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Secondary factors used to improve rain snow parameterization in surface based models

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Accurate precipitation phase determination is a primary necessity for cold region surface based hydrological, ecological, climate, and safety models. Many surface based models use a threshold temperature to determine precipitation phase. Unfortunately, precipitation phase at earth's surface is a result of cloud and atmospheric properties that are not commonly measured by surface weather stations. To bridge this gap, it is possible to use a temperature measurement along with secondary factors such as; sea surface temperature, the presence or lack of snow cover, NAO phase over a period of time, cloud height, and or change in temperature over time. These proxies should give more information about the likely atmospheric conditions such as stability and thickness of an unsaturated layer above a weather station at the time of a surface observation.

This study uses 681,620 weather observations with an air temperature (AT) -3 to 5°C and an identified precipitation phase occurring during the observation to identify rain snow thresholds resulting in the least misclassified precipitation for AT, dew-point temperature (DT), and wet-bulb temperature (WB). This dataset represents 38 and 42% of precipitation observations over a 16 year period for 85 and 84 Swedish and Norwegian weather stations respectively.

The Norwegian observations between -3 and +5°C resulted in 11.64, 11.21 and 8.42% error for DT (-0.2°C), AT (1.2°C) and WB (0.3°C) thresholds respectively. Individual station thresholds had a range of -0.7 to 1.2°C, -1.2 to 0.9°C, and -0.1 to 2.5°C for WB, DP, and AT respectively.

Optimal thresholds for landscapes should vary between landscapes, but decrease threshold variance within the stations belonging to a landscape. This is due to expected changes in land-surface energy exchanges with the atmosphere between landscapes. In this case the influence of topography and oceans was explored by grouping weather stations into landscapes based on % water, and if under 10% water, elevation range within a 15km circle around each station. The landscapes used were; windward (WW) ocean, WW coast, WW fjord, WW hill, WW mountain, leeward (LW) mountain, LW hill, LW rolling hills, and LW coast.

The secondary factors of; sea surface temperature, the presence or lack of snow cover, NAO phase over a period of time, cloud height, and or change in temperature over time were tested for landscapes and whole countries where available. It was found that just under 2% of the error for air temperature could be decreased from using landscape classification, and the secondary factors could be used to further decrease the misclassified precipitation. For example, in Norway, as the unsaturated layer depth beneath clouds increased from 0 – 1000m, AT thresholds warmed. Cloud height adjusted AT thresholds reduced error by 5% before threshold adjustments for landscapes.