Recent Improvements to CALIOP Level 3 Aerosol Profile Product for Global 3-D Aerosol Extinction Characterization

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Overview of the Level 3 Aerosol Profile Product

- **Product Release Dates:**
  - Version 3: September 2015
  - Version 1 Beta: December 2011

- **Input Data:**
  - CALIOP Level 2, Version 3.x

- **Aerosol extinction profiles & aerosol optical depth**
  - Monthly-averaged
  - Equal-angle gridded
  - Near-global coverage (82°S to 82°N) below 12 km
  - Derived from CALIOP level 2 aerosol extinction

- **Resolution:**
  - 2° latitude x 5° longitude x 60 m vertical

Motivation for Improvements

- In the Version 1 Beta release of the Level 3 Aerosol Product:
  - Sky conditions are confusing and misrepresentive
  - Due to Level 3 averaging, Column AOD Mean is biased low
  - Dust-only averages are biased high (Amiridis et al., 2013)
  - Artifacts exist in extinction profiles near surface

The Version 3 release improves these aspects of the product.

New Sky Conditions

- **All-Sky**
  - Provides view of entire column
  - All profiles averaged, regardless of cloud cover.

- **Cloud-Free**
  - Only profiles with transparent clouds averaged.
  - Inaccessible to passive observations or aerosol types coexist in passive retrievals.

- **Cloudy, Transparent**
  - Only profiles with transparent clouds averaged.
  - Inaccessible to passive observations.

- **Cloudy, Opaque**
  - Only profiles with opaque clouds averaged.
  - Inaccessible to passive observations. Useful for aerosol above cloud shadows.

"Sky condition" defines cloud cover in aerosol extinction profiles that are averaged together. Above, aerosol extinction profiles in white are excluded for the given sky condition.

Improved Profiles Near Surface

- **Undetected Surface-Attached Aerosol**
  - Level 2 Vertical Feature Mask over Pacific Ocean

Negative Signal Anomaly Mitigation

- **Anomalously negative extinction at surface**
  - **Level 2 AOD Extinction**
  - **Level 3 AOD Extinction**

Occasional anomalously negative backscatter on surface can cause very negative or low-biased extinction in lowest range bin.

**Ver. 3 Mitigation Strategy:**

1. Ignored (incorrect – Version 1 implementation)
2. Set to 0 km (i.e., for dust-only, assume marine aerosol has $a_{dust} = 0$ km$^{-1}$)

**Version 3 Mitigation Strategy:**

- Occurs in Level 3 AOD extinction when lower in V3 to focus mitigation where needed.

Makes small corrections to Level 3 aerosol extinction profile in lowest 2 km.

Changes in Extinction and AOD Relative to Version 1

- **Global Ocean Aerosol Extinction**
  - 2008-13 night

- **Global Dust Extinction**
  - 2008-13 night

- **V1**
  - Dust AOD and extinction profile

All-species extinction profile changes are confined to lowest 2-3 km. Largest difference in 1-2 bins near surface.

Updated averaging strategy recommended by Amiridis et al. (2013) greatly reduces high bias in V1 dust extinction profiles.

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Data Availability

- Level 3, Version 3 now available for the entire CALIOP mission (Jun 2006 to current month-1)
- Data and documentation: https://eosweb.larc.nasa.gov

References:

Ma et al., 2013, "Comparison of AOD between CALIOP and MODIS: significant differences over major dust and biomass burning regions," Atmos. Meas. Tech., 6, 2301-2401

Amiridis et al., 2013, "Optimizing CALIOP Saharan dust retrieval", Atmos. Chem. Phys., 13, 12109-12116

Winker et al., 2013, "The global 3-D distribution of tropospheric aerosols as characterized by CALIOP", Atmos. Chem. Phys., 13, 3345-3361