Stable water isotopes in catchment hydrology and hydrological process analysis

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Specific Research Questions

• Closing the regional water cycle: development of fully coupled atmosphere-hydrosphere model systems

• Observation & distributed modeling of joint water and energy fluxes in complex terrain

• Quantification of spatio-temporal precipitation variability in complex terrain and poorly gauged regions

• Experimental hydrological process analysis using microwave devices (precipitation analysis) and stable isotopes (water origin and process separation)
**Methods: Modeling Approaches**

- **Dynamical Downscaling** of global meteorological fields (reanalyses, forecasts, climate scenarios): *WRF, COSMO-CLM*

- **Statistical Downscaling**: Copula-based multivariate methods, Canonical Correlation Analysis, Circulation Pattern Analyses

- **Distributed water- and energy flux modeling**: *WaSIM-ETH, NDHMS, GEOtop*

- **Coupled Atmospheric-Hydrological Model Systems**: *WRF-Hydro, WRF-NoahLSM-HMS*
Methods: Measurement Techniques

- **Water and energy fluxes** via TERENO infrastructure: EC-Flux stations, climate stations, lysimeters

- **Precipitation-Radar**: DWD Hohenpeissenberg & TERENO

- **Microwave links**: from commercial cell phone companies (Ericsson) & own fully polarimetric phase coherent devices

- **Stable water isotopes**: Picarro Analyzer for δ18O and δD
Hydrometeorological Test Sites

**TERENO Ammer**
Prealpine catchment

**Berchtesgaden National Park**
High alpine catchment
Hydrometeorological Test Site TERENO *prealpine*

TERENO: Terrestrial Environmental Observatories (http://www.tereno.net)
Hydrometeorological Test Site TERENO *prealpine*
Hydrometeorological Test Site Berchtesgaden

Project WaterNPB

Water Balance Modeling in the Berchtesgaden National Park
Distributed Hydrological Modeling

Meteorological measurements

Gauges and subcatchments

33 stations (19 automatic, 14 manual)
National Park administration, township Schoenau, Bavarian avalanche service, Central Institute for Meteorology and Geodynamics (ZAMG)

433 km²
9 gauges and subcatchments
Snowmelt and Runoff

1. T-Index
   NS: 0.52
   - snowmelt
   - rainfall
   - mod. runoff
   - meas. runoff

2. EnBal
   NS: 0.58

3. EnBal + grav. slides
   NS: 0.69

4. EnBal + grav. slides + wind red.
   NS: 0.76

Institute for Meteorology and Climate Research (IMK-IFU)
Improved process analysis: interaction precipitation, snow dynamics, flow processes

- Stable isotopes of oxygen (H$_2^{18}$O) and hydrogen (HDO) as natural tracers
- Quantification of contributors to streamflow (snow melt, springs, …)
- Continuous sampling of springs, snow, and discharge water
Stable Water Isotopes

- Ammer catchment (TERENO prealpine)
  Sampling campaign summer 2011 + ?

- Berchtesgaden National Park
  Continuous sampling of precipitation, springs, snow, and discharge water since Dec. 2011

- Picarro Analyzer for δ18O and δD

- Process studies, model validation

- 2 Diploma theses (Benjamin Busl, Rebecca Johnson)
  PhD student Florian Marshall (Augsburg)

- ...