VULNERABILITY ASSESSMENT OF ECOSYSTEM SERVICES FOR CLIMATE CHANGE IMPACTS AND ADAPTATION (VACCIA)

ACTION 2: DERIVATION OF GMES-RELATED REMOTE SENSING DATA

DELIVERABLE 1: TIME-SERIES OF EARTH OBSERVATION DATA (SNOW MELT, PHENOLOGY, SNOW, WATER QUALITY AND LAKE SURFACE TEMPERATURE)

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CONTENT

INTRODUCTION

First deliverable of VACCIA Action 2 was to provide time-series of phenology, snow melt, water quality and water surface temperature from areas of interest for FinLTSER-stations based on the Finnish Environment Intitutes (SYKE) GMES-services. Required data sets and areas of interest vary between FinLTSER-sites and these were not explicitly determined in the project plan. Therefore a questionnaire survey to specify the needs of other project Actions towards Action 2 was conducted at spring 2009. Results of the survey were used to determine the specific areas and parameters of interest of different FinLTSER-sites.

Fundamental work in Action 2 is to calculate and collect various earth observation (EO) products and especially create tools to fetch time-depended data from areas of interest of FinLTSER-sites. This work is now completed and it was used to create time-series presented in this deliverable. With developed methods time-series analysis can also be applied to new areas of interest.

This document includes descriptions of used data and methods, short descriptions from the areas of interests and created-time series as figures. Numerical values are provided in a separate Web-site of VACCIA Action 2. More specific process flow descriptions are provided in separated attachments. Second deliverable of VACCIA action 2 (due at 31.9.2010) is aimed for further processing of time-series presented in this document.

TIME-SERIES OF PHENOLOGY AND SNOW COVERAGE

Length of the period between the melting and green vegetation growth is interesting for the catchment and leaching modeling. During this period, the soil is especially vulnerable for the erosion and nutrient leaching to the water systems. Remote sensing allows unceasing observation of snow melting and green vegetation growth over extensive spatial coverage. This allows the monitoring and comparison of these events in e.g. drainage basin located at different parts of Finland. Furthermore, the seasonal monitoring can be extended to different land use classes by using EO based land cover information.

Earth observation time series of snow covered area (SCA) and vegetation index (NDVI) were generated for five FinLTSER areas of interest. Aim is to provide information on the seasonal dynamics in these ecosystems. This was specifically under interest for the project actions 7, 8, 10 and 12.

DESCRIPTION OF THE USED REMOTE SENSING DATA, METHODS AND OTHER DATA SETS

Analysis was based on the interpretation of Terra/MODIS satellite images (by NASA) from the year 2001-2008. Data set included daily images from February to October, though cloud cover prevented the usage of approximately 40% of the images. All satellite images were pre-processed with tools made by Technical Research Centre of Finland (VTT) embedded into SYKE's operational data processing and archiving system. Cloud masking was carried out at SYKE mostly based on difference of infrared channels 31(10.780-11.280 µm) and 20 (3.660-3.849µm). All cloud masks were visually verified and corrected if needed.

METHOD FOR ESTIMATION THE SNOW COVERED AREA (SCA)

Snow accumulation and melting is an essential part of the hydrologic cycle. Monitoring of the snow covered area can also give information on the seasonal dynamics of ecosystems or watersheds. SYKE provides GMES Polarview service based on the fractional snow coverage estimation. Used method was designed to best perform for boreal forest areas and is feasible in operational use. In this model, the reflectance from a target area is expressed as a function of SCA. Average effective forest canopy transmissivity (generated from EO-data) for each unit area and generally applicable reflectance values for wet snow, snow-free ground and dense forest canopy are applied as model parameters. Employment of transmissivity information is beneficial as it allows SCA estimation also for the forested areas and therefore *a priori* information on forests is not needed. Methodology is presented in detail in articles by Metsämäki et al. (2004) and Anttila et al. (2006). SYKEs method was applied in to TERRA/Modis spectral band 4 (550 um) data with 500 meter spatial resolution and time-series were extracted from the areas of interest as presented below.

METHOD FOR PHENOLOGY ESTIMATION USING NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)

The Normalized Difference Vegetation Index (NDVI) is a simple numerical indicator that can be used to assess information on the amount and health of the live green vegetation in the target. It is based on the typical reflectance of green vegetation and is commonly used to space born remote sensing data. Vegetation absorbs incoming radiation strongly on the near infrared (NIR) part of spectrum. Whilst on the red part (RED) of the spectrum, the reflectance from the green vegetation is strong. NDVI takes advantage on this difference in the vegetation reflectance and is calculated as (NIR-RED) / (NIR + RED). Phenological observations are included in SYKEs GMES GSELand services. NDVI is estimated using MODIS bands 1 and 2 (645.5 and 856.5 um) with 250 meter resolution and time-series were extracted from the areas of interest as presented below.

DESCRIPTION OF CORINE LAND COVER DATA

CORINE Land Cover classification is based on integration of high resolution satellite data with other land cover information sources including GIS-data sources and register information. During the CORINE Land Cover project, a high resolution satellite image mosaic and a raster land cover database with a 25 m x 25 m resolution covering the whole Finland were produced. The CORINE nomenclature is hierarchical and it has five classes in level 1: artificial surfaces, agricultural areas, forest and seminatural areas, wetlands and water bodies. These are subdivided to 15 classes in level 2 and to 44 classes in level 3. CORINE land cover classification in Finland is presented in detail in articles by Härmä et al. (2004) and Törmä & Härmä (2004).

In order to derive time-series information from the different land cover classes in the areas of interest, the fraction of five land cover classes within each MODIS pixel were calculated from the CORINE land cover data. These classes included coniferous forests, broad leaved forests, mixed forests, agricultural areas and peat land areas. Threshold values were then used to select MODIS pixels with majority proportion of different land cover class. Threshold value of 90% was used for agricultural areas, coniferous forests and peat land areas. For mixed and broad leaved forests respective value used was 75%.

AREAS ON INTERESTS FOR NDVI AND SCA TIME-SERIES

Time-series of NDVI and SCA from the years 2001-2008 were generated for five drainage basins of different size in Finland (Figure 1). Time series were generated for the areas of interest (AoI) of FinLTER-sites of Lammi (Action 8), Lake Päijänne (Action 10), Lepsämänjoki agricultural (Action 7) and Northern LTSER (Action 12). Maps from the areas of interest with general land cover are presented in Figure 2. and general descriptions from these areas are added to Table 1.

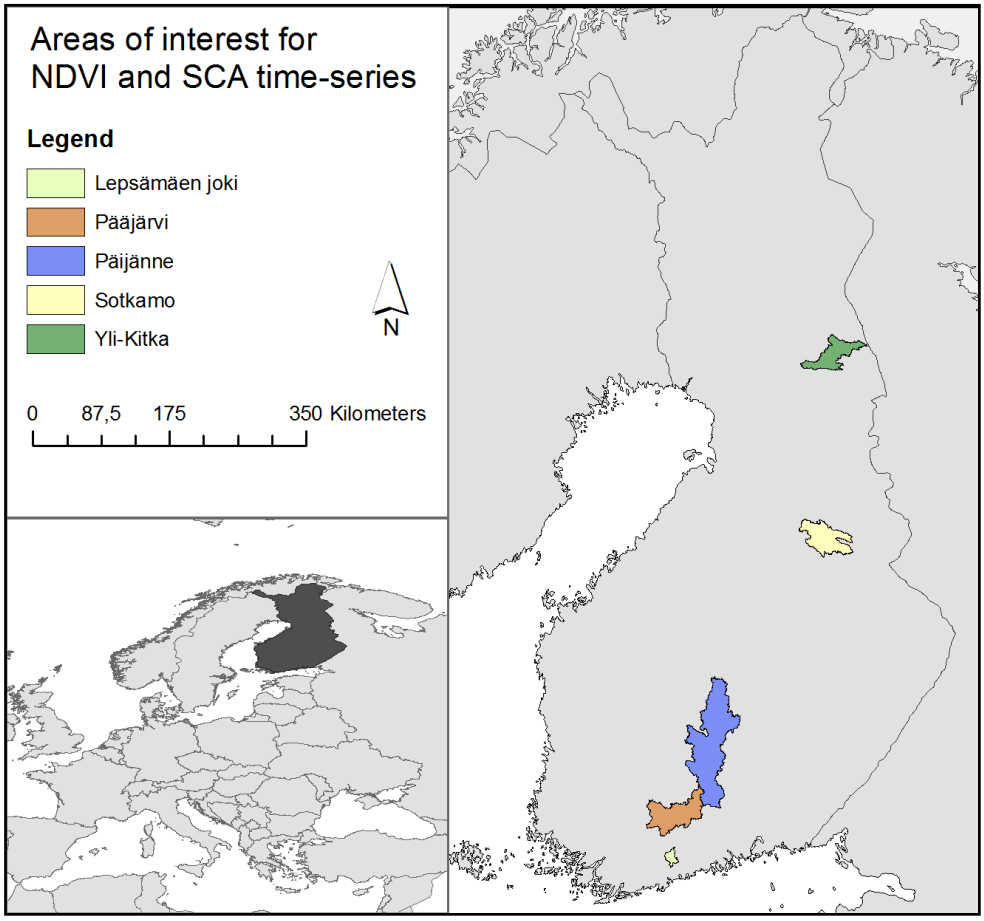


Figure 1. Areas of interest for NDVI and SCA time-series.

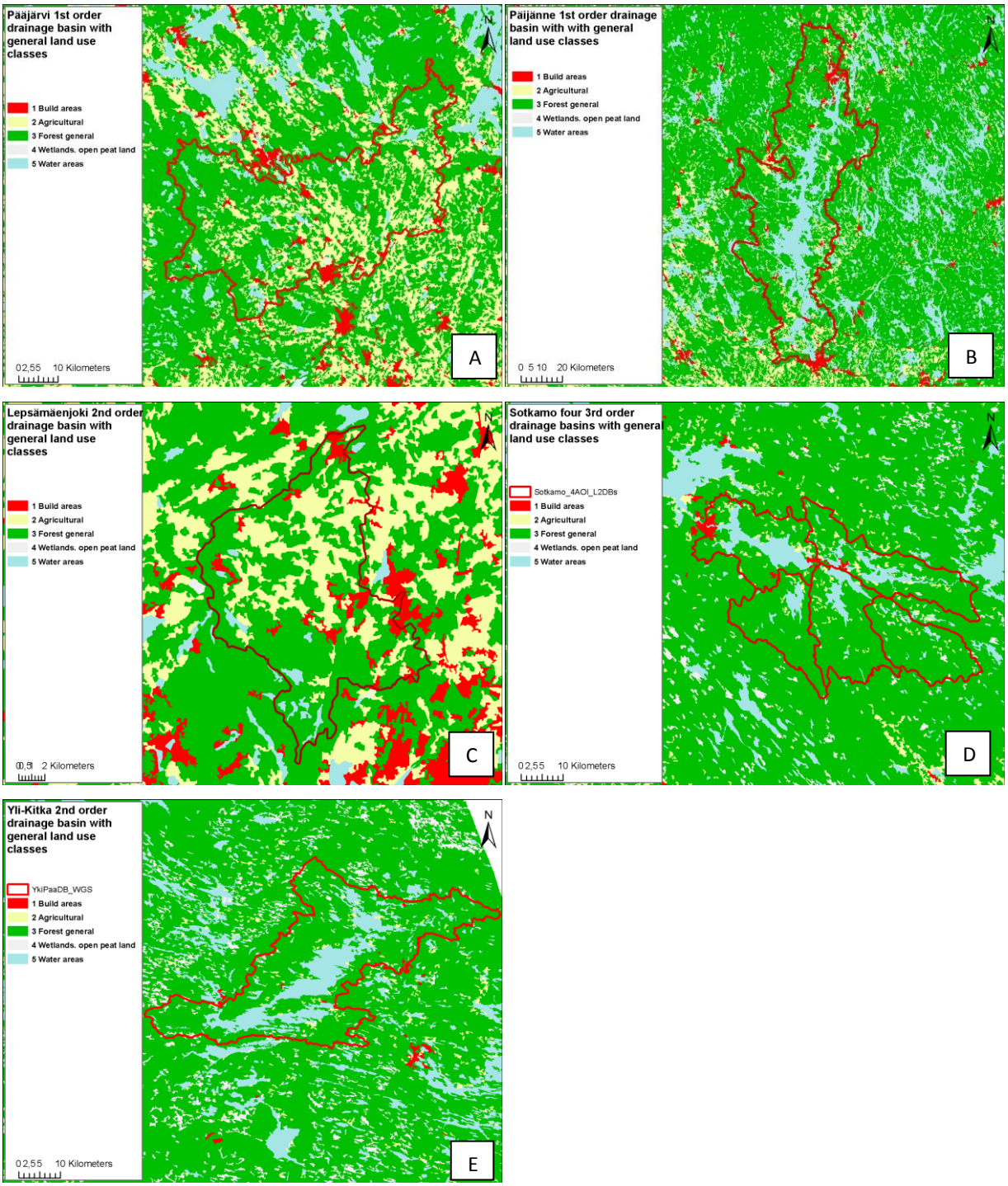


Figure 2. General land use in areas of interest (marked with polgygons in maps) for NDVI and SCA time series. Lake Pääjärvi 1st order drainage basin (A), Lake Päijänne 1st order drainage basin (B), River Lepsämäen joki 2nd order drainage basin (C), four 3rd order drainage basin in Sotkamo area (D) and Lake Yli-Kitka 2nd order drainage basin.

Table 1. Areas of interest descriptions

Area	Area of Interest	Total area (km2)	VACCIA action	FinLTSER -site
Pääjärvi	1st order DB	3621	8	Lammi
Päijänne	1st order DB	9286	10	Lake Päijänne
Lepsämäenjoki	2nd order DB	347	7	LAWA
Yli-Kitka	2nd order DB	2856	12	Northern
Sotkamo	Four second order DBs	3291	12	Northern

Areas of interest were defined using vector GIS data. This data was automatically applied when extracting time-series of NDVI and SCA-estimates from different land cover types. Each observation in time-series is a mean value from the applicable pixels of each land cover class. Estimation of NDVI and SCA is done in different spatial resolutions (250m and 500m, respectively) and therefore the number of pixels, i.e. sample size, varies according to the spatial resolution and land cover type fragmentation in areas of interest(table 2).

Table 2. Amount of pixels with different land use class in areas of interest in 250 meter resolution (NDVI) and 500 meter resolution (SCA)

Area of Interest	# of pixels in agricultural areas in 250m/500m resolution	# of pixels in coniferous in forests areas 250m/500m resolution	# of pixels in broad leaved in forest areas 250m/500m resolution	# of pixels in mixed forest areas in 250m/500m resolution	# of pixels in Open peat land areas in 250m/500m resolution
Pääjärvi	3915/835	3496/734	49/12	803/137	110/32
Päijänne	1626/317	6687/1380	185/19	2793/461	105/25
Lepsämäenjoki	470/100	330/60	2/0	92/15	0/0
Yli-Kitka	26/4	2819/575	5/1	860/133	127/28
Sotkamo	148/28	2139/458	5/0	2456/419	80/13

PROCESS DESCRIPTION

Over 3500 Terra/MODIS satellite images were processed to daily NDVI and SCA estimates covering the area between 45-71 degreed latitude and 5-45 degrees longitude. General process description for deriving time series of NDVI and SCA is described in figure 1. Processing flows are described in detail in the attachments.

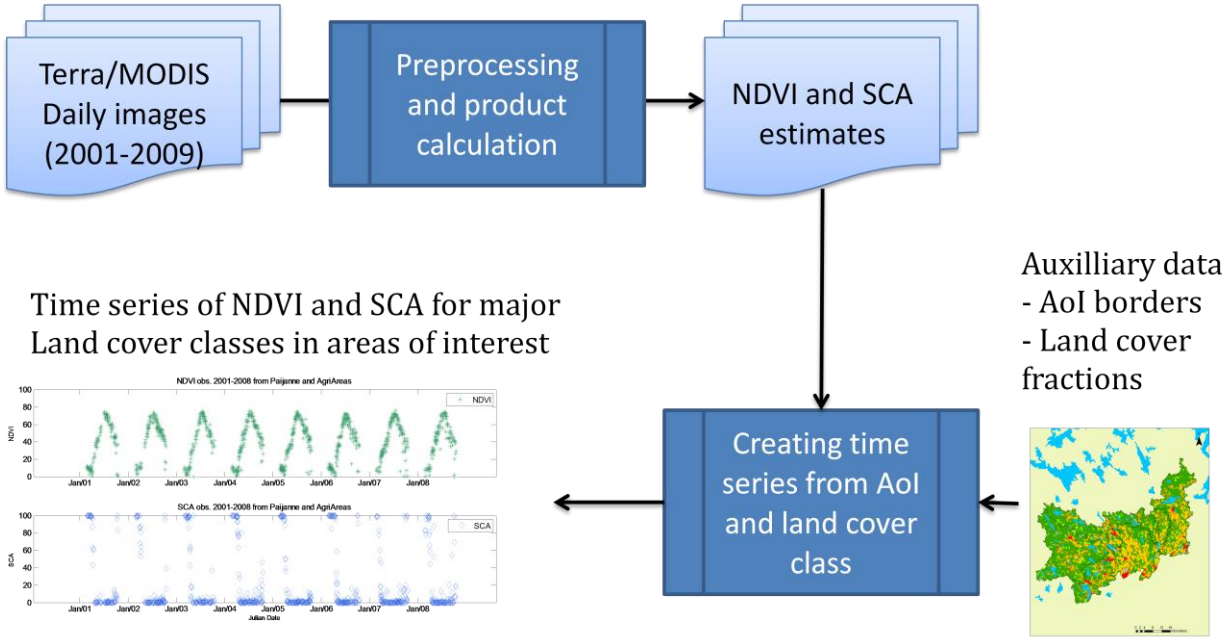
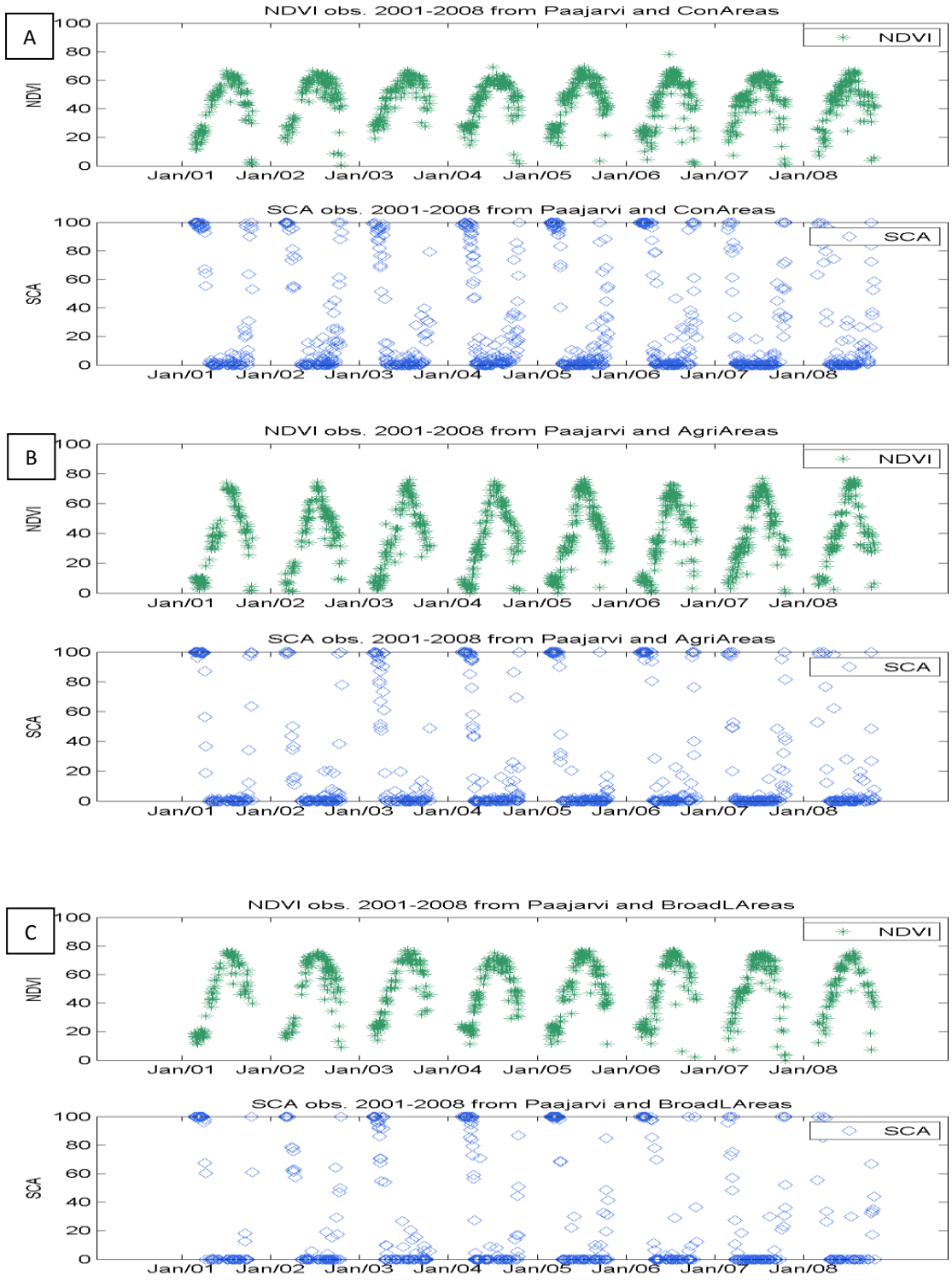


Figure 1. General process flow description for deriving time-series of NDIV and SCA from years 2001-2008.

RESULTS

Time-series from different areas of interest are presented as figures showing the daily observations of SCA and NDVI for five land cover types (coniferous forests, agricultural areas, broad leaved forests, mixed forests and open peat land areas).

TIME SERIES OF NDVI AND SCA FROM THE 1ST ORDER DRAINAGE BASIN OF LAKE PÄÄJÄRVI (2001-2008).



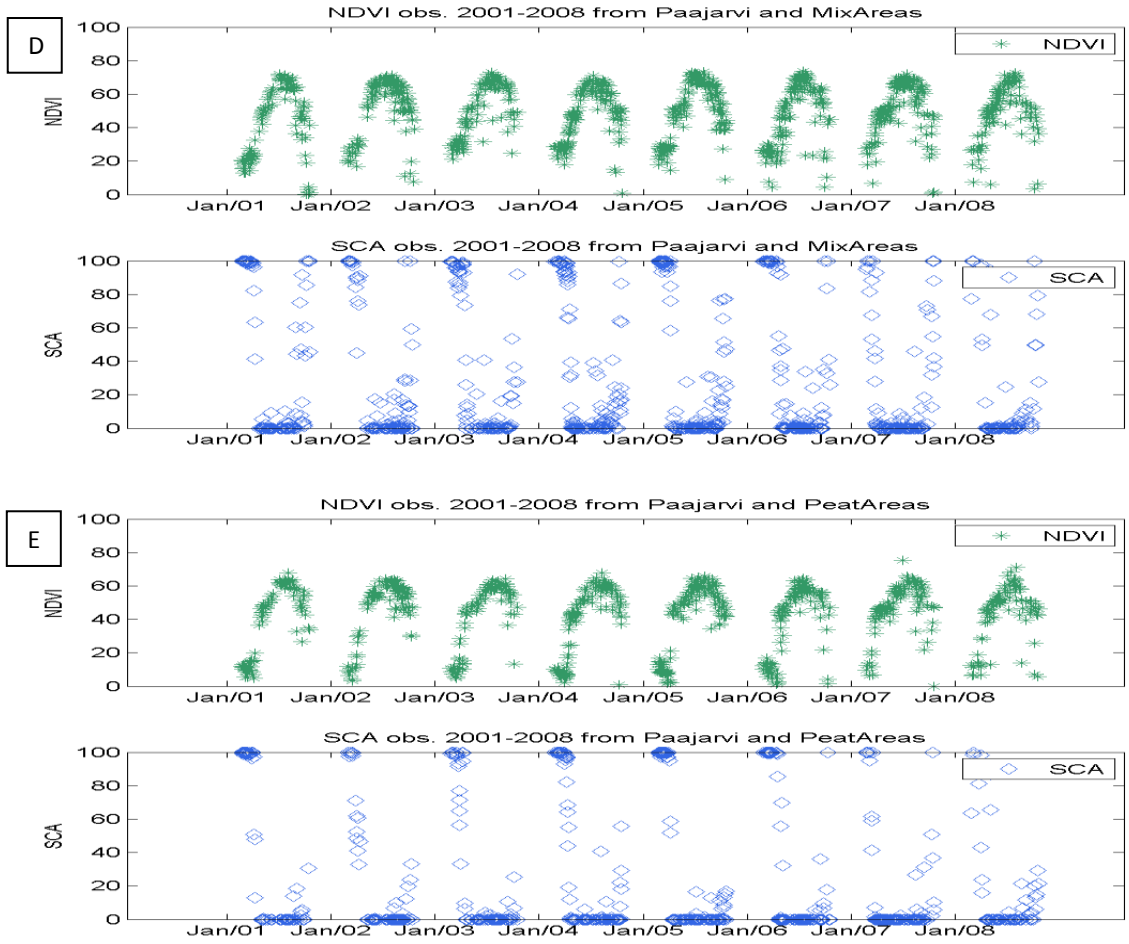
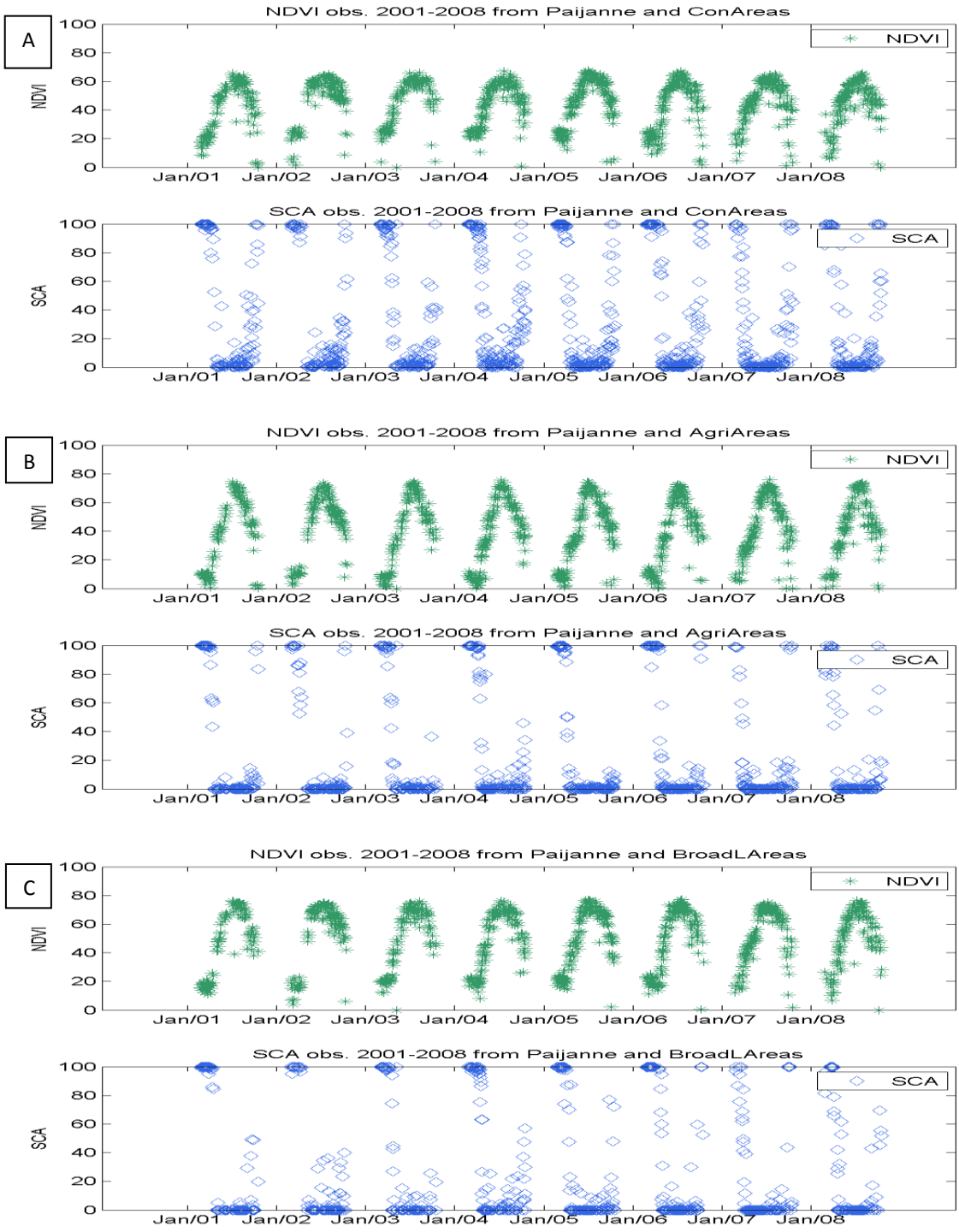


Figure 3. Time series of NDVI (green asterix) and SCA (blue circles) from the 1st order drainage basin of Lake Pääjärvi from the years 2001-2008 for different land use classes. Coniferous forests (A), agricultural areas (B), Broad leaved forests (C), mixed forests (D) and open peat land areas (E).

TIME SERIES OF NDVI AND SCA FROM THE 1ST ORDER DRAINAGE BASIN OF LAKE PÄIJÄNNE (2001-2008)



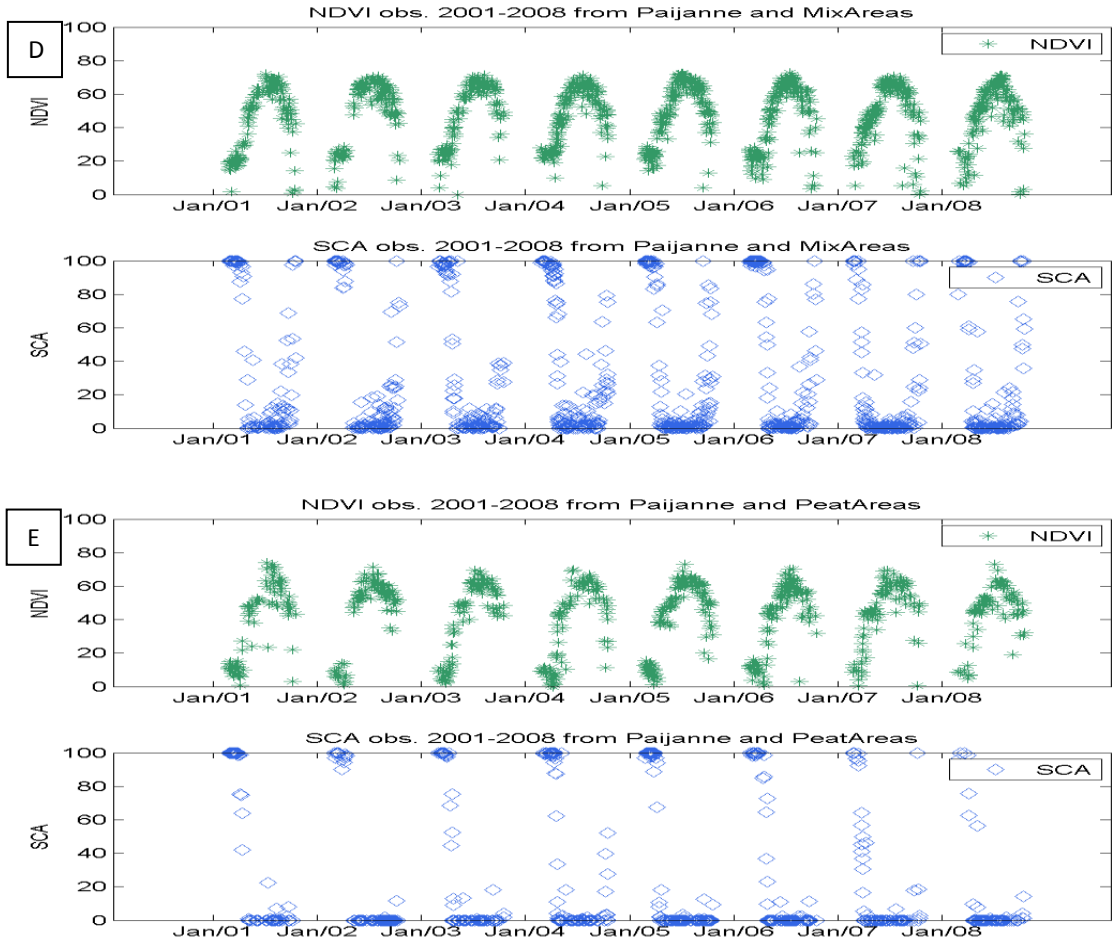
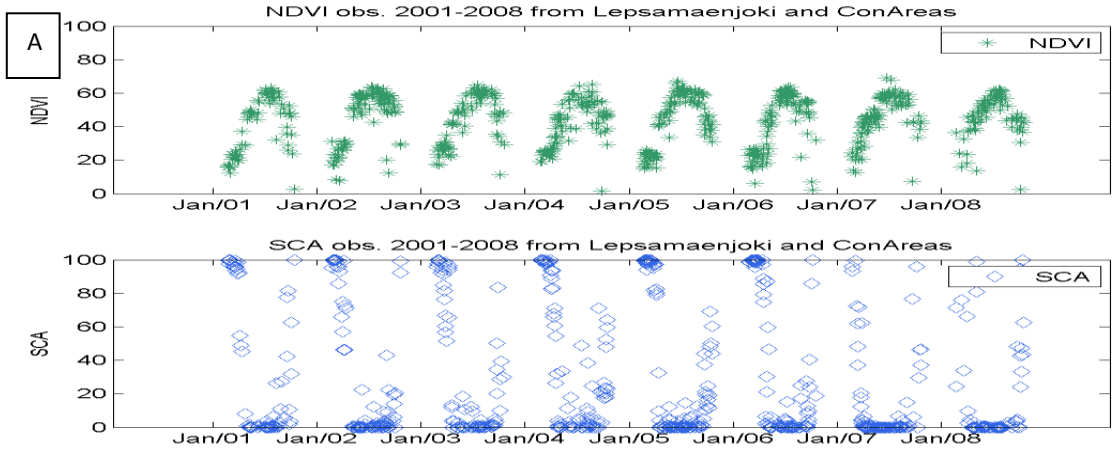


Figure 4. Time series of NDVI (green asterix) and SCA (blue circles) from the 1st order drainage basin of Lake Päijänne from the years 2001-2008 for different land use classes. Coniferous forests (A), agricultural areas (B), Broad leaved forests (C), mixed forests (D) and open peat land areas (E).

TIME SERIES OF NDVI AND SCA FROM THE 2ND DRAINAGE BASIN OF RIVER LEPSÄMÄENJOKI (2001-2008)



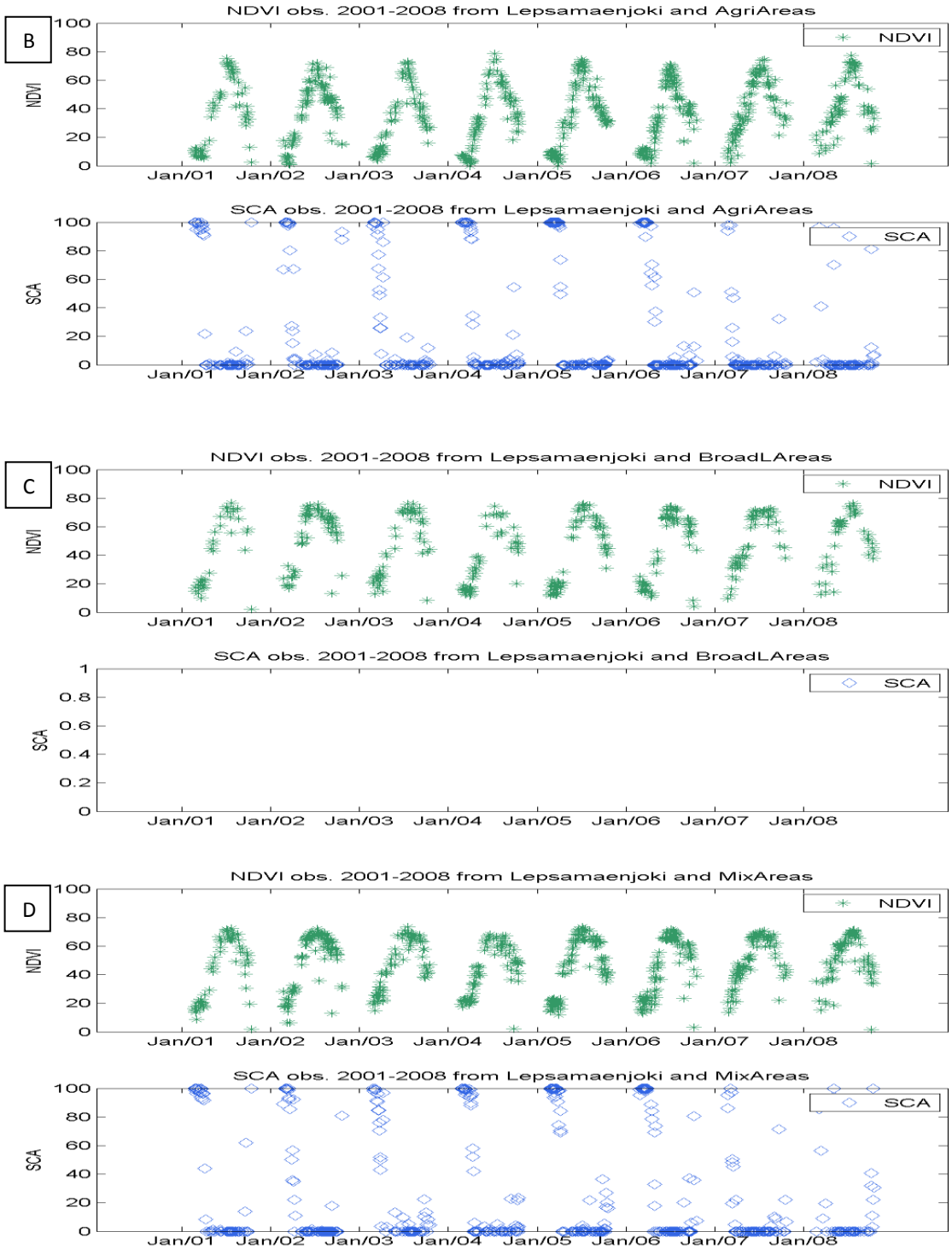
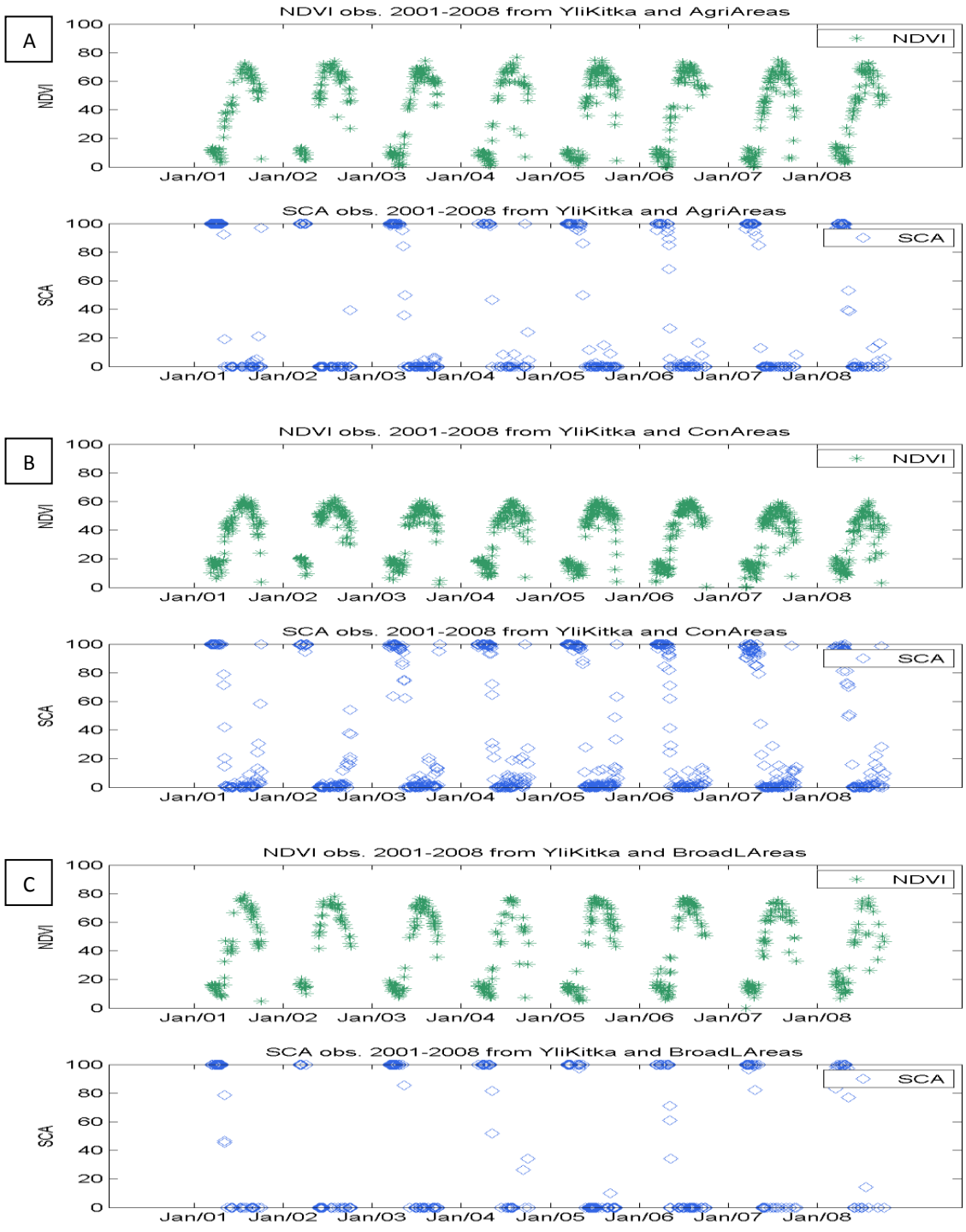


Figure 5. Time series of NDVI (green asterix) and SCA (blue circles) from the 2nd order drainage basin of Lepsämäen joki from the years 2001-2008 for different land use classes. Coniferous forests (A), agricultural areas (B), Broad leaved forests (C) and mixed forests (D). Pixels with majority land cover type of broad leaved forests did not exist in 500 m resolution that is required for SCA estimation. Pixels with majority land cover type of open peat land did not exist in larger than 250 m resolution.

TIME SERIES OF NDVI AND SCA FROM THE 2ND ORDER DRAINAGE BASIN OF LAKE YLI-KITKA (2001-2008)



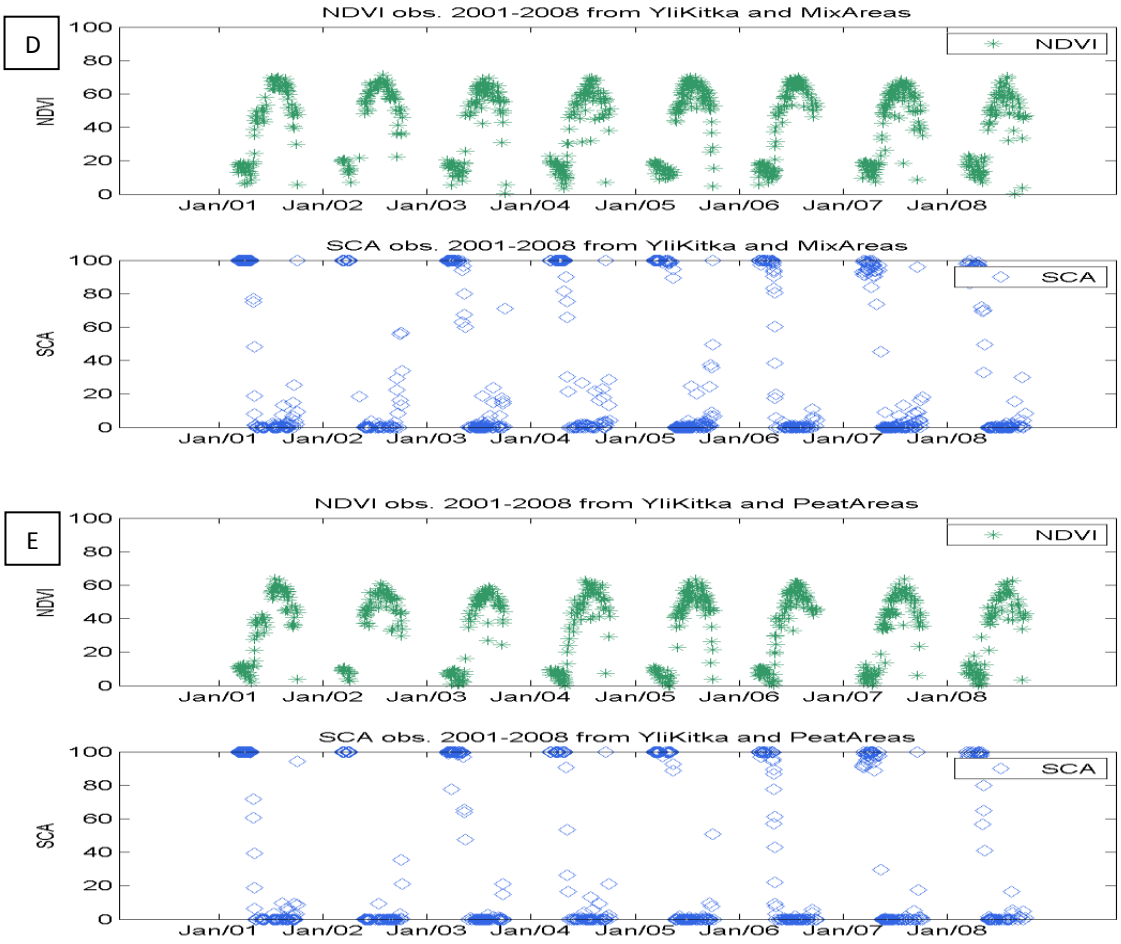
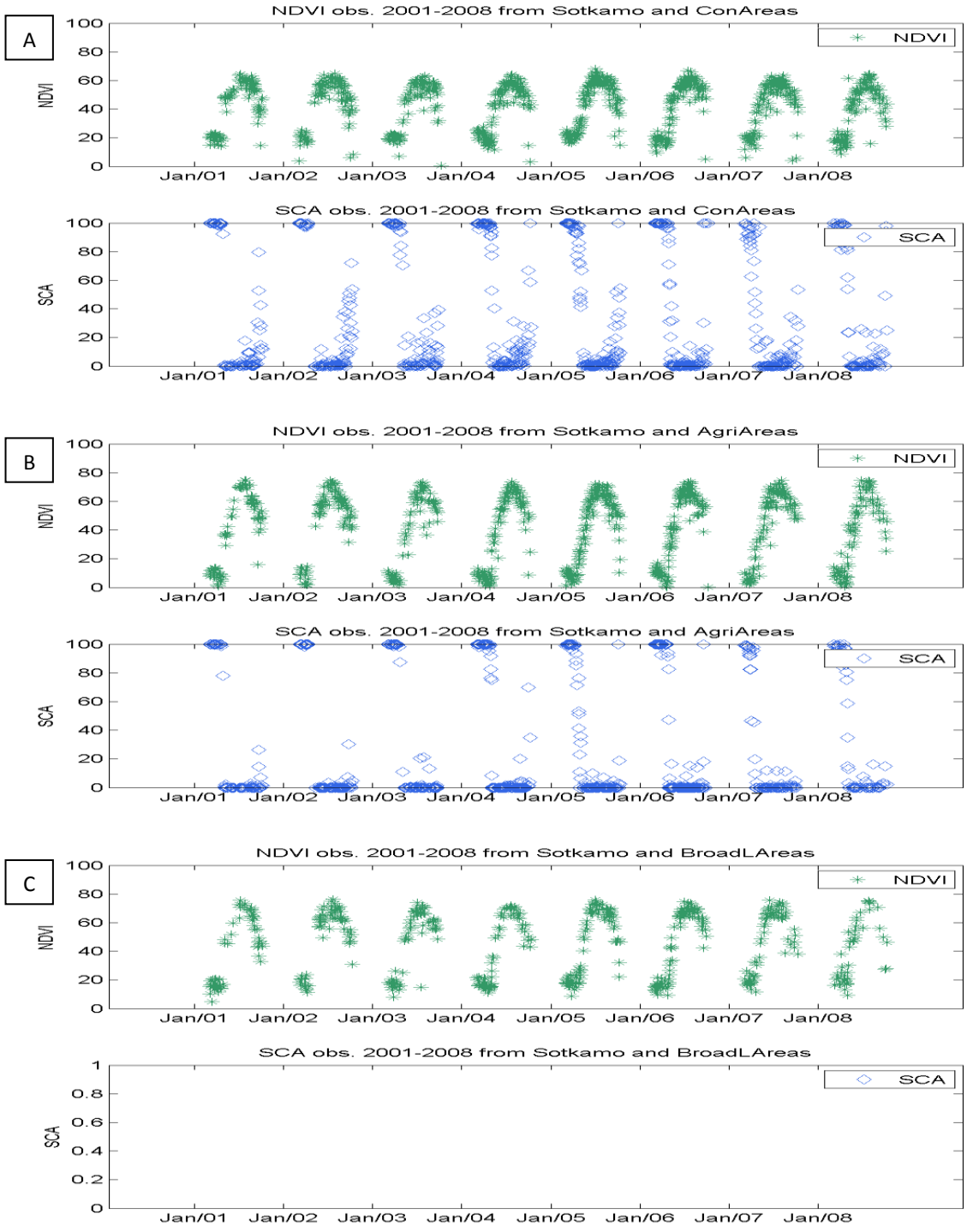


Figure 6. Time series of NDVI (green asterix) and SCA (blue circles) from the 2nd order drainage basin of Lake Yli-Kitka from the years 2001-2008 for different land use classes. Coniferous forests (A), agricultural areas (B), Broad leaved forests (C), mixed forests (D) and open peat land areas (E).

TIME SERIES OF NDVI AND SCA FROM THE FOUR 3RD ORDER DRAINAGE BASINS IN SOTKAMO AREA (2001-2008)



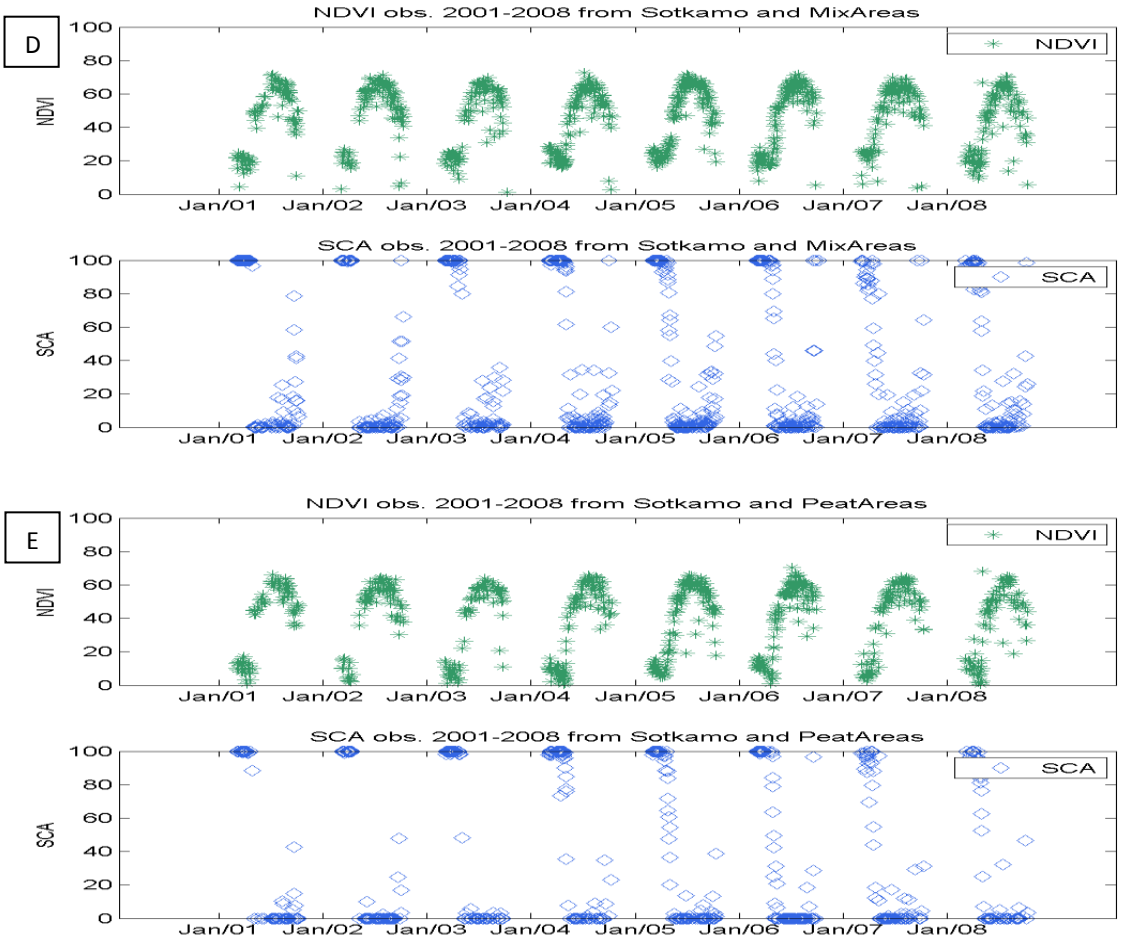


Figure 7. Time series of NDVI (green asterix) and SCA (blue circles) from four 3rd order drainage basin in Sotkamo area from the years 2001-2008 for different land use classes. Coniferous forests (A), agricultural areas (B), Broad leaved forests (C), mixed forests (D) and open peat land areas (E). Pixels with majority land cover type of broad leaved forests did not exist in 500 m resolution that is required for SCA estimation.

TIME-SERIES OF WATER QUALITY

Ecosystems in coastal water areas are highly affected by the transfer of inorganic and organic matter from the nearby drainage basins. This can cause significant variation in water quality in spatial and temporal scales. Remote sensing of coastal waters has it own difficulties due to the optically complex water properties and closeness of land areas. Time-series that are generated from these spatially extensive observations, however, can provide relevant information on seasonal changes in water quality and especially on the spatial variation.

Western Gulf of Finland LTER-site WelFin monitors water quality on several locations close to the Tvärminne biological station of University of Helsinki (Figure 7.). Areas interest include a Lappohja bay, archipelago area Stjorfjärden and Längden area more in the open sea. In Lappohja and Stjorfjärden area, land and islands limit the remote sensing observations to only few pixels.

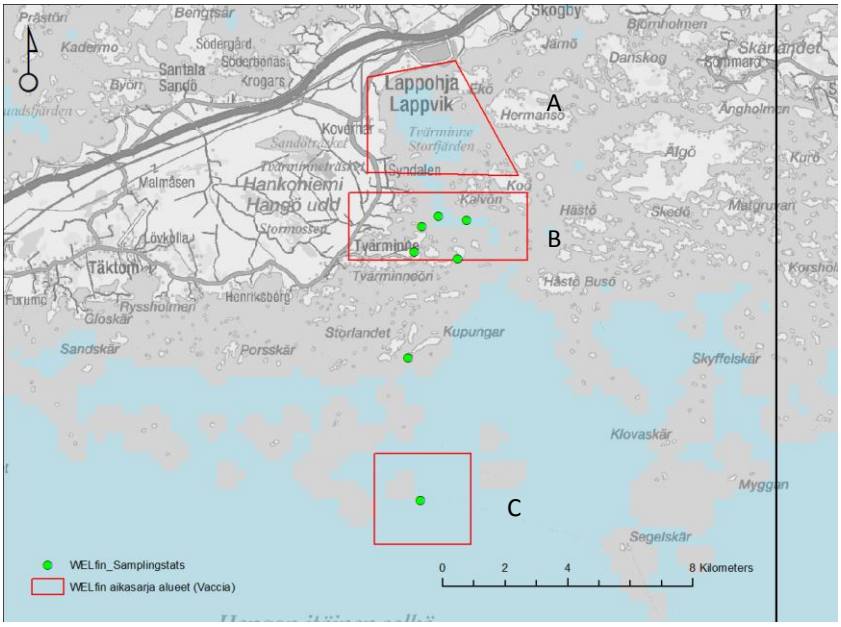


Figure 8. Areas of interest (red boxes) and sampling stations of WelFin site (dots). Lappohja (A), Stjorfjärden (B) and Längden (C).

DESCRIPTION OF THE USED REMOTE SENSING DATA AND METHODS

Finnish Environment Institute (SYKE) provides earth observation based GMES MarCoast service on the water quality from the Baltic Sea. This includes daily and weekly estimates of chlorophyll a and turbidity concentration. Estimations are based on the data from Envisat/MERIS satellite instrument provided by the European Space Agency. Satellite data is pre-processed at SYKE and operative water quality estimates are generated using semi-empirical algorithms.

PROCESS DESCRIPTION

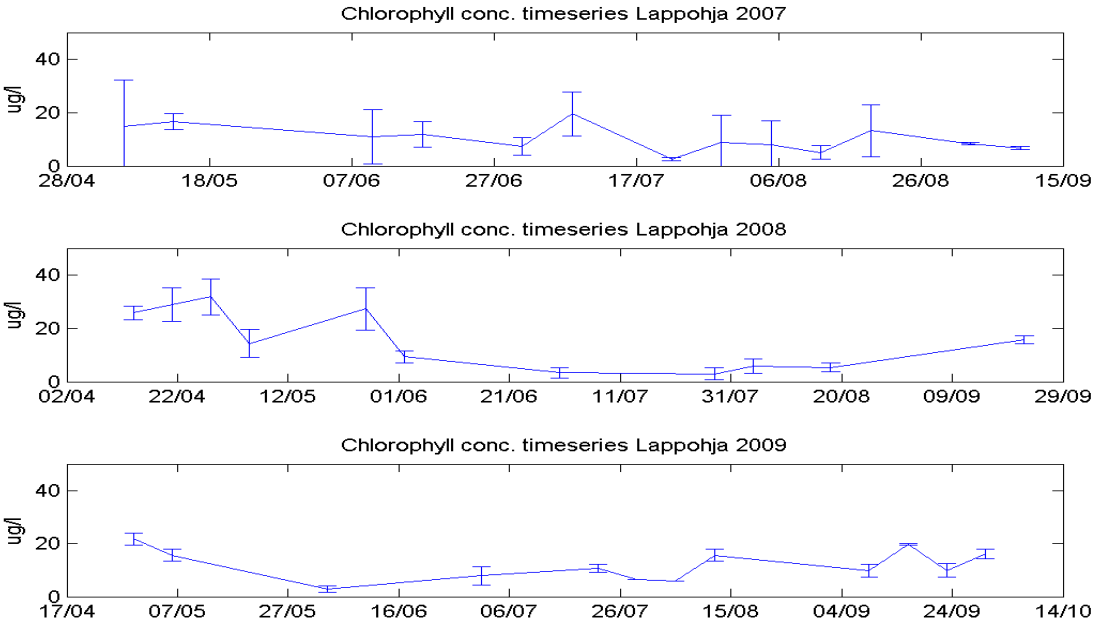
Processing of water quality time-series was based on the operative GMES MarCoast water quality products of SYKE. Water quality time-series from the three areas of interest for WelFIN LTER-site were calculated from the weekly composites of water quality estimates from years the 2007-2009. Processing flows are presented in detail in the attachments.

RESULTS

Each time-series observation is a mean value from the clear sky-pixels within each area of interest. Error bars in the time-series indicate the standard deviation of the pixel values. Time-series of turbidity were calculated only for the years 2008 and 2008 due to the lack of good quality turbidity estimates from the year 2007. ,

TIME-SERIES OF CHLOROPHYLL A CONCENTRATION FROM THE WELFIN AREAS OF INTEREST (2007-2009)

A



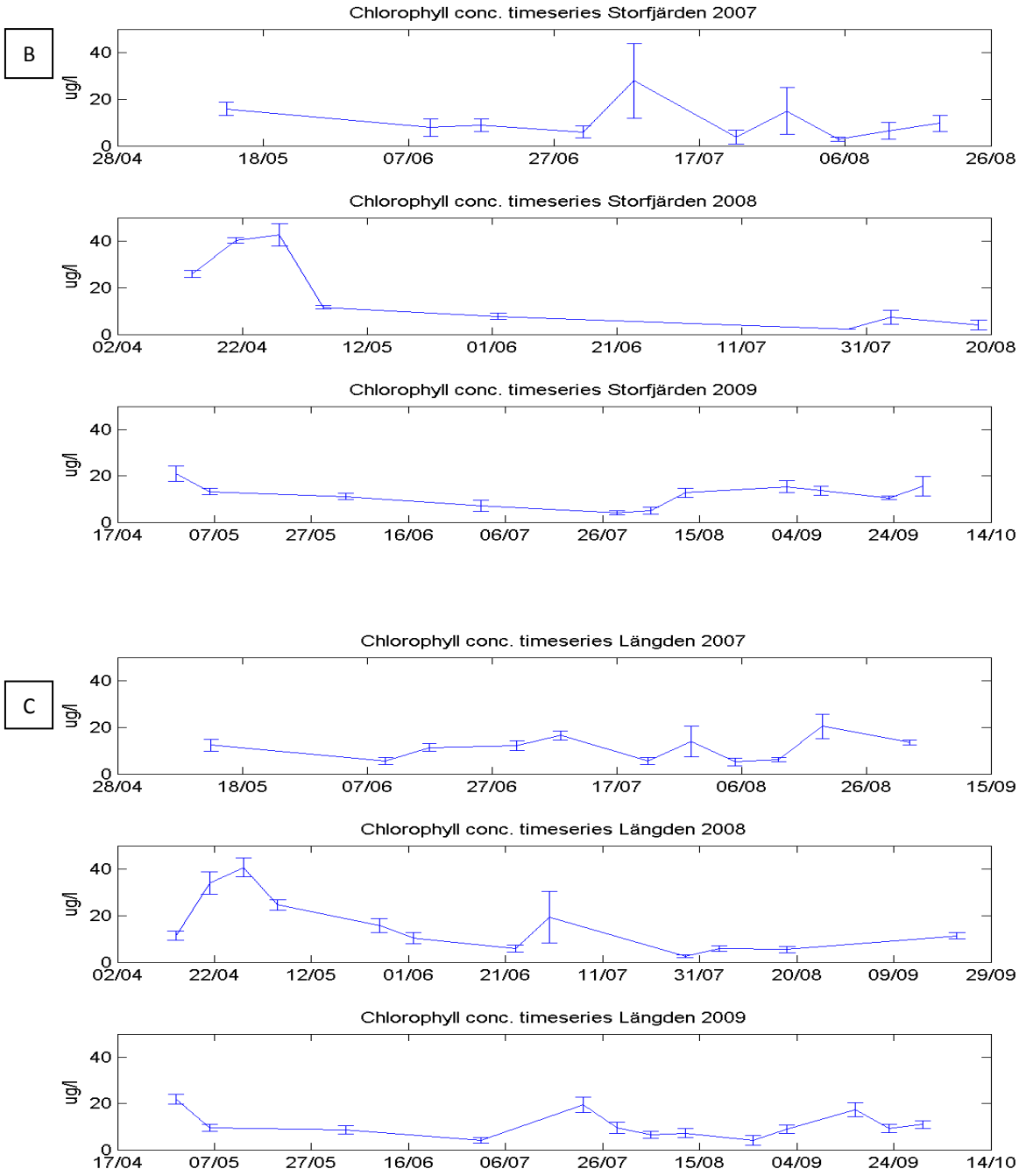


Figure 9.Time-series of chlorophyll –a concentration from 2007-2009 from Lappohja (A), Stjorfjärden (B) and Längden (C) areas of interest.

TIME-SERIES OF TURBIDITY FROM THE WELFIN AREAS OF INTEREST (2008-2009)

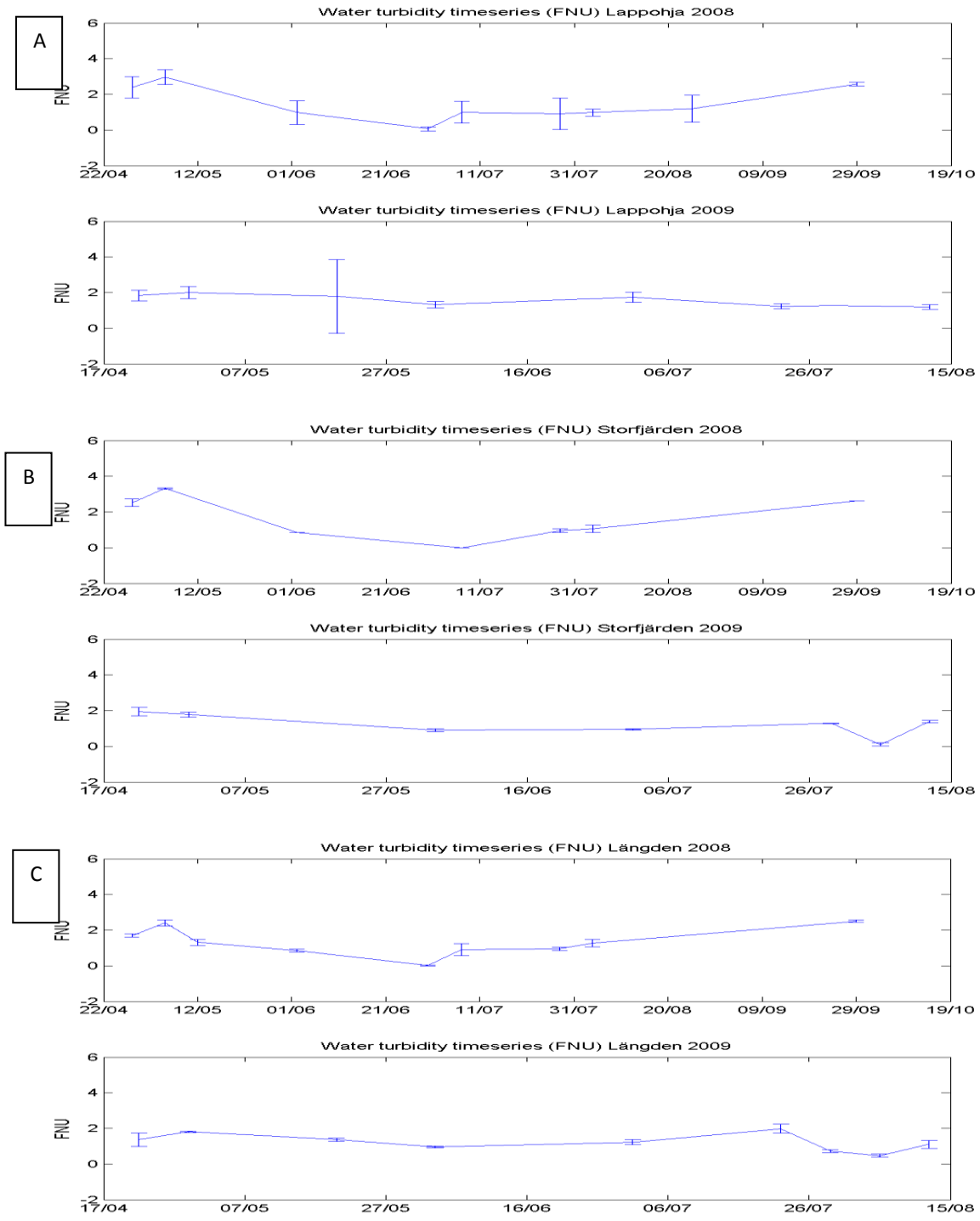


Figure 10.Time-series of turbidity from 2008-2009 from Lappohja (A), Stjorfjärden (B) and Längden (C) areas of interest.

TIME-SERIES OF LAKE SURFACE TEMPERATURE

Information on lake water temperature is essential for lake hydrology and ecosystem research. It has direct link in e.g. fisheries production and water quality on lakes. Remote sensing with current satellite instruments that are applicable in operative monitoring allows only coarse resolution observations on the lake surface temperature. It can, however, give a relative accurate mean estimate and also information on the variation in the pelagial areas of a lake.

DESCRIPTION OF THE USED REMOTE SENSING DATA, METHODS AND OTHER DATA SETS

Earth observation based water surface temperature estimation is one of the SYKEs GMES MarCoast products. Estimation is made from AVHRR satellite instrument by National Oceanic and Atmospheric Administration (NOAA). Water surface temperature is estimated using long wave nonlinear sea surface temperature (NLSST) algorithm. Algorithm was originally developed by NOAA (Sullivan *et al*, 1993) and method is widely used also in e.g. global water surface temperature estimation (e.g. http://oceancolor.gsfc.nasa.gov/DOCS/modis_sst/).

PROCESS DESCRIPTION

Processing of lake surface temperature time-series was based on the operative GMES MarCoast products of SYKE. Time-series were calculated for the 12 large lakes in Finland (Figure 11.). Processing flows are presented in detail in the attachments.

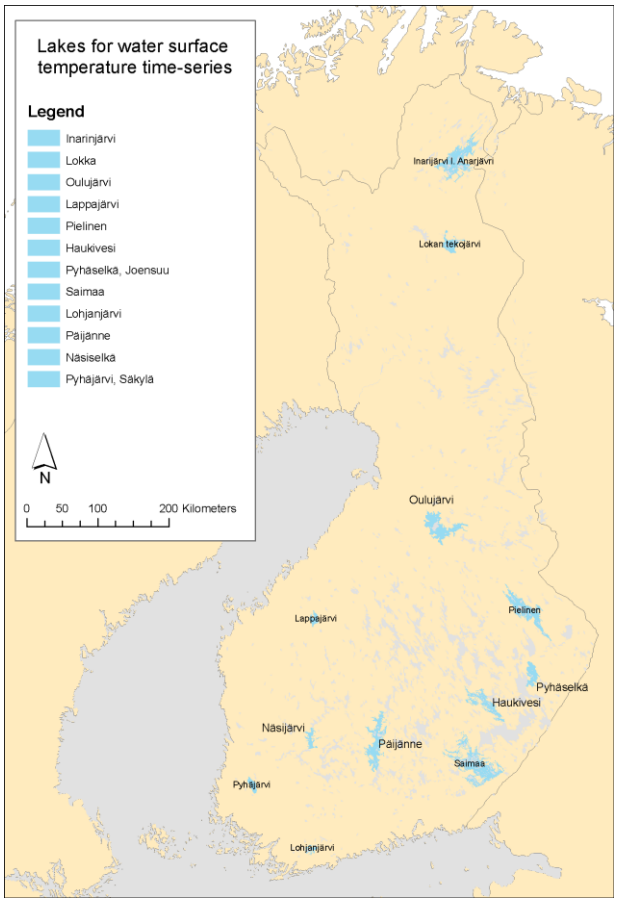


Figure 11. Lakes for water surface temperature time-series

RESULTS

Time-series include daily lake mean temperature observations from the years 2005-2009. Amount of data was hindered by the clouds and inaccuracies in the pre-processing of AVHRR data, that are typical for this relatively old satellite instrument.

TIME-SERIES LAKE SURFACE TEMPERATURE

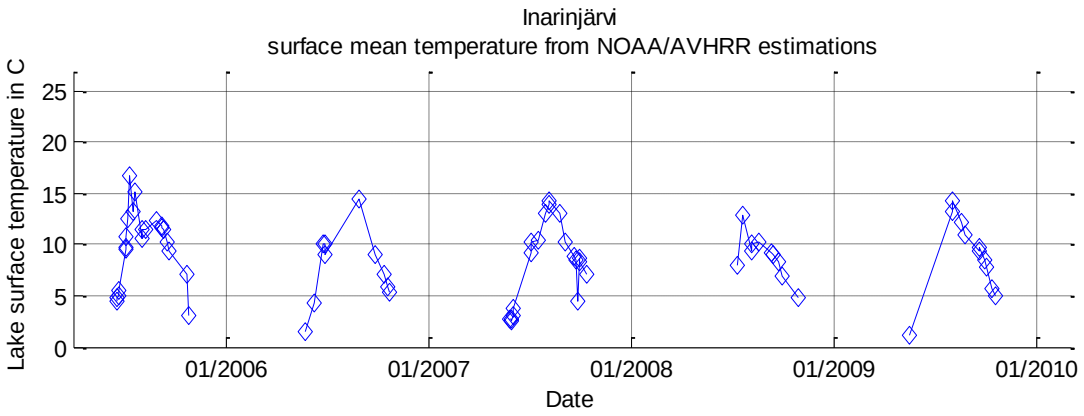


Figure 11. Time series of mean water surface temperature based on the earth observation data from Lake Inarinjärvi (2005-2009).

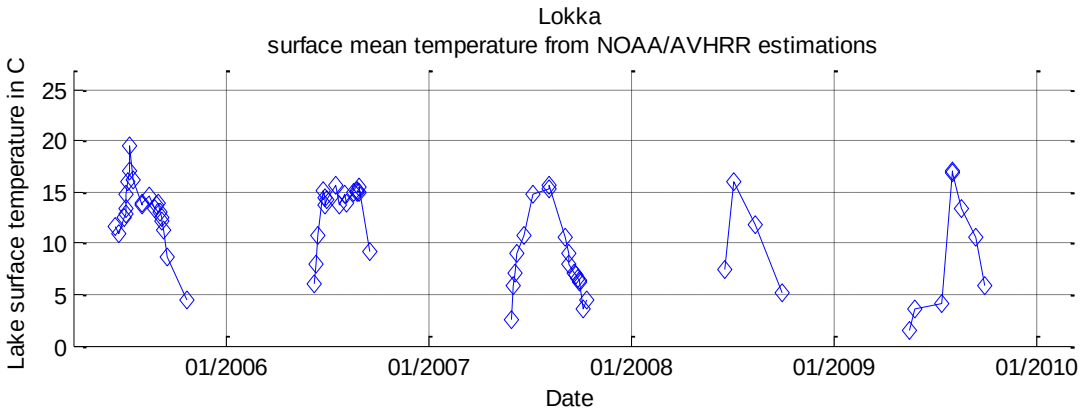


Figure 12. Time series of mean water surface temperature based on the earth observation data from Lake Lokka (2005-2009.

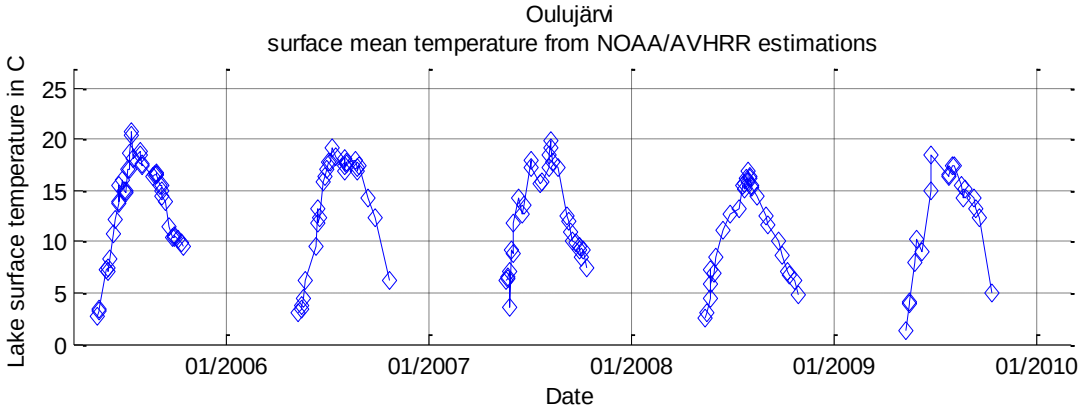


Figure 13. Time series of mean water surface temperature based on the earth observation data from Lake Oulujärvi (2005-2009.

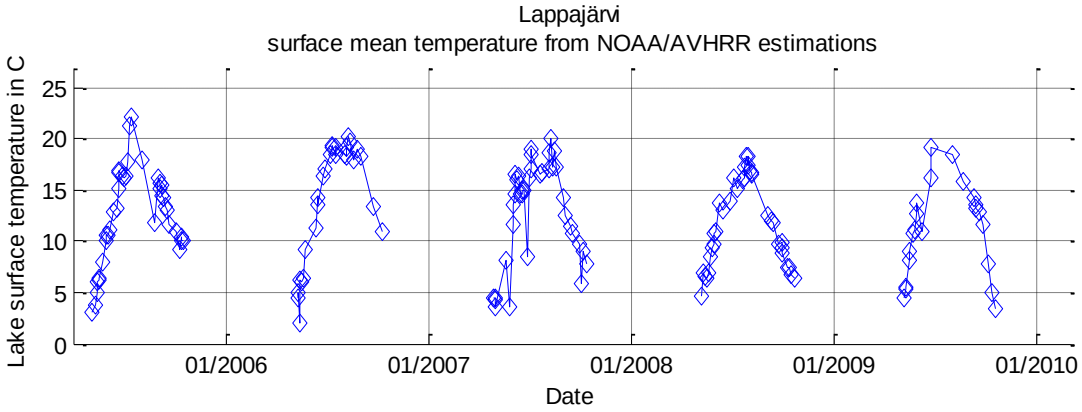


Figure 14. Time series of mean water surface temperature based on the earth observation data from Lake Lappajärvi (2005-2009.

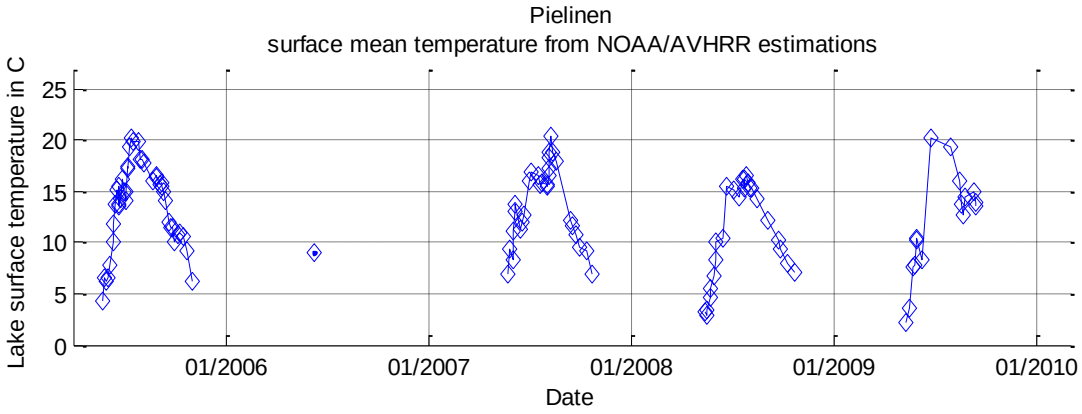


Figure 15. Time series of mean water surface temperature based on the earth observation data from Lake Pielinen (2005-2009.

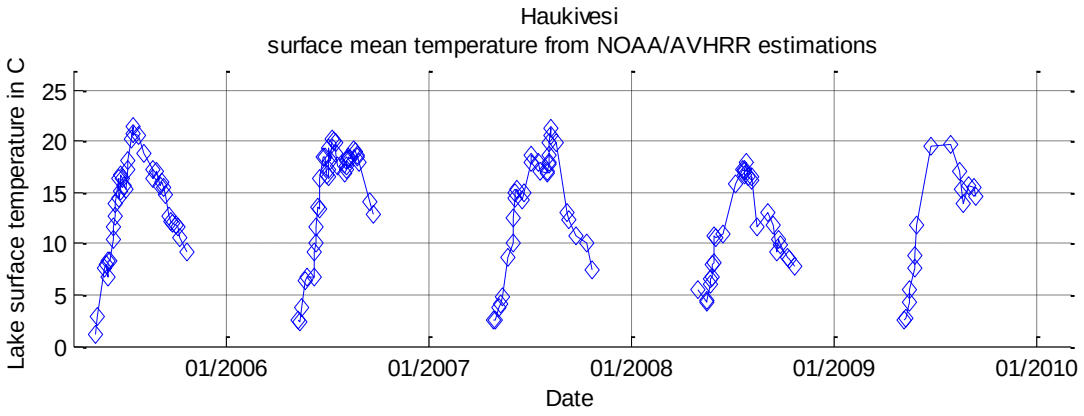


Figure 16. Time series of mean water surface temperature based on the earth observation data from Lake Haukivesi (2005-2009.

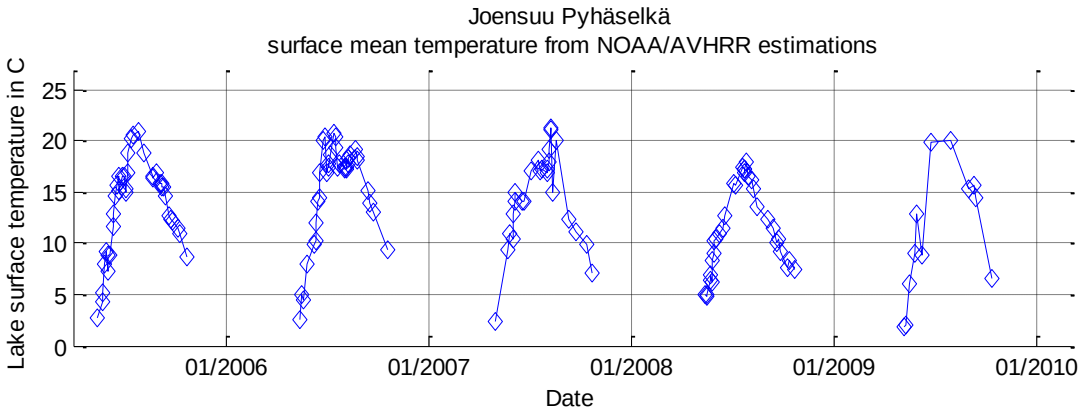


Figure 17. Time series of mean water surface temperature based on the earth observation data from Lake Pyhäselkä in Joensuu (2005-2009.

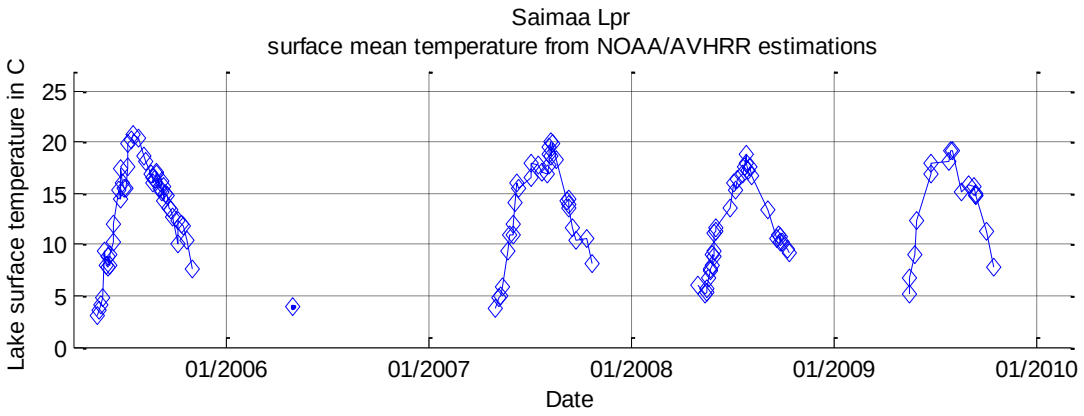


Figure 18. Time series of mean water surface temperature based on the earth observation data from Lake Southern areas of Lake Saimaa (2005-2009.

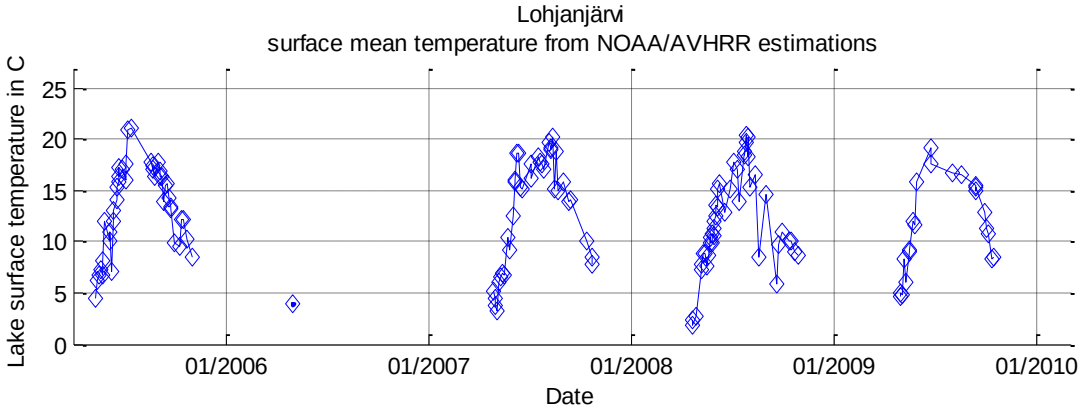


Figure 19. Time series of mean water surface temperature based on the earth observation data from Lake Lohjajärvi (2005-2009.

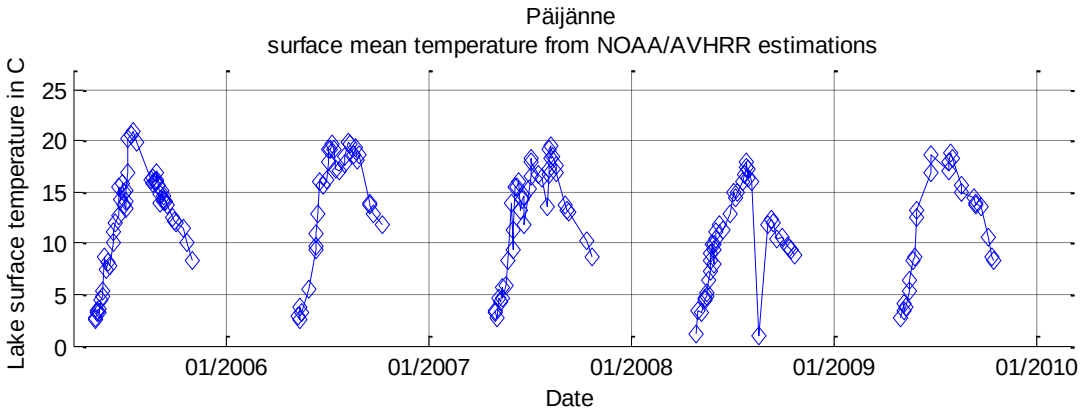


Figure 20. Time series of mean water surface temperature based on the earth observation data from Lake Päijänne (2005-2009.

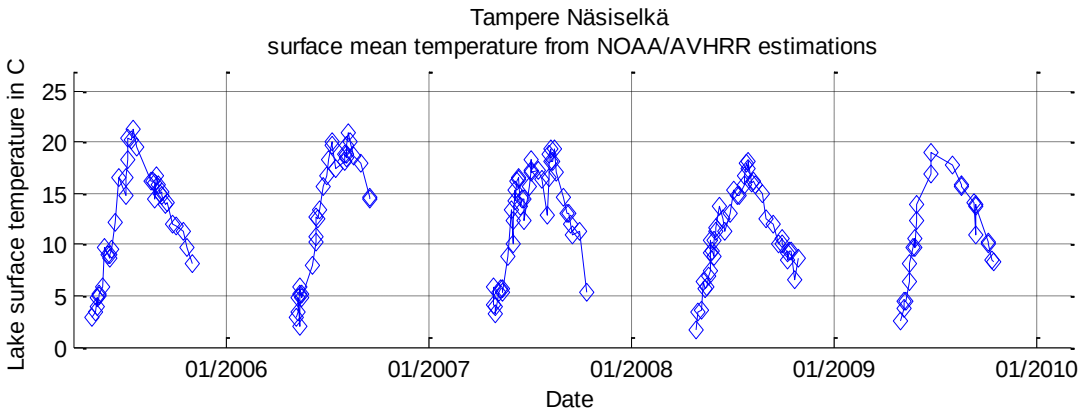


Figure 21. Time series of mean water surface temperature based on the earth observation data from Näsiselkä basin in Lake Näsi (2005-2009.

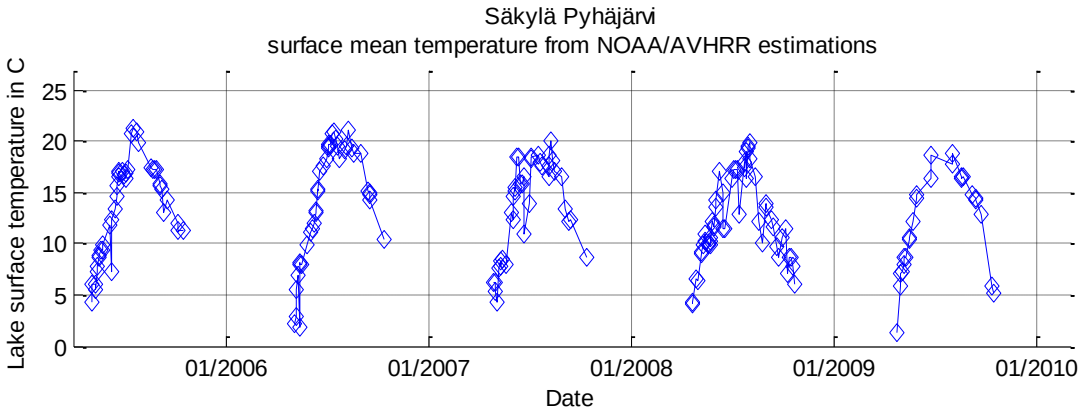


Figure 22. Time series of mean water surface temperature based on the earth observation data from Lake Pyhäjärvi in Säkylä (2005-2009.

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Sullivan, J., C.Walton, J.Brown, and R.Evans, 1993, Nonlinearity corrections for the thermal infrared channels of the Advanced Very High Resolution Radiometer:Assessment and recommendations. *NOAA Tech.Rep.NESDIS* 69, 31pp. [Available from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, DC 20233.]

ATTACHMENTS

1. VACCIADeliverable1_ProcessFlowCharts.pdf
2. VACCIADeliverable1_ProcessFlowChartDefinitions.pdf

VULNERABILITY ASSESSMENT OF ECOSYSTEM SERVICES FOR CLIMATE CHANGE IMPACTS AND ADAPTATION (VACCIA)

Deliverable 1: Time-series of Earth Observation data
(snow melt, phenology, snow, water quality and lake surface temperature)

Process flow charts

Saku Anttila
24.2.2010

VACCIA

SYKE

General

- Process flows charts to create time-series for the FinLTSER-site areas of interest
- Time-series parameters : phenology, snow cover, water quality and lake surface temperature
- Function and data/product referred in attached file (VACCIADeliverable1_ProcessFlowChartDefinitions.pdf)

VACCIA

SYKE

0 Overview

EO Data from the data provider

Pre-processing & Cloud masking

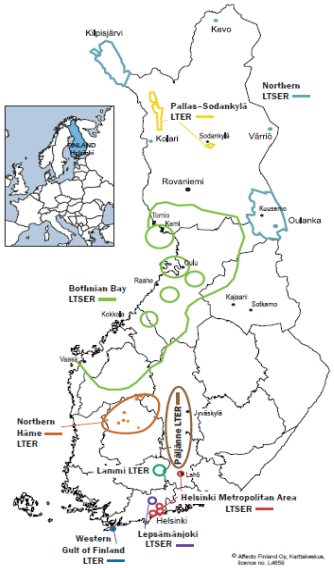
L1

Rectified and calibrated EO Data

EO product calculation

L2

FinLTSER network



EO products (NDVI, SCA, SST, WQ)

Creation and interpretation of time series from the AoIs

L3

Results from time series analysis

L4

VACCIA

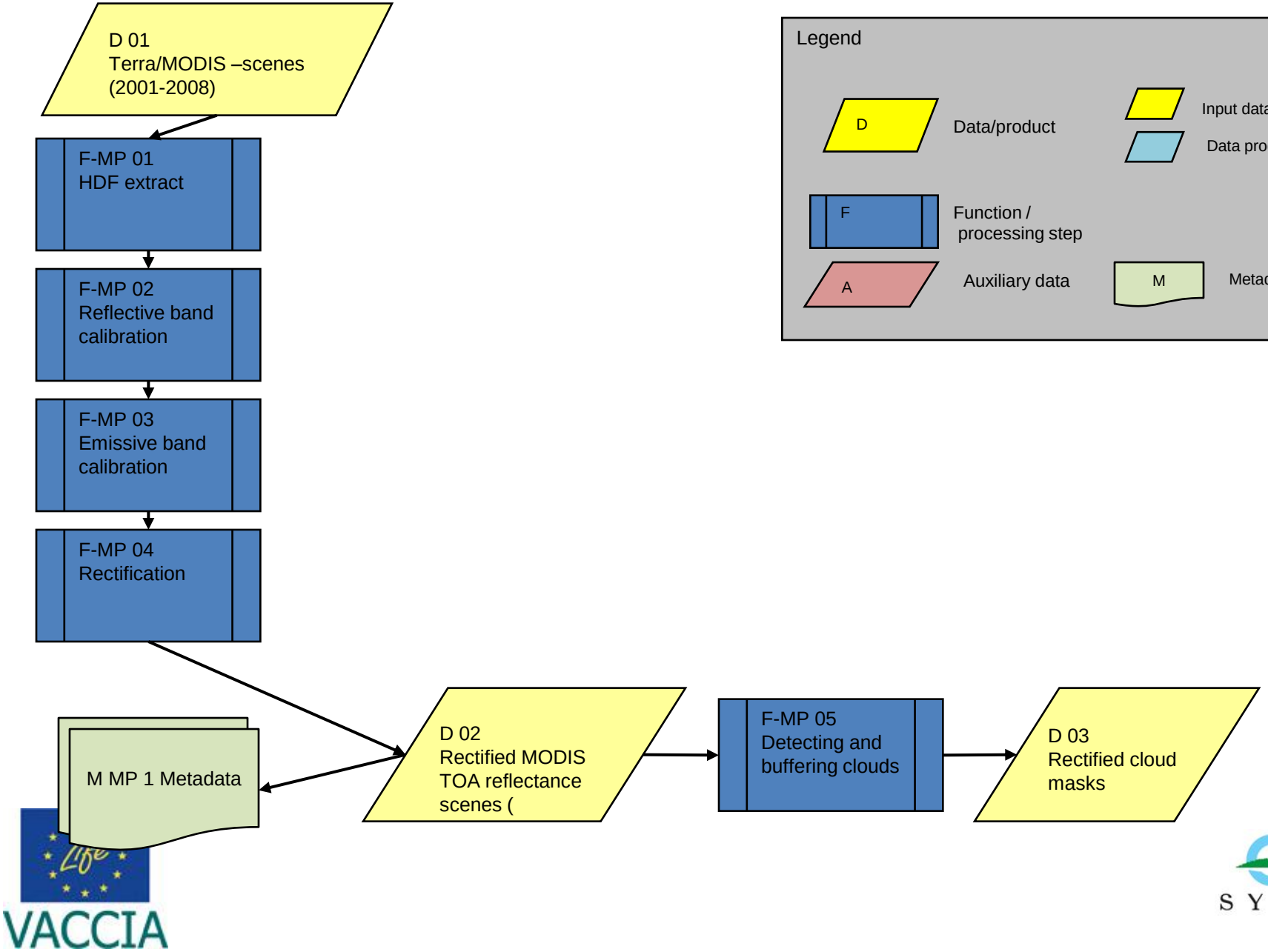
SYKE

1. Processing of NDVI and SCA time-series from the Terra/MODIS data

VACCIA

SYKE

1.1 Terra/MODIS data pre-processing



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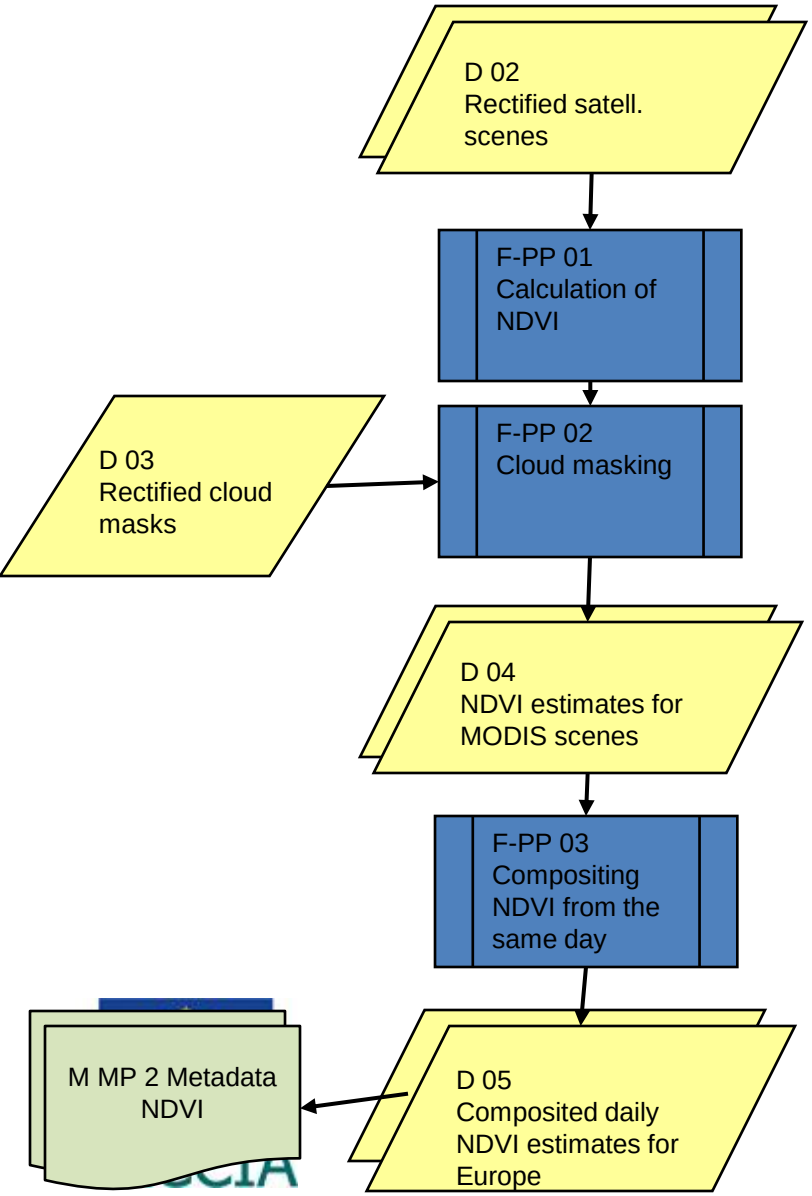
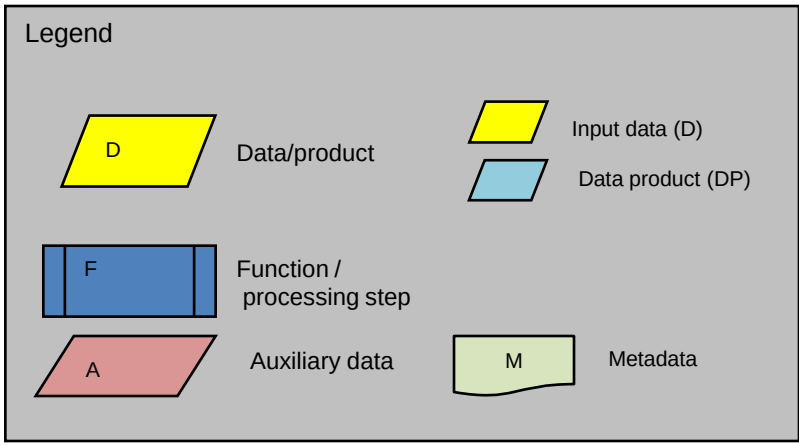
SYKE

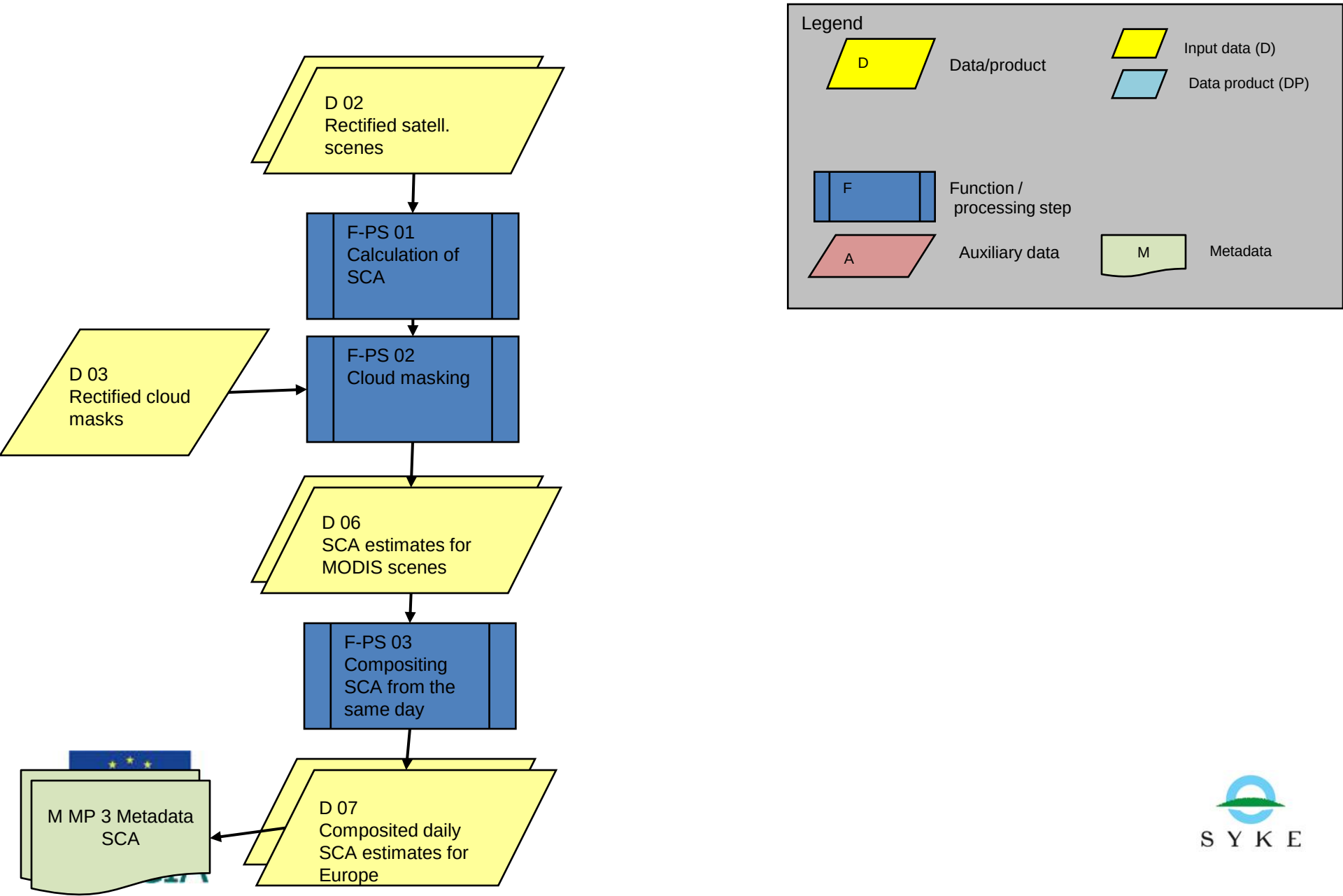
1.2 NDVI calculation and compositing (MODIS)





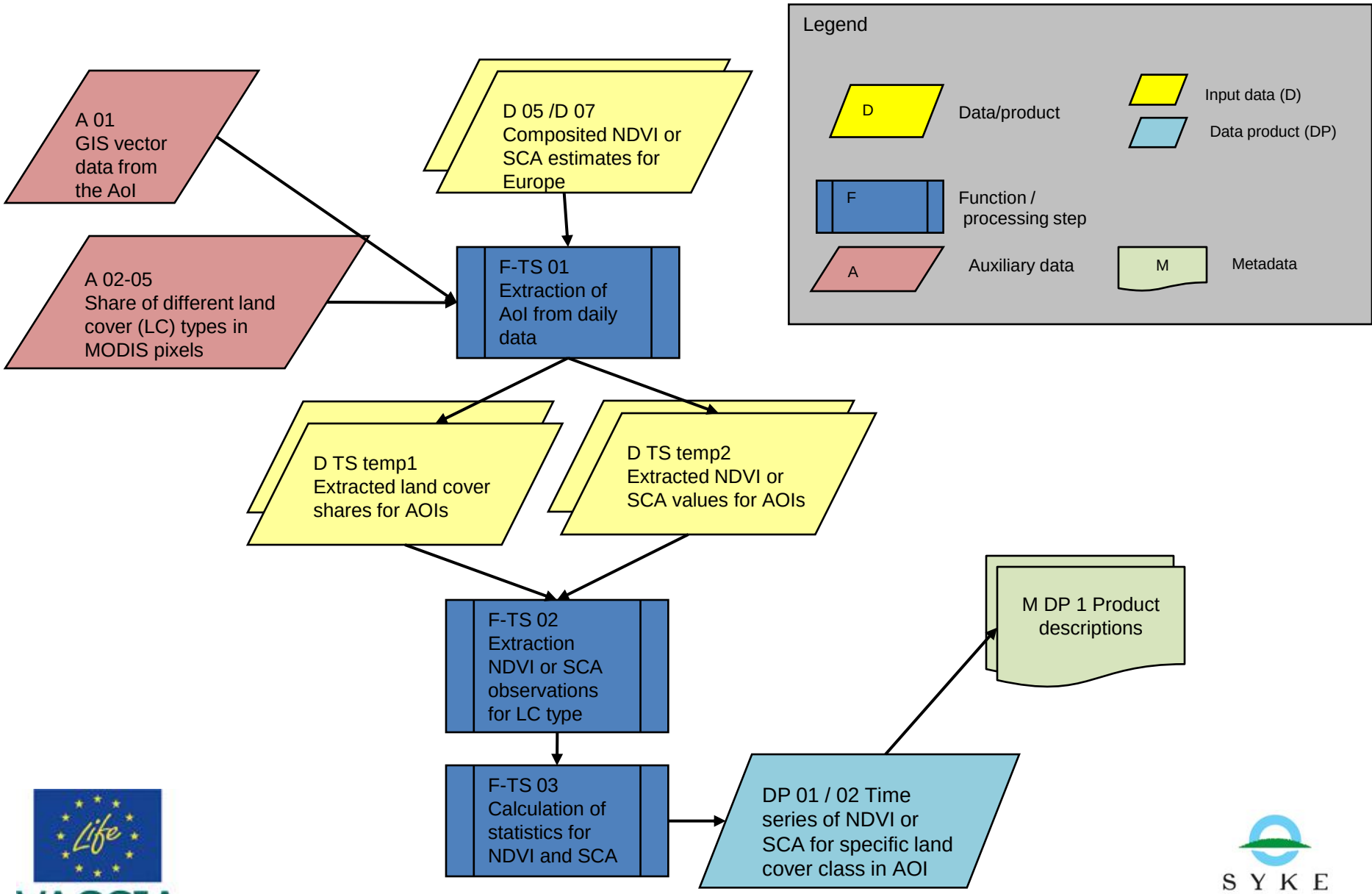
SYKE

1.3 SCA calculation and compositing (MODIS)



SYKE

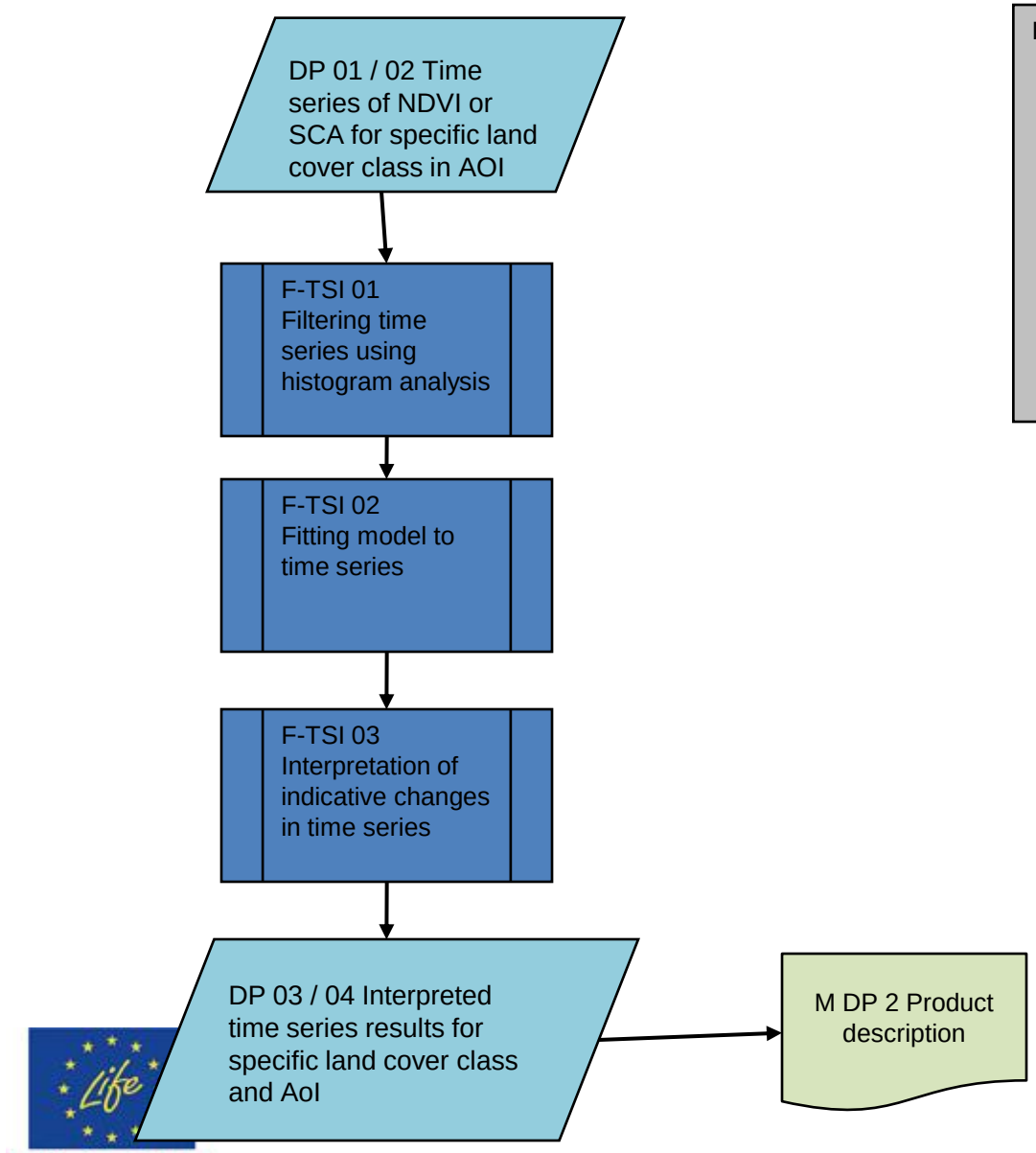
1.4 Calculation of site and land cover specified time series for NDVI and SCA

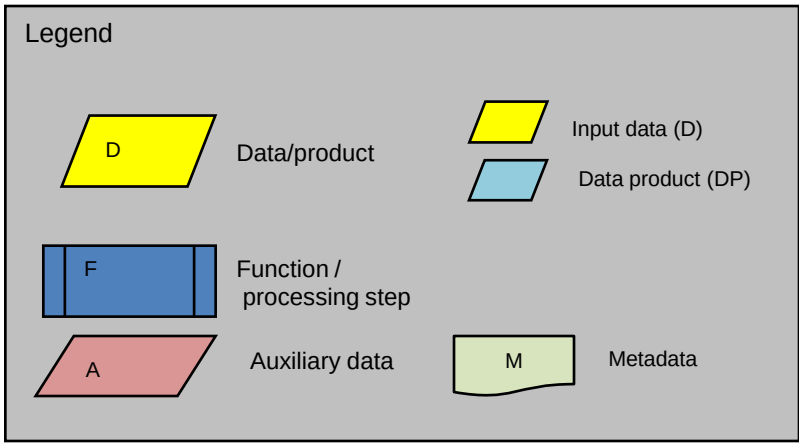


VACCIA

SYKE

1.5 Processing and interpreting time series





VACCIA

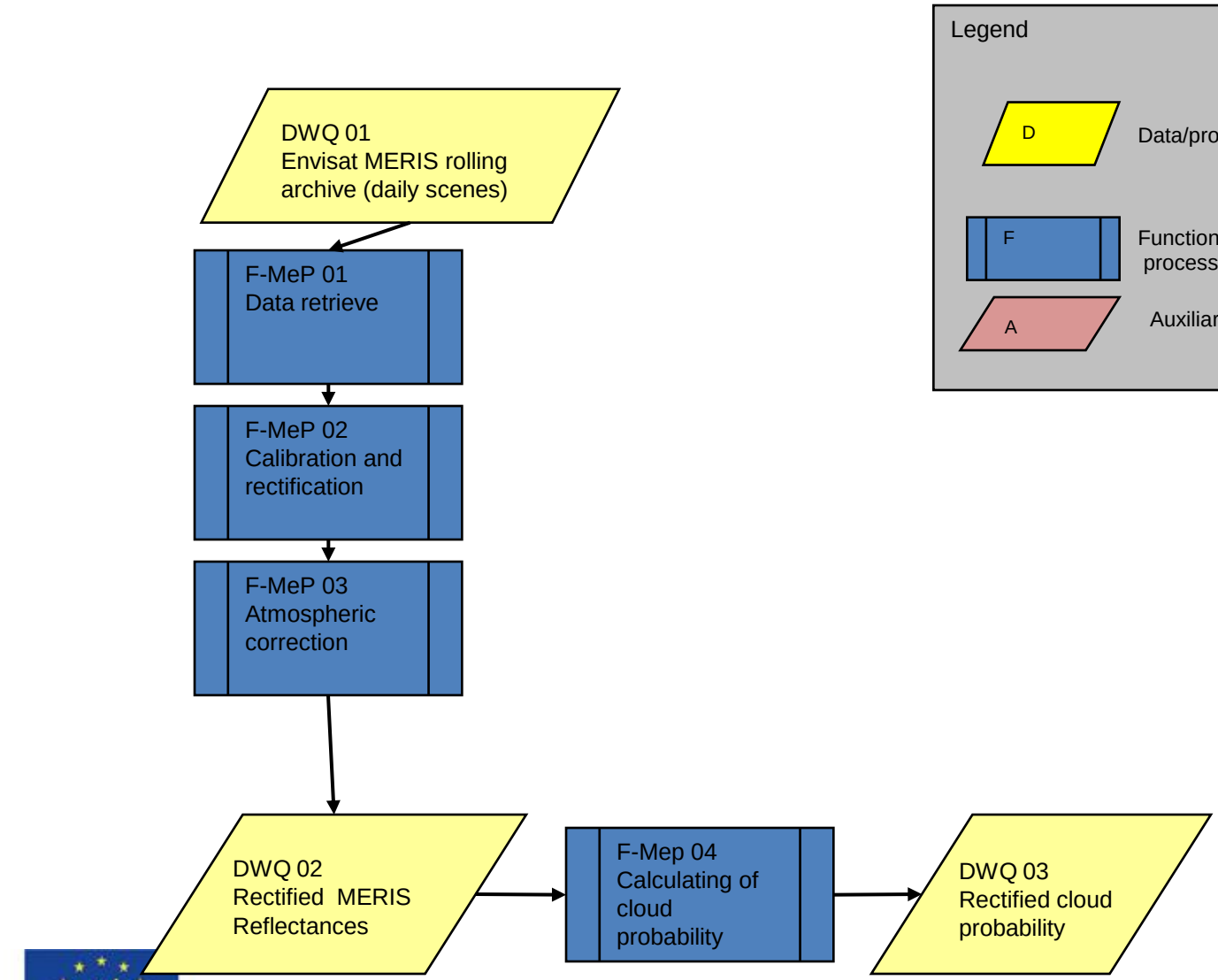
SYKE

2. Processing of water quality time-series from the Envisat/MERIS data

VACCIA

SYKE

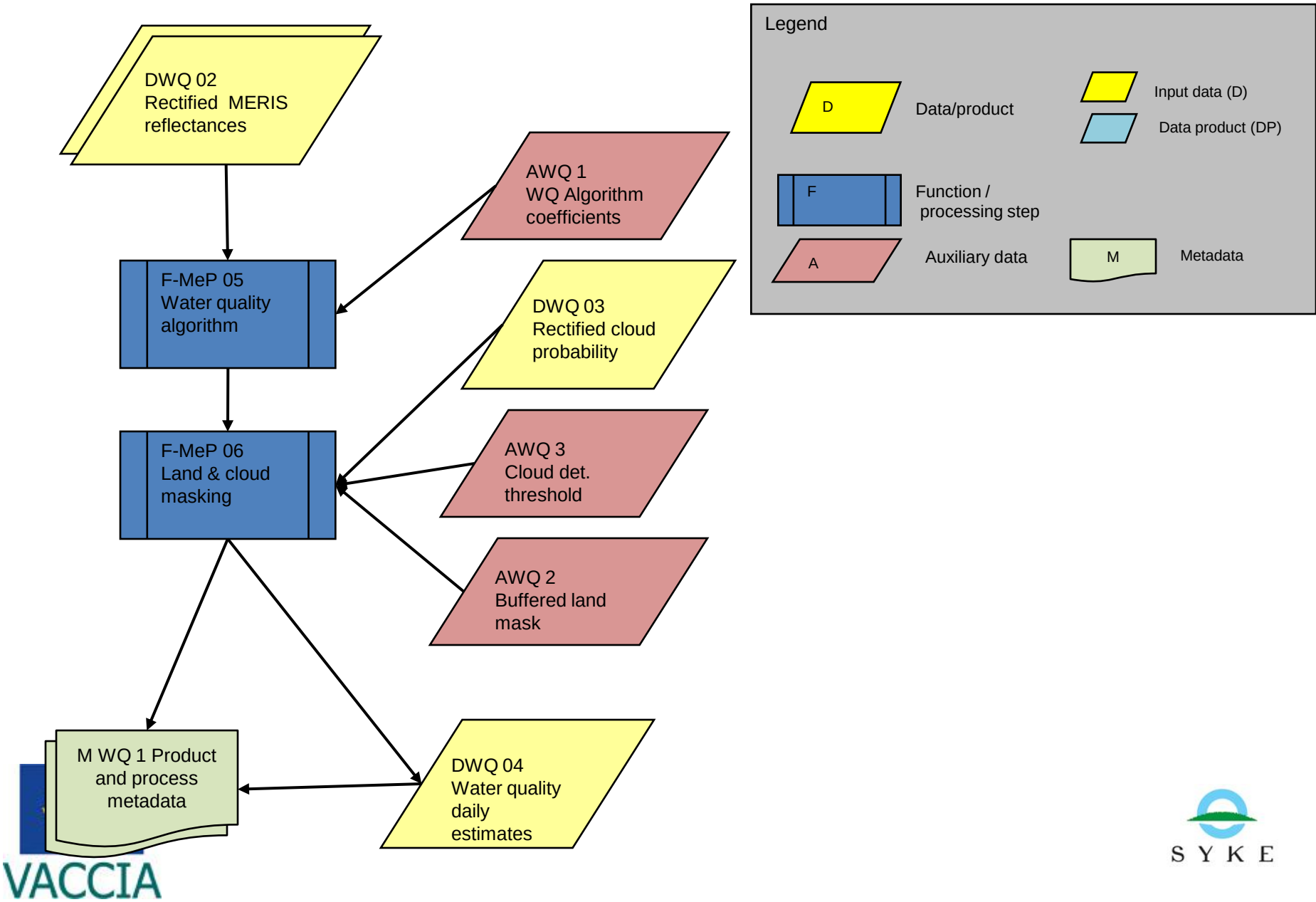
2.1 MERIS data pre-processing (operative processing)



VACCIA

SYKE

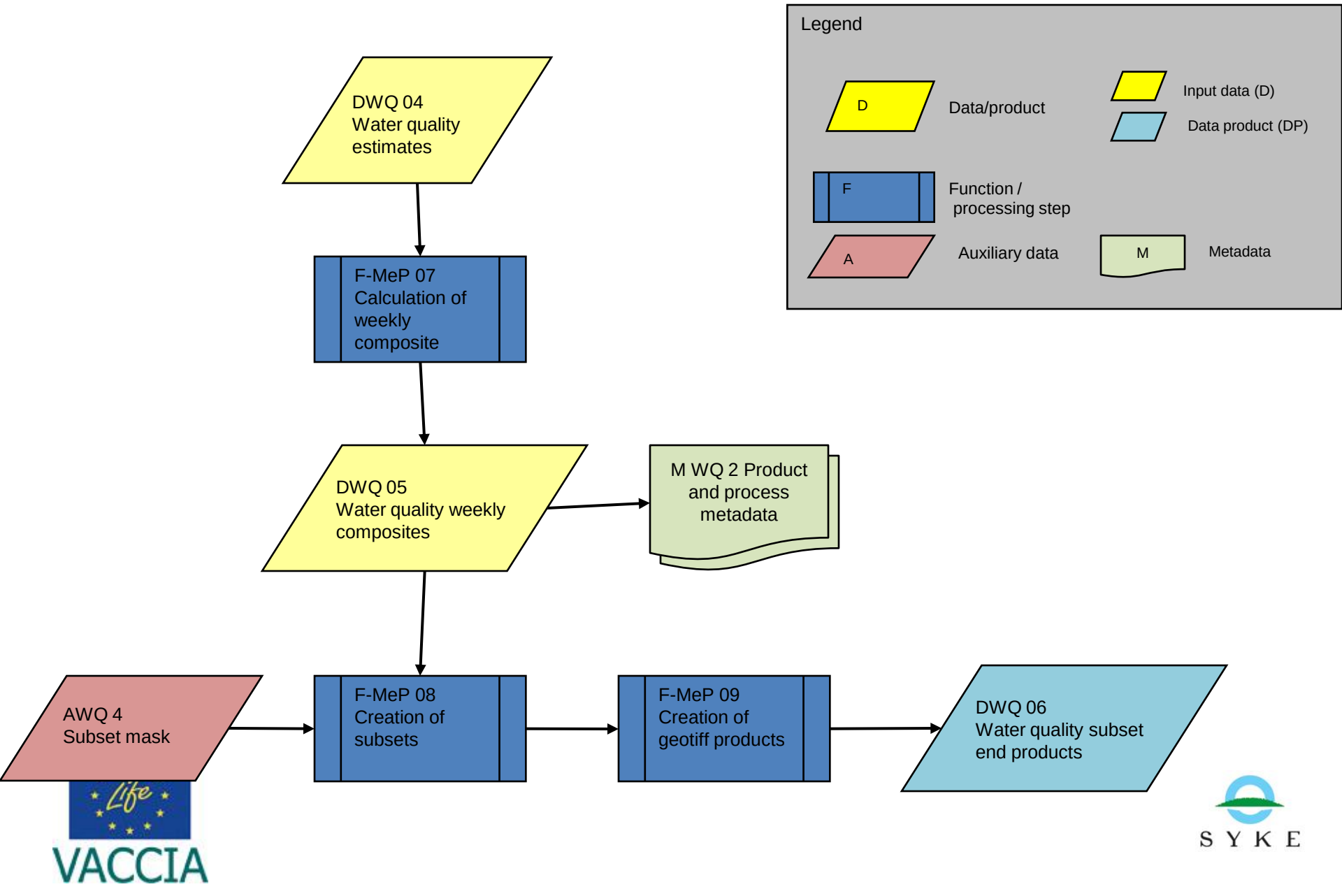
2.2 Water quality daily estimates (operative processing)



VACCIA

SYKE

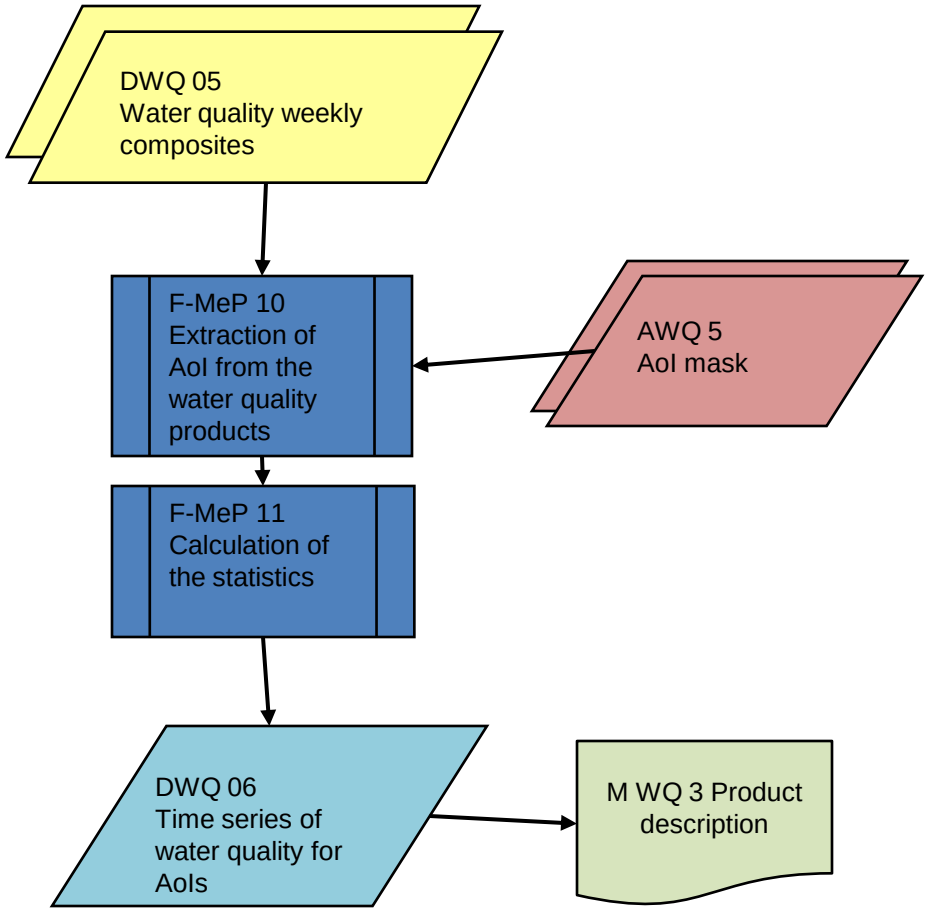
2.3 Water quality weekly composites (operative processing)

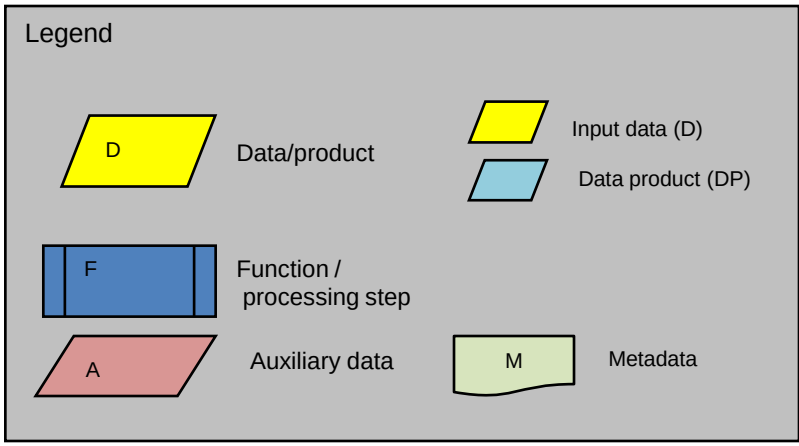


VACCIA

SYKE

2.4 Water quality time series calculation





VACCIA

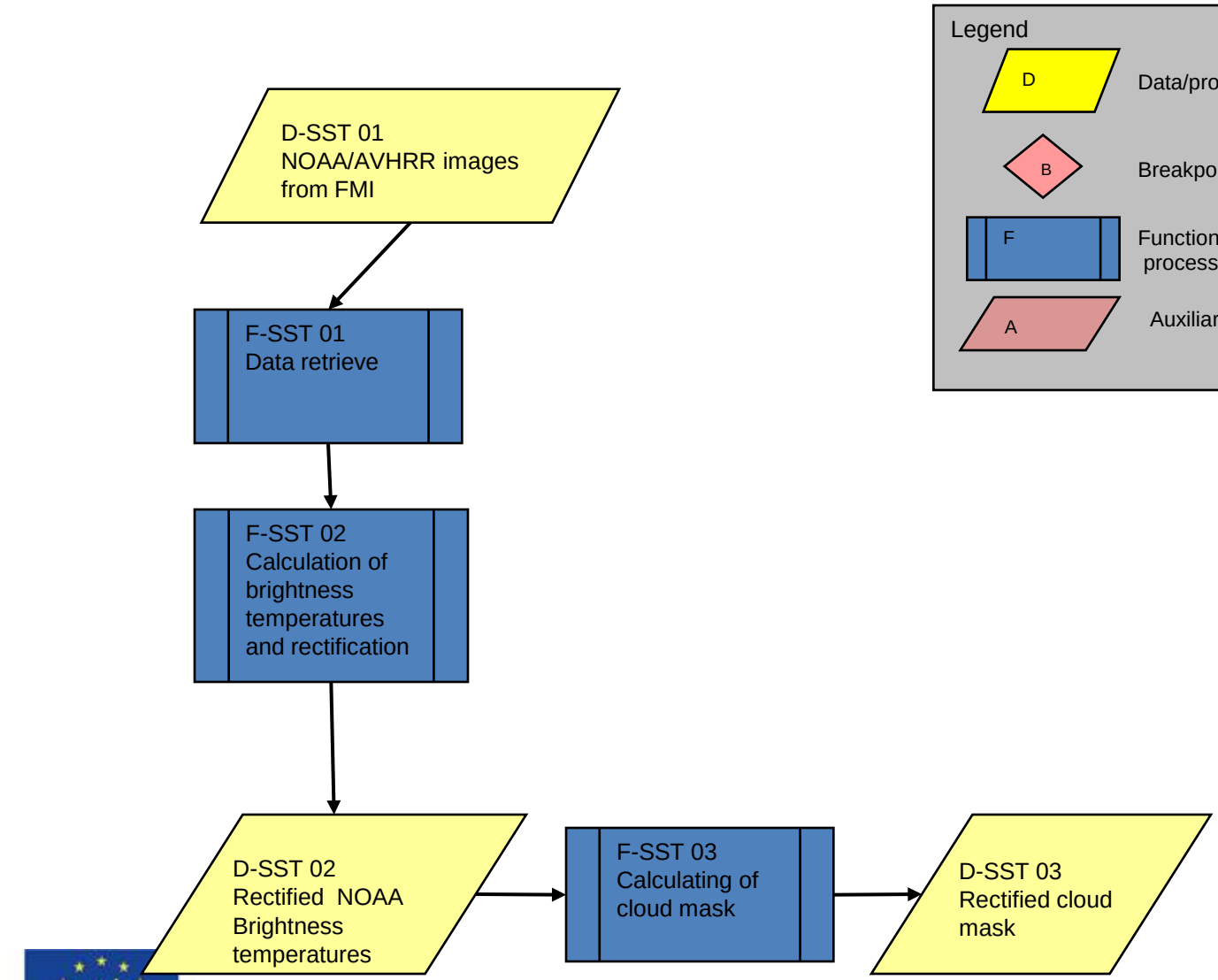
SYKE

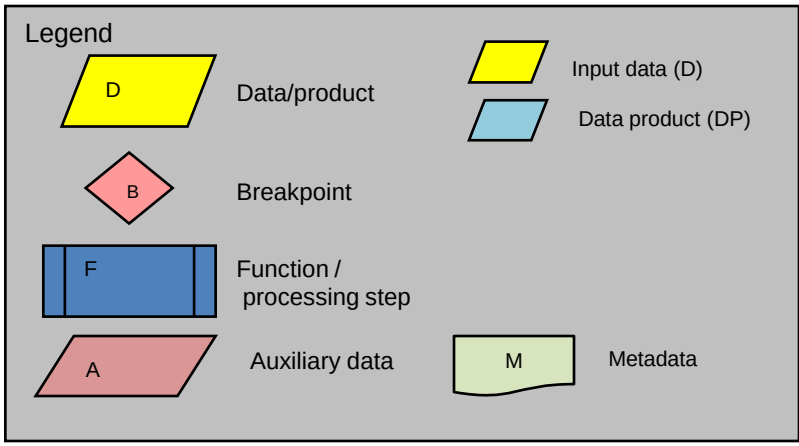
3. Processing of lake surface temperature time-series from the NOAA/AVHRR data

VACCIA

SYKE

3.1 AVHRR data pre-processing (operative processing)

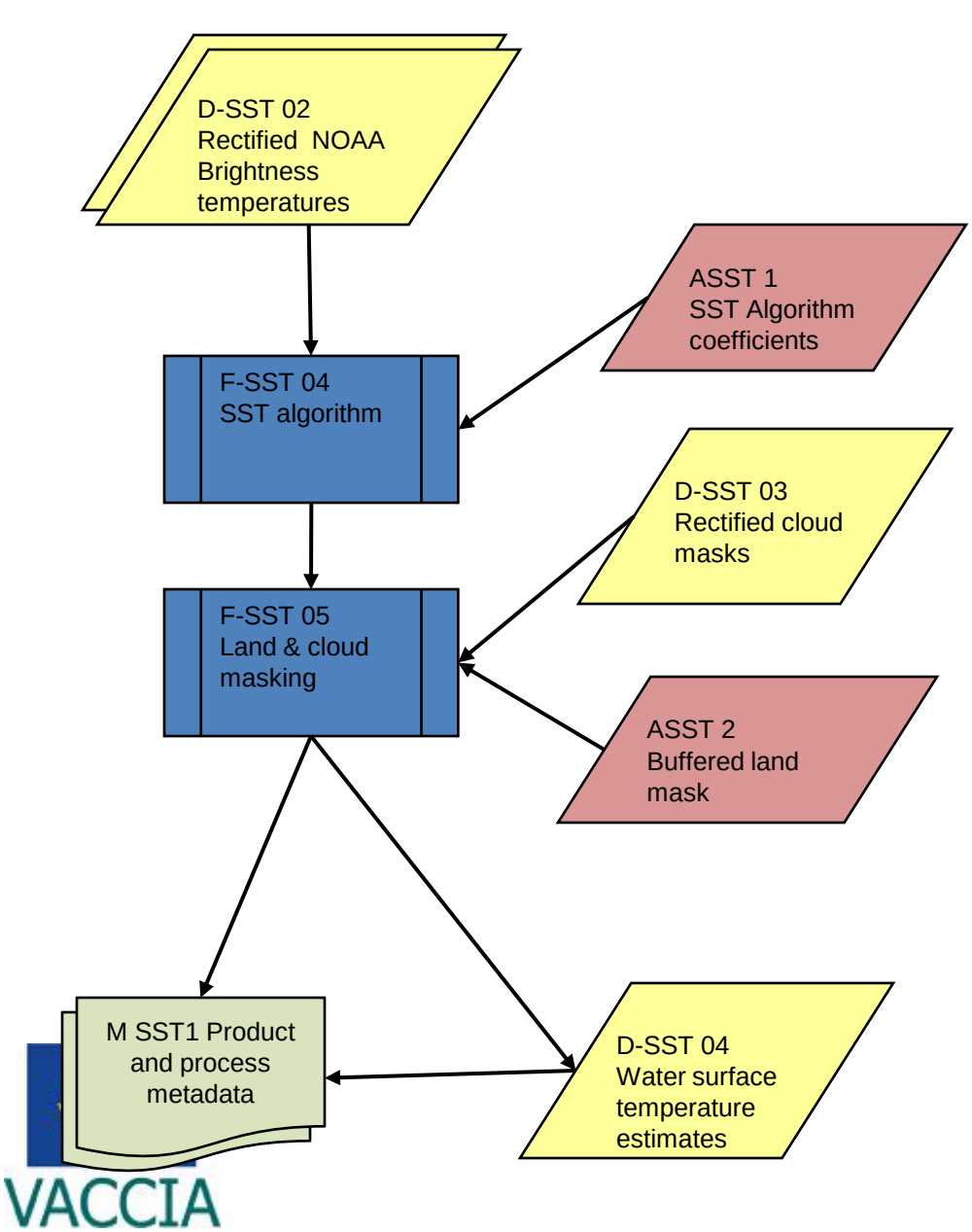


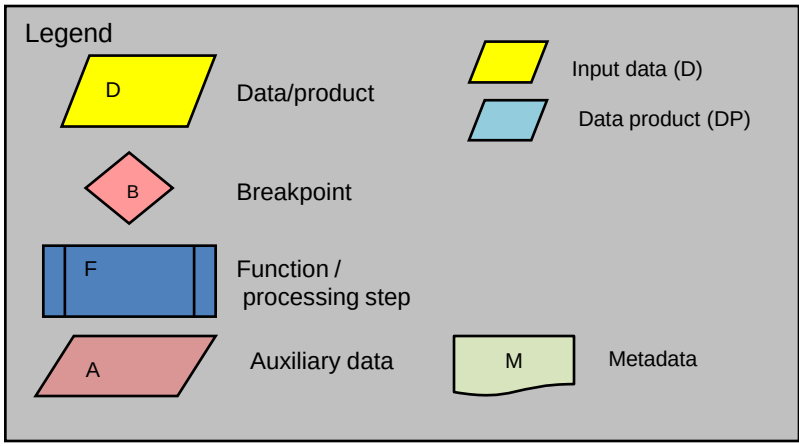


VACCIA

SYKE

3.2 Water surface temperature calculation (operative processing)

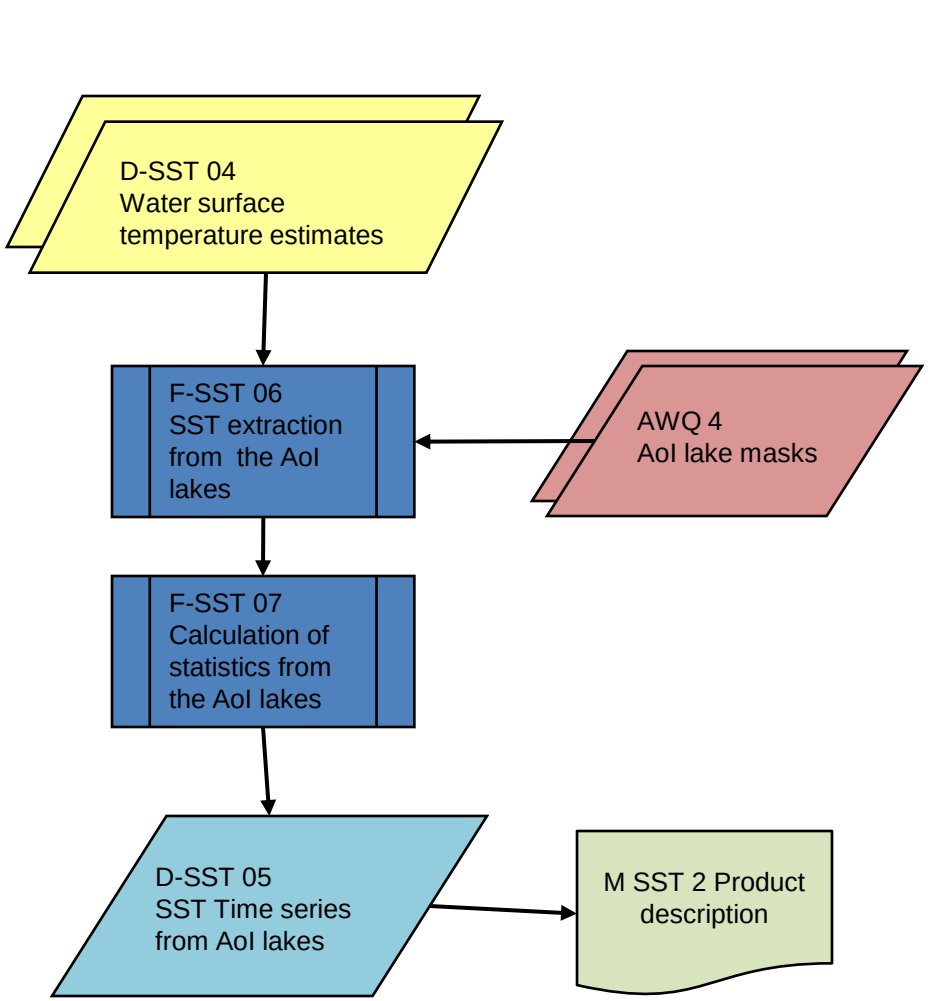


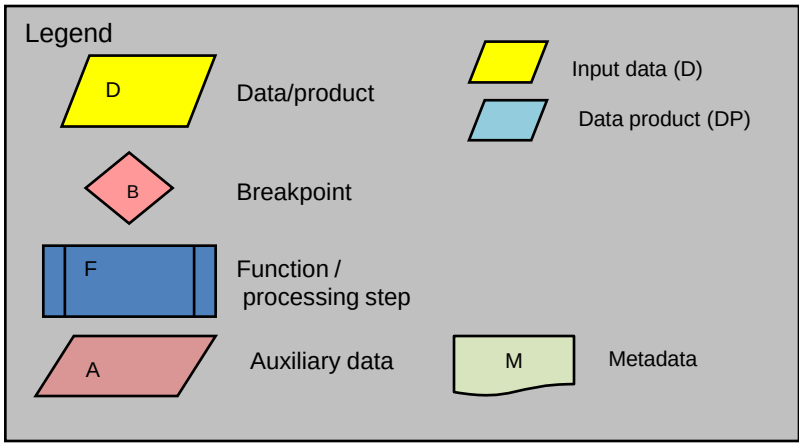


VACCIA

SYKE

3.3 Lake surface temperature time series calculation





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Vulnerability assessment of ecosystem services for climate change impacts and adaptation (VACCIA)

Action 2: Derivation of GMES-related remote sensing data

Deliverable 1: Time-series of Earth Observation data (snow melt, phenology, snow, water quality and lake surface temperature)

Processing flow definition: Processing chain for phenology,snow melt, water quality and lake surface temperature

Process flow charts are presented in the separated file (VACCIADeliverable1_ProcessFlowCharts.pdf)

Author: Saku Anttila (SYKE/GEO)
Validity: 2010

1. Processing of NDVI and SCA time-series from the Terra/MODIS data

Functions

ID top-level	ID	Name	Description/Function	Interaction	Software	Input	Output
1.1	F-MP 01	Data extract		automated	NAPS/AKO	compressed MODIS data	uncompressed data
1.1	F-MP 02	Reflective band calibration		automated	NAPS/AKO	image	calibrated image
1.1	F-MP 03	Emissive band calibration		automated	NAPS/AKO	image	calibrated image
1.1	F-MP 04	Rectification		automated	NAPS/AKO	calibrated image	rectified image
1.1	F-MP 05	Detection of clouds		semi-automated	Imagine or matlab	Cal and rect image channels	Cloud mask
1.2	F-PP 01	Calculation of NDVI	Vegetation index	automated	Matlab	Cal and rect image	NDVI
1.2	F-PP 02	Cloud masking		automated	Matlab	Cal and rect image + Cloud mask	Cloud masked NDVI
1.2	F-PP 03	Compositing NDVI from the same day		automated	Matlab	Cloud masked NDVI	Composited NDVI
1.3	F-PS 01	Calculation of SCA	Snow covered Area (SCA)	automated	Matlab	Cal and rect image	SCA
1.3	F-PS 02	Cloud masking		automated	Matlab	Cal and rect image + Cloud mask	Cloud masked SCA
1.3	F-PS 03	Compositing SCA from the same day		automated	Matlab	Cloud masked NDVI	Composited SCA
1.4	F-TS 01	Extraction of AOI from daily data	Common for both data	automated	Matlab	Composited NDVI/SCA	Daily NDVI or SCA for AOI + extracted land cover shares for AoI
1.4	F-TS 02	Extraction NDVI or SCA observations for LC type		automated	Matlab	Daily NDVI or SCA for AOI + extracted land cover shares for AoI	Observations of NDVI/SCA for land cover classes in AoI
1.4	F-TS 03	Calculation of statistics for NDVI and SCA		automated	Matlab	Observations of NDVI/SCA for land cover classes in AoI	Time-series and statistics of NDVI/SCA for land cover classes in AoI
1.5	F-TSI 01	Filtering time series using histogram analysis		automated	Matlab	Time-series and statistics of NDVI/SCA for land cover classes in AoI	Filtered time-series and statistics of NDVI/SCA for land cover classes in AoI
1.5	F-TSI 02	Fitting model to time series		manual	Matlab/TimeSat	Filtered time-series and statistics of NDVI/SCA for land cover classes in AoI	Models describing changes in NDVI/SCA
1.5	F-TSI 03	Interpretation of indicative changes in time series		manual	Matlab/TimeSat	Models describing changes in NDVI/SCA	Dates indicating start and end of snow melt and green vegetation growth

1. Processing of NDVI and SCA time-series from the Terra/MODIS data ,
Data, prodcuts and auxilliary data sets

ID top-level	ID	Category	Name	Description	Type	Data format	File format	Situation at 28.2.2010
1.1	D-01	Input data	Compressed MODIS scenes 2001-2008		EO	Binary	tar.gz	completed
1.1	D-02	Input data	Rectified satellite images		EO	Raster	img	completed
1.1	D-03	Input data	Rectified could masks		EO	Raster	geotif	completed
1.2	D-04	Input data	NDVI estimates for MODIS scenes		EO derived	Raster	geotif	completed
1.2	D-05	Input data	Composited daily NDVI estimates for Europe		EO derived	Raster	geotif	completed
1.3	D-06	Input data	SCA estimates for MODIS scenes		EO derived	Raster	geotif	completed
1.3	D-07	Input data	Composited daily SCA estimates for Europe		EO derived	Raster	geotif	completed
1.4	D-TS temp1	Interm. Product	Extracted land cover shares for AoIs		EO derived	table	matlab	completed
1.4	D-TS temp2	Interm. Product	Extracted NDVI / SCA values for AoIs		EO derived	table	matlab	completed
1.4	DP 01	Final product (deliverable 1)	Time series of Vegetation index for selected targets		EO derived	excel	xls	completed
1.4	DP 02	Final product (deliverable 1)	Time series of SCA for selected targets		EO derived	excel	xls	completed
1.5	DP 03	Final product (deliverable 3)	Interpreted time series of NDVI for specific AoI and land cover class		EO derived	value	value	Not completed (A2/ deliverable 3)
1.5	DP 04	Final product (deliverable 3)	Interpreted time series of SCA for specific AoI and land cover class		EO derived	value	value	Not completed (A2/ deliverable 3)
1.4	A 01	Auxilliary data	GIS vector data from the AoI		User defined	vector	shape	completed
1.4	A 02	Auxilliary data	Share of different land cover types in MODIS pixels		EO derived	Raster	geotiff	completed

2. Processing of water quality time-series from the Envisat/MERIS data

Functions

ID top-level	ID	Name	Description/Function	Interaction	Software	Input	Output
2.1	F-MeP 01	Data retrieve		automated	NAPS/AKO	compressed MERIS da	uncompressed data
2.1	F-MeP 02	Calibration and rectificion		automated	NAPS/AKO	image	Calibrated and rectified image
2.1	F-MeP 03	Atmospheric correction		automated	NAPS/AKO	Calibrated and rectified	Rectified MERIS reflectances
2.1	F-MeP 04	Calculation of cloud propability		automated	BEAM in NAPS/AKO	Calibrated, rectified anc	Rectified cloud probability
2.2	F-MeP 05	Water quality algorithm		automated	Matlab	Rectified MERIS reflect	Unmasked water quality estimates
2.2	F-MeP 06	Land & cloud masking		automated	Matlab	Unmasked water quality	Water quality daily estimates
2.3	F-MeP 07	Calculation of weekly composite		automated	Matlab	Water quality daily estir	Water quality weekly composites
2.3	F-MeP 08	Creation of subsets		automated	Matlab	Water quality weekly cc	WQ subset estimates
2.3	F-MeP 09	Creation of geotiff and Grid products		automated	Matlab	WQ subset estimates	WQ subset end products
2.4	F-MeP 10	Extraction of AoI from the water quality products		automated	Matlab	WQ subset end produc	Extracted WQ data from the AoIs
2.4	F-MeP 11	Calculation of the statistics		automated	Matlab	Extracted WQ data fron	Time series of water quality for AoIs

2. Processing of water quality time-series from the Envisat/MERIS data

Data, prodcuts and auxilliary data sets

ID top-level	ID	Category	Name	Description	Type	Data format	File format	Situation at 28.2.2010
2.1	D-WQ 01	Input data	Envisat/MERIS scenes		EO	Binary	N1	completed
2.1	D-WQ 02	Input data	Rectified MERIS Reflectances		EO	Raster	dim	completed
2.1	D-WQ 03	Input data	Rectified could propability		EO	Raster	geotif	completed
2.2	D-WQ 04	Input data	Water quality daily estimates		EO derived	Raster	matlab	completed
2.2	D-WQ 05	Input data	Water quality weekly composites		EO derived	Raster	geotif	completed
2.2	D-WQ 06	Interm. Product	Water quality weekly Water quality subset end products		EO derived	Raster	geotif	completed
2.3	D-WQ 07	Final product (deliverable 1)	Time series of water quality for AoIs		EO derived	Raster	geotif	completed
2.4	D-WQ 08	Final product (deliverable 3)	Interpreted water quality information for the AoI		EO derived	value	value	Not completed (A2/ deliverable 3)
2.2	AWQ 01	Auxilliary data	WQ Algorithm coefficients		numeric	constant	values	
2.2	AWQ 02	Auxilliary data	Cloud detection threshold		numeric	varies	value	
2.2	AWQ 03	Auxilliary data	Buffered land mask		EO derived	Raster	geotiff	
2.3	AWQ 04	Auxilliary data	Subset mask		User defined	Raster	geotiff	
2.4	AWQ 05	Auxilliary data	AoI mask		User defined	corner values	values	

3. Processing of lake surface temperature time-series from the NOAA/AVHRR data

Functions

ID top-level	ID	Name	Description/Function	Interaction	Software	Input	Output
3.1	F-SST 01	Data retrieve		automated	NAPS/AKO	compressed AVHRR da	uncompressed data
3.1	F-SST 02	Calculation of brightness temperatures and rectification		automated	NAPS/AKO	uncompressed data	Calibrated and rectified image
3.1	F-SST 03	Calculation of cloud mask		automated	NAPS/AKO	Calibrated and rectified	Rectified cloud mask
3.2	F-SST 04	SST algorithm		automated	Matlab	Calibrated and rectified	Unmasked SST estimates
3.2	F-SST 05	Land & cloud masking		automated	Matlab	Unmasked SST estima	SST daily estimates
3.3	F-SST 06	SST extraction from the AoI lakes		automated	Matlab	SST daily estimates	SST observations from the AoI lakes
3.3	F-SST 07	Calculatin of statistics from the AoI lakes		automated	Matlab	SST observations from	SST Time series of AoI lakes

3. Processing of lake surface temperature time-series from the NOAA/AVHRR data

Data, prodcuts and auxilliary data sets

ID top-level	ID	Category	Name	Description	Type	Data format	File format	Situation at 28.2.2010
3.1	D-SST 01	Input data	NOAA/AVHRR data	raw data	EO	Binary	.hmf	completed
3.1	D-SST 02	Input data	Rectified NOAA Brightness temperatures		EO	Raster	.img	completed
3.1	D-SST 03	Input data	Rectified could mask		EO	Raster	geotif	completed
3.2	D-SST 04	Input data	Water surface temperature estimates		EO derived	Raster	matlab	completed
3.3	D-SST 05	Interm. Product	SST Time series from AoI lakes		EO derived	excel	xls	completed
3.2	ASST 01	Auxilliary data	SSR Algorithm coefficients	Split window algorithm	numeric	constant	values	
3.2	ASST 02	Auxilliary data	Buffered land mask		EO derived	Raster	matlab	
3.3	ASST 03	Auxilliary data	AoI lake masks		User defined	corner values	values	