Potential ABL wind measurements and derived parameters from a space-based coherent Doppler Wind Lidar

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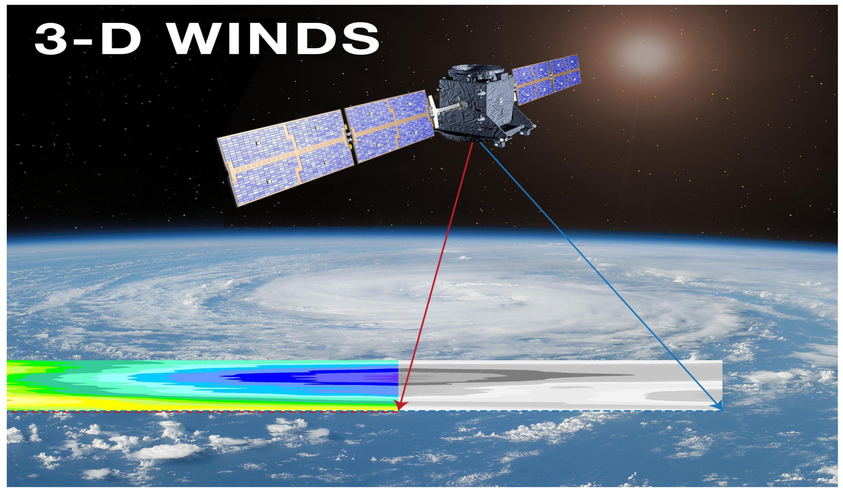


DWL Space Pathfinder Mission for ABL Measurements

- The focus upon the atmospheric boundary layer is consistent with National Academy of Sciences Boundary Layer Workshop (10/17) and the 2018 Decadal Survey recommendations. The **Mid and upper troposphere are still well represented with such a pathfinder mission.**
- Pathfinder science mission is designed to explore the lower troposphere using various sampling and data processing strategies suitable for **NASA's atmospheric processes research** and a possible follow-on operational NWP mission leveraging synergisms with AMV and OVW observation systems
- Science returns from a space-based coherent lidar will greatly benefit from a "look ahead" capability for optimizing lower troposphere/PBL access through cloud gaps. **Based upon CALIPSO data, >80% of lidar shots encounter clouds globally Recent DWL simulations suggest 60 – 70% of lidar shots could obtain returns from the PBL with optical dither scanning.**

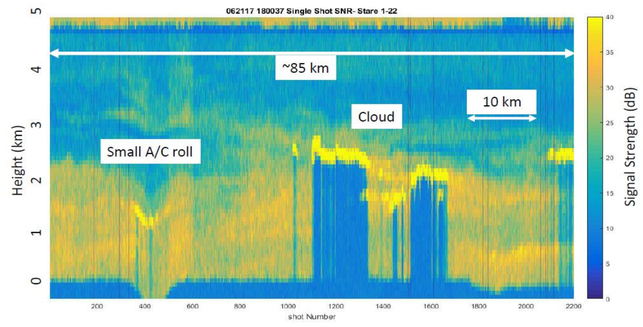
ABL Properties Observable from Space

- Profiles of the horizontal wind vector using two perspectives
  – **Maximum vertical resolution ~ 33m in high backscatter situations**
  – **Nominal horizontal resolution ~500m in high backscatter situations**
- Depth of the ABL defined by backscatter gradients
  – Vertical resolution using sliding gates ~ 10-25m for well defined ABL tops
- Shear within the ABL
  – Presence of LLJs which have a significant impact on estimating air/sea exchanges
- Presence of rolls within the ABL
  –Allows for selection of appropriate parametrization of the ABL fluxes
- Depth of sea spray layer and presence of foam
  – Large impact on air/sea fluxes; spray enhances fluxes while foam reduces fluxes

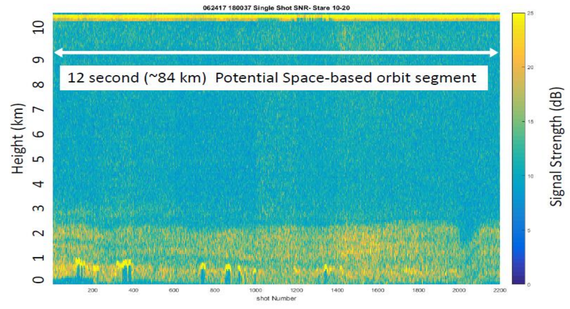
Coverage and Precision Issues

- Spatial coverage, especially cross track, is viewed by some as a major constraint for a space-based coherent DWL
  – Along track resolution potential is better than Aeolus, CALIPSO, ICESat-2 or any other space-based instrument currently in orbit
  – Cross track coverage (with no optical dither scanning) is same as Aeolus, CALIPSO and ICESat-2.
  – DWL cross track impacts could be leveraged from synergistic operations with passive sounders and scatterometers.
- Vertical resolution in the ABL air column unrivaled by any instrument in space or scheduled for launch

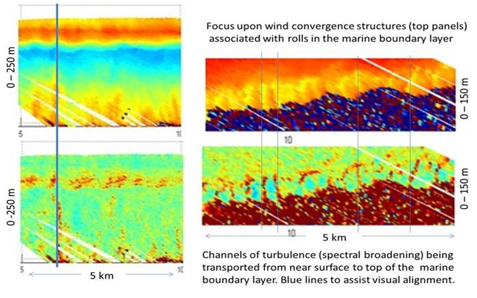
Single Shot Returns from Airborne DAWN (CPEX 2017) (~20m between shots; ~ 60m vertical resolution)



Example of Airborne DAWN mapping the ABL

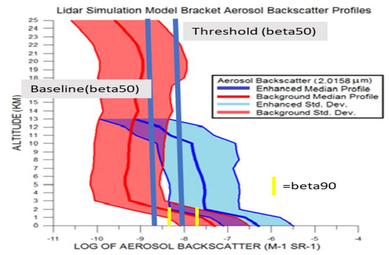


Turbulence Derived Spectral Broadening



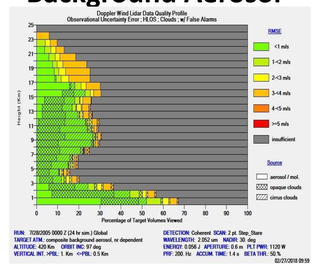
As evidenced by the airborne DAWN lidar system, the presence and intensity of turbulence could be valuable to global model energy and momentum flux parameterizations.

Aerosol Backscatter Used for Global Simulations

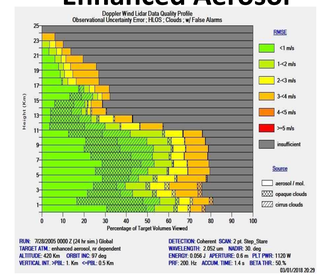


Simulated Global Vertical Tropospheric Coverage for Coherent Space-based DWL

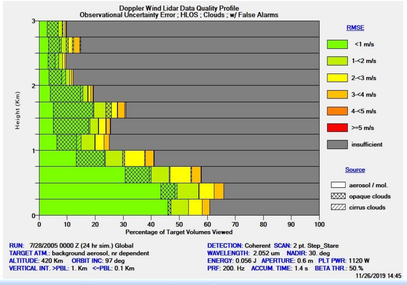
Background Aerosol



Enhanced Aerosol



Simulated Global Vertical ABL Coverage



Future Work

Perform simulations of coherent space-based lidars to predict accomplishment of the following **science and technology maturation objectives**:

- Investigate inter-hemispherical transports via LLJs and within tropical convergence zones (ITCZ)
- Develop improved parameterization schemes for ABL depths and growth rates for use in global models
- Investigate dynamic impacts such as speed/directional shear on the global trans-oceanic transport of pollution.
- Validate global attenuated backscatter distributions used to design coherent space-based lidars and establish coverage expectations, especially over oceans
- **Develop techniques for taking advantage of synergisms between the DWL and scatterometers (ASCAT), AMVs and other wind observing systems**