# Changes in the abundance of flowers at Zackenberg over time

## Abstract

Over the last decades, Arctic biome experienced an alarming warming. Long-term monitoring of biotic factors allows to disentangle the temporal response to environmental changes. Community monitoring is particularly helpful to describe the complexity at the ecosystem scale change. For instance a slight change in the phenology of plant might have a strong effect on insect pollinator and thus negatively affect plant population dynamic. Here we present a multidecadal response of Arctic plant community reproductive density in response to climate change in high and low Arctic in Greenland. We address the specific question:

* How climatic change affect community scale flower density/productivity in Arctic (i.e. temporal trend of flowering abundance)?
* How different plant species respond to climate change: testing for linear trends in flowering abundance over time, both within and across species?
  + reproductive strategy: *cross pollinated* vs *self-pollinated* (with conceptual link with pollinators?)
  + *life cycles* (e.g. annual vs perennial) explain differences such? (disentangle the mechanism: dispersal vs vegetative, community resilience)
* Is there a spatial heterogeneity in the flowering abundance between High and Low Arctic? (make possible prediction on future composition from low to high?)

Our work hypothesis are:

The increase in temperature

## Project idea

a) analyzing abiotic/climatic determinants of flowering abundance

b) assessing whether different species respond in concern to climatic forcing, i.e. whether all plant species flower profusely or little in a given year (thus making life crappy for the pollinators)

*c) [optionally] maybe assessing whether plants and pollinators respond in concern to climatic forcing, i.e. whether both flowers and insects are abundant or sparse in a given year (making life less crappy for the pollinators). Download data on insect assembly over time (or at least on the same period) to test how the two groups respond to warming (or other climate variables).*

d) testing for linear trends in flowering abundance over time, both within and across species, raising general joy over “increasing flower densities in the High Arctic” or terror over “decreasing flower densities in the High Arctic”

e) if there is a contrast in flower abundance trends for annual vs perennial plants then well wow.

f) compare low vs high Arctic trends with Nuuk and Zack.

## Introduction

- Arctic warming: climatic metrics

- stat of art on Biotic response to warming : local with ITEX, global with synthesis (network plant-polinators): *-Molau (1993) demonstrate that the occurrence of different mating systems in arctic and alpine plants may be linked to flowering phenology, such that species that flower early tend to be cross- pollinated, while late flowering species are commonly self-pollinated*

-community composition, greening, Phenology, flowering density trends

## Methods

### Study site

Our study sites are located in low arctic for Nuuk, precisely Kobbefjord southwest Greenland (64° 10’ N, 51° 43’ W), and in high Arctic for Zackenberg Research Station, northest Greenland (74° 30’ N, 21° 30’ W) Fig1.

Fig1: Study site

SITE ENVIROMENTAL DESCRIPTIONS COMING SOON

### Data set

We extracted flower abundance data from *The Greenland Ecosystem Monitoring (GEM) Database* (<https://data.g-e-m.dk>), an open access long-term monitoring on research program on ecosystems and climate change effects in Arctic.

### Sampling methods

The total flowering was used as a proxy of the maximum annual productivity. One time per year, all plots divided in four sections (A, B, C, D) were survey to quantify the total number of flowers structure. Flower structure include: *flower buds* define as all flower not yet open; *flowers* as open to insects; and *senescent flowers* when all petals are gone or with all petals almost or fully faded or brown. No or little confusion if possible, with flower from preceding years since stems are always dry and stiff while new stems are soft and flesh (BioBasi Manuals). The time of the survey varying depending of the species and the year to match the moment when most or all flower buds have bloomed.

In both Nuuk and Zackenberg, Salix total flowering was divided into males and females, but to get a total count for both sexes, one has to split the unsexed buds in a clever way. Test the proportion thought years and apply this ration?

MORE DETAILS FROM BioBasis NUUK & ZAC COMING SOON

### Response variable

To control for differences in plot area we transformed data into density by lumping the total number of flowers at the plot level for each year and by dividing the sum with plot area. We used this plot level flowering density for each year as response variable.

However, (at least as exploratory analysis) we always run two set of analysis with both total number of flowering per year and per plot and plot density.

### Covariates

Except for snow melt date, all other climatic variables were recorded at the site level, meaning one value for all plot of a given site.

* Package CLIMWIN, best climatic windows to explain a temporal series

### Statistical analysis

## Basic explorations







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