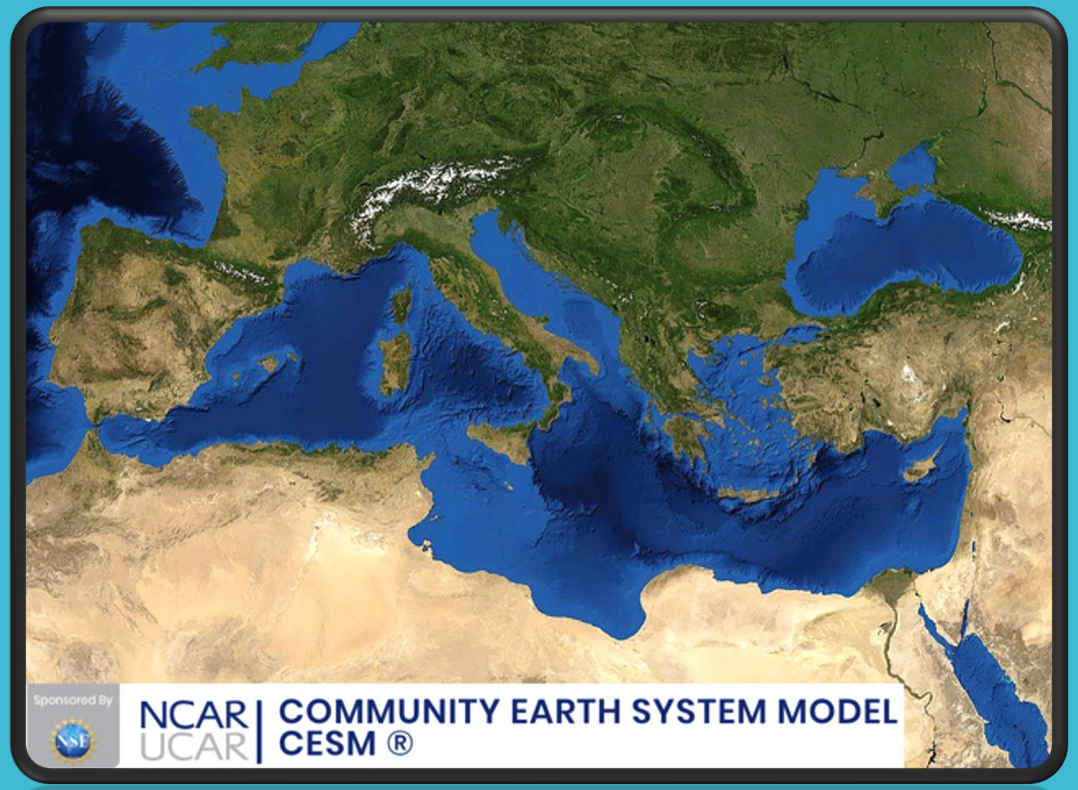
EGU General Assembly 2022

The Impacts of SST-Nudging on Performance of Community Earth System Model (CESM) in Representing the Euro-Mediterranean Climate



Thu, 26 May
09:27–09:33

Session CL4.3
Room 0.14

EGU22-12502
ECS
Virtual presentation

Emir TOKER *ITU*

Mehmet ILICAK *ITU*

Gökhan DANABAŞOĞLU *NCAR*

Ömer Lütfi ŞEN *ITU*

ITU GRADUATE SCHOOL

ITU/EIES

Motivation

- Climate variability and change *(Önol et al., 2014)*
- Water and energy budgets, Population *(Lehner et al., 2017; Lana-Renault et al., 2020)*
- Utilize ESM model in The National Center for High-Performance Computing (UHeM)
- ESMs computational challenges - **SST** *(Danabasoglu et al., 2020)*

Purpose

- Apply nudging for Mediterranean Sea SST as a simple bias-correction method
- Create Mediterranean Pacemaker Experiments (MedP) and Model Ensemble
- Evaluate the Nudging method and MedP Ensemble

Further

- ESM study - **role of Mediterranean Sea** in the regional and global climate
- Mediterranean SST Variability - Atmospheric Large Scale Circulation
- Jet streams, downstream development of Rossby Waves, and Mediterranean Trough

Scope

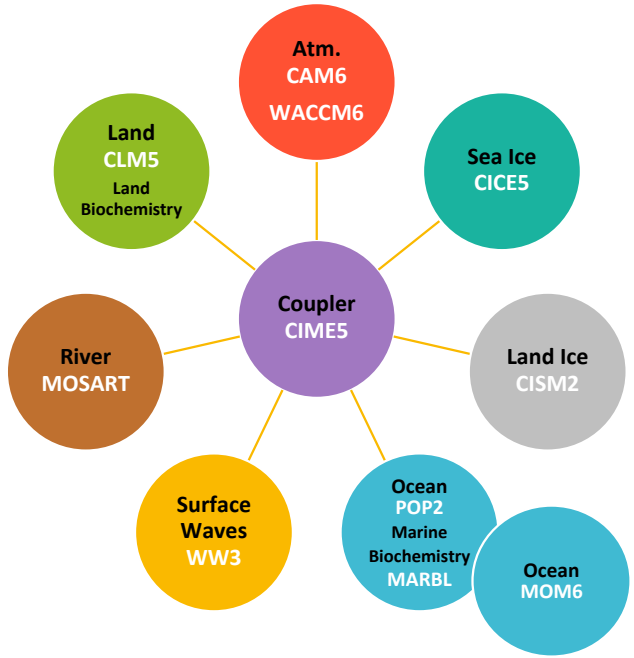
Region
Mediterranean Basin

Topic
Atm-Ocn Interaction
Climate Variability

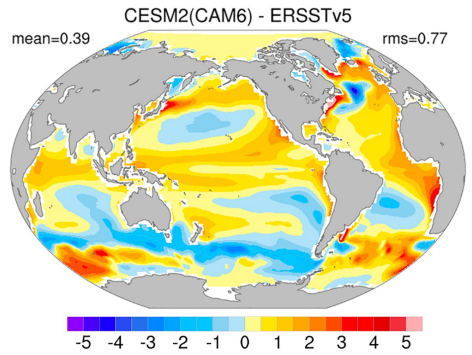
Model
CESM
NCAR

Computing
ITU-UHeM

Sponsored By NSF | NCAR UCAR | COMMUNITY EARTH SYSTEM MODEL CESM ®



Schematic of the CESM2
(Danabasoglu et al., 2020)



SST biases between CESM2 and ERSST
(Danabasoglu et al., 2020)

- Introduction
  - Motivation
  - Purpose
  - Scope
- Methodology
  - Pre - Process
  - Live - Process
  - Post - Process
- Experiments
- Results
  - Surface Layer
    - Temperature
    - Precipitation
  - Upper Layer
    - 850mb Temperature
    - 500mb Geopotential Height
    - 200mb Zonal Wind
- Conclusion and Discussion

Pre

- ITU - UHeM Check
- Spin-Up and Control
- Remap and Mask Data
- Namelist File

Installation - Test run - Stable version

Long term simulations with 'B1850' and 'BHISTcmip6' component Set

ERSSTv5 (1880-2014), OISSTv2.1 (1980-2014), CPC (1980-2014), ERA5 (1980-2014)

Rearrange the options, files, sources of POP and CAM component for nudging and perturbation

Live

- Perturbation
- Nudging Method

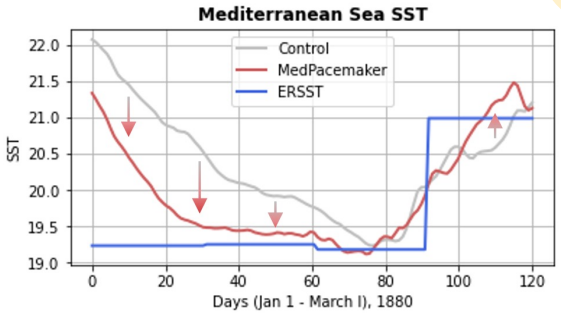
Micro-perturbation using Potential Temperature ($x10^{-14}$) in CAM, for Ensemble

$$\frac{\partial SST}{\partial t} = SST_{model} + \frac{\alpha}{\tau}(SST_{obs} - SST_{model})$$

$$\frac{\alpha}{\tau} = \frac{\text{Nudging coefficient}}{\text{Nudging time scale}} = \frac{0 \mid 1}{730\ \text{hr}}$$

$$\frac{\partial SST}{\partial t} =$$ Model + Mask + Bias

Med - Pacemaker Experiment & Ensemble



Post

- Get Variables & Analysis
- Index

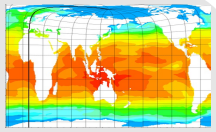
Long Term Mean, Bias, Surface Layer, Upper Layer

$$Index = \sqrt{\frac{(X_{Control} - X_{OBS})^2}{(X_{MedPace} - X_{OBS})^2}}$$

Investigating of the fidelity of the nudging method

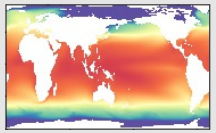
- Index > 1 $(X_{MedPace} - X_{OBS}) < (X_{Control} - X_{OBS})$ **BETTER**
- Index < 1 $(X_{MedPace} - X_{OBS}) > (X_{Control} - X_{OBS})$ **WORSE**

CESM 2.1.3
POP2
BHISTcmip6



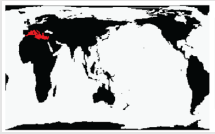
+

ERSSTv5
OISSTv2.1



+

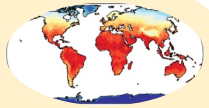
Mediterranean Sea Mask



+

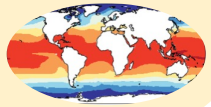
Namelists

Perturbation (CAM)

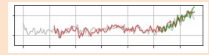


+

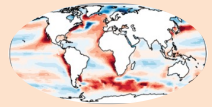
Nudging (POP)



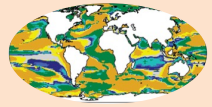
Get Variable & Analysis



Mean

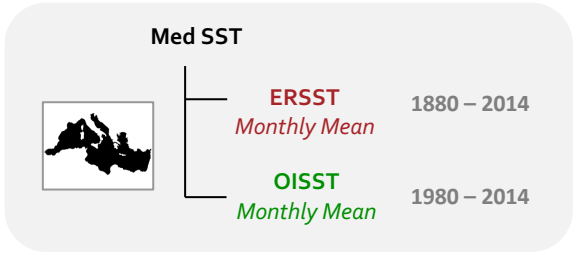


Bias

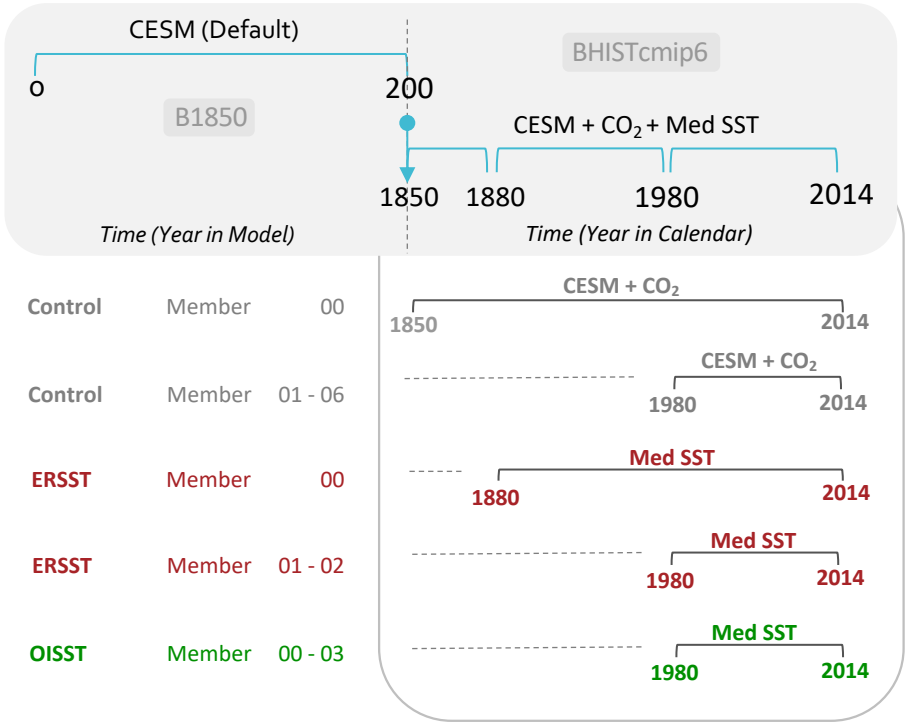


Index

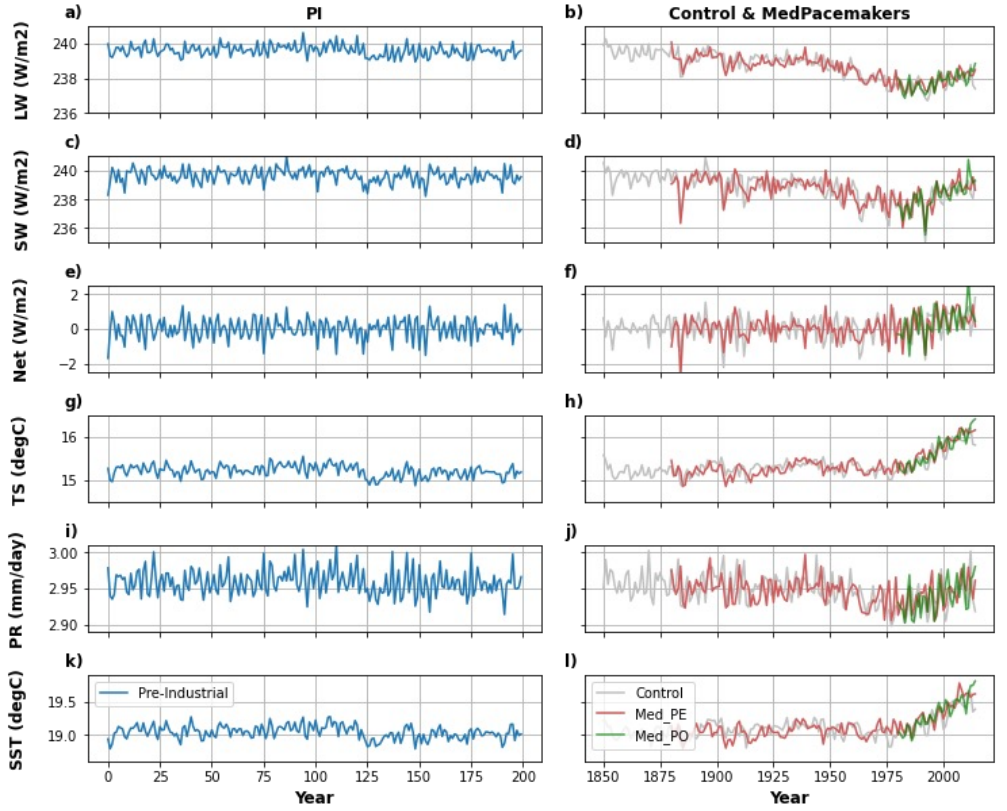
- Introduction
  - Motivation
  - Purpose
  - Scope
- Methodology
  - Pre - Process
  - Live - Process
  - Post - Process
- Experiments
- Results
  - Surface Layer
    - Temperature
    - Precipitation
  - Upper Layer
    - 850mb Temperature
    - 500mb Geopotential Height
    - 200mb Zonal Wind
- Conclusion and Discussion



Observation Data for SST



Schematic of Experiments

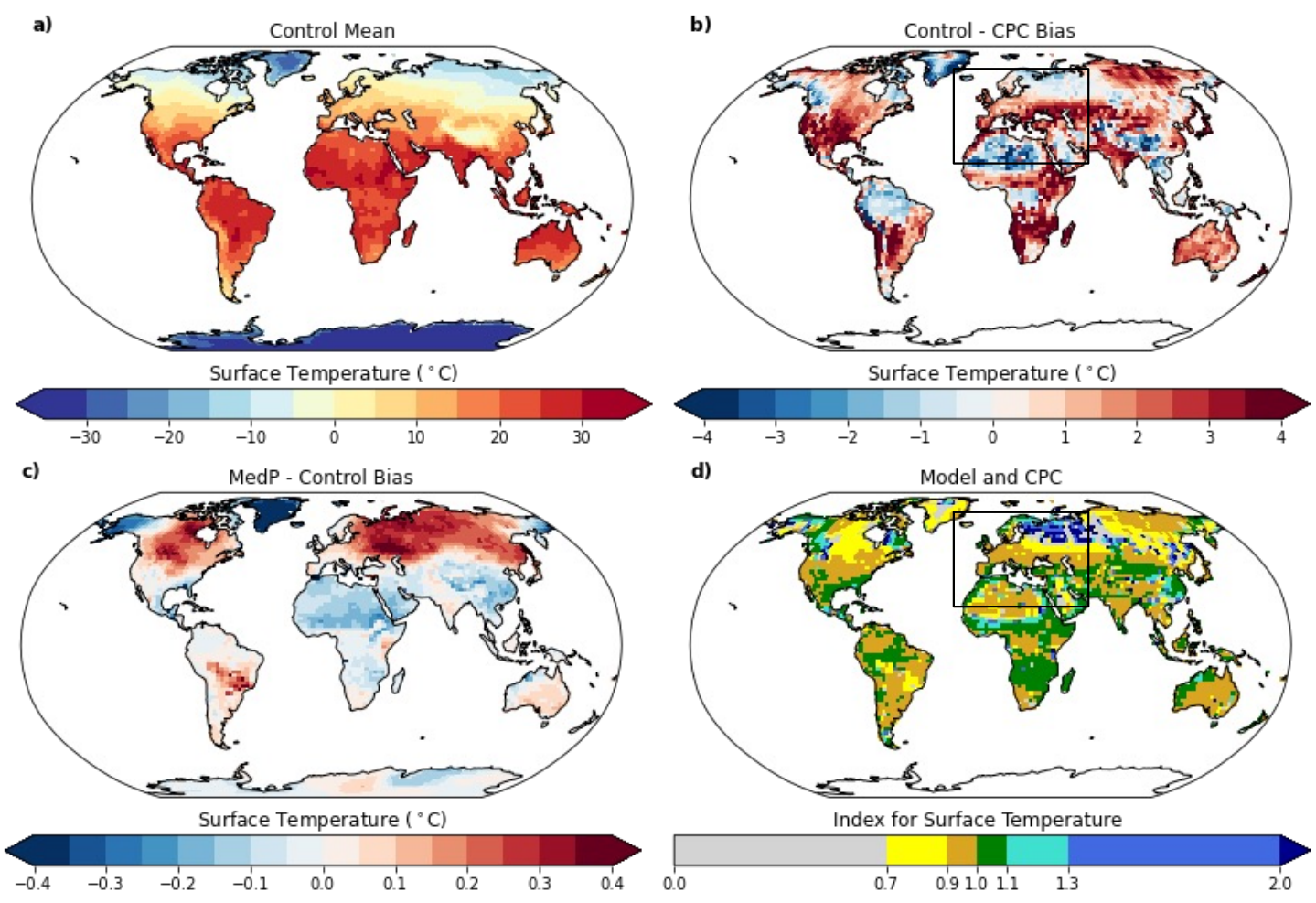


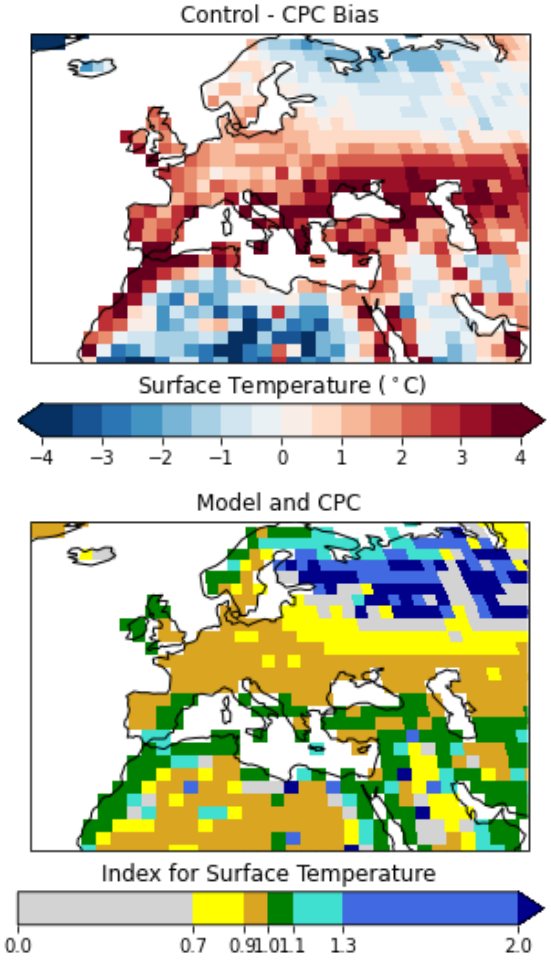
Time series of global mean net longwave radiation (W/m2) (a, and b), net shortwave radiation (W/m2) (c, and d), net flux (W/m2) (e, and f) at the top of the model, TS (°C) (g, and h), PREC (mm/day) (i, and j), and SST (°C) (k, and l) of PI (blue lines), Control (gray lines), MedP ERSST Member 00 (red lines), and MedP OISST Member 00 (green lines).

Experiments

- **PI** : **Pre-Industrial Conditions** **(0 – 200)** 200-yr
- **Control** : **Anthropogenic Conditions** **(1850 – 2014)** 165-yr (7-Members Ensemble for 1980-2014)
- **MedP** : **Control + MedSST Nudging** **(1880 – 2014)** 135-yr (7-Members Ensemble for 1980-2014)

Surface Temperature (1981 – 2010)

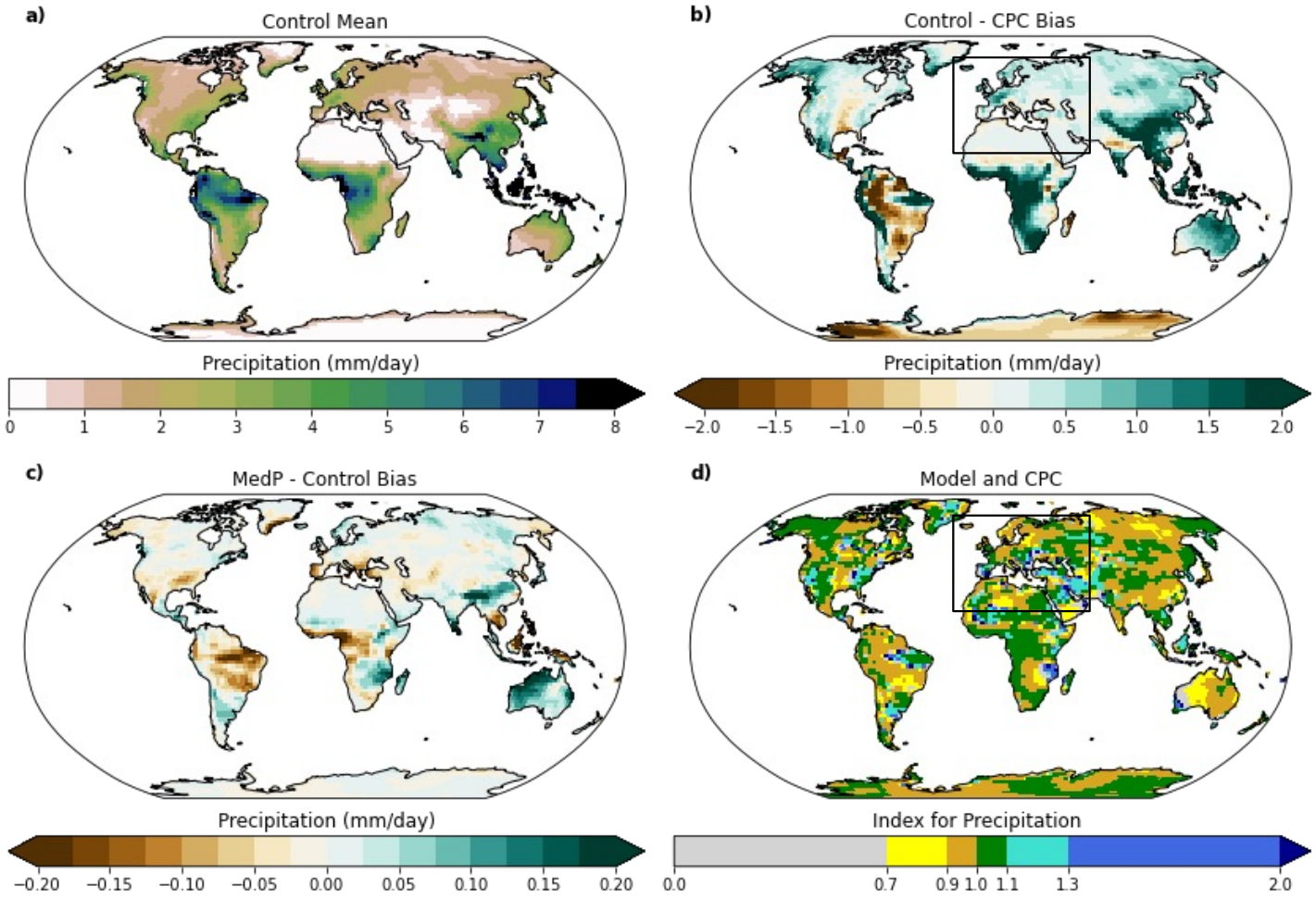




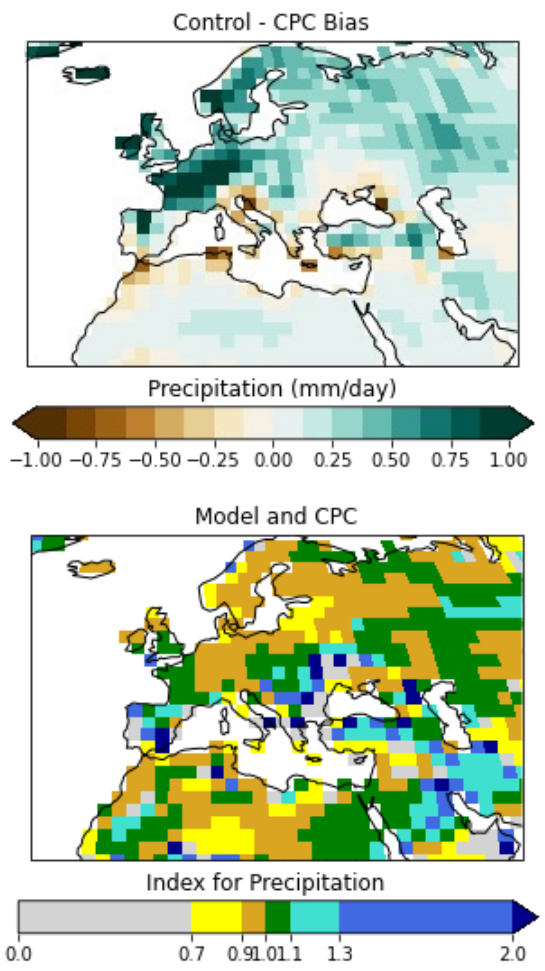
Global **Mediterranean**

Precipitation (1981 – 2010)

- Introduction
  - Motivation
  - Purpose
  - Scope
- Methodology
  - Pre - Process
  - Live - Process
  - Post - Process
- Experiments
- Results
  - Surface Layer
    - Temperature
    - Precipitation
  - Upper Layer
    - 850mb Temperature
    - 500mb Geopotential Height
    - 200mb Zonal Wind
- Conclusion and Discussion



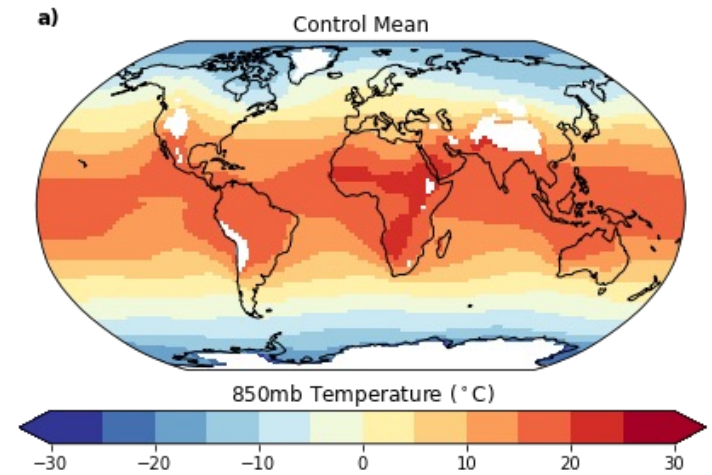
Global

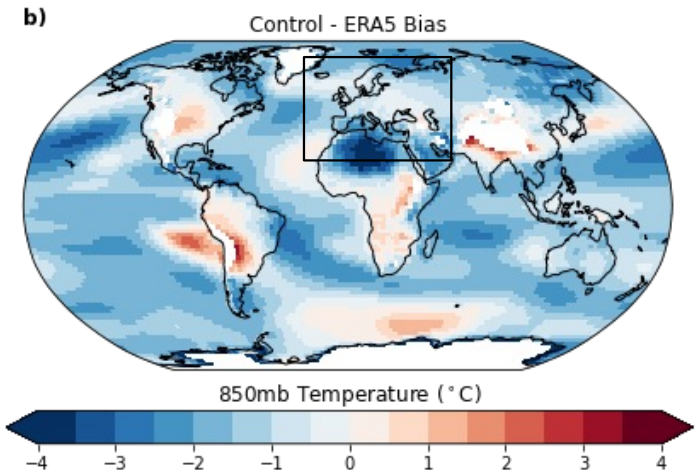


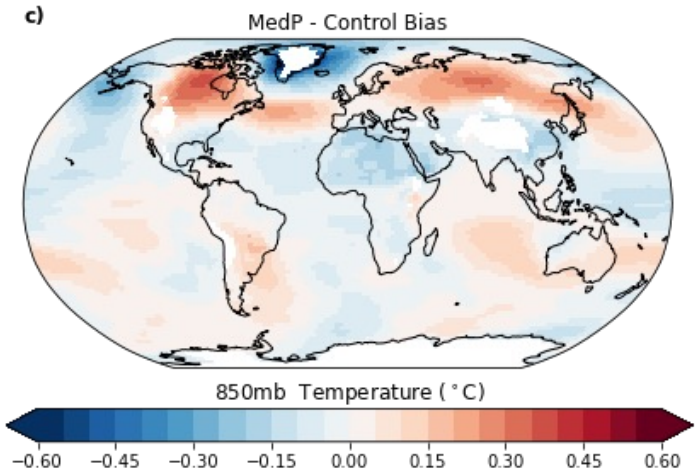
Mediterranean

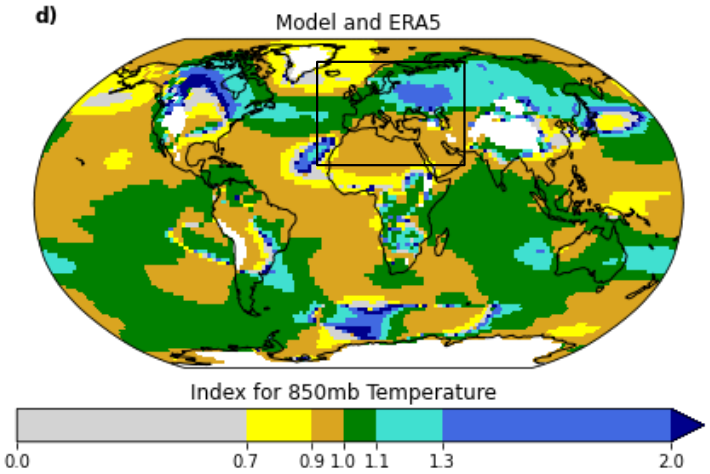
850mb Temperature (1981 – 2010)

- Introduction
  - Motivation
  - Purpose
  - Scope
- Methodology
  - Pre - Process
  - Live - Process
  - Post - Process
- Experiments
- Results
  - Surface Layer
    - Temperature
    - Precipitation
  - Upper Layer
    - 850mb Temperature
    - 500mb Geopotential Height
    - 200mb Zonal Wind
- Conclusion and Discussion

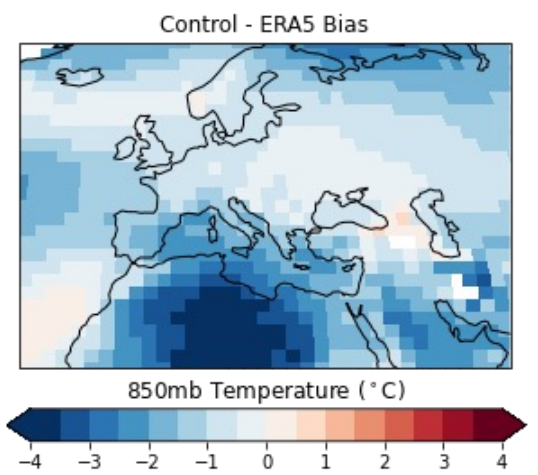


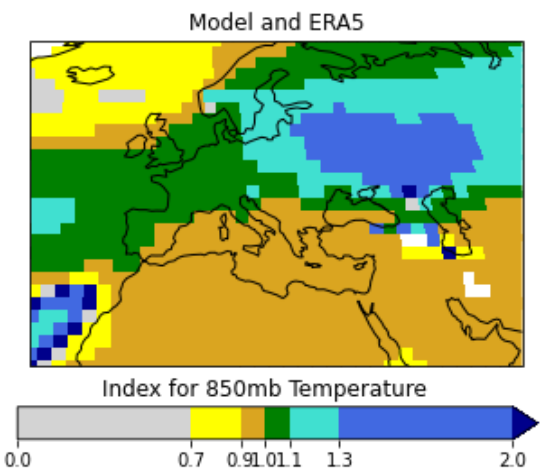






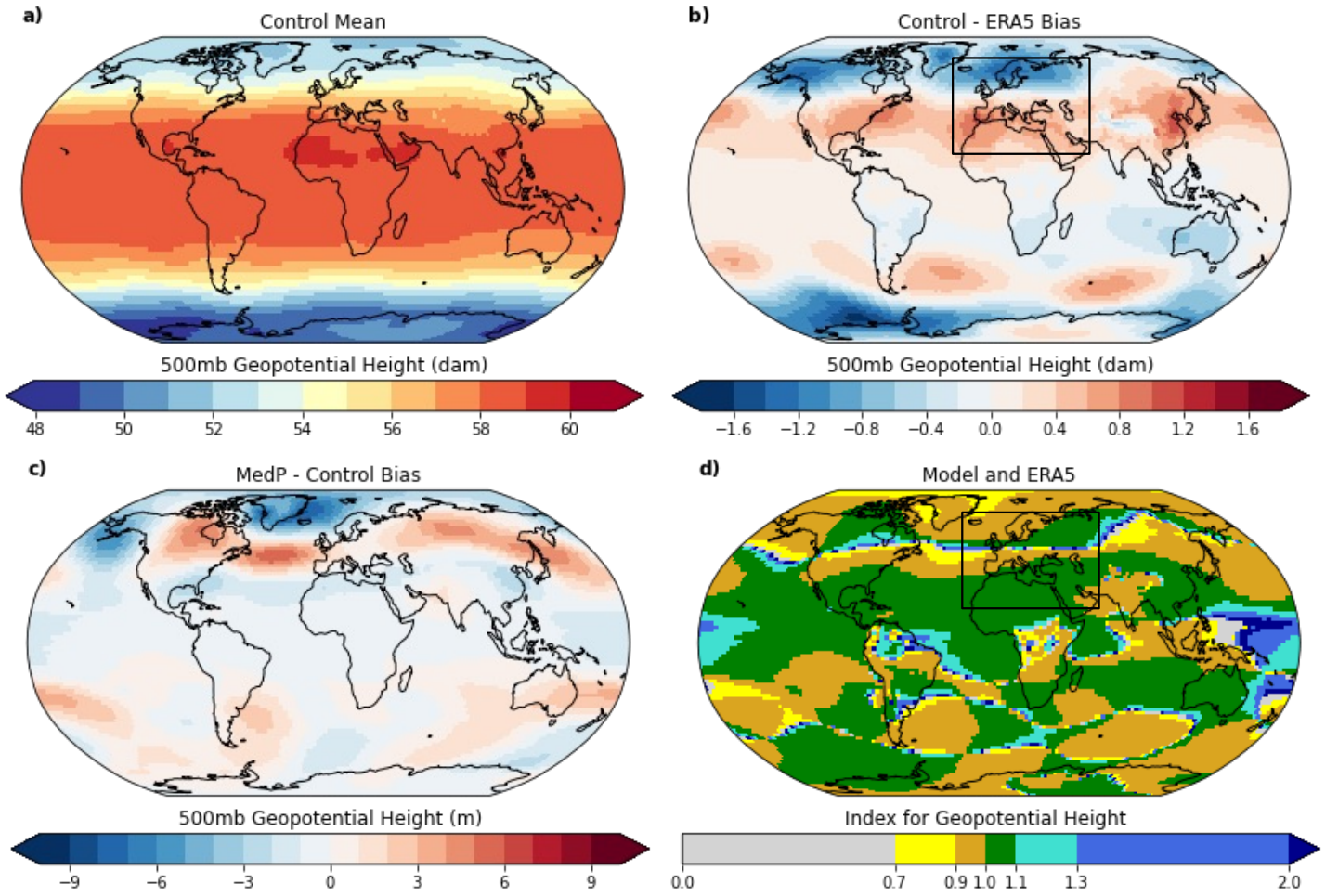
Global

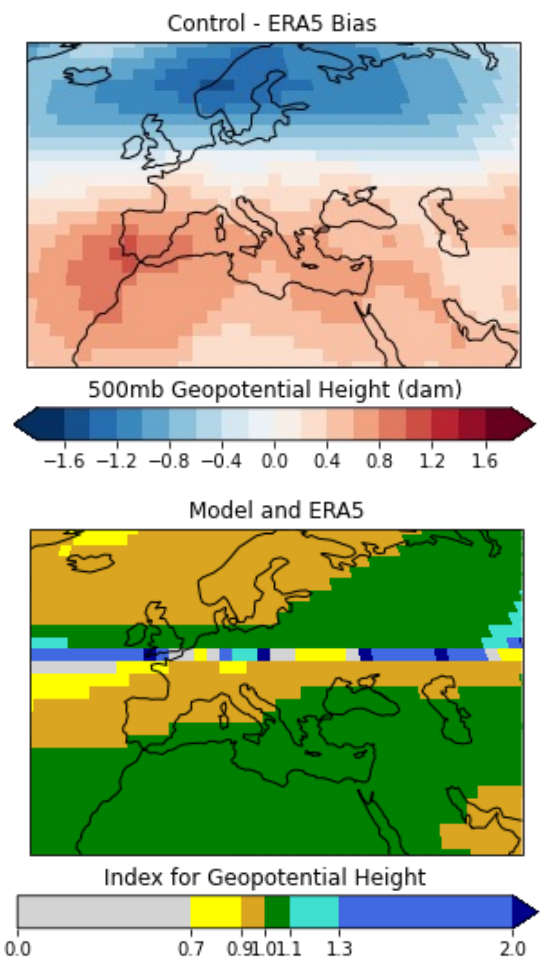




Mediterranean

500mb Geopotantial Height (1981 – 2010)

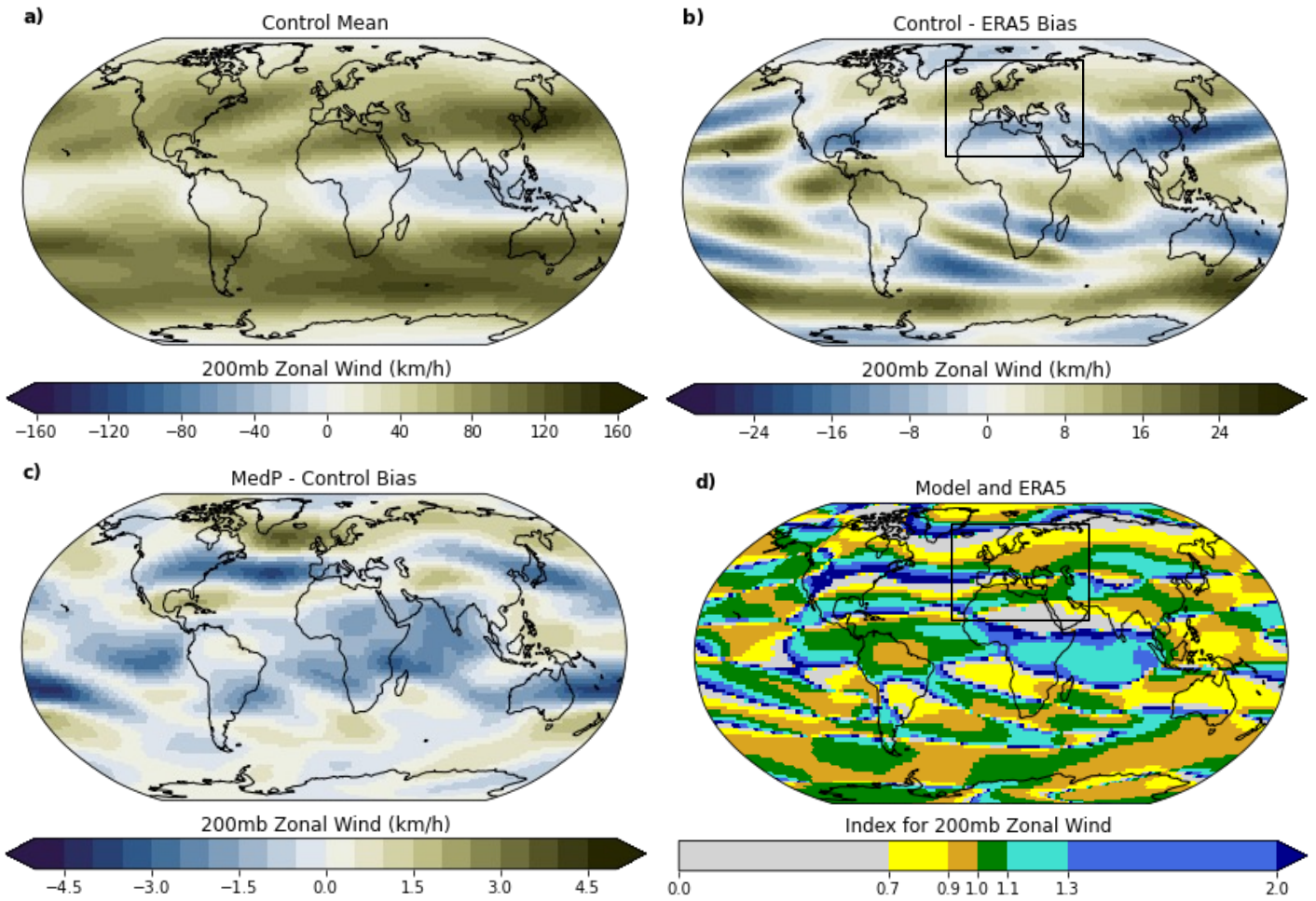


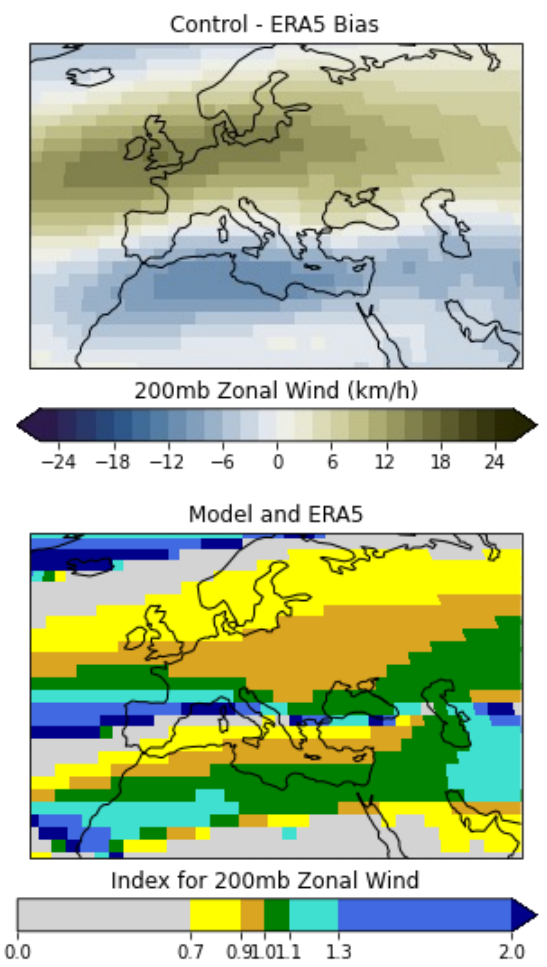


Global

Mediterranean

200mb Zonal Wind (1981 – 2010)





Global

Mediterranean

Conclusion

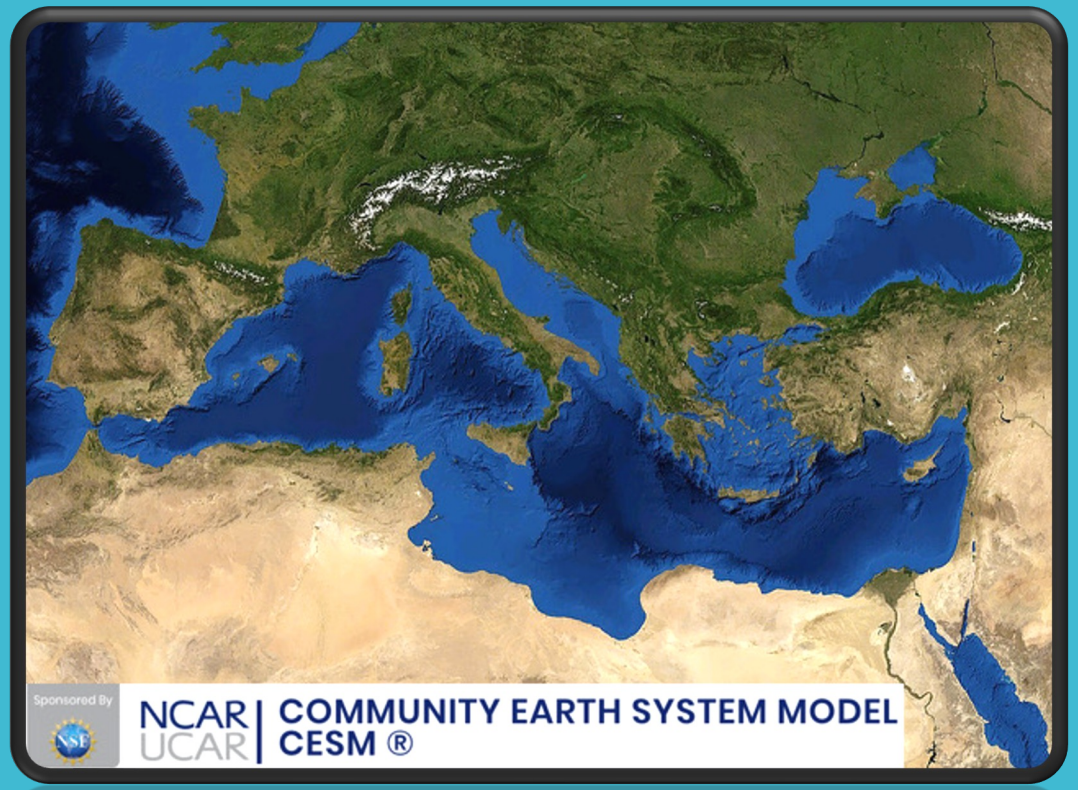
- Med Pacemaker has some improvements but also poor representation over some regions compared with Control and observation or Re-Analysis.
- In general, the pattern of biases and improvements (or disruptions) looks latitudinal.
- MedP has some improvements for Temperature over the northern part of the basin and Turkey, and for Precipitation over some parts of Europe and Turkey.

Discussion

- Statistical analysis
- Teleconnection patterns
- Ensemble members
- Nudging frequency
- Spatial resolution
- CESM with MOM Ocean Component

EGU General Assembly 2022

The Impacts of SST-Nudging on Performance of Community Earth System Model (CESM) in Representing the Euro-Mediterranean Climate



Thu, 26 May
09:27–09:33

Session CL4.3
Room 0.14

EGU22-12502
ECS
Virtual presentation

THANK YOU FOR YOUR TIME

Special contributions
Isla Simpson *NCAR*
Adam Phillips *NCAR*
Frederic Castruccio *NCAR*

Emir TOKER *ITU* *tokerem@itu.edu.tr*

Mehmet ILICAK *ITU*

Gökhan DANABAŞOĞLU *NCAR*

Ömer Lütfi ŞEN *ITU*

ITU GRADUATE SCHOOL

ITU/EIES