Wildfire and Boundary Layer Dynamics Using Micropulsed Doppler Lidar

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Micropulsed Doppler Lidar

- Micropulsed Doppler lidar utilizes high-frequency laser pulses, which are scattered by aerosols in the atmosphere
- The velocity of the scattering aerosols imparts a Doppler shift on the backscattered light which is quantified using heterodyne detection
- Based on the delay of the received signal combined with the detected frequency shift, Doppler lidar systems can characterize the spatially resolved wind fields

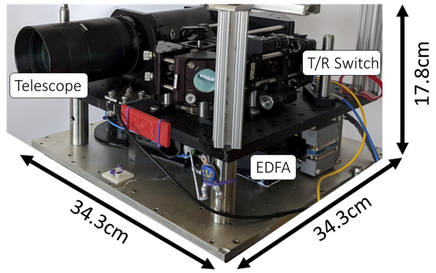
ARS Mobile Lidar System (MD2)

System consists of small robust optical head for transmitting and receiving lidar signal and separate instrument rack which houses electro-optics and data acquisition hardware.

- The two module configuration facilitates motion stabilization of optical head during field deployments
- Compact and robust design allows for lidar head to be mounted in space prohibitive platforms
- Measurements include:
  - Vertical wind velocity
  - Horizontal wind velocity
  - Aerosol backscatter intensity

Pulse Width	25-90 m
Beam Rate	10 Hz
Pulse Rate	20 kHz
Wavelength	1.5 μm
Range	up to 7.2 km

Inside MD2 Lidar Head



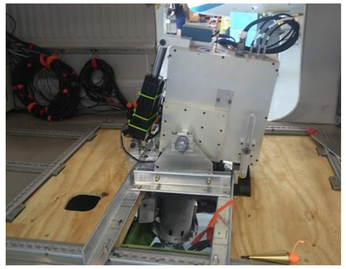
Mobile Platforms and Applications

By installing the ARS Mobile Lidar System (MD2) on mobile platforms, we are able to capture the spatial and temporal dynamics of large scale, complex flows. Beam scanning capability is added to measure three components of velocity. Motion stabilization is used to compensate for platform motion during vertical stares to reduce measurement contamination from pointing errors.

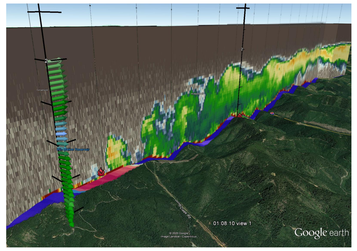
NOAA Twin-Otter DCH-6

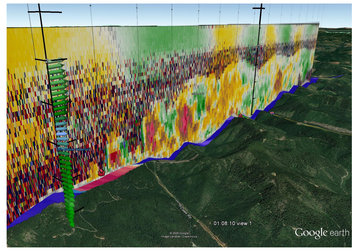
MD2 was deployed on the NOAA Twin Otter to characterize the dynamics and transport from wildfires and controlled burns for the FIREWINDS and FIREX field campaigns

- A wedge scanner was used to scan the beam 15° off nadir to characterize horizontal velocities
- A linear actuator stabilized the pitch axis of the lidar during vertical stares



Left) MD2 mounted in the instrument bay of the NOAA Twin Otter during FIREX deployment.
Right) NOAA Twin Otter



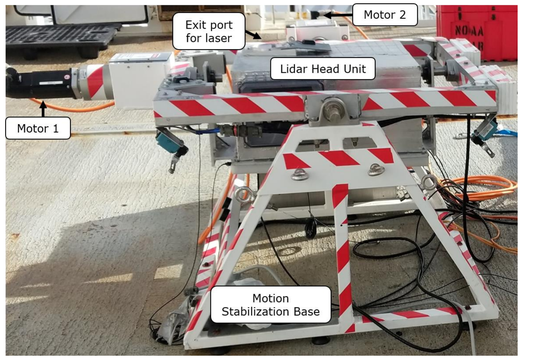


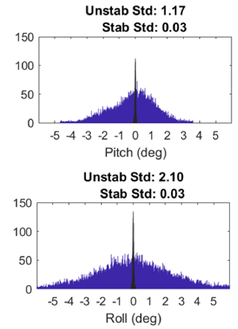
MD2 measurements from a burn during the 2019 FIREX-AQ campaign. Colored strip at ground indicates ground temperature, red areas and flame symbols indicate locations of fires. Horizontal wind velocities and directions are shown on the left of each figure.
Left) Distribution of aerosols emitted from the burn. Warmer color indicate a higher aerosol loading.
Right) Vertical velocity field above burns, warmer colors indicate updrafts, while cool colors are downdrafts.

Motion Stabilization Platform

MD2 mounted on the motion stabilized platform was deployed on the Ron Brown Research Vessel for the Atlantic Tradewind Ocean–Atmosphere Mesoscale Interaction Campaign (ATOMIC) in early 2020. The system is currently mounted on the CSL Ford F-350.

- Platform compensates for platform motion in two axes
- Improves pointing accuracy by approximately 50x
- Enables scanning up to 30 degrees of nadir for horizontal wind retrievals





Left) View from lidar head unit with and without motion compensation during ATOMIC cruise, video by Richard Marchbanks
Right) Pitch and roll of the system with stabilization (black) and without (blue)