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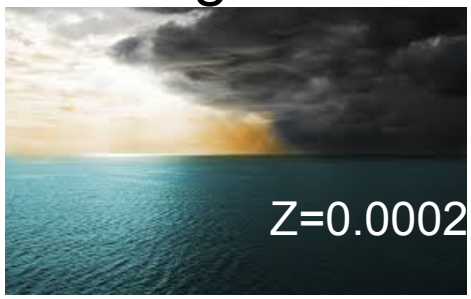
The impact of roughness length change on extratropical cyclones density and their associated precipitation over Europe

Aim of the study

- To assess the impact of the roughness length change in the extratropical cyclones over Europe, considering especifically:
  - Spatial distribution and density
  - Duration
  - Precipitation associated to them

Roughness length

Z is equivalent to the height at which the wind speed theoretically becomes zero. It is typically related to the height of terrain roughness elements.



the roughness length is approximately one-tenth of the height of the surface roughness elements

Simulations

- Control
- Deforestation
- Afforestation
- Roughness length (Z0) from afforestation with deforestation values for albedo, evapotranspiration, etc.

- All simulations were performed with RCA model over the EURO-CORDEX domain, for the period 1981-2010 forced by ERA Interim.

Cyclone detection and tracking algorithm

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Identification of objects:

- Surface pressure > 100000 Pa
- Windspeed at 850 hPa > 5 ms^{-1}

If Object:

- Eccentricity > 0.95
- Pressure gradient within it > 200 Pa

then it is considered a cyclone and its centroid is saved.

Tracking:

- Centroids from objects within a spatio-temporal window of 24h and 6 degrees are considered to belong to the same track.

Precipitation associated to cyclone:

- 5 degrees windows were extended to the border gridpoints of every object to consider the precipitation as part of the cyclone.

Cyclone density

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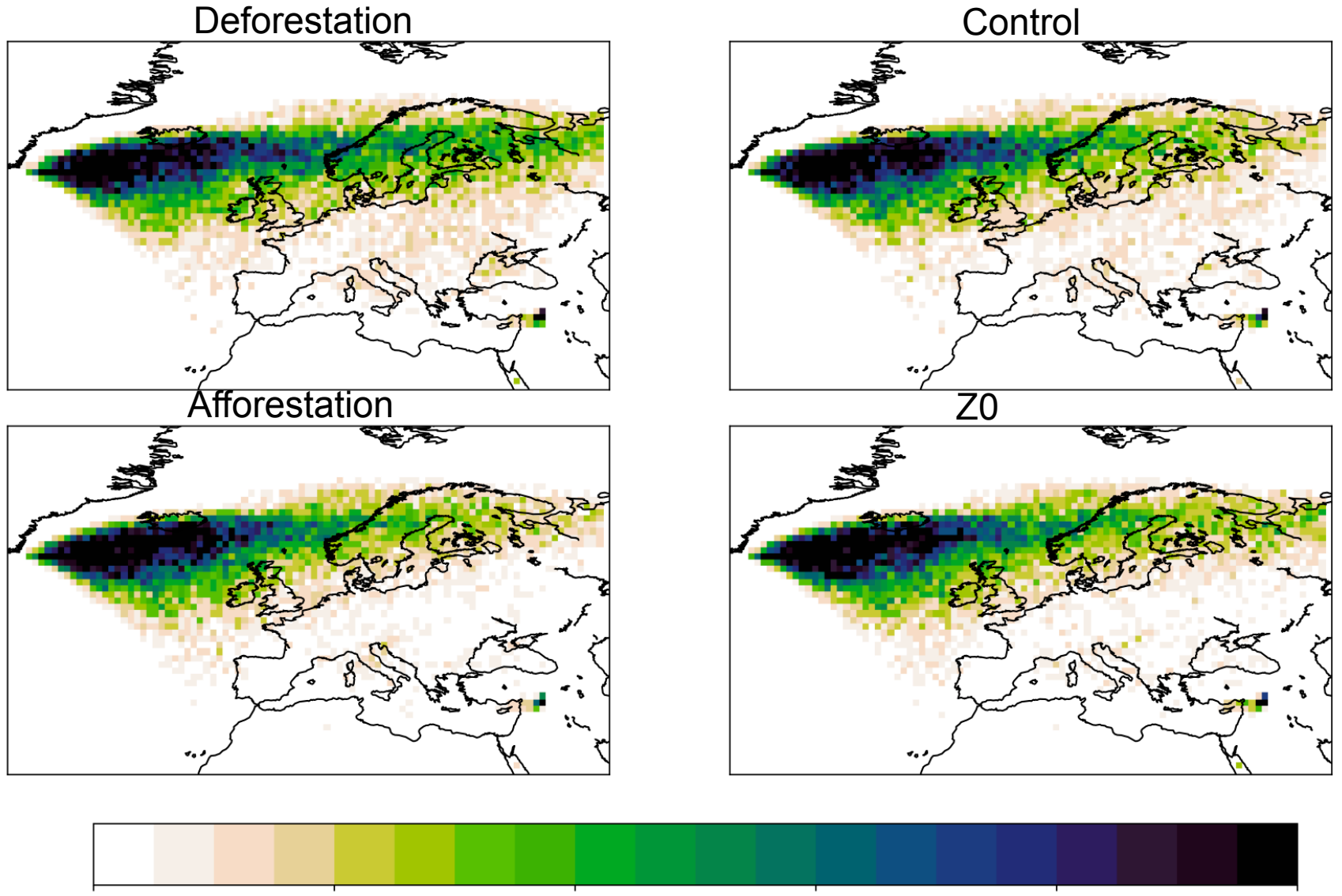

Cyclone density differences among experiments

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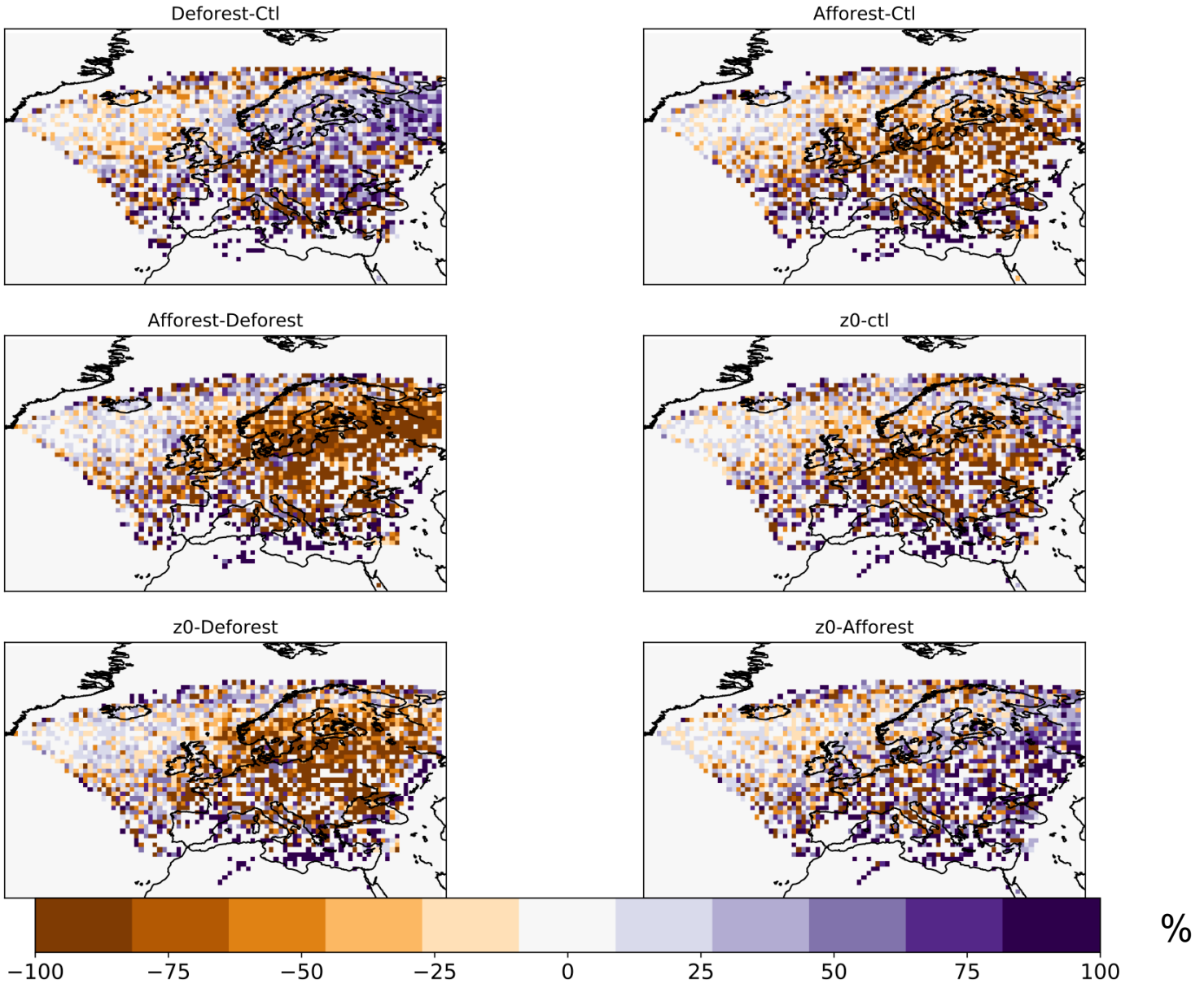

Duration of extratropical cyclones

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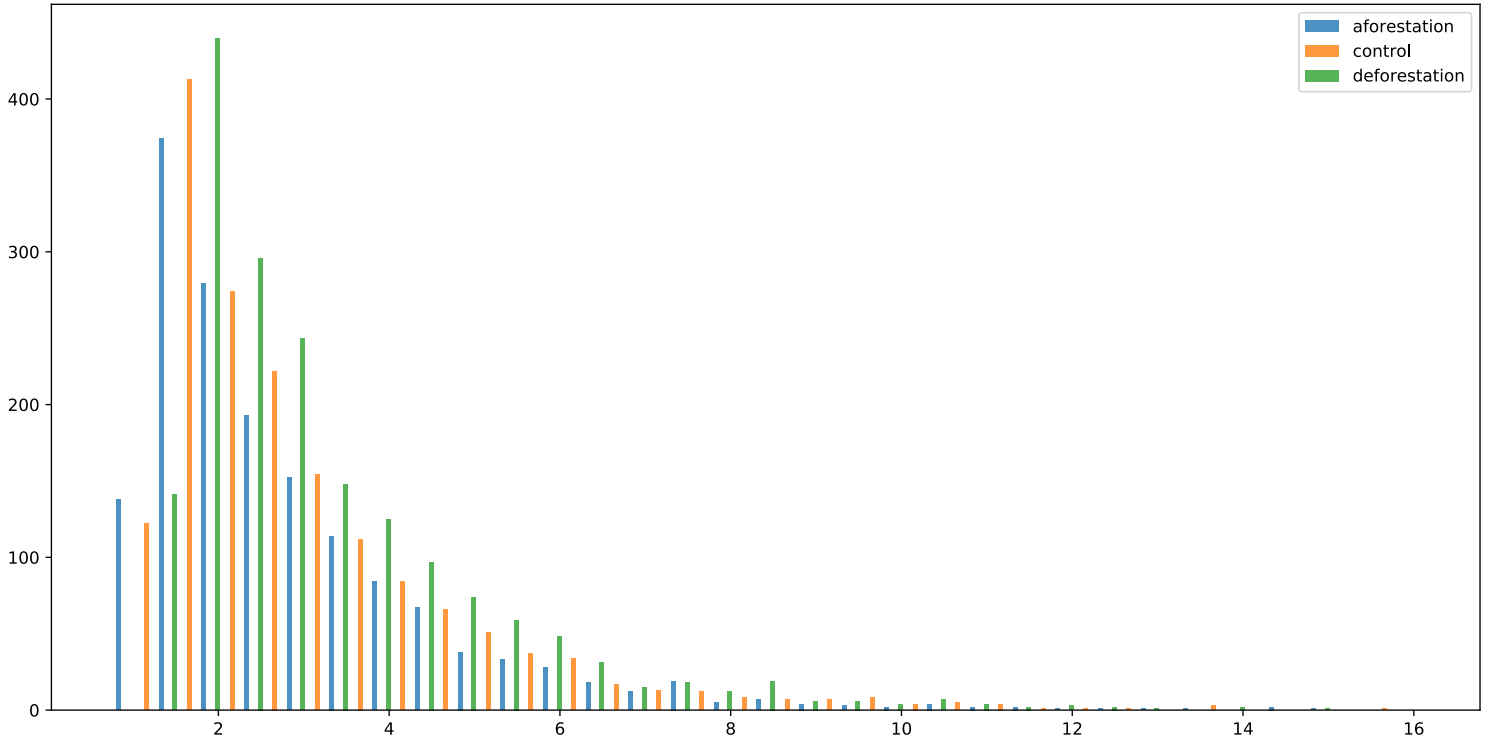

Maximum wind speed reached by the cyclones

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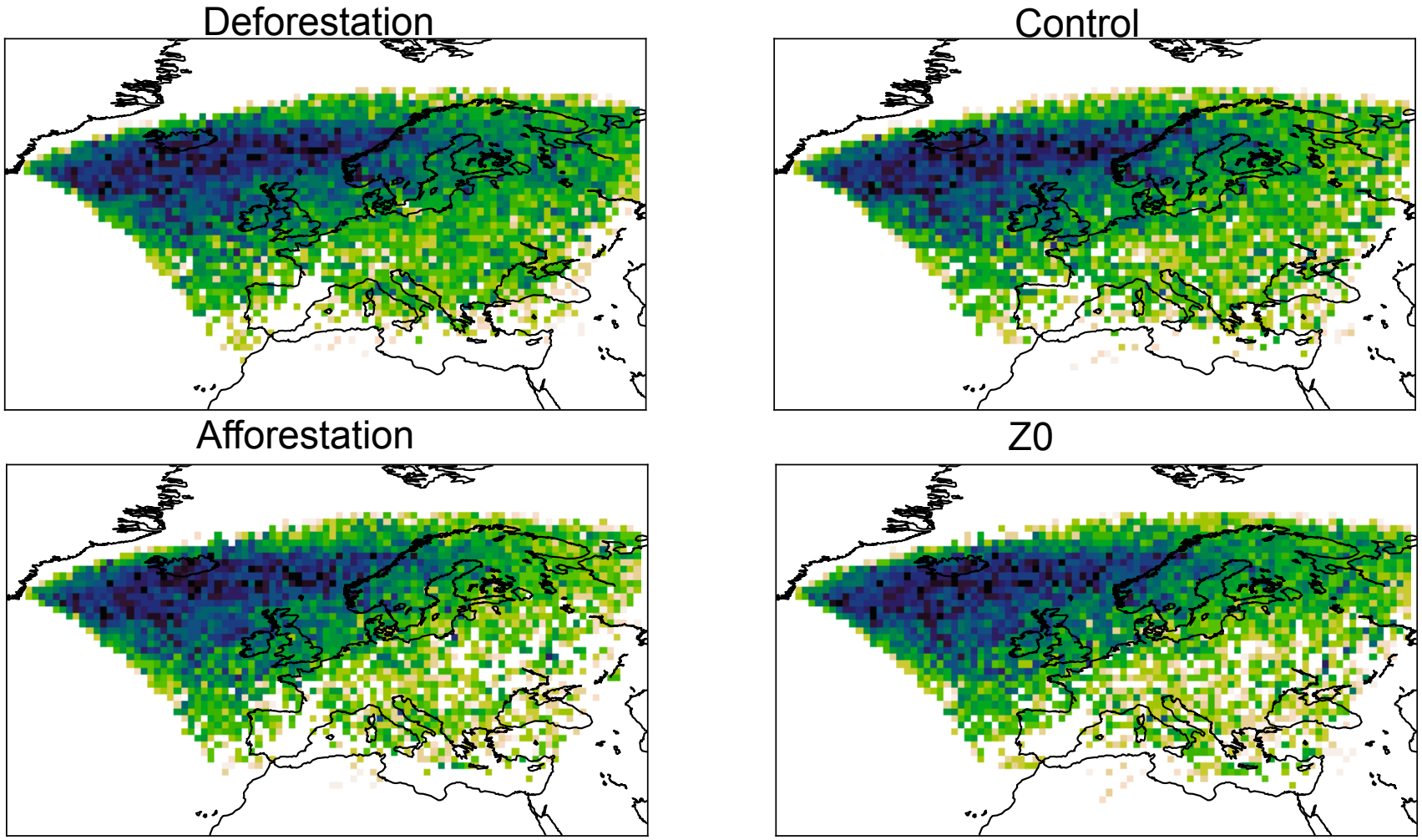

Precipitation climatology

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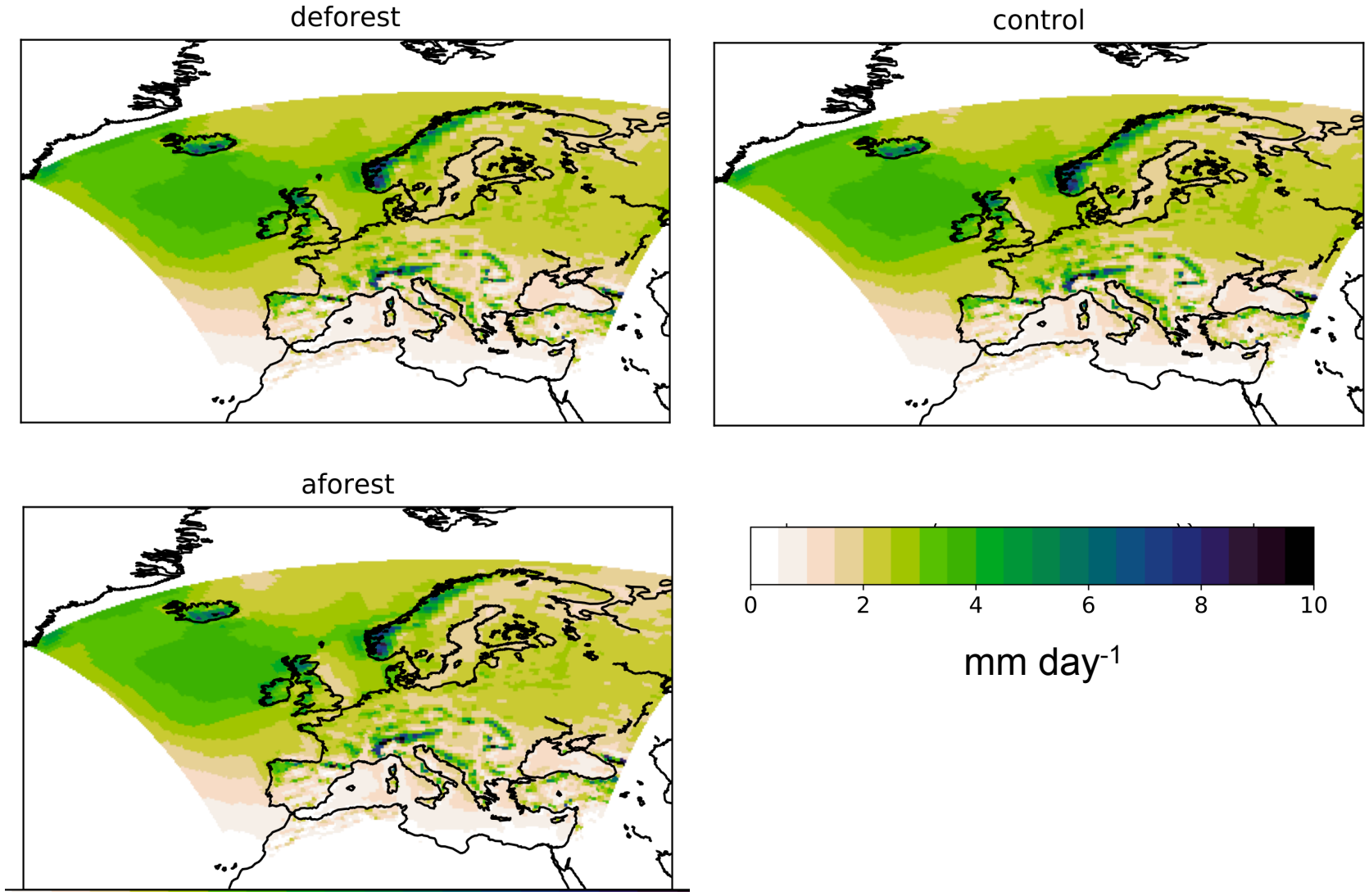

Precipitation climatology differences

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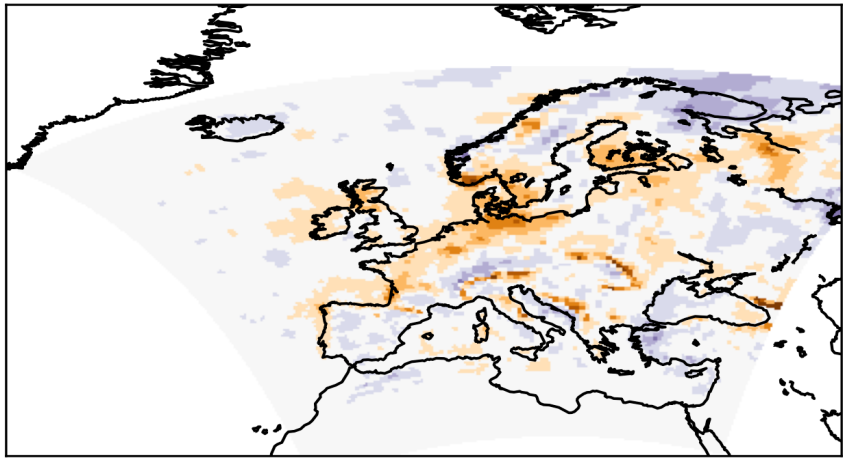
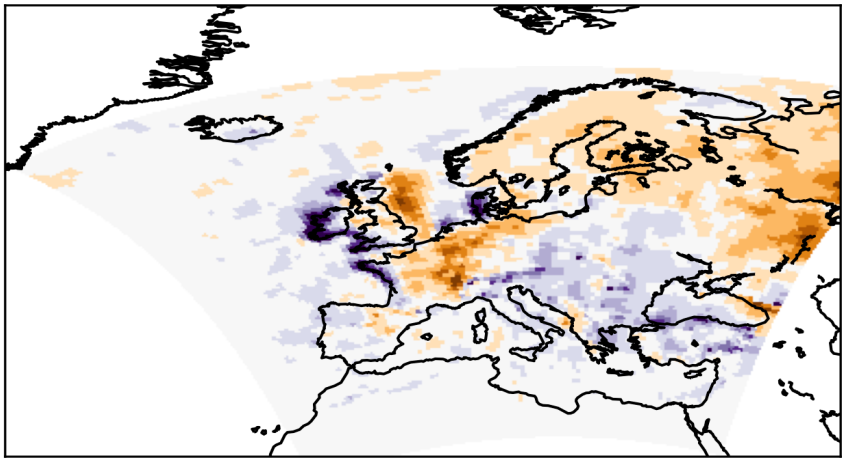
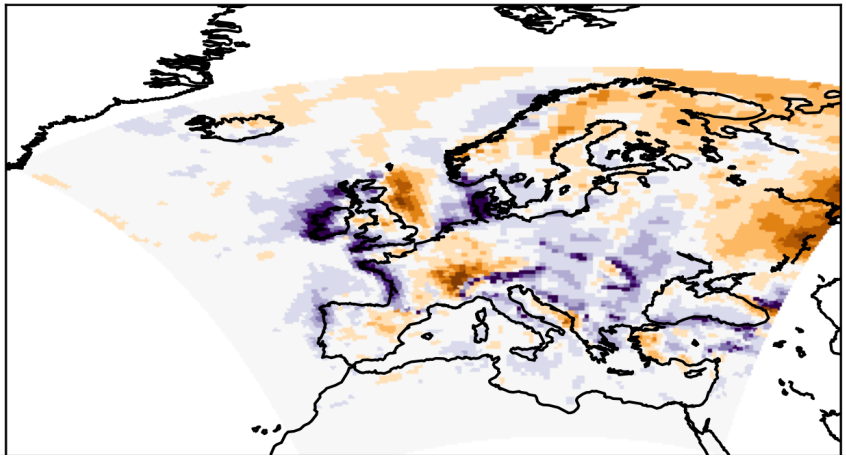
Deforest-Ctl

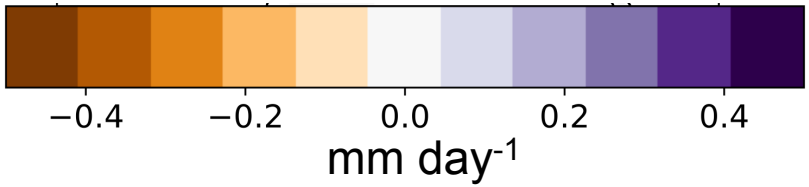


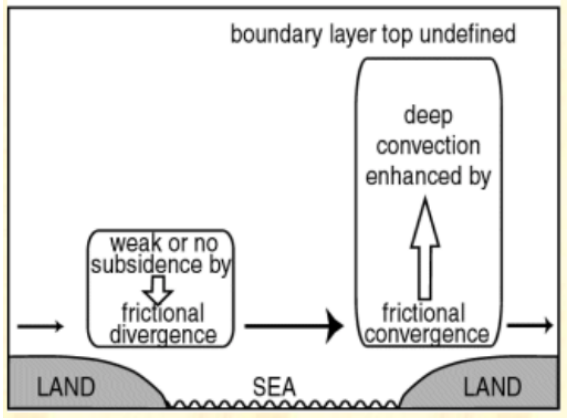
Aforest-Ctl



Aforest-Deforest







% Cyclone precip / Total precip

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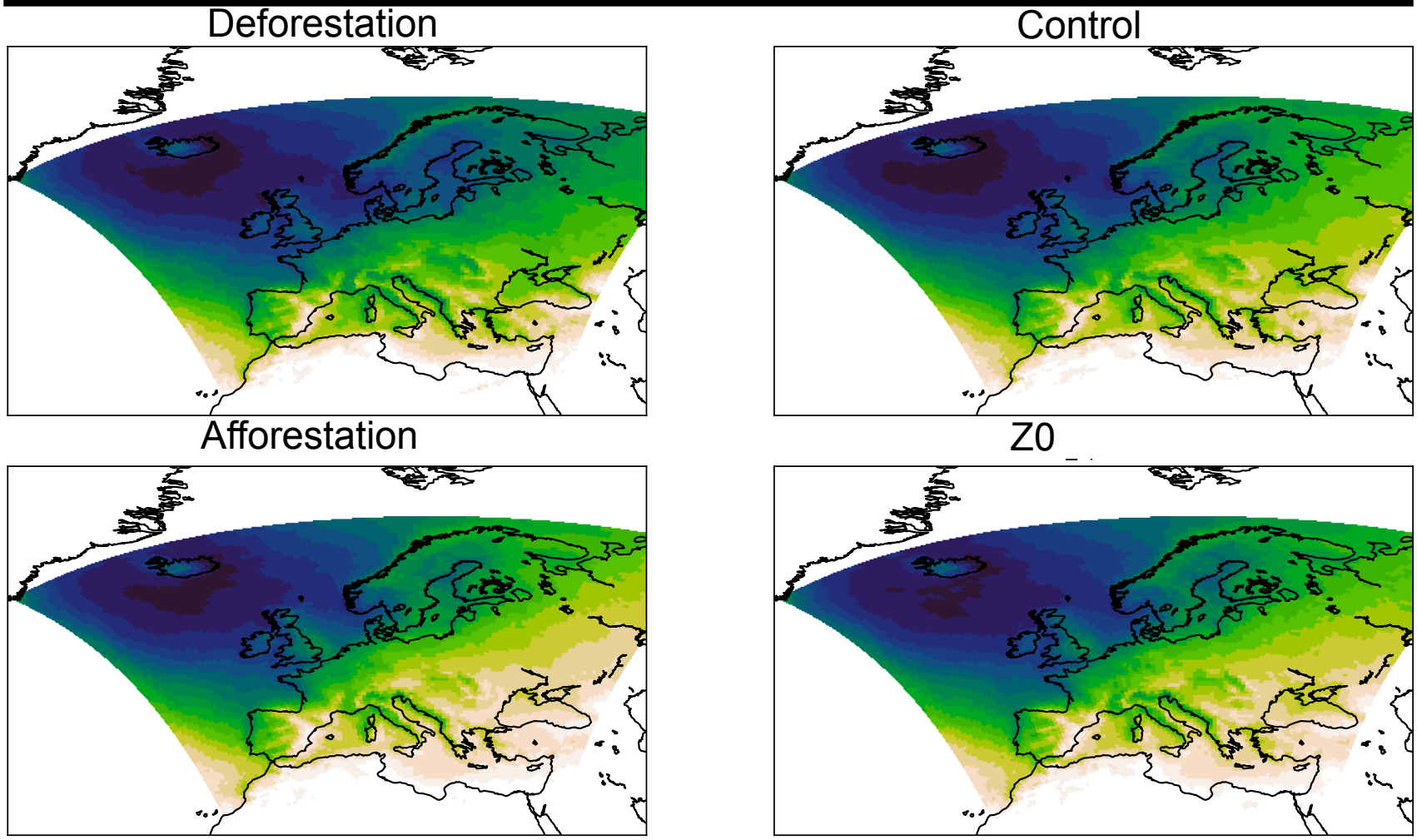

Difference Cyclone/Total precipitation percentages among experiments

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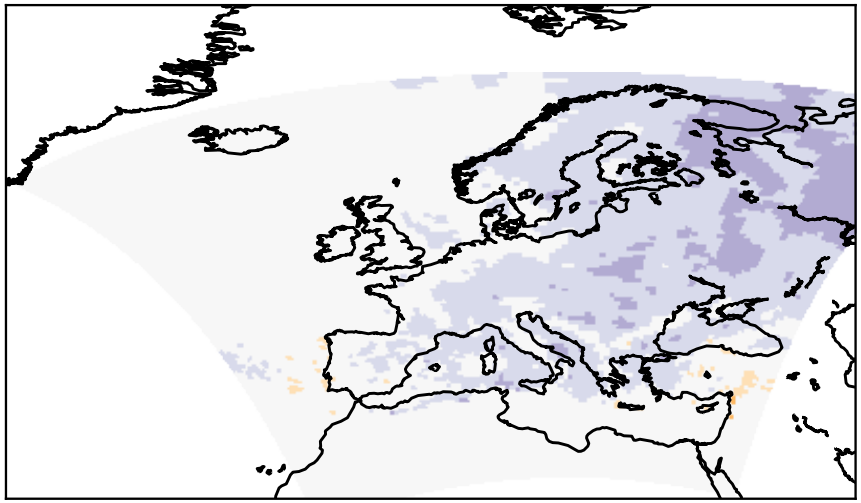
Deforest-Ctl



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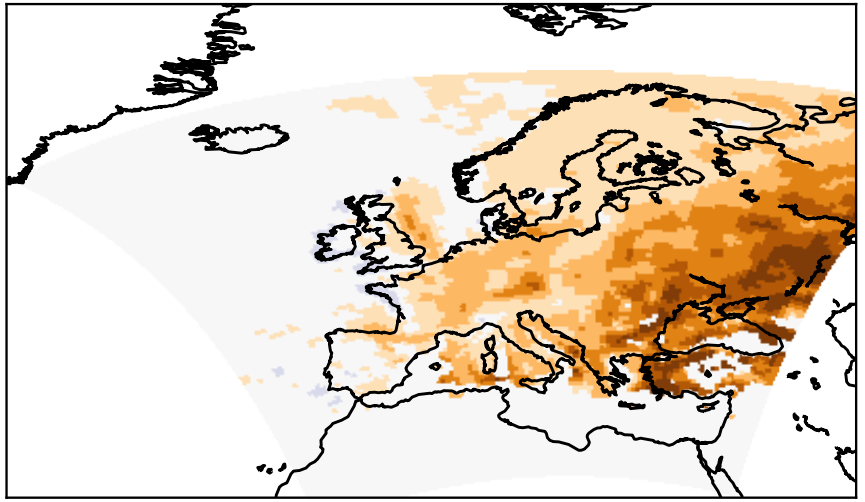

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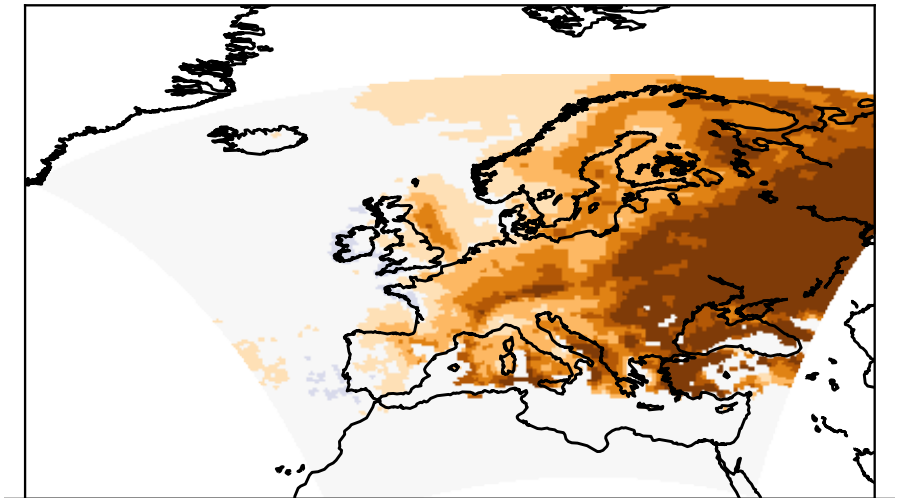

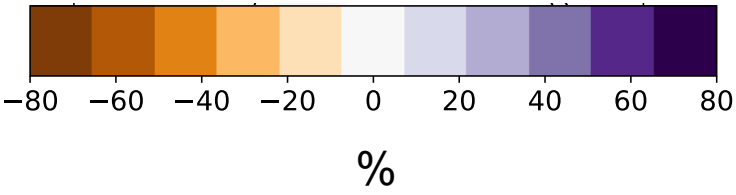

Difference NO Cyclone/Total precipitation percentages among experiments

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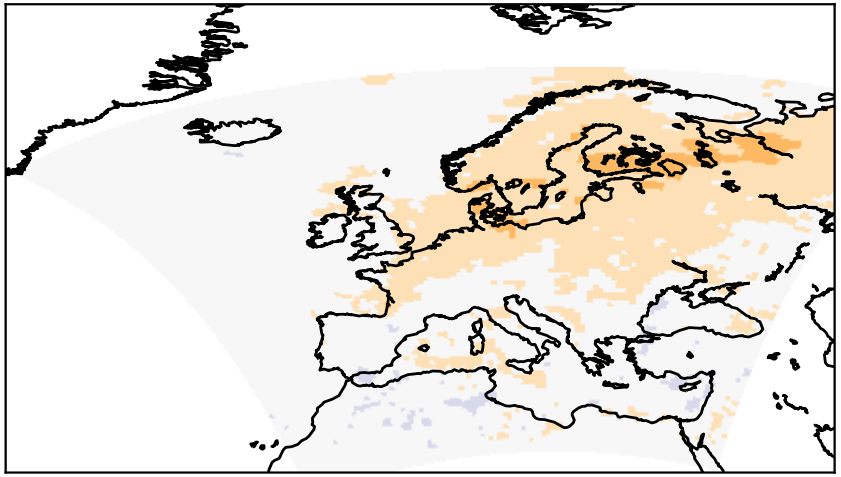
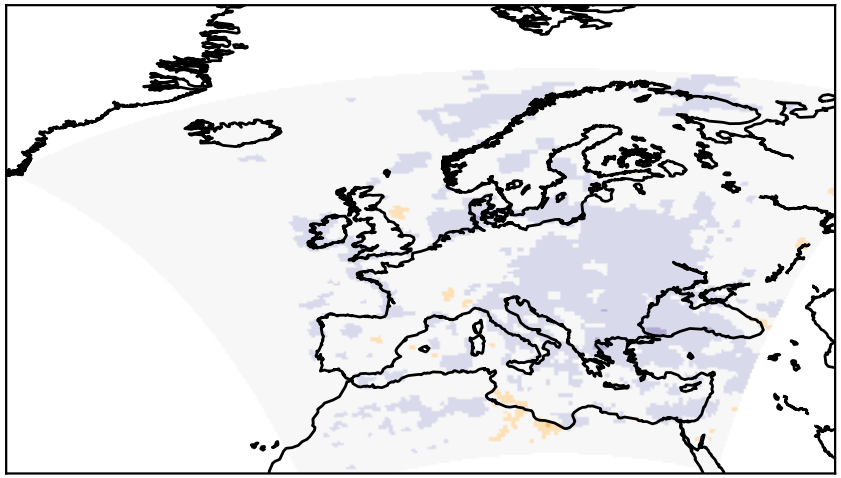
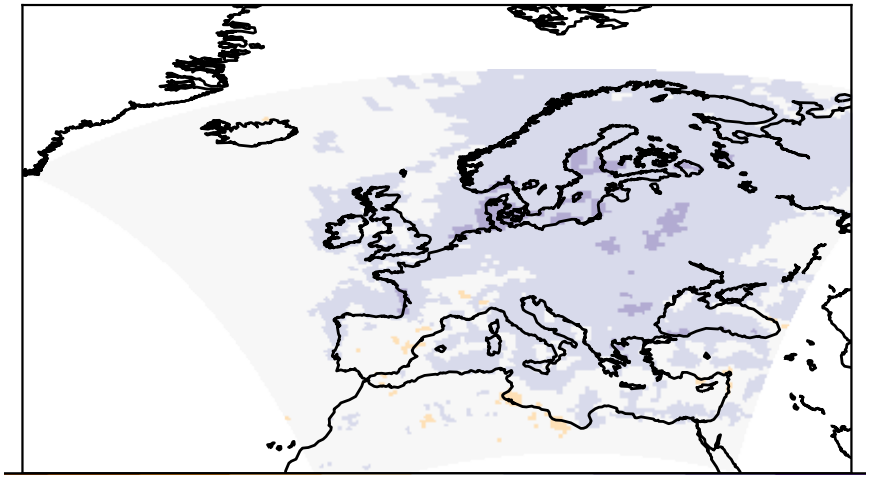
Deforest-Ctl No cycl

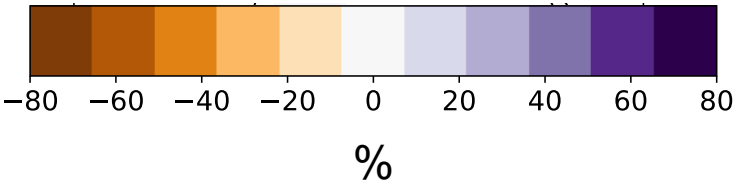


Aforest-Ctl No cycl



Aforest-Deforest No cycl





Preliminary conclusions

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- Roughness lenght increase caused:
  - Cyclone disipation, resulting in shorter cyclone tracks, and therefore
  - A reduction of cyclones travelling from West to East within Europe.
  - Wetter conditions over the western European coasts due to cloud saturation caused by an induced rising motion above the coastline due to roughness difference (roughness convergence).
- Roughness lenght decrease caused opposite results, as expected.
- Z0 experiments using same evapotranspiration, albedo, etc. as for deforestation produced similar results as afforestation, allowing us to confirm the role of roughness length change on cyclone tracks.

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THANK YOU!!