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Long term variations in the surface hydrology of the Greenland ice margin, Kangerlussuaq area

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Drainage pattern

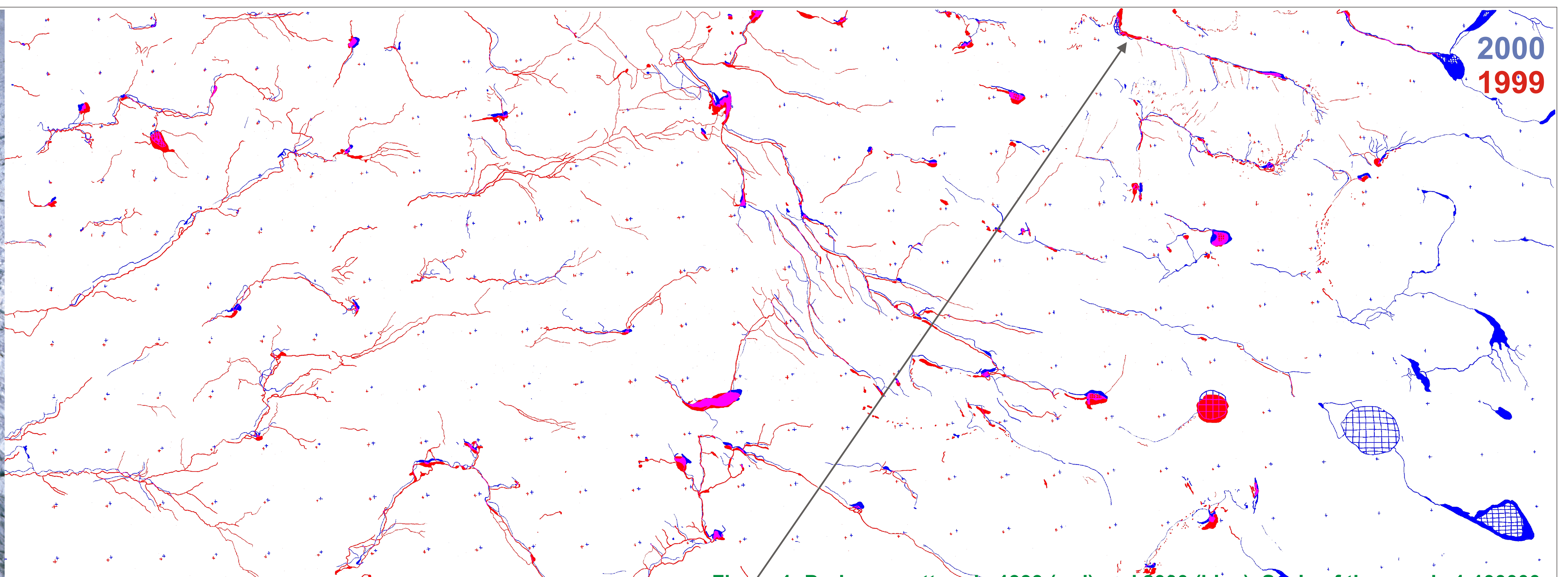
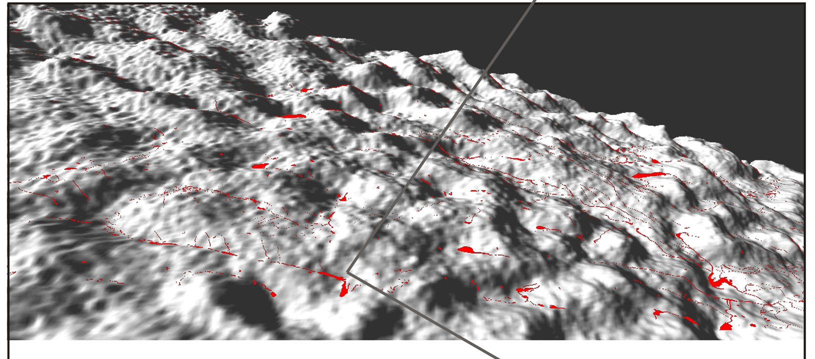


Figure 1: Drainage pattern in 1999 (red) and 2000 (blue). Scale of the map is 1:100000.

Introduction

The energy balance in the Arctic is to a large extent dependent upon the surface albedo. Since water has lower albedo than ice, which again has a lower albedo than snow, a positive feedback exists between melting processes and the energy balance. A positive change in the energy balance will initiate increased melting. This will lead to increased uptake of energy at the surface and even more melting. An example is the melt water lakes formed in the Greenland ice margin and on the arctic sea ice during summertime. In existing energy balance models for land and sea ice only resulting seasonal variations in the albedo are accounted for. This project tries to answer questions such as: How large an area of the ice margin and of the sea ice is covered by lakes? How do the lakes develop during the melt season? What is the importance of the lakes for the energy balance? How well can the evolution of the lakes be modelled? How will the feedback mechanisms influence the melting processes induced by a possible climate change?

In order to model the development of the lakes in the Greenland ice margin one has to know to which extent the drainage pattern and the lakes are controlled by topographic features. This study compares drainage data from 1958 to drainage data from 1999 and 2000. All the data is compared to a digital elevation model (DEM). The area investigated is located on the western Greenland ice margin between 67.12 - 67.30 N and 50.05 - 48.35 W.



Digital elevation model overlaid by 1999 drainage data (red). The scene is seen from the north and the vertical scale has been multiplied by 50 compared to the horizontal scale.

Data

The 1958 map is based on areal photographs from July 22, 1958. Altitude of aircraft: 4500 m. (Bauer et. al., 1968). The map is shown in figure 3 in green.

The 2000 map is based on a Landsat 7 image. August 23, 2000, 14:40:02, Path 7, Row 13. The map is shown in figure 1 and 2 in blue.

The 1999 map is based on a Landsat 7 image, August 28, 1999, 14:48:10, Path 8, Row 13. The map is shown in figure 1 and 3 in red. Both the 2000 scene and the 1999 scene were resampled to a UTM Zone 22 projection. The maps were drawn from 1:50000 printouts of the scene and digitalised. The crosses seen on the maps are fix points used in the creation of the maps. In theory the crosses should match exactly and when mismatching (figure 1) it indicates the inaccuracy of the maps.

The elevation map is produced from ERS1, October 20, 1995, orbit 22300; ERS2, October 21, 1995, orbit 02627; ERS1, December 29, 1995, orbit 23302; ERS2, December 30, 1995, orbit 03629 data. Relative accuracy is a few metres and the absolute accuracy between 10 and 50 metres. The map has been calibrated by use of control points and the other maps have been geometrically adjusted to the elevation map. (Mohr, J., pers. comm., 2002)

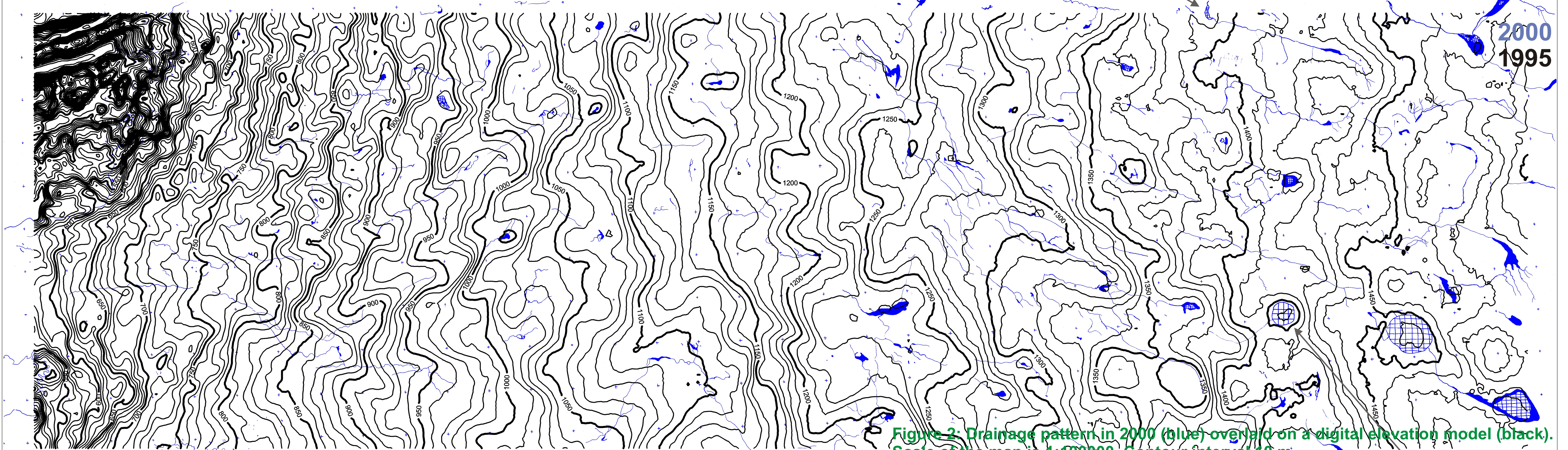


Figure 2: Drainage pattern in 2000 (blue) overlaid on a digital elevation model (black). Scale of the map is 1:100000. Contour interval 10 m.

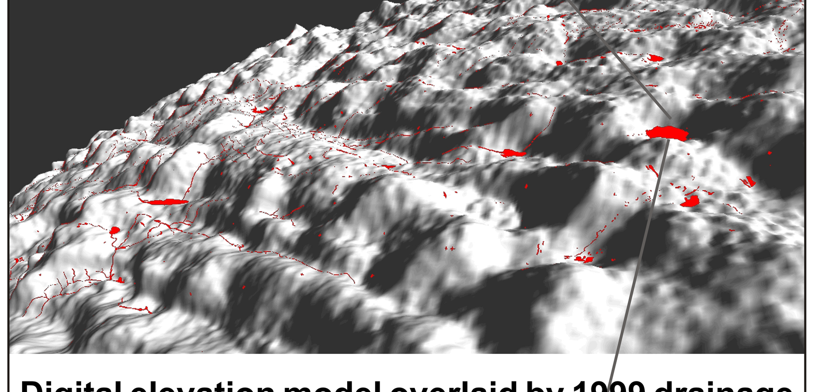
Results

By comparing the observed drainage pattern in 1999 to the one observed in 2000 only small changes are found (figure 1). The general pattern is the same within the estimated error. Fewer rivers were observed in the year 2000 and some of the lakes were covered by ice. The comparison of the 1999 map to the 1958 map gives very much the same result (figure 2). No general changes are observed during the 41 years period except that two of the easternmost lakes are missing and that the front of the ice margin appears to have retreated by around one 1 km. Figure 3 compares the drainage pattern in 2000 to a DEM. The lakes are found in suppressions and the rivers run around 90 to the contour lines as expected.

Conclusion

From the analysis we conclude that the surface hydrology in the investigated area is controlled by the topography and is more or less constant from 1958 to 2000. Since the drainage pattern is controlled by the topography, the topography of the area must have changed only slightly.

Further investigation will address to which extent the lakes influence the energy balance.



Digital elevation model overlaid by 1999 drainage data (red). The scene is seen from the south and the vertical scale has been multiplied by 50 compared to the horizontal scale.

Partly frozen lake

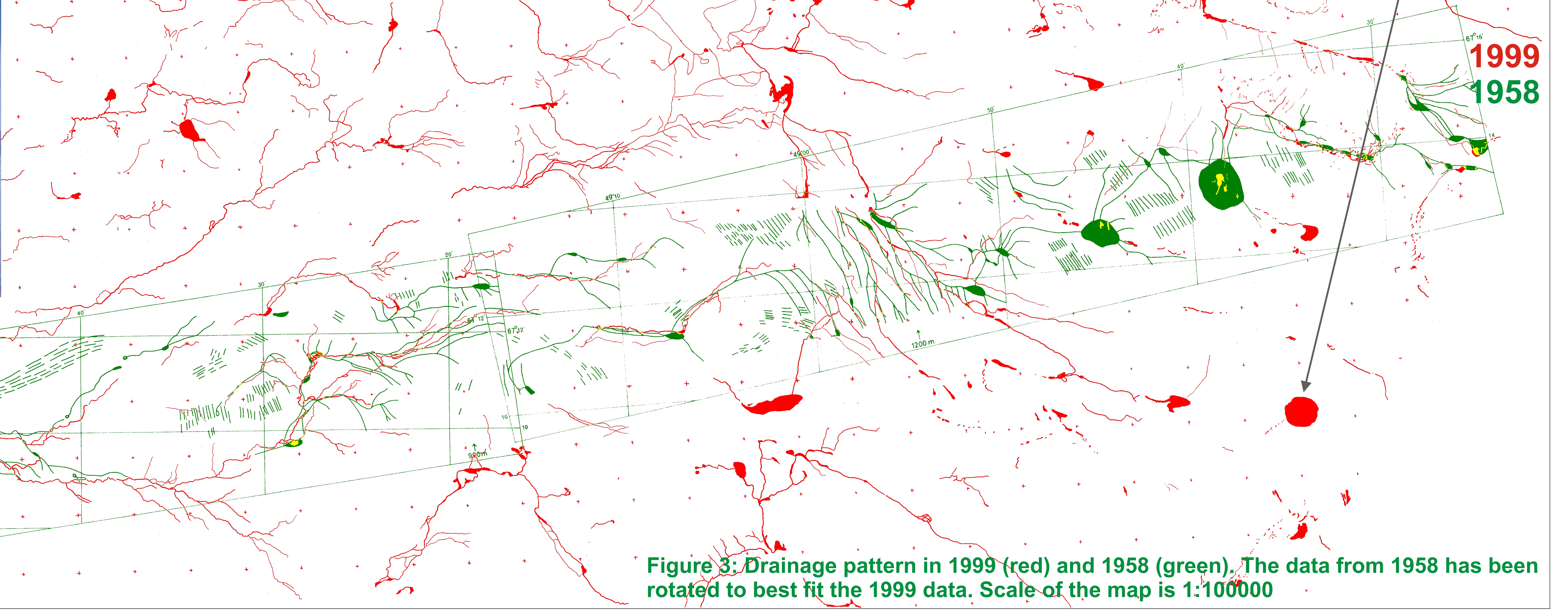


Figure 3: Drainage pattern in 1999 (red) and 1958 (green). The data from 1958 has been rotated to best fit the 1999 data. Scale of the map is 1:100000

Reference:
Bauer, A., Baussart, M., Carbonnell, M., Kasser, P., Perraud, P. & Renaud, A. 1968: Missions Aériennes de reconnaissance au Groenland 1957-1958. Meddr. Grønland 173(3), 116 pp.

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