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Exploring the Influence of Spatiotemporal and Meteorological Variation on Norwegian Atmospheric Pollen

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Background & Aims: Being able to predict plant responses to their environment is essential in many ecological, economical and medicinal disciplines. This is especially relevant in terms of climate change, which is expected to affect temperature, precipitation and all derivate meteorological patterns via changing atmospheric and oceanic circulation. Plant phenology has been shown to be strongly dependent on environmental variation, both short-term via weather fluctuations and long-term via climate change, with consequences to food-webs, production potential and pollen seasonality. This is relevant for many species, including but not limited to birches, oaks and grasses, all of which produce highly allergenic pollen to many human populations. However, to what degree different types of environmental variation is expected to alter pollen seasonality has not been fully explored for all pollen types, and many research findings remain contradictory. The primarily aim of our study is to explore how temporal, spatial and meteorological variation contributes to pollen seasonality, and if possible identify ecological relationships influencing the variation.

Methods: We modelled the daily concentrations of seven common Norwegian pollen types: hazel (*Corylus*), alder (*Alnus*), willow (*Salix*), birch (*Betula*), pine (*Pinus*), grass (Poaceae) and mugwort (*Artemisia*) using generalized linear models with negative binomial distributions. The data was obtained from 12 regional sampling stations and for up-to 28 years. The individual models contained three temporal (DOY, month and year), four spatial (latitude, longitude, altitude and sampling height) and six meteorological variables (air temperature, precipitation, relative humidity, atmospheric pressure, wind speed and solar radiation). The meteorology was obtained from the MET Nordic dataset with full cover. The variables were compared thematically and individually in a reduced-model framework using chi-squared anova tests supplemented by AIC and Nagelkerke Pseudo-R2 to assess the variation contribution.

Results: The full models were able to explain the most variation in comparison to reduced models, with R2 up-to 49.5%, 51.7% and 59.5% for pine, birch and grass pollen respectively. Temporal variables were able to explain more variation than spatial or meteorological variables on average for most pollen types, with the exceptions being hazel and grass, for which spatial variables had higher explanatory power. While the contribution of individual variables varied based on the pollen type, on average, month, altitude and maximum temperature were the variables in each thematic category with the highest contribution.

Conclusion: Temperature cues and the natural timing of phenological development were identified as the main pools of variation for the pollen seasonality. While our models could explain a substantial proportion of the variation, model understanding could likely be enhanced by including source maps and regional atmospheric transport modelling.

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