Minutes from CONVEX 2012 Workshop

Reading University

Day 1 (17th April 2012)

1. Introduction to the CONVEX Project:

- Hayley Fowler (HF) opening comments concerning tailoring results for end users, the possibility of providing such results, and communicating such results.
- Stephen Blenkinsop (SB) summarizes current research results, CONVEX objectives with models and observations, progress to date, and future plans.
- Question: Applications to London – is London precipitation getting more extremes? Can results represent interesting local precipitation phenomena around London – such as precipitation appears to go around London?
    - Answer: 1.5-km model may be able to capture mechanisms that affect local precipitation. Inclusion of aerosol physics may be important.

2. Strengths and limitation of current climate projections:

- Lizzie Kendon (LK) summarizes where confidence (or lack of confidence) in model results are.
- Discussion of UKCP09, natural variability of extremes, model imperfections and parameterisations, and pros of increasing model resolution.
- Discussion of the reasons and limitations of dynamical regional downscaling.
- Discussion of what is new in CONVEX in modelling – multi-year high resolution regional simulations.

3. Discussion: What are the minimum and ideal requirements from climate models and their projections for users of climate information?

- Key questions (to be discussed by 4 groups):
    - What temporal and spatial scales are needed?
    - To what level of detail do the projections need to be?
    - Are probabilistic projections useful?
    - What other concerns exist?
- **Some of the recommendations, requirements and issues raised in the group discussion:**

    Requirements
    - Requirements for hydrological modelling depends on catchment and event type:

  - Higher (space and time) resolution data is more useful: for flash flooding/transport drainage hourly or less, timeseries data, 1-2-km; for drought, coarse resolution data are usable (daily, 25-km, timeseries). However, the number of dry/wet days needs to be accurately represented and hence may require 1.5km climate modelling.
- At a minimum hourly timescales are required.
- Time periods needed: 25-40 years for water applications, up to 60 years for building design.
- Ideally time series data are most useful, but in case of derived metrics it would be useful to have information about any changes in clustering of events in time. Antecedent conditions are also very important for flooding.
- Need quantitative information (but some use for qualitative info e.g. removing uncertainty over signs would be beneficial e.g. summer precipitation over the UK) –useful in monte carlo analysis, could use 1 in 50 design standard (issue re antecedent conditions).
- Transport flooding/drainage/adaptation policies need numbers, sign of change is not sufficient. For cost/benefit analysis of adaptation measures, quantitative information is needed. Knowing the worst-case scenario would be useful providing this is robust.
- Need information on reliability rather than precision.
- Work towards providing thresholds for "flashy" catchments (not useful for large ones). Flash flooding in rapid response catchments – past relationships between rainfall and flooding, changes in depth-duration threshold exceedance.
- Persistence of drought – timeseries of rainfall, quantitative, multi-variable inputs.
- More than return levels: determination of critical thresholds is important; regardless, projections of returns levels are useful.

Issues

- What is the meaning of "confidence"?
- Many believe probabilistic projections have limited use; again, actual projection numbers are preferred.
- Interested in baseline vulnerability as well as future projections.
- Interest in high resolution simulations/data outside southern UK – don't be limited in terms of project dissemination to hi-res model domain.
- Important to make sure CONVEX results are well disseminated.

4. Invited speaker session (2 speakers – Heather Lammas (HL), Worcestershire County Council and Juliette Daniels (JD), London Climate Change Partnership):

- HL: Building resilience in Worcestershire

- Presented how extreme events impact the region ,economic and social impacts of the 2007 floods.
    - Need for projections to plan for adaptations ("resilience plan").
    - Data requirements: high resolution data needed for drainage and hydrological modelling.
    - Used UKCP09 projections for 2020s and 2050s for building design. In particular, one example of a new building which needed 1/100 year flood line.
    - Question: What return periods needed for adaptation policies? How to communicate flood information to the public?
        - A: Return periods: 30-250 year events; use of internet and local events.
- JD: Using climate knowledge.
    - Climate change information for government and insurance for adaptation.
    - Challenges (politics): Explaining climate change, political priorities, results that are not politically friendly, fiscal problems, media sensationalism.
    - Challenges (results): Too much information sometimes, different groups want different information, presentation of results to be accurate/concise without being dry.
    - Beyond just delivering results: more communication needed with users.

5. Discussion: How can we maximise the utility of climate projections for policy makers and flood risk assessment?

- Key questions (discussed by 4 breakout groups):
    - What difficulties & limitations have been encountered with climate products to date?
    - From discussion and presentations, what output/analysis from CONVEX is useful? How would such info be used? What additional output/analysis is helpful?
    - How can climate scientists better communicate with users?

- **Difficulties/limitations with climate models/products.**
    - **Practical issues**
        - data size too large;
        - different I/O formats;
        - too much information;
        - models with 360 days;
        - difficulty with extracting data subsets;
        - surprised by level of resource required to understand, obtain, and use UKCP09 data;
        - concerns with data licensing and availability.
    - **Fundamental model deficiencies**

- combination of risks not available e.g. water quality after dry spell – need for an understanding of the users' problem first;
    - low resolution, especially for small catchments;
    - large uncertainties in models and other uncertainties feeds in to usefulness of flood model results – can detract from use;
    - treatment of extremes – poorly represented, especially for events with long return period. 20 years of precipitation data does not adequately sample extremes of interest - we have less to say about extremes & exceedances in history;
    - lack of understanding of the current baseline – projections are helpful, but better understanding about now is as important, providing a more robust baseline;
    - other variables e.g. high resolution wind data (1.5 km), soil moisture, humidity;
    - end users do not know what data and information are available; lack of metadata - need for quality standards, quality ratings?
    - similarly, it takes a high level of resource to find out what information exists, extract, understand relevance & limitations, use effectively e.g. UKCP09, CMIP5.
  - **Interaction between modellers and end users**
    - lack of understanding the problem within "end user" community – a narrative should link to understanding the problem. Noted that different sectors need different outputs (and messages);
    - information needed on how to validate outputs locally;
    - end users may not know what their question is and what their needs are: 2-way dialogues about end user requirements are encouraged;
    - final messages of different projects can be confusing. Problems re communication of information across the subject;
    - the format of information fails to engage users – consider interactive, layered maps;
    - there is a disconnect between end user/politician data needs with researcher data and between time frame of decision framework (typically 5 years) and scientific information – decision framework needs adapting. Decision rush (regulatory world) "we need an answer in 3 months…get me an answer" – lock in for 5 years is a problem.

- **Suggestions to increase utility**
  - Data needs to be on a scale useful for small river catchment modelling.
  - Instead of expanding time, expanding space – pooling regions etc. for analysis of extremes.

- Users are concerned with apparent lack of robustness in projections. Consider provision of "ratings" to communicate quality of individual climate products.
- Need to tailor results for end user needs; the need to balance data detail and simplicity; volumes of data have limited use – climate narratives are useful. Also climate descriptions have limited use to end users – information is needed for adaptation.
- Identify risks and vulnerabilities.
- More worked examples of use of climate data are helpful.
- Visualisation of scenarios e.g. using google mapping is useful.
- Don't rely on return period but consider appropriate thresholds. Like previous discussion thresholds are as interesting as return levels. Provide information on thresholds, sensitivities & tipping points etc. which are relevant to users.
- Could enhance utility by plugging new information e.g. software.

CONVEX outputs

- Suggestion of doing case study for the London area. There is a real interest in the high-resolution model performance over London, and in particular whether there is any evidence of an urban influence on local convection. [Note this is an area where we have good confidence in the radar data.]
- The Flood Estimation Handbook (FEH) – guidance of adaptation and planning – results should be presented in a way similar to FEH as this is what practitioners are familiar with.
- Should aim for outputs to a) drive change in design standards, b) drive change in MTCE standards, c) assessing the legacy infrastructure
- Suggestion of looking into persistence/clustering of events, as well as extreme event intensity. There is considerable interest in drought, and how this may change in the high-resolution model which is able to give a much better representation of rainfall occurrence. Associated information relevant to reservoir recharge would be useful.
- Relevance to those in operational forecasting should be considered.
- Potential for land use changes to trigger tipping points in local climate is of interest.
- Outputs will lead on to more detailed studies, and there should be a case made for these at the end of the project.

Communication of CONVEX outputs

- Good to try and get representatives for the Town and Country Planning Association to attend future workshops. They could be instrumental in translating the scientific information emerging from CONVEX to that which is useful for planners.
- Make greater use of channels within NERC to broker relationships.
- Invite water authority regulator to future workshops.

- All events should allow a two-way communication.
- Need to be careful to manage user expectations.
- Reports and dissemination should:
  - Include simple summaries of methods used, data provenance etc., Terminology is important e.g. "annual expected probability" instead of return period. Users want simplified messages e.g. traffic light symbols – red, amber, green, but when is "simple enough" for baseline and projections.
  - Generate resonating messages e.g. for SMEs, senior/director level, local authorities
  - As above point re FEH, output should relate to existing tools and knowledge e.g. link to planning tools e.g. flood maps (EA?), relationship to UKCP09 messages & output. We should be sure to explain the relationship between any new info and existing info such as UKCP09, ENSEMBLES and also a focus on regions where differences appear.
  - Set the case for more detailed studies e.g. geology, topography, vulnerability and link to EA surface flood risk.
  - Messages should be tested with audiences prior to publication.

Day 2 (18th April 2012)

1. Introduction to the CONVEX Project:

- HF opening comments: summary of day 1, today's plan.
- CONVEX introduction and purpose, results to date, similar projects.
- Question/comment: Climate change detection - models and observation say no detectable change yet, but some changes are claimed to be detectable in some other parts of globe (Singapore). What are major difficulties of detecting change?
  - Response: CONVEX focus is in UK; CONVEX focus includes hourly extremes; changes may become detectable by 2020.
- Question: What does it mean by convective rainfall/extreme?
  - Response: Summer rainfall is mostly convective; methods to separate convective & stratiform precipitation exist; CONVEX not limited to convective extremes; high resolution models are convective permitting.

2. Scientific presentations from CONVEX:

- SB: Analysis of observed rainfall data.
  - Better understanding of observed extremes and their link with other variables (process understanding, understanding of extreme baseline).
  - Discussion of what data are available: ENSEMBLES, radar, gauge.

- Temporal resolution of the data.
- Specifics in data analysis (extreme value analysis, warning thresholds).
- Question: Will (surface?) temperature be examined as well?
  - Answer: Part of future work in mechanism attribution – discussion of other variables of interest: upper air variables, MSLP, climate indices (NAO).

- Steven Chan (SC): Differences between different model simulations/resolutions and observations.
  - Bias & frequency of precipitation in models: sensitivity to resolution.
  - Usability of radar data.
  - Comparison of hourly radar data with models.
  - Question: Why 1.5 km resolution over other possible resolutions?
    - Discussion: Balance between cost and realism; 1.5 km convective permitting with workable computational cost.
  - Question: Biases in SE UK?
    - Discussion: Some links with 12-km model biases.
- LK: Key problems in modelling.
  - 20 years of model simulation at 1.5 km convective permitting resolutions with no convective parameterisation (already used in NWP).
  - Realism increases at such resolution: representation of topography, etc.
  - Discussions in biases and model sensitivity to resolution.
    - Duration of precipitation better in 1.5 km simulation
    - Size of convection is too constrained in 1.5 km simulation
    - Diurnal variability – realistic late onset in 1.5 km simulation
  - Question: What causes the wet bias difference between the 12 km and 1.5 km simulations? Are they related to rain duration?
    - Answer: Yes
  - Question: Process differences between 12 km and 1.5 km simulations?
    - Answer: Differences in the environment?
- Nigel Roberts (NR): NWP and flood prediction using convective permitting models.
  - Realism of convective permitting model (common theme with LK).
  - Need 50m resolution to fully resolve storms, so will be in regime of convection-permitting models for foreseeable future.
  - DYMECS project
    - Observed 100s of storms to evaluate hi-resolution models statistically.
    - No evidence of convergence in model representation of storms as resolution decreased down to even 100m.
    - In observations see sloping updrafts and downdrafts, and new storms forming behind old storms (back-building). Hi-res models are able to capture these detailed convective processes to some extent.

  - What are the current limits in comparing radar and hi-resolution models?
  - Storm development/decay/movement more realistic hi-res simulation.
  - Possible ensemble approach of using hi-res models.
  - Synoptic/large-scale features which are associated with extreme events/convection (composites of storm location to synoptic lows and Theta-E (equivalent potential temperature) gradients).
    - Uncertainty at convection scale is essentially random, however, the risk area for one of these storms is controlled by the larger-scale environment and is potentially more predictable.
    - Large scale environment characterised by PV (potential vorticity) at 900mB or theta-w at 950mB.
    - See relationship between large-scale conditions and where storms occur, and it would be interesting to examine this relationship in longer climate runs. In particular convective storms tend to develop over low-pressure centre.
  - Question: PV anomalies related to flood risk?
    - Answer: Diabatic heating generates such PV anomalies

3. Invited speaker session (Jessica Loriaux, Delft University of Technology, Netherlands)

- Topic: Increase of (sub-)hourly extremes due to temperature
- Work analysing observations at daily, hourly and 10 minute timescales (latter available for 2003-2011).
- Difference between convective and frontal generated precipitation.
- Scaling between temperature vs. Clausius–Clapeyron (CC) changes with precipitation mechanism, temporal scale, and percentile level.
- Daily extremes –frontal generated precipitation - “usual” 1.07x scaling.
- Expectation is that convective extremes occur on shorter timescales than frontal extremes, and thus as we consider shorter timescales we will be effectively selecting convective events.
  - For daily extremes, follow Clausius-Clapeyron scaling (7% increase per degree increase in dew point temperature).
  - For hourly extremes, see shift in scaling from CC to 2CC at high temperatures. Possible explanation is that this marks transition from frontal to convective events.
  - For 10 minute extremes, now see 2CC scaling across full temperature range. This confirms the suggestion that 2CC scaling corresponds to convective extremes, whilst frontal extremes scale at CC.
- Hourly convective extremes associated with “super” (up to 2x) scaling whereby there is a feedback between latent heating and upward velocity.

- Would only expect this to occur on fine spatial and temporal scales, as at coarser scales release of latent heat will tend to stabilise the environment.
  - Investigating super-CC scaling in an updraft model, and find that condensation rate scales at about 10% per degree.
- Note in this work using dew point temperature, as this removes need for constant RH assumption. However, as go up in Td possible that may be sampling different air masses.
- Usage of updraft model to model scaling; future use of large-eddy simulation?
- Question: What variables fixed – relative humidity?
  - Answer: Only need to fix dew point for extremes.
- Question: Scaling of lower percentiles (non-extremes)?
  - Answer: Scaling not clear.
- Question: Application to climate change?
  - Answers: Results focus on current climate only.

4. Keynote speaker (Prof. Erik Kjellström, SMHI, Sweden)

- Topic: European precipitation extremes simulated by RCMs.
- Limits to model evaluation imposed by availability of observations.
- Intensification of hydrological cycle with climate change and extreme changes.
- Discussion of results from ENSEMBLES.
- Model simulations help identify problems with observations.
- Importance of choosing right metrics.
- SMHI are currently investigating benefits of hi-resolution RCMs.
  - Have run RCA3 (hydrostatic model) at 50km to 6km resolution.
  - Developing non-hydrostatic RCM (HARMONIE), and have run at 2km resolution for 5 year period 1998-2002.
  - Reanalysis forcing leading to better simulations.
  - Emergence of local climate features with increase resolution.
  - Diurnal variability improves with resolution.
- Question: Difference in large-scale and convective precipitation?
  - Answer: Only bulk amounts are examined.
- Question: With or without convective parameterisation? Based on NWP?
  - Answer: No CP simulations in development. Model based on NWP

5. Invited speaker session (Richard Allen (RA), David Lavers (DL), Chris Taylor (CT), Cameron Rye (CR), Adrian Champion (AC))

- PAGODA (RA):
  - Global focus and comparisons of GCM (CMIP3, CMIP5) simulations.
  - Mechanisms:
    - Hi-resolution GCMs favour moisture transport over recycling.
    - Intensification of hydrological cycle increases ocean salinity.

- Temperature increases lead to strengthening of extremes.
  - Wet places get wetter, dry places get drier.
  - Influence of model resolution on moisture transports.
    - At higher resolution eddies become more efficient at transporting moisture into the continental interior, leading to a decrease in E/P over land.
  - Increase in intense rainfall with tropical ocean warming.
    - dP/dT is very space and time scale dependent.
- Question: Are there (more) grid point storms in high res global models?
    - Answer: Yes

- HYDEF (DL):
  - Observed UK winter floods can be traced by atmospheric river events, regions of moisture transfer from the subtropics to the mid-latitudes which show a consistent SW-NE orientation. Western UK is more susceptible to atmospheric river events.
  - Question: How about in summer?
    - Answer: Largest historical floods are in winter.
  - Question: Atmospheric river event intensity related to flood intensity?
    - Answer: Yes
  - Question: Will HYDEF look at model data?
    - Answer: No examination of model data yet.
  - Comment: It would be good to develop an objective method of diagnosing AR events.

- SWELTER-21 (CT):
  - Discussed the role of soil moisture (and surface temperature) to precipitation (European summer) and whether soil moisture feedbacks will increase the frequency of summer droughts across Europe.
  - Looking at links between convection and land surface.
  - Analysis over Africa:
    - Mesoscale convective systems are associated with gradients of soil moisture and surface temperature; analogy with sea breezes.
    - Spatial variability of soil moisture seems to be critical for convective initiation, with greater initiation as soil moisture becomes more spatially variable.
    - See initiation on the boundary between dry warm soils and cool moist soils.
    - Question is whether such processes also operate over the UK.
  - Globally: Convection is more probable over dry/warm soil.
  - Models have difficulty capturing the above observed process.
  - Question: Gradient or soil moisture anomaly that drives convection?
    - Answer: Unknown, no data with high enough resolution to tell.
  - Question: How long do dry/wet soil patches last? How big they are?

        - Answer: ~10s km, last for a few days.

- HYDRA (CR):
    - A new experiment, “weatherathome.net” is using a regional climate model (HadRM3P) to assess simulated precipitation using a perturbed physics ensemble.
    - Climateprediction.net regional simulations: does a good job in Congo.
    - Testing sensitivity to model parameters.
    - Question: Where does Congo predictability come from?
        - Answer: Unknown, possibly SST.

- DEMON (AC):
    - Climate change parameters that hydrological models are sensitive to?
    - Dynamical downscaling over a range of resolutions in NWP timescales. ECMWF operational analysis using Unified Model at 12km, 4km and 1.5km resolution. Only running model out to 48 hours, as beyond this rainfall becomes unrealistic.
    - Methods to compare gauge data with model data? (Spatial pooling?)
    - Plans to also use WRF as downscaling model.
    - Long lead time reduces quality of simulation.
    - Comment: Long lead time leads to precipitation in different places? Minimum forecast lead time?
        - Answer: 12-hour minimum lead time.

6. Discussion: What are the potential links between this and other research? How can we all benefit from these links? Further ideas to complement other work on observations and models.

- 3 groups: Questions: Are there other research projects/groups to engage with? What links should be made with such groups? What useful results/analysis can CONVEX provide?
- Major issues raised/discussed:
    - Other projects that would be good to link to CONVEX:
        - DIAMET – role of latent heating in the structure of extra-tropical cyclones and feedbacks on large scale.
        - DEMON (Storm Risk Mitigation (SRM) project) – focus on NWP storms.
        - DYMECS (SRM) – using Chilbolton radar to look at structure of storms.
        - TEMPEST (SRM) - looking at extra-tropical cyclones.
        - SWELTER-21 (CWC) – links between convection and soil moisture.
        - HYDEF (CWC) – hydrological modelling.
        - VALUE (COST action) – developing state of the art validation measures for downscaled precipitation.

- ECLISE – high resolution climate simulations across Europe down to 2km resolution.
- EU/international project collaborations? VALUE, TEMPEST, German downscaling project, high-res modelling in Norway (Bergen), Sweden, Australia, etc.
- CORDEX network & others working on GCMs and large scale predictors.

- It would be good to foster links with SMHI as they are interested in running short-length high resolution RCM simulations. Suggestion of UK as being a potential case study region with good availability of observations, which would then allow comparison with CONVEX 1.5km simulations.
- Engagement with other work:
  - Useful data from water companies – collaboration encourages data release, but need to ask what water companies want to learn too.
  - Market results directly to users and private industry.
- Links with hydrological modelling work could employ high-res model data:
  - CEH have experience taking 25km RCM output and downscaling this for use in hydrology models.
  - 1 km input is needed for grid-to-grid model.
  - Suggestion of Thames as potential test catchment for feeding high-resolution climate model output into hydrology model.
- Common topics:
  - Large-scale drivers of small-scale extreme events. Is there any scope to predict when a localised extreme event may occur from the large-scale conditions? Possible CONVEX analysis: Land surface feedbacks, large-scale conditions favourable to local extremes.
  - Soil moisture and links to convection.
- Problems with GCM data can be managed via collaborations.
- Exposure of extremes research in major conferences/workshops.
- Need to start by asking "What are the questions that need answering?"