Improving pollen-based tree cover reconstructions

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Introduction

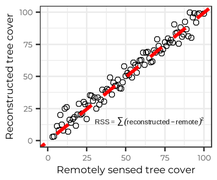
Understanding past vegetation is important for predicting future vegetation trajectories and their climatic and societal impacts. Pollen in sediments cores holds temporarily resolved information about past vegetation. But this information is biased due to taxa specific pollen productivity and dispersal. The REVEALS model aims to correct for this.

- How well can it reconstruct tree cover?
- **And can we further improve these reconstructions?**

Methodology

- Optimization of correction coefficients for 10 most common taxa
- simpler model
- remotely sensed tree cover as input

Optimization goal:
minimizing RSS



$$vegetation_i = \frac{pollen_i}{\alpha_i}$$

$\alpha \ldots taxon\ specific\ correction\ coefficient$

$$tree\ cover = \frac{\sum corrected\ tree\ taxa}{\sum all\ corrected\ taxa}$$

Validation of **reconstructed** tree cover with **remotely sensed** tree cover for ...

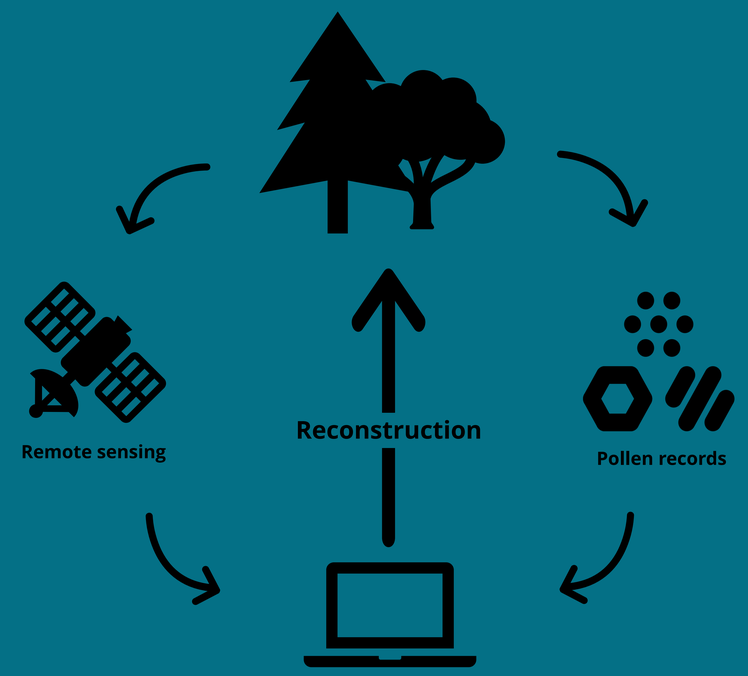
- Original Pollen Record
- REVEALS model
- Optimized model

Results

- REVEALS is only marginally better than the original Pollen records
- The optimized model reduces the MAE further → **better reconstructions possible**

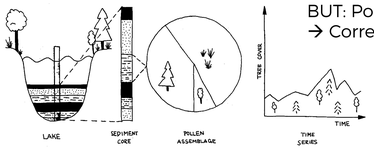
	Mean Absolute Error of the reconstruction		
Continent	Original Pollen counts	REVEALS model	Optimization
North America	16.71	15.55	14.26
Europe	16.31	14.71	13.01
Asia	17.90	13.90	10.37

Remote sensing can help optimize **reconstructions** of past **vegetation,** even with **simplified** models.



Open Questions?

How do we get vegetation records from pollen?



BUT: Pollen ≠ Vegetation
→ Correction needed!

What is REVEALS?

Regional **e**stimates of **ve**getation **a**bundance from **l**arge **s**ites (by Sugita, 2006)

Estimate of regional vegetation abundance for taxon i

Pollen counts of taxon i at site k

Estimate of pollen productivity (RPP = relative pollen productivity)

Pollen dispersal-deposition coefficient of taxon i from the border of the study site to Zmax

$$\hat{V}_i = \frac{n_{i,k} \Big/ \hat{z}_i \int_R^{Z_{max}} g_i(z)\mathrm{d}z}{\sum_{j=1}^{m}\left(n_{j,k} \Big/ \hat{z}_j \int_R^{Z_{max}} g_j(z)\mathrm{d}z\right)} = \frac{n_{i,k}/\hat{z}_i K_i}{\sum_{j=1}^{m}(n_{j,k}/\hat{z}_j K_j)}$$

What does the simplified model look like?

$$v_i = \frac{p_i}{\alpha_i * \sum_{j=1} \frac{p_j}{\alpha_j}}$$

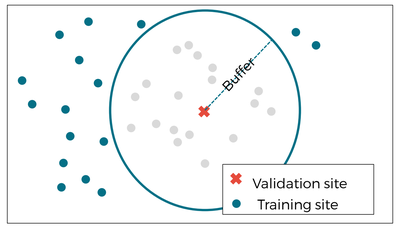
$i, j \ldots taxon\ indices$
$v \ldots vegetation\ abundance$
$p \ldots pollen\ abundance$
$\alpha \ldots correction\ coefficient$

How does the optimization work?

- Parallelized optimization using the L-BFGS algorithm
- Optimization bounds derived from REVEALS output and an added range to avoid overfitting

How was the optimized model validated?

- Spatial-Leave-One-Out Cross validation with 100 folds per continent



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