INFLUENCE OF SNOW COVER ON SOIL MOISTURE AND FROST DYNAMICS IN WINTER OF 2016–2017 IN CZECH REPUBLIC

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The timing and thickness of snow cover significantly affected the frost and soil moisture during the winter 2016/2017 in the Czech Republic. Snow began to fall at the beginning of winter in Bohemia, much later in Moravia. Very low January air temperatures caused the soil freezing. The maximum freezing depth was 0 to 20 cm in Bohemia, 20 to 80 cm in Moravia. Soil frosting had a very powerful effect on the infiltration of the melting snow and runoff. While the relatively thick frozen layer impeded infiltration in Moravia, in thin frozen layer in Bohemia, infiltration of meltwater was unimpeded. The measurement showed the rise in soil moisture in the soil profile of 0-100 cm at the end of the winter in Bohemia, on the contrary, the decrease in moisture in Moravia. Snow-cover characteristics significantly influenced soil moisture in the later growing season. These results clearly show that the changes in the timing and thickness of snow cover deposition can cause a dramatic reduction of frost depth and change in the soil water dynamics.

Keywords: soil temperature, soil moisture, snow cover, soil freezing

INTRODUCTION

Rainfall in the winter is very important for replenishment of water in the soil. The linkage between snow mass, snow disappearance and soil moisture has been studied by Shinoda (2001), who suggests that soil moisture over Eurasia recharged by snow melt has a short memory due to large overland runoff over permafrost surface, and that its direct thermal effect on land surface temperature may not be as significant as previously thought. The ecological and hydrological impacts of snow cover are important for environmental and water-resource issues (Arslan et al., 2006; Peng et al., 2010). Snow-cover model is used for soil moisture modeling in the Czech Republic (Trnka et al., 2010).

Potopová et al. (2015) analysed the role of snow cover during the cold season (October–March) on soil moisture deficit and drought development during the growing season (April–September) in the lowland and highland sites in the Czech Republic. Snow-cover characteristics can significantly influence soil water saturation during the first part of the growing season, while seasonal amount of snow water equivalent can explain up to 45% of soil moisture variability during April–June season.

MATERIALS AND METHODS

The Czech Hydrometeorological Institute operates a network of meteorological stations, which also measure snow cover, soil temperature, moisture and freezing in the Czech Republic. The selected network of stations usually measures the soil moisture content at the 0- to 0.1-m, 0.1- to 0.5-m, and 0.5- to 0.9-m layers using sensors placed within the natural soil profile under closely cropped grass cover (Možný et al. 2012, 2013). An automatic cryptopedometer is used for continuous measurement of soil freezing (www.asconsult.cz).

For the purpose of this paper, we chose the three meteorological stations – Doksany (158 m asl, 014°10' E, 50°27' N), Liberec (398 m asl, 015°01' E, 50°46' N) and Brod nad Dyjí (175 m asl, 016°32' E, 48°52' N, Fig. 1).

The measured soil moisture was expressed in % of available water content (AWC) in the soil.

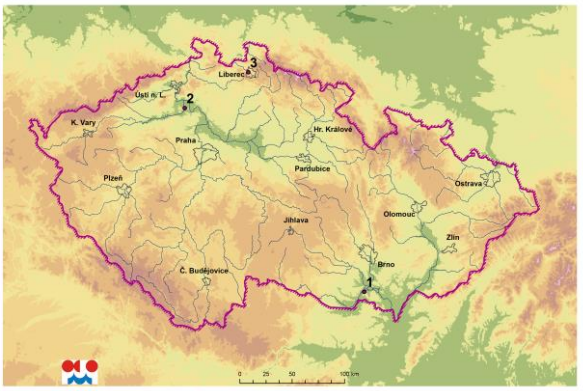

Figure 1. The selected meteorological stations in the Czech Republic: (1) Brod nad Dyjí, (2) Doksany, (3) Liberec.

RESULTS

The continuous snow cover was in Liberec from 3th January to 19th February 2017, in Doksany from 1th January to 8th February 2017, in Brod nad Dyjí from 4th to 20th January and from 1th to 5th February 2017. The maximum depth of the snow cover was 41 cm in Liberec, in Doksany 11 cm and in Brod nad Dyjí 13 cm. The continually freezing soil was in Liberec from 31th December 2016 to 3th January 2017, Doksany from 31th December 2016 to 18th February 2017, Brod nad Dyjí from 25th December 2016 to 22th February 2017. The maximum freezing depth was 1 cm in Liberec, 18 cm in Doksany and 56 cm in Brod nad Dyjí (Fig. 2).

The average soil moisture in the 0-50 cm layer fluctuated from 80 to 100% AWC in Liberec, from 45 to 54% in Doksany and from 22 to 47% in Brod nad Dyjí. While the soil moisture in Liberec and Doksany was 28th February 2017 higher than 25th December 2016, in Brod nad Dyjí was lower. The snow cover

has positively influenced the soil moisture in Liberec and Doksany, in Brod nad Dyjí practically did not affect (Fig. 3).

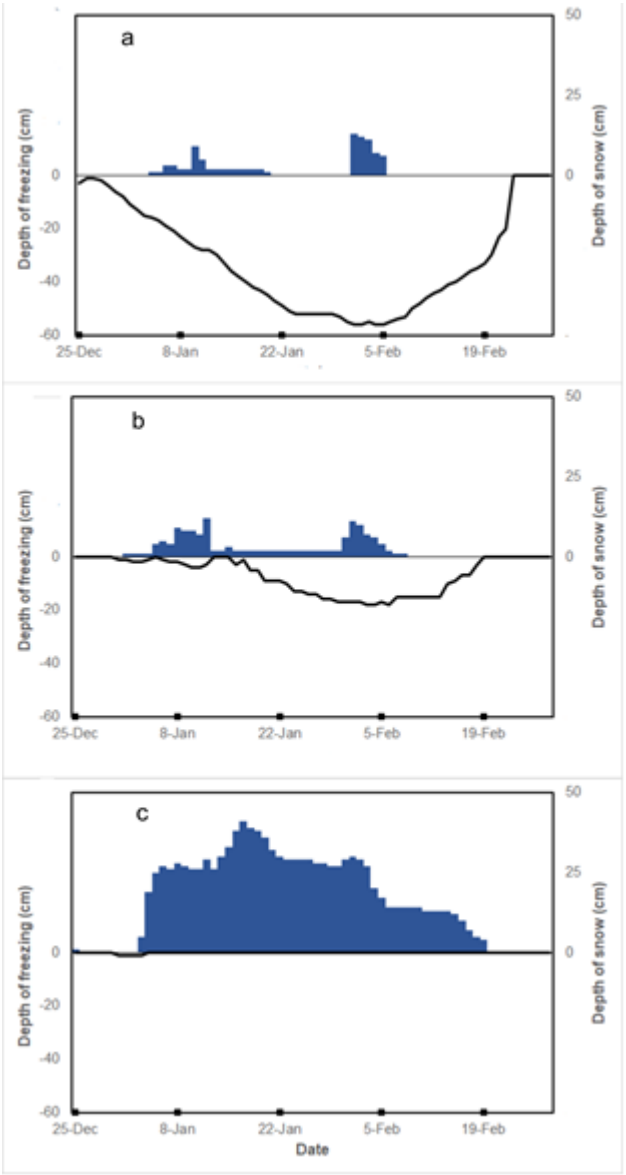

Figure 2. Fluctuations of snow cover and maximum soil freezing depth in the selected meteorological stations from 25th December 2016 to 28th February 2017: (a) Brod nad Dyjí, (b) Doksany, (c) Liberec.

The winter of 2016-2017 was again frosty and snowy in the lowlands after a long period of time in the Czech Republic. The absolute minimum air temperature was -18.4 °C in Liberec, -18 °C in Doksany and -17.8 °C in Brod nad Dyjí. During the winter, it was nine days with minimum temperatures below -10 °C.

CONCLUSION

The timing and thickness of snow cover significantly affected the frost and soil moisture during the winter 2016/2017 in the Czech Republic. Soil freezing had a very powerful effect on the infiltration of the melting snow and runoff.

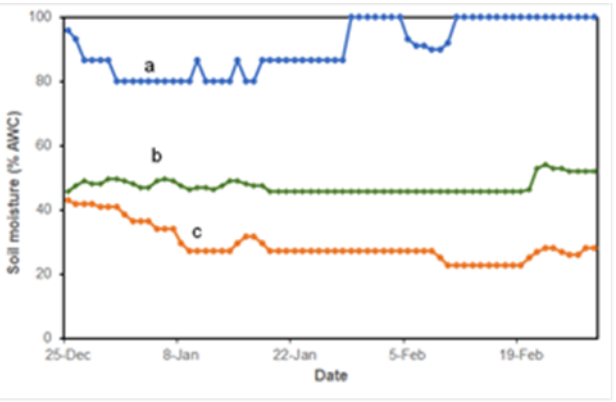

Figure 3. Fluctuations of average soil moisture in the 0-50 cm layer in the selected meteorological stations from 25th December 2016 to 28th February 2017: (a) Liberec, (b) Doksany, (c) Brod nad Dyjí

While the relatively thick frozen layer impeded infiltration in Brod nad Dyjí, in thin frozen layer in Doksany and Liberec, infiltration of meltwater was unimpeded. The measurement showed the rise in soil moisture in the soil profile of 0-100 cm at the end of the winter in Doksany and Liberec, on the contrary, the decrease in moisture in Brod nad Dyjí. Snow-cover characteristics significantly influenced soil moisture in the later growing season. These results clearly show that the changes in the timing and thickness of snow cover deposition can cause a dramatic reduction of frost depth and change in the soil water dynamics.

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