EO_Regions_Science
Basic Research in support of EO_Regions!

A STEREO III Shared-Cost Project

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Outline

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- Corner Reflector Design
- Ontologies
- Change Detection
- Methodology for User Needs and In-situ Data
- Data Assimilation to Aquacrop Model

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Context

EO_Regions! : A RW project lead by SPACEBEL:

- to develop <u>innovating EO services</u> based on Sentinel data: functional, portable methodology performing for commercial applications of satellite imagery <u>at regional scale</u>
- to <u>export as a tool-box</u> to other European regions and emergent countries, acting as promoter for the installation and operation of the EO_Regions!

Based on:

- ✓ New methodologies and services
- ✓ A clear understanding of the user needs
- ✓ Strong expertise to predict service accuracy
- ✓ Integrated infrastructure: big data storage
- ✓ Combination/re-use of geospatial data over a territory

For:

- ➢ Dynamical monitoring of territories
- ➢ Services targeted to users not expert but interested in the added value of EO information
- ➢ Correct use of the information
- ➢ Easy & flexible access
- ➢ Increased added value of local existing data

Context

Application fields :
- **Wallonia**
- **Senegal**

+ further export to other regions/ emergent countries

Thematics:
- **Land use management**
- **Forestry**
  - Change detection (clear-cut…)
  - Health monitoring and disease detection
- **Natural hazards:**
  - Ground movements
    - Follow-up of industrial and construction sites
    - Monitoring of old mineshafts
    - Follow-up of infrastructures
  - Flood and water hazards
- **Agriculture**
  - Crop survey
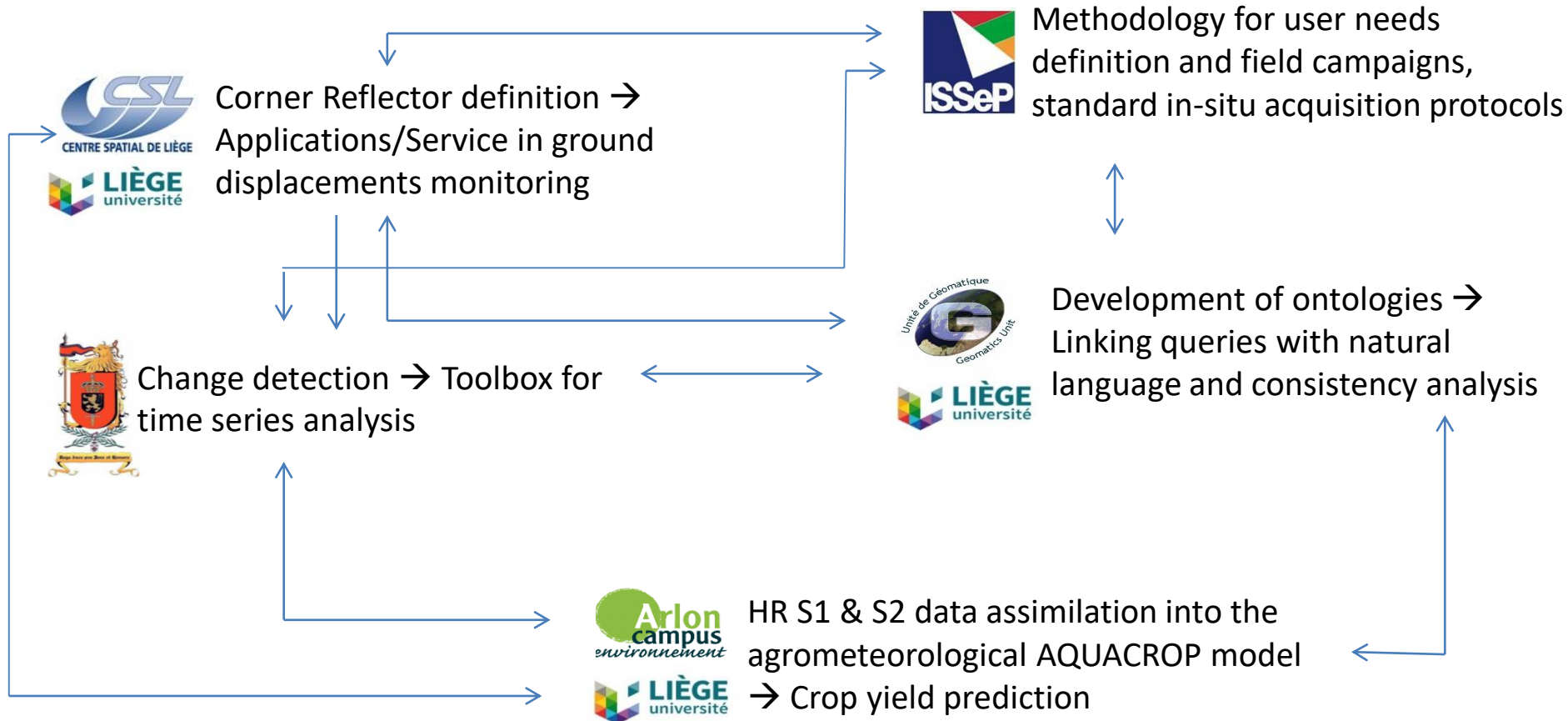 - Crop growth monitoring

Objectives

Preliminary basic research → support to EO_Regions!

- ➢ Consolidate the pillars on which the services proposed by EO_Regions! are based by developing:
  - change detection and monitoring methodologies,
  - ontologies,
  - crop modelling,
  - user needs definition
- ➢ Facilitate the operationalisation of these services.

Partnership and Tasks

Corner Reflector definition → Applications/Service in ground displacements monitoring

Methodology for user needs definition and field campaigns, standard in-situ acquisition protocols

Change detection → Toolbox for time series analysis

Development of ontologies → Linking queries with natural language and consistency analysis

HR S1 & S2 data assimilation into the agrometeorological AQUACROP model → Crop yield prediction

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WP1: Corner Reflector Design (CSL)

Exemples of possible services in EO_Regions!	Description
Monitoring of old mineshafts	Measurement of ground movements and subsidence in the old mine shafts
Regional subsidence follow-up	Measurement of ground motion during geothermal drilling, extraction of shale gas ; evolution of groundwater

Measuring ground displacements: by <u>differential SAR interferometry (DInSAR)</u>
BUT requires phase stability « islands » generally referred to as Persistent Scatterers

⟹ Proposed alternative in natural areas: use **Corner Reflectors (CR's)** as artificial permanent scatterers.

> ➢ passive devices used to reflect the incoming radar signal back to its source
> ➢ stable and strong response to the SAR signal over a long period of time

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Corner Reflector Design

Principe:

➢ 1 CR on system/area to be monitored.
➢ Additional CR's as fixed reference in the zone of interest and to subtract atmosphere and orbital residuals.
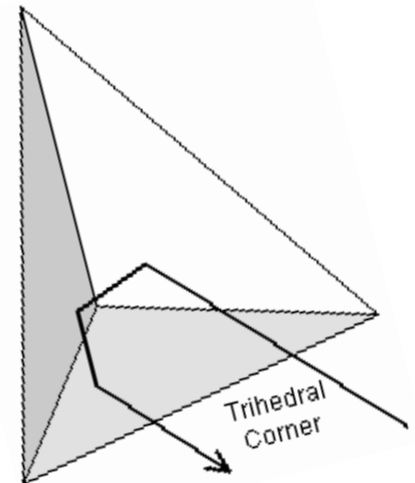➢ Initial topographic reference by GPS measurements.
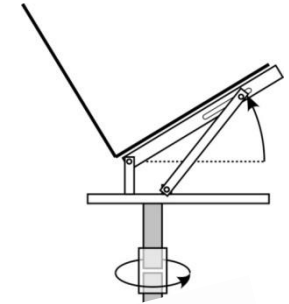
Tasks :

➢ CR specification w.r.t. EO_Regions! requirements
➢ Design and manufacturing
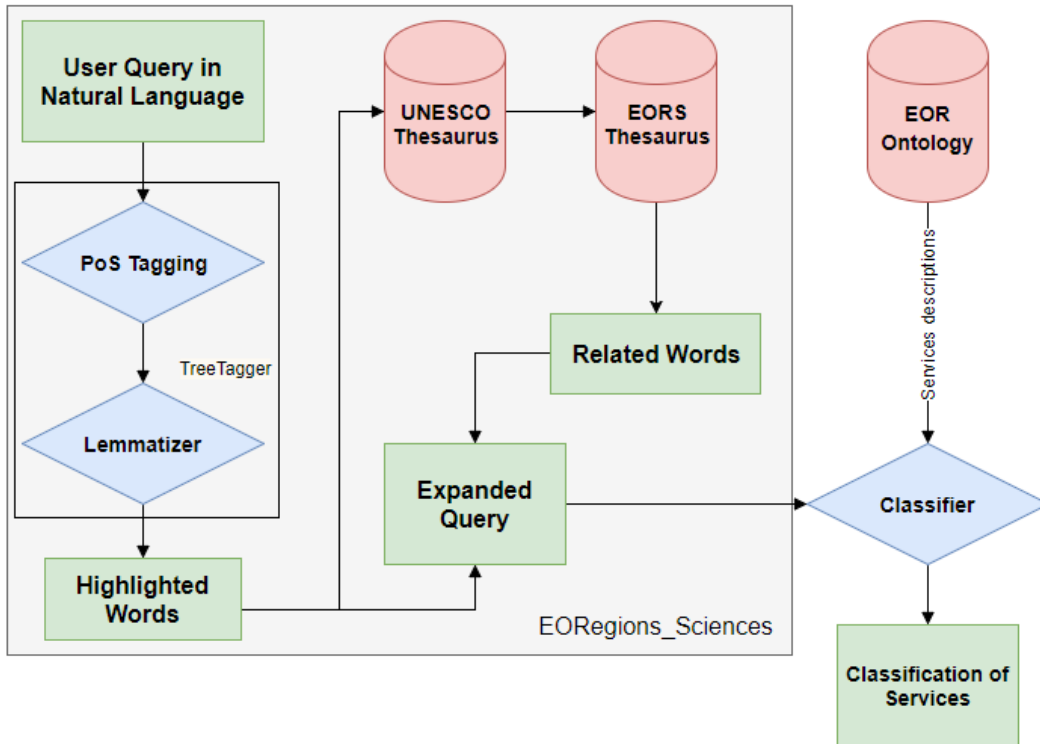➢ Testing and evaluation

Baseline: S1 imaging

Trihedral Corner

Corner Reflector Design

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WP2: Ontologies (UGEOM-ULiège)

Development of a Search Engine
based on semantic queries
using graph databases
and ontologies for services retrieval

Semantic Web
Artificial Intelligence
Natural Language Processing
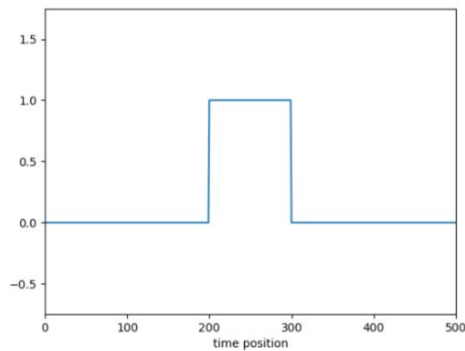
➔ the most valuable service to the user
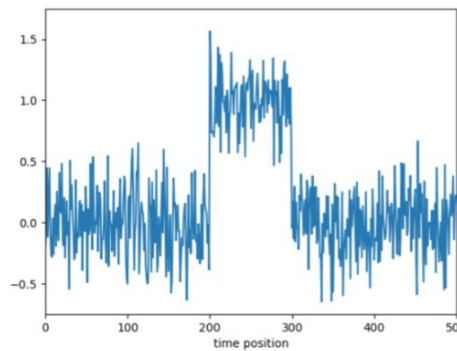
WP3: Change detection (RMA) – General Approach

"Combining Wavelets and Mathematical Morphology to Detect Changes in Time Series". Published on PIERS 2017.
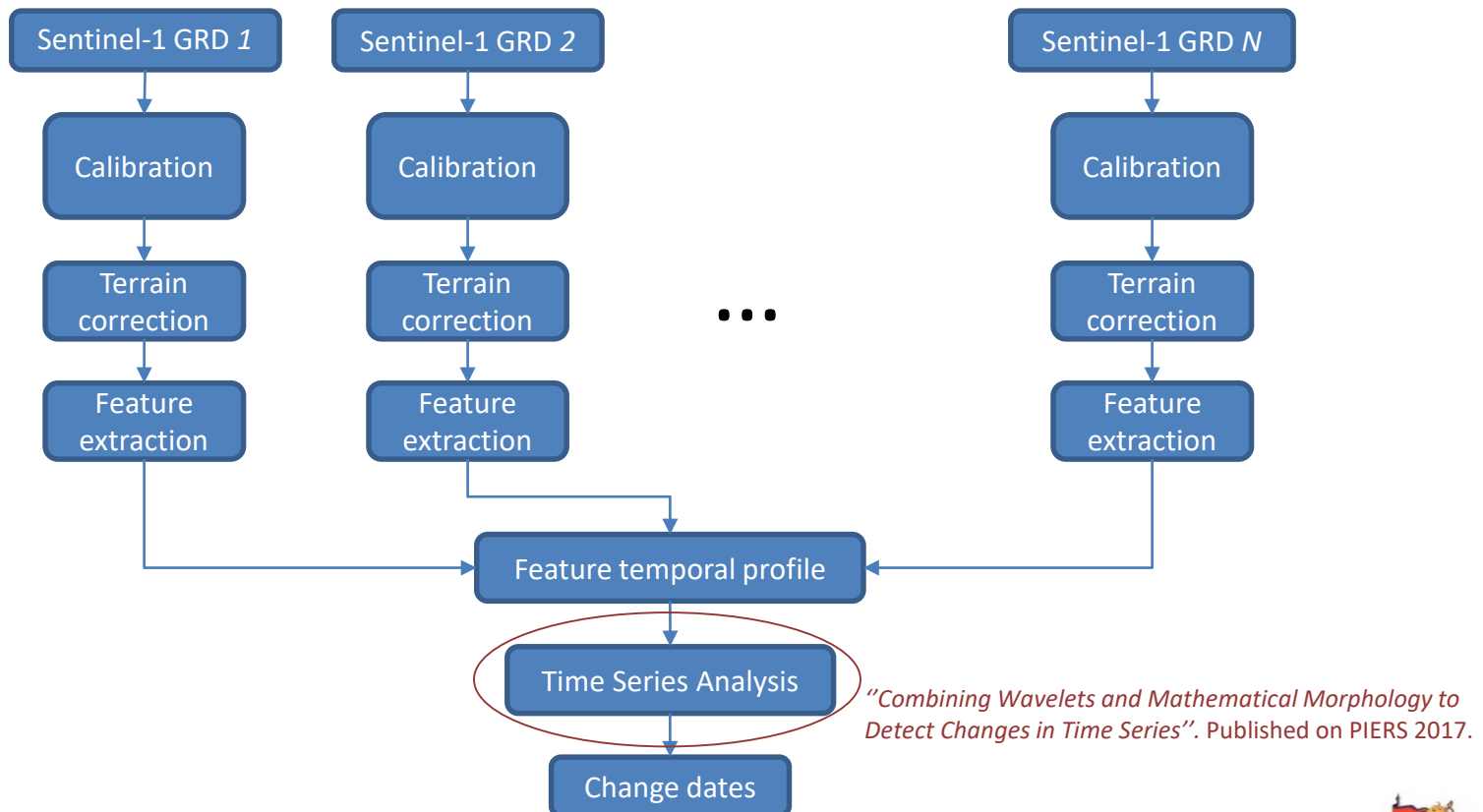
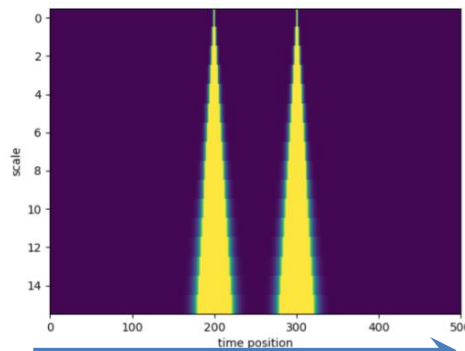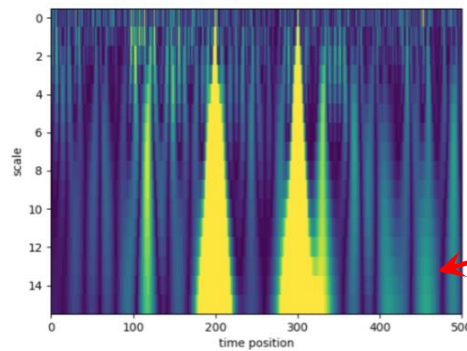# Change detection – Time Series Analysis

(a) f_I

(b) f_N

The problem of detecting the change points in a time series would consist in finding at which positions $U = \{u_1, u_2, \ldots, u_N\}$ the modulus of its Continuous Wavelet Transform (CWT) features local maxima.

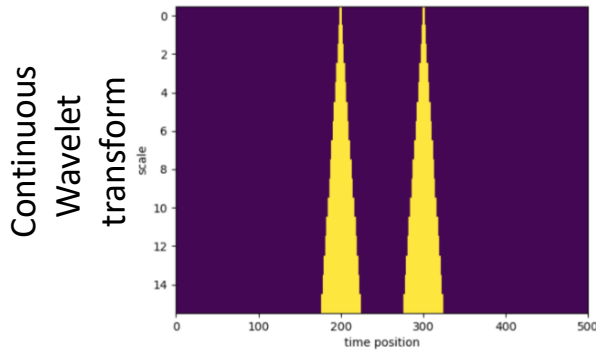Continuous Wavelet transform

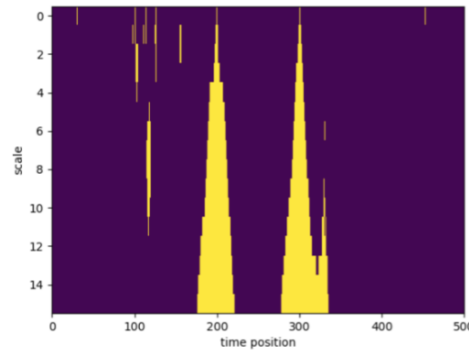(c) $|F_{W_I}|$ Time

(d) $|F_{W_N}|$

Issue: noise in the CWT coefficients
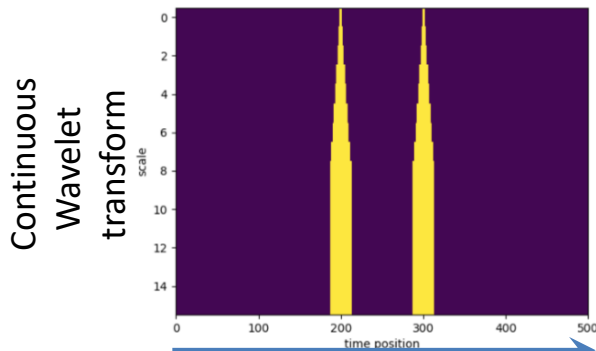
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Change detection – Time Series Analysis

Continuous Wavelet transform

(e) $|F_{W_I}|_\theta$

(f) $|F_{W_N}|_\theta$

Continuous Wavelet transform

(g) $\gamma_B(|F_{W_I}|_\theta)$ → Time
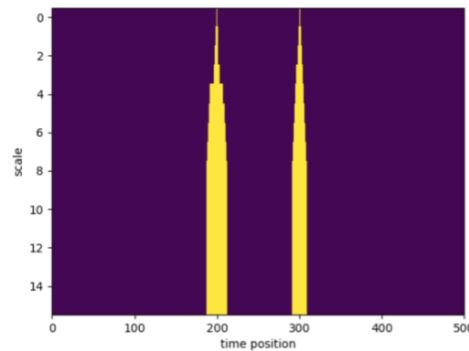
(h) $\gamma_B(|F_{W_N}|_\theta)$

The problem of detecting the change points in a time series would consist in finding at which positions $U = \{u_1, u_2, \ldots, u_N\}$ the modulus of its Continuous Wavelet Transform (CWT) features local maxima.
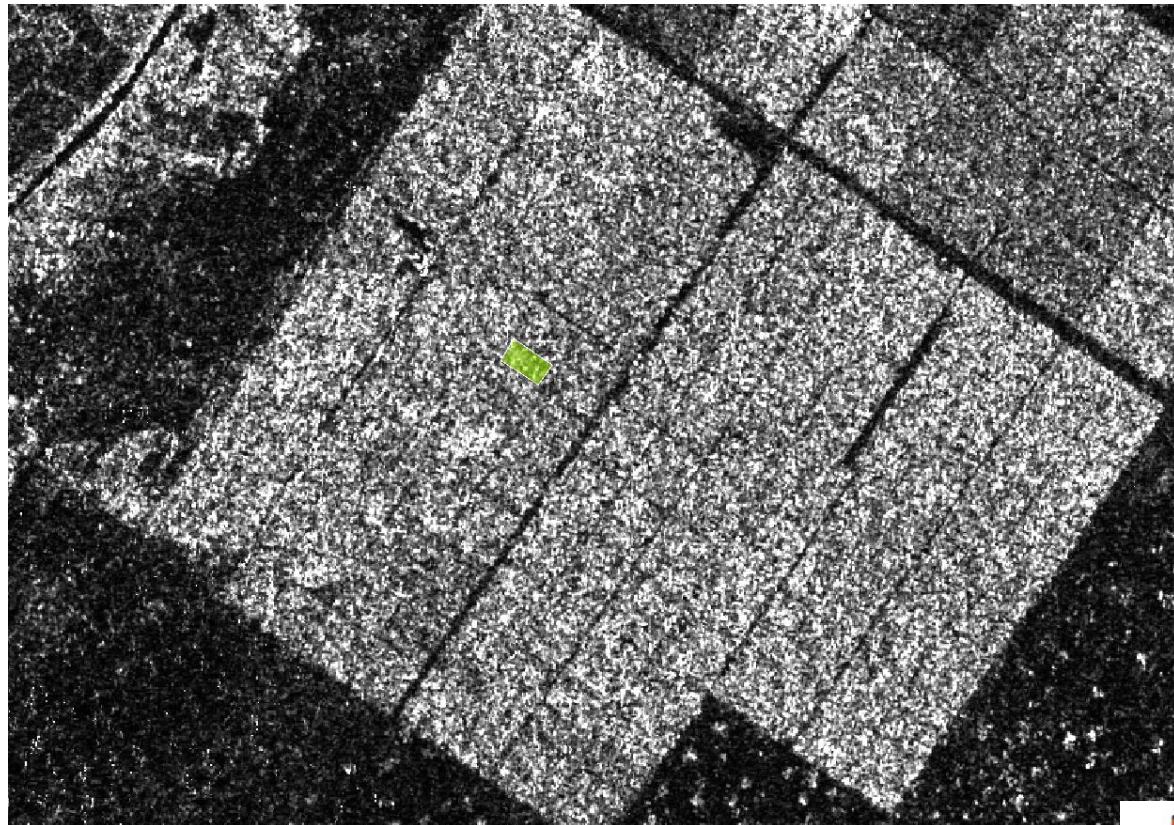
- Threshold CWT coefficients
- Mathematical morphology

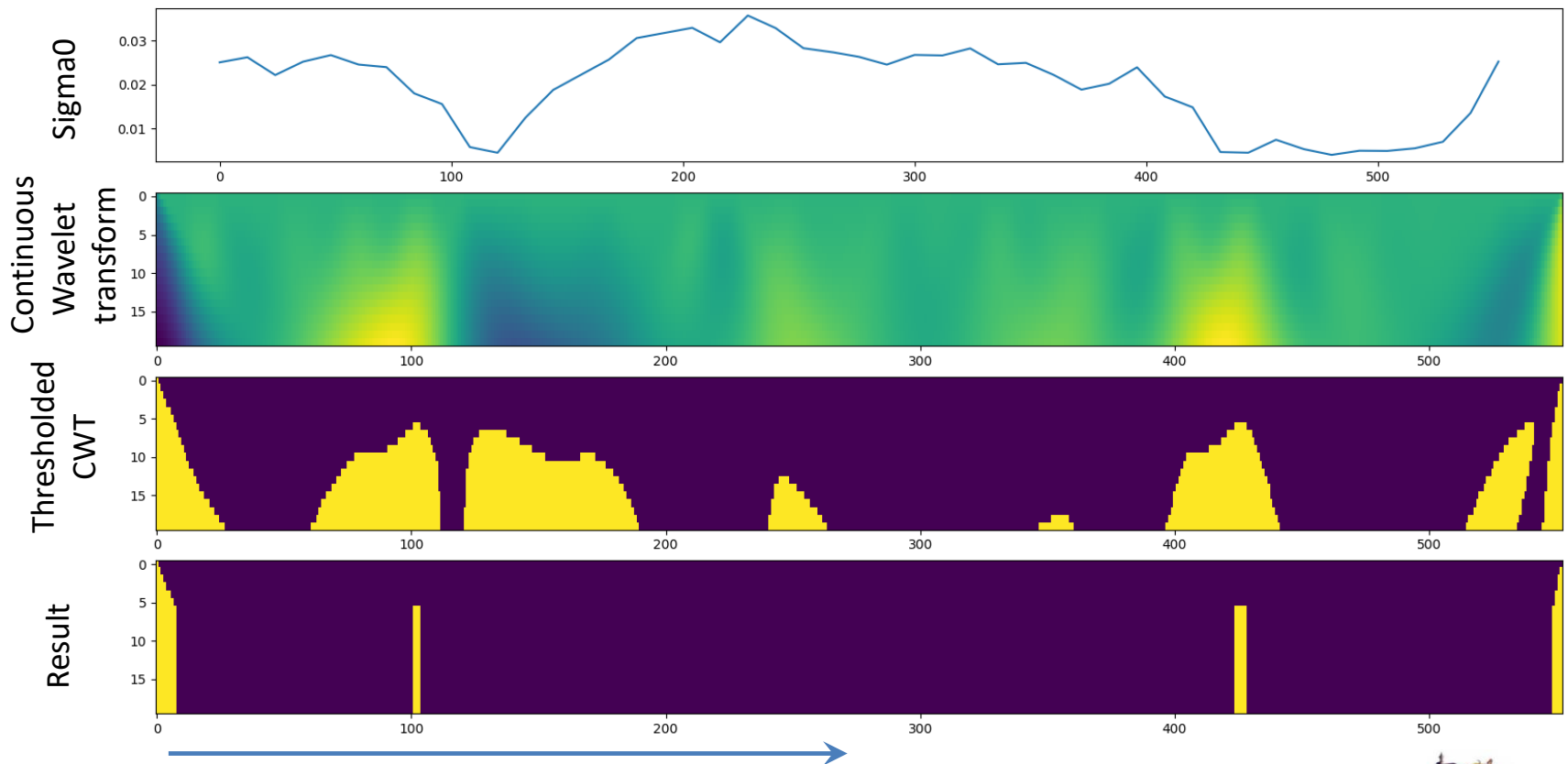**Parameters to be tuned for specific applications**

Change detection – E.g.: Rice Paddy – S1 data

**Region of interest
(S1 data in Senegal)**

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Change detection – E.g.: Rice Paddy – S1 data

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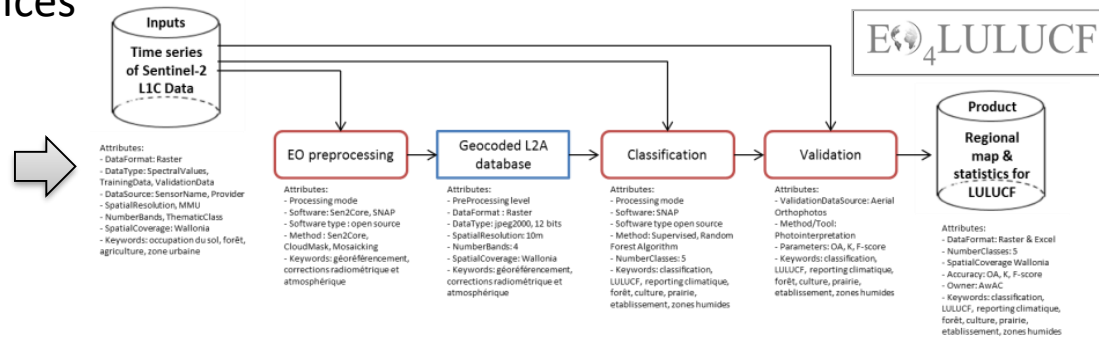
WP4: Promotion of EO & In-situ data (ISSeP)

A. Promote the use of Earth Observation, Copernicus services, Sentinel data and EO_Regions! within EO working groups (GTEO with Skywin *-> see all presentations on www.issep.be/gteo* & GT-COWAL [SPW]) , training sessions and public events

B. Support in-situ acquisition protocols, field campaigns and research activities of WP 2,3,5

Example: Field monitoring at 10 dates for validating change detection methods from WP 3 (in Eghezée)

C. Test cases of ISSeP potential EO services

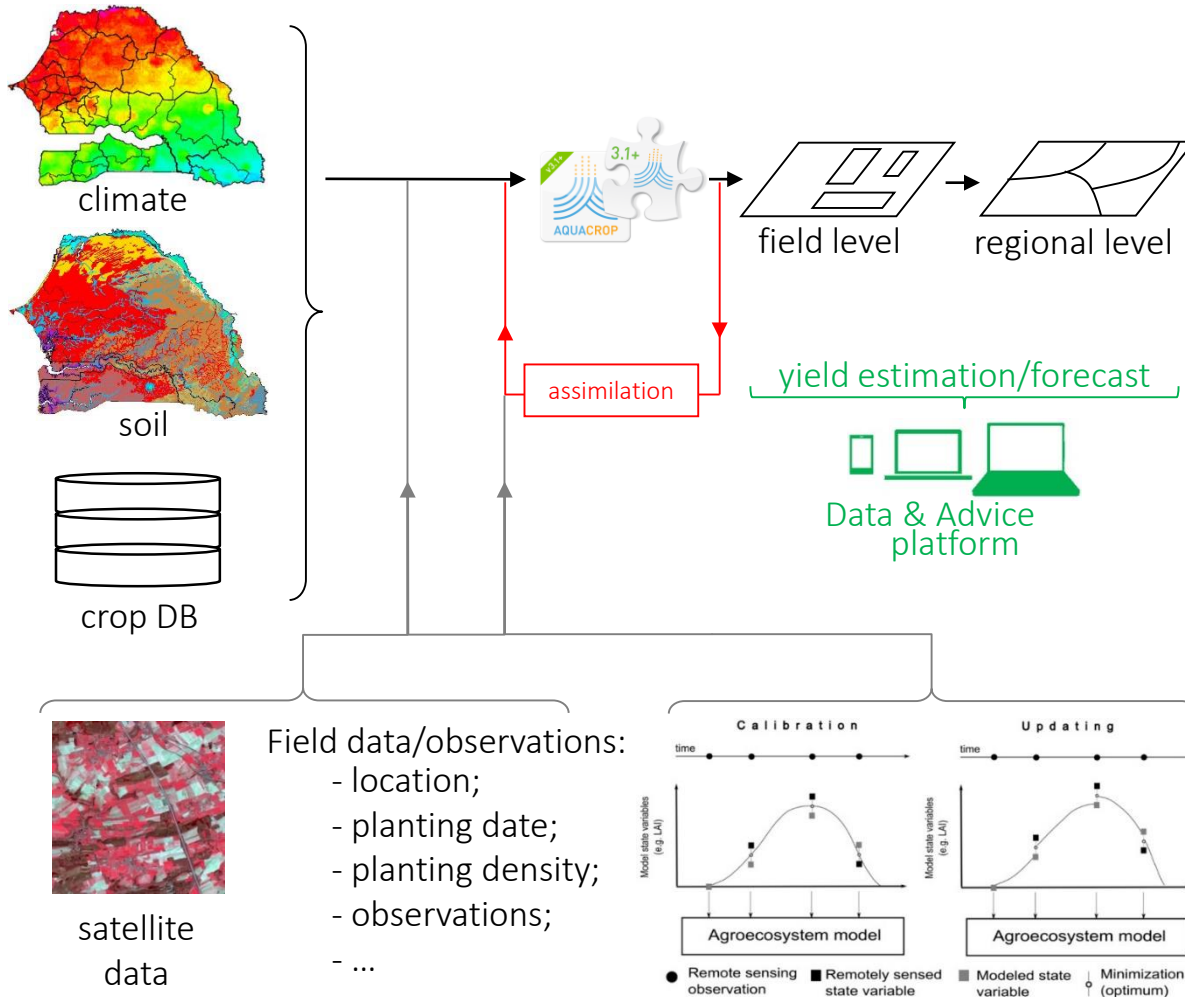Example: LULUCF reporting flow chart to support ontologies (WP2)

WP5: Aquacrop (EED-ULiège) – Technology show case

5 Km

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Aquacrop – Work flow

climate

soil

crop DB

satellite data

field level → regional level

assimilation

yield estimation/forecast

Data & Advice platform

Field data/observations:
- location;
- planting date;
- planting density;
- observations;
- …

Calibration   Updating

Agroecosystem model   Agroecosystem model

● Remote sensing observation   ■ Remotely sensed state variable   ▪ Modeled state variable   Minimization (optimum)

Thank you for your attention

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