Total Ozone Loss during the 2009/2010 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

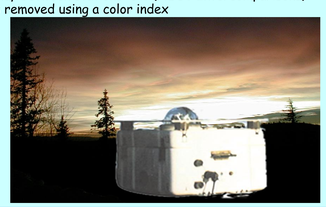
MODEL
- 3D CTM
  initialized on December 1, 2009 from ECMWF ozone fields
  => REPROBUS (ECMWF, 1000 - 0.1 hPa)
  => SLIMCAT (ECMWF, 1000 - 0.3 hPa)

  2 runs: a) Passive Ozone
  b) Full chemistry

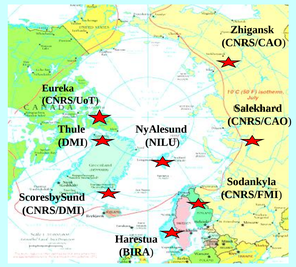
MEASUREMENTS
- Total ozone => SAOZ UV-Visible network - Twice daily

UV-Visible SAOZ

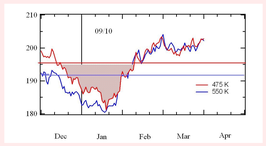
- Zenith sky visible spectrometer.
- Differential Optical Absorption Spectroscopy
- Ozone: Chappuis bands (450-550 nm)
- Consistency between stations: 3% (NDSC Intercomparisons)
- PSC days removed using a color index



UV-Visible SAOZ network



METEOROLOGY



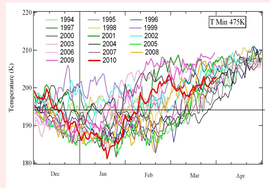
Cold Temperatures from Mid-December to end of early February.

- Temperatures < 194 K from Mid-December 1, 2009

- Final warming around February, 10 2010

Cold winter in the decade

- Low temperatures during December and January
- Final warming around February, 10 2010
-Compared to previous winters it was one of the coldest in January.
- However, the final warming occurred early this year, around February 10.



Conclusion

-Low temperatures <194K for the formation of Polar stratospheric clouds (**PSC**) only until end of January.
-On the PSC surface, **chemical reactions** occur which transform passive and 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 possible **only after January 15, 2010** when the cold areas received sunlight.

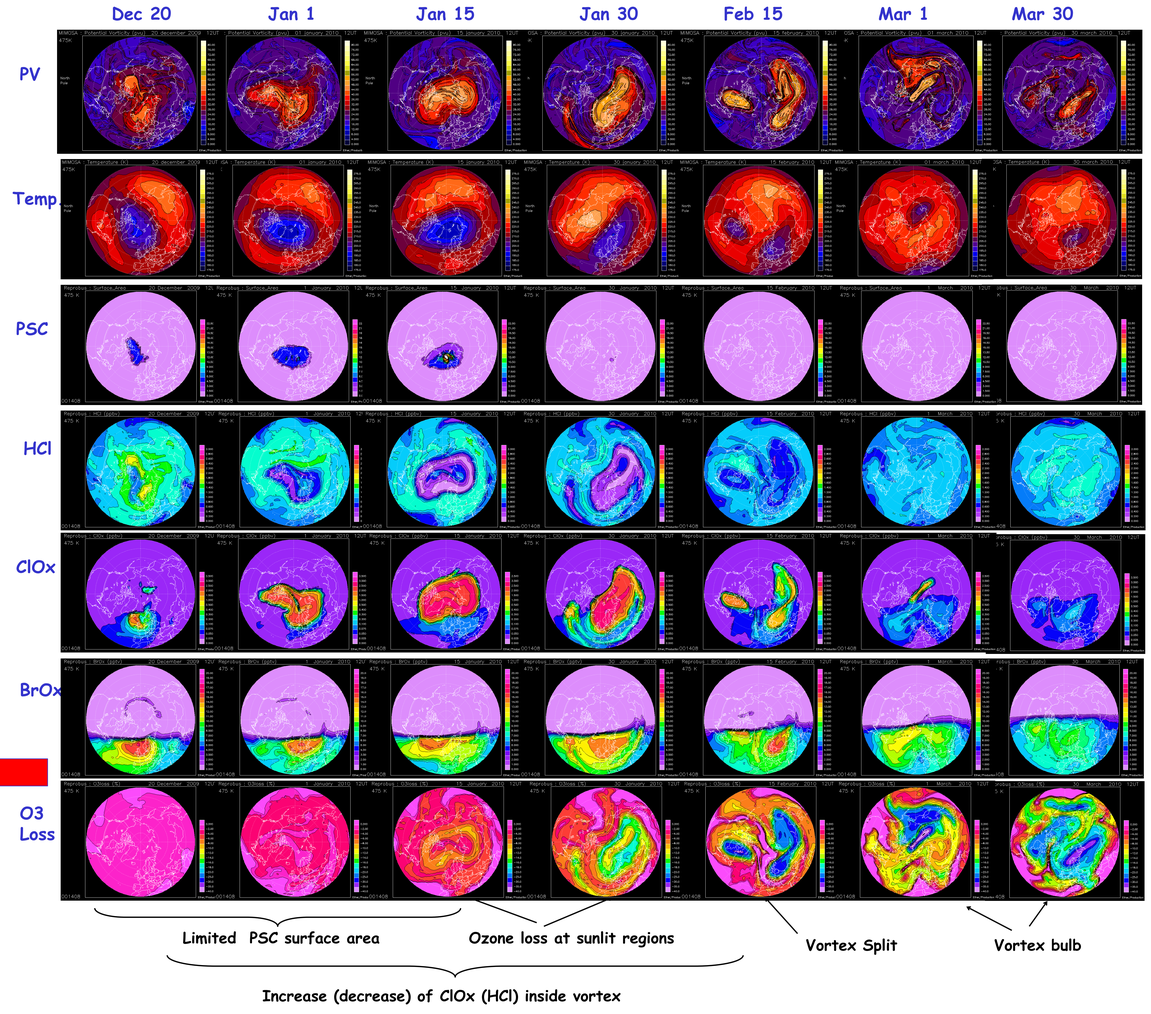
Conclusion (Reprobus at 475 K)

- The vortex was formed in early December 2009 and centered around the pole until mid- January.
- Then, it was elongated around Jan 30 and displaced to sunlit regions.
- The vortex spilt into two activated bulbs around Feb 15.

- Limited PSC surface from end of Mid-December towards Mid-January, linked to low temperatures.

- January 15, REPROBUS is simulating low HCl and high ClOx inside the vortex. However, limited O3 loss restricted to sunlit regions only.
- January 30, O3 loss reaching 18-20% at the vortex periphery.
- On February 15, after split of vortex in two bulbs, 30% O3 loss simulated increasing locally to 35-40% around Mar 1.

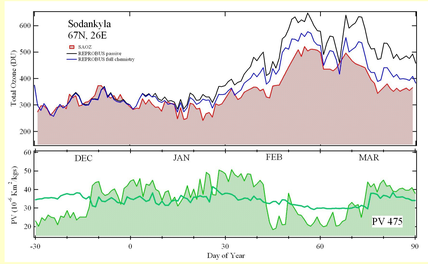
REPROBUS 3D CTM SIMULATION (475 K) – MIMOSA PV FIELDS



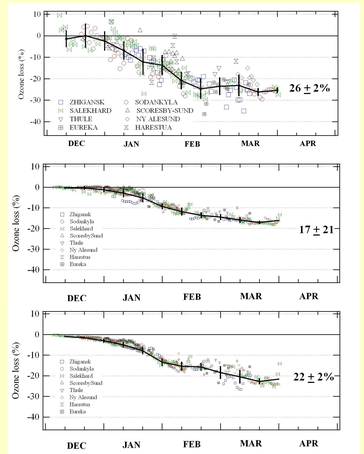
MEASUREMENTS

Ozone above SAOZ stations

At Sodankyla station (Finland):
- A difference between SAOZ O3 columns (pink) and passive O3 from REPROBUS (black) is observed at the beginning of January.
- On February 10, Sodankyla is inside vortex (PV > pv limit) the difference is ~125 DU
- REPROBUS CTM with full chemistry (blue) is underestimating the loss.



O3 Loss in 2009/2010



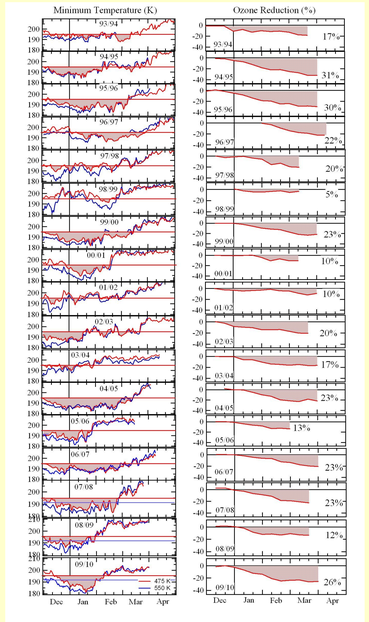
Conclusion:

- Large ozone loss in Vortex in winter 2009/2010
- According to SAOZ using Passive ozone from REPROBUS (or using passive ozone from SLIMCAT), most of the loss occurred between Jan 1 and Feb 20 at a rate of **0.5% per day** leading to a cumulative loss of 26% ± 2%. After that date the loss stopped.

- **REPROBUS:** Loss rate of **0.4% per day** between Jan 1 and Feb 10 and 0.1% between Feb 10 and Mar 20. Cumulative loss 17% on Mar 20 .

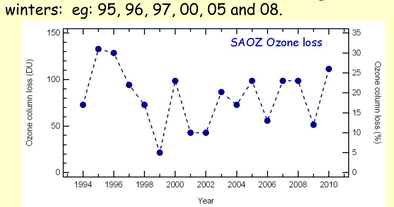
- **SLIMCAT:** Similar loss rate of **0.4% per day** between Jan 1 and Jan 30 and 0.2% between Feb 1 and Mar 20. Cumulative loss 22% on Mar 20 .

Comparison to Previous Winters



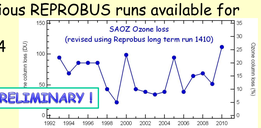
Conclusion:

- Large O3 loss occurred during the winter 09/10.
- The temperature was below that's of PSC formation during a period starting on Dec 15, until Feb 10.
- At the end of the period, around February 20, observed cumulative loss was **26 %.**
- This is similar to what was observed during the cold winters: eg: 95, 96, 97, 00, 05 and 08.



Futur:

- Ozone losses from SAOZ since 1993 will be revised using a single REPROBUS multi-annual run 1410 instead of the various REPROBUS runs available for each winters
(eg: run 200 93/94
run 813 99/00
run 1300 04/05
and now 1410)



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