ClimateInsure
Climate Change and Insurance Industry

Innovation area: Finance/Insurance

Key Innovator: Kjersti Aas

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Scope:

Produce new statistical methods and instruments for the evaluation of climate change effects aimed in particular, but not limited to, risk management for the insurance industry.

Results in 2012 and plans:

1. Calibration of dynamic downscaling

Global circulation models (GCMs) have a coarse resolution. To assess regional effects of climate change, output is needed on a higher resolution. Regional climate models (RCMs) are applied to a smaller region with a finer resolution, and with boundary conditions from GCMs, also called *downscaling.* In order to evaluate the RCM itself, and not the global model, we analyse output from the RCM forced by boundary conditions from reanalysis data (instead of boundary conditions from GCMs). *Reanalysis data* is (meant to be) the best estimate of the state of the atmosphere, obtained from consistently rerunning models back in time with various sources of observations as input. In order to evaluate the RCM itself, and not the global model, we analyse downscaled ERA-40, which is output from the RCM forced by boundary conditions from reanalysis data (instead of boundary conditions from GCMs).

A former study revealed significant weaknesses of such data when compared to interpolated observations (Orskaug et al., 2011). We are therefore developing a statistical correction to dynamically downscaled ERA-40 reanalysis precipitation data. Our calibration is based on a nearest neighbour spatial smoothing applied to distributional differences between ERA-40 data and observed precipitation, the differences being generated from Doksum's shift function locally. The model is fitted season by season on a mesh of 25x25 km^2 grid cells covering Norway. From the 40 year data period from 1961 – 1990, 20% of the data (randomly picked) are kept for validation, leaving 32 years for model fitting. Though exemplified on precipitation data, the idea and concept developed is most likely transferable to other variables (e.g. temperature) as well. This work aims for publication in a methodological journal.

2. Robustness of calibration and transferability to general circulation models
In calibrating dynamically downscaled reanalysis precipitation, we implicitly correct two potential shortcomings of the local data. First, the reanalysis data, even if regarded the best possible representation of the atmosphere, still do not fully comply with the truth. Second, the downscaling model lacks necessary detail and thus contributes and strengthens discrepancies to the resulting local-scale raw precipitation. Our calibration does not discriminate between these two sources of error but rather corrects for the cumulative divergence. This means that our calibration in principle depends on the particular reanalysis considered, as well as the downscaling model used. The influence of those two factors, and thus, the sensitivity of our calibration, can be investigated from a study involving different reanalyses and downscaling models, and combinations thereof. The aim of the calibration developed in 1 is to invent a post-processing algorithm that when applied to future downscaled climate model precipitation scenarios from GCMs improve their performance. The improvement may be measured from comparing distributional properties of original and calibrated downscaled climate model precipitation from a GCM over a historic control period to those of a set of interpolated observations representative of the same period. Possibly, our calibration might need a re-fit to downscaled climate model precipitation data from GCMs. And, furthermore, different GCMs might need different calibrations. The aim of this task is to come up with the best calibration for Norway for at least one GCM and downscaling, and document the potential need for further algorithms connected to each GCM and/or downscaling. The work should aim for publication in an (applied) climate journal.

3. Predict future burden of insurance claims
Calibrated climate model precipitation scenarios will be fed into claims models developed for Gjensidige's portfolio (Scheel et al., 2012) to provide improved projections for the number of future building water losses at municipality level. Possibly, combinations of different GCMs and CO_2 scenarios will be used to span the range of plausible outcomes. This will contribute risk information to Gjensidige, setting them in a position to take precautionary measures to reduce their clients' exposure.

Results should be precisely documented in a report aimed at the insurance industry and Gjensidige in particular. An important success criterion for ClimateInsure will be Gjensidige taking the results into consideration in their risk evaluation, however, leaving it to the company itself to decide what further action should be taken. Currently, there is no person in Gjensidige with a dedicated climate responsibility, and ClimateInsure suffers from that, particularly in its innovation aspects. Nevertheless, $(sfi)^2$ should aim for presenting the results of ClimateInsure at the highest administrative level possible in the organisation, preferably the managing director.

Of wider interest to the community is the potential of risk reduction at municipality level through recommendations for sewer systems maintenance, land use planning and building standards. Finally, impact studies in all kinds of disciplines would benefit from improved local climate scenarios.

4. Application areas beyond insurance
We should use our competence and knowledge gained so far to establish contacts with potential clients in possibly new markets. Easily interpretable graphics will be important to demonstrate the clients' challenges and communicate our ideas. Is learning GIS worthwhile? In some situations, we would need recognition and support from the climate sector. We should establish contacts with the Bjerknes Centre for Climate Research as soon as we have something written about enhancing downscaling model output that they might be interested in.

5. Extremes
Investigate further the influence on the tail of a distribution of marginally shifting its mean. There exist a few papers on this topic, and it has gained some interest among climate researchers (e.g. at a climate and insurance conference in Rungstedgaard outside Copenhagen in September 2012).

Papers:

Aldrin, M; Holden, M; Guttorp, P; Skeie, RB; Myhre, G; Berntsen, TK. Bayesian estimation of climate sensitivity based on a simple climate model fitted to observations of hemispheric temperatures and global ocean heat content. Environmetrics, 2012; Vol. 23 (3): 253-271.

Friederichs, P; Thorarinsdottir, TL. Forecast verification for extreme value distributions with an application to probabilistic peak wind prediction. Environmetrics, 2012; Vol. 23(7): 579-594.

Guttorp, P. Climate statistics and public policy. Statistics, Politics and Policy, 2012; Vol. 3(1), doi: 10.1515/2151-7509.1055.

Guttorp, Peter; Xu, Jia: Climate change, trends in extremes, and model assessment for a long temperature time series from Sweden. Environmetrics, 2011; Vol. 22(3): 456-463.

Haug, Ola; Dimakos, Xeni K; Vårdal, Jofrid F; Aldrin, Magne: Climate change and its impact on building water damage. Actuarial Studies In Non-life Insurance, ASTIN 2008, Manchester, UK, July 14, 2008.

Haug, Ola; Dimakos, Xeni K; Vårdal, Jofrid F; Aldrin, Magne; Meze-Hausken, Elisabeth: Future building water loss projections posed by climate change. Scandinavian Actuarial Journal, 2011; Vol. 2011(1): 1-20.

Lindgren F, Guttorp, P. and Rue, H: A stochastic modelling perspective on global temperature reconstruction , in preparation 2010.

Lindgren, Finn; Rue, Håvard; Lindström, Johan: An explicit link between Gaussian fields and Gaussian Markov random fields: the stochastic partial differential equation approach. Journal of the Royal Statistical Society, Series B (Statistical Methodology), 2011; Vol. 73(4): 423-498.

Ma, Y; Guttorp, P. Estimating daily mean temperature from synoptic climate observations. To appear, International Journal of Climatology, 2012, doi: 10.1002/joc.3510.

Orskaug, Elisabeth; Scheel, Ida; Frigessi, Arnoldo; Guttorp, Peter; Haugen, Jan Erik; Tveito, Ole Einar; Haug, Ola: Evaluation of a dynamic downscaling of precipitation over the Norwegian mainland. Tellus. Series A, Dynamic meteorology and oceanography, 2011; Vol. 63(4): p. 746-756.

Scheel, I; Ferkingstad, E; Frigessi, A; Haug, O; Hinnerichsen, M; Meze-Hausken, E. A Bayesian hierarchical model with spatial variable selection: the effect of weather on insurance claims. Journal of the Royal Statistical Society: Series C (Applied Statistics), 2013; Vol. 62(1): 85-100.

Scheel, I; Hinnerichsen, M. The Impact of Climate Change on Precipitation-related Insurance Risk: A Study of the Effect of Future Scenarios on Residential Buildings in Norway. The Geneva Papers, 2012; Vol. 37: 365–376.

Skeie, RB; Berntsen, TK; Aldrin, M; Holden, M. Using modelled historical concentrations of short lived climate components to constrain the climate sensitivity. Meta, 2012; Vol. 2: 8-11.

Vanem, E; Breivik, ON. Bayesian hierarchical modelling of North Atlantic windiness. Natural Hazards and Earth System Sciences, 2013; Vol. 13: 545-557.

Technical reports:

Haug, Ola; Dimakos, Xeni K.; Vårdal, Jofrid F.; Aldrin, Magne: Fremtidig utvikling i vannskader som følge av klimaendringer. NR-Note, SAMBA/12/08, 2008.

Orskaug, Elisabeth; Haug, Ola: Skadeprediksjoner basert på ECHAM4 klimamodelldata. NR-Note SAMBA/29/09, 2009.

Orskaug, Elisabeth; Scheel, Ida, Frigessi, Arnoldo; Guttorp, Peter; Haugen, Jan Erik; Tveito, Ole Einar; Haug, Ola: Supplemental material to: Evaluation of a dynamic downscaling of precipitation over the Norwegian mainland. NR-Note, SAMBA/50/10, 2010.

Vårdal, Jofrid; Haug, Ola; Dimakos, Xeni; Aldrin, Magne: Fremtidig utvikling i vannskader som følge av klimaendringer - resultater. NR-Note, SAMBA/13/08, 2008.

Hawassa, Februay 2013