

Ozone loss in the Arctic winter 2015/2016

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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, 2015

REPROBUS from ECMWF ozone operational analysis

SLIMCAT from the output of a long-term simulation

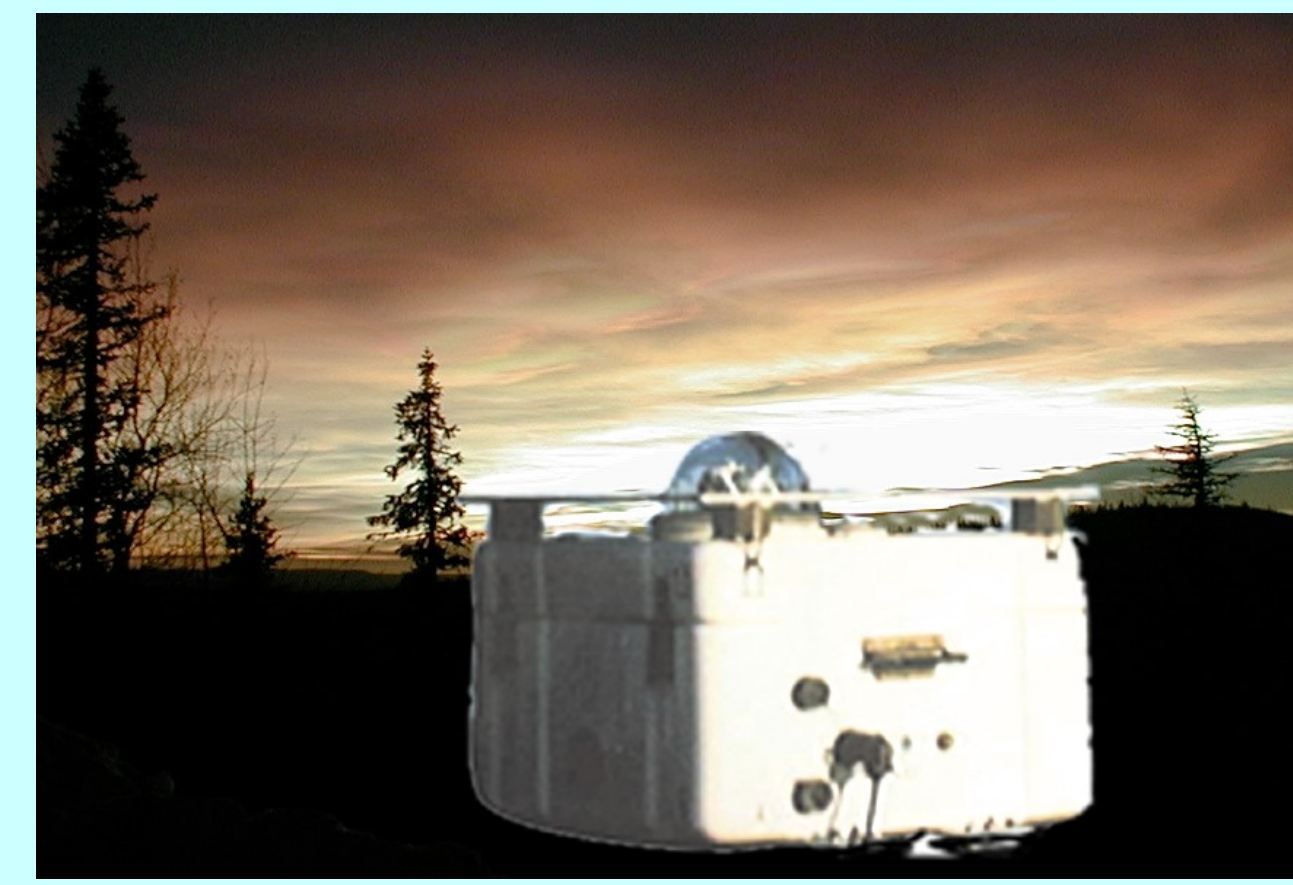
b) Full chemistry

MEASUREMENTS

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

UV-Visible SAOZ

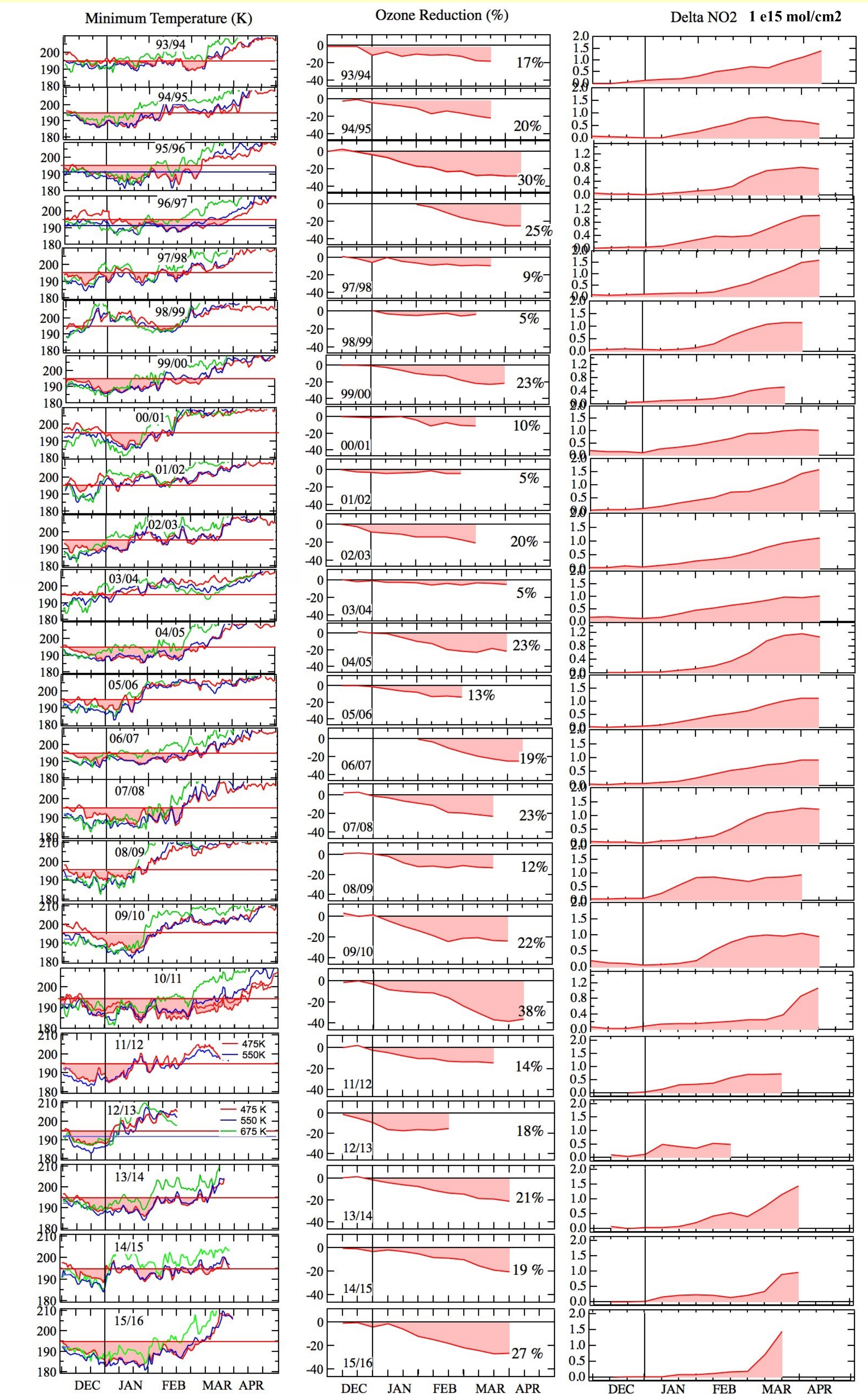
- Zenith sky UV-visible spectrometer
- Differential Optical Absorption Spectroscopy
- Ozone: Chappuis bands (450-550 nm)
- Consistency between stations: 3% (NDACC Intercomparisons)
- PSC days removed using a color index



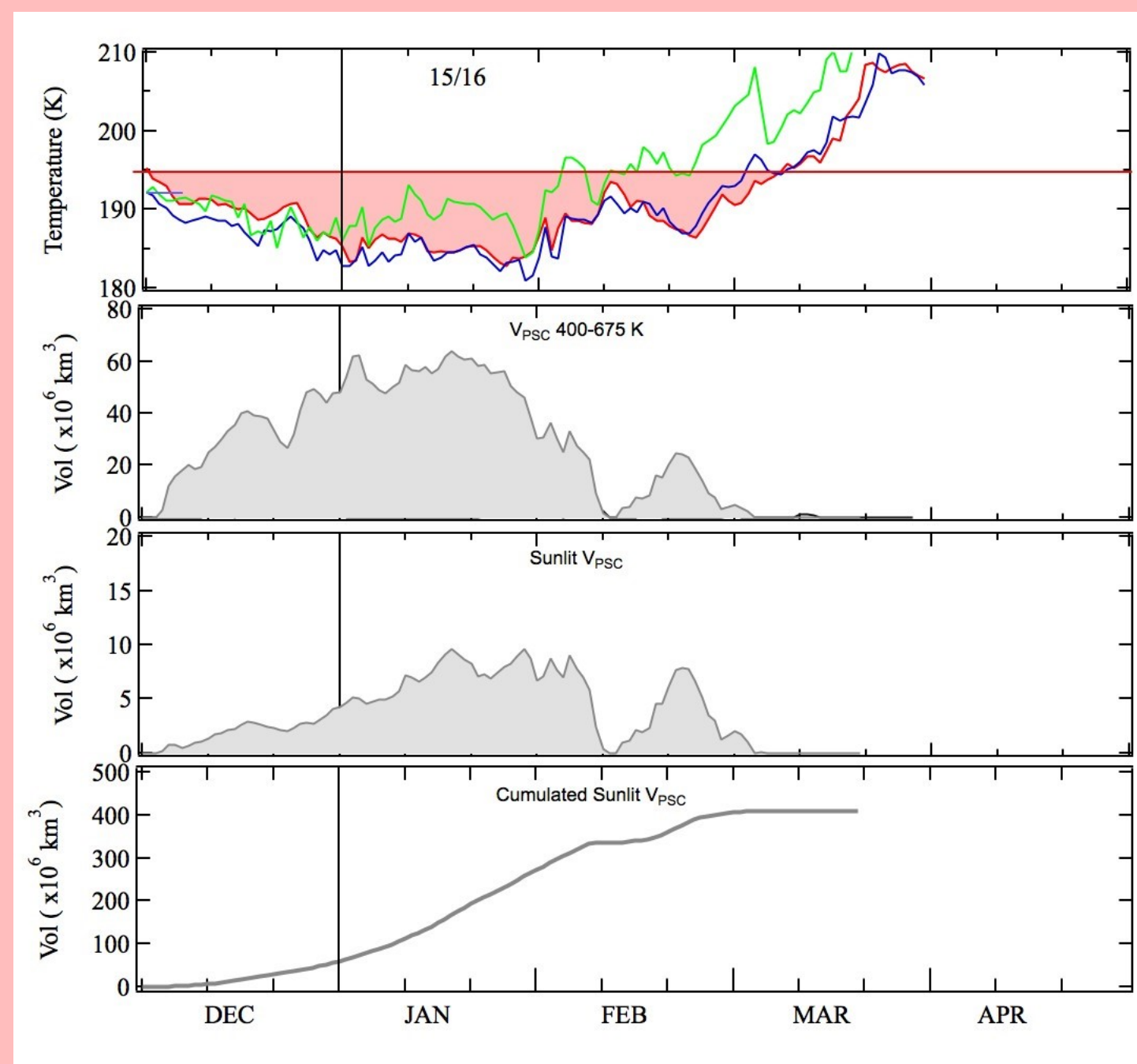
UV-Visible SAOZ network



5- COMPARISON TO PREVIOUS WINTERS



1- METEOROLOGY



Top

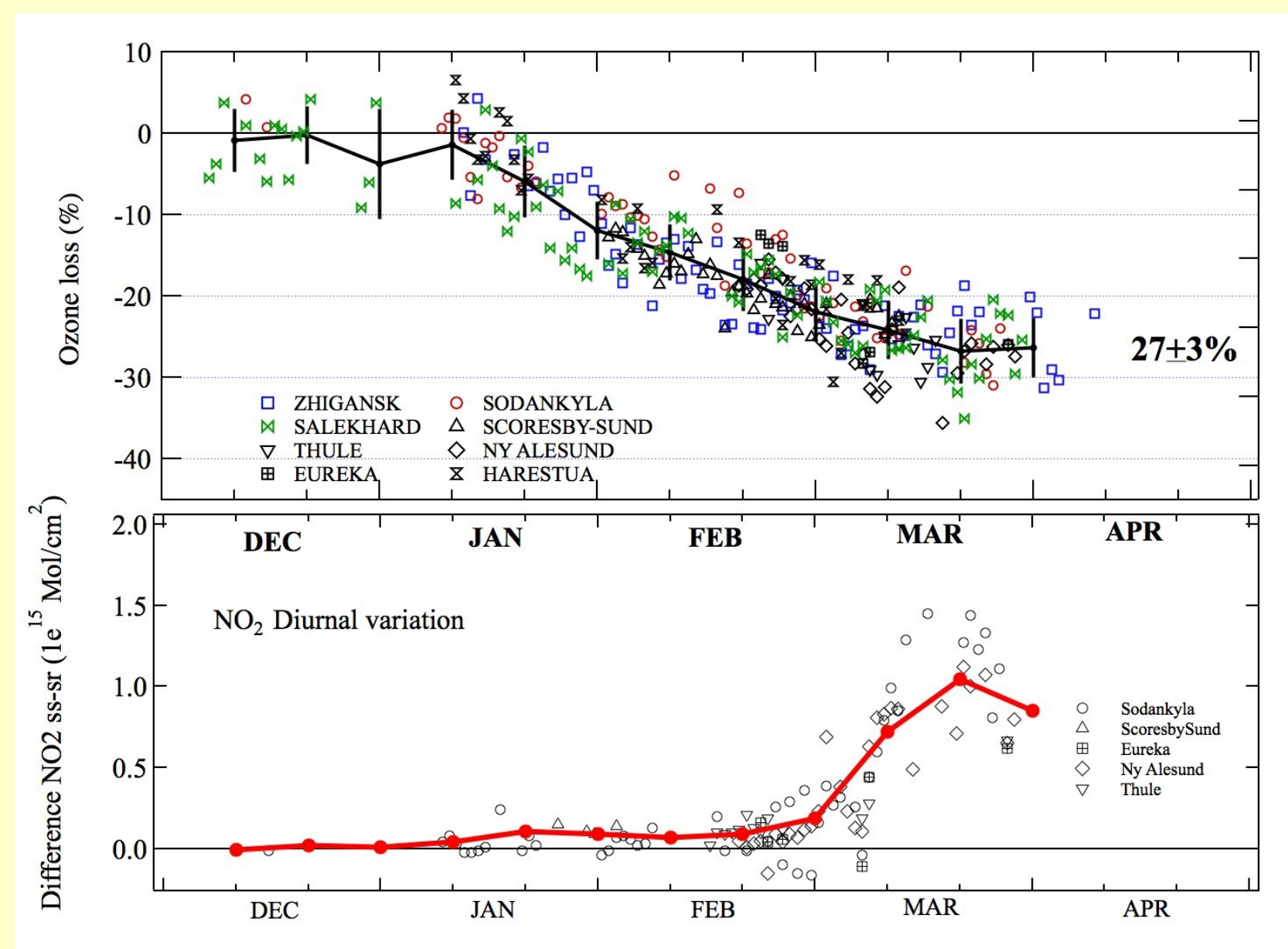
- T < T_{nat} at levels 475 (red) and 550K (blue) until early March
- T < T_{nat} until February 10 higher at 675K (green).

Bottom

- Large sunlit V_{PSC} until March 1st.

2- SAOZ OBSERVATIONS

Ozone loss and denitrification



Top

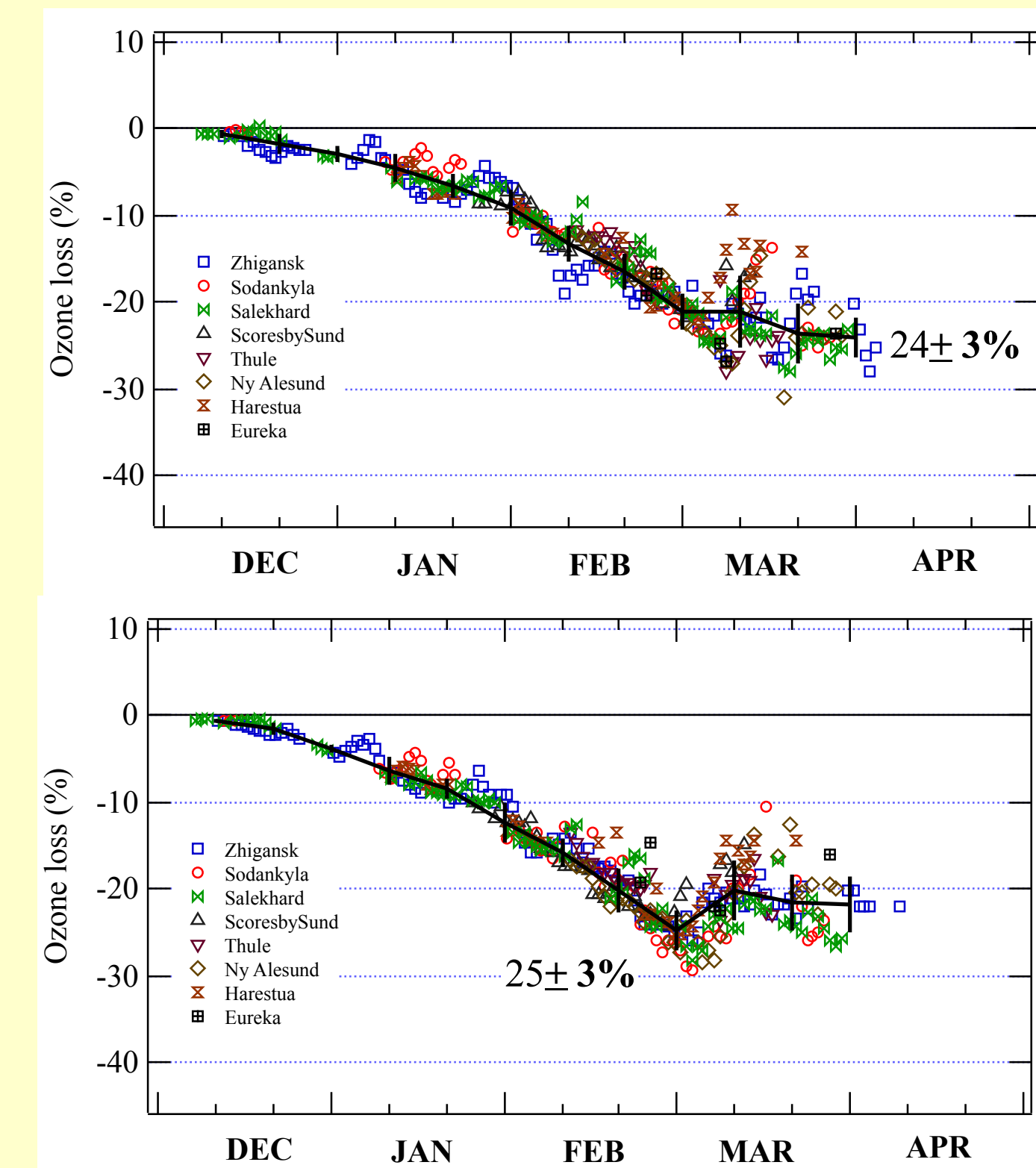
Evolution of ozone loss above SAOZ stations inside vortex
Note that larger loss after March 8 at Ny Alesund.

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
- NO₂ 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



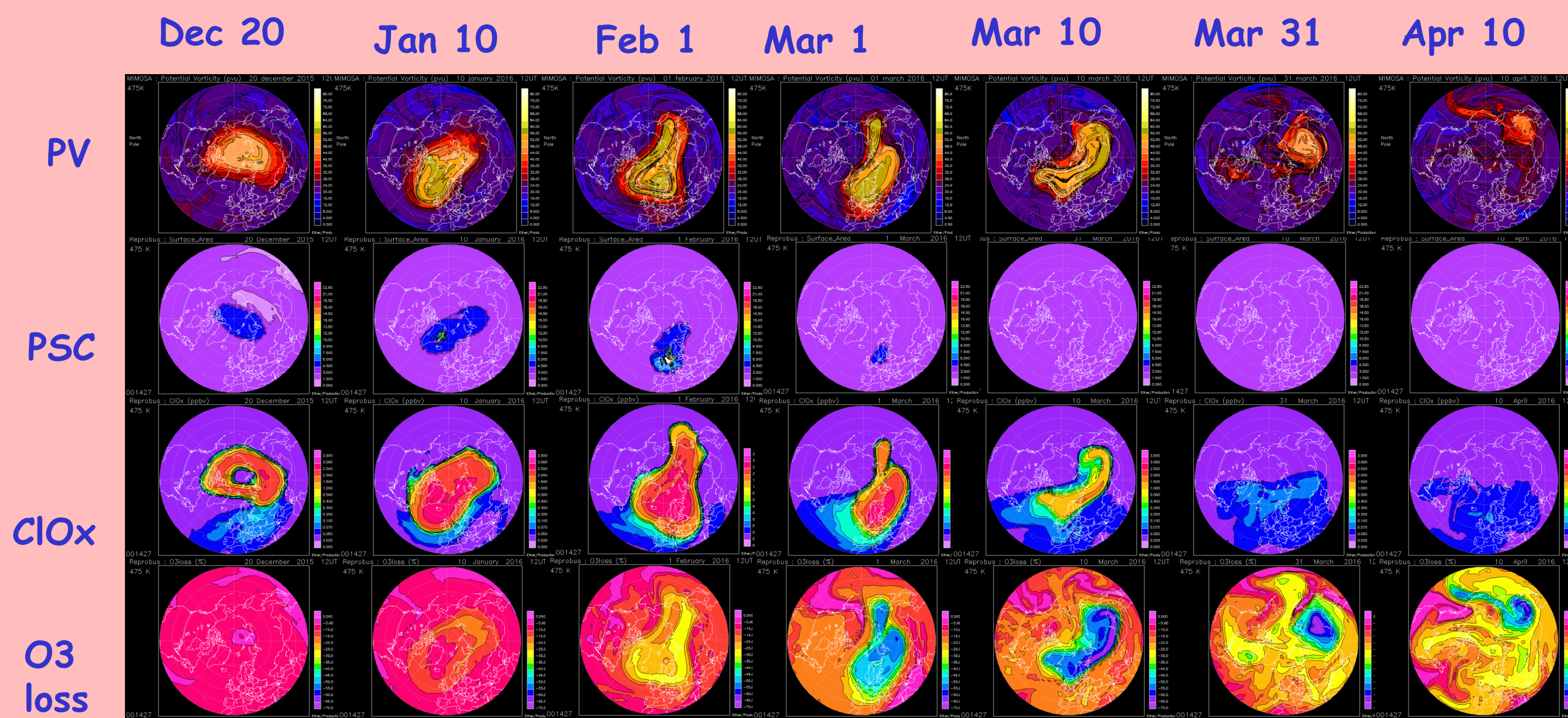
REPROBUS

- 0.25%/ day from December 20 up to January 30
- 0.35%/day from February 1 up to March 1
- Stopped on March 1
- Large scatter after March 1
- Cumulated Loss: 24% ± 3%

SLIMCAT

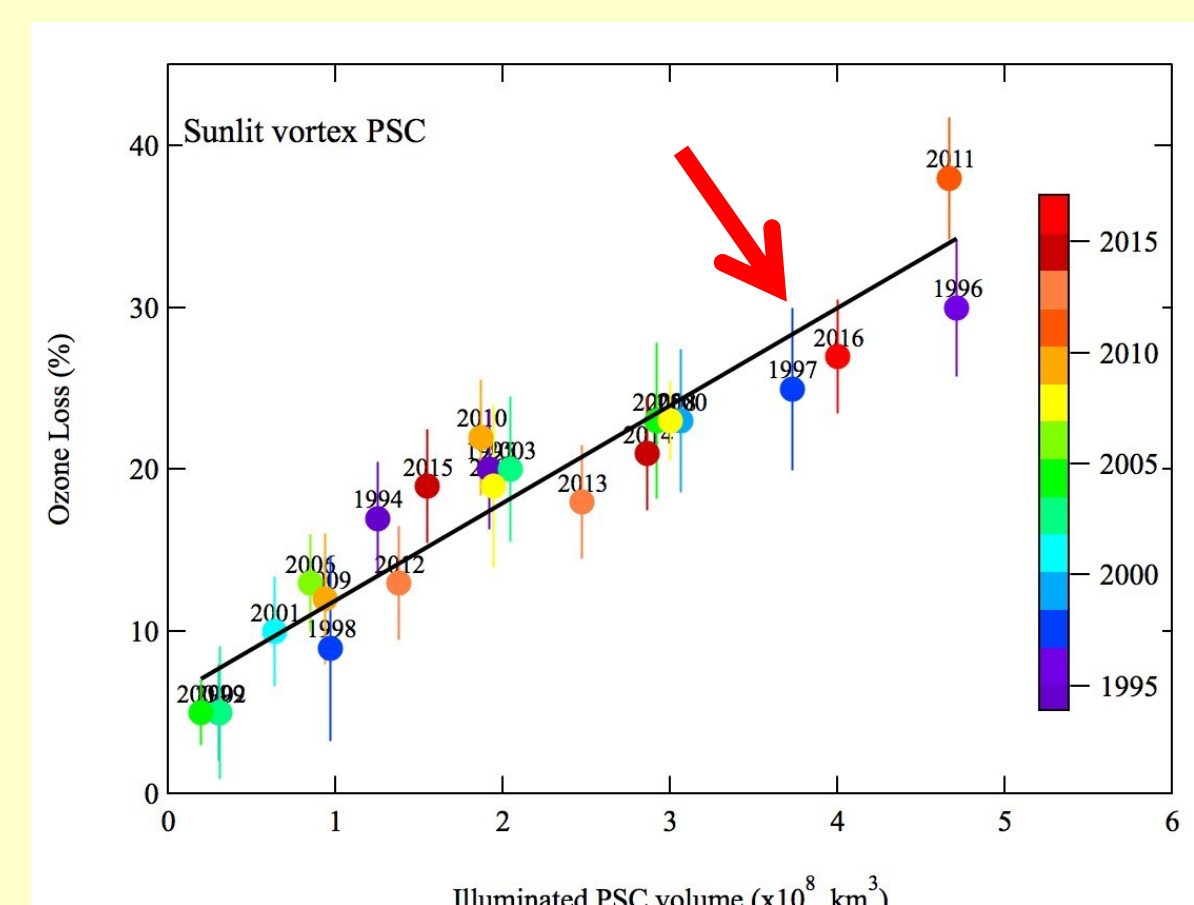
- 0.25%/ day from December 20 up to January 30
- 0.4%/day from February 1 up to March 1
- Stopped on March 1
- Large scatter after March 10
- Cumulated Loss: 25% ± 3%

4- MIMOSA PV FIELDS AND REPROBUS 3D CTM SIMULATION (475 K)



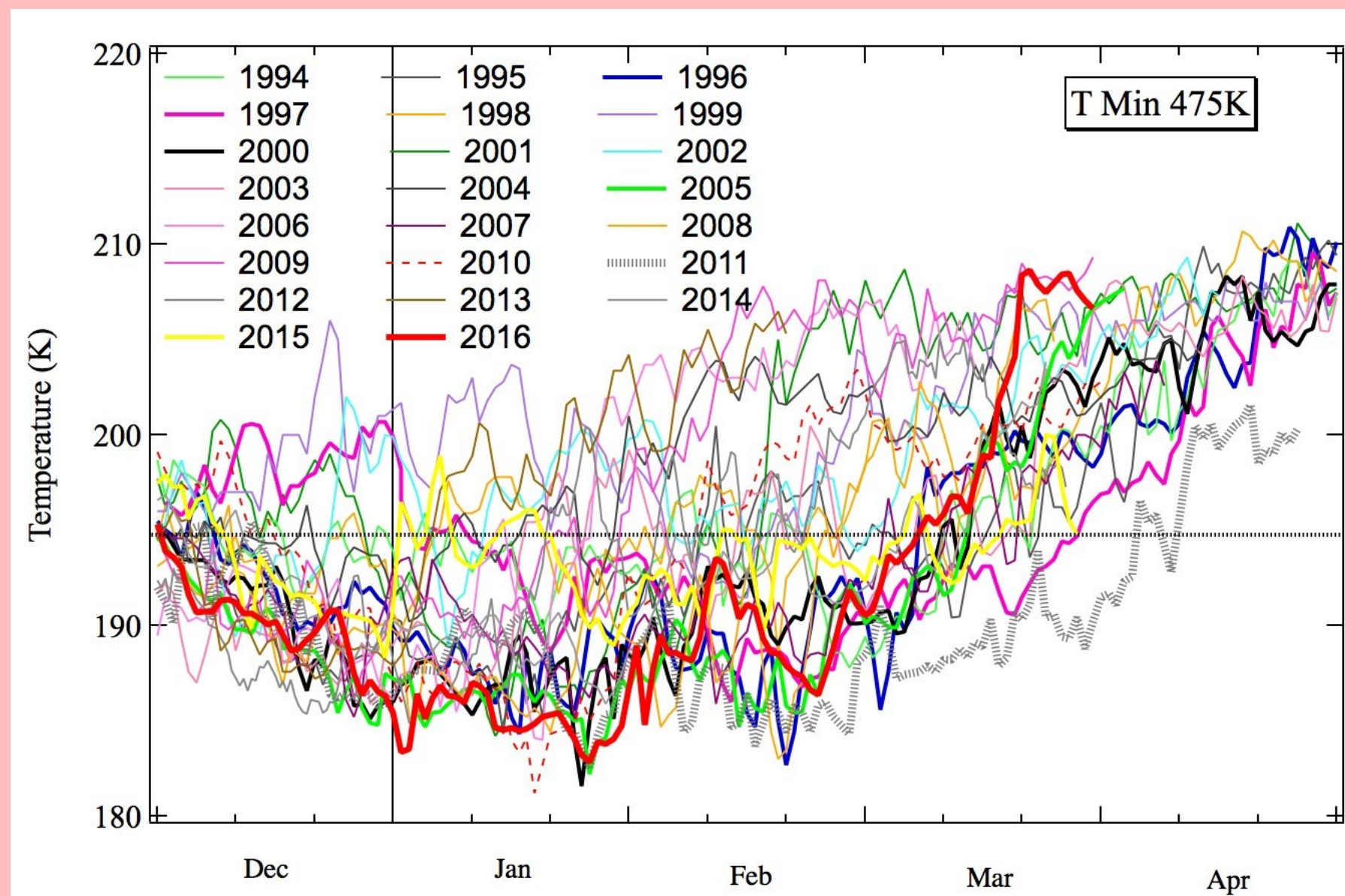
- Large vortex centered at the North Pole until early February, elongated in March, still present above Siberia on April 10.
- PSC large surface at 475K until end of February.
- Chlorine activated at 475K until March 10, deactivating progressively after.
- Ozone loss starts on early January at the periphery of the vortex, propagating until end of March.
- 65% loss still present above Eastern Siberia inside the remaining vortex on April 10.

6- OZONE LOSS vs SUNLIT PSC RELATIONSHIP

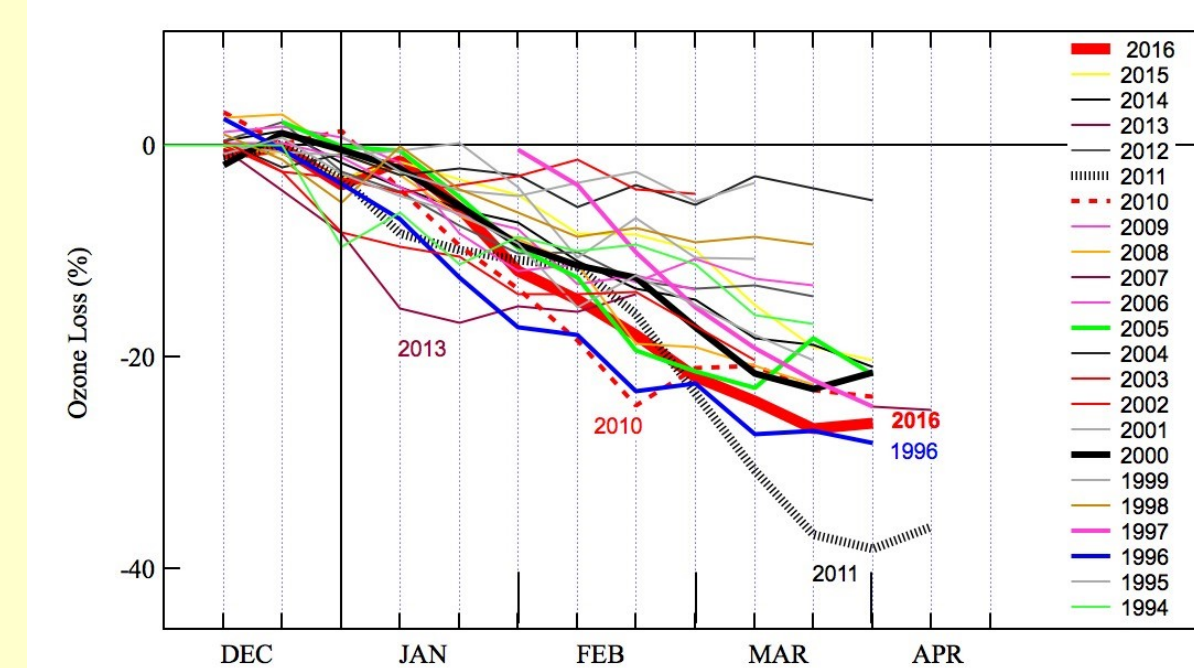


2016 ozone loss is consistent with sunlit PSC volume relationship

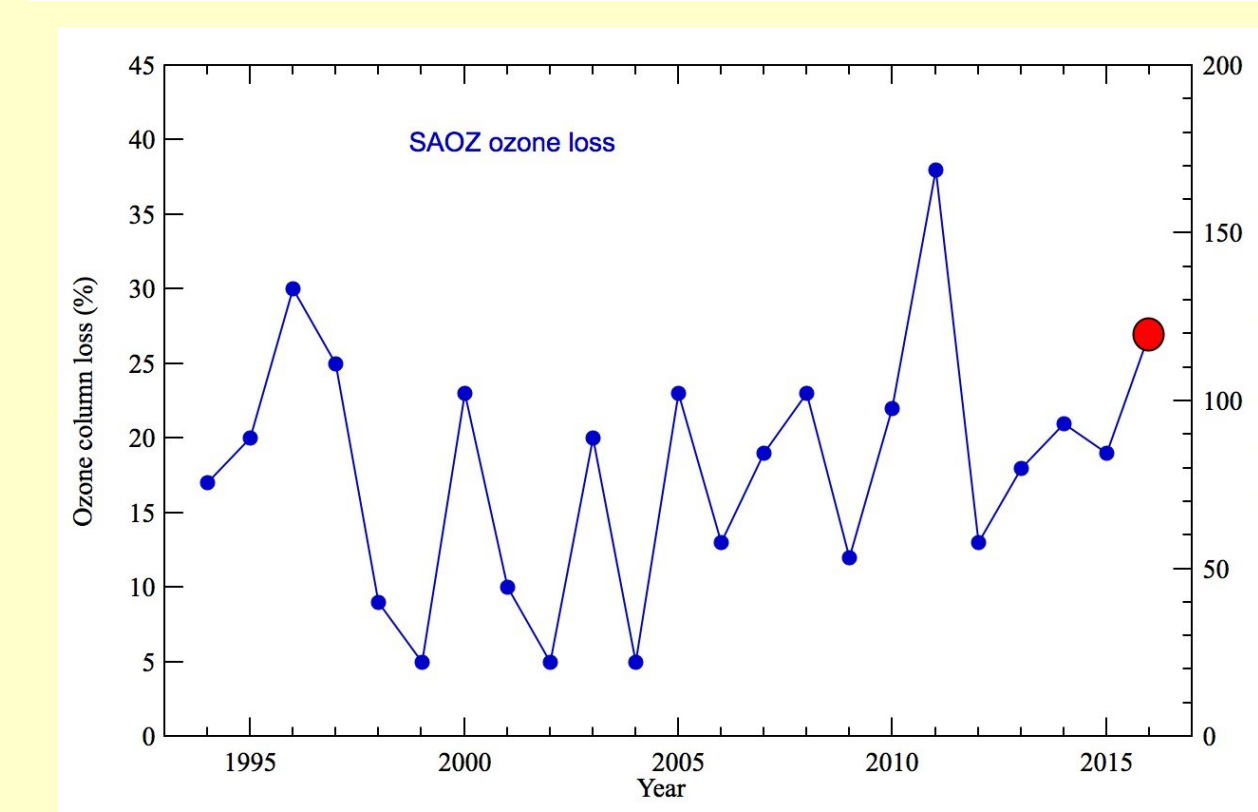
Comparison to previous winters



- Very cold temperature until March 10, 2016
- One of the coldest winter compared to all other winters until early February
- Final warming: March 10



2016 ozone loss rate: similar to 2010 and 1996



2016 ozone loss : third largest loss since 1994
2011: record 38%
1996: 30%

Acknowledgements

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CONCLUSION WINTER 2015/2016:

- Long lasting and cold vortex until April.
- Cold temperatures below T_{nat} up to March 10, 2016.
- Rapid loss rate 0.6%/day in January, a little slower 0.4%/day after
- Total ozone loss of 27%, third largest value since 1994 (2011: 38%, 1996: 30%)
- Ozone loss stopped on Mid-March when Chlorine activation stopped and vortex was re-nitrified