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**Supplemental Material**

The Role of the North Atlantic Oscillation in European Climate Projections

Clara Deser\*, James W. Hurrell and Adam S. Phillips

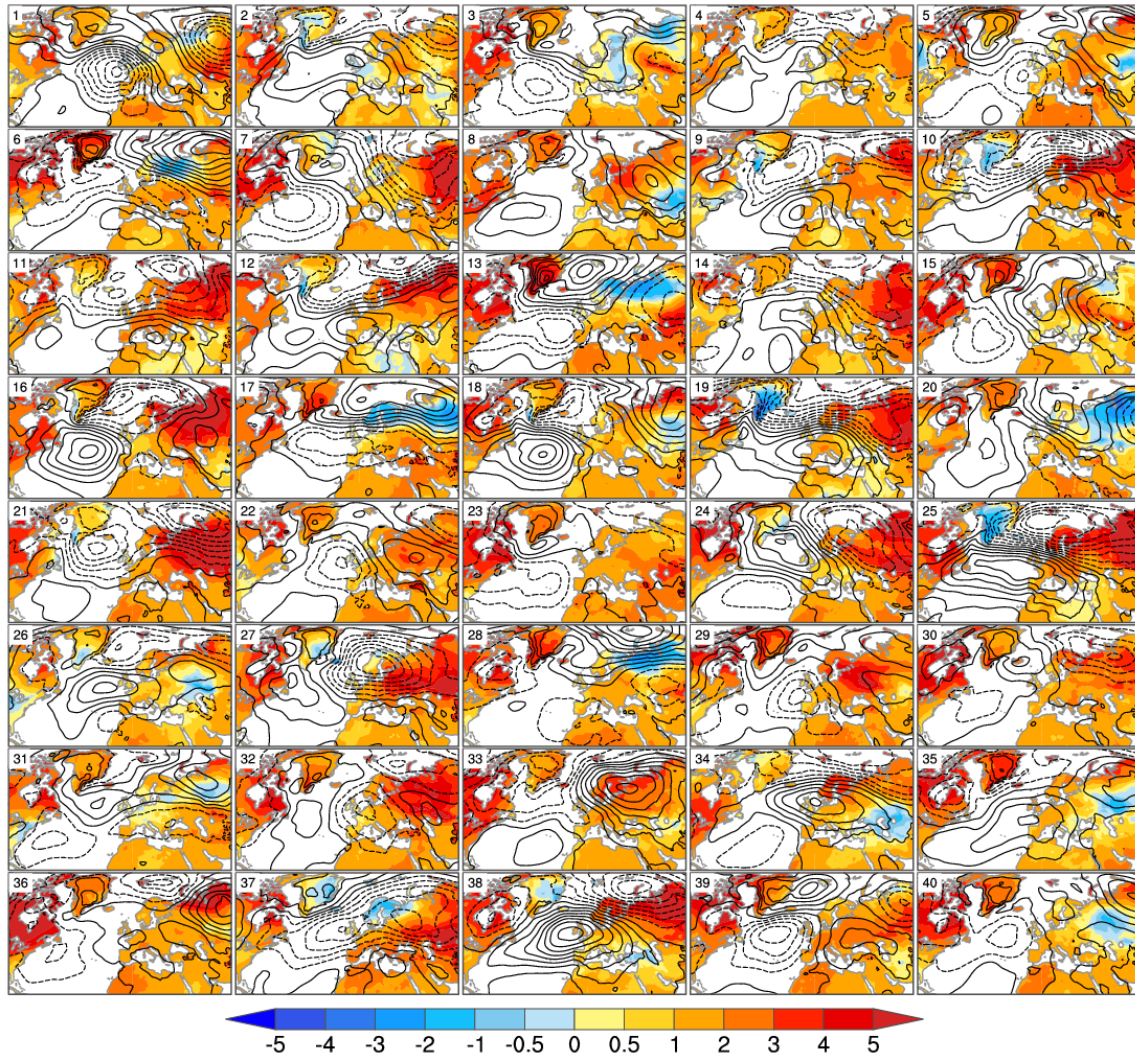
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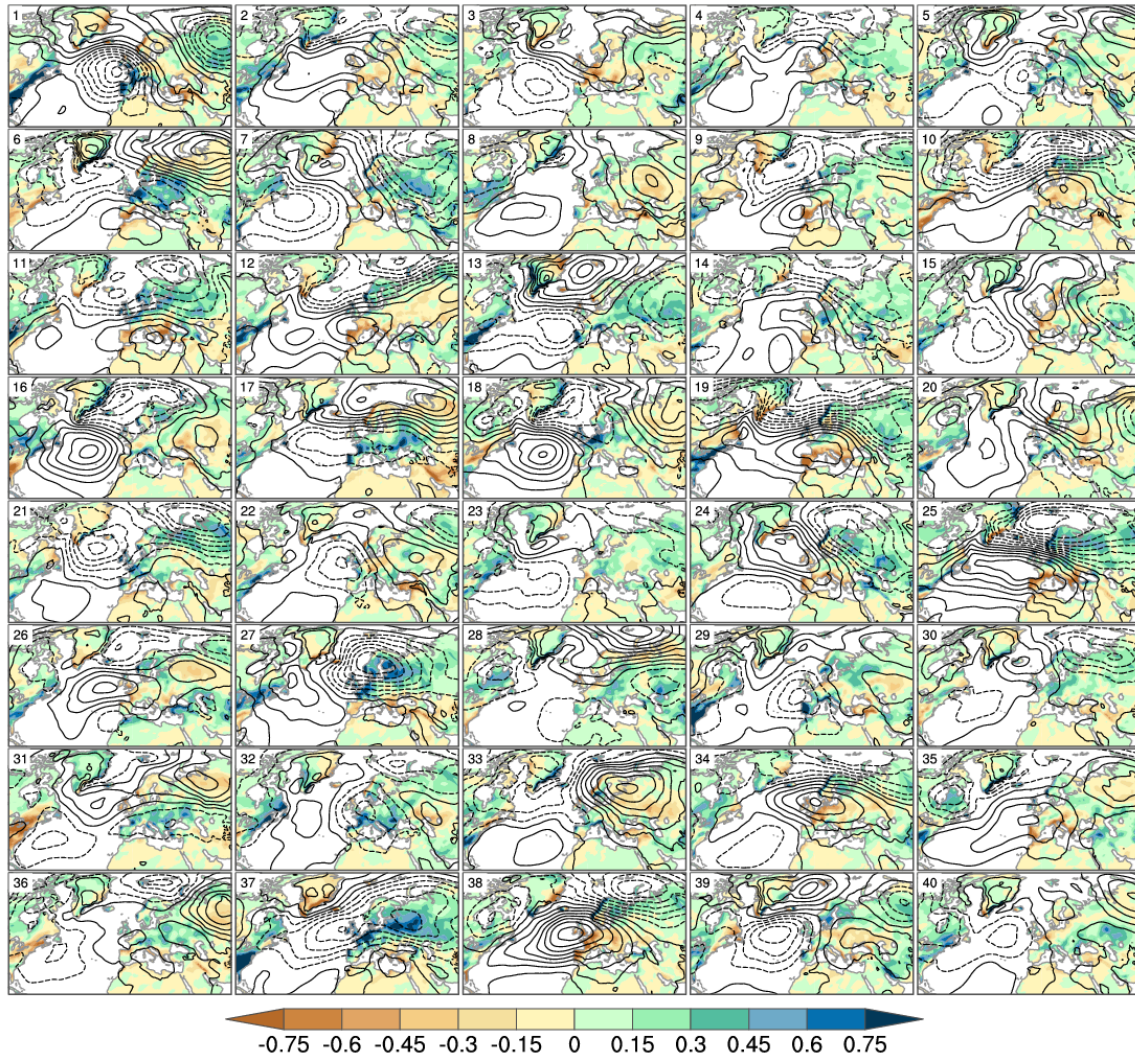
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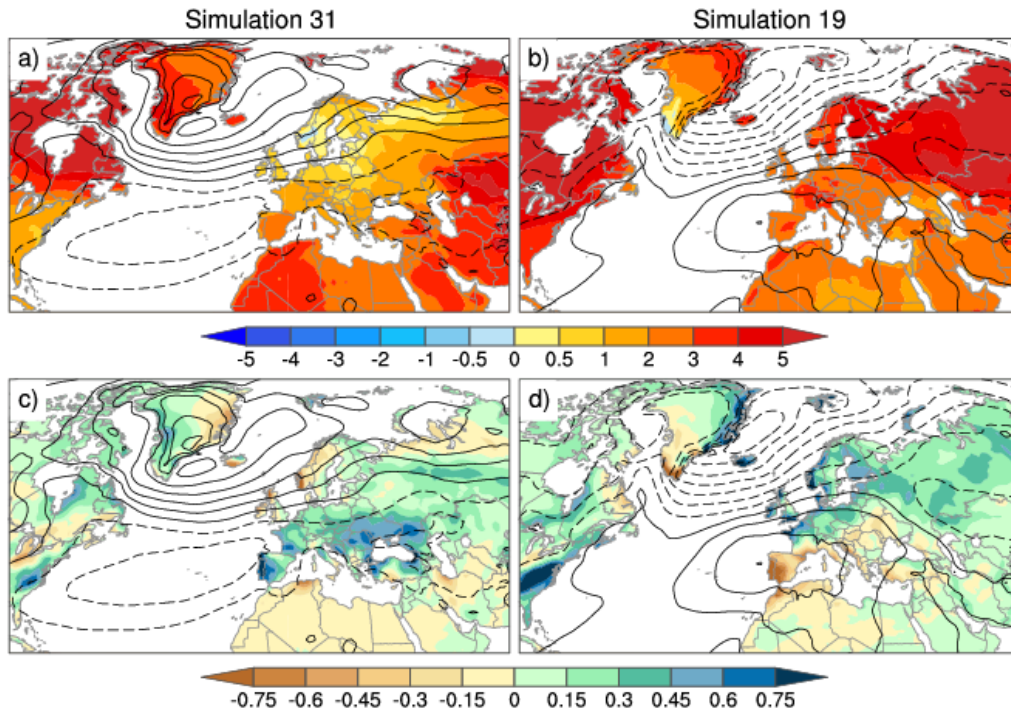
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23 **Figure S1.** Winter SAT ( $^{\circ}\text{C}$  per 30 years; color shading) and SLP (contour interval is 1  
 24 hPa per 30 years with negative values dashed) trends during 2016-45 from each of the 40  
 25 members of the CESM1 Large Ensemble.



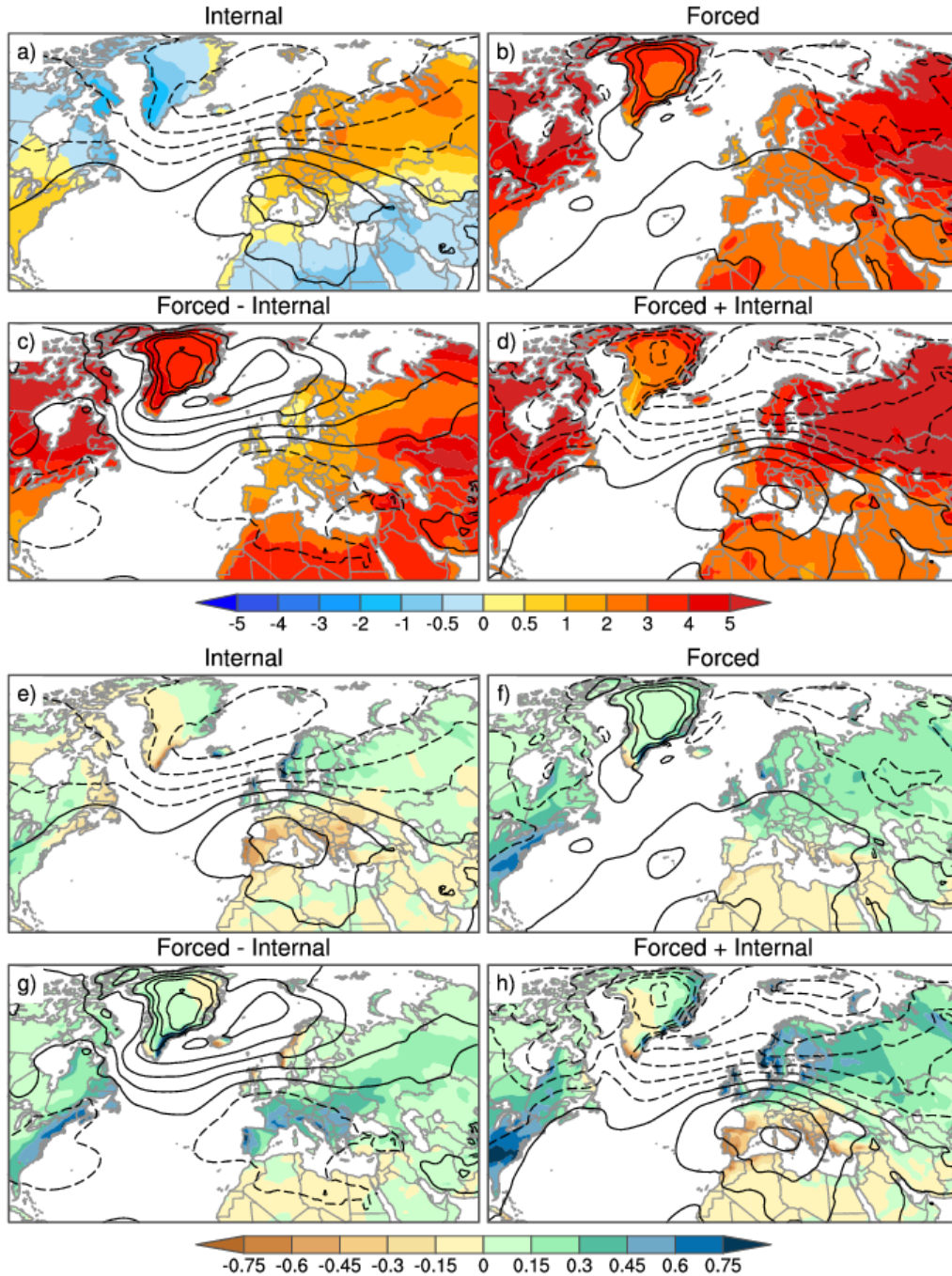
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**Figure S2.** As in Fig. S1 but for SLP and precipitation (mm day<sup>-1</sup> per 30 years).



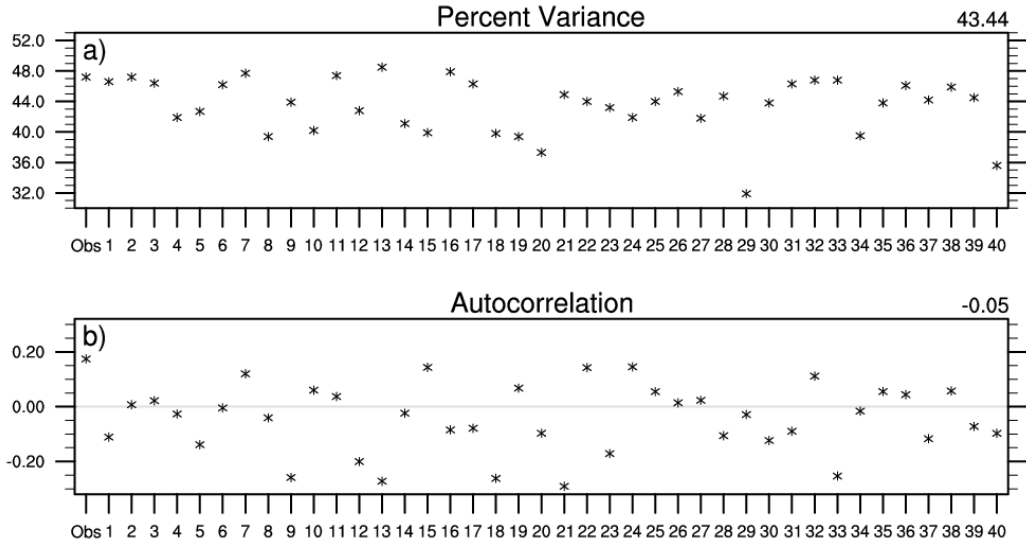
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**Figure S3.** Future 50-year trends (2016-2065) in winter (a, b) SAT (°C per 50 years; color shading) and (c, d) precipitation (mm day<sup>-1</sup> per 50 years; color shading) from simulations 31 and 19 of the CESM1 Large Ensemble, chosen for their contrasting SLP trends (contours; interval = 1hPa per 50 years with negative values dashed).



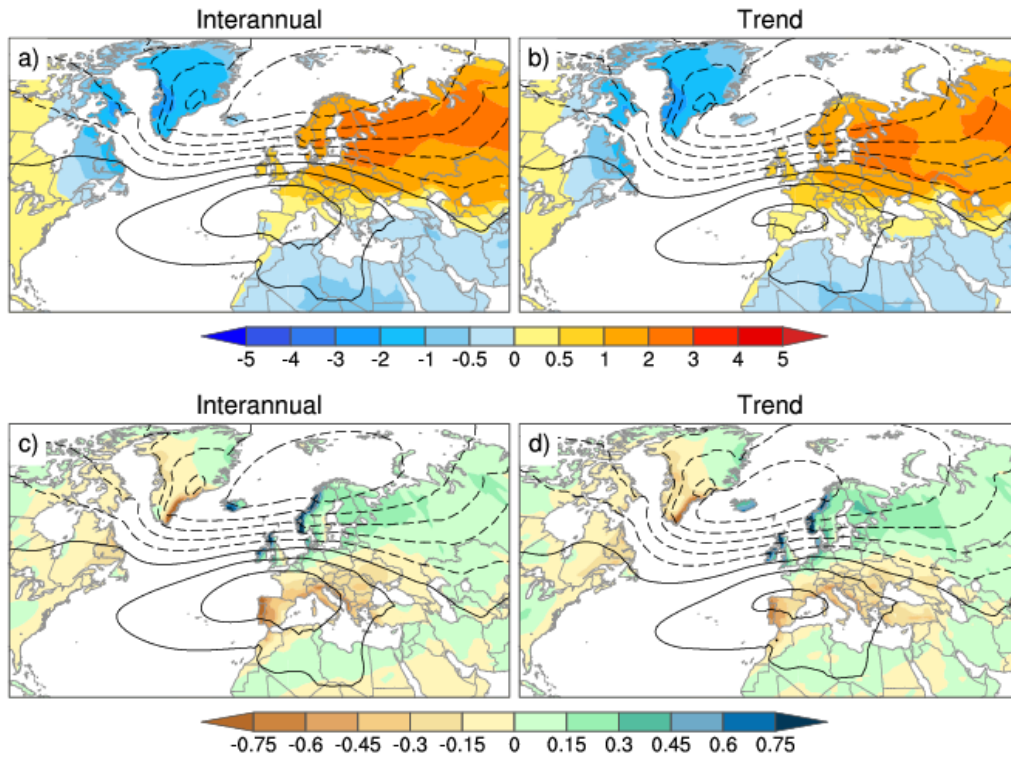
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**Figure S4.** Impact of the NAO on 50-year future climate trends (2016-2065). (a) Regressions of winter SLP and SAT trends upon the normalized leading PC of winter SLP trends in the CESM1 Large Ensemble (multiplied by two); (b) CESM1 ensemble-mean winter SLP and SAT trends; (c)  $b - a$ ; (d)  $b + a$ . SAT in color shading ( $^{\circ}\text{C}$  per 50 years) and SLP in contours (interval = 1 hPa per 50 years with negative values dashed.) Panels e-h as in a-d but for precipitation ( $\text{mm day}^{-1}$  per 50 years) in place of SAT.



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**Figure S5.** Interannual statistics of the NAO in observations (Obs) and each member (1-40) of the CESM1 Large Ensemble. (a) Percent variance explained by the leading EOF of North Atlantic winter SLP based on detrended data during 1920-2012. (b) One-year lag autocorrelation of the associated PC timeseries. The value at the upper right of each panel denotes the average over the 40 ensemble members.

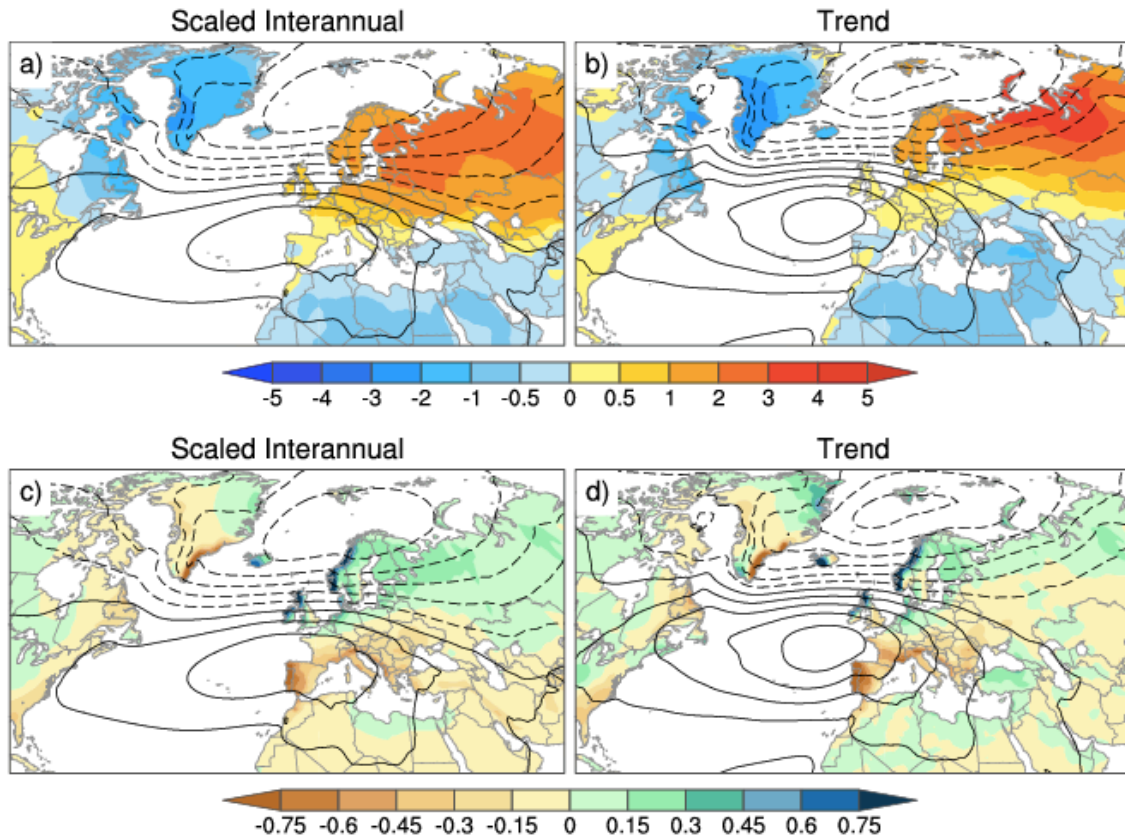


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53 **Figure S6.** Comparison between the NAO and associated climate impacts in the  
 54 2600-year CESM1 atmosphere-only control integration computed from interannual  
 55 data (scaled as described in the text) and from 30-year trends. (a) Scaled-  
 56 interannual regressions of winter SLP (contours) and SAT (color shading) anomalies  
 57 upon the normalized leading PC of winter SLP anomalies; (b) SLP and SAT trend  
 58 regressions upon the normalized leading PC of winter SLP trends; (c) As in (a) but  
 59 for precipitation in place of SAT; (d) As in (b) but for precipitation in place of SAT.  
 60 SAT in units of  $^{\circ}\text{C}$  per 30 years, precipitation in units of  $\text{mm day}^{-1}$  per 30 years, and  
 61 SLP contour interval of 1 hPa per 30 years with negative values dashed.

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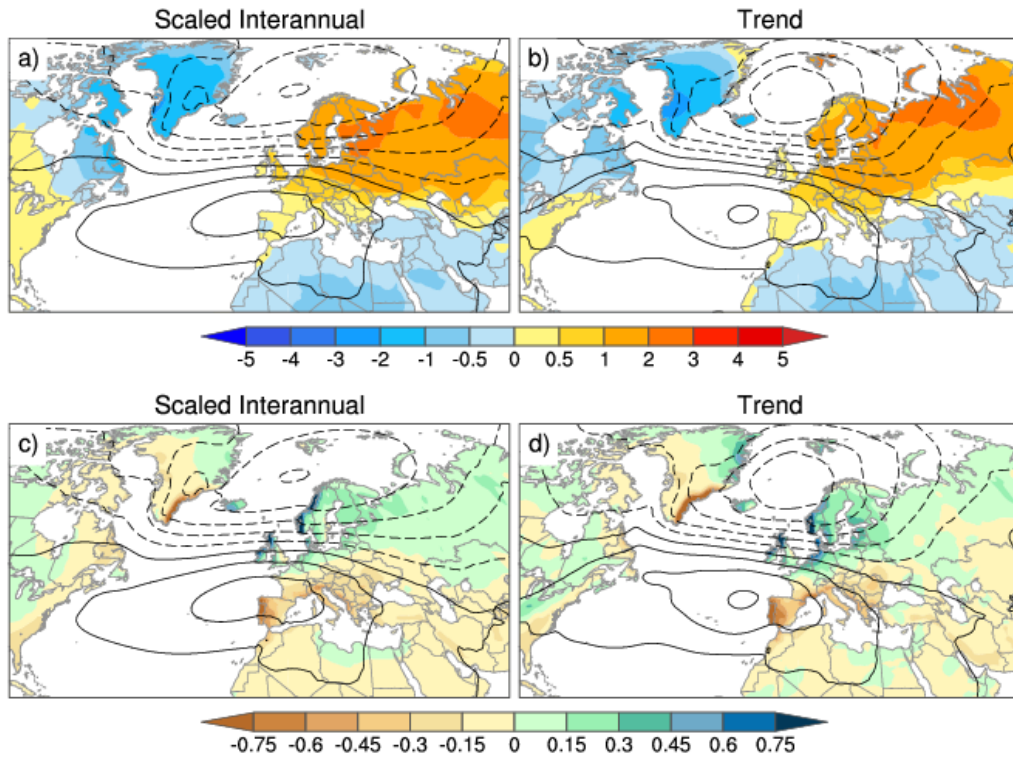
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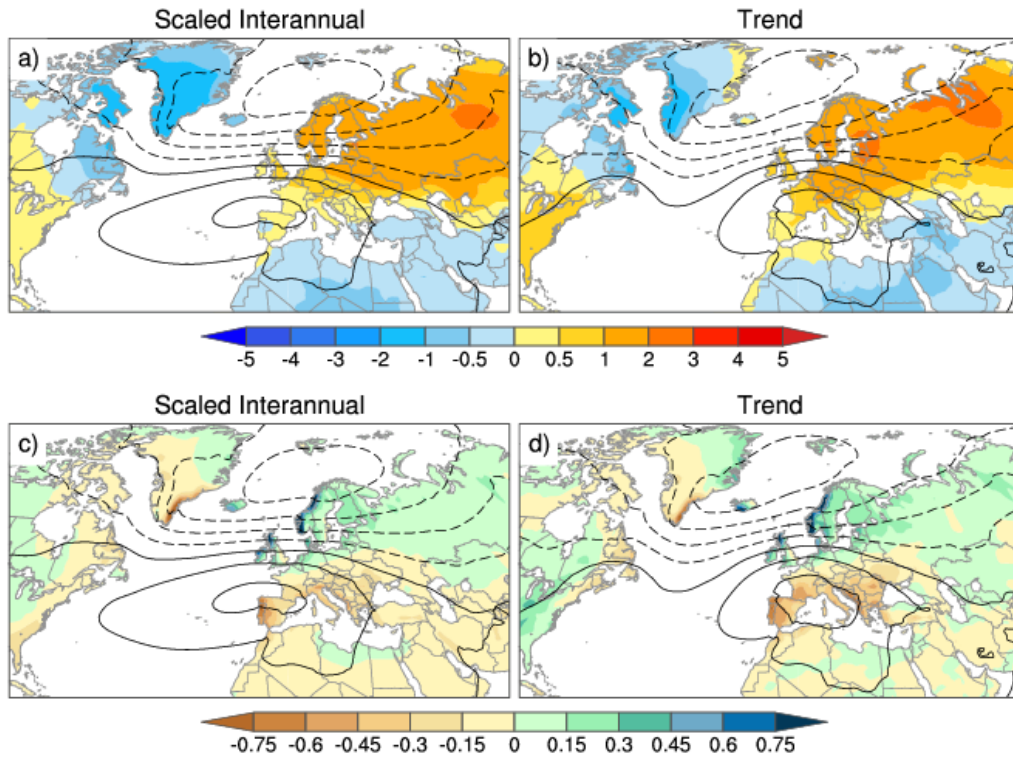
**Figure S7.** As in Fig. S6 but using the CESM1 Large Ensemble. (a) Ensemble-mean of scaled-interannual regressions of winter SLP (contours) and SAT (color shading) anomalies upon the normalized leading PC of winter SLP anomalies during 2016-2045; (b) SLP and SAT trend regressions upon the normalized leading PC of winter SLP trends based on 2016-2045; (c) As in (a) but for precipitation in place of SAT; (d) As in (b) but for precipitation in place of SAT. SAT in units of °C per 30 years, precipitation in units of mm day<sup>-1</sup> per 30 years, and SLP contour interval of 1 hPa per 30 years with negative values dashed.





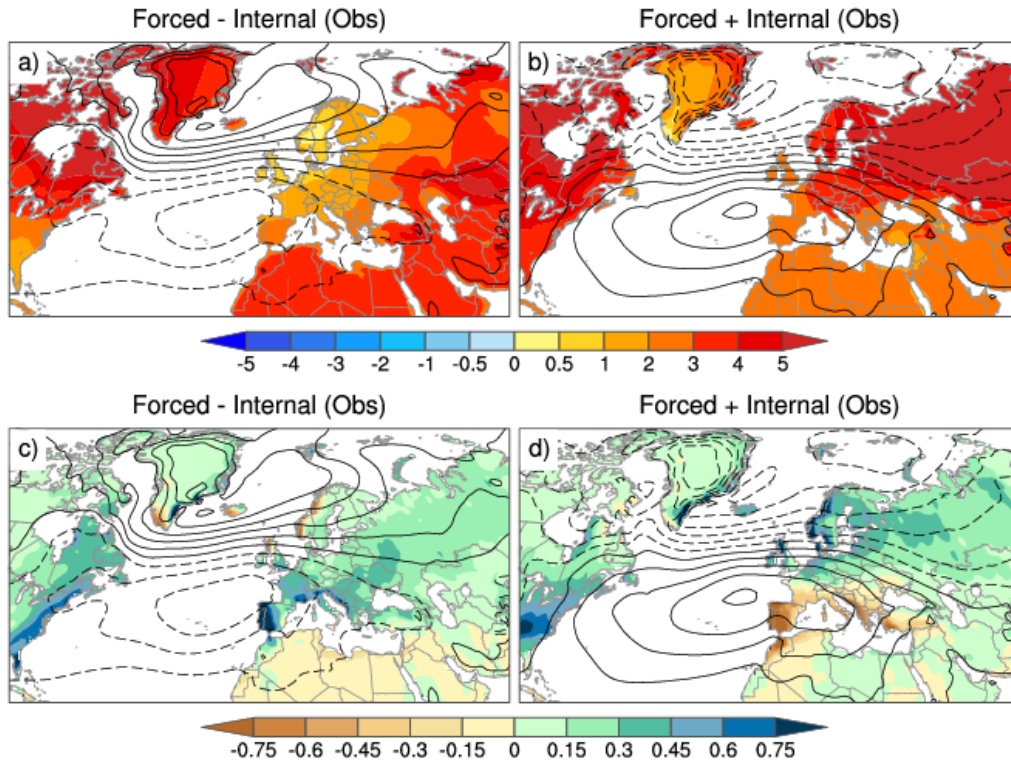
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**Figure S8.** As in Fig. S7 but for scaled-interannual and trend regressions based on the period 2016-2055. Units as in Fig. S7 but per 40 years.



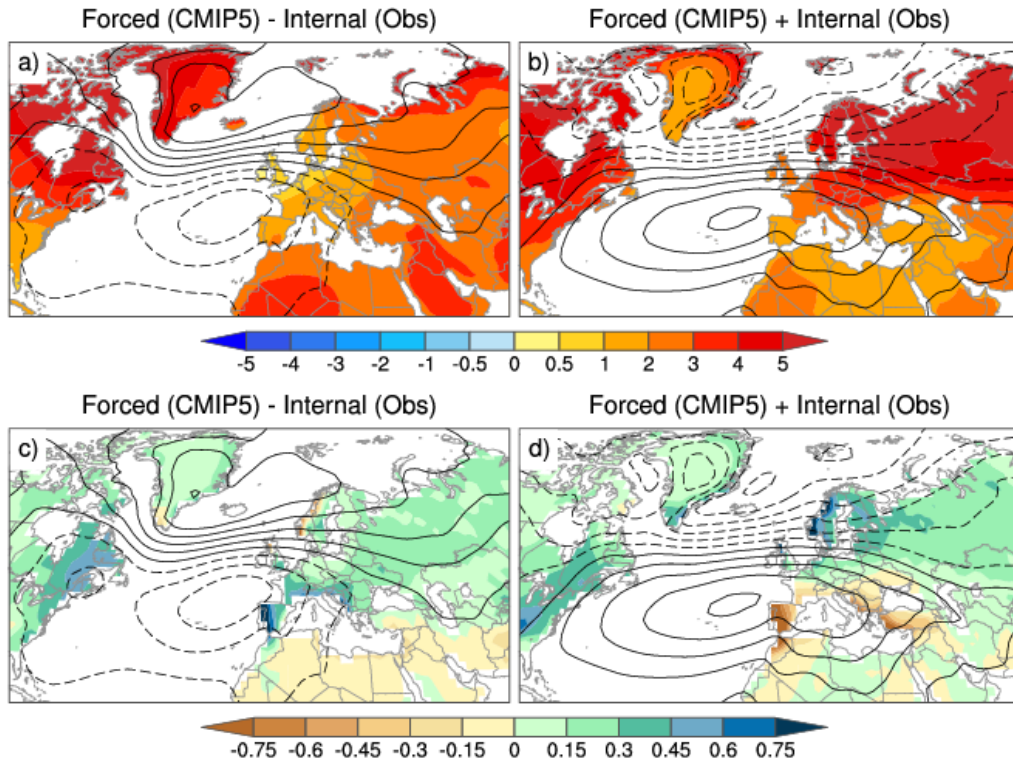
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**Figure S9.** As in Fig. S7 but for scaled-interannual and trend regressions based on the period 2016-2065. Units as in Fig. S7 but per 50 years.



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84 **Figure S10.** Impact of the NAO on future climate trends (2016-2065) based on  
 85 interannual statistics of the NAO from observations and the forced response from  
 86 the CESM1 Large Ensemble. (a) and (b) show the expected range of future SLP and  
 87 SAT trends; (c) and (d) show the expected range of future SLP and precipitation  
 88 trends. See text for details. SLP contour interval is 1 hPa per 50 years with negative  
 89 values dashed; SAT (color shading) in units of °C per 50 years; and precipitation  
 90 (color shading) in units of mm day<sup>-1</sup> per 50 years.  
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**Figure S11.** As in Fig. S10 but using the CMIP5 multi-model mean in place of the CESM1 Large Ensemble for the forced trend.