MISSION REPORT

Climate Forecasting Unit

To: CFU

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Subject: WRCP-ICTP Summer school on prediction and attribution of extremes (ICTP, Trieste, Italy, 21th July-1st August)

Meeting background

As part of the World Climate Research Programme (WRCP) grand challenge "Understanding and Predicting Weather and Climate Extremes" the International Centre for Theoretical Physics (ICTP) has assembled several experts in climate and weather extremes and students to foster the understanding in the prediction and attribution of extreme events. The ICTP is a research institution with a special mission to support developing countries and thus the participation was highly international.

The summer school consisted in lectures given by experts on different aspects of extremes and different exercises for which the students were divided in groups. The exercise was integral part of the summer school occupying a third of the two week program, with the goal to publish the obtained results in a set of scientific papers. The publications have been submitted in December 2014 to a special issue of the journal "Weather and Climate Extremes".

The exercises consisted of seven topics which were also the overarching topics of the lecture program: (1) *dataset development, (2) dimension reduction for extremes, (3) detecting human influence in Expert Team on climate Change Detection and Indices (ETCCDI) temperature indices, (4) event prediction, (5) attribution of changes of risk of extreme events using the CMIP5 models, (6) attribution of changes of risk of extreme events using the climateprediction.net initiative, and (7) Land surface drivers of droughts: The role of soil moisture persistence.*

Meeting summary and agenda

The lectures of the summer school are archived. The slides and video recording can be retrieved from (password 7a25rc):

http://users.ictp.it/~video/Conferences/2595/7a25rc.htm (videos)

http://www.wcrp-climate.org/index.php/ictp-2014-agenda (slides)

The content is briefly summarized here

(1) Introduction of extremes and extreme value theory (D. Karol, S. Seneviratne, E. Gilleland, P. Naveau)

- Extreme events are occurrences of a weather variable at upper (lower) ends of the observed range of values in region (e.g. summer extreme in UK are different than in Spain). The SREX provides the definitions of extremes.
- Extremes are described statically by the extremal type theorem. Extremes follow a Generalized Extreme Value (GEV) or a Generalized Pareto Distribution (GDP) depending on how the extremes are sampled (block maxima, peaks over thresholds).
- Theory and tools have been introduced using the NCAR R-package extRemes.
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(2) Detection and attribution (D&A) (F. Zwiers)

- The aim is to *detect* drivers of the climate system in observations and attribute the drivers to climate change (detect the human “finger print”)
- Different approaches have been described: non-optimal and optimal approach, and variants of the optimal approach: ordinary least squares, total least squares and errors in variables.
- Basic steps of D&A: (1) determine domain and period, (2) gather observations, historical model runs (with anthropogenic forcing) and control runs (only natural forcings), (3) fit a regression model on simulations and observations that attempts to explain the observations by either historical runs and natural runs, (4) compare goodness of fit of both regressions

(3) Physical mechanisms (D. Karoly, S. Seneviratne)

- Contribution of teleconnections on extreme events: The effect of ENSO and NAO for blocking over Europe
- Outreach video to explain effects of ENSO:

https://www.youtube.com/watch?v=yCsMmajLYG4

- Contribution of land surface coupling on the occurrence of heat waves and droughts. Limitation of soil moisture induces a feedback of enhanced drying and increasing surface temperatures. Feedback is further discussed in terms of a soil moisture and local precipitation coupling which is less evident.

(4) Prediction of extreme events (F. Doblas-Reyes, A. Kumar)

- The seasonal prediction approach: Why is seasonal prediction possible and what is its current status (detailed assessment of seasonal predictions well known to CFU)
- Prediction of extremes in a climate prediction perspective: unusual events but not necessarily very rare events (also termed “soft events”). No extreme value theory necessary.
- Need for verification of the predictions but typical approaches degrade with small samples of past unusual events. Possible approach is to use number of days of maximum/minimum temperature above/below 90%/10% climatological percentile.
- So far very little studies and many opportunities in this field. Some applications shown (see slides)

(5) Climate extremes: Data issues (L. Alexander)

- Problems of quality in measurements leading to inconsistencies and sparse availability of observations.
- Approaches for data homogenization
- Gridding of observations (Kriging, Natural neighbours, …)
- Observational datasets differ due to different approaches considered. Uncertainty of extreme variables very large in observations.

(6) Event attribution (P. Stott, F. Otto)

- General question: How has anthropogenic climate change altered the probability of occurrence of a specific extreme event that happened in the past.
- Description of basic methodology to define the fraction of attributable risk (FAR). Compare the probabilities that the event occurs in a world with climate change and one without
- Approach and applications using the global climate models of the CMIP5 archive for the European heat wave 2003 and recent temperature and precipitation extremes over Australia
- Approach and application using the very large model ensemble of the climateprediction.net which prescribes sea surface temperatures in a regional climate model when the event occurred. Examples are shown for European floods and temperature extremes.

Exercise on seasonal prediction of extremes (CFU exercise)

One of the exercises offered to the students was established by the CFU and NCEP and prepared and presented by Chloé. The exercise involved several aspects in the

prediction of extreme events using daily statistics of the ENSEMBLES multi model ensemble.

The exercise aimed at illustrating the ability to predict extreme events of temperature and precipitation in seasonal prediction sense. Key questions involved the comparison of prediction skill of the seasonal mean and extreme indices (e.g. days above the 90th percentile) and the partition of skill into the contribution of ENSO and long-term trend due to climate change.

The exercise is described on the CFU wiki page by the following presentation:

http://ic3.cat/wikicfu/img_auth.php/20140722_cprodhomme_project_presentation.pdf

The students worked on the data using s2dverification which was introduced during a hands-on session:

http://ic3.cat/wikicfu/img_auth.php/20140722_cprodhomme_hands-on.pdf

Each group presented their results by the end of the summer school. The presentation of the group working on the seasonal prediction exercise can be retrieved from here:

http://ic3.cat/wikicfu/index.php/File:Group_presentation.pdf

Miscellaneous

The participation of the the summer school was competitive and selected members were fully funded by the WRCP (travel, accommodation, per-diem). Although the participants were expecting sunny weather and being close to the sea, it was pouring down with rain almost the two weeks. We had nevertheless a very good time.

IC3 members participated in two of the papers submitted to the special issue. Now it is time to get a good review.