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Total ozone trends and variability at three northern high-latitude stations

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Even though ozone-depleting substances have been substantially reduced due to the Montreal Protocol, it is still not possible to state with confidence that the total column amount of ozone (total ozone) recovers globally. A special focus lies on high latitudes, as they experienced strong stratospheric ozone depletion in the 1980s and 1990s. Especially at northern high latitudes, it is still challenging to detect significant total ozone trends. It is therefore important to use carefully homogenized and stable long-term ozone measurements and advanced trend models to derive ozone trends at northern high latitudes.

This study uses ground-based total ozone measurements in Norway and the Arctic to investigate total ozone trends at northern high latitudes. We present combined total ozone time series from Brewer Spectrophotometers at Oslo (60°N) and Andøya (69°N) in Norway, from 2000 to 2020. In addition, measurements from a SAOZ instrument and a Brewer at Ny-Ålesund in Svalbard are used. The combined Brewer time series consist of direct sun (DS) and global irradiance (GI) Brewer measurements and are complemented with measurements from ground-based ultraviolet radiometers (GUV). This makes it possible to obtain measurements during cloudy conditions and in winter and spring, where DS measurements cannot be retrieved due to large solar zenith angles and reduced direct sunlight.

We present total ozone trends at the three measurement stations using the LOTUS (Long-term Ozone Trends and Uncertainties in the Stratosphere) multilinear regression model. We test various explanatory variables and select a set of predictors to obtain the best possible regression fit. We found that besides the commonly used predictors QBO, ENSO, and solar cycle, tropopause pressure and stratospheric temperature are also important to improve the fit. We finally present annual total ozone trends and trends for different months at each station. Despite that the annual trends were generally found to be insignificant, we detected significant trends in some months.

We believe that our study contributes to a better understanding of long-term ozone changes at

northern high latitudes, which is essential to assess how Arctic ozone responds to changes in ozone depleting substances and to climate change.