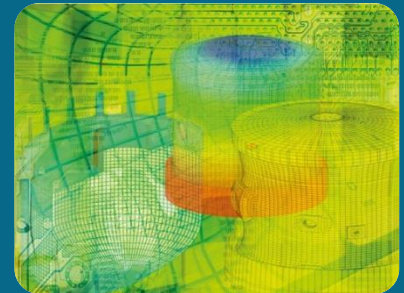




OPEN SOURCE TOOLS FOR VHR PROCESSING AND ARD GENERATION VH-RODA 2019 2019-11-20





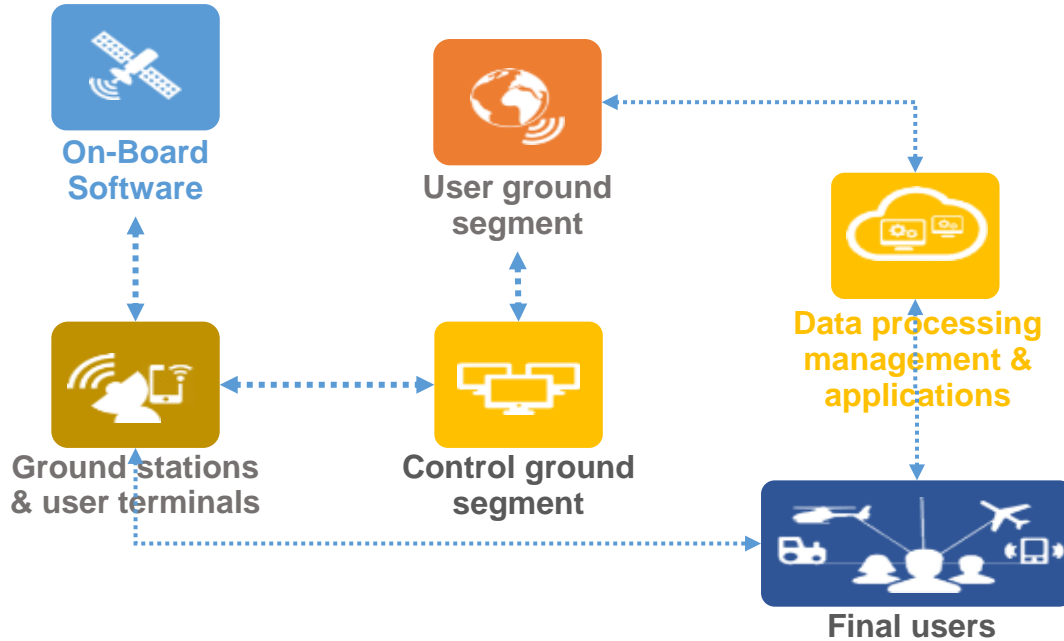
AGENDA

- CS GROUP remote sensing skill center
- VHR ARD data
- Open source geometric correction tools
- Open source radiometric correction tools
- Open source atmospheric correction tools
- Local VHR ARD processing chain example



CS GROUP REMOTE SENSING SKILL CENTER

1



SKILL CENTERS

- Mission Control
- Flight Dynamics
- Mission Planning
- Image Processing
- Geographical Information
- Embedded Software
- Simulation
- High Performance and Cloud Computing

CLIENTS



35 years

38 M€

410 Engineers

- France 320
- Germany (Moltek) 55
- Netherlands 15
- Romania 20
- Canada New project for CSA

COPERNICUS :

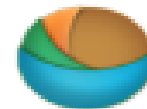
Unique set of references
in major space agencies

Unique French company as Frame Contract prime for
CNES, ESA and EUMETSAT



ENABLING INNOVATION AND INTEROPERABILITY

- ➔ CS Group, Open Source Software Promoter
- ➔ CS Group, Open Source Consulting
- ➔ CS Group, Open Source Integrator



GEOSTORM
PLATEFORME GÉOSPATIALE



PDA DEPARTMENT REFERENCES

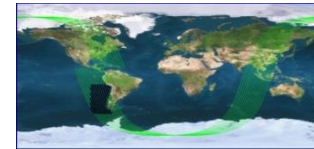
Some of our customers



Some of our projects

→ Major references Ground Segment Image Quality

- > **MPC S2** : Mission Performance Center
- > **ICC** : Pléiades Image Calibration Center
- > **VIQ** : Venus Image Quality



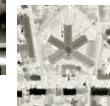
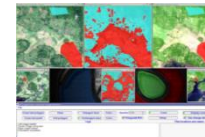
→ Major references Ground Segment Image Processing

- > **IPF S2** : Image Performance Facility
- > **MACCS** : Generic Image Processing Chain L2 and L3
- > **Venµs**, L2 and L3 products Generation
- > **VIP** : Venus Image Processing



→ Major references - Tools Box

- > **SNAP - S2 Toolbox**: Image processing libraries for Sentinel 2
- > **RUGGED** : Open source library for geolocation
- > **OTB** : Image Processing Framework



- ➔ Team : 50 collaborators (1/4 of PhD)
- ➔ Support CNES, ESA and major space industrial (Airbus, TAS, ...)
 - › In radiometric and geometric quality assessment
 - › To develop new algorithms in image processing, sensor geometry, radiometric calibration, cloud detection and radiative transfer method
 - › To develop image processing prototype chains (CNES-S2P, CNES-Kalideos)
 - › To develop and maintain image processing operational chain (S2-IPF)
- ➔ Develop and maintain Toolboxes in the field of Image Processing:
 - › Orfeo ToolBox
 - › SNAP (S2-ToolBox)
 - › CNES Common Tools
 - › Kalideos Scientific Processing Chain
- ➔ Develop and maintain tools in the field of geometry: RUGGED





VHR ANALYSIS READY DATA

2

➔ Goal :

- › Create data usable by end users
- › Merge various remote sensing data in one stack
- › Provide physical measurement
- › Exclude not usable pixel
- › Align data on the same grid

➔ Adapt all these objectives to the end user area

- › VHR data are used to monitor local sites
- › Acquisition are generally not systematic (too expensive) and with non uniform conditions

➔ Reduce cost and provide full control to user :

- › Own auxiliary data
- › Custom parameters
- › Limit resampling of data



OPEN SOURCE GEOMETRIC CORRECTION TOOLS

3

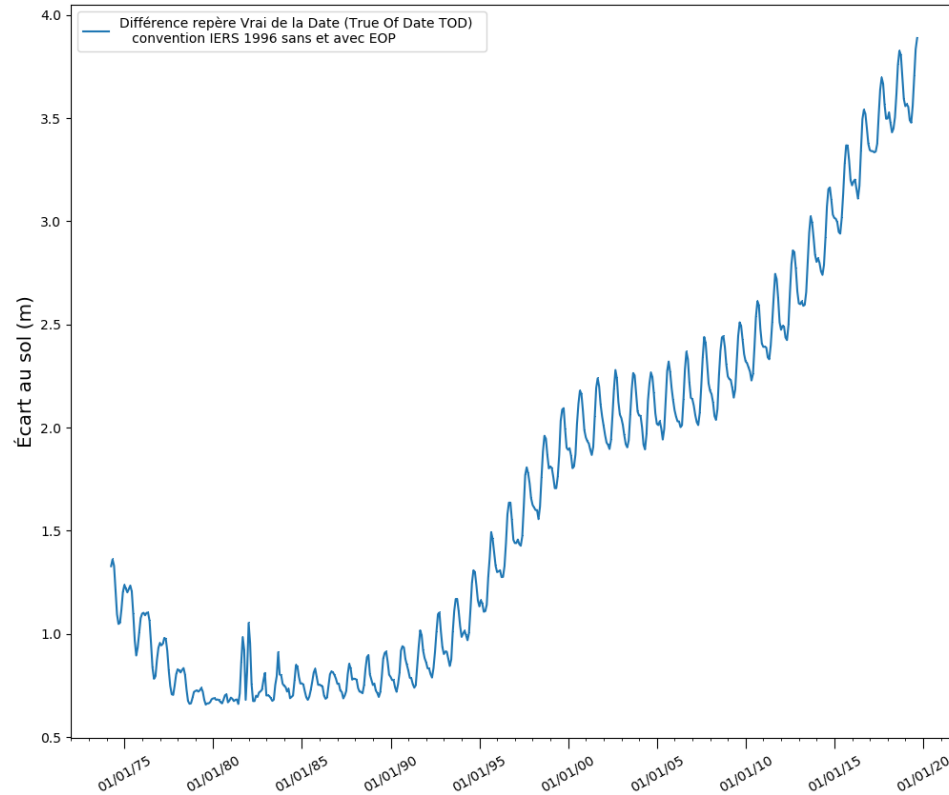


- ➔ Open source tool created for Sentinel-2 IPF
- ➔ Based on OREKIT toolbox : low level space dynamics library
- ➔ Provide up to date geometry algorithms to get high accuracy for HR and VHR data
 - › Provide up to date Earth and Time models
 - › Atmospheric effects, Light-time correction and Aberration of light
 - › Earth Tide
 - › Example PHR data :

Localization type	Mean	Standard deviation
Direct with constant altitude	3e-3 meters	1.386e-3 meters
Inverse	0,06 pixel	0,0029 pixel

- ➔ High computing performance against well establish tools
 - › Benchmarked in the frame of S2 IPF with GPP solution
 - › Benchmarked against Airbus solution for validation
- ➔ Strong association with Orfeo Toolbox (OTB) to perform grid based resampling

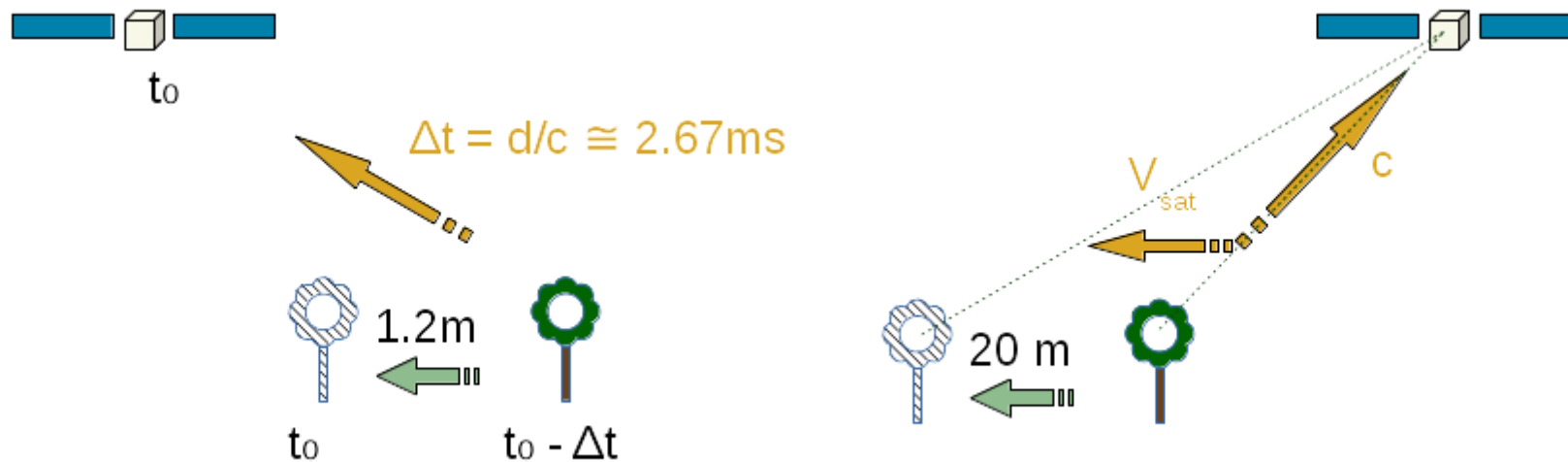
➔ Impact of old earth model



➔ Atmospheric effects :

- › Discretize atmosphere with constant refraction indices
- › Correct horizontal shift : about 2 meter

➔ Light-time correction / Aberration of light



➔ Study case 1 : Sentinel 2 IPF

- › IDPSC GEN_ORTHO_TOA : from L1B to L1C
- › Generate resampling grids (10m, 20m and 60m bands)
- › Reference GPP S2IPF (EUCLIDIUM)
- › Results :
 - 844s (45m, 90m and 180m grids) for EUCLIDIUM
 - 517s (45m, 90m and 180m grids) for S2GEO/RUGGED

➔ Study case 2 : Impact of additional corrections on PHR data with RUGGED:

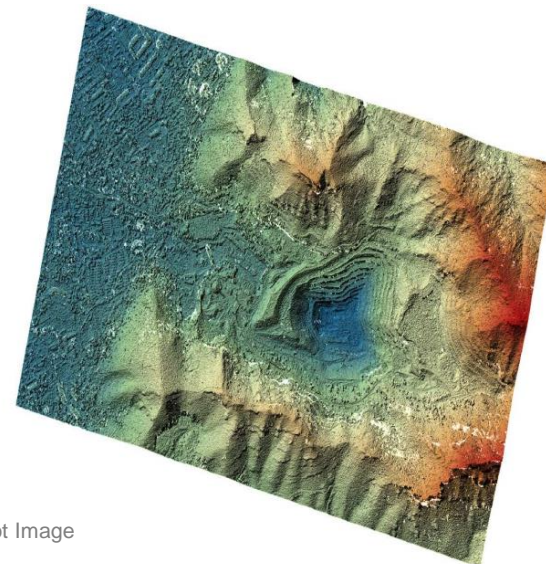
- › Grid computation and grid based image resampling

	No correction	With aberration of light correction	With atmospheric refraction correction	With both
Temps (s)	1.08 6.99	0.99 7.32	1.16 7.72	1.36 7.61

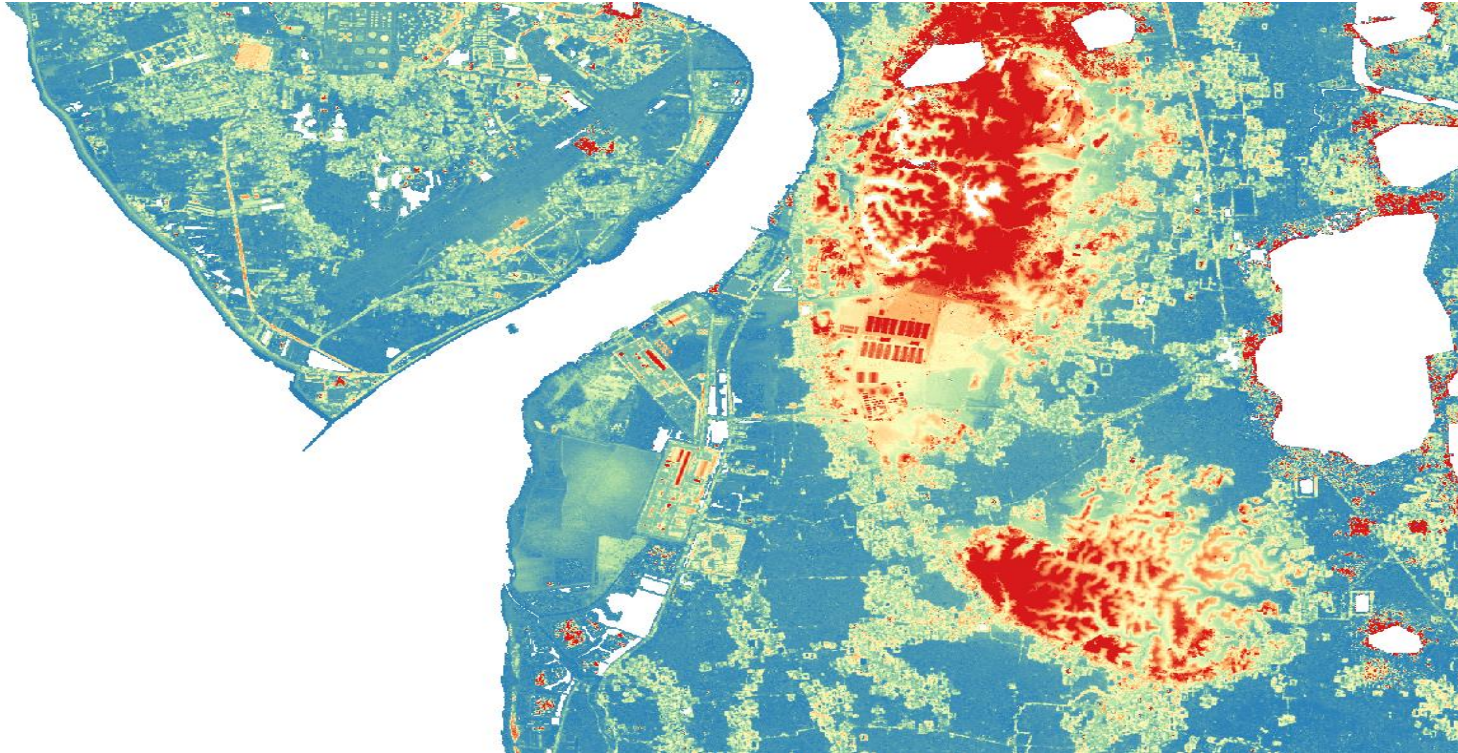
➔ In some cases,

- › DTM/DSM are outdated or inconsistent
- › satellite agility offers possibility to generate useful up to date DSM

➔ Open source S2P [2] tool allow production of DSM with high quality



© CNES (2013), distribution Airbus DS/ Spot Image



© CNES (2013), distribution Airbus DS/ Spot Image



© CNES (2013), distribution Airbus DS/ Spot Image

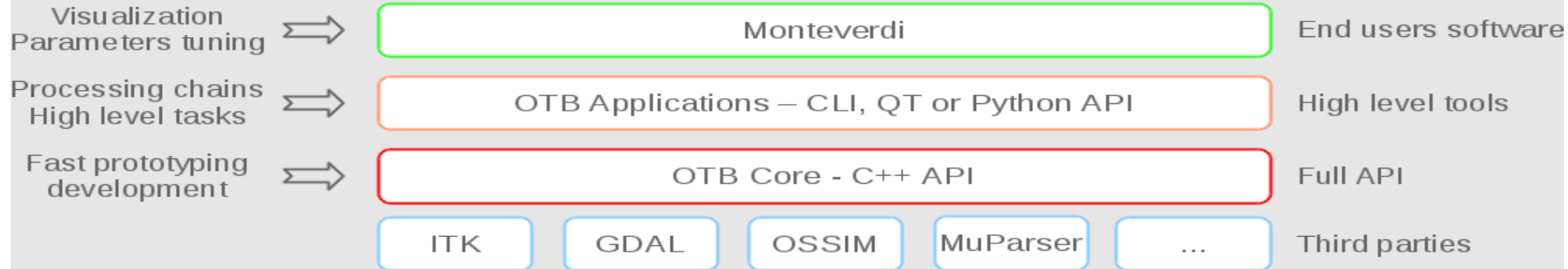
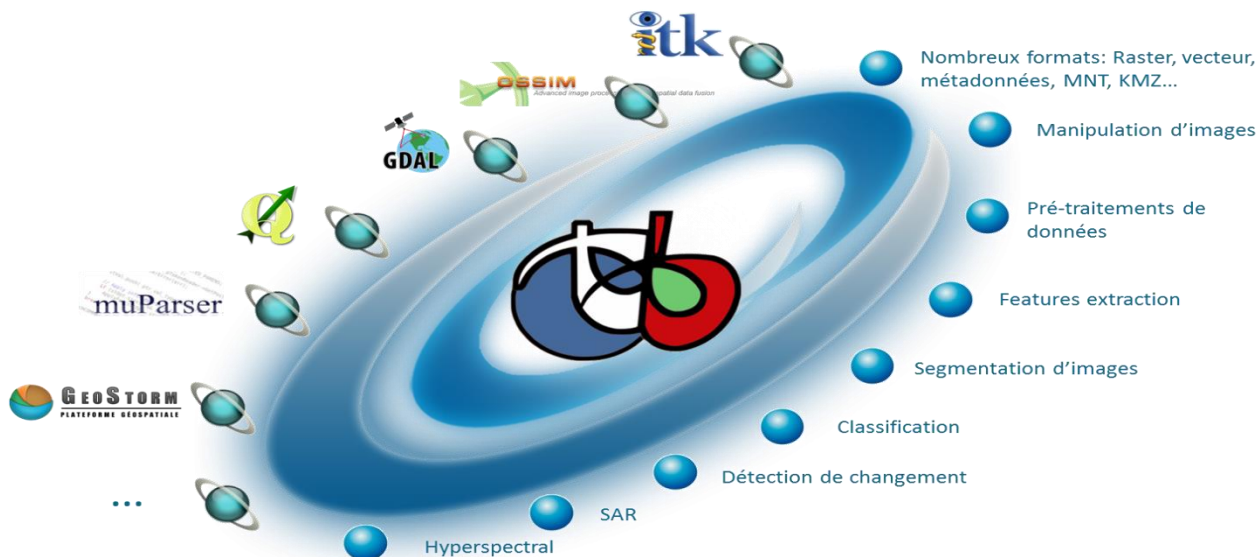


OPEN SOURCE RADIOMETRIC CORRECTION TOOLS

4

OPEN SOURCE TOOLBOX

➔ Orfeo Toolbox



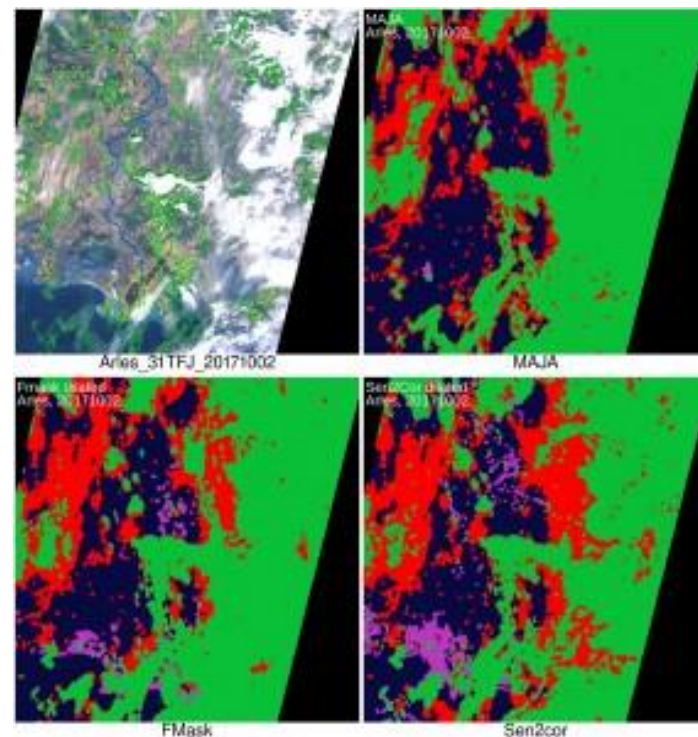
- ➔ OTB provide radiometric filters : from DN to TOA reflectance
 - › C++ implementation
 - › Highly scalable
 - › OTB filters are used in S2-IPF to perform this task
- ➔ Additional code can improve earth-sun distance estimation
- ➔ Calibration coefficient :
 - › PHR coefficient provided by CNES SADE/MUSCLE are embedded in product
 - › Custom coefficient scan be provided
- ➔ Full python implementation can be also performant based on numpy and numba
- ➔ SAR calibration can be performed



OPEN SOURCE ATMOSPHERIC CORRECTION TOOLS

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- ➔ Various open source radiative transfer code :
6SV, RTTOV, SOS, ...
- ➔ OTB embeds 6SV to performs TOA to BOA reflectance conversion
 - › FORTRAN to C++ code generation
 - › ENV and SLP correction filters are available
 - › OTB frameworks is used in MAJA to perform atmospheric correction on S2/L8 data
 - › Used in kalideos project
- ➔ For cloud detection OTB machine learning framework can be used
- ➔ BRDF correction is not currently supported






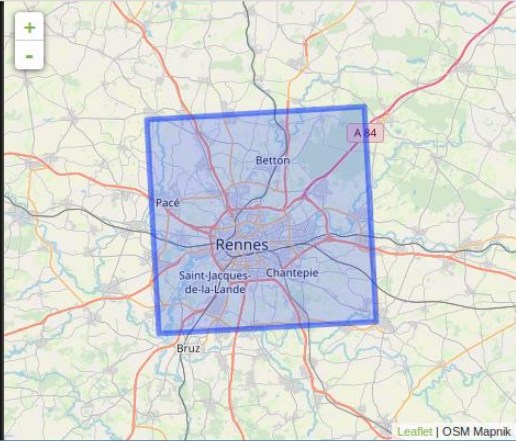
LOCAL VHR ARD PROCESSING CHAIN EXAMPLE


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- ➔ CNES kalideos.fr : four local database to support local scientific users :
 - › Since 2000 with legacy local sites
 - › Brittany, Alsace, French Alps and La Reunion island
 - › Free of charge access in order to stimulate remote sensing data usage
 - › Promote end users collaboration and results dissemination
 - › Provide geometrically aligned and well calibrated VHR data (optical and SAR)
- ➔ CNES operational chain
 - › From primary data to TOC data with (environment and slope correction)
 - › Based
 - CNES SIGMA tools for geometric part
 - on OTB for radiometric and atmospheric part (+ CAMS data)
 - › Internal preliminary work performs to replace non open source component
 - › Generate around 1000 products (Pleiades 1A/1B and SPOT6/7)

Retour à la liste
Télécharger
Afficher le produit en pleine résolution



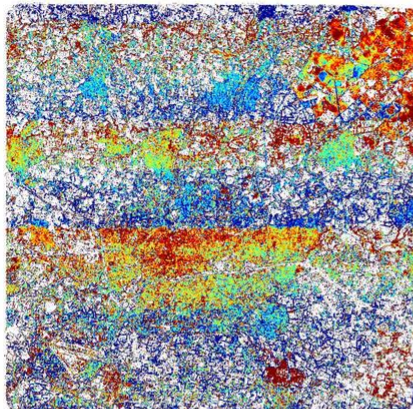


Propriétés du produit	Documentation
Titre: PLEIADES 1B XS ORTHO_TOA 2018-09-02 11:18:55Z	Description:
Satellite: PLEIADES 1B	ORTHO_TOA XS image acquired by PLEIADES 1B on 2018-09-02 at 11:18:55Z
Instrument: PHR1B	Producteur: Kalideos
Mode du Capteur: XS	Identifiant du producteur: PHR1B_MS_ORTHO_TOA_20180902_111855
Angle d'Incidence: 7.5549 °	Langue
Temps: 2018-09-02T11:18:55Z	en Pleiades license for Authorized Users
Mode de production: XS	fr Licence Pleiades Utilisateurs Institutionnels
Niveau de traitement: ORTHO_TOA	Annexes:
Résolution: 2 m	Nom
Système Carto/Géo: urn:ogc:def:crs:EPSG::2154	Quality control report
Emprise:	Liens existants
<code>{ "coordinates": [[[[343722, 6781478], [343722, 6801382], [363952, 6801382], [363952, 6781478], [343722, 6781478]]]]], "type": "Polygon" }</code>	

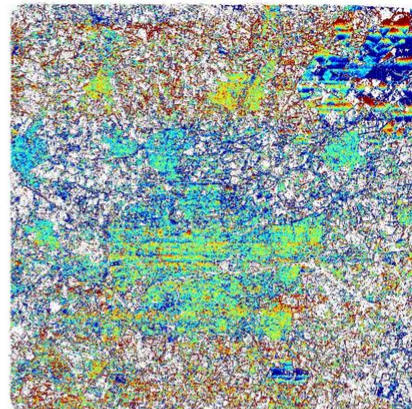
Proportion of correlated points 57 %

Shift	Minimum	Maximum	Mean	Standard deviation
Along lines (m)	-11.98	11.98	-0.13	3.13
Along columns (m)	-11.98	11.98	-0.19	3.29

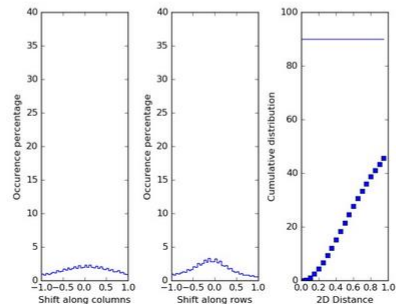
Shifts along columns



Shifts along lines



Histogram of shifts





CONCLUSION

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- ➔ Open source tools are mature to perform generation of ARD (except BRDF correction)

- ➔ Future delivery of Copernicus DEM and VHR 2018 : good auxiliary data as CAMS for atmospheric data.

- ➔ Need access
 - › to non-terrain corrected data to manage local site with custom auxiliary data or grid
 - › Need data access to sensor calibration parameters to generate with up to date data

- ➔ Local Datacube with high accuracy can be generated with high computing performance in Europe

- ➔ OTB and SNAP provides also functionalities to align and calibrate SAR data for these local sites



CS Systèmes d'information

22, avenue Galilée -
92350 Le Plessis Robinson

Tél. : 01 41 28 40 00

www.c-s.fr