SAOCOM
Calibration and Validation activities results and way forward

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Comisión Nacional de Actividades Espaciales

CEOS WGCV SAR Subgroup
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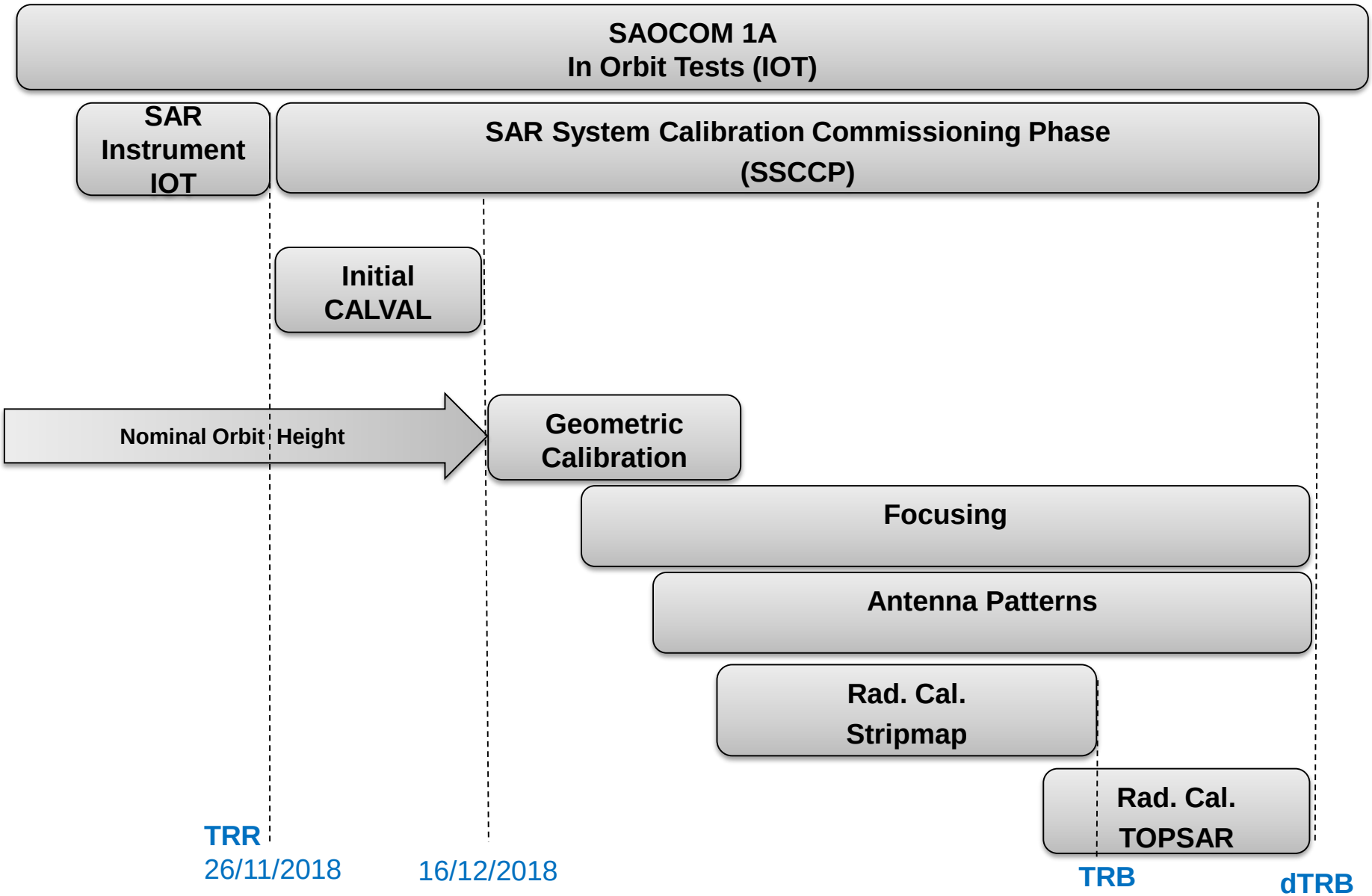
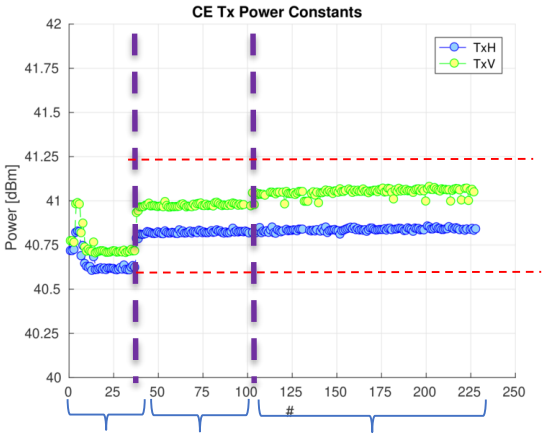
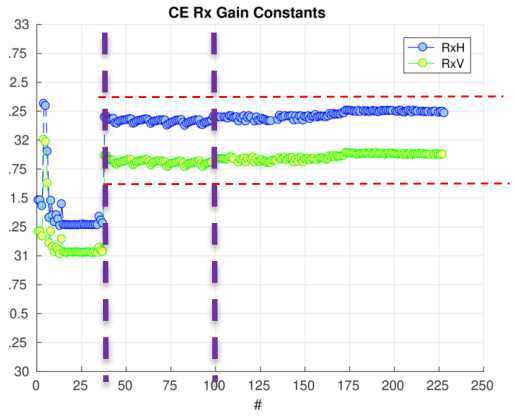
Frascati, Italy

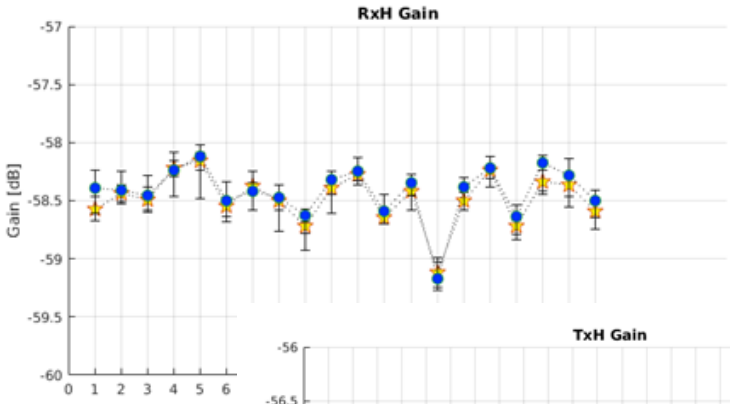
SAOCOM-1A CALVAL Commissioning Phase Overview

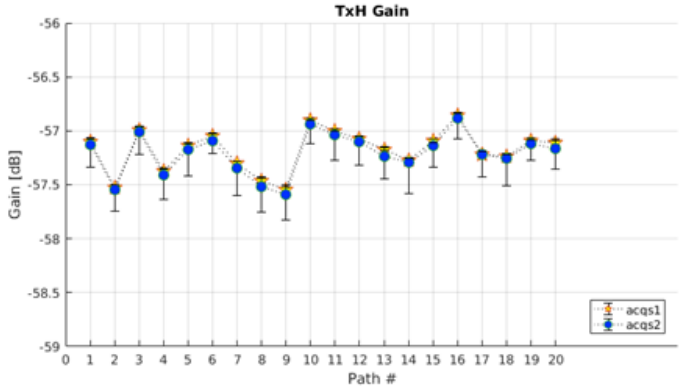


SARCE stability better than 0.1dB peak to peak



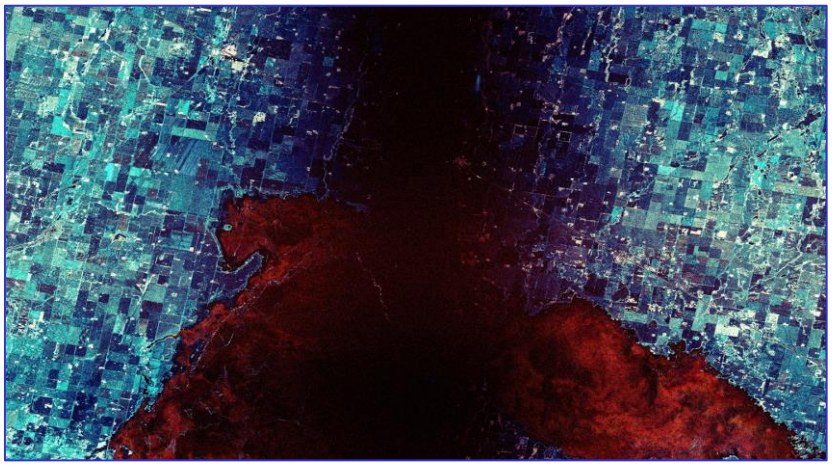




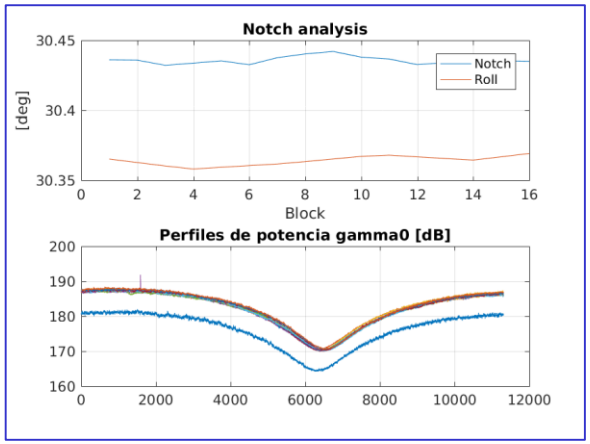


SARANT stability better than 0.5dB at element level

- Elevation pointing (EP) offset was characterized using notch antenna patterns
- EP characterization performed over rainforests including Amazonas, Congo, and New Guinea

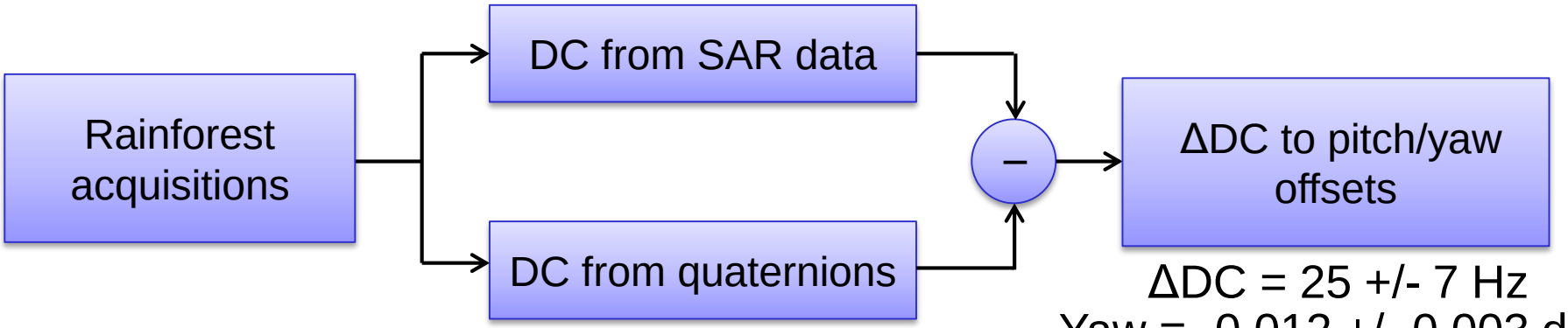


- EP characterization validated worldwide with notched and non notched acquisitions, showing no evident latitude dependence

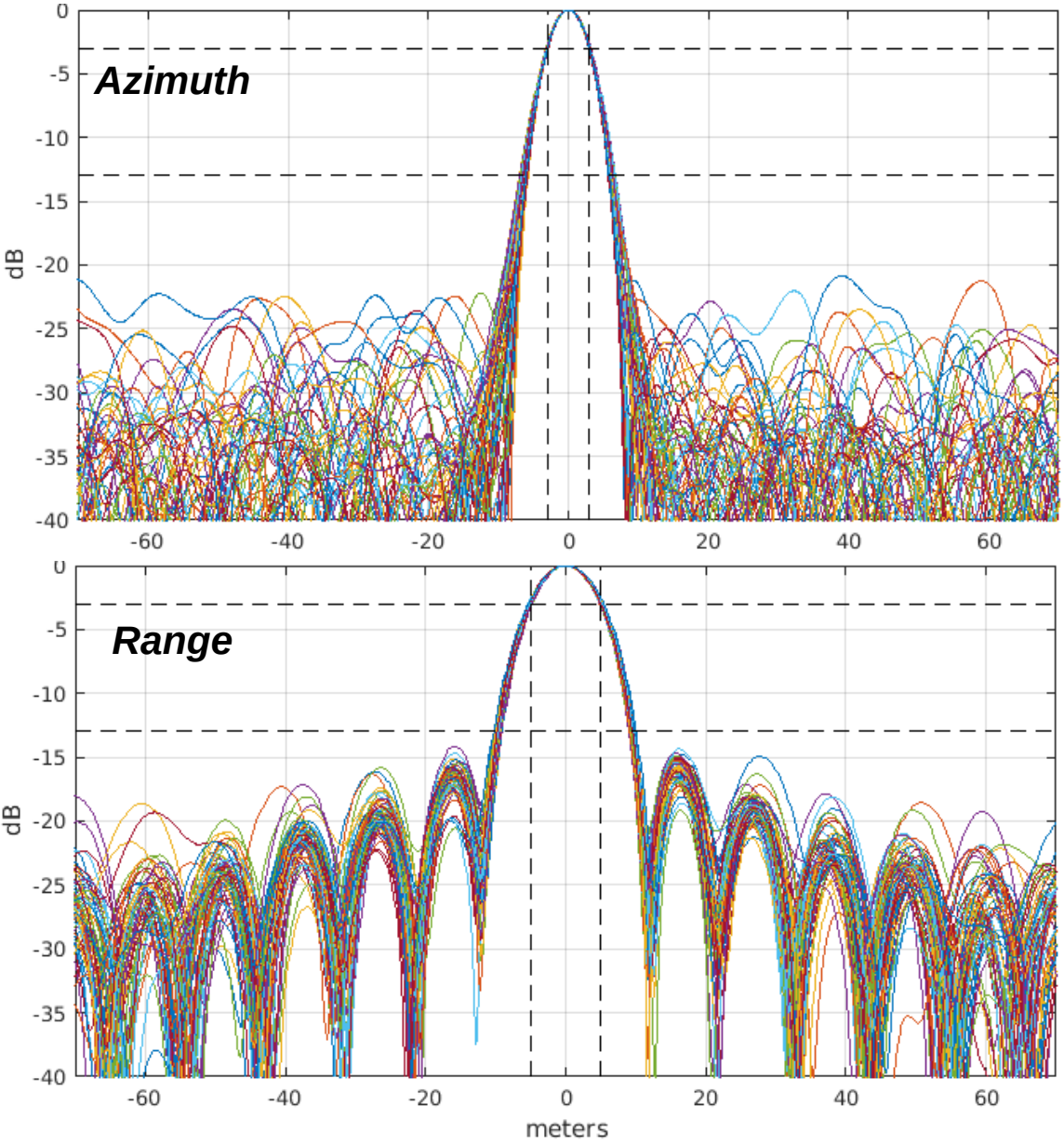


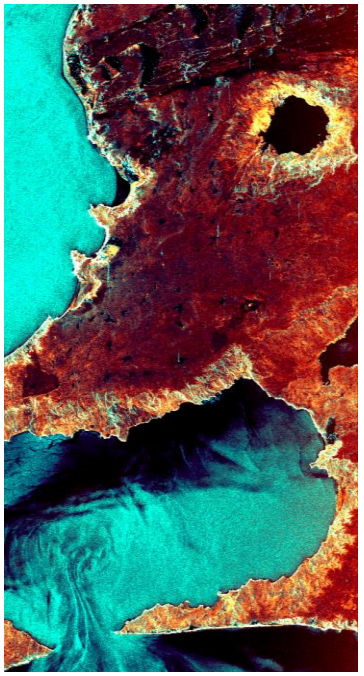
Co-Pol / Cross-Pol	Mean	Stdev
Co-Pol	0.076	0.009
Cross-Pol	0.079	0.018

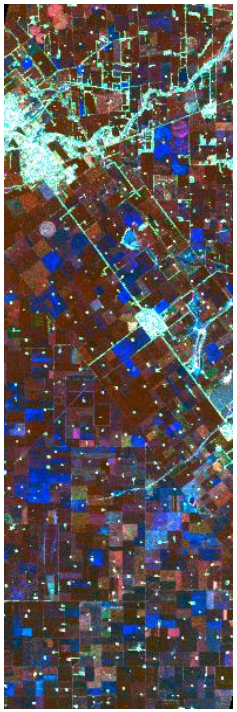
Offset compensated on ground processing

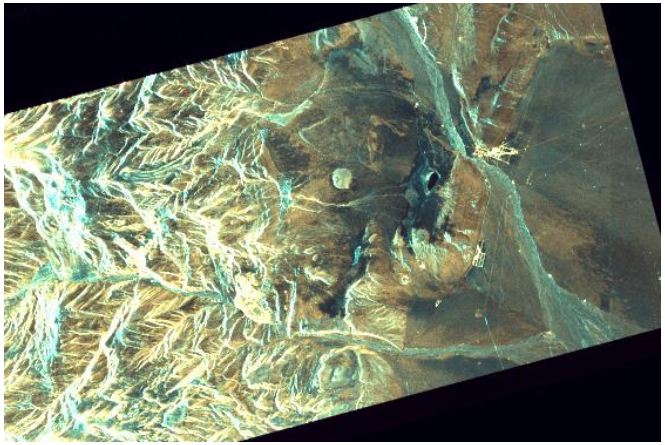


- DC when performing an acquisition is close to zero
  - DC = 19 +/- 7 Hz (rainforest mid-latitudes)
  - DC = -10 +/- 21 Hz (other latitudes)
- DC between acquisitions is very stable
- Azimuth pointing offset (pitch/yaw) was characterized and compensated on ground processing

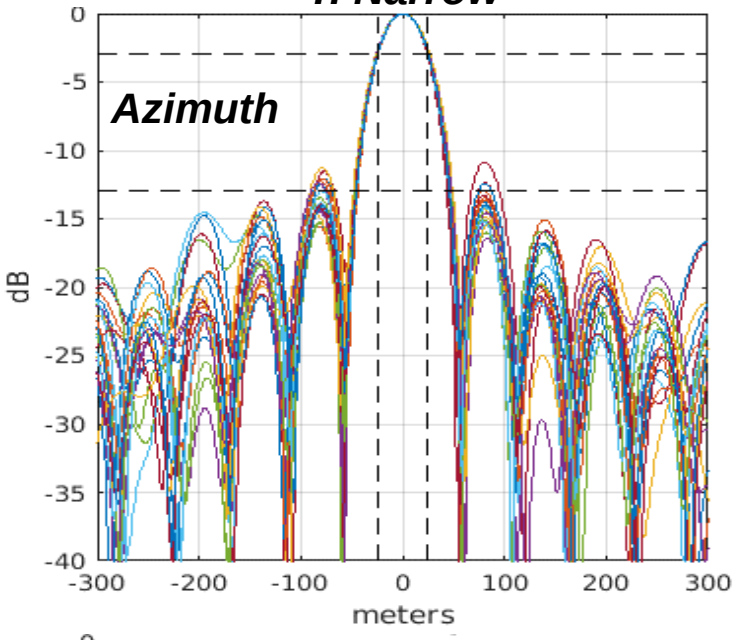

Azimuth
Range
dB
dB
0
-5
-10
-15
-20
-25
-30
-35
-40
-60
-40
-20
0
20
40
60
meters



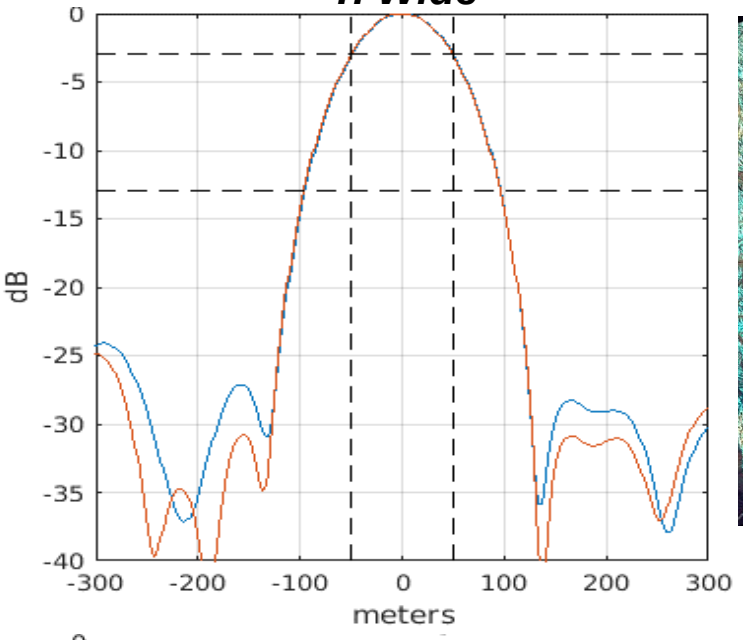


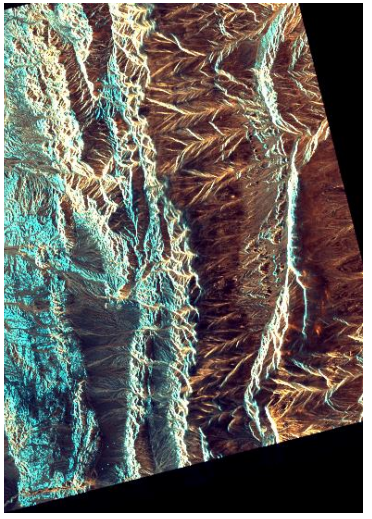


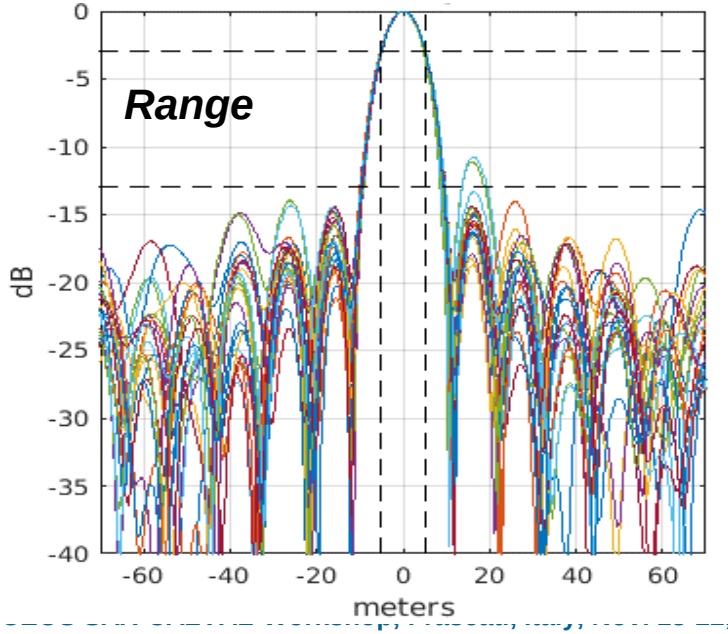
T. Narrow

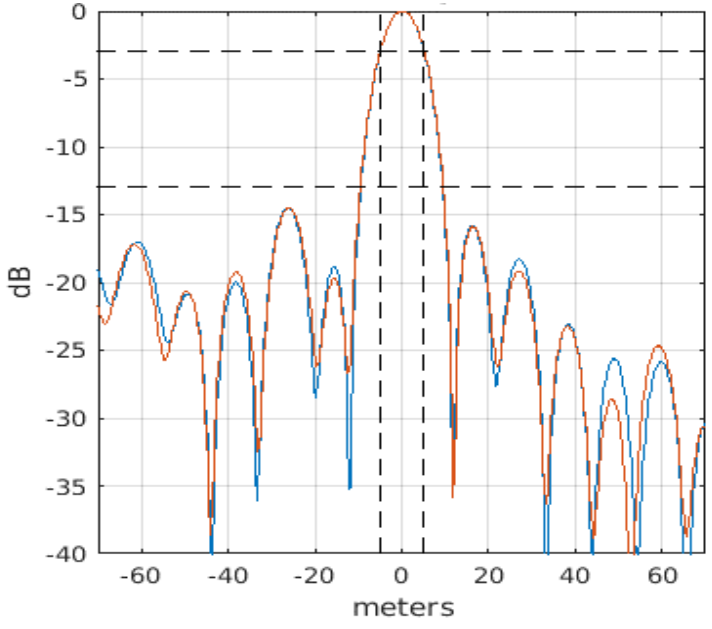


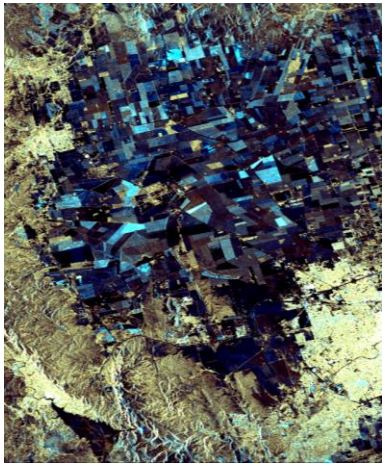
T. Wide



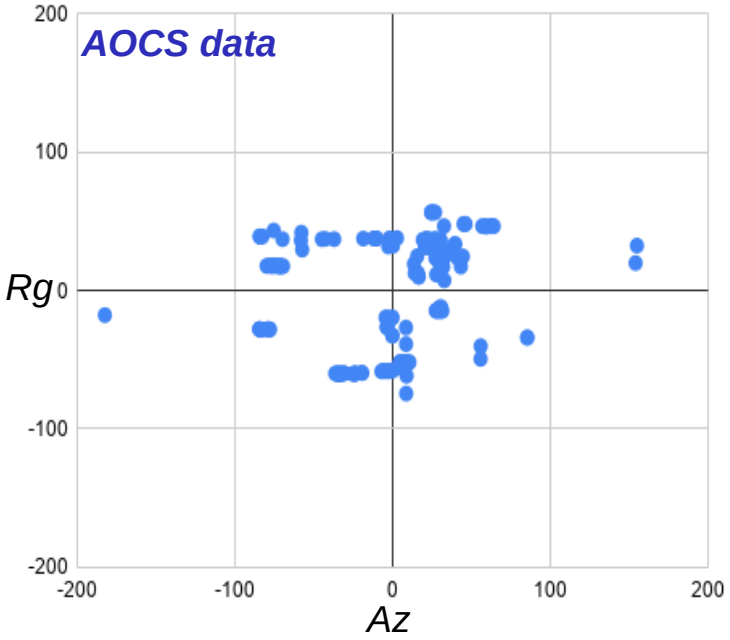


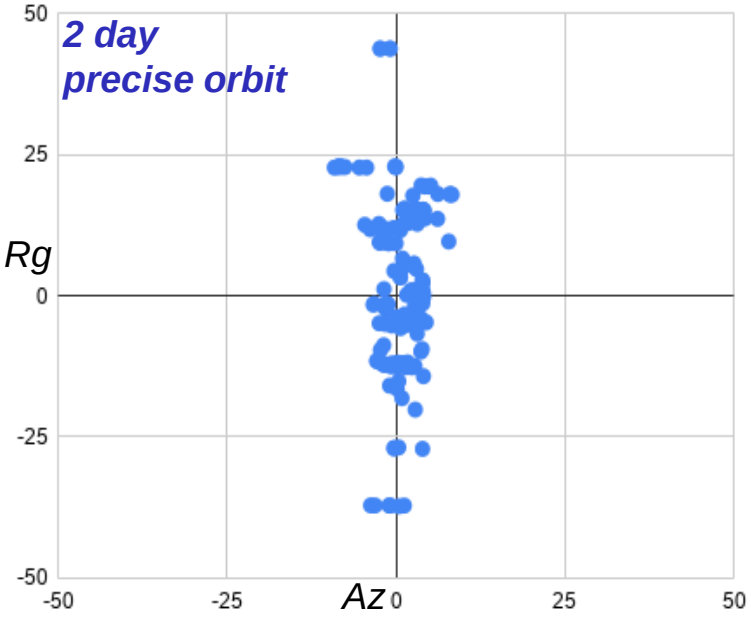


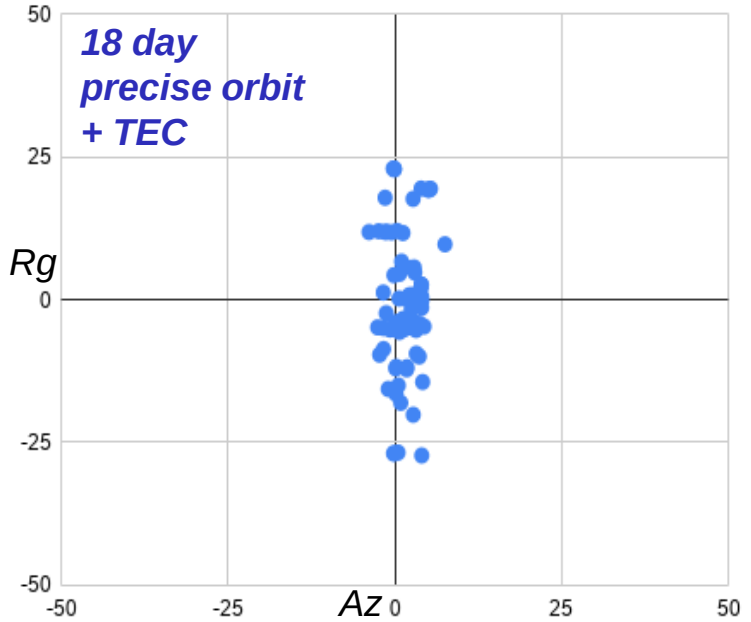




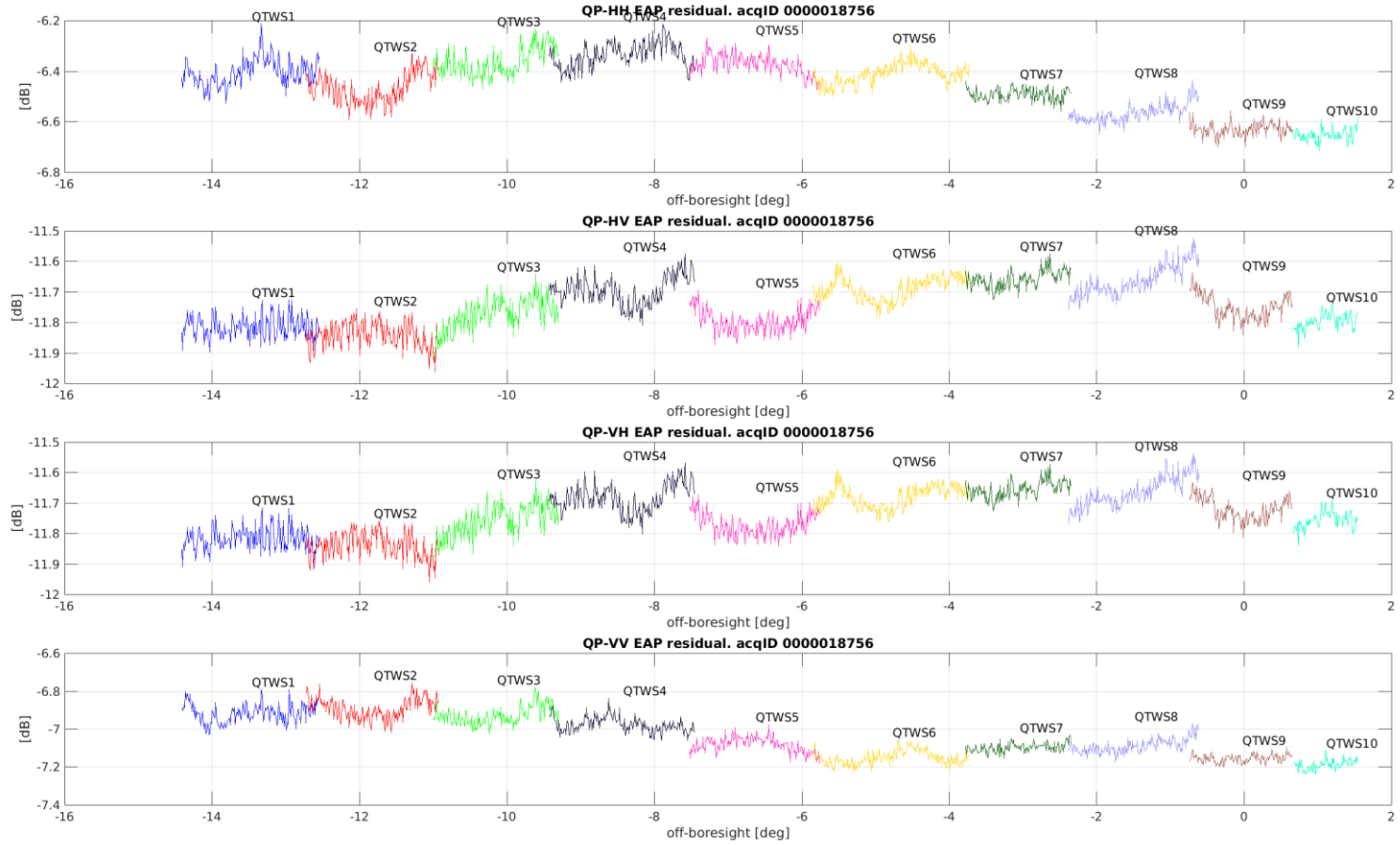
- AOCS data (real time ancillary data)
  - Better than 90m except few outsiders in azimuth direction
- 2 day precise orbit (rapid)
  - Better than 50m
- 18 day precise orbit (final) + TEC
  - Better than 25m except few outsiders in range direction

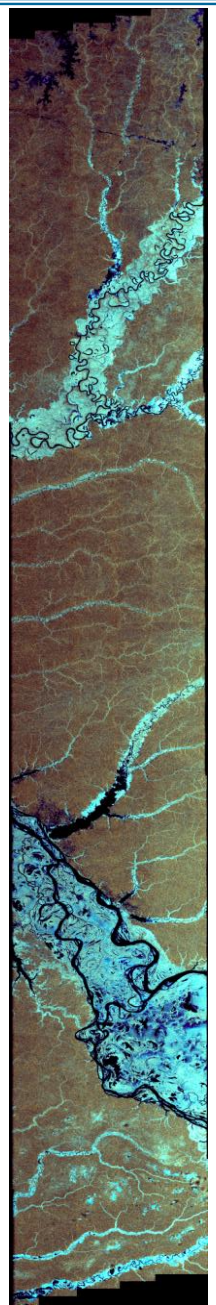






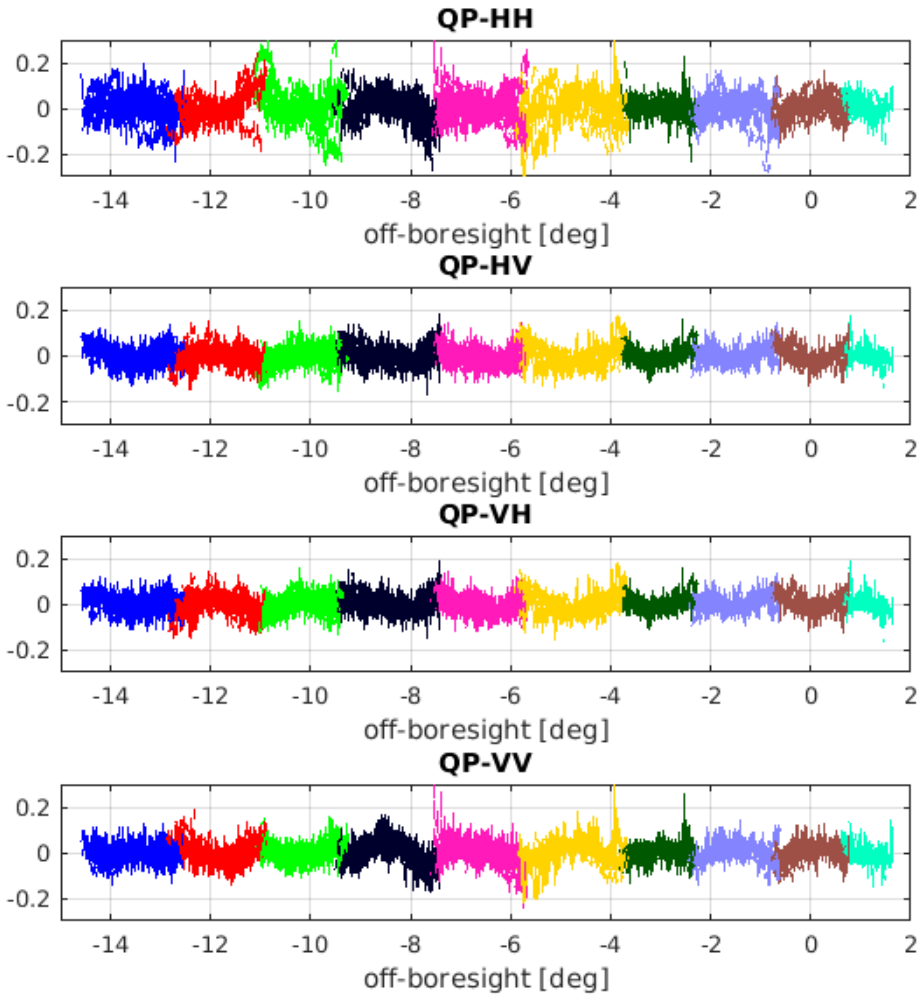
Range Antenna Patterns





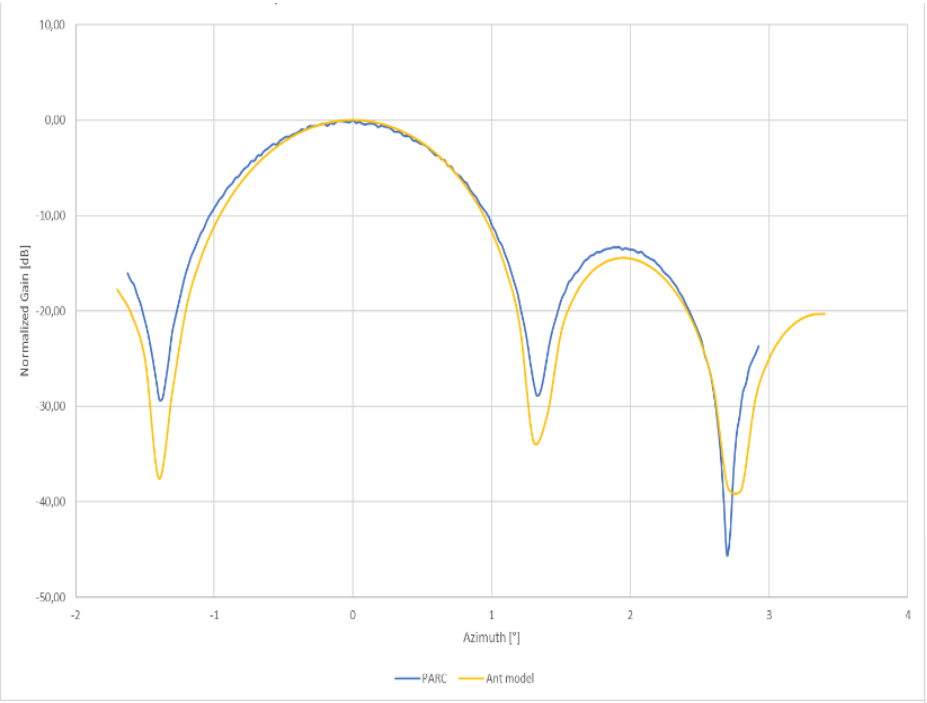
- Gamma nought over masked rivers in rain forest show very good matching between contiguos swaths

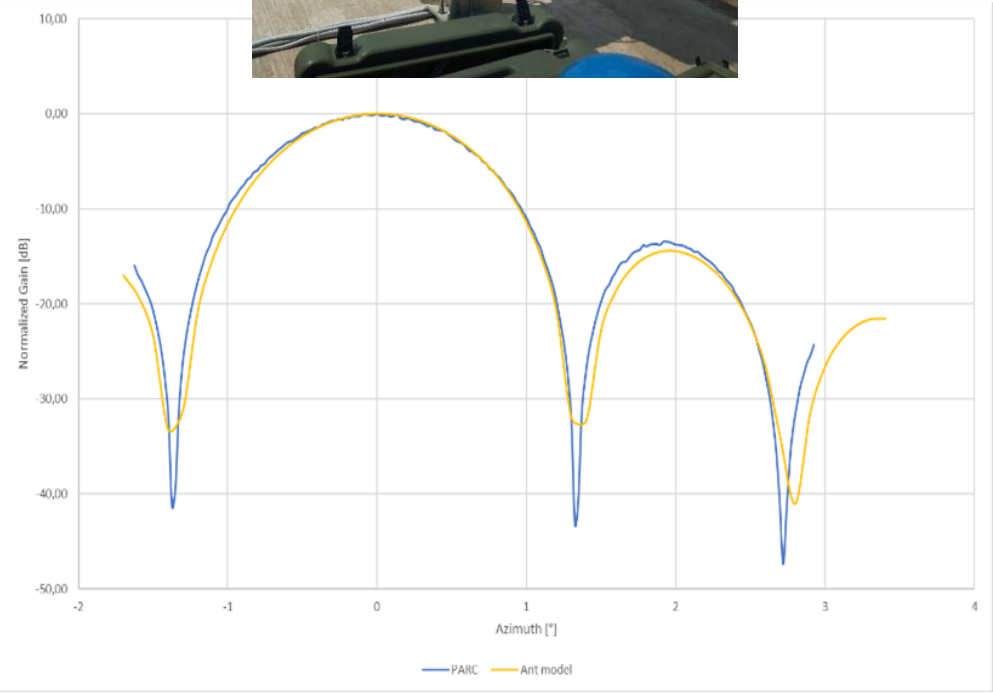
Range Antenna Patterns



- Gamma nought of many images after substracting beam mean gain to focus on pattern shape errors at +/-0.15dB 3sigma

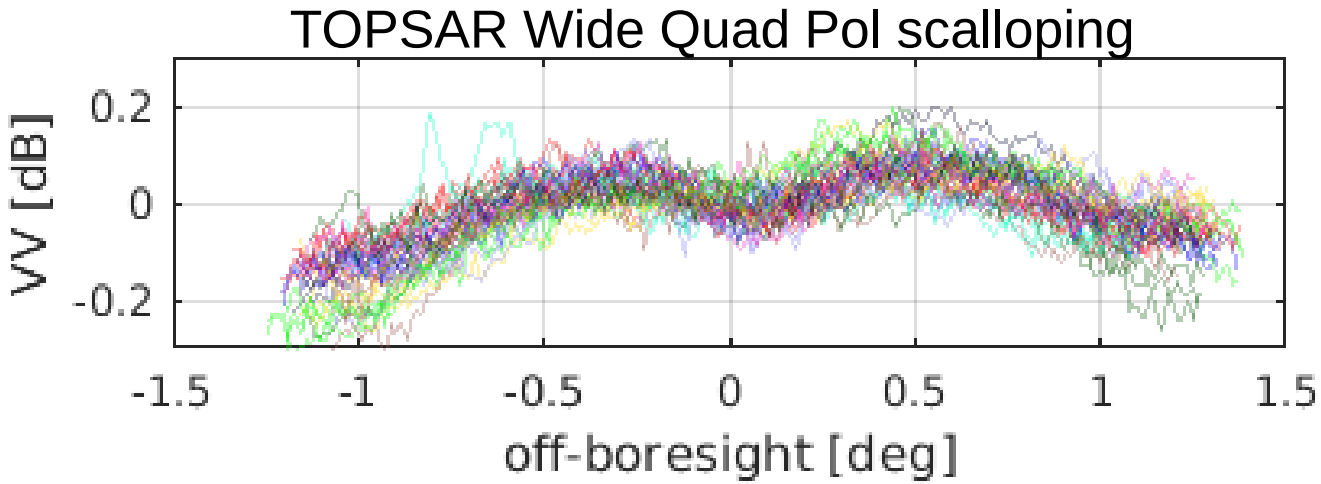
Azimuth Antenna Pattern

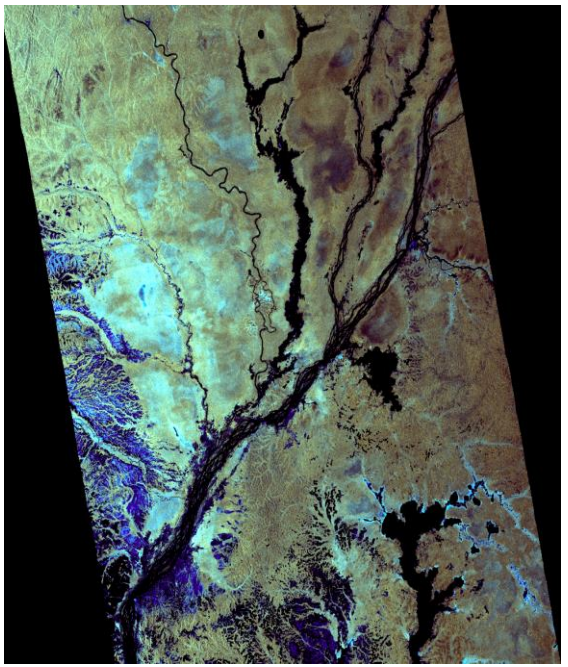


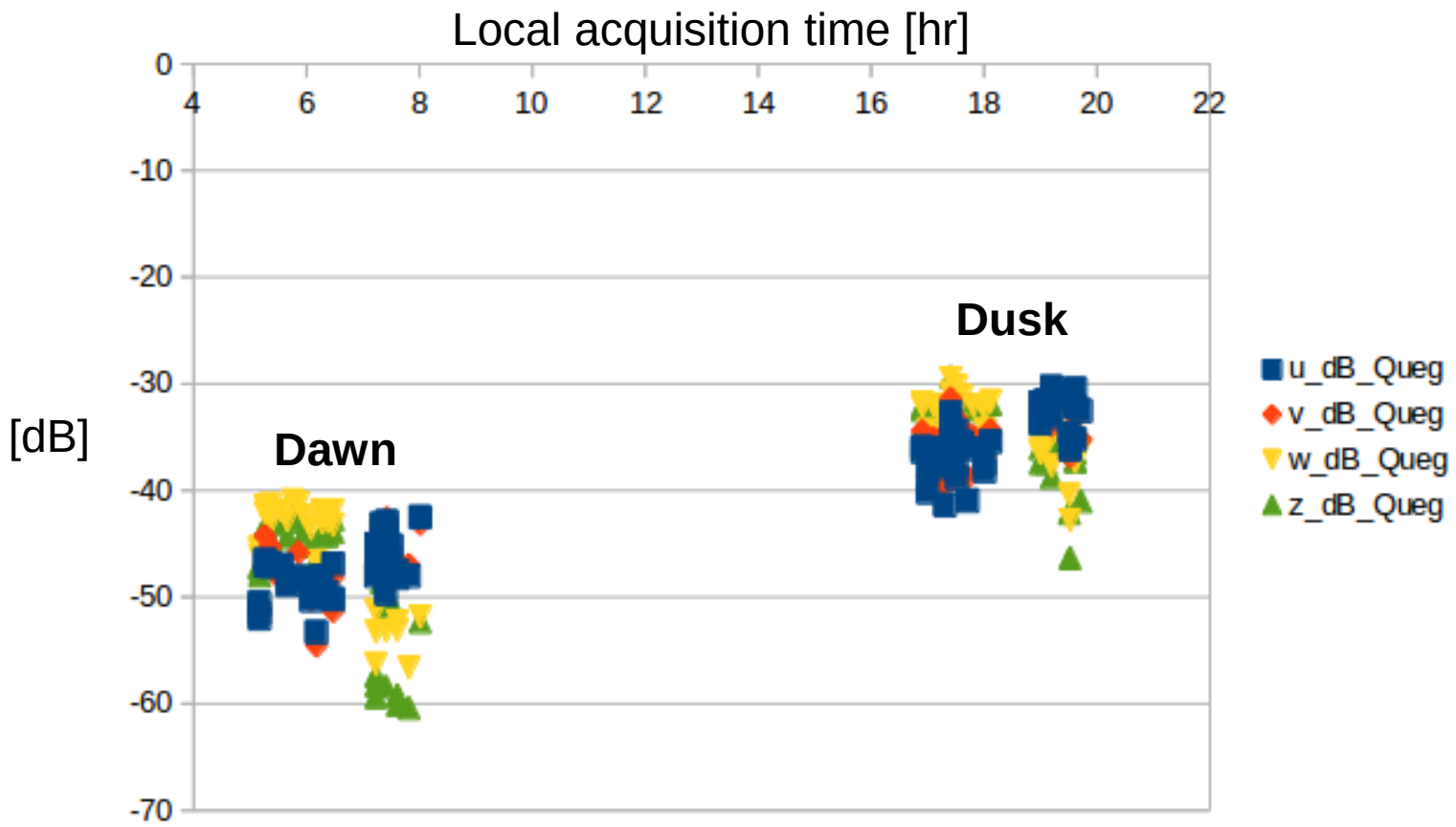


Very good agreement has been found between Antenna Model and PARC measurements

- A small residual scalloping effect has been found on TOPSAR images, +/0.15dB 3sigma at worst cases (wide swaths with highest azimuth steering angles)
- Antenna model and rain forest measurements are being exploited to derive a correction law



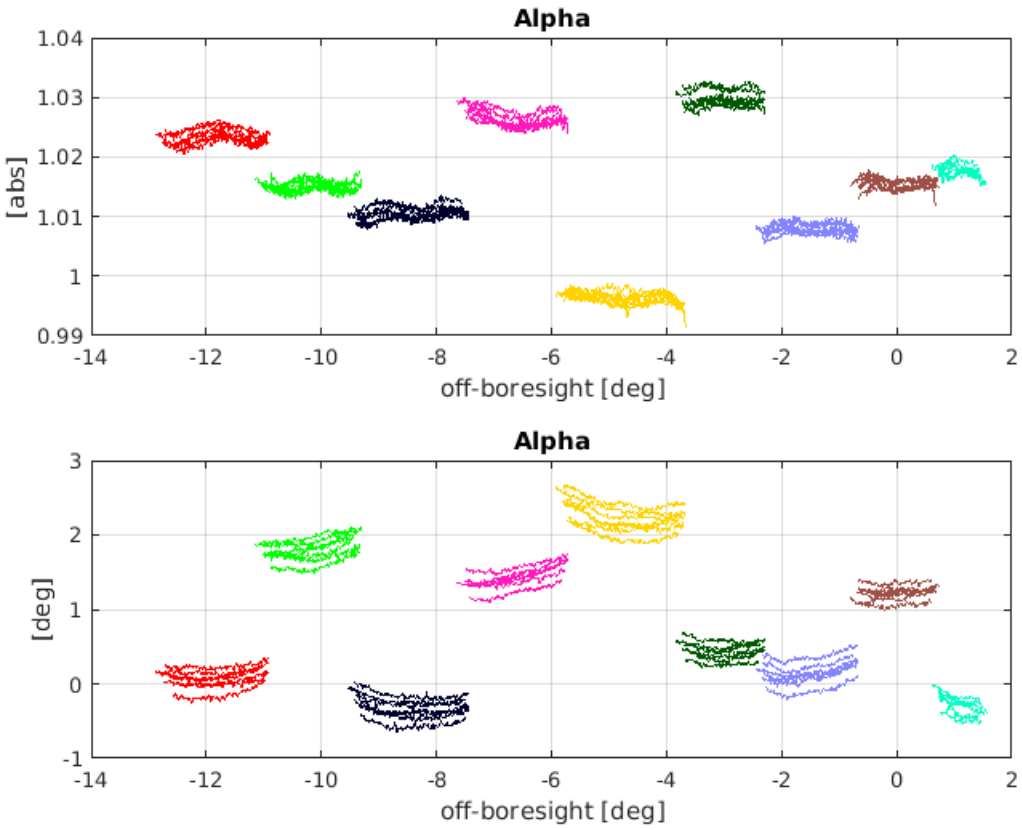




Cross-talk estimation on dusk images is biased due to Faraday rotation
FRA < 0.15 deg on dawn and up to 0.8 deg on dusk

Cross-talk already <u>below -40dB</u> for all modes dawn images

- **Alpha (Quegan Method)** was estimated from rainforest images for each swath
- Stripmap standard deviation measured as 0.03dB, TOPSAR as 0.01dB (1 sigma)



Quegan method

$HH' = \alpha \cdot f^2 \cdot K \cdot HH$

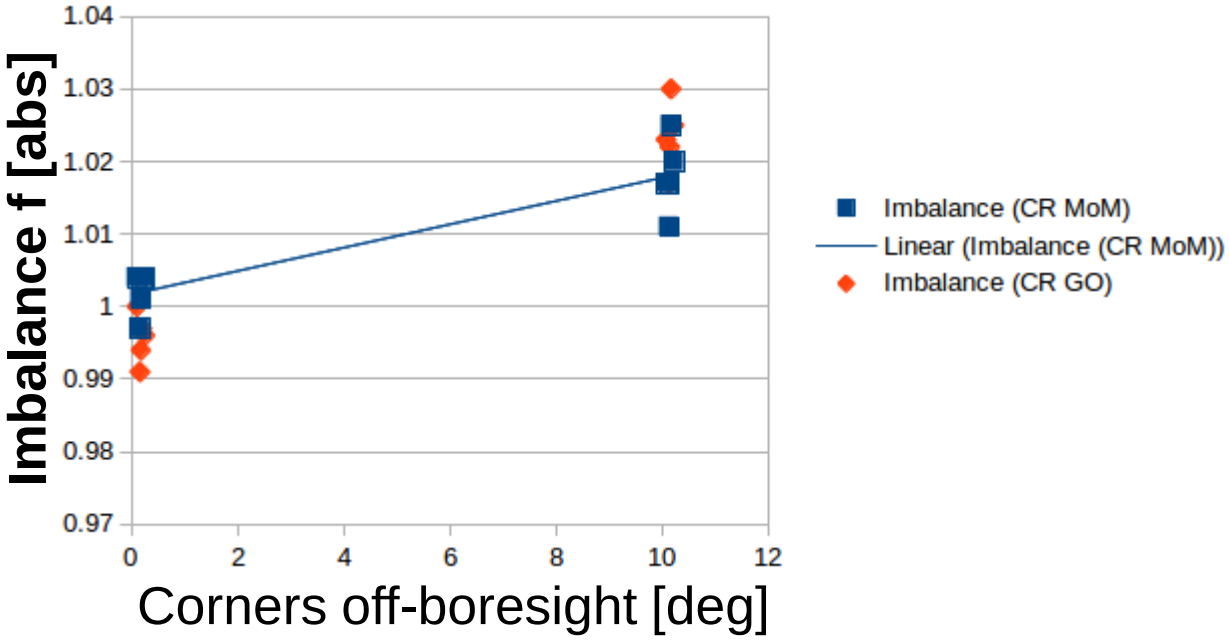
$HV' = f \cdot K \cdot HV$

$VH' = f \cdot \alpha \cdot K\, VH$

$VV' = K \cdot VV$

Polarimetric Imbalances (f)

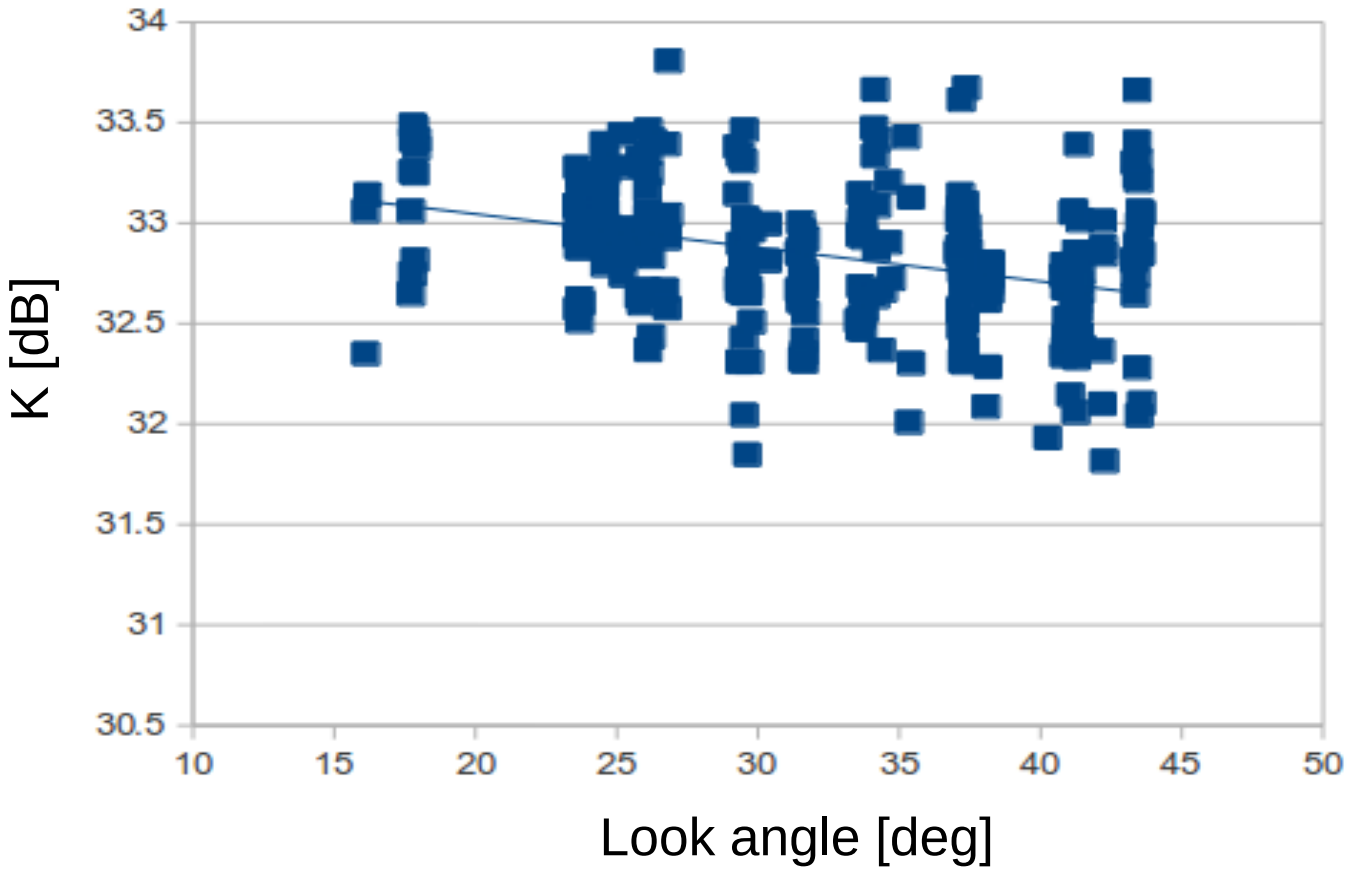
- Imbalance was estimated for each swath from images with PARC and CR and cross checked with rain forest
- Dependence on corner reflector off-boresight observation angle has been found and fitted to extrapolate at boresight case when not measured directly.



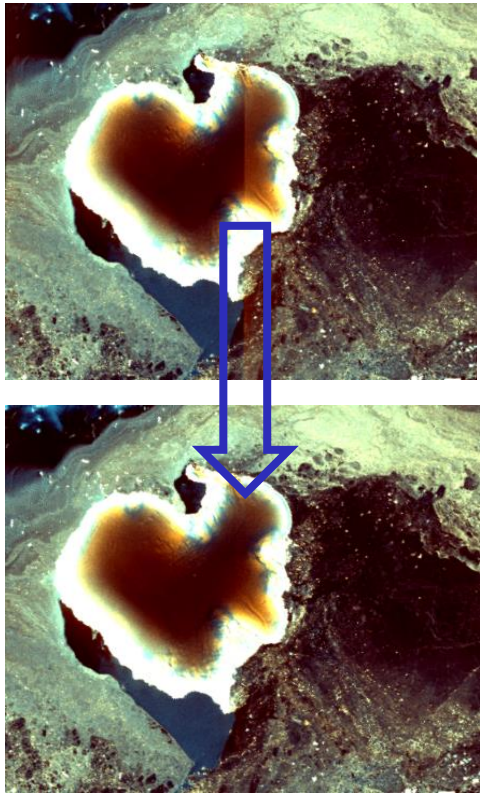
Mean co-pol ratio accuracy 0.22 dB

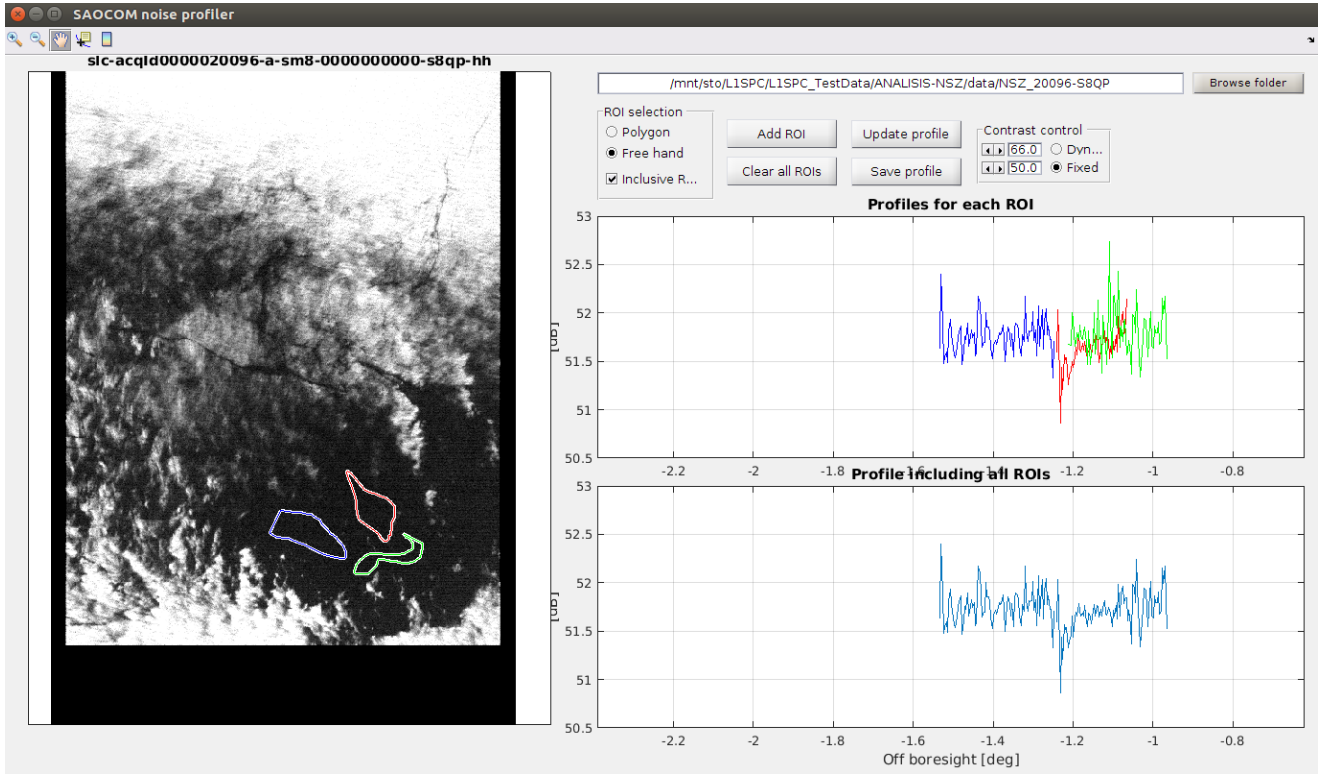
Note: $CR_{dB} = 40log_{10}\left(1 + \frac{std(f_{abs})}{mean(f_{abs})}\right)$

- Absolute calibration accuracy (1 sigma)
  - At corners: 0.28dB
  - At rainforest: 0.23dB



- NESZ evaluated over doldrums for all swaths and calibration terms determined to be applied on pre and post datatakes noise measurements
- Denoise function is currently affected when there is RFI during noise measurements so it is currently disabled in the operative environment. Work is ongoing to make this more robust against RFI.
- NESZ over all modes measurements mean = -35.4dB , stdev = 1.7dB



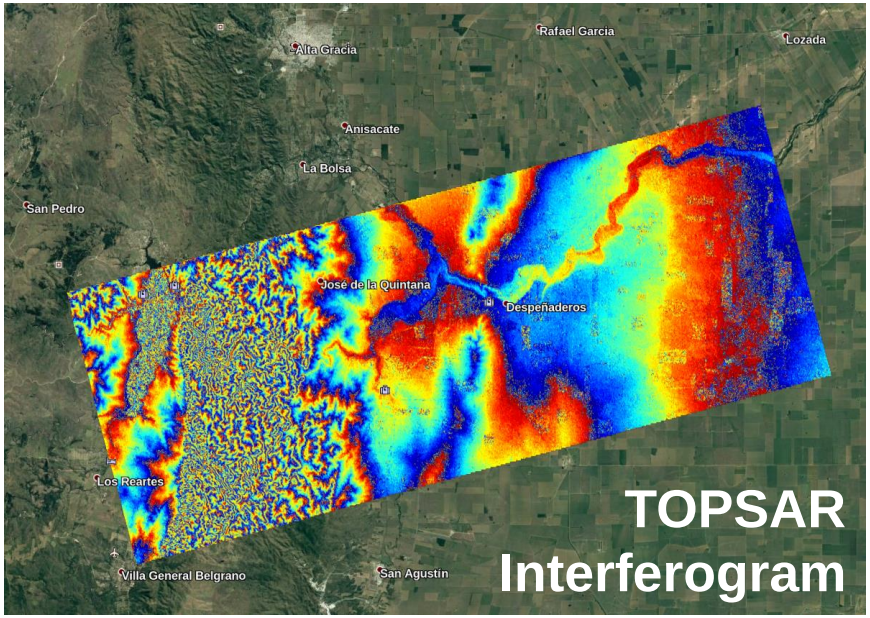


1. **SAO-1A CALVAL commissioning finished**

2. **Results are compliant to requirements**

3. **Operative CALVAL for SAO-1A has started**

4. **Future improvements:**
   1. **TOPSAR scallopping**
   2. **RFI filters**
   3. **Denoise affected by RFI**
   4. **TOPSAR interferometry potential evaluation**



5. **SAO-1B launch on March 2020**

saocom

Thank you for your attention

J. P. Cuesta González, M. Azcueta
CEOS SAR CALVAL Workshop, Frascati, Italy, Nov. 18-22, 2019