Annual Report Card 2019

AUTOMATED MONITORING
TO STUDY PLANT PHENOLOGY

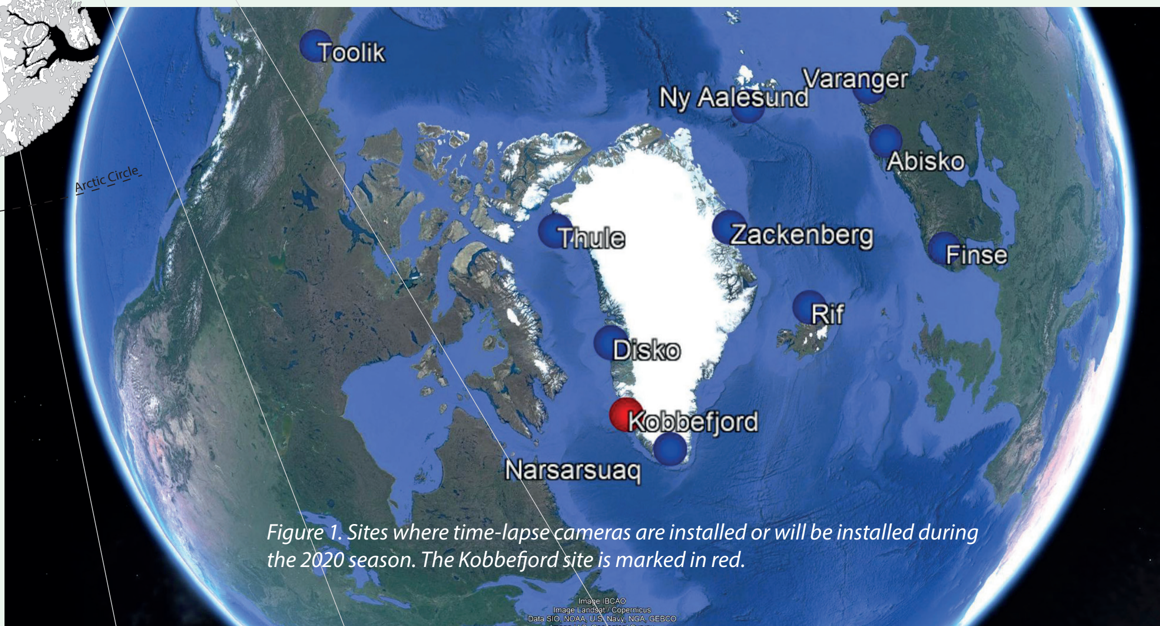

Figure 1. Sites where time-lapse cameras are installed or will be installed during the 2020 season. The Kobbefjord site is marked in red.

Cameras can record seasonal development of flower and fruits of Arctic plants and even track individual insect visits to flowers. In a new project, researchers are using state-of-the-art machine learning and computer vision methods to study the role of climate in plant-pollinator interaction with unprecedented accuracy at Kobbefjord and other Arctic field sites.

Figure 2. Steel mount with camera recording the flowering of the moss campion (Silene acaulis) insect visitors at Kobbefjord, West Greenland.

Arctic flowering seasons are becoming shorter in response to climate change (Høye et al. 2013, Prevéy et al. 2019) and flowering times are changing at different rates in response to warming across the tundra biome (Prevéy et al. 2017). Climate-driven temporal mismatches between flowering time and flight seasons of pollinating insects (Høye et al. 2013, Gillespie et al. 2016) could be driving the rapid decline of pollinator abundance and diversity observed at the Zackenberg research station, North-East Greenland (Loboda et al. 2018). Yet, we know little about how climate affects the strength of interactions among organisms (Schmidt et al. 2017). At Kobbefjord, field workers are meticulously counting flowers and recording their developmental stages in permanent plots at weekly intervals. However, the weekly observation frequency is insufficient to quantify climatic sensitivity of interactions among plants and their pollinators (Rasmussen et al. 2013, Gillespie et al. 2016). With time lapse cameras and computer vision technology, we can increase this frequency to minutes and automate the recording procedure to gain novel insights into climatic impacts on biotic interactions.

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Data source:

GEM BioBasis Vegetation Monitoring component.

Data can be accessed on: www.data.g-e-m.dk

GEM

Greenland Ecosystem Monitoring

USING TIME-LAPSE CAMERAS
AND PLANT-POLLINATOR INTERACTIONS

Figure 3. Example of a sequence of images taken during the flowering season at Kobbefjord during the 2018 growing season.

The use of image-based observations of plants and animals is on the verge of transforming research in ecology (Wäldchen and Mäder 2018, Weinstein 2018). Recent advances in computer vision and machine learning have resulted in very effective analysis pipelines, which are opening up new opportunities for automated monitoring of species, their interactions, and how they respond to environmental variation (Van Horn et al. 2017). In this project, we quantify flower season dynamics and visitation rates by using a large number of time-lapse cameras located across Arctic field sites (Figure 1 and 2). This enables a uniquely high temporal resolution of data across the full growing season (Figure 3). We focus on circum-Arctic, common, insect-pollinated plant species, such as the moss campion (*Silene acaulis*) and species of the genus *Dryas*. The first step in the project is to train deep neural network models to detect flowers and insects in the vast amount of image data. For a subset of the images, flowers are manually annotated to facilitate the training and to evaluate how well the neural network performs in the task of detecting flowers in images (Fig. 4). Data for the project are collected across a large number of sites with support from INTERACT, Nansen foundation, Villum Foundation, and the Independent Research Fund Denmark. The project aims to demonstrate how the implementation of new technology can improve the study of long-term effects of climate change in the Arctic. The expected outcome is comparable, standardized, and detailed information about how Arctic ecosystems are responding to climate change.

Figure 4. Annotation of images to extract examples of flowers of moss campion (Silene acaulis) for training a deep learning model.

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