

SnowSense

- neue Wege des Snow Monitoring –
- erste Ergebnisse aus der Praxis -

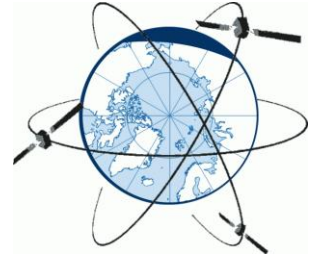
Florian Appel

Philipp Klug, Heike Bach

VISTA Remote Sensing in Geosciences GmbH - Munich / Germany

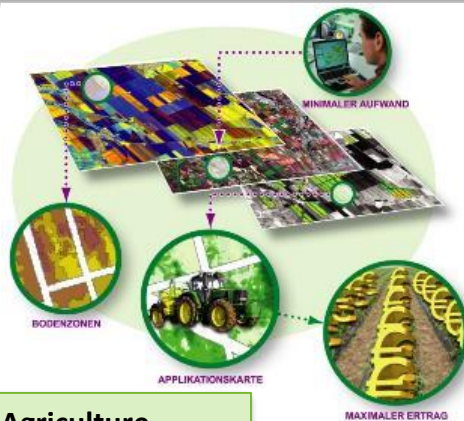
Patrick Henkel, Markus Lamm – ANAVS GmbH

Franziska Koch, Monika Prasch, Wolfram Mauser – LMU Munich

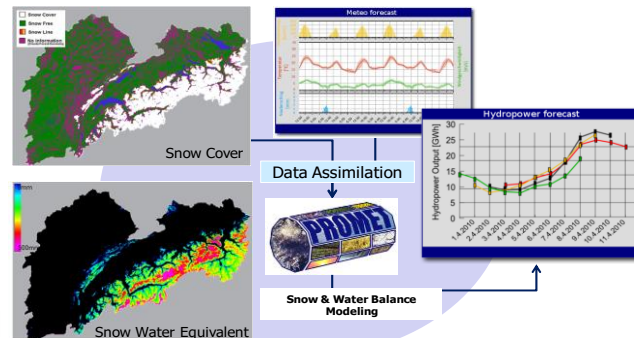


VISTA Remote Sensing in Geosciences GmbH

www.vista-geo.de



- Agriculture**
- Yield Forecast
 - Precision Farming
 - Organic Certification



- Hydrology**
- Snow monitoring
 - Soil Moisture monitoring
 - Run-off & Hydropower forecast

SnowSense
LARSIM 2017
Dornbirn/AUT



SnowSense as a ESA IAP Demo Project

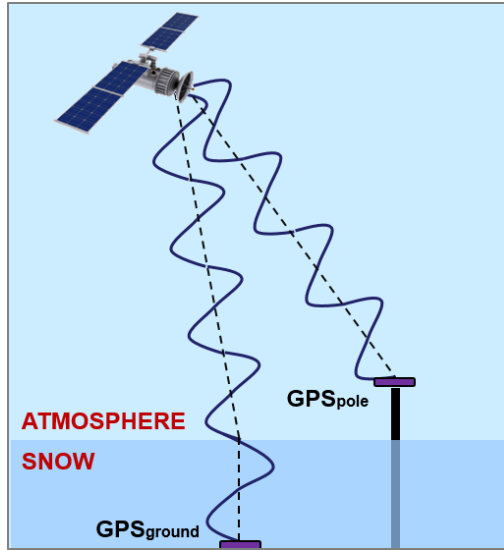
2015 – 2018

VISTA GmbH

ANAVS GmbH

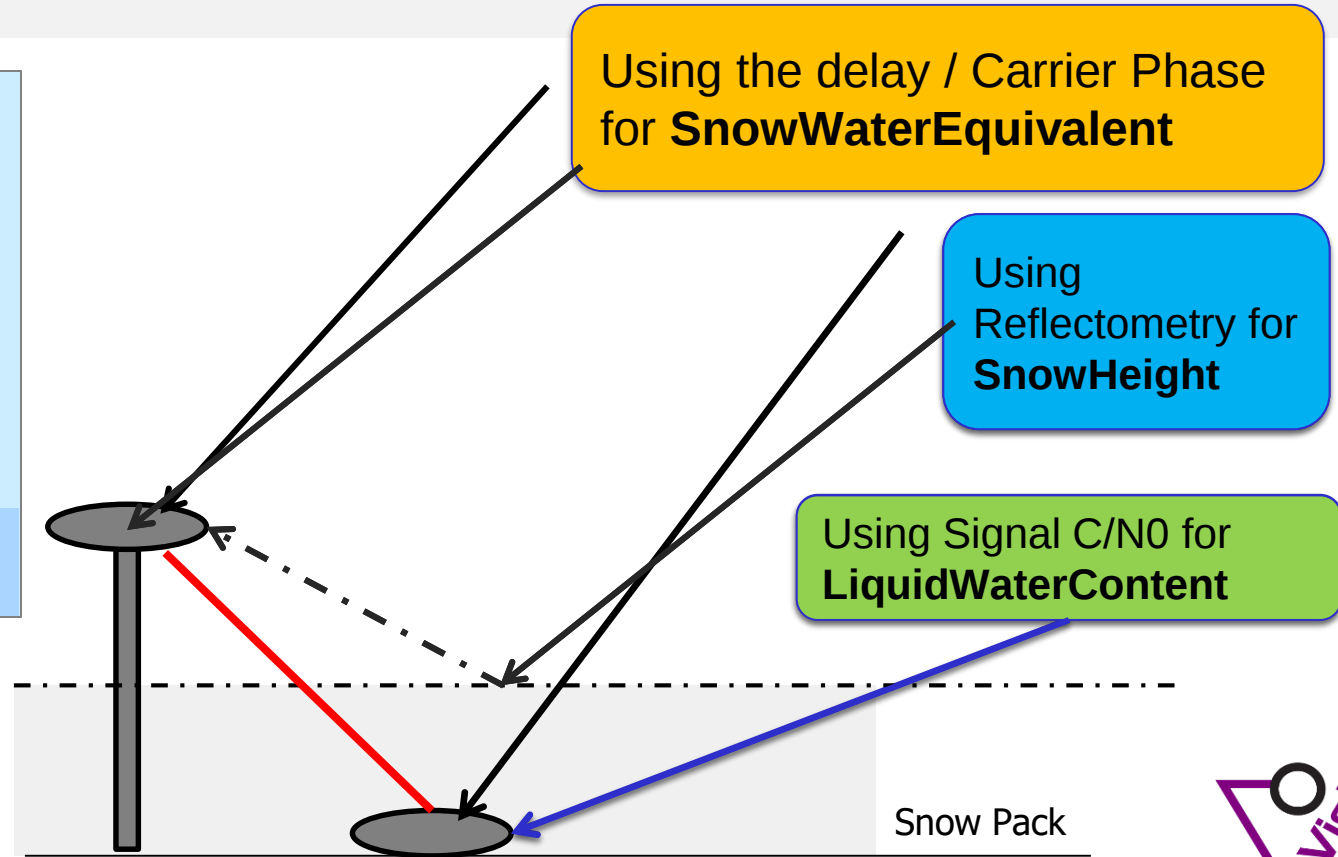
LMU München

Snow Parameter Retrieval Methodes

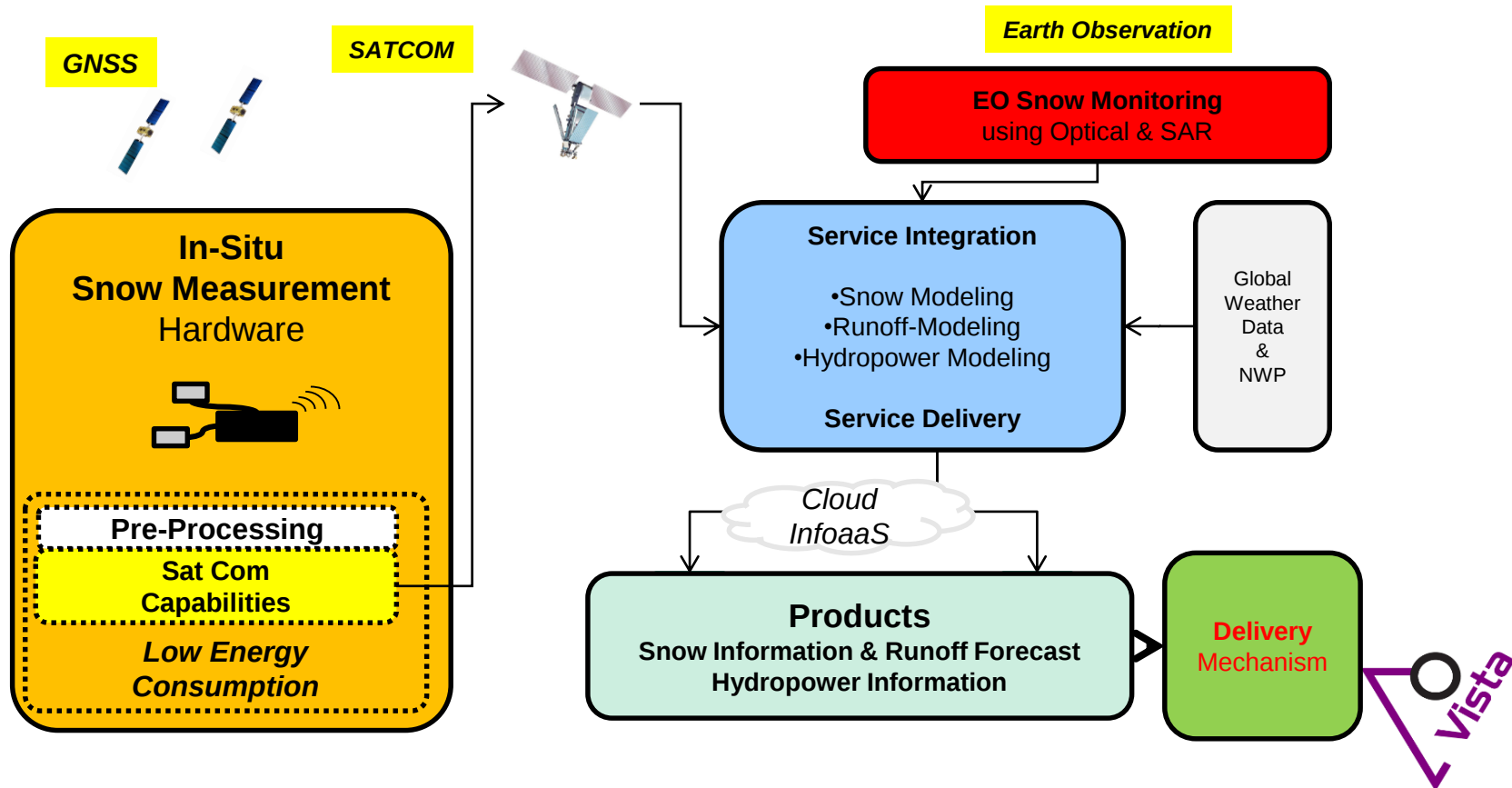


GPS: L1-Band / L2-Band
1.575 GHz / 1.227 GHz
32 Sats / 20.200 km Orbits
23h56m repetition

SnowSense
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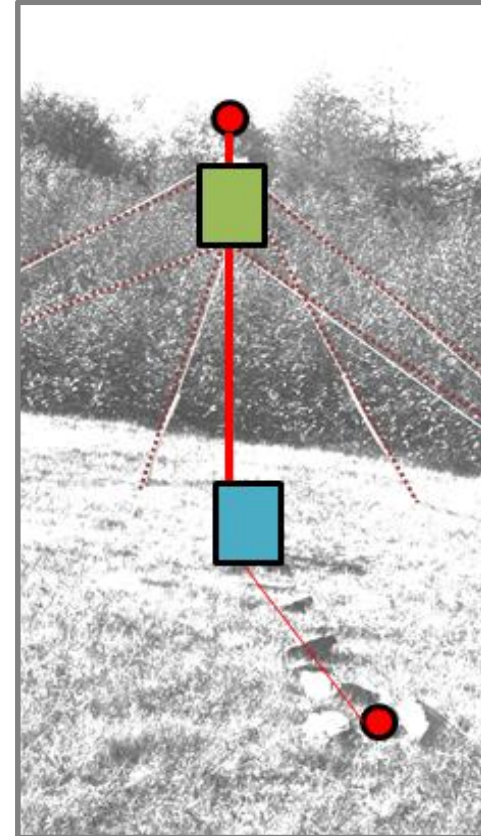
SnowSense Overall Concept



SnowSense in-situ hardware – design for remote areas

Requirements

- Weather independent operation
 - Maintenance free during operations
 - Non-Destructive Snow Parameter Retrieval
- Independent Power Supply - during winter
 - Intelligent Power & Operation Management
- On-Board Recording & Processing Capability
 - SatCom / Terrestrial Communication Cap.
- Light weight system for transportation
 - Easy installation (1-2 persons)
 - Low-Cost Hardware & Low Cost operation



Portable Mast
System

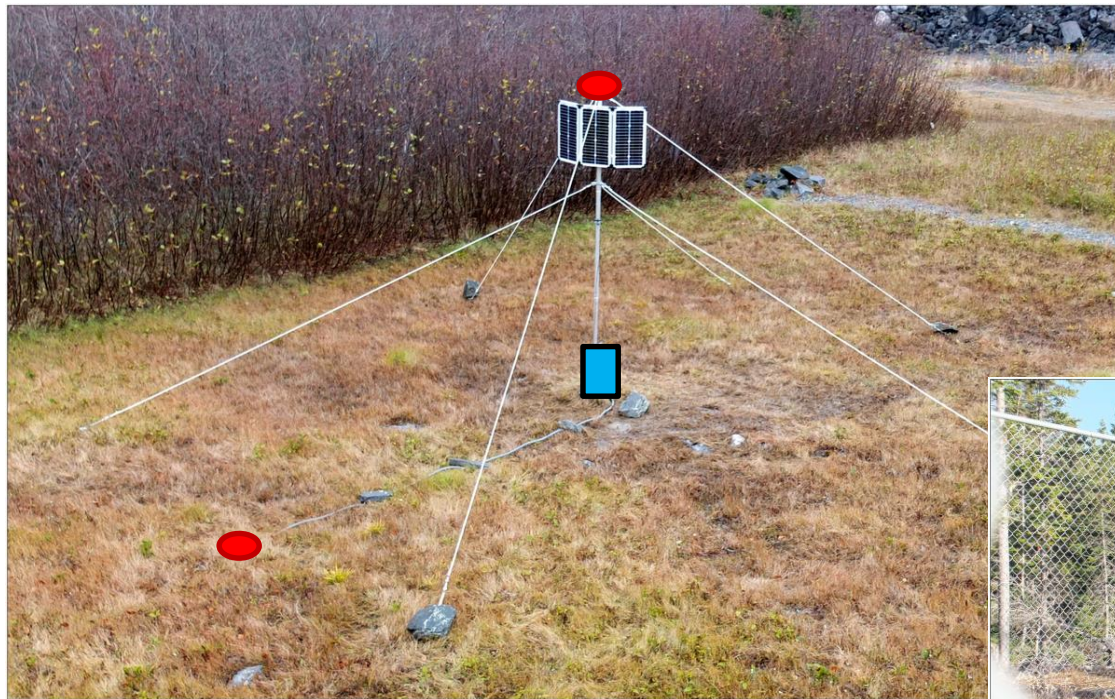
2 GNSS
antennas

Solar panel
array

Electronic Box
including
SnowSense
GNSS receivers,
power
management,
processing and
communication
boards, battery
pack



SnowSense In-Situ Hardware



- ✓ Installation as independent Mast System
- ✓ Installation at existing infrastructure or stations (but with own power and communication)



Demo Stations in Newfoundland/Canada

Experimental and Demo Stations in Europe

- Switzerland: Weissfluhjoch (2540 m)
- Austria: Großarl (1000 m)
- Germany: Hunsrück (600 m)

+ Munich (520 m): on roof top and for soil moisture retrieval



SnowSense
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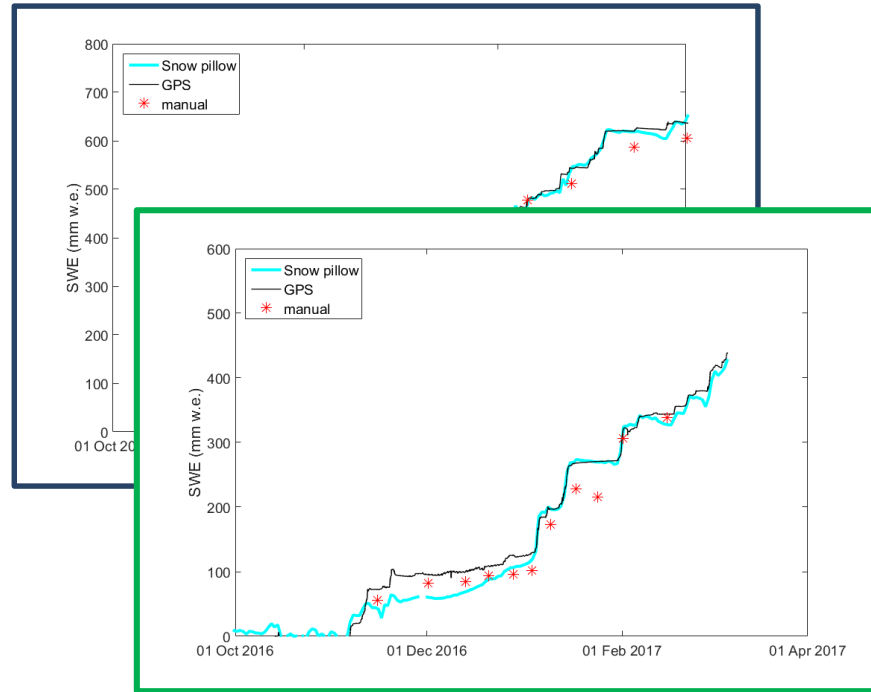
SnowSense Snow Results

Results SWE from GNSS – Alpine Testsite

Best conditions

SWE at the Weissfluhjoch 2015/2016 2016/2017

- Continuous recording data
- Processing using the original dry snow 3h algorithm
- Dry snow precisely from derived from GNSS
- Wet Snow algorithm under implementation



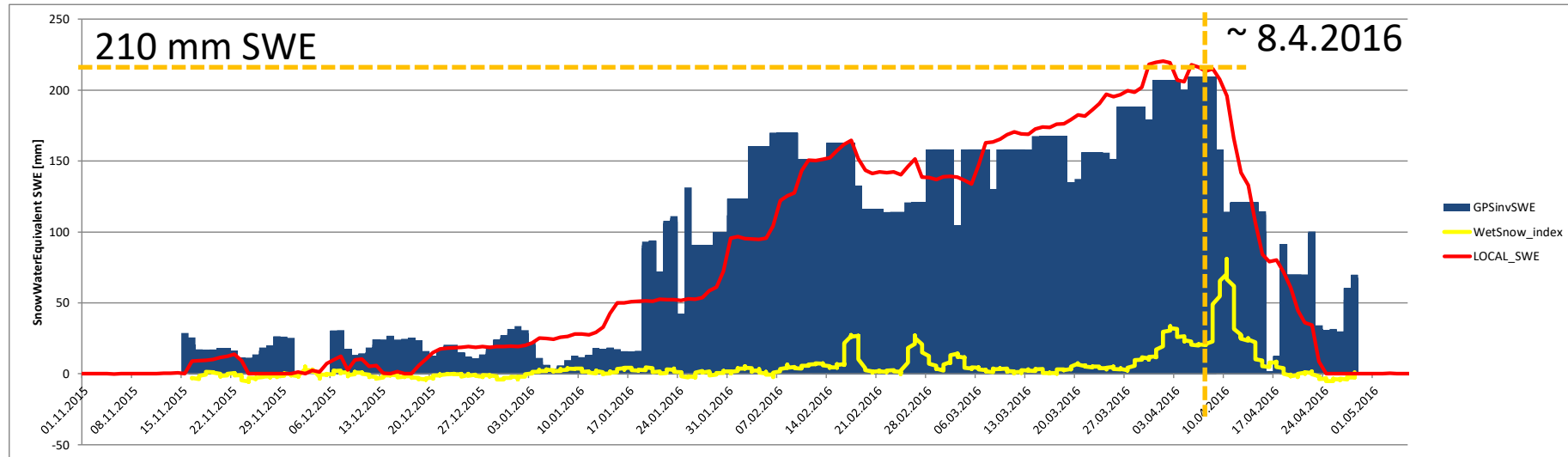
Snow pillow data
and manual SWE
measurements by
the SLF



Results SWE from GNSS – Newfoundland 2015/2016

Non optimal
data recording
schema

SWE derived at WRMD station Sandy Lake (180m)



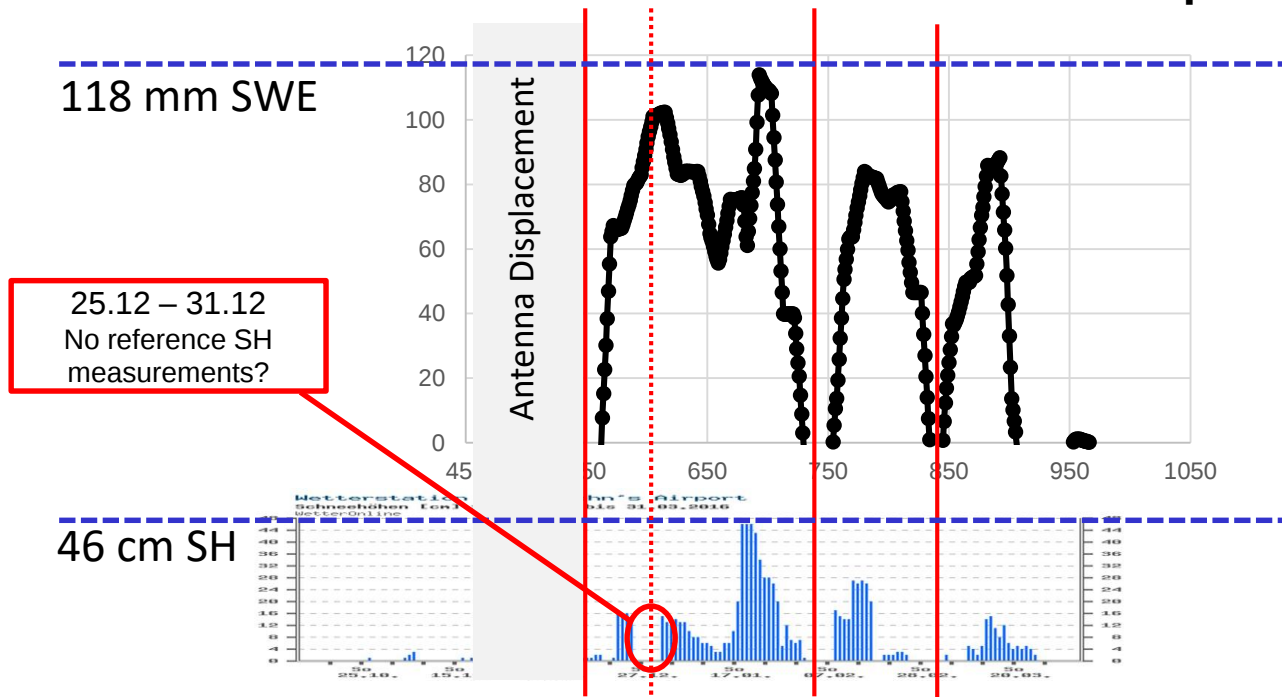
- 20min data recordings (now improved!)
- post-processing by inversion method

Here: No Wet Snow considerations

Results SWE from GNSS – Newfoundland 2015/2016

Non optimal
station location

SWE derived at St. John's – vs. SH at YYT airport (~ 5km)



Results SWE from GNSS – Rheinland Pfalz 2016/2017

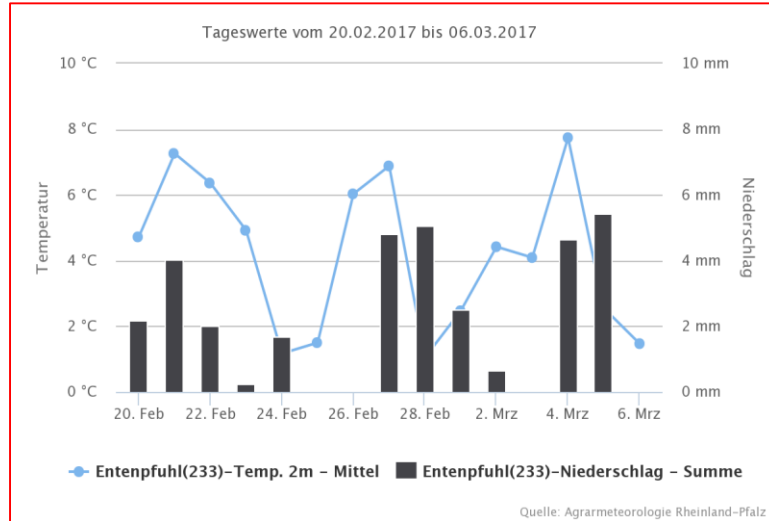
Aufbau einer SnowSense Station im Rheinland Pfalz / Hunsrück als Test-Installation

- Erster Aufbau im Dezember 2016 an Station Entenpfuhl
- Eigene Stromversorgung und eigene Satelliten Kommunikation
- 5 Messungen am Tag – davon eine dezidiert für Schnee-Wasser-Äquivalent

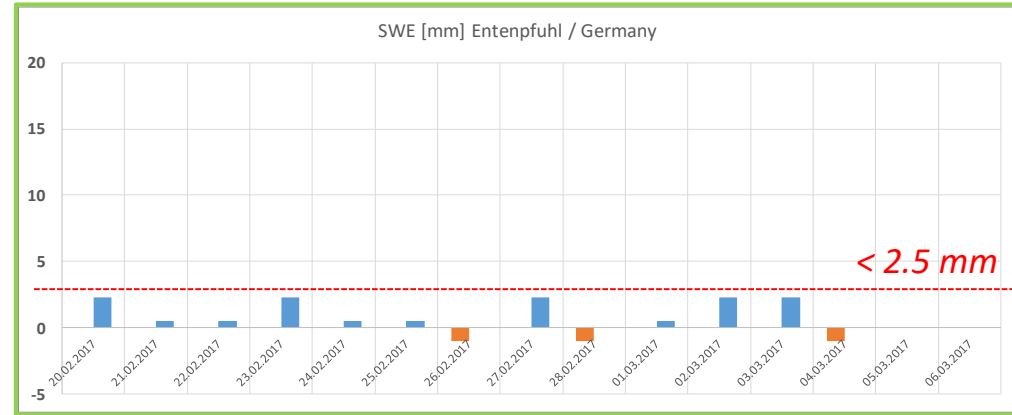


Results SWE from GNSS – Rheinland Pfalz 2016/2017

Neustart der Station ab 19. Februar



Bisher keine Messungen von Schnee
(es lag auch kleiner)



Station ist an das DLR RLP übergegangen und wird im kommenden Winter wieder – mit weiteren Verbesserungen – zum Einsatz kommen

SnowSense Summary

- **GNSS 2 antenna technique** is able to **measure relevant snow parameters**
 - Perfect correlation with measured **Snow Water Equivalent for Dry Snow**
 - **Liquid Water Content** is independently obtained from GNSS signal
 - **Wet Snow SWE** algorithm close to implementation
- **SnowSense In-Situ Sensor Hardware** successfully proven in different locations
- **EO Service, Model Integration** and **Service Provision** as prototype applied
- **Full Demo planned for Winter 2017/2018 in Newfoundland** (SWE & Runoff)
- **Further developments, applications and collaborations in preparation**
- **Hardware and Service soon ready for the market**

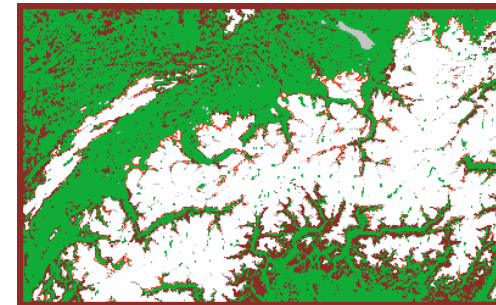
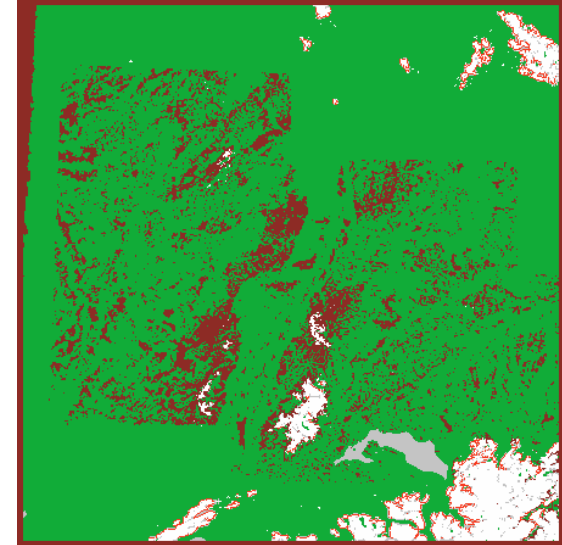
EO Snow Monitoring SWK and WetSnow – BW 2016/2017

Aktuelle Dienstleistung für die HVZ
Baden-Württemberg:

- **Tägliche Schnee Information (SWK) per Satelliten (optisch) für BW & HR**

Service bereits seit mehr als 10
Jahren (Inferno > Polar View > ...)

Einfluss von Wolken
Daten vom Vortag



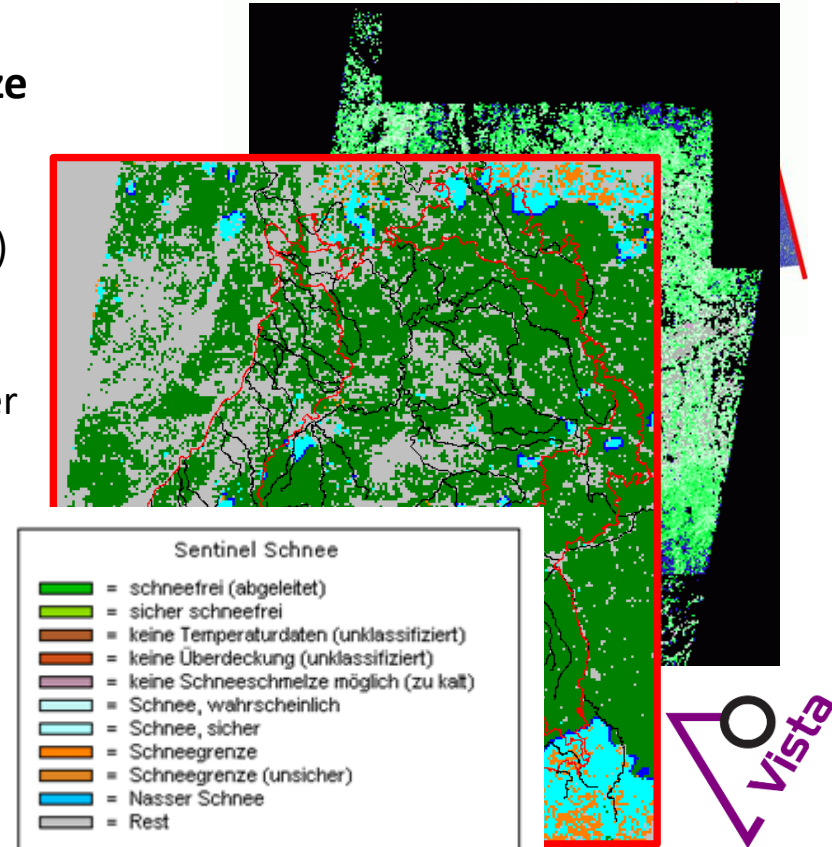
EO Snow Monitoring SWK and WetSnow – BW 2016/2017

Neu seit diesem Winter:

Ableitung der Schneefläche (bei Schnee-Schmelze aus Mikrowellen) für BW

- Nutzung von Sentinel-1 A und B
- Überflug im Schnitt alle 1-3 Tage (im Jan: 23 Feb: 16)
- Aufnahmen am Morgen (05) und am Abend (17)
- Verfahren basierend auf ENVISAT Erfahrung
- Nicht perfekte Konstellation bei S1A/B diesen Winter
- Prozessierung und Roh-Produkt sind stabil
- Schneekarten Produkt (derzeit zu komplex) zu verbessern

Verbesserung des Service nach Nutzer Vorgaben für nächsten Winter?



SnowSense

Snow Water Equivalent
Information for Remote Areas



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www.vista-geo.de/snowsense/

www.facebook.com/SnowSenseDemo/

