



Review

Atmospheric composition change: Ecosystems–Atmosphere interactions

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ABSTRACT

Ecosystems and the atmosphere: This review describes the state of understanding the processes involved in the exchange of trace gases and aerosols between the earth's surface and the atmosphere. The gases covered include NO, NO₂, HONO, HNO₃, NH₃, SO₂, DMS, Biogenic VOC, O₃, CH₄, N₂O and particles in the size range 1 nm–10 μm including organic and inorganic chemical species. The main focus of the review is on the exchange between terrestrial ecosystems, both managed and natural and the atmosphere, although some new developments in ocean–atmosphere exchange are included. The material presented is biased towards the last decade, but includes earlier work, where more recent developments are limited or absent.

New methodologies and instrumentation have enabled, if not driven technical advances in measurement. These developments have advanced the process understanding and upscaling of fluxes, especially for particles, VOC and NH₃. Examples of these applications include mass spectrometric methods, such as Aerosol Mass Spectrometry (AMS) adapted for field measurement of atmosphere–surface fluxes using micrometeorological methods for chemically resolved aerosols. Also briefly described are some advances in theory and techniques in micrometeorology.

For some of the compounds there have been paradigm shifts in approach and application of both techniques and assessment. These include flux measurements over marine surfaces and urban areas using micrometeorological methods and the up-scaling of flux measurements using aircraft and satellite remote sensing. The application of a flux-based approach in assessment of O₃ effects on vegetation at regional scales is an important policy linked development secured through improved quantification of fluxes. The coupling of monitoring, modelling and intensive flux measurement at a continental scale within the NitroEurope network represents a quantum development in the application of research teams to address the underpinning science of reactive nitrogen in the cycling between ecosystems and the atmosphere in Europe.

Some important developments of the science have been applied to assist in addressing policy questions, which have been the main driver of the research agenda, while other developments in understanding have not been applied to their wider field especially in chemistry-transport models through deficiencies in obtaining appropriate data to enable application or inertia within the modelling community. The paper identifies applications, gaps and research questions that have remained intractable at least since 2000 within the specialized sections of the paper, and where possible these have been focussed on research questions for the coming decade.

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