The atmospheric composition observatory at Princess Elisabeth Station, East Antarctica: total ozone and seasonal physical and optical aerosol properties

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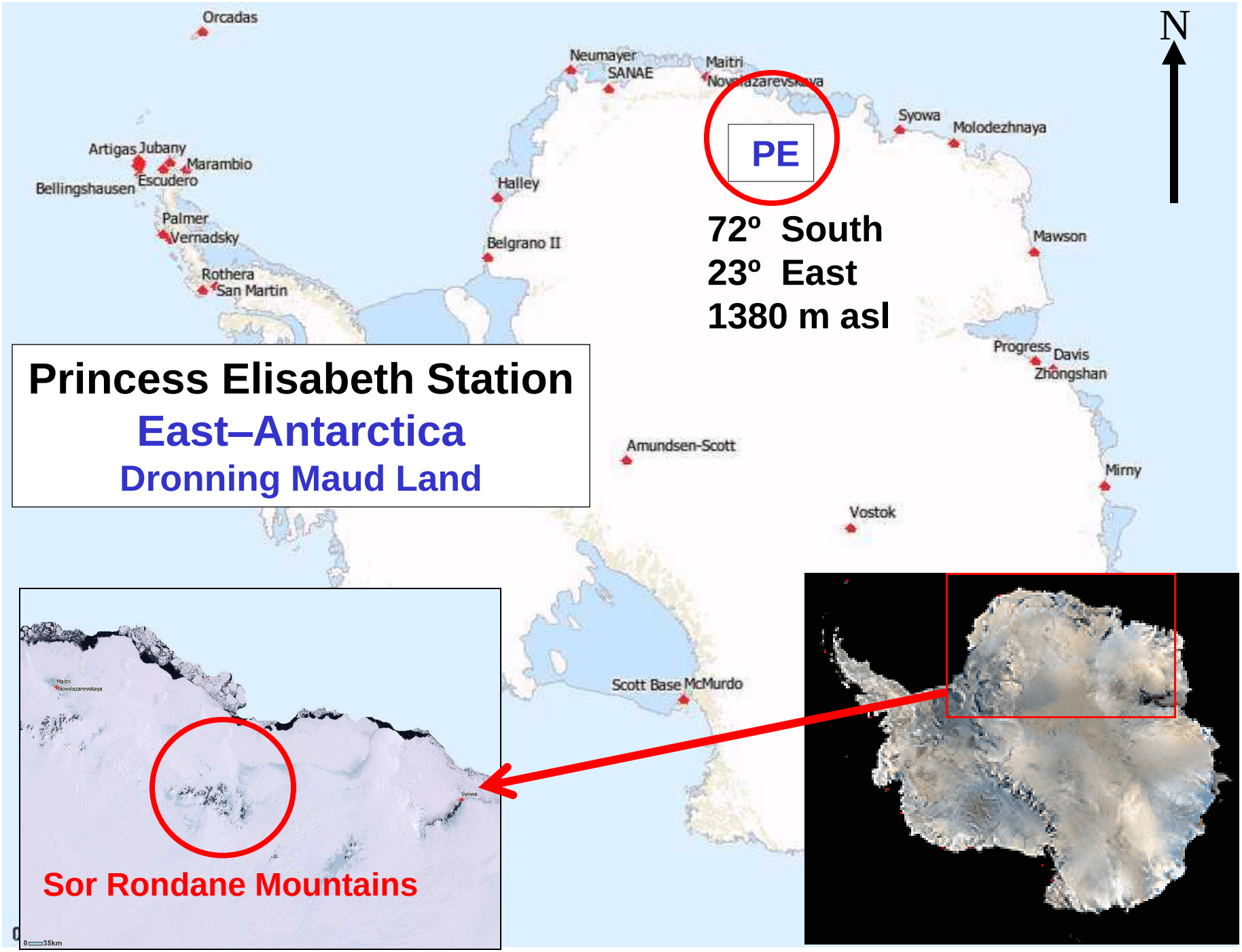
6 November 2014 / NORS Symposium


Orcadas
Neumayer
SANAE
Maitri
Novolazarevskaya
Syowa
Molodezhnaya
PE
Artigas
Jubany
Marambio
Bellingshausen
Escudero
Halley
Palmer
Vernadsky
Belgrano II
Mawson
Rothera
San Martin
72º South
23º East
1380 m asl
Progress
Davis
Zhongshan
Princess Elisabeth Station
East–Antarctica
Dronning Maud Land
Amundsen-Scott
Mirny
Vostok
Scott Base
McMurdo
Sor Rondane Mountains
N

Princess Elisabeth Station from East

container near station
→ 5 aerosol instruments inside

ozone, Cimel, UV measurements on roof of station

innovative power–system of station

solar panels, wind energy, heat insulation, batteries

generators only back-up

temporal priorities for specific power consumers

manned only November to February

Objectives

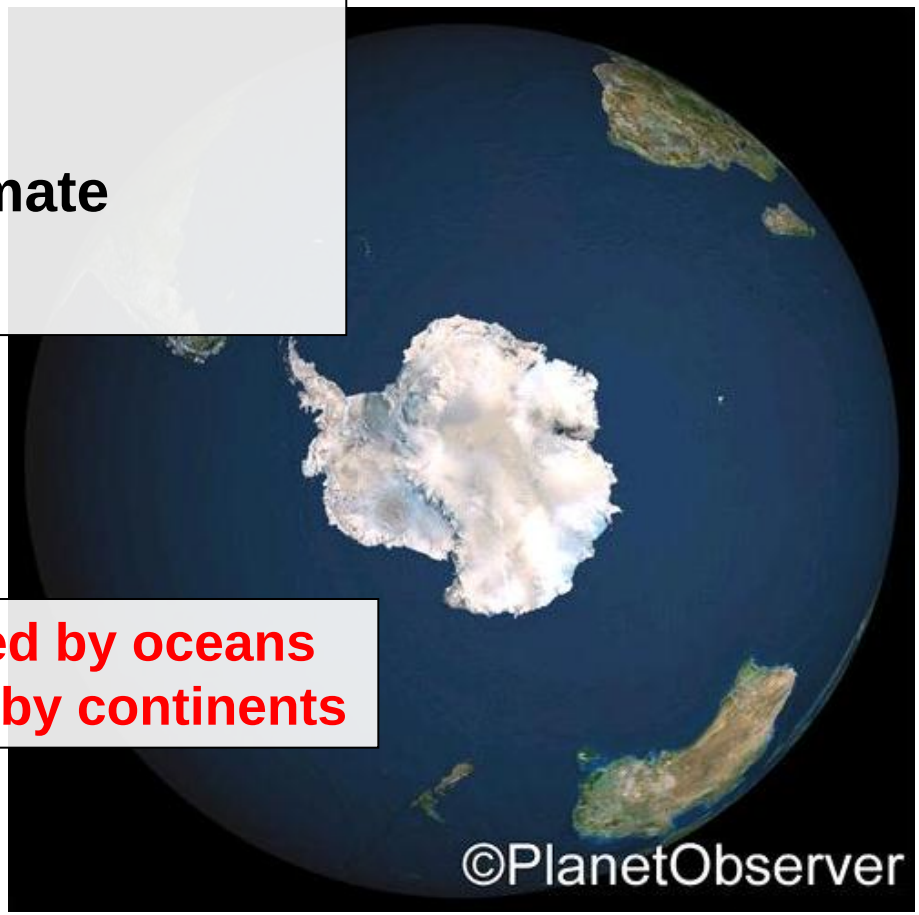
→ aerosol–cloud–precipitation interaction

→ climatology of UV-radiation

→ total ozone, ozone hole

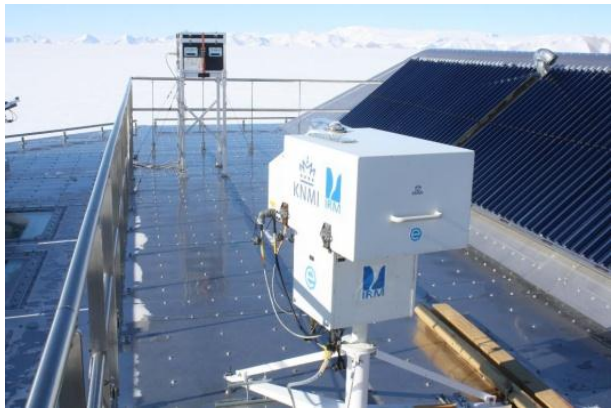
→ influence of particles on climate

→ long-term time series

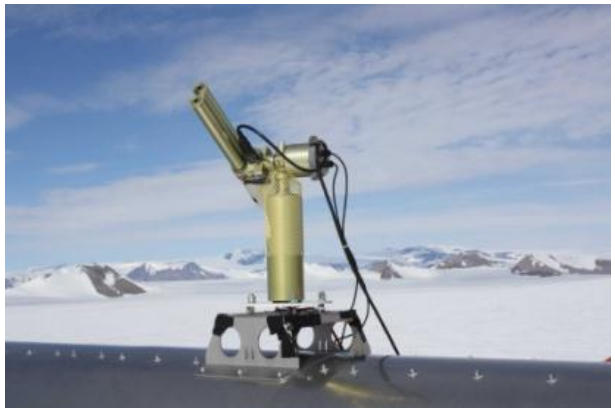


Antarctica is a continent surrounded by oceans
The Arctic is an ocean surrounded by continents

Instrumentation / summer only and whole-year operation

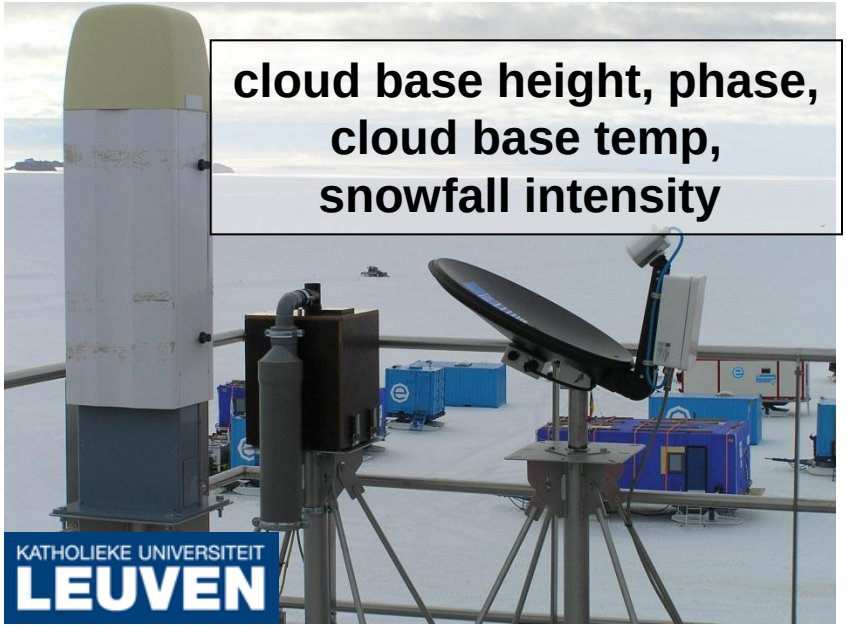


ozone,
sun radiation, UV



amount particles
total atmospheric column

aerosol boundary-layer:
number, size, mass,
optical properties



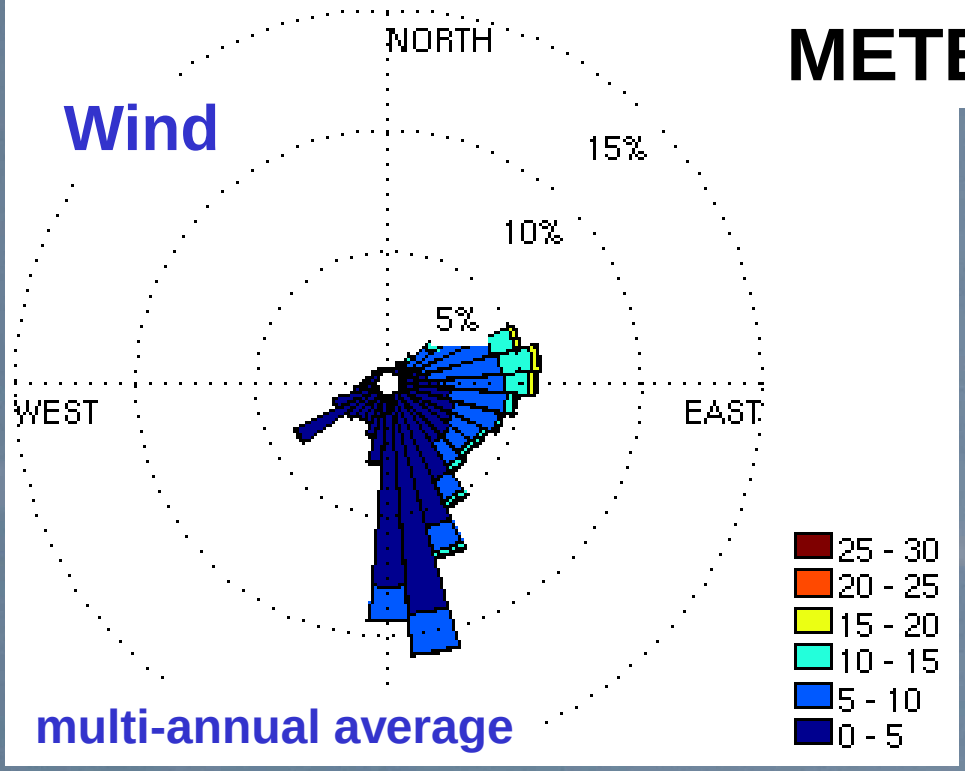
cloud base height, phase,
cloud base temp,
snowfall intensity

KATHOLIEKE UNIVERSITEIT LEUVEN

radiosonde balloon launches

Some Results

METEO



values from hourly means

Temperature:
minimum = –37.4 °C
maximum = +4.0 °C
mean = –18.2 °C

mean relative humidiy:
= 57 % (9 – 100 %)

mean wind speed :
= 5 m/s (0.1 to 26 m/s)

mean air pressure :
= 827 hPa

Gorodetskaya et al., 2013, JGR

total ozone and UV radiation

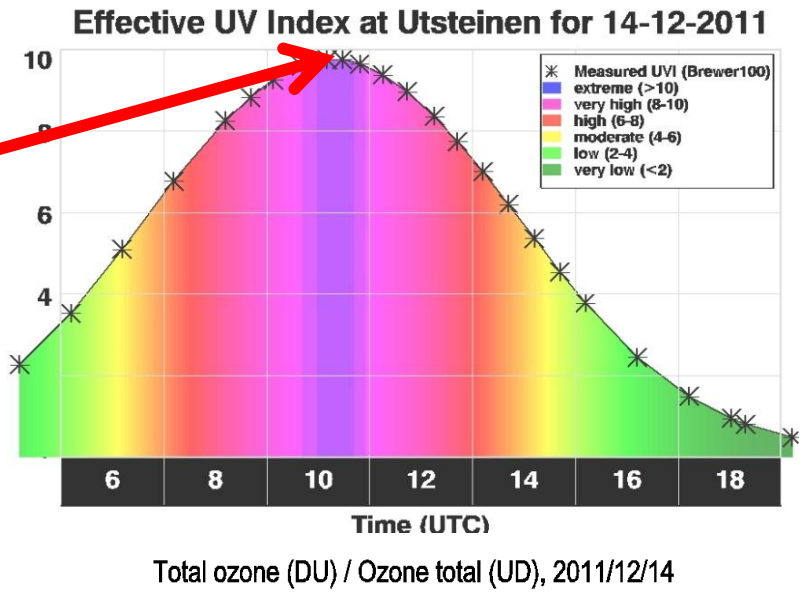
example 14 December 2011

→ remainder of ozone hole above East-Antarctica

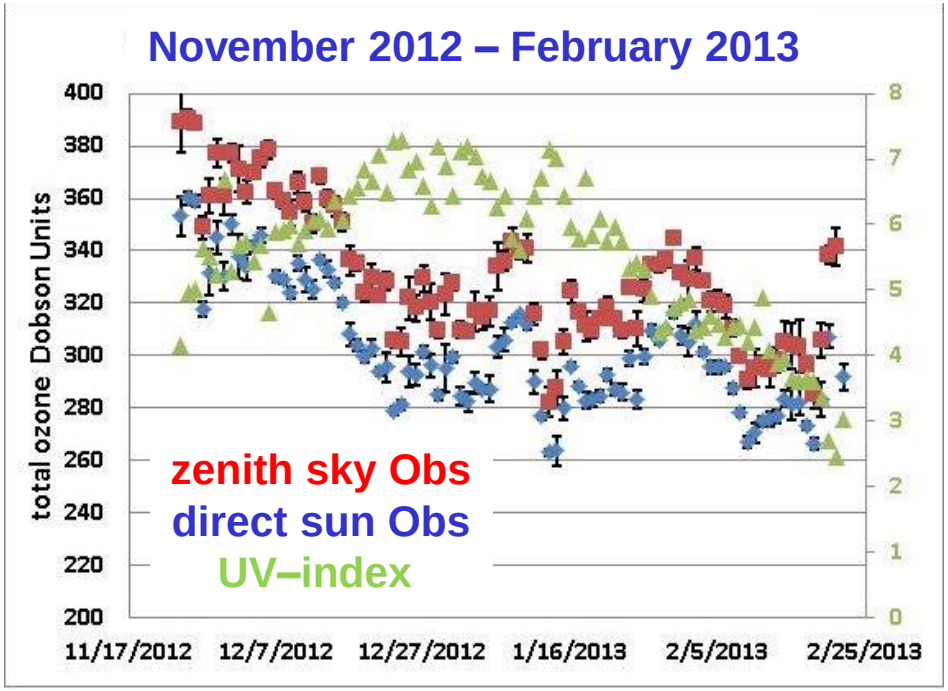
→ total ozone at PE: 225 DU

→ UV index near 10

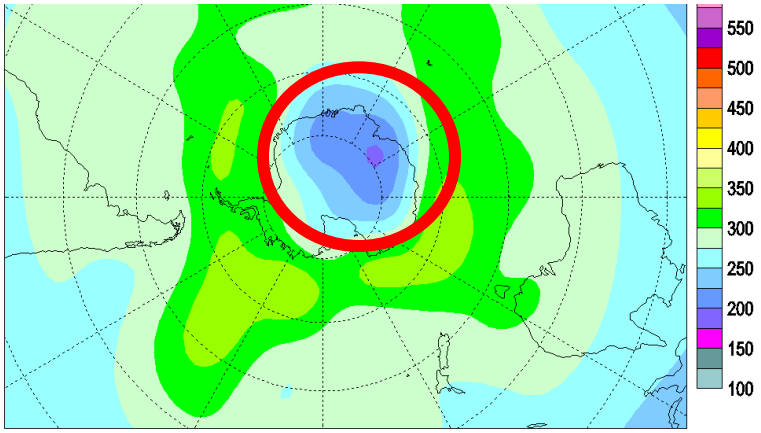
→ unprotected skin burned in minutes



Total ozone (DU) / Ozone total (UD), 2011/12/14

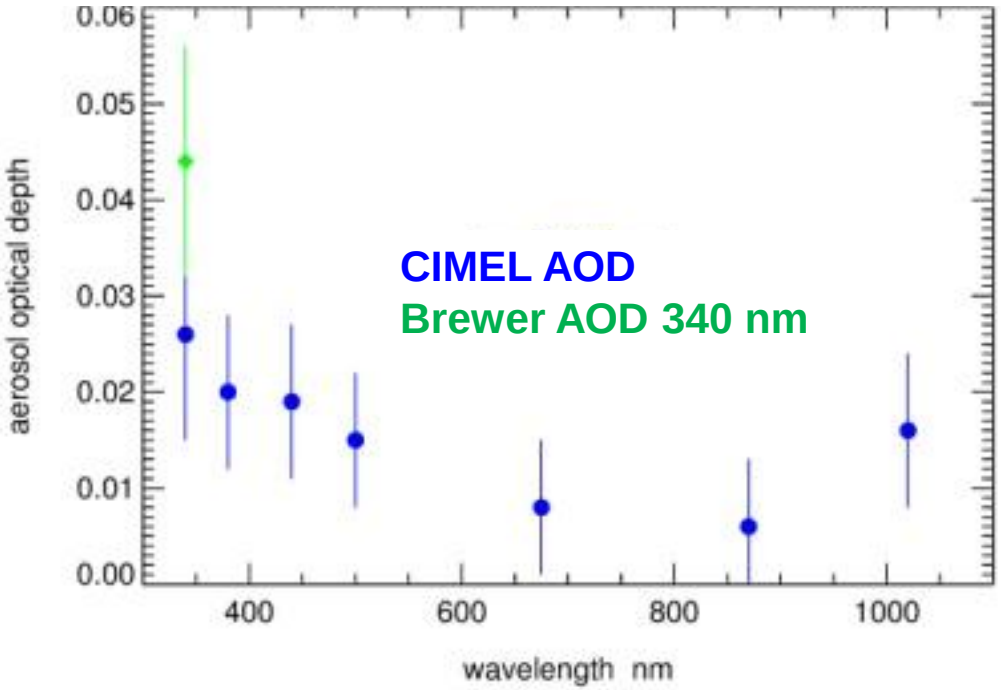


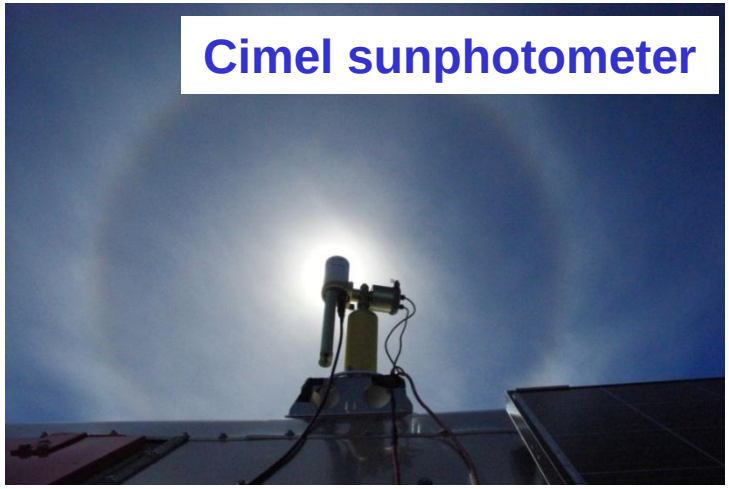
WOUDC total ozone 14-Dec 2011



aerosol total column properties

total aerosol optical depth 2009 – 2014





data since Feb–2009
only Nov, Dec, Jan, Feb

Angström Exponent
440 – 870 nm

all:	**2.0 ± 0.7**
intra-seasonal:	**1.4 – 2.4**

integrated water vapour / cm

all :	**0.14 ± 0.06**
intra-seasonal:	**0.12 – 0.18**

aerosol total mass and mass of light-absorbing aerosol

seasonal total mass	
summer (4 seasons)	1.5 ± 0.8 μg/m^3
autumn (4 seasons)	1.4 ± 0.7 μg/m^3
winter (1 season)	1.6 ± 0.8 μg/m^3

Seasonal soot/Black Carbon mass	
summer	9.2 ± 6.7 ng/m^3
autumn	5.8 ± 4.6 ng/m^3
winter	4.0 ± 3.9 ng/m^3

TEOM-FDMS

Aethalometer

aerosol optical properties – light absorption and scattering

absorption coefficient increases exponentially from 880 to 370 nm

Absorption Angstrom Exponent:

summer → 1.5 ± 1.0

autumn → 1.7 ± 1.3

winter → 0.7 ± 0.8

→ not only pure soot as absorber
(soot would be ~1.0)

combination absorption and scattering
direct measurement of
Single Scattering Albedo (SSA)

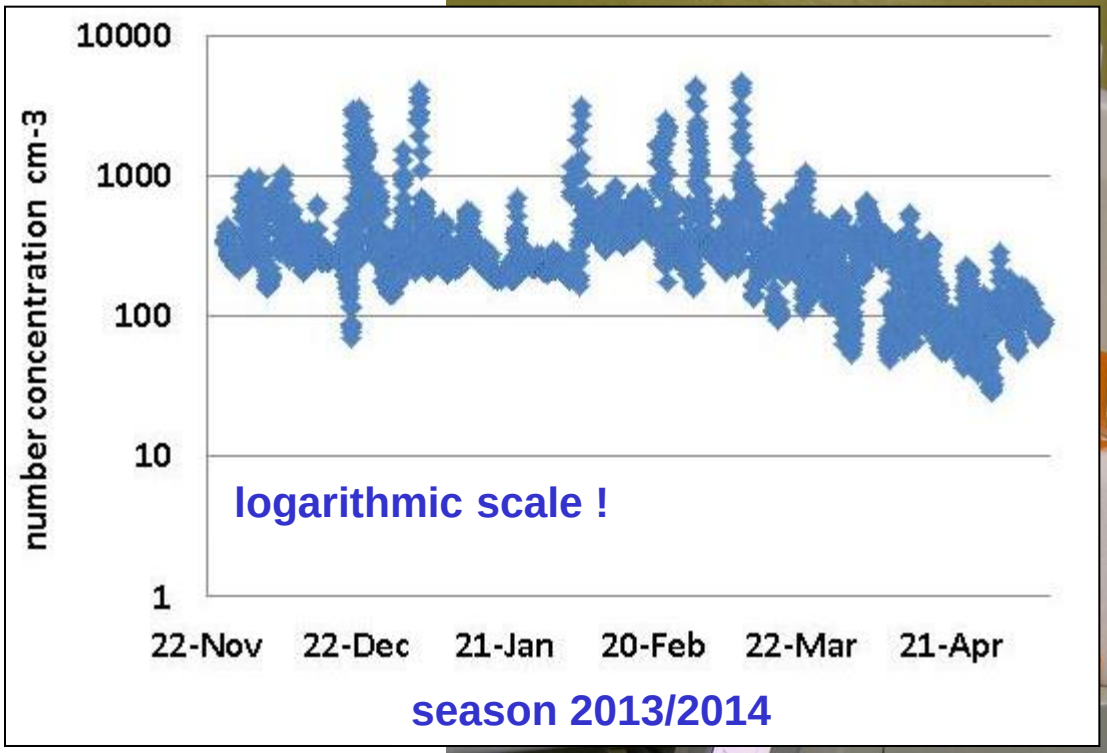
SSA =
Scattering / (Scattering + Absorption)

450 nm : 0.95 ± 0.7
525 nm : 0.96 ± 0.7
635 nm : 0.98 ± 0.8

Aethalometer

nephelometer

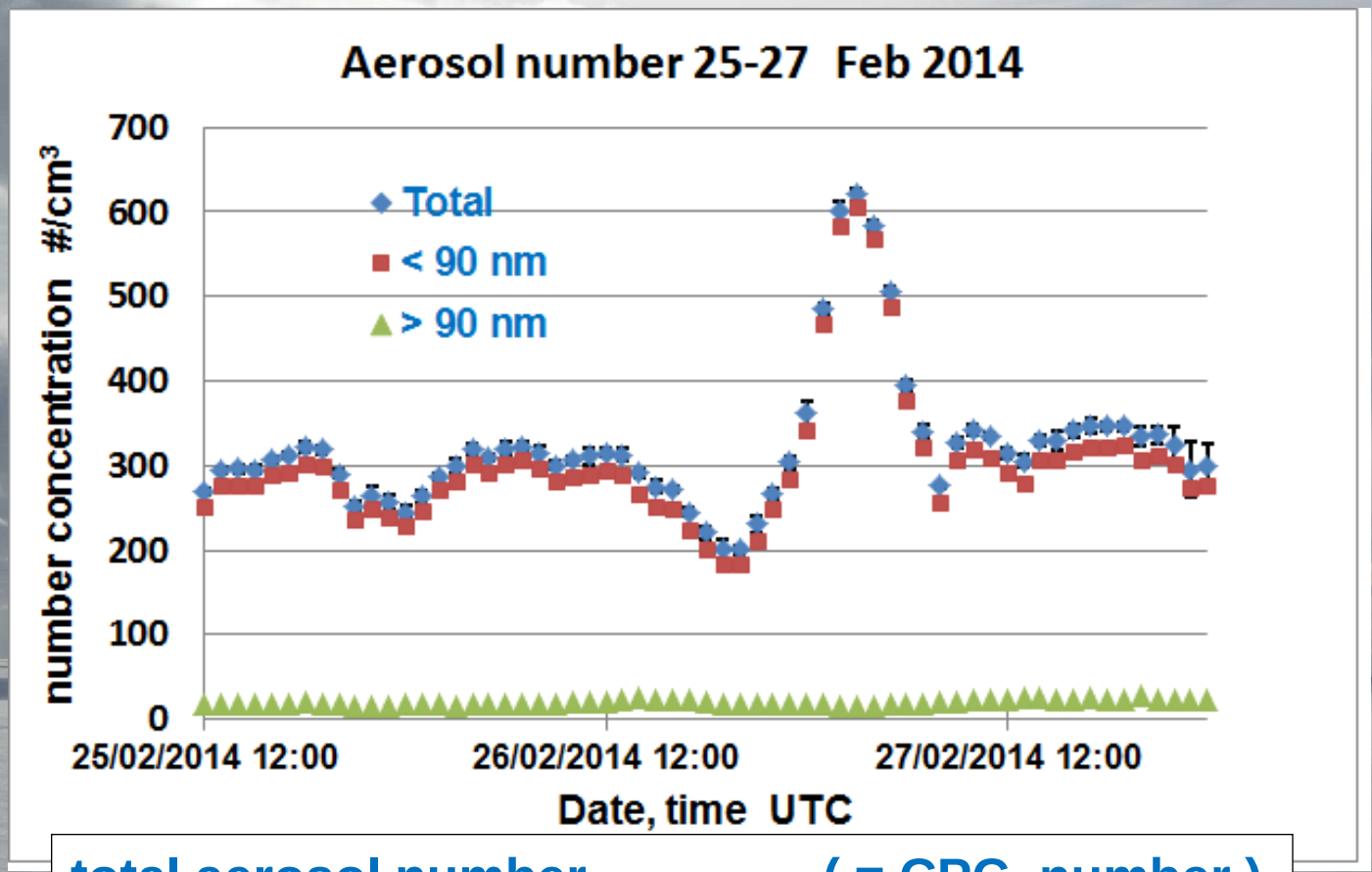
aerosol total number concentration



mean values	particles/cm³ (Medians)
November	451 ± 391 292
December	435 ± 422 286
January	365 ± 350 244
February	464 ± 386 370
March	439 ± 383 362
April	165 ± 103 121
May	92 ± 23 92

Ultrafine Condensation Particle Counter

events with increased very small particles – new particle formation ?

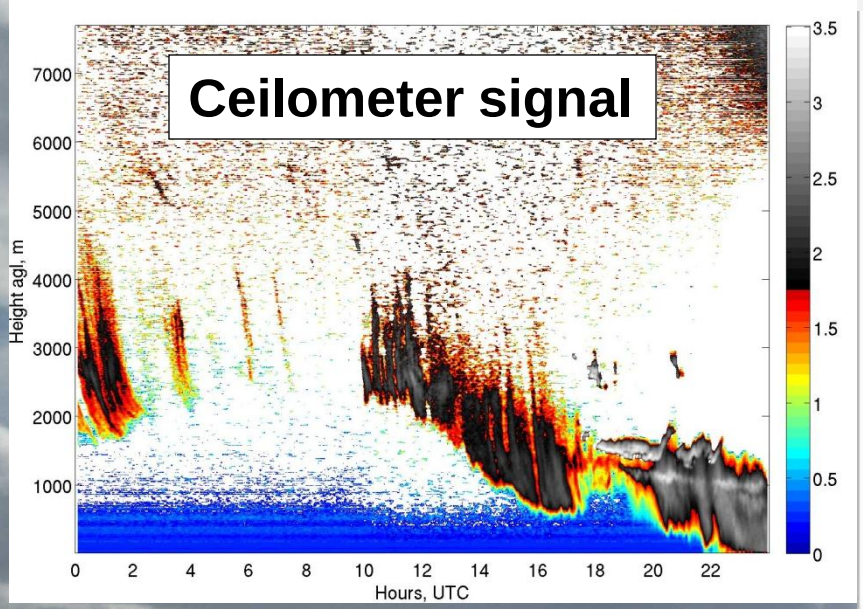


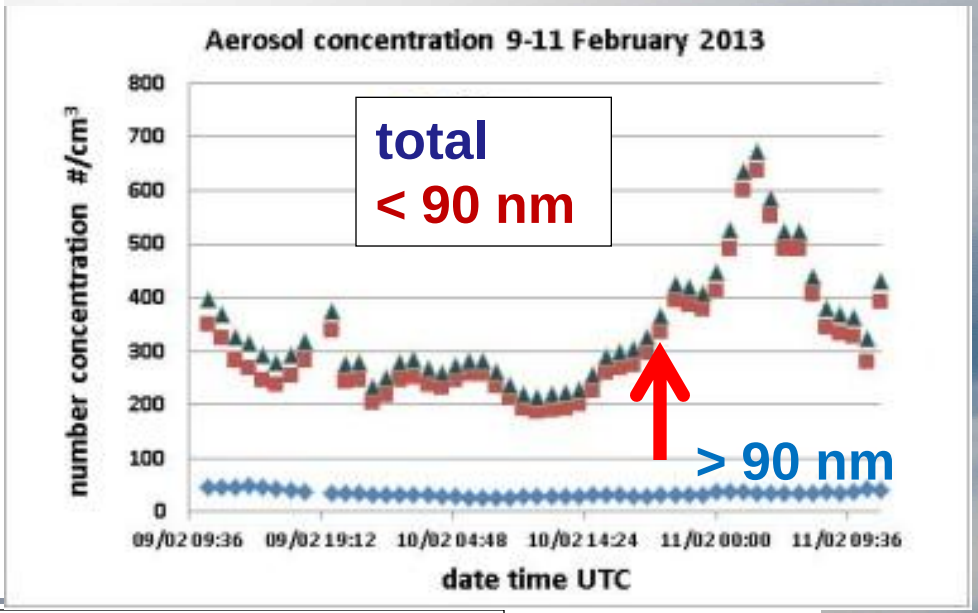
total aerosol number (= CPC–number)

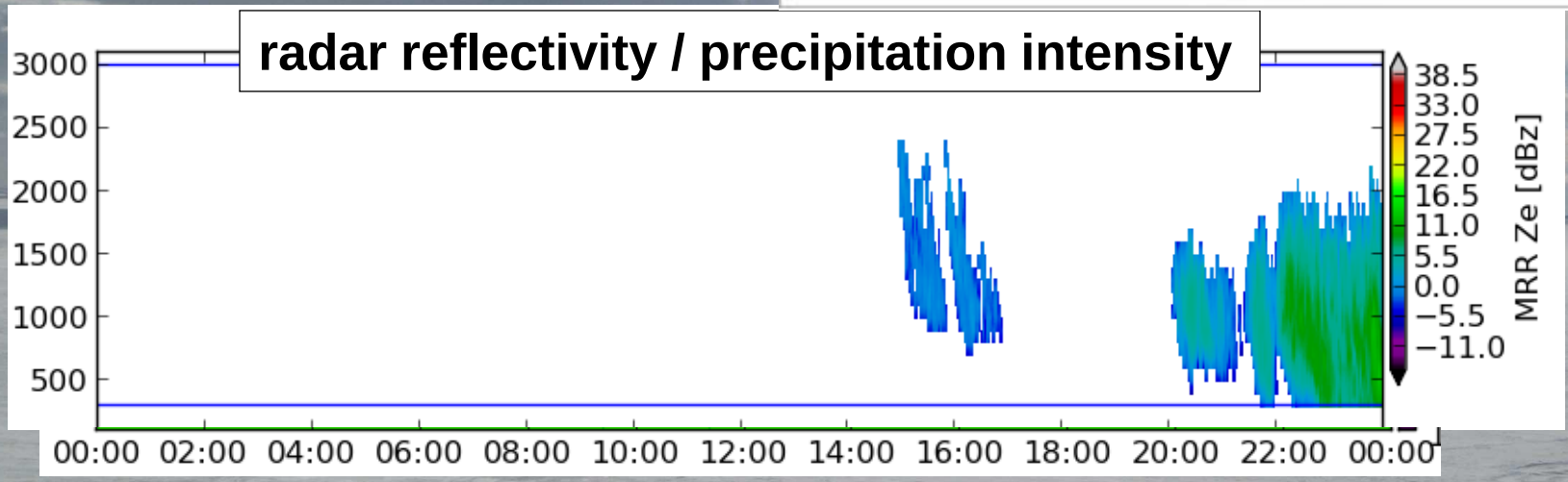
aerosol number > 90 nm (= LAS–number)

aerosol number 3 – 90 nm (= CPC – LAS)

example 9–11 Feb 2013 / increase small particles just before snowfall







Summary

- in total 8 instruments installed at PE
- 5 aerosol instruments can operate during winter
- however, only winter 2012 measured so far
- aerosol instruments work well under Antarctic conditions

- very low overall aerosol amount challenges instrumentation
- particles << 1 µm dominate
- derivation of optical parameters – careful QA needed
- particle number shows seasonal cycle
- several events with freshly formed particles –
  locally produced or entrained from upper troposphere ?

Outlook :

→ radiosonde balloon launches

MoU between WSL (CH), RMI, IPF

started season 2013/14

→ Cloud Condensation Nuclei counter

summer only / from TROPOS Leipzig, Germany

(Droplet Measurement Technol. Instrument)

started season 2013/14, again 2014/15

→ Polarsondes

experimental status / Prof. M. Hamilton, Univ. Adelaide, Australia /

aim to distinguish liquid and ice phase of cloud

→ PANDORA

multi-axis scattered sunlight measurements / lower tropospheric profiles of aerosol extinction coefficient, ozone, NO2 / total column ozone, NO2, AOD

Partner Space Aeronomy Institute; probably from season 2015/16 on

→ feasibility study for filter sampling for aerosol chemistry


Thank you very much