Advanced School on High-Perfomance Computing and Applied AI for High-Resolution Regional Climate Modeling

Climate models: examples of use

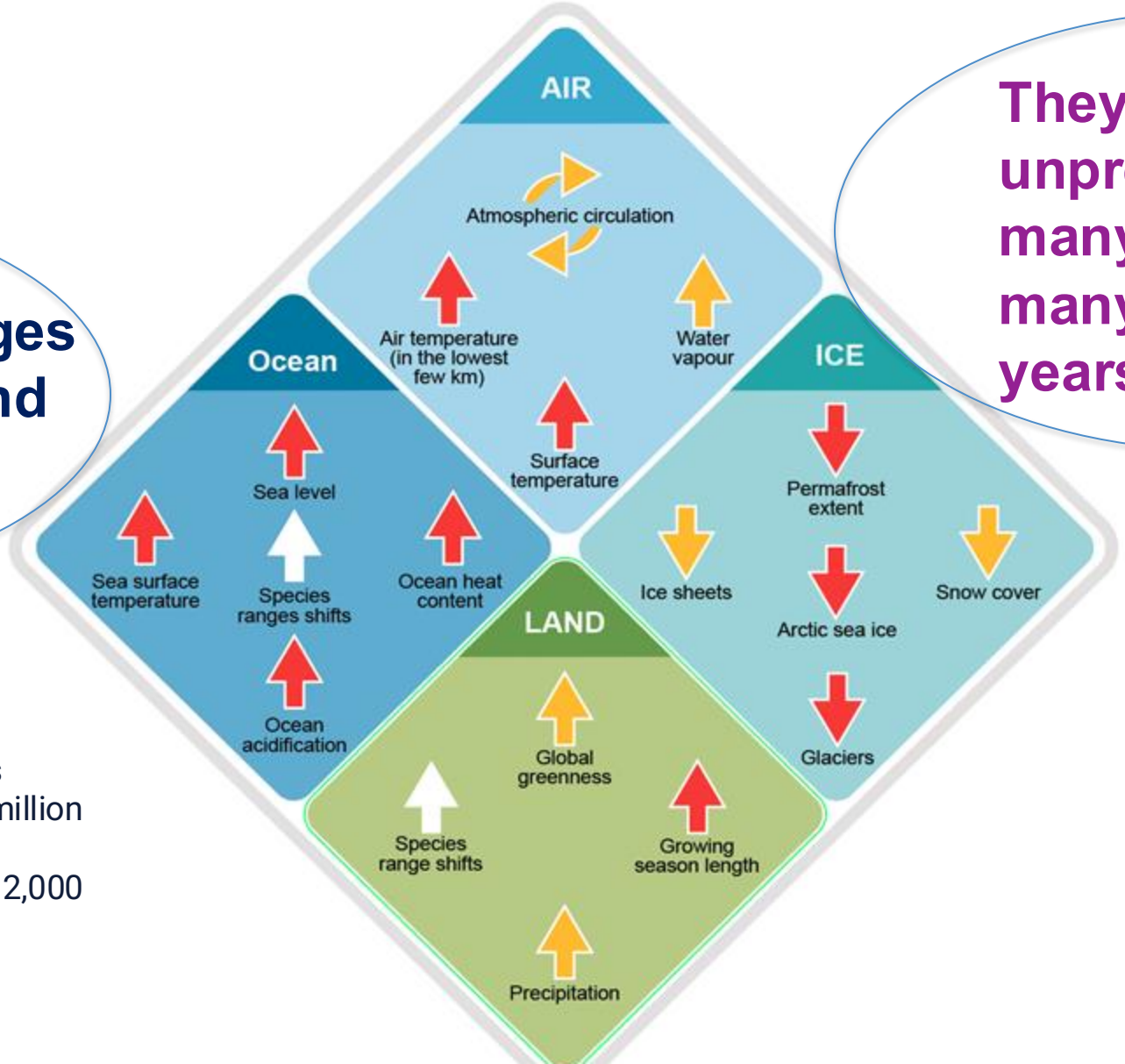
Fatima Driouech

Climate models

A climate model is a numerical representation of the climate system that reproduces the main complex interactions between the atmosphere, ocean, land surface, snow and ice, the global ecosystem, and a variety of chemical and biological processes.

For what …… ?

The recent climate changes are widespread, rapid, and intensifying



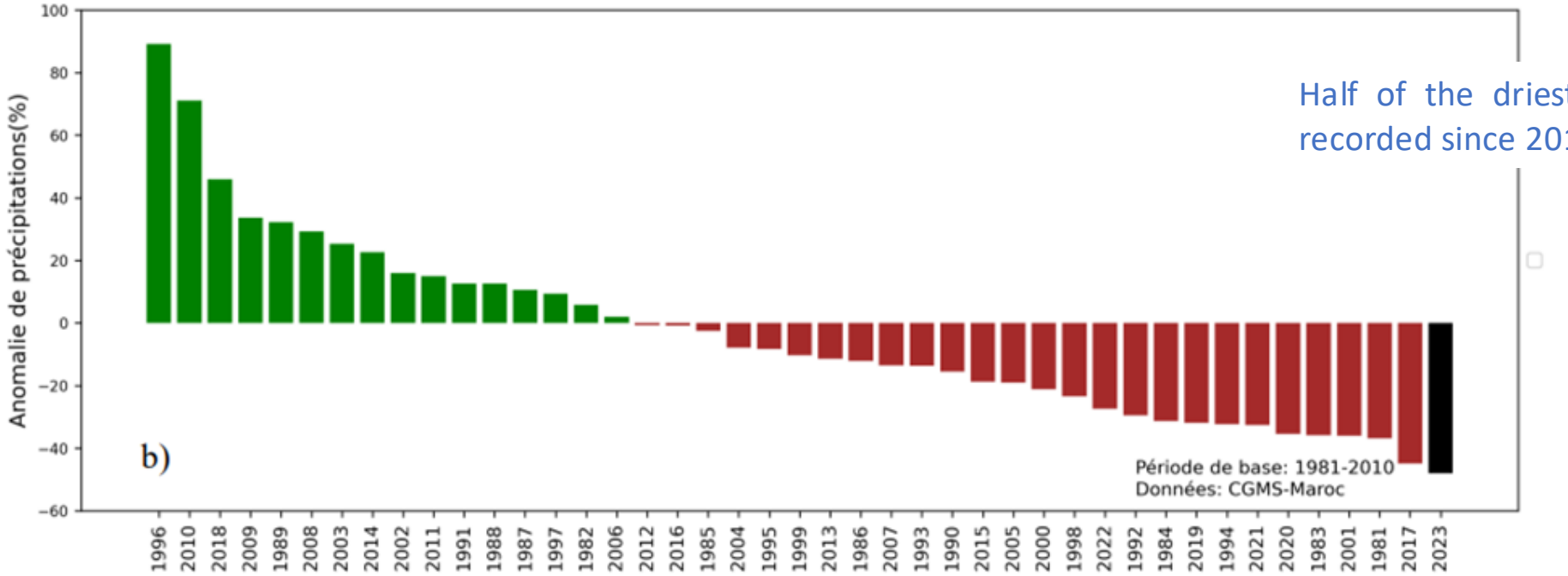
They are unprecedented over many centuries to many thousands of years.

- Fastest sea level rise in at least 3,000 years
- Unusual ocean acidification in at least 2 million years
- Melting glaciers unprecedented in at least 2,000 years

ted from Figure FAQ2.2

Case of Morocco: Drought

Years ranked by total rainfall amounts

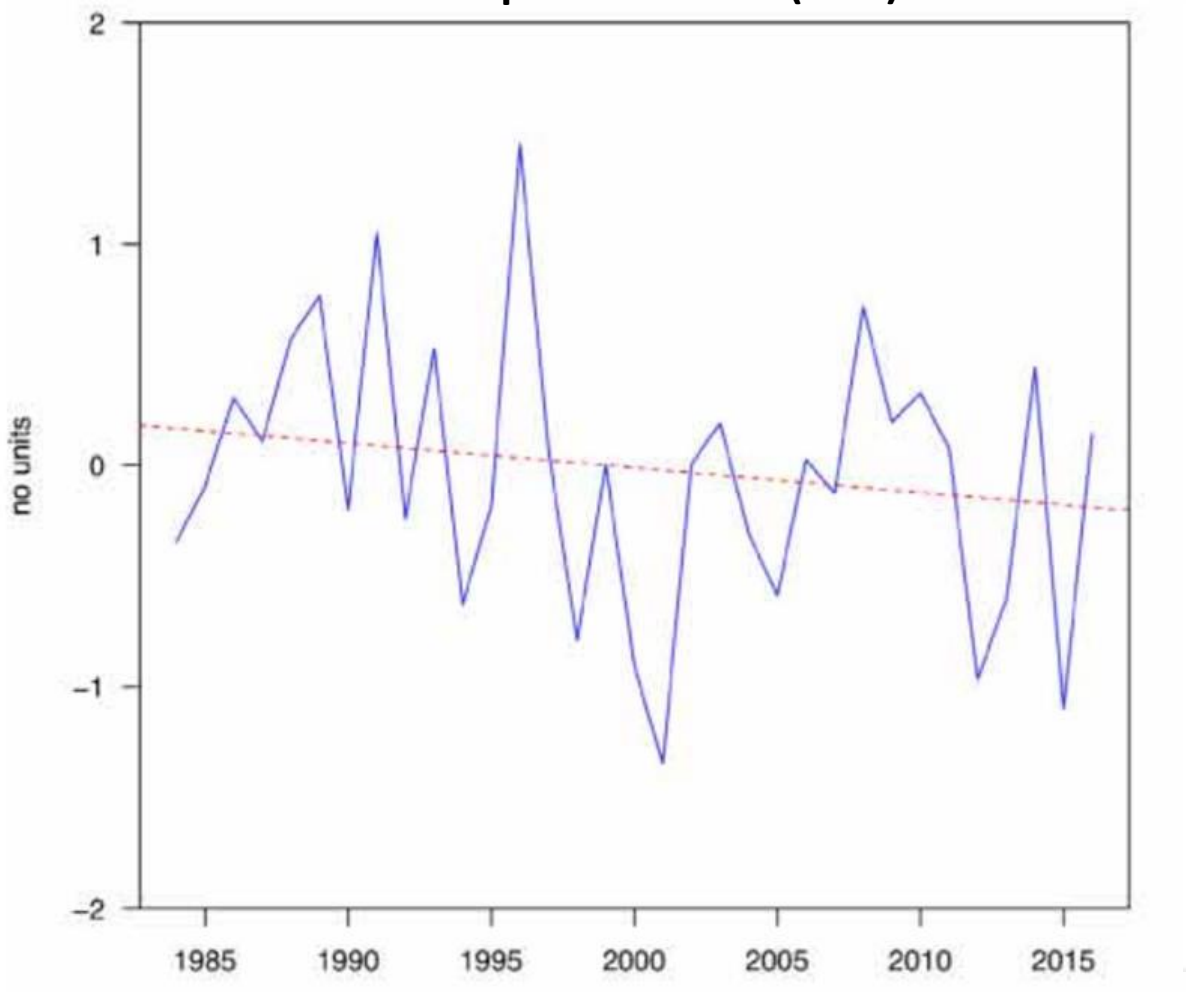


Half of the driest years have been recorded since 2017

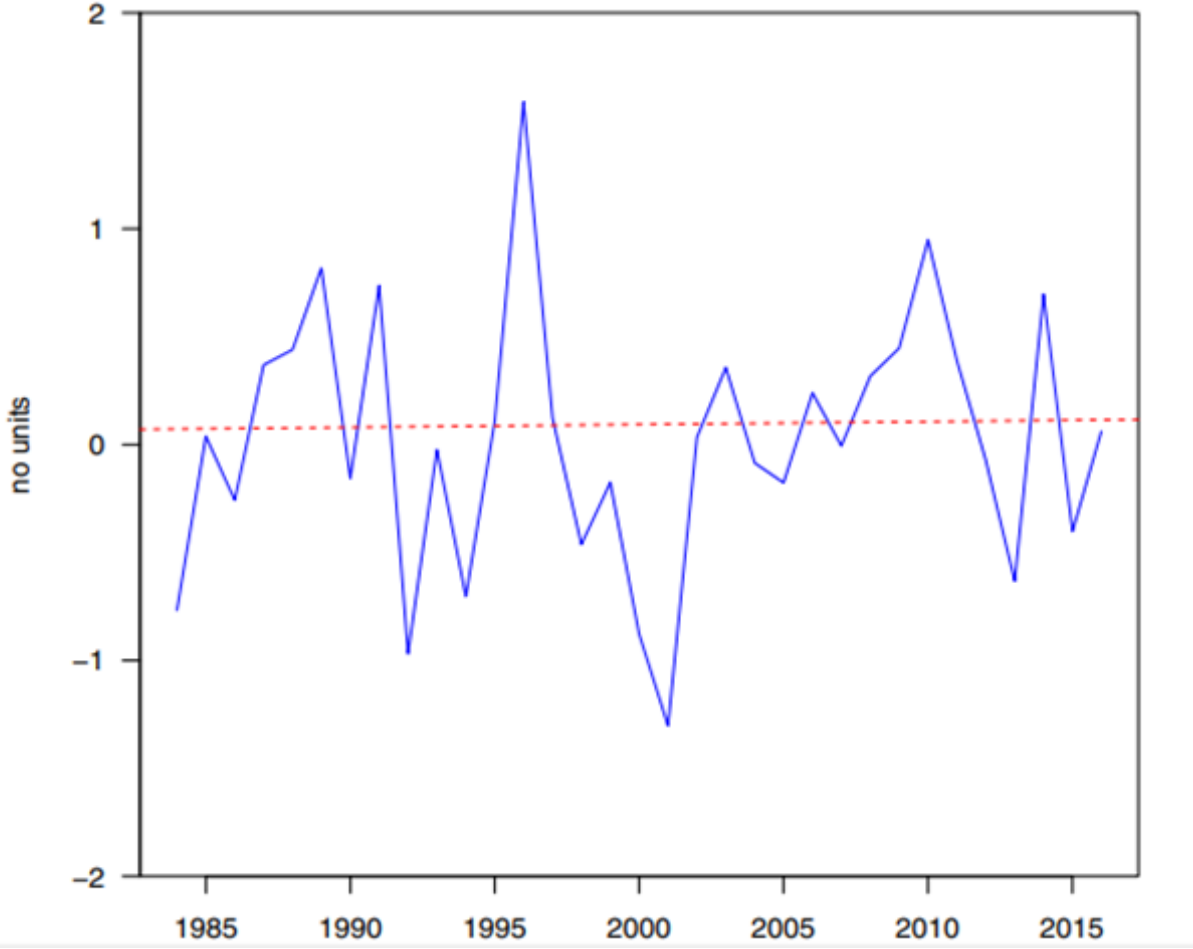
Etat du climat 2023 (DGM, 2024)

Case of Morocco: Drought

Standard Precipitation index (SPEI)

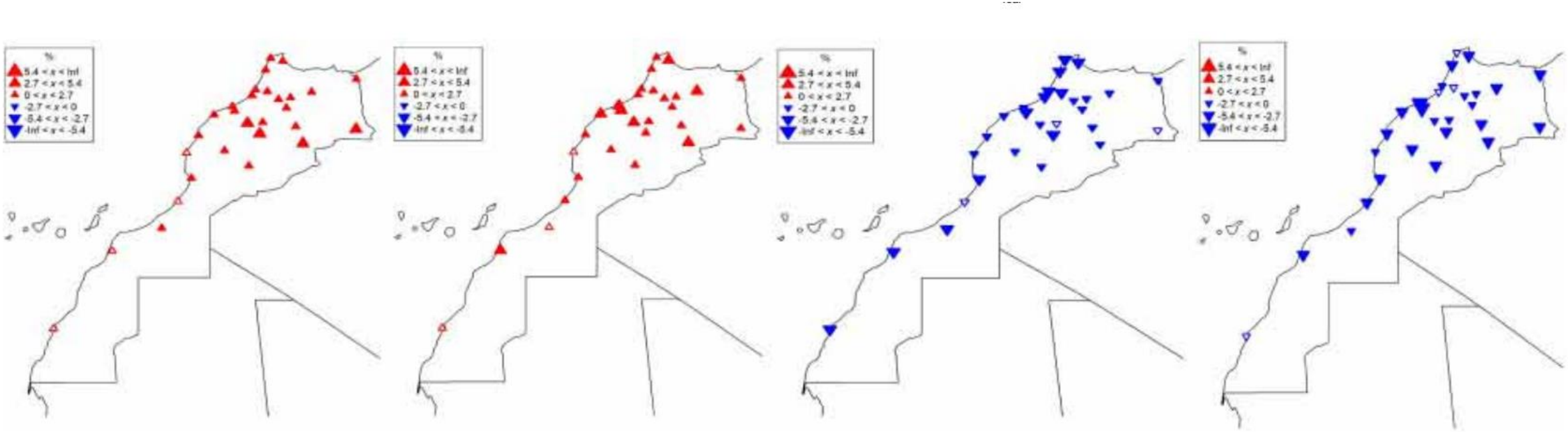


Standard Precipitation index (SPI)



Driouech F, Stafi H, Khouakhi A, et al. Recent observed country-wide climate trends in Morocco. (2020)

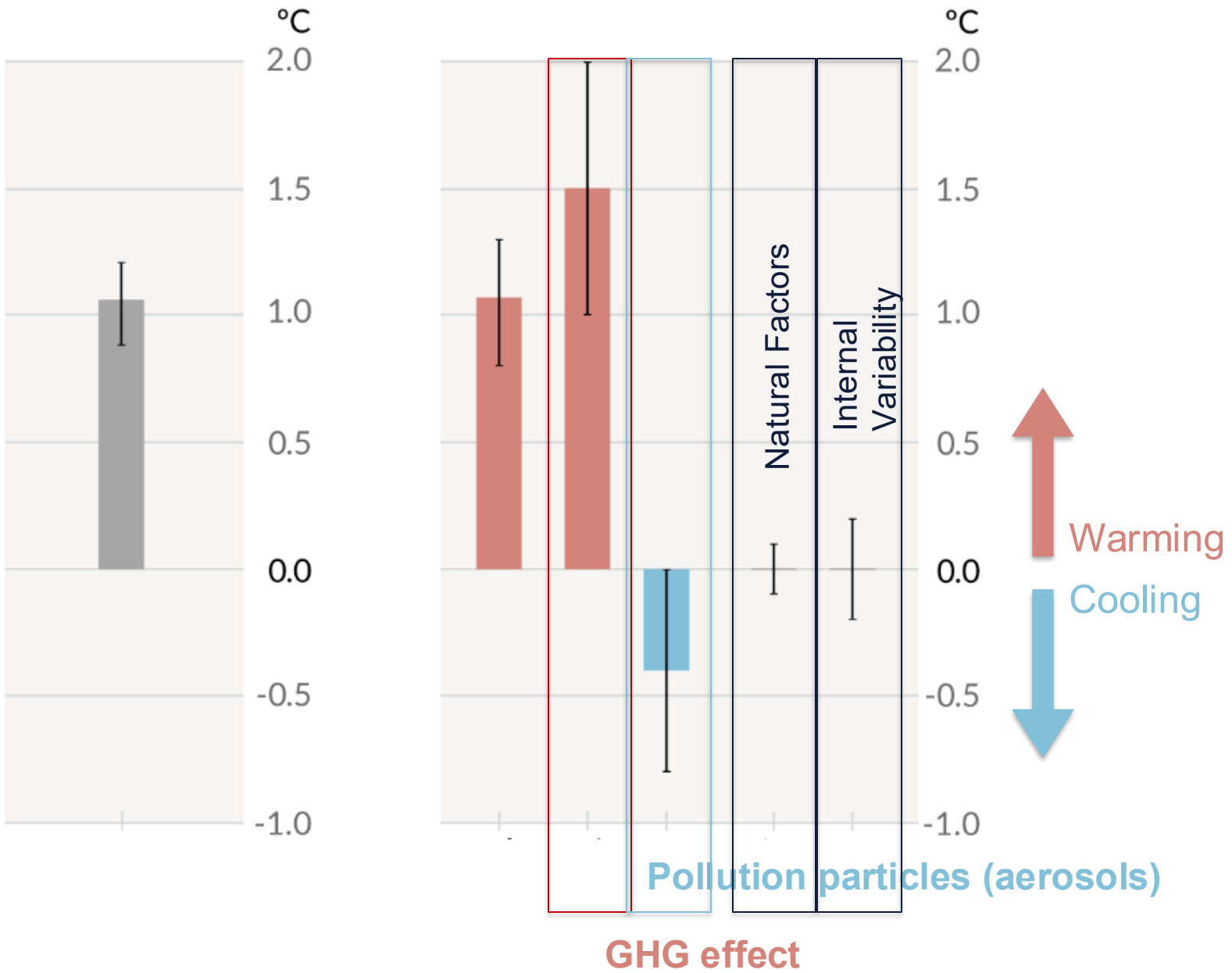
Case of Morocco: increased heat

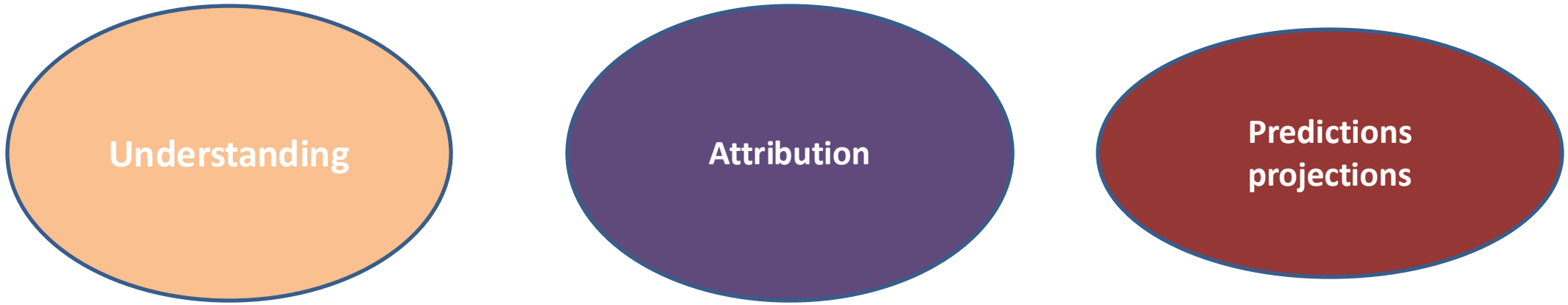


Warm days **Warm nights** **Cold days** **Cold night**

Driouech F, Stafi H, Khouakhi A, et al. Recent observed country-wide climate trends in Morocco. (2020)

It is unequivocal that human influence has warmed the atmosphere, ocean and land.





Climate models are used to study climate and predict their future changes ….

With every increment of global warming, changes get larger in regional mean temperature, precipitation and soil moisture

Annual mean temperature change (°C) relative to 1850-1900

1.5°C | 2°C | at 4°C

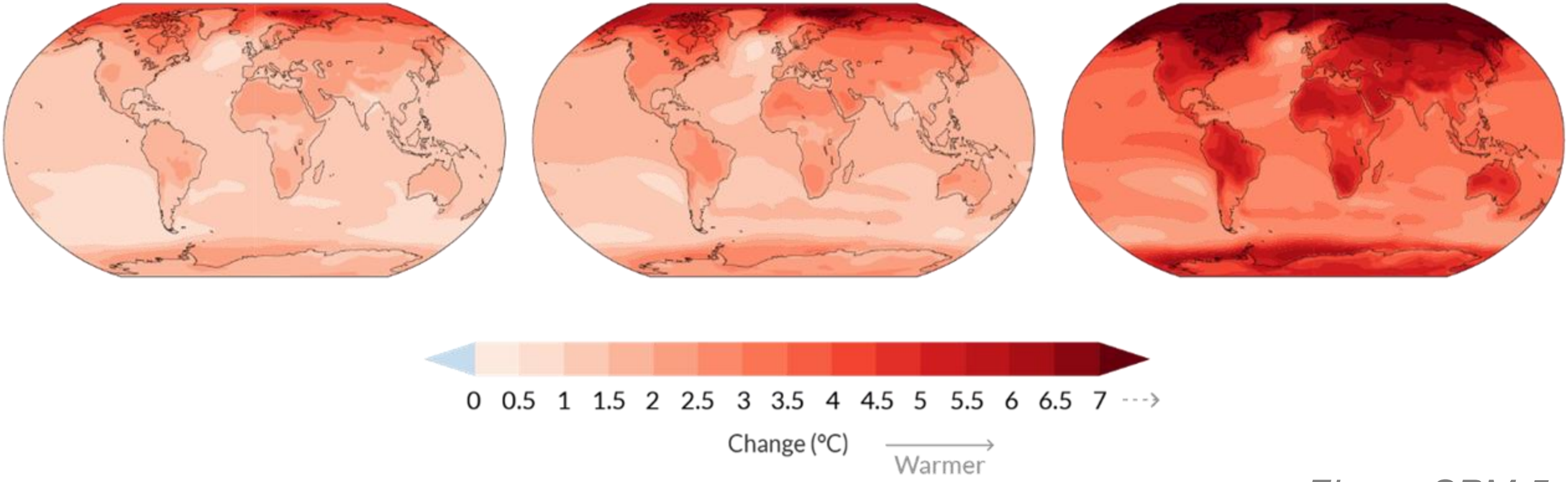
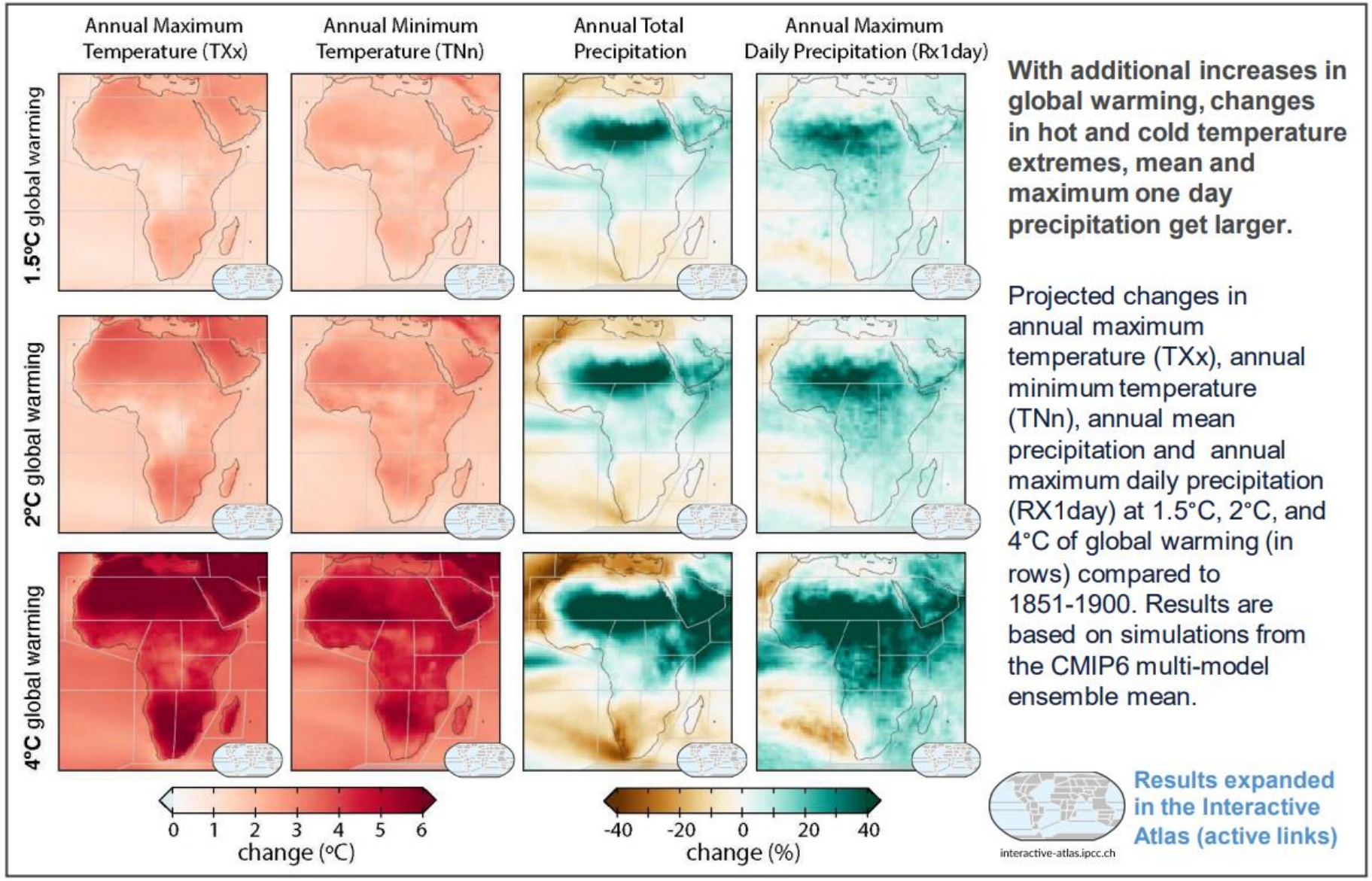


Figure SPM.5

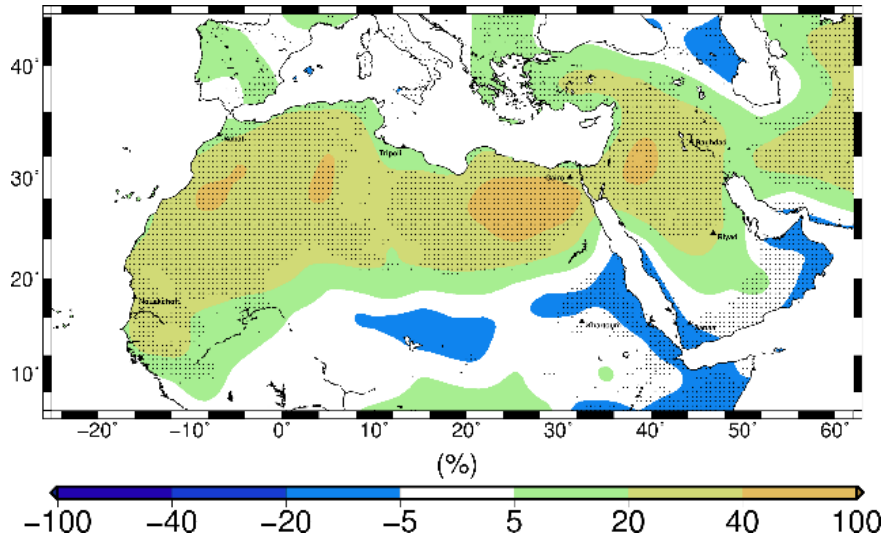


Changements futurs vers le mi-siècle

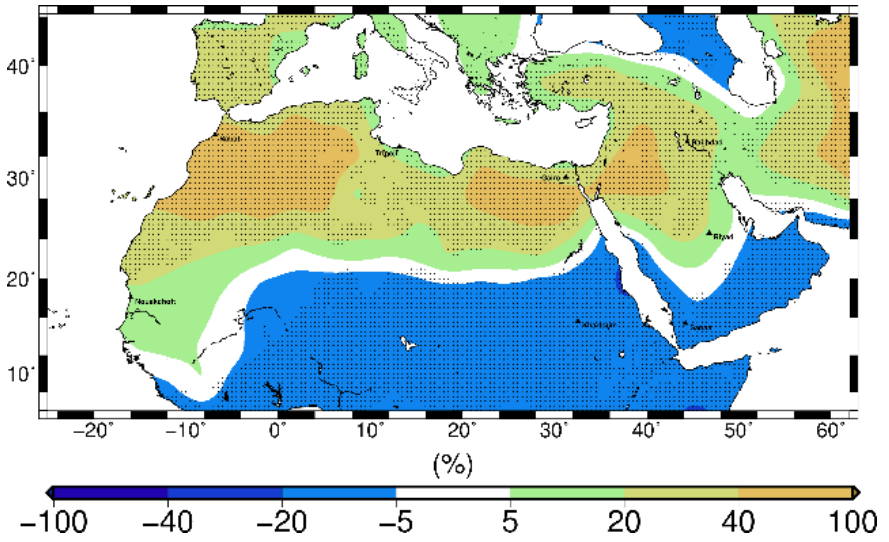
Future changes: drought and heat

SPEI (sécheresse)

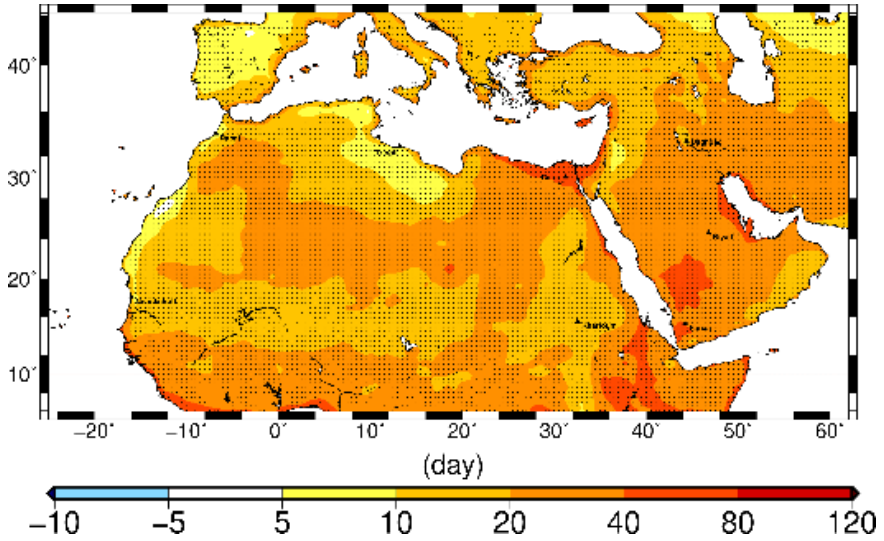
RCP4.5

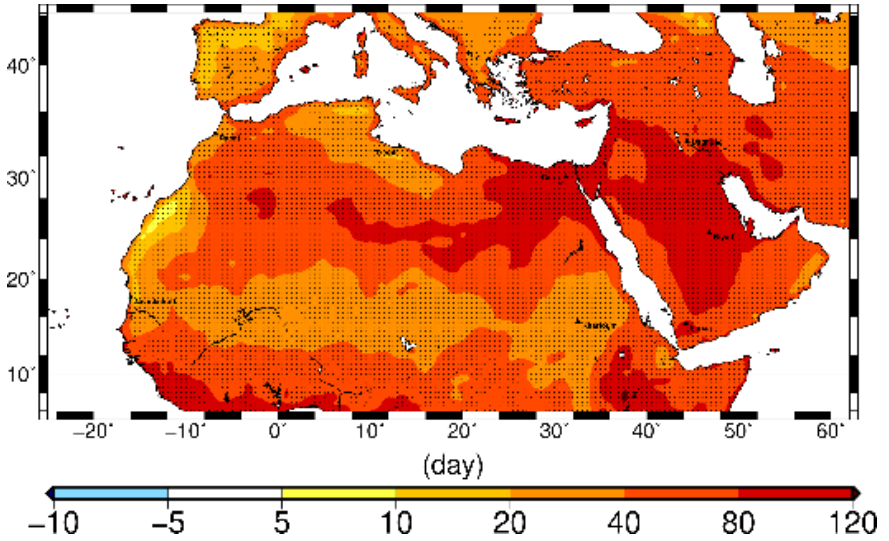


RCP 8.5

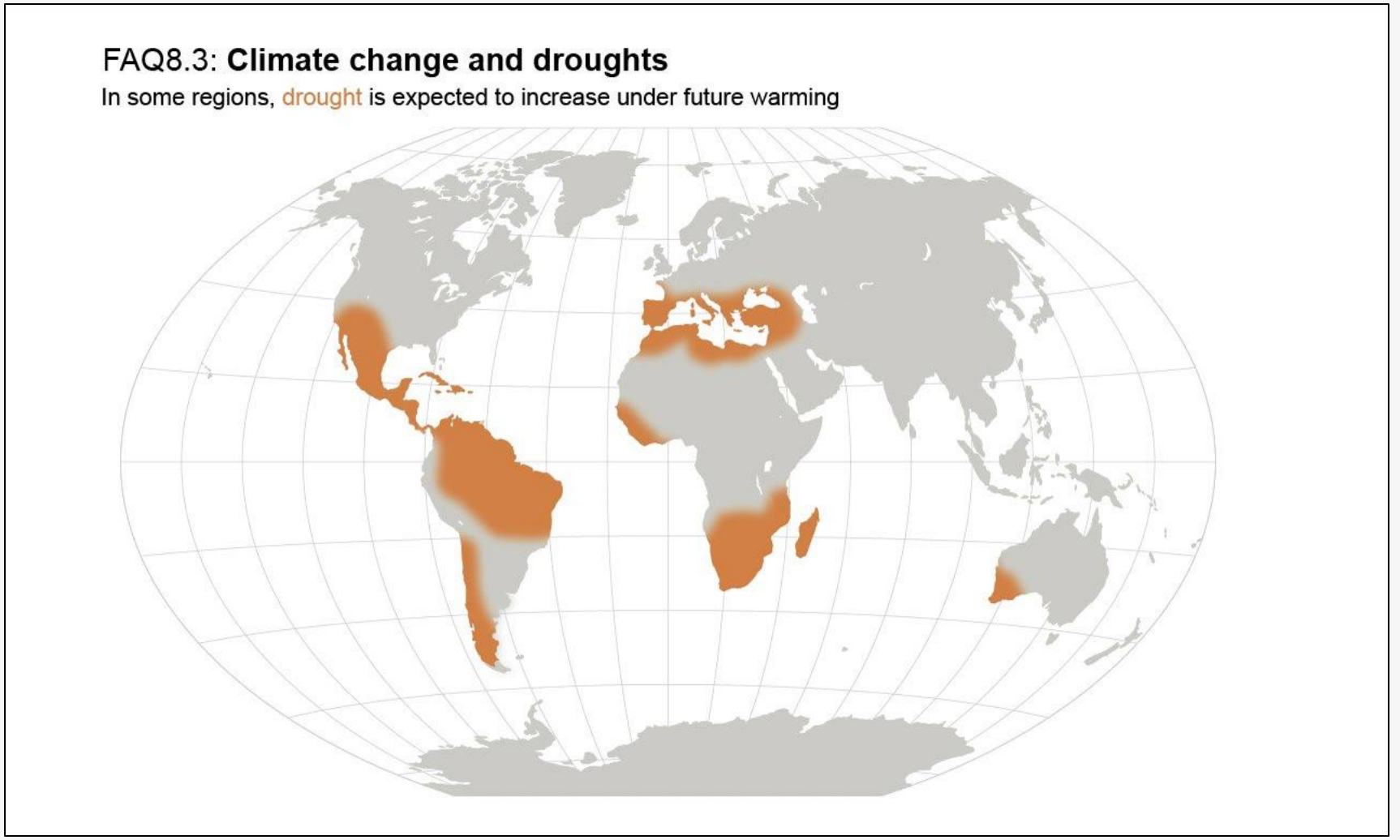


Durée des vagues de chaleur



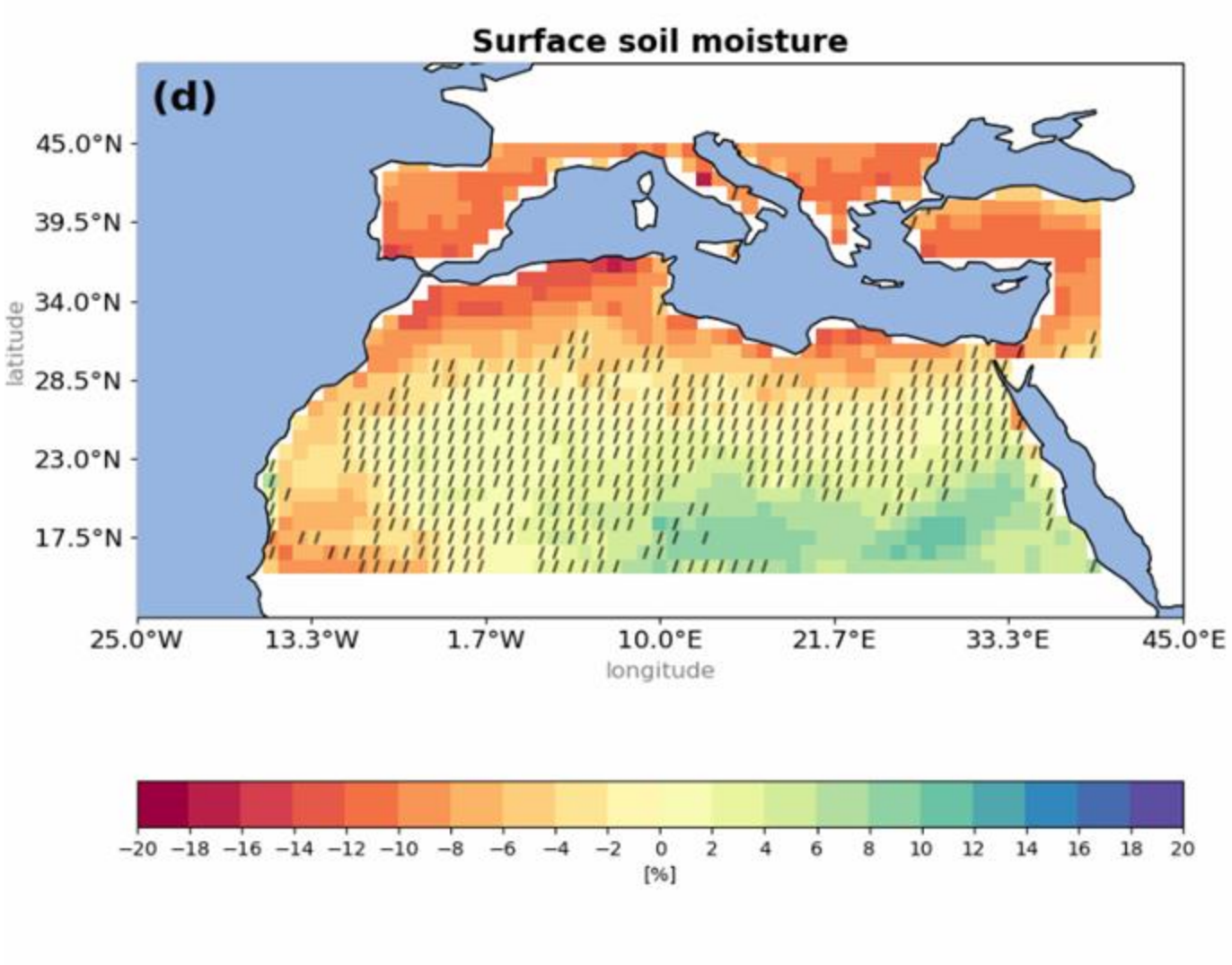


Driouech, ElRhaz et al. (2020)

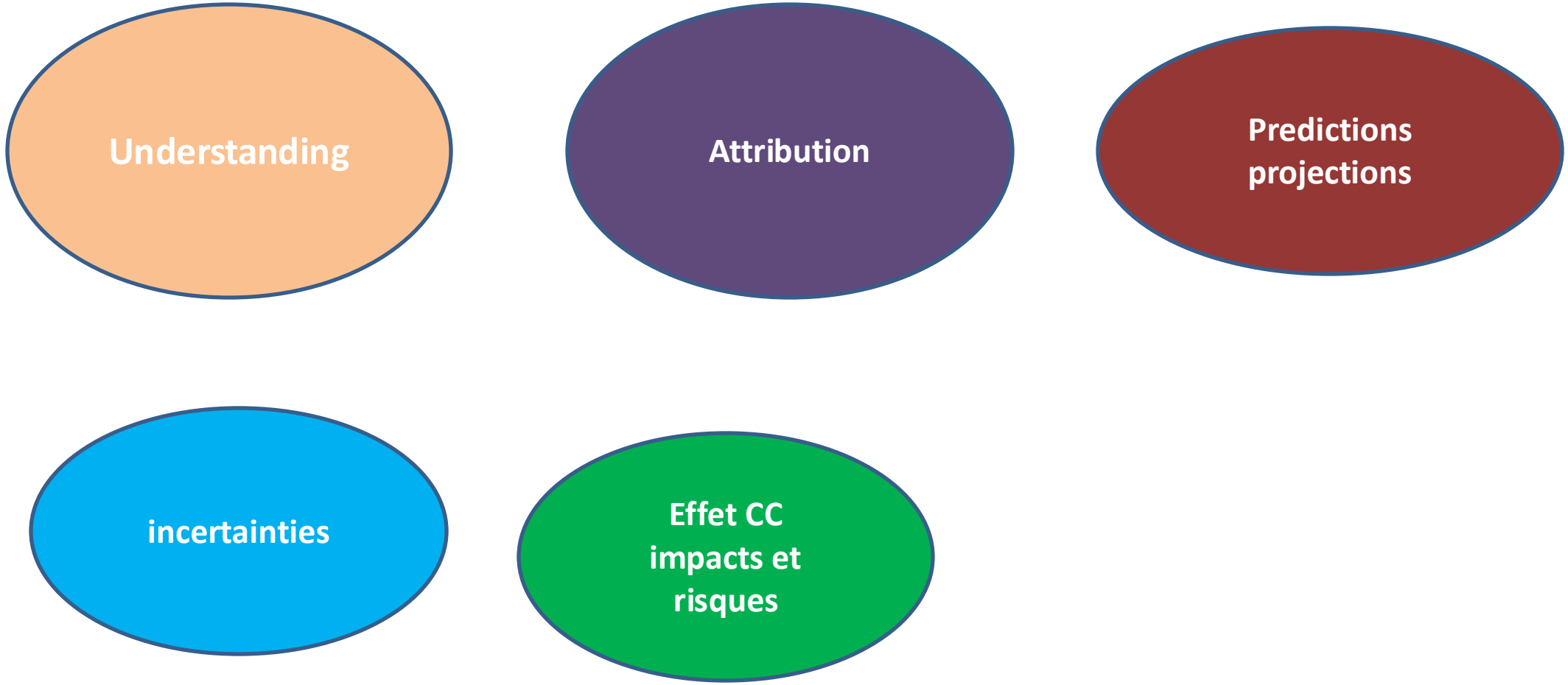


Schematic map highlighting in brown the regions where droughts are expected to become worse as a result of climate change. This pattern is similar regardless of the emissions scenario; however, the magnitude of change increases under higher emissions.

Case of Morocco: soil moisture



Arjdal, Driouech et al., 2023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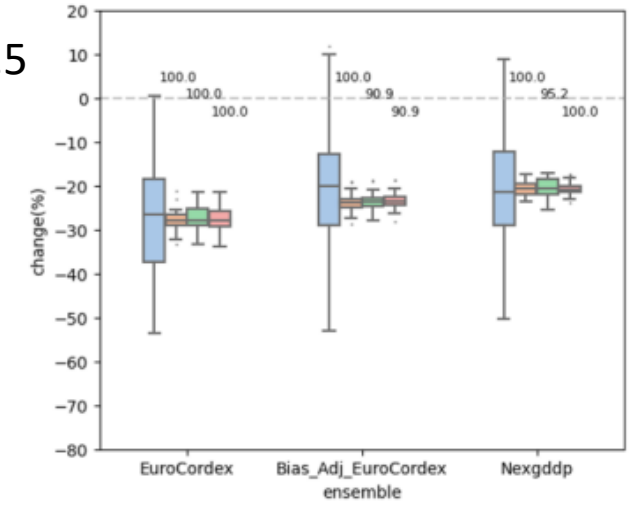
Rainfall amounts

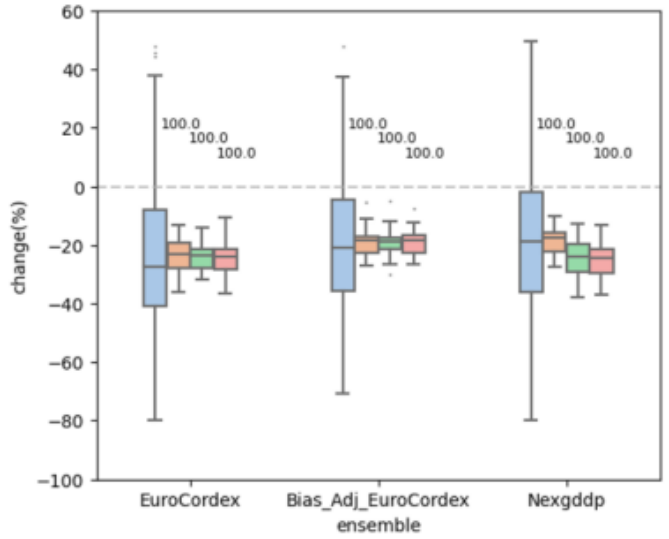
High precipitation

Drought

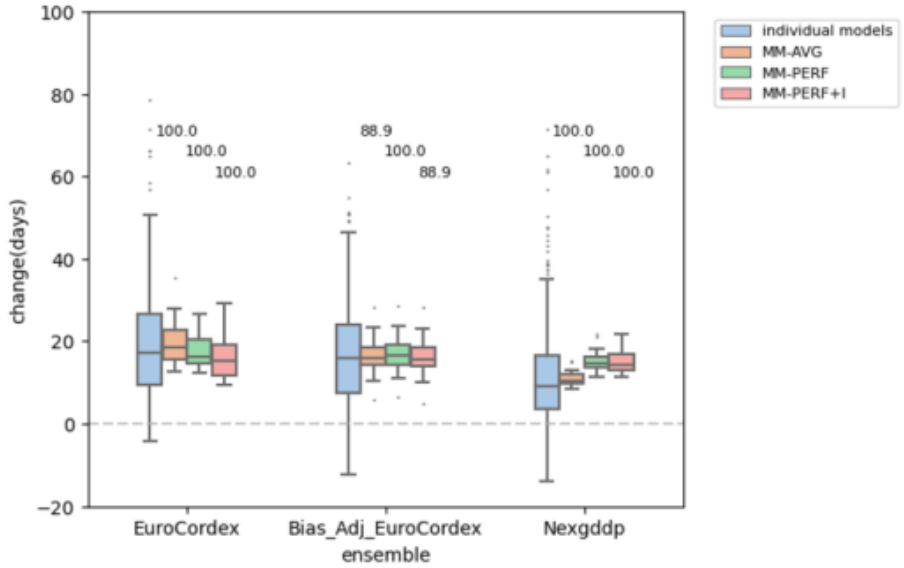
RCP4.5



(a)

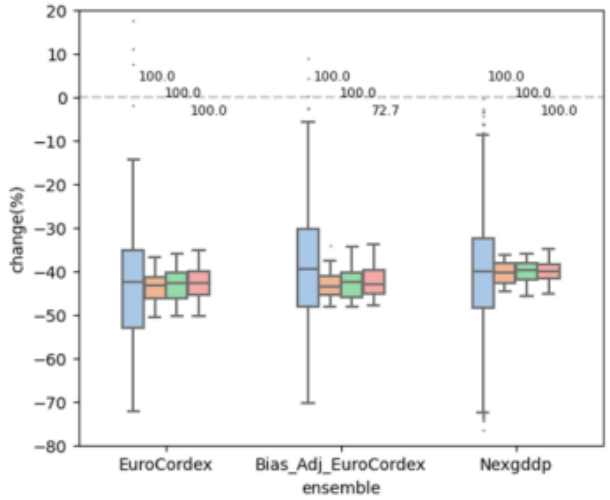


(b)

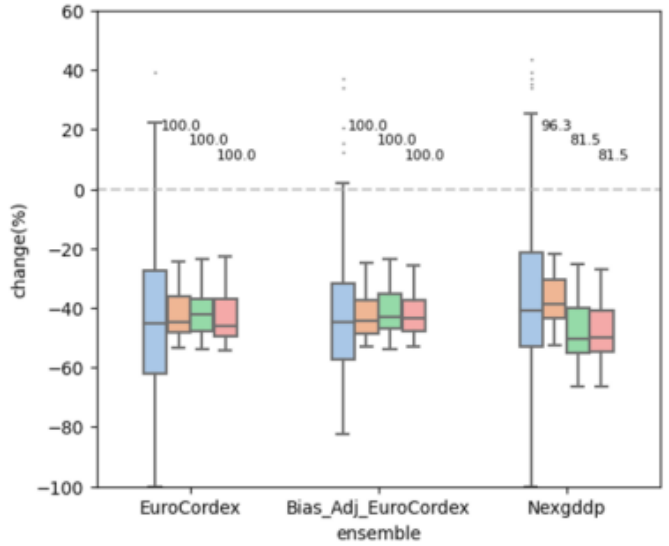


(c)

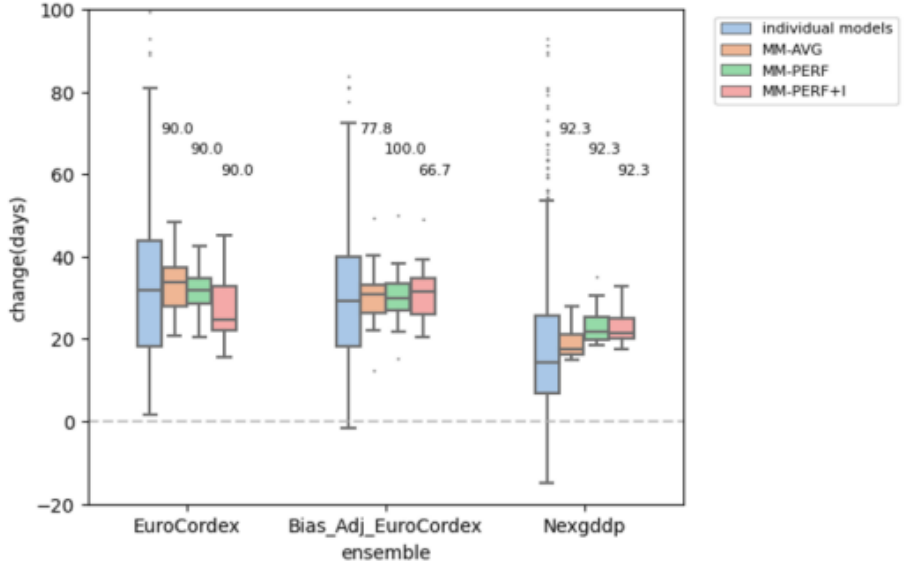
RCP8.5



(d)



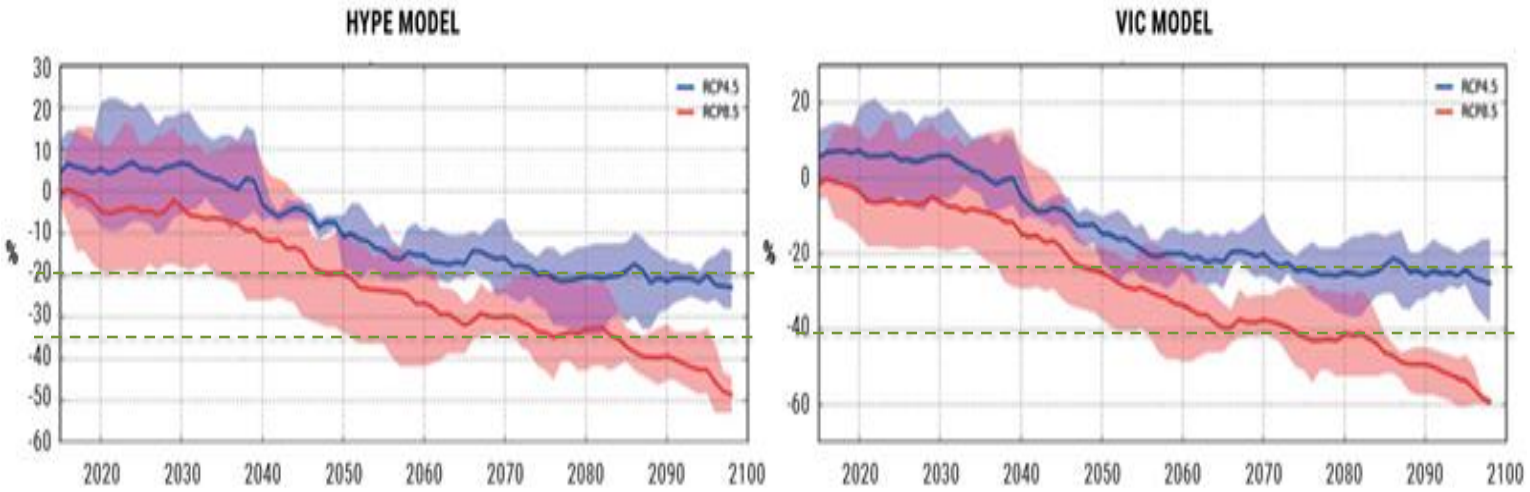
(e)



(f)

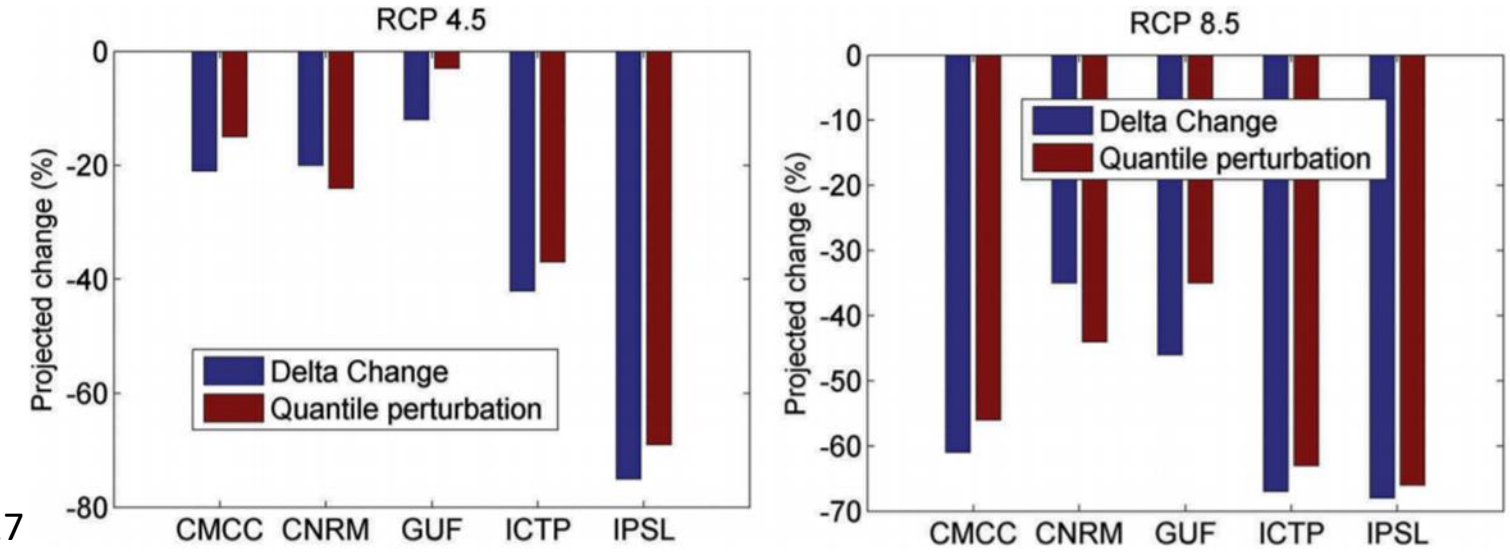
S. Balhane, F. Driouech et al., 2022

➔Baisse des débits annuels moyens au niveau des hauts plateaux



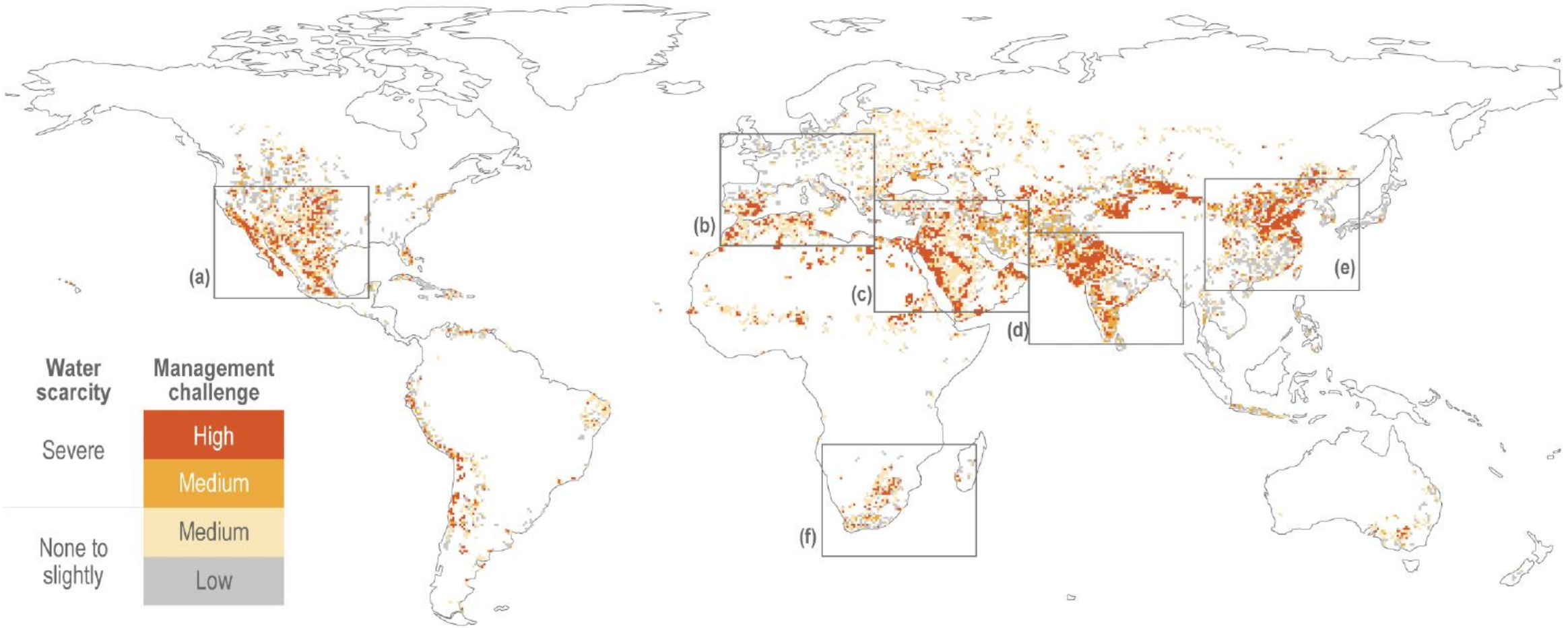
Changement futur de l'écoulement annuel moyen des hauts plateaux marocains (9W 1W 30N 35N) tels qu'issus de deux modèles hydrologiques HYPE (gauche) et VIC (droite) alimentés par différentes simulations climatiques sous les deux scénarios RCP4.5 et RCP8.5. Source : RICCAR (ESCWA et al., 2017)

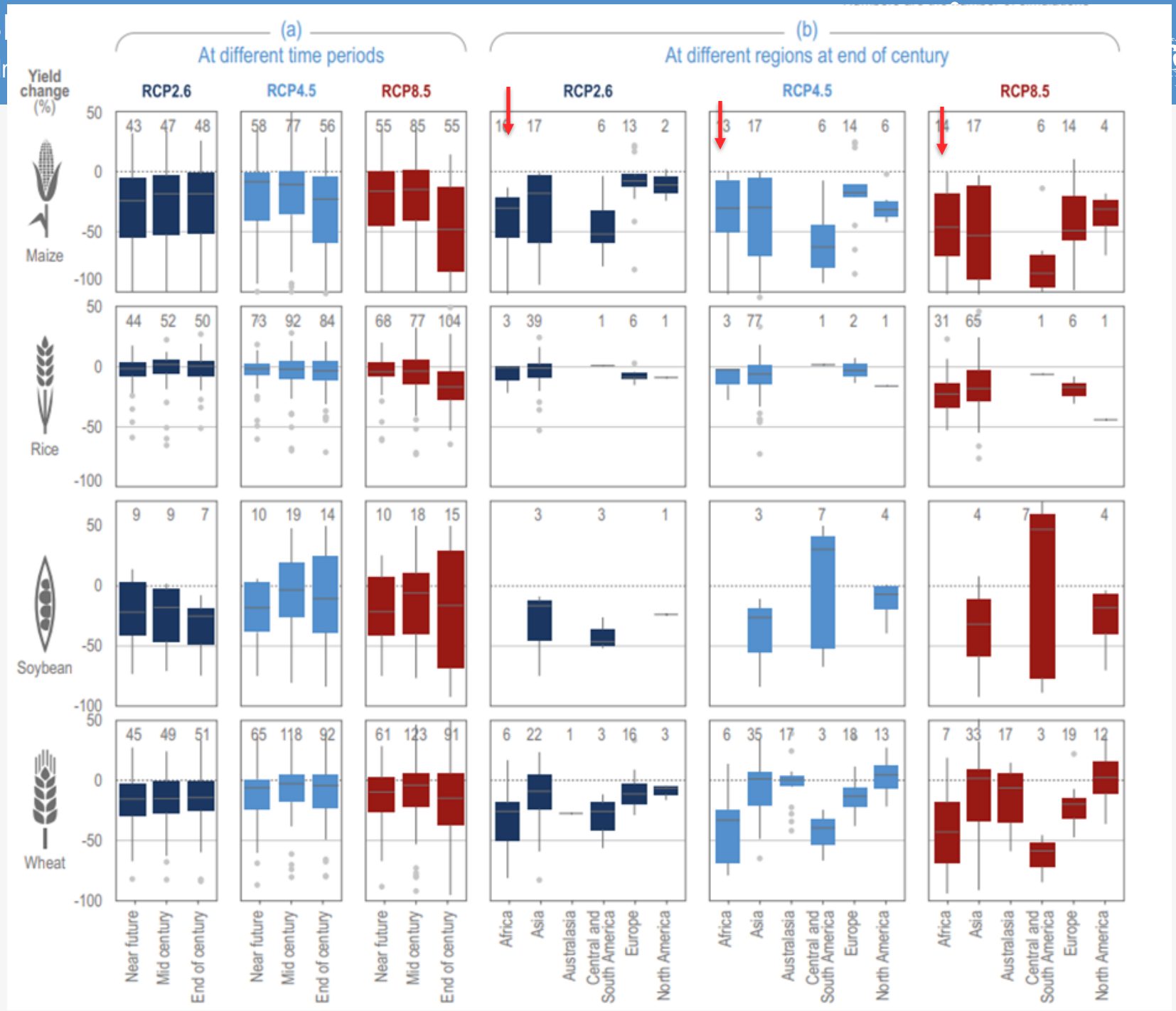
Marchane et al. 2017



Comparison of the projected changes in runoff with delta-change and quantile-perturbation methods.

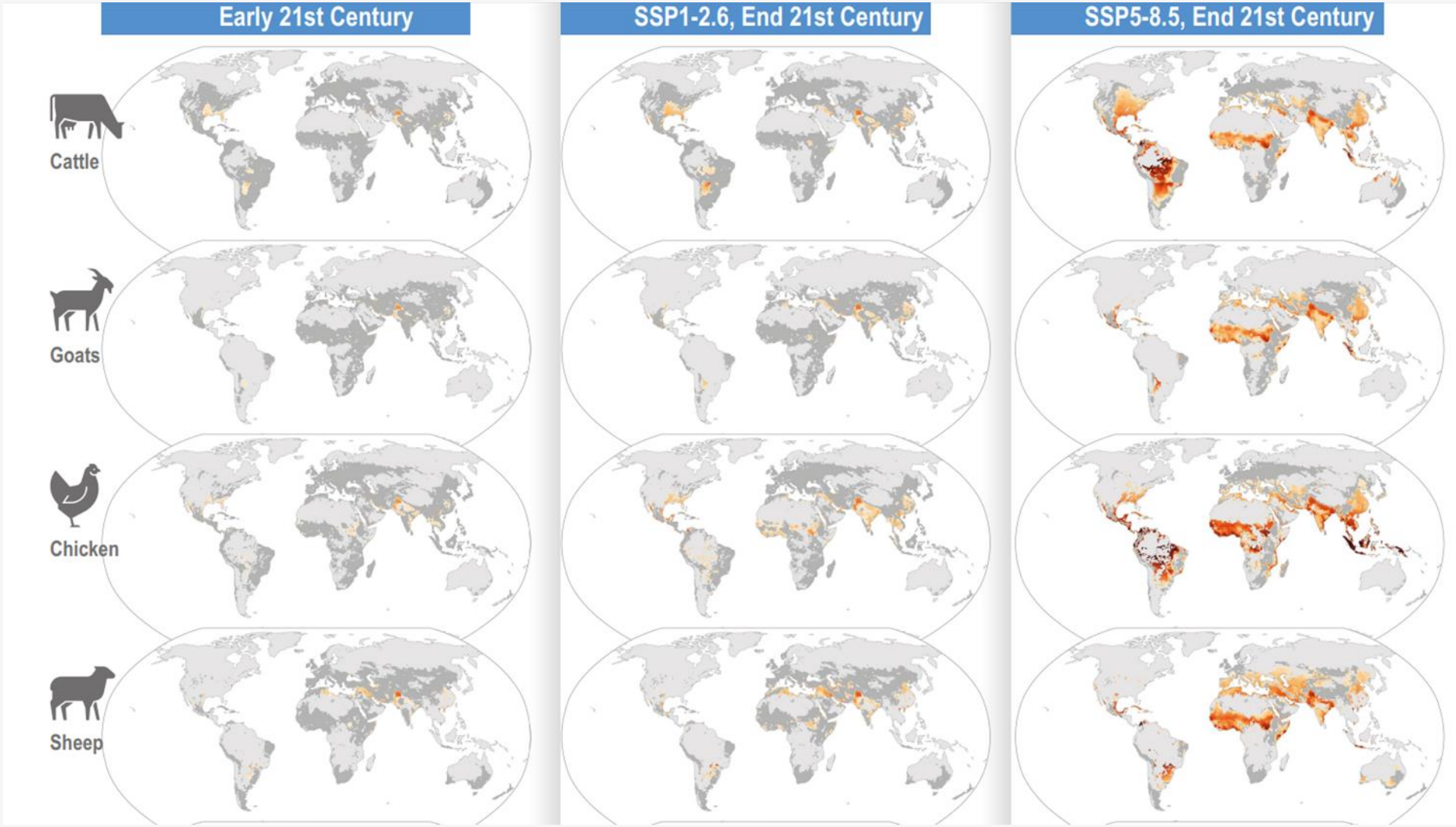
Par rapport aux situations de pénurie d'eau attendues d'ici 2050, la sécheresse exacerbe les défis en matière de gestion de l'eau, qui dépendent des régions



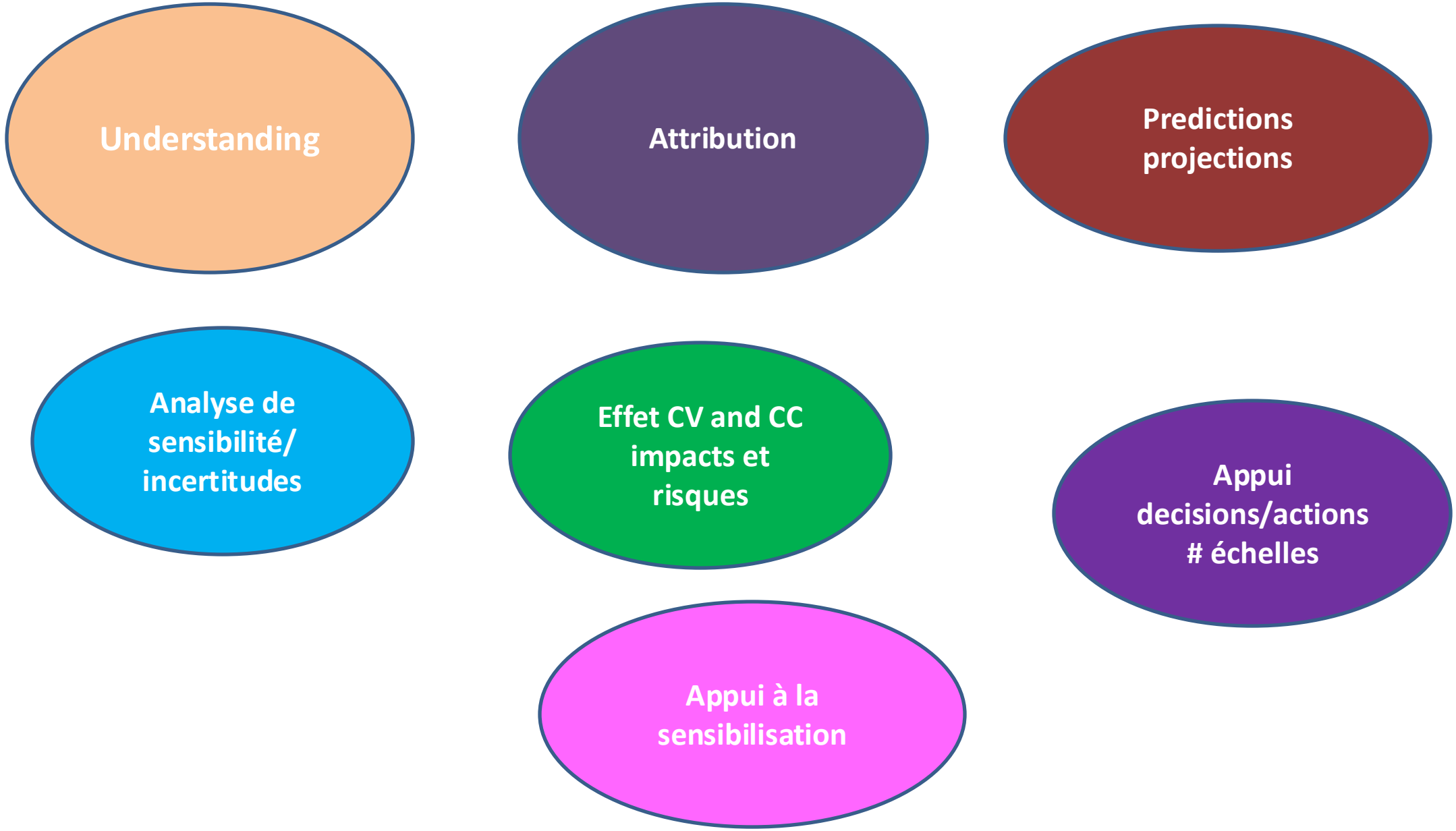


Projected yield change
taking into account the CO2 fertilization effect, without adaptation

Stress causé par la température et l'humidité pour le bétail



Changement du nombre de jours par an au-dessus des valeurs de « stress extrême » du début du 21e siècle (1991-2010) à la fin du siècle (2081-2100), sous SSP1-2.6 et SSP5-8.5.


Understanding
Attribution
Predictions
projections
Analyse de
sensibilité/
incertitudes
Effet CV and CC
impacts et
risques
Appui
decisions/actions
échelles
Appui à la
sensibilisation


Thank you for your attention