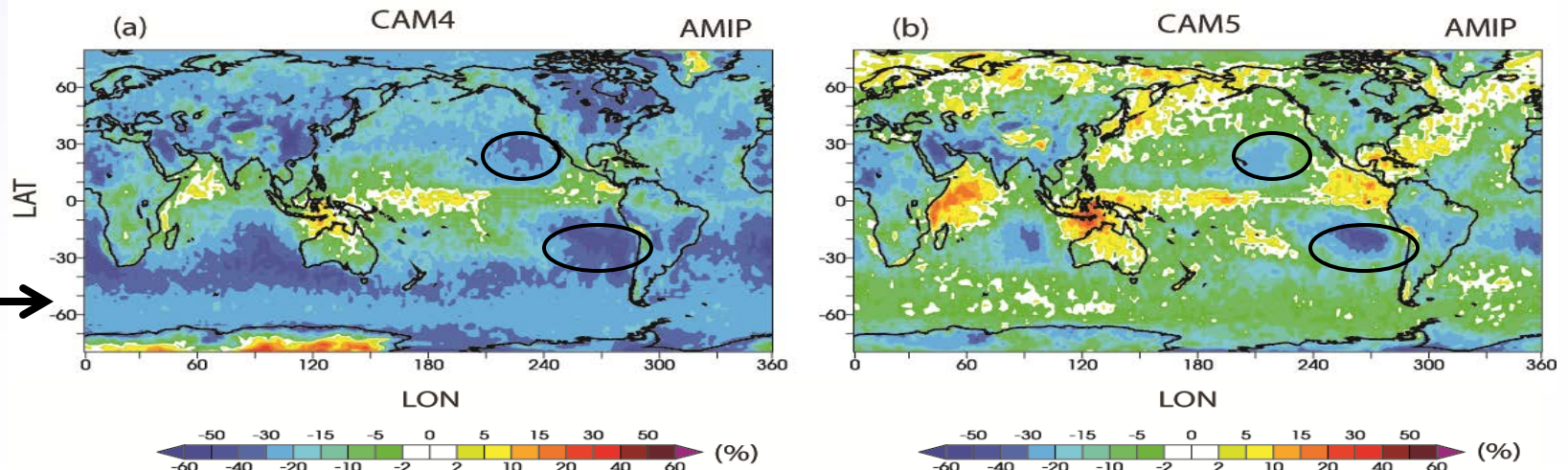
- Underestimation in the tropics
- overestimation in the subtropical stratocumulus regions
- Overestimation in the Southern Ocean near 60S

Errors in SW Absorption are closely related to errors in clouds

Model - CERES

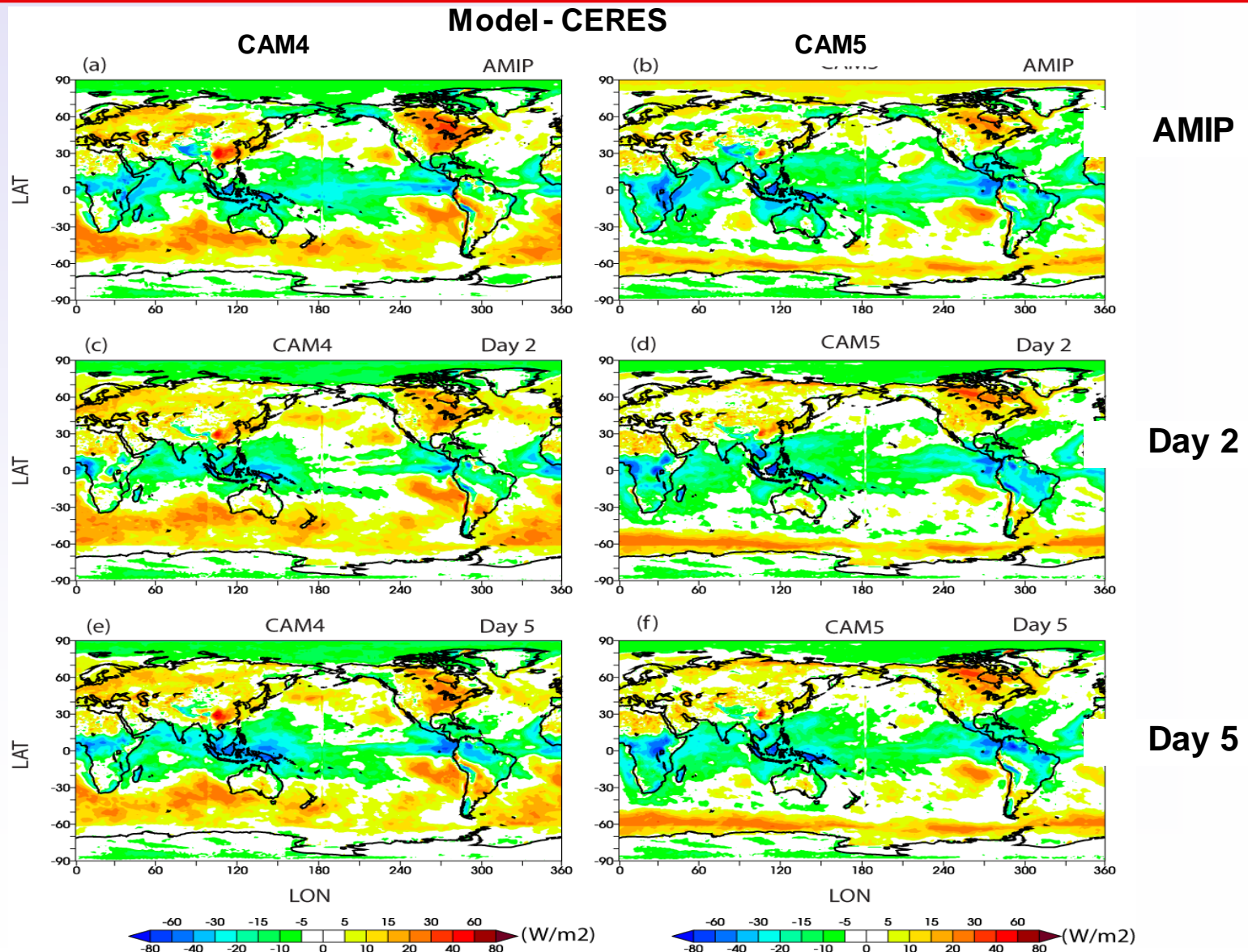


Model - CALIPSO

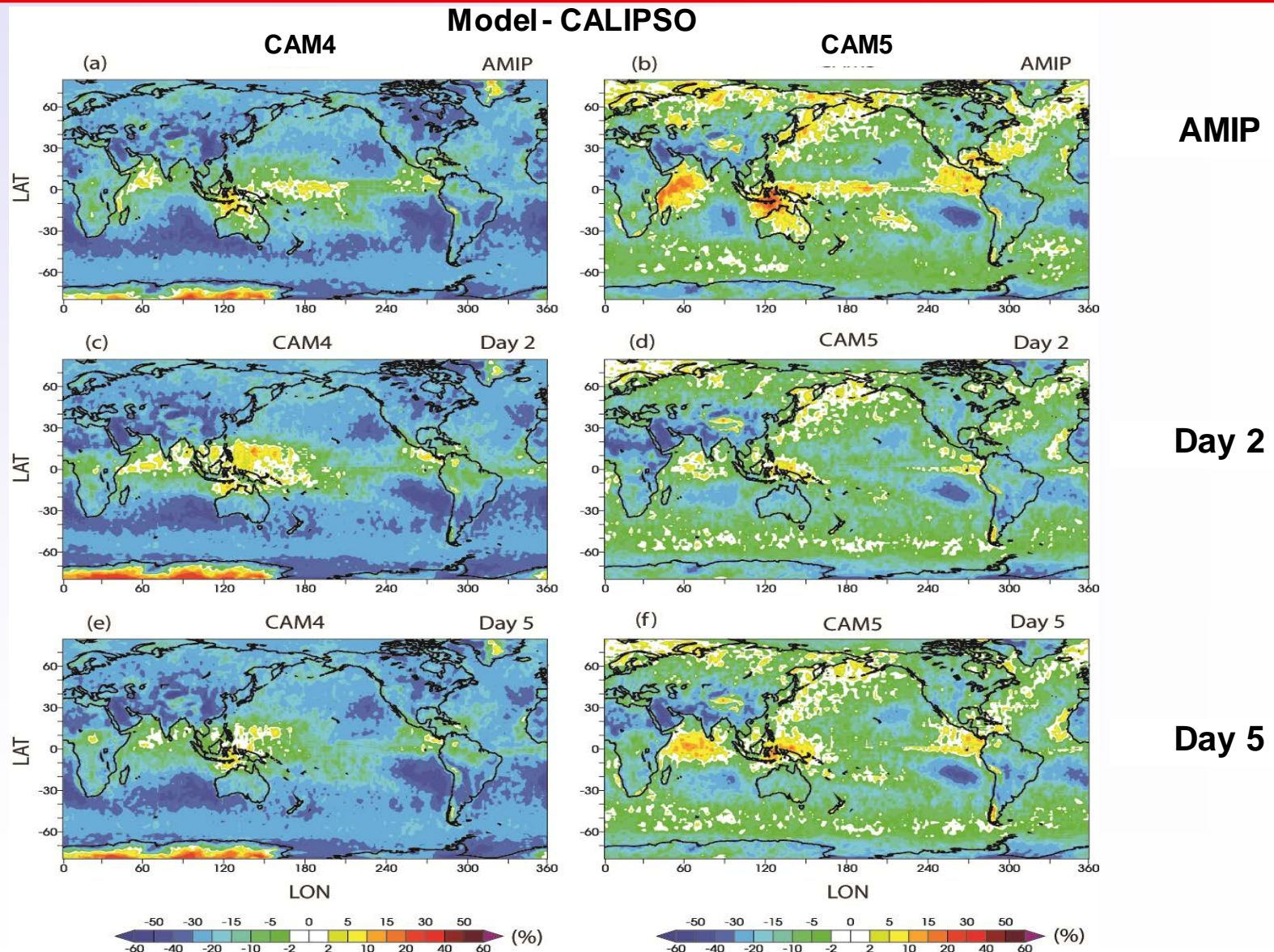


*Are these errors in clouds and SWAbs
due to errors in model dynamics or
physics?*

Errors in SW Absorption – Remarkably similar between AMIP and Hindcasts



Similar errors in total clouds between AMIP and Hindcasts

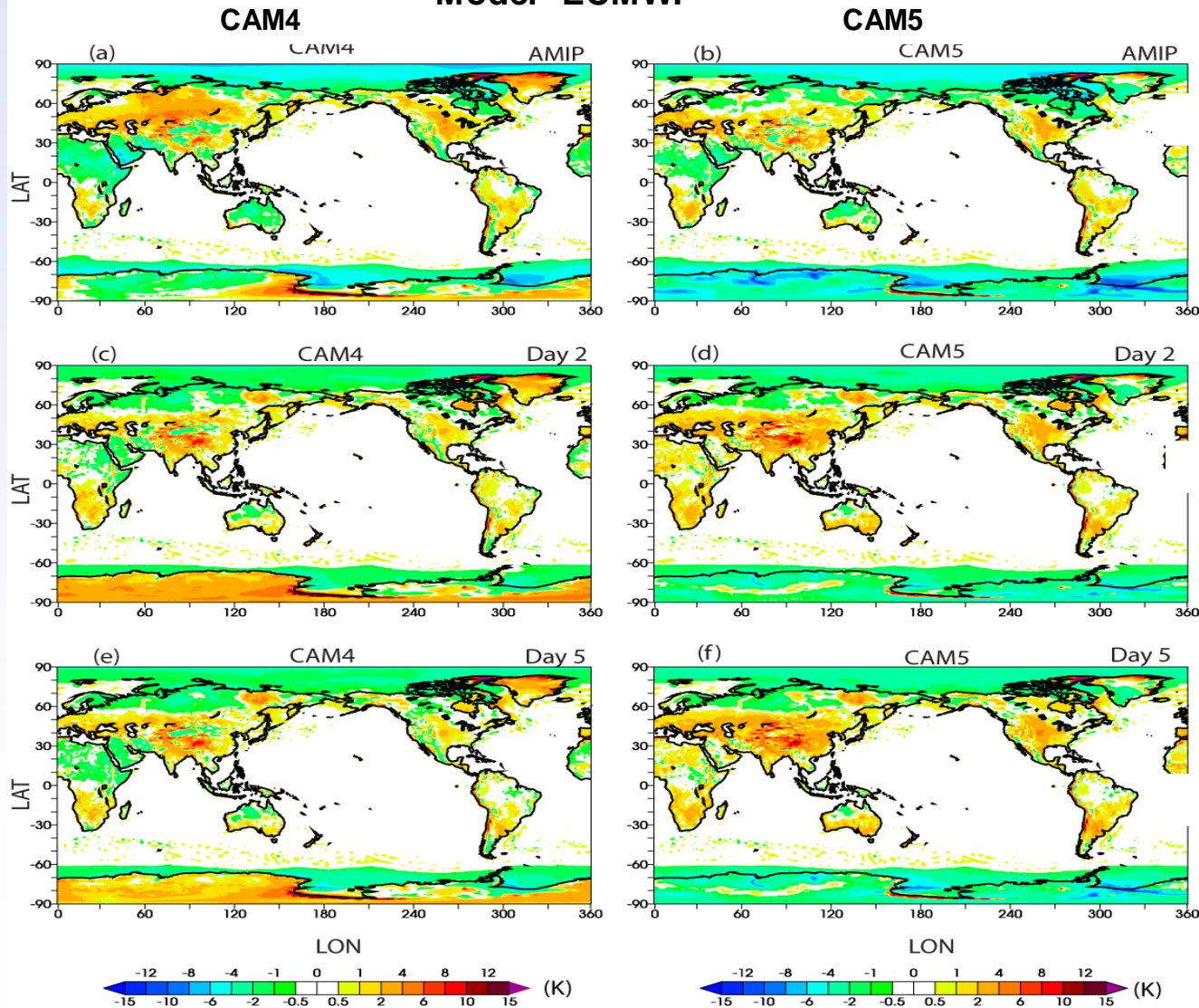


Q: Are these errors in SWAbs and clouds due to errors in model dynamics or physics?

A: Given the almost identical errors in AMIP and hindcasts, we believe that they are most likely due to deficiencies in model physics!

Surface Temp Errors

Model - ECMWF

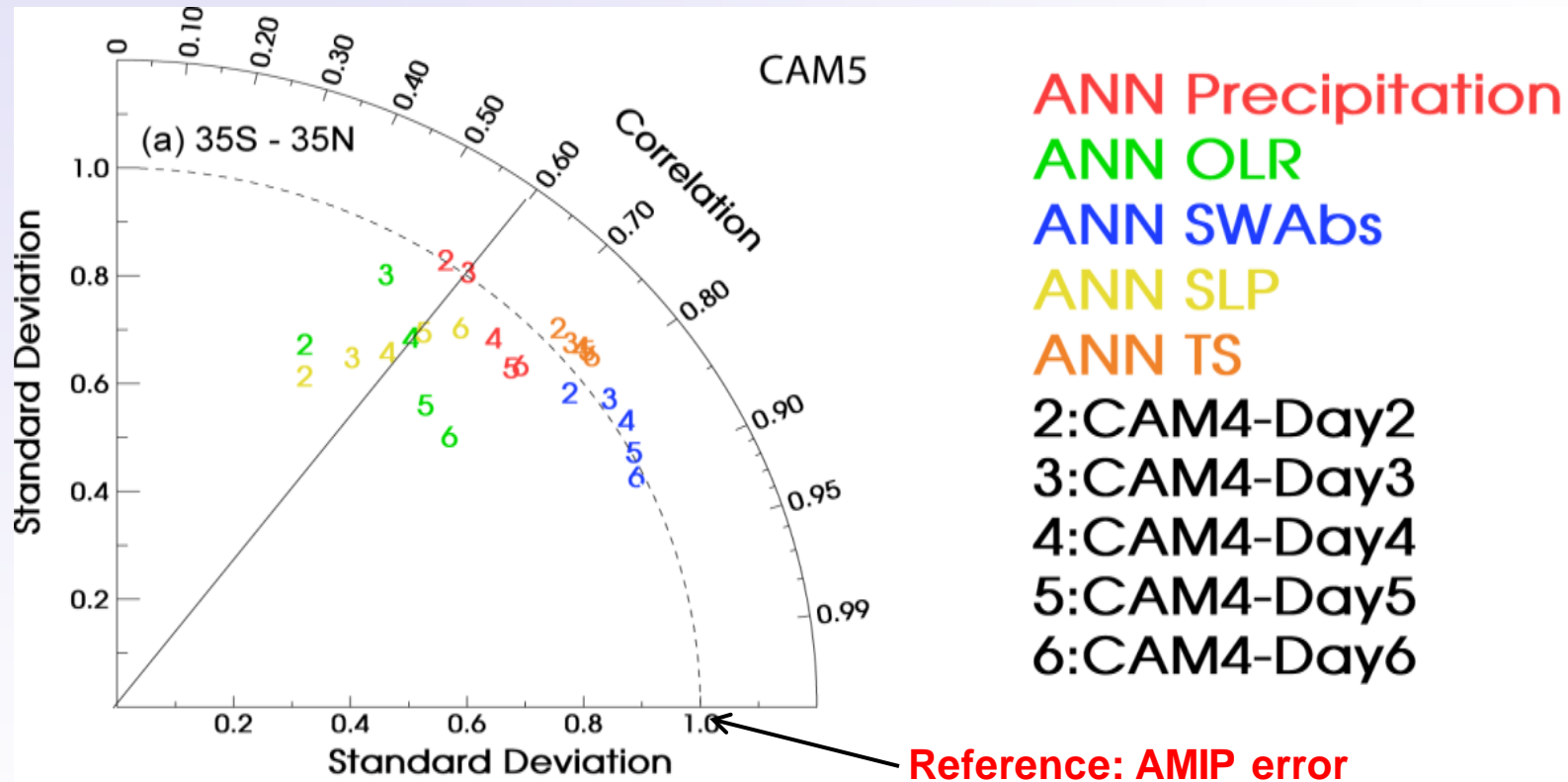


AMIP

Day 2

Day 5

Taylor diagram to demonstrate the temporal evolution of model systematic errors



- Coefficient typically larger than 0.6
- The hindcast errors gradually evolve with time toward the AMIP error

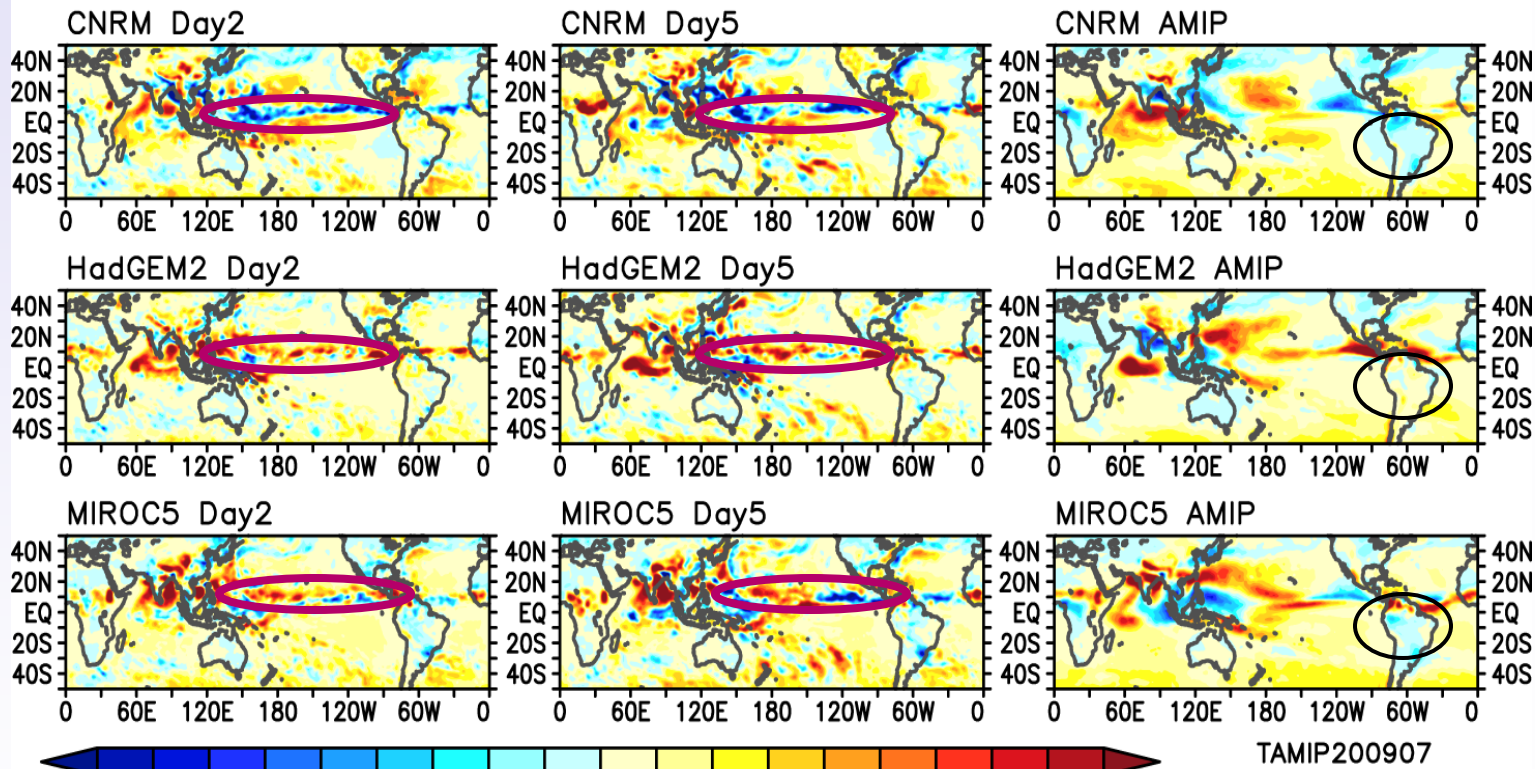
A paper submitted to J. Climate

*CAM4/5 results have been summarized in
Xie et al. 2012 (J. Climate, Accepted)*

**What about other climate models – results from
other Transpose-AMIP models**

Tropical Pr. in T-AMIP models

Precipitation Error - Summer (July)



- Major model errors are similar, but the correspondence is weaker than what we saw in CAM4/5, sampling issue?
- HadGEM2-A shows quite different errors from the other two T-AMIP models and CAM4/5
- The inter-model difference provides another chance to understand these errors

Summary and Future Work

- **Systematic errors associated with moist process often develop fast and apparent in a few days forecasts with amplitudes comparable to the climate errors (e.g., excessive tropical precipitation, TOA SWAbs in the stratocumulus cloud decks and the Southern Ocean near 60S) → likely due to parameterization errors**
- **Other climate errors are present in the hindcasts, but with amplitudes significantly smaller than climate errors (double ITCZ, cold bias in tropical tropopause) → likely due to poor interactions between physics and dynamics or slow processes**
- ***Other Transpose – AMIP models generally show similar feature, but with a lower correlation coefficient, Is this a sampling issue?***
- ***More in-depth analysis of T-AMIP runs***
 - ***Errors varies with different models, which use different parameterizations for clouds and convection → another chance to understand model errors?***
 - ***Sensitivity tests***
 - ***Metrics and diagnostics***

The End

