Geophysical Research Abstracts
Vol. 12, EGU2010-15168, 2010
EGU General Assembly 2010

Hydrology and climate change - what are the physical constraints?

William Ingram, Myles Allen, Pardeep Pall, Claudio Piani, and Dan Rowlands
Department of Physics, University of Oxford

Many of the important effects of global warming will actually be felt via hydrology rather than temperature, with drought or flood, or in some places both, expected to become more frequent, and uncertainty about possible hydrological changes itself potentially imposing major costs. Compared to the more smooth and predictable changes in temperature, changes in precipitation, runoff and soil moisture are much more variable in space and time, and much less certain.

There are some physical constraints from simple physical arguments, confirmed by the consensus of detailed models, and apparently consistent with the limited observational data:
1) Water vapour is limited by the last saturation of air parcels, and with the circulation staying much the same the distribution of relative humidity will change little on warming, giving an increase of specific humidity at the Clausius-Clapeyron rate, about 7 %/K.
2) This will tend to increase the net atmospheric transports of moisture and so the magnitude of net surface moisture flux (precipitation minus evaporation), in particular exacerbating the dryness of the subtropics.
3) It will also increase the amount of moisture available for the most intense precipitation events, and so flood risks.
4) Overall, precipitation and the accompanying latent heat release is strongly constrained by an energetic balance with net tropospheric radiative cooling, giving an increase in the global mean of about 3%/K.

However, the latter, well-understood, effect is of little relevance to local changes. Also, the expectation, from simple physical arguments confirmed by initial GCM studies, that the most intense precipitation will increase at the Clausius-Clapeyron rate has been challenged by recent observational studies indicating a more complex situation. GCM climate change simulations seem to be slowly converging (and there is encouraging evidence of their ability to predict the distribution of rain within a season as well as the total), but we are still not close to being able to make reliable local predictions for hydrological change under climate change.