Basal friction coefficient reconstruction for fast flowing ice streams in the Academy of Sciences Ice Cap

Yuri Konovalov and Oleg Nagornov

National Research Nuclear University "MEPHI", Department of mathematics (#30), Moscow, Russian Federation
(yu-v-k@yandex.ru, +7 495 3240425)

Basal friction coefficient reconstruction was performed by Tikhonov's regularization method along the flow line profiles, that cross fast flowing ice streams in the Academy of Sciences Ice Cap [Dowdeswell et. al., 2002]. Direct problem, i.e. ice flow velocity calculation for given friction coefficient distribution along the flow line, was performed by full 2D ice flow line finite-difference model [Pattyn, 2000; 2002]. Inverse problem, i.e. friction coefficient changes reconstruction from ice surface flow velocity data, is based on minimization of deviation between experimental and calculated ice surface flow velocities. Series of test experiments, when calculated ice surface flow velocities are used as experimental data in the inverse problem, have shown that the inverse problem for the full 2D ice flow line model is ill-posed. In other words, ice surface flow velocity is weakly sensitive with respect to relatively small perturbations of friction coefficient in the full 2D ice flow line model and, thus, the perturbations appear in reconstructed friction coefficient changes. The inverse ill-posed problem was solved by using Tikhonov's regularization method [Tikhonov and Arsenin, 1977], i.e. Tikhonov's stabilizing functional was added to the main discrepancy functional. The regularization parameter was defined from the discrepancy versus regularization parameter relations.

References:

Pattyn, F.: Ice-sheet modeling at different spatial resolutions: focus on the grounding zone, Ann. Glaciol., 31, 211-216, 2000.

Pattyn, F.: Transient glacier response with a higher-order numerical ice-flow model, J. of Glaciol., 48(162), 467-477, 2002.

Tikhonov, A. N., Arsenin, V. Ia.: Solutions of Ill Posed Problems. Winston & Sons, Washington, DC. 258 pp., 1977.