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The GAW Global Observatory Neumayer, Antarctic

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Station description

The 'Alfred Wegener Institut für Polar- und Meeresforschung' (AWI, Alfred Wegener Institute for Polar and Marine Research) in Bremerhaven, one of the 15 major research institutions of the Helmholtz Society of German Research Centres, is carrying out research projects in Antarctica since 1978. In 1981, AWI started to run the permanently manned Georg-von-Neumayer-Station (70°37´S, 8°22´W) next to the Atka Iceport on the Ekström Ice Shelf at the northwest edge of the Weddell Sea in Antarctica, see Figure 1.

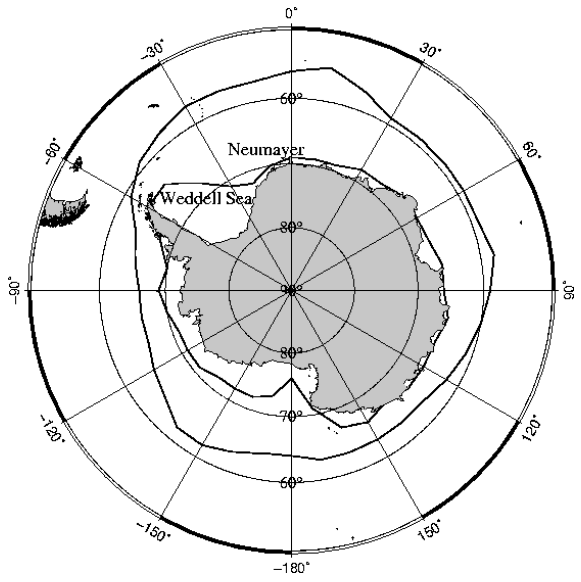

Figure 1: Mean location of the sea ice edge for February (minimum) and September (maximum).

Ice movements and heavy snow deposits necessitated the construction of a new station building in the early 1990s. The new station - just called Neumayer - took over the observatory programmes without interruption. It is situated about 6 km southeast from the former one, see Figure 2.

A third succession station (Neumayer III) will be erected within the following years. The designated lifetime of Neumayer III is about 25 years. An uninterruptible continuation of all relevant observatory programmes is planned.

Neumayer Station - as well as its predecessor - consists mainly out of two parallel steel tubes each 90 meters long and 8 meters in diameter. Originally, the tubes have been constructed on top of the snow surface. Due to snow accumulation the whole construction gets deeper and deeper covered by snow. Only the top of the entrance towers – which have to be elongated every other year - as well as some antennas and scientific equipment are kept above the snow surface.

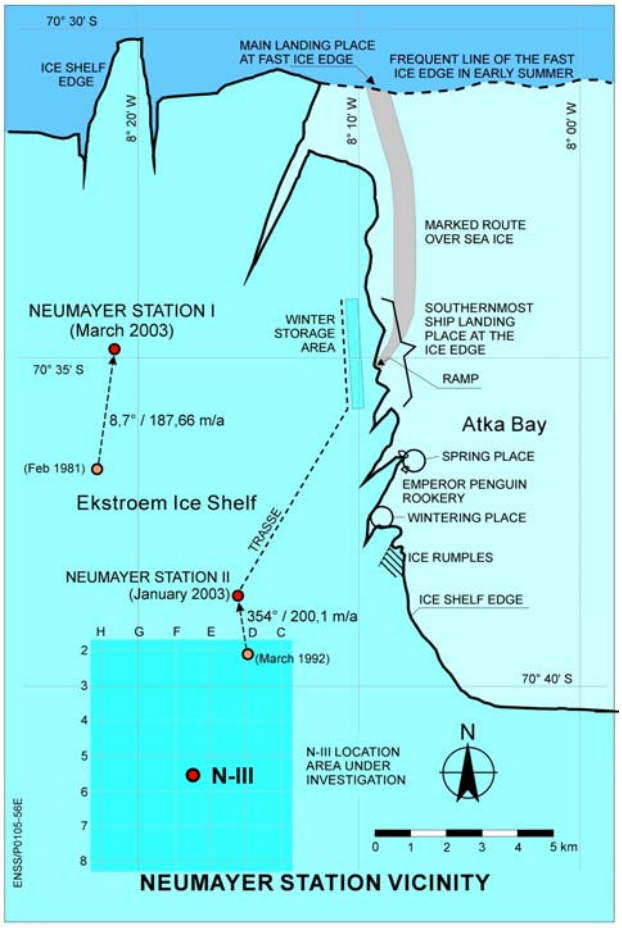

Figure 2: **The location of the "Georg-von-Neumayer" (Neumayer Station I), "Neumayer" (Neumayer Station II), and the proposed site of Neumayer III (N-III).**

First of all, Neumayer serves as research station. Research is focussed on meteorology, air chemistry and geophysics. The meteorological observatory programme started in 1981. One year later, a permanent air chemistry observatory as well as a geophysical observatory was installed. Most of these observatory programmes are of importance for climate research performed within international networks like the Global Telecommunication System (GTS), Global Atmospheric Watch (GAW), Network the Detection of Stratospheric Change (NDSC), Baseline Surface Radiation Network (BSRN).

Surrounding of the station

The Ekstöm Ice Shelf has a homogenous, flat surface, sloping gently upward to the south. Except for some insignificant nunataks about 100 km south of Neumayer, no ice free land surface exists. The ice shelf is 230 m thick at Neumayer and moves with a velocity of 170 m per year towards the breaking edge about 16 km farther north.

Atka Iceport is mostly covered with fast ice. The ice is safe enough to stand on to visit the emperor penguin colony and to watch the Weddell seals. Only during January and February the Atka Iceport becomes mainly ice free.

North of the station, at a distance of about 15 km, pack ice is predominant. In some years pack ice vanish during a few summer weeks completely, while in other years some ice floes remain. In any season strong westerly winds can open up a coastal polynia north of Neumayer.

At Neumayer the maximum solar incidence angle is 42.8°. The Sun stays permanently above the horizon from November 19 to January 24 and permanently below the horizon from May 19 to July 27.

Meteorological observatory

The meteorological observatory of Neumayer is an integral part of many international networks, mostly associated with the World Meteorological Organization. The data from Neumayer help to close significant gaps in the global weather and climate observing networks. The observatory programme contains the following parts:

3-hourly routine synoptic observations: Synoptic observations are carried out routinely every 3 hours. They include measurements of air temperature (at 2m and 10m height), air pressure (values are reduced to mean sea level), wind vector (at 2m and 10m height), dew point temperature (at 2m height), clouds (cloud amount, type and height), horizontal visibility, present and past weather snowdrift and whiteout. The full programme is carried out at 0, 9, 12, 15, 18, 21 UTC. During night time at 3 and 6 UTC the visual observations are omitted (http://www.awi.de/MET/Neumayer/latest_obse.html)

Daily upper air soundings: Routinely once daily (about 10:45 UTC) a radiosonde is launched to measure vertical profiles of air pressure, temperature, relative humidity and the wind vector (http://www.awi.de/MET/Neumayer/nrt_temp). Upper air soundings are carried out with VAISALA radiosondes which directly measure air pressure, air temperature and relative humidity. The wind vector is determined with the aid of the GPS navigation system, the height information is calculated using the hydrostatic approximation. Helium filled balloons (TOTEX 600g, 800g) are used to obtain an ascent velocity of about 5m/s. Typically the balloons burst at heights between 25 and 35 km.

Weekly ozone soundings: Normally, one ozonesonde is launched every week to measure the vertical ozone profile through the troposphere and the lower stratosphere. For the ozone soundings a VAISALA radiosonde is connected via an interface to a VAISALA ECC sonde. A 1500g TOTEX balloon is used for these ascents.

Surface radiation measurements: The surface radiation measurements are performed within the framework of the Baseline Surface Radiation Network (BSRN). The following radiation quantities are measured every other second and stored in form of 1 minute averages:

- global (solar) radiation with glas-filter (305 - 2800nm)
- global radiation with OG1-filter (530 - 2800nm)
- global radiation with RG8-filter (695 - 2800nm)
- UV radiation (300 - 370nm)
- diffuse sky radiation (305 - 2800nm)
- direct solar radiation (305 - 2800nm)
- reflected solar radiation (305 - 2800nm)
- downward long-wave radiation (4 – 50µm)
- upward long-wave radiation (4 – 50µm)
- sunshine duration. (yes/no)

Air chemistry observatory

Due to the fact that continental Antarctica is largely free of trace compound sources, aerosols and trace gases measured at Neumayer mainly originate from the marine boundary layer of the southern Atlantic or are advected by long range transport via the free troposphere. Hence, the measured trace compounds are representative for the local marine boundary layer as well as for the remote southern hemisphere. Given that the impact of local pollution is negligible, trend measurements document the global impact of civilization on the atmospheric burden of long lived trace compounds like greenhouse gases. Thus, in very close cooperation with the meteorological observatory, the air-chemistry observatory from Neumayer became a significant part of the Global

Atmospheric Watch (GAW) Network. Neumayer covers a wide range of GAW type measurements (aerosol, greenhouse gas, meteo, ozone, radio nuclide, solar radiation). Many of these measurements started 20 years ago and are ongoing (http://www.empa.ch/gaw/gawsis/default.asp)

The established research programme opens new potentialities to assess atmospheric circulation in the southern hemisphere, source regions and variability of bio-geochemical source strengths like the bioproductivity of the southern Atlantic. In addition, photochemical and deposition processes within the polar atmospheric boundary layer as well as the physico-chemical interaction of the firn-atmosphere interface are addressed. Finally, in combination with the meteorological observatory the research programme is particularly dedicated to contribute to the interpretation of trace compound profiles retrieved from Antarctic ice cores.

The first air chemistry observatory at Neumayer was initiated and constructed by the Institut für Umweltphysik, University of Heidelberg (UHEI-IUP) in 1982. Following almost 13 years of operation, the technical equipment and the data acquisition facilities had to be renewed. The present observatory was designed in collaboration between AWI and UHEI-IUP as a container building placed on a platform some metres above the snow surface, see Figure 3.

Figure 3: **The GAW Global Air Chemistry Observatory Neumayer.**

All experiments installed in the air chemistry observatory are under daily control and daily performance protocols are available. A ventilated stainless steel inlet stack (total height about 8 m above the snow surface) supplies the experiments with ambient air.

Concerning anthropogenic pollutants, the Antarctic atmosphere is "ultra clean". Local pollution by vehicles and the base itself is, thus, a potential problem for many measurements aimed at representing the background status of the Antarctic troposphere. Consequently, a central aspect of the technical concept concerns the ability of contamination-free sampling of aerosols and trace gases. This is realized by several means:

- The air chemistry observatory is situated in a clean air area about 1500 m south of Neumayer. Due to the fact that northern wind directions are very rare, contamination from the base can be excluded for most of the time.
- The power supply (20 kW) is provided by a cable from the main station, thus no fuel-driven generator is operated in the very vicinity.

- Contamination-free sampling is controlled by the permanently recorded wind velocity, wind direction and by condensation particle concentration.

In the meanwhile, the convincing research concept of the air chemistry observatory from Neumayer and the strict realization of contamination free sampling have been frequently adopted. As a consequence, several comparable observatories are now set up in Antarctica enabling the documentation of the changing composition of the atmosphere on a continental or even global scale. Obviously, the importance of the data retrieved from the air chemistry observatory will be significantly enhanced in the future and a continuing operation is of fundamental interest (http://www.awi-bremerhaven.de/GPH/SPUSO.html).

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