IEEE SA STANDARDS ASSOCIATION

Spectral reflectance measurements of soil surface covers in the Northern Antarctic Peninsula Region

IEEE-P4005 Working Group
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Introduction

- South Shetland Islands within the northern Antarctic Peninsula region and with a cold maritime climate.
- Ice-free areas represent less than 3% of the total land surface area.
- Concentration of fauna and flora where mosses and lichens are the main vegetation cover and bird and seal colonies have their breeding grounds. Furthermore, human activities around bases are common.
- At present, this region is one of the most rapidly warming places in the world over the past sixty years.
- Seasonally-exposed terrestrial area is expected to expand up to three times its current size by 2100.
- Retreat of permanent ice cover will provide new habitats for flora and fauna to colonize
- This will form bigger extensions by coalescing some areas that are currently isolated due to glaciers and permanent snowfields.

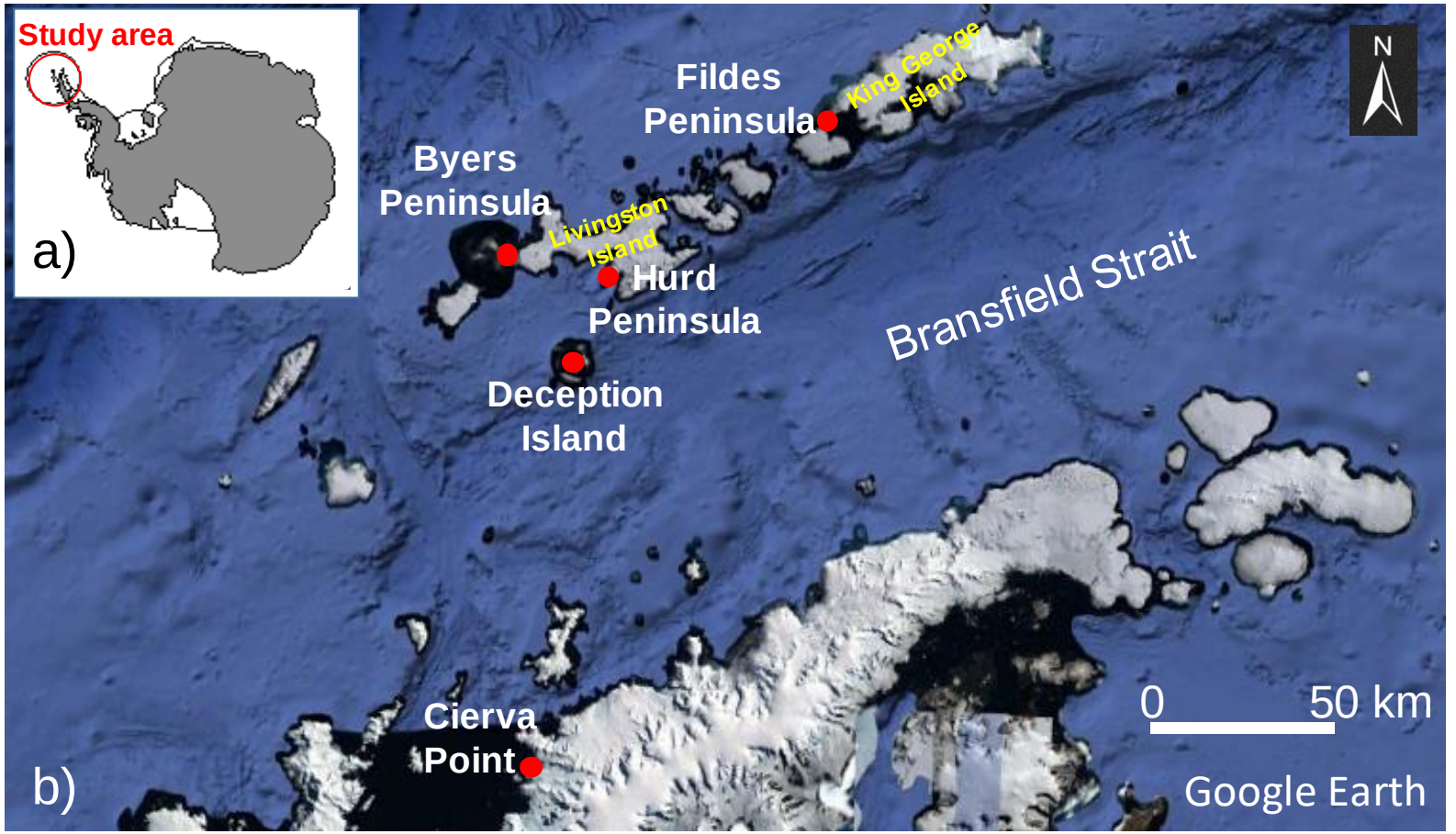
Objectives

1) Compile a site specific spectral library for representative terrestrial soil surface covers for the Northern Antarctic Peninsula Region.

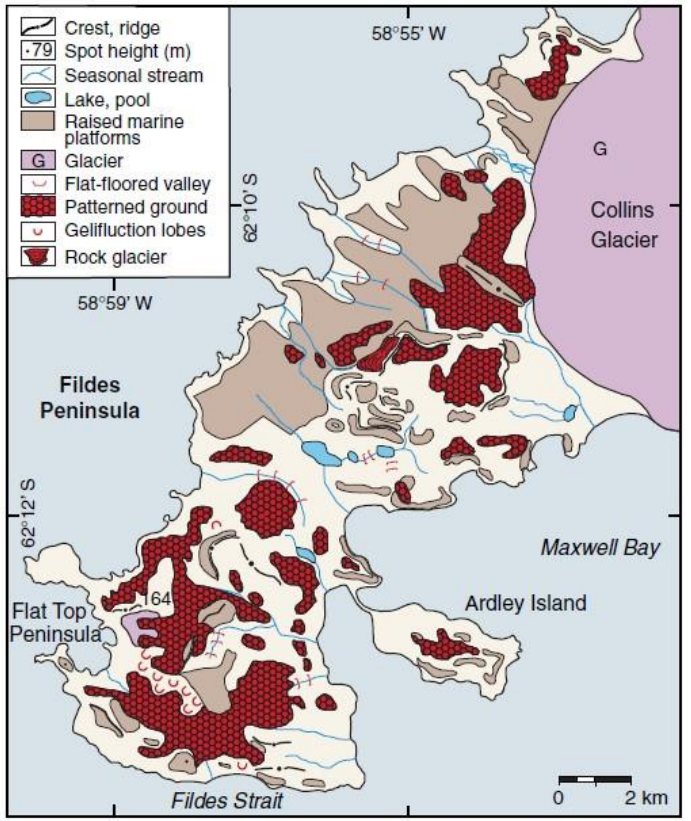
2) Obtain indicators of specific surface cover properties that are related with different stages of development within the ice-free areas and form the basis for monitoring environmental changes.

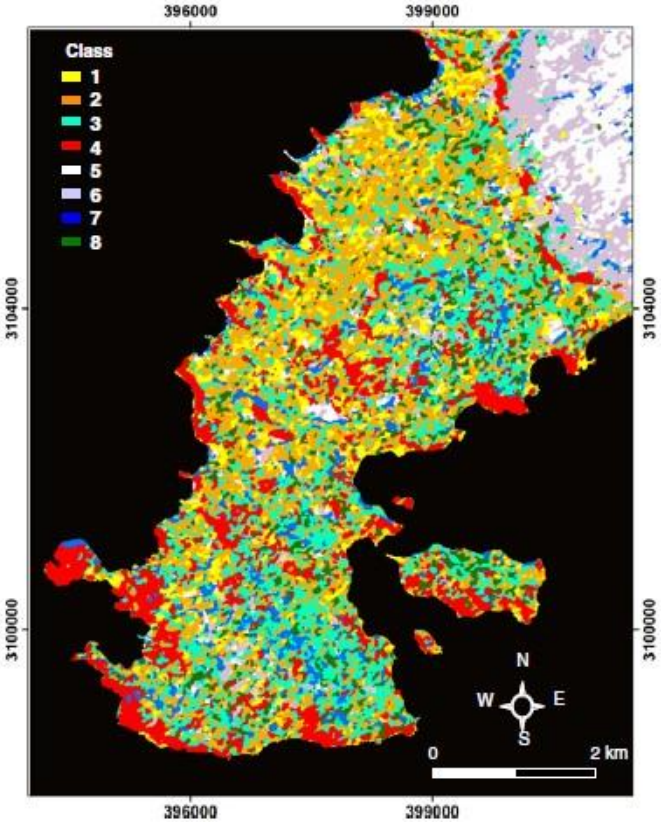
3) Use a spectral library to identify indicators of biodiversity and to monitor their distribution using remotely sensed data.

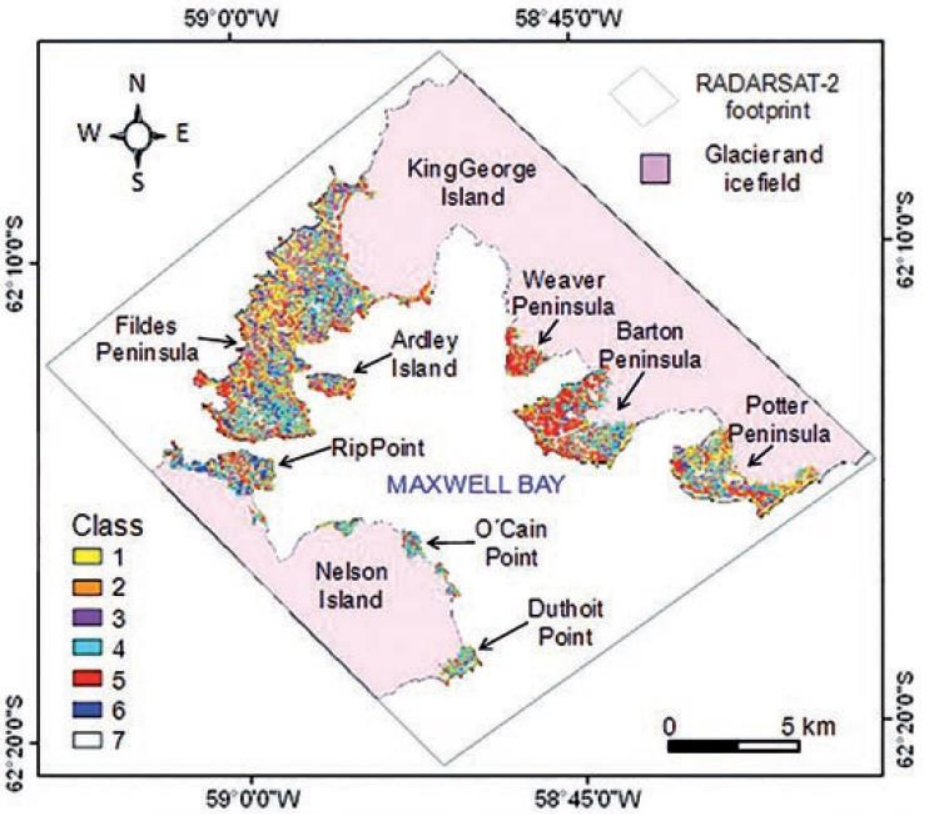
Study areas


Study area
a)
Fildes Peninsula
King George Island
Byers Peninsula
Livingston Island
Hurd Peninsula
Bransfield Strait
Deception Island
Cierva Point
b)
N
0
50 km
Google Earth

Characterizing areas





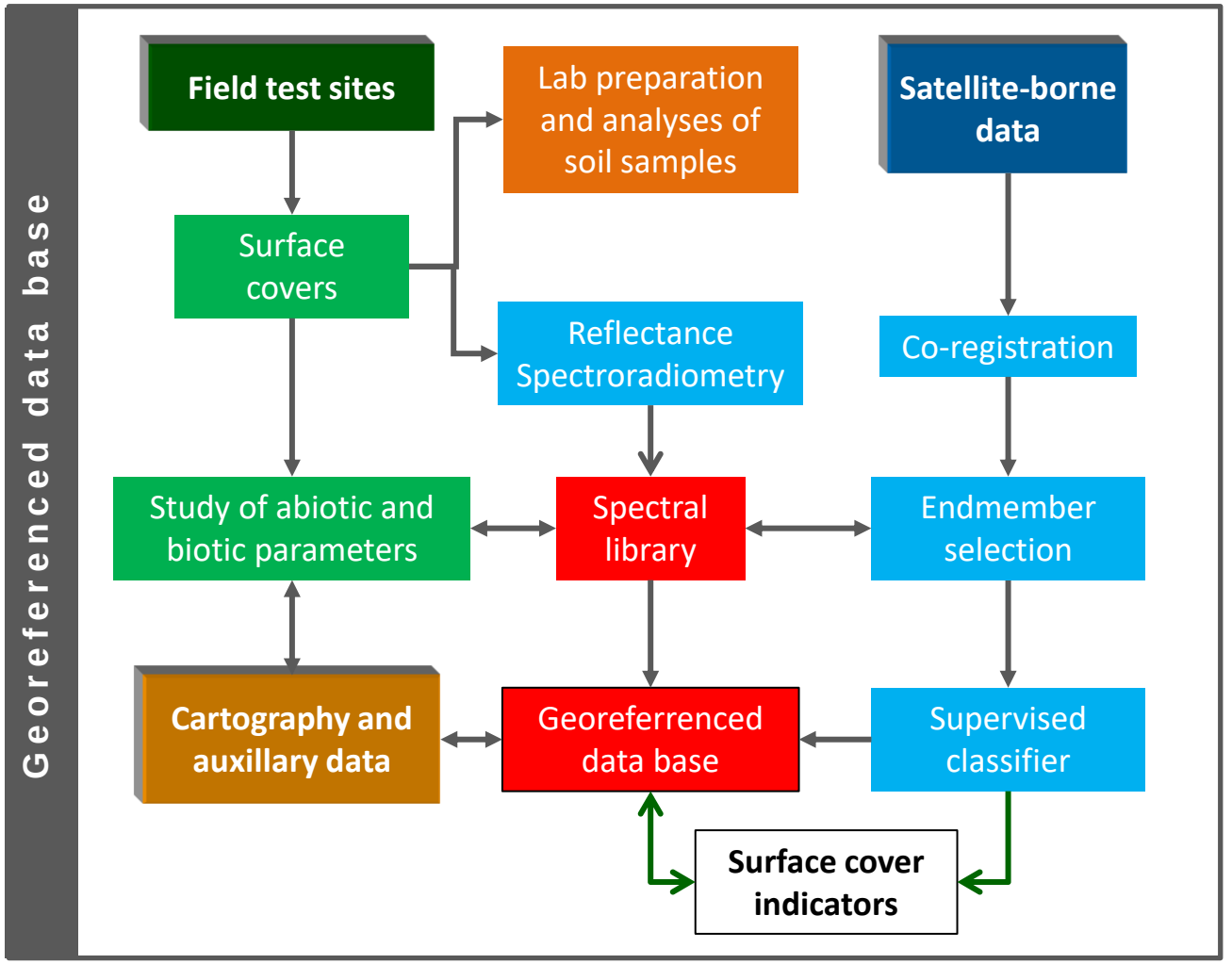


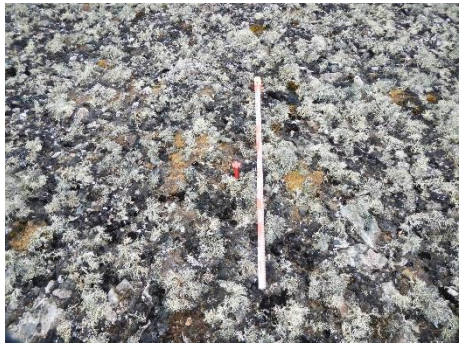
1) López-Martínez et al., 2012. Periglacial processes and landforms in the South Shetland Islands (northern Antarctic Peninsula region). Geomorphology, Vol. 155–156, 62-79.

2) Schmid et al., 2017. Geomorphological mapping of ice-free areas using polarimetric RADARSAT-2 data on Fildes Peninsula and Ardley Island, Antarctica, Geomorphology, vol. 293, 448-459.

3) López-Martínez et al., 2016. Geomorphology and surface landforms distribution in selected ice-free areas in the South Shetland Islands, Northern Antarctic Peninsula Region. Cuadernos de Investigación Geográfica, 42 (2), 447-468.

Methodology





Challenges

1) Harsh conditions: Low temperatures, cloud cover, windy, damp and rainy.

2) Protect fragile equipment. Problems of battery power at low temperatures.

3) Exposed cold fingers make it difficult to manage the equipment.

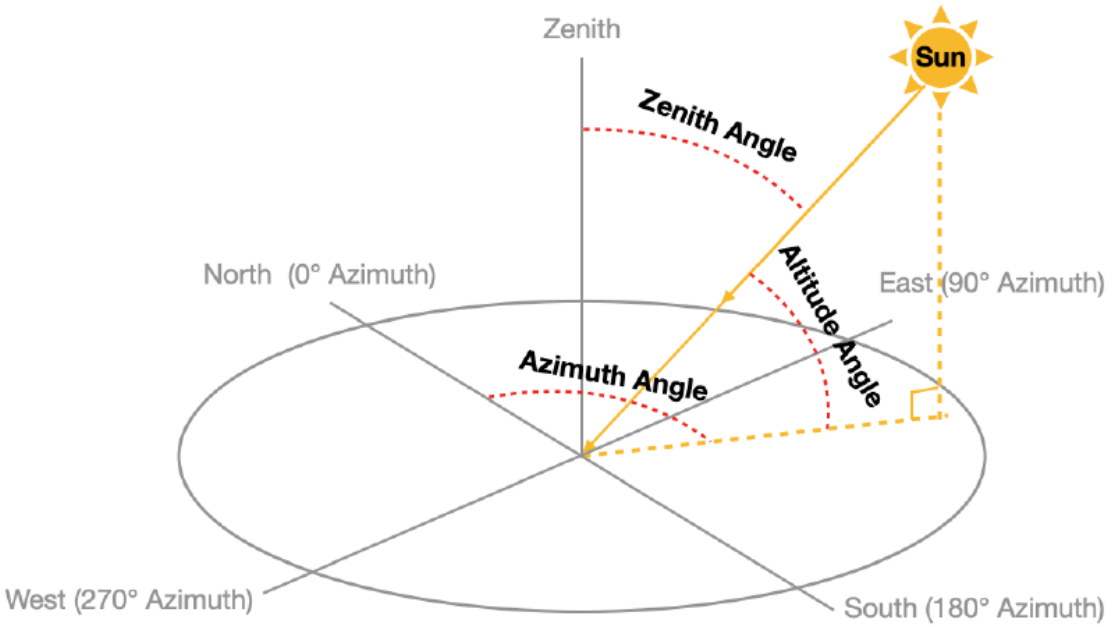
4) Low sun angle to take measurements under sunlight conditions.

Bare optical fiber

Contact probe

SoilPRO II

Sun altitude angle

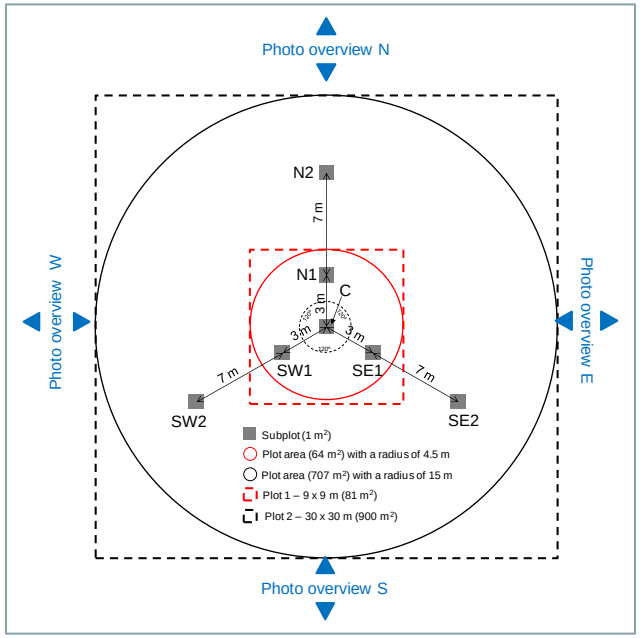


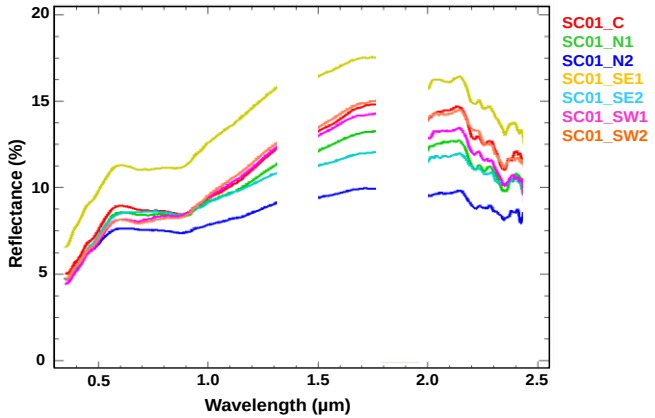
Source: Zhang et al., 2021.

- The higher the latitude the lower the local noon solar zenith angle, which decreases from summertime to wintertime.
- Close to the equator the incoming solar irradiance covers a smaller region than at higher latitudes. Here, the same amount of incoming photons are spread over a larger region, hence the solar irradiance is lower per unit area.

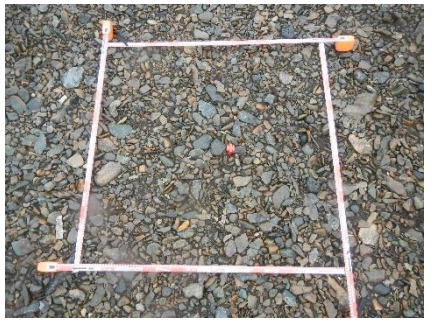
- This will depend on latitude, longitude, time of day and date. Sun altitude and zenith angle is straightforward to determine.
- Field measurements are therefore needed to be able to evaluate and calibrate sensor data from satellite platforms.

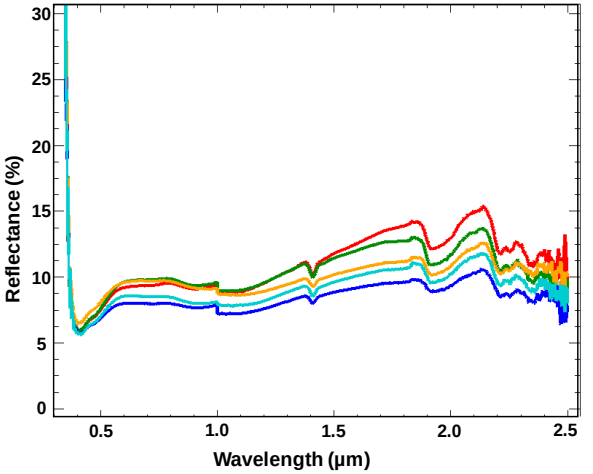
Reference spectra of bare soil surfaces



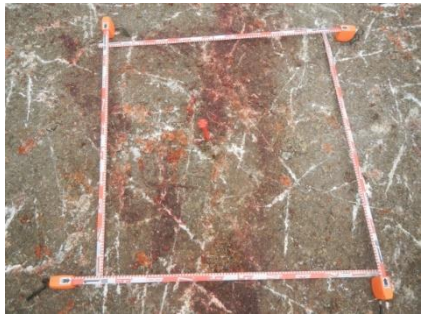


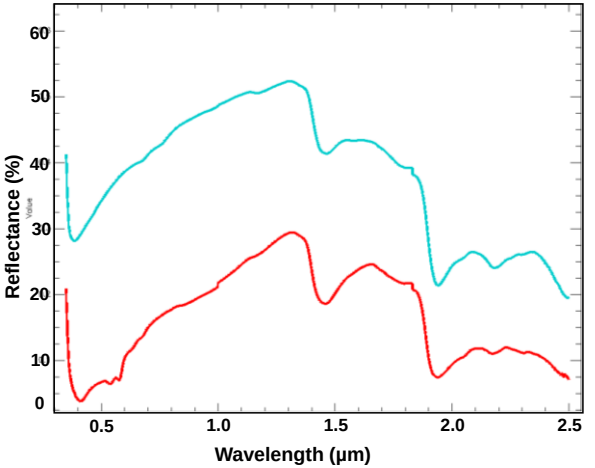
Bare soil spectra obtained with Soil PROII





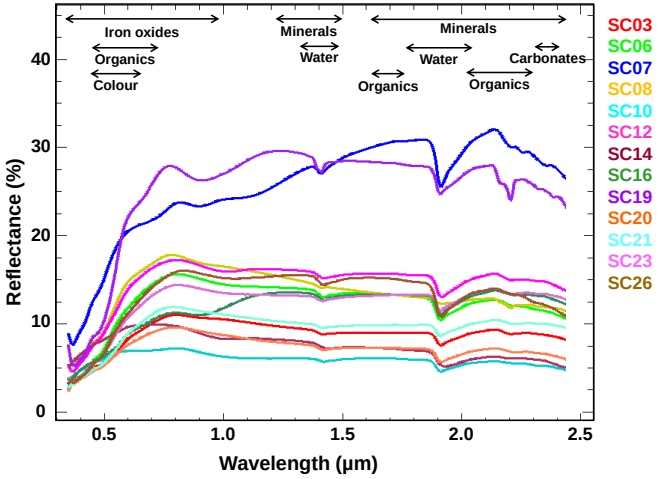
Spectra of penguin rookery obtained with SoilPRO II

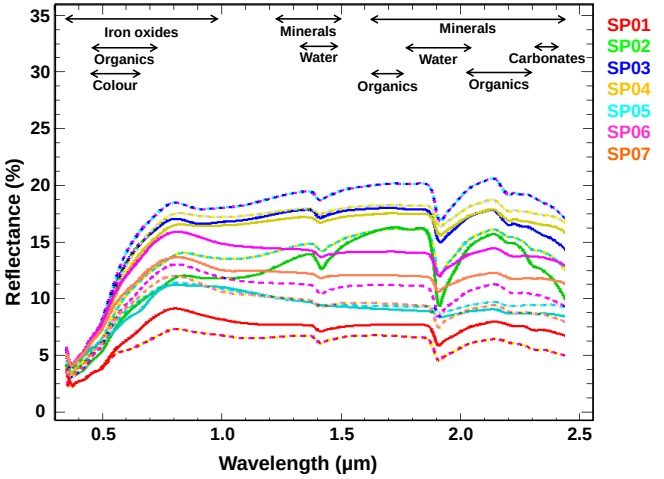




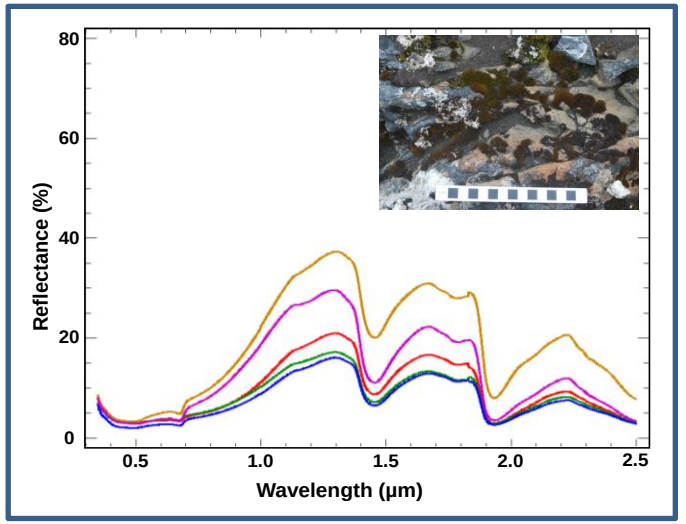
Results of the Northern Antarctic Spectral (NAPSPEC) library

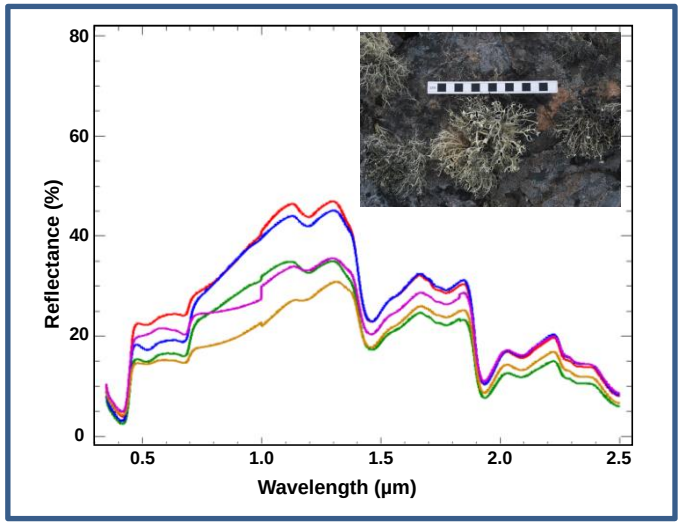
Lab spectra

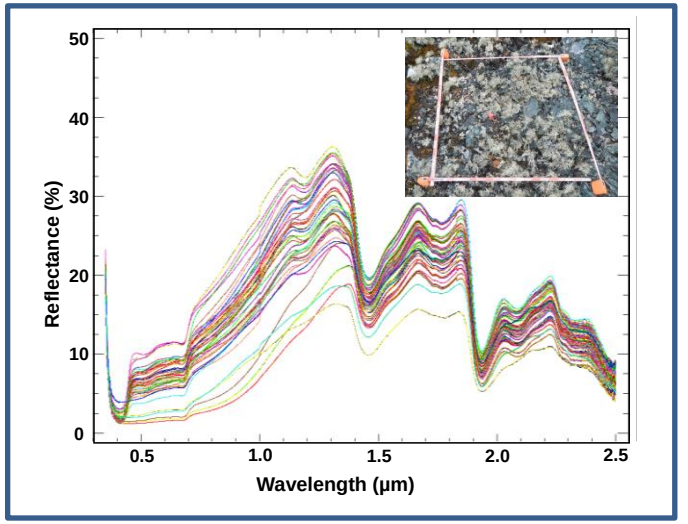




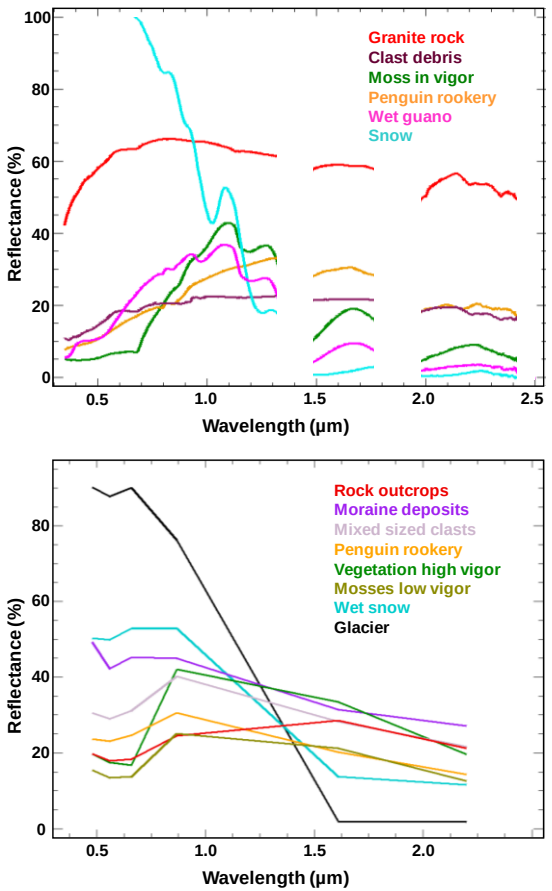
SoilPRO II spectra

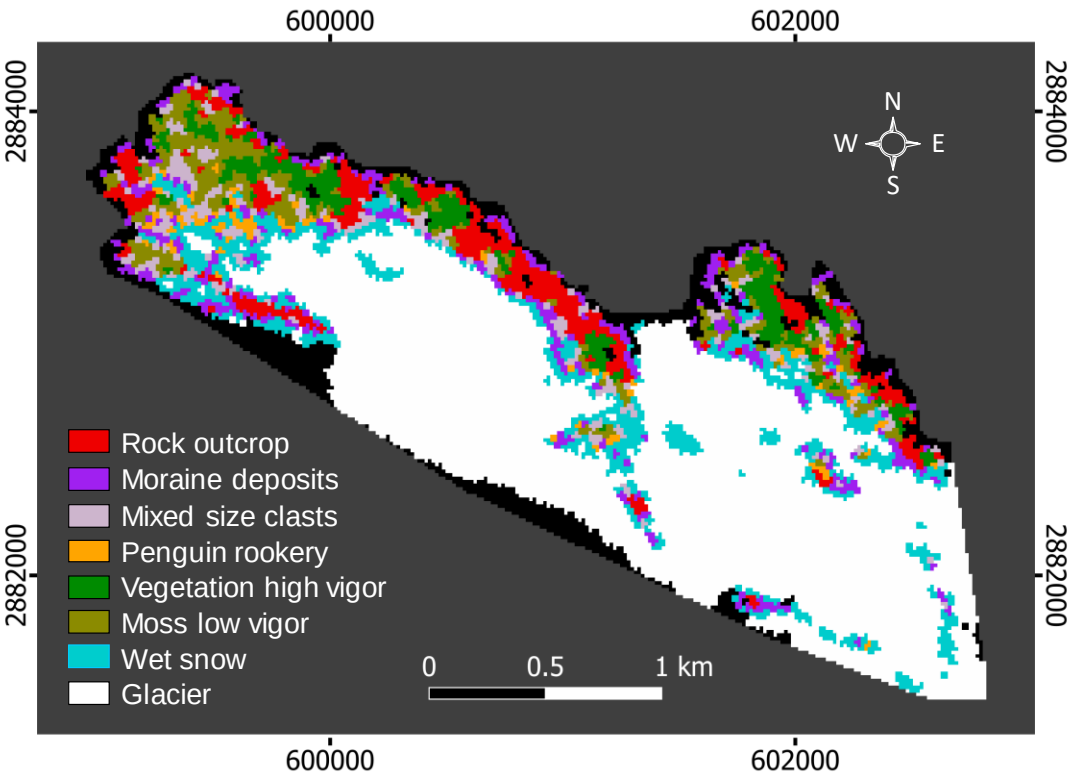






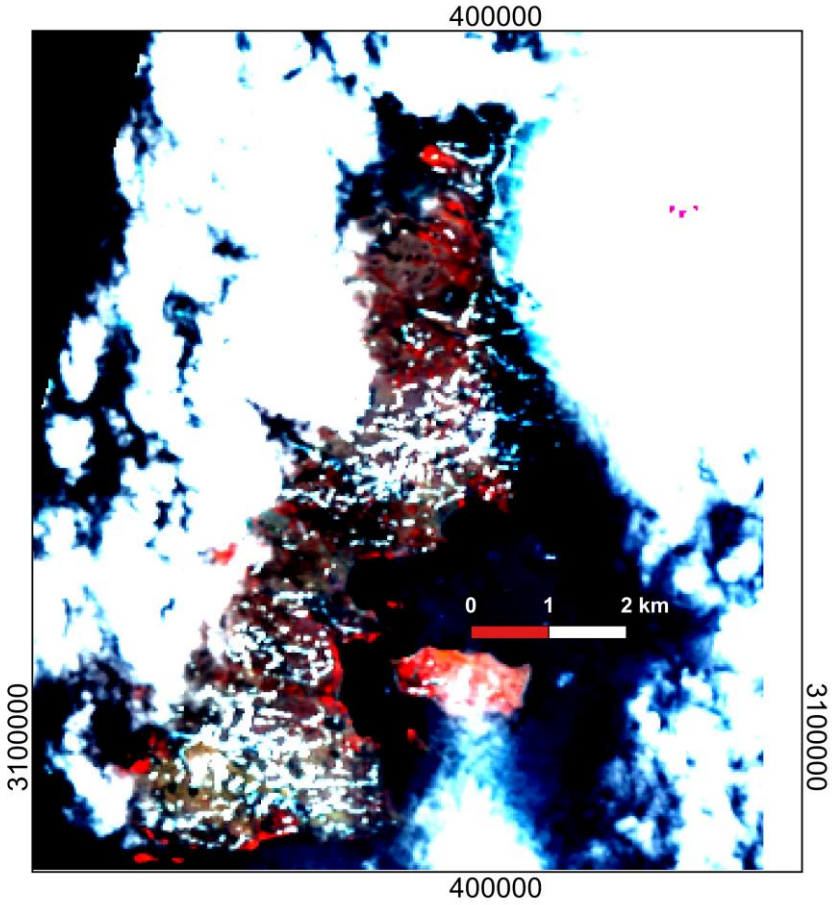
Field and multispectral data (18/02/2017)

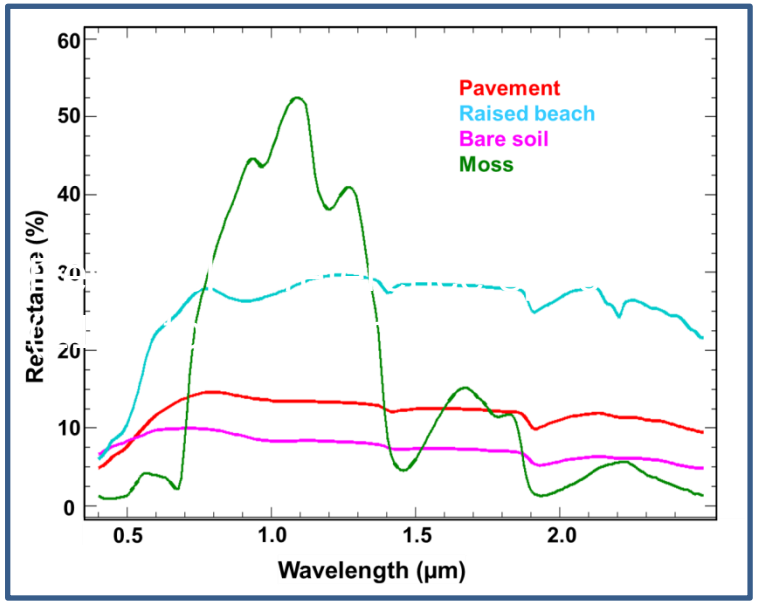




Schmid, T., et al. 2021. Characterizing the Ice-Free Area of Cierva Point (Antarctic Peninsula) Using Reflectance Spectroscopy, 2021 IEEE International Geoscience and Remote Sensing Symposium IGARSS. IEEE, pp. 6178-6181.

High spectral resolution data





1) Fine distribution of surface covers

2) Ongoing work to monitor changes

Conclusions

- The site specific information and the compilation of a spectral library of the Northern Antarctic Peninsula region (NAPSPEC) is considered important when working with remotely sensed data from the VISNIR range.
- When studying soils in this region, a minimum terrain stability and environmental conditions allow a moderate evolution of the surface covers with soils and vegetation.
- Climatic conditions pose a challenge to obtain spectral measurements under natural conditions.
- Sun altitude angle is an important issue and field spectral measurements are necessary to calibrate/validate satellite data.
- Present and future hyperspectral sensors will enable a continuous monitoring to detect the impact of climate change and human activities.

Acknowledgements

- This work is supported by the Projects CTM 2014-57119-R and RTI2018-098099-B-100 of the Spanish R&D National Plan.
- Spanish logistic personnel and the support provided by the Antarctic Programmes of Argentina, Chile, Korea, Spain and Uruguay.

Thank you