Land surface temperature and land surface air temperature measurements on the ice cap of King George Island, West Antarctica

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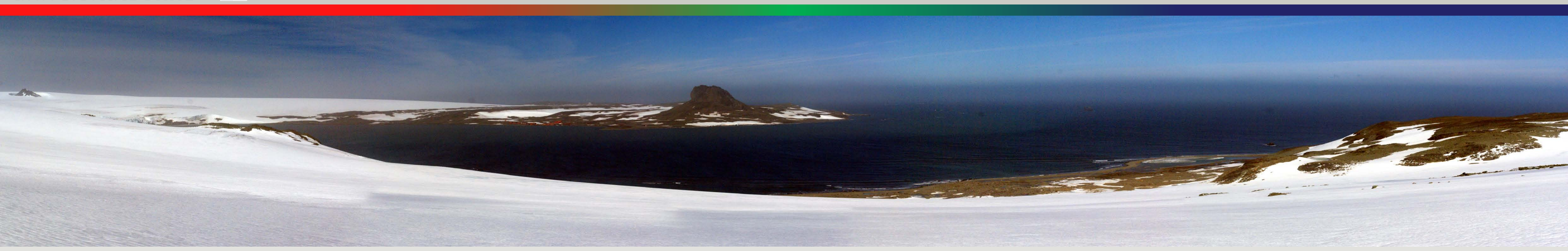
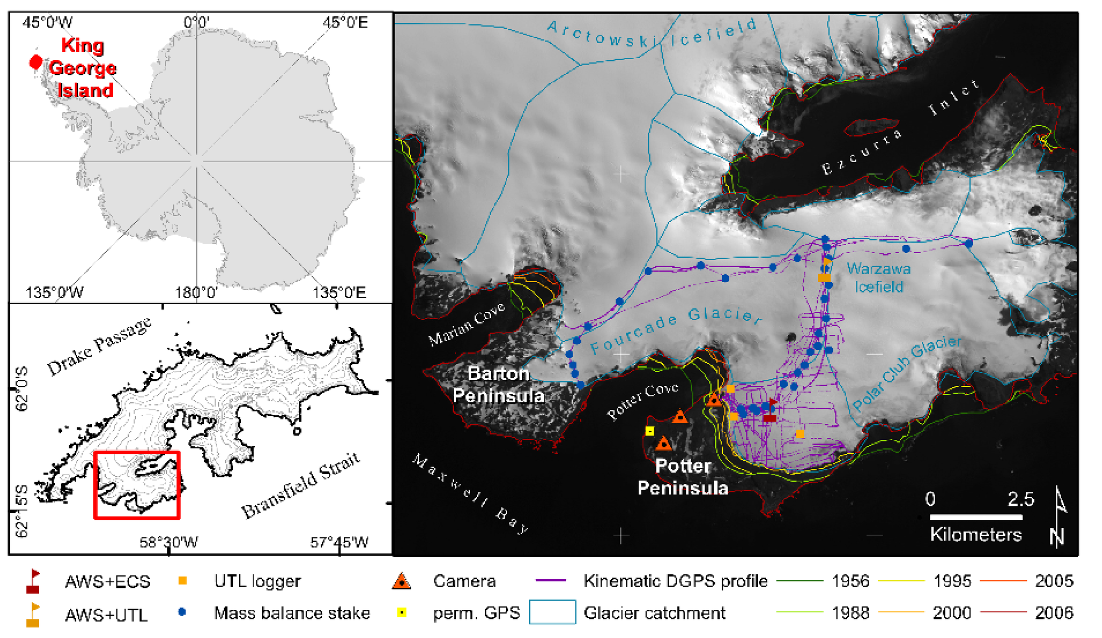
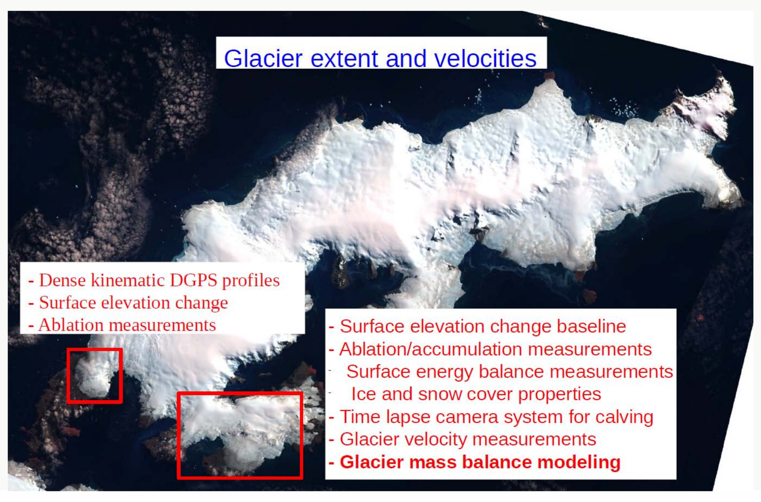


Motivation

Data of the Western Antarctic Peninsula (WAP) ice fields remains little until today, although this region represents a key area of rapid on-going climate change. Within the past 50 years a rise in average annual air temperature of 2.5°C has been reported for the region (Cook et al., 2005). Melting processes represent an important component of mass loss from the polar ice sheets. The understanding and quantification of these processes is crucial to predict future cryospheric response to climate forcing, and consequent sea level raise. Changes of the glacial runoff system have direct impact on the coastal ecosystems, due to altering freshwater and sediment transports.

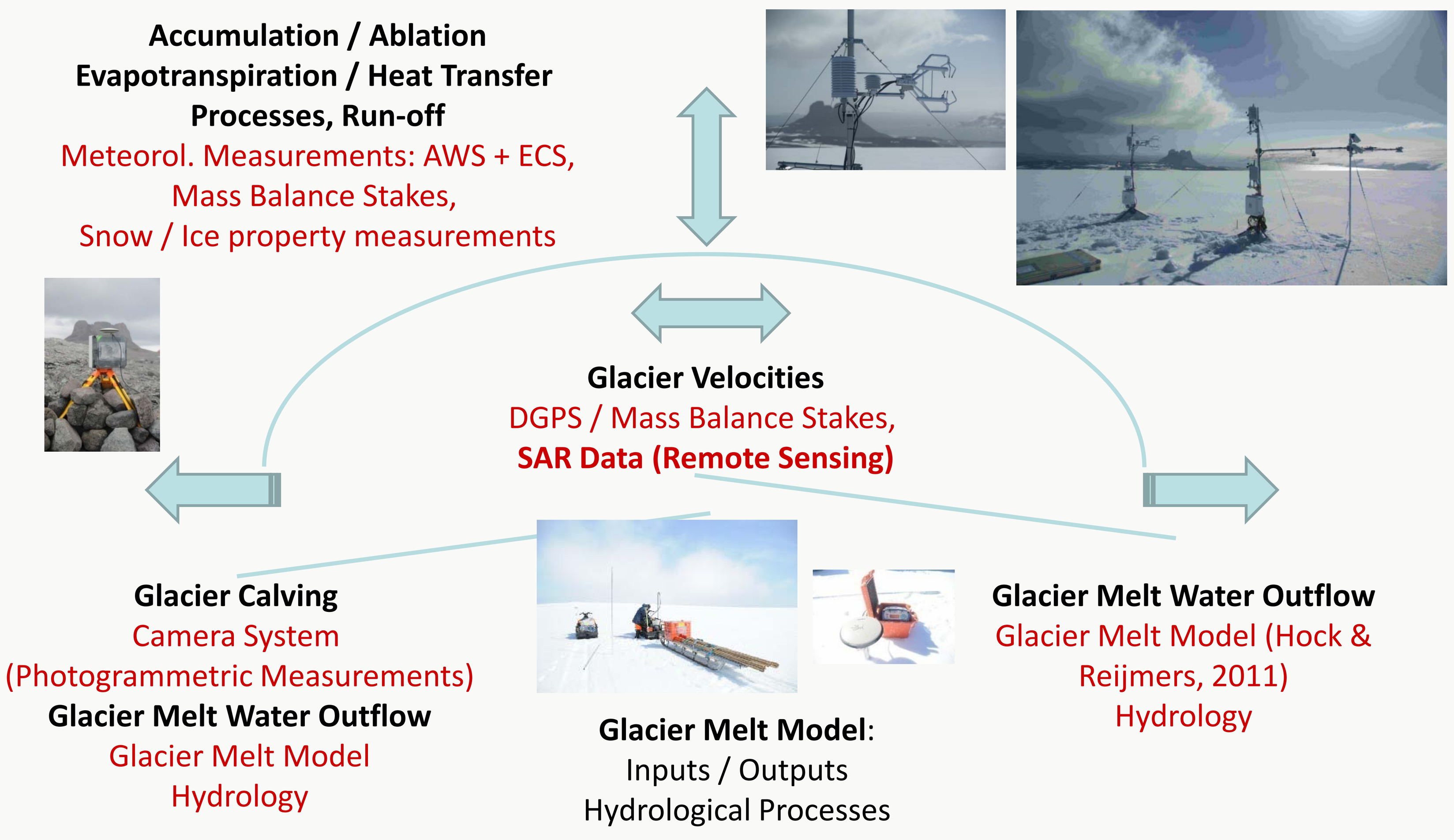
The ESF IMCOAST project (2010-2013) investigates the impact of climate induced glacial melt on marine coastal systems in the Western Antarctic Peninsula region.



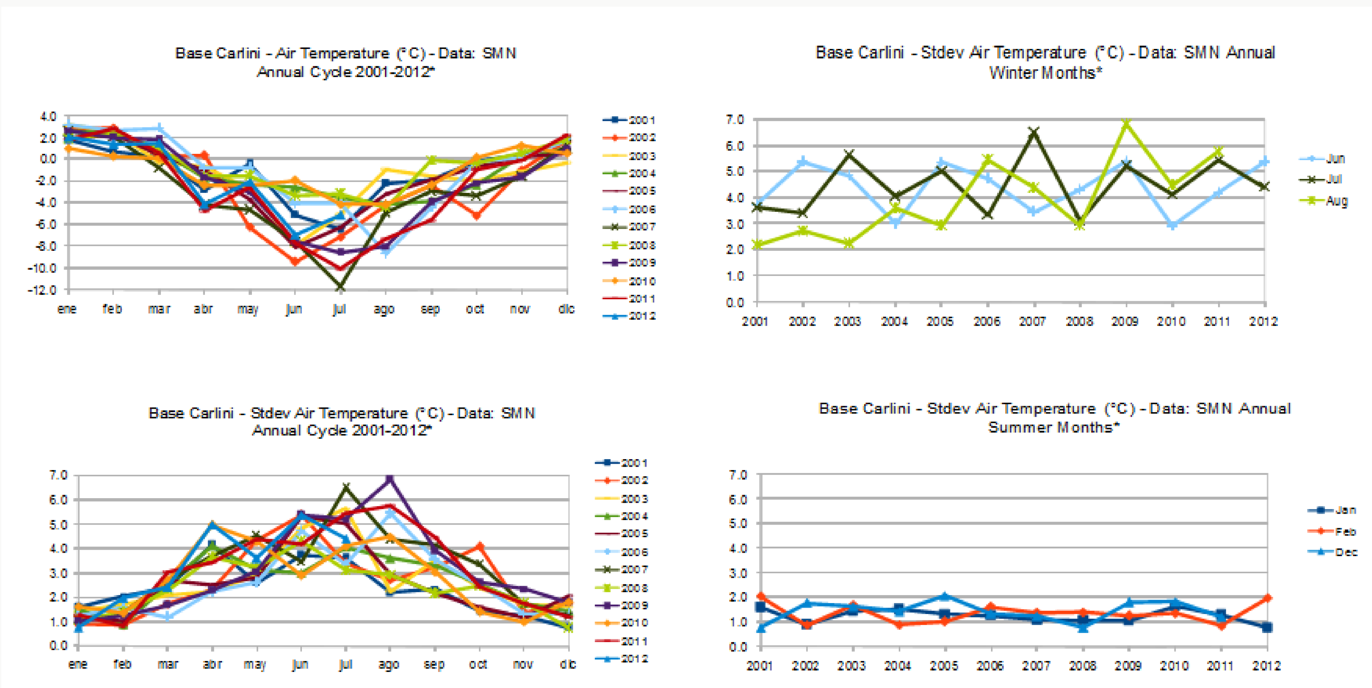


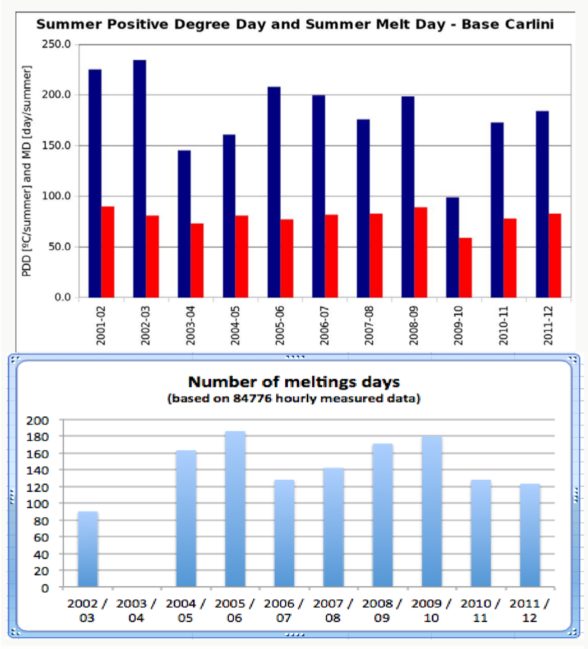
King George Island, WAP. Red square indicate special research sites of sub project IP-2 within IMCOAST. Background image: SPOT satellite image mosaic (© Eurimage, 1995/2000). Installations (starting Nov 2010): AWS: Automatic Weather Station and Turbulence Measurements; CAM: photogrammetric system; blue dots: Mass Balance Stakes; purple lines: Differential GPS Transects.

Glacier Mass and Energy Balance

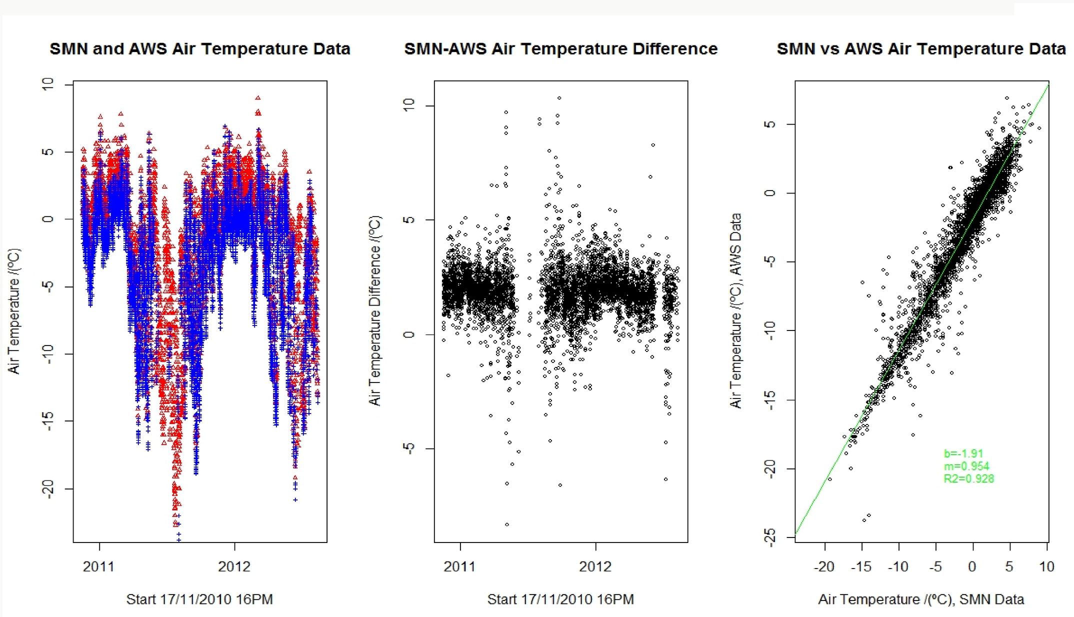


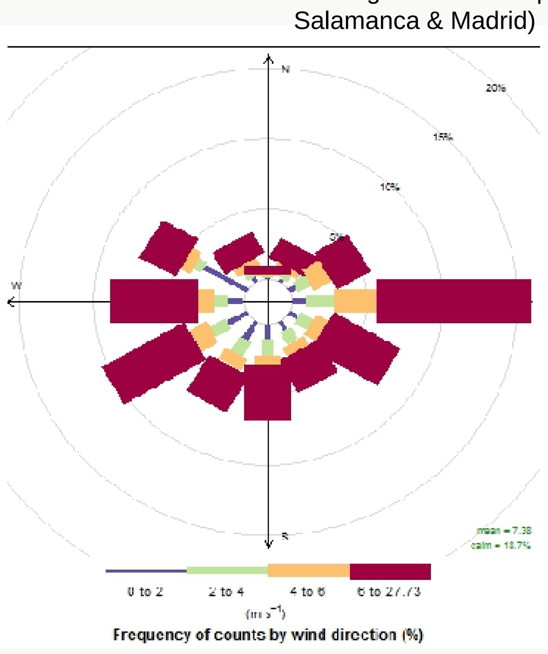
In-situ observations in the ablation zone of Polar Club and Fourcade Glacier



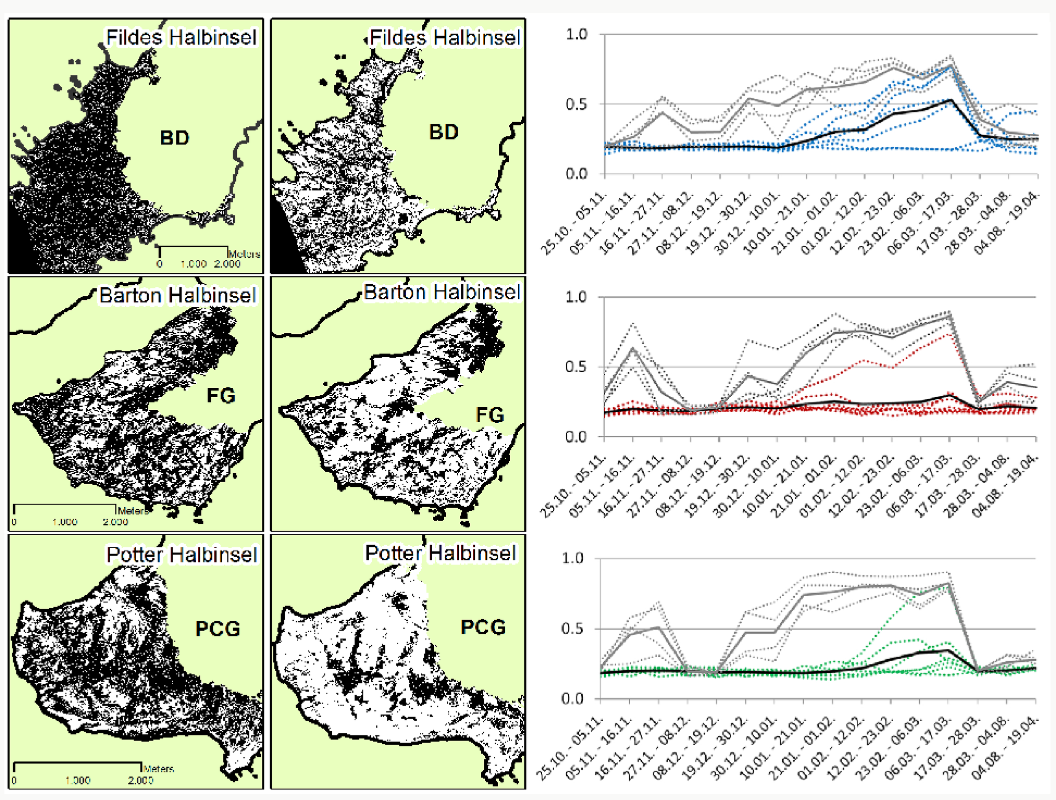


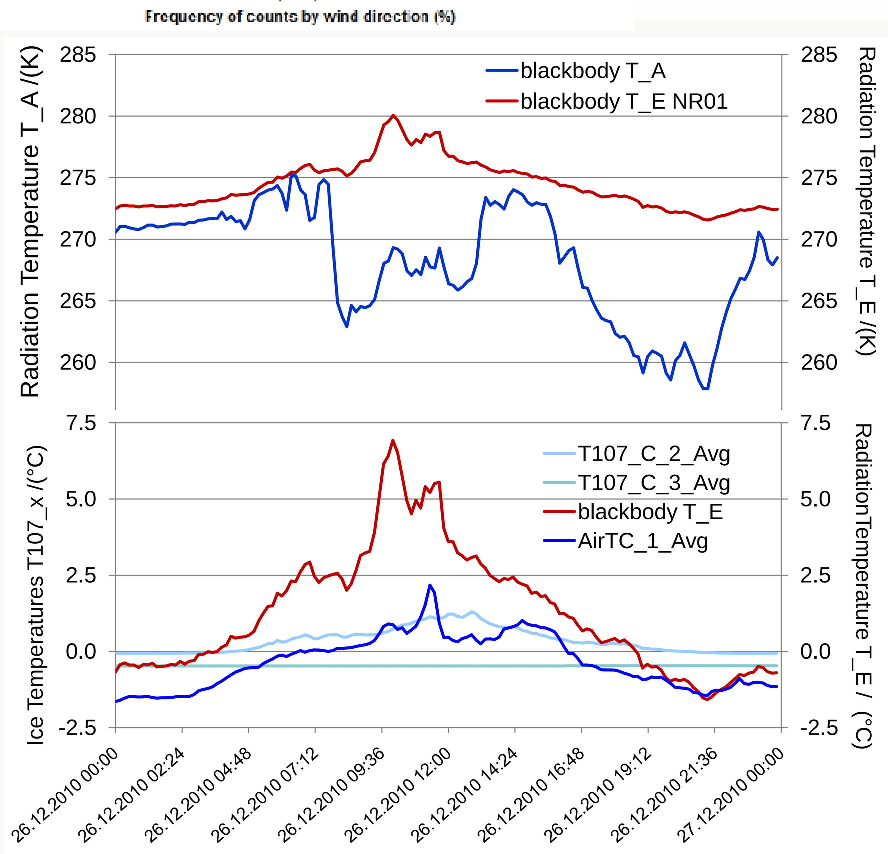
Hydrological data time series from Carmen Dominguez & Adolpho Eraso (University of Salamanca & Madrid)



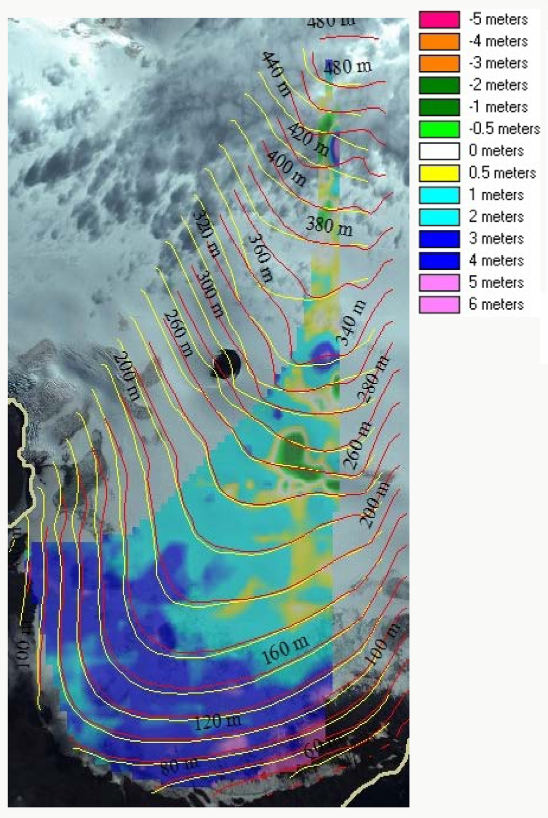


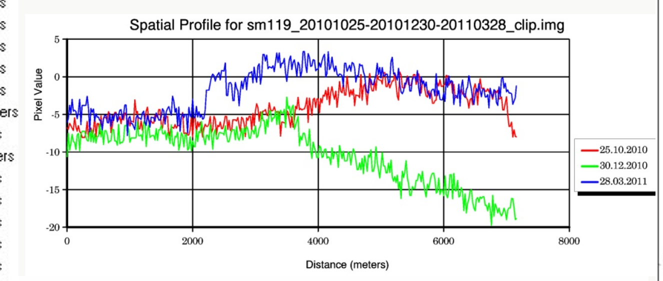
Automatic weather and turbulence station with DGPS measurements



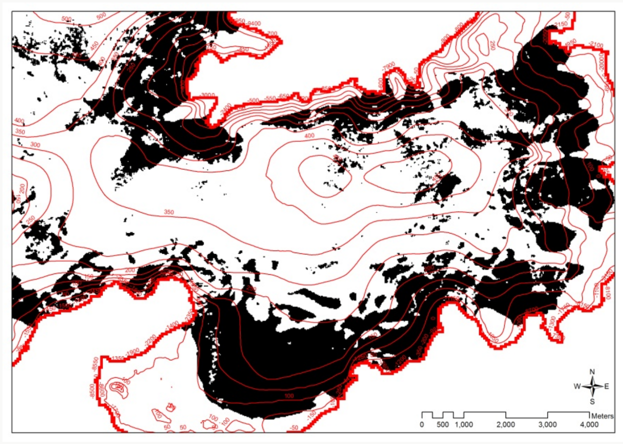


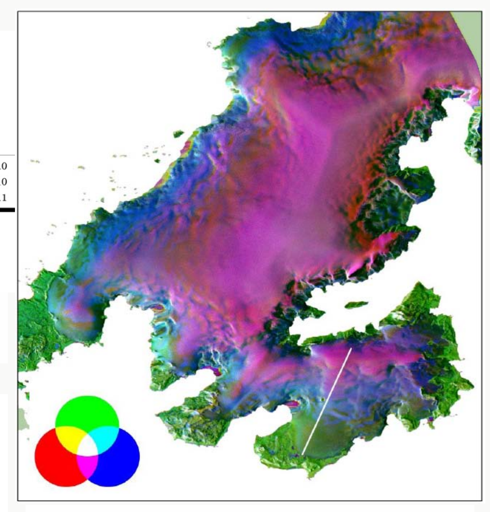
Glacier zones mapping from Differential GPS multi-temporal SAR data





Snow facies mapping for TSX SM 28.03.2011, resolution 20m. Aper glacial zones in black (intensity threshold <-2.5)





RGB – Composition of TSX StripMapMode (SM) intensity data 119 20m resolution , dates: red: 25.10.2010 (beginning of summer/ snow melt); green: 30.12.2010 (summer/ advanced snow melt); blue: 28.03.2011 (beginning of winter/ ablation and accumulation zones distinguishable). Intensities along transect (white line): upper left figure.

The Equilibrium estimates (dividing the glacial accumulation and ablation zones) from TSX glacier facies mapping is at ca. 250m compared to ca. 300m from DGPS measurements. Estimates from Braun et al. for 1995 are at 150m elevation.

Results and Conclusions

A collection of many different and large data sets: meteorological and micrometeorological data, measurements of mass balance stake transects, differential GPS measurements for surface elevation change and glacier velocities, differential GPS measurements for calibration and validation of remote sensing analysis, hydrological data for validation of glacier melt model output. The calving front of the Fourcade Glacier was determined to be 5.2 km wide and 60 m high in average. Calving rates were estimated to 4 m3 d-1 per meter glacier front length with an uncertainty of 25%.

During austral summer, air temperatures are often positive and close to 0°C. Winter air temperatures go up to 7°C, showing that melt also occurs in the austral winter. Precipitation occurs often in form of rain accelerating melt processes. Hydrological and glaciological processes are often at the triple point of water. The occurrence of water in all three phases and the exposure of the inland glaciers to mesoscale atmospheric circulation makes this research site unique for Antarctica. Glaciological and hydrological processes are clearly driven by mesoscale circulation.

Within IMCOAST, we studied the relationship between water discharge and air and surface temperature and the response of glacier melt to different weather conditions. There is a significant relationship between precipitation / air temperature and glacier melt, and also a positive feedback of glaciological changes due to warming and remote effects of teleconnection indices (SAM and ENSO)

Observed changes in intra- and interannual patterns of air and surface temperatures as well as total amount of precipitation and melt processes indicate a change in mesoscale circulation.

Observed ice temperatures show that data need to be corrected for radiation errors. Meltwater on the glacier surface and above-zero air temperatures lead to overestimation of observed radiation fluxes, as well as in the remotely sensed Infrared camera systems (daytime average 2.65°C). LandSAT and MODIS cover the research area, but due to high cloud coverage, intercomparison data has low temporal coverage.

Acknowledgements:

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