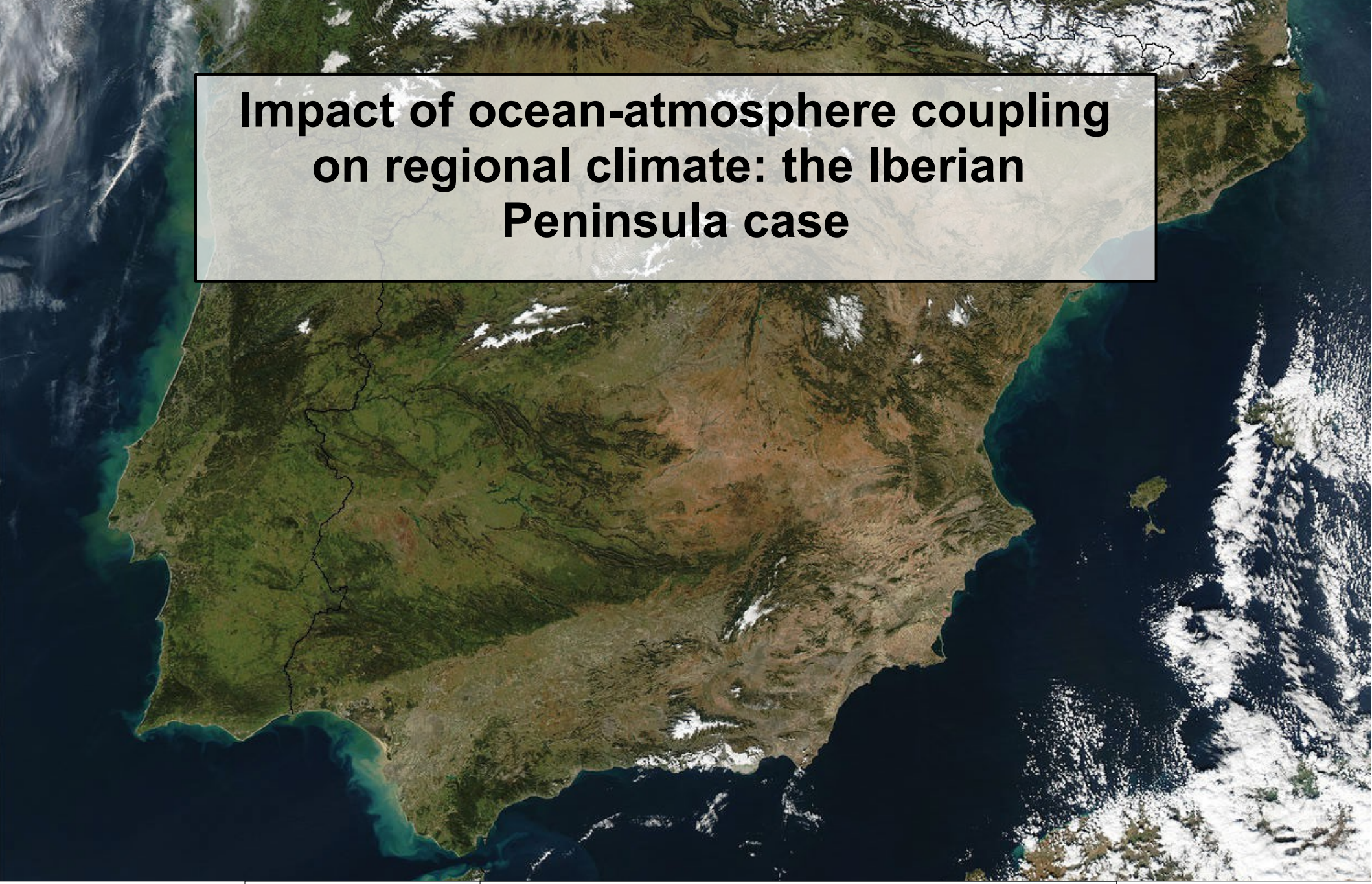
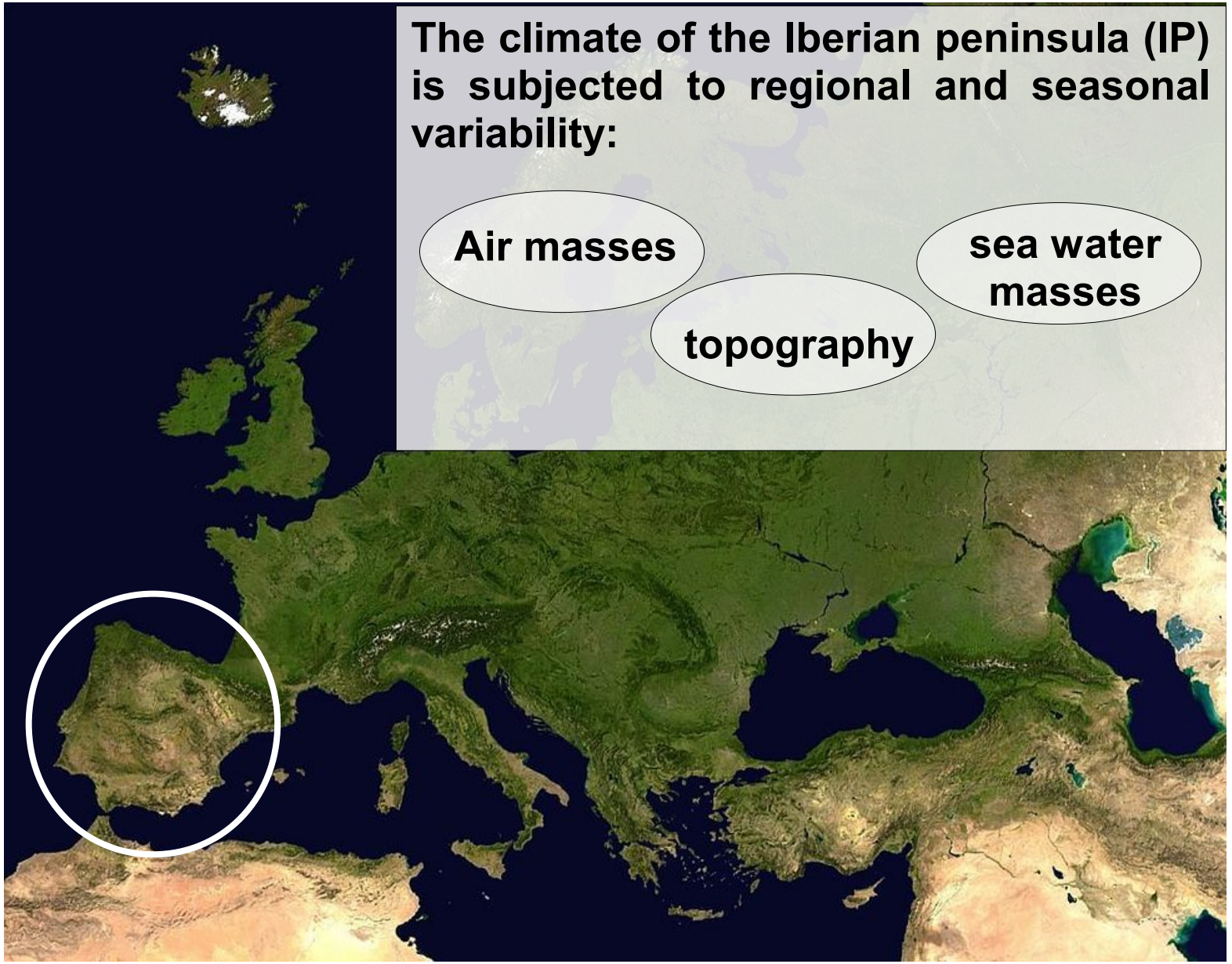
Impact of ocean-atmosphere coupling on regional climate: the Iberian Peninsula case



William Cabos, Dmitry Sein,

Alba de la Vara, Francisco Álvarez

1. Introduction



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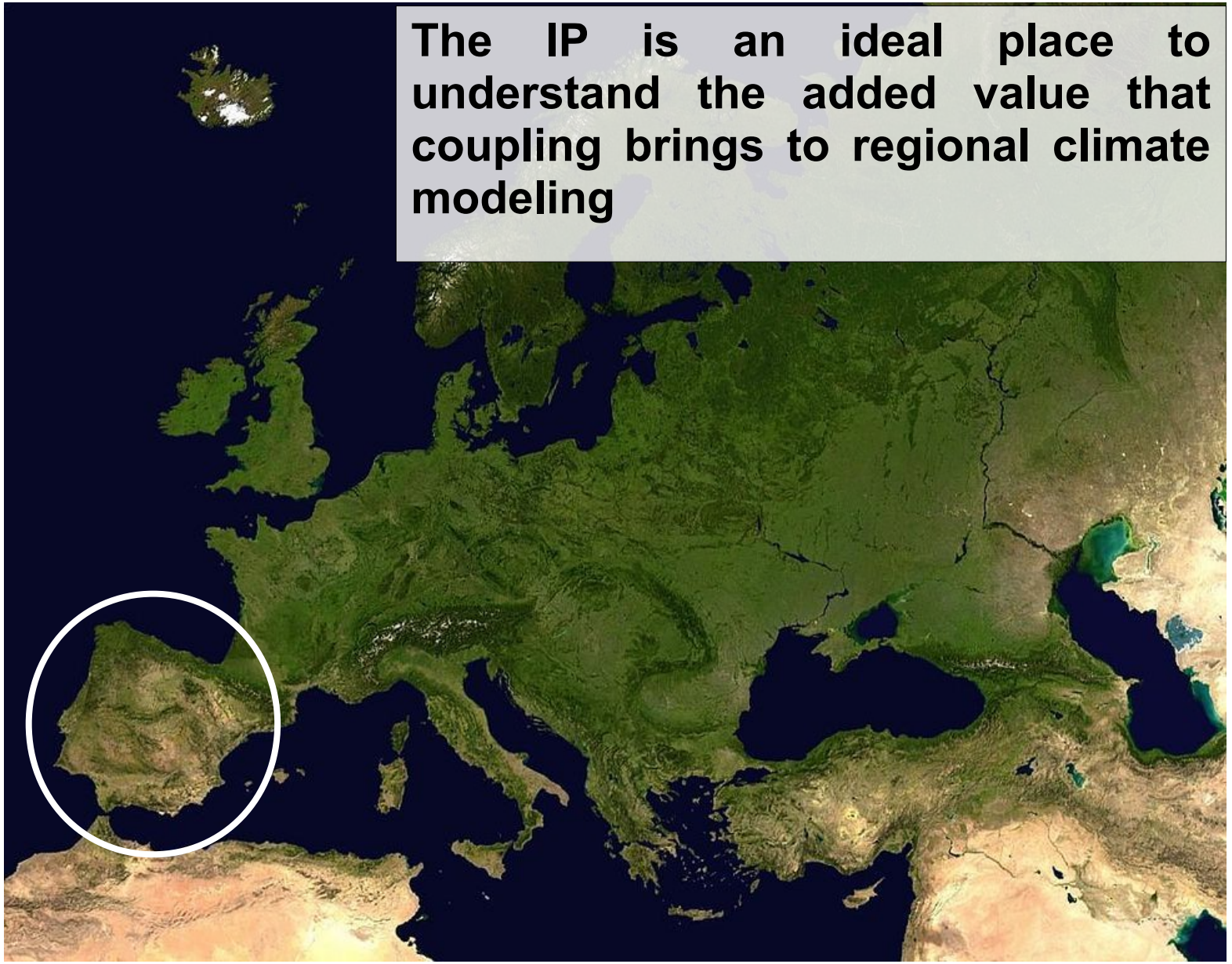


1. Introduction

To investigate the effect of air-sea coupling on the present-day climate of the IP

We use the **regionally-coupled model ROM** and its atmospheric component, the **regional atmospheric model REMO** forced by the ERA-Interim

Two companion simulations 1980-2012

1. Introduction

ROM

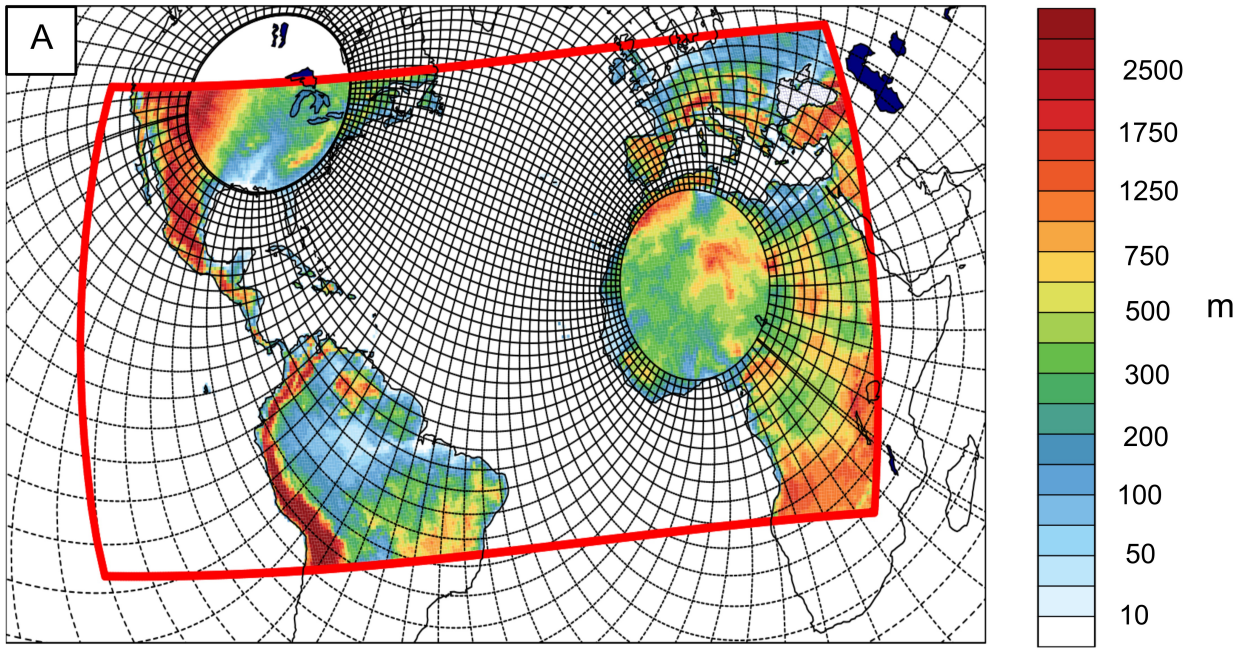
MPIOM, with a horizontal resolution of 10 km near the IP and a minimum of 100 km in the southern seas.

REMO, with a horizontal resolution of 0.25º. REMO domain allows us to take into account explicitly the North Atlantic and the Mediterranean Sea.

Both are coupled in area covered by the atmospheric domain.
Elsewhere, ERA-Interim fields are prescribed.

- **REMO stand-alone**

  The atmospheric domain remains, while boundary conditions come from ERA-Interim.



1. Introduction

Regional models used to downscale the European climate usually include a small area of the Atlantic Ocean and are uncoupled, with the SST used as boundary conditions coarser than the mesh of the regional atmospheric model.

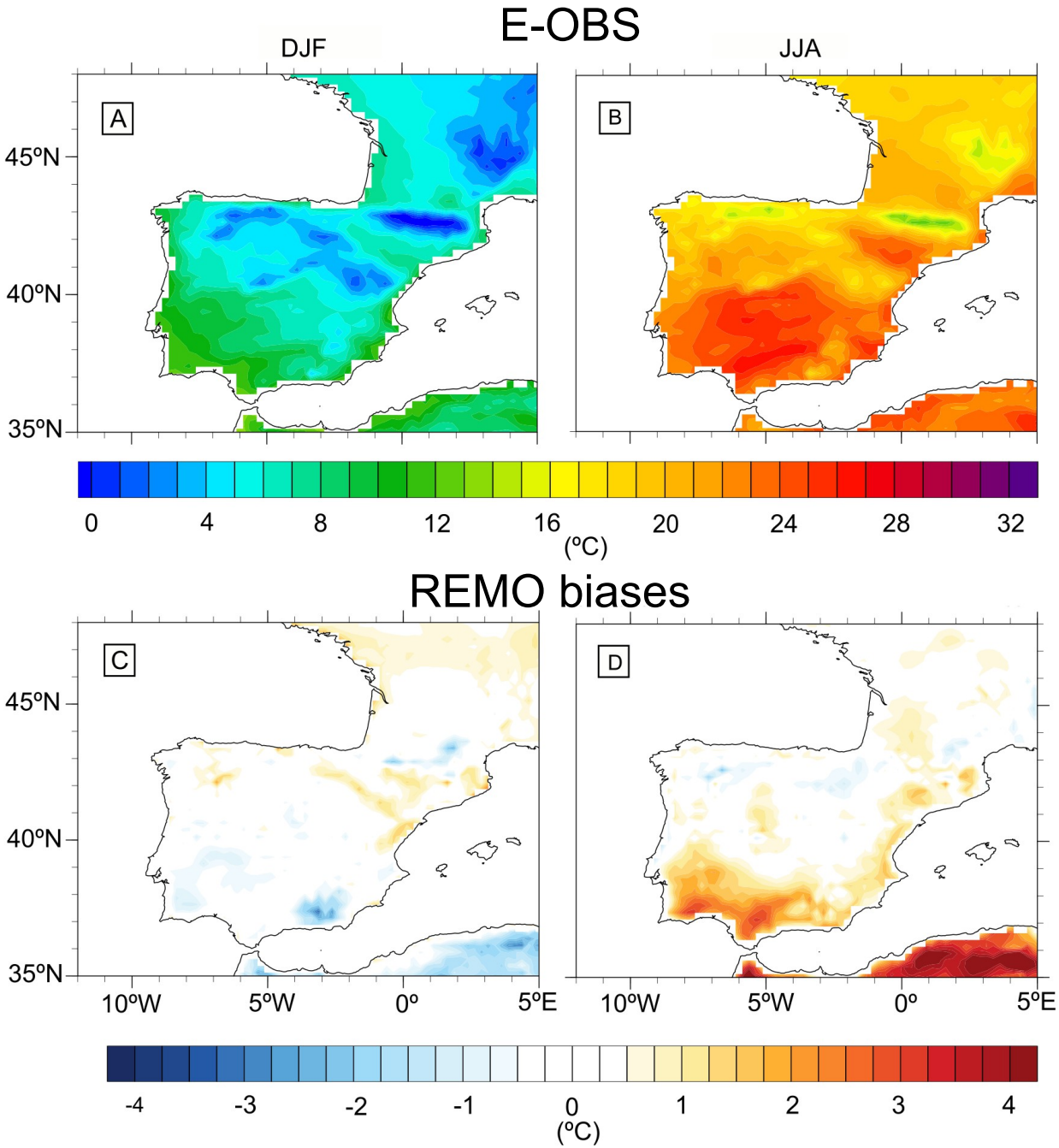
Our experiments allow us to explore: (i) the **Atlantic mesoscale circulation** and (ii) **the ocean-atmospheric coupling in the Atlantic Ocean and the Mediterranean Sea.**

2. Results: T2M

- E-OBS T2M is influenced by topography.

- In **DJF** REMO biases are modest and mostly negative.

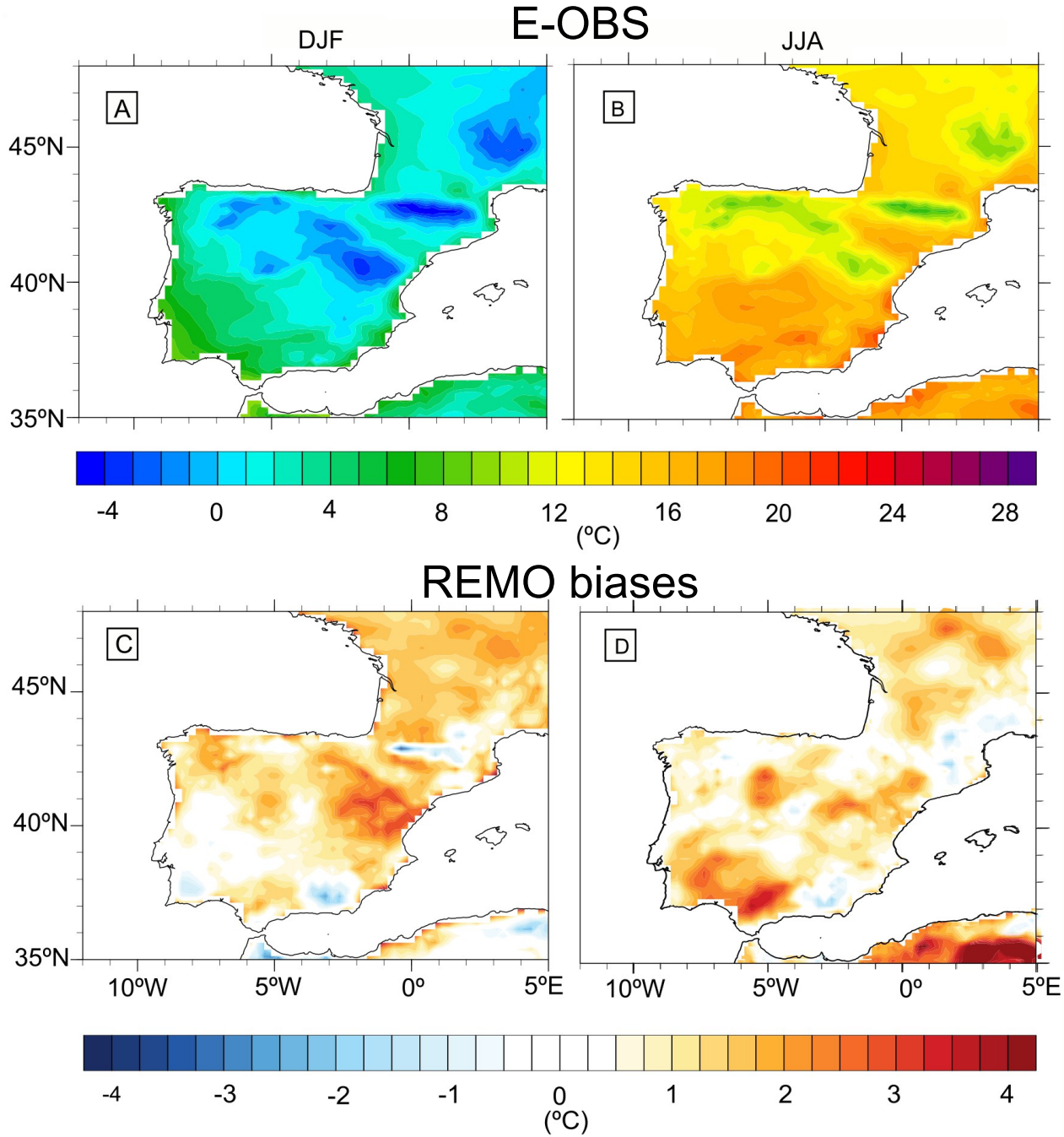
- In **JJA** REMO biases are positive and greater than in winter. These are largest in the near-shore area.



2. Results: TMIN

- E-OBS reproduces the topographic effect on TMIN.

- In **both seasons** TMIN is overestimated by REMO, especially in the major river basins.

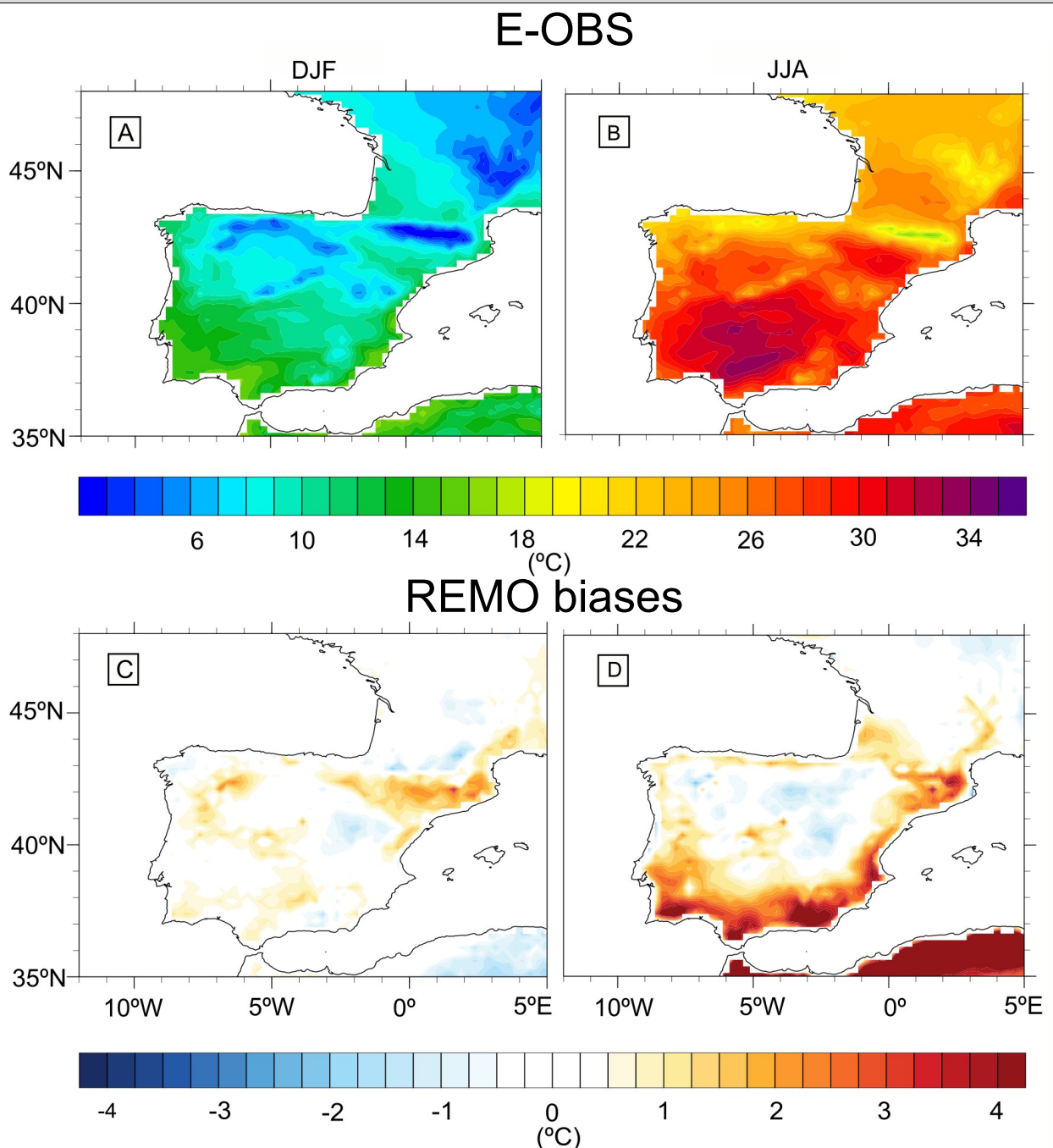


2. Results: TMAX

- TMAX from E-OBS attains the minimum values in elevated regions.

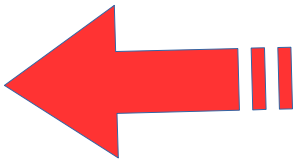
- In **DJF** REMO biases are namely positive along the major river depressions.

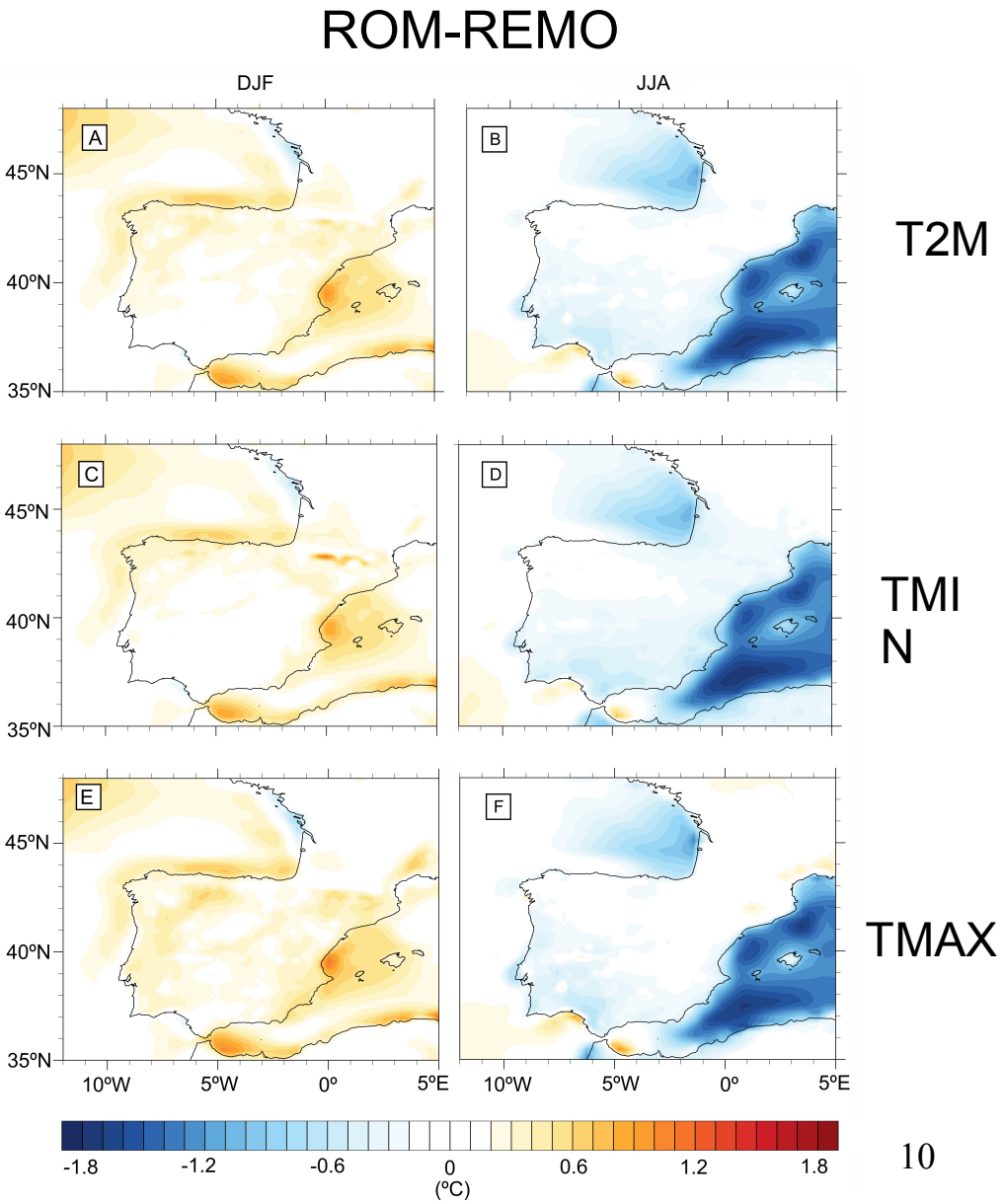
- In **JJA** REMO exhibits positive biases in the near-shore area (S-SE).



2. Results: T change due to coupling

Coupling induces a T rise in DJF





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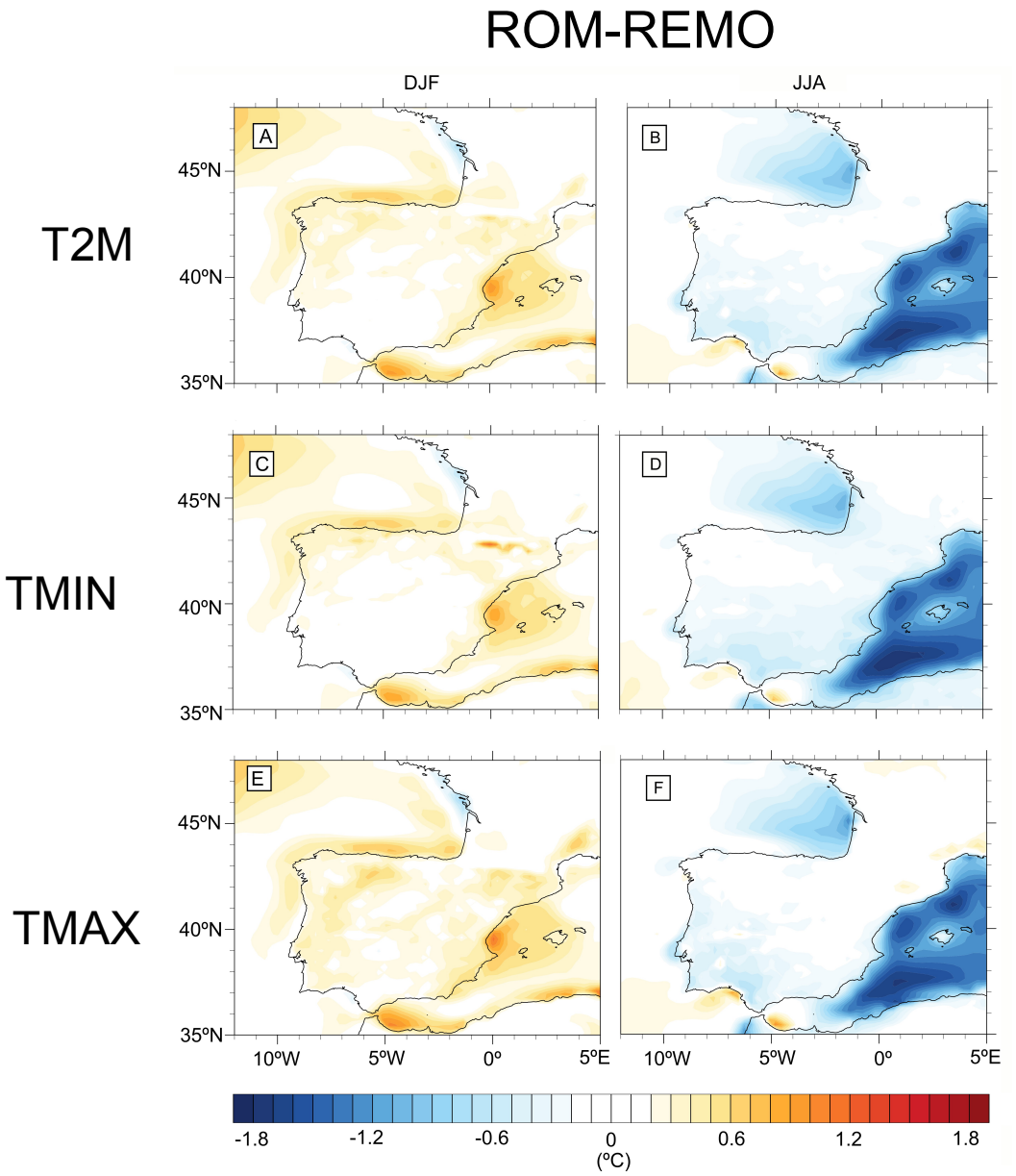


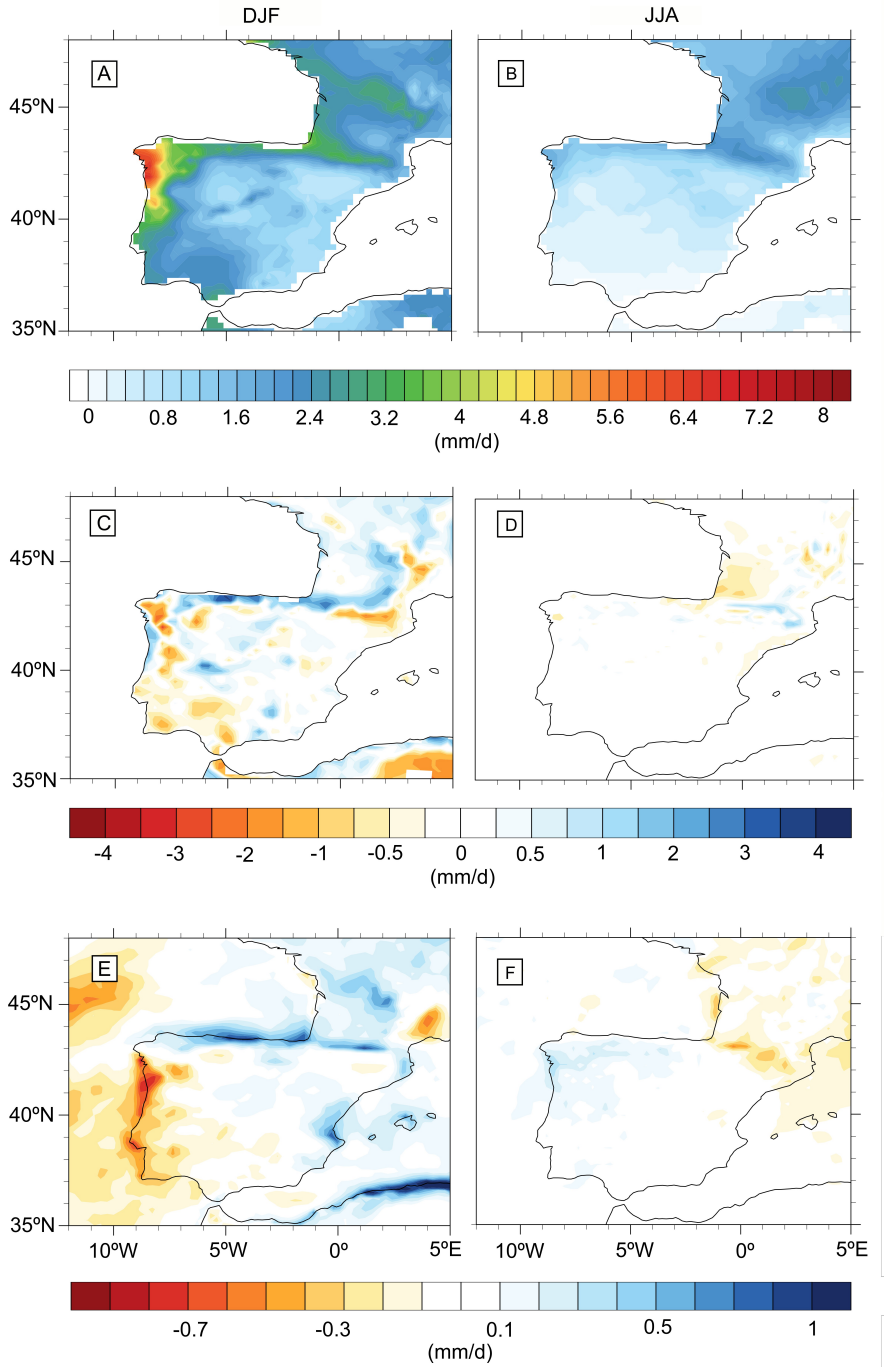
Coupling drives a T drop in JJA which reduces warm biases

2. Results: Precipitation

- E-OBS reproduces a marked NW-SE gradient in DJF.

- In **DJF** REMO presents wet biases in elevated regions and dry biases in low areas.
- In **JJA** biases are small.

- In **DJF** ROM increases precipitation in the N, NE of the IP and decreases to the W.
- In **JJA**, air-sea coupling reduces (increases) precipitation to the NE (NW).



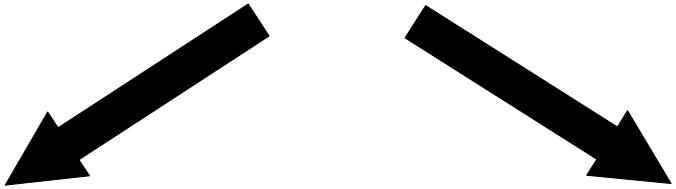
E-OBS

REMO

ROM - REMO

3. Discussion

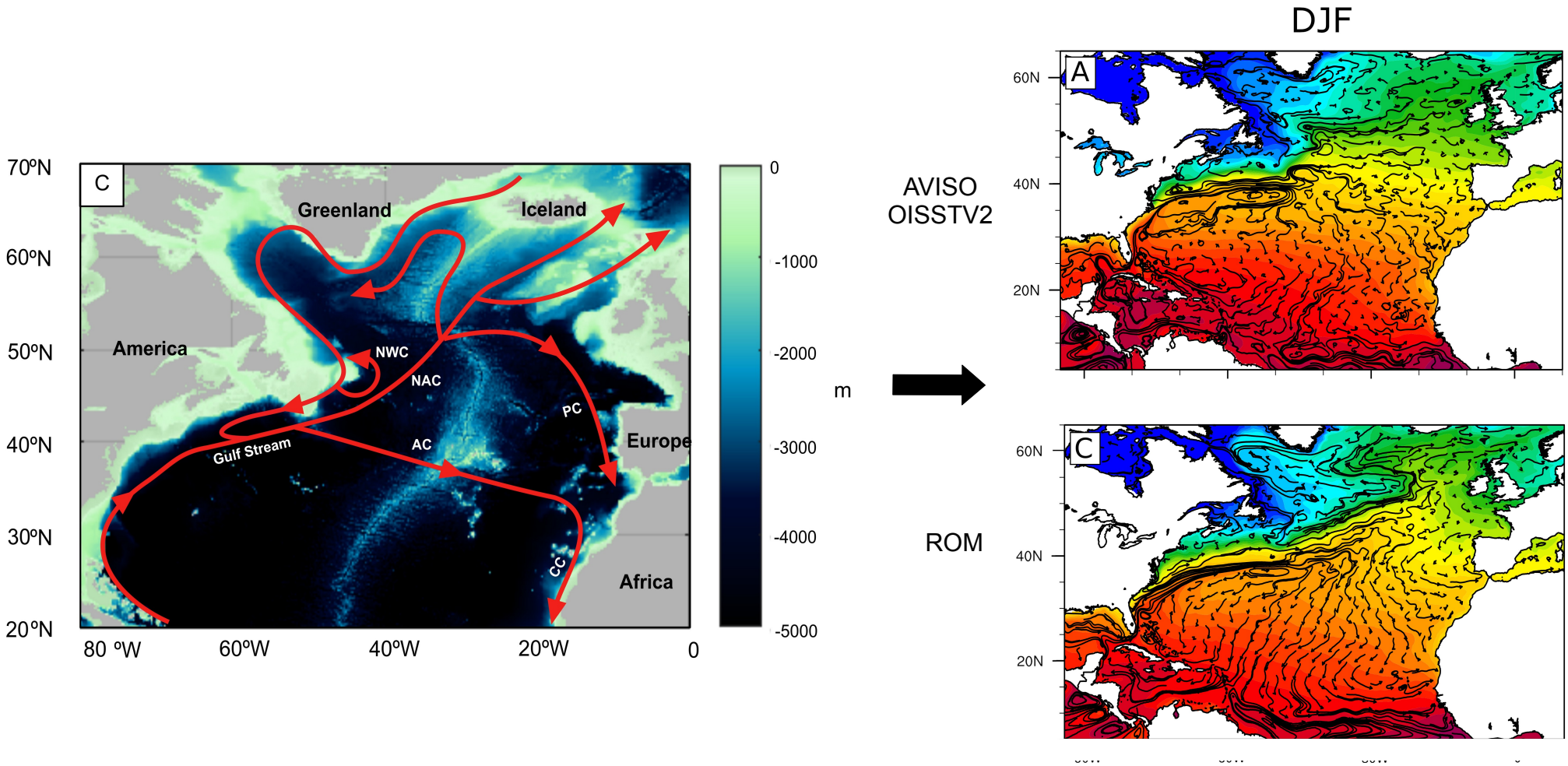
What drives the observed seasonal T and precipitation changes due to coupling?



Winter T and precipitation over the IP are more influenced by large-scale processes → North Atlantic

Summer T and precipitation within the IP are largely set by local-scale processes → areas surrounding the IP

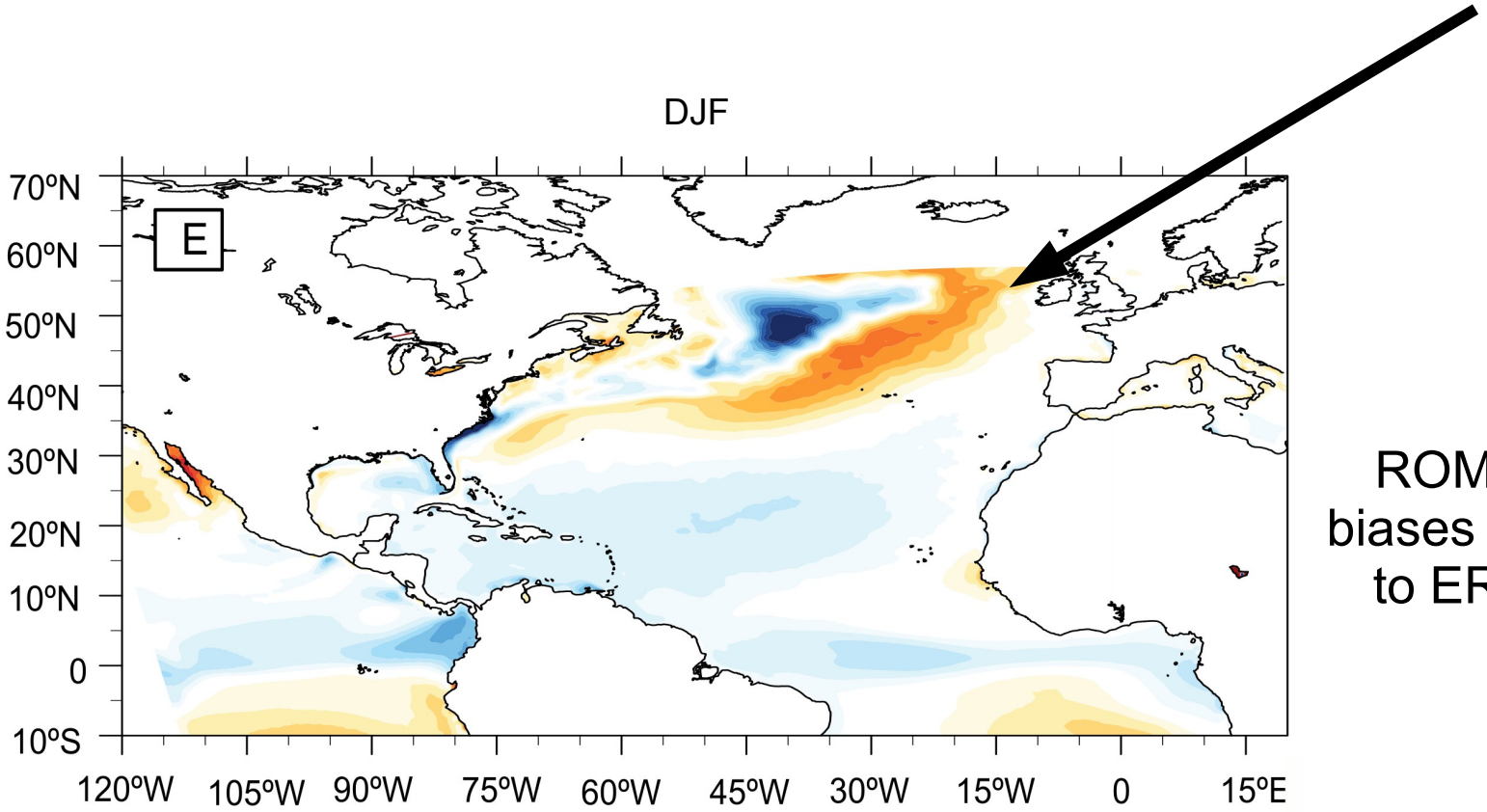
3. Discussion: Temperature changes in response to air-sea coupling in DJF



In ROM, the **Gulf Stream** is wider and separates off the North American coast at lower latitudes than in AVISO → This induces a SE displacement of the currents.

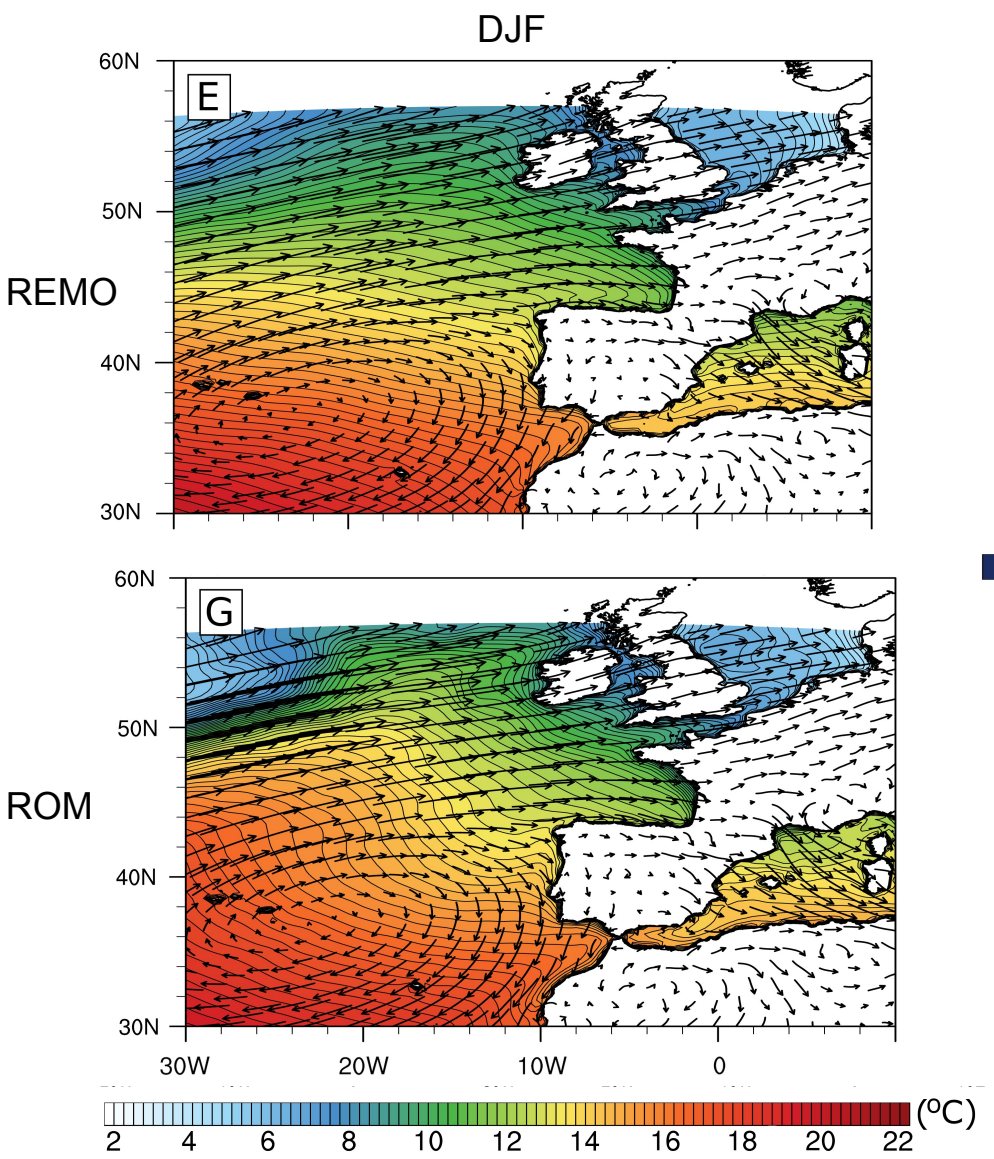
3. Discussion: Temperature changes in response to air-sea coupling in DJF

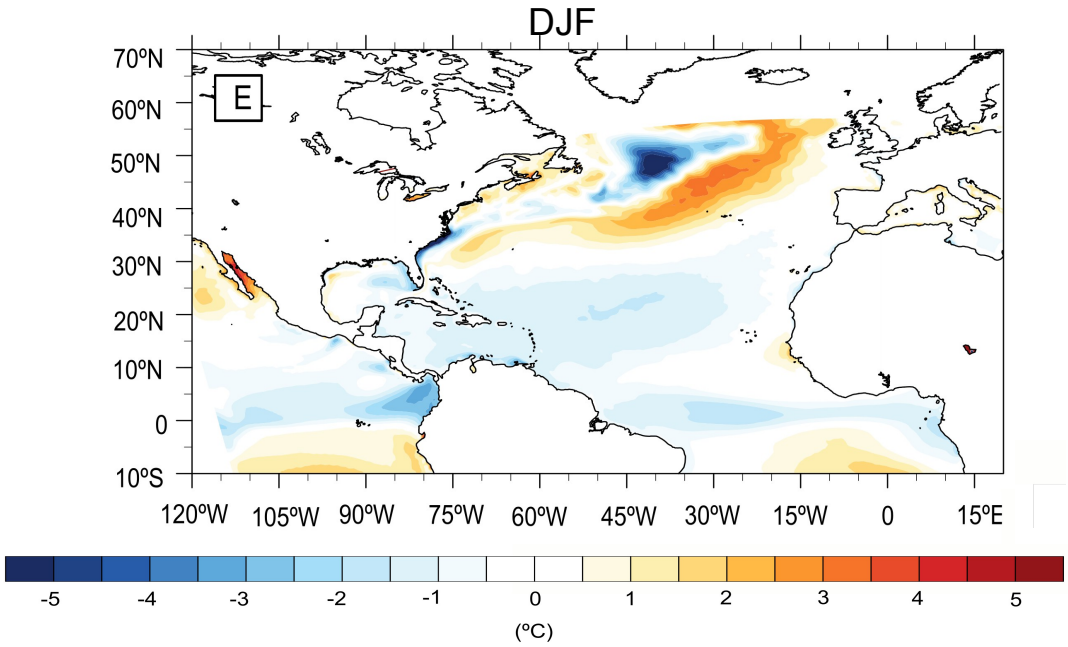
Warm SST biases arise along the path of the simulated currents, whereas cold biases appear along the expected position of these currents



ROM SST biases relative to ERA-Int

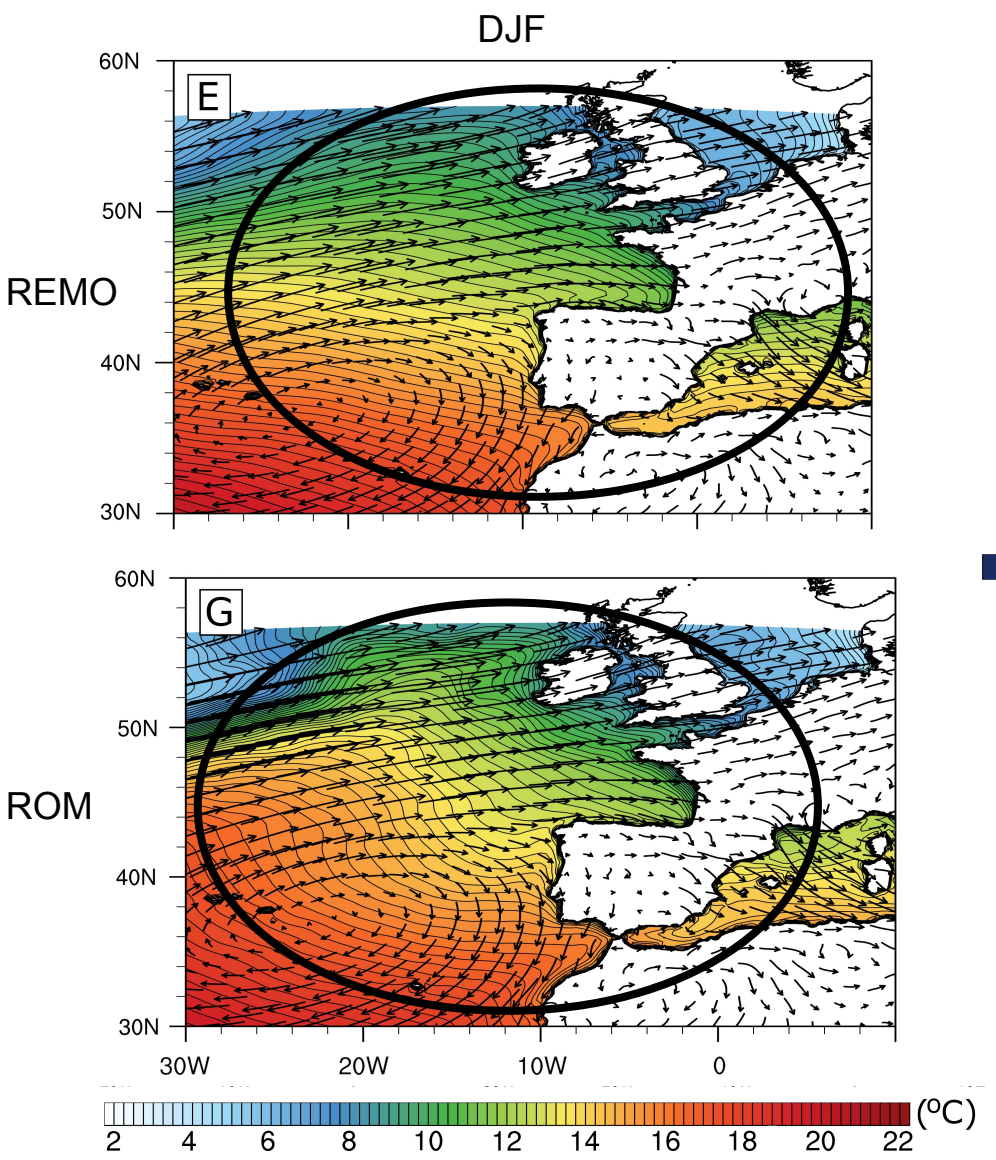
3. Discussion: Temperature changes in response to air-sea coupling in DJF

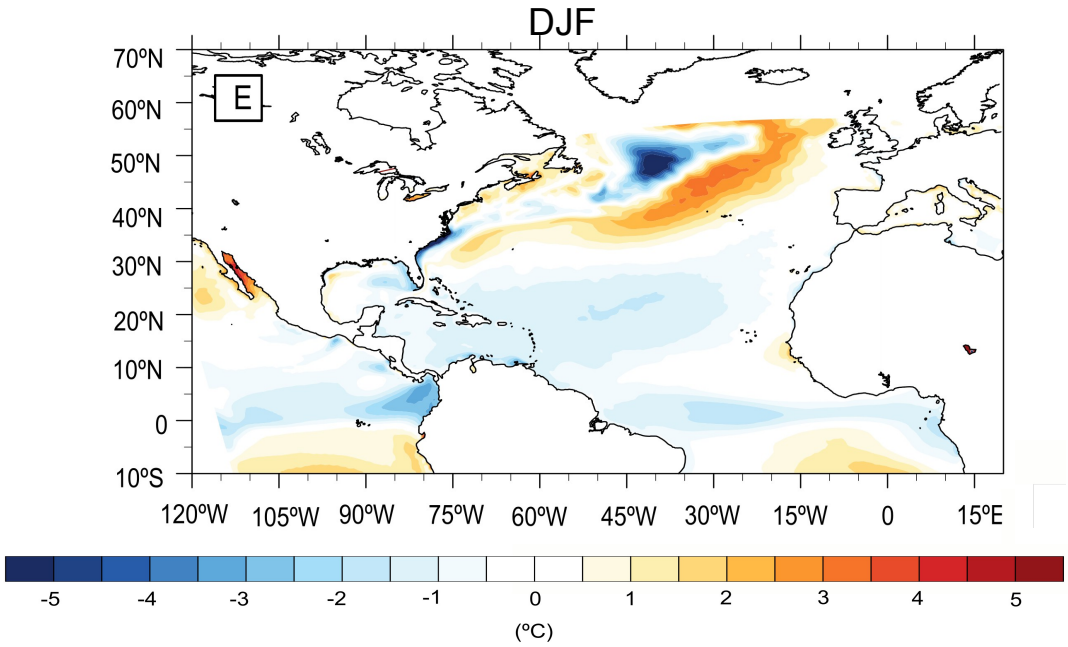




- The SST has an impact on the T2M through an anomalous latent heat flux.
- In ROM, air warmer than observations due to overheating of the SST is transported towards the NW of the IP through the North Atlantic anticyclonic cell.

3. Discussion: Temperature changes in response to air-sea coupling in DJF





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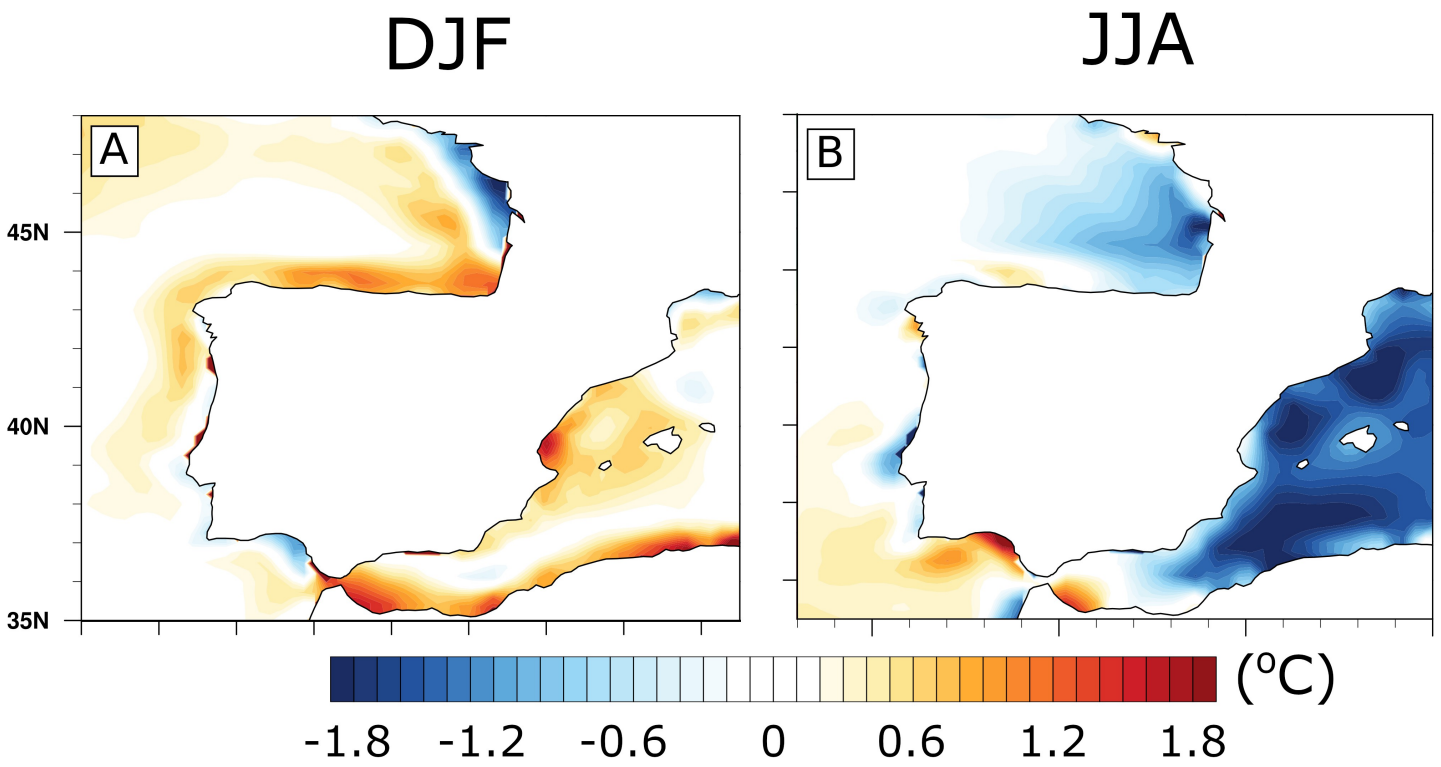
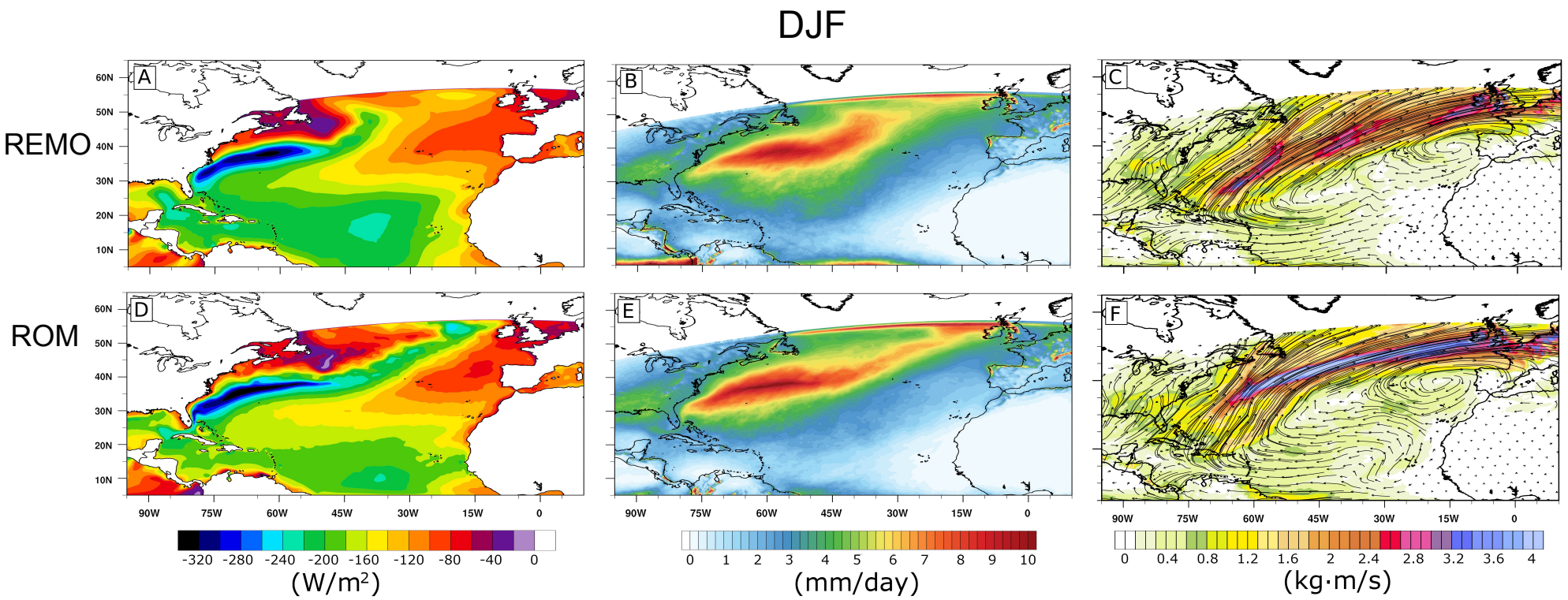
3. Discussion: Temperature changes in response to air-sea coupling in JJA



SST ROM-ERA-Int.

On a local scale, in JJA, coupling reduces the SST in the W Mediterranean and drives a decrease of the SST via coastal upwelling along the southern coast of Portugal → The lowered SST cools T2M

3. Discussion: Precipitation changes in response to air-sea coupling in DJF



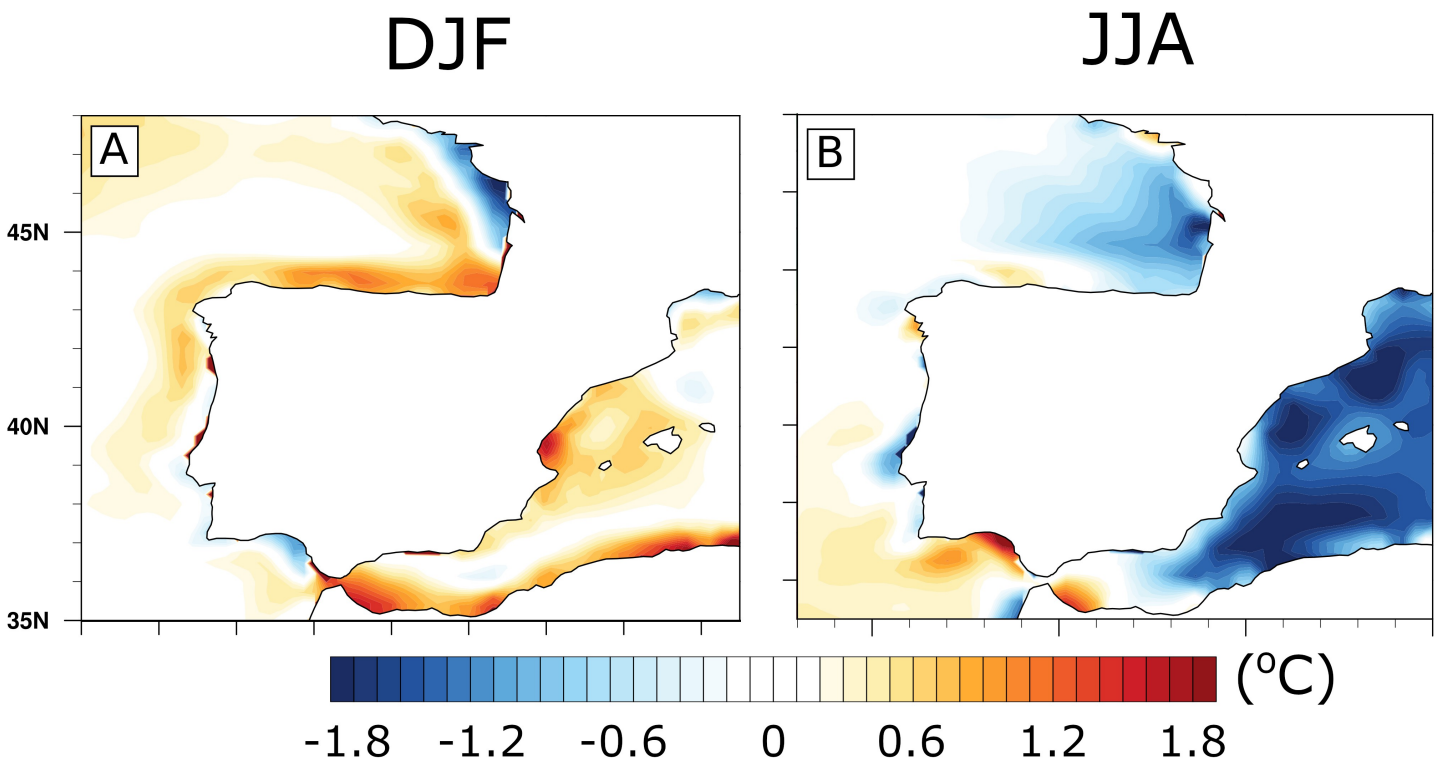
The latent heat flux has a great magnitude to the E flank of these currents.

Enhanced vapour content increases precipitation.

Air enriched in moisture is advected to the W of the IP increasing the horizontal transport of cloud water.

The SE shift of the North Atlantic Current drives on-route warm biases which displace the band of enhanced latent heat losses to the SE. The excessive evaporation over the North Atlantic in ROM increases the horizontal cloud water transport over the N and NW of the IP.

3. Discussion: Precipitation changes in response to air-sea coupling in JJA



SST ROM-ERA-Int.

On a local scale, in JJA, coupling reduces the SST in the W Mediterranean. This reduces moisture content → This lowers precipitation to the E of the IP

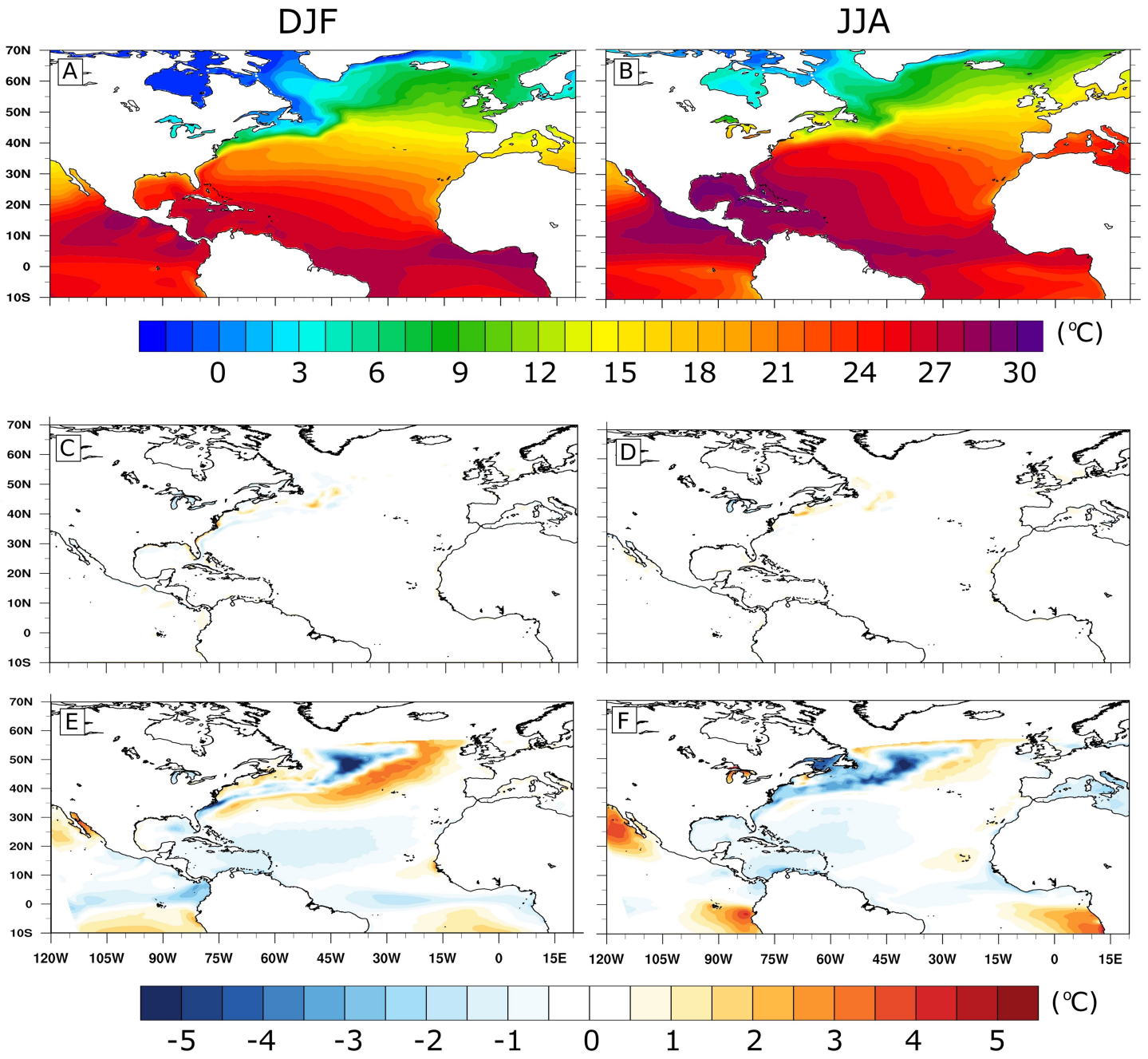
4. Conclusions

- The simulated Iberian climate is influenced by the ocean-atmosphere interactions in the North Atlantic, especially in winter. The simulated path of the Gulf Stream and the North Atlantic Current influence both remotely and locally 2-m air temperature and precipitation.

- In summer, the influence of the Atlantic large-scale circulation is reduced and local processes become dominant. Air-sea coupling near the Iberian coasts and the Western Mediterranean plays a significant role in the reduction of biases.

- Despite the eddy-permitting oceanic resolution in our simulations, the path of the Gulf Stream and North Atlantic Current are not optimally captured.

Thank you for your attention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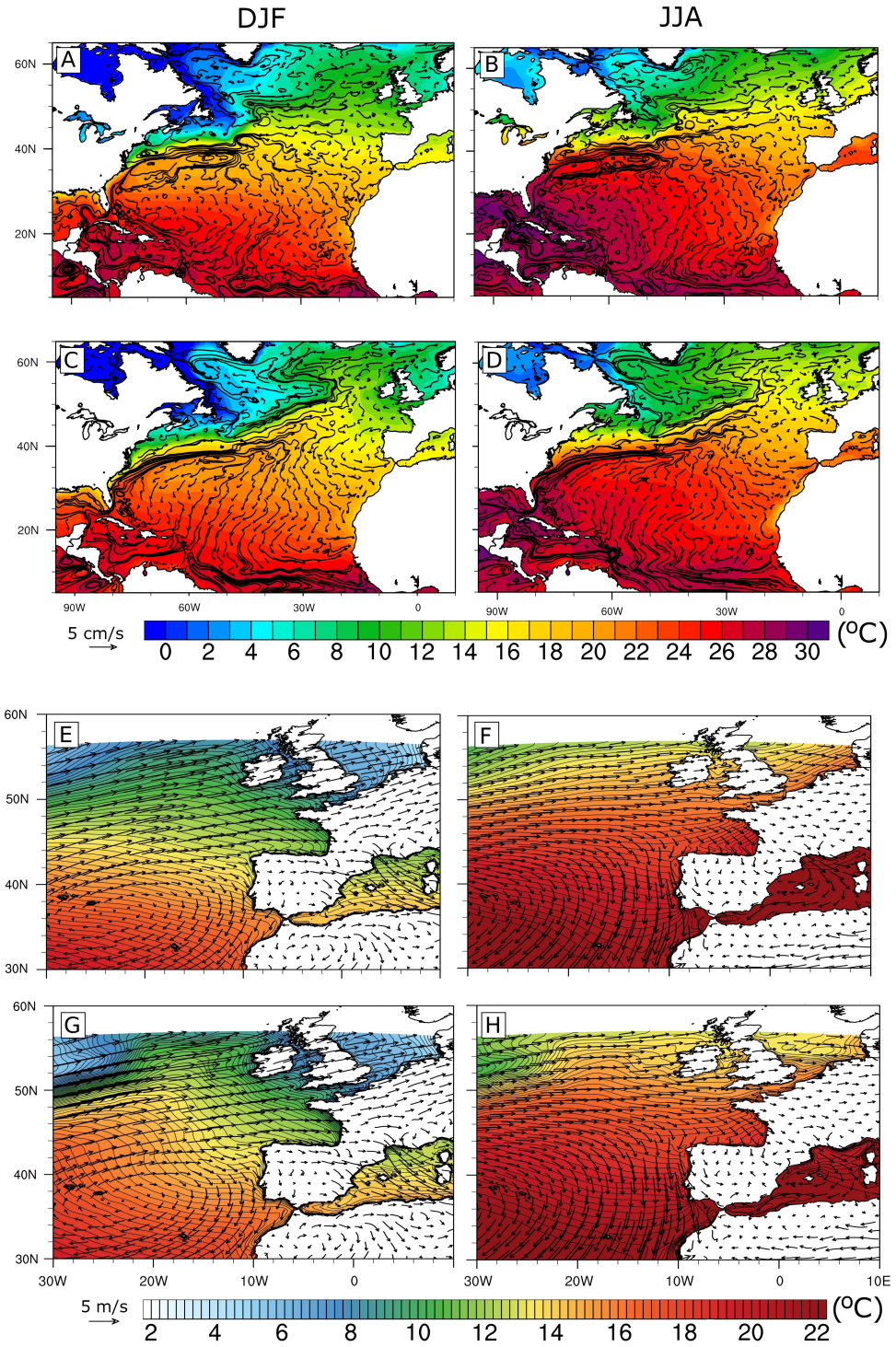
(°C)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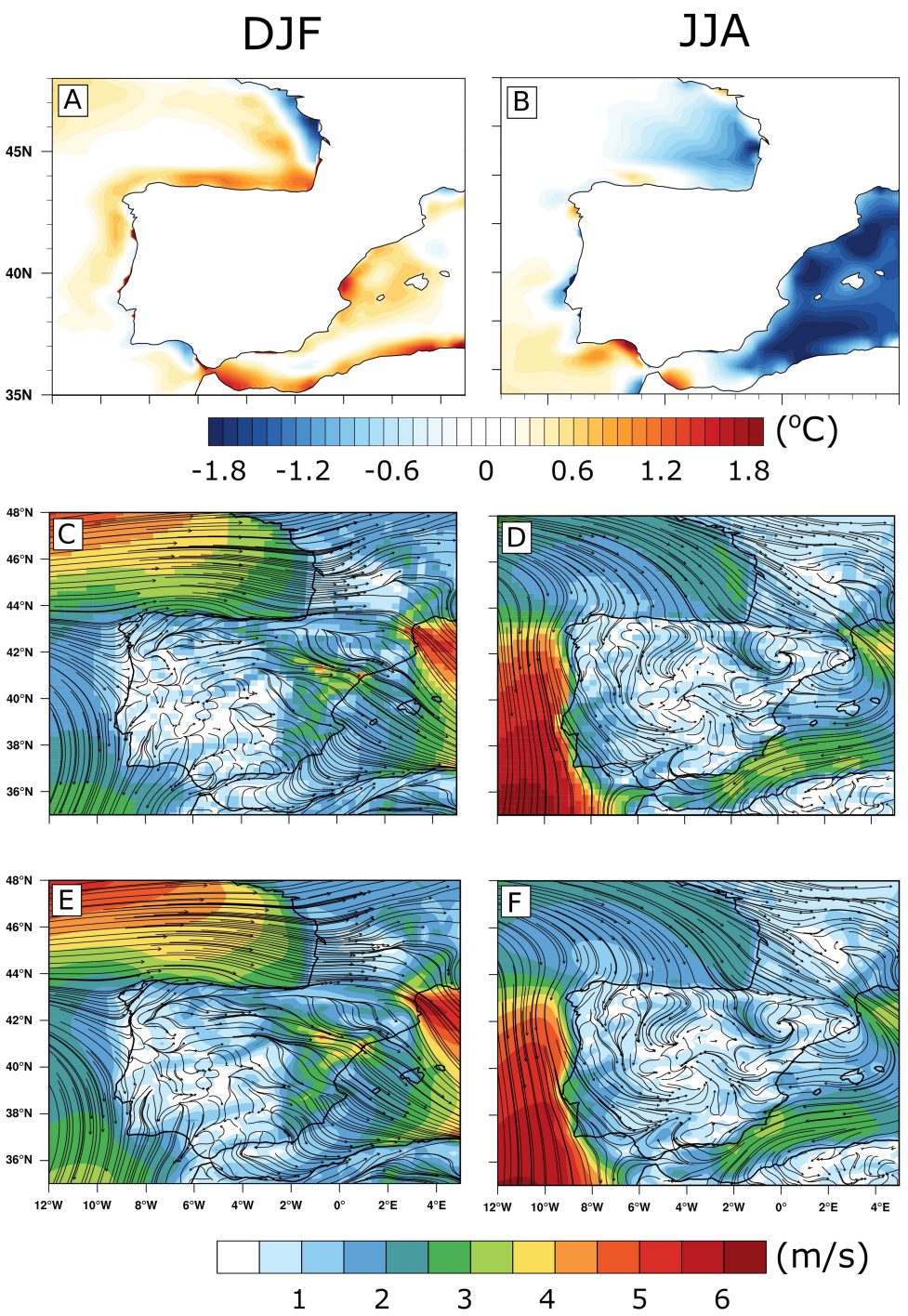
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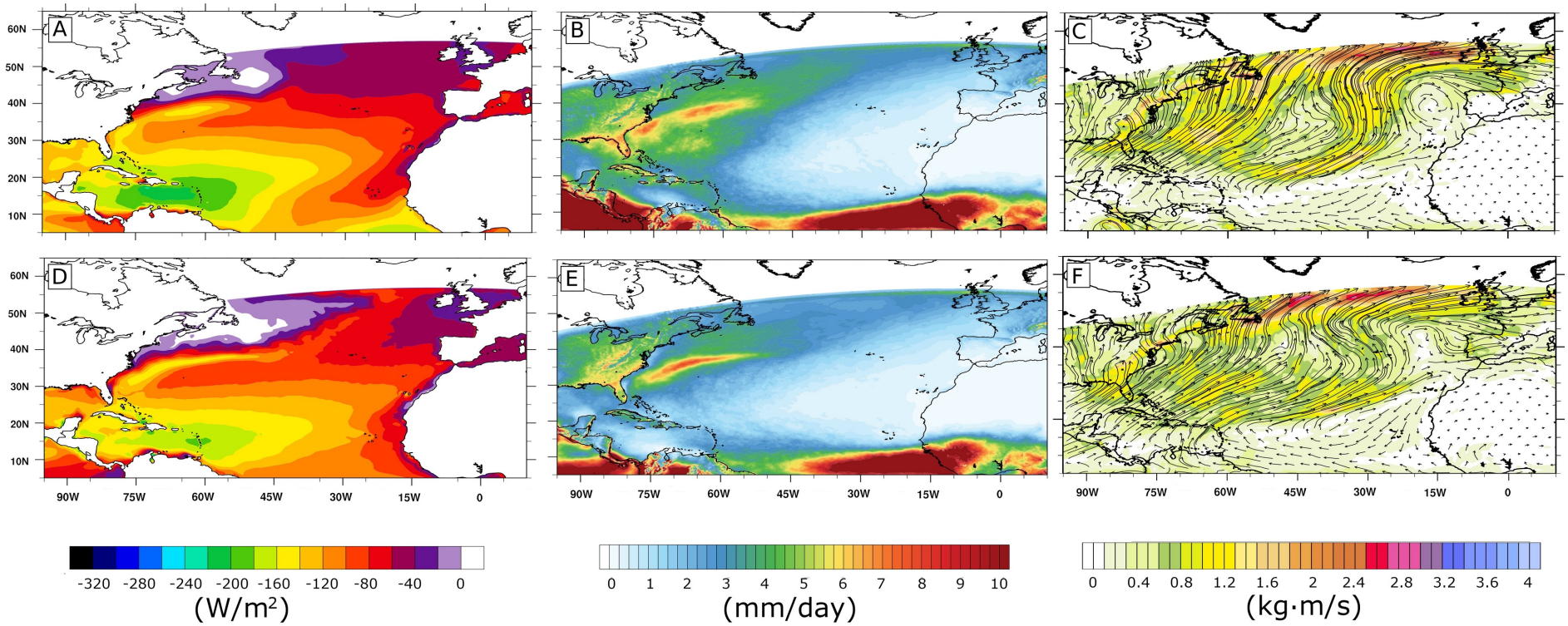
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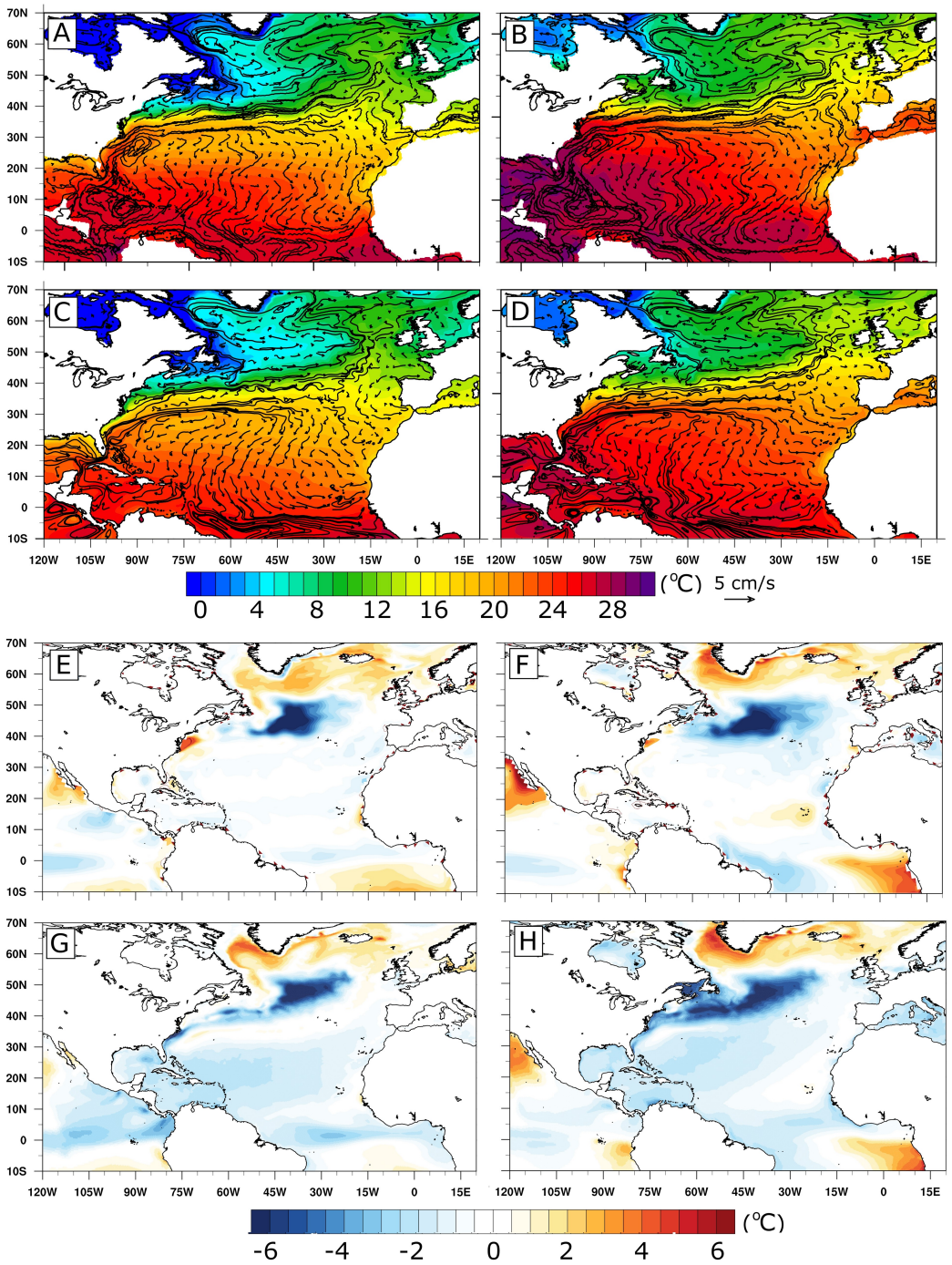
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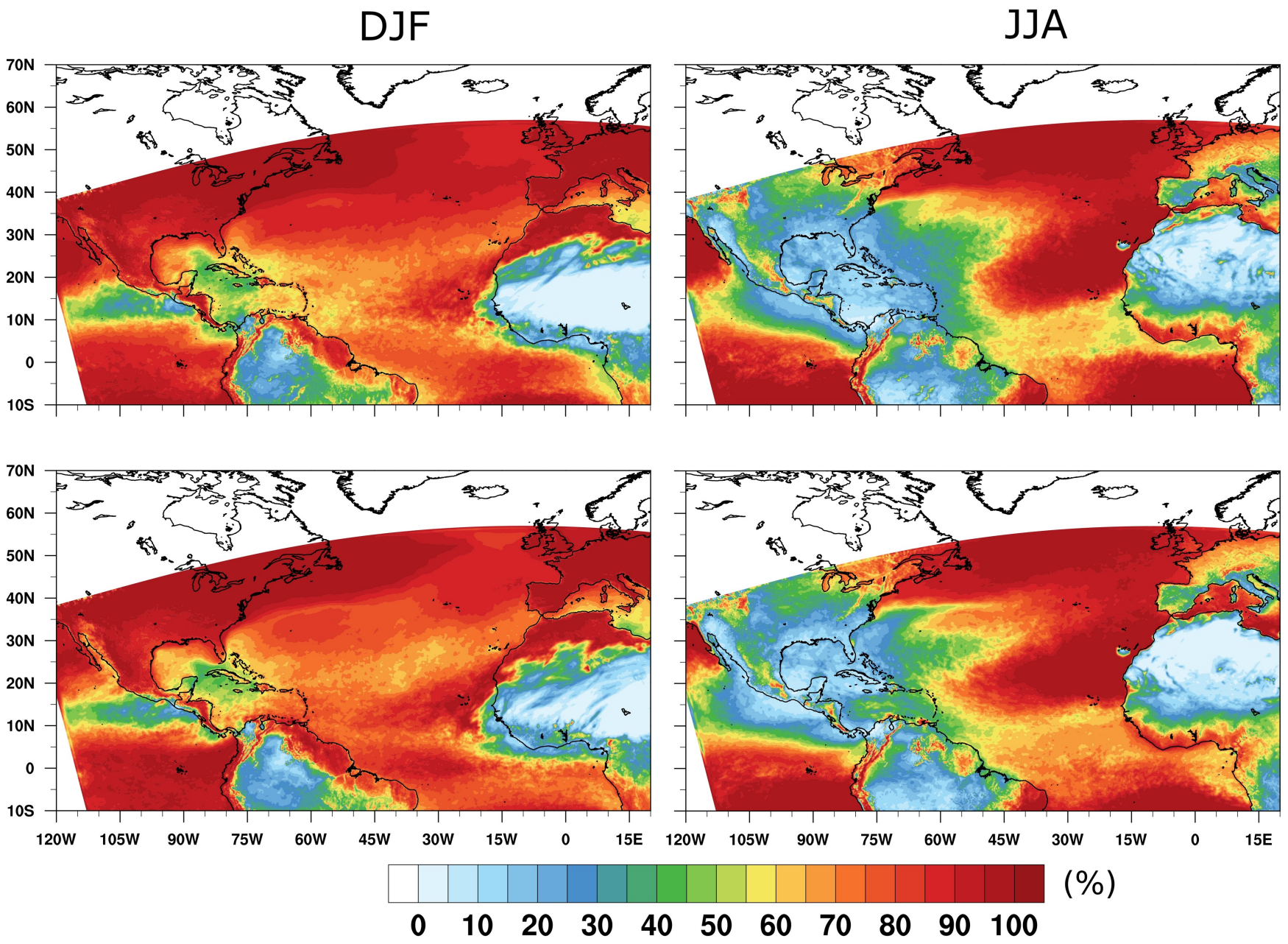
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