

FRINGE 96

Glacier flow measurements in Spitsbergen, Svalbard, from differential interferometry

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Abstract

The work was supported by the ESA under a contract with Matra CS.

Interferometric pairs have been obtained at CNES from a combination of 3 ERS-1 scenes recorded over the alpine relief of the north eastern Spitsbergen at the end of the ablation period in September and October 1991. The Norwegian Polar Institute provided a DEM based on maps at a scale of 1/100 000 and constructed from air photographs. Two differential interferogrammes have then been obtained by removing the fringes due to elevation and orbital trajectories. The residual fringes are due to ice movements over 6 and 9 days respectively and a third interferogramme over 3 days was obtained by difference of the two previous one. The result provides number of glaciological information and the possibility to determine the ice flow velocity over a number of glaciers.

I: Exemple of general information obtained from fringe morphology: a) precise determination of ice-divides and information about the relief of the subglacial bedrock; b) in many case, deduction of the main flow line; c) detection of stagnant or near stagnant ice; d) concentric and elongated fringes indicate an increasing then a decreasing ice velocity along the glacier basin. The phenomena occurred when a tributary join a glacier with a lesser ice velocity and may also be linked to the topography. On valley glaciers ending on land such fringes reflect also the subpolar nature of the glacier with a cold and near stagnant ice overlying the permafrost at the front, leading the decrease in velocity; c1) the altitude of the higher velocity (and of the center of the concentric fringes) is a relevant information about the glacier. As an exemple, the altitude of this point on two neighbouring glaciers, the "D'arod" glacier and the "Quatorze juillet" glacier is 350 and 500 m a.s.l. respectively; c2) the relative wideness of the fringes indicate that there are various velocity transverse profiles among glaciers as well as along a given glacier.

II: Ice velocities over number of glaciers: a) as exemples, the two above mentioned "D'arod" and "Quatorze juillet" glaciers flowing almost facing the satellite track, reach a maximum velocity of 56 mm and 66 mm per day. Such velocities are within the range of velocities expected from similar Svalbard glaciers; b) a differential velocity equivalent to 150 per year over 8 kilometers on the Monaco glacier seems to confirm the detection (from a previous work on coherence) of the early phase of a surge which was actually observed one year later. c) clear fringes are present all over the Holtedahlfonna, one plateau feeding the Kronebreen, the most active and calving glacier in Svalbard. These fringes allow to monitor the ice flow over the main part of the basin. Along the main flow line, the velocity increase from 15,6 cm per day at 29 km to the front in the main accumulation plateau to 28,5 cm per day at 22 km to the front and to 55,7 cm per day at 15 km to the front. Then, there are no visible fringes and lack of coherence (from there to the front are large crevasses and high velocity). Previous work indicates a mean annual velocity of 2 m per day at the front, the obtained velocity is then coherent with the ice velocity at the front and provides essential information about the ice dynamics and the balance of the glacier. In order to validate the result, three stakes were settled in the basin in May 1996, the coordinates were recorded by GPS technique. The positions will be recorded again this autumn and during the next spring season.

Keywords: