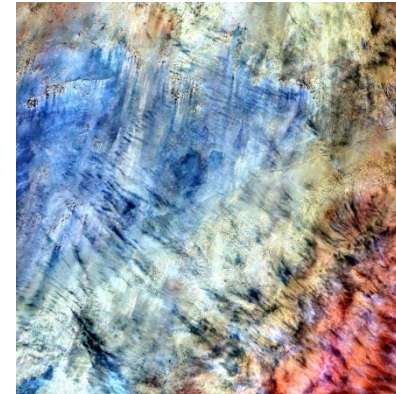
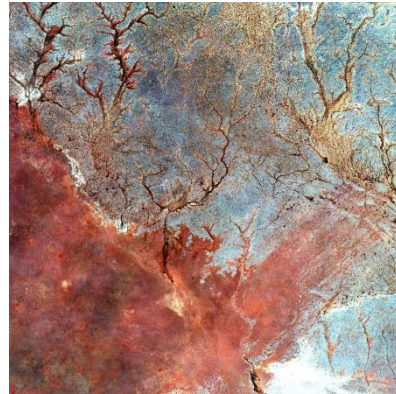


# CORA – CORRECTION OF THE ATMOSPHERE



**Grit Kirches**, Martin Boettcher, Gunnar Brandt, Carsten Brockmann,

Olaf Danne, Tonio Fincke, Jan Wevers & Kerstin Stelzer

Brockmann Consult GmbH



# PRE-PROCESSING CHAIN

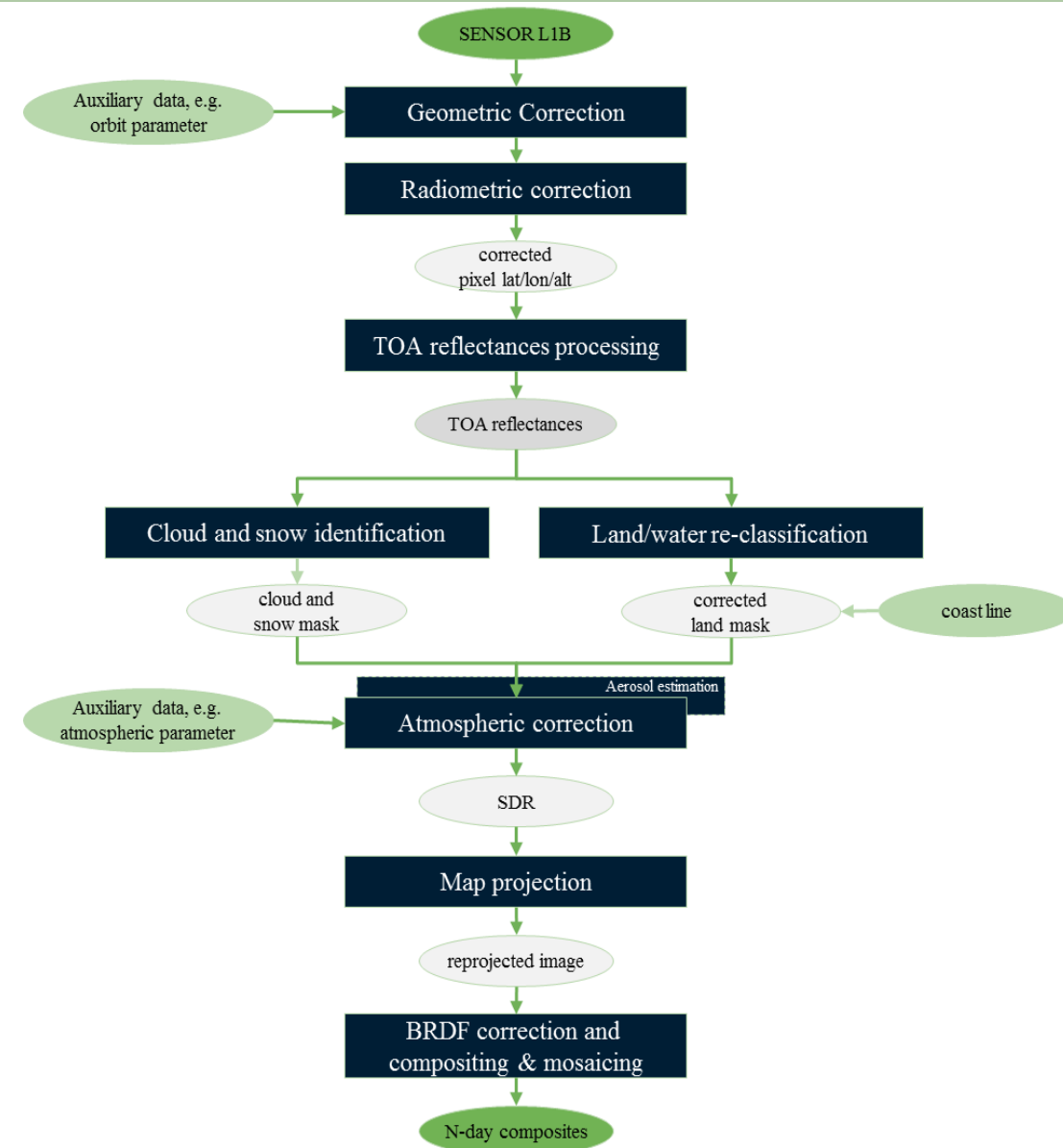


- Starting from Sensor L1b data (medium resolution) or L1c Sentinel 2 – generating n-day composites of surface reflectance
- System correction:
  - Instrument radiometric corrections
  - Inter-sensor geometric compatibility
  - Inter-sensor radiometric calibration
- Pixel Identification
  - Efficient cloud screening, cloud shadow & reliable land, water and snow discrimination
- Atmospheric Correction
  - Atmospheric conditions
  - Auxiliary data
  - Surface reflectance retrieval
- Uncertainties
- Temporal aggregation and projection
  - BRDF effects
  - Temporal cloud screening

IdePix-Presentation  
Jan Wevers  
(Brockmann Consult GmbH/Germany)



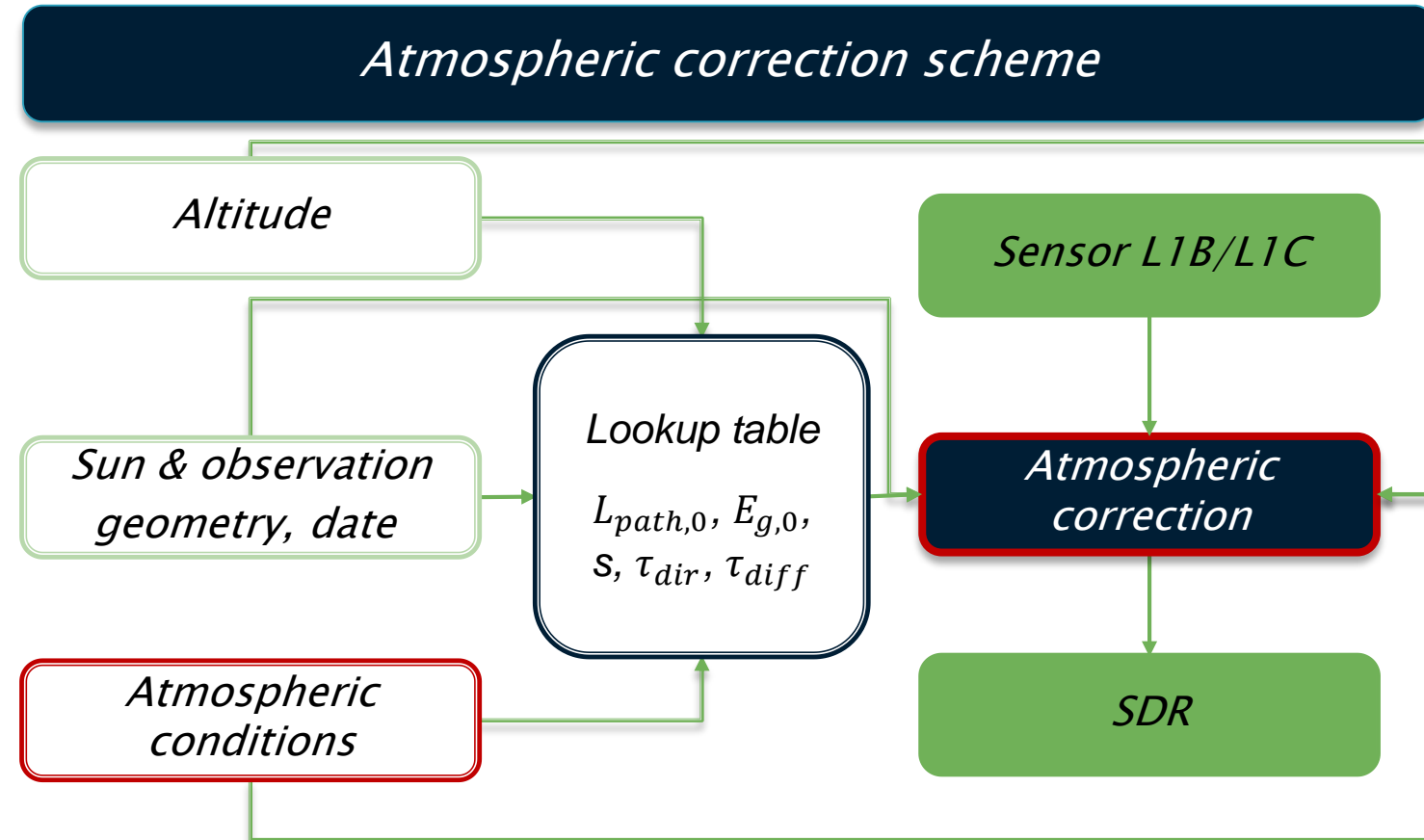
<http://2016africalandcover20m.esrin.esa.int/viewer.php>



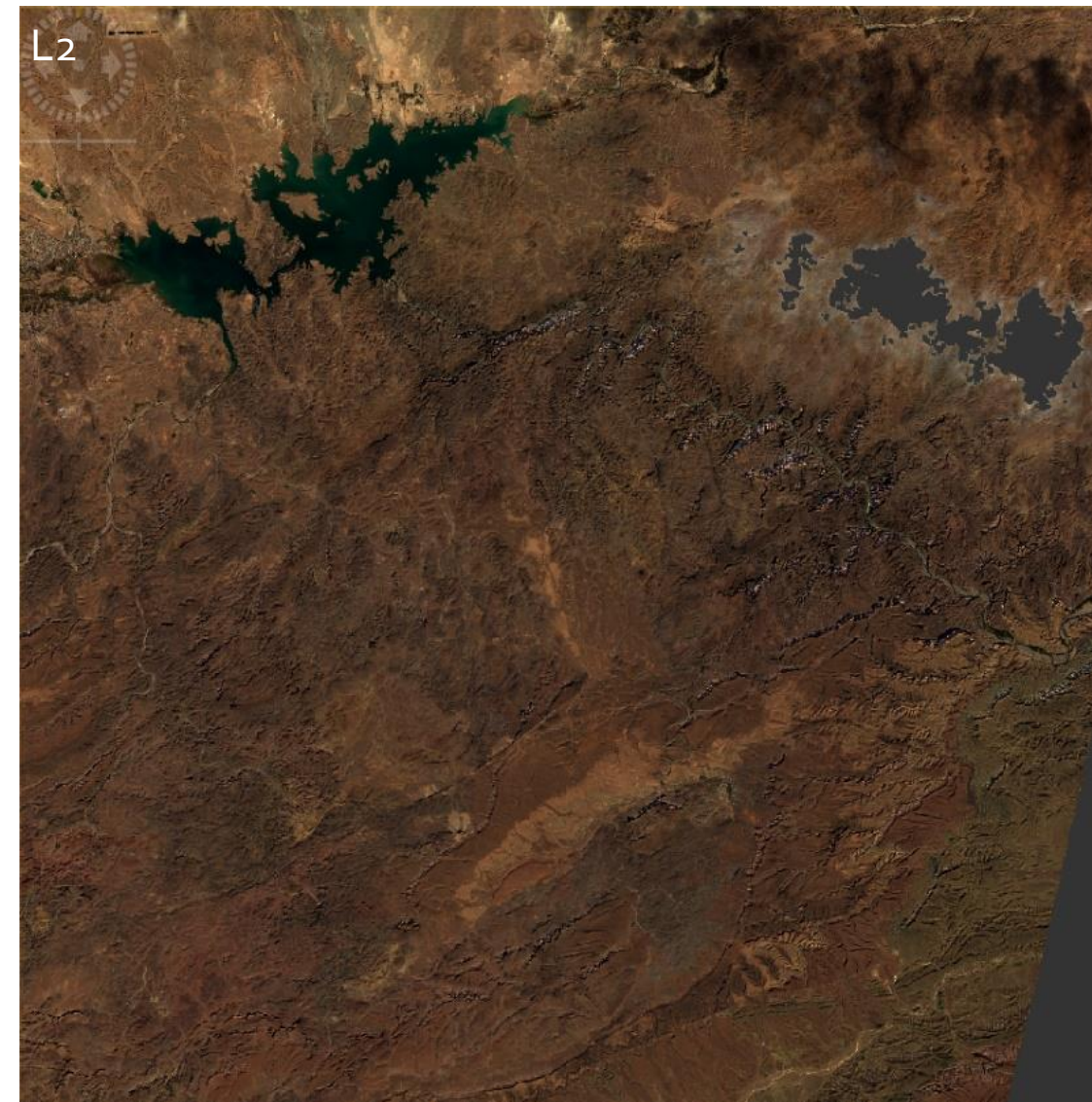
# ATMOSPHERIC CORRECTION OVER LAND

Atmospheric state characterisation & explicit solution of the RT equation

- Medium resolution baseline:
  - Radiative transfer for Lambertian flat homogeneous surface
- High Resolution baseline:
  - Heterogeneous surface, rugged terrain, Lambertian
- Atmospheric conditions
  - Retrieved from sensor observation
  - Auxiliary data set, ERA5, CAMS
  - Aerosol and water vapour retrieval module
- Uncertainty estimation



# SENTINEL 2 – SURFACE REFLECTANCE – T29RQQ – QUARZATE LAKE CITY



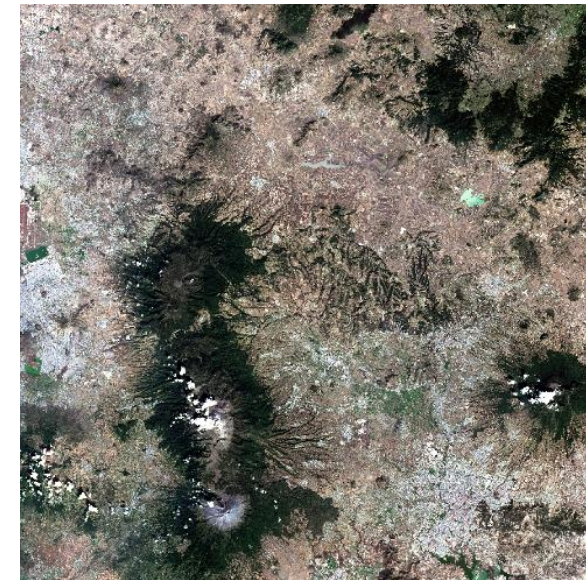
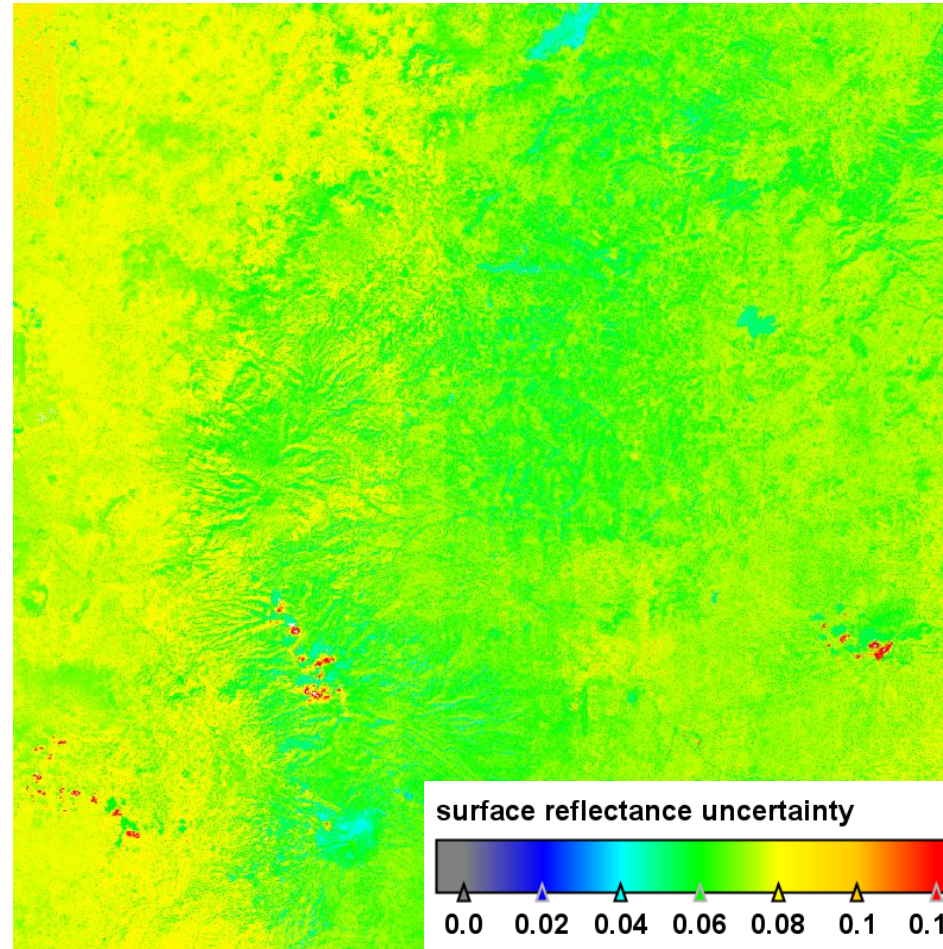
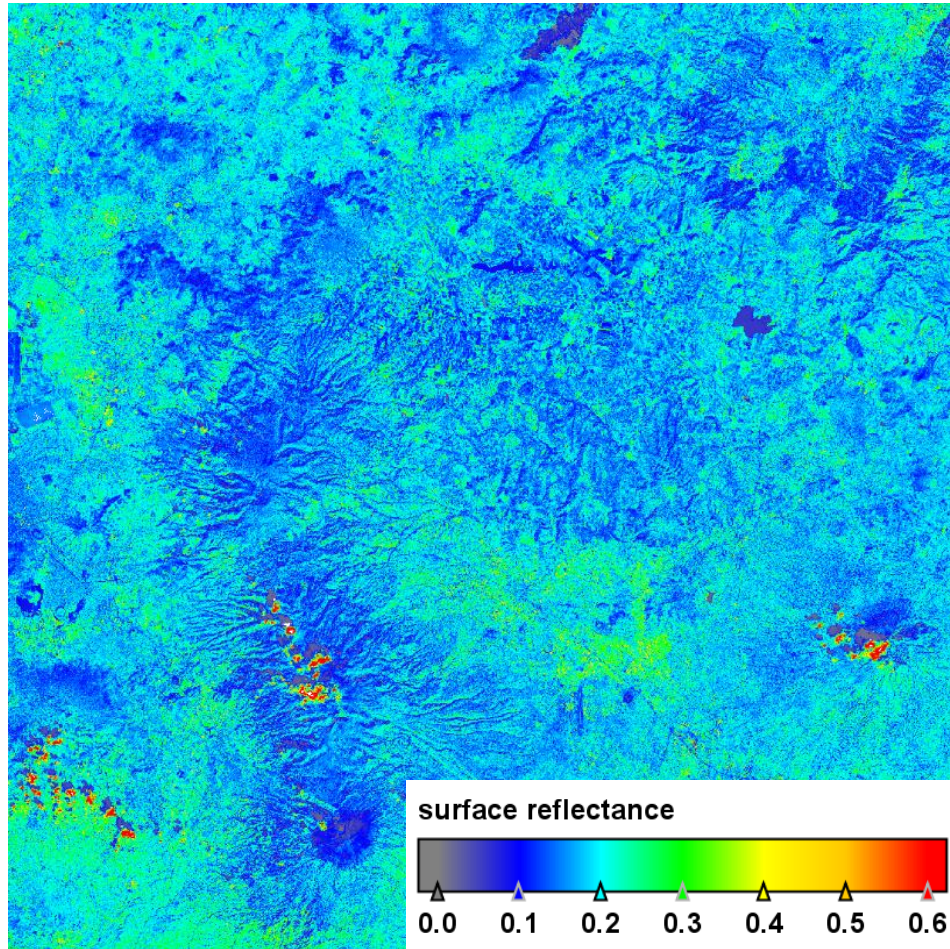
S2A\_OPER\_PRD\_MSIL1C\_PDMC\_20160204T165714\_R094\_V20160204T111022\_20160204T111022\_T29RQQ

# SENTINEL 2 – SURFACE REFLECTANCE & UNCERTAINTY – T14QNG - POPOCATÉPETL

Band 8

surface reflectance

uncertainty



Input: S2A\_MSIL1C\_20161228T170712\_No204\_R069\_T14QNG\_20161228T171337.SAFE

# PRODUCT VALIDATION & INTER-COMPARISON

## ➤ Products accuracy assessment

- Temporal variance at the pixel level
- Local variance within a LC class and across LC classes
- Intra- and inter-annual reflectance dynamics
- Validation against in-situ data

RADCALNET

## ➤ Visual quality assessment

## ➤ Products inter-comparison

- Comparison with the Landsat 8 products
- Inter-comparison with other S2 products

CMIX & ACIX

[http://www.esa.int/var/esa/storage/images/esa\\_multi-media/images/2015/03/sentinel-2/15292661-1-eng-GB/Sentinel-2\\_node\\_full\\_image\\_2.jpg](http://www.esa.int/var/esa/storage/images/esa_multi-media/images/2015/03/sentinel-2/15292661-1-eng-GB/Sentinel-2_node_full_image_2.jpg)



<https://www.radcalnet.org/#!/>

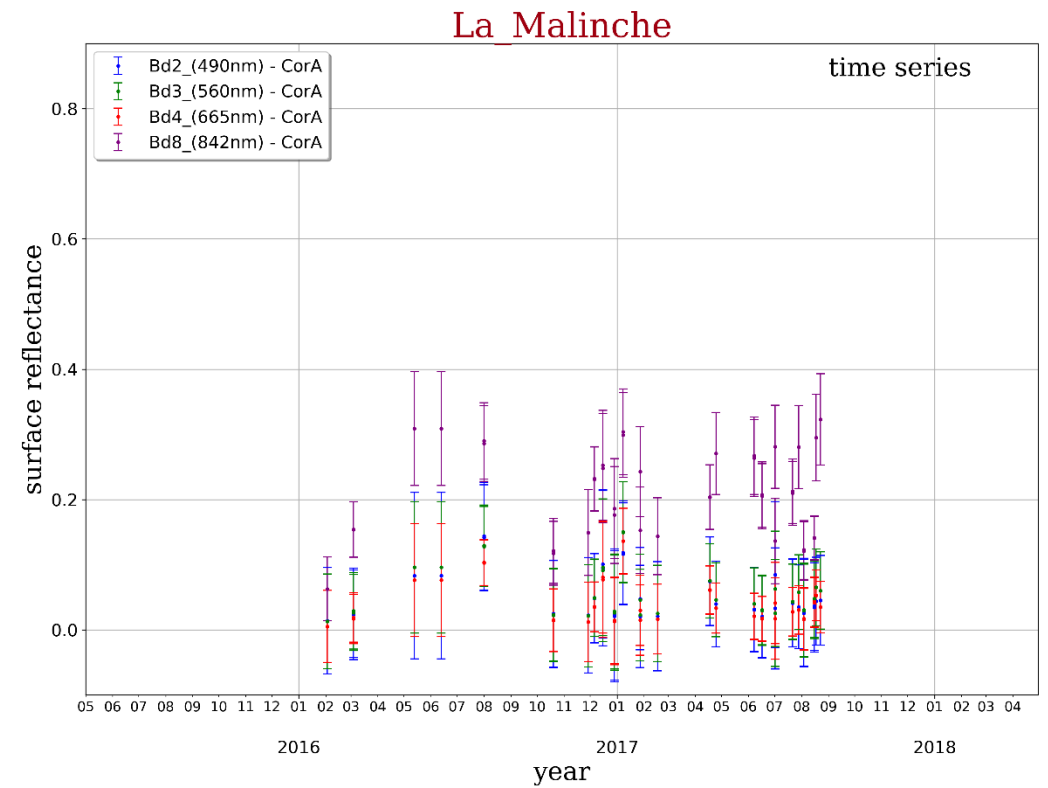
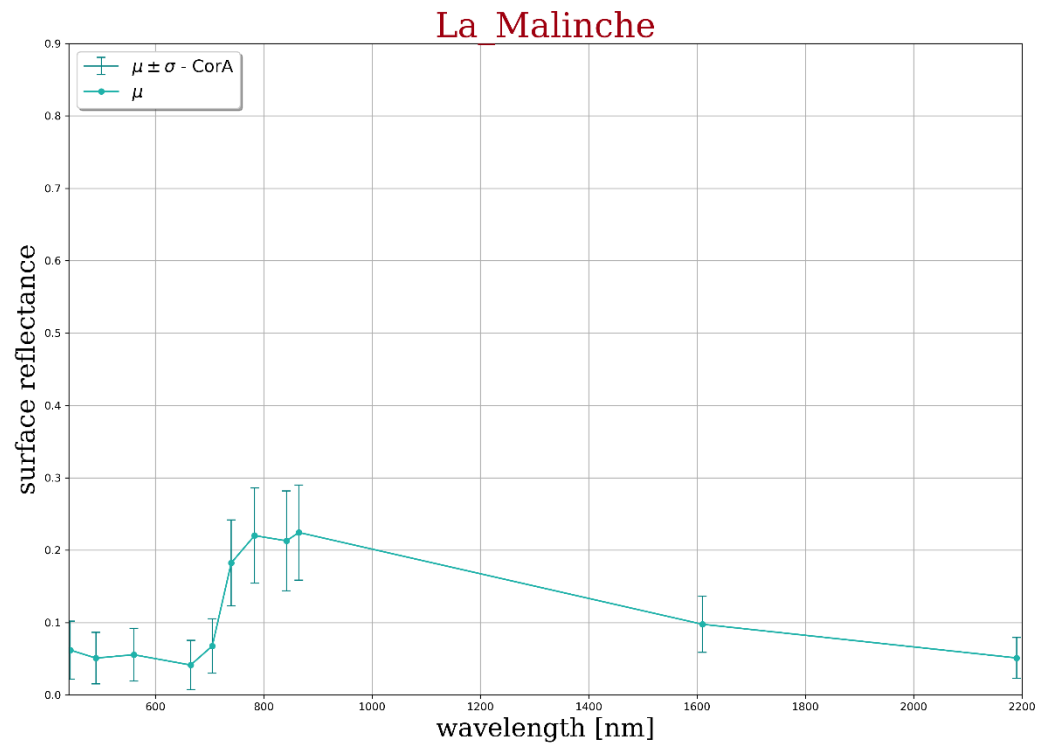
The screenshot shows the RadCalNet portal homepage. At the top, there is a navigation bar with the RadCalNet logo, the CEOS Committee on Earth Observation Satellites logo, and a 'Sign In' link. The main heading reads 'Welcome to the Radiometric Calibration Network portal'. Below this, a paragraph describes the network's mission: 'RadCalNet is an initiative of the Working Group on Calibration and Validation of the Committee on Earth Observation Satellites. The RadCalNet service provides satellite operators with SI-traceable Top-of-Atmosphere (TOA) spectrally-resolved reflectances to aid in the post-launch radiometric calibration and validation of optical imaging sensor data. The free and open access service provides a continuously updated archive of TOA reflectances derived over a network of sites, with associated uncertainties, at a 10 nm spectral sampling interval, in the spectral range from 380 nm to 2500 nm and at 30 minute intervals. Each individual site is equipped with automated ground instrumentation in order to provide continuous measurements of both surface reflectance and local environmental/atmospheric conditions needed for the derivation of TOA reflectance values. TOA reflectances provided on this portal are derived from the individual sites surface and atmosphere measurements using a common method through a central processing system. Each member site takes responsibility for the quality assurance of the surface/atmosphere measurements provided and is subject to peer review and rigorous comparison to ensure site-to-site consistency and SI traceability.'

Below the text are four site cards, each with a satellite image and text:

- Baotou**: AoE's site at Baotou, China
- Gobabeb**: The ESA/CNES site is based near the Gobabeb Research and Training Centre, in the Namib Desert, Namibia.
- La Crau**: The CNES site at La Crau, France
- Railroad Valley Playa**: University of Arizona site at Railroad Playa, Nevada, USA

At the bottom of the page, there is a 'Sign In' button and a row of logos for partner organizations: A, CNES, CESA, Magellum, NASA, NPL, and The University of Arizona. A 'Contact Admin' link is also present in the bottom right corner.

# VALIDATION OF THE SURFACE REFLECTANCE



Forest - La\_Malinche: -98.015,19.254

# VALIDATION OF THE UNCERTAINTIES

Approach:

$$\frac{x_{\text{retrieval}} - x_{\text{reference}}}{\sqrt{\sigma_{\text{retrieval}}^2 + \sigma_{\text{reference}}^2 + \sigma_{\text{method}}^2}} \approx N(0, 1)$$

$$N(0, 1) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2} \quad \text{standard normal distribution}$$

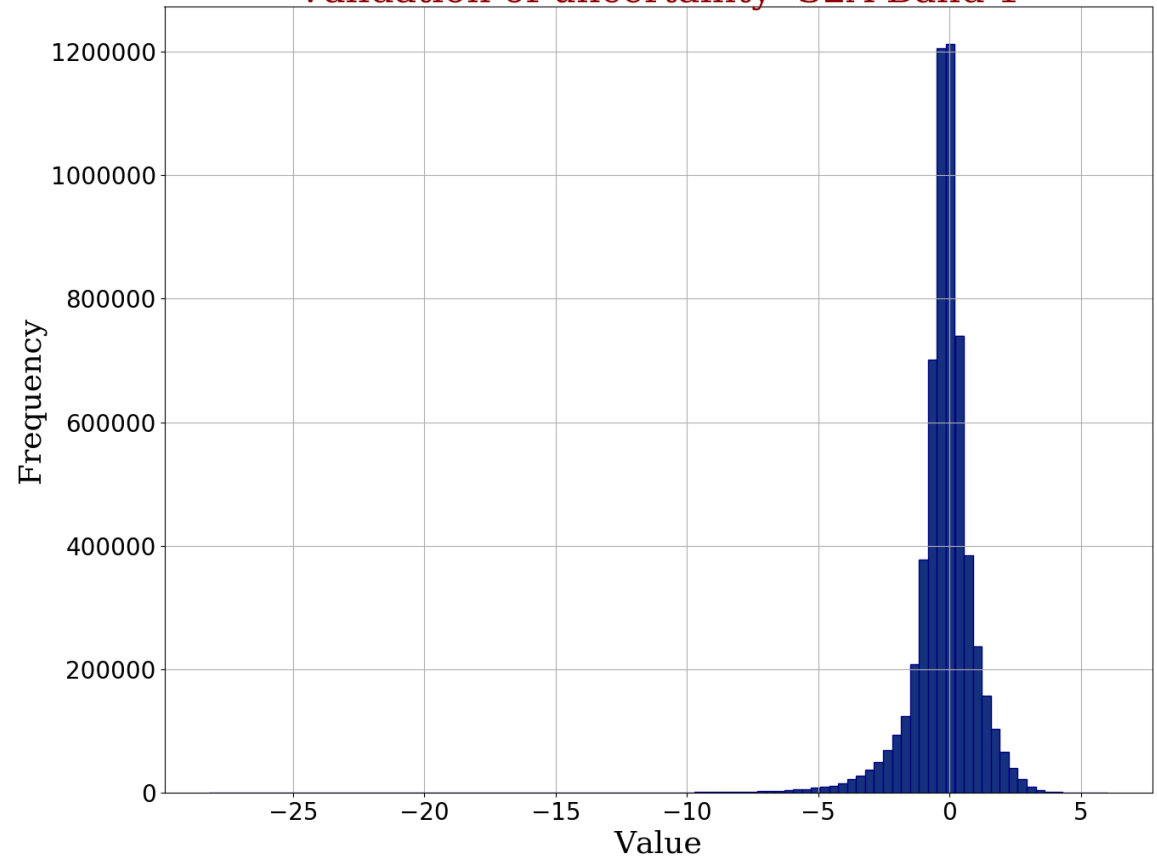
Realisation:

based on simulations, for n cases:

1. SR systematically varied
2. Ensemble of m TOA simulations (MODTRAN) with random variations of atmospheric conditions, geometry, elevation
3. AC

→ n · m couples of true SR and retrieved SR (n · m = ~ 5 970 000)

Validation of uncertainty S2A Band 1



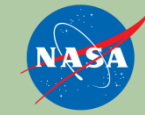


# SUMMARY & CONCLUSION

- **Source data – S2-L1C**
  - Sentinel-2A data quality followed closely
    - ESA Web reports
    - Own QA necessary
- **Careful Pixel Classification - IdePix**
- **AC including aerosol retrieval, terrain and neighbourhood correction**
  - RT Modelling approach using LUTs
  - MODTRAN RT simulations
  - Aerosol & water vapour retrieval from S2 bands and ERA5 & CAMS
- **Uncertainty**
  - Monte-Carlo-Approach
- **Auxiliary data: DEM & Land/water mask**
  - Terrain slope & L/W mask required at 5m spatial resolution
  - no DEM or L/W available to us; fall-back use coarser resolution data
- **Landsat 8**
  - Pre-processing chain is identified as applicable to Landsat 8 with some adaptations



[http://www.esa.int/var/esa/storage/images/esa\\_multimedia/images/2015/03/sentinel-2/15292661-1-eng-GB/Sentinel-2\\_node\\_full\\_image\\_2.jpg](http://www.esa.int/var/esa/storage/images/esa_multimedia/images/2015/03/sentinel-2/15292661-1-eng-GB/Sentinel-2_node_full_image_2.jpg)



# THANK YOU FOR YOUR ATTENTION!

