Project information

Keywords
Growing season, soil frost/thawing, remote sensing, Big-data
Project title
SenSyF
Year
2015
Project leader
Eirik Malnes
Participants

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Flagship
Terrestrial
Funding Source

- **Terrestrial flaggship, WP 2 "Effects of Changing Seasonality Patterns and Extreme Events".**

Summary of Results

The Fram centre project SenSyF was initiated to exploit the developments made in the EU project SenSyF.. The satellites deliver frequent high resolution SAR and optical data worldwide, and Norut is responsible for two innovative EO based services for soil-frost monitoring and growing season monitoring. The Fram centre project has focused on validating the services developed by comparing results to in situ data sets and auxiliary remote sensing datasets. We have also focused on involving other Fram centre partners (NINA and UiT). The results are currently being published in internasjonal peer-reviewed journals.

The Fram centre project had two workpackages:

WP1. Service 2 **- Landsat 8 data have been used to simulate Sentinel-2 data. Adventdalen valley and the surroundings have been the main target area. For the 15 May to 15 September period in 2014 we downloaded and used 85 images, however only 17 of these had larger cloud-free areas, hence an average on 7 days interval were achieved in 2014. In 2015, 74 images were processed and 23 of these had some cloud-free areas. All the images from 2014 and 2015 were then converted to top of atmosphere (TOA) reflectance and TOA brightness temperatures. We also detected and applied eight pseudo-invariant areas, and used it to calibrate the images of different hours of the day. For the images in 2014 the clouds cover average was 53% according to the Landsat ACCA algorithms, however, these algorithms do not works well for cloud detections on the archipelago and the average cloud cover is much higher. Hence, the quality assessment (QA) information in Landsat 8 data is only useful for some noise detection on Svalbard. Therefore a main work was to develop our own algorithms for cloud detection by different combinations of OLI and TIRS bands. Altogether 9 different cloud detection algorithms were developed for detection of different types of clouds/noise and shadows from the clouds. A master thesis with focus of cloud-detection algorithms is under development (Stendardi in prep.). With the cloud-free dataset we then interpolated for the noisy (cloudy) areas based on weighted mean values from the cloud free periods before and after. The dataset were then interpolated to daily data and double-logistic smoothing algorithms on the NDVI values were done. With the processed cloud-free time-series of daily Landsat 8 data we applied a pixel specific threshold to map the onset of the growing season.**

WP2. Service 3**. In this WP we have developed the soil frost/thaw product. We have studied Sentinel-1 data for the sites Nordnesfjellet, Troms and Kapp Linne, Svalbard for the period Oct 2015- Oct 2016. We find a consistent time dependency between radar backscatter and soil frost/thawing/snow melting which is consistent with electromagnetic models for propagation of EM-waves in soil and snow. The product has been tested and validated. Since Sentinel-1 data only have been available in one year, there is still room for improvements.**

In situ data. **For both services there has been an emphasis throughout the project to collect valuable ground**

and field data. In WP2 (service 3) we have used the already existing sampling stations for ground temperature, soil moisture and snow depth established at Nordnesfjellet (Lyngen), and Kapp Linne og Advendtdalen on Svalbard. These data are extremely valuable for developing the remote sensing retrieval algorithms, and assess the accuracy of the retrievals. For WP1 (service 2) the network of growing season stations equipped with thermistors and cameras have been supplemented with new stations that contribute to improve the significance.

Figure 1. In situ station in Advendtdalen with Decagon NDVI-sensor and RGB-camera.

This project has strengthen Adventdalen valley as a core calibration and validation site for remote sensing based monitoring of seasonal dynamics, vegetation changes, and primary production. Because of the high latitude location, the area is very frequently covered by polar

orbiting satellites like Landsat 8 and Sentinel-2. The last decade, several institutes and universities (UiT, Norut, NINA, Lund University) has established in-situ measurements of climate parameters, photosynthetically active radiation, spectral sensors, CO_2-flux, phenology and primary production in the valley, which is currently being coordinated and used in calibration and validation of remote sensing data, and linked to the Fluxnet- and the new NordSpec-networks. In spring 2015, this project in cooperation with the RCN funded project SnowEco headed by UiT established 6 sites equipped with NDVI-sensors including hemispheric sensors, phenology cameras and moisture/temp sensors in the Adventdalen. The Decagon NDVI sensors here used are mounted at 2 m height, programmable (every 4hrs) covering the wave lengths 650 nm and 810 nm. In figures we present some results…. In addition, ongoing in-situ phenological monitoring by RGB-cameras have been strengthen, and partly co-located with the other activities.

Figure 2. Comparison of snow cover observed from Landsat-8 (top left, snow in cyan) and Sentinel-1 (top right, melting snow in pink). Bottom: Time series of soil temperature, radar backscatter, precipitation and conductivity (related to soil moisture) from solifluction station (red star in upper right image).

Published Results/Planned Publications

Eckerstorfer M., Malnes E. Christiansen H.H., “An annual backscatter model of seasonal snow dynamics and ground surface freeze-thaw cycles from C-band SAR data from Kapp Linné, Svalbard”, Subm. Geomorphology, April 2015.

Karlsen SR. et al., Planned publication 1 in 2016., Between-year variability in plant biomass mapped by MODIS-NDVI data on Svalbard, Arctic Norway.

Marcia-Fauria, M. & SR. Karlsen. Planned publication 2 in 2016. Tundra productivity linked to sea ice distribution on Svalbard, Arctic Norway

Communicated Results

The results from the Fram centre project has been of mutual interest for the EU project SenSyF, and has contributed to improving the two services developed for soil frost/thawing and growing season. In particular the services have been better validated through field work and additional funding for scientific work in the project. The results have been communicated to EU through project reports and additional information material (EU prospectus leaflet). In addition the results have been presented at conferences and workshops.

Other publications related to the project:

Karlsen, S.R. 2015. Remote sensing based mapping of the growing season in alpine parts of Norway and on the High Arctic archipelago of Svalbard. In Phenology 2015. Deutscher Wetterdienst. Annalen der Meteorologie 48.

Karlsen, S.R., K.A.Høgda, B. Johansen & R. van der Wal. 2015. MODIS-based mapping of the growing season and plant production in relation to climate on Svalbard for the 2000-2014 period. Abstract B05-O09 presented at the Arctic Science Summit Week (ASSW), Toyama, Japan, 27-30 April 2015

Stendardi, L., S. R. Karlsen & B. Johansen. 2015. Time-series of Landsat 8 data in mapping the onset of the growing season in Adventdalen valley, on the Arctic Archipelago Svalbard. In Phenology 2015. Deutscher Wetterdienst. Annalen der Meteorologie 48.

Malnes E., M. Eckersforfer, H.Hindberg, H.H.. Christiansen „Quantification of snow and permafrost properties in a changing climate in Svalbard using satellite-borne and field measurements“, Oral presentation to Arctic Frontiers, 18-23 January 2015, Tromsø, Norway.

Malnes E., Eckerstorfer M., Hindberg H., and Vickers H.,“Satellite remote sensing of snow and

permafrost in Norway and Svalbard“, Poster to ESA-CliC Earth observation and arctic science priorities meeting, January 20, 2015, Tromsø, Norway.

Interdisciplinary Cooperation

Yes: Collaboration between remote sensing experts, geophysisists, and ecologistsBudget in accordance to results

Budget in accordance to results

YES

Could results from the project be subject for any commercial utilization

No

Conclusions

The Fram centre project SenSyF have successfully achieved the main objectives in the project by

1) **Exploiting the results and processing software for massive amounts of EU data obtained through the EU project SenSyF to validate the developed services and publishing the results in scientific journals**

2) **We have involved NINA and UiT in the EU project through valuable user contributions, scientific collaboration/publishing, and collaboration on in situ sampling of mutual interest.**