



Mapping of geophysical land, ocean and atmosphere products over Europe from 40 years of AVHRR data – the TIMELINE project

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www.timeline.dlr.de

Knowledge for Tomorrow



Effects of climate change on land surface dynamics

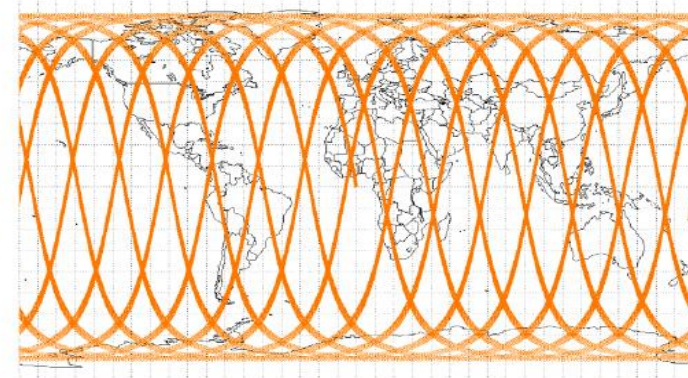
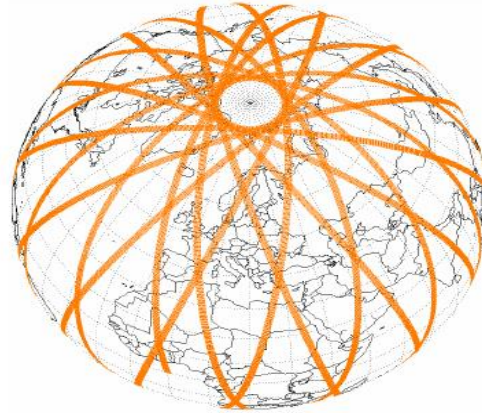
- Influence of climate change on
 - Start and length of the vegetation periods
 - Land and sea surface temperature
 - Cloud coverage
 - Number and frequency of wild fires
 - Start, extent and duration of snow cover
 - ...
- Remote sensing to quantify changes of the last 40 years



Daily coverage: high- versus medium resolution

- Landsat:

- launch of first satellite in 1972
- 60m/30m spatial resolution
- 4-11 spectral channels (blue, green, red, NIR, SWIR, TIR, Pan)
- 16-day repeat cycle



- AVHRR:

- launch of first sensor in 1978
- 1.1km spatial resolution
- 4-6 spectral channels (red, NIR, SWIR, TIR)
- daily repeat cycle



Kuenzer, C., Dech, S., Wagner, W., 2015: Remote Sensing Time Series Revealing Land Surface Dynamics: Status Quo and the Pathway Ahead. In: Künzer, C., Dech, S., Wagner, W. (eds.), 2015: Remote Sensing Time Series Analyses revealing Land Surface Dynamics. pp 2-25. ISBN 978-3-319-15967-6, Springer, The Netherlands



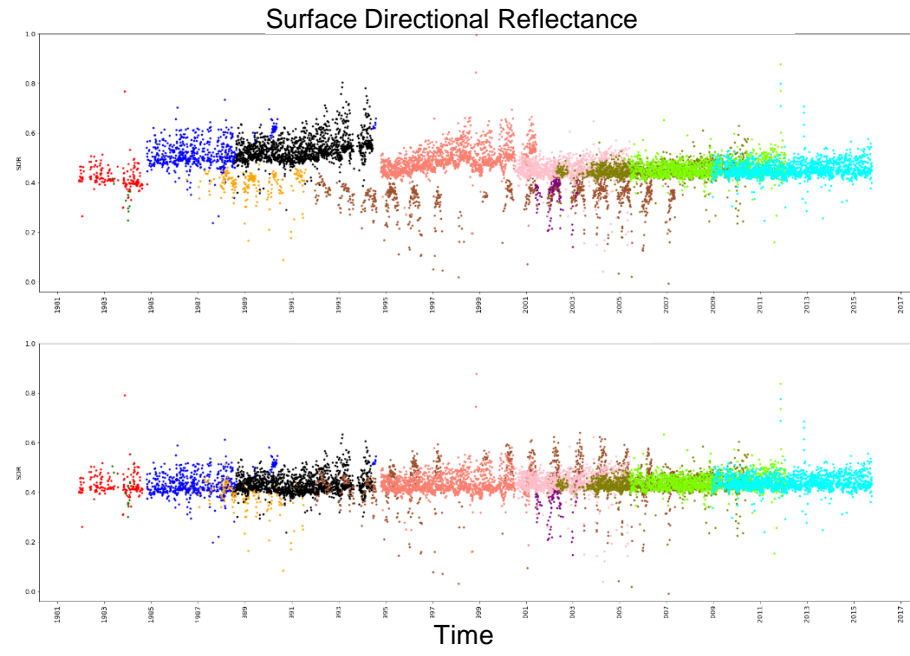


Mapping geophysical products over Europe from ~40 years of AVHRR data

Baseline:

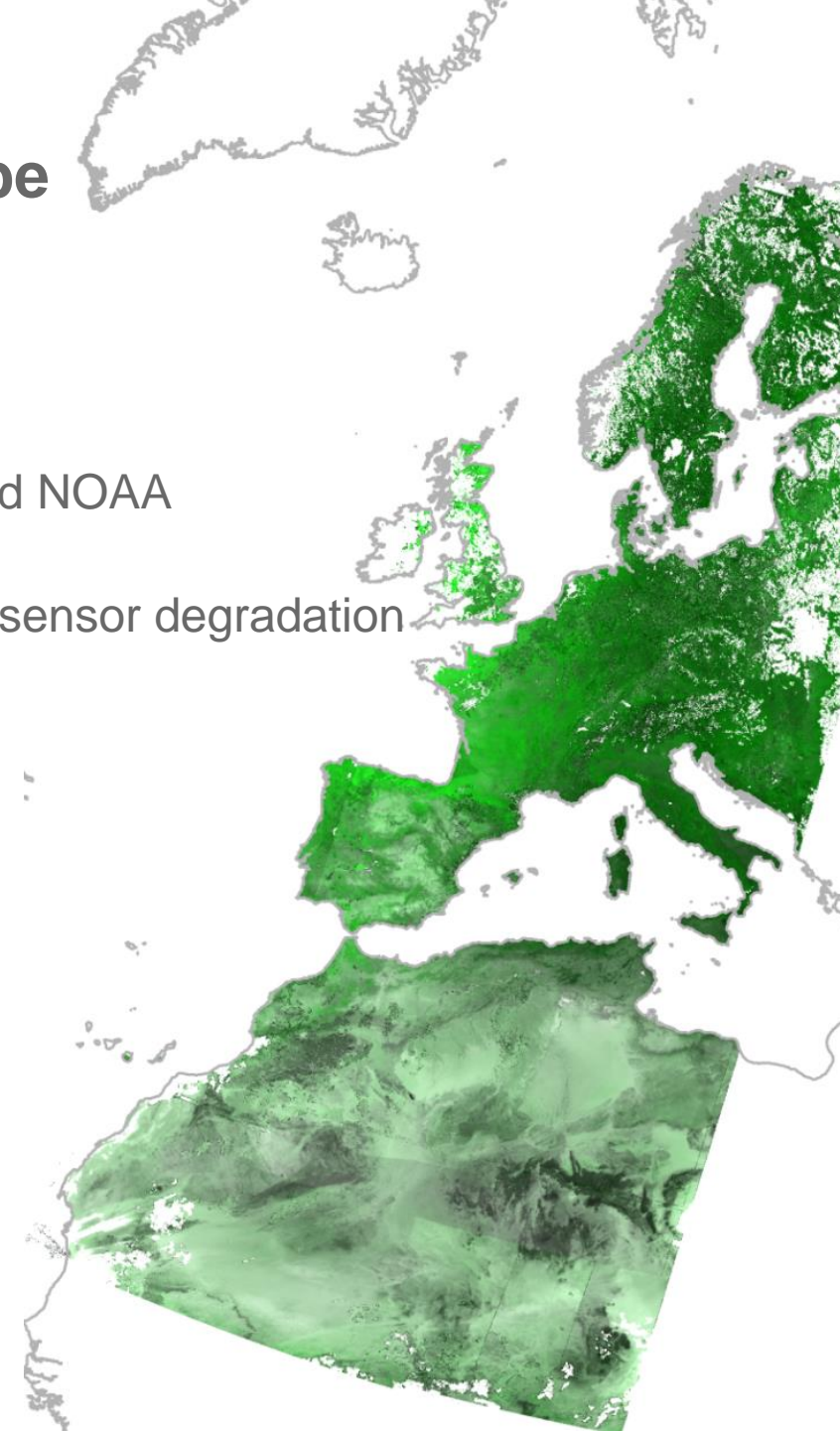
- Sensors: AVHRR-1 (4 channels), -2 (5 channels) & -3 (6 channels) onboard NOAA and EUMETSAT satellite series (14 different platforms in total)
- Known obstacles: drifting orbits, changes of local time between platforms, sensor degradation

Extensive pre-processing of data to ensure a harmonized time series



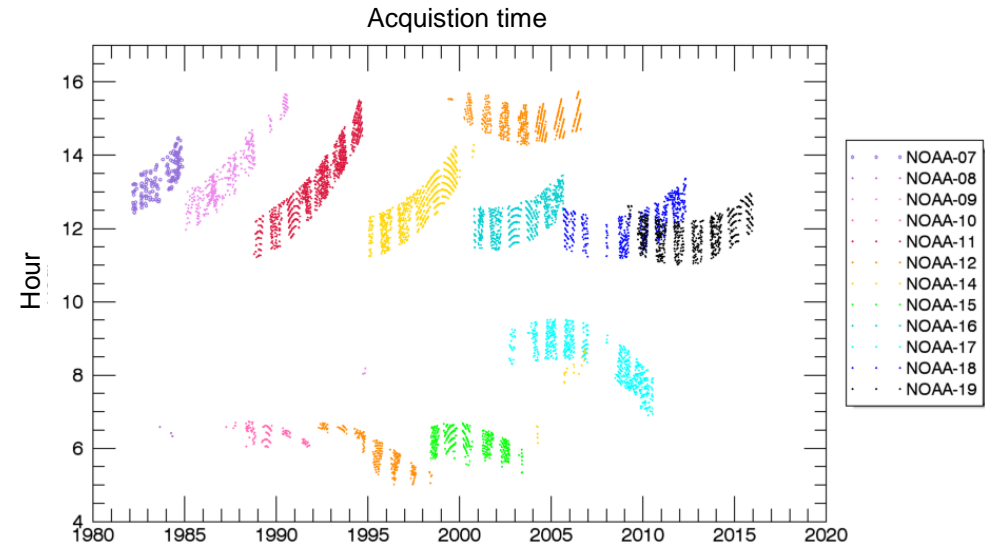
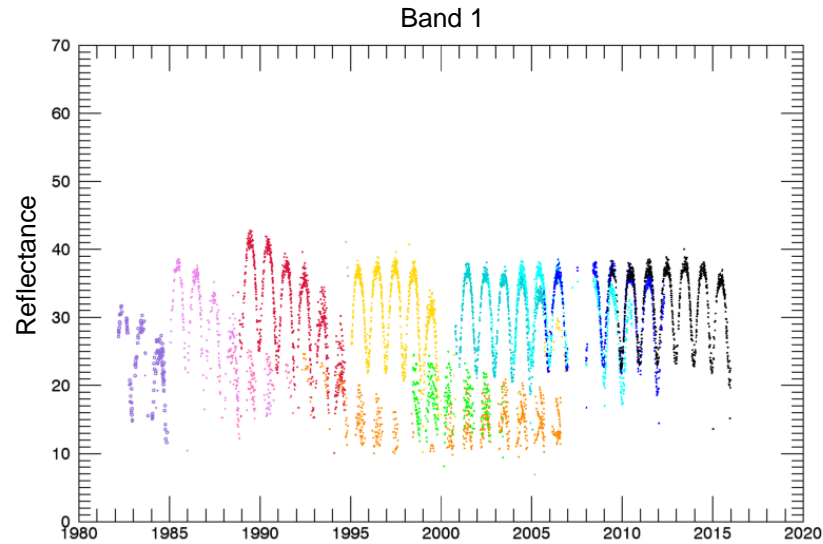
Before harmonization

After harmonization



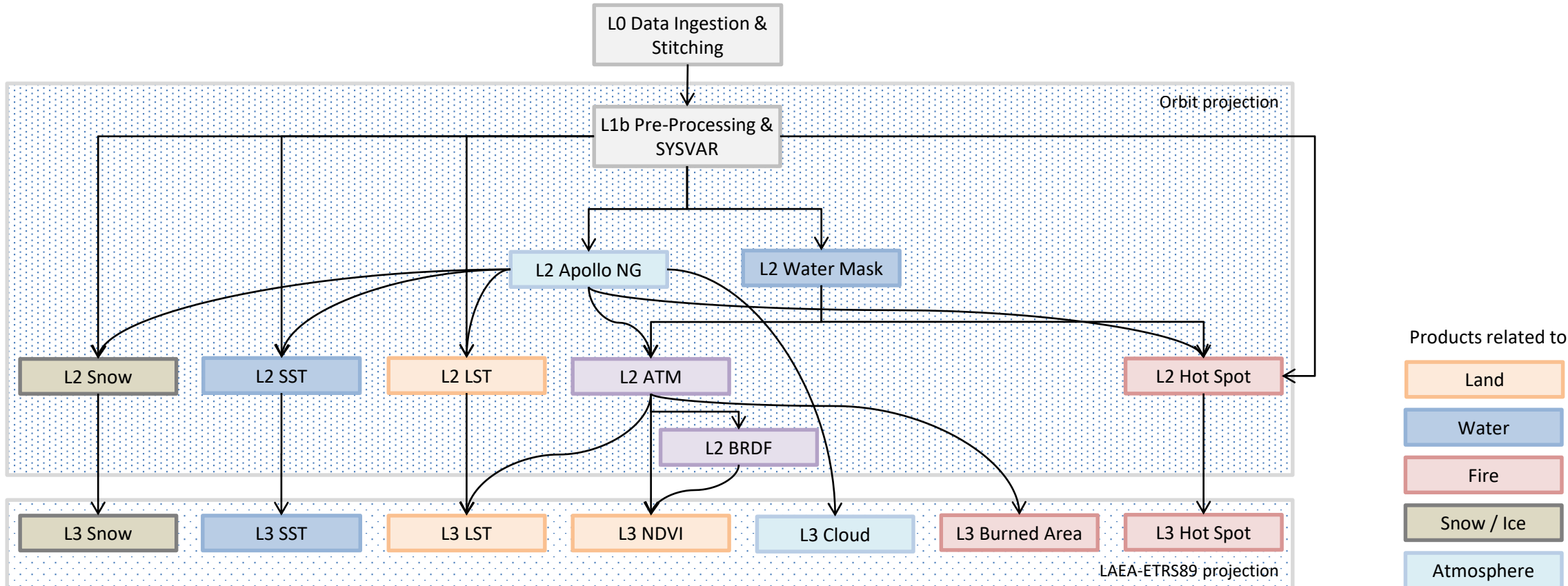
TIMELINE Challenges

- Variety of AVHRR sensors → Normalization of the sensors
- Missing on-board calibration → Recalibration of the data
- Different acquisition times → Correction of time effects
- Orbit drift → Correction of angular effects
- Noise in data → Adjusted algorithms, new accuracy measures

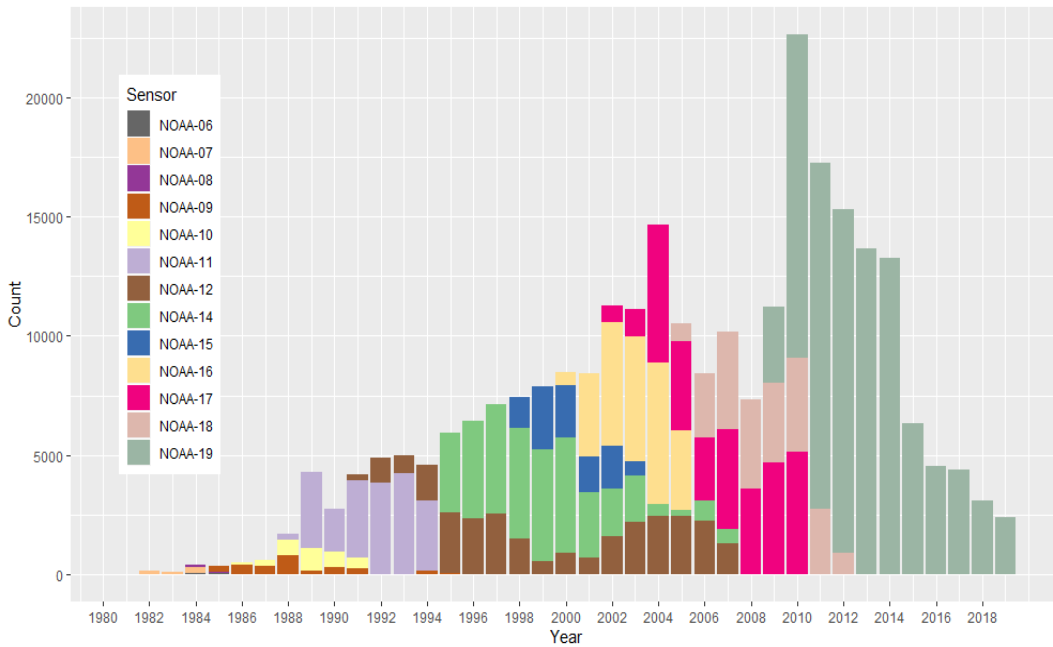




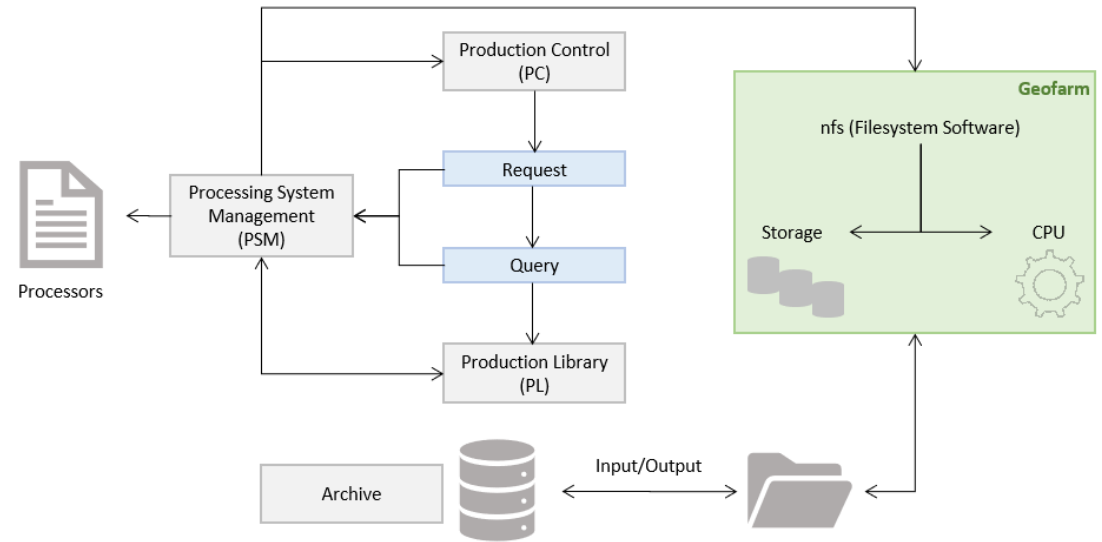
Processing workflow and product suite



Number of AVHRR scenes per NOAA sensor



Processing system



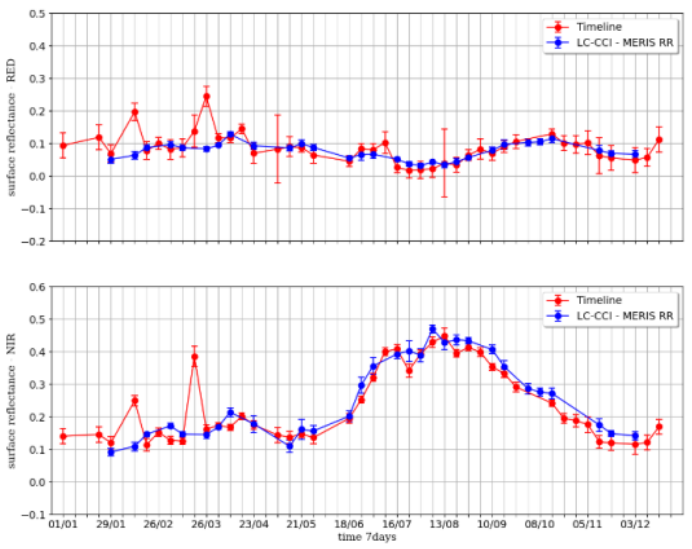
→ Processing of 128.000 raw AVHRR data to L1b products and subsequent L2 and L3 products



TIMELINE Product validation

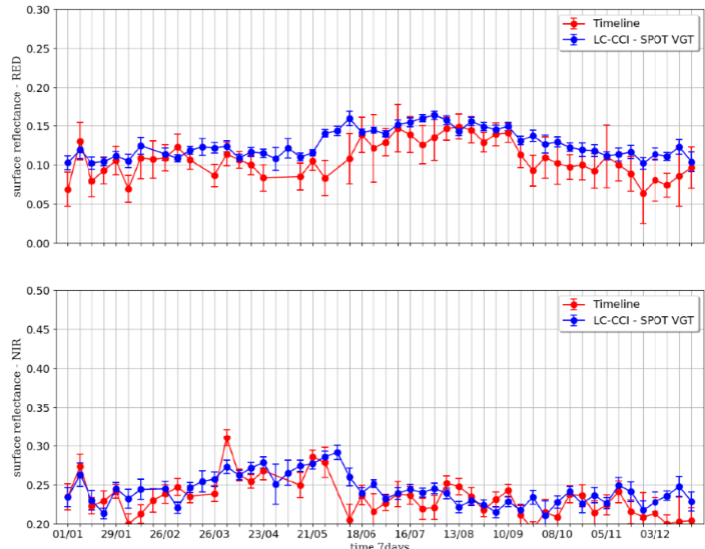
Comparison of TIMELINE AVHRR Surface Directional Reflectance (SDR) data with SDR data from other sensors

Europe_Rice_Cultivation - year 2010



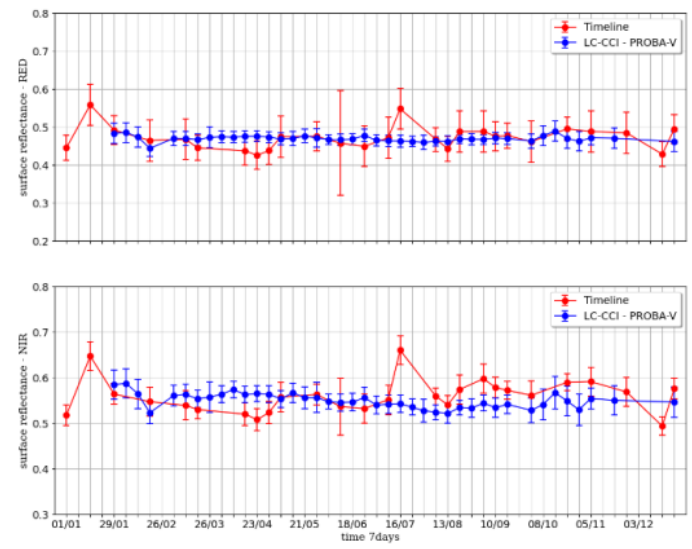
AVHRR (TIMELINE)
MERIS (CCI)

CEOS_La_Crau - year 2010



AVHRR (TIMELINE)
SPOT-VGT (CCI)

CEOS_Libya4 - year 2015



AVHRR (TIMELINE)
PROBA-V (CCI)

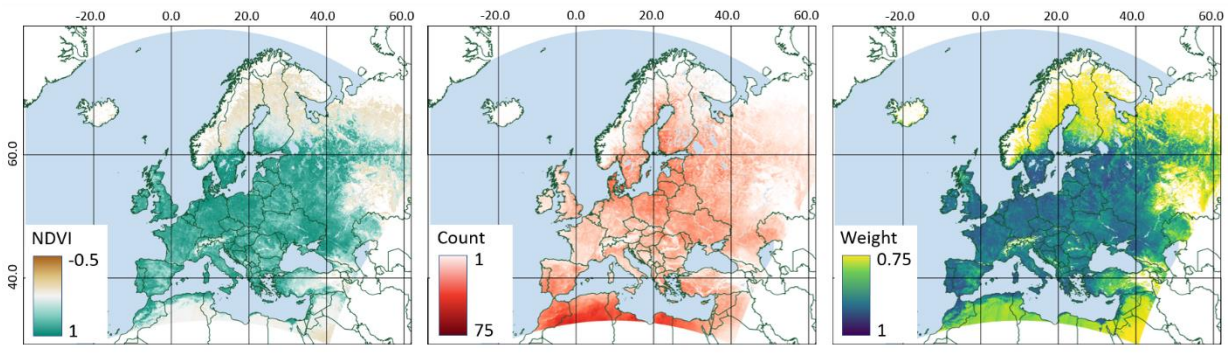


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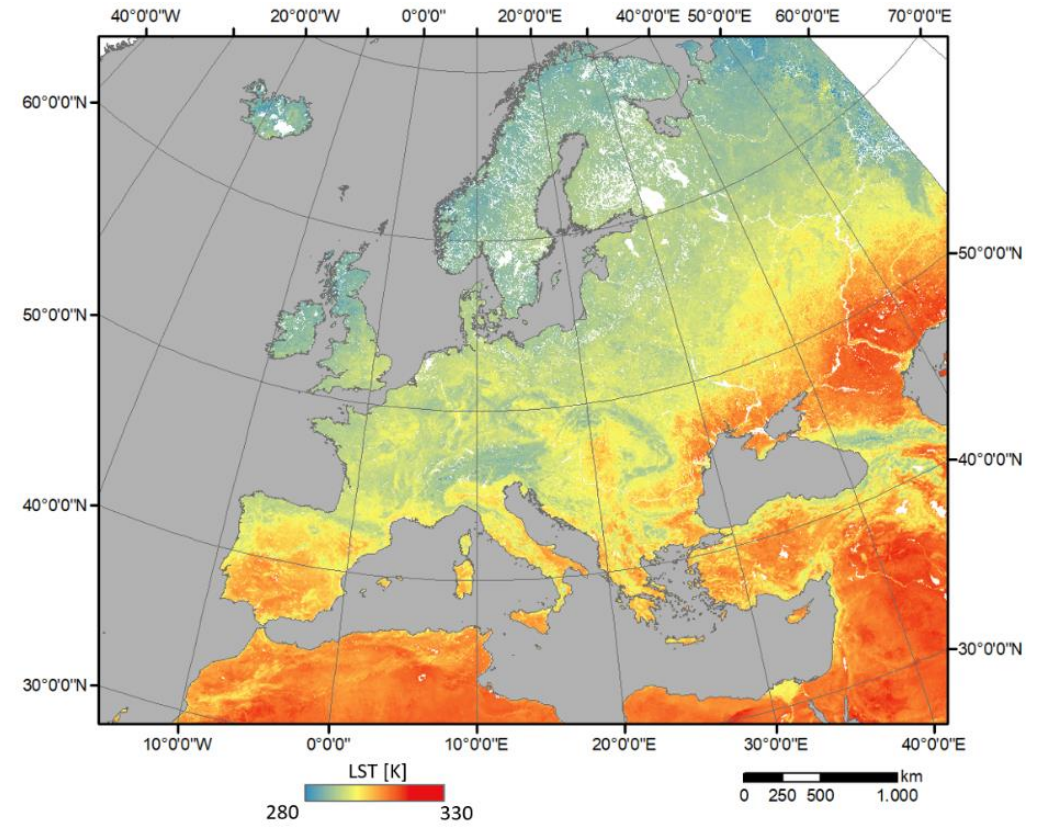


TIMELINE Product examples

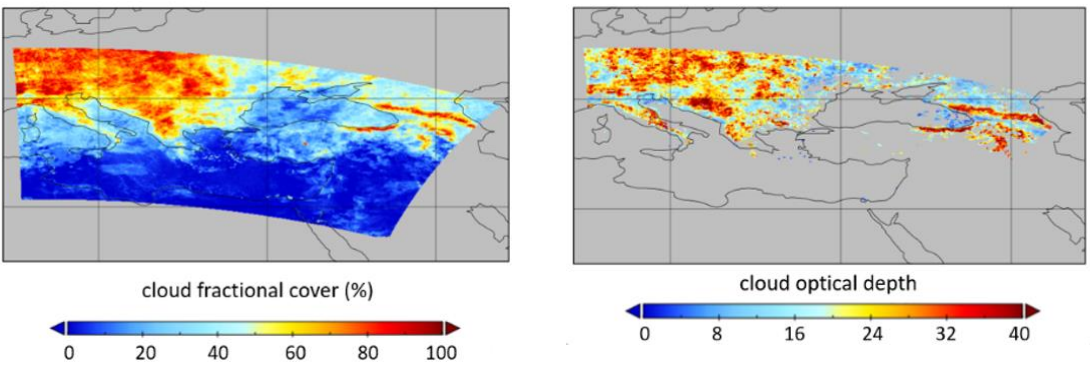
- Monthly NDVI composite for March 2007



- Mean LST in August 2007

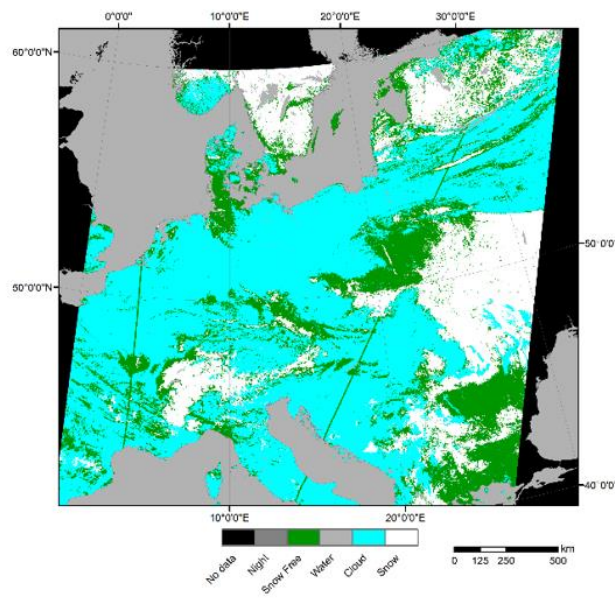


- Cloud properties in July 2001, 14:00-15:00

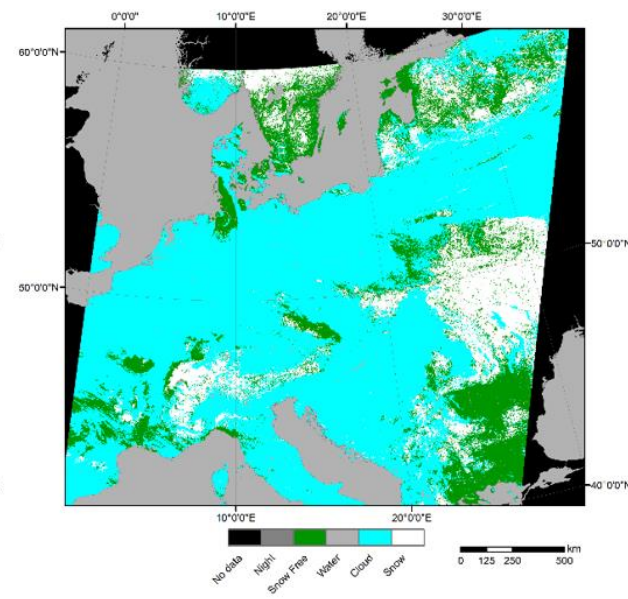


TIMELINE Product examples

- Daily snow cover composite from January 1st 2009

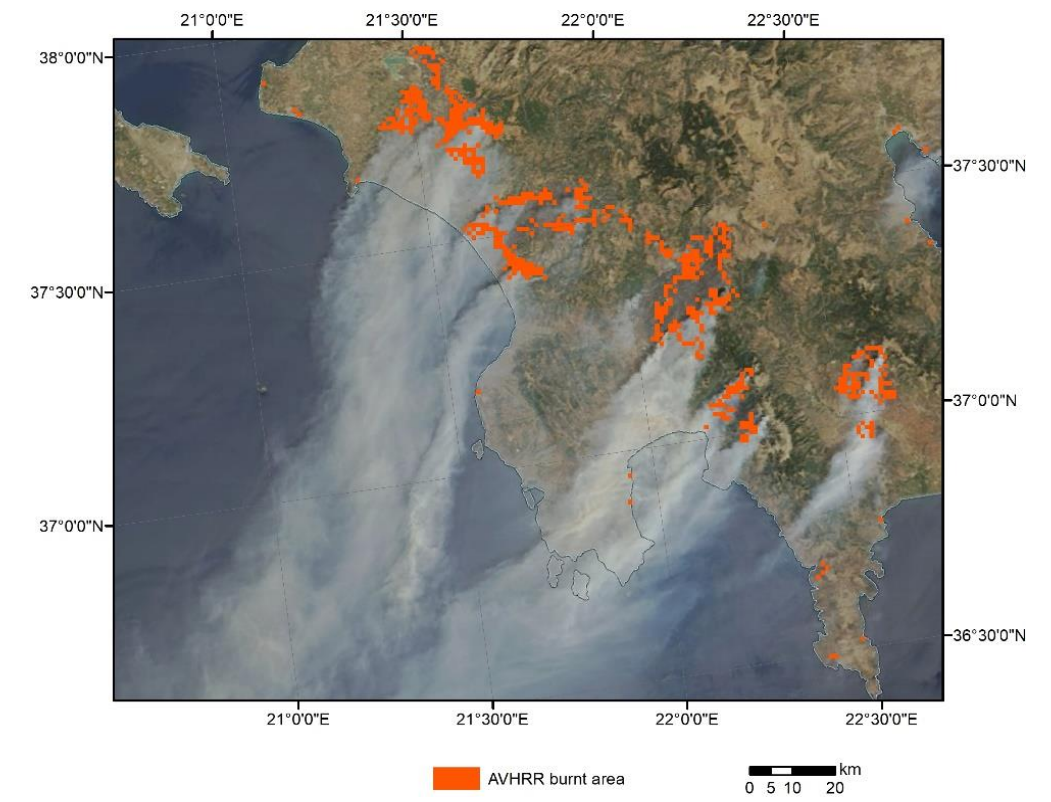


TIMELINE product



MODIS product

- Burnt areas in Greece (August 26–30, 2007)



Background: MODIS image of August 26, 2007



TIMELINE Further information

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Article
Assessment of Mono- and Split-Window Approaches for Time Series Processing of LST from AVHRR—A TIMELINE Round Robin

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Academic Editors: Zhaoliang Li and Prasad S. Thenkabail
 Received: 21 October 2016; Accepted: 10 January 2017; Published: 13 January 2017

Abstract: Processing of land surface temperature from long time series of AVHRR (Advanced Very High Resolution Radiometer) requires stable algorithms, which are well characterized in terms of accuracy, precision and sensitivity. This assessment presents a comparison of four mono-window algorithms (Price 1983, Qin et al., 2001, Jiménez-Muñoz and Sobrino 2003, linear approach) and six split-window algorithms (Price 1984, Becker and Li 1990, Ulivisetti et al., 2003, Jiménez-Muñoz and Sobrino 2003, Jiménez-Muñoz et al., 2008, Jiménez-Muñoz et al., 2010).

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 www.atmos-meas-tech.net/E-4155-2015/
 doi:10.5194/amt-8-4155-2015
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Atmospheric Measurement Techniques

APOLLO_NG – a probabilistic interpretation of the APOLLO legacy for AVHRR heritage channels

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Received: 19 March 2015 – Published in Atmos. Meas. Tech. Discuss.: 30 April 2015
 Revised: 30 September 2015 – Accepted: 30 September 2015 – Published: 12 October 2015

Abstract. The cloud processing scheme APOLLO (AVHRR Over (Land, Land and Ocean)) has been used for cloud detection and cloud property retrieval since the late 1980s. The physics of the cloud property retrieval is based on the assumption that the cloud top brightness temperature is lower than the surface brightness temperature. This assumption is not always valid, especially in the case of high surface albedo. This paper presents a probabilistic interpretation of the APOLLO legacy. Furthermore, a couple of example results from NOAA-20 are shown.

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Article
Detection of Water Bodies from AVHRR Data—A TIMELINE Thematic Processor

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Academic Editors: Deepak R. Mishra, Xiaofeng Li and Prasad S. Thenkabail
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Abstract. The assessment of water body dynamics is not only in itself a topic of strong demand, but also the presence of water bodies is important information when it comes to the assessment of land surface temperature. This paper presents a thematic processor for the detection of water bodies from AVHRR data. The processor is based on a combination of different algorithms and is able to detect water bodies in AVHRR data. The processor is able to detect water bodies in AVHRR data. The processor is able to detect water bodies in AVHRR data.

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Article
A Fully Automatic Instantaneous Fire Hotspot Detection Processor Based on AVHRR Imagery—A TIMELINE Thematic Processor

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Academic Editors: Baoliang Pu, Ioannis Gitas and Prasad S. Thenkabail
 Received: 26 September 2016; Accepted: 28 December 2016; Published: 2 January 2017

Abstract: The German Aerospace Center's (DLR) TIMELINE project aims to develop an operational processing and data management environment to process 30 years of National Oceanic and Atmospheric Administration (NOAA)—Advanced Very High Resolution Radiometer (AVHRR) raw data into L1b, L2 and L3 products. This article presents the current status of the fully automated active fire hotspot detection processor, which is based on single-temporal datasets in orbit geocentric data into L1b, L2 and L3 products. The results of the hotspot processor are presented. Three different processing levels of fire detection are provided. The results of the hotspot processor were tested with simulated fire data. Moreover, the processing results of real AVHRR imagery are presented.

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Article
A Fully Automatic Burnt Area Mapping Processor Based on AVHRR Imagery—A TIMELINE Thematic Processor

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Abstract: The German Aerospace Center's (DLR) TIMELINE project ("Time Series Processing of Medium Resolution Earth Observation Data Assessing Long-Term Dynamics in our Natural Environment") aims to develop an operational processing and data management environment to process 30 years of National Oceanic and Atmospheric Administration (NOAA)—Advanced Very High-Resolution Radiometer (AVHRR) raw data into Level (L) 1b, L2, and L3 products. This article presents the current status of the fully automated L3 burnt area mapping processor, which is based on multi-temporal datasets. The advantages of the proposed approach are (i) the combined use of different indices to improve the classification result, (ii) the provision of a fully automated processor, (iii) the generation

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Article
Validation of the TIMELINE AVHRR Land Surface Temperature product with MODIS and in situ LST—A TIMELINE Thematic Processor

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Received: 19 March 2015 – Published in Atmos. Meas. Tech. Discuss.: 30 April 2015
 Revised: 30 September 2015 – Accepted: 30 September 2015 – Published: 12 October 2015

Abstract. The cloud processing scheme APOLLO (AVHRR Over (Land, Land and Ocean)) has been used for cloud detection and cloud property retrieval since the late 1980s. The physics of the cloud property retrieval is based on the assumption that the cloud top brightness temperature is lower than the surface brightness temperature. This assumption is not always valid, especially in the case of high surface albedo. This paper presents a probabilistic interpretation of the APOLLO legacy. Furthermore, a couple of example results from NOAA-20 are shown.

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Article
Automated Improvement of Geolocation Accuracy in AVHRR Data Using a Two-Step Chip Matching Approach—A Part of the TIMELINE Preprocessor

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Abstract: The geolocation of Advanced Very High Resolution Radiometer (AVHRR) data is known to be imprecise due to minor satellite position and orbit uncertainties. These uncertainties lead to distortions once the data are projected based on the provided orbit parameters. This can cause geolocation errors of up to 10 km per pixel which is an obstacle for applications such as time series analysis, compositing/ mosaicking of images, or the combination with other satellite data. Therefore,

... more to follow



Conclusions

- Use of ~40 years of AVHRR data
- Europe-wide products with 1.1km resolution
- Until now 500 TB of data processed
- Land, sea and atmosphere products
- Free and open dissemination intended

