

# ROYAL METEOROLOGICAL SOCIETY: AUSTRALIAN BRANCH MEETING

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## Very High Resolution Satellite Studies in the Arctic

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Mr Streten, of the Australian Numerical Meteorology Research Centre, commenced his talk by presenting a brief description of the climate and topography of Alaska, making use of maps and a number of magnificent colour photographs, most of which he had taken himself while a visitor at the Geophysical Institute, University of Alaska, in 1967-68 and 1973-74. He then went on to discuss the scientific program of the Geophysical Institute, and in particular those sections of the program which were concerned with applications of VHRR (very high resolution radiometer) data obtained from the meteorological satellites NOAA 2 and NOAA 3. This work was carried out under contract to the National Oceanic and Atmospheric Administration and followed on earlier studies by the National Environmental Satellite Service.

Though NOAA 2 was launched in October 1972, it was not until March 1974 that workers at the Geophysical Institute were able to obtain direct read-out of the VHRR data, using the read-out station at Fairbanks. For the earlier period they had to rely on data recorded on tape in the satellite and then played back for read-out at Wallops Island. There were some gaps in the VHRR coverage of the Alaskan region during this earlier period; these were not a great drawback in sea-ice studies (where the time-scale of significant changes is relatively large), but proved to be a big handicap in studies of cloud distribution. Mr Streten presented some slides showing examples of direct read-out VHRR imagery obtained at Fairbanks, using visible light in some cases, and infrared 'window' radiation in others. This imagery was of very high quality, a consequence of the high resolving power of the instrument; the sub-satellite resolution of the VHRR instrument being 1 km for both visible and infrared sensors, as compared to values of 4 km (visible) and 8 km (infrared) for the ordinary scanning radiometer.

Most applications of the VHRR imagery have been concerned with studies of variations in extent of sea-ice and of the continental snow-cover. These variations are of considerable interest in terms of modern theories of climate and climatic change. The sea-ice extent, in particular, is of great practical importance in the Alaskan region, where it is the primary factor in determining access by sea to the newly-discovered oilfields on the north slope of the Brooks Range. The direct read-out satellite data has proved very valuable as an aid to safe navigation in this area; the Canadian government is installing a VHRR read-out station in order, among other reasons, to provide sea-ice data to assist ships traversing the 'Northwest Passage' and other northern sea routes.

The VHRR imagery is also being utilised in the studies of important features of the sea-ice cover; in particular, of the elongated fracture zones which often appear in the western Arctic basin in late winter or early spring, and also of the large flaw-leads which are observed along the western coasts of Banks Island and other islands in the Canadian Archipelago. Mr Streten presented examples of VHRR imagery that clearly demonstrated the characteristics of these features and diagrams illustrating their rate of growth in relation to the mean intensity of the MSL atmospheric circulation.

Mr Streten then went on to discuss some meteorological applications of the VHRR imagery. He showed some examples of pictures in which cloud bands associated with the Arctic front were distinguishable, and used these to demonstrate that both the visible and the infrared imagery must be used in order to extract the maximum information from the VHRR data. The data is being used as the basis for a climatological study of the clouds associated with the Arctic front; the speaker pointed out that this front is a significant synoptic-scale feature in the northern hemisphere, but that there is no really equivalent feature in the southern hemisphere.

Another meteorological application of the VHRR imagery is the operational monitoring of summer thunderstorms over central Alaska. The imagery is used to detect large individual storms in wilderness regions. These are often 'dry' storms, and hence may originate bushfires. Aircraft then fly out in the early afternoon and check on these storms, and if a fire is present, they radio for 'smoke-jumpers' to come into action.

The final study discussed was one concerned with the development of small-scale convective clouds, *eg*, clouds forming during periods of significant advection of cold air over the Bering Sea. The clouds originally form in lines, with open cellular patterns developing as the air mass moves further downstream. The frequency of occurrence of patterns of this type reaches a maximum in spring, and again in early winter, with a well-marked summer minimum. This is a consequence of the seasonal variation in the difference between sea and air temperatures.

The diameters of individual clouds are often observed to increase downstream along a cloud line, and this rate of growth has been found to be a maximum in winter. Mr Streten also showed examples of the way in which orographic features can produce enhancement or dissipation of particular cloud lines.

In the discussion period following the talk, Professor Morton asked the first question, inquiring as to how the exact geographic location of features such as forest fires, or sea-ice fractures, could be determined. Mr Steten replied that the accuracy of the computed positioning of the imagery could be checked by examining the images of prominent coastal features, or lakes, mountains, *etc*. Dr Budd commented that it was possible to see more detail of the sea-ice structure in the visible imagery than in contemporaneous infrared imagery, and asked whether the resolution of both instruments was the same. Mr Streten replied that it was. Mr Ackley pointed out that in winter only infrared imagery is useful in higher latitudes. Dr Radok also took up the point and explained that the contrast between sea-ice and open water is most marked (in the infrared imagery) in the winter and early spring, when the temperature difference between the water and the sea-ice is largest. In summer, this difference may become relatively small; however, a good contrast is then obtained in the visible imagery, because of the contrasting albedos of the ice and the ocean.

Dr Zillman asked for an estimate of the cost of a VHRR direct read-out station; Mr Streten replied that it was about US\$250 000. Dr Pittock pointed out that orographic features may effect the development of cloud-lines more through the action of induced convergence or divergence rather than by direct mechanical interference with the airflow. Dr Gibson inquired whether the Arctic front was primarily a summertime feature; Mr Streten replied that this was so, and that cloud systems that could be directly associated with the Arctic front could not usually be differentiated in winter.

Mr Ackley commented that several of the photographs had displayed examples of the formation of a low deck of stratus over the sea-ice in summer, and asked if it was known what conditions were associated with the onset of this phenomenon. Mr Streten said that he was unable to supply this information.

Finally, Dr Zillman asked the speaker to comment on possible applications of VHRR imagery in the southern hemisphere. Mr Streten replied that there is no reason why this data should not be just as valuable in the southern as in the northern hemisphere. It is to be sincerely hoped that imagery of a similar quality will be obtained from instruments on the planned Japanese geostationary satellite. For detailed studies of phenomena in higher latitudes, data would have to be obtained from a polar-orbiting satellite. To get complete hemispheric coverage, a number of read-out stations would have to be set up. The United States Navy may install read-out stations at Christchurch and at McMurdo; the latter station would provide coverage of almost all of Antarctica. If the imagery were to be used operationally in Australia, some way of getting the data to Melbourne would have to be found. Even if this were not initially possible, the imagery would still be very valuable for research purposes.

T.T.G.





