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Air pollution from gas flaring: new emission factor estimates and detection in a West African aerosol remote-sensing climatology

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Gas flaring, the disposal of gas through stacks in an open-air flame, is a common feature in the processing of crude oil, especially in oil-rich regions of the world. Gas flaring is a prominent source of volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAH), CO, CO_2, nitrogen oxides (NO_x), SO_2 (in “sour” gas only), and soot (black carbon), as well as the release of locally significant amounts of heat. The rates of emission of these pollutants from gas flaring depend on a number of factors including, but not limited to, fuel composition and quantity, stack geometry, flame/combustion characteristics, and prevailing meteorological conditions. Here, we derive new estimated emission factors (EFs) for carbon-containing pollutants (excluding PAH). The air pollution dispersion model, ADMS5, is used to simulate the dispersion of the pollutants from flaring stacks in the Niger delta. A seasonal variation of the dispersion pattern of the pollutant within a year is studied in relation to the movements of the West Africa Monsoon (WAM) and other prevailing meteorological factors.

Further, we have clustered AERONET aerosol signals using trajectory analysis to identify dominant aerosol sources at the Ilorin site in West Africa (4.34 oE, 8.32 oN). A 10-year trajectory-based analysis was undertaken (2005-2015, excluding 2010). Of particular interest are air masses that have passed through the gas flaring region in the Niger Delta area en-route the AERONET site. 7-day back trajectories were calculated using the UK Universities Global Atmospheric Modelling Programme (UGAMP) trajectory model which is driven by analyses from the European Centre for Medium-Range Weather Forecasts (ECMWF). From the back-trajectory calculations, dominant sources are identified, using literature classifications: desert dust (DD); Biomass burning (BB); and Urban-Industrial (UI). We use a combination of synoptic trajectories and aerosol optical properties to distinguish a fourth source: that due to gas flaring. We discuss the relative impact of these different aerosol sources on the overall radiative forcing at Ilorin AERONET site.