Methods

Study area

The study area (Figure 1) is Canada's forests region which comprises of boreal, great lakes, acadian, carolinian, subalpine, columbia, montane and coastal forest. Tree species within the zone are generally conifers such as black spruce, white spruce, Tamarack, balsam fir and jack pine while deciduous trees within the zone includes Aspen, balsam poplar and paper bitch. The climate of Canada's forest varies but it is mainly characterized by cold winters and short summer (Brandt, 2009), although we are beginning to observed more warmer winter due to climate change. The mean temperature in Canada's boreal forests ranges 10^{o}C- 20^{o}C and this varies from region to region (Zhang et al., 2019)

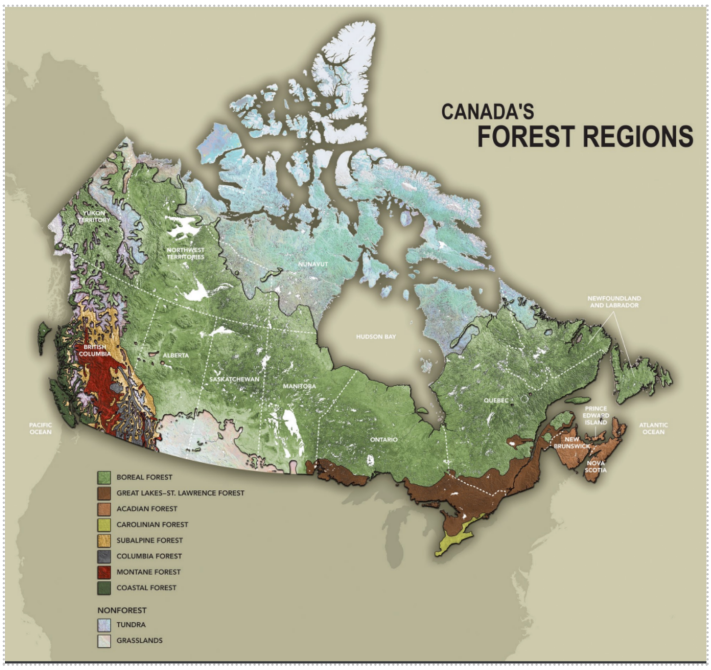

Figure 1: Canada's forests regions (Natural resource Canada)

Wildfire is the major standing disturbance within Canada's boreal forest and also other forest region with more than 2 Mha burn annually on average (Stocks et al., 2002) although this range varies from year to year.o determine areas that burned, a burned area map derived using a support vector machine learning algorithm will be used to identify area burned. To determine the areas that are primarily forests, a land cover map will be used to stratify the various land cover types. a land cover map will be used to stratify the areas of various landcover classes.

2.2 Field data

Field combustion area

To estimate the amount of C loss across Canada's major disturbances, Field combustion measurements for the year 2014 and 2015 as shown in Figure 2 were acquired from a number of publications that carried out combustion measurement within Canada's boreal forests and published online as a single database (Walker et al., 2020a).

This field measurements resulted in 456 plots and were used with other predictor variables to estimate C loss from Canada 's boreal forest fires.

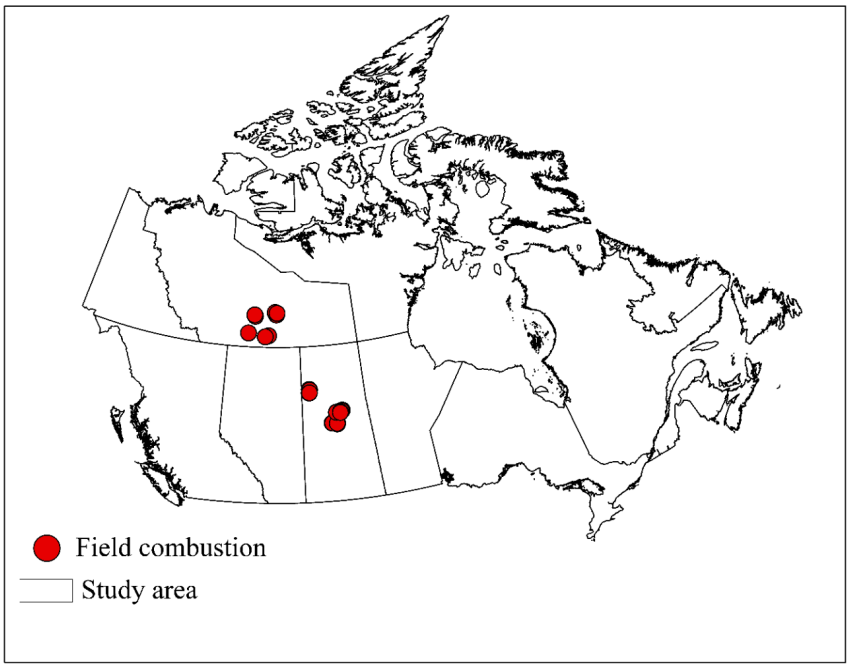

Figure 2: Field combustion area

Burned-area, harvest and insect disturbance mapping

Disturbnace map across the entire sty area will be drive using a random forest approach where we integrated different spectral indices, spectral bands and environmental variables. A threshold value established from literature and other filed collected disturbance site will be used on the final disturbance product to identify each disturbance types(fire, harvest and insect infestation) within Canada's forests.

Combustion models

Predictor variables

Field combustion measurements for aboveground and belowground C loss was obtained from Walker et al. (2020) and related to gridded environmental, fire severity and remotely sensed variables of combustion (Figure 3).

The predictor variables of combustion used in this study was selected first by spanning across the literature and also discussing with experts and also further validated with a selection from random forests.

Climate variables Climate variables used in this study was obtained from Climate NA. Climate NA provides monthly, seasonal and yearly gridded climate data. This data was used to generate climate impact of C combustion within Canada's boreal forests.

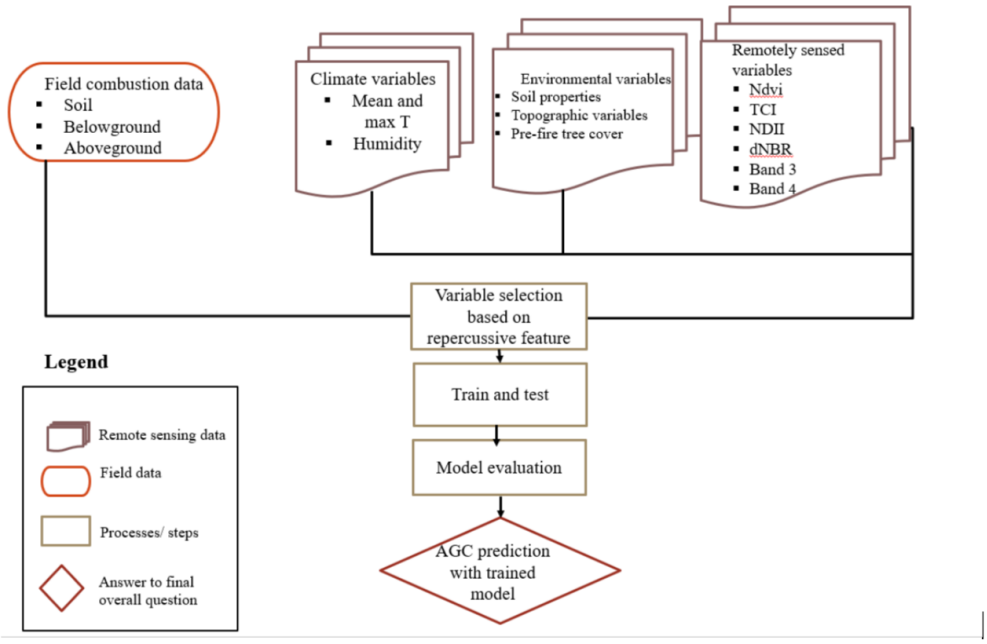

Figure 3: method to map C emissions from disturbance

2.4.3 Environmental variables Aboveground combustion from fire depends on a lot of top tree influence. The environmental variables that we will use for this research includes elevation, Soil properties , slope, aspect, and pre-fire tree cover. The elevation data will be obtained from the Advanced Spaceborne and Thermal Emission and Reflectance Radiometer Global Digital Elevation Model (ASTER GDEM), and then slope and aspect will be derived in ArcGIS or R USING THE DEM.

Prefire tree cover plays a huge factor and influences below and aboveground combustion. Tree cover influences biomass fuel for burning and it is also a measure of tree stand. Studies have found out that tree cover correlates with C loss (Rogers et al., 2014). The pre-fire tree cover used in this study will be obtained rom Sexton et al et al. (2013) for the year201 and it will serve as the pre- fire tree cover for our combustion model

The differenced normalised burn ratio (dNBR) assess changes in fire impacted vegetation using the near and shortwave infrared reflectance (Key & Benson, 2004). dNBR will also be included as a predictor variable as studies have found out the dNBR correlates significantly with biomass loss. Spectral bands of Landsat 1- 9 wil be downloaded from the USGS and the NIR and SWIR band s will be used for deriving NBR (NIRSWIR)/(NIR + SWIR). dNBR will be computed as the difference between pre-fire and post fire NBR.

2.4.4 Remotely sensed variables Remotely sensed variables used for this studies were all derived from Landsat 7 and 8. This include Landsat band 1 -9, the normalised differenced vegetation indices(NdVI), the topographic wetness index, Tasseled cap indices, and the Landsat dNBR