

Evaluating long-term changes in atmospheric ozone

David W. Tarasick, Herman G.J. Smit², Anne M. Thompson³, Gary A. Morris⁴, Jacquelyn C. Witte⁵, Jonathan Davies¹, Tatsumi Nakano⁶, Roeland Van Malderen⁷, Ryan M. Stauffer⁸, Bryan J. Johnson⁹, Rene Stübi¹⁰, Samuel J. Oltmans⁹ and Holger Vömel¹¹

¹Environment and Climate Change Canada, 4905 Dufferin Street, Downsview, ON, M3H 5T4 Canada

²Institute for Energy and Climate Research: Troposphere (IEK-8), Research Centre Juelich (FZJ), Juelich, Germany.

³NASA Goddard Space Flight Center, Greenbelt, Maryland, USA

⁴St. Edward's University, Austin, TX, USA

⁵Earth Observing Laboratory, National Center for Atmospheric Research, Boulder, Colorado, USA

⁶Japan Meteorological Agency, Tokyo, Japan

⁷Royal Meteorological Institute of Belgium, Brussels, Belgium

⁸NASA Goddard Space Flight Center and University of Maryland Earth System Science Interdisciplinary Center, Maryland, USA

⁹NOAA/ESRL Global Monitoring Division, Boulder, Colorado, USA

¹⁰MeteoSwiss Aerological Station, Federal Office of Meteorology and Climatology MeteoSwiss, Payerne, Switzerland

¹¹National Center for Atmospheric Research, Boulder, Colorado, USA

Abstract. Ozonesondes have made inexpensive, accurate measurements of ozone from the ground to 30km for more than 50 years. The data are used extensively for trend analyses and for evaluation of satellite and model data products, and are also part of climatologies that are used as a priori data for satellite retrievals. They are essential as a transfer standard when merging shorter satellite-derived time series, and are the most important source of trend-quality long-term records below about 18 km.

The importance of long-term ozonesonde records as a stable reference has led to increased attention to quantifying uncertainties and changes in ozonesonde data. Based on past intercomparison data, ECC sondes show a modest (~1-5%) high bias with respect to UV-absorption measurements (including MOZAIC-IAGOS) in the troposphere, with an uncertainty of 5%, but no evidence of a change with time. Other sonde types show an increase of 5-20% in sensitivity to tropospheric ozone from 1970-1995. Agreement in the stratosphere is much better.

In the past 20 years ozonesonde precision has improved by a factor of 2, primarily through the adoption of strict standard operating procedures. In addition, many of the most important ozonesonde records have been re-evaluated and corrected, and detailed estimates made of their biases and uncertainties. Corrections to historical data for known issues may reduce biases but simultaneously introduce additional uncertainties. The uncertainty budget for the ozone partial pressure reading has contributions from stoichiometry, cell background current, pump efficiency and temperature, sensing solution type and volume. The much-discussed “background current” has recently been shown to be primarily related to reaction stoichiometry.

Several quality assurance issues remain, but are tractable problems that can be addressed with further research. This will be required if the present goal of better than 5% overall uncertainty throughout the global ozonesonde network is to be achieved. Finally, the importance of regular sonde intercomparisons, employing UV photometers traceable to the modern UV-absorption standard, and of regular comparison of operational station records with multiple satellite sensors, is emphasized.