

Including Upper Air Measurements in Operational Weather Observing Networks

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Introduction

The number and quality of atmospheric observations used by numerical weather prediction modellers, meteorologists and forecasters are increasing year after year and yet, the ability to consistently achieve statistically significant increases in forecast skill remains challenging, even for the highest resolution numerical models. While a number of contributing factors involving these challenges have been identified, including the difficulty in accurately establishing initial conditions, improving observations at regional and local scales is required to produce skillful high-resolution numerical weather prediction output (below 2km). This requires observations of local and regional winds, necessitating measurements at higher vertical (rarely available) and horizontal (requiring denser observation networks) resolution. In addition to reducing the uncertainty of weather forecasts, the goal is also to improve the detection and forecasts of severe and extreme weather events (severe thunderstorms, tornadoes and other mesoscale phenomena) that can adversely affect life, property and commerce, especially in densely populated urban regions.

The New York State Mesonet

Following Superstorm Sandy, the state of New York, with funding from the U.S. Federal Emergency Management Agency, under the supervision of the New York State Division of Homeland Security and Emergency Services and operated and maintained by the University at Albany State University of New York, developed its own Mesonet Early Warning Weather Detection System, an advanced, state-wide weather station network. It consists of 126 surface weather stations and 17 enhanced sites dedicated to planetary boundary layer (PBL) and free atmosphere thermodynamic measurements.

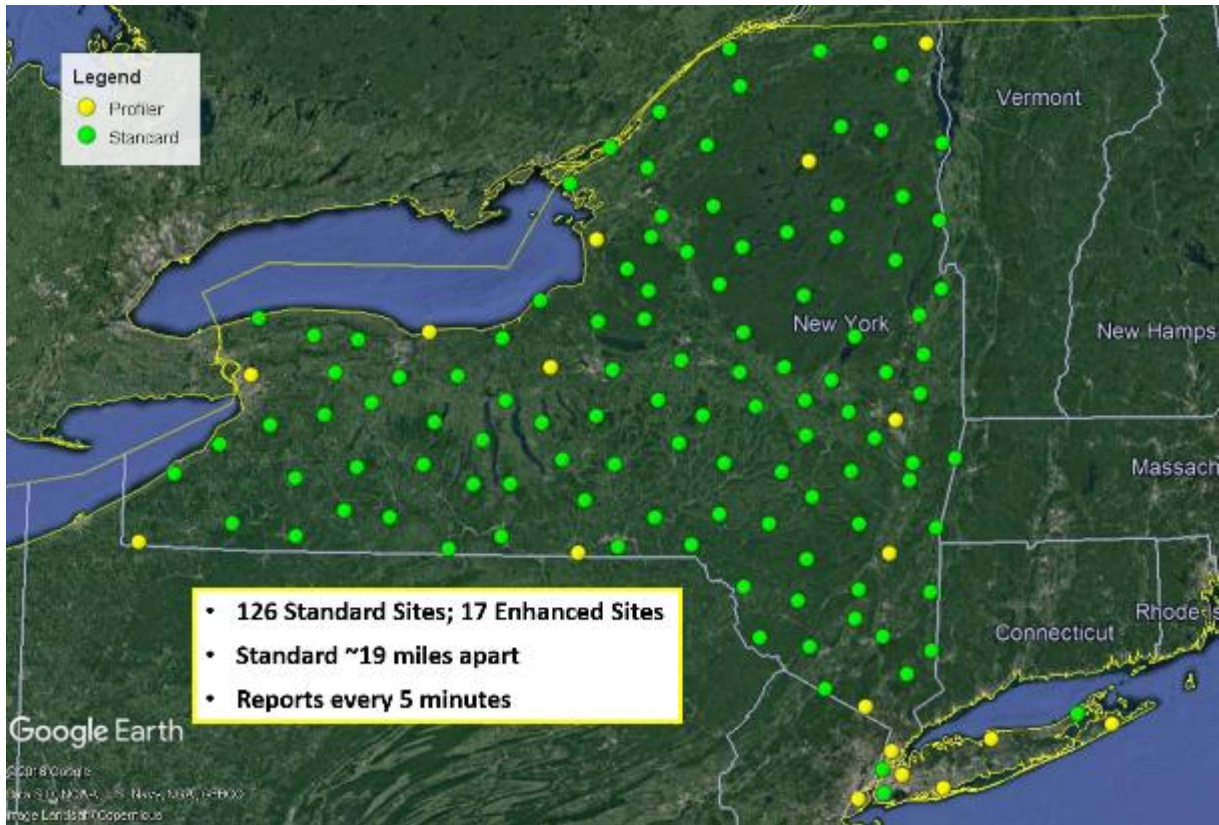


Figure 1: Locations of the stations for surface and upper air measurement of the New York State Mesonet

The enhanced sites are composed of WINDCUBE coherent Doppler Lidars and microwave radiometers providing temperature, relative humidity “3D” winds profiles measurements in the lower troposphere, especially in the boundary layer. Derived atmospheric quantities include PBL height, cloud base height fluxes, and aerosol & cloud optical properties.



Figure 2: Picture of a New York State Mesonet upper air observation station located on the rooftop of the State University of New York in Albany, NY

Configuring Doppler Lidars

All WINDCUBE Lidars are currently measuring in Doppler Beam Swinging (DBS) mode to provide frequent vertical profiles of the horizontal and vertical wind components, the wind direction, Lidar signal as basic parameters, and the heights of the PBL and residual boundary layers and cloud/aerosol layers detections as advanced parameters.

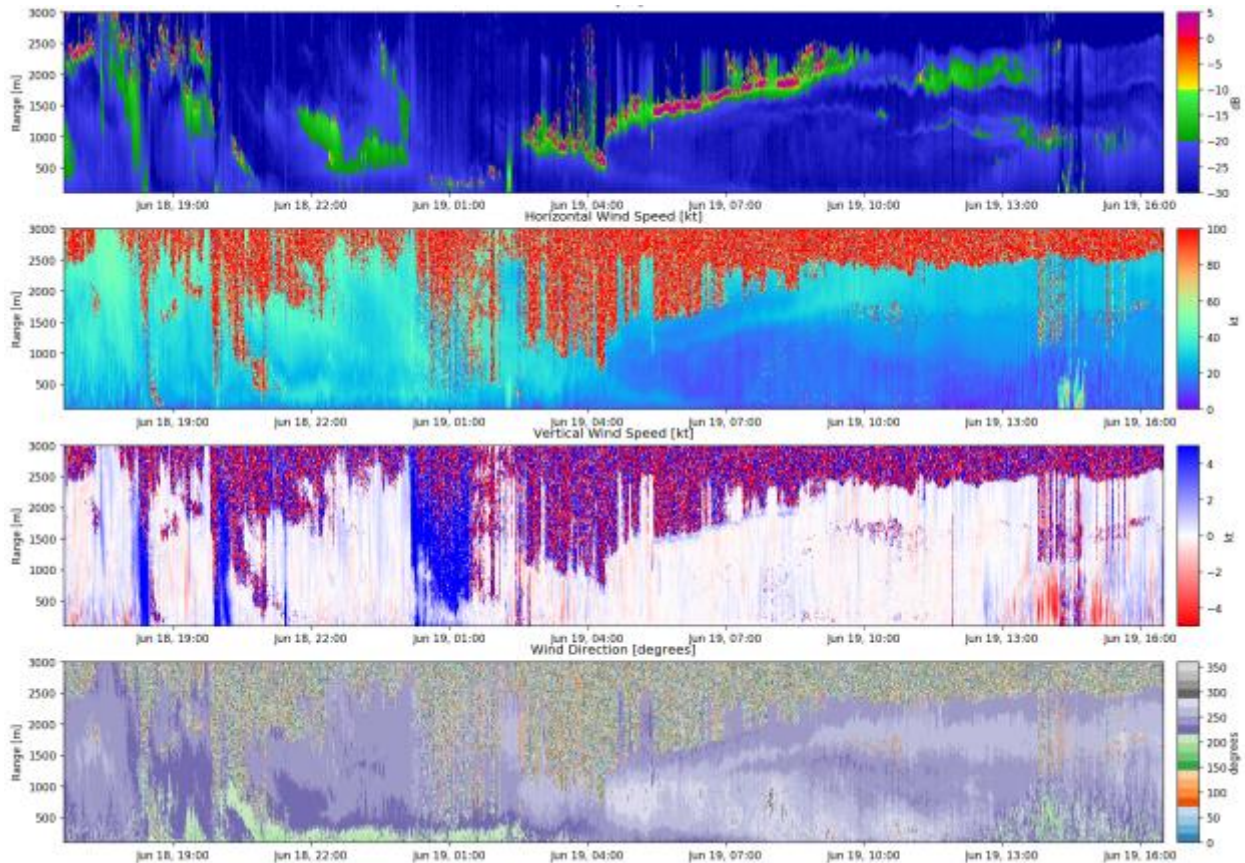


Figure 3: Time series of from Top to Bottom: Lidar signal (CNR), Horizontal wind speed, Vertical wind speed, and wind direction over one day at Buffalo, NY

Figure 3 represents an example over one day of measurements at Buffalo, NY depicting rain showers, many clouds at different altitudes from 500 – 2500m, possible low level jets, strong gusts and convection.

Validation and Intercomparison of measurements

The Configuring Doppler Lidars (CDLs) have been evaluated against radiosondes launched twice daily at the National Weather Service Forecast Office in Albany, NY. Good agreement is obtained for horizontal wind speed and wind direction as shown in Figure 4. They have also been intercompared in terms of wind measurements and data availabilities.

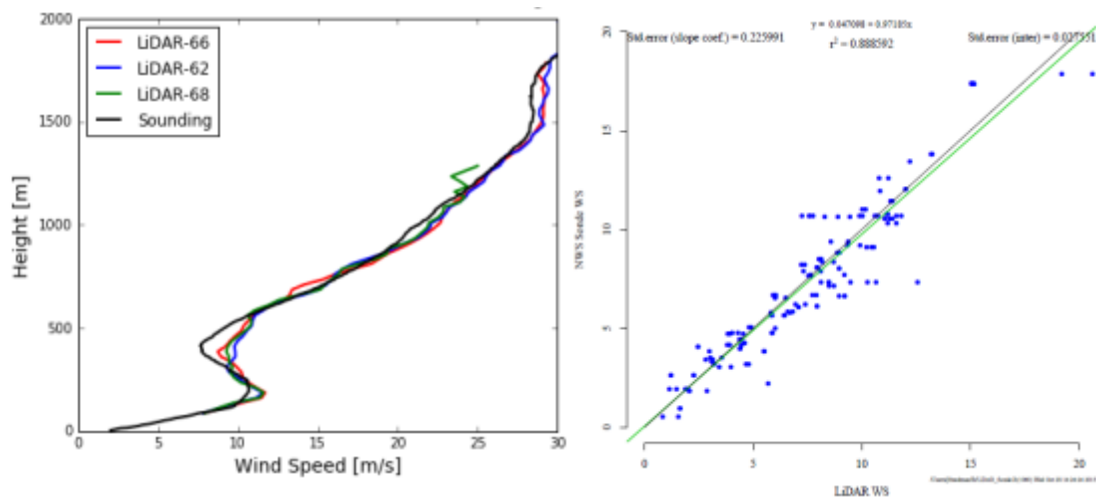


Figure 4: Comparison of a vertical profile of averaged wind speed between three CDLs and radiosondes (left) and the correlation graph (right)

Conclusions & perspectives

The NYS Mesonet is a world premier CDL-based weather network. CDLs bring high-resolved space and time vertical profiles of main atmospheric parameters like wind but also aerosol / cloud layers. These data will allow better understanding of local heterogeneities over NYS (see Figures 2 and 5 for Buffalo site close to great lakes and Suffern, close to NYC). Advanced studies are continuing to evaluate their performances for wind and aerosol/cloud data. Future steps include assimilating NYSM profiling data into NWP models and assessing their impact on forecasting. The NYS Mesonet represents a pilot project for demonstrating the benefits of deploying advanced remote sensors in operational observing networks.

References

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