CLARK: Vertical ice suction is small with respect to the water depth and thus does not noticeably influence the measurements. Vertical tilting over a short period would be partially considered by the averaging during the data-collection state, in this period 64 signals are averaged to give the single hourly reading. Tilting over a longer period would appear in the hourly readings taken. Problems associated with the movement of the ice are still being considered.

R. FREDERKING: Are you planning to carry out the development of this apparatus to the point where it can be used operationally in a drilling operation?

CLARK: Yes. At present the data is collected in a raw, unprocessed form on magnetic tape. Development is under way to use a mini-computer for on-site processing and real-time display.

S. F. ACKLEY: Have you attempted to correlate the ice-motion measurements with the measured meteorological and oceanographic parameters?

CLARK: No, the data has only been obtained recently (July 1976) and it is currently under study.

ACKLEY: Acoustic releases may be useful for recovering the pingers.

CLARK: This has been used on current meters installed in open water. However, with an ice cover, the problem is not to get the pinger to the surface, but to recover it from under the ice.

S. C. COLBECK: How much lateral ice motion can a floating drill-rig stand before it is no longer possible to re-enter the drill hole?

CLARK: The "rule-of-thumb" accepted by the oil industry is 5% of the water depth. Beyond this limit, stresses are generated in the drill pipe and re-entry also becomes more difficult.

V. SCHYTT: For how long does the ice-floe have to be stationary to permit the drilling of a hole?

CLARK: The length of time needed depends on the depth of the geological formation that is of interest and the problems encountered during the drilling. During 2–3 months, a hole of about 1 000 m can be handled.

MATHEMATICAL SIMULATION OF THE PROCESS OF MOTION OF A SNOW AVALANCHE

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ABSTRACT. A "hydraulic" model of the motion of bed-type snow avalanches is developed, its qualitative particularities are discussed, and results of comparison of prediction and observations are presented. The proposed model allows calculation of the parameters of motion of snow avalanches possible for a given bed depending on the snow situation and other conditions. The characteristics concerned are the distribution of velocities averaged over the cross-section of the flow and the thickness of snow in an avalanche at every instant of its motion.

The class of avalanches considered is that in which a compact snow flow moves along a distinct avalanche bed consisting of an accumulation region, a bed, and an avalanche cone. It is proposed to model the avalanche bed with a certain inclined and curved channel of given

width and shape of cross-section. The characteristics of the model channel are defined on the basis of a topographic map of the corresponding avalanche bed. The motion of avalanche snow is modelled by the flow of an incompressible "liquid" subjected to the action of gravity, internal resistance, and external friction. Destruction and capture of undisturbed snow by an avalanche from the slope is accounted for by introducing into the equations of motion distributed sources of mass the intensity of which depends on the sought characteristics of the problem and which is defined while solving the problem.

On the basis of simple physical considerations connected with the finite shear stress in the snow, it is shown that for sufficiently large avalanches the specific friction force becomes inversely proportional to the thickness of the flow. The proposed mechanism of friction explains the abnormally high mobility of catastrophically large avalanches.

The adopted model possesses a number of properties agreeing qualitatively with the observational data for avalanches. Computer solutions have the form of rather prolonged flows with the shape of the front part typical for avalanches and with characteristic wave formations in the flow which sometimes result in pulsating regimes of motion. The report concludes with results of comparison of predicted and observed characteristics of motions of avalanches for some real avalanche beds demonstrating possibilities of the proposed model.

A NUMERICAL ICE-ACCRETION MODEL

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Abstract. A numerical model is developed for calculating the rate and total amount of ice accretion under atmospheric conditions. The principal application of the numerical approach is to aircraft icing and more specifically, helicopter icing problems. These problems are best solved using numerical techniques because of three factors: (1) the dependence of the ice accretion rate on the amount of ice previously deposited, (2) the existence of two different ice growth regimes, the "dry" and "wet" growth regimes, determined by the surface temperature of the accreting surface, and (3) variable velocities (e.g. along rotor blades) which affect the rate of capture of swept-out water droplets and the amount of heat generated by the flow on the accreting surface. These three factors cause feedback in the two governing equations for determining the mass rate of ice accumulation.

The first of these equations is for the mass rate of water captured, and the second equation is for the heat balance of the accreting interface. For the numerical calculation, the object, such as a helicopter rotor blade, is broken down into elements of constant velocity, and for each time step the resulting ice thickness is used to recompute new cross-sectional and surface areas which are then used as input to the next time step. Changes in the cross-sectional and surface areas caused by ice build-up affect both the mass rate (directly through the cross-section and indirectly through a change in collection efficiency) and the heat balance (directly through the cross-sectional and surface areas and indirectly through changes in the collection efficiency and Reynolds number). An additional instability in the ice growth rate develops when the transition between wet and dry growth occurs, enhancing the feed-back that already exists between the mass rate of ice accumulation and the thickness previously deposited. Numerical icing simulations using various helicopter configurations and the icing conditions they typically encounter are presented.