

# The Long History of Ozone Measurements: Climatological Information Derived from Long Ozone Records

Johannes Staehelin, Christian Vogler, and Stefan Brönnimann

**Abstract** Long-term measurements of total ozone started in the 1920s and a large number of column ozone observations using different techniques were performed prior to the International Geophysical Year (IGY 1957/58) when the presently used method for Dobson spectrophotometry (using two wavelength pair measurements) was introduced as a standard method. Only for a few series the prerequisites (considering, e.g. length of the record, sufficient documentation of observations including wavelengths used, calibration, etc.) are given for a useful and successful re-evaluation of pre-IGY total ozone measurements. In this chapter we summarize the re-evaluation and homogenization of the record of Oxford, performed in the laboratory of Dobson who is one of the most outstanding pioneers of the early atmospheric ozone research history. The Oxford series adds to a few other long-term series extending backwards beyond the IGY which were either recently re-evaluated and homogenized or tested for their reliability. The European sites Arosa (Switzerland), Oxford (United Kingdom), Lerwick (UK), Tromsø (Norway), Svalbard (N), and Vigna di Valle (Italy) allow constructing a long-term interannual ozone climatology extending over more than 4 decades prior to start of the anthropogenic ozone depletion. (However, we only recommend the use of a subset of these series for long-term trend analysis.) The re-evaluated data sets are believed to be particularly useful to compare long-term ozone variability with anthropogenic forcings of the ozone layer (such as anthropogenic ozone depletion, its expected recovery from ozone depleting substances and stratospheric temperature decrease as a consequence of climate change) and to test numerical simulation performance for the pre-CFC era. Examples of other scientific applications of the ozone series related to the study of climate variability are highlighted as well.

**Keywords** Dobson instruments · Ozone · historical measurements · ozone layer · recovery

---

J. Staehelin (✉), C. Vogler, and S. Brönnimann  
Institute for Atmospheric and Climate Science, Swiss Federal Institute of Technology, Zürich,  
Switzerland  
e-mail: Johannes.staehelin@env.ethz.ch

## Introduction

Christian Friedrich Schönbein discovered ozone by electrochemical experiments in the laboratory in 1840 and the following fascinating history of the molecule ozone reflects many aspects of the evolution of modern chemistry in the nineteenth century. Two years after its discovery Schönbein was able to show that ozone is present in ambient air (Schönbein 1844), which was the beginning of the long history of atmospheric ozone research leading to the present text book knowledge that ozone is indeed a key species of the atmosphere—today we know that this molecule is responsible for the protection of the biota living on the Earth's surface from the detrimental part of solar radiation, it is a significant greenhouse gas, the most important precursor for tropospheric oxidation capacity, and the most important species of photochemical air pollution. Based on scientific knowledge, political action was taken to protect the ozone layer with the pioneering Vienna convention (1985) and the subsequent Montreal Protocol. Its 20th anniversary was celebrated in Athens in September 2007 by many involved scientists. Atmospheric ozone history, however, is not only instructive for the development of atmospheric sciences and the interaction between science and politics, but total ozone measurements performed between the 1920s and the late 1950s contain very valuable information not only about the ozone layer prior to the disturbance by human emissions but also about the climate during an important period, e.g., when modern meteorological measurements by observations from space were not available.

Regular total ozone measurements started in the 1920s, after the production of an instrument by Dobson which allowed atmospheric ozone observations with reasonable efforts (Dobson & Harrison 1926). The next generation of instruments designed by Dobson allowed for more sensitive measurements and required much shorter time for evaluation of the measurements (for more details see Section “Main design of Dobson spectrophotometers”). In this earlier time the measurements were motivated by atmospheric science questions, namely the study of the processes determining ozone in the stratosphere (Dobson & Harrison 1926; Dobson et al. 1927, 1929, 1930). In the late 1920s the basic relations between total ozone and synoptic weather conditions were established and the climatology of the worldwide ozone layer in extratropics was derived; in the early 1930s the basic features of stratospheric ozone profiles variability were established (Götz et al. 1934). In the 1930s a chemical theory for stratospheric ozone formation was presented (Chapman 1930) and the basic features of stratospheric ozone transport were determined in the following decades (Brewer 1949; Dobson 1956).

A paradigm change in stratospheric ozone research occurred in the early 1970s, when anthropogenic ozone destruction started to be discussed. The effect of nitrogen oxides emitted by supersonic aircraft was first debated (Johnston 1971). However, no large such passenger fleet was ever built and therefore the problem of stratospheric ozone depletion by nitrogen oxides was no longer a topic of scientific research and public debate. In 1974 ozone depletion by chlorine radicals was studied independently by Stolarski and Cicerone (1974) and Molina and Rowland (1974) and the latter additionally discovered a significant anthropogenic source of