MapMaker

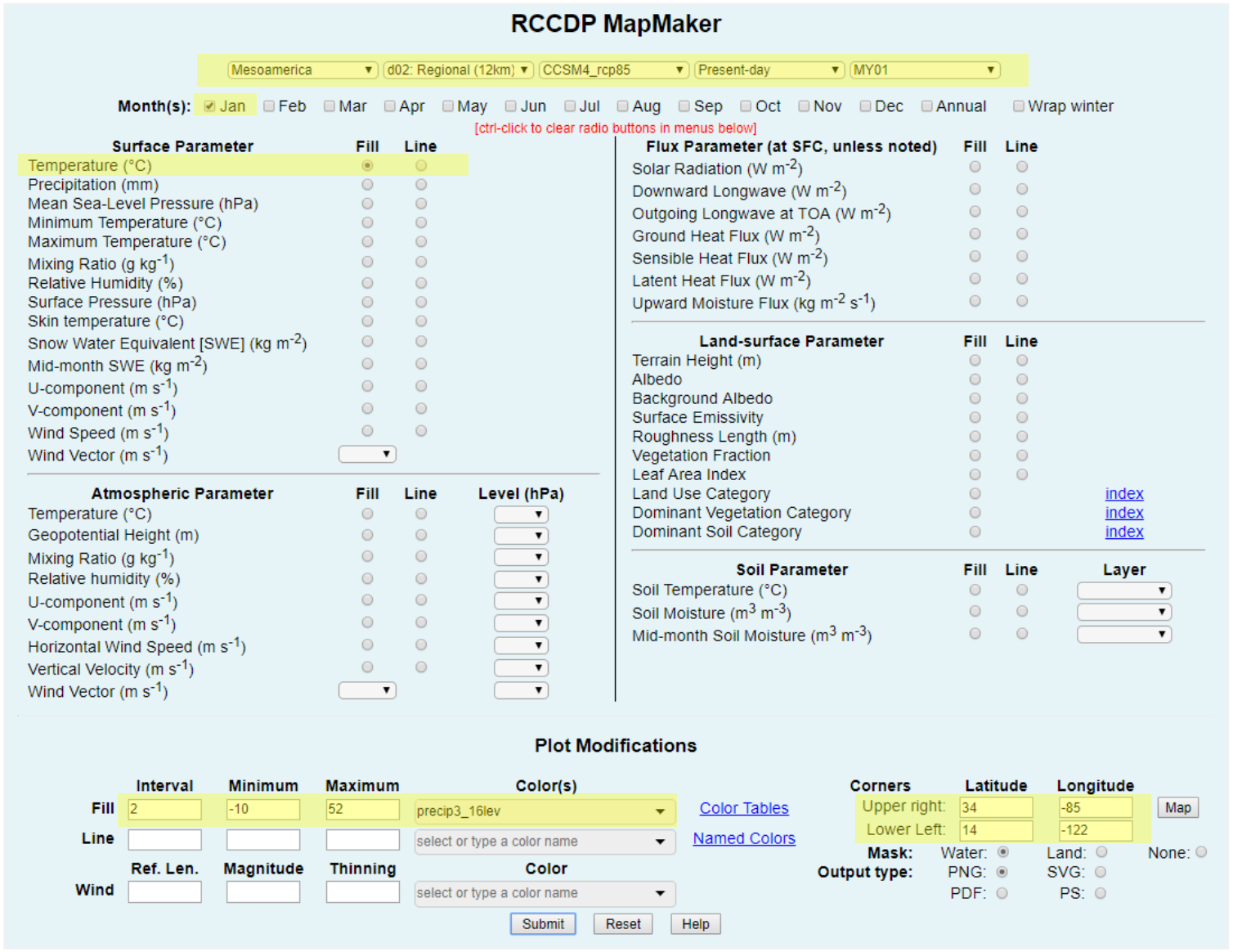
UNL Regional Climate Modeling Facility
UNIVERSITY OF NEBRASKA–LINCOLN

Hurricane Group

Jayaka D. Campbell
Francisco J. Argeñal Pinto
Alberto López López

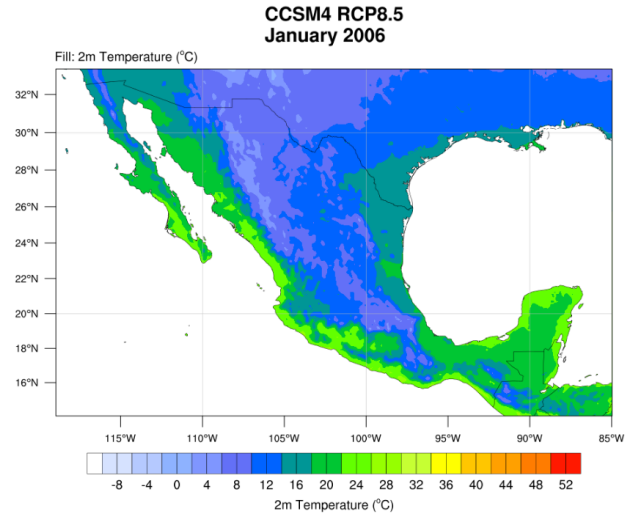
Test 1 – Average temperature

Average temperature

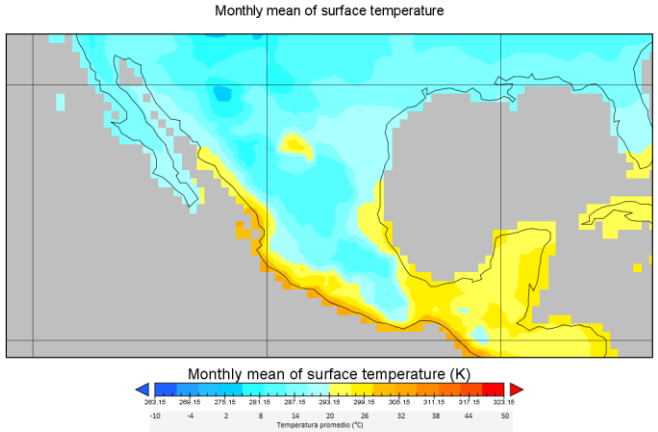


Comparative January/2006

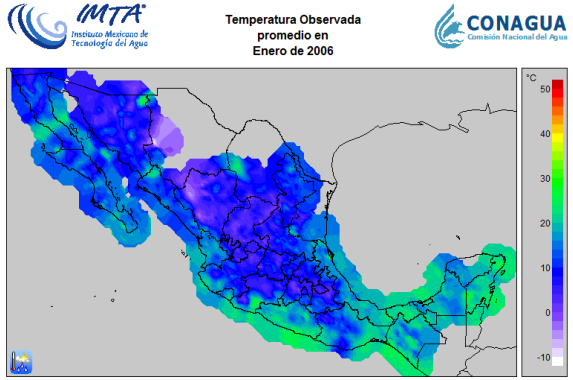
- MapMaker



- NASA



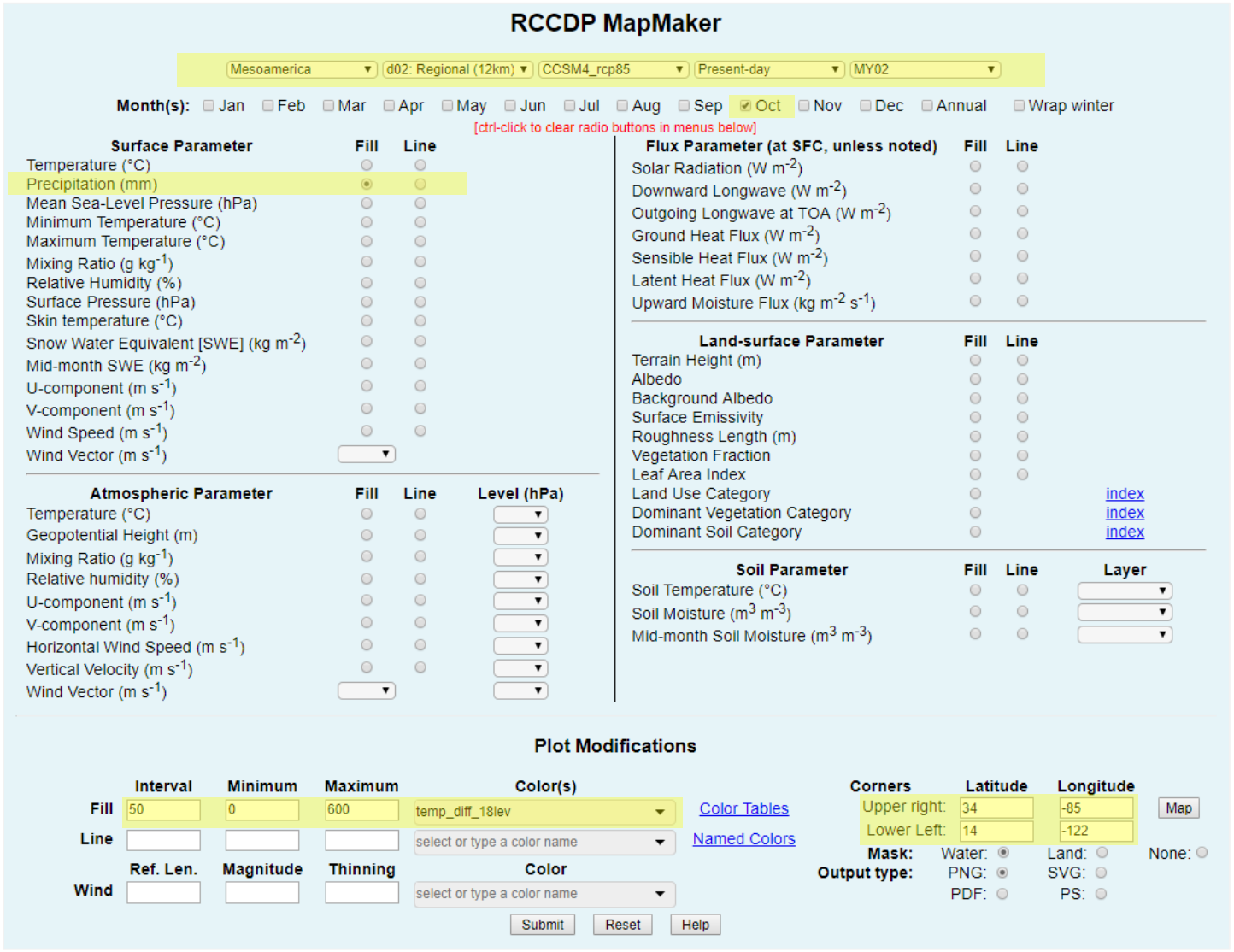
- ERICIII



https://www.esrl.noaa.gov/psd/data/gridded/data.ghcncams.html

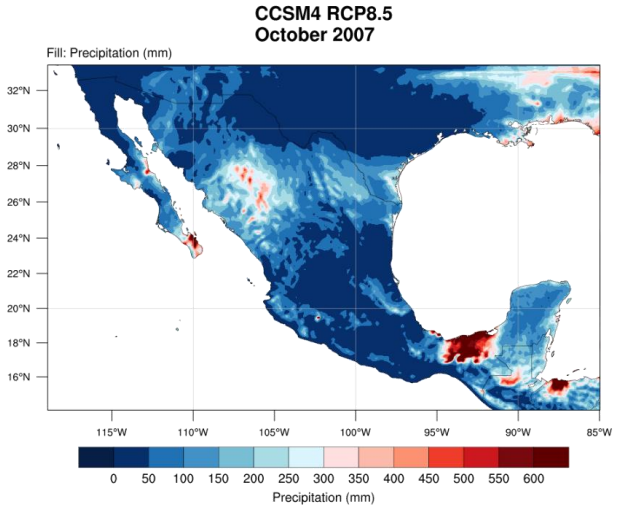
Test 2 – Cumulative rainfall

Cumulative rainfall

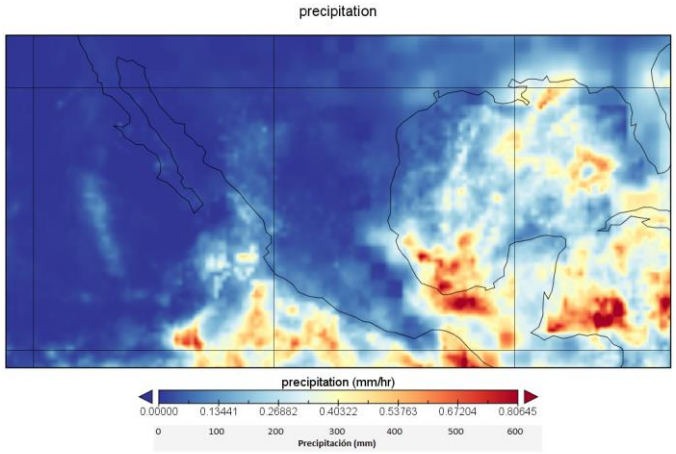


Comparative October/2007

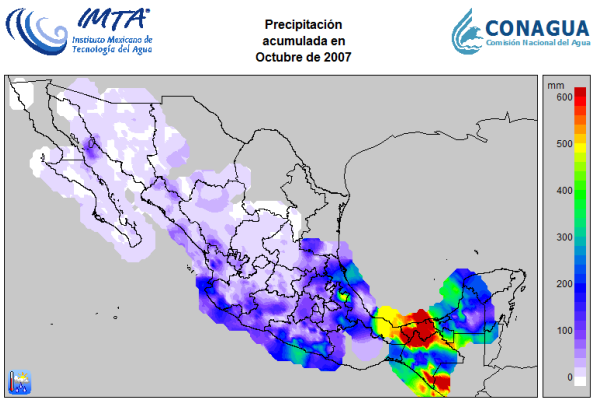
- MapMaker



- NASA



- ERICIII



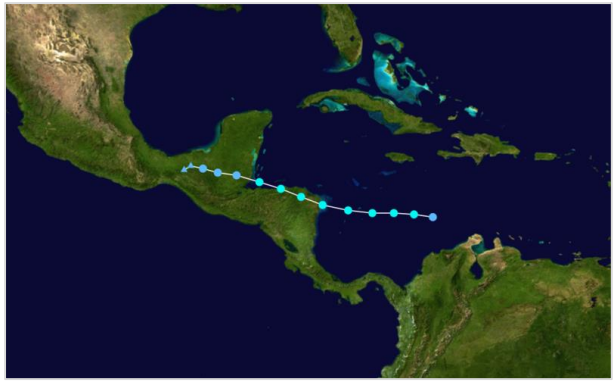
Test 3 – Wind Speed

Tropical Cyclones Septiember/2010

- Hermine (TT)

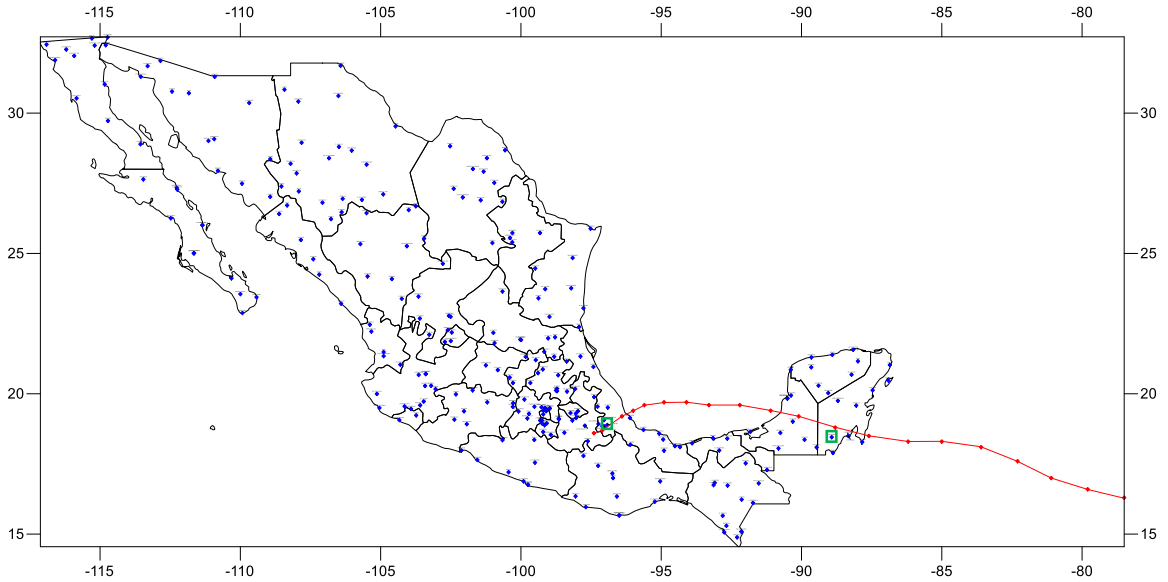
- Karl (H cat.III)

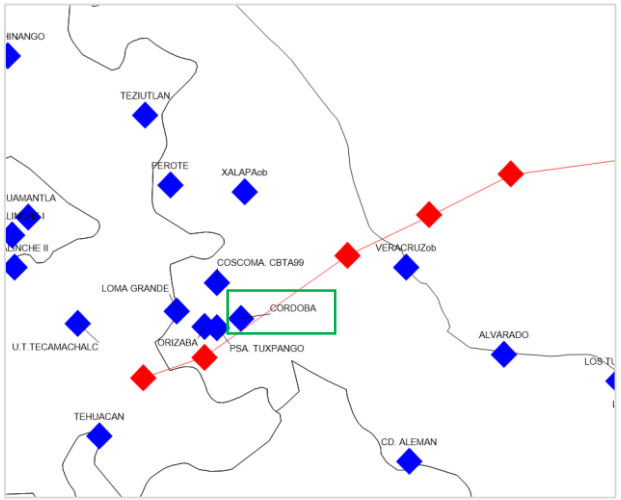
- Matthew (DT)

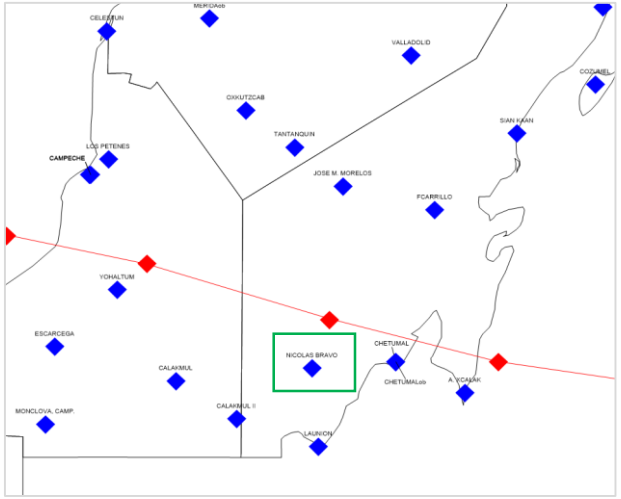


Cuadro resumen de ciclones tropicales 2010 en el Océano Atlántico	
Ciclones tropicales directamente sobre México	6 Huracán "Alex" (27-30 junio) Depresión tropical No. 2 (8 julio) TT. "Hermine" (6 sept) Huracán "Karl" (15-17 sept) Depresión tropical "Matthew" (25 sept) Depresión tropical "Richard" (25 oct)

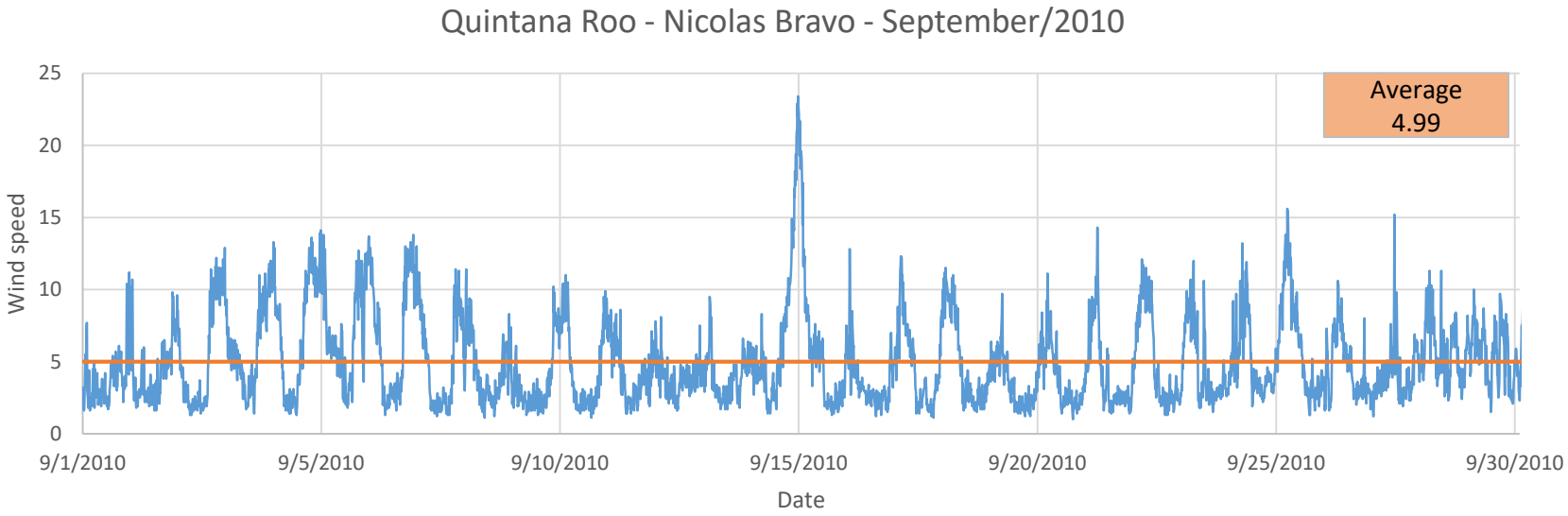
Karl (H cat.III) September/2010

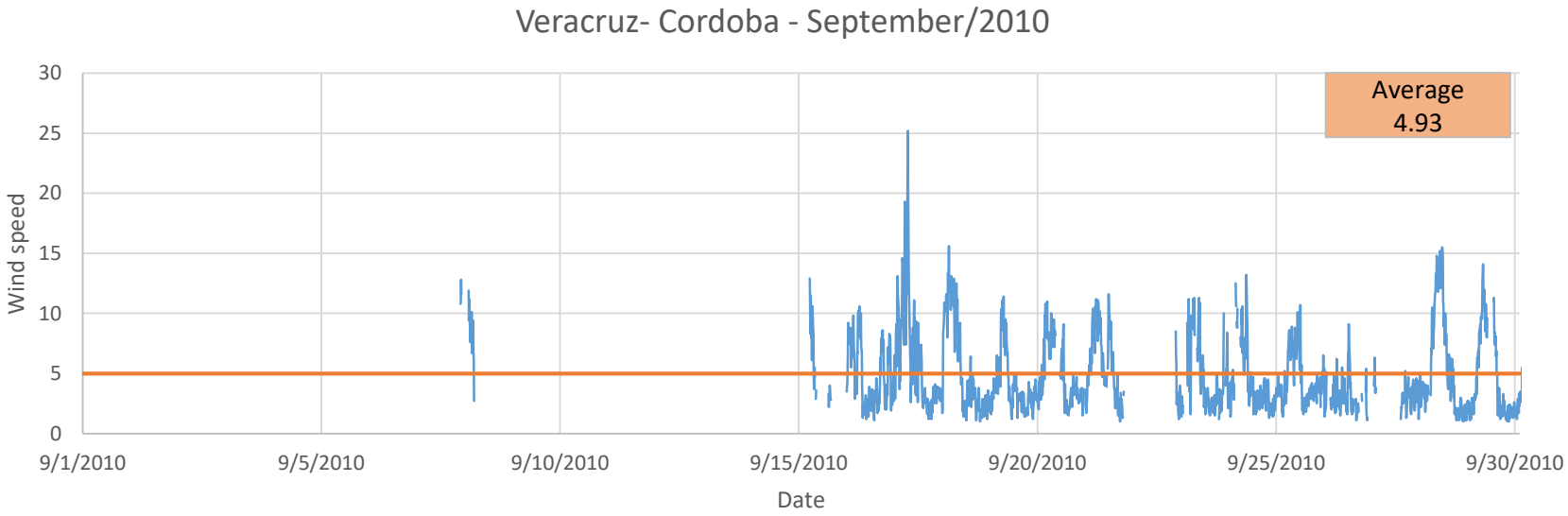




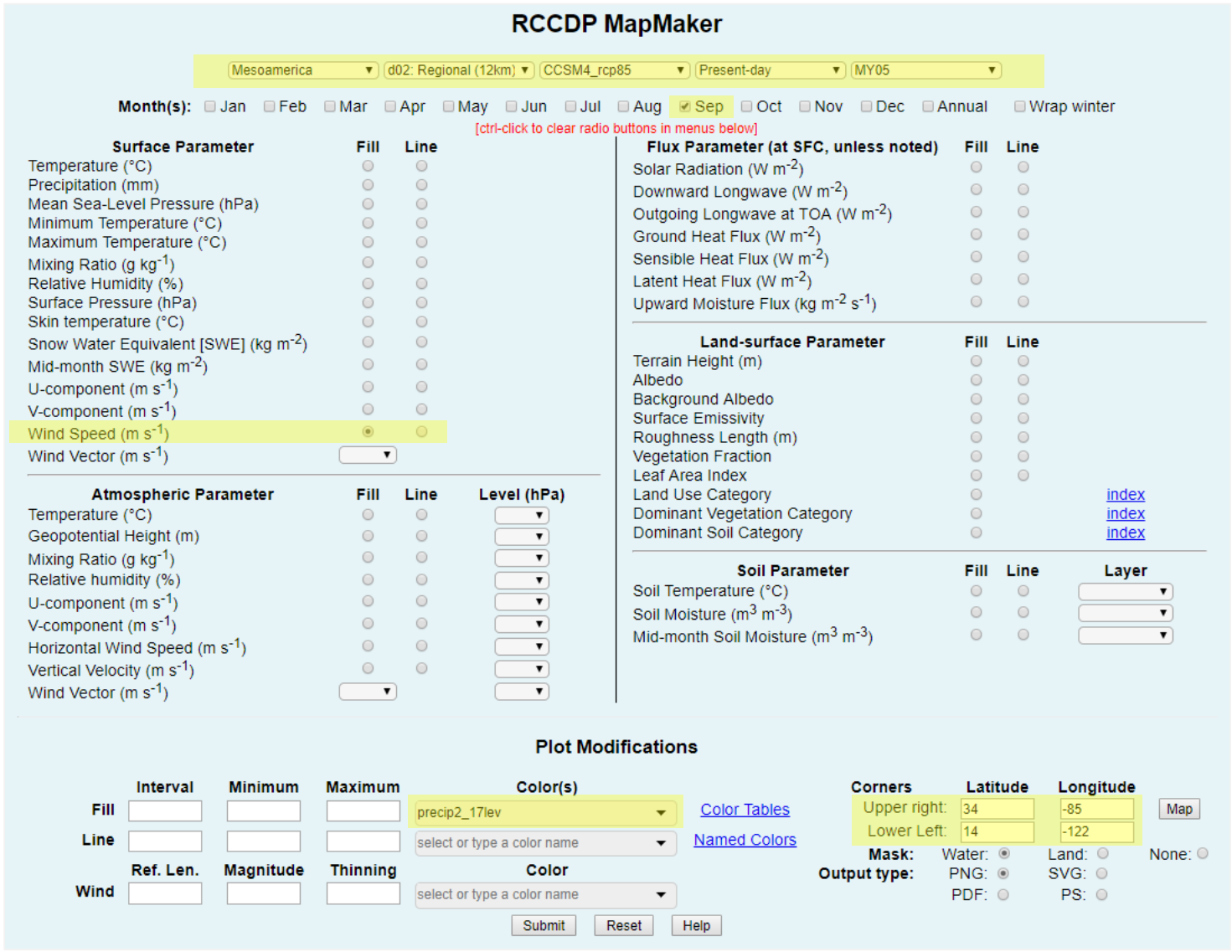


Karl (H cat.III) September/2010

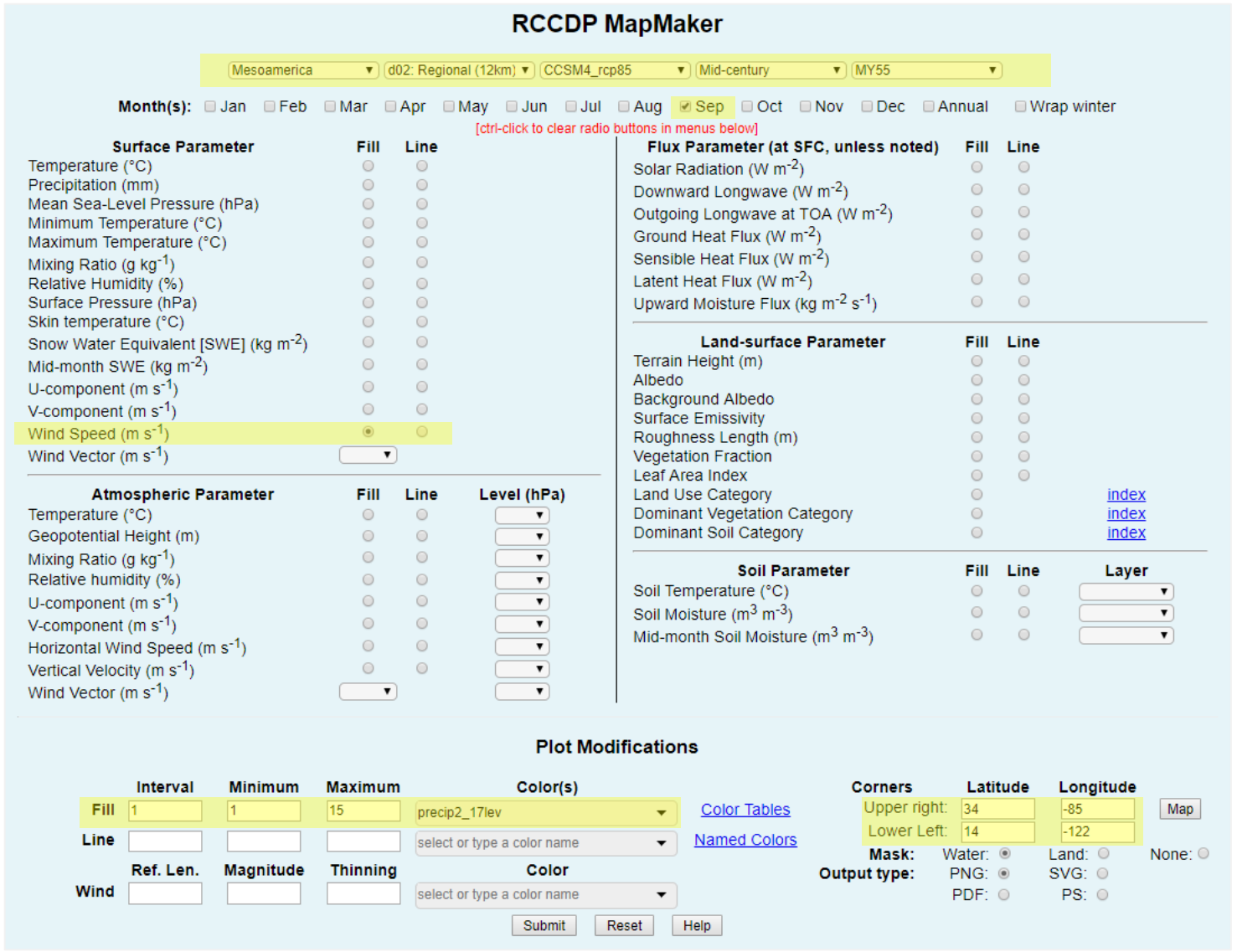




Average wind speed 2010

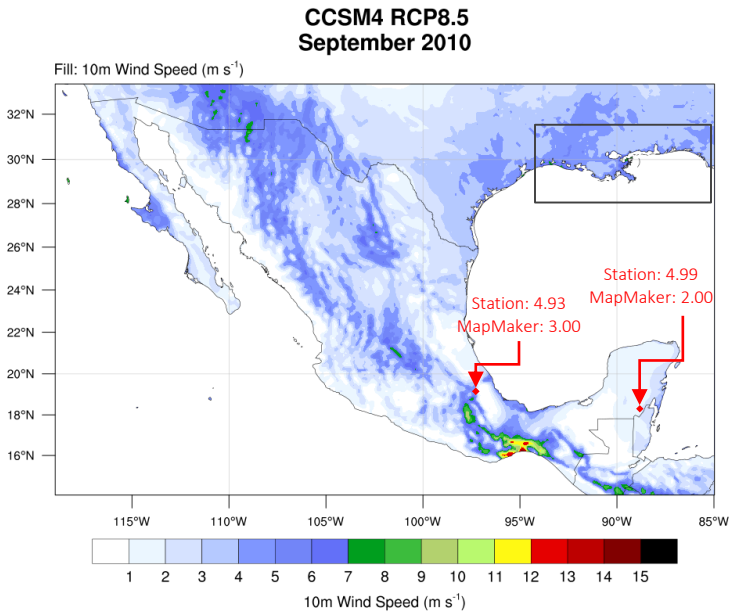


Average wind speed 2060

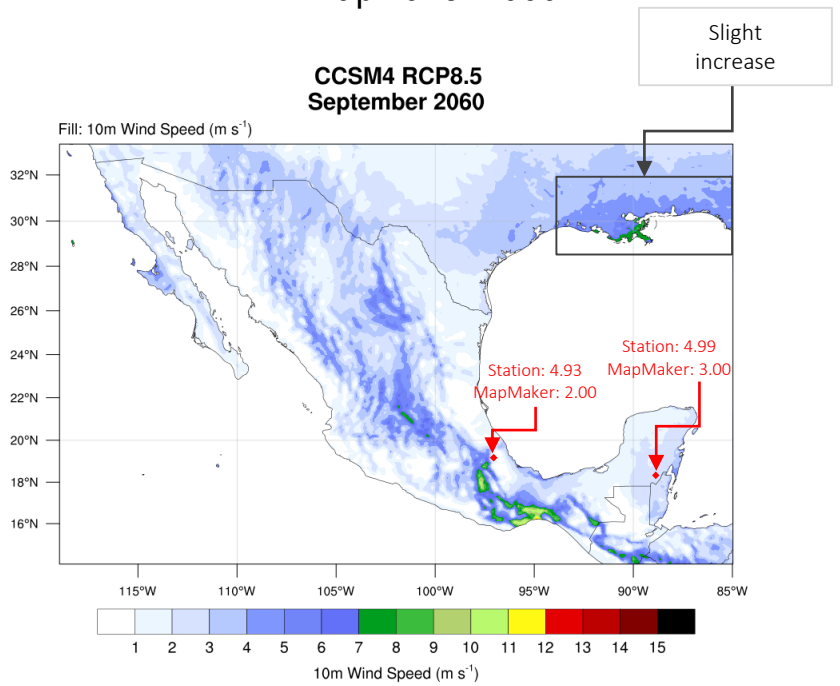


Comparative
September/2010 – September/2060 (d02)

- MapMaker 2010



- MapMaker 2060

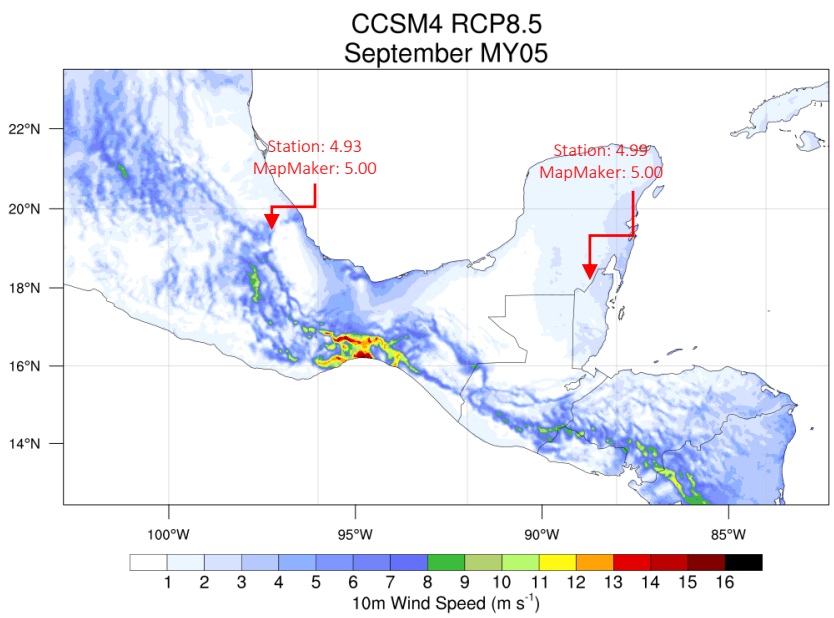


Cuadro resumen de ciclones tropicales 2010 en el Océano Atlántico

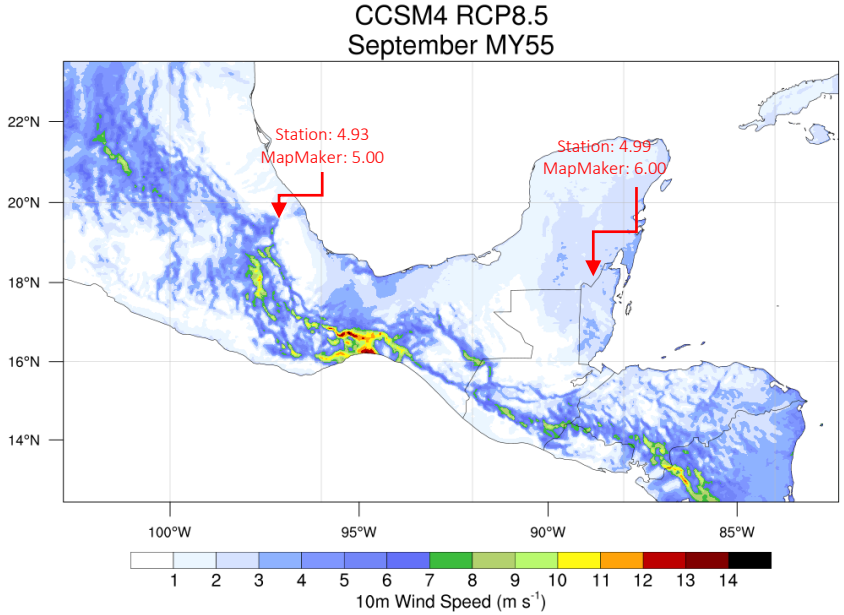
Ciclones tropicales directamente sobre México	6 Huracán "Alex" (27-30 junio) Depresión tropical No. 2 (8 julio) TT. "Hermine" (6 sept) Huracán "Karl" (15-17 sept) Depresión tropical "Matthew" (25 sept) Depresión tropical "Richard" (25 oct)

Comparative
September/2010 – September/2060 (d03)

- MapMaker 2010



- MapMaker 2060



Cuadro resumen de ciclones tropicales 2010 en el Océano Atlántico

Ciclones tropicales directamente sobre México	6 Huracán "Alex" (27-30 junio) Depresión tropical No. 2 (8 julio) TT. "Hermine" (6 sept) Huracán "Karl" (15-17 sept) Depresión tropical "Matthew" (25 sept) Depresión tropical "Richard" (25 oct)

Methods for Detection of TCs

Methods for Detection of TCs (Bengstsson, Oouchi, Gualdi and Zhao)

For tropical cyclones, Gray has proposed a criterion which reproduces the geographical repartition of their seasonal frequency occurrence in the current climate. Gray (1979) related this seasonal tropical cyclone frequency to a combination of six seasonal genesis parameters divided in two groups, three dynamical variables (Lower-tropospheric relative vorticity, Coriolis parameter and vertical wind-shear) and three thermodynamical variables (ocean thermal energy, humidity and moist instability of lower atmosphere)computed from seasonally (3-months) averaged large scale field.

Bengstsson (1995) and Walsh(1997) propose thresholds for following para meters:
1) Relative Vorticity, 2) Minimum surface pressure, 3) Temperature anomalies,
4) Ratio at 300 hPa and 850 hPa, 5)Wind speed and 6)Duration of the event

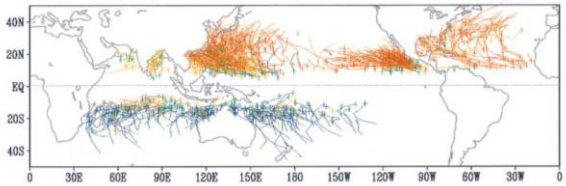
PARAMETER	BENGTSSON (1996)	OOUCHI (2006)	GUALDI (2008)	ZHAO (2009)
Vorticity	Relative vorticity at 850 hPa > 3.5 x 10^{-5} s^{-1}	The magnitude of the maximum relative vorticity at 850 hPa exceeds 3.5 x 10^{-5} s^{-1}	In A, relative vorticity at 850 hPa is >3 x 10^{-5} s^{-1}	At each time, 850-hPa relative vorticity maximum exceeding 1.6 x 10^{-4} s^{-1} are located within areas of 6° x 6° latitude and longitude.
Minimum surface pressure	A maximum velocity of 15 m s^{-1} and a minimum surface pressure within a 7x7 grid point area around the point which fulfils condition 1.	Across the 45S–45N latitudinal belt, the grid point corresponding to a TC-center candidate was defined as the one where the minimum surface pressure is at least 2 hPa lower than the mean surface pressure over the surrounding 7° x 7° grid box.	There is a relative minimum surface pressure and wind velocity > 14 m s^{-1} in an area of 2.25° around A	The local minimum of sea level pressure, which must be within a distance of 2° latitude or longitude from the vorticity maximum, is defined as the center of the storm. And the local maximum surface (lowest model level) wind speed is recorded.

Identification algorithms of TCs Bengstsson, Oouchi, Gualdi and Zhao

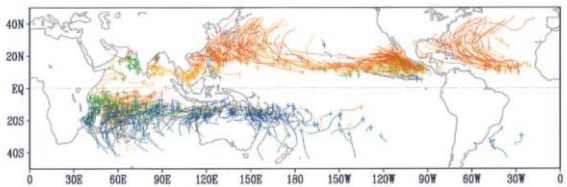
PARAMETER	BENGTSSON (1996)	OOUCHI (2006)	GUALDI (2008)	ZHAO (2009)
Temperature anomalies	The sum of the temperature anomalies for the levels 700, 500 and 300 hPa > 3°C	The temperature structure aloft has a marked warm core such that the sum of the temperature deviations at 300, 500 and 700 hPa exceeds 2°K.	The sum of temperature anomalies at 700, 500, and 300hPa is >2°K, where the anomalies are defined as the deviation from a spatial mean computed over an area of 13 grid points in the east–west and 2 grid points in the north–south direction	The local maximum temperature averaged between 300 and 500 hPa is defined as the center of the warm core. The distance of the warm-core center from the storm center must not exceed 2°. The warm-core temperature must be at least 1°C warmer than the surrounding local mean.
Ratio at 300 hPa and 850 hPa	The temperature anomaly at 300 hPa > temperature anomaly at 850 hPa	The maximum wind speed at 850 hPa is larger than that at 300 hPa	The temperature anomaly at 300 hPa is greater than the temperature anomaly at 850 hPa	
Wind speed	The mean wind speed at 850 hPa > mean wind speed at 300 hPa.	The maximum wind speed at 850 hPa is larger than 15 m s-1	The wind velocity at 850 hPa is > wind velocity at 300 hPa	
Duration of the event	Minimum duration of the event ≥ 1.5 days	The duration is not shorter than 36 hours	The above conditions persist for a period longer than 1.5 days	

- Several authors (OOUCHI, 2006 and ZHAO, 2009) have performed simulations of tropical cyclones with good results.

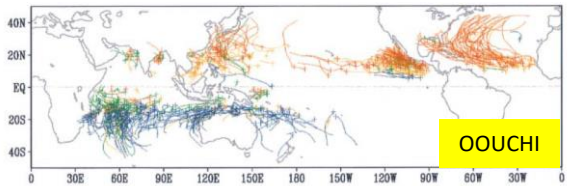
Observation 1979-1988 10 years



Present-day expt. 1989-1998* 10 years

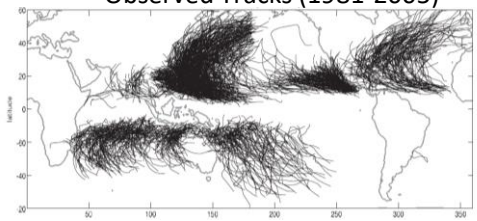


Future expt. 2090-2099* 10 years

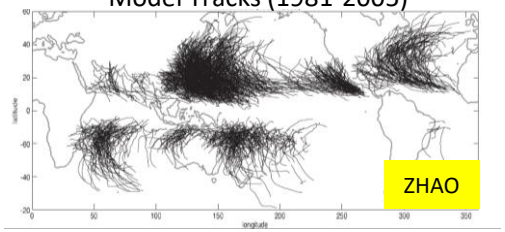


*Global warming conditions

Observed Tracks (1981-2005)

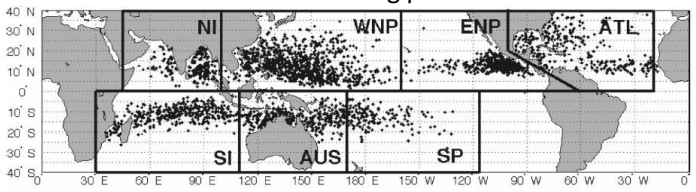


Model Tracks (1981-2005)

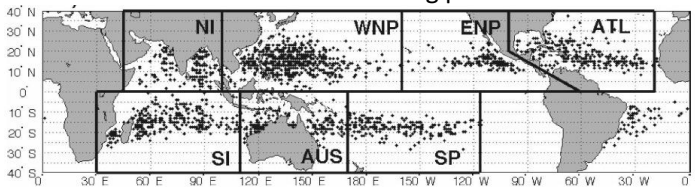


- Gualdi, 2008, has analyzed the changes in the activity of tropical cyclones due to global warming.

OBS TC track starting points 1970-1999



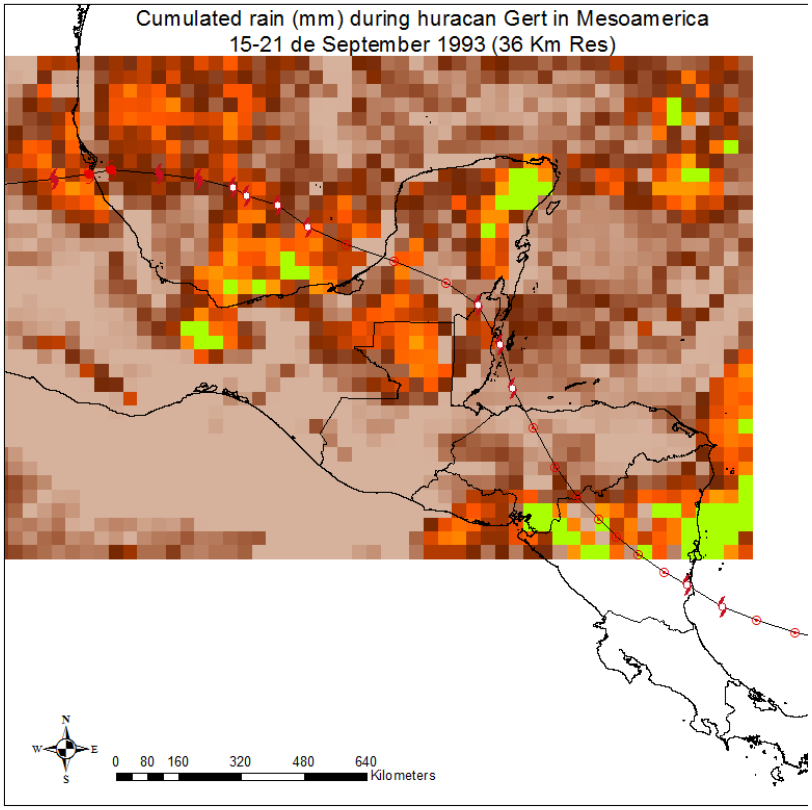
Model SXG TC track starting points 1970-1999

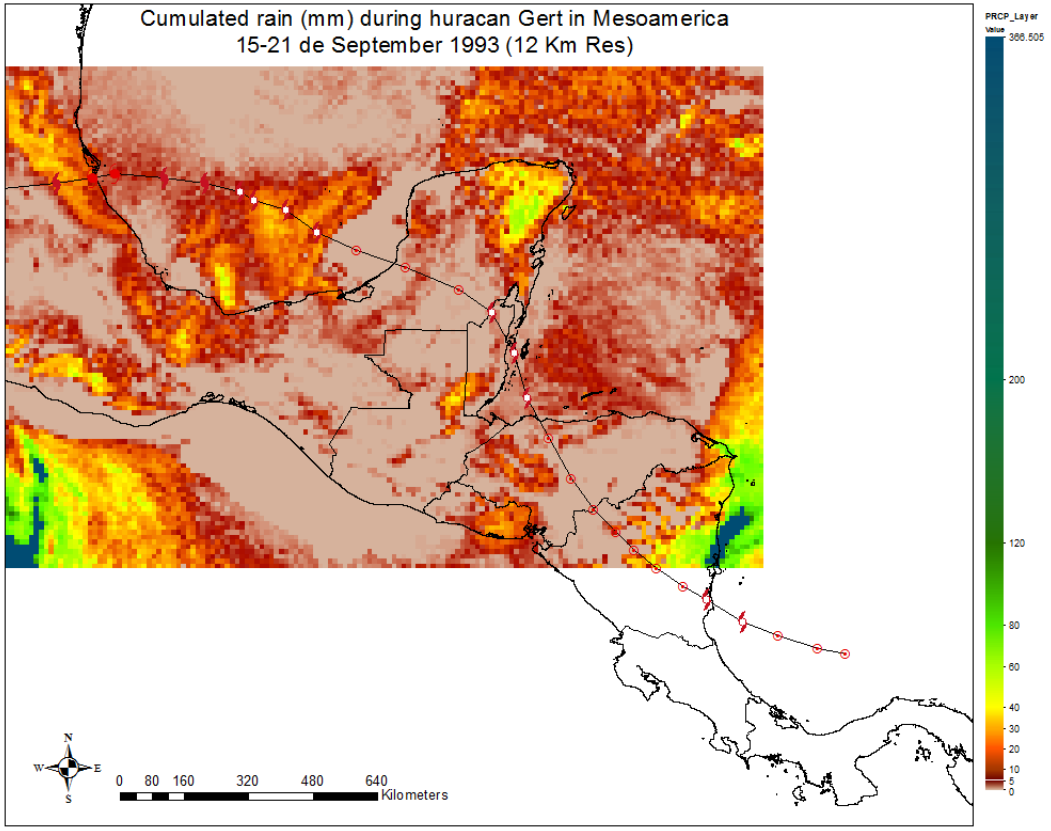


- A higher resolution of the mesh is required to efficiently detect the increase in tropical cyclones.
- Having the possibility of visualizing the maximum speeds, and not only the means, would be of great help.

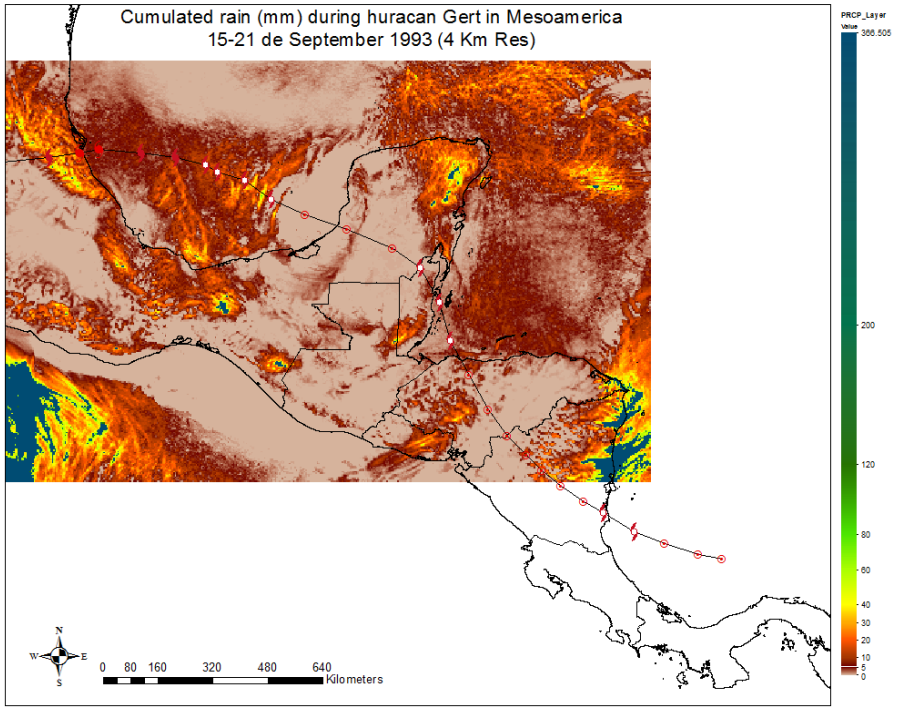
TC Changes

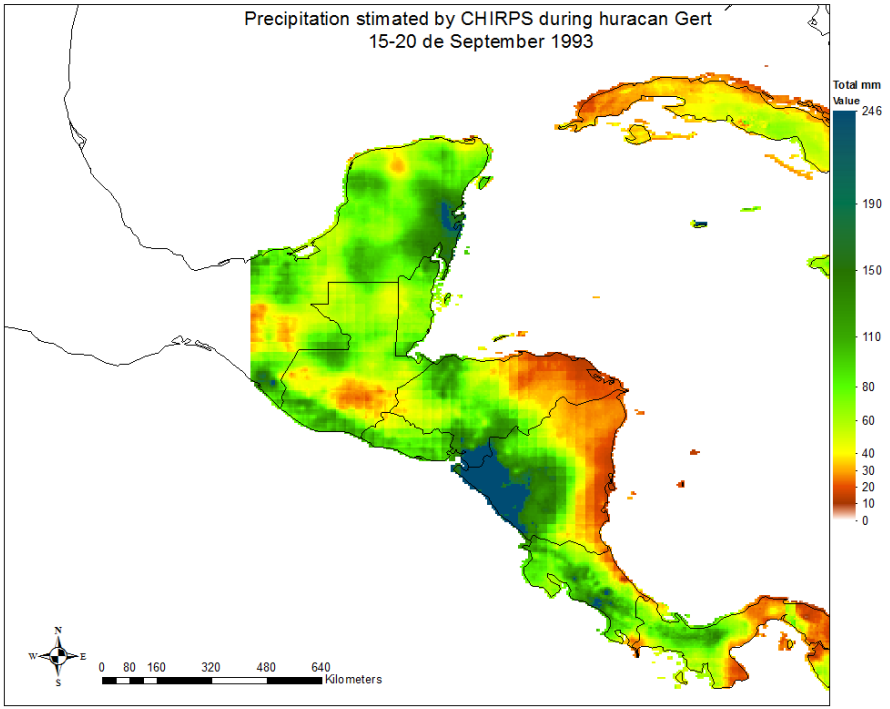
Comparison between 36 Km and 12 Km of Resolution





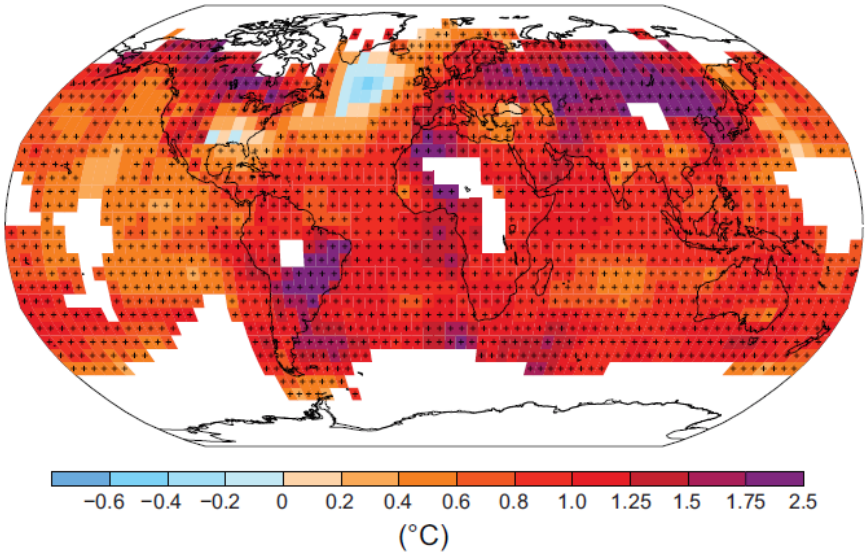
Precipitation





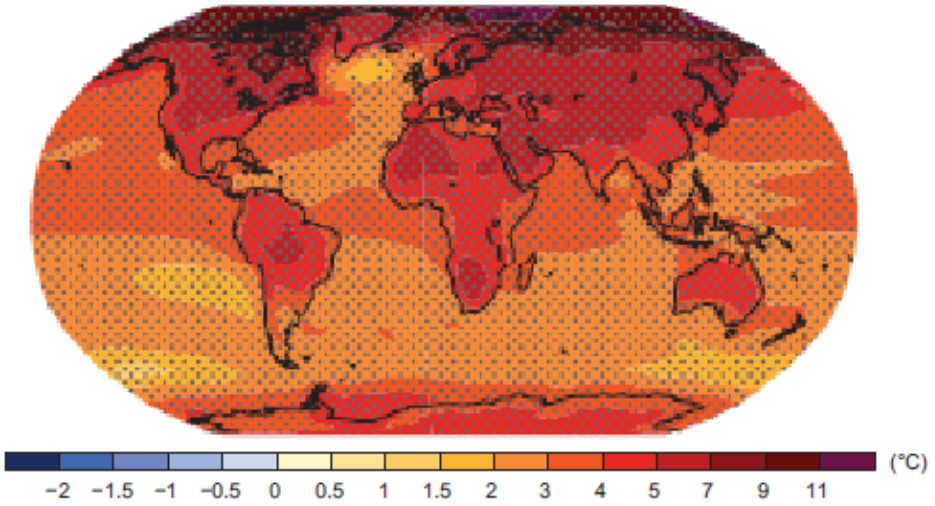
Changes in Surface Temperature

Observed change in surface temperature 1901–2012

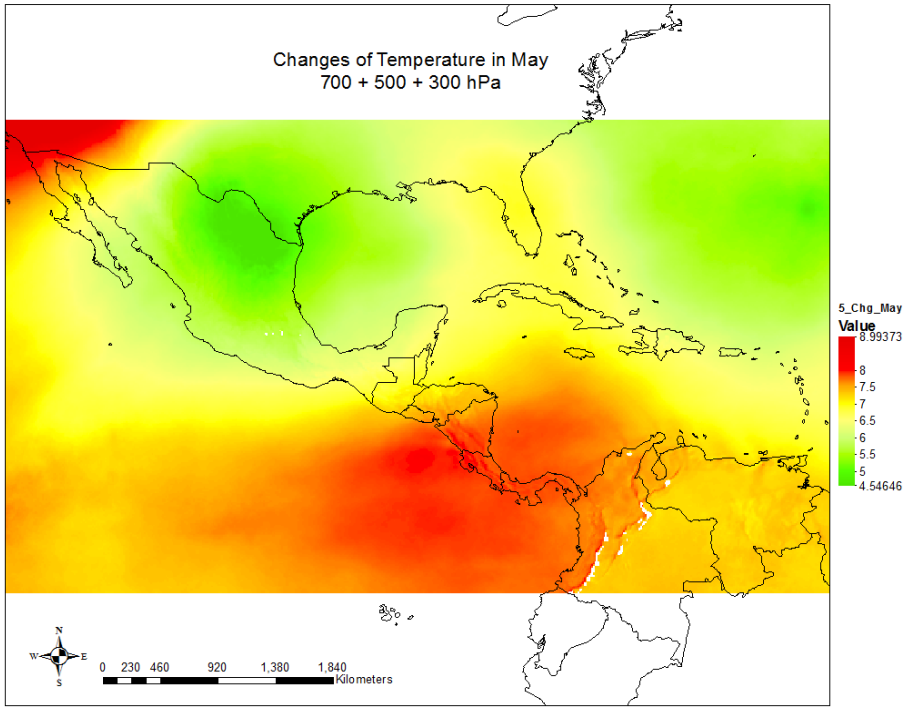


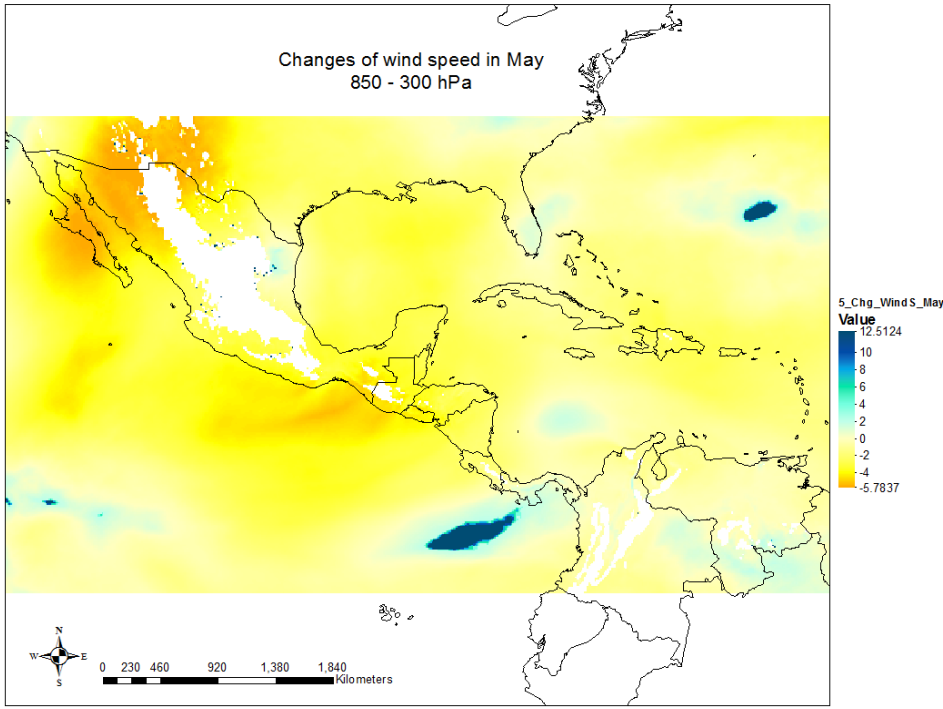
RCP 8.5

Change in average surface temperature (1986–2005 to 2081–2100)

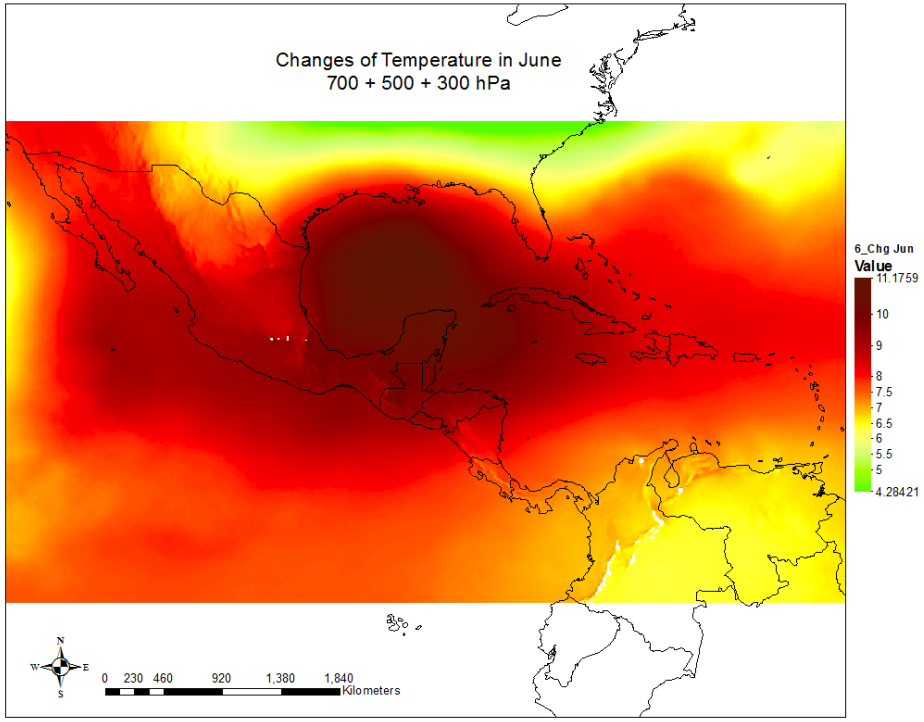


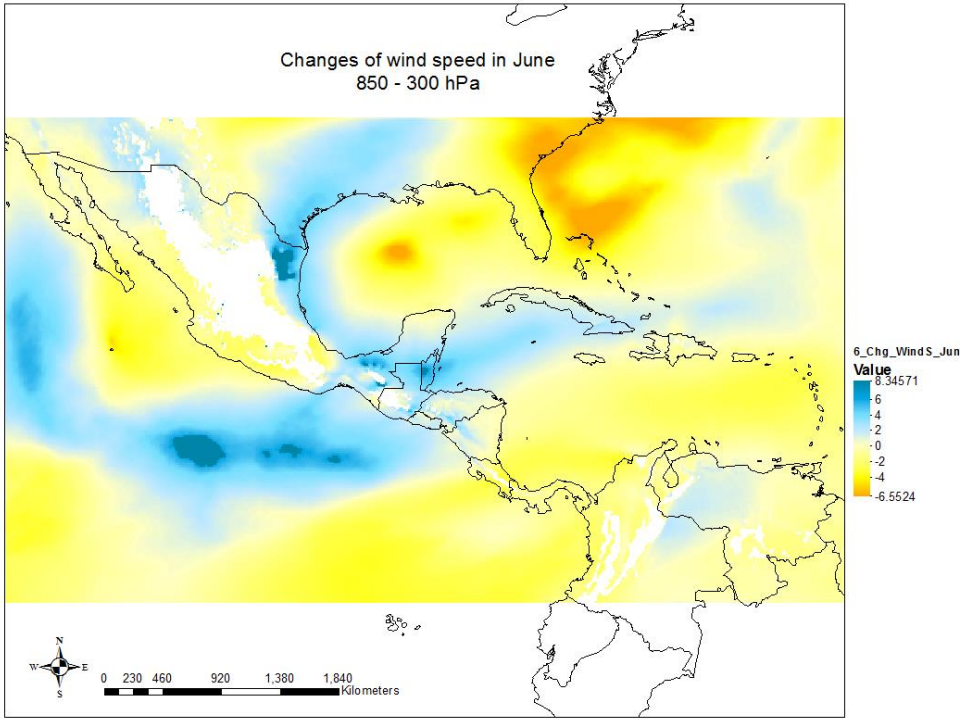
Changes in Temperature and Wind Speed in May



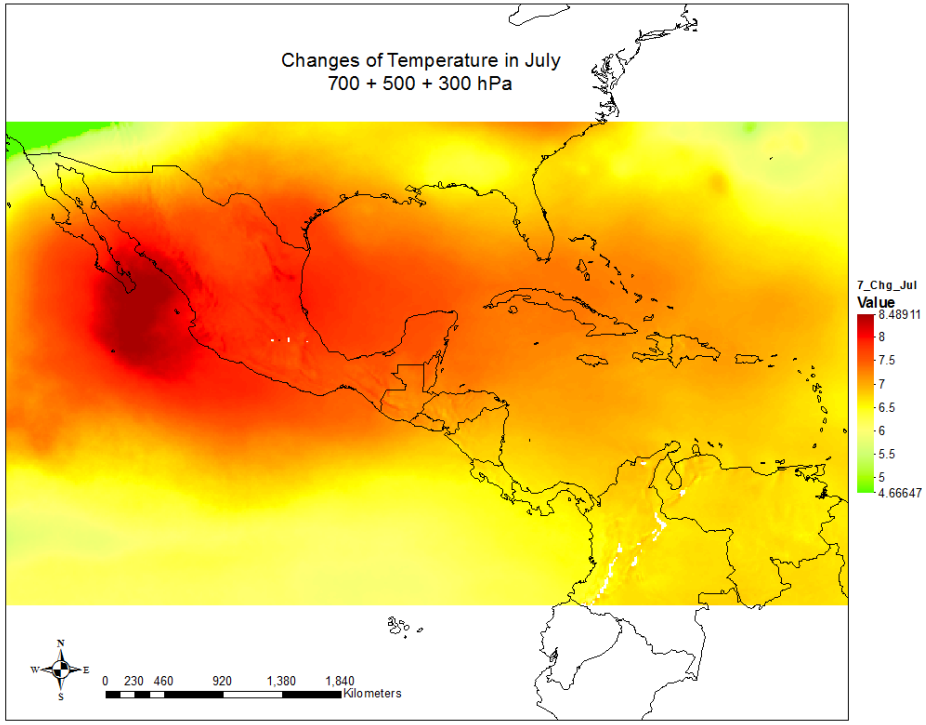


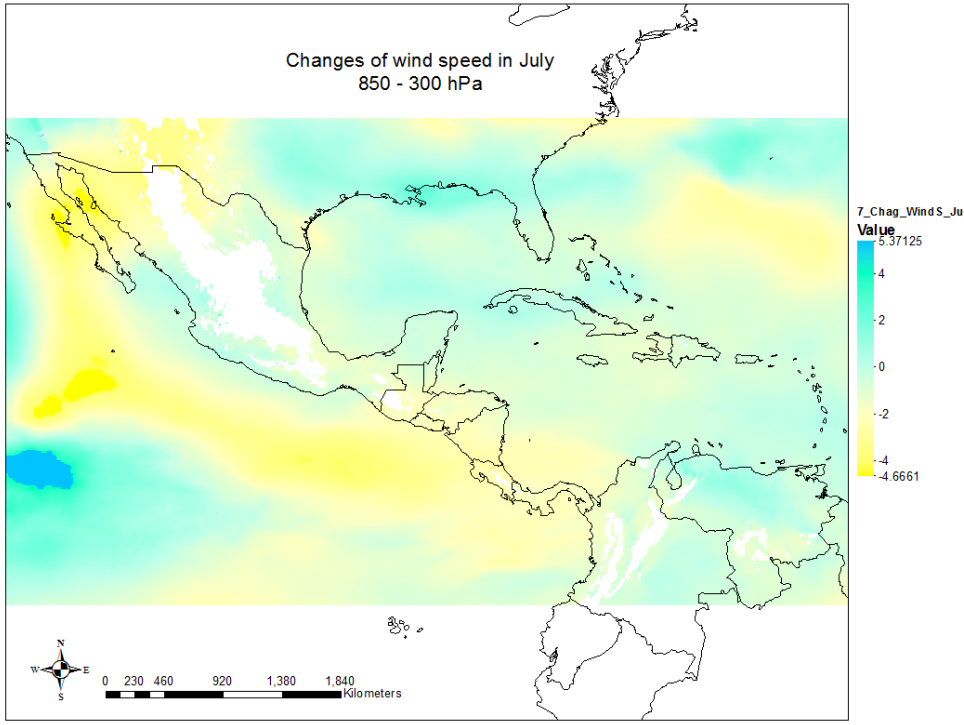
Changes in Temperature and Wind Speed in June



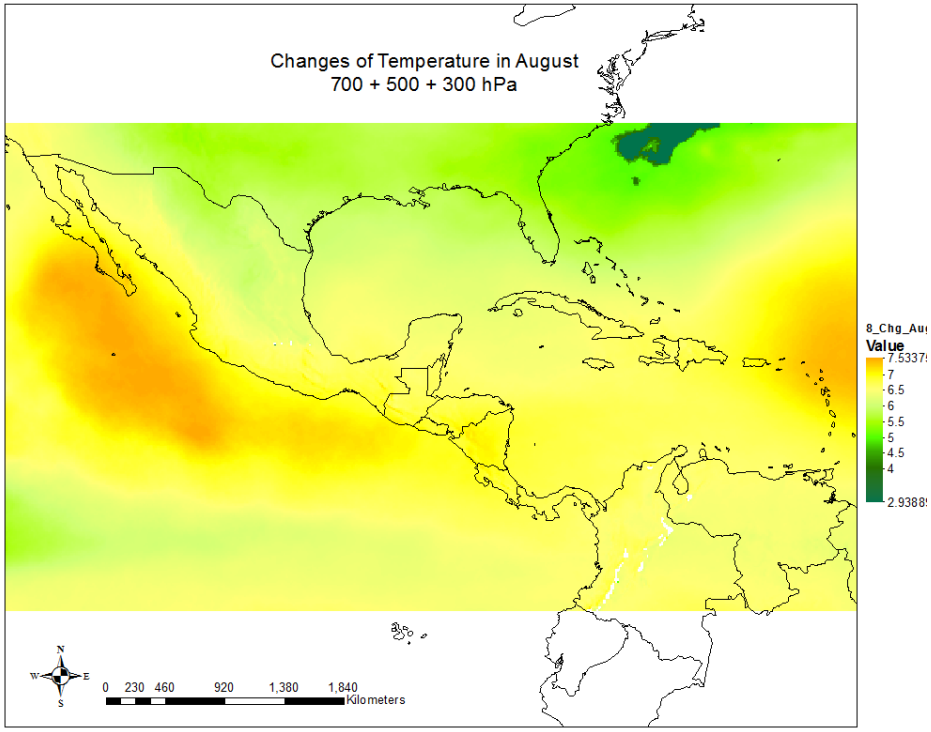


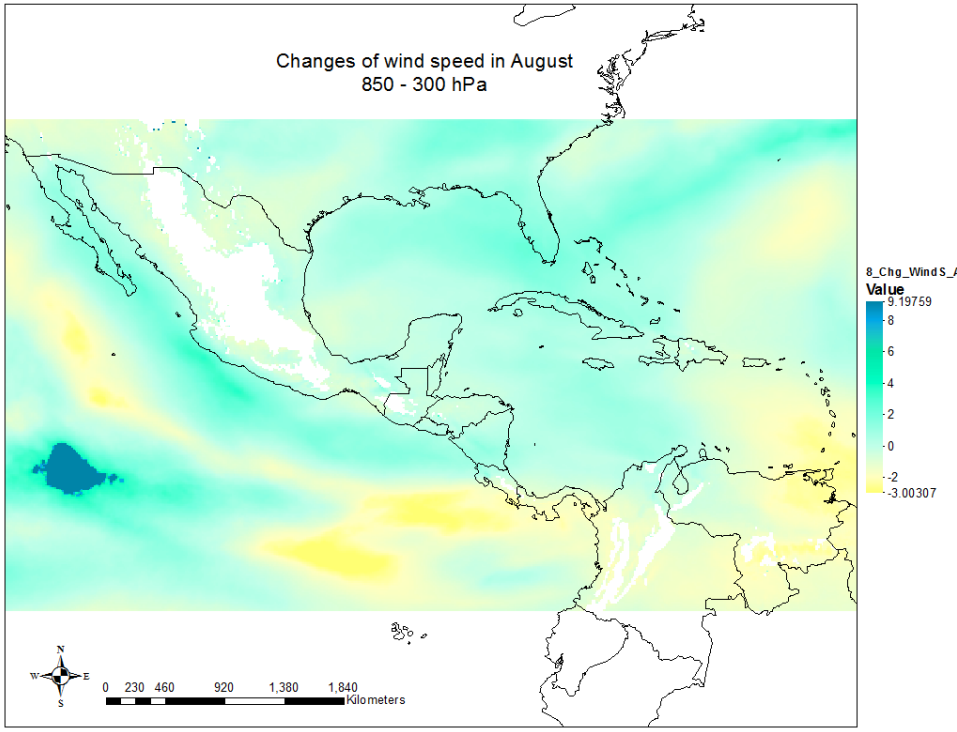
Changes in Temperature and Wind Speed in July



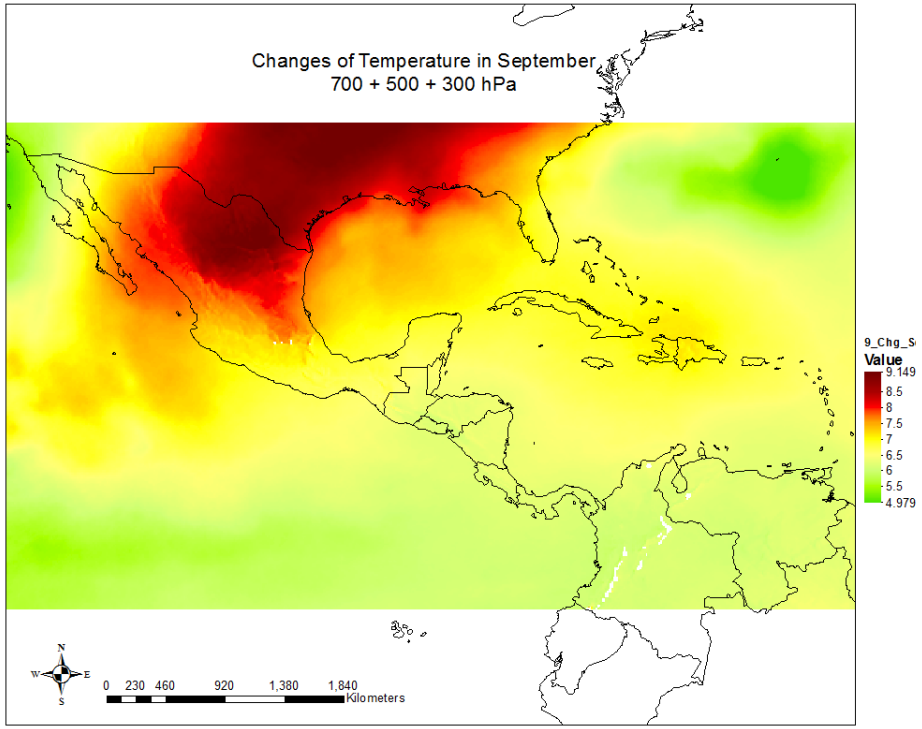


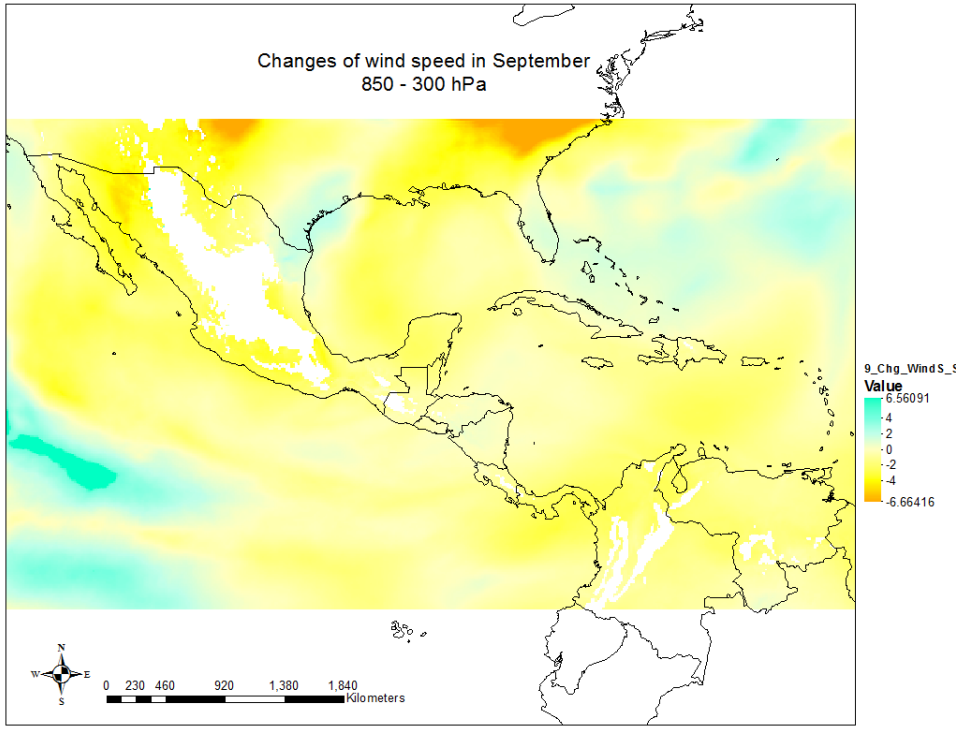
Changes in Temperature and Wind Speed in August



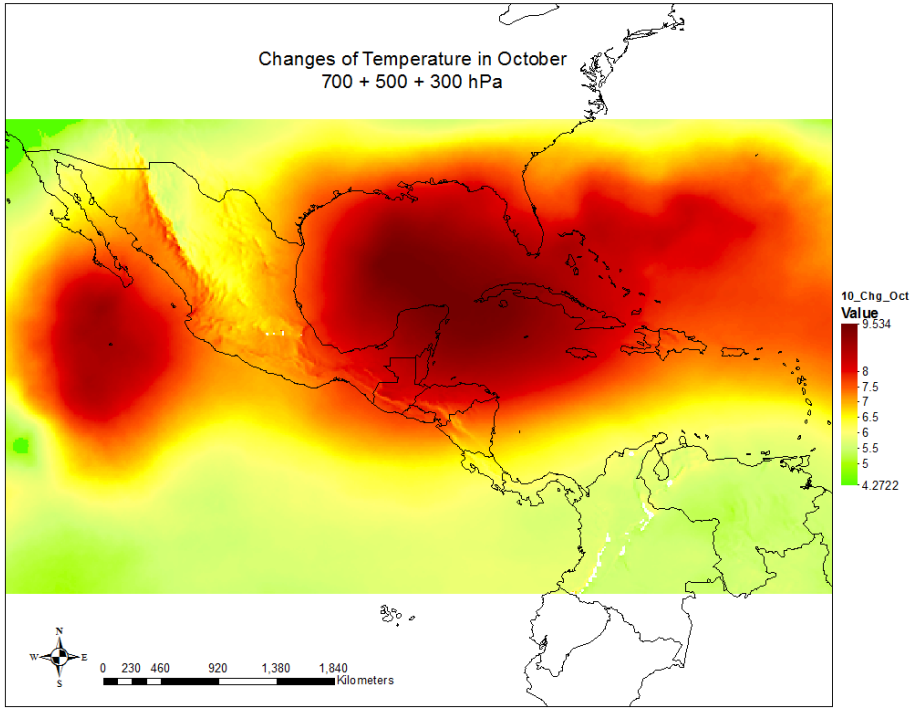


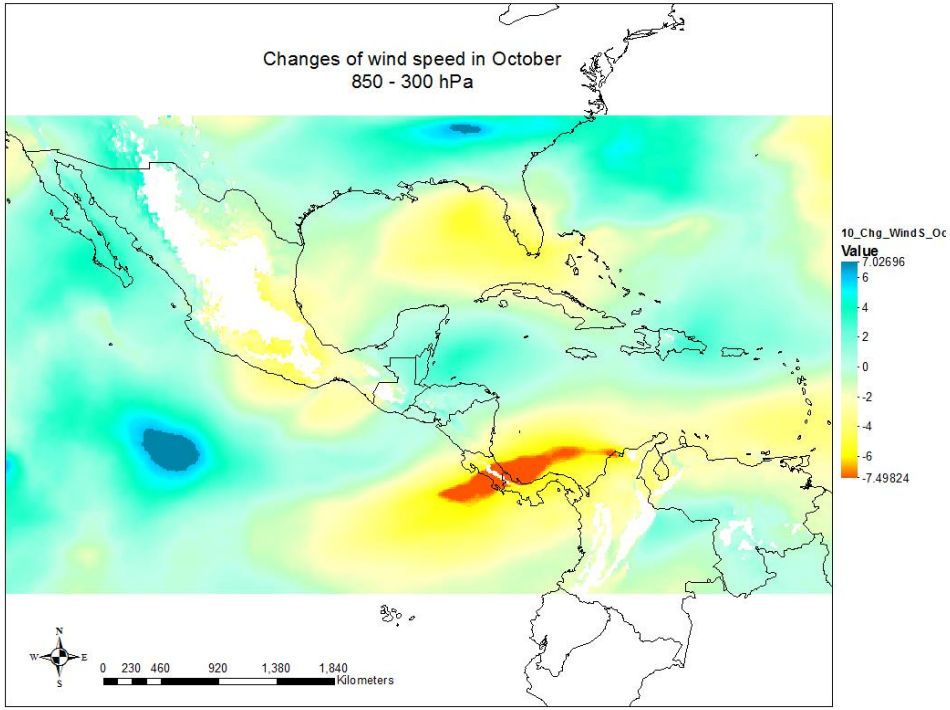
Changes in Temperature and Wind Speed in Sept



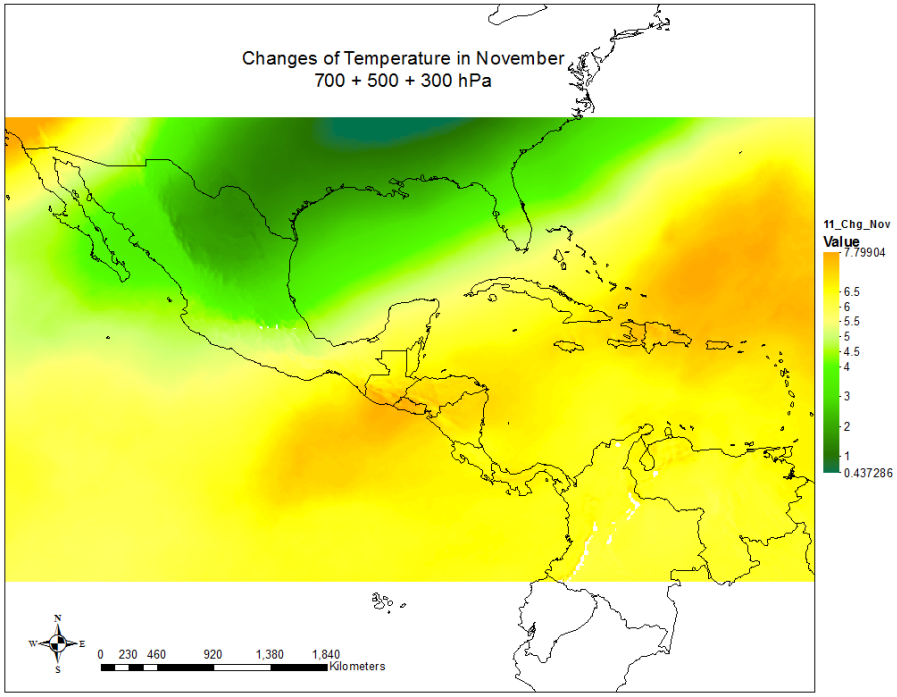


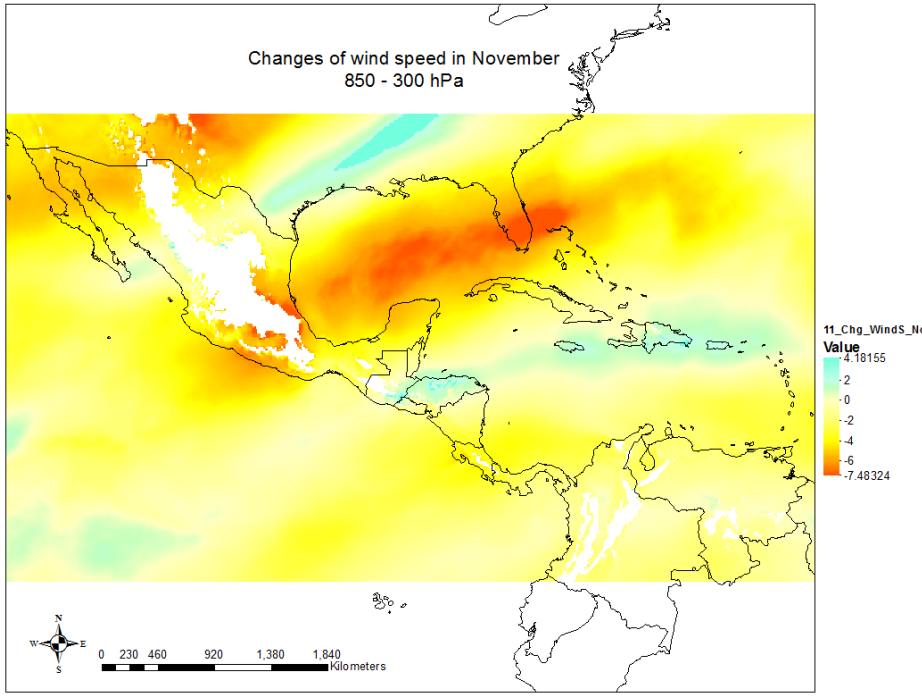
Changes in Temperature and Wind Speed in Oct





Changes in Temperature and Wind Speed in Nov





Improvements for MapMaker

Improvements

- It is necessary to have the option of choosing any of the IPCC scenarios. (2.6,4.5, 6.0 y 8.5).

- Implement the option to scale the results to intermediate times.

$$\bar{T}_{INT} = \bar{T}_{PD} + (\bar{T}_{FT} - \bar{T}_{PD}) \left(\frac{t_{INT} - t_{PD}}{t_{FT} - t_{PD}} \right)$$

where $\bar{T}$ and t are temperature and time, respectively, and the subscripts PD, FT, and INT refer to the present-day, future, and intermediate climatologies, respectively.

- Include analysis results for the years 2000 to 2005 and 2011 to 2015 for Mesoamerica and define an additional domain for the pacific.

- Add genesis parameters in MapMaker as relative and absolute vorticity,

- Create a window to make different calculations with different parameters as for exemple the sum of temperaturas anomalies at different levels of hPa for a date and point of interest

Thanks