Science for Environment Policy
DG Environment News Alert Service
European Commission

22 March 2012

Climate change impacts of aerosols may be underestimated

The Earth is now absorbing more energy from the Sun than it is radiating into space. A recent analysis indicates that most models of this energy imbalance underestimate the impacts of human-made aerosols and overestimate time lags in response to the climate. As such, the energy imbalance and future impacts on climate may be greater than predicted.

The energy balance of Earth is influenced by several types of 'forcing'. Natural forcings include radiation from the sun and volcanic eruptions that inject fine particles, aerosols, into the atmosphere. Human forcings include greenhouse gases (GHGs) and human-made aerosols, such as sulphates and black soot.

The Earth's energy is currently imbalanced - i.e. it is absorbing more energy than it is radiating at a rate of 0.58 Watts per m^2 of its surface. The imbalance defines how much additional global temperature change is 'in the pipeline', so is an important estimation. Recently, there have been improvements in estimation methods, but this study, supported by the EU MyOcean project[1], explored several remaining uncertainties, as follows:

Climate Response - The rate of Earth's response to climate forcing is fundamental to climate impact. Several models used by the Intergovernmental Panel on Climate Change (IPCC) use a slow response rate, which reflects the assumption that oceans distribute heat efficiently and minimise the immediate warming effect. However, recent observations from ocean floats[2] positioned globally, indicate that the response may not be as slow as assumed, which could mean that global warming impacts may be more imminent.

Aerosol climate forcing – As yet, there are no practical measurements of the impact of human-made aerosols. It is complex to achieve, because aerosols both reflect solar radiation (a cooling effect) and absorb solar radiation (a warming effect), and may alter cloud properties. Aerosol forcing is inferred from other measurements and the current study derived a forcing in 2010 of -1.6 W per m^2 (where the minus sign indicates a radiation or cooling effect. Although this does not exceed the range of IPCC estimations, it does exceed the value used in most climate simulations carried out for the IPCC. This suggests current projections may underestimate impacts of human-made aerosols.

Solar variability - The 'solar minimum' is the period of weak activity in the sun's cycle when solar flares and sunspots diminish. The cycle lasts about 10 years and the last minimum (ending in 2008) was the deepest and most prolonged in solar monitoring history since the 1970s. During a time of low solar activity, a clearer picture of human-induced climate forcing (from GHGs and aerosols) can be derived and it has been estimated that during this recent solar minimum, the energy imbalance exceeded + 0.5 W per m^2 (where the + sign indicates absorption or a warming effect). This suggests human-made climate forcing is in fact a dominant factor in driving global climate change.

These findings suggest we may be under-estimating future climate change. More precision is needed, particularly for human-made aerosols, which need better estimations of their impact and a better understanding of which aerosols are causing the forcing.

1. MyOcean is supported by the European Commission under the Seventh framework programme. See: www.myocean.eu.org
2. See: www.argo.ucsd.edu

Source: Hansen, J., Sato, M., Kharecha, P. & von Schuckmann, K. (2011) Earth's energy imbalance and implications. *Atmospheric Chemistry and Physics.* 11:13421-13449.

Contact: james.e.hansen@nasa.gov

Theme(s): Air pollution, Climate change and energy