Version: 0.2
Date: 26/07/2012
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ECRA Collaborative Programme: High Impact Events and Climate Change

The European Climate Research Alliance was formed in October 2011. Members are research performing organisations (RPOs) of European countries. The scientific backbone of ECRA is formed by four collaborative programmes (CPs). One of which is 'High Impact Events and Climate Change'. This document serves two purposes

1. the formulation of the general scope of the CP, and
2. the description of some initial joint activities in the network created by the CP.

Like ECRA the CP is not static. Scope and activities should be flexible and subject to review. They will develop and adapt over time to serve the needs of scientists in the ECRA RPOs. The science requirements will be driven by societal needs and rely on stakeholder inputs (e.g. identification of high impact events, and coincident events forming a high impact event). Impact specialists in the network will assure that high-level science output is delivered in a usable form to stakeholders. Even though the CP is focused on science, it realises its part in a chain that ranges from societal need via actionable science to innovation and economic benefit.

1 General scope

There is growing awareness that **climate change** cannot solely be considered as a **"mean state"** modification. Changes in the characteristics, frequency, and severity of **extreme events** are typically responsible for the most important impacts, and consequently are amongst the most significant aspects of climate change to understand and predict. This Collaborative Programme will examine how **high impact events** work, how they can be simulated accurately in fluid-dynamical and statistical models, and how we might be able to project future changes reliably. End-user engagement will be critical to establish requirements.

Elements of the general scope currently include:

1. **Scale interactions and critical processes**
    a. Scale interactions in the atmosphere including dynamics/energetics and composition (as forcing or feedback), for example in the context of mid-latitude blockings, tropical or extratropical cyclones. Consequences of scale interactions for predictability (reliability of projections): Propagation of large scale climate change simulations to the regional scale using statistical downscaling and high resolution regional modelling.
    b. Critical processes involved in high impact events (extreme weather phenomena), for example the factors that govern the structure and characteristics of extratropical and tropical cyclones (including internal modes such as ENSO or NAO), and how these factors are influenced by greenhouse gas and other climate forcings (including composition changes).
2. **Evaluation and quantification**
    a. Assessment (e.g. comparison with observations and model intercomparison exercises) and improvement of numerical simulations of high impact events, including assessment of the extent to which increases in resolution improve the fidelity of numerical simulations.
    b. Assessment and improvement of statistical models of high impact events, including assessment of the extent to which new methodologies improve the fidelity of climate change impact predictions.

c. Better quantification of impacts and vulnerabilities associated with extreme climate events by linking large and regional scale simulations to physical, chemical and economic impact models, recognising the inherent uncertainties in long-term projections with global climate models. This includes assessing relations between hazards and impacts (risk assessments) and the identification of multiple drivers and coincidences.

2 Activities

We have identified a number of activities that add extra value to ongoing research at no (or very low) extra cost

- Working group meeting: Statistical models used in conjunction with model data (possible calibration)
    - Require daily precipitation data (validation)
    - Understanding underlying physics
    - Impact deliverables (decadal predictions/variability) – Action: TeleCon in September
- ENSO: Statistical analysis of observations (past and present-day) and of model simulations, the possibility of super (extremely strong)-El Niños in response to global warming– extreme El Niños of the past – what will happen to ENSO-related teleconnections under global warming (change of background)?
- Storms (climatic description) in high resolution time slice experiments (right data in archives)
    - Extratropical (high- latitude cyclones, MEDICANEs): Developing our understanding of how extratropical cyclones might respond to climate change is central to evaluating future weather risk from windstorm, flooding and coastal storm surge. Climate projections are often performed with climate models (for example, the climate projections in CMIP5) with resolutions that are not able to capture the mesoscale processes that give rise to extreme rainfall or winds. The climate modelling groups that participate within ECRA have performed present-day and climate change time-slice experiments with climate models at much higher-resolutions than those used in the CMIP5 (EC-EARTH T799, HadGEM3 N512, ECMWF IF Athena simulations). One of the proposed activities with ERCA is to exchange model output to understand how intense extratropical cyclones, and their subsequent impacts, might respond to climate change in very high-resolution climate models.
    - Tropical systems (Hurricanes, Typhoons, Borneo Vortices): Tropical storm systems that form over open oceans and move towards shores are a source of high impact weather for coastal communities on their landfall. Diagnosing the variability of such systems and the link to large scale modes of variability (e.g. ENSO) will help to put confidence limits on modelled future projections of extreme event in coastal regions. Sharing high resolution climate model data and applying novel statistical methods will boost our level of understanding regarding tropical storms.
    - Thunderstorms: Analysis of the actual hazard, identify regions with high intensity and density, investigation of structure and intensity in the future with regional climate models. Important: high resolution climate models for calculating convection parameters and local scale effects.
- Effect of soil moisture on lead time (predictability) (new schemes)

- Coincidence (gauging exercise): Many extreme situations in society are due to a combination of factors, including meteorological and non-meteorological issues (state of maintenance, management practice). In this activity an inventory will be made of European sectors/areas where the coincidence of (mildly or very) extreme conditions have lead or can lead to strong adverse society impacts. Included in this inventory are the ongoing, planned or desired research activities in this direction.
- Collaborative space on BADC: see above for examples what could/should be stored
- Sub-webpage on ECRA page