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# Evaluation of RegCM4 simulations over South America CORDEX domain – focusing on the AMZ and LPB Basins

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# *Introduction*

- RegCM4 (Giorgi et al., 2012) has been largely used over South America continent (SA)
  - Present climate
  - Future climate
  - Impact studies
  - ...
- Climate over SA is affected by local climate feedbacks (e.g. soil moisture) as well as large scale climate patterns (e.g. associated with sea surface temperature)



- La Plata Basin (LPB) is the fifth most extend basin in the world, the second largest in SA, and covers parts of five countries

- Amazon Basin (AMZ) is on of the most important watershed on the planet and contains one of the largest areas of tropical rain forests on Earth (Foley et al. 2002)

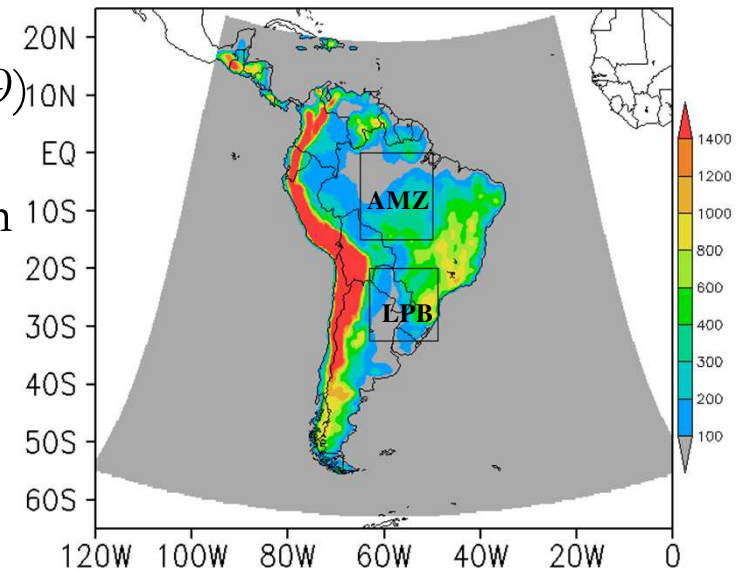


## *The aim is ...*

- Evaluation of three RegCM4 simulations over South America CORDEX domain, using different: resolution, parametrization and model version
  - focusing on AMZ and LPB basins
- ✓ Show that even if not identical the tuned model version of any version work well over SA
- ✓ And there is no meaning in using the exact model setting when model version or resolution is changed

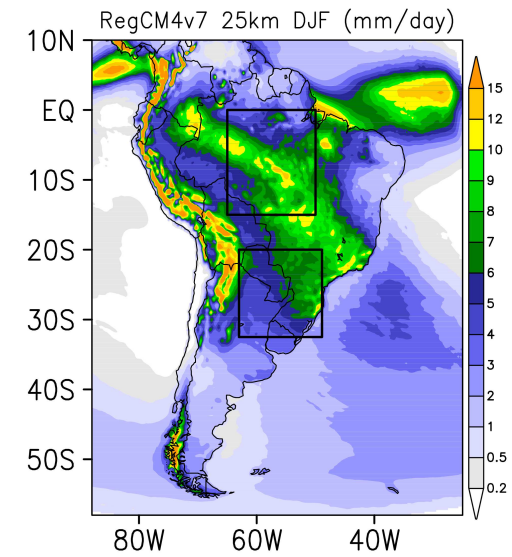
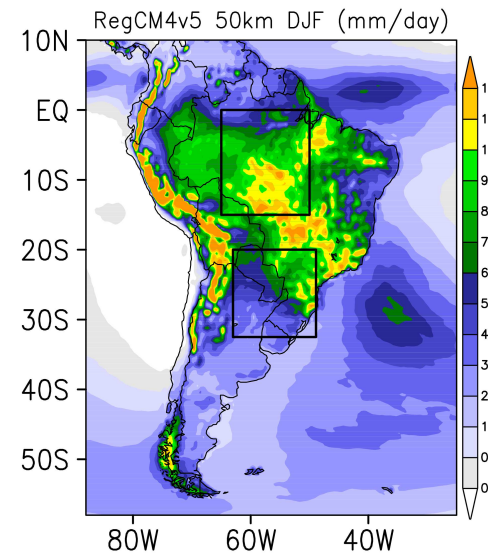
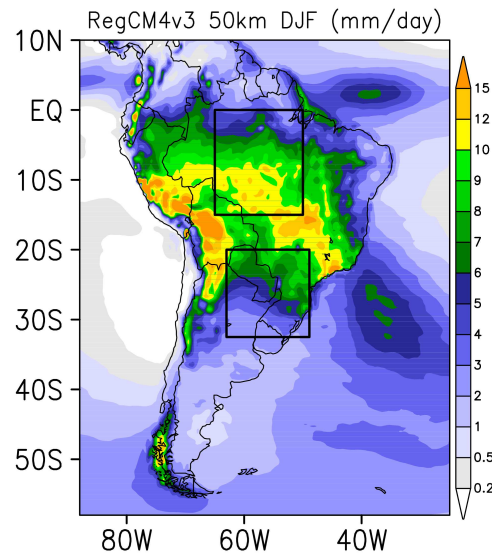
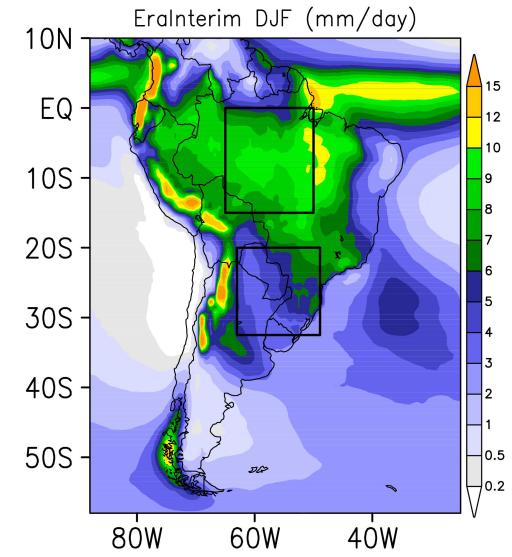
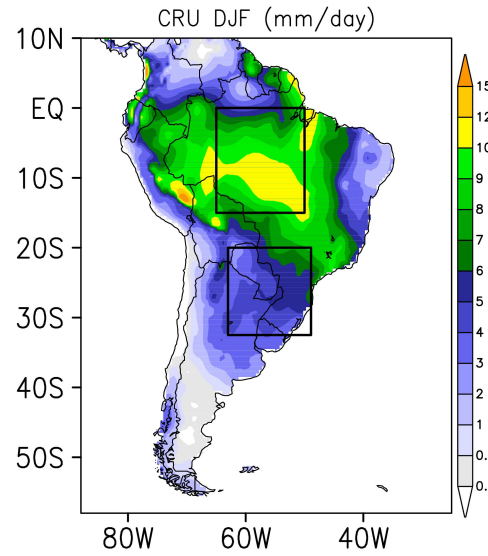
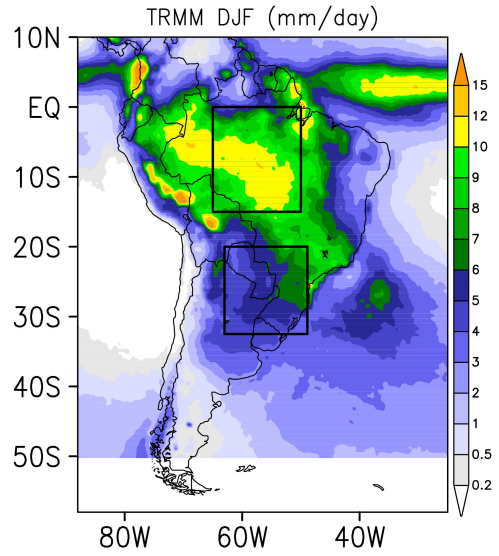
# Experiments set-up

- CORDEX domain specifications (Giorgi et al., 2009)
- Three RegCM4 simulations (all simulations has been tuned to better capture the SA climate)
- All simulations were driven by Era Interim (EIN75)
- Data used to validation:
  - **Precipitation:** CRU, TRMM and EIN75
  - **Temperature:** CRU and EIN75

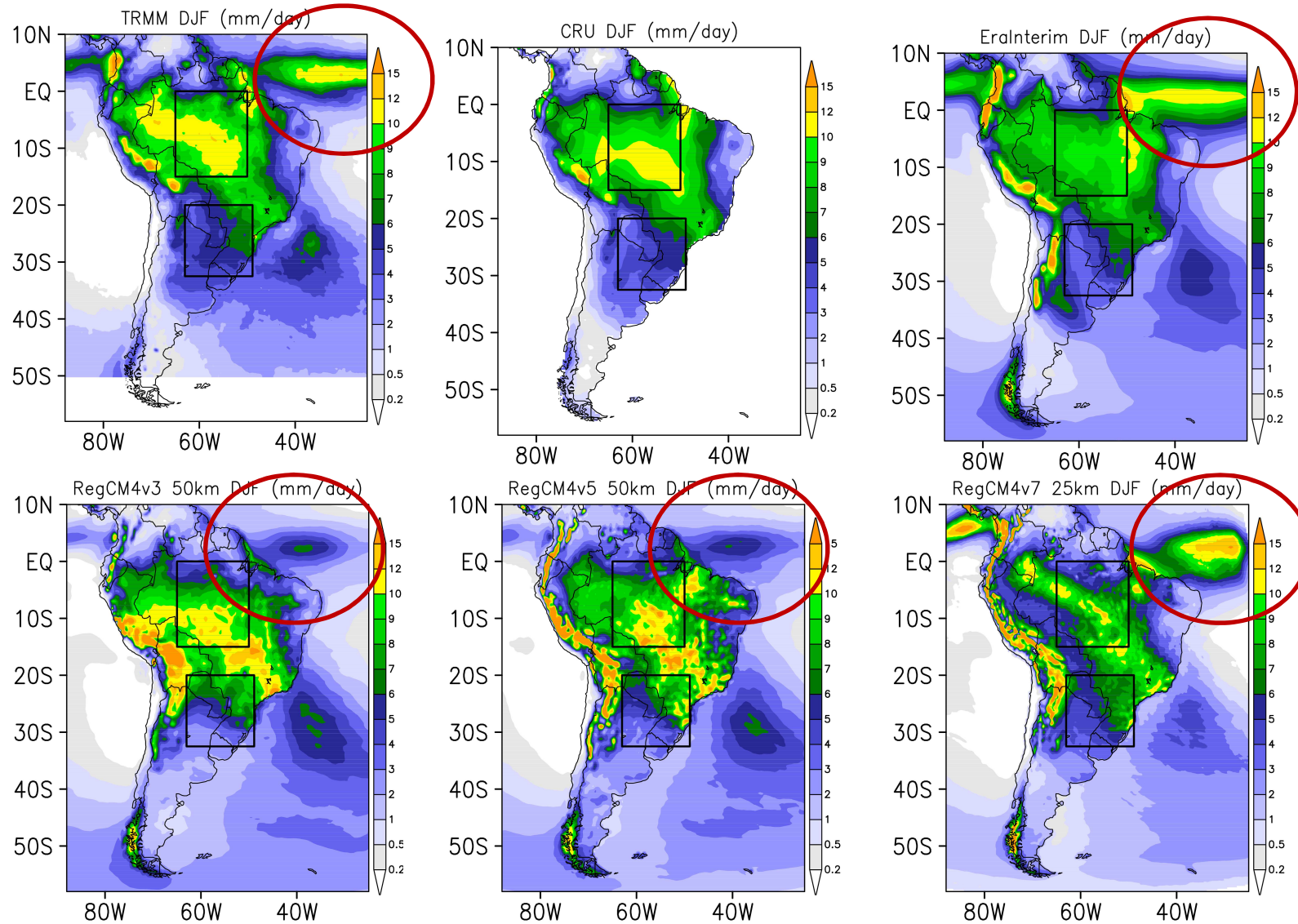


Experiments Acronyms	Land Surface Scheme	Cumulus Convection Scheme	Simulation Period	Resolution
RegCM4.3	CLM3.5	Emanuel	1979-2009	50 km
RegCM4.5	CLM4.5	Emanuel	1979-2009	50 km
RegCM4.7	CLM4.5	Tiedke (land) Kain Fritsch (ocean)	1979-2015	25 km

# Precipitation Climatology (DJF)

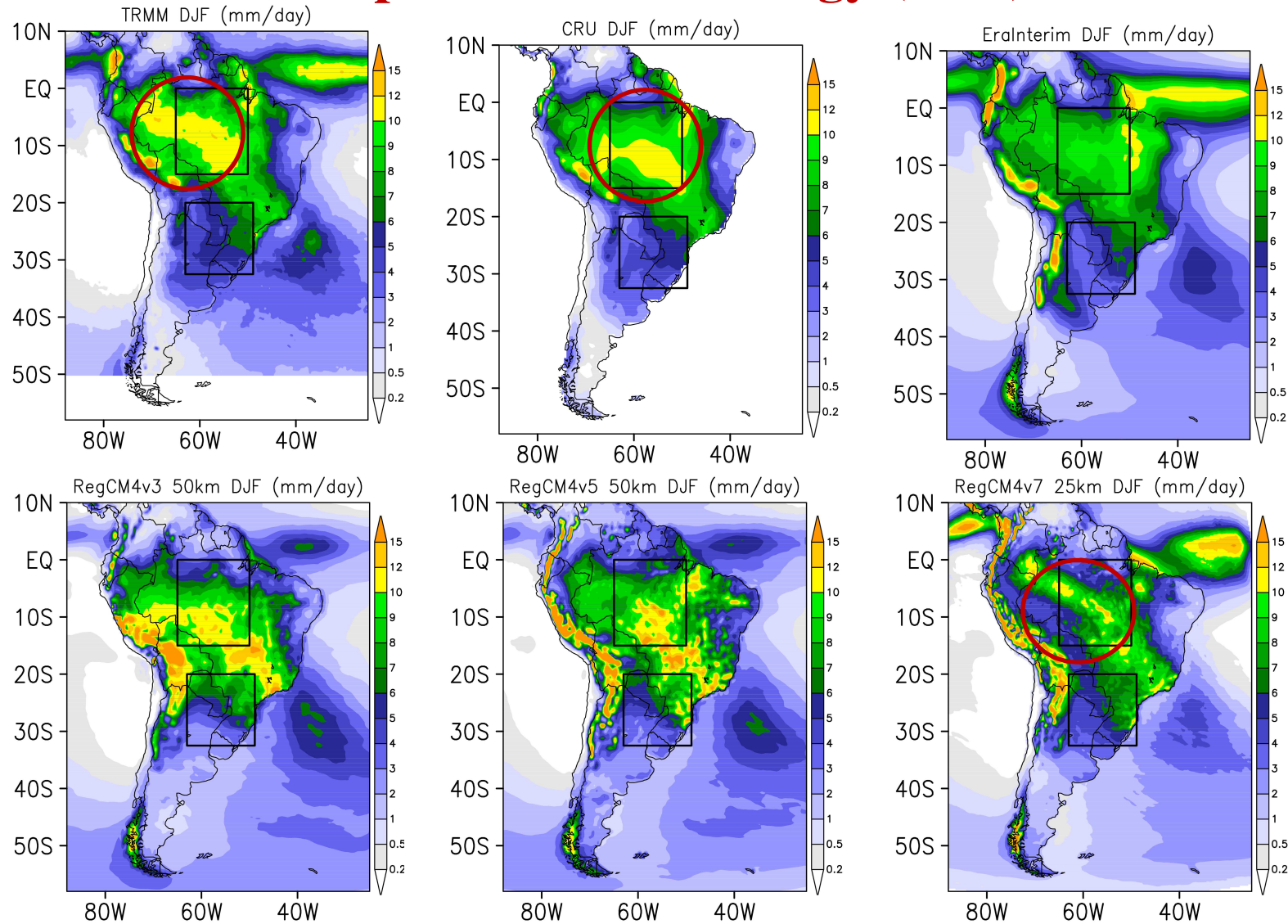


# Precipitation Climatology (DJF)



**Intertropical Convergence Zone (ITZC) – better simulated by RegCM4.7**

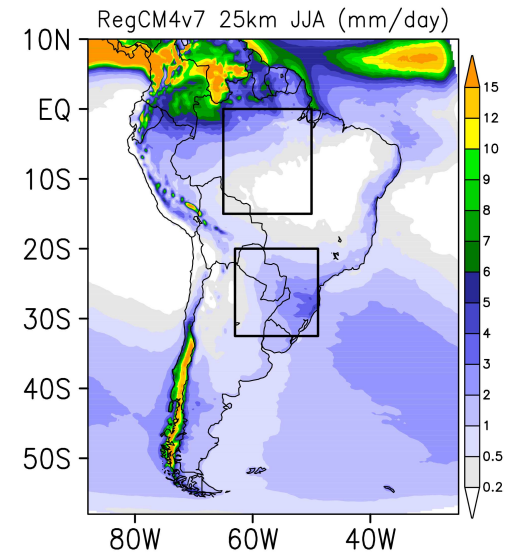
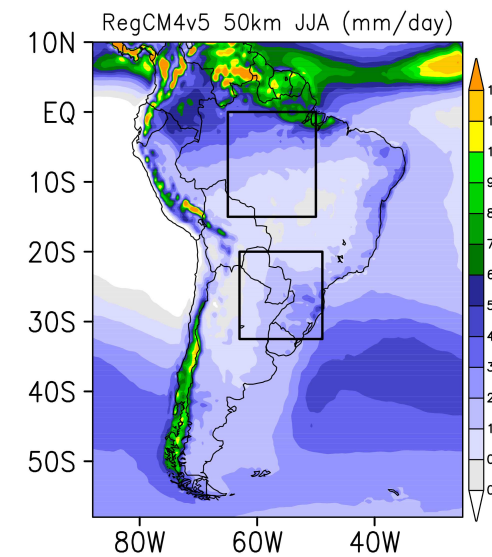
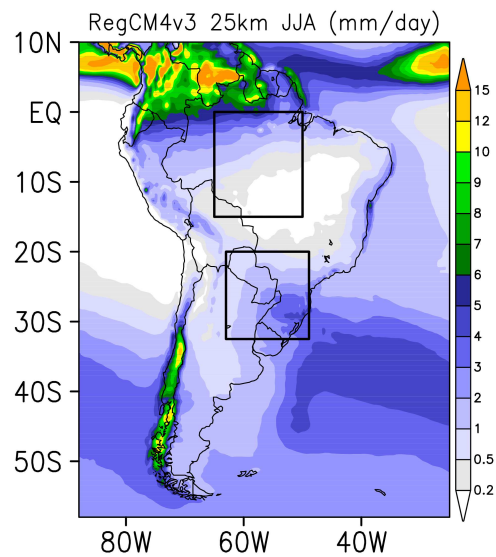
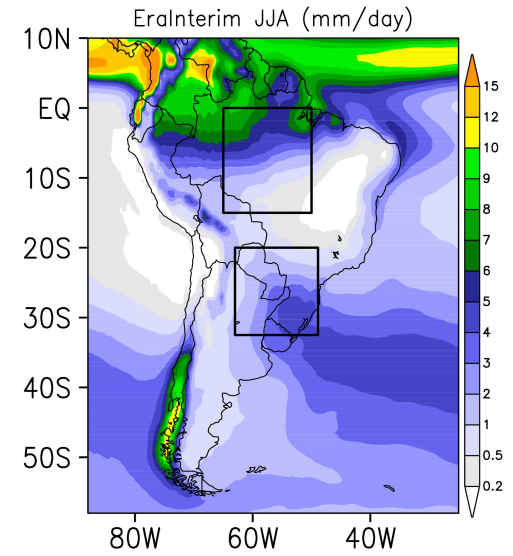
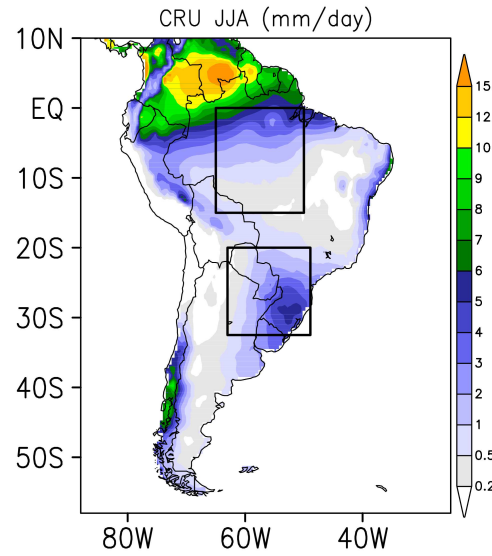
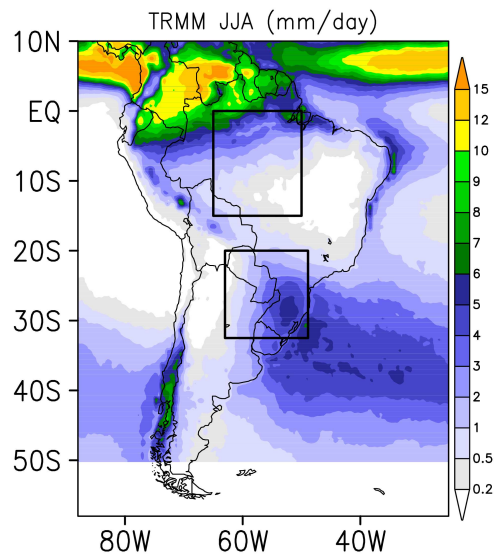
# Precipitation Climatology (DJF)



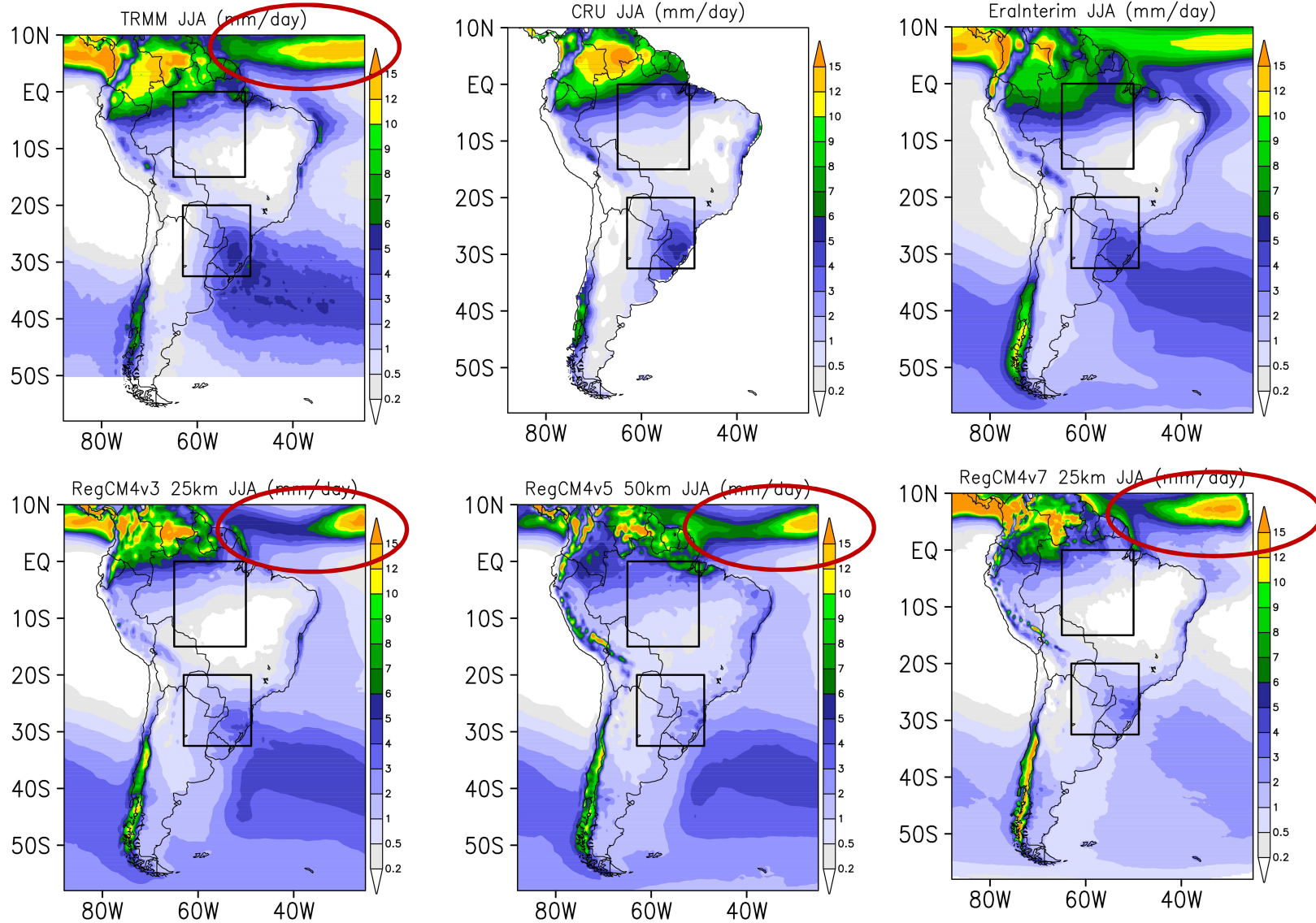
**South Atlantic Convergence Zone (SACZ) – In RegCM4.7 is narrow**



# Precipitation Climatology (JJA)

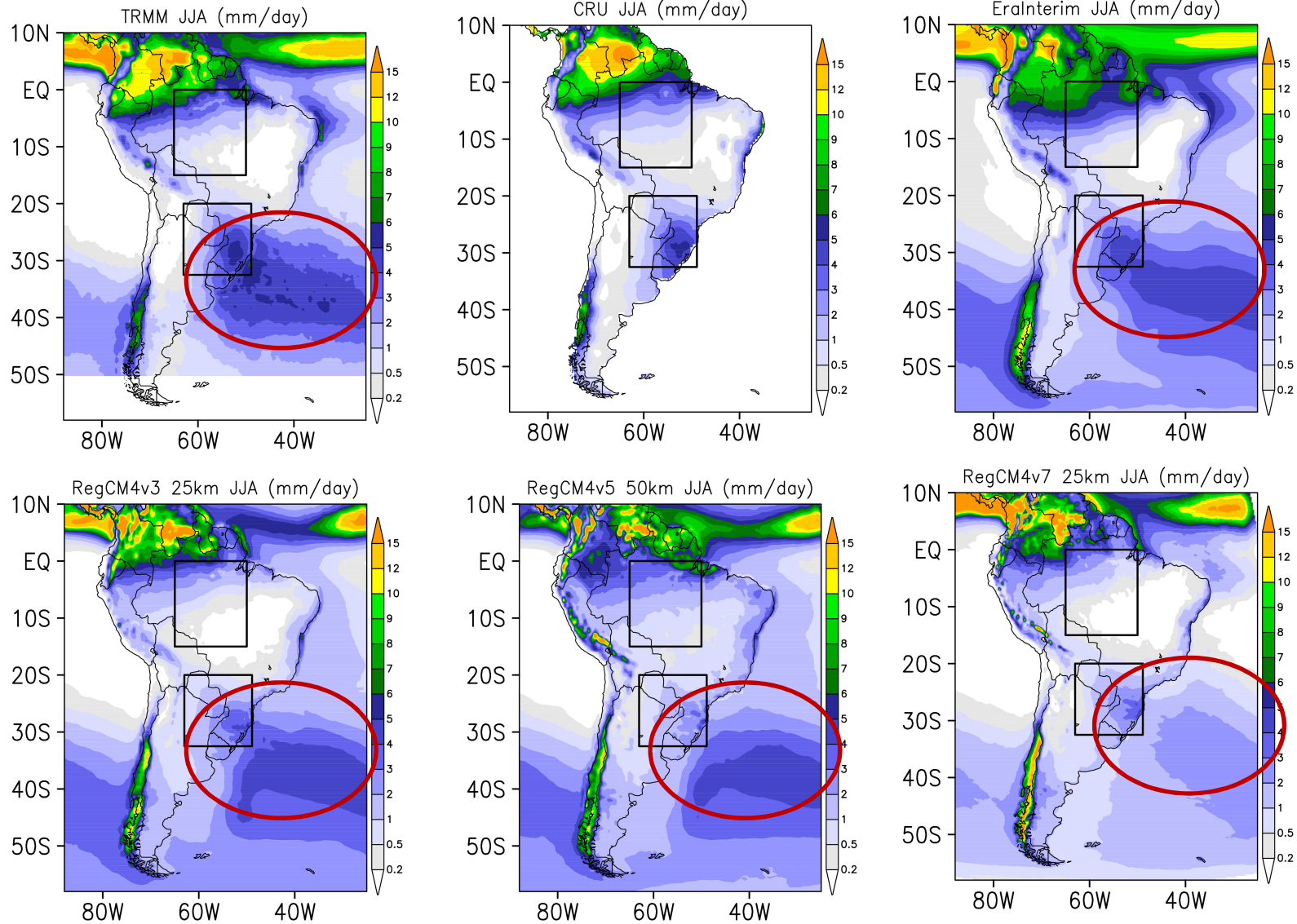


# Precipitation Climatology (JJA)



**Intertropical Convergence Zone (ITCZ) – better simulated by RegCM4V.7**

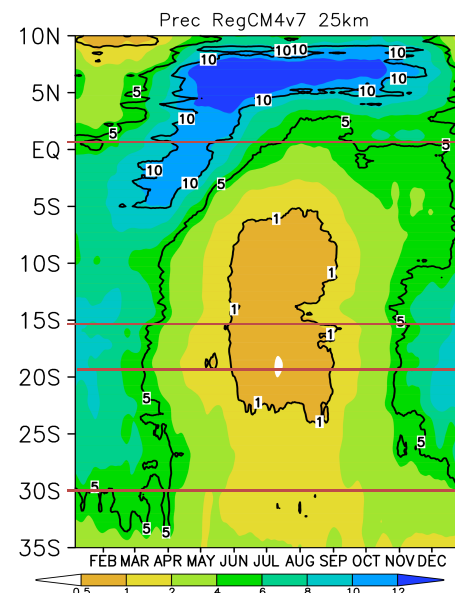
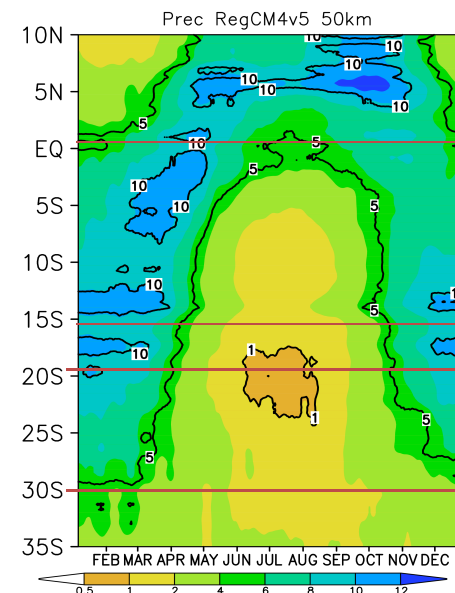
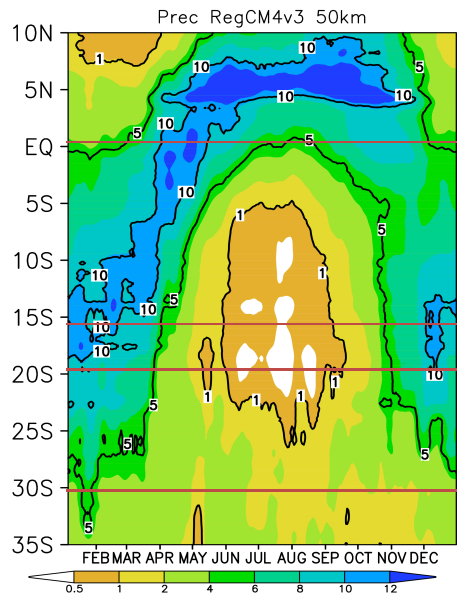
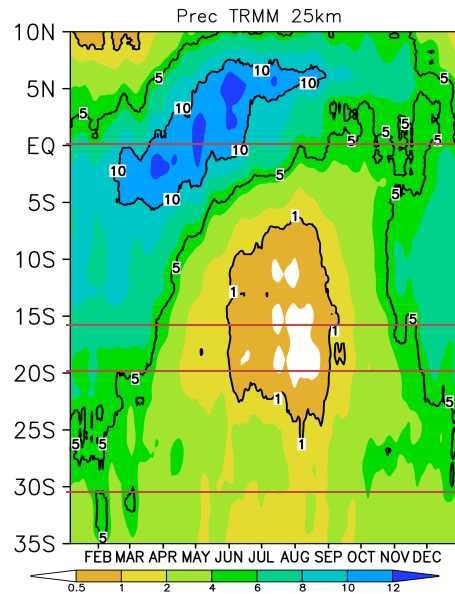
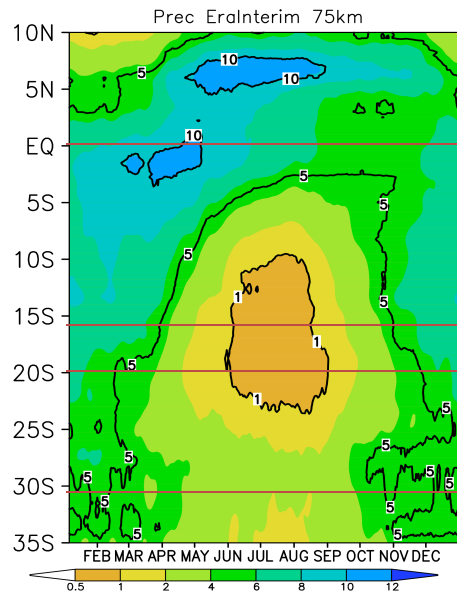
# Precipitation Climatology (JJA)



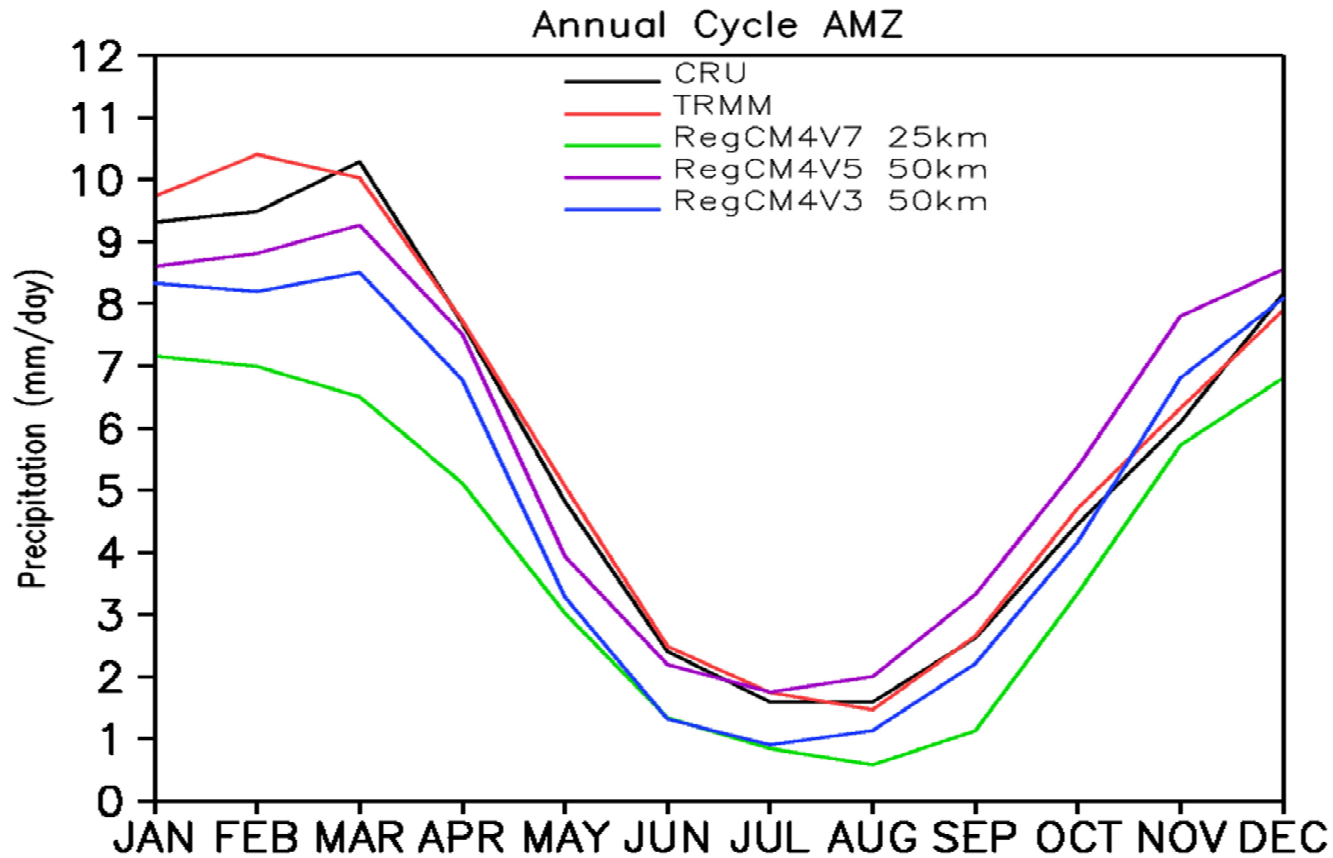
Precipitation associated with cold fronts and cyclogenesis (see Reboita's talk)

# Hovmoller diagram

- The contour lines illustrate the evolution of the continental convection associated with the retreat and expansion of the South American Monsoon (SAM) system (Vera et al. 2006).

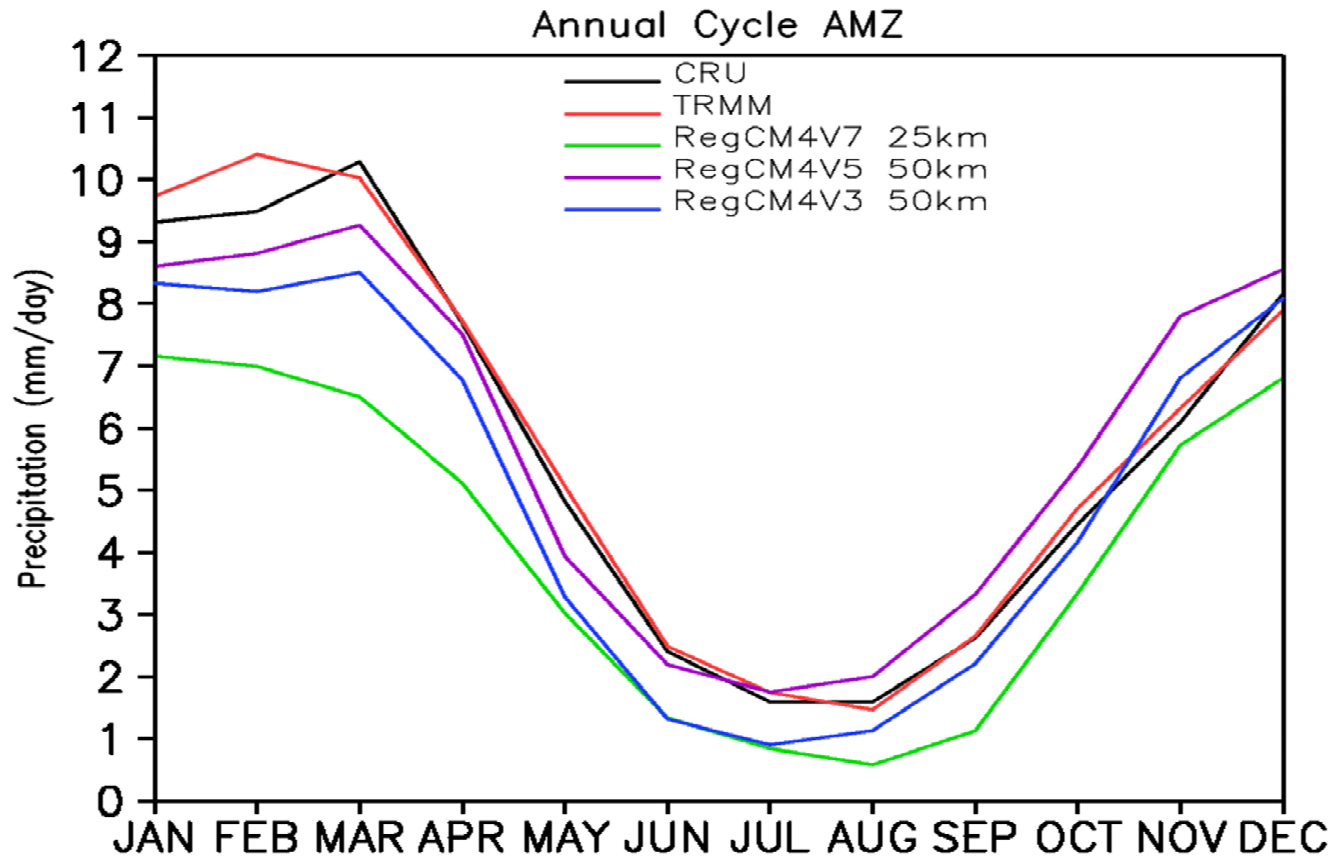


**Annual cycle of observed and simulated precipitation averaged over the AMZ region**



Over the Amazon the seasonal precipitation is marked

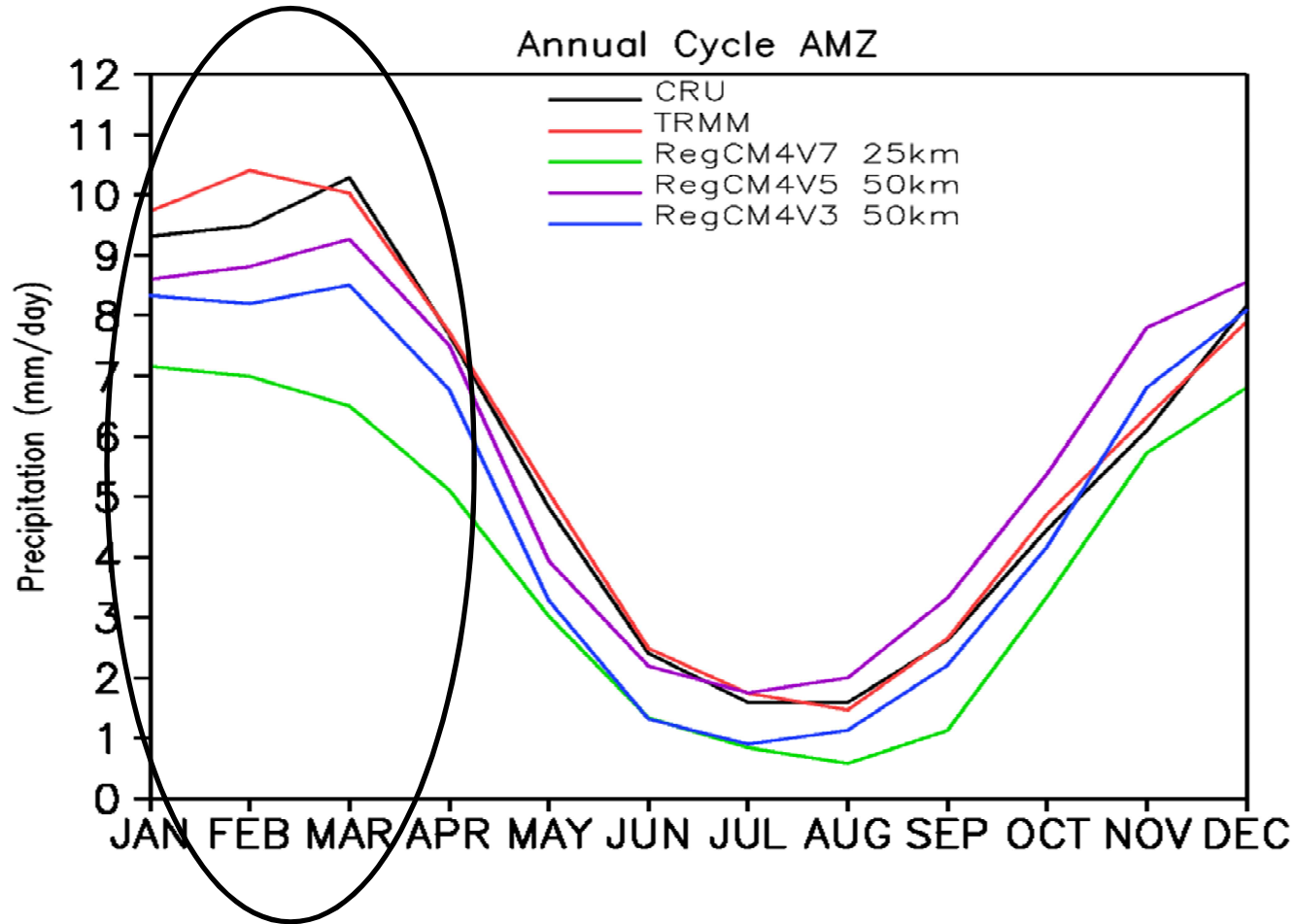
## Annual cycle of observed and simulated precipitation averaged over the AMZ region



Precipitation is underestimated by all simulations throughout the year

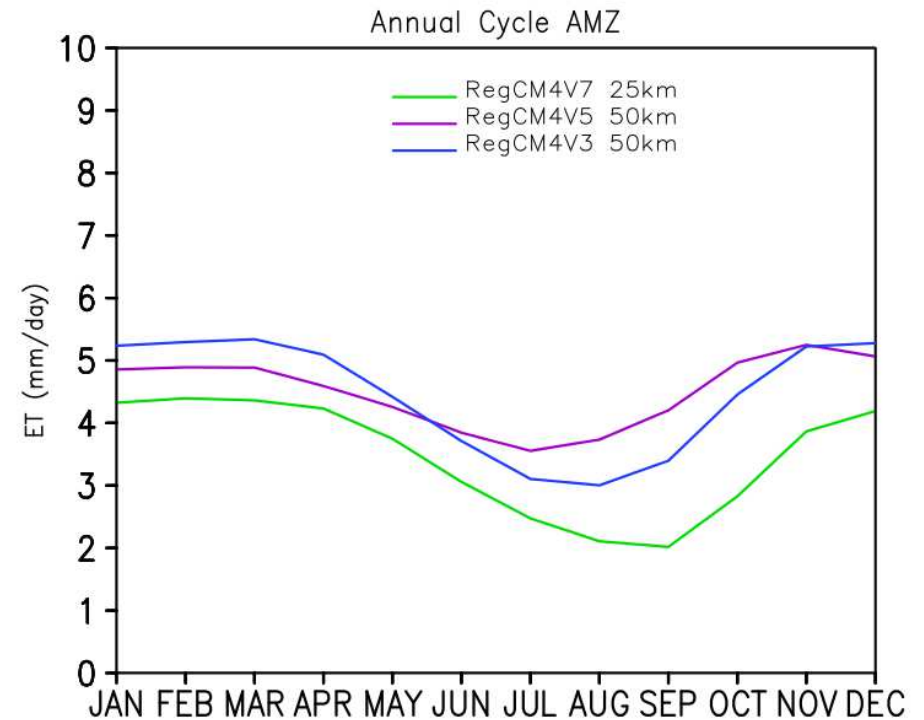
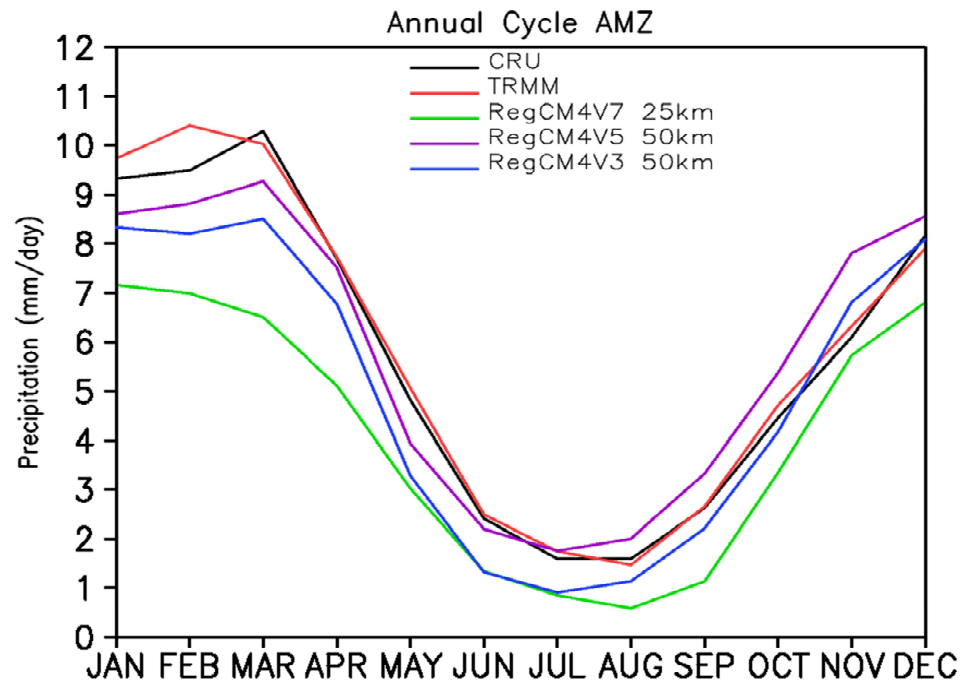
- except for RegCM4.5 from July to December (purple line)
- except for RegCM4.3 from October to December (blue line)

**Annual cycle of observed and simulated precipitation averaged over the AMZ region**



Precipitation is underestimated by all simulations mainly during the peak of monsoon phase

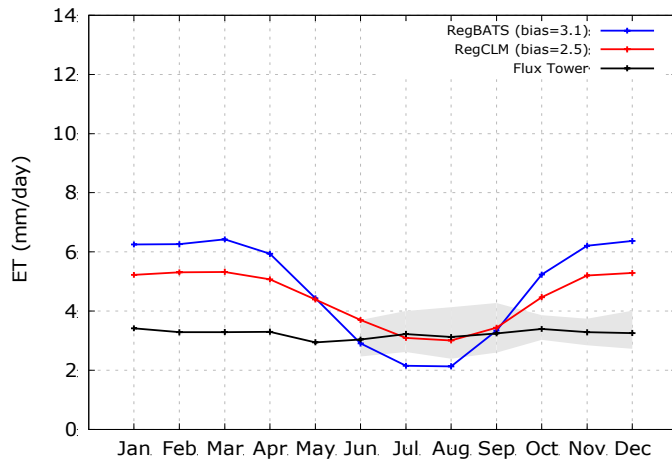
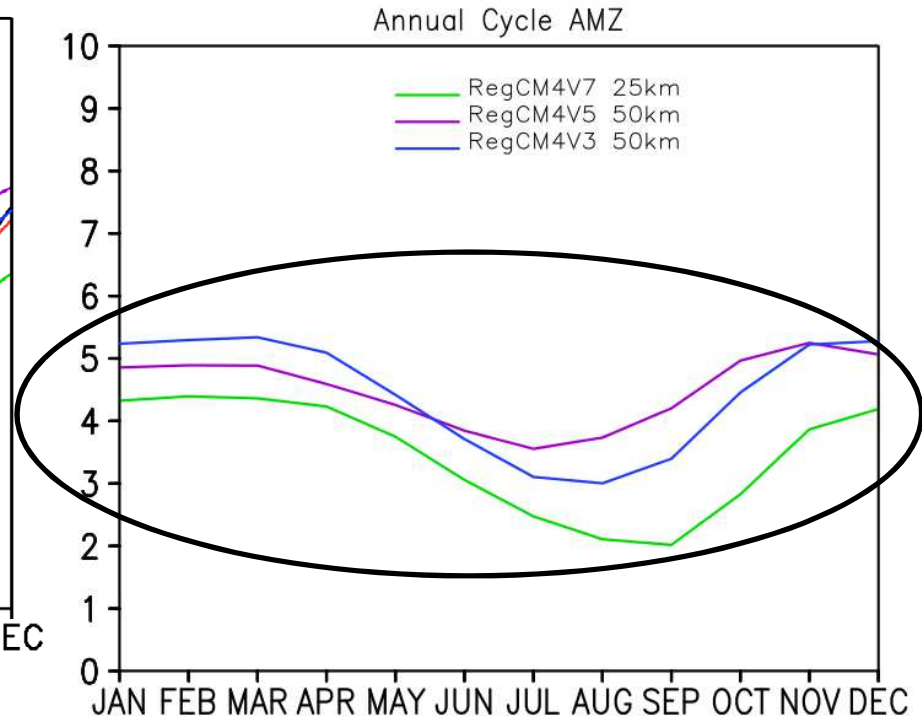
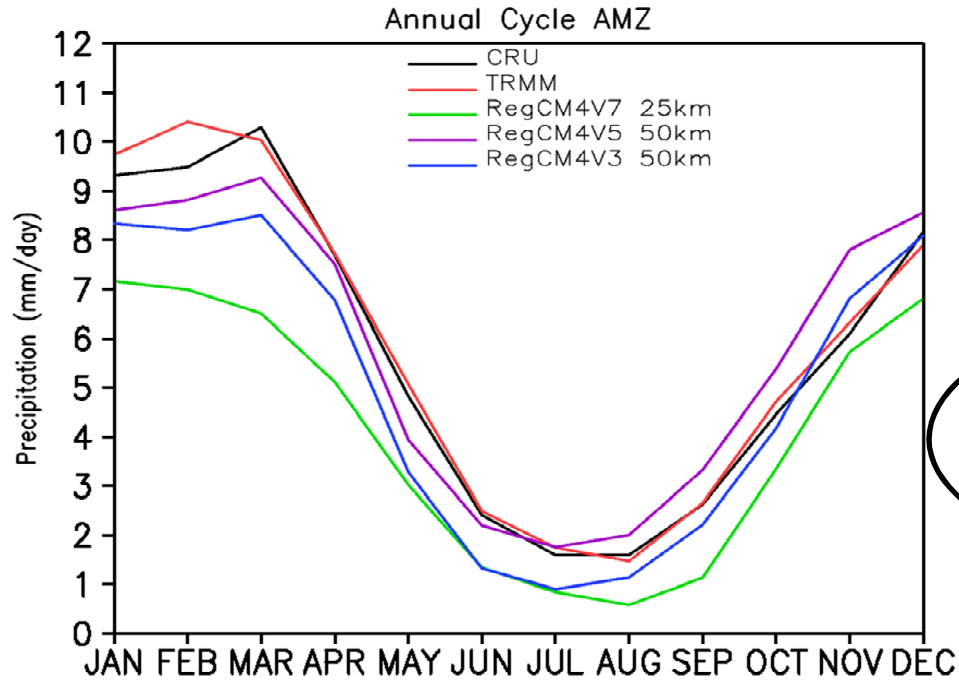
## Annual cycle of observed and simulated precipitation and evapotranspiration averaged over the AMZ region



In general the precipitation follows the shape of ET



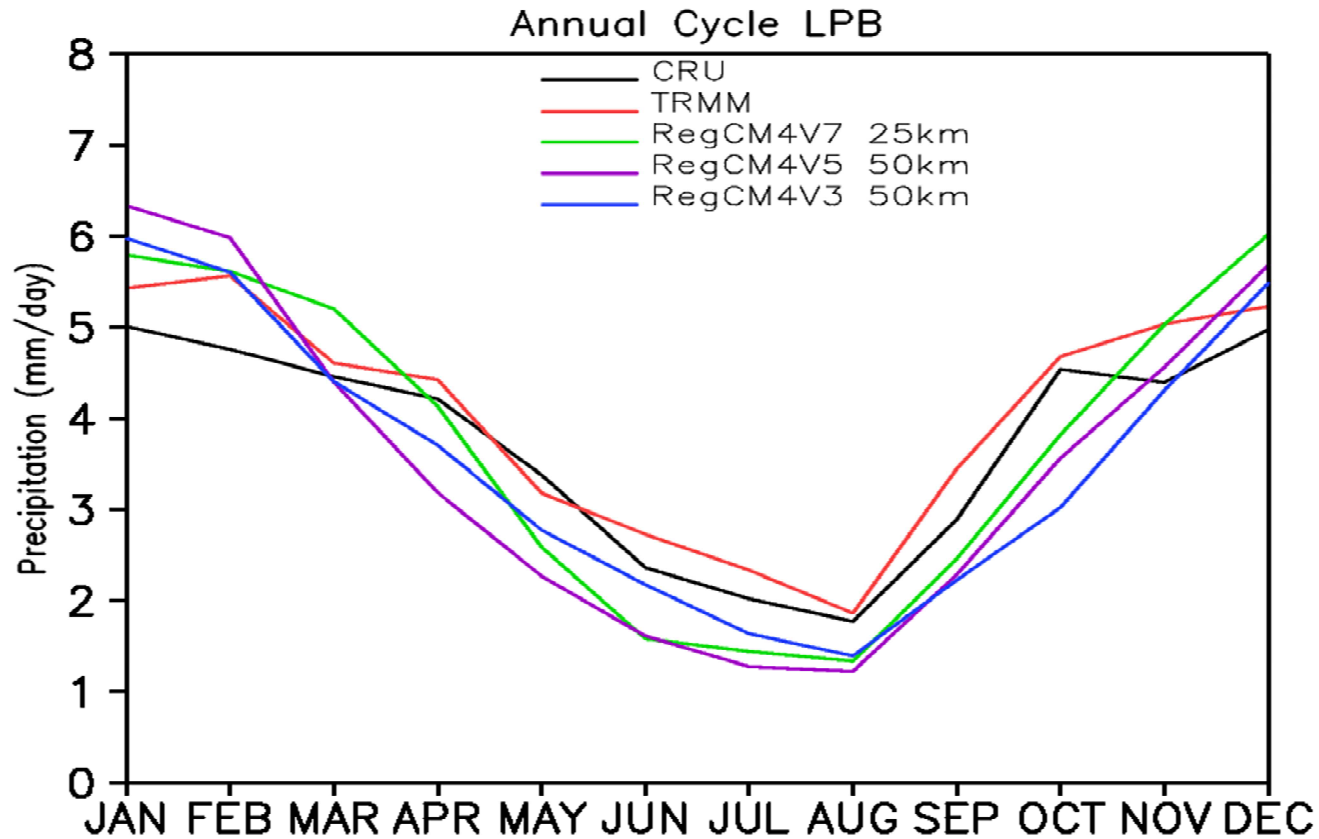
# Annual cycle of observed and simulated precipitation and evapotranspiration averaged over the AMZ region



Over the AMZ region the values of observed ET are  $\sim 4 \text{ mmday}^{-1}$

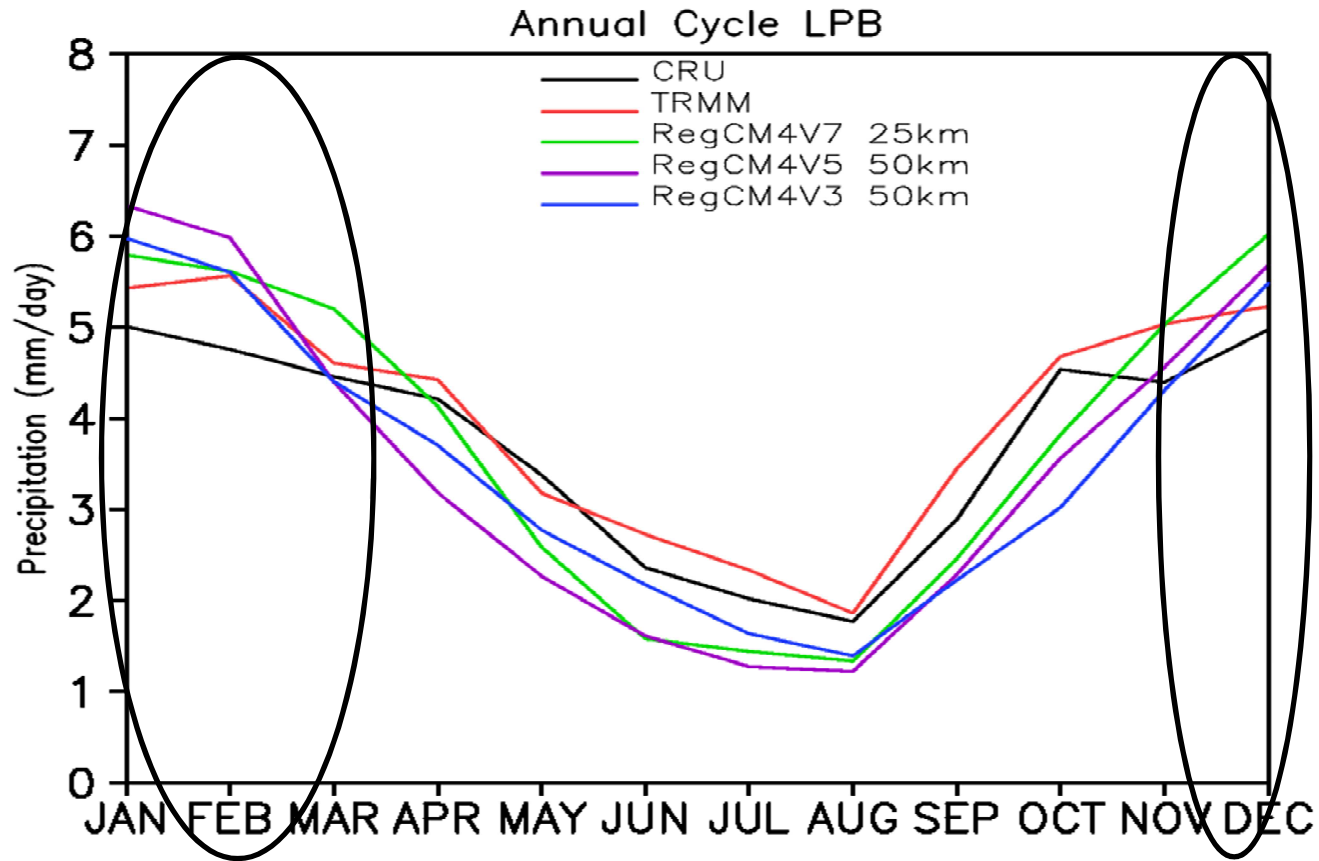
Llopart et al., 2017  
C. Dynamics

**Annual cycle of observed and simulated precipitation averaged over the LPB region**



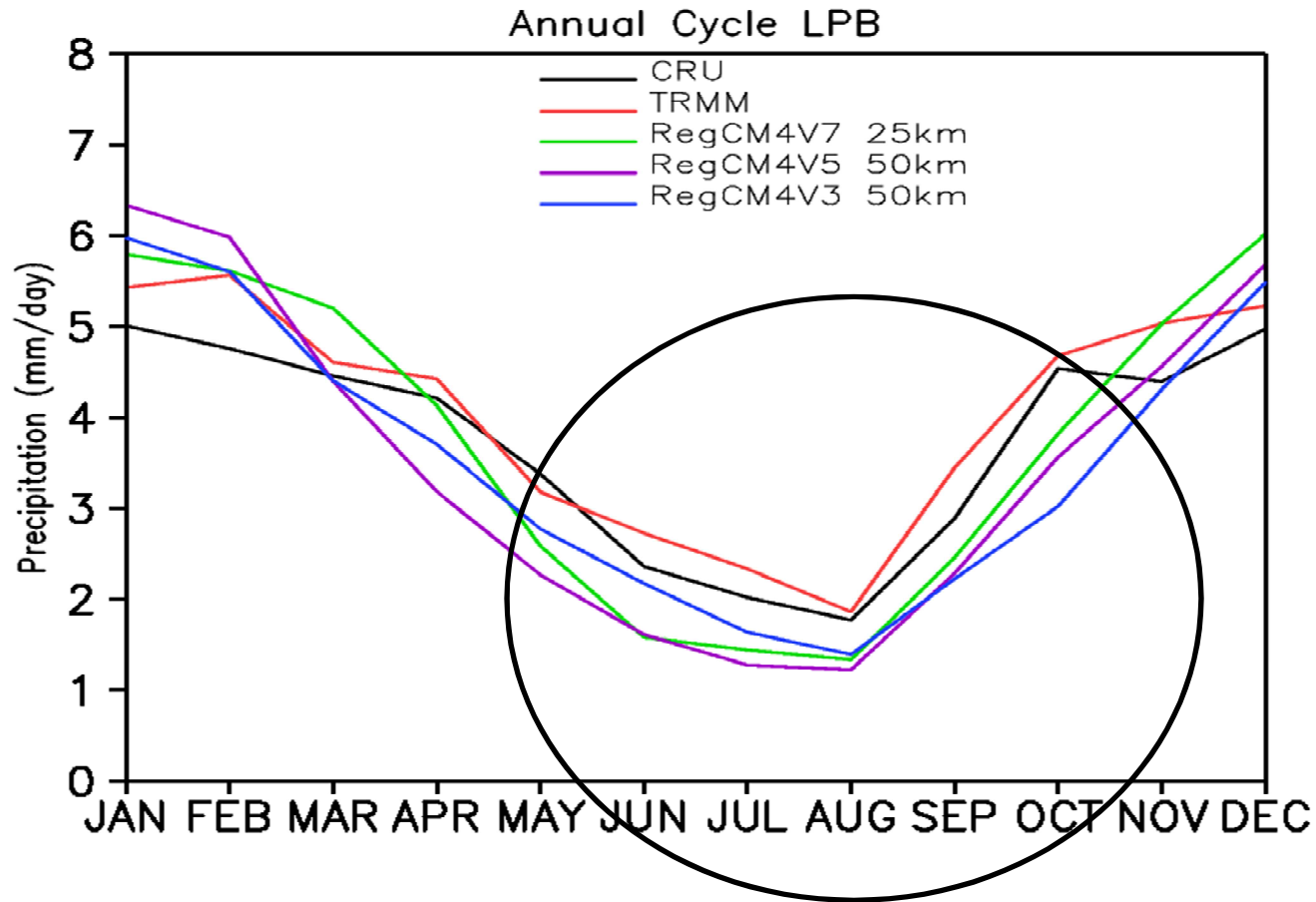
Over the LPB basin the annual cycle seasonal precipitation of precipitation is less pronounced than in the AMZ, a feature captured by all simulations

**Annual cycle of observed and simulated precipitation averaged over the LPB region**



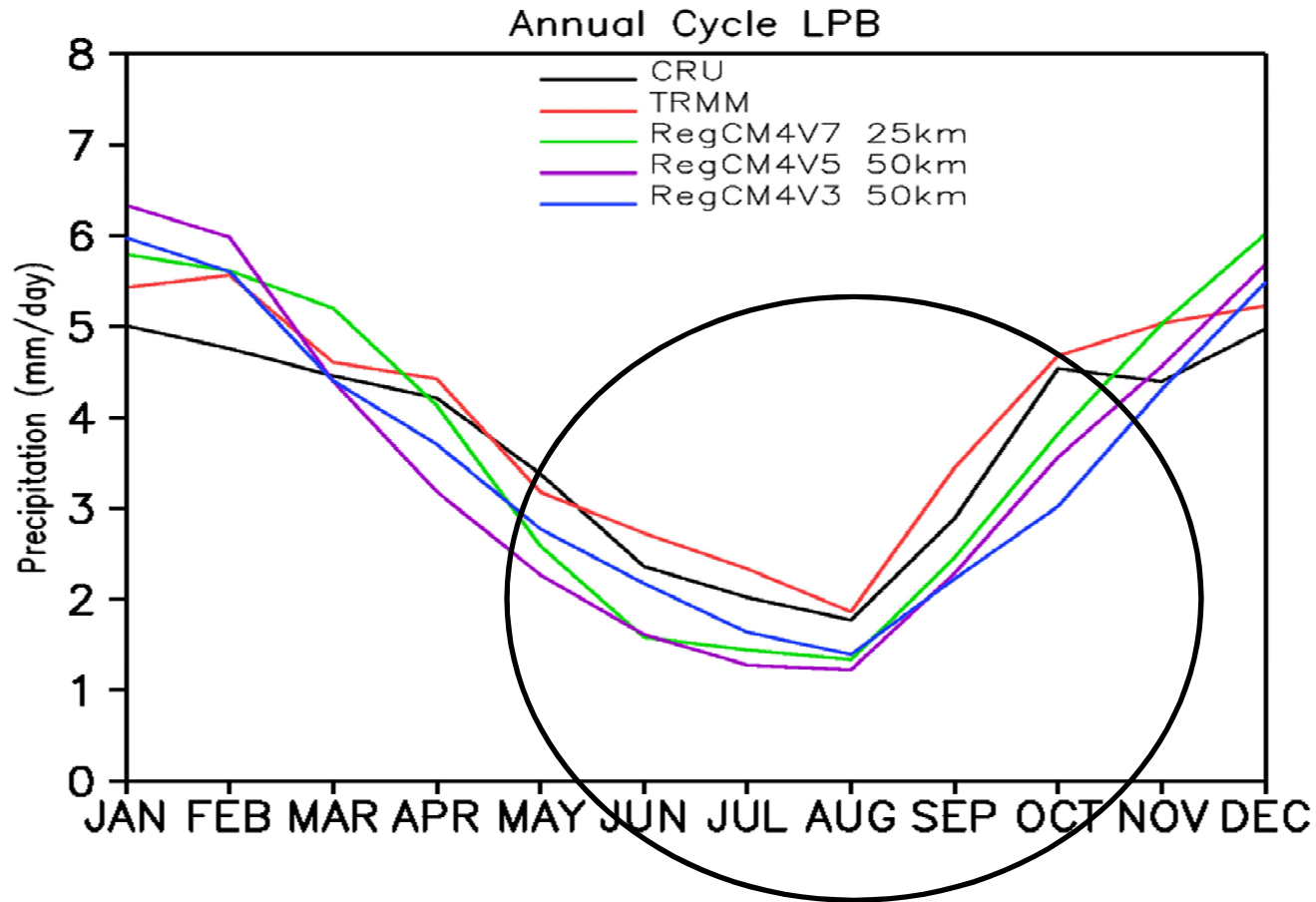
Precipitation is overestimated during the mature monsoon phase

**Annual cycle of observed and simulated precipitation averaged over the LPB region**



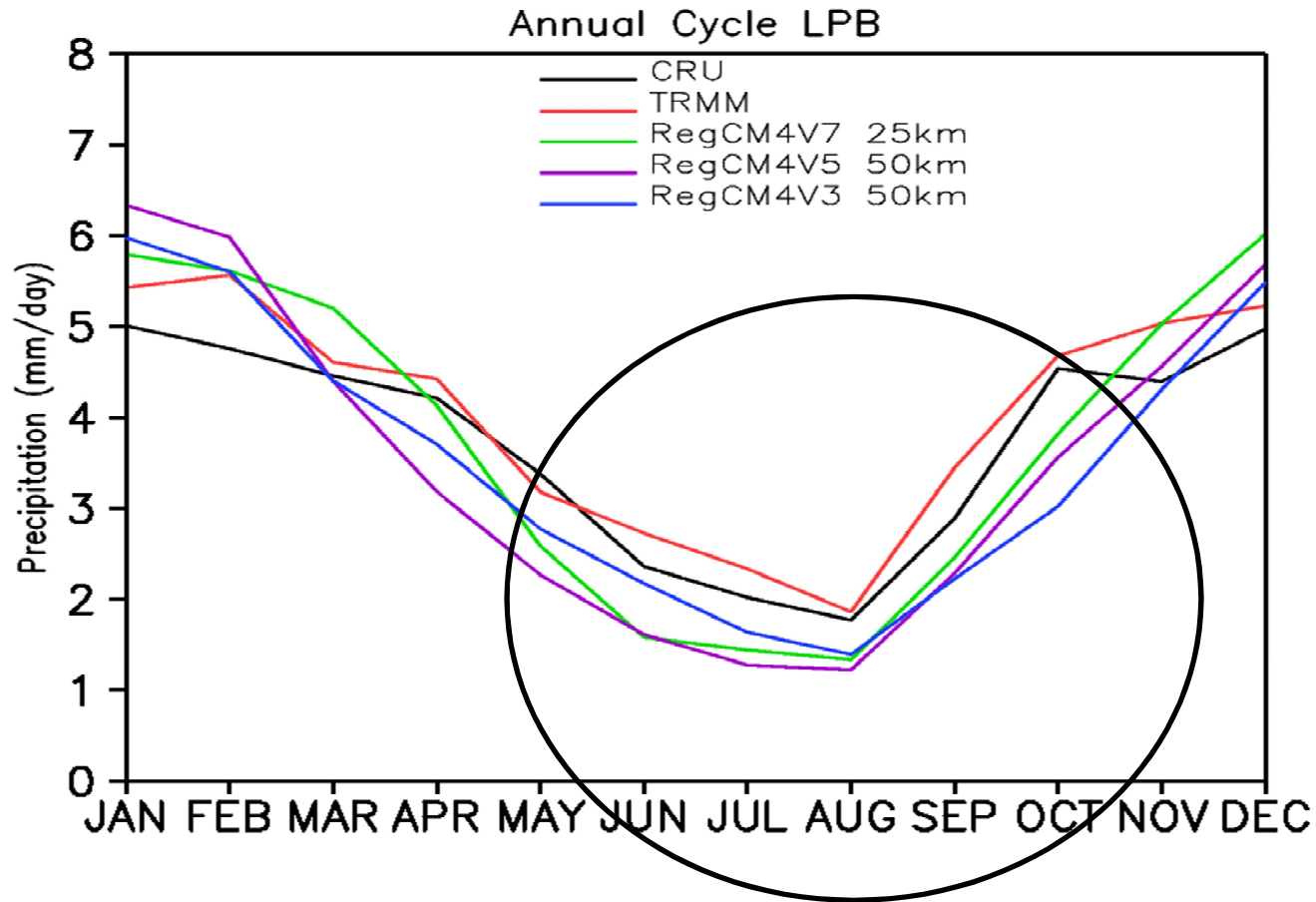
Precipitation is underestimated from May to November by all simulations

**Annual cycle of observed and simulated precipitation averaged over the LPB region**



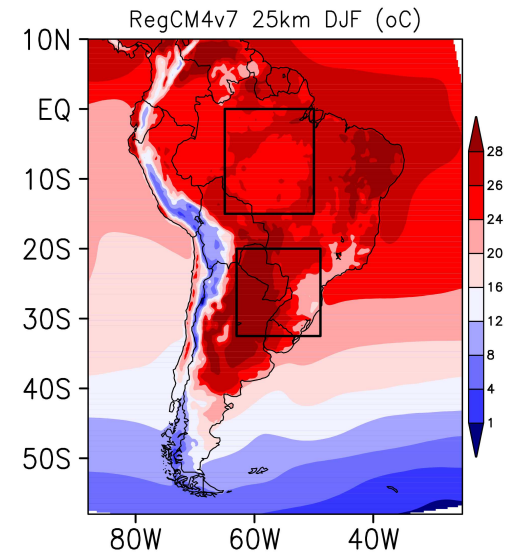
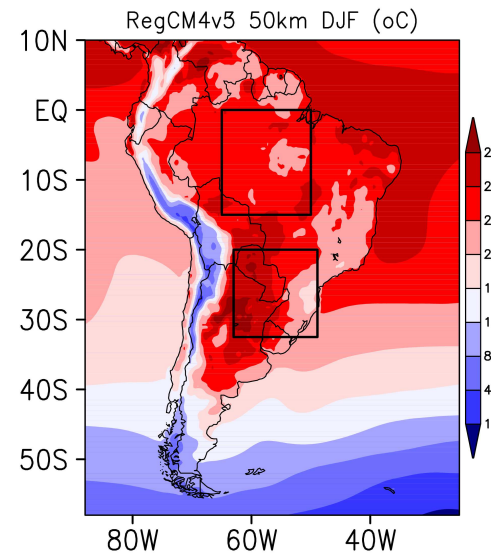
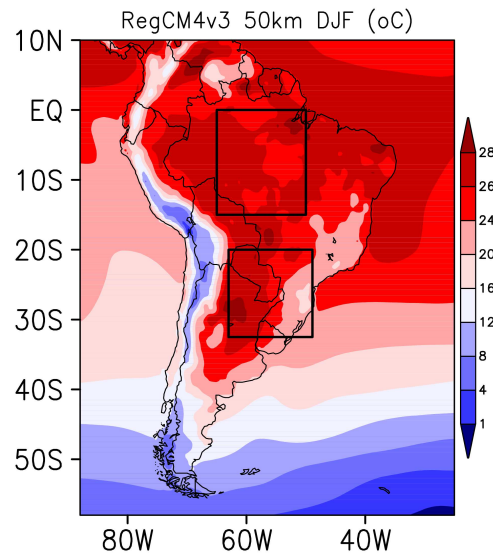
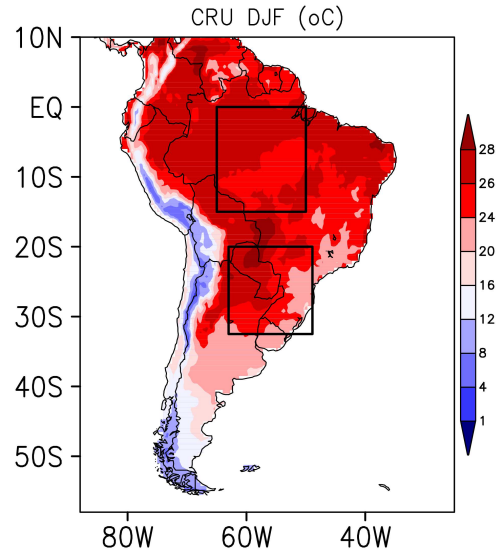
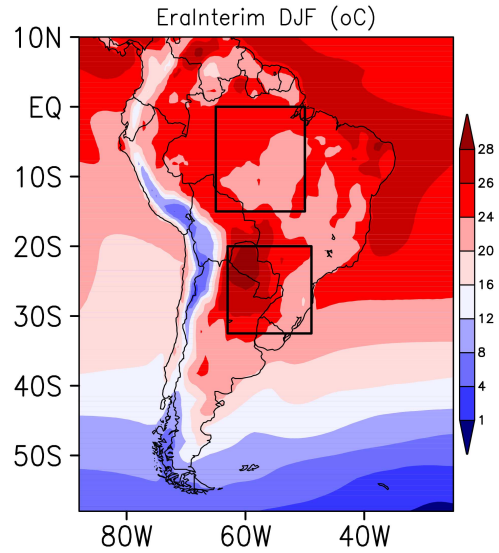
Precipitation is underestimated from May to November  
a common error of GCMs and RCMs on simulated precipitation over LPB  
(Solman et al., 2013)

**Annual cycle of observed and simulated precipitation averaged over the LPB region**

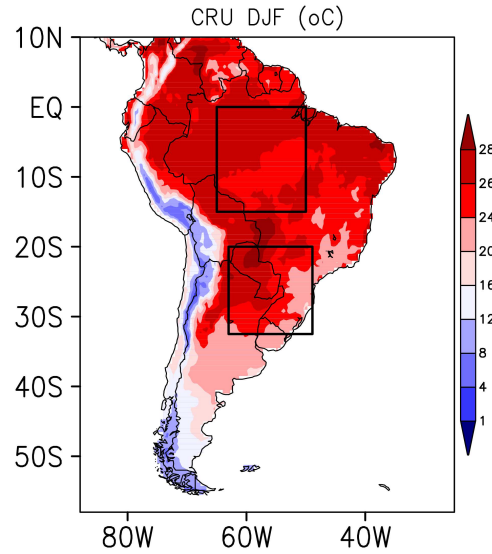
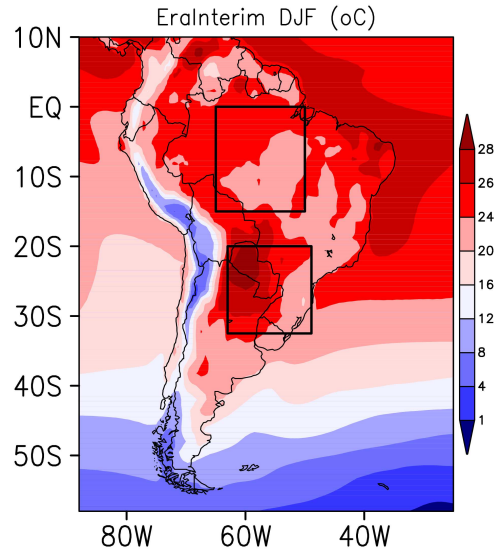


Precipitation is underestimated from May to November  
RegCM4.3(blue line) the precipitation underestimation is associated with less rain during cold front events (de Jesus et al., 2016)

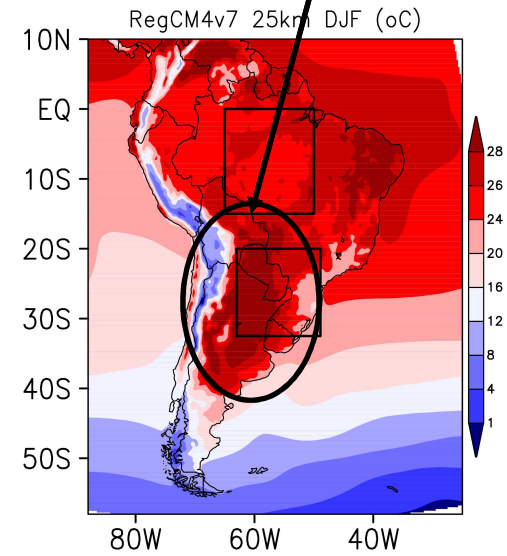
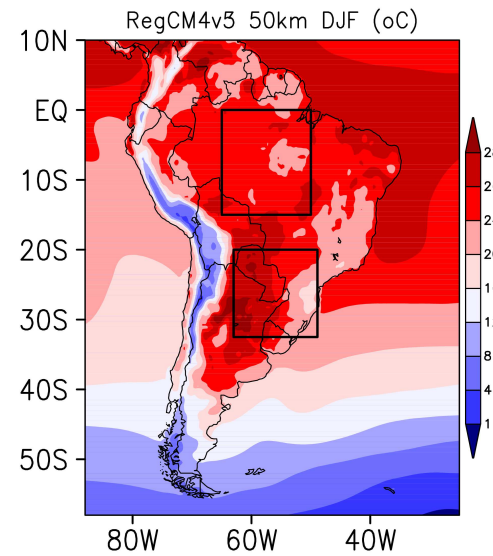
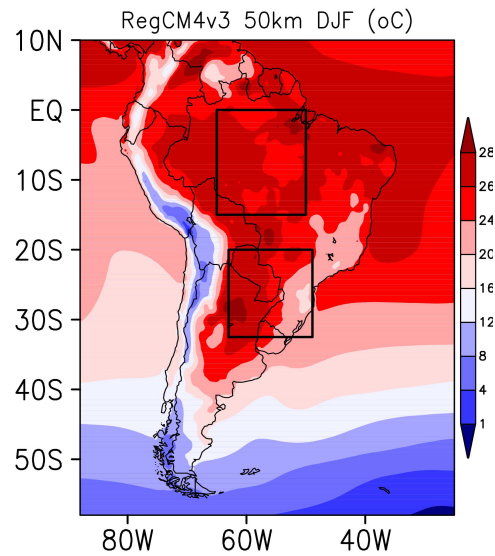
# Air Temperature Climatology (DJF)



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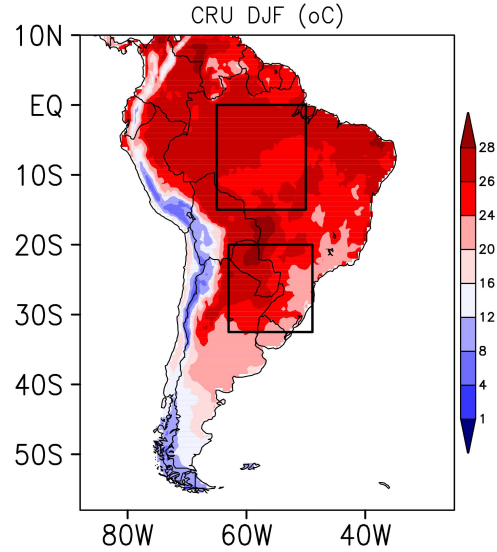
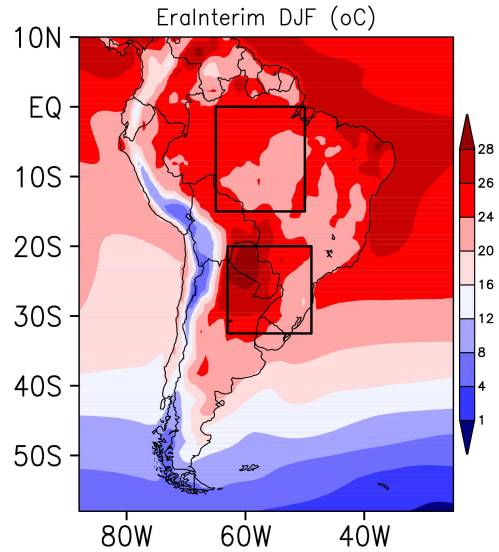


**RegCM4.7 warmer than the others simulations**

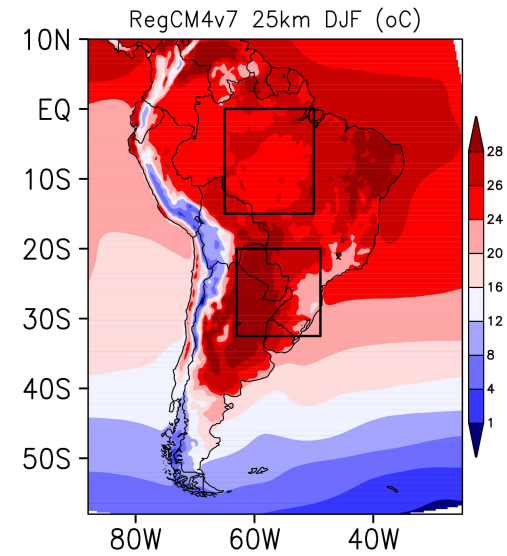
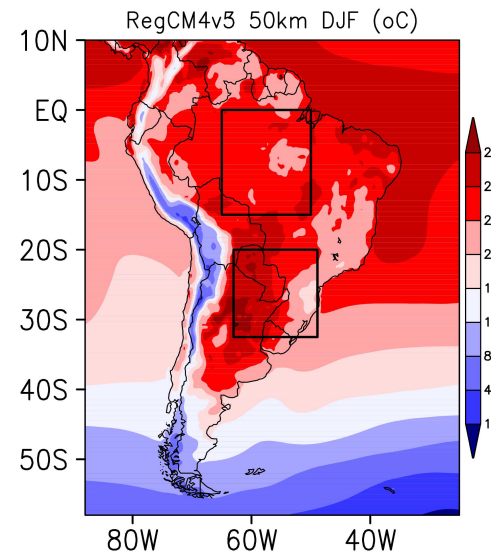
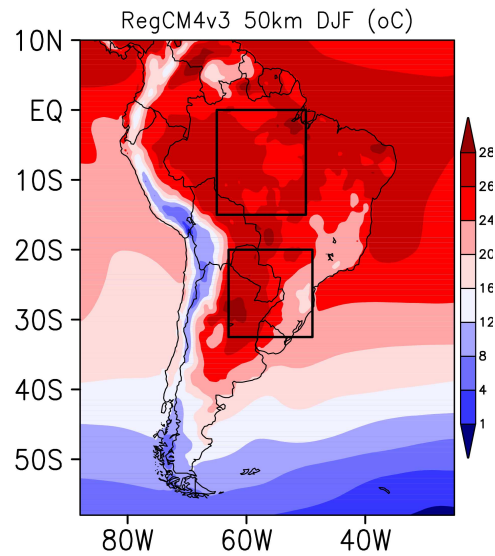




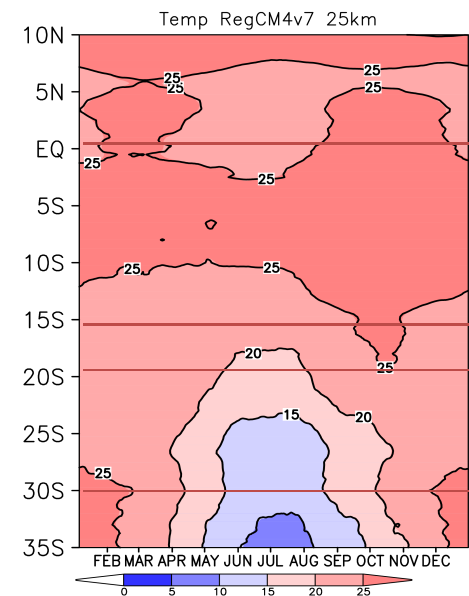
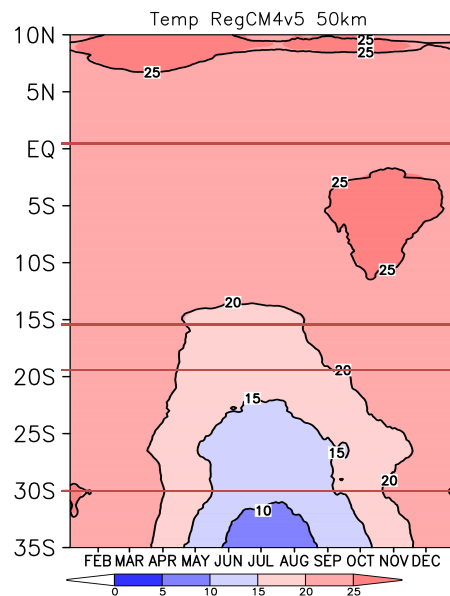
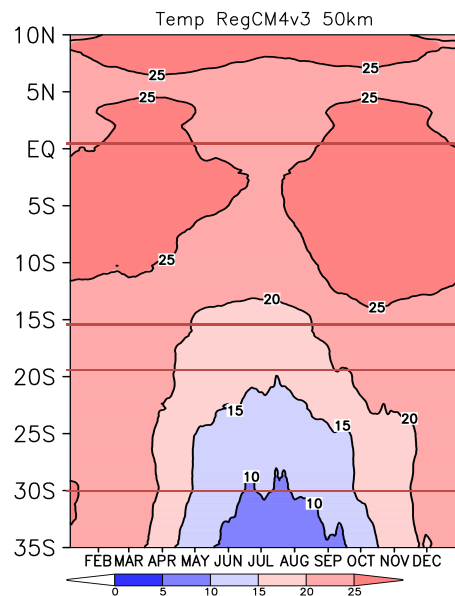
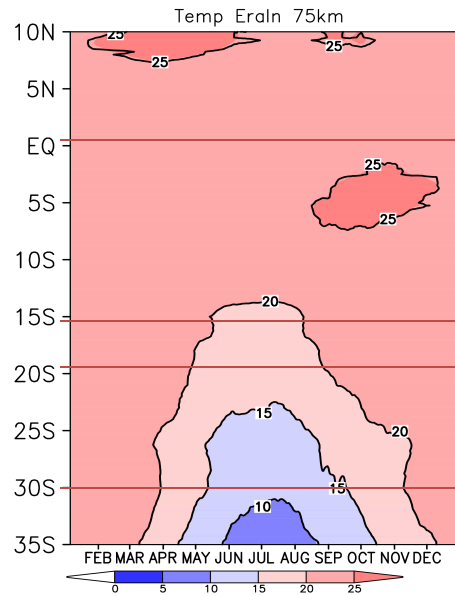
# Air Temperature Climatology (DJF)



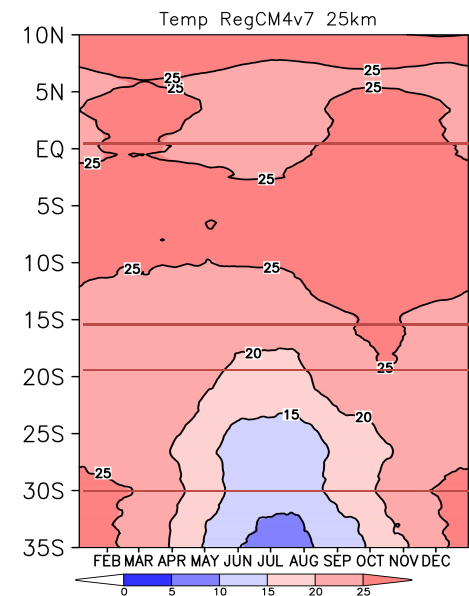
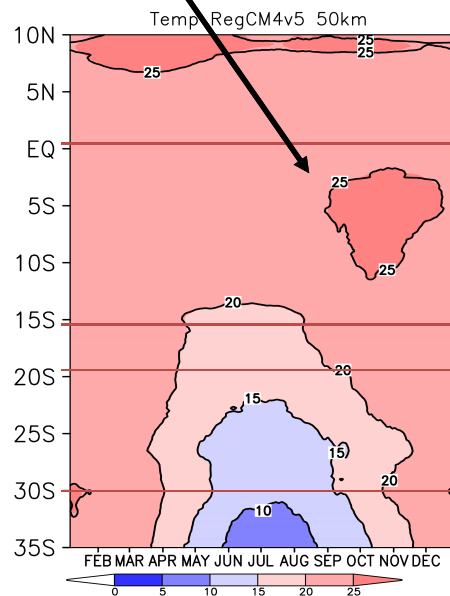
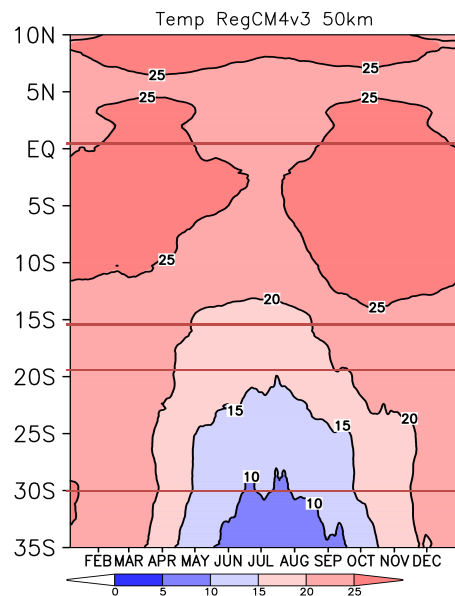
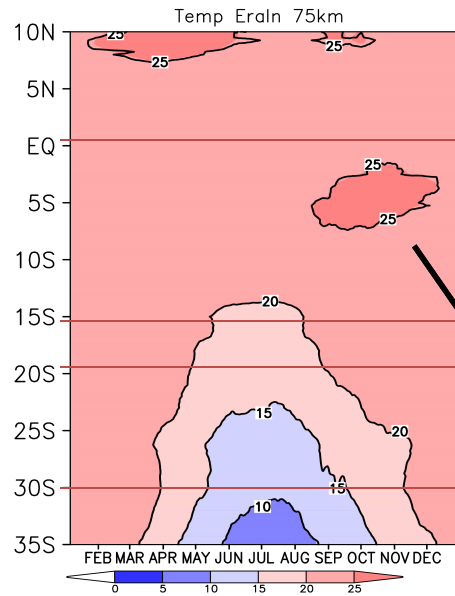
**Over the AMZ all simulations are warmer than EIN and similiar to the CRU data**



# Hovmoller diagram Air Temperature

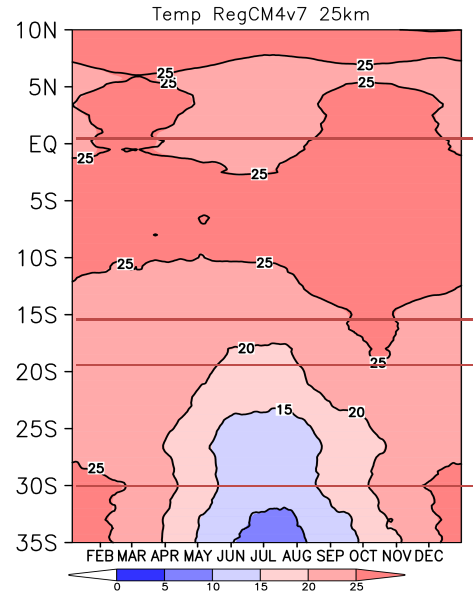
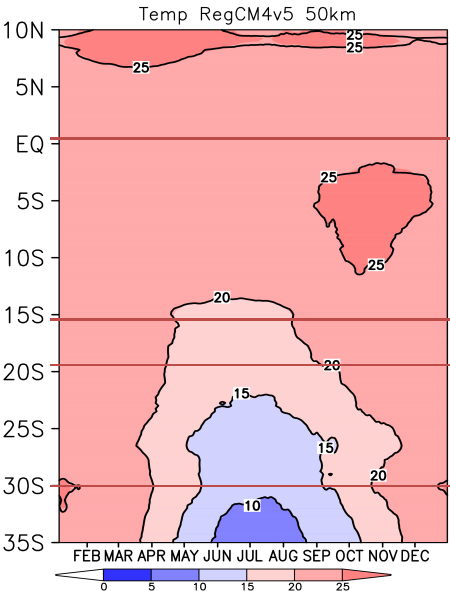
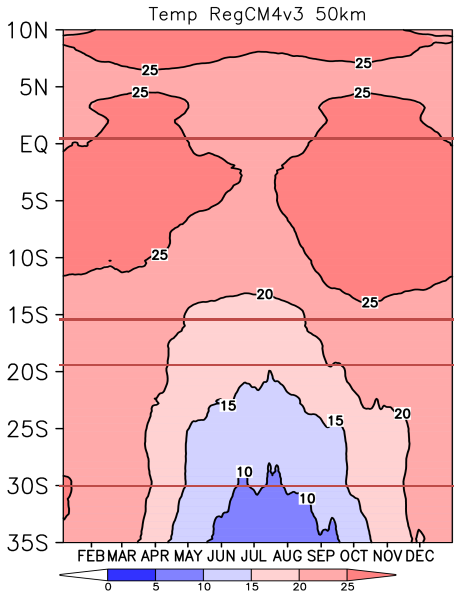
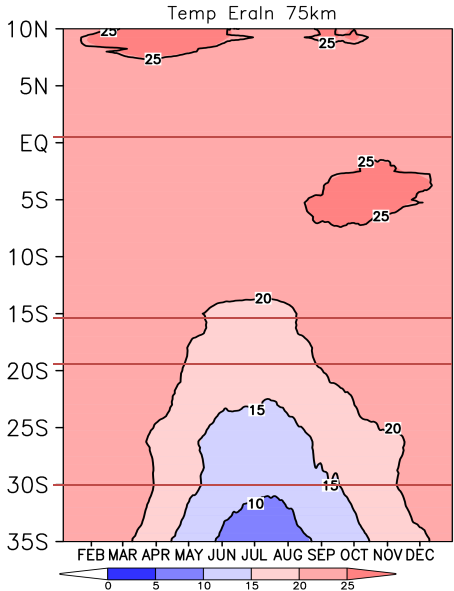


# Hovmoller diagram Air Temperature

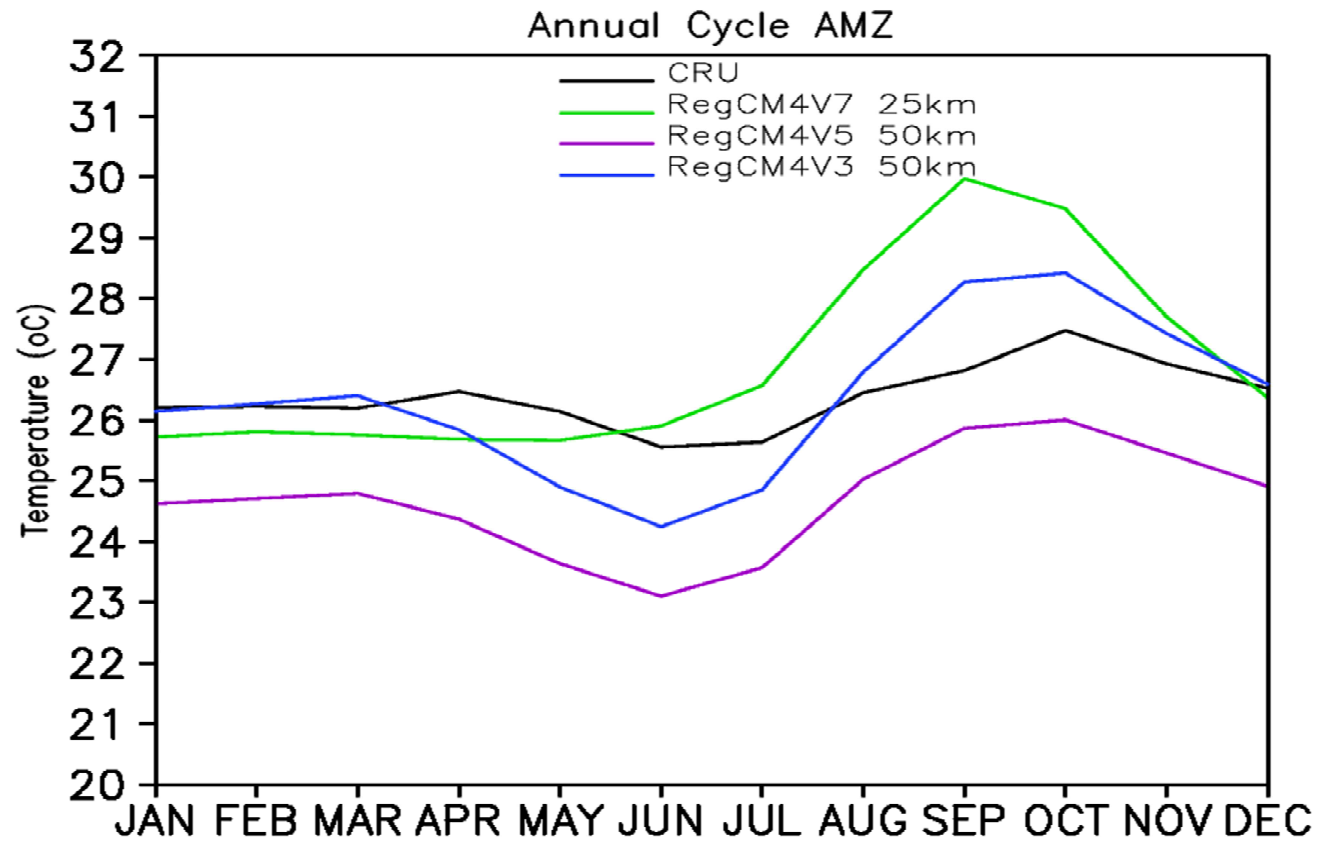


# Hovmoller diagram for air temperature

These simulations exhibit different responses of air temperature over the tropics

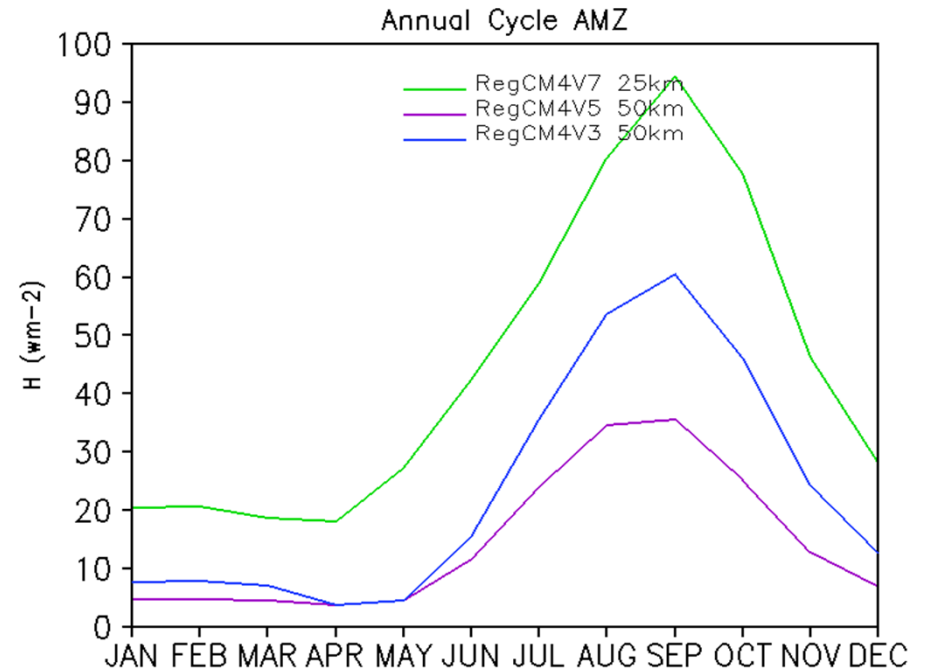
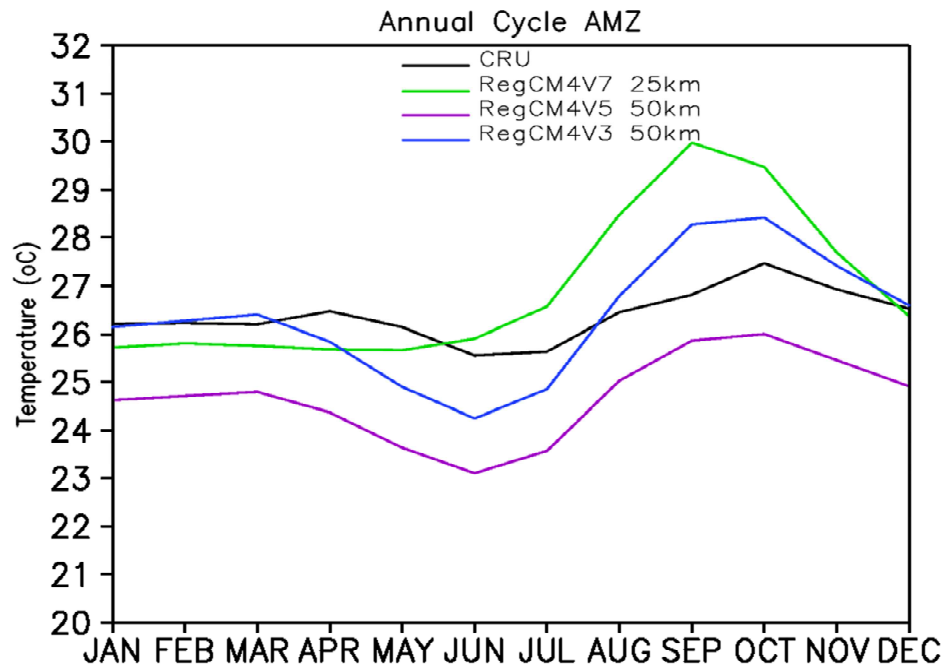


## Annual cycle of observed and simulated temperature averaged over the AMZ region



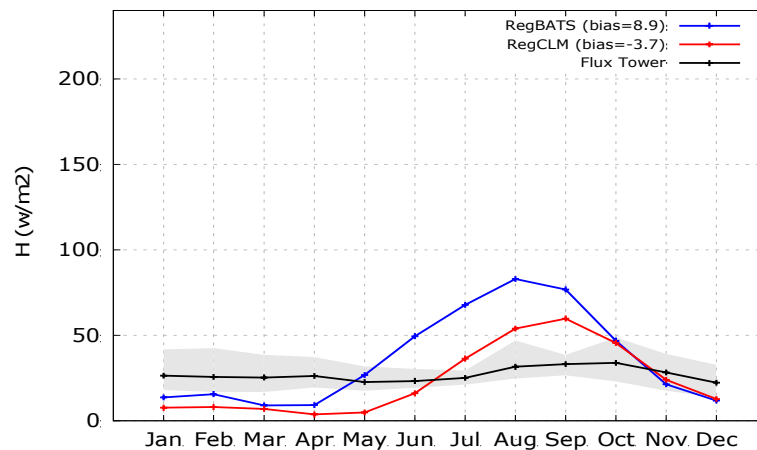
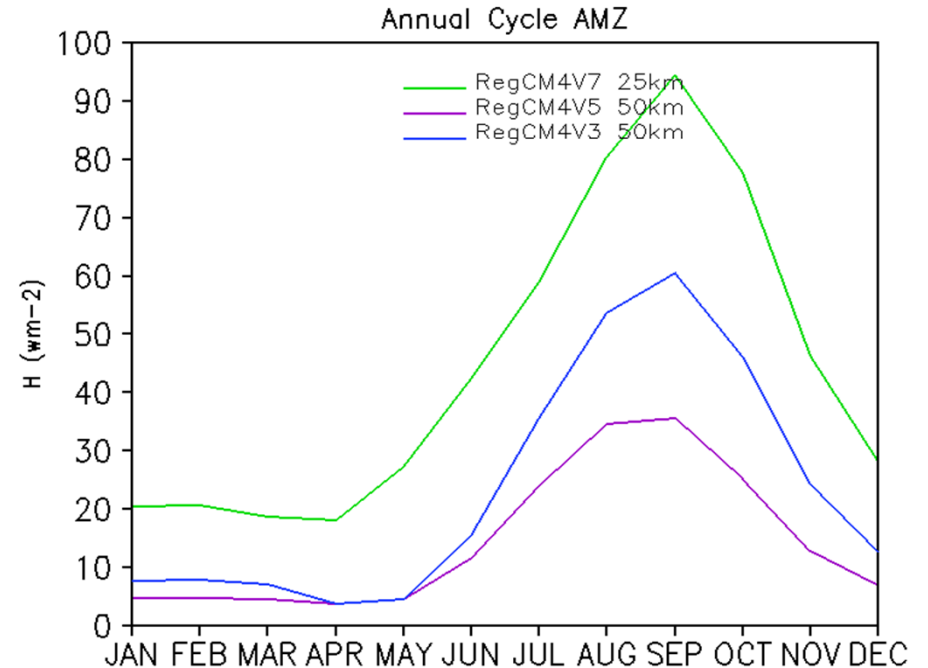
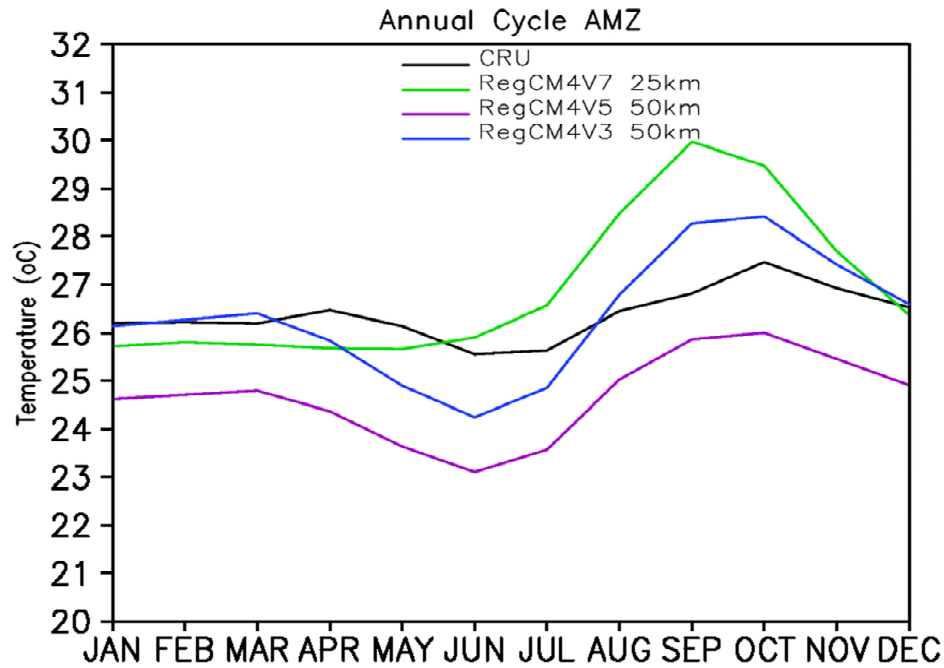
RegCM4.3 underestimated the air temperature throughout the year  
RegCM4.5 and RegCM4.7 overestimated the temperature from  
August to December

## Annual cycle of observed and simulated temperature and sensible heat flux averaged over the AMZ region



In general the temperature follows the shape of Sensible Heat Flux  
(H)

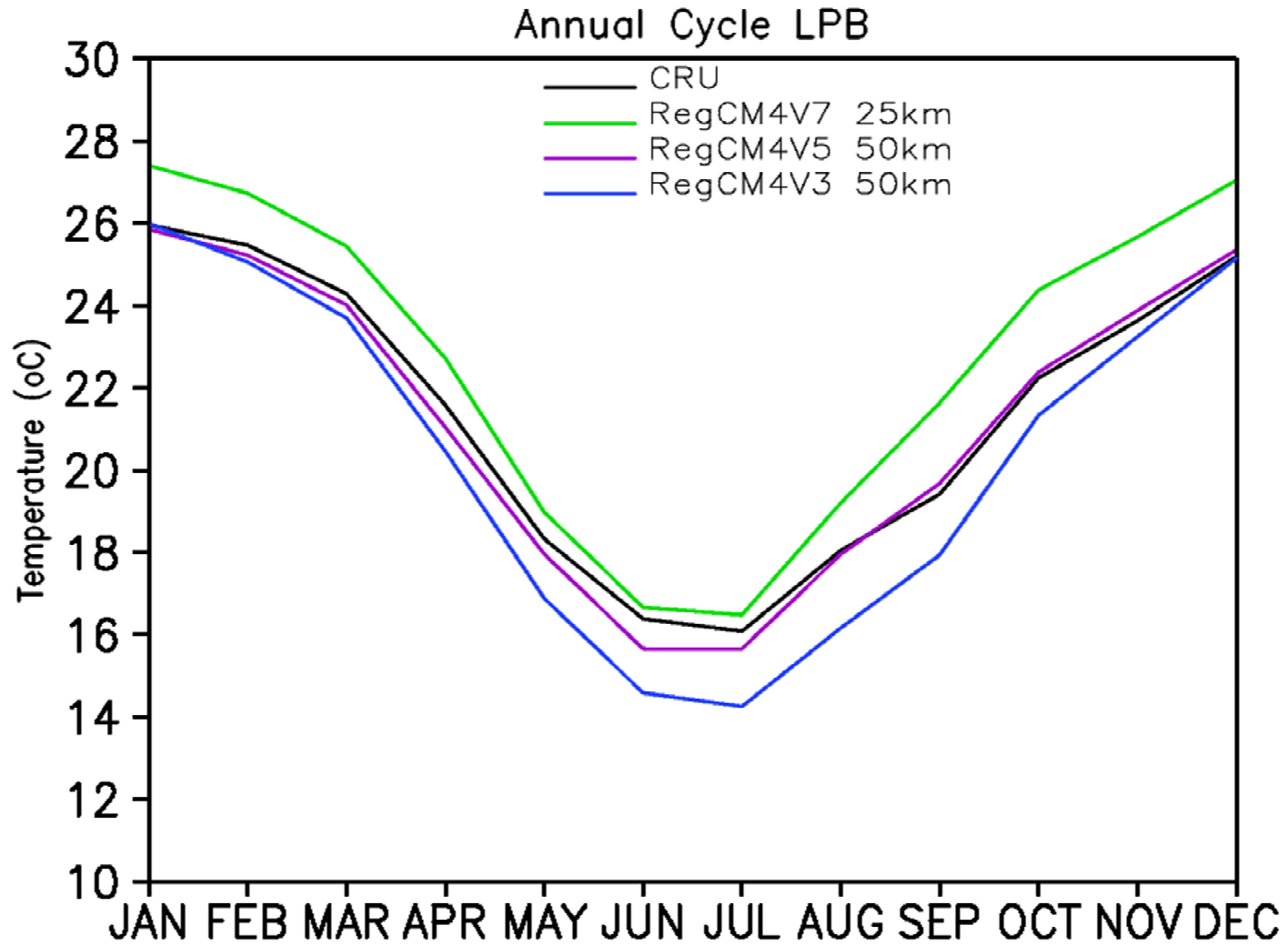
# Annual cycle of observed and simulated temperature and sensible heat flux averaged over the AMZ region



Over the AMZ region the  
observed values of H are  
 $\sim 30 \text{ Wm}^{-2}$

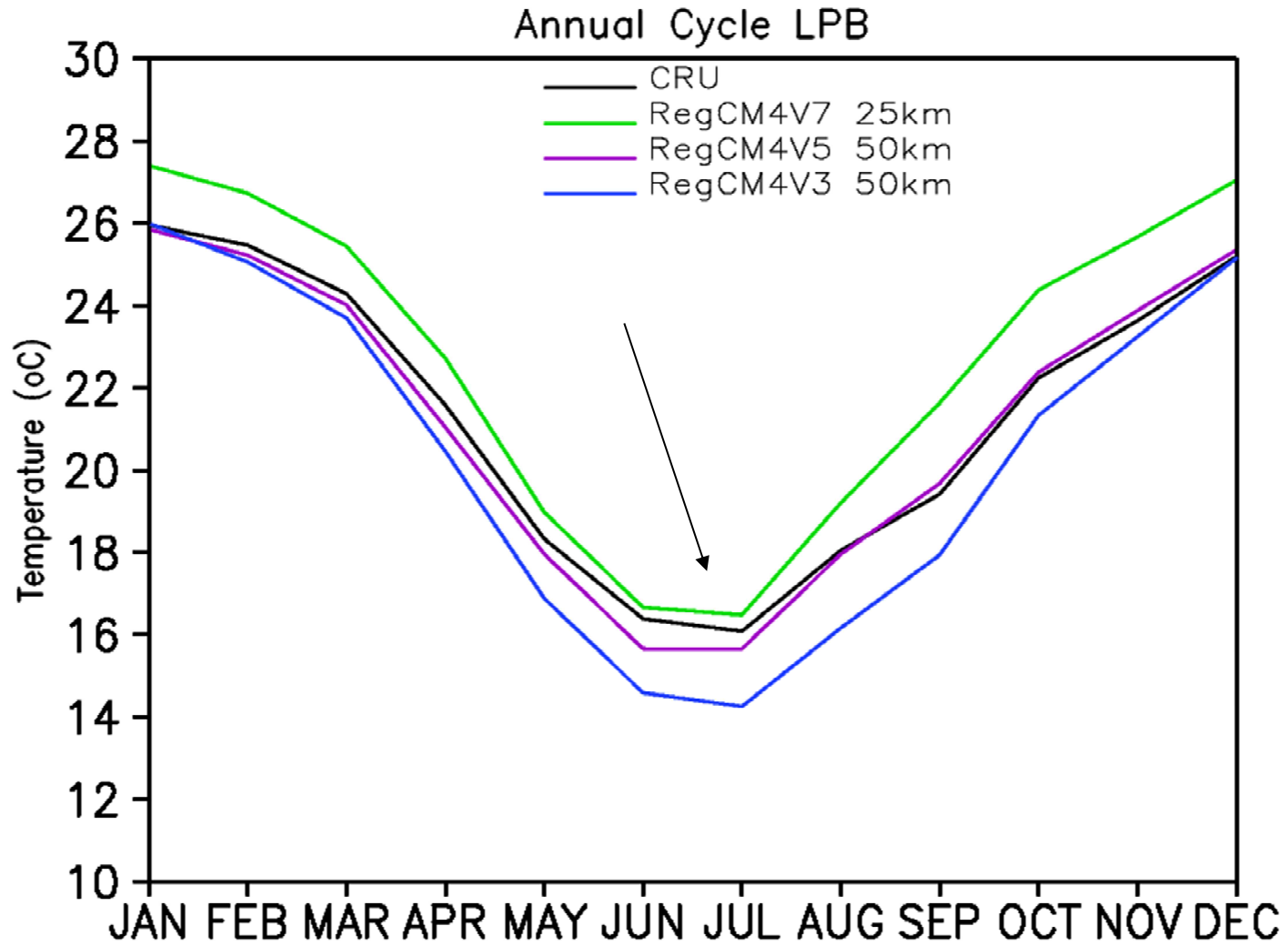
Llopart et al., 2017  
C. Dynamics

**Annual cycle of observed and simulated temperature averaged over the LPB region**

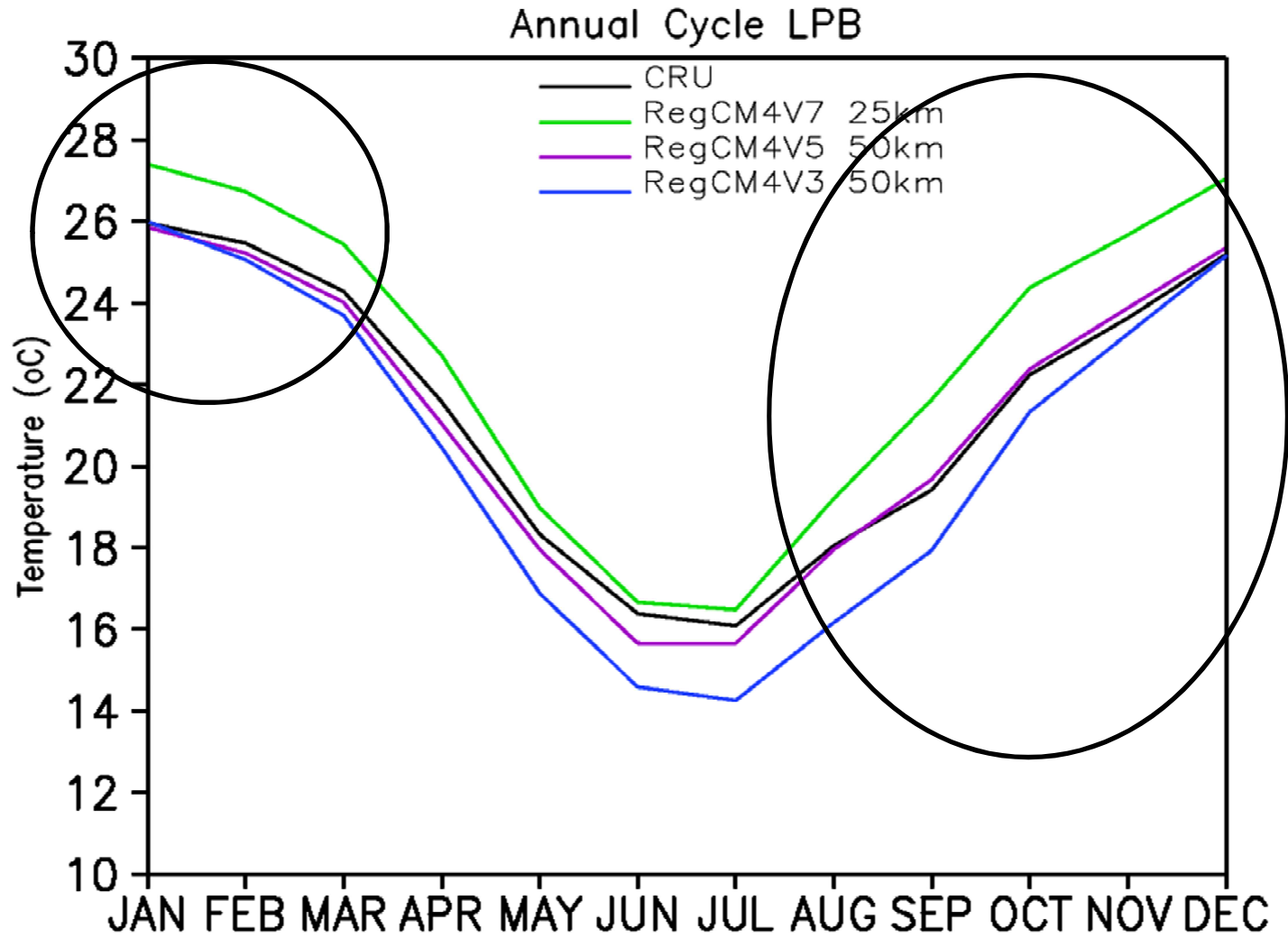




**Annual cycle of observed and simulated temperature averaged over the LPB region**



**Annual cycle of observed and simulated temperature averaged over the LPB region**



# Conclusions

- The different simulations (resolution, parametrization and model version) are comparable if it is tuned
- A systematic bias was found along all simulations
  - ✓ dry bias over LPB
  - ✓ underestimation of the precipitation over the AMZ during the peak of the monsoon phase
- RegCM4 climatology is consistent across the model version tuned although some differences are there
- Next step, we will look at the add value in the extreme events of the RegCM4.7 (25 km) compared to the previously simulations (RegCM4.3 and RegCM4.5)