EXAMINING CHANGES IN ARCTIC PLANT ASSEMBLAGES: PAST, PRESENT, AND FUTURE

Mary S. Wisz, Loïc Pellissier, Lærke Stewart + collaborators
OUTLINE: MODELLING CHANGE IN ARCTIC PLANT COMMUNITIES

› Big Questions: Climate, history, biotic interactions, and dispersal
› Emerging data and collaboration
› Greenland, North America, Eurasia
› Tools for solutions?
› SDM, structural equation models, mechanistic models
› Modelling patterns and processes; past present and future
› PhD project (Lærke)
› Post doc (Loïc)
UNDERSTANDING AND PREDICTING CHANGES IN ARCTIC ECOSYSTEMS...

\[ Y_1 = \beta_1 X + \gamma_1 Y_{-1} + e_1 \]
\[ Y_2 = \beta_2 X + \gamma_2 Y_{-2} + e_2 \]
\[ Y_n = \beta_n X + \gamma_n Y_{-n} + e_n \]

Simonsen et al. 2011
Turnover: Which places and which groups of species will/have experience/d the most/least change? Consider:
› history, glaciation
› origin of species’ pools
› velocity of climate change
› functional groups
› dispersal strategy
› ?
WHAT SHAPES SPECIES ASSEMBLAGES?

Global species pool

Biogeographic history

Environmental conditions (climate, habitat...)

Dynamic processes

Dispersal

Biotic factors

Extant species assemblage

How do we quantify these relationships?

Wisz et al in Press Biological Reviews
USING SPECIES DISTRIBUTION MODELLING TO PREDICT CURRENT AND FUTURE PLANT DISTRIBUTION

Data collection -> Water

Statistical modelling

Temperature

Spatial projection

- Biotic interactions
- Dispersal
- Disturbances

Stacking SDMs

Communities
SDM APPLICATIONS

› Scenarios
› Diversity and richness patterns
› Turnover
› Role of functional groups
› Dispersal
› Historical events (glaciation, etc)
› Species’ invasions
› Many, many others
CANDIDATE PREDICTOR VARIABLES

› **Predictors**
  › Temperature
  › Precipitation + winter precipitation
  › Solar radiation
  › Potential evapotranspiration
  › Terrain (DEM elevation, slope, aspect)
  › NDVI, NDWI, Snow (250 M)
  › Bedrock
  › Large mammals (caribou, muskox)

› **Scenarios**
  › (DMI- Greenland) 25 km assuming 2 scenarios of glacial melt
  › IPCC
  › Historical

DERIVATIVES/COMBINATIONS OF THESE RELAVANT FOR VEGETATION?
Should 2-m air temperature or more proximal temperature (e.g. 5cm aboveground) be used?
DESIGNING RELEVANT PREDICTORS FOR ARCTIC PLANTS USING THERMOLOGGERS

a) NERO, vegetation transect, Nuuk, GL

b) Design applied in the Swiss Alps
VEGETATION DATA

› Details in this workshop
› Daniels Data
› Bay
› IAVD collaborators?
› CBIONET collaborators?
› Others?
21st century climate change threatens mountain flora unequally across Europe

But what about Greenland?
Lærke Stewart, Aarhus University
(February 2012-January 2016) MS on the way:

Funding: Greenland Climate Research Centre (500K), Greenland Ecosystem Monitoring (250K), NERI (250K) + AU (400K)

Supervisors:
Mary S. Wisz (main)
Mads C. Forchhammer
Jens-Christian Svenning

Key-collaborators: Bay, Schmidt, Guisan Group UNIL, Skip Walker-IAVD, Daniels, Miska Luoto and hopefully others
PHD PROJECT: AIMS PART 1

- Coordinate effort with Daniels, Walker, IAVD, etc.
- Collate existing information: recent past + contemporary.
- Data sources: Daniëls, CAFF, GEM, GBIF, ITEX, Back to the Future etc.
  - Locations and functional traits
- Fieldwork and training

Picture: arctic.ac.uk, modified by Stewart
PHD PROJECT: AIMS PART 2

Predicting contemporary distributions of plant species and assemblages in Greenland

› SDM methods
› Combining monitoring and biodiversity data
› New methods
› Herbivore distributions
PHD PROJECT: AIMS PART 3

› How has glaciation and climate change shaped plant assemblages in Greenland for different species pools?
› SDM based on contemporary data predicted to historical scenarios
› Comparing historical, contemporary and future species assemblages in Greenland
› Stability + resilience of species, functional groups (e.g. source pools, dispersal or reproductive strategies) & habitats
› Comparing future scenario modelling results with ITEX warming experiments
PHD PROJECT: AIMS PART 4

› How has circumpolar glaciation history since LGM influenced plant assemblages?

› Compare vegetation data to historical scenarios
› Which functional groups, dispersal strategies, etc predominate in a given region depending on velocity of climate change and glacial history?
› Multivariate stat analyses/SDM?

Picture: Lomolino et al. 2010
The biggest challenge is preparing the vegetation data. These must be harvested in the most efficient way.

- how we can contribute to the IAVD? Discuss Day 3
- Flexible approach to project. Suggestions?
- Ecological and biogeographic questions are big but realistic progress can be made once the data are available