eurac research

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NOI TECHPARK SOUTH TYROL

Embracing CI/CD workflows for building ETL pipelines

how we will gather and monitor multi-source spatially-interpolated meteorological parameters in near-real time

Elena Maines

11.11.23

Who

ELENA MAINES

Junior Researcher

PIERO CAMPALANI

Software Engineer

ALICE CRESPI

Senior Researcher

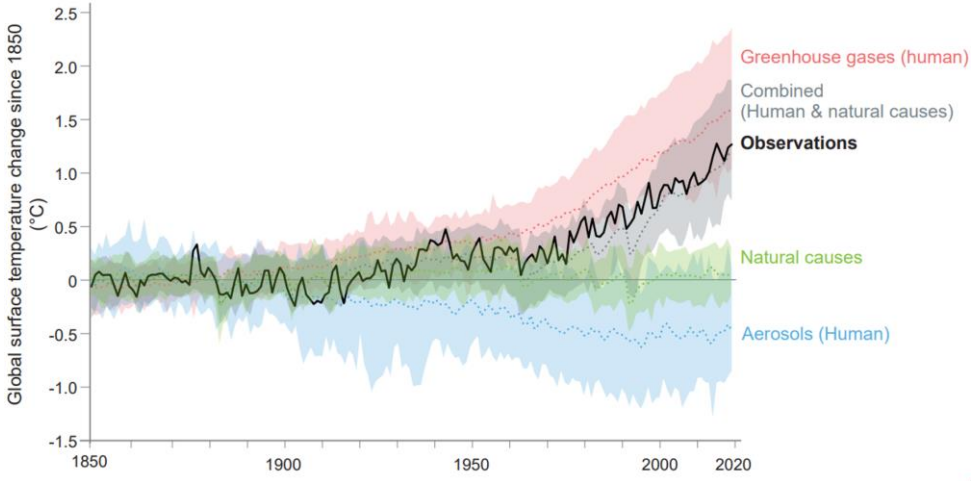
Pipeline: motivation

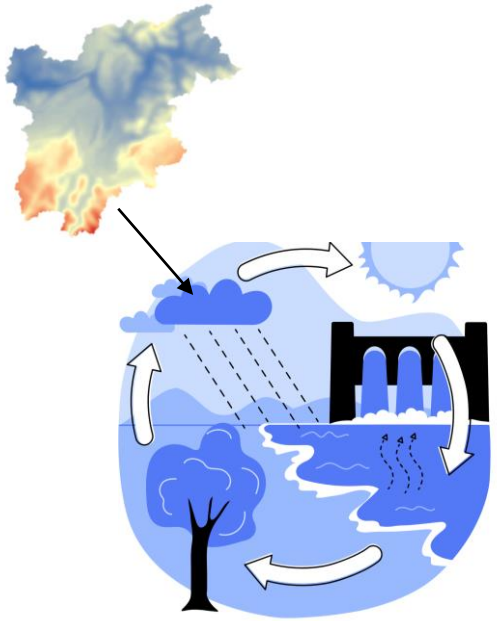
Having **reliable and up-to-date long-term meteorological data** is crucial for

Monitoring current meteorological conditions at regional level

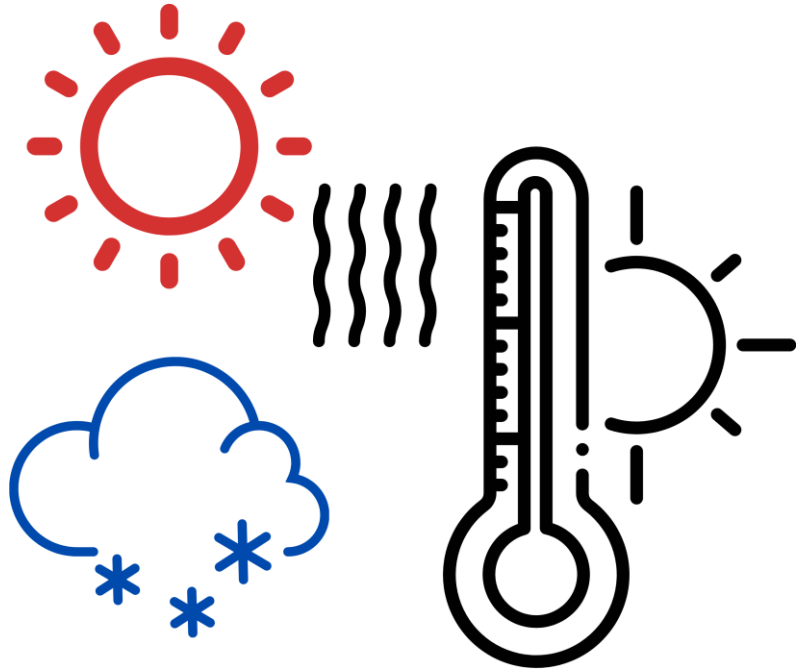
Monitoring **climate variability** at local level

Providing spatially distributed meteorological inputs for **impact models** (e.g., for hydrological simulations)

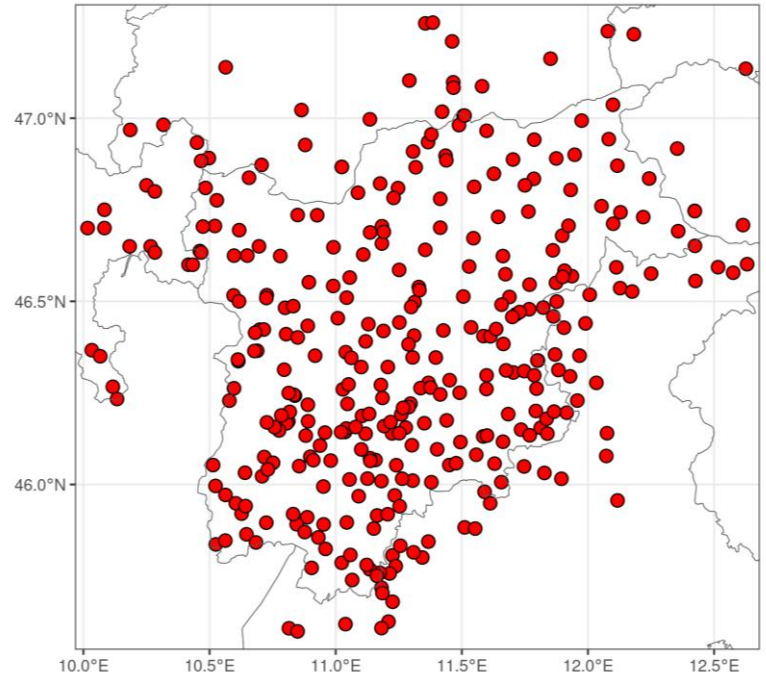




Meteorological data and data preparation



Time series of key weather variables: e.g., precipitation, min/max temperatures.



These data are recorded at daily and sub-daily resolution by weather stations

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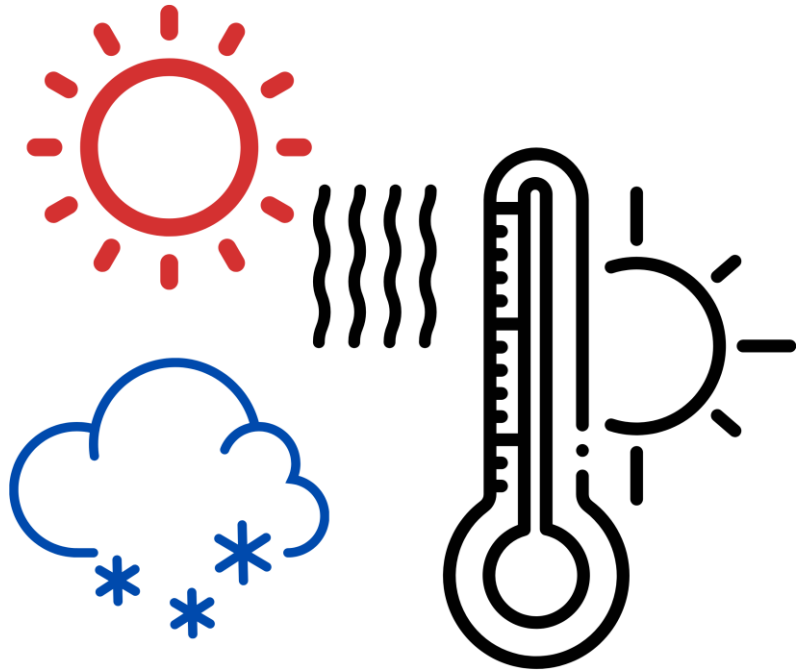

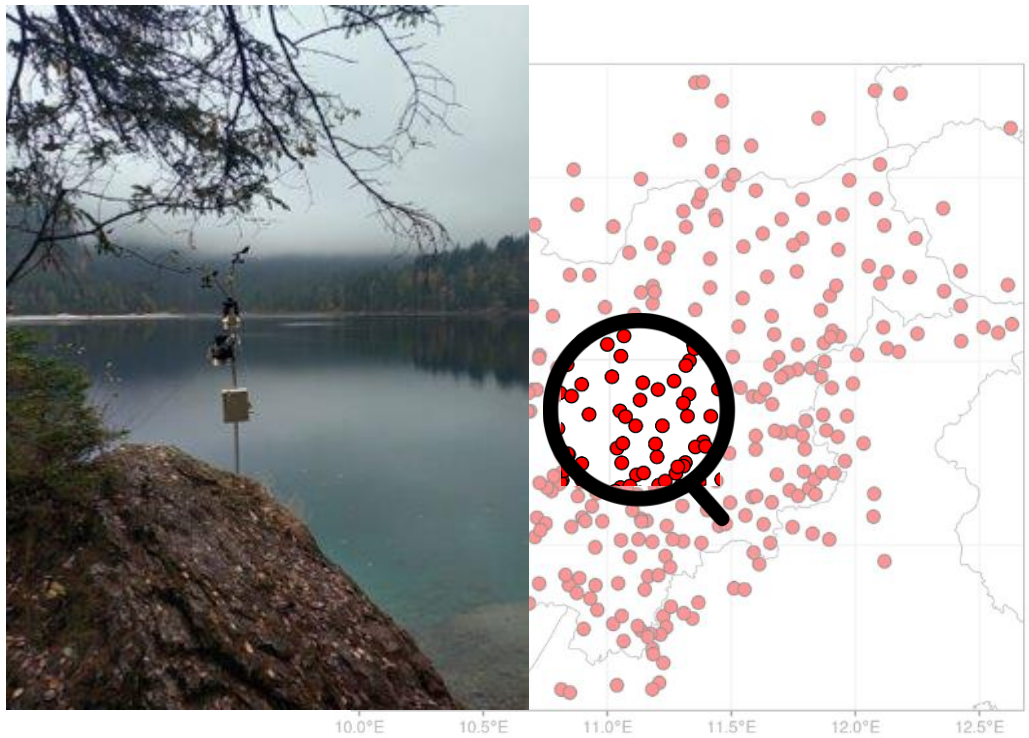

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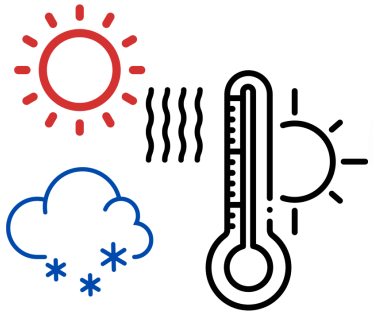
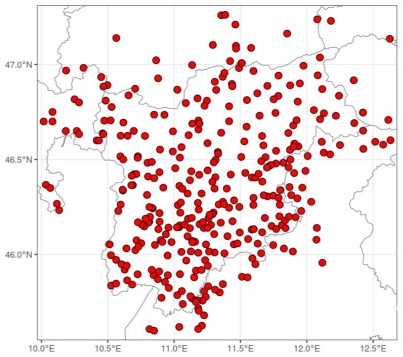


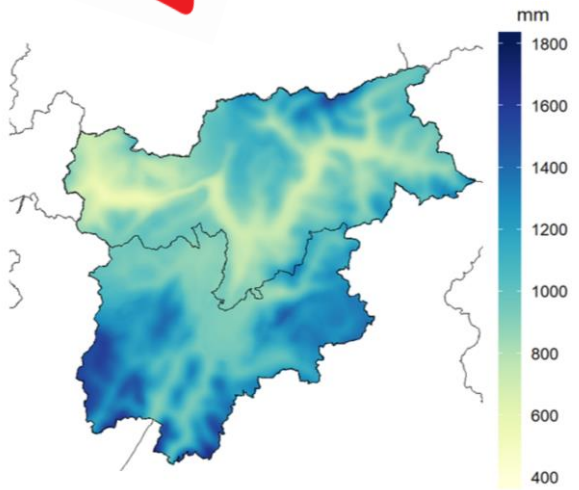
Comprehensive and updated time-series dataset: a robust compilation of at-site meteorological conditions

PostgreSQL



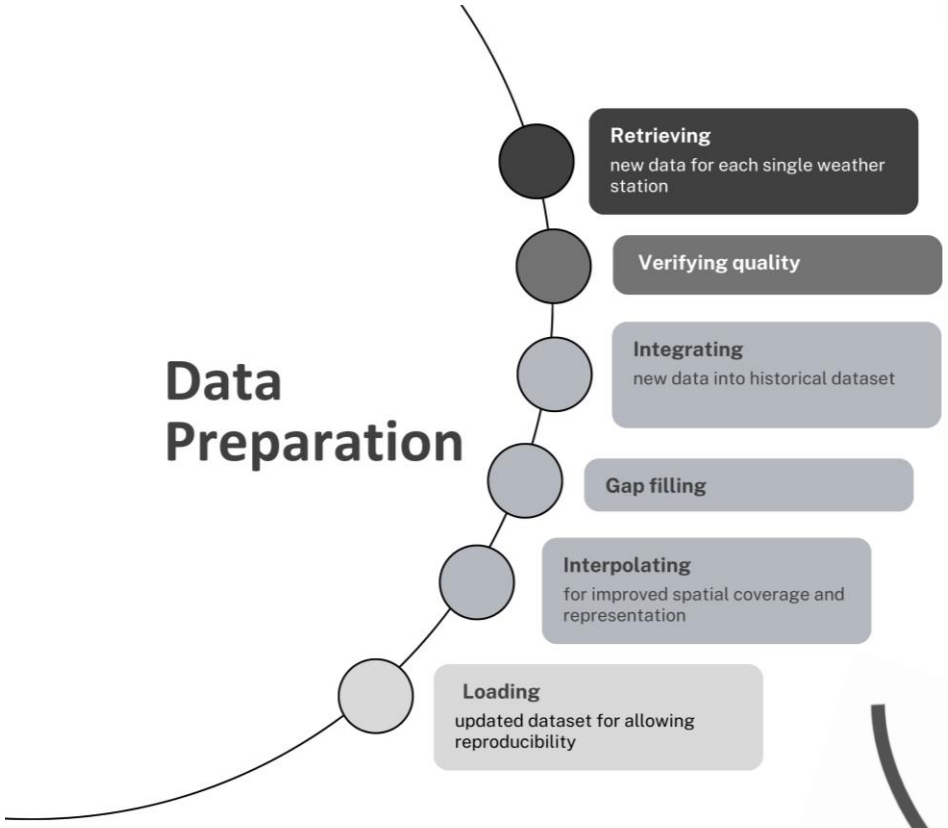
Irregular spatial coverage of weather stations

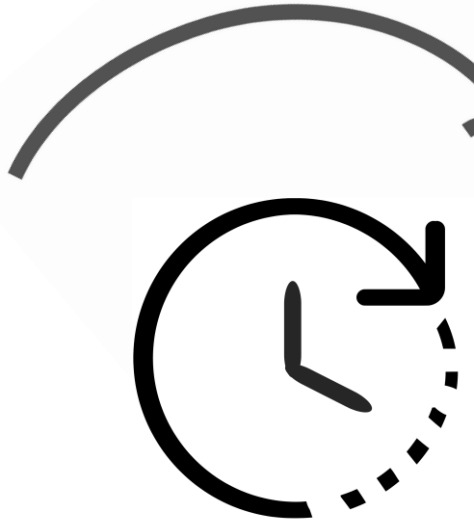
Interpolation for obtaining a gridded dataset



open EO

Pipeline: motivation



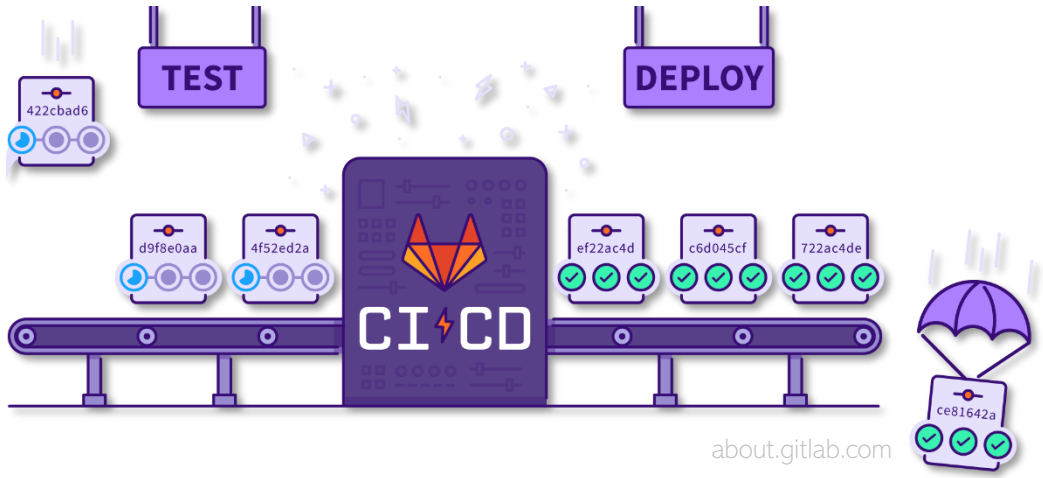


Focus on analysis

Accurate data

Pipeline: implementation

- **GitLab** CI/CD pipeline



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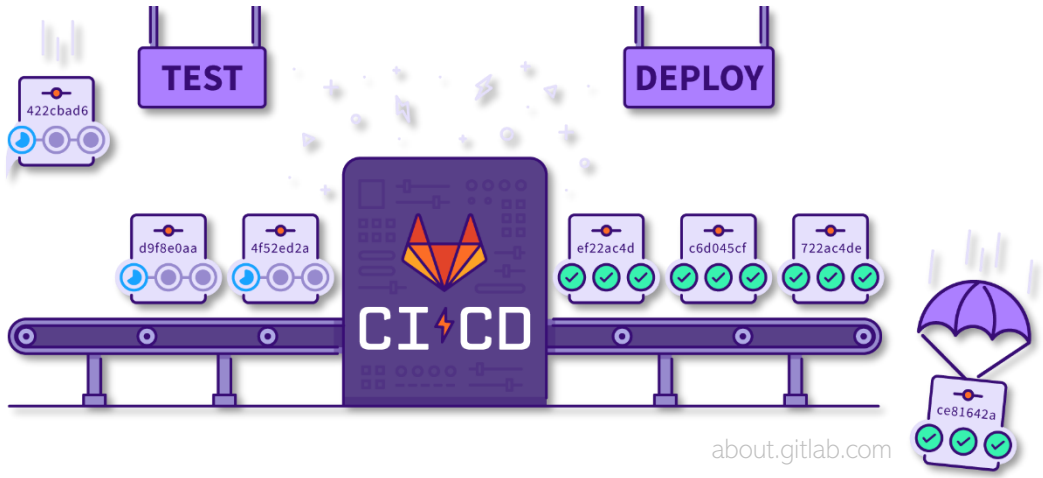
- **Dockerized** jobs runners



Pipeline: implementation

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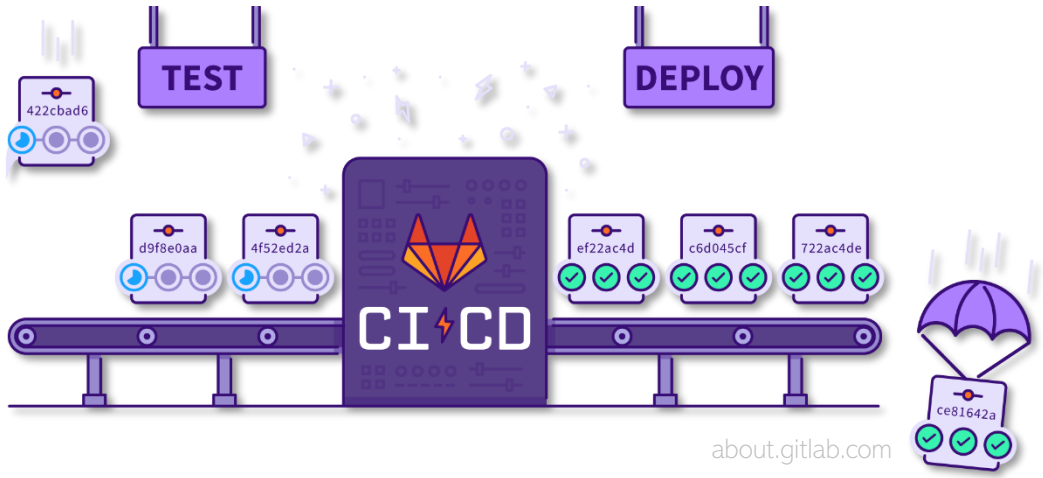

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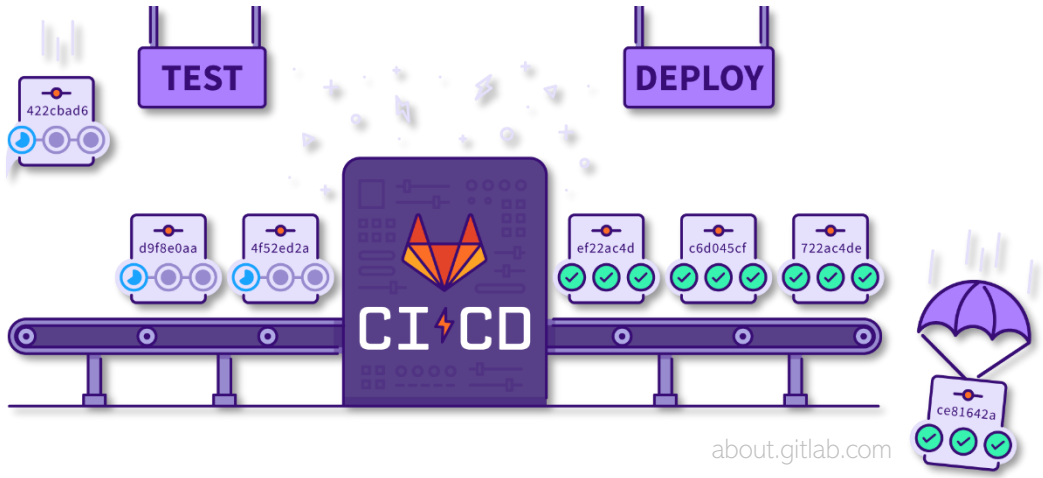

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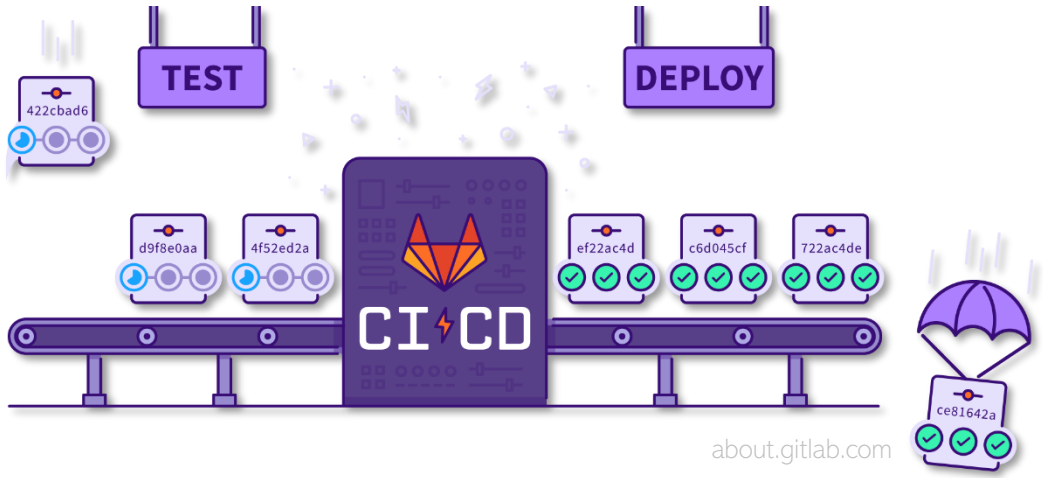

Pipeline: implementation

- **GitLab** CI/CD pipeline
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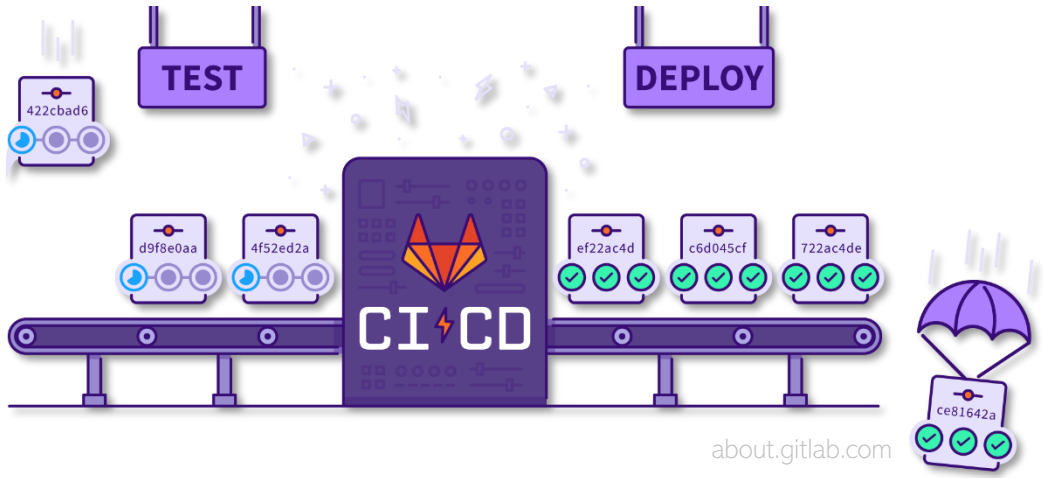
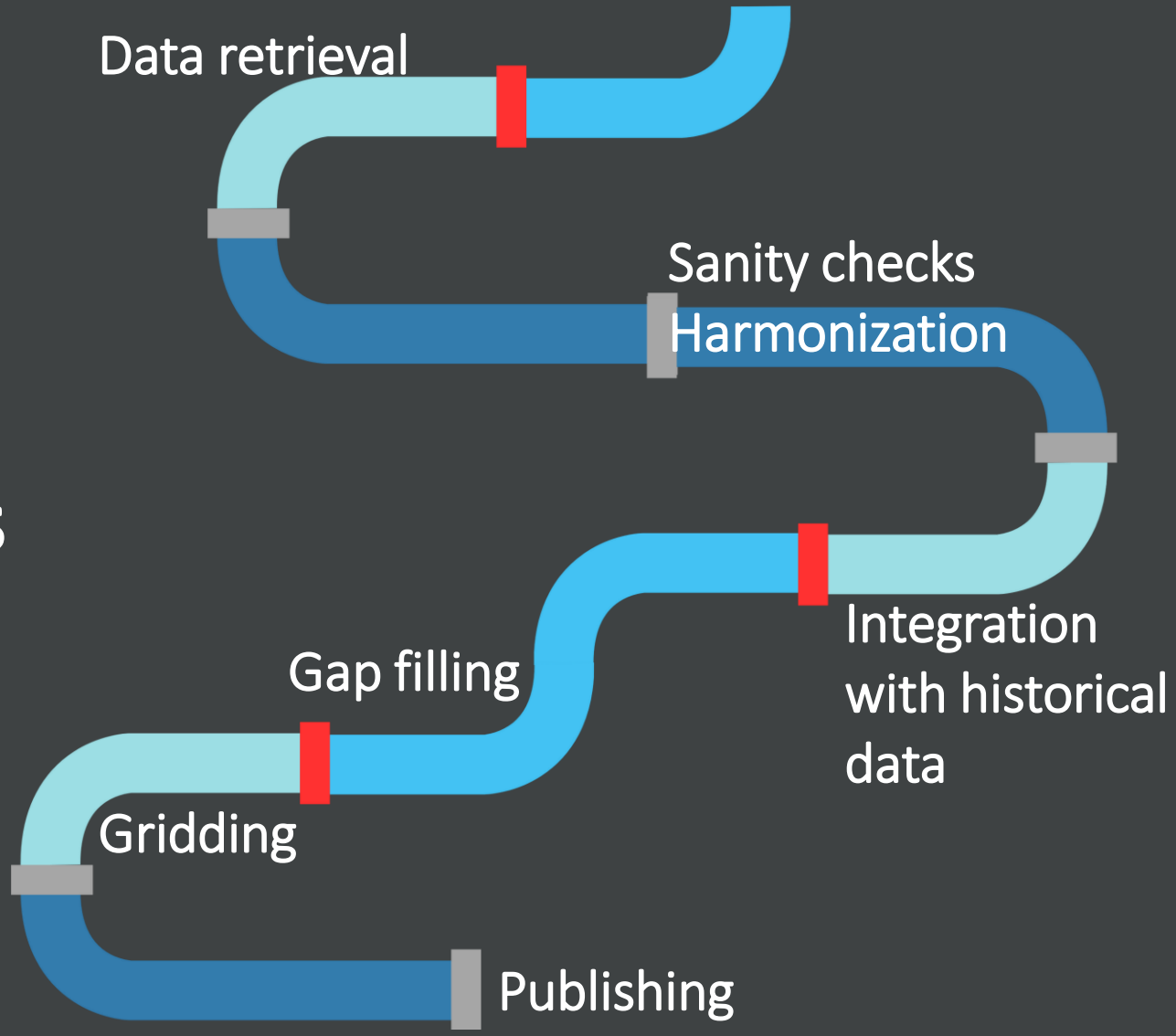
- R modules + geo-spatial libraries
- **testthat** + shell-based unit test suites
- **renv** for reproducibile environment
- **bash** scripts and wrappers



ETL pipeline for updating meteorological datasets in near real-time



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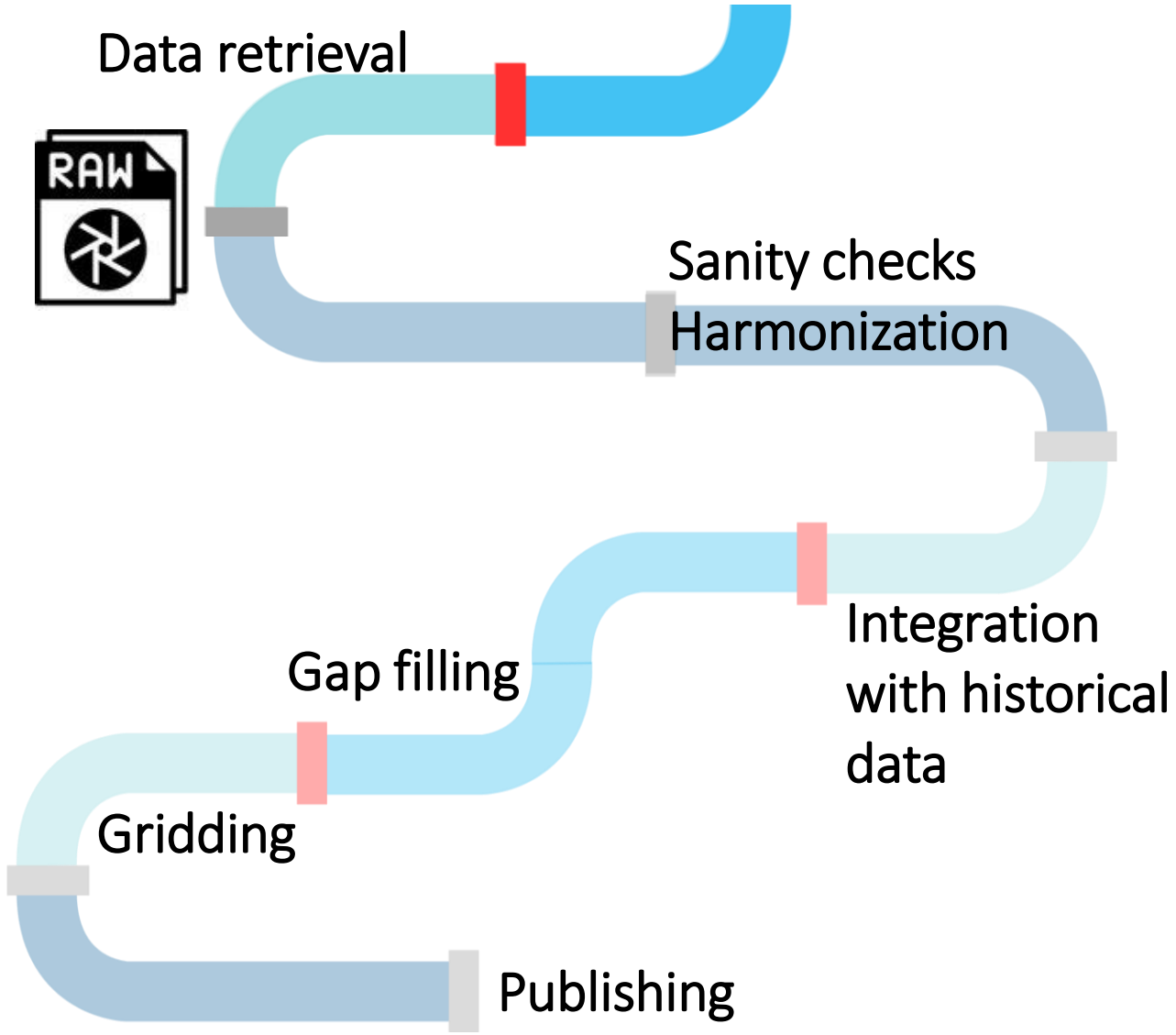
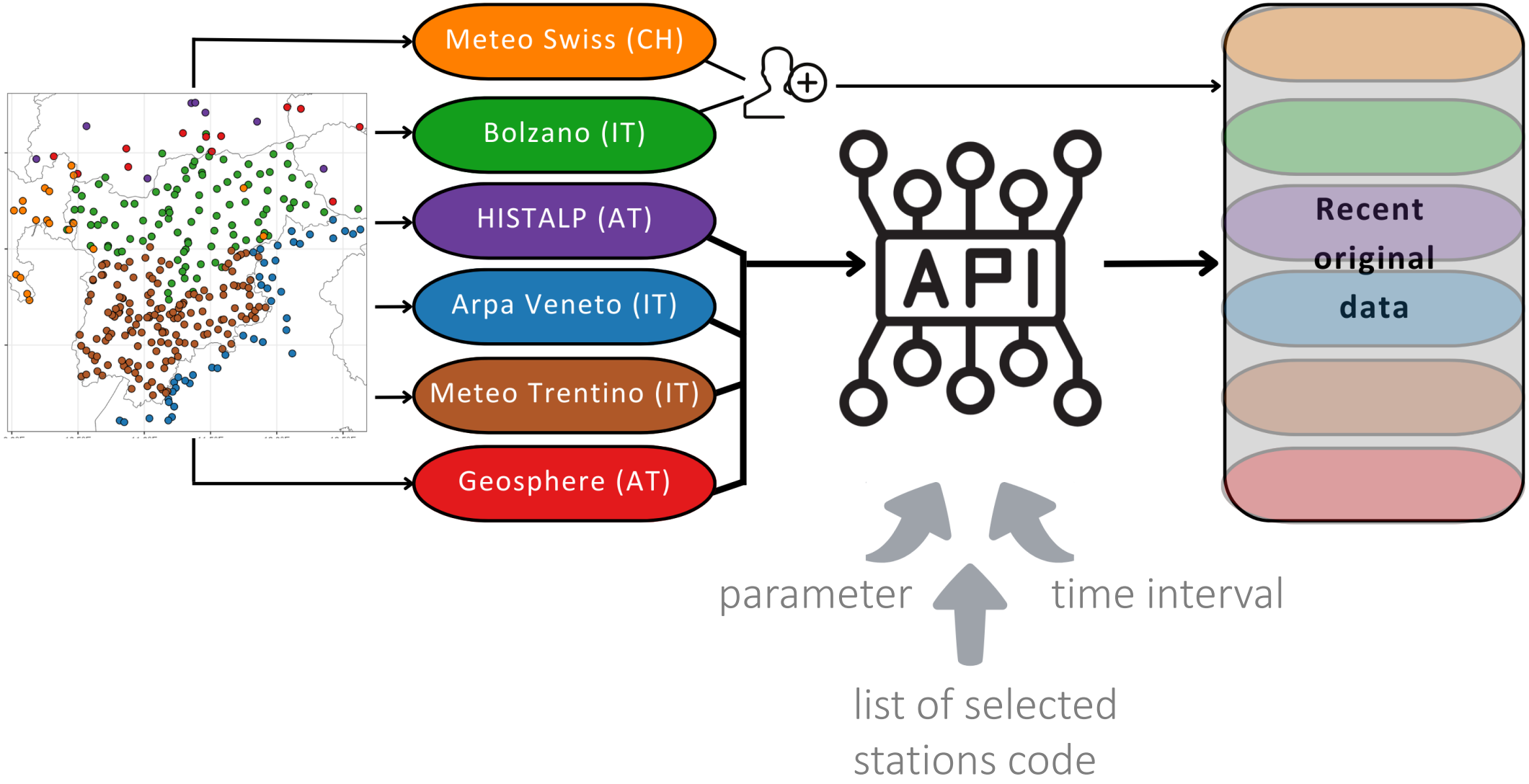


01 : Data extraction



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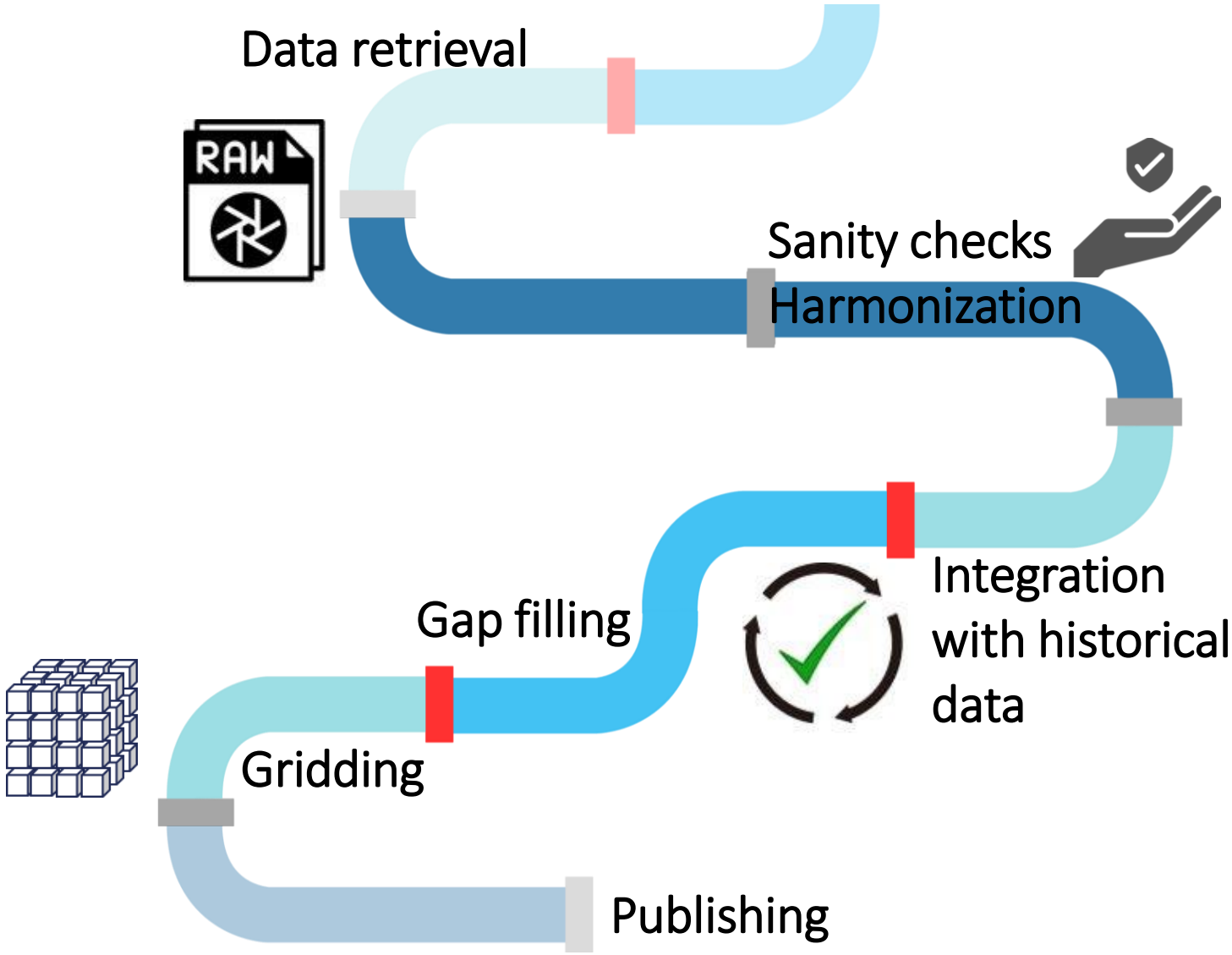
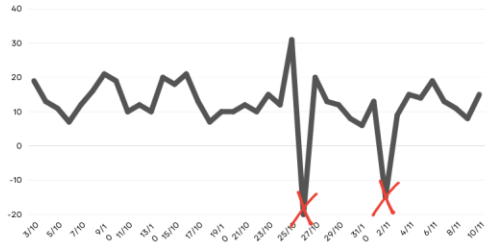


02 : Sanity checks and harmonization



REMOVE INCONSISTENCIES

CLEANING USING QUALITY FLAGS

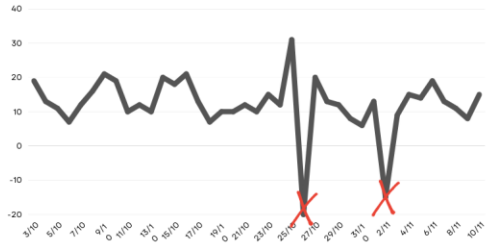
Date	Value	Quality flag
3/10/2023	~~13~~	bad!
4/10/2023	~~15~~	nope!
5/10/2023	11	ok!

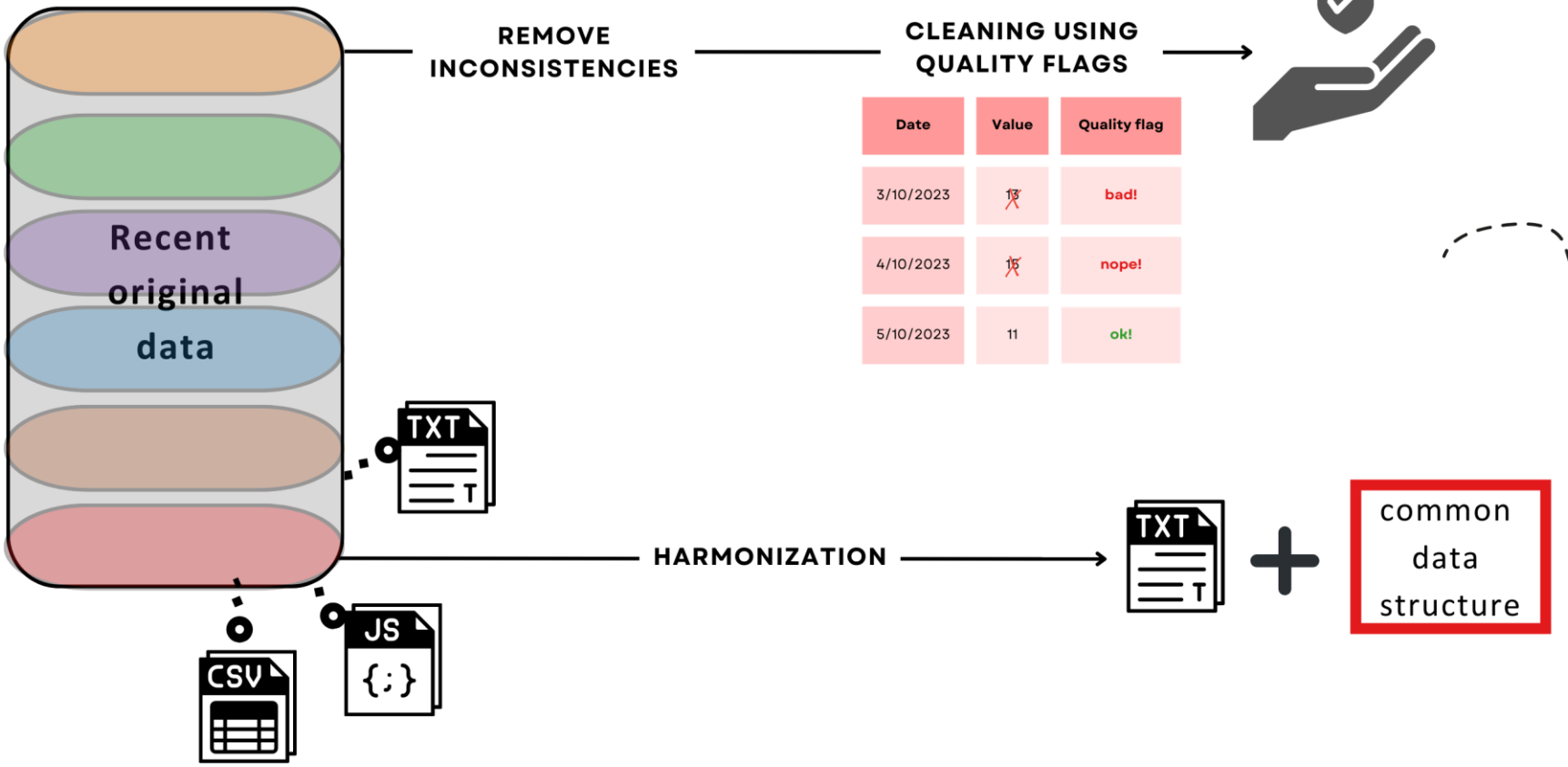
Recent original data

HARMONIZATION

common data structure

02 : Sanity checks and harmonization

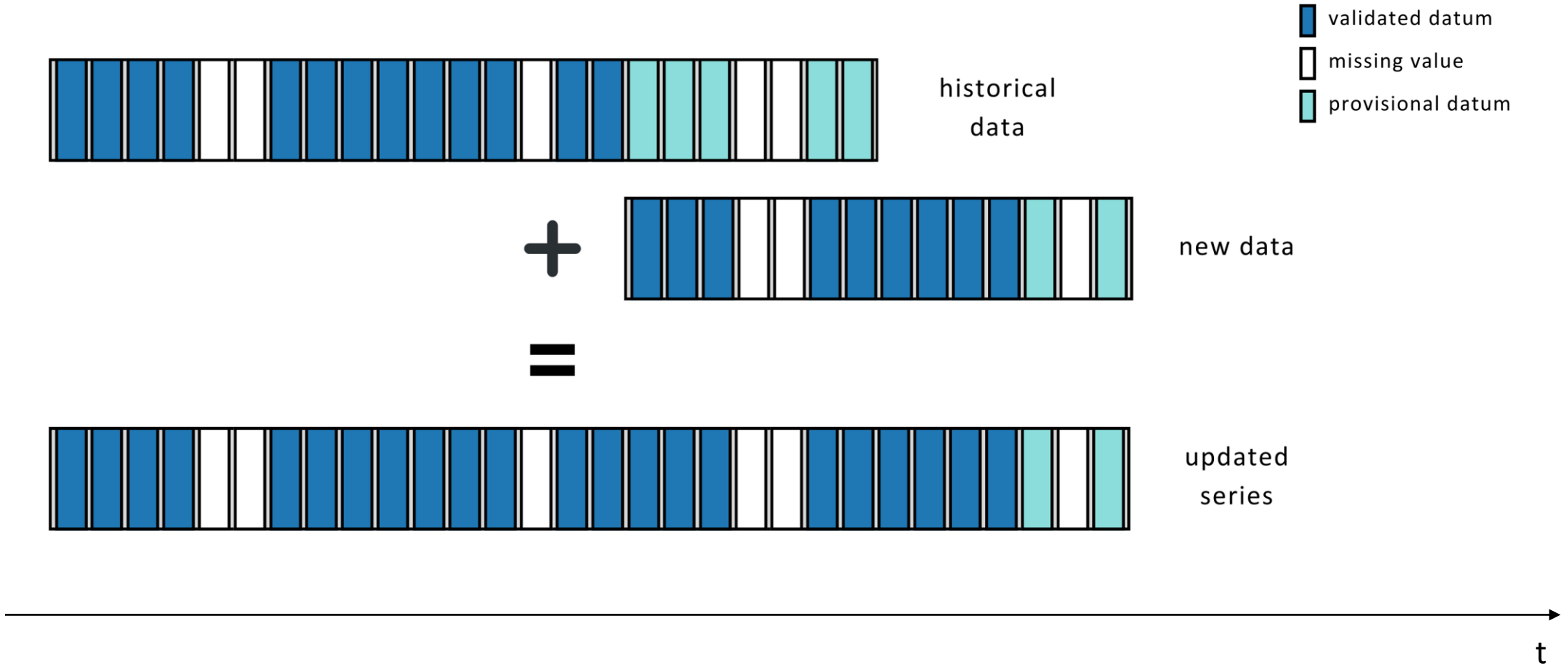




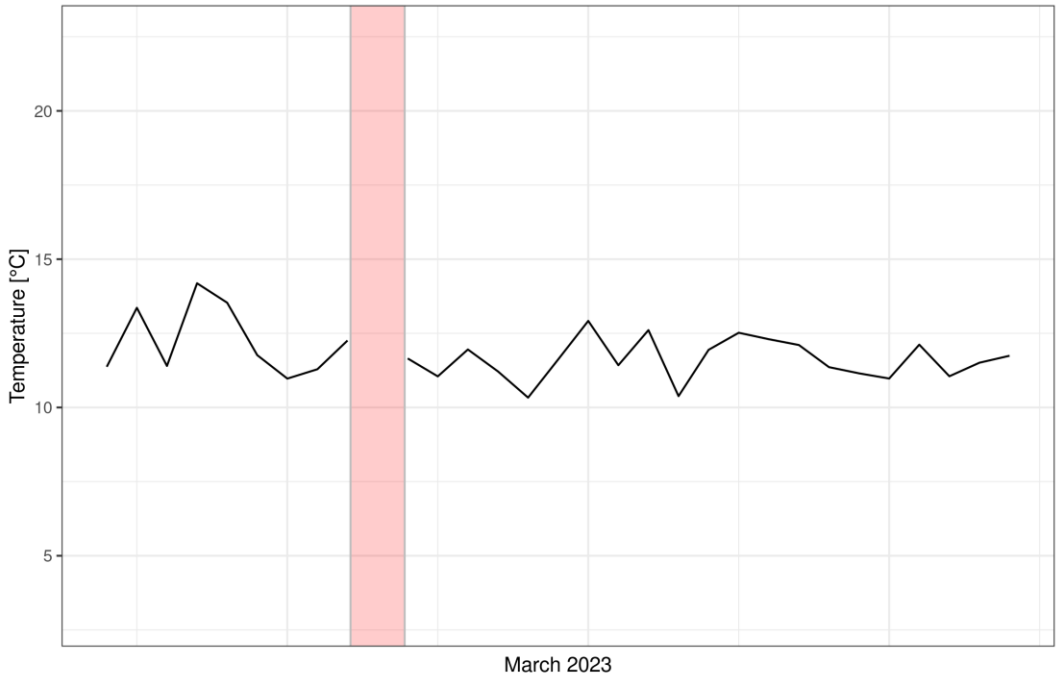
Date	Value	Quality flag
3/10/2023	~~13~~	bad!
4/10/2023	~~15~~	nope!
5/10/2023	11	ok!

Daily mean temperature calculated as mean(min, max)

03 : Integration with historical data



04 : Gap filling



Only isolated gaps

04 : Gap filling

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Interpolation based on surrounding stations

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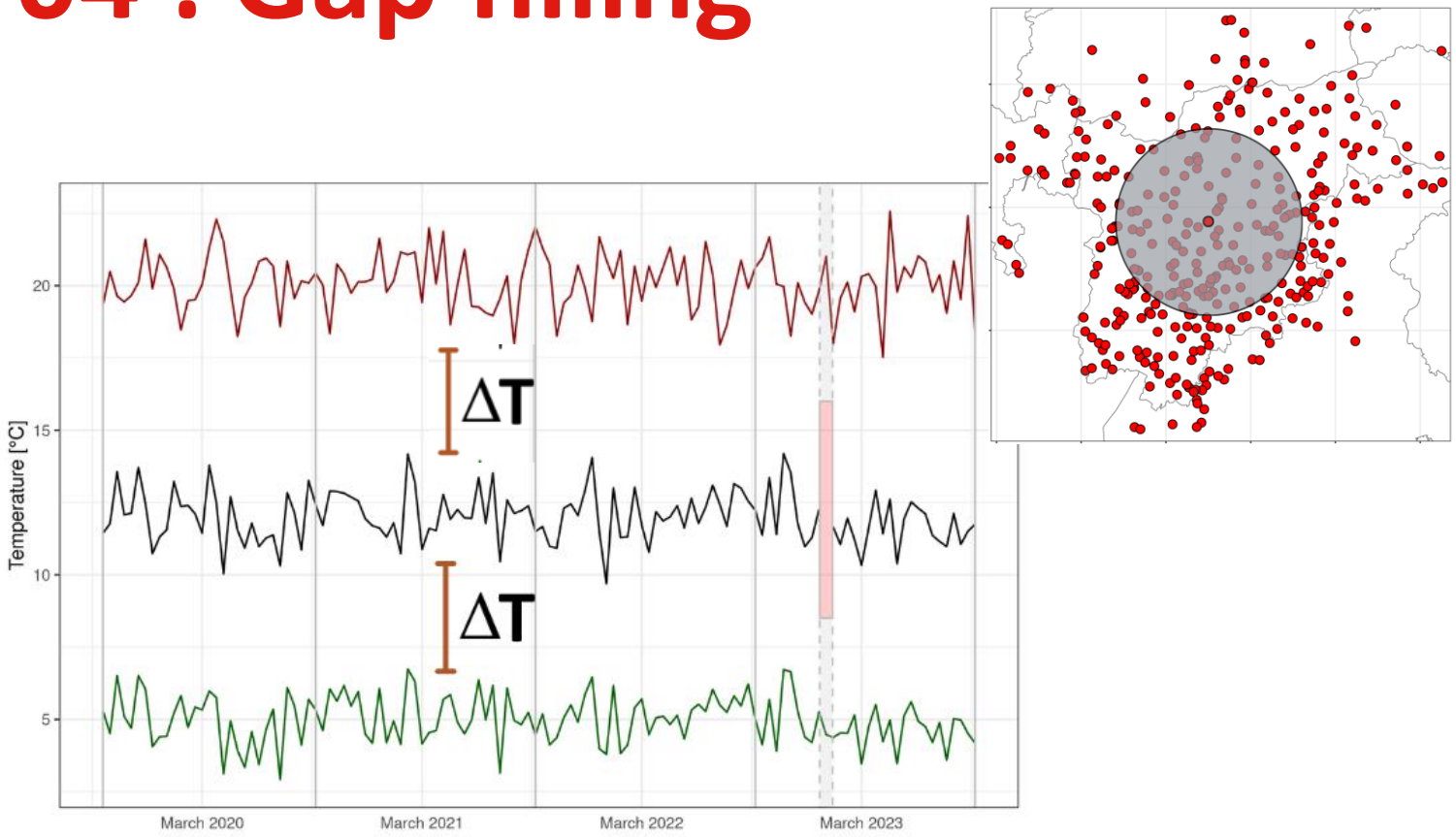

Only isolated gaps

Interpolation based on surrounding stations

Considering common historical data

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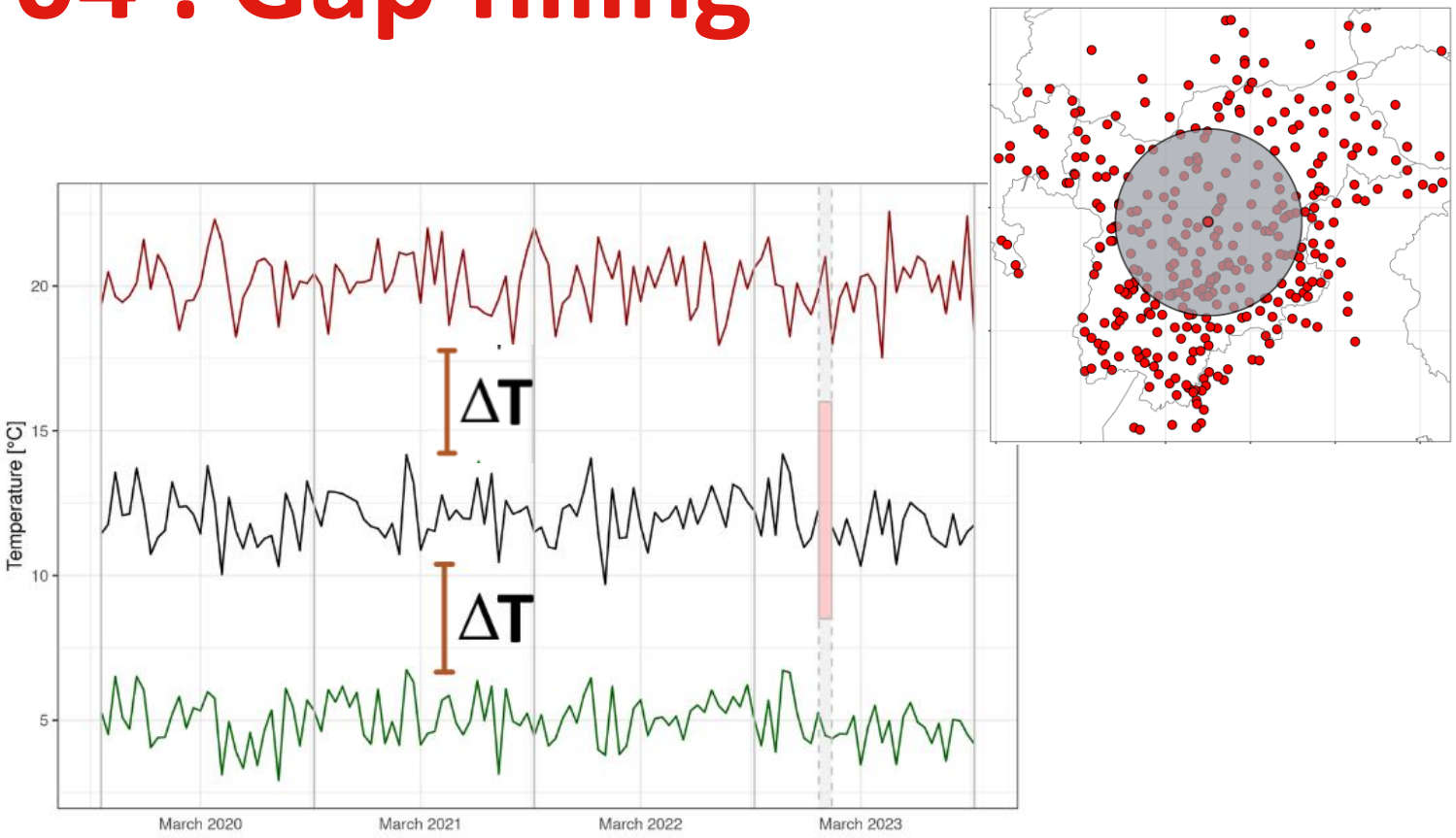

Only isolated gaps

Interpolation based on surrounding **correlated** stations

Considering common historical data

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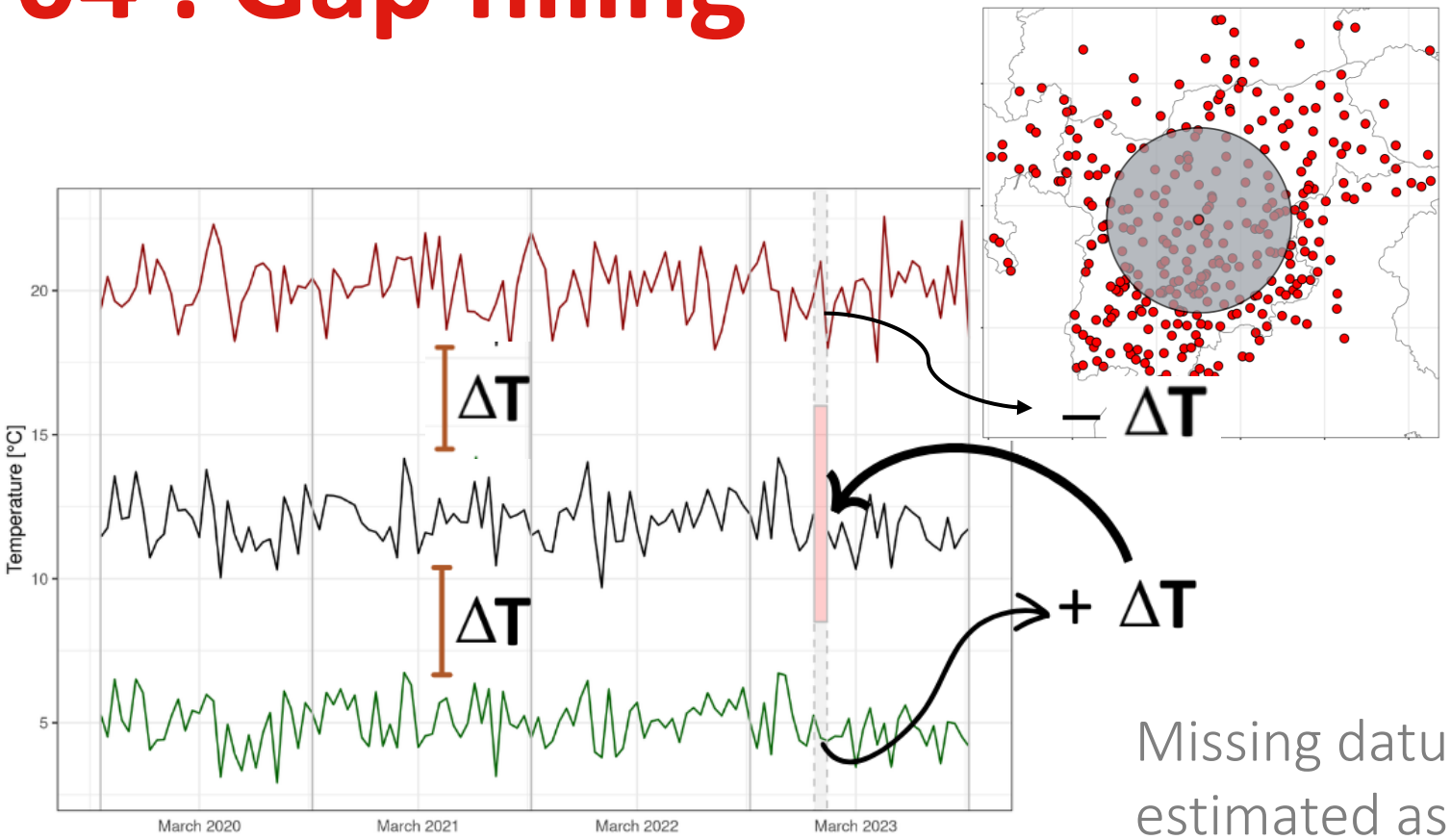

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Interpolation based on surrounding **correlated** stations

Considering common historical data

Missing datum estimated as the **weighted average of rescaled values**

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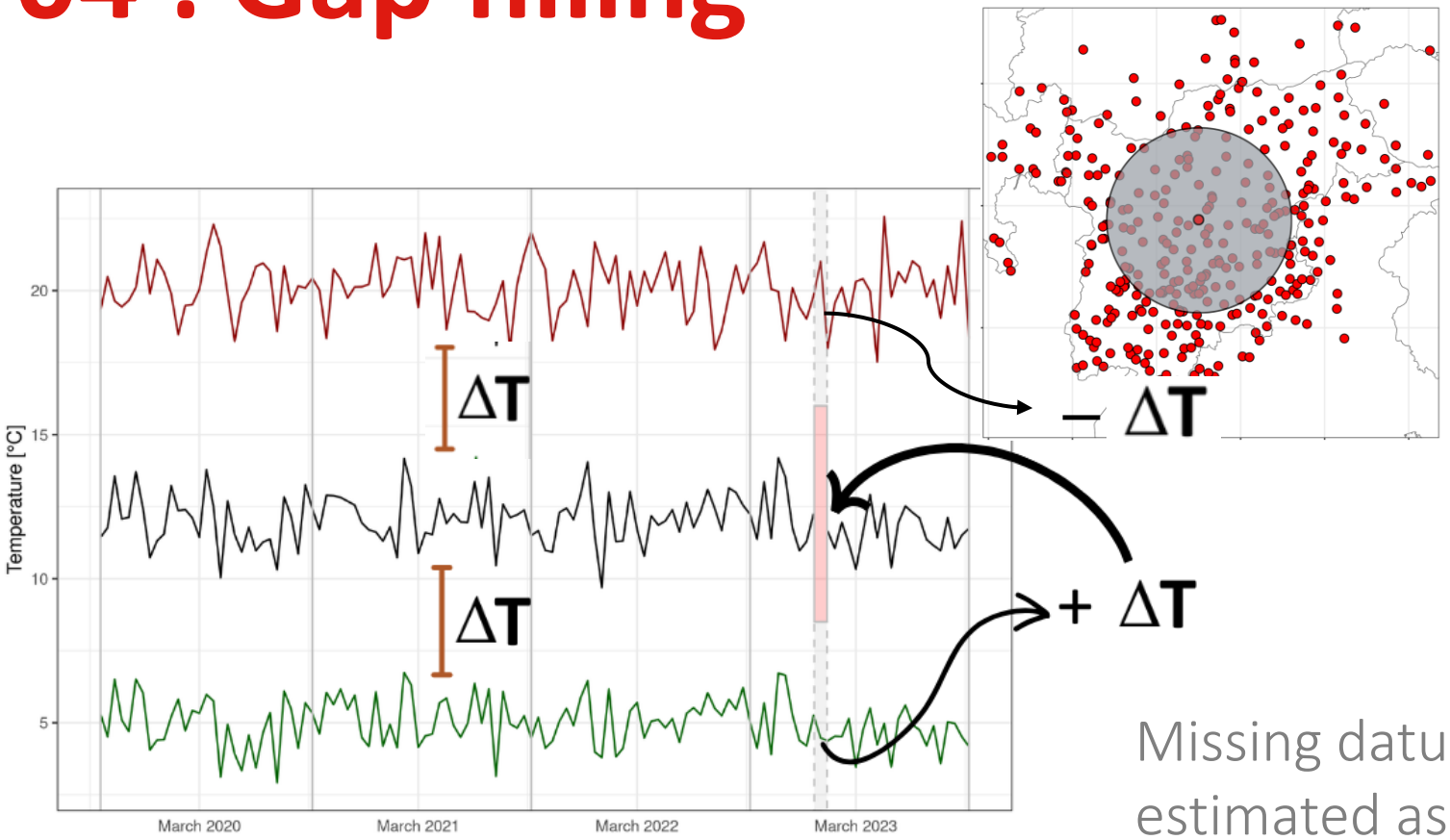

Only isolated gaps

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Missing datum estimated as the **weighted average of rescaled values**

Simulated values are **checked for consistency and mean temperature missing values** are determined from reconstructed values of min and max temperatures

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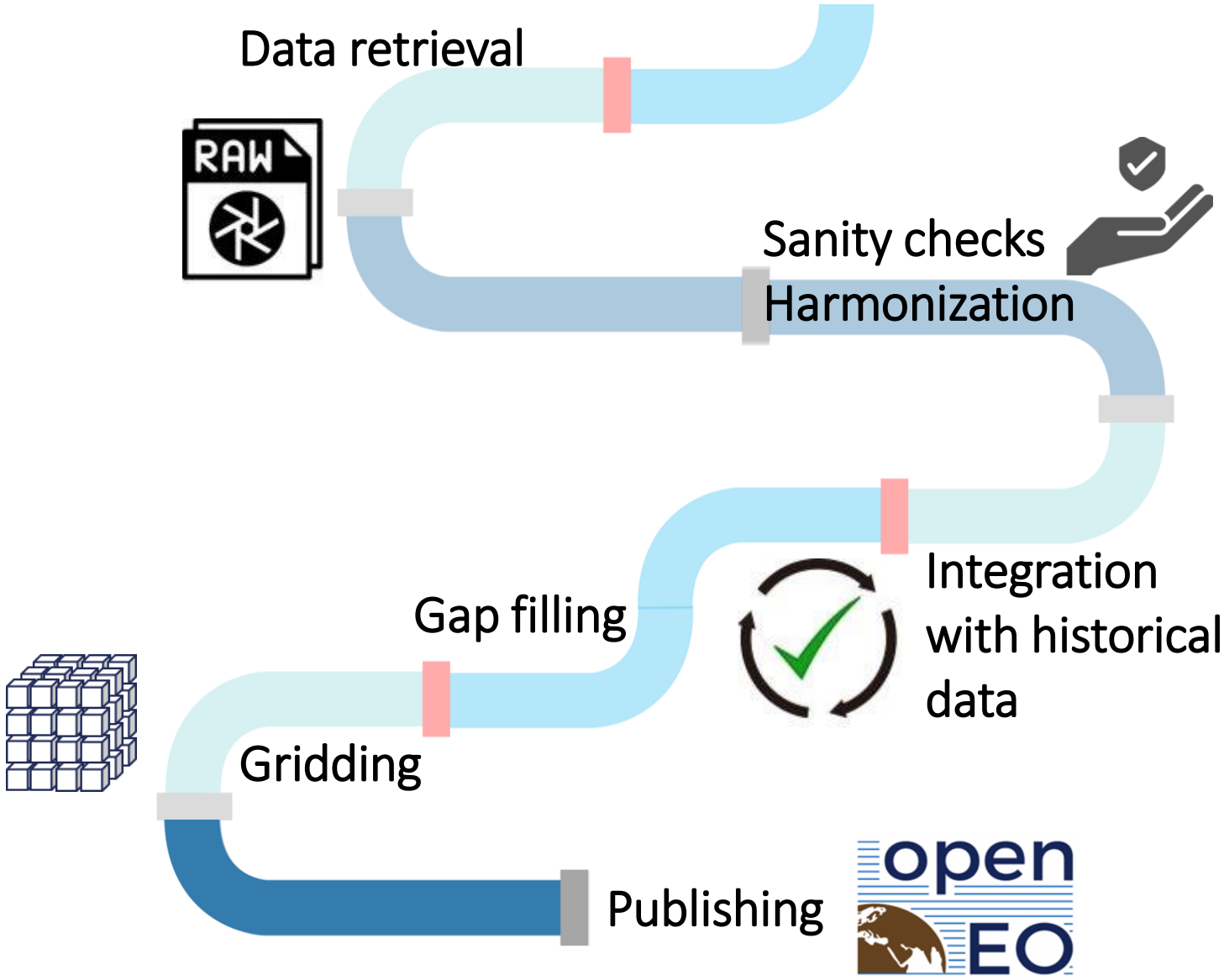
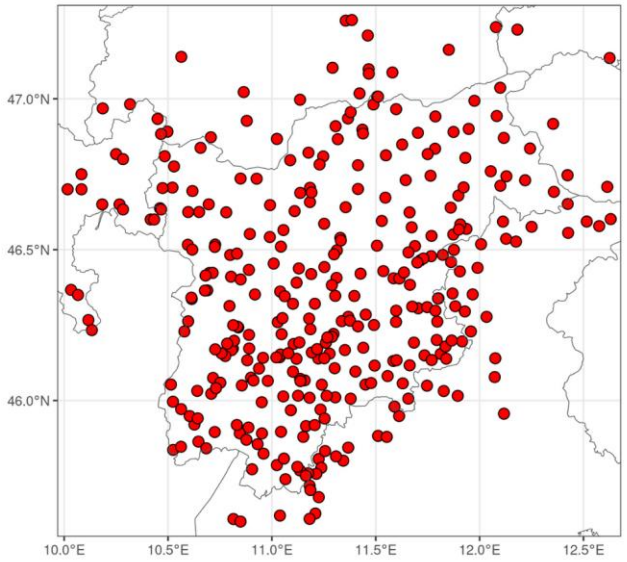
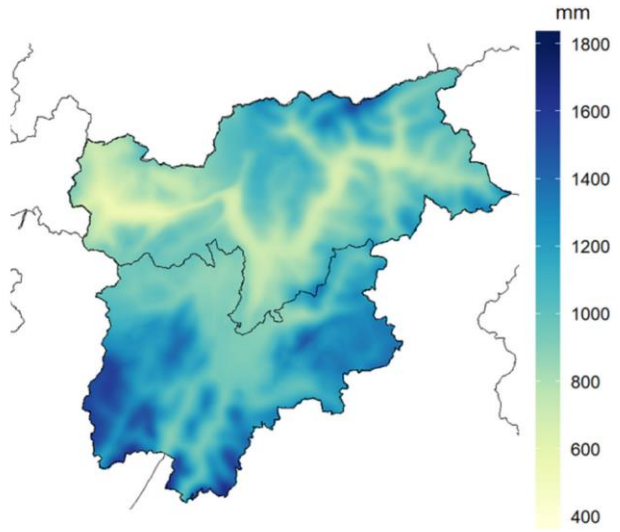


05 : Interpolation/gridding

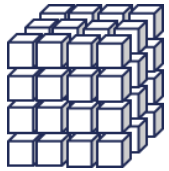


daily at-site time series

interpolation



daily grids



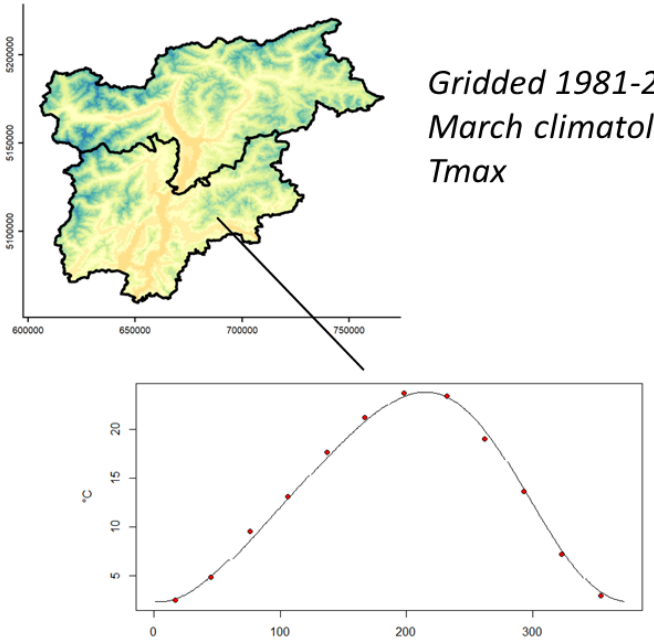
250m x 250m

NetCDF

05 : Interpolation/gridding: temperature

Local weighted linear regression
of temperature normals *vs*
elevation and weights depending
on topographic features

$$\bar{t}_m(x,y) = a_m(x,y) + b_m(x,y) \cdot h(x,y)$$



Gridded 1981-2010
March climatologies of
Tmax

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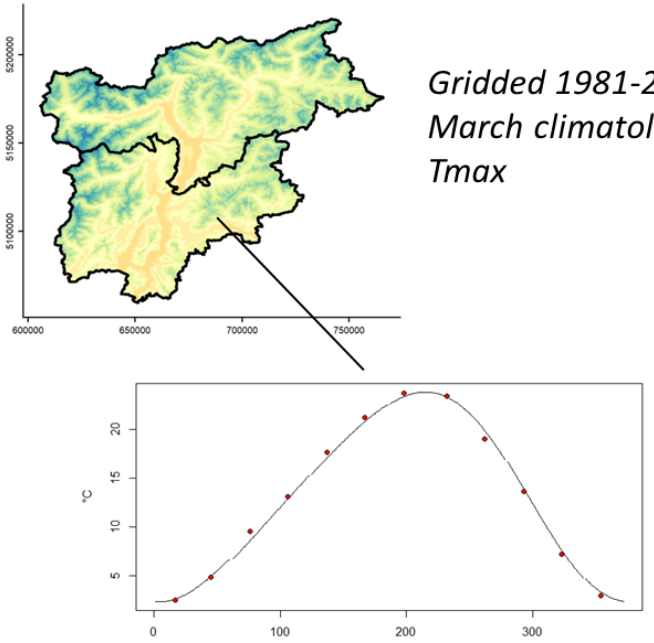

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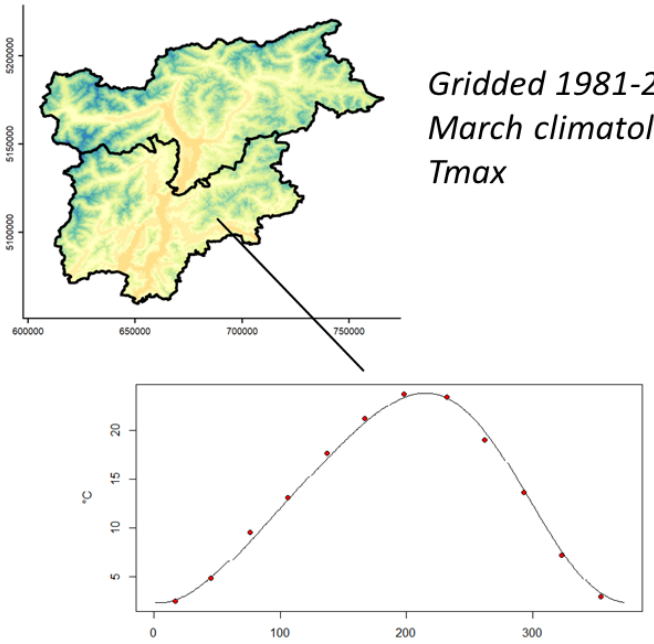
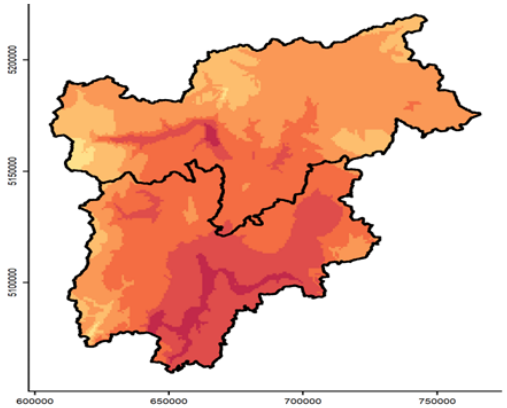


Gridded 1981-2010 March climatologies of Tmax

Daily normals based on a trigonometric fit from monthly normals

Local weighted average of station daily anomalies based on distance and elevation difference

$$a_d(x,y) = \frac{\sum_j w_j(x,y) \cdot a_{d,j}}{\sum_j w_j(x,y)}$$



Gridded anomalies on 5th March 2001

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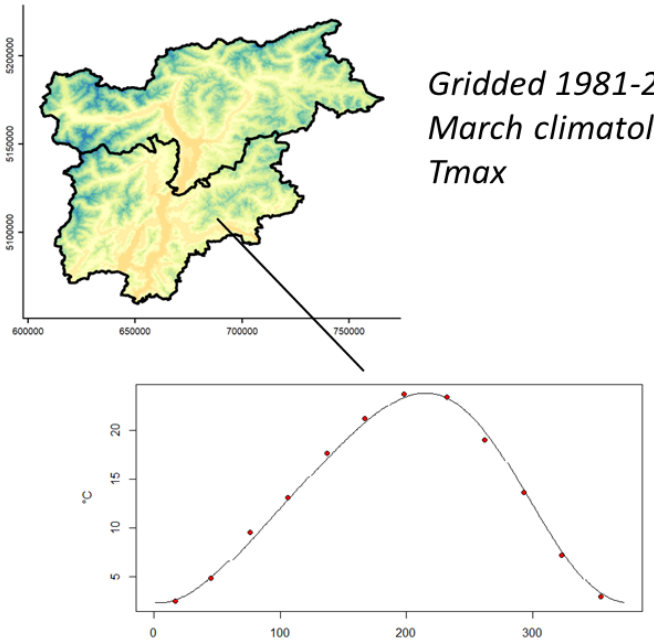

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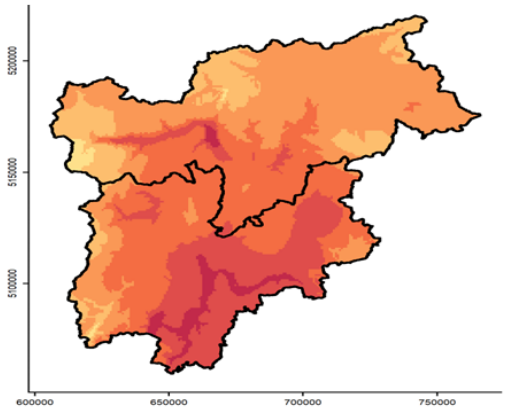
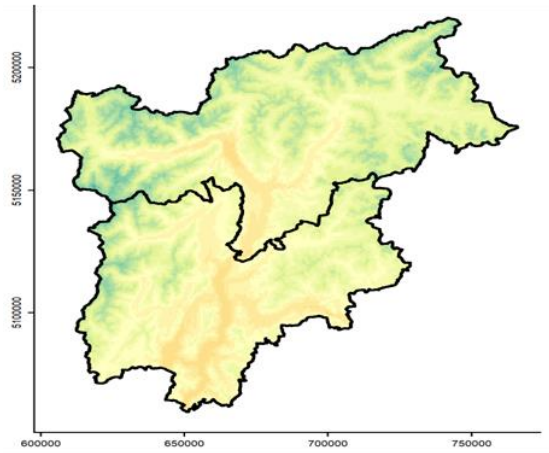


Gridded anomalies on 5th March 2001

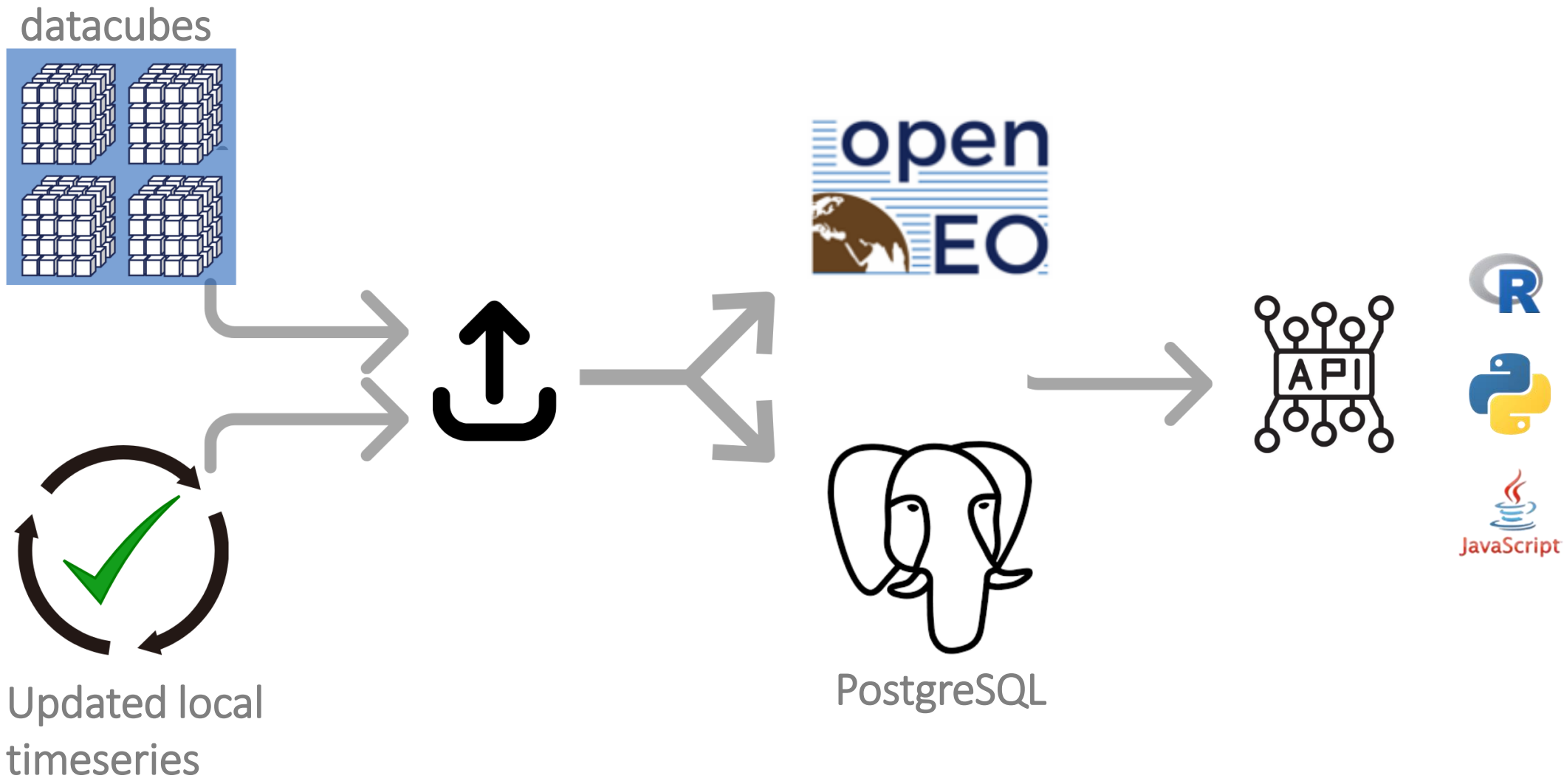
Superimposition (sum) of gridded anomalies and climatologies

$$t_d(x,y) = a_d(x,y) + \bar{t}_d(x,y)$$



Gridded Tmax on 5th July 2001

06 : Publishing



Automating the pipeline

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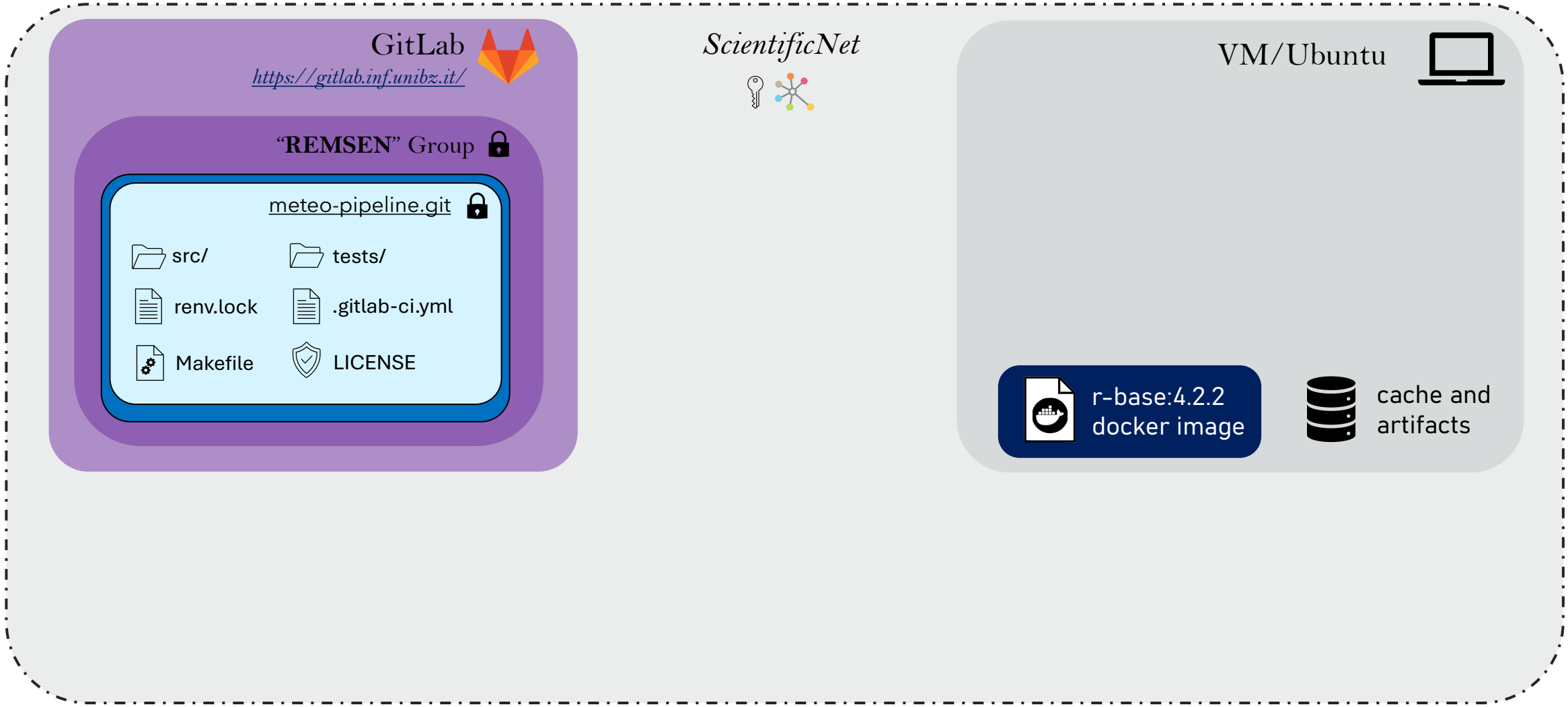

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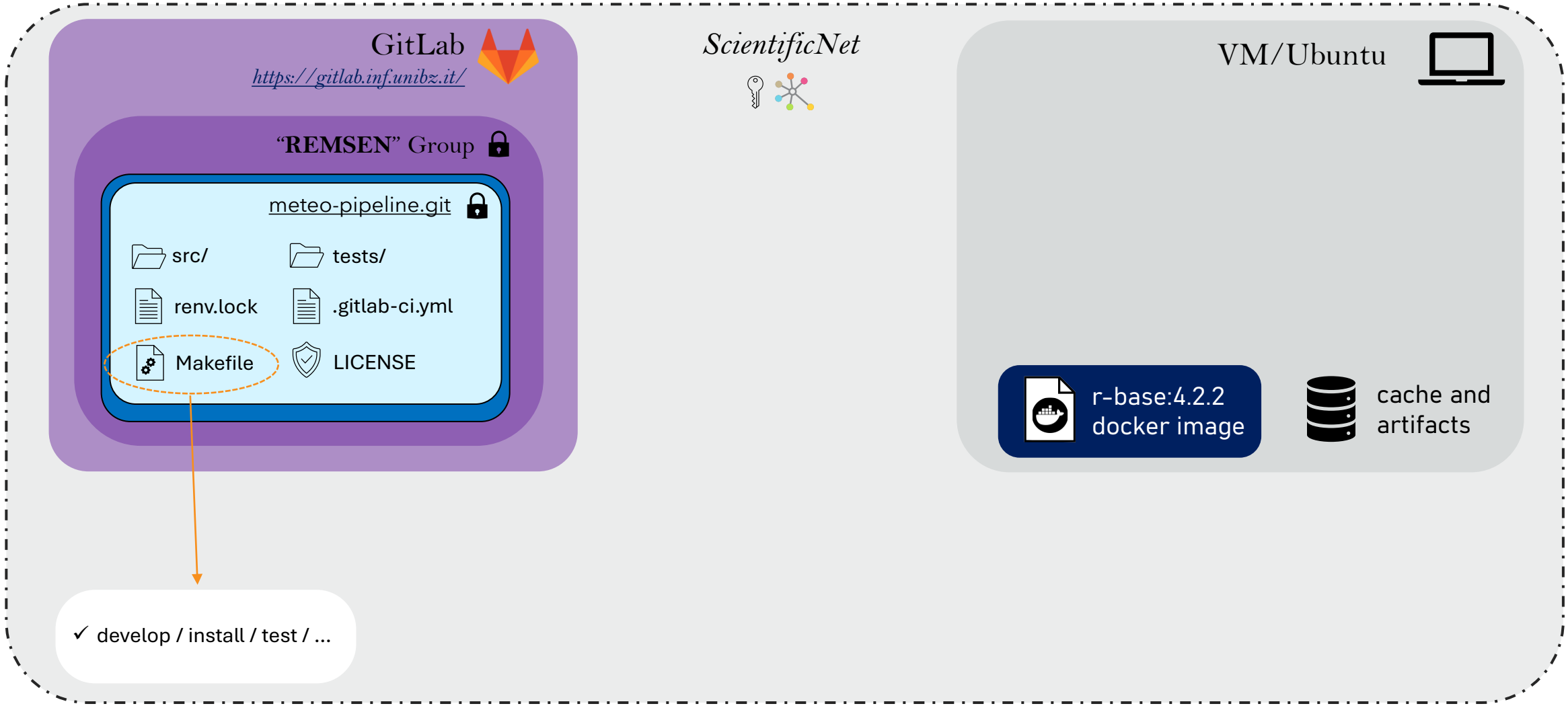

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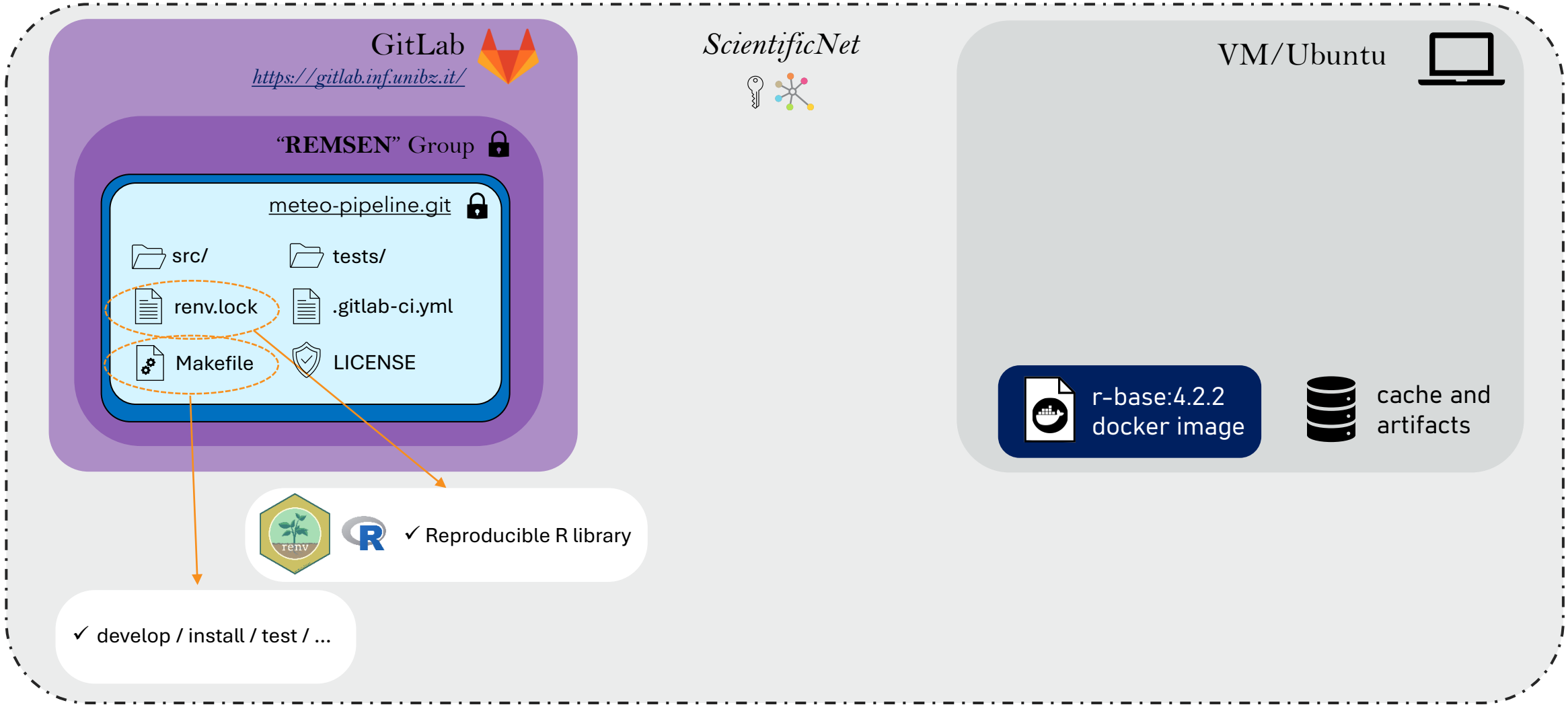

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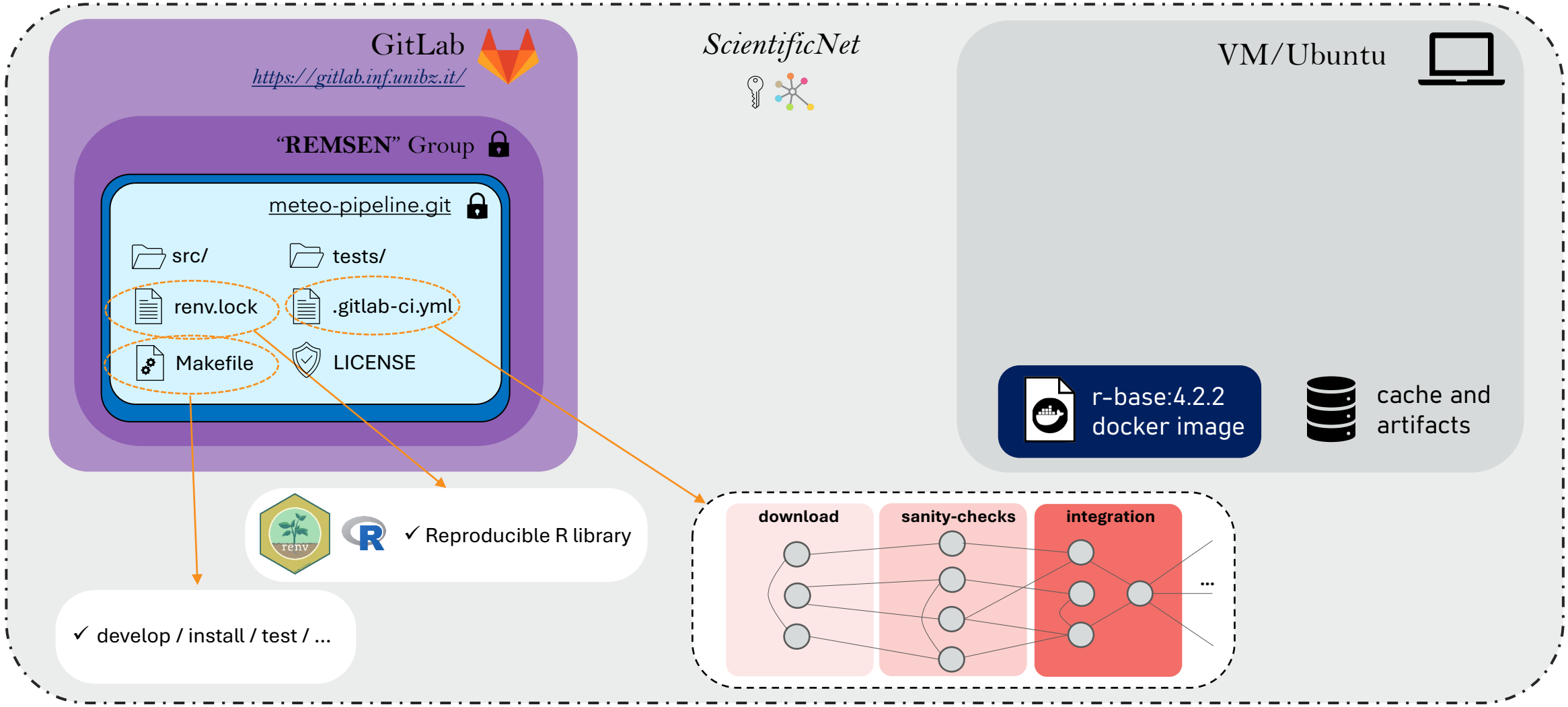

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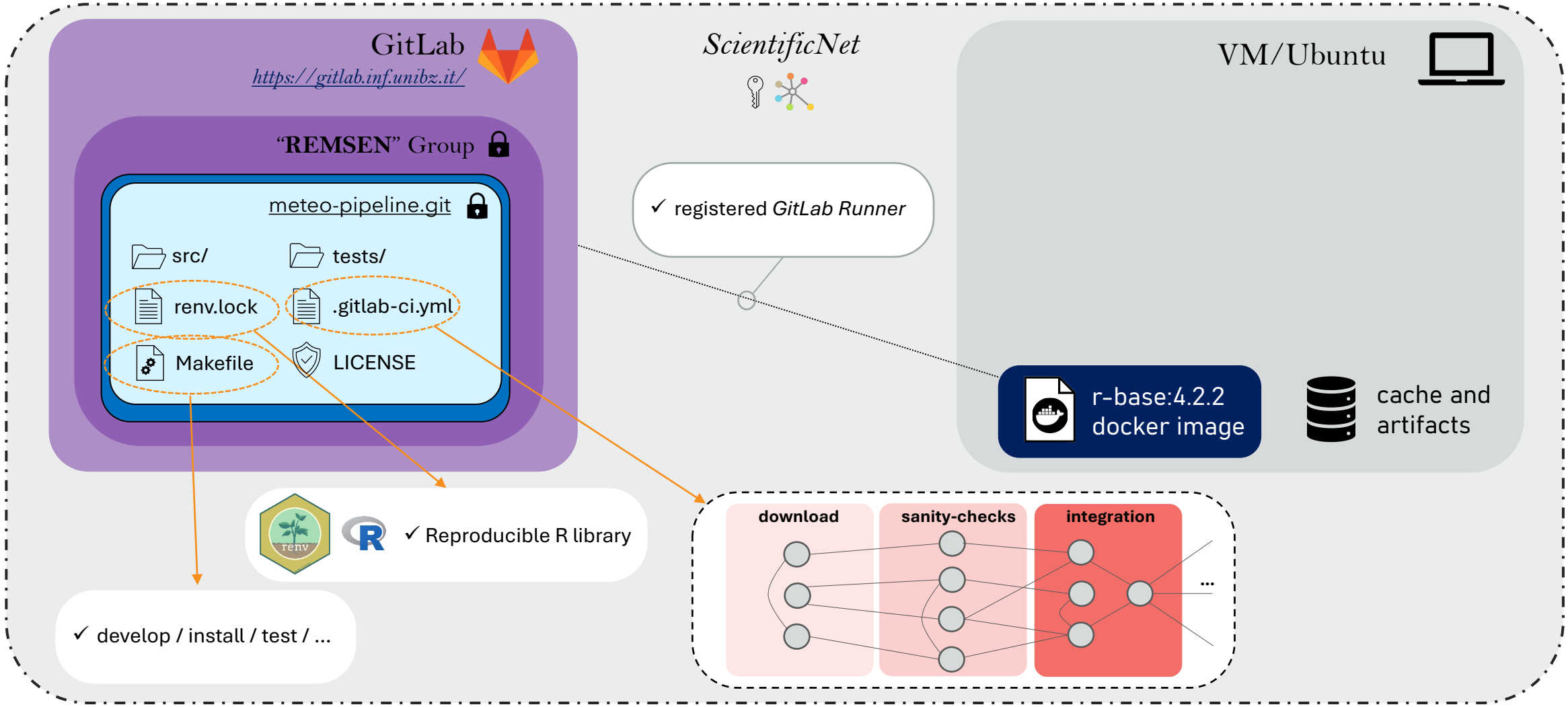

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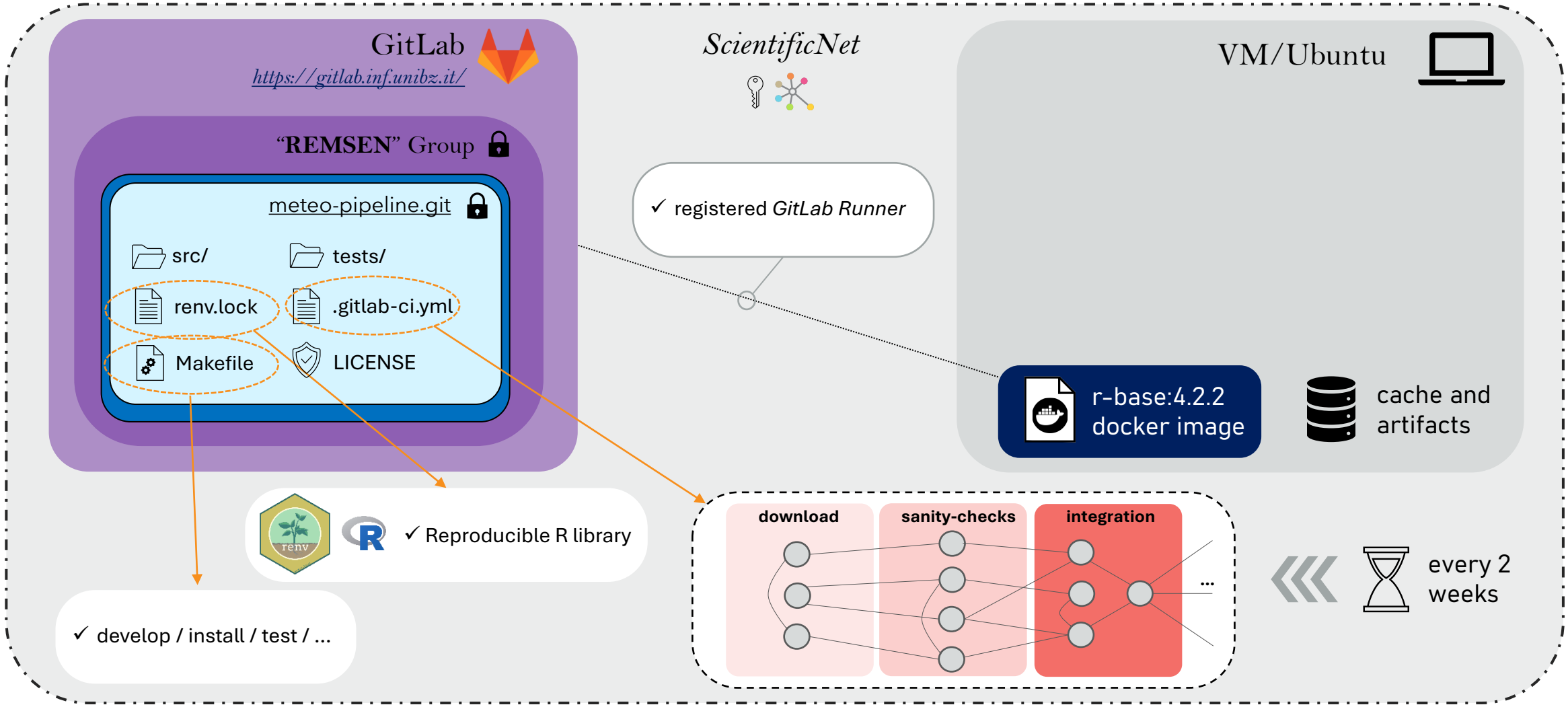

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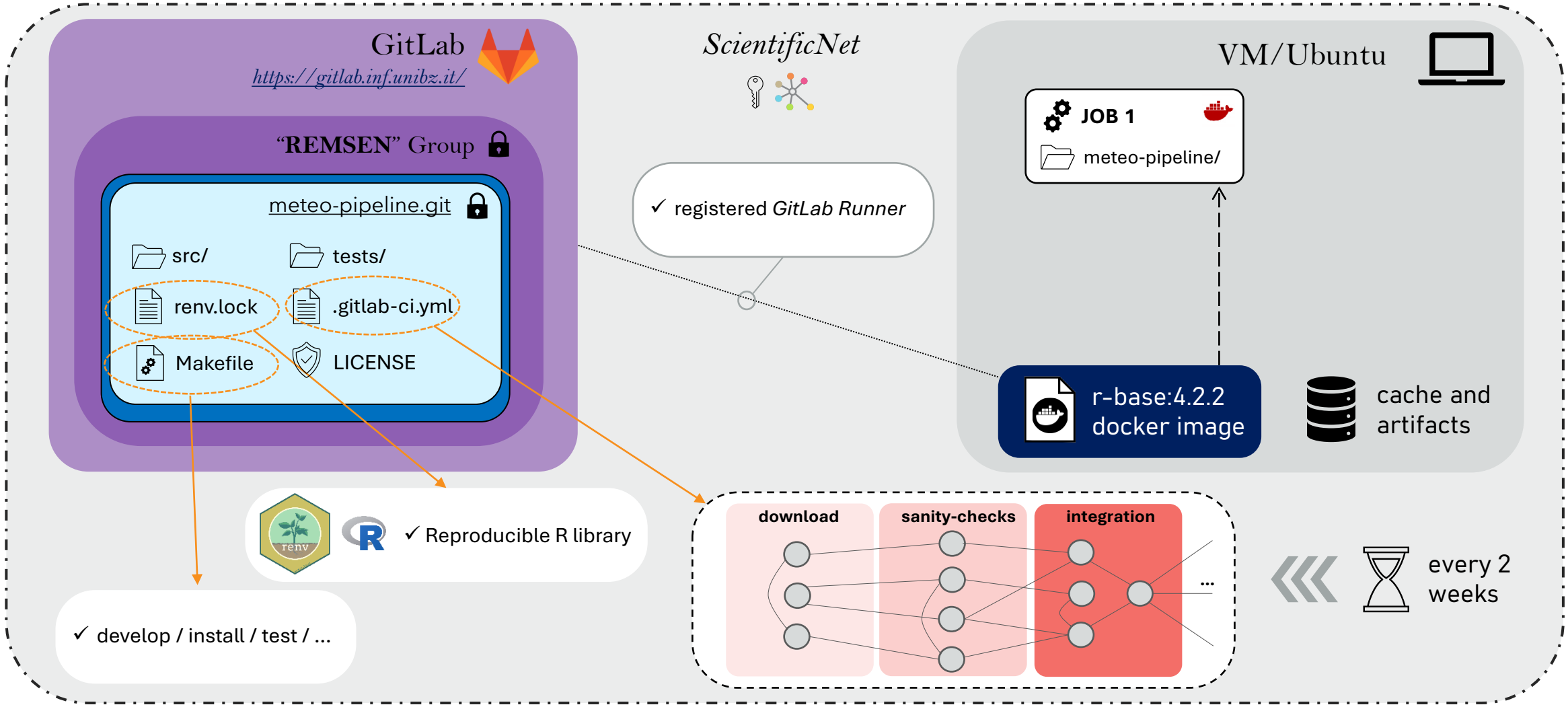
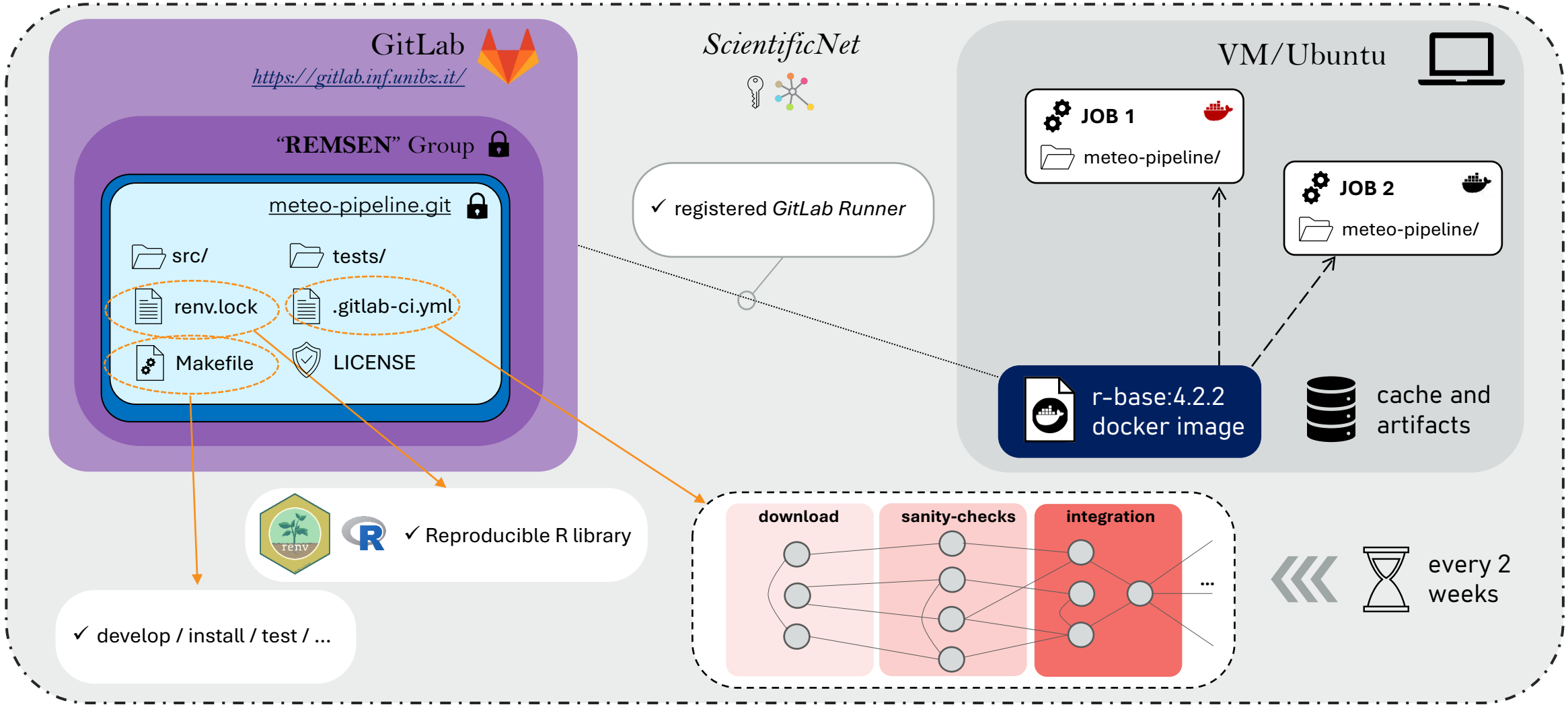
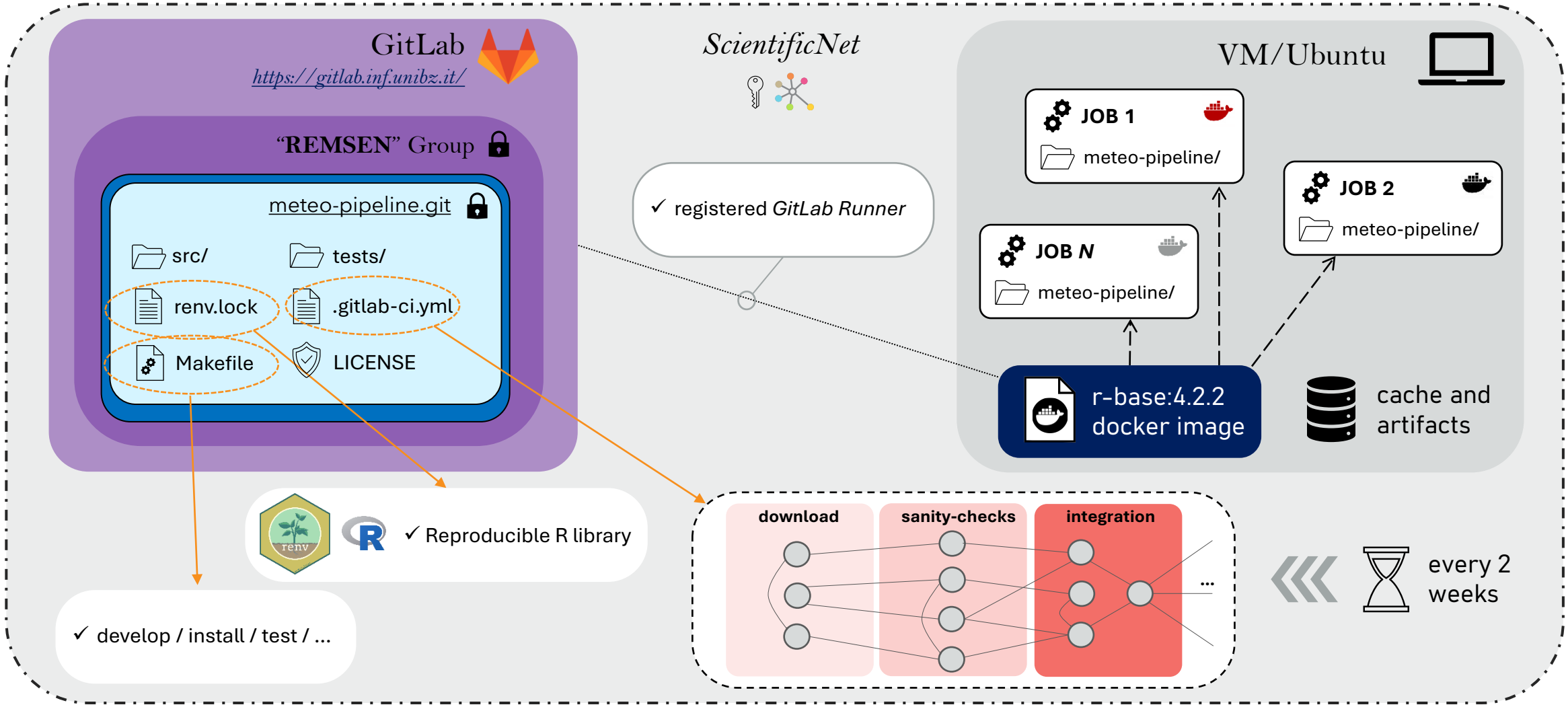


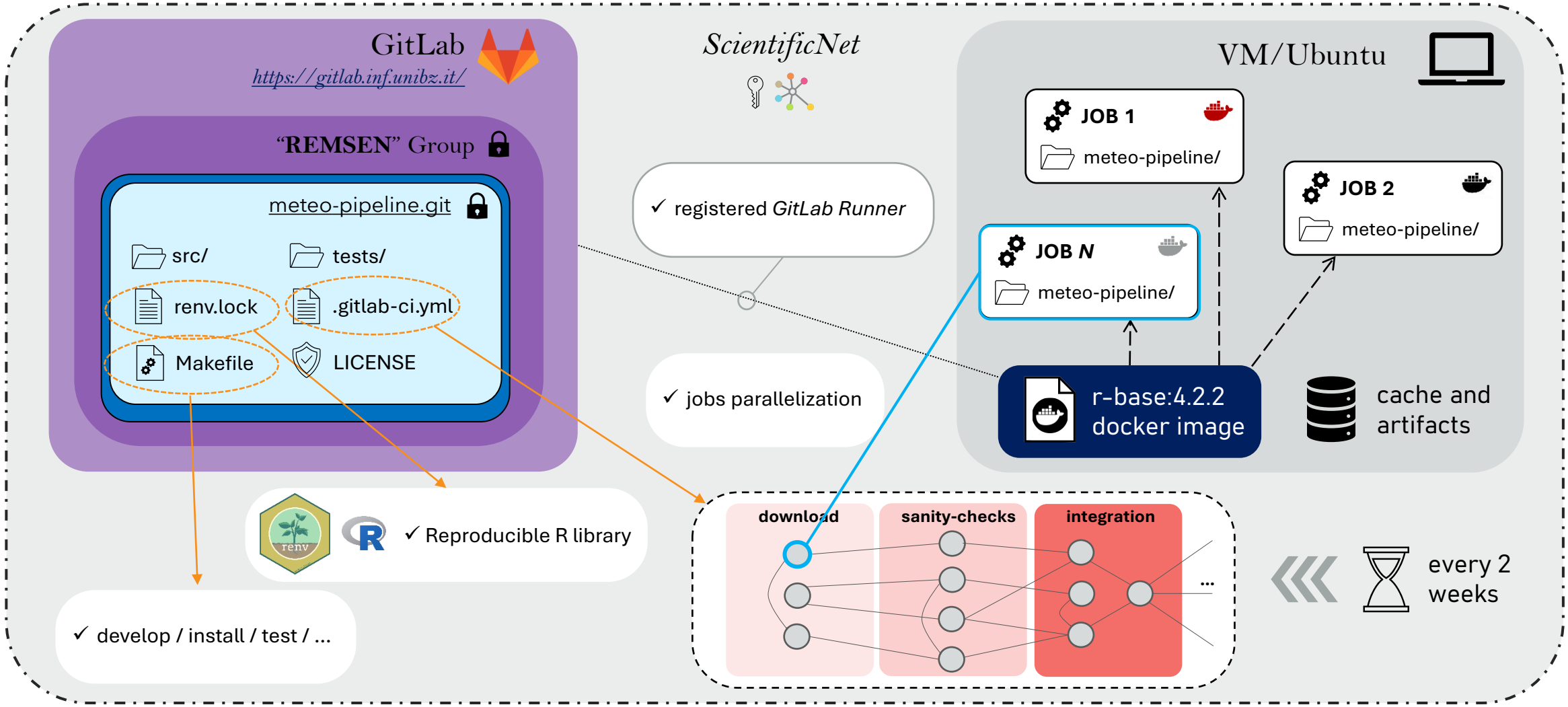
Automating the pipeline



Automating the pipeline



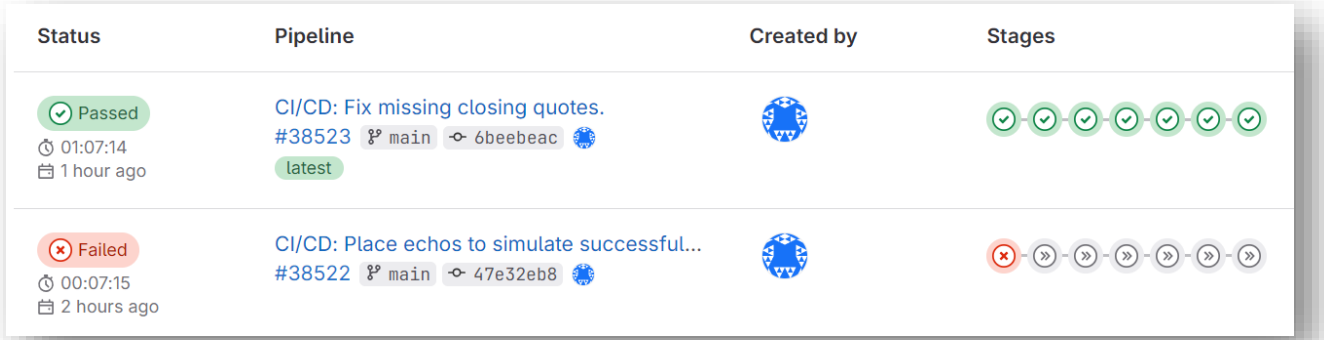
Automating the pipeline



GitLab's out of the box:
Monitoring & Troubleshooting

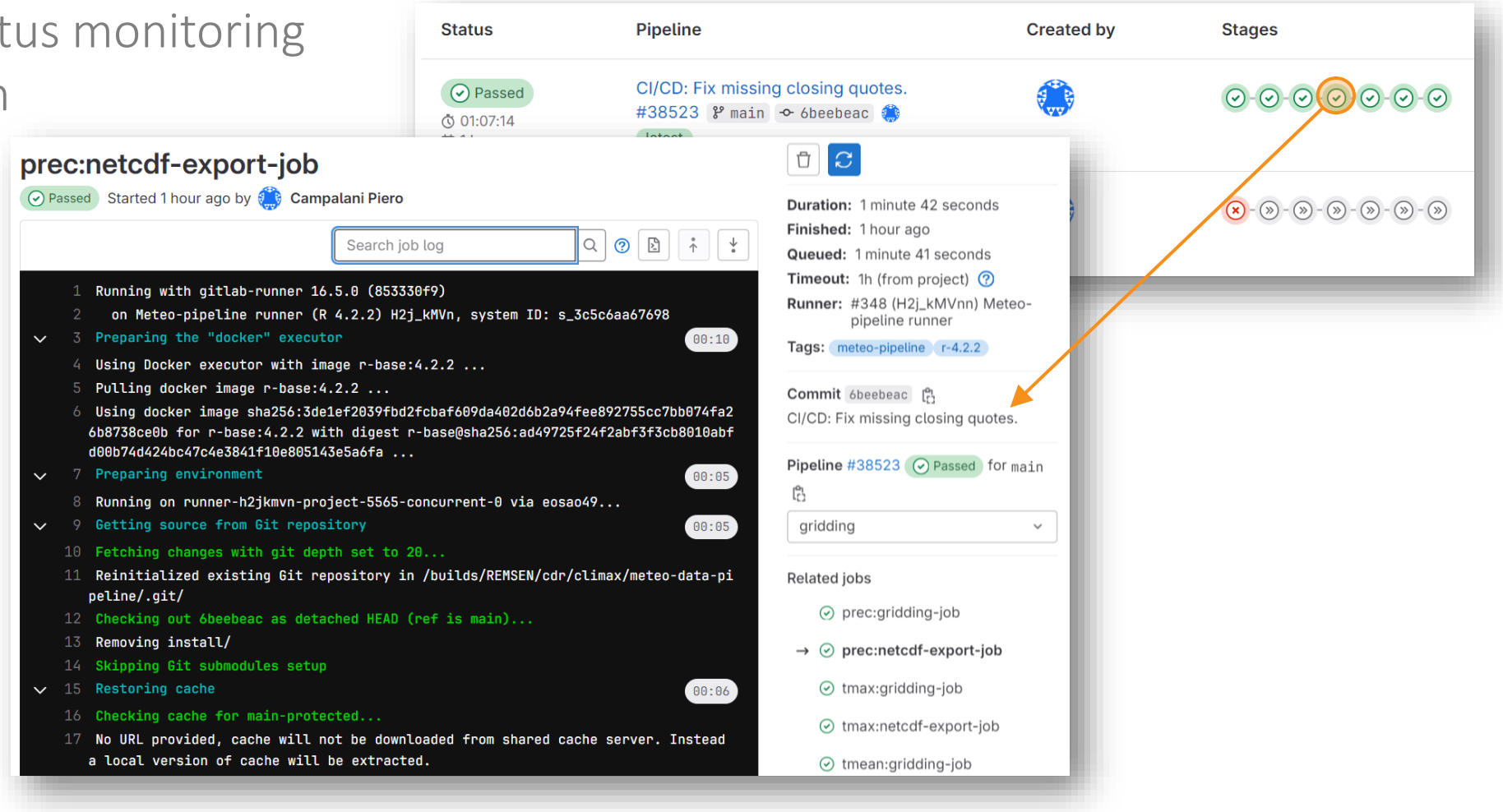
GitLab’s out of the box:
Monitoring & Troubleshooting

✓ UI-based pipeline status monitoring



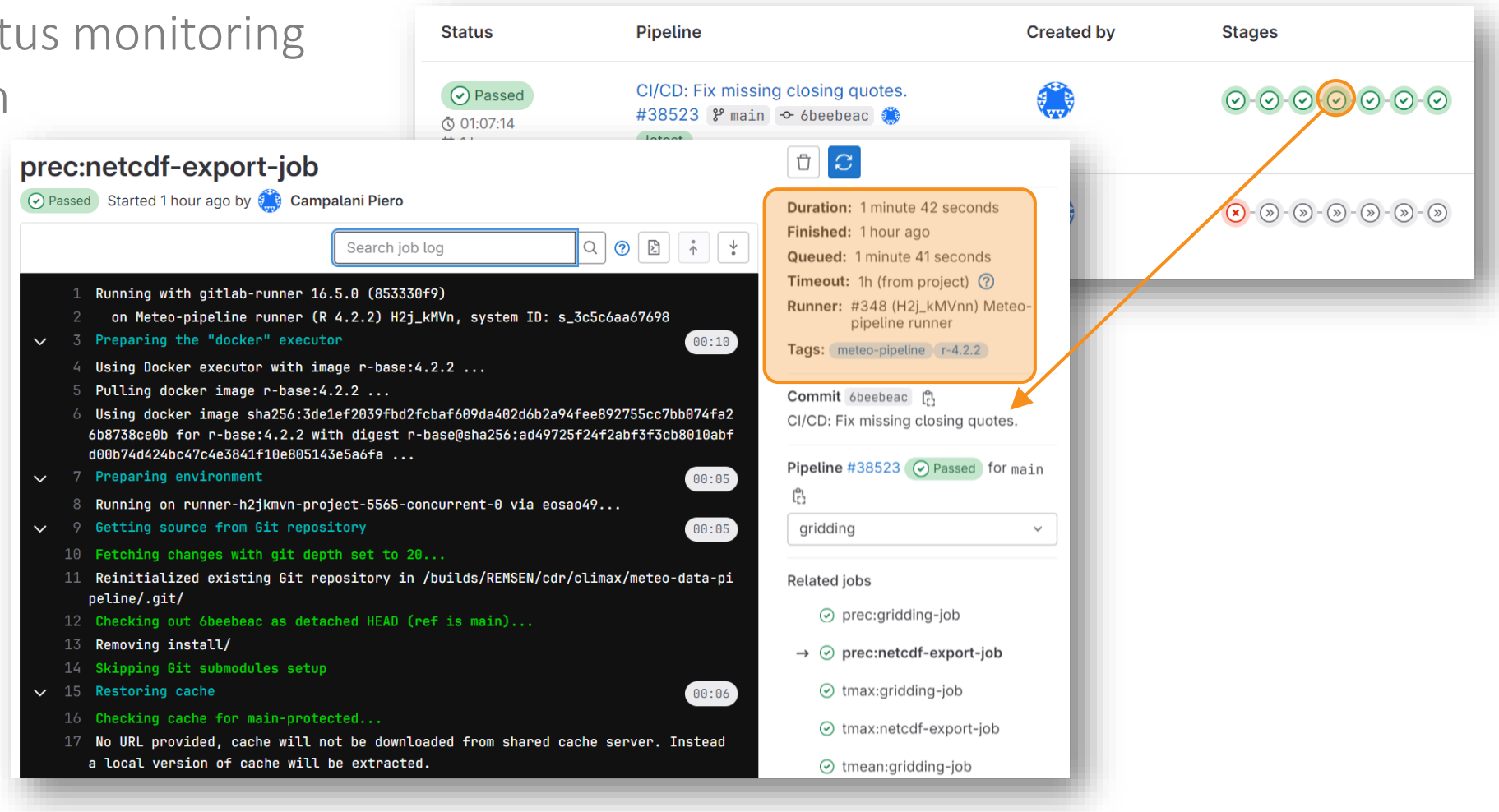
GitLab's out of the box:
Monitoring & Troubleshooting

- ✓ UI-based pipeline status monitoring
- ✓ Jobs logs visualization



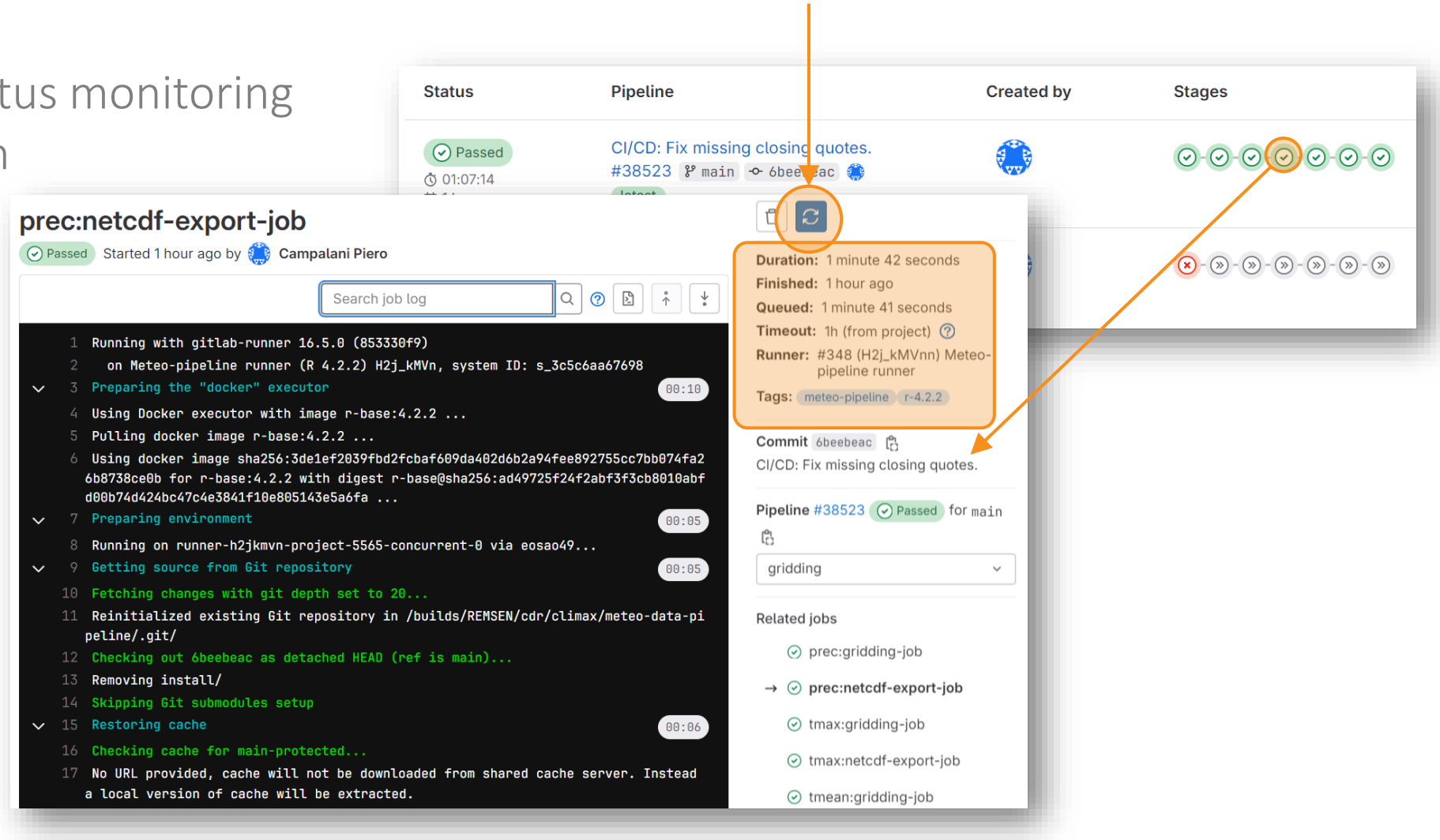
GitLab's out of the box:
Monitoring & Troubleshooting

- ✓ UI-based pipeline status monitoring
- ✓ Jobs logs visualization
- ✓ Timing information



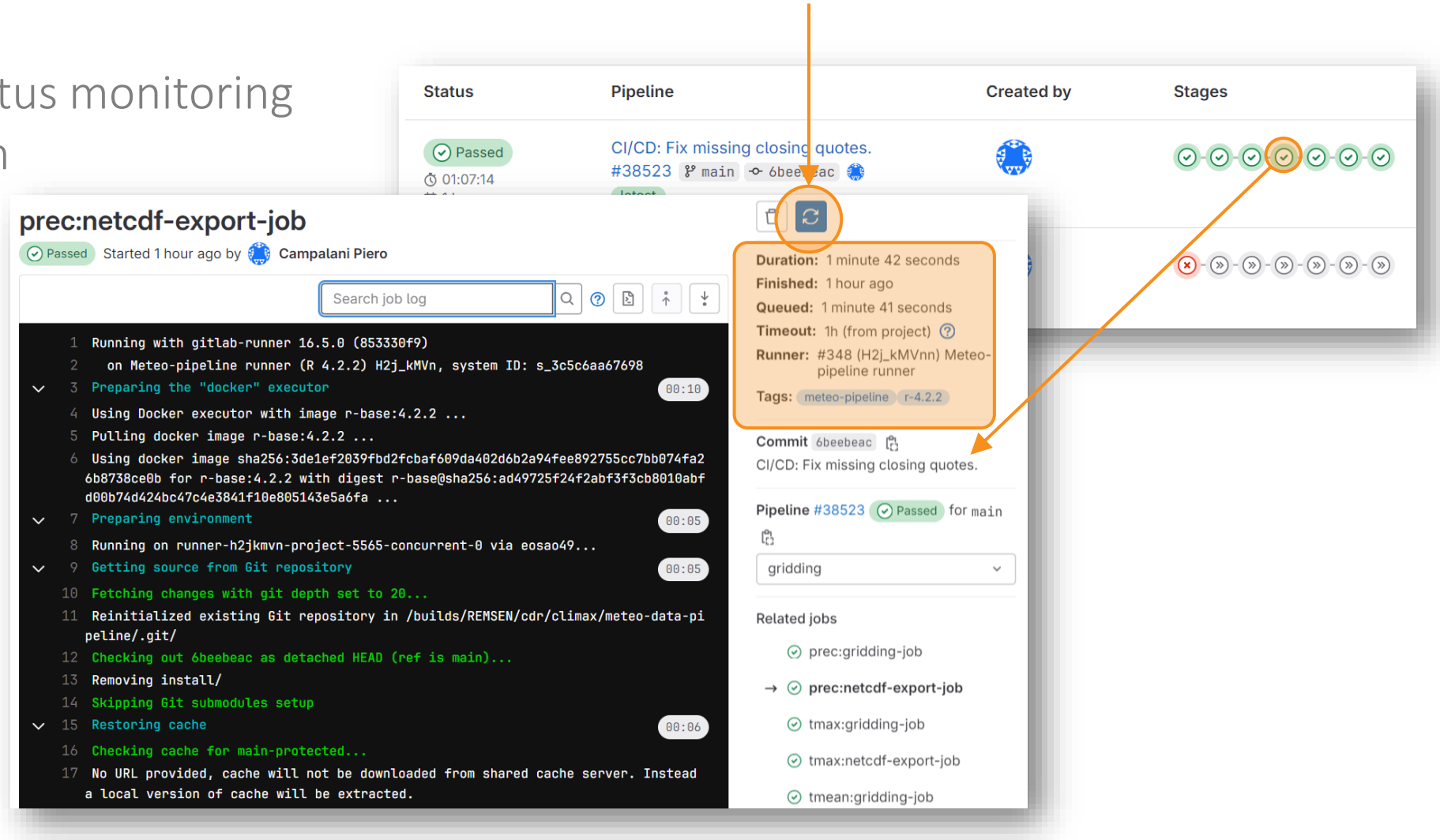
GitLab's out of the box:
Monitoring & Troubleshooting

- ✓ UI-based pipeline status monitoring
- ✓ Jobs logs visualization
- ✓ Timing information
- ✓ Job's manual re-runs

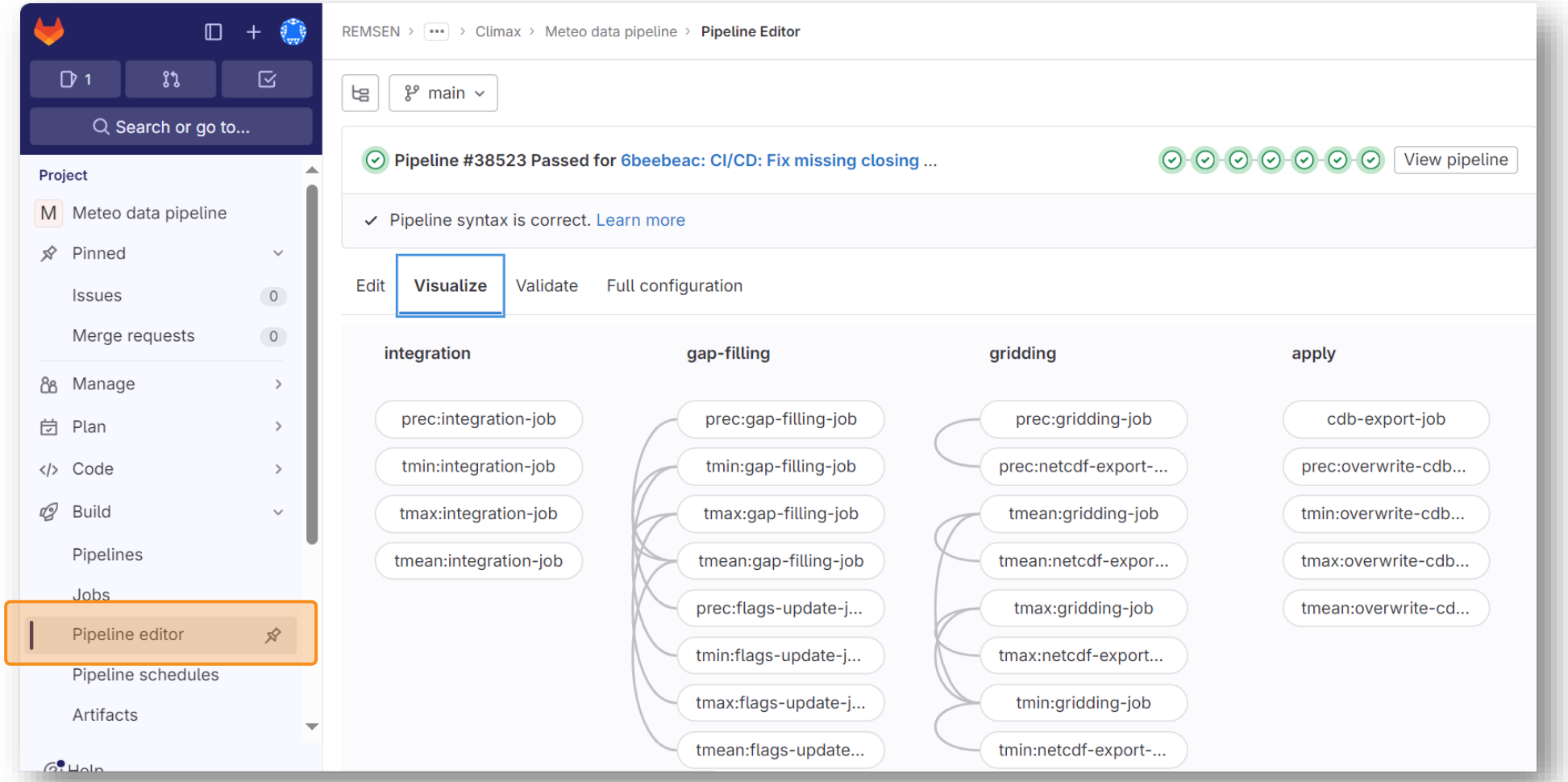


GitLab's out of the box:
Monitoring & Troubleshooting

- ✓ UI-based pipeline status monitoring
- ✓ Jobs logs visualization
- ✓ Timing information
- ✓ Job's manual re-runs
- ✓ API also available



GitLab’s out of the box:
The Pipeline Editor



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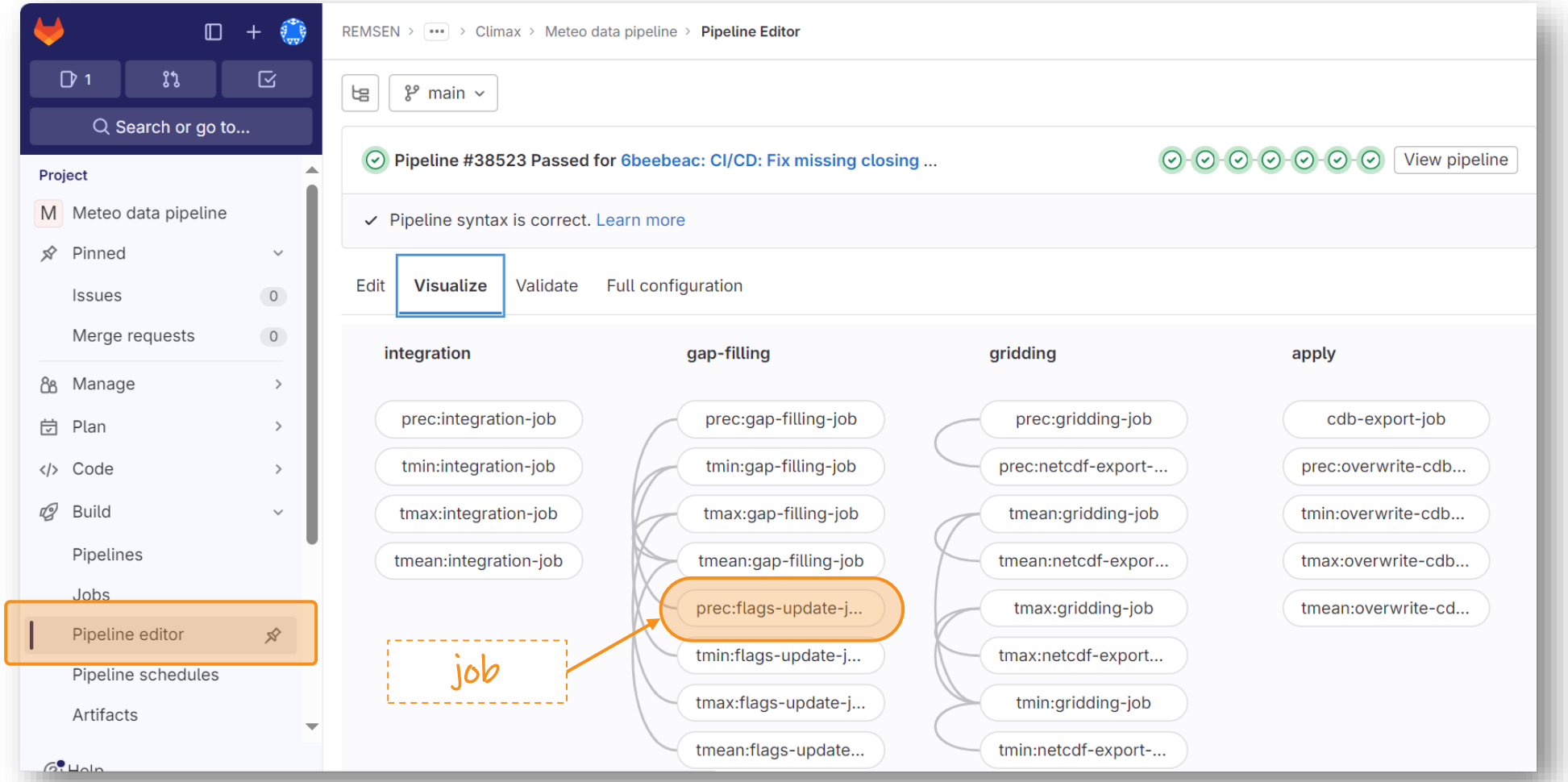

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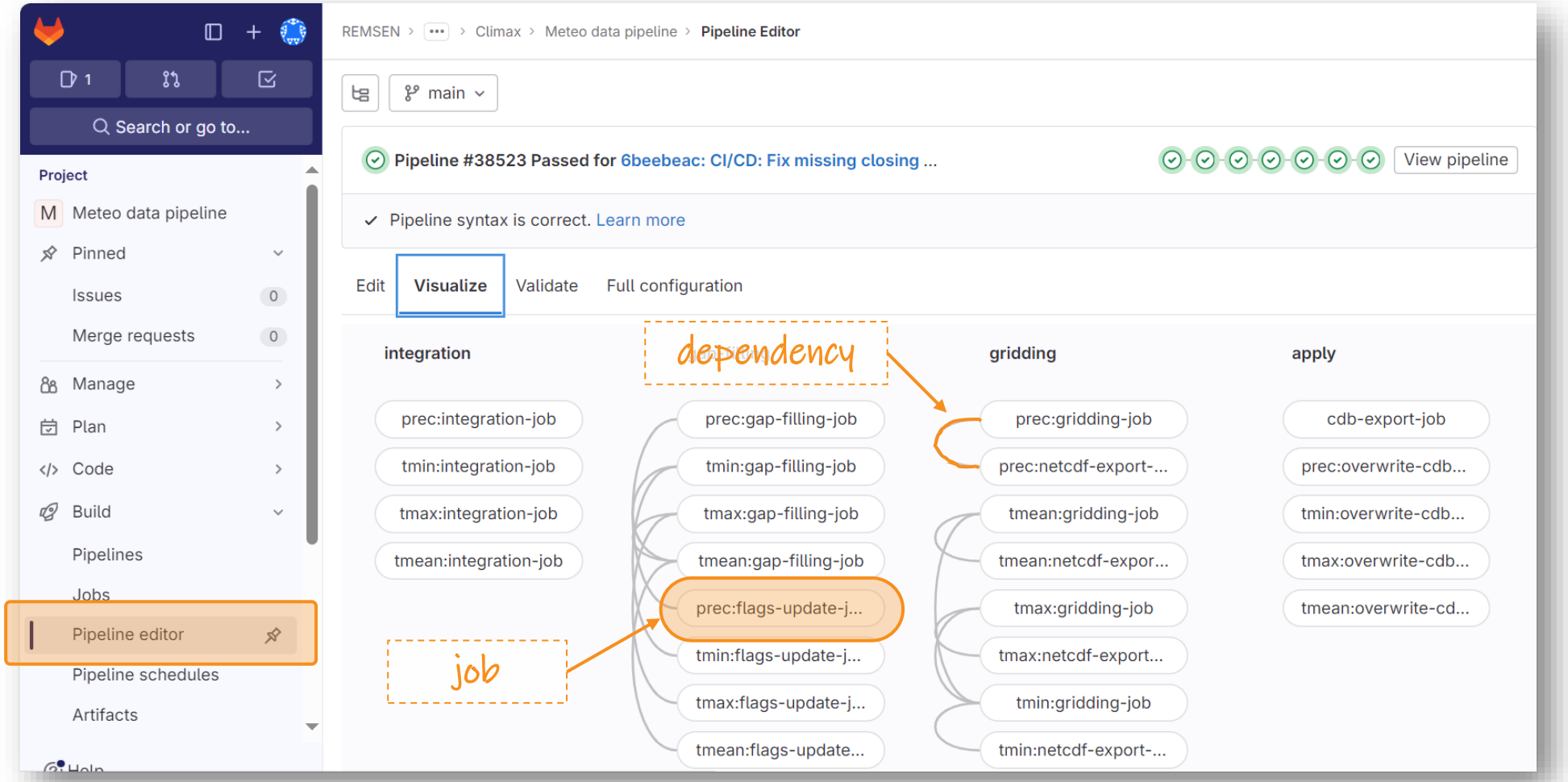

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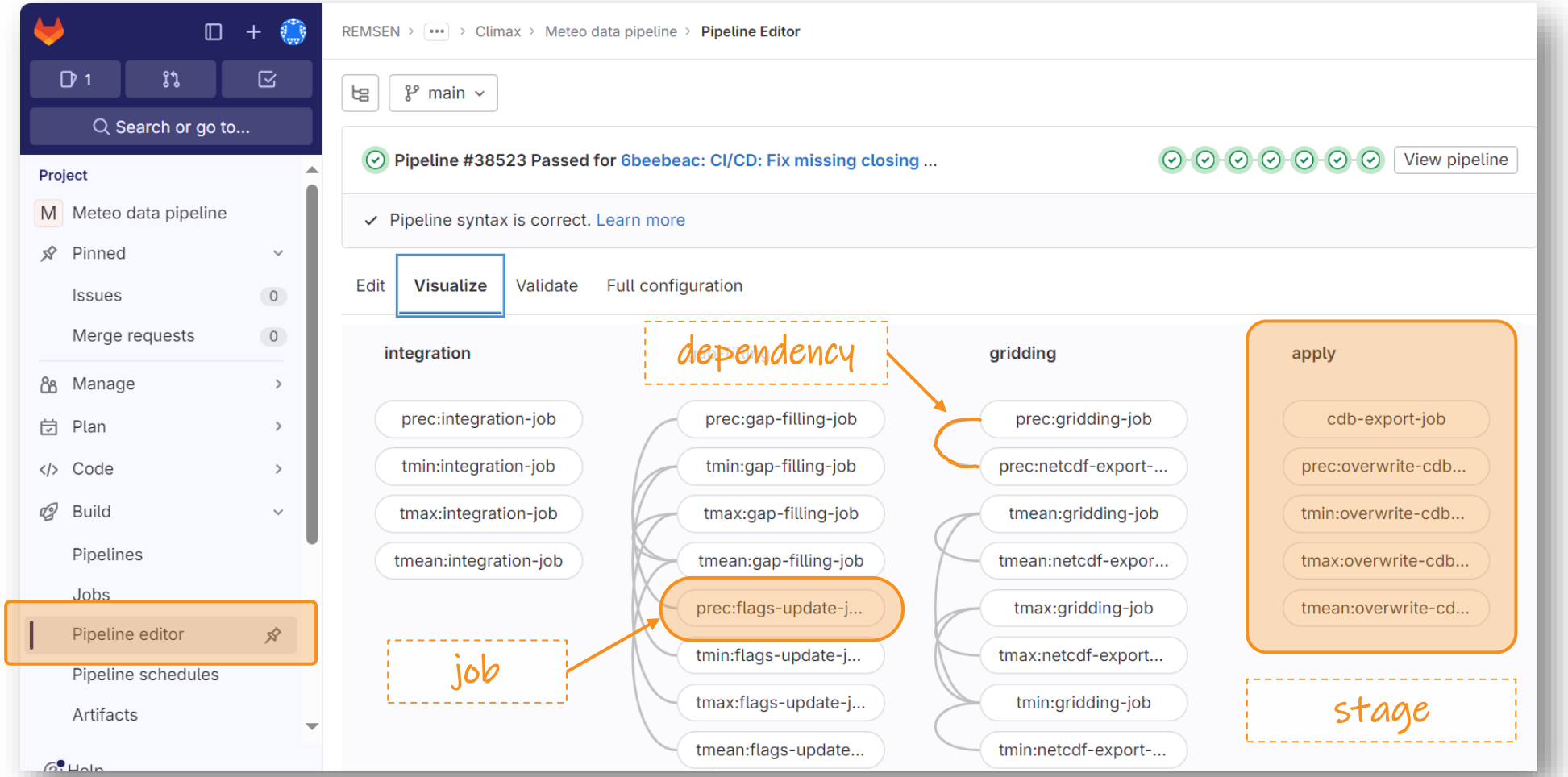

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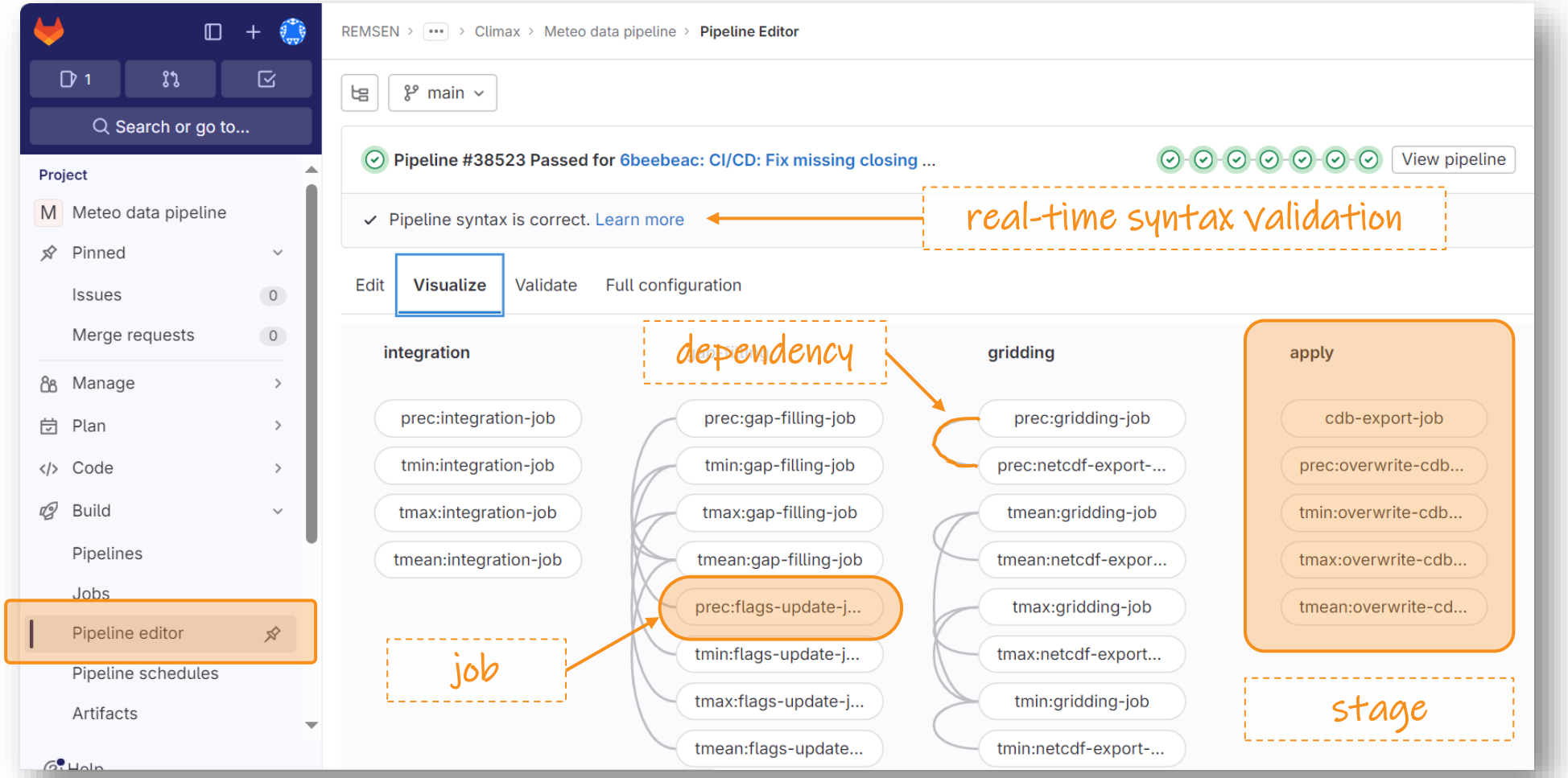
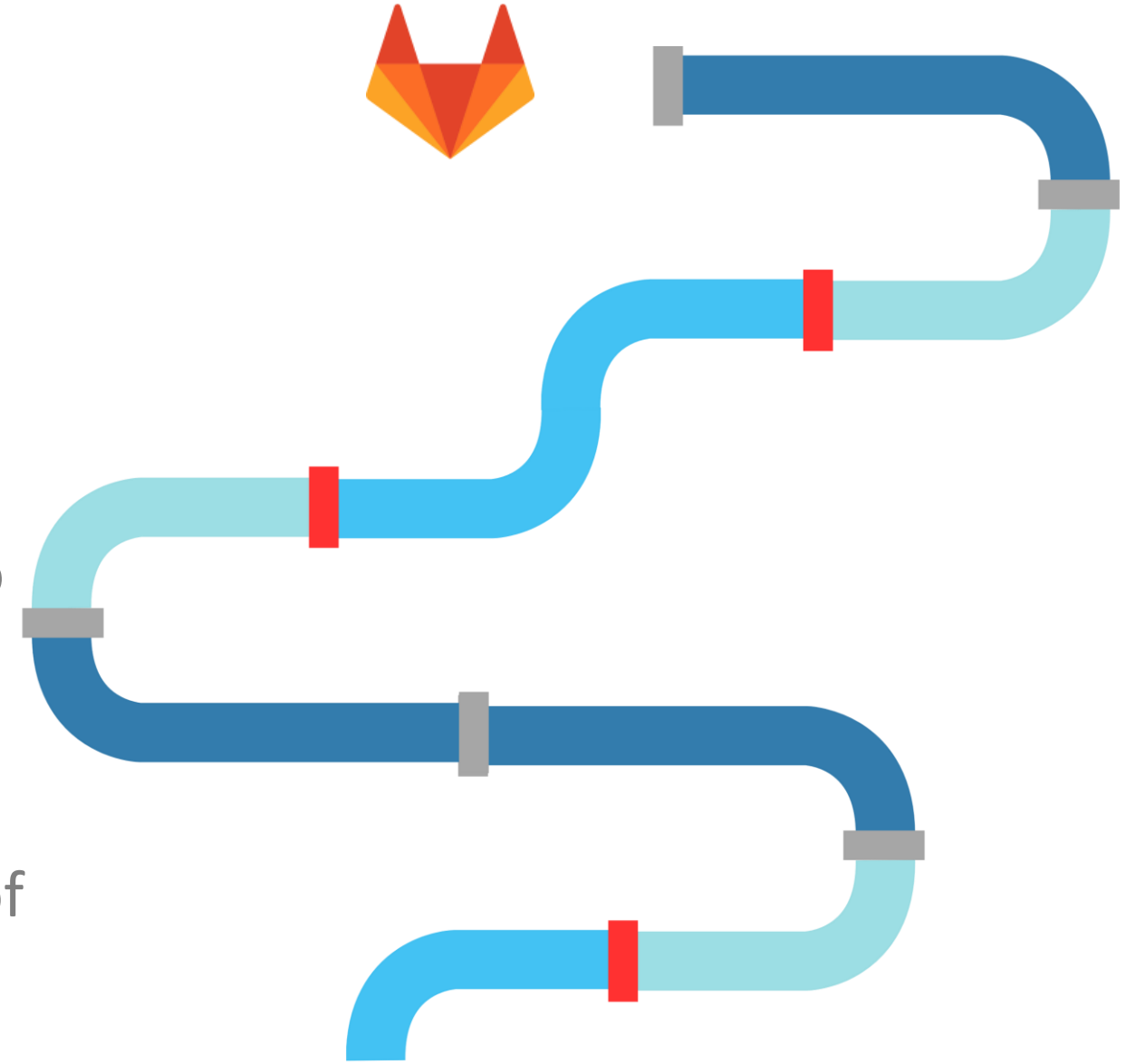


What's next

What's next

- Finalized implementation of the GitLab pipeline
- Automating the connectors with online catalogues
- Set up of webhooks for reporting to MS Teams channel(s)
- Implementation of a monitoring dashboard with GIS-based visualization of the data store and of near-real time updated fields



Thank you!

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