

# A climatological look at precipitation in NWP systems

Thanks to Daniel Klocke, Nils Wedi, François Bouyssel  
Irina Sandu, Brian Medeiros, Rich Neale

# Outline

- Motivation
- Testing the waters
- Results
- Where from here?

Motivation: *Julia Slingo (October 2017)* “NWP precip may be as good as observations”

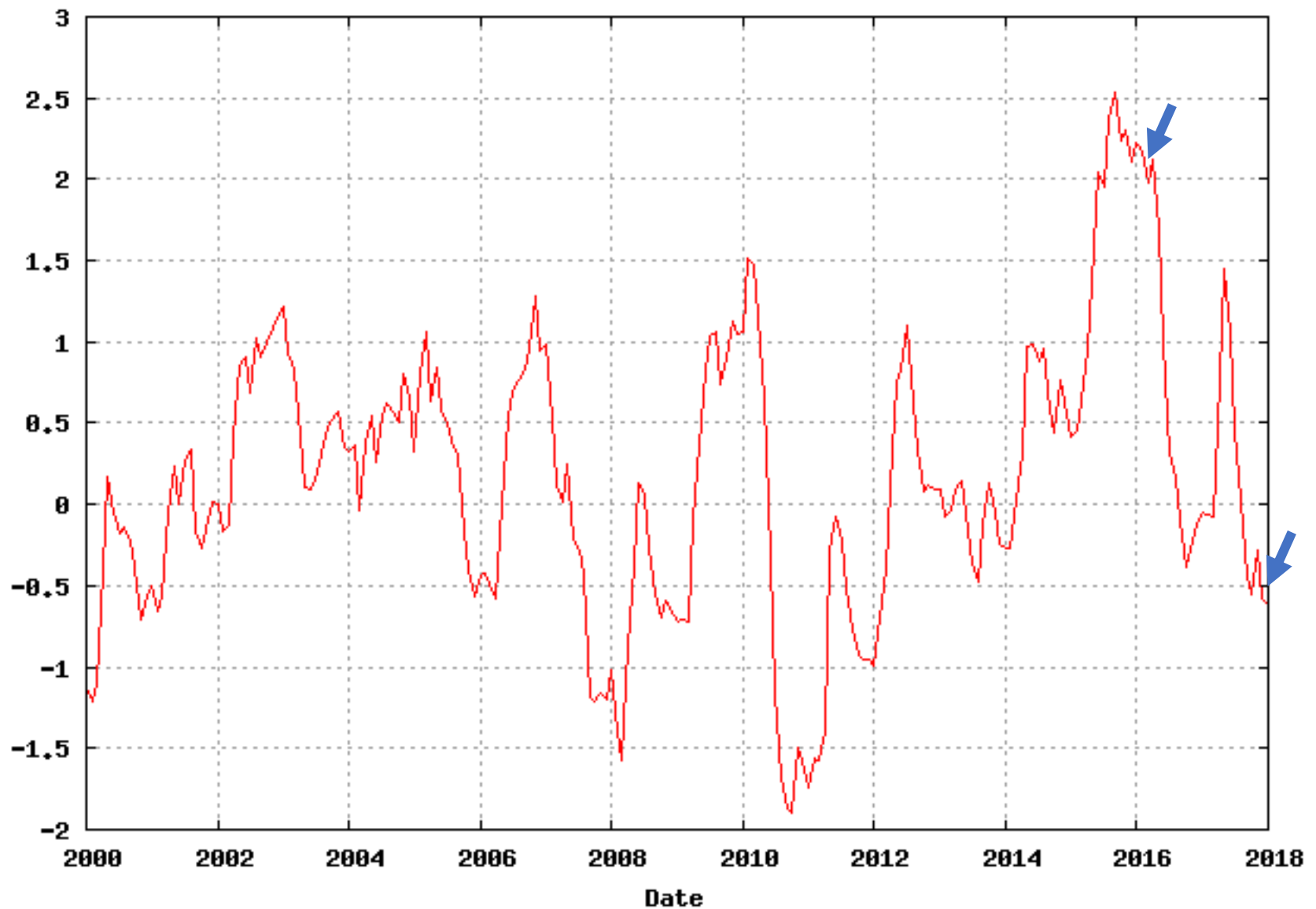
- Let’s look at NWP precip with a “climate lens”
  - Comparisons with TRMM
  - Andes biases
  - Are different NWP models similar
- Can we use NWP precip as “data”?

# Testing the waters

- Beginning with limited look at results from 3 centers: DWD, ECMWF, Meteo-France
- No real protocol yet
  - Approached individuals that seemed interested last October
  - Took what was relatively painless to provide
  - NH Winter is nice to look at Andes bias
- What I've gotten
  - DWD 1 year (2016) ... 2x daily (0Z, 12Z) 24 ... 120... Total
  - ECMWF 1 year (2016) 1x daily (0Z) 24 ... 120 Total, Conv, LS
  - Meteo-France Jan (**2018**) 1x daily (0Z) Conv, LS, solid, liquid

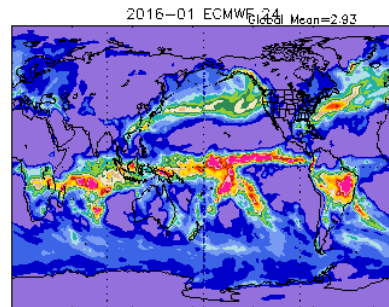
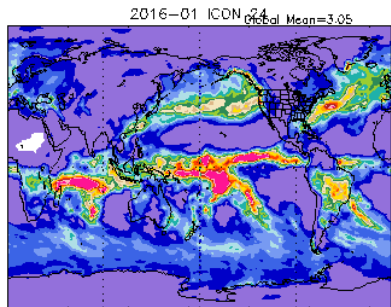
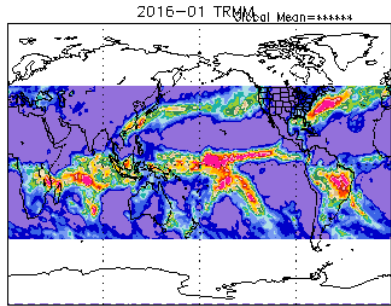
Multivariate ENSO Index (MEI): from NOAA/PSD  
Jan to Dec: 1950 to 2018

Jan 2016 has strong  
El Niño conditions

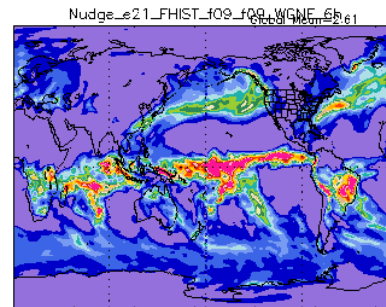


# January 2016

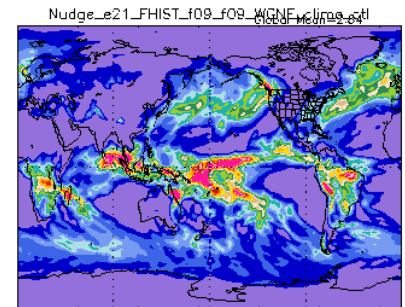
TRMM 3B42, Mean Forecast Precipitation for ICON, ECMWF (0-24 F-hour Accum) and monthly means for CAM6



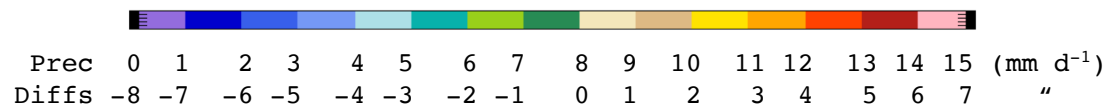
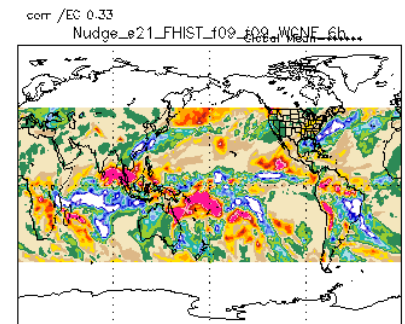
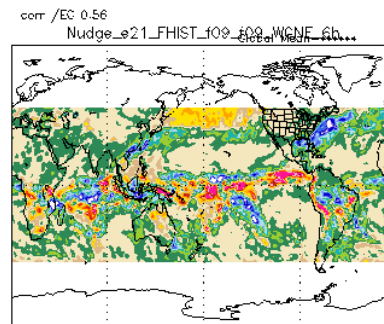
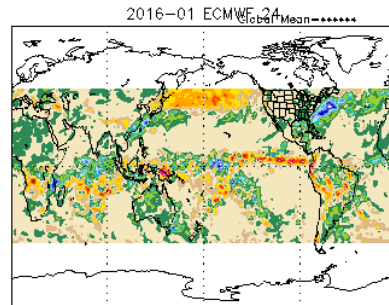
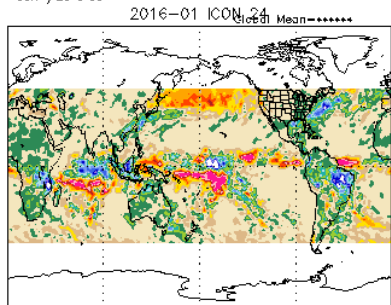
## Nudged CAM6



## Free-running CAM6

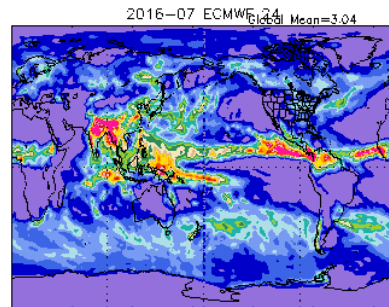
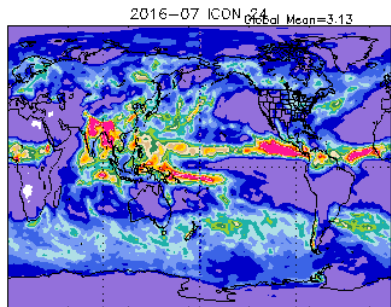
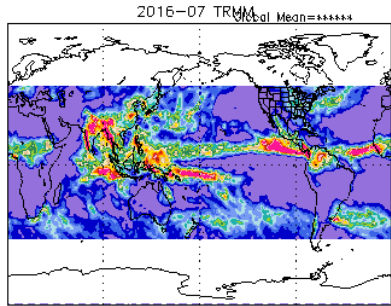


Differences with TRMM  
corr / EC 0.60

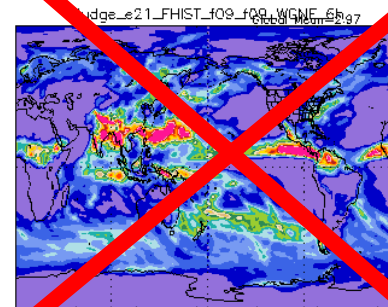


# July 2016

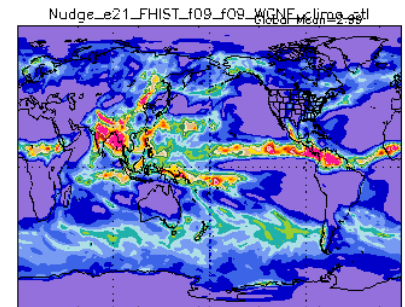
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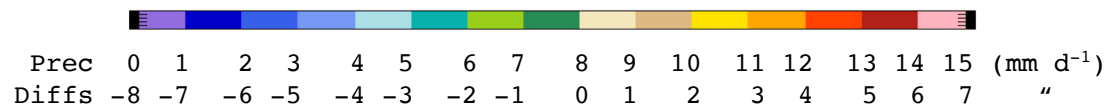
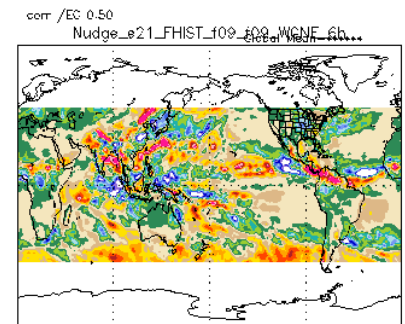
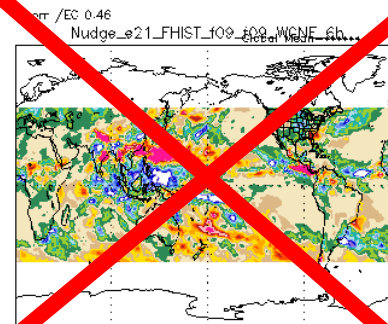
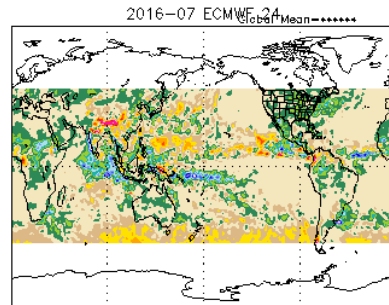
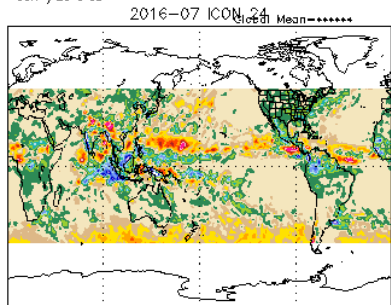
~~Nudged CAM6~~



Free-running CAM6



Differences with TRMM  
corr /EC 0.65



# Monthly averages of 24 hour Accumulated Precip. Vs TRMM

0-24 hour lead time

24-48 "

48-72 "

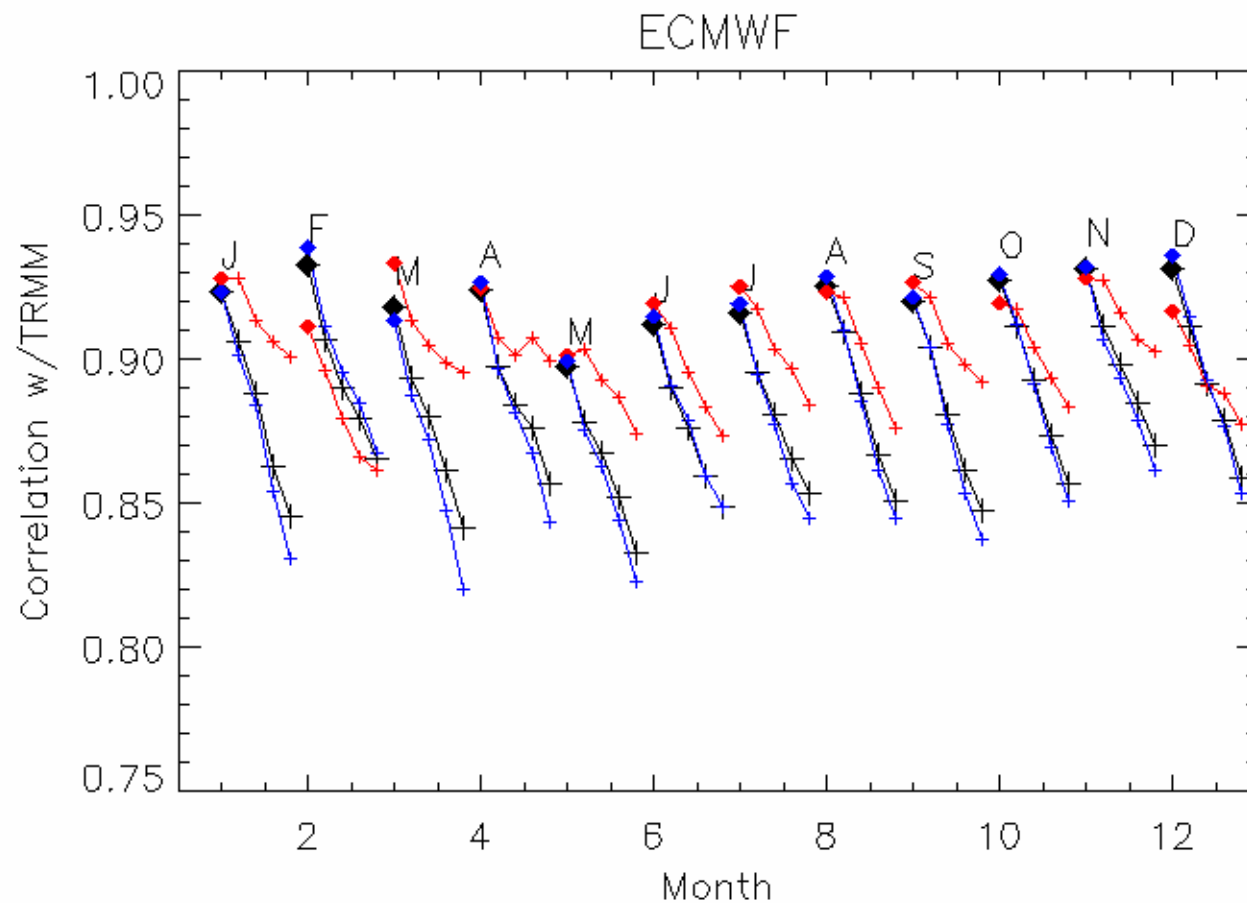
72-96 "

96-120 "

Global

Ocean

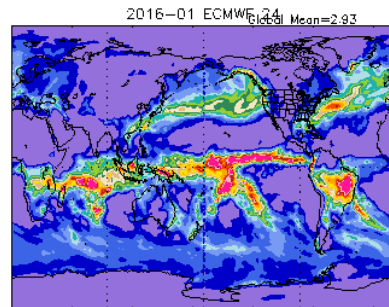
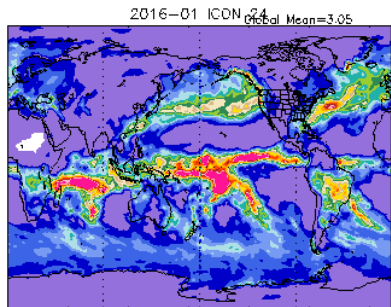
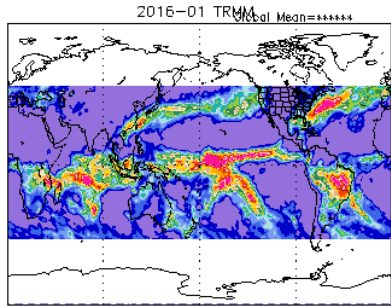
Land



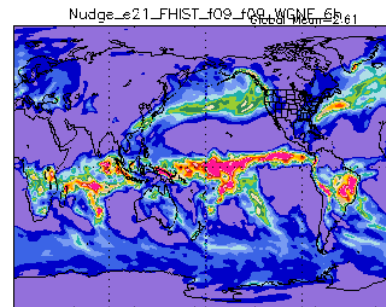


# January 2016

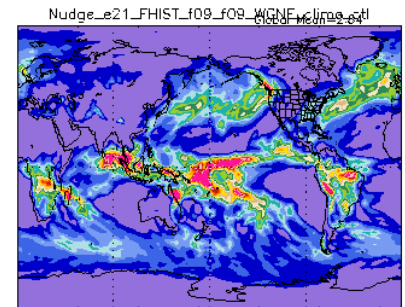
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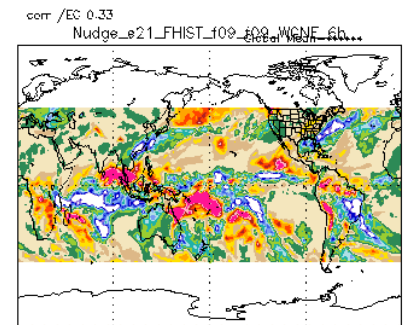
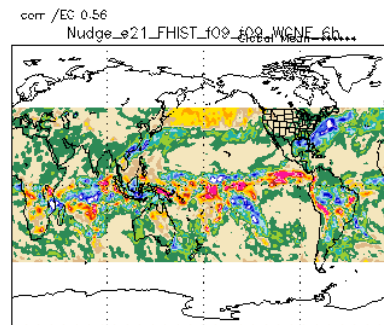
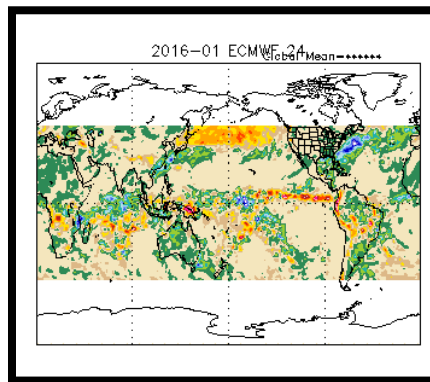
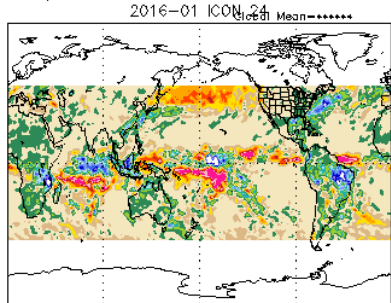
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## Free-running CAM6

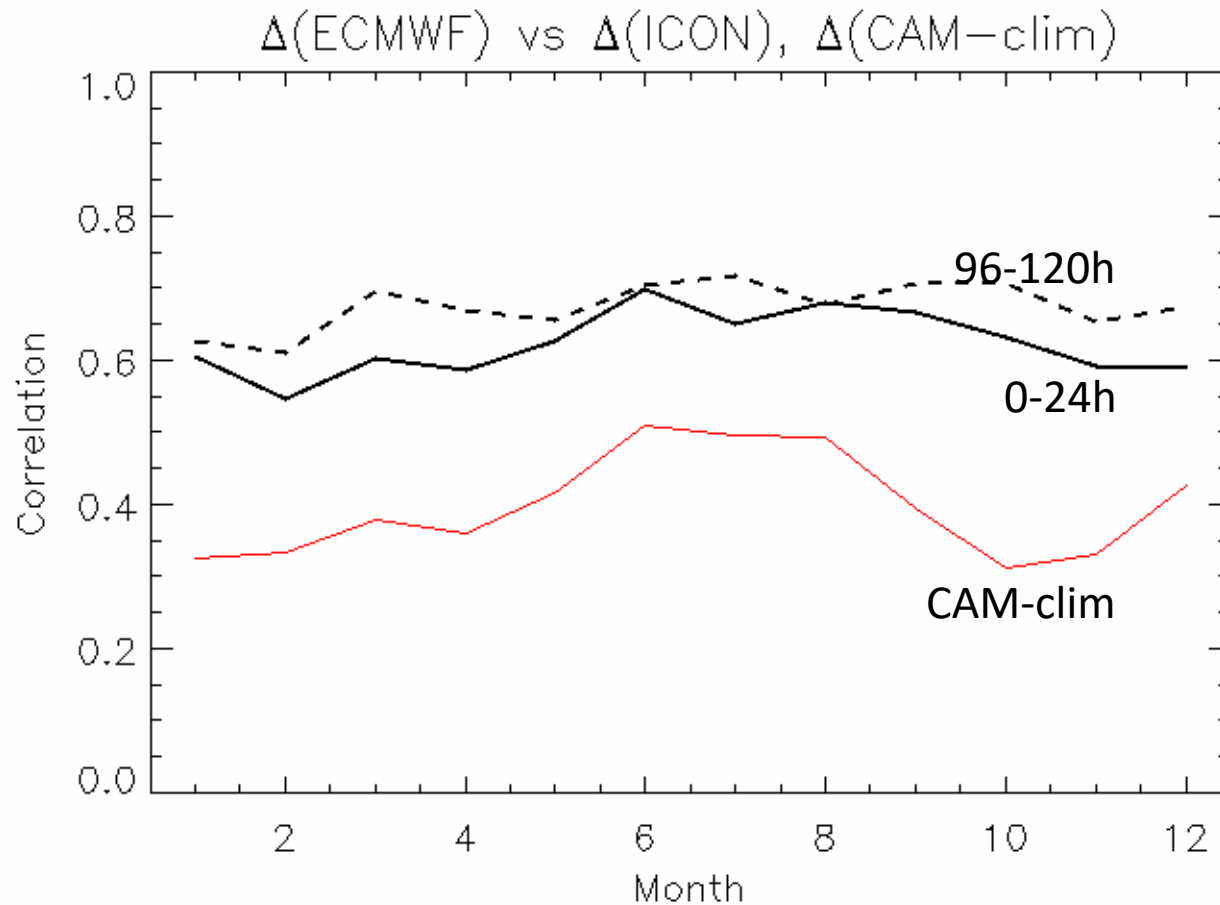


Differences with TRMM  
corr /EC 0.60



Prec 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 (mm d<sup>-1</sup>)  
Diffs -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 "

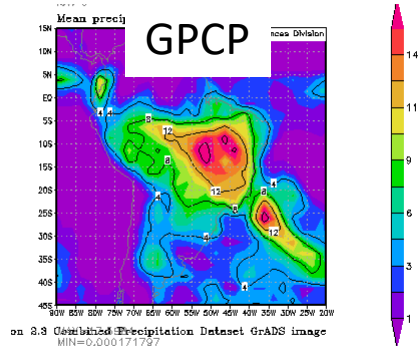
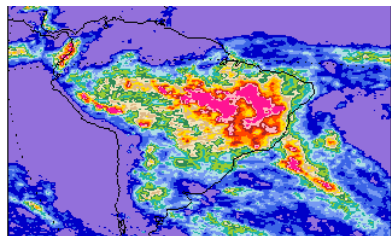
## Correlations of *differences* from TRMM



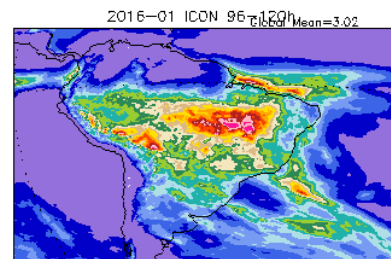
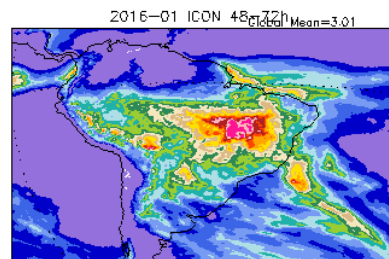
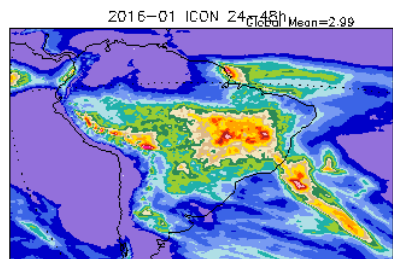
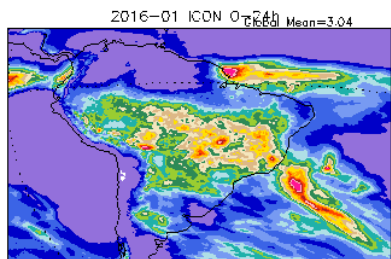
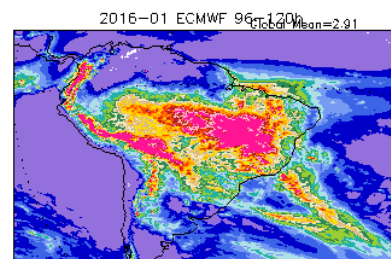
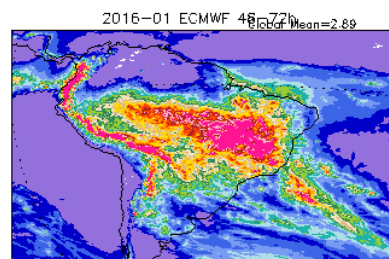
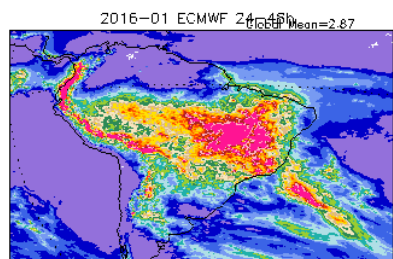
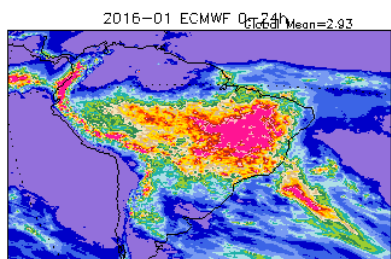
Models become more alike (significance?) as forecasts progress

Andes bias

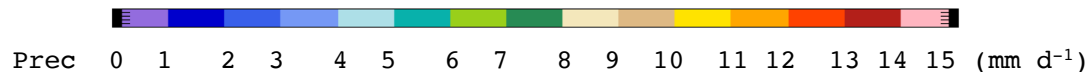
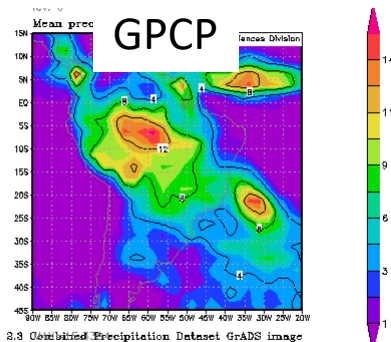
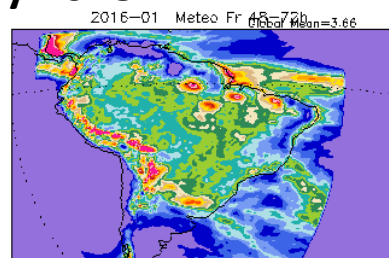
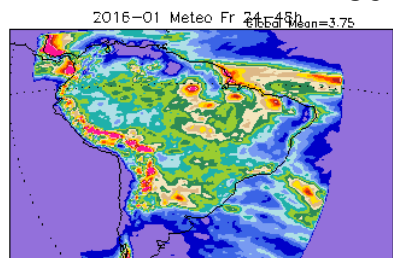
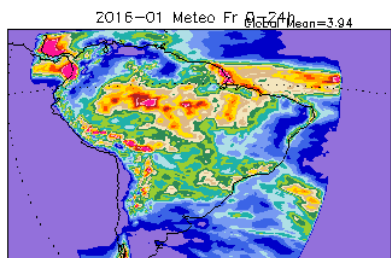
# TRMM



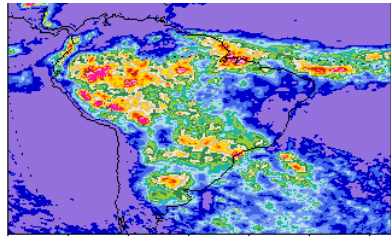
## January 2016



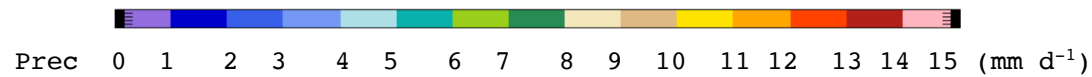
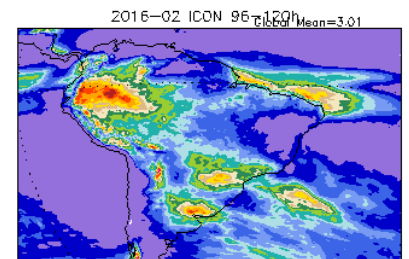
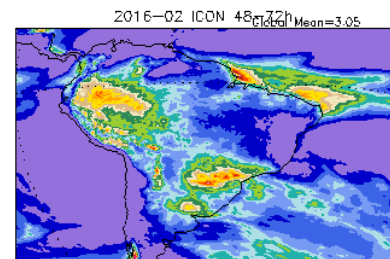
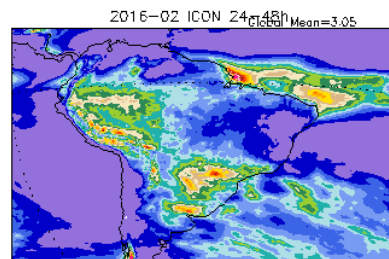
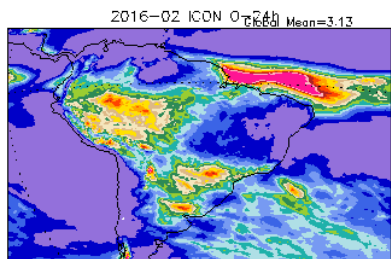
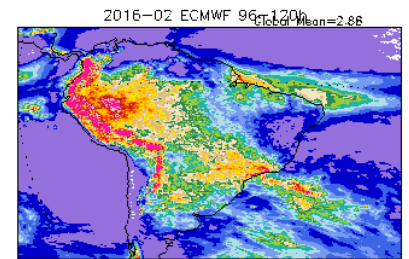
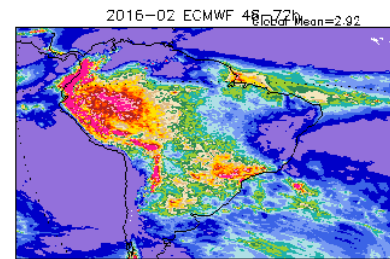
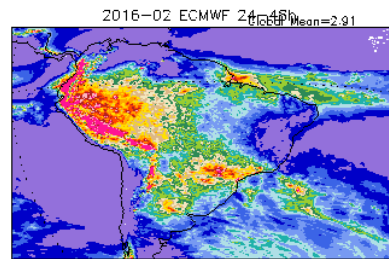
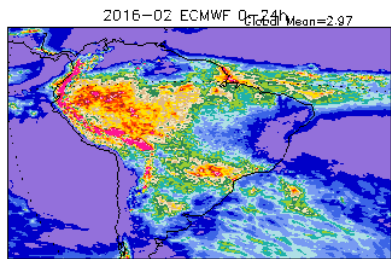
## January 2018



TRMM

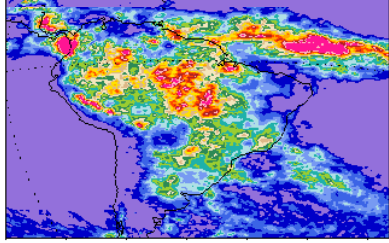


February 2016

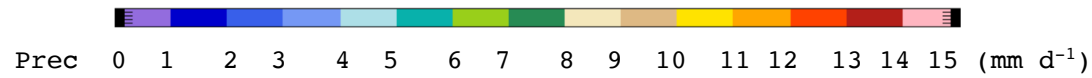
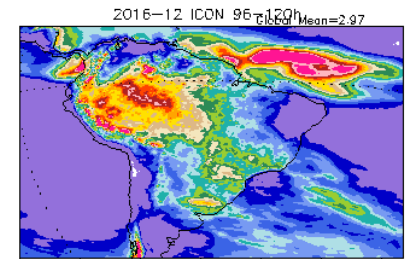
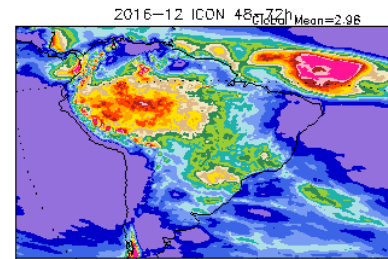
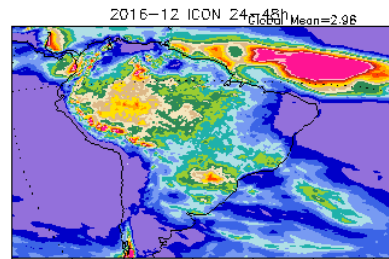
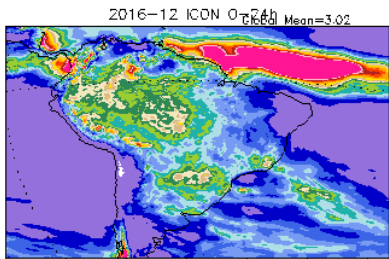
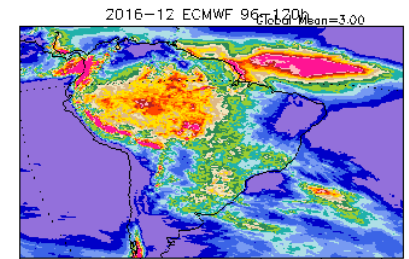
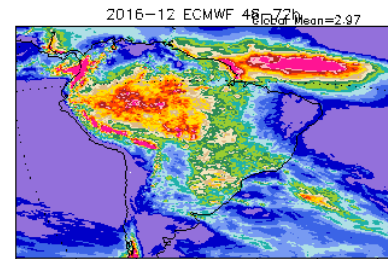
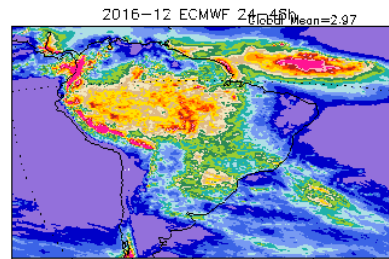
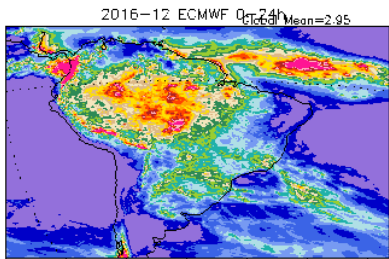




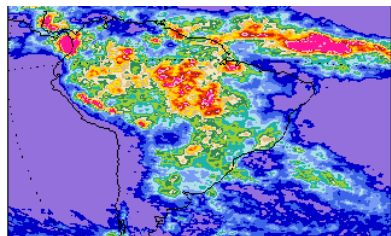
TRMM



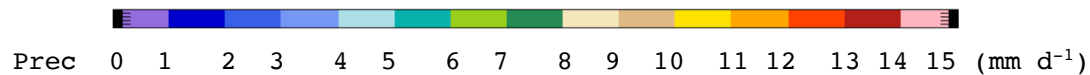
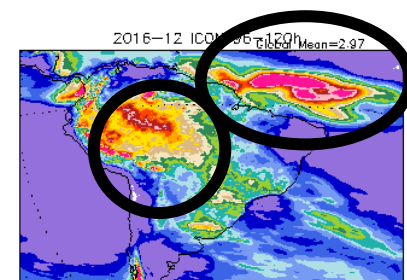
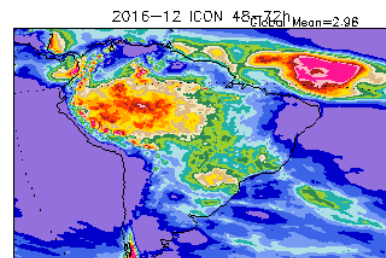
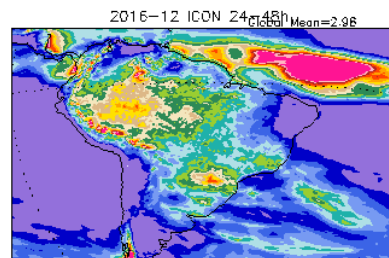
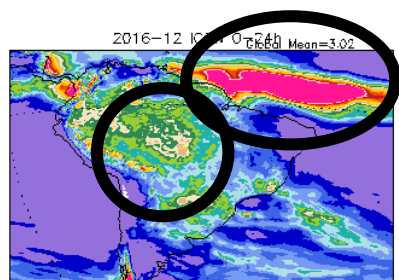
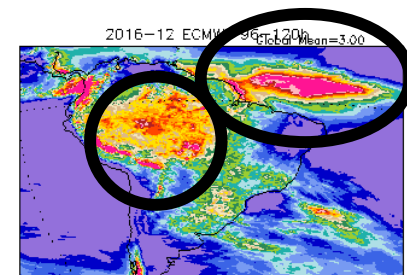
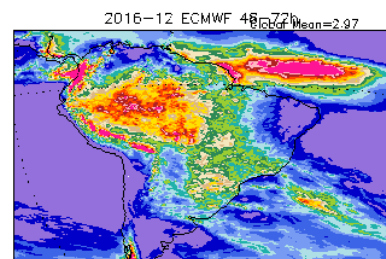
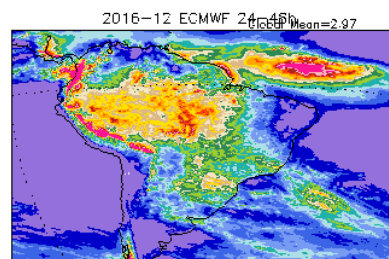
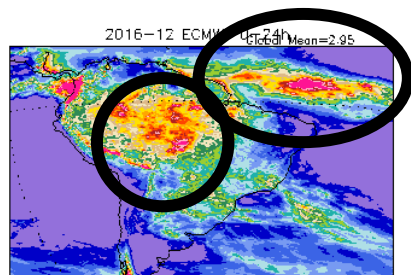
December 2016



TRMM



December 2016



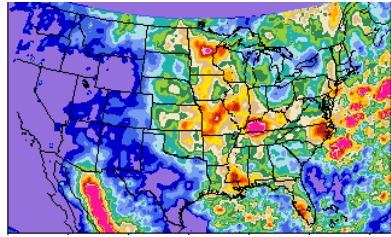
Interesting land/sea swap with  
opposing sense in ICON and ECMWF

# Andes bias

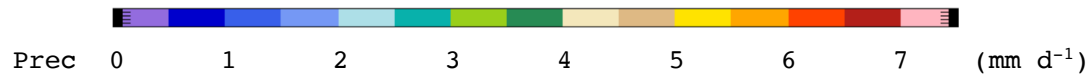
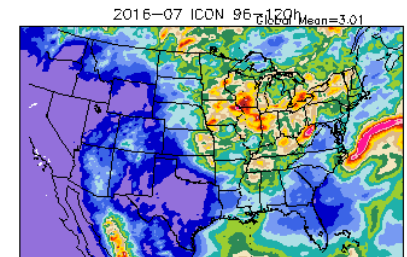
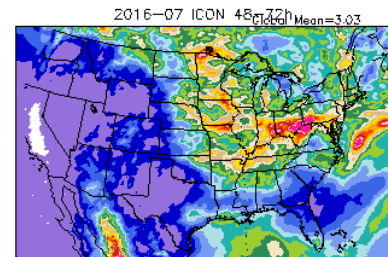
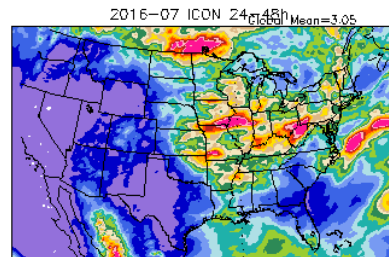
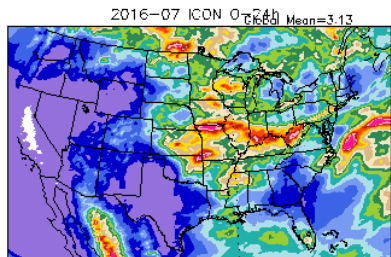
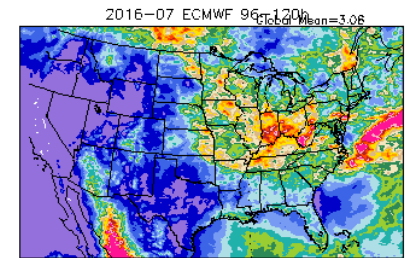
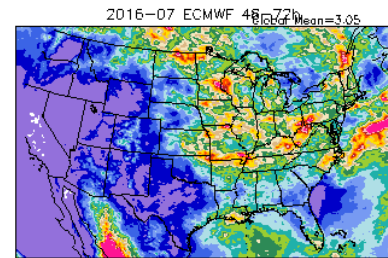
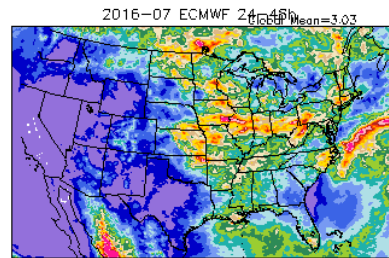
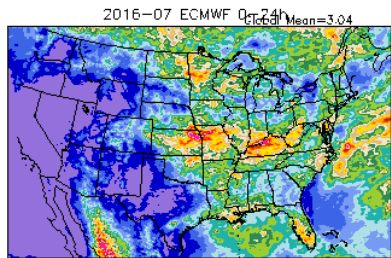
- Amazon/Andes start out drier in ICON, but seem to converge at longer lead times
- Orographic precip increases in all models with lead time



# TRMM



July 2016

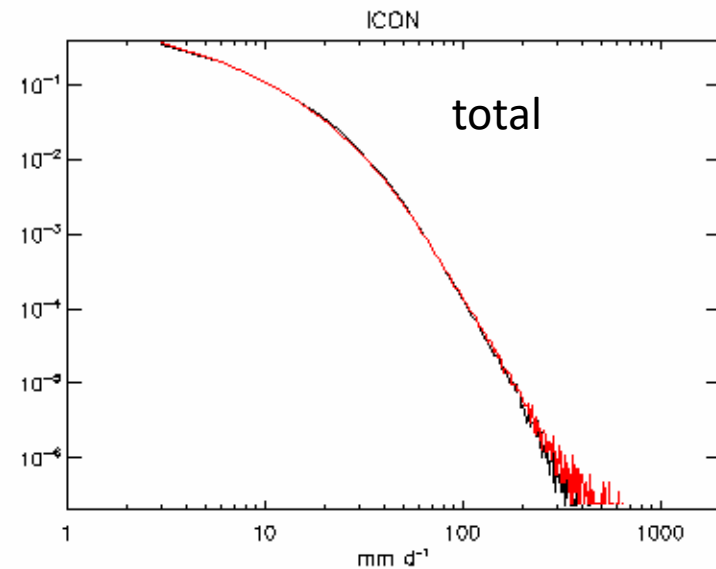
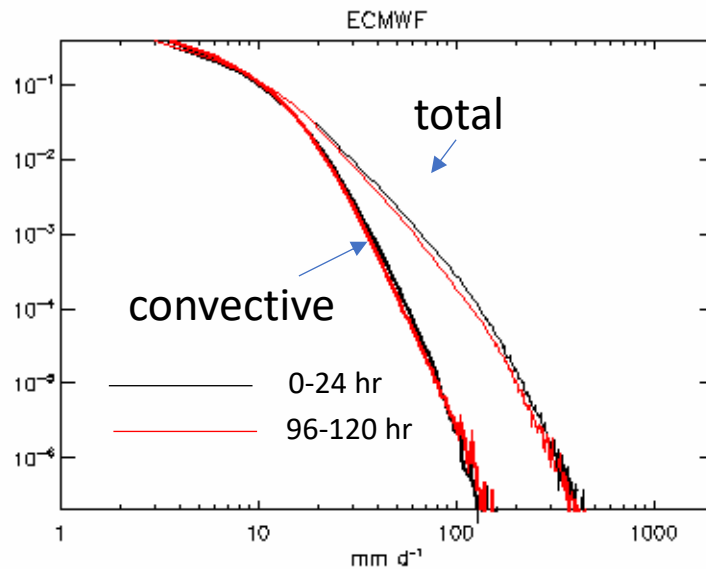


- Little systematic evolution with lead time apparent
- Note orographic details (western US) in model precipitation fields – not present in TRMM

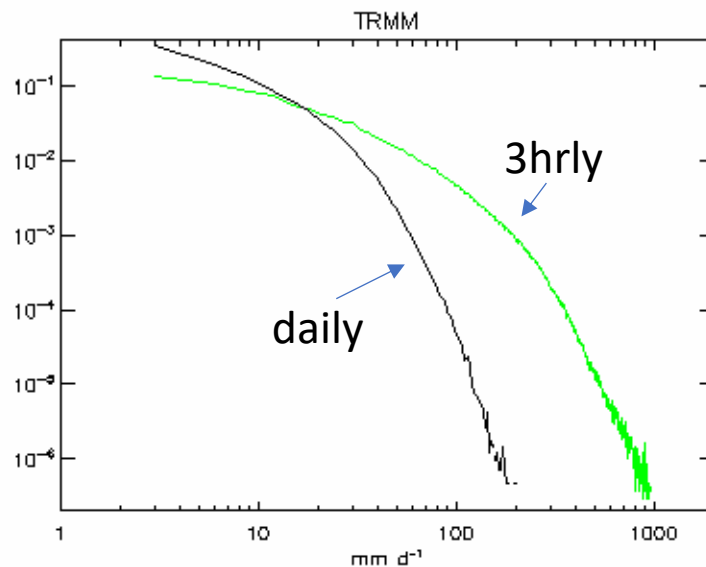
Intensity PDFs of precipitation

# Intensity PDFs accumulated between 49S and 49N

Precip PDFs 2016-07



Little change with lead time



Note: Precip data is accumulated at different resolutions

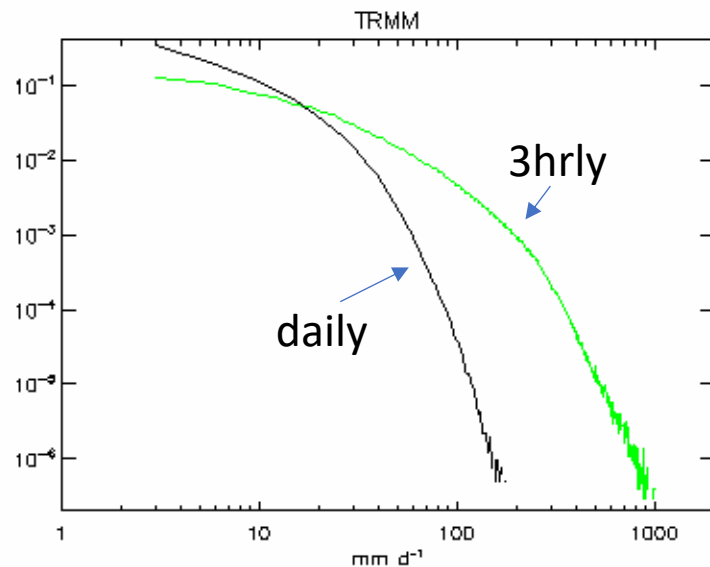
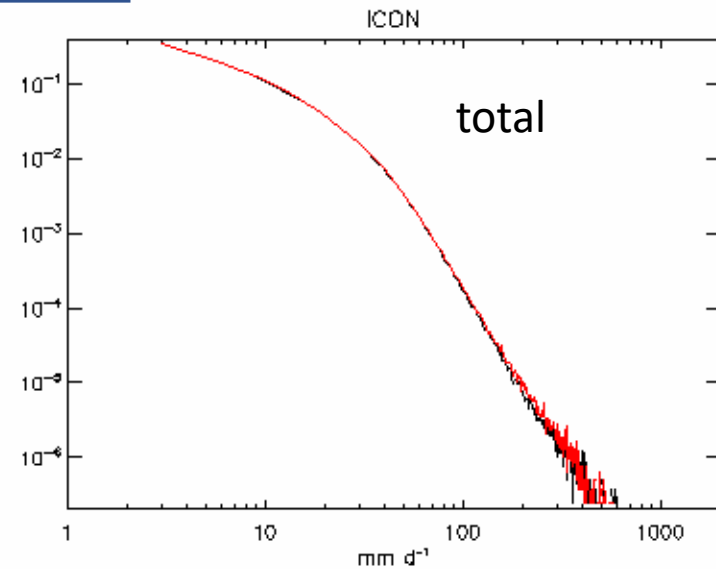
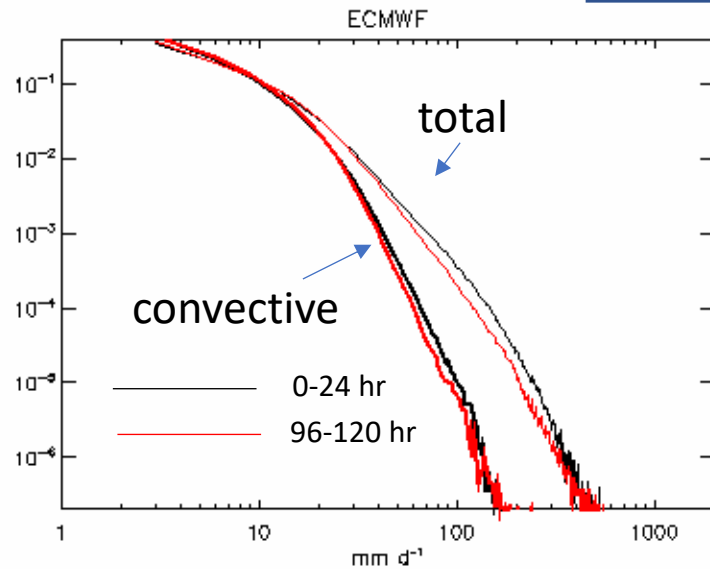
ICON  $\sim 0.25^\circ$

ECMWF  $\sim 0.12^\circ(?)$

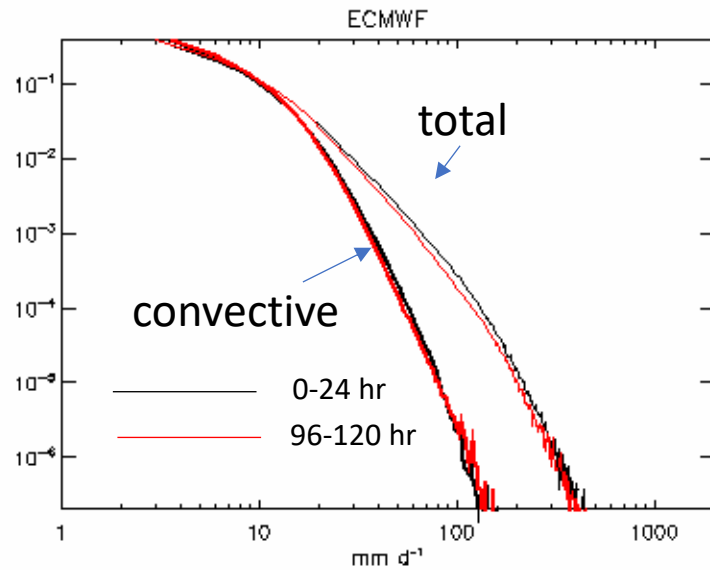
TRMM 3B42  $\sim 0.25^\circ$

# Intensity PDFs accumulated between 49S and 49N

Precip PDFs 2016-01



***Not much change month-to-month***



Extreme values in precipitation  $\sim 500 \text{ mm d}^{-1}$  aren't produced by convective scheme.

Same is true in CAM

## CAM (3hrly)

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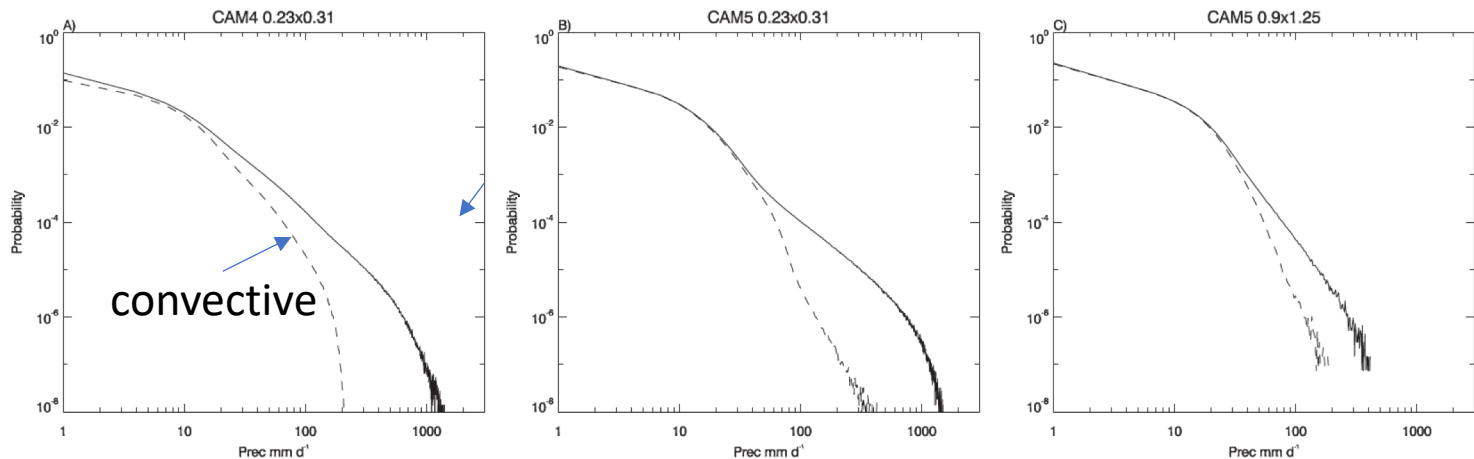
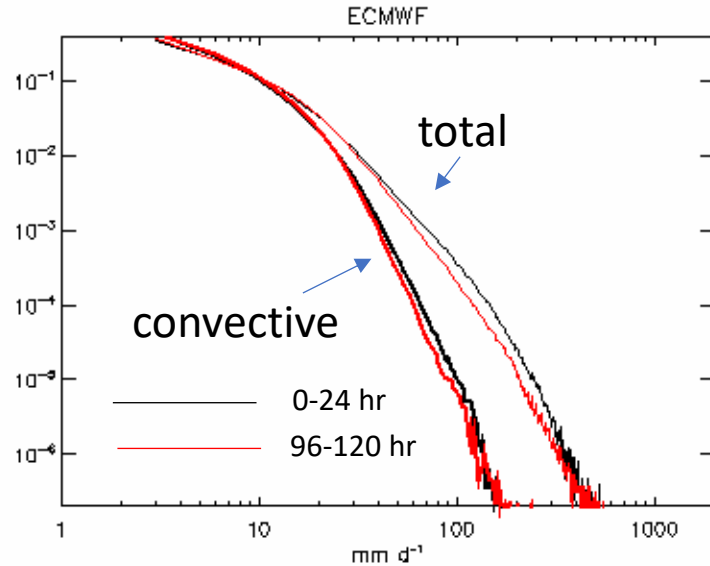


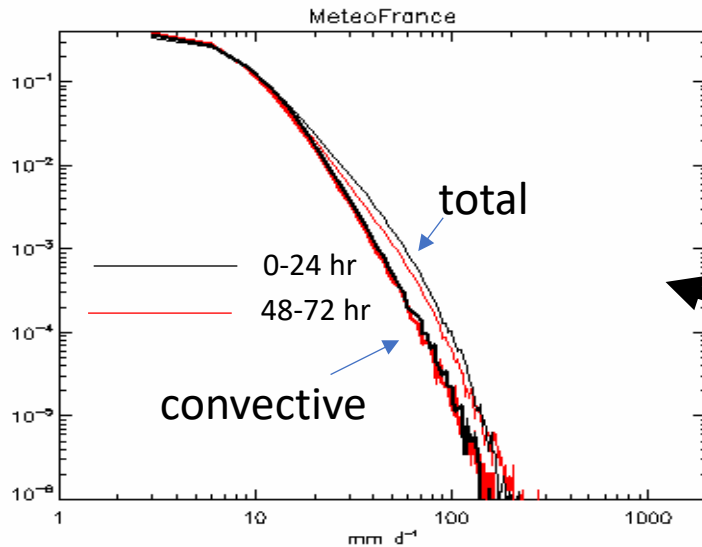
FIG. 11. PDFs of tropical precipitation for (a) CAM4  $0.23 \times 0.31$ , (b) CAM5  $0.23 \times 0.31$ , and (c) CAM5  $0.9 \times 1.25$ . Solid lines show PDFs of total precipitation as in Fig. 10. Dashed lines show PDFs of precipitation produced by deep and shallow convection parameterizations.

# Precip PDFs 2016-01

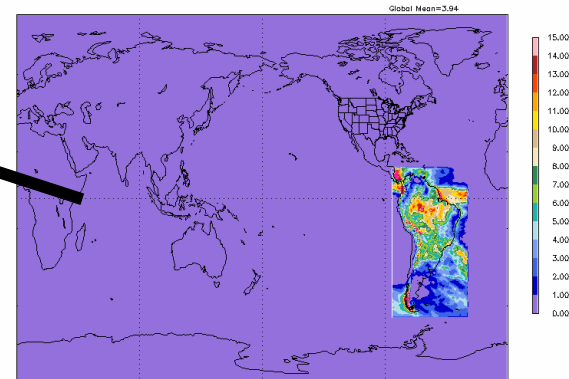


MeteoFrance may behave like ECWMF and CAM but need to look beyond limited region

## Meteo Fr. Precip PDFs 1/20182018-01



*Haven't yet checked this region in ECMWF and ICON*



# Summary

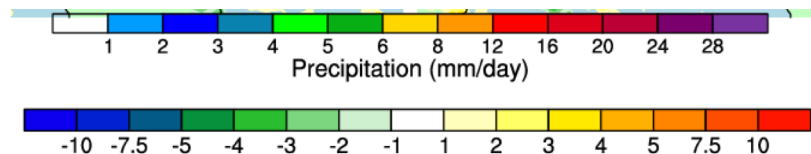
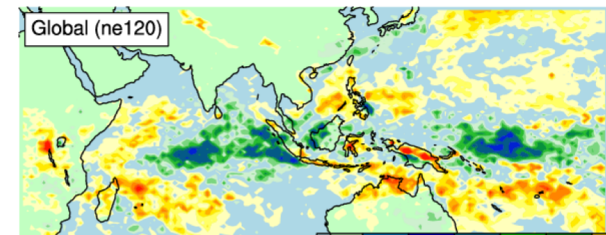
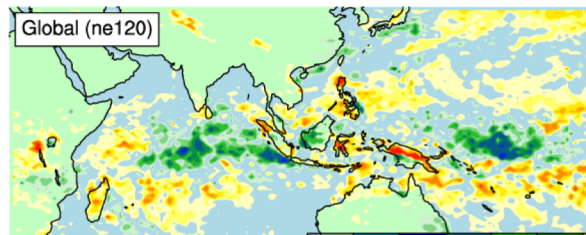
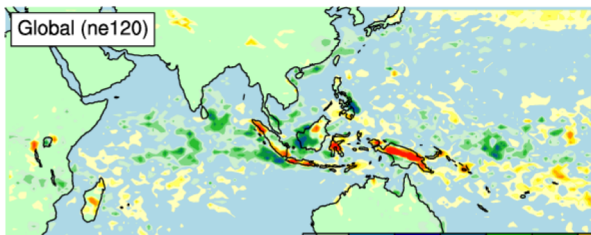
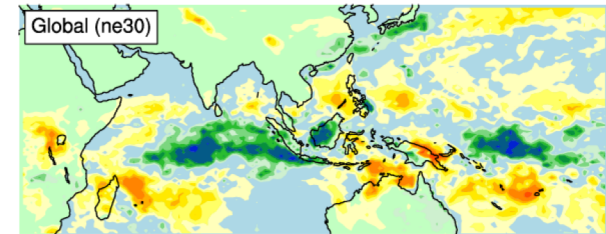
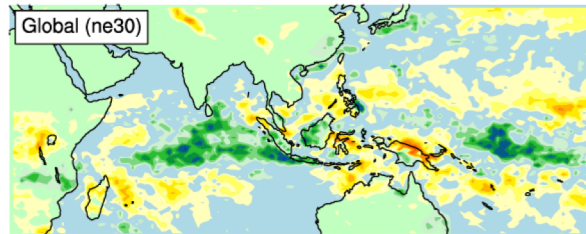
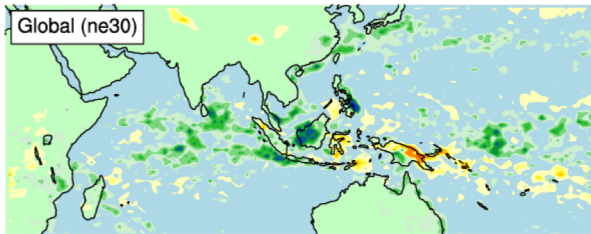
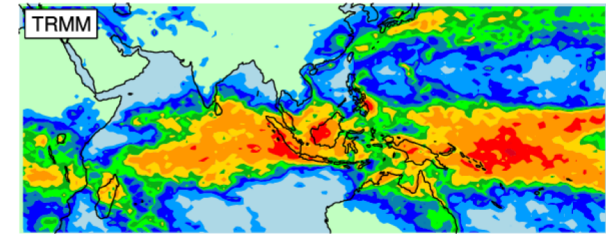
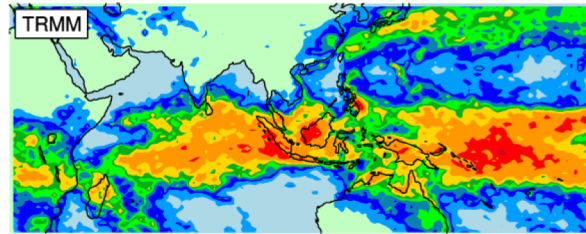
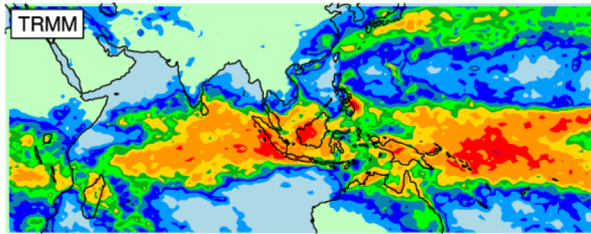
- Some interesting agreements between models
- Topographic detail worth exploring more carefully
- Interesting convective/large-scale behavior

# Daily 20d forecasts (00Z 21 Oct 2009 to 00Z 01 Mar 2010)

Day 1 forecast average bias (00Z

Day 5 forecast average bias (00Z

Day 10 forecast average bias (00Z



*Courtesy, Rich Neale*



# Where to go from here?

- So far, limited look at results from 3 centers: DWD, ECMWF, Meteo-France. Extend to more years  
more centers?
- Extended validation, esp. in complex terrain.
- Proposed protocol
  - Accumulated precipitation at 24,48,72,96,120 hours  
(and 216, 240? )
  - Convective and total if relevant
  - Global fields