# Report on discussion of C20C+ Detection and Attribution Subproject at the C20C 6th Workshop

Documented by Dáithí Stone (dstone@lbl.gov)
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## Summary

The 6th Workshop was attended by both the modelling and analysis sides of the C20C project, allowing a more integrated discussion of the D&A Subproject than had been possible at the 5th Workshop. This report summarises the agreed experimental design of the project and the plans for implementation. Updates on the project are posted at http://portal.nersc.gov/c20c/.

## Experimental design

The proposed experimental design for the project was confirmed at the workshop. This involves the comparison of simulations of atmospheric models following a scenario of observed "real world" boundary conditions against simulations following a scenario of "natural world" boundary conditions that might have existed had humans never emitted greenhouse gases. Because there are large uncertainties over the boundary conditions for the latter scenario, a number of estimates for those boundary conditions will be used.

The experiment consists of three components:

- A set of simulations of the past ~half century, to provide the baseline (for instance for estimation of thresholds) and for analysis of long-term trends
- A set of simulations of the past ~decade, to provide the "real world" reference.
- A set of simulations of the past ~decade, to provide the counterfactual "natural world" that might have been.

Technically, each model will be run under the following scenarios for the core experiment:

| Scenario | Radiative boundary conditions | Ocean surface boundary conditions | Simulations |
|---|---|---|---|
| Real world (baseline) | Varying as observed: Greenhouse gas concentrations, anthropogenic aerosol burdens (or emissions), stratospheric ozone concentrations, land cover, stratospheric (volcanic) aerosol burden, solar luminosity | Sea surface temperatures and sea ice concentrations varying as observed (monthly or higher frequency) | 10 or more covering the 1960 to ~1995 period |
| Real world (reference) | Same as for "Real world (baseline)" | Same as for "Real world (baseline)" | ~50 covering the ~1995-2012 period |
| Natural world (CMIP5-est1 estimate) | Varying as observed: Stratospheric (volcanic) aerosol burden, solar luminosity<br>Constant at pre-industrial (ca. 1850) values: Greenhouse gas concentrations, anthropogenic aerosol burdens (or emissions), stratospheric ozone | Observed sea surface temperature and sea concentration values minus an estimate of the change attributable to anthropogenic interference derived from a collection of CMIP5 simulations | ~50 covering the ~1995-2012 period |

| | | | |
|---|---|---|---|
| | concentrations, land cover | Identical attributable warming estimate used across all models | |
| Natural world (second estimate) | Same as for "Natural world (first estimate)" | Observed sea surface temperature and sea concentration values minus another estimate of the change attributable to anthropogenic interference<br>Different attributable warming estimates to be used across the models, using different estimation techniques and data sources | ~50 covering the ~1995-2012 period |
| Natural world (third estimate) | Same as for "Natural world (first estimate)" | Observed sea surface temperature and sea concentration values minus another estimate of the change attributable to anthropogenic interference<br>Different attributable warming estimates to be used across the models, using different estimation techniques and data sources | ~50 covering the ~1995-2012 period |

Details of the generation of the sea surface temperatures for the "CMIP5-est1" estimate of the "natural world" scenario are described in a technical report to be published in December 2013. A near-final draft is available at http://portal.nersc.gov/c20c/input_data/C20C-DandA_dSSTs_All-Hist-est1_Nat-Hist-CMIP5-est1.20130530.pdf.

## Modelling status

Following discussions at the 6th Workshop, there are now 15 modelling groups who have at least expressed interest in contributing simulations to the project. A few of these have already started running the simulations.

| Institution | Models | PI | Status |
|---|---|---|---|
| DSITIA-Queensland (Australia) | CCAM | Josef Syktus | Interested, decision pending |
| IC3 (Spain) | ? | Paco Doblas-Reyes | Interested, maybe not planning |
| LBNL (U.S.A.) | CAM5.1-1degree | Dáithí Stone (dstone@lbl.gov) | Contributing |
| | CAM5.1-2degree? | | |
| | CAM5.1-0.25degree (in 2015?) | | |
| MOHC (U.K.) | HadGEM-3A-N96 | Nikos Christidis | Contributing |
| | HadGEM-3A-N216 | | |
| MRI (Japan) | ? | ??? | ? |
| MRO (Russia) | MGO-AGCM3-T42L25 | Petr Sporyshev | Was interested |
| NIES (Japan) | MIROC5-T85 | Hideo Shiogama | Contributing |

| | | | |
|---|---|---|---|
| POSTECH (South Korea) | ? | Seung-Ki Min | Interested |
| UCT-CSAG (South Africa) | HadAM3P-N96 | Piotr Wolski | Contributing |
| UC-Davis (U.S.A) | WRF-10km/CAM5.1-1degree (California) | | Interested |
| UMelbourne (Australia) | HadAM3P-N96/HadRM3P-?km (Australia / New Zealand) | Mitchell Black | ? |
| UOxford (U.K.) | HadAM3P-N96/HadRM3P-?km (Europe) | ? | Planning |
| | HadAM3P-N96/HadRM3P-50km (Africa north of equator) | Fredericke Otto | Contributing |
| IAP (China) | ? | Tianjun Zhou | ? |
| COLA (U.S.A.) | ? | Ben Cash? | ? |
| CAWCR-GE (Australia) | ? | David Karoly? | ? |

## Data dissemination and analysis

A data portal has been set up for the project on the Earth System Grid Federation (the same facility used to disseminate CMIP5 output) under the project label "c20c". Currently output from a trial experiment conducted by LBNL and UCT have been published, along with boundary condition data sets for the core experiment. A project directory has only been set up on the NERSC node (http://esg.nersc.gov and accessible via the other ESGF portals) but setting up directories on other nodes, e.g. in Australia, China, Japan, and the U.K., should be straightforward. The idea of the ESGF is that data can be distributed across multiple nodes around the world but appear as one project data set to a user through a portal. Each node also has an http portal, all of them should appear identical to a user.

The current NERSC directory is limited to a few tens of TBs, probably expandable by a factor of ten; an application for expansion is about to be submitted. It should be possible for the ESGF to include data located on tape archive and we are currently in the process of applying for that to be done over the coming year at NERSC. The tape archive can hold PBs.

## Specific actions

**November 2013**: Access to data portal on NERSC ESGF node from other ESGF nodes to be confirmed [*Done*]
**December 2013**: D. Stone to submit application for development of capability of NERSC ESGF node to access tape archive
**December 2013**: D. Stone to publish technical report on Nat-Hist/CMIP5-est1 scenario generation.
**December 2013**: D. Stone to publish revised output variable list following from workshop discussions
**December 2013**: D. Stone to contact Karl Taylor re CF converter
**December 2013**: D. Stone to check on status of climate modelling contributions
**Mid 2014**: Data portal to include access to HPSS tape archive

**Mid 2014**: Inquire with journals about special issue on first results from core experiment
**End 2014**: First core set of simulations to be completed.
**Mid-to-late 2015**: Special issue on first results from core experiment

## General plans

Once the simulations toward to core project are completed, we may update the simulations periodically (e.g. every 6 or 12 months) to provide data in support of near-real-time analysis of extreme events. This could also provide a central component supporting the Bulletin of the American Meteorological Society's now-annual State of the Climate attribution supplement.

With a main set of core simulations completed toward the end of 2014, it would make sense to have a journal special issue providing an overview of first results from the project. Suggestions for journals include "Climate Dynamics" and the new "Weather and Climate Extremes" (contact is Lisa Alexander). The target date would be mid to late 2015. Possible leads for contributions are:

- Dáithí Stone lead on design
- Nikos Christidis lead on European interests, including integration with EUCLEIA project
- Sarah Perkins lead on heatwaves
- Andrew King lead on ENSO
- Tianjun Zhou lead on global monsoons
- Probably Piotr Wolski lead on African hydrology
- Probably Friederike Otto (or Dáithí Stone) lead on other African interests

The core experiment will examine the total anthropogenic contribution to climate change. Possible future experiments discussed at the workshop include:

- examining just the effect of land use change
- examining just the effect of stratospheric ozone depletion
- examining just the effect of greenhouse gas emissions
- examining projections for some future period
- examining the effect anthropogenic radiative forcings but with ocean conditions at natural (non-anthropogenic) values (e.g. a geoengineering experiment)

## Relevant publications (since 5th Workshop)

### Peer-reviewed (published):

Christidis, N., P. A. Stott, G. S. Jones, H. Shiogama, T. Nozawa, and J. Luterbacher. **2012**. Human activity and anomalously warm seasons in Europe. *International Journal of Climatology*, **32**, 225-239.

Christidis, N., P. A. Stott, D. J. Karoly, and A. Ciavarella. **2013**. An attribution study of the heavy rainfall over eastern Australia in March 2012. In: Explaining extreme events of 2012 from a climate perspective, Eds: T. C. Peterson, M. P. Hoerling, P. A. Stott, and S. Herring. *Bulletin of the American Meteorological Society*, 93, S58-S61.

Christidis, N., P. A. Stott, A. A. Scaife, A. Arribas, G. S. Jones, D. Copsey, J. R. Knight, and W. J. Tennant. **2013**. A new HadGEM3-A-based system for attribution of weather- and climate-related extreme events. *Journal of Climate*, **26**, 2756-2783.

Imada, Y., M. Watanabe, M. Mori, M. Kimoto, H. Shiogama, and M. Ishii. **2013**. Contribution of atmospheric circulation change to the 2012 heavy rainfall in southwestern Japan. In: Explaining extreme events of 2012 from a climate perspective, Eds: T. C. Peterson, M. P. Hoerling, P. A. Stott, and S. Herring. *Bulletin of the American Meteorological Society*, **94**, S52-S54.

Shiogama, H., M. Watanabe, Y. Imada, M. Mori, M. Ishii, and M. Kimoto. **2013**. An event attribution of the 2010 drought in the South Amazon region using the MIROC5 model. *Atmospheric Science Letters*, **14**, 170-175.

Pall, P., T. Aina, D. A. Stone, P. A. Stott, T. Nozawa, A. G. J. Hilberts, D. Lohmann, and M. R. Allen. **2011.** Anthropogenic greenhouse gas contribution to flood risk in England and Wales in Autumn 2000. *Nature,* **470,** 382-385.

### Peer-reviewed (submitted):

Wolski, P., D. Stone, M. Tadross, M. Wehner, and B. Hewitson. **2013.** Attribution of floods in the Okavango Basin, Southern Africa. *Journal of Hydrology,* submitted.

### In preparation:

Stone, D. Boundary conditions for the C20C Detection and Attribution Project: the All-Hist/est1 and Nat-Hist/CMIP5-est1 scenarios. Technical report.

Stone, D. A., C. Lennard, M. Tadross, M. F. Wehner, O. Angélil, M. R. Allen, P. A. Stott, and P. Pall. Designing a real-time weather risk attribution forecast system.