Global Atmospheric Chemistry Monitoring

ECVs: Carbon dioxide, Methane and other long-lived greenhouse gases, and Ozone and Aerosol supported by their precursors

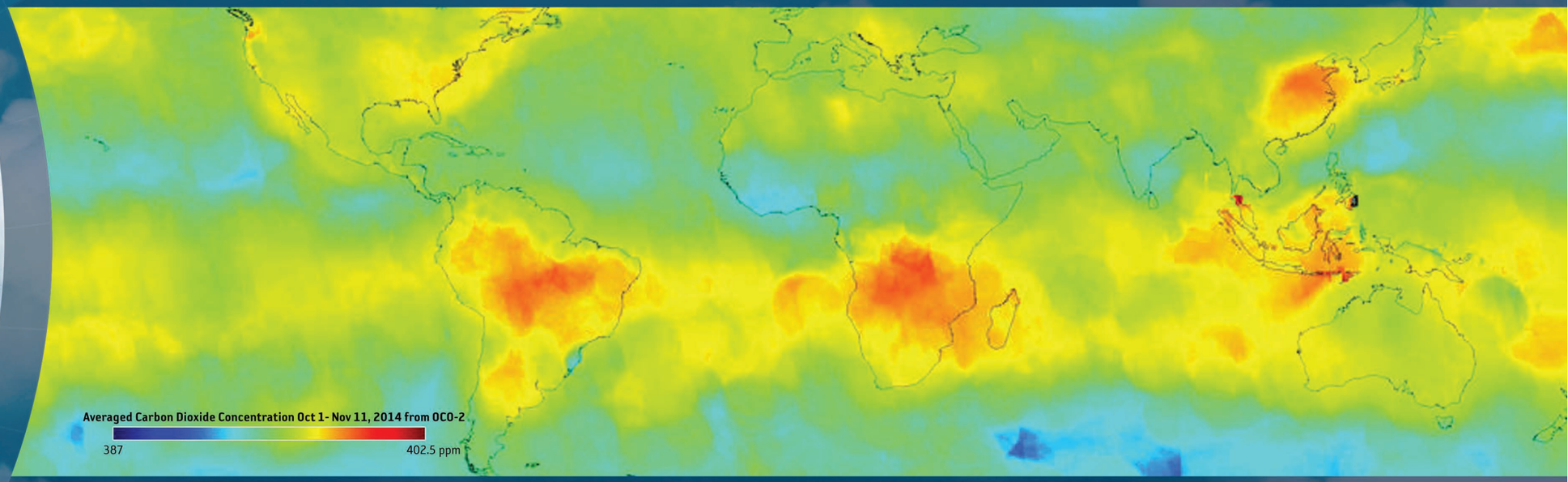
The Role of Satellites

'Atmospheric chemistry instruments' are used to characterise the composition of the Earth's atmosphere, and enable the monitoring of a variety of gases including the greenhouse gases carbon dioxide, methane and ozone. Satellites sense the electromagnetic 'signatures' of these gases, measuring their concentration through the full thickness of the atmosphere, as well as in layers at different altitudes. They provide unparalleled, near-continuous global coverage resulting in a synoptic picture of the atmosphere and how it is changing on a daily, seasonal, annual and decadal basis.

The Earth's atmosphere is a complex, highly interconnected system, with gases produced in one location quickly mixing and travelling vast distances at very high speeds. For example, volcanic eruptions can produce massive gas plumes that are transported in the high atmosphere and impact seasonal weather and climate on a global scale. The only way to provide the comprehensive, consistent and cross-border observations required globally is via satellites.

Tracking the Ozone Hole

Reducing damage to the Earth's ozone layer from chlorofluorocarbons (CFCs) became an important international priority in the 1980s when it was discovered they were partially responsible for thinning the layer worldwide and allowing a large hole to open up over Antarctica during the southern spring. The international community agreed to mitigate the issue by phasing out the use of CFCs under the Montreal Protocol, which came into effect at the beginning of 1989.



This image represents the atmospheric carbon dioxide concentrations from 1 October 2014 through 11 November 2014, as recorded by NASA's Orbiting Carbon Observatory (OCO-2). Carbon dioxide concentrations are highest above northern Australia, southern Africa and eastern Brazil. Preliminary analysis of the African data shows the high levels there are largely driven by the burning of savannahs and forests. Elevated carbon dioxide can also be seen above industrialised Northern Hemisphere regions in China, Europe and North America.

Credit: NASA/JPL-Caltech

Monitoring Carbon Dioxide

Anticipating the policy needs of their governments, space agencies have been developing missions to provide detailed global measurements of greenhouse gases. Two recent missions have focused on the monitoring of carbon dioxide: Japan's GOSAT and the USA's OCO-2.

OCO-2 enables the global tracking of sources and sinks in the carbon cycle, significantly reducing uncertainty about the ultimate destination of carbon dioxide, much of which is thought to be absorbed by the oceans where in-situ observations are limited. In addition, OCO-2 has a 'target' mode that allows for much more detailed observations of a specific location, for example a particular source or sink. Ultimately these observations could be used to produce detailed surveys of sites known to be big emitters of carbon dioxide, such as megacities. Future satellite-based observing systems are envisaged to monitor the evolution of carbon dioxide emissions from local to continental scales. As technology evolves, these systems could also play a role in monitoring the outcomes of adaptation and mitigation actions agreed by governments.