Modelling occurrences of alpine – lowland species pairs
a case study from western Norway

NINA
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Introduction:

Background:
A spatial displacement of species´ climatic niche is expected as a result of Climate Change. Species differ in the size and the shape of their climatic niches, and all species are therefore not expected to start migrating at the same time, or to displace at the same rate. This predicts new species assemblages, and new species interactions in the future.

Many lowland and alpine species pairs from the same genus have limited overlapping distributions today and consequently do not interact much with each other. Can that pattern change in the future? What new species interactions can be expected?

Aim:
We used spatial logistic regression to model the realized climatic niche of 3 alpine/lowland species pairs in western Norway. The models will serve to investigate the expected alpine/lowland species interactions under projected future climates. The methodological approach and the first results are presented here.

Predictor variables:
- Tetraterm temperature
- Annual precipitation
- Solar radiation
- Bedrock
- Land-use

Species data:
- Obtained from the GBIF database
- Pseudo-absences: Sites where target species were absent, but species sharing similar habitats preferences (e.g. grassland species) were present.

	Predictors		
	Tetraterm temperature	Annual precipitation	Bedrock
Veronica alpina	2 - 9°C	~	~
Veronica officinalis	>8°C	~	~
Viola biflora	4 - 8°C	< 2000mm	~
Viola palustris	>8°C	>1000mm	Poor
Carex capillaris	3 -11°C	< 3500mm	Rich
Carex pallescens	>8°C	~	~

Table 1: Environmental modeled preferences for the studied species. Explanatory variables are ordered by predicting power. ~ = not significant, absent variables were significant for none of the species

• Climate factors were overriding all other predictor variables for all six species.

• Temperature ranges and optima varied between the alpine species

• Two of the alpine species responded negatively to precipitation

-> Not all species will be similarly affected by climate change.

-> New species interactions and new plant communities can be expected over the next decades

Models accounting for spatial autocorrelation:
Spatial Autocorrelation (SAC) can arise from e.g. the structure of environmental predictors, aspects of species dynamics such as limited dispersal, or from sampling. SAC creates a bias in models because it violates the assumption of independently and identically distributed errors. SAC was incorporated in the presented model by using Binomial glms with exponential spatial correlation structures fitted using penalized quasi-likelihood (glmmPQL in R).

• Spatial autocorrelation was present for all species except *Viola palustris* and *Carex pallescens*.

• Spatial models efficiently decreased SAC in the normalized residuals for all six species.

•No improvement or change in model accuracies.

Validation and models accuracies:
Kappa, AUC, sensitivity and specificity on training and external independent datasets.
High AUC for all species but *Viola palustris* and *Carex pallescens* (<0.65).

Modeling approach and specific results for the two *Veronicas*:

Explanatory spatial variables

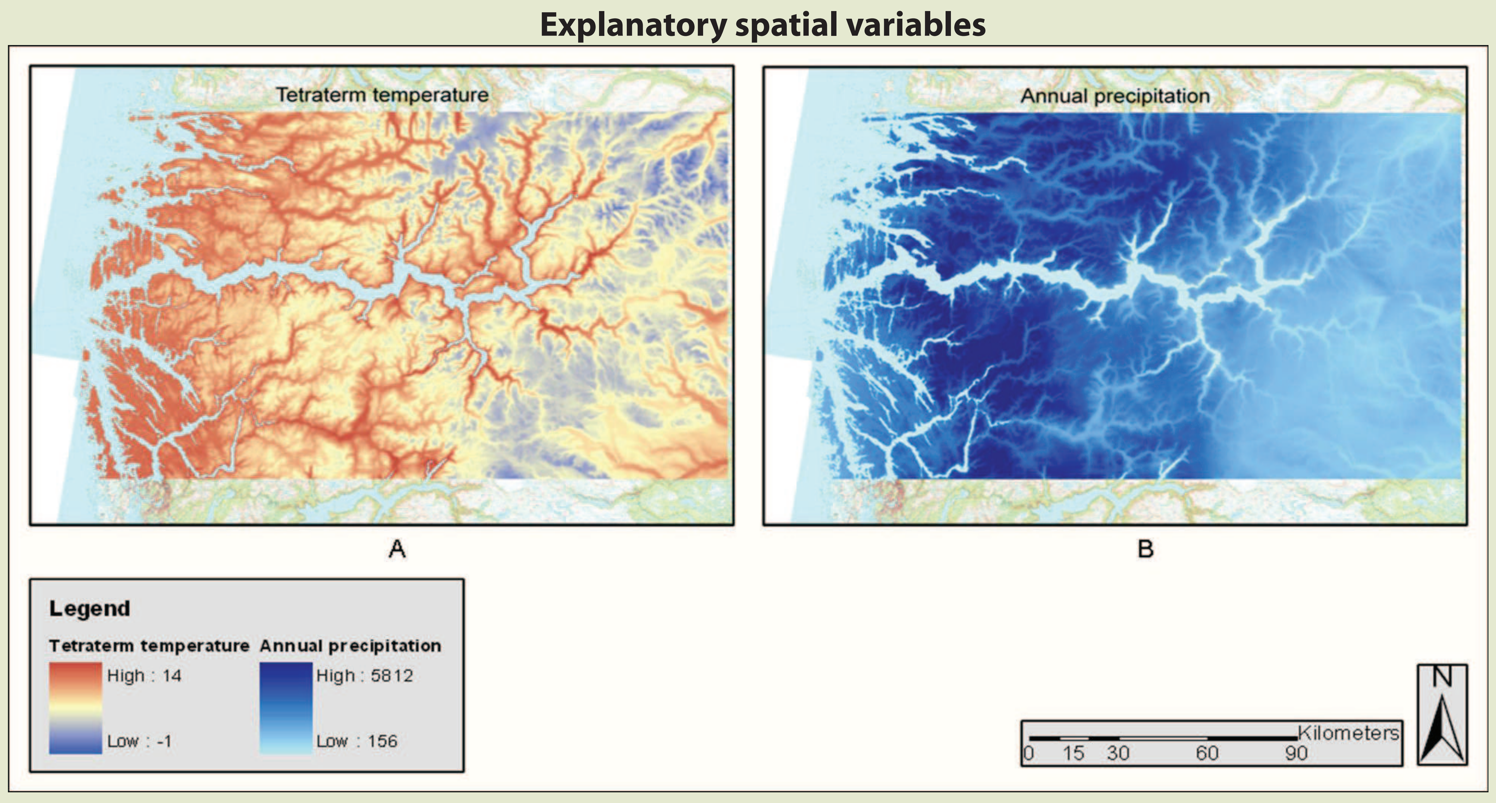

Figure1: Climate interpolations used as explanatory variables (data from the Norwegian Meteorological Institute)

Building models

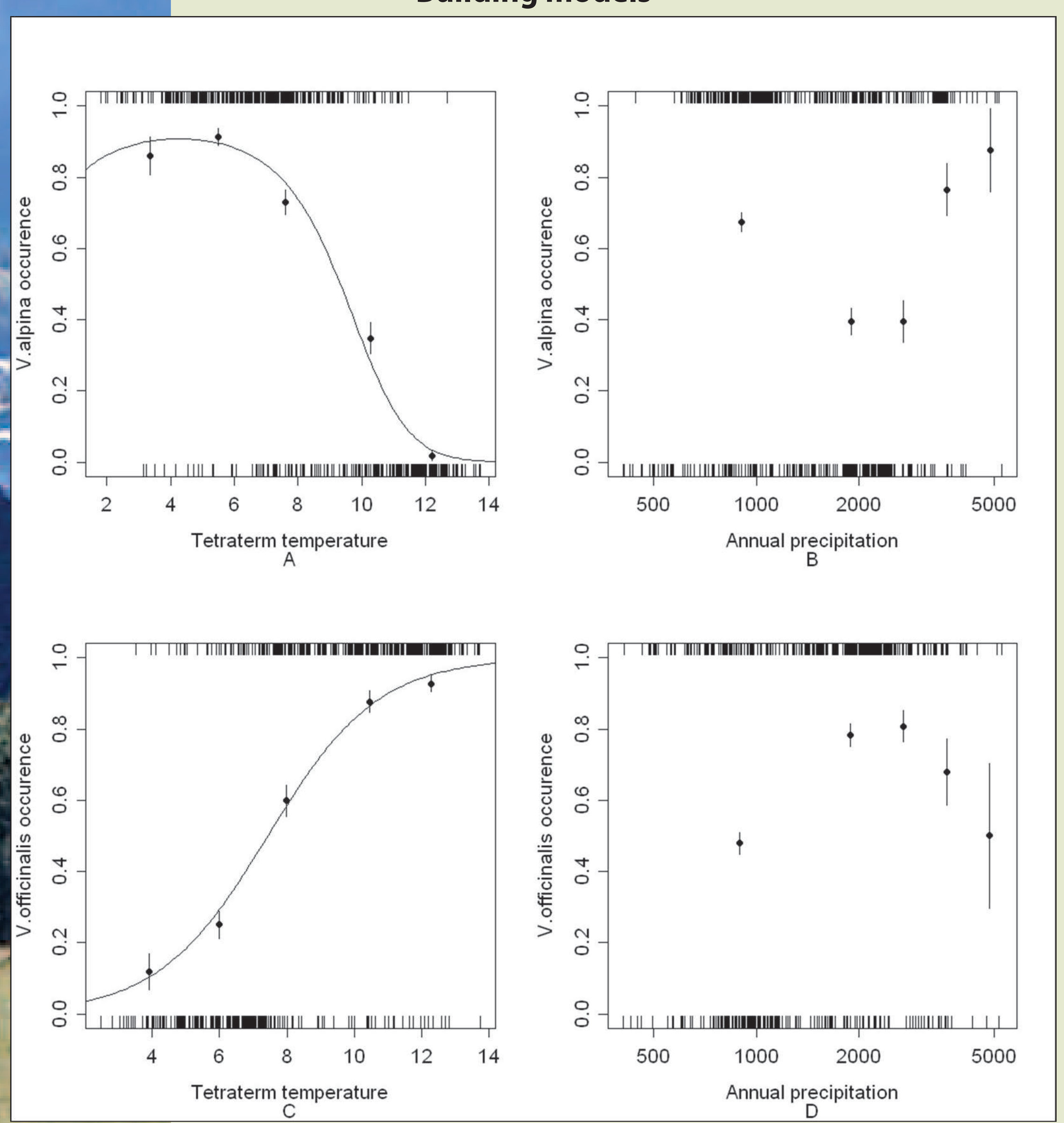

Figure 2: Species response to climate factors. Curves = predicted response to tetraterm temperature at mean annual precipitation (A,C), and predicted response to annual precipitation at mean tetraterm temperature (B, D). Dots and vertical lines: Dots = mean values of species occurrence after dividing the dataset into 5 equal bins; Vertical lines=standard errors. Lines at the top and the bottom = Observations of presence absence from the training dataset.

Assessing spatial autocorrelation for spatial and non spatial models

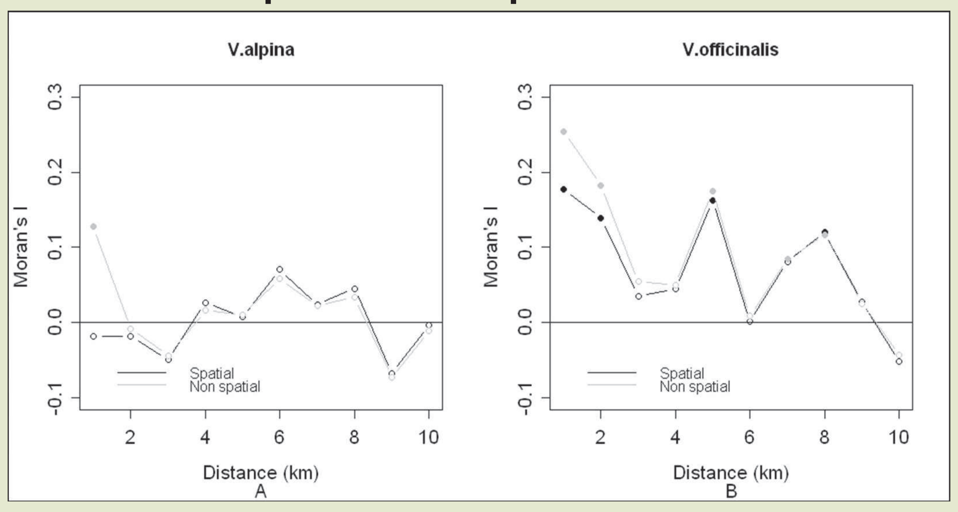

Figure 3: Assessing spatial autocorrelation for spatial and non spatial models

Optimization and validation

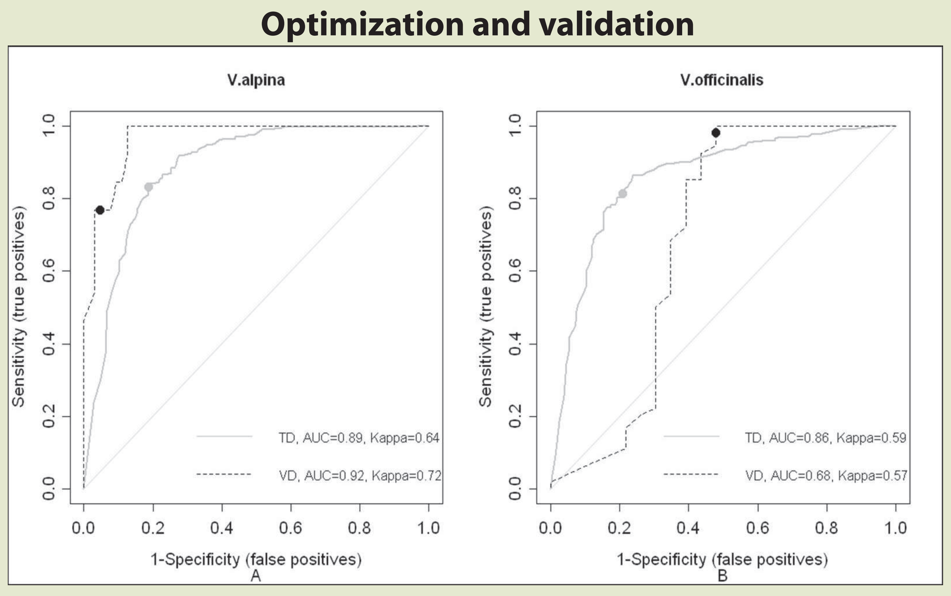

Figure 4: ROC plots using training dataset (TD) and validation dataset (VD). Chosen threshold are represented by the dots on the AUC curves.

Spatial predictions and external validation

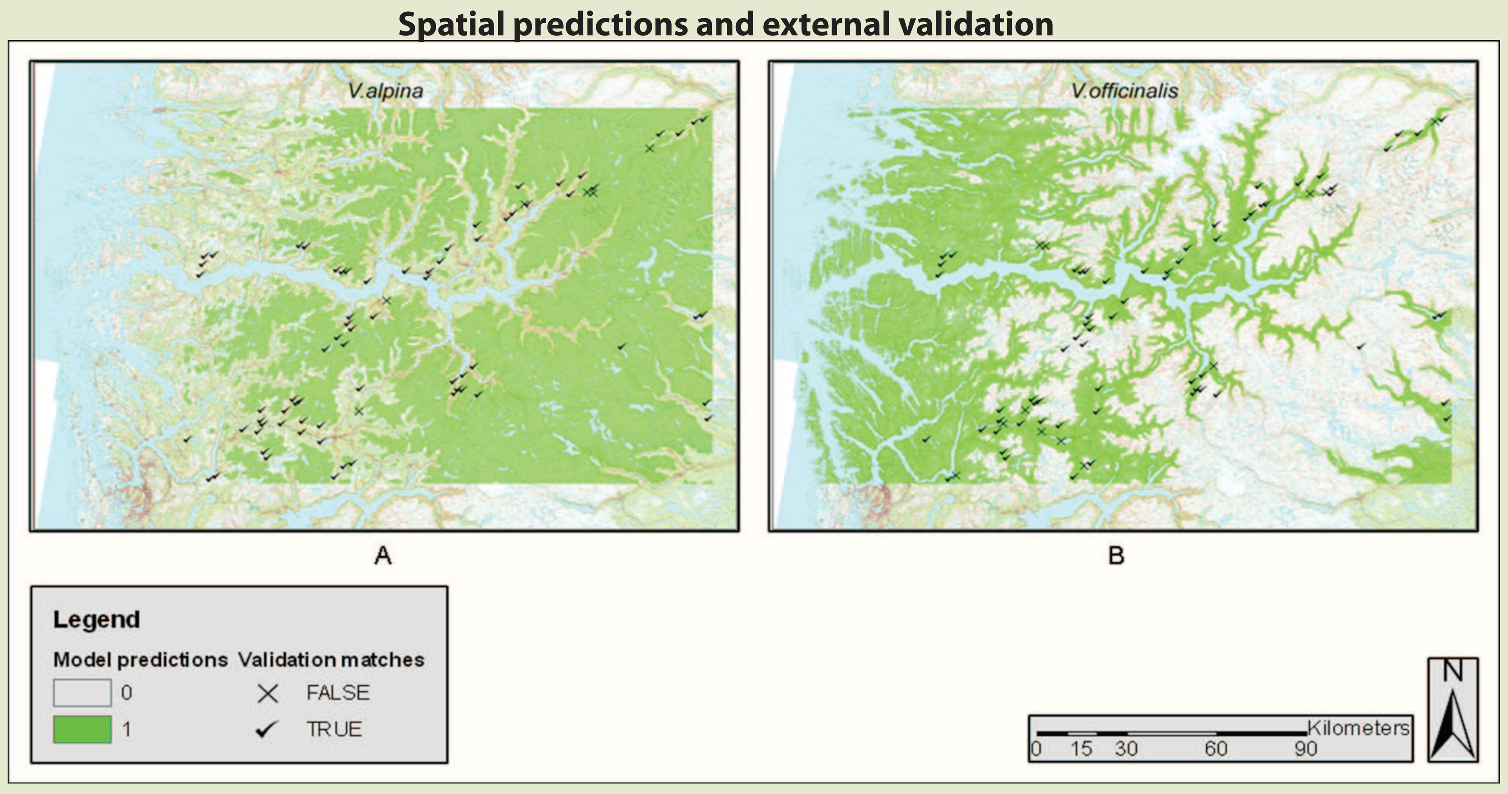

Figure 5: Model predictions in Western Norway (1=present, 0=absent) and validation dataset matches (False=mismatches, True=matches).

Potential further use of these models:

Combine with Climate Change scenarios to predict the potential species niche shift and investigate:
- Expected species interactions in the future.
- Potential habitat gained/lost for the six species according to their climatic niche.

Specific questions:
- Will alpine and lowland species ecological niches displaced at different speed?
- Are increased interactions between lowland/alpine species pairs expected?

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Poster design: Beate Helle, 2009