Statistical Approaches to Regional climate Models for Adaptation

Georg Lindgren
Lund University

SARMA Scientific Board
September 15, 2108
Variability, uncertainty, and the role of statistics

Basic things
- Variability and uncertainty
- How to calibrate and communicate uncertainty
- How to communicate variability

Challenging things
- Validating complex models
- Reconstruction of the past and prediction of the future
- Prediction of extremes – where the models have not been tested
- New statistical methods for complex problems
The ASA endorses the IPCC conclusions

- Adopted November 30, 2007 by the ASA Board of Directors
- ASA is the world's largest statistical association
New statistical methods for complex problems

New technology needs new statistics – a look at the history:

• Insurance and health planning – "Insurance mathematics" (1900-)
• Telephone and radio – "queueing theory and stochastic processes" (1910-)
• Safety of structures, Tacoma Narrows Bridge, Comet – "random vibration and random fatigue" (1940-)
• Flood control, reliability technology – "statistical extreme value analysis" (1940-, 1970-)
• Heart transplantation – "statistical survival analysis" (1970-)
• Gene technology – "bioinformatics" (1990-)
Statistical challenges for complex climate

- Interpreting climate observations
  - Combining data from different sources – Bayesian statistics
  - Identify and adjust for bias – are reconstructed baseline temperatures unbiased? Monte Carlo based inference
  - Interpolation in time and space – space-time models
  - (one of) the most active fields of contemporary statistical research
- INTEREST FOR WIND POWER PLANNING
18 nodes at 13 places, including all 5 Met services
Goals

- Increased communication between statisticians and climate scientists
- Joint supervision of interdisciplinary PhD students
- Increasing interest in postgraduate studies in applied mathematical statistics
- Develop links with international groups and networks in statistical climatology
Initial activities

- February 1-2: International Workshop on Modern Statistics for Climate Research, Norwegian Academy, Oslo. 75 participants from all Nordic countries and met services
- July 12-16: International Meeting on Statistical Climatology, Edinburgh. 13 participants from the network
- August 23-27 Workshop on Climate Extremes, Banff, Canada. 7 participants from the network
Upcoming activities

- April 2011: Statistical downscaling workshop in Lund, together with strategic research initiatives MERGE and BECC on Climate models and Ecosystems effects – how to move knowledge between global – regional – local scales

- August 2011: Visualization workshop, Island University, jointly with the TIES, the International Environmetric society. Novel solutions for common climate science graphical displays
Other network activities

- Travel grants to visit other nodes or go to meetings
- Summer courses, joint with other programs
- Nordic conference on statistical climatology
How describe the uncertainties in climate maps?

Förändring av månadsmedelnederbörden i januari, RCA3-EA2

From the Swedish "Klimat- och sårbarhets-utredningen", 2007
Estimation of long term changes in vegetation index over the African Sahel.
Brown areas = significant improvement

Upper image = pointwise estimation (method from 1950)

Lower image = estimation with regional dependence (Bolin et al 2008)
More statistical challenges

- Climate models based on physical laws
  - Design and analysis of computer experiments
  - Identifying and quantifying uncertainties
  - Calibration and parameter estimation
  - How can one detect when the model goes wrong?
- Summary measures and presentation of multivariate data
- Regional models – downscaling to local conditions
- Human health effects
- Environmental "health" effects
Challenges for risk analysis

• Good models describe the normal state of affairs – do they describe the extreme events equally well?
• How do extreme event mechanisms change with changing climate? Do they follow a general trend? Do they have their own laws?
• All statistical analyses show that the Gudrun storm damage was "just a natural 100-year event" – but how do we know?
• The REAL challenge – quote from the Swedish vulnerability study:

  "The changes in the extremes have been calculated from a model developed to describe changes of average values – which makes them somewhat uncertain"
Trends in extremes?

- Statistical extreme value analysis – Gumbel, Weibull, 1940 –
- Statistical estimation – 1970 -
- Methods to find trends in extreme values – 1990/2000 –
- Challenge? Statistical methods and software for analysis of change in extremes exists – are the climate and weather models reliable?
The forest damage from the Gudrun storm, January 2005 – was it "just a 100-year event?"

Statistics says: Yes – it could very well be a 100-year event!

Bengtsson and Nilsson, Natural Hazards and Earth System Science, 2007
The Swedish Climate and vulnerability study

• Careful and very detailed studies of how Sweden can be affected by climate change

• Too detailed? Example: "The consequence of increased wind climate on crayfish catch with cage- and trawl-fishing will be 1,4 and 14,1 MSKR, respectively"

• Little discussion of what is certain – probable – less probable, and what is uncertain
Exaggerated illusory precision …

- Lowers credibility and
- Opens up for criticism
- But most answers to blogger’s questions and ”letter to the editor” are there