

# HCLIM43 Evaluation

Evaluation group (Alphabetical order of first name):

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# HCLIM consortium

- Started in 2019
- Participants:

Full members:

SMHI, MET Norway, MET Éireann, KNMI, FMI, DMI, AEMET

Possibly, associated member:

Hungary

<https://hirlam.org/trac/wiki/HarmonieClimate>

# HCLIM consortium

Projects where HCLIM has/will be used:

- EUCP (<https://www.eucp-project.eu/>) (European Climate Prediction system, H2020)
- CORDEX-FPS Convection and URB-RCC (Urban environments and Regional Climate Change)
- Climate scenarios (with several GCMs)
- EUREC4A (<https://eurec4a.eu>)
- EWC (Early Warning Center)
- PolarRes (EU)
- NorCP (Nordic Convection Permitting Climate Projections)
- CORDEX
- BiodivERsA: "Scenario-based decision support for policy planning and adaptation to future changes in biodiversity and ecosystem services (BioDiv-Support)"
- FORMAS:
  - "Effectively designing and communicating next generation climate simulations over Sweden (EDUCAS)"
  - "Heat stress in Swedish cities and the role of urban nature (GreenWave)"
  - "Advancing knowledge and tools for the adaptation of Swedish cities to heat (BRIGHT)"

Some other experiments:

- Coupling of cy38 with CTRIP hydrology
- Very-high runs cy38 750m over Denmark; 7 months for each of 5 years, ERA5 driven

# HCLIM43-AROME evaluation

- **Experiment setup**

- Settings as in `harmonie-43h2.2.target.3` for testing HCLIM43-AROME at 3 km resolution
  - LICERAD=.TRUE.; CSEA\_FLUX=ECUME6; XRIMAX=0.2; CROUGH=NONE; 'RFRMIN(22)' => '0.25', 'RFRMIN(24)' => '2.5', RFRMIN(26)=250E6, 'RFRMIN(29)' => '1000.'
- **ERA5** data with 3 hour interval
- Simulation from **1-Dec-2014 to 31-Dec-2015** (1 month spin-up, 2015 for analysis)
- 3 domains: Scandinavia, Iberia, DIN3K

- **AROME 3 km simulations**, run on ECMWF and saved on ec. First step is compare both cycles:

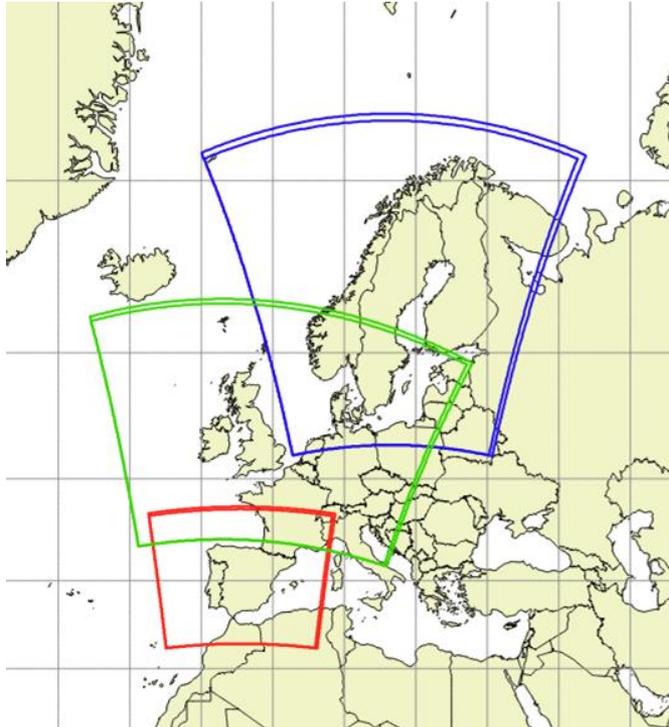
- HCLIM43\_ARO3\_Ref (default setup)
- HCLIM38\_ARO3\_Ref (change output frequency to be the same as HCLIM43); HCLIM38h1 (r19018, latest)

- **RCAT tool for evaluation on ECMWF (Jan - Feb 2022)**, both cca and aa (new machine).

- [https://hirlam.org/trac/wiki/HarmonieClimate/HCLIM43/HCLIM\\_output/RCAT](https://hirlam.org/trac/wiki/HarmonieClimate/HCLIM43/HCLIM_output/RCAT)
- **Evaluation data:** EOBS20, ERA5, CLARA-A2 (clt, rsds)

# DOMAINS

- **DIN3K** (75s step)
- **SCANDINAVIA3** (75s step)
- **IBERIAxxm\_2.5** (60s step)



**DIN3K** domain is further divided into:

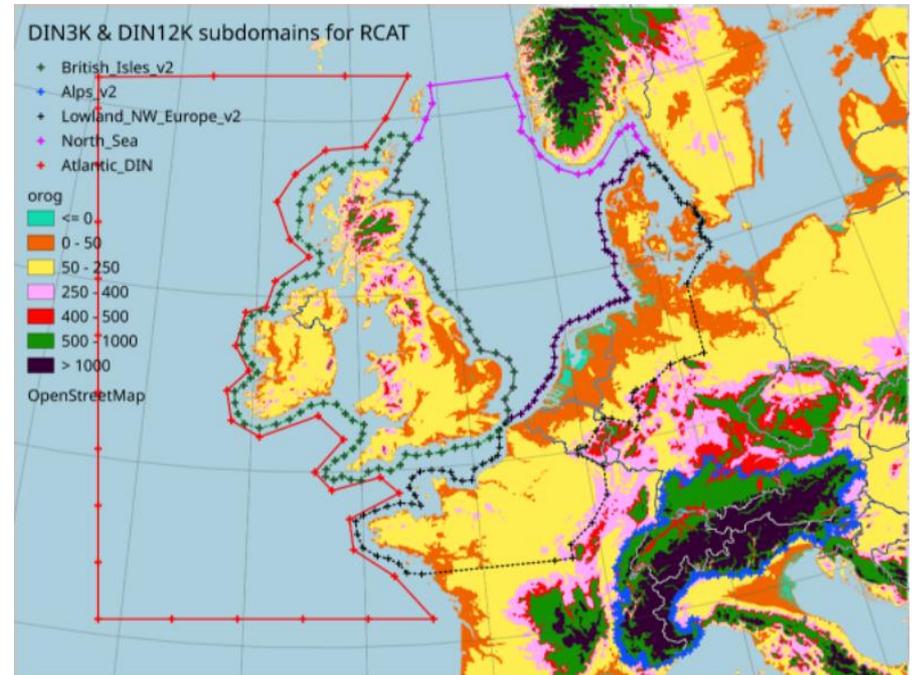
British Isles

Lowland NW Europe

Alps

North Sea

Atlantic

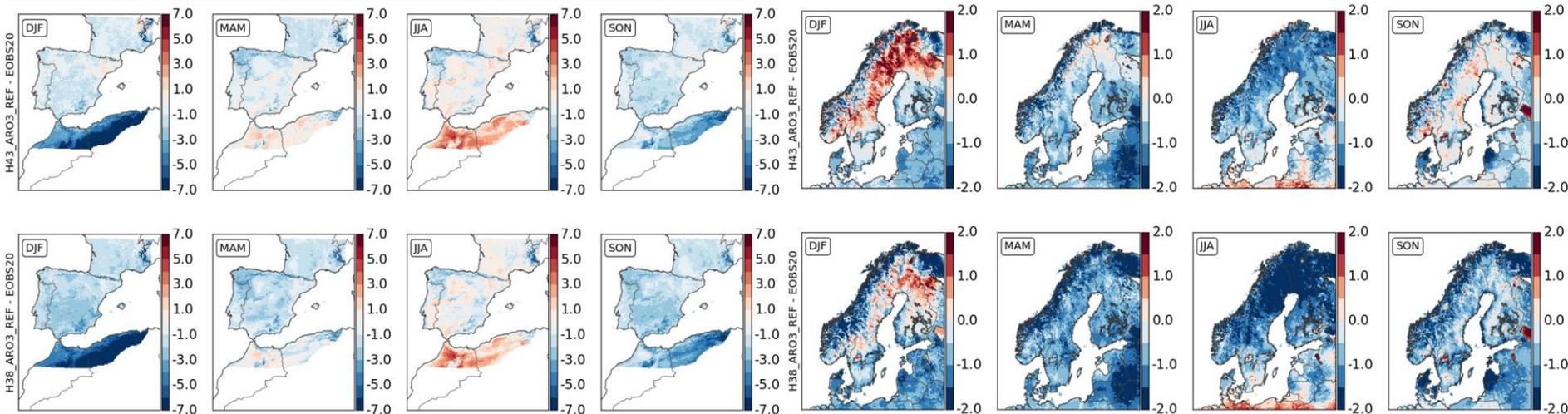
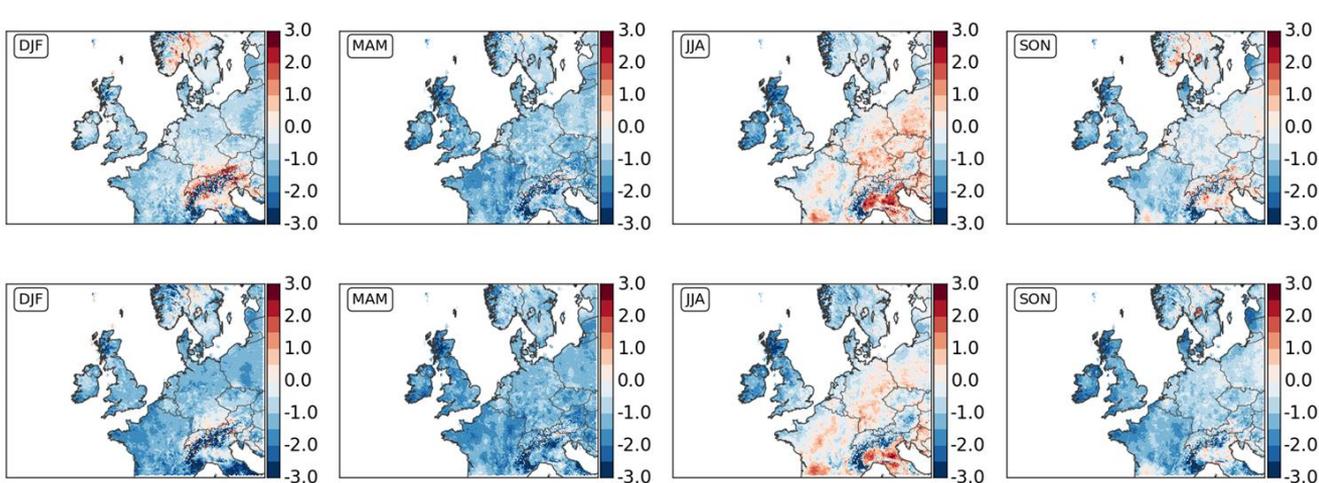


# HCLIM43-AROME evaluation

tas - eobs (K)

cold bias generally

HCLIM38\_ARO3\_REF - EOB520IM43\_ARO3\_REF\_DIN3K - EOB5

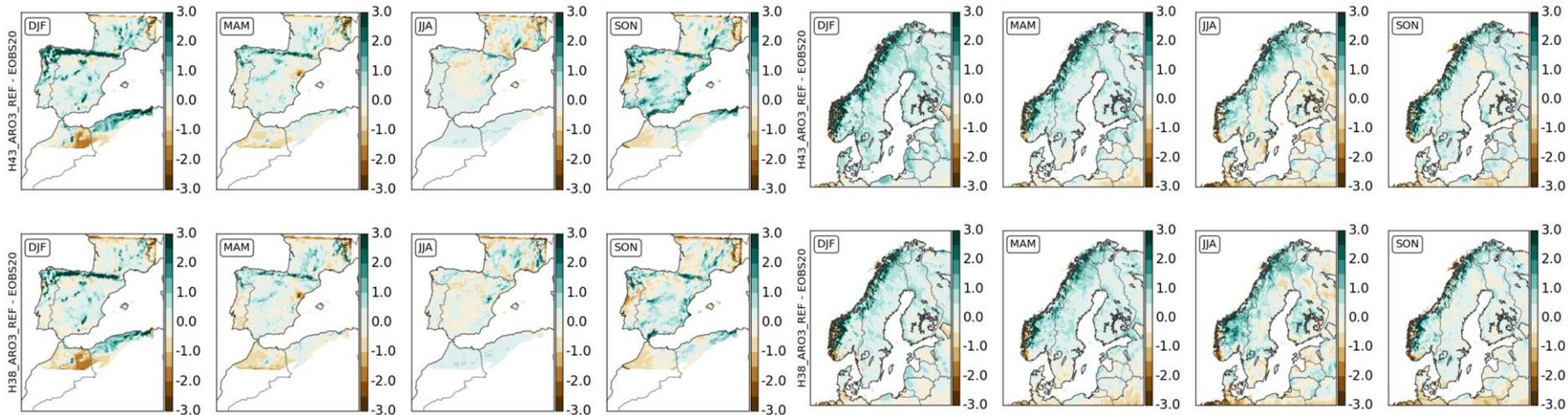
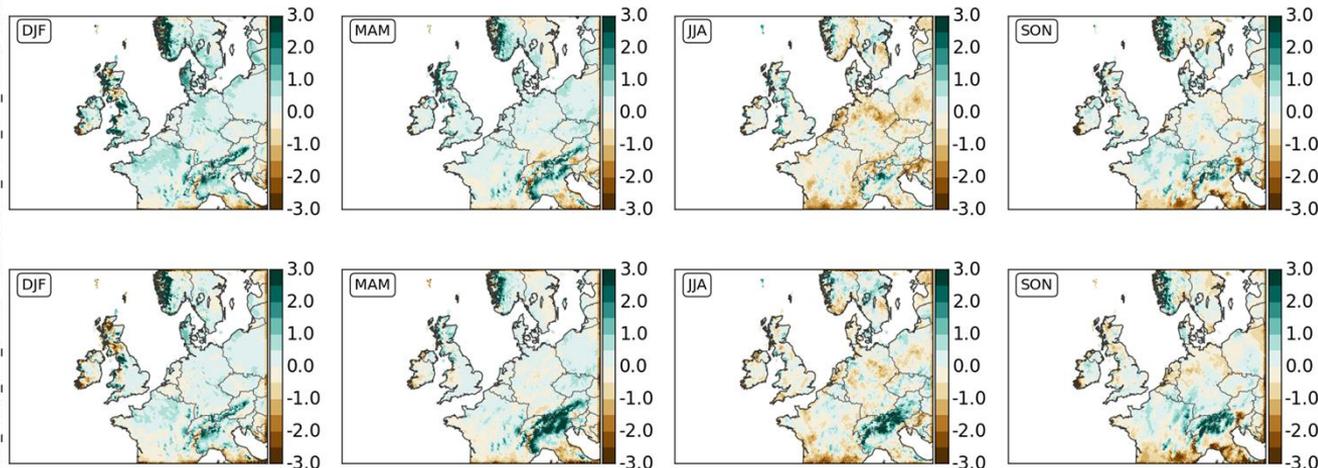


# HCLIM43-AROME evaluation

pr - eobs (mm/day)

Overestimation  
except in summer in  
some zones

HCLIM38\_ARO3\_REF\_DIN3K - EOBS20143\_ARO3\_REF\_DIN3K - EOB

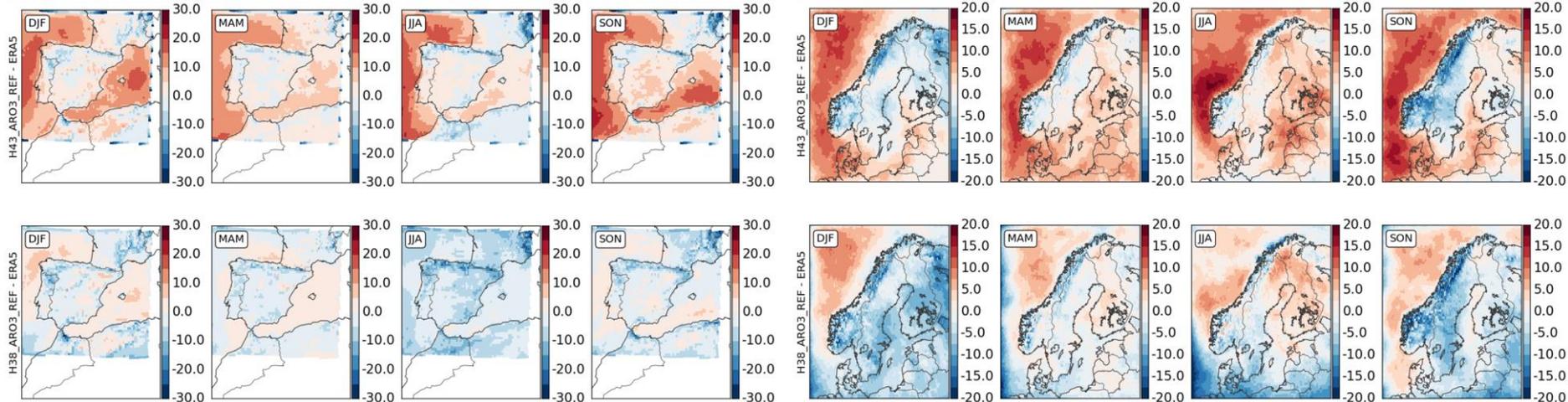
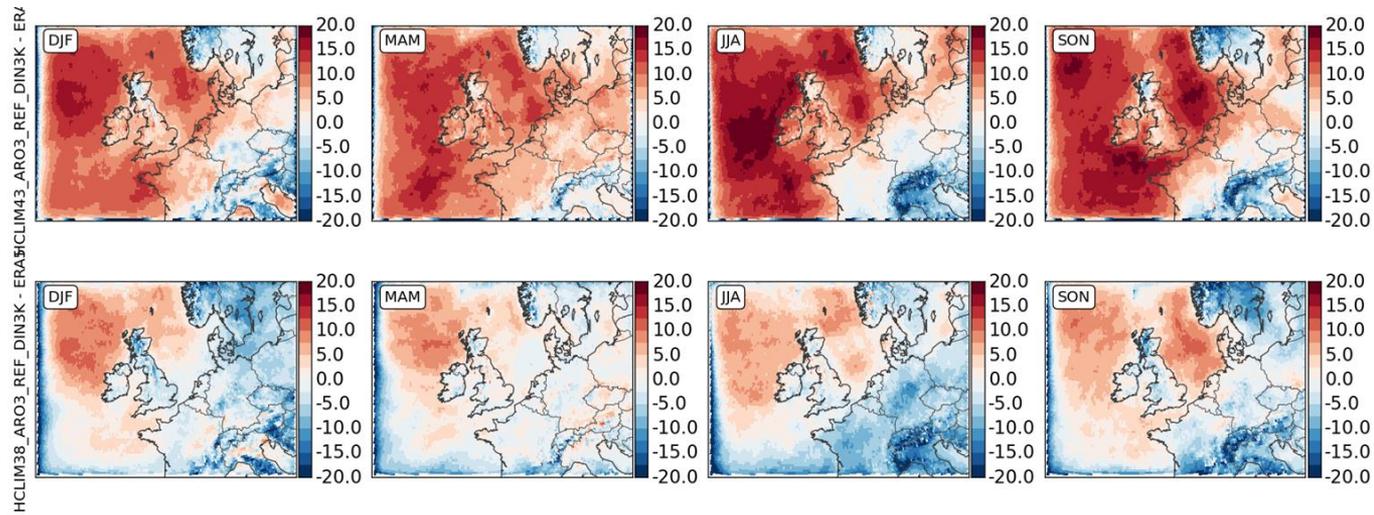


# HCLIM43-AROME evaluation

clt - era5 (%)

Strong positive bias  
over sea

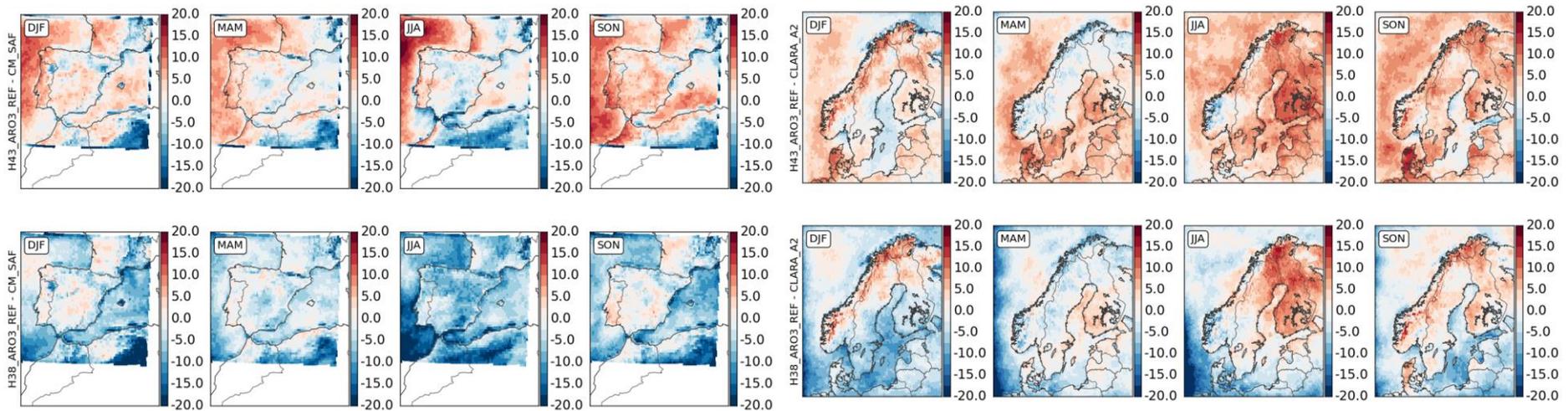
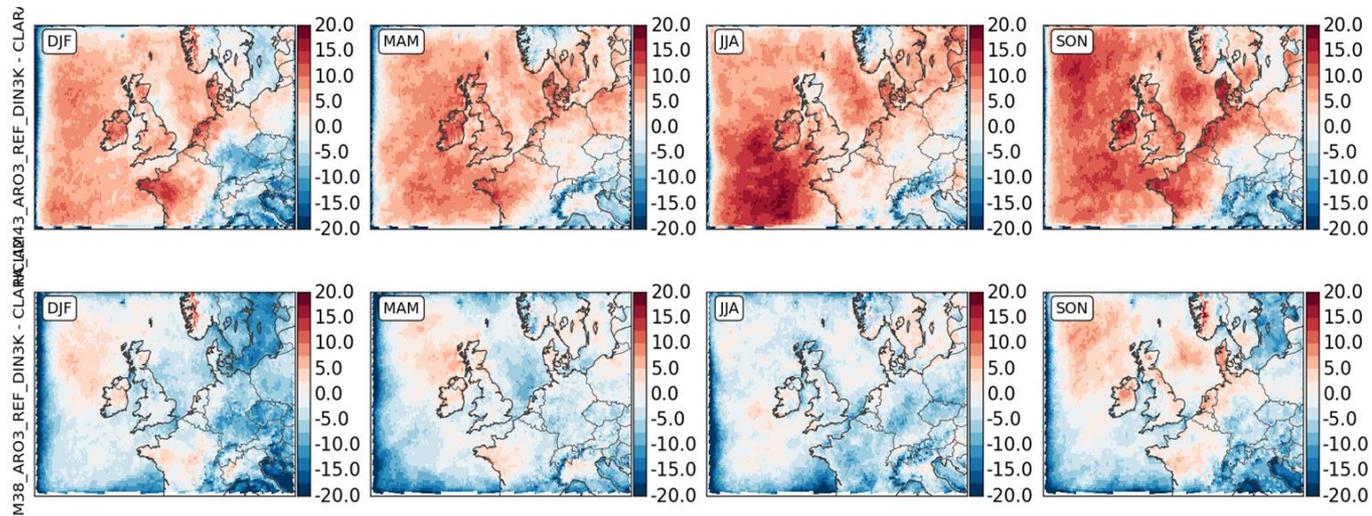
(clt is accumulated in H43,  
different as H38)



# HCLIM43-AROME evaluation

clt - clara\_a2 (%)

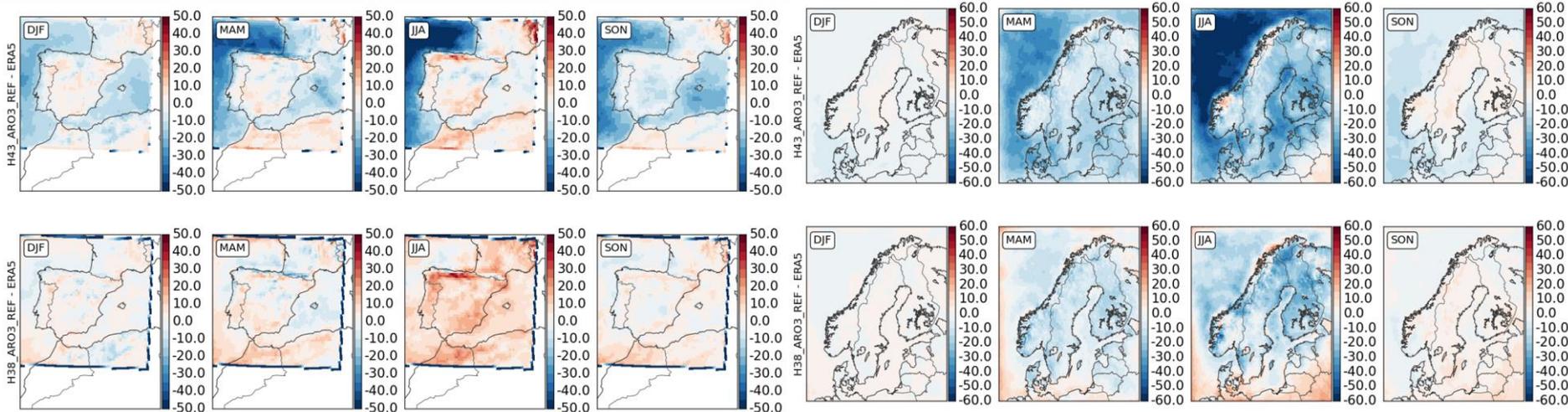
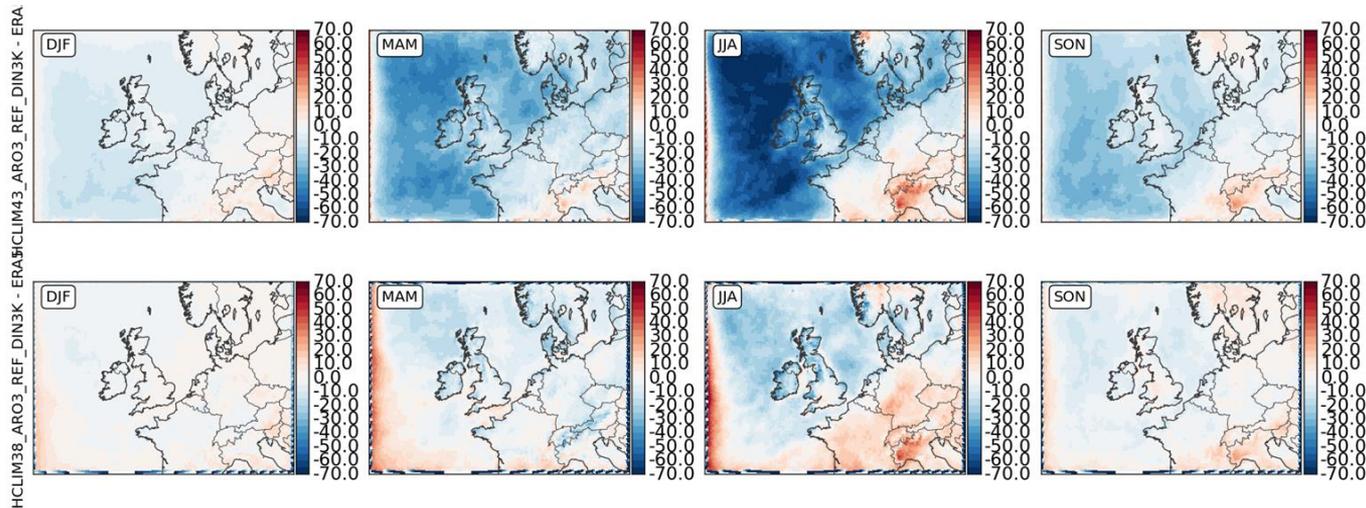
Strong positive bias  
also with this dataset



# HCLIM43-AROME evaluation

rsds - era5 (Wm-2)

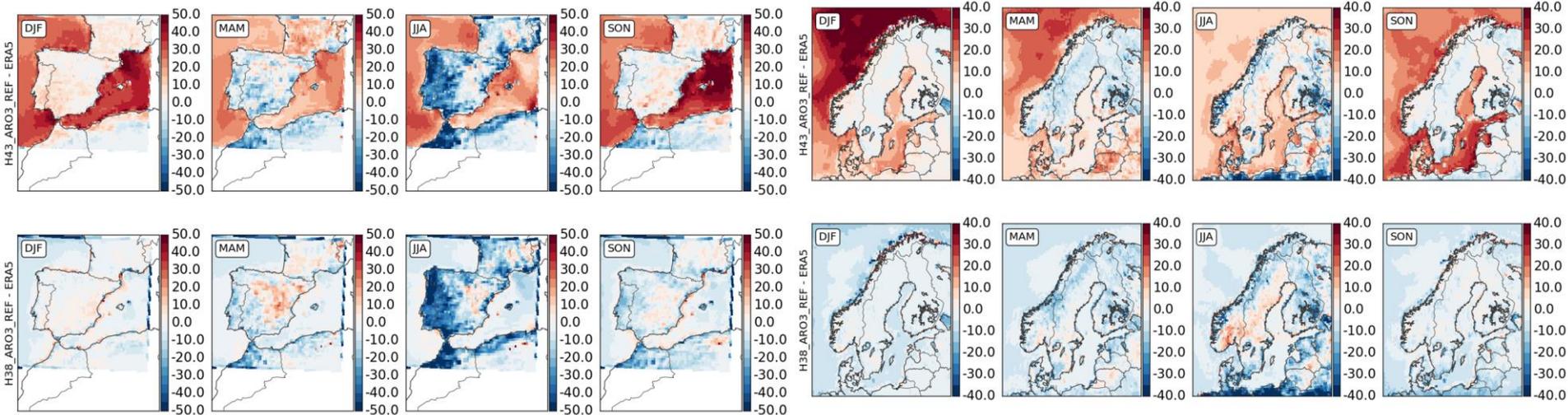
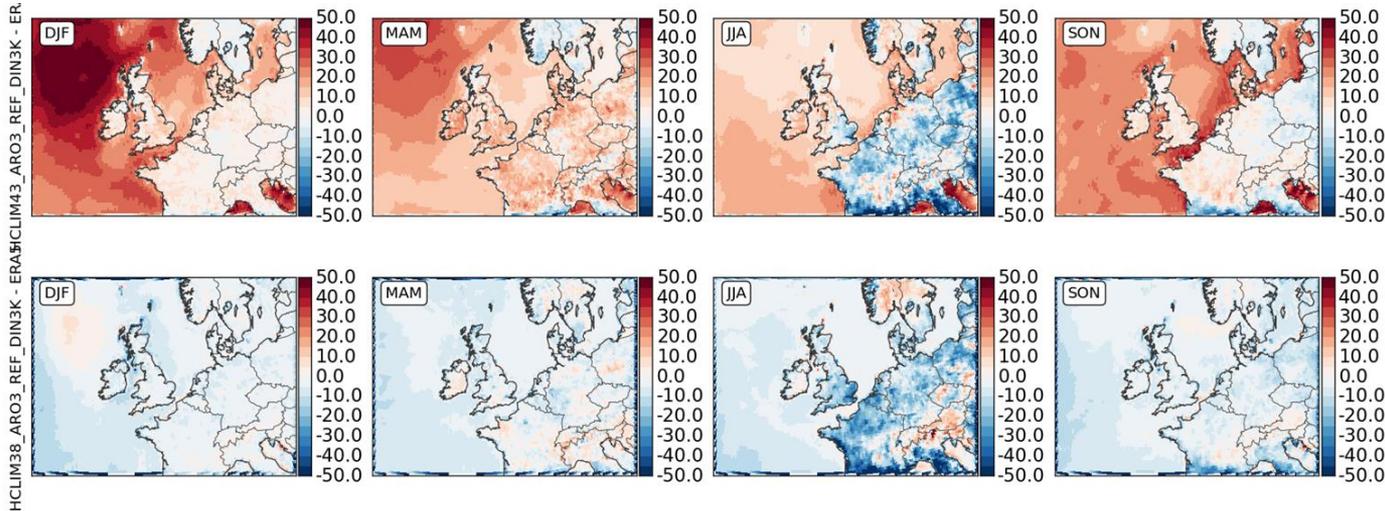
Negative bias well  
correlated with clt  
bias



# HCLIM43-AROME evaluation

hfls - era5 (Wm-2)

Strong positive bias  
over sea, specially  
in winter.



# HCLIM43-AROME

## evaluation

Domain-average (Scandinavia)

HCLIM38\_ARO3\_Ref (left) and

HCLIM43\_ARO3\_Ref (right) for

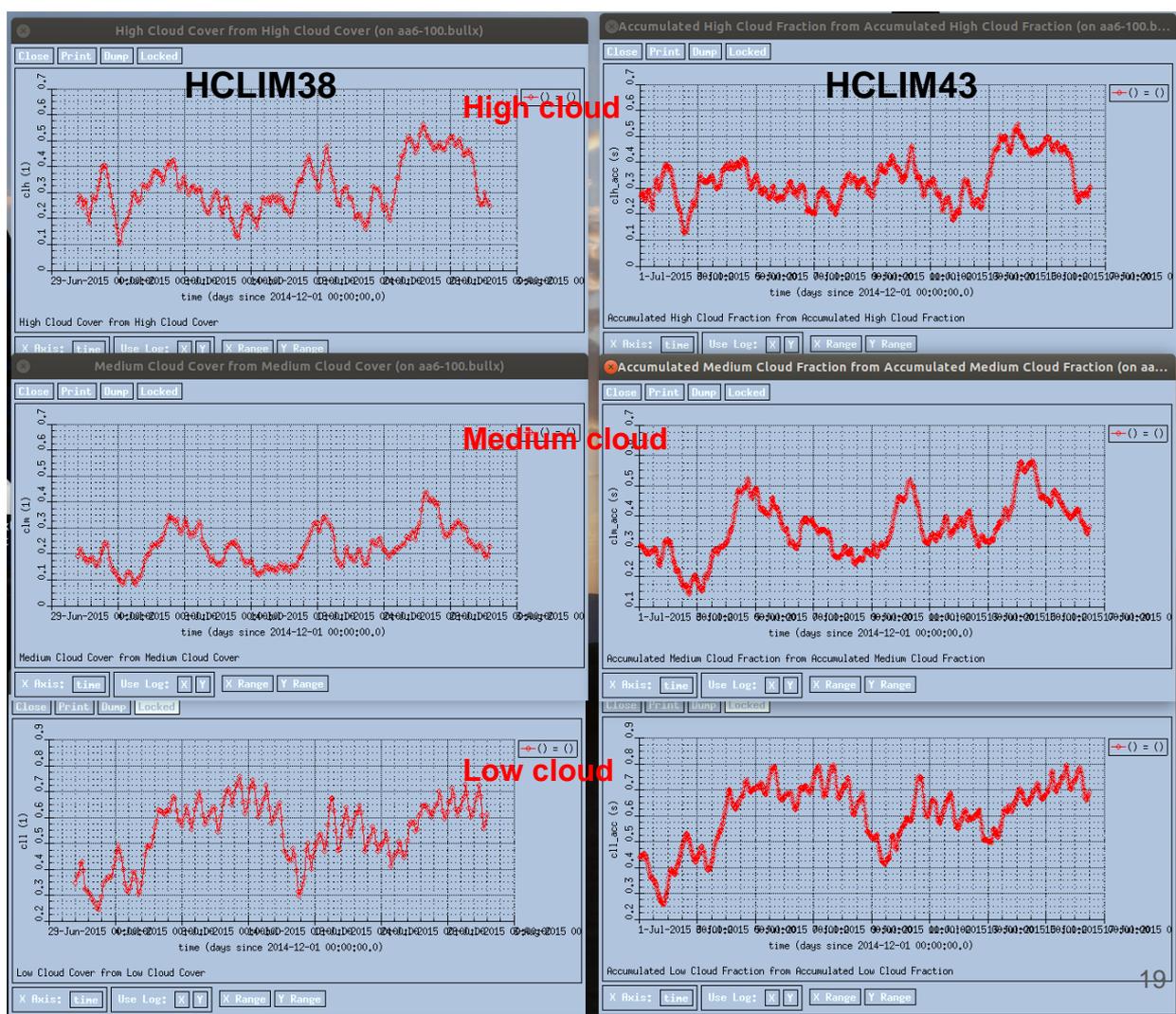
2015-08.

- the **low** level clouds fraction (cli) is **higher** in H43 than in H38

- the **middle** level clouds fraction (clm) is also **higher** in H43 than in H38

- the high level clouds fraction (clh) is similar in H43 and H38

- the **bias shows up quickly at the start**, seems not an issue of the model drifting towards too many clouds in a long-term, i.e. climate simulation.



# HCLIM43-AROME evaluation

Summing up:

- Positive bias in clt
- Negative bias in rsds
- Positive bias in hfls

Are these biases related ?

- clt and rsds seem to be very correlated in the maps
- hfls and clt are not so well correlated (specially in summer)

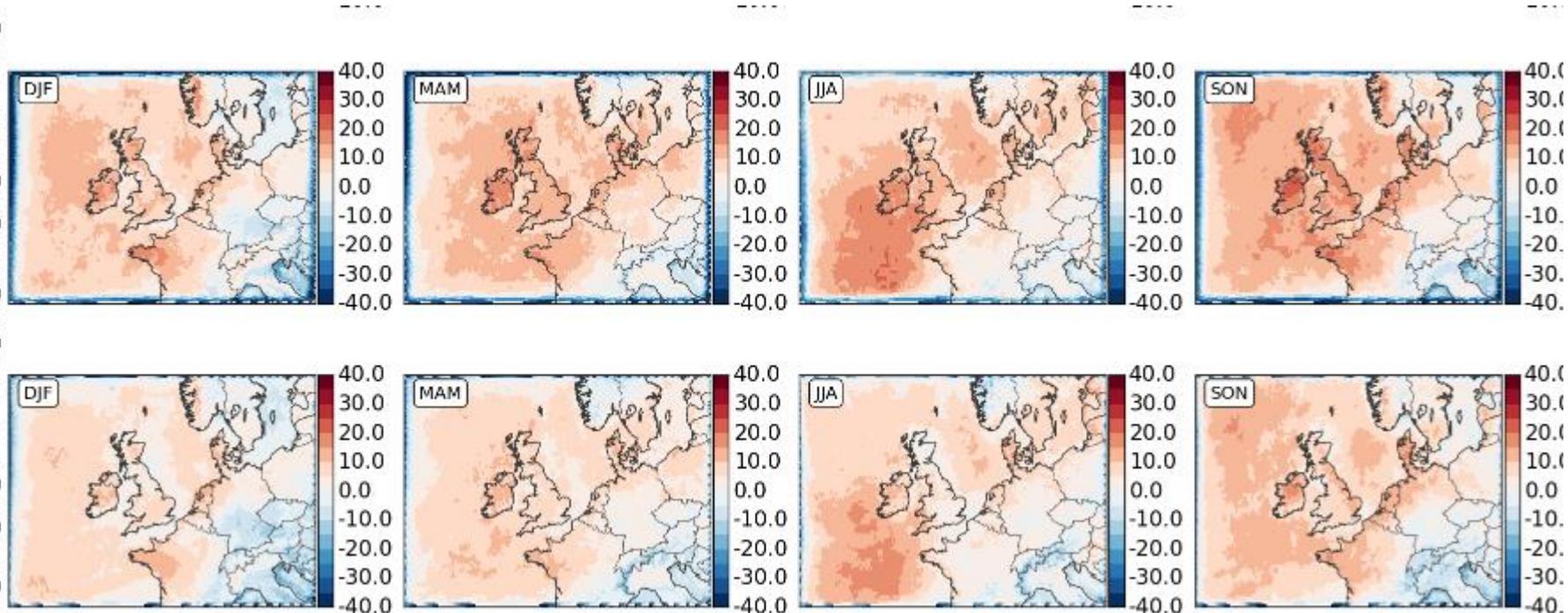
We need to do more experiments but HCLIM-AROME at 3 km is too expensive. Could we use HCLIM-AROME at 12 km in our tests? -> For answer this question we run at 12 km with the same settings to see if the results are comparable to the 3 km simulation.

Let's see what happened...

clt - clara\_a2 (%)

Upper row HCLIM43-ARO-12 , lower row HCLIM43-ARO-3

HCLIM43\_ARO3\_REF\_DIN3K - CLARA\_A2 - CLARA\_A2

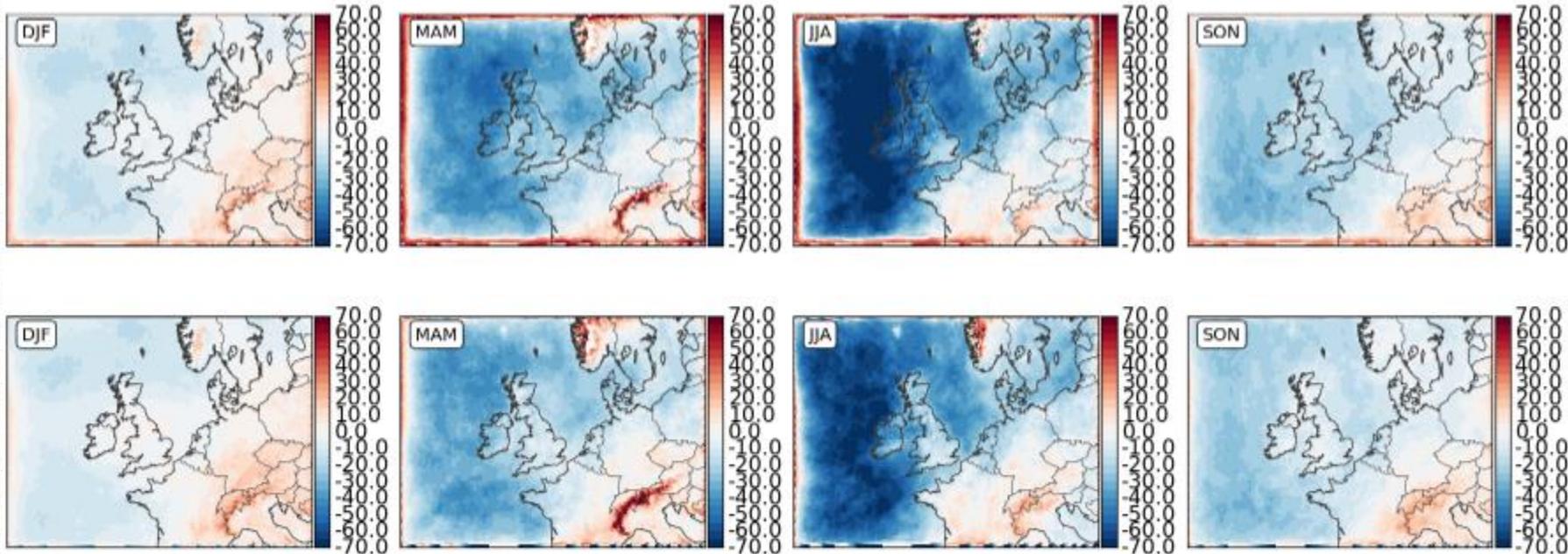


HCLIM43-ARO-12 and HCLIM43-ARO-3 are comparable (also for rsds and hfls). So, we can do tests at lower resolution

rsds - era5 (Wm-2)

Upper row HCLIM43-ARO-12 , lower row HCLIM43-ARO-3

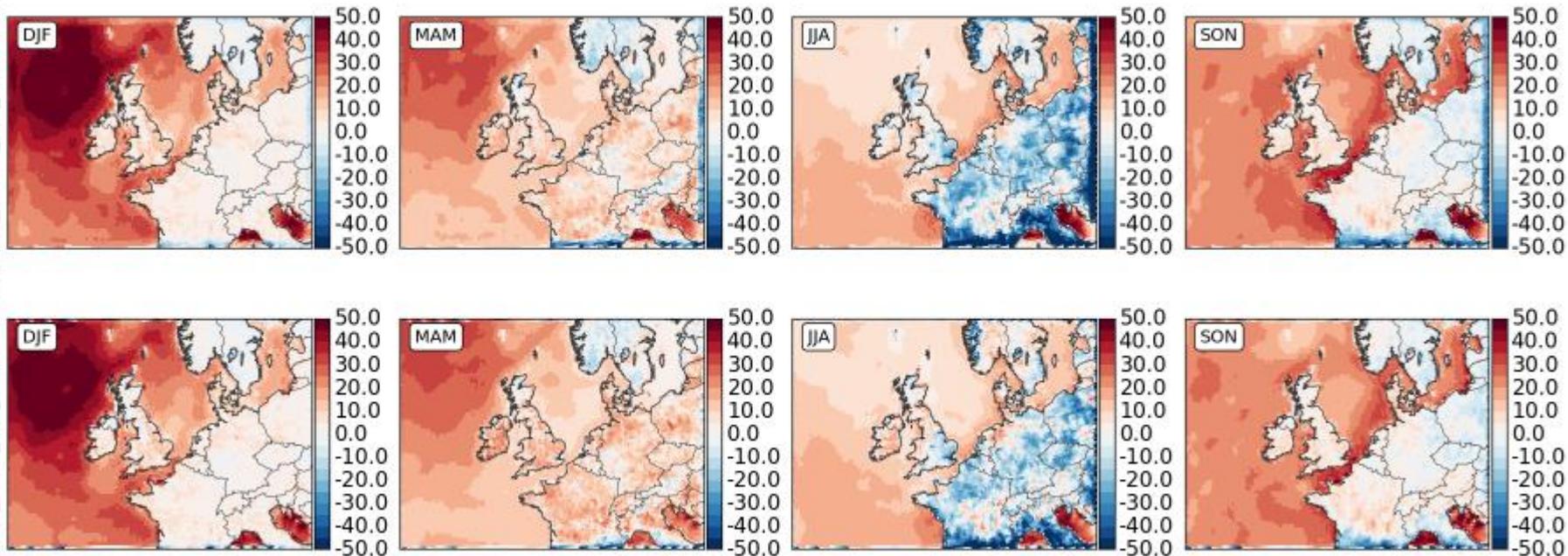
HCLIM43\_ARO3\_REF\_DIN3K - CLARA2\_14023\_ARO12\_REF\_DIN12K - CLARA\_A



# hfls - era5 (Wm-2)

Upper row HCLIM43-ARO-12 , lower row HCLIM43-ARO-3

HCLIM43\_ARO3\_REF\_DIN3K - ERA5 HCLIM43\_ARO12\_REF\_DIN12K - ERA5

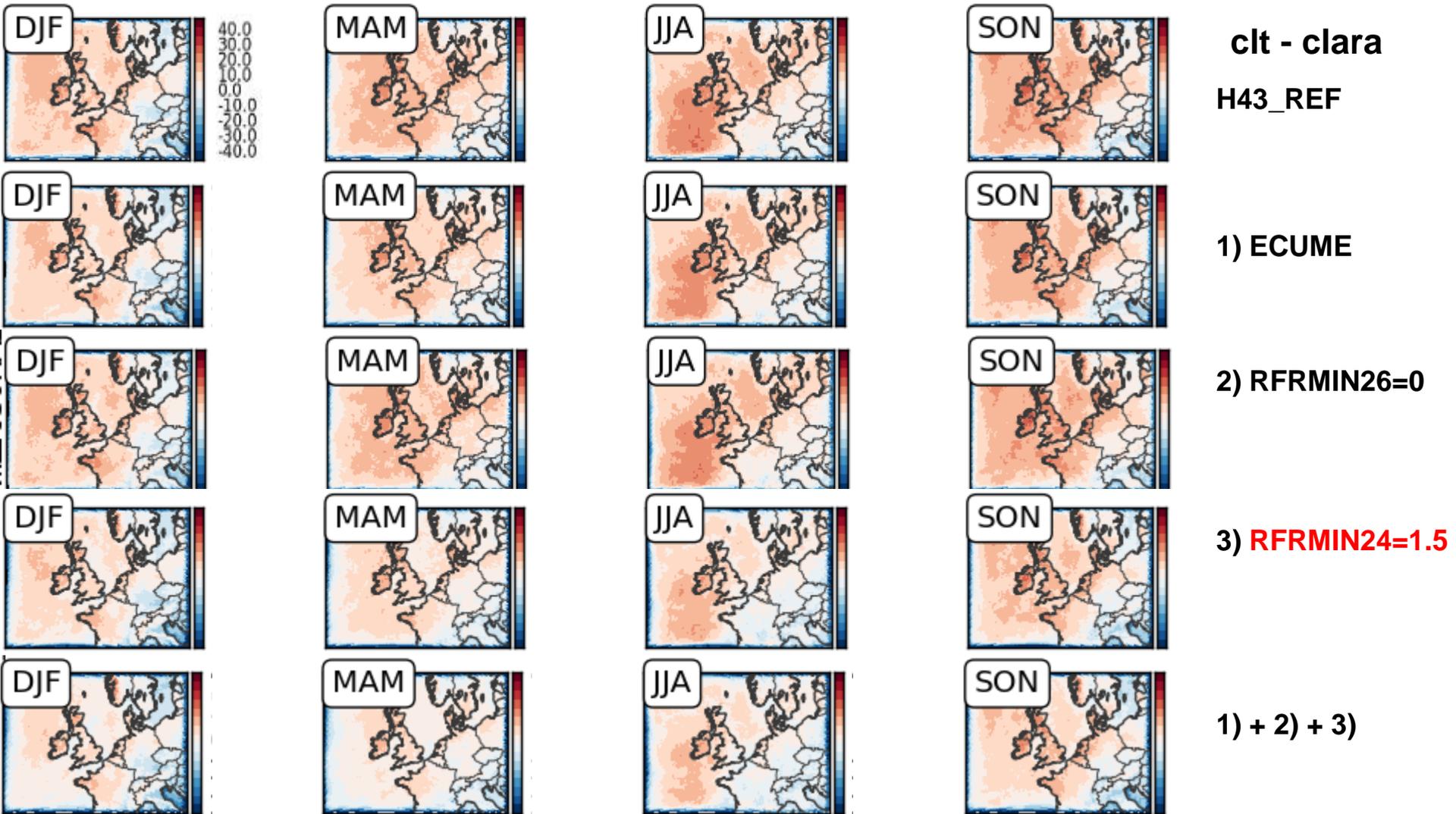


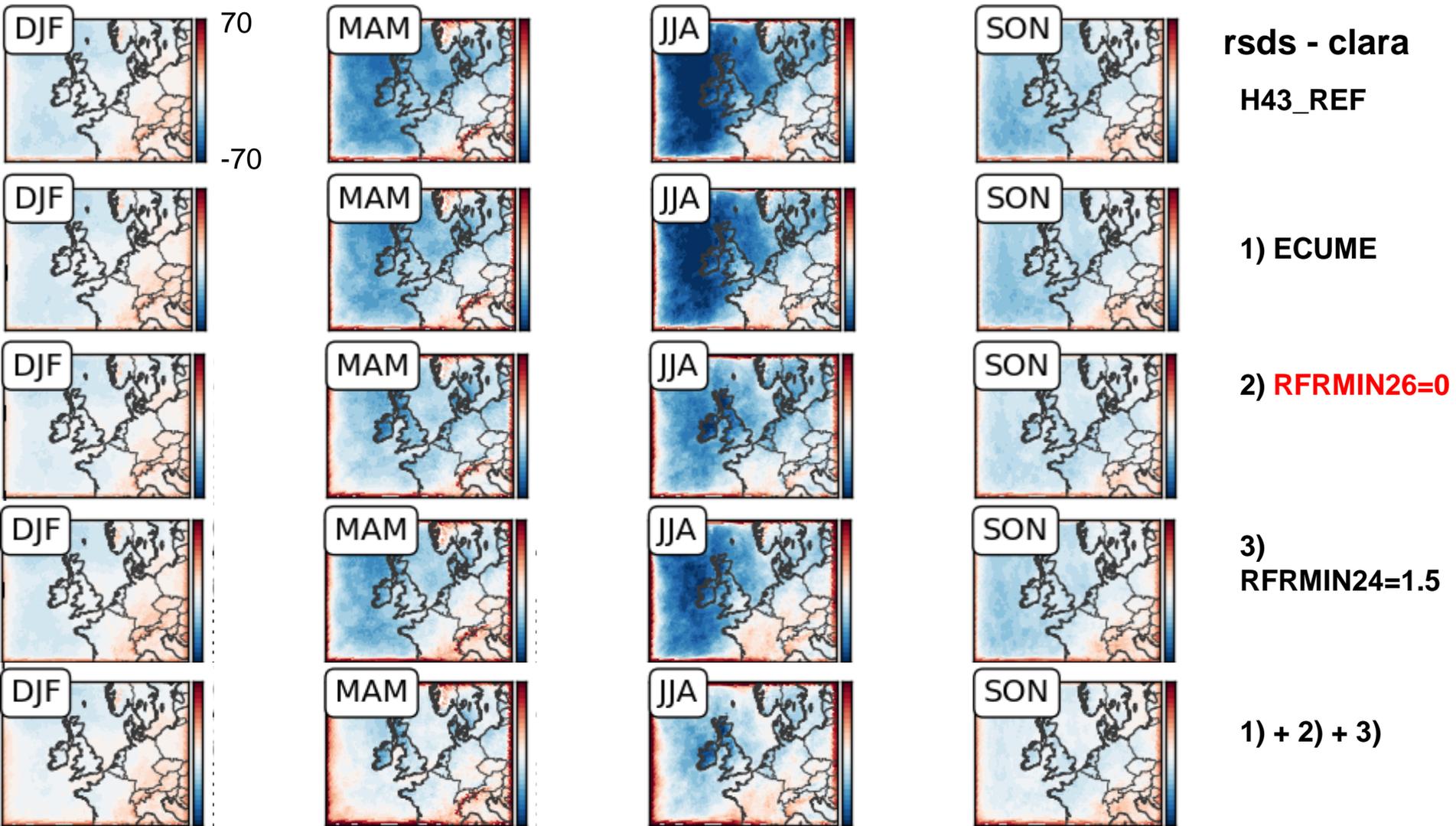
HCLIM43-ARO-12 and HCLIM43-ARO-3 are comparable. We can do tests at lower resolution

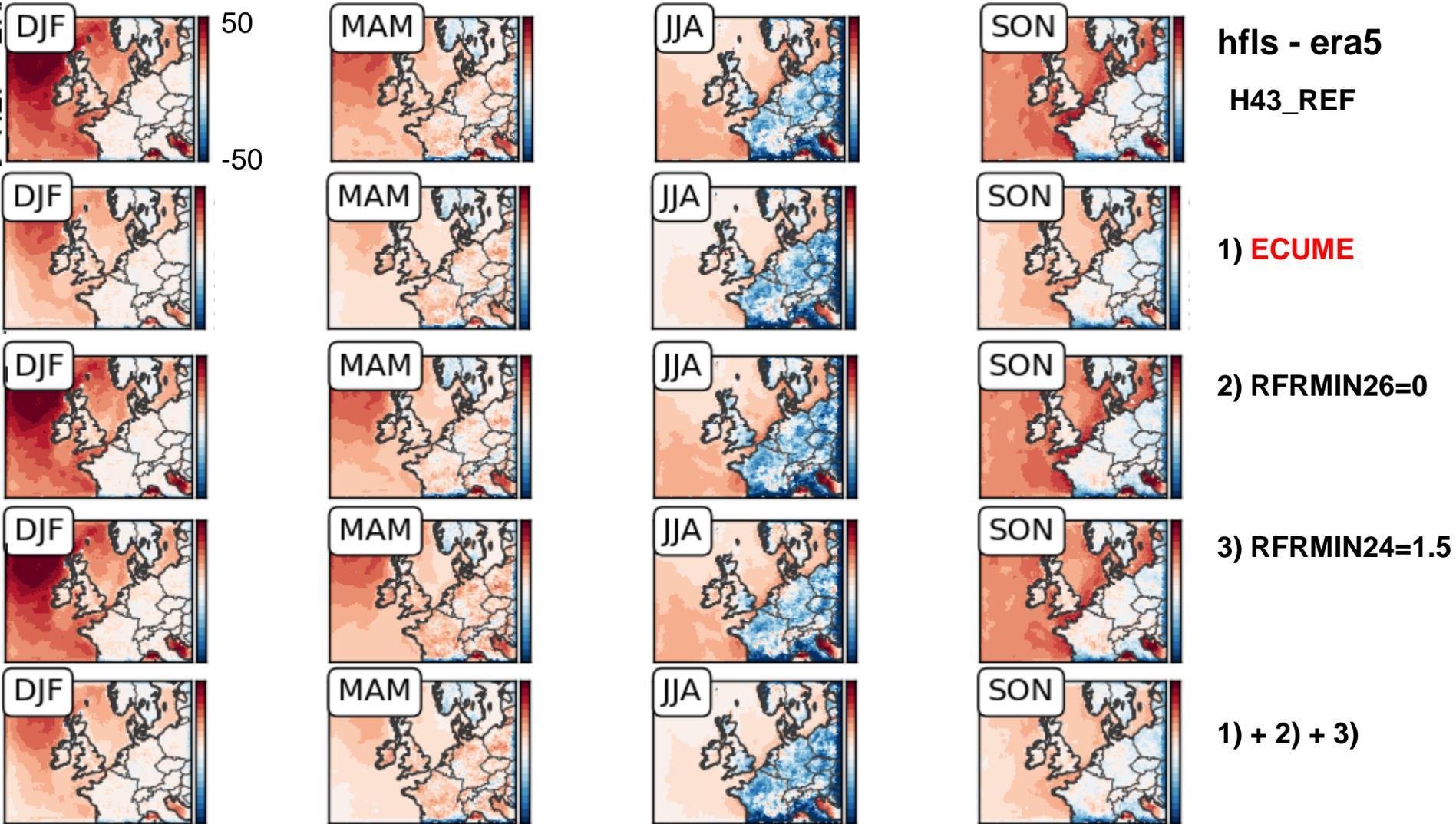
# HCLIM43-AROME evaluation

## Some tests to understand the bias in clt, rsds, hfls

- **RFRMIN(26)=0** (same as previously in HCLIM-43hc2.1-rc.1). The droplets number is 100 for sea and 300 for land (less droplets, mainly in sea) and constant in the vertical.
  - Now RFRMIN(26)=250E6 in HCLIM-43hc2.1-rc.3: with RFRMIN(22)=0.25 and RFRMIN(29)=1000 gives a CCN number of 62 (0.25 x 250) at the surface, 225 at 1000 m and slowly decreasing with pressure above that.
- Karl-Ivar suggests **RADSN = 0.5 and RADGR = 0.25** when using ECUME6 (now they equal 1 and 0.5 in HCLIM-43hc2.1-rc.3 with ECUME6).
- **CSEA\_FLUX=ECUME**, same as previously in HCLIM-43hc2.1-rc.1
- There are some namelists settings related with RFRMIN array ([http://www.umr-cnrm.fr/accord/IMG/pdf/kii\\_metcoop\\_phys\\_202104.pdf](http://www.umr-cnrm.fr/accord/IMG/pdf/kii_metcoop_phys_202104.pdf)). Currently RFRMIN(24) = 2.5, but higher value leads to more low clouds. Test **RFRMIN(24) = 1.5** as in HCLIM-43hc2.1-rc.1
- Also, we test a combination of previous beneficial parameters:  
**ECUME + RFRMIN26=0 + RFRMIN24=1.5**



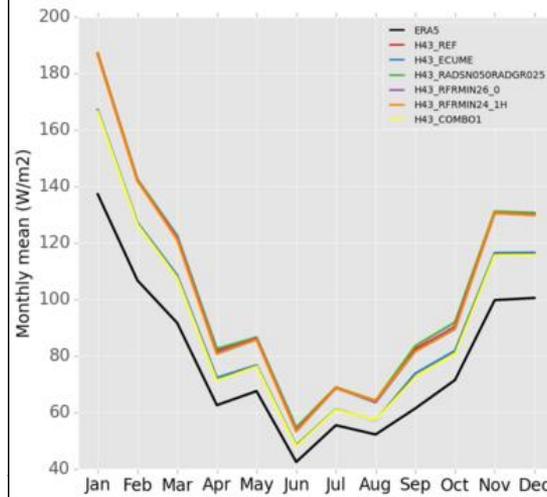




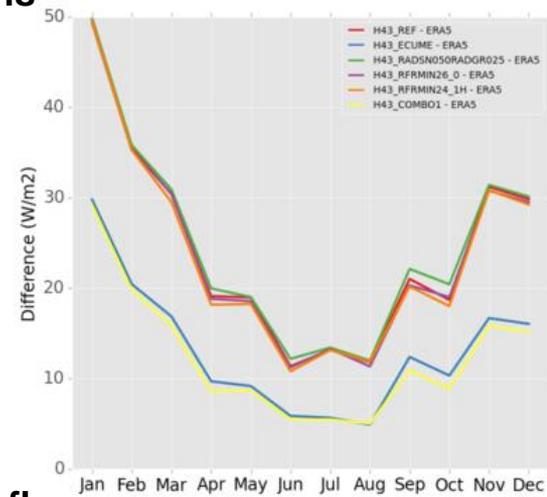
# HCLIM43-AROME evaluation

- H43\_Ref **red**
- H43\_ECUME **blue**
- H43\_RADSN = 0.5 and RADGR = 0.25 **green**
- H43\_RFRMIN26=0 **purple**
- RFRMIN(24) = 1.5 **orange**
- ECUME+RFRMIN26=0+RFRMIN(24) = 1.5 **yellow**

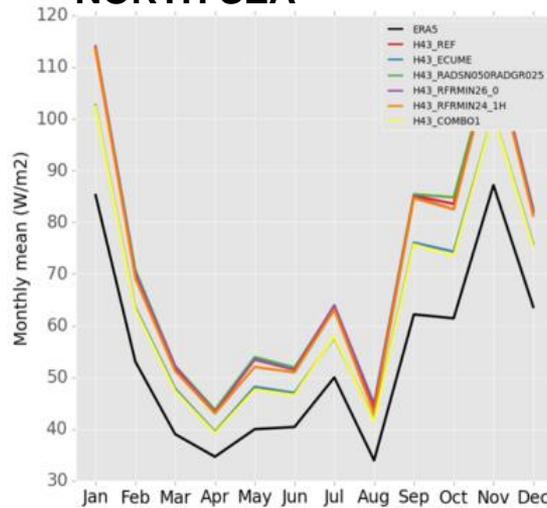
## ATLANTIC



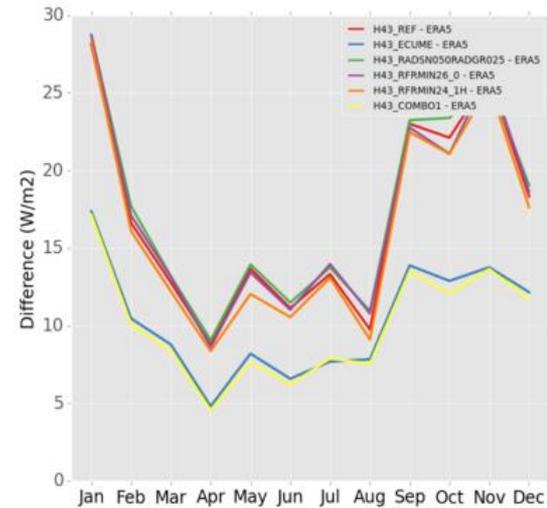
## hfls



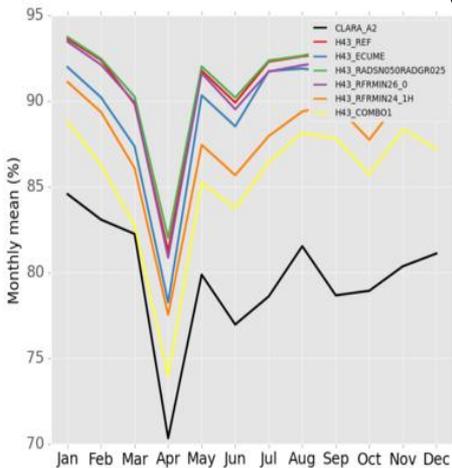
## NORTH SEA



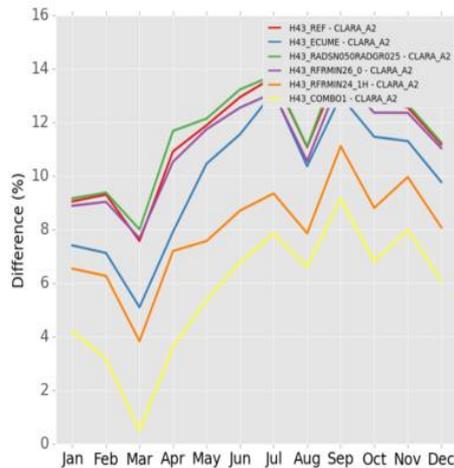
## hfls



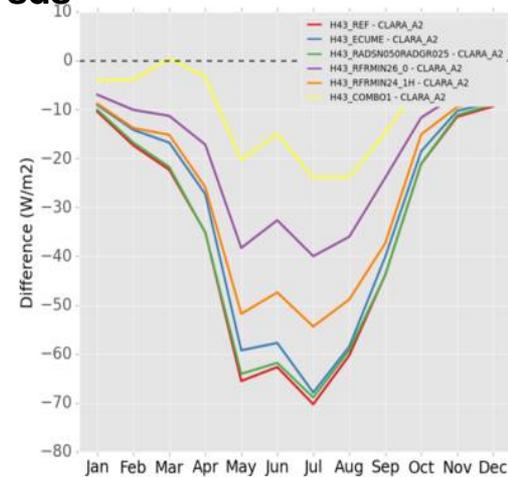
clt



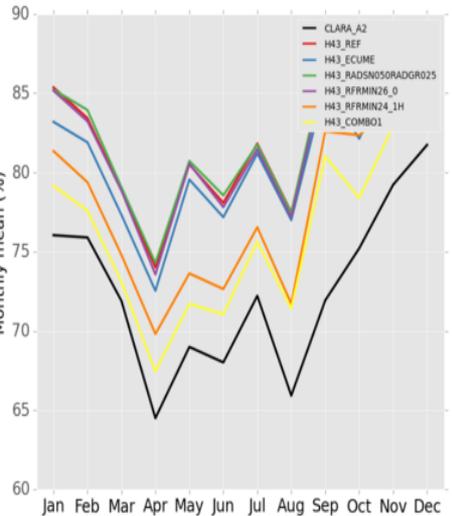
ATLANTIC



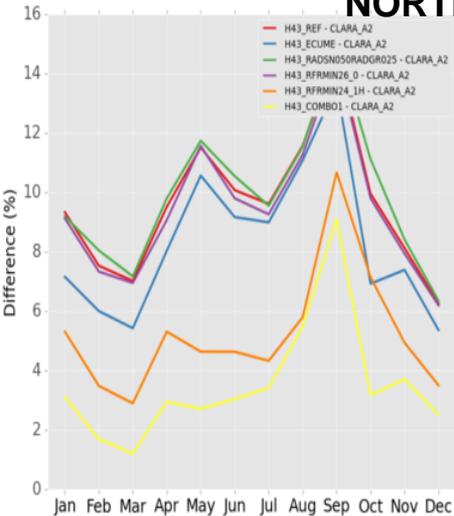
rsds



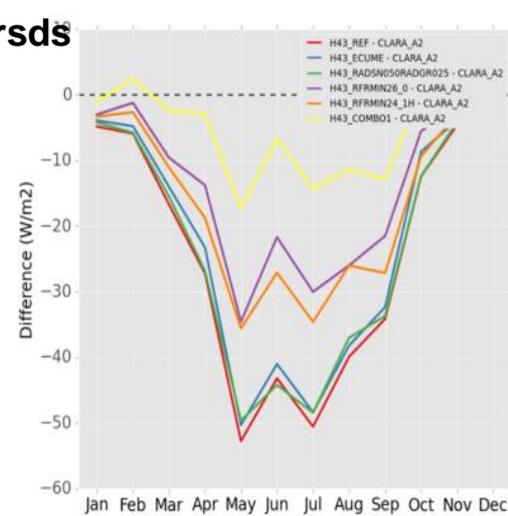
clt



NORTH SEA

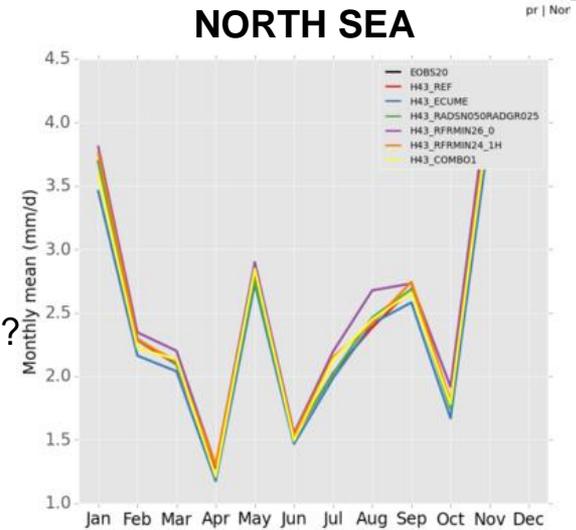
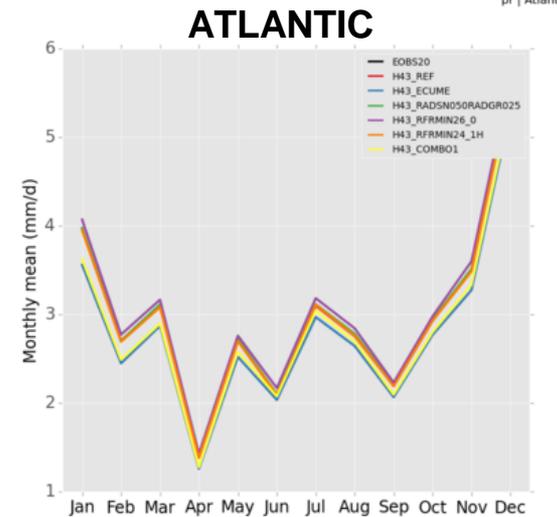
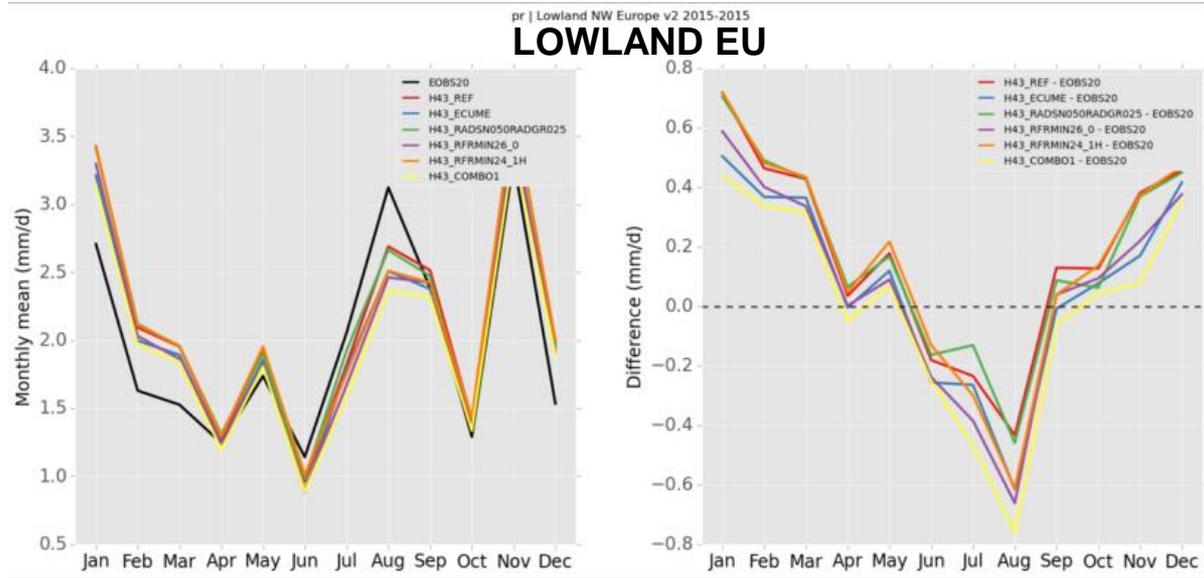


rsds



# HCLIM43-AROME evaluation

But it comes with a cost... Worse pcp in summer over land in some places



¿Could these tunings affect the more extreme convective precipitation events?

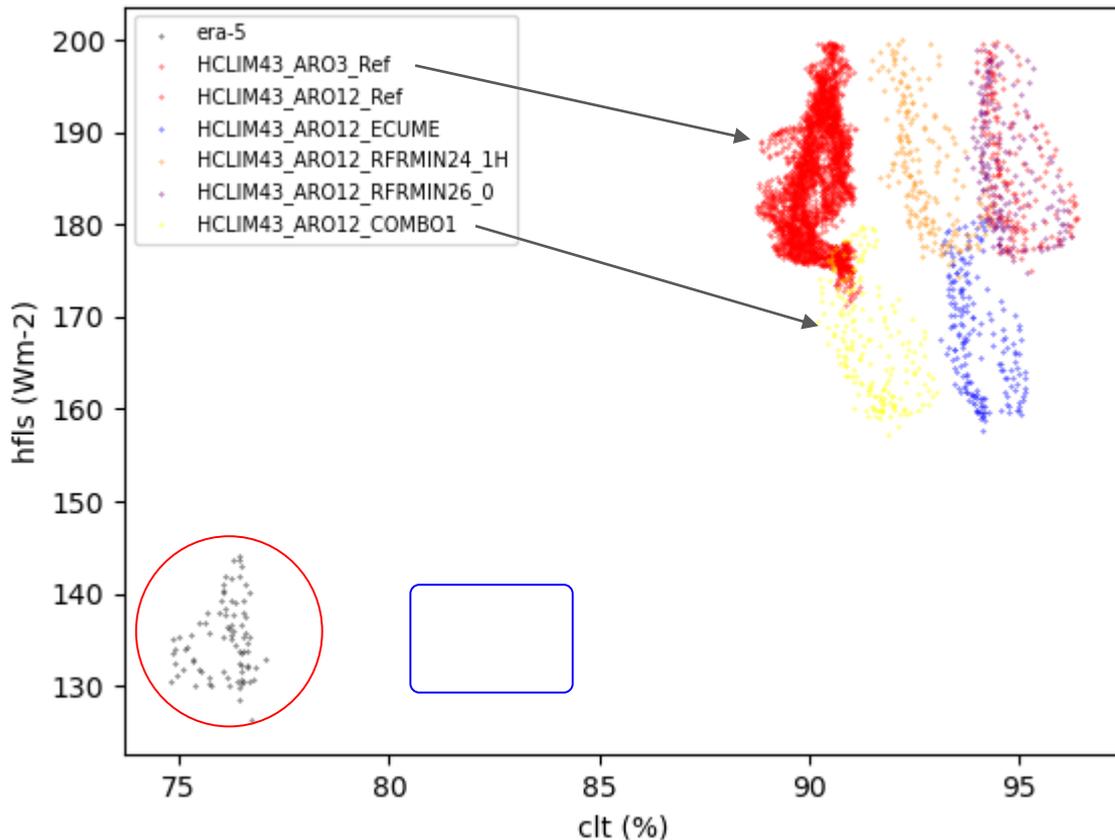
In the ocean domain there are no EOBS pcp data to compare with but the graphs show that all experiments are very close to each other

# HCLIM43-AROME evaluation

2015-01 monthly means in  
selected zone over the  
Atlantic ocean

**hfls vs. clt** scatter plots  
for different experiments

More dense cloud of points  
correspond to 3km reference  
sim. The observations are  
circled and the blue square  
marks the place where clara  
obs would lie in the plot.  
There not seems to be much  
correlation between the two  
vars neither in obs nor in  
simulations

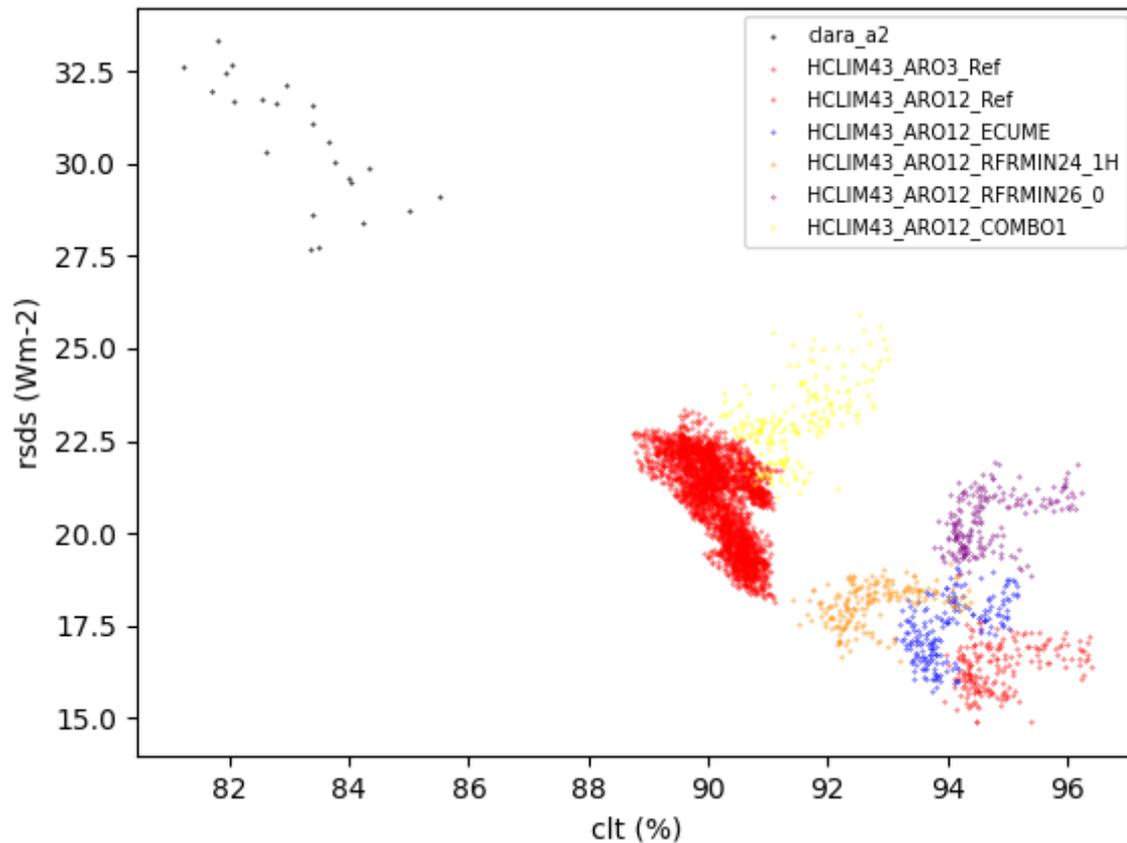


# HCLIM43-AROME evaluation

2015-01 monthly means in selected zone over the Atlantic ocean

## **rsds vs. clt**

It is observed a correlation between rsds and clt, reproduced by 3km AROME but not at 12 km

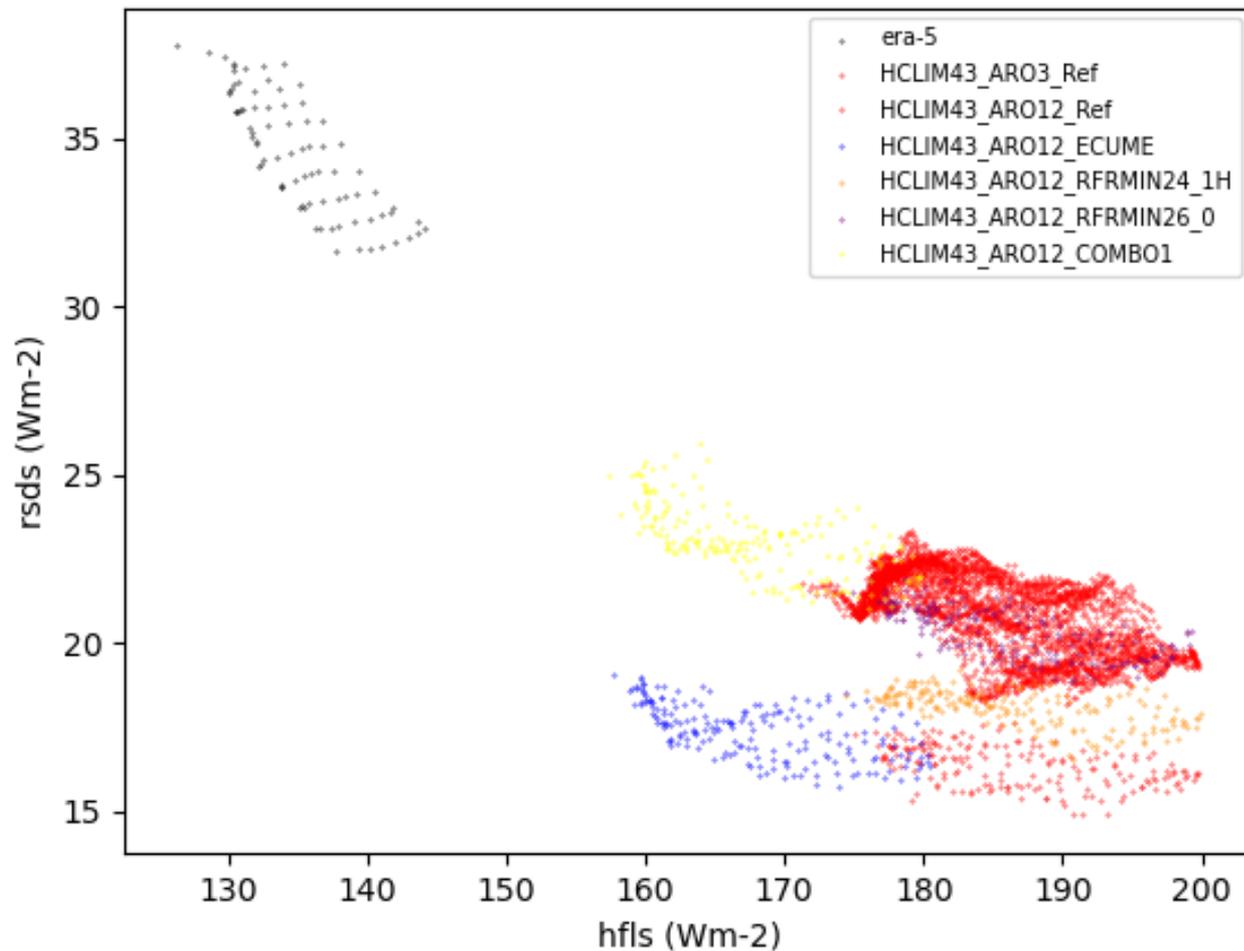


# HCLIM43-AROME evaluation

2015-01 monthly means in selected zone over the Atlantic ocean

## rsds vs. hfls

It is observed a correlation between rsds and hfls. The experiments show some correlation but not the same slope as the data.



# Conclusions for HCLIM43-AROME

- HCLIM43 has a comparable performance to previous HCLIM38 but some variables show strong biases in the default configuration
- Experiments point to cloud processes and energy fluxes with feedbacks between them
- Different behaviour between land and ocean
- Tuning some parameters seem to improve the results. Is it possible further tuning? Too much tuning can affect long simulations
- The process of tuning and testing is slow and expensive. Is there a way of know a-priori the impact or at least narrow the range and number of parameters?

# Future work

- Continue evaluation with HCLIM43-AROME
- Include aerosols
- Use HCLIM43 for CORDEX simulations
- Start the HCLIM46 configuration and testing
- Work in the coupling of HCLIM with other subsystems: ocean, hydrology, ...
- Development of RCAT and new evaluation methods