

TanDEM-X Acquisition Planning and DEM Performance in the Third Year of Operation

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and TanDEM-X Team**

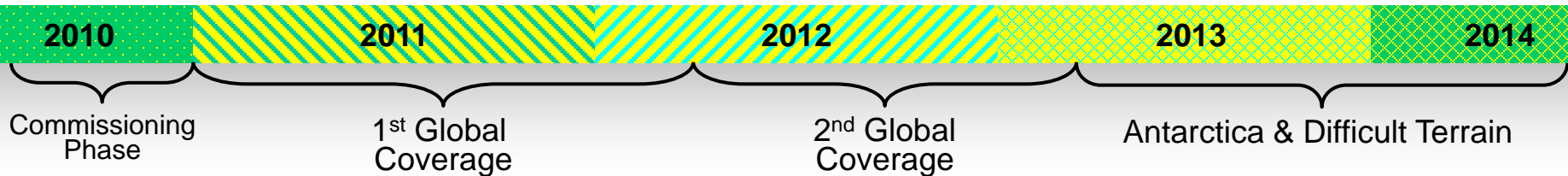


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in der Helmholtz-Gemeinschaft



Advanced SAR Workshop 2013

TanDEM-X Global DEM Acquisition Plan



1st Global Coverage

- Small baseline (~200 m)
- Height of Ambiguity ~ 50 m



2nd Global Coverage

- Increased baseline (~300 m)
- Height of Ambiguity ~ 35 m

Combination:

- Dual Baseline Phase Unwrapping
- Improved relative height accuracy

3rd Year Acquisitions

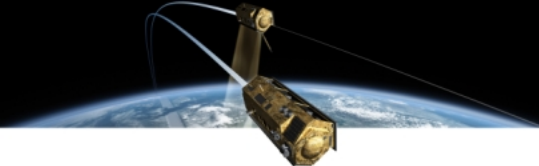
- Antarctica
- Difficult terrain to account for shadow & layover
=> Different viewing geometry
- Deserts



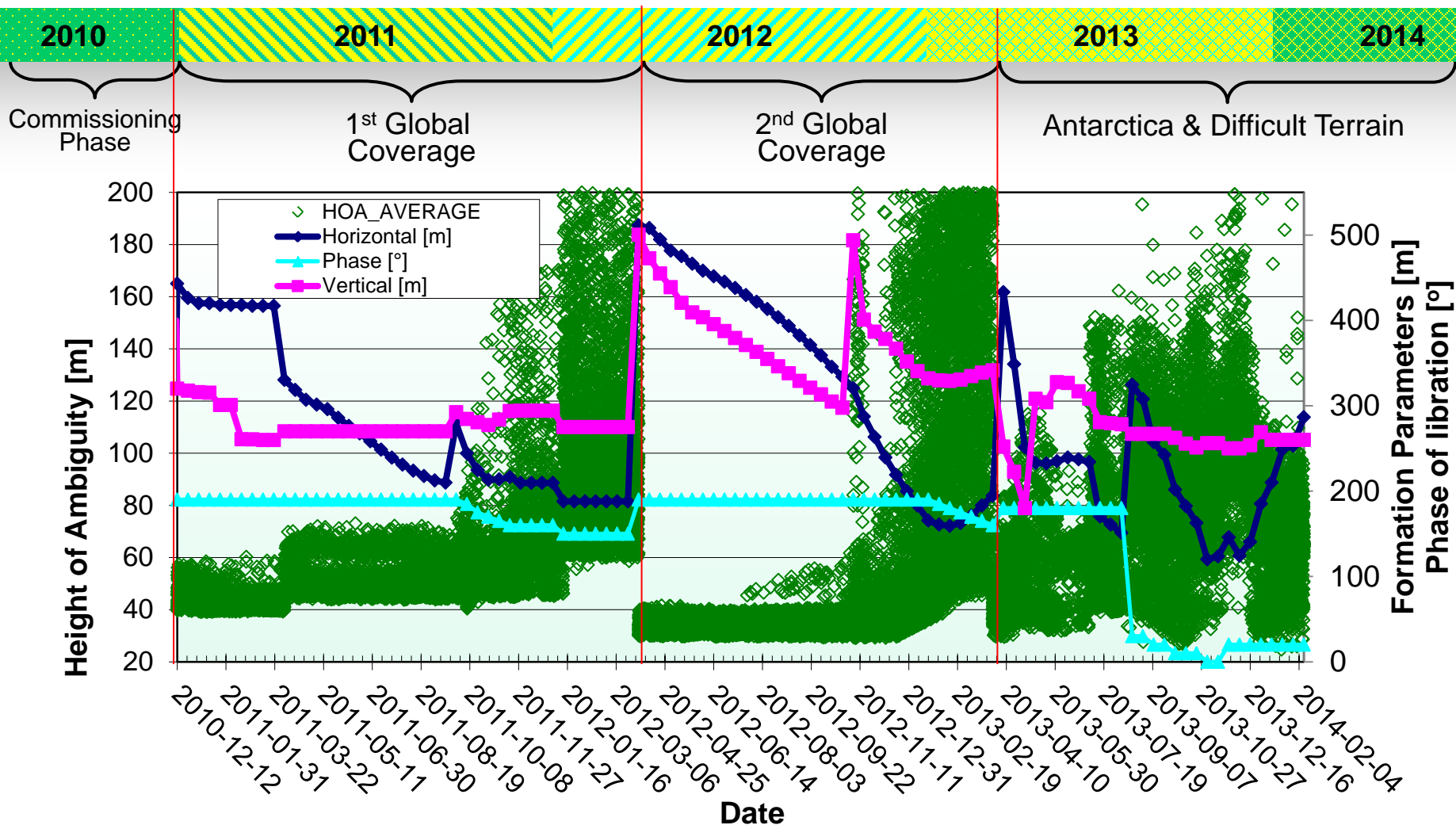
Requirement for Relative Vertical Accuracy

- < 2 m for flat terrain
- < 4 m for mountainous terrain

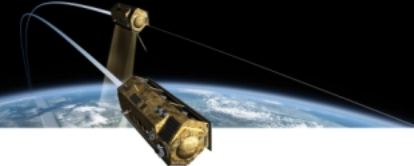




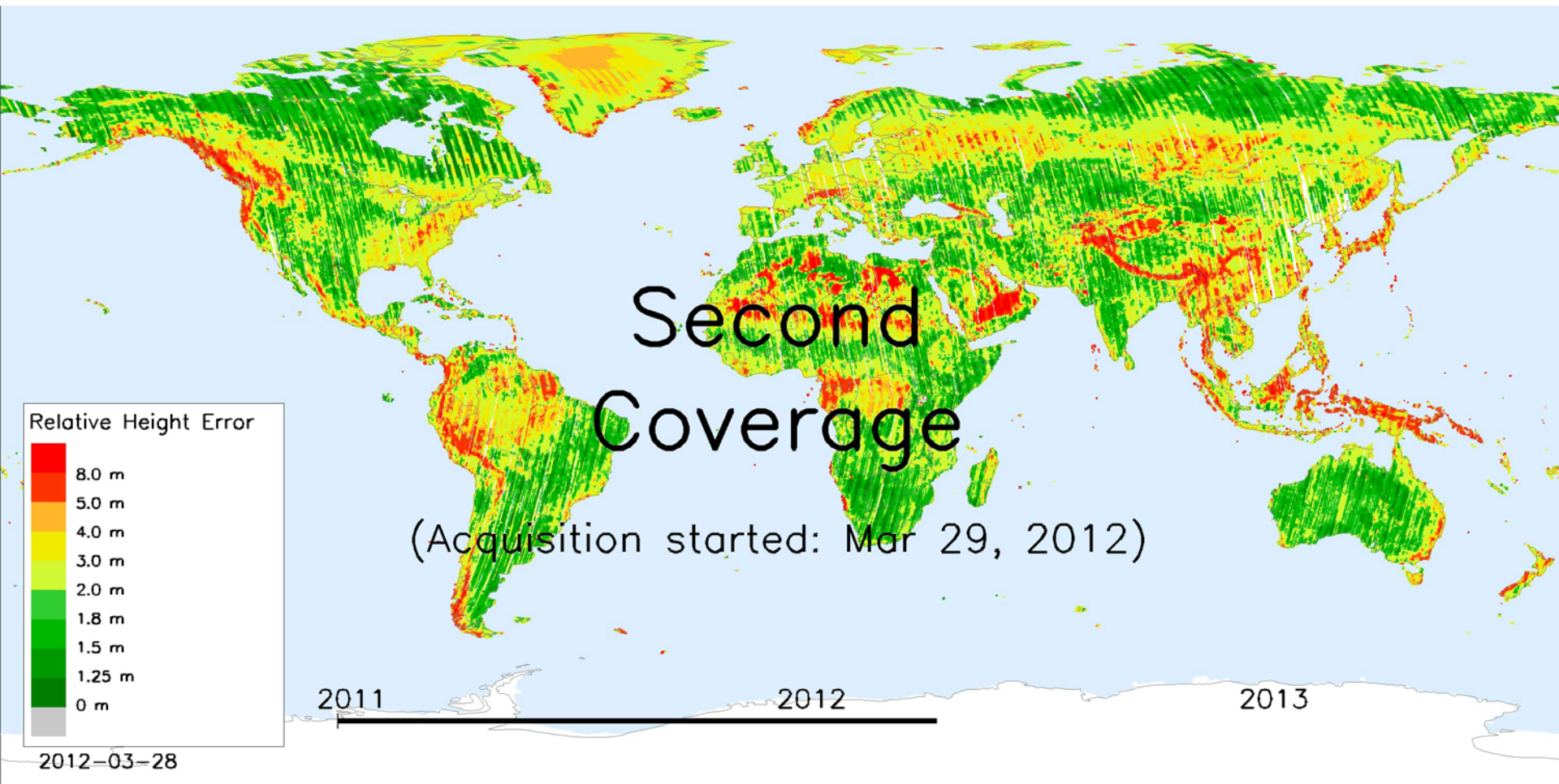
Formation Flying Configuration



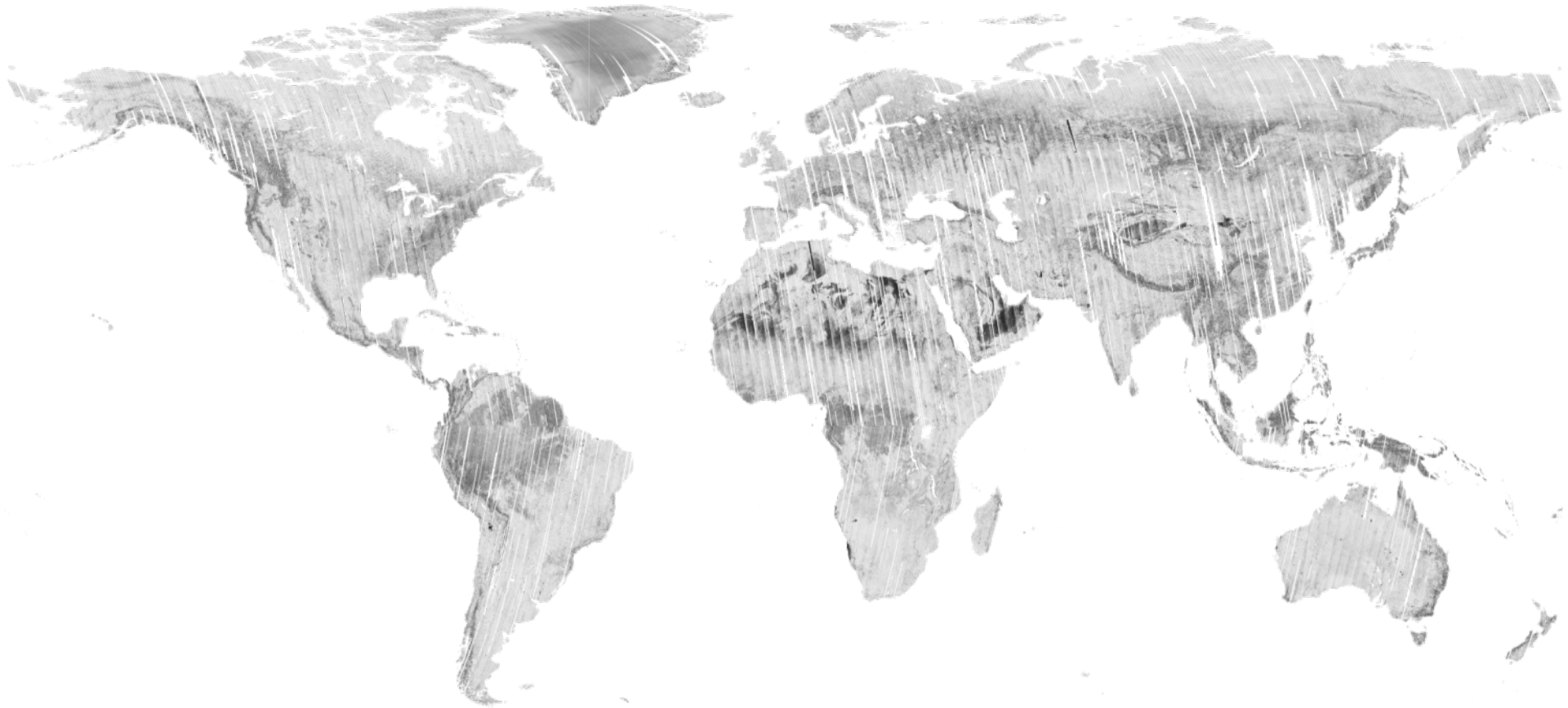
Height of Ambiguity $\leftrightarrow 2\pi$ Interferometric Phase large baseline \leftrightarrow small HoA \leftrightarrow small rel. height error



Relative Height Error



Quicklook Mosaic: Coherence

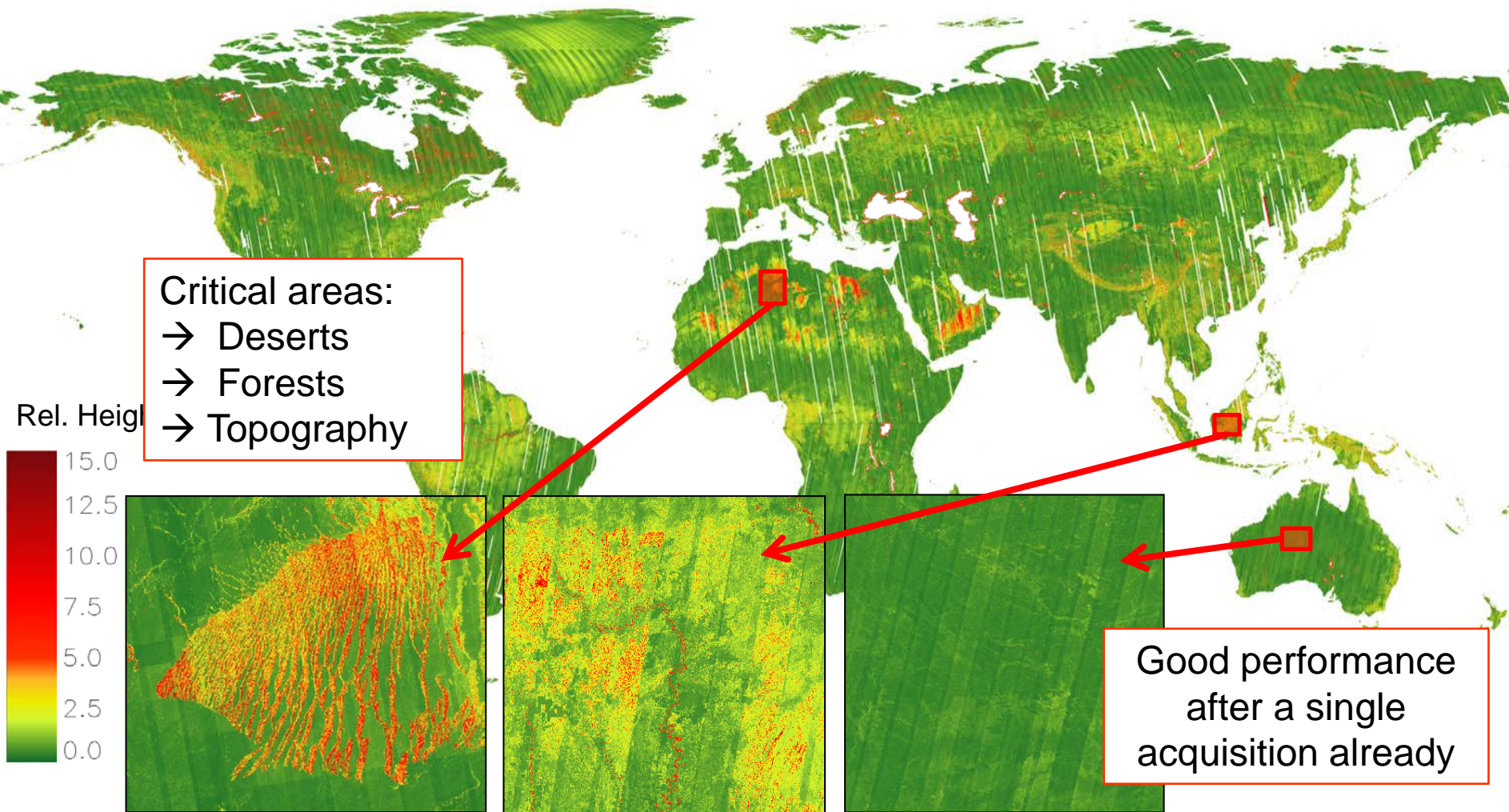


Map resolution: 500m x 500m



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Quicklook Mosaic: Relative Height Error from Coherence



Height error estimated from $f(\text{coherence, HoA, \# Looks})$

Map resolution: 500m x 500m



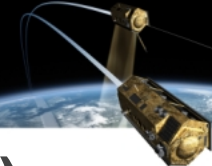
Global Relative Height Error on Quicklook Mosaic Basis

Coverage	p-to-p 90% RHE < 2 m (slope < 20%)	p-to-p 90% RHE < 4 m (slope > 20%)
1 st Global DEM	66.40%	79.40%
2 nd Global DEM*	75.42%	84.91%
Combination of 1 st and 2 nd Global DEM*	90.30%	95.64%

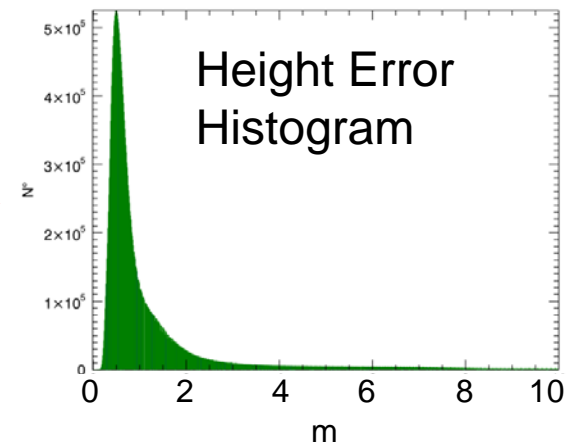
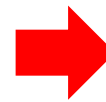
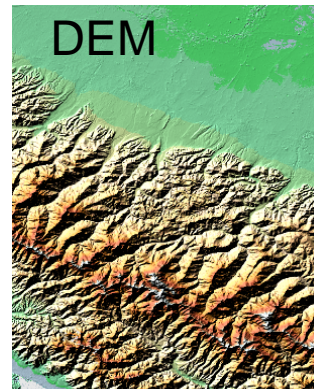
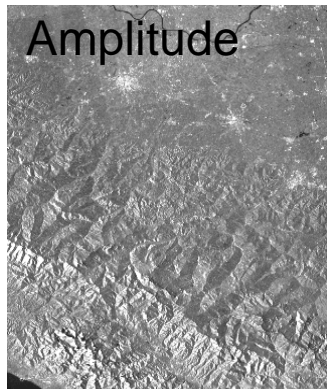
- More than 300,000 bistatic scenes analyzed (until mid July)
- 3rd & 4th Coverage for Difficult Terrain necessary

* For second coverage more easier / good quality regions have been processed so far





Evaluation of first DEM Tiles (1° x 1°)



Height Error Statistics

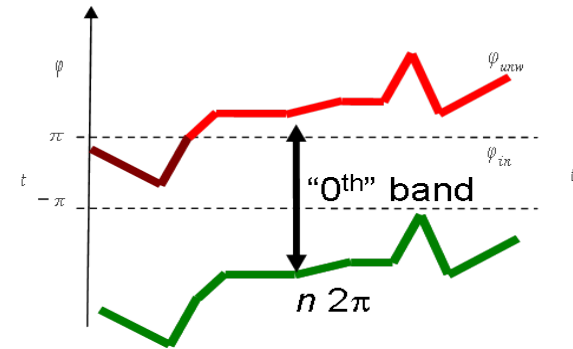
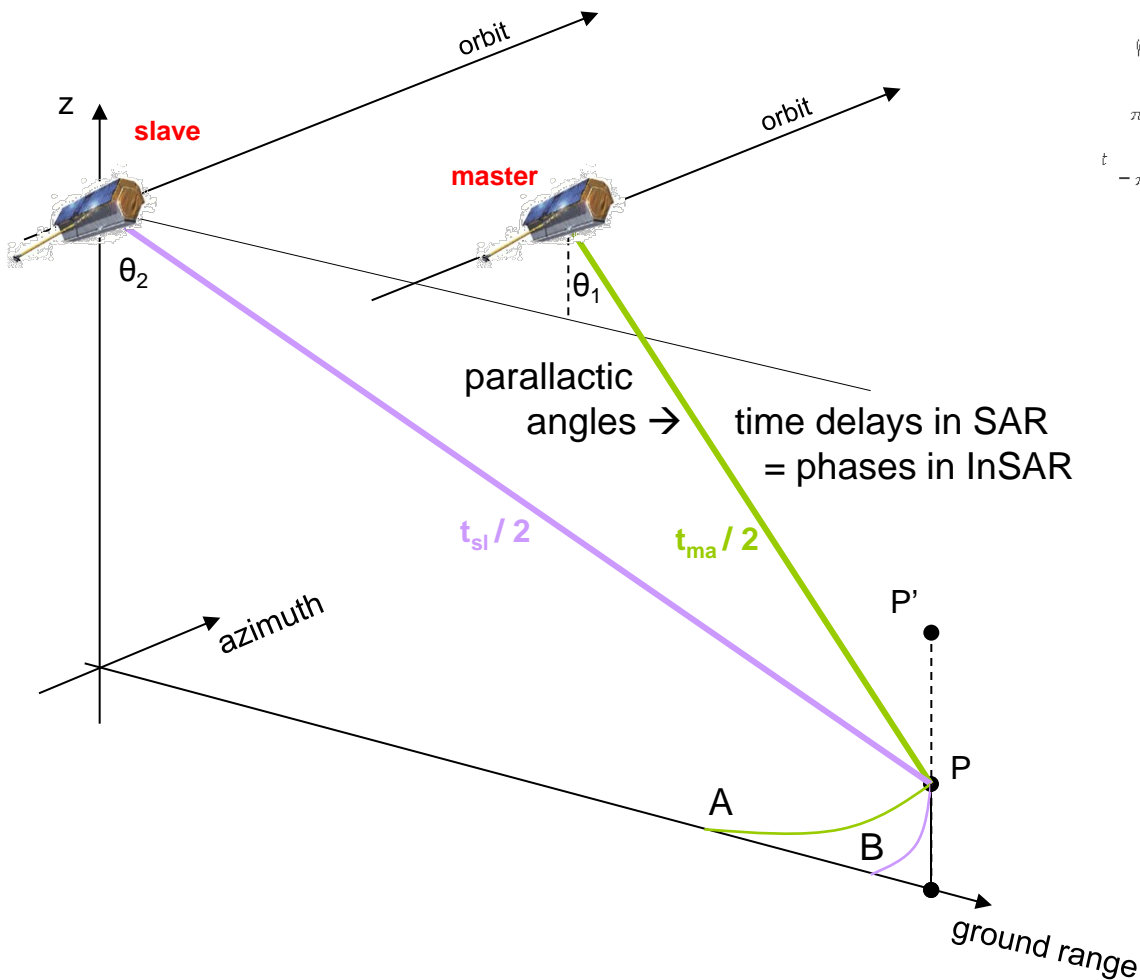
	Steep (>20% slope)		Flat (<20% slope)		void		water		total pixels
	pixels	%	pixels	%	pixels	%	pixels	%	
N44E010	34633176	42,75	43931092	54,22	420240	0,52	2033494	2,51	81018001
N44E011	21395660	26,41	58661668	72,41	0	0,00	960675	1,19	81018001

Results Height Error PDF

	% below	
	4m	2m
N44E010	98,98	94,40
N44E011	99,59	98,71



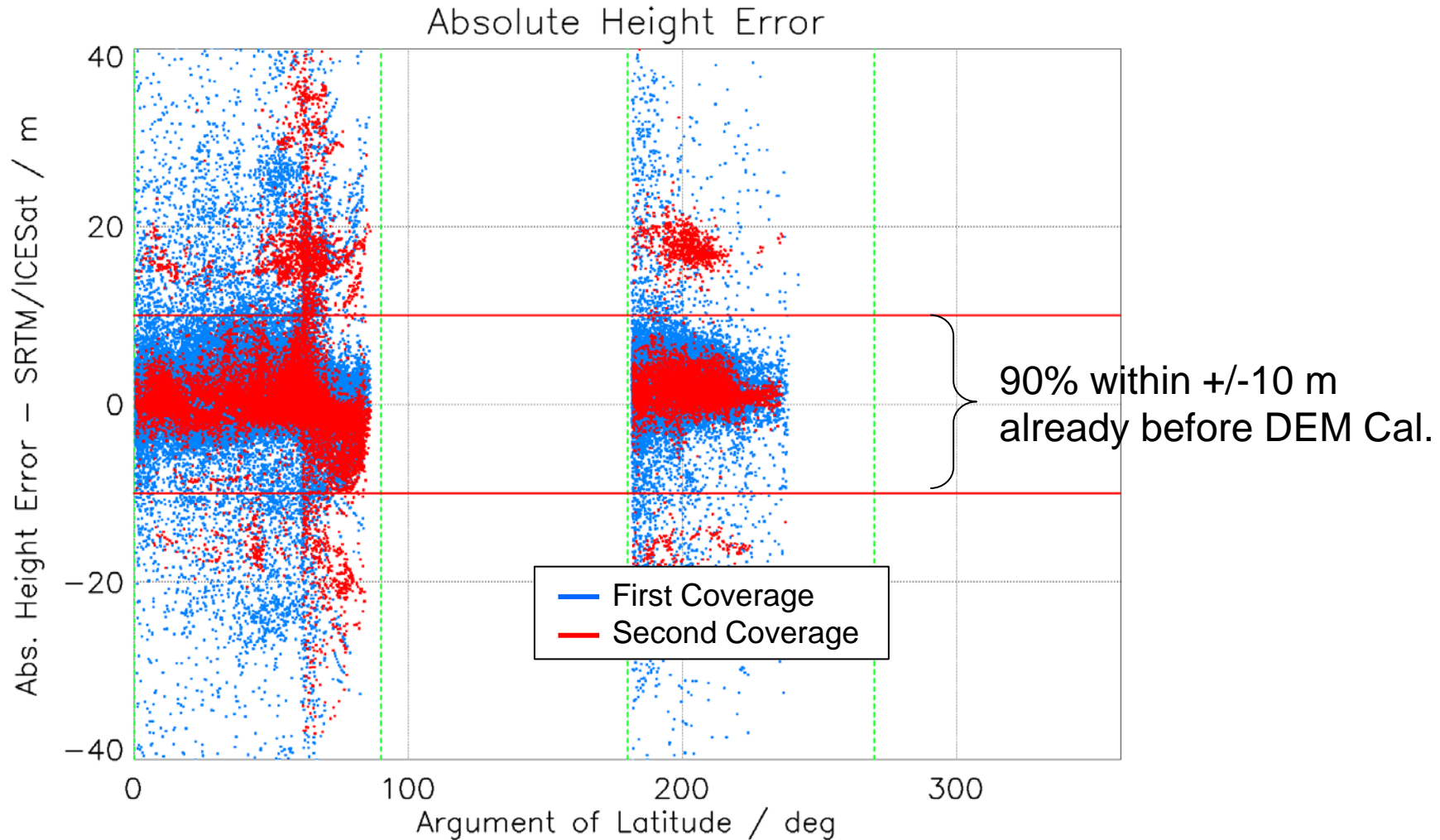
Radargrammetry to Resolve Phase Ambiguity Band



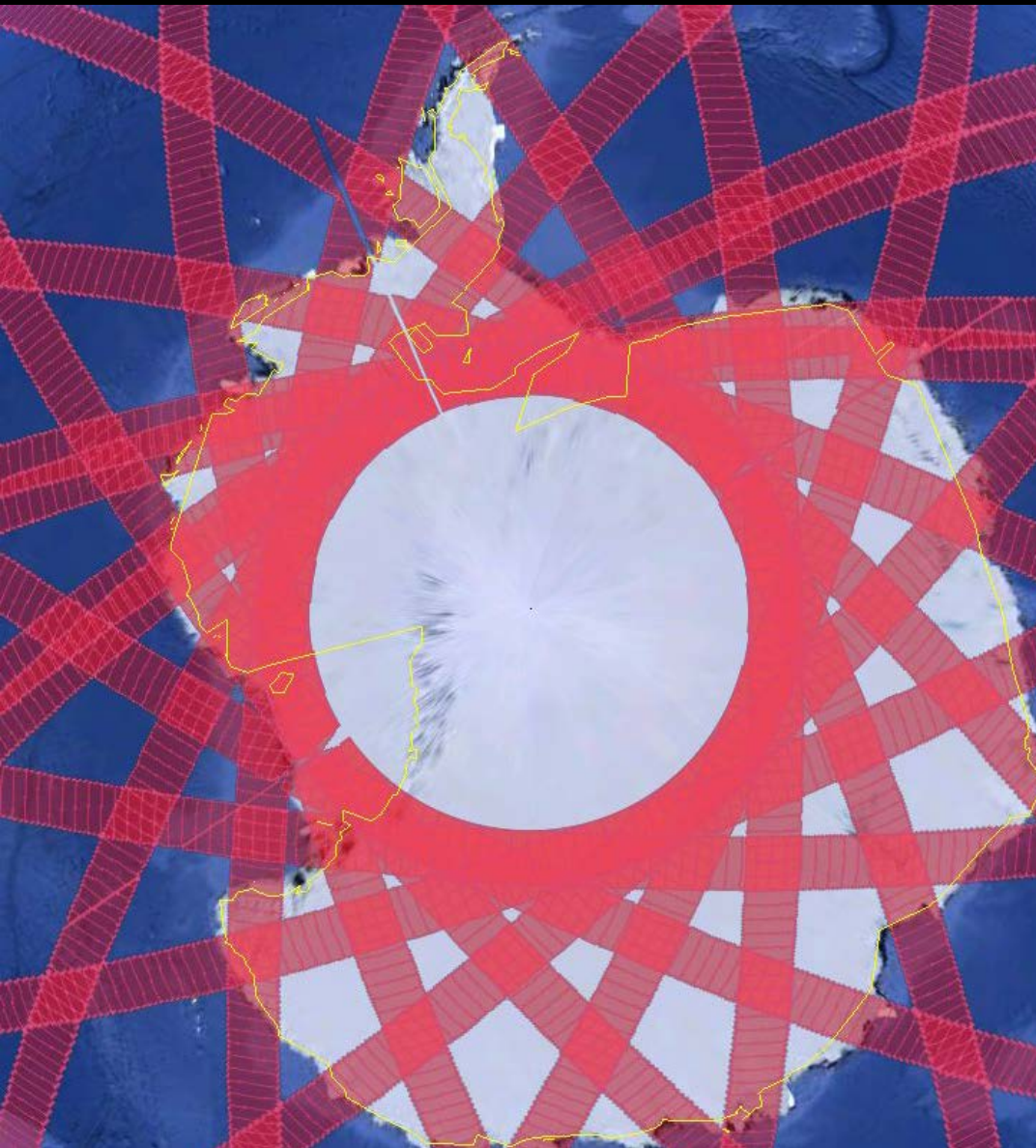
- becoming globally independent of SRTM DEM as reference
- especially important in regions > 60 deg latitude where no SRTM is available



Absolute Height Error of Scene-Based RawDEMs



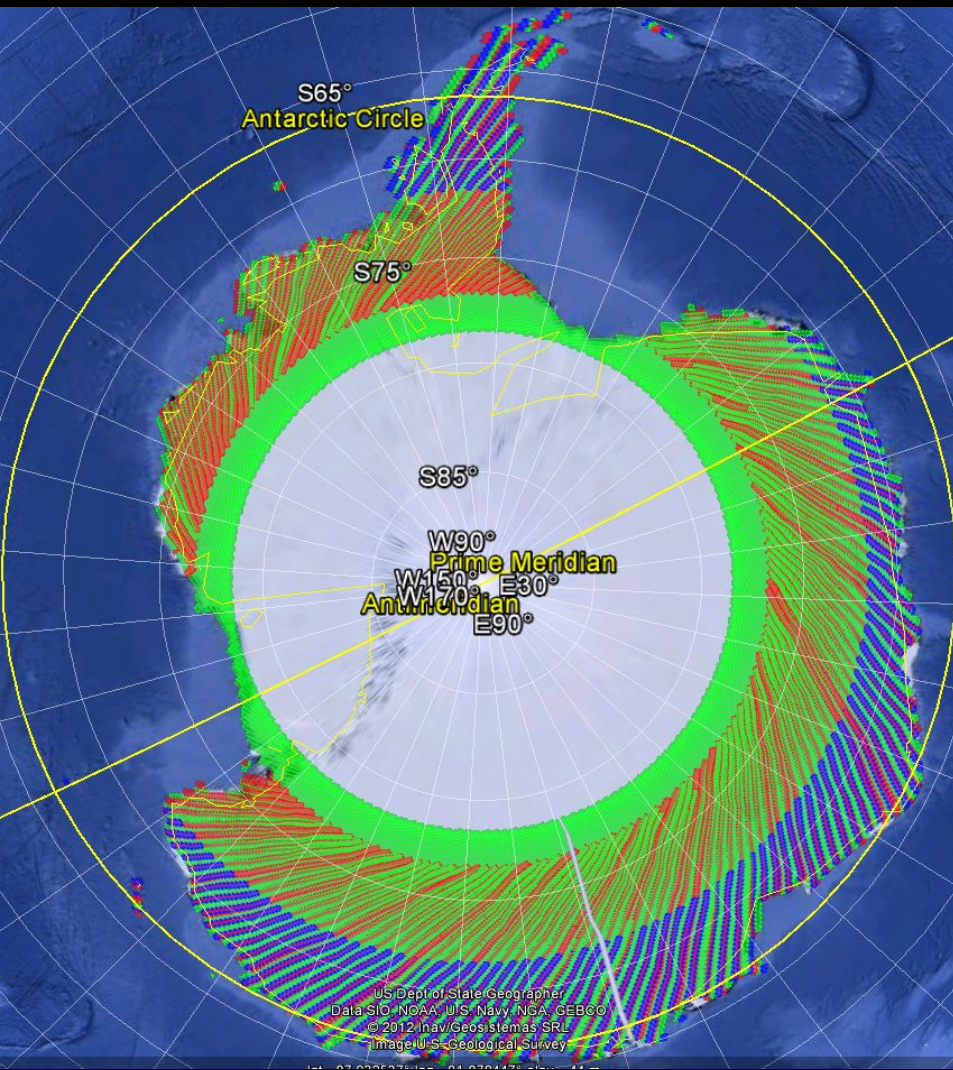
Antarctica Acquisitions



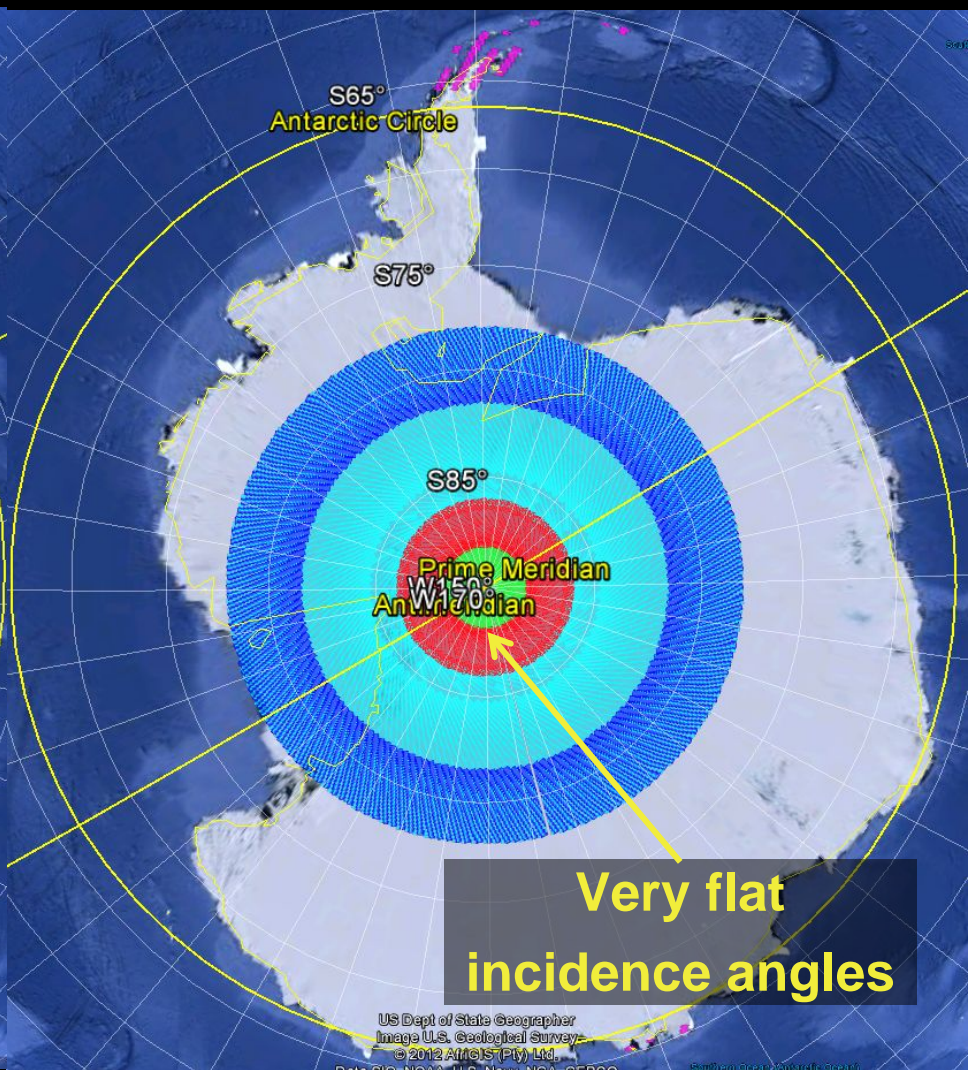
- **Acquisition in local winter**
to avoid melted ice → improve quality
- **Orbital inclination**
→ Left-Looking acquisitions required
- **Left-Looking acquisitions**
→ lower energy provision by solar panels

Antarctica Acquisitions

Right-Looking



Left-Looking



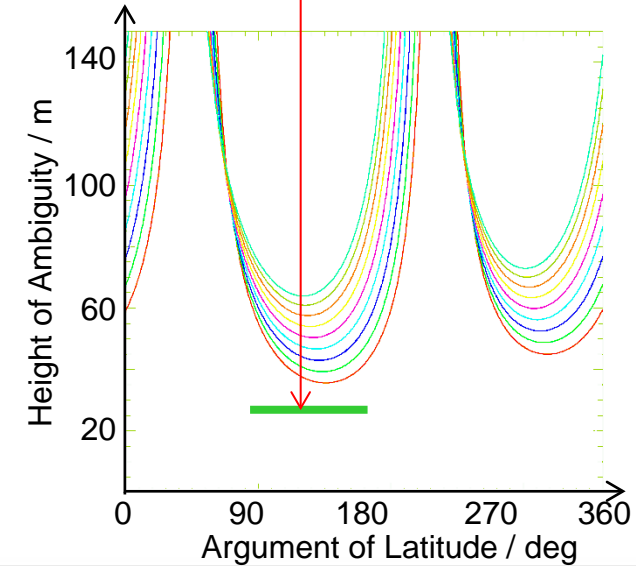
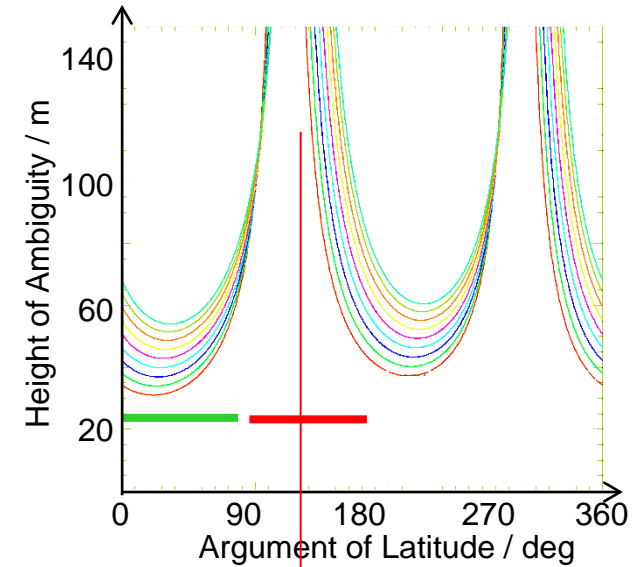
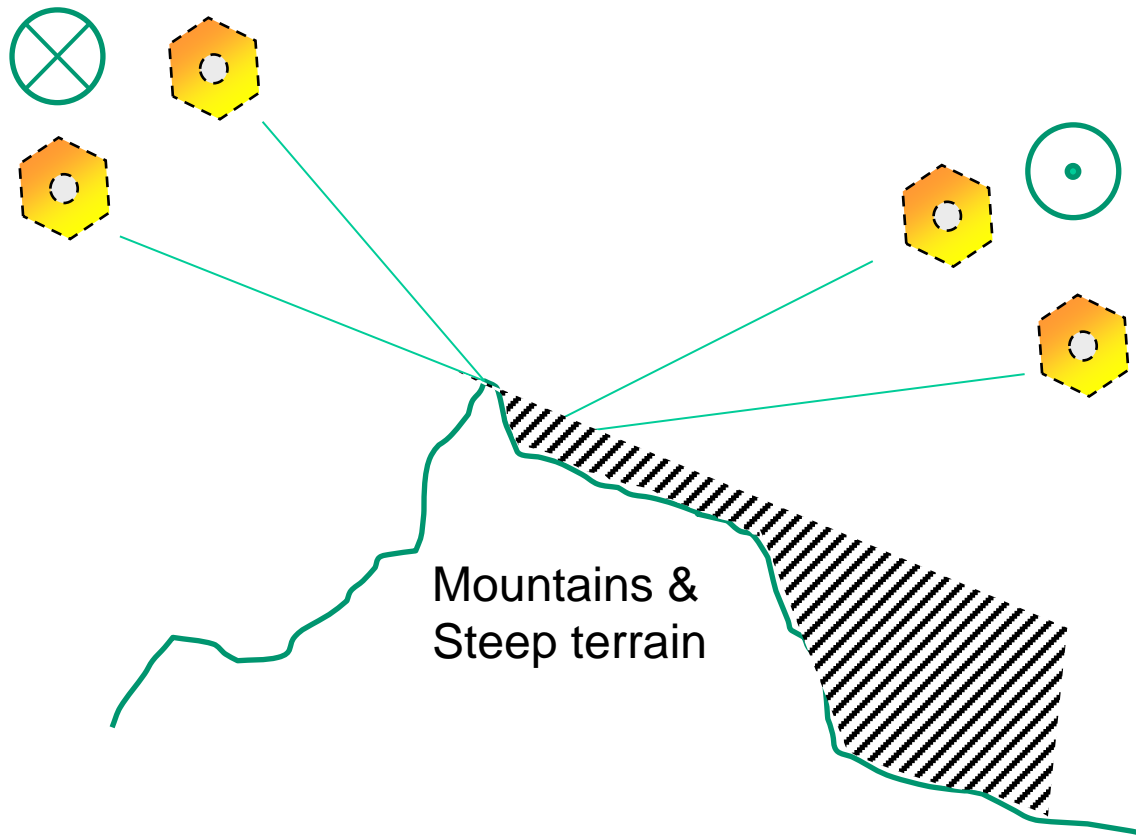
Antarctica Acquisitions – flat incidence angles

- Very flat incidence angles required for center Antarctica (61°)
→ Thorough performance analysis performed
- Updated SAR instrument configuration for lower PRFs performed

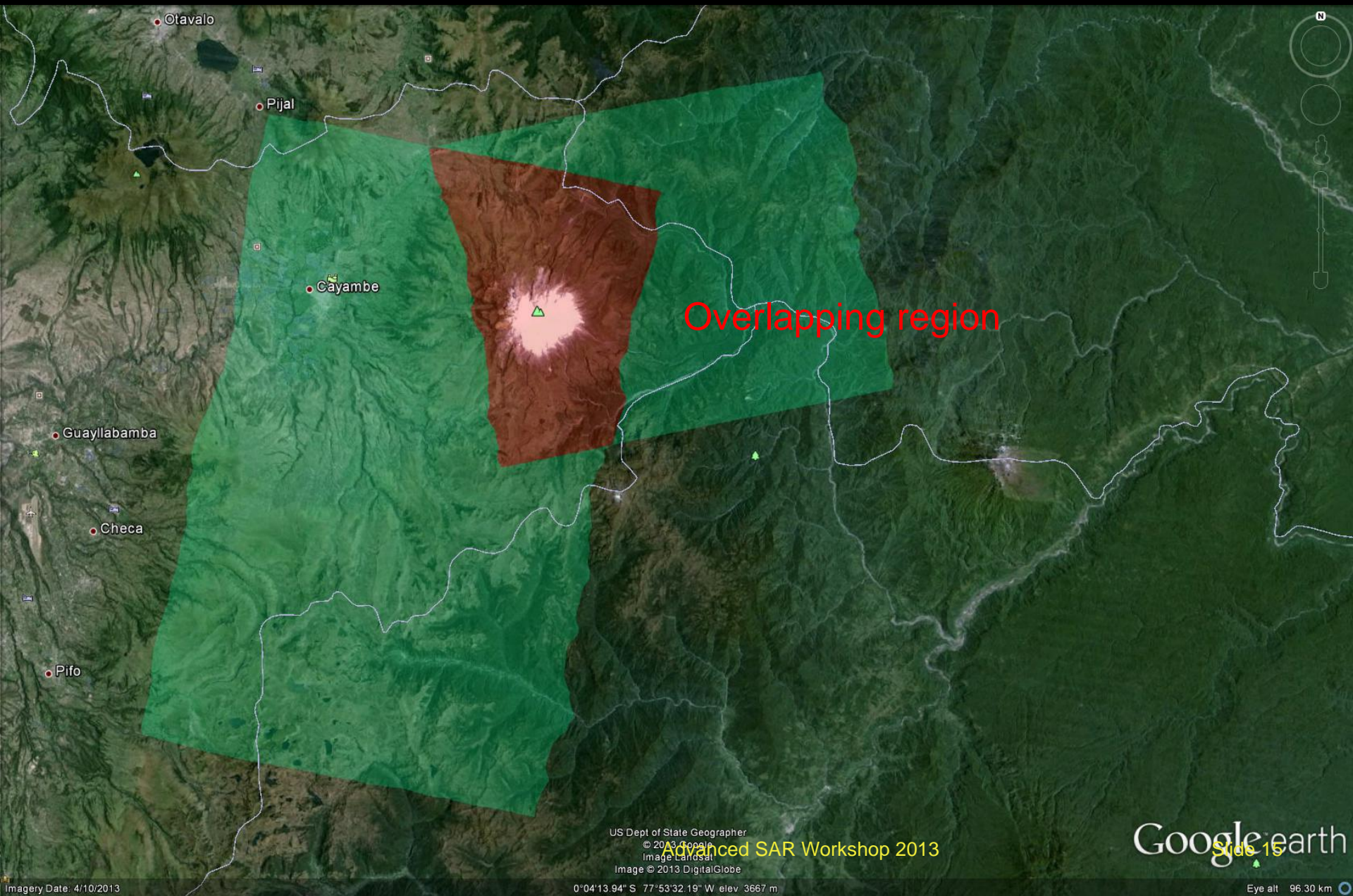
2000 Hz

3350 Hz

Difficult Terrain: Shadow/Layover Acquisitions

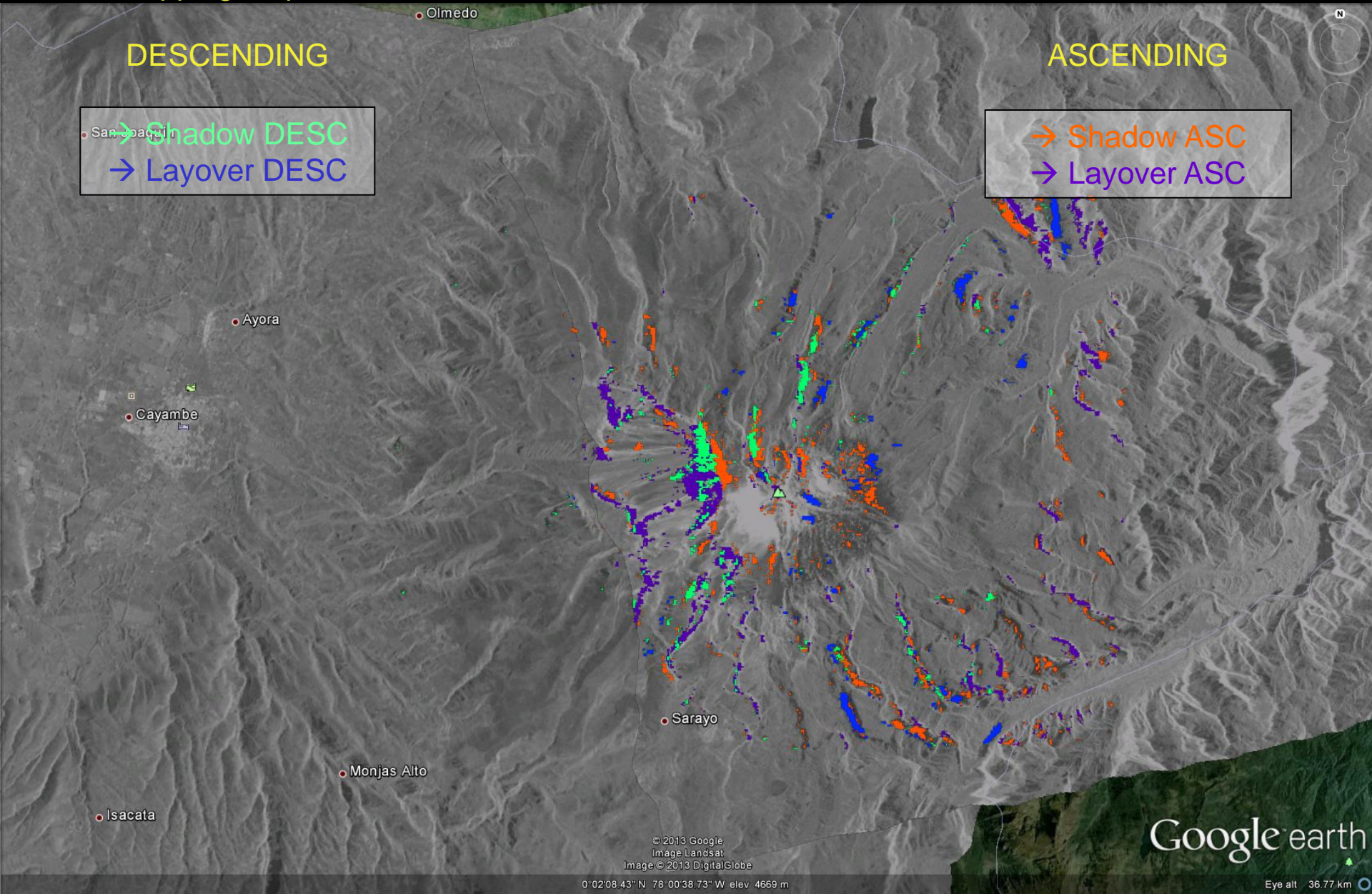


Crossing Orbits over Andes



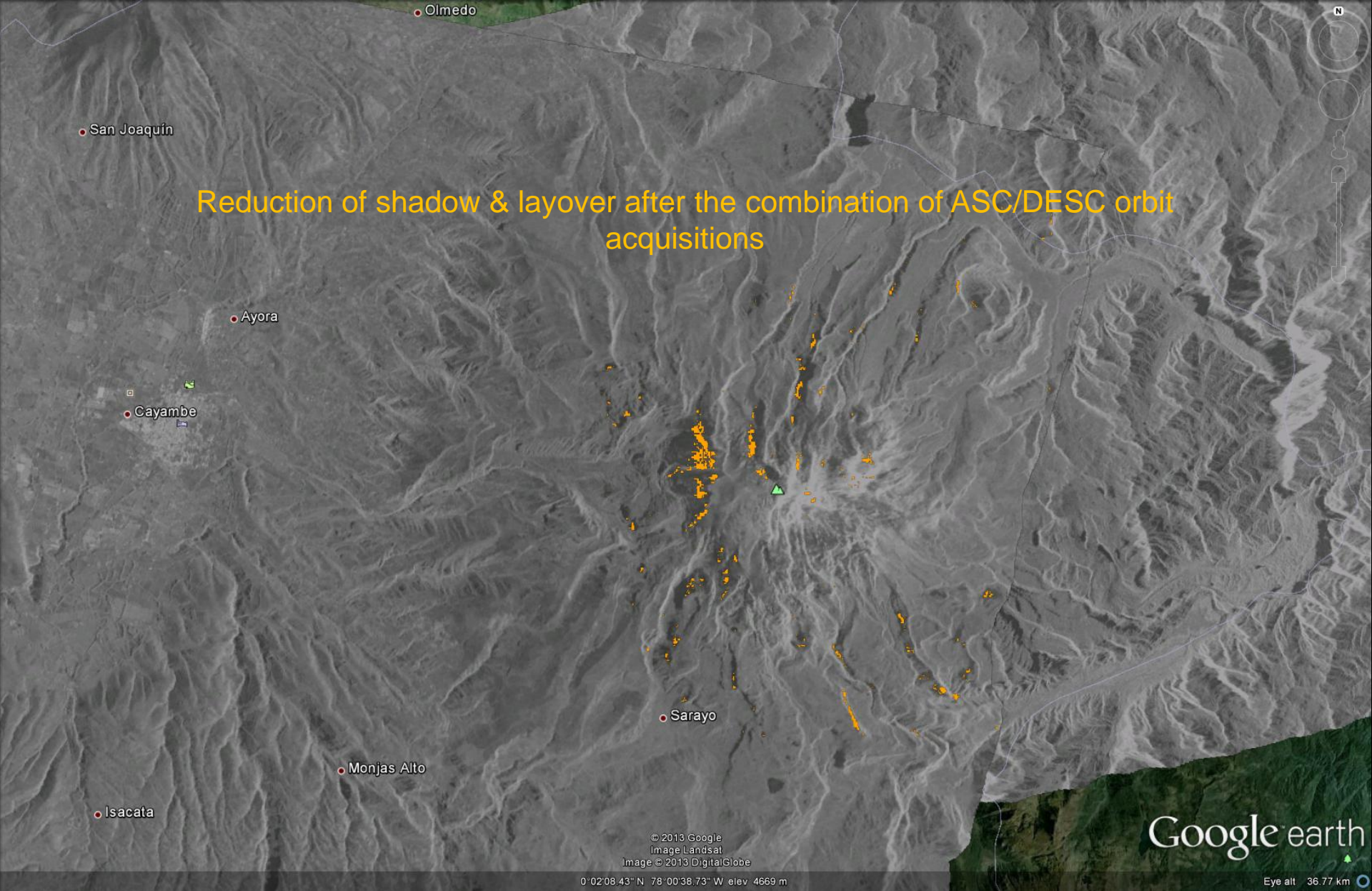
Crossing Orbits over Andes

2 overlapping acquisitions available: ASCENDING + DESCENDING



Crossing Orbits over Andes

2 overlapping acquisitions available: ASCENDING + DESCENDING



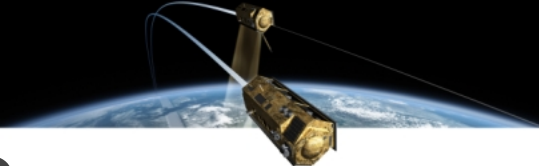
Reduction of shadow & layover after the combination of ASC/DESC orbit acquisitions

© 2013 Google
Image Landsat
Image © 2013 DigitalGlobe

0°02'08.43" N 78°00'38.73" W elev 4669 m

Google earth

Eye alt 36.77 km



Formation Change for 3rd & 4th Coverage

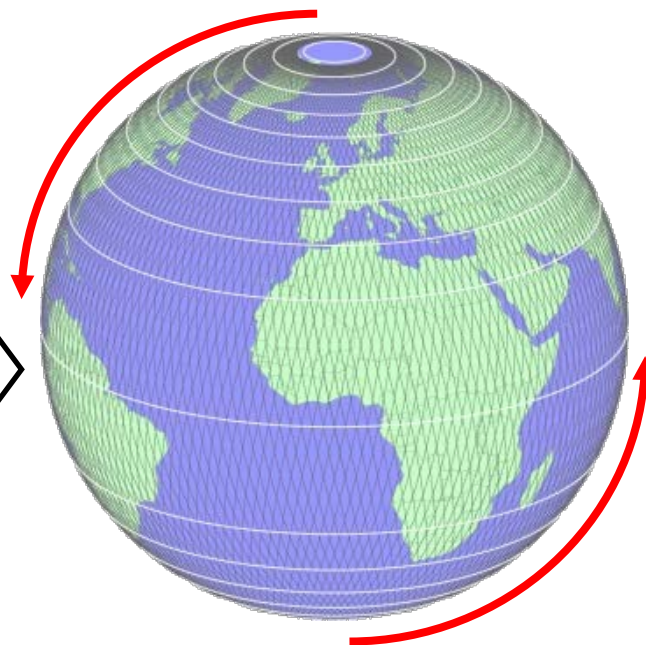
1st & 2nd coverage



Useful cross-track baselines on northern (southern) hemisphere in ascending (descending) orbit

3rd & 4th coverage

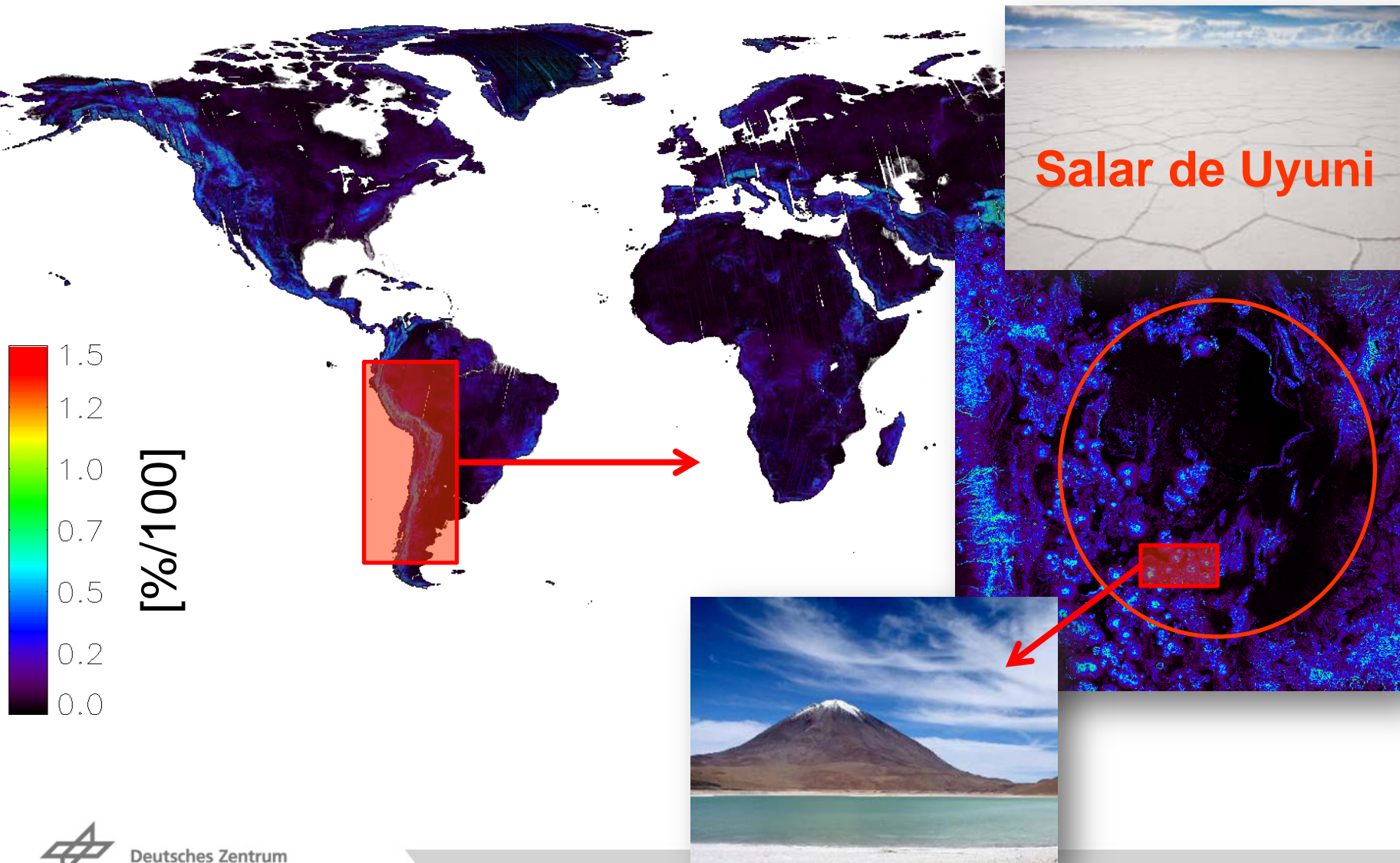
August 2013 for 8 month



Useful cross-track baselines on northern (southern) hemisphere in descending (ascending) orbit

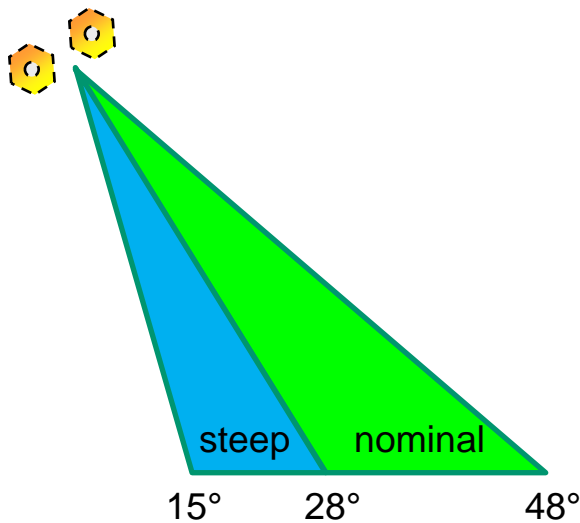
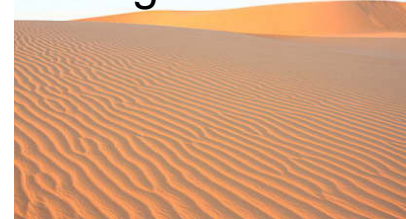


Identification of Difficult Terrain Areas via Slope Map



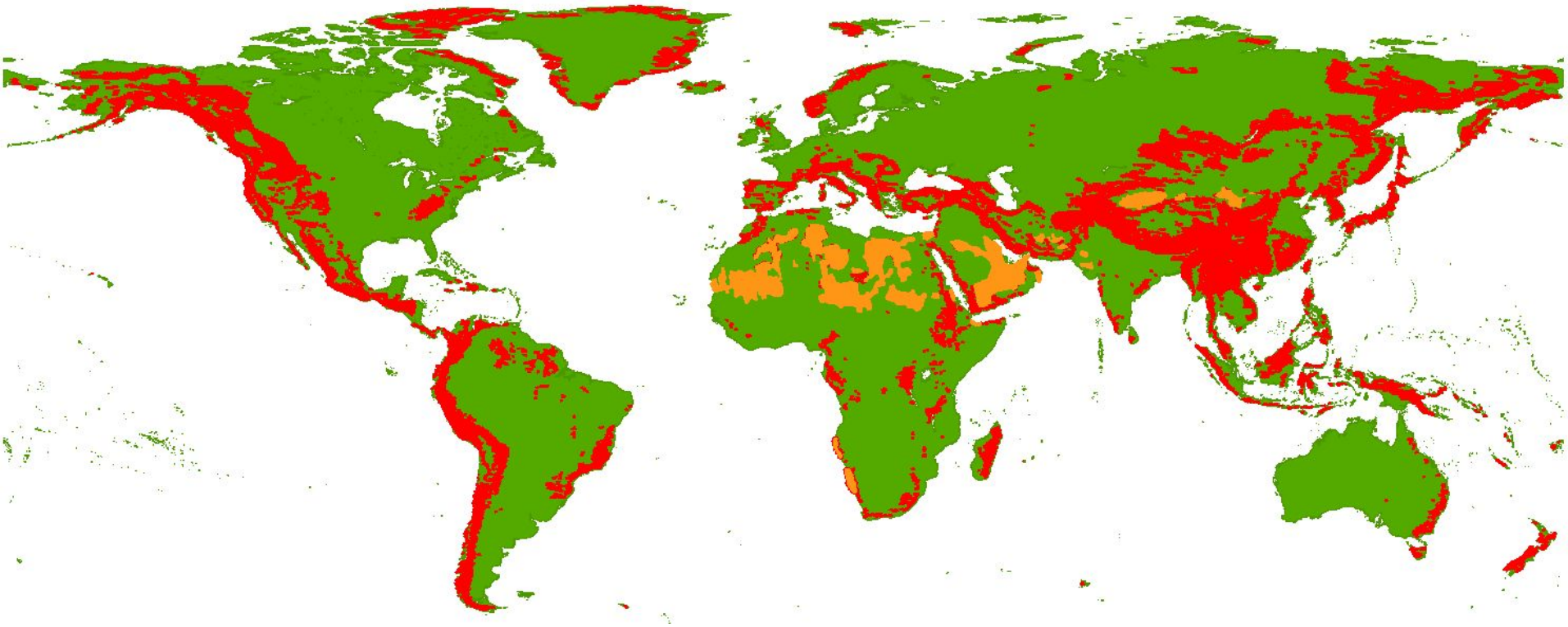
Re-Acquisition of Deserts

- Sandy Deserts: low backscatter => low coherence => high relative height error
 - Smaller incidence angles: $15^\circ - 28^\circ$ (nominal $28^\circ - 48^\circ$)
- Rocky deserts present difficult topography
 - acquisition with different viewing geometry as for mountainous regions





Coverage of 3rd & 4th Acquisition



- Shadow and Layover
- Desert





Conclusion

- DEM performance statistics
 - Global relative height error: < 2 m for > 90% of all scenes
 - First DEM tile analysis ($1^\circ \times 1^\circ$): Relative height error fulfills requirement for > 90% of all pixels
- Status of acquisition plan in the 3rd year
 - Antarctica: Leftlooking & flat incidence angles
 - Difficult terrain: Shadow/Layover reduced by ascending + descending acquisitions
 - Deserts: Better performance with steeper incidence angles
- TanDEM-X System is very flexible and performs remarkably well