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# felyx version 2 – the cat is back!

felyx

## new release of the distributed and cloud/HPC-ready multi-matchup dataset production framework

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## 7th Sentinel-3 Validation Team Meeting 2022

18-20 October 2022 | ESA-ESRIN | Frascati (Rm), Italy

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# Context

**felyx** is a **generic open-source** tool for **extracting** Earth Observation data over **static** or **moving** locations, in particular for the production of Matchup Databases

**generic** means here it is agnostic wrt the type of variables, the source of data, the observation domain,...

Initially developed under ESA funding

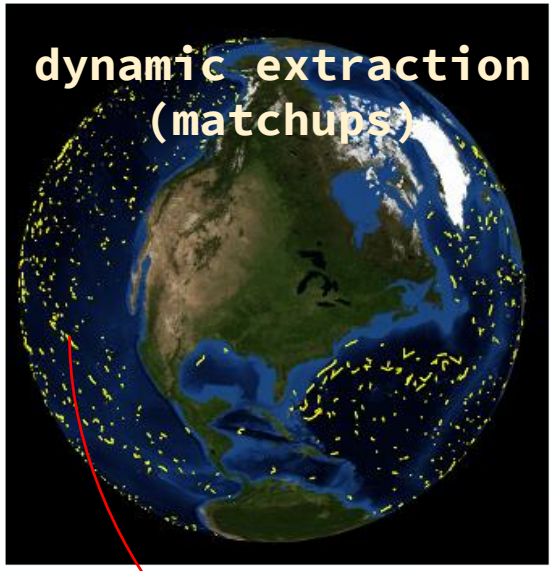
Has been around for some years, suffered some **flaws** and **missing functionalities**

**new requirements** defined by EUMETSAT based on previous experience, new version **funded by Copernicus through EUMETSAT (**https://www.eumetsat.int/Sci4MaST**)**

implementation by an **Ifremer** team (cooperation LOPS/CERSAT with Marine Data & Information Systems Department) over 2021-2022 within EUMETSAT/Sci4MaST project

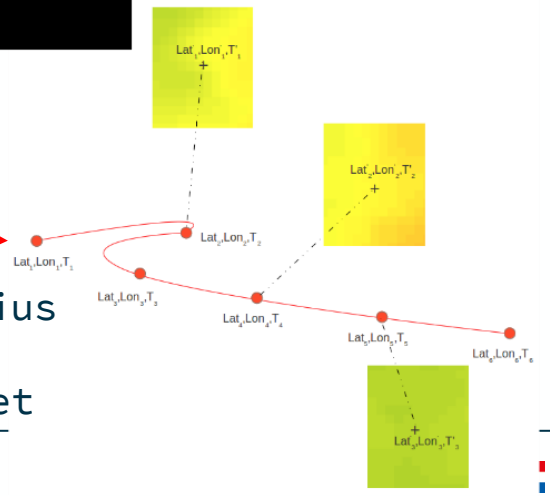
# felyx extraction principle

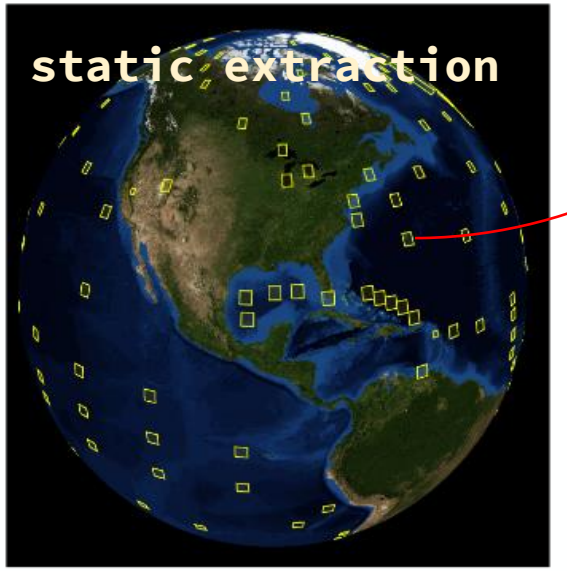





trajectories in parquet format or Elasticsearch

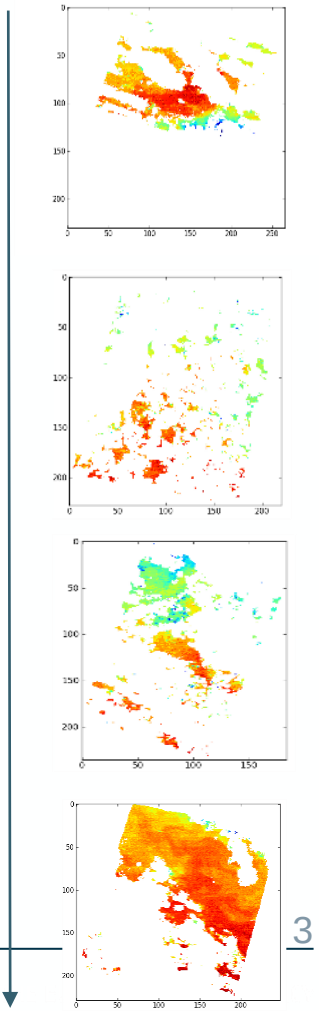
configurable subset size, colocation radius and maximum time difference per dataset






extracted subsets (**child products** from main source files) can be saved to disk or just indexed (and collected/assembled later)

**metrics** can be computed for child product (configurable)



# Multi matchup assembly

The extracted matchups (previous step) are then assembled into NetCDF files containing multiple matchups

jointure with in situ data - configurable in situ history can be provided for each matchup

Flexibility in MMDB output format through YAML configuration file:

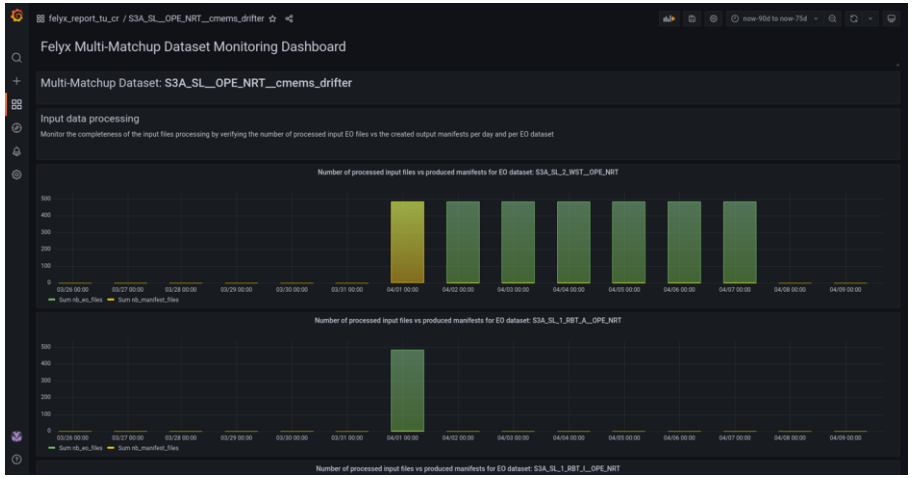
- configurable periodicity (hours, days, etc…)
- combining different datasets (or processing level: SLSTR L1, L2, L2P)
- keeping only relevant variables and attributes from each source product (right side)
- dividing into subproducts => different files (core MMDB, expert MMDB, ancillary fields, ...)

An end to end command allows to process all steps from input SST files to MMDB output in one go

```yaml
# The output products that will be written to disk, where keys are the
# identifier of each product and the values their definition.
# In most case, there would be only one output product with all the
# selected dataset variables and attributes. However, one can define
# multiple products, each one having a particular selection of EO
# datasets, variables and attributes.
products:
  SLSTRA-MAR-L2P-v1.0_test4dyn:
    # file pattern for the output product
    filenaming: '%Y/%Y%m%d%H%M%S_SLSTRA-MAR-L2P-v1.0__test4syn.nc'
    # tailor the content of the assembled files for the output product
    content:
      SLSTRA-MAR-L2P-v1.0:
        # [Optional] list of variables to include in the assembled files
        # (all of them by default). Python regexp can be used to select
        # several variables at once.
        variables: [.*]

        # [Optional] variables NOT TO include in extracted child products
        # (none of them by default)
        #except_variables:

        # [Optional] list of global attributes to include in the assembled
        # files (all of them by default)
        #attributes:

        # [Optional] list of global attributes NOT TO include in the assembled
        # files (none of them by default)
        except_attributes: [.*]

        # [Optional] list of global attributes from the child products
        # to stack as new variables into the assembled files.
        attributes_as_variables:
          - date_created

        # prefix by which to rename all variables and global attributes
        # coming from this dataset (by default the dataset id is used)
        prefix: s3a
```

# Main improvements

- **lighter system** :
  - **reduced dependencies** on third party tools
  - **configuration** is entirely file based (YAML), no more web interface and front-end
  - **storage of in situ data** is based on Apache/parquet format (Elasticsearch storage is still possible)
  - for MMDB, no need to store extracted intermediate child products (replaced within **indexing**)
  - **easier installation**: pypi repo, docker images, soon conda
  - can run in local env in sequential mode with **minimal installation**
- complementary **distributed processing framework** (jobard)
- complementary package for **graphical reporting** and **alerting** (felyx-report)



# Other new functionalities

Multi-matchup data files:

- sister datasets : extract/combine simultaneously from L1/L2/L2P without searching twice or more for matchups (ex: for SLSTR)
- traceability to source measurement (both EO and in situ data)
  - file name and index within file of matched data
  - transformation of attributes to traceability variables (version, creation date, UUID,...)

# Input data

## in situ data

- need to be converted to periodic **Apache/parquet** files
- parquet = compact column based format for big data
- **id, time, lat, lon, (z)**, any param

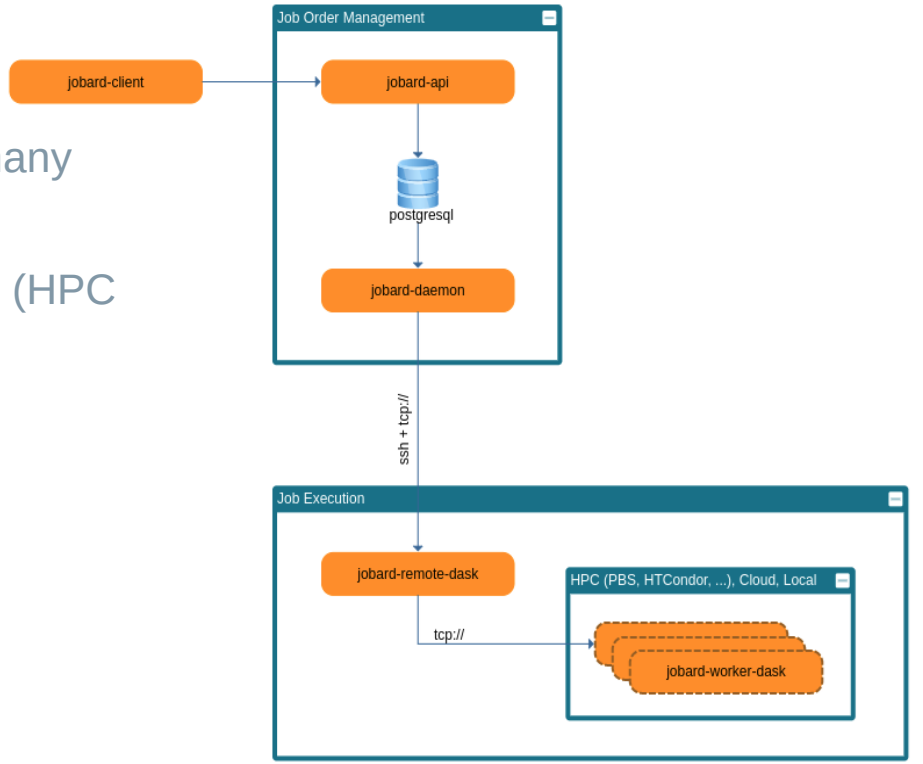
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | lat | lon | depth | water_temperature |
| quality_level | | | | | | | |
| id | time | | z | | | | |
| 2903425 | 2021-09-15 00:03:06 | 0 | 28.231291 | 153.017426 | 0.715198 | 29.293001 | |
| | 5 | | | | | | |
| | | 1 | 28.231291 | 153.017426 | 0.794664 | 29.284002 | |
| | 5 | | | | | | |
| | | 2 | 28.231291 | 153.017426 | 1.033063 | 29.275002 | |
| | 5 | | | | | | |
| | | 3 | 28.231291 | 153.017426 | 1.191995 | 29.278002 | |
| | 5 | | | | | | |
| | | 4 | 28.231291 | 153.017426 | 1.231728 | 29.258001 | |
| | 5 | | | | | | |
| ... | | | | ... | ... | ... | ... |
| | ... | | | | | | |
| 6902756 | 2021-09-15 23:57:00 | 0 | 49.208000 | -47.723999 | 0.000000 | 11.371000 | |
| | 2 | | | | | | |
| | | 1 | 49.208000 | -47.723999 | 0.991496 | 11.374001 | |
| | 2 | | | | | | |
| | | 2 | 49.208000 | -47.723999 | 1.982988 | 11.376000 | |
| | 5 | | | | | | |
| | | 3 | 49.208000 | -47.723999 | 2.974475 | 11.383000 | |
| | 5 | | | | | | |

## satellite data

- data read through **cerbere** generic reading lib (based itself on xarray)
  - https://cerbere.gitlab-pages.ifremer.fr/cerbere/
  - https://gitlab.ifremer.fr/cerbere
- should work straight away with CF compliant datasets
- can be extended through contribs for other formats or conventions (many existing already)
- GHRSST plugin natively available for SLSTR L1/L2

# Distributed processing with jobard

- **jobard** is framework developed for **job-array distributed processing**: running independent processings simultaneously (embarrassingly parallel)
  - e.g. running matchup extraction from multiple GHRSST files in parallel
- **Jobard** come as an independent **python** package based on Dask - usable for many reprocessing tasks
- currently works over **Docker SWARM** (cloud environment) or **PBS** & **HTCondor** (HPC environment), planned **kubernetis** support
- in a cloud environment it will deploy and instantiate workers on multiple VMs
- can process thousands of entries put in a queue
- progress can be monitored, access to processing context (logs,...)
- docs: https://jobard.gitlab-pages.ifremer.fr/documentation
- gitlab repo: https://gitlab.ifremer.fr/jobard
- **public release**: Q1 2023



# Implementation

full **python** implementation

relies on Ifremer **cerbere** lib for generic access to data (itself built upon **xarray**)

emphasis on robustness and operations:

- unitary testing with **PyTest** framework
- continuous integration and deployment (**gitlab**)
- code quality checker: **flake8**, **pylint**
- packaging and dependencies with **poetry**
- trained maintenance team and support

# Installation

felyx and complementary packages can be installed:

- in conda from source or with pip
  - repo will be moved to pypi
- through docker
- next:
  - conda package
  - deployment through singularity on HPC

**Continuous Integration (CI) / Continuous Deployment (CD)** workflows for various environments have been set-up with gitlab & Ansible for deployment to operational environments, automatic updates or deployment to new targets

installation tests to external clouds (WEkEO, AWS) to be done

**conda, from GIT repo**

```
conda create -n felyx_processor_from_git -y --file
https://gitlab.ifremer.fr/felyx/felyx_processor/-/raw/master/assets/conda/felyx-dev-linux-64.lock
conda activate felyx_processor
pip install --upgrade --force-reinstall
git+https://gitlab.ifremer.fr/felyx/felyx_processor[plugins_metrics_base]
```

**conda, with pip repo**

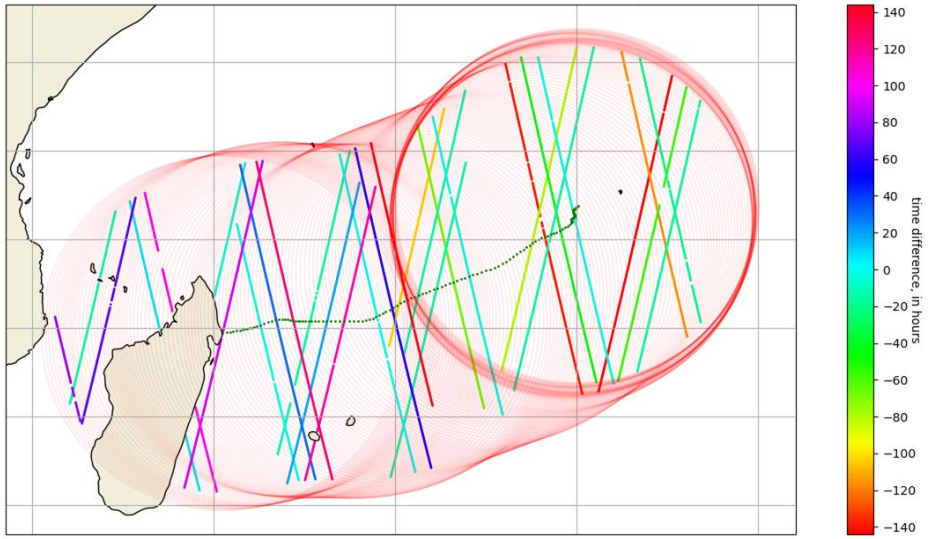
```
conda create -n felyx_processor -y --file
https://gitlab.ifremer.fr/felyx/felyx_processor/-/raw/master/assets/conda/felyx-dev-linux-64.lock
conda activate felyx_processor
pip install --upgrade --force-reinstall \
  --extra-index-url
https://gitlab.ifremer.fr/api/v4/projects/1225/packages/pypi/simple \
  felyx_processor[plugins_metrics_base]
```

**docker**

```
docker run /
  gitlab-registry.ifremer.fr/felyx/felyx_processor:2.1.0 \
  felyx-extraction \
            -c /home/felyx/conf/mmdb/test/s3a_mmdb.yaml \
            --dataset_id S3A_SL_2_WST__OPE_NRT \
            --manifest_dir /home/felyx/data/manifests/
```

# Applications

- EUMETSAT Multi-Sensor Matchup Databases for Sentinel-3 A & B/SLSTR, METOP/AVHRR & IASI, NPP/VIIRS
  - from CMEMS Insitu TAC for drifters/moored buoys and Argo
  - TRUSTED buoys
  - Ship4SST radiometer data
  - coming: saildrone data
- EUMETSAT Ice Temperature MDB (coming)
- EUMETSAT Sentinel-3 SRAL validation of wind & wave
- ESA CCI Sea State: colocation of altimeter data with wave buoys
- ESA MAXSS project (https://maxss.org) : Atlas of observations over tropical, extra-tropical and polar lows
- ESA OceanSoda carbonate database (https://doi.org/10.12770/0dc16d62-05f6-4bbe-9dc4-6d47825a5931)
- SWOT mission preparation (Ifremer)
- Future applications
  - validation of very high resolution SST (Landsat, TRISHNA,...)
  - CDAF intercomparison framework
  - MDB intercomparison framework




extraction of altimeter tracks along hurricane path (ABELA)

# Sentinel-3 MMDB @ EUMETSAT

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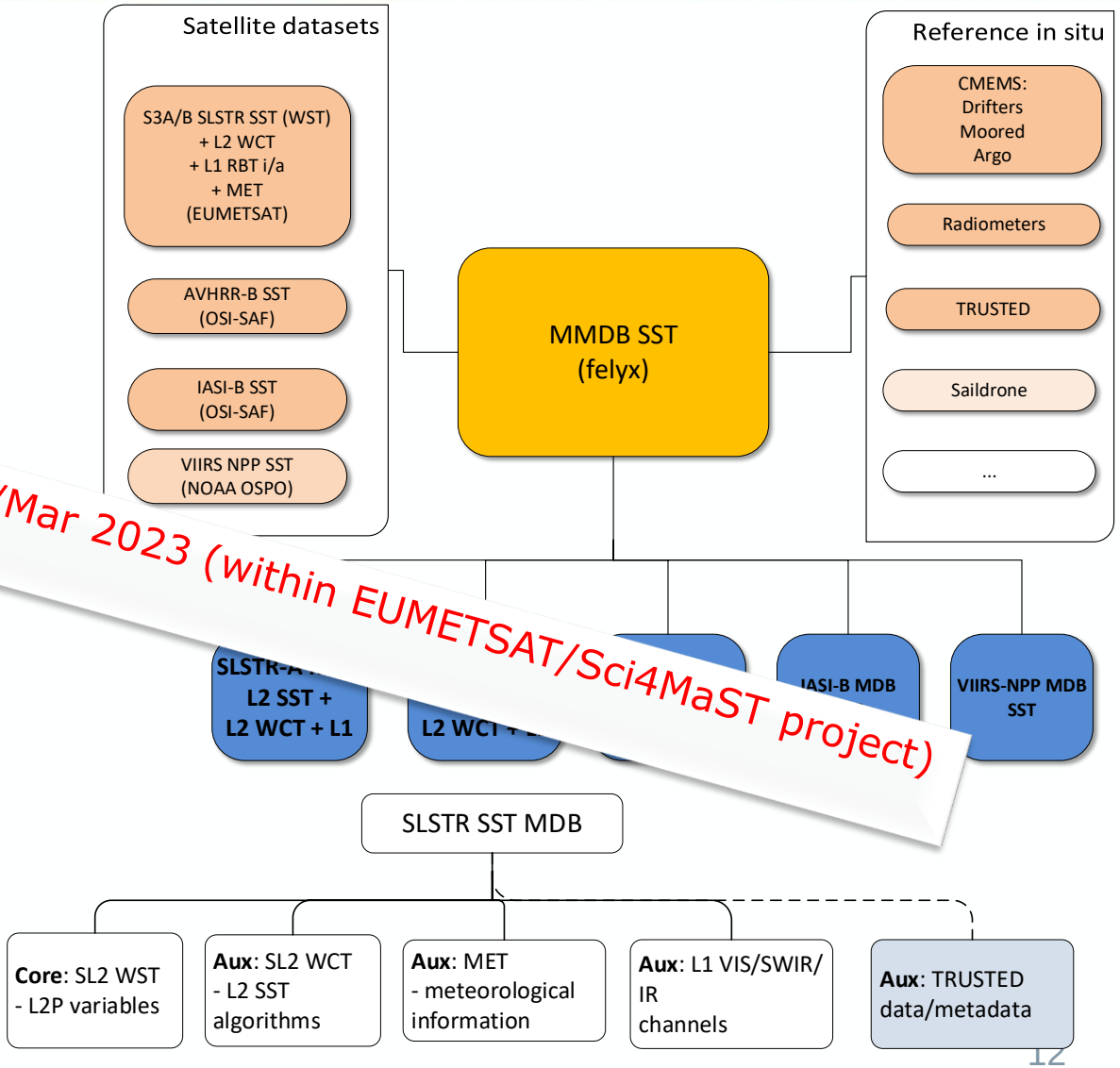
**Matchup criteria (initial):**

- Drifters, moored, radiometers:
  - 2h, ± 5 km
  - 5 km

**Format**

- Split in core MDB (netcdf files):
  - Core: WST + AUX: WCT, ...
- Per in situ type
  - Drifters (in NRT) + TRUSTED: 6 h (4 per day)
  - Argo, moored, radiometers: 24 h (1 per day)
- Variables:
  - All L2p variables and selected L1
  - <parent><variable>: e.g. “s3a_sl_2_wst____o_nr__lat”
- Extracts
  - 21x21 or 401x401 (radiometers) pixels in i-grid (1 km)
  - a-grid (500 m) - twice the size
  - MET data: only TCWV is full extract, others are center pixel only
- In situ history around matchup

Upgrade to new version with similar format scheduled for Feb/Mar 2023 (within EUMETSAT/Sci4MaST project)




cf: Igor Tomazic (EUMETSAT)

# Conclusion and perspective

- https://felyx.ifremer.fr :
  - documentation, installation, configuration
  - jobard distributed framework
  - Reporting, alerting, traceability, sister products, parquet
- public release of felyx v2 planned in Q1 2023
- next steps:
  - conda packages
  - some more optimizations
  - test on external cloud platforms w/ object storage hosting GHRSST datasets: WEkEO, PO.DAAC/AWS
  - demonstrate the ability to produce in a consistent manner multiple GHRSST MMDBs close to data location for fair intercomparison
- Any question: jfpiolle@ifremer.fr