UNIVERSITY OF WISCONSIN MILWAUKEE

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October 15, 1998

To whom it may concern:

I have followed with interest Dr. Sergei F. Rudnev's excellent researches on the currents and internal waves in Lake Onega. That work, on one of the Karelian Great Lakes, is relevant to the hydrodynamics of the North American Great Lakes in particular and to the "oceanography" of inland seas in general.

Therefore, I welcome and support Dr. Rudnev's plans to pursue his distinguished career in oceanography or marine engineering.

Yours sincerely,

C. H. Mortimer

Clifford H. Mortimer
Distinguished Professor Emeritus
Fellow Royal Society of London
Former President American Society of
Liminology and Oceanography

As Notary of the State of Wisconsin, Professor Mortimer is known to me, and I hereby witness his signature.

Signed before me on this 15th day of October, 1998 at Milwaukee, Wisconsin.

Patricia A. Marshall   Oct. 15, 1998

My commission expires March 1?, 2002.

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<u>To whom it may concern</u>

Dr Sergei Fjodorovich Rudnev

For some 10 years I have been in occasional scientific correspondence by letter with Dr Rudnev about our mutual interests in physical process in lakes, particularly about internal waves and Langmuir circulation.

Whilst I have never met him and cannot comment on his personality or character, Dr Rudnev is evidently a clever scientist with interesting ideas who has made some careful measurements in lakes. He would contribute significantly to a scientific organisation in which his area of expertise was relevant.

Dr S.A.Thorpe FRS
Professor of Oceanography
1 October 1998

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External gravity oscillations in Lake Onega

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Abstract. Lake Onega is located in the southern part of Karelia, in the north-west of Russia. We report data taken by various limnigraphs and current meters and isolate, by spectral analysis, the most conspicuous barotropic periods of these signals. The analysis that follows is based on the linearized shallow-water equations, that are solved for the free oscillations and thus identify the eigenperiods and corresponding mode structures for this lake. Computational results are presented for a finite difference representation for these surface-seiche equations applied to the entire Lake Onega including its bays. The grid consists of quadratic elements of 1000 m side length corresponding to 9344 active cells. The emerging matrix eigenvalue problem exceeds the storage and compuational capacity of standard PCs or workstations and thus requires use of the approximate Lanczos procedure to isolate the first ten eigenperiods and corresponding mode structures of the barotropic seiches, lying between 12.1 and 2.2 h. Comparison of computational results and inferences from the water level and current-meter records, disclose satisfactory agreement between theory and observation.

1 Introduction

In this paper we describe and interpret some features of the barotropic motion recorded by limnigraphs and current meters moored or fixed at various positions and depths in Lake Onega. The measurements were done by Russian limnologists in the mid to late sixties and early seventies and are reported by Malinina and Solntseva (1972). Spectral analyses of time series of water level and velocity records disclose conspicuous signals at periods of 13 h and smaller. These periods can be interpreted in terms of the eigenperiods of the barotropic, linearized shallow-water equations, applied to the complex basin system of Lake Onega. However this interpretation is not so straightforward, first because the relatively couplex geometry of the lake requires the use of a finite difference representation of the shallow-water equations with high resolution. This implies that a very large matrix-eigenvalue problem must be solved, which, on standard PCs or workstations, is only possible with a sophisticated reduction of the matrix-eigenvalue problem to a form that allows accurate identification of but the few lowest order eigenfrequencies and corresponding modes. In the present situation the ten lowest eigenfrequencies are reliably computed. A second reason for the difficulty in interpreting the observations is that the complex lake geometry gives rise to correspondingly complex mode structures of the pertinent seiches. They need to be rather well known in order for the recorded data to be adequately interpreted. As a consequence, thumb rules such as Merian's formula will not lead very far in this interpretation.

After Lake Ladoga, Lake Onega is the second largest European lake, situated in Karelia, in the north-west of Russia. Owing to its complicated geomorphometry and a fringed northern shoreline the lake differs from the other great lakes of the world (Molchanov, 1946). There are five finger-like main bays extending north-westwards from the central part of the lake, and each possesses a number of small connected bays (see Fig. 1). The lake length, together with the length of the individual bays varies from 130 to 250 km. The average depth is 30 m, the maximum depth is 120 m, the surface area 9692.6 km^2 and the volume 291.2 km^3 (Kaufmann, 1990). After Stabrovskiy (1857) who performed the first limnological study, the latest and most detailed investigation on surface seiches of Lake Onega was carried out and described by Malinina and Solntseva (1972). Figure 1 displays the lake shoreline together with the 20, 40 and 60 m isobaths. The various numbers and letters in the figure indicate shore positions and offshore locations where instruments were deployed. Some of these positions carry local names which are also indicated in the figure. We will use the names and symbol identifications interchangingly.

A summary of results from the observations reported by Malinina and Solntseva (1972), are shown in Table 1;

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