Synthesis report for the joint ENSEMBLES RT5/RT9 Workshop on climatic extremes Riederalp, Switzerland, January 28-31, 2009

The Riederalp-2009 Workshop was a follow-up meeting following on from several similar events that took place in Switzerland during both the EU-FP5 "PRUDENCE" project (Chateau-d'Oex 2004, 2005) and the EU-FP6 "ENSEMBLES" project (Riederalp 2006, 2007). It brought together 25 scientists from 8 countries working within the ENSEMBLES project to present the latest research results on extreme weather and climate events and to discuss progress made in this field since the previous meetings.

The principal workshop topics included:

- Analysis of extremes in transient climate model runs
- Comparing trends in extremes in RCM simulations driven by ERA40 with those in observed data; Circulation patterns associated with climatic extremes
- Changes in very rare events
- Heat waves and droughts
- Extreme precipitation and wind storms
- Seasonal forecasting of extremes
- Impacts and adaptation

The full list of talks and breakout session summaries is provided below; the report is completed by the list of participants and the group photograph taken on January 30.

Thursday, January 29, 2009

- Introductory remarks and Workshop objectives *Martin Beniston, University of Geneva, Adri Buishand, Royal Netherlands Meteorological Institute, De Bilt and Paul van der Linden, ENSEMBLES Director, UK Met Office, Exeter*
- Detecting changes in UK seasonal precipitation extremes and implications for managing fluvial flood risk *Hayley Fowler, University of Newcastle upon Tyne*
- A non-stationary index-flood model for precipitation extremes in transient RCM runs *Martin Hanel, Royal Netherlands Meteorological Institute, De Bilt*
- Evaluation of temperature extremes from an ensemble of transient RCM simulations driven by several AOGCMs *Grigori Nikulin, Rossby Centre, SMHI, Norrköping*
- Daily extremes from regional models: a comparison between the RCM ERA-40 driven integration and the present period of the A1B GCMdriven simulations *Erasmo Buonomo, UK MetOffice, Exeter*
- Preliminary analysis of heavy precipitation over the Alpine region by ERA40 driven RCMs *Pardeep Pall, ETH Zürich*
- Time series resampling of ENSEMBLES RCM output to derive future changes in large quantiles of multi-day precipitation in the Rhine basin *Jules Beersma, Royal Netherlands Meteorological Institute, De Bilt*
- Mechanisms and reliability of future changes in extreme precipitation *Elizabeth Kendon, UK MetOffice, Exeter*

- ***Breakout session 1 (see summary below)***

Friday, January, 30, 2009

- Reporting back from Breakout session 1 *Breakout group leaders*

- The characteristics of daily precipitation in Europe derived from the ENSEMBLES observational dataset *Wilhelm May, Danish Meteorological Institute Copenhagen*
- Diagnostics of European wind storms and related impacts from ensemble(s) simulations *Gregor Leckebusch, Institut für Meteorologie, Freie Universität Berlin*
- Seasonal forecasts of winter storm activity *Gregor Leckebusch, Institut für Meteorologie, Freie Universität Berlin*
- Clustering of extreme storm events *David Stephenson, University of Exeter*
- Synoptic conditions of extreme windstorms over Switzerland *Stéphane Goyette, University of Geneva*

- ***Breakout session 2 (see summary below)***

Posters

- Circulation patterns related to extreme weather conditions as identified in observational and RCM data sets *Ferdinand Beck, University of Stuttgart*
- Analysis of the meteorological factors triggering debris flows *Michelle Bollschweiler, University of Geneva*
- Using ENSEMBLES Regional Climate Models to study extreme temperature and precipitation conditions in the Mediterranean region *Efi Rousi, University of Thessaloniki*
- Preliminary validation of 8 ENSEMBLES regional climate models with observations in the area of Greece *Konstantinos Varotsos, National Observatory of Athens*

Saturday, January, 31, 2009

- Reporting back from Breakout session 2 *Breakout group leaders*

- Decadal-scale changes in the tails of probability distribution functions of climate variables in Switzerland *Martin Beniston, University of Geneva*

- Description of extremes in the final report Reminders of extremes-oriented meetings in other contexts

Summary of breakout group sessions

Breakout session 1A: Strategies for analyseis of extremes in transient climate model runs

A popular method to analyse extremes in transient climate model runs is to assume stationarity within time-slices. The use of covariates like global temperature change and circulation indices was discussed. Another possibility is to include weather type classifications that are relevant in the description of the extreme. There is no single best method. The comparison of different methods was encouraged. The importance of checking the assumptions of statistical models was stressed.

Spatial pooling techniques were considered to be very useful to reduce the uncertainty. It was noted that spatial pooling is not the same as the use of max-stable processes, where the emphasis is on the simulation of spatial fields of extremes (Schlather, Extremes, 2002). Apart from spatial pooling, multimodel pooling could also be taken into account.

Time series generation using resampling techniques was also discussed. These techniques should take into account the existence of trend and natural variability.

Breakout session 1B: Understanding differences between modeled and observed extremes

Much attention was given to differences in trends in extreme events between RCM simulations driven by ERA-40 and E-Obs (a gridded 25 km $\times$ 25 km daily dataset of observed daily temperature and precipitation developed in the ENSEMBLES project). Phil Jones showed results for trends in extreme daily minimum temperature (Tn-05), extreme daily maximum temperature (Tx-95) and maximum 5-day rainfall (R5d). Both for the RCM and E-Obs data linear trends were estimated for each 25 km $\times$ 25 km grid box. Histograms of the differences in trends between RCMs and E-Obs showed for Tn-05 a good agreement in the summer season (trends in cold summer nights), but for the other seasons there were considerable differences between the trends in the various RCM simulations and the trend in E-Obs. For R5d, RCMs are both under- and overestimating the trends in E-Obs. Taylor diagrams (Taylor, *J. Geophys. Res*., 2001) were constructed to compare spatial fields of the estimated trends in the RCM simulations with the field of the estimated trends from E-Obs. For Tx-95 the best correspondence between the RCM fields and the E-Obs field was found for the autumn season and the worst correspondence for the summer season. The statistical significance of the differences in trends of extreme events is explored. It was suggested to compare the results of the trends in extremes with the RT3 model weighting.

Breakout session 2A: What can we say about changes in very rare events?

Some doubts were raised about the possibility to give reliable estimates of 100-yr return levels or larger ones since it is very difficult to test or validate such estimates. On the other hand, it was recognized that very large return levels are sometimes asked for by society (e.g., 1000-year return levels are needed for the planning of a nuclear power plant in Finland, and the design of reservoir dams in the UK and river dikes in the Netherlands). When such very large return levels are given they should be supplemented with confidence intervals even though such intervals may become very long (and therefore difficult to interpret by decision makers). It was also suggested that one should not concentrate too much on individual return levels but look at the change of the whole distribution, which gives a more general picture and helps to serve more stakeholders. There was also a bit more philosophical discussion on whether knowledge from physical processes should or could be included to constrain the estimates of (changes) in extreme events, and on how very large values in observed or modeled series should be interpreted. Reference was made to the current debate in the statistical literature if such very large values are to be considered as "outliers" or as "informative". Typically, "outliers" in model runs are not mistrusted as in observations, even though they are the result of numerical approximations of physical processes which can be in error as well.

Breakout session 2B: Comparison of extremes from different data sets

Due to lack of participants, this breakout session was merged with session 2A. Characteristics of extremes in the E-Obs gridded dataset were briefly discussed. It was recognized that people using the E-Obs gridded data set should be aware of its limitations regarding the extremes (e.g., systematic reduction of return levels of daily precipitation and maximum temperature due to the interpolation and systematic differences with data sets that are based on a much larger station density). Due to these limitations users of the E-Obs data set are urged to take notice of the papers by Haylock et al. (*J. Geophys. Res*., 2008) and by Hofstra et al. (recently submitted to *J. Geophys. Res*.). Copies of the latter were made available by Phil Jones.

Riederalp-2009 List of Participants

Family Name	*First Name*	*Affiliation*
Beck	Ferdinand	University of Stuttgart
Beersma	Jules	Royal Netherlands Meteorological Institute
Beniston	Martin	Environmental Sciences, University of Geneva
Bollschweiler	Michelle	Environmental Sciences, University of Geneva
Bosshard	Thomas	ETH Zürich
Buishand	Adri	Royal Netherlands Meteorological Institute
Buonomo	Erasmo	MetOffice, Exeter UK
Fowler	Hayley	University of Newcastle
Goyette	Stéphane	Environmental Sciences, University of Geneva
Hanel	Martin	Royal Netherlands Meteorological Institute
Jones	Phil	Climatic Research Unit, Norwich
Jylhä	Kirsti	Finnish Meteorological Institute, Helsinki
Kendon	Elizabeth	MetOffice, Exeter UK
Kotlarski	Sven	ETH Zürich
Leckebusch	Gregor	Institut für Meteorologie, Freie Universität Berlin
May	Wilhelm	Danish Meteorological Institute
Nikulin	Grigori	Rossby Centre, SMHI, Sweden
Pall	Pardeep	ETH Zürich
Rousi	Efi	University of Thessaloniki
Stephenson	David	University of Exeter
Stoffel	Markus	Environmental Sciences, University of Geneva
Van der Linden	Paul	MetOffice, Exeter UK
Vänälainen	Ari	Finnish Meteorological Institute, Finland
Varotsos	Konstantinos	National Observatory of Athens

Group photograph, taken on January 30, 2009 in front of the meeting venue