Glaciers_cci

Second CMUG integration meeting

Frank Paul and the Glaciers_cci consortium

Sciene challenges: other CCIs

- only one product (a global glacier map) that comes:
- in a completely different format (vector outlines)
- with a different standard (GLIMS vs. netCDF)
- for a different user community (slr modellers)
- using different sensors (TM, RA-2, SRTM, Palsar)
- together with a global collaboration of partners
- … and needed to be ready by Jan 2012

Glaciers_cci challenges: Products

- **What are the products that Glaciers_cci will create?**
- Glacier area (a global map of the area covered by glaciers)
- Elevation Changes from DEM differencing (EC-DEM)
- Elevation Changes from repeat altimetry (EC-ALT)
- Velocity fields from repeat optical & microwave data

- **What is the purpose of these products?**
- Improvement of knowing water resources and slr contribution
- Assessment of climate change impacts on a global scale
- Modelling future glacier development under climate change

Glaciers_cci challenges: Products

- **How do the products created by Glaciers_cci differ?**
- **input data sets: Satellites (optical and microwave), Altimeters (LIDAR and RADAR), DEMs (quality, resolution, coverage)**
- **data processing: fully to semi-automatic to manual digitzing**
- **algorithms: very simple (band ratio) to rather complex**
- **spatio-temporal coverage: from local to global, from 1 month repeat to 40 years merged product**
- **user communities: outlines, elevation change, velocity**

- **Response: we have the respective experts in the team / CRG**

Product specific challenges I

- **Area**
  - selection of appropriate scenes for glacier mapping from a huge archive
  - global coordination of who is doing what in which region
  - manual corrections required for each outline (debris, shadow, snow)
  - DEM errors propagate into orthorectfication (outlines do not fit to DEM)
- **EC-DEM**
  - co-registration, differences in spatial resolution, sensor artefacts/data voids
  - considerable variation in import function from various softwares complicates generation of a standard tool (pixel corner vs. pixel centre definition)
  - data accuracy dependent upon the input data (i.e. radar, lidar, photogrammetry), characteristics of the terrain and glacier at the time of data acquisition
  - The larger the glacier changes and the longer time between DEM acquisitions, the more accurate/precise is the EC product

Product specific challenges II

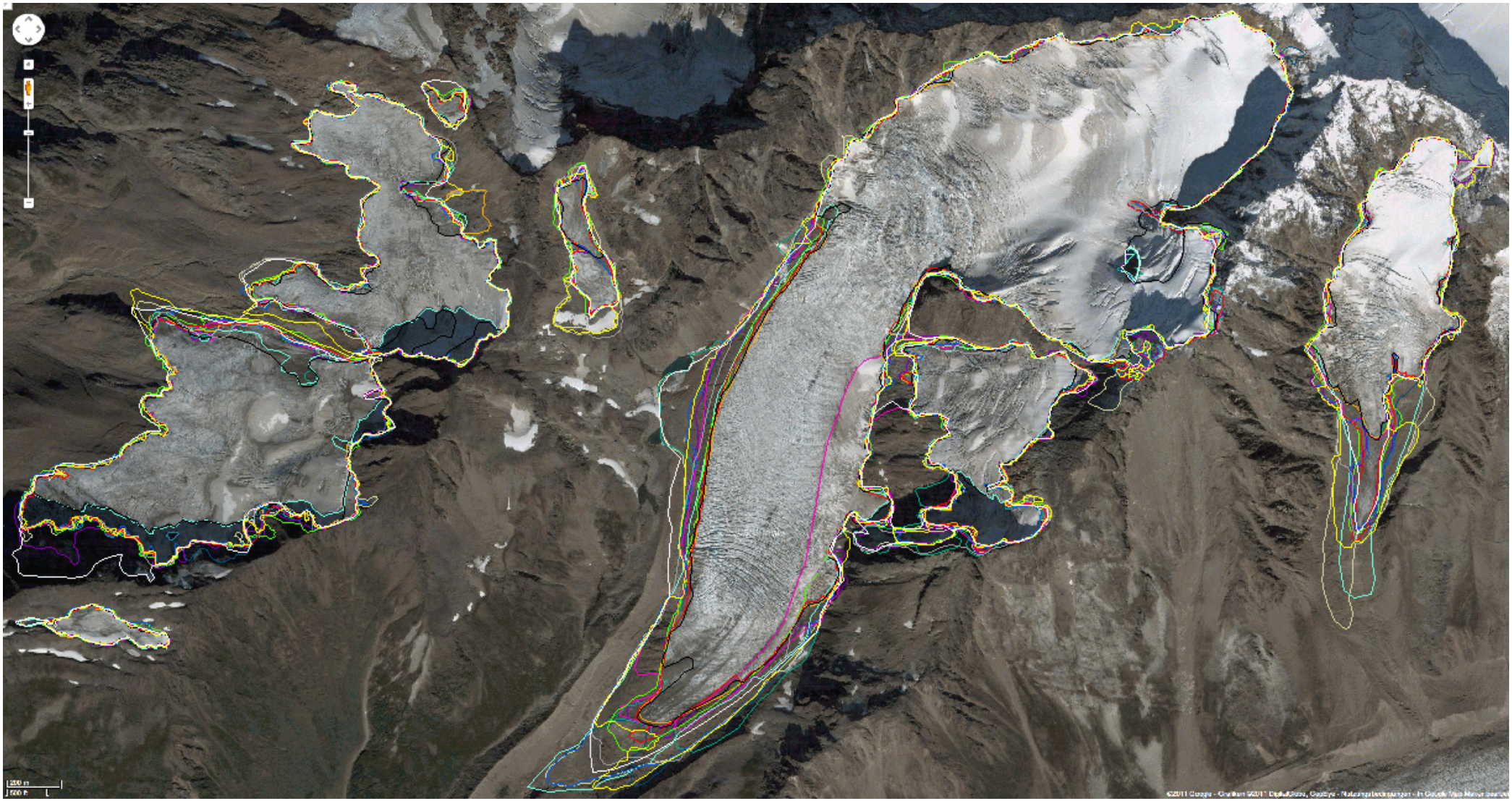
- **EC-ALT**

  - challenging targets for conventional altimetry
  - although spatial and temporal sampling sparse, greatly exceeds ground surveys
  - preparation for CryoSat-2 and Sentinel-3 datasets

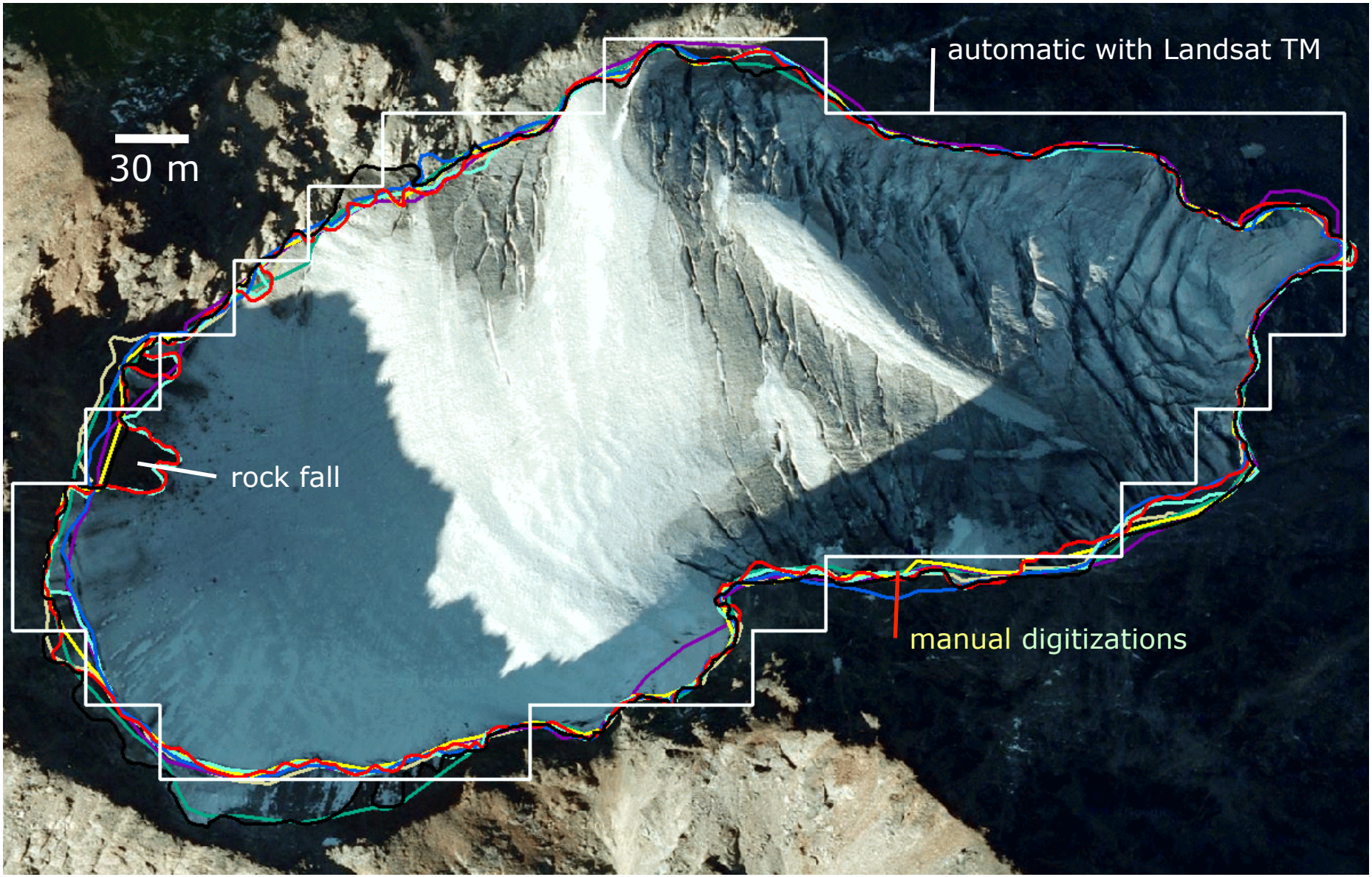
- **Velocity**

- selection and availability of appropriate scenes, ETM+ pan / ASTER, VHR SAR / HR SAR, snow free (optical) / wet-snow free (SAR)
- DEM errors influence processing (geocoding, InSAR)
- glacier size versus matching window size

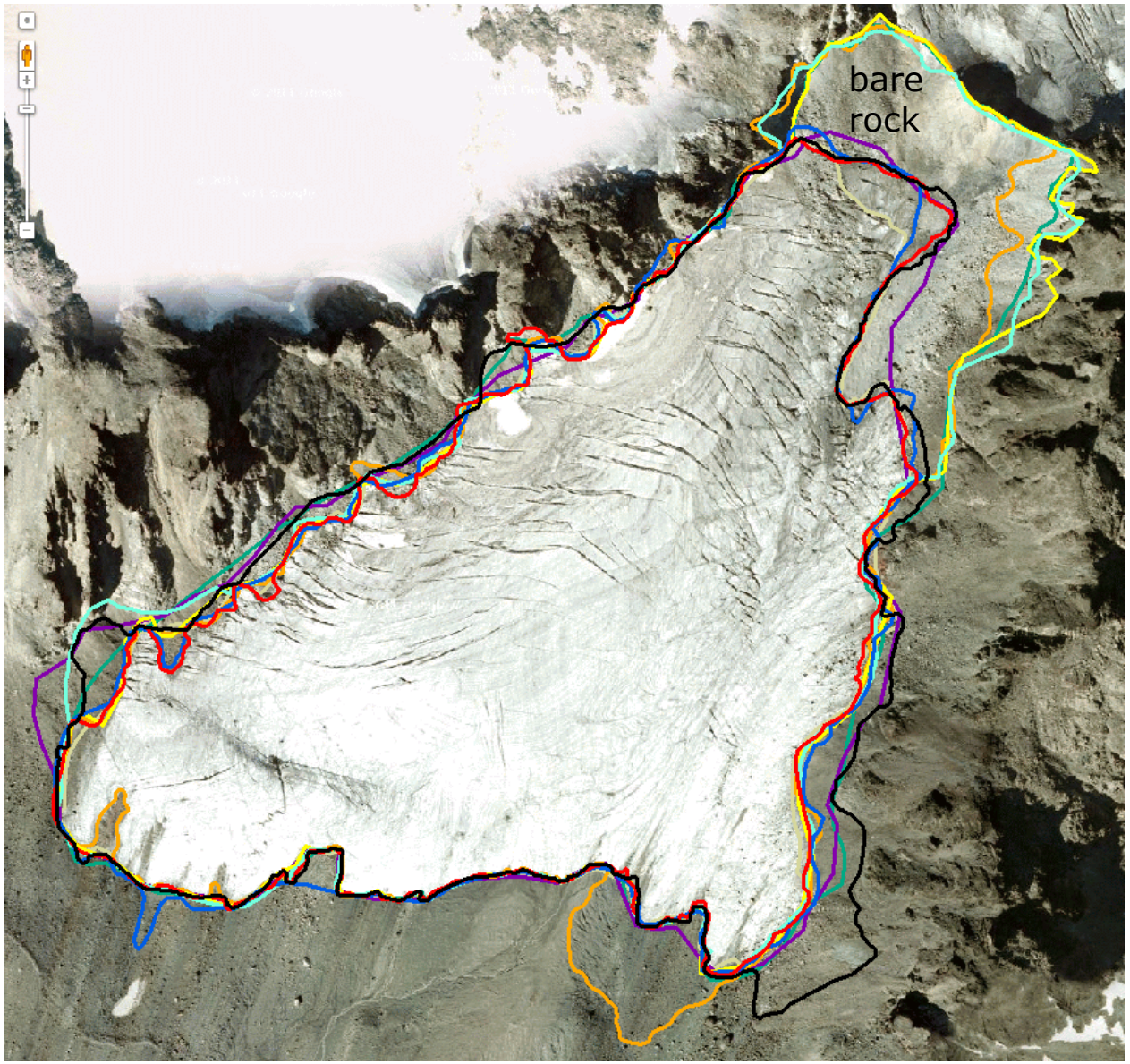
RR results area: Quickbird



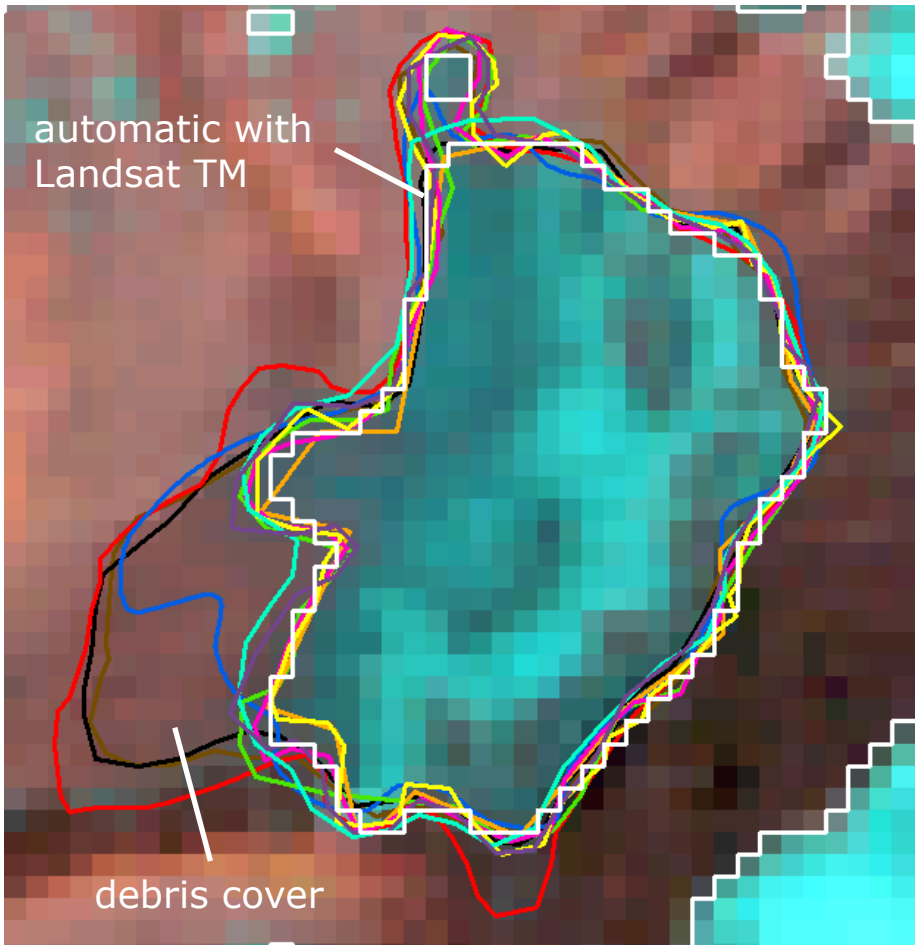
RR results area: Aerial without debris

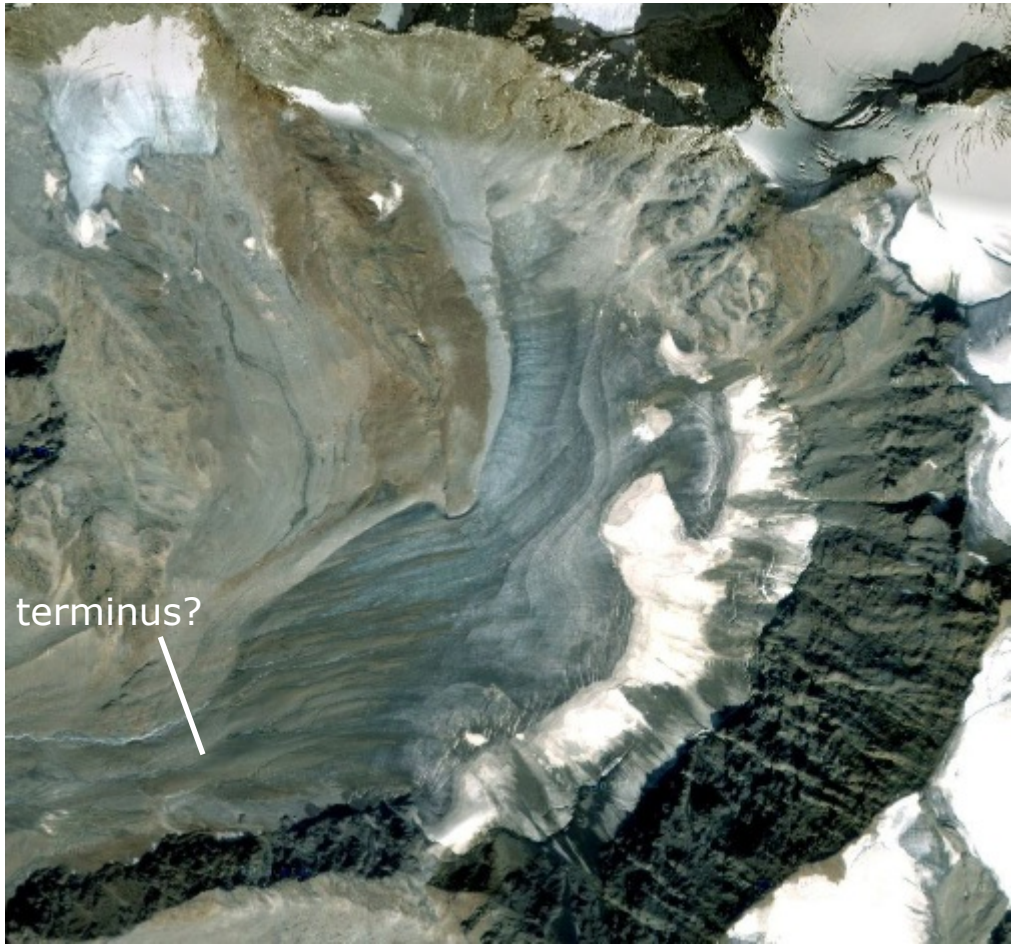


RR results area: Aerial with debris

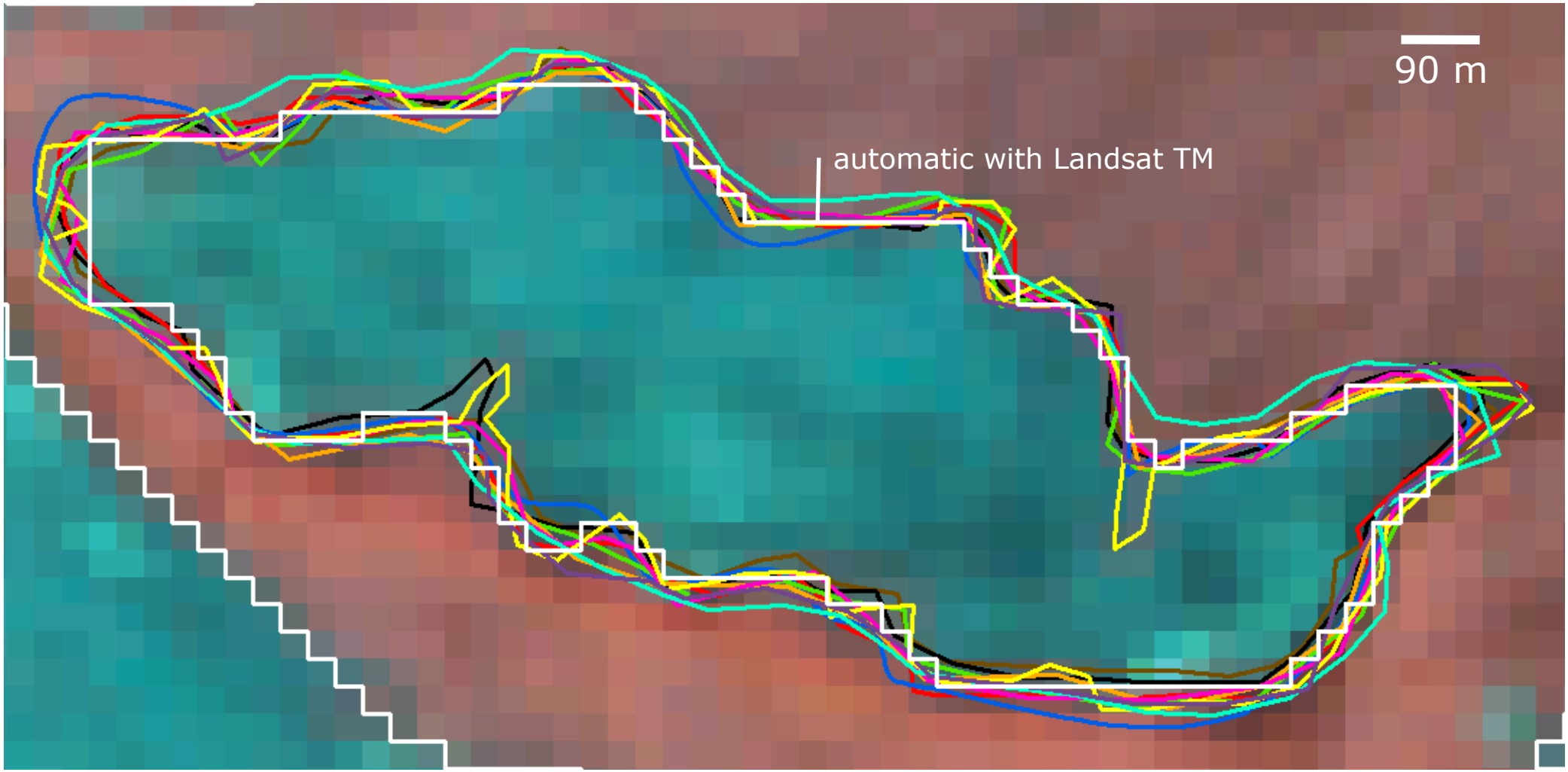


RR results area: Landsat with debris

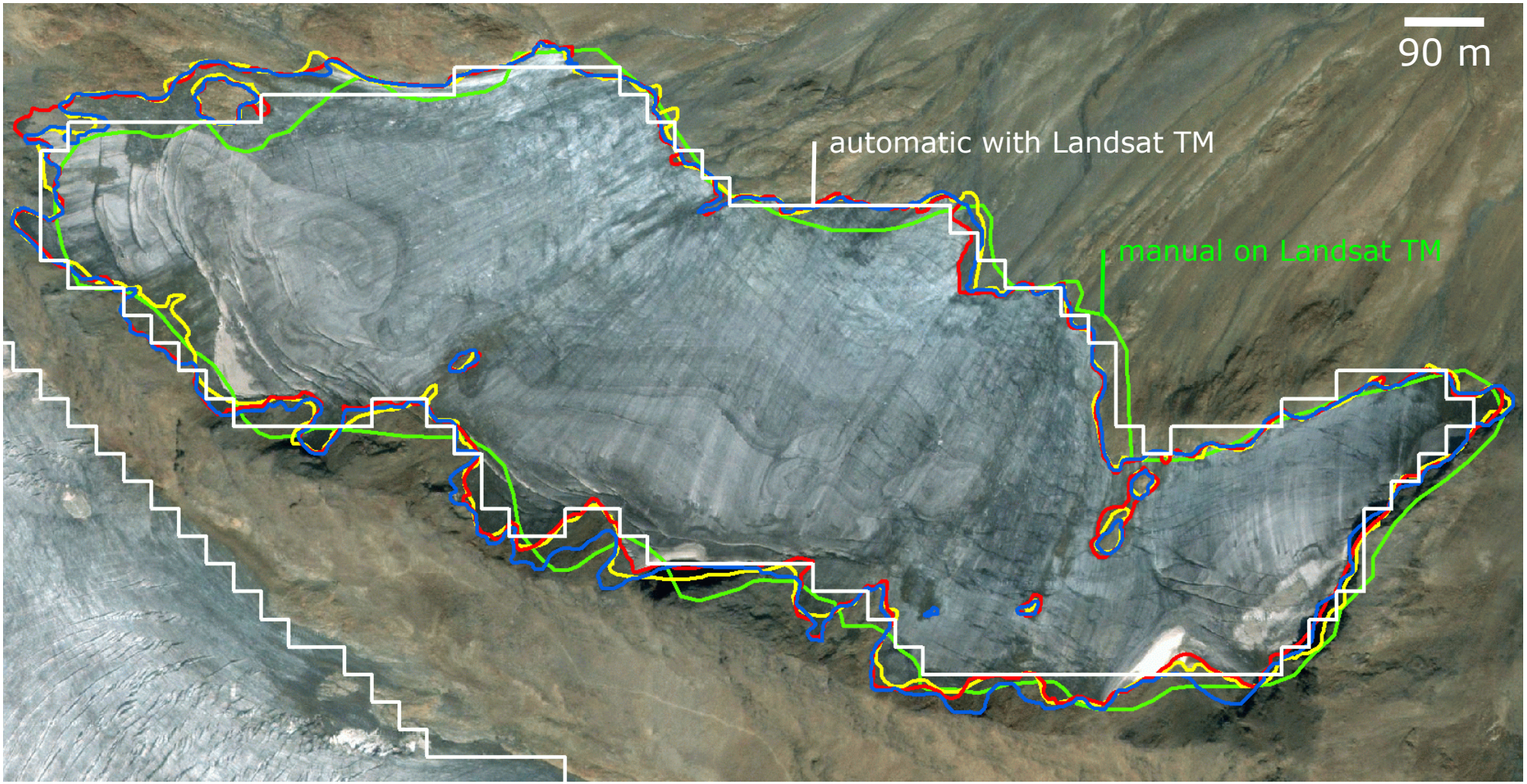




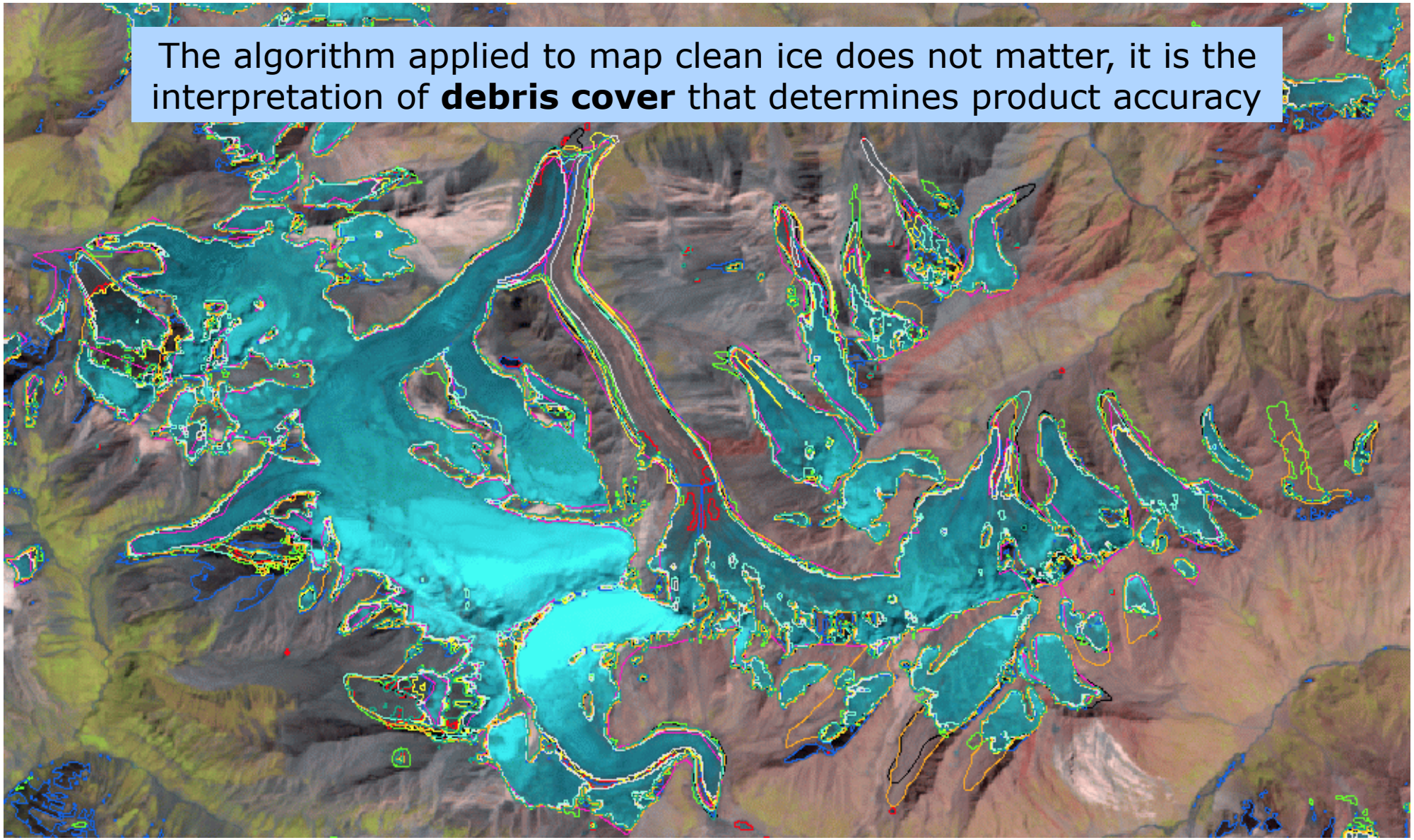
RR results area: Landsat debris free



RR results area: Ikonos (reference data)

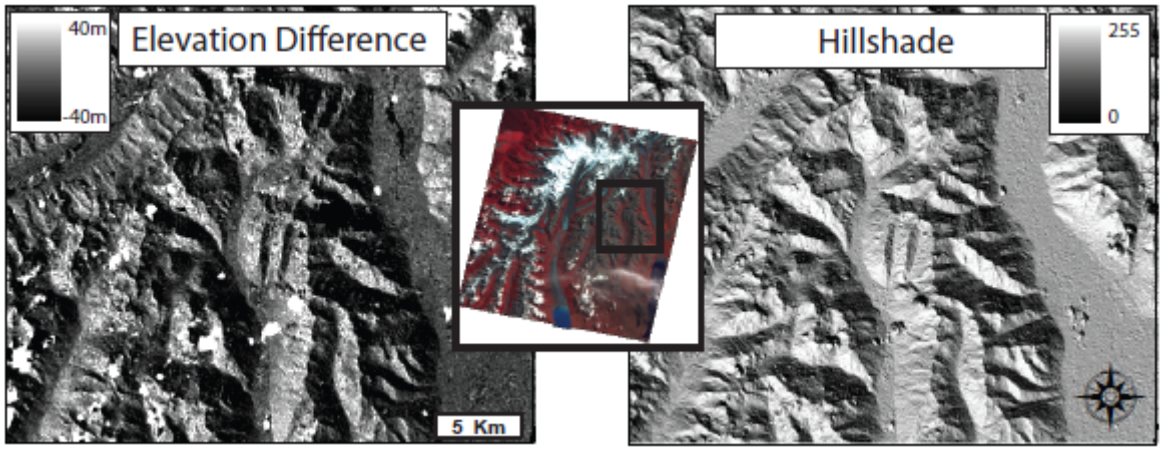


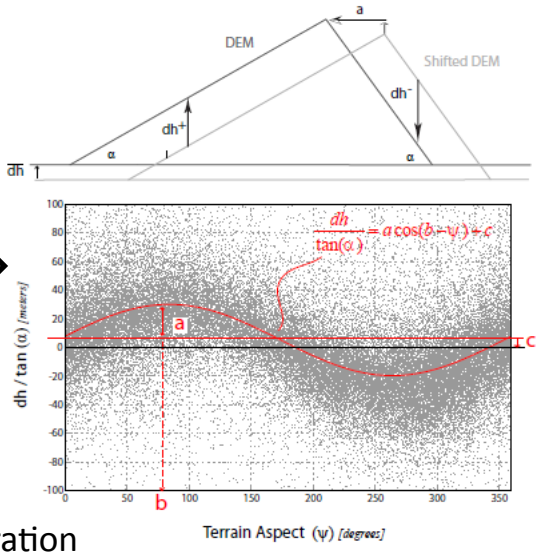
RR results area: Algorithms

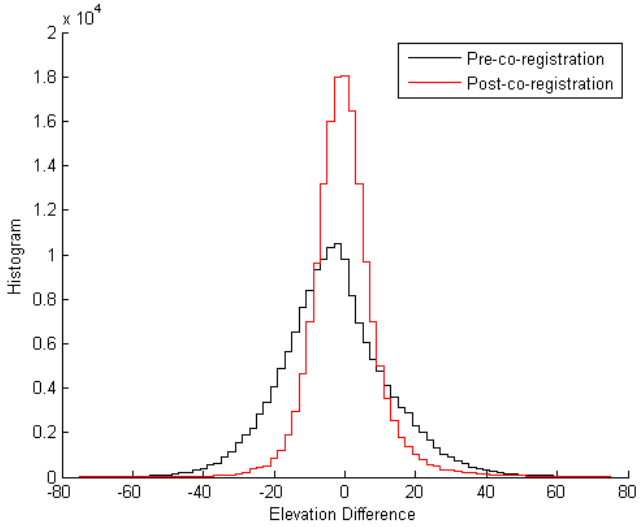


RR results: DEM co-registration

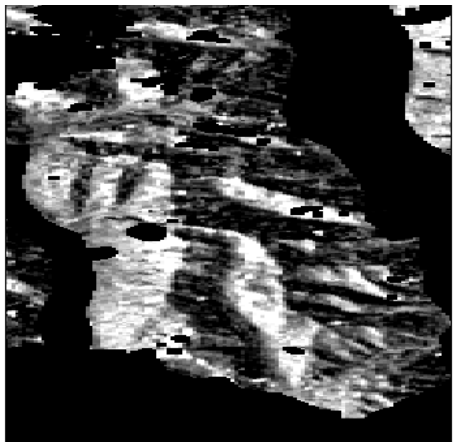
An essential *universal* pre-processing step to improve accuracy (removes bias) for elevation change products from 2 DEMs



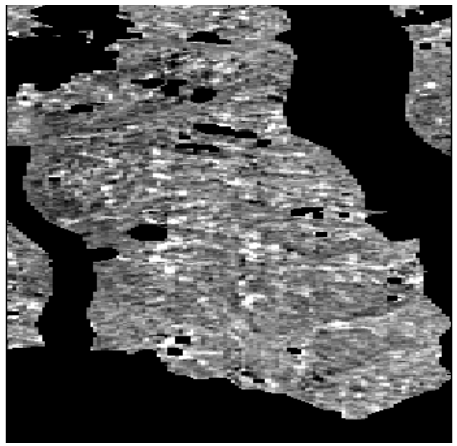




Pre-co-registration



Post-co-registration



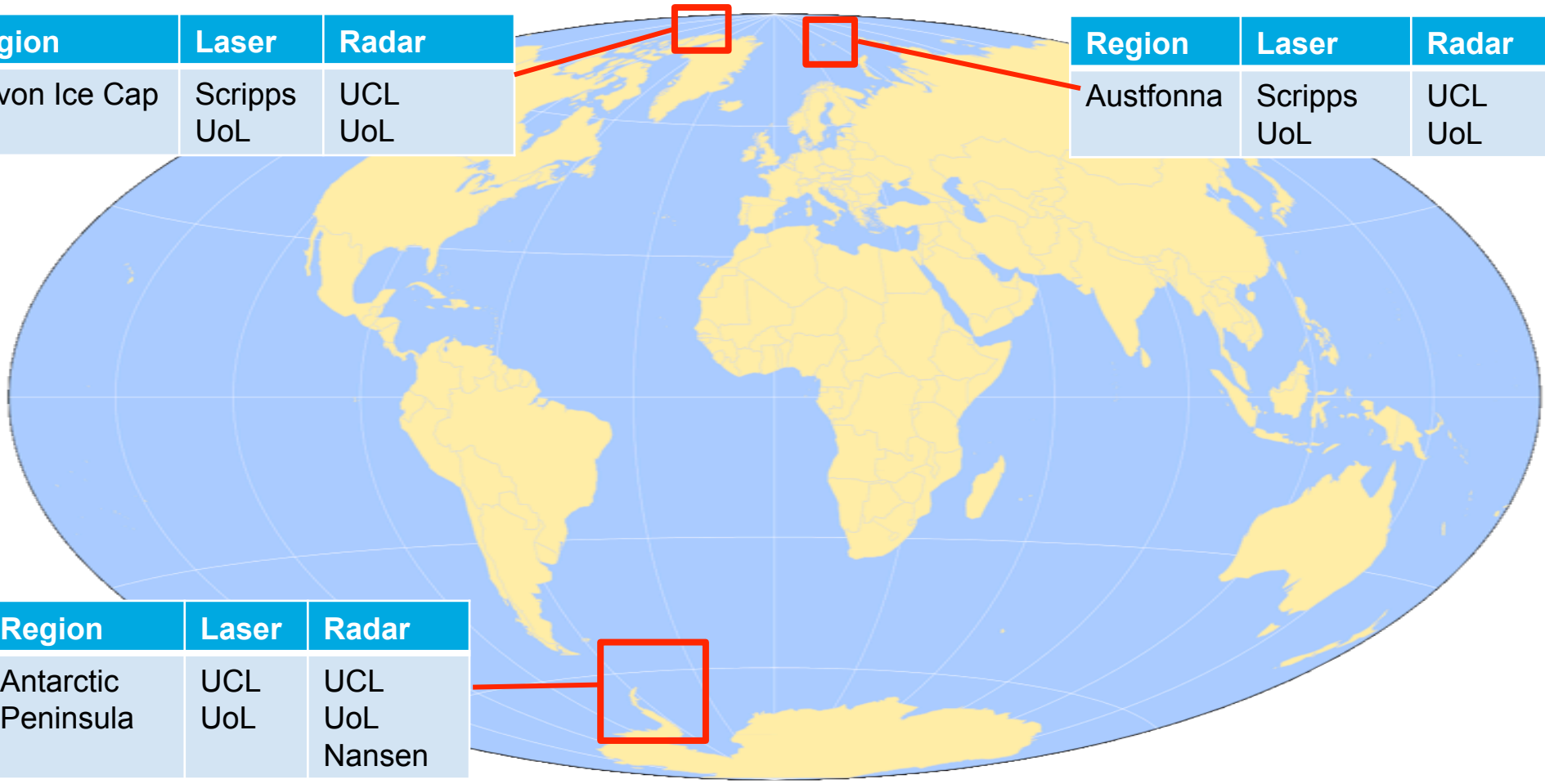
A simple, efficient, & analytical solution!

RR elevation change: Altimetry

Radar & laser, crossover & repeat track, altimetry algorithms tested at 3 sites

Region	Laser	Radar
Devon Ice Cap	Scripps UoL	UCL UoL

Region	Laser	Radar
Austfonna	Scripps UoL	UCL UoL

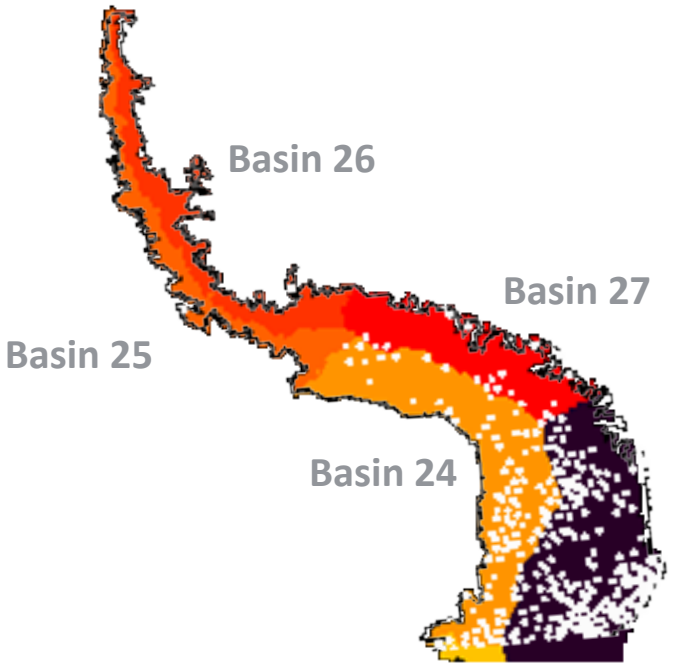


Region	Laser	Radar
Antarctic Peninsula	UCL UoL	UCL UoL Nansen

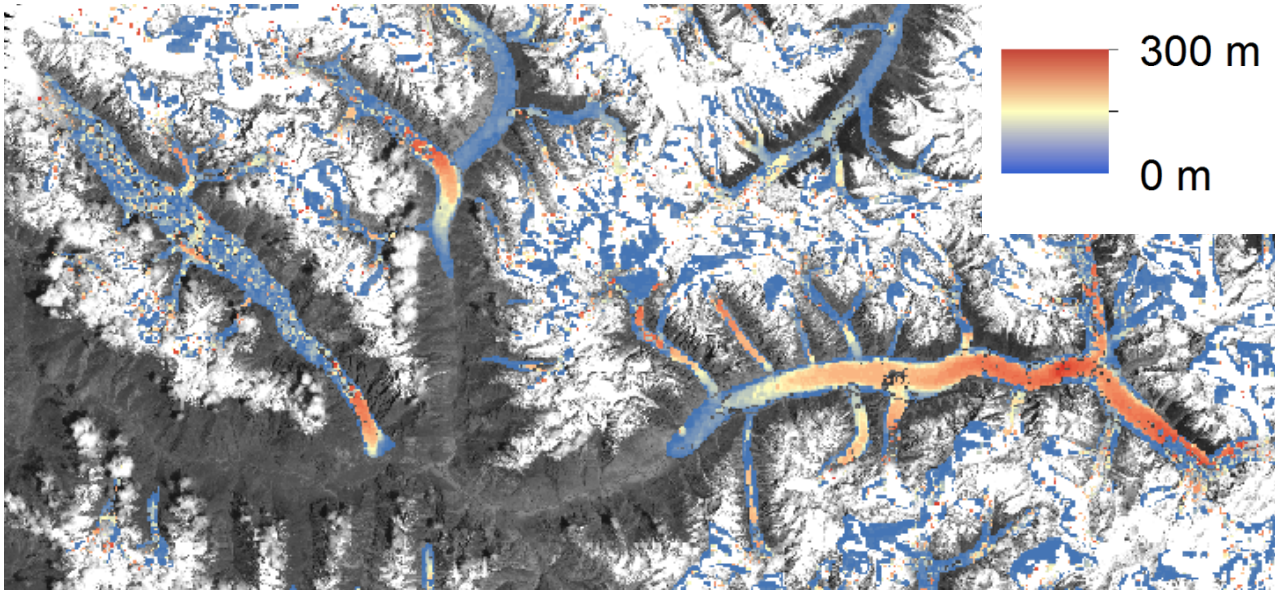
RR elevation change: Altimetry

Two radar altimeter re-tracking algorithms were tested at Antarctic Peninsula

Region	Elevation rate Method 1 (cm/yr)	Sampling (%)	Elevation rate Method 2 (cm/yr)	Sampling (%)
BASIN 24	0.3 ± 7.4	13.9	3.4 ± 6.7	9.8
BASIN 25	5.4 ± 5.4	0.3	-4.3 ± 10.6	0.3
BASIN 26	-15.2 ± 18.9	0.2	*no data*	No data
BASIN 27	7.4 ± 7.8	2.9	-0.3 ± 4.7	2.3

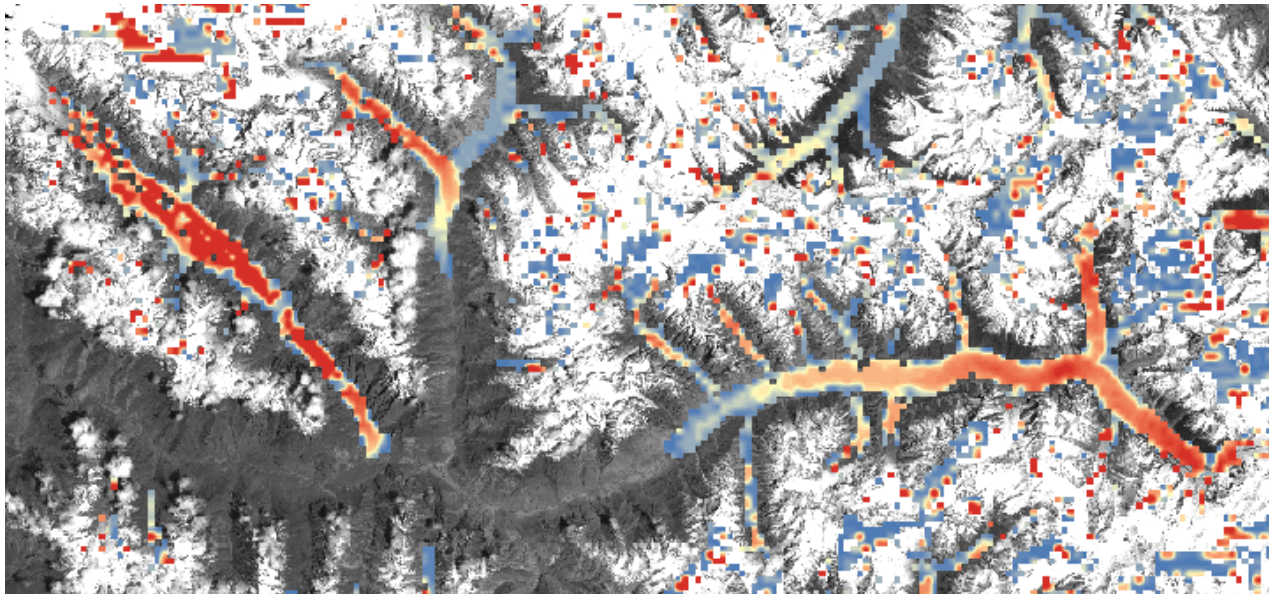


RR results velocity: Algorithms



Glacier speeds over Karakoram from matching of two repeat Landsat images

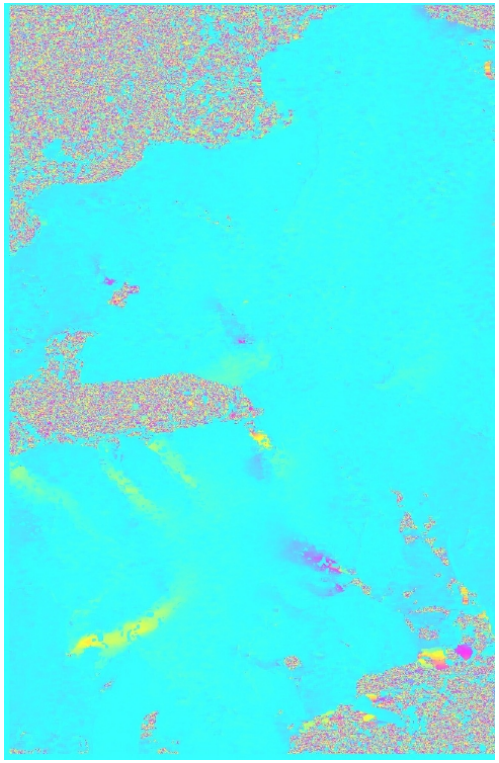
Algorithm 1:
Orientation correlation



Algorithm 2:
Normalized cross-correlation

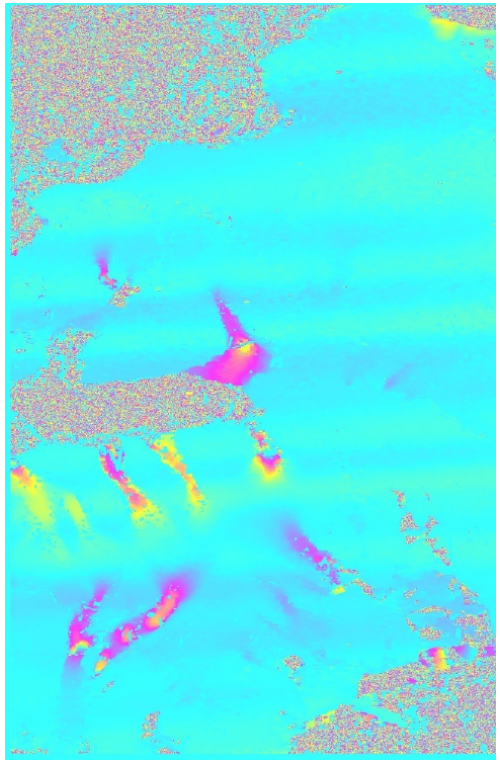
RR results velocity: Algorithms

Intensity-cross correlation slant-range



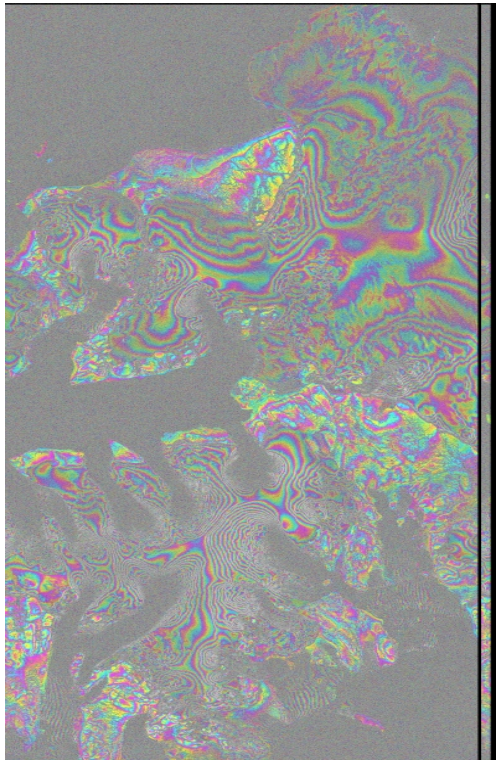
+/- 5 pixels

Intensity-cross correlation azimuth



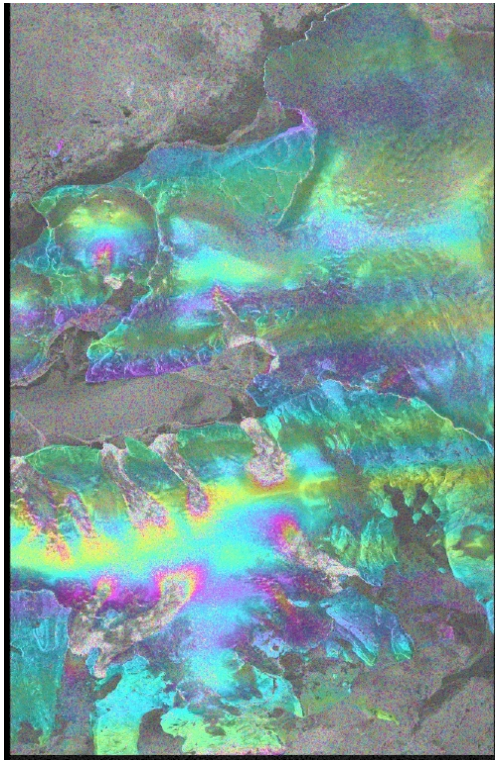
+/- 10 pixels

Interferometry slant-range



2π

Multiple aperture interferometry azimuth



2π

Succes stories

- key contribution to global glacier map for IPCC
- successful RR for area and the other products
- several papers about methods already published
- review paper in Science about Himalaya glaciers
- intense public outreach activities
- very supportive network of global collaboration
- ...

Anticipated outcomes of Glaciers_cci

- **A globally complete glacier inventory (level 2)**
- **A most important contribution to IPCC AR5**
- **An end-to-end processing system for EC-ALT & VEL**
- **A set of tools for glacier area and EC-DEM**
- **illustrated mapping guidelines for the community**
- **several more (joint) papers ...**

Questions?