Evaluating the Accuracy of Reanalysis Products for Wind Energy Development: A Comparison with In-Situ Observations

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Poster Summary: Reanalysis products are vital for analyzing historical weather patterns in wind energy resource evaluations, especially in wind energy-focused South Asian countries. Differences between actual and simulated land surface wind speeds emphasize the need for simulated products in long-term assessments. This study compares reanalysis products with station observations to verify wind energy estimations and support wind farm development.

1. Brief Introduction

- **Reanalysis products are crucial** for analyzing historical weather patterns, especially in wind energy resource evaluations.
- **South Asian countries prioritize wind energy** development to address climate change and meet energy demands.
- **Wind speed measurements indicate global terrestrial stilling,** a decline in land surface wind speed since the 1960s, followed by a reversal around 2010 (**Fan, W., Liu, Y., et al. 2021**).

2. Objective

- **Highlight the difference** between actual and simulated land surface wind speeds.
- **Emphasize the importance of caution** when utilizing reanalysis products.
- **Focus on the need for accurate** assessment and forecasting of winds in the Subcontinent area.

3. DATA AND METHODOLOGY

Table 1. Data

Data		Time resolution	Variable (10-m)	Period	Horizontal grid spacing
Station data	HadISD	3, 6, 12-hr	Wind Speed	1973-2005	
Reanalysis	ERA5	1-hr	SfcWind (Uas,Vas)		0.25° × 0.25°
	NCEP	6-hr			1.875° × 2.5°
	JRA-55				1.25° × 1.25°

- **Hourly data** calculated to daily mean and **regridded** by the bilinear (bill) interpolation method at reference grid of 0.1 degrees spacing.
- **The arbitrary threshold** of 90% is used as a criterion for selecting station data with valid values (Molina et al., 2022; 2021;Gbode et al., 2019).

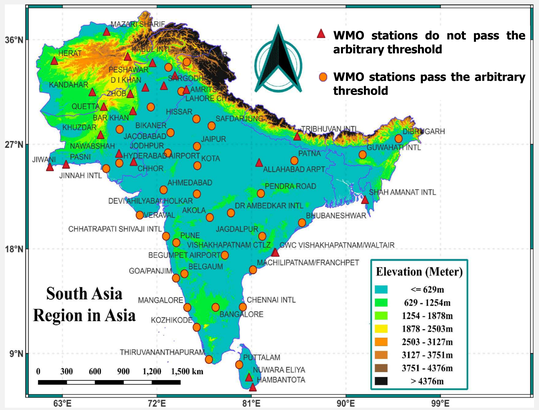

Figure 1. Location of WMO stations in the South Asia domain.

4. RESULTS

Table 2. Summary Statistics for 10m wind speed between reanalysis and observations

Dataset	SD (m/s)	RMSE (m/s)	Mean Bias (m/s)	Pearson Correlation Coefficient, R	Coeff. of Determination (R^2)	Climatological Mean (m/s)
ERA5	1.33	1.70	0.49	0.52	0.31	2.53
JRA55	0.96	1.40	0.36	0.60	0.40	2.38
NCEP	1.09	1.97	1.19	0.40	0.21	3.15
Multi-Reanalysis Ensemble (MRE)	0.99	1.49	0.63	0.57	0.37	2.67
HadISD	1.46					2.04

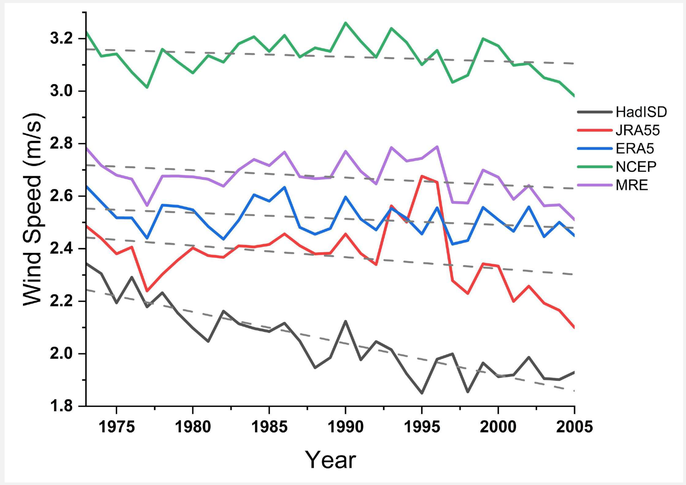

Figure 2. Annual mean 10m wind speed in Reanalysis and compared to HadISD

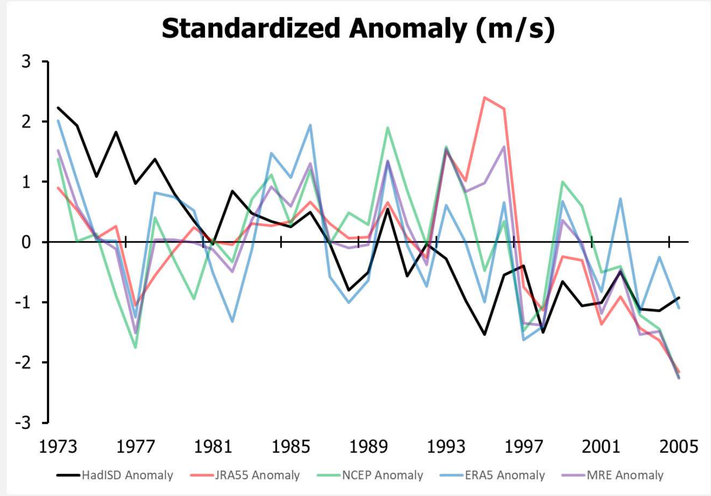

Figure 3. Annual Standardized anomaly for 10m wind

5. CONCLUSIONS

- **Analyzed the Subcontinent land surface wind speed trend using** three global reanalysis products and 36 meteorological stations for 1973-2005**.**
- **Compared to other products, JRA55 reanalysis** had a higher correlation coefficient (0.40), mean bias (0.36), and lower Root Mean Square Error (1.40).
- **In the Subcontinent, wind speed** showed a decreasing trend from 1973 to 2005 based on in-situ measurements, as confirmed by Fan et al. (2021).
- **This study emphasizes the need** for careful selection of reanalysis datasets in long-term wind energy assessments due to significant data discrepancies.
  - **This assessment might help wind energy** companies predict changes in production and maximize economic benefits.

References

1- Fan, W., Liu, Y., Chappell, A., Dong, L., Xu, R., Ekström, M., … Zeng, Z. (2021). Evaluation of global reanalysis land surface wind speed trends to support wind energy development using in situ observations. *Journal of Applied Meteorology and Climatology*, *60*(1), 33-50. doi:10.1175/jamc-d-20-0037.1
2- Molina, M. O., Careto, J., Gutiérrez, C., Sánchez, E., & Soares, P. (2022). The added value of high-resolution EURO-CORDEX simulations to describe daily wind speed over Europe. doi:10.5194/egusphere-egu22-1043
3- Gbode, I. E., Adeyeri, O. E., Menang, K. P., Intsiful, J. D., Ajayi, V. O., Omotosho, J. A., & Akinsanola, A. A. (2019). Observed changes in climate extremes in Nigeria. *Meteorological Applications*, *26*(4), 642-654.

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