Total Ozone Loss during the 2007/2008 Arctic Winter and Comparison to Previous Years.

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Objectives and Method

- To quantify the chemical ozone loss inside Vortex
- Comparison between modeled passive ozone and measurements

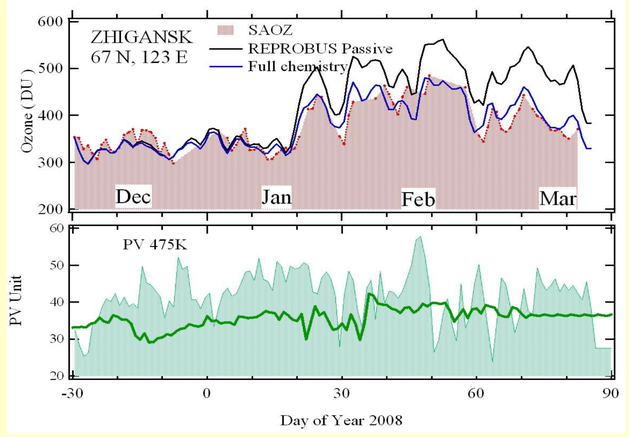
MODEL
- 3D CTM
  initialized on December 1, 2007 from ECMWF ozone fields
  => REPROBUS (ECMWF, 1000 - 0.1 hPa)
  => SLIMCAT (ECMWF, 1000 - 0.1 hPa)

  2 runs: a) Passive Ozone
  b) Full chemistry

MEASUREMENTS
- Total ozone => SAOZ UV-Visible network
  - Twice daily

MEASUREMENTS

Ozone above SAOZ stations



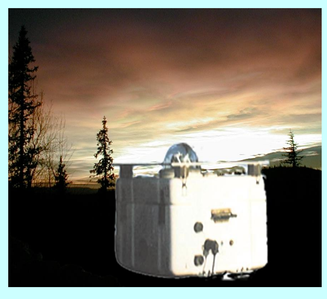
At Zhigansk station (Eastern Siberia):
- A difference between SAOZ O3 columns (pink) and passive O3 from REPROBUS (black) is observed after January 20.

- This difference is increasing throughout the winter indicative of an O3 loss building up inside the polar vortex.

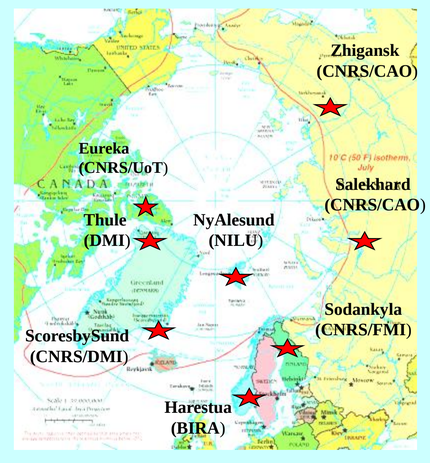
- Around March 15, Zhigansk is inside vortex (PV > pv limit) the difference is ~ 100 DU

UV-Visible SAOZ

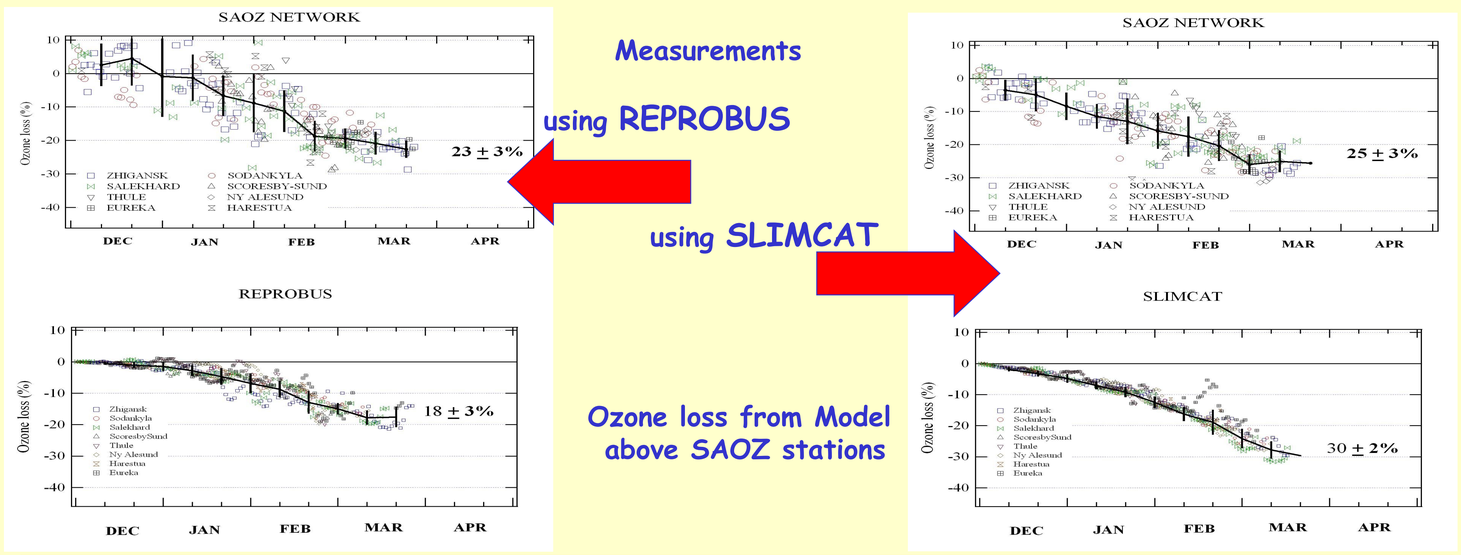
- Zenith sky visible spectrometer.
- Differential Optical Absorption Spectro.
- Ozone: Chappuis bands (450-630nm)
- Consistency between stations: 3% (NDSC Intercomparisons)
- PSC days removed using a color index



UV-Visible SAOZ network



Ozone loss above SAOZ stations



Measurements using REPROBUS

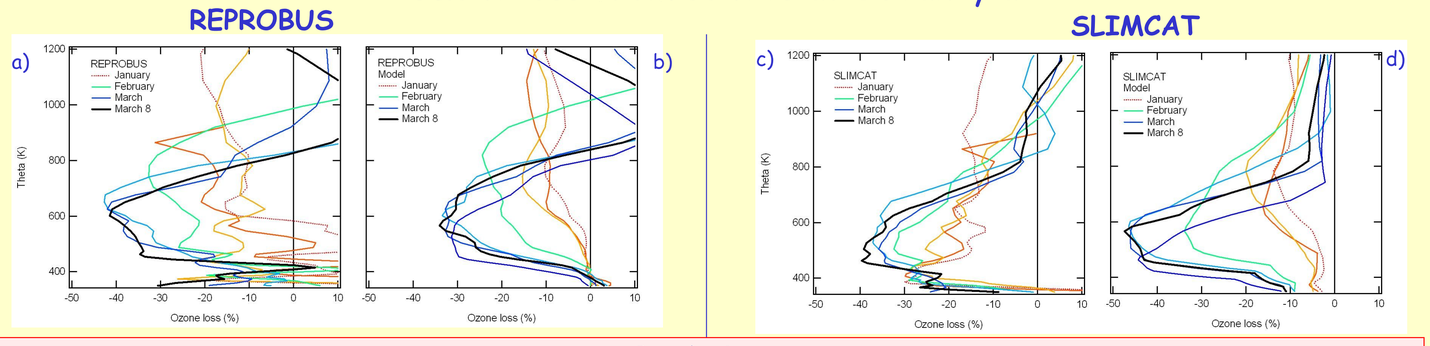
using SLIMCAT

Ozone loss from Model above SAOZ stations

Conclusion:

Significant ozone loss in Vortex in winter 2007/2008
According to SAOZ (using Passive ozone from REPROBUS), most of the loss occurred between Jan. 10 and Feb. 20 at a rate of 0.5% per day leading to a loss of 20%. After that date the loss significantly slowed down at a rate of 0.1% per day. The cumulative loss on Mar. 10 reached 23% ± 3%.
Smaller results are simulated by REPROBUS : 18% on Mar. 10. Larger loss are simulated by SLIMCAT : 30 % on Mar. 10
The difference between the 2 models has been investigated using ozone sondes profiles above one of the SAOZ stations (see below).

Ozone loss from sondes at Sodankyla

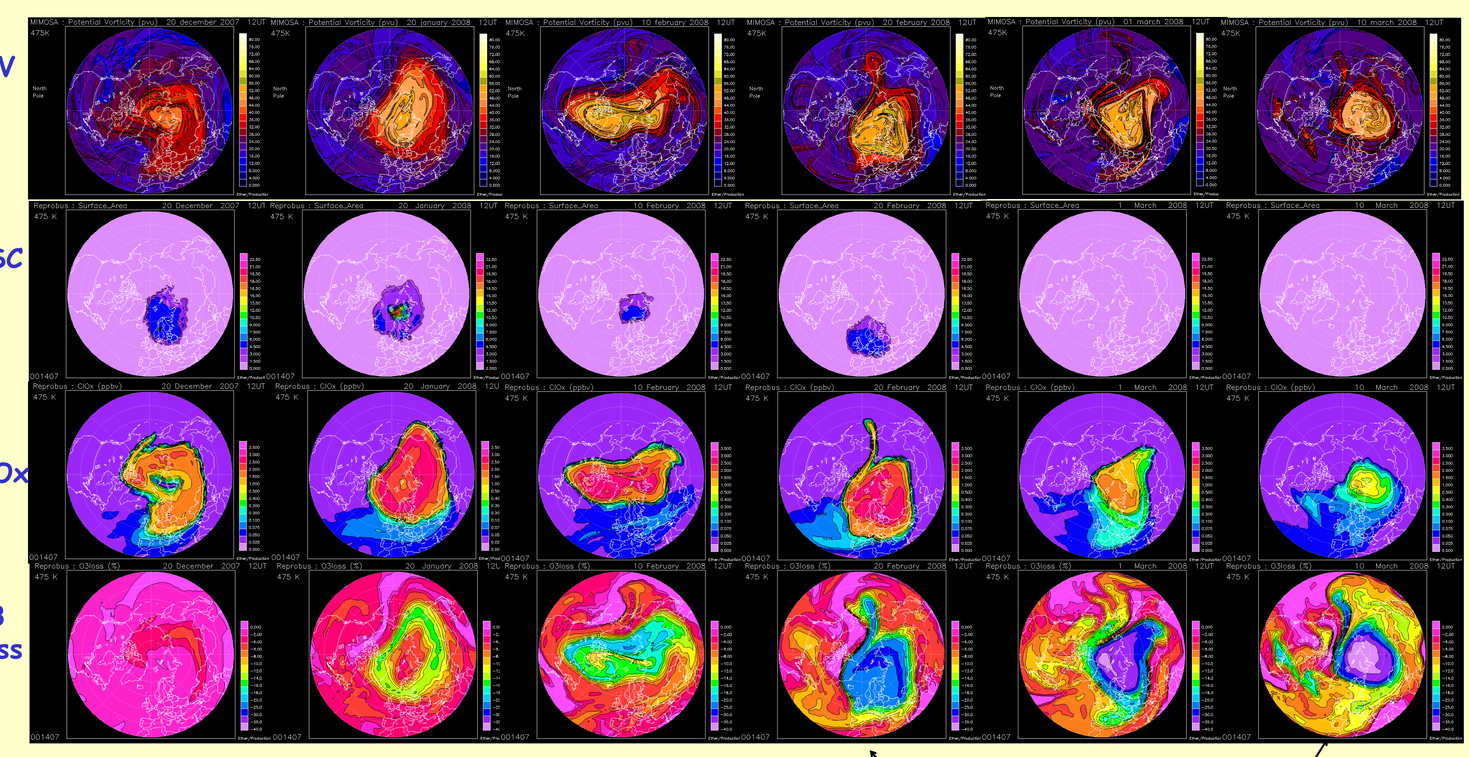


Conclusion:

- SONDES March 8: maximum ozone loss is similar with Reprobus (40% at 600K) (a) or Slimcat (40% at 475K) (c), but at lower altitude with Slimcat
- MODEL: simulated ozone loss show that the loss started at higher levels (750K) in January 2008 (red) then it was around 600 K in February (green).
  In March the maximum loss was between 420K and 650K using Slimcat Model (d) with a maximum ozone loss of 47% at 550K.
  The loss was on a larger altitude range: 420K and 800K using Reprobus Model (c), but of smaller amplitude of 35% at 550K.

A possible reason for the differences between the two model simulations will be investigated in the future using OClO vertical profiles from SCIAMACHY (when available).

REPROBUS 3D CTM SIMULATION (475 K) – MIMOSA PV FIELDS



Conclusion:

The vortex was formed in late December 2007.
and centered around the pole until mid- January.
Then, it was elongated and displaced to sunlit regions.
The surface of the vortex reduced after March 1.
Important PSC surface from second half of December towards February 20, linked to low temperatures.
January 20, REPROBUS is simulating low HCl and high ClOx inside the vortex. However, limited O3 loss restricted to sunlit regions only.
On February 1, after displacement of vortex toward sunlit areas, 15-20% O3 loss are simulated.
The O3 loss is rapidly increasing during the month of February.
On March 10, low ClOx and low BrOx. However, the model simulates more than 40 % O3 loss in the remaining vortex.

Acknowledgements

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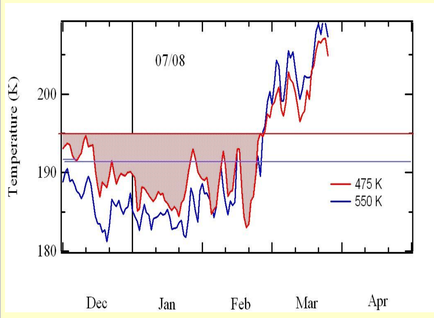
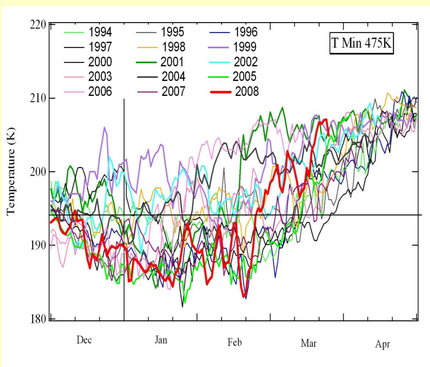
METEOROLOGY

Cold Temperatures from December to end of February.



- Temperatures < 194 K from December 1, 2007
- Minor warming at the end of January and in February
- Final warming around February 25, 2008

Cold winter in the decade

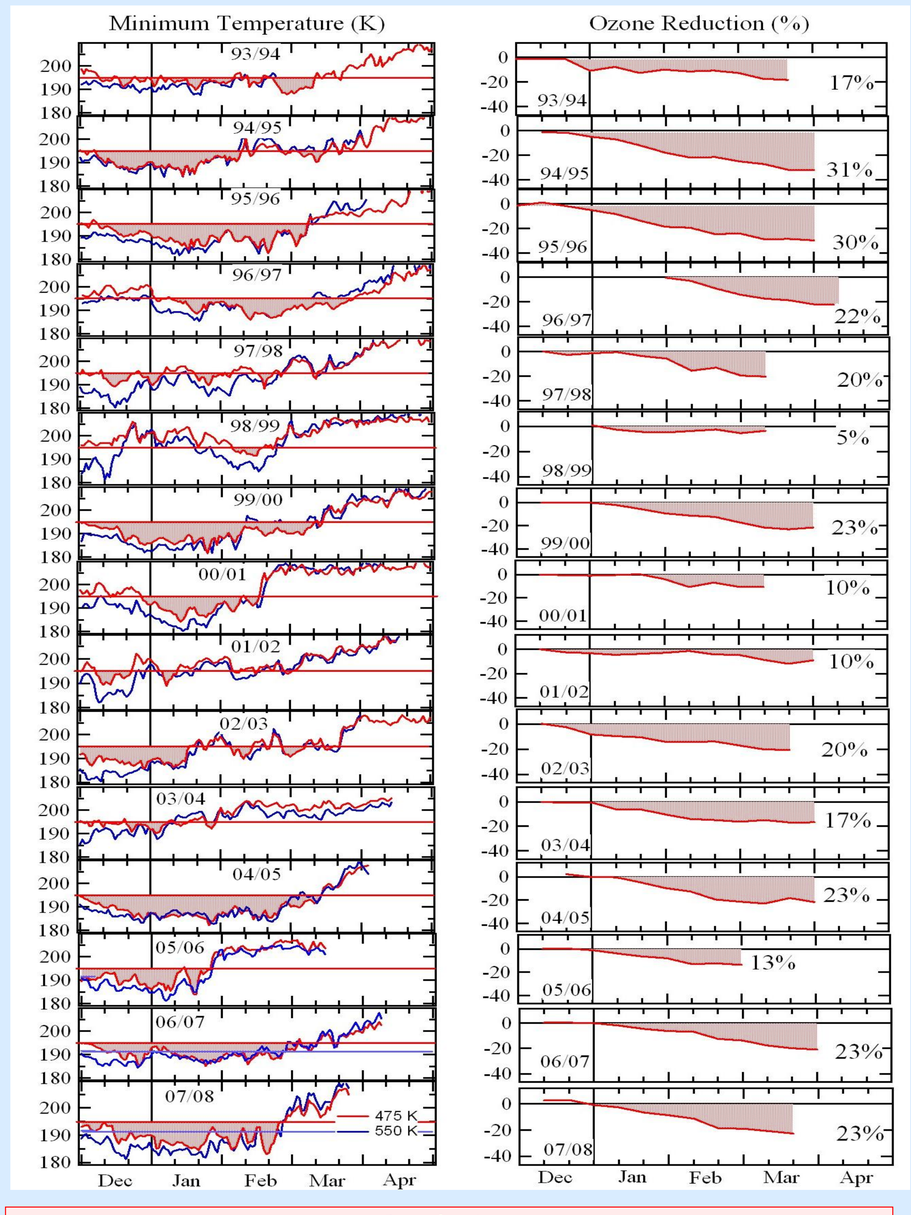


- Persistence of low temperatures as in the cold winter of 2004/05
- Compared to previous winters the final warming occurred earlier this year, around February 25.

Conclusion:

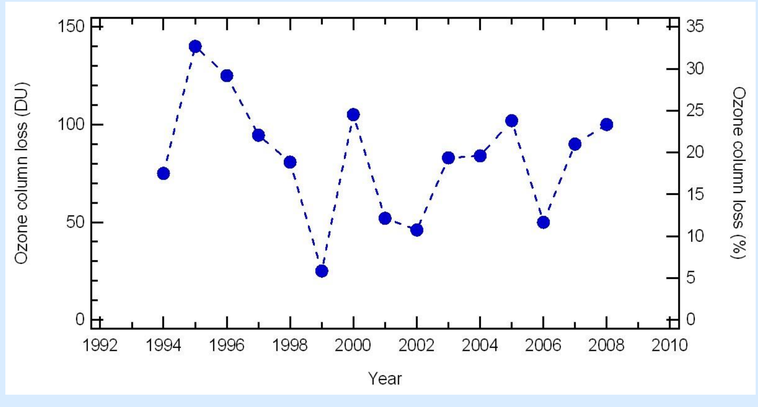
- Low temperatures <194K allow the formation of Polar stratospheric clouds (**PSC**)
- On the PSC surface, **chemical reactions** occur which transform passive and innocuous halogen compounds (e.g. HCl and HBr) into **active chlorine** and bromine (e.g. ClO and BrO).
- Under sunlit conditions, these active species react with ozone through **catalytic cycles** which cause rapid **ozone destruction.**
- This processes were only possible **from January 15, 2008** when the cold areas were displaced toward sunlit region;

Comparison to Previous Winters



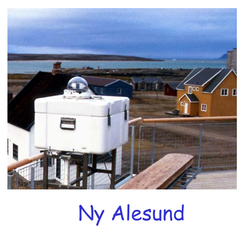
Conclusion:

Significant O3 loss occurred during the winter 07/08.
The temperature was below that's of PSC formation during a long period starting on December 1, with a final warming occurring around February 25.
At the end of the period, around March 10, observed cumulative loss was **23 %.**
This is smaller than the 30% observed in 94/95 and 95/96 values but larger than the 5-10% observed in 98/99, 00/01, 01/02 and 05/06 winters




Zhigansk


Eureka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