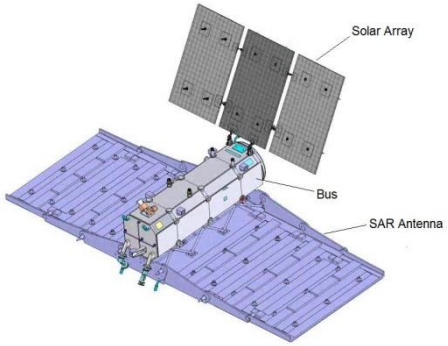

SAOCOM-CS
A passive companion to SAOCOM for single-pass L-band SAR interferometry

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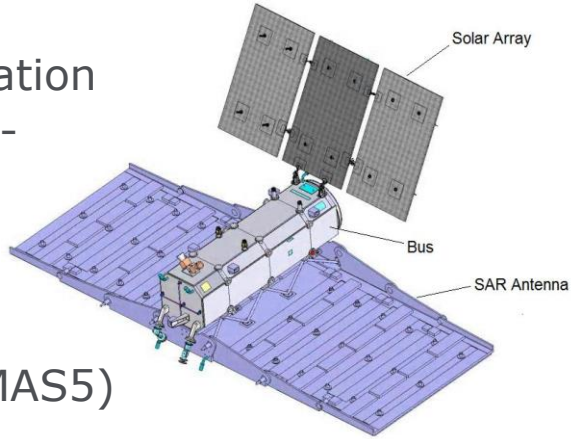
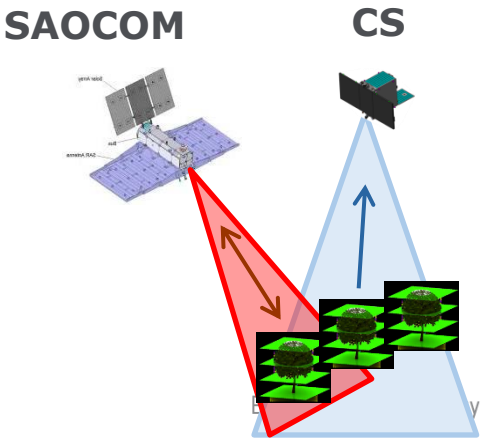
Background: a resume' of the SAOCOM L-band SAR mission

- CONAE, with contributions from ASI and BE, is developing an L-band SAR mission, primarily for long-term monitoring
- First generation: two satellites (1a, 1b) flying in constellation with COSMO-SkyMed, forming together the SIASGE L+X-band SAR system, mainly for emergency management
- In 2013, CONAE offered ESA the free launch of a small satellite together with SAOCOM-1b taking advantage of excess launcher capacity and developing new adaptor (MAS5)
- Based on past EE proposals, ESA, with European experts and CONAE' support, assessed feasibility of passive add-on satellite in formation with SAOCOM to enhance its science return
- Receive-only, dual-pol L-band SAR satellite
- New radar science - with tomography, bistatic measurements, specular measurements - shown feasible





Science and Observation Geometry

- Four configurations w.r.t baselines and viewing geometry
- Three science mission phases: tomographic, bistatic, specular

Tomographic phase

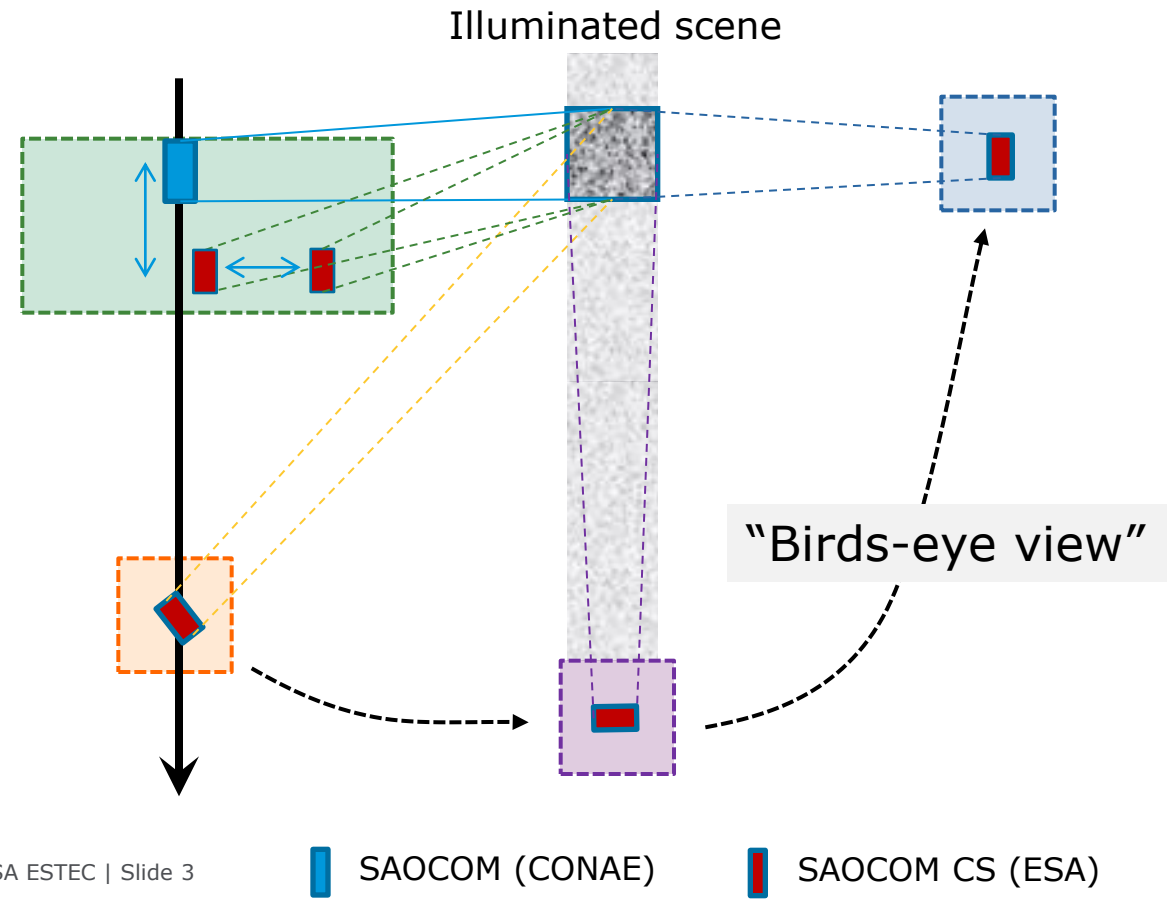
✓**AT baseline < 6km**
✓**XT baseline varies ~1–6 km**
✓**Science mission driver**
✓**Duration ~2.5 years**

Bistatic 1, Bistatic 2

✓**AT baseline ≈ 250 km**
✓**Small XT baseline (phase 1)**
✓**Large XT baseline (phase 2)**
✓**Duration ~2 years**

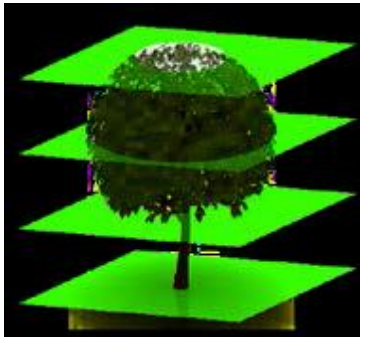
Specular phase

✓ **Experimental**
✓ **Short duration**

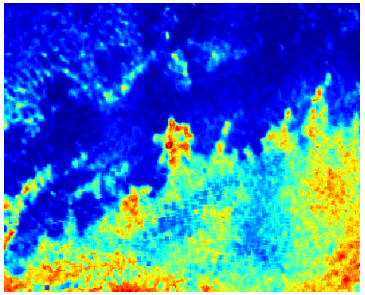


Science objectives

1. **Tomographic Configuration**
   a. **Boreal forest structure (mission science driver)**
   b. Tropical forest structure (demonstration)
   c. Ice subsurface feature mapping (demonstration)



2. **Bistatic interferometry and radar signatures**
   a. Dense persistent scatterers (PS) for urban environments (demonstration)
   b. Bistatic interferometry for surface motion and land cover properties (experimental)
   c. Soil moisture (experimental)

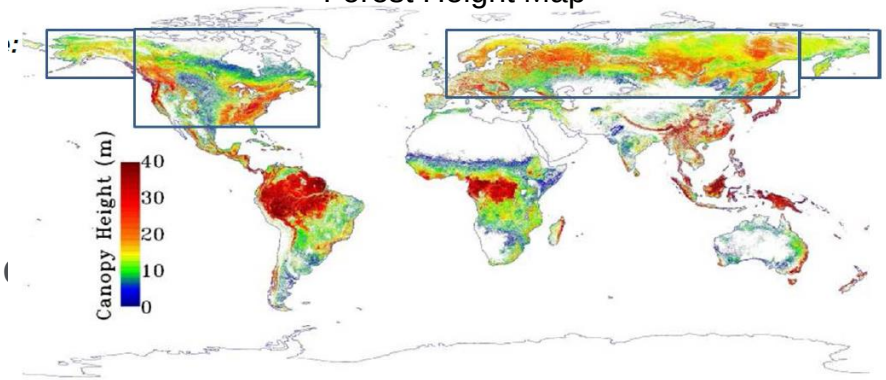


3. **Specular configuration**
   a. Soil moisture (experimental)

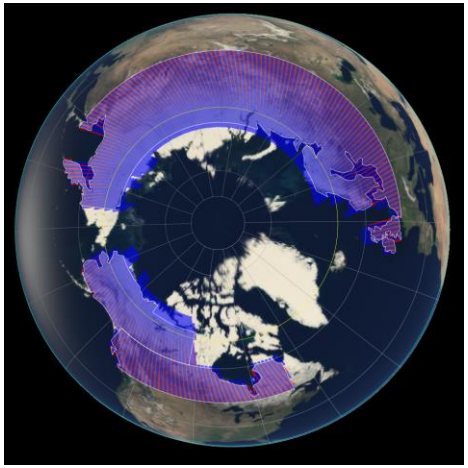
Example Application – Boreal forest structure (mission science driver)

1. Main science goal for SAOCOM CS mission: to produce a complete map of boreal forest structure (forest height, vertical structure) and derive products including forest biomass
2. Important synergies with other EO missions
    a. Fill-in coverage gaps due to SOTR (Biomass)
    b. Support development of L2 processing chain (Biomass)
    c. Precursor mission to other mission concepts such as Tandem-L (DLR/JAXA) and L+S-band SAR (NASA/ISRO)

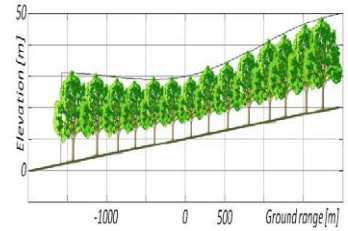
Forest Height Map

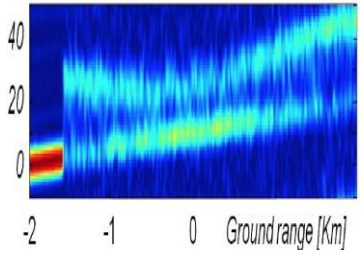


SAOCOM CS Coverage



CS Tomography

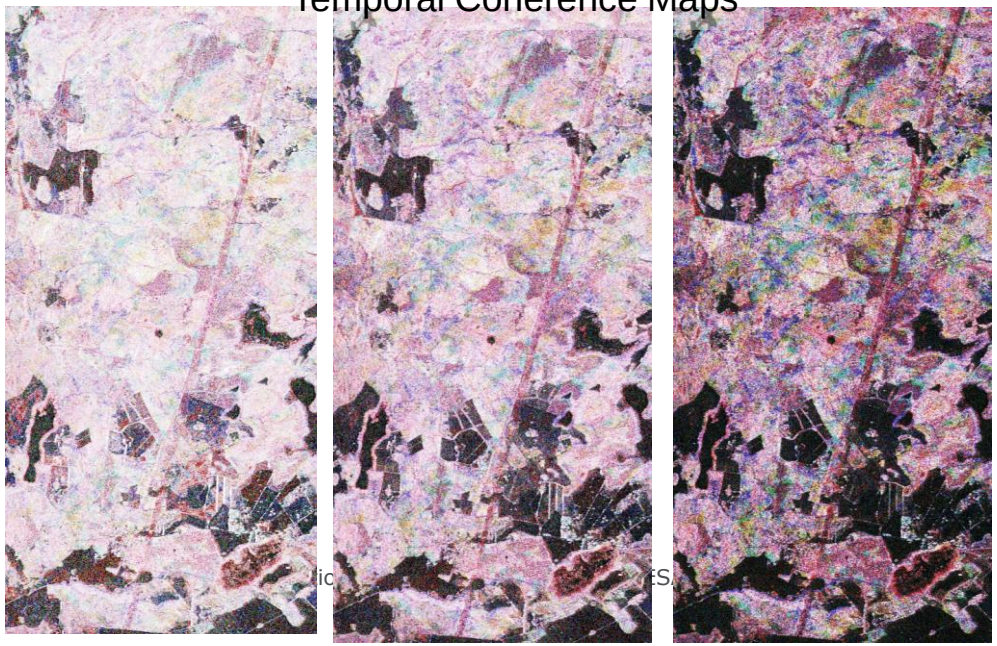




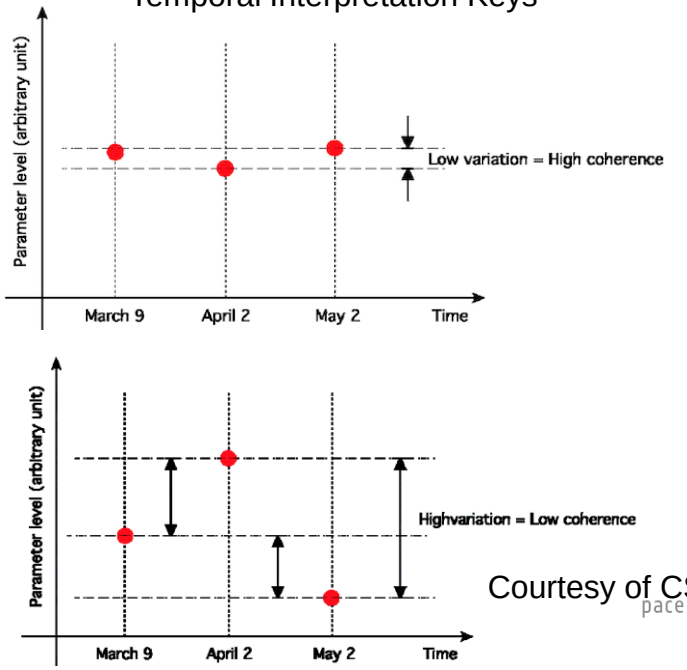
Example application – land cover

1. Land cover information in radar usual derived from radar brightness in different channels
2. Radar brightness measurements using bistatic geometries contain new information about land cover properties (e.g. vertical vs non-vertical structures)
3. Radar coherence between SAOCOM CS and SAOCOM also rich source of information about change detection

Temporal Coherence Maps



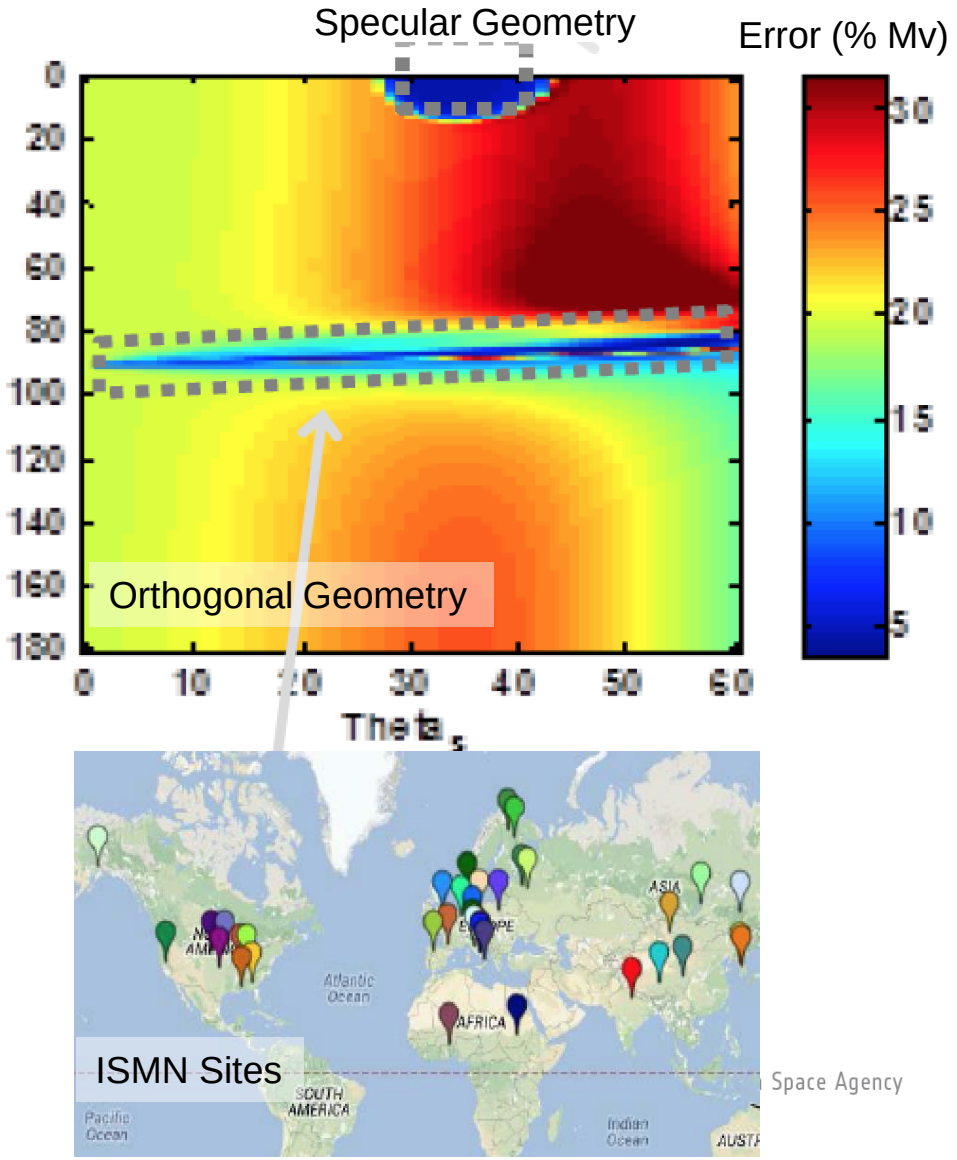
Temporal Interpretation Keys



Courtesy of CSL

Example – Soil Moisture

1. Soil moisture retrieval from mono-static SAR data still challenging at high resolutions due to roughness impact
2. Studies based on scattering models have shown that the absolute accuracy of retrieval much better with special observation geometries
3. **Geometry 1**: Measurement orthogonal to illumination
4. **Geometry 2:** Measurement in specular direction
5. Validation required over limited number of sites (new opportunities here)



Measurement type	Applications	d	RC	SAOCOM mode	AT baseline (km)	XT baseline (km)
Bistatic Interferom. & Radiometry	Surface Deform., Dense PS, Glacier Motion, Land Cover	400	25	SM/DP Swath2	250	0
Tomographic	Boreal Forest (Structure, Height, Biomass)	160	10	SM/DP Swath2	≤ 6	≤ 1.2 (RC1) ≤ 6.0 (RC2-RC9) ≤ 1.2 (RC10) at 55^0 N
Tomographic	Tropical Forest (Structure, Height, Biomass)	160	10	SM/QP Swath2	≤ 6	≤ 0.6 (RC1) ≤ 12 (RC2-RC19) ≤ 0.6 (RC20) at 0^0N
Tomographic	Boreal Forest (Structure, Height, Biomass)	160	10	SM/DP Swath2	≤ 6	≤ 1.2 (RC1) ≤ 6.0 (RC2-RC9) ≤ 1.2 (RC10) at 55^0N
Tomographic	Tropical Forest (Structure, Height, Biomass)	160	10	SM/QP Swath2	≤ 6	≤ 0.6 (RC1) ≤ 12 (RC2-RC19) ≤ 0.6 (RC20) at 0^0N
Tomographic	Ice subsurface structure	160	10	SM/DP Swath2	≤ 6	≤ 1.0 (RC1) ≤ 6.0 (RC2-RC9) ≤ 1.0 (RC10) at 70^0N
Bistatic Interferom. & Radiometry	Surface Deform., Dense PS, Glacier Motion, Land Cover	400	25	SM/DP Swath2	250	0
Bistatic Interferom. & Perp. Radiometry	Surface Deform., Soil Moisture, Land Cover	80	5	TBC	250	260

Summary

- SAOCOM-CS represents a new ESA mission concept with attractive elements
  - ✓ high degree of R & D with novel radar measurements (tomography, bistatic, specular) and processing techniques
  - ✓ new approach to some established applications such as forest structure and biomass, surface motion detection, land cover and soil moisture
  - ✓ short development schedule (ready for launch by 2nd half 2018)
  - ✓ demonstrator or pre-cursor for more operational or larger-scale SAR convoy missions e.g. Tandem-L or Sentinel-1 companion
  - ✓ Collaboration between Agencies and with the science community
- Studies (including BE) to date demonstrated principle mission feasibility & science return
- Missions brings with it new opportunities for the Belgium science community interested in cutting edge techniques applied to specific application areas (e.g. soil moisture, land cover) and exploring new mission ideas based on convoys
- SAOCOM CS undergoing science and programme review with confirmation of mission implementation expected in Feb 2015