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MCP studies with reanalysis models: get a forecast of the uncertainty and complexity without observational data

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Abstract

Reanalysis models are widely used in the wind industry when facing projects that need long term data correction adjustments. The available data from monitoring towers is also a required source in such studies. Reanalysis limitations arise only after comparison between both are performed. We present several maps with the purpose to give quantitative information of correlations, directional patterns and tendencies between the different models. This information should lead to prior knowledge of the complexity of the long term adjustment process before comparing to tower data, for example.

Objectives

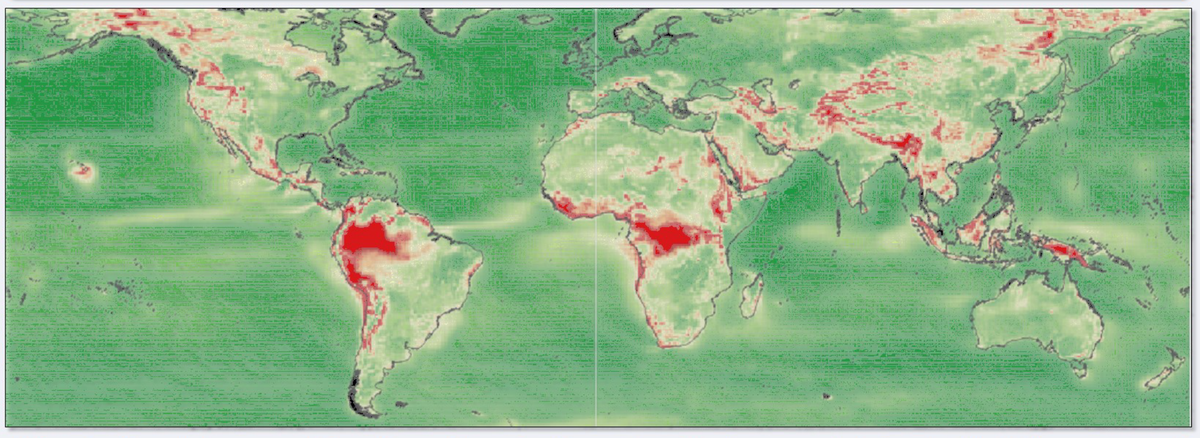
The study shows first-approach results of a global reanalysis models study. The goal is to achieve a better understanding of how representative and reliable reanalysis models are globally prior to any on-site data measurements or regional mesoscale simulations. Correlation has been used with an important role in this study. In addition more information is needed to quantify reliability and uncertainty of the results and to choose the models to use as reference data. With the described model-to-model comparison method it emerges new information to the classical tower-models comparison. GIS results are presented in order for a quick overview for the large amount of data generated when analyzing the whole area that reanalysis models cover.

Methodology

- Wind speed at 80m and 60 m from CFSR[1], ERA-I[2] and MERRA[3] reanalysis models have been used have been used.
- For each model and node we generate monthly average series and wind direction frequency distribution for the 2000-2014 period.
- For each model pair and in each virtual grid point we obtain 4 statistics with information about correlation, wind speed differences, wind distribution across directions and tendencies.
- Averaging each statistic for the 3 pairs of models we obtain a single value (correlation, wind speed differences and wind distributions). For tendency we use the median value of the three models.
- Repeating this process for all the virtual grid we generate a grid which is represented in different maps.

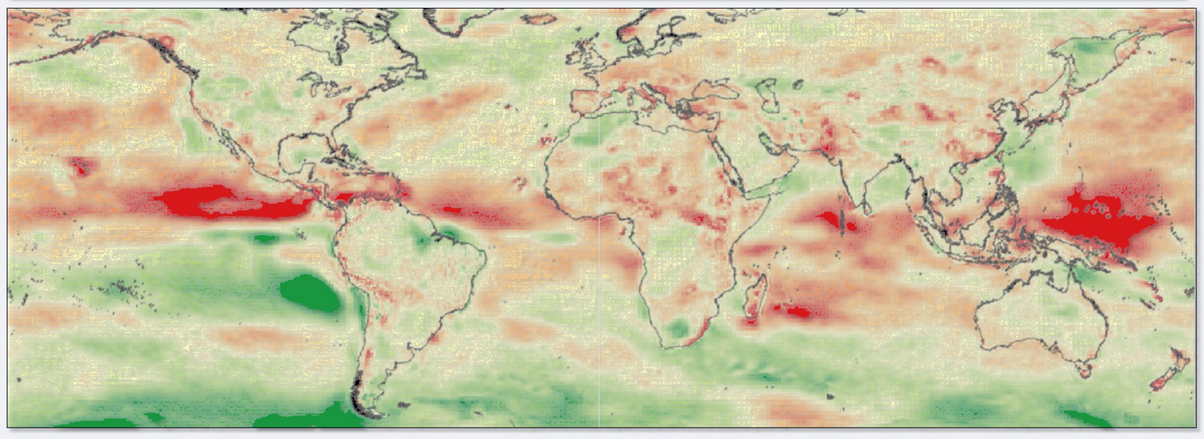
Results - Maps

Correlation



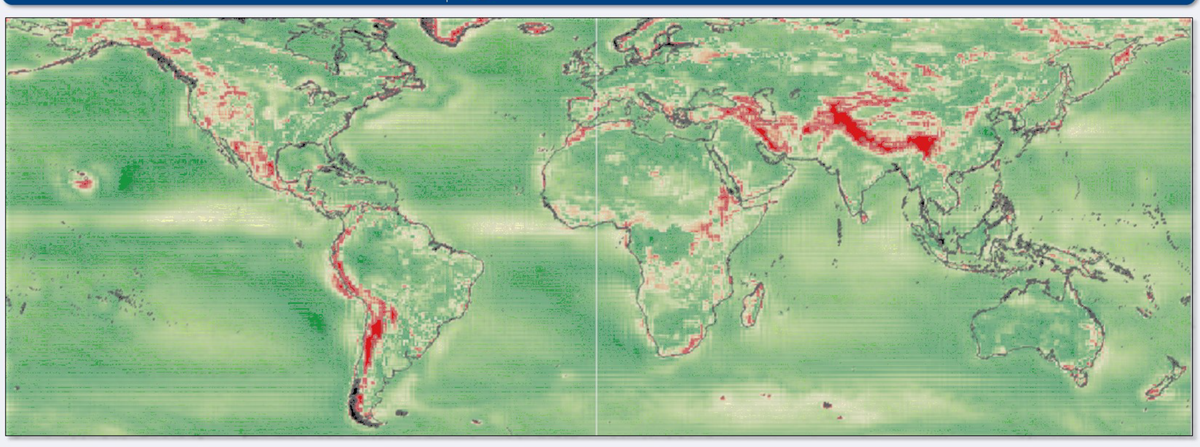
Using the 3 models, a correlation of monthly series for each pair between models is calculated. The average of those 3 correlations is represented.

Tendency – Slope



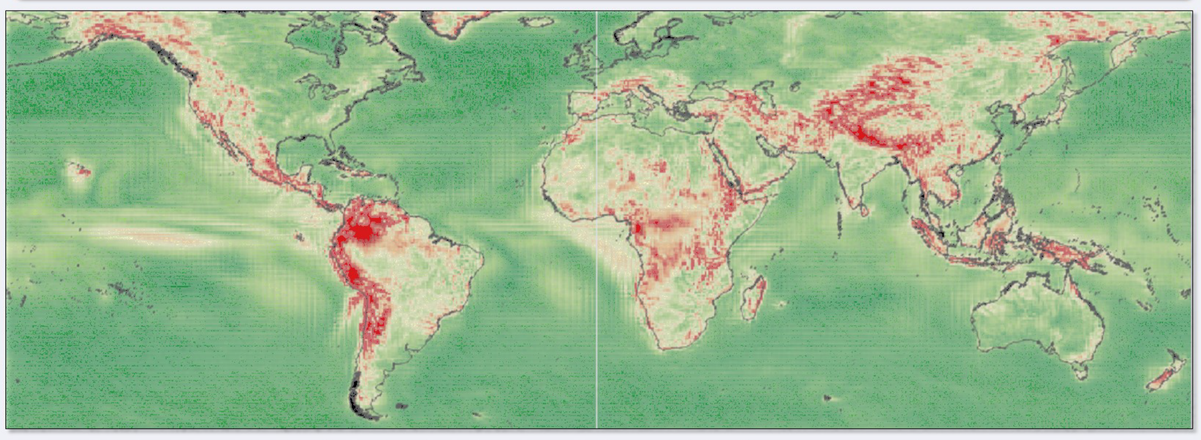
A linear regression (slope) of the monthly series vs time for each of the 3 models is calculated. The median value of those is used as a tendency representation for the 2000-2014 period.

Average Difference ERAI-MERRA (m/s)



Only using MERRA and ERA-i models at 60m height. The absolute wind speed difference is calculated for each time and averaged for all the 2000-2014 period.

Wind Direction Frequency Difference



The wind directions are classified in 12 sectors. For each model the frequency in each sector is calculated. The absolute difference in frequencies between model pairs is then calculated. The average of the 3 is represented.

Conclusions

In addition to correlation, more information is needed to quantify reliability and uncertainty of the models and to choose the ones to use as reference data. The distribution of the models uncertainty and their similarity in behavior is not spatially uniform. Emerging information about trends also reveals surprising and unexpected behaviors which reinforces motivation of further studies for projects that considers stability in the wind patterns. In areas with high correlations and similar wind direction frequency distributions the reliability of the information provided by models in general is higher. The patterns observed in the maps have not then the same reliability across the whole analyzed area.

Reanalysis Models Used

1. “Climate Forecast System Reanalysis” (CFSR) from the National Centers for Environmental Prediction (NCEP)
2. “European Reanalysis Archive interim” (ERA-i) from the European Center for Medium-Range Weather Forecasts (ECMWF).
3. “Modern-Era Retrospective Analysis for Research and Applications” (MERRA) from the National Aeronautics and Space Administration (NASA)

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