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Understanding and reconciling differences in stratospheric ozone composites to improve long-term trend estimates

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Observations of stratospheric ozone from multiple satellite instruments span several decades. But, for long-term trends to be estimated they need to be combined into composite datasets. While several ozone composites have been published, trends disagree by latitude and altitude, even for composites constructed with the same data. We confirm that the main differences in decadal trend estimates are due to steps when different instruments are introduced and instrument drifts, which then lead to inaccurate trend estimates in multiple linear regression (MLR) analysis.

We introduce a new method to remove these artefacts using Bayesian methods to infer the underlying ozone time series from a set of composites, which is called the BAyeSian Integrated and Consolidated (BASIC) approach. We apply BASIC to four stratospheric ozone composites as an example of what can be achieved with this method, in 10-degree bands from 60 S to 60 N and from 46 to 1 hPa (∼21-48 km) for 1985–2012 with two main outcomes: (i) we independently identify and confirm many of the data problems previously identified, but which remain unaccounted for in existing composites; (ii) we construct a new 'BASIC composite' of stratospheric ozone, with uncertainties, that is free from most of these problems. To analyse the new BASIC composite, we use dynamical linear modelling (DLM), which provides a more robust estimate of long-term changes through Bayesian inference than MLR. Together, BASIC and DLM provide a step forward in improving estimates of decadal trends.

Our results indicate a significant recovery of ozone since 1998 in the mid-latitudes in the upper stratosphere. The results from BASIC also show no hemispheric difference in the recovery at mid-latitudes, in contrast to an apparent feature that is present, but not consistent, in other composites. Overall, we conclude that it is possible to effectively combine different ozone composites, account for artefacts and drifts, and identify a clear and significant recovery in upper stratospheric ozone since 1998, following an earlier decline.