Pacific Northwest Hydrologic and Climate Change Scenarios for the 21st Century: A Brief Introduction to New Products and Overview of Downscaling Approaches

Answers to questions posted during the 3.17.10 webinar

Q1. Can someone type the project website into the chat?

Reply: The URL for the Columbia project is: http://www.hydro.washington.edu/2860/

Q2. [Referring to slide 12, Climate Change Scenarios] Please define precip...total annual?

Reply: Slide 12 summarizes projected changes in annual average temperature and precipitation, compared with the 1970-1999 mean.

Q3. What was the basis for evaluating GCM performance for inclusion (citations?)?

Reply: Chapter 4 of the draft report for the Columbia Basin Climate Change Scenarios Project (CBCCSP) describes the basis for the choice of GCMs using for hydrologic simulations (specifically section 2.2.2).

“For this study, we have used projections based on a selection of 10 global models whose 20th century simulations have the smallest bias in temperature and precipitation and that simulate the most realistic annual cycle in these parameters. These 10 models are sufficient to span the range of future climate change while reducing the computational demands of an even larger ensemble.”

The draft report is located on the project website at: http://www.hydro.washington.edu/2860/report/

The GCM evaluation and inter-comparison used in the CBCCSP is reported in the following paper:
http://cses.washington.edu/db/pdf/wacciach1scenarios642.pdf

Q4. What years define "Historical"

Reply: Historical is water years 1916-2006

Q5. Averaging results from different models of the same system seems like an odd technique. If five models provide a poor representation of future system behavior, does averaging results automatically imply a more reliable prediction?

Reply: Averaging all GCMs together minimizes noise in monthly statistics, and accounts for decadal variations in precipitation that are part of GCM simulations to reveal a consensus statement of systematic
changes. Averaging doesn’t produce an answer that is any more “correct”, but it defines a robust consensus of all the models with reduced noise in the monthly statistics.

With regard to performance, different GCMs have their own strengths and weaknesses in terms of simulating various features of the climate system across the globe. For this study, we evaluate the performance of GCMs over the Pacific Northwest for 20th century with respect to a number of chosen metrics and choose those models that perform best according to these metrics. As mentioned in response to question 1, we used metrics of temperature (T) and precipitation (P) bias as well as annual cycle (in T and P) to choose the best 10 GCMs of the available 23 from the IPCC Fourth Assessment Report for use in the CBCCSP. Composite Delta Method scenarios are based on mean monthly changes across the 10 chosen models, such that we do not incorporate information from GCMs that poorly simulate historical climate over the Pacific Northwest.

Q6. Has a time series of the historic data been done which shows how the rain/snow pattern has changed over past 80 to 90 years?

Reply: We have not done a comparative analysis showing the historical change of characteristic watersheds (rain dominant, snow dominant and mixed rain/snow). However, there are a number of studies that summarize historical changes in snowpack across the western US. A few examples are listed below:


In the case of the Mote et al. study (HESS 2008) for the Cascades, for example, the ratio of SWE to precipitation was shown to be declining in the historical period in both observations and VIC simulations. So there is clear evidence that these fundamental relationships are changing as expected (although the contribution due to increasing greenhouse gas forcing in the 20th century is uncertain).

Q7. Re historical question, what about for sites that don't have that long of a [historical] record

Reply: This was a follow up question to #4 in regards to Slide 21. The VIC hydrologic model was implemented over the period 1916-2006 (water years) across the entire PNW domain (Columbia Basin plus coastal drainages of WA and OR) and both spatial datasets and point datasets (at 297 streamflow locations) are available for this period. The meteorological station data used to develop the input dataset to VIC (daily temperature and precipitation) cover a wide range of time periods, some short and some
long. However, information from a number of stations is used to develop the input dataset at each model grid cell; therefore, if one station has a short or intermittent record other stations (the nearest available) are used instead. More information on construction of the met data sets is available in Chapter 3 of the draft report for the Columbia Basin Climate Change Scenarios Project (CBCCSP): http://www.hydro.washington.edu/2860/report/

Historical streamflow records were used in some watersheds for VIC model calibration, in which case only sites with >30 years of record were used.

Q8. Approximately when do you expect to have results/products for the additional watersheds (e.g., Upper Missouri River)?

Reply: Draft products are currently available for a smaller subset of scenarios for the Upper Missouri River, Colorado River, and Great Basin. These products were not developed as part of the Columbia Basin Climate Change Scenarios Project (CBCCSP) and are therefore not included on the project website. Draft products that are available for these extended regions include:

- A1B Composite Delta Method scenarios (which use mean changes in T and P across the same 10 GCMs as in the CBCCSP) for the 2040s and 2080s future time periods
- Bracketing Delta Method scenarios (PCM1 A1B – cool; MIROC_3.2 A1B – warm) for the 2040s and 2080s future time periods

Note: These scenarios use a slight variation of the Delta Method downscaling approach presented in this webinar. A date for public release of the data has not yet been determined, but is expected in the coming year.

Q9. To what degree is flow data incorporated into the models (I had to step away briefly, so apologies if you’ve already mentioned this)?

Reply: Historical flow data is used for model calibration and validation, but is not incorporated into the VIC hydrologic model as an input. The hydrologic model uses temperature, precipitation, and windspeed as input to calculate the water balance at each model grid cell. Outputs from the VIC model include runoff and baseflow at each grid cell, which are then used in a separate river routing model to compute streamflow at chosen locations.

Q10. Whom can I call to ask technical questions about the downscaling methodology? I know that the leaders of this project are very busy people, and from my experience, don't have time to answer phone calls. Is there someone you can suggest I contact who has worked with the creation of these data?

Reply: You may contact the following individuals for assistance:

- Hydrology: Alan Hamlet (hamleaf@uw.edu), Marketa McGuire Elsner (mmguire@uw.edu)
- Climate and Downscaling: Eric Salathe (salathe@uw.edu), Guillaume Mauger (gmauger@uw.edu)
We are attempting to expand the list of people who can respond to questions in the hopes of speeding up the response time. We will also create a FAQ page that addresses commonly asked questions. These don’t provide a complete solution to the problems created by the heavy demands on our time, but should at least improve matters. The website is also intended to be self-documenting to a large extent, and improvements in the documentation over time will presumably reduce the number of basic questions from users.

Q11. Where can we get more information on the 'hybrid' downscaling method?

Reply: For information on the hybrid downscaling method, please refer to the draft report for the Columbia Basin Climate Change Scenarios Project (CBCCSP), Chapter 4 (http://www.hydro.washington.edu/2860/report/)

Q12. The CCSM3 precip slide doesn't appear to mesh with Alan's statements/slides regarding model uncertainty - what's the difference?

Reply: We think this question refers to an apparent discrepancy between the CCSM3 results in Eric’s talk and the slide in Alan’s talk showing the small systematic changes in annual precipitation in the GCM projections (albeit with large uncertainties). CCSM3 is very wet model over the PNW, and so we see very large changes in that single run despite the fact that all models taken together suggest little systematic change in precipitation on an annual basis. In other words, CCSM3 is one of the very wet models that partly defines the large spread in the precipitation results. It should also be noted that slide 12 shows changes in the annual mean precipitation, which shows very little change in the multi-model average. Fall precipitation, however, shows a more consistent increase across models (see Mote and Salathe, 2009, http://cses.washington.edu/db/pdf/wacciach1scenarios642.pdf). Reducing this uncertainty one of the main reasons we need ensemble results.

Q13. Any thoughts on climate change impacts on regional wind patterns (i.e. more wind or less wind?)

Reply: Changes in wind remains a challenge (even in defining a baseline), but ensemble RCM simulations may provide some information in the future. We are in the process of analyzing wind results for the RCM simulations, but do not have any results to report yet.

Q14. Why B1 & A1b, too optimistic: what was basis for not modeling A2 or A1fi, rather than B1?

Reply: GCM output, using predominantly three greenhouse gas emissions scenarios, were archived and reported in the IPCC Fourth Assessment Report: B1 (low), A1B (medium), and A2 (high). The data archive of GCM simulations using the A1FI scenario (which is the worst case emissions scenario used by the GCMS) is quite limited. Although simulations based on the A2 scenario project greater temperature increases than B1 and A1B by the end of the 21st century, A1B and A2 follow similar trajectories, with
A1B being even slightly higher at mid-century. Given the greater focus on mid-century impacts, the fact that emissions for A1B are slightly higher than A2 by the mid-21st century, and in order to be consistent with the Washington Climate Change Impacts Assessment, we chose the B1 and A1B scenarios for the Assessment.

Q15. I don't recall an explicit definition/explanation of what 'ensemble' modeling means...?

Reply: An “ensemble” (literally “group” in French) in the context of modeling is defined as a group of model simulations that are compared to give a sense of the range possible outcomes. A single model simulation would be called an “ensemble member”. See webinar slide 24 as an example. The collection of projections of future snow water equivalent (shown in pink) are an ensemble and the projected average across the ensemble members is called the ensemble mean (represented by red line).

We can construct an ensemble of regional climate model simulations by running the same regional model with multiple different global models providing input fields (i.e., by dynamically downscaling multiple models) and by varying the regional model itself. Most ensemble experiments include both sorts of ensemble members.

Q16. Have you done any analysis on how much of the current variability is correlated with PDO or ENSO signals?

Reply: The CIG has some general information on PDO and ENSO impacts on the regional climate here: [http://cses.washington.edu/cig/pnwc/clvariability.shtml](http://cses.washington.edu/cig/pnwc/clvariability.shtml)

Precipitation variability is highly correlated with ENSO and PDO, and this effect is well simulated by many global and regional climate models. We have examined the effect of ENSO on results of WRF and HadRM regional climate model simulations and on variability in extreme precipitation in particular. These results are currently submitted for publication; draft manuscripts are available on-line at: [http://www.atmos.washington.edu/~salathe/Papers.html](http://www.atmos.washington.edu/~salathe/Papers.html)

Citations for these manuscripts are:


Q17. More specifics on simulation outputs for high resolution extreme weather predictions would be helpful in future presentations.

Reply: Good suggestion.

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