ASSessing the impact of different measurement time intervals on observed long-term wind speed trends

CESAR AZORIN-MOLINA, SERGIO M. VICENTE-SERRANO, TIM McVICAR, SONIA JEREZ, JESUS REVUELTO, and JI. LOPEZ-MORENO

(1) Instituto Pirenaico de Ecología, Agencia Estatal Consejo Superior de Investigaciones Científicas (IPE-CSIC), Zaragoza, Spain
(2) CSIRO Land and Water, Canberra, ACT, Australia
(3) University of Murcia, Physics of Earth, Physics of the Earth, Spain

ABSTRACT. During the last two decades climate studies have reported a tendency toward a decline in measured near-surface wind speed in some regions of Europe, North America, Asia and Australia. This weakening in observed wind speed has been recently termed “global stilling”, showing a worldwide average trend of -0.140 m s^{-1} dec^{-1} during last 50 years. The precise cause of the “global stilling” remains largely uncertain and has been hypothetically attributed to several factors, mainly related to: (i) an increasing surface roughness (i.e. forest growth, land use changes, and urbanization); (ii) a decrease in large-scale atmospheric circulation; (iii) instrumental drifts and technological improvements, maintenance, and shifts in measurements sites; (iv) wind speed trends attributed to air pollution; and (v) stratospheric changes. This study proposes a novel investigation aimed at analyzing how different measurement time intervals used to calculate a wind speed series can affect the sign and magnitude of long-term wind trends. For instance, National Weather Services across the globe estimate daily average wind speed using different time intervals and formulate that may affect the trend results. Here we analyzed near-surface wind speed trends recorded at 19 land-based stations across Spain comparing monthly mean wind speed series obtained from: (a) daily mean wind speed data averaged from standard 10 min mean observations at 0000, 0700, 1300 and 1800 UTC; and (b) average wind speed of 24 hourly measurements (i.e., wind run measurements) from 0000 to 2400 UTC. As a complementary analysis, in this study we also quantified the impact of anemometer drift (i.e. bearing malfunction) by presenting preliminary results (i.e. 11 months of paired measurements) from a comparison of one new anemometer sensor against one malfunctioned anemometer sensor due to old bearings.

Wind Speed Series - Measurement Time Intervals

- Data: We compared monthly wind speed series obtained from:
  - (a) Daily mean wind speed data averaged from standard 10 min mean observations at 0000, 0700, 1300 and 1800 UTC (hereafter WS);
  - (b) Daily mean wind speed data averaged from wind speed of 24 hourly measurements (i.e., wind run) from 0000 to 2400 UTC (hereafter WR).

- Stations: 19 land-based stations across Spain.
- Study periods: 1961-2011 (12 stations), 1979-2008 (19 stations), and also 1979-2011 (19 stations).

- Wind Speed Series - Measurement Time Intervals

<table>
<thead>
<tr>
<th>Periods</th>
<th>Winter (DJF)</th>
<th>Spring (MAM)</th>
<th>Summer (JJA)</th>
<th>Autumn (SON)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual</td>
<td>-0.171</td>
<td>-0.063</td>
<td>-0.057</td>
<td>-0.072</td>
</tr>
<tr>
<td>Winter (DJF)</td>
<td>-0.140</td>
<td>-0.054</td>
<td>-0.063</td>
<td>-0.078</td>
</tr>
<tr>
<td>Spring (MAM)</td>
<td>-0.036</td>
<td>-0.049</td>
<td>-0.049</td>
<td>-0.056</td>
</tr>
<tr>
<td>Summer (JJA)</td>
<td>-0.036</td>
<td>-0.049</td>
<td>-0.049</td>
<td>-0.056</td>
</tr>
<tr>
<td>Autumn (SON)</td>
<td>-0.036</td>
<td>-0.049</td>
<td>-0.049</td>
<td>-0.056</td>
</tr>
</tbody>
</table>

- Quality Control, Reconstruction and Homogenization

Because of the limited metadata, the following multistep approach was applied to create robust wind speed series of WS and WR for comparison: (i) quality control, (ii) reconstruction, and (iii) homogenization. For details see Azorin-Molina et al. 2014 (JCR, 27, 3692-3712). The accuracy of changes and years of breakthrough (in decades) is highlighted on the axes, for some non-significant breakthroughs, green dots are detected.

Conclusions

- The main findings of this assessment of the impact of two different measurement time intervals on observed long-term wind trends are the following:
  1. We detected that monthly mean wind speed data values are greater when averaged from standard 10 min mean observations at 0000, 0700, 1300 and 1800 UTC (WS) than from 24-hourly wind run measurements (WR), particularly in summer.
  2. We found that the different measurement time intervals used has an impact on the sign and magnitude of wind speed trends, showing WR data less negative long-term wind speed trends than WS.
  3. Additionally, we presented preliminary results of an ongoing intercomparison of anemometers aimed at evaluating the impact of anemometer drift on wind speed measurements. Statistically significant differences are found.

Acknowledgements. We would like to thank the AEMET for supplying wind speed data. C. A-M. received a postdoctoral fellowship # P11-TEC-1681/01. Research supported by projects CSIC61-27070-C03-01, CSIC61-27070-C03-02 and CSIC61-27070-C03-03 funded by the Spanish Commission of Science and Technology.