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Neumayer III and Kohnen Station in Antarctica operated by the Alfred Wegener Institute

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Abstract: The Alfred Wegener Institute operates two stations in Dronning Maud Land, Antarctica. The German overwintering station Neumayer III is located on the Ekström Ice Shelf at 70°40'S and 08°16'W and is the logistics base for three long-term observatories (meteorology, air chemistry and geophysics) and nearby research activities. Due to the vicinity to the coast (ca. 20 km from the ice shelf edge), the Neumayer III Station is the junction for many German Antarctic expeditions, especially as the starting point for the supply traverse for the second German station Kohnen.
The summer station Kohnen is located about 600 km from the coast and 750 km from Neumayer III Station on the Antarctic plateau at 75°S and 00°04'E. It was erected as the base for the deep-drilling ice

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core project, which took place between 2001 and 2006. Since then Kohnen Station is used as a logistics base for different research projects.

1 Neumayer III Station

Planned under the supervision of Hartwig Gernandt, Neumayer III Station (70°40'S and 08°16'W) was inaugurated on 20th February 2009 as the new German Antarctic research base. It is operated by the Alfred-Wegener-Institut (AWI) Helmholtz-Zentrum für Polar- und Meeresforschung and follows the Georg-von-Neumayer Station (1981-1992) and Neumayer II Station (1992-2009) as the German overwintering station on the Ekström Ice Shelf in Antarctica (Gernandt & Huch, 2009; Gernandt et al., 2007) (in German). Neumayer III Station integrates research, operational and accommodation facilities in one building. Situated on a platform above the snow surface, Neumayer III Station stands on 16 hydraulic foundation slabs that are regularly adjusted to the changes in snow cover (Figure 1). A garage below the station offers shelter for polar vehicles.
The energy consumption is covered by a block heat and power plant, containing four diesel generators (each 150 kW, three are in alternating operation, one serves as an emergency power supply), and a 30 kW wind generator, which is directly connected to the energy system. The energy concept includes the use of the waste heat from the generators for the heating system and melting snow (Gernandt & Huch, 2009) (in German).
During Antarctic winter, nine people live and work at Neumayer III Station, consisting of four researchers (two geophysicists, one air-chemist and one meteorologist), one station engineer, one electrician, one radio operator/electronics engineer, one doctor, and one cook. The overwintering team is responsible for the continuity of the data series of the long-term observatories (see Section 1.1).
In Antarctic summer, the station is the base for up to 50 people and serves also as the weather forecast center for Dronning Maud Land, to support the Dronning Maud Land Air Network (DROMLAN).

Figure 1: Neumayer III Station. Photo: Alfred-Wegener-Institut/S. Christmann (CC-BY 4.0).

1.1 Long-term observatories at Neumayer III Station

Since the Neumayer III Station follows Georg-von-Neumayer Station and Neumayer II Station on the Ekström Ice Shelf, over 30 years of data have been gained. The meteorological observatory program is carried out since 1981 comprising of three-hourly synoptic observations, daily upper air soundings including weekly ozone profiling and substantial surface radiation measurements (König-Langlo & Loose, 2007). The observatory takes part in the Global Telecommunication System (GTS), the Global Climate Observatory System (GCOS), the Global Atmospheric Watch (GAW), the Network for Detection of Atmospheric Composition Change (NDACC) and the Baseline Surface Radiation Network (BSRN). The observed data are transmitted to other Antarctic stations, as well as in the GTS, to serve as a basis for weather forecasting. The data of the meteorological observatory are freely available via links on the webpage of the observatory (www.awi.de) and on the webpage of PANGAEA, Data Publisher for Earth & Environmental Science (www.pangaea.de).
The scientific program of the air chemistry observatory is partly established since 1982 and is linked to the meteorological observatory. To assure extreme air purity, the observatory is installed about 1.5 km south of Neumayer III Station. The long-term measurements consist of high volume aerosol sampling, in-situ measurements of reactive trace gases together with aerosol physical properties, and whole air samples, to study long-term concentration trends of greenhouse gases. The evaluation of the data is performed at AWI Bremerhaven and the Institut für Umweltphysik at the University of Heidelberg, Germany. The data are available at the World Data Center for Aerosols (WDCA) and the World Data Center for Greenhouse Gases (WDCGG). The results are published in international journals (e.g. Weller et al. (2013, 2011)). For more information, please visit the webpage of the observatory: www.awi.de.
Seismology and geomagnetism are the main topics of the geophysical observatory which have been followed since 1982. The primary objective of continuous seismographic monitoring is to complement the international network of seismographic monitoring stations in the southern hemisphere. Of special interest is the detection of local and regional earthquakes within Antarctica. The local network comprises three 3- component broadband stations, the observatory itself on the Ekström Ice Shelf and two remote stations located on the ice rises Halvfarryggen and Søråsen, where the ice is laying on solid rock and thus the recording conditions are substantially better compared to a location on the floating ice shelf. Additionally, at Halvfarryggen a 15-stations small aperture detection array has been in operation since 1997. Network data is transmitted continuously via satellite to AWI Bremerhaven and are accessible at the data center of the GEOFON program (www.webdc.eu), operated by the Helmholtz-Zentrum Potsdam, Deutsches Geoforschungszentrum (GFZ).
At the geomagnetic observatory, which is located 1.5 km south of the Neumayer III Station, the variations of the Earth's magnetic field are continuously recorded, both total intensity and three field components. Recordings are transmitted continuously to AWI Bremerhaven and via Niemegk observatory (GFZ) to the Intermagnet data center.
Approximately 3 km south-west of Neumayer III Station the infrasound array I27DE is located, which is operated in cooperation with the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) in Hannover and on behalf of the Comprehensive Test Ban Treaty Organisation (CTBTO), Vienna. It is part of a global infrasound station network to monitor the international nuclear test ban compliance (for further reading see Eckstaller et al. (2007).

1.2 Other observatories near Neumayer III Station

From 2005 to 2014, the Perennial Acoustic Observatory (PALAOA) recorded the underwater soundscape in the vicinity of the ice shelf edge. Four hydrophones were placed through boreholes beneath the ice shelf. The data were continuously transferred to Neumayer II/ III via wireless LAN (Boebel et al., 2006). The observatory was dismantled in season 2014/15. In January 2013, the Single Penguin Observation and Tracking (SPOT) observatory was installed at the ice shelf edge. The goal of this project is to monitor the process of penguin huddles using cameras (http://biosyp.org/index.php/projects?id=15).

2 Kohnen Station

The Kohnen Station (75°S and 00°04'E) was inaugurated in 2001 as a logistics base during Antarctic summers. It is named after Heinz Kohnen (1938-1997), who was the head of the AWI logistics department. The station consists of eleven standard 20-feet containers sitting on a 32 m long and 8 m wide platform. The platform rests on steel pillars and can be jacked up (Figure 2) in order to compensate for snow accumulation. A 100 kW generator provides all power needs for the base and the deep drilling operations. The logistics for Kohnen Station is based mainly on land-transport facilities. Once during a field season, a sledge traverse from Neumayer III Station supplies Kohnen Station with fuel, food and scientific equipment. Smaller amounts of cargo and the majority of the personnel are transferred via aircraft to Kohnen Station. The station can accommodate up to 20 people.

Figure 2: Kohnen Station. Photo: Alfred-Wegener-Institut/H. Gernandt.

2.1 European Project for Ice Coring in Antarctica (EPICA)

During summer seasons 2001/02 to 2005/06, Kohnen Station was the logistic base camp for a deep ice core drilling project. Within the framework of the European Project for Ice Coring in Antarctica (EPICA), two deep ice cores were drilled in Antarctica, one in the Indian sector close to the Italian/French Concordia Station (75°6' S and 123°20' E) and the second in the Atlantic sector at Kohnen Station. The drilling took place in a 66 m long, 6 m high and 4.8 m wide combined drill and science trench, which was extended by 12.5 m in season 2004/05. In four summer seasons (no drilling in 2004/05), a 2774.15 m long ice core was drilled until the bottom was reached (Oerter et al., 2009; Wilhelms et al., 2014).
The ice core provides high-resolution records of methane, oxygen isotopes and mineral dust back to the age of 150,104 years BP at a depth of 2416 m (EPICA Community Members, 2006; Oerter et al., 2009; Wegner et al., 2015). A synchronization with ice cores from North Greenland and Antarctica revealed an interhemispheric climate coupling by a bipolar seesaw (for further reading on this topic EPICA community members (2006)).

2.2 Other activities at Kohnen Station

Parallel to and beyond the deep ice core drilling, different programs took place at or near Kohnen Station, including topography and ice velocity measurements using geodetic GPS measurements, ground-

based radio-echo sounding, meteorological measurements using an automatic weather station and aerosol sampling with high- and low-volume devices (Birnbaum et al., 2006; Eisen et al., 2006; Piel et al., 2006; Wesche et al., 2007). Additionally, several snow pits and firn cores were sampled during a 280 km long traverse along the ice divide upstream of the drill site. In season 2005/06, firn air sampling took place in a cooperation with the University of Bern, Switzerland (Oerter et al., 2009).
Since 2012/13, the Coldest Firn (CoFi) project uses Kohnen as its logistic base. The primary objective of this project is to understand the densification and the air enclosure process of the coldest firn. To reach this goal several shallow firn and ice cores were and will be drilled and trenches were excavated in the vicinity of Kohnen Station and along the ice divide to Dome Fuji (Japanese Station at 77°30' S and 37°30' E). First results were published by Münch et al. (2016). Furthermore Kohnen Station ensures continuous access to the deep borehole, where repeated borehole measurements are carried out in order to study deformation and flow of the ice sheet.

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