Comparison of short range Met Office and ECMWF forec

Bruce Ingleby[1], Lars Isaksen[2] and Mohamed Dahoui[2]
[1] Met Office, [2] ECMWF

Introduction

Land stations, primarily SYNOP and METAR, are compared with short range global forecasts – the background fields used in data assimilation. These are nominally 6 and 12 hour forecasts for Met Office and ECMWF respectively, but the forecasts are interpolated to the report time and location. Here we consider temperature, relative humidity and wind speed (T, RH and FF). The Met Office assimilates most of these data, ECMWF only assimilates daytime RH (both systems assimilate pressure), but the forecasts can be considered independent of later observations. Both NWP systems have separate updates of soil properties (primarily moisture) that use surface T and RH reports.

We present mean statistics for observation-minus-background (O-B). These contain both observation & background errors – in this poster the emphasis is on background/forecast errors but we note where observation errors may be significant. Some account should be taken of differences between station height and the model surface height. The report coverage is similar but not identical between the two systems the biggest difference is that the Met Office has more METAR reports over North America. There was a preliminary comparison in 2009 and recently we have looked at January and July 2012 – results for July 2012 are presented here. The data from the two centres has been processed as consistently as possible (excluding values with excessive |O-B|) using the ECMWF obstat program.

Temperature

In the Met Office system temperature is adjusted using a lapse rate of 6.5 °/km for differences between station height and model height (Zstn and Zmodel; on average this reduces O-B because more stations are below model height rather than above it). ECMWF does not currently perform such an adjustment (this is probably responsible for the large differences over the East Tibetan plateau in Figure 4b, the need for adjustment is also shown in Figure 5).
Relative to observations ECMWF is slightly cool and Met Office slightly warm in the Northern Extratropics (both by about 0.2 C in July and about 0.5 C in January 2012). In July 2012 (Figure 4) both models are too warm over much of N America and Siberia. Both are too cool at many coastal stations in Alaska/Canada/Greenland. The ECMWF model is too cool over much of South and East Asia. The Met Office model is too cool in the Middle East. The warm bias over the American mid-West is thought to be related to the lack of propagation of convective storms triggered by the Rockies (cf Klein, 2006, GRL), but may also be partly due to the fact that agricultural irrigation isn't included in the model hydrological cycles.

As for other variables the standard deviations of O-B (not shown) tend to be larger in mountainous regions. The standard lapse rate used in the Met Office system generally works well in neutral and unstable conditions, it is less appropriate in stable conditions but finding an adjustment with good performance in all conditions is not straightforward.

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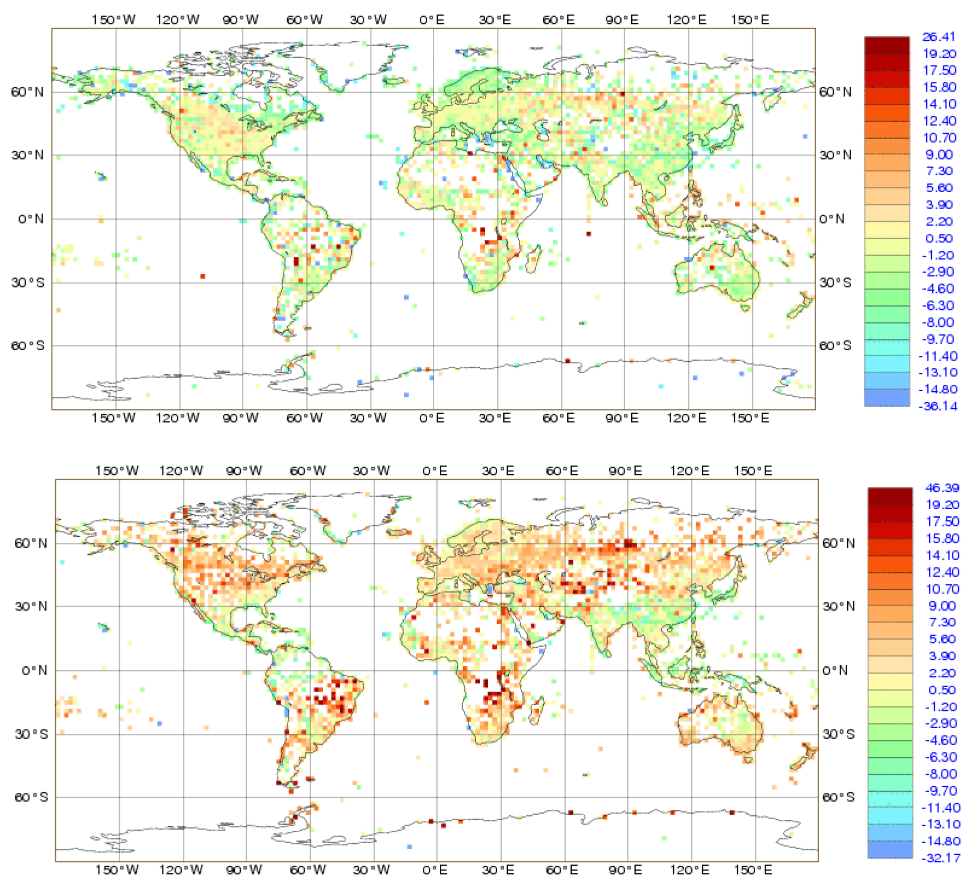

Figure 1. July 2012 **RH** mean O-B for Met Office (mean -1.4%) and ECMWF (bottom, mean 2.5%), calculated in 2 squares.

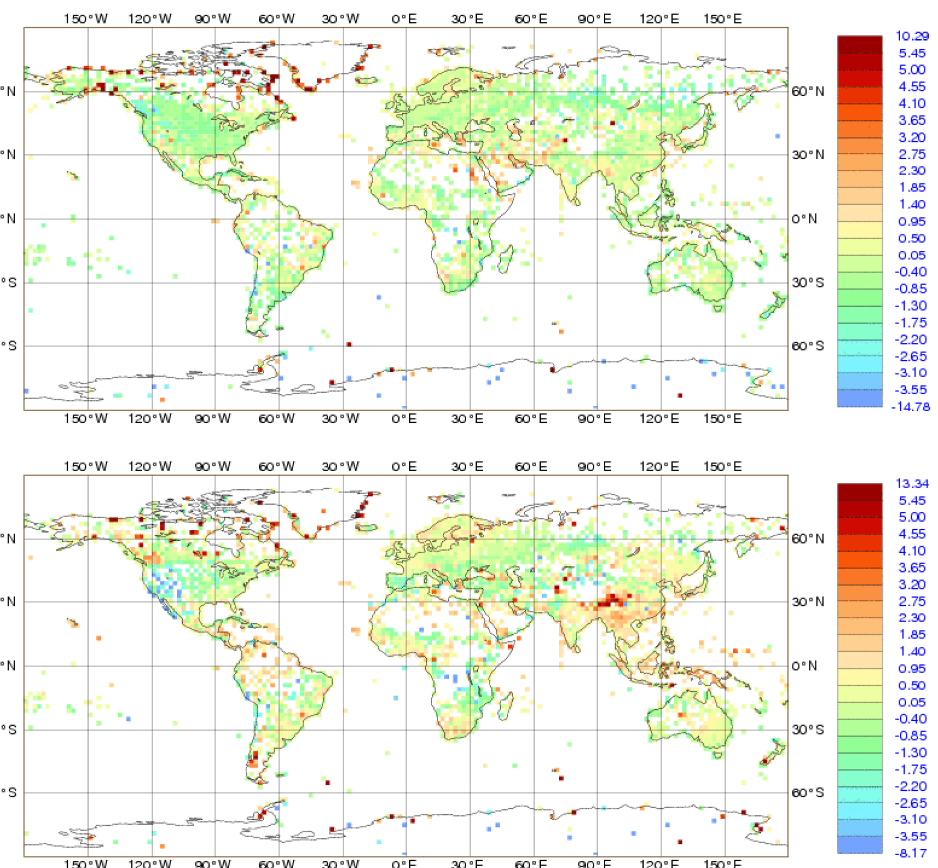

Figure 4. As Figure 1 but for **temperature**. Mean O-B values are -0.23 C and 0.27°C.

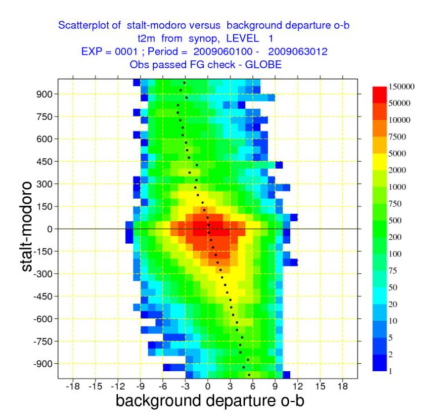

Figure 5. Unadjusted temperature O-B vs Zstn – Zmodel, see text.

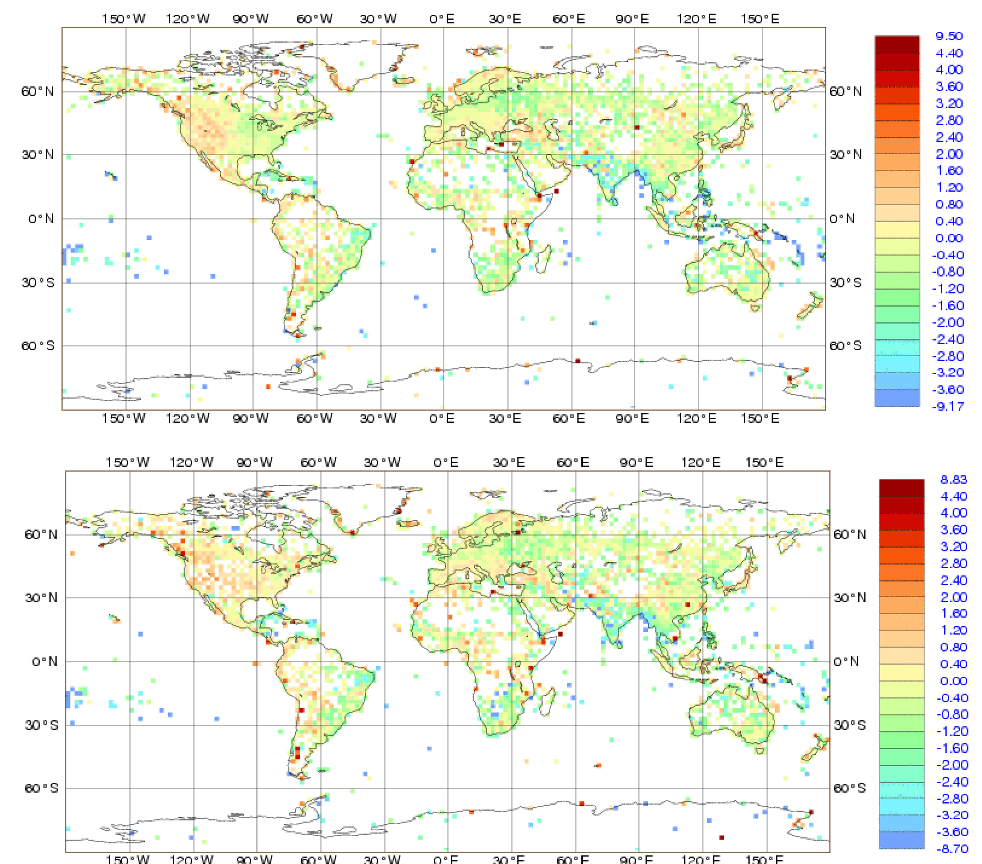

Figure 6. As Figure 1 but for 10 m **wind speed**. mean O-B values are -0.26 and -0.16 m/s.

Relative Humidity

Overall the Met Office fields are slightly wetter than the observations and the ECMWF fields are slightly drier (Figure 1, the biggest differences between the models are in southern Brazil and eastern Canada). This is a robust signal seen in the other months examined and is probably mainly due to biases in the forecast precipitation (Haiden et al, 2012, MWR). Ingleby et al (2012, QJRMS) show that Met Office model precipitation is especially high in the first hour after the assimilation. There seems to be a tendency for forecast RH to be a bit too high near the coasts but too low in continental interiors, particularly for the Met Office model.

Mean Met Office O-B RH as a function of latitude (Figure 2) shows a northward moving moist bias in the model in northern hemisphere spring – this is thought to be due to the model melting snow a few weeks early (a change to a multi-level snow model is planned). Traditionally surface humidity was measured by wet bulb thermometer (psychrometer) but in the last 10 or 20 years some countries have changed – usually to capacitive sensors. Figure 3 (from Ingleby et al, 2013, JTech, submitted) shows that capacitive sensors tend to drift to higher values over time, whereas the psychrometer was about 1%RH dry.

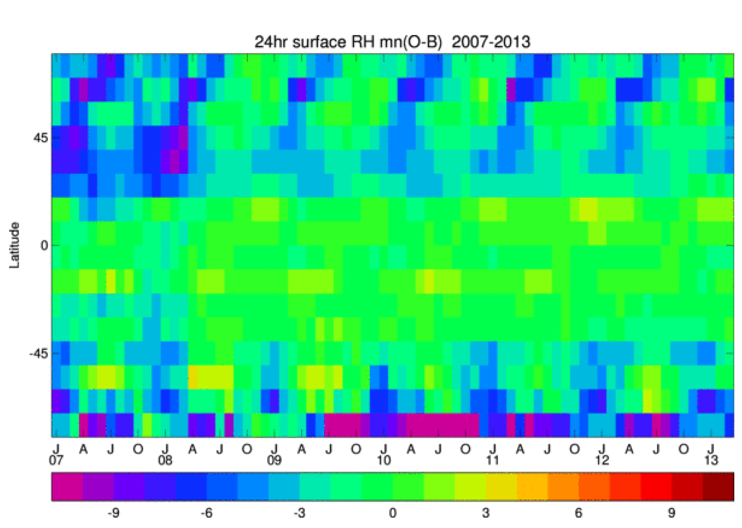

Figure 2. Mean O-B RH in 10 latitude zones by month, January 2007 to March 2013, Met Office. The improvement in April 2008 was due to improved soil properties (Dharssi et al, 2009, Met Office Tech Rep 528) and the introduction of surface T and RH assimilation.

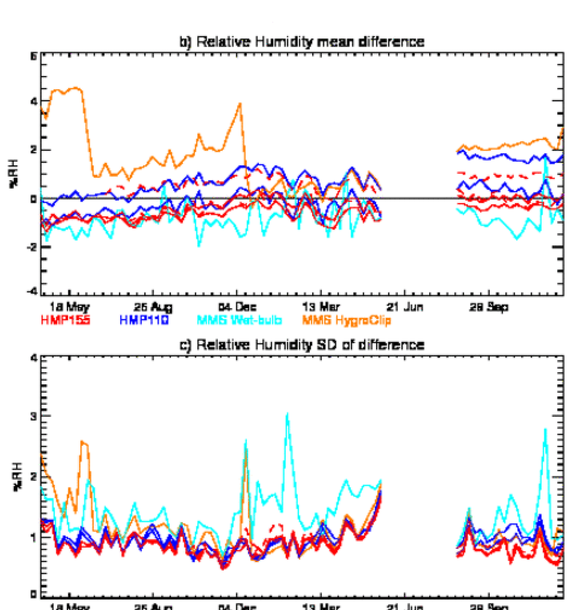

Figure 3. Mean and SD differences vs a Thygan chilled mirror reference instrument, field trial April 2011- Dec 2012. Light blue is for wet bulb, other lines are capacitive sensors (Hygroclip was replaced twice).

Wind speed

Both models have slightly strong 10 m winds compared to observations (Figure 6). Unsurprisingly the bias is very marked for stations on islands that aren't resolved by the models (winds from these stations, along with all land stations between 30 S and 30°N, aren't assimilated in the Met Office system; ECMWF doesn't assimilate wind from land stations). Figure 7 shows mean reported and Met Office model wind speed as a function of distance offshore (using a 10 km land-sea mask). This emphasises the difference between typical speeds over land and sea and the relatively narrow transition (10s of km) between the two. The global forecast model appears to "smooth out" the transition a little – this should reduce as model resolution improves. Since 2007 relatively large speed biases have been noted for central Southern Asia (e.g. Figure 8). The biases are worse at night – probably because the models have excessive mixing under stable conditions (Lock, 2011, ECMWF workshop; Sandu et al, 2013, JAME). The causes of the daytime biases are less clear cut: model roughness lengths and anemometer stall speeds (Sloan and Clark, 2012, ASL) are both possibilities.

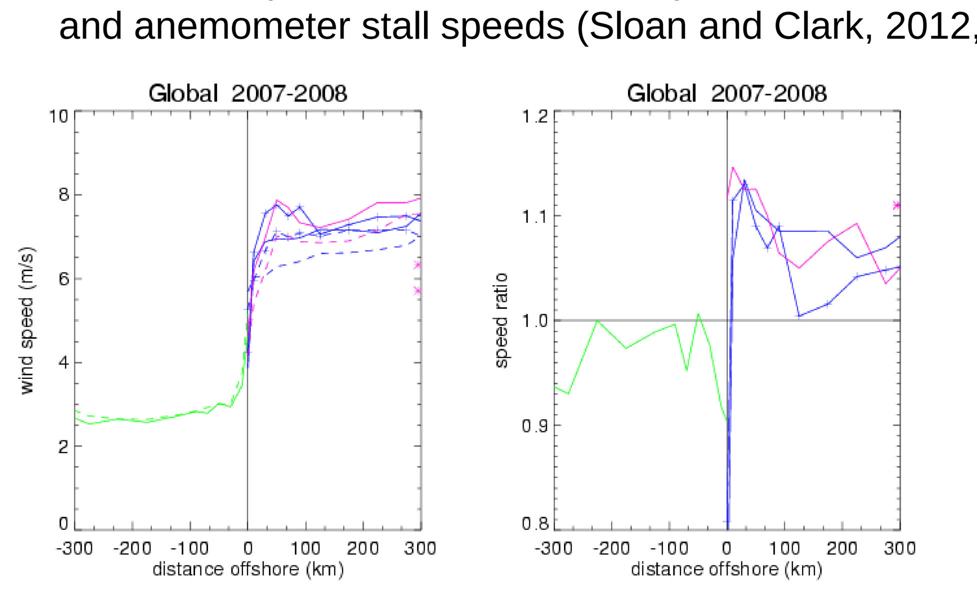

Figure 7. a) wind speed (m/s) and b) speed ratio as a function of distance from coast (green – Synops, blue – Ships, pink – Buoys). In open ocean the model is about 6% too weak increasing to 12% near the coast.

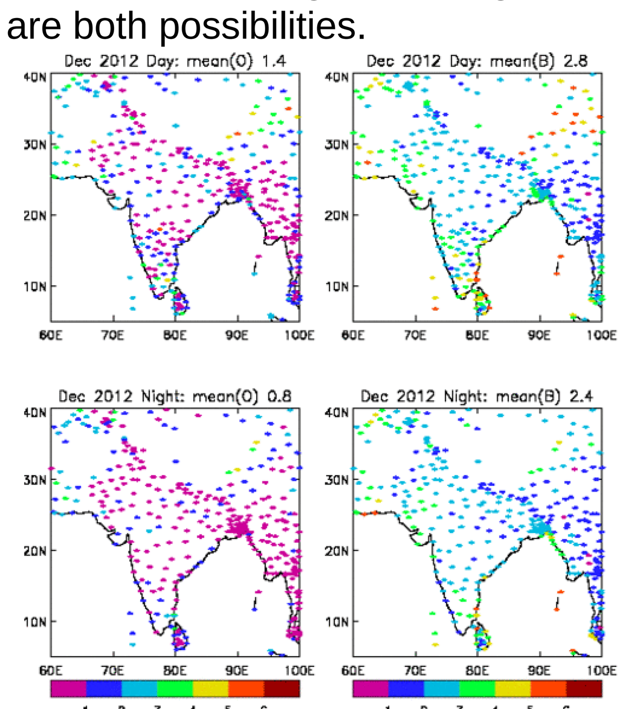

Figure 8. Wind speed (m/s) from Synops and Met Office model, Dec 2012.

Summary

Representation of near surface conditions in global forecast models has improved in recent years due to increased resolution, improved soil and boundary layer parameterization and (to some extent) data assimilation. The remaining differences from surface observations often provide insight into model errors, but observation and representativity errors also have to be borne in mind. There are both similarities and differences between the Met office and ECMWF O-B statistics which help in understanding the processes/effects involved.

Met Office FitzRoy Road, Exeter, Devon, EX1 3PB United Kingdom
Tel: 01392 884430 Fax: 01392 885681
Email: bruce.ingleby@metoffice.gov.uk