UW-HSRL PISTON 2019 - Release 1

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Description of the data

The directory contains the first release of the vertical pointing UW-HSRL data during the 2019 ONR PISTON deployment. The netCDF4 files are in the directory `netcdf4`, and the corresponding quicklook imagery of the geophysical variables is in the `quicklooks` directory.

Retrievals of the extinction cross-section and lidar ratio were done using the Poisson Total Variation (PTV) method (Marais et al., 2016) in order to provide high vertical (30 meter) and horizontal (4 minutes) resolution measurements.

Every effort has been made to ensure high quality extinction cross-section and lidar ratio measurements. The UW-HSRL during PISTON, however, has a calibration parameter that is not uniquely identifiable which is called the geometeric overlap function (GOF) (Eloranta, 2014). The UW-HSRL reduces the solar background radiation noise by having a narrow field of view (FOV) which is achieved by having a focal point at approximately 5.5km altitude. As a result, the HSRL instrument is out of focus below 5.5km and the GOF models the loss of detectable energy due to the small FOV. Consequantly, inaccuaries in the GOF calibration parameter induces sysmatic biases in some of the extinction cross-section and lidar ratio measurements. The following dates and time intervals are where it is suspected that the extinction cross-section and lidar ratio have apparent sysmatic biases:

- 2019-09-09 between 15:00 - 16:00, 17:00 - 18:00 and after 23:00.
- 2019-09-11 between 12:00 - 15:00, 17:50 - 18:30, 20:30 - 21:00, 21:15 - 22:40 and 23:15 - 23:30.
- 2019-09-12 between 00:00 - 06:00, and 22:30 - 23:59.
- 2019-09-14 between 06:00 - 18:00.
- 2019-08-17 between 01:00 - 01:35.
- 2019-08-18 after 03:00.
- 2019-08-19 after 14:00.
- 2019-08-21 between 11:30 - 14:00 and near 19:00.

NetCDF4 format

```
dimensions:
```

```
    range = 260 ;
    time = 54 ;
variables:
    double backscatter(range, time) ;
        backscatter:_FillValue = NaN ;
        backscatter:long_name = "backscatter cross-section" ;
        backscatter:units = "1/m 1/sr" ;
        backscatter:coordinates = "altitude" ;
    double extinction(range, time) ;
        extinction:_FillValue = NaN ;
        extinction:long_name = "extinction cross-section" ;
        extinction:units = "1/m" ;
        extinction:coordinates = "altitude" ;
    double lidar_ratio(range, time) ;
        lidar_ratio:_FillValue = NaN ;
        lidar_ratio:long_name = "lidar ratio" ;
        lidar_ratio:units = "sr" ;
        lidar_ratio:coordinates = "altitude" ;
    double optical_depth(range, time) ;
        optical_depth:_FillValue = NaN ;
        optical_depth:long_name = "optical depth" ;
        optical_depth:units = "null" ;
        optical_depth:coordinates = "altitude" ;
    double depolarization_ratio(range, time) ;
        depolarization_ratio:_FillValue = NaN ;
        depolarization_ratio:long_name = "depolarization ratio" ;
        depolarization_ratio:units = "null" ;
        depolarization_ratio:coordinates = "altitude" ;
    double nfov_gof(range, time) ;
        nfov_gof:_FillValue = NaN ;
        nfov_gof:long_name = "Wide field of view geometric overlap function" ;
        nfov_gof:units = "null" ;
        nfov_gof:coordinates = "altitude" ;
    double telescope_scan_angle(time) ;
        telescope_scan_angle:_FillValue = NaN ;
        telescope_scan_angle:long_name = "Telescope scan angle" ;
        telescope_scan_angle:units = "degrees" ;
        telescope_scan_angle:description = "The angle at which the lidar telescope was
point at" ;
    double lidar_altitude(time) ;
        lidar_altitude:_FillValue = NaN ;
        lidar_altitude:long_name = "Lidar instrument altitude above mean sea level" ;
        lidar_altitude:units = "m" ;
    double range(range) ;
        range:_FillValue = NaN ;
        range:long_name = "range" ;
        range:units = "m" ;
        range:description = "Distance between lidar instrument and atmospheric volume
at an acute angle" ;
    double altitude(range, time) ;
        altitude:_FillValue = NaN ;
```

```
        altitude:long_name = "altitude" ;
        altitude:units = "m" ;
        altitude:description = "Altitude above mean sea level" ;
    int64 time(time) ;
        time:long_name = "time" ;
        time:description = "UTC" ;
        time:units = "minutes since 2019-09-23T00:16:00.373000" ;
        time:calendar = "proleptic_gregorian" ;

// global attributes:
        :version = 1LL ;
        :date = "2021-02-16 21:25:14.501922" ;
        :vertical_resolution = 30LL ;
        :horizontal_resolution = 240LL ;

group: mask {
  dimensions:
    range = 260 ;
    time = 54 ;
  variables:
    double altitude(range, time) ;
        altitude:_FillValue = NaN ;
        altitude:long_name = "altitude" ;
        altitude:units = "m" ;
        altitude:description = "Altitude above mean sea level" ;
    int64 time(time) ;
        time:long_name = "time" ;
        time:description = "UTC" ;
        time:units = "minutes since 2019-09-23T00:16:00.373000" ;
        time:calendar = "proleptic_gregorian" ;
    double range(range) ;
        range:_FillValue = NaN ;
        range:long_name = "range" ;
        range:units = "m" ;
        range:description = "Distance between lidar instrument and atmospheric volume
at an acute angle" ;
    ubyte water_cld_mask(range, time) ;
        water_cld_mask:long_name = "Water cloud mask" ;
        water_cld_mask:description = "1 indicates invalid, 0 indicates valid" ;
        water_cld_mask:coordinates = "altitude" ;
    ubyte ice_cld_mask(range, time) ;
        ice_cld_mask:long_name = "Ice cloud mask" ;
        ice_cld_mask:description = "1 indicates invalid, 0 indicates valid" ;
        ice_cld_mask:coordinates = "altitude" ;
    ubyte melting_ice_cld_mask(range, time) ;
        melting_ice_cld_mask:long_name = "Melting ice cloud mask" ;
        melting_ice_cld_mask:description = "1 indicates invalid, 0 indicates valid" ;
        melting_ice_cld_mask:coordinates = "altitude" ;
    ubyte precip_mask(range, time) ;
        precip_mask:long_name = "Precipitation mask" ;
        precip_mask:description = "1 indicates invalid, 0 indicates valid" ;
```

```
        precip_mask:coordinates = "altitude" ;
    ubyte nfov_snr_mask(range, time) ;
        nfov_snr_mask:long_name = "Narrov field of view (NFOV) Signal to Noise Ratio
(SNR) mask" ;
        nfov_snr_mask:description = "1 indicates invalid, 0 indicates valid" ;
        nfov_snr_mask:coordinates = "altitude" ;
  } // group mask
}
```

References

- Eloranta, Edwin. "High spectral resolution lidar measurements of atmospheric extinction: progress and challenges." In 2014 IEEE Aerospace Conference, pp. 1-6. IEEE, 2014.
- Marais, Willem J., Robert E. Holz, Yu Hen Hu, Ralph E. Kuehn, Edwin E. Eloranta, and Rebecca M. Willett. "Approach to simultaneously denoise and invert backscatter and extinction from photon-limited atmospheric lidar observations." Applied optics 55, no. 29 (2016): 8316-8334.