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Assessing the efficiency of machine made snow production using observations in ski resorts

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The interannual variability of snow conditions has encouraged ski resorts to mitigate their dependency to weather conditions through snowmaking facilities. However the efficiency of the method i.e. the ratio of water actually converted into snow on ski fields to the water used for production may highly differ depending on meteorological conditions and is still poorly known. Previous investigations of water losses accounting for sublimation and evaporation estimated that 5 to 10% of the water was lost during the snowmaking process. A recent study consisting in a field campaign on four distinct sites (2014-2015 winter season) estimated that water losses may exceed 50% and speculated this to be due to a combination of wind effects (suspension, further sublimation and transport beyond ski slopes limits) and trapping by the vegetation.
The present study introduces a method we set up to assess water losses during the snowmaking process by using differential GPS measurements on machine made snow piles: snow depth observations are interpolated on a regular spatial grid from the originally variable grid. Snow and water volumes are deduced thanks to complementary density measurements. The uncertainty of the interpolation method was assessed using a high-resolution laser scanner of a given snow pile and with respect to a digital terrain. Uncertainties on snow depth, snow density and the resulting water equivalent volume are presented and discussed. The method provided relevant measurements of water volumes within a 20 to 30 m distance to the snowgun. Beyond this distance, the relative error due to increasing interpolation error and decreasing snow depth highlighted the limits of the method. However water volumes were derived in several occasions during the season and confirmed that a significant ratio of the water volume either falls beyond a 30 m distance to the snowgun or is lost due to sublimation and evaporation.