A quantitative link between CO2 emissions from tropical vegetation fires and the daily tropospheric excess (DTE) of CO2 seen by NOAA-10 (1987-1991)

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Four years of monthly mean mid-tropospheric CO2 columns over the tropics have been retrieved from evening and morning observations of NOAA-10 (1987-1991). The difference between these two columns shows a “Daily Tropospheric Excess” (DTE) up to 3 ppm over regions affected by fires. At regional scale over Africa, America, and Australia, the variations of the DTE are in good agreement with those of independently derived biomass burning CO2 emissions. In particular, a strong correlation (R2~ 0.8) is found between regional mean DTE and fire CO2 emissions values from the Global Fire Emissions Data base (GFEDv2) even though the two products span over periods ten years apart from each other. The DTE distribution over Africa is in good agreement with interannual variation of climate as indicated by temperature, precipitation and ENSO index. For instance, the southern hemisphere experiences 20% more fire activity during El Niño conditions than during La Niña conditions and the reverse for the northern hemisphere, even if the estimated one sigma uncertainty on the DTE remains close to the DTE ENSO variability. The physical mechanism linking DTE with emissions is not fully elucidated. Hot convective fire plumes injecting CO2 into the troposphere during the afternoon peak of fire activity, seen by the satellite at 1930 LT, and then being diluted by large scale atmospheric transport, before the next satellite pass at 0730 LT, could explain the tight observed relationship between DTE and fire CO2 emissions. Through the reprocessing of the 25-year archive of TOVS observations, the DTE data may prove very useful to quantitatively reconstruct fire emission patterns before the ATSR and MODIS era when better quality fire count and burned area data became available.