

A STUDY OF THE FLUCTUATIONS IN SEA-ICE EXTENT OF THE BERING AND OKHOTSK SEAS WITH PASSIVE MICROWAVE SATELLITE OBSERVATIONS

(Abstract)

by

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ABSTRACT

The seasonal sea-ice cover of the combined Bering and Okhotsk Seas at the time of maximum ice extent is almost 2×10^6 km² and exceeds that of any other seasonal sea-ice zone in the Northern Hemisphere. Although both seas are relatively shallow bodies of water overlying continental shelf regions, there are important geographical differences. The Sea of Okhotsk is almost totally enclosed, being bounded to the north and west by Siberia and Sakhalin Island, and to the east by Kamchatka Peninsula. In contrast, the Bering Sea is the third-largest semi-enclosed sea in the world, with a surface area of 2.3×10^6 km², and is bounded to the west by Kamchatka Peninsula, to the east by the Alaskan coast, and to the south by the Aleutian Islands arc.

While the relationship between the regional oceanography and meteorology and the sea-ice covers of both the Bering Sea and Sea of Okhotsk have been studied individually, relatively little attention has been given to the occasional out-of-phase relationship between the fluctuations in the sea-ice extent of these two large seas. In this study, we present 3 day averaged sea-ice extent data obtained from the Nimbus-5 Electrically Scanning Microwave Radiometer (ESMR-5) for the four winters for which ESMR-5 data were available, 1973 through 1976, and document those periods for which there is an out-of-phase relationship in the fluctuations of the ice cover between the Bering Sea

and the Sea of Okhotsk. Further, mean sea-level pressure data are also analyzed and compared with the time series of sea-ice extent data to provide a basis for determining possible associations between the episodes of out-of-phase fluctuations and atmospheric circulation patterns.

Previous work by Campbell and others (1981) using sea-ice concentrations also derived from ESMR-5 data noted this out-of-phase relationship between the two ice packs in 1973 and 1976. The authors commented that the out-of-phase relationship is "... surprising as these are adjacent seas, and one would assume that they had similar meteorologic environments". We argue here that the out-of-phase relationship is consistent with large-scale atmospheric circulation patterns, since the two seas span a range of longitude of about 60°, corresponding to a half wavelength of a zonal wave-number 3, and hence are quite susceptible to changes in the amplitude and phase of large-scale atmospheric waves.

REFERENCE

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1981 Structure and variability of Bering and Okhotsk sea-ice cover by satellite microwave imagery. In Halboury M T (ed) *Energy Resources of the Pacific Region*. American Association of Petroleum Geologists. Tulsa, OK: 343-354

AIRBORNE UHF RADAR MEASUREMENTS OF CALDERA GEOMETRY AND VOLCANIC HISTORY, MOUNT WRANGELL, ALASKA, U.S.A.

(Abstract)

by

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ABSTRACT

The ice-filled caldera of Mount Wrangell, Alaska, provides an unusual opportunity to examine the interaction between a glacier and an active volcano. The caldera acts as a giant calorimeter, preserving a rough balance between snow precipitation at the glacier surface and bottom melting. In April 1982 we sounded the glacier using an airborne 840 MHz pulsed radar (Narod B B, Clarke G K C 1983 UHF radar system for airborne surveys of ice thickness.

Canadian Journal of Earth Sciences 20(7): 1073-1086). The data were recorded on magnetic tape, then computer processed and plotted as depth, rather than time, sections.

In addition to mapping ice thickness, we detected extensive internal layers presumed to have been deposited during past eruptions of Mount Wrangell. The challenge of interpreting these internal reflectors inspired us to develop a unified interpretation model that incorporates both glaciological measurements and phenomenological equations for

firn and ice. The interpretation model yields the variation with surface-normal depth z of temperature T , heat flux q , ice pressure p , density ρ , surface-normal component of flow velocity w , down-slope component of flow velocity u , depositional age t_a , two-way wave travel time τ_2 , and two-way propagation loss P_2 . The following system of linear differential equations is integrated using the Runge-Kutta method:

$$\frac{dT}{dz} = -\frac{q}{K} \quad (1)$$

$$\frac{dq}{dz} = -pcw \frac{dT}{dz} + 2B_0 \exp(-Q/RT) (Fp \tan \alpha)^{(n+1)} + \frac{pw}{3\rho} \frac{d\rho}{dz} \quad (2)$$

$$\frac{dp}{dz} = pg \cos \alpha \quad (3)$$

$$\frac{d\rho}{dz} = m_1 \rho^2 \left[\frac{\rho_I - \rho}{\rho_I} \right] \quad p \leq p^* \quad (4)$$

$$= m_2 \rho^2 \left[\frac{\rho_I - \rho}{\rho_I} \right] \quad p > p^*$$

$$\frac{dw}{dz} = -\frac{w}{\rho} \frac{d\rho}{dz} - \Delta_0 \quad (5)$$

$$\frac{du}{dz} = -2B_0 \exp(-Q/RT) (Fp \tan \alpha)^n \quad (6)$$

$$\frac{dt_a}{dz} = \frac{1}{w} \quad (7)$$

$$\frac{d\tau_2}{dz} = \frac{2\sqrt{\epsilon}}{v_0} \quad (8)$$

$$\frac{dP_2}{dz} = 2D \quad (9)$$

together with physical property relations such as the following

$$c(T) = 2115.343 + 7.7929 (T - T_0) \quad (10)$$

$$K(\rho, T) = 2\rho K_I(T)/(3\rho_I - \rho) \quad (11)$$

$$K_I(T) = 2.1725 - 3.403 \times 10^{-3}(T - T_0) + 9.085 \times 10^{-5} (T - T_0)^2 \quad (12)$$

$$\epsilon(\rho) = (1 + 8.5 \times 10^{-4}\rho)^2 \quad (13)$$

$$D(T) = D_0 \exp(-E/RT). \quad (14)$$

The boundary conditions on the integration variables are $T(0) = T_s, T(h) = T_m, p(0) = 0, \rho(0) = \rho_s, w(0) = w_s, u(h) = u_B, t_a(0) = 0, \tau_2(0) = 0$, and $P_2(0) = 0$, where T_s is surface temperature, T_m is bottom temperature, ρ_s is surface density, w_s is surface-normal velocity measured at the glacier surface, and u_B is sliding velocity. The remaining variables are thermal conductivity K , specific heat capacity c , flow-law constant B_0 , creep activation energy Q , universal gas constant R , shape factor F , surface slope α , flow-law exponent n , gravity acceleration g , empirical constants m_1, m_2 , and p^* from Benson's firn-densification law (Benson C S 1962 Stratigraphic studies in the snow and firn of the Greenland ice sheet. *SIPRE Research Report 70*), ice density ρ_I , surface value of two-dimensional flow divergence $\Delta_0 = (\partial u/\partial x + \partial v/\partial y)_s$, relative dielectric permittivity ϵ , free-space electromagnetic wave velocity v_0 , propagation loss rate $D, T_0 = 273.16^\circ \text{K}$, thermal conductivity of ice K_I , loss-law constant D_0 , and activation energy for propagation loss E . The units of temperature and density in the above equations are respectively $^\circ \text{K}$ and kg m^{-3} .

Preliminary modelling has yielded an age-depth relationship for internal reflecting layers that roughly matches the known eruption record for Mount Wrangell and extends the volcanic history by more than 200 years. High signal absorption rates restrict interpretation of the caldera geometry. Reflections from the bed are not consistently detectable beyond a depth of approximately 350 m, suggesting a loss rate of 7-8 dB per 100 m of path length. The anomalous losses are attributed to abnormally high concentrations of ionic impurities and scattering sources.

INTERPOLATION TECHNIQUES FOR THE DISPLAY OF REMOTELY SENSED GLACIOLOGICAL DATA

(Abstract)

by

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ABSTRACT

The use of many display techniques for remotely sensed glaciological data requires the reduction of the data to a regularly spaced rectangular grid of values. Most remotely sensed data are not immediately suitable for display, because the area of interest is covered by more than one set of data on mutually incompatible grids (e.g. Landsat, AVHRR), or because the data are available as profiles along widely spaced ground tracks (e.g. radio

echo-sounding, satellite altimetry). In addition, data may be sparsely and randomly scattered (e.g. surface elevations from TWERLE balloons).

A variety of techniques is available to reduce data to a specified grid system. These include spatial averaging, interpolation from nearest neighbours, and surface-fitting techniques, notably polynomial fitting and bi-cubic splines. All of these are useful under differing circumstances.