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Statistical analysis of the precision of the Match method

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Abstract. The Match method quantifies chemical ozone loss in the polar stratosphere. The basic idea consists in calculating the forward trajectory of an air parcel that has been probed by an ozone measurement (e.g., by an ozonesonde or satellite instrument) and finding a second ozone measurement close to this trajectory. Such an event is called a "match". A rate of chemical ozone destruction can be obtained by a statistical analysis of several tens of such match events. Information on the uncertainty of the calculated rate can be inferred from the scatter of the ozone mixing ratio difference (second measurement minus first measurement) associated with individual matches. A standard analysis would assume that the errors of these differences are statistically independent. However, this assumption may be violated because different matches can share a common ozone measurement, so that the errors associated with these match events become statistically dependent. Taking this effect into account, we present an analysis of the uncertainty of the final Match result. It has been applied to Match data from the Arctic winters 1995, 1996, 2000, and 2003. For these ozonesonde Match studies the effect of the error correlation on the uncertainty estimates is rather small: compared to a standard error analysis, the uncertainty estimates increase by 15% on average. However, the effect may be more pronounced for typical satellite Match analyses: for an Antarctic satellite Match study (2003), the uncertainty estimates increase by 60% on average.
The analysis showed that the random errors of the ozone measurements and the "net match errors", which result from a displacement of the second ozone measurement of a match from the required position, are of similar magnitude. This demonstrates that the criteria for accepting a match (maximum trajectory duration, match radius, spread of trajectory clusters etc.) ensure that, given the unavoidable ozone-measurement errors, the magnitude of the net match errors is adequate. The estimate of the random errors of the ozonesonde measurements agrees well with laboratory results.

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