Total Ozone Loss during the 2005/2006 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**

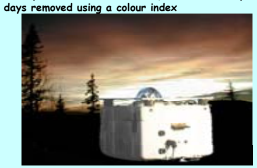
MODEL
- **3D CTM**
  - **=> REPROBUS (ECMWF, 1000 - 0.1 hPa)**
    (RUN 001300 Ozone: initialized on December 1, 2005 from ECMWF ozone fields (assimilation from GOME + SBUV).
    Other constituants: from 2D Climatology initialized on July 1st, 2002)
  - **=> SLIMCAT (ECMWF, 1000 - 0.3 hPa)**
    New version of Slimcat: RUN 323

2 runs: **a) Passive Ozone** **b) Full chemistry**

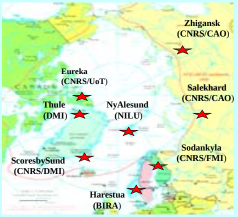
MEASUREMENTS
- **Total ozone => SAOZ UV-Visible network - Twice daily**

UV-Visible SAOZ

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

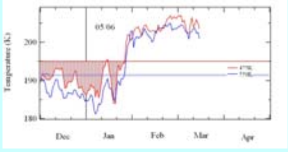


UV-Visible SAOZ network



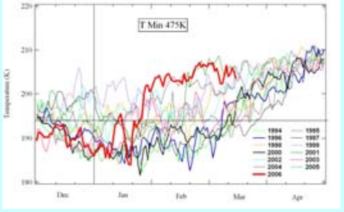
METEOROLOGY

Cold Temperatures in December and Januuary



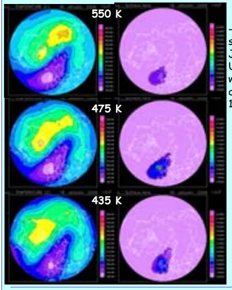
- Minimum temperature north of 30°N at two levels: 475K (18km) and 550K (21km)
- Final warming accured on January 26, 2006

Warm winter in the decade



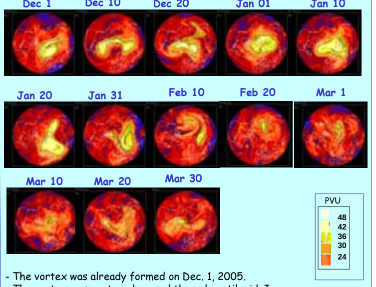
PSC surface areas

-PSC observed above Sodankyla on January 7 and 8, 2006 by SAOZ (colour index > 2)
-PSC observed above OHP (Observatoire de haute Provence) by Lidar on January 18 and 19, 2006



-Maximum PSC surface area on January 18, above UK and France, when temperature decreased below 185K.

Vortex evolution

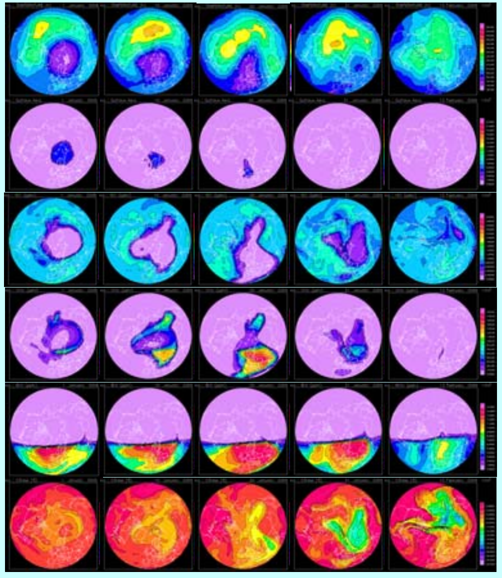


- The vortex was already formed on Dec. 1, 2005.
- The vortex was centered around the pole until mid-January
- After mid-January the vortex was displaced toward sunlit areas.
- After Jan. 31, the vortex became weaker.
- On Feb 20, only a small bulb is visible above eastern Siberia.
- It vanished almost completely after mid-March

Conclusion

-Low temperatures <195K 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 **in January** when the cold areas were displaced toward sunlit regions, that is UK and France

REPROBUS 3D CTM SIMULATION on 475 K isentropic surface



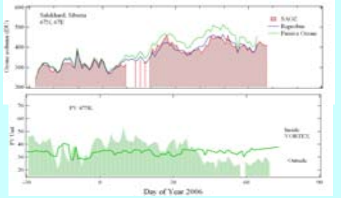
Conclusion

- During second half of January, after low temperatures allowing PSC formation, REPROBUS is simulating low HCl and high ClOx. However, very limited O3 loss by that date at 475K.
- On January 31, after displacement of vortex toward sunlit areas a 14-16% O3 loss at 475K is simulated.
- On February 13, ten to fifteen days after the final warming, low ClOx and low BrOx are simulated. However, around 18-20% O3 loss at 475K are modelled in the vortex.

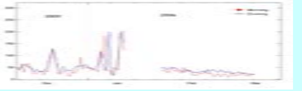
MEASUREMENTS

Ozone above SAOZ stations

At Salekhard station (Western Siberia):
- A difference between SAOZ O3 columns (pink) and passive O3 from REPROBUS (green) is observed at the end of January.
- This difference is slightly increasing throughout the winter indicative of an O3 loss building up inside the polar vortex.
- Around February 10, Salekhard is inside vortex (PV > pv limit) the difference is ~ 50 DU

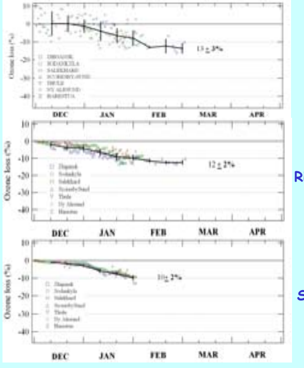


OClO above Harestua station



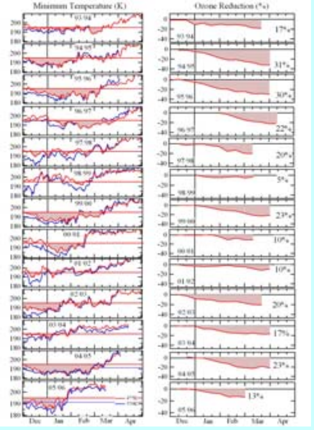
Peaks of OClO indicative of ClO activation around Dec 20, 2005 and between January 5 and January 20, 2006

O3 Loss in 2005/2006

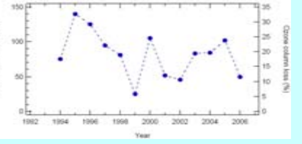


Conclusion:
- Significant ozone loss in Vortex in winter 2005/2006
- According to SAOZ, most of the loss occured between Jan 1 and Feb. 10 at a rate of 0.32% per day leading to a cumulative loss of 13%.
- After that date the loss stopped.
- Similar results are simulated by REPROBUS (12% on Feb. 20.) and by SLIMCAT (10% on January 31).

Comparison to Previous Winters



Conclusion:
- Winter 05/06 is one of the lowest O3 loss of the decade.
- Ozone reduction started after January 1, 2006 at a rate of **0.32 % /day**, similar to 99/00 winter.
- But in contrast with 99/00, the final warming occured very early on January 26.
- At the end of the period, observed cumulative loss of **13 %**, a little larger than in 00/01 and 01/02.



Acknowledgements

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- The SAOZ stations are part of the NDSC (Network for Detection of Stratospheric Changes).
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