Comments from Public Consultation on ECV Requirements 13/01 – 13/03 2020 for:

# Snow

## ECV Product: Snow-water equivalent

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Snow-water equivalent | | | | |
| **Definition** | It is depth of water that result from the snowpack melting in a unit of area. | | | | |
| **Unit** | mm – average over grid cell | | | | |
| **Note** |  | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km | Size of grid cell | G | 100m | In complex terrain |
| B |  |  |
| T | 1km | The resolution 1km refers to the homogeneous snow coverage in the frat field and high local variation in the mountain areas. |
| **Vertical Resolution** | N/A | N/A | G |  |  |
| B |  |  |
| T |  |  |
| **Temporal Resolution** | days | time | G |  |  |
| B |  |  |
| T | 1 | The frequency “Daily” refers to the rapid changing cycle retrieved by satellite observation.[VA1] |
| **Timeliness** |  |  | G |  |  |
| B |  |  |
| T |  |  |
| **Required Measurement Uncertainty** | mm |  | G |  |  |
| B |  |  |
| T | 10 | The required measurement uncertainty “10 mm” refers to the complexity of snow cover edge. |
| **Stability** | mm |  | G |  |  |
| B |  |  |
| T | 10 | The stability is recommended to be better than “10 mm”. |
| **Standards and References** |           Frei, A., Tedesco, M., Lee, S., Foster, J., Hall, D. K., Kelly, R. and Robinson, D. A. (2012): A review of global satellite-derived snow products, Advances in Space Research, 50, 1007–1029.            Goodison, B. and Walker, A. (1994): Canadian development and use of snow cover information from passive microwave satellite data, B. Choudhuly et al. (ed), Passive Microwave Remote Sensing of Land-Atmosphere Interaction, Utrecht: VSP BV, 245-262.            Robinson, D.A. (2013): Climate Data Record Program (CDRP): Climate Algorithm Theoretical Basis Document (C-ATBD) Northern Hemisphere Snow Cover Extent, CDRPATBD-0156. Asheville, North Carolina, USA 28 pp.            Sturm, M., Taras, B., Liston, G. E., Derksen, C., Jonas, T. and Lea, J. (2010): Estimating Snow Water Equivalent Using Snow Depth Data and Climate Classes. Jour. Hydromet. 11, 1380-1394. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest values for this field | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest values for this field | | |

[1]Goal (G); Breakthrough (B)(not mandatory, more as one possible); Threshold (T), for definitions see [Guidelines](http://tiny.cc/ecv-review)

[2] Is the ECV Product directly relevant to support Climate Adaptation?

[3] Can the ECV Product be used to monitor climate extremes or aspects of extremes?

 [VA1]Should be instrument independent. These are user requirements.

### Comment 1

|  |  |
| --- | --- |
| Author: ECMWF | Email: ecresgcosreqs@gmail.com |
| - Horizontal resolution for NWP and reanalysis: T (25km), B (5km), G (1km)  - Temporal resolution for NWP and reanalysis: T (2 days), B (24h), G (6hours)  - Timeliness should be updated to: T (10 days), B (1 day), G (3 hours).  - Adaptation: Yes and yes, snow varies in time and space and climate adaptation measures this into account  - Extremes: Yes and yes | |

### Comment 2

|  |  |
| --- | --- |
| Author: MRI Scnatweb | Email: mountainresearchinitiative@gmail.com |
| In mountains SWE is considered important for instance for processes such as snow melt and runoff. Daily to sub-daily measurements are needed for spatial resolution of < 500m for runoff and snow melt.  Based on discussions and preliminary outcomes of the GEO GNOME workshop for identifying ECVs to monitor and understand mountain climate change. More information on the workshop here: LINK. | |

### Comment 3

|  |  |
| --- | --- |
| Author: Andrew Ferrone | Email: pr.wmo.luxembourg@gmail.com |
| Luxembourg considers that Snow water equivalent is also relevant as adaptation indicator because the variation concerning snow can influence several areas such as for example water supply of rivers: drinking water, fluvial transport, flood events ... In addition, this can affect mountain tourism and an entire sector will be forced to adapt to these modifications. | |

### Comment 4

|  |  |
| --- | --- |
| Author: Fierz Charles | Email: fierz@slf.ch |
| I would suggest to change name, definition, and unit to the following:  Name: Water equivalent of snow cover Note: Indeed, some people start using SWE as the water equivalent of distinct layers of the snowpack. This change makes clear that the whole snow cover is concerned  Definition: The Vertical depth of the water that would be obtained if the snow cover melted completely, which equates to the snow-cover mass per unit area.  Unit: kg m-2 (mm w.e. is complementary but not the proper SI unit) Note: adapt unit for Required Measurement Uncertainty and Stability accordingly  Required Measurement Uncertainty: I kind of doubt uncertainty only depends on "snow cover edge". The threshold value of 10 kg m-2 looks rather like the Goal to attain. | |

### Comment 5

|  |  |
| --- | --- |
| Author: Chris Derksen, Env. Canada | Email: pr.wmo.luxembourg@gmail.com |
| Horizontal Resolution: While 100 m/1 km may be a requirement for specific regions/watersheds, a distinction needs to be made for hemispheric gridded SWE products. In the case of climate analysis, I agree with the input from ECMWF: T (25km), B (5km), G (1km).  Temporal Resolution (for climate studies): 1 day is sufficient (already met).  Accuracy: 10 mm accuracy is not at all realistic or achievable, particularly at the scales of products used for climate analysis. Current products struggle to reach 50 mm accuracy, so even getting to 40 would be quite a breakthrough. So I suggest: T (50 mm), B (40 mm), G (30 mm), which equates approximately to 40%, 30%, and 20%. A distinction probably needs to be made for deep mountain snow, perhaps expressed only as percentages: T (40%), B (30%), G (20%).  Adaptation: Yes and yes  Extremes: Yes and yes  . | |

### Comment 6

|  |  |
| --- | --- |
| Author: Thomas Nagler | Email: tommynagler@gmail.com |
| Snow Cover Area:  Parameter from Satellite data is Fractional Snow Cover, which gives the fraction (or per cent) of one pixel covered by snow. Two Parameters Needs to be discriminated:  (i) the snow cover at the surface in open areas and on top of vegetation cover that is present, such as forest canopies (called ‘viewable snow’) and  (ii) snow extent on ground for open land (same as ‘viewable snow’) and corrected for masking by trees in forested areas (called ‘snow on ground’).  Horizontal Resolution:  (G) 100 m needed for complex terrain, e.g. mountains; Goal for global products  (T) 1 km, for global products  Temporal Resolution:  (T) Daily, with full global coverage and complex terrain  TimelineNess:  (G) 6 hours,  for meteo and hydro services  (T) 24 hours  for general applications  Uncertainty:  (G) < 10% RMSE  in estimation of fractional snow extent  (T) < 20 % RMSE in estimation of fractional snow extent  Total snow area calculation (T) < 5%   - total snow cover estimation  Adaptation:  Yes   Yes  Extremes:    Yes   Yes  . | |

## ECV Product: Snow Depth

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Snow Depth | | | | |
| **Definition** | Snow depth is the perpendicular distance between snowpack surface and the underlying ground. | | | | |
| **Unit** | mm – average over a grid cell | | | | |
| **Note** | Snow-water equivalent is the water amount of snow loading on the ground in mm (or inch). Usually, snow-water equivalent is observed by measuring snow weight, and melting snow by meteorological station, field campaign. This can be estimated by the statistic snow density data (Sturm et al., 2010). The passive microwave radiometer has been estimated snow-water equivalent, however, there are still corrections required to retrieve regional and temporal variations(Goodison and Walker, 1994; Frei et al., 2012). | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km | Size of grid cell | G | 100m | In complex terrain |
| B |  |  |
| T | 1km | The resolution 1km refers to the homogeneous snow coverage in the frat field and high local variation in the mountain areas. |
| **Vertical Resolution** | mm | Depth of snow - the perpendicular distance between snowpack surface and the underlying ground | G |  | Reviewers are invited to suggest values for this field |
| B |  |  |
| T |  | Reviewers are invited to suggest values for this field |
| **Temporal Resolution** | days | time | G |  | Reviewers are invited to suggest values for this field |
| B |  |  |
| T | 1 | The frequency “Daily” refers to the rapid changing cycle retrieved by satellite observation.[VA1] |
| **Timeliness** |  |  | G |  | Reviewers are invited to suggest values for this field |
| B |  |  |
| T |  | Reviewers are invited to suggest values for this field |
| **Required Measurement Uncertainty** | mm | 2 Standard Deviations | G |  | Reviewers are invited to suggest values for this field |
| B |  |  |
| T | 10 | The required measurement uncertainty “10 mm” refers to the complexity of snow cover edge. |
| **Stability** | mm |  | G |  | Reviewers are invited to suggest values for this field |
| B |  |  |
| T | 10 | The stability is recommended to be better than “10 mm”. |
| **Standards and References** |           Frei, A., Tedesco, M., Lee, S., Foster, J., Hall, D. K., Kelly, R. and Robinson, D. A. (2012): A review of global satellite-derived snow products, Advances in Space Research, 50, 1007–1029.            Goodison, B. and Walker, A. (1994): Canadian development and use of snow cover information from passive microwave satellite data, B. Choudhuly et al. (ed), Passive Microwave Remote Sensing of Land-Atmosphere Interaction, Utrecht: VSP BV, 245-262.            Robinson, D.A. (2013): Climate Data Record Program (CDRP): Climate Algorithm Theoretical Basis Document (C-ATBD) Northern Hemisphere Snow Cover Extent, CDRPATBD-0156. Asheville, North Carolina, USA 28 pp.            Sturm, M., Taras, B., Liston, G. E., Derksen, C., Jonas, T. and Lea, J. (2010): Estimating Snow Water Equivalent Using Snow Depth Data and Climate Classes. Jour. Hydromet. 11, 1380-1394. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest values for this field | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest values for this field | | |

[1]Goal (G); Breakthrough (B)(not mandatory, more as one possible); Threshold (T), for definitions see [Guidelines](http://tiny.cc/ecv-review)

[2] Is the ECV Product directly relevant to support Climate Adaptation?

[3] Can the ECV Product be used to monitor climate extremes or aspects of extremes?

### Comment 1

|  |  |
| --- | --- |
| Author: ECMWF | Email: ecresgcosreqs@gmail.com |
| Same comments as for SWE | |

### Comment 2

|  |  |
| --- | --- |
| Author: Andrew Ferrone | Email: pr.wmo.luxembourg@gmail.com |
| Luxembourg considers that Snow depth is also relevant as adaptation indicator because the variation concerning snow can influence several areas such as for example water supply of rivers: drinking water, fluvial transport, flood events ... In addition, this can affect mountain tourism and an entire sector will be forced to adapt to these modifications. | |

### Comment 3

|  |  |
| --- | --- |
| Author: Fierz Charles | Email: fierz@slf.ch |
| Note that quite a lot of text belong to water equivalent of snow cover and not snow depth!  I'd suggest to change the definition and unit to:  Definition: Vertical distance from the snow surface to a stated reference level.  *Notes: 1) snow depth is measured on sea ice, on ice sheets, on ice shelves, on glaciers, etc.where the notion of ground cannot be applied.            2) measurements taken perpendicularly refer to snow thickness (see International Classification of Seasonal Snow on the Ground, IACS/UNESCO, 2009)*  Unit: why not stick to the SI base units, that is m in that case  Uncertainty: Threshold should be 10-2 m  Snow depth is certainly relevant to both adaptation and extremes | |

## ECV Product: Area Covered by Snow

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Area Covered by Snow | | | | |
| **Definition** | Snow cover refers to the area of land covered by snow at a given time | | | | |
| **Unit** | m2 – average over a grid cell | | | | |
| **Note** | Area covered by snow is observed in-situ and satellite observation (Robinson, 2013; Frei et al., 2012). The visible satellite identifies the snow cover with few millimeter of snow depth. The microwave radiometer can detect at first from few centimeter of snow depth. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | m | Size of grid cell | G | 100m | In complex terrain |
| B |  |  |
| T | 1000m | The resolution 1km refers to the homogeneous snow coverage in the frat field and high local variation in the mountain areas. |
| **Vertical Resolution** |  |  | G |  |  |
| B |  |  |
| T |  |  |
| **Temporal Resolution** | days | Frequency of measurement | G | Missing |  |
| B |  |  |
| T | 1 | The frequency “Daily” refers to the rapid changing cycle retrieved by satellite observation.[VA1] |
| **Timeliness** |  |  | G |  |  |
| B |  |  |
| T |  |  |
| **Required Measurement Uncertainty** | % | 2 Standard Deviations | G | Missing |  |
| B |  |  |
| T | 5 %, local accuracy for 1/3 of 100m and 1km | The required measurement uncertainty “5 %, local accuracy for 1/3 of 100m and 1km” refers to the complexity of snow cover edge. |
| **Stability** |  |  | G | Missing |  |
| B |  |  |
| T | 4% |  |
| **Standards and References** |           Frei, A., Tedesco, M., Lee, S., Foster, J., Hall, D. K., Kelly, R. and Robinson, D. A. (2012): A review of global satellite-derived snow products, Advances in Space Research, 50, 1007–1029.            Goodison, B. and Walker, A. (1994): Canadian development and use of snow cover information from passive microwave satellite data, B. Choudhuly et al. (ed), Passive Microwave Remote Sensing of Land-Atmosphere Interaction, Utrecht: VSP BV, 245-262.            Robinson, D.A. (2013): Climate Data Record Program (CDRP): Climate Algorithm Theoretical Basis Document (C-ATBD) Northern Hemisphere Snow Cover Extent, CDRPATBD-0156. Asheville, North Carolina, USA 28 pp.            Sturm, M., Taras, B., Liston, G. E., Derksen, C., Jonas, T. and Lea, J. (2010): Estimating Snow Water Equivalent Using Snow Depth Data and Climate Classes. Jour. Hydromet. 11, 1380-1394. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  |  | | |
| **Extremes[3]** |  |  |  | | |

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[3] Can the ECV Product be used to monitor climate extremes or aspects of extremes?

 [VA1]Should be instrument independent. These are user requirements.

### Comment 1

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| --- | --- |
| Author: ECMWF | Email: ecresgcosreqs@gmail.com |
| Same comments as for SWE. | |

### Comment 2

|  |  |
| --- | --- |
| Author: MRI Scnatweb | Email: mountainresearchinitiative@gmail.com |
| In mountains snow melt is considered important for monitoring and understanding processes in hydrosphere, cryosphere and biosphere. Daily measurements are needed for spatial resolution of < 500m for glacial retreat but resolution of <100m would be needed to pair with ecological changes such as shifts in treeline.  Based on discussions and preliminary outcomes of the GEO GNOME workshop for identifying ECVs to monitor and understand mountain climate change. More information on the workshop here: LINK. | |

### Comment 3

|  |  |
| --- | --- |
| Author: Andrew Ferrone | Email: pr.wmo.luxembourg@gmail.com |
| Luxembourg considers that Area covered by snow is also relevant as adaptation indicator because the variation concerning snow can influence several areas such as for example water supply of rivers: drinking water, fluvial transport, flood events ... In addition, this can affect mountain tourism and an entire sector will be forced to adapt to these modifications. | |

### Comment 4

|  |  |
| --- | --- |
| Author: Fierz Charles | Email: fierz@slf.ch |
| I am much more familiar with the concept of 'snow cover extent', that is, the area of snow-covered ground, ice, or firn based on a fractional threshold per pixel (for example 50%). Also remember snow does not only cover land.  This 'product' is certainly relevant to adaptation and extremes. | |

### Comment 5

|  |  |
| --- | --- |
| Author: Tommy Nagler | Email: tommynagler@gmail.com |
| Snow Cover Area:  Parameter from Satellite data is Fractional Snow Cover, which gives the fraction (or per cent) of one pixel covered by snow. Two Parameters Needs to be discriminated:  (i) the snow cover at the surface in open areas and on top of vegetation cover that is present, such as forest canopies (called ‘viewable snow’) and  (ii) snow extent on ground for open land (same as ‘viewable snow’) and corrected for masking by trees in forested areas (called ‘snow on ground’).  Horizontal Resolution:  (G) 100 m needed for complex terrain, e.g. mountains; Goal for global products  (T) 1 km, for global products  Temporal Resolution:  (T) Daily, with full global coverage and complex terrain  TimelineNess:  (G) 6 hours,  for meteo and hydro services  (T) 24 hours  for general applications  Uncertainty:  (G) < 10% RMSE  in estimation of fractional snow extent  (T) < 20 % RMSE in estimation of fractional snow extent  Total snow area calculation (T) < 5%   - total snow cover estimation  Adaptation:  Yes   Yes  Extermes:    Yes   Yes | |