

Supplementary Materials

Review of Snow Data Assimilation Methods for Hydrological, Land Surface, Meteorological and Climate Models: Results from a COST HarmoSnow Survey

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1. Questionnaire on using snow observation data in the modeling environment

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.

* required information

Multiple choice

List of possible options. Allows you to select more than one option.

2. Personal information

Name and Surname*

Position

Institute*

Country*

3. Modeling environment and snow observation data

Do you use snow observation data in your modeling environment?*

Examples: NWP, Hydrology, Snow models

- Yes
 No

4. Modeling environment and snow observation data

If possible, please give some reasons for not using snow observation data. *

Examples: not enough information in real time, density of the network

5. Modeling environment

In which modeling environment are you using snow observation data? *

- 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

6. Modeling environment

Please give a short description of your modeling environment. *

Examples: Full NWP system with data assimilation, stream flow model.

7. Modeling domain

Please specify the modeling domain used in your application. *

If you are running global and limited area/nested models with your own snow data assimilation, please fill out the form for each of the models.

- Global
 Limited area

- One-way/two-way nesting of domains
- Other

8. Model resolution

Please specify the model horizontal resolution. *

- Below 1 km
- Between 1 km and 5 km
- Between 5 km and 10 km
- Between 10 km and 20 km
- Between 20 km and 50 km
- Larger than 50 km
- Other

9. Data assimilation questions

I would like to answer the questions regarding data assimilation.*

- Yes
- No

10. Data assimilation method

Which data assimilation method is used in your system for snow observations? *

If "Other" is used, please give a short description or reference.

- Optimum interpolation
- Cressman analysis method
- Kalman Filter
- Ensemble Kalman filter
- Other

11. Data assimilation update frequency

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

12. Data assimilation window

During which time interval (window) are snow observations considered in your snow data assimilation? *

Example: Observations are collected during a prescribed time interval for consideration in the assimilation cycle.

- 1 hour

- 3 hours
- 6 hours
- 12 hours
- Other

13. SYNOP information

Which information from SYNOP is used for your snow data assimilation? *

Example: Snow height, SWE, Precipitation in combination with T2M-temperature

14. Model variables

What model state variable(s) is/are analyzed in your snow data assimilation system? *

Example: Snow depth, snow water equivalent, snow density

15. Processing

How is the key parameter/ How are the analyzed variable(s) processed in your snow data assimilation system? *

Please use "Other" to give a description if the processing differs between the horizontal and vertical directions.

- Update of absolute values
- Incremental update of first guess from model forecast
- Other

16. Background field

Which background field is used in your snow data assimilation? *

- Model forecast
- Pre-Analysis
- External analysis
- Climatology
- Other

17. Background error estimates

Which estimates of the background error are used in your snow data assimilation?

Example: distance weighted (horizontal/vertical)

18. Observation error estimates

Which estimates of observation errors are used in your snow data assimilation?

19. Observation data

I would like to answer the questions on snow observations from WG1/WG2.*

Please note: the WG1/WG2 questionnaire is focused on observations and the developing of instruments.

Yes

No

20. Observation data

Please access the questionnaire from WG1/WG2 in your own tab or window using the address: <http://costsnow.fmi.fi/index.php?page=Q1>.

The WG1/WG2 questionnaire is focused on observations and the developing of instruments.

21. Further questions on snow observation data

22. 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 (ultrasonic, laser)

remote sensing satellite (radiances)

remote sensing satellite (preprocessed product - SAF)

climatological datasets

Other

23. Remote sensing ground-based

Do you use ground-based remote sensing measurements or products*?

Example: Snow height from ultrasonic or laser scanner.

Yes

No

24. Remote sensing ground-based

Please specify the system you use for ground-based remote sensing snow property measurements.*

25. Preprocessed product

Do you use preprocessed snow products?*

Example: H-SAF or Land-SAF snow products

Yes

No

26. Preprocessed product

Please specify the system you use for preprocessed product of snow properties.*

Example: H-SAF or Land-SAF products

27. Processing—Quality control

Do you perform quality control of snow observations or products*?

Yes

No

28. Processing—Quality control

What kind of data quality control is performed? *

Please describe the quality checks applied on observation data: Handling of missing data, data management, preprocessing (which?)

29. Data consistency

Do you perform a consistency check of snow observations or products? *

Example: In order to find inconsistent data that passed quality control.

Yes

No

30. Data consistency

Which data consistency checks are performed in your modeling environment? *

Connecting data: example: snow height only when snow cover is larger than zero

31. Observation data latency

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

Example: The acceptable time needed from measurement, data transmission, storage in a database until use in a data assimilation code

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

32. Access requirements

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

- Yes
- No

33. Access requirements

Which access requirements exist for the snow observation datasets you are using? *

Examples: FTP access, GTS only, special data format

34. Additional observation sources

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

- Yes
- No

35. Additional observation sources

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

Example: Satellite datasets currently in development, new ground-based observation from GPS sensors, wet snow from SAR, etc.



36. Additional observation sources

What are the particular barriers that prevent you from using new observation sources?



37. Additional comments and suggestions



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



38. Thank you very much, once again, for your support.