Wind Resource Analysis For Airborne Wind Energy Systems

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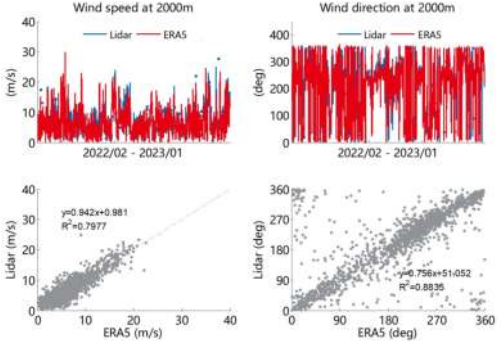
High-altitude wind energy has a rich resource, high power densities, and more stable wind direction and speed than close to the ground. Different from many existing airborne wind energy systems (AWES), we consider in this paper a parachute-based AWES containing a cascade of parachutes exploiting aerodynamics drag forces. Such a conceptual design has a high power-to-weight ratio of the aerial components and is easy to scale up (possibly to the order of 10 MW, much greater than the nominal power of other AWES techniques). In this paper, the principle of parachute-based AWES will be present.

Wind resource assessment is a critical step for site selection of high-altitude wind farms, and its accuracy is crucial for the future actual operation and benefits of wind farms. For studying the wind energy that could be captured by the Airborne Wind Energy System (AWES), we conducted year-round monitoring of wind speed, wind direction at heights between 300 meters and 3,000 meters using laser wind profilers and wind profiling radars at the test site. The spatial distribution, vertical profile, and temporal variation of wind speed and wind power density between 300 and 3,000 m were analyzed using the monitoring data and the ERA5 reanalysis data from 2012 to 2021. As shown in the figure, the laser wind profiler monitoring data and the ERA5 data for wind speed and wind direction have a good match. We also proposed a method for assessing high-altitude wind resources:

1. Data collection and organization
2. Statistical analysis of basic wind condition parameters
3. Analysis of wind energy resource characteristics
4. Estimation of equivalent wind power density
5. Evaluation of high-altitude wind energy resources



Correlation of wind speed and wind direction between laser wind profiler and reanalysis data (at 2000 m).