Weather at Home: large ensemble regional climate modelling

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The climate*prediction*.net volunteers
Everywhere!

Environmental *Change* Institute

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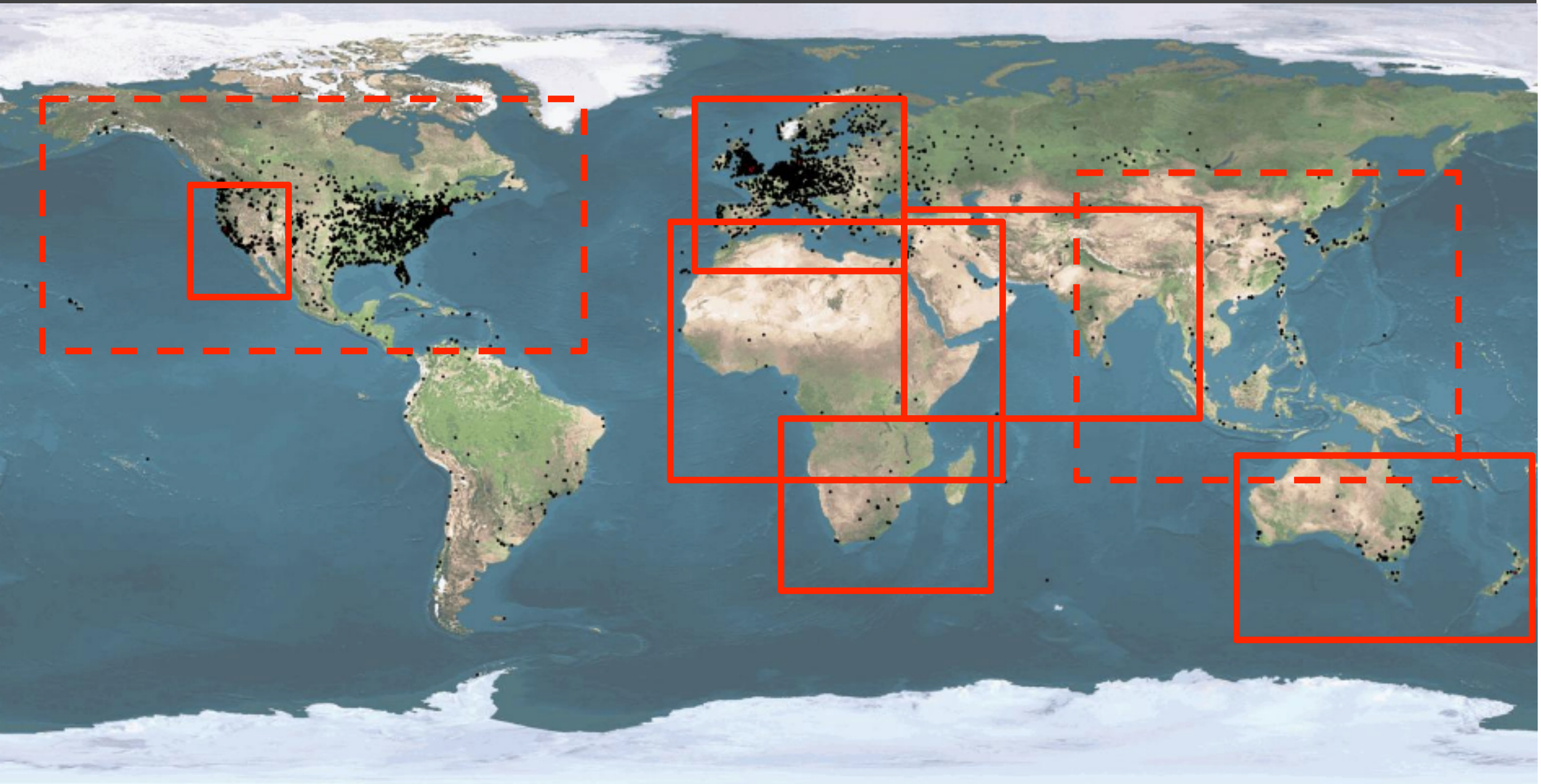
Outline

- What is Weather at Home?
- Experimental setup
- What we have used it for, so far
- What we could use it for in the future

The weather at home project

- Largest regional climate modelling project ever undertaken
- Uses a regional climate model (RCM) nested inside a global climate model (GCM)
- Models are HadAM3P and HadRM3P – same as PRECIS
- Volunteer distributed computing is used to compute many thousands of ensemble members
- The BOINC VDC system is used (cf SETI@home, Rosetta, Einstein, etc.)

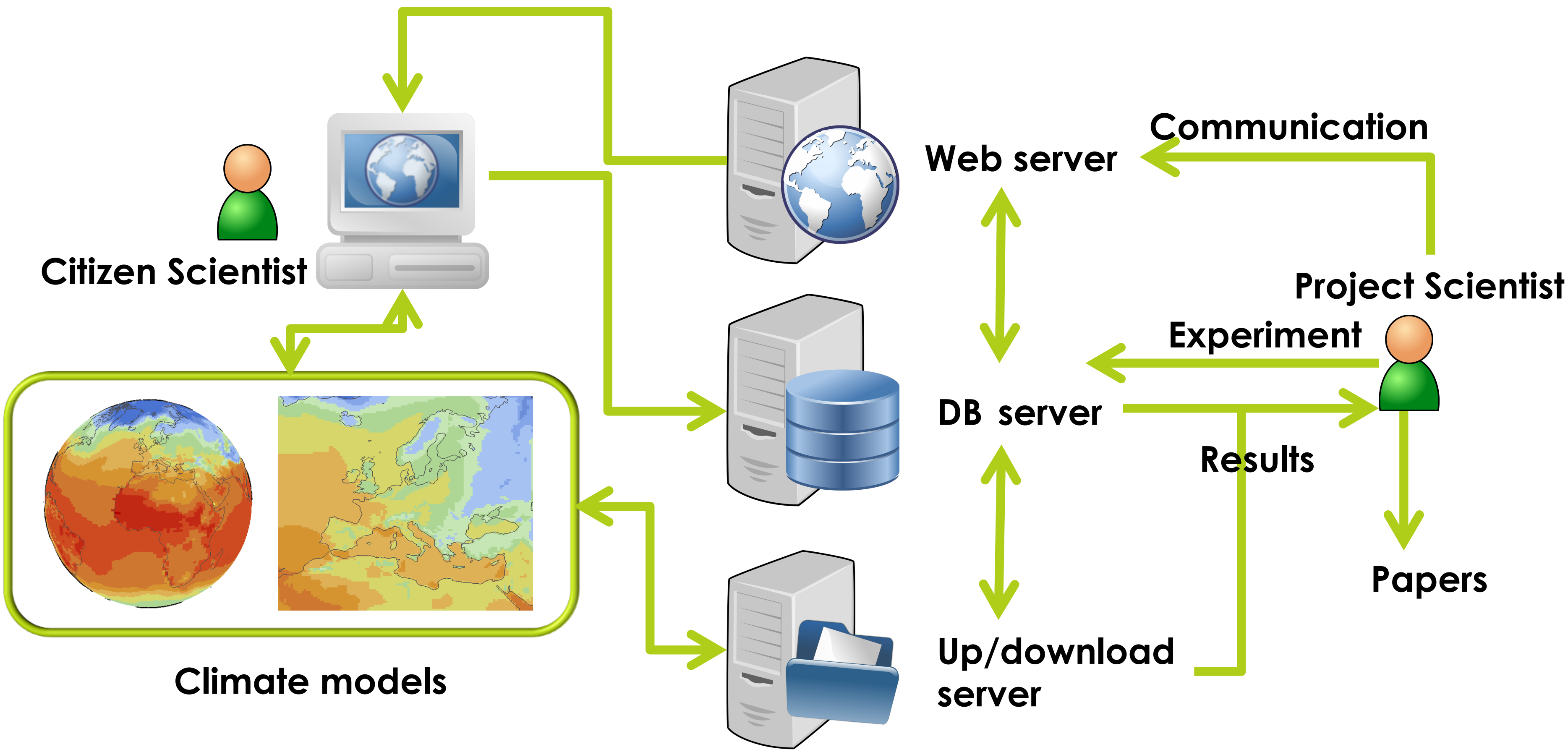
Regions



Regions - collaborations

- Currently three regions modelled:
  - Europe and the North Atlantic - Oxford
  - Pacific North West of USA – Phil Mote, University of Oregon
  - Southern Africa – Bruce Hewitson, University of Cape Town
- Three new regions available shortly:
  - Australia and New Zealand – David Karoly, Uni of Melbourne
  - South West Asia – R. Krishnan, IITM, Pune, India
  - East, West and North Africa – Oxford (ACE Africa)
- System has potential to model any region

Volunteer distributed computing



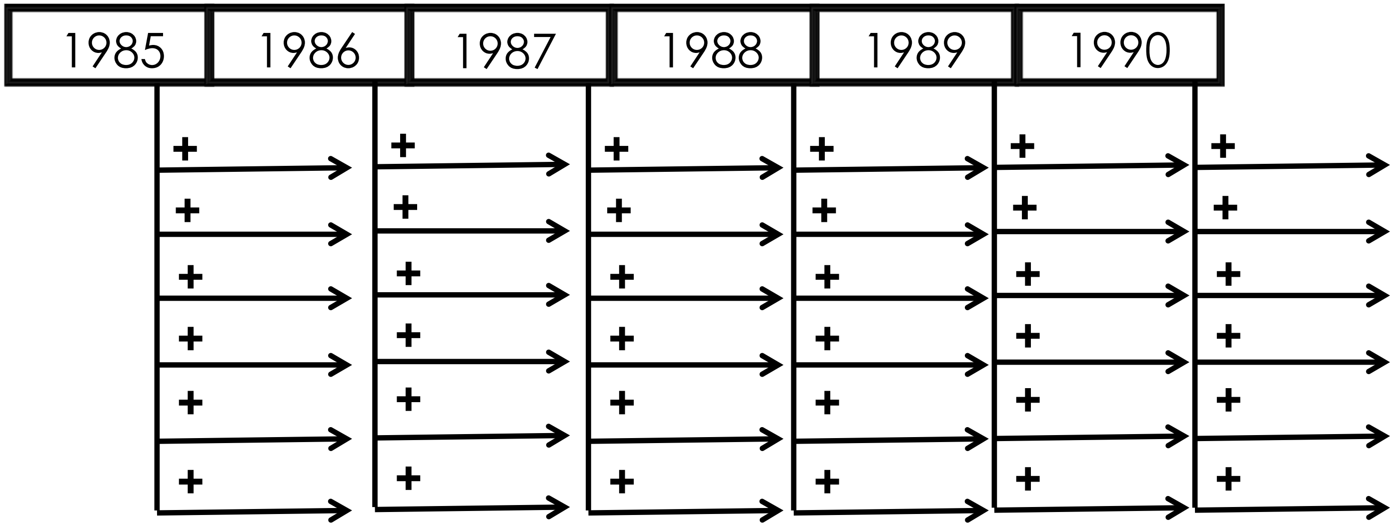
GCM and RCM

- The GCM runs independently on the client computer
- There is no nudging, or relaxing to (e.g.) ERA-40 conditions – completely free-running atmosphere
- The GCM is forced by observations of sea-surface temperatures (SST) and sea-ice fraction (SIF), along with concentrations of greenhouse gases (GHG), aerosols, etc.
- The RCM is forced at its boundaries by output from the GCM

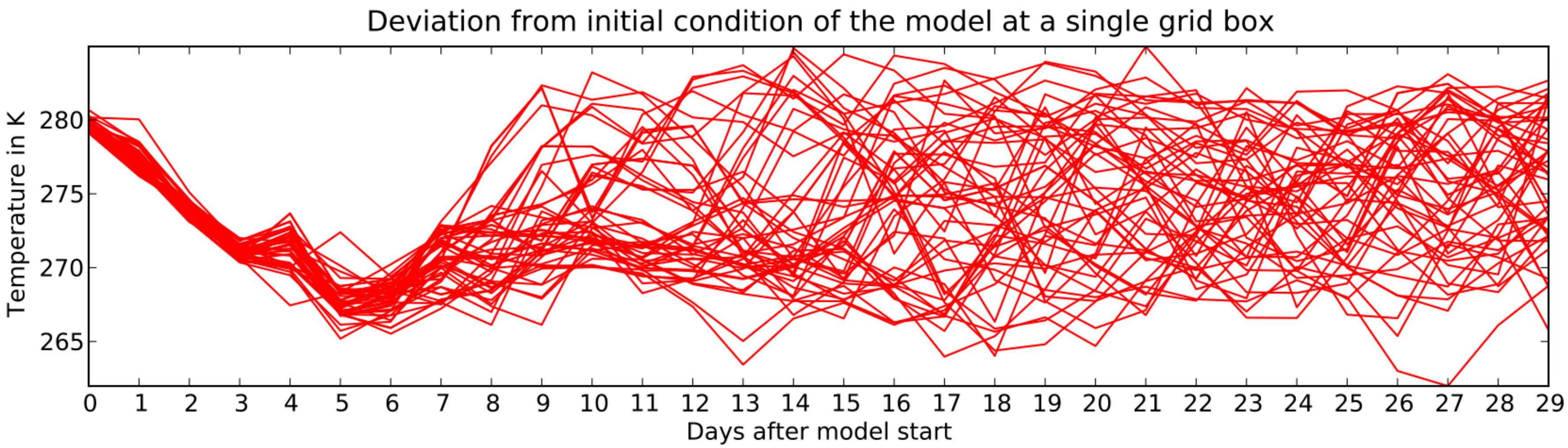
Experimental setup

- Each client computer runs one ensemble member at once
- Each ensemble member is given a description of the experiment to run (the workunit)
- This includes the GHG forcing, SST & SIF, the year, and the initial condition (IC)
- The IC is derived from a single long model run of the same GCM & RCM, using the same forcings as the distributed experiment
- There is one IC per year but each ensemble member gets a (unique) perturbation to the IC

Initial condition perturbations



Initial condition perturbations

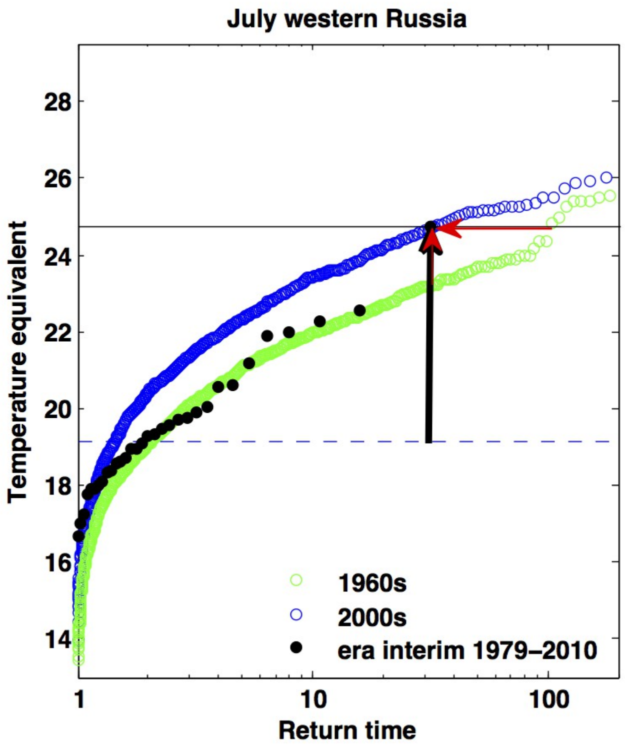


Current completed experiments

- HadISST forced SSTs and SIF, observed GHG and other forcings, 1960 to 2010, for PNW, SAF and EU
- OSTIA forced SSTs and SIF, observed GHG and other forcings, 1985 to 2012, for EU region only
- One natural ensemble, OSTIA SSTs with global warming pattern due to GHG removed

Results – Russian heatwave 2010

- Otto et al 2012 (GRL)
- Reconciling two different conclusions for the human contribution to the Russian heatwave of 2010
  - Dole (2011): "mainly natural in origin"
  - Rahmstorf & Coumou (2011) – 80% probability that occurrence due to anthropogenic climate change
- Again, large ensemble of GCMs with 1960s scenario and 2000s scenario

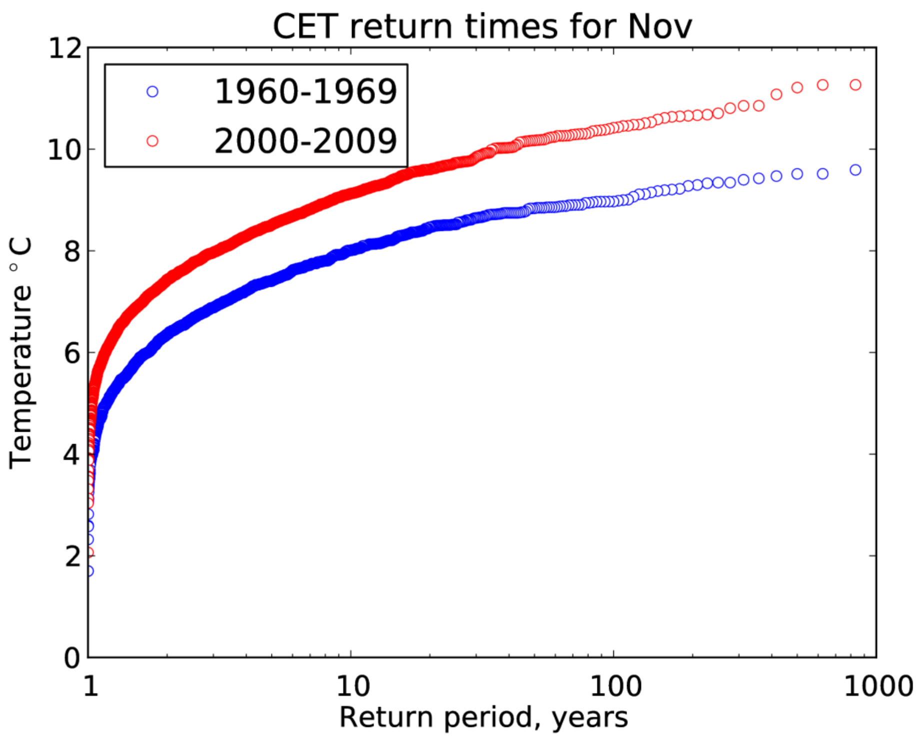


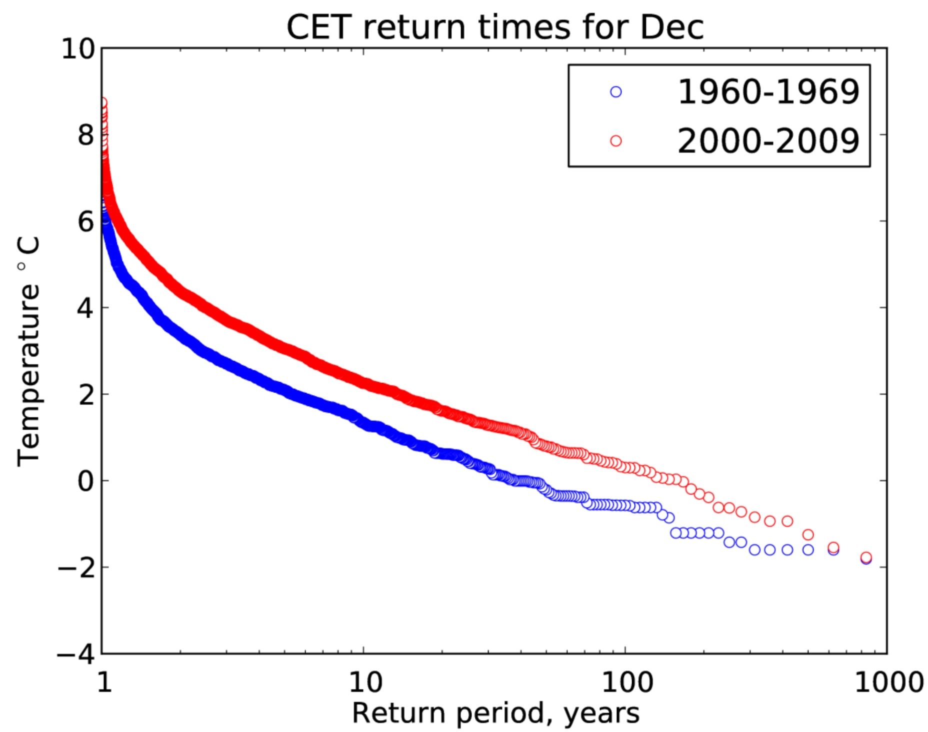
- Black line: anomaly from Russian mean summer temperature
- Red line: difference in return time between 1960s and 2000s
- Vertical: proportion that can be attributed to anthropogenic climate change

- Conclusion: While the temperature value could occur within the observations (Dole), the probability of occurrence has increased (Rahmstorf)

Results – UK autumns / winters

- Massey et al 2012
- Have the odds of getting a warm November or cold December in the UK changed between 1960 and 2000?
- Two large ensembles produced via volunteer computing, one for 1960 to 1969, one for 2000 to 2009
- Both have observed forcings for their scenarios
- Comparing the change in return period of the cold December 2010 (2nd coldest on record) and the warm November 2011 (2nd warmest on record)





- Conclusions:
  - The warm November of 2011 (2nd in CET), will occur 62 times more frequently in the 2000s than in the 1960s
  - The cold December of 2010 (2nd coldest in CET) is half as likely to occur in the 2000s than in the 1960s

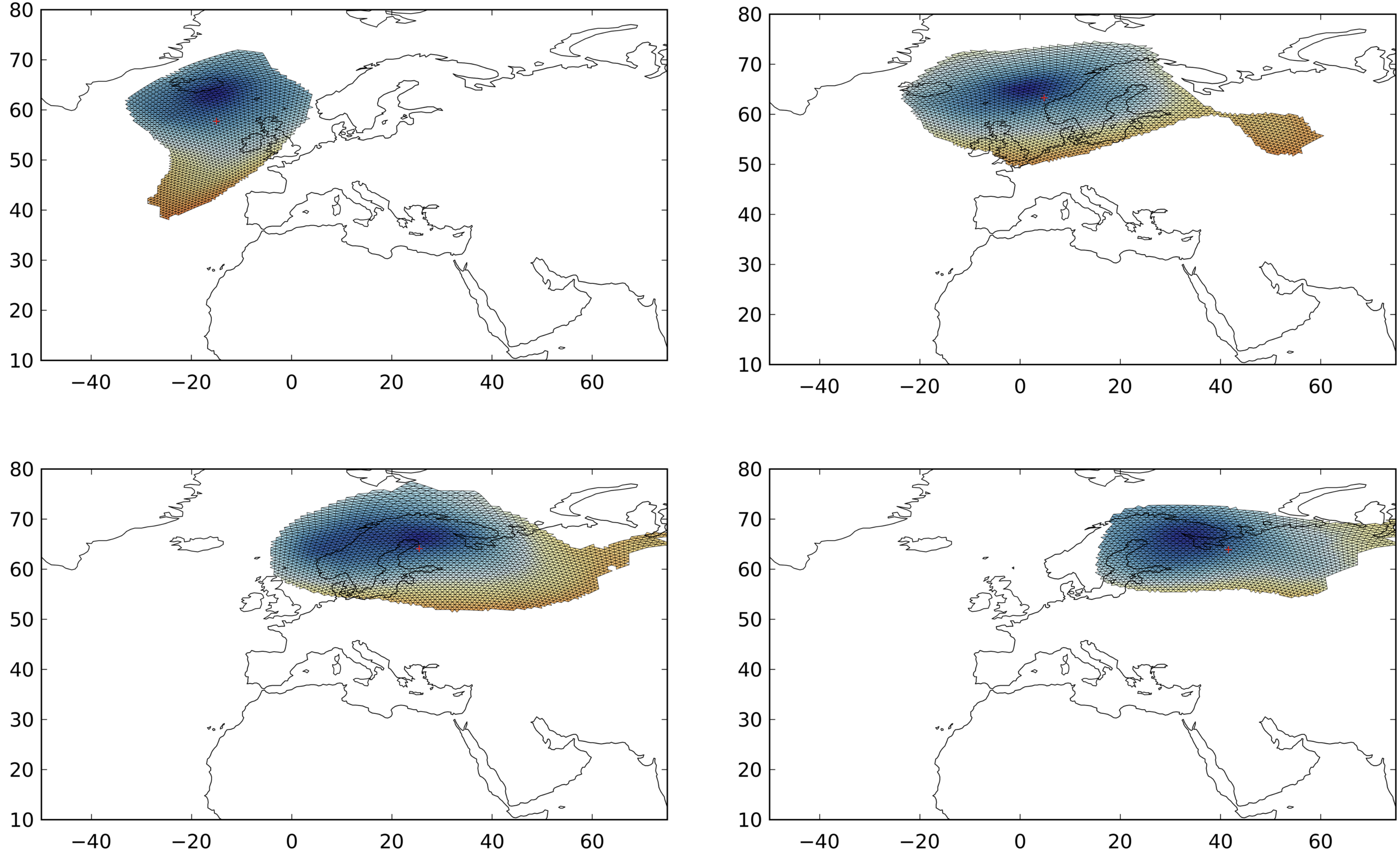
Future work – probabilistic event attribution

- 10 000 to 100 000 model simulations over a historical period

- Objective feature detection and tracking
  - Detecting extreme events in the output from the VLE
  - Tracking events over the lifecycle of the event

- Defining a probabilistic event set
  - Probability distributions of severity of events
  - Specific examples of events
  - Can then drive a cat model in a probabilistic manner

Probabilistic event sets



Future work – seasonal attribution

- Instead of attributing events after they occur, attempt to quantify the increase in risk of an event occurring within the next season.
- Use the ensemble of SSTs and SIF from the seasonal forecast.
- "Spin up" the model to get initial conditions consistent with the beginning of the season.
- Produce the large ensemble of GCM driven RCMs via VDC
- Identify the extreme events and quantify their change in risk