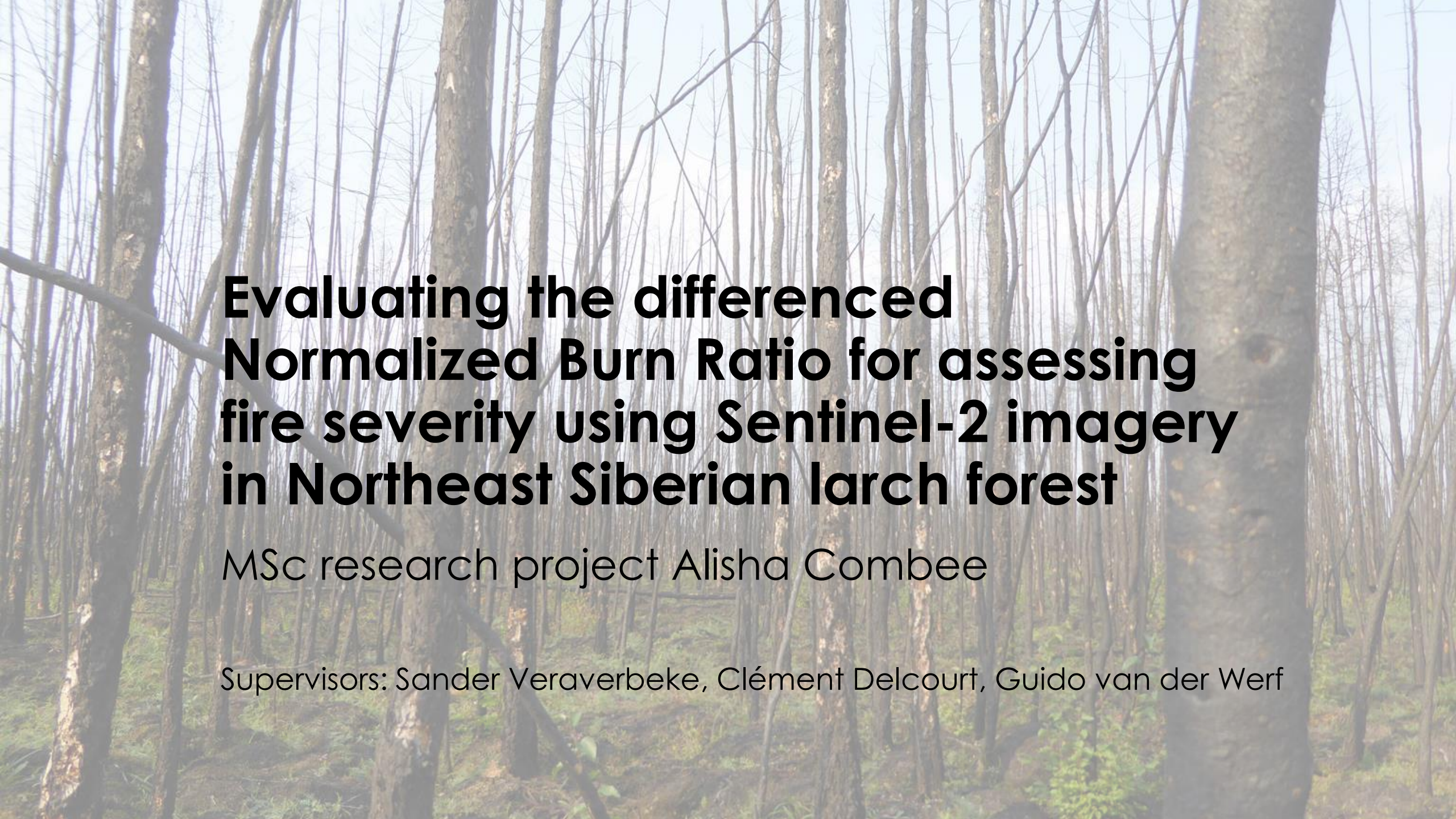

Evaluating the differenced Normalized Burn Ratio for assessing fire severity using Sentinel-2 imagery in Northeast Siberian larch forest

MSc research project Alisha Combee

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Introduction

- Remote sensing
- Boreal forest → large carbon stock
- Organic rich soils consumed by fires
  - Emissions → belowground combustion
- Climate change & fire regime

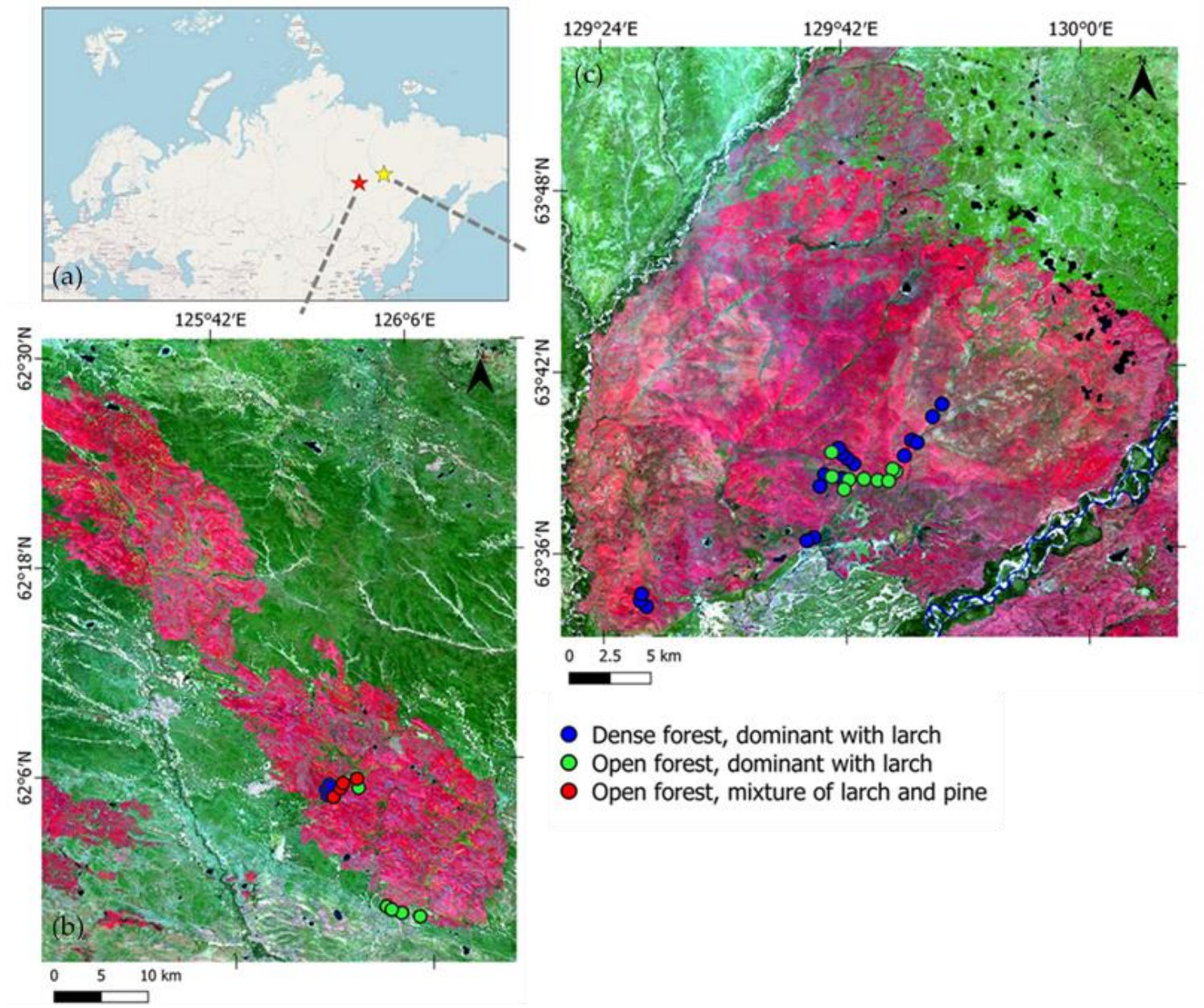
Image source: Greenpeace international

Introduction

- Fire severity assessment
- Boreal North America
  - Black spruce forests
  - Landsat
- Siberia:1/3rd of all boreal forest
  - very little research conducted
- Novelty: usage of Sentinel-2 in Siberia

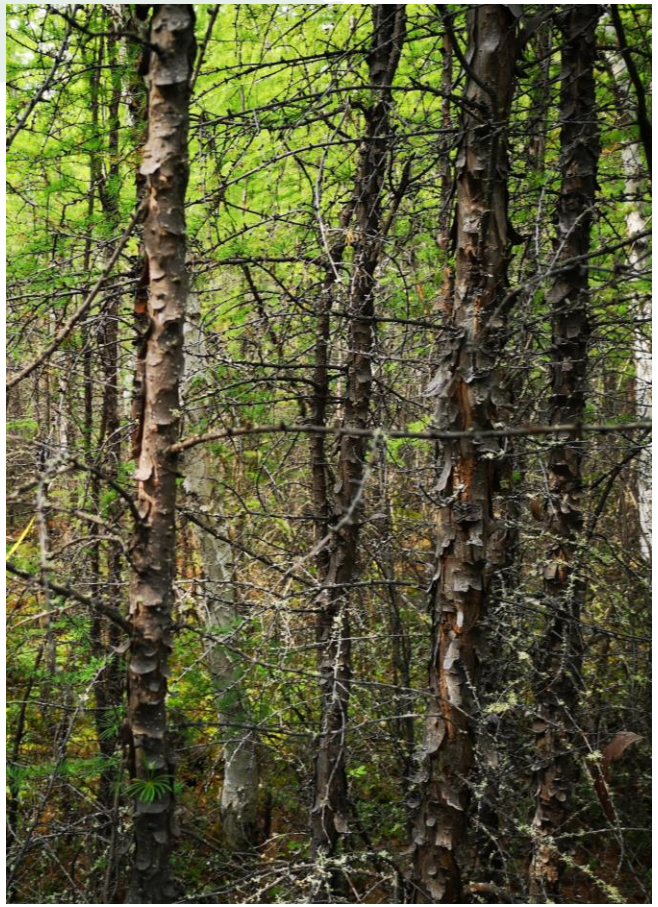
Study area

- Yakutsk, Russia
- 2 fire scars
  - Batamay (2017)
  - Yert (2018)
- 800 and 900 km2 respectively



False color composite (Level 2A, RGB-8a43)

Forest types



- Dense, larch (*Larix cajanderi*) dominated

- Open, mixture of larch and pine (*Pinus sylvestris*)

- Open, larch dominated

Images by C.J.F. Delcourt

Field data

- Data collected in summer 2019
- 41 burned plots

- 2 Field variables:
  - **GeoCBI**, focussed on aboveground severity
  - **Burn depth**, focussed on belowground severity

GeoCBI

- Visual assessment tool
- Values range between 0.0 and 3.0

→ Unburned to burned

- Unburned plot
- GeoCBI= 0

- Moderate fire severity
- GeoCBI= 1.33

- High fire severity
- GeoCBI= 2.71

Images by C.J.F. Delcourt

Burn depth

- Soil organic layer (SOL) depth measured in each burned plot
- Adventitious roots
  - Used to estimate pre-fire soil surface and burn depth
- Burn depth = pre-fire SOL depth – residual SOL depth

Image by C.J.F. Delcourt

Imagery and pre-processing

- Sentinel-2 (20 m resolution)
- Anniversary data
- Atmospherically corrected using Sen2cor

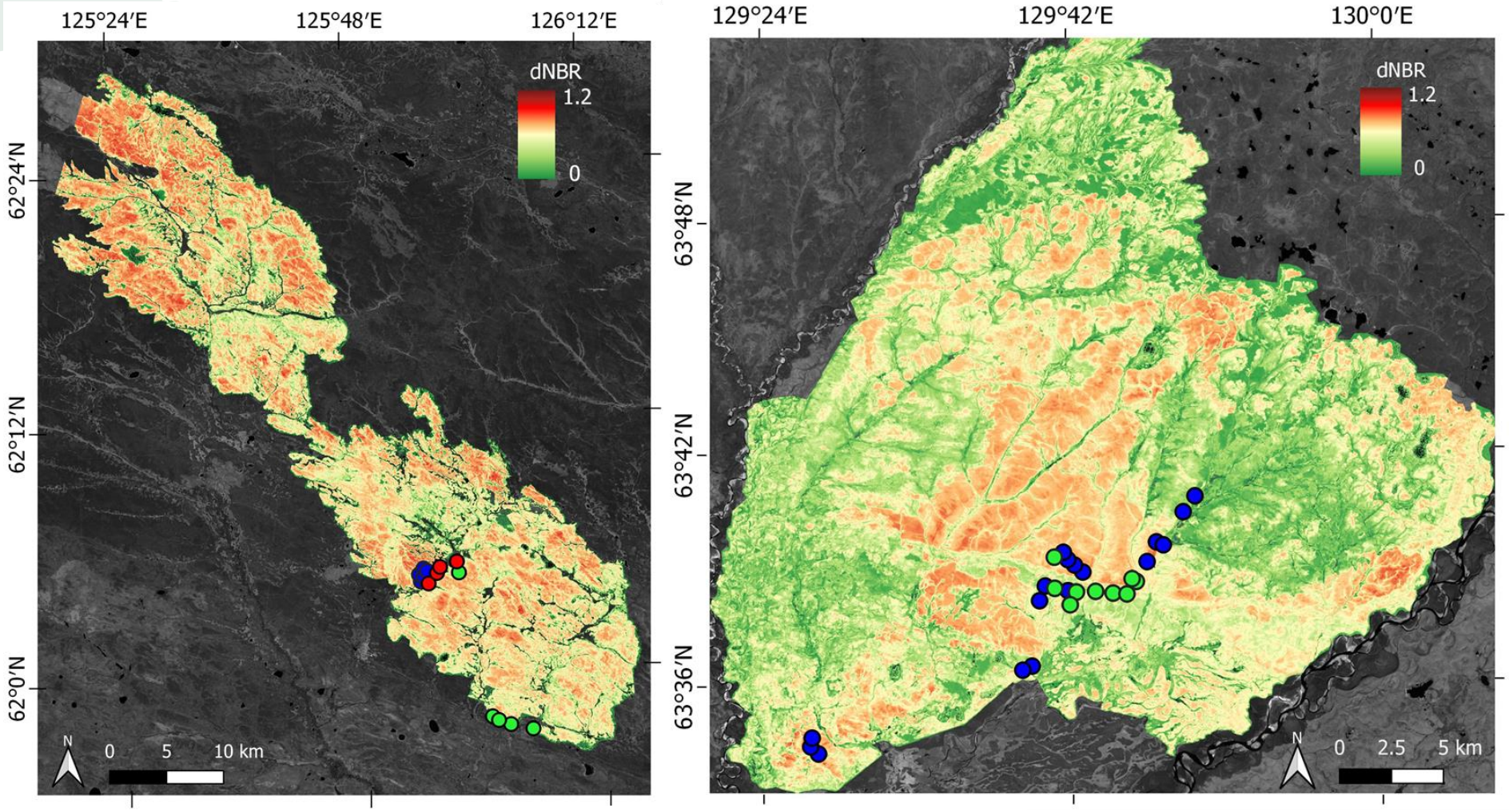
- NIR (B8a) & SWIR (B12)
- Normalized Burn Ratio (NBR) → $NBR = \frac{NIR-SWIR}{NIR+SWIR}$
- Differenced NBR (dNBR) → $dNBR = NBR_{pre-fire} - NBR_{post-fire}$

Results

- dNBR map representing overall fire severity

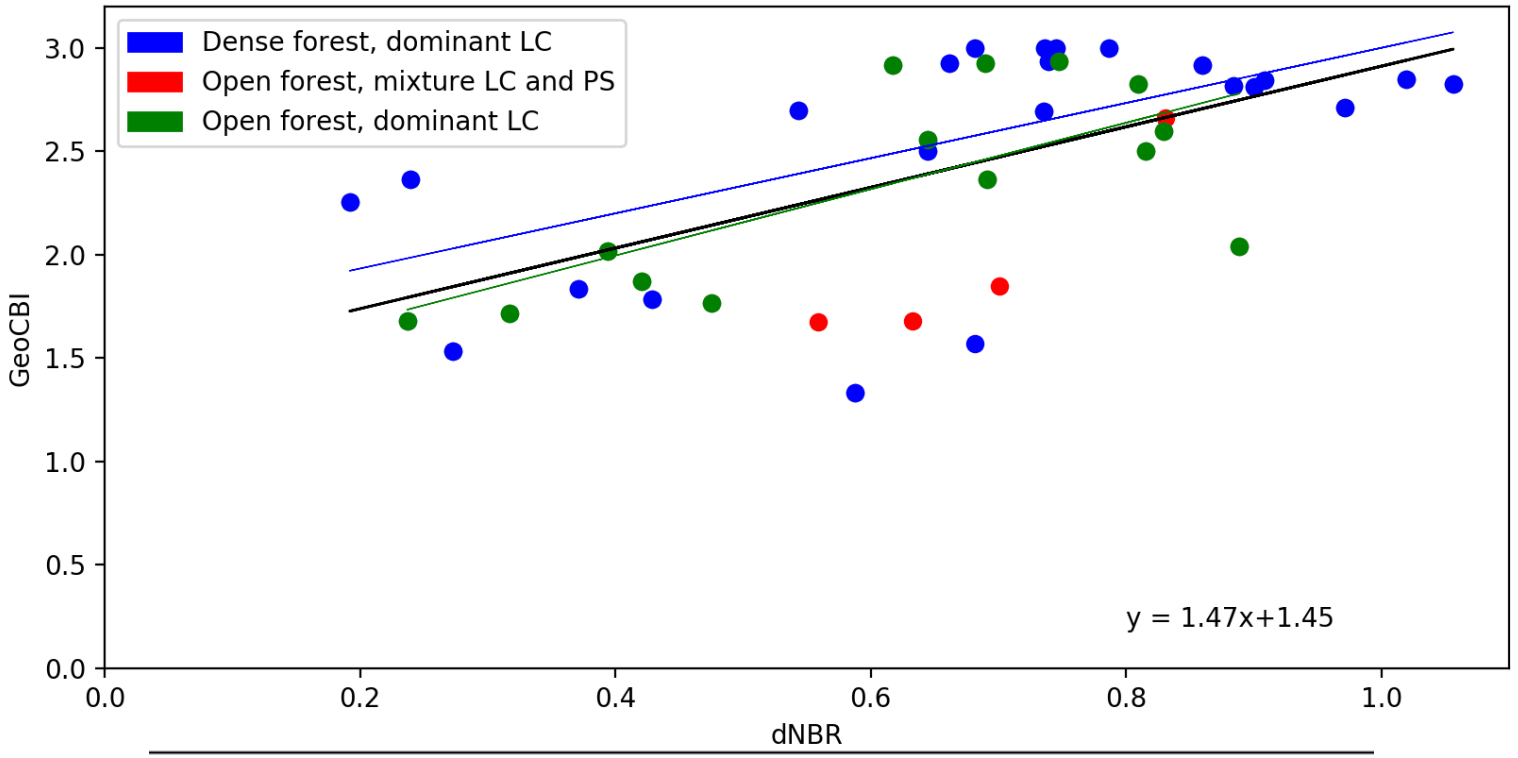
- Relationships between:
  - GeoCBI and dNBR
  - Burn depth and GeoCBI
  - Burn depth and dNBR

dNBR map


125°24′E
125°48′E
126°12′E
62°24′N
62°12′N
62°0′N
dNBR
1.2
0
N
0
5
10 km
129°24′E
129°42′E
130°0′E
63°48′N
63°42′N
63°36′N
dNBR
1.2
0
N
0
2.5
5 km
Dense forest, dominant with larch
Open forest, dominant with larch
Open forest, mixture of larch and pine

GeoCBI – dNBR

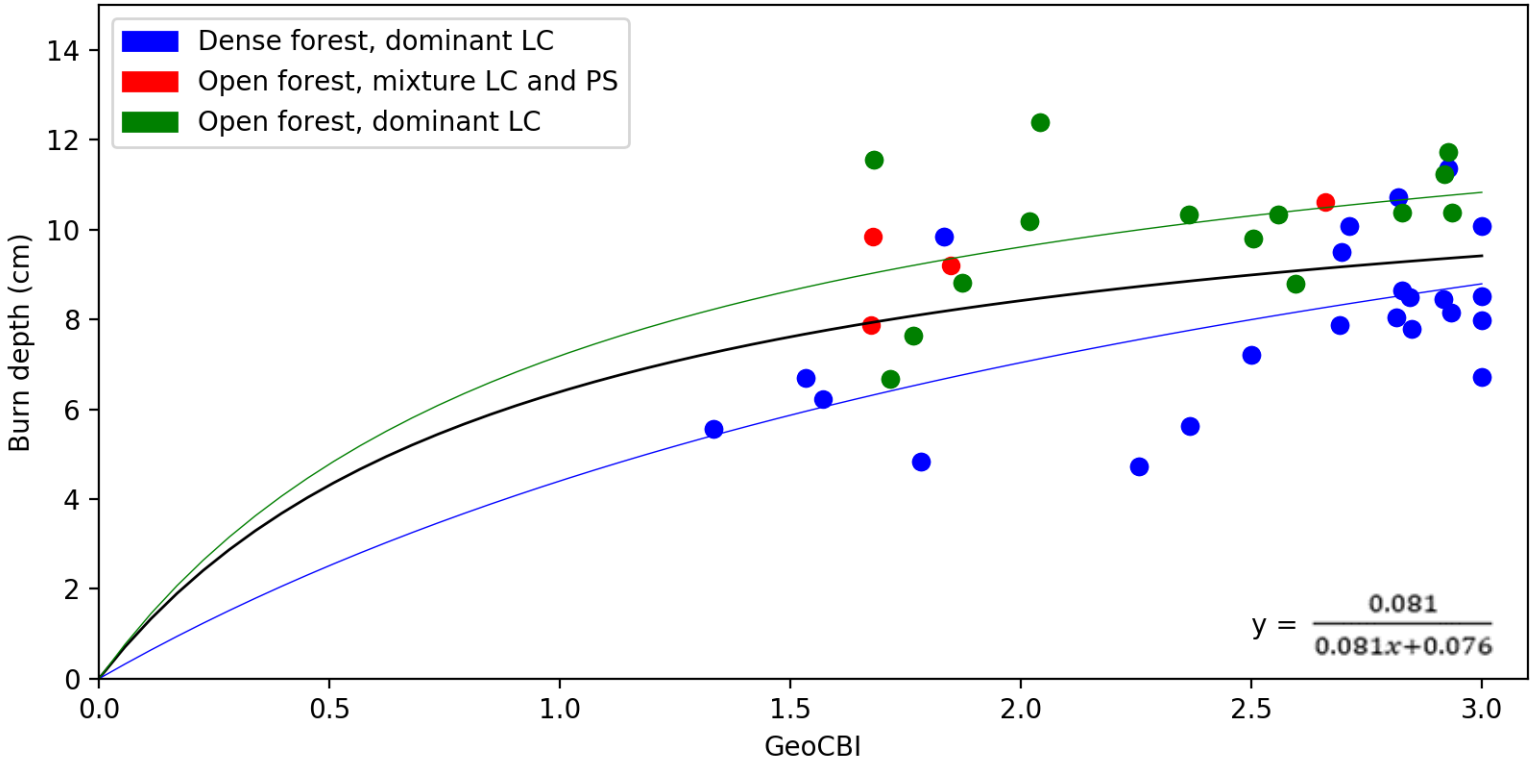
- Linear regression
- Overall $R^2 = 0.38$ ($p < 0.001$)
- Higher R^2 when separated in forest type



	GeoCBI-dNBR			
	a	b	R^2	RMSE
All plots	1.466	1.446	0.378	0.412
Dense plots, dominant LC	1.334	1.667	0.436	0.373
Open plots, dominant LC	1.606	1.354	0.491	0.329

Burn depth- GeoCBI

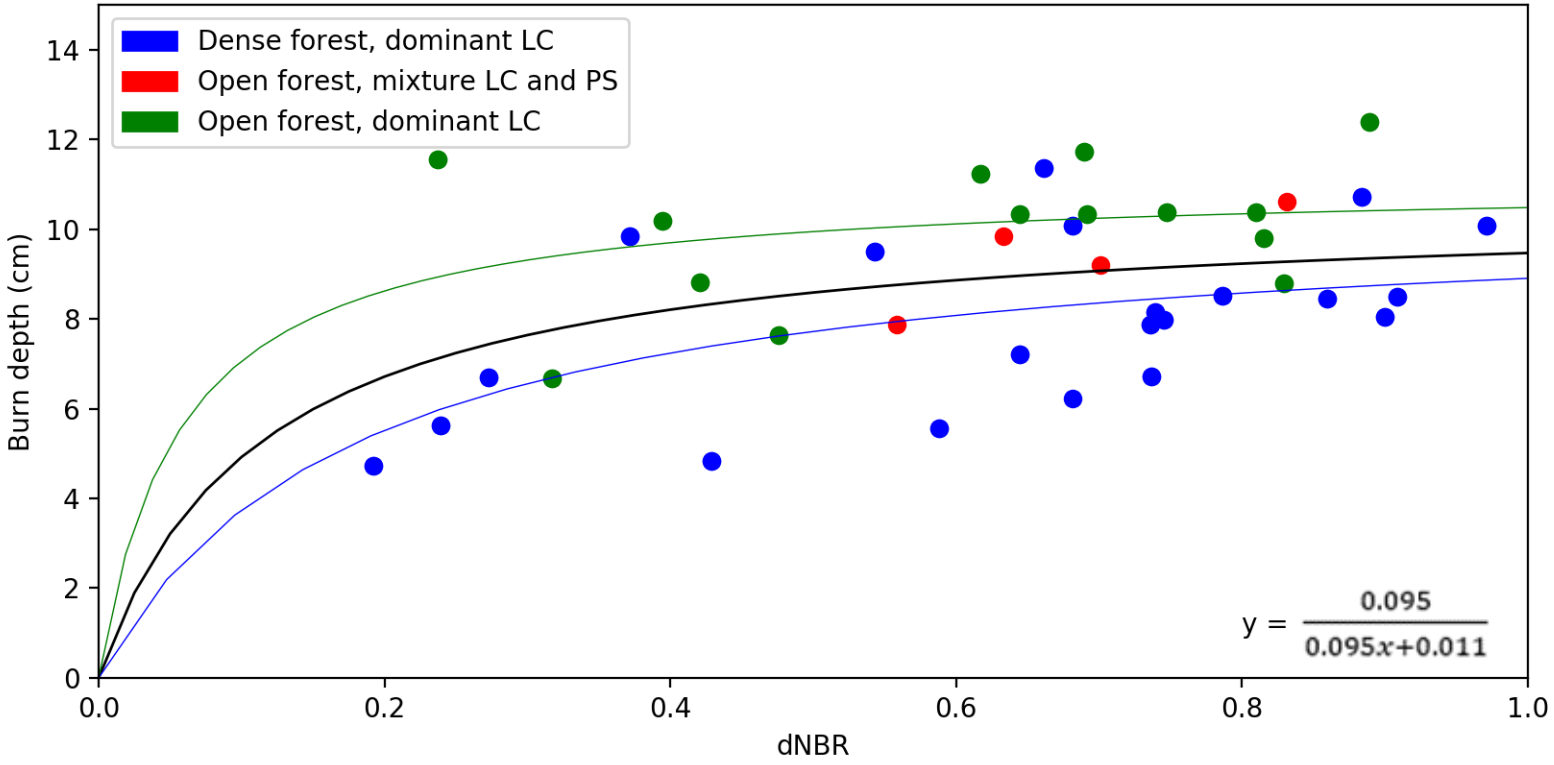
- Non-linear relationship
- Saturated growth model
- Overall not strong (R^2 =0.11) but significant p<0.05



	Burn depth-GeoCBI			
	a	b	R^2	RMSE
All plots	0.081	0.076	0.110	3.709
Dense plots, dominant LC	0.057	0.017	0.272	4.073
Open plots, dominant LC	0.069	0.070	0.173	3.982

Burn depth- dNBR

- Non-linear relationship
- Saturated growth model
- Strongest relationship: dense larch forest



	Burn depth-dNBR			
	a	b	R^2	RMSE
All plots	0.095	0.011	0.137	3.068
Dense plots, dominant LC	0.095	0.017	0.309	3.164
Open plots, dominant LC	0.090	0.005	0.063	3.302

Discussion

- Similarities with boreal North American forests
  - dNBR predictor above ground severity
  - potential for predicting burn depth
  - Vegetation specific dependency

- Above- and belowground severity are partly correlated

  → Explains the burn depth- dNBR relationship

- Belowground combustion cannot be derived from satellite data only → synergies dNBR important
  - e.g. weather conditions and moisture content

Conclusion

- Sentinel-2 imagery useful for determining fire severity in Siberian larch forest
- dNBR strong predictor for GeoCBI, some potential for predicting burn depth
- Results confirm earlier findings in boreal North America (spruce-dominated forest)

Thank you