Possible tropical sources of predictability for inter-annual variability of summer precipitation over Nordic European countries

SMHI

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Introduction

We analyse the inter-annual variability of summer precipitation over Nordic European countries, focused particularly on Sweden and Finland, and its connection to global variability. After finding a link between summer precipitation over Nordic European countries and tropical and subtropical variability over the Pacific and the Caribbean during early spring, we show the potential predictability of summer precipitation over Nordic European countries based on a multi-linear regression model.

Methodology

Lagged Pearson correlations between the averaged summer (JJA) precipitation over a region covering portions of Sweden and Finland (SwedFin, see Figure 2f) and global monthly (from January to July) geopotential height at 500 hPa (z500) data were calculated. We then identified the lag that allowed the strongest correlation values between precipitation and z500. Two areas exhibiting high correlation were tested to be used as predictors for a multiple linear regression model, to predict precipitation in all Nordic European countries. We assess the skill of the model to predict summer precipitation data with a leave-one-out cross-validation procedure (where each yearly sample is left out of the model calibration in turn and predicted once). We use the Heidke skill score (HSS), which is a measure of categorical hits versus misses based on terciles (wet, normal or dry).

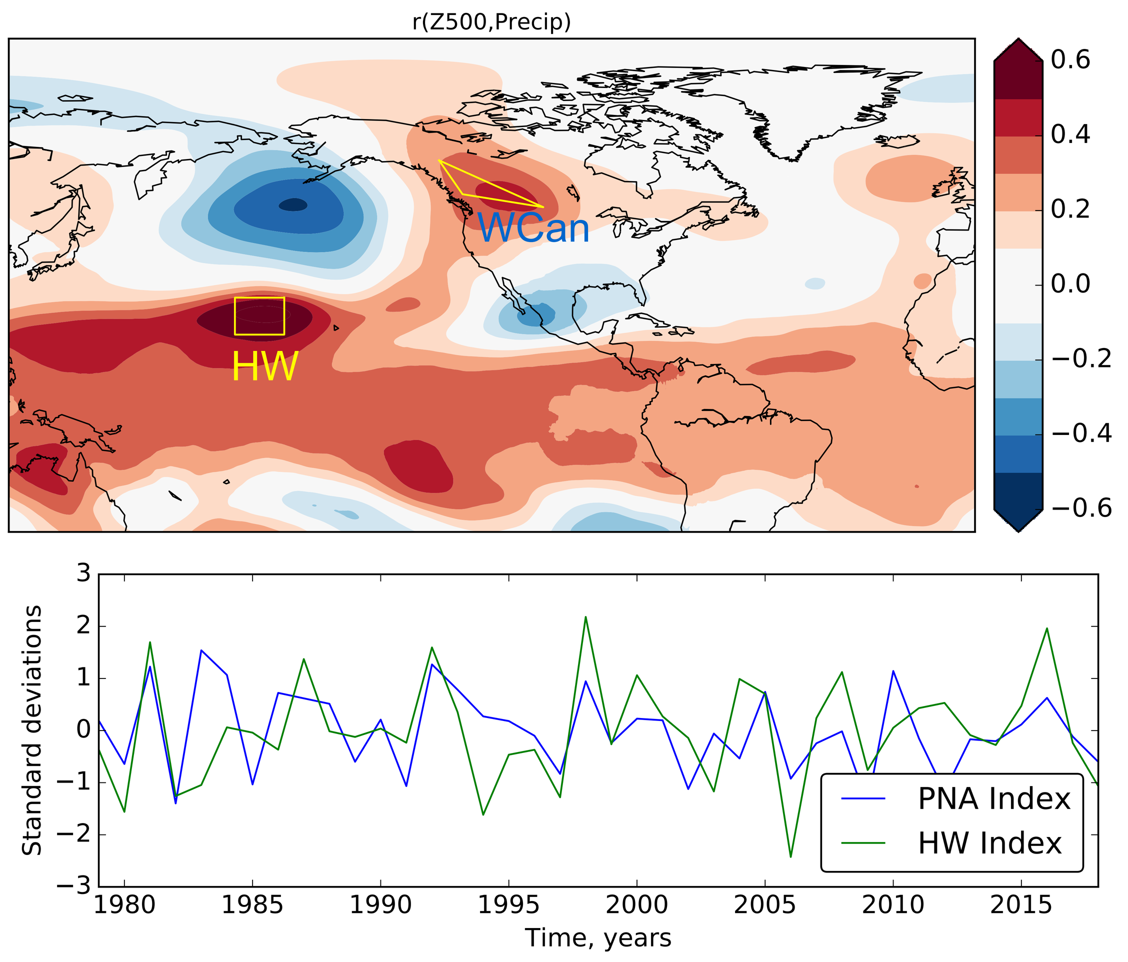

Figure 1. a) Correlation between summer (JJA) SwedFin precipitation and Z500 during March. Regions used as predictors (HW and WCan) for the multiple linear regression model for summer SwedFin precipitation are enclosed with yellow lines. Z500 data from ERA5 and summer SwedFin precipitation from EOBS dataset at 25km. b) PNA and HW Z500 standardized timeseries.

Results and discussion

A PNA-like pattern emerged from the correlation between summer SwedFin precipitation and Z500 during March (Figure 1). The predictor HW, shows global linkages across different variables (Figure 2). Implying a modified walker circulation, with intensified air-rising motion over the Eastern tropical Pacific, Mexico and over the Caribbean Sea, while intensified descending motion over the western Pacific during positive HW. This large-scale signal over the Pacific starts on late winter and remains until summer. Wulff et al. (2017) proposed that an the increased convection induce an extra-tropical Rossby wave train crossing the North Atlantic. However, western Pacific Z500 anomalies could also cause a second Rossby wave train reaching Northern Europe across the western Arctic, region that shows positive Z500 and negative sea ice concentration correlations with HW.

Using as predictors observed March HW and WCan, we propose an lagged empirical multi-linear regression model for summer precipitation over Nordic European countries. The leave-one-out cross-validation shows a correlation between modelled and observed summer precipitation of r=0.60 (Figure 3a). Spatial weights for every predictor are shown in Figure 3b-c. The result of applying the model to everygrid point shows r(model,obs)>0.6 for some regions, while the HSS>90% for large portions of Sweden and Finland. Our simple model allow us to reproduce the spatial patterns of observed dry and wet years.

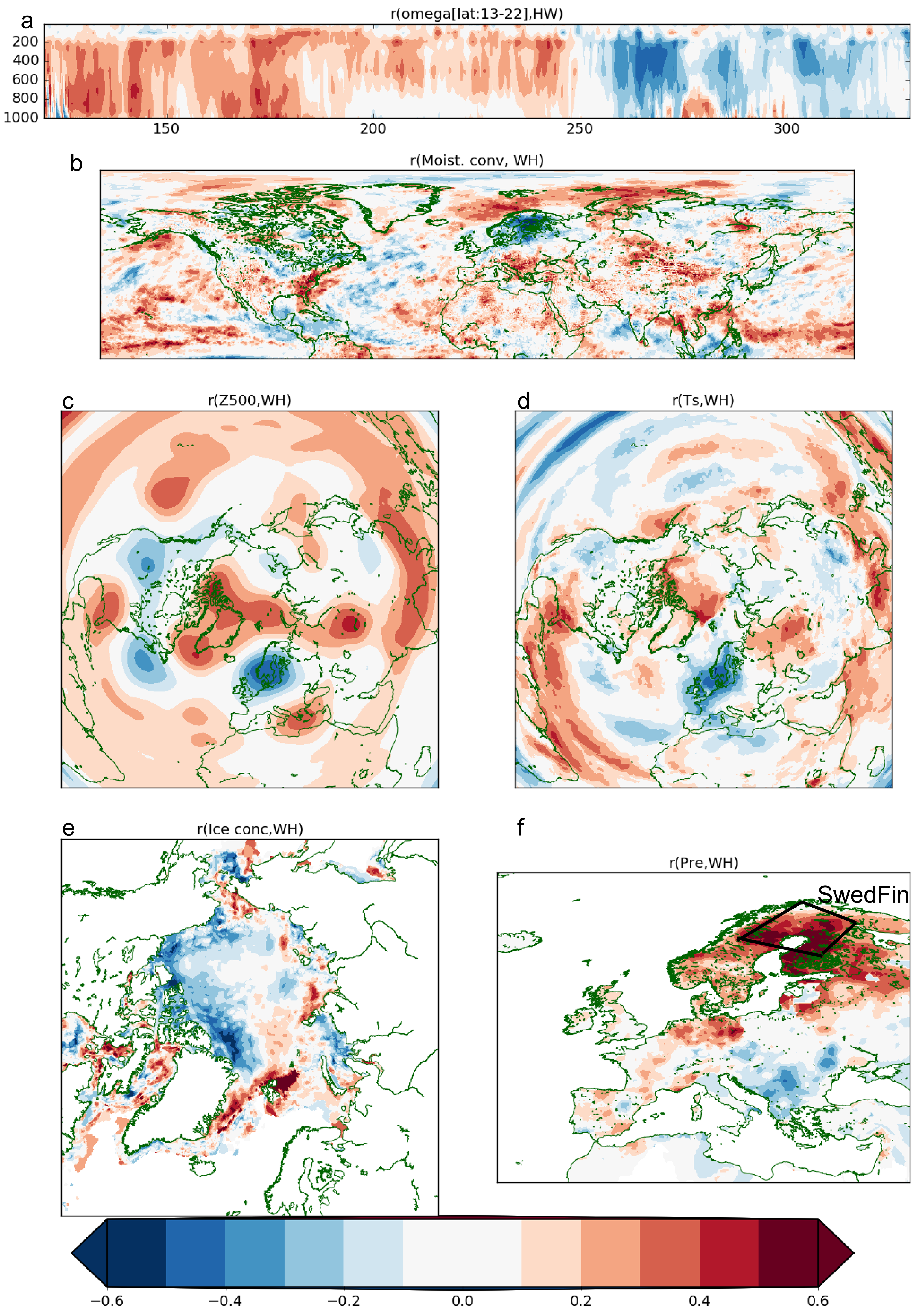

Figure 2. a) Correlation between HW during March and a) omega, b) vertically integrated moisture divergence, c) Z500, d) surface temperature, e) sea Ice concentration and f) precipitation during JJA..

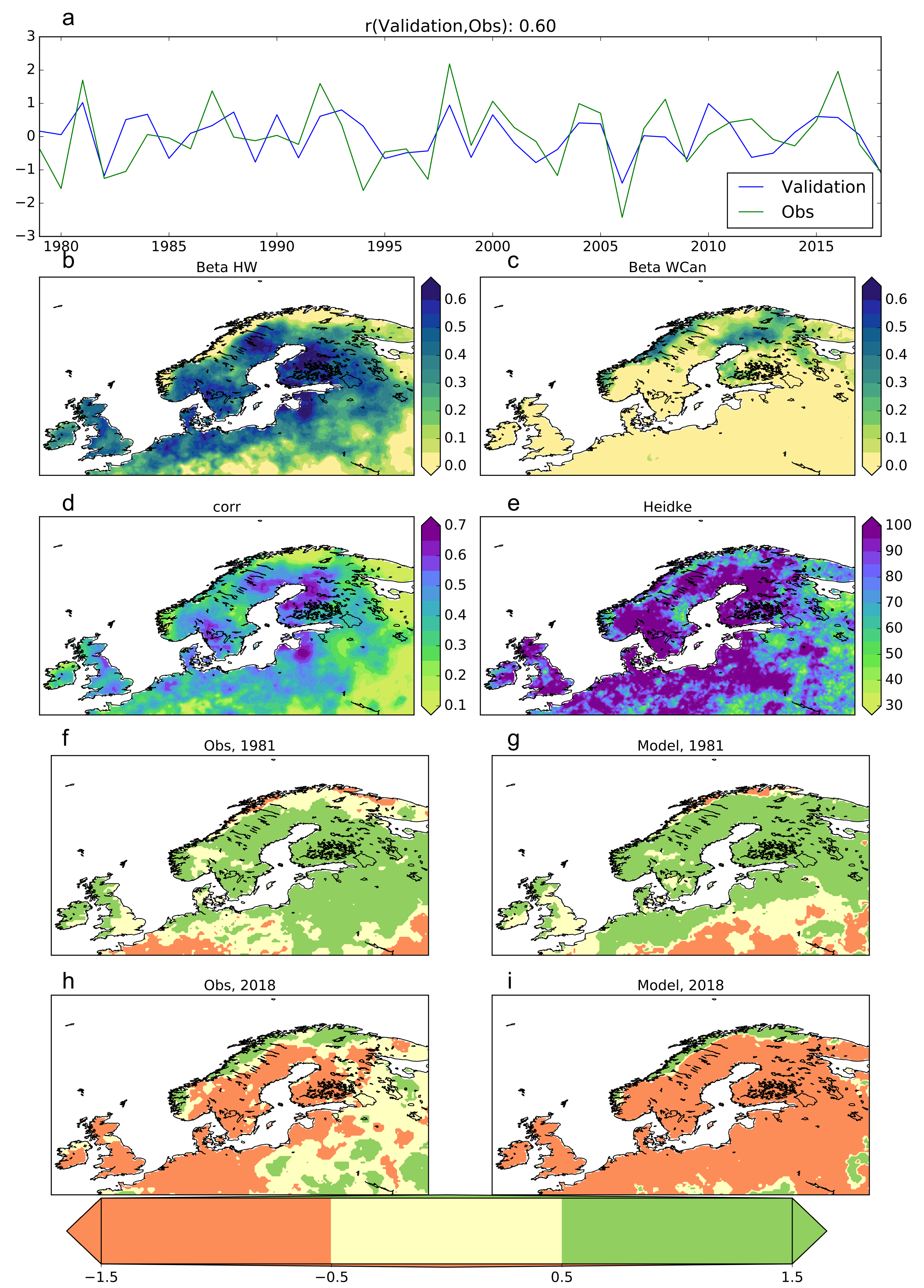

Figure 3. a) Observed JJA precipitation over the SwedFin region and leave-one-out cross-validation (where each yearly (summer) sample is left out of the model calibration in turn and predicted once) time series. Estimated coefficients for the linear regression for b) HW, and c) WCan predictors. d) Correlation between observations and model by gridpoint. e) Heidke skill score. f) Observed and g) modelled precipitation anomaly for 1981. h) Observed and i) modelled precipitation anomaly for 2018. Anomalies are shown in standard deviations, the colorbar show wetter than normal (green), normal (yellow), and drier than normal (orange) conditions.

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