



THE WIND ENGINEER

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Estimating Surface Wind Speeds from WSR-88D Radar Velocity Azimuth Display Wind Profiles

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Historical studies have been conducted to estimate surface winds from flight-level and global positioning system (GPS) dropwindsonde wind measurements (Powell and Black 1990; Franklin et al. 2003; Dunion et al. 2003; Powell et al. 2009). These techniques are employed over open ocean waters and do not apply over land during tropical cyclone landfalls. Another issue is that surface wind platforms over land tend to fail due to mechanical and power loss, leaving forecasters without the tools necessary to verify sustained and gust speeds during landfall events (Powell et al. 1996; Blessing and Masters 2005).

Velocity Azimuth Displays (VADs) generated by Weather Surveillance Radar-1988 Doppler (WSR-88D) systems located along the United States coastline can be leveraged to construct vertical wind profiles in landfalling tropical cyclones (Giammanco et al. 2012).

Depending on the volume coverage pattern (VCP) utilized, a VAD wind profile can be generated every 4-10 minutes. A large database containing approximately 21,000 VAD wind profiles has been created to assess the relationship between VAD winds and standardized Automated Surface Observing System (ASOS) surface wind measurements.

(Continued on page 2)

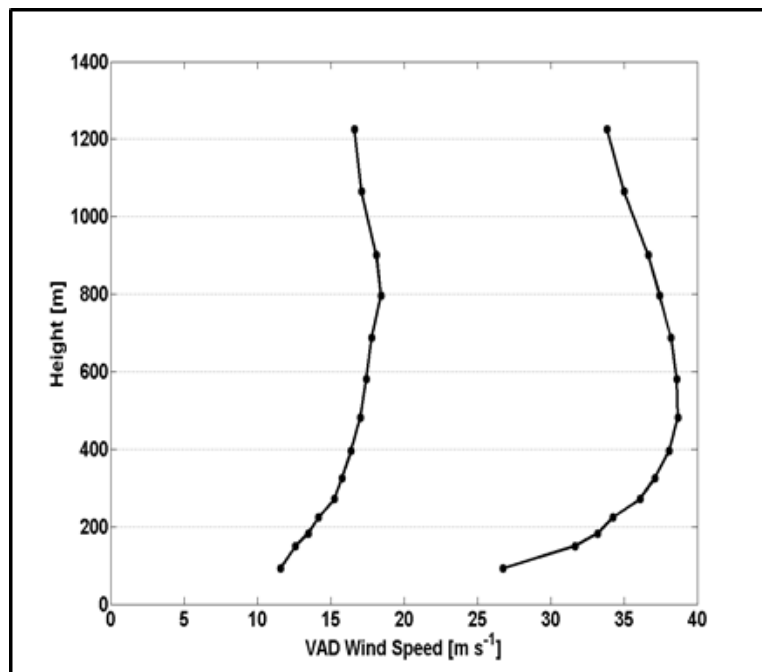


Figure 1. VAD wind speed profiles generated at the WSR-88D radar in Brownsville, Texas in the outer rainband (A) and inner core (B) regions of Hurricane Dolly (2008).

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Standardization of Surface Wind Measurements

ASOS 2-minute averaged wind speed data were retrieved from the National Climatic Data Center (NCDC) land-based archive for 16 landfalling tropical cyclone events and 7 ASOS/WSR-88D radar sites. The data were averaged over the data collection time of each VAD wind profile and adjusted to a 1-hour average wind speed using an empirical relationship derived by Simiu and Scanlan (1986):

$$U_t(z) = U_{3600}(z) \left[1 + \frac{\beta^{\frac{1}{2}} c(t)}{2.5 \ln\left(\frac{z}{z_0}\right)} \right] \quad (1)$$

where $U_t(z)$ is the adjusted wind speed at height z above ground level with time duration t (seconds), $U_{3600}(z)$ is the hourly mean wind speed at height z , β and $c(t)$ are empirical values obtained from Table 2.3.1 and Table 2.3.3 in Simiu and Scanlan (1986), and z_0 is the roughness length.

A similarity model described in Simiu and Scanlan (1986) was also utilized to determine the friction velocity for an open exposure ($z_0 = 0.03$ m) 1-hour wind speed at 10 m above ground level (AGL). The open exposure friction velocity was used in conjunction with the log-law to compute an ASOS 1-hour open exposure mean wind speed at 10 m AGL using the method outlined by Powell et al. (1996).

Preliminary Results

Scatter plots of the ASOS 1-hour open exposure mean wind speeds versus various VAD layer mean wind speeds were generated to explore any relationships between the two unique data sets. Second-degree linear polynomial models were fit to the scatter plots. The VAD layer mean wind speed between 0-746 m was found to explain 86% of the variance and had a root mean square error (RMSE) of 1.62 m s⁻¹ (Figure 2).

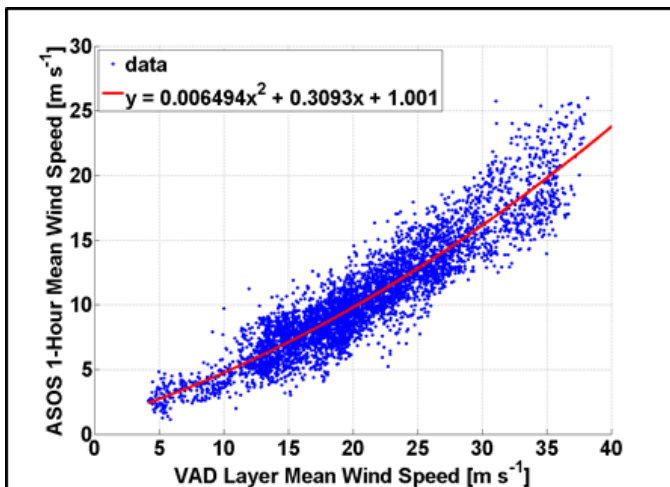


Figure 2. Scatter plot of ASOS 1-hour open exposure mean wind speeds versus VAD layer mean wind speeds between 0-746 m. The 2nd degree linear polynomial model is overlaid (red line).

A fair amount of spread is observed in Figure 2 for VAD layer mean wind speeds ranging from approximately 12-38 m s⁻¹. The variance is attributed to differences between the measurement platforms, internal boundary layer processes, and the terrain conditions around each WSR-88D radar site (Giammanco et al. 2012).

Site-relative 1st degree linear polynomial models were constructed for various VAD layer mean wind speeds in an attempt to explain more of the variability noted in Figure 2. For some radar sites, the coefficient of determination increases by 5-10% when using a different VAD layer, while the RMSE decreases by 0.17-0.61 m s⁻¹ (Table 1).

Table 1. Doppler radar model fit statistics

Radar ID	Layer (m)	R ² (%)	RMSE (m s ⁻¹)
KBRO	0-167	91	1.24
KBYX	0-245	91	1.39
KJAX	0-245	85	1.19
KLCH	0-245	96	1.01
KLIX	0-167	86	1.16
KMOB	0-245	93	1.45
KTLH	0-167	63	1.09

The preliminary model results are being refined to predict the most reliable 1-hour open exposure mean wind speeds. Once confidence is established for the 1-hour open exposure mean wind speed prediction, gust factors will be employed to compute estimates of 1-minute sustained and 3-second gust speeds.

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President's Corner

This will be my final column in the newsletter as President of AAWE before I hand over the reigns to the capable hands of Prof. Chris Letchford in the new year. These two years have passed very quickly. Over this period we have supported the continued growth of AAWE, as the primary representative of the wind engineering discipline in North America, particularly by providing opportunities for students to present their wind engineering research findings to national and international audiences. The aspect that pleased me most during my tenure was the number of students who attended the 12 ACWE in Seattle, and were then able to also write brief articles for this newsletter. I consider the large number of students involved with wind research in North America to be our strength as an organization, in addition to our well-run and well-respected international conference and workshops. Our awards program is also important as it encourages our students towards excellence. I would encourage our senior members to continue to nominate our talented young researchers for awards, both those sponsored by AAWE and those in the larger international community.

The aspect of this role that surprised me most was the effort that it took to keep on top of administrative matters. Some issues, such as having to deal with the (byzantine) US tax system, surprised me, while others, such as keeping our website and membership lists up to date, were more challenging than anticipated. Members of the Board spent much time on such matters. In fact, these issues are something we need to think about seriously as a volunteer-run organization with a small annual budget. While our institutional memory is good, the turnover period of our leadership team roughly every two years poses some challenges. In fact, the Board is looking at these issues seriously as it plots a course for the future so that we can continue to effectively achieve our mission “to promote and disseminate technical information in the research community” (which is described on our website, aawe.org). A range of possibilities are being discussed including partnering with other organizations, such as ASCE, in order to reduce the administrative overhead,



while allowing us to be more effective in achieving our mission of disseminating wind research findings into the broader society. I truly believe that our work solving wind-related problems, and AAWE's mandate of aiding the dissemination of these findings, is more important than ever, particularly in our changing climate. We need to continue to adapt as an organization in order to meet these challenges, and I am certain that the incoming team will be able to do this effectively.

With warm regards,

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