Using the Transpose-AMIP framework to disentangle atmospheric biases in the equatorial Atlantic

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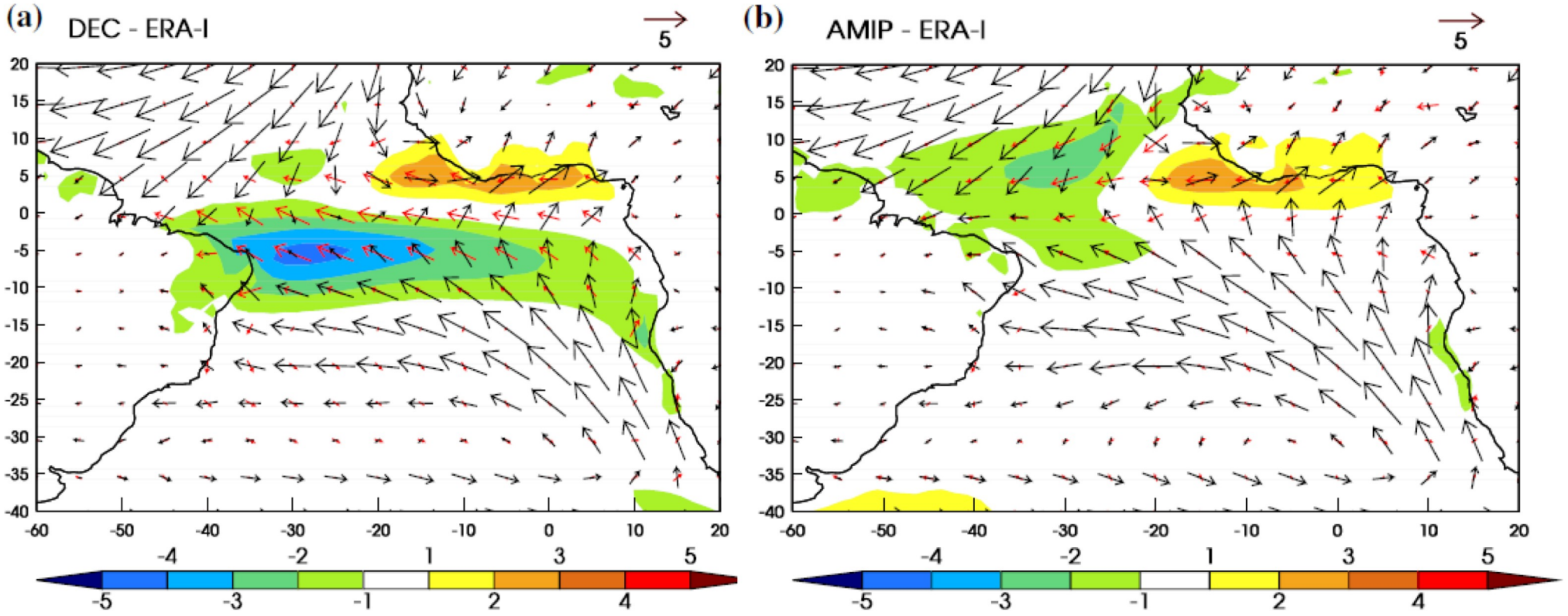
Motivation

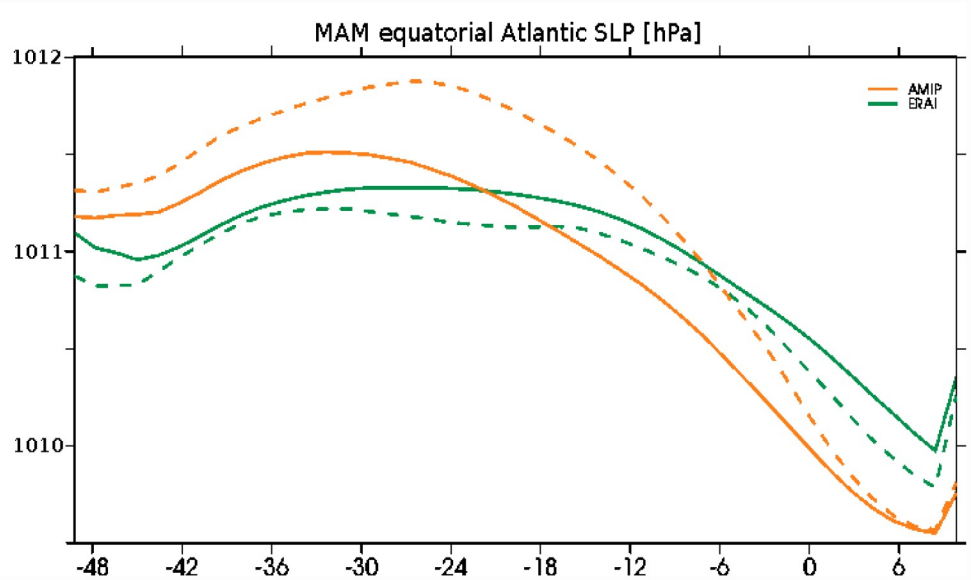


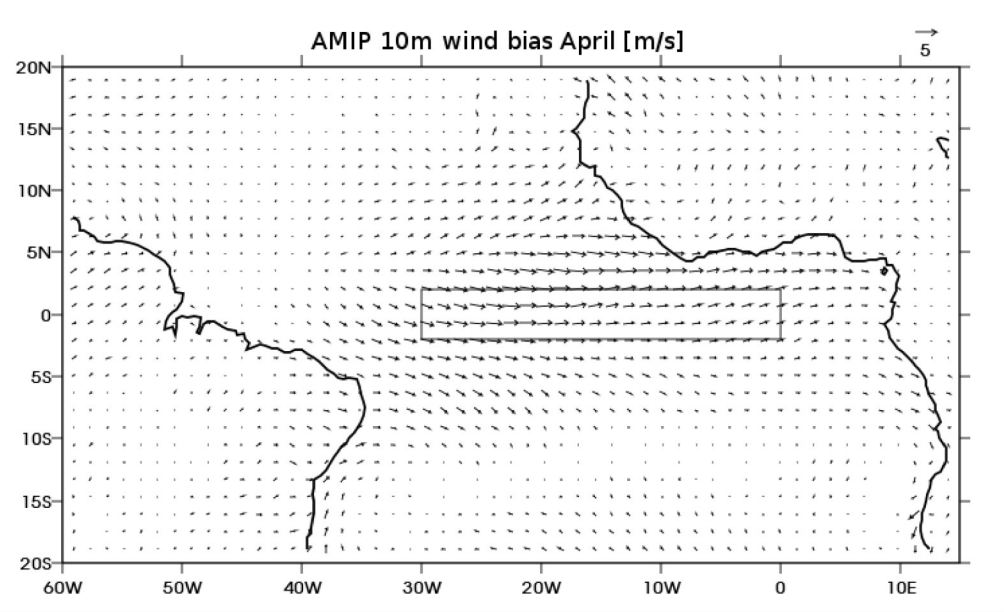
Voldoire et al., 2014

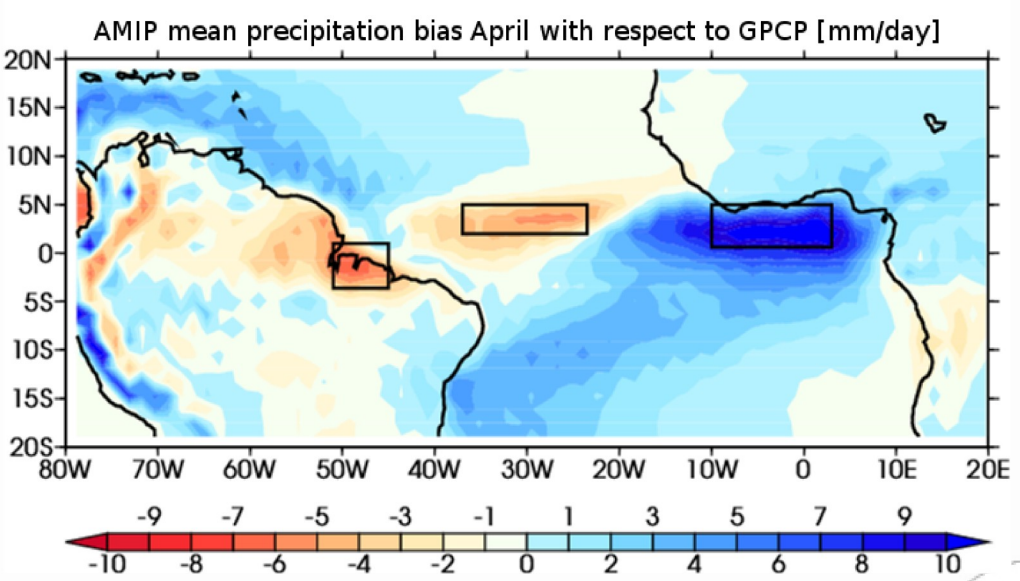
AMIP model setup

- Atmospheric model: ARPEGE V6.1
- Surface model: SURFEX V7.3
- Horizontal resolution 1.4°, 31 vertical levels
- Prescribed SSTs: HadISST
- 30 year simulation 1979-2008

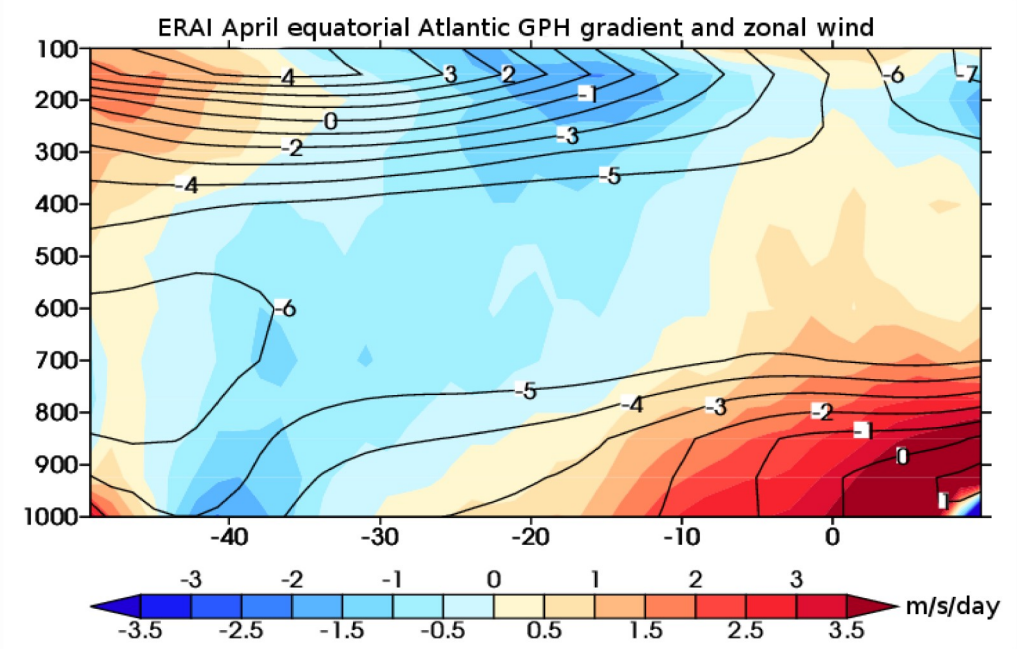
AMIP biases

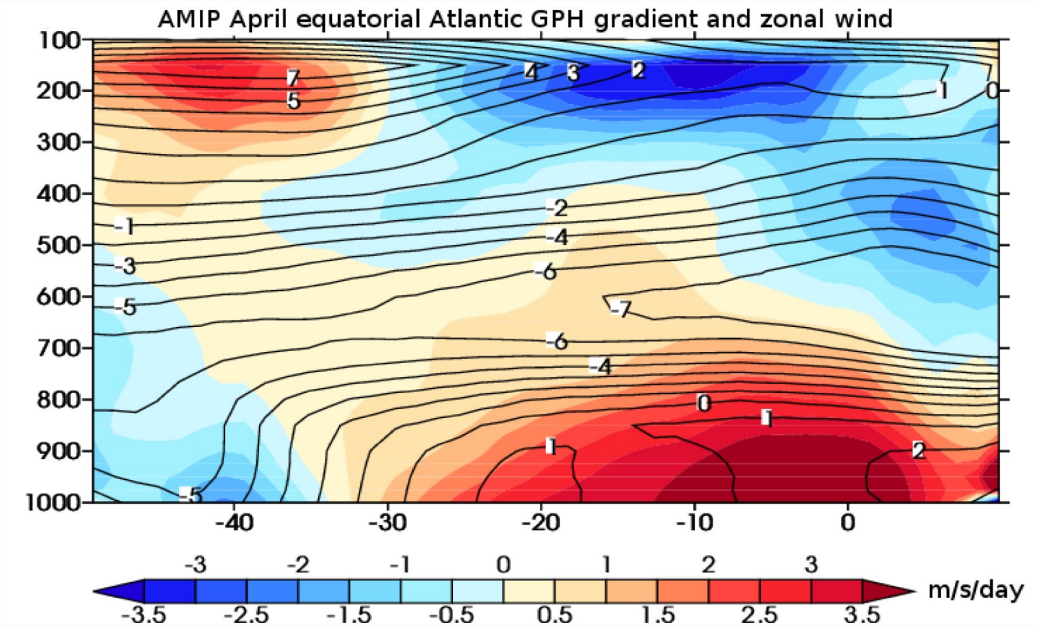

MAM equatorial Atlantic SLP [hPa]
AMIP
ERAI
1012
1011
1010
-48
-42
-36
-30
-24
-18
-12
-6
0
6


AMIP 10m wind bias April [m/s]
5
20N
15N
10N
5N
0
5S
10S
15S
20S
60W
50W
40W
30W
20W
10W
0
10E


AMIP mean precipitation bias April with respect to GPCP [mm/day]
20N
15N
10N
5N
0
5S
10S
15S
20S
80W
70W
60W
50W
40W
30W
20W
10W
0
10E
20E
-9
-7
-5
-3
-1
1
3
5
7
9
-10
-8
-6
-4
-2
0
2
4
6
8
10

AMIP biases – GPH and zonal wind





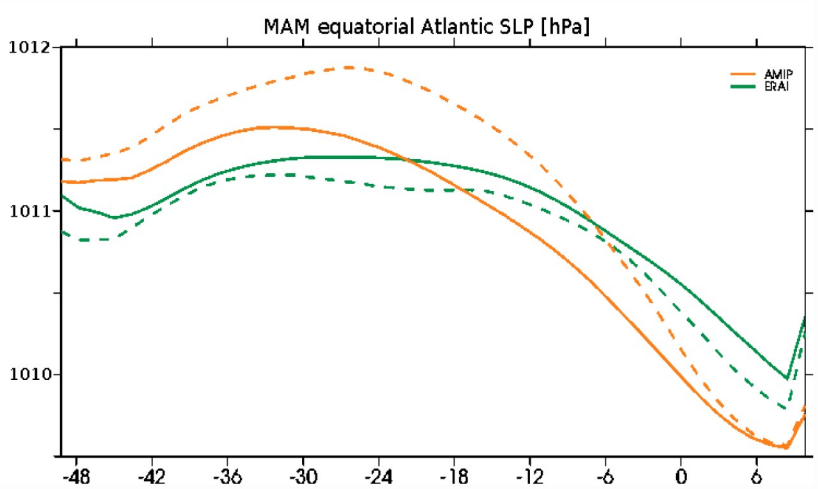
Contour interval 1m/s

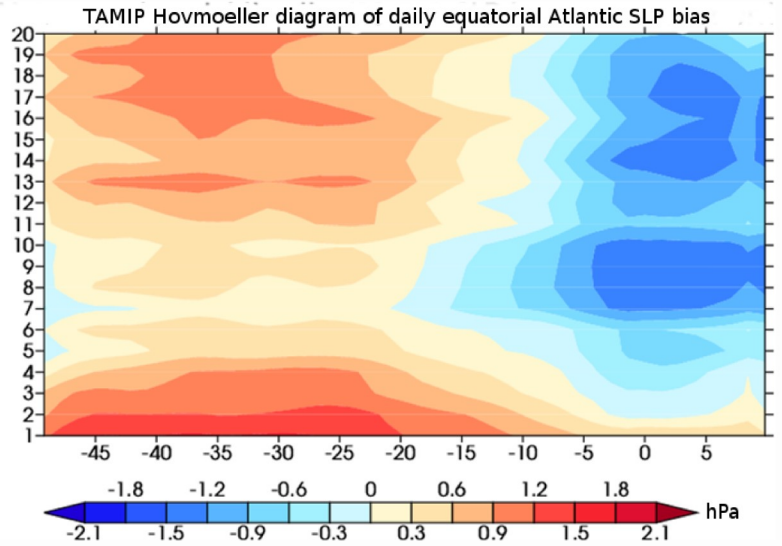
as in Richter et al., 2014

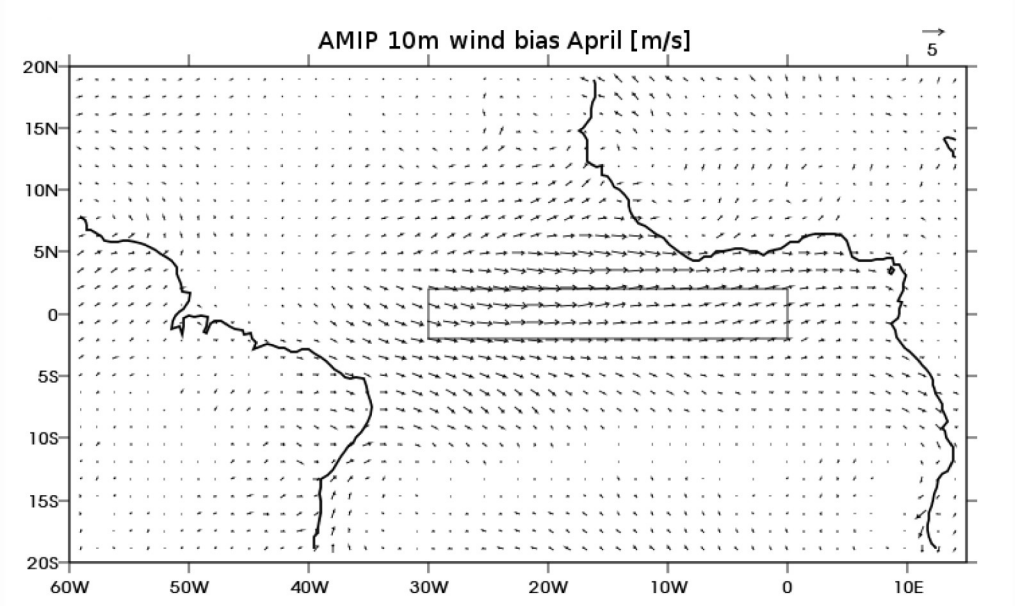
TAMIP setup

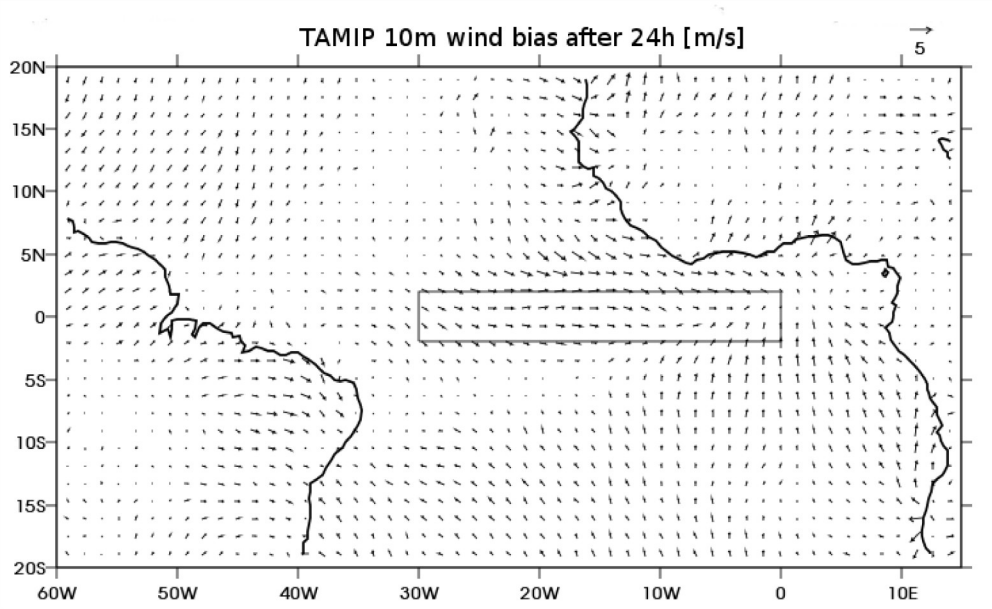
- Transpose AMIP (TAMIP) – ensembles of very short initialized hindcast experiments with atmosphere-only models
- This framework has been used in several studies to analyze bias development in „fast“ processes (i.e. cloud or tropical precipitation biases (Bodas-Salcedo et al., 2008; Williams and Brooks, 2008; Martin et al., 2010))
- Here: Ensemble of 20-days long hindcast experiments with the same model setup as for the AMIP experiments initialized at each day of April 2007 from ERA-INTERIM (=>30 members)

TAMIP - SLP and 10m wind biases

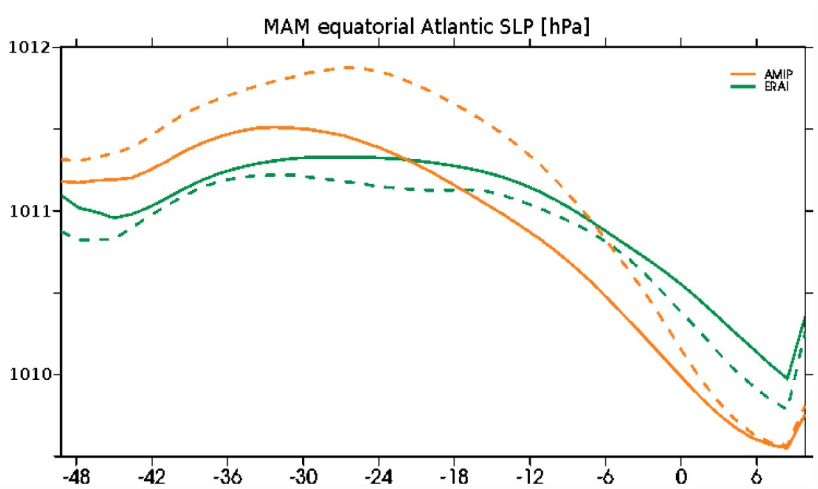


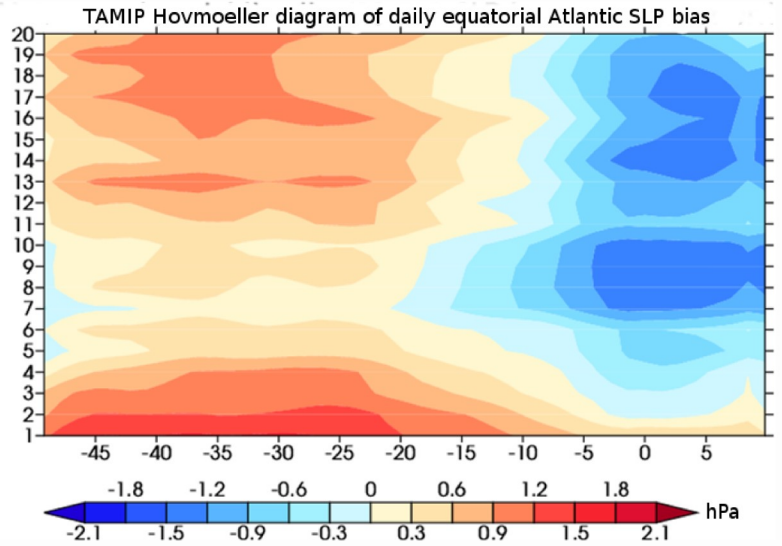


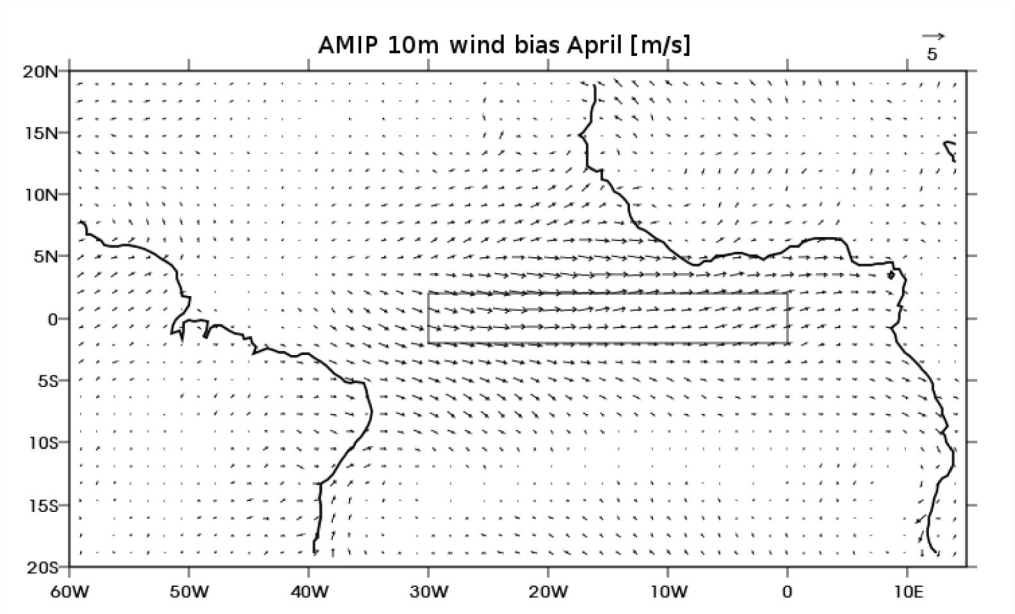


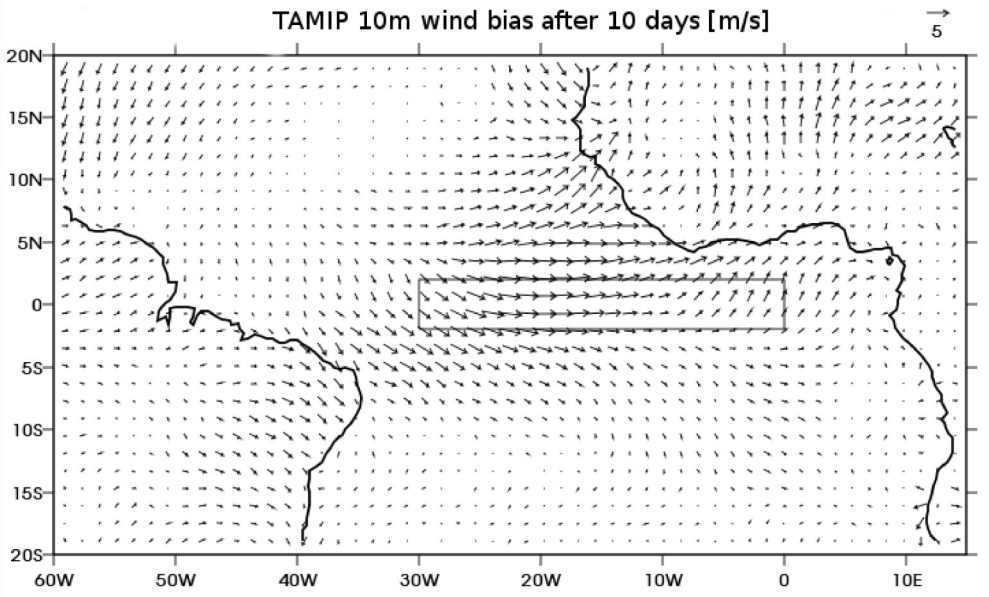


TAMIP – SLP and 10m wind biases









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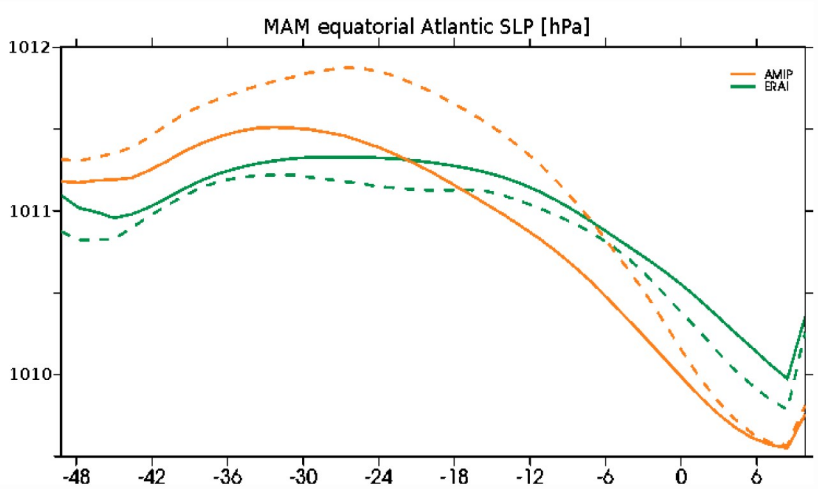
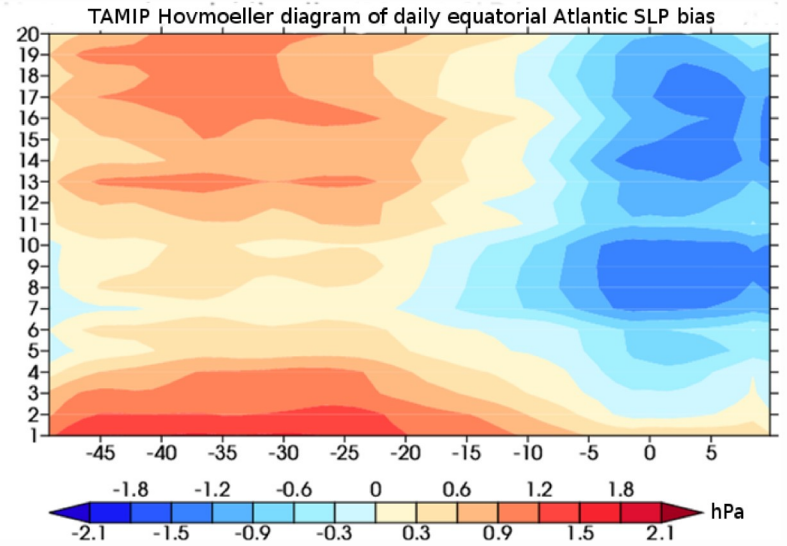
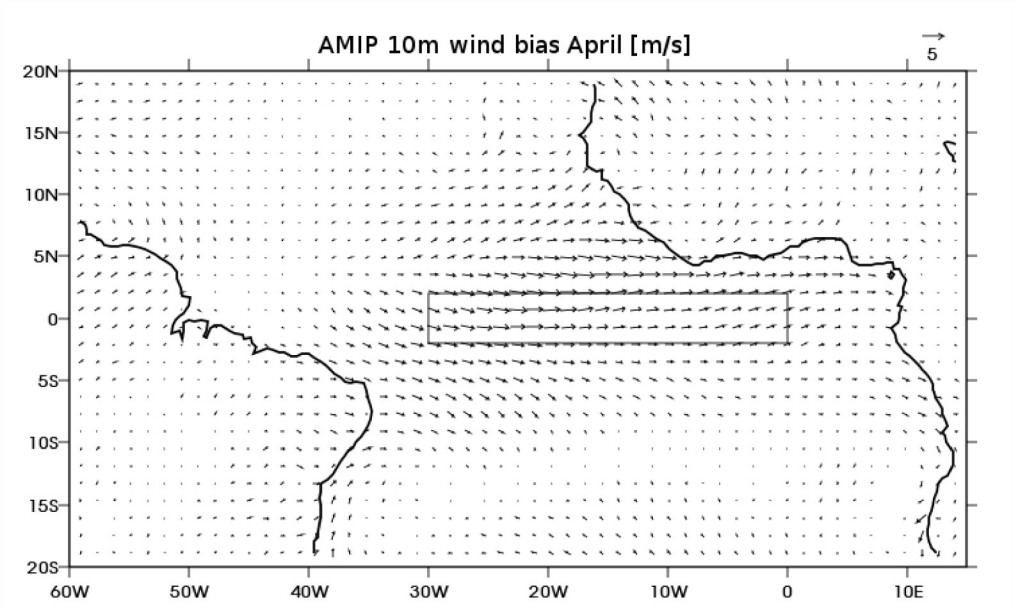
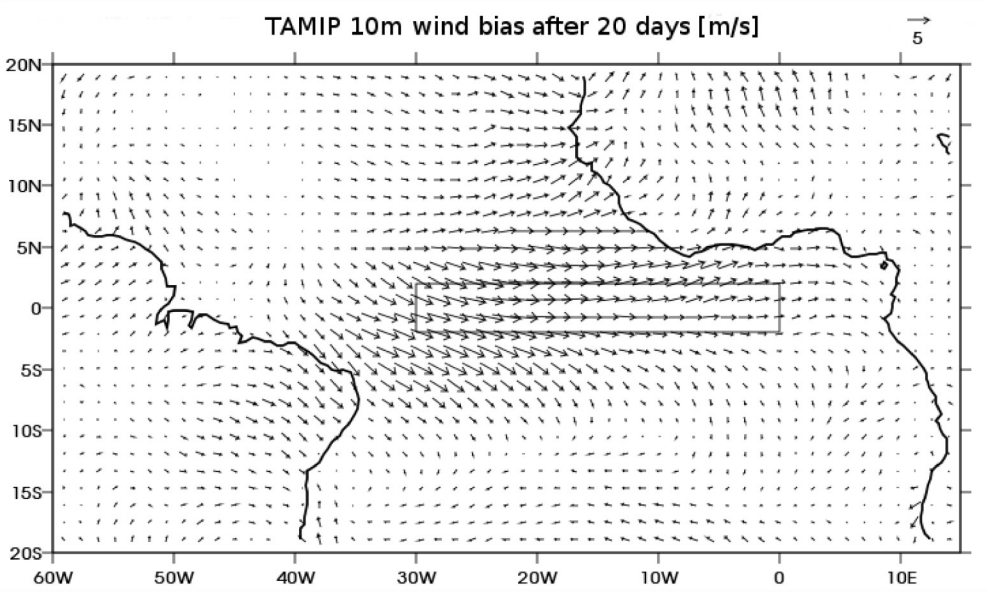
TAMIP - SLP and 10m wind biases









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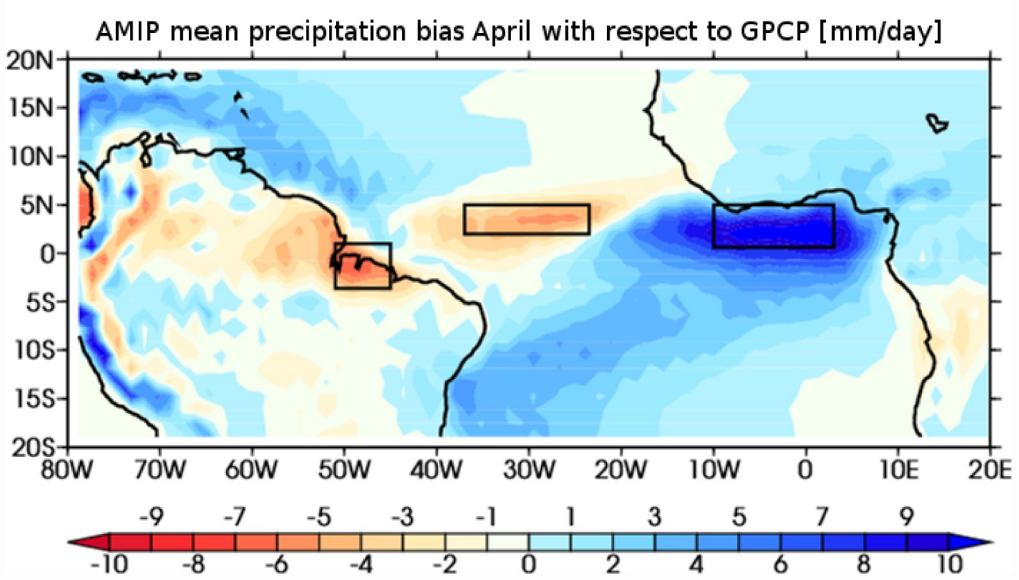
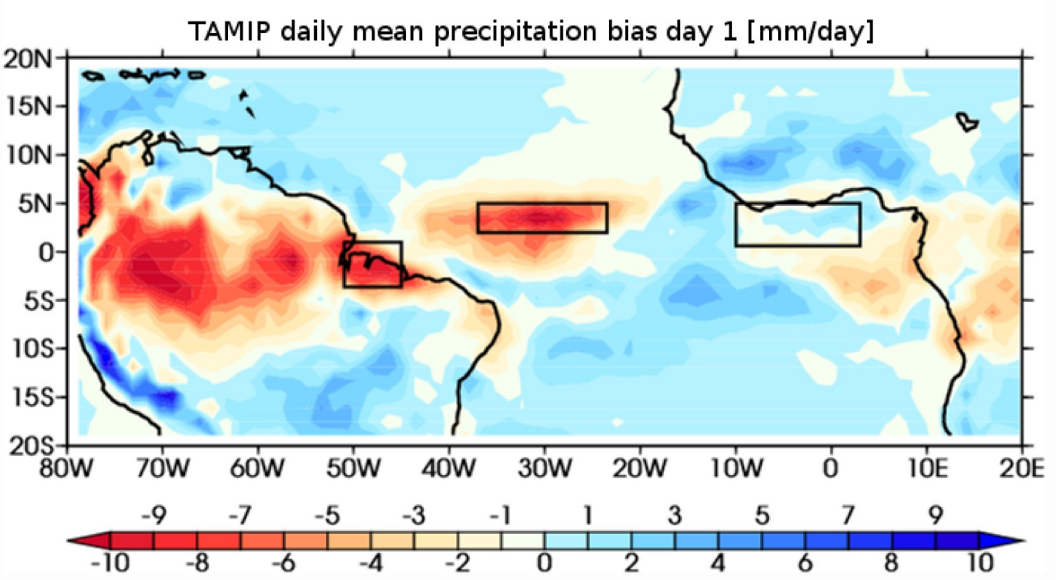
TAMIP- rainfall biases





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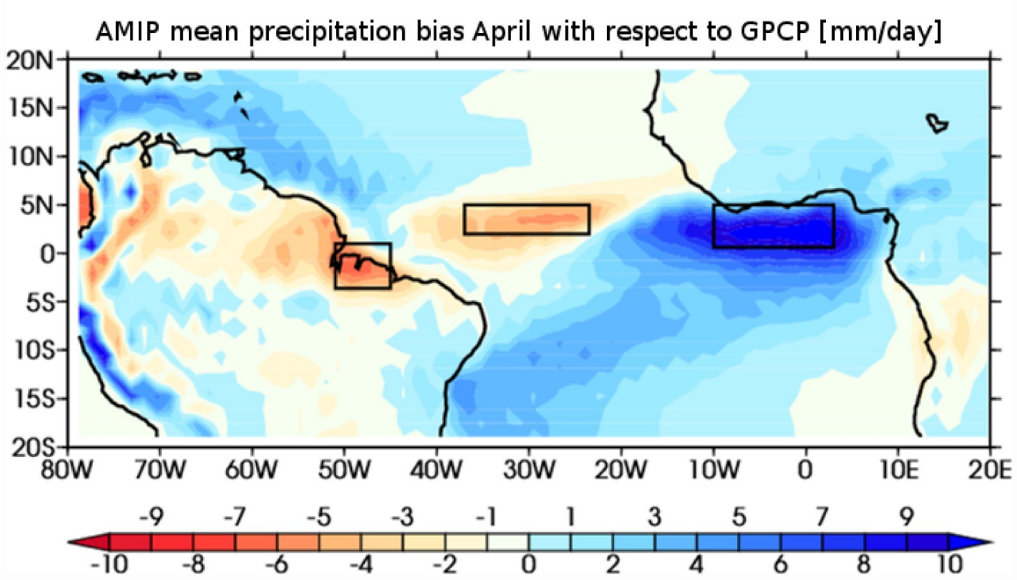
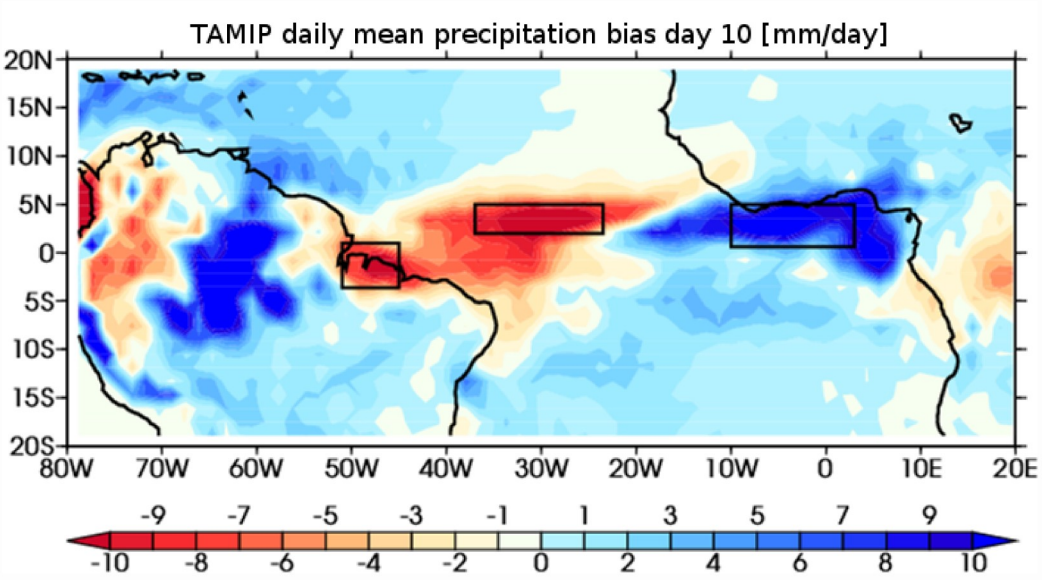
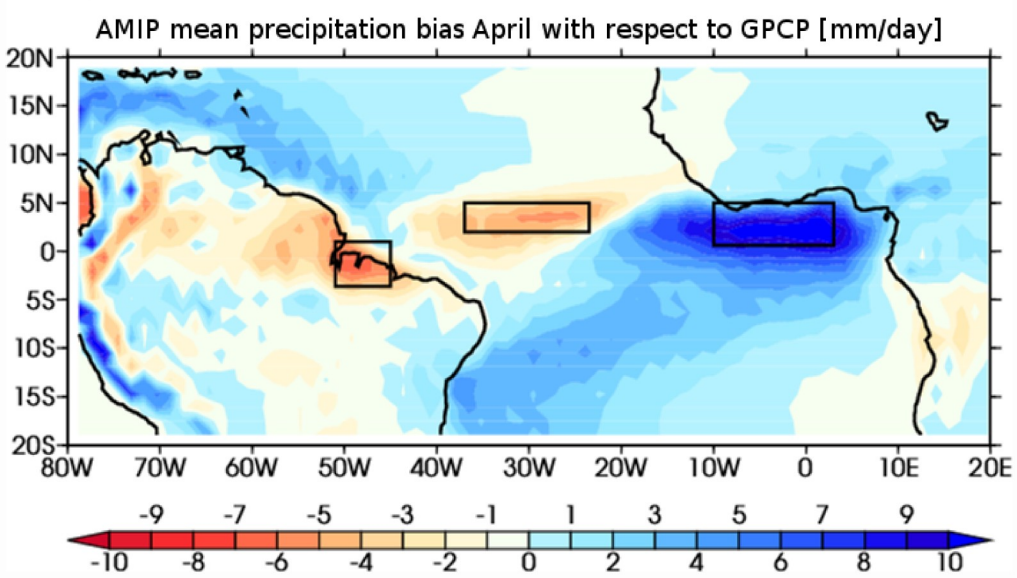
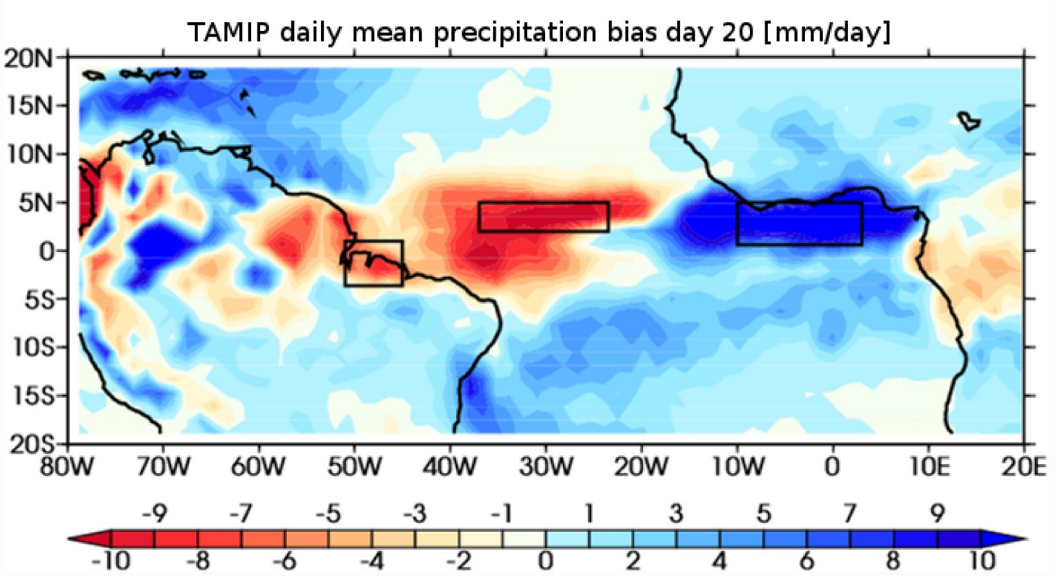
TAMIP - rainfall biases



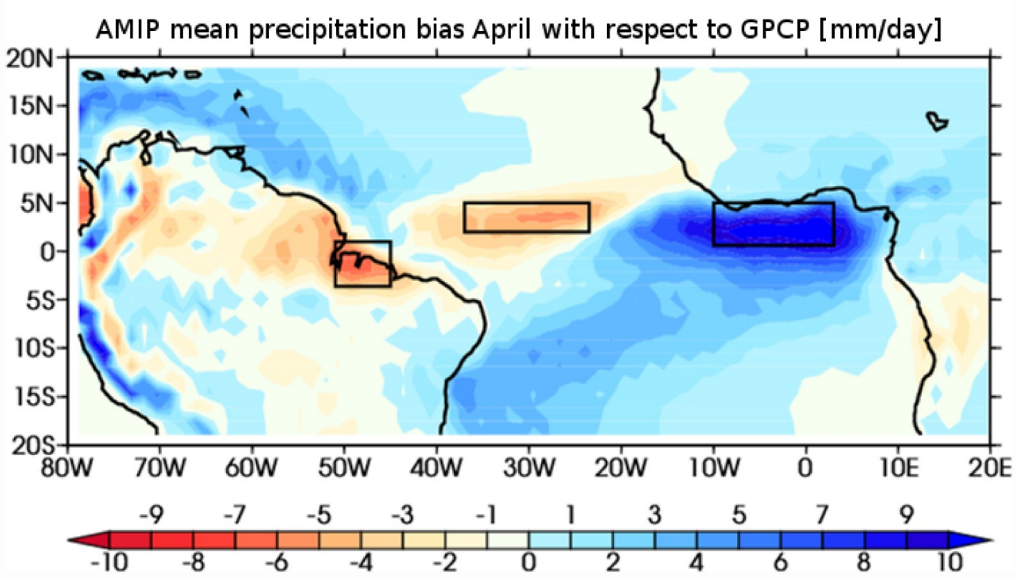


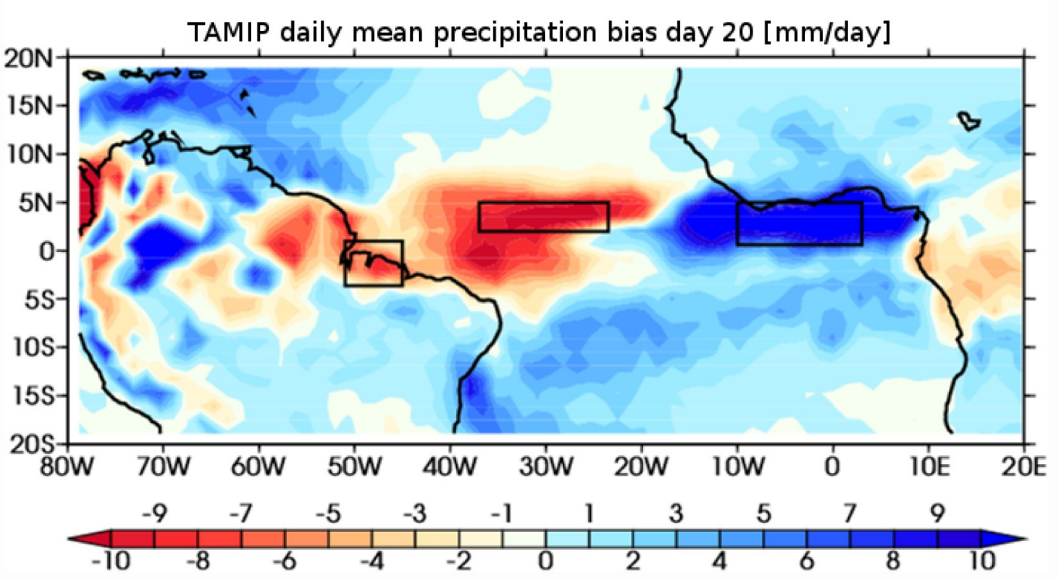
TAMIP - rainfall biases



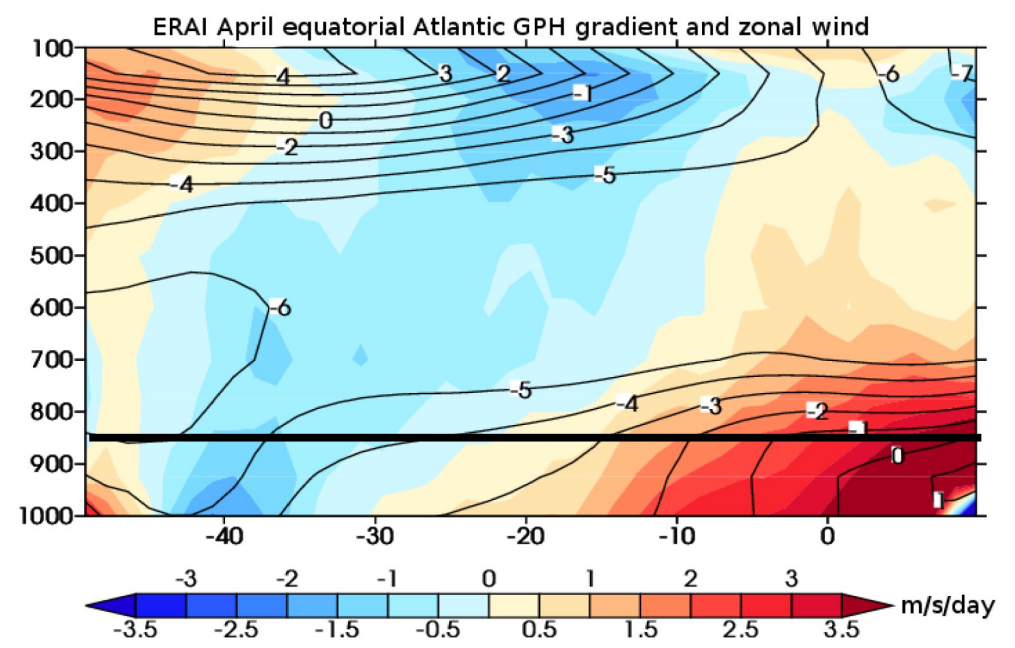


TAMIP - rainfall biases

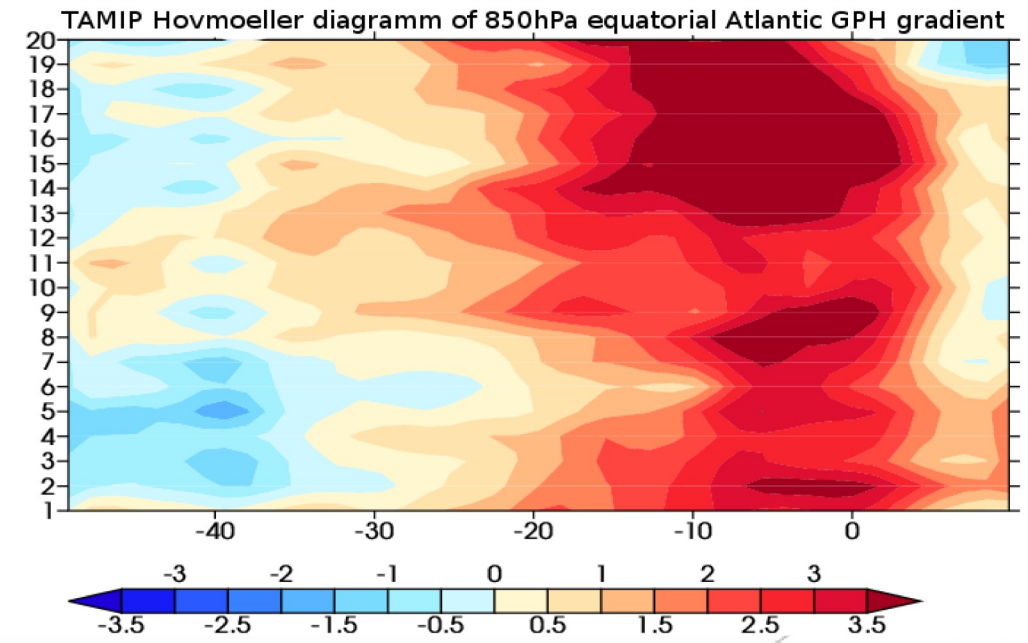




TAMIP - GPH biases



Contour interval 1m/s



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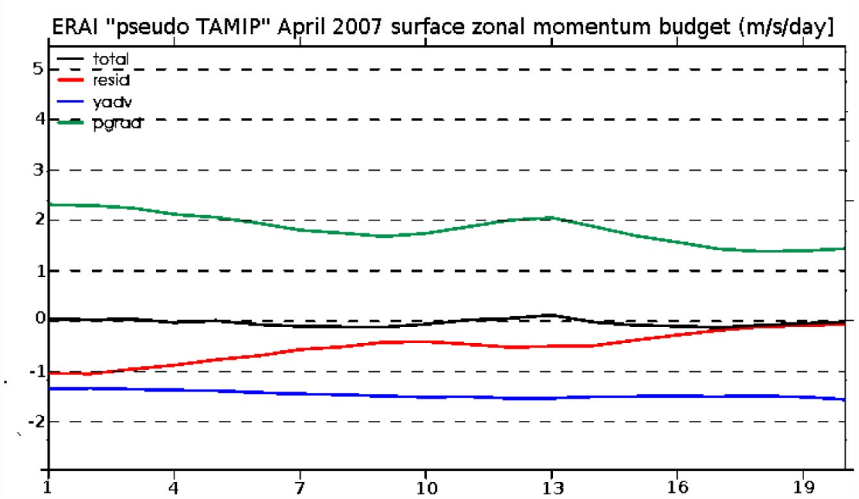
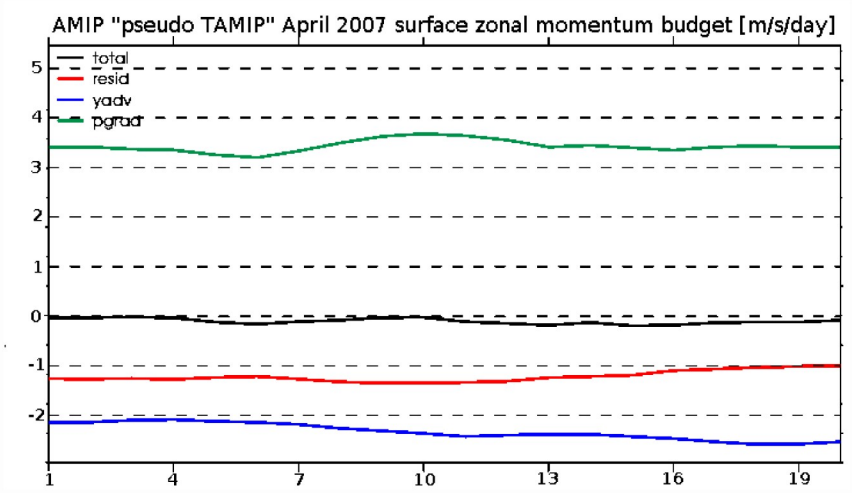
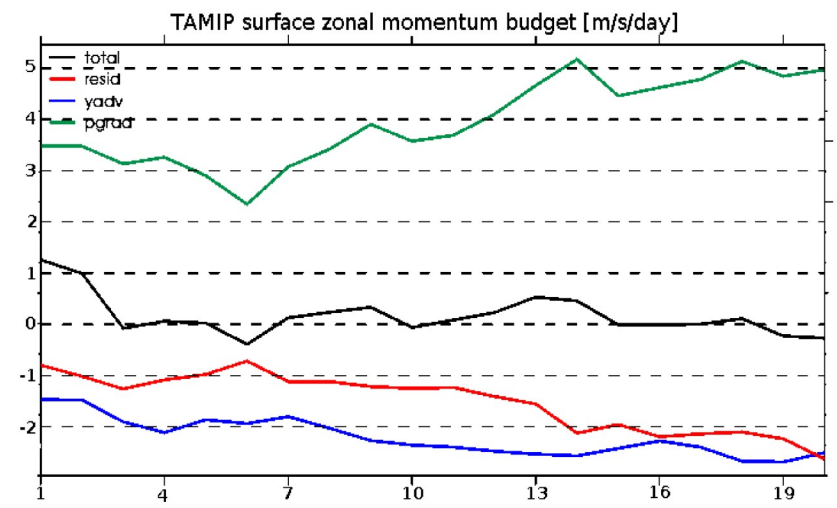
Surface zonal momentum budgets

$$\frac{\partial U}{\partial t} + U\frac{\partial U}{\partial x} + V\frac{\partial U}{\partial y} + \alpha_0\frac{\partial p}{\partial x} + \epsilon = 0$$

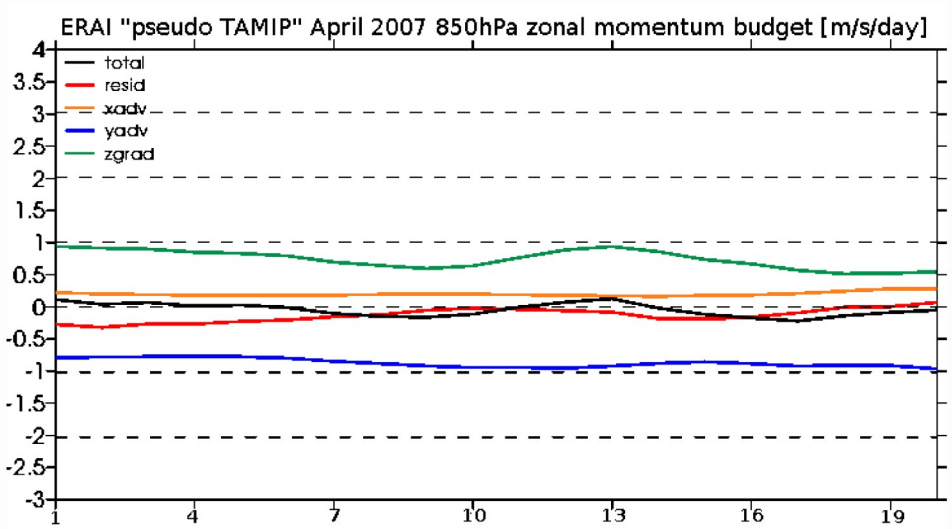


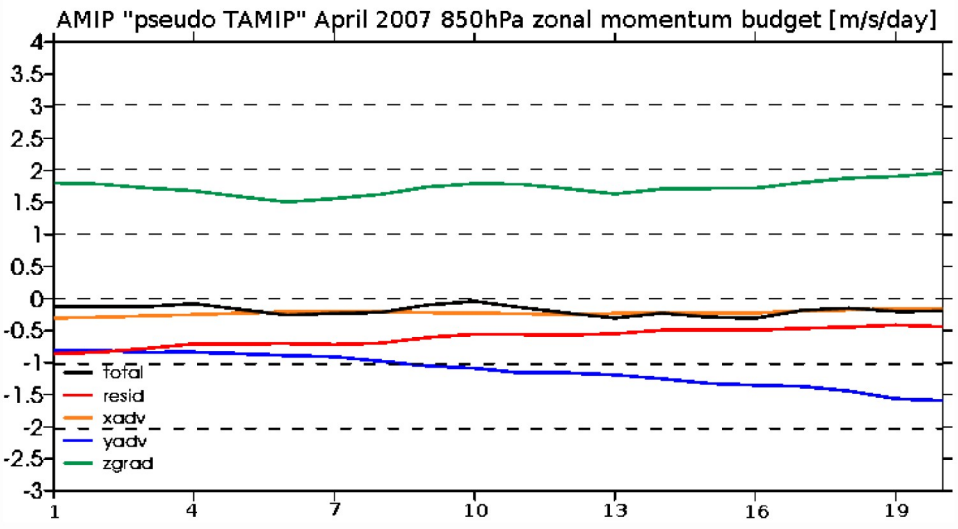


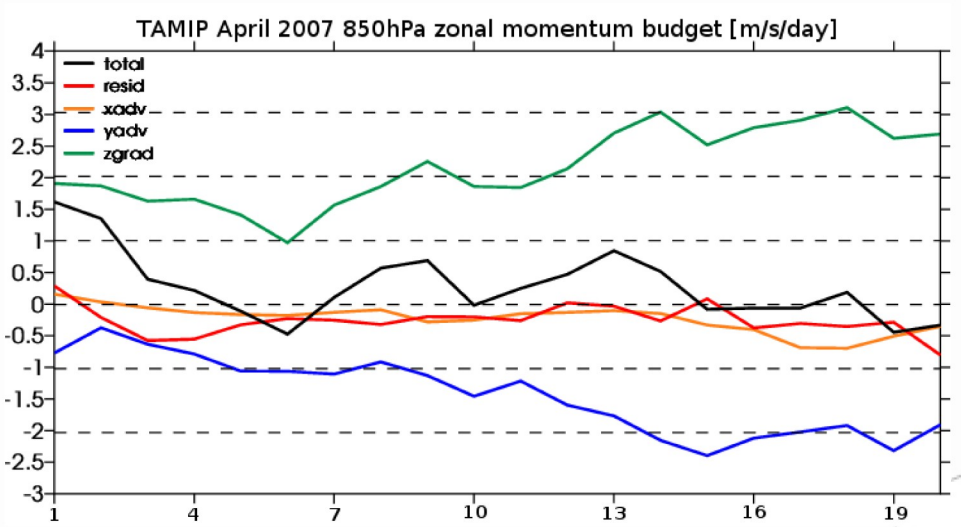


850 hPa zonal momentum budgets

$$\frac{\partial U}{\partial t} + U\frac{\partial U}{\partial x} + V\frac{\partial U}{\partial y} + \alpha_0\frac{\partial z}{\partial x} + \epsilon = 0$$







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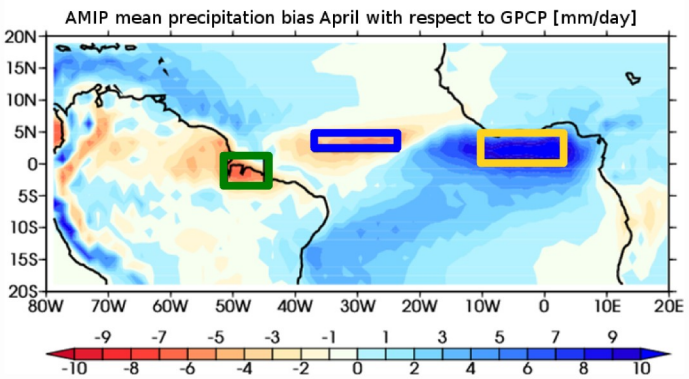
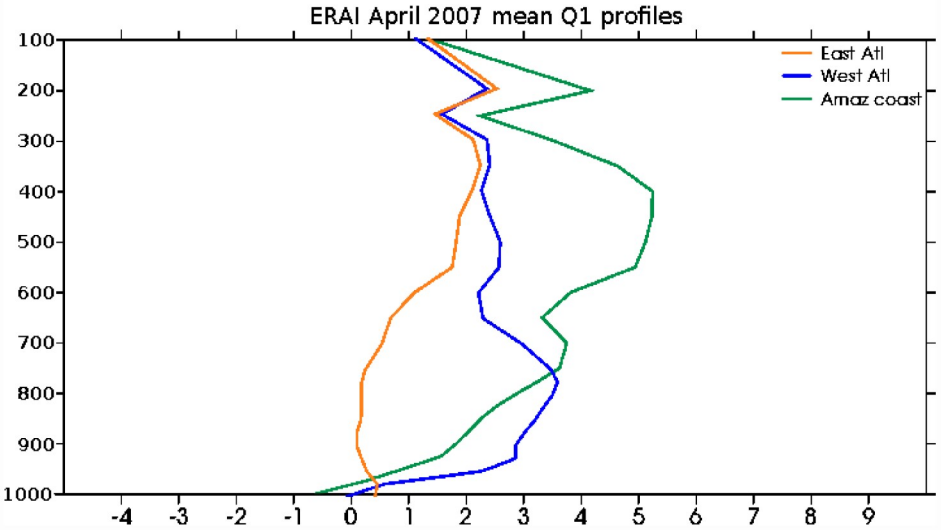
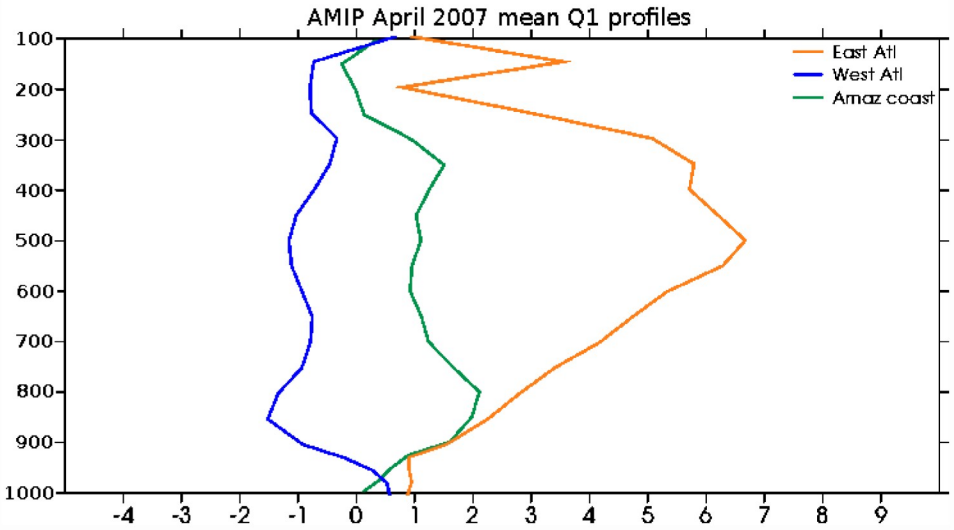
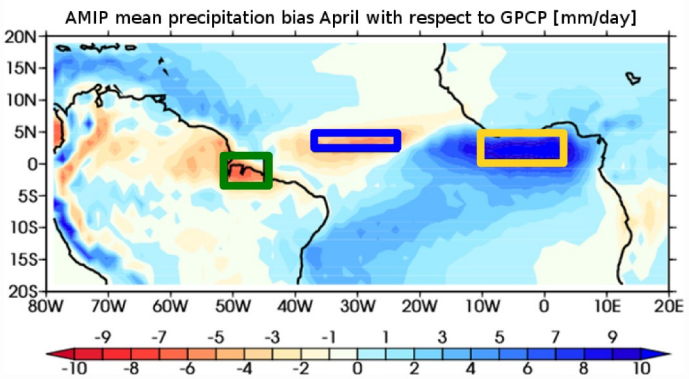
Apparent heat source (Q1) profiles

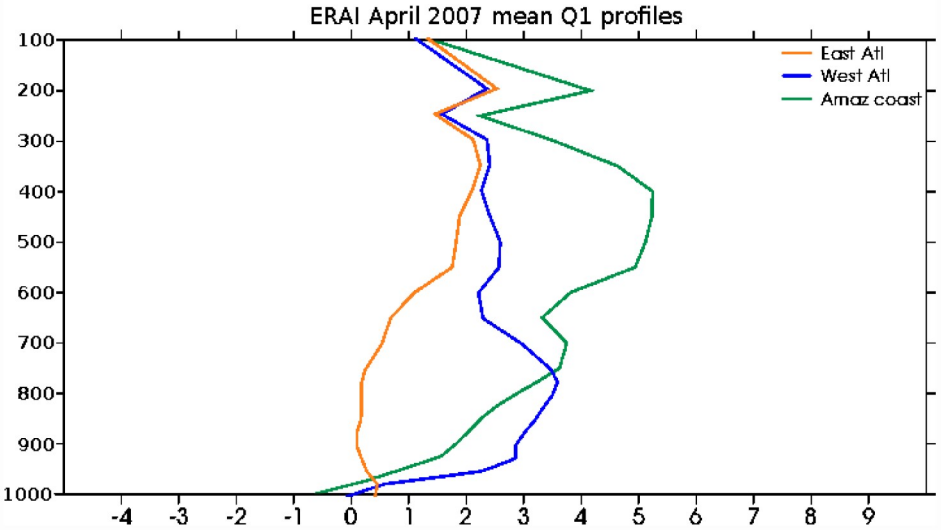


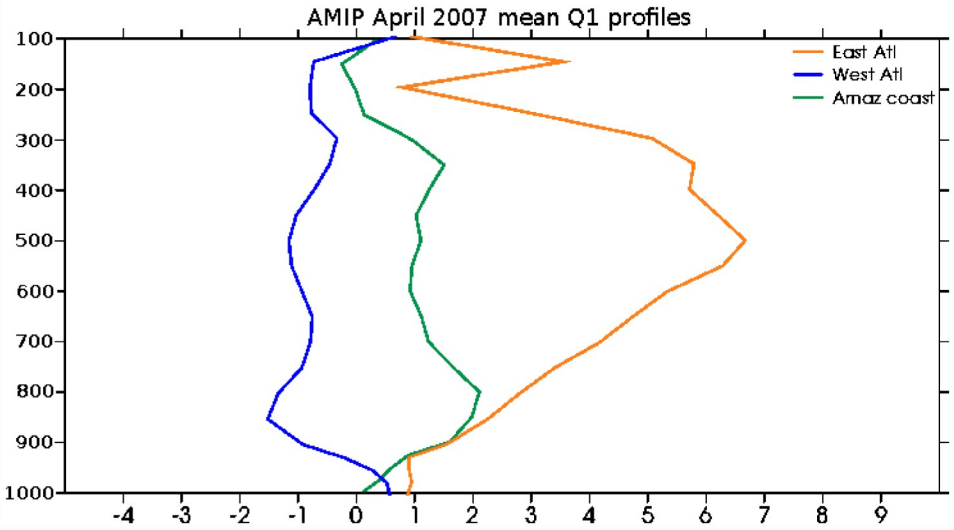




Apparent heat source (Q1) profiles

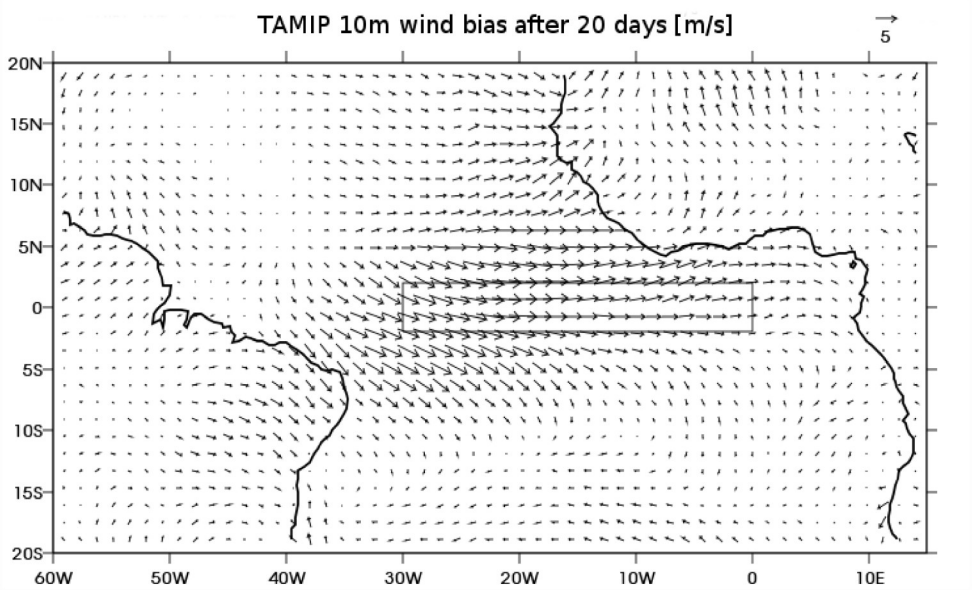


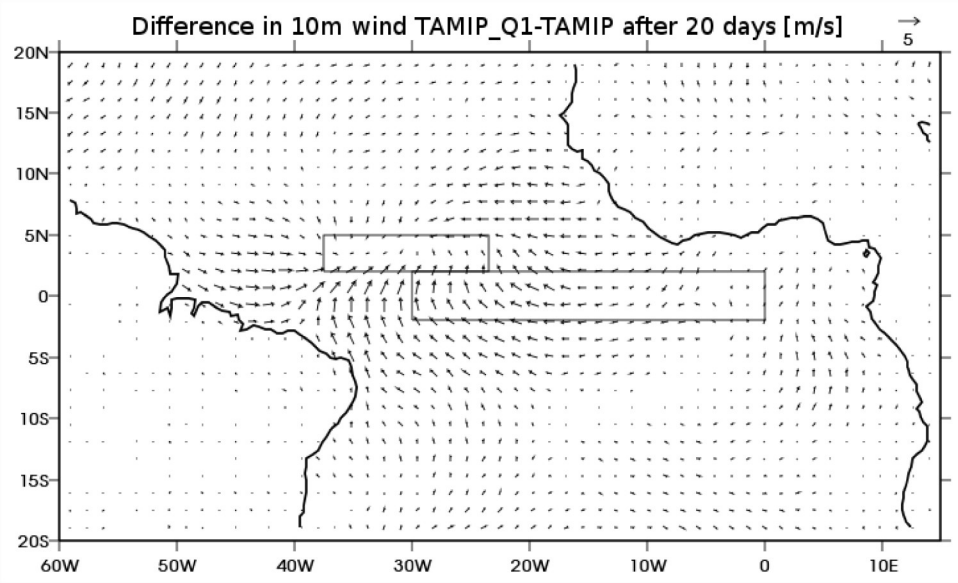


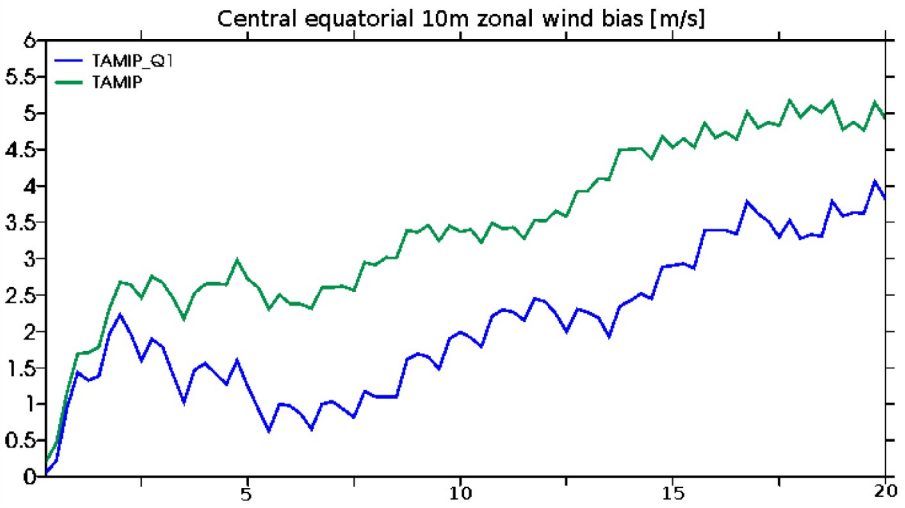


- Idea for first sensitivity experiment: Perform TAMIP experiment with same setup as before but prescribe observed Q1 profile over the WATL box (23.5°-37°W, 2°-5°N) with a tapering buffer of 2° in latitude and 5° in longitude

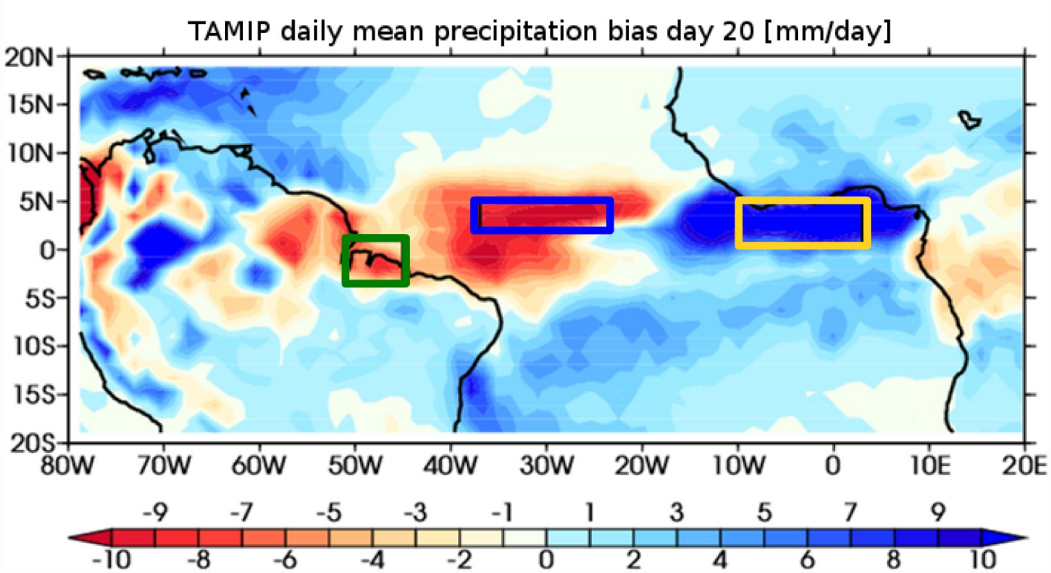
Sensitivity experiment – 10m wind

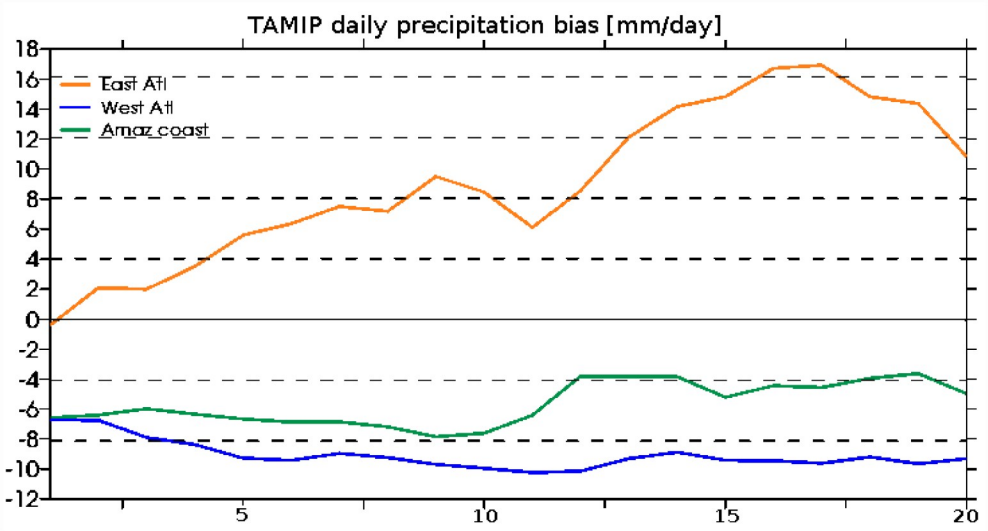


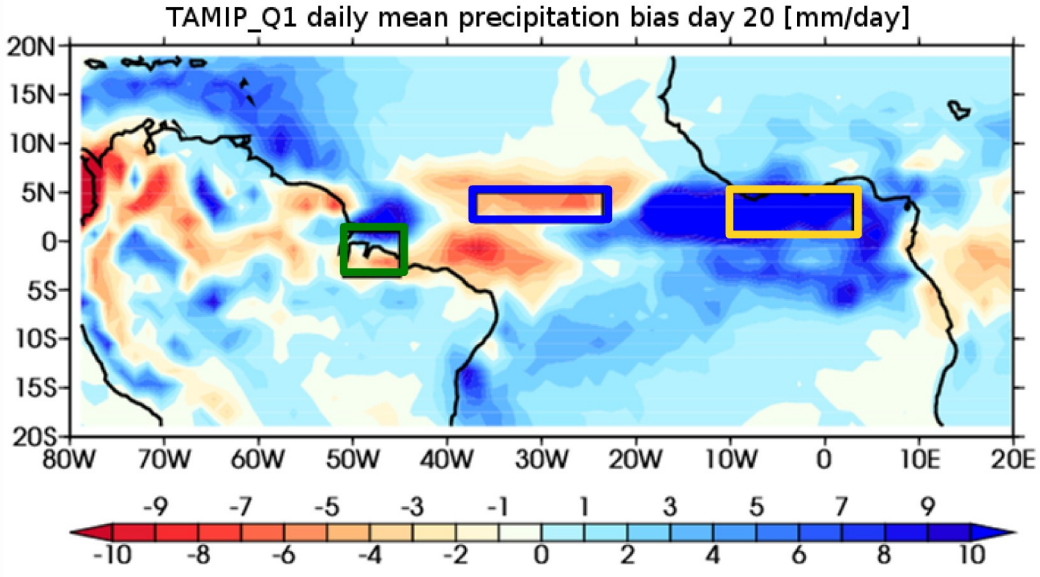


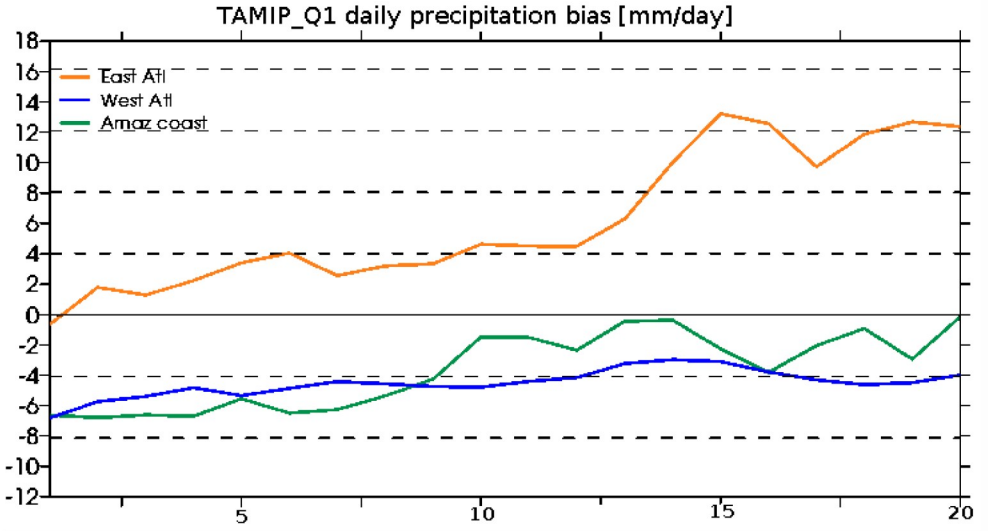


Sensitivity experiment - rainfall









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Summary, conclusion and outlook

- Significant zonal wind biases in the equatorial Atlantic region are already found in AMIP simulations
- These biases develop very quickly and can be well reproduced in TAMIP simulations
- The TAMIP framework allows to look into the development of these biases
- An analysis of the momentum budget points to the important role of biases in the pressure / GPH gradient for the development of the zonal wind biases
- These are likely related to rainfall biases

Summary, conclusion and outlook

- Within the TAMIP framework it is relatively easy to test this hypothesis by performing sensitivity experiments
- In a first simple sensitivity experiment we prescribe the observed Q1 profile over the western equatorial Atlantic and find an impact on the biases
- However, the design of the experiments needs to be refined

Thank you for your attention!

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