Global Biomass Burning Emissions Product from a Constellation of Geostationary Satellites

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I. INTRODUCTION

Air quality in the United States is continuing to improve due to Environmental Protection Agency (EPA) rules such as Clean Air Interstate Rule (CAIR) and regional haze rule to mitigate anthropogenic emissions of oxides of nitrogen (NOx) and Volatile Organic Compounds (VOCs) [1, 2]. Despite the positive impact, large regions of the United States are often under exceptional events such as biomass burning (prescribed and natural) that lead to non-attainment of ozone and particulate matter standards [3].

Biomass burning emissions and long-range transport of biomass burning smoke impact local and regional air quality. Accounting for these emissions in global and regional air quality prediction models, using satellite detected fires and emissions, is expected to improve the accuracy of model predictions. Recent studies have shown that accuracy of particulate matter (PM2.5) forecasts is less than 20% for episodic events dominated by biomass burning emissions [4].

Near real time availability of biomass burning emissions is not possible from ground observations and reports. Ground reporting of fires and estimated emissions is typically used for retrospective analysis. For operational forecasting, the immediate availability of data is critical. Remotely sensed fires from National Oceanic and Atmospheric Administration (NOAA) operational Geostationary Operational Environmental Satellite (GOES) are widely used for hazard monitoring [5]. NOAA expanded this capability by developing GOES biomass burning emissions product (GBBEP) that became operational in July 2008. This algorithm, described in [6, 7, and 8] is a conventional algorithm that linearly multiplies fuel load (kgC/ha), fraction of fuel consumed (%), burned area (ha), and emissions factors for individual species (kg/kgC). Fuel consumption and burned area information comes from satellites and emissions factors are obtained from published literature. Fuel load information is derived from MODIS vegetation products and is a static dataset [6]. However, this fuel load dataset was developed only for the North American continent and developing a dataset for the whole globe is currently difficult due to the non-availability of supporting datasets. Therefore, we developed a new algorithm which uses fire radiative energy (FRE) obtained from multiple geostationary satellites. The FRE based algorithm circumvents the need for fuel load dataset. This paper describes the FRE algorithm and the application of this algorithm to GOES-East, GOES-West, and MetoSAT SEVIRI sensors.

II. BIOMASS BURNING EMISSIONS ALGORITHM

Study by [9] showed that biomass combusted (kgC) is proportional to FRE. The proportionality constant is the same for different biomass type. Figure 1 shows the relationship between biomass combusted (BC) and FRE that we derived using Landsat Thematic Mapper (TM) and GOES FRE data. To derive biomass combusted from TM data, we used burned scar (ha) and available fuel load (kgC/ha) information. The product of these two variables is plotted on y-axis of Figure 1. The slope is similar to the one reported by [9]. FRE can be obtained by integrating Fire Radiative Power (FRP) over time and FRP is obtained from burned area and fire temperature. FRP and FRE can be computed from fire radiance and duration observed from satellites. Once BC is determined using the relationship shown in Figure 1, emissions (kg) can be computed by multiplying FRE and BC (kgC) with emissions factors of different species (kg/kgC).

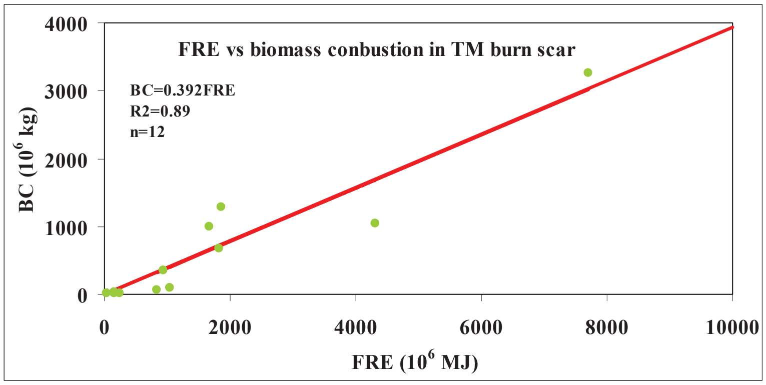

Fig. 1: Relationship between biomass combusted and FRE. Value of proportionality constant (slope in this figure) is similar to 0.368 reported by [9].

III. RESULTS AND DISCUSSION

Figure 2 shows an example of PM2.5 emissions across the whole globe. To generate this product, fire data from GOES-East, GOES-West, MTS01, and MetoSAT-9 were processed through the FRE based emissions algorithm. Only data derived from GOES-East and GOES-West has been validated by comparing to the emissions derived from the conventional biomass burning algorithm. Efforts are underway to derive global emissions for a longer period of time in 2009 and compare the data to MODIS. Comparisons, initially, will be at the FRP level. If FRPs from different geostationary satellites are found to be biased, MODIS data will be used as a calibration to normalize individual geostationary satellite data. The validated emissions data will be used in WRF-CHEM aerosol model simulations. These results are expected to be ready by summer 2010 for presentation at the IGARSS meeting.

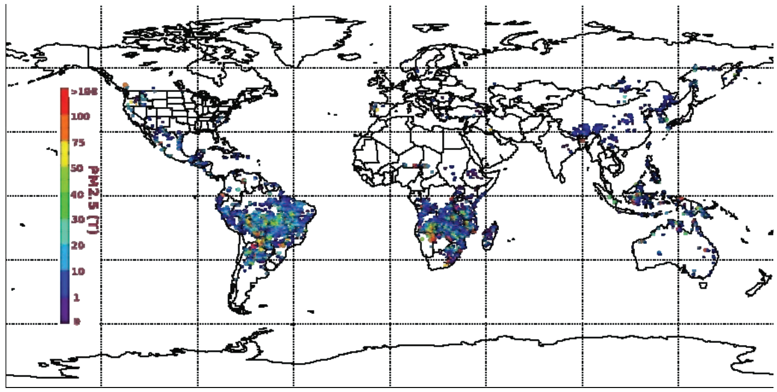

Fig.2. Global estimates of biomass burning emissions (PM2.5) using FRP from GOES, MET09, and MTS01 on September 15, 2009.

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