Middle Atmosphere Research at NILU: current activities and opportunities

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NILU, Norway

Ny-Ålesund Atmosphere Flagship seminar

9 December 2025

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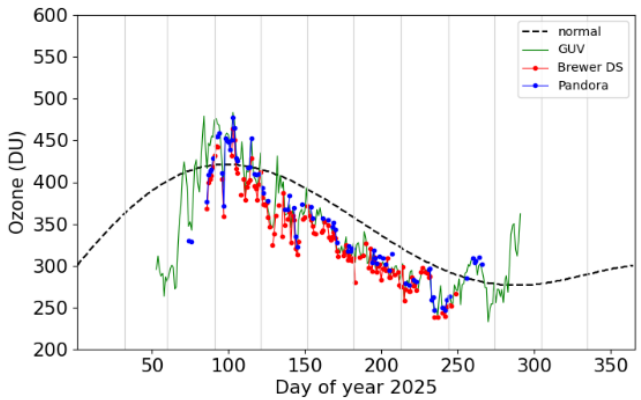
NILU in Svalbard

NILU's very first air measurements in Svalbard were made in Ny-Ålesund in 1974. NILU has monitored air quality at the Zeppelin observatory since 1989 (Platt et al., 2022).

Lower atmosphere: measurements of greenhouse gases, hydrocarbons, aerosols, inorganic components, organic matter and trace elements, organic environmental pollutants, mercury and trace elements.

Middle atmosphere: stratospheric ozone monitoring.

Ny-Ålesund



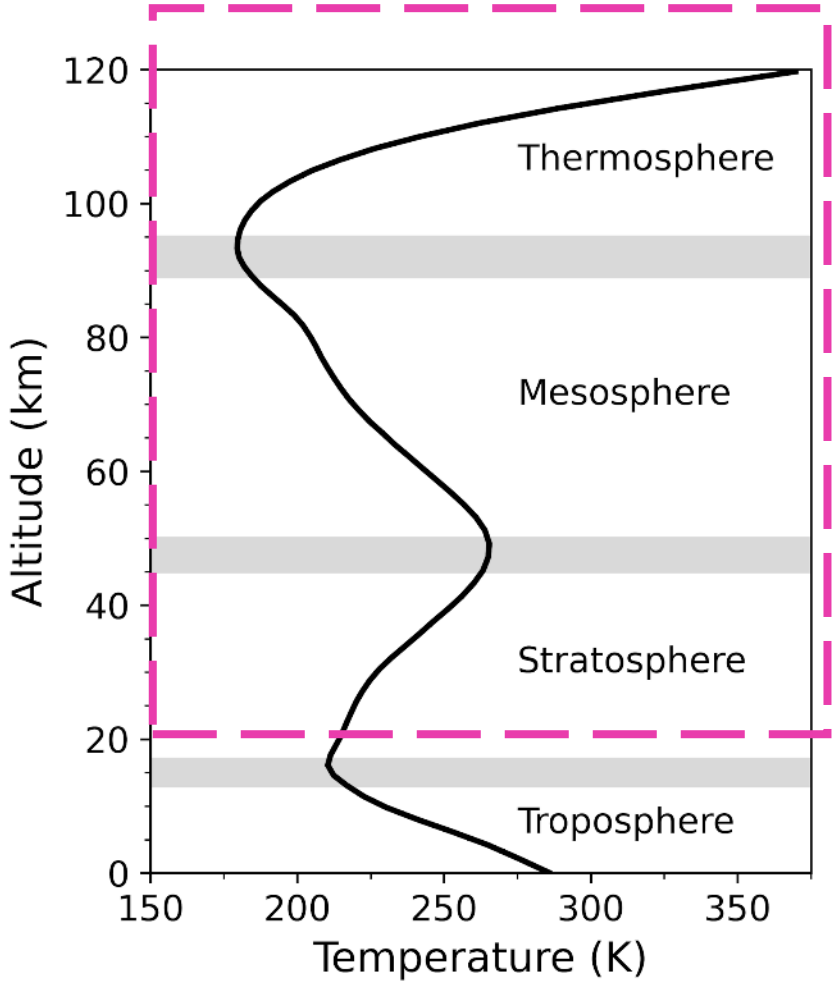
Latitude : 78.92 (North)
Longitude: 11.92 (East)
NILU operates two total ozone instruments in Ny-Ålesund: A GUV filter instrument (no. 9275) and a SAOZ instrument. SAOZ has been in operation since 1990, whereas the GUV instrument has been running since 1995. The SAOZ instrument is a zenith-sky spectrometer where ozone is retrieved from radiation in the visible band. This makes the SAOZ measurements most reliable during spring and fall. We have also access to data from the Italian Brewer no.50 instrument.
SAOZ:
http://saoz.obs.uvsq.fr/saoz/L1_ny2025.png

Tove Svendby, NILU

Platt et al. (2022) «Atmospheric composition in the European Arctic and 30 years of the Zeppelin Observatory, Ny-Ålesund».

Our middle atmosphere expertise

- Stratospheric dynamics and coupling (including SSWs)
- Mesospheric gravity-wave characterization
- Mesospheric and lower-thermospheric (MLT) general circulation
- Oxygen airglow emissions in MLT and upper-atmosphere remote sensing
- Distribution of trace species (O_3, O, H, NO_x, HNO_3, CH_4)
- Planetary waves, tides and gravity-wave processes
- Energetic particle precipitation and its atmospheric impacts



Models: High-top atmospheric models, seasonal forecast models

(Re)analysis: including new-generation high-altitude reanalyses

Measurements: radar measurements (SuperDARN), rocket measurements (WADIS) , satellite retrievals (MLS, SABER, Odin/SMR), infrasound recordings

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2024/2025 relevant articles

JGR Space Physics

Research Article | Open Access

Tidal Amplification in the Lower Thermosphere During the 2003 October–November Solar Storms

Jiarong Zhang, Yvan Orsolini, Varavut Limpasuvan, Han-li Liu, Jens Oberheide

First published: 28 October 2025 | https://doi.org/10.1029/2024JA033236

Article | Open access | Published: 20 May 2024

Energetic particle precipitation influences global secondary ozone distribution

Jia Jia, Lise E. Murberg, Tiril Løvset, Yvan J. Orsolini, Patrick J. Espy, Lilou C. G. Zeller, Cornelius Csar Jude H. Salinas, Jae N. Lee, Dong Wu & Jiarong Zhang

Communications Earth & Environment **5**, Article number: 270 (2024) | Cite this article

2887 Accesses | **7** Citations | **1** Altmetric | Metrics

Abstract

Open Access Article

Modulation of the Semi-Annual Oscillation by Stratospheric Sudden Warmings as Seen in the High-Altitude JAWARA Re-analyses

by Jiarong Zhang [1,*], Yvan Orsolini [2] and Kaoru Sato [3]

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[2] NILU—The Climate and Environmental Research Institute, 2007 Kjeller, Norway
[3] Department of Earth and Planetary Science, The University of Tokyo, Tokyo 113-0033, Japan
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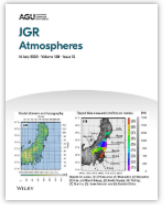
Atmosphere **2025**, *16*(12), 1320; https://doi.org/10.3390/atmos16121320

JGR Atmospheres



Volume 128, Issue
16 July 2023
e2023JD038725

Research Article | Open Access

Probing Gravity Waves in the Middle Atmosphere Using Infrasound From Explosions

Ekaterina Vorobeva, Jelle Assink, Patrick Joseph Espy, Toralf Renkwitz, Igor Chunchuzov, Sven Peter Näsholm

Figures References Related Informa

First published: 28 June

Article

Articles / Volume 6, issue 3 / WCD, 6, 1015–1026, 2025

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https://doi.org/10.5194/wcd-6-1015-2025
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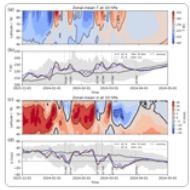
Article | Assets | Peer review | Metrics | Related articles

Research article | 26 Sep 2025

The impact of tropospheric blocking on the duration of the sudden stratospheric warmings in boreal winter 2023/24



Ekaterina Vorobeva and Yvan Orsolini

RESEARCH ARTICLE | Open Access

Estimating stratospheric polar vortex strength using ambient ocean-generated infrasound and stochastics-based machine learning

Ekaterina Vorobeva, Mari Dahl Eggen, Alise Danielle Midtfjord, Fred Espen Benth, Patrick Hupe, Quentin Brissaud, Yvan Orsolini, Sven Peter Näsholm

First published: 30 April 2024 | https://doi.org/10.1002/qj.4731 | Citations: 2

Ekaterina Vorobeva and Mari Dahl Eggen contributed equally to this study.

Ny-Ålesund Atmosphere Flagship WG5 (current status)

- Currently, WG5 “Middle and upper atmosphere” is put on hold due to the lack of activities.
- The WG5 description from nyalesundresearch.no:

The **mesosphere and lower thermosphere** (MLT), spanning altitudes from 80 to 120 km, are influenced by general wind circulation, atmospheric waves of various scales, solar radiation, and energetic particle precipitation from space. Understanding the MLT’s thermal structure, dynamics, and composition is crucial, as these are closely linked to the broader atmospheric system. The temperature of emission layers in the middle and upper atmosphere can be determined through spectral analysis of airglow emissions. **The work group focuses on the temporal evolution of auroral emission bands** and how gravity and planetary waves, solar thermal tides, and lunar gravitational tides modulate mesospheric and thermospheric temperatures and emission intensity fields.

focus is on MLT altitudes and spectral analysis of atmospheric emissions

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Ny-Ålesund Atmosphere Flagship WG5 (opportunities)

Could:

- Include the stratosphere → extend altitudes to 15 - 120 km
- Stratosphere-troposphere coupling (SSW, cold-air outbreaks)
- For MLT: impact of radiative changes from solar events on planetary tidal wave forcing, response of solar tides to SSWs
- Involve atmospheric **high-top models**: WACCM (130 km) or WACCM-X (~300 km), mechanistic global-scale wave model simulations (PRISM), TIME-GCM
- Involve **re-analyses**, extending to high altitudes (NAVGEM, JAWARA)
- Middle and upper atmosphere observations could include rocket, lidar, radar and satellite measurements.

Suggested new focus:

The work group focuses on studying how atmospheric waves, energetic particle precipitation, solar thermal tides, and lunar gravitational tides modulate middle atmosphere temperatures, wind fields and chemistry by the combination of measurements with re-analyses and the whole-atmosphere-ionosphere modelling tools.

That way, can collaborate with WG1 Atmospheric dynamics and radiation (e.g. linking SSWs and jet stream shifts) and WG4 Aerosols and Trace gases (e.g. aerosol injections into the middle atmosphere)

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Summary

- NILU’s current middle atmosphere research activities in Svalbard focus primarily on ozone monitoring.
- However, we have extensive expertise in middle and upper atmosphere research.
- Currently, WG5 is put on hold. But …
- Expanding the description of WG5 could help strengthen and highlight interest in middle and upper atmosphere research in the Arctic, including Svalbard.
- NILU’s expertise in the filed of the middle and upper atmosphere would complement the new scope of WG5.

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Thank you for attention!