CLASH – WP4: Modeling the Hydrological Cycle over the Tibetan Plateau for the Late Holocene, present and future time slices

Objectives of WP4 within the CLASH context

The CLASH project (Climate variability and Landscape dynamics in Southeast-Tibet and the eastern Himalaya during the Late Holocene reconstructed from tree rings, soils and climate modeling) aims to model and analyze atmospheric processes and climatic variations over the Tibetan Plateau. A special focus is put on landscape and vegetation dynamics. As environmental processes in the target area are mainly determined by temporal and spatial variations of the hydrological cycle, we study the relationship between the monsoonal and mid-latitude weather systems as well as small-scale local influences.

Major goals are:

- production of high resolution atmospheric fields for studies of dendro-ecological dynamics, of carbon and oxygen isotope signals, and sediment archives
- statistical analyses of hydrological extreme events (drought and wetness) and estimation of future risks
- provision of a data base for calibration of paleo-climatic proxy data sets e.g. synthetic tree ring and sediment time series
- identification of global and regional factors responsible for threshold behavior in strength and extent of the monsoon
- projection of future changes of the hydrological cycle for alternative climate scenarios

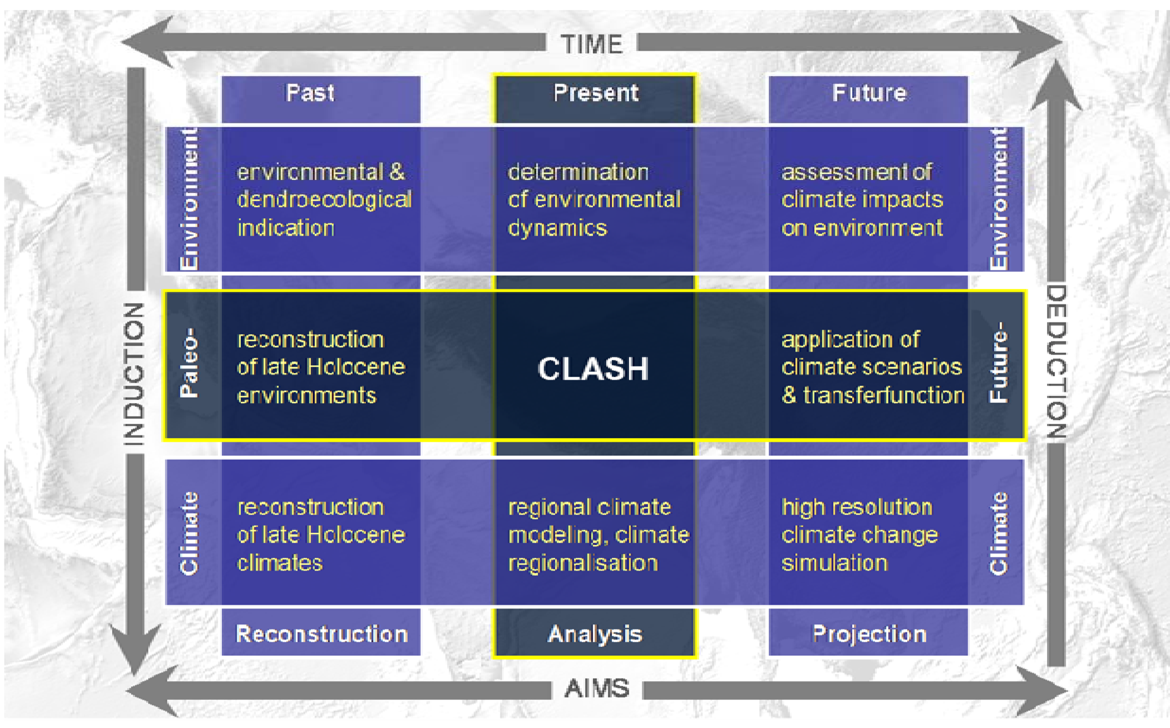


Fig.1: Time scales and aims of CLASH

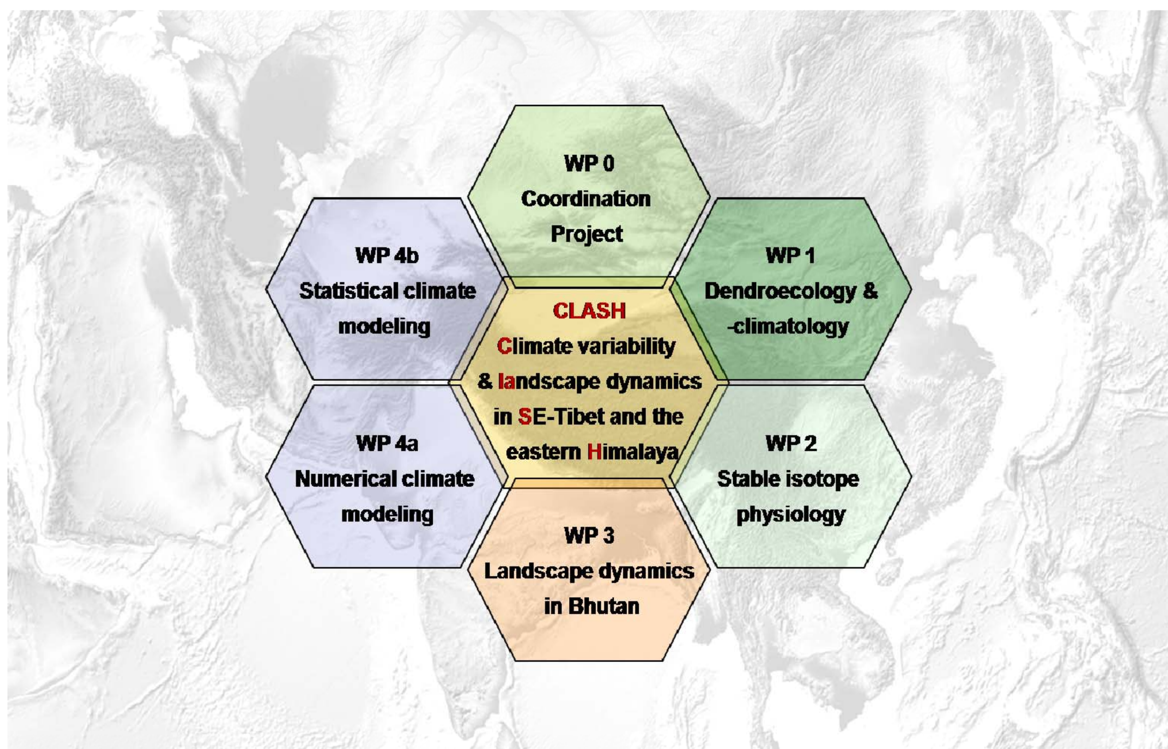


Fig.2: Work packages in CLASH

Downscaling approach and components of the CLASH climate modeling chain

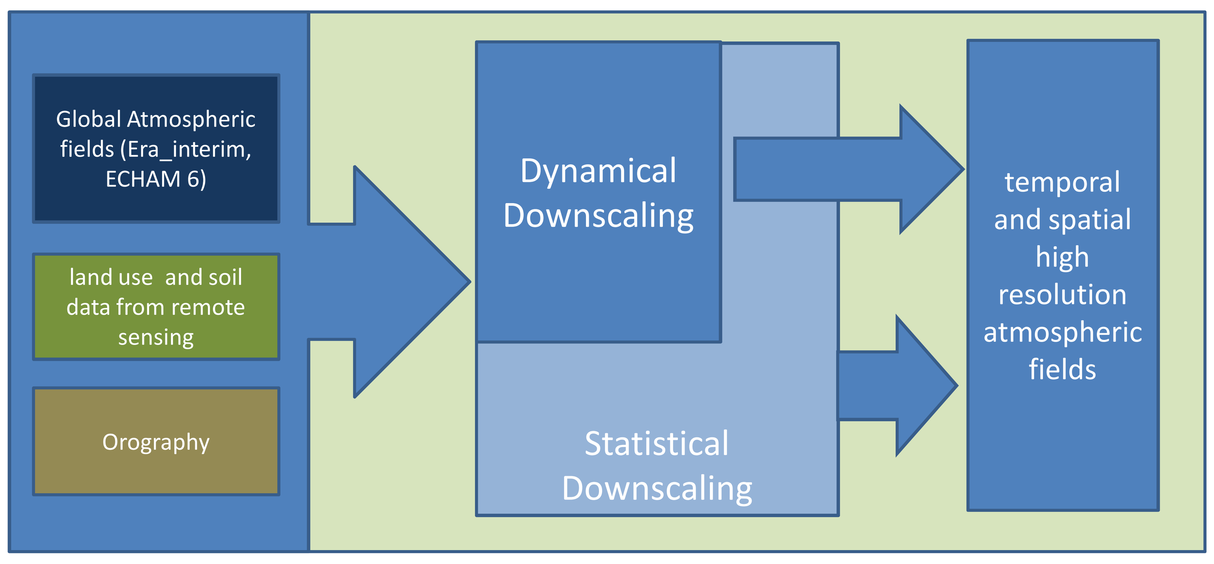


Fig. 3: Schematic drawing of modeling chain components

- Large -scale forcing from global atmospheric data sets e.g. ERA-Interim reanalyses (hindcast mode), GFS (forecast mode), ECHAM6 or PlaSim GCM simulations (scenario mode)
- Dynamical Downscaling Model for the simulation of regional scale atmospheric processes with the advanced Weather Research and Forecasting (WRF-ARW)
- Statistical Downscaling via direct parameterization of topographically determined boundary layer processes using SAGA
- Geostatistical optimization of spatial estimates applying alternative interpolation techniques

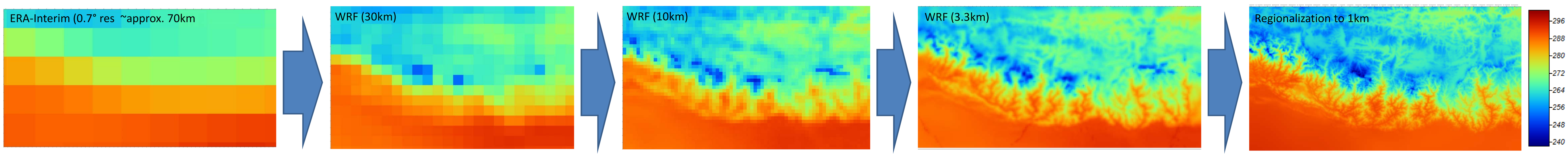


Fig. 4: Improvement of daily mean 2m temperature with increasing horizontal resolution in modeling chain from original ERA-Interim resolution of approx. 70 km to 1 km in regionalized product

Dynamical Downscaling with WRF

- 6-hourly ERA-Interim Reanalysis (0.7° horizontal resolution)
- Multi-year runs with sufficient spin-up to permit memory of e.g. soil moisture and snow cover and their feed back to atmospheric dynamics
- Spectral nudging of parent domain to prevent model deviating too far away from boundary conditions
- Parent domain 30 km with large 10 km nest including several high resolution domains (3.3 km), 36 vertical layers

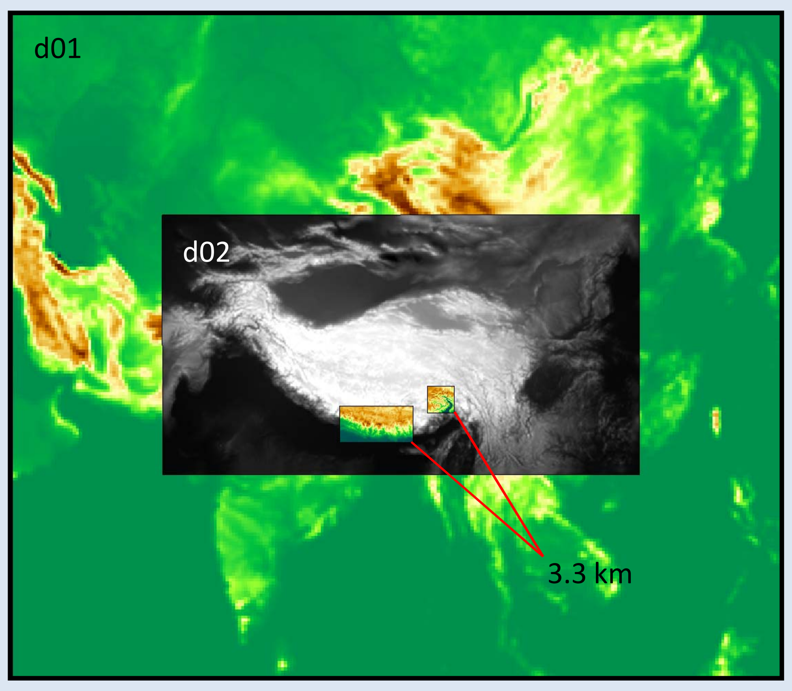


Fig.5: WRF model domains

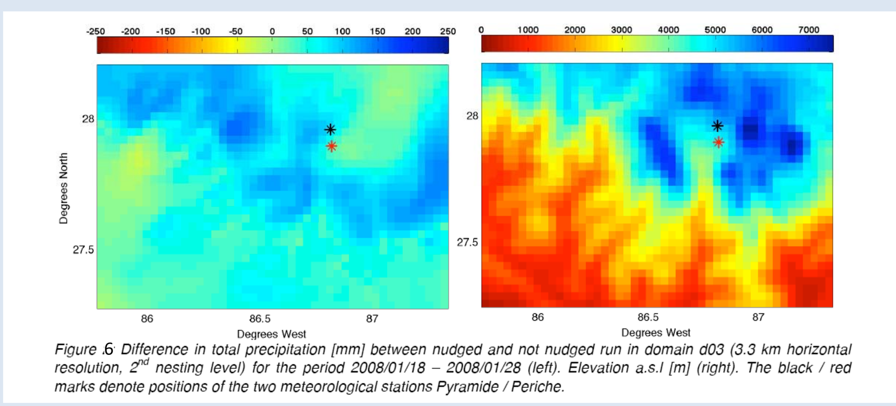


Fig. 6 shows that the un-nudged run overestimates the total precipitation at the slopes. The un-nudged run produces almost twice as much precipitation. A comparison with the hourly data of two stations confirmed that the onset of precipitation could be simulated correctly by the nudged run. In the un-nudged run the event started too early.

Statistical Downscaling

- Estimation of high resolution temperature fields (1 km²), derived from a SAGA-GIS-based altitude- and bias-correction approach interpolating climate model output data on different pressure levels
- Statistical Downscaling and regionalisation of precipitation and temperature by linking climate model output data with in situ observations and terrain parameters

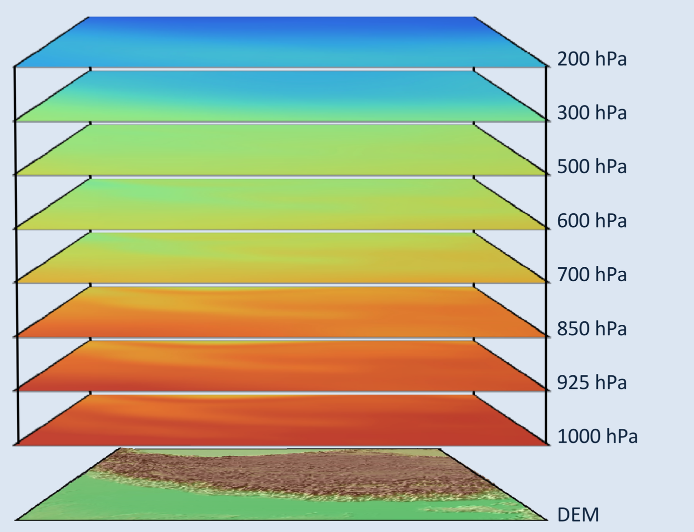
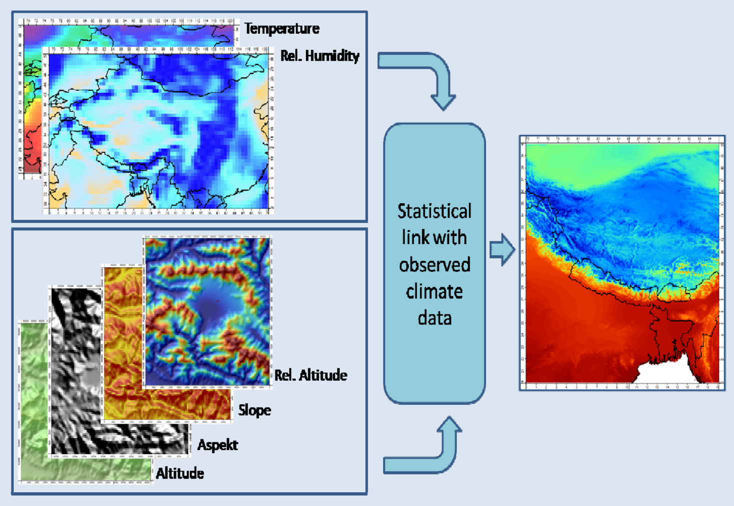


Fig.7(above): ERA-Interim temperature fields on selected pressure levels over the Tibetan Plateau used for Altitude-Correction of Surface Temperatures.

Fig. 8 (left): Main statistical downscaling components. Terrain parameters influencing temperature and precipitation distribution on a local scale are derived from a high resolution DEM in SAGA-GIS.



Researchers:
Jürgen Böhner, Valerio Lucarini, Klaus Fraedrich,
Eleonore Rauch, Lars Gerlitz, Shabeh Ul-Hasson, Tobias Kawohl, Hartmut Borth

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Federal Ministry of Education and Research