

QOS 2021

October 3 (Sunday) - 9 (Saturday), 2021

 Online Meeting

QUADRENNIAL OZONE SYMPOSIUM

[SAT2_17] Long Term Ozone-sonde Observations at Sodankylä

Rigel Kivi¹, Esko Kyrö¹, Pauli Heikkinen¹, Kenneth Nilsen², Roeland Van Malderen³,
Deniz Poyraz³, Ryan M. Stauffer⁴, Herman G. J. Smit⁵

¹Finnish Meteorological Institute, Sodankylä, Finland, ²Sodankylä Geophysical Observatory,
University of Oulu, Finland, ³Royal Meteorological Institute of Belgium, Uccle,

⁴NASA Goddard Space Flight Center, Earth Sciences Division, Greenbelt, USA,

⁵Forschungszentrum Jülich, IEK-8, Germany.



Instrumentation at Sodankylä

- Sodankylä site is located in Northern Finland at 67.4° N, 26.6° E.
- Site is operated by the Finnish Meteorological Institute (FMI)
- Ozonesonde launches started in 1988.

Ozonesondes used:

- SPC 5a from 1988 until end of 1997
- SPC 6a from Jan 1998 to Jan 2006
- ENSCI z since Feb 2006 until present
- Change from RS80 to RS92 in late 2005, also the ground equipment was replaced then.
- Since early 2006 RS92 and z sondes with no changes
- Since August 2020 Vaisala RS41 radiosonde has replaced RS92

Sensing solutions used:

- SPC 1% 1.0 B; ENSCI 0.5% 0.5 B
- Multisensor flights were needed to investigate the influence of using various ozonesonde sensing solutions

Multiple sensor flight

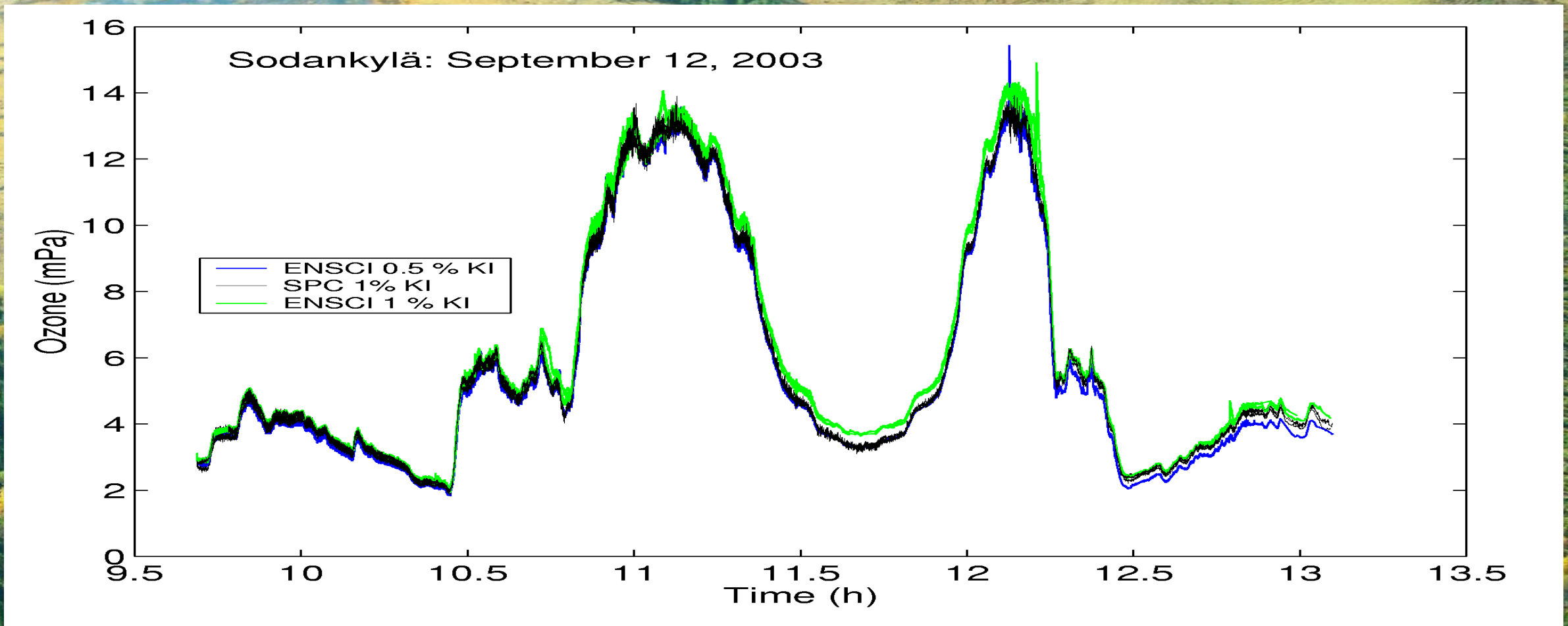


Figure: An example of a multisensor flight over Sodankylä: ENSCI 0.5% KI, SPC 1% KI, ENSCI 1% KI in the same payload.

Dual ozonesondes

Relative difference to ENSCI is calculated by
 $(\text{SPC} - \text{ENSCI})/\text{ENSCI}$.

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

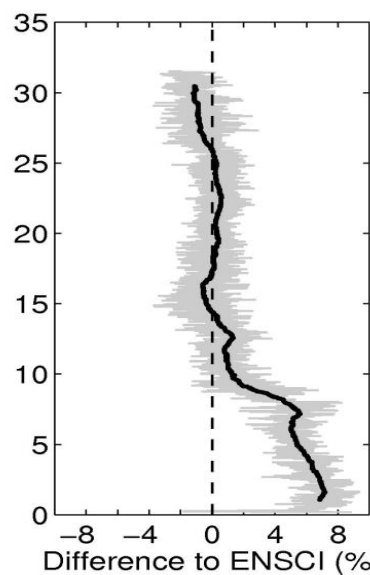
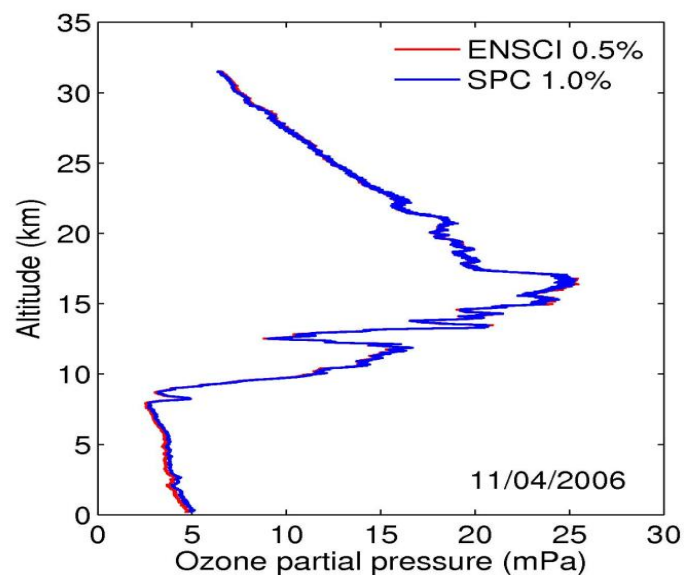
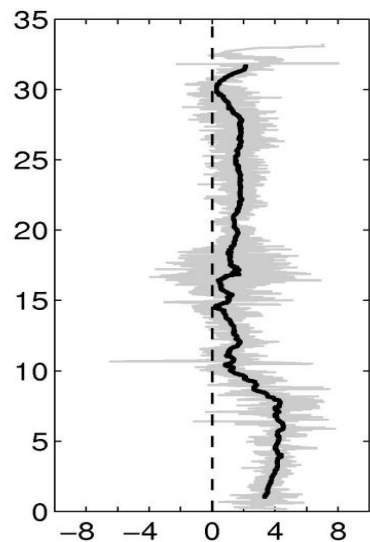
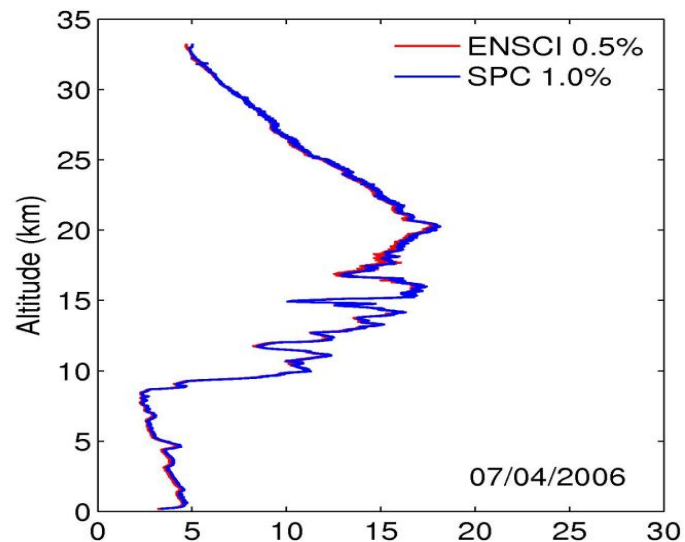
1z10640, 438 DU measured

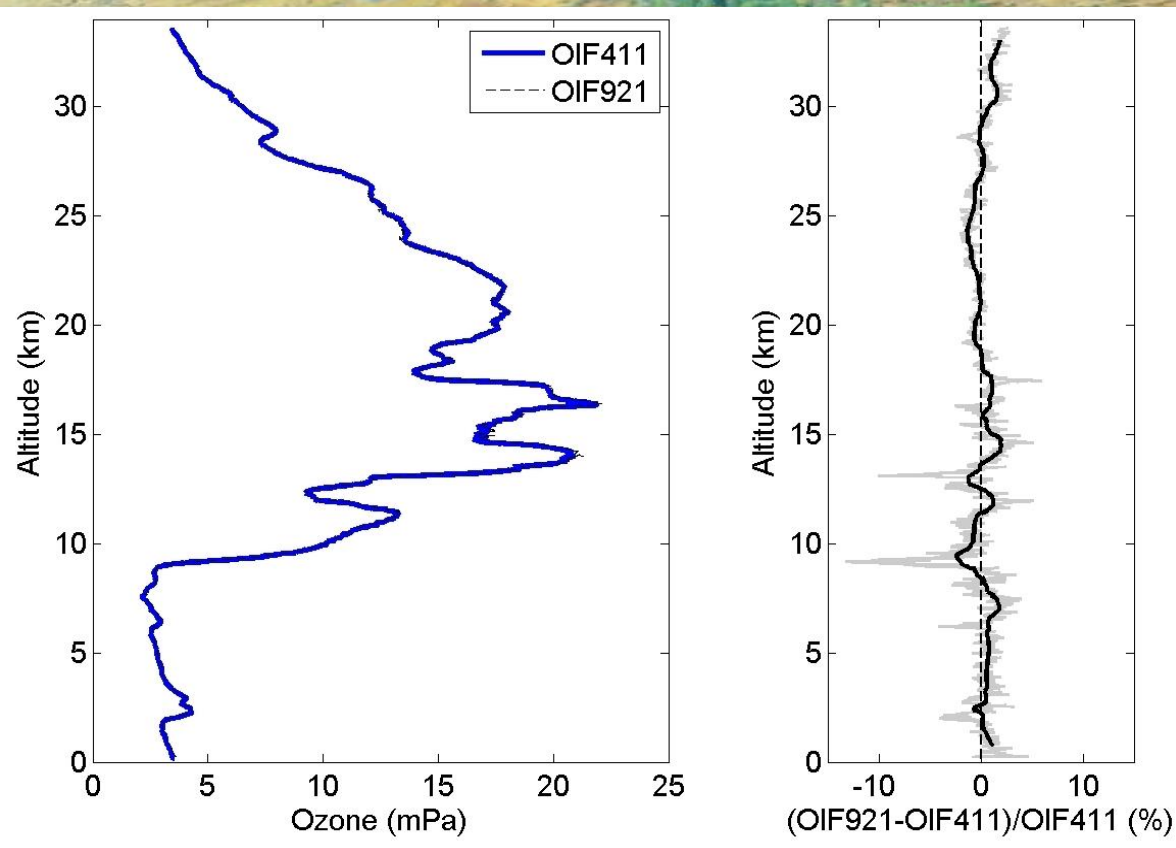
Brewer/sonde: 1.005 (6a)

Brewer/sonde: 1.008 (1z)

OMI/sonde: 1.009 (6a)

OMI/sonde: 1.011 (1z)



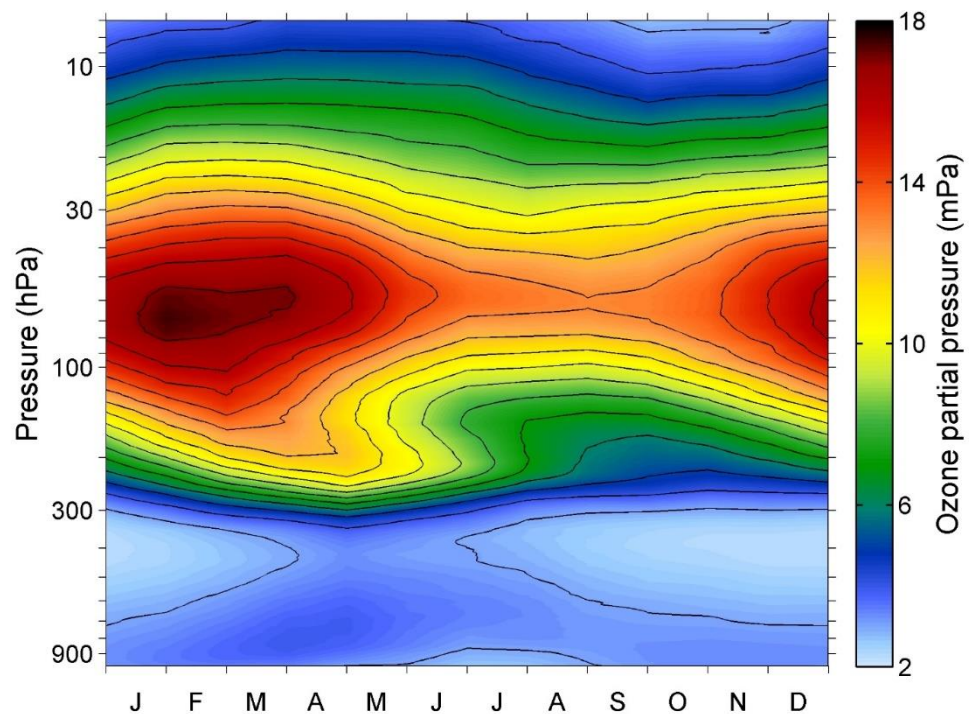


RS92/RS41 flights

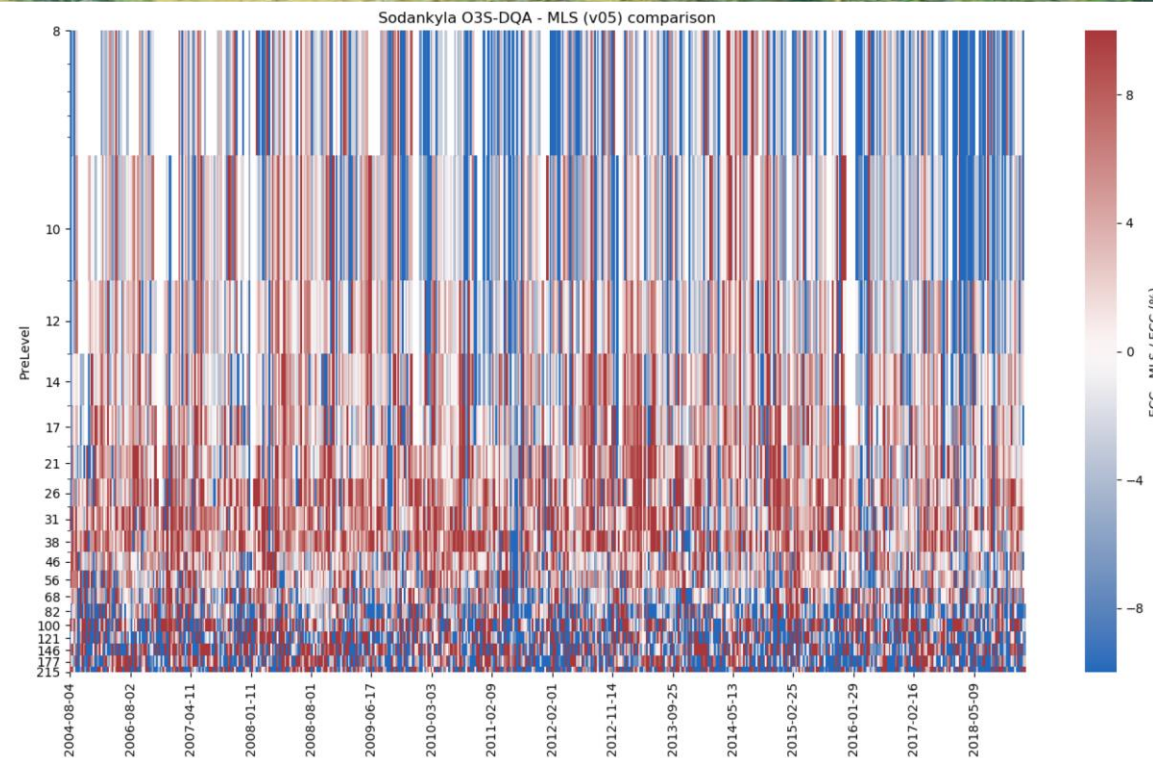
Total ozone comparisons					
Sonde launch time	OIF411 (DU)	OIF921 (DU)	Brewer or SAOZ (DU)	GB/OIF411	GB/OIF921
February 6, 2014 8:43 UT	283.0	284.3	287.3	1.02	1.01
February 6, 2014 12:47 UT	273.4	278.7	287.3	1.05	1.03
April 8, 2014 9:00 UT	425.6	421.4	422.8	0.99	1.00
April 8, 2014 13:00 UT	427.7	429.5	425.7	1.00	0.99
April 9, 2014 12:37 UT	360.6	368.8	373.0	1.03	1.01

Left panel: A test flight at Sodankylä using separate ozone sensors. In each dual sensor flight we had the first ENSCI ECC type of ozonesonde attached to an RS92 radiosonde and the data were received via the OIF921 interface and the MW31 system; the second ozonesonde of the same type and production batch was attached to the RS41 radiosonde and the data were received via the OIF411 interface and the MW41 system. Shown are profiles of ozone partial pressure from surface to the stratosphere and relative differences in percent between the two systems $(\text{OIF921}-\text{OIF411})/\text{OIF411}$. Black curve represents medium averaged differences, while each single data point comparison, with 1 second time resolution, is shown by the grey line in the background. Right panel: comparisons with the ground based instruments: Brewer #037 and SAOZ.

Climatology of soundings at Sodankylä



Comparisons with satellite data



Left: Climatological profiles based on long term observations. Right: Comparisons with MLS v05 profile data after post-processing of the ozonesonde data. The post-processing has included corrections for conversion efficiency; background current; pump temperature measurement; moistening effect of the pump flow rate and pump flow efficiency at low pressures, according to the Guidelines for homogenization of ozonesonde data, SI2N/O3S-DQA activity as part of “Past changes in the vertical distribution of ozone assessment”.

Summary

- At Sodankylä, Finland (67.4° N, 26.6° E) ozonesonde observations have been performed since late 1980s. The sondes have been launched on regular bases during each season.
- Since the start of the measurements electrochemical concentration cell sondes have been flown. Historically we have flown both SPC and ENSCI type of ozonesondes, while since February 2006 mostly ENSCI sondes have been in use at Sodankylä.
- We have performed dual and multiple ozonesonde flights in the context of change management of the ozonesondes. The dual sonde measurements have confirmed data consistency between SPC and ENSCI ozonesondes.
- Recent activities include ozonesonde data post-processing, based on the network-wide principles of data homogenization.

References

- [1] Kivi, R., et al., Ozonesonde observations in the Arctic during 1989–2003: Ozone variability and trends in the lower stratosphere and free troposphere, *J. Geophys. Res.*, 112, D08306, doi:[10.1029/2006JD007271](https://doi.org/10.1029/2006JD007271) (2007).
- [2] Christiansen, B., et al., Trends and annual cycles in soundings of Arctic tropospheric ozone, *Atmos. Chem. Phys.*, 17, 9347–9364, <https://doi.org/10.5194/acp-17-9347-2017> (2017).
- [3] Deshler, T., et al., Methods to homogenize ECC ozonesonde measurements across changes in sensing solution concentration or ozonesonde manufacturer, *Atmos. Meas. Tech.*, 10, 2012-2043, doi:10.5194/amt-10-2021-2017 (2017).