Using Unmanned Aerial Vehicles (UAV's) to model landscape features in Western Dronning Maud Land, Antarctica.

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Introduction

Antarctica contains 90% of the world's ice, has the highest mean elevation at 3000m and has the lowest mean annual air temperature at -40^{0}C[1]. An ice mass this large yields influence global atmospheric and cryospheric systems, however, there is a lack of information the permafrost side of the cryosphere[1, 2]. Permafrost is one the controlling and driving factors of Antarctic terrestrial ecosystems[2,4]. Due to the exceptionally large area of Antarctica which is mostly covered by ice, there is a lack of aerial photographs which makes it difficult for mapping features. Landscape features found include: heaving and sorting of sediments, contraction crack polygons, circles, steps and stripes[5].

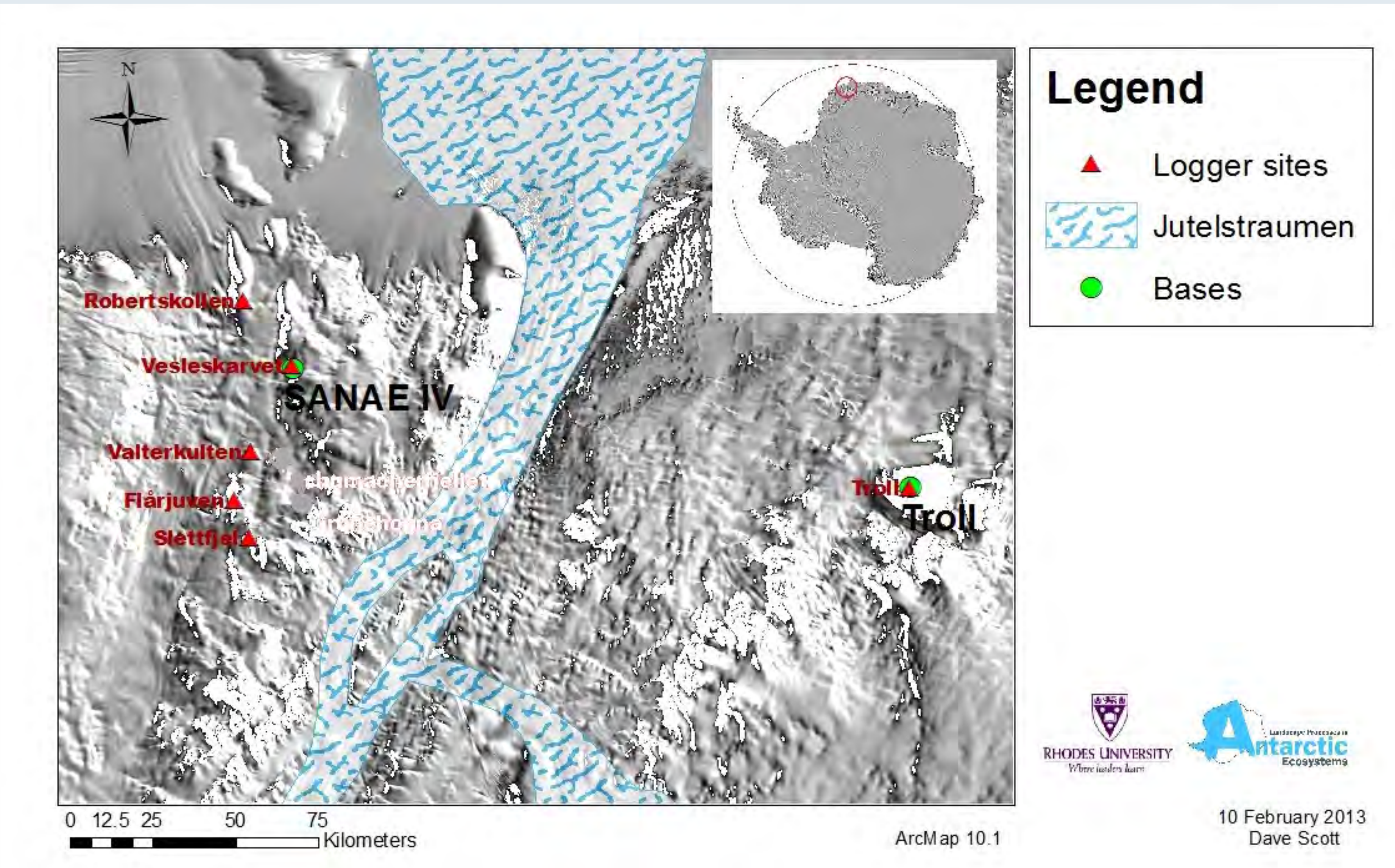

Figure 1: Map showing the six study sites in Western Dronning Maud Land, Antarctica.

Aim

To investigate and document the environmental processes and landforms on specific nunataks in Western Dronning Maud Land (WDML), Antarctica.

Objectives

- Set up baseline data for future studies.
- Measure air temperatures, ground temperatures and ground soil moisture at the six study sites.
- Determine the depth of the active-layer.
- Develop and utilise new technologies to document landforms.
- Develop an inventory of active-layer and permafrost landforms.
- Build DEM's for the study sites.

Figure 2: the UAV at work (photos by R. Dwight).

Methods

1. Ground and air climate recording by data loggers.
2. Using Aerial photography to map the landscape - to document this, a UAV was built.
   - Create inventories of landforms.
   - Create baseline data for looking at longer term processes.
   - Evaluating a new method for landscape analysis in WDML.

UAV

A camera was mounted to the UAV facing directly downwards and set to one second time lapse interval. The UAV was flown in a grid pattern and at a reasonably slow speed in order to get at least 60% overlap in every adjacent photo (Fig. 3).

The photos are stitched together through the process of Aerial Triangulation (AT) which involves optimally piecing together a block of overlapping aerial images such that you can create a map[3]. The objective is to determine the position and orientation of each image in a mapping frame (exterior orientation parameters) which allows for measuring positions of every object in the block[3]. The program will tie together pixel correlation using features which are common in overlapping images (e.g. the corner of a building)[3]. In addition ground control points were captured with high accuracy GPS coordinates. The Agisoft software makes use of all this information to create a georeferenced 3D model of the landscape in study (Fig. 4 and Fig. 5).

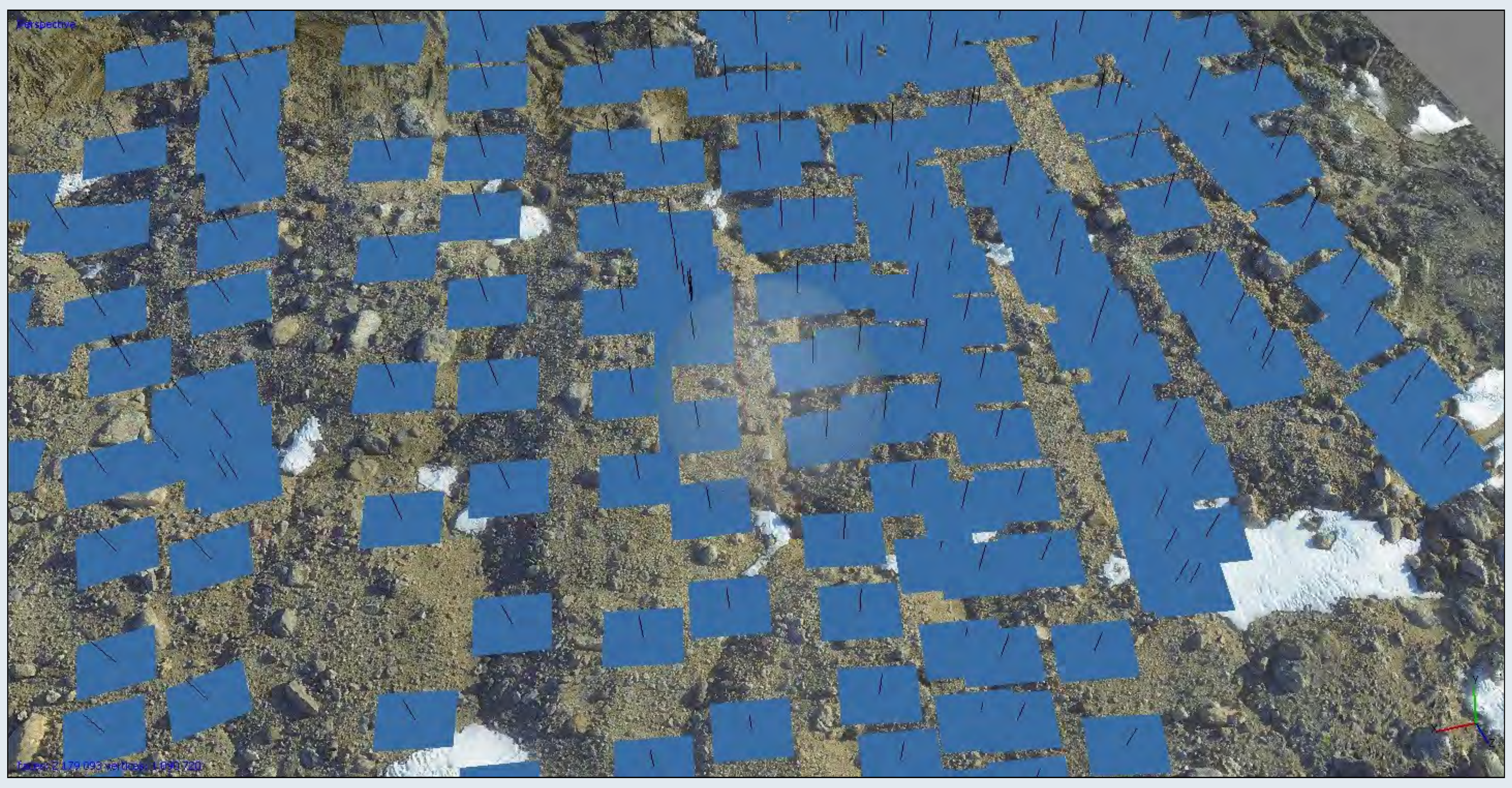

Figure 3: Flight path grid pattern flown by the UAV over a polygon field at the Troll study site.

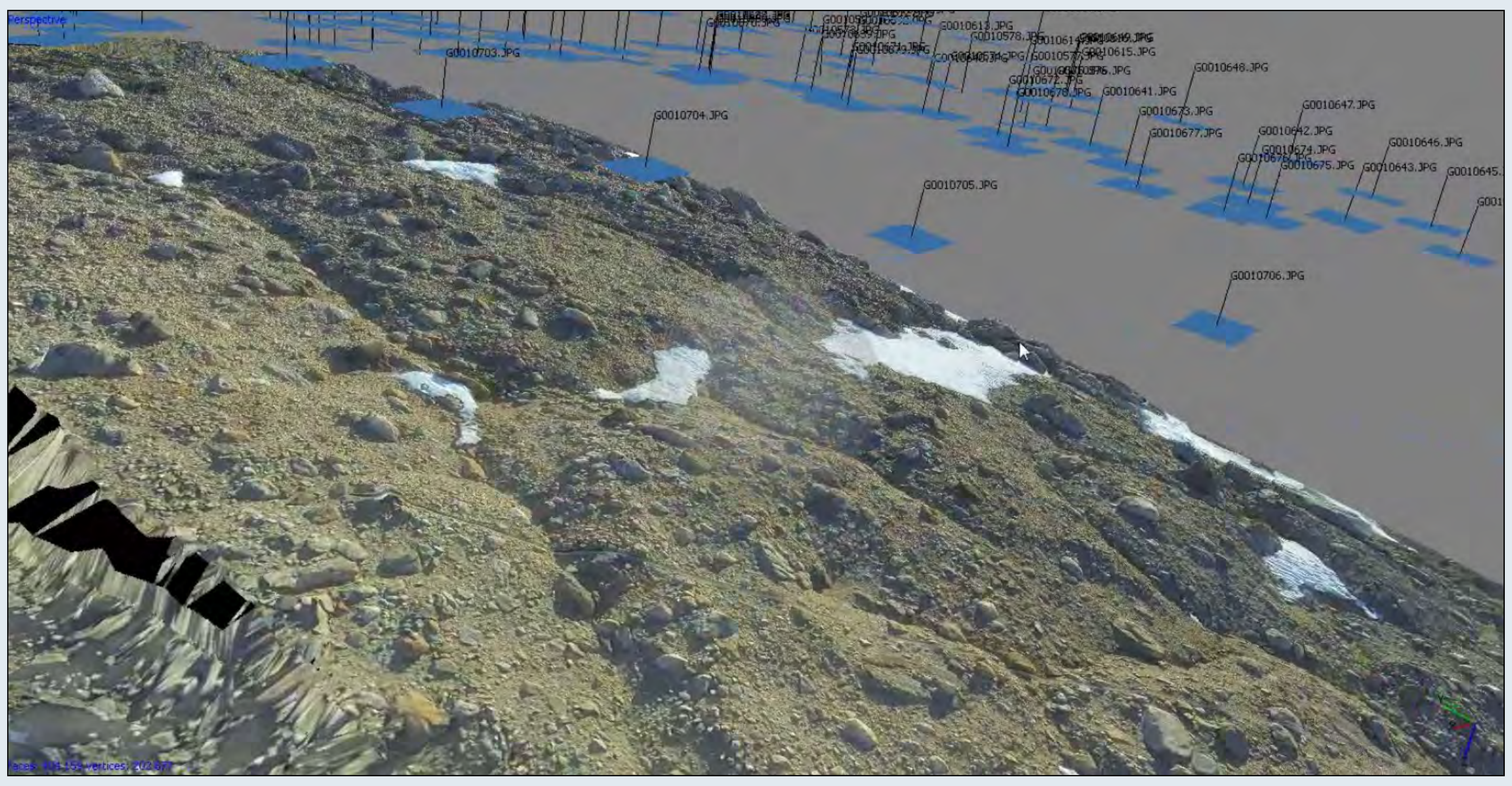

Figure 4: 3D model of the Troll study area created in Agisoft each photo's position is illustrated by a blue rectangle.

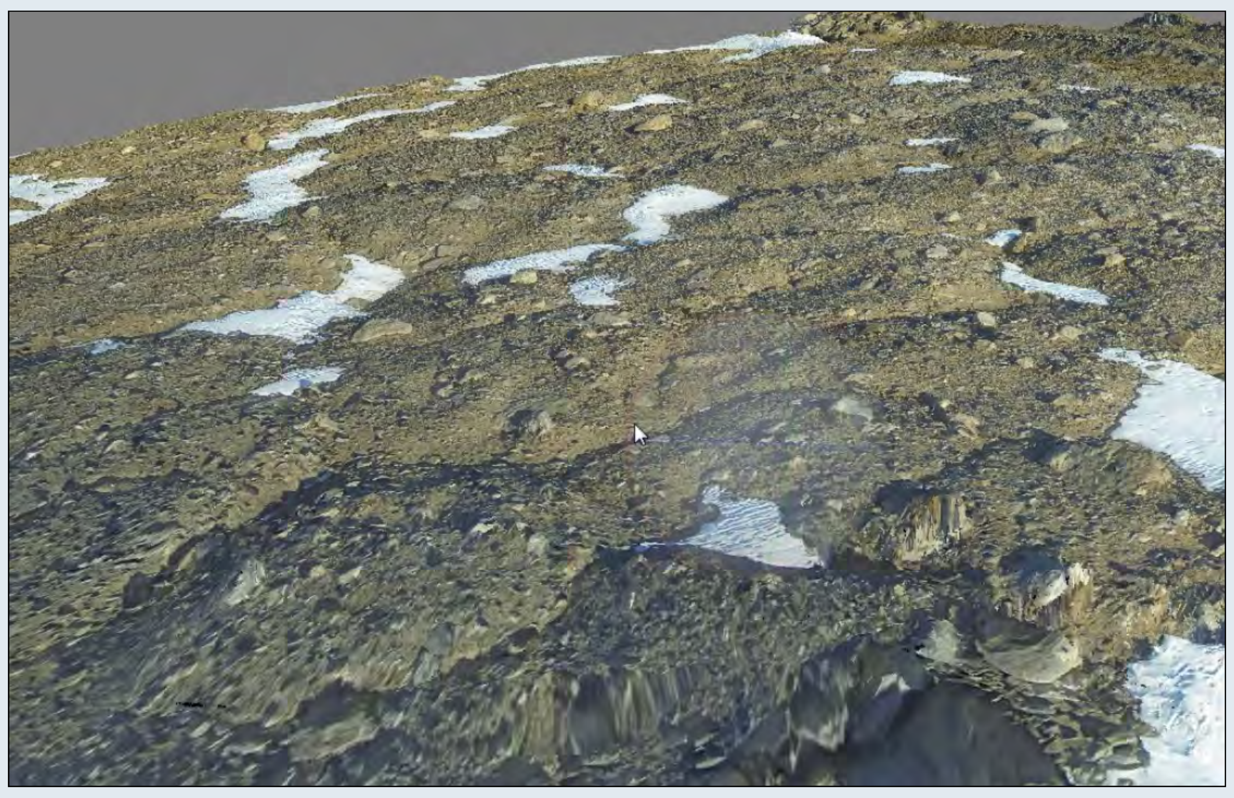

Figure 5: 3D model of the Troll NE study area created in Agisoft .

Conclusion

Due to time constraints on field studies in Antarctica models such as in Fig. 4 and Fig. 5 allow for post fieldwork studies to be done at a desktop level and is an excellent form of baseline data for future studies in this field. It is recommended that these techniques be used in future studies and for similar projects around the globe.

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