

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”

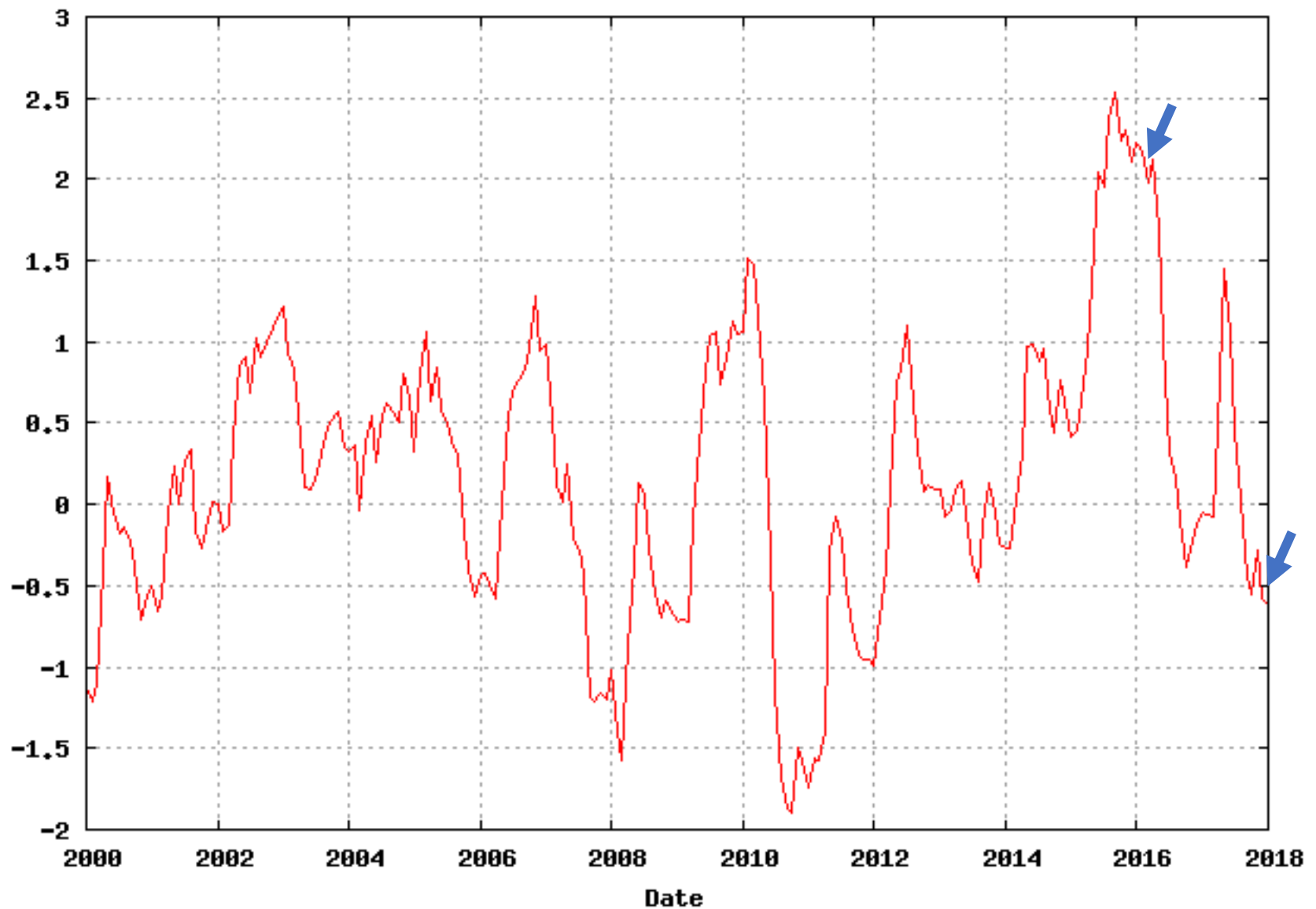
- Let’s look at NWP precip with a “climate lens”
 - Comparisons with TRMM
 - Andes biases
 - Are different NWP models similar
- Can we use NWP precip as “data”?

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

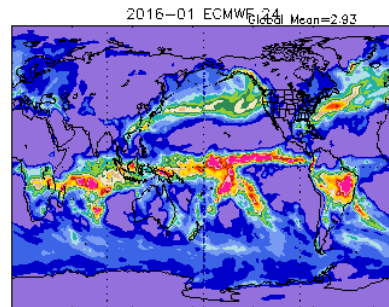
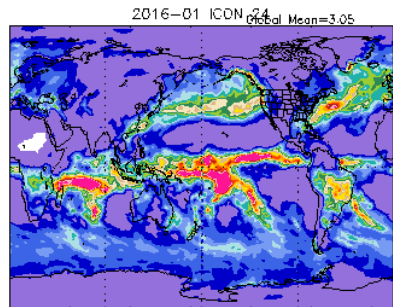
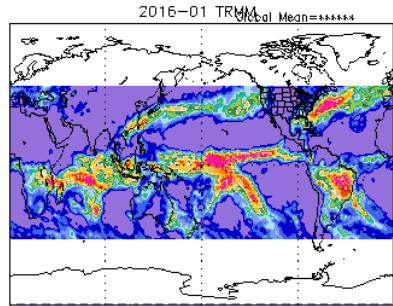
Multivariate ENSO Index (MEI): from NOAA/PSD
Jan to Dec: 1950 to 2018

Jan 2016 has strong
El Niño conditions

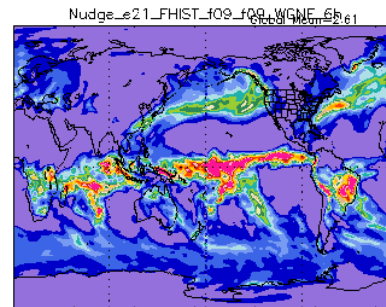


January 2016

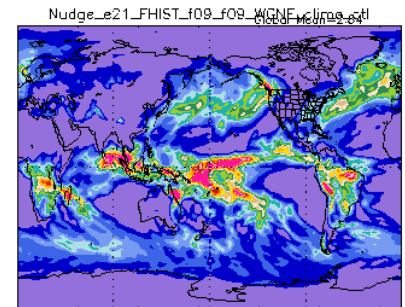
TRMM 3B42, Mean Forecast Precipitation for ICON, ECMWF (0-24 F-hour Accum) and monthly means for CAM6



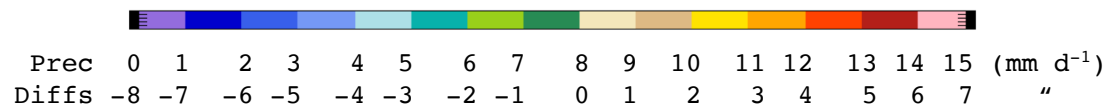
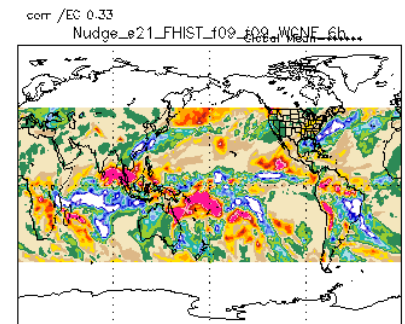
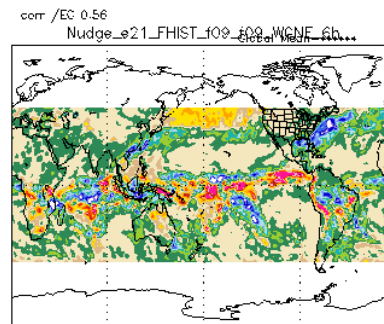
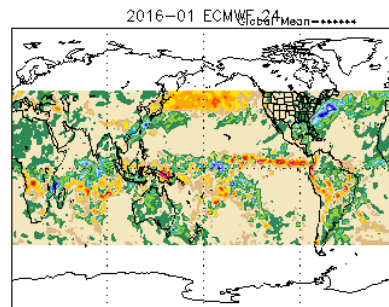
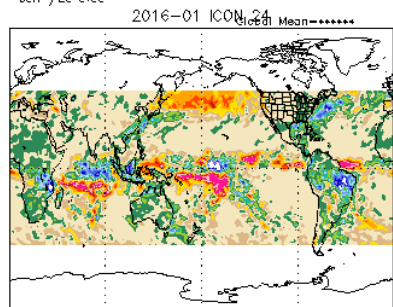
Nudged CAM6



Free-running CAM6

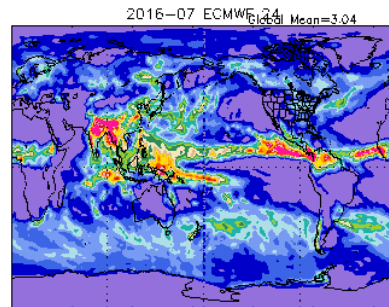
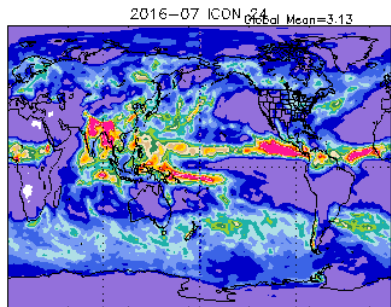
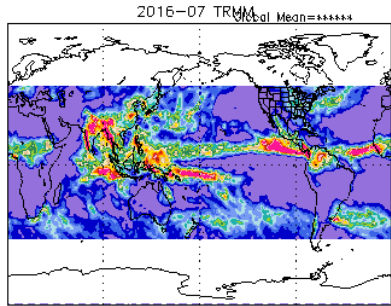


Differences with TRMM
corr / EC 0.60

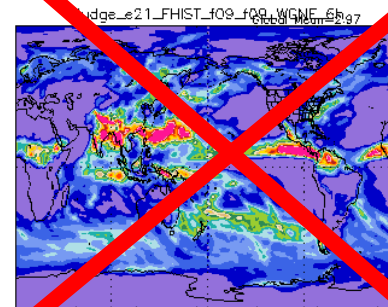


July 2016

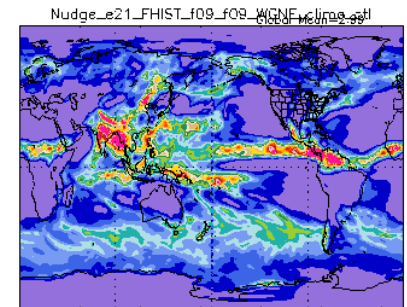
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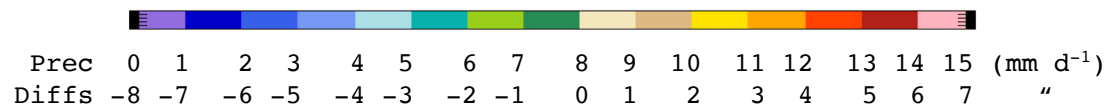
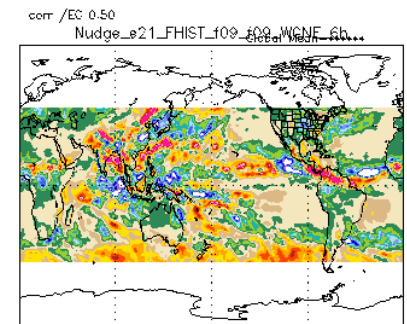
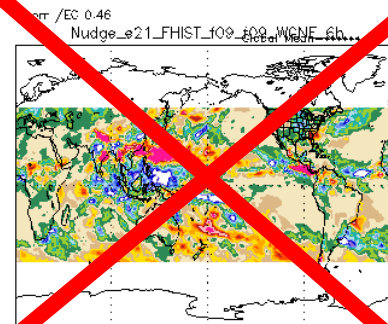
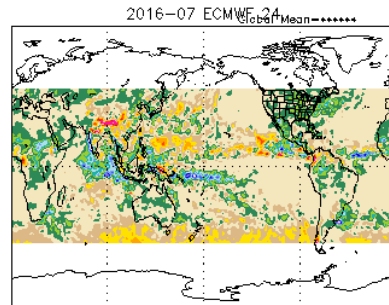
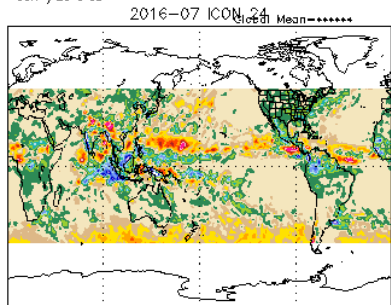
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Free-running CAM6



Differences with TRMM
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Monthly averages of 24 hour Accumulated Precip. Vs TRMM

0-24 hour lead time

24-48 "

48-72 "

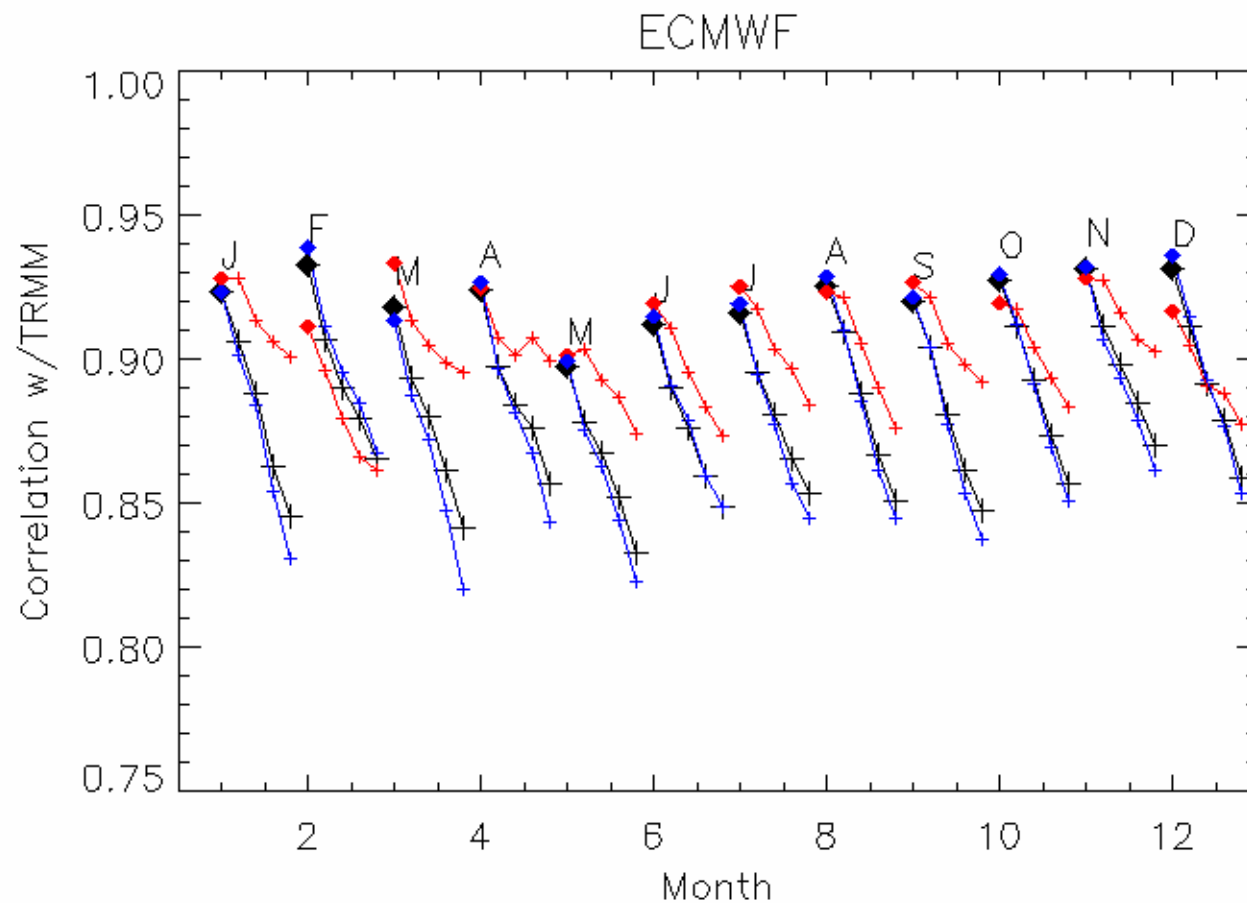
72-96 "

96-120 "

Global

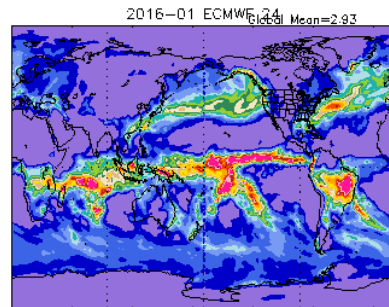
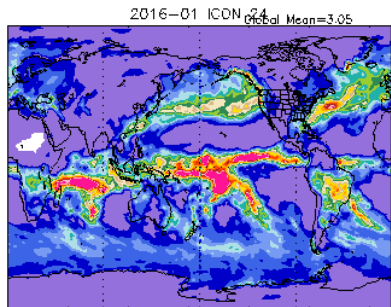
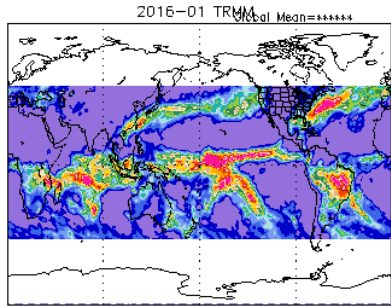
Ocean

Land

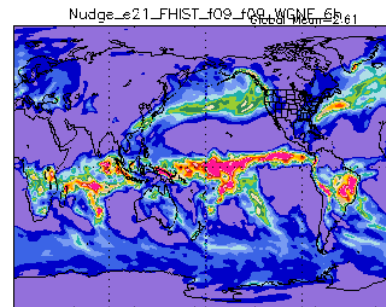


January 2016

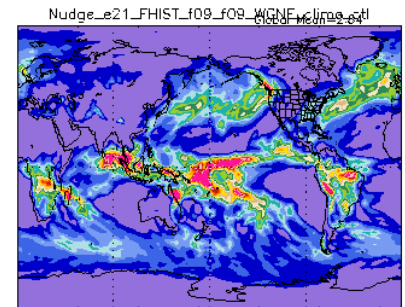
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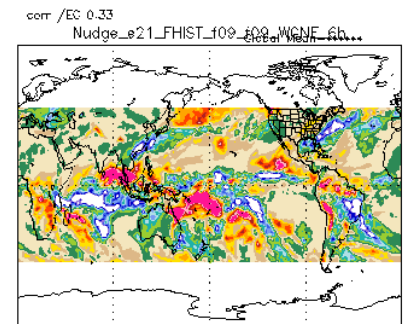
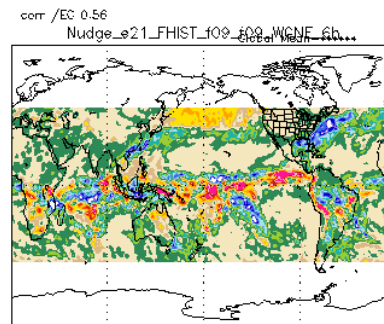
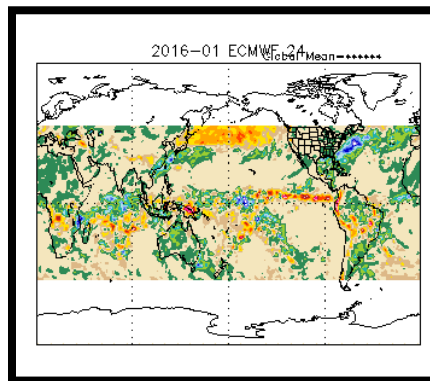
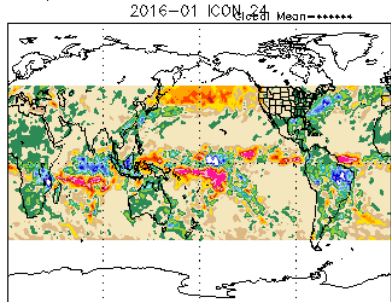
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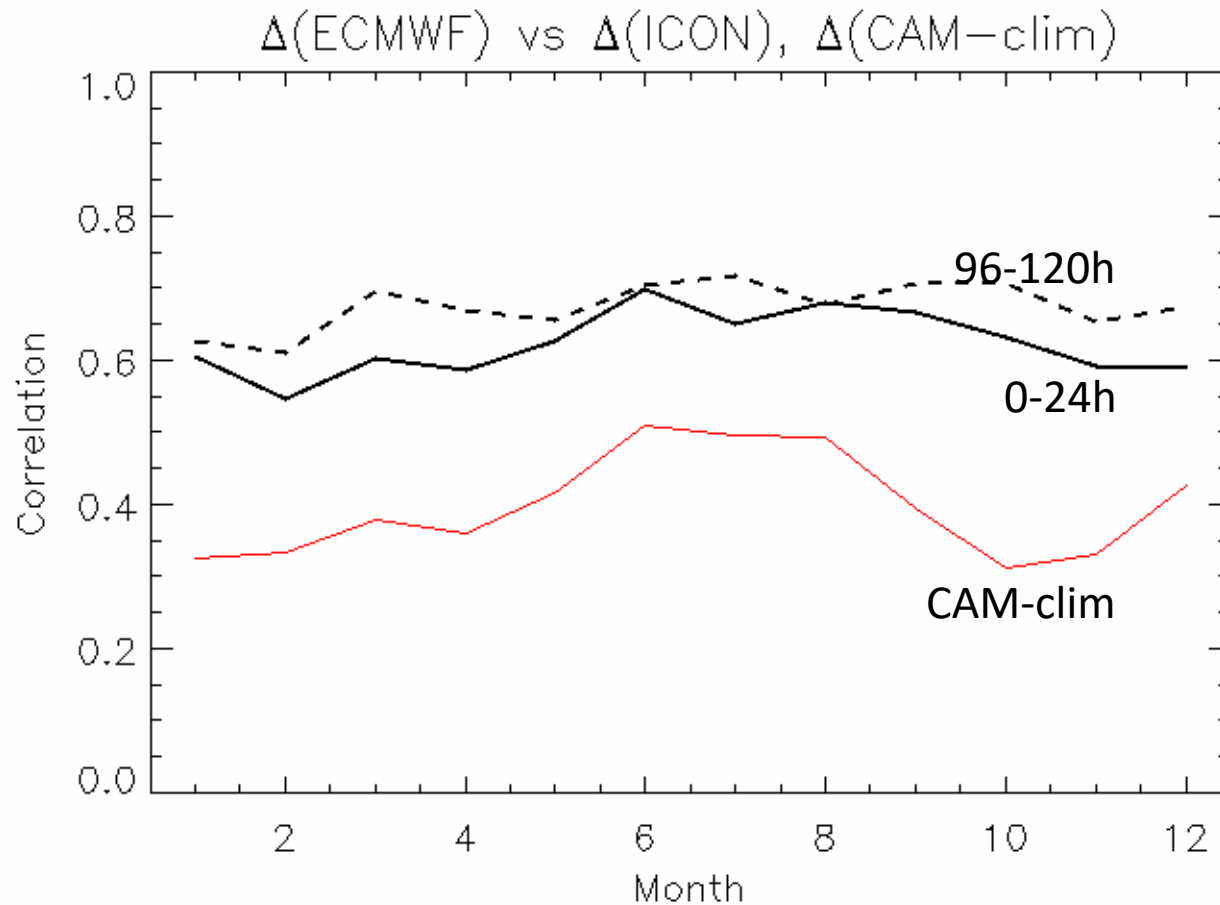


Differences with TRMM
corr / EC 0.60



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

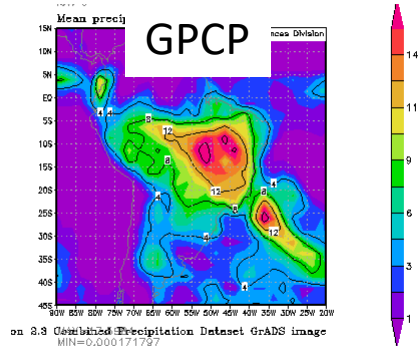
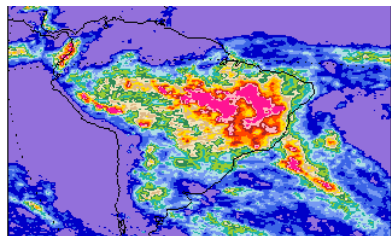
Correlations of *differences* from TRMM



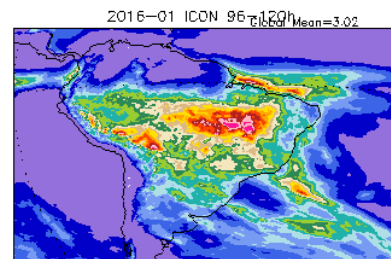
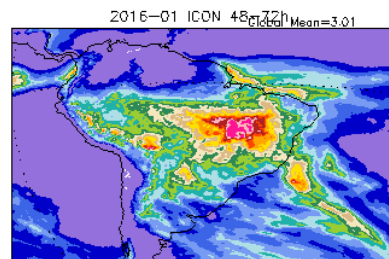
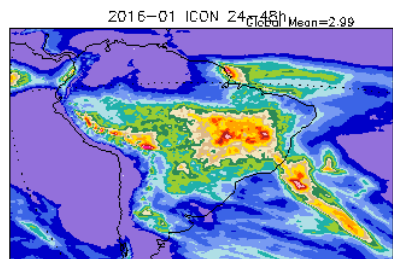
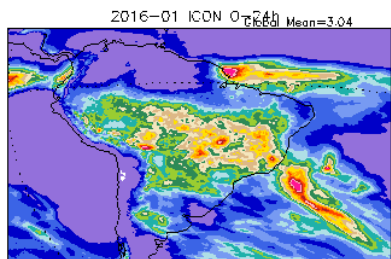
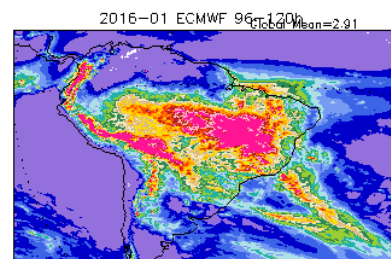
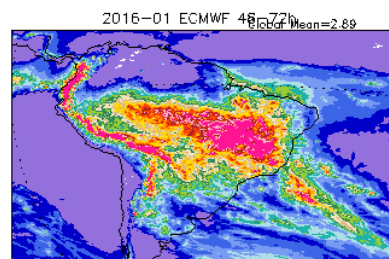
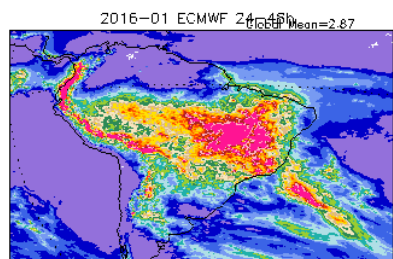
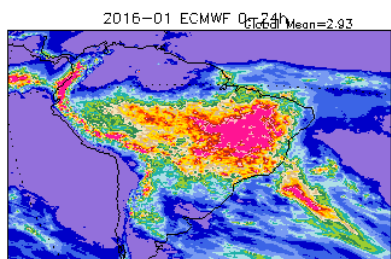
Models become more alike (significance?) as forecasts progress

Andes bias

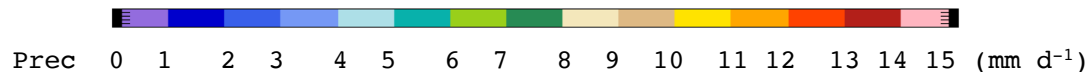
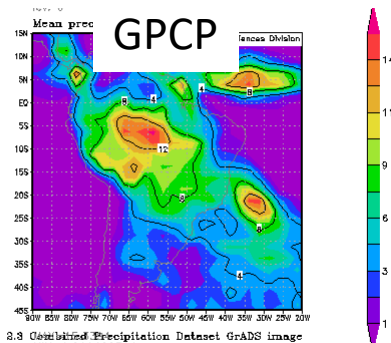
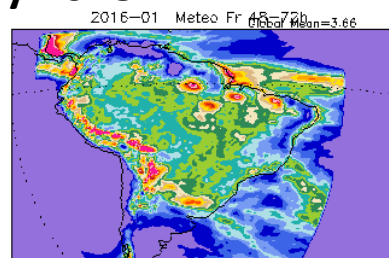
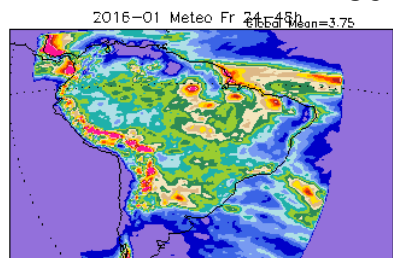
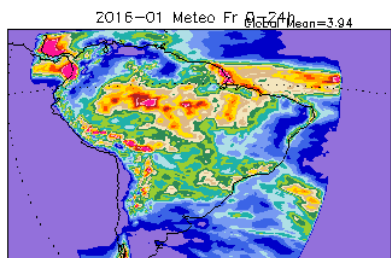
TRMM



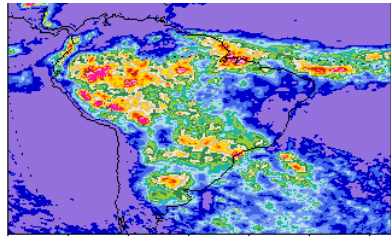
January 2016



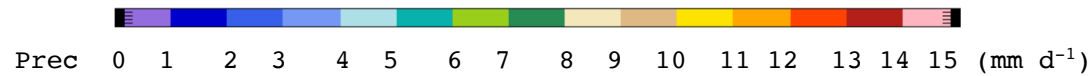
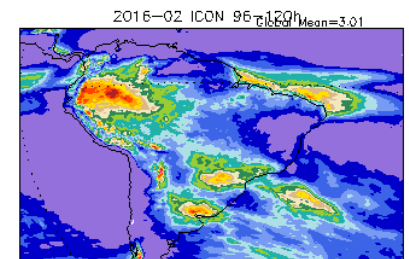
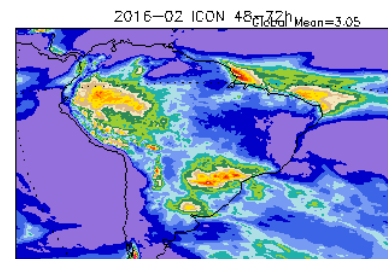
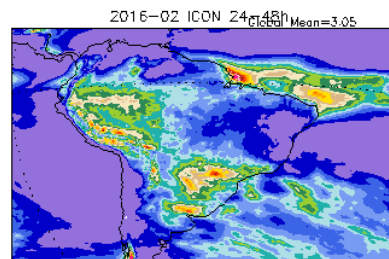
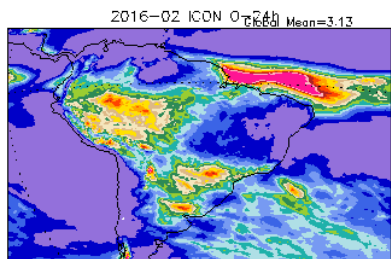
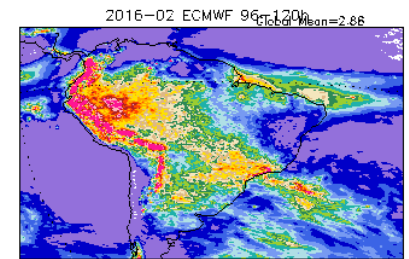
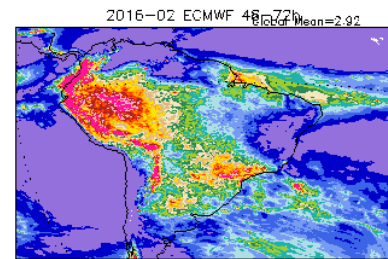
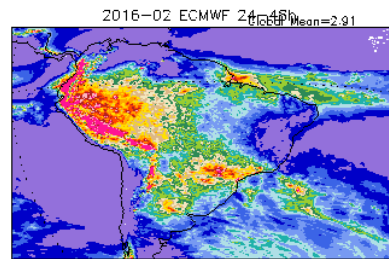
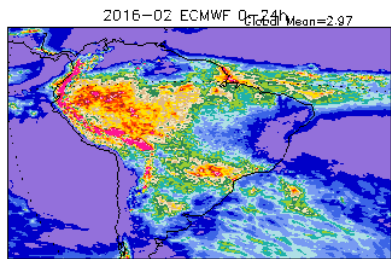
January 2018



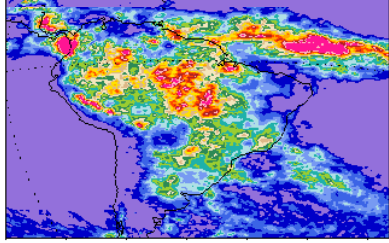
TRMM



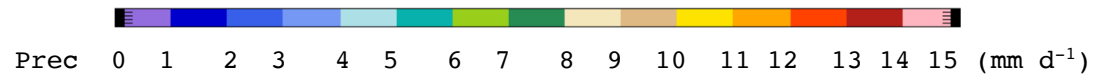
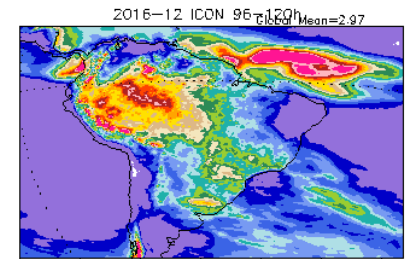
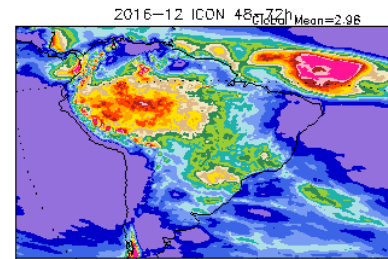
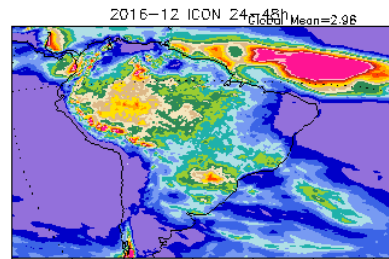
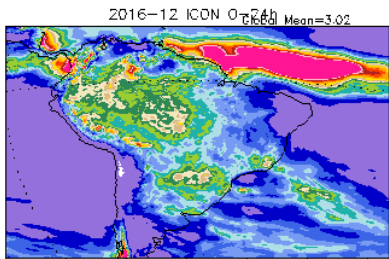
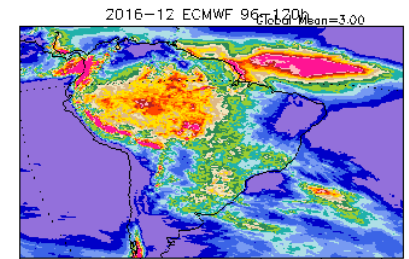
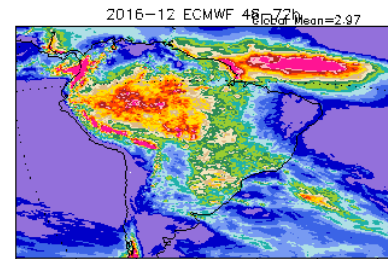
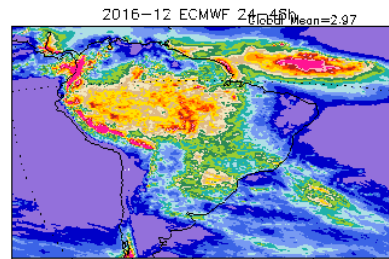
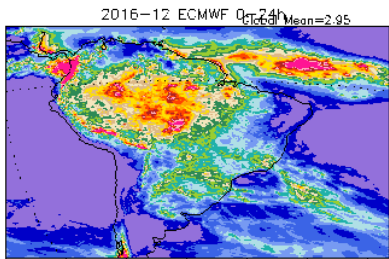
February 2016



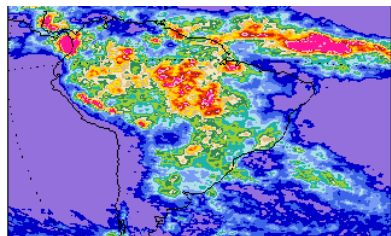
TRMM



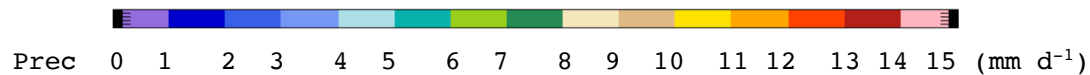
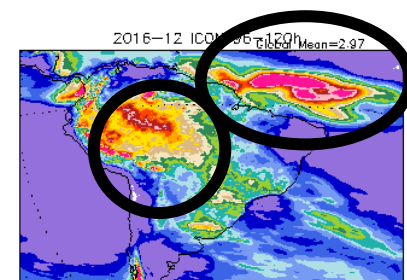
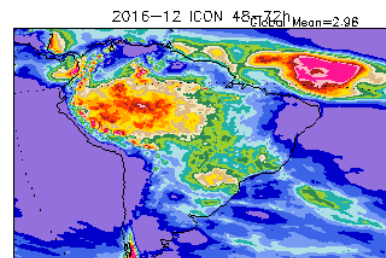
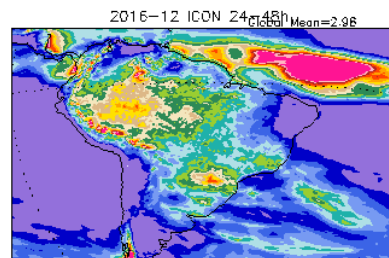
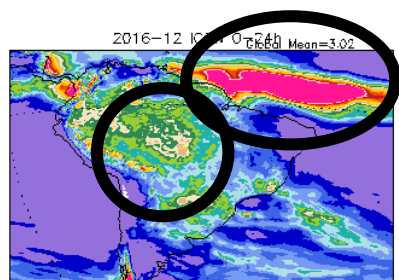
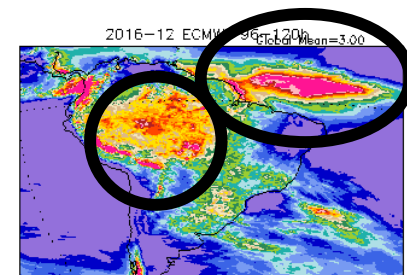
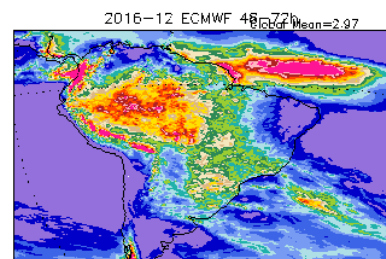
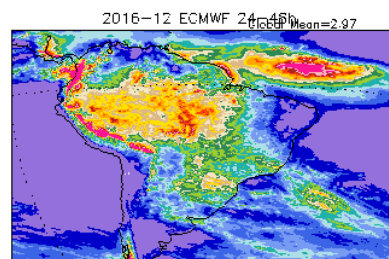
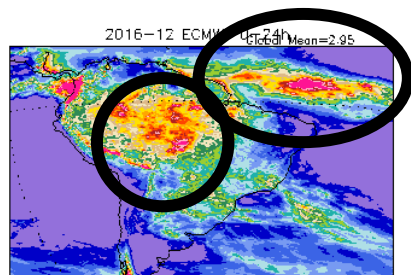
December 2016



TRMM



December 2016

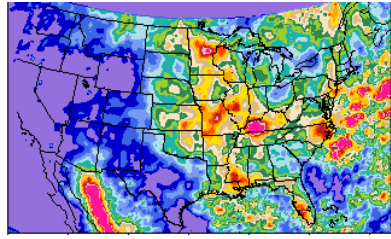


Interesting land/sea swap with
opposing sense in ICON and ECMWF

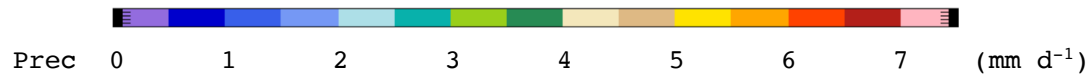
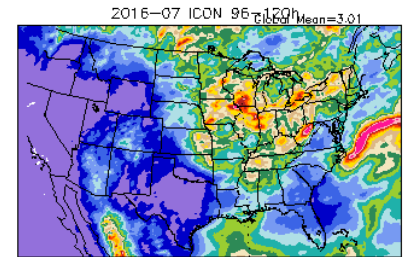
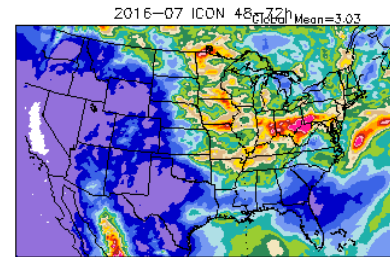
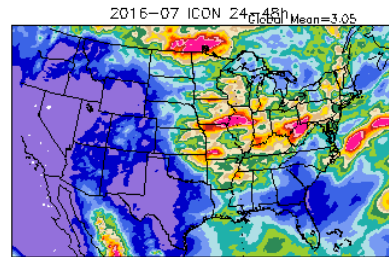
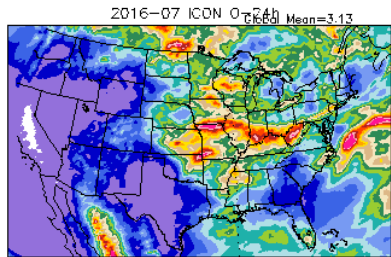
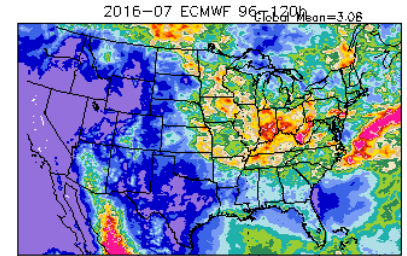
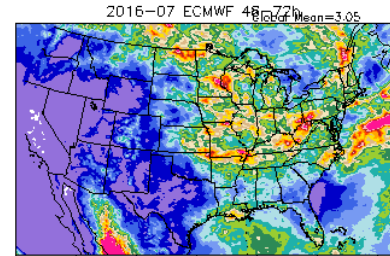
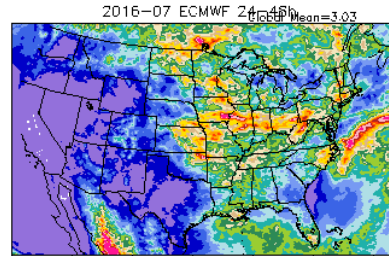
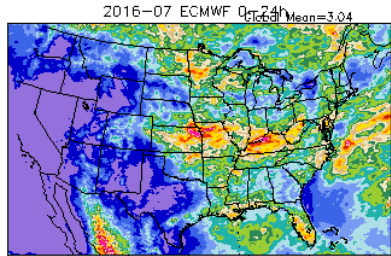
Andes bias

- 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

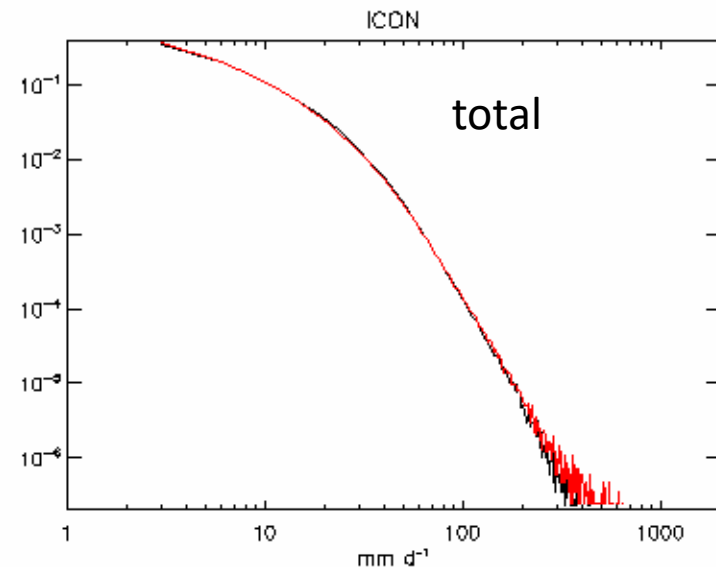
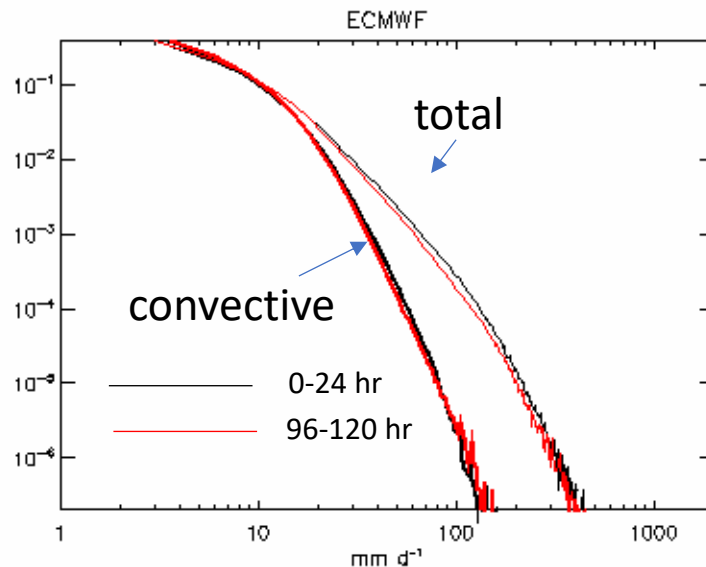


- Little systematic evolution with lead time apparent
- Note orographic details (western US) in model precipitation fields – not present in TRMM

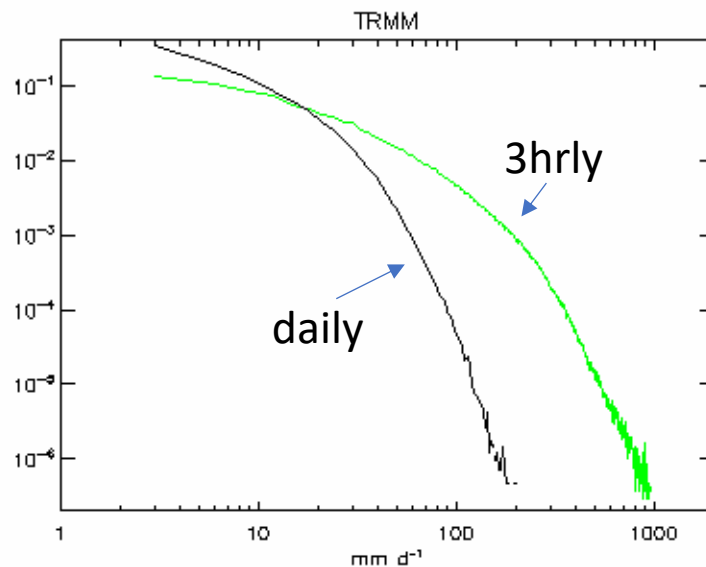
Intensity PDFs of precipitation

Intensity PDFs accumulated between 49S and 49N

Precip PDFs 2016-07



Little change with lead time



Note: Precip data is accumulated at different resolutions

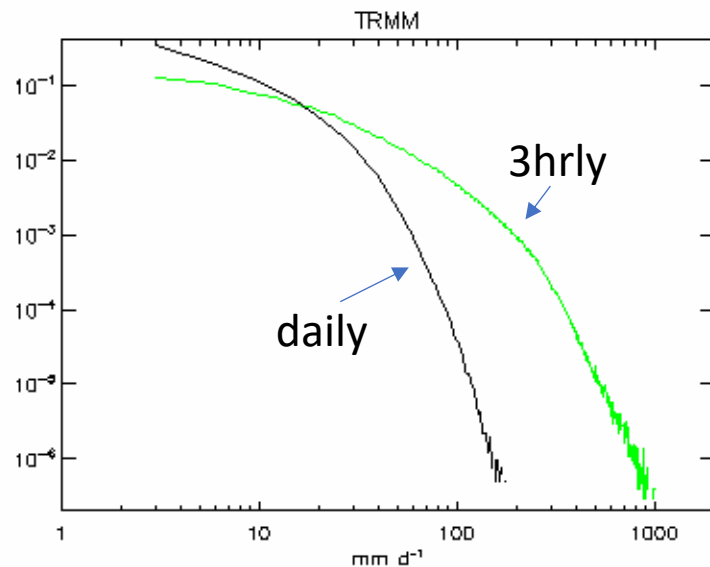
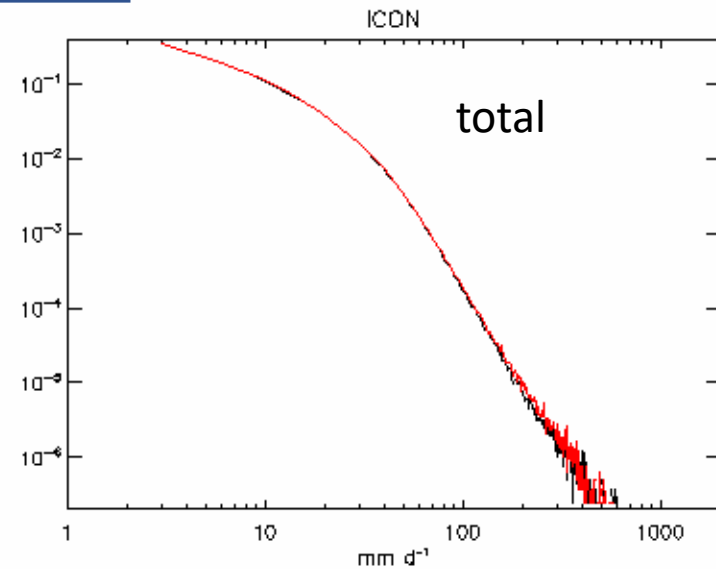
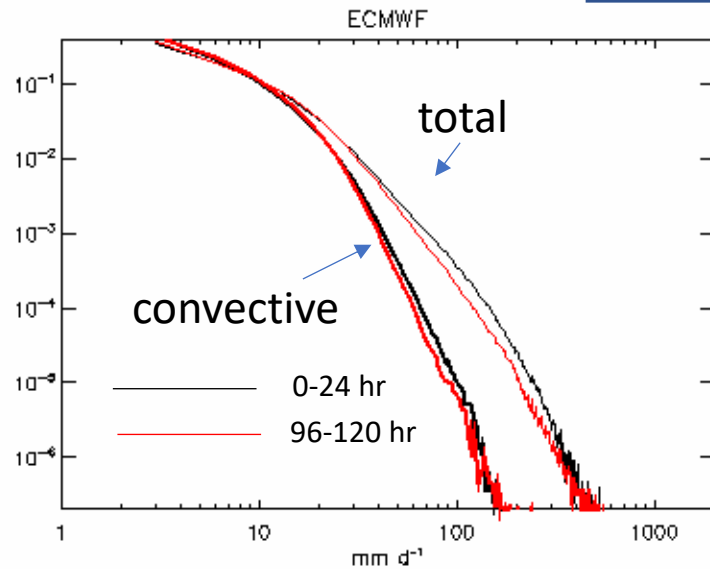
ICON $\sim 0.25^\circ$

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

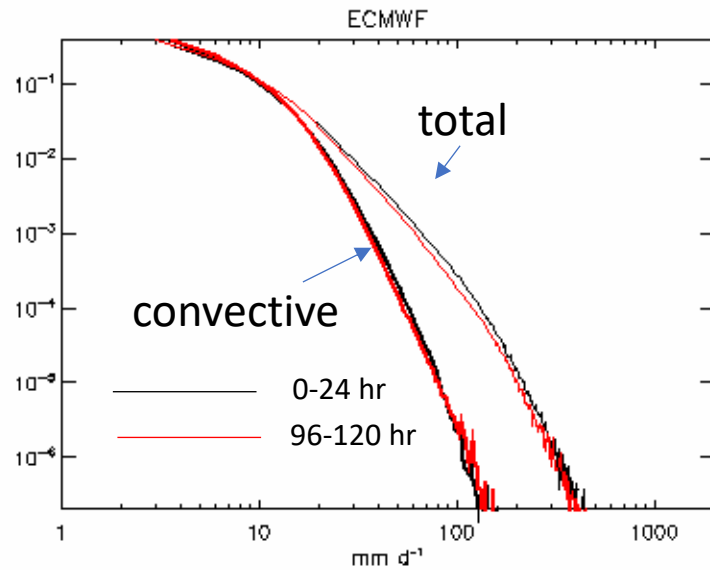
TRMM 3B42 $\sim 0.25^\circ$

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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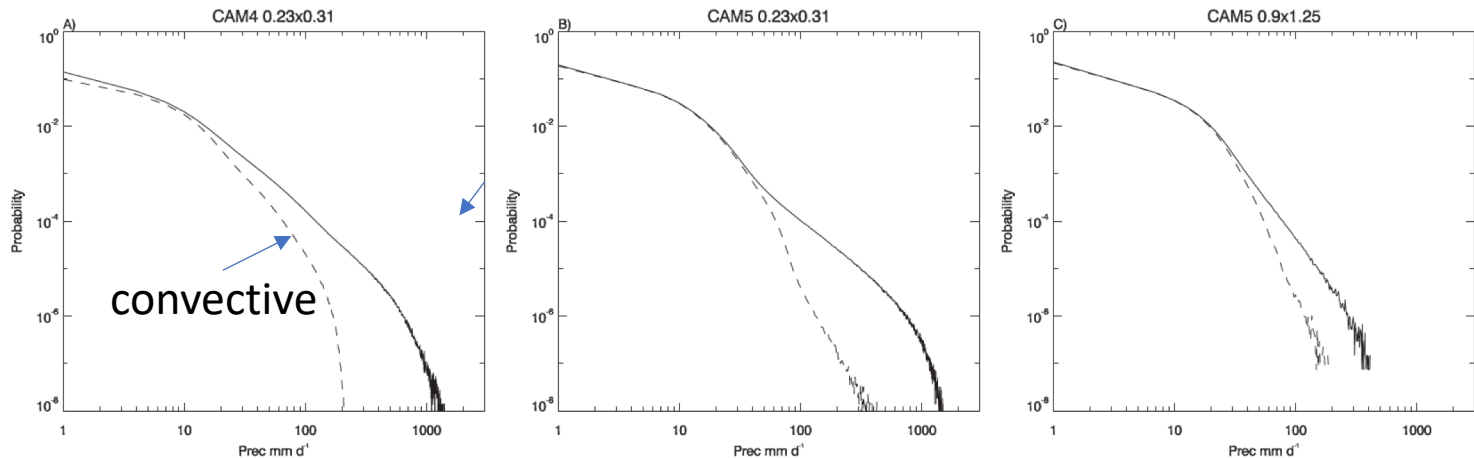
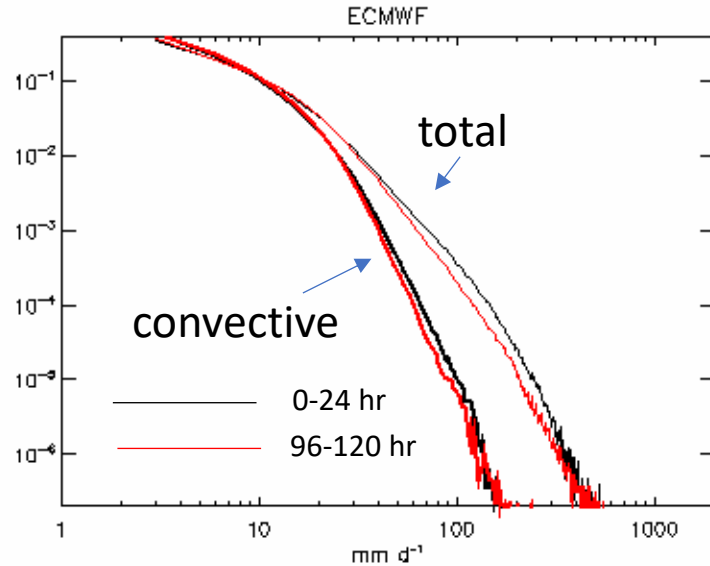


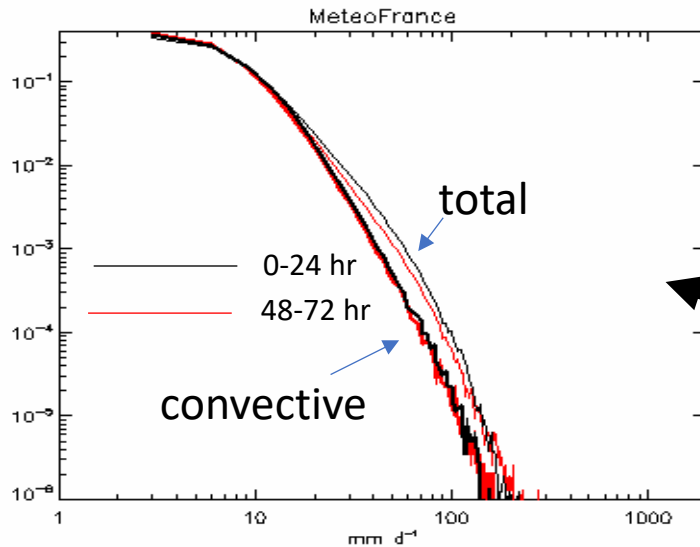
FIG. 11. PDFs of tropical precipitation for (a) CAM4 0.23×0.31 , (b) CAM5 0.23×0.31 , and (c) CAM5 0.9×1.25 . Solid lines show PDFs of total precipitation as in Fig. 10. Dashed lines show PDFs of precipitation produced by deep and shallow convection parameterizations.

Precip PDFs 2016-01

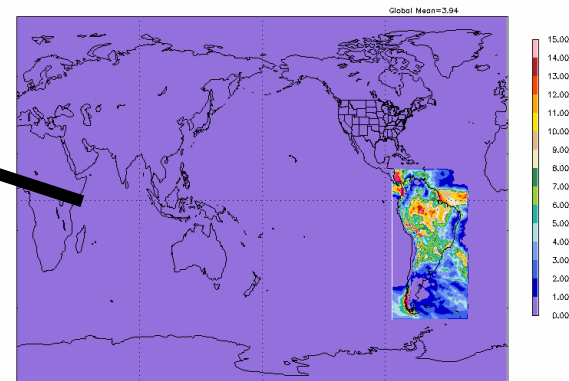


MeteoFrance may behave like ECMWF and CAM but need to look beyond limited region

Meteo Fr. Precip PDFs 1/20182018-01



Haven't yet checked this region in ECMWF and ICON



Summary

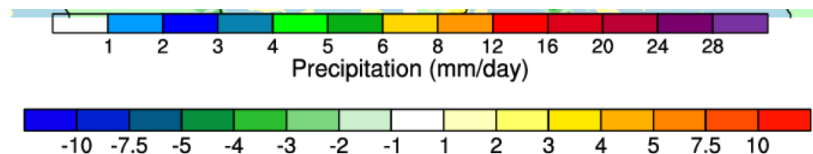
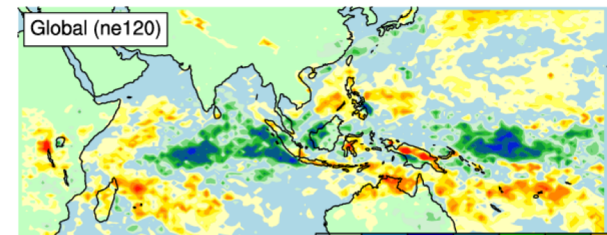
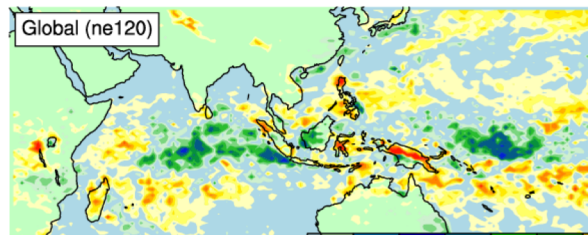
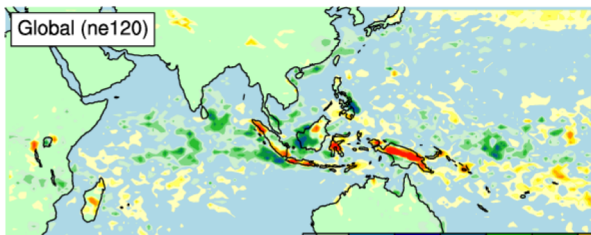
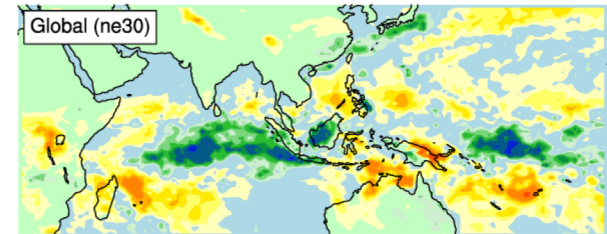
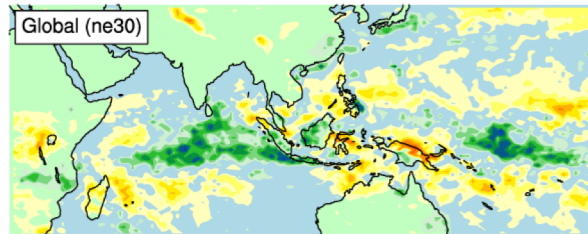
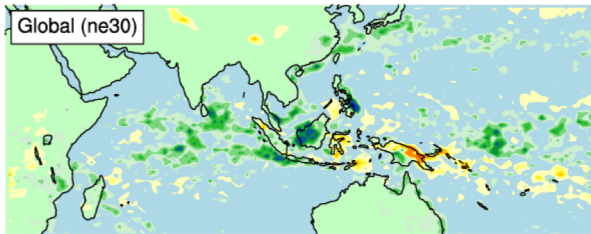
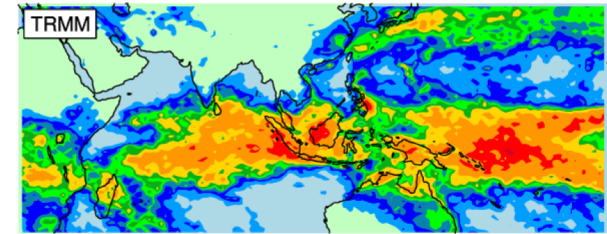
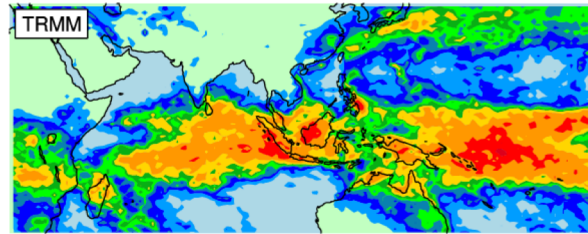
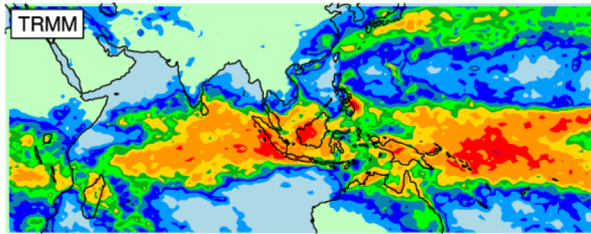
- Some interesting agreements between models
- Topographic detail worth exploring more carefully
- Interesting convective/large-scale behavior

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