Boundary Layer Observations at Mauna Loa Observatory, Hawaii

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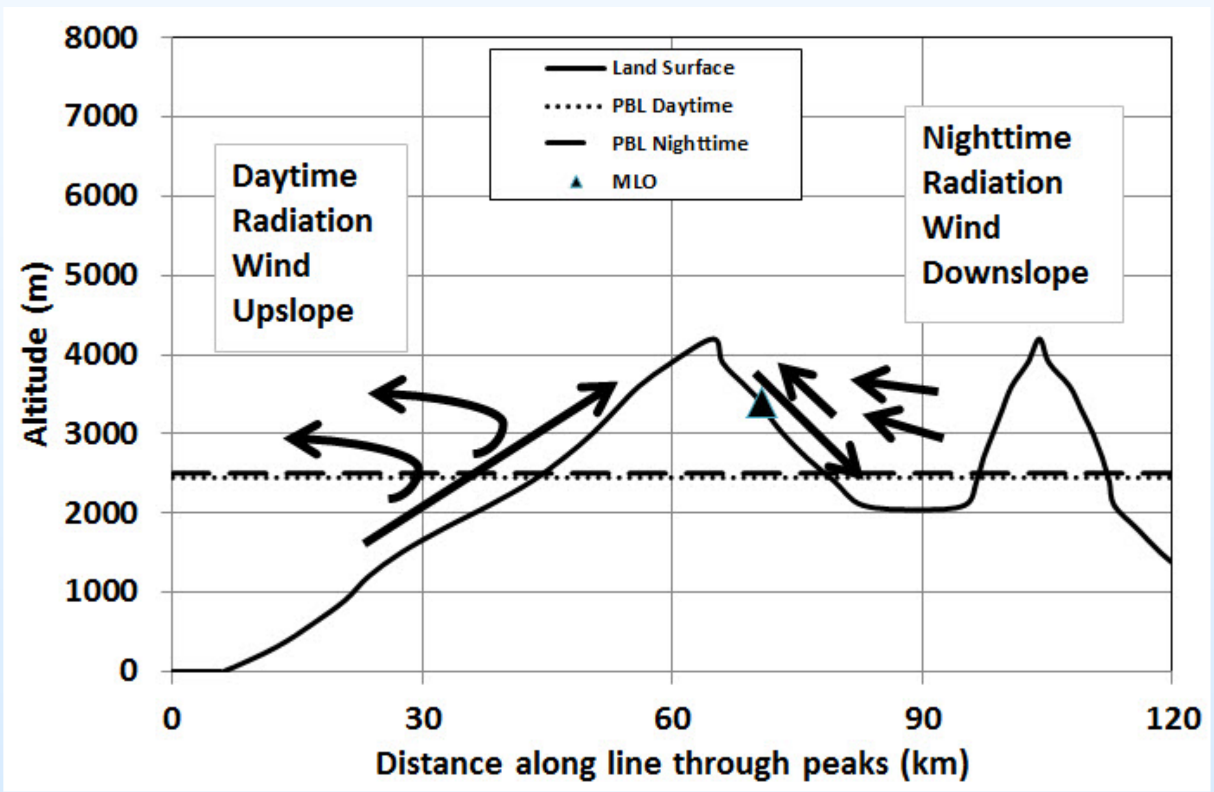
Mauna Loa Observatory (MLO)

MLO is located on the North side of the Mauna Loa volcano (4169 m) at 3396 m. Normally above the Planetary Boundary Layer, the station monitors greenhouses gases, aerosols, ozone and ozone depleting compounds, and solar radiation.

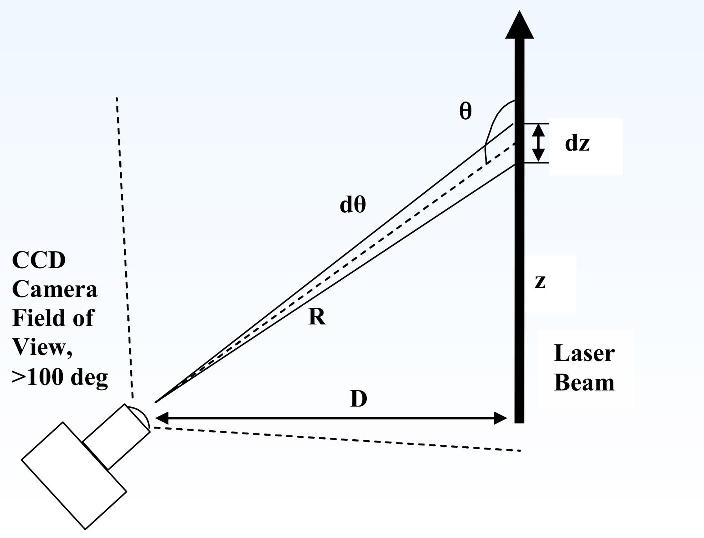
Radiation Wind

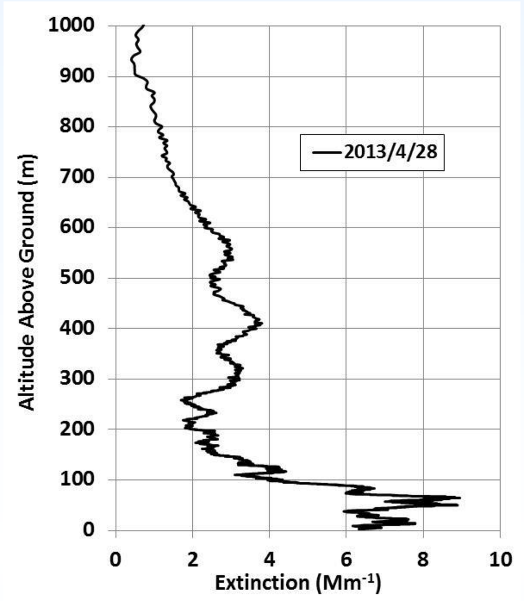
The dark black and brown lava warms during the daytime and creates an upslope wind of 2.5-3.0 m/s. At nighttime the reverse happens creating a downslope wind as the lava cools. The off-island wind interacts with the radiation wind depending on its direction and strength.



CLidar (Camera Lidar)

CLidar measures nighttime aerosol profiles by using a fisheye lens to image a vertically-pointed laser onto a CCD camera. The image is then analyzed to get the brightness of the beam at each pixel, and then normalized to clear air in a way similar to Lidar.

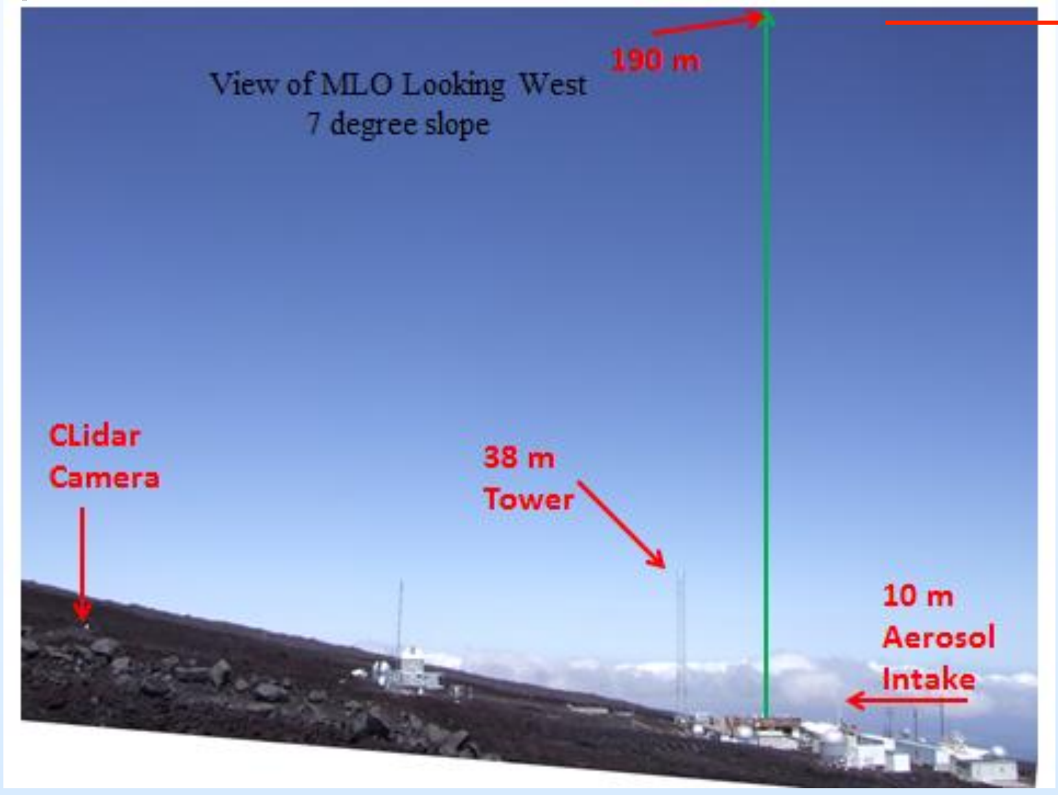




There is no overlap function as in lidar, and altitude resolution near the ground is sub-meter as shown in the plot above. Below, the layout at MLO is shown.

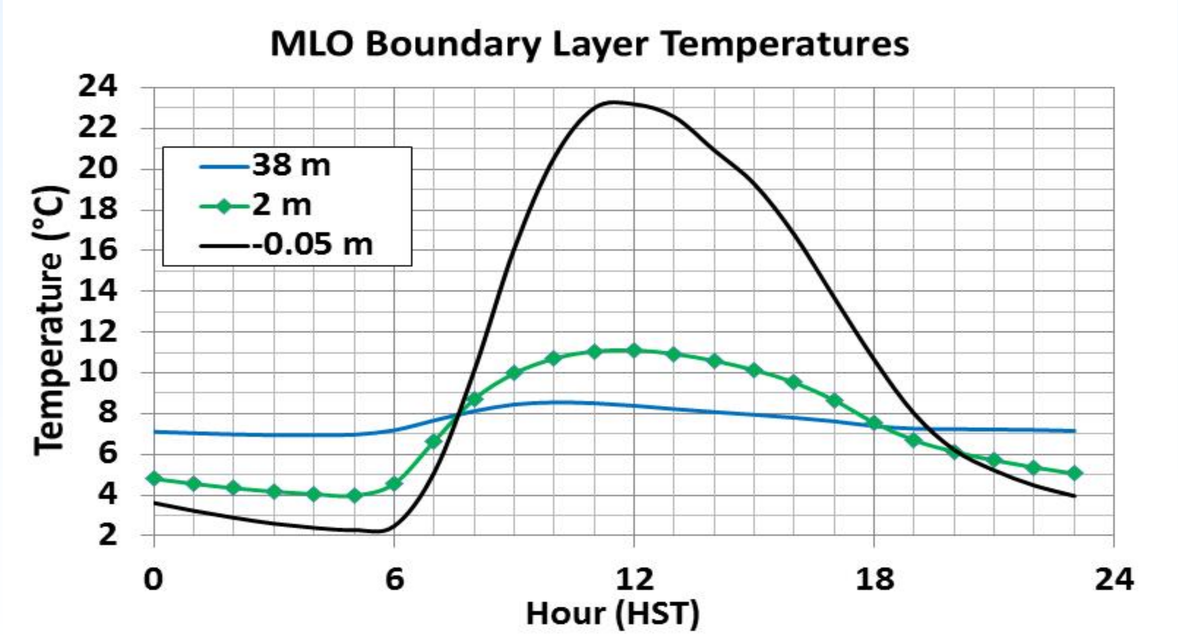
Barnes, John E., S. Bronner, Robert Beck, and N. C. Parikh, 2003: Boundary Layer Scattering Measurements with a Charge-Coupled Device Camera Lidar, *Applied Optics*, **42**, no. 15, 2647-2652.

Barnes, John E., N.C. Parikh Sharma and Trevor Kaplan, Atmospheric aerosol profiling with a bistatic imaging lidar system, 2007: *Applied Optics*, **46**, no. 15, 2922-2929.

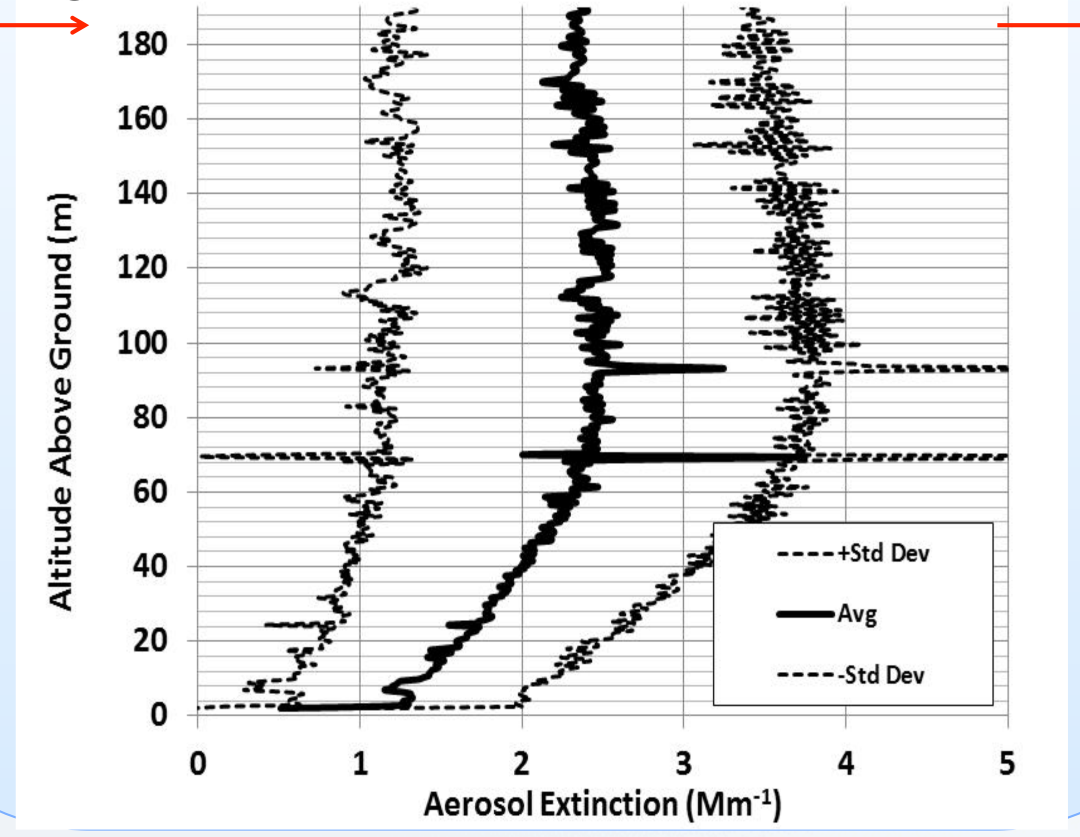


MLO Boundary Layer

Shown below are average temperatures for 38 m, 2 m, -0.05 m (slightly below the surface of the lava). Little change is seen at 38 m from day to night. The cooling of the lava after sunset creates a nighttime temperature inversion.



The plot below is an average of 8 nights of CLidar aerosol profiles and shows the increase from the surface to 100 m. The increase is verified with in-situ tower measurements. The aerosol reaches background levels around 600 m.



Source of Sampled Air

Daytime upslope air may be influenced by local features such as lower altitude rain forests and the active Kilauea volcano. Nighttime air comes mainly from the free troposphere, as shown by very low aerosol levels and global background levels of trace gases such as CO_2. But the increasing aerosol in the downslope air indicates a possible local source under certain conditions.

Nighttime Counter-Flow

Shown below is the transition from downslope to upslope at 70 m measured with a GPS radiosonde launched from MLO. The transition isn't always this clear, a better wind profiling system is needed, but the nighttime upslope wind provides a mechanism to bring local air to MLO.