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SNOW COVER SURVEYS IN ALASKA FROM ERTS-1 DATA

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ABSTRACT

September and October ERTS scenes have been analyzed to delineate snow cover patterns in Northern Alaska's Brooks Range and on Mt. Wrangell, an active volcano in South Central Alaska.

ERTS images demonstrate that the snow on the Northern foothills of the Brooks Range are significantly more affected by katabatic wind action than are the Southern foothills. Aufeis deposits along arctic rivers also can be identified in late summer. A survey of such aufeis deposits could identify additional summertime sources of fresh water supplies.

Images of Mt. Wrangell enable us to monitor the interaction between volcanic heat and the mass balance of glaciers that exist on active volcanoes. Temporal changes in the areas of bare rock on the rim of the caldera on the summit reveal significant melting of new snow from an extensive storm on August 18. Digital analysis of data from subsequent passes over the summit on September 7, 23 and 24 reveal considerable bare rock exposed by melting, which is virtually impossible from solar heating at this altitude and date.

INTRODUCTION

This report contains a brief description of two of three University of Alaska projects dealing with ERTS applications to studies of snow and ice in Alaska. One project is titled "Survey of the seasonal snow and ice cover in Alaska", and the other is "Glaciological and volcanological studies in the Wrangell Mountains, Alaska".

The build up of the seasonal snow cover was observed on the images obtained in September and October 1972. The sharp climatic boundary of the Brooks Range was especially evident. The distribution of snow by winds can be seen in the first snowfalls. This is especially true when the snow does not cover the entire region. An excellent example is provided by the images from the arctic on 12 September 1972. The images 1051-20595 and 1051-21002 show the Brooks Range with snow on hill tops but with more snow on the North than on the South foothills. Also, the Northern foothills are significantly more affected by wind action. South of the Brooks Range the snow lies in a relatively undisturbed state on the higher ground.

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In sharp contrast to this, the snow on the North slope of the Brooks Range is drawn out into long windswept patterns. The drainage of katabatic winds down major stream valleys is evident. The winds channeled by topography redistribute the snow and actually remove it from selected regions. The problem of determining snow line altitude is especially complicated because of winds in the Brooks Range, and also because the snow line paridly descends to sea level in early October. In the Alaska Range the Chugach Range we are beginning to employ the area integration approaches developed and reported by Mark Meier, USGS.

Aufeis deposits on arctic rivers can be identified in the late summer and early fall. This gives us the possibility of making an inventory of the aufeis deposits which persist through the summer season.

After freeze up has occurred and a continuous snow cover exists, it is still possible to identify open water reaches on streams flowing through the region. Such cases are especially identifiable on the MSS 7 images.

The purpose of the glaciological and volcanological project is to study the interaction between volcanic heat and the mass balance of glaciers existing on active volcanoes. It may also be considered as one of the first steps in the general problem of observing geothermal phenomena by satellites, but a thermal infrared channel on ERTS B is essential for future geothermal studies.

In order to monitor the interaction between volcanic heat and the ice and snow cover of Mt. Wrangell, it is necessary that changes in the area of bare rock exposed by melting at the summit be observed. Our results to date indicate that this can be done. On image 1010-20331 (2 August 1972) areas of bare rock on the summit are clearly visible on 9½ x 9½ inch paper prints. The image 1026-20220 (18 August 1972) shows high, thin clouds over the summit being driven by southerly winds, which usually indicates a storm developing in the area. This was verified on image 1027-20275 taken the following day (19 August 1972) when the summit was under heavy clouds. Finally, on 20 August 1972, the third day of this sequence, the summit is again clearly shown. Visual inspection of the image was sufficient to show that the summit was entirely snow covered.

Subsequent clear weather satellite passes over the summit occurred on September 7 (1046-20332), September 23 (1062-20221), September 24 (1063-20273/1063-20280), September 25 (1064-20331), and October 12 (1081-20275/1081-20281). However, the sun angle during these passes changed from 31 degrees on September 7 to 20 degrees on October 12. This caused heavy shadows in the summit area so that bare rock could not be identified with certainty. As a result, we decided to investigate enhancement techniques which could be utilized to separate snow and bare rock in areas covered by heavy shadows.

Digital tape of one of the September 23 images was processed, and printouts of density levels (by pixel) over the summit were obtained from bands 5 and 7 of this image. These were partly contoured, so that the relevant areas could be located, and the densities in these areas were then examined. The results showed clearly that a significant variation exists in the densities within the areas of heavy shadow, which could not be observed on the photographic products and further that the darker localities coincide with the bare rock outcrops which were present prior to the storm of August 19.

The possibility that melting could occur from solar heating at the summit of Mt. Wrangell during September is virtually non-existent--we know this from our previous field work at the summit. Therefore, the removal of snow from the outcrops must, of necessity, be attributed to volcanic heat.

As a result of these studies, we believe that the ERTS data are adequate to supply the information needed to study the effects of volcanic heat on the melting of snow. The applicability of ERTS data to the study of the mass balance of the Wrangell ice cap is still under investigation. However, there is no doubt that it will be possible to assign a qualitative (i.e., positive or negative) value to the mass balance of each glacier flowing off the Wrangell Mountains, based upon the relationships between snow, firn and glacier ice at the end of the yearly melt season. Boundaries between these zones are visible on the ERTS images without enhancement.