

**PEPS platform and services.**

**FLATSIM Form@ter LArge-scale multi-Temporal Sentinel-1  
Interferometry in MUSCATE processing chain.**

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*Raphaël Grandin (IPGP), Marie-Pierre Doin & Cecile Lasserre & Franck Thollard (ISTERRE)*

❖ **PEPS overview**

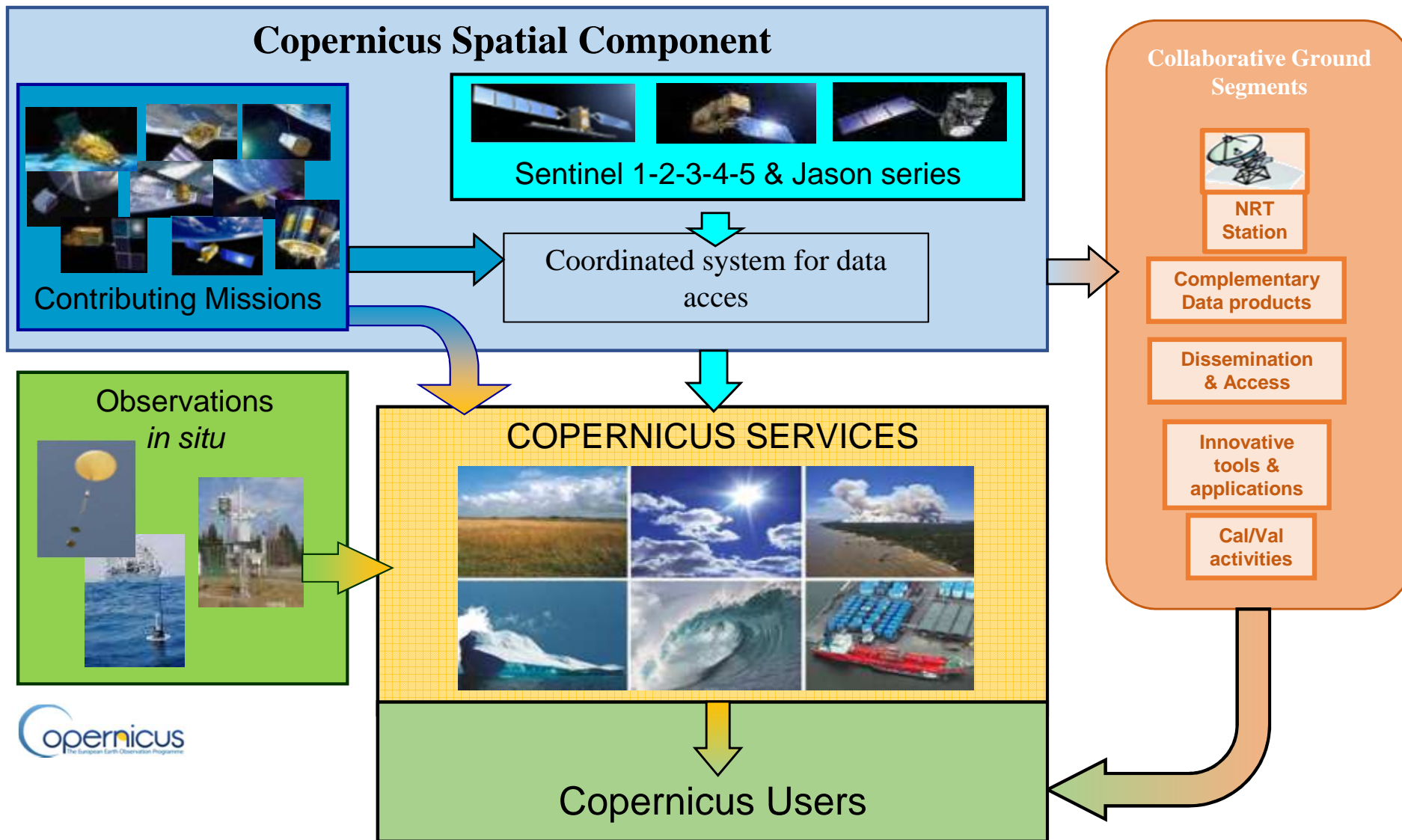
❖ **MUSCATE chain (optical) overview**

❖ **Form@ter LArge-scale multi-Temporal Sentinel-1  
Interferometry in MUSCATE (FLATSIM) processing chain**

# PEPS

## Sentinel Product Exploitation Platform





## **2014 : CNES develops PEPS (Sentinel Product Exploitation Platform)**

- ❖ **European Union distributes free Sentinel data from Copernicus via the infrastructures developed by ESA (Sentinels Scientific Data Hub, now Copernicus Open Access Hub).**
- ❖ **Each European Member has the possibility to rebroadcast the data (mirror site). ESA offers a privileged access to each country.**
- ❖ **PEPS is the French distribution and processing platform for Sentinel 1,2 et 3 from Copernicus program**

### ➤ **Goals :**

- promote the use of remote sensing data by redistributing data while enabling users to process them on servers close to the data source.
- Free access with long term guaranty
  - For institutional users, scientist and industries (start-up, SME...)
  - It is designed to develop into a European-wide coordinated system involving Cloud businesses (IGS-DIAS in 2018)



3,5 M image products : 4 Po

Imaging Radar  **sentinel-1** since Oct 2014

Optic Super Spectral  **SENTINEL 2** since Aug 2015

and Altimeter/Radiometers  **SENTINEL 3** since Oct 2016



**Two satellites per family with frequent revisit (some days) : huge volume of data 13 To/day**

### Search



RECHERCHE PAR CRITÈRES RECHERCHE SÉMANTIQUE

#### Période d'acquisition

Début

Fin

SENTINEL-1

Plateforme

Instrument

Niveau de traitement

GRD

Mode du capteur

Non

Polarisation

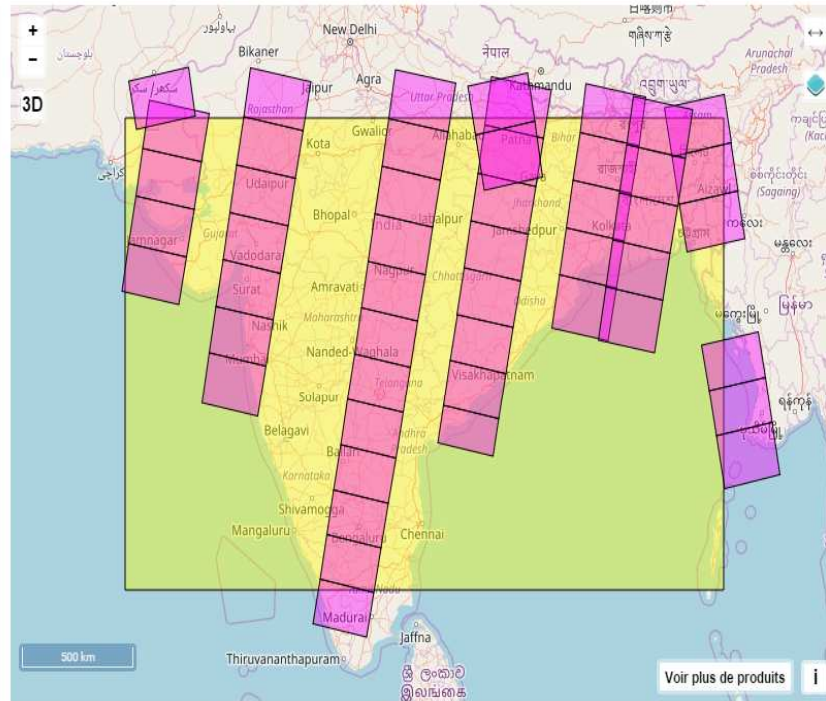
Sens de l'orbite

Numéro d'orbite absolue

Numéro d'orbite relative

Numéro de cycle

RÉINITIALISER RECHERCHER



Haut-gauche: 26° 16' 25" N 67° 36' 11" E Bas-droite: 10° 50' 00" N 93° 05' 29" E

DÉFINIR LA ZONE D'INTÉRÊT EFFACER

- Search
- Visualizations
- Downloading
- Subscribing
- Processing



https://peps-q.cst.cnes.fr/rocket/#/search?collection=S1&productType=GRD&box=67.60299682617186,10.83330598364249,93.09127807617186,26.

ACCUEIL EXPLORER MOSAIQUE MONDIALE PEPS-RSS PLUS

3249 produits trouvés





Nombre de résultats : 50

<input type="checkbox"/>		Collection : SENTINEL-1 Localisation : Inde Date : 23 septembre 2017 - 00:04:56	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD Produit NRT : Non	Numéro d'orbite : 18495 Niveau de traitement : LEVEL1 Mode du capteur : IW	<input type="checkbox"/>		
<input type="checkbox"/>		Collection : SENTINEL-1 Localisation : Inde Date : 23 septembre 2017 - 00:04:31	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD Produit NRT : Non	Numéro d'orbite : 18495 Niveau de traitement : LEVEL1 Mode du capteur : IW	<input type="checkbox"/>		
<input type="checkbox"/>		Collection : SENTINEL-1 Localisation : Inde Date : 23 septembre 2017 - 00:04:06	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD Produit NRT : Non	Numéro d'orbite : 18495 Niveau de traitement : LEVEL1 Mode du capteur : IW	<input type="checkbox"/>		
<input type="checkbox"/>		Collection : SENTINEL-1 Localisation : Inde Date : 23 septembre 2017 - 00:03:41	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD Produit NRT : Non	Numéro d'orbite : 18495 Niveau de traitement : LEVEL1 Mode du capteur : IW	<input type="checkbox"/>		
<input type="checkbox"/>		Collection : SENTINEL-1 Localisation : Inde Date : 23 septembre 2017 - 00:03:16	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD Produit NRT : Non	Numéro d'orbite : 18495 Niveau de traitement : LEVEL1 Mode du capteur : IW	<input type="checkbox"/>		

- Search
- Visualizations
- **Downloading**
- *or*
- **Subscribing**
- **Processing**



https://peps-q.cst.cnes.fr/rocket/#/processings/cart


ACCUEIL EXPLORER MOSAIQUE MONDIALE PEPS-RSS PLUS    

MA SÉLECTION MES TRAITEMENTS MES RÉSULTATS

Sélectionner un traitement >> Choice of processing : S1 orthorectification on S2 Tiles in this example

ORTHO\_S1\_GRD (3)

Nom de votre traitement (facultatif)







**TRAITER LES PRODUITS (3)** 

ORTHO\_S1\_GRD

Ortho-rectification et tuilage sur la grille Sentinel 2 (MGRS) des produits S1 GRD : La durée moyenne du traitement est de 20 minutes. s1tiling

Sélectionner les produits à traiter

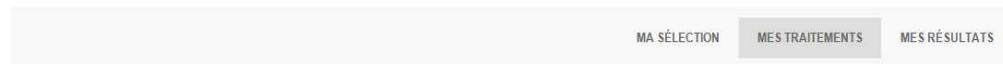
*Seuls les 3 produits affichés ci-dessous sont compatibles avec le traitement sélectionné.* **SUPPRIMER TOUS LES PRODUITS**

<input checked="" type="checkbox"/>		Collection : SENTINEL-1 Localisation : India Date : 23 septembre 2017 - 00:04:06	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD Produit NRT : Non	Numéro d'orbite : 18495 Niveau de traitement : LEVEL1 Mode du capteur : IW	
<input checked="" type="checkbox"/>		Collection : SENTINEL-1 Localisation : India Date : 23 septembre 2017 - 00:04:31	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD Produit NRT : Non	Numéro d'orbite : 18495 Niveau de traitement : LEVEL1 Mode du capteur : IW	
<input checked="" type="checkbox"/>		Collection : SENTINEL-1 Localisation : India Date : 23 septembre 2017 - 00:04:56	Plateforme : S1A Instrument : SAR bande C Type de produit : GRD Produit NRT : Non	Numéro d'orbite : 18495 Niveau de traitement : LEVEL1 Mode du capteur : IW	

Nombre de produits compatible : 3

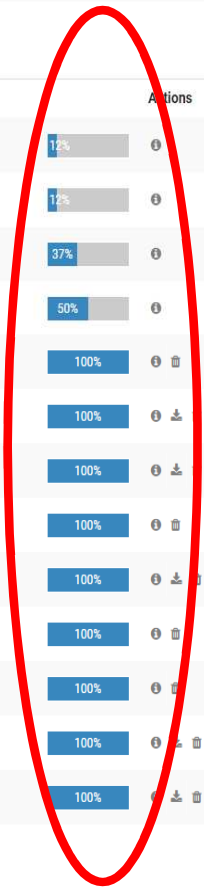
- Search
- Visualization
- Downloading
- Subscribing
- Processing

# Processing available to everyone via the « tools » section (public mode)



## Liste des traitements

Identifiant	Nom	Date	Status	Progression	Actions
39	ORTHO_S1_GRD	2017-10-10 14:23:17	🕒	12%	🔍
40	ORTHO_S1_GRD	2017-10-10 14:23:17	🕒	12%	🔍
38	ORTHO_S1_GRD	2017-10-10 14:23:17	🕒	37%	🔍
37	ORTHO_S1_GRD	2017-10-10 13:54:06	🕒	50%	🔍
36	ORTHO_S1_GRD	2017-10-10 12:58:18	✖	100%	🔍 🗑️
32	ORTHO_S1_GRD	2017-09-29 11:03:15	✔	100%	🔍 📄
31	ORTHO_S1_GRD	2017-09-29 11:02:45	✔	100%	🔍 📄
30	ORTHO_S1_GRD	2017-09-29 10:59:59	✖	100%	🔍 🗑️
18	ORTHO_S1_GRD	2017-09-28 13:24:11	✔	100%	🔍 📄
15	ORTHO_S1_GRD	2017-09-28 12:39:37	✖	100%	🔍 🗑️
17	ORTHO_S1_GRD	2017-09-28 12:39:37	✖	100%	🔍 🗑️
16	ORTHO_S1_GRD	2017-09-28 12:39:37	✔	100%	🔍 📄 🗑️
14	ORTHO_S1_GRD	2017-09-28 12:36:51	✔	100%	🔍 📄 🗑️

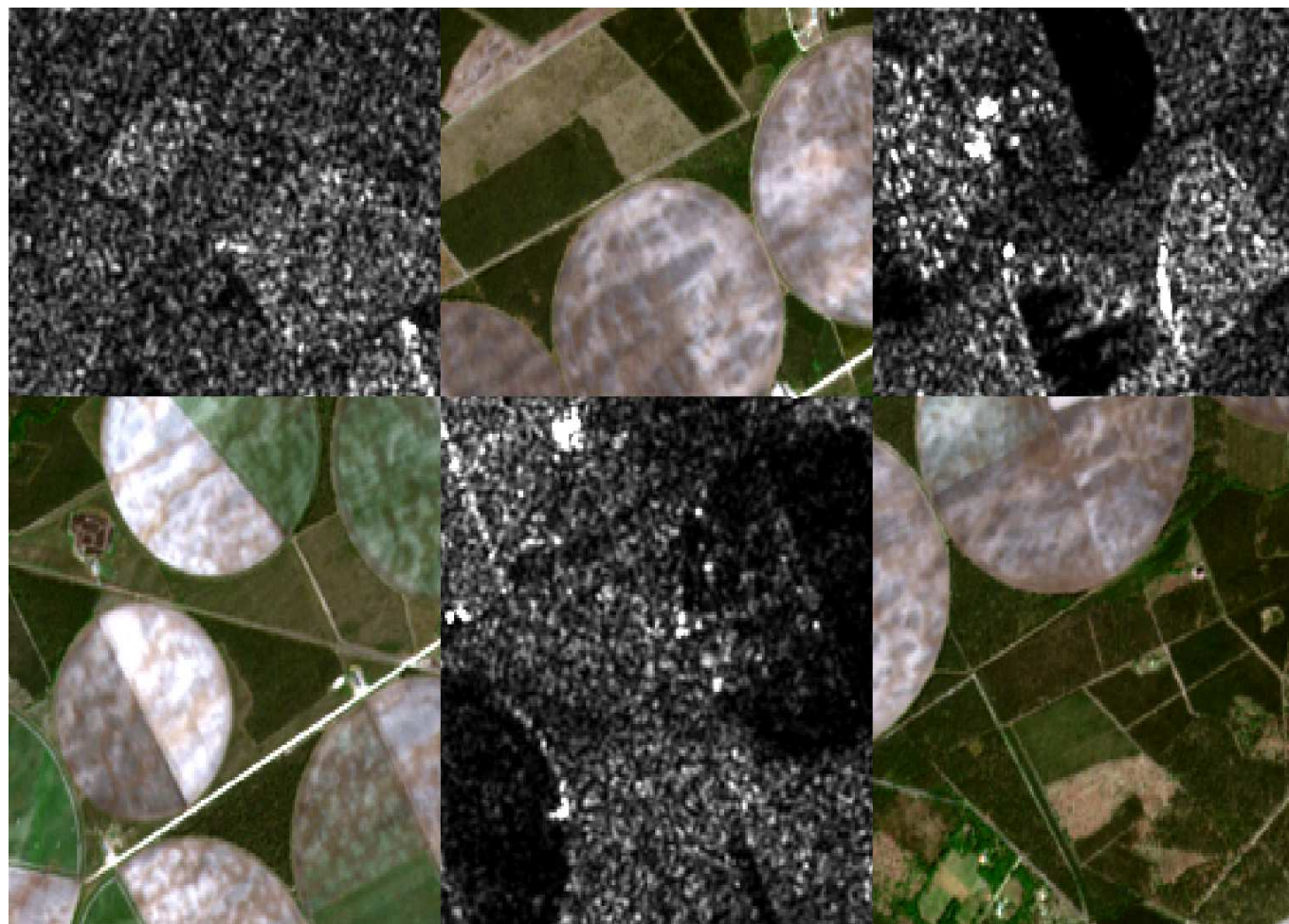


Ongoing processing.

Possibility to download just the results.

- Search
- Visualization
- Downloading
- Subscribing
- **Processing**

**Orthorectification  
S1 on S2 tiles**



# Experimental processing accessible via PEPS (private mode)



WPS Request

```
curl http://peps-vizo.cnes.fr:XXXX&service=WPS&identifier=COHERENCE_S1&datainputs=first_product=XXXX;second_product=XXXX
```



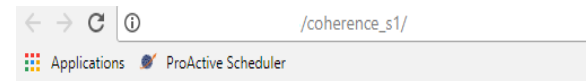
Download PEPS product



Computation on the CNES cluster with SNAP



Publication of the result



## Index of /coherence\_s1

Name	Last modified	Size	Description
<a href="#">Parent Directory</a>	-	-	-
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-03 17:42	256M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-08-07 12:14	256M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-09-15 12:56	256M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-08-02 14:35	256M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-12 09:27	256M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-28 09:50	256M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-12 08:12	256M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-12 15:42	408M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-12 15:40	362M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-12 15:46	323M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-12 15:04	262M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-21 14:34	169M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-12 09:32	262M	
<a href="#">S1A_IW_SLC_1SDV_201.&gt;</a>	2017-07-12 10:19	262M	



## ❖ Some figures HPSS

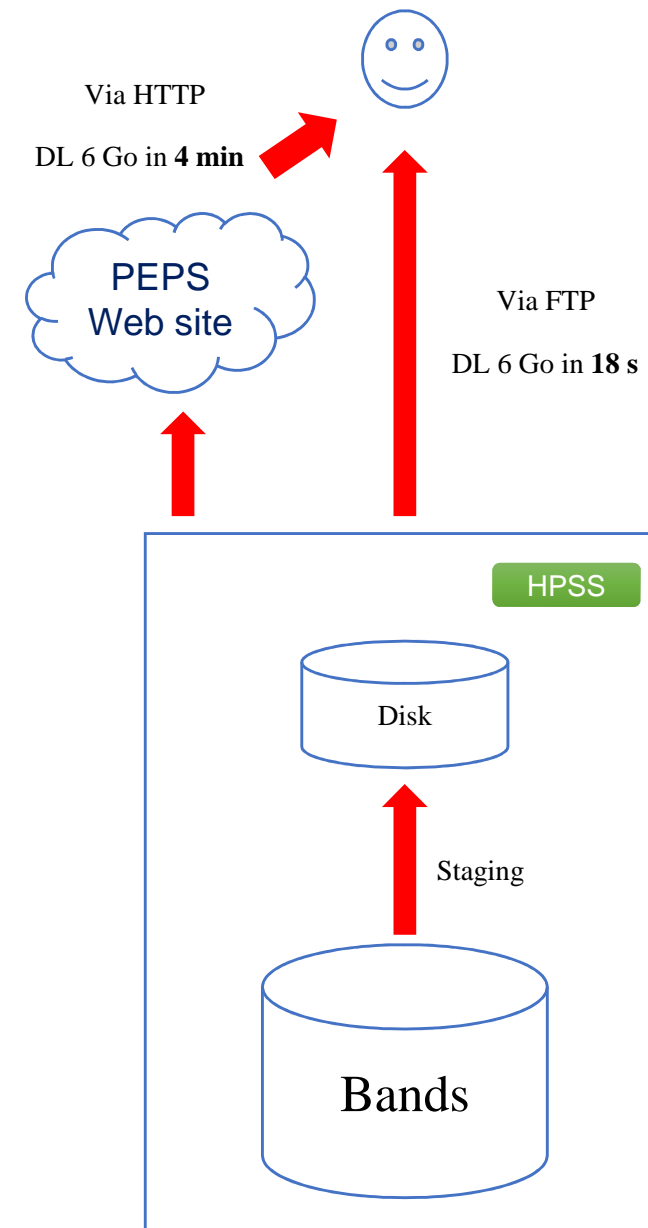
- 1,8 Po (disk) / 3,5 Po (bands),
- 3,5 Millions of S1, S2 et S3 products

## ❖ Search of data catalogue RESTO

- Via PEPS web site
- Via OpenSearch query

## ❖ Data downloading

- Via PEPS web site <https://peps.cnes.fr> : Explorer / Downloading. Downloading of 6 Go data in **4 min**,
- Via scripts available at « PLUS » section <https://peps.cnes.fr/rocket/plus/plus.htm>
- Via direct FTP connection to HPSS. Downloading of 6 Go data product in **18 s**.





## ❖ Needs

- Simple processing on images (quicklooks, orthorectification etc...)
- Direct processing on data at PEPS instead of moving raw data to end users

## ❖ Infrastructure

- Interface WPS 
- Schedulers ProActive et PBS 
- Docker 
- Storage : HPSS 
- Codes : OTB, Sentinel Toolbox ...  
- Computing : HAL (cluster HPC of CNES), exclusive machines

❖ **Processing available to everyone via the « tools » section (public mode)**

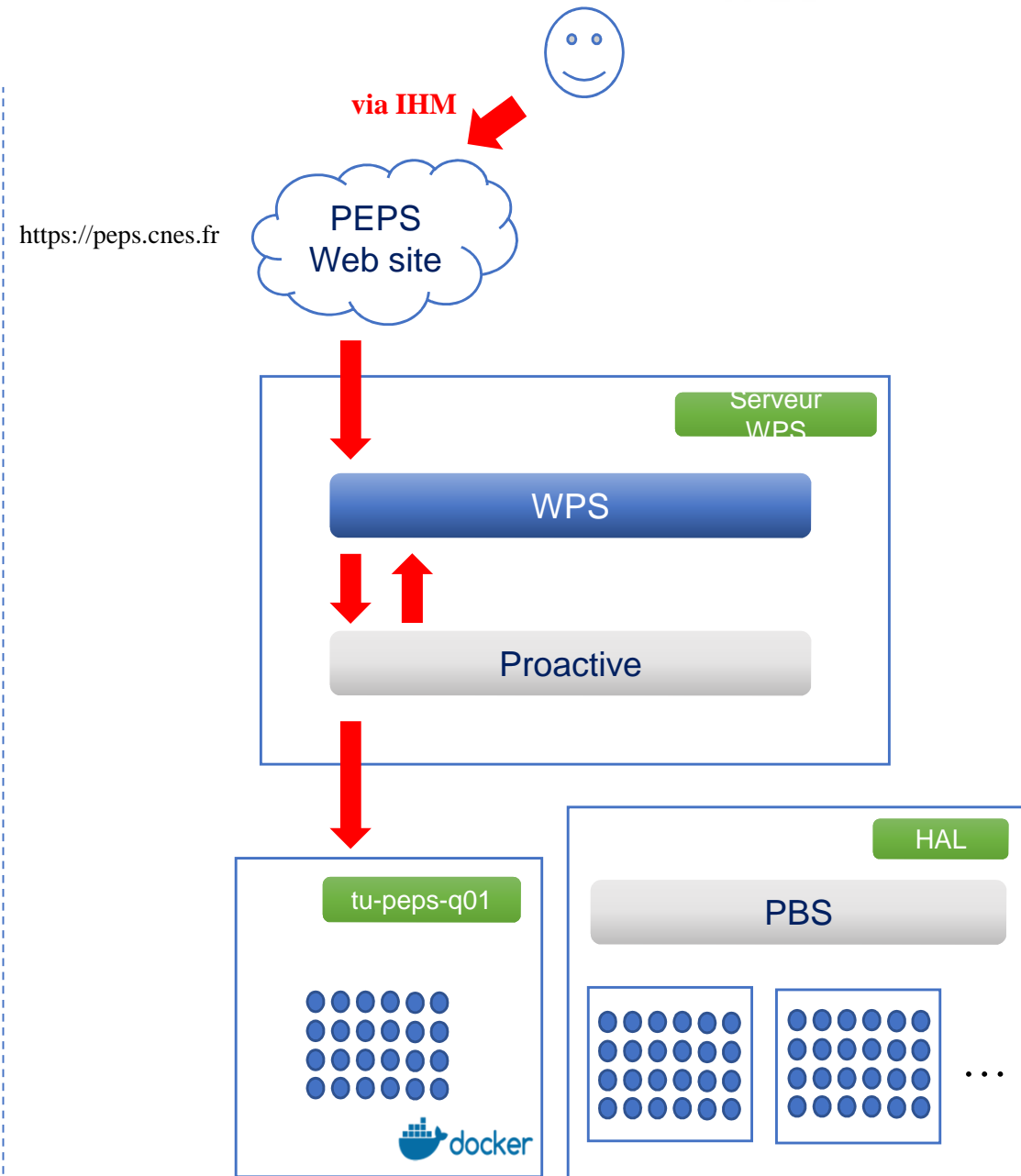
- Distant access available end of 2017 with PEPS V2.0
- Applied to one product
- To expand simple processing in a collaborative way between PEPS users community

➤ **Experimental processing accessible via PEPS (private mode)**

- Distant access only
- Applied to one or more products (mass production on cluster)
- To optimize and demonstrate feasibility and operability before this processing migrates to other infrastructures.

❖ **Direct integration of processing into CNES cluster (private mode)**

- Direct access to HPC cluster HPC if necessary
- Scientific operational or experimental processing chains like MUSCATE S2 (operational) & S1 interferometry large temporal series (in development)



❖ **Processing available to everyone via the « tools » section (public mode)**

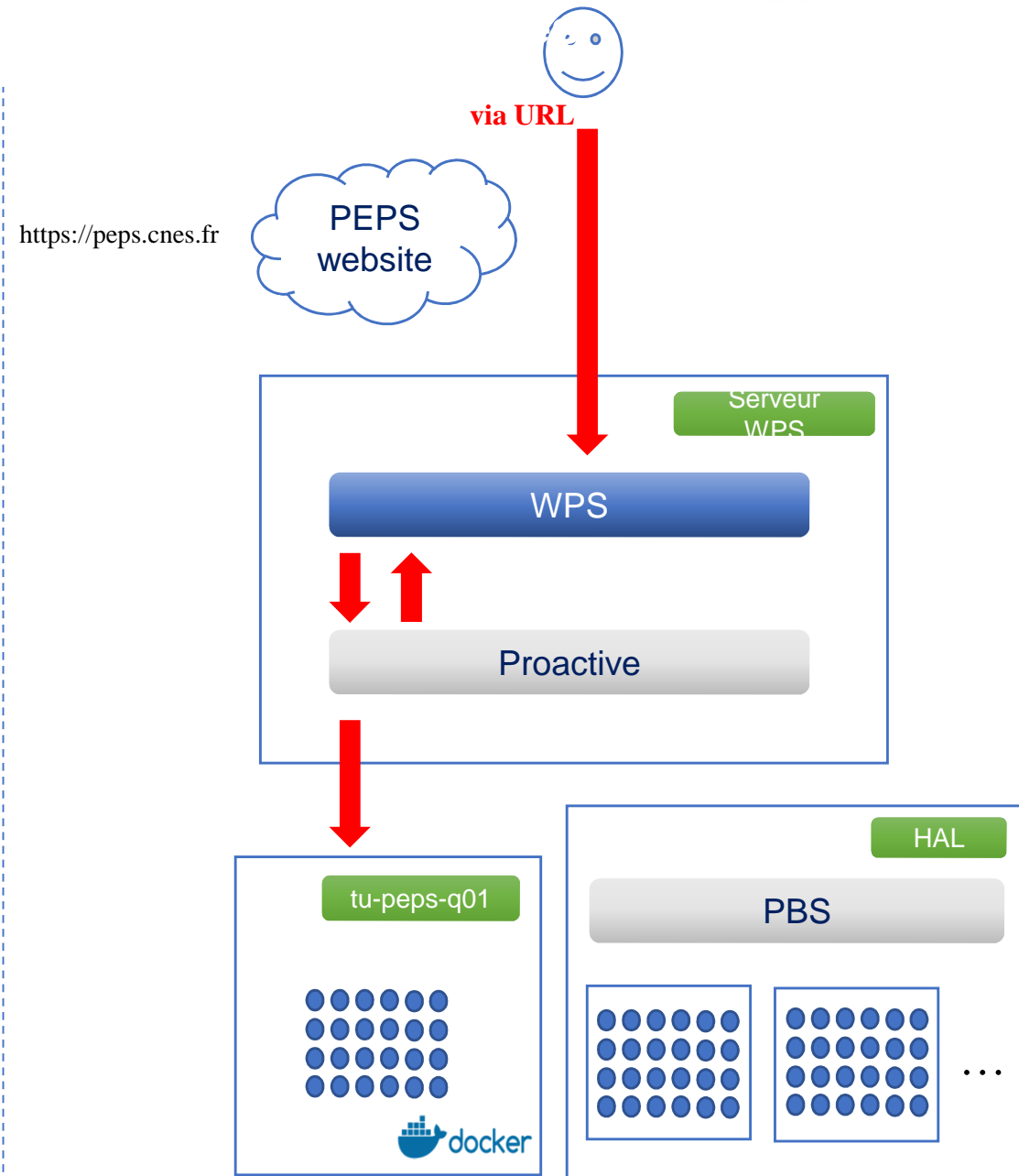
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➤ **Experimental processing accessible via PEPS (private mode)**

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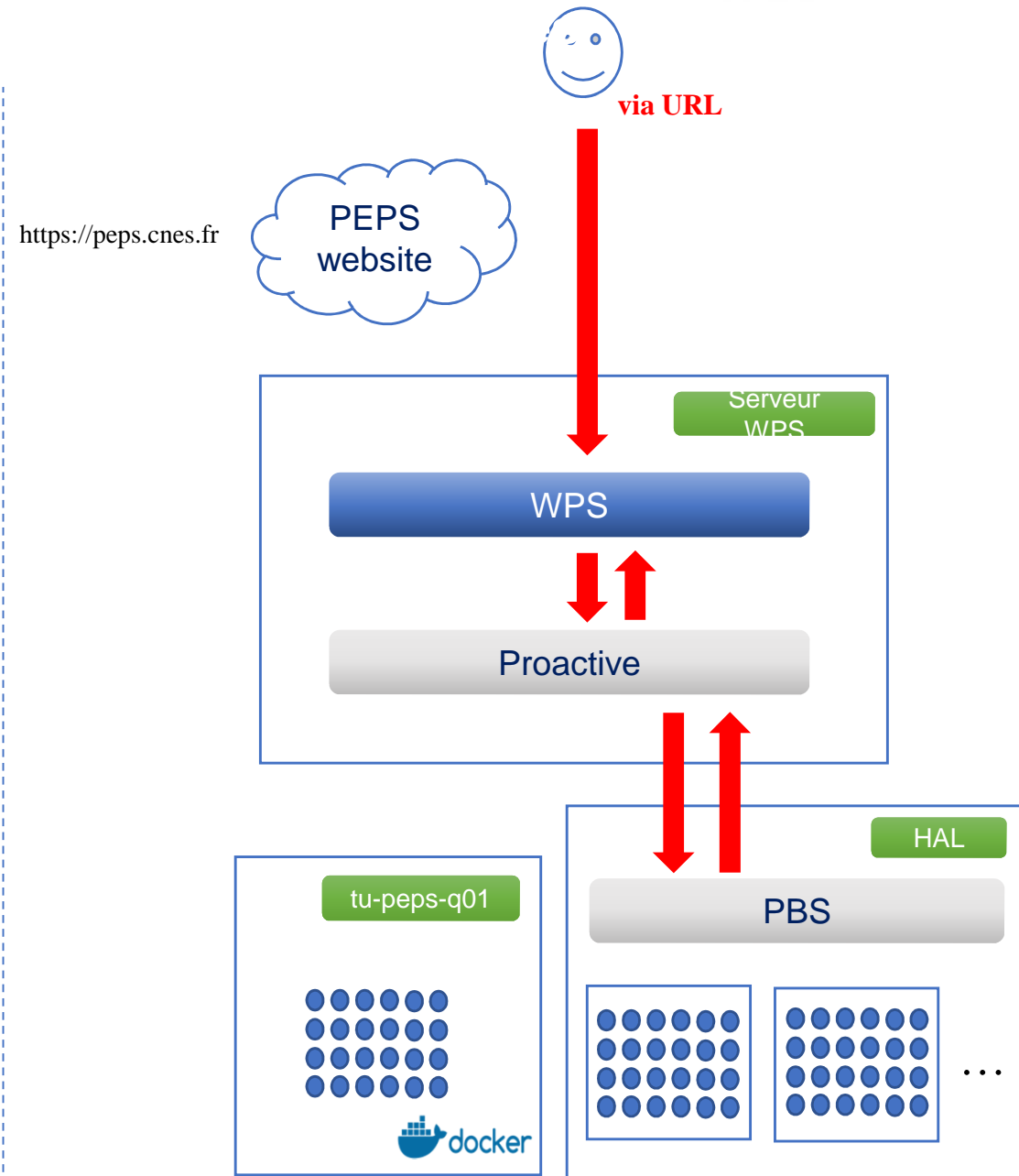
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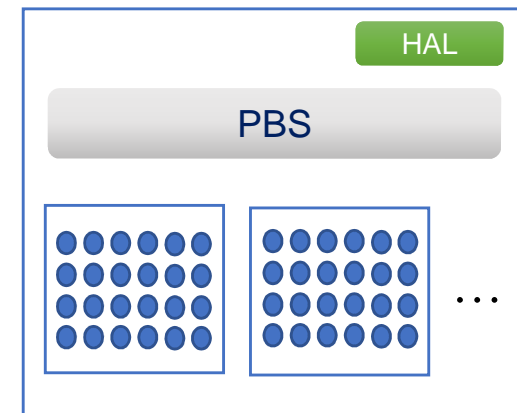
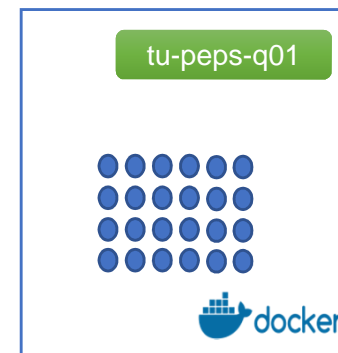
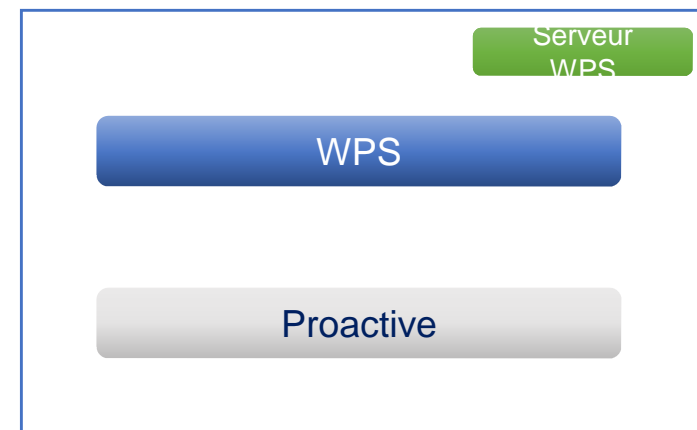
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<https://peps.cnes.fr>



via SSH



## Examples of current projects with processing in development at PEPS (SME)

**Who :** (BOOSTER MORESPACE )

OceanDataLab Private laboratory of 11 pers.  
Associated to IFREMER



Oceanographic research on waves, wind and currents.  
Expert Support Laboratory (ESA ESL) Sentinel1

**Object, context :** Innovative compression processing on S1 and S2 images



**POC :** Massif processing of the archive S1, S2. Optimization of the contrasts on RGB images of S2 data. Distant integration.

**Results available on [peps.oceandatalab.com](http://peps.oceandatalab.com)**



1x 6-Hour Daily **3-Day** Weekly Bi-weekly 217 datasets 100 displayed 49.13°, 33.47°

REVEXE PEPS - 21 novembre 2016

January February **April** May June July August September October November December

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31



THEIA: French national multi-agency organisation for continental surface studies  
THEIA promotes the use of satellite data by scientific community and public policy actors.

[www.theia-land.fr](http://www.theia-land.fr)



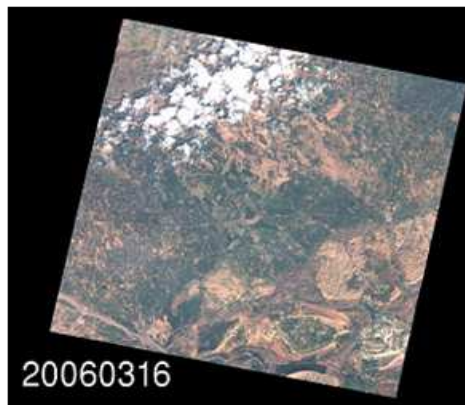
## MUSCATE = THEIA processing centre of HR optical satellite products

### 3 Families of Satellites:

- SPOT 1 to 5: Spot World Heritage project (more than 5 years old data)
- LANDSAT 5-7-8
- SENTINEL-2A and 2B

### 3 Types of Products (CEOS standard):

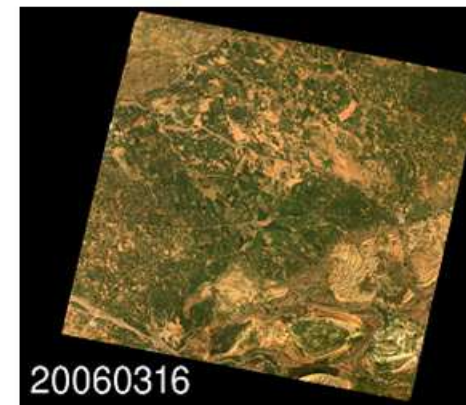
- Level 1C: orthorectified product in TOA reflectance (SPOT)
- Level 2A: level 1C product in surface reflectance (LANDSAT)
- Level 3A : temporal synthesis of level 2A products (SENTINEL2)



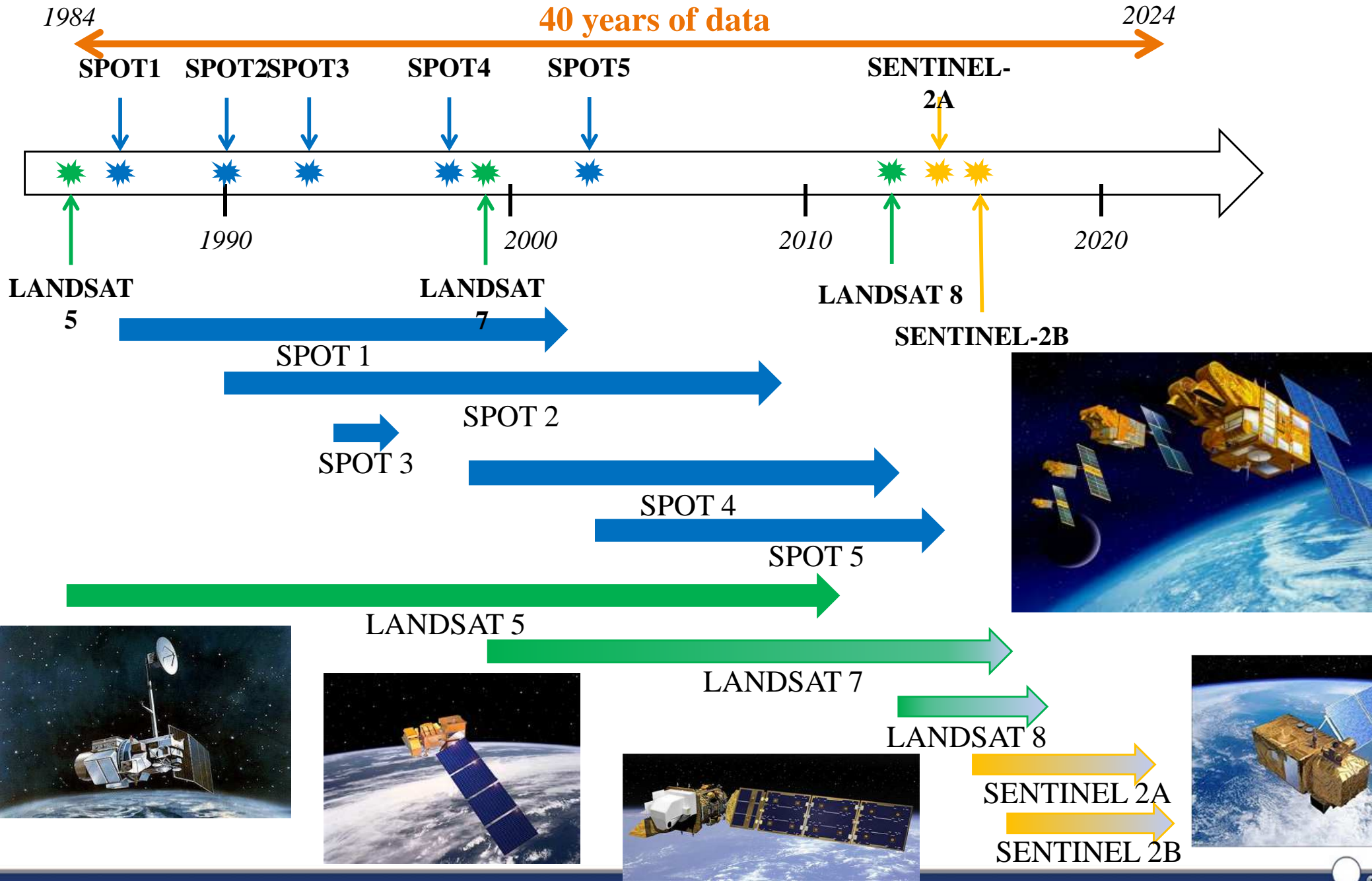
Level 1C



Level 2A

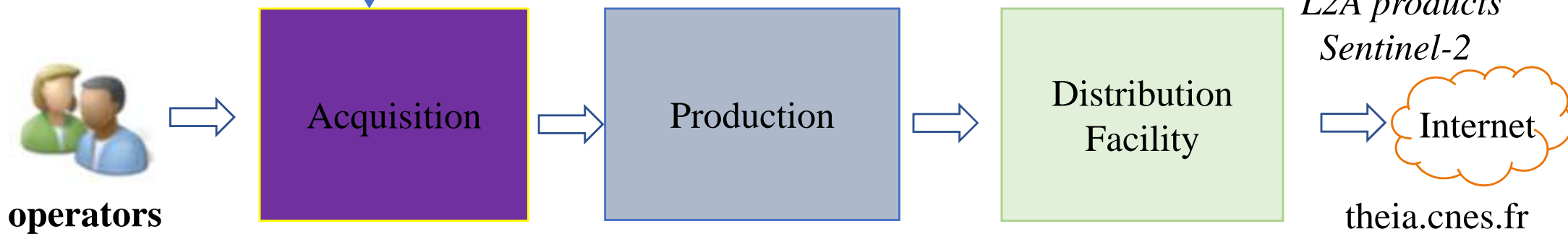


Level 3A





*L1C Sentinel-2 Products*



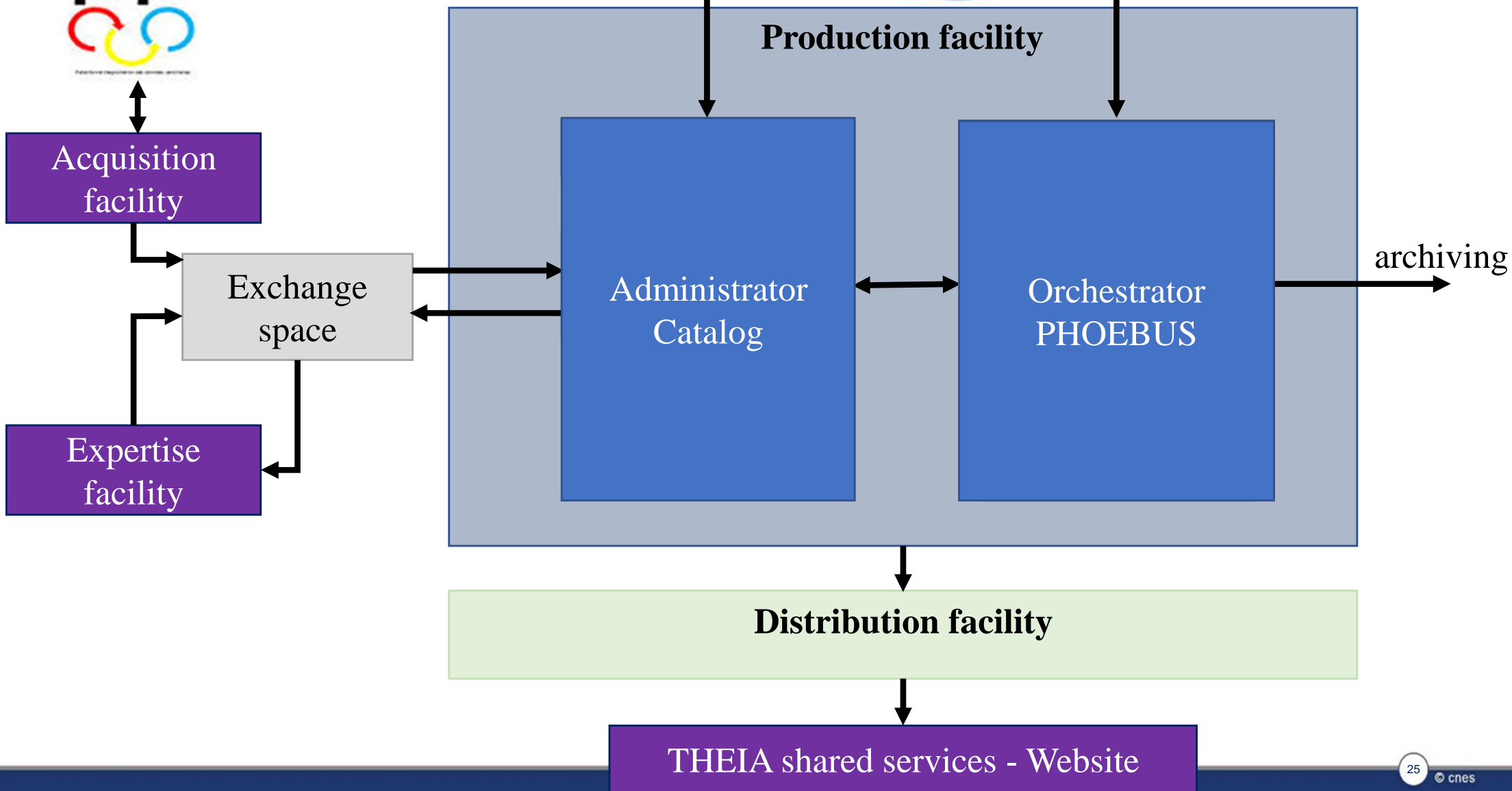
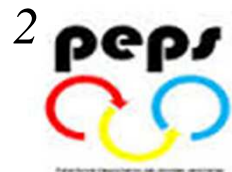
introduce new case (new geographic areas)  
→ automatic processing with new data

Already Available Datasets:

- MUSCATE is operational
- Possibility to download LEVEL2 products from THEIA website :  
**theia.cnes.fr**



*SENTINEL*



## MUSCATE administrator/Catalog HMI

Atelier de Production MUSCATE - musrecadmin (on tu-mutcalc-d01)

Fichier Mon compte

Produits Données auxiliaires Traitements Tâches Utilisateurs

Requête

QuickLook Synthèse

Afficher le quicklook

Condition Et ET OU

Executer la requête

Résultat

(0/0)

Nom	Niveau	Etat	Etat Distribution	Date Acquisition	Etat Archivage	Date Produc +
Aucun contenu dans la table						

## PHOEBUS orchestrator HMI (ZEUS)

Zeus [PHOEBUS] - Centre Toulouse - musrexec (Installation pour MUSCATE) (on tu-mutcalc-d01)

Administration Configuration Etape Plan de travail Outils Aide

Macrotraitement Macro-Echanges Tous les plans de travail En attente En exécution Stoppés En erreur Terminés Annulés

Macrotraitement Macro-Echanges-Acquisition Macrotraitement Retraitement\_Landsat\_Sentinel Macrotraitement Landsat\_Sentinel Macrotraitement Spot

Niveau...	Debug	Etat	Action ...	Erreur	Nom	Opérateur	Satellite	Parent	Début	Fin	Avancement

Plan de travail :

Etapes Fichiers d'entrée Commentaire Actions opérateur Alarmes Message opérateur

Reprise	Arrêt	Etape	Sous-...	Nombr...	Interr...	Etat	Etat d...	Fin

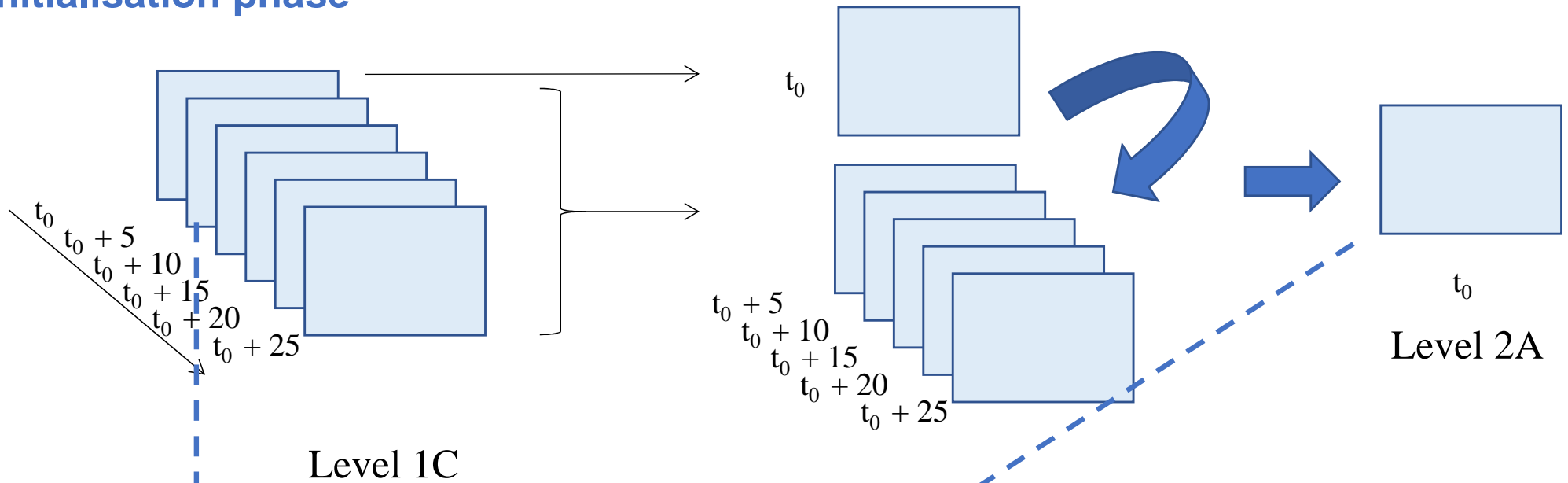
27/01/2016 09:10:45

# MUSCATE: production FACILITY

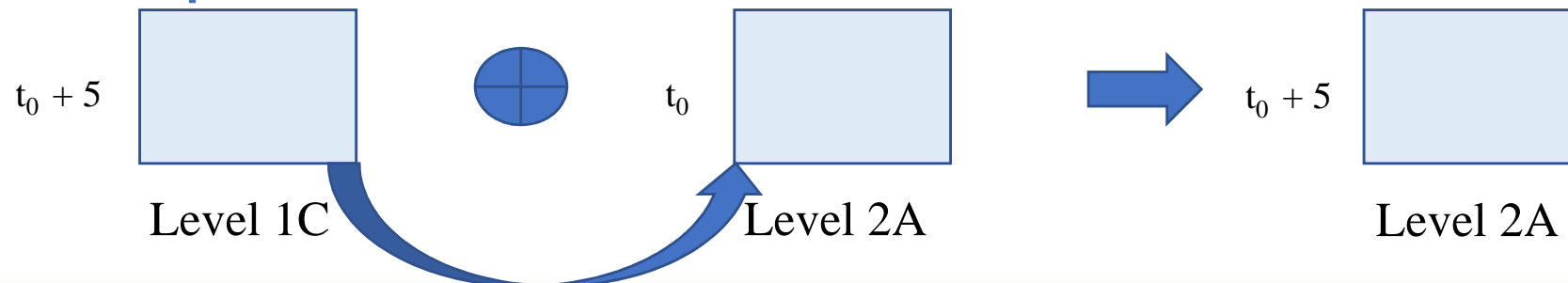
## Example OF SENTINEL 2 PROCESSING

### Bottom reflectance algorithm

### Initialisation phase



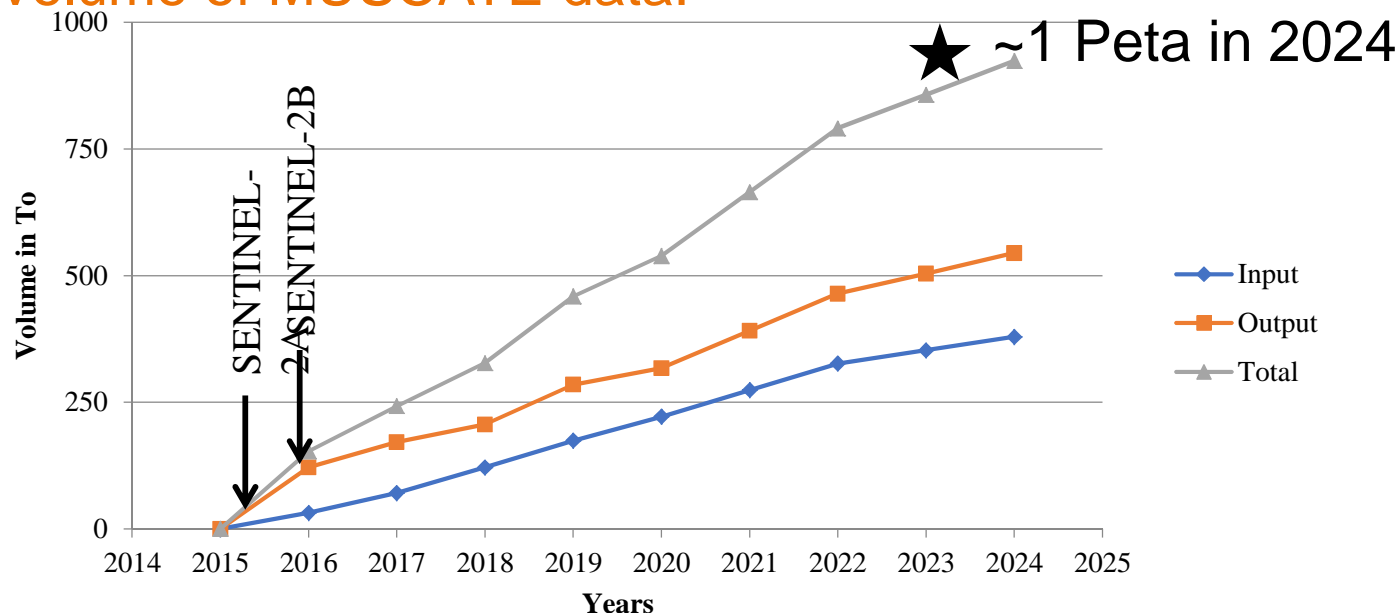
### Nominal phase



## MUSCATE: an Ambitious Project at Low Cost

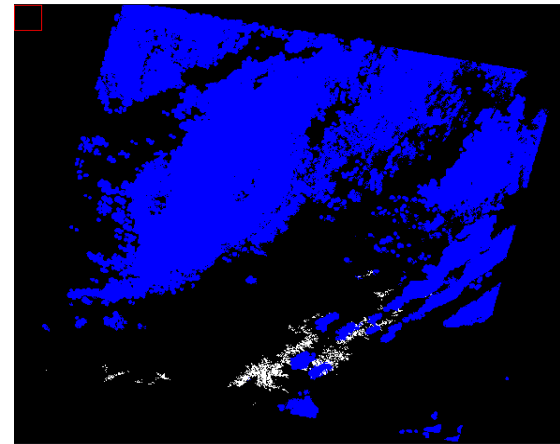
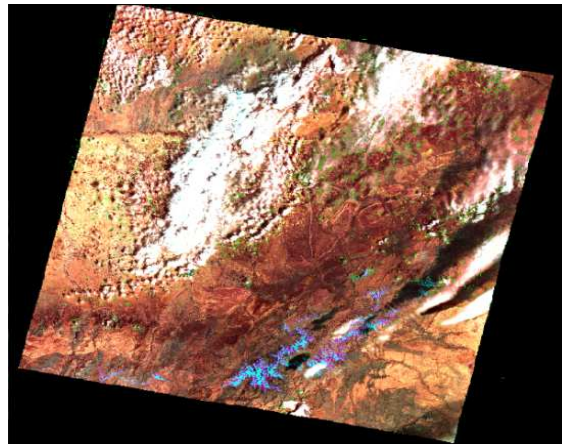
- To process automatically up to 2000 products a day
- Based on the shared CNES computing facilities
- Re-use of CNES software: PHOEBUS (orchestration), SIGMA (orthorectification), and MACCS-MAJA (conversion in surface reflectance)

### Cumulative Volume of MUSCATE data:



## Integration of new processings

- MUSCATE should host new processings developed by CESBIO :
  - Snow detection

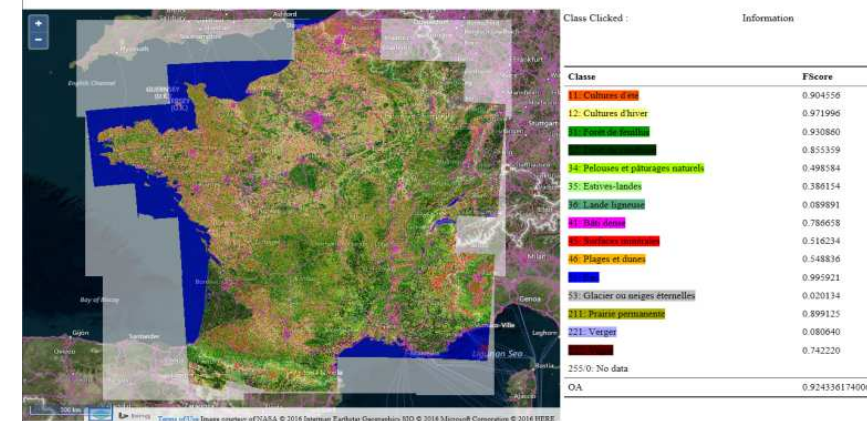


- Soil occupation map
- Temporal Synthesis levels 3A & 3B

## Multi-satellites and sensors

- Addition of new satellites and sensors

France Landsat8 2014 v1



Internet website: [http://www.cesbio.ups-tlse.fr/multitemp/wp-content/uploads/2016/02/SudOuestMosaic\\_France2014\\_VI\\_ColorIndexedT.html](http://www.cesbio.ups-tlse.fr/multitemp/wp-content/uploads/2016/02/SudOuestMosaic_France2014_VI_ColorIndexedT.html)

## **MUSCATE transposed to Sentinel-1 InSAR**

**Objective : land deformation monitoring in natural environments**

**Means :** to develop a Science-driven processing platform (automatic processing with possible input parameters tuning and reprocessing)

**Targets :** Faults, volcanoes, landslides

**Final products :** High Quality

Regularly updated Deformation **in Long Time Series at Large Scale**

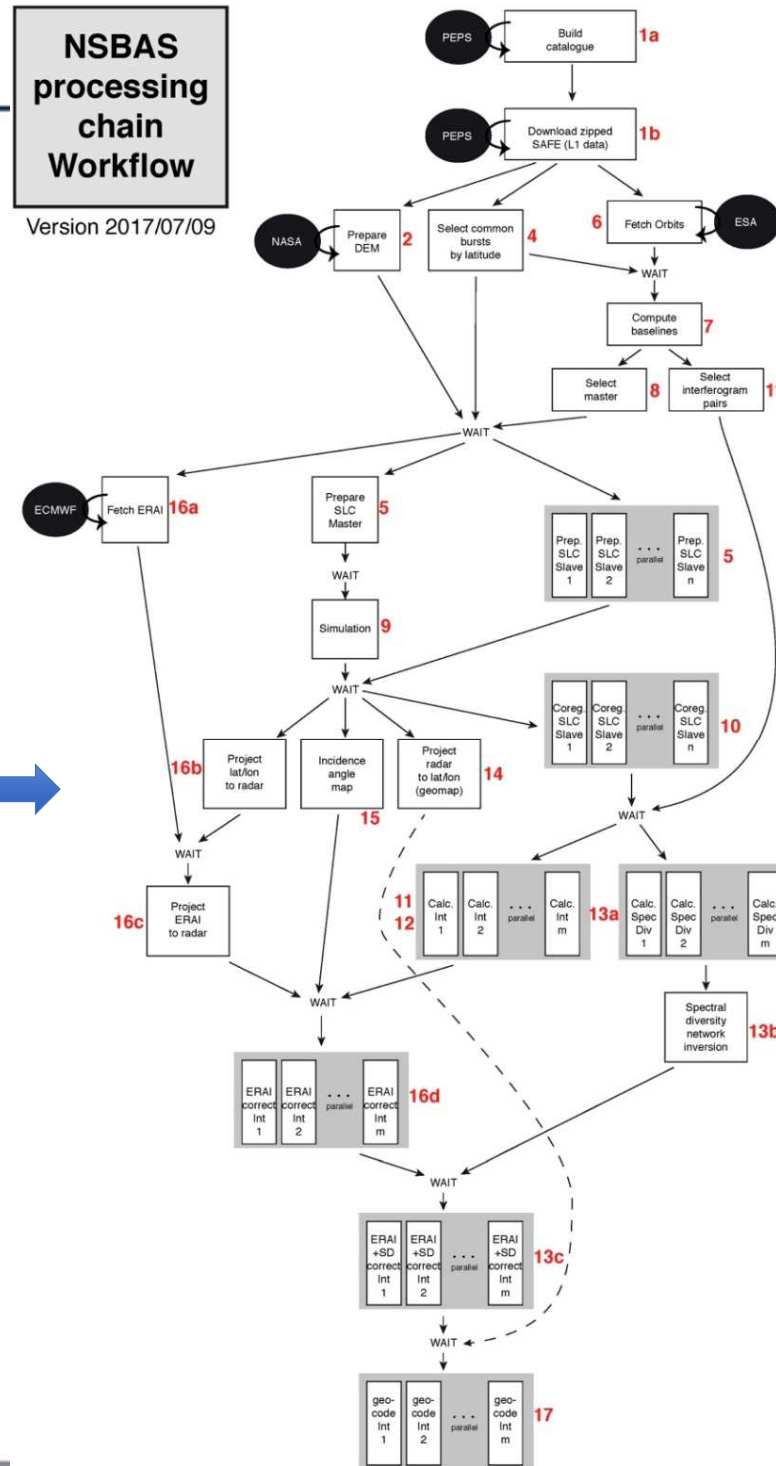
**Prototype :** North Tibet ( $2 \cdot 10^6$  km<sup>2</sup>), Mexique ( $1 \cdot 10^6$  km<sup>2</sup>), Turkey ( $0.5 \cdot 10^6$  km<sup>2</sup>)

**Processing :** on CNES HPC

**NSBAS  
processing  
chain  
Workflow**  
Version 2017/07/09

**Based on Small Baseline  
processing chain  
(NSBAS, Doin et al.,  
2011, Grandin 2016)**

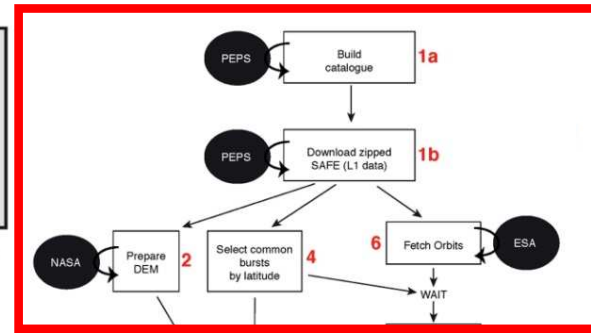
- 1- Stack of coregistered interferograms
- 2- Time Series



External  
data :  
Orbits,  
ECMWF,  
DEM

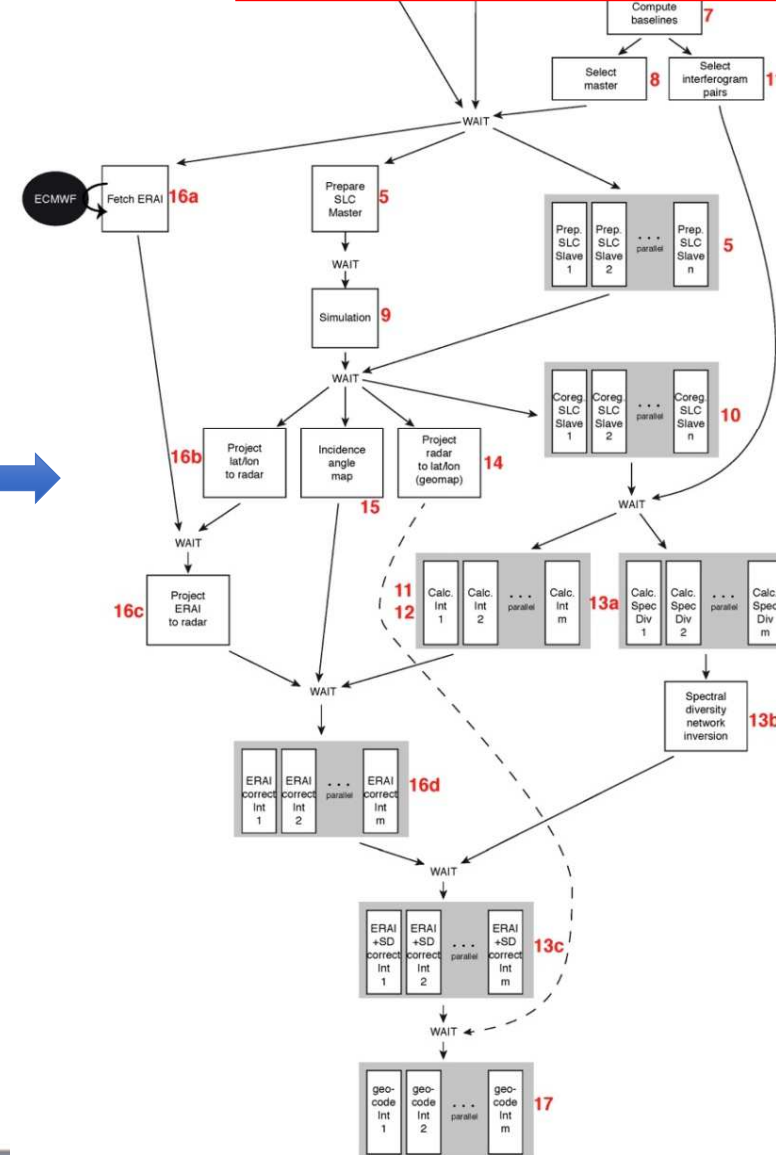


**NSBAS processing chain Workflow**  
Version 2017/07/09



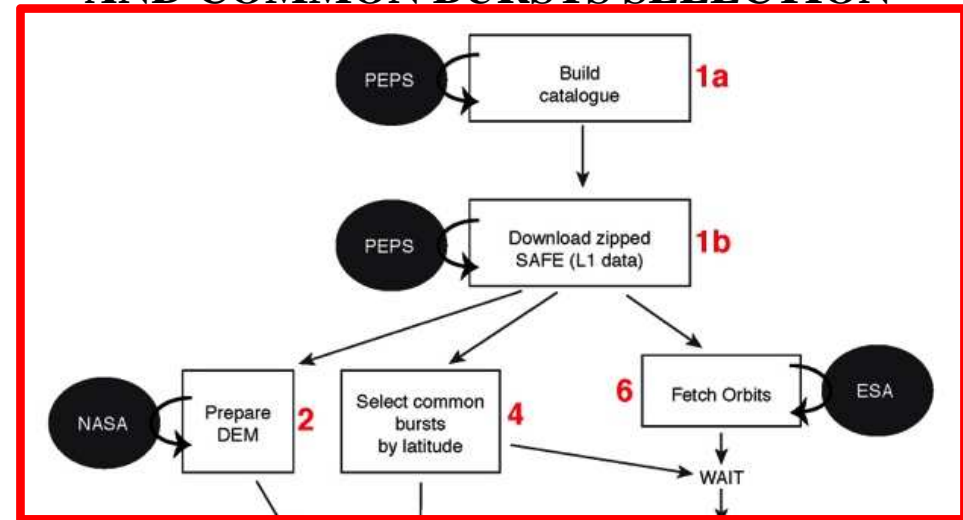
**Based on Small Baseline processing chain (NSBAS, Doin et al., 2011, Grandin 2016)**

- 1- Stack of coregistered interferograms
- 2- Time Series



## DATA DOWNLOAD FROM PEPS AND COMMON BURSTS SELECTION

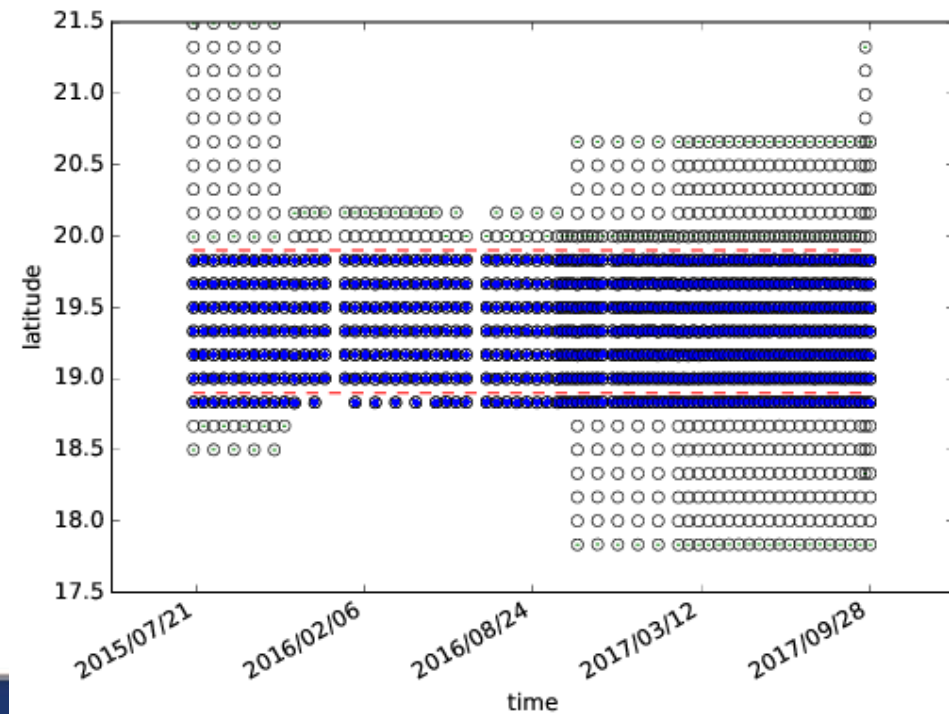
**Based on Small Baseline processing chain (NSBAS, Doin et al., 2011, Grandin 2016)**



1- Stack of coregistered interferograms



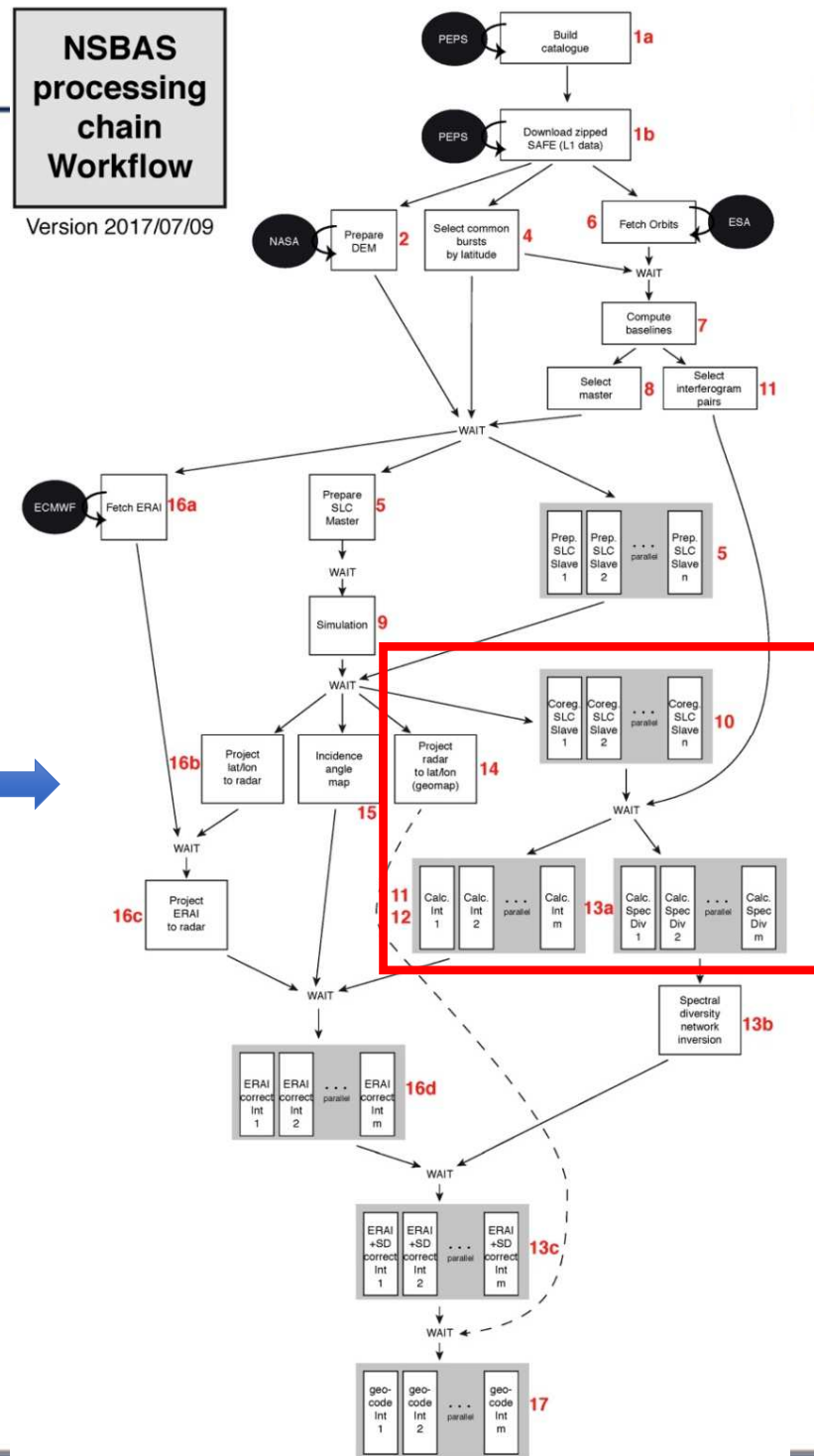
2- Time Series



**NSBAS processing chain Workflow**  
Version 2017/07/09

**Based on Small Baseline processing chain (NSBAS, Doin et al., 2011, Grandin 2016)**

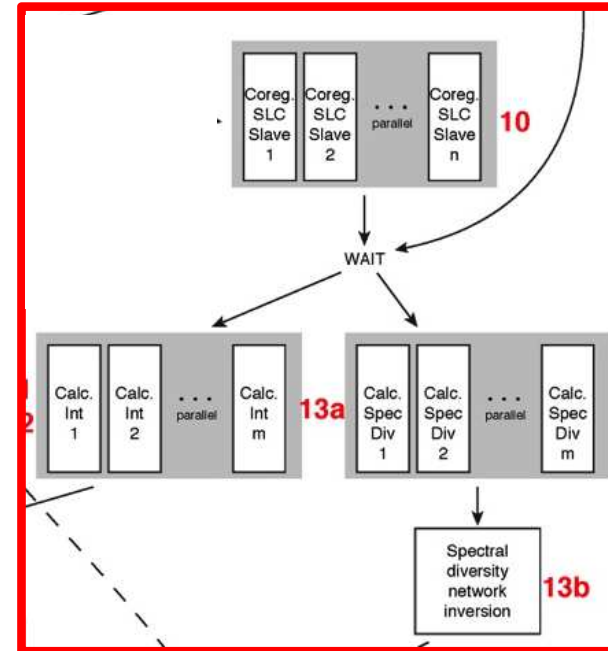
- 1- Stack of coregistered interferograms
- 2- Time Series



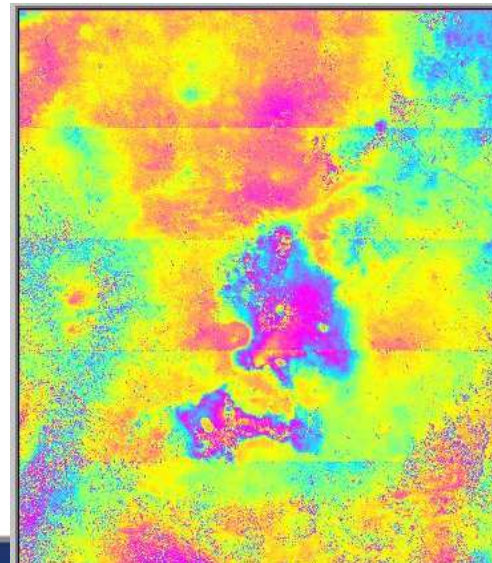
# COREGISTERED SLCs, INTERFEROGRAMS AND SPECTRAL DIVERSITY CORRECTION

**Based on Small Baseline processing chain (NSBAS, Doin et al., 2011, Grandin 2016)**

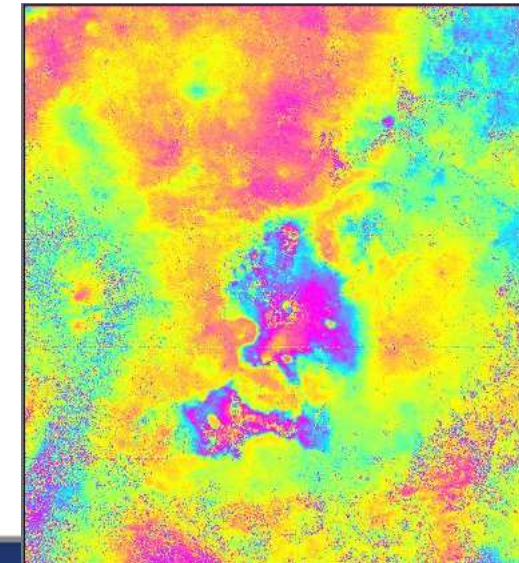
- 1- Stack of coregistered interferograms
- 2- Time Series



Before SD correction



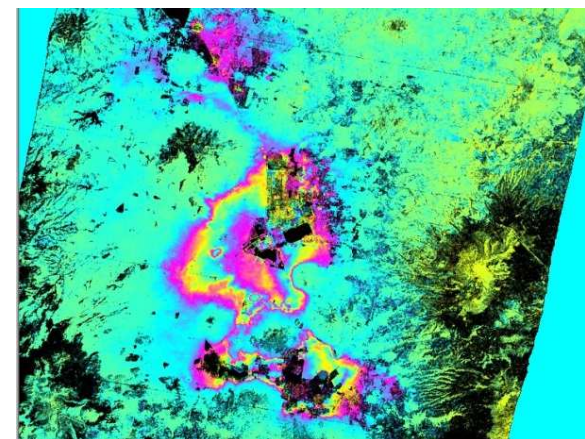
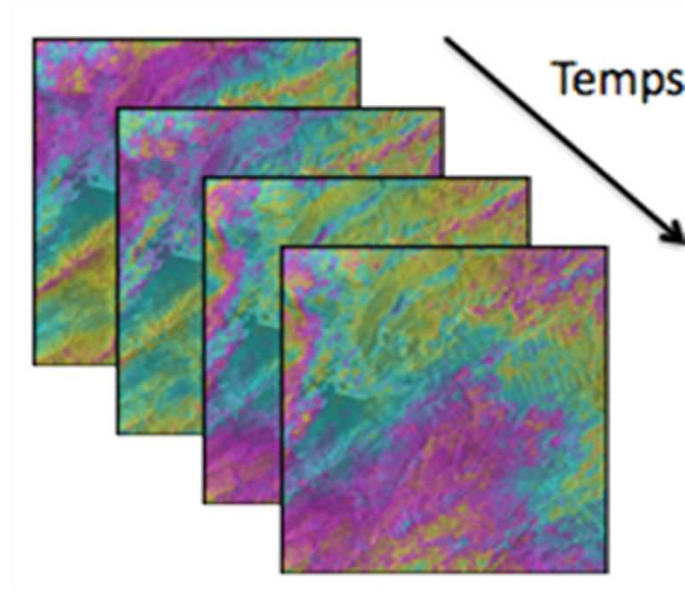
After SD correction



**Based on Small Baseline  
processing chain  
(NSBAS, Doin et al.,  
2011, Grandin 2016)**

1- Stack of coregistered  
interferograms

2- Time Series &  
Velocity maps



Velocity maps

## **Schedule:**

- Project Launch June 2016 with Form@ter scientific board
- End 2016 – mid 2017 : specifications – New NSBAS chain production validation at Isterre - Machine environnement checking bw. CNES HPC & Isterre Center
- End 2017 : firsts tests of Isterre Chain on CNES HPC
- End 2018 : sizing of temporary directories - first areas fully tested – scheduler – specific products to be delivered (to be expressed by form@ter users...)
- Validation : experts from Isterre - IPGP

## **Other needs expressed by the community :**

- define output/intermediate results
- process new large areas

**If interested in this project to participate/give inputs, please contact us quickly**

# Thank you

