



## **Remote sensing measurements of biomass burning aerosol optical properties during the 2015 Indonesian burning season from AERONET and MODIS satellite data**

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The strong El Nino event in 2015 resulted in below normal rainfall leading to very dry conditions throughout Indonesia from August through October 2015. These conditions in turn allowed for exceptionally large numbers of biomass burning fires with very high emissions of aerosols. Over the island of Borneo, three AERONET sites (Palangkaraya, Pontianak, and Kuching) measured monthly mean fine mode aerosol optical depth (AOD) at 500 nm from the spectral deconvolution algorithm in September and October ranging from 1.6 to 3.7, with daily average AOD as high as 6.1. In fact, the AOD was sometimes too high to obtain any significant signal in the mid-visible wavelengths, therefore a previously developed new algorithm in the AERONET Version 3 database was invoked to retain the measurements in as many of the red and near-infrared wavelengths (675, 870, 1020, and 1640 nm) as possible to analyze the AOD in those wavelengths. These AOD at longer wavelengths are then utilized to provide some estimate the AOD in the mid-visible. Additionally, satellite retrievals of AOD at 550 nm from MODIS sensor data and the Dark Target, Beep Blue, and MAIAC algorithms were also analyzed and compared to AERONET measured AOD. Not surprisingly, the AOD was often too high for the satellite algorithms to also measure accurate AOD on many days in the densest smoke regions.

The AERONET sky radiance inversion algorithm was utilized to analyze retrievals of the aerosol optical properties of complex refractive indices and size distributions. Since the AOD was often extremely high there was sometimes insufficient direct sun signal for the larger solar zenith angles (> 50 degrees) required for almucantar retrievals. However, the new hybrid sky radiance scan can attain sufficient scattering angle range even at small solar zenith angles when 440 nm direct beam irradiance can be accurately measured, thereby allowing for many more retrievals and also at higher AOD levels during this event. Due to extreme dryness occurring in the region, significant biomass burning of peat soils occurred in some areas. The retrieved volume median radius of the fine mode increased from ~0.18 micron to ~0.25 micron as AOD increased from 1 to 3 at 440 nm. These are very large size particles for biomass burning aerosol and are similar in size to smoke particles measured in Alaska during the very dry years of 2004 and 2005 when peat soil burning also contributed to the fuel burned. The average single scattering albedo over the wavelength range of 440 to 1020 nm was very high ranging from ~0.96 to 0.98, indicative of dominant smoldering phase combustion. These very high values of single scattering albedo for biomass burning aerosols are similar to those retrieved by AERONET for the Alaska smoke in 2004 and 2005.