7A.4 RADIATIVE EFFECTS OF BIOMASS BURNING AEROSOLS

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1. **INTRODUCTION**

Aerosols play a pivotal role on the radiation balance of the earth-atmosphere system. Each year increasing amounts of aerosols are released into the atmosphere from biomass burning (Kaufman et al. 1998). The effects of biomass burning aerosols have received much attention in recent years due to their large spatial distribution (Herman et al. 1998). In 1998, several large biomass-burning events were reported in Central America, Indonesia, South America and Africa. In order to understand the radiative effects of biomass burning, the source regions must be first identified. The next step is to separate the smoke aerosols from cloudy regions. A combination of radiative transfer models and observations are then necessary to characterize the radiative effects of these aerosols. This paper is focussed upon examining the "direct" radiative effects of biomass burning. Using the Advanced Very High Resolution Radiometer (AVHRR), the Visible Infrared Scanner (VIRS), and the Clouds and the Earth's Radiant Energy System (CERES) instruments the direct radiative effects of biomass burning aerosols are presented. Radiative transfer calculations are also performed to estimate the optical thickness of aerosols. Broadband radiative transfer computations are performed to estimate the TOA radiative effects of biomass burning aerosols.

2. **DATA SETS AND APPROACH**

In this paper, we present results over Indonesia for October 1997 and March-April 1998 and over Central America for April and May 1998. The detection of fires from AVHRR imagery is a well-established procedure (Kaufman et al. 1998). The multi-spectral information can be used to detect fire pixels on a routine basis. The AVHRR multi-spectral data are used to map fires and smoke and results are presented as a function of major ecosystems. We also present results from April-May 1998 over Central America where AVHRR, VIRS and CERES data were available. We further use this information to separate smoke aerosols from cloudy regions. The newly available VIRS data set from the Tropical Rainfall Measuring Mission (TRMM) platform is also examined for detecting fires and smoke aerosols. The major advantage of VIRS data is the increased temporal resolution and the addition of a 1.6 μm channel. However, the spatial resolution of the VIRS data set is limited to about 2km at nadir. The CERES broadband scanner on the TRMM platform also provides top of atmosphere (TOA) broadband radiances, which are then converted to fluxes using the Earth Radiation Budget algorithms (Barkstrom et al. 1997). After fire pixels are identified from satellite imagery (Christopher et al. 1998), smoke aerosols are identified. For these pixels, aerosol optical thickness values are computed using a look-up-table approach. Aerosols are characterized as spheres with a black carbon core and an inorganic shell. The retrieved aerosol optical thickness values are then compared with ground-based sunphotometer measurements.

3. Results and discussion

3.1 Fire counts over Indonesia

During October a total of 10 files between 88E-132E longitude and -10S to 25N latitude were analyzed for fire counts. For the same region, a total of 33 AVHRR images were analyzed in April-May 1998. Results are characterized according to an ecosystem database. The distribution of fires in

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percentages are shown in Table 1 as a function of several major ecosystems within the region. TRF stands for Tropical Rain Forest and TBS stands for Tropical Broadleaf Seasonal.

TABLE 1

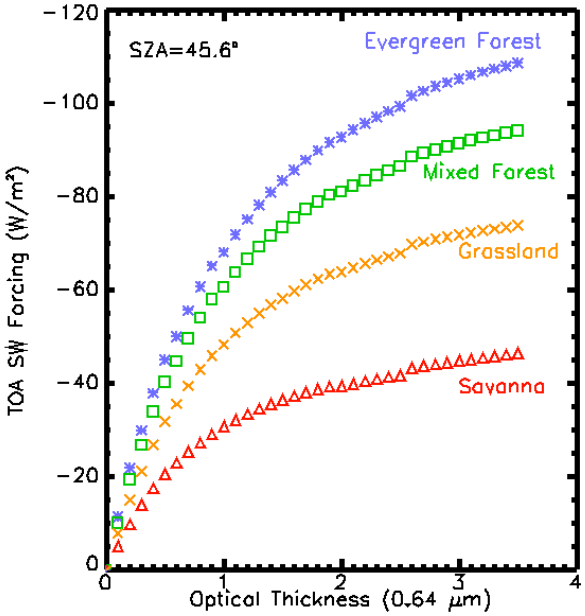
Ecosystem	10/97	3/98	4/98
Marsh	30	2	2
TRF	40	4	4
Rice	4	36	28
Regrowth	6	7	9
TBS	-	41	50
Savanna	14	7	6
Others	6	3	1

According to this ecosystem classification, the majority of fires in October 1997 were in the Tropical Rainforest ecosystem with a notable shift in 1998 towards the TBS category. However, note that these results do not account for fire pixels when cloudy conditions exist.

3.2 Fire Counts over Central America

During April-May 1998 large number of fires were reported in Central America. The smoke plumes were transported over long distances and had a significant impact on the earth-atmosphere sytem. Using more than a month of AVHRR data our analysis shows that the majority of the fires were in the Grassland ecosystem.

Figure 1 shows the results of radiative transfer calculations for four different ecosystems at a solar zenith angle of 45.6°. The aerosol optical thickness at 0.64 μm which roughly corresponds to the center of the AVHRR visible channel is plotted as a function of TOA direct radiative forcing. As aerosol optical thickness increases, the TOA DRF values increase at a different rate depending upon the background. For a unit change in optical depth, the TOA DRF values change by about -10 to -30W/m^2. The two main parameters affect the TOA DRF values are aerosol optical thickness and single scattering albedo. For an aerosol optical thickness of 1, the difference between savanna and evergreen forest DRF values range from -20 to -70W/m^2. These values are roughly in agreement with the ERBE analysis presented in Christopher et al. (1998). A first look at the CERES ERBE like product over the Central American fire episode (May 1998) show that the TOA SW flux differences between background and smoke are of similar magnitudes as shown in Figure 1.



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