



## Supplemental Material for

# Was the Cold European Winter 2009/10 Modified by Anthropogenic Climate Change? An Attribution Study

Bo Christiansen,<sup>a</sup> Carmen Alvarez-Castro,<sup>b</sup> Nikolaos Christidis,<sup>c</sup> Andrew Ciavarella,<sup>c</sup> Ioana Colfescu,<sup>d</sup> Tim Cowan,<sup>e</sup> Jonathan Eden,<sup>f</sup> Mathias Hauser,<sup>g</sup> Nils Hempelmann,<sup>b</sup> Katharina Klehmet,<sup>h</sup> Fraser Lott,<sup>c</sup> Cathy Nangini,<sup>b</sup> Geert Jan van Oldenborgh,<sup>f</sup> René Orth,<sup>g</sup> Peter Stott,<sup>c</sup> Simon Tett,<sup>e</sup> Robert Vautard,<sup>b</sup> Laura Wilcox,<sup>i</sup> and Pascal Yiou<sup>b</sup>

<sup>a</sup> *Danish Meteorological Institute, Copenhagen, Denmark*

<sup>b</sup> *Laboratoire des Sciences du Climat et de l'Environnement, Institut Pierre-Simon Laplace, Université Paris-Saclay, Gif sur Yvette, France*

<sup>c</sup> *Met Office Hadley Centre, Exeter, United Kingdom*

<sup>d</sup> *National Centre for Atmospheric Science, University of Leeds, Leeds, United Kingdom*

<sup>e</sup> *School of GeoSciences, University of Edinburgh, Edinburgh, United Kingdom*

<sup>f</sup> *Royal Netherlands Meteorological Institute (KNMI), De Bilt, Netherlands*

<sup>g</sup> *Institute for Atmospheric and Climate Science, ETH Zurich, Zurich, Switzerland*

<sup>h</sup> *Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany*

<sup>i</sup> *Department of Meteorology, University of Reading, Reading, United Kingdom*

(Manuscript received 30 August 2017,

in final form 19 January 2018)

© Copyright 2018 American Meteorological Society

Permission to use figures, tables, and brief excerpts from this work in scientific and educational works is hereby granted provided that the source is acknowledged. Any use of material in this work that is determined to be “fair use” under Section 107 of the U.S. Copyright Act or that satisfies the conditions specified in Section 108 of the U.S. Copyright Act (17 USC §108) does not require the AMS’s permission. Republication, systematic reproduction, posting in electronic form, such as on a website or in a searchable database, or other uses of this material, except as exempted by the above statement, requires written permission or a license from the AMS. All AMS journals and monograph publications are registered with the Copyright Clearance Center (<http://www.copyright.com>). Questions about permission to use materials for which AMS holds the copyright can also be directed to the AMS Permissions Officer at [permissions@ametsoc.org](mailto:permissions@ametsoc.org). Additional details are provided in the AMS Copyright Policy statement, available on the AMS website (<http://www.ametsoc.org/CopyrightInformation>).

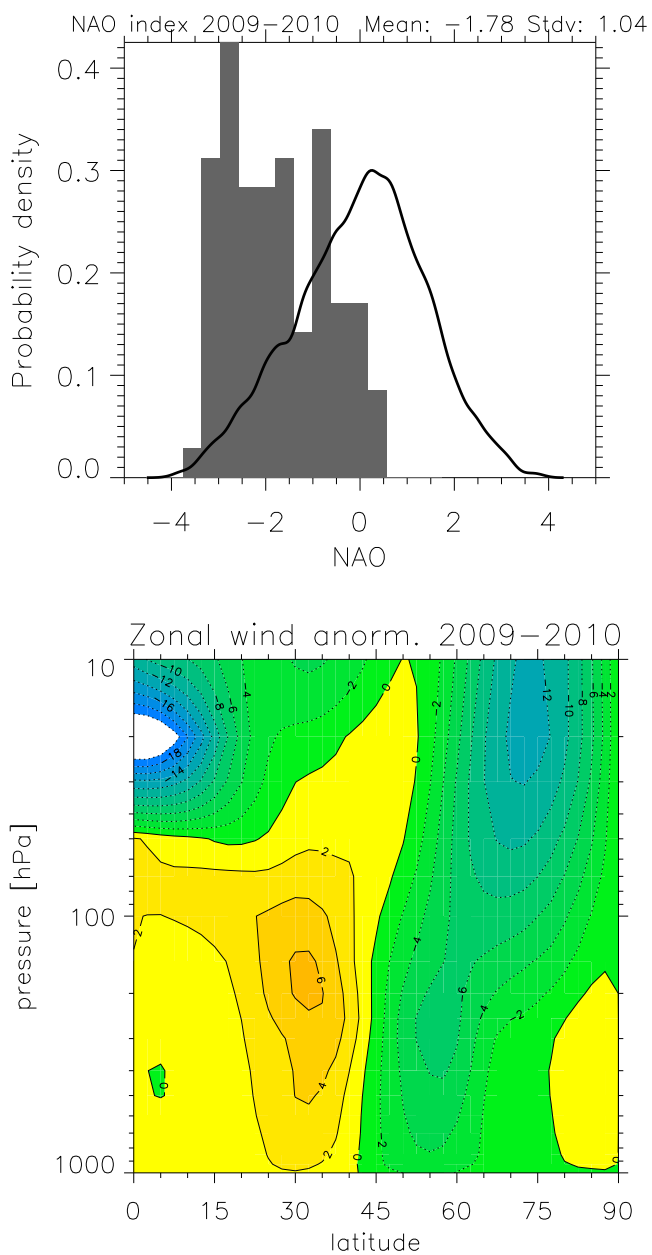


Figure S1: Top: Histogram of the daily NAO index 2009-2010. Full curve shows the density of the daily NAO index in all winters 1960-2013 (kernel estimator with binwidth 0.15). Bottom: Zonal mean zonal wind anomalies [m/s] averaged over the winter as function of latitude and height.

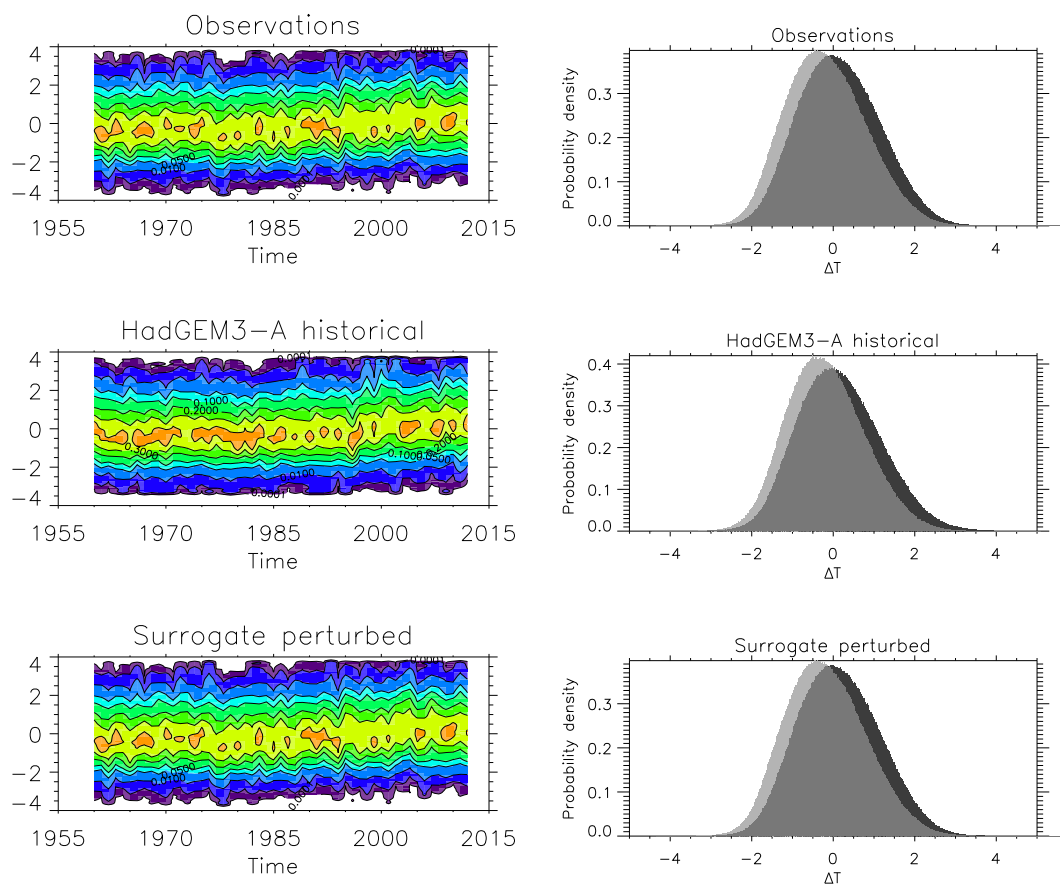


Figure S2: As Fig. 5 in the main text but for summer. Local daily summer temperatures have been normalized with their seasonally varying standard deviation and pooled. Left panel shows the distribution as function of time. Right panel shows the distributions before (light shading) and after (dark shading) 1985. From top: Observations (E-OBS), HadGEM3-A historical, and perturbed surrogate.

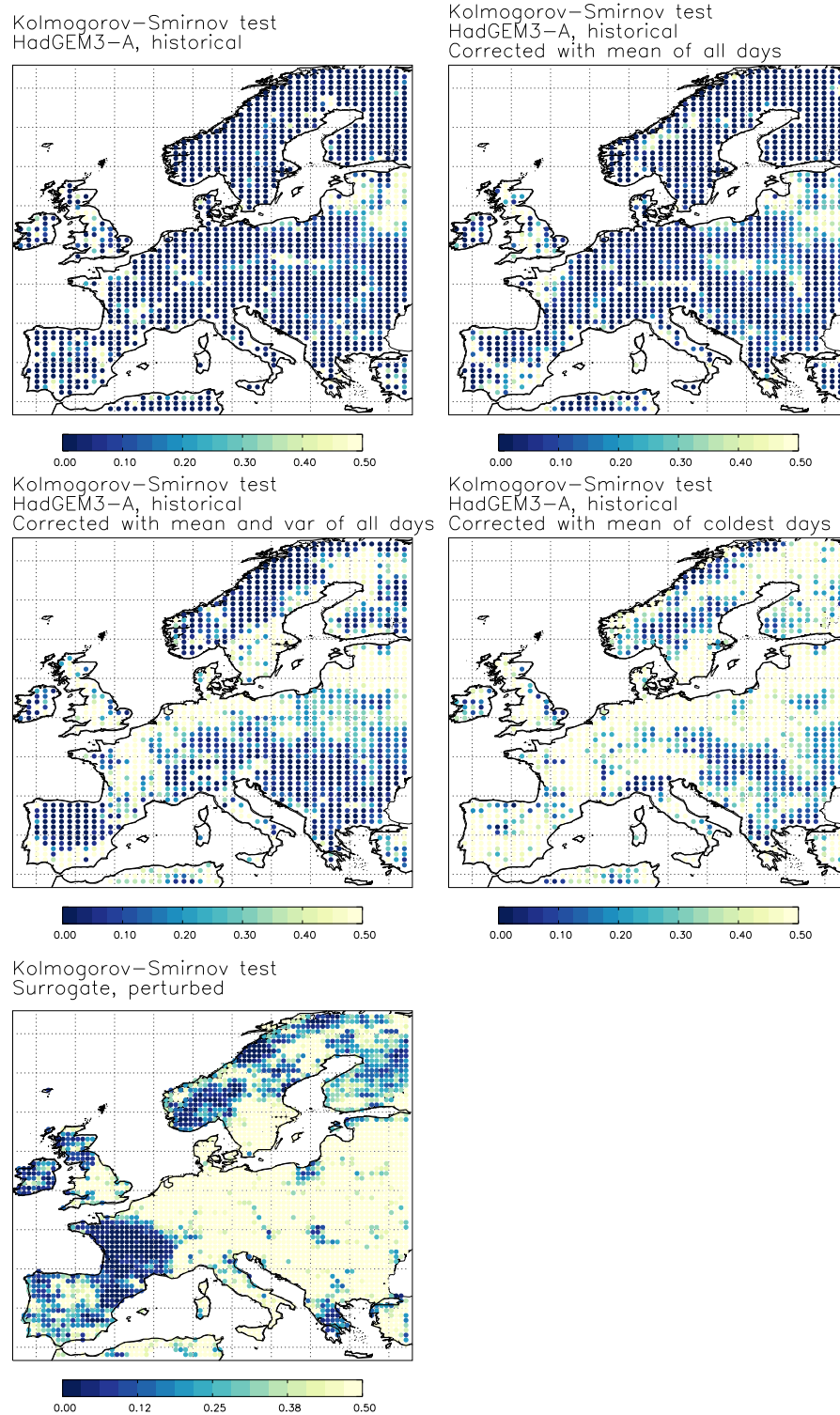


Figure S3: The p-values from a Kolmogorov-Smirnov test comparing the distributions of the coldest winter days in observations and HadGEM-3 historical ensemble. Small p-values indicate that we can reject the null-hypothesis that the distributions are equal.

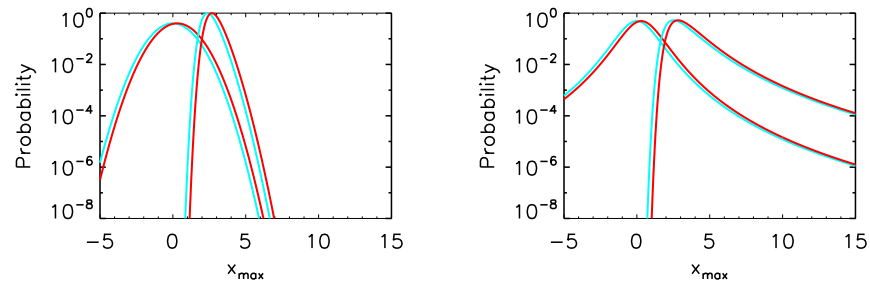


Figure S4: As the upper panel in Fig. A1 in the main text but in logarithmic scale.