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Aerosols strongly influence sea surface temperature

Sea surface temperatures in the North Atlantic may be significantly influenced by air pollution, with knock-on effects for climatic events, such as drought and hurricanes, according to a new study. The findings indicate that estimates of man-made aerosol emissions over coming decades should be refined within climate models to improve predictions of future climate change.

The temperature of the air just above the surface of the North Atlantic Ocean is strongly linked to climate and its impacts. Earlier climate models suggested that changes in surface temperature over the decades was a response to the ocean's internal variability. However, this study suggests that aerosols could be linked to 76% of surface temperature variation from 1860 to 2005. Aerosols from human activity account for around two-thirds of this.

Aerosols are fine solid particles or liquid droplets suspended in gas that can cool the climate by reflecting sunlight back into space. Natural aerosols are produced in vast quantities from sulphur dioxide emissions from volcanoes. Another important source is ocean biological activity (this produces DMS - DiMethyl Sulphide - which then forms sulphur dioxide in the atmosphere). Man-made aerosols are produced from sulphur dioxide emitted predominantly by power stations, and by the smoke from deforestation and the burning of crop wastes. Aerosol particles cool the climate by directly reflecting sunlight; they can also stimulate the formation of clouds, which causes an indirect cooling effect.

Previous studies have found a link between aerosols and long-term changes in sea surface temperatures, but climate models have previously not directly modelled these complex interactions. This study used a state-of-the-art climate model that incorporated direct and indirect aerosol effects. Introducing the varying levels of volcanic and man-made aerosol emissions that occurred over the period 1860-2005 revealed a corresponding pattern with sea surface radiation over the same time frame. This radiation is largely responsible for long-term variations in sea surface temperature. When aerosol emissions were excluded from the model, the observed changes in sea surface temperature were not reproduced, demonstrating that aerosols are a key driver of sea surface temperature fluctuations.

North Atlantic sea surface temperature has been associated with significant climatic phenomena in neighbouring continents. Reductions in aerosol emissions since the 1980s (in line with the legislation) are linked to warmer north Atlantic temperatures, resulting in greater hurricane activity and much reduced African drought. In a similar way, large increases in aerosol emissions in the decades leading up to this point, are linked to cooler Atlantic temperatures and reduced Atlantic hurricane activity and persistent drought in Sahel Africa. This temperature variation has also been linked to rainfall in eastern South America and the European summer climate. The researchers suggest that aerosol emissions, rather than natural ocean variability, could play a role in such climatic events.

The findings indicate that explicitly modelling aerosol-cloud interactions within climate models could improve future climate change predictions. Man-made aerosol emissions are directly linked to legislation. Emissions of sulphur dioxide (SO_2) decreased by 76% between 1990 and 2009 across Europe[1]. Levels of sulphur oxide gases are now below the 2010 upper limit emission targets as set by the National Emission Ceilings Directive[2] for EU Member States. Incorporating direct estimates of future man-made aerosol emissions into climate models will strengthen predictions of future climate change.

1. Assessment of sulphur dioxide emissions (APE001), European Environment Agency, 2011 http://www.eea.europa.eu/data-and-maps/indicators/eea-32-sulphur-dioxide-so2-emissions-1/assessment-1#toc-1
2. See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:309:0022:0030:EN:PDF

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