

# 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 characterization** 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 Environment 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.

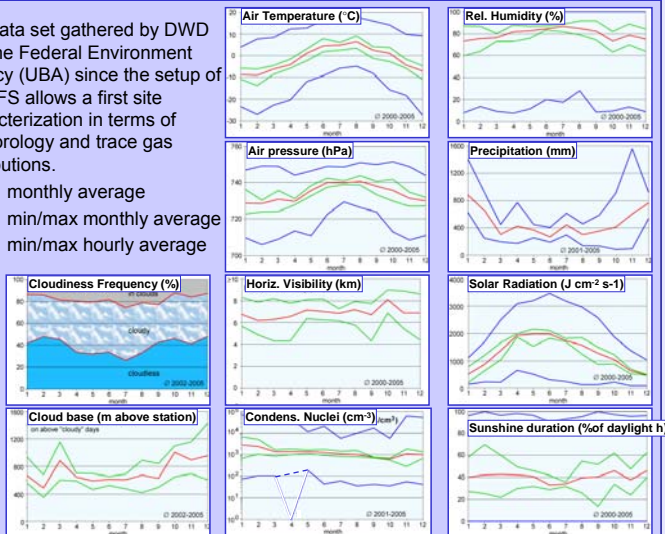
Altitude	2.650 m asl.
Latitude	N 47° 25,0'
Longitude	E 10° 58,9'
Total area	2.540 m <sup>2</sup>



## Meteorological Conditions

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

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



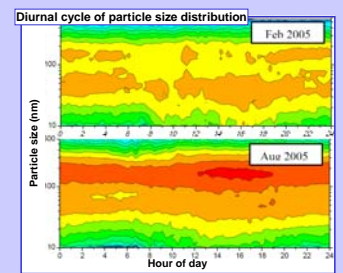
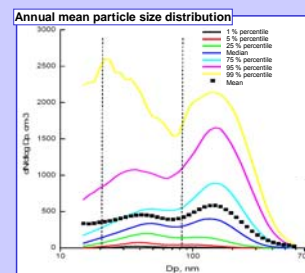
## GAW Activities

- 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

Greenhouse Gases	Reactive Trace Gases
Water vapor (H <sub>2</sub> O)*	Ozone (O <sub>3</sub> )
Carbon dioxide (CO <sub>2</sub> )	Carbon monoxide (CO)
Methane (CH <sub>4</sub> )	Nitrogen oxides (NO, NO <sub>2</sub> , NO <sub>x</sub> )
Nitrous oxide (N <sub>2</sub> O)	Nitric acid (HNO <sub>3</sub> )
Sulphurhexafluoride (SF <sub>6</sub> )	Peroxiacetylnitrate (PAN)*
Hydrochlorofluorocarbons (HCFC's)	Volatile organic compounds (≤ c <sub>6</sub> and >c <sub>6</sub> *)

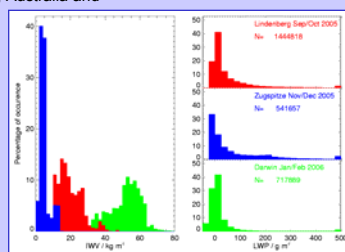
**Precipitation, fog and cloud water chemistry \***  
pH, conductivity, sulfate, nitrate, chloride, ammonia, sodium, potassium, calcium, magnesia, heavy metals

\* in preparation



## Microwave Profiling & Clouds

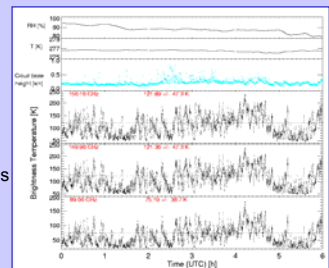
- Since 2005 the Humidity and Temperature Profiler (**HATPRO**) has been operated continuously at the UFS observing thermal emission at 14 frequencies in the microwave spectral range.
- Elevation scans are possible practically down to 0° and are being exploited to derive the temperature profile of the 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 kgm<sup>-2</sup> 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



## Outlook

### Remote sensing

- The basic instrumentation of the UFS is increasingly extended with automated remote sensing instruments.
- A new polarized millimetre wavelength instruments of LMU Munich is used for the investigation of snow crystals. Polarization differences as high as 20 K are possible, oblate particles cause stronger signals than prolate ones.
- Dedicated field campaigns with active instruments (cloud and micro rain radar) are planned to further investigate snow crystal microphysics.



### UFS Organisation

- Under the lead of the Bavarian Ministry Bavarian State Ministry of the Environment, Public Health and Consumer Protection (StMUGV) scientific cooperation is enhanced by forming new focus areas
  - **Global Atmosphere Watch**, Contact: W. Fricke, 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