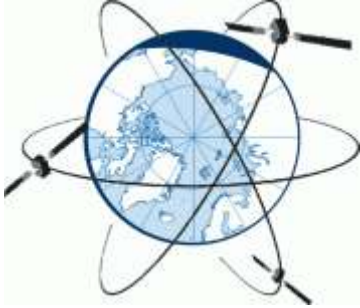
SnowSense



Using satellite navigation, communication and remote sensing for timely access to high-quality and reliable information on snow

Vista Remote Sensing in Geosciences GmbH

Florian Appel

Heike Bach

with

Franziska Koch, Monika Prasch, Wolfram Mauser,

LMU, München - Department of Geography

VISTA Remote Sensing in Geosciences GmbH

www.vista-geo.de

SME

Founded in 1995 Number of staff: 10
Managing Director: Dr. Heike Bach

Expertise

Remote Sensing and Modeling for Agriculture and Hydrology

Major ESA Projects

Talking Fields (IAP)
2008 -> Demo -> Service

Polar View & SnowSense
2005 - 2013 2013 – 2014

Major EU Projects

myEOrganics ***(2013 - 2015)***
Mobile Technology supp. Sustainable Agriculture

LEO ***(2013-2015)***
Linked Open EO Data for Precision Farming

Selected National Projects

APPS4GMES ***(2012 - 2014)***
Development of Operational Products and Services for GMES / Copernicus

M4Land ***(2012 - 2015)***
model based, multi-temporal multi-scale and multi-sensoral extraction of continuous land management information

Users & Customers

Agriculture management
Farmers
Energy Provider / Trader
Re-/ Insurance Industry
Finance and Banking
Space Agencies
Space Companies
Environmental Agencies
Governmental Authorities
Development Aid

Regions of Applications

2/3 Europe
including new member states
1/3 International

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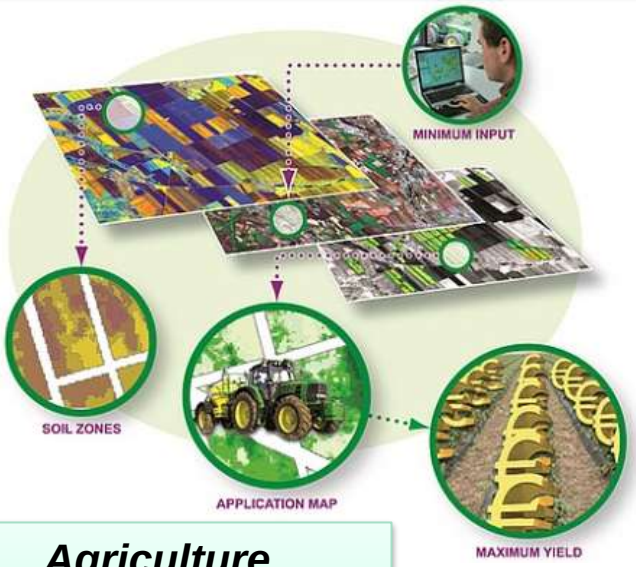
VISTA Remote Sensing in Geosciences GmbH

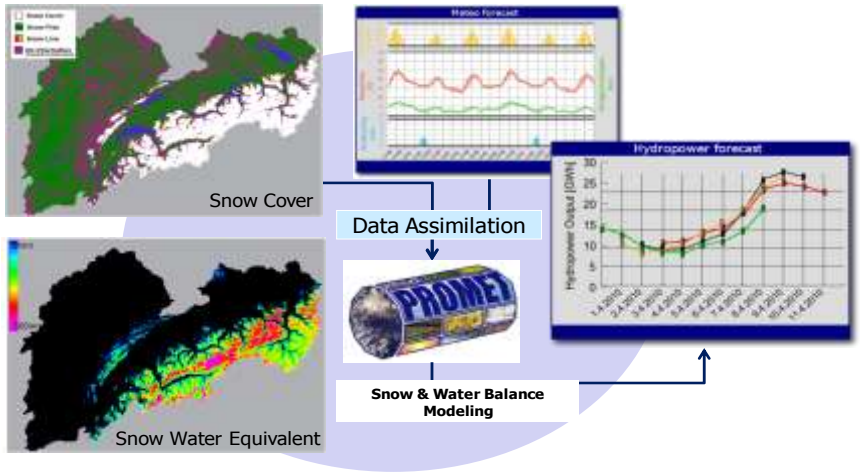
www.vista-geo.de

SME → ***Founded in 1995 Number of staff: 10***
Managing Director: Dr. Heike Bach

Expertise → ***Remote Sensing and Modeling for Agriculture and Hydrology***

Operational Services:



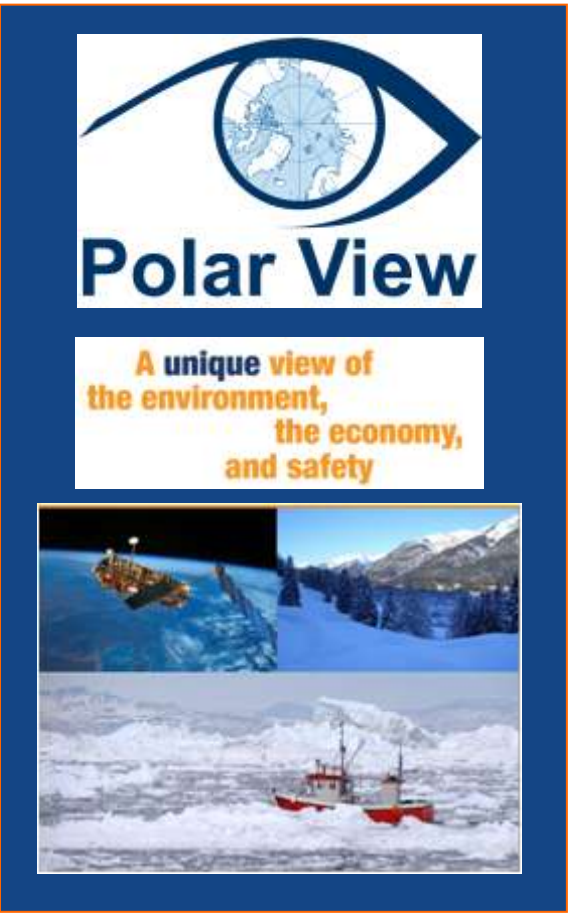


Agriculture
- *Yield Prediction*
- *Precision Farming*
- *Certification Support*

Hydrology
- *Snow Monitoring*
- *Run-off modelling*
- *Hydropower*

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Polar View Legacy



- **GMES Service Element (GSE)**
  ESA funded 2005 - 2013
- Offers and coordinates integrated **monitoring and forecasting services** in the Polar Regions and parts of the mid-latitudes with **significant snow and ice cover** using satellite Earth Observation

Services of Polar View

- Sea Ice & Iceberg & Ice Edge Monitoring
- Glacier & River Ice & Lake Ice Monitoring
- Snow Monitoring (*Baltic Area, Scandinavia, Central Europe*)

Network of Polar View

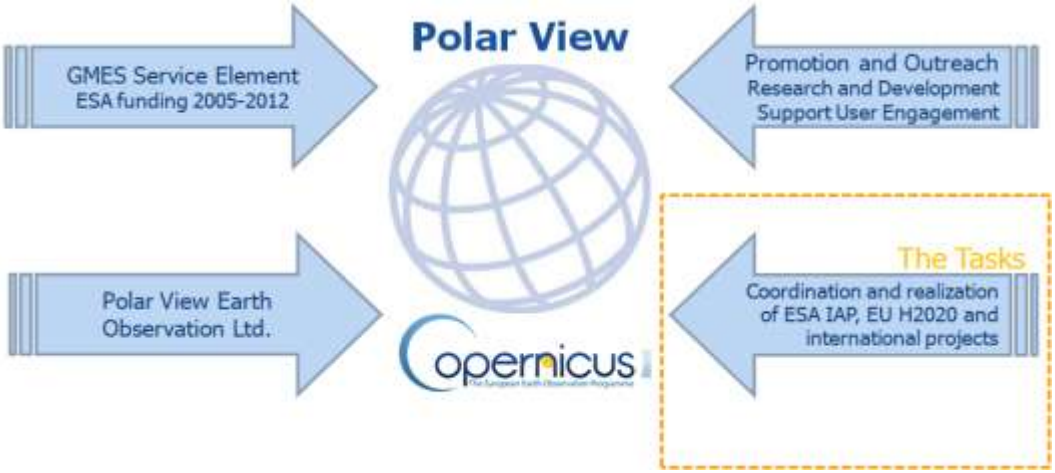
- Commercial service providers, government agencies and research organizations
- 9 Full and 9 Associate Members
- Since Oct. 2011 represented by

Polar View Earth Observation Ltd. (UK)

www.polarview.org

Polar View Now

"Implementing Copernicus in the Polar Regions"



Associated Projects

ICEMAR (GMES)
ISABELIA (IAP)
POLAR ICE (FP7)
….

Communication

Snow Workshop Darmstadt 2012
ESA Living Planet Symposium
2013 – PVEO Stand
….

www.polarview.org

Polar View Earth Observation Ltd.
3, Great Farm Offices
West Woodhay, Newbury Berkshire,
RG20 0BP United Kingdom

Polar View Office Germany
c/o Anwendungszentrum
Oberpfaffenhofen GmbH
D-82205 Gilching

Polar View Office UK
c/o Satellite Applications Catapult
Harwell Didcot; Oxfordshire
OX11 0QR United Kingdom

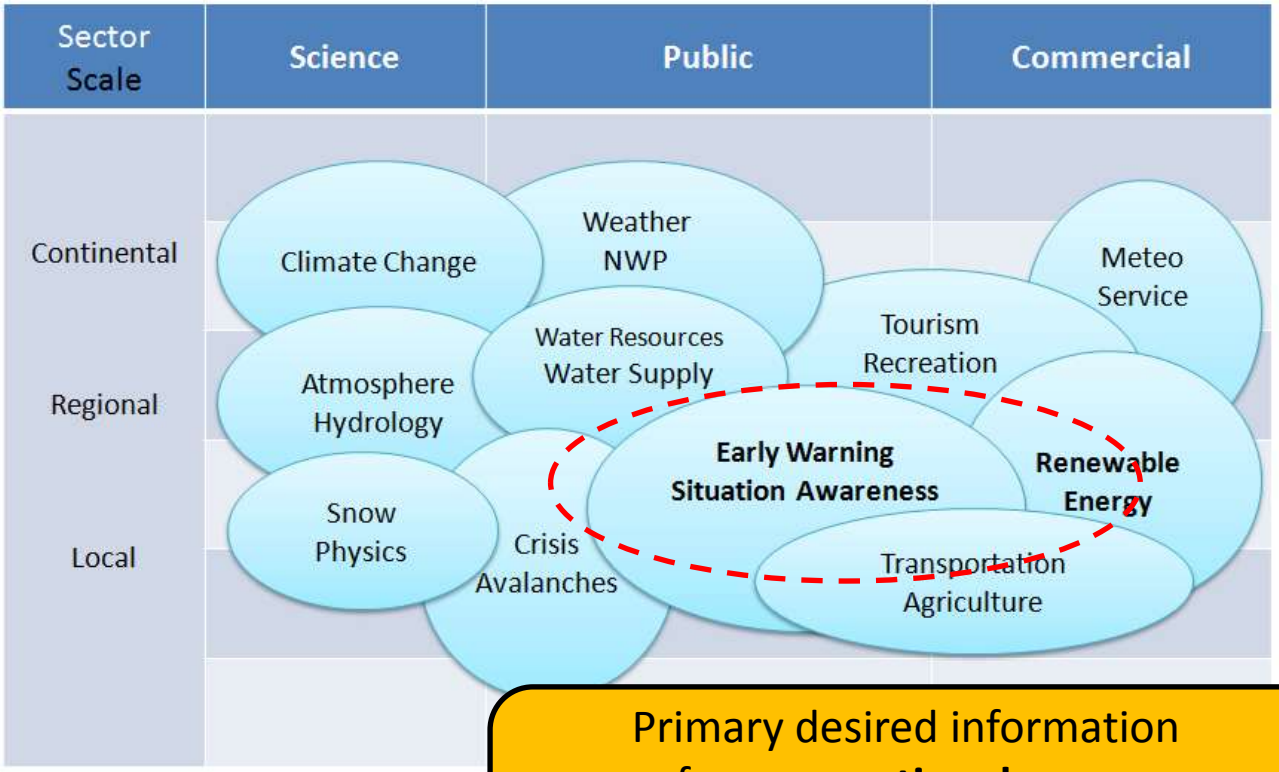
Polar View Office Canada
c/o C-CORE
Morrissey Road ; St. John's, NL
Canada A1B 3X5

Vista

Polar View

Snow Sense: Motivation and Idea

Port **Need for Snow Monitoring:**



Primary desired information
from **operational** users:
Snow Water Equivalent
= Water Stored as Snow (up-to-date)

Snow Information on local and regional scale: Ways of assessment



Remote Sensing *Snow Covered Area* *Snow Melt*	**In-Situ** *Stations* *Field Campaigns*	**Snow Modeling** *Snow Water Equivalent*
✓ spatial information ✓ covering large areas ✓ operational available ✓ existing infrastructure ○ depending on satellite pass ○ depending on clouds	✓ accurate information ✓ physical measurements ✓ transparent data ○ maintenance needed ○ no spatial cover	✓ spatial information ✓ snow water equivalent ✓ water balance parameters ○ need of input data ○ need of model control

Obstacles

- Low density of suitable in-situ stations, especially in remote areas
- Observers are no practicable solution
- Automated station costly and not perfect
- SWE from passive MW only solution for very large scales and periods

Idea:

Integrative use of existing technologies

+

Novel GNSS based in-situ sensor

potential of low cost solutions multiple sensors

ESA Integ Space Award 2013
(promoting ESA IAP in Germany)

INTEG SPACE AWARD

ESA IAP PRIZE 2013

GEWINNER

SNOWSENSE: Using satellite navigation, communication and re sensing for timely access to high-quality and reliable informati snow

VISTA Geowissenschaftliche Fernerkundung GmbH

Lehrstuhl für Geographie und geographische Fernerkundun der Ludwig-Maximilians-Universität München

München, den 28.02.2013

Prof. Amnon Ginati, ESA — Anke Freimuth, DLR e.V. — Hans J. Steininger, MT Aerospace AG — Bärbel Dekting, bayAIRia e.V.

esa DLR MT AEROSPACE bayAIRia







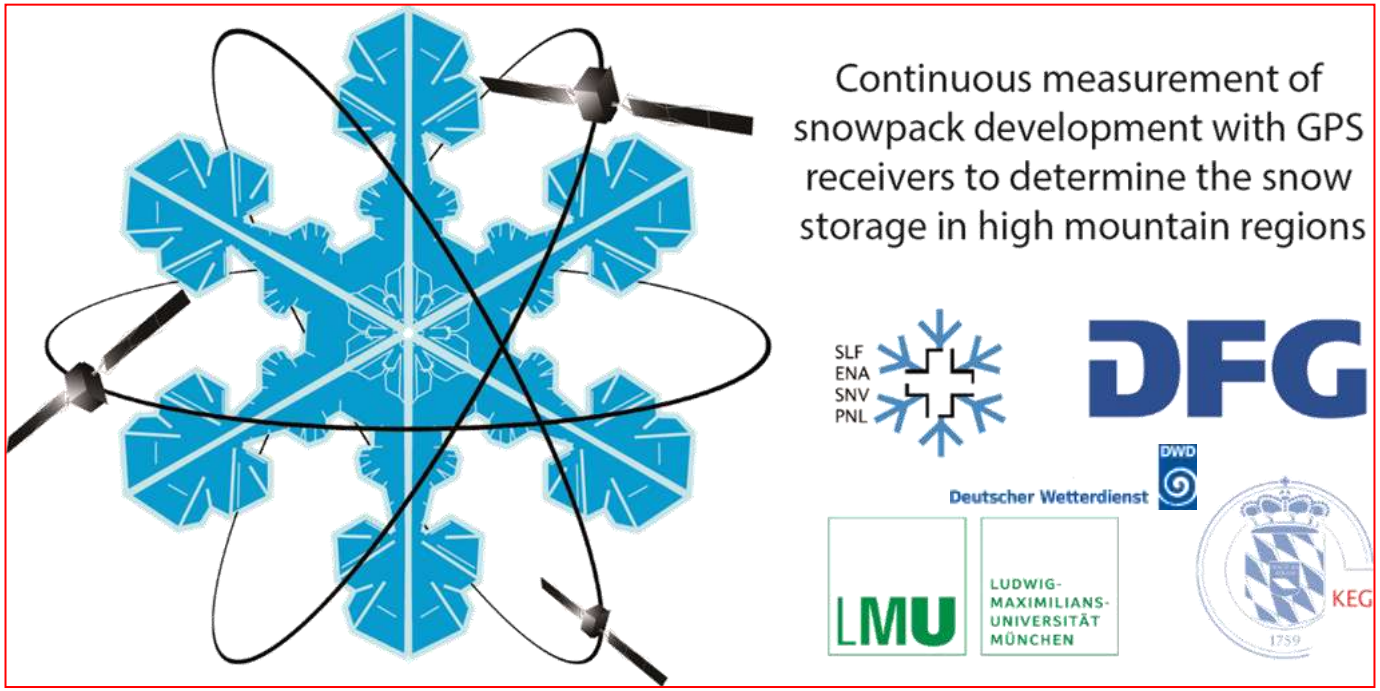
SnowSense

ESA IAP Feasibility Study

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Observing snow with GPS receivers

The science part



Continuous measurement of snowpack development with GPS receivers to determine the snow storage in high mountain regions

SLF ENA SNV PNL

DFG

Deutscher Wetterdienst

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

KEG





F. Koch, M. Prasch and W. Mauser

LMU Munich
Department of Geography
Chair for Geography and Remote Sensing

Funded by: DFG (German Research Foundation)
Project partners: SLF (Institute for Snow and Avalanche Research)
KEG (Commission for Geodesy and Glaciology)
Coop. partner: DWD (German Weather Service)

vista

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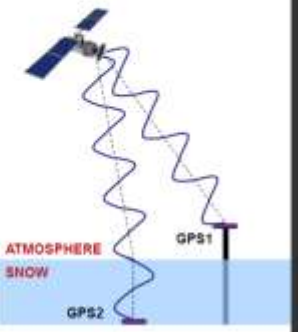
Slides from of F. Koch (LMU) on preliminary results

Final results of PhD thesis will be published

Experimental Setup and Test Sites

GPS snow measuring idea

- **Two GPS receivers**
  - GPS1: above the snow cover
  - GPS2: underneath the snow cover
- Non-destructive snow measurement setup
- **Differences in GPS** signals are caused by snow
- **Continuous GPS data collection** during entire winter / snow covered period
- Measurement parameters:
  snow characteristics, e.g. liquid water content, snow depth
- Validation basis:
  meteorological and snow-hydrological data



Data Analysis and Preliminary Results

Start of winter 01.10. – 15.11.2012; C/No values received at GPS2 (below snow)

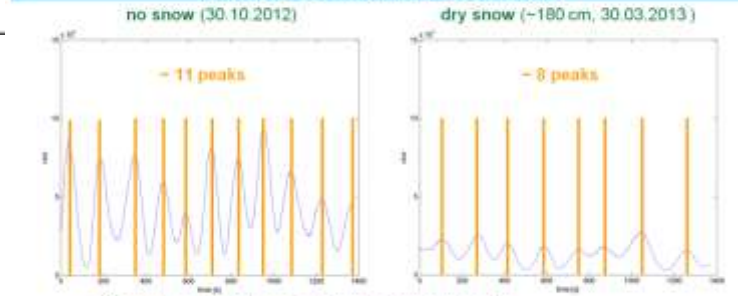


Data Analysis and Preliminary Results

Start of melt period, daily melt-freeze conditions: 12.04. – 28.04.2013

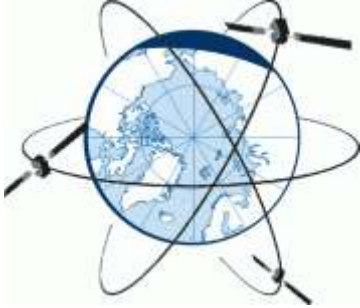
Data Analysis and Preliminary Results

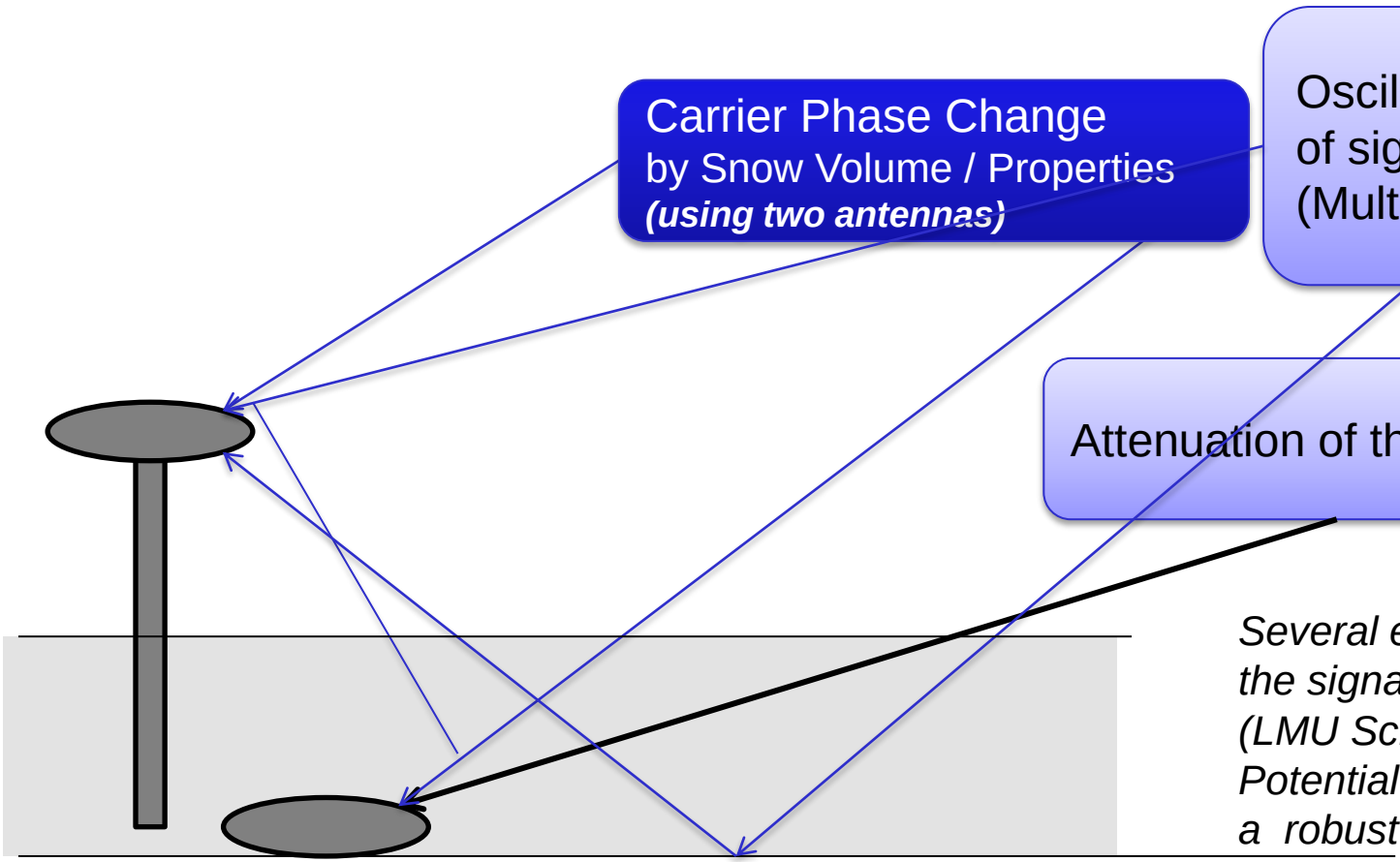
Multipath C/No analysis of GPS1 (above the snow cover)
satellite 1, elevation: 10-20°, descending



- Snow has an influence on amplitude and frequency of the signal in the low satellite elevation range
- Less peaks and lower C/No amplitudes with snow cover

Summary of GNSS capabilities
Theory



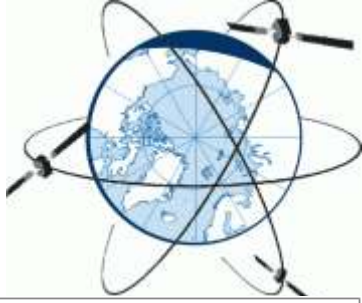


Several effects from snow on the signal had been identified (LMU Science & Literature) Potential scenarios for a robust service are investigated

Vista

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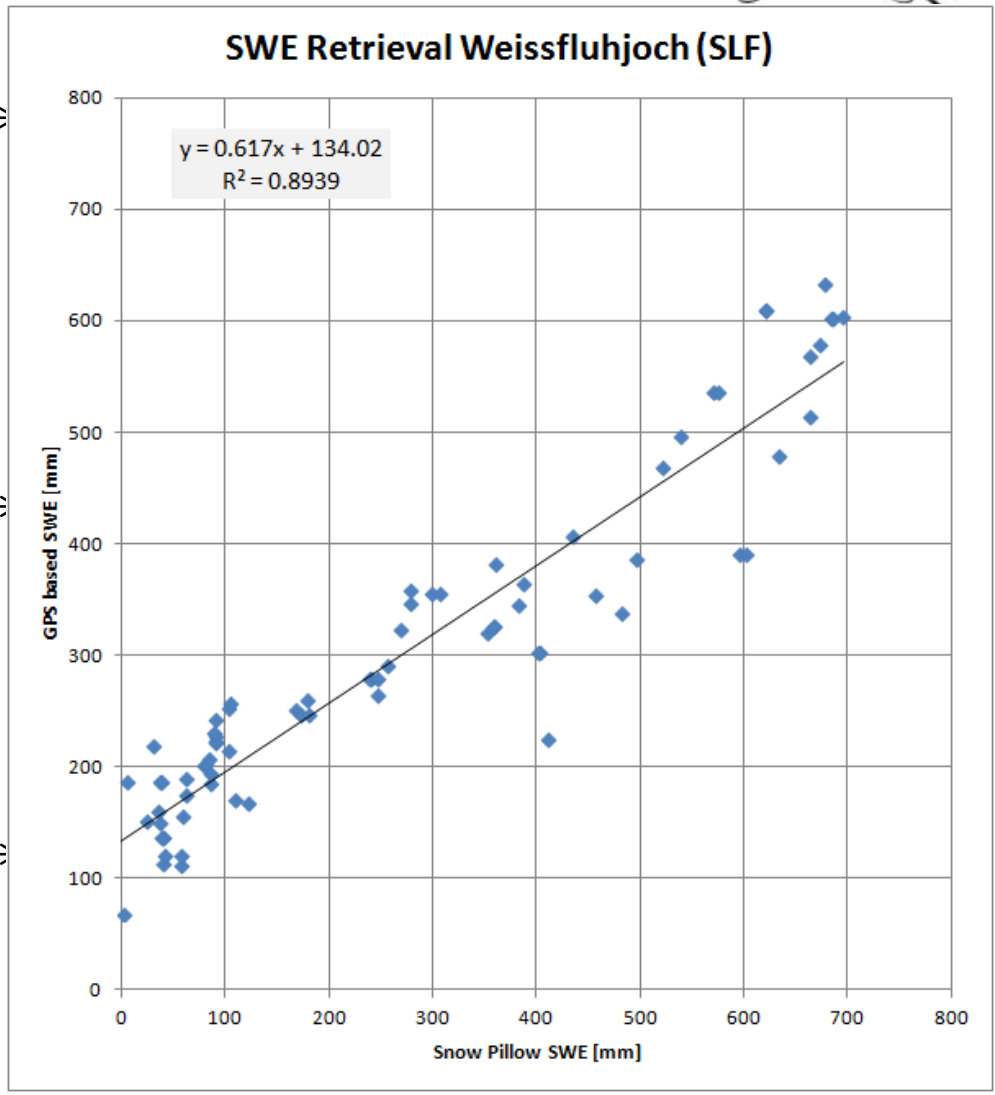
Summary of GNSS capabilities Experiences



Attenuation of the signal

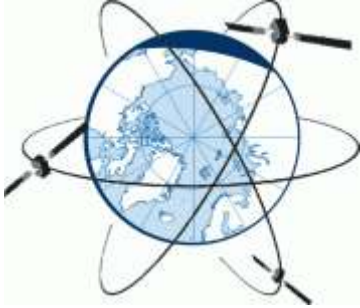
Oscillation of signal

Carrier Phase Change by the Snow Volume
(using two antennas)



- **Very promising results from prototype algorithm**
- **Science & Algorithm retrieval is ongoing**
- **Science results will be published (PhD at LMU)**

Service Concept of SnowSense Targeted for Remote Areas



GNSS



SATCOM



EO Snow Monitoring
using Optical & SAR

In-Situ Component
using GNSS Signal



Pre-Processing

Sat Com Capabilities

Low Cost & Low Energy Design

Service Integration

•Snow Modeling
•Runoff-Modeling
•Hydropower Modeling

Service Delivery

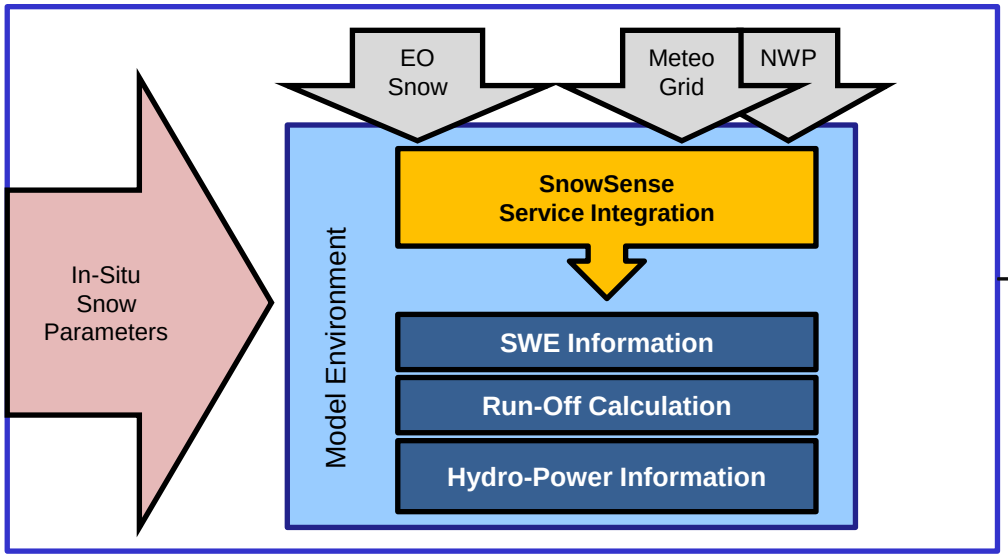
Global Weather Data & NWP

User Support

Internet

Regional User
Hydropower Companies & Flood Forecast Center

Service Design of SnowSense Key Features



Service optimal for Remote Areas

Variable temporal and spatial resolution

In-Situ components can be located at sensible points

Key advantage one:
Novell in-Situ components of Snow Property Assessment

Own Power and Communication
Maintenance Free
Low Cost Hardware

Key advantage two:
EO Snow Monitoring

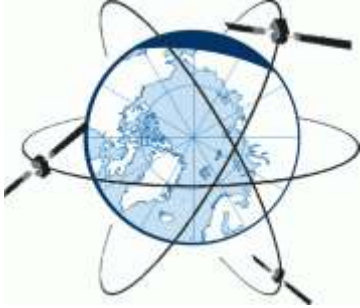
Established method to assess snow cover in large and remote areas
Existing Infrastructure
Free and open data basis

Key advantage three:
Snow and Water Balance Calculation from Meteo Grid Data

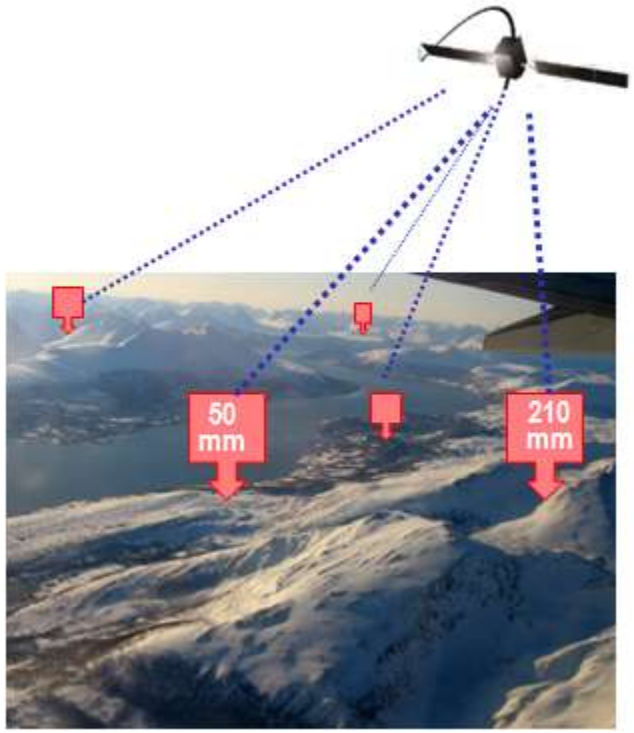
Independent from other in-situ stations
Physically based / Fully transferable
Forecasts included



Summary on SnowSense



- Use of a novel snow measurement sensors (developed by the LMU) is promising for snow properties retrieval
- Designed to be autonomous with low power consumption and integrated satellite communication
- Service is designed to provide low cost system to be multiple installed in remote areas
- Remote sensing products based on optical and SAR data will provide additional snow information
- In-situ measurements and EO products will be integrated in model environment for spatial information (SWE & run-off & hydo power forecast)
- The provision of timely access to high-quality and reliable information on snow is new commercial opportunities in the water resource management market



Status:

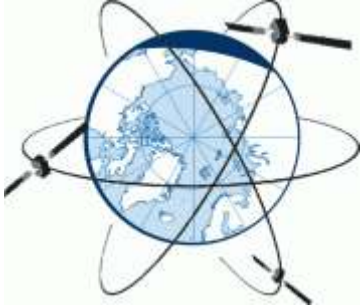
ESA IAP Feasibility Study: 1. September 2013 – 28. February 2014

ESA IAP Demo Study: targeted

Vista

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Thank for your attention…



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