The weather roulette: communicating probabilistic predictions for wind energy

Isadora Christel, Llorenç Lledó, Verónica Torralba, Albert Soret, Nube González-Reviriego, Francisco Doblas-Reyes
Barcelona Supercomputing Center (BSC), Institució Catalana de Recerca i Estudis Avançats (ICREA)

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Current use of climatology

Climate predictions can provide new insights in the future variability of climate from sub-seasonal to decadal time scales, which can potentially benefit the wind energy sector. However, current energy practice relies on climatology to estimate what is going to happen in the future. Assuming that future conditions will be similar to the past doesn't take into account extreme events, limited information of the past, variability in past conditions or climate change.

Seasonal wind speed predictions

Based on ECMWF System 4 data, RESILIENCE provides seasonal wind speed predictions for the energy sector (more info in **www.project-ukko.net**)

However, to foster the adoption of new technology we have to demonstrate the added value of the predictions compared to climatology.

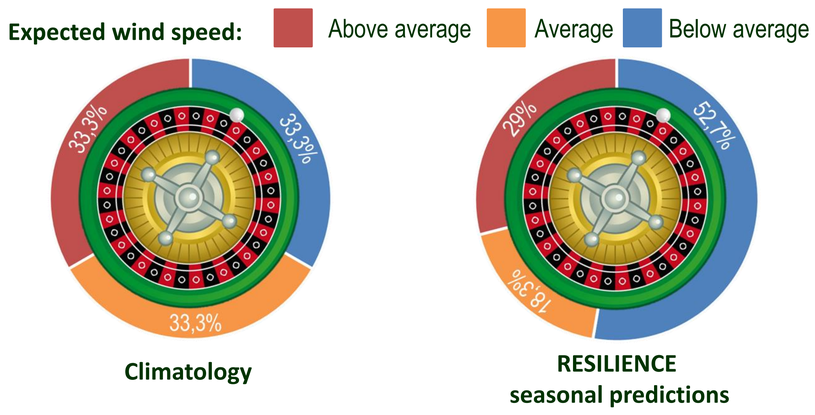
Predictions vs. past climatology

The performance of seasonal predictions is currently quantified with skill scores but… Is there a better way to present this to users?

How can we improve the communication of probabilistic predictions?

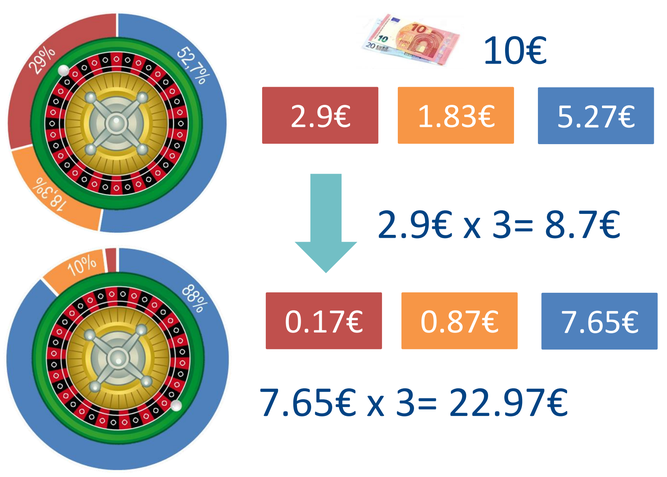
The Weather Roulette framework is based on Hagedorn & Smith 2009. This method translates skill scores into commonplace concepts as interest ratios or return of investment.

The Weather Roulette: Methodology

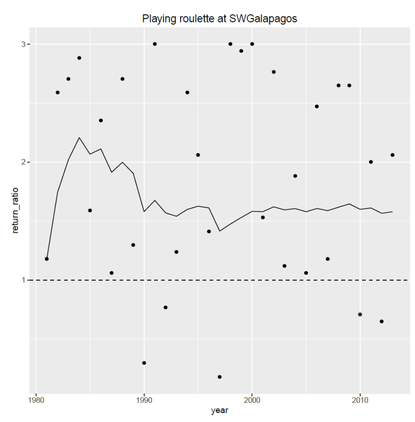


Climatology assumes a fixed probability to each category while climate predictions adjust the category probabilities of the 'climatology' forecast.

There is an initial investment of 10€ and everything earned is reinvested in the next run.



In the game, the user bets proportionally to the probabilities estimated in the seasonal forecast and the amount invested in the observed category is multiplied by 3 (i.e. the inverse of the climatology probability)



The dots are the performance of the forecast in each year (i.e. interest ratio). Over the dashed line, seasonal predictions outperform climatology; below the line, climatology is better.

These dots are used to calculate the geometric average of the interest ratio (solid line)

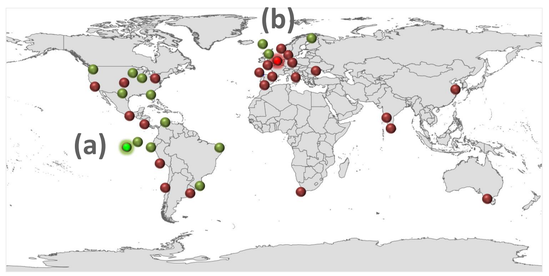
After 33 runs with historical data (one for the prediction of each year from 1981 to 2013) we calculate the average **interest ratio** for the wind farm that, with this value we obtain the total **return of investment**:

Results

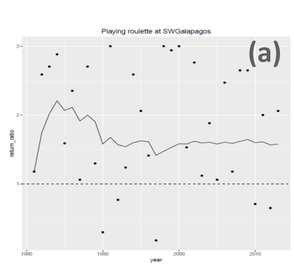
The performance of seasonal predictions is assessed with skill scores. The **Ignorance Score (IS)** measures the average information deficit. The **Ranked probability score (RPS)** uses the probabilities assigned to the three categories and the outcome category to compute the verification.

For both scores we compute the skill over climatology (**ISS, RPSS**). Skill scores > 0 mean that the prediction system performance is better than climatology, whereas skill scores < 0 mean that it is not better than making a guess based on historical data.

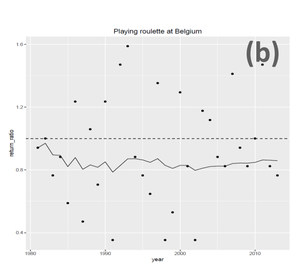
- All wind farms with an ISS > 0 had Interest ratios over 1
- All wind farms with RPSS > 0.06 had return ratio over 1, between 0 and 0.06 there was not clear advantage between climatology and seasonal predictions
- RPSS is more widely used than ISS. Although they do not measure exactly the same concepts, they share information and this yields a high correlation between them. i.e. forecasts with high RPSS will typically have high ISS and vice versa.
- IS can be translated to interest ratio using a mathematical equation.



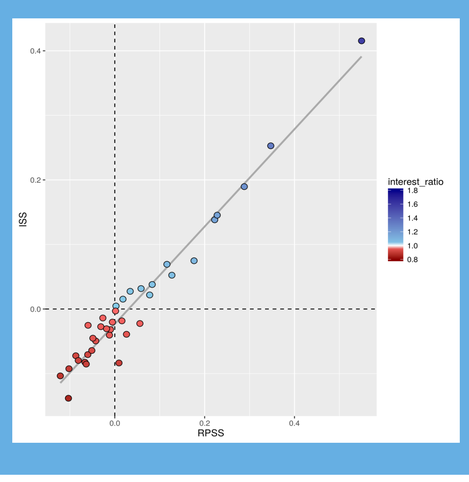
Prediction for the Winter period (Dec-Jan-Feb) from 1981 to 2013 in 37 wind farms around the world.
Green dots: wind farm in skillful areas
Red dots: wind farm in unskillful areas

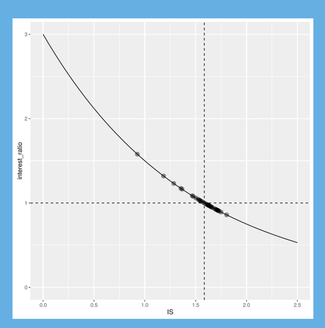


Skill: 0.55 RPSS; 0.42 ISS
Interest ratio: 1.578
34 772 654€ returned



Skill: -0.10 RPSS; -0.14 ISS
Interest ratio: 0.859
10 cents returned





$$\textit{Interest ratio} = 3 * 2^{(-IS)}$$

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