10) Was auch Helge Ingstad, der an das Vorrücken der Grönländer bis an 79 ° N. glaubt zugeben muß: „. . . the most northerly rune-stone ever found, Land under the Pole Star, London 1966, 88, jetzt auch in: Westward to Vinland, Jonathan Cape, London 1969, 21.

11) O. Pettersson, Climatic Variations in Historic and Prehistoric Time, Svenska Hydr. Biol. Komm. Skrifter, Nr. 5, 1912.

12) Rachel L. Carson, The Sea Around Us, London 1955, 179—180. Mehrere Auflagen zwischen der ersten Ausgabe in 1950 und der von R. A. Skelton benutzten Ausgabe von 1960.

13) In einem Briefe des Bischofs von Bergen, Haakon, aus dem Jahre 1341, können wir lesen: „ad Groenlandiam per mare non minus tempestuosissimum quam longissimum . . ." (Dipl. Norv. Bd. V, Nr. 152). — Um die Eisverhältnisse in den Polarregionen zu veranschaulichen, führt man oft die bekannte Stelle aus dem Speculum Regale aus dem Jahre von etwa 1250 vor: „As soon as one has passed over the deepest part of the ocean, he will encounter such masses of ice in the sea that I know no equal of it anywhere else in all the earth . . . They . . . extend so far out from the land that it may mean a journey of four days or more to travel across. There is more ice to the northeast and north of the land than to the south, southwest and west . . ." K. Aagaard and L. K. Coachman, The East Greenland Current North of Denmark Strait: Part I, Arctic, 21, 3 (1968), 181—200.

14) Ich muß gestehen, daß mir die Arbeit von Hans Peter Kosack, Die Polarforschung, Braunschweig 1967, 471 S. (Die Wissenschaftl. Sammlung von Einzeldarstellungen aus allen Gebieten der Naturwissenschaft, Bd. 128) unzugänglich war.

Some measurements of the extinction coefficients of river ice

By Gerd Wendler

Abstract: The extinction coefficient of two different types of river ice was investigated in relation to its dependence on the wave length of the transmitted light.

Zusammenfassung: Einige Messungen des Extinktionskoeffizienten von Flußeis. Der Extinktionskoeffizient wurde für zwei verschiedene Eissorten in seiner Abhängigkeit von der Wellenlänge der durchtretenden Strahlung untersucht.

In the spring of 1967, some measurements of the extinction coefficient were made using samples of the river ice of Goldstream Creek, near Fairbanks, Alaska. A Linke Feussner actinometer in conjunction with a galvanometer, both constructed by Kipp and Zonen, Holland, were used for this purpose. The measurements were carried out with direct solar radiation in a mean temperature of — 6° C, as well as in a cold room with an artificial light source (— 20° C).

Two very different types of ice were used, normal river ice, which is formed when the stream freezes over in the fall, and "overflow ice", viz., ice which occurs when the stream is solidly frozen, fresh ground water is forced to the surface, and the resultant mixture of snow and water freezes. The "overflow ice" has a higher air content than the normal river ice and consequently, a brighter appearance (Fig. 1). These overflows are frequently found in Alaskan streams and occur several times during one winter, as can be inferred from the stratified structure of the ice. By spring time these overflows can build up to a thickness of several meters (Benson and Kreitner, 1969. Kreitner, 1969). With a motor saw, large blocks of ice were cut out of the stream. The "overflow ice" is situated near the surface, while the river ice was found in greater depth. With different hand saws plates of ice were cut with a thickness between 0.2 and 6.0 cm.

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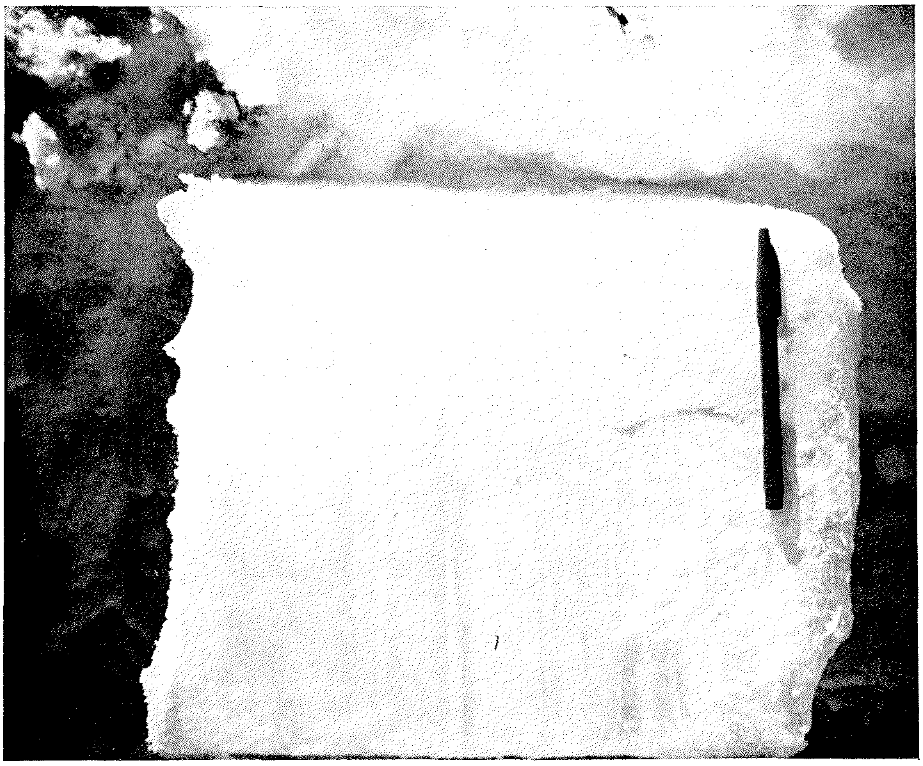

Fig. 1. A block of "overflow ice" cut out of the Goldstream Creek, a stream near Fairbanks. The stratified structure shows that several overflows have occured

Fig. 1. Ein Block von aufgefrorenem Eis, der aus dem Goldstream Creek, einem Bach in der Nähe von Fairbanks, geschnitten wurde. Die geschichtete Struktur zeigt, daß mehrfach Überflutungen vorkamen

The extinction coefficient ϱ can be calculated from the following equation.

$$I_d = I_o e^{-\varrho x}$$

Where I_d is the radiation which is transmitted through the plate, I_o is the incident radiation, and x is the thickness of the plate.

In Fig. 2 $\ln \frac{I_o}{I_d}$ ist plotted against the thickness of the plate. The slope of the straight line gives the extinction coefficient which becomes constant for a thickness of ice plate greater than about 1.5 cm. An average value of the extinction coefficient for clear river ice was found to be 0.092 cm^{-1}.

This value shows good agreement with measurements made by Jaffe (1960) for glacier ice. The "overflow ice" absorbed much more radiation, because of the much higher air content. The mean value for the extinction coefficient for this type of ice was 0.43 cm^{-1}. No values for this type of ice could be located in the literature. The value which was found here agrees much better with those given for snow (Liljequist, 1954) than with values given for glacier ice (Jaffe, 1960; Ambach and Mocker, 1959).

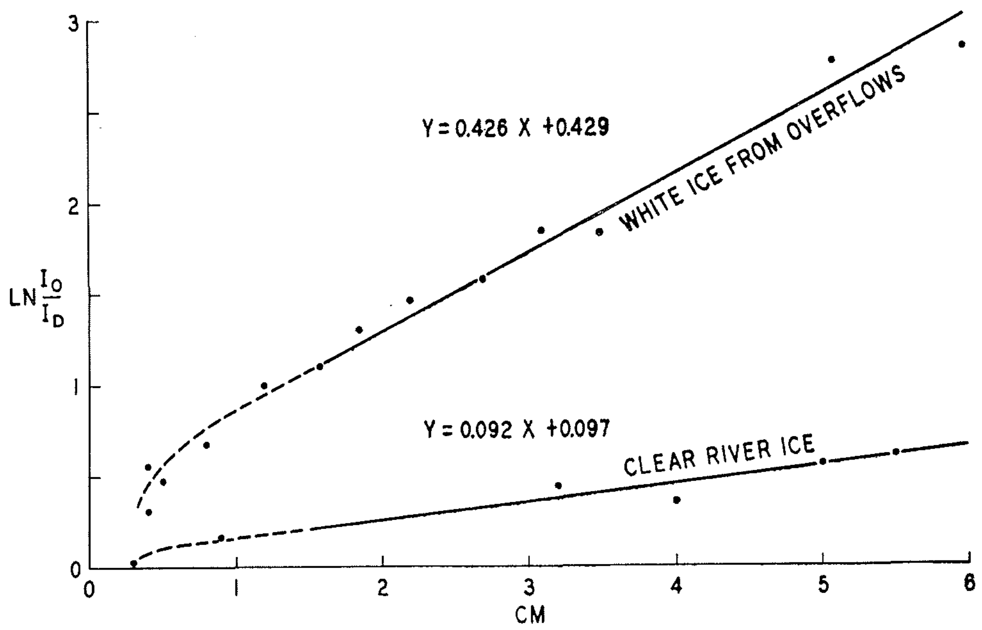

Fig. 2. ln $\frac{Io}{Id}$ (Io incident radiation, I_d transmitted radiation) is plotted against the thickness of ice plates. The slope of the straight line which is fitted using the least square method, gives the transmission coefficient. The average value for river ice was found to be 0.092 cm^{-1}, and for "overflow ice" 0.426 cm^{-1}

Fig. 2 ln $\frac{Io}{Id}$ (Io einfallende Strahlung, I_d durchtretende Strahlung) ist gegen die Plattendicke aufgetragen. Die Neigung der Geraden, die nach dem Quadrat der kleinsten Abweichungen eingezeichnet wurde, gibt den Transmissionskoeffizienten. Der Mittelwert für Flußeis ist 0.092 cm^{-1}, für aufgefrorenes Eis 0.426 cm^{-1}

A dependence of the extinction coefficient on the wave length was found for both kinds of the ice. It was observed that an increase of the absorption occurred from blue to red. Figure 3 shows the extinction coefficient for the colors yellow (using filters RG 2—OG 1) and blue (open — OG 1). The result agrees with the observations of Liljequist (1954) and Ambach (1958).

The measurements have shown that when ice is melting in the streams, after overflows have occurred, the internal ablation is unimportant as 95 % of the radiation is absorbed in the upper 3 cm. This is quite dissimilar to conditions on glaciers. If no overflows have occurred and the ice is free of snow, only about 50 % of the incoming radiation is absorbed in the upper 3 cm.

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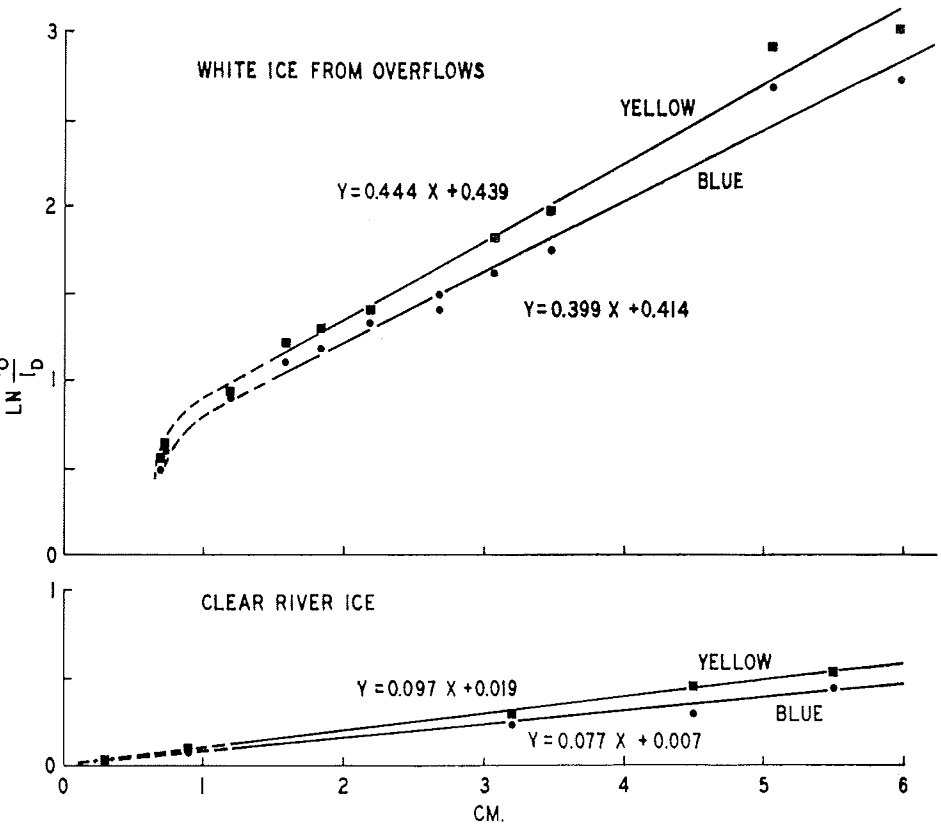

Fig. 3. The same as Fig. 2, using blue and yellow light

Fig. 3. Die gleiche Darstellung wie in Abbildung 2, jedoch für blaues und gelbes Licht