

Nowcasting Wind Hazards for Renewable Power Plants Protection with a Doppler Wind LiDAR

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Introduction

Sudden changes in wind speed can adversely affect the operation of renewable energy power plants. For example, hi-tech solar tracking mirrors (heliostats), which are designed to operate within a certain wind speed range, can suffer catastrophic damage if they are not protected from hazardous winds. The Vaisala WindCube Scan's ability to measure the incoming wind up to 10/15 kilometers away, combined with real time wind hazard detection algorithms, allows threats to be detected 5 to 15 minutes in advance and enables plant operators to take protective action.

Methodology

- The horizontal wind field is reconstructed with the **Volume Wind algorithm**. Volume wind is based on the Velocity Volume Processing (VVP) technique widely used in weather radars.
- Contiguous regions of hazardous wind speed values are identified from the reconstructed horizontal wind field.
- Regions are associated and tracked in time to provide advance warnings.

Results

- Hazardous gusts can be identified** from the horizontal wind field reconstructed from LiDAR measurements **and tracked** in time to provide advance warnings.
- The horizontal wind speeds are also retrievable along the zero radial velocity line with the volume wind algorithm.

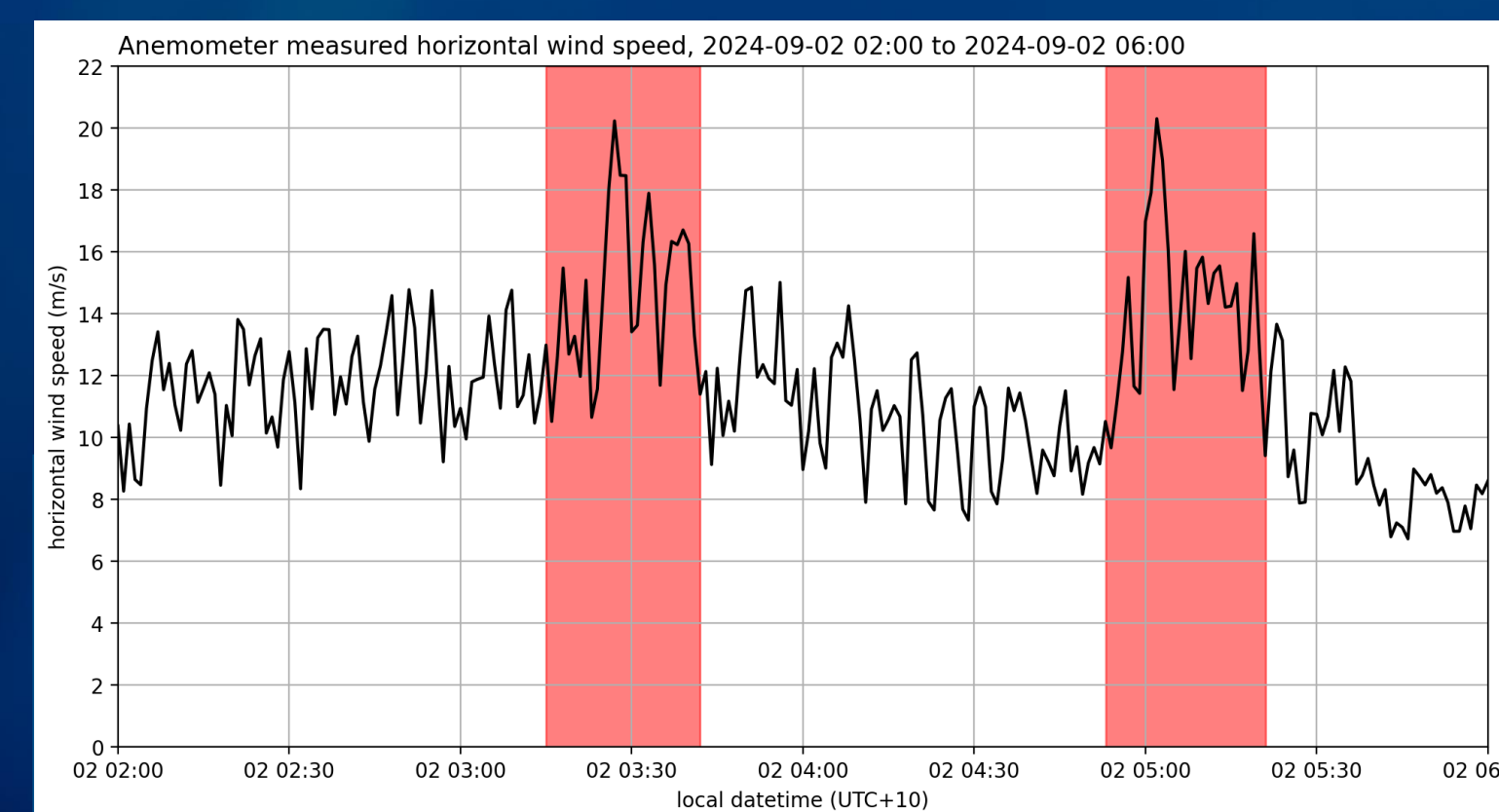
Case study: Advance Warning of Cold Front at RayGen Hi-Tech Solar and Thermal Storage Plant



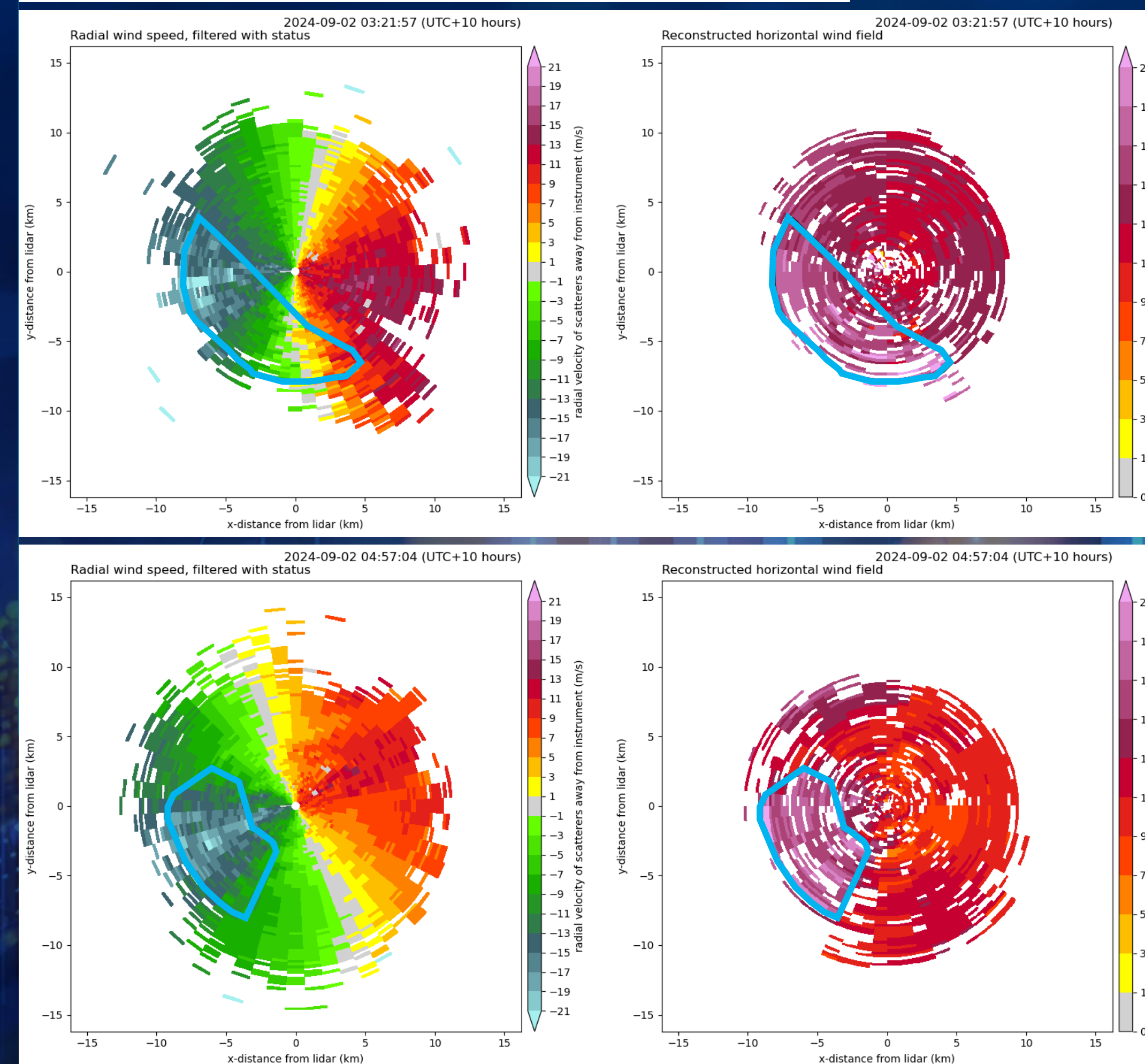
Cold front, September 2nd, 2024

- Cold front approaches power plant from the south-west. Sudden, significant increase in the horizontal wind speed.**
- The approaching gusts are detectable well in advance** from the horizontal wind field reconstructed from LiDAR observations. **Minimum achievable advance warning time** for these events was **6- and 8-minutes**, respectively.

- The nowcasting capability of the WindCube Scan is being validated at the RayGen power plant in Carwarp, Australia.
- Sunlight is focused with fields of tracking mirrors (heliostats) onto central photovoltaic receivers and converted into electricity and heat.
- It can take several minutes for the heliostats to adjust to a safe horizontal position, known as stowing.
- Stowing should be done while the wind load on the drive motor is still within its operating limits which makes accurate wind alerting crucial for timely action.
- The key benefits RayGen is looking to realise using LiDAR technology is mitigating risk of damage to heliostats, minimising design costs and maximising plant yield.



(Top) Horizontal wind speed measured by an anemometer on-site, gusts highlighted in red. (Center) Cold front identified from LiDAR data. (Bottom) Second gust identified from LiDAR data.



RESOURCE & TECH



Vaisala WindCube Scan

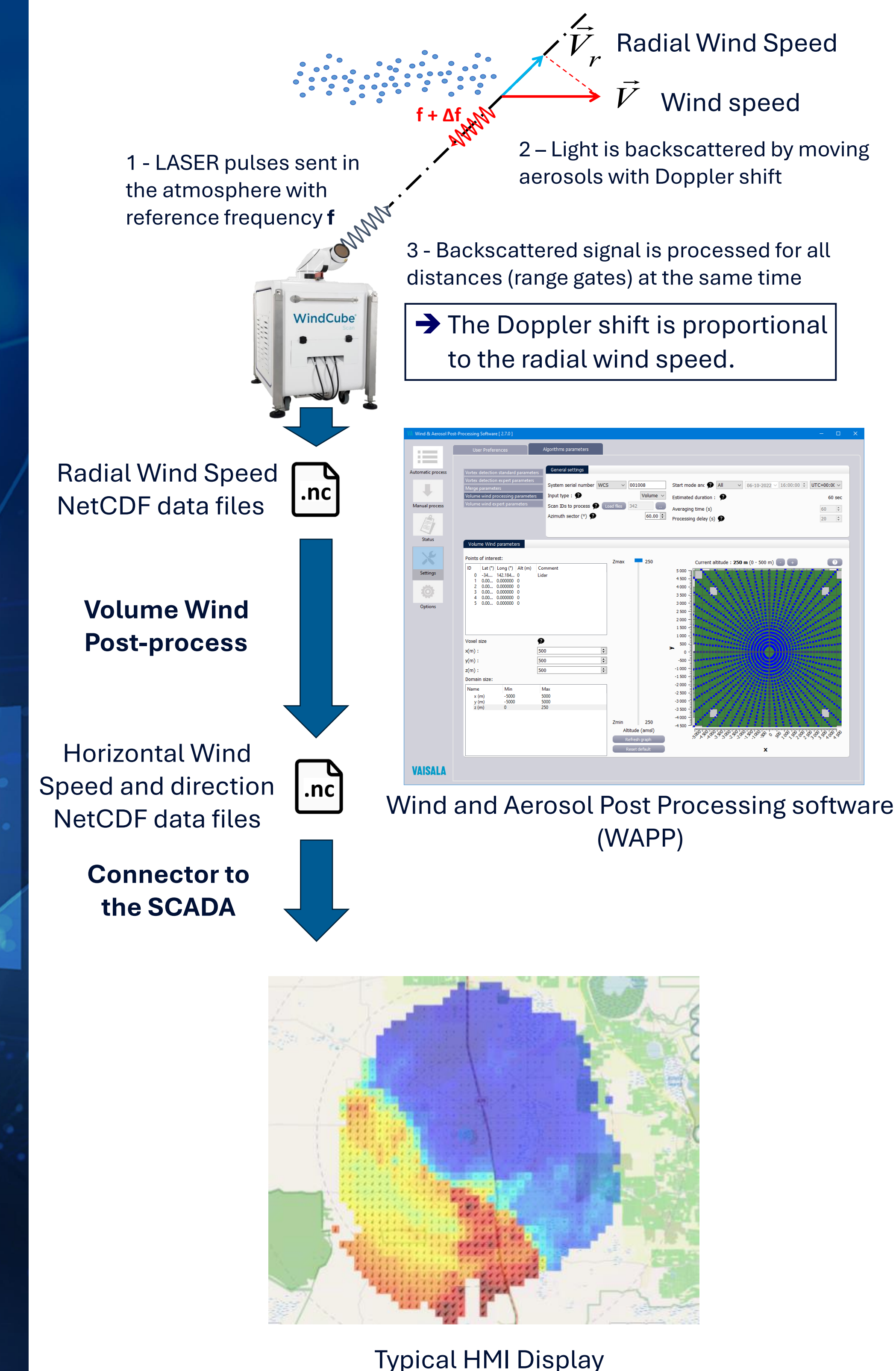


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Vaisala WindCube 400S looking over and around the RayGen power plant in Carwarp, Victoria, Australia.

LiDAR data flow



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