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**Title:**

Atmospheric carbon and the statistical science of measuring, mapping, and uncertainty quantification

**Abstract:**

This is a longer version of a talk presented at the conference, "Science in the Shine Dome 2018," in Canberra last month: Too much carbon dioxide (CO<sub>2</sub>) in the atmosphere is a threat to long-term sustainability of Earth's ecosystem. Atmospheric CO<sub>2</sub> is a leading greenhouse gas that has increased to levels not seen since the middle Pliocene (approximately 3.6 million years ago). One of the US National Aeronautics Space Administration's (NASA) remote sensing missions is the Orbiting Carbon Observatory-2, whose principal science objective is to estimate the global geographic distribution of CO<sub>2</sub> sources and sinks at Earth's surface, through time. This starts with the measurement of radiances from soundings, moves on to retrievals of the atmospheric state, from which maps of gap-filled and de-noised geophysical variables and their uncertainties are made. With the aid of a model of transport in the atmosphere, CO<sub>2</sub> fluxes can be estimated. Uncertainty quantification using hierarchical statistical models is critical at all stages.