1475 SPECTRAL STRUCTURE OF 5-YEAR TIME SERIES OF HORIZONTAL WIND SPEED
AT THE BOULDER ATMOSPHERIC OBSERVATORY

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Introduction & Research goal

• A long-term high-frequency time series of wind speed provides an opportunity to explore the spectral characteristics of wind speed fluctuation. In practice, the observed spectral characteristics are used to validate atmospheric modeling.

• We examine the spectral structure of 5-year, 1-min time series of horizontal wind speeds at 100 m and 10 m heights at the Boulder Atmospheric Observatory (BAO) tower.

Data


<table>
<thead>
<tr>
<th>Year</th>
<th>Period</th>
<th>Nm/N (%)</th>
<th>Pm (hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yr. 1</td>
<td>Mar. 2011-Feb. 2012</td>
<td>2.28</td>
<td>2.96</td>
</tr>
<tr>
<td>Yr. 2</td>
<td>Mar. 2012-Feb. 2013</td>
<td>0.41</td>
<td>1.15</td>
</tr>
<tr>
<td>Yr. 3</td>
<td>Mar. 2013-Feb. 2014</td>
<td>4.85</td>
<td>4.55</td>
</tr>
<tr>
<td>Yr. 4</td>
<td>Mar. 2014-Feb. 2015</td>
<td>0.71</td>
<td>0.60</td>
</tr>
<tr>
<td>Yr. 5</td>
<td>Mar. 2015-Feb. 2016</td>
<td>2.23</td>
<td>2.10</td>
</tr>
</tbody>
</table>

Table 1. The percentage of missing data points Nm per total data points N, and the longest period of consecutive missing data points Pm of the wind speed time series at the heights of 10 m and 100 m on the BAO tower over the 5-yr study period from Mar. 2011 to Feb. 2016 and for each year during the period.

5-year Time Series Analysis

In the full-scale spectra, the diurnal spectral peak, which is usually insignificant at a coastal or offshore site, is the most significant at both heights.

Seasonal Spectra

The spectrum is enhanced on the low-frequency side of the diurnal peak during winter, but on the high-frequency side during summer, which indicates frequent synoptic weather events during winter supplanted by mesoscale events during summer.

Turbulence intensity vs. Wind speed

The TI-wind speed relationship with the summer time series more sensitively responds to the choice of the averaging period in the spectral gap region than with the TI-wind speed relationship with the winter time series.

Upscale energy & downscale enstrophy cascade of turbulent 2D flows

In terms of the spectral density over the freq. band btxn. $10^{-4}$ - $10^{-3}$ Hz, the 42 summer top 10 percentile and the 44 winter bottom 10 percentile cases are selected.

Summer cases

Winter cases

\[
\delta u(\tau) = u(t + \tau) - u(t) \quad \text{Velocity increments with a time lag } \tau
\]

\[
\langle \delta u(\tau) \rangle = -4\varepsilon \tau^{2/3} \quad \varepsilon: \text{ The mean kinetic energy dissipation rate per unit mass}
\]

Positively skewed velocity increment distributions

Negatively skewed velocity increment distributions