

## CFS Activities Relevant to ABoVE

<b>1. Project Title</b>
<b>Multi-Sensor Remote Sensing Data for Forest Inventory in the NWT</b>
<b>2. Investigators (include email).</b> <b>a) Project Lead;</b> <b>b) CFS collaborators,</b> <b>c) external collaborators (individuals/institutions)</b>
<p>a) Ron Hall (CFS – NoFC) <a href="mailto:ron.hall@canada.ca">ron.hall@canada.ca</a></p> <p>b) With addition of Canadian Space Agency linkage 2015-2018:          Co-PI: Andre Beaudoin (CFS –LFC) <a href="mailto:andre.beaudoin@canada.ca">andre.beaudoin@canada.ca</a>          Co-PI: Ron Hall (CFS – NoFC) <a href="mailto:ron.hall@canada.ca">ron.hall@canada.ca</a>          Co-PI: Guillermo Castilla (CFS – NoFC) <a href="mailto:guillermo.castilla@canada.ca">guillermo.castilla@canada.ca</a>          Others: H. Chen, D. Leckie (CFS –PFC); R. Skakun, M. Gartrell, M. Filiatrault (CFS-NoFC); P. Villemaire, L. Guindon (CFS-LFC)</p> <p>c) Hopkinson (ULeth); D. Goodenough (UVic); J. Kellndorfer (WHRC); L. Smith, K. Groenewegen, T. Lakusta (GNWT).</p>
<b>3. Project Description (200 words maximum)</b>
<p>The forested area of the NWT is a widely distributed land mass 33Mha in size, much of which is inaccessible and costly to survey. National and regional reporting and NWT policies related to biomass, greenhouse gases, and caribou management require more current inventory data and detailed maps of natural disturbances such as wildfires. Two adjoining study areas occupying 470,000 km<sup>2</sup>, falling within the ABoVE core area, are under investigation to map four key forest structural attributes (height, crown closure, volume and biomass) based on k-NN imputation. The k-NN process employs a combination of actual field plots and pseudo-plots from ICESat GLAS, satellite optical (Landsat) and radar (PALSAR) data, along with measures of physiography and climate. With fire being the main natural disturbance, detailed maps of annual burned areas from 2004 to 2015 are also being derived from temporal Landsat change detection. Aside from supporting studies into sensor interoperability/complementarity, the information derived is to support carbon accounting of managed/unmanaged forests in the NWT, and to update the National Forest Inventory. A new project to study climate change impacts within the context of a forest vulnerability and adaptation framework in collaboration with several CFS scientists is also in development.</p>
<b>4. Timelines and current funding (level and source)</b>
<p>Project originally started in 2005 and has evolved from an expansion of the study area and information objectives. Multiple funding sources have been employed including support from GNWT. A new collaboration with the Canadian Space Agency began in July 2015 and ends in March 2018 through the Northern Forests project co-managed by A. Beaudoin (CFS-LFC) and R. Hall/G. Castilla (CFS-NoFC). Total budget is \$970,000 CAD, \$395,000 from the Canadian Space Agency, \$420,000 from CFS (in kind) and \$155,000 from partners (in kind and funding support).</p>
<b>5. Reference (1-2 key publication, website)</b>
<p>Beaudoin, A., P.Y. Bernier, P.Y., Guindon, L., Villemaire, P., Gao, X.J., Stinson, G., Bergeron, T., Magnussen, S., and Hall. R.J. 2014. Mapping attributes of Canada's forests at moderate resolution through kNN imputation and MODIS imagery. Can. J. For. Res. 44: 521-532.</p>

Van der Sluijs, J., Hall, R.J., and Peddle, D.R. 2016. Influence of field-based species composition and understory descriptions on spectral mixture modeling of tree species in the Northwest Territories. Canadian Journal of Remote Sensing. Canadian Journal of Remote Sensing. Accepted.

Skakun, R.S., Hall, R.J., Arsenault, E.J., Smith, L., Cassidy, A., Lakusta, T., Beaudoin, A., Guindon, L. 2007. Using multi-sensor satellite imagery to map forest stand attributes in the lower Mackenzie Valley, NWT. *in* Proceedings IPY GeoNorth 2007 Conference - First International Circumpolar Conference on Geospatial Sciences and Applications, August 19-24, 2007, Yellowknife, NWT.

Website: <http://www.nrcan.gc.ca/forests/measuring-reporting/remote-sensing/13441>

#### 6. ABoVE question being mainly addressed (please highlight)

1. How are environmental changes affecting critical ecosystem services - natural and cultural resources, human health, infrastructure, and climate regulation - and how are **human societies** responding?

*Human dimension is not a direct part of this project. However, the outputs of this work will feed into the disturbance footprint and habitat elements of Barren-ground caribou and provide forest inventory information to support assessment of timber supply and sustainability. We have observed dynamic changes to forest structure caused by climate change whose impact on NWT forest provision of ecosystem services, on which remote rural communities rely, are unknown. Measurements and monitoring is needed to quantify these impacts.*

2. What processes are contributing to changes in **disturbance** regimes and what are the impacts of these changes?

*The changing climate may be impacting the health and productivity of NWT forests that in turn are resulting in potential changes to disturbance regimes relative to fire and insects.*

3. What processes are controlling changes in the distribution and properties of **permafrost** and what are the impacts of these changes?

*Field work in this project included establishment of approximately 200, 20 by 20 m forest inventory plots from 2005-2009 across 4 study regions. Field plots revisited in 2014 near Fort Providence showed clear signs of decline that maybe related to drought and thawing permafrost –further research is needed.*

4. What are the causes and consequences of changes in the **hydrologic system**, specifically the amount, temporal distribution, and discharge of surface and subsurface water?

*This research does not address hydrological or hydrogeological questions although the thawing of the discontinuous permafrost has consequences to the hydrologic systems.*

5. How are **flora and fauna** responding to changes in biotic and abiotic conditions, and what are the impacts on ecosystem structure and function?

*The impacts of fire and changes to forest composition and structure will affect Barren-ground caribou habitat and are appearing to cause physical changes to forest productivity. The magnitude and nature of these changes require further investigation.*

6. How are the magnitudes, fates, and land atmosphere exchanges of **carbon** pools responding to environmental change, and what are the biogeochemical mechanisms driving these changes?

*This project does not include direct carbon research, but information generated by the project will be used by the CFS Carbon Accounting Team.*

**7. Linkages with ABoVE:**

- a. Data being collected/generated**
- b. Expected key benefits and potential challenges from collaborating with ABoVE**
- c. Ongoing and / or interest in future involvement in ABoVE**

- a. There is the intent to re-measure field plots across multiple sites that occur within the ABoVE core study area. These data could be used to calibrate remote sensing measurements proposed in the Airborne Science Research Strategy white paper. The coordinates of three CFS study areas have already been incorporated as part of the proposed NASA mission in 2017. In addition, yearly 25m PALSAR 2007-2010 global mosaics were processed and optimized over the ABoVE core area in Canada resulting in optimized L-band dual pol coverage that could be of interest to ABoVE for spatializing various attributes. Linkages also exist with Drs. Marc Andre Parisien and Dan Thompson with PhD student Ellen Whitman in collection and study of fire ecology and burn severity stemming from the 2014 fires. Linkages between Canadian fire and burn severity work already exist with NASA ABoVE investigators.
- b. The CFS work is in collaboration with, and of direct relevance to, GNWT science and policy questions. Work directed at plot re-measurement and investigations into climate impacts would serve as a Canadian contribution to ABoVE science questions. Challenges are largely in leveraging sufficient financial and human resources to support Canadian investigations given that direct financial resources from NASA support of ABoVE is not available to Canada.
- c. CFS can play an important role in helping NASA answer the ABoVE questions through involvement in new, ongoing or longer term research to understand changes to biotic and abiotic conditions in northern boreal ecosystems.