
Exploring Forecast Models for Day of Launch Winds

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Introduction

- Launch vehicles require a Day of Launch (DOL) wind profile to optimize steering in order to reduce ascent loads.
- These wind profiles are obtained from either balloon or Doppler radar systems.
- Due to DOL processes, wind profiles are typically measured several hours before launch, and are meant to represent the wind profile the vehicle flies through.
- Wind profiles change over time. Therefore, there is uncertainty in using profiles several hours old.
- This uncertainty is accounted for through time dependent margins (knockdowns), which will reduce launch availability (the bigger the knockdown, the less availability).
- A potential alternative to measured winds, is to utilize a forecast model wind profile, valid for time of launch (or as close as possible).
- Hope is that the forecast uncertainty will be less than the uncertainty due to several hours of wind change, therefore reducing needed margin and increase availability.



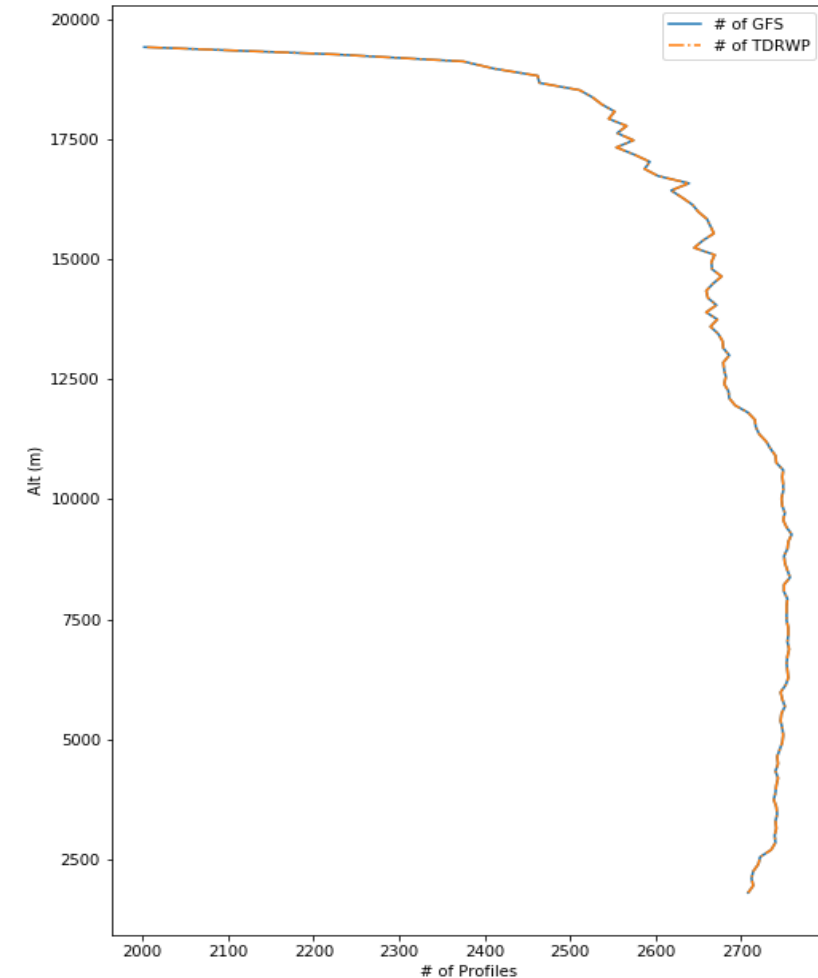
Methodology

- Objective: Compare uncertainties between forecast “accuracy” and 2 hour wind change.
- The Global Forecast System (GFS) bufr files for Cape Canaveral are used for the model data portion of this study. The Tropospheric Doppler Radar Wind Profiler at Kennedy Space Center (KSC) is used for the measured data portion of this study.
- Period of record: June 22, 2016 – December 23, 2018.
- 12 hour GFS forecasts were used as it was found to be the oldest potential forecast that could be used based on the day of launch timeline.
- A TDRWP profile at the theoretical launch time was considered “truth”, and compared against a 2 hour old TDRWP profile and the 12 hour GFS forecast that is interpolated via cubic spline to the TDRWP altitudes.
- Root Mean Square (RMS) values and 3-sigma values are calculated for both cases.



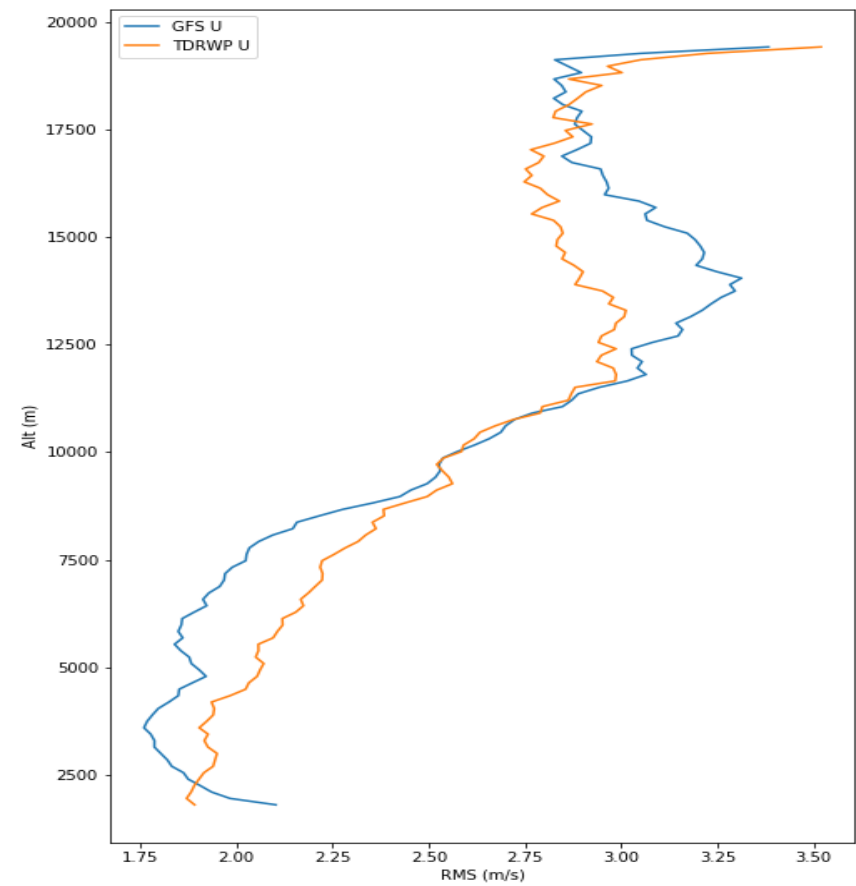
Number of profiles per altitude

- It was possible to have cases where a forecast time period did not have a 2 hour old TDRWP to compare to, so data was restricted to only use points where all data sources were available.
- The TDRWP has a higher percentage of missing data after QC processes at higher altitudes, so the number of data points generally decreases with height.

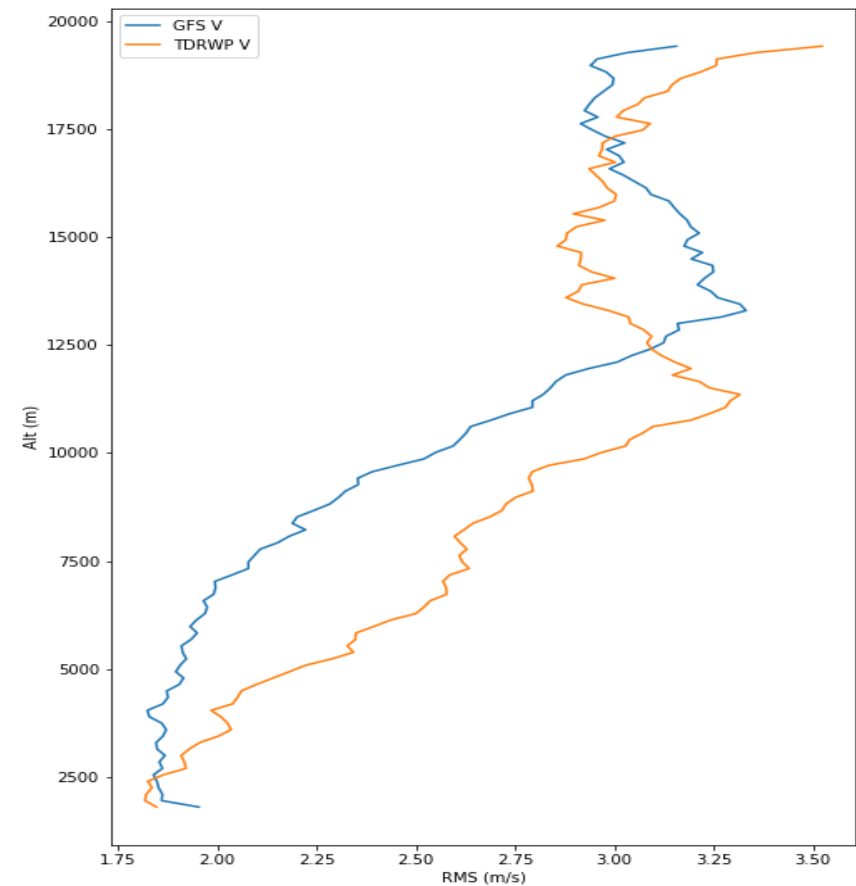


RMS Profiles

U-Wind

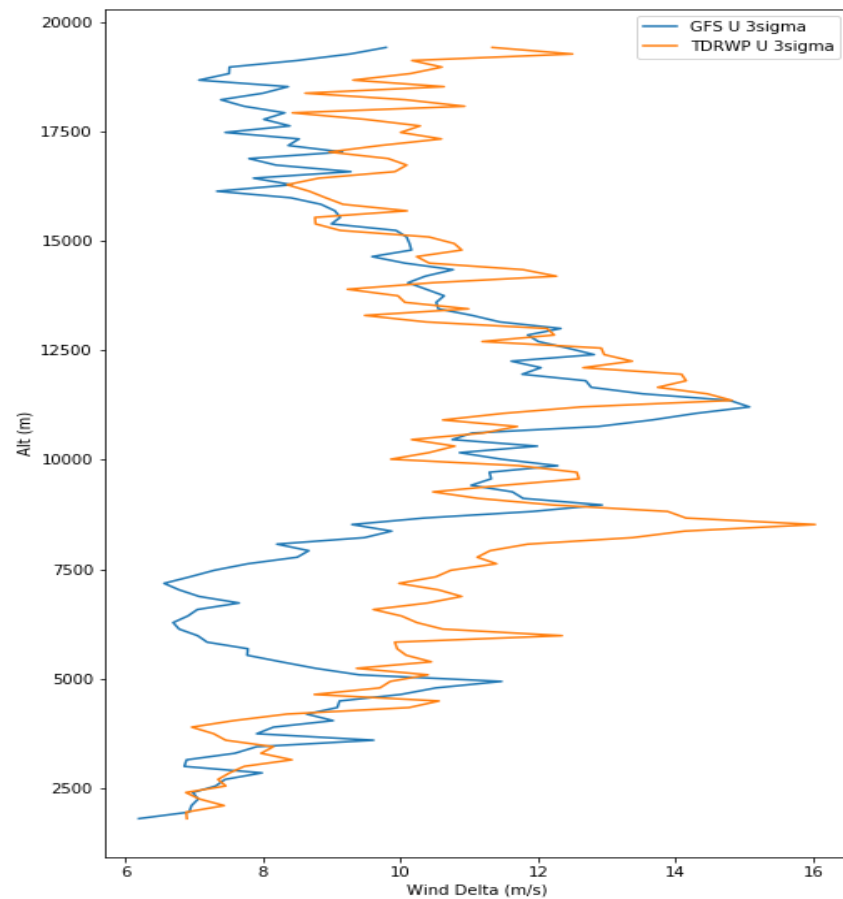


V-Wind

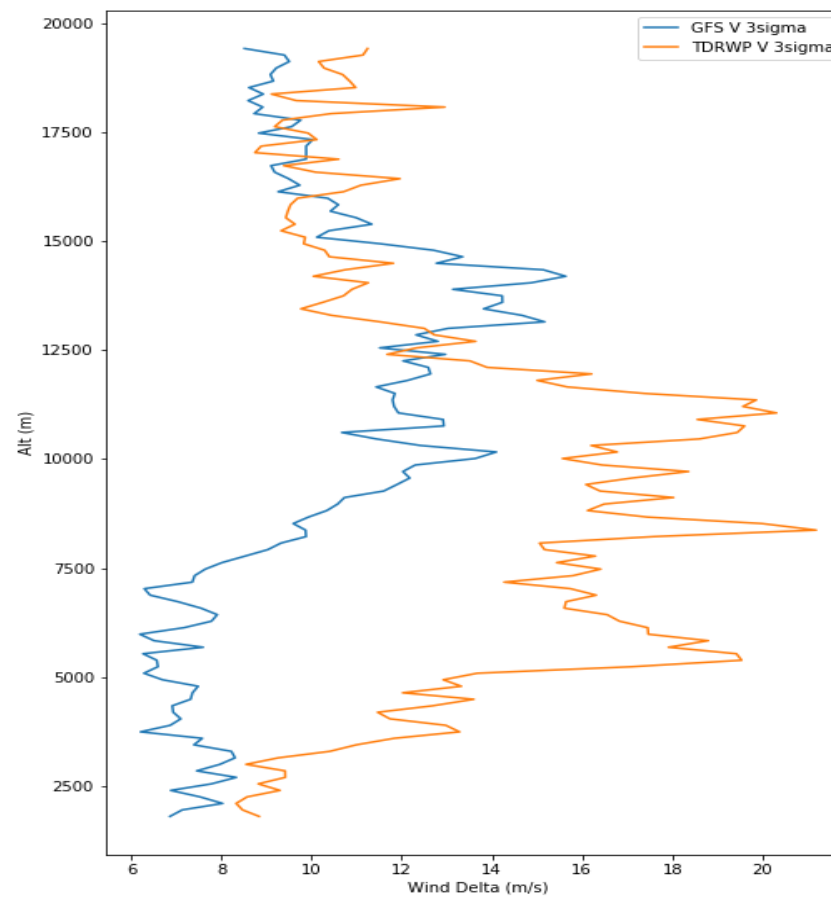


3-Sigma Profiles

U-Wind



V-Wind



Discussion

- Using GFS appears to be more representative, especially below about 12 km.
 - Unknown at this time how much improvement there would be in knockdowns/launch availability.
 - Would need MSFC flight mechanics group to assess sensitivity.
- Are there any other forecast models better suited for this type of assessment?
 - Space Meteorology Group can provide blended/enhanced forecast profiles for DOL, but impossible to assess accuracy statistically.
 - Would also need a large database of forecast profiles in order to develop DOL knockdowns.

