Name(s)

Alexander G. Krolewski

Project Number

S0804

Project Title

Shape, Optical Properties, and Age of Borneo Smoke Plumes Imaged by MISR

Abstract

Objectives/Goals

The purpose of this research was to determine the shape, size, optical properties, and age of Borneo smoke plumes imaged by the MISR instrument between 2001 and 2009. The Multi-angle Infrared SpectroRadiometer (MISR) is an instrument on board the Terra satellite that images the earth using nine different cameras oriented at various angles to the ground.

Methods/Materials

My analysis relied on two precompiled databases of smoke plumes in Borneo, created by the MISR Interactive eXplorer (MINX) software. One database consisted of 388 plumes and was used to analyze plume geometric properties; the other database, with 333 plumes, was a modified version of the first, intended to reduce bias from cloud contamination and used for optical properties. I used the scientific programming language NCAR to analyze and plot the plume data. I primarily considered relative plume shape, in which I adjusted each plume to a standard nondimensionalized length of 1. I also considered various plume optical properties, such as optical depth, single-scattering albedo, and top-of-atmosphere albedo, all of which were measured in the green band (wavelength = 558 nm). To parameterize relative plume shape, I created a plume probability density function by dividing each plume fraction value by the sum of all the plume fraction values, and I evaluated the parameterization using the root mean square error. Lastly, plume age was defined as the age of smoke at the most distant point from the origin, and was approximated by dividing plume length by average down-plume wind speed.

Results

Across the primary database, plume length averaged approximately 40 km, and plumes were aligned about 55° N of due west. Plumes had a roughly ovoid shape, with a width on average 27% of their length. Lastly, I found that smoke at the edge of a plume is on average three hours old.

Conclusions/Discussion

Optical depth increased slightly over the length of the plumes, a result of particulate aging and an artifact of the coarseness of the data. Albedo initially increased before decreasing, a result consistent with ground-feature bias and particulate aging. A four-parameter model of plume density by relative location was constructed; this model could be used in further climatological studies to approximate the probability of finding a plume in a given region. Lastly, wind speed had only a very weak effect on nondimensional plume shape.

Summary Statement

I analyzed the shapes, sizes, ages, and optical properties of smoke plumes created by fires in Borneo, which will allow climatologists to better understand the climate effects of smoke plumes.

Help Received

Worked under the supervision of Professor Charlie Zender in the UCI Department of Earth System Sciences; I worked independently and met with Professor Zender once a week to look at my results and plan what I would do next.