The Abdus Salam International Centre for Theoretical Physics

Assessment of the Regional Climate Earth System Model (RegESM) in reproducing observed climatic features of the atmosphere over the CORDEX Central America domain

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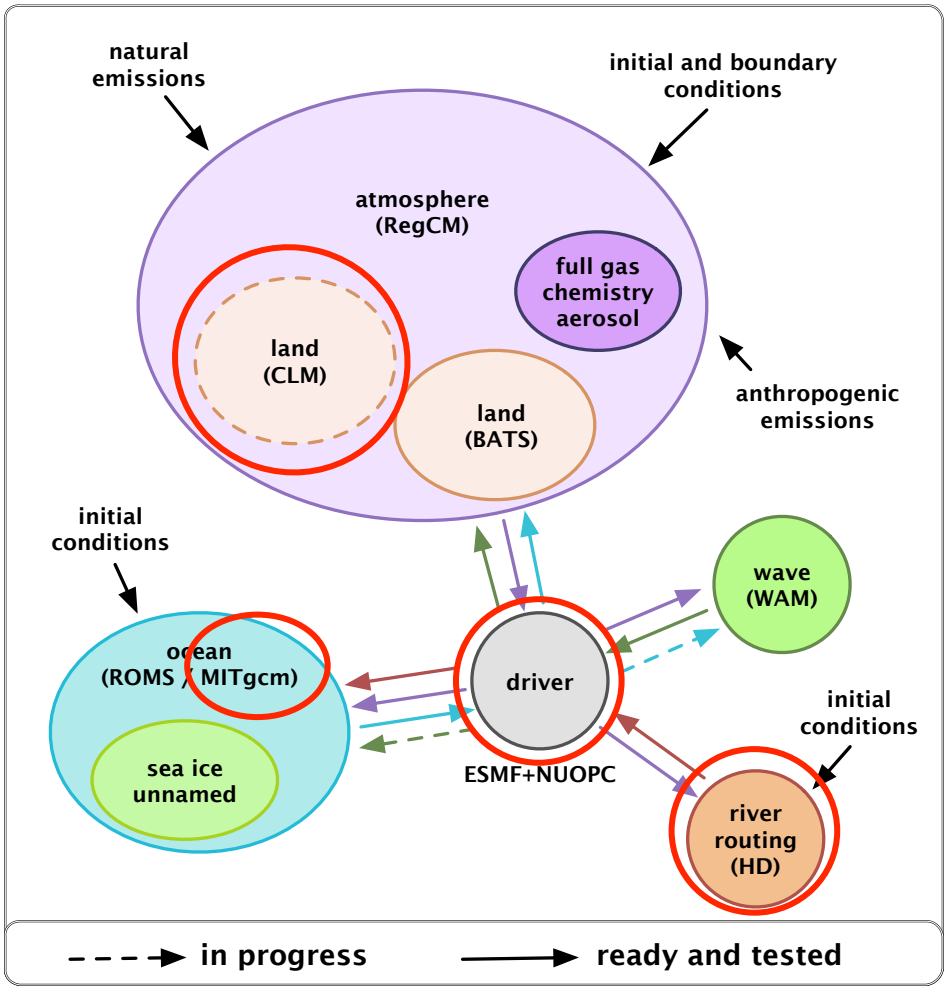
Outline

- Description of the RegESM system
- Methodology
  - Detection and tracking of tropical cyclones
- Processes and variables analyzed
  - Seasonal precipitation, SST and atmospheric circulation differences between the atmosphere-only and coupled simulations.
  - Tropical cyclones and some of their statistics

Regional Earth System Model is coupled modeling system that allows using variety of different earth system models (RegESM)

- Components:



ATM:
ICTP's RegCM (4.4.5.8)

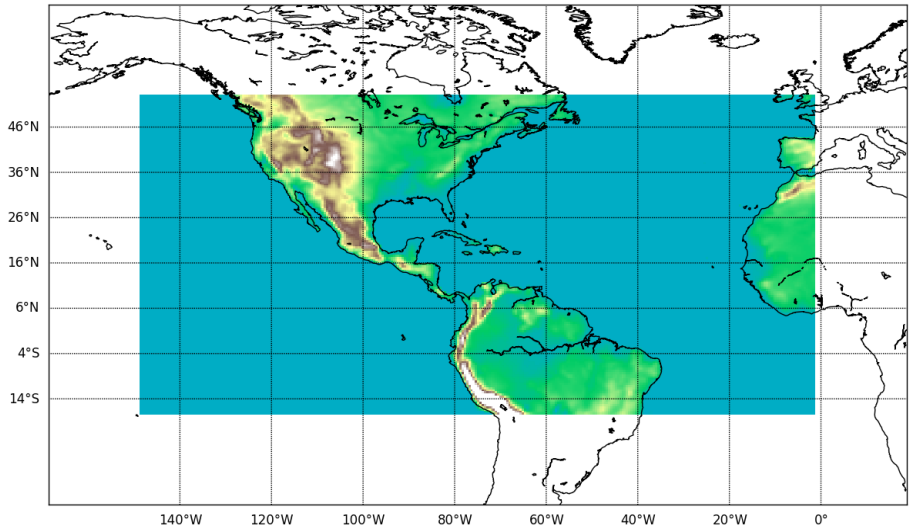
OCN:
MIT, MITgcm (c63s)

RTM:
Max Planck's HD (mod. 1.0.2)

DRV:
RegESM (7.0.0b38)

RegCM4 configuration

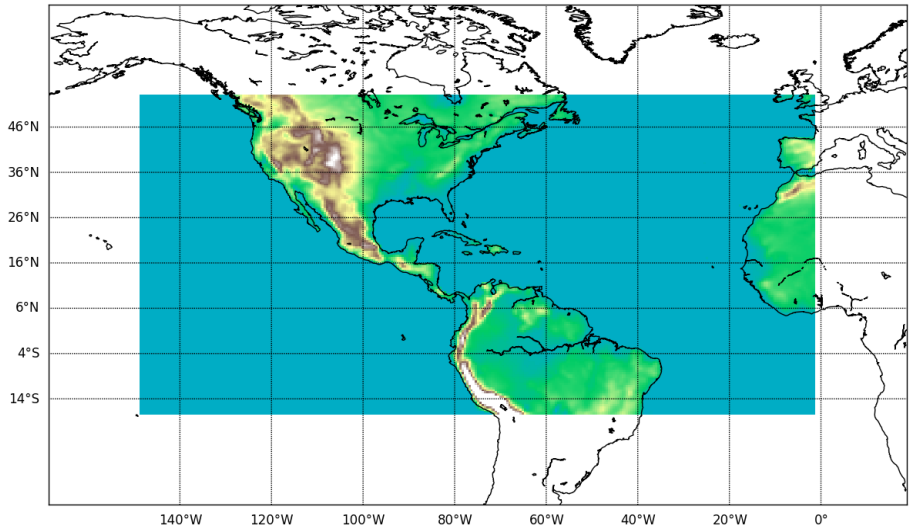
Central America CORDEX domain



- Period 1988-1994
- ERA Interim 0.75 degrees ICBC
- Radiation: Kiehl et al. [1996],
- Planetary boundary layer: Holtslag et al. [1990],
- Resolvable scale precipitation: Pal et al. [2000],
- Community Land Model 4.5
- Grell convection scheme over the land points of the domain, Emanuel over Ocean
- Ocean flux parameterization from Zeng et al. (1998)
- 50 km resolution

MITgcm configuration

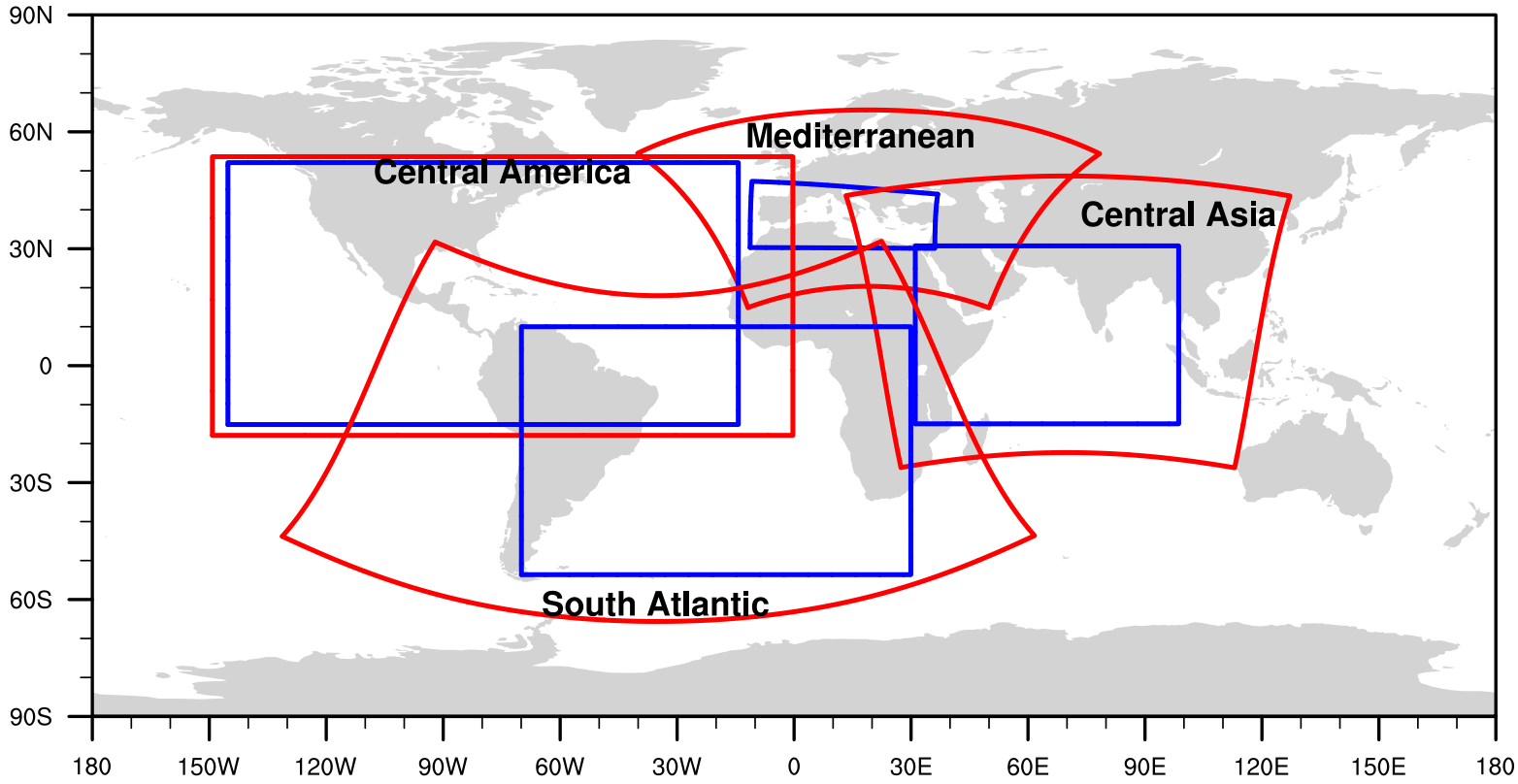
Central America CORDEX domain



- Period 1988-1994
- Resolution 25km
- K-profile parameterization of Large et al (1994) for vertical mixing,
- Viscosity scheme of Smagorinsky, with a biharmonic coefficient of 3 following Griffies and Hallberg [2000].
- Background viscosity $1x10^{-5}$ m^2/seg
- Initial and boundary conditions from GFDL-MOM025 CORE-II
- Background tracer diffusion:

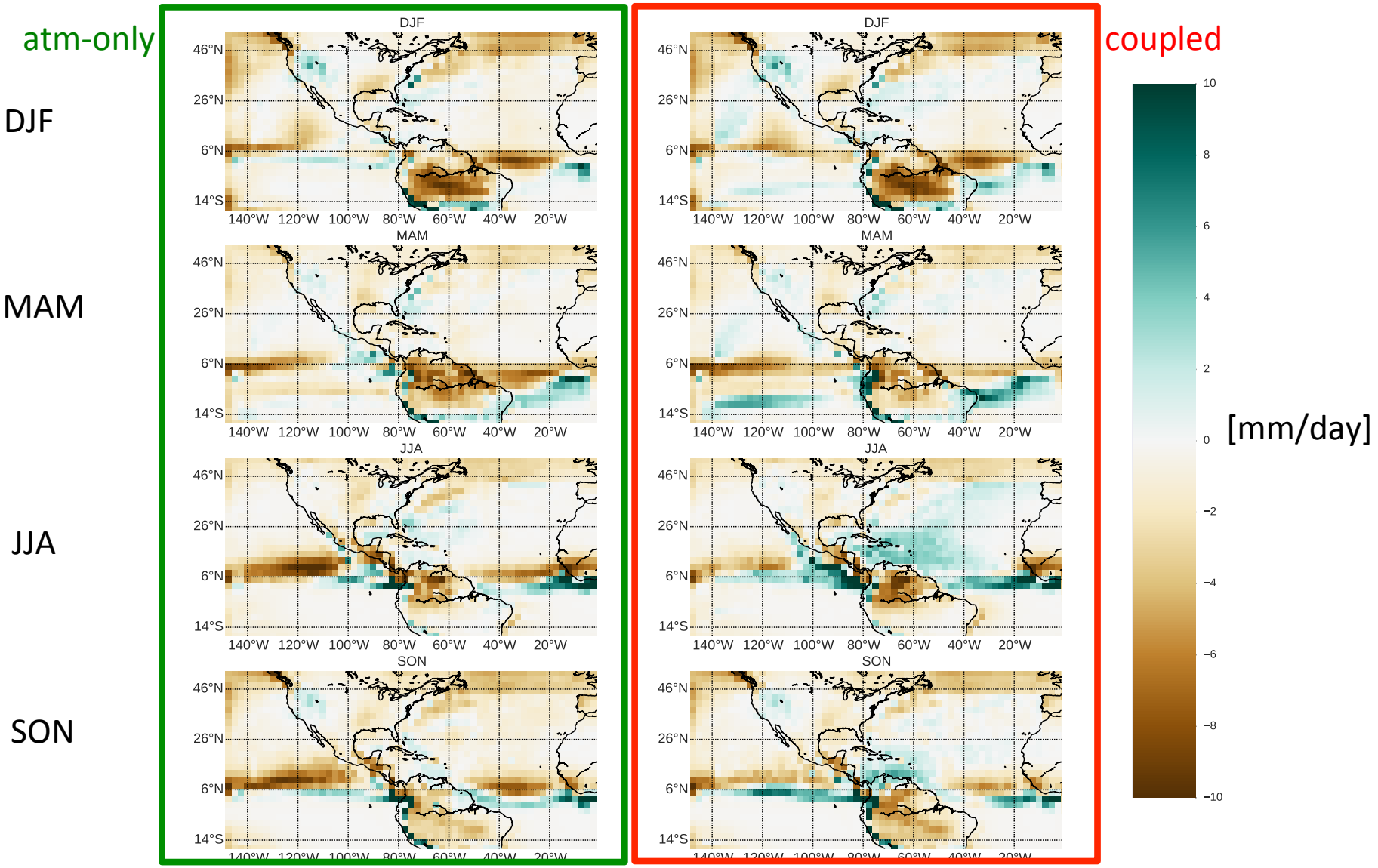
  - CPL1: $5X10^{-5}$ m^2/seg.
  - CPL2: $1X10^{-5}$ m^2/seg.

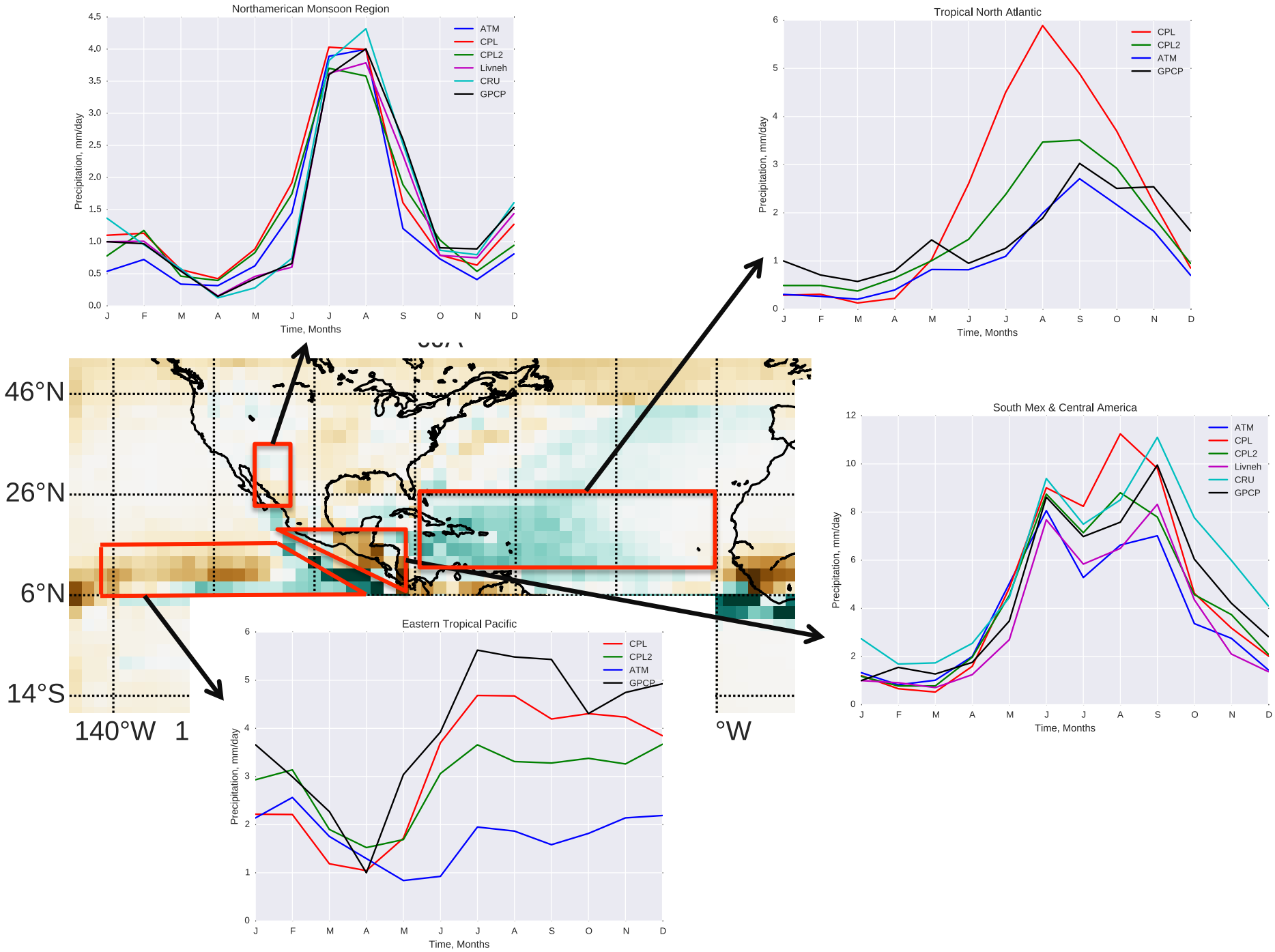
Tests in different CORDEX domains



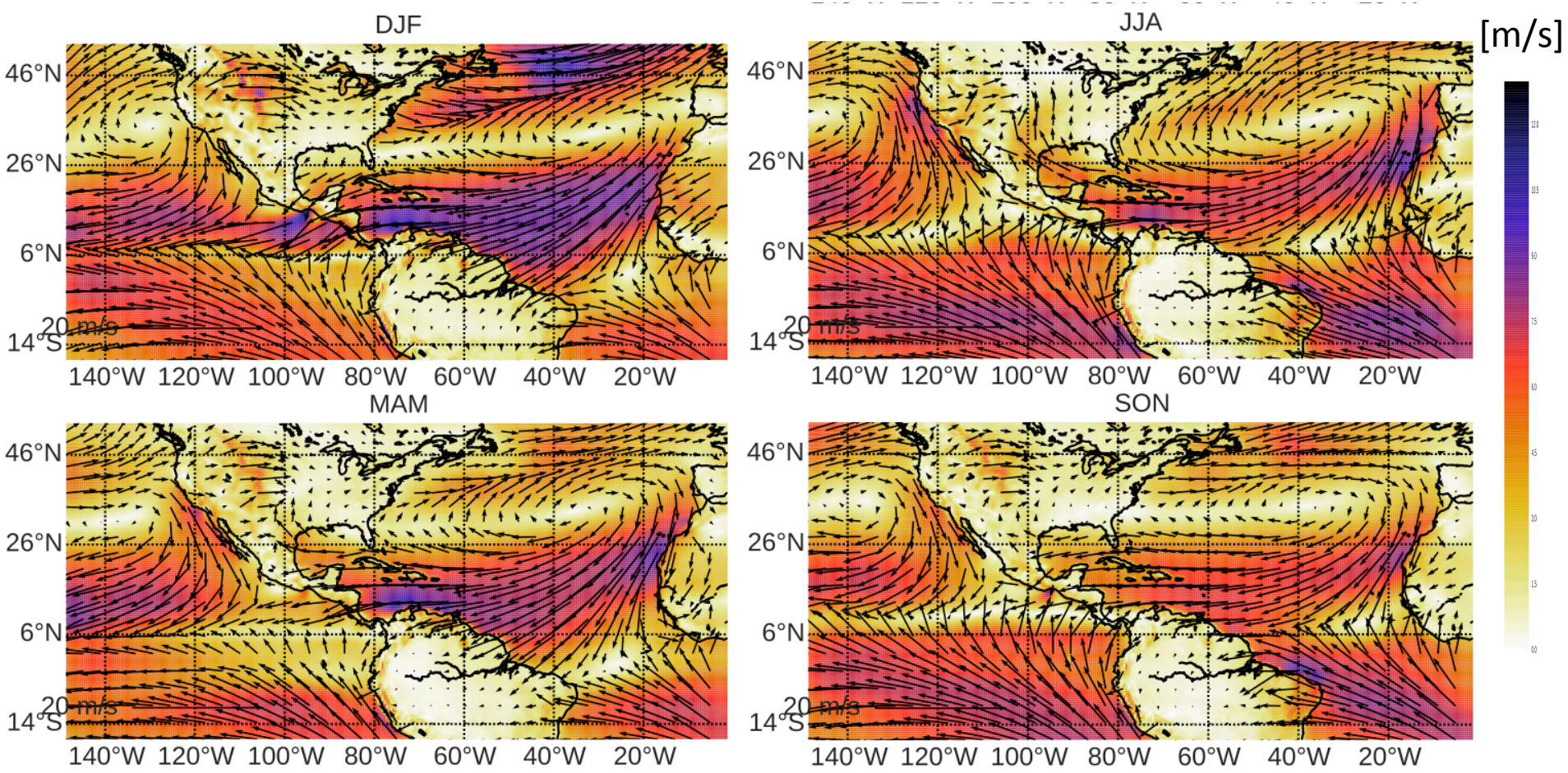
South Atlantic. Lina Sitz, Ramón Fuentes Franco, Marcelo Barreiro
Mediterranean: Ufuk Turuncoglu, Laura Mariotti
Central Asia: Fabio Di Sante

Precipitation bias (Model - GPCP)

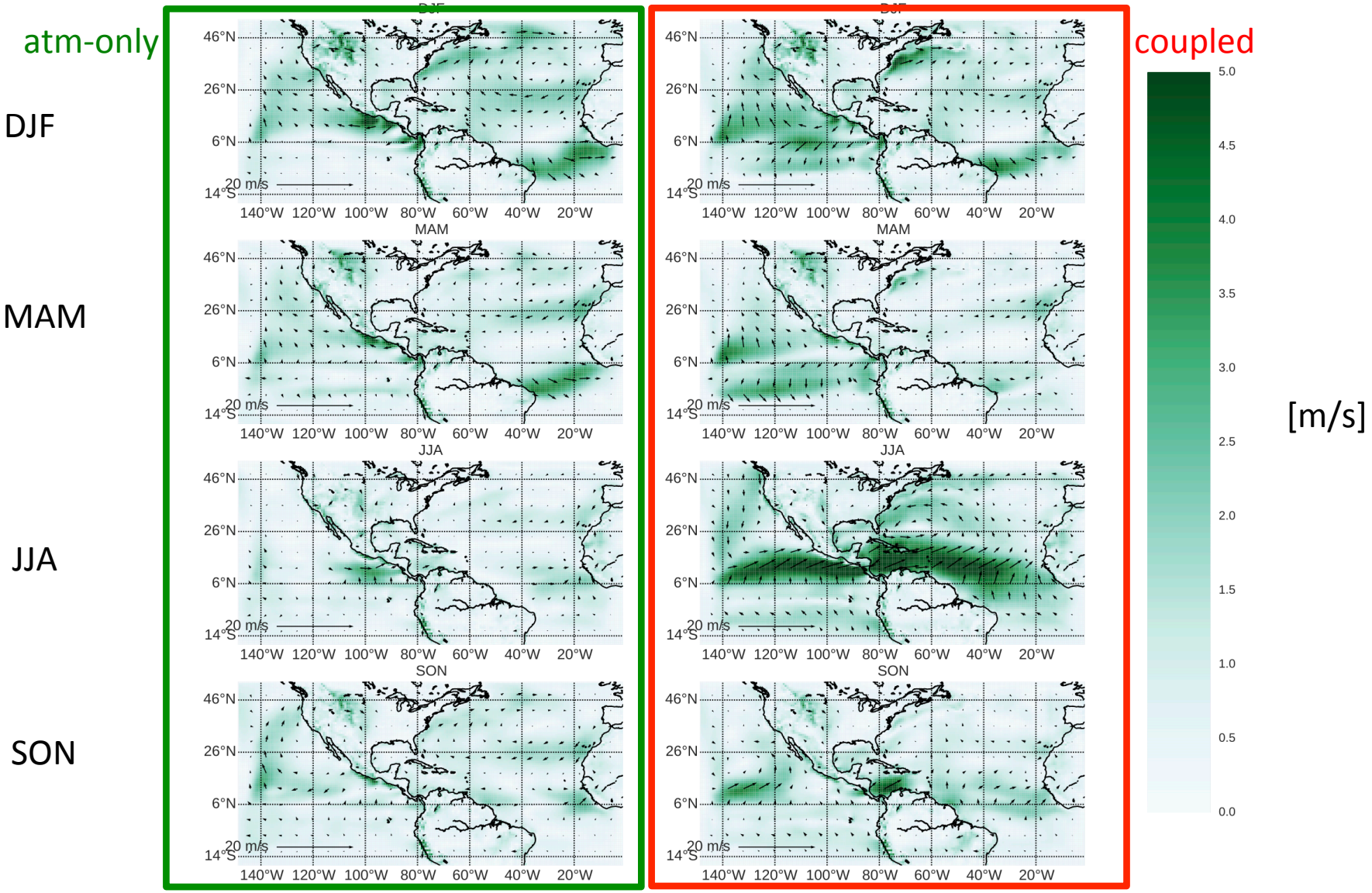



Northamerican Monsoon Region
Precipitation, mm/day
Time, Months
ATM
CPL
CPL2
Livneh
CRU
GPCP
J F M A M J J A S O N D
Tropical North Atlantic
Precipitation, mm/day
Time, Months
CPL
CPL2
ATM
GPCP
J F M A M J J A S O N D
46°N
26°N
6°N
14°S
140°W
°W
South Mex & Central America
Precipitation, mm/day
Time, Months
ATM
CPL
CPL2
Livneh
CRU
GPCP
J F M A M J J A S O N D
Eastern Tropical Pacific
Precipitation, mm/day
Time, Months
CPL
CPL2
ATM
GPCP
J F M A M J J A S O N D

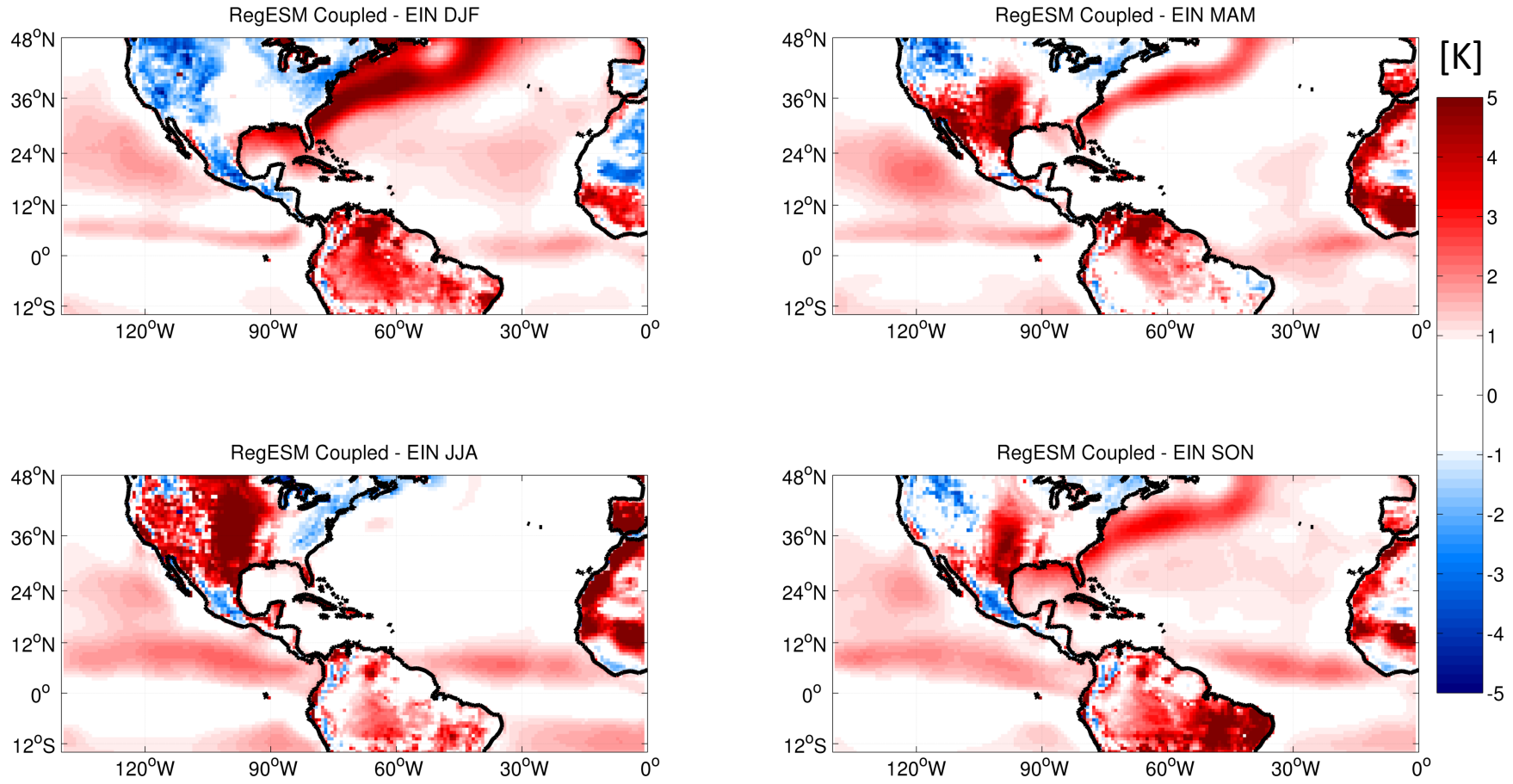
Atmospheric circulation



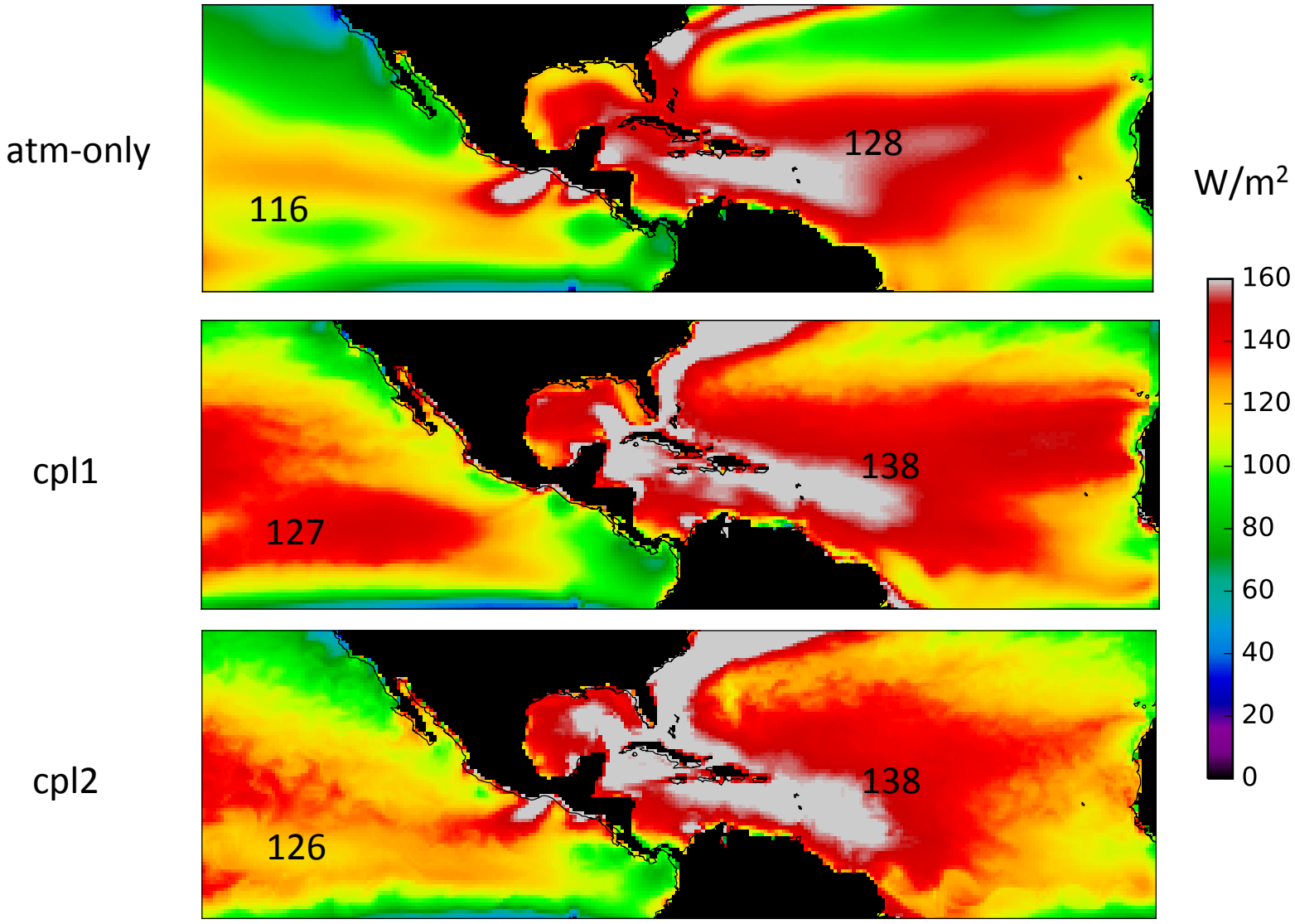
Surface wind bias (Model - EIN)



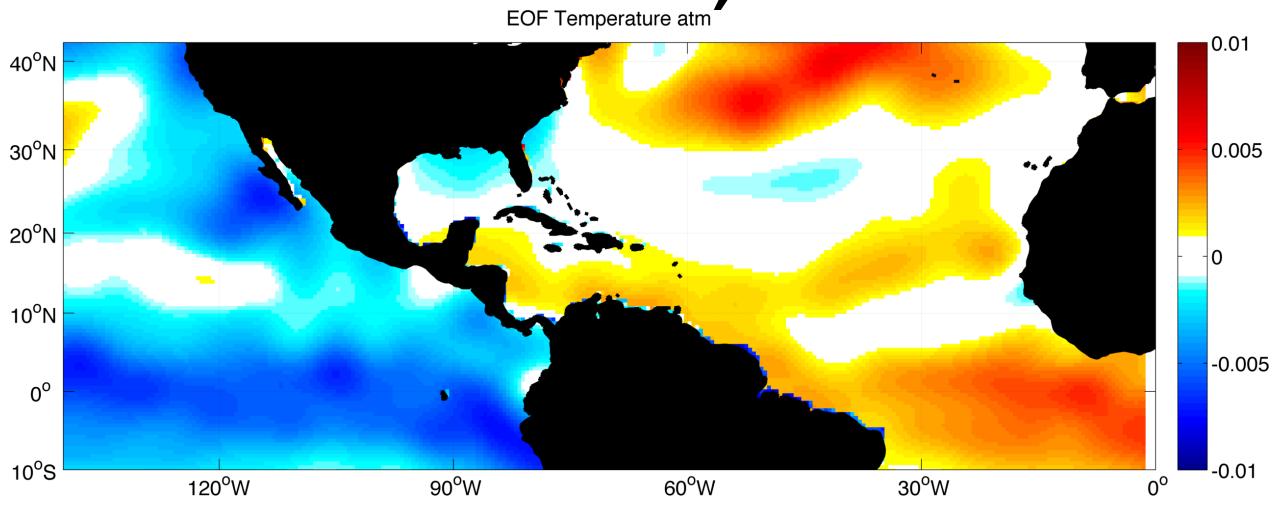
Sea surface temperature bias (Coupled - EIN)



Surface Latent Heat flux

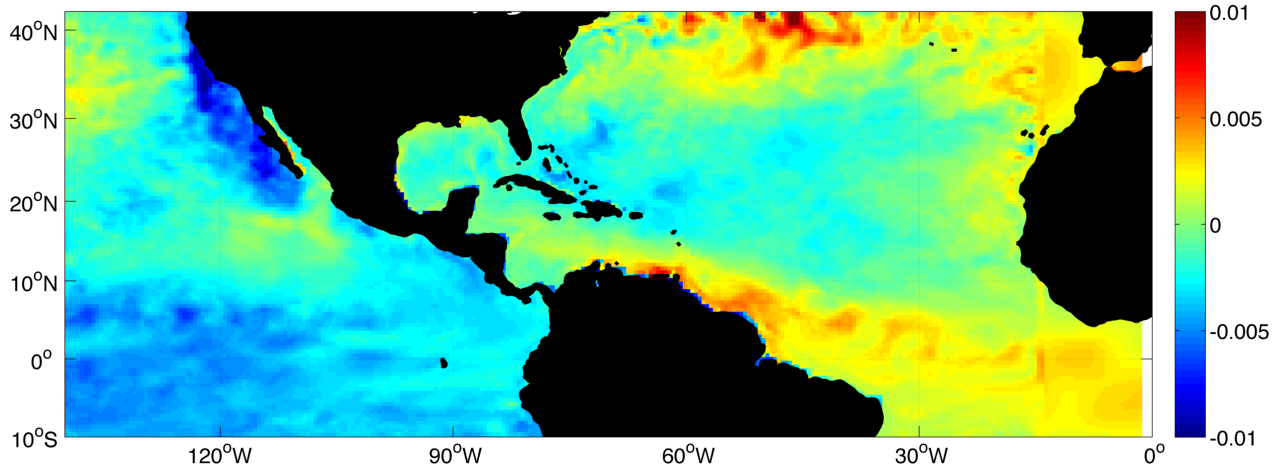


Spatial pattern of the main variability mode, SST



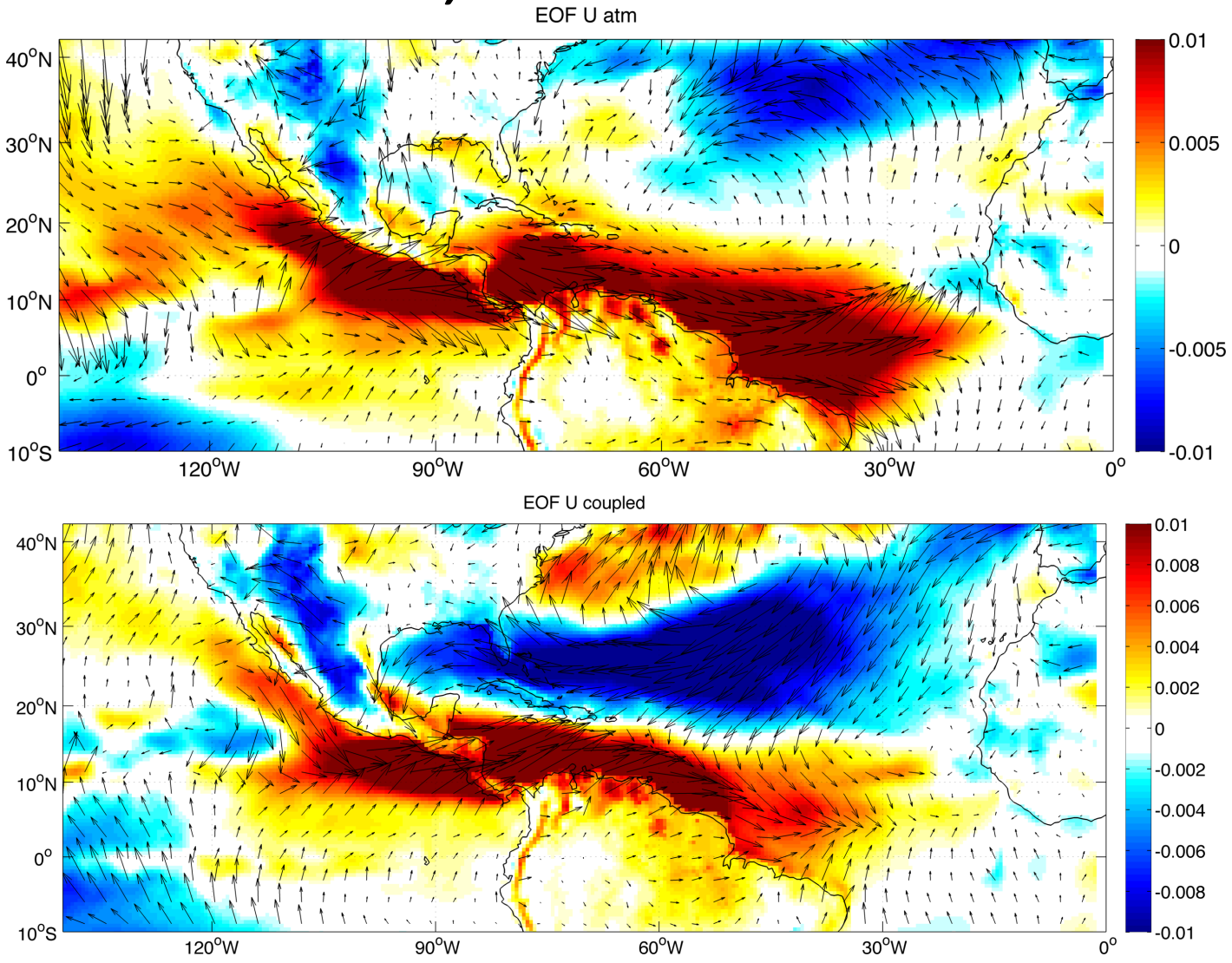
56% of total variance

1st EOF of SST

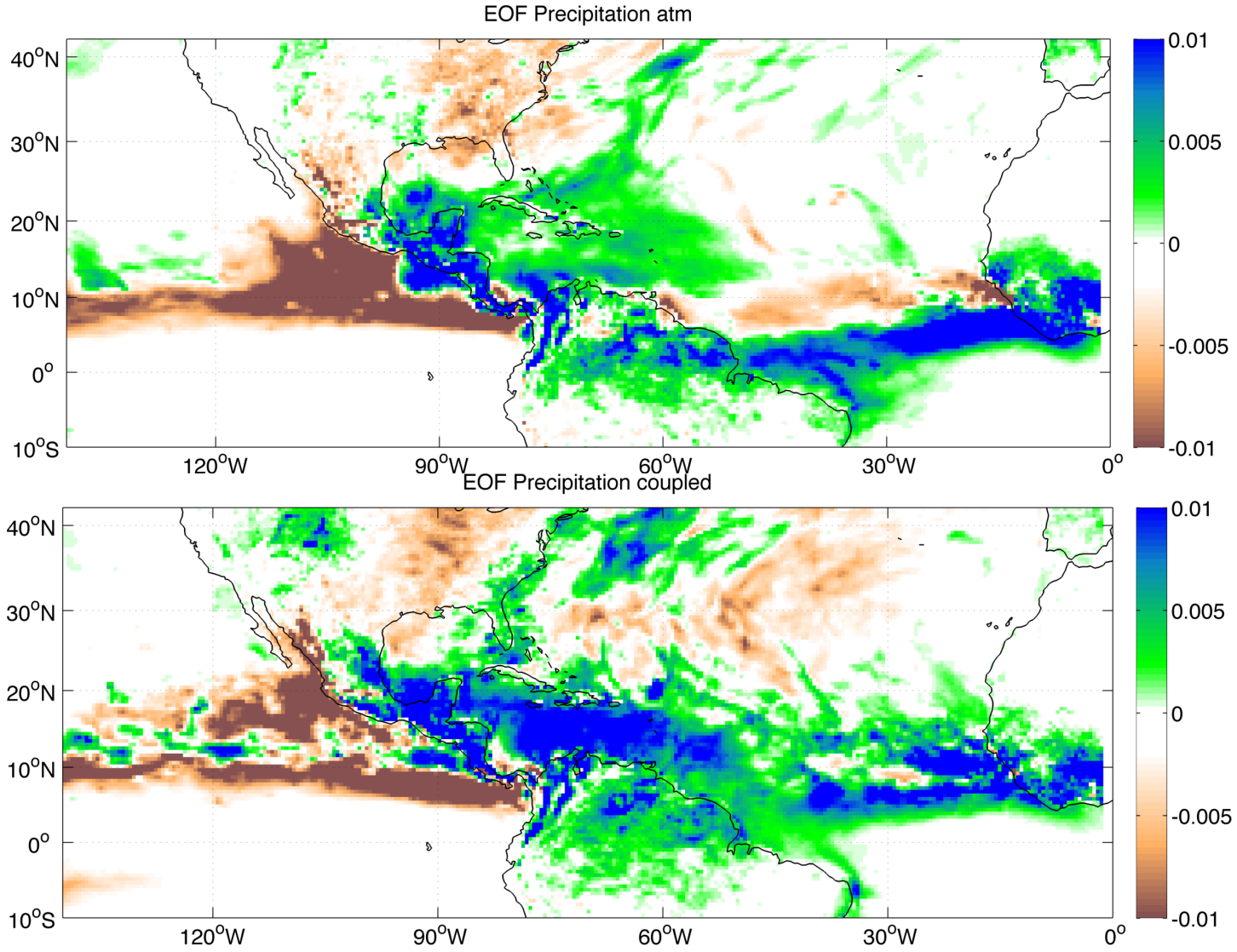


44% of total variance

Spatial pattern of the main variability mode, surface wind



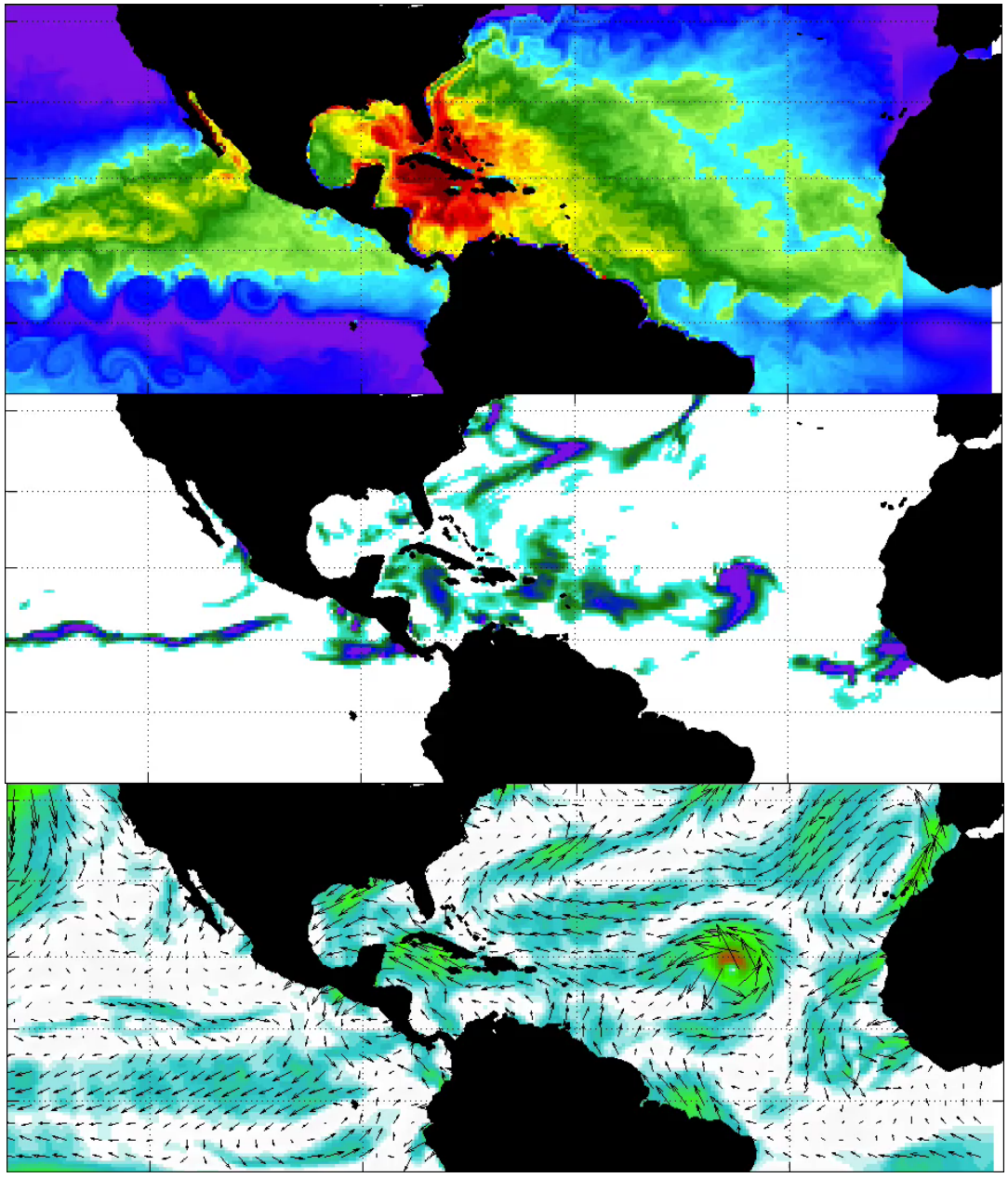
Spatial pattern of the main variability mode, precipitation



SST

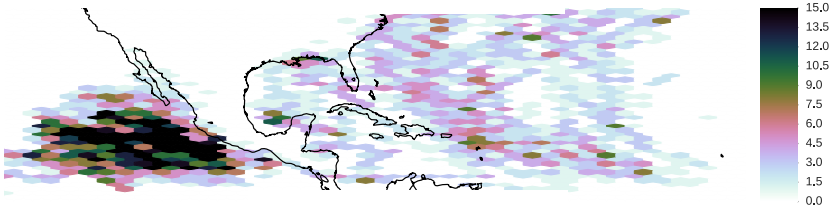
Precipitation

Wind

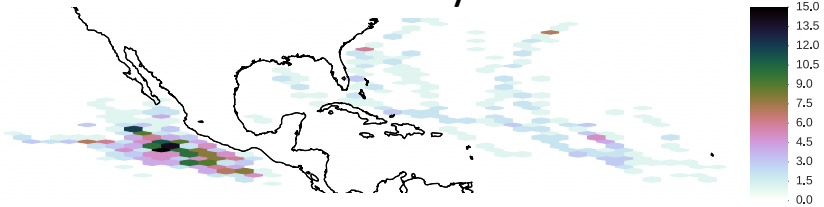


Tropical cyclones density

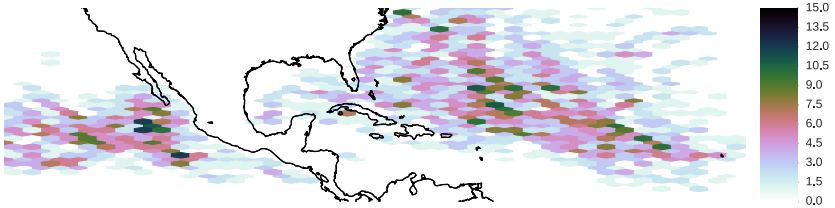
Observations



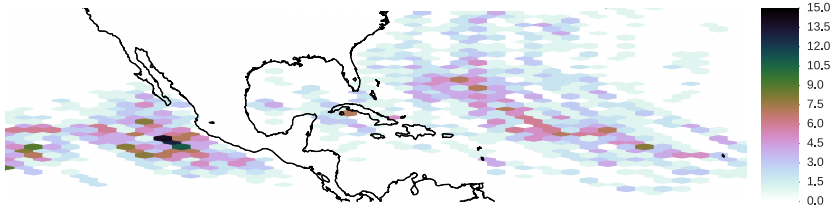
Atm-only



CPL1

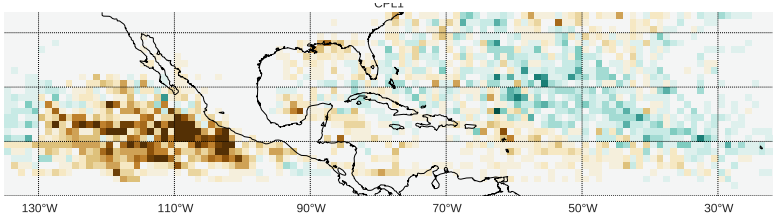


CPL2

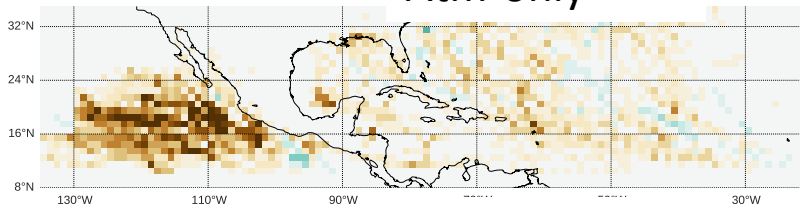


Biases

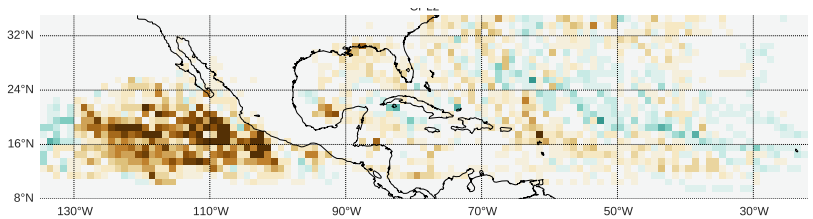
CPL1



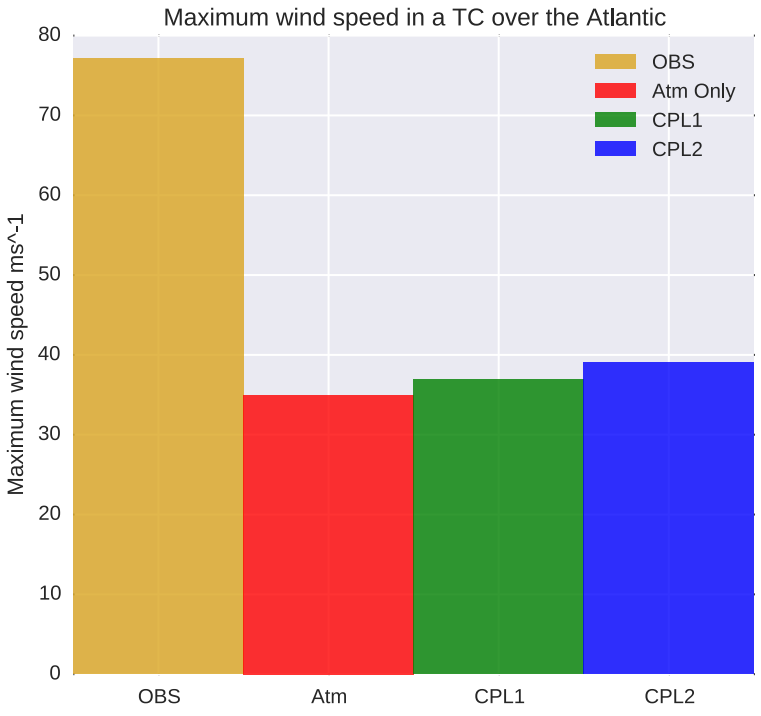
Atm-only

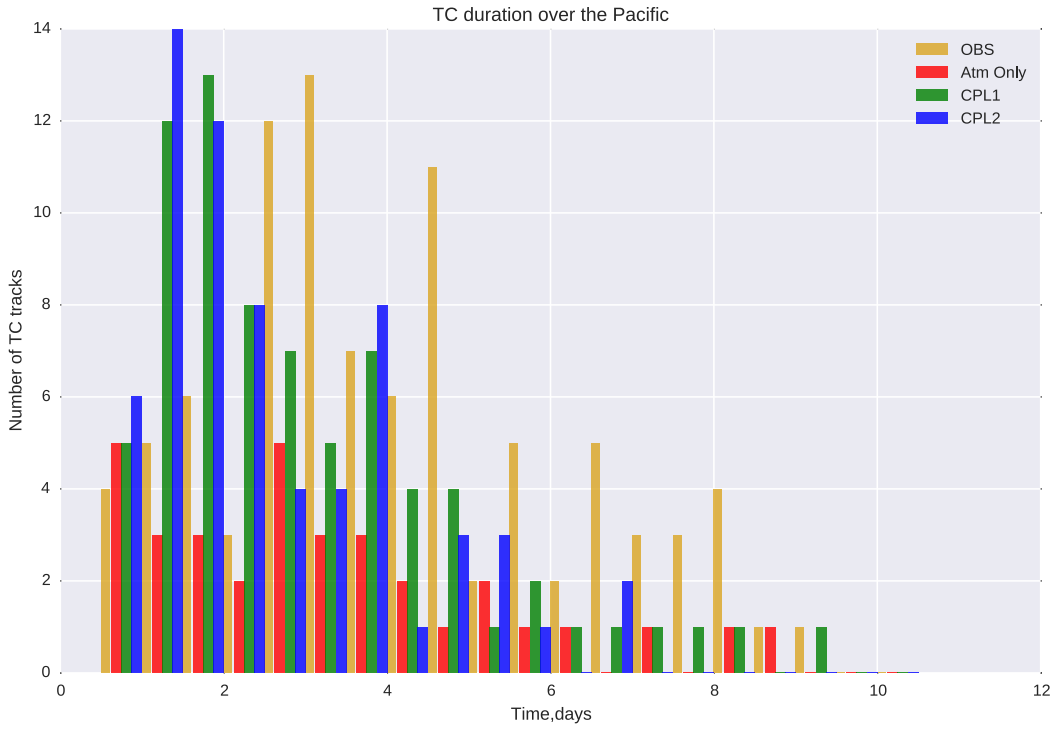


CPL2



Duration and intensity of tropical cyclones





Preliminary conclusions

- Pros of our coupled simulation
  - Better representation of precipitation over the Pacific ocean.
  - The spatial density of tropical cyclones.
  - The position and intensity of the ITCZ.
  - Location of the equatorial cold tongue over the Pacific.
  - Good representation of the Mid-summer drought over Central America and Southern Mexico.
- Cons:
  - Overestimation of precipitation over the Atlantic ocean.
  - Weakening of the Caribbean Low Level Jet.
  - SST warm biases.

Preliminary conclusions

- The warm biases found in the SST might be caused by atmospheric processes (since we did not find the warm bias in the ocean-only simulations).
- Possible candidates for this biases are:
  - Convection scheme
  - Representation of clouds
  - Boundary layer of the atmosphere

THANK YOU

- Exchange fields between model components

```
6 atm2ocn T
taux:eastward_10m_wind_stress:bilinear:cross:u:N/m2:m2/s2:cf3:0.0:F
tauy:northward_10m_wind_stress:bilinear:cross:v:N/m2:m2/s2:cf3:0.0:F
psfc:surface_air_pressure:bilinear:cross:cross:mb:mb:1.0:0.0:F
swrd:shortwave_radiation:bilinear:cross:cross:W/m^2:Cm/s:cf2:0.0:T
sflx:water_flux_into_sea_water:bilinear:cross:cross:kg/m^2s:m/s:0.001:0.0:T
nflx:surface_heat_flux:bilinear:cross:cross:W/m^2:Cm/s:cf2:0.0:T
1 ocn2atm T
sst:sea_surface_temperature:bilinear:cross:cross:C:K:1.0:293.16:F
2 atm2rtm F
rnof:surface_runoff:bilinear:cross:cross:mm/s:m/s:0.001:0.0:F
snof:subsurface_runoff:bilinear:cross:cross:mm/s:m/s:0.001:0.0:F
1 rtm2ocn F
rdis:river_discharge:nearstod:cross:cross:m^3/s:m^3/s:1.0:0.0:F
```

- the exchange fields from the field pool