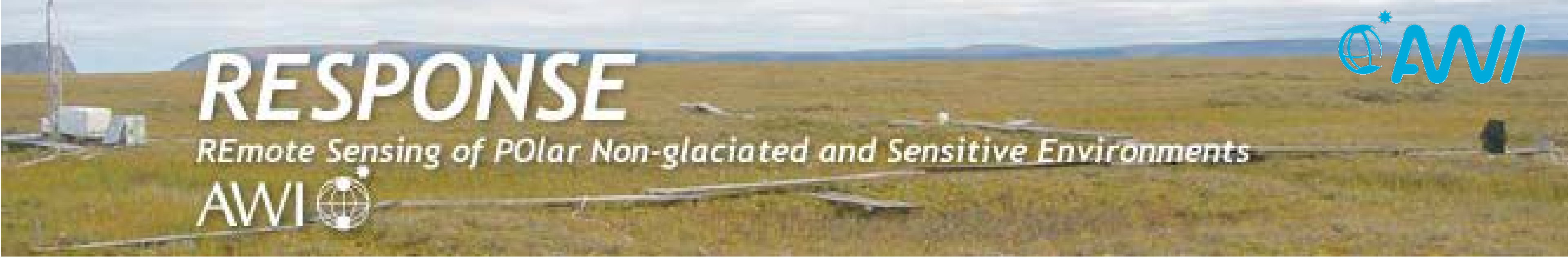


EnMAP Hyperspectral Imager

GFZ POTSDAM

thanks for your contributions

4th National EnMAP User Workshop
final presentations of EnMAP Projects 2010-2013

hyARCVEG
hyperspectral method development for ARCtic VEGetation biomes

Greening of the Arctic (GOA)

Humboldt-Universität zu Berlin

DLR

Alfred Wegener Institute,
Helmholtz Centre for Polar and Marine Research
Research Unit Potsdam

University of Fairbanks Alaska

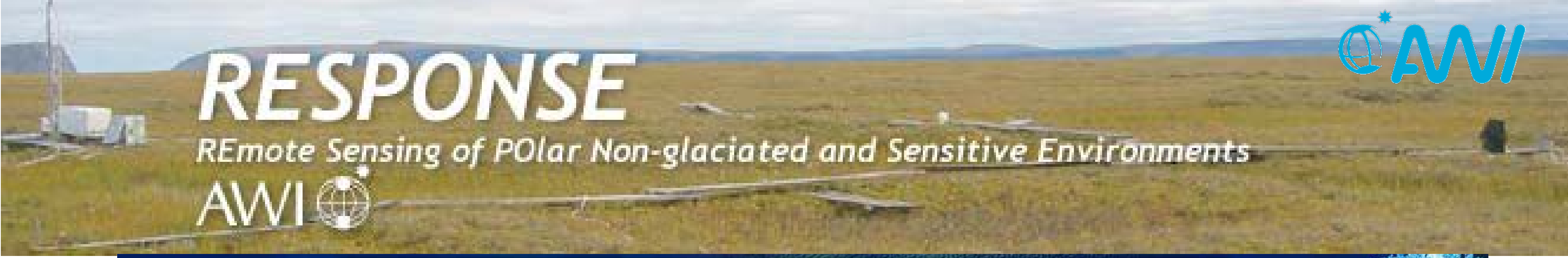
Earth's Cryosphere Institute Moscow-Tyumen

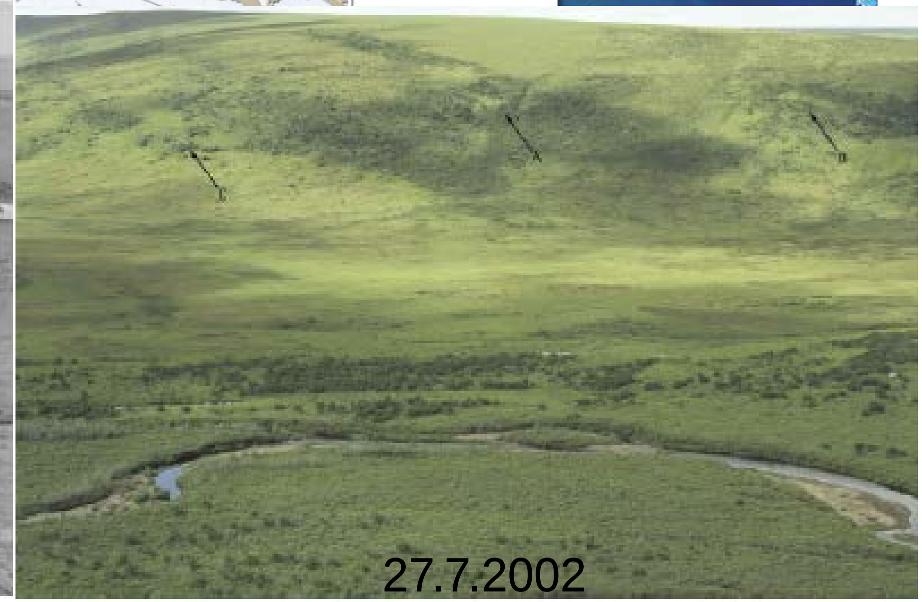
Thesis eingereicht ! Universität Potsdam

Marcel Buchhorn, Dr. Birgit Heim, Prof. Hans-Wolfgang Hubberten

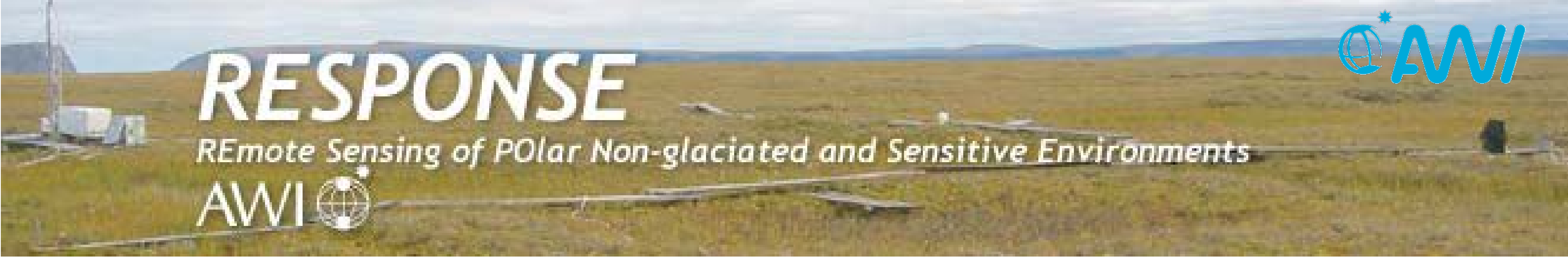
…nen DLR/BMWi 50 EE 1013

Bundesministerium für Wirtschaft und Technologie DLR



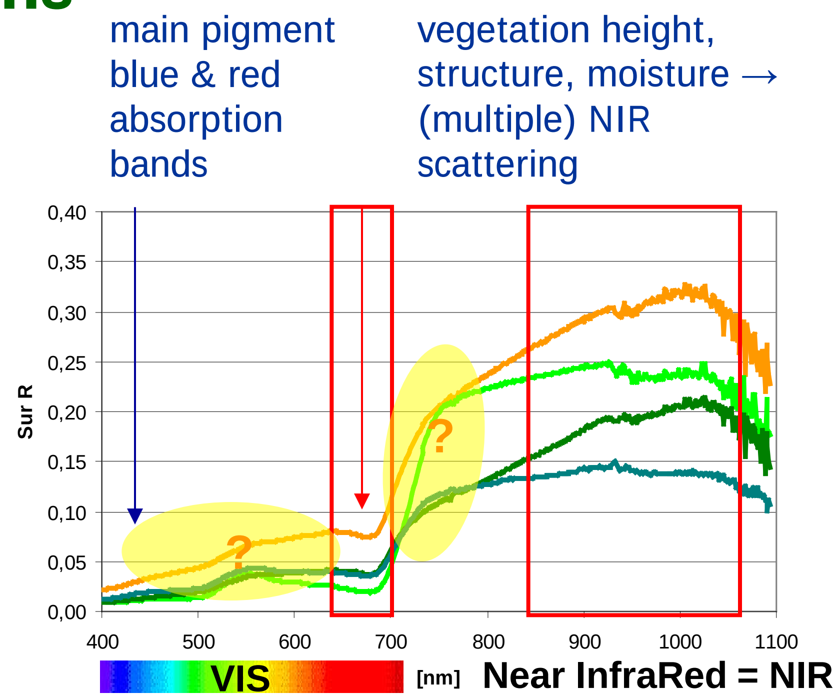


The Arctic tundra is one of Earth’s few remaining wilderness areas, but shows an increase in the productivity, or “greenness”



Many open research questions for optical RS applications

- are broadband RS Vegetation Indices$_{tundra}$ (like NDVI, LAI or fAPAR) directly linked to vegetation structure and biomass in Arctic biomes?
- Can the intense vegetation colouring at high latitudes be used? development of VIS applications?
- What are the effects of high Sun Zenith angles SZA and low canopy structure ?
- ....

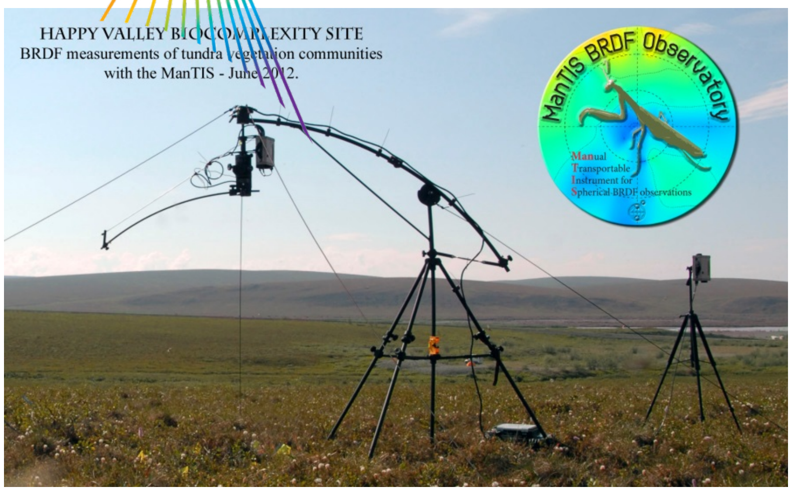


Sur R = surface reflectance
(Lena Delta, polygonal wet tundra, subzone C)

Vegetation Indices (VI$_{tundra}$),
Leaf-Area-Indices (LAI$_{tundra}$)
fraction of Absorbed Photosynthetically Active Radiation (fAPAR$_{tundra}$)

EnMAP Hyperspectral Imager

PhD–Marcel Buchhorn (2010-2013): OUTCOME



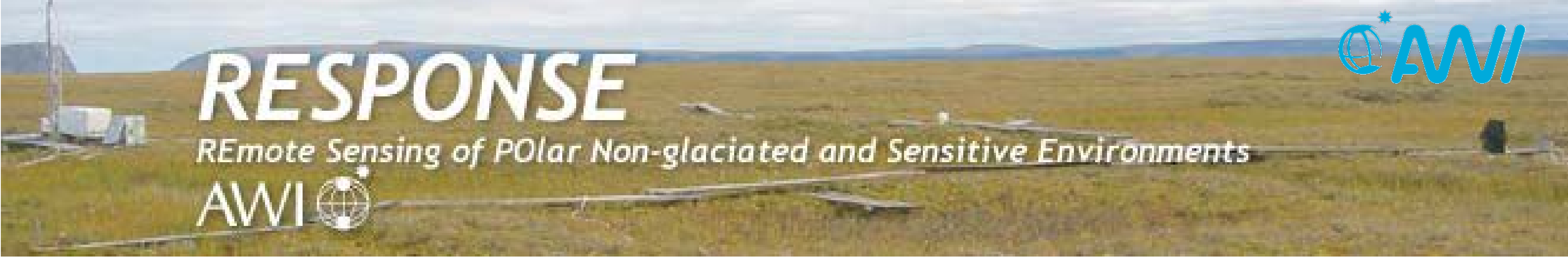
Hyperspectral Arctic Vegetation Indices hyARCVEG: to technically investigate & optimize satellite-derived vegetation parameters for tundra

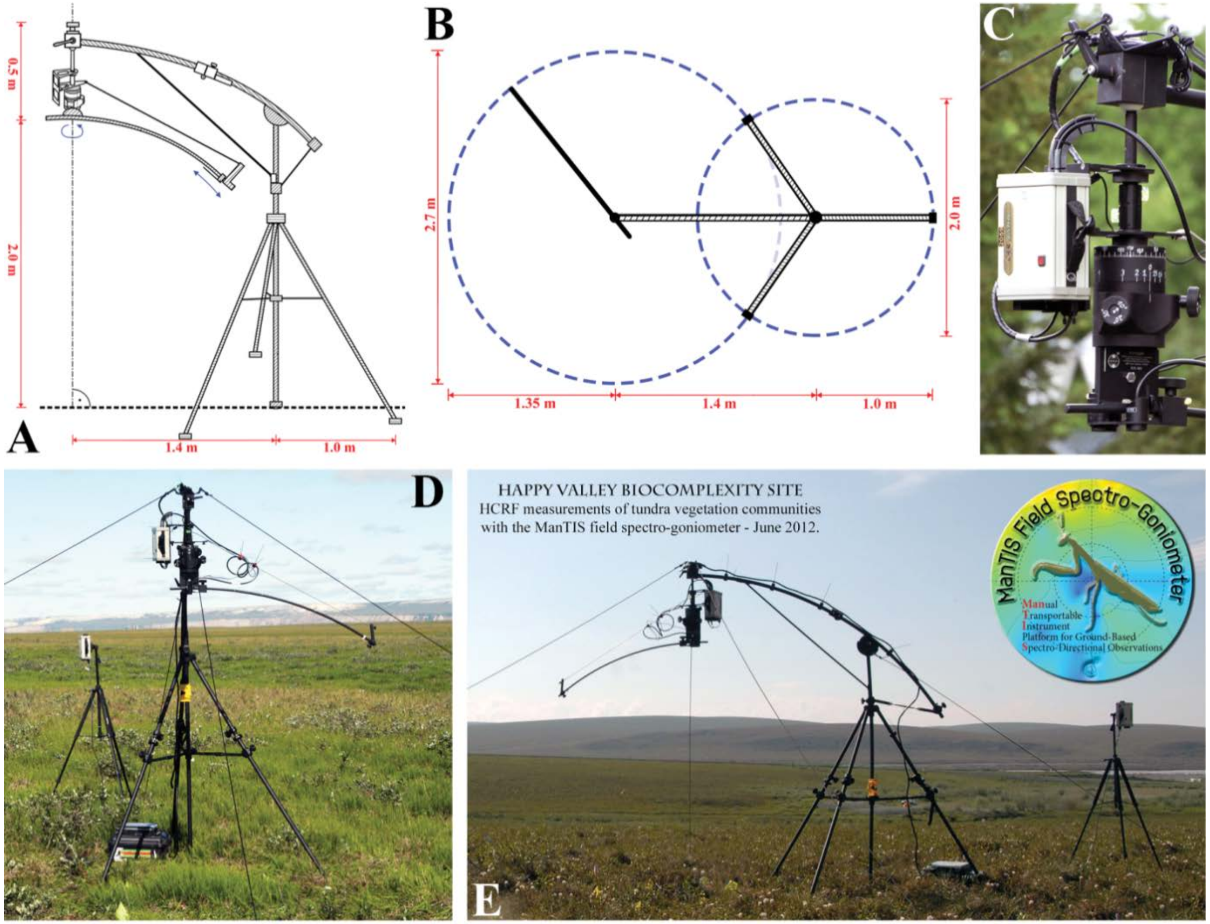
see ManTIS Flyer & Poster

AWI-Patent: EnMAP spezifisches Geländegoniometer **ManTIS** 2011 eingereicht, 2012 auf internationale Patentanmeldung ausgeweitet. **Patent N°: DE10 2011 117 713 A1**, Buchhorn.

Buchhorn, Walker, Heim, et al. (2013) Ground-Based Hyperspectral Characterization of Alaska Tundra Vegetation along Environmental Gradients, *REMOTE SENSING*, 5(8), 3971-4005.

Buchhorn, Petereit, Heim (2013) The **Man**ual **T**ransportable **I**nstrument Platform for Ground-based **S**pectro-Direcitonal Observations (**ManTIS**) and the Resultant Hyperspectral Field Goniometer System, *SENSORS*.





ManTIS

-can be equipped with various sensor systems -

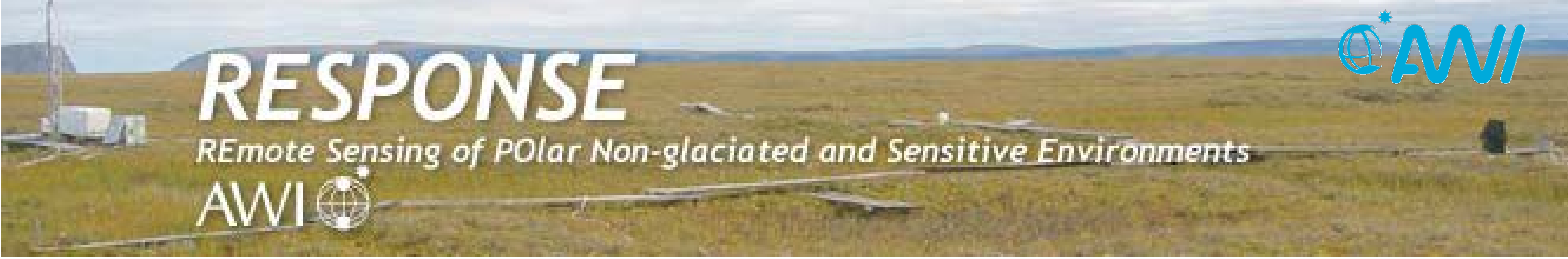
-allows spectro-directional measurements with viewing zenith up to 30° and viewing azimuth 360°

-offers a 2 m distance between the target and the sensor,

-offers a high angular accuracy and a fast measurement cycle

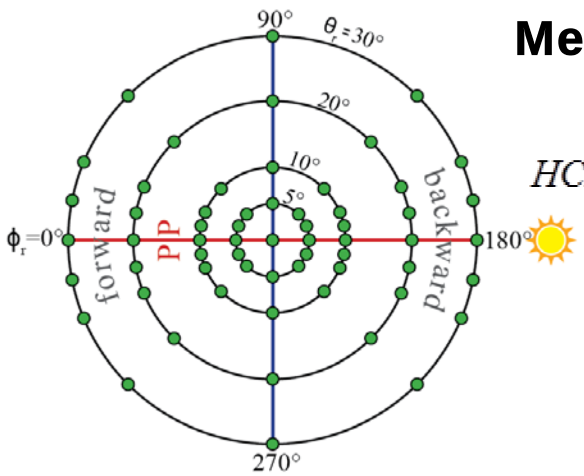
see ManTIS Flyer & Poster

Buchhorn et al., SENSORS 2013 **Patent DE10 2011 117 713 A1**



Measurement scheme

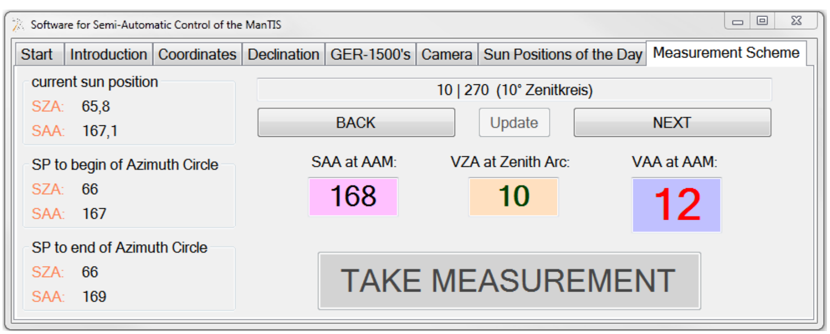
ManTIS



$$HCRF(\lambda;\theta_i,\phi_i;\theta_r,\phi_r)=\frac{L_r(\lambda;\theta_i,\phi_i;\theta_r,\phi_r;t_x)}{L_{ref}(\lambda;\theta_i,\phi_i;t_0)\cdot c_{diff}(\lambda;\theta_i,\phi_i;t_x)}\cdot c_{ref}(\lambda,\theta_i,t_0)$$

-custom-developed data processing chain
-self-developed software for the semi-automatic control

GUI of software

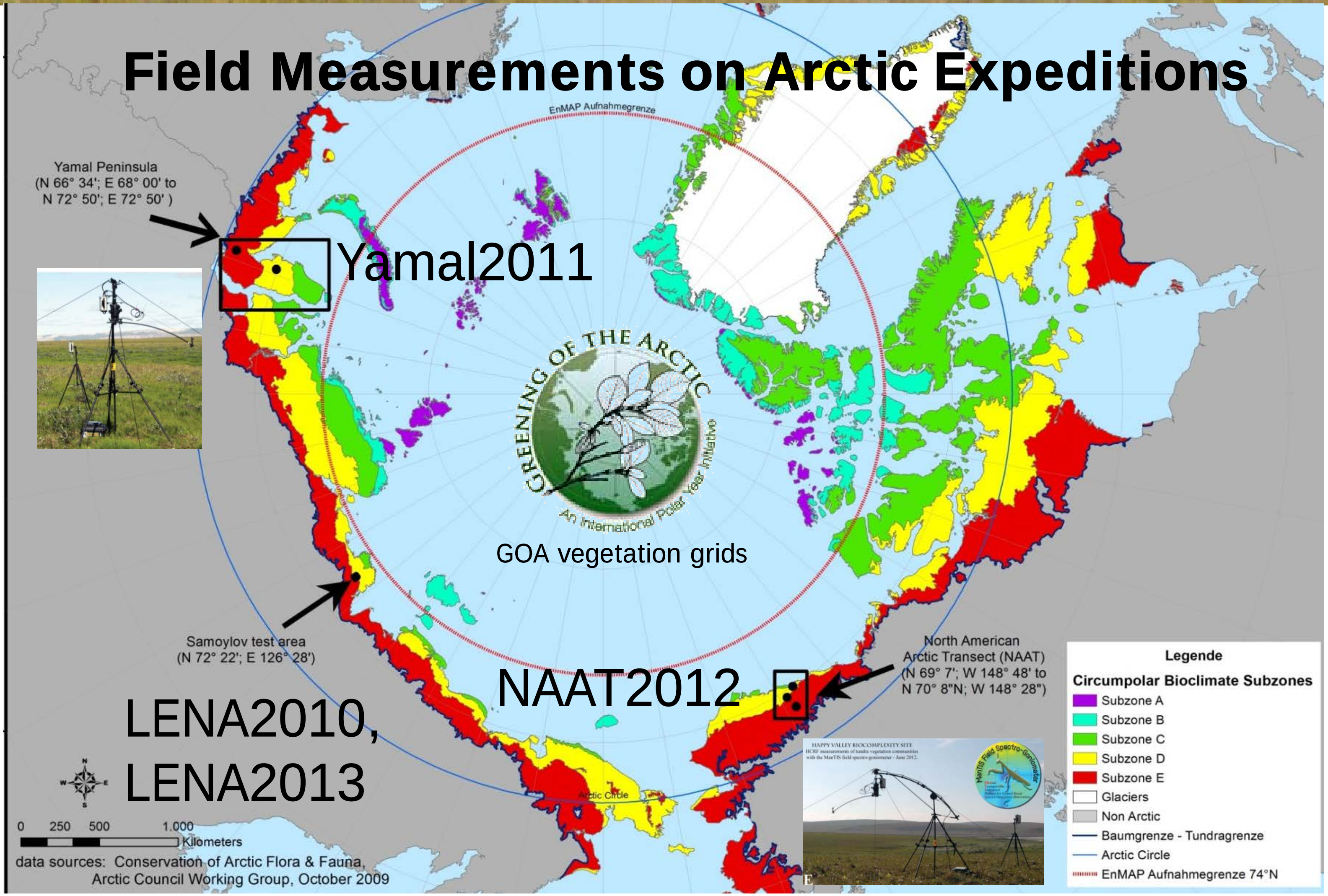


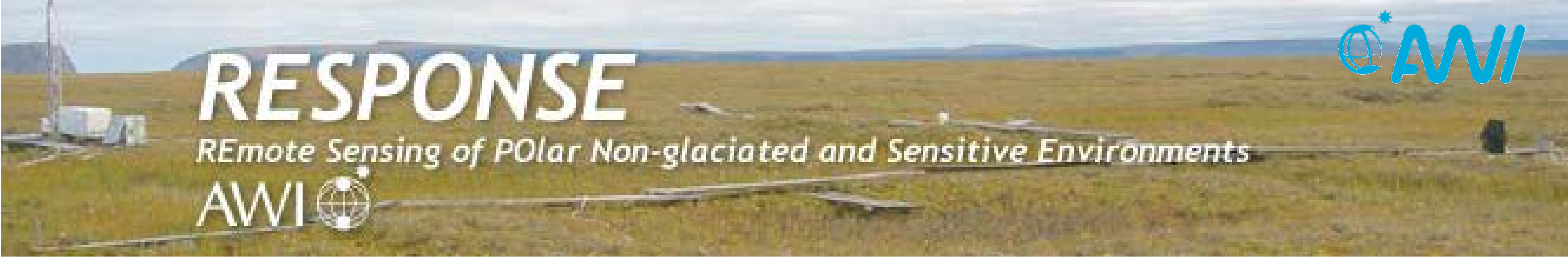
Buchhorn et al., SENSORS 2013

The ManTIS instrument platform will go into serial production under license by Ludolph GmbH & Co. KG in Bremerhaven, DE

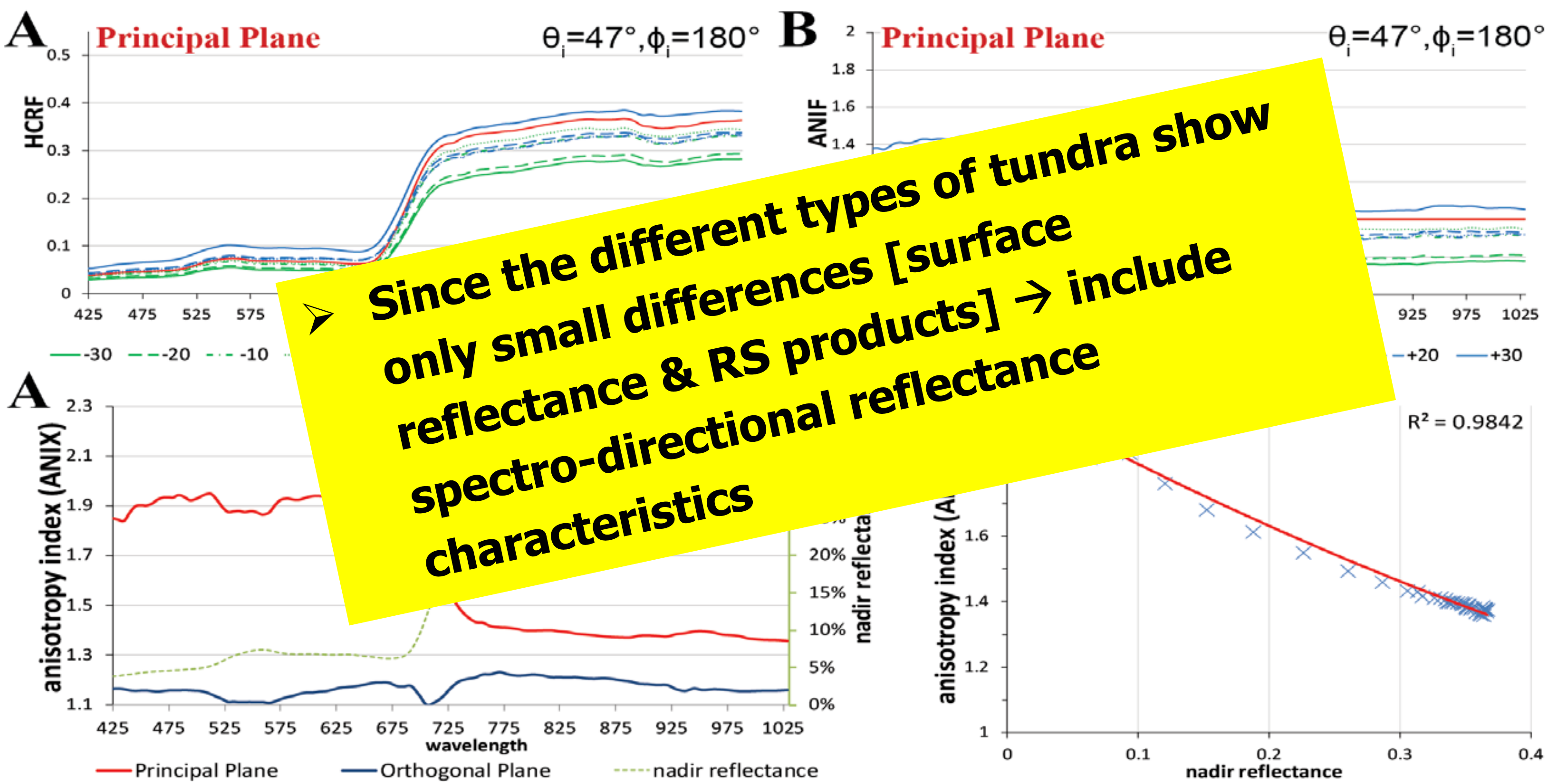
see ManTIS Flyer & Poster

Field Measurements on Arctic Expeditions





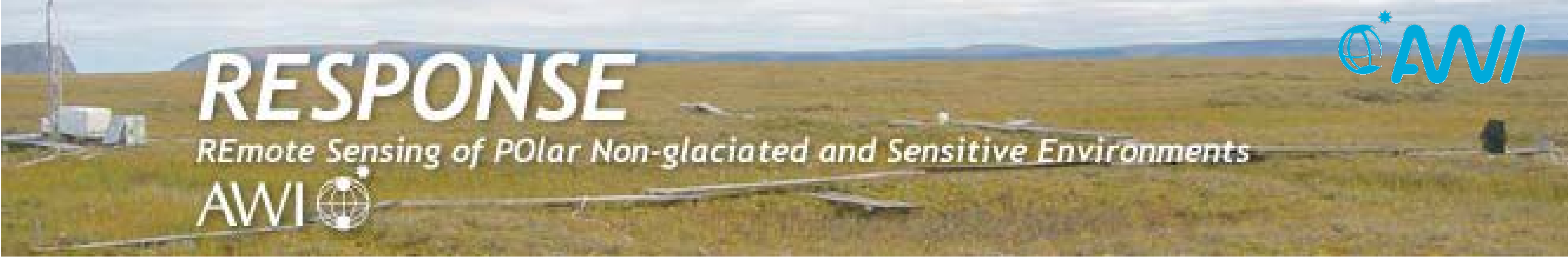
hyARCVEG: GER/ASD field spectrometry @9 GOA sites NAAT2012, 5 GOA sites YAMAL2011
ManTIS field spectrogoniometry covers main tundra types @10 GOA sites



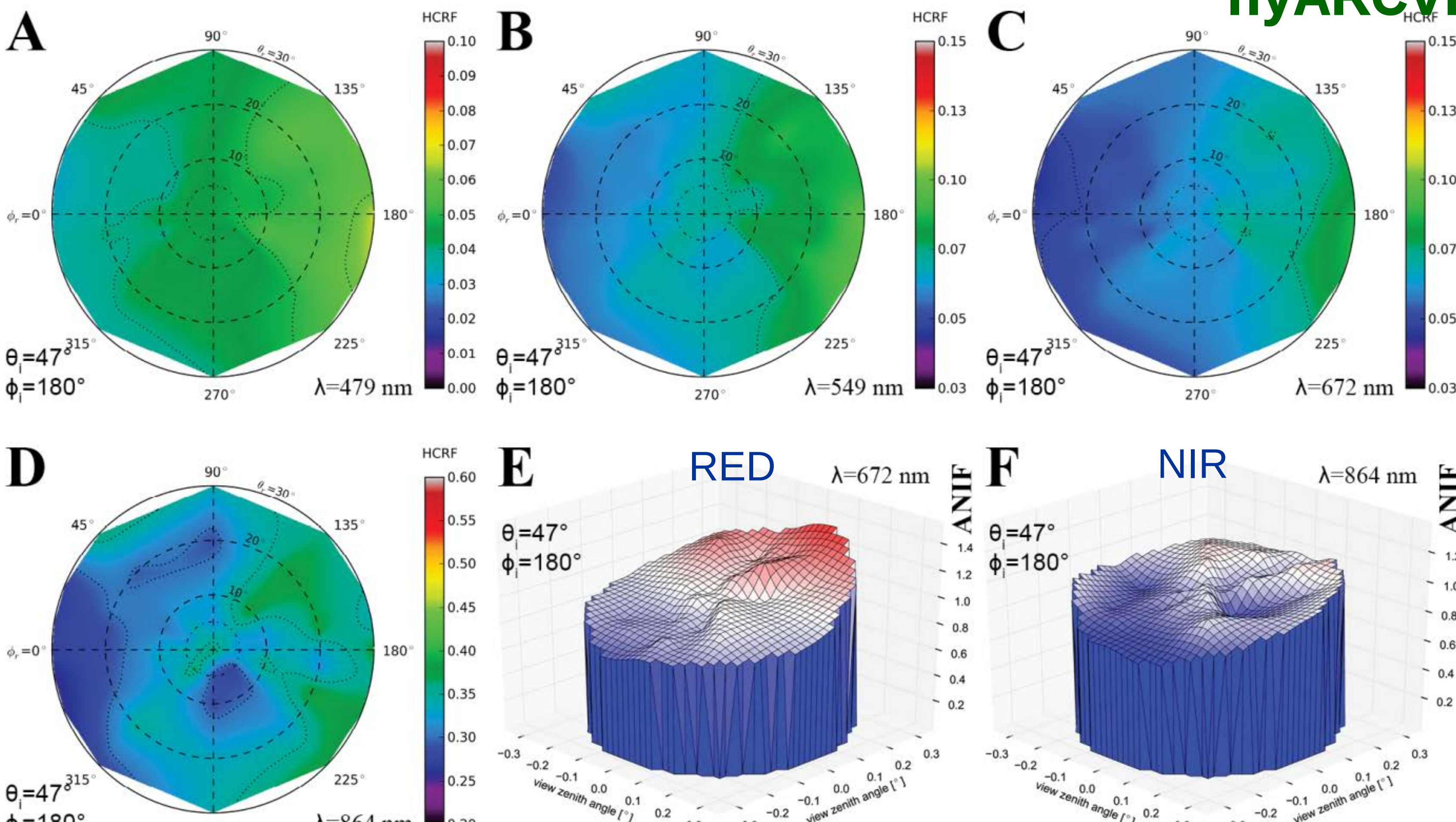
- Since the different types of tundra show only small differences [surface reflectance & RS products] → include spectro-directional reflectance characteristics

prostrate dwarf shrub community

Dissertation, Buchhorn 2013



hyARCVEG

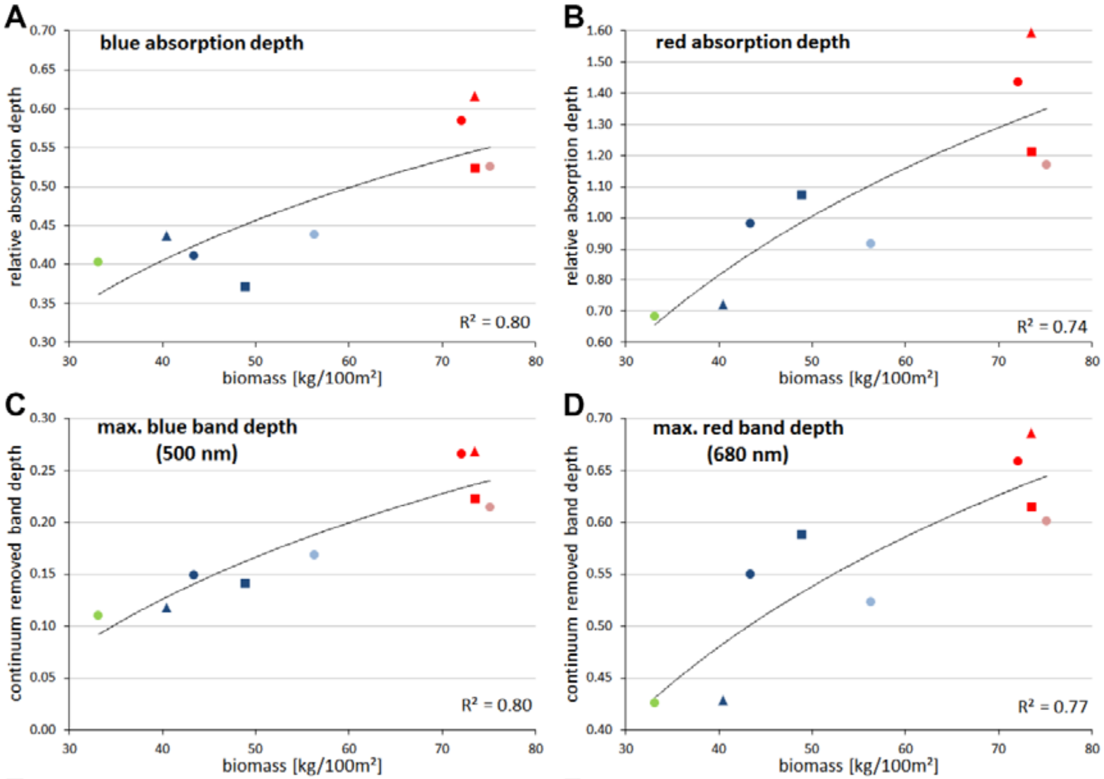


prostrate dwarf shrub community

Dissertation, Buchhorn 2013

hyARCVEG

VIS-NIR proxies for tundra biomass, Vaskiny Dachi (Yamal) & NAAT (North Slope, Alaska)

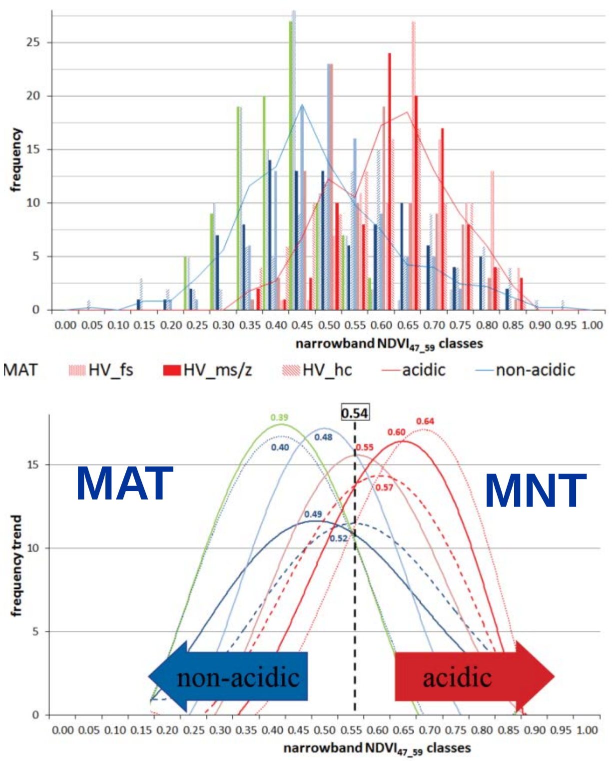


Exploring the prediction power of VIS for biomass of tundra types, Example: Pigment absorption [blue and red]

Buchhorn et al. 2013

hyARCVEG

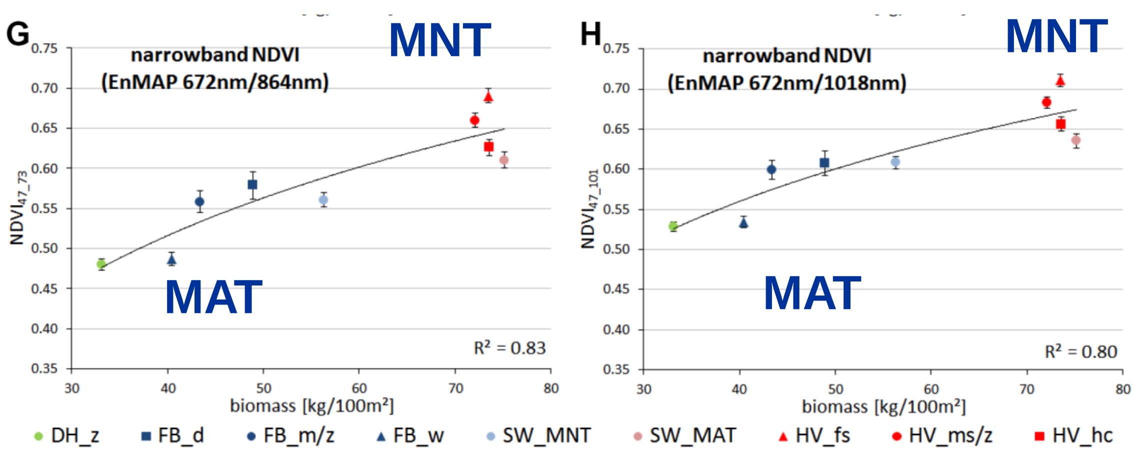
Spectral proxies show separability between the Moist Acidic Tundra MAT and the Moist Non-acidic Tundra (greener)

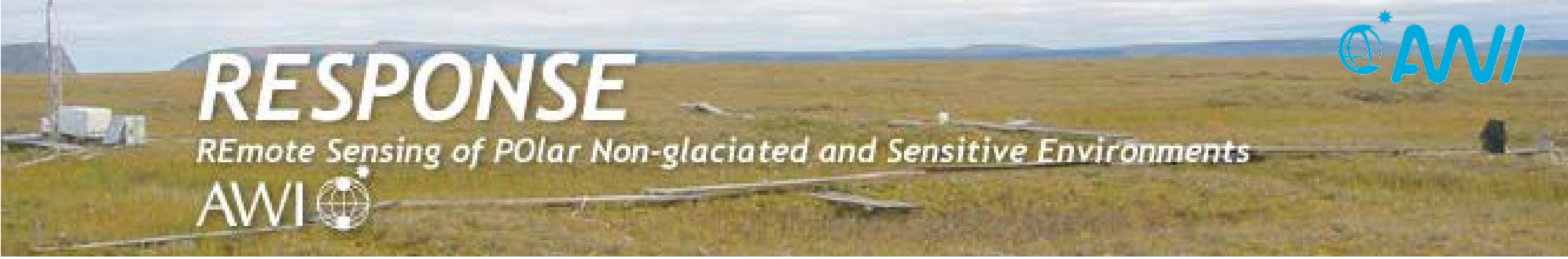


Buchhorn et al. 2013

Exploring the prediction power of Red Edge and NIR bands for biomass of tundra types

Exploring the separability between Moist Acidic Tundra **MAT** and Moist Non-acidic Tundra **MNT**

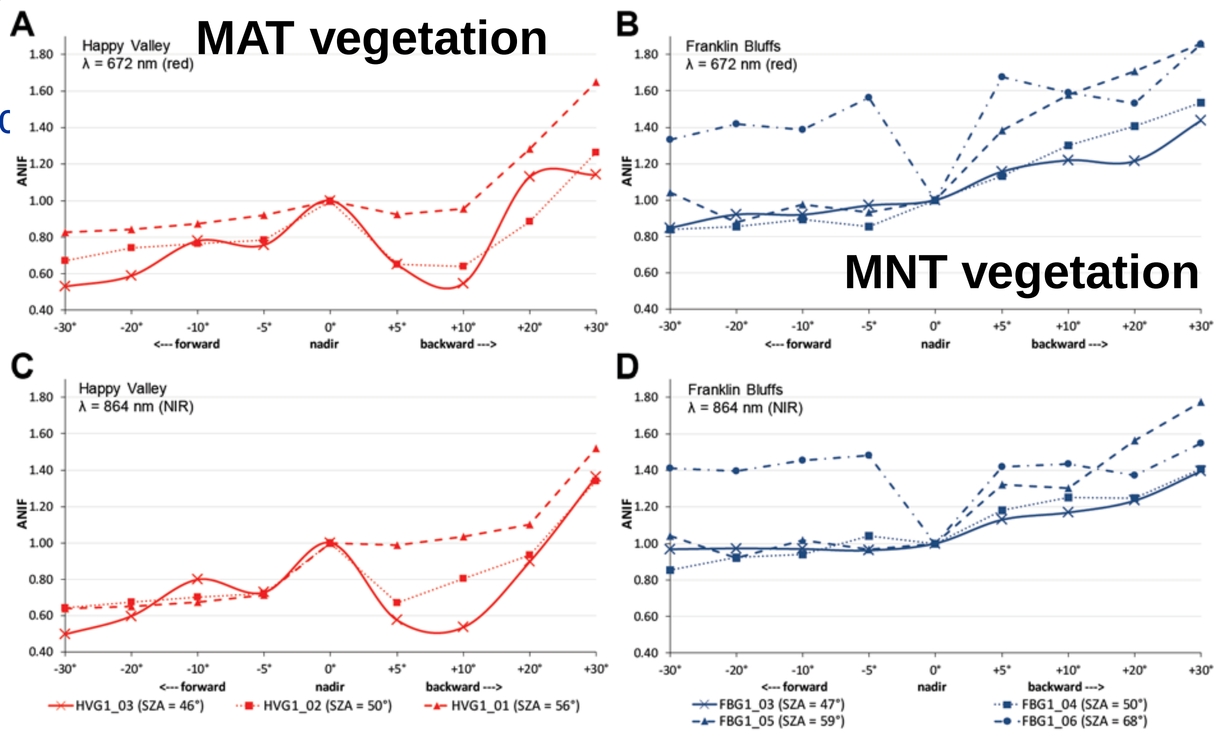




hyARCVEG

Influence of High Sun Zenith Angles at high latitudes

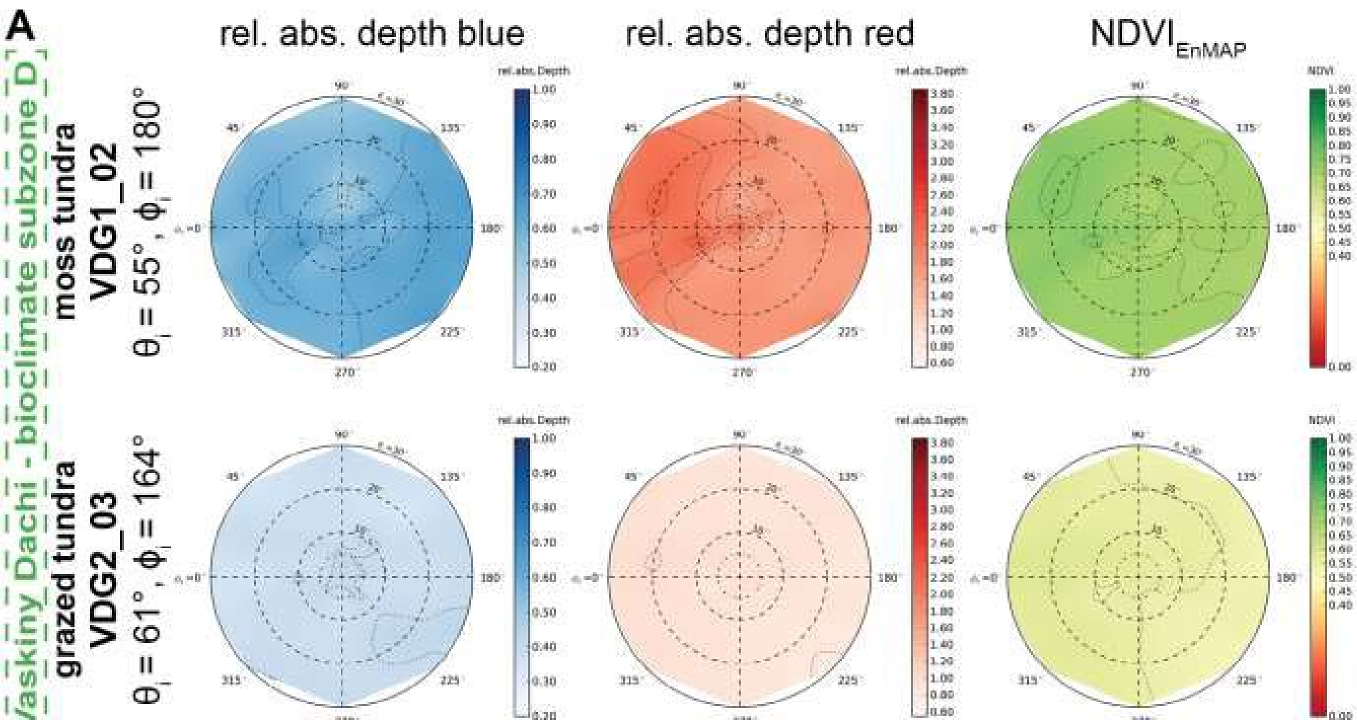
- up to a sensor view zenith angle of 30°, the *backshadow effect dominants* the gap effect, lower reflectance in the forward viewing directions compared to the nadir or backward
- With increasing SZA, the reflectanc anisotropy changes to an *azimuthally symmetrical, bowl-shaped distribution of reflectance values* with the lowest reflectance values in the nadir position
- At a SZA of 55° to 60°, the *gap effect starts to become dominant* in the more erectophile tundra canopy



Dissertation, Buchhorn 2013

hyARCVEG

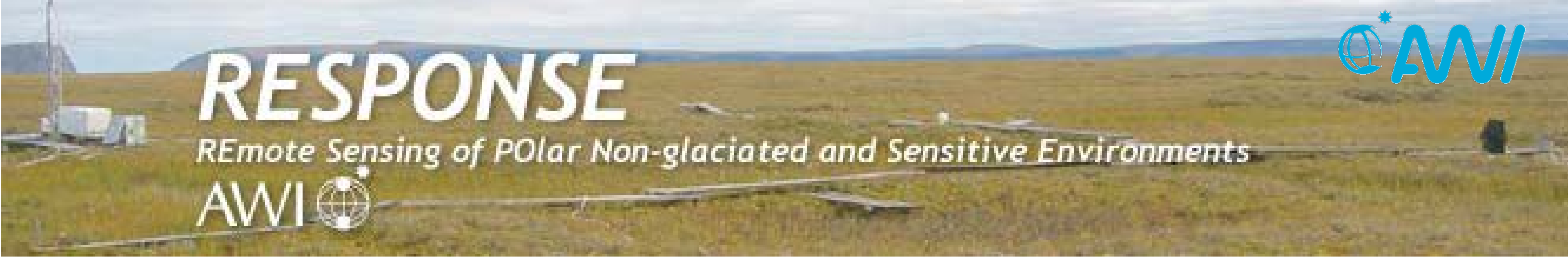
VIS-NIR Anisotropy in Vegetation RS products, Vaskiny Dachi (Yamal) & NAAT (North Slope, Alaska)



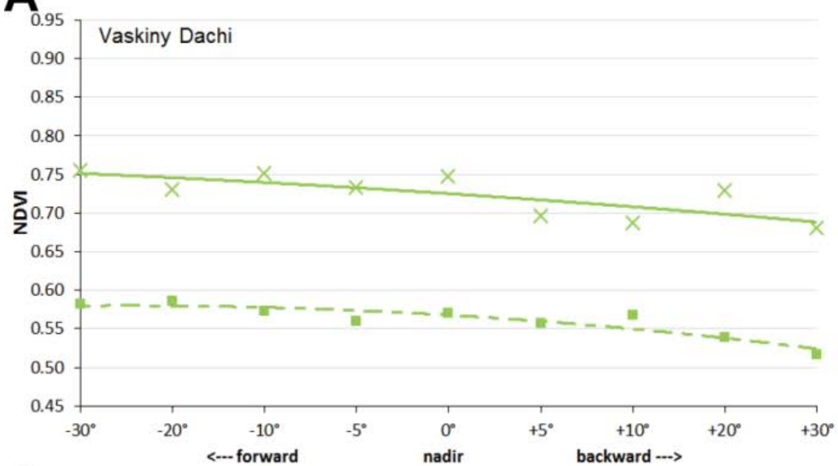
Anisotropy Effects on Tundra Multi-Angular Remote Sensing Products:
BRDF effects on NDVIs < absorption depth products.

But: already the NDVI shows at 30° ZA a min. of 15% deviation to Nadir

Buchhorn et al. 2013



A



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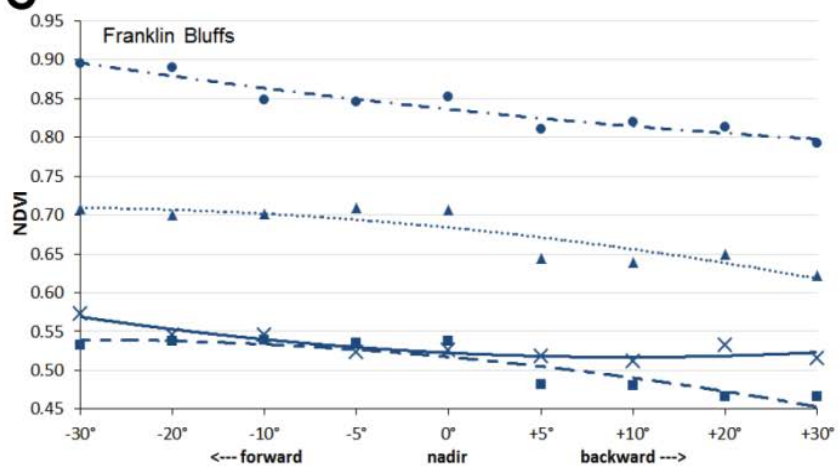
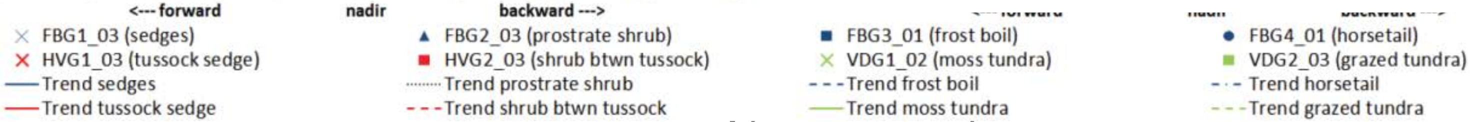
Dissertation, Buchhorn 2013

Anisotropy Effects on Tundra Multi-Angular Remote Sensing Products: NDVI

C



Site	SZA	View Zenith Angle			
		± 5°	± 10°	± 20°	± 30°
grazed dwarf shrub-moss tundra (VD)	61°	2%	1%	6%	10%
non-tussock sedge tundra – MNT (FB)	47°	2%	4%	4%	9%
horsetail community (FB)	48°	5%	4%	5%	7%
dwarf shrub-moss tundra (VD)	55°	7%	8%	2%	9%
erect dwarf shrub btwn tussock (HV)	46°	7%	6%	12%	8%
prostrate dwarf shrub community(FB)	47°	9%	9%	8%	12%
frost boil community(FB)	48°	10%	11%	13%	13%
tussock sedge tundra - MAT (HV)	46°	6%	1%	12%	8%



Outlook: hyperspectral airborne data takes (AWI AISA)

HGF-TEAM, T. Sachs (GFZ) AIRMETH flight campaigns 2013, 2014, 2015, airborne measurement campaigns of CH4, CO2 and energy fluxes [Alaska, Canada, Siberia]

GFZ-AWI AIRMETH2013 Team (T. Sachs, GFZ & J. Hartmann, AWI) Barrow, Alaska, Juy 2013, with AWI Polar-5 and the NASA C-23 CARVE (Carbon in Arctic Reservoirs Vulnerability Experiment).

Hyperspectral AISA Data Take: e.g. 2013-07-11: Alaska Barrow, Dead Horse
– NorthSlope transects
+ western coastline

Thaw slump, Herschel Island (CA)
AISA 2013-07-22