Campus Alpin - Institute of Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU)

A high density observation station network in the Berchtesgaden Alps for snow hydrological model evaluation

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Research Focus

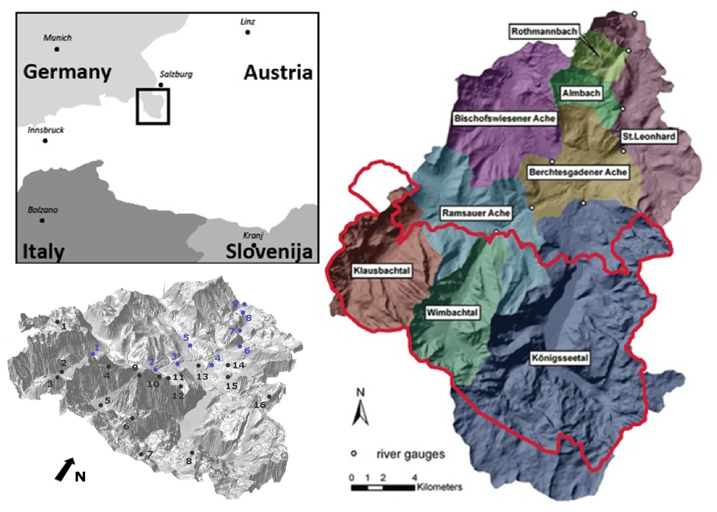
- Observing and modeling hydrometeorological processes in a climate-sensitive alpine catchment characterized by complex mountainous terrain (steep terrain gradients, high spatio-temporal heterogeneities, large proportion of forested area)
- Snow model development, verification and validation (snow cover distribution and energy balance, interaction vegetation-snow-micrometeorology, lateral snow processes)
- Model coupling at the interface between atmosphere and terrestrial hydrosphere

Catchment Berchtesgaden National Park

Berchtesgaden National Park, Bavarian Alps, Germany

http://www.nationalpark-berchtesgaden.bayern.de

Catchment "Berchtesgadener Ache", 433 km², 607 m - 2713 m MSL



Methods

Observation Network

- 34 meteorological stations from 604 m to 2522 m MSL
- 10 met. stations measuring snow depth
- 3 met. stations measuring snow water equivalent

+

- 25 SnoMoS (Snow Monitoring Station)
- 12 paired stations forest-open
- 10 time-lapse cameras

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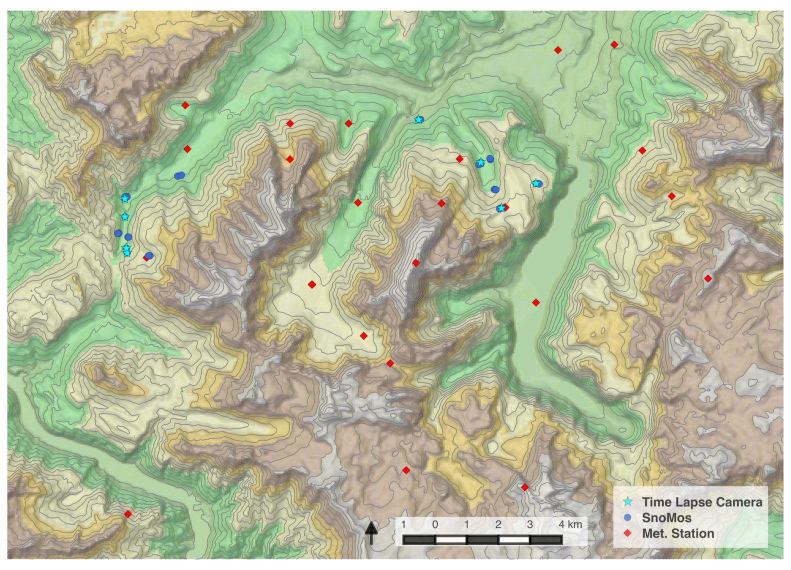
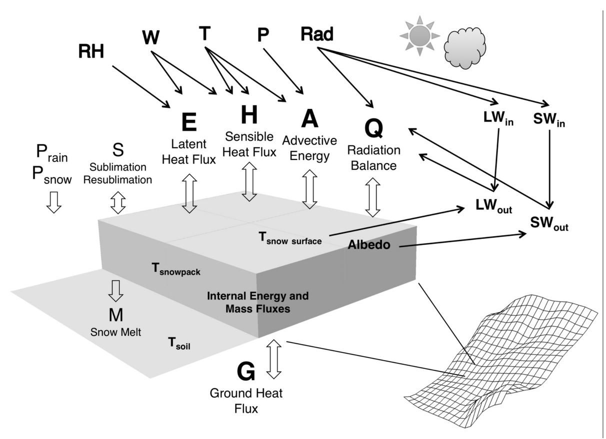
- Snow Pack Analyzer
- 9 runoff gauges
- Sampling of stable water isotopes



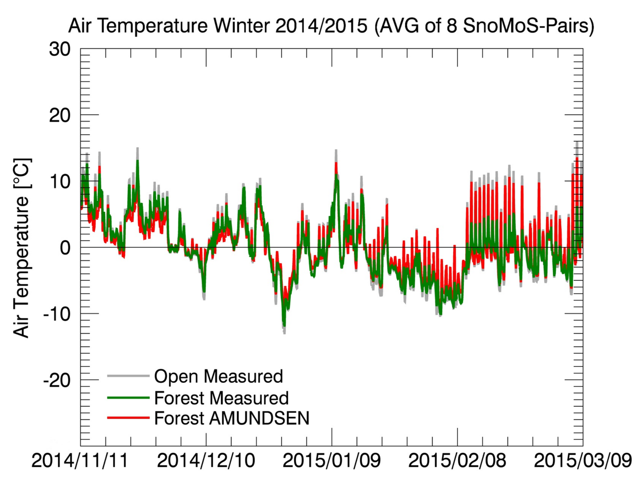
Snow Modeling

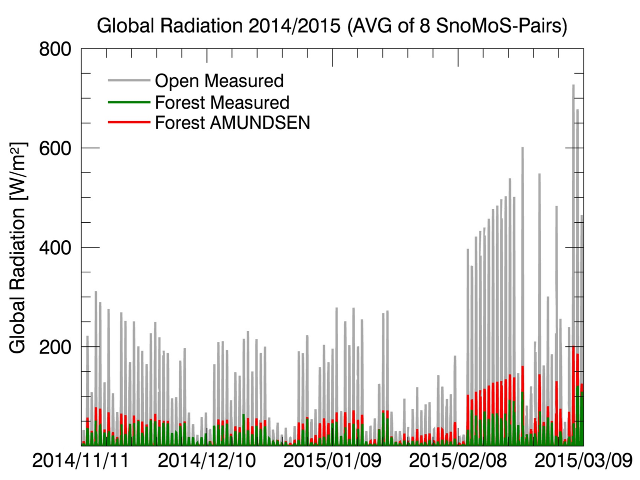
Physically-based (snow) hydrological process models
- ESCIMO(.spread): point snow cover model
- AMUNDSEN: distributed alpine specific snow cover model
- WaSiM: fully distributed hydrological model

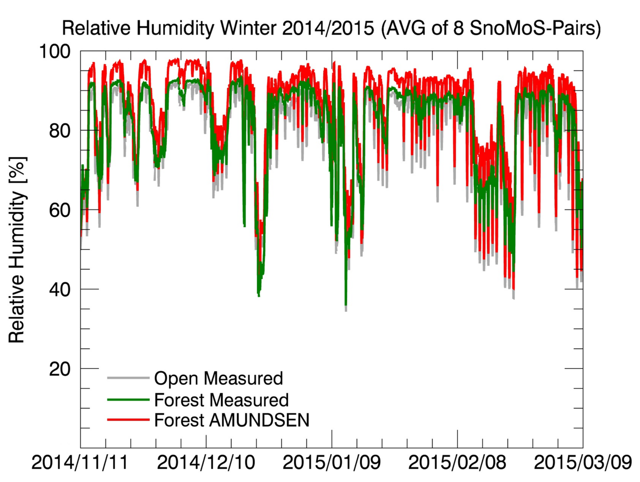
Model Development and Coupling
- Development: snow cover energy balance, lateral snow processes (wind / gravitation), interaction vegetation-snow-micrometeorology, snow melt and runoff dynamics
- Coupling: atmosphere - terrestrial hydrosphere (RCM WRF - hydrol. models), dynamical downscaling of global atmospheric model data, multivariate bias correction, climate change impact analyses

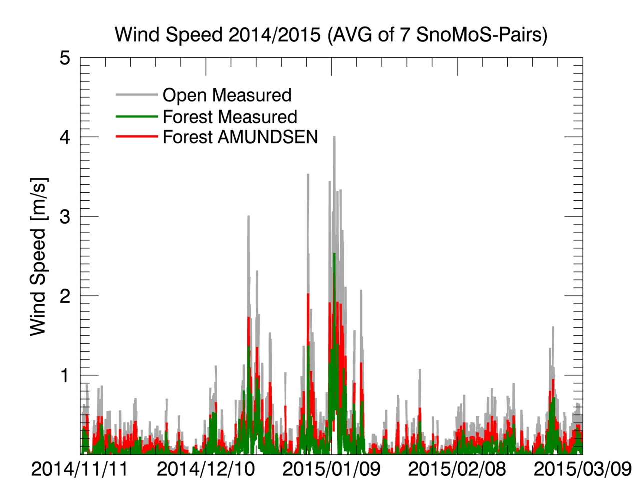


Results

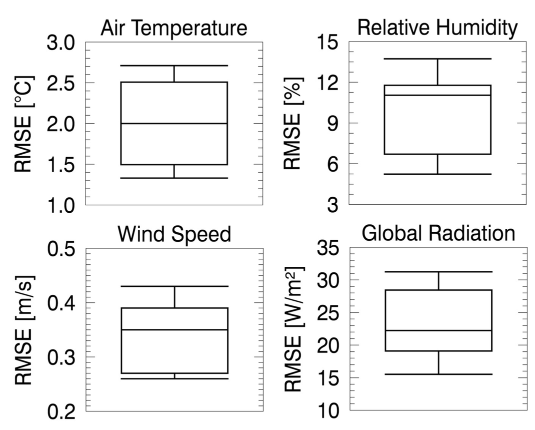


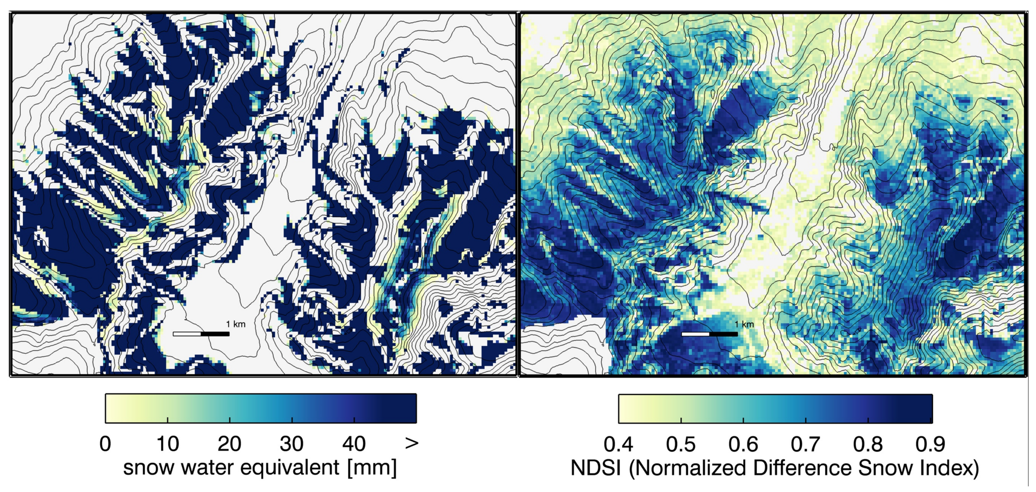




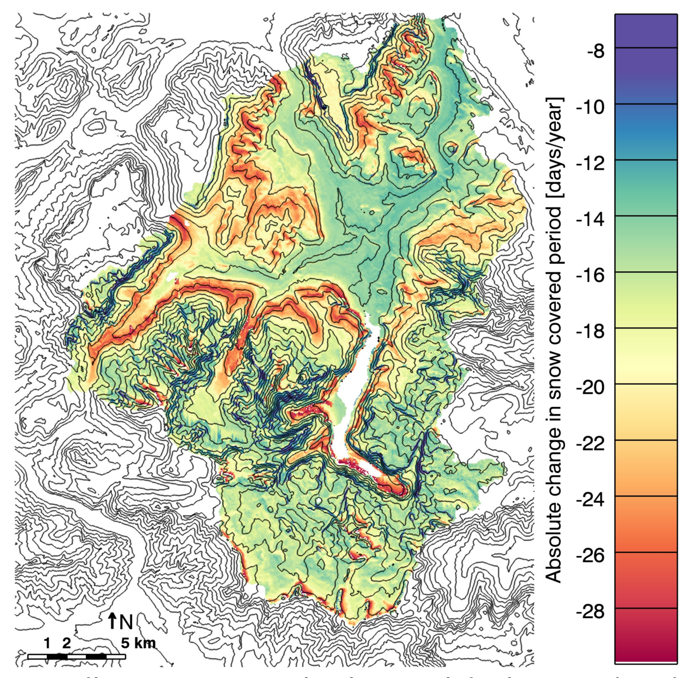


Evaluation of a beneath canopy micrometeorological model scheme: Air temperature, relative humidity, wind speed and global radiation were measured by paired SnoMoS stations at open and adjacent forest sites. The observed open site meteorology was used as forcing input data to model (AMUNDSEN) the values at the forest locations. The observed forest meteorology was consequently used to evaluate the calculated model outputs using the RMSE as a efficiency measure.



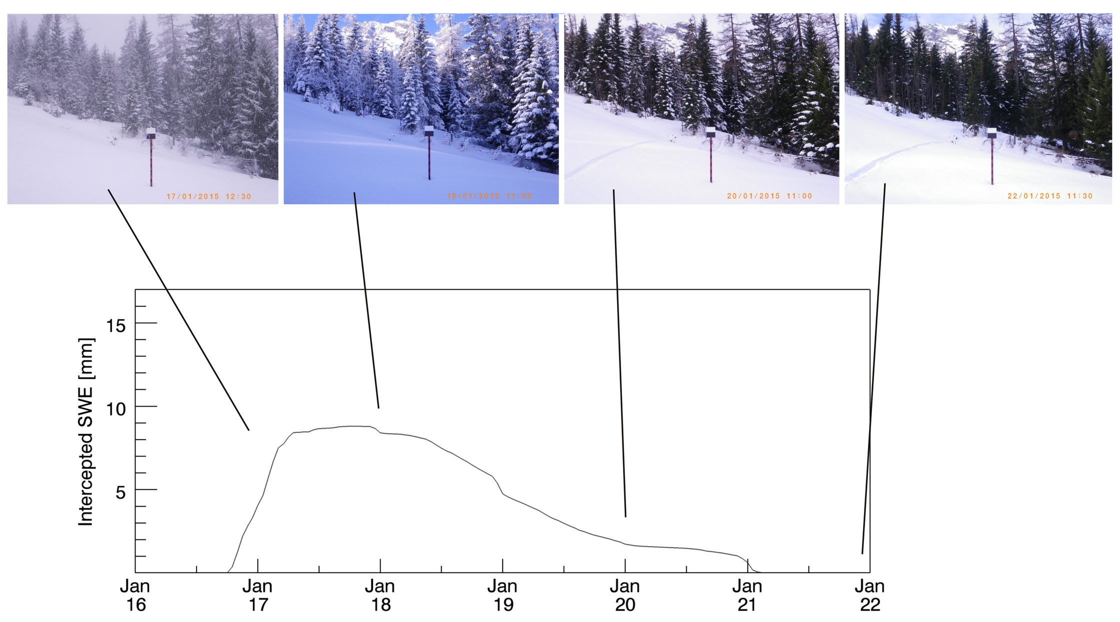


Distributed snow modeling including lateral redistribution processes: Modeled SWE (WaSiM, left) and NDSI extracted from Landsat ETM+ data (right) on 1 May 2005 (right). Percentage of cells that are in agreement between observation and model (snow covered / snow free) is 72.5%.

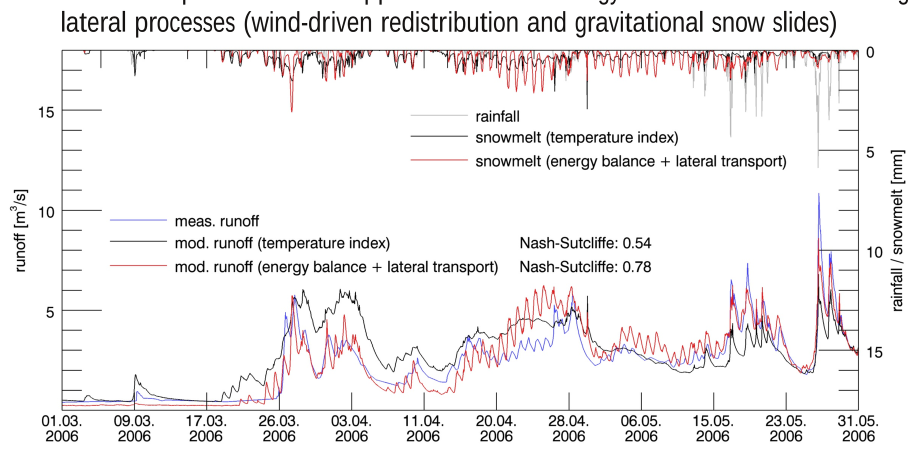


Coupling to atmospheric model data: Projected absolute change in mean seasonal snow coverage from 1971-2000 to 2021-2050 (Scenario SRES A1B, GCM ECHAM5, RCM WRF 7km, Bias Correction: Quantile Mapping)

Using time-lapse photography to (yet qualitatively) evaluate a canopy interception model: Modeled interception storage in mm SWE from 16 to 22 January 2015 (AMUNDSEN)



Snow model development within a fully distributed hydrological model: Runoff at gauge Hintersee measured and modeled (WaSiM) using different snow modeling methods. Snow melt (and redistribution) is simulated with a temperature index approach and an energy balance method including lateral processes (wind-driven redistribution and gravitational snow slides)



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