Tundra change at the dawn of drone ecology

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Abstract:

Climate is warming and arctic ecosystems are changing. These ongoing changes are expected to accelerate during coming decades and might have profound effects on Arctic biodiversity and ecosystems[1]. Warming-induced vegetation dynamics is expected to vary across geographic space depending on climatic and non-climatic factors (e.g., soil conditions, biotic interactions, dispersal constraints[2]) and will initially manifest itself at the scale of individual plants. Therefore, high resolution data across larger spatial scale are needed to study the spatial dynamics of individuals across larger areas and for understanding how these factors affect the rate of arctic vegetation change.

We are at the *dawn of drone ecology*[3] and it is possible to map the fine-scale distribution of individuals from light-weighted Unmanned Aerial Systems (UAS) with mounted specific sensors (e.g. conventional cameras, multispectral sensors, and thermal cameras). UAS allow direct control of acquisition time for generating massive spatial data at very high resolution. Until now, spatial data of large coverage have either been collected from satellites or airplanes at relative coarse resolution or from field observation at small spatial scales, but with low coverage. This has resulted in a *data scale gap* which hinders the study of spatial dynamics of individuals across larger extents (Fig. 1). Plot-based surveys provide detailed, but spatially non-continuous information, on plant species composition, and thus are suboptimal for capturing fine-scale vegetation dynamics under rapid change. Data obtained with satellites or airplanes is an appropriate basis for deriving spectral and structural information of vegetation across large areas. The main limitation of these data sources are the scale gap between the obtained pixel resolution (20-1m) and the scale of the dynamics of individuals (Fig. 1). Fine-scale imagery (to ~0.5 cm resolution) obtained from light-weighted UAS has the potential to close this gap and to revolutionize vegetation ecology. This allows individual plants to be spatially resolved and identified to species if flight paths are sufficient low and vegetation composition is relatively simple. Flights at increasing heights have the potential to provide the basis for scaling the information from the individuals to the landscape, and even broader scales by sequential linking with remotely sensed data from satellites. Imagery from UAS thus

provide a very promising missing link in multi-scale integration of plot-based field surveys with high-flying manned aircrafts and/or earth-observing satellites (Fig. 1).

In this talk we present ongoing work towards a multiscale integration of field-based, UAS, and satellite obtained data to bridge the scale gap and improve our ability to monitor, understand, and predict Arctic vegetation change across space and time. Specifically, we use UAS to study the dynamics of tundra vegetation at different sites in Greenland and combine this data with plot-based sampling of mainly arctic shrub vegetation and ecological relevant parameters.

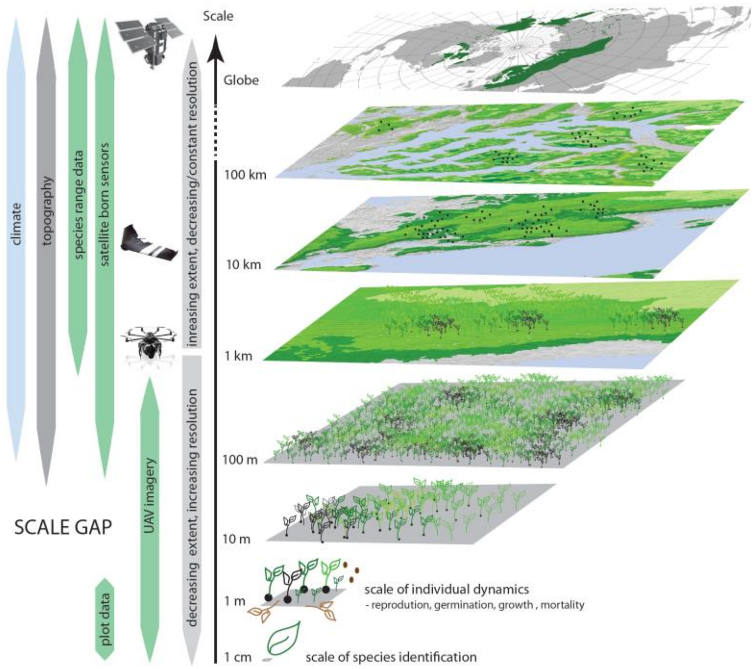

FIGURE 1 Schematic illustration of the data scale gap and how the use of rotor-based and fixed winged UAS (drones) can be used to bridge this gap (Illustration by Signe Normand).

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