

Twenty-two years of Arctic ozone depletion observations and simulations. Is there a trend ?

Florence Goutail, Franck Lefèvre, Andrea Pazmino, Jean-Pierre Pommereau, M. Chipperfield, W. Feng, Michel van Roozendaël, P. Eriksen, K. Stebel, R. Kivi, et al.

▶ **To cite this version:**

Florence Goutail, Franck Lefèvre, Andrea Pazmino, Jean-Pierre Pommereau, M. Chipperfield, et al.. Twenty-two years of Arctic ozone depletion observations and simulations. Is there a trend ?. Quadrennial Ozone Symposium 2016, Sep 2016, Edinburgh, United Kingdom. pp.QOS2016-224. insu-01369332

HAL Id: insu-01369332
https://insu.hal.science/insu-01369332

Submitted on 20 Sep 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Twenty-two years of Arctic ozone depletion observations and simulations. Is there a trend ?

F. Goutail, F. Lefèvre, A. Pazmiño, J. P. Pommereau, LATMOS/IPSL/UVSQ - CNRS, France, **M. Chipperfield, W. Feng,** U. Leeds, UK, **M. Van Roozendael,** BIRA-IASB, Belgium , **P. Eriksen,** DMI, Denmark, **K. Stebel,** NILU, Norway, **R. Kivi,** FMI, Finland, **K. Bognar, X. Zhao, K. Walker, K. Strong** , U Toronto, Canada.
Contact: florence.goutail@latmos.ipsl.fr

Objectives and Method

Quantification of chemical total ozone loss inside polar vortex by comparison between modeled passive ozone and measurements

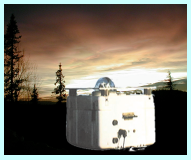
MODELS- 3D CTM
REPROBUS and SLIMCAT
Both models use ECMWF operational analysis 1000 - 0.01 hPa (80 km)
2 runs: a) Passive ozone - initialized on December 1, each winter
REPROBUS from ECMWF ozone operational analysis
SLIMCAT from the output of a long-term simulation
b) Full chemistry

MEASUREMENTS
Total ozone => SAOZ/NDACC UV-Visible network
Twice daily at twilight

UV-Visible SAOZ

- Zenith sky UV-visible spectrometer
- Differential Optical Absorption Spectroscopy
- Ozone: Chappuis bands (450-550 nm)
- Consistency between stations: 3% (NDACC)
- PSC days removed using a color index





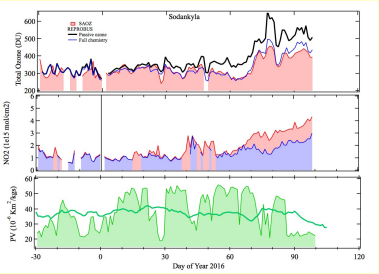
UV-Visible SAOZ network



Winter 2016

1- MEASUREMENTS

Column ozone and NO2 above SAOZ stations



Example: At Sodankyla (Finland)

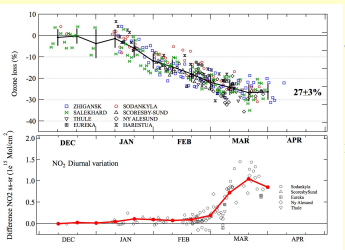
Top:
- Model passive O3 (Black:)
- Model Full chemistry (Blue)
- SAOZ O3 columns (Pink)

Middle:
- SAOZ NO2 at sunrise (blue)
- SAOZ NO2 at sunset (pink)

Bottom
- PV at 475 K from Mimosa contour advection model

2- SAOZ OBSERVATIONS

Ozone loss and denitrification

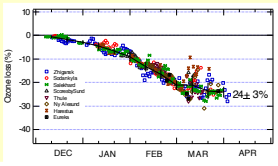


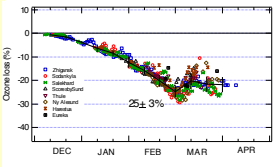
Top
Evolution of ozone loss above SAOZ stations inside vortex
Note the larger loss after March 8 at Ny Alesund.

Bottom
Difference between sunset and sunrise NO2 columns inside vortex

- **Ozone depletion** rate - 0.6% / day between January 10 and February 1
  - 0.4% February 1 and March 10
  - Stopped on March 20
- **NO_2 diurnal increase** (indicating chlorine deactivation) after March 10
- **Total cumulated loss of 27 ± 3%** one of largest Arctic Spring Loss

3- MODEL LOSS ABOVE SAOZ STATIONS



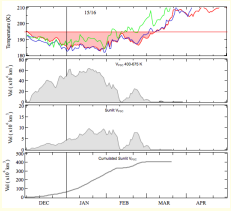


similar results: rate, timing, cumulated loss

REPROBUS
u0.25%/ day from December 20 up to January 30
u0.35%/day from February 1 up to March 1
uStopped on March 1
uLarge scatter after March 1
uCumulated Loss: 24%±3%

SLIMCAT
u0.25%/ day from December 20 up to January 30
u0.4%/day from February 1 up to March 1
uStopped on March 1
uLarge scatter after March 10
uCumulated Loss: 25%±3%

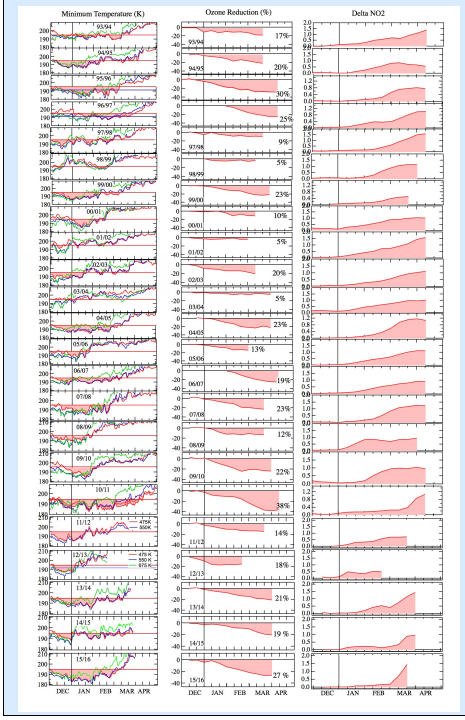
4- METEOROLOGY



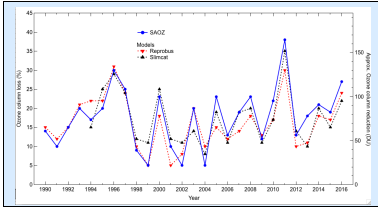
Top
-T<Tnat at levels 475 (red) and 550K (blue) until early March
-T<Tnat athigher level, 675K (green) stopped around February 10

Bottom
- Large sunlit VPSC until March 1st.

Comparison of all winters since 1994

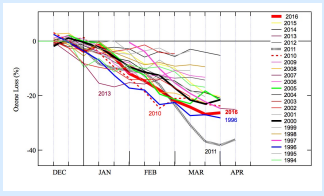


5-OZONE LOSS AND DENITRIFICATION

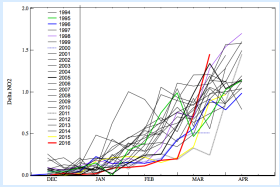


6-SAOZ OZONE LOSS Comparison with REPROBUS and SLIMCAT

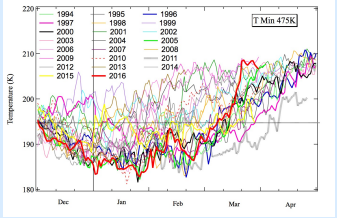
7-OZONE LOSS RATE



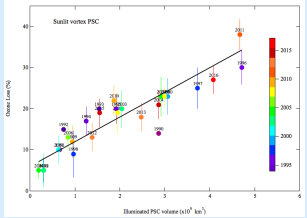
8-DENITRIFICATION



9-METEOROLOGY



10- OZONE LOSS vs SUNLIT PSC



Acknowledgements

- The authors thank the SAOZ stations operators and ECMWF for the meteorological analysis.
- This work was supported by the French CNES and CNRS/INSU within the NDACC/OVSQ
- The SAOZ network is part of NDACC (Network for Detection of Atmospheric Composition Change).
- The authors thank gratefully Cathy Boone at French "ESPRI Data Center" (former ETHER) for providing MIMOSA and REPROBUS maps and data above SAOZ stations.
- The authors thank Vera Sitnikova and the Russian CAO/Roshydromet ozone network for providing Zhigansk and Salekhard SAOZ and Mini-SAOZ data

CONCLUSIONS

- **Large ozone loss interannual variability, dependent on vortex duration**
- **Good agreement between measurements and recent version of CTM models: SLIMCAT and REPROBUS**
- **No indication of ozone loss amplitude reduction**