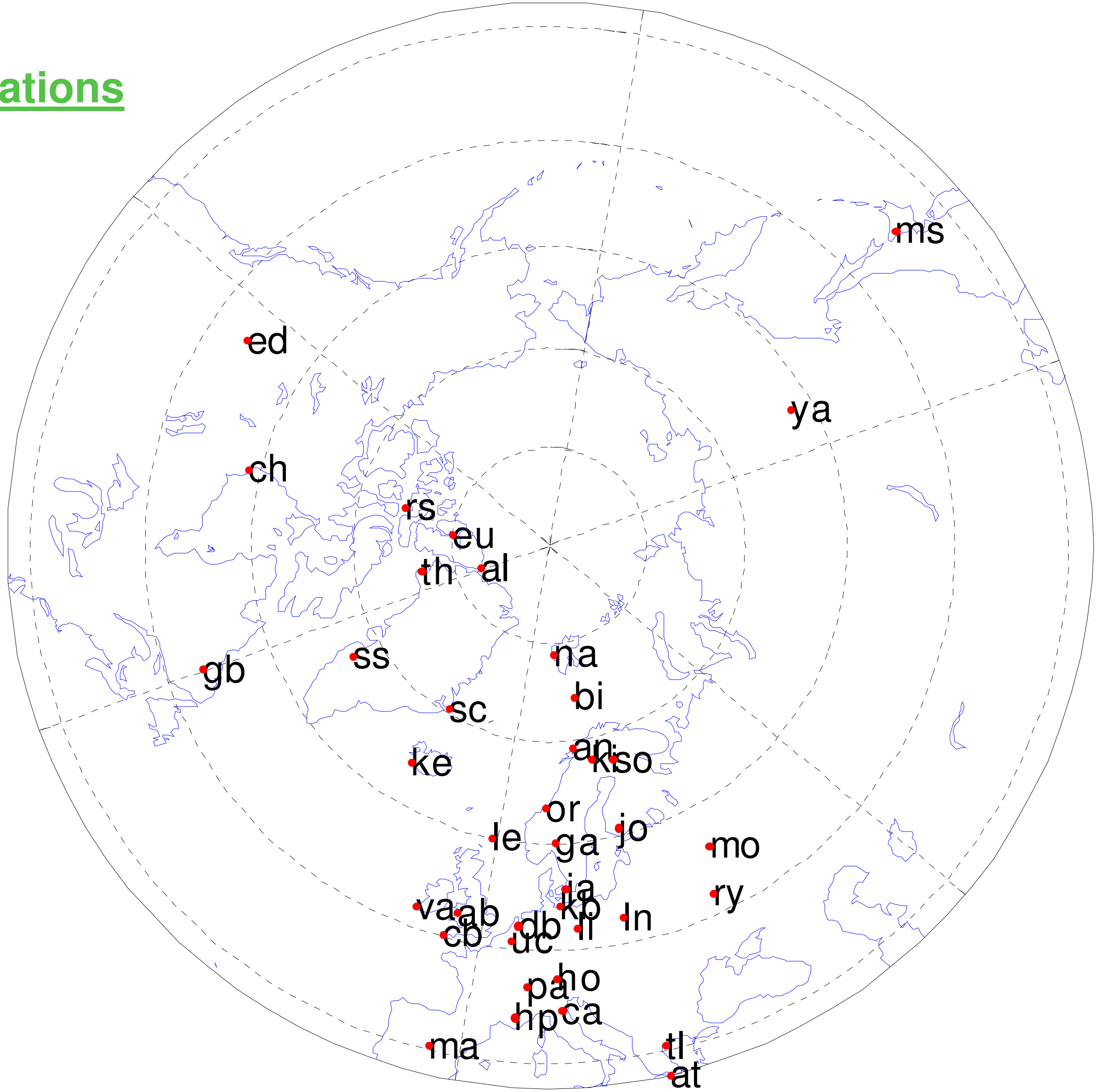
High-latitude Ozone Soundings

Rigel Kivi, Esko Kyrö, Pauli Heikkinen
Finnish Meteorological Institute
Arctic Research

Outline

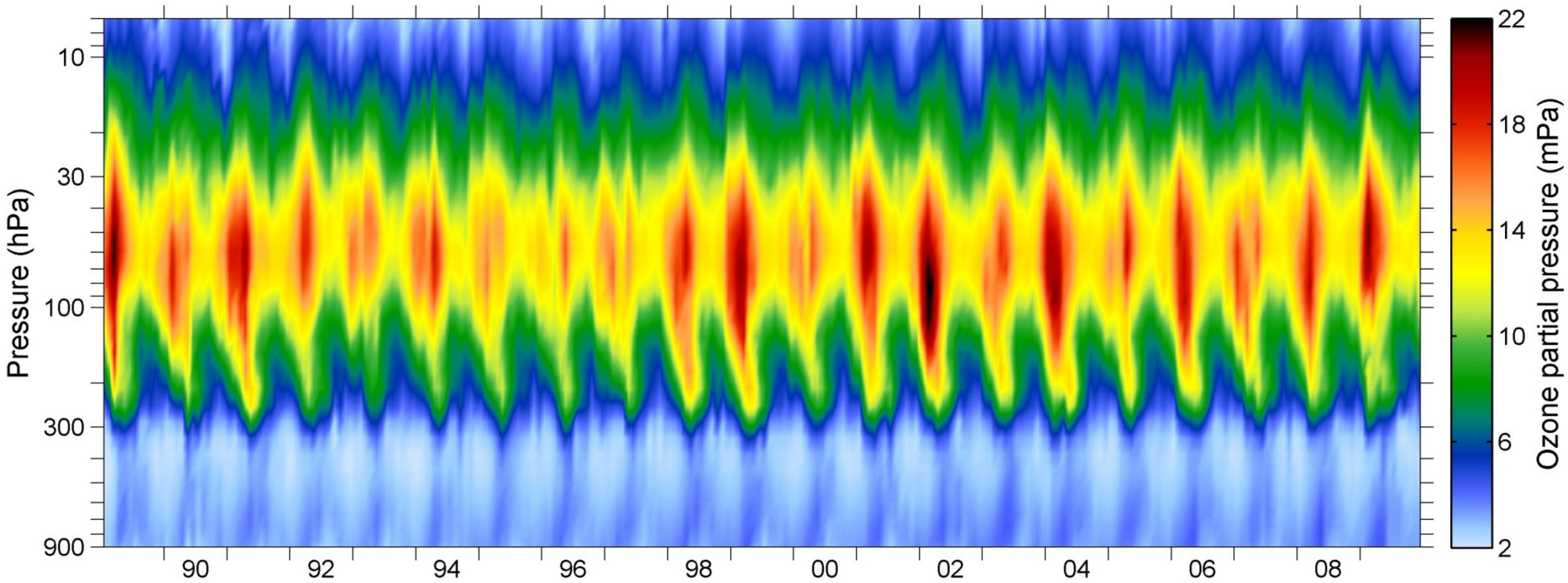
- Sonde data record from high-latitude stations 1989-2009
- Dual sonde flights
- Comparisons with total ozone observations
- MLS profiles versus sondes
- trends

Ozonesonde stations



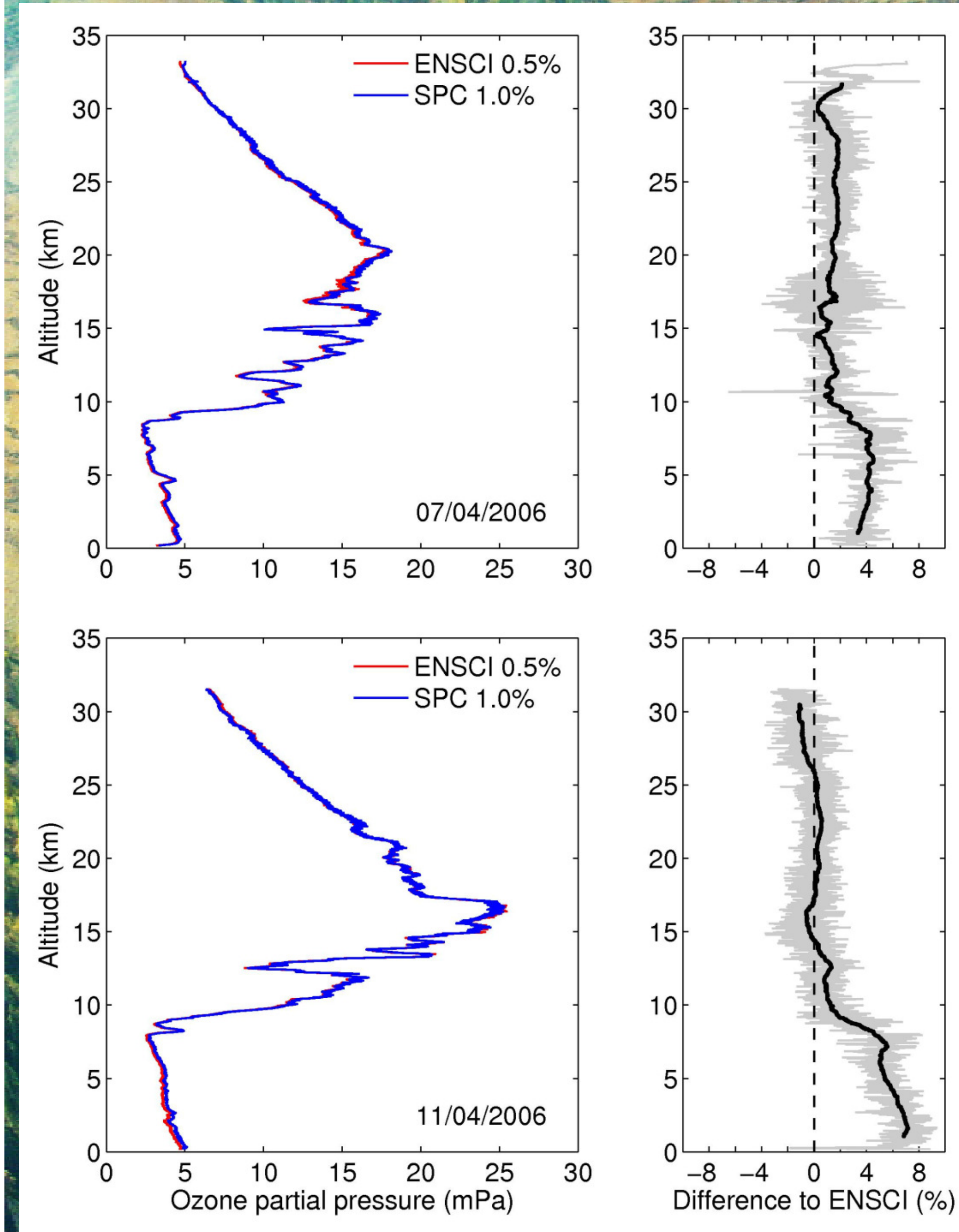
Station	Country	WMO Number	Latitude	Longitude	Data Record
Resolute	Canada	024	74.7°N	95.0°W	1979–
Alert	Canada	018	82.5°N	62.3°W	1987–
Sodankylä	Finland	262	67.4°N	26.6°E	1989–
Ny-Ålesund	Svalbard	089	78.9°N	11.9°E	1989–
Lerwick	UK	043	60.1°N	1.2°W	1992–
Eureka	Canada	315	80.0°N	85.9°W	1992–
Scoresbysund	Denmark	717	70.5°N	22.0°W	1993–[a]

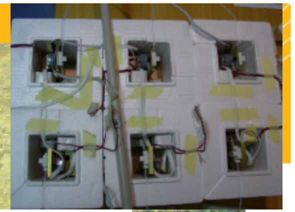
[a]Additional data in February–May 1989 and November 1991 to April 1992.


Pressure (hPa)
10
30
100
300
900
90
92
94
96
98
00
02
04
06
08
Ozone partial pressure (mPa)
22
18
14
10
6
2

Sources of possible inconsistency in the sonde data set include:

- changes in sonde type, sensing solution
- thermistor placement inside the ozone box
- pump efficiency corrections
- background current correction method





Dual sonde flights

Difference to ENSCI is calculated by (SP1.0-ES0.5)/ES0.5.

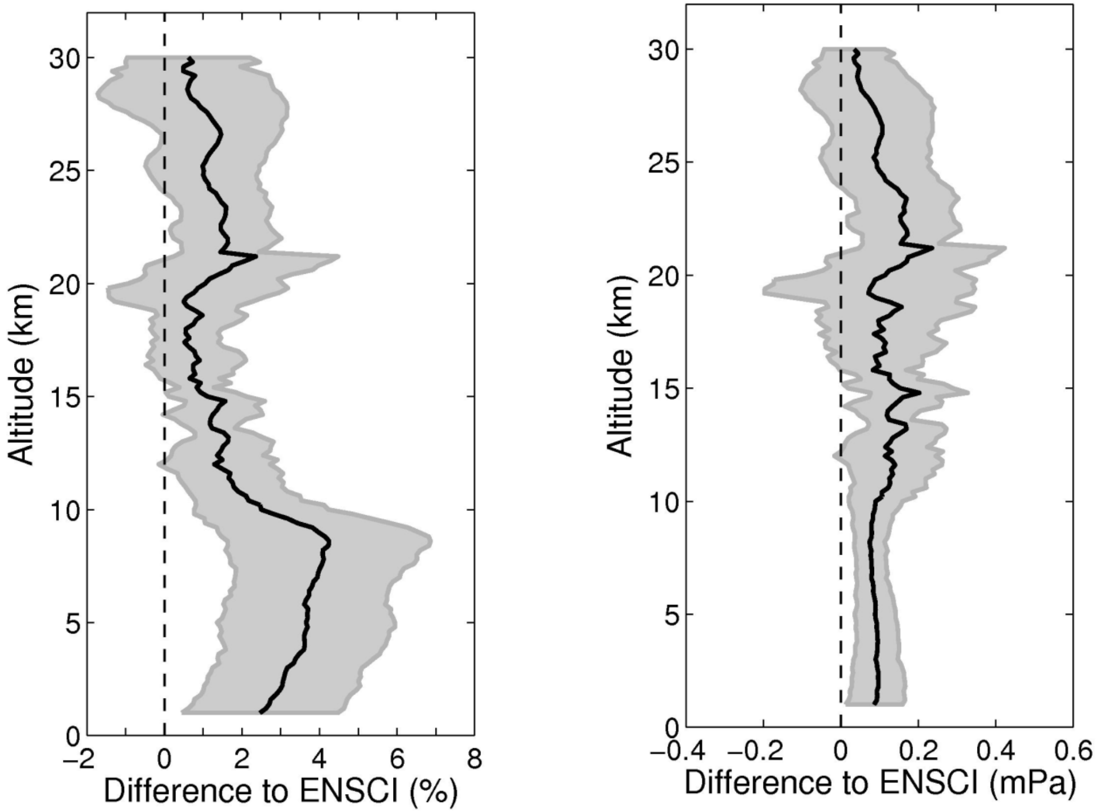
April 7 launch time 20:32 UT

6a17355, 387DU measured
2z3283, 381 DU measured

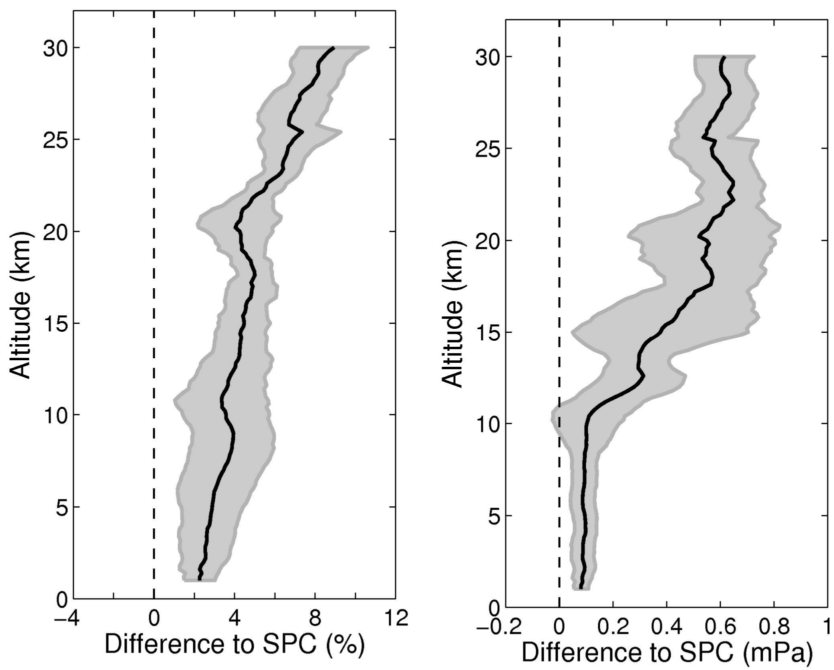
April 11 launch time 10:02 UT
6a19454, 440 DU measured
1z10640, 438 DU measured

Brewer/sonde: 1.005 (6a)
Brewer/sonde: 1.008 (1z)

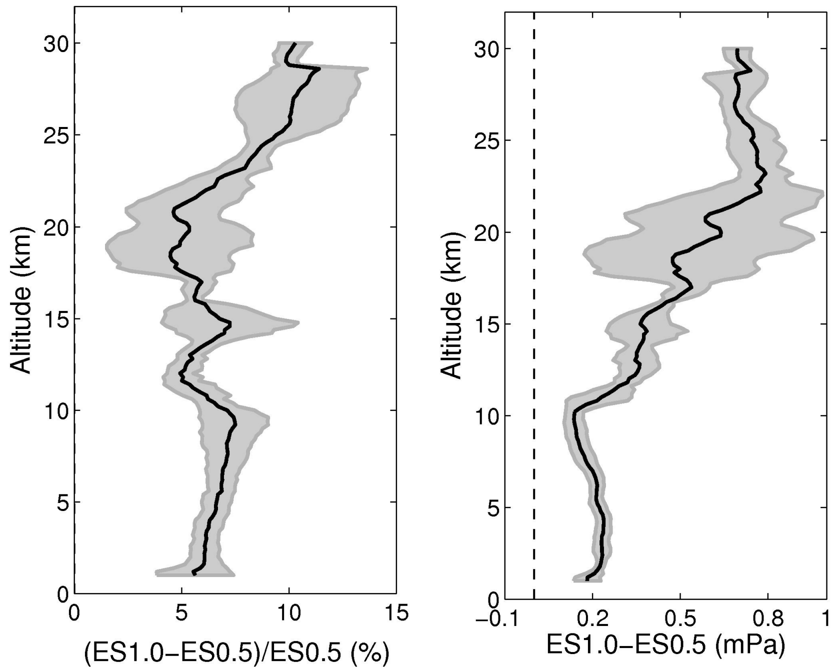
OMI/sonde: 1.009 (6a)
OMI/sonde: 1.011 (1z)



Average of 14 dual soundings ((SP1.0-ES0.5)/ ES0.5)

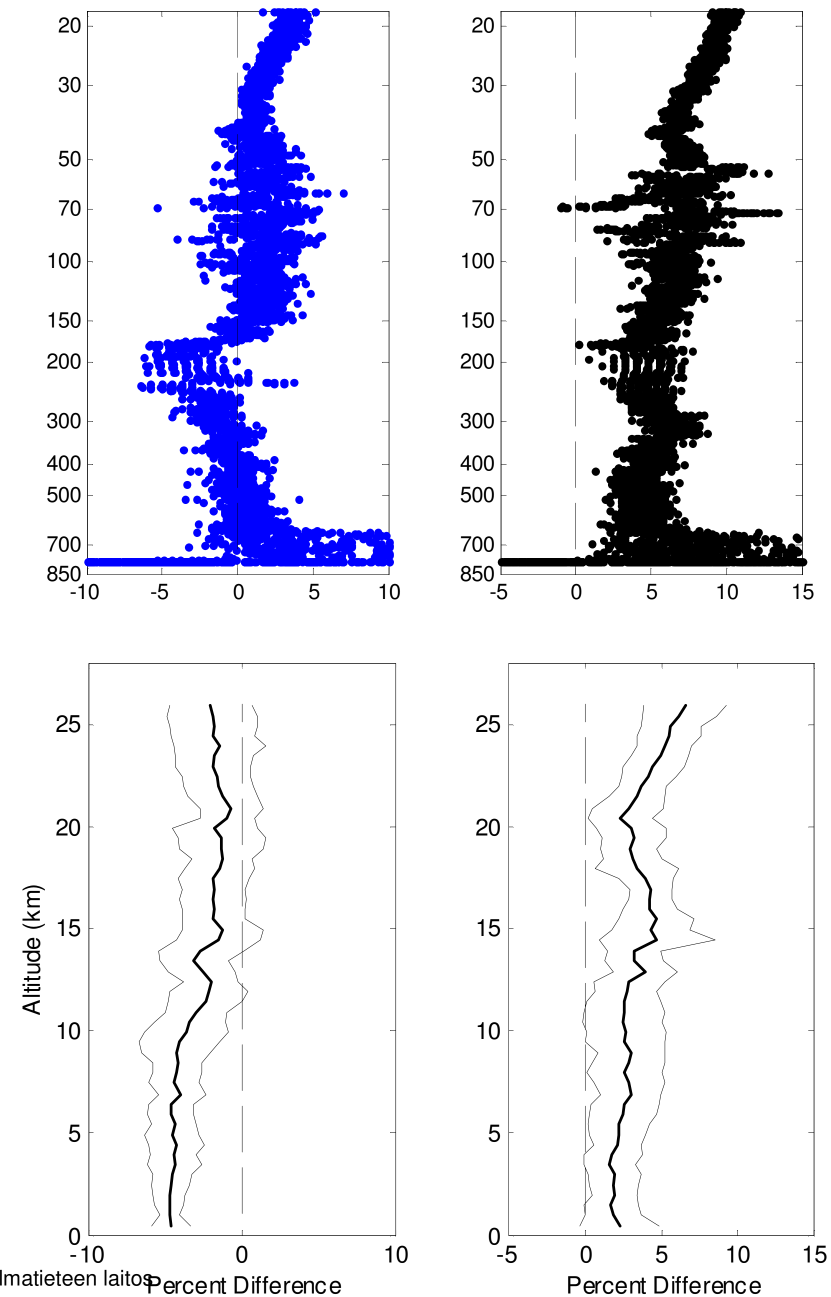


Average of 7 dual soundings ((ES1.0-SP1.0)/ SP1.0)



Average of 6 dual soundings ES1.0 vs. ES0.5

0.5 % EN-SCI   1 % EN-SCI



BESOS

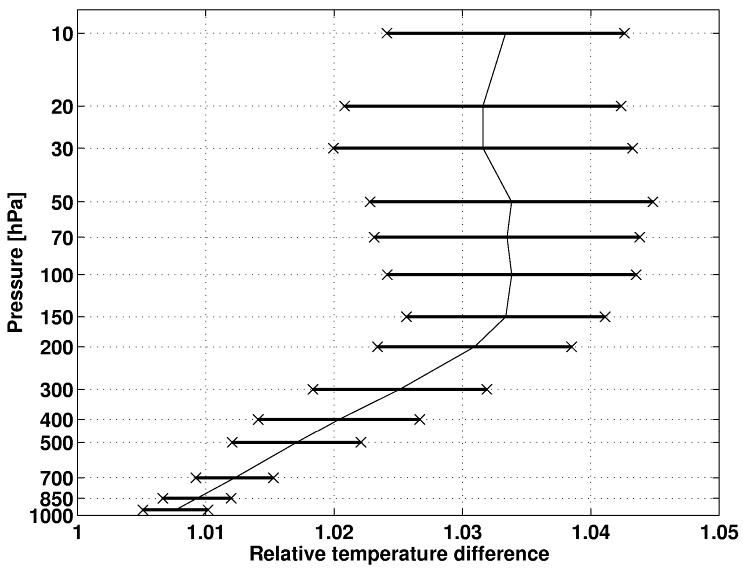
Percent difference is calculated by (ENSCI-SPC)/ENSCI.

FMI dual soundings,

average of 7 non-standard dual flights (left) and 9 standard dual flights (right)

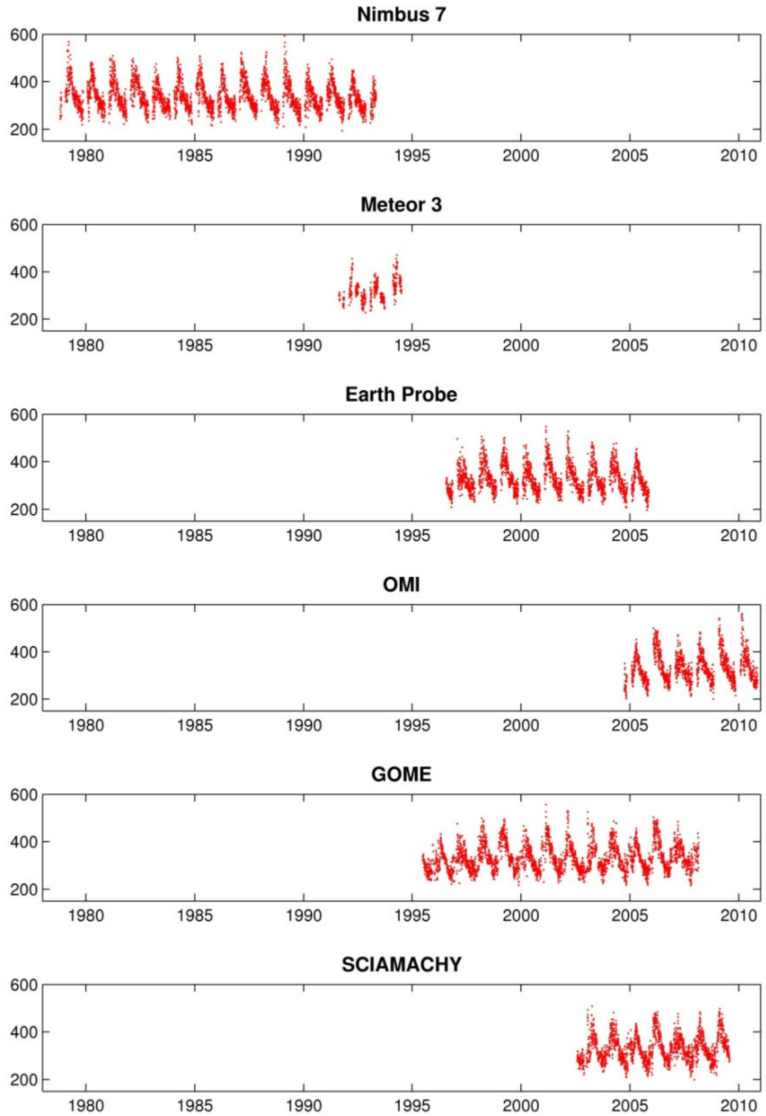
Deshler et al., J.Geophys.Res., 2008;
Kivi et al., J.Geophys.Res, 2007

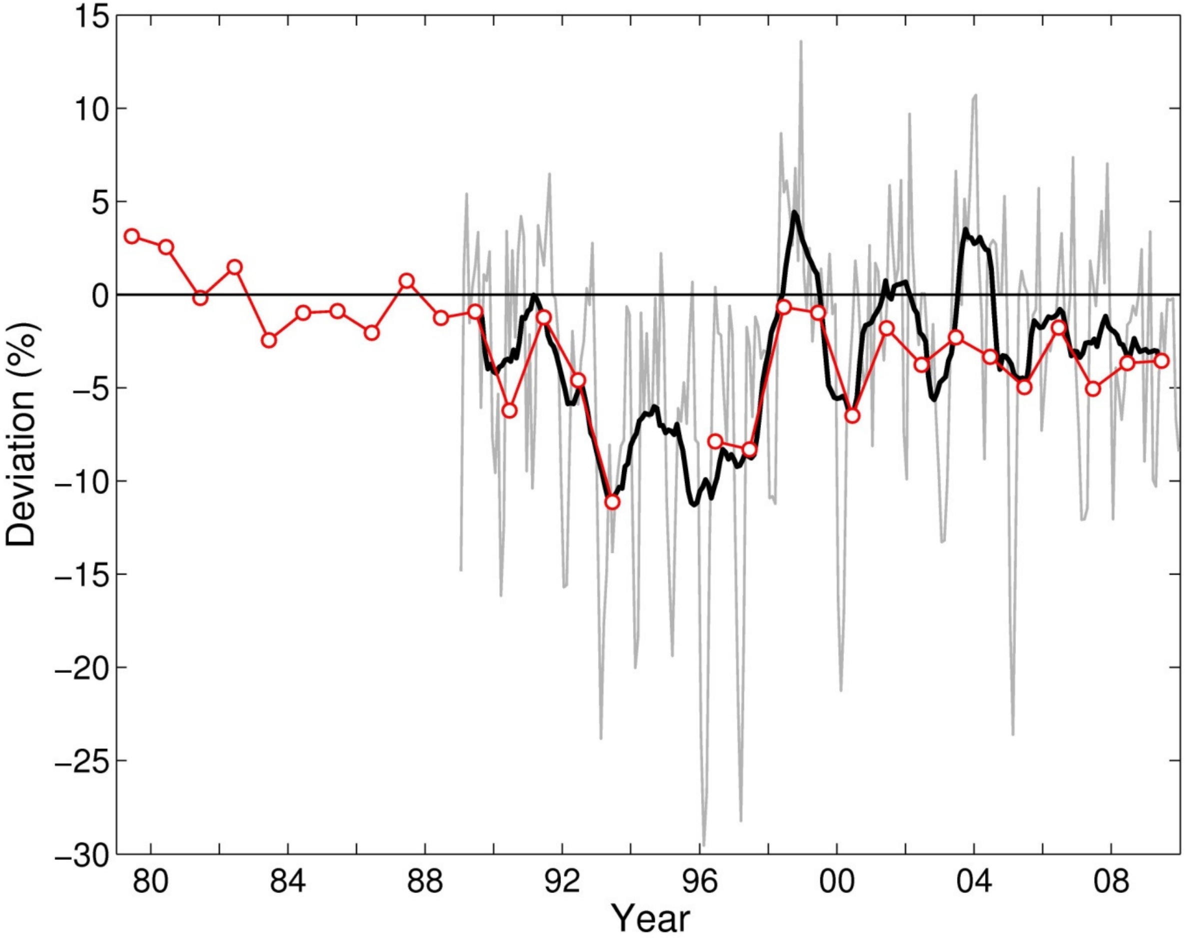
Thermistor position



Relative difference between ambient **temperatures measured from the pump hole and the cathode inlet tube** with one sigma confidence intervals. The data is from 13 soundings performed at Sodankylä with SPC 6A- and EN-SCI 1z –sondes. Generally in ozone soundings we aim to determine the volume of the gas in the pump cylinder, and therefore cylinder temperature should be recorded. The new sonde models (SPC 6A-, and EN-SCI 1z-series) approximate this temperature quite well by providing a hole for the placement of thermistor in the pump base close to the cylinder. In earlier models it was customary to measure the temperature at cathode inlet tube close to pump. The relative difference between these temperatures, which will introduce the same relative difference in the final ozone data can be significant, it can be approximated by formula, that depend linearly on logarithm of pressure:

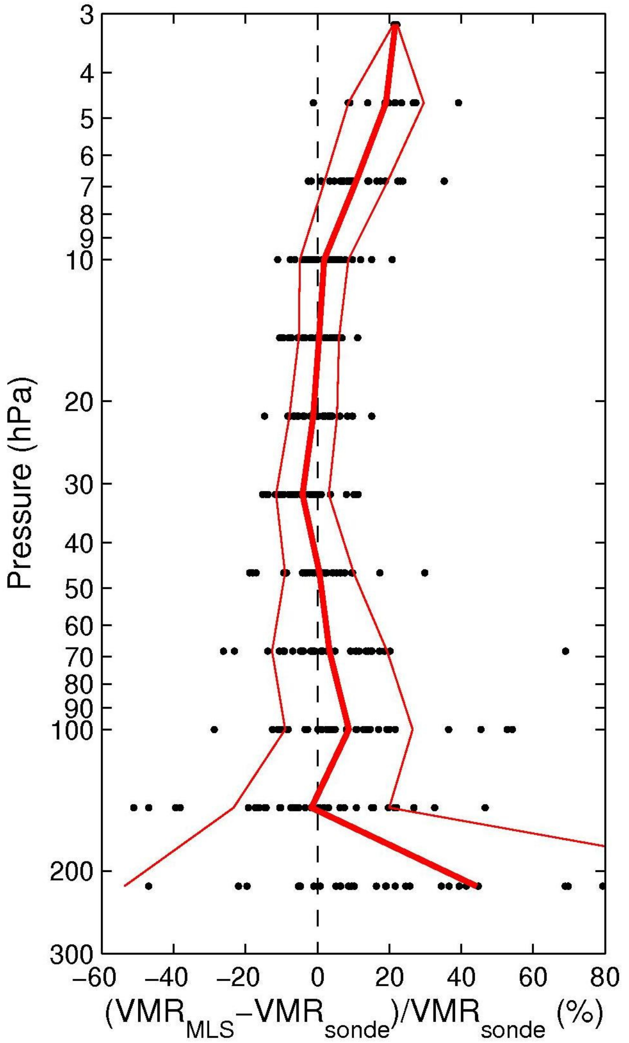
$$C = \begin{cases} -0.0144 * \ln P + 1.1064 & \text{if } P > 165 \text{ hPa} \\ 1.033 & \text{if } P \leq 165 \text{ hPa} \end{cases}$$


Nimbus 7
Meteor 3
Earth Probe
OMI
GOME
SCIAMACHY
600
400
200
1980
1985
1990
1995
2000
2005
2010

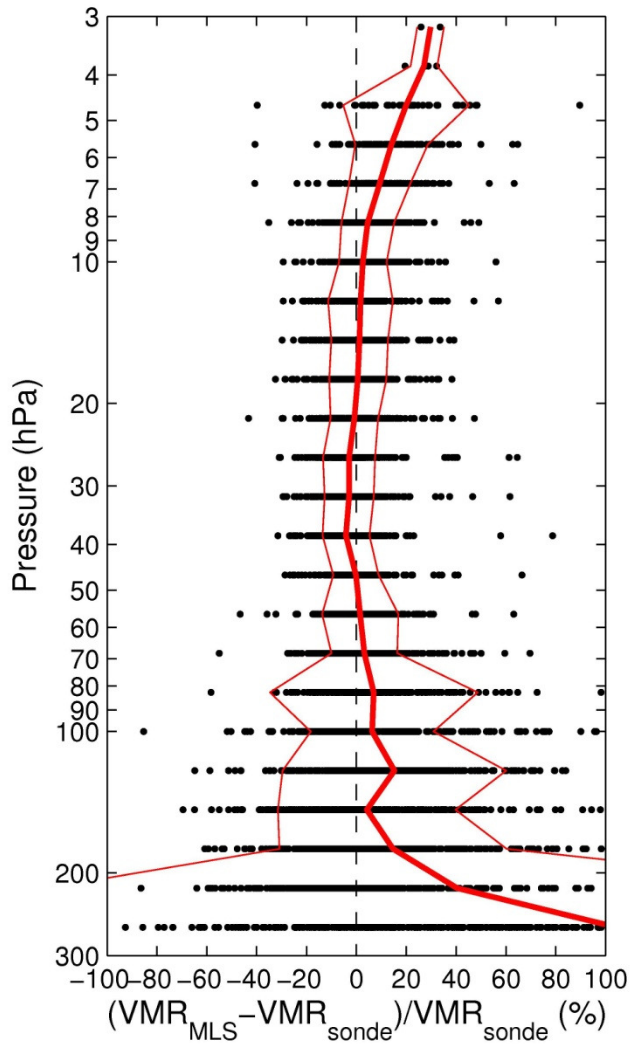


TOMS/GOME (red), sondes (grey and black (smoothed)).

MLS-Sonde



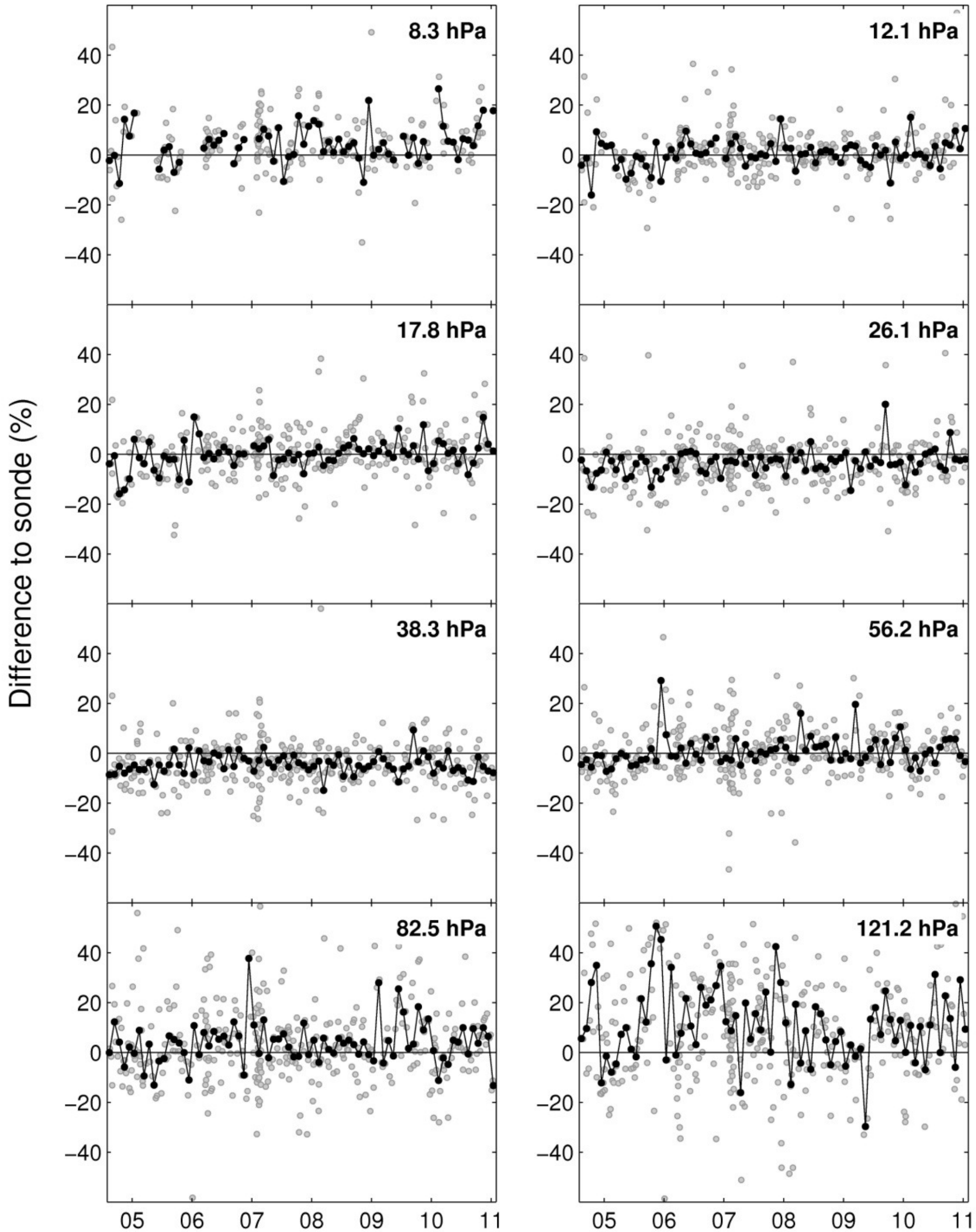
AURA MLS V 2.2



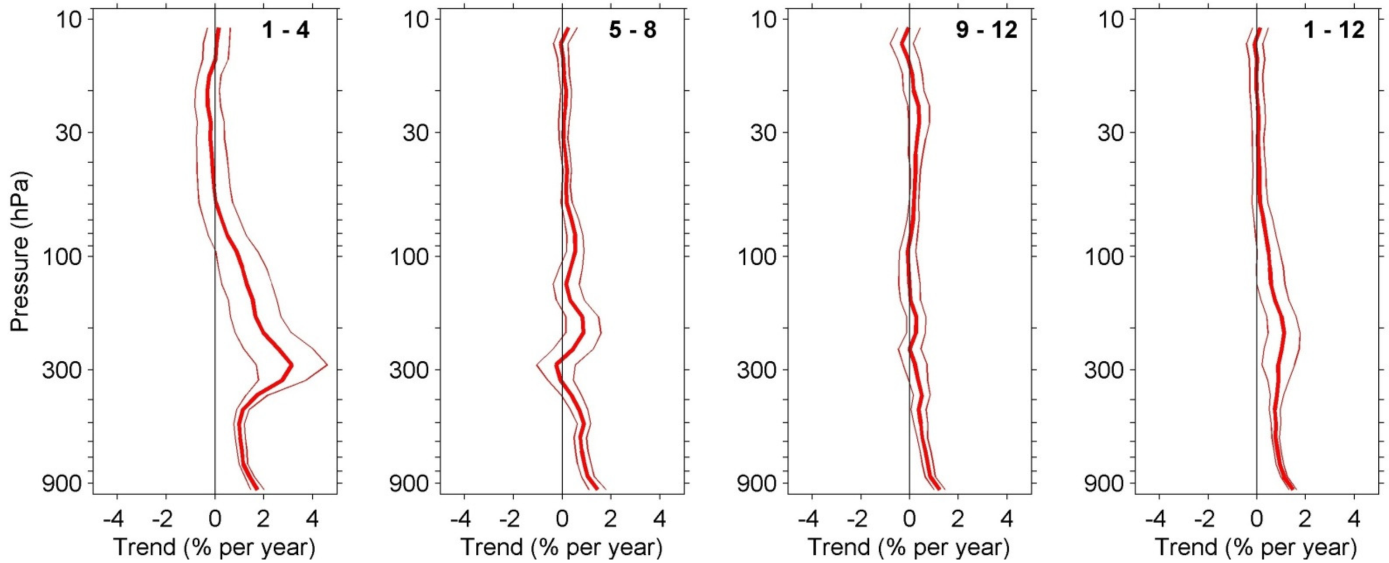
AURA MLS V 3.3

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INST

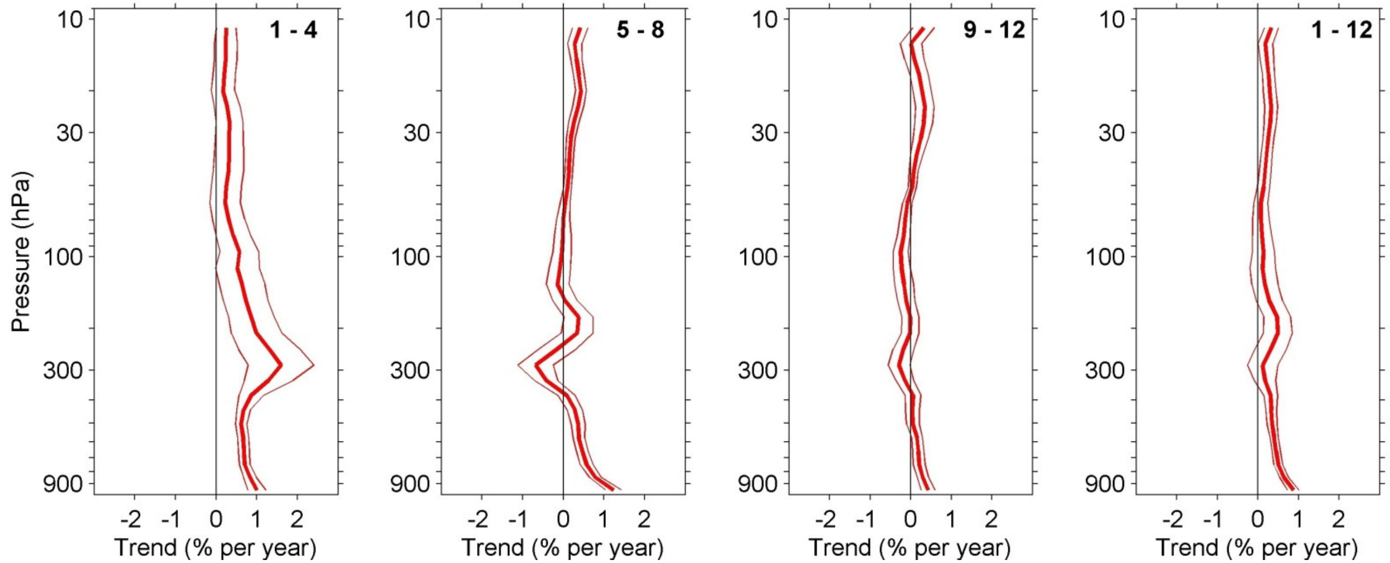
MLS-Sonde



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

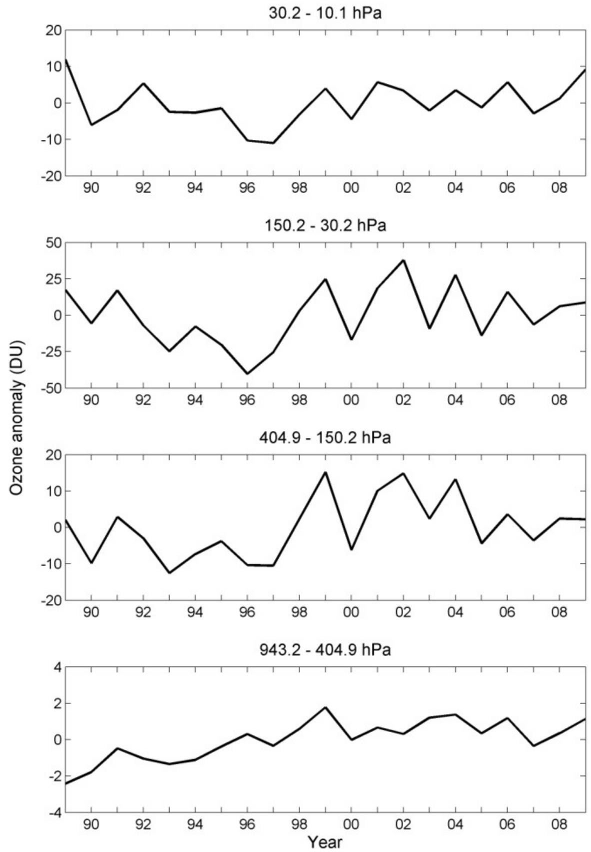


1989-
2003

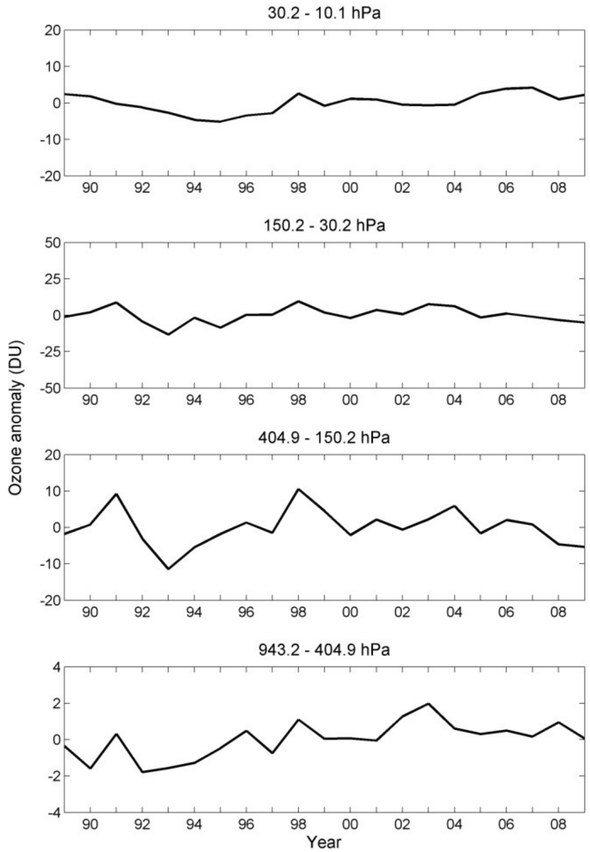


1989-
2009

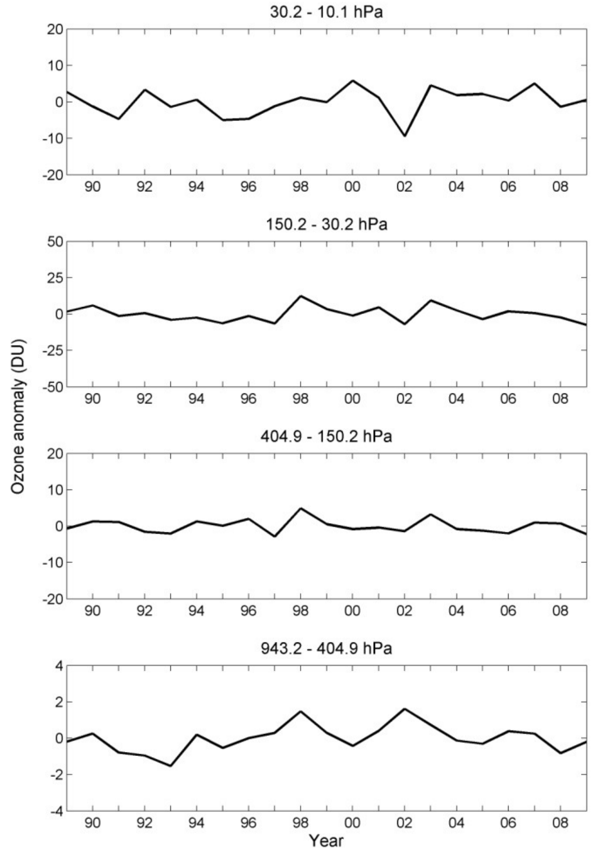
1-4

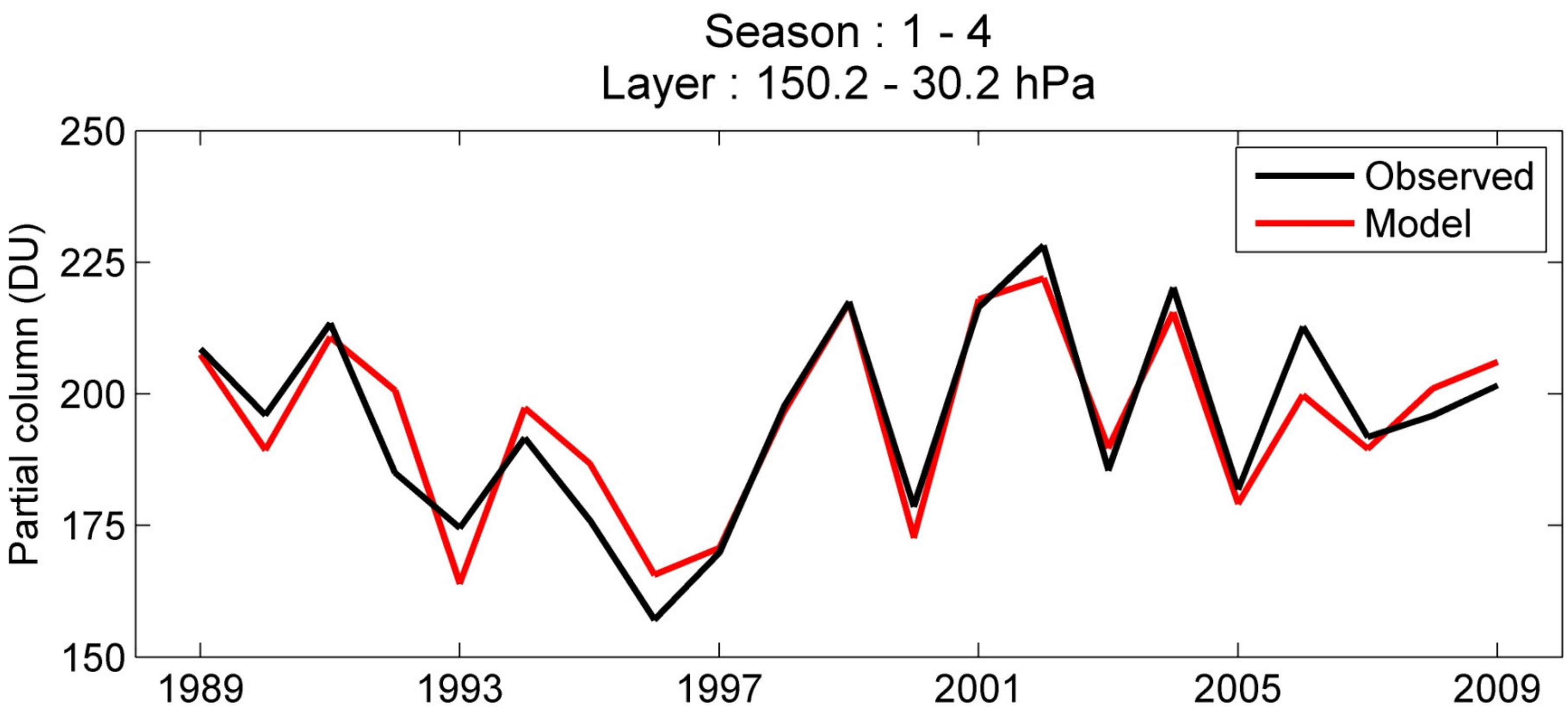

30.2 - 10.1 hPa
150.2 - 30.2 hPa
404.9 - 150.2 hPa
943.2 - 404.9 hPa
Ozone anomaly (DU)
Year
90 92 94 96 98 00 02 04 06 08

5-8


30.2 - 10.1 hPa
150.2 - 30.2 hPa
404.9 - 150.2 hPa
943.2 - 404.9 hPa
Ozone anomaly (DU)
Year
90 92 94 96 98 00 02 04 06 08

9-12


30.2 - 10.1 hPa
150.2 - 30.2 hPa
404.9 - 150.2 hPa
943.2 - 404.9 hPa
Ozone anomaly (DU)
Year
90 92 94 96 98 00 02 04 06 08



Changes in meteorology, Arctic EESC, VPSC and Volcanic aerosols explain 86.2% of the JFMA variability.

Summary:

•Sonde data record from high-latitude stations 1989-2009
•Dual sonde flights
•Comparisons with total ozone observations
•MLS profiles versus sondes, difference less than 2 % from 20 to 30 km, but 9 % bias above 30 km.
•Sonde JFMA trends at 300 hPa 2%/year; free troposphere 1%/year, no significant increase above 100 hPa.
•trend model including changes in meteorology, Arctic EESC, VPSC and Volcanic aerosols explain 86.2% of the JFMA variability.

Future work:
Sonde transfer functions, how good is the agreement between locations?