Working Group 3

Snow data assimilation and validation methods for NWP and hydrological models

in

COST ES1404

WG3

Models

Snow schemes

NWP

Hydrology

Climate

Observations

Assimilation

Conventional

Remote Sensing

High-res networks

WG1

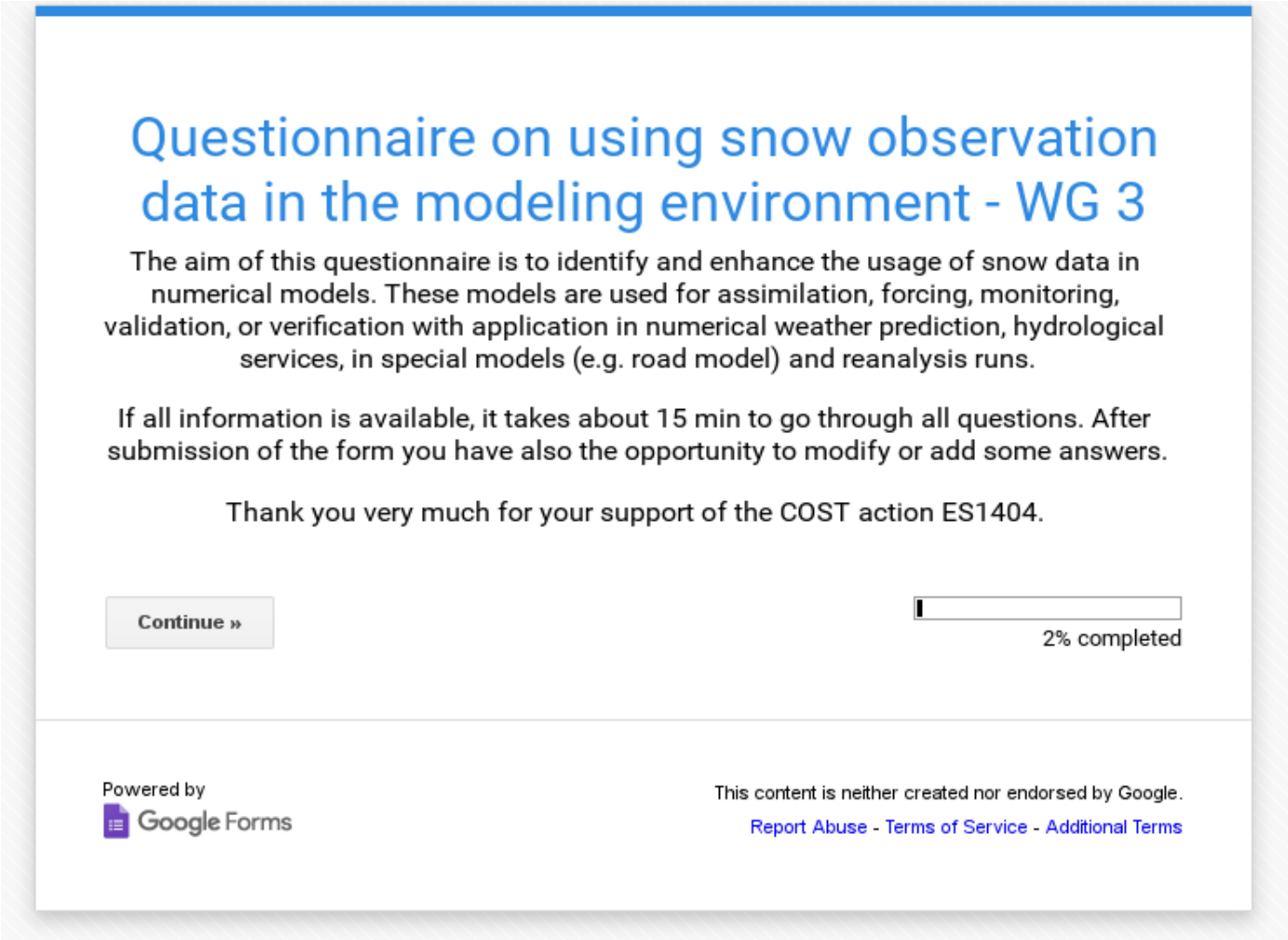
WG2

COST ES1404

Key questions from 2015:

- How many and which kind of snow observations are assimilated in numerical weather prediction and hydrological models?
- What are the data assimilation methods used in meteorology and hydrology for snow observations?

Tasks



Questionnaire on using snow observation data in the modeling environment - WG 3

The aim of this questionnaire is to identify and enhance the usage of snow data in numerical models. These models are used for assimilation, forcing, monitoring, validation, or verification with application in numerical weather prediction, hydrological services, in special models (e.g. road model) and reanalysis runs.

If all information is available, it takes about 15 min to go through all questions. After submission of the form you have also the opportunity to modify or add some answers.

Thank you very much for your support of the COST action ES1404.

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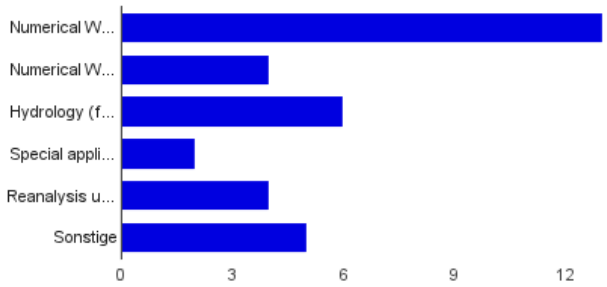
Results - 26 responses

Countries: Europe and North America

Germany
UK
France
Norway
Switzerland
Poland
UK
Austria
Turkey
Finland
Italy
Hungary
Austria
Denmark
Canada
Cyprus
SPAIN

Modeling environment

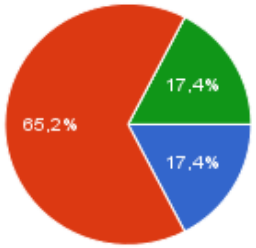
In which modeling environment you are using snow observation data?



Numerical Weather Prediction with snow data assimilation	13	54.2 %
Numerical Weather prediction without snow data assimilation	4	16.7 %
Hydrology (forcing using snow data)	6	25 %
Special application (e.g. road model with snow data)	2	8.3 %
Reanalysis using snow data	4	16.7 %
Sonstige	5	20.8 %

Modeling domain

Please specify the modeling domain used in your application.

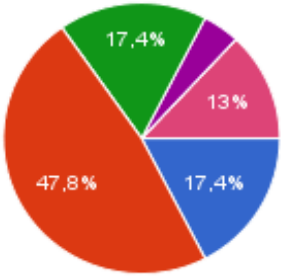


Global	4	17.4 %
Limited area	15	65.2 %
One-way/two-way nesting of domains	0	0 %
Sonstige	4	17.4 %

Results - 26 responses

Model resolution

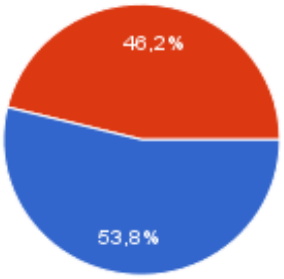
Please specify the model horizontal resolution.



Below 1 km	**4**	17.4 %
Between 1km and 5 km	**11**	47.8 %
Between 5km and 10 km	**0**	0 %
Between 10 km and 20 km	**4**	17.4 %
Between 20km and 50 km	**1**	4.3 %
Larger than 50 km	**0**	0 %
Sonstige	**3**	13 %

Data assimilation questions

I would like to answer the questions regarding data assimilation



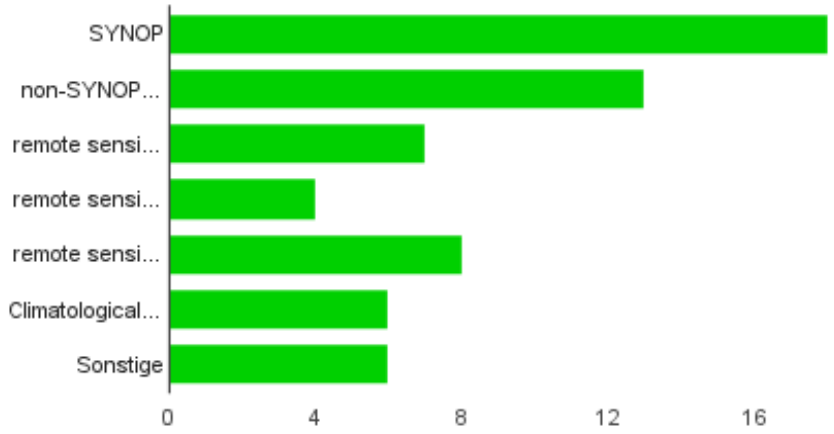
Yes	**14**	53.8 %
No	**12**	46.2 %

Results - 26 responses

Focus on answers regarding snow observations

Snow observations and products used in the modeling system

Snow observations and products

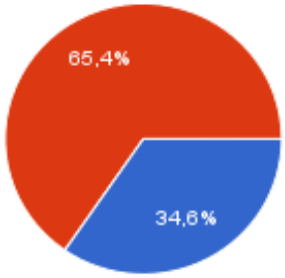


SYNOP	**18**	69.2 %
non-SYNOP ground based	**13**	50 %
remote sensing ground based (utrasonic, laser)	**7**	26.9 %
remote sensing satellite (radiances)	**4**	15.4 %
remote sensing satellite (preprocessed product - SAF)	**8**	30.8 %
Climatological data sets	**6**	23.1 %
Sonstige	**6**	23.1 %

Results - 26 responses

Remote sensing ground-based

Do you use ground-based remote sensing measurements or products



Yes	**9**	34.6 %
No	**17**	65.4 %

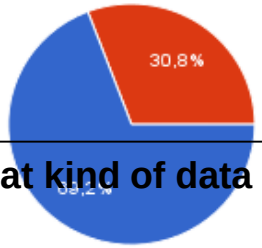
Please specify the system you use for ground-based remote sensing snow properties measurements

- Lufft (Jenoptik) distance measurement with laser. Ground network of 50+ stations across all regions and altitudes in Austria.
- ultra-sonic
- ultrasonic depth gauges microwave radiometers
- MODIS
- Campbell SR50 sensors are mounted to stations of the Swiss automatic snow monitoring network IMIS
- USH-8
- Campbell SR50 the main utrasonic snow depth sensor in use in Canada
- Jenoptik SHM 30 Snow Depth Sensor

First results - 15 responses

Processing - Quality control

Do you perform a quality control of snow observations or products



Yes	**18**	69.2 %
No	**8**	30.8 %

- **What kind of data quality control is performed?**

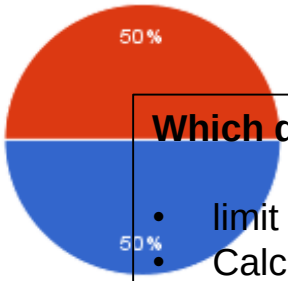
- Temperature check, redundancy (in time and space) check, first guess departure check, blacklist.
- Outlier, physical possible range
- satellite viewing angle filtering
- check against background, OI check
- Observations are compared to first guess
- Working with relatively small data volumes, so can perform quality control by visual inspection
- Manual processing
- for every single data point: plausibility checks, filling gaps or replacing unplausible data where possible + useful
- …
- includes manual screening
- Handling of missing data
- QC of surface snow depth observations for climate monitoring. Check the internal consistency of snow depth changes (change from one day to the next) against observed precip and air temperature.
- Manual comparison of recorded data with visual observations provided from web camera.

Results - 26 responses

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Data consistency

Do you perform a consistency check of snow observations or products



Yes	9	50 %
No	9	50 %

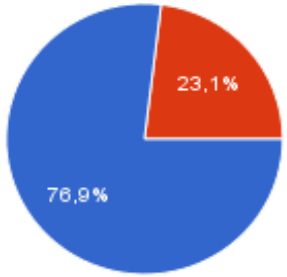
Which data consistency checks are performed in your modeling environment?

- limit snow depth depending on air temperature
- Calculation of sum of weights for snow depth (1) and snow depth increments calculated from precip and t2m (2) Use snow height only when weight from contributing obs (1) exceeds min value, use snow depth increment (2) else when average weight of (1) and (2) exceeds min value.
- snow water equivalent only greather than zero when snow depth is greather than zero.
- Analysis increments will only be added if surface T is below a threshold Snow-free state of ground reports will only be used if snow depth is absent
- consistency of accumulated snow mass and snowfall
- Manual check
- apart from the obvious checks we use statistical and visual intercomparision tools between data from similar stations, where similar = same region and same elevation
- manual checking based on observations changing in time.
- Compare regionally-average time series over regions with relativley dense surface observations.

Results - 26 responses

Access requirements

Is it possible to exchange the snow data used in your modeling environment with other groups



Yes	**20**	76.9 %
No	**6**	23.1 %

Which access requirements exist for the snow observation data sets you are using?

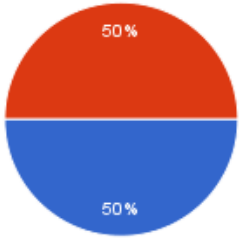
- GTS only
- FTP access, NetCDF, ASCII
- ftp from MODIS web site
- GTS only, data is already there for everyone to use.
- FTP access, GTS
- FTP access, data in GRIB2 format
- GTS, EUMETCast
- At that point, certain data is available on request. We use data from various sources / providers, so there is no simple answer to this question.
- They are provided to ECMWF.
- Mainly FTP (NSIDC)
- Web access, SFTP

Results - 26 responses

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Additional observation sources

Do you have concrete plans to use the new or upcoming observation sources that could be interesting for your modeling environment?



Yes	13	50 %
No	13	50 %

Which of the new or upcoming observation sources could be interesting for your modeling environment?

- Additional in situ data - Satellite datasets currently in development
- Sentinel products, in-situ SWE from GPS, snow liquid water and snow surface ground observations.
- Sentinel2
- SWE microwave satellite; snow cover optical and microwave satellite; (snow) albedo optical, microwave - still quite far from operational application but developed hopefully within the COST collaboration
- AMSR2, SAR
- Plan to use ground-based observations of snow depth from non-SYNOP networks (in addition to SYNOP obs), where available on the GTS. Plan to assess AMSR-2 snow depth and SWE products for potential assimilation.
- wet snow cover from SAR (sentinel-1)
- …
- Snow microstructure measures from reflectance
- Satellite datasets in development, new ground-based observation from GPS sensors, wet snow from SAR,. Etc.

Results - 26 responses

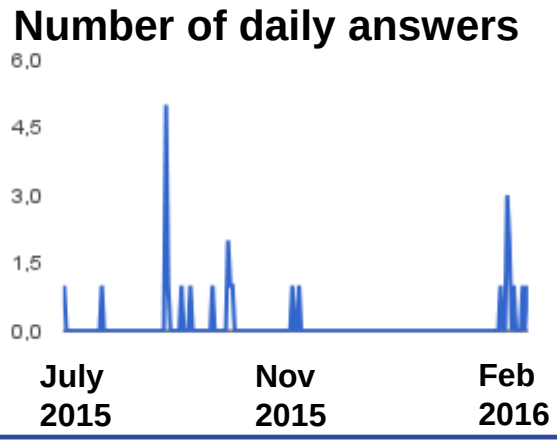
What are particular barriers, which prevent you from usage of new observation sources, if you do not use these data?

- none
- technology and accuracy for in-situ SWE observations still a big problem. time and financial ressources for snow surface temperature and snow liquid water content.
- pricing
- Lack of manpower to do the development and implementation
- time to evaluate the potential improvements and introduce the data with operational chain
- Available limited ressources for implementation into DA system, limited access to special snow measurement networks
- The quality of operationally available remote sensing data (snow water equivalent) or the data availability itself (snow depth).
- human ressources
- Non-SYNOP ground-based network snow depth observations are currently only exchanged on the GTS by a few countries. Obs need to be put on the GTS to be able to use them for data assimilation in operational NWP systems. Active reporting of snow-free conditions (zero snow depth) is infrequent, in both SYNOP and other stations. This needs to change to enable the provision of a huge amount of additional data for use in NWP systems.
- Not yet an operational product, and temporal resolution not really sufficient until there are 2 platforms in operation. Our limited area snow DA is still in development so not ready to use new obs yet anyway. Anticipate 2 year timeframe.
- ….
- Our current focus is on enhancing our models / data assimiliation methodology; not on integrating more observational data into our system.

Results - 26 responses

Please use the following text box to write down important points, which are missed in the questionnaire or which were not explicitly asked.

- Collaboration in snow DA community. What kind of new snow observation data exist - information exchange with measurement community about new snow observation data
- See http://www.cosmo-model.org/content/model/documentation/core/cosmoAssim.pdf Further questions to jean-marie.bettems@meteoswiss.ch or martin.lange@dwd.de
- Choosing suitable methodology is very much linked to the availability of data, which in the case of snow data hugely differs from country to country. This is why collaboration between partners from different countries can be difficult.
- Status on snow observations based on satellite is at present not well known to us.
- - no mechanism exists for real-time exchange of in situ SWE obs
- n/a
- None



Working group topics for 2016

Next Tasks

Meeting Notes from then Helsinki meeting

See https://agora.fmi.fi/display/HSCE1404/2015-11-03+COST+ES1404+WG3+-+Meeting+notes

Action items

- Implement technical improvements in the questionnaire
  - 20160211: solved
- Inform Snow Watch Team (Snow Watch meeting in June 2016)
  20160215: Snow Watch Team contacted (S. Pullen)
- Inform NWP consortia contact persons - **20160211: EWGLAM/SRNWP contacted**
- Use mailing list for users of hydrologic models
- First draft of questionnaire for offline snow models
- COST statement on snow observation situation in GTS
- Ask for COST contribution at ISDA2016

Next Tasks

- A critical review of *snow models* utilizing physical snow *parameters* as input and used as parametrization schemes or for downstream applications (CROCUS, Snowpack, SNTHERM) will be included.

  Preparing a questionnaire, using existing model intercomparison experience (e.g. SNOWMIP2), investigating interoperability of snow models with data assimilation, consider model sophistication.

- Establish *links* between different *communities* of users of snow observation.

  Two-way feedback between working groups, preparing a guide for end users.

Models

Snow schemes

CROCUS | TERRA | JULES | Snowpack | SNTHERM

- Treatment of snow processes (metamorphism, liquid water)
- Considered complexity (one-layer, multi-layer schemes)
- Grid-scale and subgrid-scale features (snow tiles)
- Interaction with other land-surface properties (e.g. vegetation)

Next Tasks

Key question for next phase of the project :

- How could the assimilation of snow observations be improved?

Next Tasks

- Finding a *new* method for combining *satellite* observations with *conventional* in-situ snow measurements and *modelling* results: Microwave satellite observations are combined with conventional in-situ observations in some products (Hydro-SAF), while optical satellite observations together with conventional in-situ observations are assimilated into NWP models.
  Will be considered in a later stage of the project.

- *Sustainable* principles to *combine* all types of information should be found. This will allow *advanced assimilation* of new and forthcoming satellite observations of different snow properties (snow-melt, snow extent and SWE).
  Will be considered in a later stage of the project.

- This approach will also need *new methods* to update *non-observed* simulated physical snow variables (such as snow wetness, density profiles and mechanical properties) based on the observed ones (such as snow depth and extent).
  Will be considered in a later stage of the project.

Next Tasks

- Looking for *strategies* towards a more *extended usage* of *conventional* snow observations to include observations from high-resolution *national networks* into NWP, hydrological and climate models, as the use of data from national networks is currently very limited.

  Considering a Web-Portal solution for data exchange (e.g. similar to OPERA for radar data); taking into account zero snow height information; Inform national and international institutions about COST action needs.

- Their *impact* will be assessed and *recommendations* how to increase their availability will be given.

  Will be considered in a later stage of the project.

- *Acquiring* more information about *observational errors* relevant for DA by establishing *links* between the *modelling* and *measurement* communities via *WG1* and *WG2*. These links will also provide the *users' feedback* to the measurement community by reporting about the *quality of data* and potential problems.

  Exchange of information about representativeness of data, making realistic estimation of observation errors, managing deficiencies of observations.

Next Meetings of the WG3

Two proposals:

- Already approved workshop, "Remote Sensing Products of Cryosphere using Sentinels" which will take place on April 18, 2016 in Vienna. WG3 meeting could be on April 19, 2016 in Vienna so that you can participate both and also EGU.

Vienna, April 19, 2016 http://doodle.com/poll/xqub9txgc5dvxahm

- There is also an initiative from HIRLAM countries to organize a COST Action WG3 workshop in Oslo, April 14-15 (Thursday-Friday), as a continuation of the HIRLAM land surface data assimilation Workshop (which will be held in the beginning of that week, April 11-14). Representatives from Norway, Sweden, Finland and Iceland will be there. They have a lot of snow activities, which unfortunately was not presented at the previous Harmosnow meetings. Local people in Met.no are ready to help with practical issues.

Oslo, April 14-15, 2016 http://doodle.com/poll/gknvedcum3x8fug7

Please sign in for to supporting organization of the meetings
Thank you.