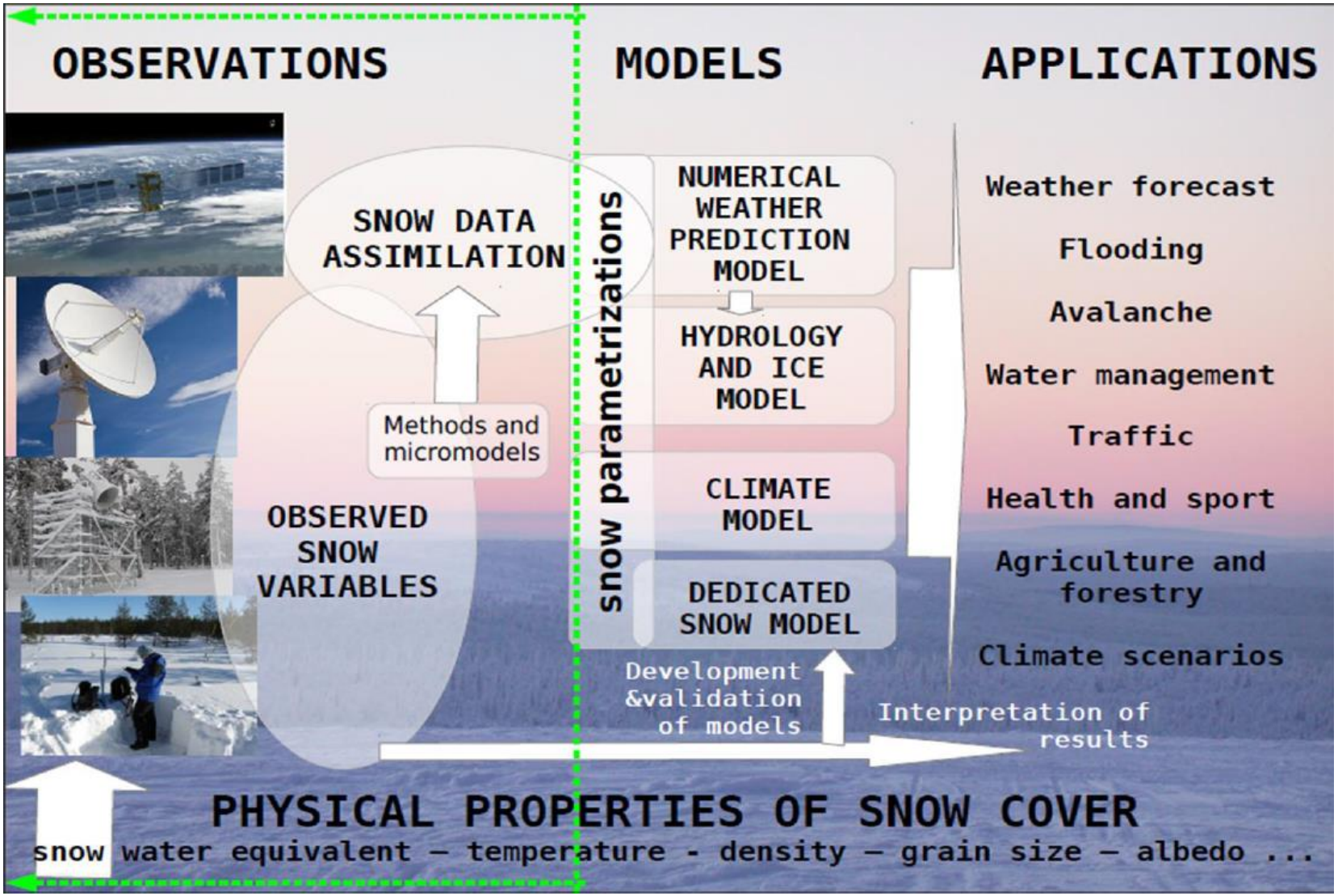
COST ES1404

Snow Data Assimilation Methods for Hydrological, Land Surface, Meteorological and Climate Models: Results from COST HarmoSnow (2014-2018)

Jürgen Helmert, Aynur Şensoy Şorman, Rodolfo Alvarado Montero, Carlo De Michele, Patricia De Rosnay, Marie Dumont, Samantha Pullen, David Christian Finger, Martin Lange, Ghislain Picard, Vera Potopová, Dagrun Vikhamar-Schuler, and Ali Nadir Arslan

Motivation


OBSERVATIONS
MODELS
APPLICATIONS
SNOW DATA ASSIMILATION
Methods and micromodels
OBSERVED SNOW VARIABLES
snow parametrizations
NUMERICAL WEATHER PREDICTION MODEL
HYDROLOGY AND ICE MODEL
CLIMATE MODEL
DEDICATED SNOW MODEL
Weather forecast
Flooding
Avalanche
Water management
Traffic
Health and sport
Agriculture and forestry
Climate scenarios
Development &validation of models
Interpretation of results
PHYSICAL PROPERTIES OF SNOW COVER
snow water equivalent – temperature - density – grain size – albedo ...

Tasks WG3

Task 3.1: Overview of the various **snow observations** used in NWP, hydrology and climate **studies** for different purposes including validation and **data assimilation**

Sources for information about snow observations
COST HarmoSnow dissemination:


European Snow Booklet

THIS IS A TEMPORARY TITLE PAGE
It will be replaced for the final print by a version
provided by Global Concept Consulting
in order to meet the COST branding guidelines

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY


sensors

MDPI

Article

European In-Situ Snow Measurements: Practices and Purposes

Roberta Pirazzini [1,*], Leena Leppänen [1], Ghislain Picard [2], Juan Ignacio Lopez-Moreno [3], Christoph Marty [4], Giovanni Macelloni [5], Anna Kontu [1], Annakaisa von Lerber [1], Cemal Melih Tanis [1], Martin Schneebeli [4], Patricia de Rosnay [6] and Ali Nadir Arslan [1]

1 Finnish Meteorological Institute (FMI), FI-00101 Helsinki, Finland; leena.leppanen@fmi.fi (L.L.); anna.kontu@fmi.fi (A.K.); Annakaisa.von.Lerber@fmi.fi (A.v.L.); Cemal.Melih.Tanis@fmi.fi (C.M.T.); Ali.Nadir.Arslan@fmi.fi (A.N.A.)
2 UGA, CNRS, Institut des Géosciences de l'Environnement (IGE), UMR 5001, F-38041 Grenoble, France; ghislain.picard@univ-grenoble-alpes.fr
3 Instituto Pirenaico de Ecología, CSIC, 50059 Zaragoza, Spain; nlopez@ipe.csic.es
4 WSL Institute for Snow and Avalanche Research (SLF), CH-7260 Davos Dorf, Switzerland; marty@slf.ch (C.M.); schneebeli@slf.ch (M.S.)
5 CNR, Institute of Applied Physics "Nello Carrara" (IFAC), 50019 Sesto Fiorentino, Italy; g.macelloni@ifac.cnr.it
6 European Centre for Medium Range-Weather Forecasts (ECMWF), Reading RG2 9AX, UK; Patricia.Rosnay@ecmwf.int
* Correspondence: roberta.pirazzini@fmi.fi; Tel.: +358-50-380-2653

Received: 8 May 2018; Accepted: 18 June 2018; Published: 22 June 2018

check for updates

Model requirements

Deutscher Wetterdienst
aus einer Hand

DWD

How can we measure this fit?
What are the consequences for observation networks and modeling systems of snow data?

Models

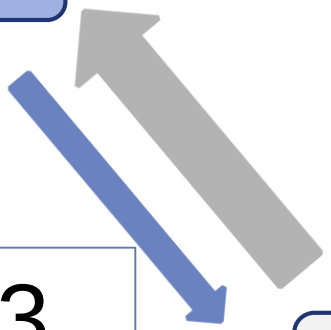
Snow schemes

NWP | Hydrology | Clima

Assimilation

Needs a fit in terms of:

- **Resolution (time,space)**
- **Coverage (global, limited area)**
- **Data content**
- **Errors (sensor, clouds), backup?**
- **Ready to use**



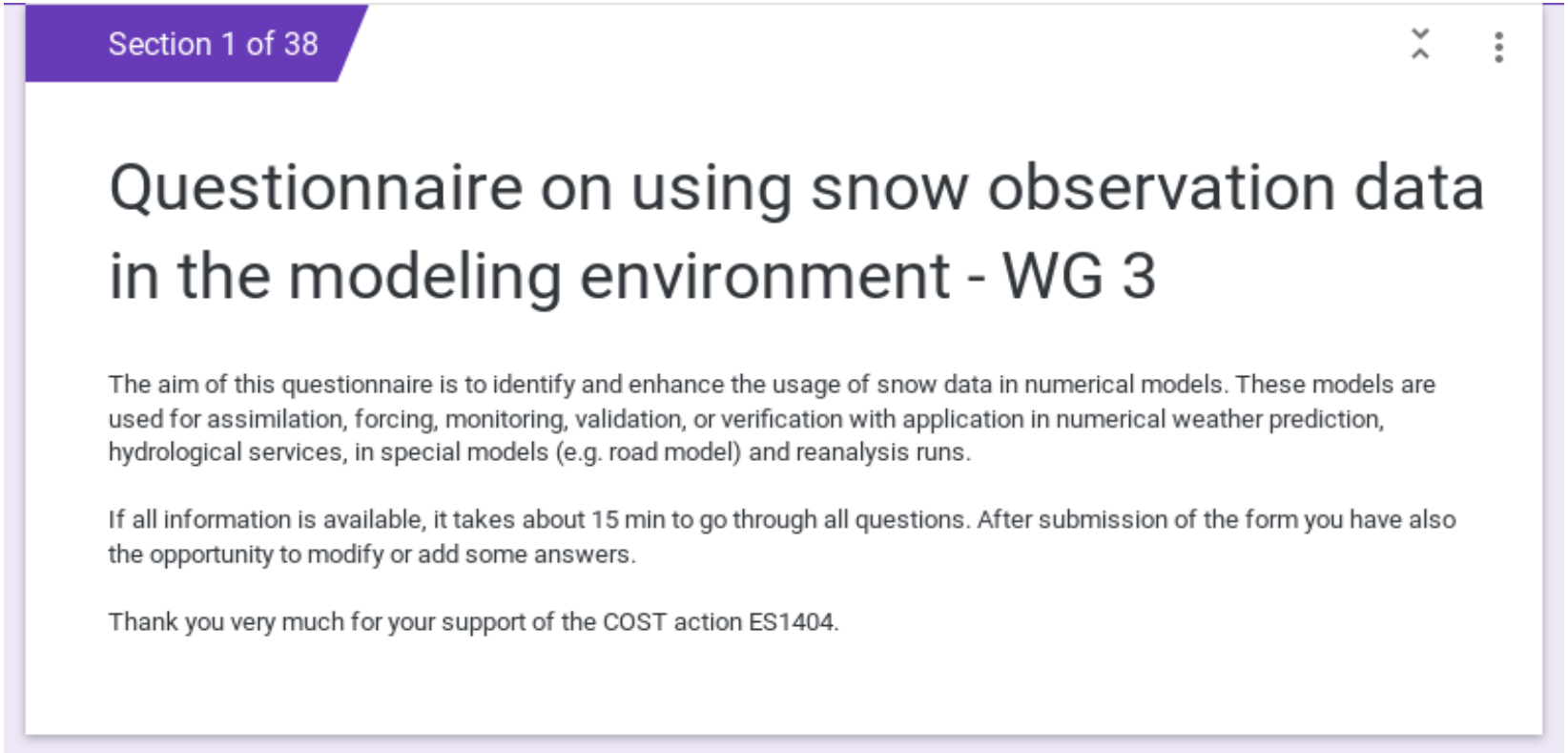
COST WG3 Survey

Observations

Conventional | Remote Sensing

High-res networks

Survey



- September 2015 – December 2017
- Distributed across COST, EUMETSAT H-SAF and GCW member networks
- 51 participants from 31 countries

Survey

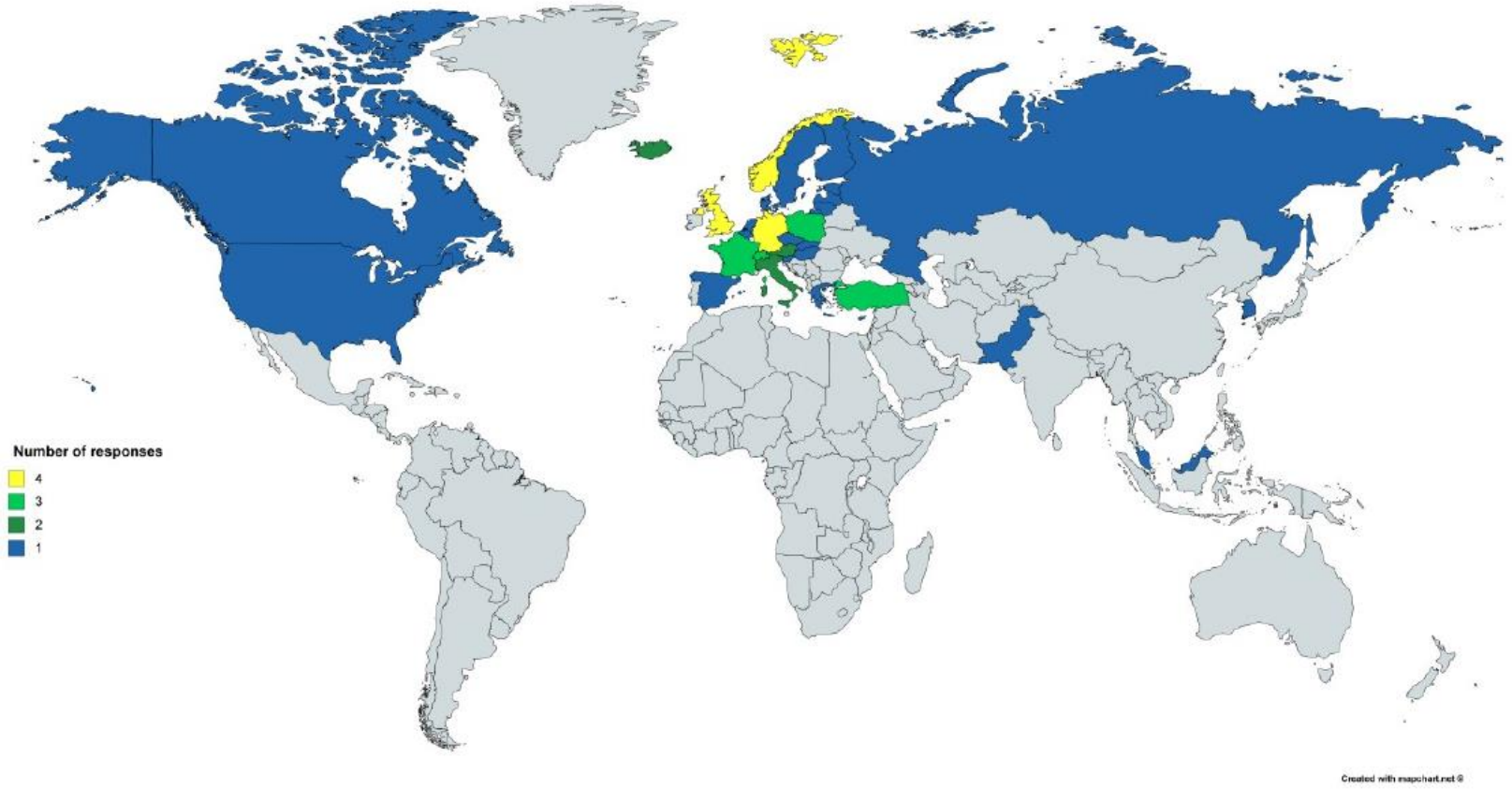


Figure 1. Geographical distribution of number of responses in the survey.

Results

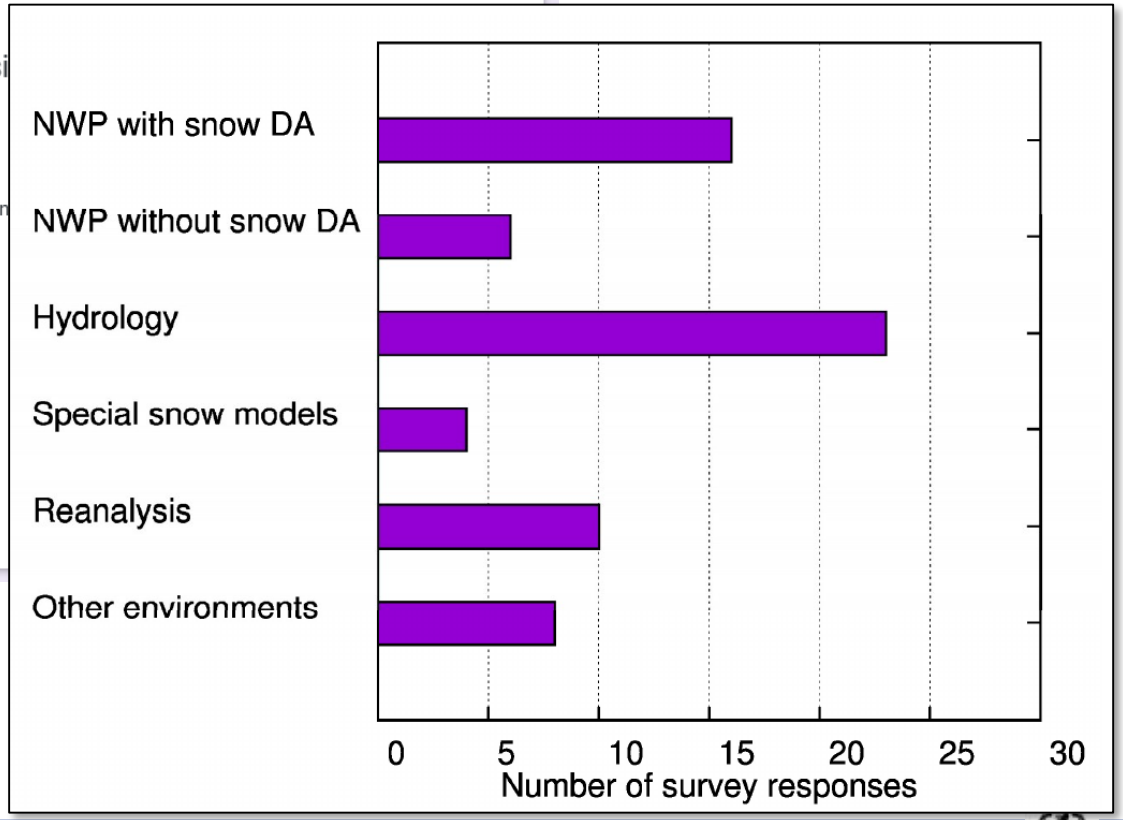
Section 5 of 38

Modeling environment

Description (optional)

In which modeling environment you are usi

- [ ] Numerical Weather Prediction with snow data assimilation
- [ ] Numerical Weather prediction without snow data assimilation
- [ ] Hydrology (forcing using snow data)
- [ ] Special application (e.g. road model with snow data)
- [ ] Reanalysis using snow data
- [ ] Other...



Results

Section 10 of 38

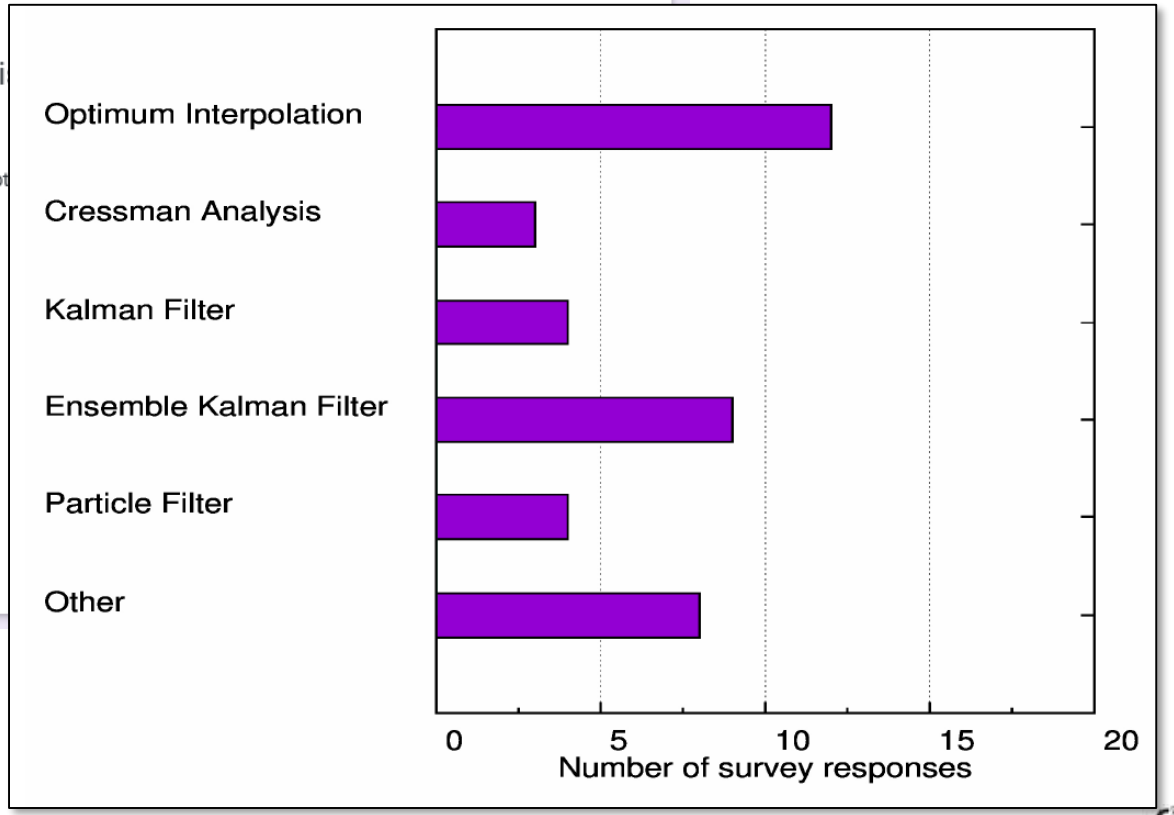
Data assimilation method

Description (optional)

Which data assimilation method i
observations?

If "other" method is used, please give a short descript

- [ ] Optimum Interpolation
- [ ] Cressman analysis method
- [ ] Kalman Filter
- [ ] Ensemble Kalman Filter
- [ ] Other...



Results

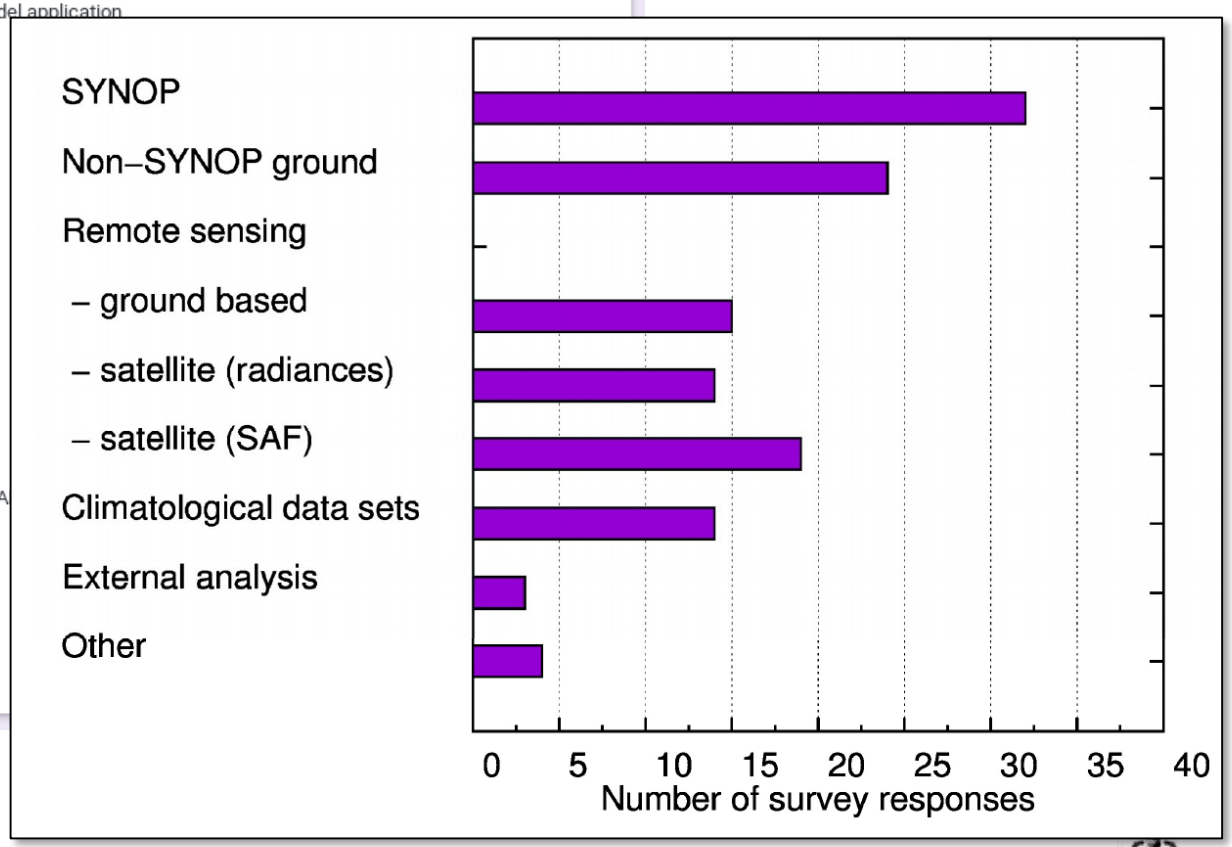
Section 22 of 38

Snow observations and products used in the modeling system

Please describe the snow data sources used for the model application

Snow observations and products

- [ ] SYNOP
- [ ] non-SYNOP ground based
- [ ] remote sensing ground based (utrasonic, laser)
- [ ] remote sensing satellite (radiances)
- [ ] remote sensing satellite (preprocessed product - SA
- [ ] Climatological data sets
- [ ] Other...



Results

Section 11 of 38

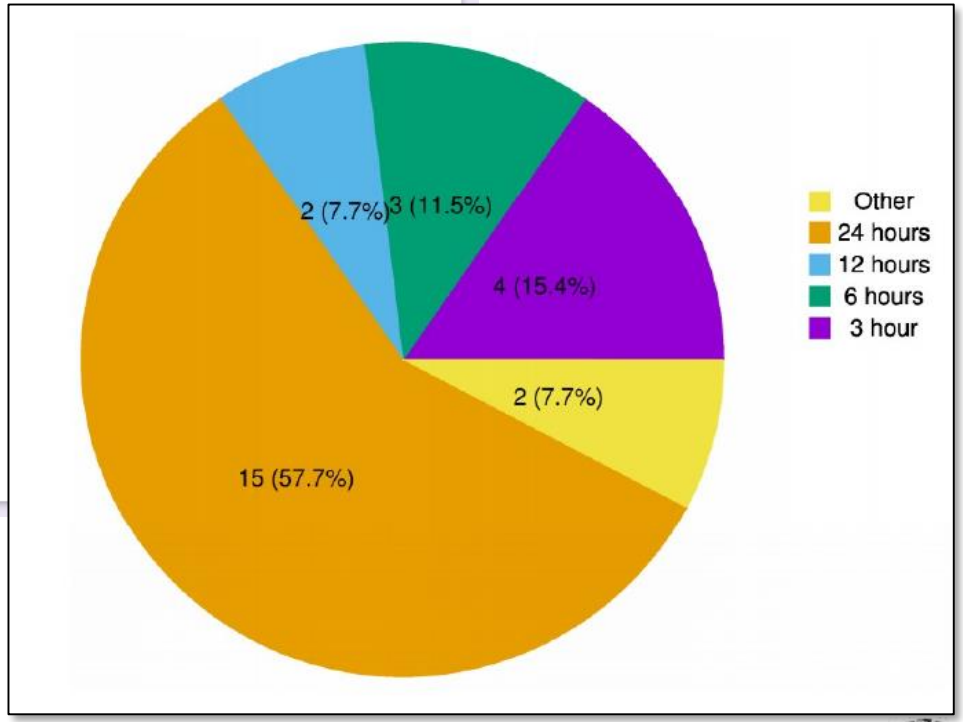
Data assimilation update frequency

Description (optional)

Which update frequency is used for your snow data assimilation? *

Example: data assimilation is running hourly or once a day

- 1 hour
- 6 hours
- 12 hours
- 1 day
- Other...



Results

Section 31 of 38

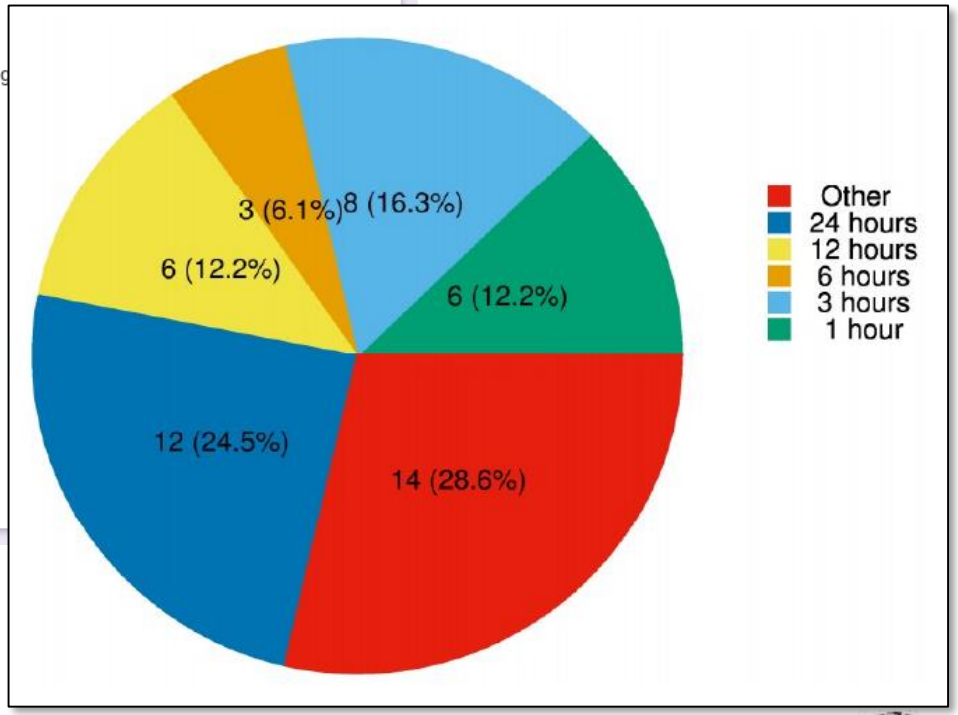
Observation data latency

Description (optional)

Which observation data latency is acceptable for your modeling environment? *

Example: The acceptable time needed from measurement, data transmission, storag
assimilation code

- Below 1 hour
- Below 3 hours
- Below 6 hours
- Below 12 hours
- Other...



Results

Section 27 of 38

Processing - Quality control

Description (optional)

Do you perform a quality control of snow observ

- Yes
- No

Section 29 of 38

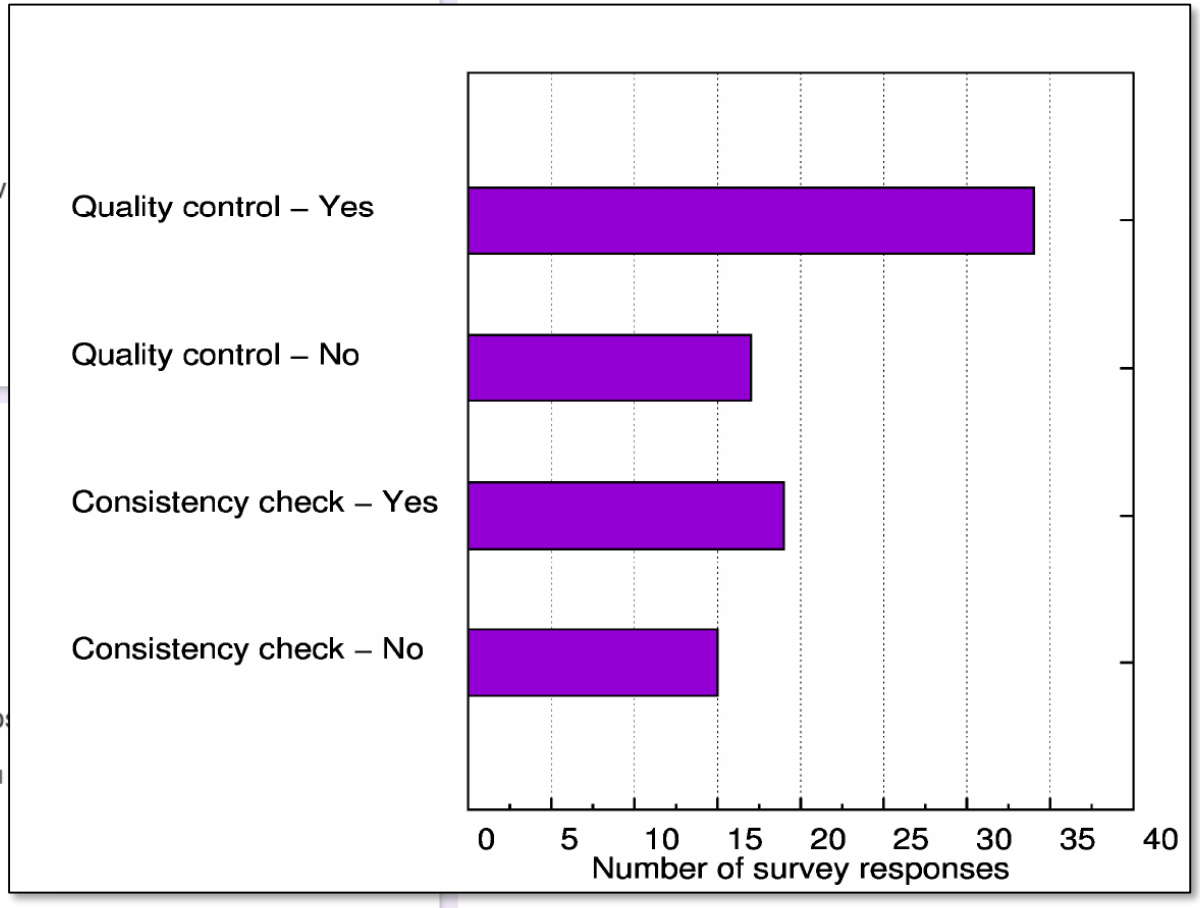
Data consistency

Description (optional)

Do you perform a consistency check of snow ob

Example: In order to find inconsistent data which passed the quality control

- Yes
- No



Conclusions

Needs a fit in terms of:

- **Resolution (time,space)**
- **Coverage (global, limited area)**
- **Data content**
- **Errors (sensor, clouds), backup?**
- **Ready to use**

What are the consequences for observation networks and modeling systems of snow data?

In-situ observations (resolution, coverage, data content, errors, ready to use)

- Sparse in some interesting regions
- Need for more observations in the GTS
- Improve SYNOP snow reporting practice (e.g., zero-snow depth)

Remote sensing: VIS/NIR (resolution, coverage, data content, errors, ready to use)

- Cloud problem – additional data needed (e.g., web cameras, drones in future?)
- Time-resolution issue for polar-orbiting systems

Remote sensing: MW (resolution, coverage, data content, errors, ready to use)

- No impact from clouds
- Low temporal but high resolution in space for active systems

Conclusions

Needs a fit in terms of:

- **Resolution (time,space)**
- **Coverage (global, limited area)**
- **Data content**
- **Errors (sensor, clouds), backup?**
- **Ready to use**

What are the consequences for observation networks and modeling systems of snow data?

Models:

- Large degree of heterogeneity : global and limited area systems, NWP, hydrology, special models
- Differences in used snow observation data (in-situ, remote sensing)
- Differences in applied DA methods
- Observation data every and within 24 hours are appreciated
- Revise assumptions about observation error for snow measurements
- Snow observation quality control and consistency checks are considered as important for DA

Lessons learned

- Future of snow DA – on long term to use radiances
- Snow-vegetation interaction is not well captured in many models
- Snow monitoring is performed at different centers (ECMWF, SMHI, DWD)
- Long way to adapt snow reporting practises and improve data exchange
- Important to have a network of scientists and cooperation with other projects
- There is a need and willingness of communities to use snow data in their models – existing cooperation with experts in WG1 and WG2 should be intensified