Weather at Home sub-project in climate*prediction*.net

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Weather at Home

- Weather at Home (WAH) is a sub-project within climate*prediction*.net

- Weather at Home started in November 2010

- Weather at Home a collaboration between climate*prediction*.net and UK Met Office, initially funded by Microsoft Research

- Currently involves three apps in climate*prediction*.net: one for European region (WAH EU), one for Southern Africa region (WAH SAF), and one for Pacific North West region (WAH EU)

Weather at Home

- The computational model: this uses HadAM3P global atmosphere only model and HadRM3P regional atmosphere only model, both climate models produced by the Hadley Centre in the UK Meteorological Office

- Regional model nested within global model -> global model feeds into the higher resolution regional model

- Both models can be run on a single core, HadRM3P model is derived from the Met Office PRECIS regional model

- Data from the regional model produced with a resolution of 50km by 50km (Europe and Southern Africa) and 25km by 25km (Pacific North West)

- 19 levels of atmosphere (in both global and regional model)

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What do we want to study

- A large amount of research has been done on global mean temperature, but the greatest impacts are likely to be seen at local/regional scales (this is especially with regards to extreme events)

- We also investigate how the risk of extreme weather events has changed due to human influence -> so-called 'event attribution experiments'

- And how the climate might change in the future with higher levels of CO_2, SO_2, Ozone emissions

- Perturbed physics experiments (to study the uncertainty arising from how we represent physical processes in the model) -> 500 different arrangements of 12 parameters are used

- Initial conditions perturbations -> model's initial state of atmosphere is uncertain (aka 'the butterfly effect') -> can sample many possible initial states of the model given the forcings

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Why do we use BOINC?

- Most climate science based on probabilistic results -> a distribution of scenarios is needed

-> Framework allows large number of models (order of thousands) can be run

-> In turns allows experiments be designed to be large enough so that missing results do not matter

-> Advantage of using so many model runs is we can get a better handle on uncertainties, especially with extreme events, which may occur for example, 1 in 100 years or 1 in 1000 years

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Simulation size

- No other climate science group is able to do this -> the world's largest climate modelling facility

- For example, in climate*prediction*.net a typical ensemble size for a study is of the range of thousands (for example: 2,000 simulations, 4 x 500 parameter sets)

- This is compared to the Met Office QUMP study looking at perturbed physics parameters, in which 128 simulations have been run

Length of simulation

- Want to study climate of specific regions over a long period

- Simulations are run from 1960 to 2011 (51 model years) -> this would equate to 230 days (on average) of runtime on volunteer's machines

-> Volunteers favour shorter tasks

-> So simulations are broken down by model year, for a computational time of 4.5 days (average)

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Resubmission and Batches

- When a model year completes a 'dump' is produced, this dump allows the simulation to be restarted from the point the dump was produced

- Allows the restarting of the simulation as a new model year. This is managed by an in-house resubmission script, this uses the dump to produce a new model year of the simulation

- Batches - individual studies are assigned a batch id (a collection of workunits)

-> Enables management of the resubmission of collections of workunits

-> Need to integrate this with BOINC batches

Data produced – Download files

- Download:

- A single task (including the workunit file, dump files and supporting files) is: 131MB

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Data produced – Upload files

- Each successful task produces produces either: 203MB (WAH EU), 74MB (WAH SAF), 122MB (WAH PNW) of upload data

- To date in Weather at Home 629,839 simulation years completed

- Each simulation year produces 13 upload files, so this means to date the project has received: 13 x 629839 = 8,187,907 upload files

- This equates to: 72TB of WAH EU, 6TB of WAH SAF and 23TB of WAH PNW (in total 101TB) of results have been uploaded since November 2010

- Equates to: inflow of data of 146GB per day or 1TB of new data per week

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Management of data

- Inflow of data rate poses challenge of dealing with this data, in terms cleansing, moving and cataloguing -> space has been added piecemeal

- Primarily data needs to be accessible to project scientists

- Data is managed by a number of server-side scripts, data files are recorded in a separate database, and there is a facility for the download of raw data for scientists

- Scientists are typically dealing with data sets of around 10TB, result sets which are within a range of observable values

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Recent results - Large scale warming in 2010 Russian heatwave

- Heatwave in Russia in 2010, caused worst drought in 40 years, record temperatures recorded in Russia and Ukraine -> 58 confirmed fatals and 15,801 indirect deaths

- Magnitude of heatwave was due to natural variability in the climate

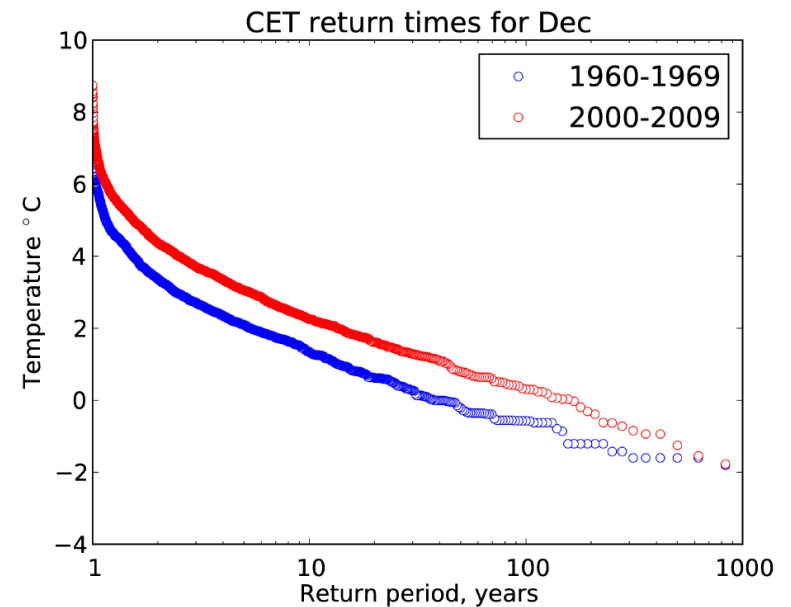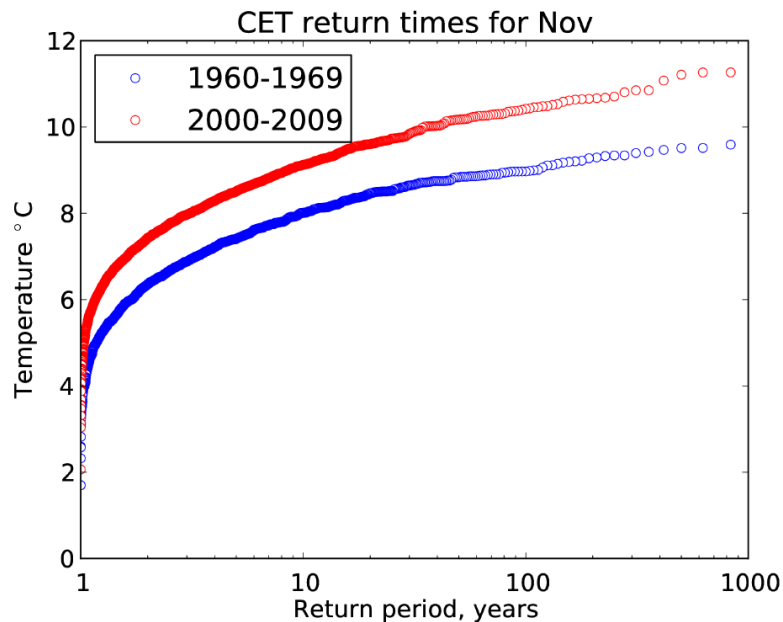- However increase in likelihood was due to climate change
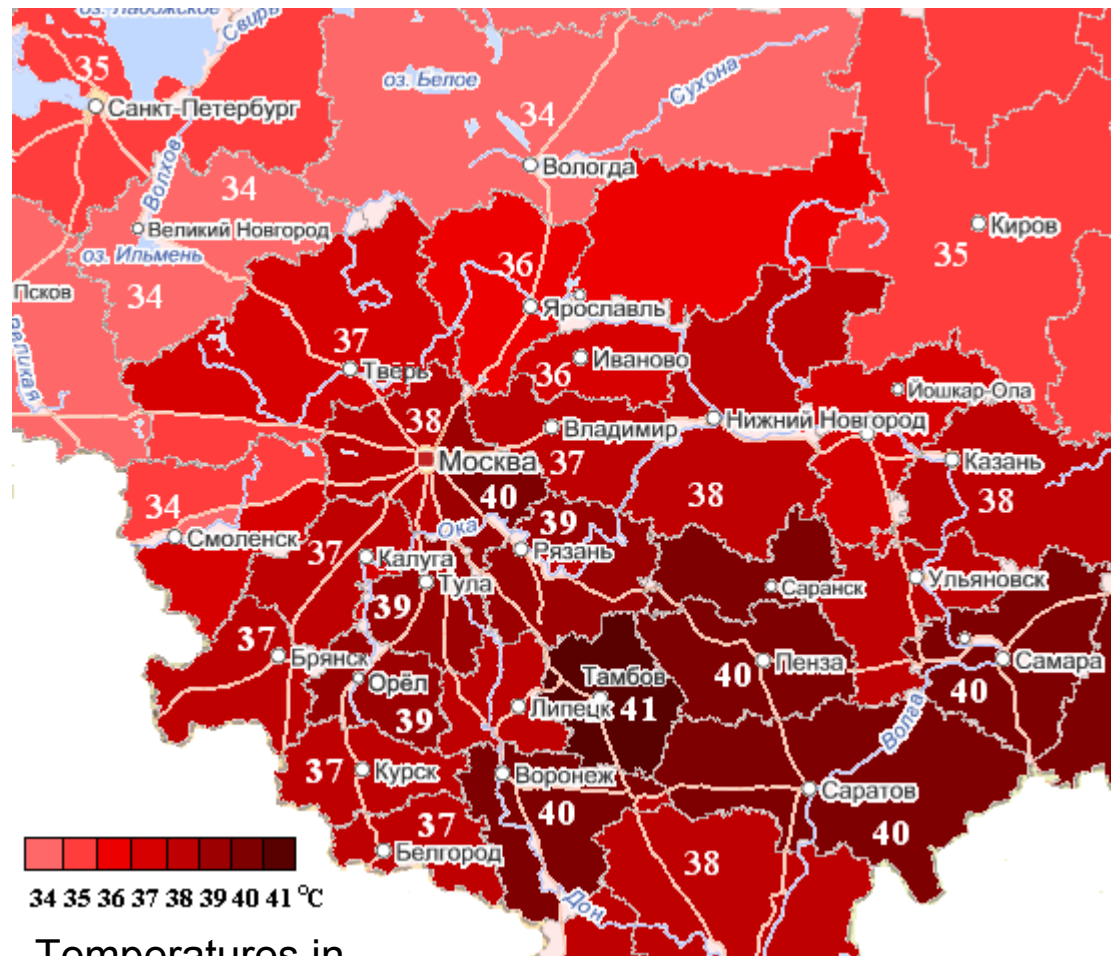
34 35 36 37 38 39 40 41 °C

Temperatures in western Russia 31 July 2010. Picture credit: Sergius1989 (ru.wikipedia)

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Recent results - warm Novembers and cold Decembers in the UK

- Increased likelihood of warm Novembers

- Decreased likelihood of cold Decembers

Upcoming Studies

- Geoengineering study -> Studying the affects of artificially changing aerosol concentration

- Perturbating the sea-surface temperatures -> Providing random perturbations to the sea-surface temperature on one ocean and measuring the effects on the temperatures on another ocean

- Studying 2011 and 2012 data -> Comparing the climate with pre-industrial CO_2 levels to current levels of CO_2

- Climate in 2040s -> comparing the current climate to the future climate, looking at the change of likelihood of extreme events

Future plans in Weather at Home

- Upcoming regions:

- WAH Australia New Zealand region -> Ready to be deployed

- WAH West Asia region -> Development in progress

- WAH Africa region -> Bid submitted -> This new region will be used for looking at changes in the likelihood of extreme weather events in Africa

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BOINC wish list and interests

Wish list:

- Support for other forum software with greater capability

Interests:

- Multicore app -> we are planning a multicore app

- Native virtualisation in BOINC

- Remote job submission