Summary of the High Latitude Drone Ecology Network (HLDN) meeting

Location: San Francisco
Date of meeting: 14 December 2016
Compiled by: Jeff Kerby with input from Isla Myers-Smith and Andrew Cunliffe

Attendees: listed at end

Executive summary:
The meeting began with a short presentation by Isla Myers-Smith outlining session goals and a brief introduction to various UAV applications to Arctic Research (with a specific focus on research being currently conducted on Qikiqtaruk - Herschel Island). Participants followed with short introductions of their personal research interests/uses of UAVs in the region, and their interest in this session. This led in to open ended discussion on the following general themes: 1. Shared methods across sites, 2. High-latitude UAV synthesis paper, 3. Strategic planning for funding, research, and policy development. I have briefly summarized each theme's discussion and listed bulleted talking points that were brought up.

1. Shared methods

   Summary: There are many applications for UAVs for high latitude research, so methods will vary by question. Most common applications relate to creating orthomosaics and 3D landscape models. Potential for coordination on how to create consistent models through time and to improve georeferencing of models. Current protocols for spatially constraining collected drone imagery and data are perhaps underused within the group including ground control markers and the fast approaching era of on-board RTK image geotagging. These are key starting places to improve change detection, scaling, and ultimately cross-site comparisons. Most research groups were using Agisoft Photoscan Pro (http://www.agisoft.com/) or Pix4D (https://pix4d.com/) software for making image composites and 3D models. Sensor calibration is another pressing issue. Calibration cards in R, G, B, Black, White, Gray and/or spectral reference plates captured before, after and during flights will make cross-site and time-series comparisons more valuable. Myers-Smith group has experience with card choice. Do others? Multispectral sensors increasingly affordable and common. Much work to be done here, tech is outpacing use and ecological application in some areas. Greg Crutsinger from Parrot (http://edu.parrot.com/index.html) pointed out lack of online venues for active scientific discussions on these matters (though many venues exist for details of DIY UAV use, for example DIY drones).

   Bullet-pointed notes from discussion:
   a) Discussion on platform choice (multi-rotor vs fixed wing).
   b) Research question dependent, and varies broadly by platform.
      a. Best practices should provide the framework for why you are doing the work:
      b. What are the goals
      c. Then establish methods
   c) No existing common methods or protocols
   d) No existing common community to share/discuss methods and protocols as they relate to ecological monitoring

a. GitHub (creation of a soon to be publically accessible DroneHub repo is currently underway, many folks in attendance currently use GitHub for code version control)
b. Slack (another option available)
c. Traditional blogging platform (we already have our drone ecology website, that could be expanded and developed: https://droneecology.wordpress.com/)

e) Critical common protocols
    a. Use ground control markers to improve constraint of orthomosaics/SfM builds whenever possible.
    b. Metadata on flight plans and image capture is important for contextualizing data and for many regulatory frameworks.
        i. What metadata to collect? Variety of hardware/sensor options make some protocols very situation specific, but there does not seem to be a structured guide anywhere that explains what information from UAV flights and from sensors is required to a. build best quality datasets, b. allow for replication/ future analysis (make data of peak archival value).
    c. Merits of different stitching software choices.
        i. Primarily using Photoscan Pro and Pix4D
    d. Potential R package in development by Christian John for orthomosaic processing and curve fitting.

f) Strong DIY community, but requires increasing time investment to keep pace with development.
    a. Greg from Parrot –DIY has its purposes, but can also be a large time sink relative to other tasks required to accomplish research goals. Rapid tech advances on the horizon.
        i. Sensor advances on near term: cheaper multispectral, thermal, Lidar, RGB
        ii. Coming but longer-term: gas flux sensors
    b. Cross sensor comparison and calibration still in early days. Even commercial multispectral sensors still relatively untested in field ecological settings. A need to adapt concepts from traditional remote sensing to ensure accuracy in spectral comparisons.

2. High Latitude UAV synthesis paper

Summary:
Perhaps greatest potential for a group like HLDN is identifying ecological (rather than technological) questions that may be appropriate for cross-site UAV deployments. Potential to augment existing plot studies, UAV only questions, or use UAVs as a means to augment and evaluate satellite data. A few groups pointed out potential to integrate fine-grained UAV measurements in space with high resolution time series from time-lapse cameras. The group at the meeting spanned various interests, but for those that are interested in contributing to a cross-site or synthesis paper (rather than learning some of the basics of UAV use) focused on identifying critical “cross site” questions, please contact Jeff or Isla in the next week or so, and we will send out a separate email going into details about getting a paper together.

Greg from Parrot suggested that science is moving too slowly to keep up with pace of technological development in UAVs, and that synthesis of tech-developments would, by definition be outdated by the time it came out. There was some discussion of this within the group and some shared the opinion that manuscripts can still provide a way to focus research attention perhaps in parallel with technological advances that can be disseminated over blogs or other more rapid media. There was agreement that there is an urgent need to test and validate sensors.

Bullet point Notes from Discussion:

a) Historically, there has been too much focus on the technology rather than the questions that can be addressed
b) Where are drones really needed to answer the big questions?
c) Questions to address:
    a. Greening patterns across scales
    b. Scaling mismatch?
    c. Phenology
    d. Herbivory impacts
    e. Animal behavior
    f. Spectral and structural comparisons
    g. Processes and interactions between biophysical variables (plants, snow, permafrost disturbances, etc.) and comparison to satellite data
    h. Arctic browning (extreme winter warming, freeze thaw, rain on snow events)?
    i. How do we quantify heterogeneity?

d) Methodological issues – filtering the data of interest and discussion of metadata standards
    a. Sun angle – a particular issue at high latitudes. Solar noon (minimal shadows) angle differs by latitude.
    b. Cloud cover
    c. Time of data collection (Latitude)
    d. Ground control markers – need to be visible in all spectral bands being surveyed
    e. Absolute versus relative accuracy of imagery/data collected
    f. Calibration plates – spectral precision of the data

e) Distributed data collection
f) Long-term vs. short term initiatives
g) A new view on biophysical processes in the Arctic…

3. Strategic planning for funding, research, and policy development relevant to high latitude use cases

    Summary:
    Initially develop papers to focus on key questions. Drones are a potentially transformative tool in this region, with some uses focused on local questions, and others that have potential to resolve long-standing gaps in understanding across sites, linking plots to satellites. Future challenges include dealing with immense amount of data, learning curve as tools become more widely used, and matching granting requirements of data sharing with new magnitude of data collection. Reach out to data centers – NASA, Polar Data Catalogue, Polar Data Centre, etc…. find a data home - support for data hosting.

Call to identify sources for funding?

NERC International Opportunities Fund:
http://www.nerc.ac.uk/research/partnerships/international/iof/

NSF Polar Programs calls:
https://www.nsf.gov/div/index.jsp?div=PLR

Look to other circum-polar research groups for ideas on cross site collaboration (Herbivory Network, ITEX, CARMA?).

a. Where are best sources of funding for this work?
    i. NERC (I. Myers Smith)
    ii. National Geographic?
    iii. Support from Parrot other industry groups?
b. Regulatory framework for working in various countries
    i. Centralized information about this (see https://www.droneregulations.info/)?
    ii. Sharing of permitting tips
c. New directions
    i. Big data
    ii. Data networks
    iii. 360 data (VR – teaching, phenology?)
    iv. Video
    v. Beyond line of site (more a regulatory than a technical challenge)
    vi. Tie to citizen science projects

Attendees:
Thomas Fox, U. Calgary
Maja Kucharczyk, U. Calgary
Paul Nesbit, U. Calgary
Christian John, Penn State University
Scott Davidson, U. Sheffield
Johan Oloffson, Umea
Janet Prevey, Swiss Federal Institute for Snow and Avalanche Research
Teal Potter, U. Colorado
Sophie Gilbert, U. Idaho
Christophe Kinnard, U. Québec à Trois-Rivières
Christian Andresen, Los Alamos National Lab
Mike Loranty, Colgate University
Greg Crutsinger, Parrot
Petya Campbell, U. Maryland Baltimore County
Fred Huemmrich, NASA
Ran Meng, Brookhaven National Lab
Jeffrey Kerby, Dartmouth College
Isla Myers-smith, U. Edinburgh
Andrew Cunliffe (remote from Edinburgh)