

Supplementary material

Comparison between observations and simulations over the historic period

Over the historical reference period (1956–2005), all regions experience a warming trend. Precipitation increases across most areas, while eastern Sweden shows slight decrease. Despite rising precipitation, snow depth declines, indicating a shift from snowfall to rainfall and reduced snow accumulation over time, except in the Norwegian mountains that show increase in snow-depth trends (Fig. S1a).

Raw simulations reproduce the observed large-scale spatial patterns over the historical period, including the 50-year ensemble mean averages and the overall direction of trends (Fig. S1b). However, systematic biases in averages are evident, with all three variables showing higher ensemble mean values than the observations (Fig. S1a,b). The simulated trends also differ from the observations with all variables exhibiting weaker mean trends than observations.

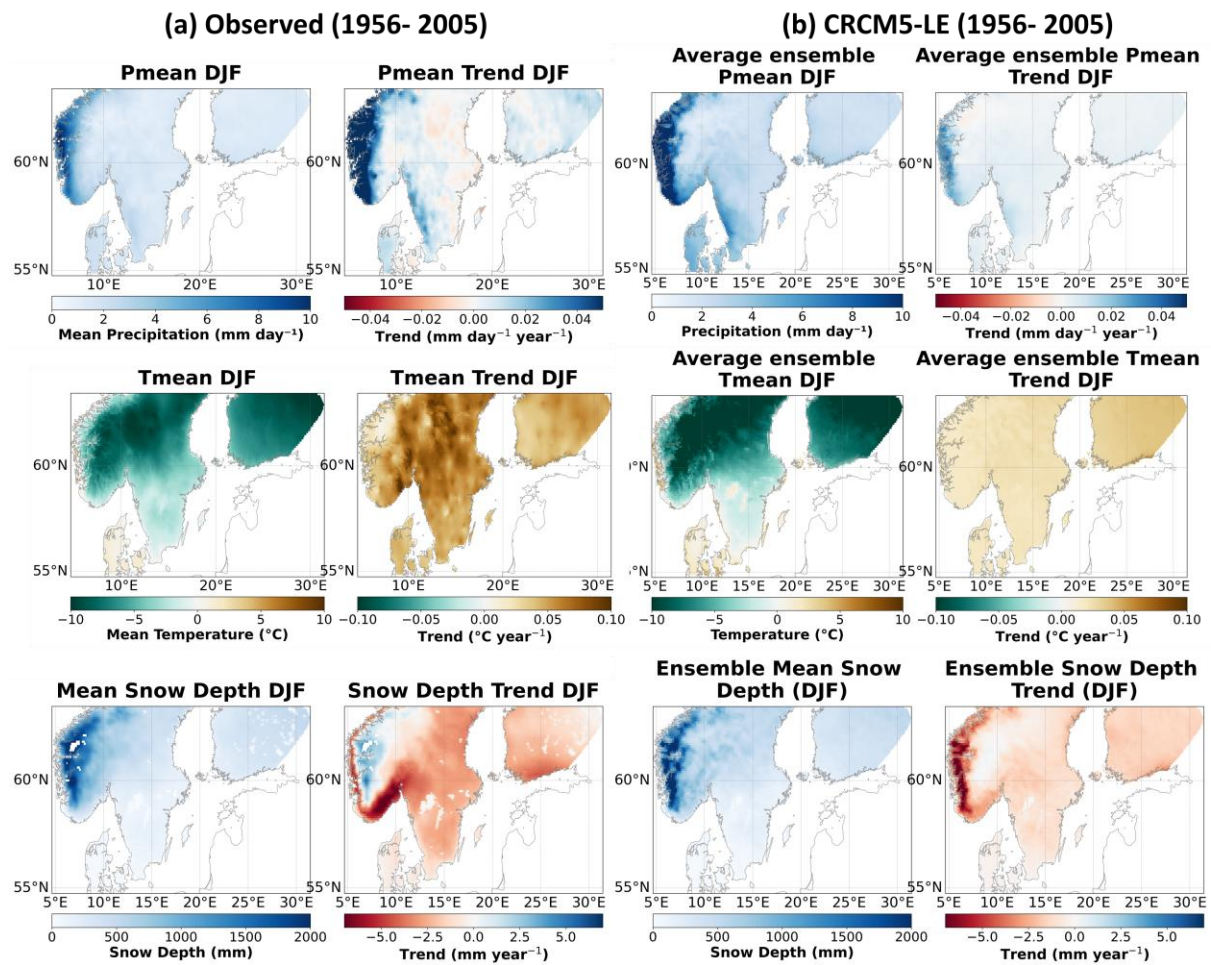


Figure S1: Historical (1956–2005) winter (DJF) daily mean precipitation (Pmean), temperature (Tmean), and snow depth (SNDmean), and their long-term trends, shown for (a) observations and (b) the 50-member ensemble mean of CRCM5-LE.

20 Comparison of time of emergence via two methods

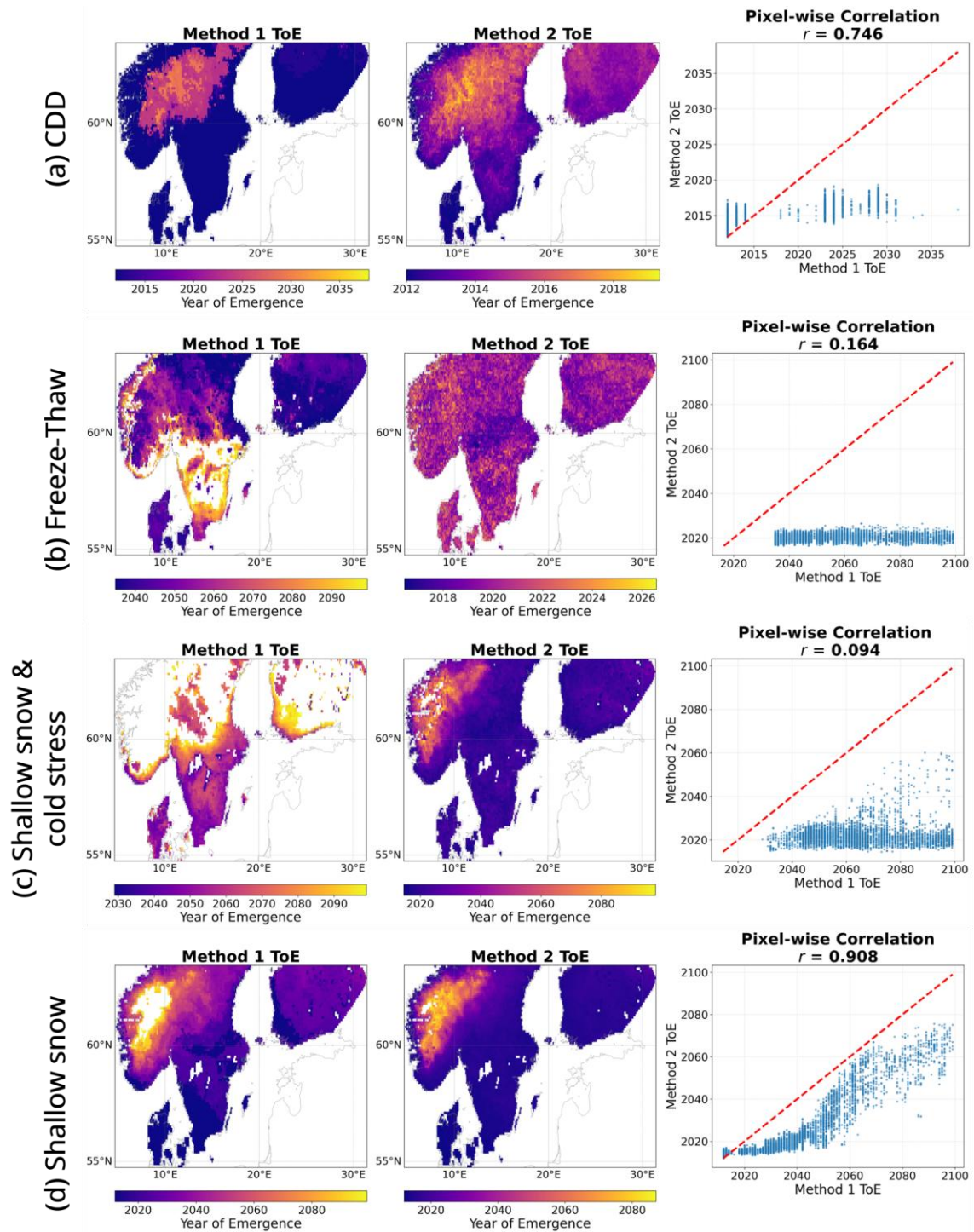


Figure S2: Comparison between the Time of Emergence estimates from two methods, including pixel-wise correlations for (a) CDD, (b) freeze-thaw cycles, (c) shallow-snow cold stress, and (d) cold stress.