Global inequalities in weather forecasts

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Quick summary

What do we find?
The accuracy of weather forecasts (here: temperature) is very unequal: Highest in rich countries and lowest in poor countries.

Why is that?
Because weather is less predictable in the tropics, and tropical countries tend to be poor. But also because there are only few weather stations in poor countries.

Does it matter?
Recent research indicates enourmous benefits of accurate weather forecasts. Forecasts are also part of adaptation to climate change.

What can be done about it?
Our results suggest that the installation of only a few hundred targeted weather stations can close the gap between poor and rich countries by about 20 percent. (This seems to be a good investment, doesn't it.)

Want to know more? Scan QR code for link to working paper:

Results

Figure 1: Weather forecasts are most accurate in rich countries.

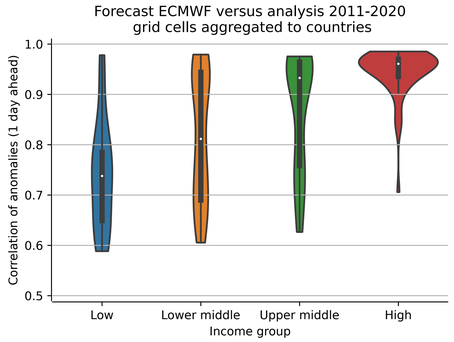


Figure 2: Even among neighbouring countries, poor countries have worse forecasts.

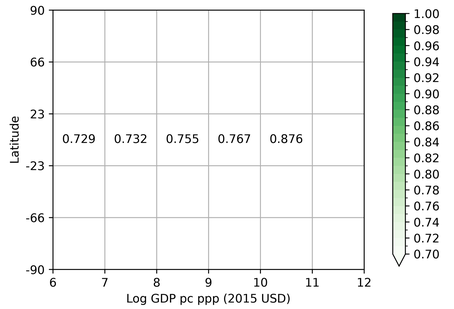


Figure 3: Weather stations are very unequally distributed.

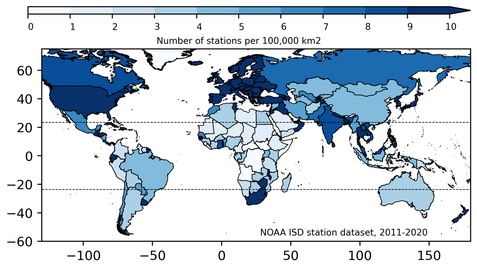
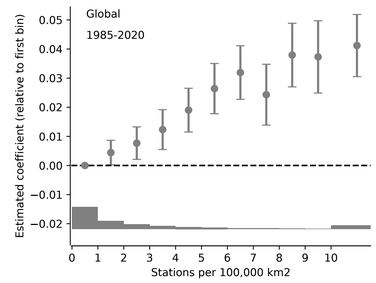


Figure 4: Increases in station density improve forecasts.



Motivation

Recent evidence on heat mortality (Shrader et al., 2023), labor supply decisions (Song, 2023), and the construction sector (Downey et al., 2023) suggests that economic benefits of accurate weather forecasts exceed multiple times their production costs.

Routine verifications tend to focus on atmospheric pressure, often focus on parts of the world or the world as a whole, and ignore socio-economic dimensions.

Prior academic work focused on trends over time instead of spatial differences (Magnusson and Källén, 2013), used coarse spatial aggregation or excluded part of the world (Bauer et al.,2015), focused on longer forecast horizons (Barnston et al., 2010), and generally focused primarily on atmospheric pressure (Bauer et al., 2015) and sometimes rainfall (Wheeler et al.,2017).

Methods

We use daily weather forecasts from the European Center for Medium-Range Weather Forecasts (ECMWF), NOAA, and the UK MetOffice for every day for every place in the world over the time period 1985-2020.

We also use the world's largest dataset of historical weather observations from land-based measurement stations.

Forecast accuracy is quantified using the correlation of anomalies (forecast versus verification).

We estimate a regression model

forecast accuracy ~ f(station density, grid cell, year) + error

to relate changes in forecast accuracy to changes in station density. This model includes grid cell and year fixed effects.

Conclusions and outlook

Weather forecasts are least accurate in the poorest countries. This is partly because of certain features of the Earth's climate system, but also because of sparse measurement infrastructure.

Ground-based observations are an important input into weather forecasts. Investments in this infrastructure appear highly net beneficial.

This work is currently extended to include:
- monetarisation of forecast accuracy
- spatial spillovers
- forecasts of rainfall
- ... (your suggestion!)

Want to know about Manuel's other work? Scan QR code for link to personal website: