Total ozone loss during the 2021/22 Arctic winter and comparison to previous years

A. Pazmiño[1] , F. Goutail[1], J. P. Pommereau[1], F. Lefèvre[1], S. Godin-Beekmann[1], A. Hauchecorne[1], A. Lecouffe[1], M. Chipperfield[2], W. Feng[2], M. Van Roozendael[3], N. Jepsen[4], G. Hansen[5], R. Kivi[6], R. Alwarda[7], K. Strong [7], K. Walker [7] and S. Colwell[8]

[1]LATMOS/IPSL, UVSQ, Université Paris-Saclay, Sorbonne Université, CNRS, Guyancourt France,
[2]School of Earth and Environment, University of Leeds, Leeds, UK,
[3]Belgian Institute for Space Aeronomy (BIRA), Brussels, Belgium,
[4]Danish Meteorological Institute, Copenhagen, Denmark,
[5]Norwegian Institute for Air Research, Kjeller, Norway,
[6]Finnish Meteorological Institute, Sodankylä, Finland,
[7]Department of Physics, University of Toronto, Toronto, Canada,
[8]British Antarctic Survey, Cambridge, UK
andrea.pazmino@latmos.ipsl.fr

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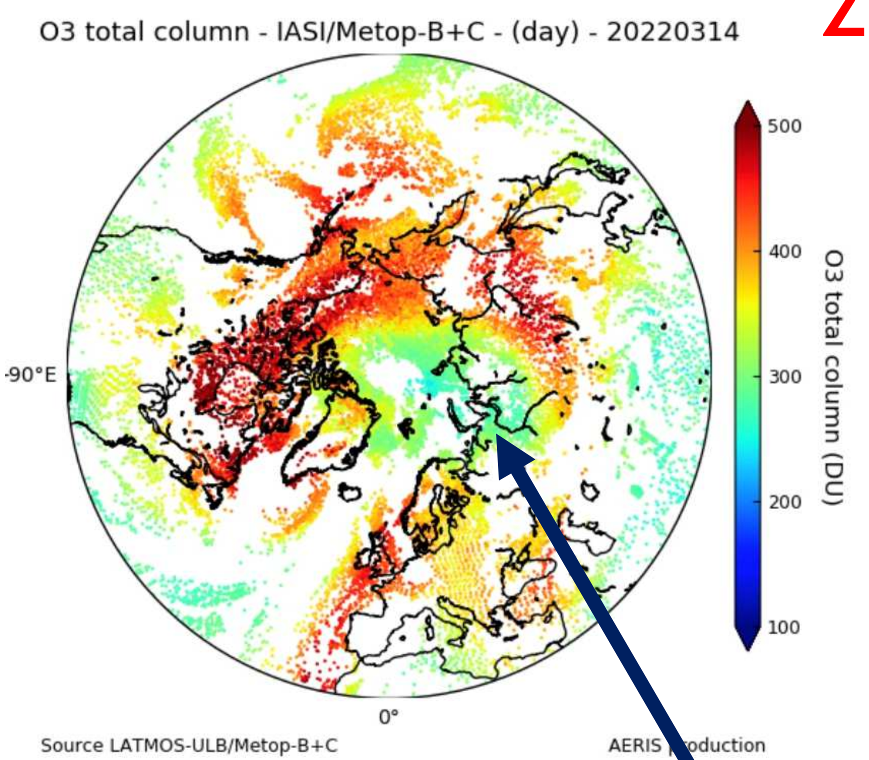
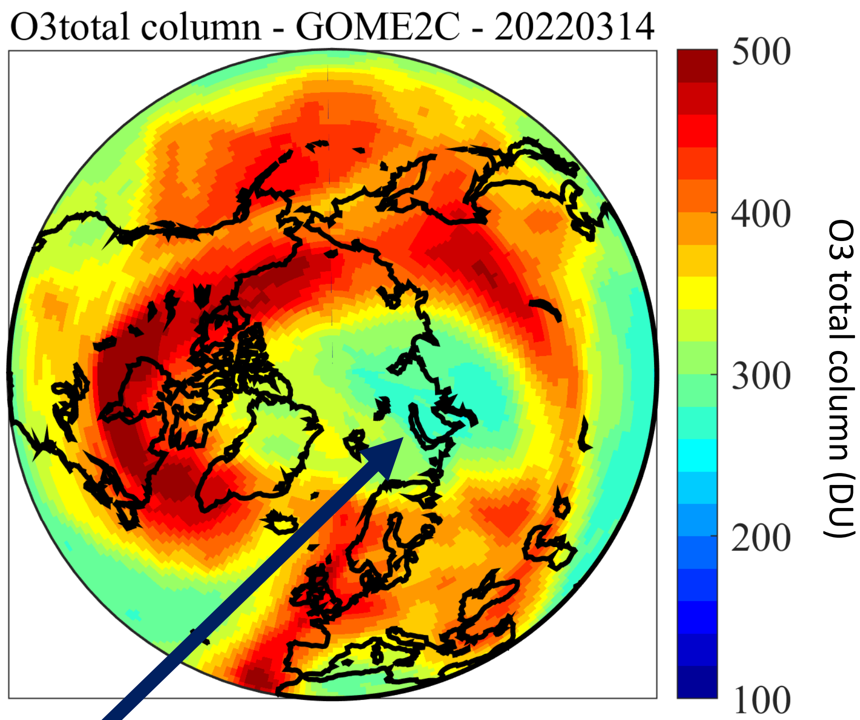
Ozone low values still appearing in the Arctic?

2022





Ozone Fields from IASI measurements onboard METOP-B and C

Region of low ozone values in the Arctic

Assimilated Ozone Fields based on GOME-2 measurements onboard METOP-C

Data and method

Goal: Analyze a possible chemical ozone recovery

- Follow o3loss evolution using passive tracer method

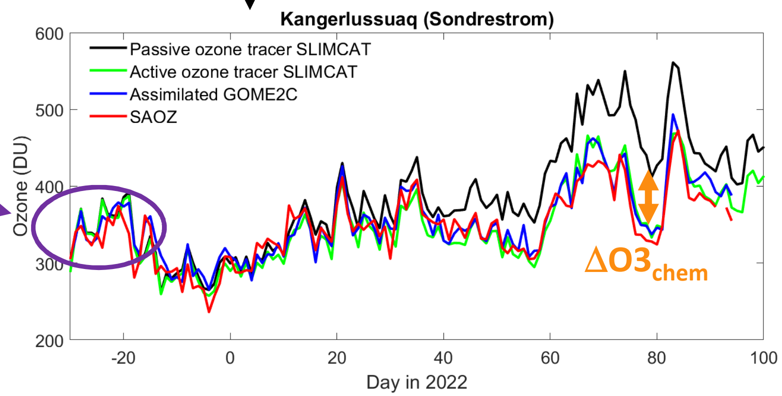
  O3loss=$O3_{passive\_tracer}$- $O3_{observations}$

  Tracer: Chemical Transport Model SLIMCAT (Chipperfield, 2006)
  1) Passive ozone (only dynamics)
  2) Full chemistry (dynamics + chemistry)

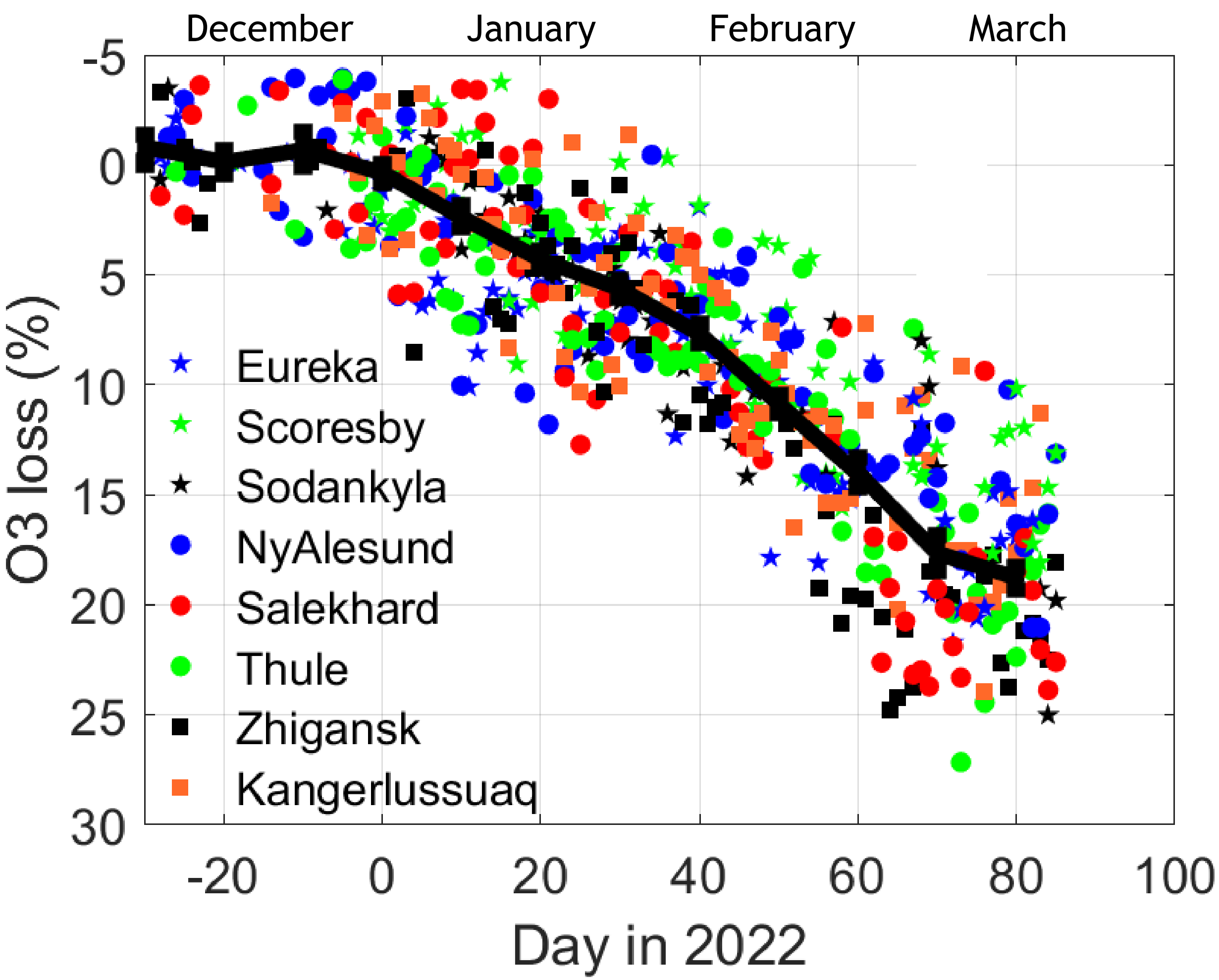
  Forced by ERA5 reanalysis until Feb. 2022 and OPER in March 2022

  OBS: 1) SAOZ UV-Vis network
  2) Assimilated fields
  MSR2 1990-2019 NH winters
  GOME2C 2020-2022 NH winters

- Normalization beginning winter
- Selection of data inside the vortex (Nash method)
- O_3 loss above Arctic stations



Evolution of ozone loss in the 2021/22 winter



- O_3 loss above Arctic stations
- 10-day average of ozone loss
- Cumulative O3 loss at the end of winter

Loss rate:

0.18 %/day in January

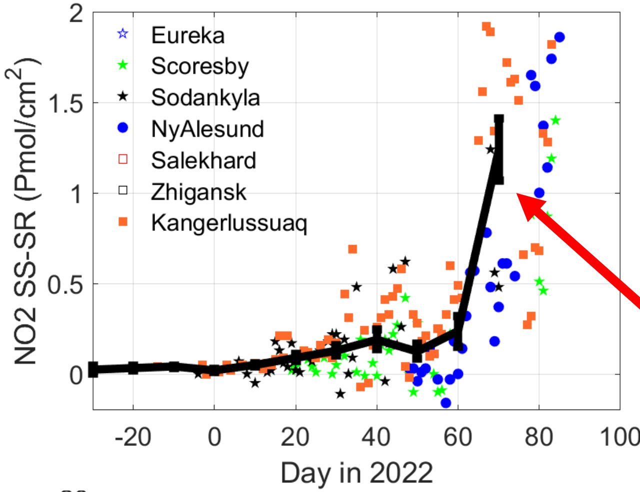
0.3%/day Feb.-March 10

Cumulative loss:

18.8 ± 0.5 %

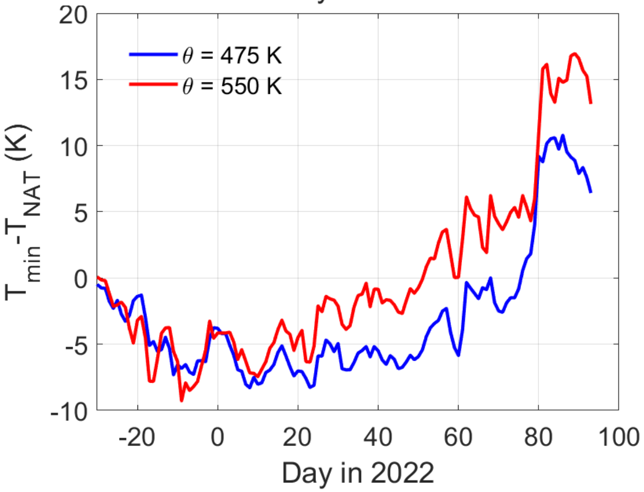
(92.7 ± 3.2 DU)

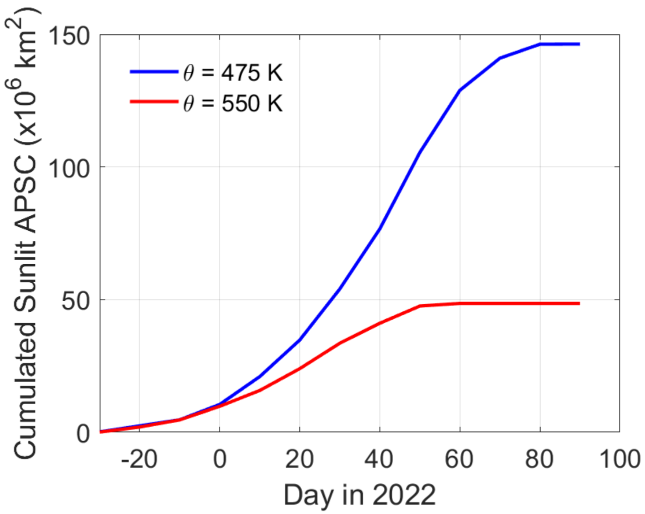
Meteorological conditions and denitrification

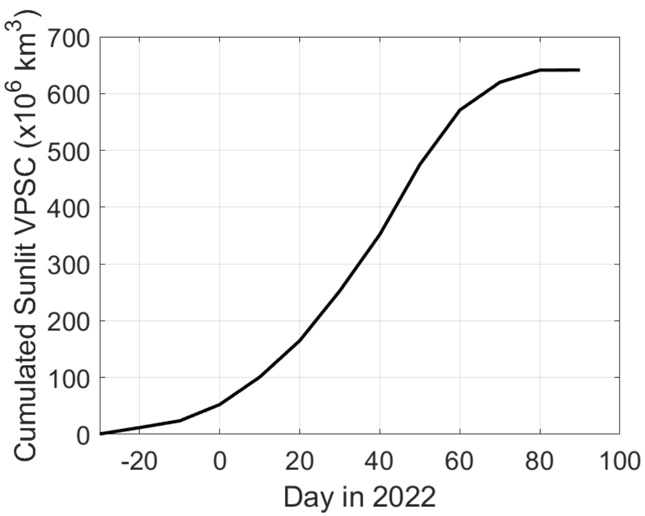


Difference sunset - sunrise SAOZ NO_2 columns inside vortex
=> index of chlorine activation

Dec: No diurnal variation - Absence of NOx in vortex - Chlorine activated
Jan-Feb: ΔNO_2 slow increase -> Partial chlorine deactivation
March 10: ΔNO_2 fast increase -> Chlorine fully deactivated





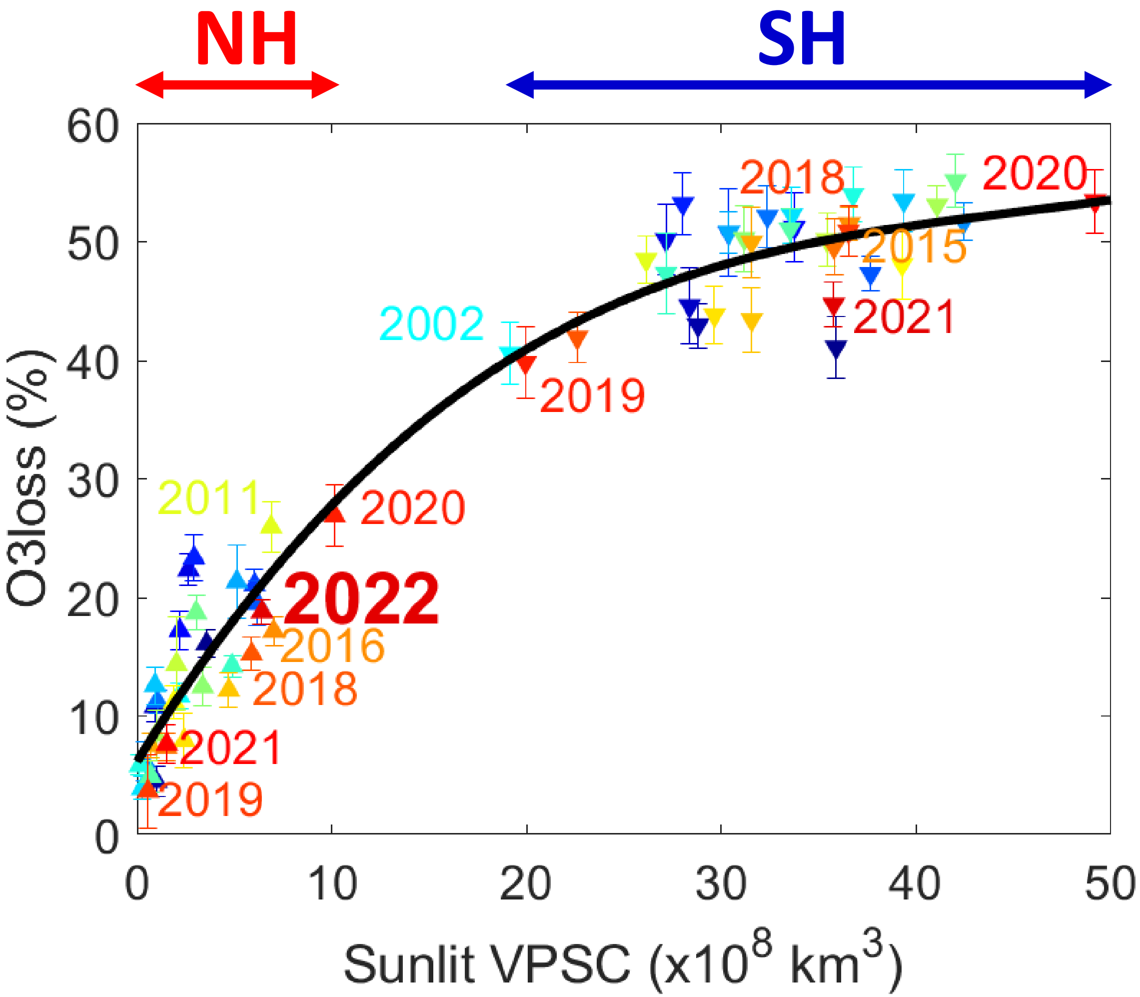


$T_{min}<T_{NAT}$: 195K at θ=475K (105 days)
192K at θ=550K (80 days)

Compute area of PSC ($APSC_\theta$) at SZA<93°

Volume calculated following Rex et al., (2004) => $(APSC_{475K}*0.8+APSC_{550K}*0.2)*5.06$

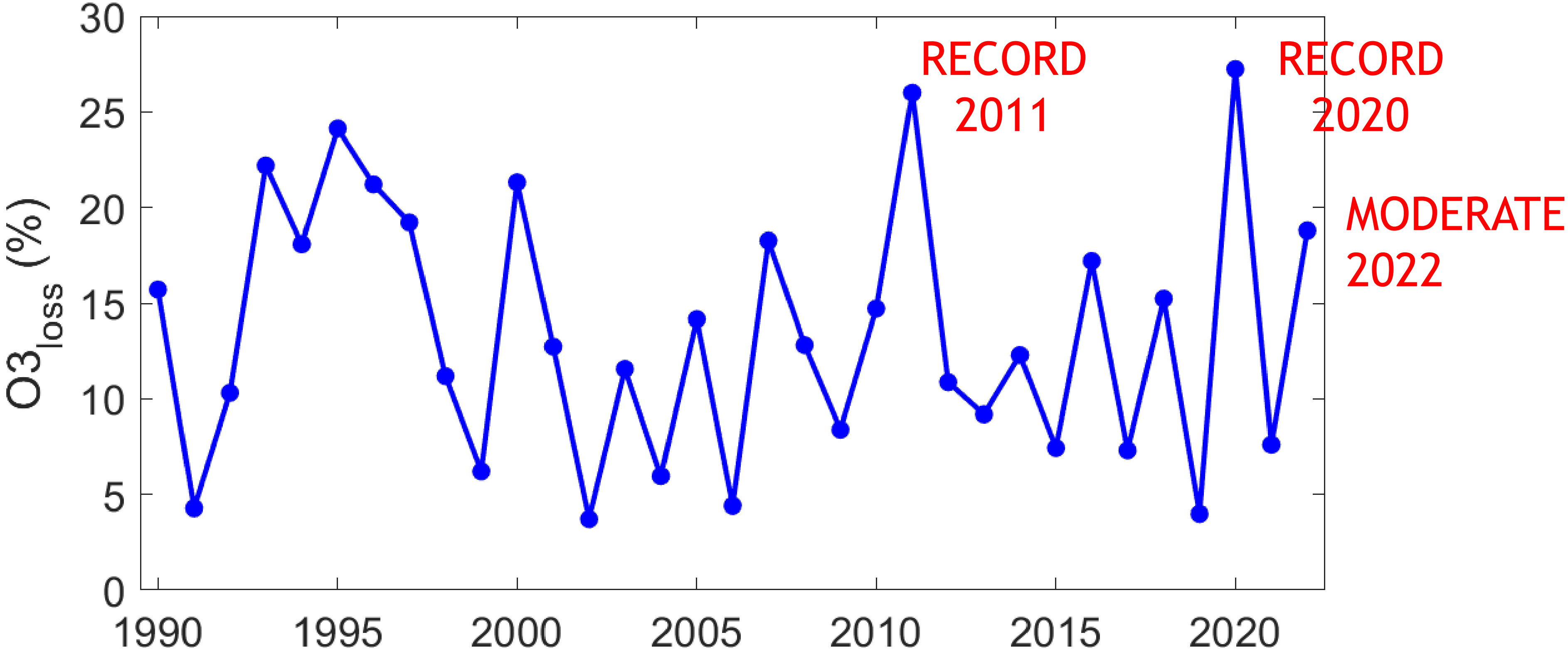
O3loss vs Sunlit VPSC



SH:
saturation of O_3 loss towards 55 %

NH:
quasi-linear fit
2022 within the fit

Interannual variability

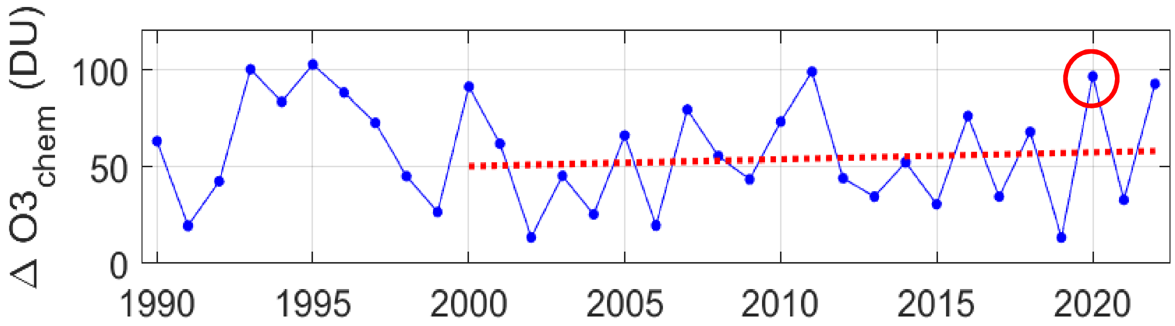


Sensibility of O_3 loss to history of stratospheric T => high interannual variability

x Warm winters: 5-13%

x Cold winters: 20-28%

Dynamical and chemical contributions

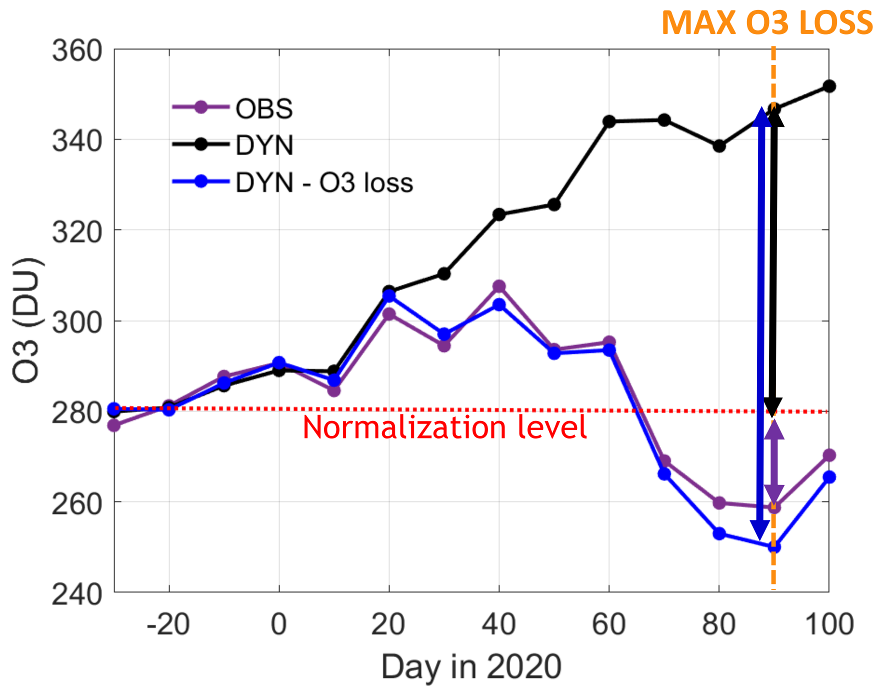


Absolute O3 loss

Slightly positive trend since 2000 but **NOT** significant. Mostly influenced by record years.
Mean value 54.4 ± 26.9 DU

What about contribution of dynamics ?

Ex. 2019/2020

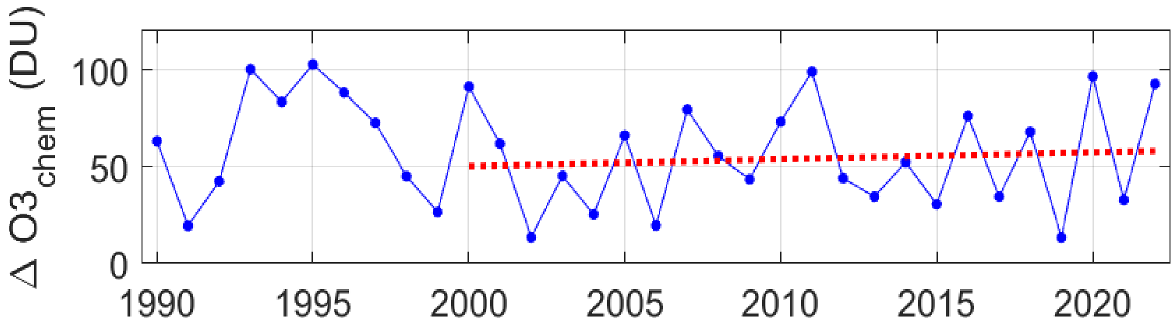


$\Delta O3_{dyn}$

$\Delta O3_{chem}$ = 96.6 DU

$\Delta O3_{meas.\ column}$

Dynamical and chemical contributions



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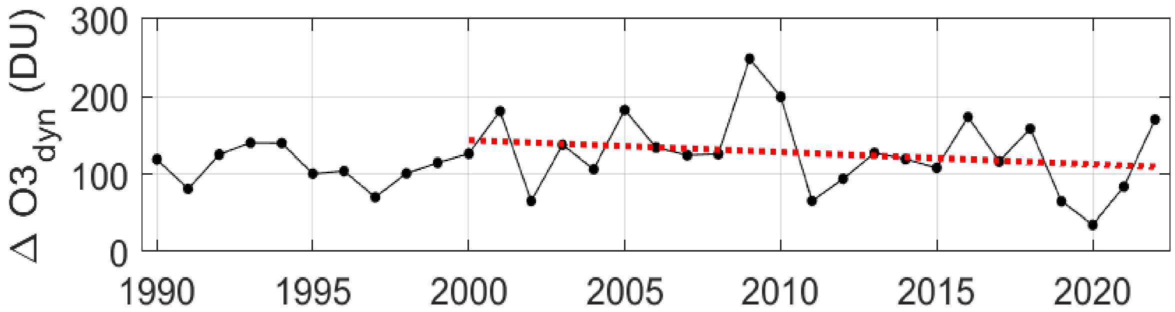
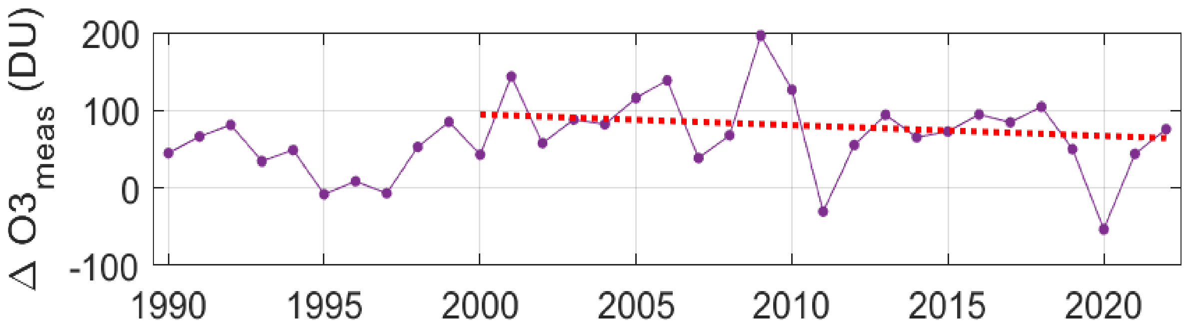


Dynamical contribution

Stable before 2000, higher variability after and negative trend but **NOT** significant



Ozone column anomalies

Similar to the interannual evolution of dynamical ozone contribution
Negative trend but **NOT** significant

Conclusion
In Northern Hemisphere

- **2022** moderate O3 loss winter:
  - >3 months PSC at 475 K
  - Rapid T increase & chlorine deactivation beginning of March
  - follows the quasi-linear relationship with sunlit VPSC
  - O3loss rate max **0.3 DU/day** Feb. 1 - March 10
  - Cumulated o3loss **19%**
- Dynamics contribution is predominant on ozone anomalies, both with similar negative trends but **NOT** significant.
- O3 loss seems to increase with time but **NOT** significant trend either. Up to now impossible to detect ozone chemical recovery.