Forecasting the number of extreme daily events on seasonal timescales

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Questions addressed
1) Is it possible to skilfully predict the number of daily temperature extremes within a 3 month season using the new Met Office Global Prediction System, GloSea4? [Arribas et al., 2011]
2) How much of the skill in predicting extremes can we explain with the forecasted seasonal mean alone?
3) Is the skill a result of ENSO and climate change?

Extreme daily temperatures mean different things to different people
- Temperature related mortality studies, including those by Curriero et al. [2002] and Gosling et al. [2007], show that temperature-related mortality rates can start to increase at fairly modest temperature anomalies of either sign. They also show that, due to acclimatisation, people living in warm climates have a higher heat-related mortality threshold than those living in cold climates.
- To orange farmers in Florida, ‘extreme cold’ means temperatures less than -4°C, below this long term damage to citrus trees can occur [Rogers and Rohli, 1991]. Whereas cattle can be reared in harsh Canadian winters; they can survive temperatures as low as -35°C [Young, 1981].

What is a daily temperature extreme in this study?
Here an extreme daily temperature is defined as one in either the upper or lower decile of the daily temperature distribution from the relevant three month season (Dec-Feb, Mar-May, Jun-Aug, Sept-Nov). We consider minimum and maximum daily near surface temperatures. (Tmin and Tmax). There are therefore 24×2=48 different types of extreme temperature.

Methodology
a) Count the number of extreme days in observations (HadGHCND dataset, [Cesarra et al., 2006]). See left-hand plot below.

b) Calculate the ensemble mean number of extreme days in the model by either method 1 or method 2:

Method 1: Count extreme days in each hindcast (retrospective forecast, 1989-2009).
Method 2: Infer the number of extreme days in each hindcast from the predicted seasonal mean and the observed relationship between extremes and mean.

c) Compute skill as the Spearman’s rank correlation coefficient between the smoothed observations and smoothed hindcasts for method 1 or method 2.

Method 2: Infer the relationship between each index and the seasonal mean at each grid-point (see figures opposite).

- Smooth the resulting observations and hindcasts using a 17.5° (lat) by 18.75° (lon) box.
- Compute the correlation of all 16 types of extreme.
- Plot the mean correlation (skill) at each grid-point (see figures opposite).

References
Hamill, E., et al. (2012), Forecasting the number of extreme daily events on seasonal timescales, J. Geophys. Res., 117, D03114