ESA sponsorship awarding with Request ID 2b0441, Service Sentinel Hub VAS - EDC

Cloud Mask Intercomparison eXercise II

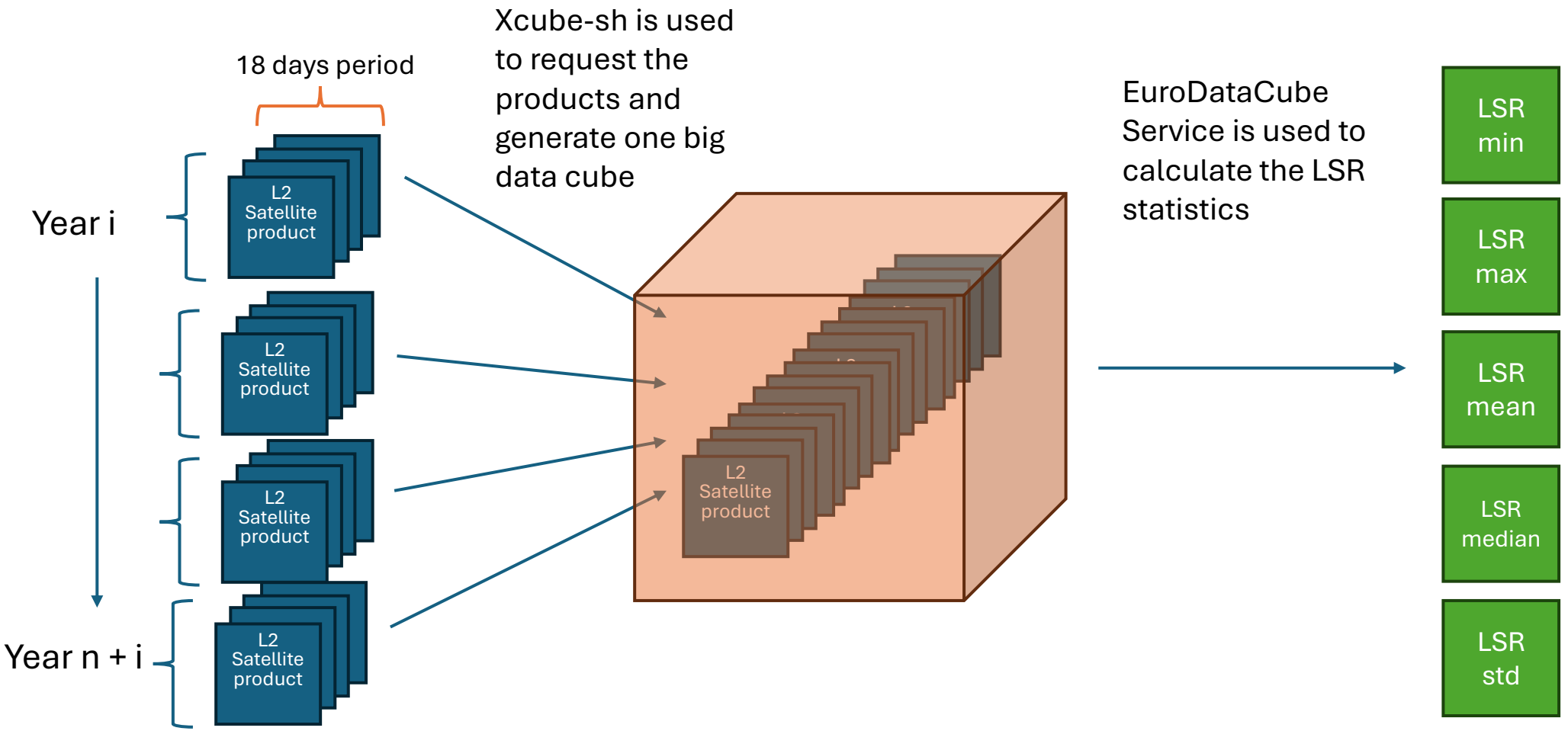
Project objective

- CMIX II is the second edition of the joined ESA and NASA Cloud Mask Intercomparison eXercise activity in the frame of CEOS WGCV. It is an international collaborative effort aimed at intercomparing cloud detection algorithms for moderate-spatial resolution (10-30 m) spaceborne optical sensors. The focus of CMIX is on open and free imagery acquired by the Landsat 8 (NASA/USGS) and Sentinel-2 (ESA) missions.
- Within the second addition of CMIX, dedicated reference datasets will be created to validate the participating cloud masking algorithms. One of these datasets is an expert pixel collection conducted on Sentinel-2 L1C and Landsat 8 /9 Level1 data. Together with the participants, it was decided to provide information on cloud optical depth (COD) in addition to the expert classification, to have a numerical reference on different cloud transparency classes. To derive COD for any Sentinel-2 L1C or Landsat 8/9 L1 product, a surface reference is required. This reference can be a surface albedo or anything comparable.
- In context of CMIX II an approach was developed using all S2 L2A data within an 18 day window of all years since the S2 launch, do derive a long-term average. The same is done for L8 L2 data. For this approach only the read and NIR band of the two sensors is needed, as well as cloud masking bands. The resulting product will be called Land Surface Reflectance (LSR). The LSR can be used as a reference to estimate the COD. The reference dataset including the COD estimates will be published at the end of CMIX II. The reference dataset will comprise approx. 100 Sentinel-2 and 100 Landsat 8 products, the expert pixel collection and the COD estimates for all collected pixels.

Methodology and Results

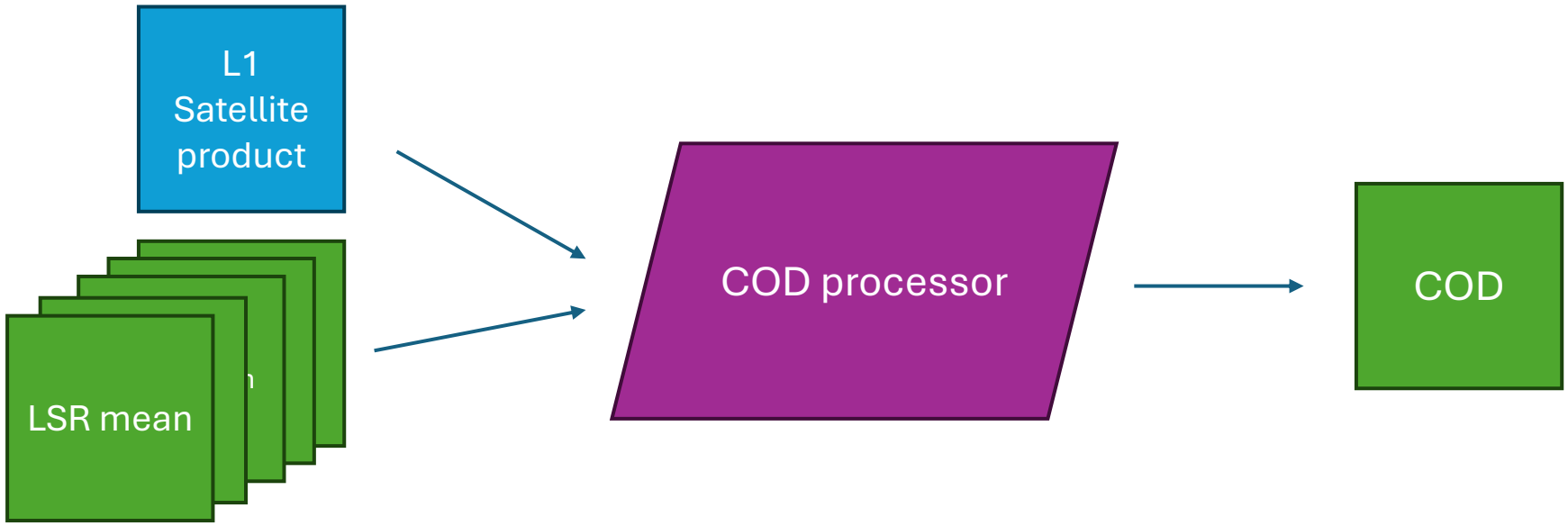
- Xcube-sh is used to request Sentinel-2 L2A and Landsat L2 data from SentinelHub. The requested data is then stored in a datacube on AWS. The data is later masked with the included cloud masks and then statistical features (min, max, mean, median, stdev) are calculated for the two bands (red, NIR). These statistical features provide previously described LSR that is then used in conjunction with the COD estimation algorithm developed by Brockmann Consult GmbH to derive COD from Sentinel-2 L1C and Landsat L1 data.
- The result of this work, are pixel wise COD estimates for 100 Sentinel-2 and 100 Landsat 8/9 products combined with an expert pixel classification of different cloud classes. The thereby generated reference dataset is called PixBox. The reference dataset including the COD estimates will be published at the end of CMIX II (possibly end of 2025).

Workflow



LSR = Land Surface Reflectance

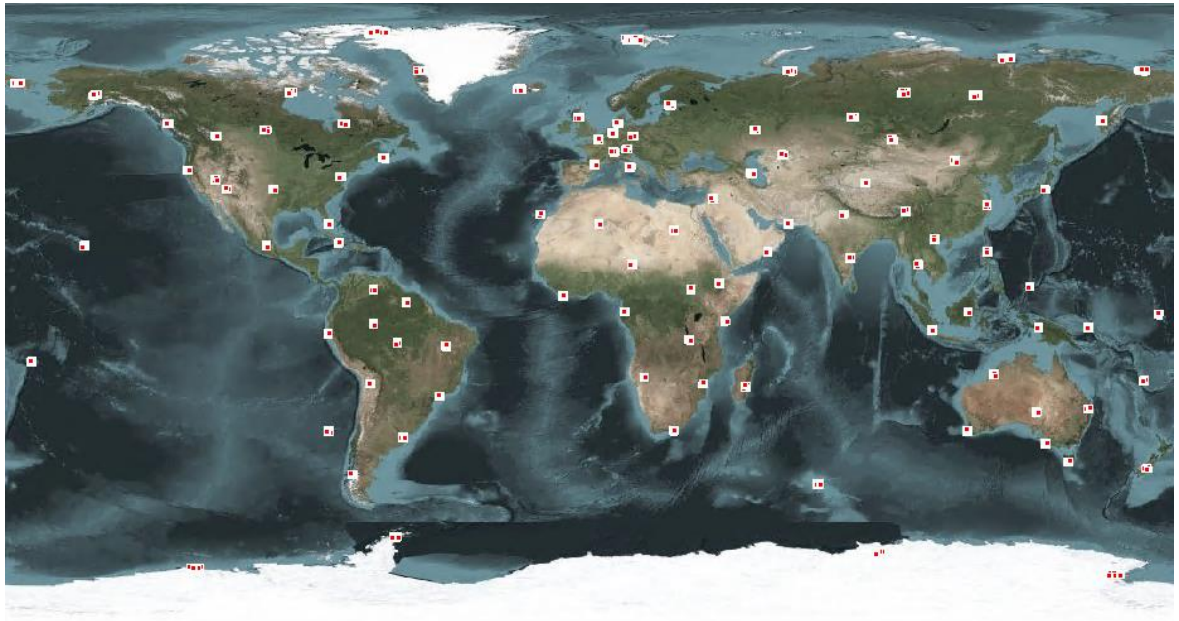
Workflow



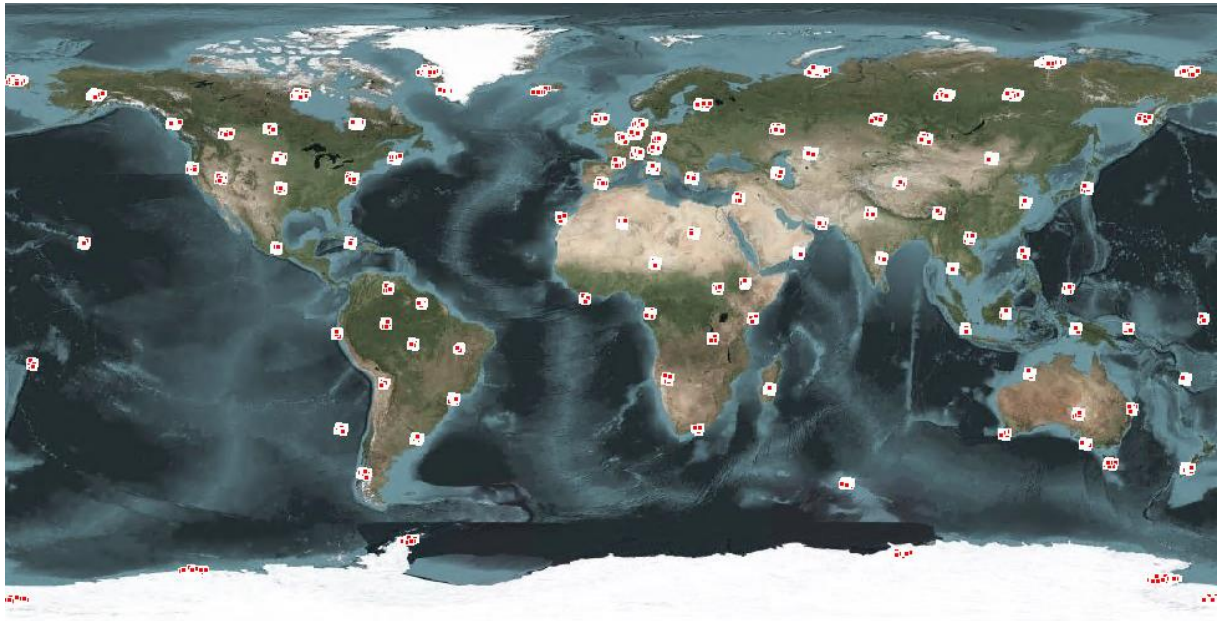
The reference datasets

Roughly 300 pixels have been collected on each single satellite product. Leading to 30.000 collected pixels per dataset. Thematically the collection includes different cloud types (opaque and multiple levels of transparencies), as well as clear observations. In addition, the state of the surface is collected as well as additional aiding information.

Sentinel- 2 PixBox expert pixel collection



Landsat PixBox expert pixel collection

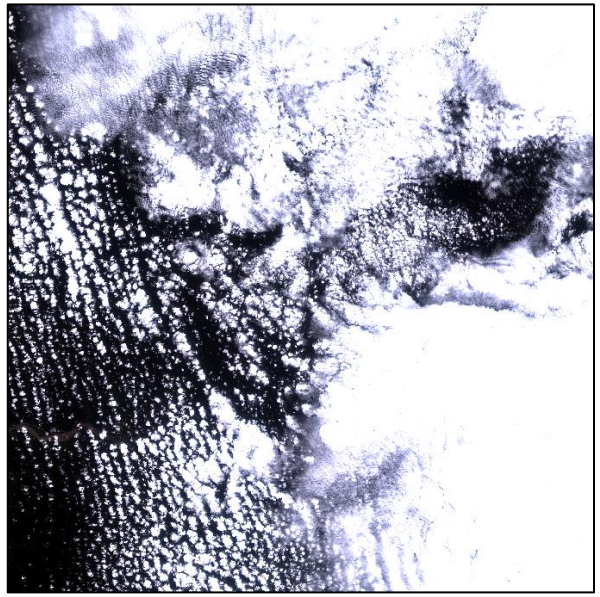


The red dots show the location of the collected pixels

Example

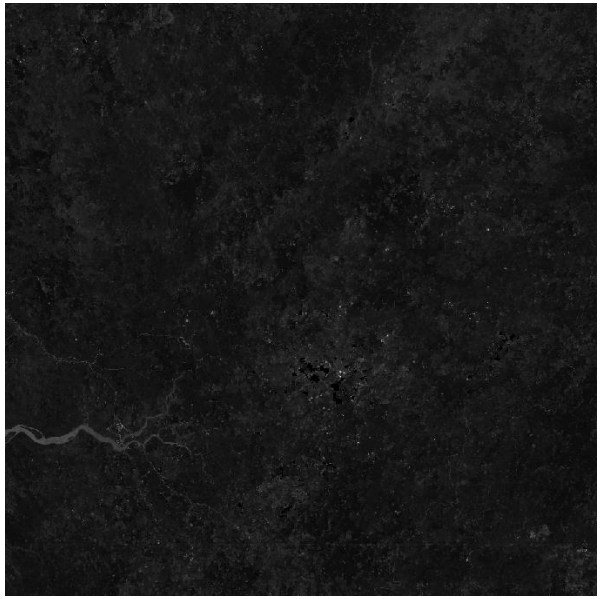
The example below shows on the left, the Sentinel-2 L1C for which the COD will be estimated. The second image from the left shows the TOA refl. of B4 of the same product. The second image from the right shows the median LSR of Sentinel-2 B4 derived by using the Xcube-sh service (funded by NoR) and EuroDataCube Service. Both input products together are used to create the COD estimates shown on in the right image.

Sentinel-2 L1C RGB

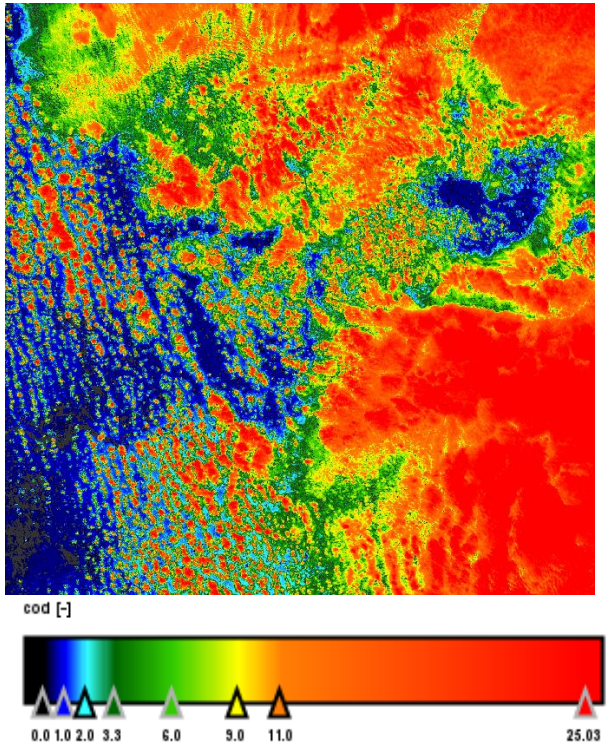


Sentinel-2 L1C B4

Sentinel-2 LSR B4 median



COD estimates



Impact of the activity

- The derived COD estimates will be used in combination with the expert pixel collection. The COD estimates are used to strengthen the confidence in the made classification by the expert.
- This reference dataset will be used in the second edition of the Cloud Masking Inter-comparison eXercise (CMIX-II) where multiple sate-of-the-art cloud detection algorithms are compared. The exercise helps to identify strengths and weaknesses of all compared algorithms and thus helps to improve cloud detection algorithms.
- As a good cloud screening is key to all subsequent processes and wrong detections can have severe impact on the quality of the subsequent product, any improvement to cloud detection always leads to an improvement of the subsequent products.
- Some of these higher-level products are distributed by the Copernicus Services where they can be used by any European entity and citizen. Therefor, a high quality is required to strengthen the confidence in the provided products.