1. PROJECT

------------

Title: The climatic space of European pollen taxa

Dates: 1/09/2018-31/02/2019

Funding organisation: ERC

Grant no.: ERC (Global Change 2.0: Unlocking the past for a clearer future (grant number 694481))

2. DATASET

------------

Title: The climatic space of European pollen taxa

Description: Pollen data are widely used to reconstruct past climate changes, using relationships between modern pollen abundance in surface samples and climate at the surface sample sites. Visualisation of these data in multi-dimensional climate space provides an important way to establish that pollen taxon abundances are well-behaved before using them in climate reconstructions, but visualisation can also be helpful for ecological interpretation of the pollen diagrams. Here we present data created using Generalized Additive Models (GAMs) on the distribution of 195 European pollen taxa in climate space defined by seasonal temperature, as defined by the mean temperature of the coldest month (MTCO) and growing degree days above a baseline of 0°C (GDD0), and an annual moisture index (MI) expressed as the ratio of annual precipitation to annual potential evapotranspiration. These models can be used to explore the realised climate niche of individual pollen taxa and to build statistical models for climate reconstruction.

Publication Year: 2019

Creator(s): D. Wei, S.P. Harrison, I.C. Prentice

Organisation(s): University of Reading, Imperial College London

Rights-holder(s): University of Reading, Imperial College London

References:

Wei, D., González-Sampériz, P., Gil-Romera, G., Harrison, S.P., Prentice, I.C. Climate changes in interior semi-arid Spain from the last interglacial to the late Holocene. Climate of the Past Discussions <https://doi.org/10.5194/cp-2019-16>, 2019.

Harrison, S.P. Modern Pollen Data for Climate Reconstructions, version 1 (SMPDS). University of Reading Dataset. <http://dx.doi.org/10.17864/1947.194>, 2019.

3. TERMS OF USE

-----------------

Copyright 2019 University of Reading, Imperial College London. This dataset is licensed by the rights-holder(s) under a Creative Commons Attribution 4.0 International Licence: https://creativecommons.org/licenses/by/4.0/.

4. CONTENTS

------------

File listing:

Abies.csv - reconstructions of the 3D climate space of Abies;

Acer.csv - reconstructions of the 3D climate space of Acer;

Aconitum.csv - reconstructions of the 3D climate space of Aconitum;

Adonis.csv - reconstructions of the 3D climate space of Adonis;

Aesculus.csv - reconstructions of the 3D climate space of Aesculus;

Alnus.alnobetula.csv - reconstructions of the 3D climate space of Alnus.alnobetula;

Alnus.csv - reconstructions of the 3D climate space of Alnus;

Amaranthaceae.csv - reconstructions of the 3D climate space of Amaranthaceae;

Amaryllidaceae.csv - reconstructions of the 3D climate space of Amaryllidaceae;

Amygdaloideae.csv - reconstructions of the 3D climate space of Amygdaloideae;

Andromeda.csv - reconstructions of the 3D climate space of Andromeda;

Apiaceae.csv - reconstructions of the 3D climate space of Apiaceae;

Aquilegia.csv - reconstructions of the 3D climate space of Aquilegia;

Arbutus.csv - reconstructions of the 3D climate space of Arbutus;

Arctostaphylos.csv - reconstructions of the 3D climate space of Arctostaphylos;

Argania.csv - reconstructions of the 3D climate space of Argania;

Artemisia.csv - reconstructions of the 3D climate space of Artemisia;

Asparagaceae.csv - reconstructions of the 3D climate space of Asparagaceae;

Asteraceae.csv - reconstructions of the 3D climate space of Asteraceae;

Asteroideae.csv - reconstructions of the 3D climate space of Asteroideae;

Astragalus.csv - reconstructions of the 3D climate space of Astragalus;

Berberis.csv - reconstructions of the 3D climate space of Berberis;

Betula.csv - reconstructions of the 3D climate space of Betula;

Betula.Chamaebetula.csv - reconstructions of the 3D climate space of Betula.Chamaebetula;

Boraginaceae.csv - reconstructions of the 3D climate space of Boraginaceae;

Brassicaceae.csv - reconstructions of the 3D climate space of Brassicaceae;

Bruckenthalia.csv - reconstructions of the 3D climate space of Bruckenthalia;

Buxus.csv - reconstructions of the 3D climate space of Buxus;

Calluna.csv - reconstructions of the 3D climate space of Calluna;

Campanulaceae.csv - reconstructions of the 3D climate space of Campanulaceae;

Caprifoliaceae.csv - reconstructions of the 3D climate space of Caprifoliaceae;

Caragana.csv - reconstructions of the 3D climate space of Caragana;

Carduoideae.csv - reconstructions of the 3D climate space of Carduoideae;

Carpinus.betulus.csv - reconstructions of the 3D climate space of Carpinus.betulus;

Carpinus.orientalis+Ostrya.csv - reconstructions of the 3D climate space of Carpinus.orientalis+Ostrya;

Caryophyllaceae.csv - reconstructions of the 3D climate space of Caryophyllaceae;

Cassiope.csv - reconstructions of the 3D climate space of Cassiope;

Castanea.csv - reconstructions of the 3D climate space of Castanea;

Cedrus.csv - reconstructions of the 3D climate space of Cedrus;

Celastraceae.csv - reconstructions of the 3D climate space of Celastraceae;

Celtis.csv - reconstructions of the 3D climate space of Celtis;

Ceratonia.csv - reconstructions of the 3D climate space of Ceratonia;

Cichorioideae.csv - reconstructions of the 3D climate space of Cichorioideae;

Cistaceae.csv - reconstructions of the 3D climate space of Cistaceae;

Cistus.csv - reconstructions of the 3D climate space of Cistus;

Clematis.csv - reconstructions of the 3D climate space of Clematis;

Colchicaceae.csv - reconstructions of the 3D climate space of Colchicaceae;

Convolvulaceae.csv - reconstructions of the 3D climate space of Convolvulaceae;

Cornus.csv - reconstructions of the 3D climate space of Cornus;

Corylus.csv - reconstructions of the 3D climate space of Corylus;

Cotinus.csv - reconstructions of the 3D climate space of Cotinus;

Crassulaceae.csv - reconstructions of the 3D climate space of Crassulaceae;

Crataegus.csv - reconstructions of the 3D climate space of Crataegus;

Cupressaceae.csv - reconstructions of the 3D climate space of Cupressaceae;

Cyperaceae.csv - reconstructions of the 3D climate space of Cyperaceae;

Cytinaceae.csv - reconstructions of the 3D climate space of Cytinaceae;

Daphne.csv - reconstructions of the 3D climate space of Daphne;

Delphinium.csv - reconstructions of the 3D climate space of Delphinium;

Dennstaedtiaceae.csv - reconstructions of the 3D climate space of Dennstaedtiaceae;

Diapensia.csv - reconstructions of the 3D climate space of Diapensia;

Dryas.csv - reconstructions of the 3D climate space of Dryas;

Empetrum.csv - reconstructions of the 3D climate space of Empetrum;

Ephedra.csv - reconstructions of the 3D climate space of Ephedra;

Equisetum.csv - reconstructions of the 3D climate space of Equisetum;

Erica.csv - reconstructions of the 3D climate space of Erica;

Ericaceae.csv - reconstructions of the 3D climate space of Ericaceae;

Euonymus.csv - reconstructions of the 3D climate space of Euonymus;

Euphorbiaceae.csv - reconstructions of the 3D climate space of Euphorbiaceae;

Fabaceae.csv - reconstructions of the 3D climate space of Fabaceae;

Fabaceae.herbs.csv - reconstructions of the 3D climate space of Fabaceae.herbs;

Fagus.csv - reconstructions of the 3D climate space of Fagus;

Frangula.csv - reconstructions of the 3D climate space of Frangula;

Fraxinus.csv - reconstructions of the 3D climate space of Fraxinus;

Genisteae.csv - reconstructions of the 3D climate space of Genisteae;

Gentianaceae.csv - reconstructions of the 3D climate space of Gentianaceae;

Geraniaceae.csv - reconstructions of the 3D climate space of Geraniaceae;

Halimium.csv - reconstructions of the 3D climate space of Halimium;

Hedera.csv - reconstructions of the 3D climate space of Hedera;

Helianthemum.csv - reconstructions of the 3D climate space of Helianthemum;

Helleborus.csv - reconstructions of the 3D climate space of Helleborus;

Hippophae.csv - reconstructions of the 3D climate space of Hippophae;

Huperzia.csv - reconstructions of the 3D climate space of Huperzia;

Hypericaceae.csv - reconstructions of the 3D climate space of Hypericaceae;

Ilex.csv - reconstructions of the 3D climate space of Ilex;

Impatiens.csv - reconstructions of the 3D climate space of Impatiens;

Iridaceae.csv - reconstructions of the 3D climate space of Iridaceae;

Jasminum.csv - reconstructions of the 3D climate space of Jasminum;

Juglans.csv - reconstructions of the 3D climate space of Juglans;

Juncaceae.csv - reconstructions of the 3D climate space of Juncaceae;

Kalmia.csv - reconstructions of the 3D climate space of Kalmia;

Lamiaceae.csv - reconstructions of the 3D climate space of Lamiaceae;

Larix.csv - reconstructions of the 3D climate space of Larix;

Lavandula.csv - reconstructions of the 3D climate space of Lavandula;

Ledum.csv - reconstructions of the 3D climate space of Ledum;

Liguliflorae.csv - reconstructions of the 3D climate space of Liguliflorae;

Ligustrum.csv - reconstructions of the 3D climate space of Ligustrum;

Liliaceae.csv - reconstructions of the 3D climate space of Liliaceae;

Linaceae.csv - reconstructions of the 3D climate space of Linaceae;

Linnaea.csv - reconstructions of the 3D climate space of Linnaea;

Linum.csv - reconstructions of the 3D climate space of Linum;

Lonicera.csv - reconstructions of the 3D climate space of Lonicera;

Lycopodium.csv - reconstructions of the 3D climate space of Lycopodium;

Lysimachia.csv - reconstructions of the 3D climate space of Lysimachia;

Lythraceae.csv - reconstructions of the 3D climate space of Lythraceae;

Malus.csv - reconstructions of the 3D climate space of Malus;

Malvaceae.csv - reconstructions of the 3D climate space of Malvaceae;

Melanthiaceae.csv - reconstructions of the 3D climate space of Melanthiaceae;

Mercurialis.csv - reconstructions of the 3D climate space of Mercurialis;

Montiaceae.csv - reconstructions of the 3D climate space of Montiaceae;

Moraceae.csv - reconstructions of the 3D climate space of Moraceae;

Myrica.csv - reconstructions of the 3D climate space of Myrica;

Myrtaceae.csv - reconstructions of the 3D climate space of Myrtaceae;

Nartheciaceae.csv - reconstructions of the 3D climate space of Nartheciaceae;

Nerium.csv - reconstructions of the 3D climate space of Nerium;

Nitrariaceae.csv - reconstructions of the 3D climate space of Nitrariaceae;

Olea.csv - reconstructions of the 3D climate space of Olea;

Oleaceae.csv - reconstructions of the 3D climate space of Oleaceae;

Onagraceae.csv - reconstructions of the 3D climate space of Onagraceae;

Ononis.csv - reconstructions of the 3D climate space of Ononis;

Ophioglossaceae.csv - reconstructions of the 3D climate space of Ophioglossaceae;

Orobanchaceae.csv - reconstructions of the 3D climate space of Orobanchaceae;

Osmundaceae.csv - reconstructions of the 3D climate space of Osmundaceae;

Oxalidaceae.csv - reconstructions of the 3D climate space of Oxalidaceae;

Oxyria+Rumex.csv - reconstructions of the 3D climate space of Oxyria+Rumex;

Paliurus.csv - reconstructions of the 3D climate space of Paliurus;

Papaveraceae.csv - reconstructions of the 3D climate space of Papaveraceae;

Parrotia.csv - reconstructions of the 3D climate space of Parrotia;

Phillyrea.csv - reconstructions of the 3D climate space of Phillyrea;

Picea.csv - reconstructions of the 3D climate space of Picea;

Picea.orientalis.csv - reconstructions of the 3D climate space of Picea.orientalis;

Pinus.diploxylon.csv - reconstructions of the 3D climate space of Pinus.diploxylon;

Pinus.haploxylon.csv - reconstructions of the 3D climate space of Pinus.haploxylon;

Pistacia.csv - reconstructions of the 3D climate space of Pistacia;

Plantaginaceae.csv - reconstructions of the 3D climate space of Plantaginaceae;

Platanus.csv - reconstructions of the 3D climate space of Platanus;

Plumbaginaceae.csv - reconstructions of the 3D climate space of Plumbaginaceae;

Poaceae.csv - reconstructions of the 3D climate space of Poaceae;

Polemoniaceae.csv - reconstructions of the 3D climate space of Polemoniaceae;

Polygalaceae.csv - reconstructions of the 3D climate space of Polygalaceae;

Polygonaceae.csv - reconstructions of the 3D climate space of Polygonaceae;

Polygonum.csv - reconstructions of the 3D climate space of Polygonum;

Polypodiales.csv - reconstructions of the 3D climate space of Polypodiales;

Populus.csv - reconstructions of the 3D climate space of Populus;

Portulacaceae.csv - reconstructions of the 3D climate space of Portulacaceae;

Potentilla.csv - reconstructions of the 3D climate space of Potentilla;

Primulaceae.csv - reconstructions of the 3D climate space of Primulaceae;

Prunus.csv - reconstructions of the 3D climate space of Prunus;

Pteridaceae.csv - reconstructions of the 3D climate space of Pteridaceae;

Pterocarya.csv - reconstructions of the 3D climate space of Pterocarya;

Quercus.deciduous.csv - reconstructions of the 3D climate space of Quercus.deciduous;

Quercus.evergreen.csv - reconstructions of the 3D climate space of Quercus.evergreen;

Quercus.intermediate.csv - reconstructions of the 3D climate space of Quercus.intermediate;

Ranunculaceae.csv - reconstructions of the 3D climate space of Ranunculaceae;

Ranunculus.csv - reconstructions of the 3D climate space of Ranunculus;

Resedaceae.csv - reconstructions of the 3D climate space of Resedaceae;

Rhamnaceae.csv - reconstructions of the 3D climate space of Rhamnaceae;

Rhamnus.csv - reconstructions of the 3D climate space of Rhamnus;

Rhododendron.csv - reconstructions of the 3D climate space of Rhododendron;

Rhus.csv - reconstructions of the 3D climate space of Rhus;

Ribes.csv - reconstructions of the 3D climate space of Ribes;

Rosaceae.csv - reconstructions of the 3D climate space of Rosaceae;

Rosmarinus.csv - reconstructions of the 3D climate space of Rosmarinus;

Rubiaceae.csv - reconstructions of the 3D climate space of Rubiaceae;

Rubus.csv - reconstructions of the 3D climate space of Rubus;

Ruscus.csv - reconstructions of the 3D climate space of Ruscus;

Salix.csv - reconstructions of the 3D climate space of Salix;

Salvia.csv - reconstructions of the 3D climate space of Salvia;

Sambucus.csv - reconstructions of the 3D climate space of Sambucus;

Sanguisorba.group.csv - reconstructions of the 3D climate space of Sanguisorba.group;

Santalaceae.csv - reconstructions of the 3D climate space of Santalaceae;

Saxifragaceae.csv - reconstructions of the 3D climate space of Saxifragaceae;

Scrophulariaceae.csv - reconstructions of the 3D climate space of Scrophulariaceae;

Solanaceae.csv - reconstructions of the 3D climate space of Solanaceae;

Sorbus.csv - reconstructions of the 3D climate space of Sorbus;

Styrax.csv - reconstructions of the 3D climate space of Styrax;

Tamarix.csv - reconstructions of the 3D climate space of Tamarix;

Taxus.csv - reconstructions of the 3D climate space of Taxus;

Teucrium.csv - reconstructions of the 3D climate space of Teucrium;

Thalictrum.csv - reconstructions of the 3D climate space of Thalictrum;

Thymelaeaceae.csv - reconstructions of the 3D climate space of Thymelaeaceae;

Tilia.csv - reconstructions of the 3D climate space of Tilia;

Tofieldia.csv - reconstructions of the 3D climate space of Tofieldia;

Trollius.csv - reconstructions of the 3D climate space of Trollius;

Ulmus.csv - reconstructions of the 3D climate space of Ulmus;

Ulmus+Zelkova.csv - reconstructions of the 3D climate space of Ulmus+Zelkova;

Urticaceae.csv - reconstructions of the 3D climate space of Urticaceae;

Vaccinium.csv - reconstructions of the 3D climate space of Vaccinium;

Valerianaceae.csv - reconstructions of the 3D climate space of Valerianaceae;

Verbenaceae.csv - reconstructions of the 3D climate space of Verbenaceae;

Viburnum.csv - reconstructions of the 3D climate space of Viburnum;

Violaceae.csv - reconstructions of the 3D climate space of Violaceae;

Viscum.csv - reconstructions of the 3D climate space of Viscum;

Vitex.csv - reconstructions of the 3D climate space of Vitex;

Ziziphus.csv - reconstructions of the 3D climate space of Ziziphus;

Zygophyllaceae.csv - reconstructions of the 3D climate space of Zygophyllaceae.

5. METHOD and PROCESSING

--------------------------

We constructed GAMs for 195 individual pollen taxa using modern relationships between pollen abundance and climate variables, specifically mean temperature of the coldest month (MTCO), a measure of growing season warmth as expressed by growing degree days above a of 0°C (GDD0) and an index of plant-available moisture (MI) expressed as the ratio of annual precipitation to annual potential evapotranspiration. The modern pollen dataset consists of records from 6458 terrestrial sites from Europe, the Middle East and Eurasia (Harrison, 2019). Climatological values (1961-1990) of mean monthly temperature, precipitation, and fractional sunshine hours were obtained from the CRU CL v2.0 gridded dataset (New et al., 2002). Geographically weighted regression in ArcGIS was used to correct for elevation differences between the CRU grids and the pollen sites, using a fixed bandwidth kernel of 1.06° (~140km). The climate of each pollen site was estimated based on its longitude, latitude, and elevation. MTCO was taken directly from the GWR regression; GDD0 was estimated from daily data using a mean-conserving interpolation of the monthly mean temperatures. MI was calculated for each pollen site using SPLASH v1.0 (Davis et al., 2017), based on daily values of precipitation, temperature and sunshine hours obtained using a mean-conserving interpolation of the monthly values of each. The GAMs were implemented with the mgcv R package (Wood, 2017). MI was square root transformed, since differences between MI values at the dry end have a bigger effect than differences at the wet end on vegetation. Logistic models were constructed. Interaction terms were not included, because we assume that each bioclimatic variable has an independent influence on taxa distribution. The fitted response surfaces show pollen taxon abundance in climate space. Convex hulls, implemented using the alphahull package in R (Pateiro-Lopez & Rodriguez-Casal, 2016), were used to delineate the area with samples and avoid representing parts of the fitted surface that are not closely constrained by data. We sample the resultant GAMs at regular intervals across the range spanned by each climate variable to derive estimates of taxon abundance, sampling each GAM at increments of 0.6°C for MTCO, 100 degree days for GDD0 and 0.03 for √MI (unitless). Full details of the methods are given in Wei et al. (2019).We provide a csv file for each individual pollen taxon. The file name specifies the taxon name (e.g. Abies.csv). Each file the value of the potential taxon abundance for a given combination of the three climate parameters: sqrt(MI) (column 1), MTCO (column 2) and GDD0 (column 3). sqrt(MI) is the square root result of Moisture index, a unitless number and ranges from 0 to 2.4. MTCO is given in °C (range: -43 to 14.6°C) and GDD0 in degree days (range: 300 to 8200 degree days). Potential taxon abundance (column 5) is expressed as a decimal probability.

References:

Davis, T. W., Prentice, I. C., Stocker, B. D., Thomas, R. T., Whitley, R. J., Wang, H., Evans, B. J., Gallego-Sala, A. V., Sykes, M. T., Cramer, W. Simple process-led algorithms for simulating habitats (SPLASH v.1.0): Robust indices of radiation, evapotranspiration and plant-available moisture. Geosci. Model Dev. 10, 689-708, https://doi.org/10.5194/gmd-10-689-2017, 2017.

New M., Lister D., Hulme M., Makin I. A high-resolution data set of surface climate over global land areas. Clim. Res. 21, 1-25, http://doi.org/10.3354/cr021001, 2002.

Pateiro-Lopez, B., Rodriguez-Casal, A.: alphahull: Generalization of the Convex Hull of a Sample of Points in the Plane, CRAN, available at: https://CRAN.R project.org/package=alphahull, 2016 (last access: 19 January 2019).

Wood, S.: mgcv: Mixed GAM Computation Vehicle with Automatic Smoothness Estimation, CRAN, available at: https://CRAN.R-project.org/package=mgcv, 2017 (last access: 19 January 2019).

The individual fields are:

# sqrt(MI) (unitless)

# MTCO (°C)

# GDD0 (degree days)

# taxon abundance (decimal probability)