Quantifying uncertainty and identifying sources of bias in Irish weather forecasting

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Background/Introduction

•Can grass growth in Ireland be predicted using weather?
- Historical weather data is useful (Hurtado-Uria et al. 2013).
- Forecast data is needed to predict future growth.

•How accurate is the weather forecast in Ireland?
- Are some weather variables/locations forecast better than others?
- How far into the future are forecasts useful?
- Can we improve the forecast quality?

Data

- Daily observations between 2007 and 2013 from the 25 Met Éireann synoptic stations (Fig. 1). Observations at some stations begin after 2007.
- Corresponding daily forecasts from European Centre for Medium-Range Weather Forecasting (ECMWF) deterministic forecast model. These daily forecasts have forecast periods from day-1 to day-10.
- Weather variables studied are rainfall and mean, maximum and minimum temperature.

Figure 1: Locations of Met Éireann synoptic stations

Methods

- Investigate the relationship between forecast and observed at each station using comparison statistics such as correlation and root mean squared error (RMSE) to measure uncertainty and mean systematic bias (MSB) to measure bias (Joliffe & Stephenson 2011).
- Bias-correct the forecasts within each year by subtracting the MSB computed excluding the target year.
- Fit regression models to each forecast period and each weather variable with observed as the response and forecast, month and station as the predictors, with the target year excluded. Model predictions serve as new forecasts.
- Raw ECMWF, bias-corrected (by month and year) and regression model based forecasts were each assessed for accuracy using RMSE and for bias using MSB.

Results/Conclusions

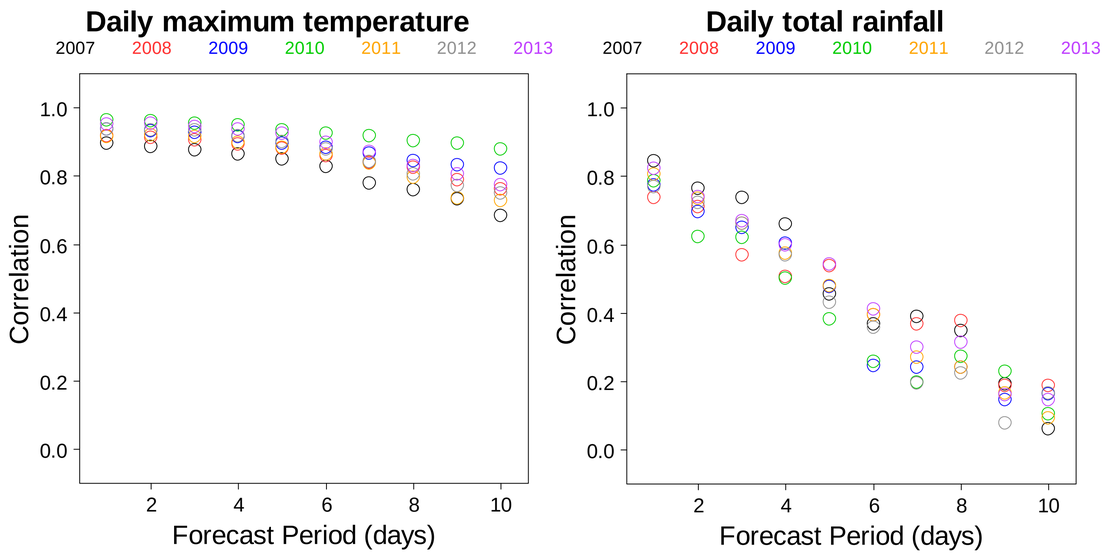

Figure 2: Yearly correlation values at Belmullet

- Correlation between forecasts and observations decreases with forecast period for both rainfall and all temperature variables (Fig. 2). Day-10 temperature forecasts appear to be valuable, while equivalent rainfall forecasts do not.
- In the ECMWF model, MSB tends to be constant for each temperature weather variable across forecast periods, with maximum temperature forecasts displaying a large negative MSB (Table 1a).

Table 1: Forecast assessments across all stations in 2012 for (a) maximum temperature and (b) rainfall. BC = bias-corrected.

(a)

Forecast	MSB day1	MSB day10	RMSE day1	RMSE day10
ECMWF	-2.336	-2.453	2.658	3.774
Year BC	0.192	0.075	1.189	2.825
Month BC	0.216	0.099	1.194	2.835
Model	0.203	0.152	1.172	2.572

(b)

Forecast	MSB day1	MSB day10	RMSE day1	RMSE day10
ECMWF	0.466	0.158	3.163	6.387
Year BC	0.190	-0.117	3.107	6.359
Month BC	0.194	-0.113	3.109	6.351
Model	0.059	-0.053	2.961	4.812

- Model approach usually gives improved forecast accuracy, particularly for longer forecast periods (Table 1).
- Simple bias correction does not improve rainfall forecasts, suggesting that there is not a systematic bias in the raw rainfall forecasts (Table 1b).

Hurtado-Uria, C. et al. (2013). Relationships between meteorological data and grass growth over time in the south of Ireland Irish Geography, 46, pp. 175 - 201.
Joliffe, I.T. and Stephenson, D.B. (2011). Forecast Verication: A Practitioner's Guide in Atmospheric Science. 2nd Edition, Chichester, UK: Wiley.
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