



Supplement of

Sensitivity of surface solar radiation to aerosol–radiation and aerosol–cloud interactions over Europe in WRFv3.6.1 climatic runs with fully interactive aerosols

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Supplementary Figure S1. Spatial domains used for the WRF simulations. The outer domain (gray shaded) has an horizontal resolution of 1.32° in latitude and longitude; the inner target domain (colored) of 0.44° (Euro-Cordex compliant). The nesting was one-way (outer-to-inner domain).

RSDS JJA climatologies for 1991-2010



Supplementary Figure S2. RSDS summer climatologies in the historical period from the GCM (a), ERA5 (b) and the WRF simulations (d to f); units: Wm^{-2} , same colorbar in all cases (the upper one). Panel c depicts relative differences between the GCM and ERA5, panels g to i between each WRF simulation and the GCM, and panels j to l between each WRF simulation and ERA5, squared if statistically significant (p<0.05); units: %, same colorbar in all cases (the bottom one).

(a) RSDS ARI-BASE (b) RSDS ARCI-BASE (c) RSDS ARCI-ARI × m

(e) CCT ARCI-BASE

 $s_{-}corr$ with (b) = -0.75

(d) CCT ARI-BASE $s_{-}corr$ with (a) = -0.75



(g) AOD ARI

 s_corr with (a) = -0.15

(h) AOD ARCI







 ${\rm Wm^{-2}}$ 10

8 6 4 2 0 -2 -4 -6 -8 -10

5

4 3 2 1 0 -1 -2 -3 _4 -5

(i) AOD ARCI-ARI $s_{-}corr$ with (c) = -0.05



Supplementary Figure S3. As Figure 1 of the main manuscript but with plain differences depicted (non-relative values). Units: RSDS in Wm^{-2} , CCT in % of the grid cell area, AOD dimensionless.

RSDS, CCT & AOD JJA climatologies for 1991-2010: differences between experiments

Temporal correlations between RSDS, CCT & AOD differences JJA-mean series in 1991-2010



Supplementary Figure S4. Temporal correlations between JJA-mean temporal series of differences in RSDS and CTT (a to c), RSDS and AOD (d to f), and RSDS_{cs} and AOD_{cs} (g to i; gray-shaded areas where the number of time steps in the clear-sky series is below 75% of total time steps) between ARI and BASE (first column), ARCI and BASE (second column), and ARCI and ARI experiments (third column) in the historical period (1991-2010). Little stars indicate statistical significance (p<0.05).



$RSDS_{cs}$ & AOD_{cs} JJA climatologies for 1991-2010: differences between experiments

Supplementary Figure S5. As Figure 6 of the main manuscript but with plain differences depicted (non-relative values). Units: $RSDS_{cs}$ in Wm^{-2} , AOD_{cs} dimensionless.

RSDS, CCT & AOD JJA climatologies for 2031-2050: differences between experiments



Supplementary Figure S6. As Figure 1 of the main manuscript but for the future period (2031-2050).

Temporal correlations between RSDS, CCT & AOD differences JJA-mean series in 2031-2050

(a) RSDS vs CTT diffs ARI-BASE



(d) RSDS vs AOD diffs ARI-BASE



(g) RSDS_{cs} vs AOD_{cs} diffs btw ARI-BASE



(b) RSDS vs CTT diffs ARCI-BASE



(e) RSDS vs AOD diffs ARCI-BASE

3mm

zin

(c) RSDS vs CTT diffs ARCI-ARI



(f) RSDS vs AOD diffs ARCI-ARI





Supplementary Figure S7. As Supplementary Figure 4 but for the future period (2031-2050).



 $RSDS_{cs} \& AOD_{cs} JJA$ climatologies for 2031-2050: differences between experiments

Supplementary Figure S8. As Figure 6 of the main manuscript but for the future period (2031-2050).

RSOT, TAS, RH & CLD JJA climatologies for 2031-2050: differences between experiments



Supplementary Figure S9. As Figure 3 of the main manuscript but for the future period (2031-2050).

Precipitation-related JJA climatologies for 2031-2050: differences between experiments



Supplementary Figure S10. As Figure 4 of the main manuscript but for the future period (2031-2050).

Contribution of each aerosol species to the JJA-mean total surface aerosol concentration (period 2031-2050)



Supplementary Figure S11. As Figure 2 of the main manuscript but for the future period (2031-2050).

RSDS, CCT & AOD JJA changes (2031-2050 vs. 1991-2010)



(e) GCM CCT s_{-corr} with (a) = -0.91



(i) GCM AOD s_corr with (a) = -0.57



(f) BASE CCT s_{-corr} with (b) = -0.88



(j) BASE AOD $s_{-}corr$ with (b) = N.A.

zhn



(g) ARI CCT

(c) ARI RSDS

(k) ARI AOD s_corr with (c) = 0.21





(d) ARCI RSDS

(h) ARCI CCT

 s_{-corr} with (d) = -0.77

Wm⁻²

%

10

8 4 2 -2 -4 -6 -8 -10

16 12 8 4 0 -4 -8 -12 -16 -20

-0.10 -0.05 0.00 0.05 0.10

Supplementary Figure S12. As Figure 7 of the main manuscript but with plain differences depicted (non-relative values). Units: RSDS in Wm^{-2} , CCT in % of the grid cell area, AOD dimensionless.



$RSDS_{cs}$ & AOD_{cs} JJA changes (2031-2050 vs. 1991-2010)

Supplementary Figure S13. As Figure 8 of the main manuscript but with plain differences depicted (non-relative values). Units: $RSDS_{cs}$ in Wm^{-2} , AOD_{cs} dimensionless.

RSDS, CCT & AOD DJF climatologies for 1991-2010: differences between experiments



Supplementary Figure S14. As Figure 1 of the main manuscript but for the winter (DJF) season.





Supplementary Figure S15. As Figure 6 of the main manuscript but for the winter (DJF) season.

RSDS, CCT & AOD DJF changes (2031-2050 vs. 1991-2010)

(a) GCM RSDS

(b) BASE RSDS

(c) ARI RSDS



(e) GCM CCT s_{-corr} with (a) = -0.88



(i) GCM AOD s_{-corr} with (a) = 0.03





(f) BASE CCT s_{-corr} with (b) = -0.80



(j) BASE AOD s_{-corr} with (b) = N.A.





(k) ARI AOD s_{-corr} with (c) = 0.37







Supplementary Figure S16. As Figure 7 of the main manuscript but for the winter (DJF) season.





%

%

(h) ARCI CCT s_{-corr} with (d) = -0.67





 $RSDS_{cs} \& AOD_{cs} DJF$ changes (2031-2050 vs. 1991-2010)

Supplementary Figure S17. As Figure 8 of the main manuscript but for the winter (DJF) season.