TEMPORAL SOIL COMPOSITES FROM THE ENMAP AND DESIS HYPERSPECTRAL IMAGE ARCHIVE

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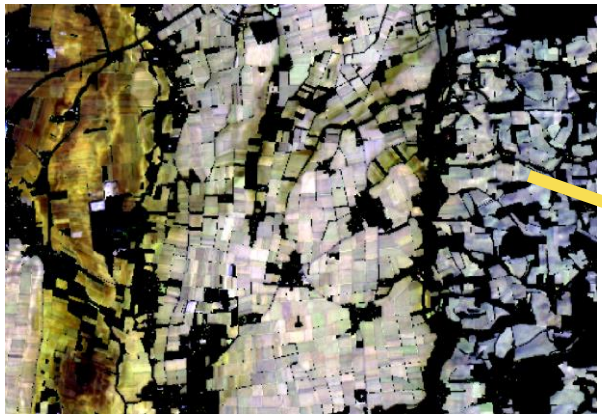
(1): IMF-PBA, DLR

(2): DFD-LAX, DLR

Soil Reflectance Composite (Derived from S2)

Map of soil and bare surfaces



- Is used to derive soil properties (e.g. Organic carbon)

→ Hyperspectral ?

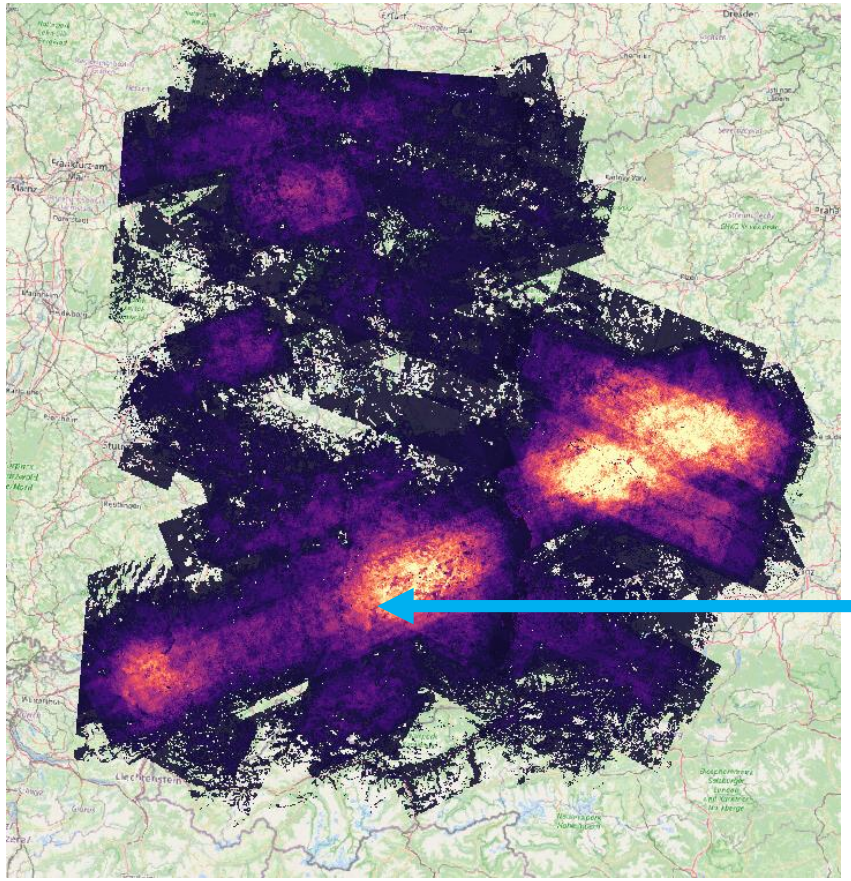
Soil Reflectance Composites

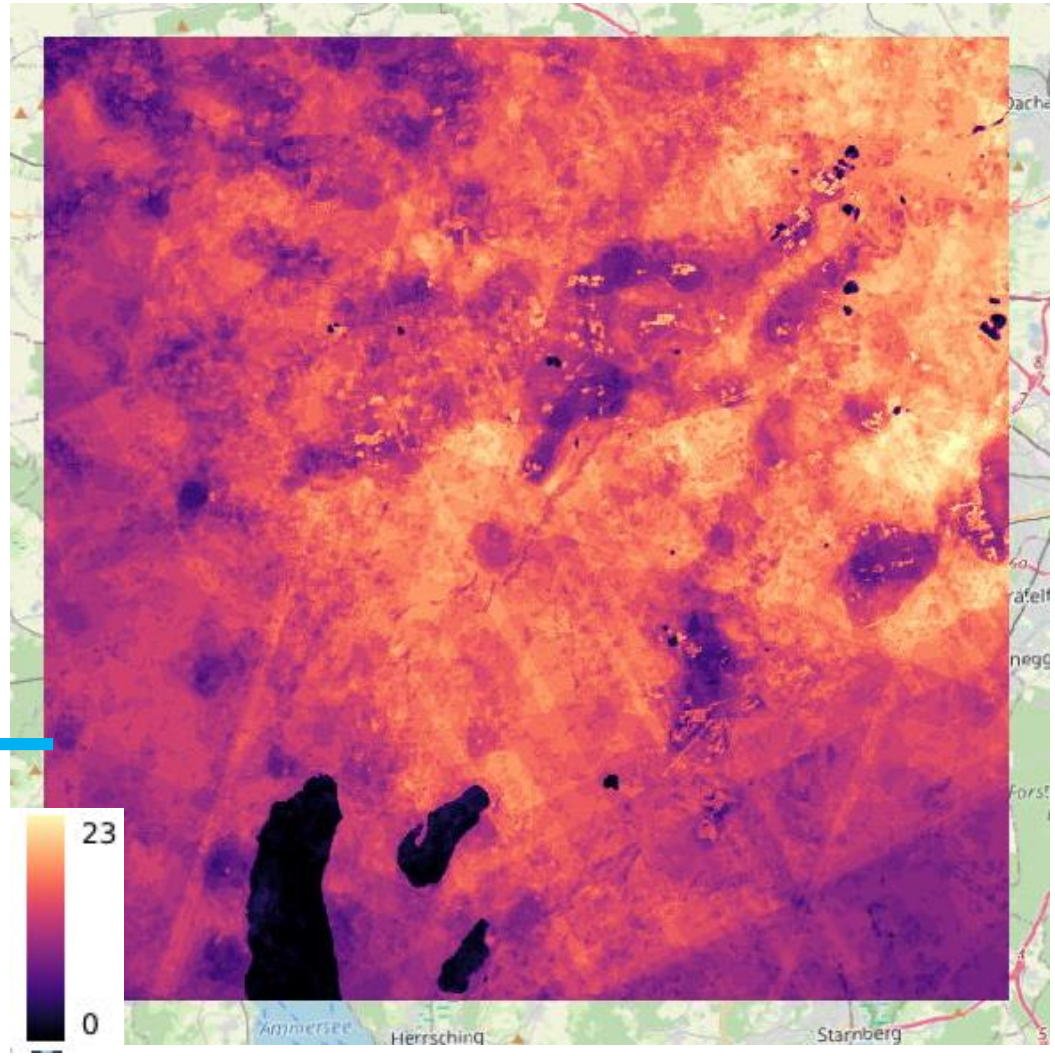
- Cloud-free mosaic of pixels, showing bare soil
  - This requires a dense temporal stack
- Built-up of hyperspectral time series is in progress…
- **Desis Hyperspectral Image archive**
  - German state of Bavaria (~70.000 km²) → **850** L2A Desis Scenes
  - Used as a testbed

- Q: How many scenes are required to generate SRCs?

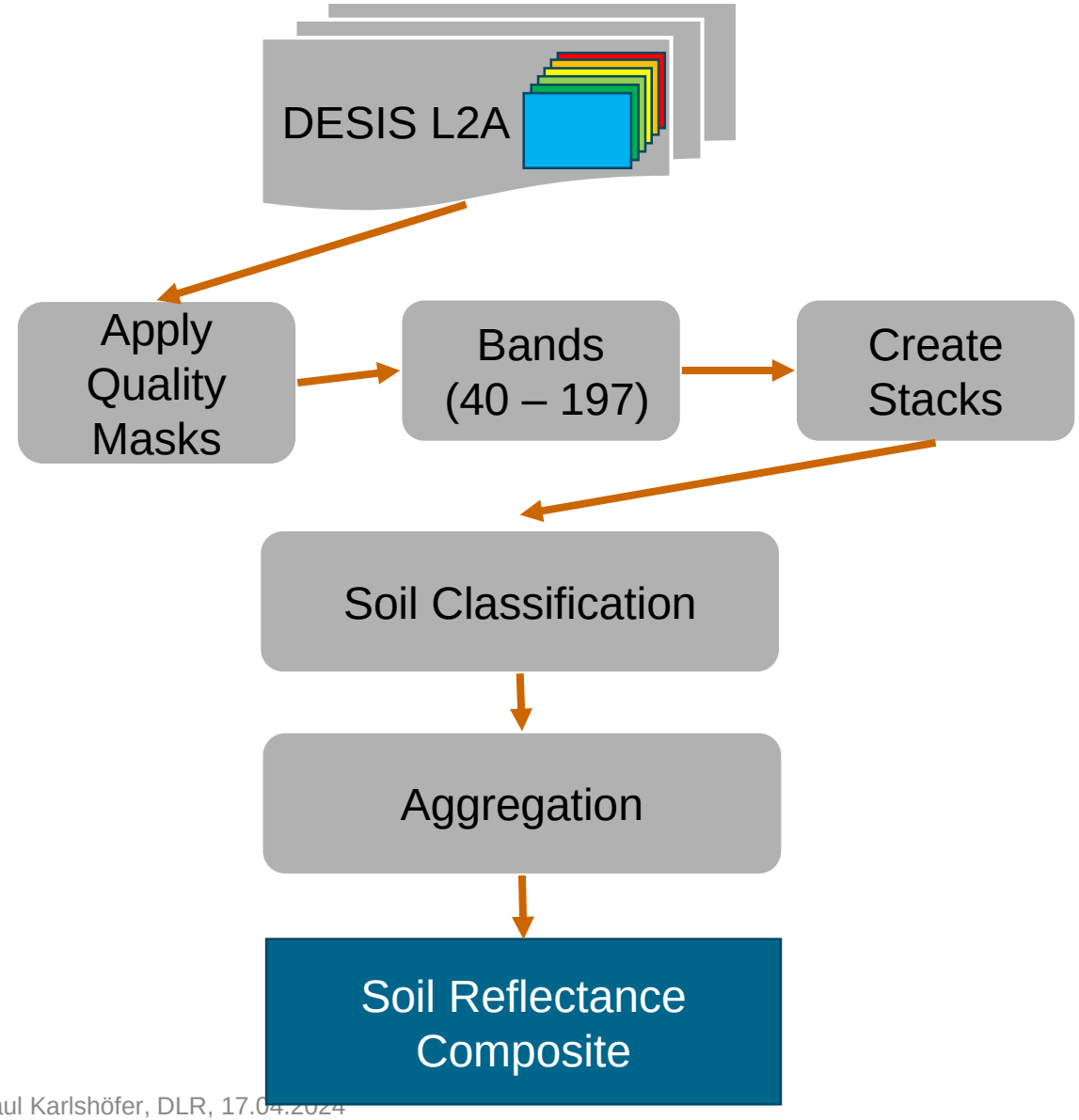
Desis coverage of Bavaria

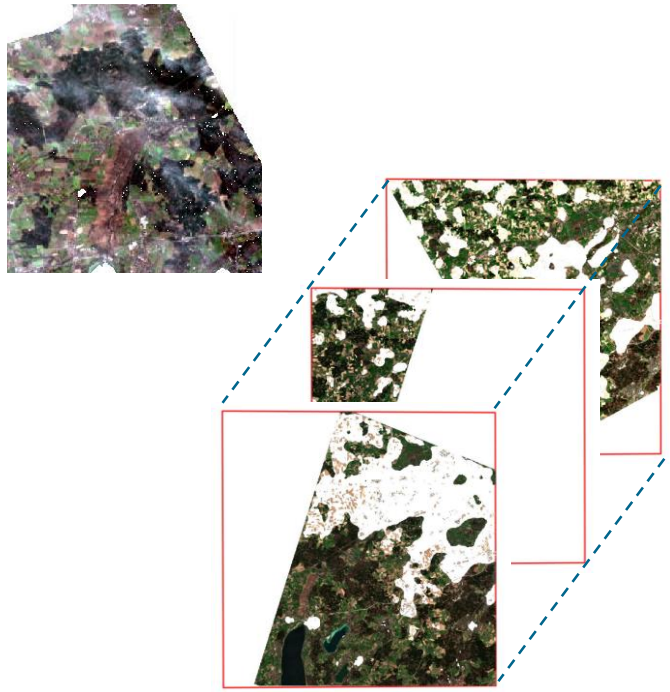
- Heatmap of *cloud-free* observations per pixel
  - Not homogeneous (on demand sensor)

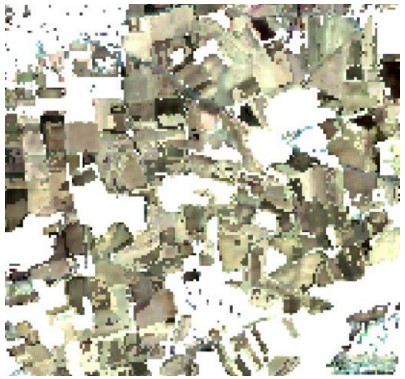




Soil Reflectance Composite - Processing





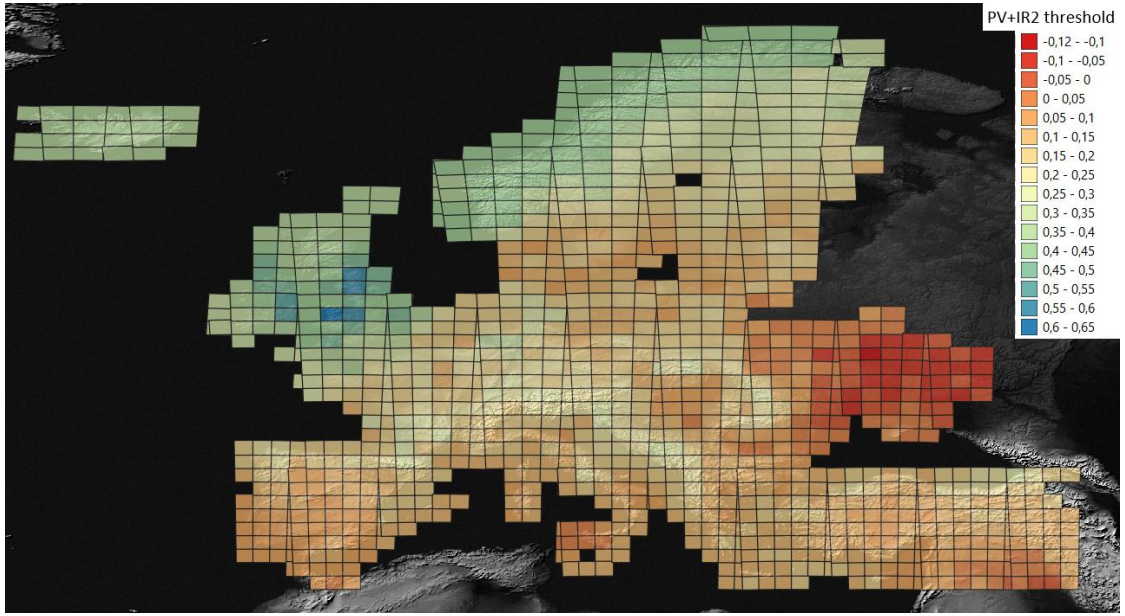


Soil Classification
Sentinel 2

DESIS

EnMap

- Based on a spectral Feature (linear combination of indices)
  - Adapted to local properties (soil color, …)
- Choice of index with its thresholds in part based on the spectral distance between LUCAS* and resulting SRCs
  - Formulated as a optimization problem
  - Explored using a method based on sparse grids and gradient descent



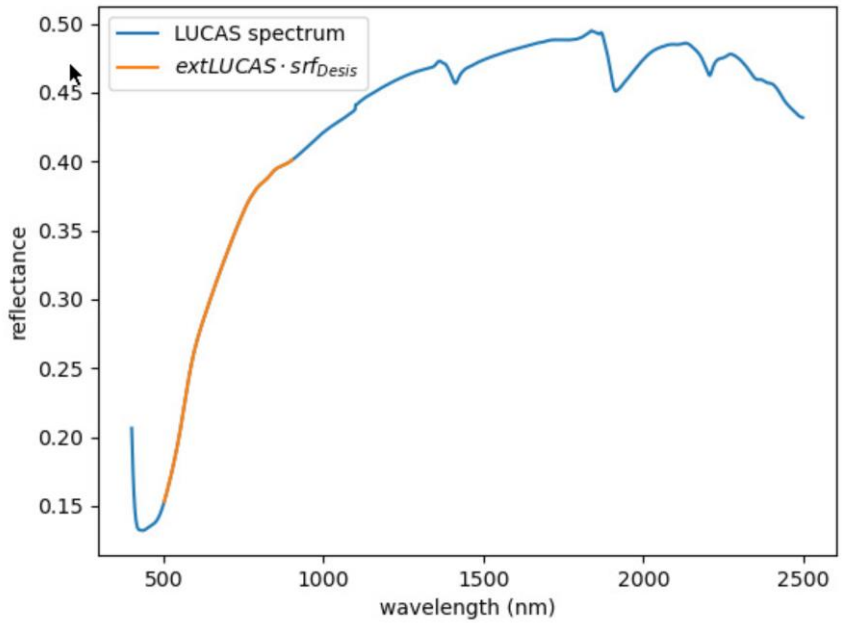
* LUCAS topsoil spectral database from 2015

Soil Classification

Sentinel 2 | **DESIS** | EnMap

- At larger scales, the S2 method could be valid, however:
  - Only VNIR cube available → NDVI $\frac{(B_{nir} - B_{red})}{(B_{nir} + B_{red})}$
  - Regional scale does not require adaptive thresholds

- Additional Thin Cloud and Haze detection
  - Outlier detected via Normalized Mean Absolute Deviation
  - NMAD on “bluest” band s_b
  - $NMAD = \frac{mean\ of\ absolute\ deviations}{k * median(absolute\ deviations)}$
  - $|s_b - median(s_b)| < 3 * NMAD$



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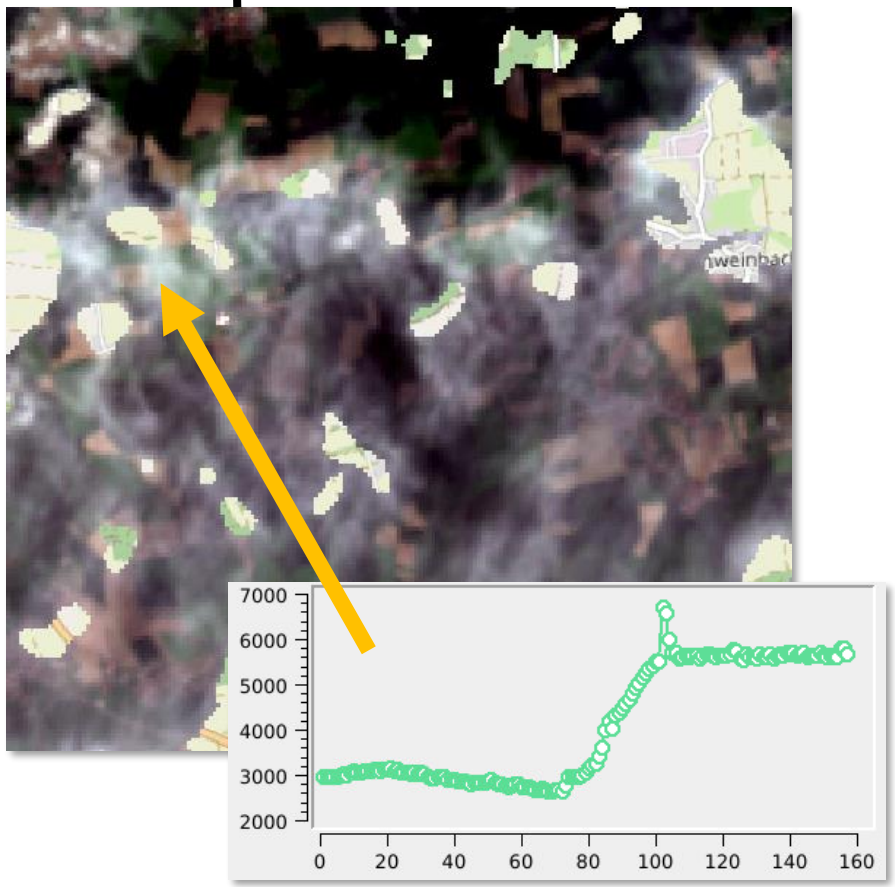

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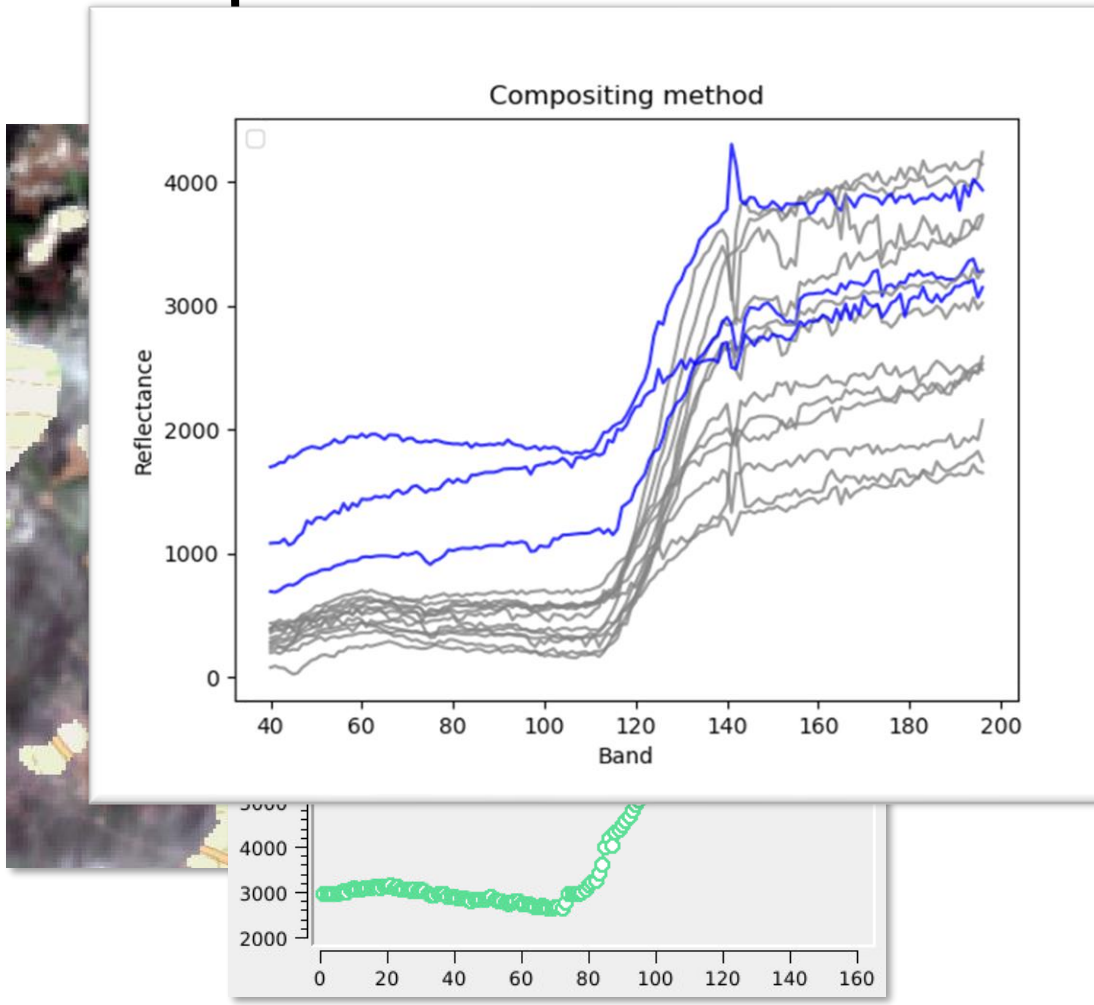
- urban areas, permanent water bodies masked with a landcover mask



Soil Classification

Sentinel 2

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- Additional Cloud detection
  - NMAD on “blue” band s_b
  - $NMAD = \frac{mean\ of\ absolute\ deviations}{k * median(absolute\ deviations)}$
  - $|s_b - median(s_b)| < 3 * NMAD$

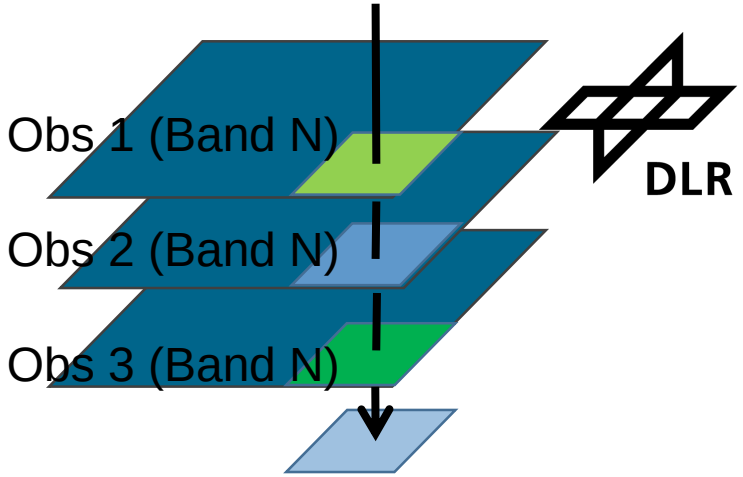
DESIS

EnMap

- Features in the SWIR
  - Distinguish from NPV
- Fcover (fractional vegetation cover)

- Once data is available at a broader scale

Aggregation



- Mean or median (bandwise)
  - Creates synthetic spectra

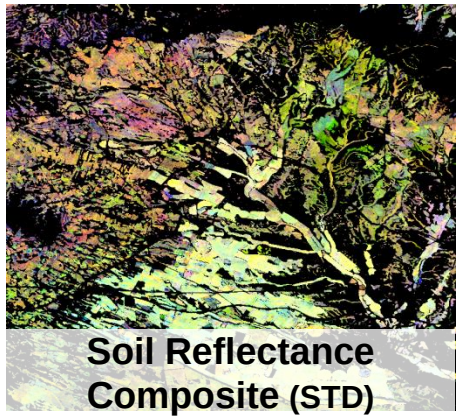
Mean Composite

Median Composite

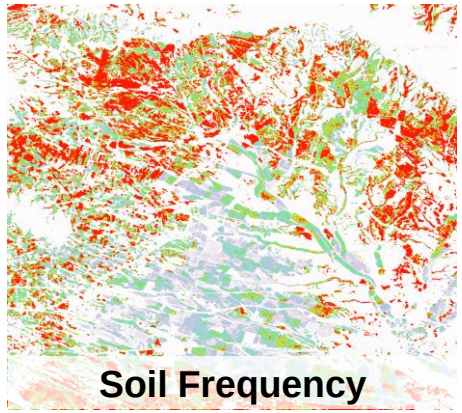
- Barest / best pixel
  - Preserves a true spectrum
  - Select spectrum closest to the geometric median (in the vector space of the spectra)

Additional products

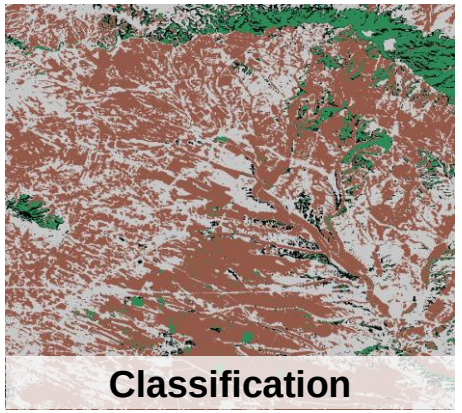
Soil Reflectance Composite



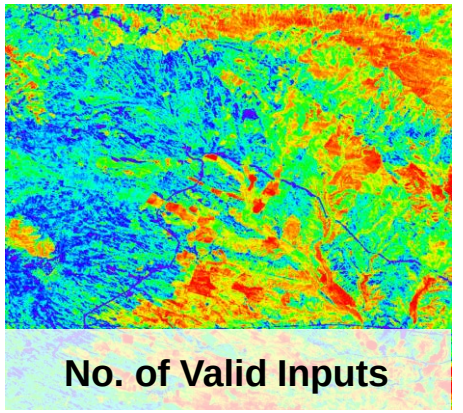
Soil Reflectance Composite (STD)



Soil Frequency



Classification

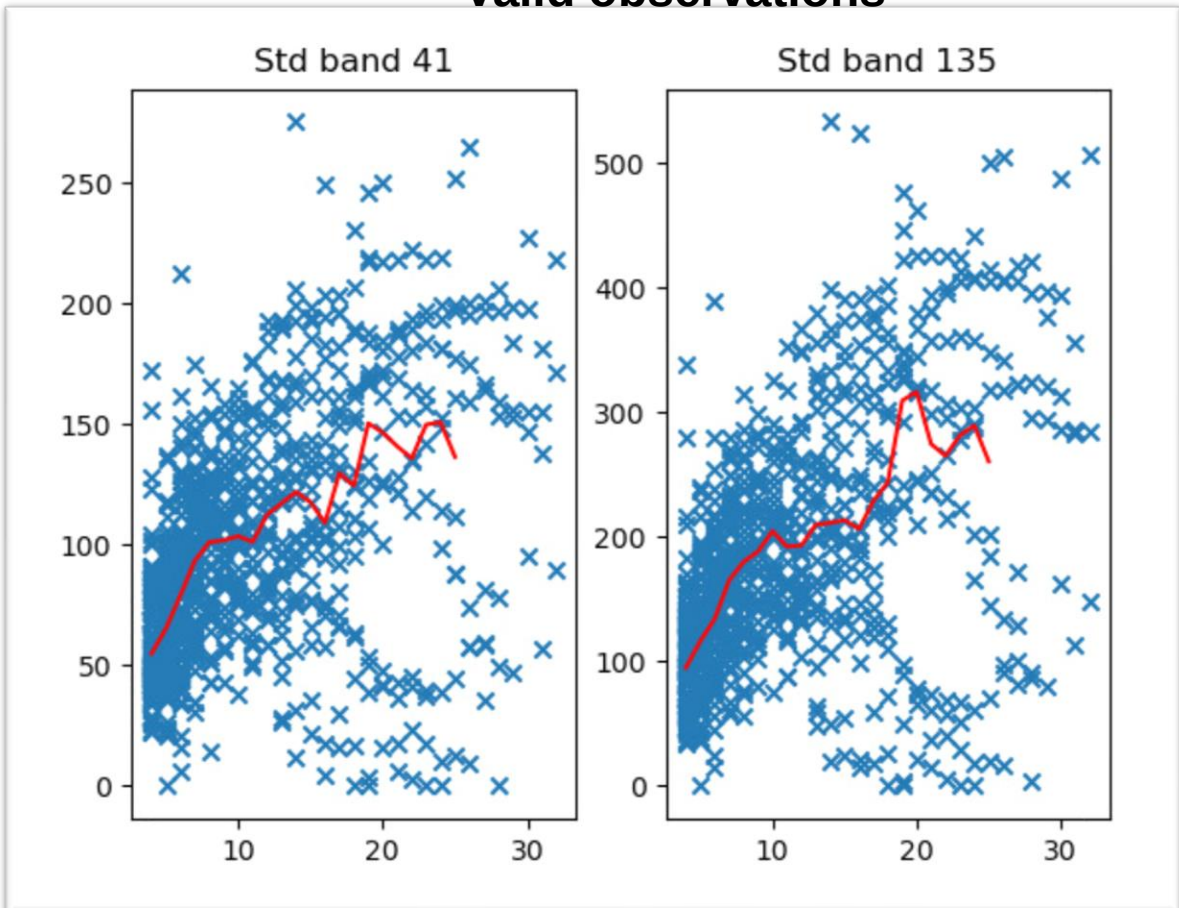


No. of Valid Inputs

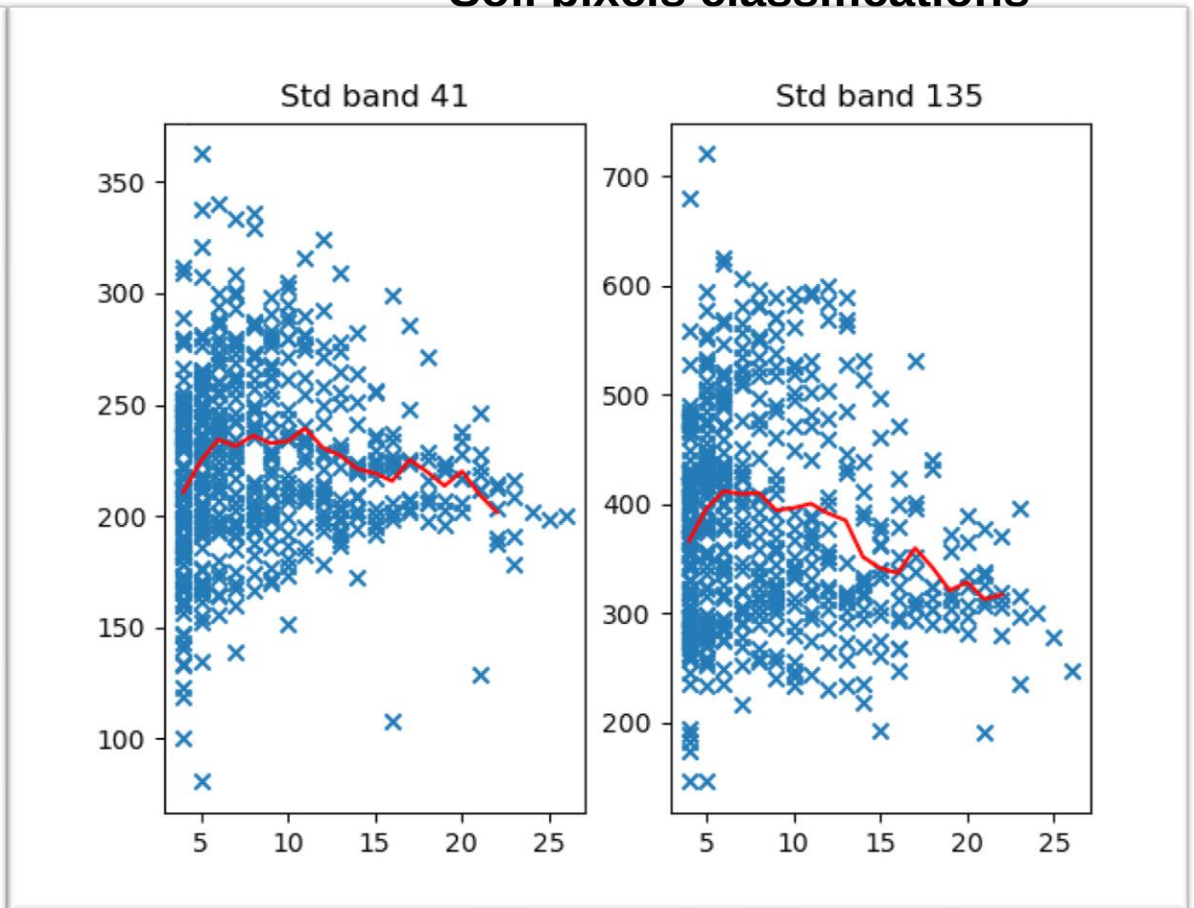
Dependence on the number of observations

Plots of the standard deviation per pixel

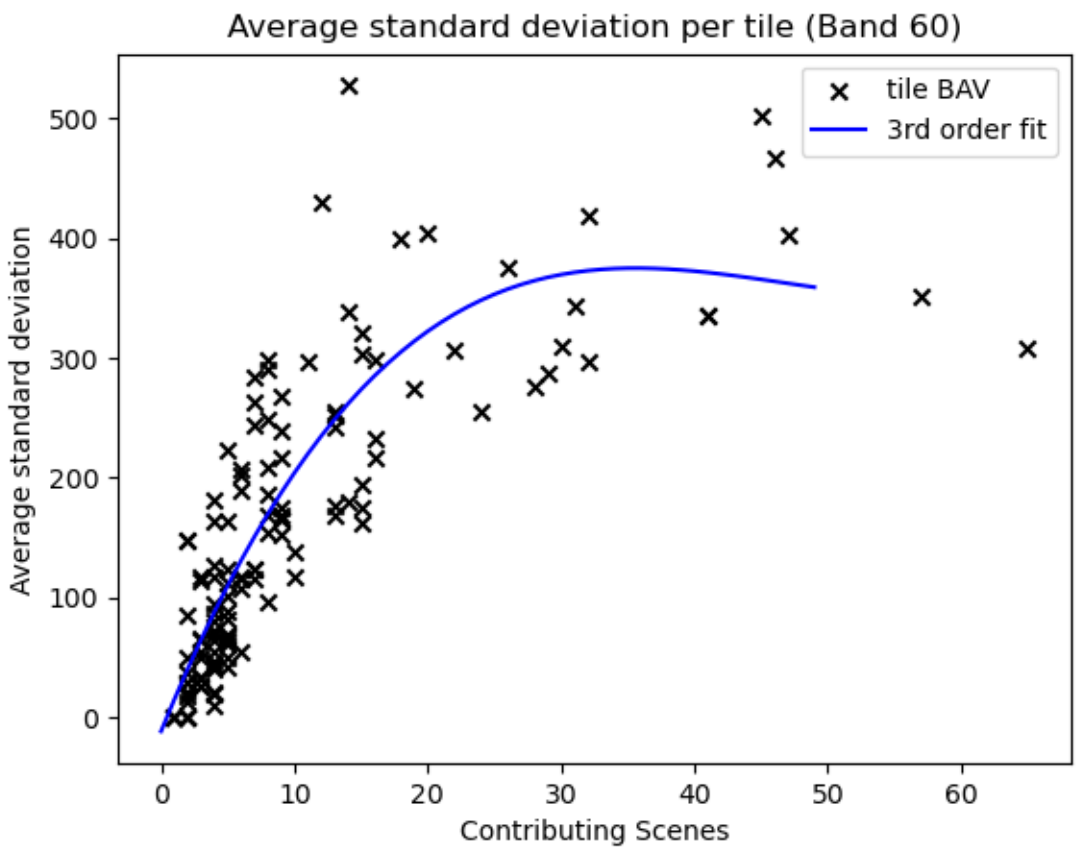
Valid observations

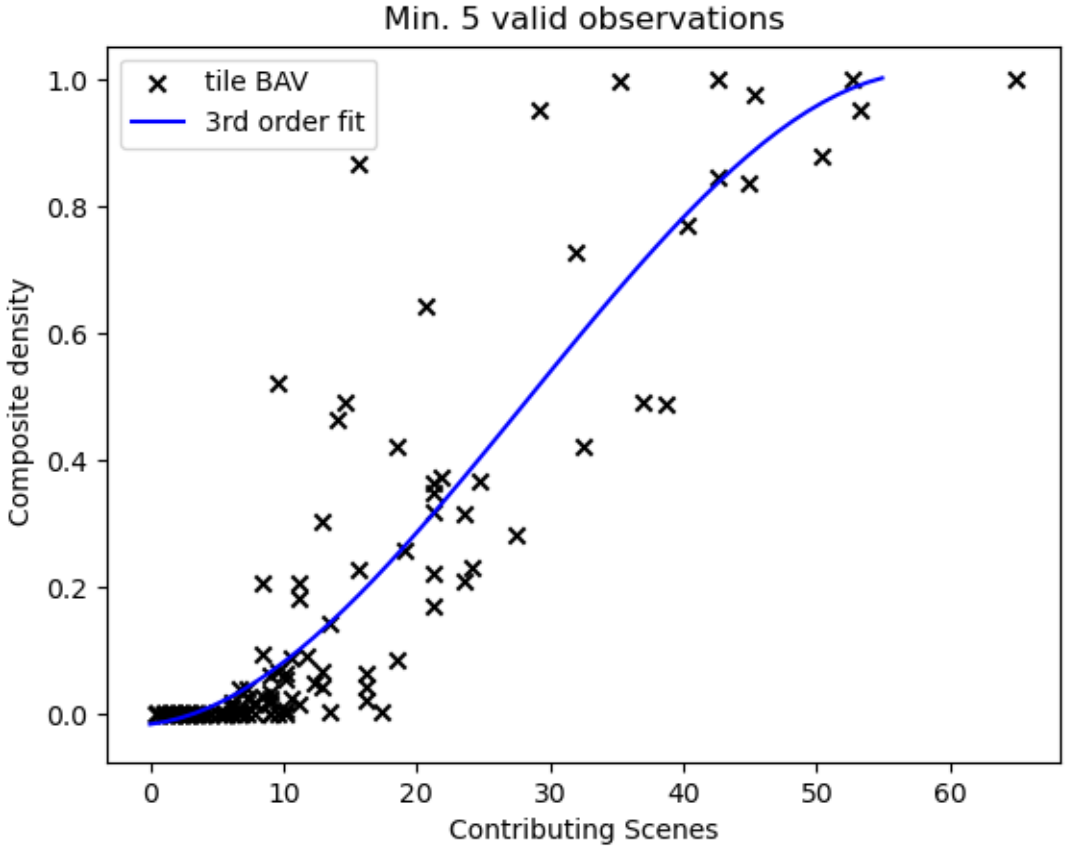


Soil pixels classifications



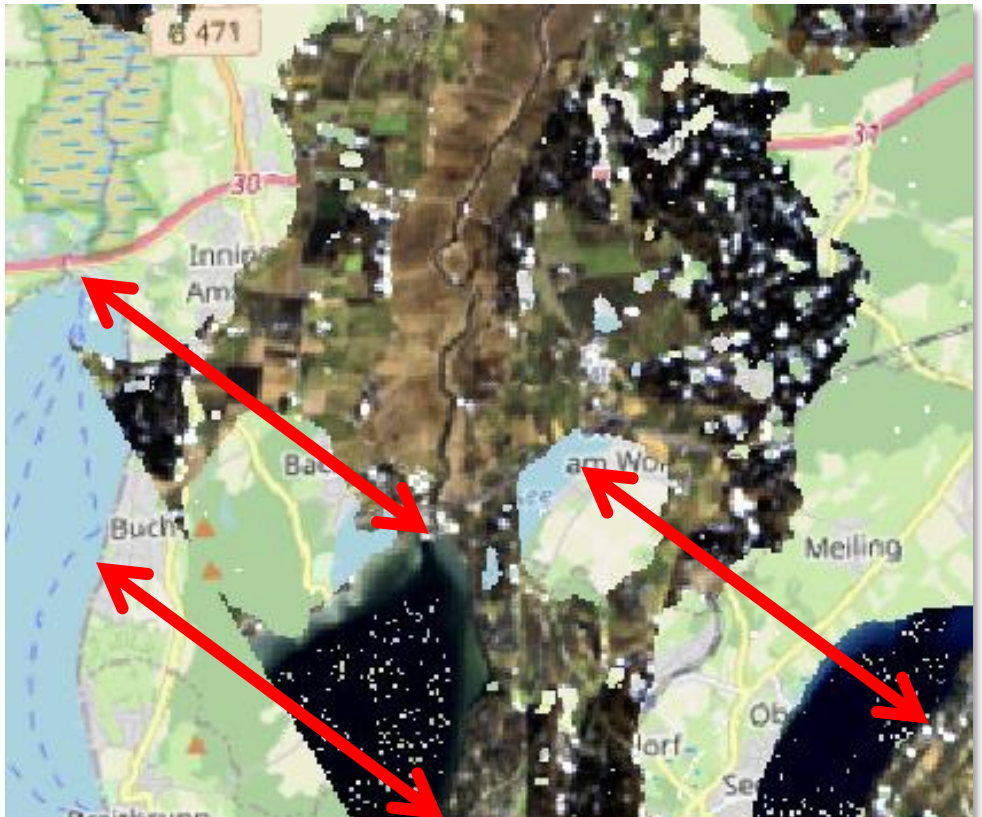
How many scenes are required?





Some thoughts for DESIS

- Don't use scenes with elevated cloud cover, because the georeferencing might be bad
- Additional filter for cloud and haze is necessary
- DESIS lacks BRDF correction, variance introduced by its orbit, which is not helio-synchronous (shadows)
  - Filter by time of day?



Thank you