

**Tropical cyclones and their
associated precipitation under
climate change conditions from a set
of RCA projections over the Central
America/Mexico CORDEX domain**

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Grigory Nikulin**

**Ninth ICTP workshop on theory and use of
Regional Climate Models**

- To evaluate the representation of Tropical Cyclones (TCs) on the RCA simulations.
- Identify processes involved on the good (or bad) representation of the spatial distribution of TCs.
- To identify climate change signals from the ensemble of GCM and RCA projections, which are related to changes on the distribution of TCs and their associated precipitation.
- To assess changes in the contribution of TCs-induced precipitation to total precipitation.

- Based on Hirlam
- Bechtold-KainFritsch convection scheme (Bechtold et al., 2001).
- A few additional modifications including a diluted CAPE (Convective Available Potential Energy) profile for calculating the CAPE closure have also been implemented (Jiao and Jones, 2008).
- Cloud formation following Tiedtke (1996).
- Physiography data bases as ECOCLIMAP (Masson et al., 2003) for vegetation.
- Gtopo30 (USGS, 1996) for topography,

GCM simulations

List of GCMs

- CanESM2
- CSIRO-Mk3-6-0
- CNRM-CM5
- EC-Earth
- GFDL-ESM2M
- HadGEM2-ES
- IPSL-CM5A-MR
- MIROC5
- MPI-ESM-LR
- NorESM1-M

Forcings:

- Historical simulation.
- RCP8.5 (2.6,4.5,6,8.5)

Periods analyzed:

- Historical: 1976-2005.
- RCP8.5: 2071-2100.

Tropical Cyclones tracker



kyklop-climate / kyklop

Watch

2

★ Star

1

Fork

4

<> Code

Issues 0

Pull requests 0

Projects 0

Pulse

Graphs

No description, website, or topics provided.

5 commits

1 branch

2 releases

0 contributors

MIT

Branch: master

New pull request

Find file

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Ramon Fuentes Franco Removed basemap from setup.py requirements. ...

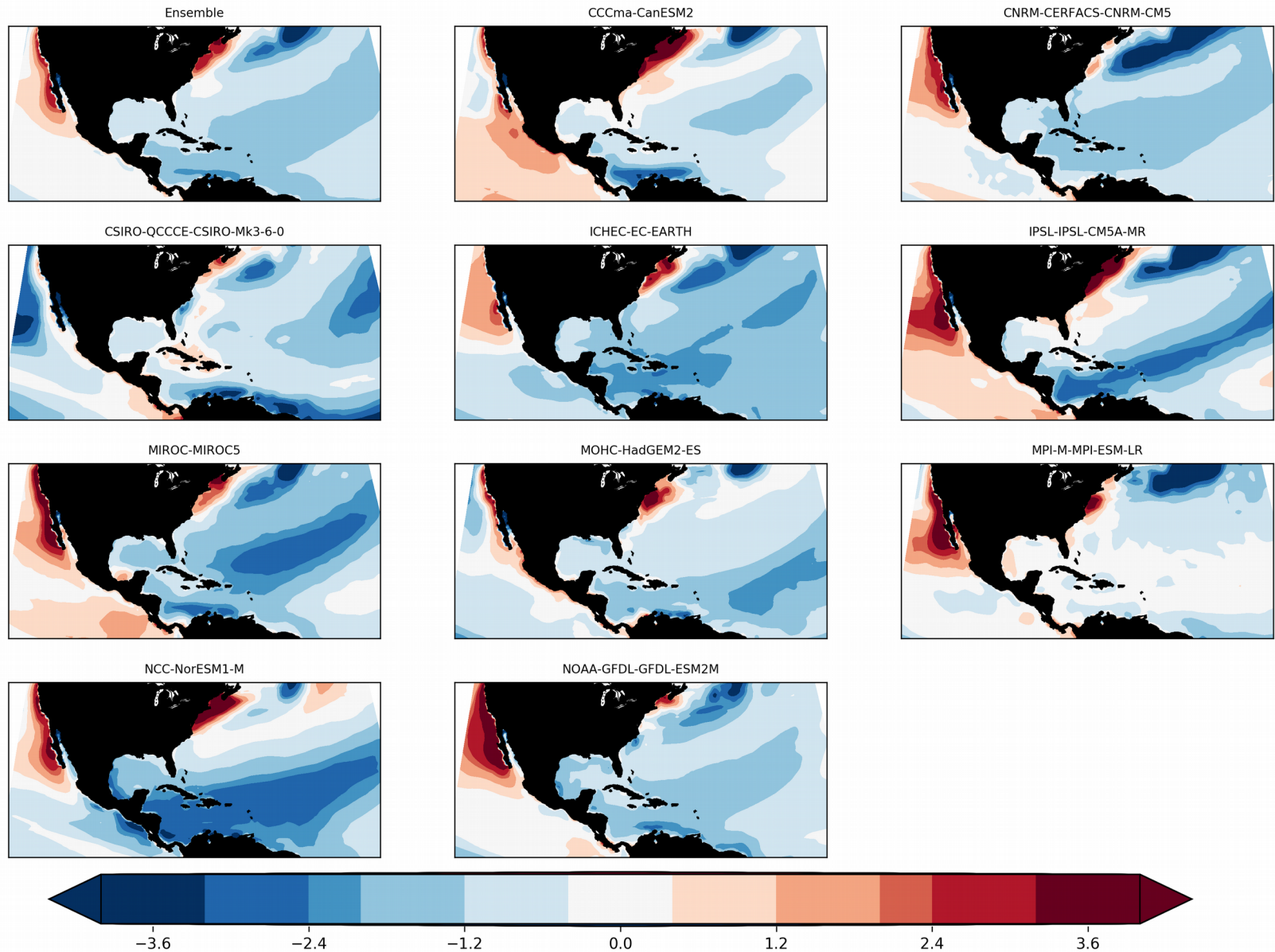
Latest commit f45e19b on Jun 24, 2016

kyklop	Renamed project to kyklop to avoid name clash.	9 months ago
.gitignore	Updated .gitignore.	9 months ago
LICENSE	Initial commit.	a year ago
README.md	Renamed project to kyklop to avoid name clash.	9 months ago
setup.py	Removed basemap from setup.py requirements.	9 months ago

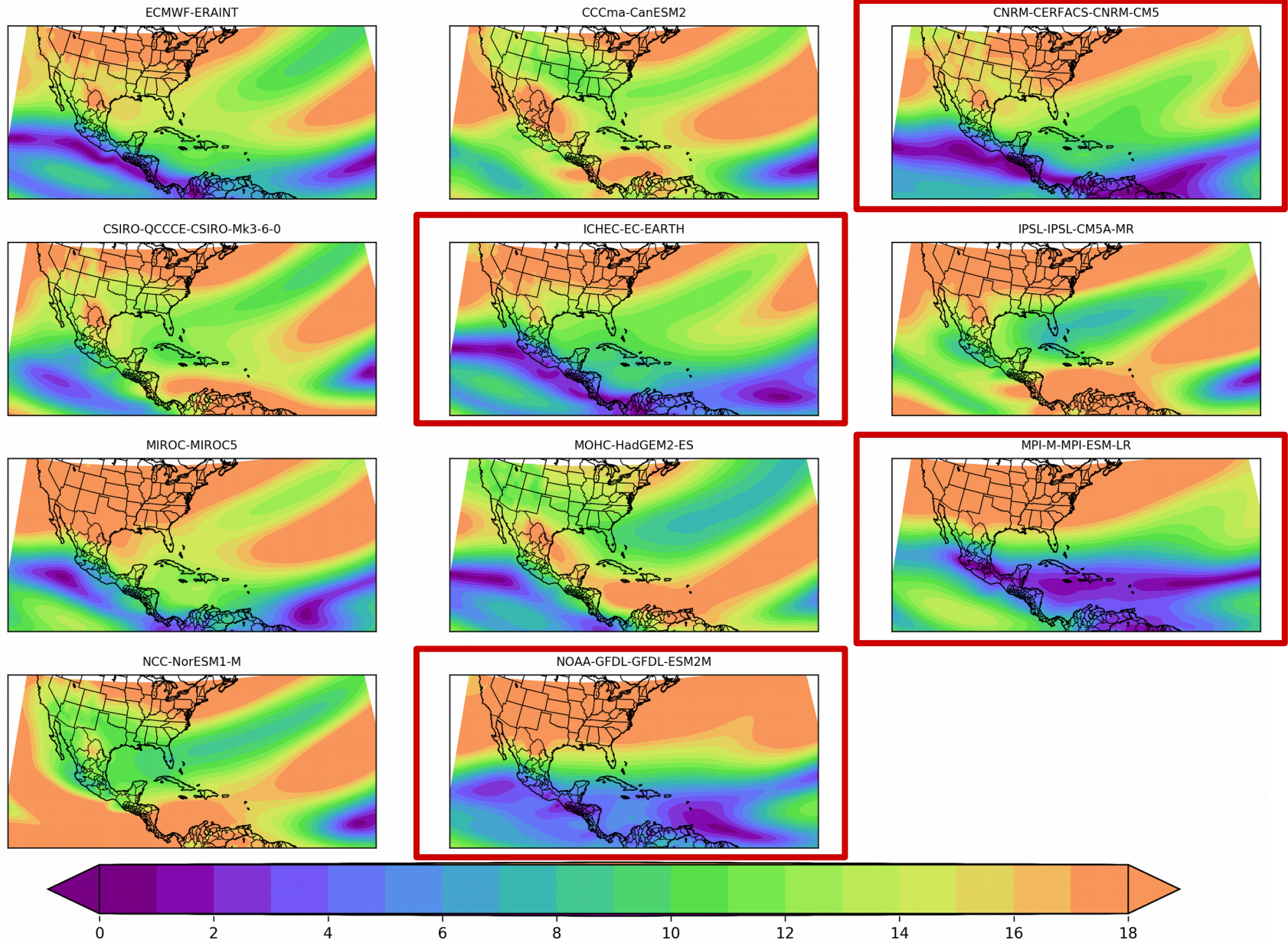
<https://github.com/kyklop-climate/kyklop>

Historical period (1976-2005)

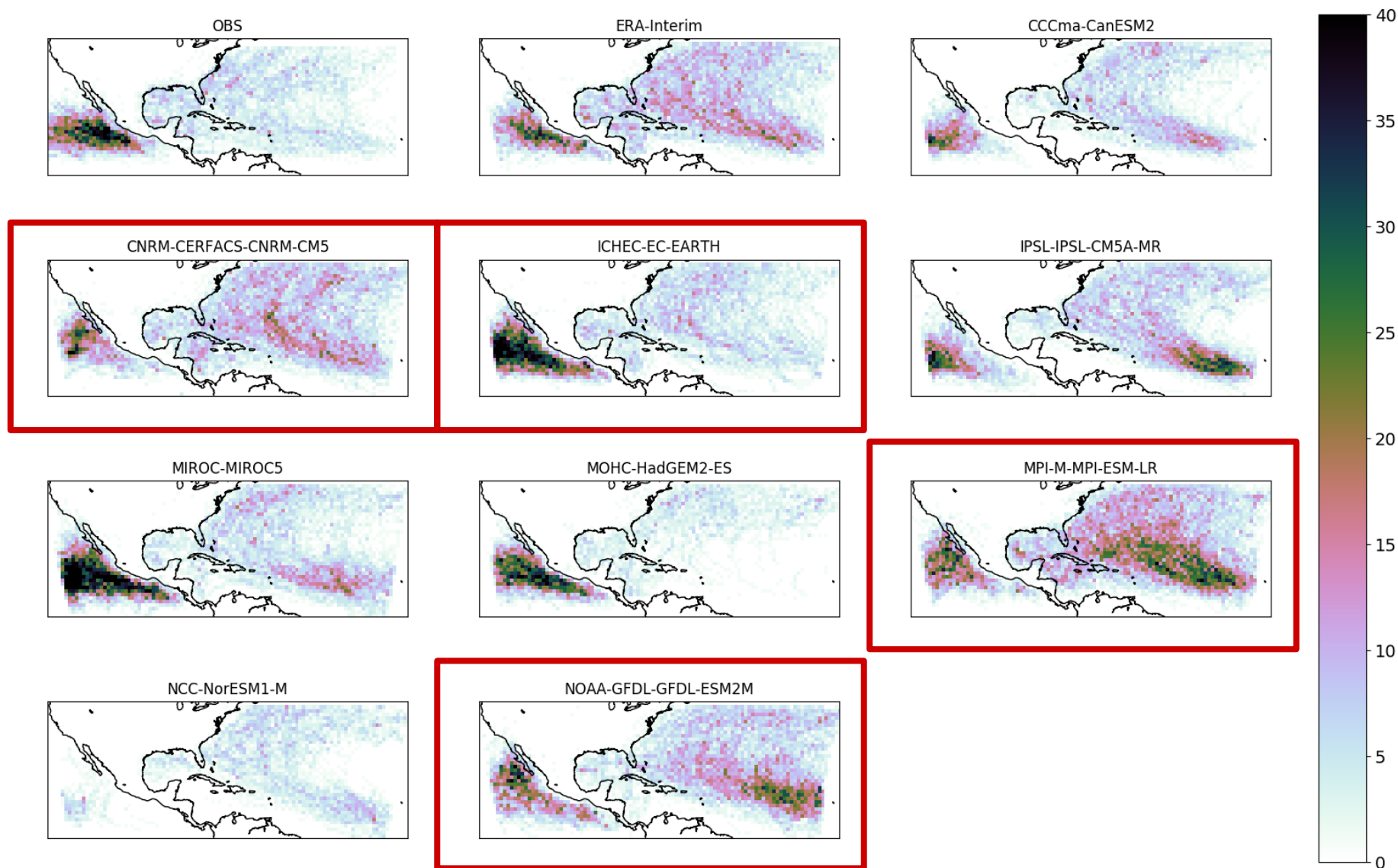
SST bias for MJJASON (GCMs minus ERA-Interim) **SMHI**



Mean wind shear MJJASON (U200 – U850) on GCM driven RCA historical simulations

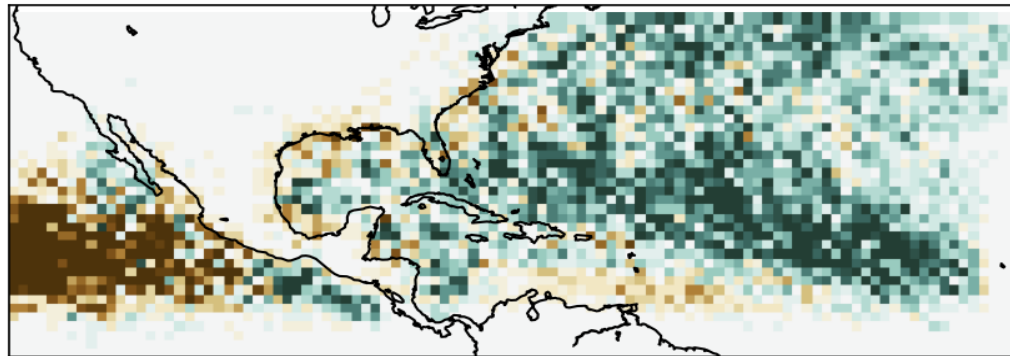


TCs in RCA (1976-2005)

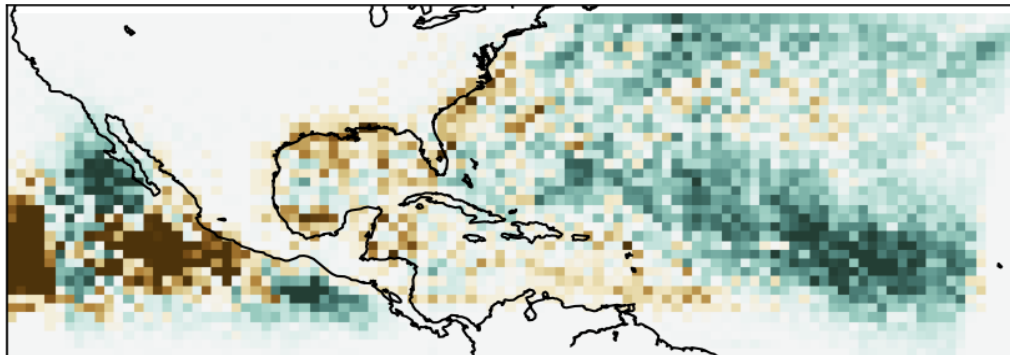


Biases of TCCs in RCA compared with observations

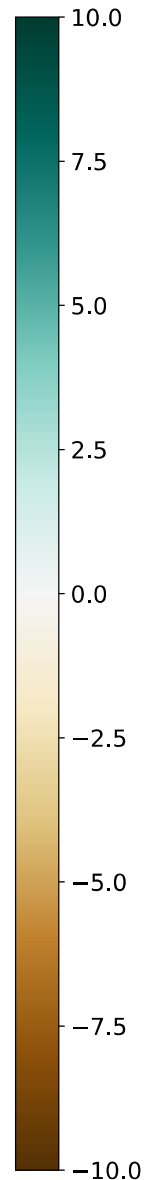
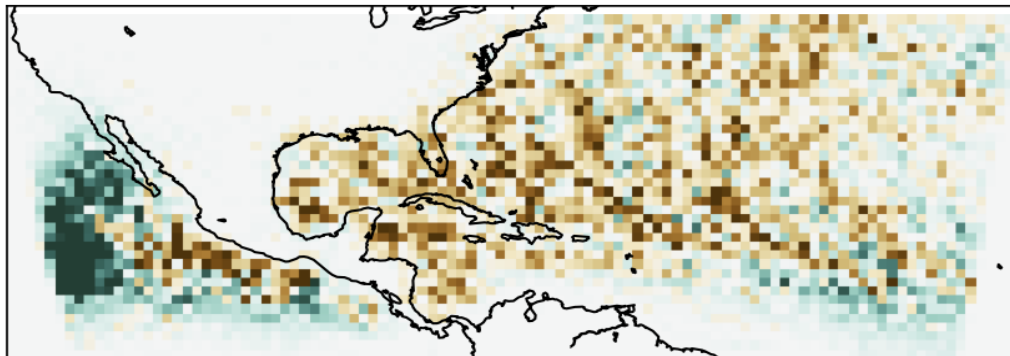
RCA (EIN) - OBS



RCA (ENSEMBLE)
- OBS

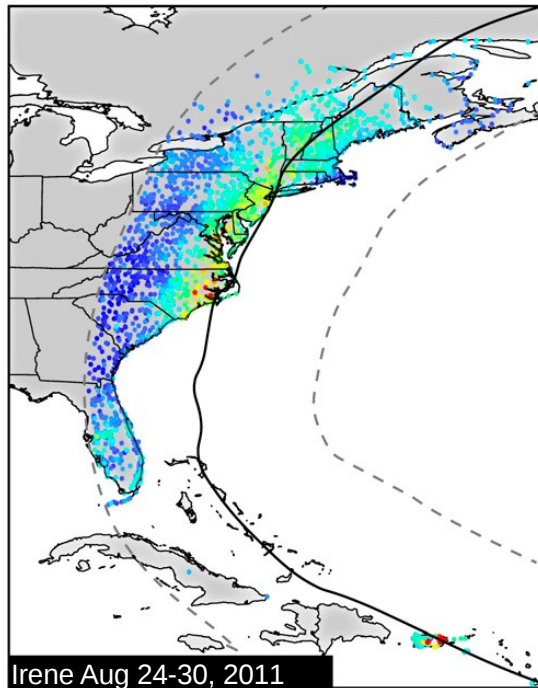


RCA (ENSEMBLE)
- RCA (EIN)

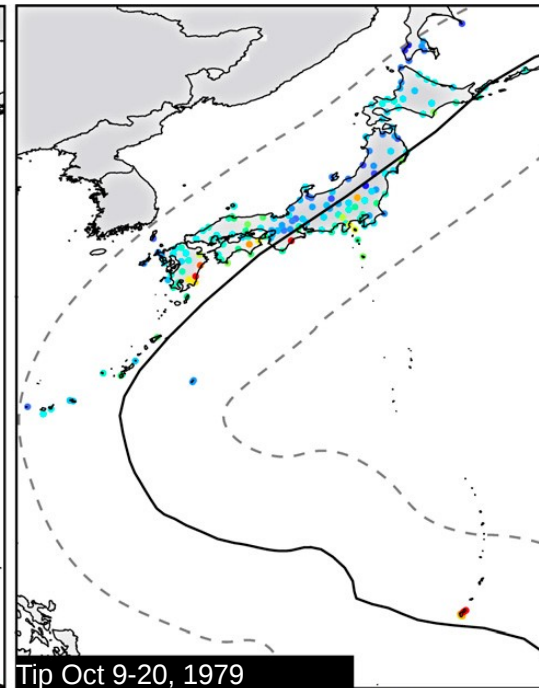


Precipitation associated to tropical cyclones

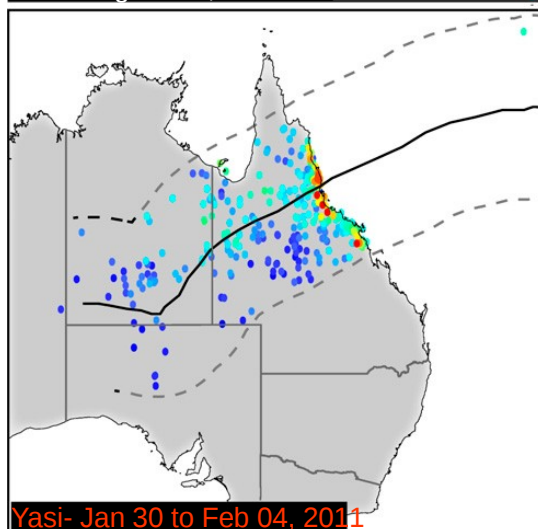
Examples of TCs and their induced rainfall totals (mm). Each panel shows the TC track (black line) and the recorded amount of rain (colors) at stations located within 500 km (dashed line) from the center of each storm track.



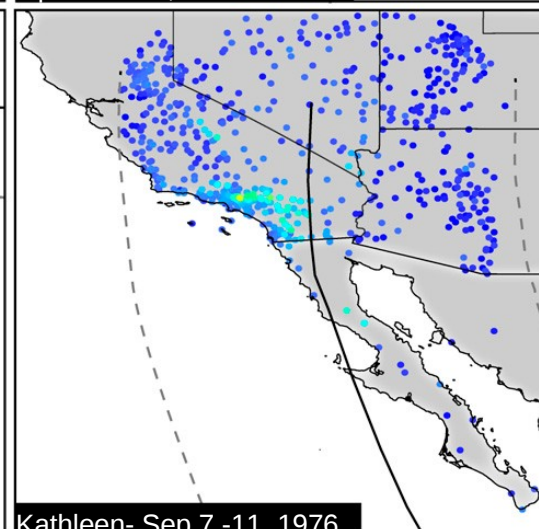
Irene Aug 24-30, 2011



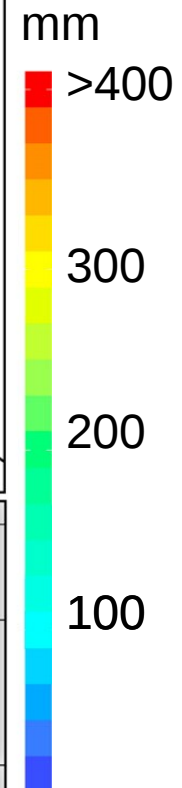
Tip Oct 9-20, 1979



Yasi- Jan 30 to Feb 04, 2011

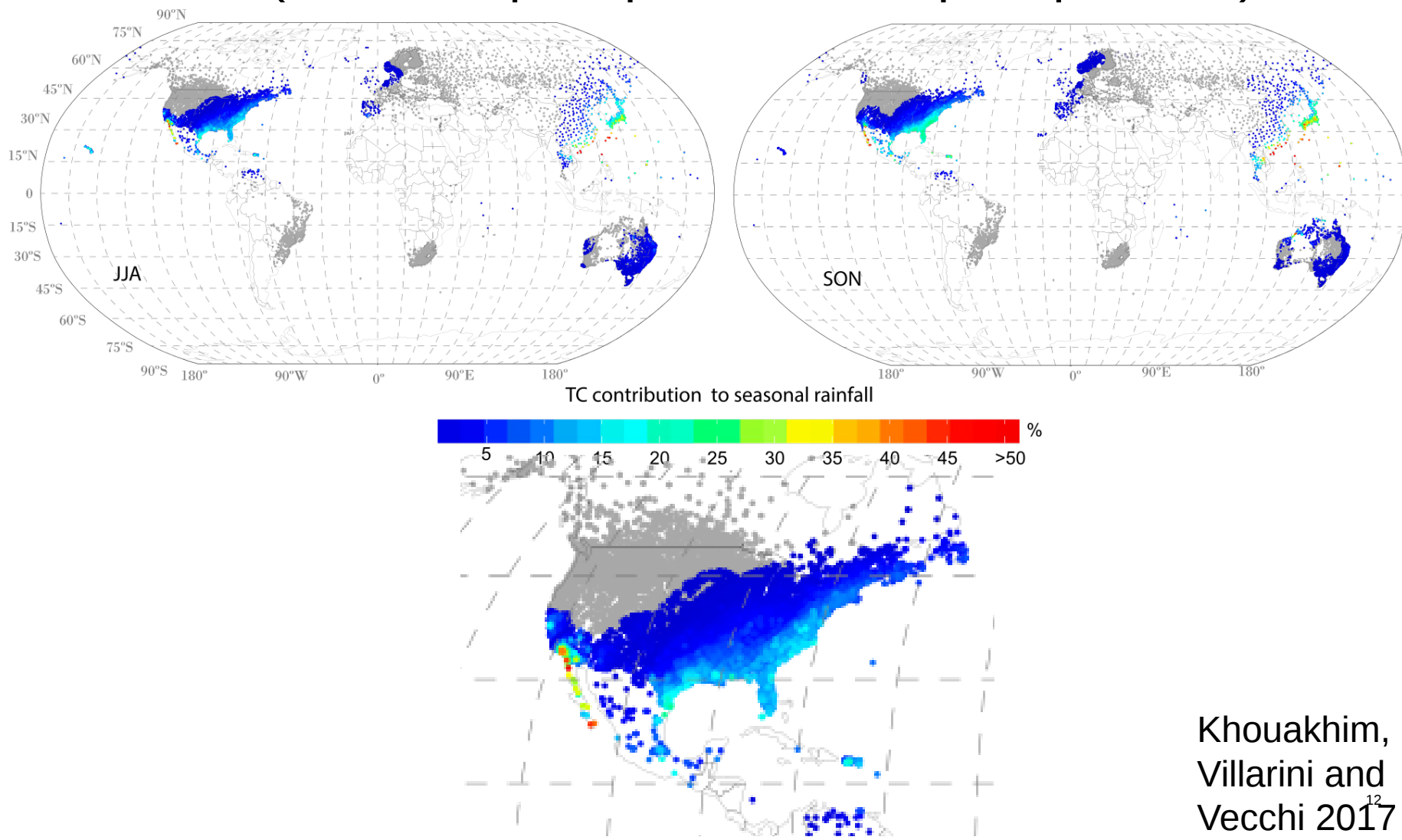


Kathleen- Sep 7 -11, 1976



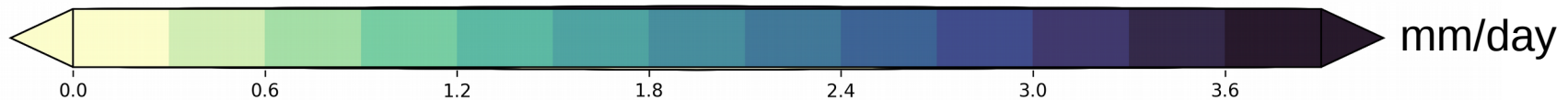
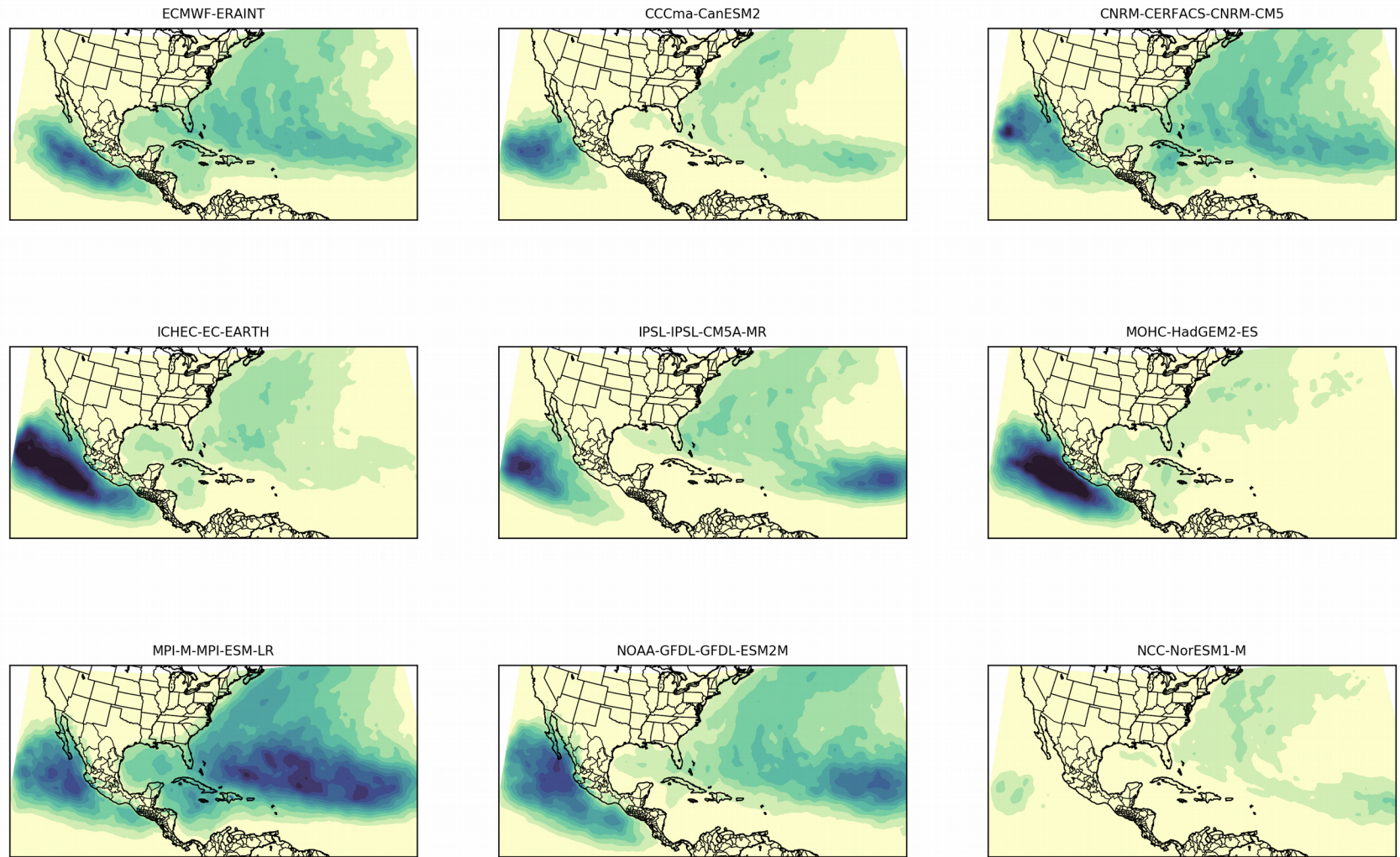
Khouakhim,
Villarini and
Vecchi 2017

Relative contribution of TCs to the mean seasonal rainfall ($100 * \text{TC precipitation} / \text{Total precipitation}$)



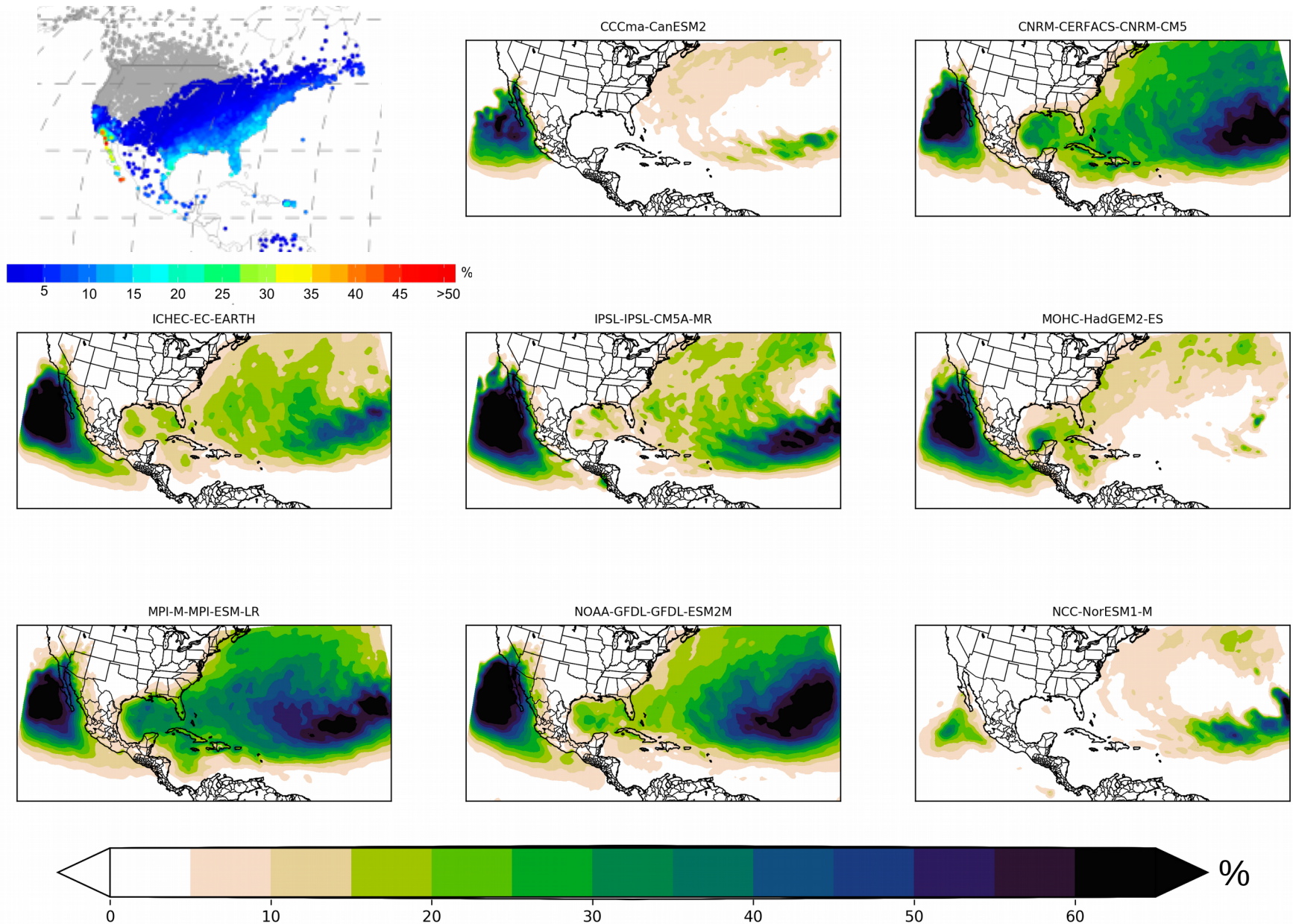
Mean precipitation associated to tropical cyclones in RCA (1976-2005)

SMHI



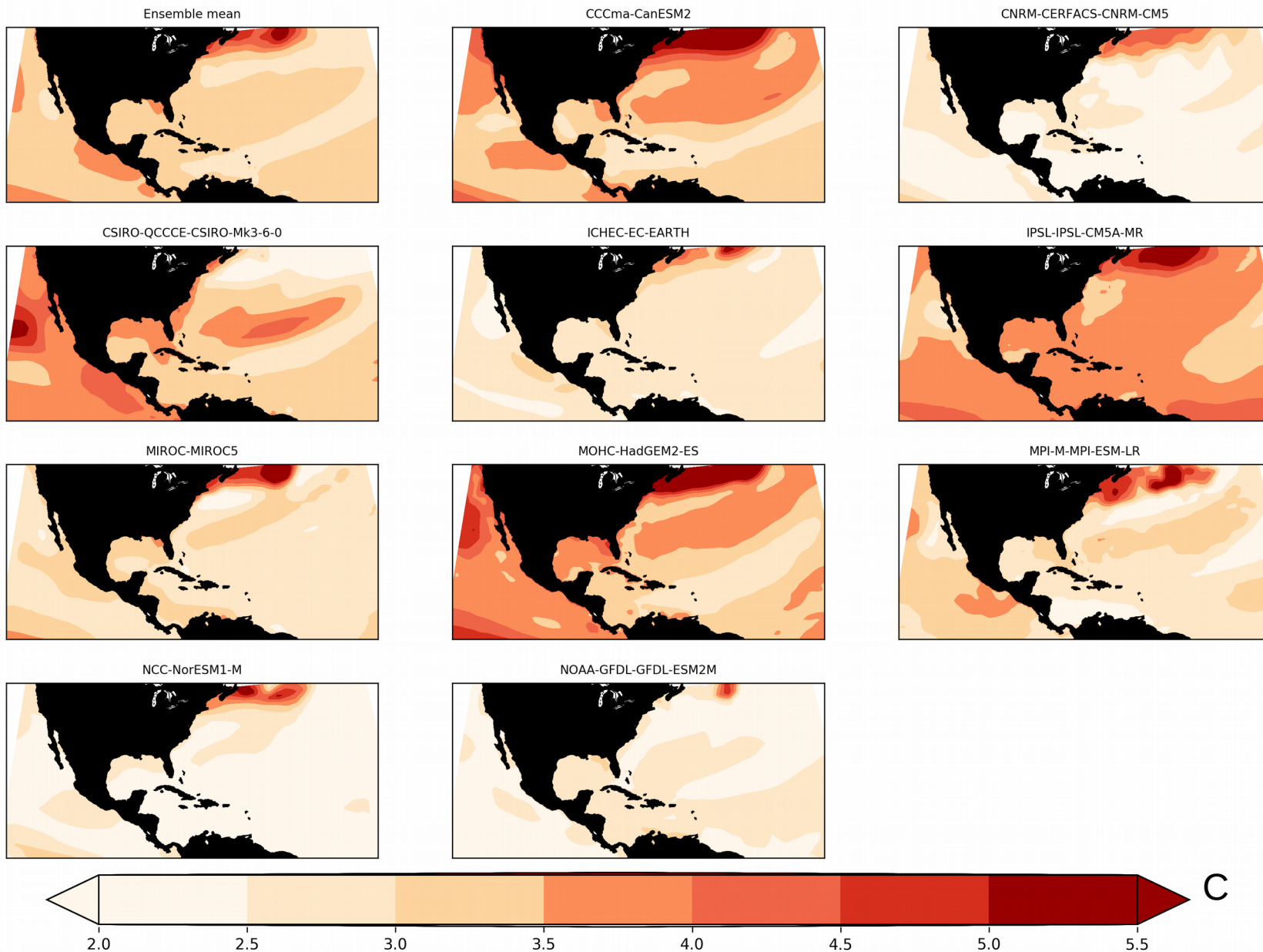
Relative contribution of TCs to the mean seasonal rainfall ($100 * \text{TC precipitation} / \text{Total precipitation}$)

SMHI

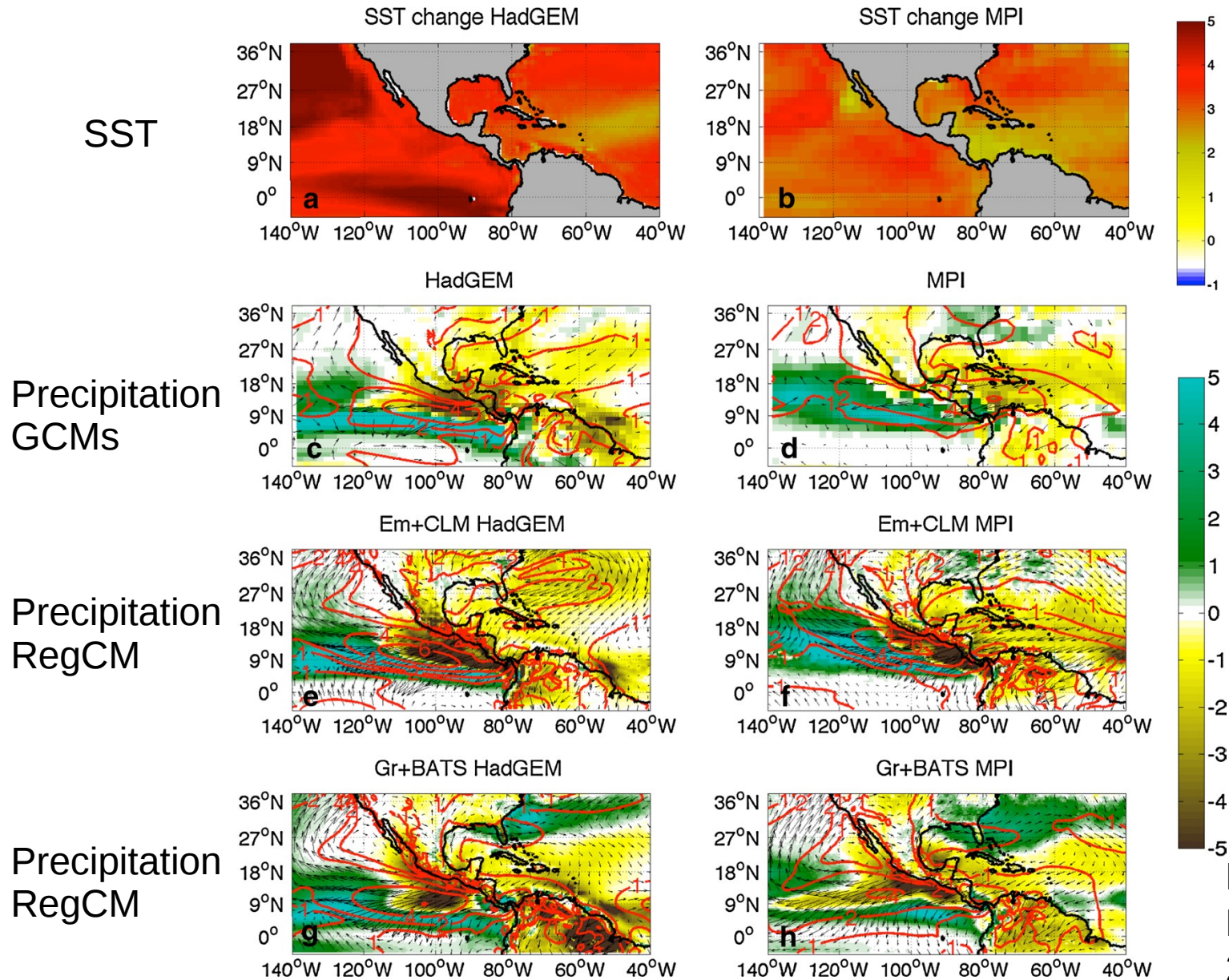


Future period (2071-2100)

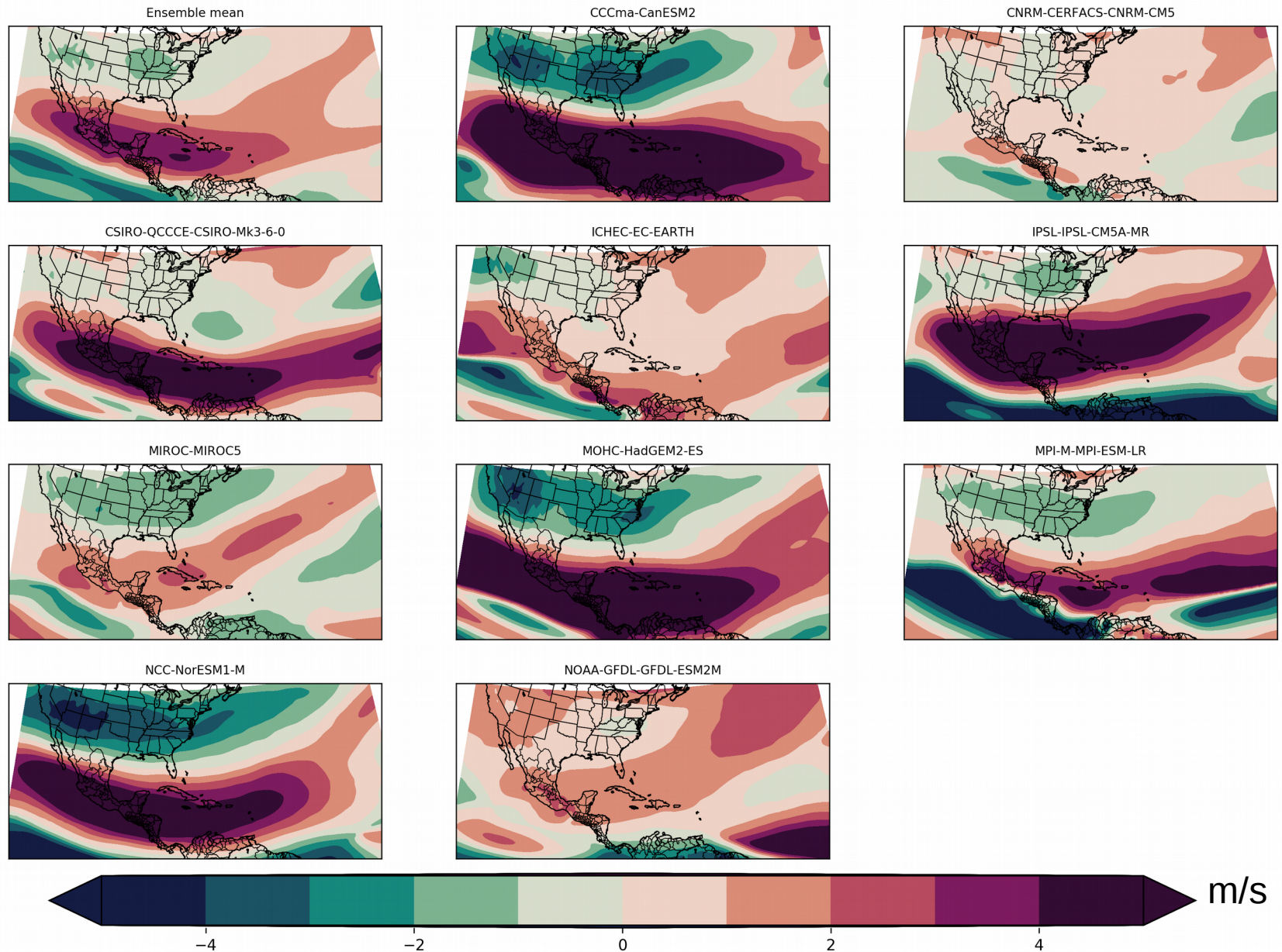
SST change (2071-2100 minus 1976-2005)



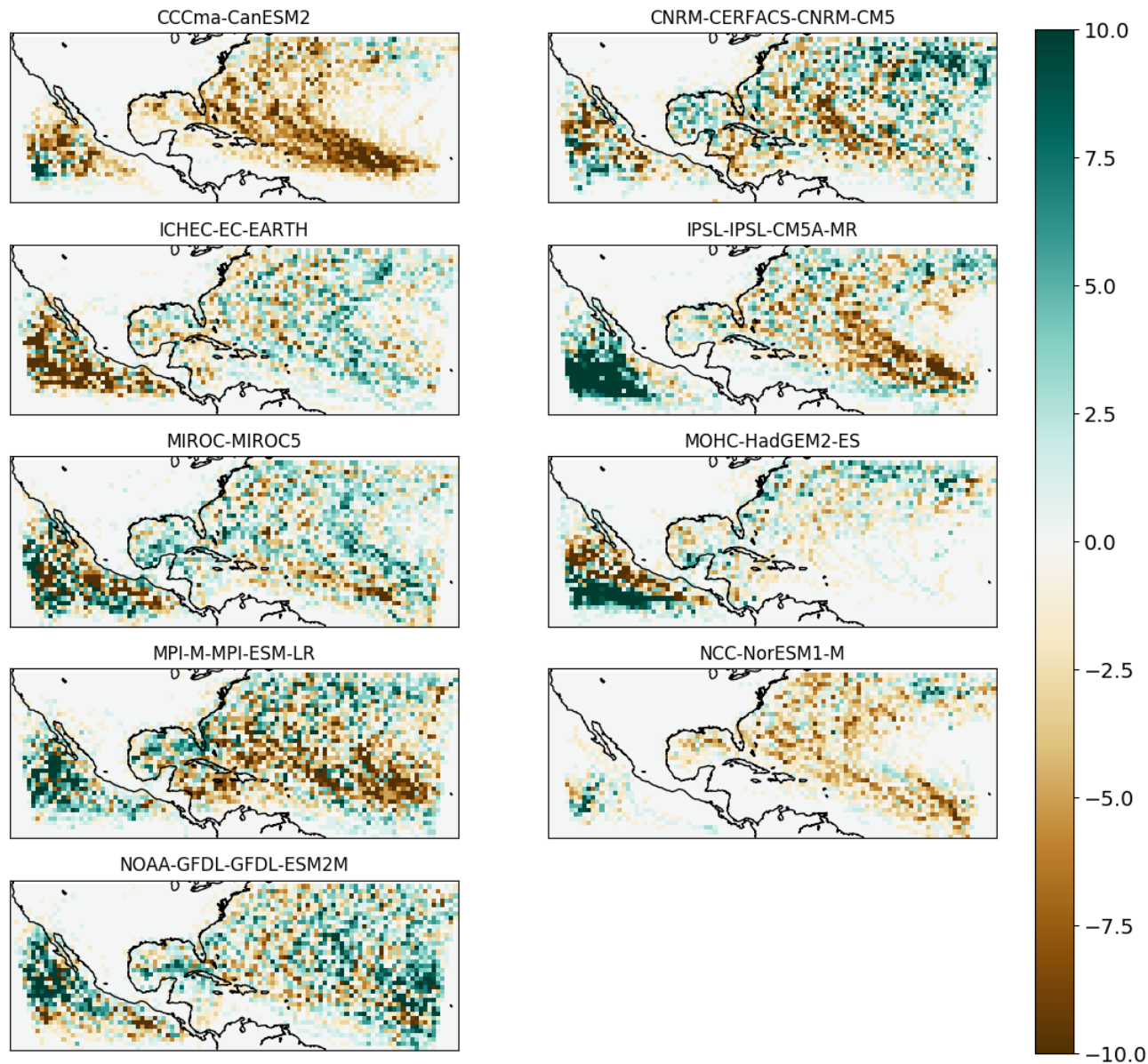
SST change: the main driver for precipitation change. Future(2071-2100)- Hist (1976-2005)



Wind shear change (2071-2100 minus 1976-2005) **SMHI**



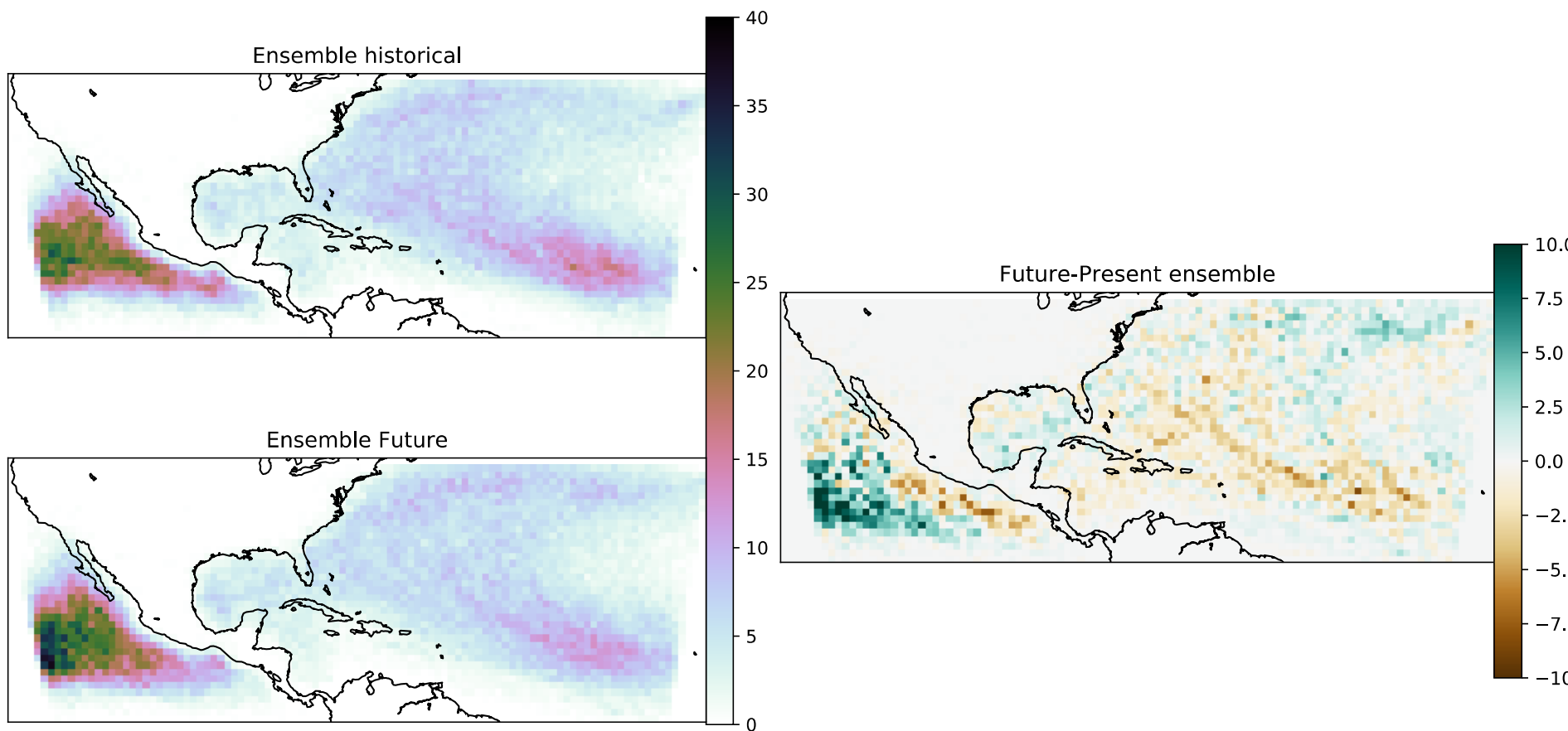
Change on density of TC Future(2071-2100)- Hist (1976-2005)



TCs density and its change

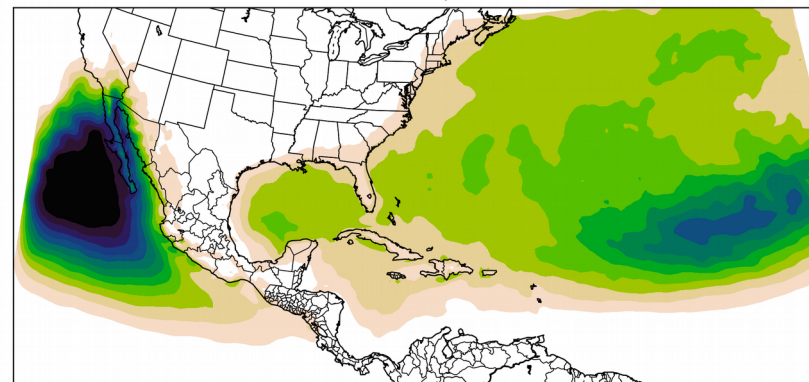
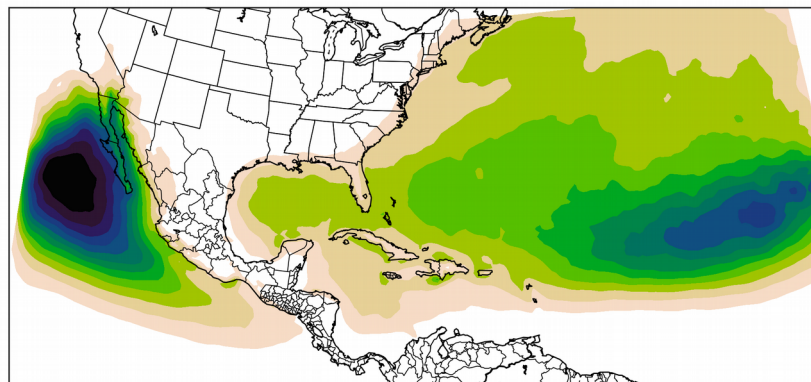
Future(2071-2100)- Hist (1976-2005)

SMHI



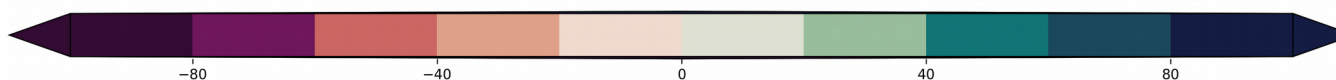
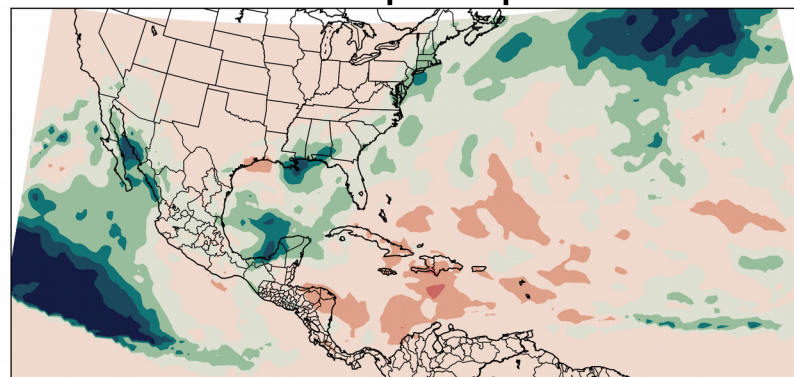
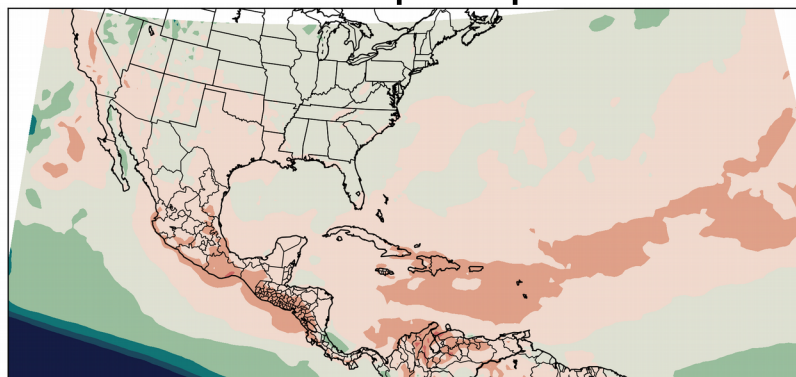
Ratio TCs precipitation

1976-2005 2071-2100



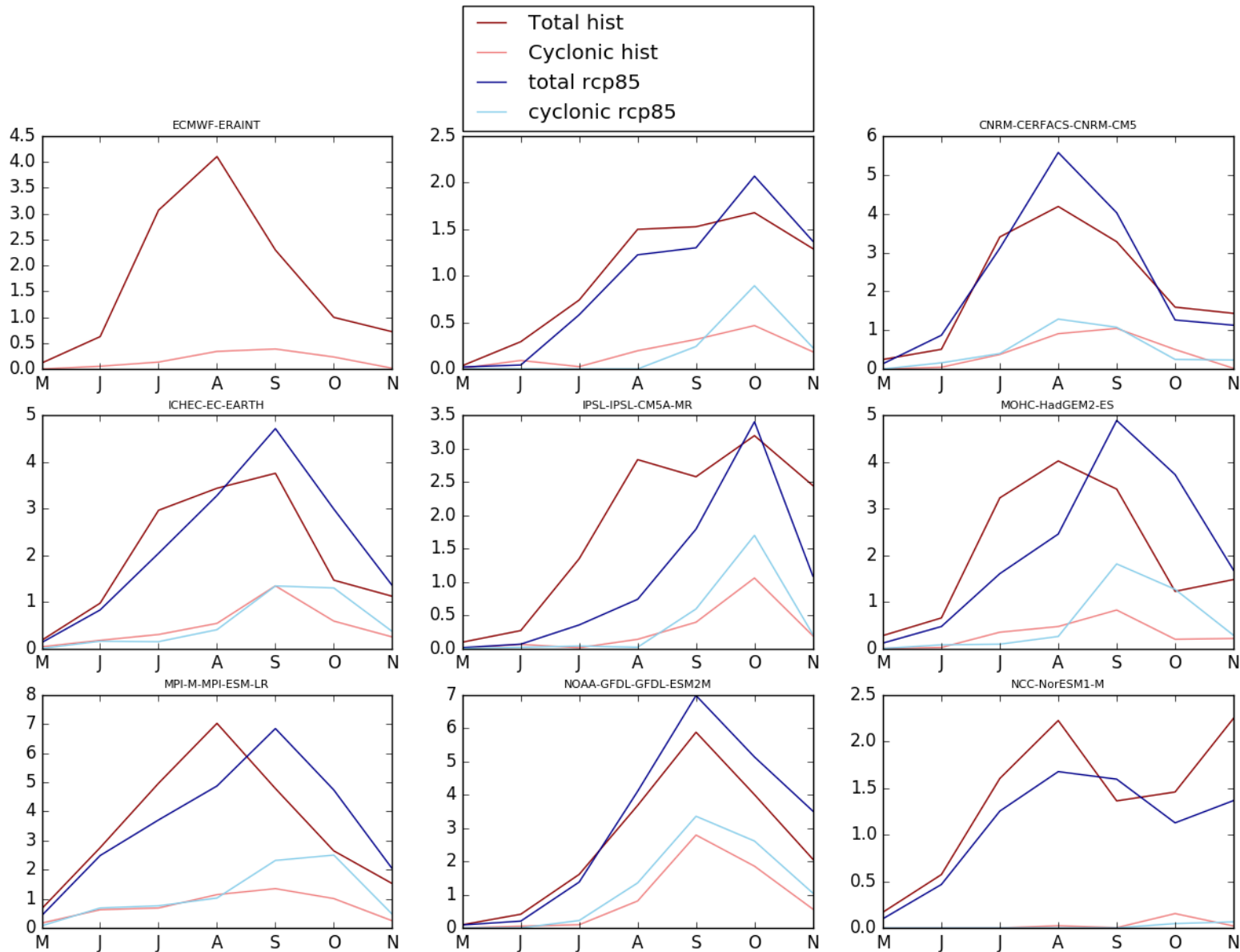
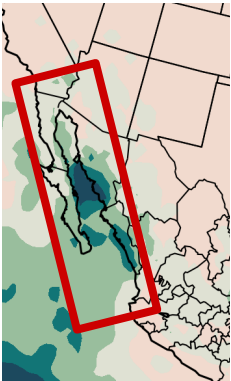
Mean change from ensemble

Total precipitation TCs precipitation

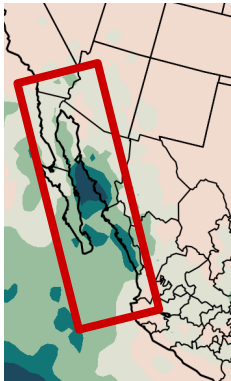


Precipitation during the rainy season Future(2071-2100) and Hist (1976-2005)

SMHI

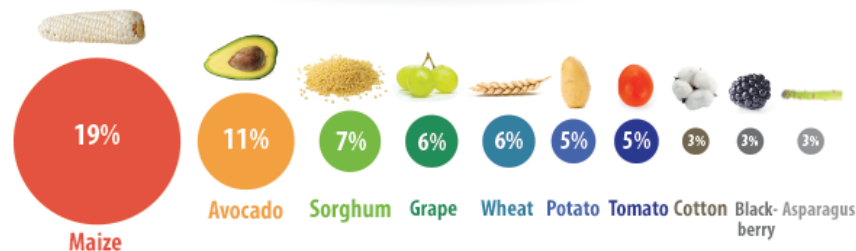


Agricultural production susceptible for changes on precipitation changes



Mexico is the Top 7 in agriculture exports in the world.
Total agricultural production reached a total value greater than US\$20 billion in 2012. Of the 2,457 municipalities of Mexico, 35 contributed with one quarter of that total.

MAIN CROPS OF THE 35 MUNICIPALITIES



- The RCA ensemble shows a overestimation of TCs over the North Atlantic, and an underestimation over the Eastern Tropical Pacific.
- The TCs-associated precipitation is comparable with observations, especially on those showing good representation of TCs spatial distribution.
- For the future period, the GCMs ensemble shows a warmer eastern tropical Pacific ocean compared to the tropical north Atlantic. This is in-line with previous studies.

Conclusions

- The GCMs scenario ensemble shows a decrease of precipitation over Mexico and Central America, which is robust across ensemble members (8/10). This decrease appears to be due to a more intense easterly winds over the Caribbean and therefore an increased vertical wind shear.
- The density of TCs in the future show a change towards a higher concentration towards the North subtropical Atlantic ocean, and a decrease over the Tropical Atlantic. Similarly it is found a higher concentration away from the Mexican coasts and a decrease of TCs concentration close to coastal regions.
- Although the total precipitation shows a decrease all along Mexico, the TCs-associated precipitation shows an increase over Northwest Mexico, especially over the Gulf of California, increasing the contribution of TCs-associated precipitation to total precipitation over that region.
- To be submitted to Climate Dynamics.