

Processing Large Satellite Image Collections as Data Cubes with gdalcubes

OpenGeoHub Summer School
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Satellite Imagery is Irregular

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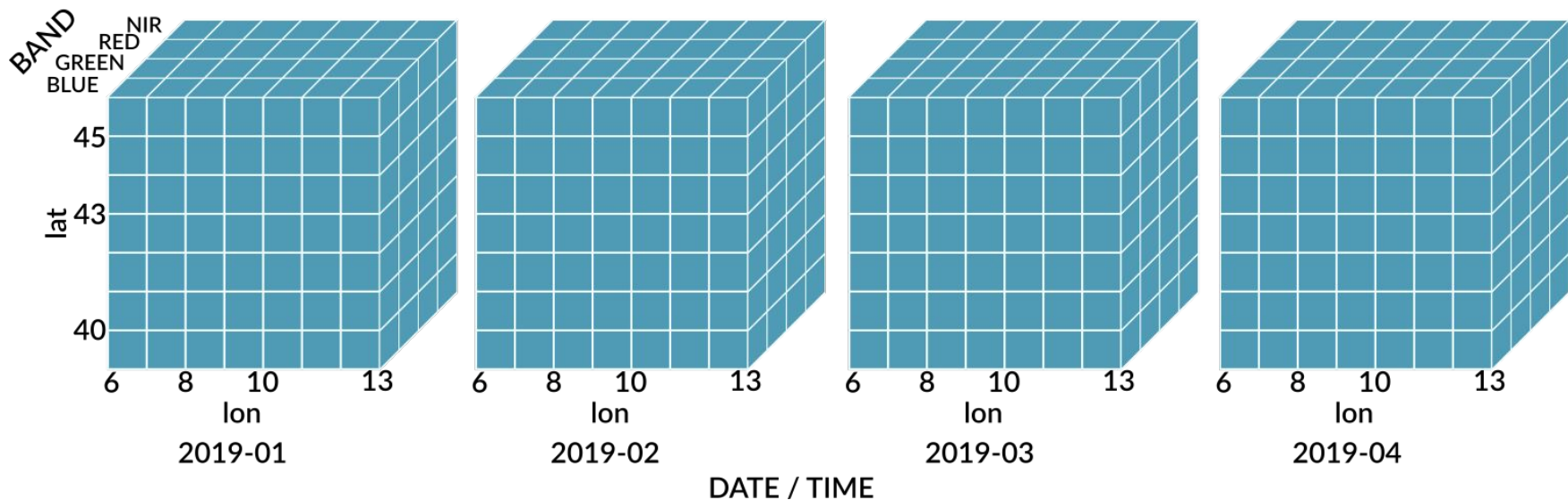
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Products per page: 150 << >> page: 1 of 3 >>

Four-dimensional regular raster data cubes

- 4d array (x, y, time, bands)
- Spatial axes aligned with SRS axes
- $b \times t \times y \times x \rightarrow \text{real value}$
- Single spatial reference system (SRS)
- Cells have constant temporal duration, and spatial size



How to create data cubes from satellite image collections

1 Define Data Cube Parameters

- Extent
- Cell size
- SRS
- Bands

2 Understanding data products

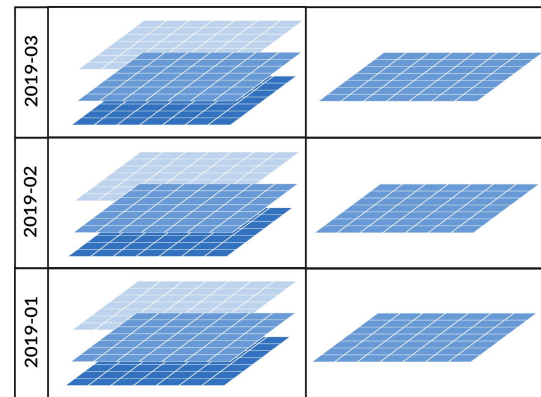
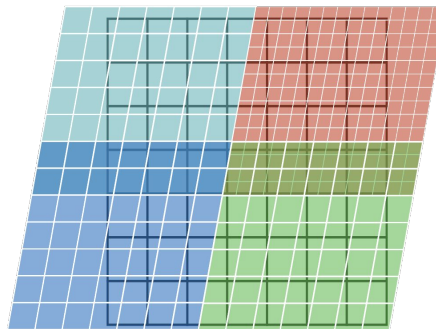
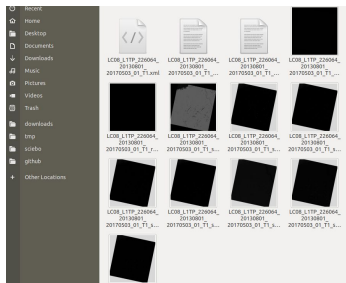
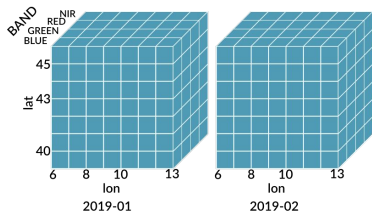
- File organization
- Metadata

3 Image Warping

- Reprojection
- Rescaling
- Cropping
- Resampling

4 Temporal Aggregation

- Combine values at the same data cube cell from multiple images



Open source C++ library and R package; building and processing data cubes from image collections:

- Users define image collections and the geometry of the target cube
- Includes operations to reduce dimensions, apply arithmetic expressions, filter on dimensions and pixel values, and more
- Image data is read on the fly, when needed (lazy evaluation), chunk-wise
- Includes predefined formats to understand specific data products



A minimal Sentinel-2 example (in R)

```
library(gdalcubes)

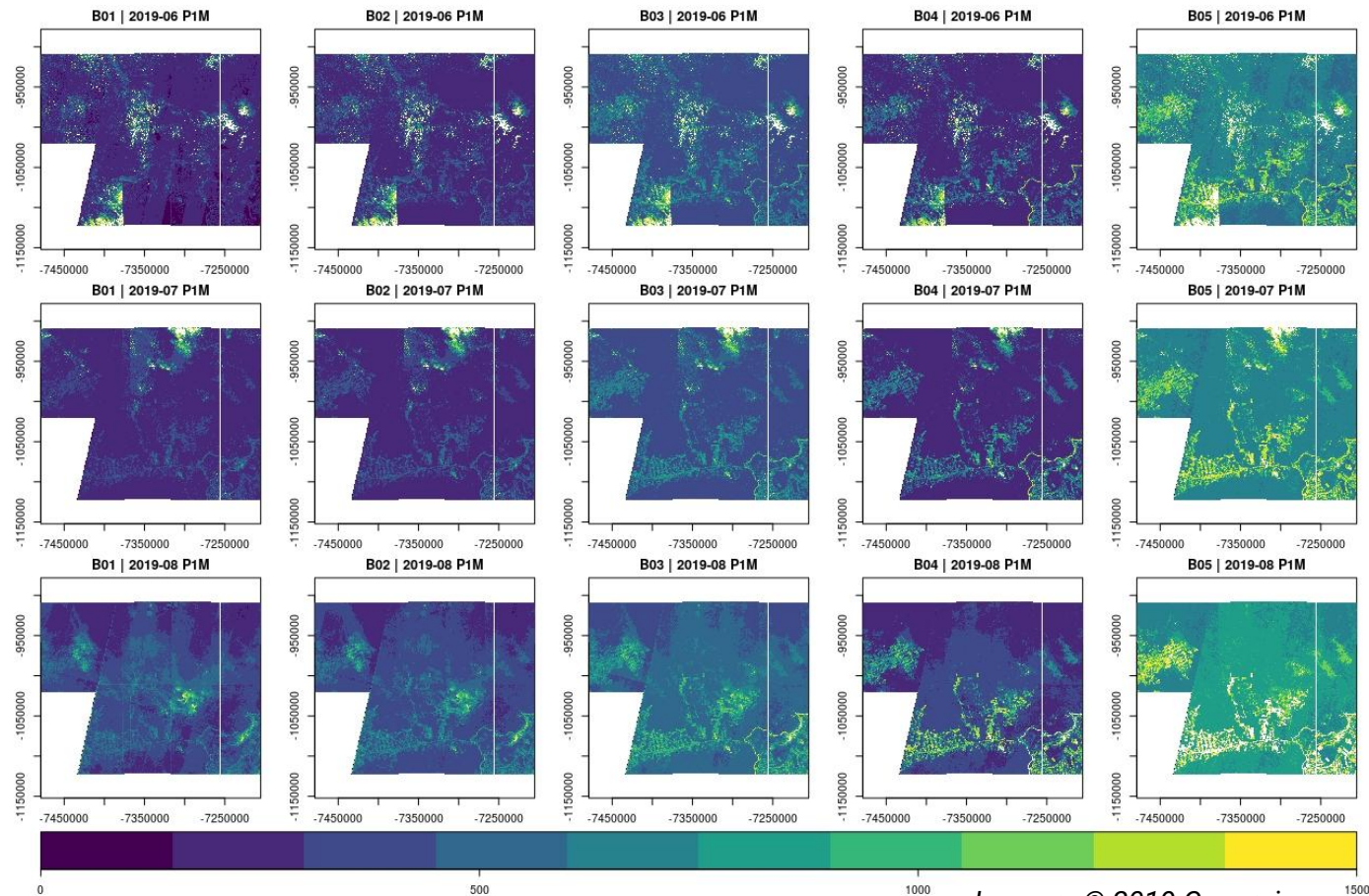
files = list.files("/path/to/s2_data", pattern = ".zip",
                  full.names = TRUE)

S2.col = create_image_collection(files, "Sentinel2_L2A")

v.overview.250m = cube_view(srs="EPSG:3857", extent=S2.col, dx=250,
                           dt = "P1M", resampling="average", aggregation="median")

raster_cube(S2.col, v.overview.250m) %>%
  select_bands(c("B01", "B02", "B03", "B04", "B05")) %>%
  plot(key.pos=1, zlim=c(0,1500), col=viridis::viridis)
```


Example: Data Cube from Sentinel-2

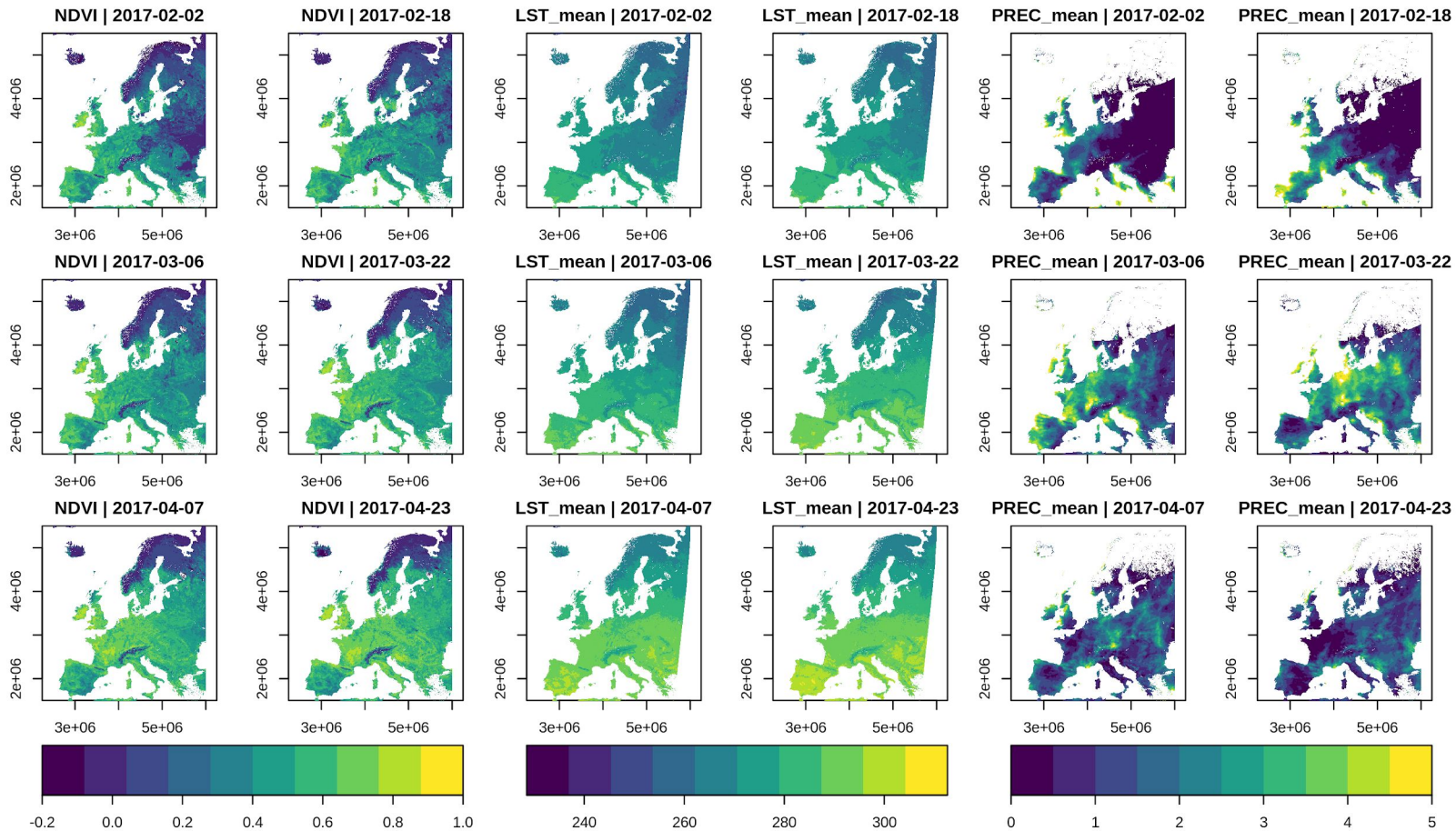


Data cubes are created on-the-fly; it is straightforward to go from low resolution experiments to applying algorithms on high resolution.

Example: *Derive median RGB values over all pixel time series at different spatial resolution of a collection with approx. 90 GB compressed Sentinel 2 L2A images:*

Pixel size	Computation time
300m x 300m	40 seconds
50m x 50m	26 minutes
10m x 10m	2 hours

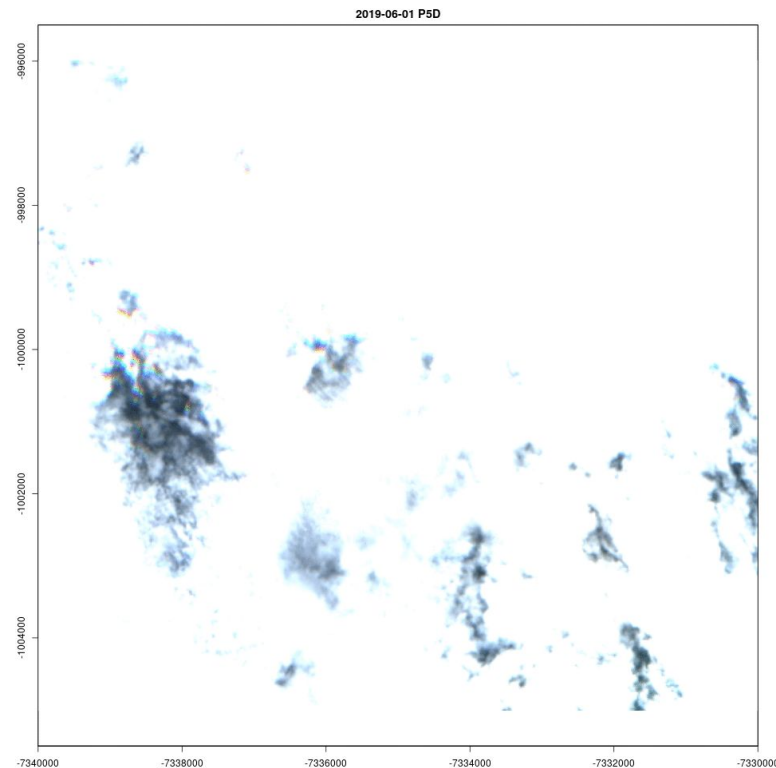
Example: Multi-Sensor Data Cube from MODIS and GPM



Workshop Outline

What we will do:

- Introduce the gdalcubes R package
- Create and process data cubes from Landsat, Sentinel-2, and MODIS image collections (up to a few hundred gigabytes) in a live demonstration
- Discuss basic concepts and limitations
- Work on practical exercises



Thank You for Listening!

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Workshop materials: https://github.com/appelmar/opengeohub_summerschool2019