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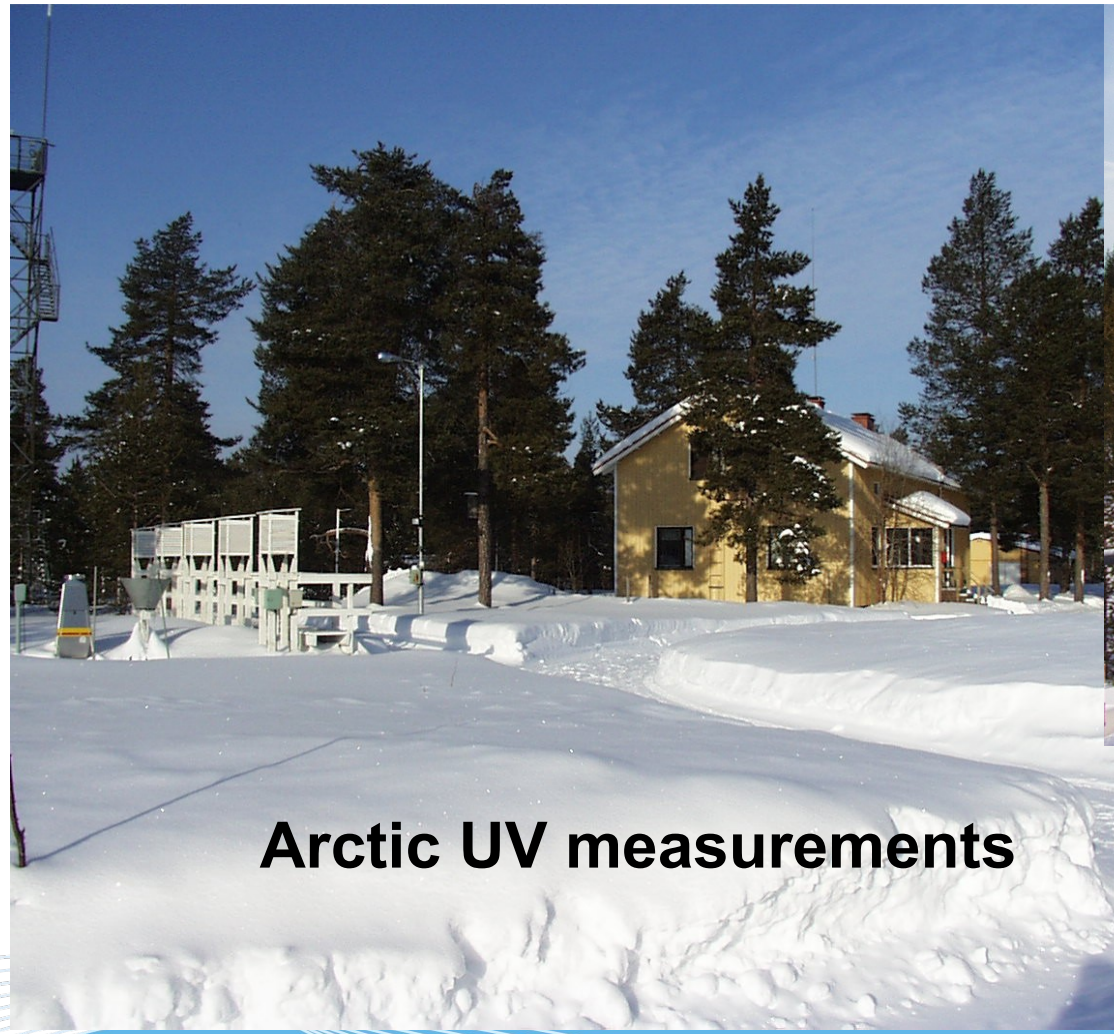
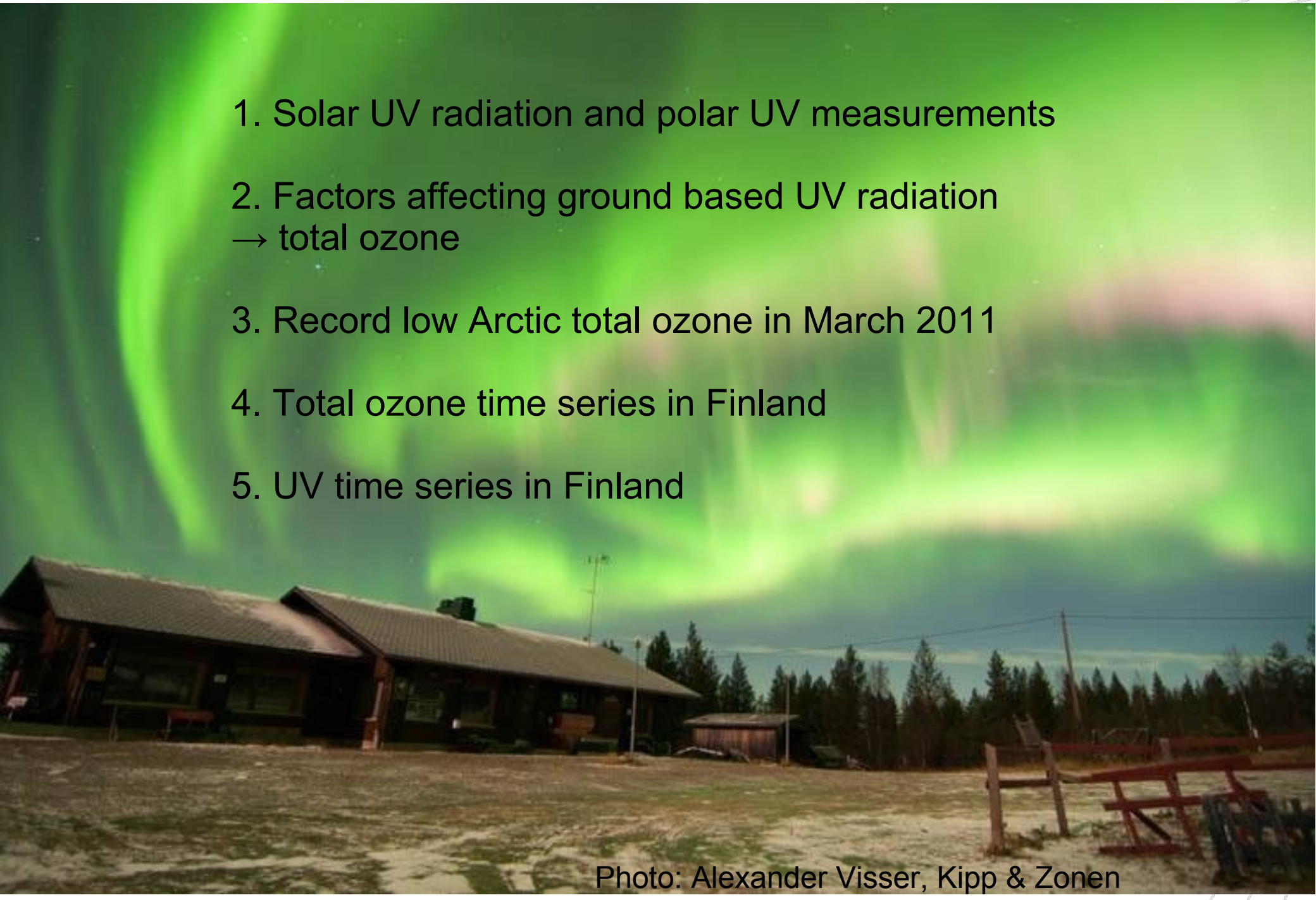


# Arctic UV measurements

Kaisa Lakkala, Finnish Meteorological Institute

8.3.2016, COST1207 STSM at AEMET



1. Solar UV radiation and polar UV measurements

2. Factors affecting ground based UV radiation
→ total ozone

3. Record low Arctic total ozone in March 2011

4. Total ozone time series in Finland

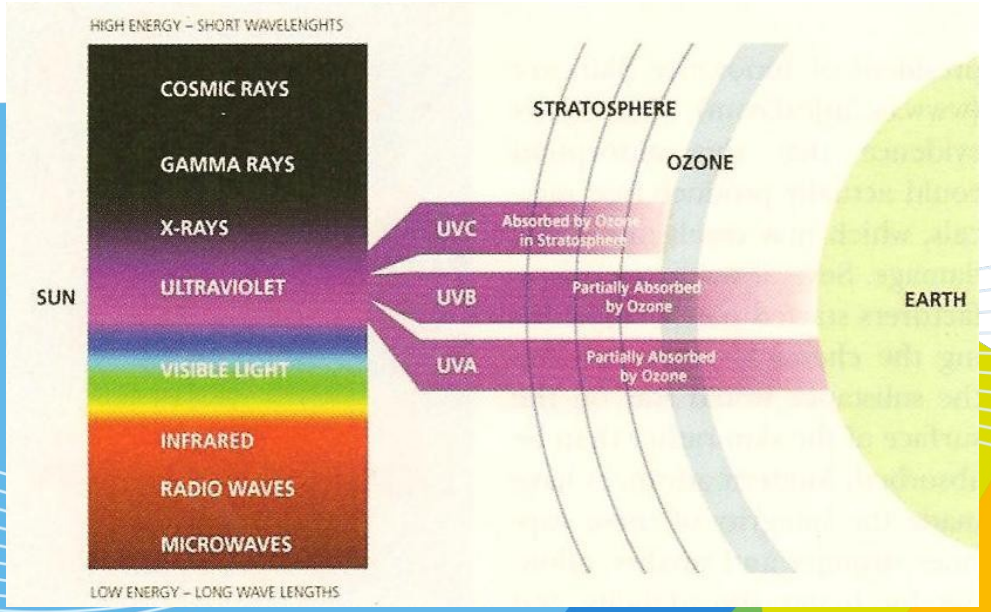
5. UV time series in Finland

Photo: Alexander Visser, Kipp & Zonen

# 1. Solar ultraviolet (UV) radiation

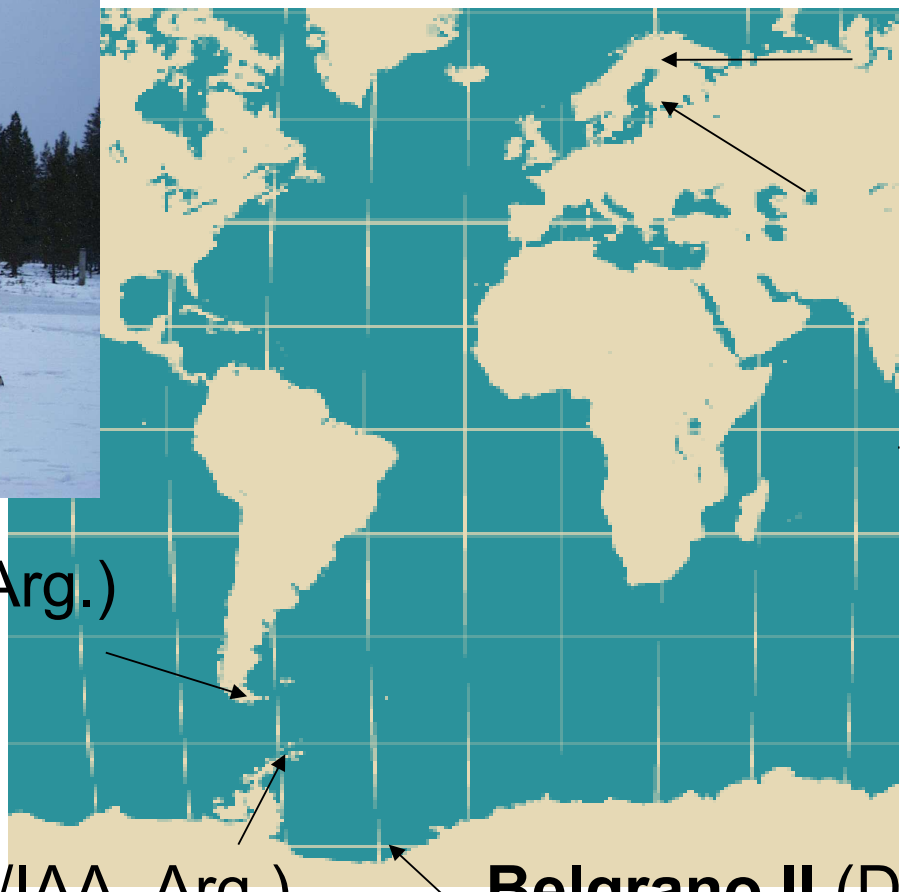
- Electromagnetic radiation
- Biological effectiveness depends on wavelength.
- Atmospheric oxygen and ozone protect the Earth from the most dangerous wavelengths.

- From solar radiation reaching the top of the atmosphere
  8 % UV radiation
  39 % visible light
  53 % infrared radiation




Picture from:http://www.spraytanningsolutioninfo.com/

# High latitude UV measurements



**Sodankylä** (FMI)
67ºN, 27ºE

**Jokioinen** (FMI)
61º N, 24ºE

**Ushuaia** (CADIC, Arg.)
54ºS, 68ºW

**V. Marambio** (DNA/IAA, Arg.)
64ºS, 56ºW

**Belgrano II** (DNA/IAA, Arg.)
77ºS, 34ºW

**Antarctic NILU-UV network (INM, Spain)**

# UV instruments at the Finnish Meteorological Institute -Arctic Research Centre (FMI-ARC)

2 NILU-UV multifilter radiometers, since 2002

2 SL501A broadband radiometers, since 1995

2 Brewer spectroradiometers, since 1990

Photos: Hanne Suokanerva

Forest: 2002-2011

Peatland: 2002-2010


Peatland site
Forests site
Sounding station
POLARIA

# Main factors affecting UV radiation

solar zenith angle (SZA)

ozone

clouds

aerosols and pollutants

elevation

albedo

# Polar UV measurements

- Depletion of stratospheric ozone in the Antarctic and Arctic during spring time: concern about the effects of increasing UV irradiances

- Challenges: large SZA, rapidly-changing cloud conditions, winter snow and low temperatures

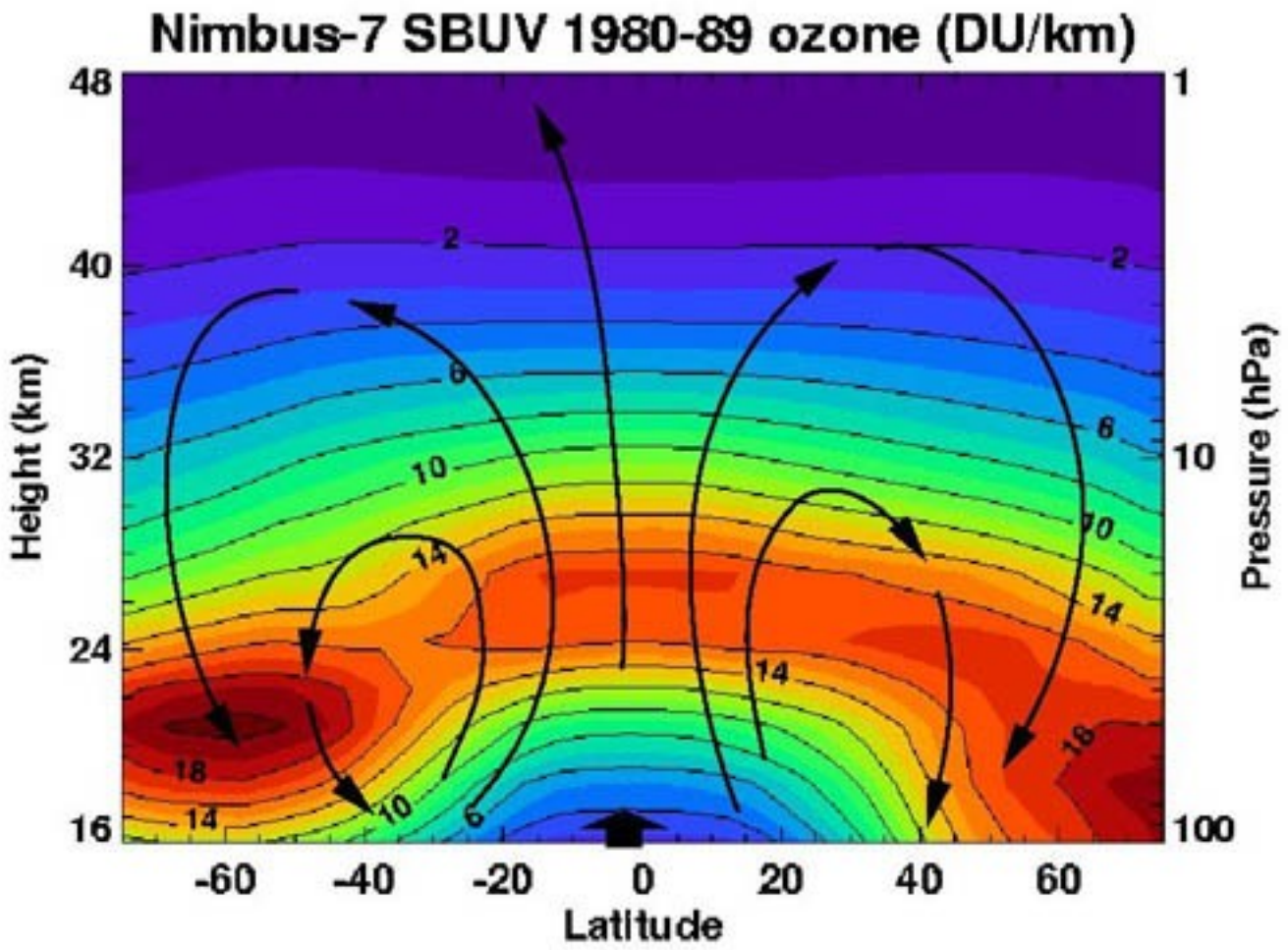
**low irradiances**

**cosine error**

**temperature dependence**

**daily maintenance**


Photo: A. Redondas




Picture from Wikipedia

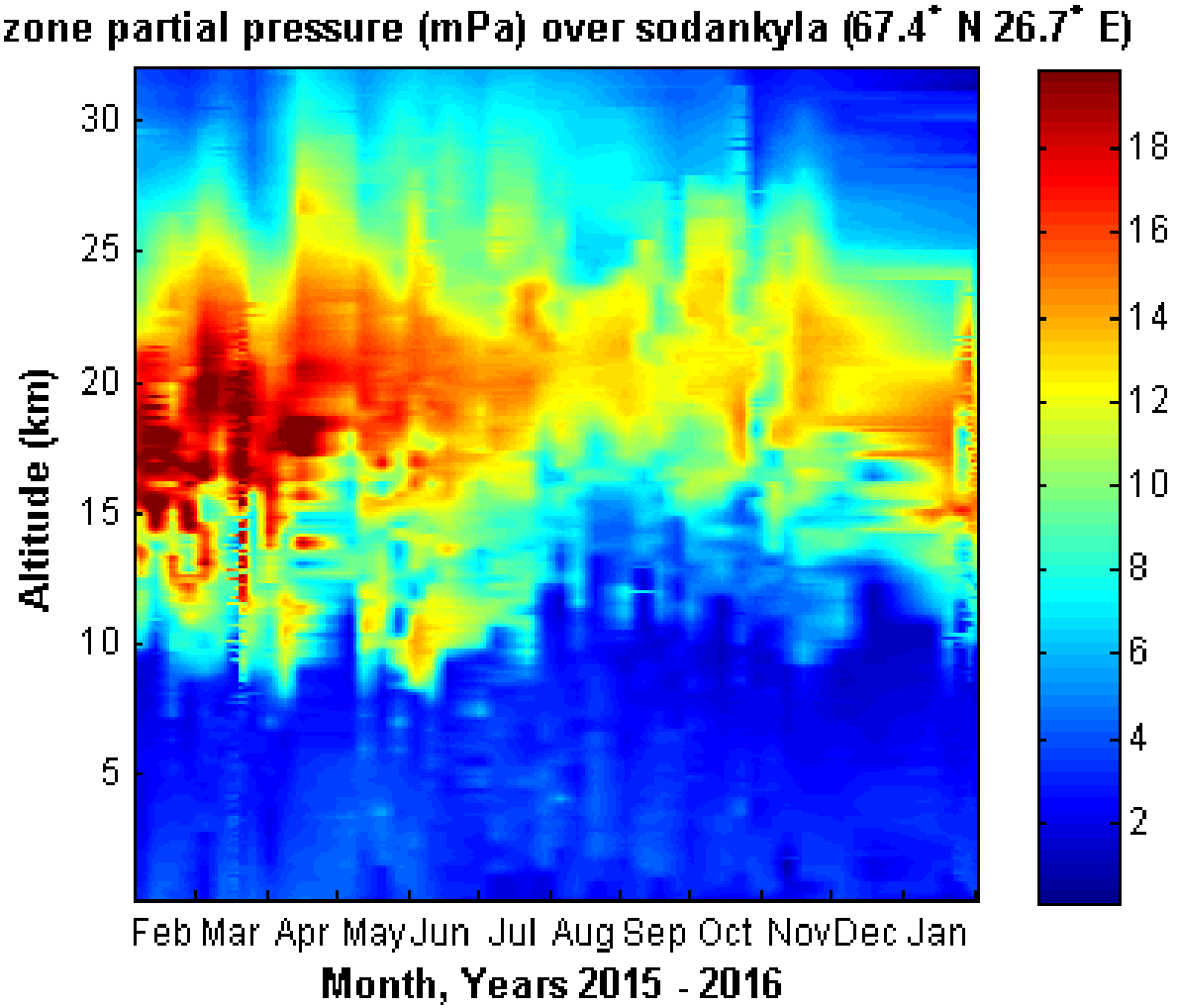



Photo: Pentti Pirttijärvi

WMO Arctic Ozone Bulletin no. 1 – 2016,
http://www.wmo.int/pages/prog/arep/WMOArcticOzoneBulletins2016.html

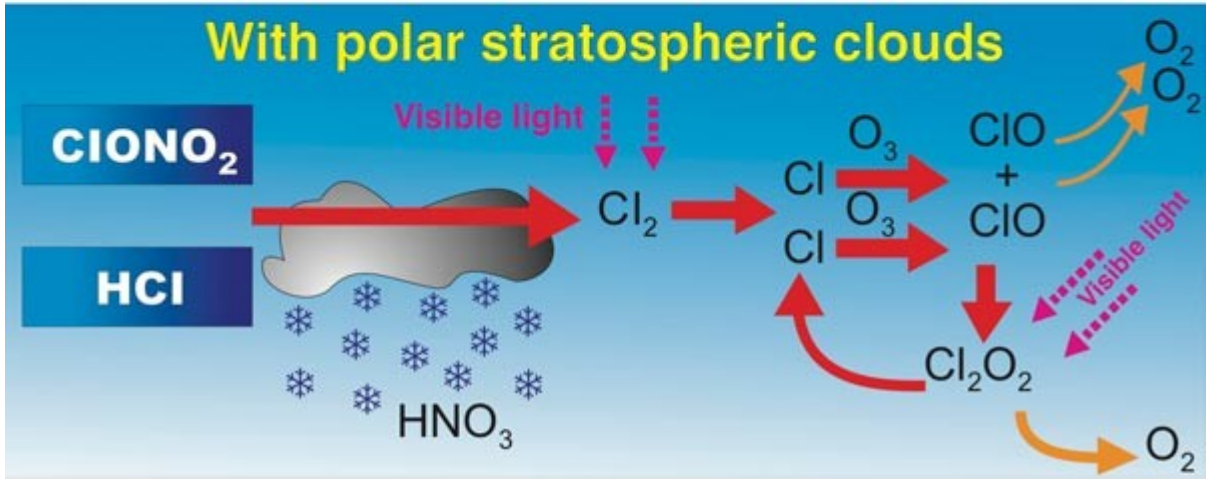




Photo: Rigel Kivi

http://www.wmo.int/bulletin/
Vol 64 (1) - 2015

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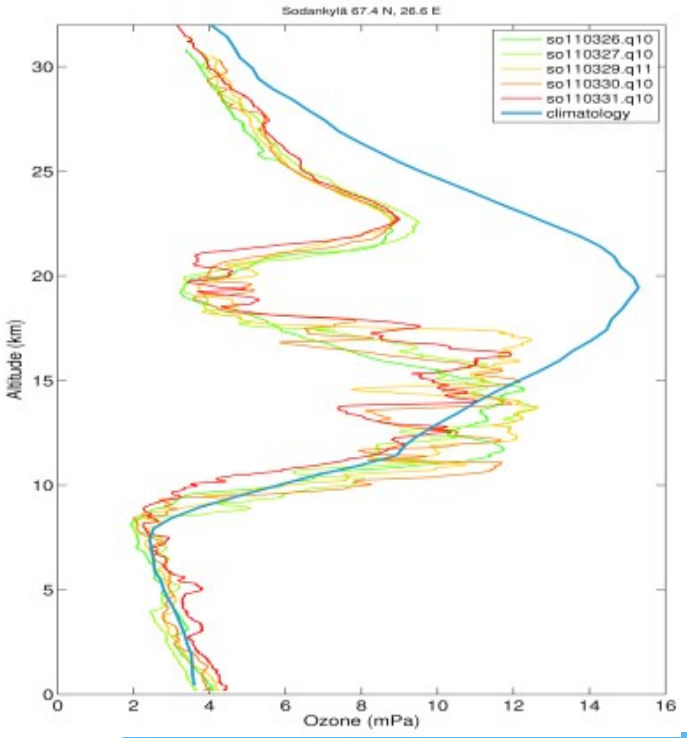
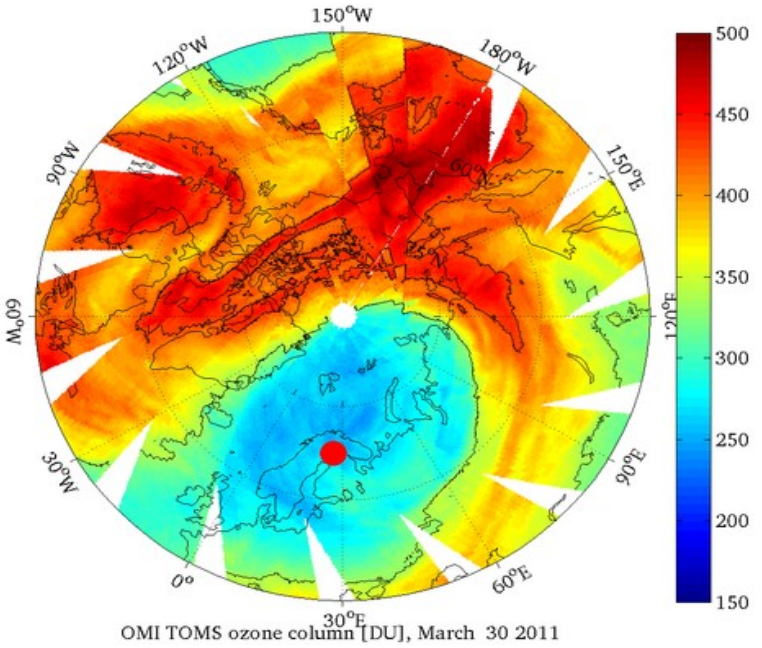
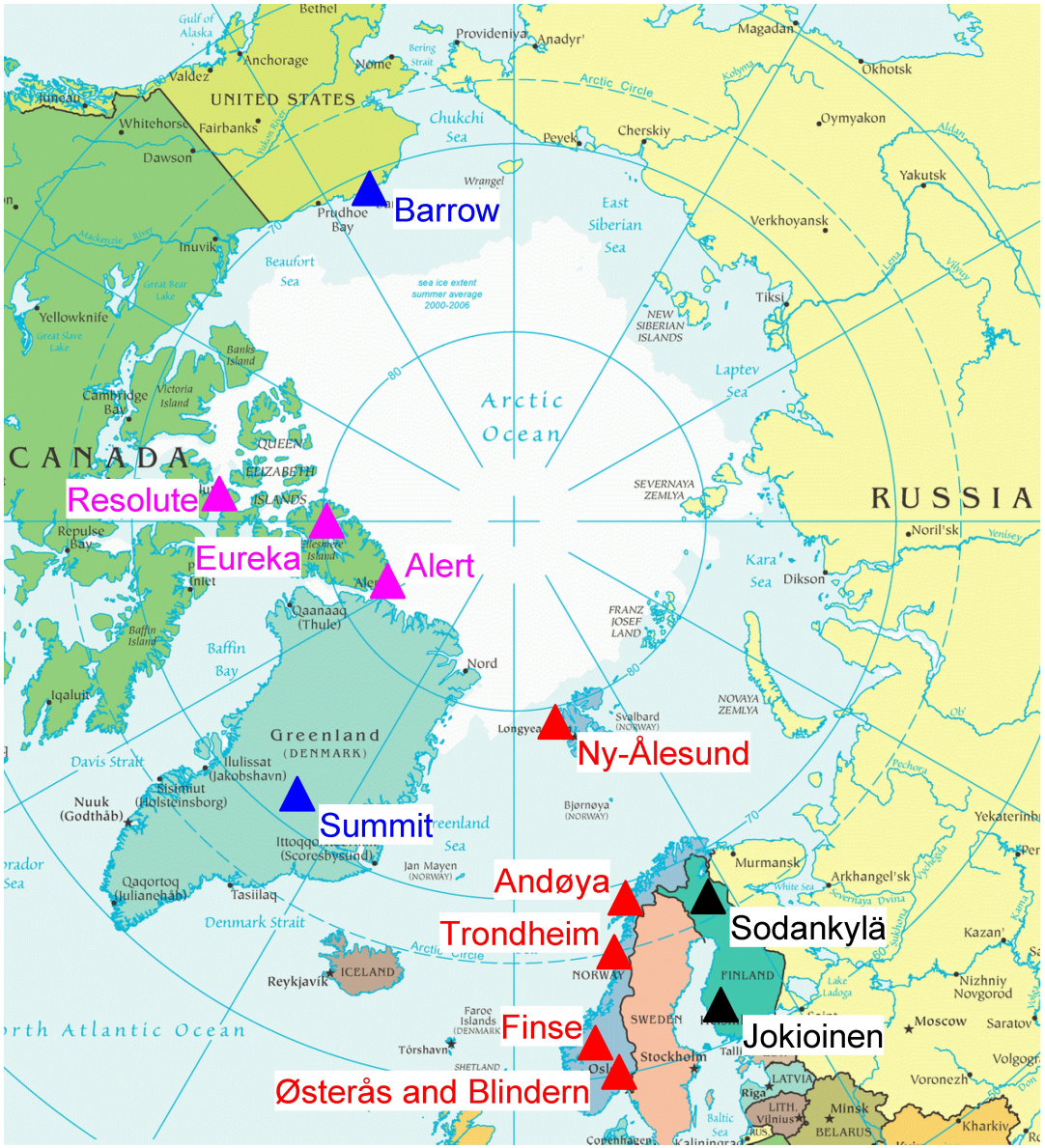
# Ozone in March 2011

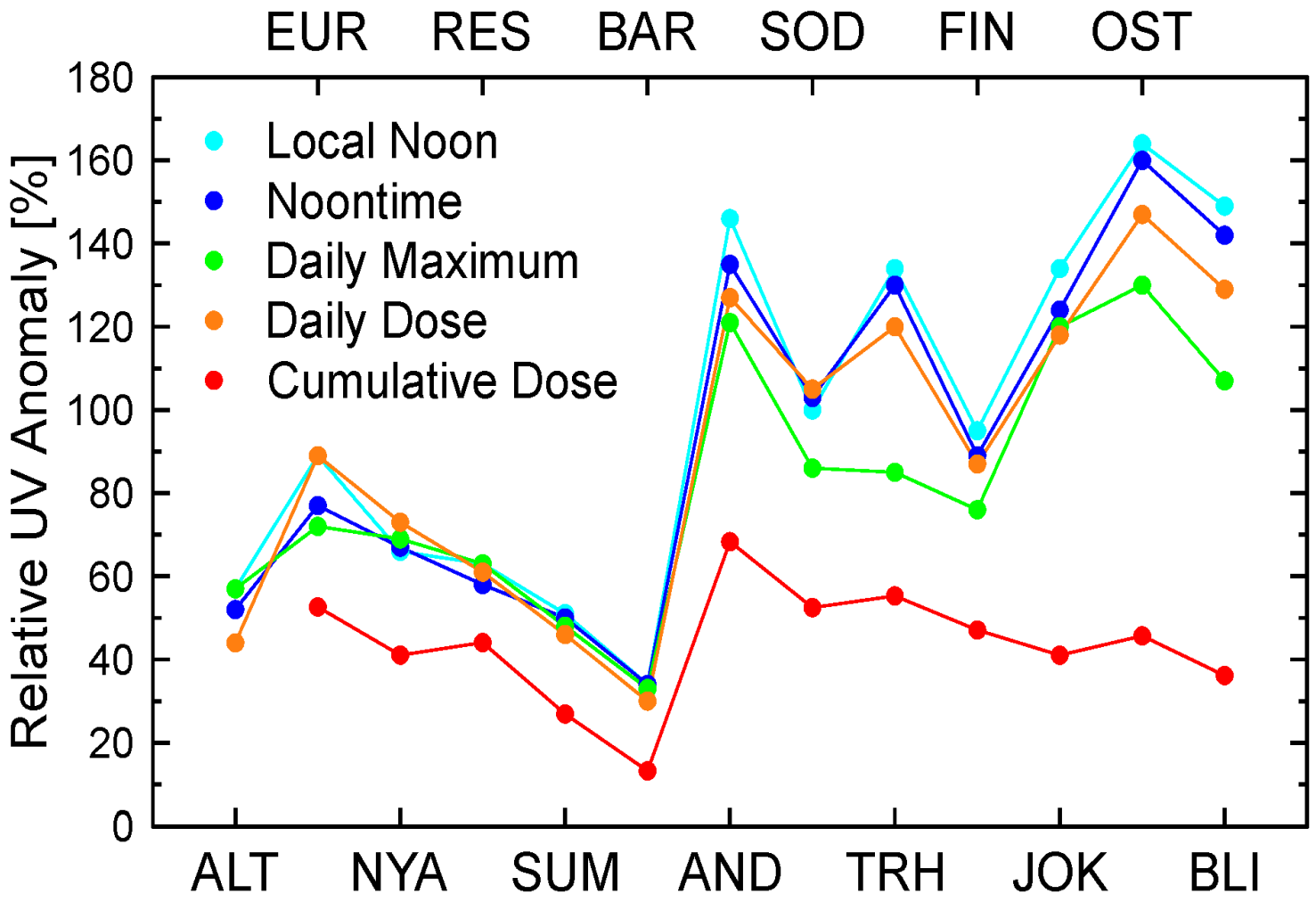



Left: Sodankylä sonde profiles from March 26 until March 31, 2011. They show ozone depletion in the vortex at around 20 km. Lowest values of ozone partial pressure in the soundings were around 3 mPa. Right: OMI TOMS total ozone on March 30, 2011. Red dot marks the location of Sodankylä station. OMI figure courtesy Janne Hakkarainen. Slide from Rigel Kivi, FMI-ARC.

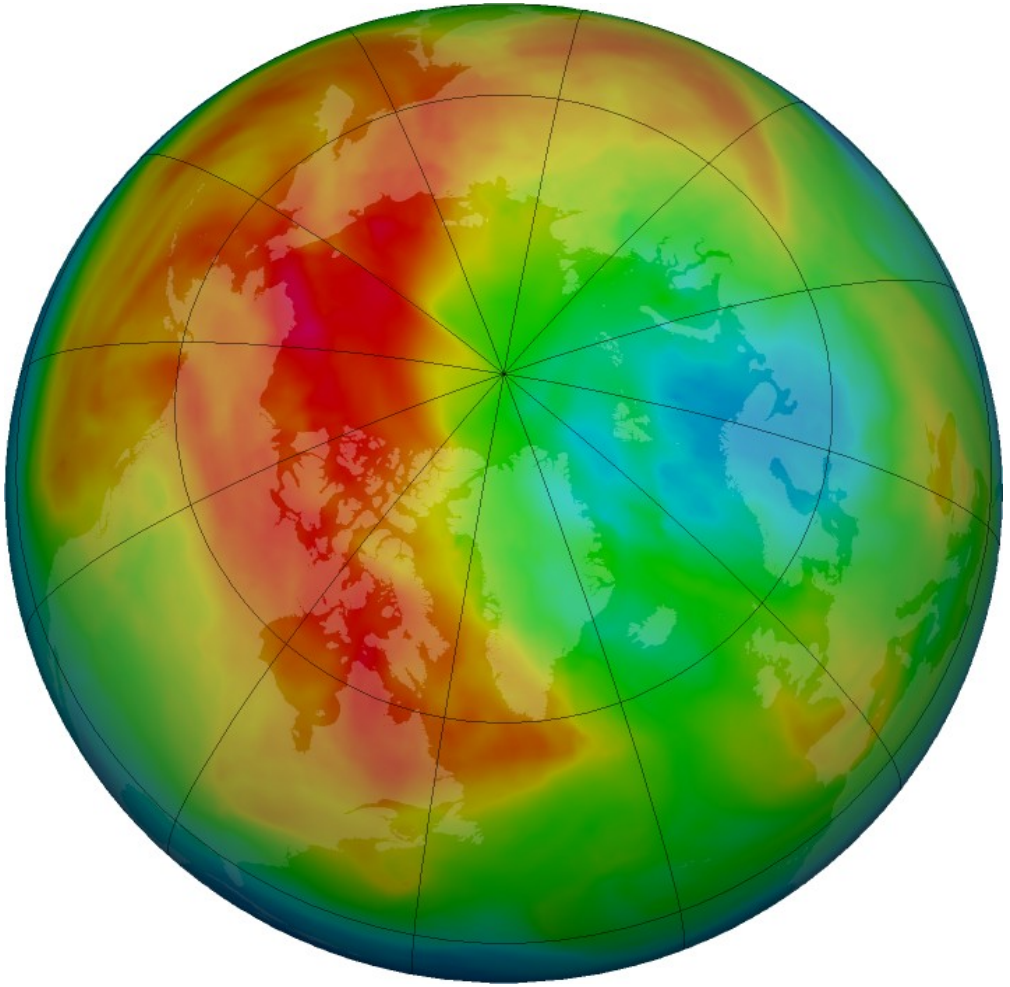



G. Bernhard et al.:
High levels of ultraviolet radiation observed by ground-based instruments below the 2011 Arctic ozone hole, Atmos. Chem. Phys., 13, 10573-10590, doi:10.5194/acp-13-10573-2013, 2013.

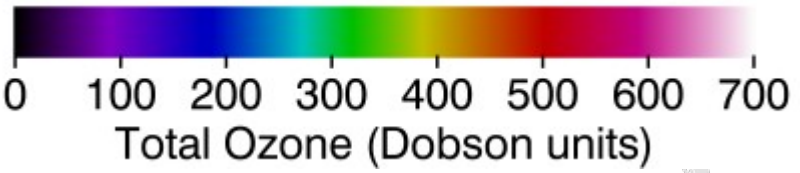



From G. Bernhard et al. 2013, Atmos. Chem. Phys., 13

# Arctic Ozone Watch: Latest status of Arctic ozone

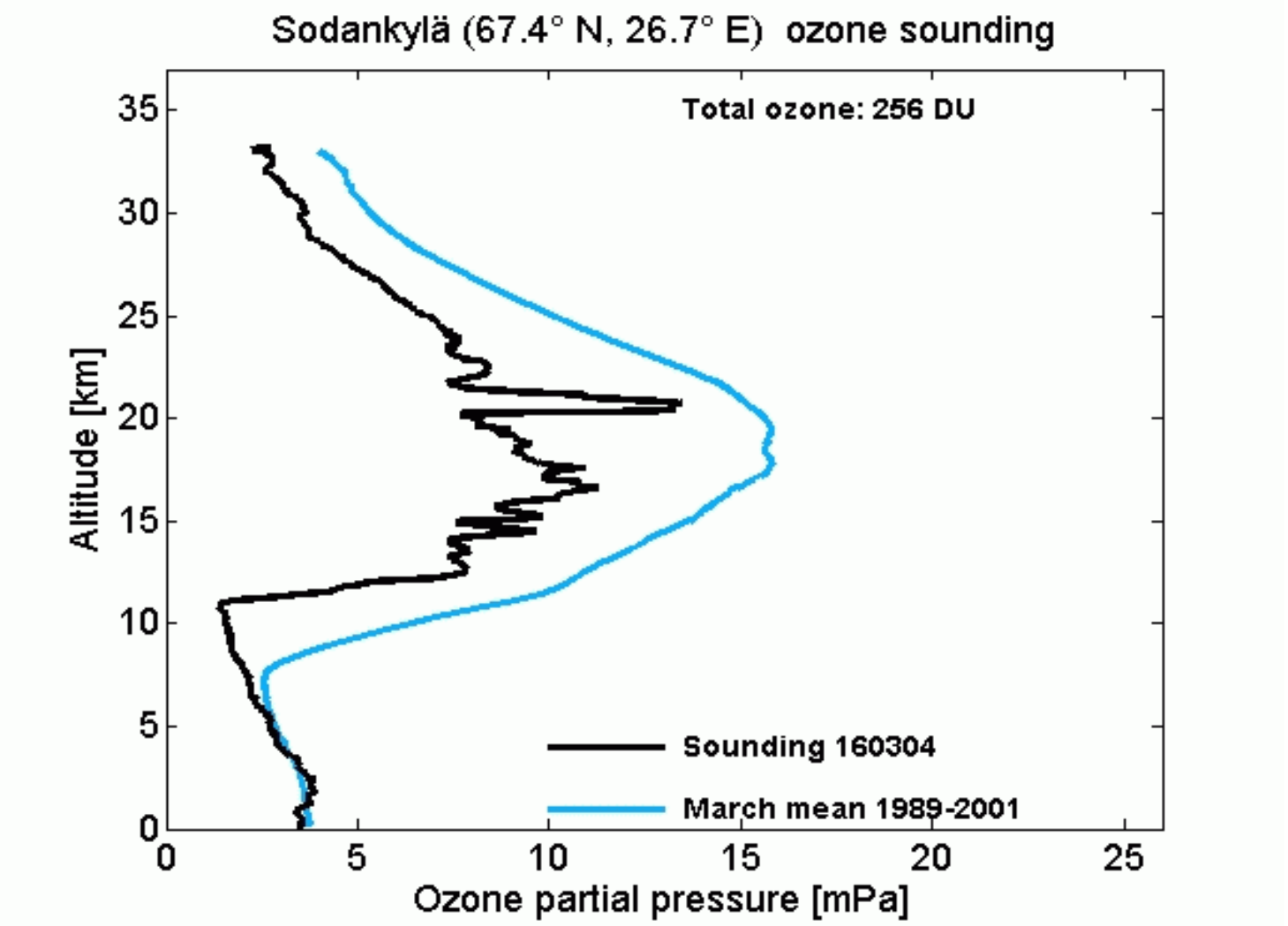


5 March 2016



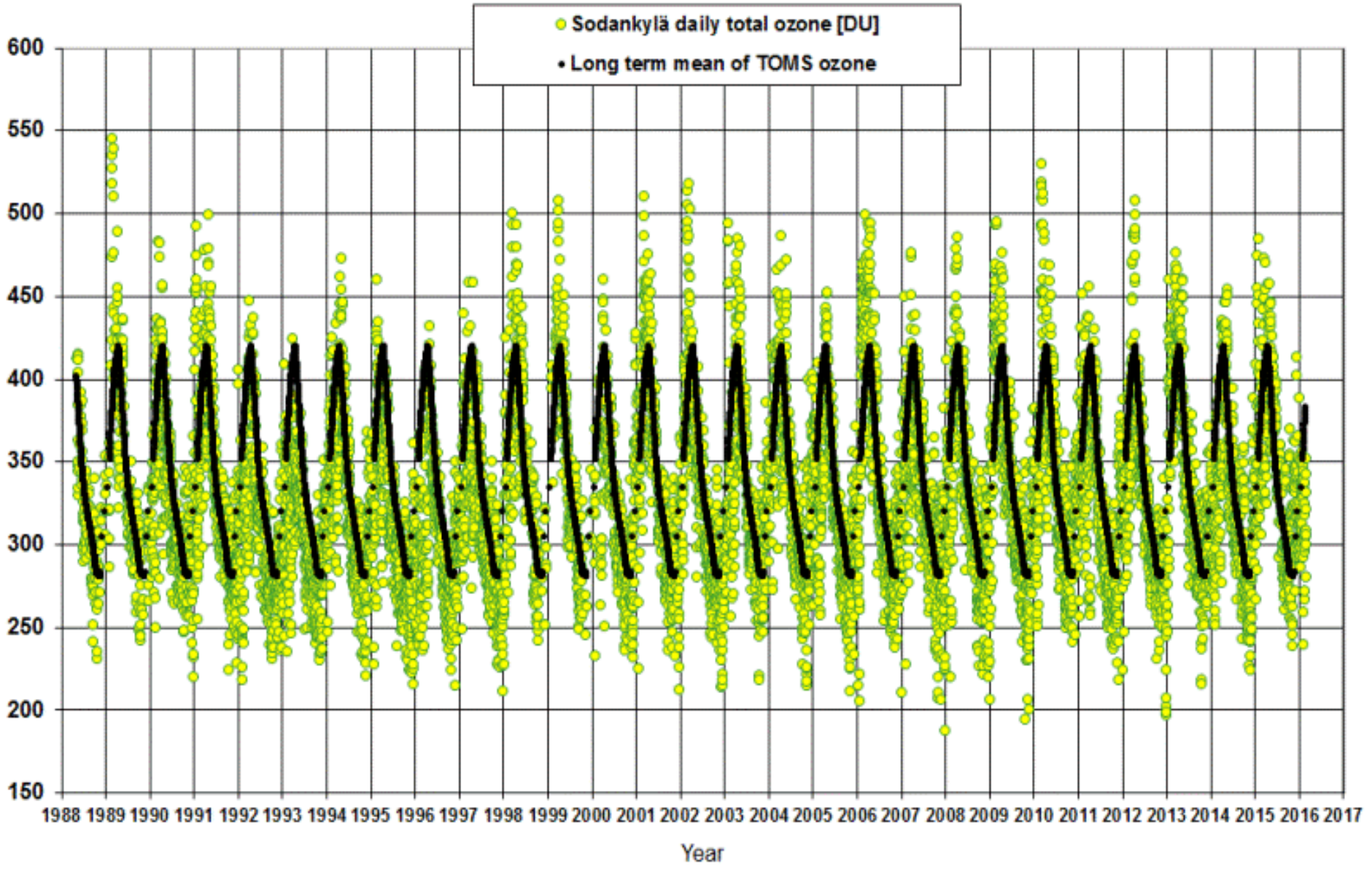

http://ozonewatch.gsfc.nasa.gov/NH.html

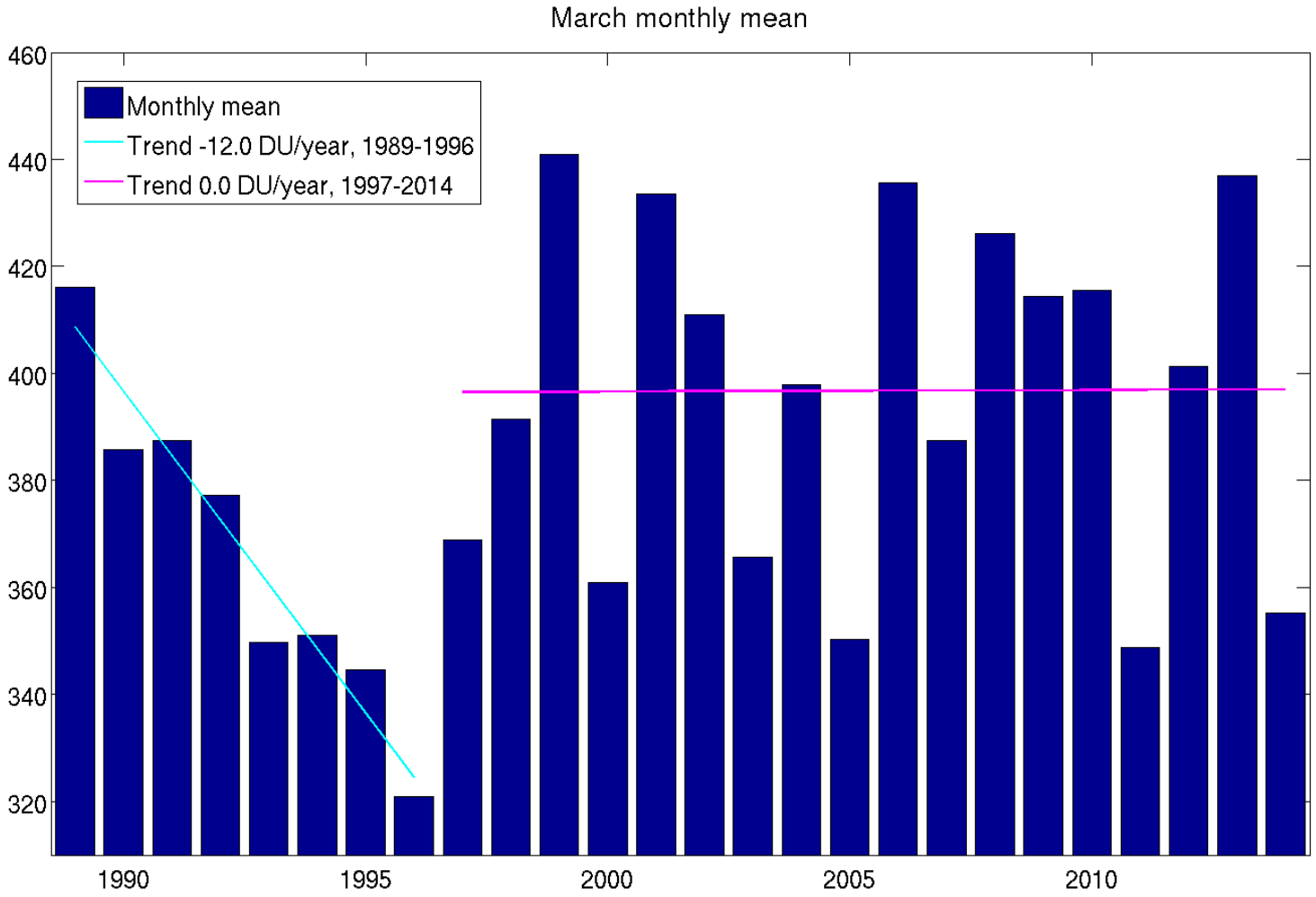
WMO Arctic Ozone Bulletin no. 1 – 2016,
http://www.wmo.int/pages/prog/arep/WMOArcticOzoneBulletins2016.html




http://fmiarc.fmi.fi

# Daily total ozone at Sodankylä 1988-2016






From Karppinen et al. 2016: Brewer spectrometer total ozone column measurements in Sodankylä Geosci. Instrum. Method. Data Syst. Discuss., doi:10.5194/gi-2015-41, 2016

From:
G. Bernhard et al. 2016,
Submitted to BAMS,
[The Arctic] UV Radiation
[in “State of the Climate in 2015”]

# 2. NRT UV processing

UV raw

5 min

Total ozone

Automatic weather obs.
Visibility

Unix server:

NRT UV processing, perl

Libradtran:
Dir/Diff for cos.cor.

Web interface: UVI

FMI
Climate database:
UV index

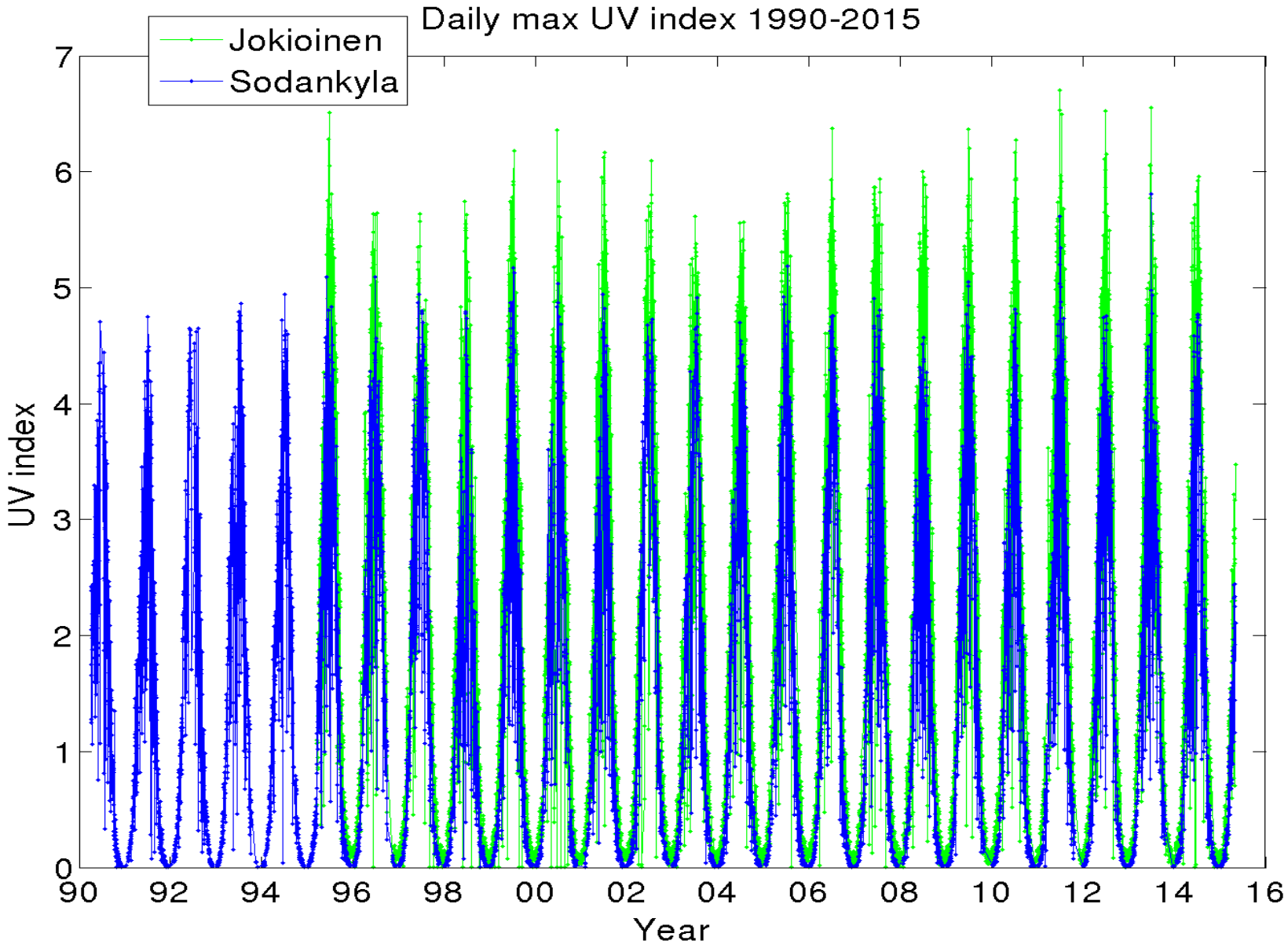
Error messages

20 min rawdata

rawdata 10 min

EUBREWNET

QC / IDEAS server


Daily max UV index 1990-2015
Jokioinen
Sodankyla
UV index
Year
0
1
2
3
4
5
6
7
90
92
94
96
98
00
02
04
06
08
10
12
14
16

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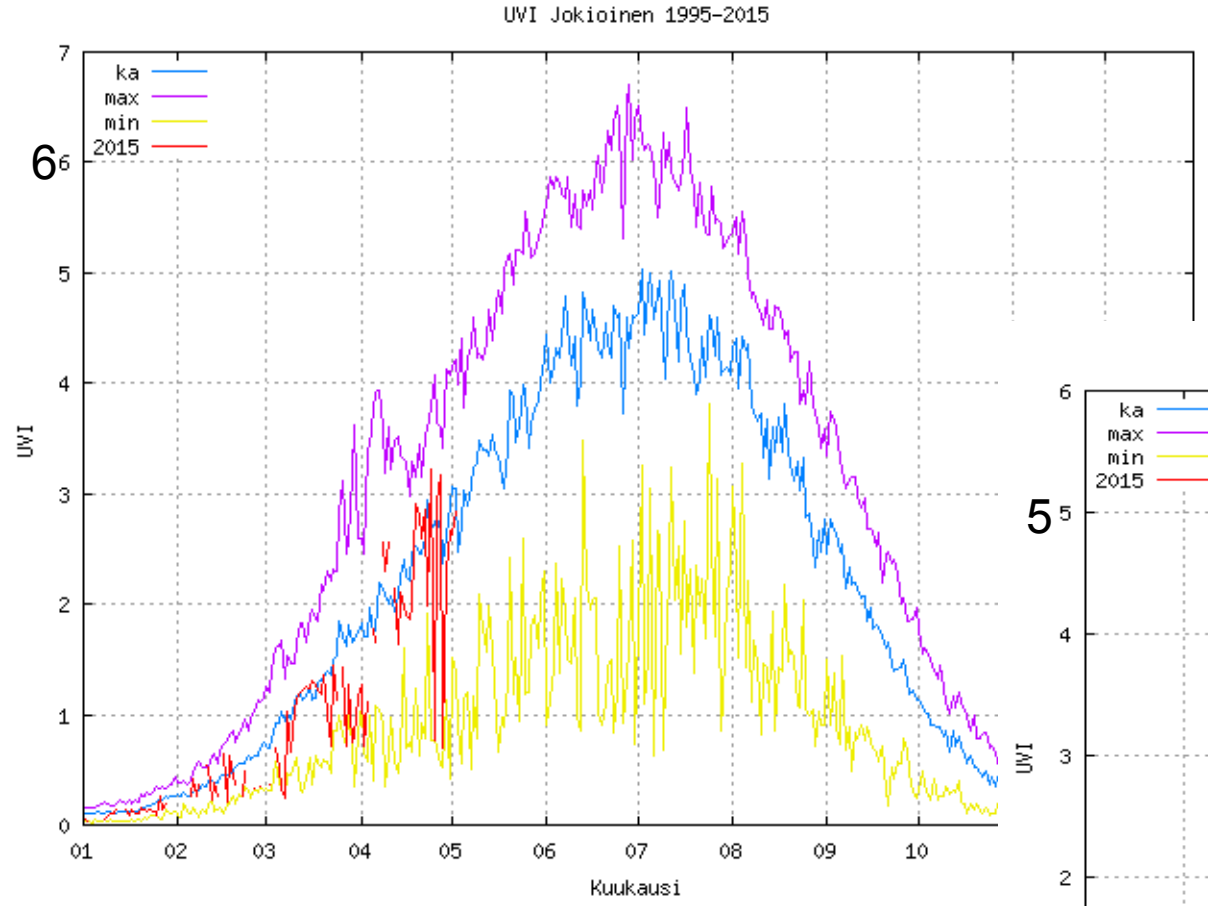
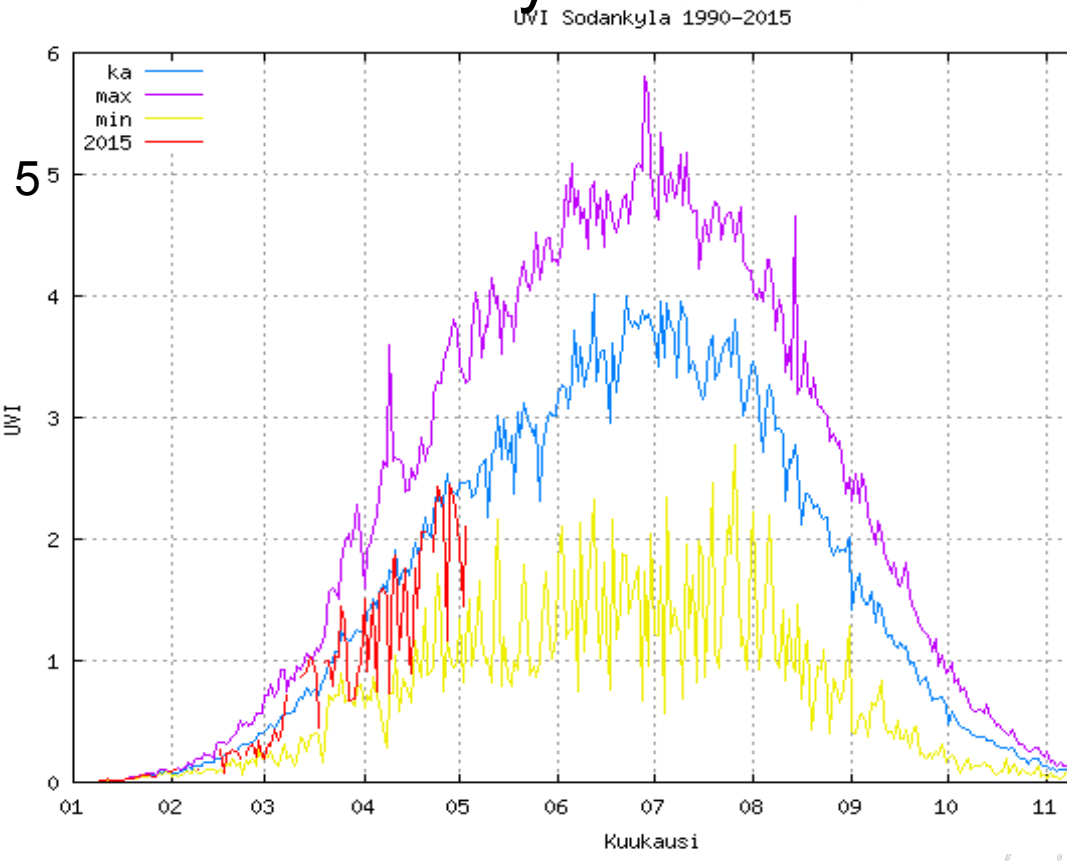
# Jokioinen 1995-2015




Daily Maximum UV index is plotted each day

# Sodankylä 1990-2015




Maximum of all meas.

Average of all meas.

Minimum of all meas.

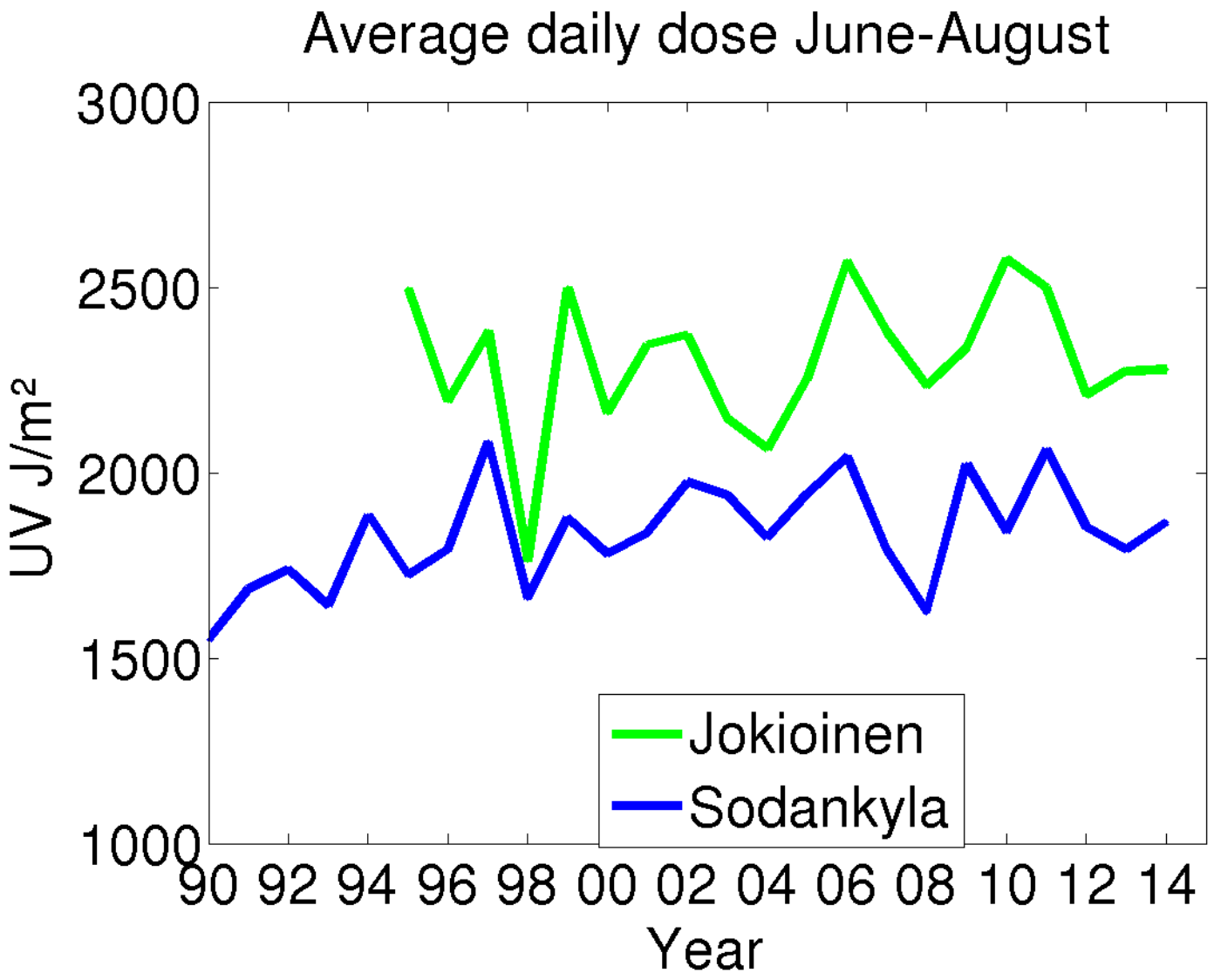
Year 2015

Month

# Top 5 UV index

| | Jokioinen | O3 | UVI |
|---|---|---|---|
| 1. | 29.06.2011 at 10:31:39 SZA 37.6 | 281 | 6.70 |
| 2. | 28.06.2013 at 10:12:16 SZA 37.7 | 291 | 6.55 |
| 3. | 28.06.2011 at 10:31:28 SZA 37.5 | 299 | 6.53 |
| 4. | 01.07.2012 at 09:48:10 SZA 38.5 | 298 | 6.52 |
| 5. | 25.06.1995 at 10:23:58 SZA 37.4 | 272 | 6.51 |

| | Sodankylä | O3 | UVI |
|---|---|---|---|
| 1. | 29.06.2013 at 09:40:20 SZA 44.5 | | 5.81 |
| 2. | 30.06.2011 at 10:22:06 SZA 44.2 | 272 | 5.62 |
| 3. | 04.07.2011 at 09:52:56 SZA 44.6 | 299 | 5.35 |
| 4. | 29.06.2011 at 09:21:51 SZA 45.0 | 275 | 5.20 |
| 5. | 12.07.2005 at 11:00:58 SZA 45.9 | 284 | 5.18 |


Average daily dose June-August
UV J/m²
3000
2500
2000
1500
1000
90 92 94 96 98 00 02 04 06 08 10 12 14
Year
Jokioinen
Sodankyla

My STSM was financed by the ESSEM COST Action ES1207,
A European Brewer Network (EUBREWNET)

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