The Environmental Research Station Schneefernerhaus: Overview and Potential for Climate Research

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Objectives
- After several years of converting a former hotel into a high-alpine research facility the environmental research station Schneefernerhaus (UFS) located 300 m below the summit of Germany’s highest mountain Zugspitze was established in 1998 by the state of Bavaria as its centre for Altitude and Climate Research.
- Under the umbrella of an observatory UFS combines the long-term continuous characterisation of the atmosphere’s physical and chemical properties with basic research (alternating scientific users and field campaigns) and applied studies (Small Medium Enterprises, industry).
- Together with the Observatory Hohenpeissenberg of the German Weather Service (DWD) the UFS forms one of the 24 global stations in the world-wide network of the “Global Atmosphere Watch”- Programme (GAW) of the World Meteorological Organisation (WMO). The trace gas observations at UFS are performed by the German Federal Environmental Agency (UBA).
- Further permanent users of UFS are:
  - German Aerospace Center (DLR)
  - GSF – National Center for Environment and Health
  - Institute of Meteorology & Climate Research, FZ Karlsruhe (FZK)
  - University of Munich; Medical Clinic and Meteorological Institute (LMU)

Location and Infrastructure
- The UFS offers well-equipped laboratories, observation and experimental decks, offices, overnight accommodation for up to 44 persons, conference and meeting facilities to the national and international scientific community.
  - Currently permanent and alternating (short term experiments) users spend about 2000 working days at UFS.
- Optimal laboratory conditions are guaranteed through an innovative energy and refrigeration engineering.
- Year-around access is provided by cable cars and - ideal for heavy and bulky cargo transport and special events – by a directly linked cogwheel train.
- Online (http://www.schneefernerhaus.de) display of meteorological and trace gas observations.
- Excellent cooperation with close-by research and university institutes is fostered and exchange of observations encouraged.
- Representative location for mid-European conditions located above the planetary boundary layer for about half of the time.

Meteoro logical Conditions
The data set gathered by DWD and the Federal Environment Agency (UBA) since the setup of the UFS allows a first characterization in terms of meteorology and trace gas distribution.

- monthly average
- min/max monthly average
- min/max hourly average

Microwave Profiling & Clouds
- Since 2005 the Humidity and Temperature Profiler (HATPRO) has been operated continuously at the UFS observing thermal emission at 14 frequencies in the microwave spectral range.
- Elevation scans are possible practically down to 0 m and are being exploited to derive the temperature profile of the lowest atmospheric levels with high vertical resolution (~100 m). These data will be of interest for studies on atmospheric boundary layer development as well as radiative transfer studies.
- The observations allow also the determination of the integrated column amounts of water vapor (IWV) and cloud water (LWP) with high accuracy in nearly all weather conditions (except liquid precipitation).
- Comparisons with climatologies from Darwin, Australia and Lindenberg, Germany reveal
  - that IWV is mostly very low < 5 kg/m² providing excellent conditions for remote sensing observations which are affected by water vapor
  - a bimodal distribution of IWV indicating the interplay between dry and humid air masses caused by synoptic disturbances
  - an unexpected high number of medium LWP clouds which might be caused by stationary clouds which are persistent through orographic flows

GAW Activities
- UBA and DWD operate the GAW global station Zugspitze/Hohenpeissenberg
- Host of the GAW training programme GAW-TEC
- Investigation of the northern hemisphere background of ultrafine particles and particulate matter

Remote sensing
- The basic instrumentation of the UFS is increasing increasingly extended with automated remote sensing instruments.
- A new normalized millimetre wavelength instruments of LMU Munich is used for the investigation of snow crystals. Polarization differences are used for the determination of the ice crystal orientation.

Outlook
- Under the lead of the Bavarian Ministry Bavarian State Ministry of the Environment, Public Health and Consumer Protection (SMUGV) scientific cooperation is enhanced by forming new focus areas
  - Global Atmosphere Watch. Contact: W. Frick, DWD & L. Ries, UBA
  - Regional Climate and Atmosphere. Contact: W. Seiler, FZK
  - Satellite Observations and Early Warning Systems. Contact: M. Bittner, DLR
  - Cosmic Radiation and Radioactivity. Contact: H. Paretzke, GSF
  - Environmental and Altitude Medicine. Contact: R. Huber, LMU

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