C20C – Climate of the 20th Century: A multi-model effort to detect and attribute trends in weather risk

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1 Abstract

This poster outlines a new core project of the international C20C programme. This project is an important component of the activities of ACE (Attribution of Climate-related Events), a group seeking to develop the science and understanding needed to provide sound and authoritative assessments of extreme weather and climate events and their impacts (see P. Stott, Session A5). The project aims to examine trends in attributable risk, in particular:

- to characterise historical trends and variability in the probabilities of damaging weather events;
- to estimate the fraction of the historical, present, and near-future probabilities of damaging weather events that is attributable to anthropogenic emissions, and to characterise underlying uncertainties in these estimates.

It should provide an understanding of the importance of atmospheric model reliability, model design, natural variability in sea surface conditions, and attributable warming estimation to the quantification of attributable weather risk. It should also allow a characterisation of the relative contributions of the various thermodynamic, dynamic, and impact processes for a variety of event types.

2 Main experiment

The ~30 participating modelling groups in C20C will run moderate (50 member) initial-condition ensembles of the 1960-2020 period with atmospheric models forced with observed/forecast sea surface temperatures (see poster W192B in this session), sea ice concentrations, land use change, and radiative forcings. Parallel ensembles will then be run under counterfactual scenarios of the climate that might have been had all or some anthropogenic activities never interfered with the climate.

Scenarios to be studied under the main experiment:

Name	Description	SSTs and SICs
ALL	Including change in "all" known external forcings	HadISST2/DePreSys
NAT	Including changes in natural external forcings only	HadISST2/DePreSys minus anthropogenic signal
NON-GHG	Including changes in non-greenhouse gas external forcings only	HadISST2/DePreSys minus non-GHG signal

3 Estimation of the counterfactual SSTs

SSTs for the counterfactual scenarios NAT and NONGHG will be estimated using the "error-in-variables" optimal fingerprinting regression method (Huntingford et alii, 2006) applied to historical simulations from atmosphere-ocean models from the CMIP3 and CMIP5 projects. If $\hat{T} + i(x)$ is the spatio-temporal SAT response pattern to forcing scenario i averaged across all A-O models, $\mu_i(x)$ is the spread of models response patterns about that average, and $\nu_i(x)$ is noise from limited sampling, then the regression takes the form:

$$T_{obs}(x) = \Sigma_i \, \beta_i \left(\hat{T}_i(x) + \nu_i(x) + \mu_i(x) \right) + \nu_{obs}(x)$$

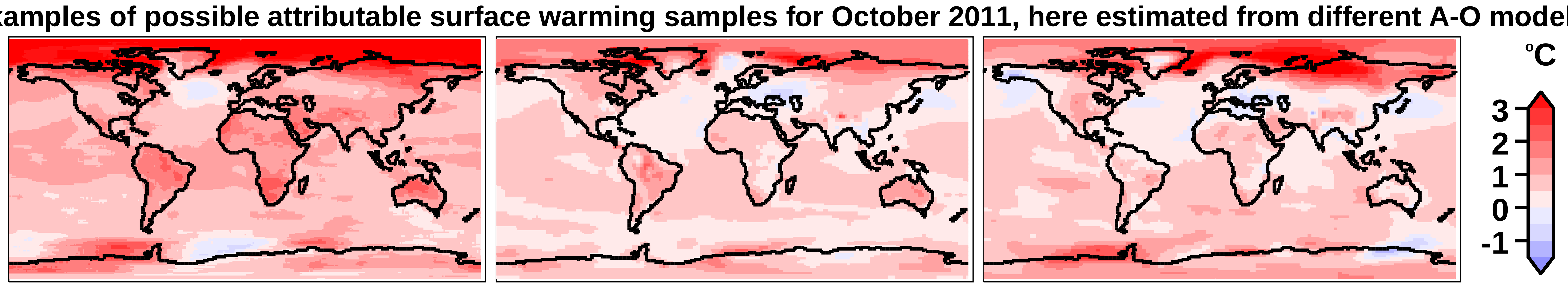
where:

i	Includes variations in
ALL	"all" known external forcings
NAT	natural external forcings only
GHG	ghreenhouse gas forcings only

The β_is are regression factors which provide an observationally constrained estimate for scaling the $\hat{T} + i(x)$ response patterns. Several realisations of each counterfactual scenario will be used to sample its likelihood distribution.

Sea ice will be adjusted using an algorithm based on a inversion of the HadISST2 calculations (J. Imbers, in prep.).

Examples of possible attributable surface warming samples for October 2011, here estimated from different A-O models:

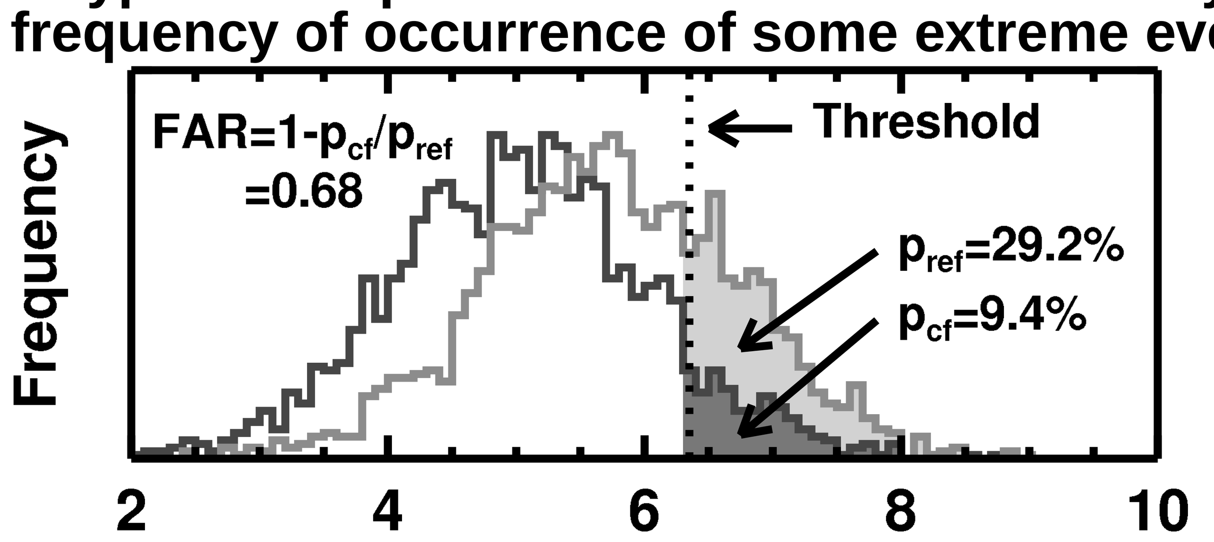


4 Analyses

Analyses will be conducted by participating modelling groups and other interested researchers. There are three anticipated broad categories of studies:

- analyses of model reliability and other performance measures;
- analyses of variations and trends in weather risk and derivatives in the ALL scenario;
- comparisons of weather risk and derivatives between the ALL scenario and counterfactual scenarios.

A typical comparison between scenarios may compare the frequency of occurrence of some extreme event:



To join the project or for more information please contact any of the above authors.

- Huntingford, C., P. A. Stott, M. R. Allen, and F. H. Lambert. 2006. Incorporating model uncertainty into attribution of observed temperature change. Geophysical Research Letters, 33, L05710, 10.1029/2005GL024831.