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Individual power stations' emissions can be identified from a distance

Air pollutants and greenhouse gases (GHGs) from a coal-fired power station have been correctly identified 12 km away, researchers report in a new US study. Their monitoring method paves the way for a space-based satellite system which can check emissions reported by individual power stations against actual emissions.

It is challenging to check the accuracy of emissions reported by nations under international treaties that regulate emissions, such as the Kyoto protocol. Reported estimates are known to contain uncertainties and can be unreliable. This represents a major obstacle in the progress of international emissions treaties.

Emission inventories of air pollutants and GHGs are typically estimated using a 'bottom-up' approach. They use emission factors that depend on the type of fuel burned, the plant's efficiency and clean technologies used. For air pollutants, this approach may be complemented by directly measuring emissions. Plant-level data are then used to draw up the national emissions inventories reported by each country.

The authors of this study argue that their 'top-down' technological approach offers promise for an independent, more accurate way of verifying emissions that could be used to develop enforceable, transparent and fair treaties. The method could also be used by satellite-based measurements in future, they suggest. Compared to ground-based systems, satellites have the advantage of being able to verify emissions over denied territory, such as China or India.

The method's possibilities were demonstrated using the case of two large coal-fired plants in New Mexico, US: Four Corners and San Juan. The researchers set up a ground-based monitoring station 12 km from Four Corners and 3.7 km from San Juan. Levels of CO_2, carbon monoxide and nitrogen dioxide were monitored continuously over four months using solar spectrometers. These analyse the composition of a vertical column of air stretching from the ground to 100 km above – the 'top' of the atmosphere. In particular, they looked at the levels of gases relative to one another (i.e. the ratios) in the column, which were very different for each station (the study does not consider how to distinguish power plant emissions with similar ratios).

They compared these remote recordings with recordings taken by monitors inside the plants' chimney stacks to test how well their method worked. The results showed that recordings from the solar spectrometers also closely matched those made by *in situ* gas analysers at the plants. For example, data show that they both recorded an early-morning rise in emissions on one particular, but typical, day.

The different column ratios of NO_2/CO_2 allowed the researchers to identify which station the emissions came from. They used meteorological information, including on wind direction and temperature, to help them understand how local weather affected the spread of the stations' plumes. The emission ratios also allowed them to distinguish power station pollution from wildfire pollution, because the latter has a higher carbon monoxide-to-CO_2 ratio.

Furthermore, CO_2 released by coal is slightly different to CO_2 from other sources; it has its own 'chemical signature'. By tracking this particular form of the gas ($^{13}CO_2$), the researchers could also see how much CO_2 in the atmosphere came specifically from the two stations, which both used the same local source of coal.

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