MUSCATE:

MULTI-SATELLITES, MULTI-SENSORS AND MULTI-TEMPORAL THEIA INFRASTRUCTURE

Arnaud Sellé

CNES – Toulouse, France

On behalf of main authors: S.BAILLARIN, J. DONADIEU, C L'HELGUEN

MUSCATE OVERVIEW

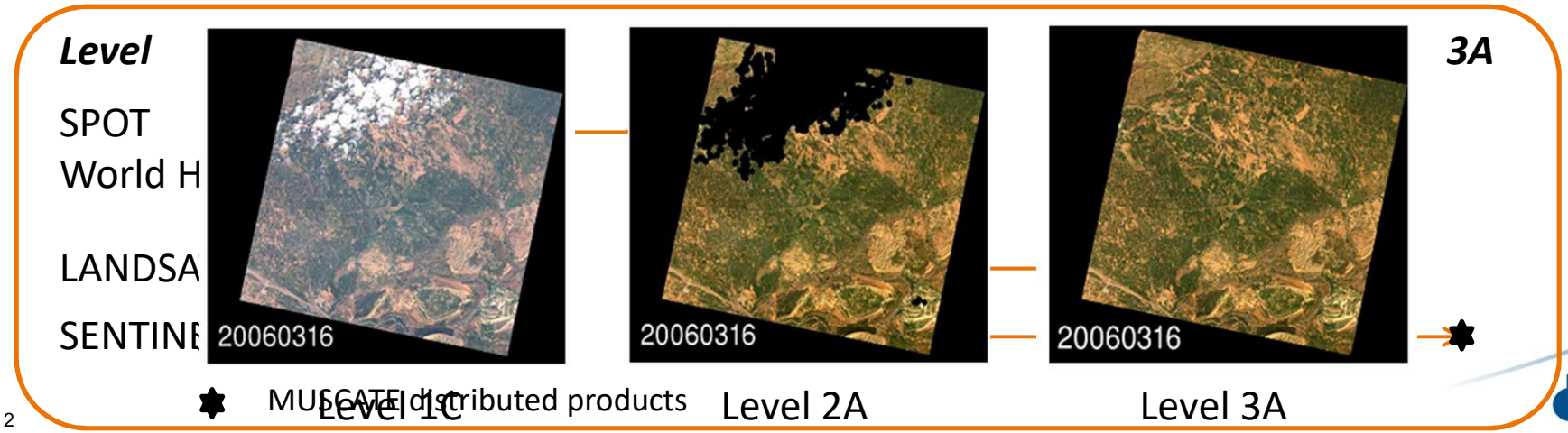
MUSCATE = THEIA processing facility of HR optical satellite products

3 Families of Satellites:

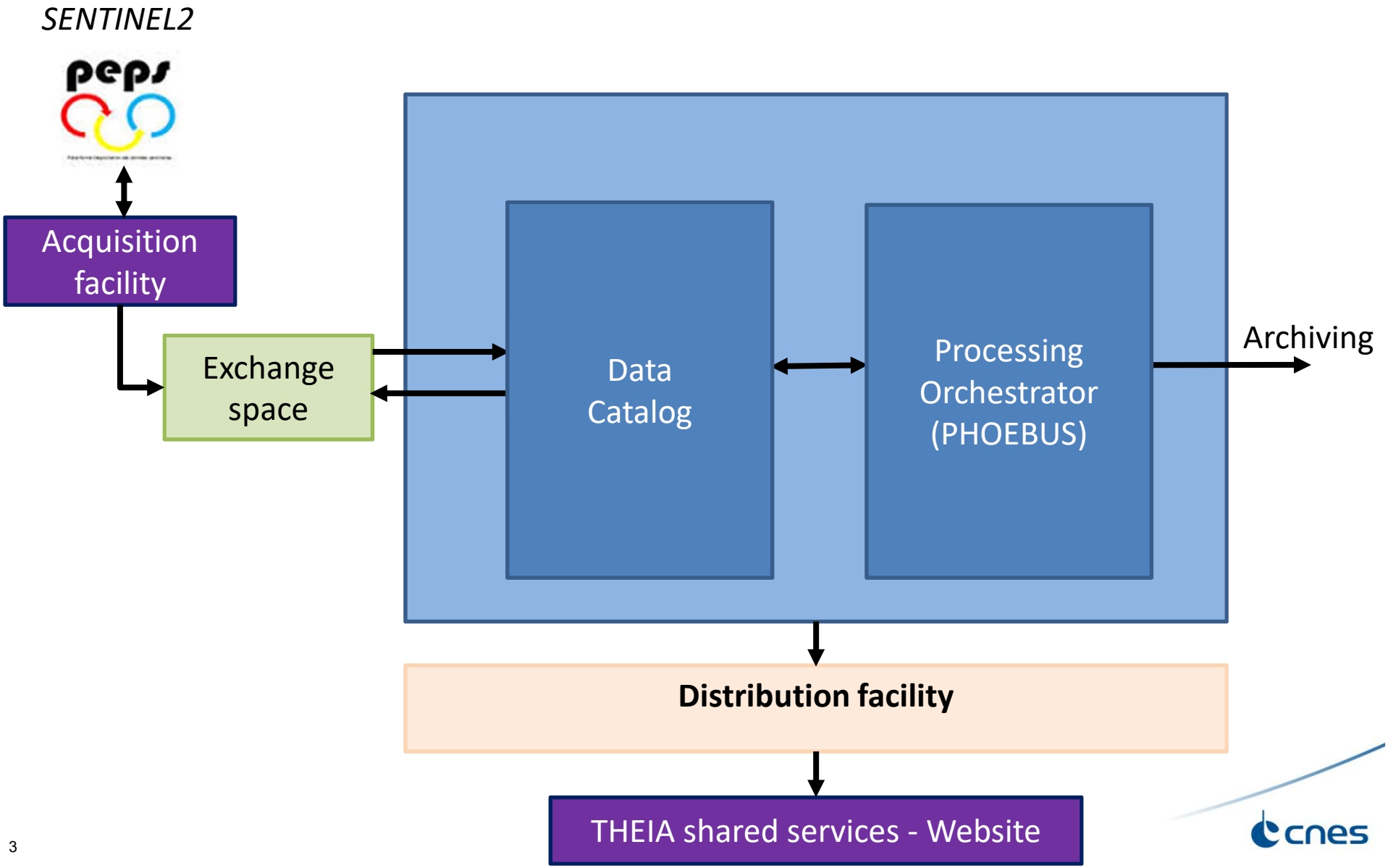
- SPOT 1 to 5: Spot World Heritage project
- LANDSAT 5-7-8
- SENTINEL-2 (A & B)

3 Types of Products (CEOS standard):

- Level 1C: ortho-rectified product in TOA reflectance
- Level 2A: level 1C product in surface reflectance
- Level 3A : temporal synthesis of level 2A products



MUSCATE ARCHITECTURE



MUSCATE: PRODUCTION FACILITY
EXAMPLE OF SENTINEL 2 PROCESSING

MACCS algorithm (multi-temporal) :

- Clouds (and shadows) detection,
- Aerosol Optical Thickness (AOT) & Water Vapour estimation,
- Atmospheric effects Correction

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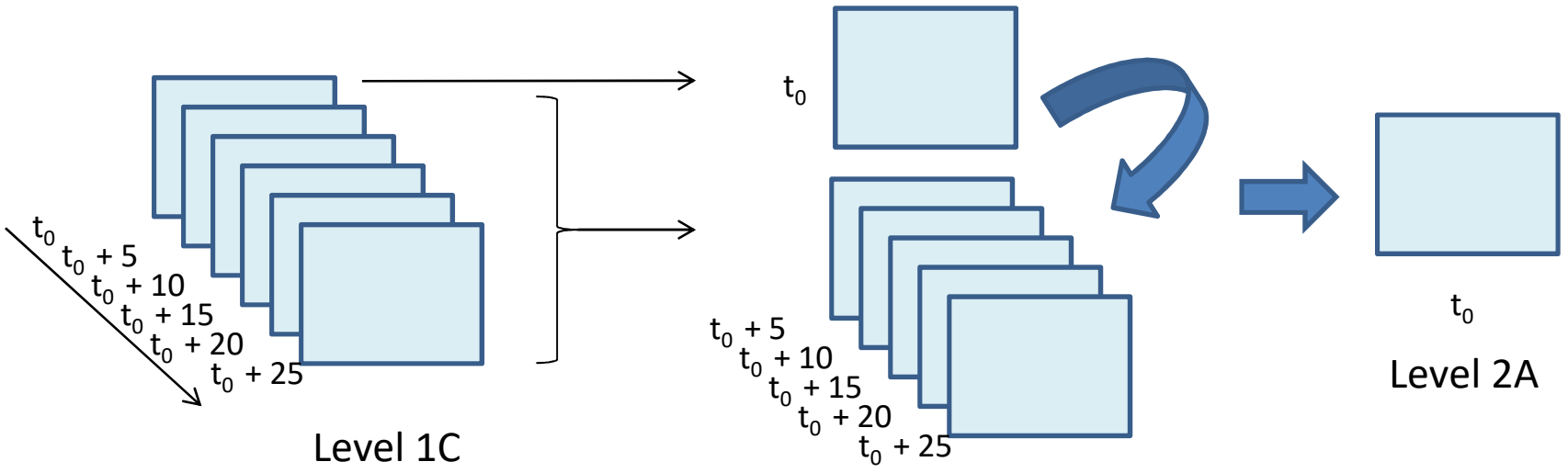
Initialisation phase (backward)



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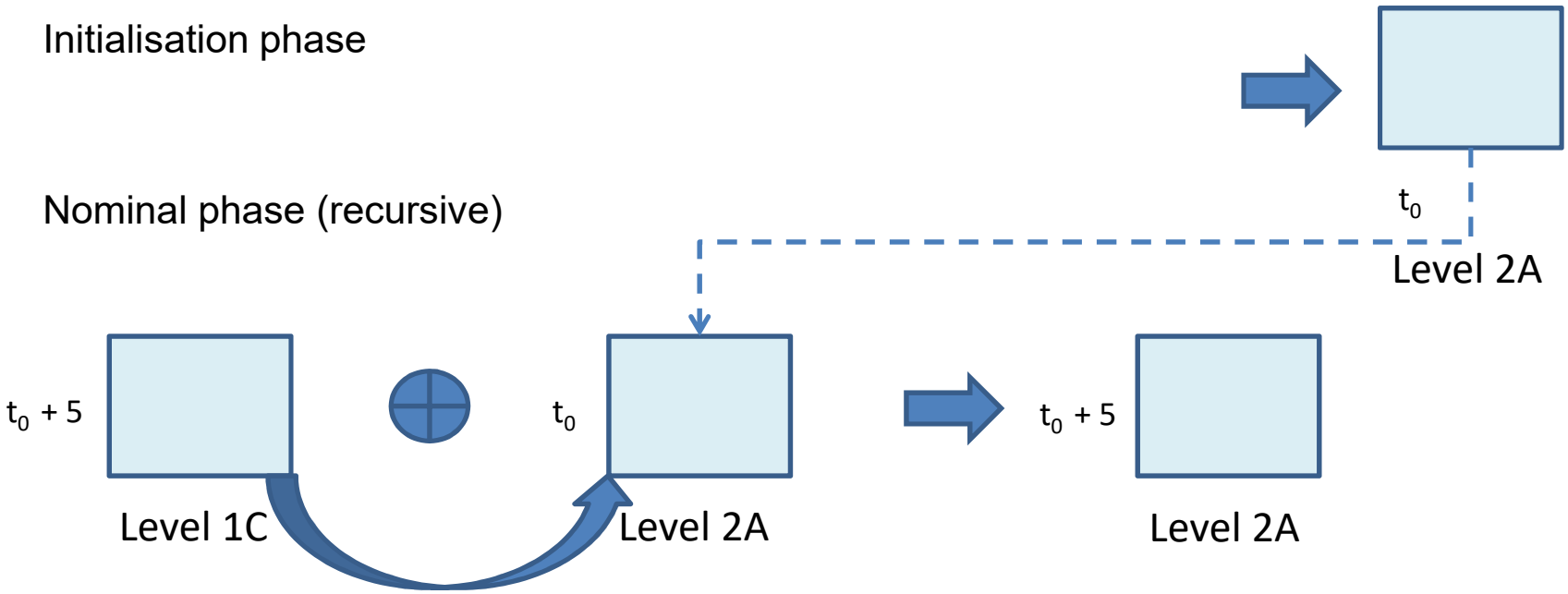
Initialisation phase

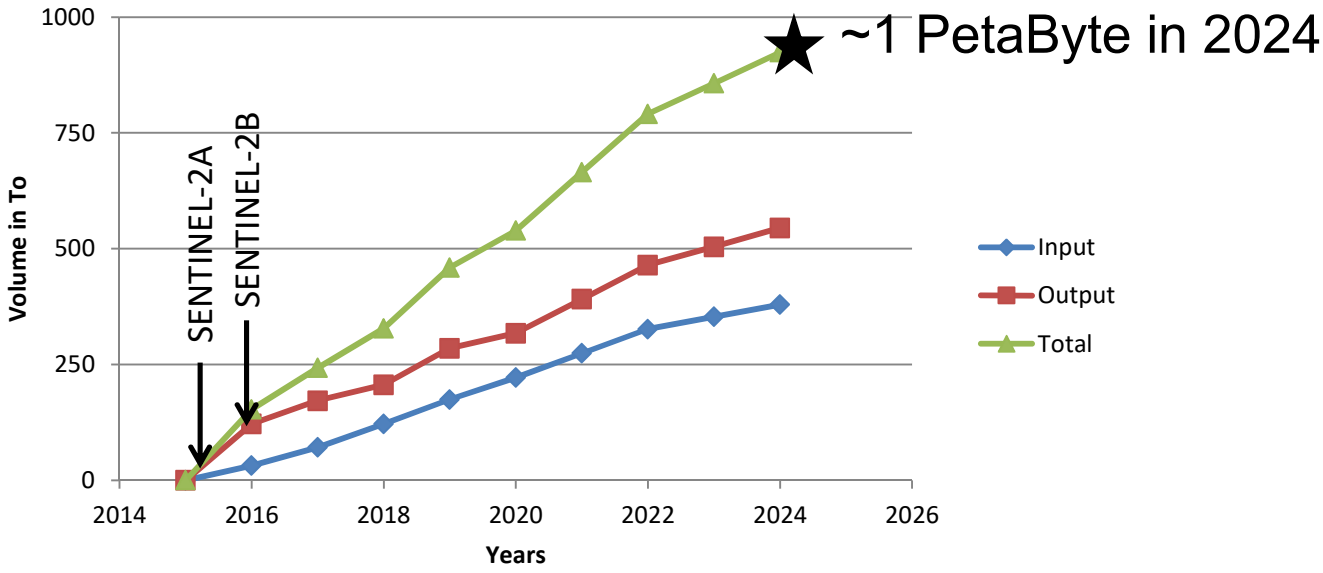
Nominal phase (recursive)



MUSCATE PROCESSING CAPACITY

MUSCATE : an Ambitious Project …

- Automatically process up to 2000 products a day (SPOT / LANDSAT / SENTINEL-2)
- Offer reprocessing capabilities
- Cumulative Volume of MUSCATE data ~1 PB



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… with “limited budget”!

- Use of CNES HPC centre (resources shared among projects)
  - 150 computing nodes
  - Common storage means
- Extensive re-use of CNES software components:
  - PHOEBUS (processing orchestration framework),
  - SIGMA (ortho-rectification), and MACCS (conversion in surface reflectance) processors

CONCLUSION

MUSCATE Objectives:

- Deliver high quality products
- Offer a full coverage of France over 40 years by SPOT, and LANDSAT.
- Distribute 10 times the surface of France with level 2A SENTINEL-2 products (area in progress)
- Host and promote new algorithms developed by scientists

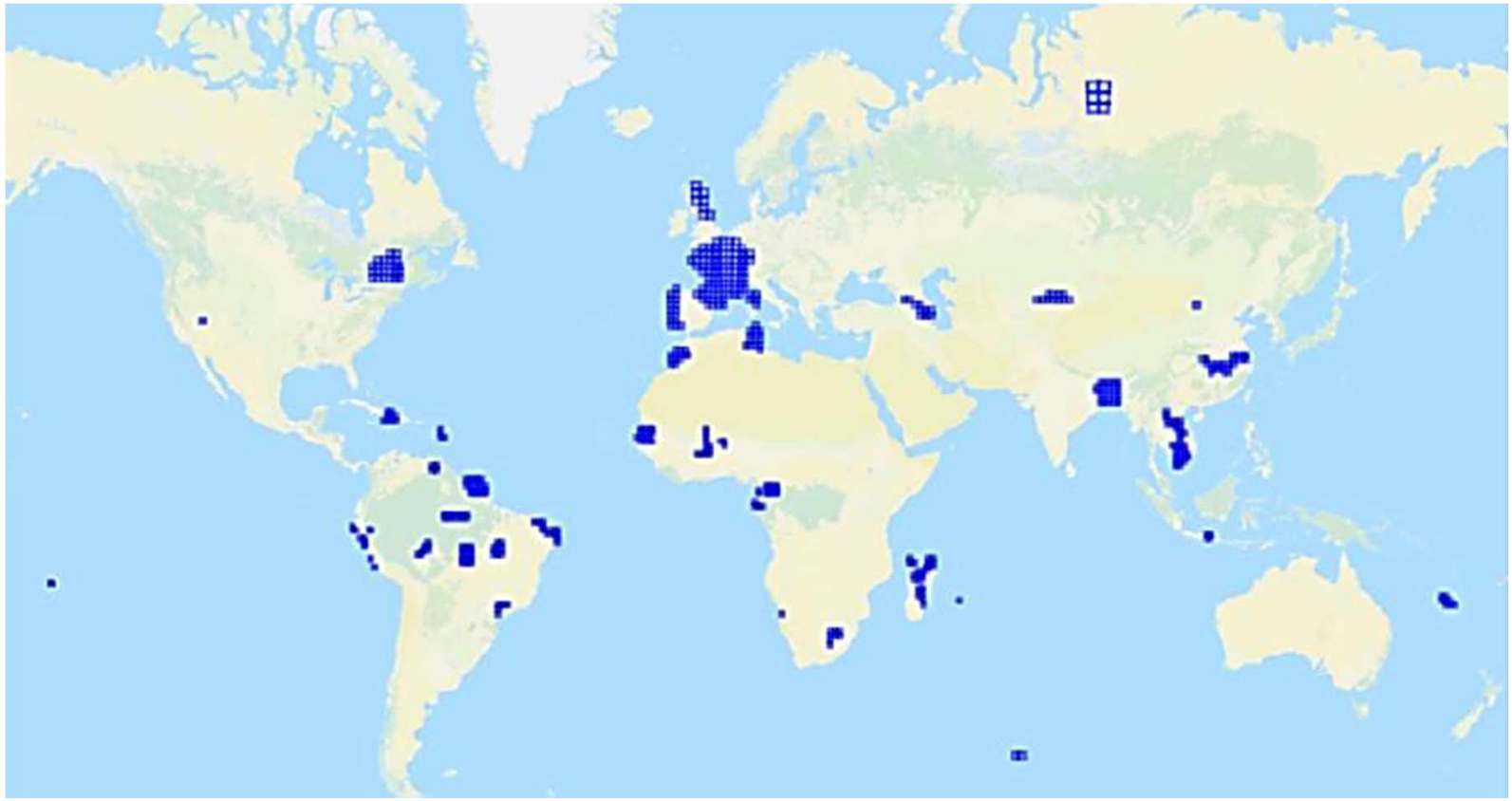
Already Available Datasets:

http://www.theia-land.fr/en

cnes

AREAS THAT WILL BE COVERED BY THEIA FOR SENTINEL-2 REFLECTANCES

- Once Theia production will be 100% on the fly and once all these areas will be covered by Sentinel-2 system



Theia
Pôle Thématique
Surfaces Continentales

Multi-sensor Atmospheric Correction and Cloud Screening level 2A processor

MACCS, how it works

MACCS (Multi-sensor Atmospheric Correction and Cloud Screening) is a level 2A processor,

- detects the clouds and their shadows,
- estimates aerosol optical thickness (AOT) & water vapour
- corrects for the atmospheric effects.
- jointly developped by CESBIO and CNES. CESBIO developed the methods and a prototype, while CNES funded the operational version of the processor, with a strong support from CESBIO for the validation.

Development started in 2005

Key features

- For high resolution time series
- to do that, a time series must be processed in chronological order
- After each processing, a composite image is updated with the unclouded pixels from the processed date
- This composite image is used as a reference for the cloud detection and the AOT estimate

MACCS at a glance

- Can only be applied to the optical missions which observe the earth under **constant viewing angles :**
  - Formosat-2
  - LANDSAT 5, 7 and 8
  - SPOT4 et SPOT5 in the configuration of Take5 experiments
  - Sentinel-2
  - VENµS, soon.
- Uses 910~940 nm band if available (water vapour channel) for atmospheric correction
- Cloud masking :
  - Use of Landsat-8 & Sentinel-2 cirrus band (at 1380 nm)
  - high difference in blue between 2 subsequent images
  - If two different "clouds" with same shape are detected on successive dates => it is not a cloud

Estimation of Aerosol Optical Thickness

- Computation of a global cost function with following criteria
- Multi-temporal criterion :
  - 2 successive observations should provide nearly the same surface reflectance. The squared residuals are inserted in the cost function
- Multi-spectral criterion :
  - above vegetation, and also above many bare soils, the surface reflectance in the blue is close to half the reflectance in the red.
- AOT :
  - AOT cannot be negative, and should not get higher that the one measured using the dark pixel method

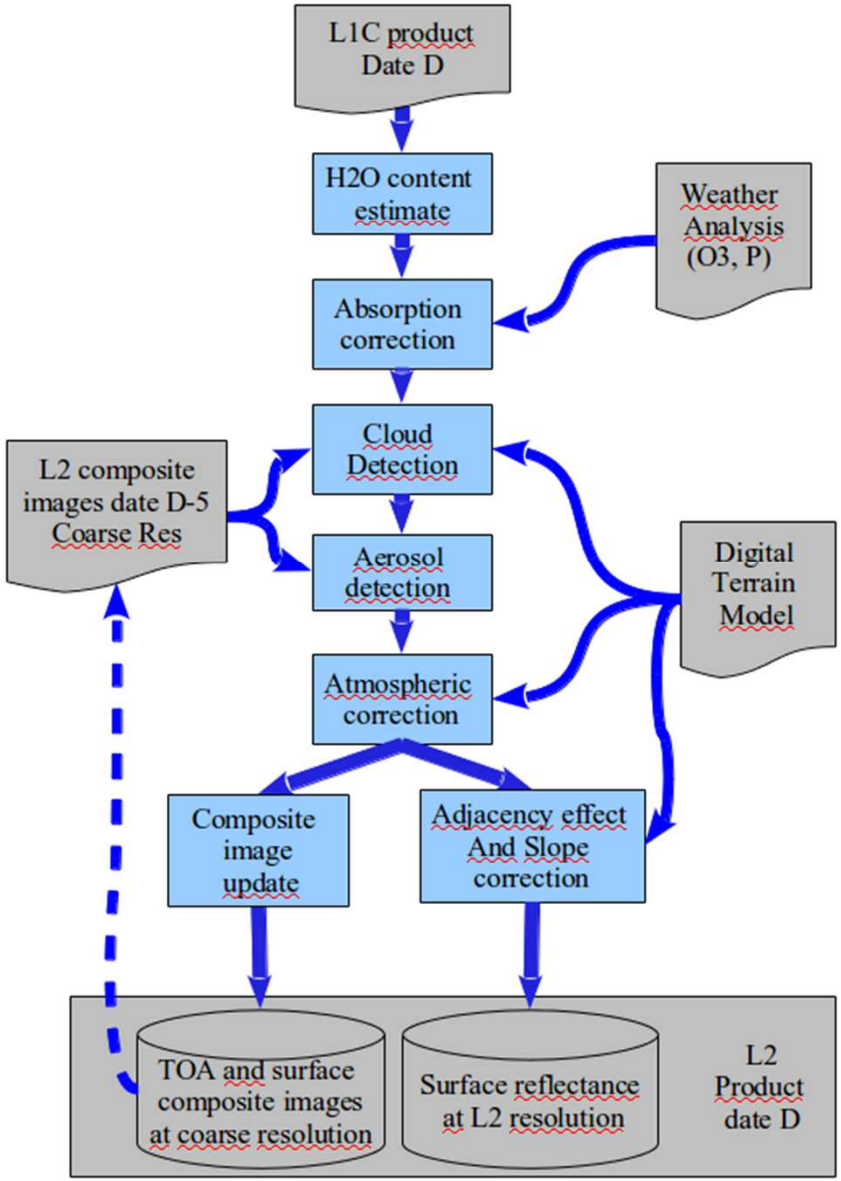
- Then, inverted using non linear least mean squares inversion

Postprocessing

Once the AOT is known, the surface reflectance can be retrieved

- To do that, we are using look-up tables (LUT) which are computed using the SOS radiative transfer code (Successive Orders of Scattering, Lenoble, 2007)

- Before editing the output product, we still need to correct for two other points, already described in this blog : the adjacency effects and the effects of terrain slopes on the illumination.


L1C product
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H2O content
estimate
Weather
Analysis
(O3, P)
Absorption
correction
Cloud
Detection
L2 composite
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Coarse Res
Aerosol
detection
Digital
Terrain
Model
Atmospheric
correction
Composite
image
update
Adjacency effect
And Slope
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at coarse resolution
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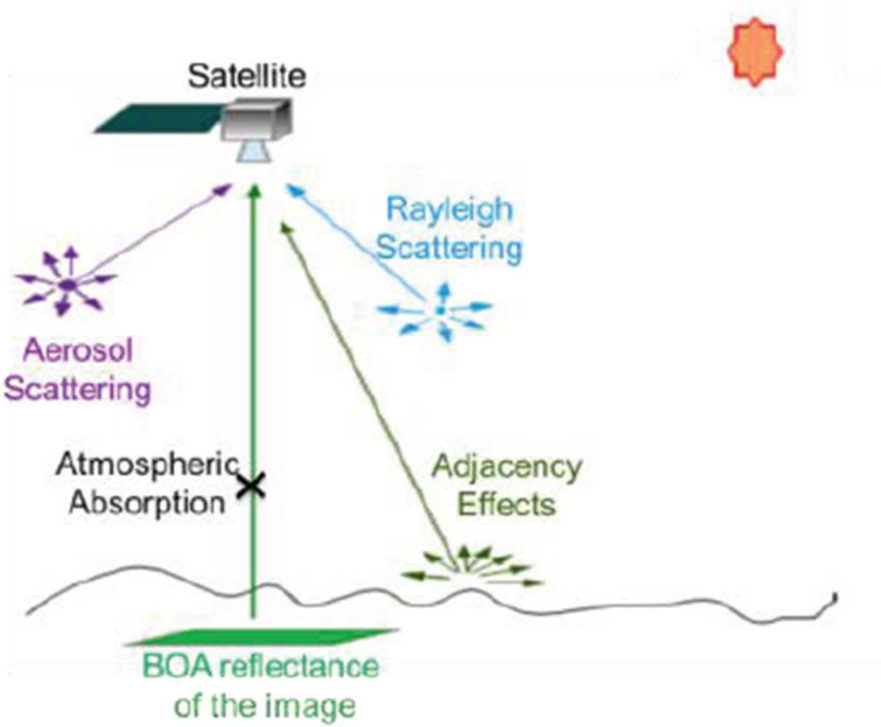
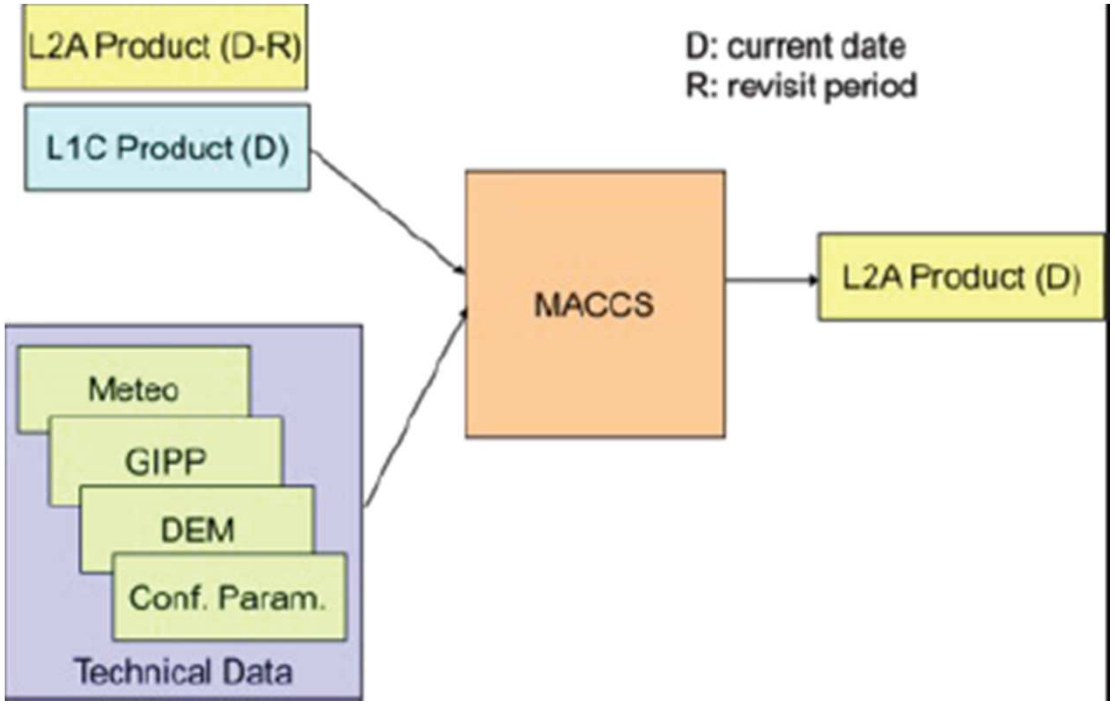
L2
Product
date D

MACCS

Bottom of Atmosphere reflectance



Processing mode



Agreement with German DLR

CNES and DLR have merged their efforts in order to have a common L2A algorithm : MAJA (MACCS ATCOR JOINED ALGORITM)

- MAJA based on MACCS, with several methods from ATCOR :
  - Better water mask
  - Directional correction method (for dual angle of views)
  - Better water vapor estimation method
  - Add of haze and cirrus correction methods from ATCOR

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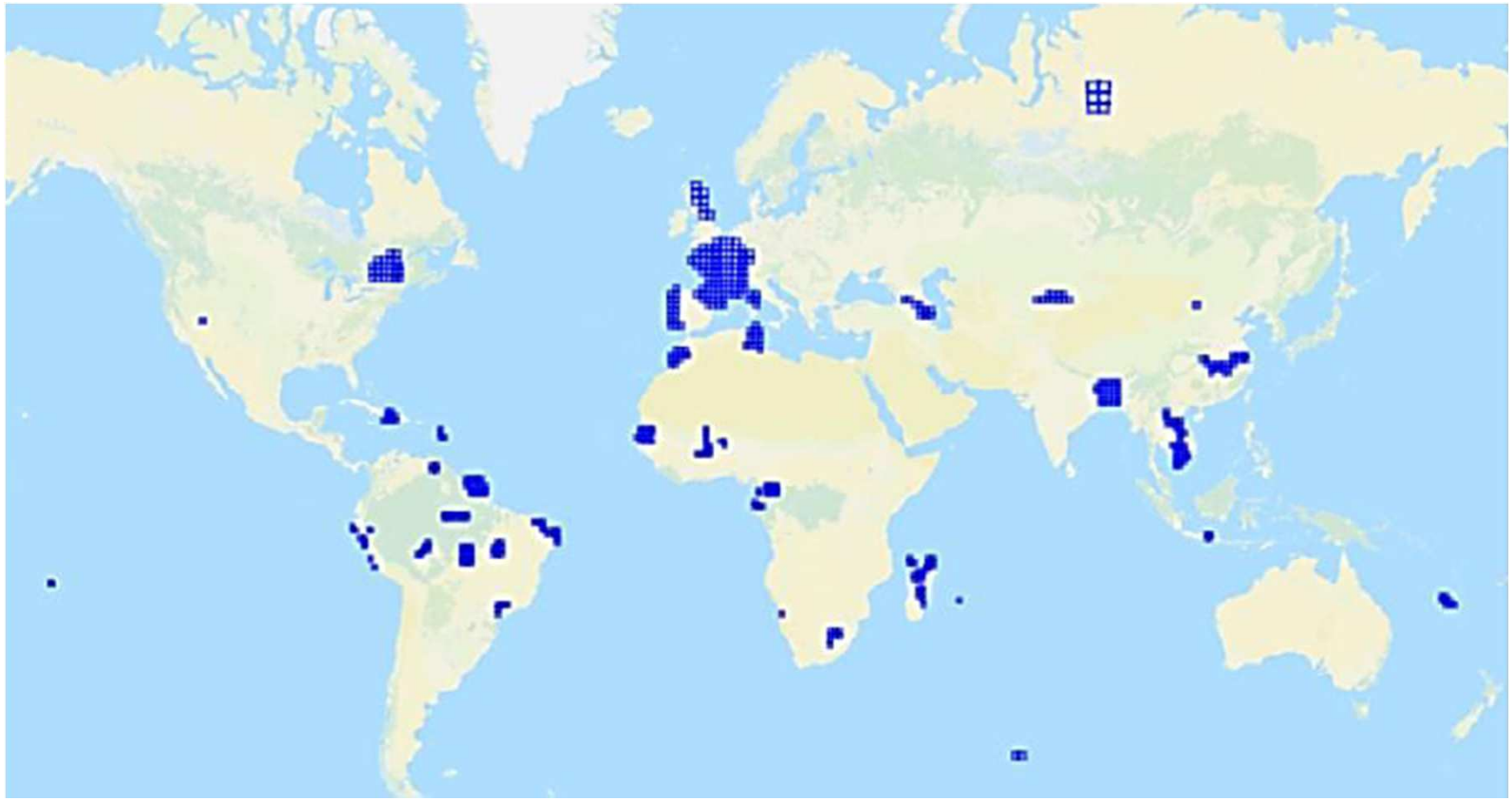

Implementation scenarios

- Diffusion of MAJA binary executable
  - License agreements will be granted for non commercial use
- Current study for a release of the whole exploitation framework "MUSCATE"
  - See video
- Lightweight and yet available alternative :
  - http://tully.ups-tlse.fr/olivier/lance_maja