REVIEWS

C. W. M. SWITHINBANK. *Ice atlas of Arctic Canada.* Ottawa, Defence Research Board, 1960. [ii], 67 p., 67 figs. $7.50. (Obtainable from the Queen's Printer, Ottawa.)

WHEN cautiously used, charts of the occurrence of sea ice would be useful to seamen in Canadian Arctic waters; these charts compiled by Dr. Swithinbank should also be studied in detail by scientists with interests in polar seas. There are 29 charts showing by sector diagrams the frequency of occurrence of ice derived from 29 ice summary diagrams. In addition there is a reference chart showing the numbered locations of stations, one showing mean surface currents and five monthly charts showing the mean extent of fast ice.

The cartography is pleasing, both in style and definition. On the frequency charts the base chart is printed in dark grey, the outline of the circles of the sector diagrams in black, and the ice formation in clearly contrasting colours. Perhaps the registration might have been more precise but this is a minor criticism. It is agreeable to see the legend repeated on each page and also the clearly printed dates at the head of each sheet. The size of the atlas is somewhat cumbersome, 34 × 20 in. (86 × 51 cm.), but this is understandable as the area studied stretches from the north coast of Alaska, from Icy Cape eastwards through Canadian Arctic waters to West Greenland waters north of Disko Bugt. It is somewhat regrettable that the projection is not stated.

This reviewer is particularly conscious of the patience needed in accumulating so many data from so many sources in a number of countries. Dr. Swithinbank explains in a short but admirable text the method employed in making the ice summary diagrams and from these the frequency charts. It is also well worth while to read his paper (1958) on the compilation of this atlas, presented at the 1958 conference on Arctic sea ice. Ice data collected from ships' logs, 1900–58, and from aerial observations obtained from the U.S. Hydrographic Office, from 1952 onwards, were plotted on 998 separate weekly plotting charts (a sample of which is given in the atlas as Figure 38) covering 1 March to 30 November. This information was tabulated for the 324 reference stations in the ice summary diagrams, one for the whole month of March, two for April, weekly for May to October, and two for November. The sector diagrams, plotted at the position of the reference stations on the frequency charts, were constructed by collating all the material for one week, or other selected period, given in the ice summary diagrams; different colours denote varying ice conditions, and each sector of the circle represents a proportion of years in which ice of a particular concentration was observed. It is apparent from the text, as well as from the diagrams, that the emphasis is on the effect of sea ice on shipping and there is a careful statement of the possible relationships between ice concentration as measured in tenths of the sea surface covered and the navigability of such ice. The reports in ships' logs more frequently referred to the passage of the ship through the ice than to the coverage or type of ice, but the reports in recent years from aircraft state in tenths the proportion of the sea surface covered by ice. There is almost inevitably a subjective element in ships' reports and these have to be compared with the more objective estimations from aircraft. A further complication is that thickness of ice is not usually reported and concentrations beyond $\frac{8}{10}$ may vary from young ice of 5–20 cm. thickness formed that autumn and navigable even though widespread, to one winter's growth of 20 cm. to 2 m. thickness, to several years' growth to 3 m. and more in thickness. The symbol Y has been inserted against the appropriate sector or on the relevant portion of the ice summary diagram when young ice has been reported. Furthermore ships' observations of proved navigability (in contradistinction to ice concentration as observed by aircraft) have been shown by means of symbols representing the different types of vessels reporting ice.

This ice atlas (as also a similar and recently compiled atlas by Dr. T. E. Armstrong (1958) on the waters north of the U.S.S.R.) differs from previous atlases in not attempting to show

mean, normal, or extreme ice conditions, but in so presenting the accumulated data in a graphic form that the user of the atlas is in a position to hazard an opinion as to the possibility of ice being found at any given station at a time when it would be possible for a ship to be in the particular area. The legend on each frequency chart bears the warning that observations reported for a few years only may refer to exceptional conditions. The possibility of secular change may be ascertained by inspecting the ice summary diagrams; in addition there are cumulative sector diagrams for four selected stations showing changes at about 20-year intervals.

The atlas is so valuable that it is perhaps permissible to make a few adverse criticisms. Some of the terms relating to ice could be more formally defined; there is no indication of the reliability or source of the chart of mean surface currents. A more disturbing feature is the limiting positions of the stations; it is understood that on a chart the non-existence of a sector diagram does not necessarily imply either non-occurrence of sea ice or lack of information about ice conditions. Quite reasonably there are no sector diagrams for the north of the Beaufort Sea; presumably Hudson Strait and Hudson Bay have been omitted as constituting a separate problem but it is difficult to understand why there are no stations, south of lat. 70° W., between long. 58° W. and the west Greenland coast. Perhaps it was considered that ice from the west and Middle Pack in Davis Strait did not extend sufficiently far east to warrant stations in this area yet it would seem that ice was present on a number of occasions in March, April and May.

Also, there is no mention of icebergs which although land-derived and not strictly sea ice, yet are a notable feature of ice found at sea. As this atlas is peculiarly related to shipping, it would seem relevant to have some record of the frequency of occurrence and observed location of icebergs in Davis Strait particularly in the latter half of the year, when this area is relatively free of floes but when icebergs have been reported. Possibly it may be presumed that icebergs have been recorded as "ice of less than $\frac{1}{10}$ concentration" or $\frac{1}{10}-\frac{5}{10}$ concentration, but there is a particular and peculiar hazard to navigation by icebergs compared with floes. This atlas is obviously so carefully compiled that the problem of recording and graphically depicting icebergs must surely have been considered; nevertheless it is a pity that there is no information on such dangers.

An admirable feature of the atlas is that stations where no observations have been recorded are distinguishable from stations where ships or aircraft have observed open water or ice of less than $\frac{1}{10}$ concentration. Such is the confidence that one can put in the atlas that it is salutary to observe whether preconceived ideas on the distribution of ice are correct or not. The expected North Open Water at the head of Baffin Bay and the mouth of Smith Sound is apparent in March and April, but the Middle Pack of Baffin Bay is not so extensive in August as had been thought. The stretch of Canadian coast from Icy Cape eastwards to Banks Island is surprisingly well-documented in July, August and September both from aircraft reports during the last decade and from ships' reports over the whole period from 1900 onwards; the ice summary diagrams also emphasize the value of air reconnaissance in providing information for the various channels through the Canadian Archipelago.

This atlas, emphasizing caution in its use, and drawing no conclusions but presenting so well all the years in which observations on sea ice have been made is rewarding to study solely in an academic manner. It is much to be hoped that it will prove valuable to mariners.

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REFERENCES

Armstrong, T. E. 1958. *Sea ice north of the U.S.S.R.* London, Admiralty. Hydrographic Department. 2 vols. (H.D. 511.)

Swithinbank, C. W. M. 1958. An ice atlas of the North American Arctic. (*In Arctic sea ice.* Washington, D.C., p. 22–28. ([U.S.] National Academy of Sciences—National Research Council Publication 598.))