

## TERRESTRIAL IMAGERY AS ADDITIONAL DATA TO VALIDATE AND ENHANCE FUSION ALGORITHMS FOR SATELLITE SOURCES

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- **SEMIARID ENVIRONMENTS CLIMATE**

- High level of solar energy income throughout the year
- Variable character with lower precipitation

→ **HYDROLOGICAL REGIME**

- Extreme
- Highly variable

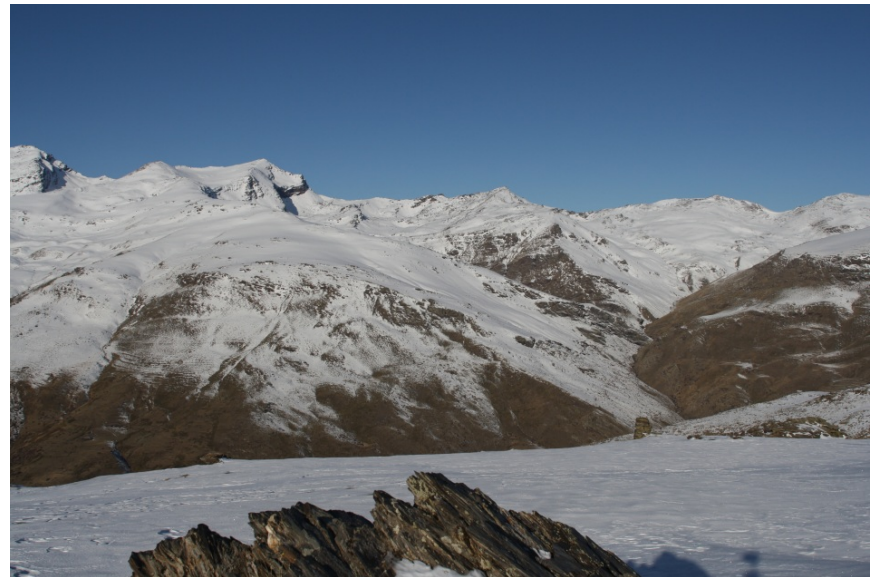
Water in the snowpack

- **SNOW**

- Strong spatiotemporal variability
- High evaporation rates
- Several snowmelt cycles



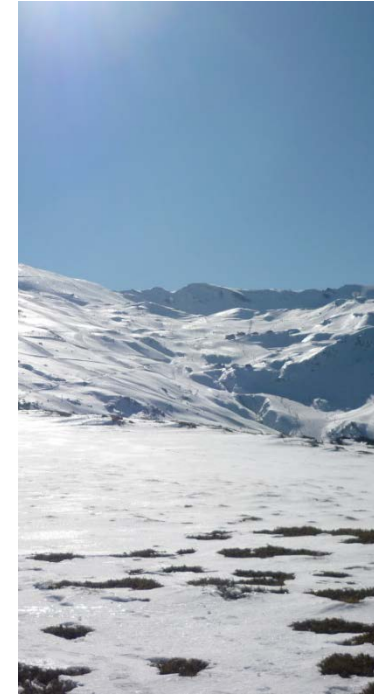
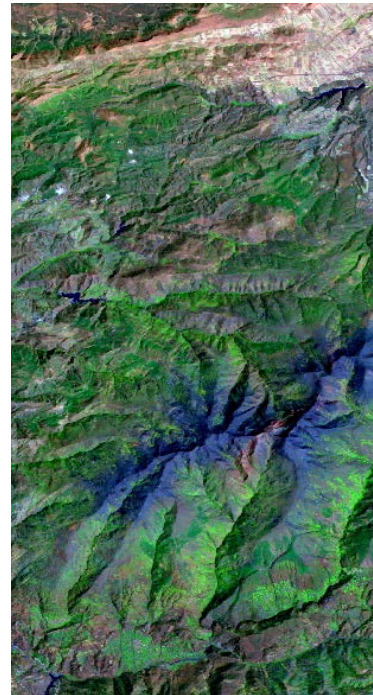
**SNOW COVER AREA (SCA)**



# IMAGES TO STUDY SCA

## SOME LIMITATIONS OF USE OF SATELLITE IMAGES

- Complex topography
- Clouds
- Self- shadowing
- Processes on a small scale
  - Rapid melting
  - Persistence of small patches

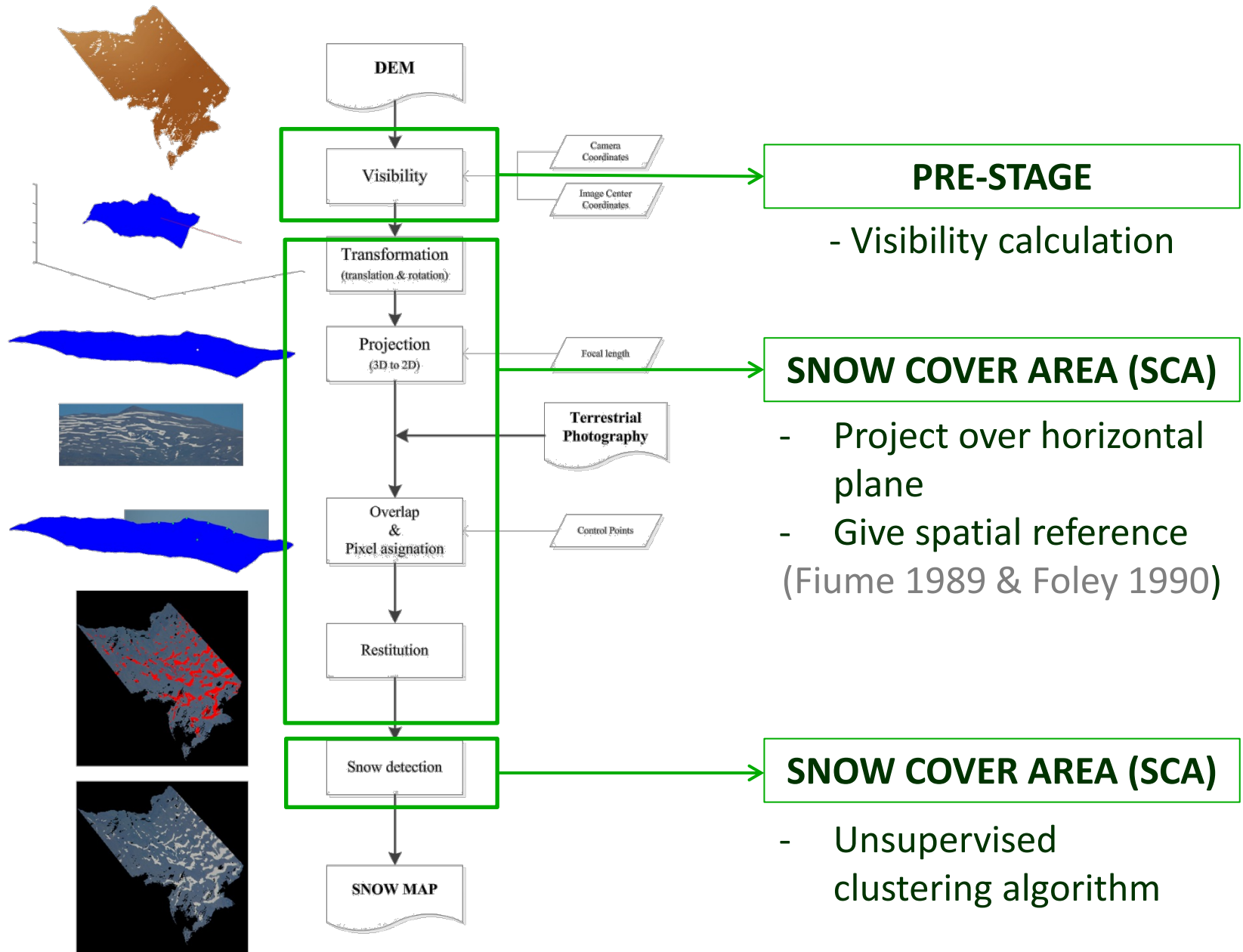


IMAGES	SATELLITE	TERRESTRIAL
Spatial Resolution	Fixed	Variable
Temporal Resolution	Fixed	Variable
Cost	High	Low

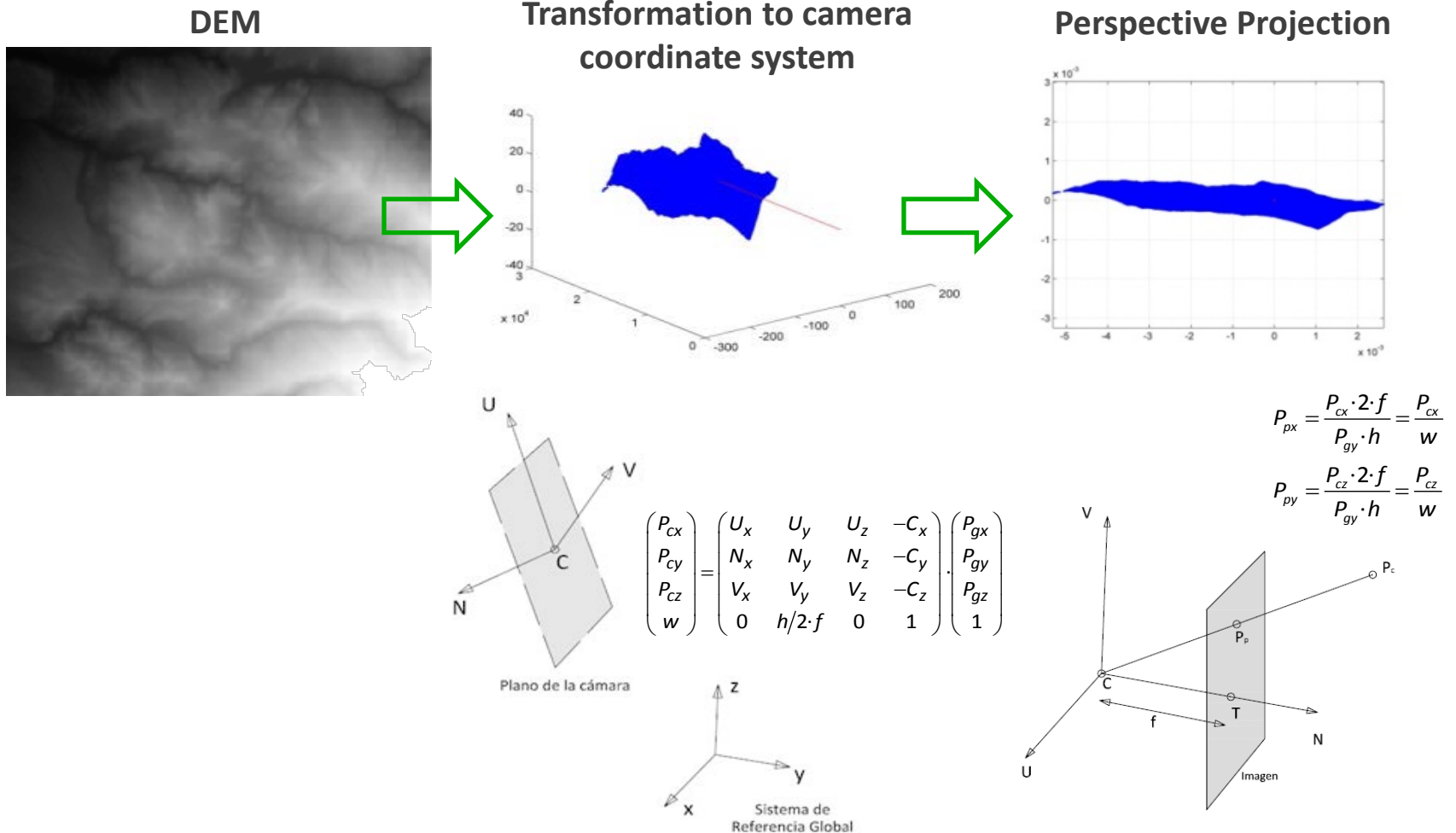
PREPROCESSING

# IMPLEMENT THE NEEDED ALGORITHMS TO OBTAIN SNOW COVER AREA FROM TERRESTRIAL PHOTOGRAPHY

- **Develop a Graphic User Interface (GUI), to create a friendly environment for an easy employment by different users**
- **Test the GUI over different areas to asses its applicability**



- Based on graphics desing principles
- AIM: To find a function to relate 2D pixel to 3D point DEM (10x10 m)





- 2D projection of the DEM scaled according the image resolution
- Stablish the correspondence between pixel and projected coordinates

## Scaling and Overlay



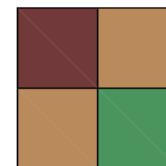
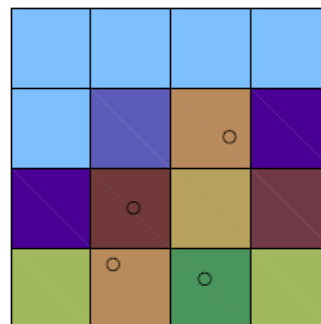
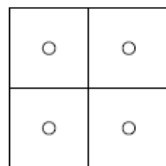
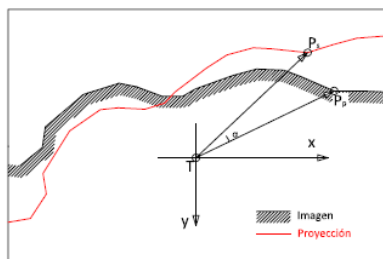
## Assignment



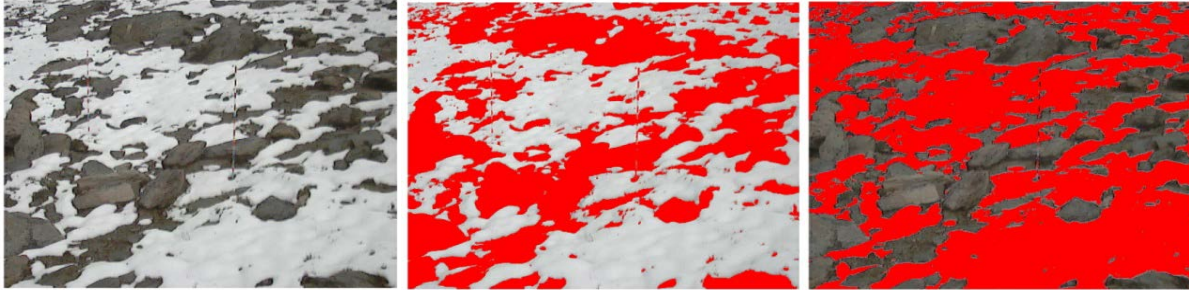
## Georeferenced image



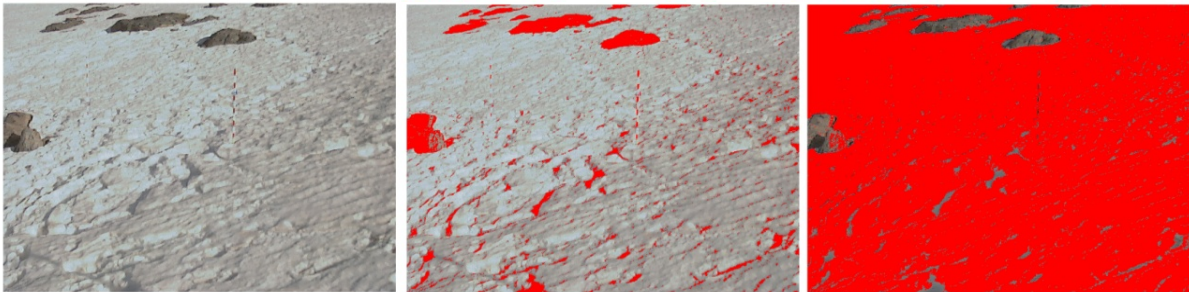
## Ground Control Points



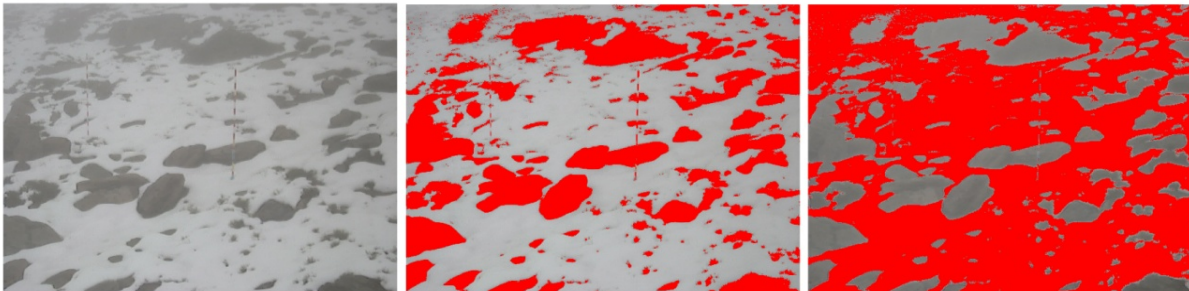
CLOUDS



SHADOWS

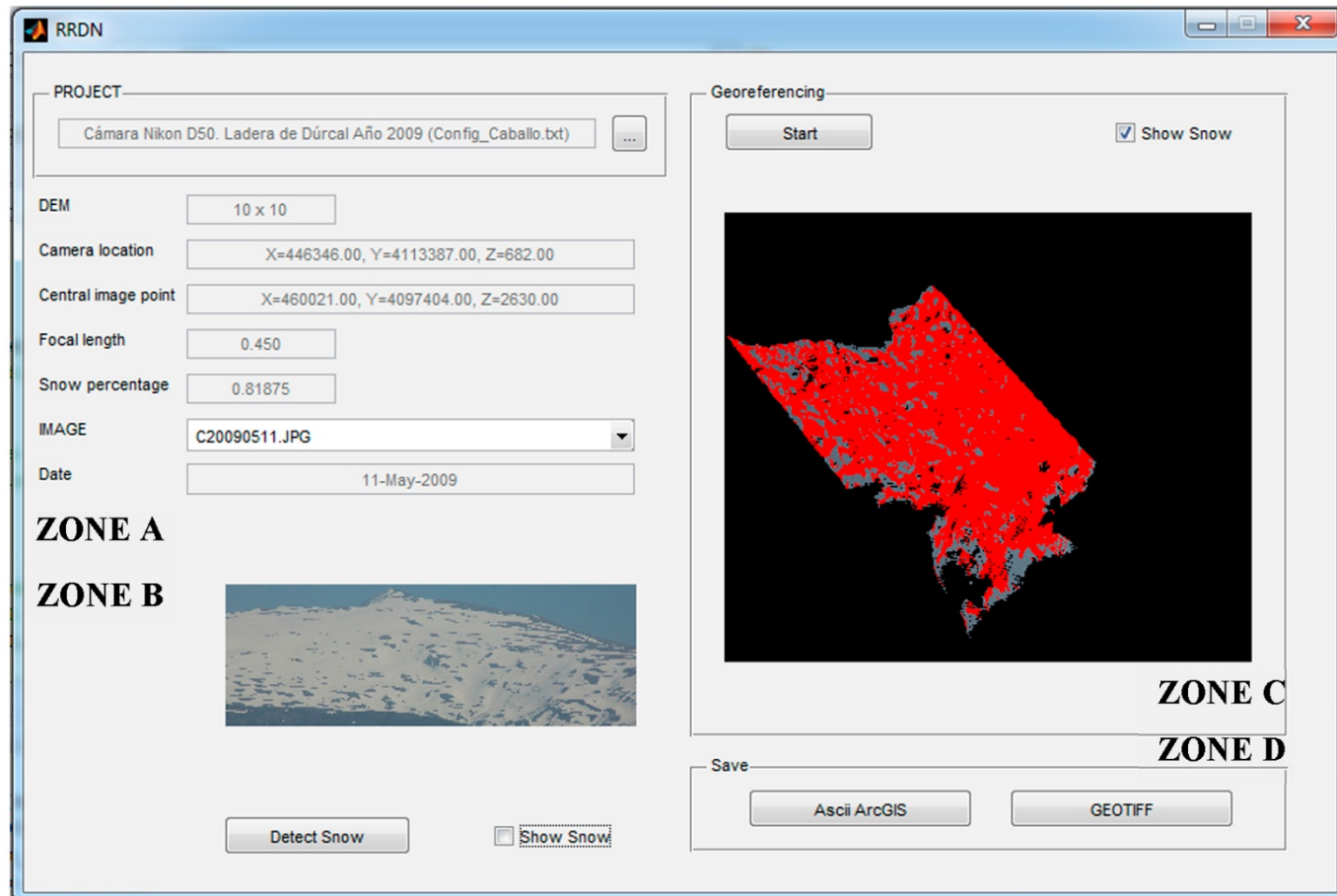


FOG



- Based on machine learning techniques
- K-mean algorithm
- No fixed thresholds
- Small misclassifications related to hard shadows





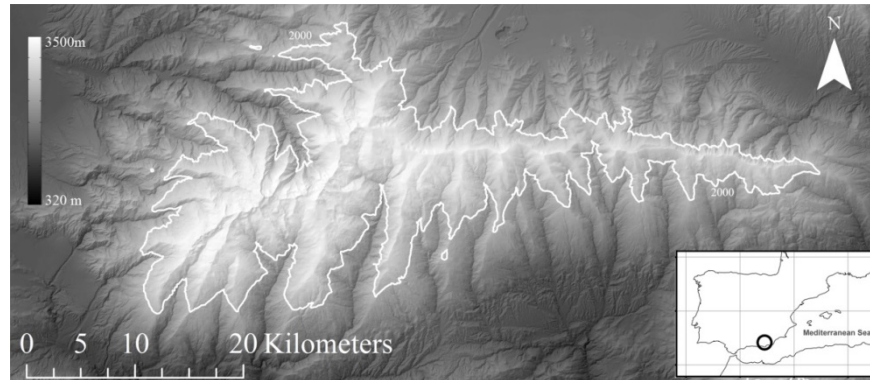
## SIERRA NEVADA

**PHYSICAL FEATURES**

Altitudes (1500-3500 m)

Long (60 km)

Distance to the sea (35 km)

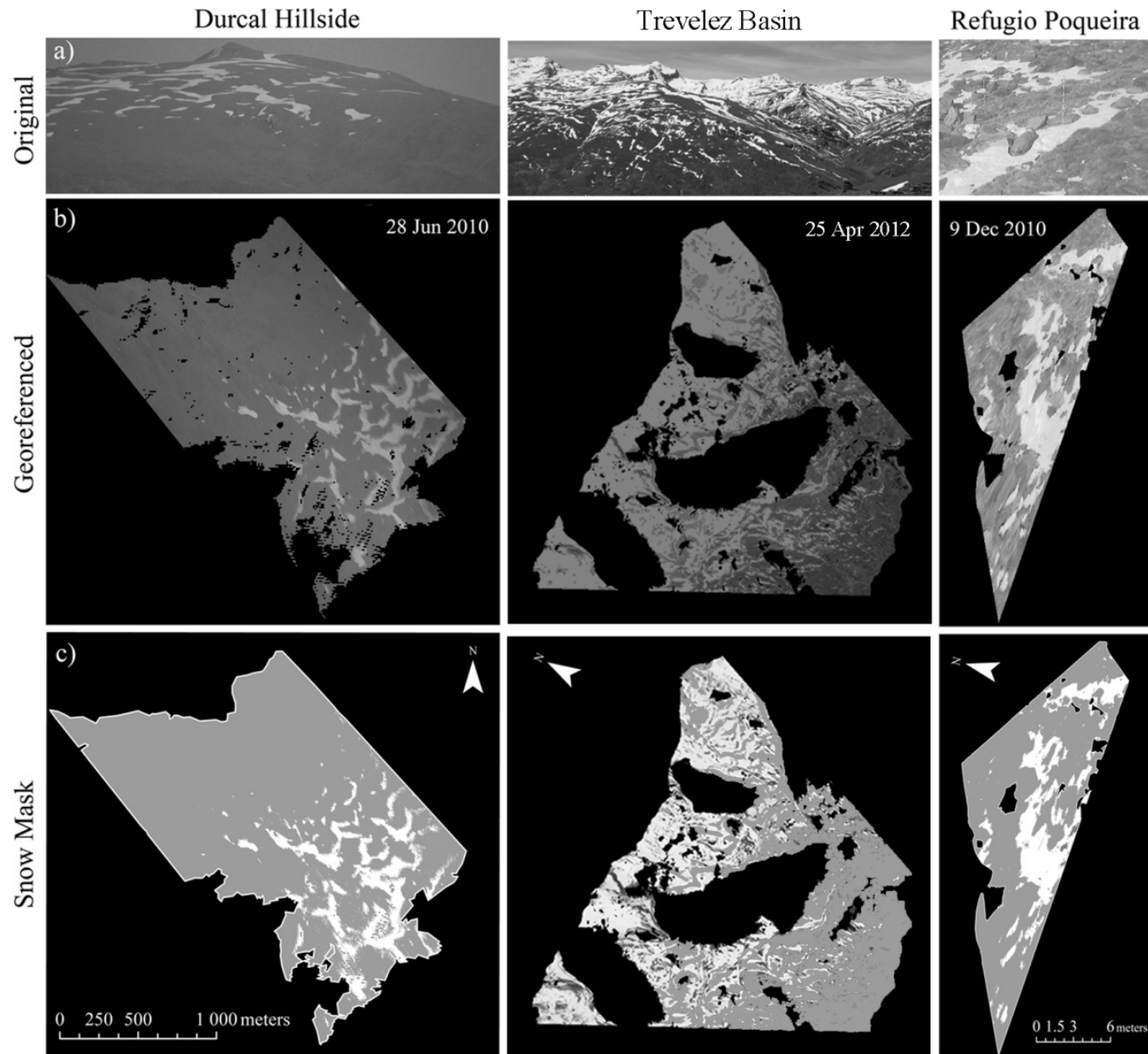
Climate (mountain modified by  
the surrounding conditions)**METEOROLOGICAL DATA**

Annual Precipitation (400-1500mm)

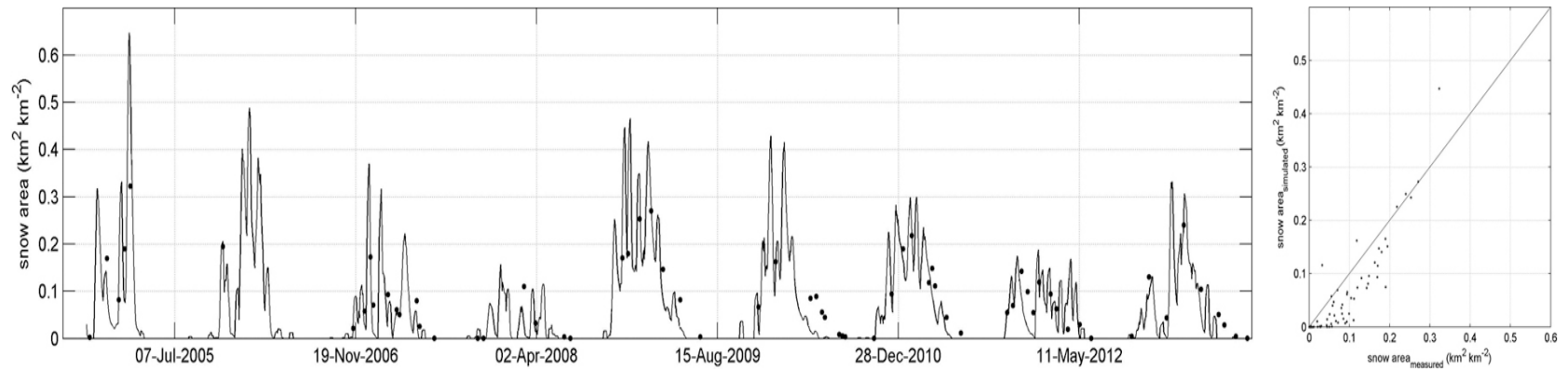
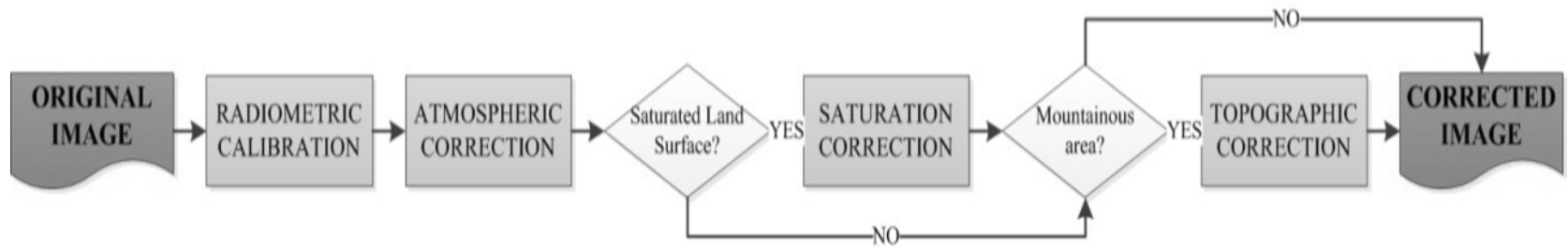
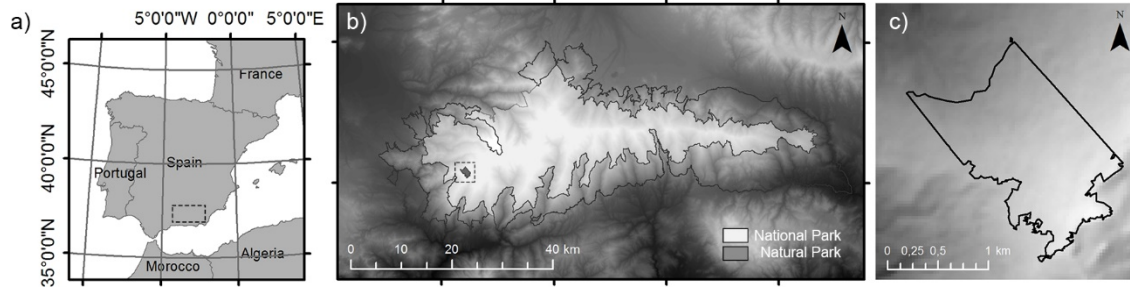
Percent of snow (40-70%)

Average Temperature in snow  
season (-5,+5 °C)Sunny days dominant even  
during winter

Camera	Installation	Temporal resolution	Spatial scale	Photo resolution (pixels)
Sony IPELA SNC-RZ50P	2011/11/20- operational	4 images per hour (4 different location, from 7 a.m. to 7 p.m.)	Hillside (O~10m)	640 x 480
Canon EOS Digital Rebel XS	2011/09/15- 2013/09/15	8 images per day (from 8 a.m. to 19 p.m.)	Basin (O~100m)	3888 x 2592
CC640 Campel Scientific	2009/07/22- operational	5 images per day (from 8 a.m. to 4 p.m.)	Detail (O~m)	640 x 504



# VALIDATION OF SATELLITE DATA: APPLICATION TO A SPECTRAL MIXTURE ALGORITHM ON LANDSAT DATA



- The use of terrestrial photography greatly improve the quality of snow cover evolution measurements and provides us with a deeper insight into the seasonal, weekly, and daily variability exhibited by snow processes in semiarid climates.
- The implemented GUI facilitates the automation of the georeference process in a easy and friendly way.
- This techniques is applied under different spatial scales, showing a good accuracy in all the cases. Thus, the capability and versatility of terrestrial photography for easy and continuous monitoring of snow has been demonstrated.
- The different output format allow its inclusion in other software like ENVI or ArcGIS, frequently used in GIS-based applications.



# ACKNOWLEDGEMENT

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WE THANK THE DRAGON4 PROJECT FOR THE OPPORTUNITY OF SHARING OUR RESULTS AND APPLYING THESE METHODS TO OTHER REGIONS IN THE WORLD

# THANKS FOR YOUR ATENTION

谢谢！