Response of permafrost to SRES A2 forcing in a climate model of intermediate complexity with a detailed soil module

M.M. Arzhanov, P.F. Demchenko, A.V. Eliseev, and I.I. Mokhov

A.M. Obukhov Institute of Atmospheric Physics RAS,
3 Pyzhevsky, 1191017 Moscow, Russia, e–mail: eliseev@ifaran.ru

The climate model of intermediate complexity developed at the A.M. Obukhov Insitute of Atmospheric Physics RAS (IAP RAS CM) [5] is extended by a detalied module for thermal and hydrological processes in soil [1, 2]. WIth the IAP RAS CM, a simulation is performed which is forced by the anthropogenic emissions of CO_2 and atmospheric concentration of CH_4, N_2O, and sulphate aerosols in accordance to historical data for the 19th-20th centuries and in accordance to scenario SRES A2 for the 21st century (more detailed description of these forcing scenarios is reported in [4].

The simulated area of the permafost extension varies little till the late 20th century varying in the range $20 - 21$ $mln\ km^2$ (Fig. 1). This value is between the estimated areas of the continious (10.7 $mln\ km^2$) and total (22.8 $mln\ km^2$). permafrost extensions [6]. Geographical distribution of the simulated permafrost (top panel in Fig. 2) is also realistic if compared with the empirical map from [6]. A notable exception is the region near the Baltic Sea where IAP RAS CM simulates permafrost absent in the observations.

In 21st century, permafrost cover shrinks rapidly. In the middle (late) 21st century the area of the permafrost extension attains the value 9 $mln\ km^2$ (2 $mln\ km^2$). (Fig. 1). The response in the second half of the 21st century is much stronger than obtained with the previous IAP RAS CM version [3]. To the middle of the 21st century, permafrost shrinks greatly in North America, and seasonal thaw depth increase drastically in Eurasia (middle panel in Fig. 2). To late 21st century, permafrost cover basically disappears in North America and shrinks about threefold in Eurasia (bottom panel in Fig. 2). In the latter case, typical thaw depth is larger than 2 m.

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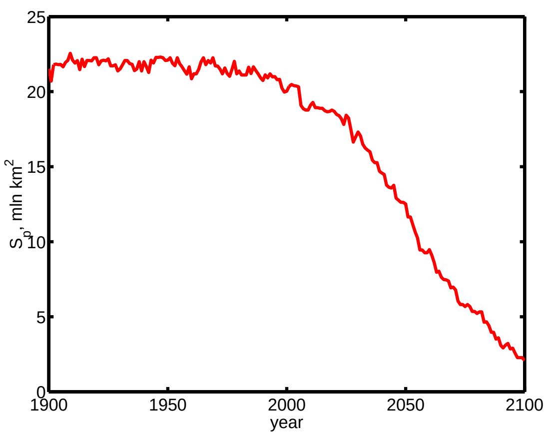

Figure 1: Area of the permafrost extension simulated by IAP RAS CM.

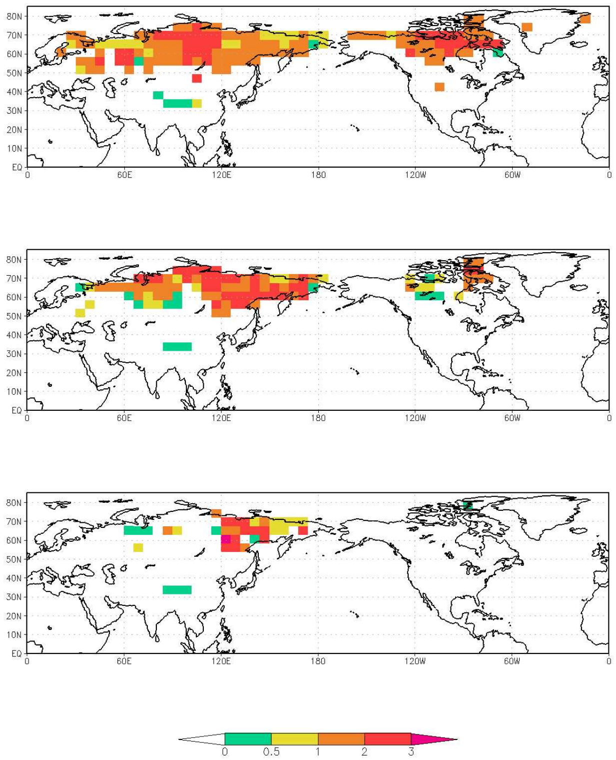

Figure 2: Mean seasonal thaw depth (meters) in the Northern hemisphere simulated by IAP RAS CM for 1961–2000, 2035–2065, and and 2071–2100 (top, middle, bottom panels respectively) under the SRES A2 forcing scenario.

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