Generation of Global Biomass Burning Emissions Product Using Fire Radiative Power Retrieved from Multiple Geostationary and Polar-orbiting Satellites

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Biomass burning release a significant amount of aerosol and trace gas emissions to the atmosphere. These emissions and their long-distance transports contribute significantly to the simulation of both local and global air quality that has strong impacts on human health and environmental pollution. Because the aerosol emitted from biomass burning is currently one of the major sources of uncertainty in air quality forecasting, it is critical to produce a Biomass Burning Emissions (BBE) product in near real time for improving air quality modeling. Therefore, we develop a near real time BBE product using Fire Radiative Power (FRP) observed from multiple geostationary and polar-orbiting satellites. The geostationary satellites consist of two Geostationary Operation Environmental Satellites (GOES) that are GOES-east and GOES-west, the Meteosat Second Generation Satellites (Meteosat), and the Multi-functional Transport Satellite (MTSAT). The constellation of these geostationary satellites observe wildfires at an interval of 15–30 minutes and a spatial resolution of 3-4 km over most part of the globe. On the other hand, polar-orbiting satellites include Terra MODIS, Aqua MODIS, and Suomi NPP VIIRS, which observe separately wildfires twice a day globally at a spatial resolution of 750-1000m. We collect geostationary satellite fire product and VIIRS active fire product that are operationally produced in NOAA and MODIS active fire products the produced in NASA. The FRP observations from these fire products are applied to estimate global daily BBE at a grid cell of 0.25°x0.315° according to the following steps. (1) BBE from MODIS data. Daily MODIS FRP density (Terra and Aqua separately) is calculated, which is used to calculate biomass burning emissions based on an empirical model. MODIS-based emissions are then calibrated using MODIS smoke Aerosol Optical Depth (AOD). (2) BBE from VIIRS data. VIIRS FRP data are compared with MODIS FRP detections and are used to establish relationships with MODIS-AOD-calibrated biomass burning emissions for each continent using daily data from April 2016 to March 2017. The relationships are used to estimate biomass burning emissions from VIIRS FRP. (3) BBE from geostationary satellites. Diurnal FRP pattern is reconstructed using fire detections from geostationary satellites, which is used to calculate daily fire radiative energy (FRE) for each fire pixel. Combining with biomass combustion factor and emission factors, the FRE from geostationary satellites are also used to calculate biomass burning emissions. The geostationary satellite derived emissions are further adjusted using MODIS-AOD-calibrated emissions; (4) Global BBE product. The biomass burning emissions product is finally generated by averaging the valid emission estimates from MODIS, VIIRS, and geostationary satellite data in each grid cell. We further evaluate this product by analyzing the temporal and spatial pattern of global biomass burning emissions in 2016 and 2017.