Monitoring the hydrological regime in snow areas in Mediterranean regions: the Sierra Nevada case (Spain)

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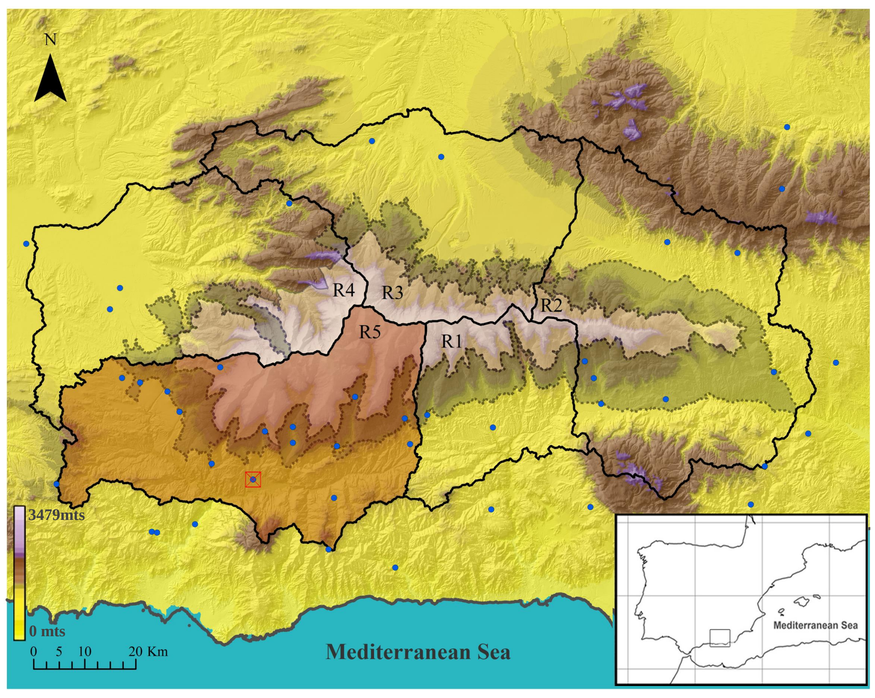
INTRODUCTION

Snow plays a crucial role in the hydrological regime in mountainous regions. The specific features of **Mediterranean regions**, with the alpine climate modified by semiarid conditions, **difficult the monitoring** and modelling of the snow evolution. The combination of both physically based modelling and remote sensing information constitutes a good approach for studying snow dynamics; however, the strong topographic gradients found in this semiarid environment require a thorough study of the snow representation. In this context, this work shows **the 40-yr spatiotemporal trends of the hydrological regime** in this area, in terms of selected weather, snow and other hydrological variables on an annual and daily basis, and discusses their projection over different climate scenarios.

STUDY SIZE

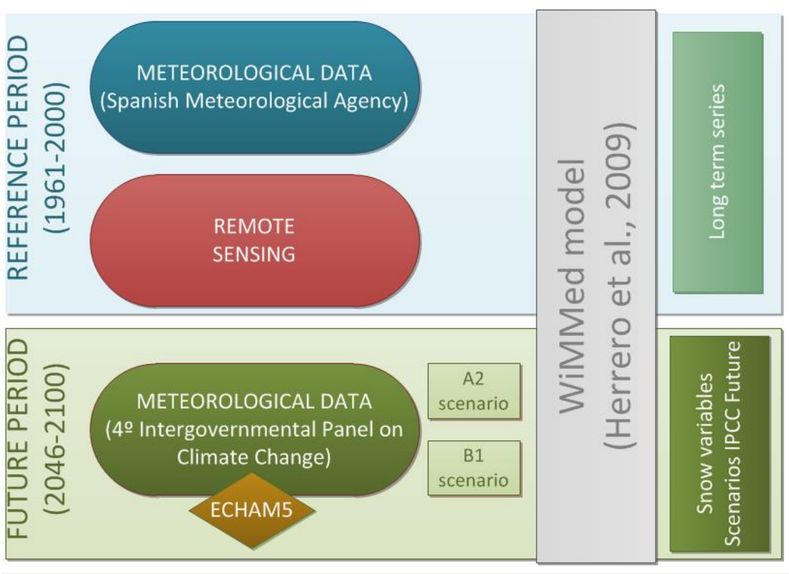


Sierra Nevada Mountains, in Southern Spain, are a linear mountainous range parallel to the shoreline of the Mediterranean Sea. The typical alpine climate is modified by **the proximity to the Mediterranean sea**, only 40 km south and snow is significantly affected.

METEOROLOGICAL DATA (year)	Mean	Max	Min
Precipitation (mm)	510	888	222
Temp $_{\text{daily mean}}$ (ºC)	12.5	28.9	-3.4

Location of Sierra Nevada Mountain Range in Spain; limits of the protected areas: National Park (light grey coloured area) and Natural Park (dark grey coloured area); location of the different weather station (blue dots); location of the point for water flow study (red square); region selected for Climate Change study (Brown coloured area);and limits of the 5 regions in which the study area has been divided: R1-Adra, R2-Andarax, R3-Fardes, R4-Genil and R5-Guadalfeo.

METHODOLOGY



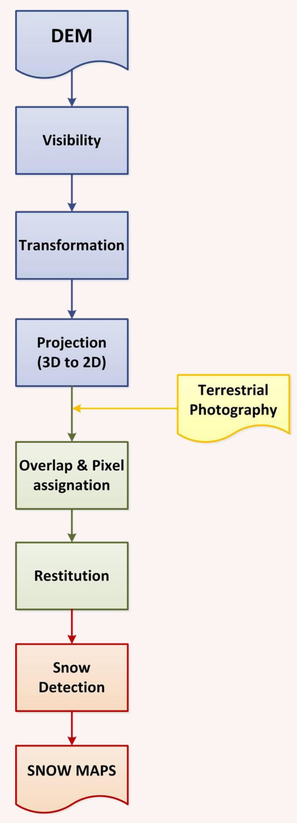
LONG TERM SERIES

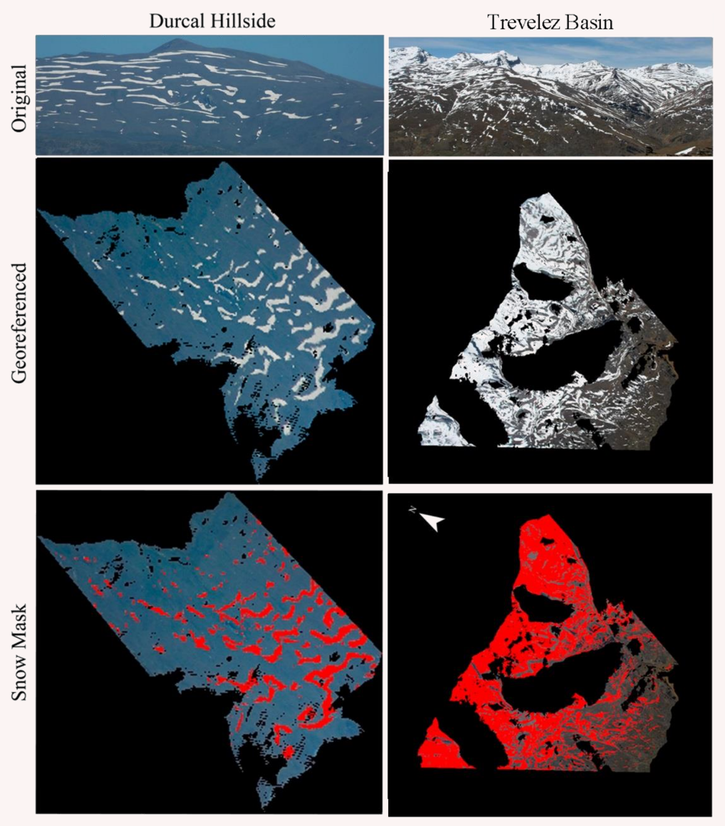
Annual and decadal regime for 40 year period (1960-2000)

Meteorological variables	Snow variables	Hydrological variables
• Precipitation • Snow Precip. • Temperature	• SCF • Nº of days with snow • SWE	• Water flow • Soil moisture

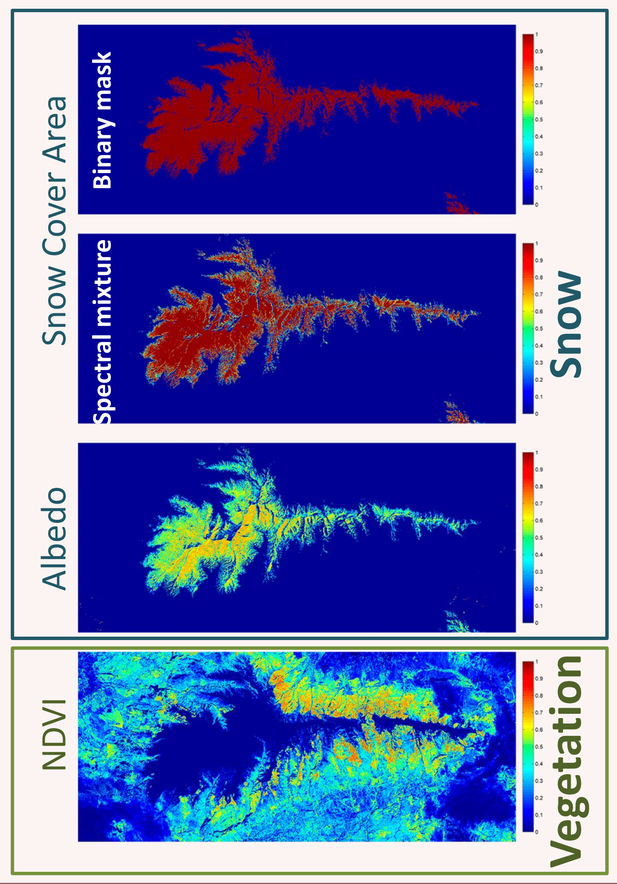
REMOTE SENSING INFORMATION

TERRESTRIAL PHOTOGRAPHY





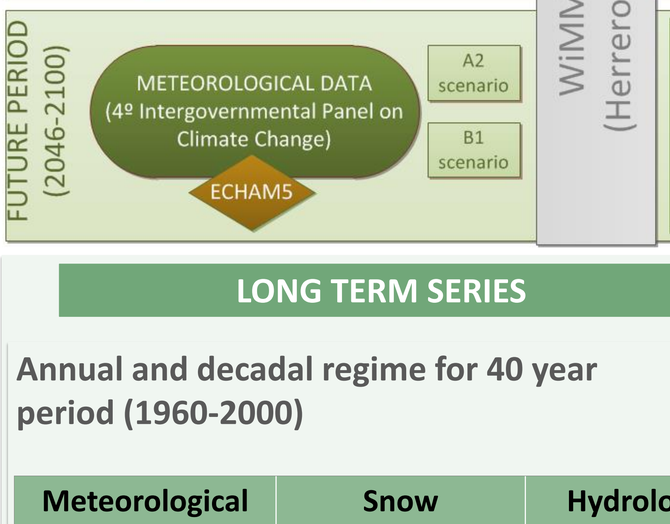
SATELLITE SCENES



RESULTS

REFERENCE PERIOD (1961-2000)

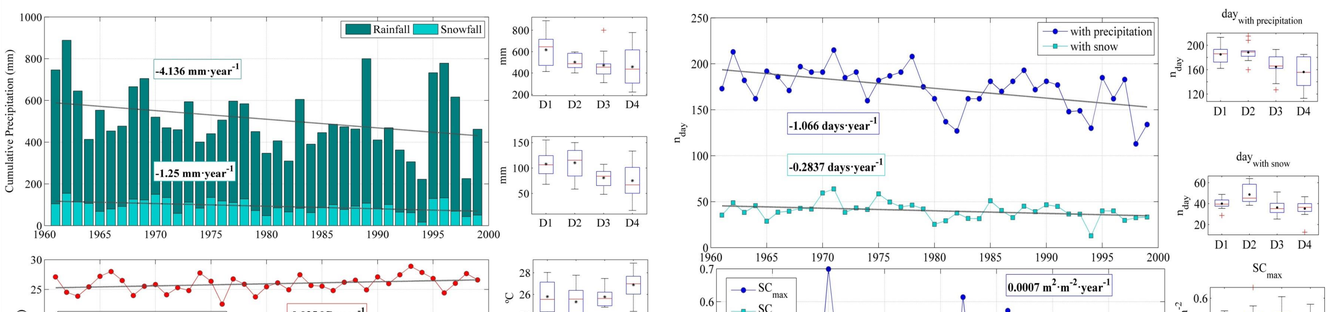
1. METEOROLOGICAL VARIABLES



The annual precipitation and the annual mean temperature experimented a mean decreasing and increasing global trend of -4 mm yr^{-1} and 0.02 ºC yr^{-1}, respectively, during the 40-yr reference period. This involved a reduction in snowfall,-1mmyr^{-1}, and in the number of days with snow cover, -0.3 days yr^{-1} as mean global values.

2. SNOW VARIABLES

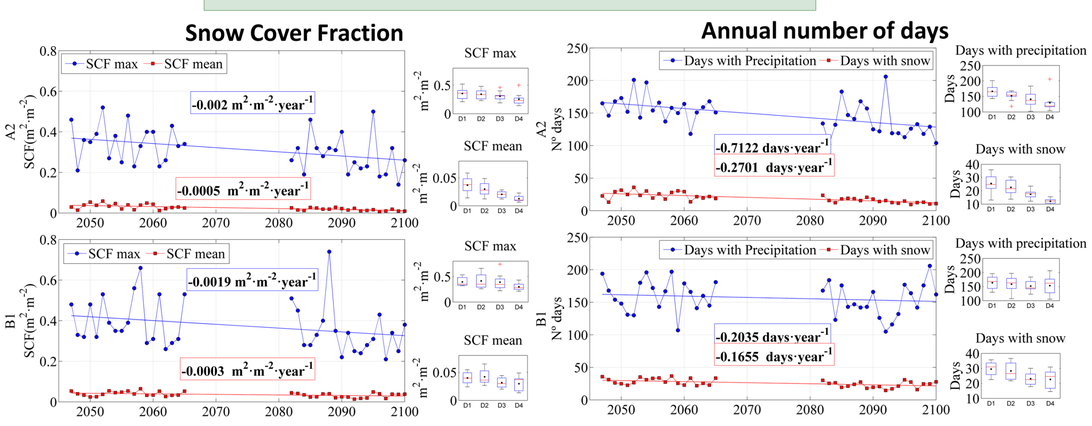
3. HYDROLOGICAL VARIABLES



FUTURE PERIOD (2046-2100)

1. METEOROLOGICAL VARIABLES

2. SNOW VARIABLES



CONCLUSION

The precipitation rather than the temperature regime seems to be the most relevant driver on the snow regime in this Mediterranean area. This poses a constraint for rigorous scenario analysis, since the precipitation pattern is poorly approximated by climatic models in these regions. The high spatial variability induced by the topographic gradient required the combination of terrestrial and remote sensing data, with a significant improvement of the snow evolution representation by the model. The estimated trend of snow regression over the reference period was significantly related to the measured increase of flow in the rivers. The modelling allowed the analysis of the impact of such changes in every component of both the energy and water mass budget in the study area. The results highlight the importance of coupling remote and ground data sources with physically based modelling for snow processes in Mediterranean regions.

ACKNOWLEDGEMENTS

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