Tracking forest seasonal physiology using Hyperion images for a boreal forest in central Finland

Hernández-Clemente R.[(1)], Kolari P.[(2)], Porcar-Castell .[(2)], Mottus M.[(1)]

(1) Department of Geosciences and Geography P.O. Box 64 FI-00014 University of Helsinki, Finland
(2) Department of Forest Sciences P.O. Box 27 FI-00014 University of Helsinki, Finland.

PhD Rocío Hernández Clemente

Post Doctoral Researcher

Seasonal physiological changes regulate the growth and productivity of the forest.

Physiological indicators:
Physiological processes at different scales

Forest structure (Tree heights, diameters of the crowns, DBH)

Leaf Area Index

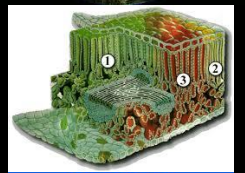
Pigment composition (Cab, Car)

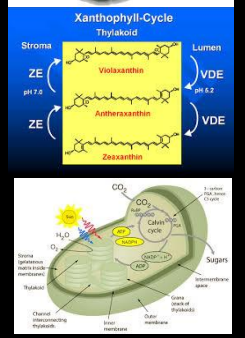
Cycling pigment dynamics (*xanthophylls)*

Fluorescence

Photosynthesis

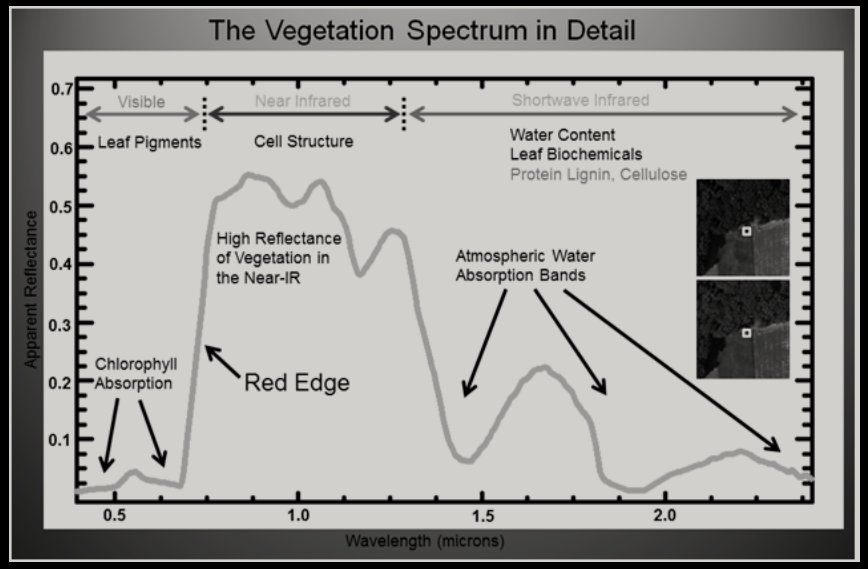
Light Use Efficiency

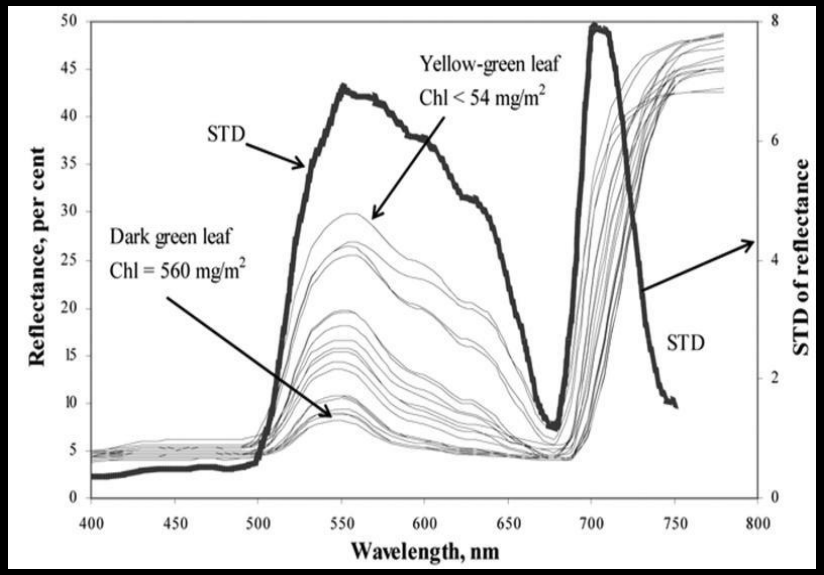




Remotely sensed spectral bio-indicators to analyze seasonal changes in boreal forest.

Narrow band vegetation indices (VIs): quantifying biophysical and biochemical vegetation parameters from VIs.





OBJECTIVES

The main objective of this research was

To evaluate the annual seasonal changes based on *in situ* physiological measurements and different narrowband spectral vegetation indices related with the physiological condition of the vegetation taking into account the potential influence of forest structure, species and composition.

Material and Methods

Study site:

The study area is located at SMEAR II Station in Hyytiälä, southern Finland (61˚51’N, 24˚18’E).

Meteorogical data (Air temperature, air humidity , PAR)

Carbon fluxes rates at the shoot level.

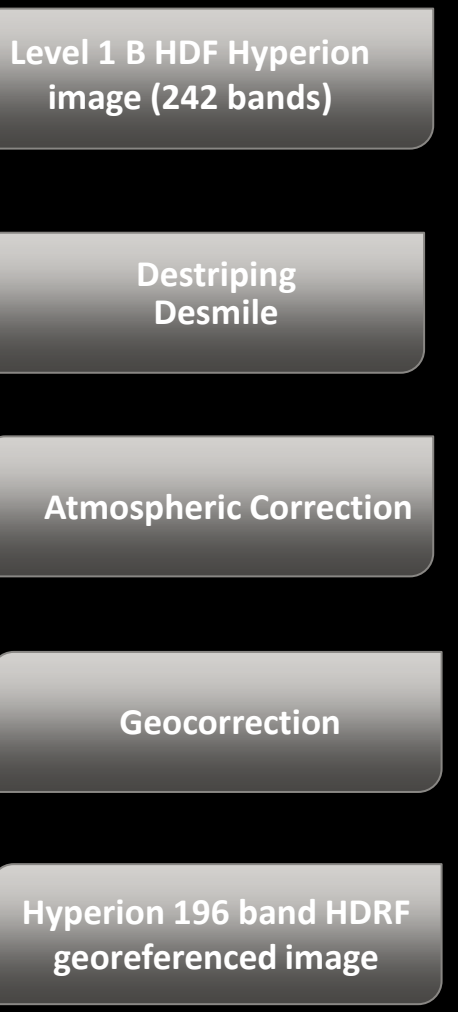
Pigment composition.

Forest inventory: canopy structure and LAI, a The total of plots was 63, covering different boreal forest stand structure and species composition (Scots pine (*Pinus silvestris* L.), Norway spruce (*Picea abies* L.) and birch (*Betula pendula* Roth).

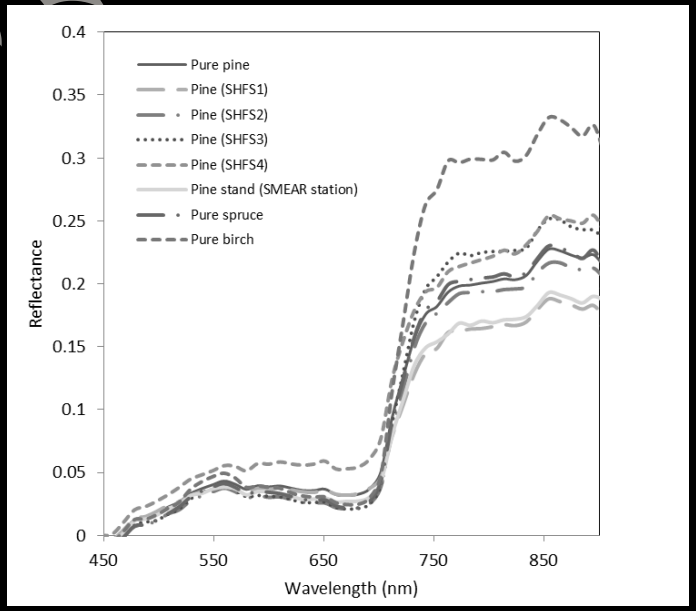
Material and Methods

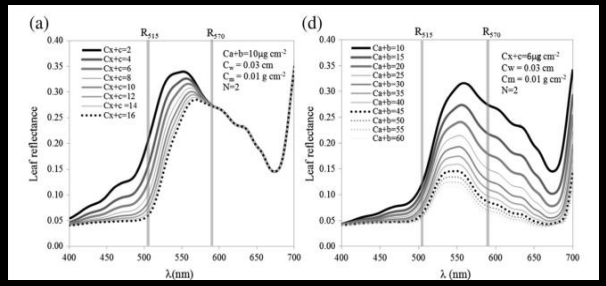
Hyperion data acquisition and processing:

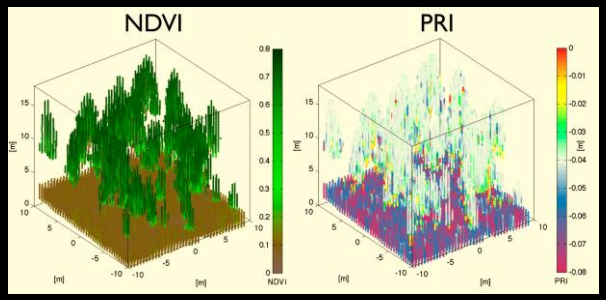
DOY	Time	Day	Month	Year	Solar Azimuth	Solar Zenith	Look angle	Observation viewing	Scattering angle
125	09:21:44	5	May	2010	161.51	46.65	-0.51	Nadir	2.32
153	09:07:27	2	Jun	2010	154.71	41.5	-14.84	Off-nadir*	2.31
161	09:17:16	10	Jun	2010	157.36	40.3	-5.07	Nadir	2.41
181	09:29:08	30	Jun	2009	159.79	39.72	7.13	Nadir	2.41
184	09:08:48	3	Jul	2010	152.73	40.99	-13.75	Off-nadir*	2.32
192	09:18:32	11	Jul	2010	155.94	41.41	-3.9	Nadir	2.39
210	09:31:16	29	Jul	2011	160.82	44.14	10.42	Nadir	2.32
215	09:24:22	3	Aug	2011	158.86	45.6	3.49	Nadir	2.33
*Backscattering									



Narrowband vegetation indices and time series analysis.:

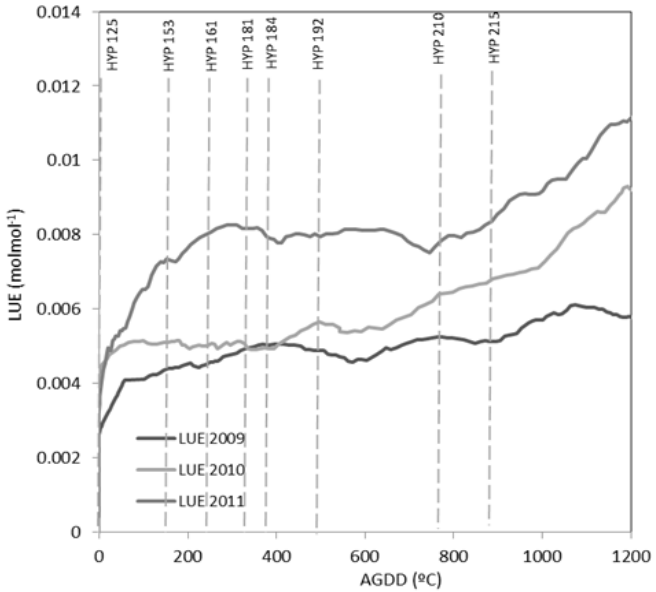


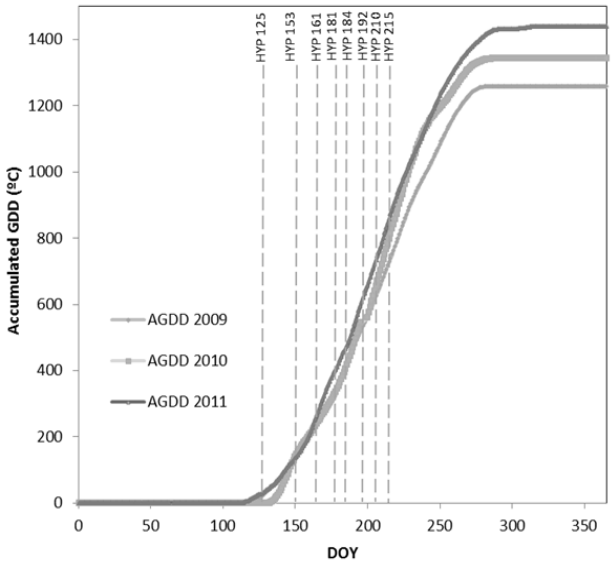


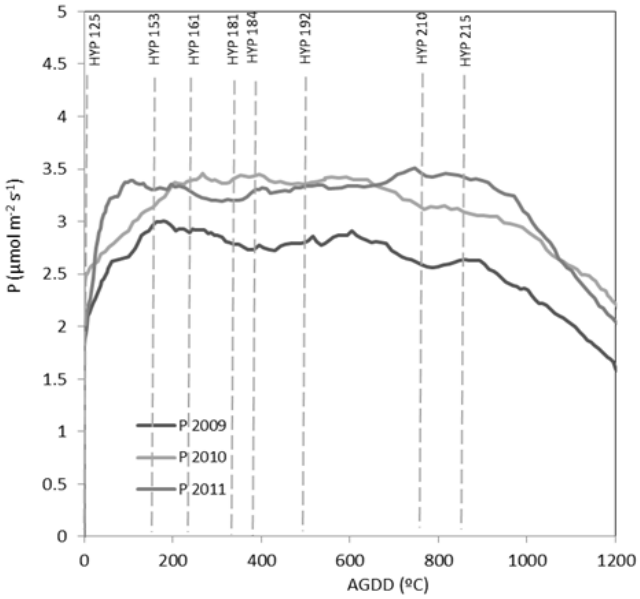


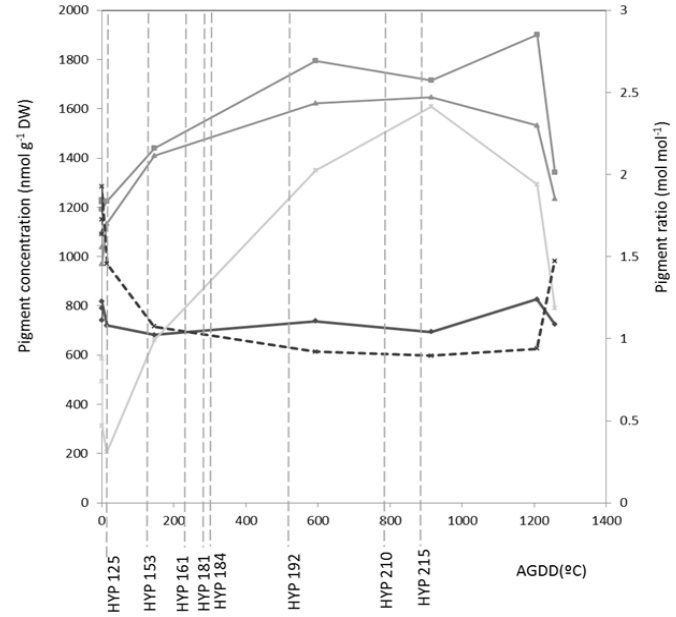
Ecophysiological variable	Vegetatio Index	Formulation	Reference
Chlorophyll content estimation	CI	ρ752/ ρ711	Zarco-Tejada et al. 2004
Carotenoids content estimation	SR_{Car}	ρ569/ ρ518	Hernández-Clemente et al., (2012)
Xanthophyll cycle	PRI_{570}	(ρ529- ρ569)/(ρ529+ ρ569)	Gamon et al. 1997
Fractional Vegetation Cover (FVC)	NDVI	(ρ864- ρ671)/(ρ864+ ρ671)	Rouse et al. (1974)

Results


HYP 125
HYP 153
HYP 161
HYP 181
HYP 184
HYP 192
HYP 210
HYP 215
LUE (molmol-1)
LUE 2009
LUE 2010
LUE 2011
AGDD (ºC)


HYP 125
HYP 153
HYP 161
HYP 181
HYP 184
HYP 192
HYP 210
HYP 215
Accumulated GDD (ºC)
AGDD 2009
AGDD 2010
AGDD 2011
DOY

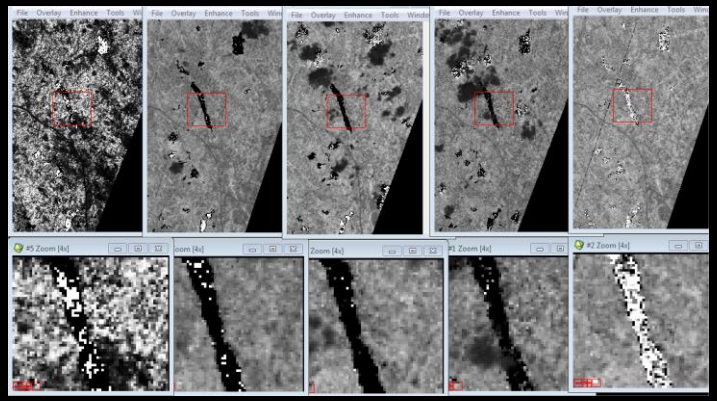

HYP 125
HYP 153
HYP 161
HYP 181
HYP 184
HYP 192
HYP 210
HYP 215
P (µmol m-2 s-1)
P 2009
P 2010
P 2011
AGDD (ºC)


Pigment concentration (nmol g-1 DW)
Pigment ratio (mol mol-1)
HYP 125
HYP 153
HYP 161
HYP 181
HYP 184
HYP 192
HYP 210
HYP 215
AGDD(ºC)

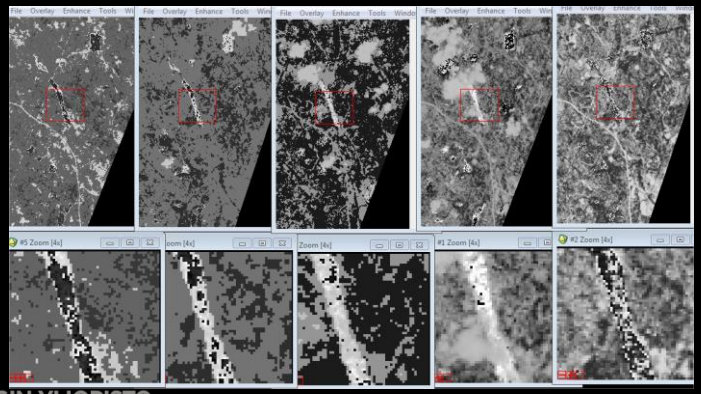
Results

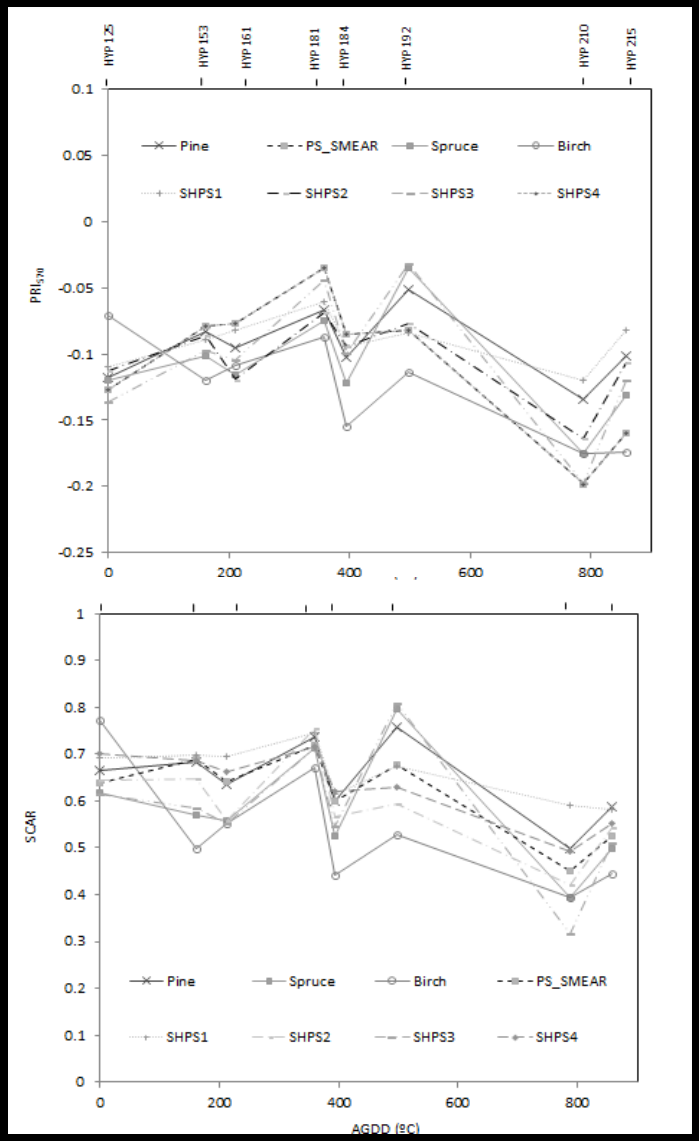
PRI

DOY 125 DOY 153 DOY 161 DOY 192 DOY 210



SCAR

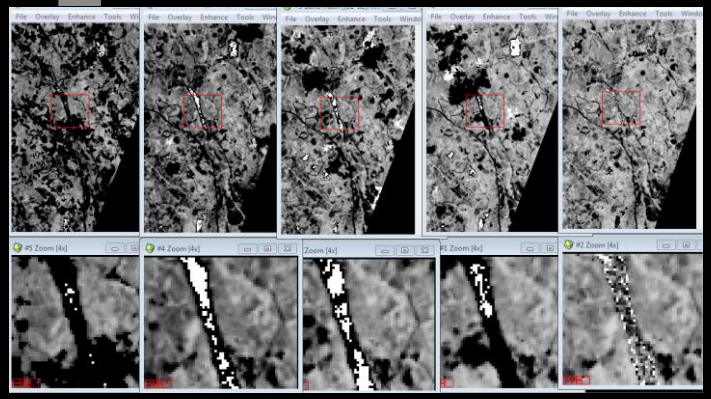




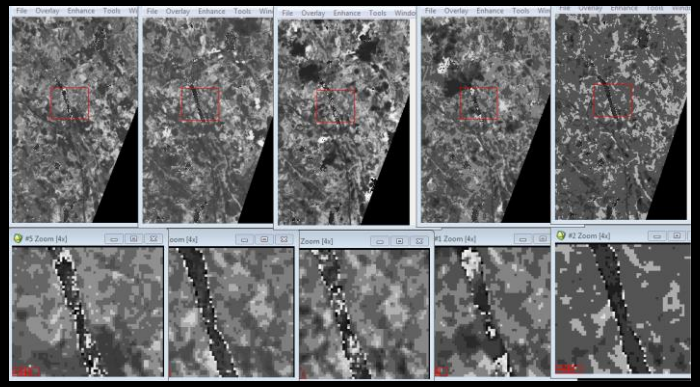
Results

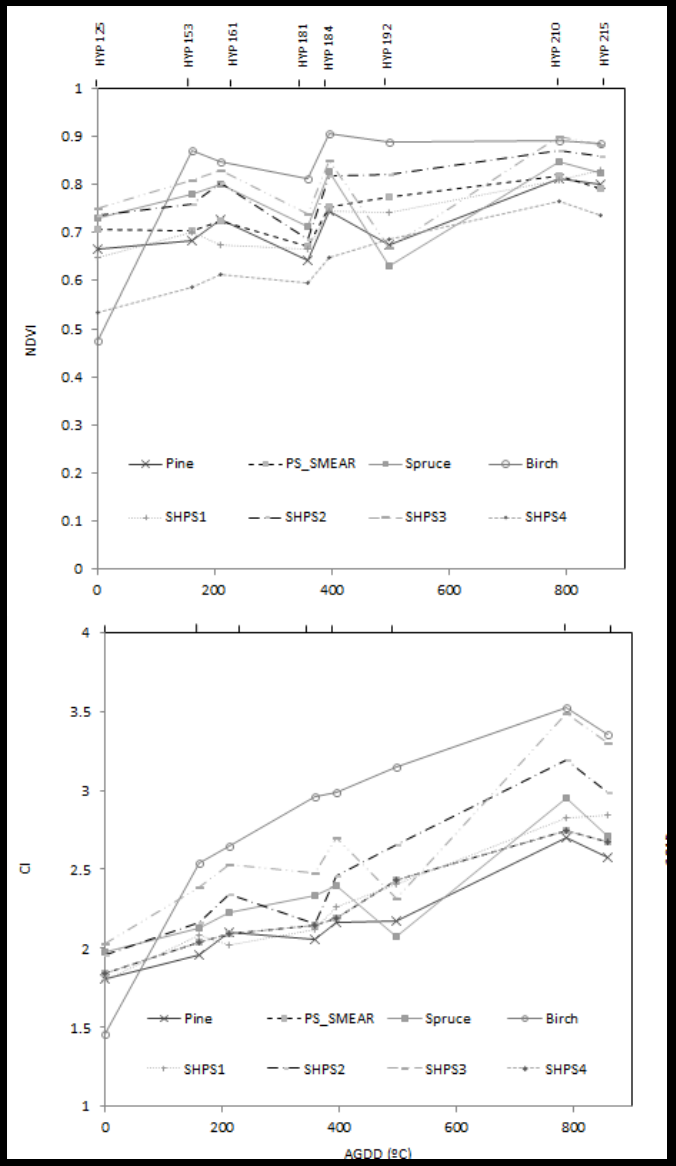
NDVI

DOY 125 DOY 153 DOY 161 DOY 192 DOY 210



Red edge





Conclusions

-A better understanding of both physiological indicators and the spectral vegetation indices (VI) variations during the year is needed in order to evaluate seasonal changes based on remote sensing data.

-There is a wide range of remotely sensed physiological variables sensitive to variations produced during the growing season.

-The dynamic in biochemical indicators are linked to some narrowband vegetation indices as CI, SRCar, and PRI, and therefore, it may have potential in determining growing season length.

-Mapping chlorophylls, carotenoids and xanthophyll's cycle using narrowband vegetation indices derived from Hyperion images may contribute to a better understanding of seasonal variations in boreal forest.

Tracking forest seasonal physiology using Hyperion images for a boreal forest in central Finland

THANKS!!

KIITOS!!