



**MDIS 2019**  
**CO3D PROGRAMME & DOWNSTREAM**

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Contract signature, July 2019



Stereovision for terrain mapping and 3D

# CO3D main challenges



Worldwide Optical DEM  
Goal 2025  
Local and regional revisited worksites



Altimetric accuracy  
Goal 1m (relative)  
GSD 1m full resolution

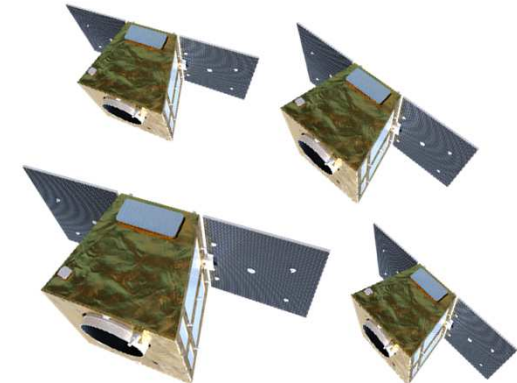


Cost-effective and massive 3D production (DSM)

Full automatic

Up to 50 Mkm<sup>2</sup>/year

Investment in cloud technology easing further deployment of digital platforms for downstream services

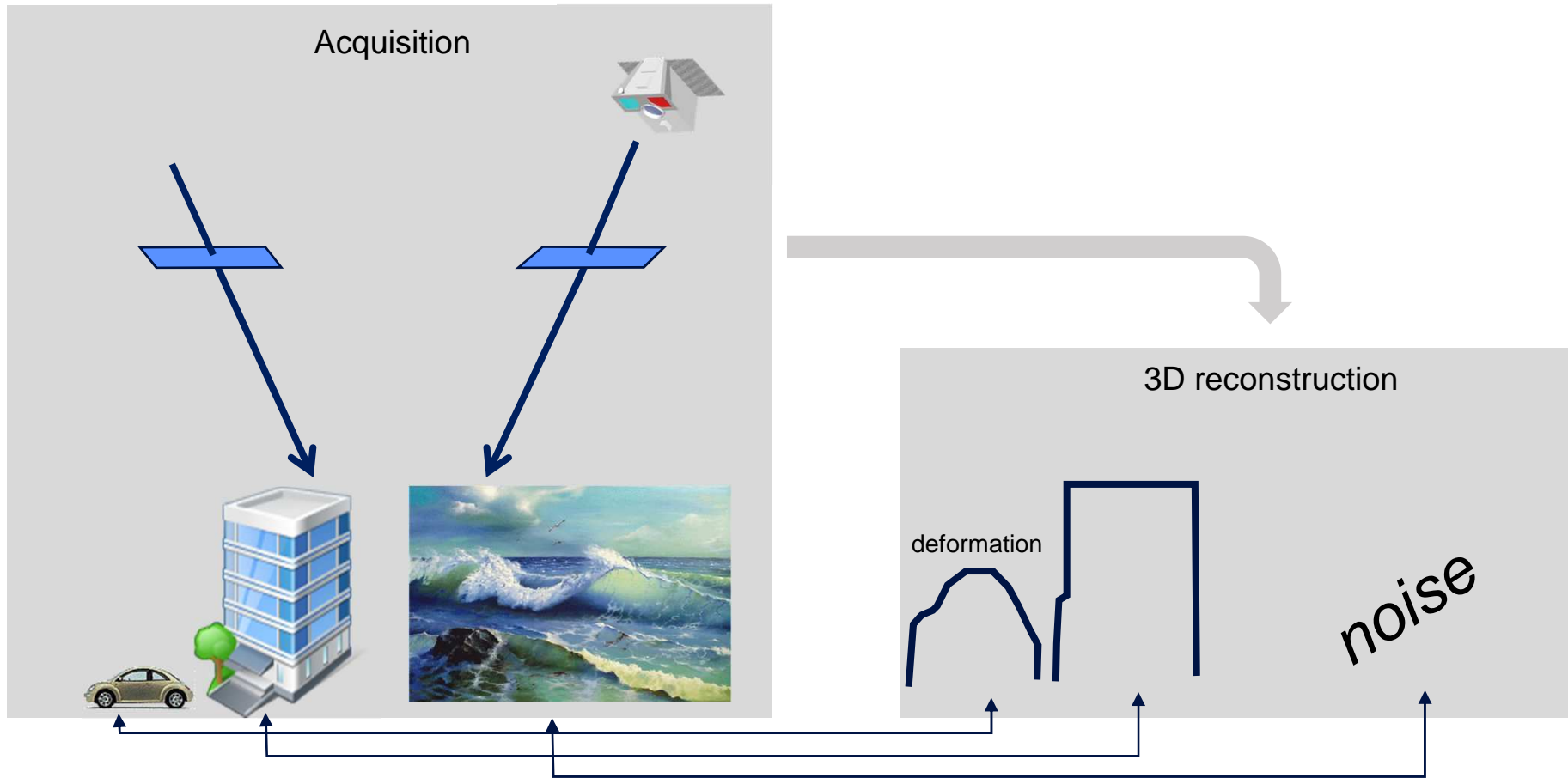


Low-cost satellite constellation

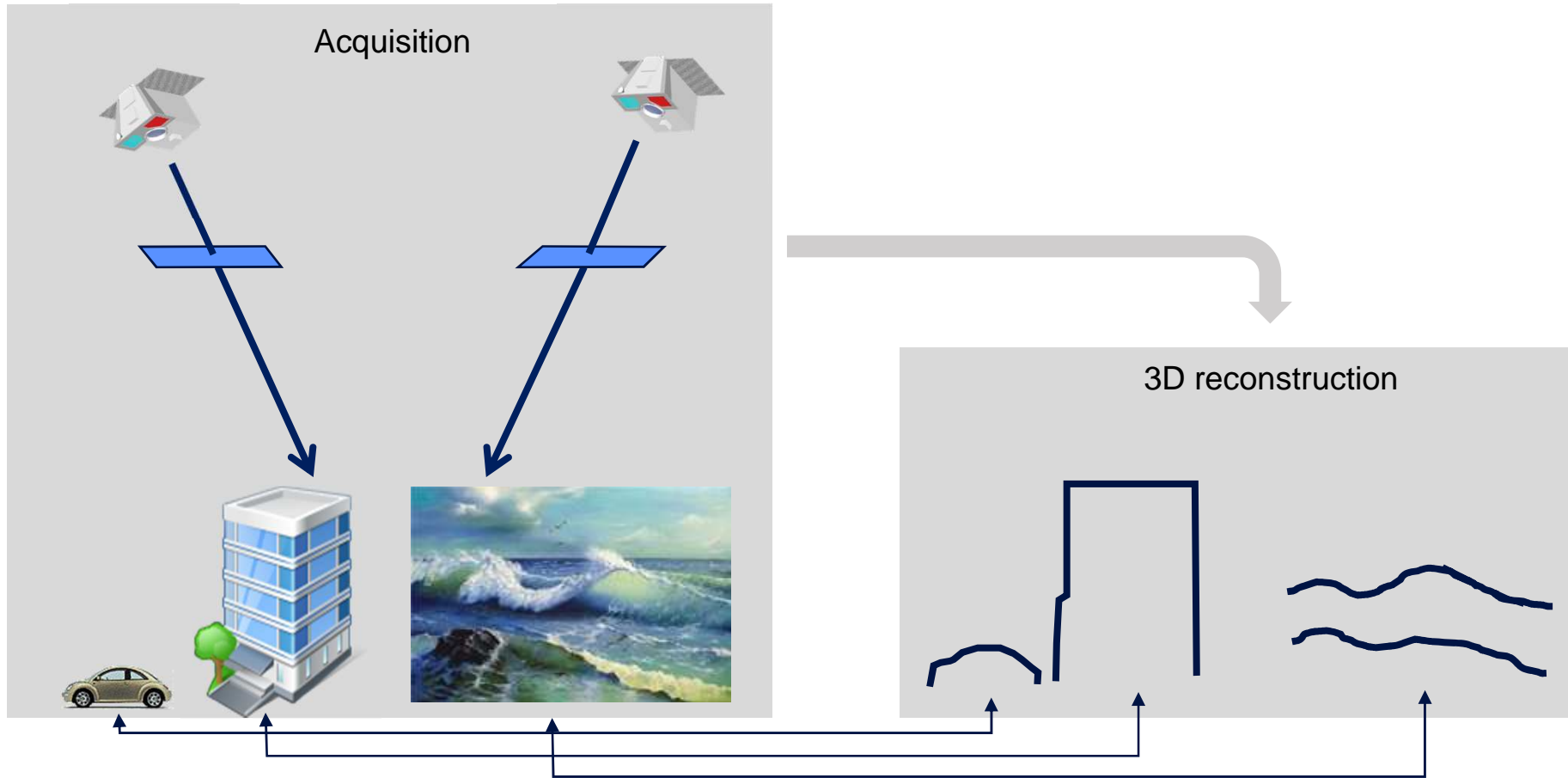
50 cm-class imagery  
R, G, B (NIR) bands  
Bayer array sensor

Synchronous stereo by pair of satellites

# Asynchronous Stereo



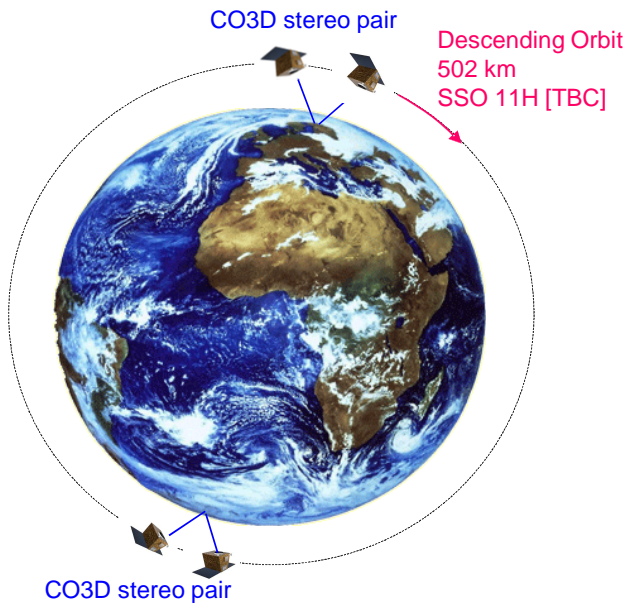
# Synchronous Stereo



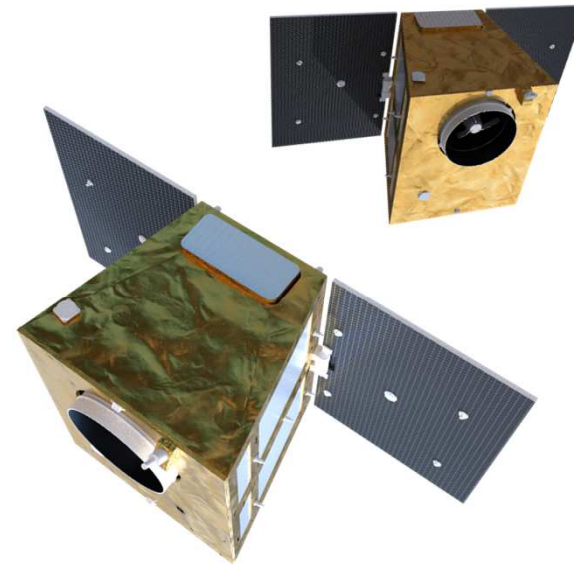
# CO3D Space Segment



**AIRBUS**



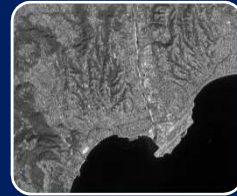
Vega-C rocket fairing  
accommodating  
4 CO3D satellites



CO3D spacecraft

More details under embargo

# CO3D System Products



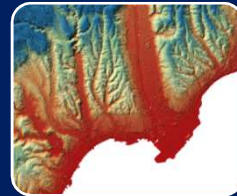
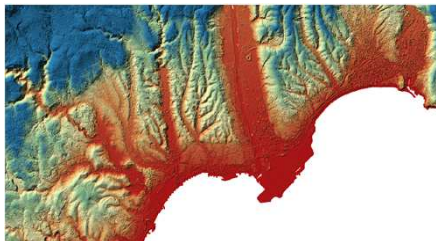
## Level 1

- N-tuple Perfect Sensors



## Level 2

- Ortho-images



## Level 3

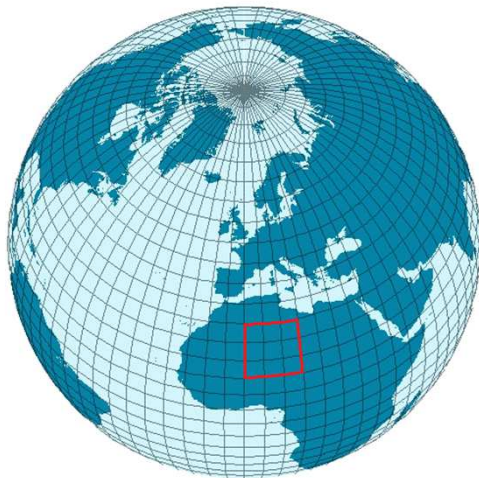
- DSM 1m GSD, dated
- « True » ortho-image

R,G,B,NIR,Z

# Level 4 : half-degree tile world coverage

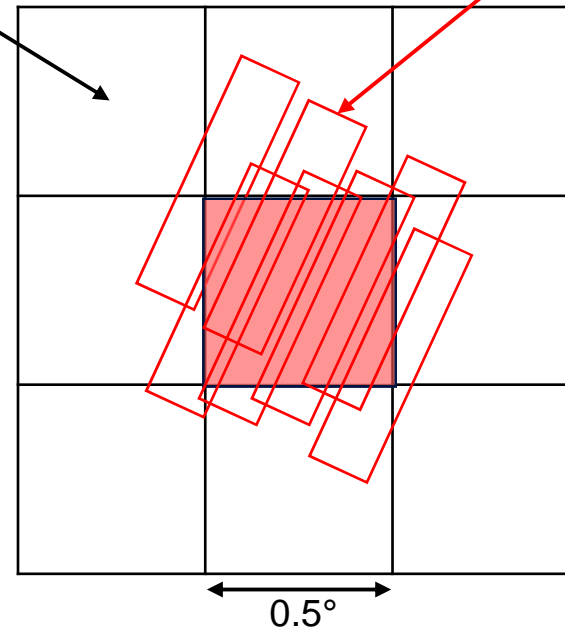


Coverage « not dated »  
Regular tiling 0.5 x 0.5 deg  
Normalized product DGED 4 to 6  
[DGED standard : https://www.dgiwg.org](https://www.dgiwg.org)



Level 4 tile

CO3D image segment



DEM4Ortho  
(being studied)

GSD @5m AND absolute planimetric accuracy @5m  
Product adapted to orthorectification of VHR images with depointing



## Interest of DEM4Ortho for orthorectification of VHR images (50 cm or below)



SRTM (30m)

Animation illustrating unwanted displacements between 9 Pleiades orthorectified images (9 angles)

## Interest of DEM4Ortho for orthorectification of VHR images (50 cm or below)



DSM MicMac (50cm)

Animation illustrating absence of unwanted shift between 9 Pleiades orthorectified images (9 angles)

## Interest of DEM4Ortho for orthorectification of VHR images (50 cm or below)



DSM/DTM HR (5m)  
Illustration

Animation illustrating absence of unwanted shift between 9 Pleiades orthorectified images (9 angles)

# CO3D Downstream



## Data access – first year on orbit (probatory phase)

### DSM mission large-scale demonstration

CHANTIER FRANCE METROPOLITAINE  
500 000 km<sup>2</sup>  
90% DE COMPLETUE

ARC DE CRISE  
27 Mkm<sup>2</sup>  
80% DE COMPLETUE

France



Arc of Crisis

DSM performances  
validated with



RGE®

Land surfaces : 150 Mkm<sup>2</sup>  
World DSM 60°S – 70°N : 120 Mkm<sup>2</sup>

- ❖ Results of large-scale demonstration will belong to CNES (full ownership)
- ❖ Data also available to French Ministry of Defense to feed military geo-information systems
- ❖ CNES et French MoD can share data with institutional partners (French, European, International)
- ❖ Data accessible to downstream ecosystem players including science community

# Data access – exploitation phase (commercial)

## General license philosophy

- ❖ CO3D system commercially operated by Airbus DS GEO
- ❖ Airbus DS GEO owns products and added-value products (patrimonial)
- ❖ But, in co-investment context, CNES and French MoD benefit from :
  - a granted access to the satellite resource
  - a large concession of rights of data usage and sharing, and creation of added-value products
  - a cession of rights for derivative works
  - preferential conditions for data acquisition
- ❖ As part of its missions, CNES will be able to use CO3D products (2D or 3D)
  - for its own purposes (e.g. R&D, derivative works, improvement of existing products)
  - in the frame of projects with French institutional users (with same preferential conditions)
  - in the frame of international partnerships
  - supporting private players for application demonstrations or downstream services with no immediate commercial purpose (e.g. priming)

A JOINT PROJECT shall be set up beforehand

Nota : French institutional user = legal entity governed by public law, or legal entity governed by private law but performing a general interest mission by delegation of a public legal entity

# Data access – exploitation phase (commercial)

## Local and regional worksites

- ❖ Free access up to 600 000 km<sup>2</sup> every year (DSM full resolution)
  - Preliminary sizing for R&D (e.g. coverage of ice caps), but possible to include other thematics (e.g. geophysical risks) → scientific arbitration to be envisaged
- ❖ Above 600 000 km<sup>2</sup> : price conditions decreasing with surface = 1/10th Pleiades institutional price
- ❖ Maximum annual surface for regional worksites : 15 000 000 km<sup>2</sup>
- ❖ Coverage rate 100% (requiring multi-pass)

Consumption annual monitoring

## Worldwide DSM

- ❖ In parallel, production of Worldwide DSM within 2-5 years (completeness 90%)
  - N-tuple required for DSM production collected by constellation within the 2 years following IOV
- ❖ Cost price conditions if commissioned by CNES
- ❖ Worldwide DSM free for CNES and partners if commissioned by a third party, public or private
- ❖ Airbus DS is exclusive operator for commercialization of full resolution
- ❖ Commercialization opened to CNES and partners at lower resolution (10 or 15 m)

Production capability : estimated between 30 and 50 Mkm<sup>2</sup> a year

## Data access – exploitation phase (commercial)

### Drawing rights

- ❖ Priority mechanism based upon notions of **update rate, completion time, notice**
  - Update rate : DSM product update period
  - Completion time : worksite completion duration starting from 1<sup>st</sup> acquisition
  - Notice : delay between commissioning and starting
  - New worksites counted by fraction of 625 km<sup>2</sup> (25 x 25 km)

❖ Examples below

Type of DSM worksite	Characteristics	Maximum surface yearly
Country belonging to Arc of Crisis	Notice : few months to 1 year Completion time : 1 year Update : [TBD]	5 Mkm <sup>2</sup> /year
50x50 km <sup>2</sup> worksite Miscellaneous, regional	Notice : 6 months Completion time : 6 months Update : 6 months	40 worksites - TBC (twice a year)
50x50 km <sup>2</sup> worksite Glaciology in Artic Area Access to high latitudes up to 80°N	Notice : 3 months Completion time : 1 month Update : 2 months	40 worksites - TBC (6 times a year)

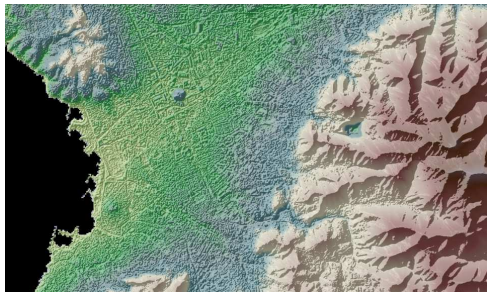
- ❖ Access to commercial archive through Airbus DS GEO digital platform (One Atlas or other)

## Objectives

### Main goals of the downstream programme are the following :

- ❖ Prepare users to the arrival of future CO3D data
- ❖ Make demonstration of relevance/suitability of application cases elaborated with players of the downstream ecosystem and science community ([preparation programme – usages](#))
- ❖ Carry out associated studies, engineering and developments ([preparation programme - technical](#))
- ❖ Organize access to satellite resource (acquisition policy) and governance within users communities, in particular after the DSM demonstration phase
- ❖ Prepare data dissemination and identify distribution channels

Meet the users need as early as possible





## Objectives

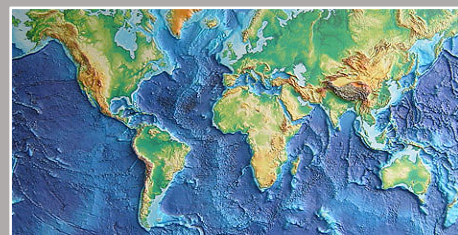
### Some highlights of the downstream programme :

- ❖ The highly innovative aspect of CO3D mission and the wide spectrum of applications encourage to open the downstream programme right now together with phase B



- ❖ Programme to be built on devoted budget line (in addition to CO3D project budget line)
- ❖ CNES positioned as co-prime at system level, responsible for image quality activities, 3D products performances and supply of operational image processing chain

Master card : institutional capacity of expertise, support and advice for the benefit of downstream services and users



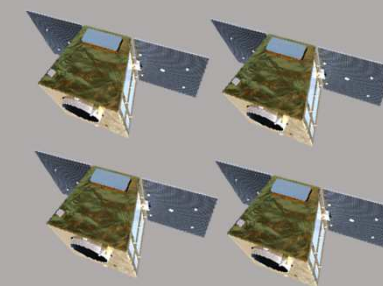
Worldwide DEM (goal 2025)



1 m-class altimetric accuracy



Low-cost  
full-automatic  
3D products



A new generation of  
low-cost EO satellite

A public-private partnership to help industry addressing a large domain of business around terrain mapping and 3D  
But giant opportunities for Earth Science !

Thank you for your attention

Time for calls and thinking

Contact CNES (Toulouse)

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Catherine Proy (ForM@Ter) [catherine.proy@cnes.fr](mailto:catherine.proy@cnes.fr)

Thanks to Laurent Lebegue (CO3D project team) [laurent.lebegue@cnes.fr](mailto:laurent.lebegue@cnes.fr)

# CO3D Downstream

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## Spare slides



# CO3D Image Quality

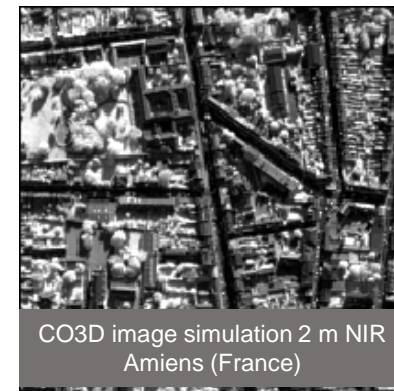


**AIRBUS**

- R,G,B
  - 0.50 m GSD
  - $MTF_{static} \sim 7\% @ Fe/2$
  - $SNR_{R,G,B} \sim 30 @ 15 W/m^2/sr/\mu m$
- NIR
  - 2 m GSD
  - $MTF_{static} \sim 20\% @ Fe/2$
  - $SNR_{NIR} \sim 20 @ 15 W/m^2/sr/\mu m$
- 14 km swath
- System Geoloc
  - < 10 m CE90



CO3D image simulation 50 cm R,G,B – Tarragone (Spain)



CO3D image simulation 2 m NIR  
Amiens (France)

# Testing of CO3D algorithmic chain with Pleiades

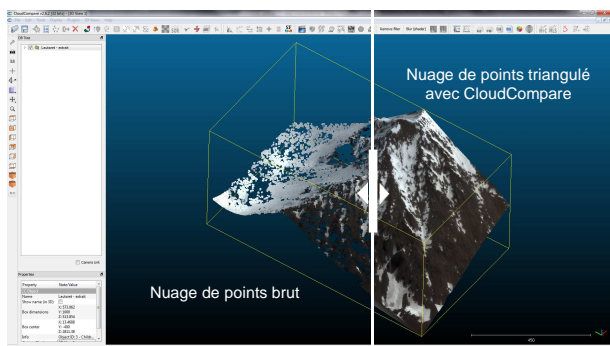


Full automatic 1 m  
DSM derived from  
stereo images over  
Nice downtown  
(France)

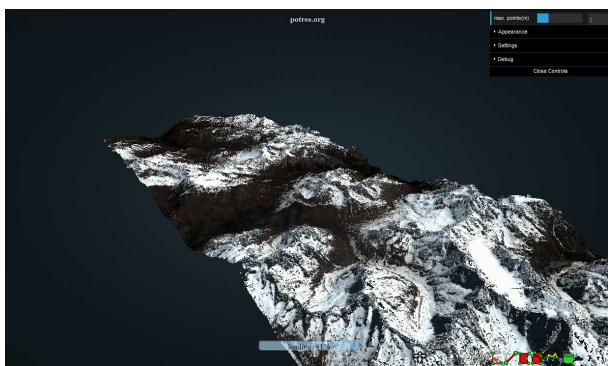
# Output Formats



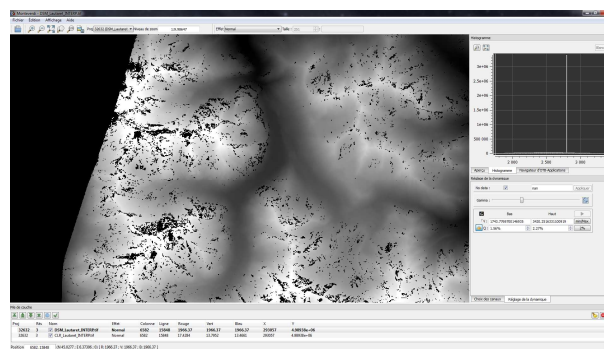
**Point Cloud raw or with triangular mesh**  
Coordinates text file (X, Y, Z)



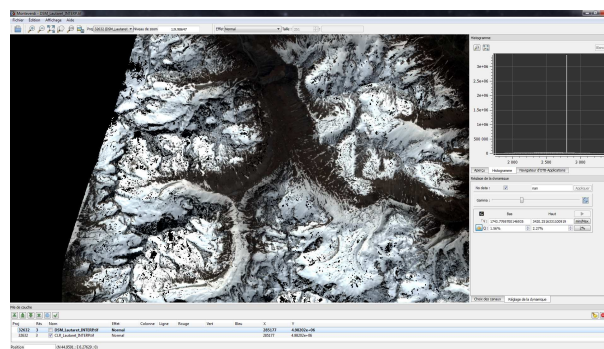
**Structure optimized for display**  
[https://www.kalideos.fr/drupal/Potree\\_Lautaret](https://www.kalideos.fr/drupal/Potree_Lautaret)



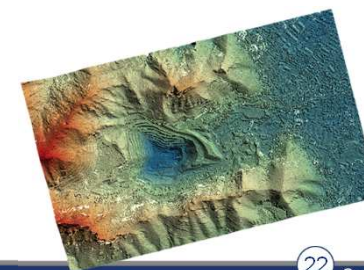
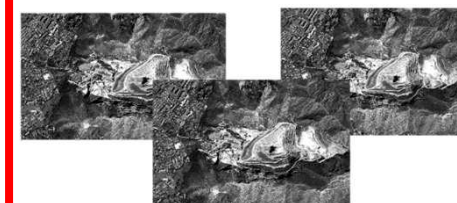
**Digital Surface Model (DSM)**  
Projected altitudes



« True ortho » matching with DSM  
Projected radiometry



**Other examples :**  
**Tri-Stereo Pléiades**  
(Calanques, Marseille)  
© CNES (2013), distribution  
Airbus DS/ Spot Image



# CO3D system product masks

## Data masks



Land cover  
*(under discussion)*

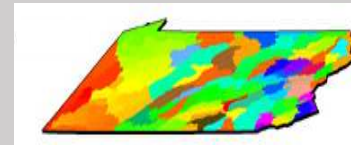


Snow mask



Water mask

## Quality masks



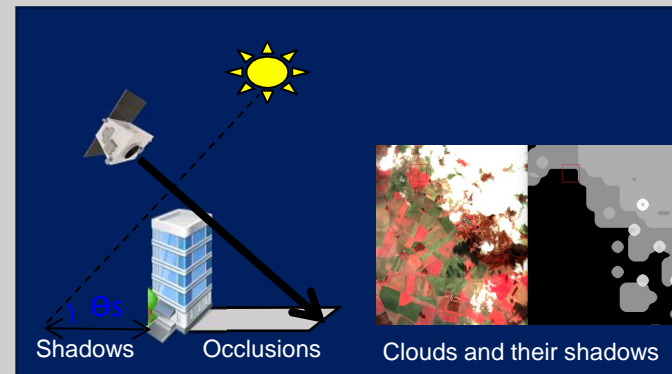
Performance confidence mask



No data mask

No data  
Source

No data  
filling  
process



Interpolation,  
External  
DSM, ...