Polar Symposium: Climate

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Climate and Ice Sheets
Ice sheet mass decrease causes sea level rise

Ice calving from an ice cliff face in Antarctica. (Photo: Ian Phillips)

The UCLA research team at work in August 2014. (Photo: Mia Bennett)
Mass of polar ice sheets is changing
What affects the ice sheet mass?
- Melt
- Snowfall
- Ice flow
Observations
Ground-based remote sensing
In-situ observations

Satellite remote sensing

Observatory at the Princess Elisabeth Antarctica Gorodetskaya et al. (2015)

Firn aquifers #Sentinel1 Brangers et al. (2020)

Ice shelf hydrology Antarctica #Sentinel2 @steflhermitte

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Insight in future change requires modelling

- regional climate modelling (bipolar) MAR, COSMO-CLM
- coupled regional climate model (bipolar)
- Statistical downscaling
Models reveal causes of change

Influence of air temperature, sea-ice concentration and atmospheric circulation on surface mass balance

Recent changes in atmospheric flow patterns exacerbate Greenland melt (Delhasse et al. 2020)
Polar clouds and aerosols
Clouds affect radiation

- Sun’s radiation
- Thermal radiation
Aerosols affect radiation

- sun’s radiation
- thermal radiation

NO AEROSOL

AEROSOL
Aerosols affect radiation

- Sun’s radiation
- Thermal radiation

Aerosols (cloud condensation nuclei and ice nuclei) are an agent for cloud formation.

NO AEROSOL

Particles suspended in the atmosphere

Surface

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Aerosols affect radiation

- Sun’s radiation
- Thermal radiation

Driver of climate change

Aerosol particles suspended in the atmosphere

NO AEROSOL

Surface

IPCC 6th assessment 2021
Observations

Aerosol – Cloud – Precipitation observatory at Princess Elisabeth Antarctica since 2010

• cloud properties
• precipitation properties
• aerosol physical properties
• aerosol optical properties
• cloud condensation nuclei
• ice nuclei
• meteorology
• air mass origin

How do the aerosols form?
Observations

• Chemical characteristics of atmospheric particles and Volatile Organic compounds (VOCs)
• Since December 2017
• At Princess Elisabeth Antarctica and along transect
• Passive Sampling (red): Year-average
• Active Sampling (orange): seasonality; power required
Volatile Organic Compounds can be precursors for new particle formation.

Sunlight is needed for these chemical reactions.

What did Belgian researcher find out?
Very low Antarctic ice nuclei concentrations

Potential air mass origins for cloud concentration nuclei Herenz et al. 2019

measured at PEA Wex et al., 2022
Dust origin might have changed

- isotopic analyses in recent surface snow samples
- change potential dust origin – compared to glacial and interglacial periods
- shift to Southern Africa

Gili et al., 2022
Arctic and Antarctic ozone hole
Stratospheric ozone protects

• against "hard" UV which would otherwise damage human health

• depleted by human-made products

• banned by Montreal protocol in 1987

Recovery still not clearly detectable
Monitoring polar ozone with IASI instrument onboard of EUMETSAT METOP satellites
Ground-based remote-sensing

- Long-term Fourier transform Infrared (FTIR) measurements (from the mid-90s for the oldest): total, tropospheric and stratospheric ozone
- Network for the Detection of Atmospheric Change; about 24 stations; 6 stations above 60°N; 1 in Antarctica
- Contribution to WMO ozone assessment reports
Ground-based remote-sensing

Observations of stratospheric chemistry at PEA from MAXDOAS instrument

Princess Elisabeth Station - Ozone hole development in 2022

vertical profiles of meteorological parameters needed for retrieval algorithms

TOAR = Tropospheric Ozone Assessment Report

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Modelling of stratospheric composition

Copernicus Atmosphere Monitoring Service (CAMS) provides near real-time data for air quality and the ozone layer, both globally and with a focus on Europe.

Next upgrade of the system:
• add stratochemistry module BASCOE
• improved ozone forecasts
Thanks to BELSPO, IPF, other funding schemes, universities and federal institutes

BELSPO projects
• Hydrant
• Belatmos
• Aerocloud
• Chase
• Climb
• Mass2Ant

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