SCOR WORKING GROUP 58

THE ARCTIC OCEAN HEAT BUDGET

Preliminary Report submitted to 21st Meeting of SCOR Executive Committee

During 17–19 October 1977, SCOR WG 58 met at the Bedford Institute in Nova Scotia. Our terms of reference were

I) to assess the present state of knowledge of the Arctic Ocean heat budget and the physical processes which control it, and

II) to recommend a coordinated and international research effort to significantly improve the understanding of the heat budget and the controlling processes, taking into account the plans for the Polar Sub-programme of the Global Atmospheric Research Programme.

We made considerable progress on item I and were able to identify the major components and processes of the Arctic Ocean heat budget, including the important information gaps. We also made a good start on discussions of an appropriate plan of research (item II), at least in outline. The following brief summary is a preliminary report only;a full report is being prepared as the basis for the next meeting.

The group unanimously desires to meet again in September 1978, at the Geophysical Institute in Bergen, to discuss in detail the various research plan components (item II) as well as certain unresolved matters under item I.

1. The Arctic Ocean heat budget relates to a number of general questions of atmospheric and oceanic circulation, to climate and its modification, and to the rapidly increasing human use of the north. While a number of heat budget studies have been done for the Arctic, they tend to be fragmetary and incomplete, nor is there very much information on variability at almost any frequency. The budget studies to date do, however, point toward the more important component processes.

   The heat budget can be thought of in terms of the storage of energy within the basin (including internal rearrangement with time), and of changes in the energy storage through exchange with the seas to the south and with the atmosphere. We note that in the physics of the Arctic Ocean, the role of fresh water is extremely important, since it is the salinity stratification which limits convective mixing (and sensible heat exchange with the atmosphere) and permits ice formation. The storage and flux of buoyancy is therefore an integral part of the general heat budget problem, and processes causing vertical exchanges will be of major interest.

2. With respect to energy storage, there is a very great need for synoptic inventory studies of heat and buoyancy on a regional scale, with some emphasis on more localized areas of special importance. Good vertical profiling is essential in these studies. The synoptic oceanographic sections that are so common at lower latitudes are not available over large parts of the Arctic Ocean and constitute a serious lack. The technical and logistical aspects of such synoptic work are well within present capability.

3. Heat exchange with the atmosphere is a strong function of the ice thickness distribution. Two problems appear to be particularly important. One is the parameterization of areally integrated surface heat fluxes as a function of ice thickness. Matters both of physics and of statistics (e.g., over what scales is the ice distribution stationary?) are involved. The second problem relates to the surface exchange through large areas of open water (polynyas). The exchange through relatively small leads has been studied on several occasions, but the physics of exchange processes in large open-water areas appears to be more complex. Such exchange raises both oceanographic and meteorolocial questions (e.g., the possible penetration of the arctic atmospheric temperature inversion).

4. The most important avenue of advective flux is the passage between Greenland and Spitsbergen. Low-frequency variability is of particular interest. Present work on the transport of sensible heat and salt through the eastern part of this passage needs to be continued and expanded to include the more difficult western portion as budget studies will inevitably require total flux measurements. The export of ice through the western portion is also a first-order term in the heat budget, and it is necessary to undertake an appropriately designed study of this export on rather long time scales (years).

5. Finally, the Greenland–Norwegian Sea is of considerable importance. While it is formally not part of the Arctic Ocean, it connects with the Arctic Ocean and many of the processes that occur there are intimately tied to the Arctic Ocean heat budget. Experiments designed to elucidate the transformation of water masses in the Greenland–Norwegian Sea (e.g., bottom water formation) and their subsequent redistribution, are therefore of major consequence to the present discussion.

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