Human influence on meteorological drought risk in Europe

L. Gudmundsson & S. I. Seneviratne

Drought constitutes a significant natural hazard in Europe. Here we investigate whether anthropogenic emissions have altered drought risk in Europe using an observational and a model driven approach. We investigate how the probability of years with unusually little precipitation in pre-industrial condition (20 year return period), has changed in Northern Europe (NEU), Central Europe (CEU) and the Mediterranean (MED). Changes are quantified in terms of the Risk Ratio, \( RR = p_i/p_0 \), which puts the probability of drought occurrence with \( p_i \) and without \( p_0 \) anthropogenic emissions into context.

Observational changes in drought risk are estimated assuming that annual precipitation, \( P \), is Gamma distributed with the density

\[
f(P) = \frac{1}{\Gamma(k)\mu^k} P^{k-1} e^{-\frac{P}{\mu}}
\]

The mean, \( \mu = \beta_0 \), of the distribution is allowed to depend on the North Atlantic Oscillation index, NAO, and on global mean temperature, \( T_0 \), such that

\[
\log(\mu) = \beta_0 + \beta_N NAO + \beta_T T_0
\]

to account for internal north Atlantic variability and anthropogenic effects on the climate. \( p_i \) is then estimated by taking both NAO and \( T_0 \) variability into account. \( p_0 \) is estimated by considering NAO variability only.

Model based changes in drought risk are estimated from a multi model ensemble of CMIP5 simulations, \( p_0 \) is estimated from historical simulations with anthropogenic and natural forcing, \( p_i \) is estimated from historical simulations with natural forcing only.

The results show that Mediterranean drought risk has increased in response to global warming, whereas drought risk in Northern Europe has decreased. The fact that both estimates are significantly correlated highlights the consistency of the observational and the model based assessment. Therefore we conclude that it is very likely that anthropogenic climate change has altered drought risk in the Mediterranean region and Northern Europe.
Predictability of the NAO in seasonal hindcasts from 1900-2009
Nathalie Schaller, Antje Weisheimer and Tim Palmer

A) How well do seasonal forecast models predict winter NAO and extreme winter weather in Europe?

B) What does an event attribution statement mean if forecast is unreliable?
Synoptic and oceanic conditions during heat wave events: A case study for southern Australia

Tim Cowan (University of Edinburgh/CSIRO)

Circulation (MSLP) anomalies averaged over all first heat wave days for southeast Australia

1) CMIP5 models accurately capture atmospheric circulation (pressure couplet) pattern associated with southern Australian heat waves

2) Non-classical synoptic setup in the future will produce more heat waves given the increased temperatures across inland (e.g. desert) regions of Australia

3) Projected poleward shift in the anticyclones responsible for heat waves
Decadal prediction of Sahel rainfall using dynamics-based indices

Assess the skill of CMIP5 decadal hindcast in predicting Sahelian summer rainfall (JAS) at decadal time scales using dynamics-based indices, and the role of the initialization.

ACC and RMSE metrics between the observed Standardized Precipitation Index (SPI: 10N20N-15W15E) and the simulated dynamic index WAMI

- Predictive skill model dependent
- Contribution of initialization: better ACC scores for initialized experiments (decadal hindcasts)

Noelia Otero, Elsa Mohino and Marco Gaetani
Standardized drought indices: A novel uni- and multivariate approach

Existing Indices
- PDSI
- EP
- SWSI
- SPI
- RDI
- SRI
- VCI
- deciles
- SMDI
- SPEI
- CMI
- BMDI
- RAI

Different types
- Meteorological drought
- Agricultural drought
- Hydrologic drought
- Ground water drought, ...

Multivariate
- Precipitation
- Soil moisture
- Evapotranspiration
- Stream flow, ...

Flexible, general, multivariate, statistically sound approach
Observed and Simulated Linkage between Ural Blocking and East Asian Winter Climate

Hoffman H. N. CHEUNG (hoffmancheung@gmail.com)

UBI = blocking frequency over 45°–90°E

SHI = MSLP anomaly over 40°–65°N and 80°–120°E

Future climate (RCP8.5)

Trend of 30-year running mean

r = 0.701, p = 0.001

Current climate

30-year running mean

$p_{UBI} < 0.01$

$p_{SHI} < 0.01$
Impacts of sea ice / SST changes for the observed climate change

Questions to address

- **Climatic trend**
  - Arctic Amplification?
  - Weather extremes?
  
- **Climate variability**
  - NAO-like correlation?

To be shown in the poster

- Ongoing coordinated AGCM experiments
  - contributed by 7 models

- Prescribing observed sea-ice/SST of the recent 33 years
  - OI-SST (1982-2014)

- Preliminary results are discussed.
  - CAM4, EC-EARTH