REGIONAL PRECIPITATION IN SWEDEN IN RELATION TO LARGE-SCALE CLIMATE

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ABSTRACT

Variations in regional precipitation have practical implication on for example energy production, agriculture and forestry. In this work, spatial and temporal patterns of precipitation variations in Sweden in relation to the large-scale climate were studied based on instrumental records. The studies were made with respect to monthly and extreme daily precipitation. The knowledge of the links between monthly precipitation and the large-scale climate was applied in statistical downscaling of scenarios produced by General Circulation Models (GCMs).

The patterns of variation were examined by applying Empirical Orthogonal Function analysis and Canonical Correlation Analysis (CCA) on monthly precipitation data for 33 stations and on sea level pressure (SLP) of a European-North Atlantic sector for the period 1899-1990. The CCA were used in the development of statistical downscaling models of Swedish precipitation, which were applied to data of the HadCM2 GCM. Three dominant SLP modes were identified to largely affect precipitation in Sweden: 1) a North Atlantic Oscillation pattern; 2) a cyclonic/anticyclonic structure centred over the British Isles; 3) a dipole structure with a west/east gradient over Scandinavia. Changes in frequency or strength of these are shown to be linked to identified shifts in Swedish precipitation.

Another type of statistical downscaling model of monthly precipitation was based on multiple linear regression using large-scale circulation indices of the two geostrophic wind components, vorticity and large-scale humidity at 850 hPa as predictors. The regression models were applied to output of ECHAM4 and HadCM2 GCMs. The control and scenario climates of the GCMs were all based on ten-year periods. The multiple regression-based downscaling models are significantly better than the CCA models in reproducing the present precipitation climate. The statistically downscaled scenarios were compared with dynamically downscaled scenarios generated by a 44 km version of the Rossby Centre regional climate model driven by the two GCMs. There are quite large differences between the statistically and dynamically downscaled scenarios, but they all show a tendency of larger increases in winter, autumn and annual precipitation in the northern half than in the southern half of Sweden.

In the analysis of extreme daily precipitation 366 stations are used. Regional patterns of extreme daily precipitation are identified through Maximum-likelihood factor analysis. Based on the 11 regions identified, the climatological differences in the atmospheric conditions during extreme (≥40 mm) and non-extreme (1-39.9 mm) precipitation events are studied. As expected, most significant differences among all variables examined were found for specific humidity and vertical velocity. With respect to atmospheric circulation, extreme precipitation is favoured by a strong southerly wind component and weak westerly wind and wind speed. The cyclonic weather type is much more common during extreme events (~70%) than during non-extreme events (~45%).

KEYWORDS: precipitation variations, statistical downscaling, extreme precipitation, regionalisation, Sweden