



The Role of Atmospheric Instability and Importance of Wind Shear Exponent on Wind and Solar Energy Potential

Onur Pamuk (1), Altan Akyol (1), and Zafer Aslan (2)

(1) Ari Force Academy, Institution of Aerospace Technologies , 34149 Yesilyurt Istanbul (onurpamuk@hho.edu.tr, altanakyol@hho.edu.tr), (2) Istanbul Aydin University, Faculty of Engineering and Architecture, Department of Computer Engineering, Inonu Cad. No: 38, 34295, Florya, Istanbul, Turkey (zaferaslan@aydin.edu.tr)

Spatial and temporal distributions of wind and solar energy potential are function of atmospheric stability, wind shear exponent, aerosol contents, heat fluxes etc. Richardson number is one of the indicators of the evolution of atmospheric instability. It is a function of the static stability and wind shear exponent. The logarithmic wind profile is commonly used for wind energy evaluation processes in the atmospheric surface layer. Definition of the vertical variation of horizontal wind speeds above the ground by logarithmic profile is limited by 100 meters. The main objective of this study is to take into account atmospheric instability and wind shear exponent in wind power assessment. In the first part of this paper, stability parameters and wind shear exponent have been calculated by using radiosonde data and the wind measuring system for the local area of Istanbul; northwestern part of Turkey between 2011 and 2012. These data were analyzed to define hourly, daily, monthly and seasonal variations of the Richardson number and wind shear exponent. Analyses of early morning soundings produced negative skewness and afternoon soundings produced a positive skewness for Ri numbers. The larger negative values of Ri numbers (extremely unstable conditions) have been observed in early morning in winter at the lower levels of atmosphere. The second part of this study covers temporal variations of wind speed and daily total radiation in Istanbul. By using time series and wavelet techniques, small, meso and large scale factors and their roles on wind speed and total daily solar radiation variations have been analyzed. The second part of the paper underlines the role of atmospheric stability and importance of wind shear exponent on variations of wind and solar energy potential. The results of this study would be applicable in the field of wind and solar combined energy systems.

Keywords: Wind shear exponent, total daily radiation, wavelet wind and solar energy.

Corresponding Author: zaferaslan@aydin.edu.tr