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SOME FEATURES OF VERTICAL TEMPERATURE DISTRIBUTION

IN THE CANADIAN ATLANTIC

by

H. B. Hachey

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Introduction

The climate of a land mass may be described by means of such features as temperature, rainfall, humidity and sunshine. Land masses on various portions of the globe exhibit different climates, due to the differences in latitude, altitude, position relative to a water mass, or other influencing features.

The "climates" of a portion of the ocean may be described in part by means of water temperature and salt content. Like land masses, these water masses exhibit different "water climates" due to differences of latitude, physical features of neighbouring land masses, position relative to ocean currents or large land drainage, or other influencing features.

The water areas of the Canadian Atlantic exhibit a wide variety of "climates", partly due to the influence of latitude and neighbouring land masses, but chiefly due to the influences of such impressive water movements as the Labrador Current and the Gulf Stream.

Some features of the vertical distribution of water temperatures are used herein to illustrate some striking differences in the seasonal development of temperatures in the upper layers of the waters of three Canadian Atlantic areas, the Gulf of St. Lawrence, the Scotian Shelf, and the Bay of Fundy.

Winter Chilling

Winter climatic conditions on the immediate eastern seaboard are reflected in our coastal waters. The surface water temperatures register as low as 29°F. (-1.8°C), the freezing point of sea water, and ice forms and thickens in the harbours and bays over a large portion of the coast. During the winter season too, large quantities of ice and ice cold water are transported from the north to more southerly latitudes. As a result, the Gulf of St. Lawrence area is ice-bound throughout the winter months, and an upper layer of a wide band of open water bordering our east coast during the winter months is not much above freezing temperatures. On the Scotian shelf and the Grand Banks this band of cold water may extend offshore as much as 100 miles (161 Km.) Inshore this comparatively cold water extends to the bottom, but offshore in the greater depths, it is underlain by a layer of warmer water, with temperatures even as high as 50°F. (10°C.), beyond the edge of the continental shelf. In the Bay of Fundy strong tidal action enhances vertical mixing, so that in the winter comparatively warmer water is brought to the surface, thus moderating the winter water temperatures to a considerable degree.

Vernal Warming

As winter cooling of surface water, together with lessened contributions of less saline coastal water, is productive of water of greater density than that immediately below, the cooling process, as it progresses, enhances vertical mixing and it is this mixing that is in part responsible for the penetration of lower temperatures to the greater depths. On the other hand, as the sun's rays become stronger

in spring, warming of the surface waters produces water that is of lesser density than that immediately below it, and this warming process, together with increased contributions of less saline coastal water, through the spring and summer months, tends to create an upper layer of comparatively higher temperatures.

Autumnal Cooling

Throughout the fall and winter months, the waters give up heat to the air, surface water densities increase, thus aiding vertical circulation from which follows a thickening of the upper layer, even though the temperature of the upper layer, as a whole, is decreasing. The stage is finally reached where the temperature of the upper layers merge with those of the deeper layers and a surface layer can no longer be distinguished. While this upper layer is a feature of the hydrographic conditions in the Gulf of St. Lawrence and the Scotian Shelf, tidal action in the Bay of Fundy producing intense vertical mixing distributes the absorbed heat to all depths, and the vertical temperature distribution is comparatively uniform throughout the Bay.

Seasonal Progress of the Water Climates

The progress of the water climate from May to November in three specified areas of the Canadian Atlantic coast is shown in figure 1. In the Gulf of St. Lawrence the upper layer becomes sharply defined by July, with a thickness of approximately 30 feet (9 M.). At the same time the maximum temperature of approximately 66°F. (14.9°C) is reached. Through the months of August, September, October and November the thickness of the layer increases to 150 feet (46 M.)

but the temperature of the upper layer as a whole has decreased to 40°F. (4.4°C). On the Scotian Shelf the development of the thickness of the upper layer is more rapid than in the Gulf of St. Lawrence, as shown by the July observation when the layer is more than 50 feet (15 M.) thick. At the same time the temperature of the upper layer is roughly 48°F. (8.9°C.) in July as compared with 66°F. (14.9°C.) in the Gulf of St. Lawrence. Throughout August and September the temperature of the upper layer on the Scotian Shelf continued to increase, reaching 67°F. (19.5°C.) in September, as compared to 58°F. (14.4°C.) in the Gulf. In November the upper layer on the Scotian Shelf has a temperature of 48°F. (8.9°C.) and a thickness of approximately 150 feet (46 M.). In the Gulf of St. Lawrence sharp gradients in salinity are associated with the gradients in temperature, and the thermoclines, as illustrated, are indicative of very strong density layering. In contrast, on the Scotian Shelf, neither the salinity gradients nor the temperature gradients reach the extremes found in the Gulf of St. Lawrence, and hence the density layering is not as marked.

In contrast to both the Gulf of St. Lawrence and the Scotian Shelf, the seasonal progression of water temperatures in the Bay of Fundy is general at all depths, and an absence of layering features these waters. Surface temperatures in the open waters do not reach much above 54°F. (12.2°C.), and by late autumn bottom water temperatures may reach 50°F. (10.0°C.). Progressive cooling during the autumn and winter months will produce temperatures as low as 35.6°F. (2.0°C) in the open waters of the Bay, given lower in extreme winters.

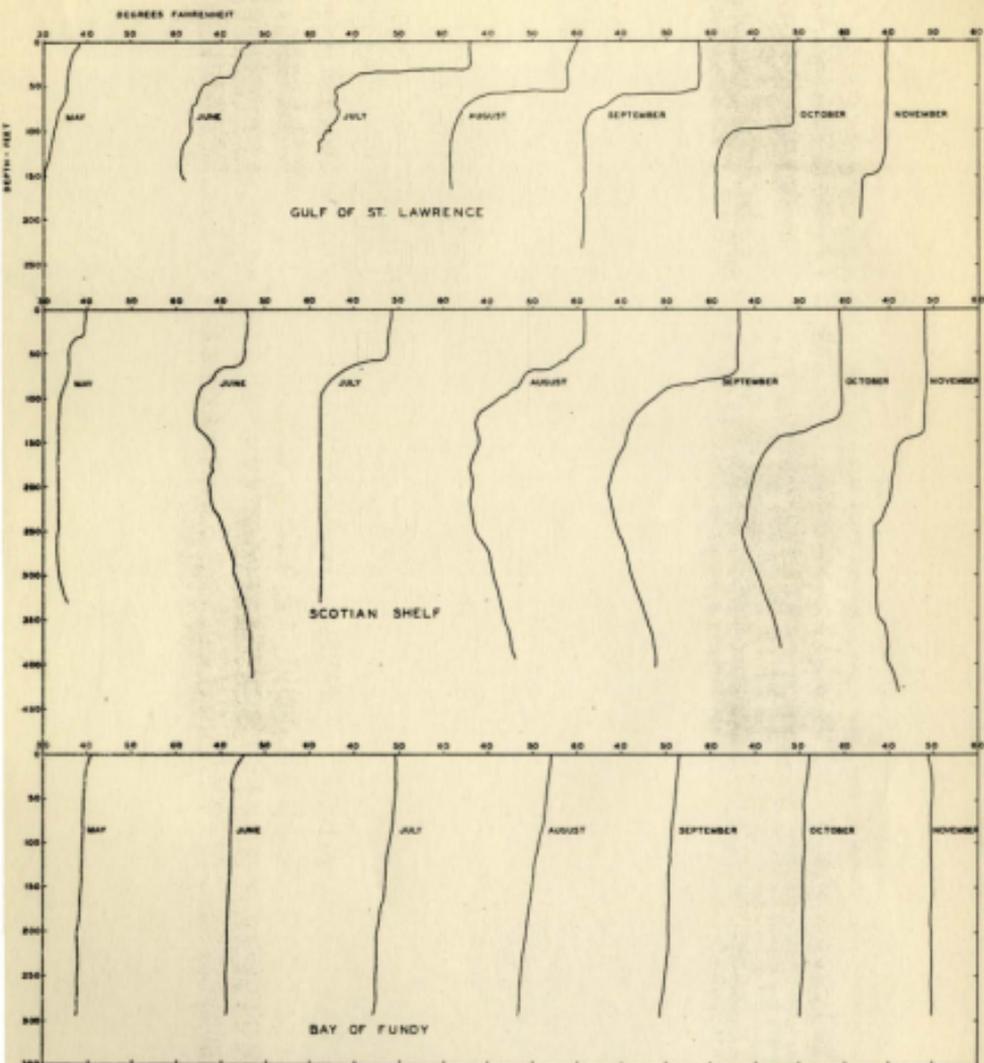


Fig. 1. Some Vertical Temperature Distributions in the Canadian Atlantic.

