Using an integrated hydrological model for a climate impact assessment study

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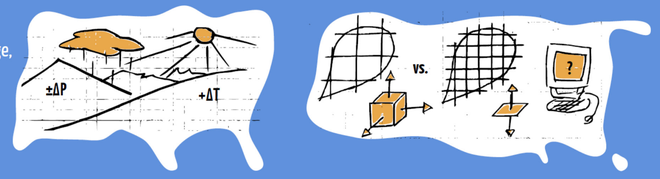
MOTIVATION

Mountain regions are considered particulary vulnerable to climate change, esp. considering alterations of the water cycle[1].
In the European Alps air temperature increase in the 20th century has been twice the average increase on a global scale[2].



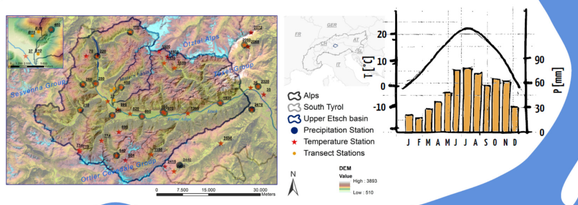
Modeling the water cycle for a meso-scale basin in complex mountain terrain adresses the trade-off between appropriate scale, simulation model (1d vs. 3d) and computational power.

AIMS

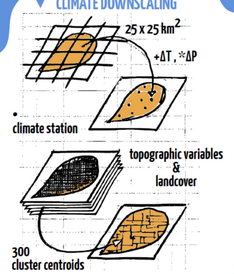
Temporal and spatial investigation of climate change impact on snow cover, evapotranspiration and soil moisture in a dry alpine basin .
Identification of topographic | landcover characteristics of especially vulnerable regions.

MATERIAL | METHODS

The Venosta region in the Italian Alps presents a particulary dry inner alpine climate: precipitation in the valley bottom acounts for 600 mm per year.
Current climatic conditions induce annual dry spells.



CLIMATE DOWNSCALING

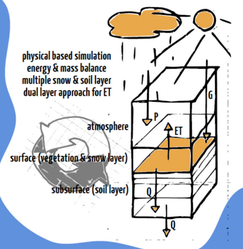


LANDSCAPE CLUSTERING

TopoSUB[4] tool for clustering the most important aspects of land surface heterogenities and land cover with the K-Means algorithm.

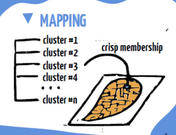
RCM ENSEMBLE based on SRES A1B [3]
Baseline 1990-2010, future scenario 2080-2100
Δ approach results in daily Δ change signals for T (JJA +4.2°C) and P (JJA -13%, SON & DJF +15%).

1 DIMENSIONAL SIMULATIONS



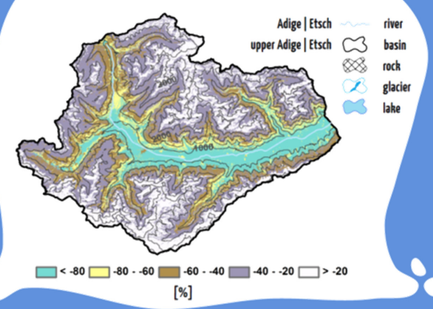
GEOtop[5,6] 1d simulations for individual cluster centroids result in maps of target variables for baseline & future scenarios

MAPPING



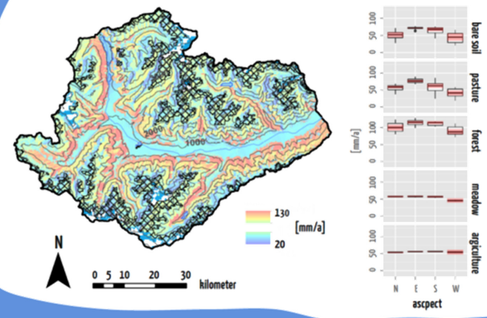
RESULTS

CHANGE in SNOW COVER DURATION



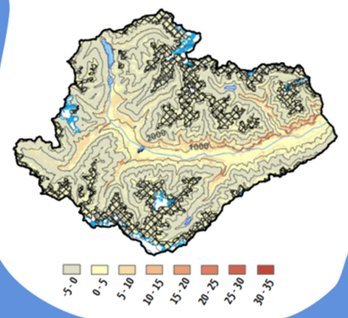
Projections show a severe shortening of snow cover duration.
Mean absoute change is accounting for -40 days,
the major shortening of -60 days is revealed for the forest belt.

CHANGE in ANNUAL ACTUAL EVAPOTRANSPIRATION



Areal mean shows a plus of 25% for future evapotranspiration rates.
Major impact is projected for south-east exposed pastures and forests.
During summer evapotranspiration is decreasing for specific sites due to more frequent occuring water limitation conditions.

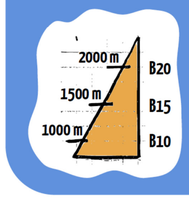
CHANGE in Nr. of DAYs with CRITICAL SOIL MOISTURE



The frequency of critical water stress is increasing in the valley bottom.
Especially pasture sites on south-east exposed slopes are affected.

MODEL VALIDATION

GEOtop is calibrated | validated on an elevation transect within the LTER site Mazia, where climatological data , soil water content and evapotranspiration were measured for the years 2010 & 2011[7].



	RMSE Θ_{5cm} / RMSE Θ_{20cm} [vol%]	RMSE ET [mm/m]
B20	9 / 7	--
B15	9 / 11	16
B10	9 / 7	--

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CONCLUSION

Projections show a general decrease in snow cover duration, which drives major seasonal increase in actual evapotranspiration.

Specific sites show a decrease in summer evaportanspiration rates, due to more frequent water limitation conditions.

Accordingly, an increase in drought days for these specific sites is projected.

FURTHER WORK

Sensitivity of lateral water fluxes (3d vs. 1d simulation)
Sensitivity of soil parametrisation
Consideration of dynamic vegetation
Improvement of climate downscaling (e.g. extended statistical downscaling - XDS[8])

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