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Understanding satellite-based snow cover products over alpine terrain through high-quality in-situ measurements over Switzerland

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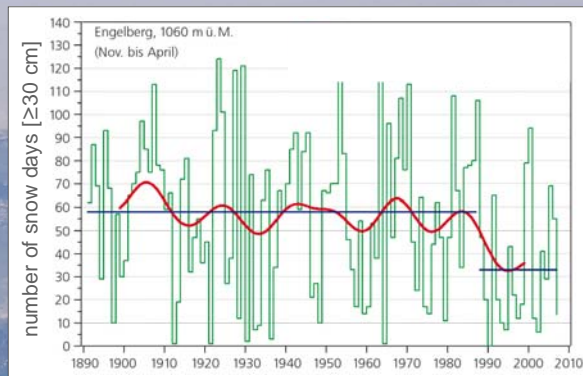
7th Workshop on Remote Sensing of Land Ice and Snow
Bern, 03-06 February 2014

Satellite-based observations complement the long-term in-situ data; essential for validation/intercomparison studies



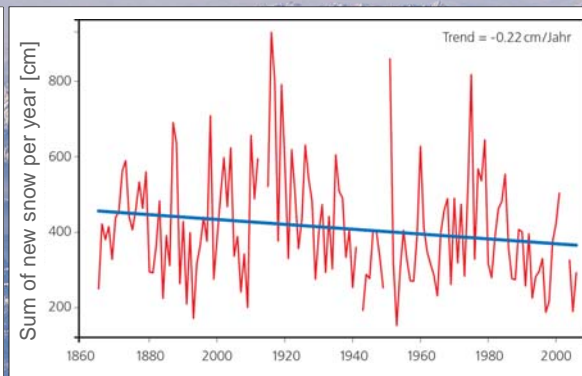
Switzerland has a long tradition in the systematic observation of the snow cover

→ snow depth



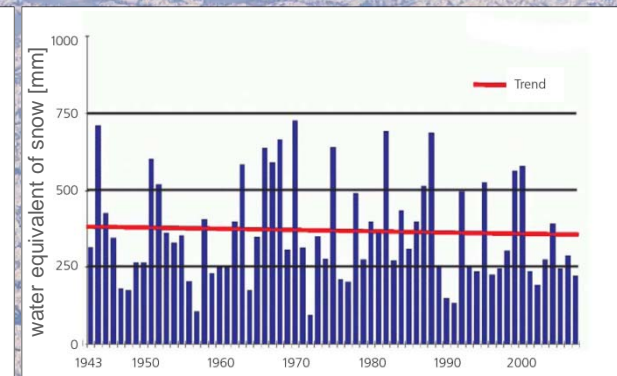
WSL/SLF

→ new snow depth



MeteoSwiss

→ snow water equivalent



Meteodat GmbH

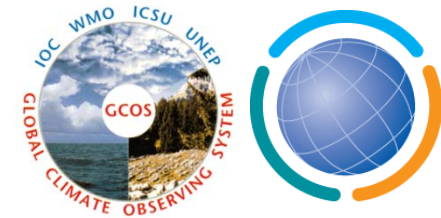


Outline

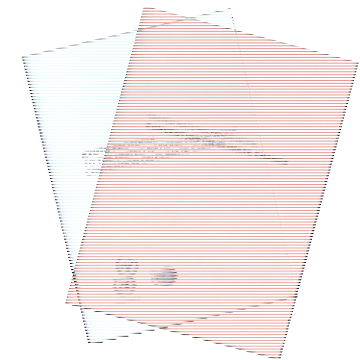
- Brief overview of activities of the Swiss GCOS Office
- National Basic Climatological Network for Snow NBCN-S
- Metadata analysis: selection of Swiss GCOS Snow station sites
- Preliminary results with ESA GlobSnow-2 data
- Concluding remarks



Global Climate Observing System



- Established in 1992; co-sponsored by WMO, UNEP, IOC-UNESCO and ICSU
- 3 Scientific Panels: '**Atmosphere**', '**Ocean**' and '**Terrestrial**'
- 'Systematic observation' in UN Framework Convention on Climate Change (UNFCCC)
- **Objective:** ensure that the observations and information needed to address climate-related



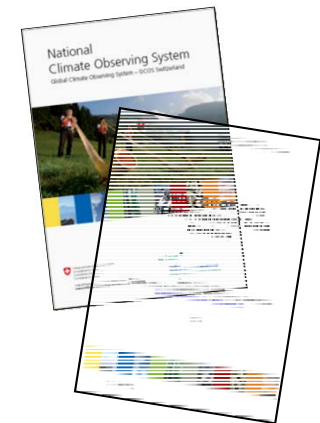
→ **GCOS Secretariat at WMO = International Coordination**
→ **Swiss GCOS Office at MeteoSwiss = National Coordination**



Swiss GCOS Office – National Coordination

- **Coordination** of climate relevant measurements from Federal Offices, Research Institutes and Universities
→ national annual **GCOS roundtable**
- National Climate Observing System (Seiz and Foppa, 2007): **first inventory** of climate measurement time series and international data centres in Switzerland
- Report on Swiss GCOS Data in **International Data Centers**
- **Promote** use of satellite data

→ Ensure the continuation of important **long-term measurement series** and **international data centers** as well as foster **new measurement techniques** and data series





National Basic Climatological Network for Snow NBCN-S



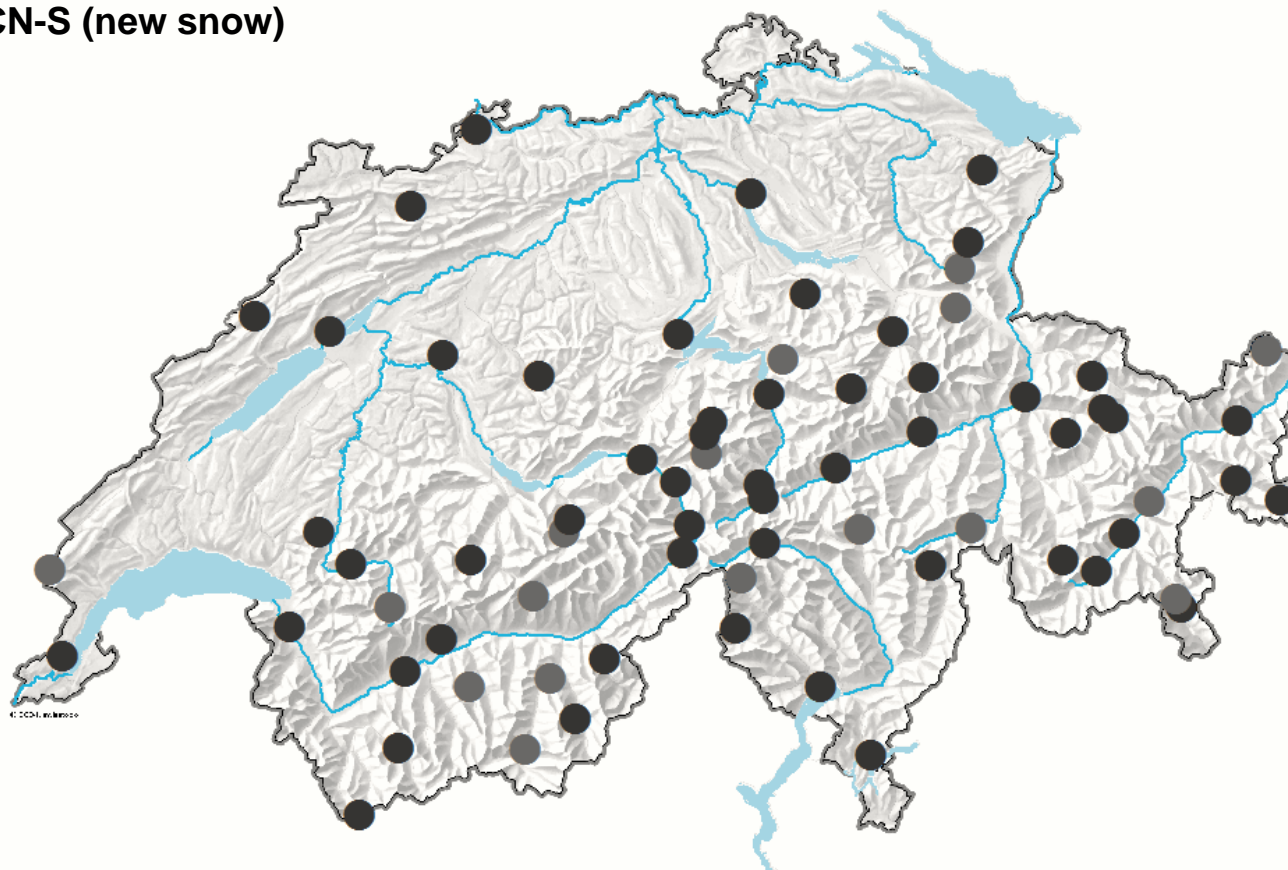
- Stations networks operated by different national agencies with different focuses, applications and spatial distribution
 - 137 station sites with manual daily observations of snow depth and new snow depth
 - Measurement series dating back to the end of 19th and beginning 20th century
- urgent need to define most valuable snow cover series to guarantee **sustainable** operation for **climatological** aspects
- based on cluster analysis, selection of 71 station sites (Wüthrich et al.) = **National Basic Climatological Network for Snow NBCN-S**
- Subset as potential **Swiss GCOS Snow Stations** following **specific criteria**



National Basic Climatological Network for Snow NBCN-S



- NBCN-S (snow depth)
- NBCN-S (new snow)

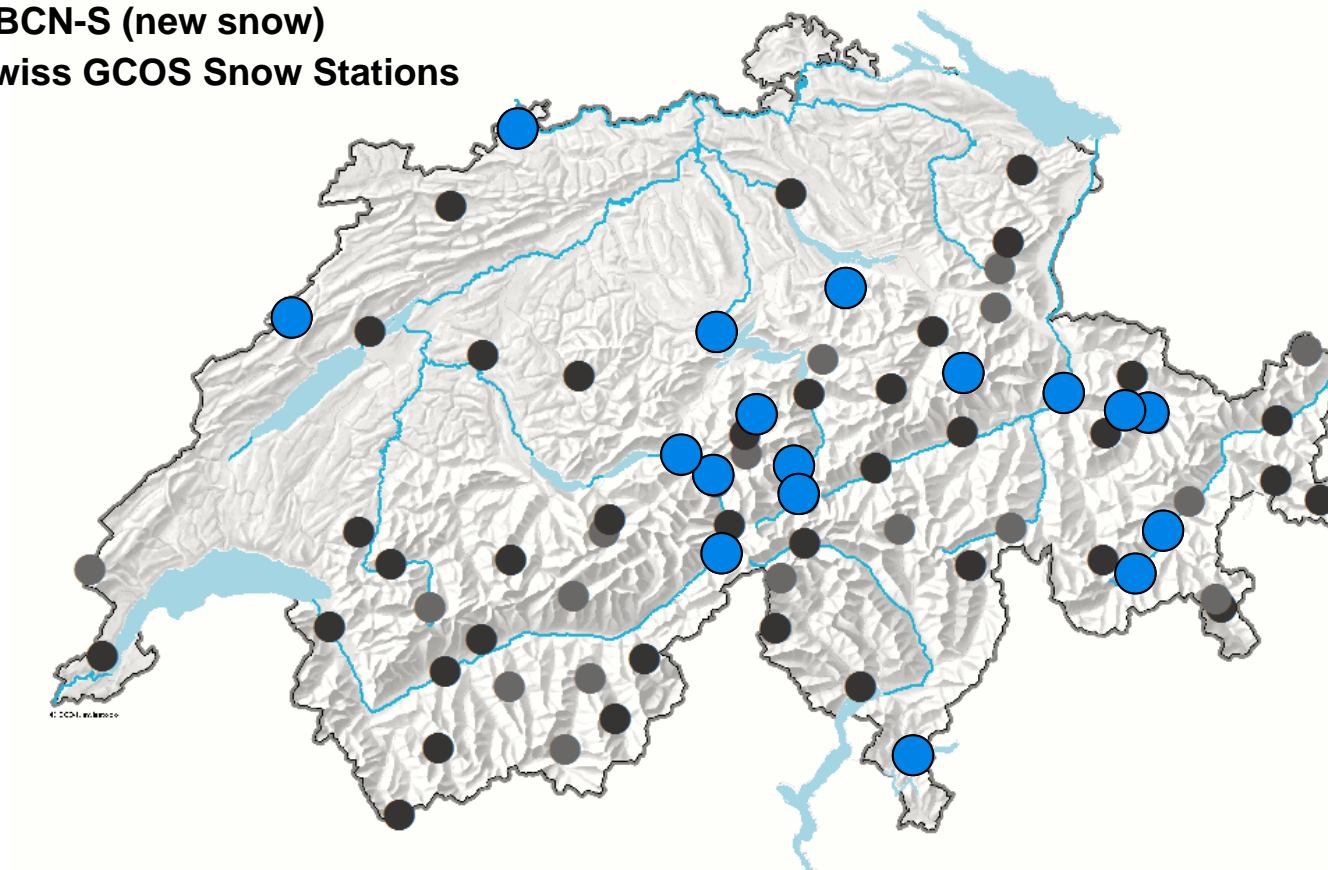




National Basic Climatological Network for Snow NBCN-S



- NBCN-S (snow depth)
- NBCN-S (new snow)
- Swiss GCOS Snow Stations



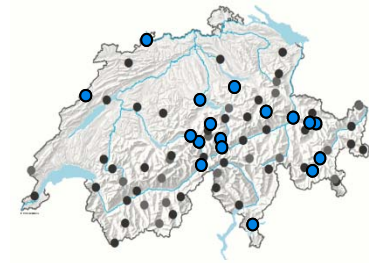


Potential Swiss GCOS Snow Stations for satellite-based product validation



Metadata analysis including:

- Station history (vertical, horizontal shifting)
- Data gap analysis after 1980
- Environmental analysis



Elevation gradient

→ 90 m, 300 m based on SRTM

Land cover Classification

→ 300 m, 1000 m (ESA GlobCover)

→ 3D profiles



3. Agents for Implementation

The global observing system for climate requires observations from all domains – atmospheric, oceanic, and terrestrial – which are then transformed into products and information through analysis and integration in both time and space. Since no single technology or source can provide all the needed observations, the ECVs will be provided by a composite system of *in situ* instruments on the ground and on ships, buoys, floats, ocean profilers, balloons, samplers, and aircraft, as well as from all forms of remote sensing, including satellites. Metadata (i.e., information on where and how the observations are taken) are absolutely essential, as are historical and palaeoclimatic records that set the context for the interpretation of current trends and variability. Although these individual activities

Maintenance of adequate, representative surface networks of snow observations must begin with documentation and analysis of the network densities required in different environments. Resolution of the problem of data inaccessibility requires: promoting political commitment to data sharing, removing practical barriers by enhancing electronic inter-connectivity and metadata, and data rescue and digitization. The provision of necessary resources to improve, and to make available, existing archives

Action T15 [IP-04 T10]

Action: Strengthen and maintain existing snow-cover and snowfall observing sites; ensure that sites exchange snow data internationally; establish global monitoring of that data on the GTS; and recover historical data.

Who: National Meteorological and Hydrological Services and research agencies, in cooperation with WMO GCW and WCRP and with advice from TOPC, AOPC, and the GTN-H.

Time-Frame: Continuing; receipt of 90% of snow measurements in International Data Centres.

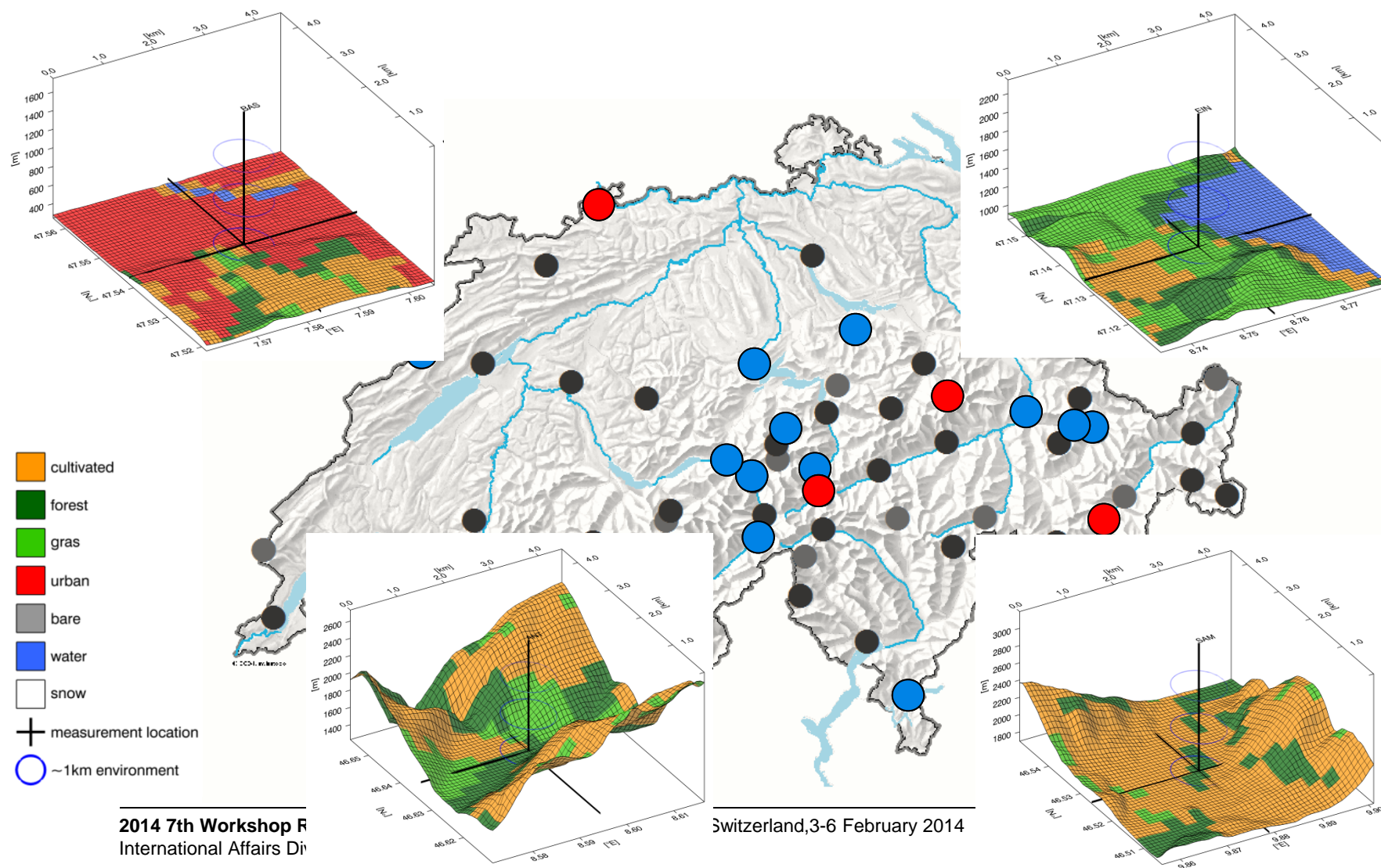
Performance Indicator: Data submission to national centres such as the National Snow and Ice Data Center (USA) and World Data Services.

Annual Cost Implications: 1-10M US\$ (20% in non-Annex-I Parties).

Source: GCOS Implementation Plan, Satellite Supplement

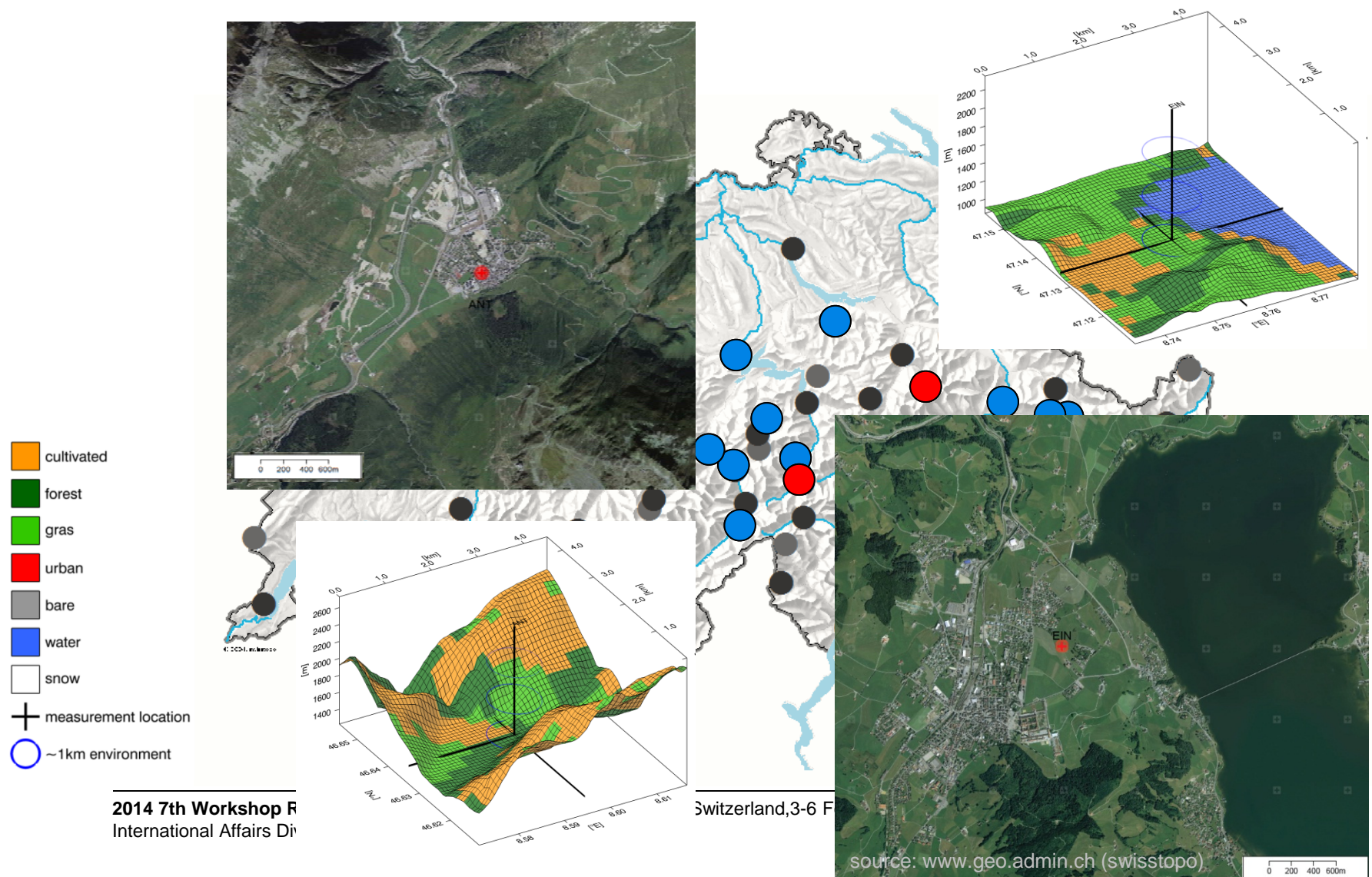


Potential Swiss GCOS Snow Stations for satellite-based product validation





Potential Swiss GCOS Snow Stations for satellite-based product validation

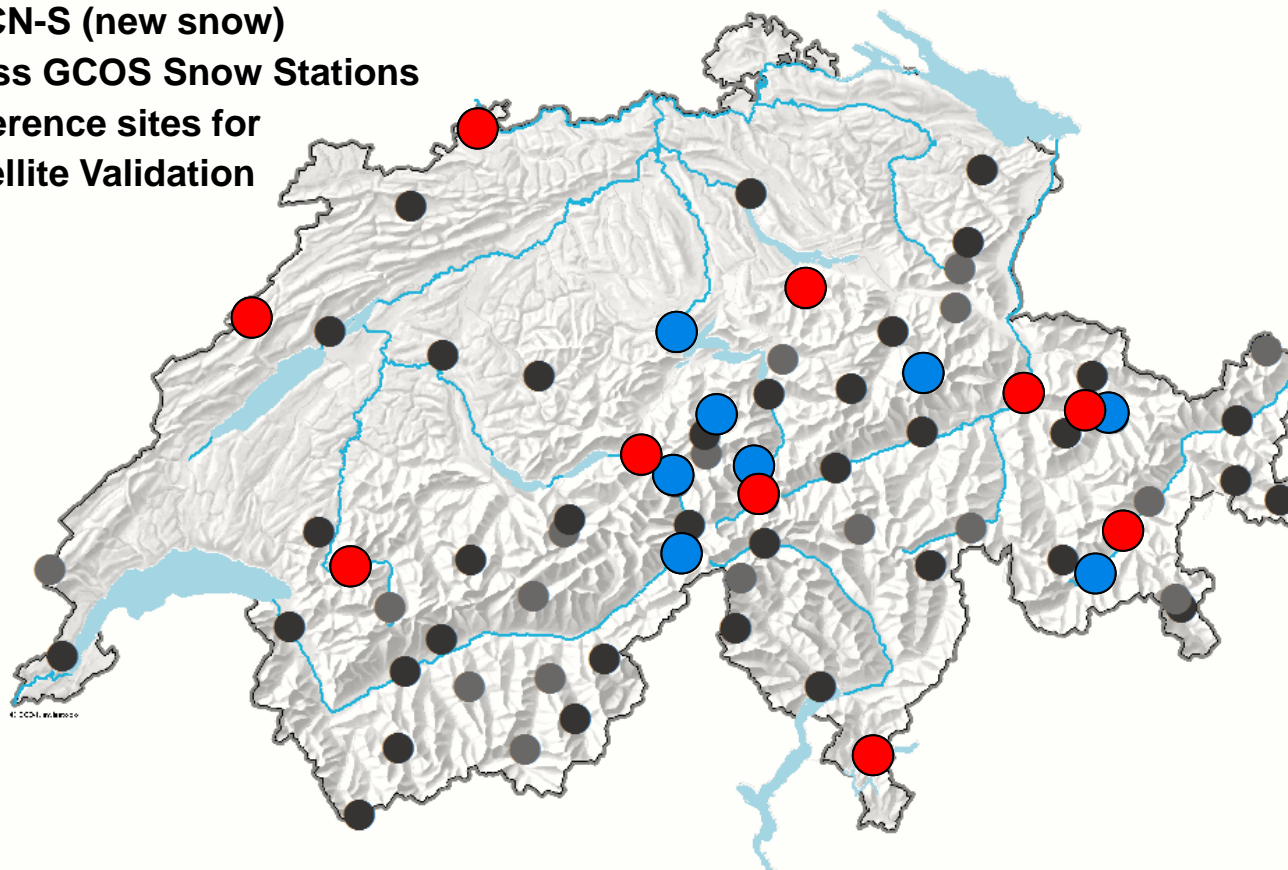




Potential Swiss GCOS Snow Stations for satellite-based product validation



- NBCN-S (snow depth)
- NBCN-S (new snow)
- Swiss GCOS Snow Stations
- Reference sites for Satellite Validation





Environment
Canada
Environnement
Canada

Potential Swiss GCOS Snow Stations for satellite-based product validation



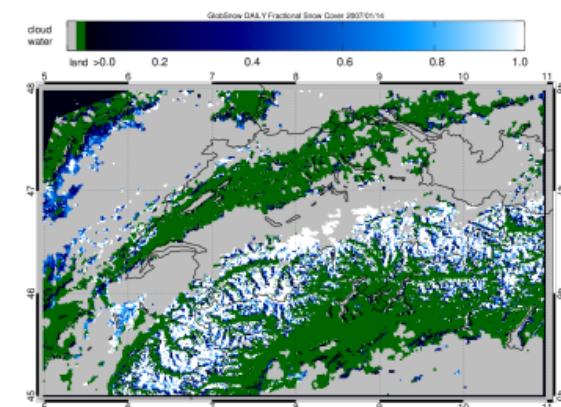
Preliminary Results (ESA GlobSnow-2)

ERS-2 ATSR data
1 August 1995 - 31 December 2002

ENVISAT AATSR data
20 May 2002 – 8 April 2012

Northern Hemisphere from 25° N to
84° N

Daily FSC (0.01° x 0.01°)
→ binary re-classification
→ in-situ snow depth threshold



[**→ More details on Wednesday pm \(ESA GS-2 session\)**](#)

2014 7th Workshop Remote Sensing of Land Ice and Snow | Bern, Switzerland, 3-6 February 2014
International Affairs Division | Swiss GCOS Office | Nando Foppa

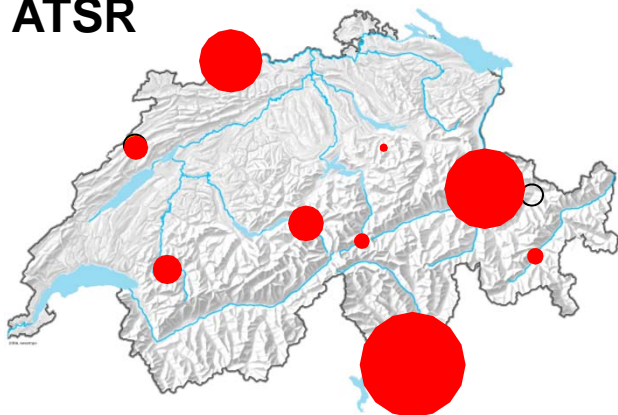


Potential Swiss GCOS Snow Stations for satellite-based product validation

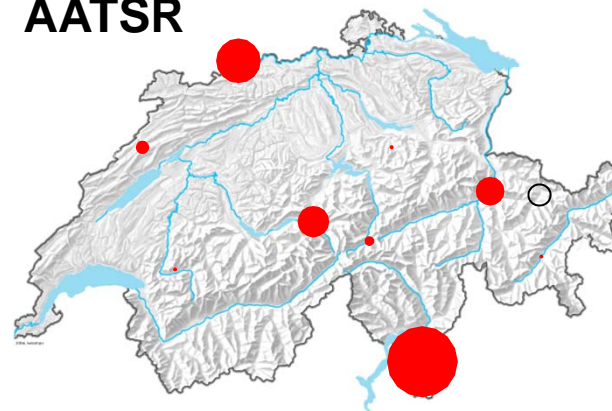
1.0

FAR

ATSR



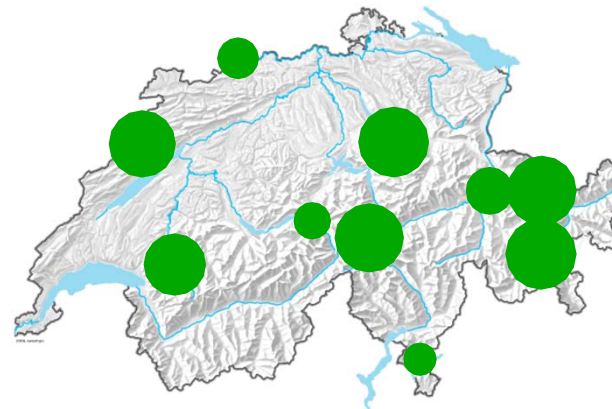
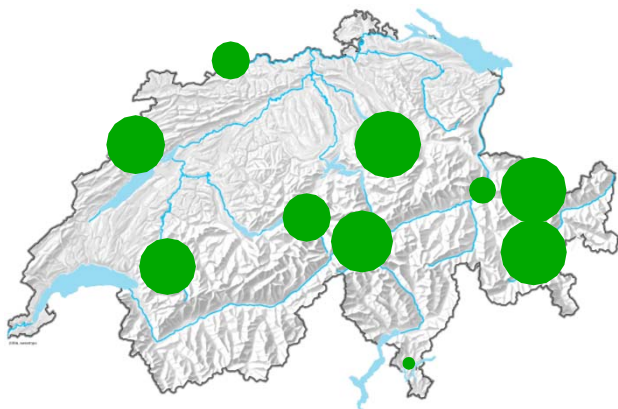
AATSR



preliminary
results

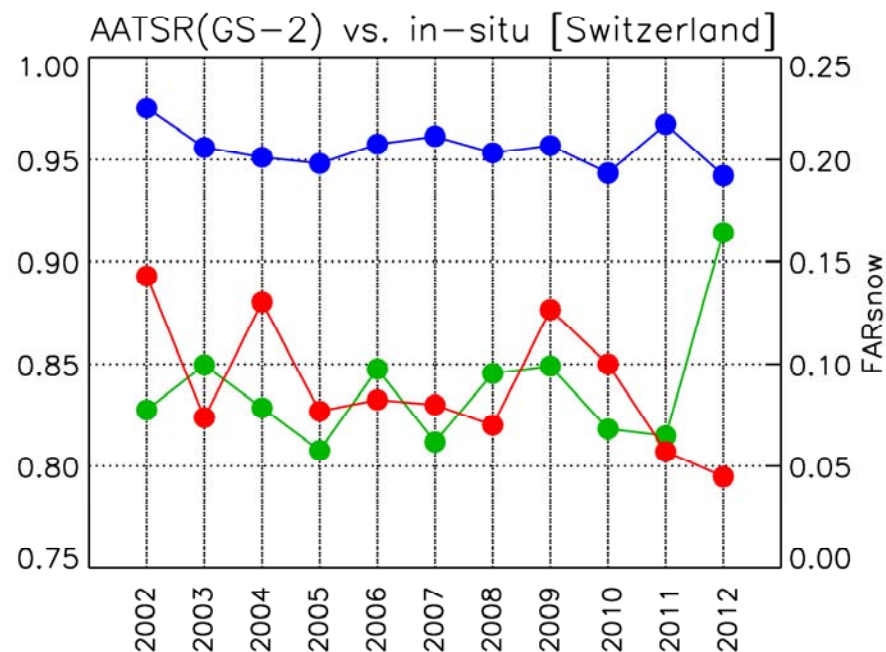
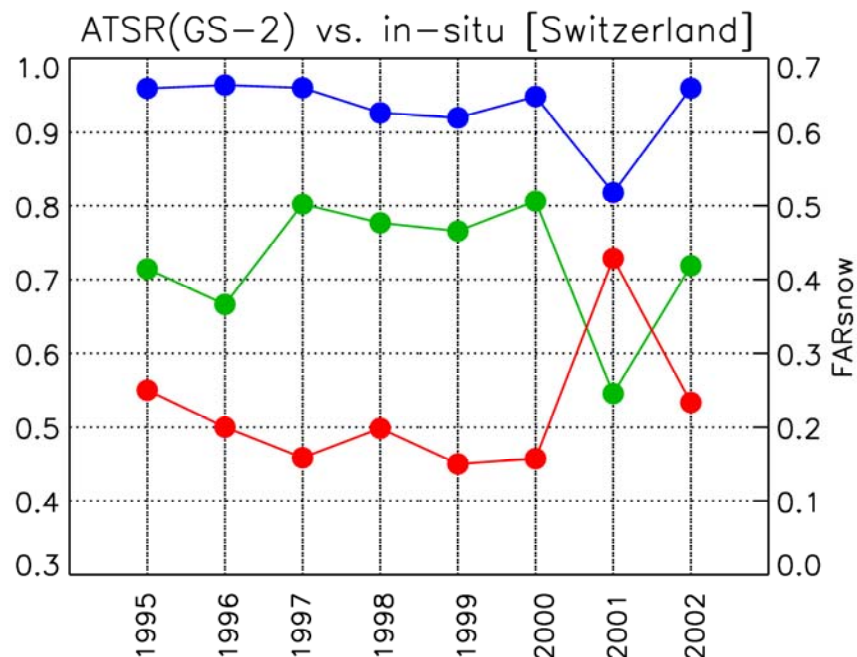
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TS
(CSI)





Potential Swiss GCOS Snow Stations for satellite-based product validation



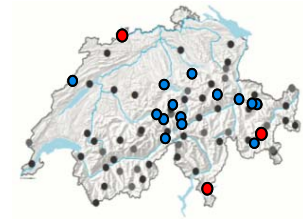
ACC
TS
FARsnow

preliminary
results

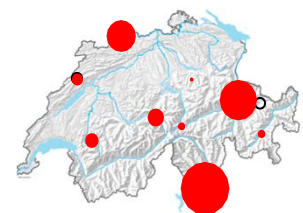
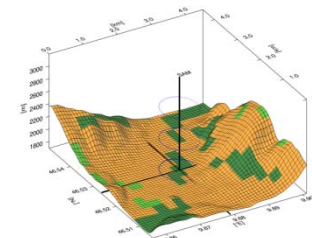


Conclusions and Outlook

- Vulnerability of **mountain regions** to climate change: importance of **systematic observation**, including from satellites
- **Definition of (reference) station sites** for validation/intercomparison of satellite-based snow product over Switzerland → networks within **sustainable frameworks** (e.g. NBCN-S) guarantee a continued **provision of reference data**
- In-situ snow **station sites** must be **characterized comprehensively** (metadata)
- **Further** analysis of in-situ vs. satellite differences: To increase **confidence of users and decision makers** in satellite-based snow products, **high quality in-situ data** is required



Picture: Ch. Marty





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Thank you for your attention!

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