

## Overview of the Level 3 Aerosol Profile Product

### Product Release Dates:

**Version 3:** September 2015

**Version 1 Beta:** December 2011

### Input Data:

CALIPOP 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 CALIPSO level 2 aerosol extinction

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

### Sky Conditions

All Sky

Cloud Free

Cloudy-Sky, Transparent

Cloudy-Sky, Opaque

*New in Version 3*

## Motivation for Improvements

In the Version 1 Beta release of the Level 3 Aerosol Product:

- Sky conditions are confusing and misrepresentative
- 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.

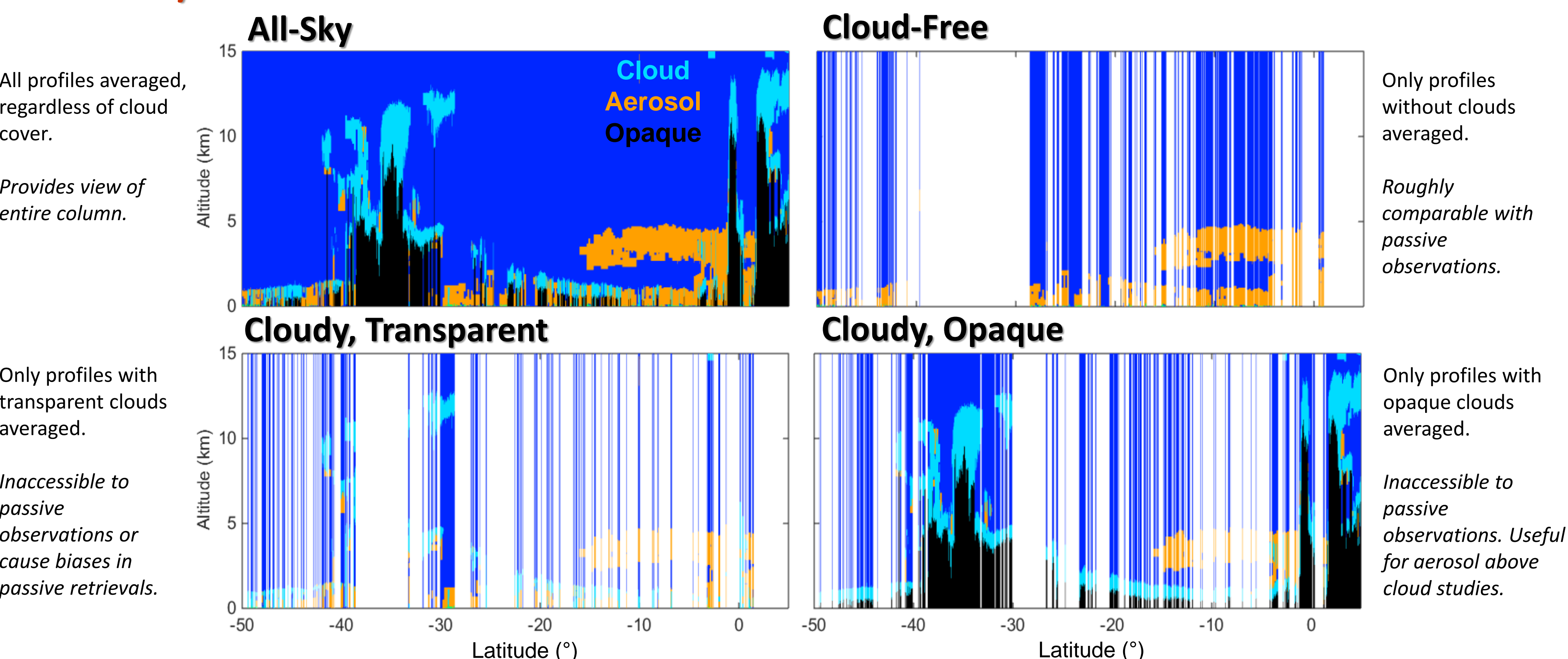
## Data Availability

Level 3, Version 3 now available for the entire CALIPSO mission (Jun 2006 to current month-1)

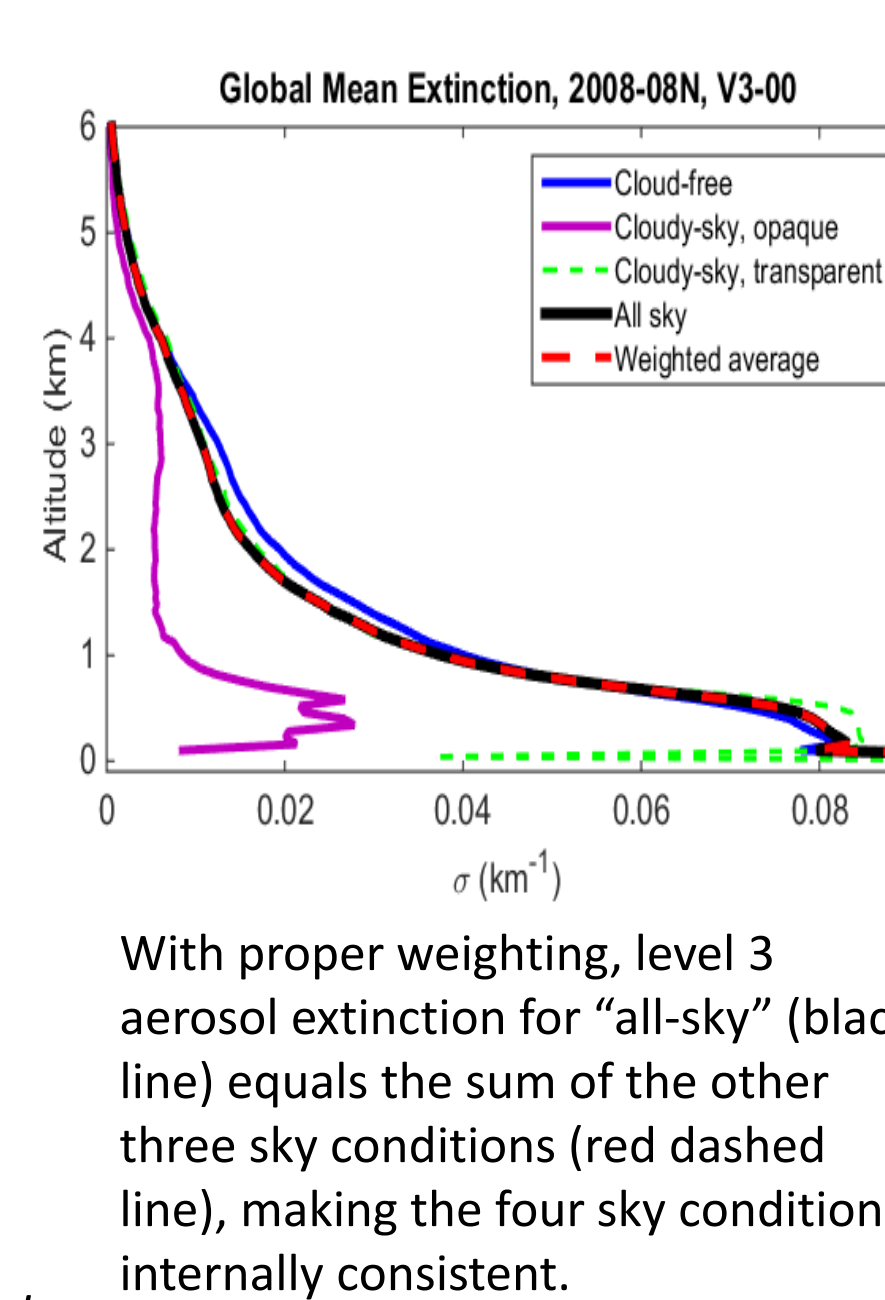
Data and documentation:  
<https://eosweb.larc.nasa.gov>

Winker et al., 2013 ACP

## New Sky Conditions



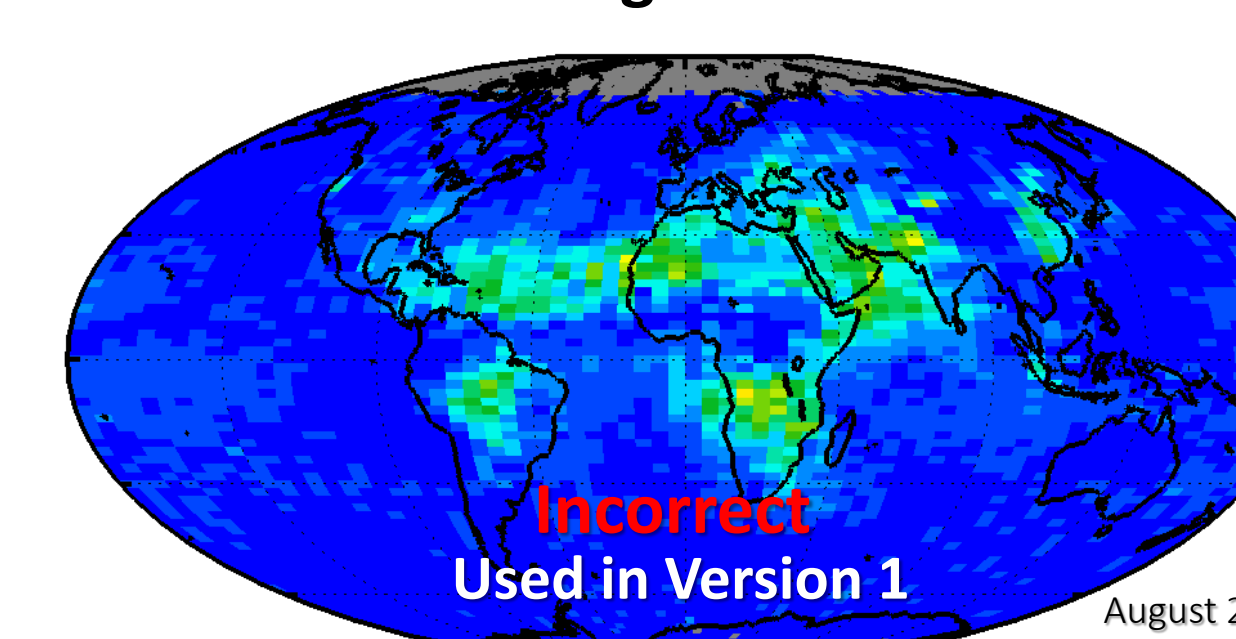
“Sky condition” defines cloud cover in aerosol extinction profiles that are averaged together. Above, aerosol extinction profiles in white are excluded for the given sky condition.



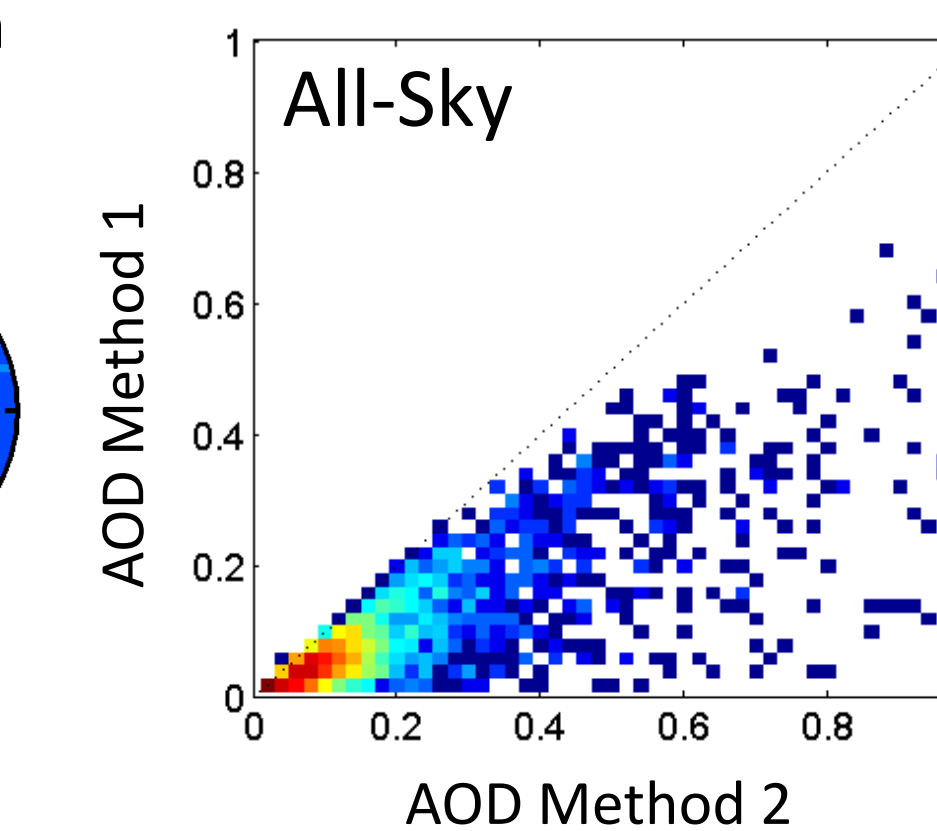
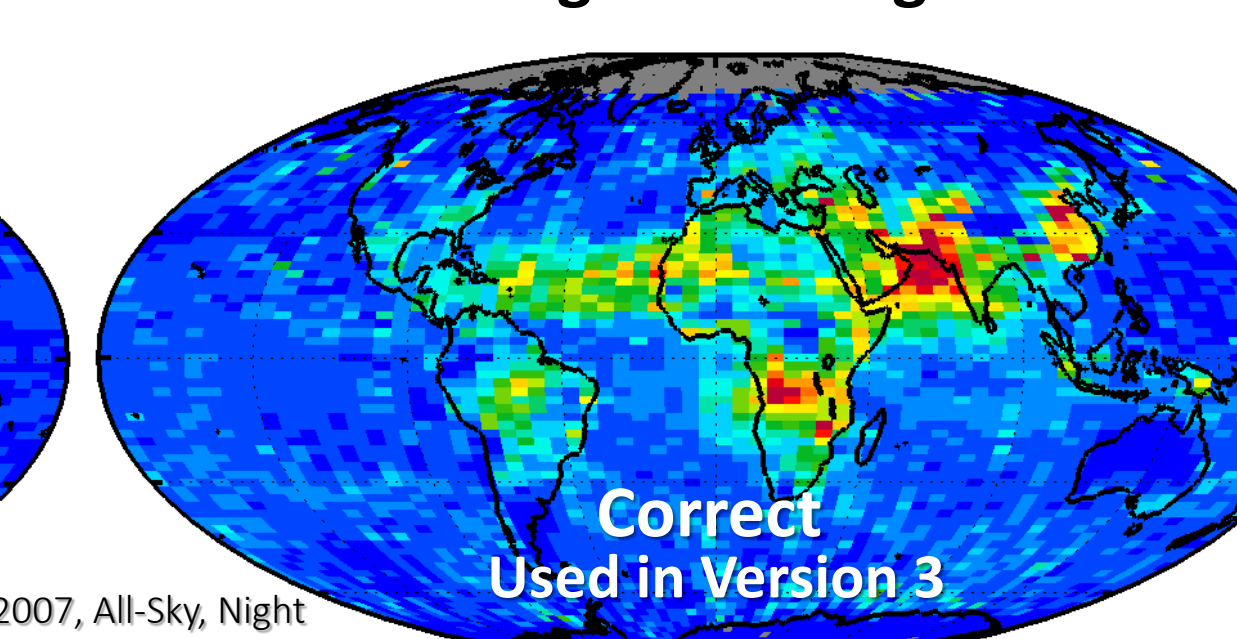
## Corrected Column AOD Computation

Two methods to compute monthly-mean column AOD from level 2 aerosol extinction profiles:

### Method 1: Average column AODs



### Method 2: Integrate averaged extinction

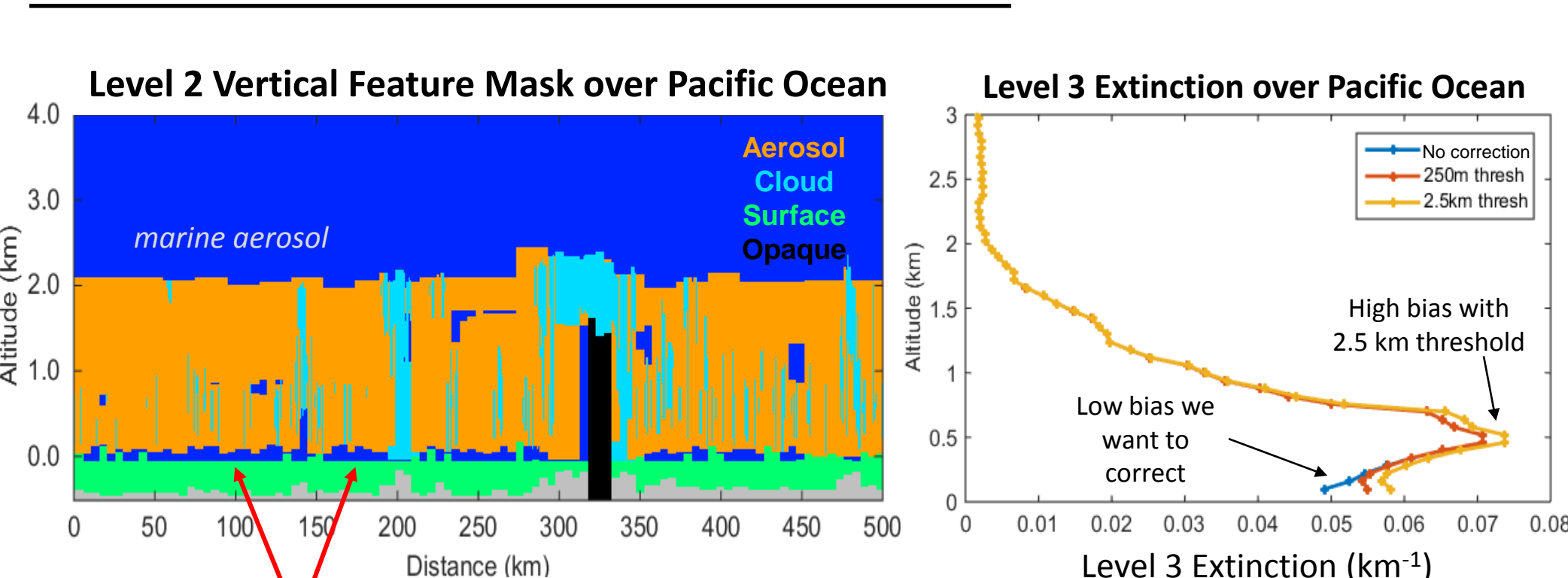


Averaging column AODs (method 1) causes a strong low bias in monthly-mean AOD because columns have unequal geometric depths due to cloud cover or quality screening, yet they are weighted equally in the average. The low bias exists because the Level 3 averaging method 1 is inappropriate – not because of biases in Level 2 aerosol extinction itself.

**Mean AOD in Version 3 correctly uses integrated monthly-mean aerosol extinction (method 2).**

## Improved Profiles Near Surface

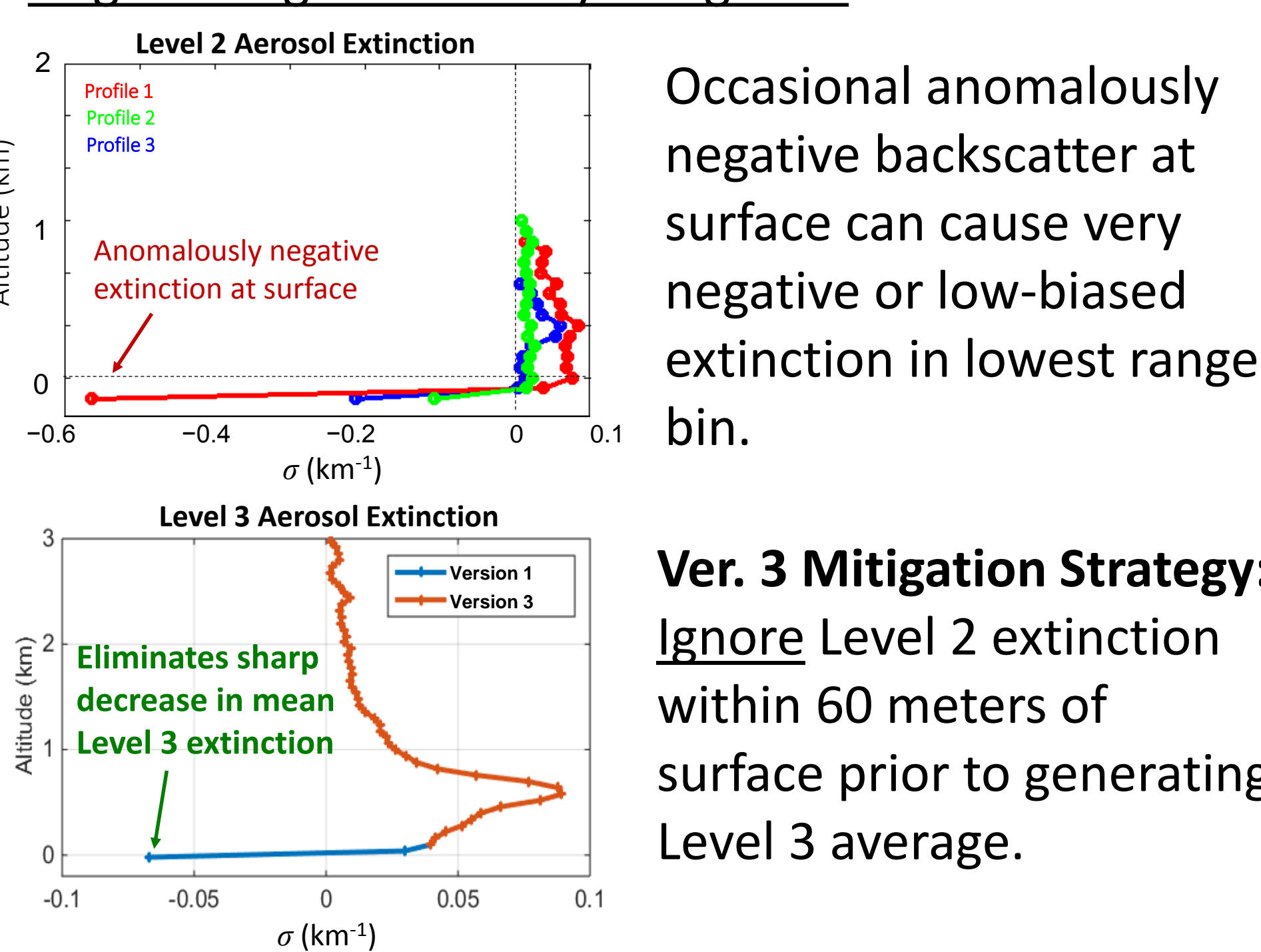
### Undetected Surface-Attached Aerosol



**Mitigation Strategy:** Ignore all “clear-air” below lowest aerosol base that is...  
(Version 1) Below 2.5 km — Too high, leads to high bias in mean Level 3 extinction  
(Version 3) Below 250 meters — Lowered in V3 to focus mitigation where needed

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

### Negative Signal Anomaly Mitigation



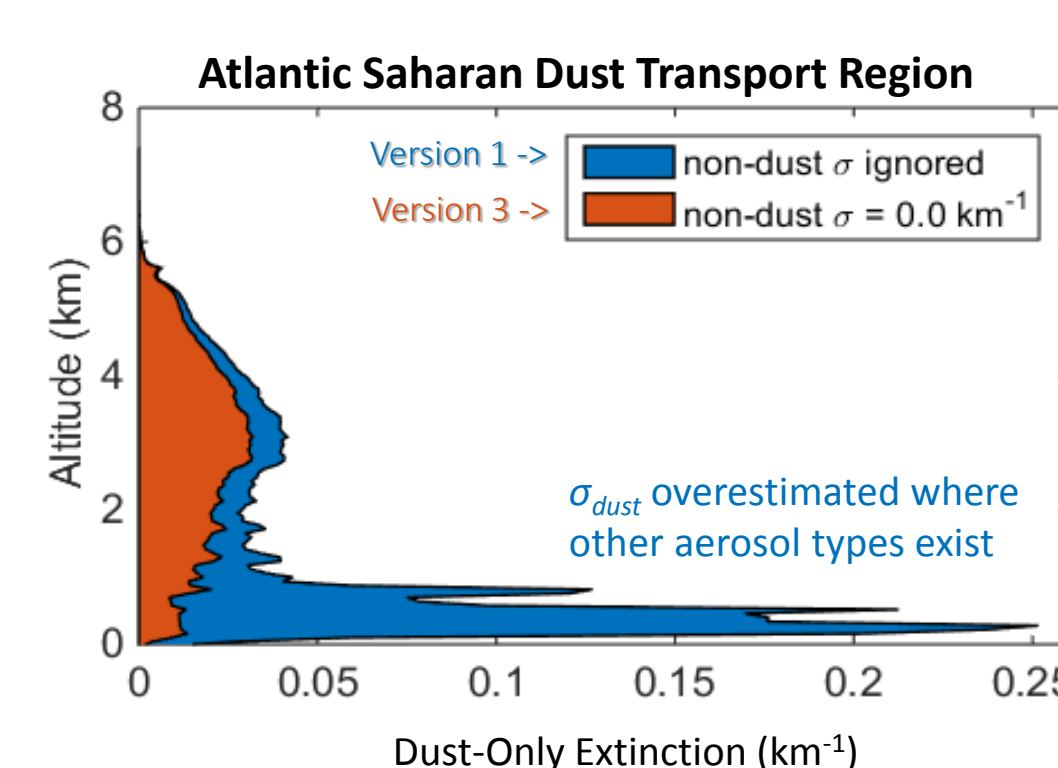
## Improved Single Aerosol Species Averages

When computing mean extinction for single aerosol species, extinction from other aerosol species can be either:

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

Extinction and AOD reported separately:

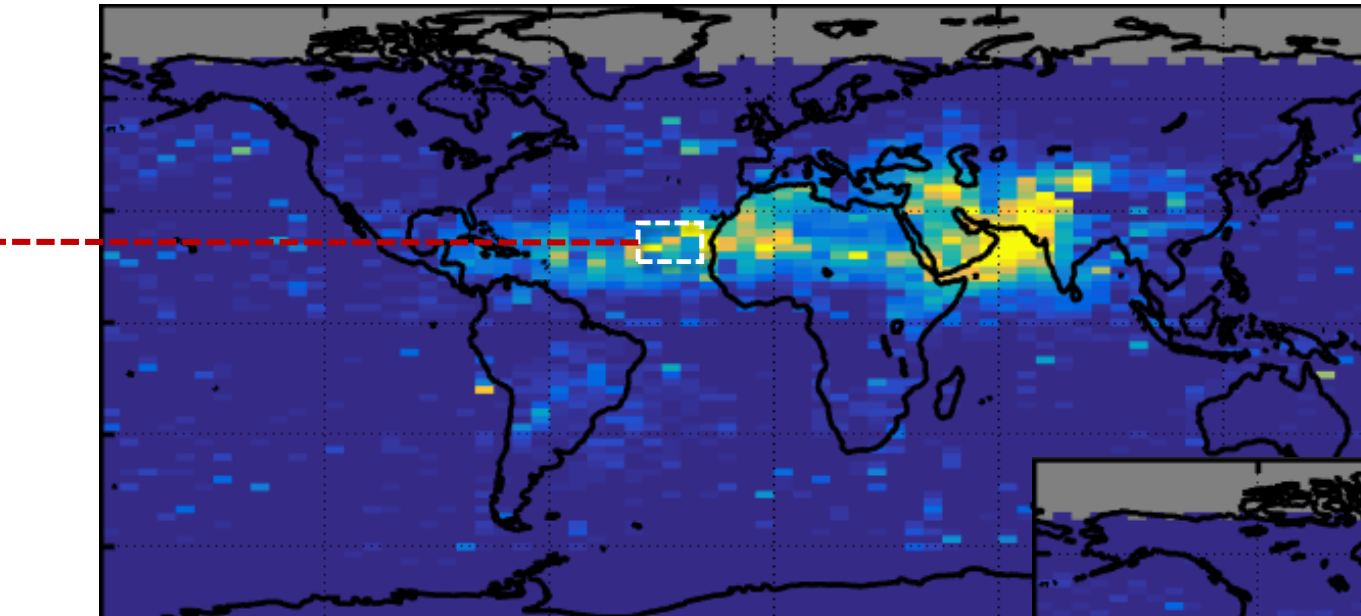
- All aerosol species
  - Dust
  - Polluted dust
  - Smoke
- New in Version 3*



**Version 3 uses convention 2, above.**

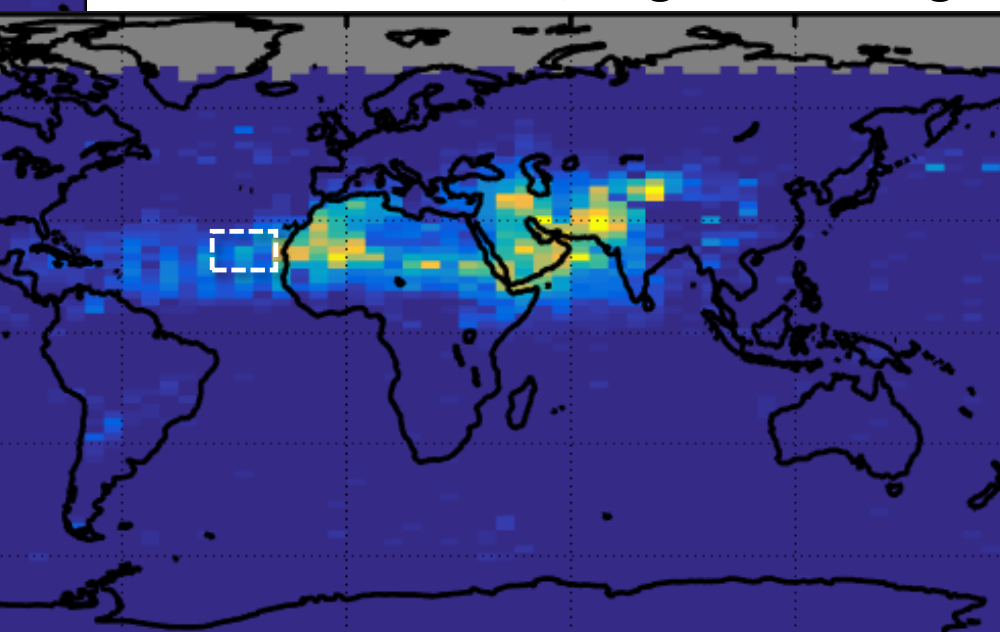
Data is August 2008 @ Night over Atlantic Saharan dust transport region.

### Version 1 Dust AOD, Aug. 2008 @ Night



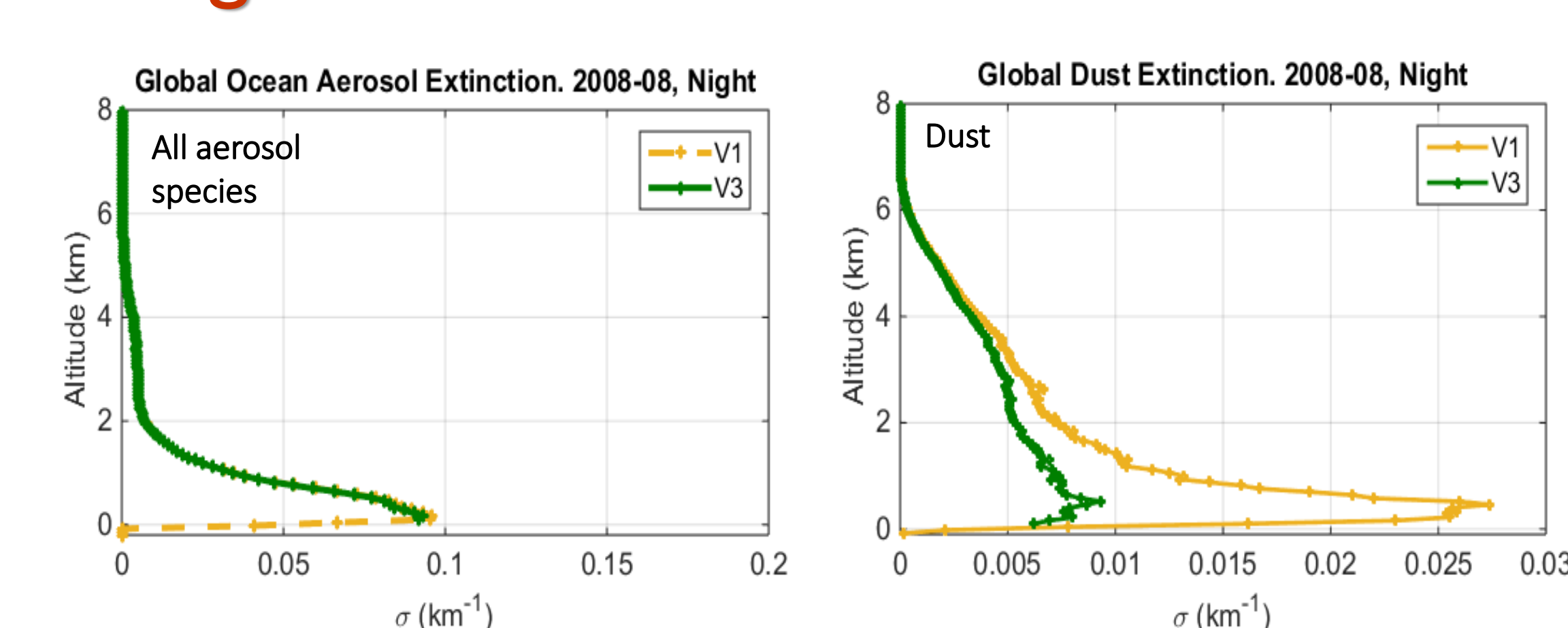
Version 1 overestimates dust-only AOD where other aerosol types exist.

### Version 3 Dust AOD, Aug. 2008 @ Night

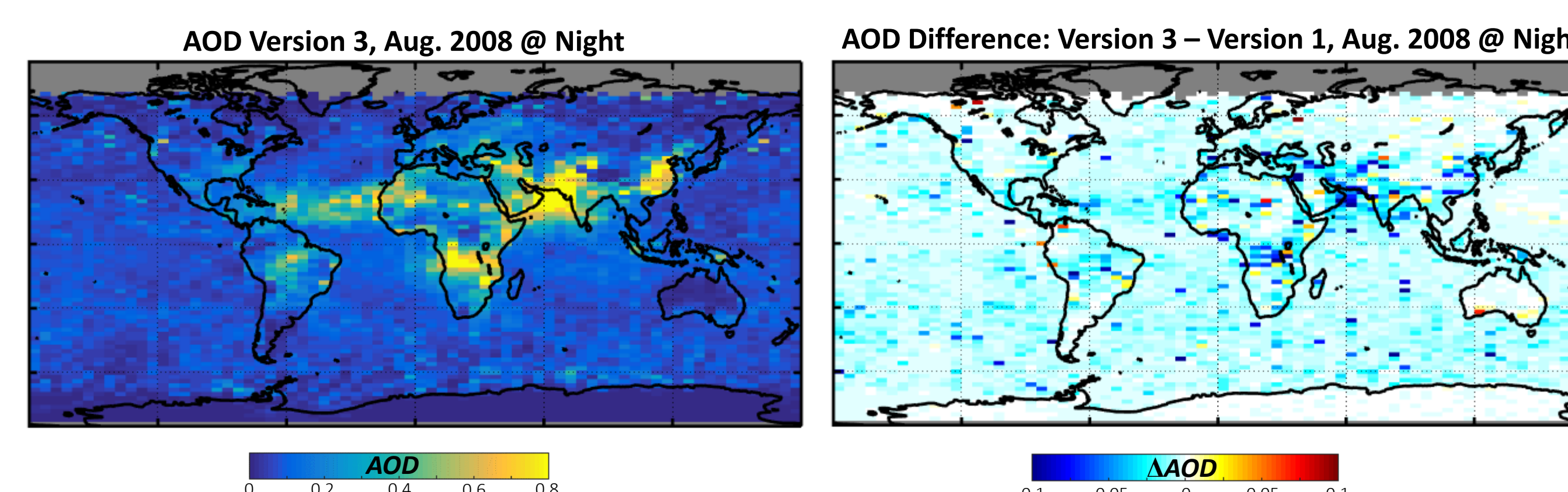
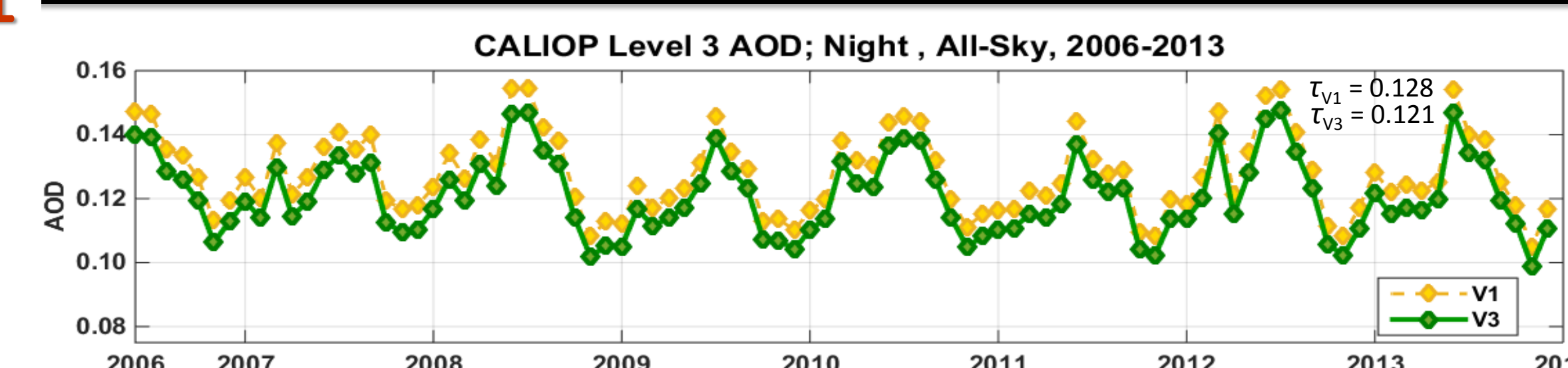


Version 3 dust-AOD lower and more realistic where multiple aerosol types coexist.

## Changes in Extinction and AOD Relative to Version 1



- 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.



### Global AOD for 2008, All-Sky

	V1	V3	% change
AOD, night	0.132	0.125	-5.3%
AOD, day	0.099	0.095	-4.0%

Overall, the revised averaging scheme and mitigation of near-surface artifacts yield improvements in aerosol extinction profile shape, albeit at the cost of a slight decrease in Level 3 mean AOD.

### Global Dust AOD for 2008, All-Sky

	V1	V3	% change
AOD, night	0.045	0.027	-40%
AOD, day	0.033	0.023	-30%

Revised single-species averaging scheme corrects overestimates in dust AOD and extinction profile shape due to previous Level 3 averaging scheme.