

Characterizing and understanding large-scale GCM-RCM inconsistencies in future projections: the European Summer case study

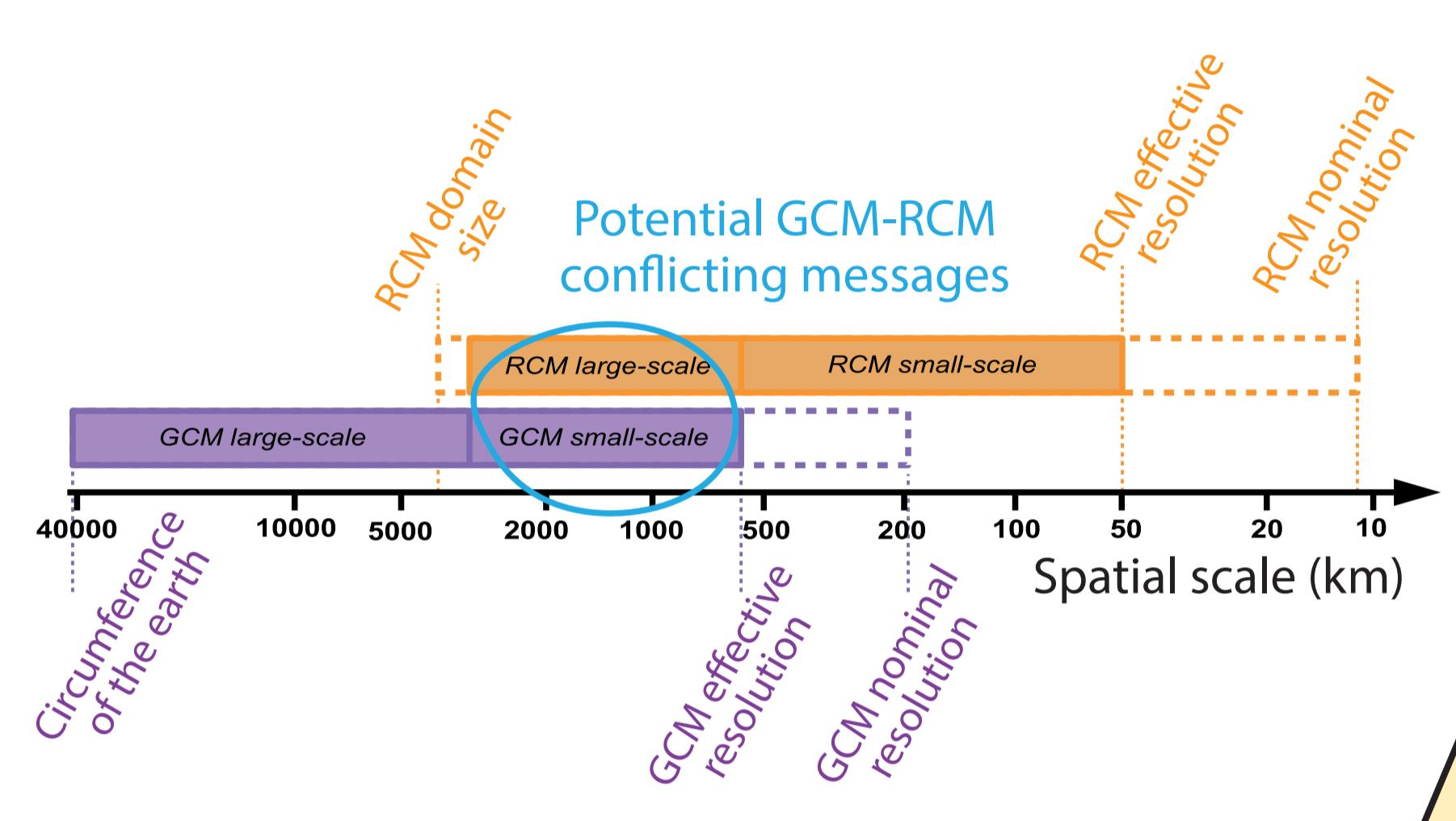
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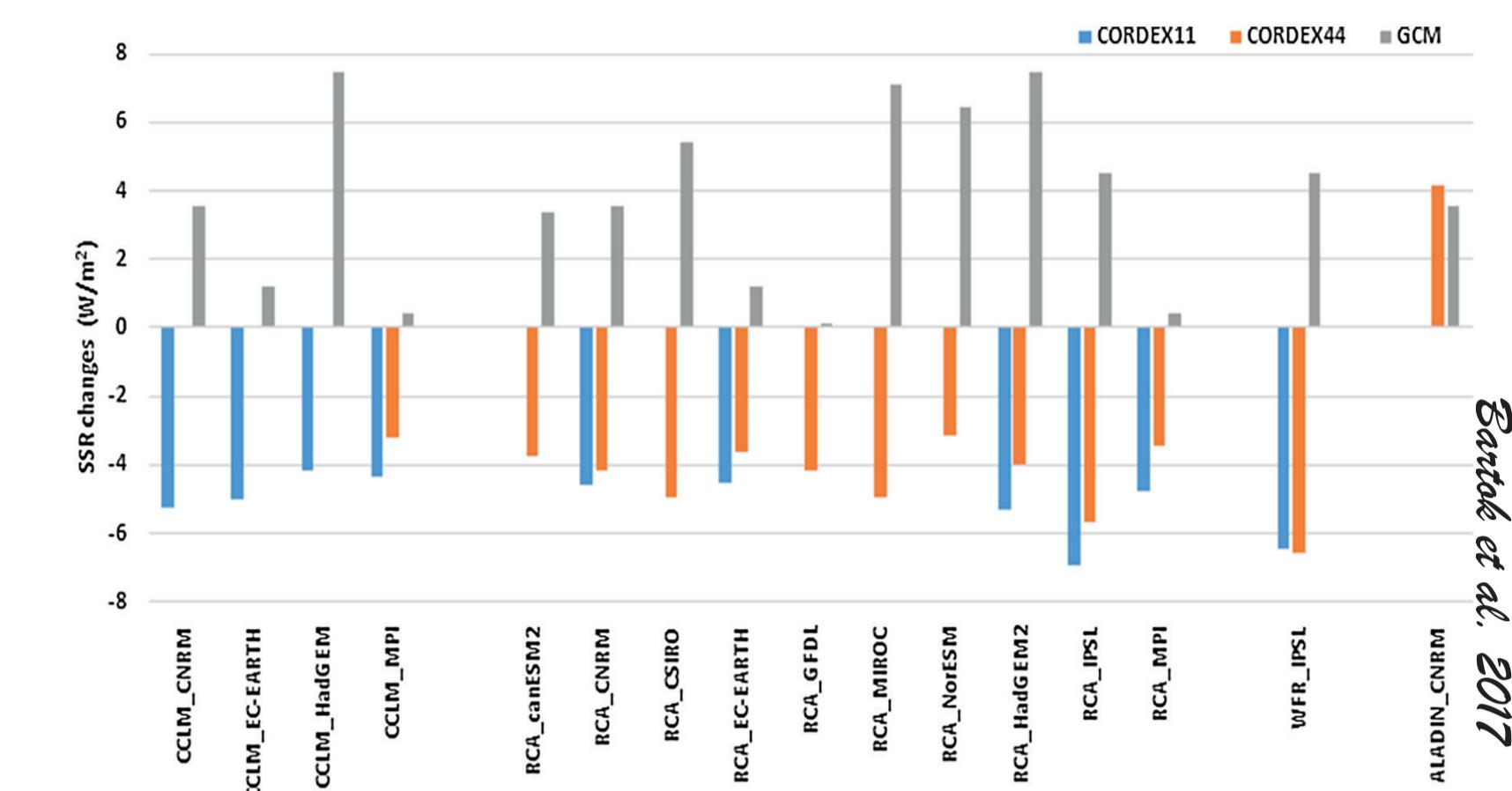
MOTIVATIONS

- RCMs show added-value at small scales and for extremes
- However significant large-scale inconsistencies between GCMs and RCMs in future projections have been reported for various key variables
- Based on published literature, we use the European Summertime climate change to illustrate this issue by
 - (1) assessing the level of inconsistency in GCM-RCM 12-km EURO-CORDEX pairs,
 - (2) proposing a GCM-RCM inconsistency metric generalisable to any GCM-RCM pair and CORDEX domain,
 - (3) quantifying the minimal inconsistency level in a so-called "perfect" GCM-RCM pair (see ALD150 below),
 - (4) investigating the possible causes of the detected GCM-RCM inconsistencies: differences in external forcings, resolution, model physics

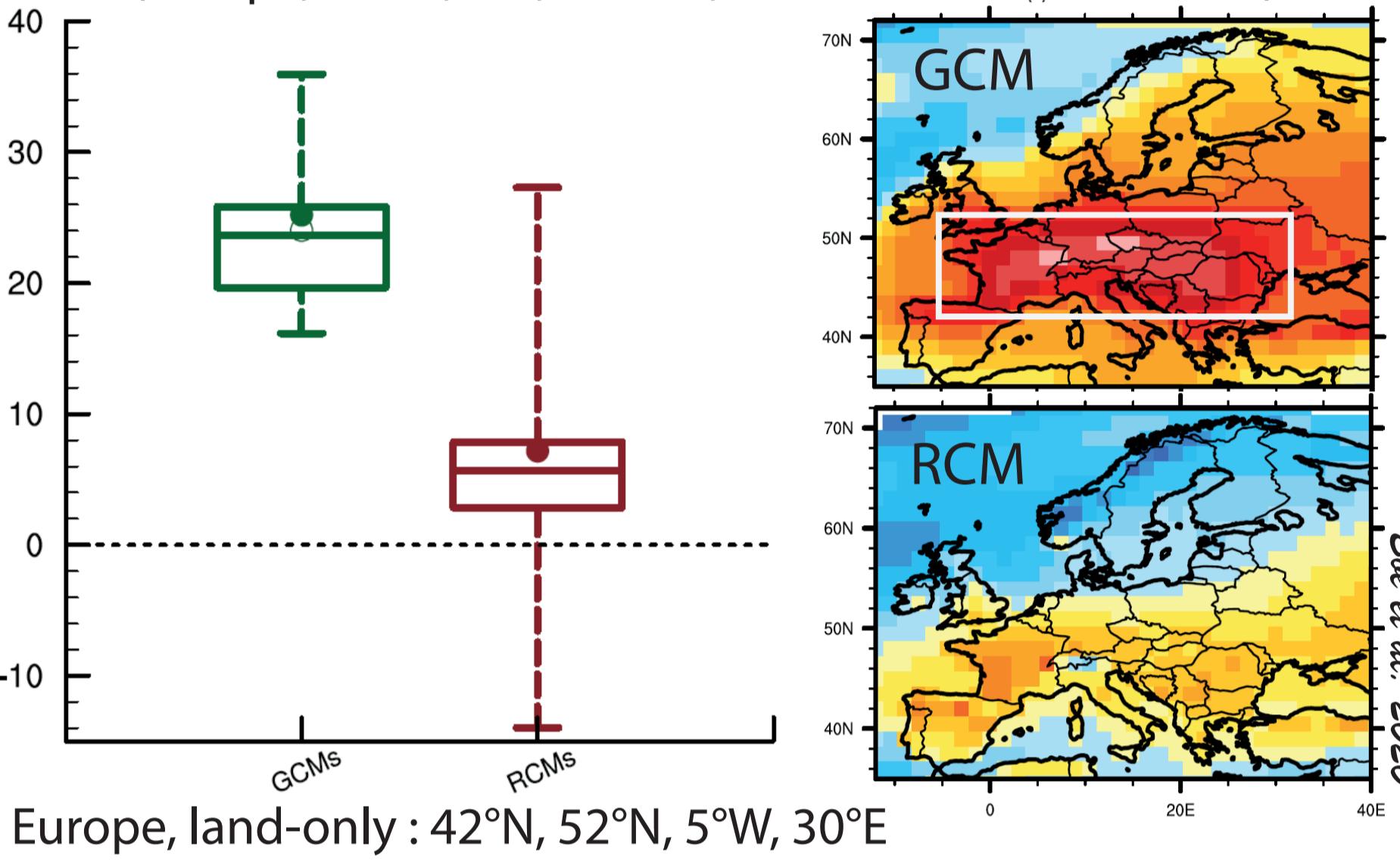


INCONSISTENCY ASSESSMENT

Change in surface shortwave radiation
(Europe, W/m², 2071-2100 vs 1971-2005, RCP8.5, Annual)

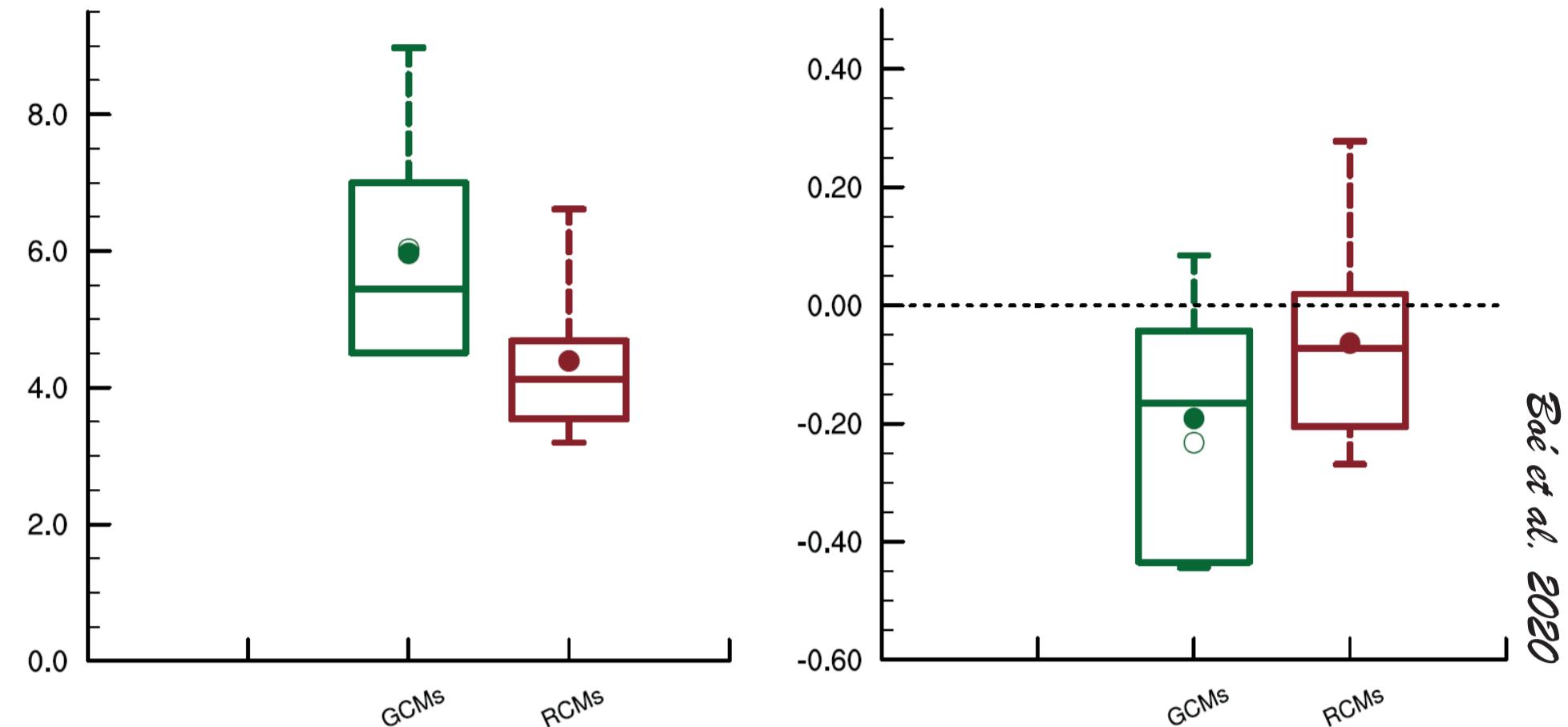


Change in surface solar radiation
(Europe, W/m², JJA, RCP8.5, 2070-2099 vs 1970-1999)



Keywords : Regional climate models, Europe, Summer, CORDEX, Confidence, Future projections, Inconsistency

Change in Temperature (°C) and Precipitation (No Unit)
(Europe, JJA, RCP8.5, 2070-2099 vs 1970-1999)



Level of large-scale GCM-RCM inconsistency in projection
% of statistically significant land grid boxes,
JJA, 48 EURO-CDX runs, 2070-2099 vs 1970-1999, RCP8.5

	Euro-CDX	TAS	RSDS	PR	EVPSBL	CLT	PSL	Mean
MM5	73	77	37	61	60	58	61	[20,40]
MIN	30	29	8	22	19	6	19	[40,60]
MAX	99	96	74	92	96	100	93	[60,80]
BEST*	30	29	12	42	36	52	34	[80,100]
WORST**	91	93	61	83	96	86	85	

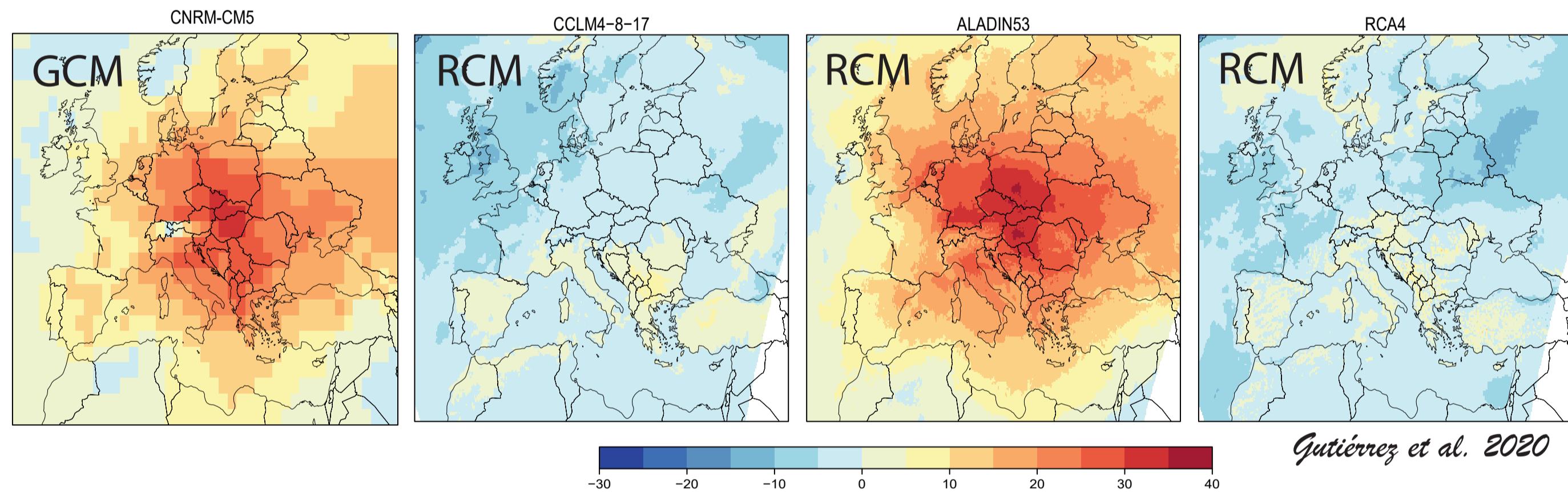
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*: the best pair is CNRM-CMS / CNRM-ALADIN63

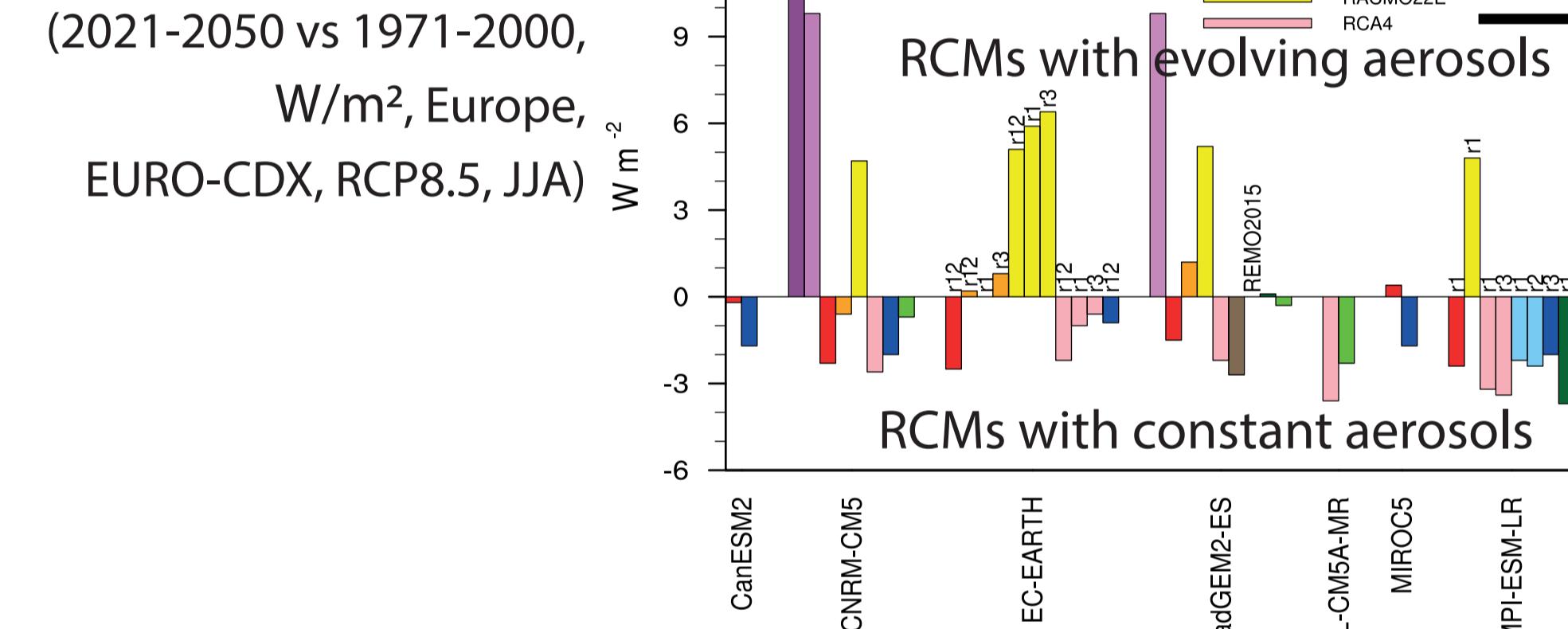
**: the worst pair is MOHC-HadGEM2-ES / CLMcom-ETH-COSMO-crCLIM-v1-1

ANALYSIS of the EURO-CORDEX 12-km ENSEMBLE

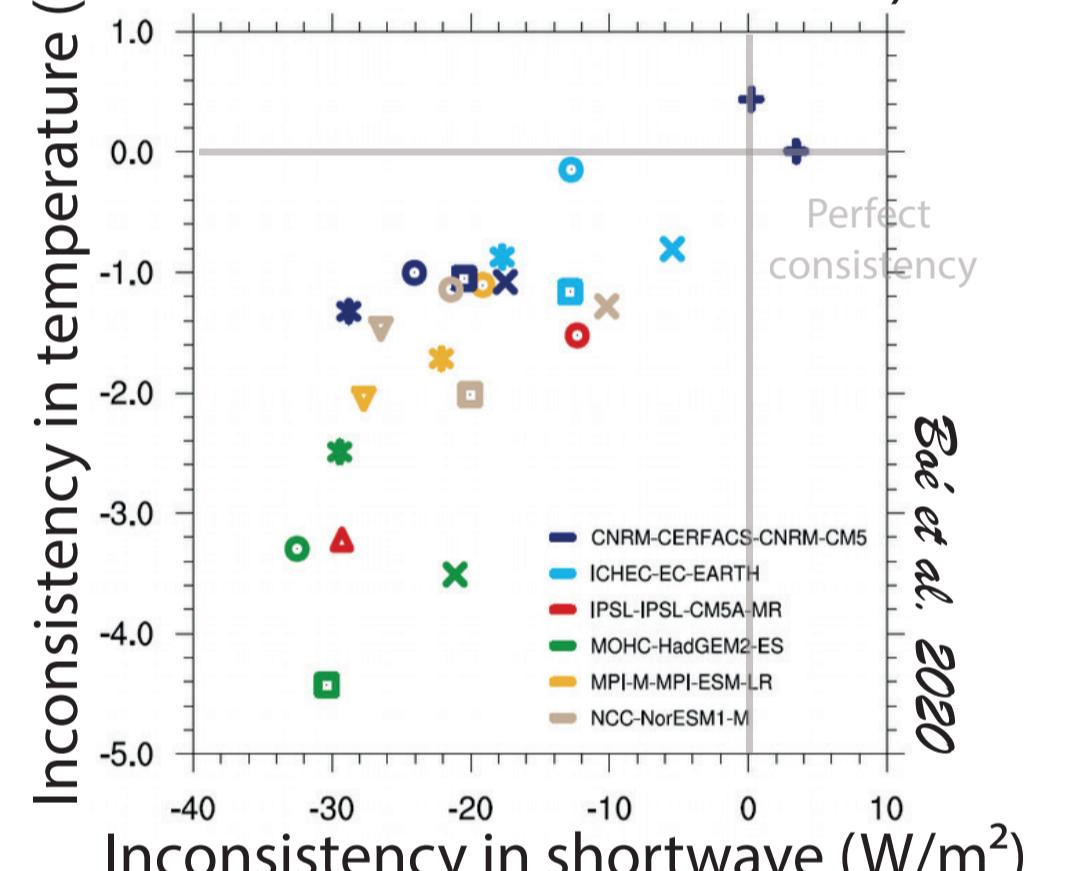
Change in surface shortwave radiation (W/m², JJA, RCP8.5, 2021-2050 vs 1970-1999)



Change in surface shortwave radiation
(2021-2050 vs 1971-2000, W/m², Europe, EURO-CDX, RCP8.5, JJA)

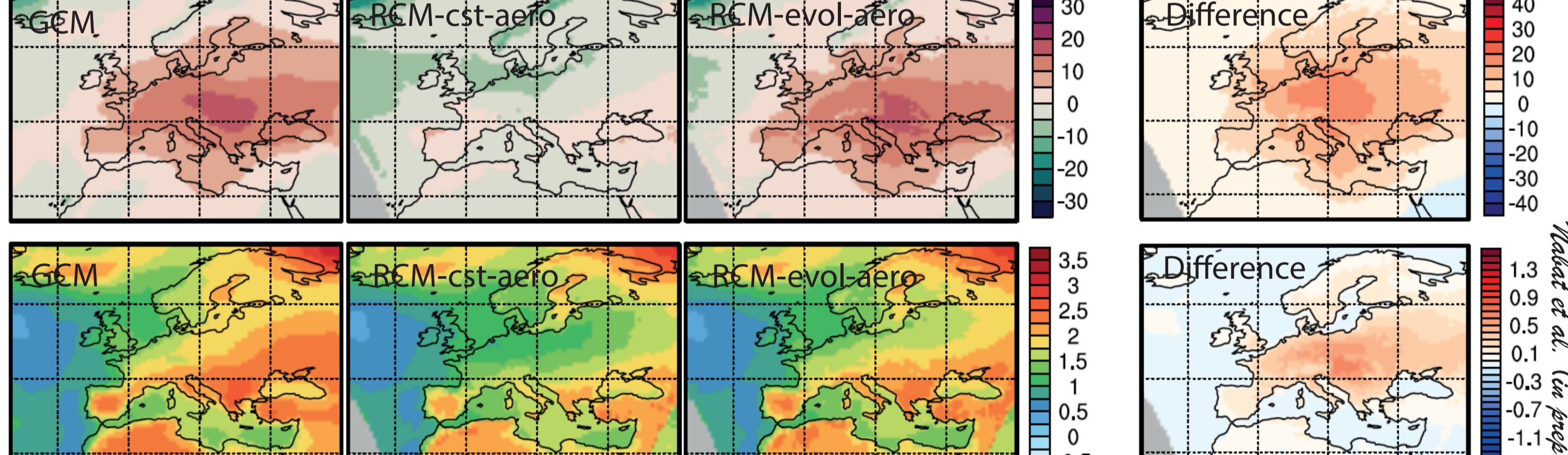


GCM-RCM signal difference
(Europe, JJA, RCP8.5, 2070-2099 vs 1970-1999)



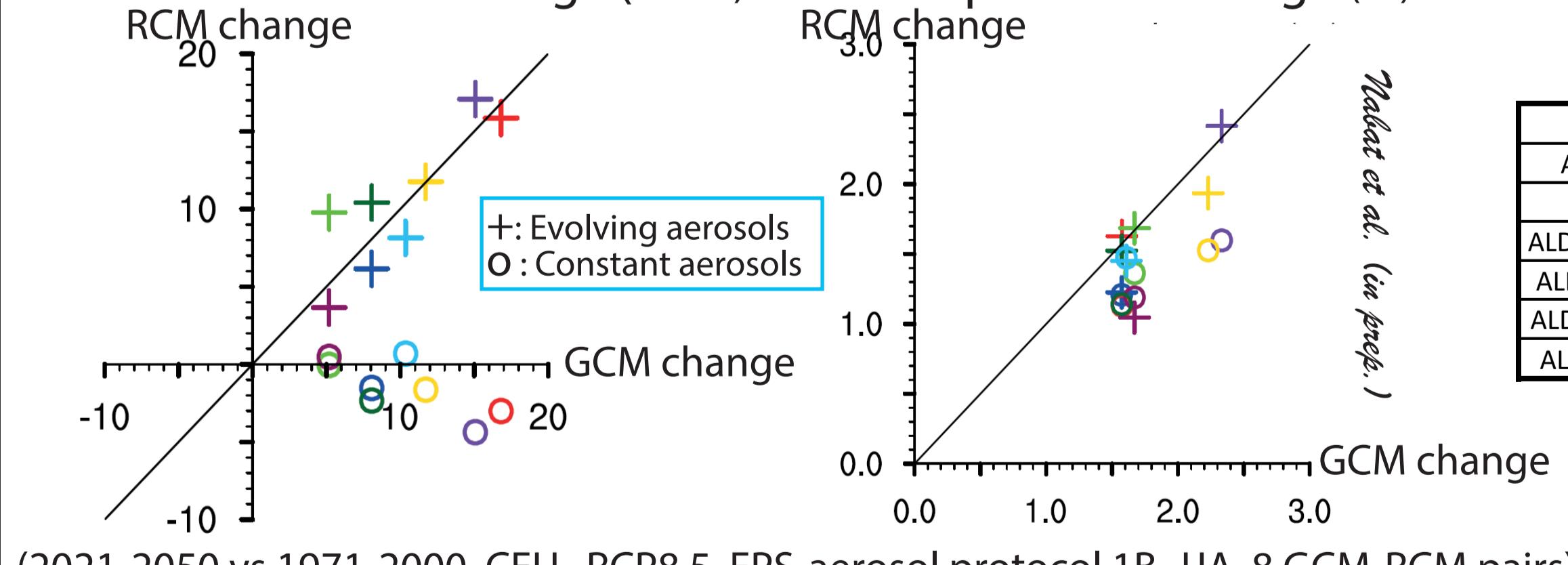
DEDICATED SENSITIVITY EXPERIMENTS

Change in surface shortwave radiation and temperature
(2021-2050 vs 1971-2000, W/m², °C, Europe, FPS-aerosol, RCP8.5, JJA)



SWsurf radiation change (W/m²)

Temperature change (°C)

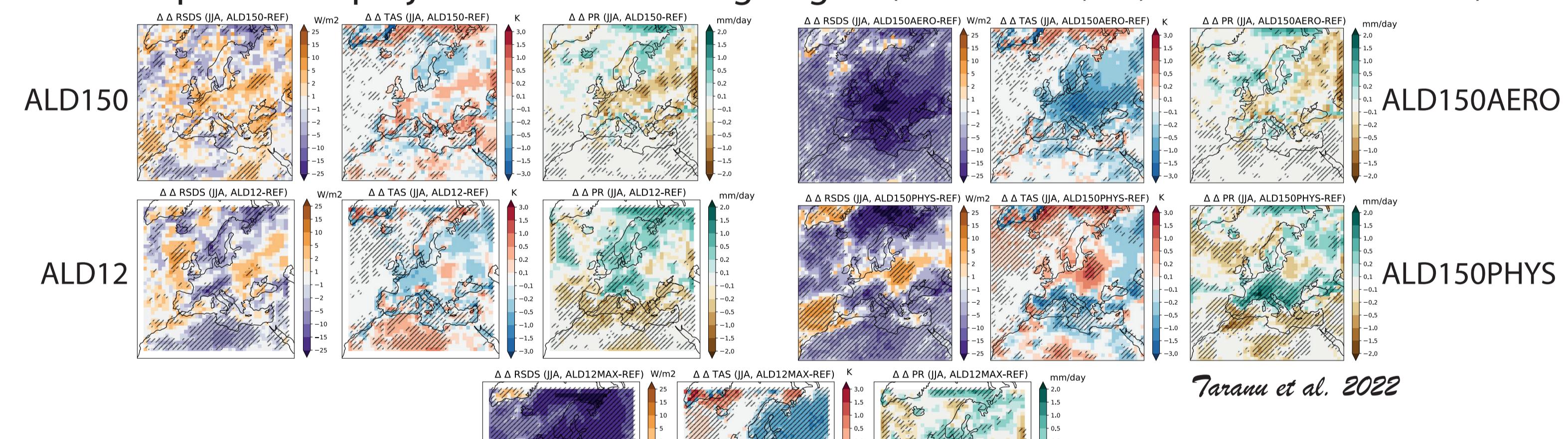


Level of GCM-RCM inconsistency
% of Europe land grid boxes, JJA,
2071-2100 vs 1970-1999, RCP8.5

Model	TAS	RSDS	PR	EVPSBL	CLT	PSL	Mean
ALD150	10.5	12.0	26.6	35.1	7.4	6.8	16.4
ALD12	22.3	29.3	34.3	44.1	24.2	10.3	27.4
ALD150AERO	39.5	96.9	23.2	35.2	10.1	41.0	41.0
ALD150CO2	19.0	7.2	17.0	39.5	5.2	21.0	18.1
ALD150PHYS	20.8	58.3	41.5	57.7	46.7	41.0	44.3
ALD12MAX	76.2	100.0	52.2	60.5	45.2	61.6	66.0

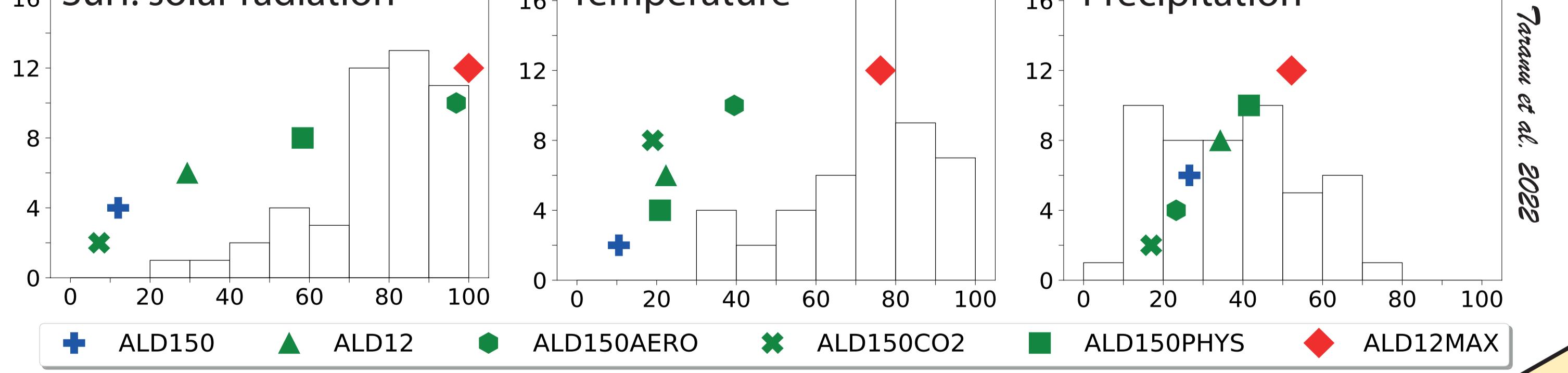
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Discrepancies in projected climate change signal (RCM - refGCM, JJA, 2070-2099 vs 1970-1999)



Incoherence fraction (%)

% of Europe land grid box 2070-2099 vs 1970-1999, Europe, EURO-CDX, RCP8.5, JJA)



CONCLUSIONS

- Large-scale inconsistencies between GCMs and RCMs in future projections for the European Summertime climate change are robust and significant for various key climate variables : surface shortwave radiation, temperature, precipitation, ...
- Inconsistencies are detected for most of the EURO-CORDEX simulations, for different climate warming levels, at different spatial scales and with different methodological approaches
- A perfect pair in which GCM and RCM share the same resolution, physics, forcings and level of complexity show a low level of inconsistency
- Higher resolution in RCMs can not explain the identified large-scale inconsistencies in EURO-CORDEX
- Difference in external forcings (e.g. aerosols) and difference in physics are the main explaining factors
- Today it is likely that, at large-scale, RCMs are not always a better source of information than GCMs
- Our findings have important implications for the use of current CORDEX runs in the climate services and for the development of the CORDEX-CMIP6 RCM-based simulations

REFERENCES

- Bartok et al. 2017, Clim. Dyn., doi: 10.1007/s00382-016-3471-2
- Sørland et al. 2018, ERL, doi: 10.1088/1748-9326/aacc77
- Gutiérrez et al. 2020, GRL, doi: 10.1088/1748-9326/ab6666
- Boé et al. 2020, Clim. Dyn., doi: 10.1007/s00382-020-05153-1
- Coppola et al. 2021, Clim. Dyn., doi: 10.1029/2019JD032356
- Taranu et al. 2022, Clim. Dyn., doi: 10.1007/s00382-022-06540-6
- Nabat et al. (in prep.) Assessing the role of anthropogenic aerosols in GCM-RCM conflicting messages for European Summertime climate change

Lets' finish with 3 questions
(you can answer without reading the poster before)

Q1



Q2



Q3

