



The TIMELINE Project

TIMELINE stands for "**TIM**e Series Processing of Medium Resolution Earth Observation Data assessing Long -Term Dynamics In our **N**atural **E**nvironment". Within the TIMELINE project, a homogenized time series of NOAA and METOP AVHRR data over Europe and North Africa is being generated using the historical data archive of DLR-DFD. The main goal is to develop long time series of geoscientific variables for global change research that are consistent, reproducible, transparent, reliable and generic. TIMELINE will:

- Derive a 40-year time series with AVHRR land and atmosphere products
- Enable change detection analyses and the identification of geo-scientific phenomena and trends
- Answer climate-relevant research questions

We focus on the preliminary analysis of the snow cover, for information about the project and other products see [1].

Data Set and Study Area

The availability of data has been increasing continuously since 1981, and there are more data gaps in winter due to polar night and cloud cover (Figure 1).



Figure 1. Data availability and NDSI derived snow coverage.

The TIMELINE area includes Europe, North Africa and the Middle East (Figure 2).



Figure 2. Study area with the long-term snow cover duration.

A European Time Series Of Daily Snow Cover from AVHRR Data Over 36 Years: Results Of The TIMELINE Project

Sebastian Roessler, Andreas Dietz, Stefanie Holzwarth

German Remote Sensing Data Center (DFD), German Aerospace Center (DLR), Oberpfaffenhofen, 82234 Wessling, Germany

Snow Cover Duration

The snow cover duration (SCD) is given per pixel as a cumulative sum of days with snow cover. Data gaps (caused by clouds or polar night) are interpolated by the Global SnowPack processor [2]. The SCD is calculated for the hydrological year, which runs from the beginning of the meteorological autumn to the end of the meteorological summer.



Figure 3. Duration of snow cover in the hydrological year and subdivision into early and late season.

The subdivision into early and late snow cover duration in midwinter (Figure 3) can be used as a proxy for the onset of the snow cover and for the beginning of melting.



Figure 4. Mean early and late snow cover duration.

We found a general decrease in the early SCD, which is particularly strong in areas of the Baltic States, Belarus, Ukraine and Russia. From a hydrological point of view, the decrease (which is also of high significance in this area) affects the Volga catchment area. Interestingly, almost the entire Caucasus also shows a decrease in early SCD with a high level of significance; the trend is also significant but lower in Arkhangelsk Oblast.



It is planned to overlay the product and the trends with TIME-LINE data sets for vegetation (NDSI) and land surface temperature (LST).

Trend of Early Snow Cover Duration

A (mostly) significant decline in the late SCD for the Volga region, the Caucasus and large parts of Turkey (Pontic and Taurus Mountains) and further south at Mount Lebanon. In large parts of central and southern Europe, however, we were able to determine an increase in late SCD that was predominant in terms of area. These developments are also significant, particularly on the Iberian Peninsula and in Morocco.

Lessons Learned and Outlook

Improve input data

By improving the processors, there should be fewer gaps in the input data set. This makes the trends more resilient.

Merge with other products



[2] Andreas J. Dietz, Claudia Kuenzer, and Stefan Dech, "Global SnowPack: a new set of snow cover parameters for studying status and dynamics of the planetary snow cover extent," Remote Sensing Letters, vol. 6, no. 11, pp. 844–853, Nov. 2015.



Trend of Late Snow Cover Duration



Figure 6. Theil-Sen slope (top) and p-value of the Mann-Kendall test (bottom) for pixel-based trend analysis of late SCD.

References

[1] Stefan Dech, Stefanie Holzwarth, Sarah Asam, Thorsten Andresen, Martin Bachmann, Martin Boettcher, Andreas Dietz, Christina Eisfelder, Corinne Frey, Gerhard Gesell, Ursula Gessner, Andreas Hirner, Matthias Hofmann, Grit Kirches, Doris Klein, Igor Klein, Tanja Kraus, Detmar Krause, Simon Plank, Thomas Popp, Sophie Reinermann, Philipp Reiners, Sebastian Roessler, Thomas Ruppert, Alexander Scherbachenko, Ranjitha Vignesh, Meinhard Wolfmueller, Hendrik Zwenzner, and Claudia Kuenzer, "Potential and Challenges of Harmonizing 40 Years of AVHRR Data: The TIMELINE

Remote Sensing, vol. 13, no. 18, pp. 3618, Sept. 2021.

sebastian.roessler@dlr.de