SNOWBALL

Newsletter

Dear readers,

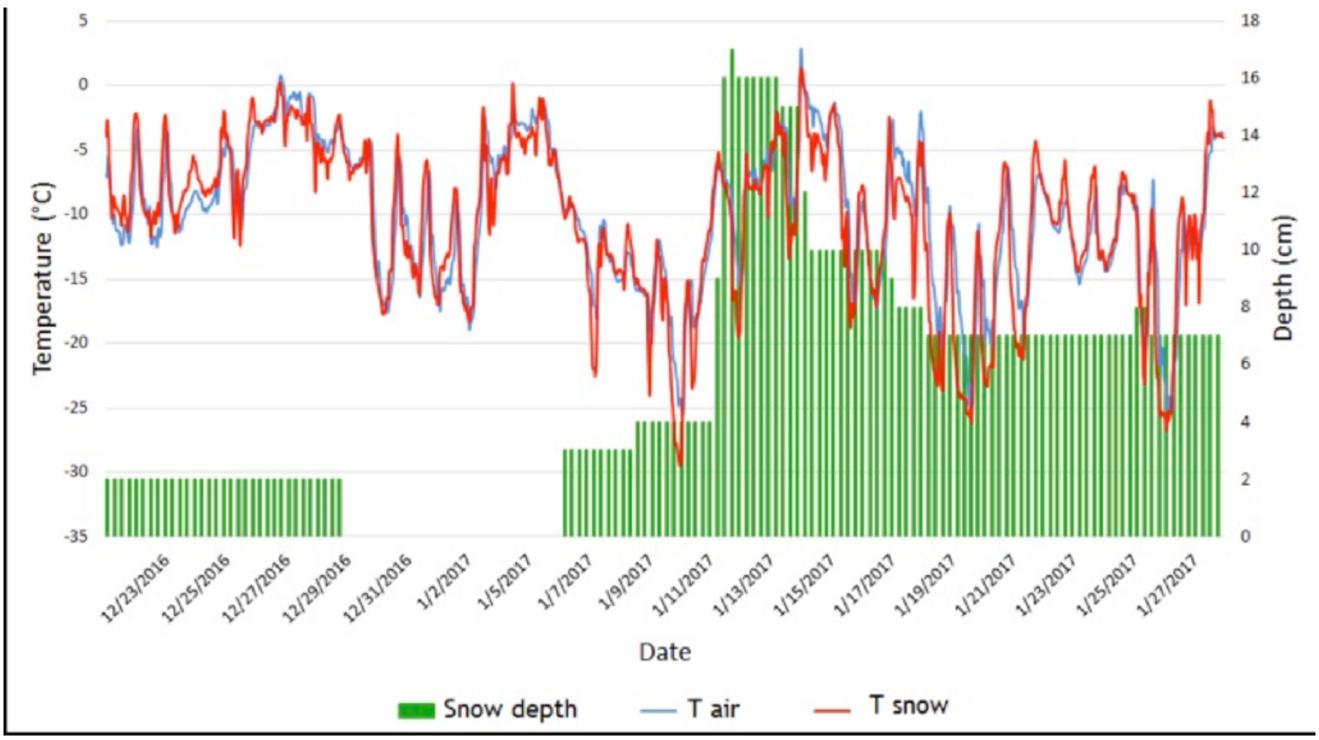
The Snowball team presents the third newsletter dedicated to disseminating the results achieved in the project. The Snowball (Remote sensing, model and in-situ data fusion for snowpack parameters and related hazards in a climate change perspective) is a scientific research project won by the National Meteorological Administration in partnership with the Norwegian Computing Center, Technical University of Civil Engineering of Bucharest, National Institute of Hydrology and Water Management and the West University of Timisoara. The project is funded under the EEA Financial Mechanism 2009 – 2014. The main goal of the project is to develop a new service to provide to national authorities and to general public, consistent information, in quasi real time to monitor the spatiotemporal characteristics of snow cover and the associated hazards (floods caused by the sudden melting snow and avalanches), in the context of present and future climate conditions, based on in-situ and provided by satellites data.

In-situ snow parameters measurement

During February 2017, the air temperature probes have been re-deployed at the Sinaia and Babele test zones on an altitude gradient slope every 100 meters, from Sinaia 2000 to Valea Dorului and from Babele to Pestera.

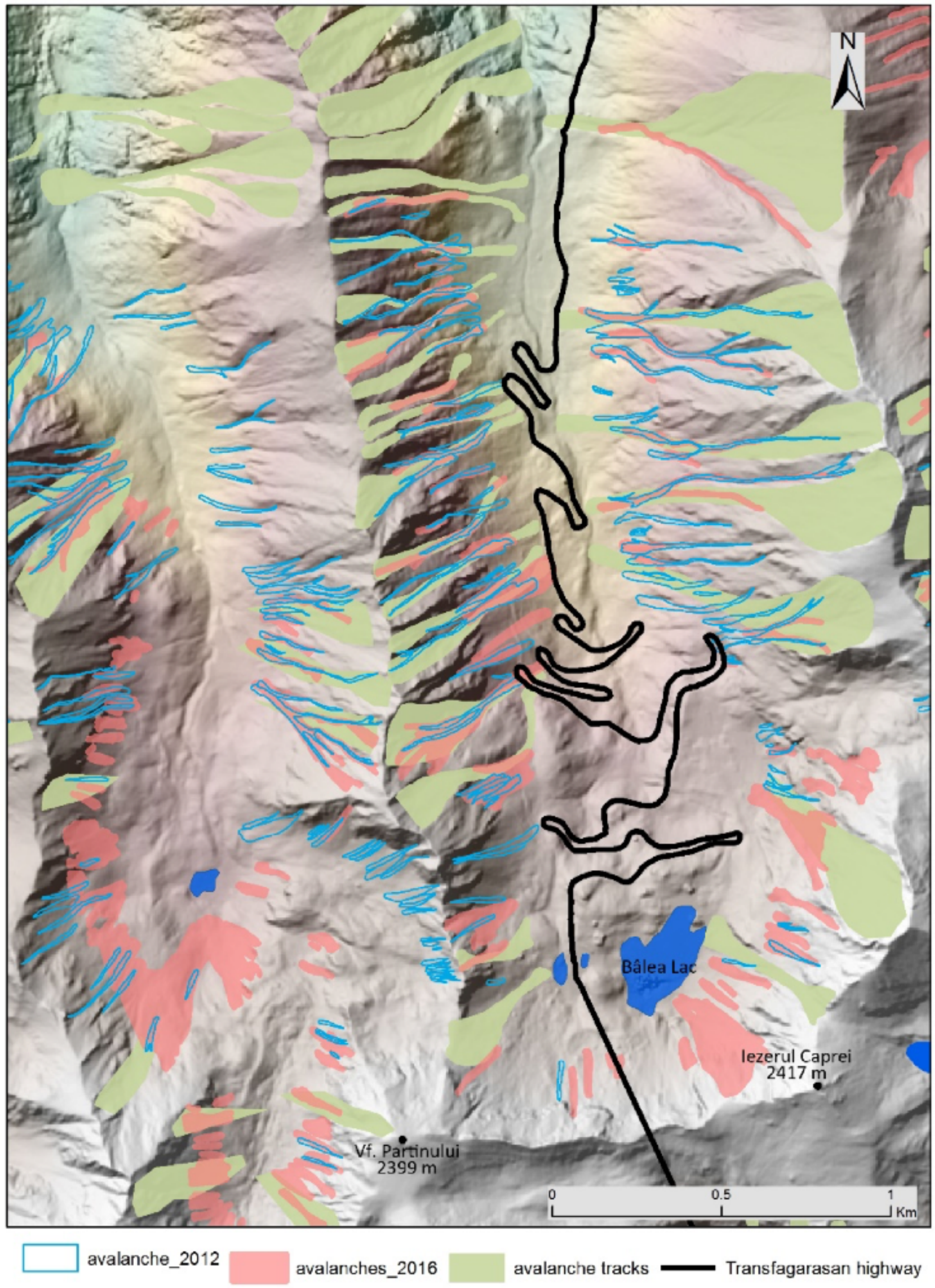
The air temperature probes are providing hourly measurements, which are stored in the device memory for further retrieval. Data have been uploaded at the end of the winter season after the probes were collected in April, and have been used to help identify the snow melt episodes, contributing to the validation of optical and microwave satellite derived snow products.

In 2017, 7 snow stations and 4 cal/val stations collected and uploaded snow parameters to the SnowBall server . Maintenance and software updates have been carried out at all stations while faulty modules/probes have been replaced at the Vf.Omu, Predeal, Sinaia 1500, Joseni si Tg.Secuiesc snow/cal-val stations.



During February-April 2016, Meteo Romania carried out in-situ snow data collection campaigns at the test zones Sinaia 2000 – Valea Dorului and Babele – Pestera. The measurements have been collocated with the optical and microwave satellite overpasses and served in the validation of the satellite derived snow moisture products. Snow data collected includes snow surface temperature, snow moisture, snow depth and density, snow and air temperature and snow spectra.

Avalanche inventory and automated detection of avalanche deposits



A detailed avalanche inventory based on GeoEye-1 satellite image aquired in April 2012 and drone based images from 2016 was developed for the central part of Făgăraș Mts. Several other documented events that caused damages to roads and forest in the teste area in 2005, 2009, 2013, 2015 were also included in the database. The database includes information related to terrain parameters (mean slope, plan curvature, profile curvature, mean altitude, altitude range) related to the avalanches runout zone and release areas.

Avalanche detection was manually performed in this step, using various band combinations, principal component analysis and normalized differentiation indices for a better visual analysis and delineation of avalanches. A total of 1069 avalanches were detected on the satellite image and 374 avalanches on the drone – based image. Most avalanches are of small or medium size, less than 1000 m long. The results showed that in the Romanian Carpathians the avalanches are much more numerous and their activity is much more intense than previously thought. They are the main natural hazard for the Carpathians in winter.

This knowledge has been incorporated into alghorithms for automated detection of avalanches based on VHR optical using a two-stage classification approach. The algorithm is based on texture classification of the image, where avalanche texture has been enhanced using filters learned unsupervisely from the image data. The avalanche detection algorithm consists of two stages: a superpixel based texture classification stage that is based on the learned feature representation approach and a random forest classifier, and Stage-2:, a post-classification step that also consists of a random forest classifier, but uses the probability output of Stage-1, the panchromatic values and the NDI-values as features.

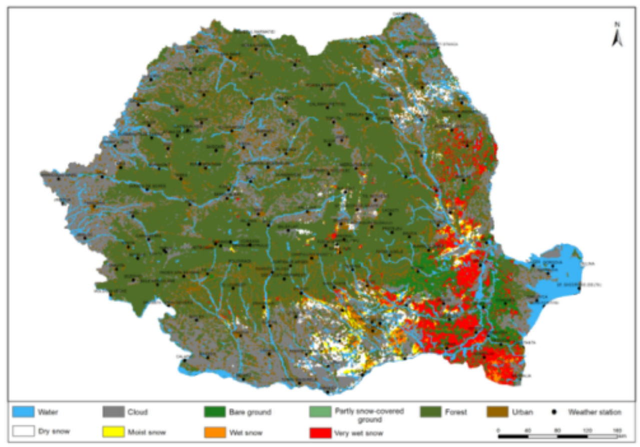
The detected avalanche segments (red areas) correspond to a large degree with the manually delineated areas (blue lines), as seen in example for Făgăraș Mountains. However, some avalanches are missed by the detection algorithm to due to less texture contrast and some false detections are caused by rugged snow wind-patterns.

Developement of the estimation of snow cober parameters algorithms from satellite data

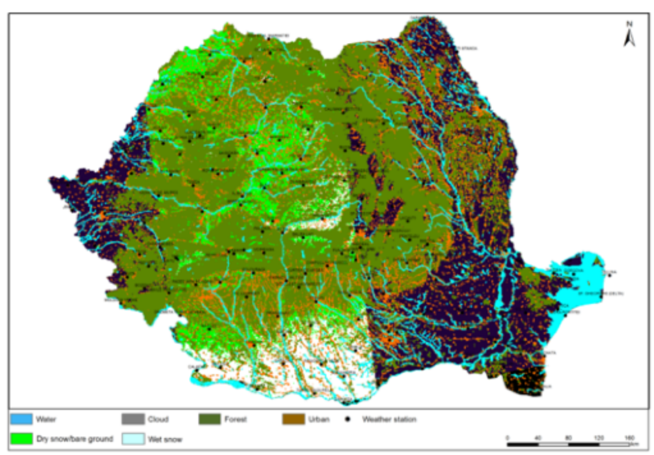
Methods and algorithms have been developed in order to achieve the snow parameters from satellite data for optical and radar spectral domain and for each specific parameter.

The Multi-sensor/multi-temporal Wet Snow (MWS) algorithm is novelty of this project, and fuses optical and SAR data to map the wet-snow area. The idea was to combine multi-temporal observations of optical and SAR wet snow in a fusion model to generate improved coverage in space and time. The developed algorithm fuses the optical and SAR observations using a Hidden Markov Model (HMM) approach. The snow map includes four thematic snow classes, based on the international standard classes (dry snow, moist snow, wet snow and very wet snow) obtained from Sentinel-1 (radar) and Sentinel-3 (optical) satellite data.

The results obtained for both study areas from Norway and those from Romania were validated using data recorded by sensors placed at meteorological and hydrometrical stations or measurements collected within field campaigns.

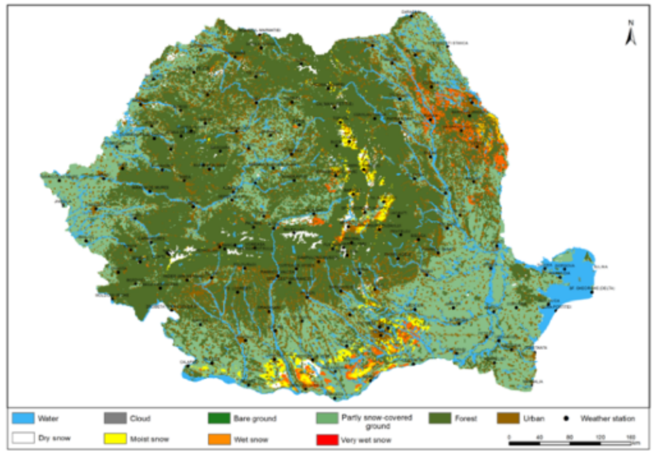


OWS snow wetness map based on Sentinel-3 for 4th February 2017



SAR snow wetness map for 5th of February 2017

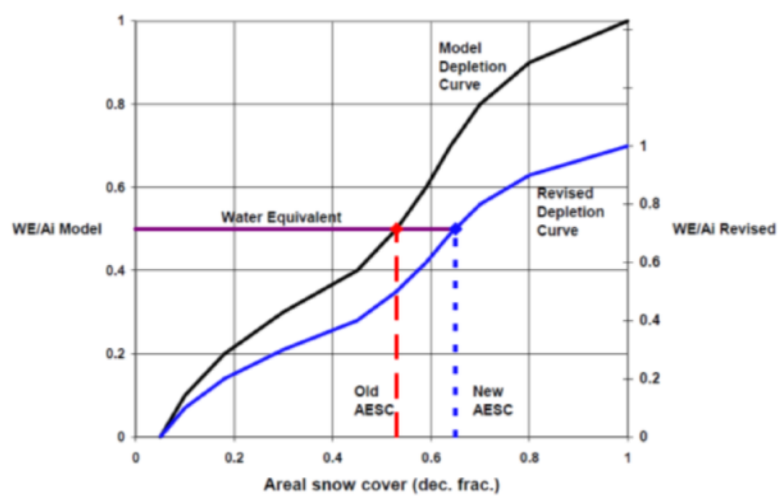
The validation results are very promising and the quality and temporal resolution of the products increased from 2015 with the launch of European satellites Sentinel-1B and Sentinel-3A.



MWS snow wetness map for 22nd of February 2017

Assimilation of snowpack parameters in the National Flood Forecasting and Warning System

One of the main application of the improved detailed estimations of the snow water equivalent, is to update this important state parameter in the operational hydrological forecasting models.



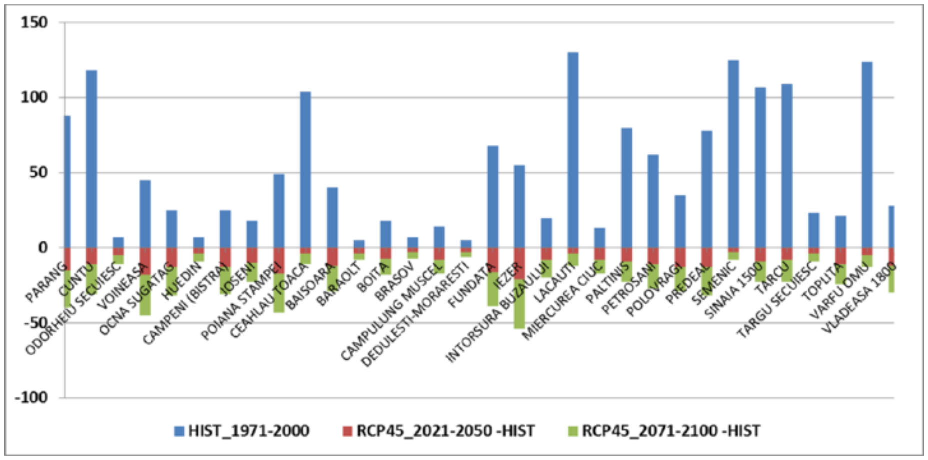
The Romanian National Hydrological Forecasting and Modelling System is composed by specialized hydrological modelling modules, adequate for the real-time simulation and forecasting of hydrological processes at different spatial and temporal scales: National Weather Service River Forecasting System – USA (NWSRFS) conceptual lumped models, NOAH-R distributed modelling component, and the Flash-Flood Guidance component.

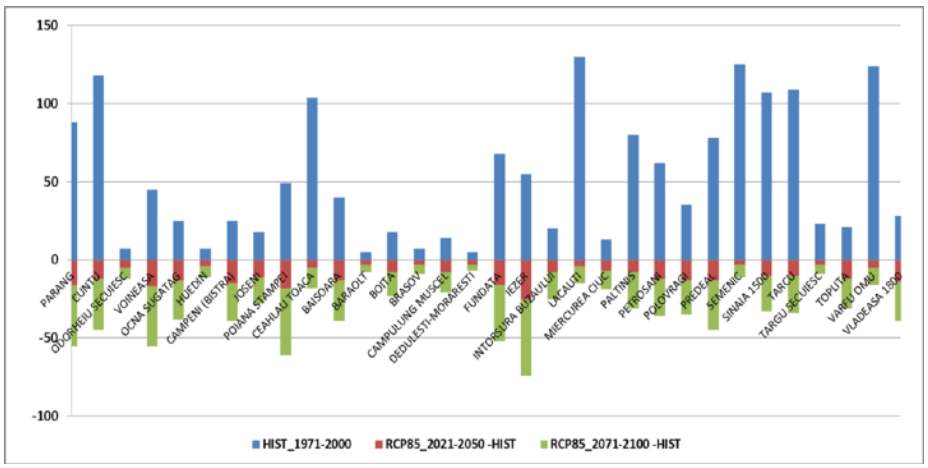
Taking into account that the gridded SWE product generated using the data fusion approach represent the best estimate of this parameter, using detailed model simulation, satellite products and ground observation, the direct insertion method is used as data assimilation approach.

The specific data assimilation processing steps have been implemented using the open-source software components, and starting with the next winter season the data assimilation will be applied in operational mode, using the output from the data fusion methodology.

Snow-related impact of climate change in Romanian Carpathians

The reduction in snow amounts has an impact on many socio-economic activities. For instance, the number of days with good ski conditions in a season is decreasing in the Carpathians under climate change.

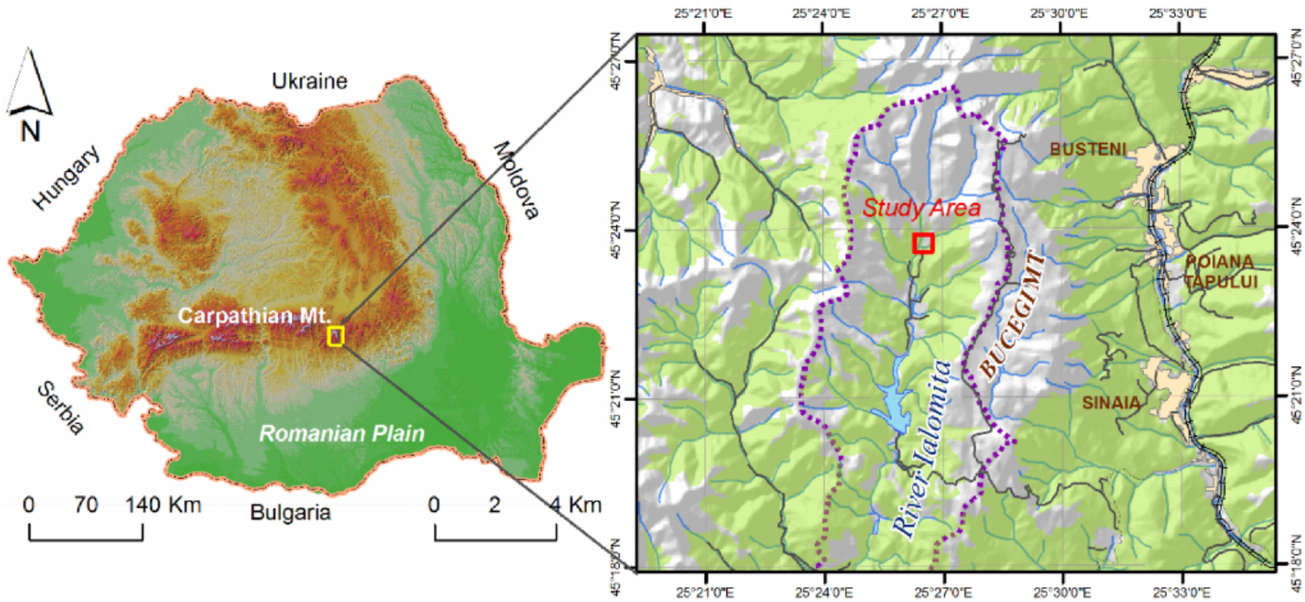




Mean number of days in a ski season with snow depth larger than 30 cm at 32 Romanian stations (blue) in the Romanian Carpathians and changes under RCP 4.5 (top) and RCP 8.5 (down) scenario for periods 2021-2050 (red) and 2071-2100 (green) based on bias corrected output of 5 RCM models.

Evaluation of snowmelt water infiltration in unsaturated zone for aquifers recharge

There are many models that attempt to predict snowmelt infiltration to soil water and groundwater. In order to estimate groundwater recharge in areas with seasonal snow cover, any model involves first a snowmelt algorithm to simulate the water balance into the snowpack followed by an estimation of infiltration in the unsaturated zone and of the surface runoff.



The challenge is to select the right model depending on available data. A group of model configurations that give consistently good results was develop for Padina area. In order to predict the snowmelt infiltration during spring thaw we investigate the contribution of snowmelt due to temperature increase, analyze soil freezing and thawing behaviour and influences of these factors to the seasonal water balance.

By applying modESC algorithm, using meteorological data, the following parameters have been computed: the shortwave radiation flux, the long wave radiation, sensible and latent flux, and also melt rates for a 48-hour period. As no precipitation has been registered, the advective flux was neglected.