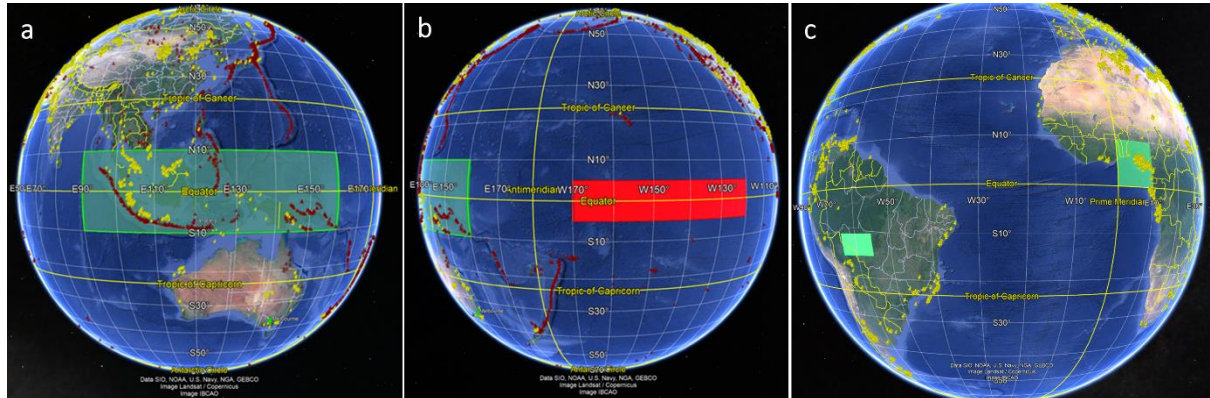


## Supporting Information

### Areas Used



**Fig.S1 | a, SEAP Area. b, Nino 3.4 Area. c, SAMP and WAP Areas with volcanoes (red) and oil industry gas flares (yellow).**

	HadISST1	Canada	CSIRO	France	UK	Japan	NASA	NCAR	NOAA	Norway
1870	0	0	0	0	1	0	0	0	0	0
1871	0	0	0	0	0	0	0	0	0	1
1872	0	0	0	0	0	0	1	1	0	0
1873	0	0	0	1	0	1	1	0	0	0
1874	0	0	0	0	0	0	0	0	0	0
1875	0	0	0	0	0	0	0	0	0	0
1876	0	0	0	0	0	0	0	0	0	0
1877	1	0	0	1	0	0	1	0	0	1
1878	1	0	0	0	0	0	1	0	0	1
1879	0	0	0	0	0	0	0	0	0	1
1880	0	0	0	0	0	0	0	1	0	1
1881	0	0	0	0	0	0	0	0	0	0
1882	0	0	0	1	0	1	0	0	0	0
1883	0	0	0	0	0	1	0	0	0	0
1884	0	0	0	0	0	0	0	0	0	0
1885	0	0	0	0	0	0	0	0	0	0
1886	0	0	0	0	0	0	0	0	0	0
1887	0	0	0	0	0	0	0	0	0	0
1888	1	1	0	0	0	1	0	0	1	0
1889	0	0	1	0	0	0	0	0	0	1
1890	0	0	0	1	0	0	0	0	0	0
1891	0	0	0	0	0	0	0	0	0	1
1892	0	0	0	0	0	0	0	0	0	0
1893	0	0	0	1	1	0	0	0	0	0
1894	0	0	0	1	0	0	1	0	0	1
1895	0	0	0	0	0	0	1	0	0	1
1896	1	0	0	0	1	0	0	0	0	0
1897	0	0	0	1	0	0	0	0	0	0

1898	0	0	0	0	0	0	1	0	0	0
1899	0	0	0	0	0	1	0	0	1	0
1900	1	0	1	1	0	1	0	0	0	0
1901	0	0	0	0	0	1	0	0	0	0
1902	1	0	0	0	0	0	0	0	0	0
1903	0	0	0	1	0	0	0	1	0	1
1904	0	0	0	0	0	0	0	0	1	1
1905	1	0	0	0	0	0	1	0	0	0
1906	0	0	0	1	0	0	1	0	0	0
1907	0	0	0	0	0	0	0	0	0	0
1908	0	0	0	0	0	1	0	0	0	1
1909	0	0	0	0	0	1	0	0	0	1
1910	0	1	0	0	1	0	0	1	1	0
1911	0	1	1	1	0	0	0	0	0	0
1912	0	0	1	0	0	0	0	0	0	1
1913	0	0	0	0	1	0	1	0	0	0
1914	1	0	0	0	0	0	0	0	1	0
1915	0	0	1	0	0	0	0	0	0	0
1916	0	0	0	0	0	0	1	0	0	0
1917	0	0	0	0	0	1	0	0	0	0
1918	0	0	0	0	1	0	0	0	0	0
1919	1	0	0	1	1	0	1	0	1	1
1920	0	0	1	1	0	0	1	0	0	0
1921	0	0	0	0	0	0	0	0	0	0
1922	0	0	0	0	0	1	0	0	1	0
1923	0	0	1	0	1	1	1	0	1	1
1924	0	1	0	0	0	1	1	1	0	0
1925	0	0	1	0	0	0	1	0	0	0
1926	1	0	0	0	0	0	0	0	0	0
1927	0	0	0	1	1	0	0	0	1	1

1928	0	1	0	0	1	0	0	1	0	0
1929	0	0	0	0	0	0	0	1	0	1
1930	1	0	0	0	0	0	0	0	0	0
1931	1	0	0	0	0	0	1	0	1	1
1932	0	0	0	0	0	0	0	0	1	0
1933	0	0	0	0	0	0	0	1	0	0
1934	0	0	1	0	0	0	1	1	0	0
1935	0	0	0	0	0	0	1	1	0	1
1936	0	0	0	0	0	1	0	1	0	0
1937	0	0	1	1	0	1	0	0	0	0
1938	0	0	0	0	0	0	1	0	0	0
1939	0	1	0	0	0	0	1	0	1	0
1940	1	1	0	0	1	0	0	0	0	1
1941	1	0	0	1	1	0	0	0	0	0
1942	0	0	1	0	0	0	0	1	0	0
1943	0	1	0	0	0	1	1	1	1	1
1944	0	0	0	0	1	1	0	0	0	0
1945	0	0	0	0	0	0	0	1	0	0
1946	0	1	0	0	0	0	0	0	0	0
1947	0	0	0	0	0	0	0	0	1	1
1948	0	1	0	0	0	1	0	0	0	0
1949	0	1	0	0	0	1	0	0	1	0
1950	0	0	0	0	0	0	0	0	0	1
1951	0	1	1	0	0	0	0	0	0	0
1952	0	0	0	0	1	0	0	1	1	0
1953	0	0	0	0	1	0	1	0	1	0
1954	0	0	1	1	0	0	1	0	0	1
1955	0	0	0	0	0	1	0	1	0	1
1956	0	0	0	0	0	1	0	1	0	0
1957	1	0	0	1	1	1	0	0	0	0



1988	0	0	0	0	0	0	0	0	0	0
1989	0	1	0	0	0	0	1	0	1	1
1990	0	0	0	0	1	0	1	1	1	1
1991	1	1	0	0	0	0	1	1	1	1
1992	1	0	0	1	1	1	0	0	0	0
1993	1	0	0	0	0	1	0	1	0	0
1994	0	0	0	0	0	1	0	0	0	0
1995	0	0	1	0	0	0	1	0	0	0
1996	0	1	0	0	1	0	0	0	0	0
1997	1	1	1	0	0	0	0	1	0	1
1998	0	1	1	0	0	1	0	0	0	0
1999	0	1	0	0	1	1	0	0	1	0
2000	0	1	0	1	0	0	1	1	1	1
2001	0	1	1	0	1	0	1	1	1	0
2002	1	1	1	0	0	0	0	1	0	0
2003	0	0	0	1	0	1	0	0	1	0
2004	0	1	1	1	0	1	0	0	1	1
2005	0	0	1	0	1	0	0	0	0	0
2006	0	0	0	0	1	0	0	1	0	0
2007	0	1	0	1	0	1	0	1	0	1
2008	0	0	1	1	0	1	1	0	1	1
2009	0	1	1	1	1	1	1	0	1	0
2010	0	1	1	1	1	0	0	0	0	1
2011	0	1	1	1	1	0	0	1	0	1
2012	0	0	1	0	0	1	0	1	1	0
2013	0	1	1	0	0	1	1	0	0	1
2014	0	1	1	0	1	0	1	0	0	1

**Table S1 | Years identified as ENSO years by the UK Met Office definition (Temperature more than 0.5C above the long term average.) from the HadISST1 (highlighted in red) and the nine models analysed.**

	<b>HadISST1</b>	<b>Canada</b>	<b>CSIRO</b>	<b>France</b>	<b>UK</b>	<b>Japan</b>	<b>NASA</b>	<b>NCAR</b>	<b>NOAA</b>	<b>Norway</b>	<b>Average</b>
<b>HadISST1</b>	1	0.034	-0.092	0.018	0.086	-0.050	0.004	0.003	0.058	0.079	0.016
<b>Canada</b>	0.034	1	0.223	0.124	0.158	0.070	-0.025	0.054	0.216	0.145	0.111
<b>CSIRO</b>	-0.092	0.223	1	0.176	0.006	0.055	0.066	-0.002	-0.060	0.066	0.049
<b>France</b>	0.018	0.124	0.176	1	0.148	0.068	0.042	-0.203	-0.005	0.077	0.050
<b>UK</b>	0.086	0.158	0.006	0.148	1	-0.081	0.006	-0.066	0.139	-0.066	0.037
<b>Japan</b>	-0.050	0.070	0.055	0.068	-0.081	1	-0.151	-0.039	0.151	-0.086	-0.007
<b>NASA</b>	0.004	-0.025	0.066	0.042	0.006	-0.151	1	0.033	0.155	0.140	0.030
<b>NCAR</b>	0.003	0.054	-0.002	-0.203	-0.066	-0.039	0.033	1	0.068	0.131	-0.002
<b>NOAA</b>	0.058	0.216	-0.060	-0.005	0.139	0.151	0.155	0.068	1	0.188	0.101
<b>Norway</b>	0.079	0.145	0.066	0.077	-0.066	-0.086	0.140	0.131	0.188	1	0.075
<b>Average</b>	0.016	0.111	0.049	0.050	0.037	-0.007	0.030	-0.002	0.101	0.075	

**Table S2 | Correlation matrix of Nino 3.4 temperature from the HadISST1 dataset and the nine models.**

## The Eight Continental Scale Aerosol Plumes

The locations of the eight continental scale aerosol plumes are shown in Figures S1 and S2. The average monthly MERRA-2 AOD level<sup>1</sup> (1980 to 2020) of each plume is shown in Figure S3. Four plumes peak in the boreal summer, one in the boreal winter, two in September and one in August. The major sources of the plumes are shown in Table S1.

All plumes create local climate change when they exist, some cause regional change and at least one causes global change.

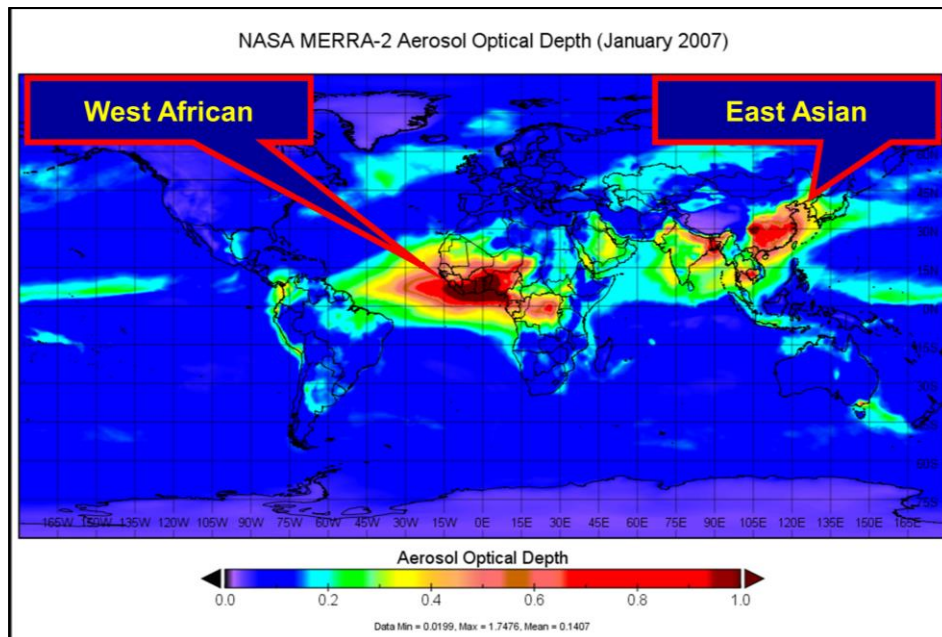


Fig.S2 | MERRA-2 AOD Jan 2007 showing two of the eight plumes.

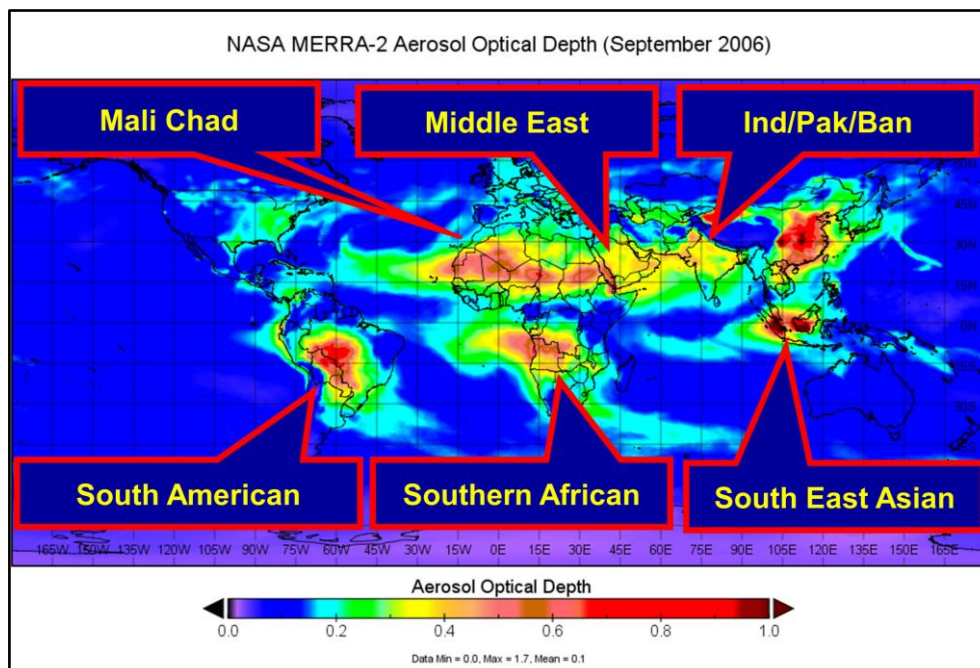
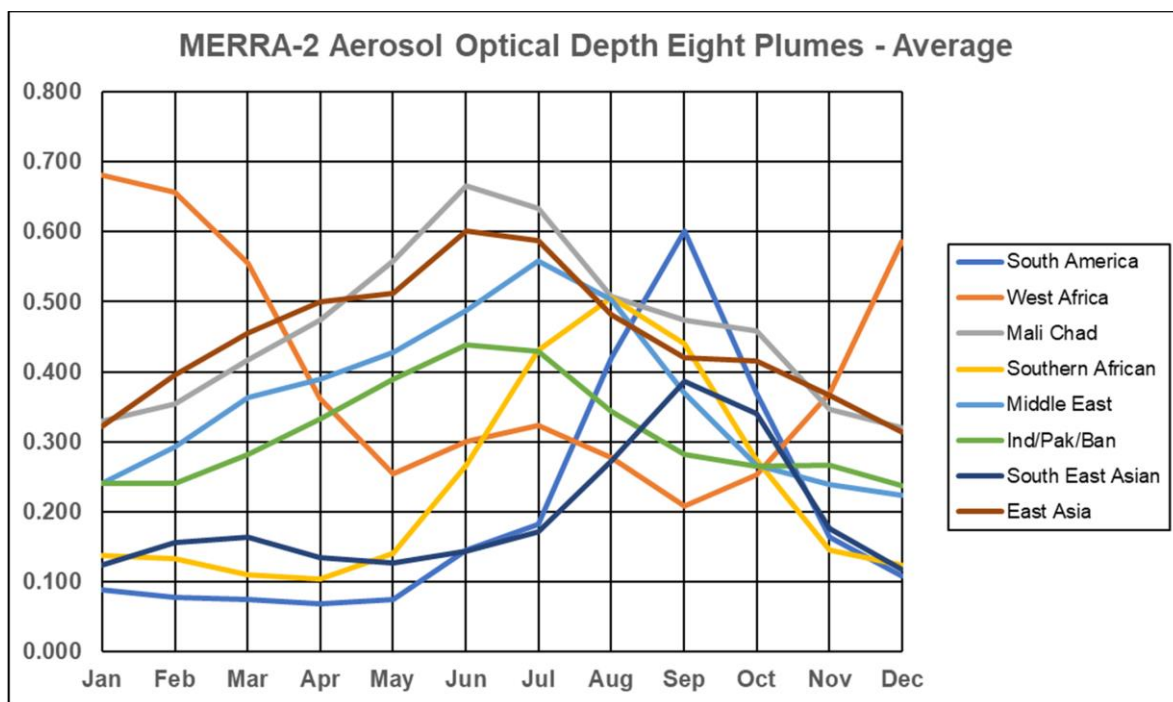


Fig.S3 | MERRA-2 AOD September 2006 showing six of the eight plumes.





**Fig.S4 | Average monthly MERRA-2 AOD of the eight plumes 1980 to 2020.**

Plume	Anthropogenic Source	Natural Source
South American	Biomass	Volcanoes
West African	Biomass, Gas Flares	Dust, Volcanoes
Mali/Chad	Peat fires under dried up lakes?	Dust
Middle East	Gas Flares	Dust, Volcanoes
Southern African	Biomass	Volcanoes, Dust
India/Pakistan/Bangladesh	Biomass, Industry	Dust
South East Asian	Biomass, Gas Flares	Volcanoes
East Asian	Industry, Biomass	Dust

**Table S3 | The aerosol sources of the eight continental scale aerosol plumes.**