



CCI Land Surface Temperature

LST_cci Regridding and Subsetting Tool Verification Report

WP3.4 – DEL-D3.4-2

Ref.: LST-CCI-D3.4-2-VR

Date: 28/11/2022

Organisation: ACRI-ST



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Change log

Version	Date	Changes
1.0	20/09/2022	First version
1.1	28/11/2022	Verification of the updated features (MW products) Tests re-run as non-regression campaign

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1. Executive Summary

This document reports the test results of the regridding and subsetting tool developed in the frame of the Land Surface Temperature (LST) Climate Change Initiative (CCI) project (phase 1). The LST CCI project aims to produce climate data records of LST, which is an Essential Climate Variable (ECV). LST is used for applications such as climate and land surface modelling, crop monitoring, and urban heat island studies. The LST ECV Products generated by LST CCI are also expected to be used by climate user communities for long-term analysis.

2. Introduction

2.1. Purpose and scope

The Re-gridding and sub-setting tool has been developed in the frame of the LST_cci project. Its main objective is to map a LST product on a new grid in a coarser resolution, while propagating the uncertainties in a trustable way. This document is a reporting of the test campaign run in the frame of the LST CCI regridding and subsetting tool v1.1 delivery.

2.1.1. Item being tested:

Software	Revision
LST_cci Regridding and Subsetting Tool	1.1

2.2. References and applicable documents

The references used in this document are listed in document “References and Acronyms” (ref. LST-CCI-D6.5-REFACR [RD-3]). In addition, we have:

RD-1	Re-gridding and Sub-setting ATBD v0.1
RD-2	Product Specification Document D1.2
RD-3	References and Acronyms

2.3. Acronyms

The list of references and acronyms is given in document “References and Acronyms” whose reference is LST-CCI-D6.5-REFACR [RD-3].

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3. Global status

All tests have been run and passed successfully.

All TDS tests run both on Jasmin CENT-OS 7 environment and local VM with Ubuntu 20.04, with the same result.

The test campaign verifies CCI LST files treatment: only the selected subset of CCI LST variables (see Table 1) is retained for regridding, other variables are ignored.

The comparison of the regridded products with the corresponding TDS reference file shows no discrepancy in the differences: two variables only show consequent deltas.

- ❖ Lst_unc_ran
- ❖ Lst_uncertainty

Explanation:

- ❖ The Lst_unc_ran variable regridding is done with the integration of Lst variable, Lst_unc_ran variable, and the provision of an external land mask. The TDS reference file is made up of monthly at different resolutions and these monthly are not derived from a direct regridding of the finer monthly resolution but recalculated from the daily files with a method different to that of the ATBD for Lst_unc_ran.
- ❖ Lst_uncertainty is impacted with Lst_unc_ran: The regridding of Lst_uncertainty variable is postponed at the end of the regridding process with the integration of previously regridded variables, including Lst_unc_ran. The Lst_unc_ran differences impact and explain the differences between the Lst_uncertainty variable in the test campaign and in TDS file.

➔ The differences derived from different computation method used for Lst_unc_ran

Conclusion: All tests passed, test campaign v1.1 is successful

4. Verification approach

4.1. Re-gridding and sub-setting tool objectives

As derived from [RD-1] ATBD, the re-gridding and sub-setting tool technical objectives are:

- ❖ Sub-setting: the tool crops the input file to a sub-area defined in user parameters
- ❖ Re-gridding: the tool propagates uncertainties and ancillary data to coarser resolution with the appropriate mean function (depending on input resolution, target resolution and product type)
- ❖ CCI LST file format: the output product conforms to CCI LST NetCDF file format as described in RD-2.
- ❖ The LST variables to be subsetting and regridded are defined in RD-1 and presented in Table 1. Other variables (if any) are ignored.

Table 1: List of regridded LST variables as defined in RD-1

CCI LST variables to subset and regrid	Description
time	Time coordinate. Reference time of file.
dtime	Time difference from reference time.
lat	Latitude coordinates.
lon	Longitude coordinates.
Channel	Channel coordinates.
lst	Land Surface Temperature.
lst_time_correction	LST offset from local time to 6AM/6PM.
lst_uncertainty	Land Surface Temperature Total Uncertainty.
lst_unc_ran	Land Surface Temperature uncertainty from uncorrelated errors.
lst_unc_loc_atm	uncertainty from locally correlated errors on atmospheric scales
lst_unc_loc_sfc	uncertainty from locally correlated errors on surface scales
lst_unc_loc_cor	uncertainty from locally correlated errors on LST corrections
lst_unc_time_correction	land surface temperature uncertainty from time correction errors
lst_unc_sys	uncertainty from large-scale systematic errors
satze	Satellite zenith angle.
sataz	Satellite azimuth angle.
solze	Solar zenith angle.
solaz	Solar azimuth angle.
n	number of clear-sky pixels

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4.2. Description of the tests

4.2.1. Functional tests

Functional test approach is to run the `lst_cci_regrid` tool and check output result and status regarding inputs and parameters. The mean function selection and algorithm used for regridding is also verified.

The functional tests rely on a set of reference files (called TDS for Test Data Set hereafter) used both in input to apply the tool on and in output for comparison, and a set of random CCI LST public file picked up to exercise the tool on LST product from various origins.

TDS Tests are run on Jasmin environment (Linux CentOS 7) with the delivered package, and re-run on a virtual machine with Linux Ubuntu 20.04.

4.2.1.1. scope

The objective of these functional tests is to verify the correctness of the `lst_cci_regrid` tools functionalities. It ensures robustness to errors and guaranty the adequacy of the output product with the specifications.

The functional verification tests do not cover validation of the output file, but the validation of the regridding of the CCI LST variables in input. The use of netcdf tools (`ncdump`, `snap` ...) validates the NetCDF format compatibility.

The functional tests run the `lst_cci_regrid` tool and verify (regarding the Tests Scenarios):

- ❖ the output status
- ❖ the output console content
- ❖ the presence of LST_cci variables in the output file
- ❖ the comparison with the reference files

On top of this verification, a NetCDF file viewer is used to have a human control over produced files.

15 scenarios have been identified and described in §4.2.2 Tests Scenarios.

4.2.1.2. Test tools

Ncdump: `ncdump` command line tool is used to inspect NetCDF produced files with bash scripts

Bash scripts: Bash scripts are implemented to automatically run the `lst_cci_regrid` tool on a directory and check no error occurred during production as well as LST_cci variables (as defined in ATBD) are correctly forwarded to output with attributes.

NetCDF file viewers: Panoply and snap are used to open and compare input and output files. Ncview is another alternative.

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4.2.2. Tests Scenarios

4.2.2.1. usage

Display help message and return silently

- ◆ Status equal "0"
- ◆ Output console contains usage instructions

4.2.2.2. no argument

Error case: Display help message and return with error

- ◆ Status equal "2"
- ◆ Output console contains a missing argument error message
- ◆ Output console contains usage instructions

4.2.2.3. wrong argument

Error case: Display help message and return with error

- ◆ Status equal "2"
- ◆ Output console contains usage instructions

4.2.2.4. wrong input resolution: finer resolution claimed

Error case: Display related error message and return with error

- ◆ Status equal "255"
- ◆ Output console contains an invalid resolution error message

4.2.2.5. wrong input resolution: wrong window size

Error case: Display related error message and return with error

- ◆ Status equal "255"
- ◆ Output console contains an invalid resolution error message

4.2.2.6. wrong input resolution: subset coordinates outside main window frame

Error case: Display related error message and return with error

- ◆ Status equal "255"
- ◆ Output console contains an "out of window" error message

4.2.2.7. Same regridding run twice

Warning: output file exists

- ◆ A warning is displayed. The warning does not stop the process.
- ◆ The regridding ends without error and the product is created and overwritten

4.2.2.8. Regridded product attributes

Output product attributes are updated

- ◆ History attribute update.
- ◆ Coordinates attributes updated

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- ◆ Resolution attribute updated
- ◆ Creator attribute updated

4.2.2.9. Functional tests: tests with TDS

The TDS tests aims at regridding TDS files to different valid resolutions and validate results with comparison against TDS reference file with the same resolution, when available. It executes the regridding and check in the results:

- ◆ Return status
- ◆ Error messages
- ◆ Number of regridding steps
- ◆ Mean functions used, according to product type and IN/OUT resolutions
- ◆ Compare result against TDS reference

4.2.2.9.1 Sub-setting: No resolution provided

Sub-setting applied only

- ◆ Status equal "0"
- ◆ No error
- ◆ Result file resolution is same as input
- ◆ CCI LST Variables are copied without regridding

4.2.2.9.2 Sub-setting on a sub-area: No resolution provided

Sub-setting applied on a sub-area only

- ◆ Status equal "0"
- ◆ No error
- ◆ Result file resolution is same as input
- ◆ CCI LST Variables are copied without regridding
- ◆ Other variables are ignored
- ◆ Result file focus on the sub-area only

4.2.2.9.3 regridding from 0.25 to 1.0

One step success regridding

- ◆ Status equal "0"
- ◆ No error.
- ◆ LST variables are regridded with appropriate mean function
- ◆ Other variables are ignored (out of ATBD scope)

4.2.2.9.4 regridding from 0.05 to 0.05: output_resolution = UOL_2_STEPS_RES_LIMIT

same resolution: Success subsetting, no regridding

- ◆ Status equal "0"
- ◆ No error
- ◆ No regridding performed, only sub-setting
- ◆ CCI LST Variables are copied without regridding
- ◆ Other variables are ignored (out of ATBD scope)

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4.2.2.9.5 regriding from 0.05 to 0.25: output_resolution > UOL_2_STEPS_RES_LIMIT

One step success regriding in one step

- ◆ Status equal "0"
- ◆ No error
- ◆ Regriding performed in one step
- ◆ Appropriate mean functions are called for CCI LST variables
- ◆ Other variables are ignored (out of ATBD scope)

4.2.2.9.6 regriding from 0.01 to 0.05: output_resolution = UOL_2_STEPS_RES_LIMIT

One step success regriding

- ◆ Status equal "0"
- ◆ No error
- ◆ Regriding performed in one step
- ◆ Appropriate mean functions are called for CCI LST variables
- ◆ Other variables are ignored (out of ATBD scope)

4.2.2.9.7 regriding from 0.01 to 0.25: input_resolution < UOL_2_STEPS_RES_LIMIT and output_resolution > UOL_2_STEPS_RES_LIMIT

Two steps success regriding

- ◆ Status equal "0"
- ◆ No error
- ◆ Regriding performed in two steps
- ◆ Appropriate mean functions are called for CCI LST variables
- ◆ Other variables are ignored (out of ATBD scope)

4.2.2.10. Complementary tests

Some CCI LST variables are absent from TDS file: in order to complete the test coverage and validate those variables too, two files have been picked up from Jasmin public directory and added to the test campaign.

The variables missing in TDS files are:

- lst_unc_time_correction: land surface temperature uncertainty from time correction errors
- lst_time_correction: LST offset from local time to 6AM/6PM.
- lst_unc_loc_cor: uncertainty from locally correlated errors on LST corrections

The LST files added for testing are:

- ❖ ESACCI-LST-L3S-LST-IRCDR_-0.01deg_1DAILY_DAY-19950801000000-fv2.00.nc
- ❖ ESACCI-LST-L3C-LST-SSM17-0.25deg_1DAILY_ASC-20171202000000-fv2.23.nc

4.2.2.10.1 Regrid uncertainty from locally correlated errors on LST corrections

One step success regriding

- ◆ Status equal "0"
- ◆ No error
- ◆ Regriding performed in one step
- ◆ Appropriate mean functions are called for CCI LST variables
- ◆ Other variables are ignored (out of ATBD scope)

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- ♦ Visually check variable `lst_unc_loc_cor`

4.2.2.10.2 Regrid time corrections

One step success regridding

- ♦ Status equal "0"
- ♦ No error
- ♦ Regridding performed in one step
- ♦ Appropriate mean functions are called for CCI LST variables
- ♦ Other variables are ignored (out of ATBD scope)
- ♦ Visually check variable `lst_unc_time_correction` and `lst_time_correction`

4.2.2.10.3 Issue 6: MicroWave files uncertainties wrongly handled

One step success regridding

- ♦ Status equal "0"
- ♦ No error
- ♦ Regridding performed in one step
- ♦ Non-initialized LST uncertainties are copied (regridded) and not meaned
- ♦ LST total uncertainty is a square mean function of input LST total uncertainty

4.3. Test Data Sets

A Test Data Set (referred hereafter as TDS) has been provided by ULeic and is composed of 3 files:

- ❖ ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
- ❖ ESACCI-LST-L3C-LST-MODISA-0.05deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
- ❖ ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc

Those files are used as references for comparisons: in the tests, a regridding of a TDS file toward a coarser resolution should produce a file identical to the TDS one corresponding to the target resolution. Differences in tests should be quantified and minimal.

Two files have been picked up from Jasmin public folder and added to the test set in order to complete test coverage and address CCI LST variables missing in the TDS reference files:

- ❖ ESACCI-LST-L3S-LST-IRCDR_-0.01deg_1DAILY_DAY-19950801000000-fv2.00.nc
- ❖ ESACCI-LST-L3C-LST-SSM17-0.25deg_1DAILY_ASC-20171202000000-fv2.23.nc

Have been added to cover:

- ❖ `lst_unc_loc_cor`
- ❖ `lst_unc_time_correction`
- ❖ `lst_time_correction`

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5. Results

5.1. Console tests

5.1.1. Usage

Scenario: usage

```
(base) [hillel@ccil lst_cci_regrid]$ lst_cci_regrid --help
charset normalizer/assets/ _init_ .py:17: UserWarning: Charset-Normalizer require '/home/users/hillel/conda_env/conda_topack/lst_cci_regrid_package/lst_cci_regrid/charset_normalizer/assets/frequencies.json' to be existent for lang
uage/coherence detection. Detection WILL be weaker.
usage: lst_cci_regrid [-h] [--resolution RESOLUTION] [--output-file OUTPUT_FILE] [--coords COORDS] [--threads THREADS] [--comp-level COMP_LEVEL] [--keep-log KEEP_LOG] input_file output_dir

Re-grid a set of CCI LST variables in a LST_cci product on a selected area (default applies to whole product).

positional arguments:
  input_file             input LST_cci product
  output_dir             output directory

optional arguments:
  -h, --help             show this help message and exit
  --resolution RESOLUTION
                        Output resolution. If not provided, the input resolution is used and only sub-setting is applied, without re-gridding.
  --output-file OUTPUT_FILE
                        force output file name
                        a string surrounded with "" representing the extremum coordinates of the rectangular sub-area to process.
                        Expected format is "latmin[-90; 90] latmax[-90; 90] lonmin[-180; 180] lonmax[-180; 180]".
                        Example: lst_cci_regrid <input_file> <output_dir> --coords "-20 10 -180 180"
                        NB: values must be provided in that order: latitude min, latitude max, longitude min, longitude max
                        Latitude values are in range [-90; 90] and longitude values in range [-180; 180]
  --threads THREADS      number of parallel CPU threads to use during processing, by default use all (8 on this machine, ignoring hyper-threading).
  --comp-level COMP_LEVEL
                        WEGCP4 compression level (0=none 9=max), by default use 1
  --keep-log KEEP_LOG   true/false: keep or not the log file (log file is kept in case of error)
(base) [hillel@ccil lst_cci_regrid]$ echo $?
```

Test execution: The help message is correctly displayed, and program exits with no error

Conclusion: Test run successfully.

5.1.2. no argument

Scenario: no argument

```
(base) [hillel@ccil lst_cci_regrid]$ lst_cci_regrid
charset normalizer/assets/ _init_ .py:17: UserWarning: Charset-Normalizer require '/home/users/hillel/conda_env/conda_topack/lst_cci_regrid_package/lst_cci_regrid/charset_normalizer/assets/frequencies.json' to be existent for lang
uage/coherence detection. Detection WILL be weaker.
usage: lst_cci_regrid [-h] [--resolution RESOLUTION] [--output-file OUTPUT_FILE] [--coords COORDS] [--threads THREADS] [--comp-level COMP_LEVEL] [--keep-log KEEP_LOG] input_file output_dir
lst_cci_regrid: error: the following arguments are required: input_file, output_dir
(base) [hillel@ccil lst_cci_regrid]$ echo $?
```

Test execution: A simplified help message is correctly displayed, and program exits with error code 2. The error message indicates the type of error.

Conclusion: Test run successfully.

5.1.3. wrong argument

Scenario: wrong argument

```
(base) [hillel@ccil lst_cci_regrid]$ lst_cci_regrid -a 1 -b
charset normalizer/assets/ _init_ .py:17: UserWarning: Charset-Normalizer require '/home/users/hillel/conda_env/conda_topack/lst_cci_regrid_package/lst_cci_regrid/charset_normalizer/assets/frequencies.json' to be existent for lang
uage/coherence detection. Detection WILL be weaker.
usage: lst_cci_regrid [-h] [--resolution RESOLUTION] [--output-file OUTPUT_FILE] [--coords COORDS] [--threads THREADS] [--comp-level COMP_LEVEL] [--keep-log KEEP_LOG] input_file output_dir
lst_cci_regrid: error: the following arguments are required: output_dir
(base) [hillel@ccil lst_cci_regrid]$ echo $?
```

Test execution: A simplified help message is correctly displayed, and program exits with error code 2. The error message indicates the type of error.

Conclusion: Test run successfully.

5.1.4. wrong input resolution: finer resolution claimed

Scenario: wrong input resolution: finer resolution claimed

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```
(base) [hillel@cci lst_cci_regrid] $ ls lct_cci_regrid /home/users/hillel/lst_regrid_tool/TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc /home/users/hillel/test_output/subset_a --threads 4 --comp-level 4
--resolution 0.1 --coords "-60 -60 20 110"
CharSetNormalizer/assets/_init_.py:17: UserWarning: CharSetNormalizer require '/home/users/hillel/conda_env/conda_topack/lst_cci_regrid/package/lst_cci_regrid/charset_normalizer/assets/frequencies.json' to be existent for lang
uage/coherence detection. Detection will be weaker.
2022-09-16 14:28:49,702 - INFO - log file: /home/users/hillel/conda_env/conda_topack/lst_cci_regrid/package/lst_cci_regrid/charset_normalizer/assets/frequencies.json
2022-09-16 14:28:49,819 - INFO - spatial resolution used is geospatial lat_resolution
2022-09-16 14:28:49,821 - ERROR - New resolution 0.1 cannot be finer than original one 0.25
2022-09-16 14:28:49,821 - ERROR - Aborting.
2022-09-16 14:28:49,821 - ERROR - Cannot compute regrid factor
(base) [hillel@cci lst_cci_regrid] $ echo $?
255
```

Test execution: An error message is displayed indicating the wrong resolution, and program exits with error code 255.

Conclusion: Test run successfully.

5.1.5. wrong input resolution: wrong window size

Scenario: wrong input resolution: wrong window size

```
hillel@hillel:~/work/LST/denaria/lst_cci_regrid$ p3 lst_cci_regrid.py TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc --resolution 0.5 output_dir --coords "-89.875 -60 20.8 110.7"
2022-11-08 10:42:44,479 - INFO - log file: lst_cci_regrid.py ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc to 0.5.log
2022-11-08 10:42:44,733 - INFO - Command: lst_cci_regrid.py TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc output_dir --resolution 0.5 --coords "-89.875 -60 20.8 110.7" --
threads 4 --comp_level 1 --keep_log false
2022-11-08 10:42:44,854 - INFO - spatial_resolution used is geospatial_lat_resolution
2022-11-08 10:42:45,246 - INFO - Input file name: ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
2022-11-08 10:42:45,262 - INFO - Open 0.65 degree resolution land mask
2022-11-08 10:42:45,278 - INFO - use a sub selection of land map
2022-11-08 10:42:45,281 - INFO - regrid land map to 0.25
2022-11-08 10:42:45,282 - ERROR - Invalid sub-coordinates values: Could not coarsen a dimension of size 598 with window 5 and boundary='exact'. Try a different 'boundary' option.
2022-11-08 10:42:45,282 - ERROR - Unhandled error occurred during regridding.
2022-11-08 10:42:45,282 - ERROR - Could not coarsen a dimension of size 598 with window 5 and boundary='exact'. Try a different 'boundary' option.
Traceback (most recent call last):
  File "lst_cci_regrid.py", line 1548, in <module>
    raise e
  File "lst_cci_regrid.py", line 1539, in <module>
    da_regrid = snda.coars.reduce(func=landmask_mean)
  File "/home/hillel@hillel:/local/lib/python3.8/site-packages/xarray/core/rolling.py", line 999, in reduce
    return wrapped_func(self, keep_attrs=keep_attrs, **kwargs)
  File "/home/hillel@hillel:/local/lib/python3.8/site-packages/xarray/core/rolling.py", line 940, in wrapped_func
    reduced = self.obj.variable.coarsen(
  File "/home/hillel@hillel:/local/lib/python3.8/site-packages/xarray/core/variable.py", line 2291, in coarsen
    reshaped_axis = self.coarsen.reshape(windows, boundary, side)
  File "/home/hillel@hillel:/local/lib/python3.8/site-packages/xarray/core/variable.py", line 2327, in coarsen.reshape
    raise ValueError(
ValueError: Could not coarsen a dimension of size 598 with window 5 and boundary='exact'. Try a different 'boundary' option.
2022-11-08 10:42:45,285 - ERROR - Aborting.
```

Test execution: An error message is displayed indicating the wrong window size.

Conclusion: Test run successfully.

5.1.6. wrong input resolution: subset coordinates outside main window frame

Scenario: wrong input resolution: subset coordinates outside main window frame

The file ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc is first cropped to lat[0; 50] lon[0; 50]. Then a regridding is run on that result on coordinates lat[-10; 10] lon[-10; 10].

```
hillel@hillel:~/work/LST/denaria/lst_cci_regrid$ p3 lst_cci_regrid.py output_test/ESACCI-LST-L3C-LST-MODISA-0.5deg_1MONTHLY_DAY-20060701000000-fv3.00.nc output_test --coords "-10 10 -10 10" --reso
lution 0.5
2022-11-14 13:41:42,742 - INFO - log file: lst_cci_regrid.py ESACCI-LST-L3C-LST-MODISA-0.5deg_1MONTHLY_DAY-20060701000000-fv3.00.nc to 0.5.log
2022-11-14 13:41:42,924 - ERROR - The selected area coordinates are outside input window frame: [ lat:[-10.0 ; 10.0] lon:[-10.0 ; 10.0] ] is outside [ lat:[0.25 ; 49.75] lon:[0.25 ; 49.75] ]
2022-11-14 13:41:42,924 - ERROR - Error occurred parsing arguments: wrong argument 'lst'
```

Test execution: An error message is displayed indicating the wrong window size.

Conclusion: Test run successfully.

5.1.7. Same regridding run twice

Scenario: Same regridding run twice



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```

[base] [init]:(fsl)lsc /lst_cci_regrid_package/home/users/hillel/test_output -comp level 4
2022-09-16 13:41:00.990 fv3.80.nc /home/users/hillel/test_output -comp level 4
charset normalizer/assets/.init py:17: UserWarning: Charset-Normalizer require '/home/users/hillel/conda/env/conda_topack/lst_cci_regrid_package/lst_cci_regrid/chartset_normalizer/assets/frequencies.json' to be existent for lang
age/coherence detection. Detection will be weaker.
2022-09-16 13:41:22.532 INFO lon file: /home/users/hillel/conda/env/conda_topack/lst_cci_regrid_package/lst_cci_regrid/lst_cci_regrid_ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.80.nc to None.log
2022-09-16 13:41:22.599 INFO - spatial resolution used is geospatial lat resolution
2022-09-16 13:41:22.608 INFO - 'lcc' variable found in input file;
2022-09-16 13:41:22.661 INFO Use n parallel CPU threads
2022-09-16 13:41:22.682 WARNING - Output file /home/users/hillel/test_output/ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.80.nc exists and will be replaced.
2022-09-16 13:41:22.931 INFO Input file resolution: 0.01
2022-09-16 13:41:22.932 INFO Output file resolution: 0.01
2022-09-16 13:41:22.932 INFO -----
2022-09-16 13:41:45.386 INFO COPY 'dtm' variable
2022-09-16 13:41:45.387 INFO COPY 'satze' variable
2022-09-16 13:41:45.389 INFO COPY 'satbz' variable
2022-09-16 13:41:45.392 INFO COPY 'solzr' variable
2022-09-16 13:41:45.394 INFO COPY 'solaz' variable
2022-09-16 13:41:45.396 INFO COPY 'lst' variable
2022-09-16 13:41:45.398 INFO COPY 'lst_uncertainty' variable
2022-09-16 13:41:45.400 INFO COPY 'lst_unc_ran' variable
2022-09-16 13:41:45.403 INFO COPY 'lst_unc_loc_atm' variable
2022-09-16 13:41:45.406 INFO COPY 'lst_unc_loc_sfc' variable
2022-09-16 13:41:45.408 INFO COPY 'lst_unc_sys' variable
2022-09-16 13:41:45.410 INFO COPY 'lcc' variable
2022-09-16 13:41:45.413 INFO COPY 'n' variable
2022-09-16 13:41:45.415 INFO COPY 'variance' variable
2022-09-16 13:41:45.418 INFO COPY coordinates "channel"
2022-09-16 13:41:45.687 INFO =====
2022-09-16 13:41:45.687 INFO Writing output file
2022-09-16 13:41:45.687 INFO File /home/users/hillel/test_output/ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.80.nc written
2022-09-16 13:49:27.965 INFO Regridding successfully ended.
2022-09-16 13:49:27.965 INFO Regridding duration: @08:05.439212
2022-09-16 13:49:27.965 INFO

```

Conclusion: Test run successfully.

5.1.8. Regridded product attributes

Scenario: Regridded product attributes

```
// global attributes:
; title = "ESA LST CCI Land surface temperature data at product level L3C from Moderate Resolution Imaging Spectroradiometer." ;
; institution = "University of Leicester" ;
; source = "ESA LST CCI MODIS L3C V3.00" ;
; history = "Regridded product on 2022.11.08 10:02:32 with lst_cci_regrid.py version 1.00 - command: lst_cci_regrid.py TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc output_dir --resolution 0.5 --coords \"0.5 -80 20 110\" --threads 4 --comp_level 1 --keep_log false;\nCreated using software developed at University of Leicester" ;
; references = "https://climate.esa.int/en/projects/land-surface-temperature" ;
; tracking_id = "4d86dd7-ffa4-4c6a-8dca-21c2ba45f8d2" ;
; conventions = "CF-1.8" ;
; product_version = "3.00" ;
; summary = "This file contains level L3C global land surface temperatures from AVHRR. L3C data are L2 data provided at orbit swath temporal resolution in a gridded map projection format." ;

; keywords = "Earth Science, Land Surface, Land Temperature, Land Surface Temperature" ;
; id = "ESACCI-LST-L3C-LST-MODISA-0.5deg_1MONTHLY_DAY-20060701000000-fv3.00.nc" ;
; naming_authority = "le.ac.uk" ;
; keywords_vocabulary = "NASA Global Change Master Directory (GCMD) Science Keywords" ;
; cdm_data_type = "grid" ;
; comment = "These data were produced as part of the ESA LST CCI project." ;
; date_created = "20221108T100232Z" ;
; creator_name = "lst_cci_regrid.py version 1.00 regrid tool" ;
; creator_url = "https://climate.esa.int/en/projects/land" ;
; creator_email = "djo200le.ac.uk" ;
; project = "Climate Change Initiative - European Space Agency" ;
; geospatial_lat_min = -80.75f ;
; geospatial_lat_max = -60.25f ;
; geospatial_lon_min = 20.25f ;
; geospatial_lon_max = 109.75f ;
; geospatial_vertical_min = 0.f ;
; geospatial_vertical_max = 0.f ;
; time_coverage_start = "20060701T000000" ;
; time_coverage_end = "20060701T235959" ;
; time_coverage_duration = "P1M" ;
; time_coverage_resolution = "P1M" ;
; standard_name_vocabulary = "CF Standard Name Table v71" ;
; license = "ESA CCI Data Policy: free and open access" ;
; platform = "Aqua" ;
; sensor = "MODIS" ;
; geospatial_lat_units = "degrees_north" ;
; geospatial_lon_units = "degrees_east" ;
; geospatial_lon_resolution = 0.5f ;
; geospatial_lat_resolution = 0.5f ;
; key_variables = "land_surface_temperature" ;
; svn_version = 5721 ;
; format_version = "CCI Data Standards v2.2" ;
```

Test execution: Global attributes are updated: creator_name, history, date_created, lat_min, lat_max, lon_min, lon_max, spatial_resolution, geospatial_lat_resolution, geospatial_lon_resolution. DOI attribute removed. Other attributes unchanged.

Conclusion: Test run successfully.

5.2. Functional TDS Files tests

5.2.1. ESACCI-LST-L3C-LST-MODISA-0.25deg 1MONTHLY DAY-20060701000000-fv3.00.nc

5.2.1.1. Subsetting without regridding (no resolution provided)

Scenario: Sub-setting: No resolution provided

```

habedrik@habedrik:~/work/LST/denarta/lst-cci-regrid$ p3 lst_cci_regrid.py TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc output_dir
2022-11-08 10:46:44,883 - INFO - log files: lst_cci_regrid.py TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc to None.log
2022-11-08 10:46:45,236 - INFO - Command: lst_cci_regrid.py TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc output_dir --threads 4 --comp_level 1 --keep_log false
2022-11-08 10:46:45,366 - INFO - spatial_resolution used is geospatial_lat_resolution
2022-11-08 10:46:45,748 - INFO - Input file name: ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
2022-11-08 10:46:45,749 - INFO - Use 4 parallel CPU threads
2022-11-08 10:46:45,749 - INFO - Output files: output_dir/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
2022-11-08 10:46:45,749 - INFO - Input file resolution: 0.25
2022-11-08 10:46:45,749 - INFO - Output file resolution: 0.25
2022-11-08 10:46:45,749 - INFO - -----
2022-11-08 10:46:46,113 - INFO - COPY 'dtm' variable
2022-11-08 10:46:46,115 - INFO - COPY 'satze' variable
2022-11-08 10:46:46,118 - INFO - COPY 'sataz' variable
2022-11-08 10:46:46,121 - INFO - COPY 'solze' variable
2022-11-08 10:46:46,124 - INFO - COPY 'solaz' variable
2022-11-08 10:46:46,127 - INFO - COPY 'lst' variable
2022-11-08 10:46:46,131 - INFO - COPY 'lst_uncertainty' variable
2022-11-08 10:46:46,134 - INFO - COPY 'lst_unc_ran' variable
2022-11-08 10:46:46,138 - INFO - COPY 'lst_unc_loc_atn' variable
2022-11-08 10:46:46,142 - INFO - COPY 'lst_unc_loc_sfc' variable
2022-11-08 10:46:46,146 - INFO - COPY 'lst_unc_sys' variable
2022-11-08 10:46:46,149 - INFO - COPY coordinates 'channel'
2022-11-08 10:46:46,168 - INFO - =====
2022-11-08 10:46:46,169 - INFO - Writing output file
2022-11-08 10:47:08,672 - INFO - File output_dir/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc written
2022-11-08 10:47:08,748 - INFO - Regridding successfully ended.
2022-11-08 10:47:08,749 - INFO - Regridding duration: 0:00:23.869422
2022-11-08 10:47:08,758 - INFO - =====
  
```

Figure 1: console output

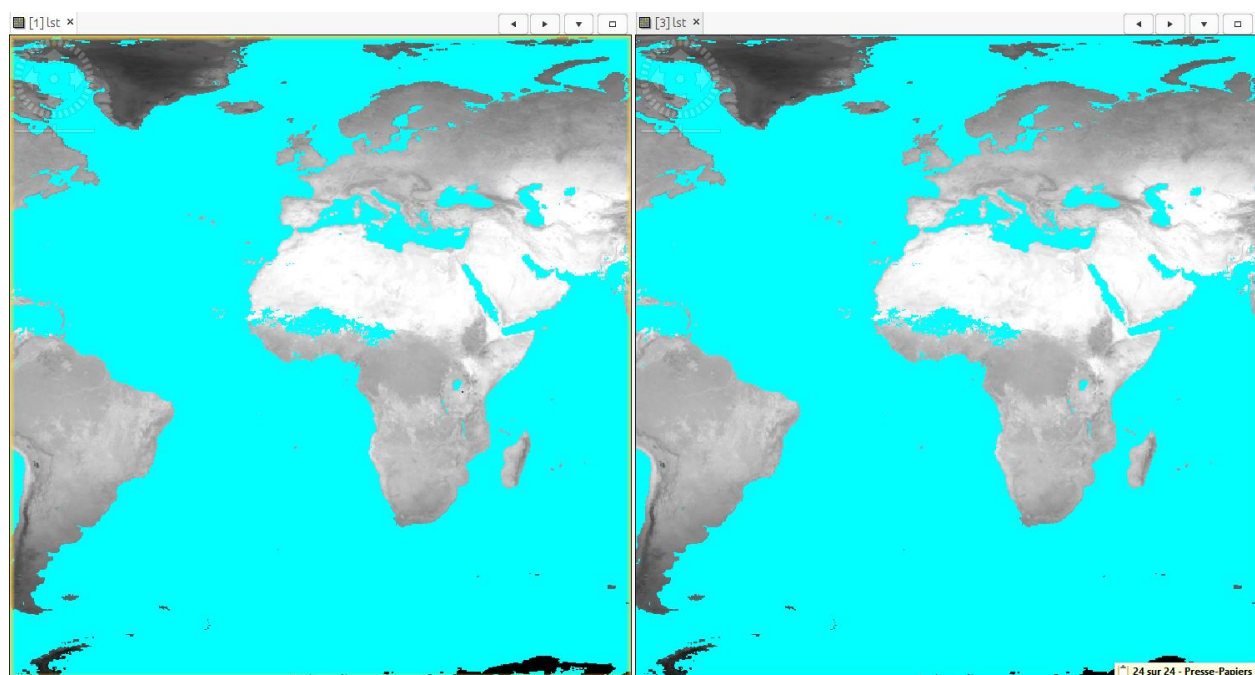
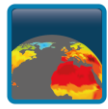


Figure 2: Original Land Surface Temperature vs subsetting result (data is copied)



land surface temperature

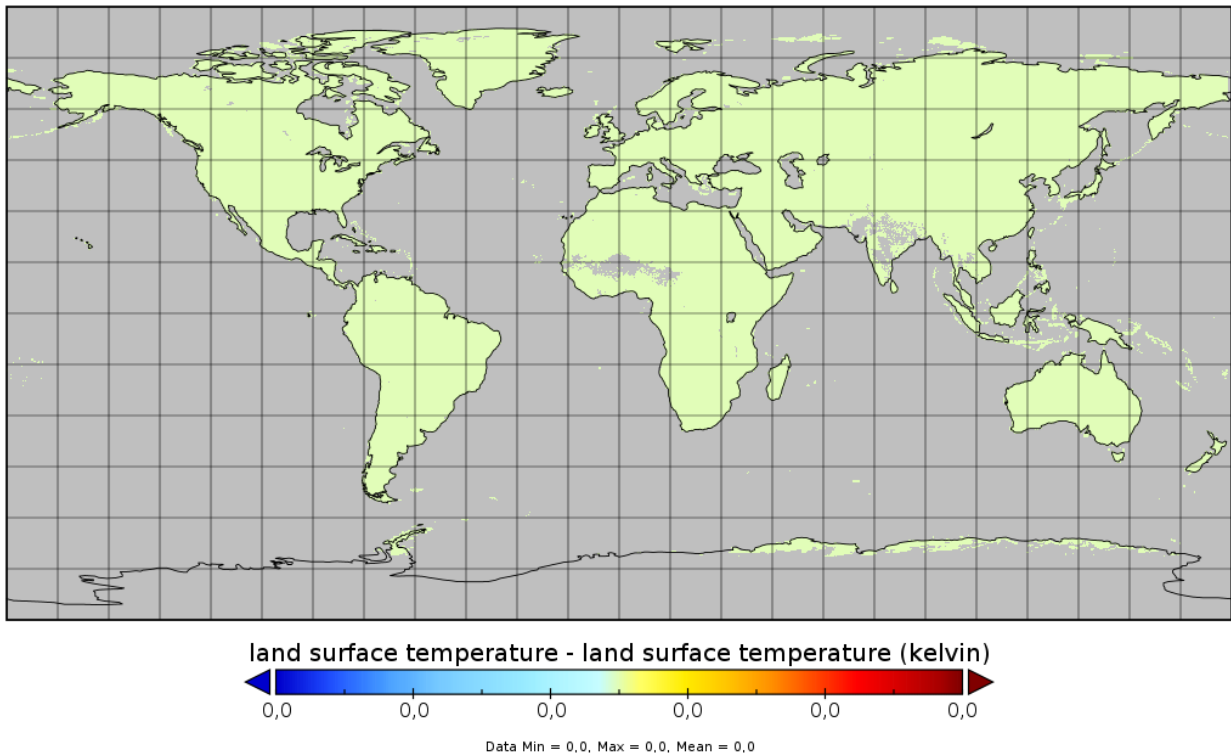


Figure 3: Delta LST temperature original TDS 0.25 - subsetting product

Test execution: As no resolution nor coordinates are provided in parameters, the CCI LST variables are copied from input file to output product. No error occurred. The output resolution is as expected.

Conclusion: Test run successfully.

5.2.1.2. Subsetting without regriding on a sub-area

Scenario: Sub-setting on a sub-area: No resolution provided

```
2022-11-08 10:59:00,284 - INFO - log files: lst_cci_regrid.py,ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc to None.log
2022-11-08 10:59:00,492 - INFO - Command: lst_cci_regrid.py TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc output_dir --coords "-60.12 30.7 -110 35" --threads 4 --comp_level 1 --keep_log false
2022-11-08 10:59:00,596 - INFO - spatial_resolution used is geospatial_lat_resolution
2022-11-08 10:59:00,947 - INFO - Input file name: ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
2022-11-08 10:59:00,947 - INFO - Use 4 parallel CPU threads
2022-11-08 10:59:00,948 - INFO - Output file: output_dir/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
2022-11-08 10:59:00,948 - INFO - Input file resolution: 0.25
2022-11-08 10:59:00,948 - INFO - Output file resolution: 0.25
2022-11-08 10:59:00,948 - INFO - Sub grid coordinates: [-60.12 30.7 -110 35]
2022-11-08 10:59:00,949 - INFO - -----
2022-11-08 10:59:01,287 - INFO - COPY 'datetime' variable
2022-11-08 10:59:01,289 - INFO - COPY 'satze' variable
2022-11-08 10:59:01,291 - INFO - COPY 'sataz' variable
2022-11-08 10:59:01,294 - INFO - COPY 'solze' variable
2022-11-08 10:59:01,297 - INFO - COPY 'solaz' variable
2022-11-08 10:59:01,300 - INFO - COPY 'lst' variable
2022-11-08 10:59:01,303 - INFO - COPY 'lst_uncertainty' variable
2022-11-08 10:59:01,306 - INFO - COPY 'lst_unc_ran' variable
2022-11-08 10:59:01,309 - INFO - COPY 'lst_unc_loc_atn' variable
2022-11-08 10:59:01,313 - INFO - COPY 'lst_unc_loc_sfc' variable
2022-11-08 10:59:01,317 - INFO - COPY 'lst_unc_sys' variable
2022-11-08 10:59:01,321 - INFO - COPY coordinates 'channel'
2022-11-08 10:59:01,329 - INFO - -----
2022-11-08 10:59:01,330 - INFO - Writing output file
2022-11-08 10:59:07,292 - INFO - File output_dir/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc written
2022-11-08 10:59:07,859 - INFO - Regridding successfully ended.
2022-11-08 10:59:07,859 - INFO - Regridding duration: 0:00:07.578698
2022-11-08 10:59:07,860 - INFO - -----
```

Figure 4: Console output: one step without error

uncertainty from locally correlated errors on surface scales

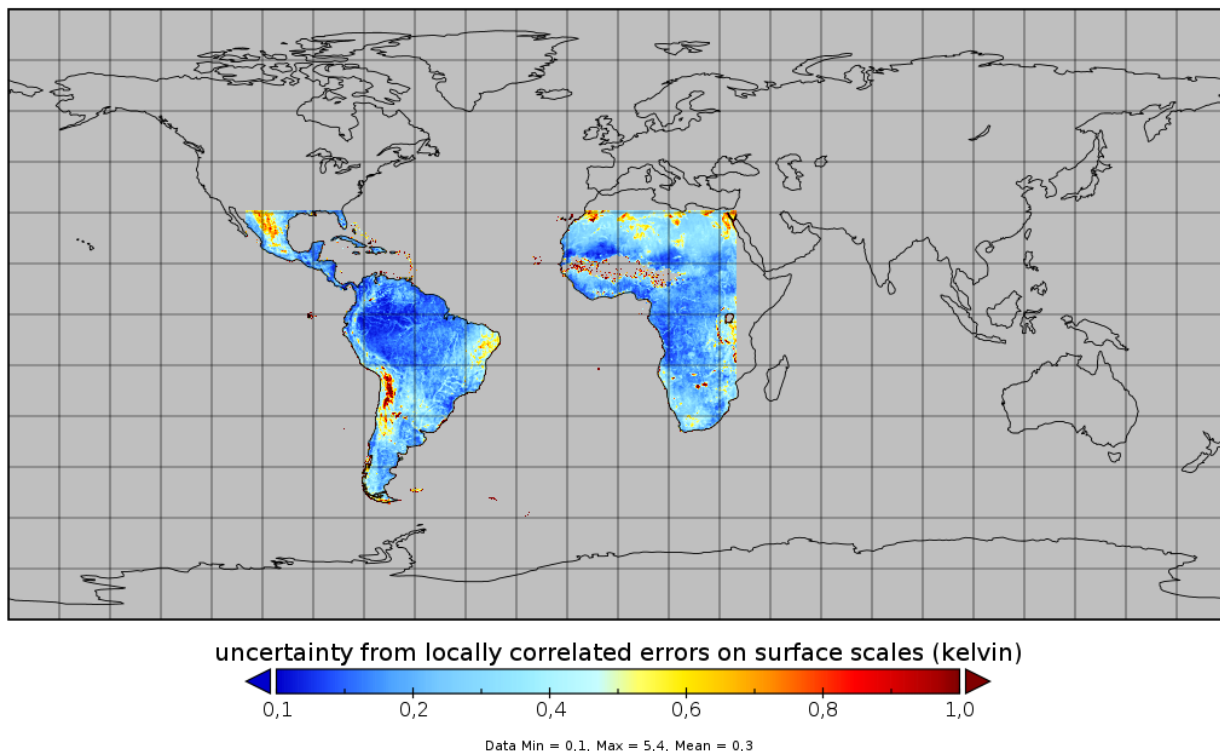


Figure 5: example of subsetting product with locally correlated errors on surface scales

Test execution: As no resolution is provided in parameters, the CCI LST variables are copied from input file to output product, focused on the `--coords` parameter. No error occurred. LST variables are copied in output.

Conclusion: Test run successfully.

5.2.1.3. Regridding from 0.25 to 1.0 degree

Scenario: regridding from 0.25 to 1.0

```

$ python3 /work/LST/demarc/LST_cci_regridding.py TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc output_dir --resolution 1.0
2022-11-08 11:02:18,523 - INFO - log file: lst_cci_regridding.py TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc to 1.0.log
2022-11-08 11:02:18,832 - INFO - Command: lst_cci_regridding.py TDS/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc output_dir --resolution 1.0 --threads 4 --comp_level 1 --keep_log false
2022-11-08 11:02:18,935 - INFO - spatial_resolution used is geospatial lat_resolution
2022-11-08 11:02:19,292 - INFO - Input file name: ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
2022-11-08 11:02:19,304 - INFO - Open 0.05 degree resolution land mask
2022-11-08 11:02:19,317 - INFO - regrid land map to 0.25
2022-11-08 11:02:21,402 - INFO - Use 4 parallel CPU threads
2022-11-08 11:02:21,403 - INFO - Output file: output_dir/ESACCI-LST-L3C-LST-MODISA-1.0deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
2022-11-08 11:02:21,403 - INFO - Input file resolution: 0.25
2022-11-08 11:02:21,403 - INFO - Output file resolution: 1.0
2022-11-08 11:02:21,403 - INFO - -----
2022-11-08 11:02:21,741 - INFO - REGRID 'dtm' Method mean
2022-11-08 11:02:21,820 - INFO - REGRID 'satze' Method mean
2022-11-08 11:02:21,855 - INFO - REGRID 'solze' Method mean
2022-11-08 11:02:21,889 - INFO - REGRID 'solze' Method mean
2022-11-08 11:02:21,930 - INFO - REGRID 'lst' Method mean
2022-11-08 11:02:21,969 - INFO - REGRID 'lst_uncertainty' Method sqrtmean_lst_uncertainty
2022-11-08 11:02:22,247 - INFO - REGRID 'lst_unc_ran' Method nanmean_uncorrelated_unc
2022-11-08 11:02:37,425 - INFO - REGRID 'lst_unc_loc_atn' Method nanmean_uncorrelated_loc
2022-11-08 11:02:37,526 - INFO - REGRID 'lst_unc_loc_atn' Method nanmean_uncorrelated_loc
2022-11-08 11:02:37,522 - INFO - REGRID 'lst_unc_loc_sfc' Method nanmean_uncorrelated_loc
2022-11-08 11:02:37,522 - INFO - REGRID 'lst_unc_loc_sfc' Method nanmean_uncorrelated_loc
2022-11-08 11:02:37,741 - INFO - REGRID 'lst_unc_sys' Method nanmean_fullcorr_large_scale_unc
2022-11-08 11:02:40,157 - INFO - Copy coordinates 'channel'
2022-11-08 11:02:47,159 - INFO - Computing total uncertainties
2022-11-08 11:03:53,616 - INFO - -----
2022-11-08 11:03:53,616 - INFO - Writing output file
2022-11-08 11:04:34,204 - INFO - File output_dir/ESACCI-LST-L3C-LST-MODISA-1.0deg_1MONTHLY_DAY-20060701000000-fv3.00.nc written
2022-11-08 11:04:34,814 - INFO - Regridding successfully ended.
2022-11-08 11:04:34,815 - INFO - Regridding duration: 0:02:16.295145
2022-11-08 11:04:34,815 - INFO - -----
  
```

Figure 6: Console execution

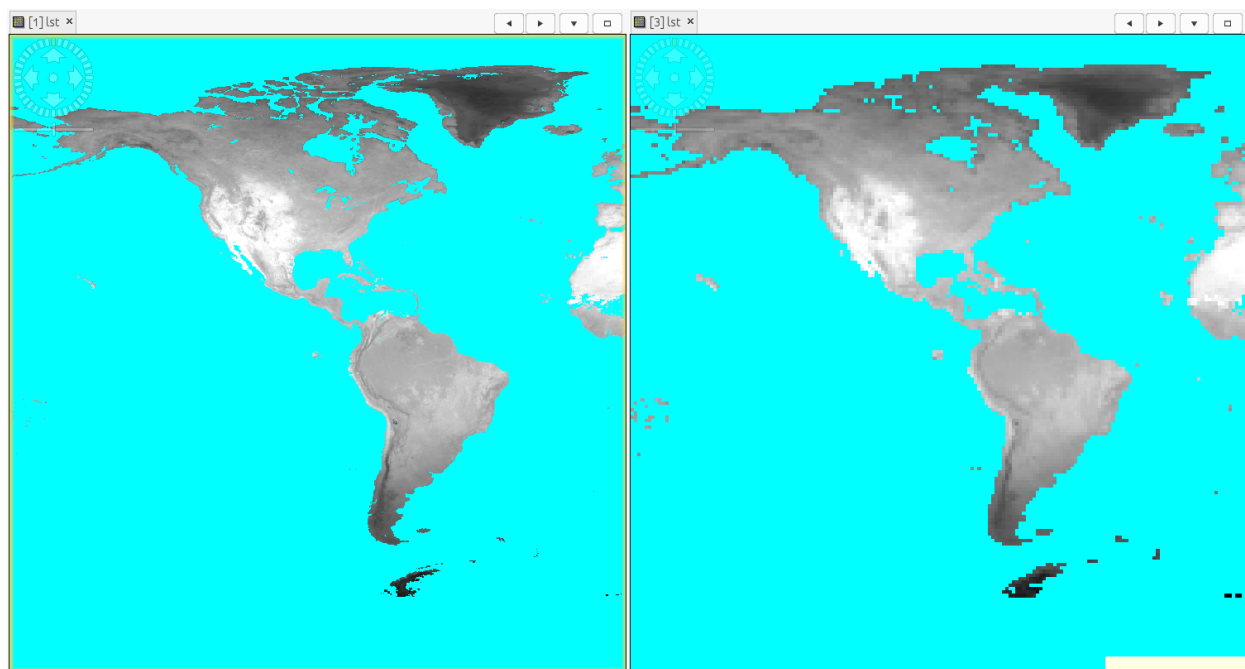


Figure 7: Original 0.25 Land Surface Temperature vs regridded 1.0 degree

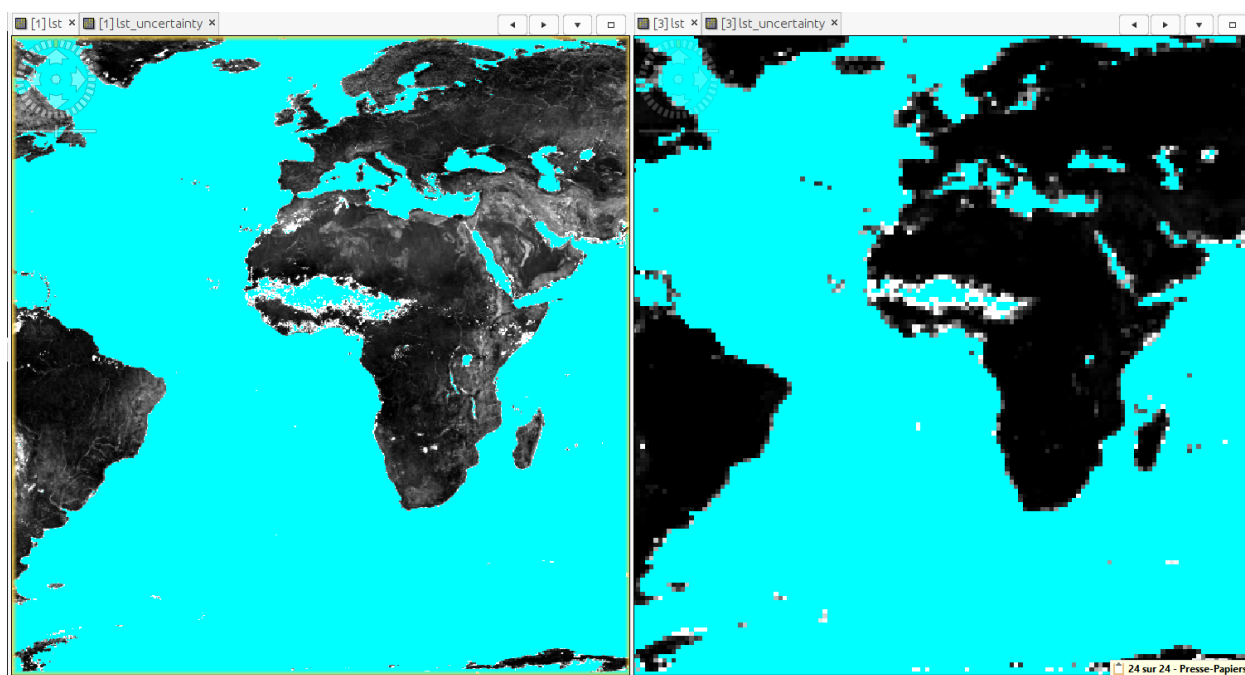


Figure 8: Original 0.25 Land Surface uncertainties vs regridded 1.0 degree

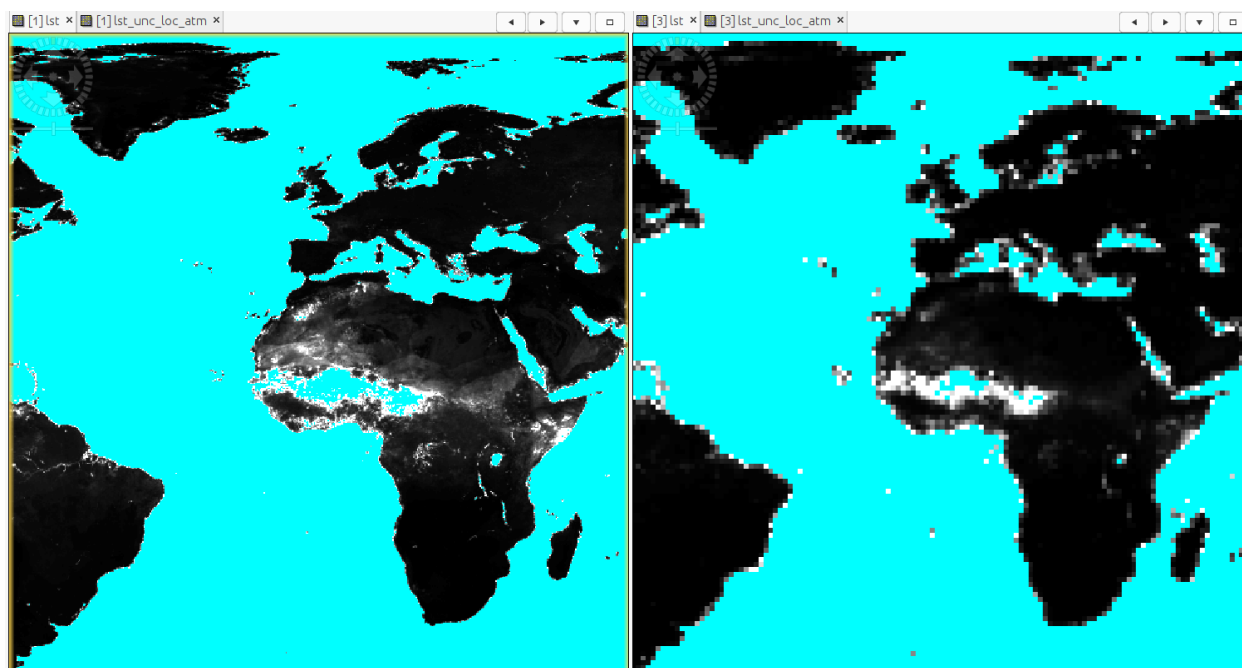


Figure 9: Original 0.25 atmospheric uncertainties vs regridded 1.0

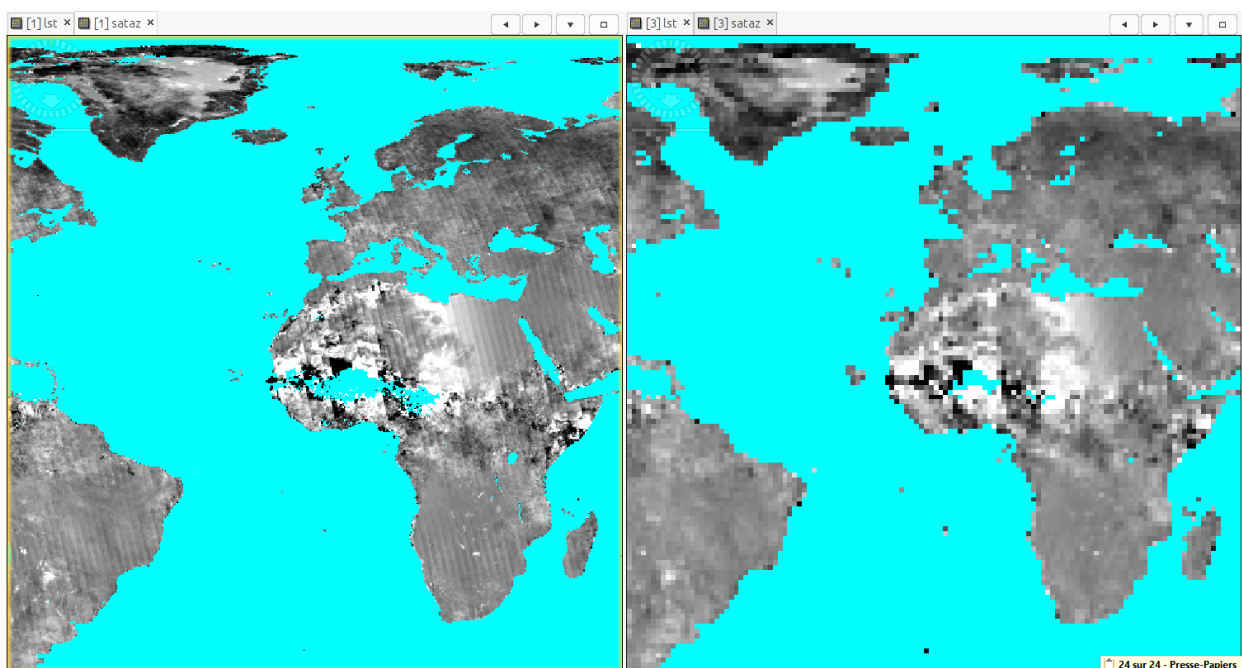


Figure 10: Original 0.25 satellite azimuth angle vs regridded 1.0 degree

Test execution: The regridding process ended with no error. The regridded product do not show any anomaly (no TDS comparison, visual evaluation). CCI LST variables present in input file are regridded in output file. Other variables are ignored. In the logs, the `lst_unc_loc_atm` and `lst_unc_loc_sfc` mean function are changed to match output resolution, as expected.

Conclusion: Test run successfully.

5.2.2. ESACCI-LST-L3C-LST-MODISA-0.05deg_1MONTHLY_DAY-20060701000000-fv3.00.nc

5.2.2.1. regridding from 0.05 to 0.05

Scenario: regridding from 0.05 to 0.05: output_resolution = UOL_2_STEPS_RES_LIMIT

land surface temperature

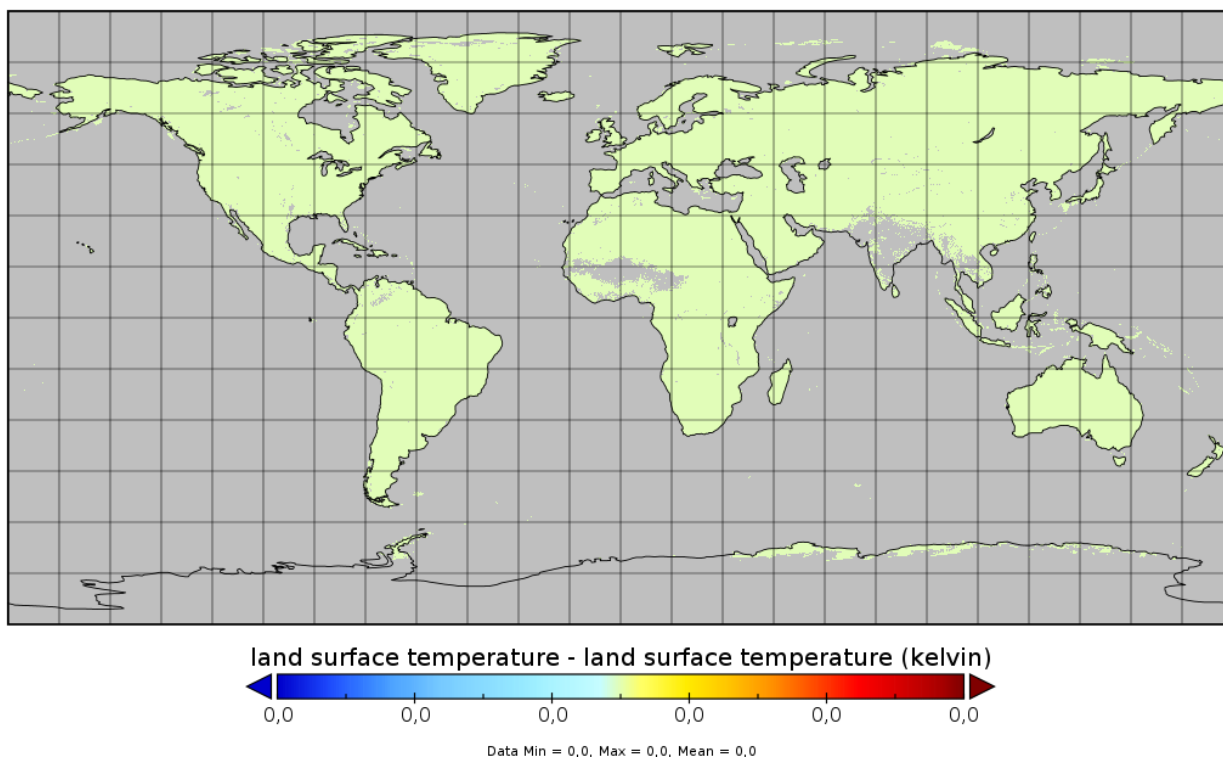
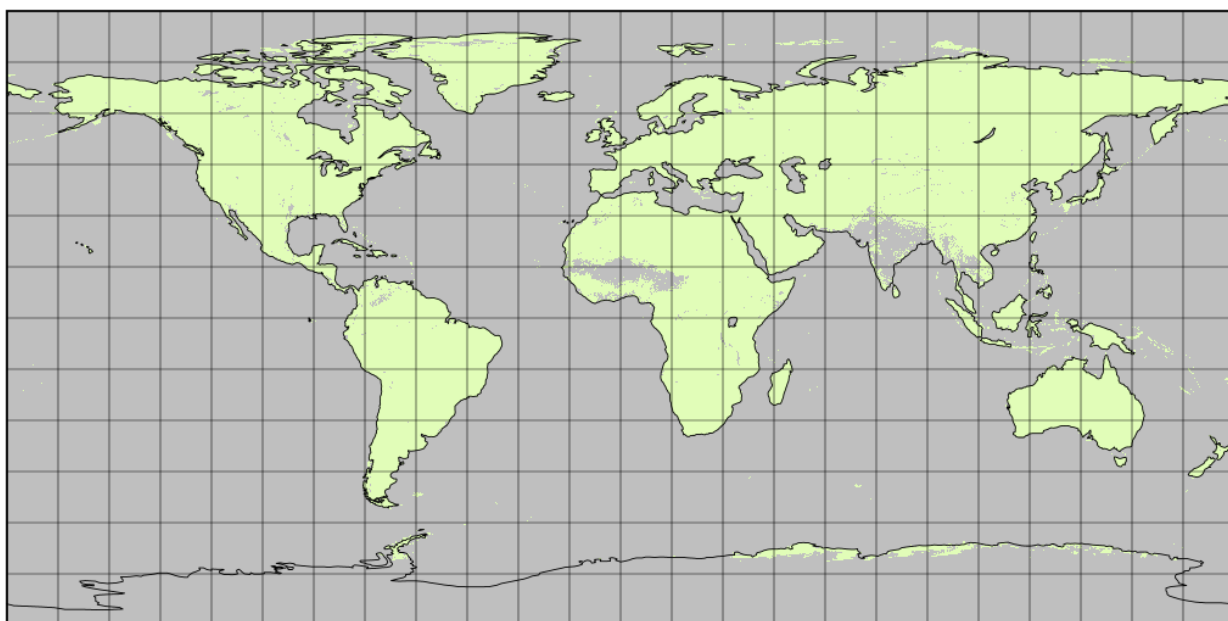


Figure 11: Delta Original 0.05 LST temperature - regridded 0.05

uncertainty from locally correlated errors on atmospheric scales

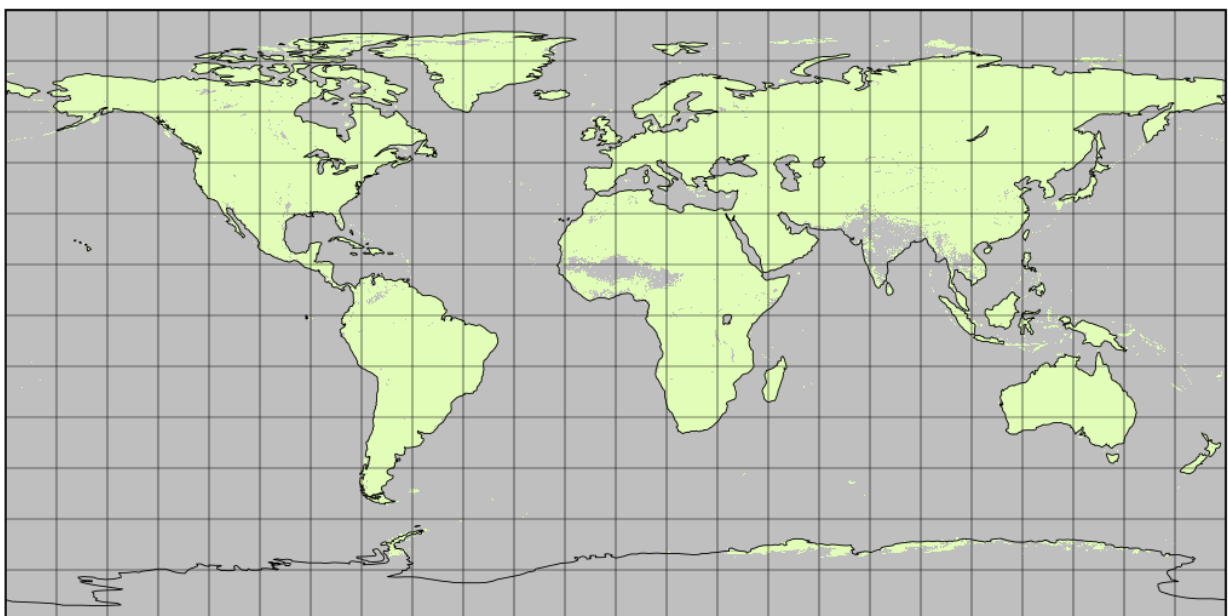


uncertainty from locally correlated errors on atmospheric scales - uncertainty from locally correlate...



Data Min = 0,0, Max = 0,0, Mean = 0,0

Figure 12: Delta Original 0.05 LST locally correlated errors on atmospheric scales - regrided 0.05
uncertainty from locally correlated errors on surface scales



uncertainty from locally correlated errors on surface scales - uncertainty from locally correlated erro...



Data Min = 0,0, Max = 0,0, Mean = 0,0

Figure 13: Delta Original 0.05 LST locally correlated errors on surface scales - regrided 0.05

Test execution: The output resolution is identical to input resolution: CCI LST variables are copied (subsetting without regridding). No error in execution. No difference with CCI LST variables in output.

Conclusion: Test run successfully.

5.2.2.2. regridding from 0.05 to 0.25

Scenario: regridding from 0.05 to 0.25: output_resolution > UOL_2_STEPS_RES_LIMIT

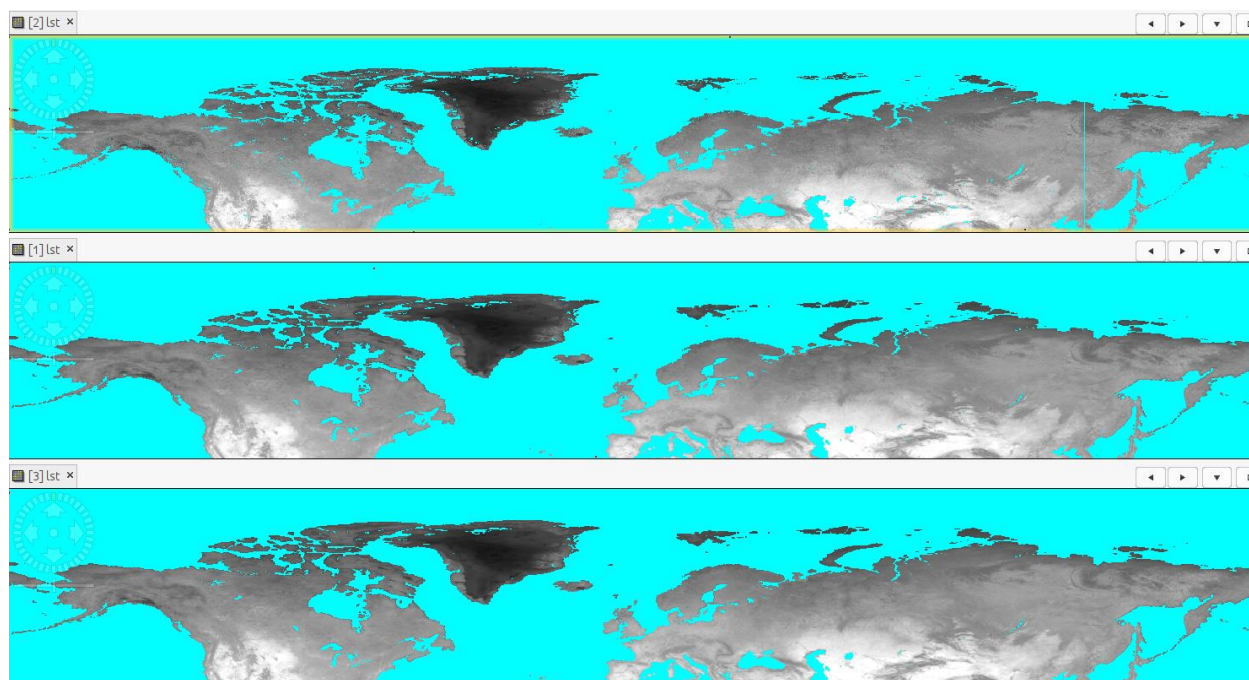


Figure 14: Original 0.05 Land Surface Temperature, regridded 0.25 product, Reference TDS 0.25

land surface temperature

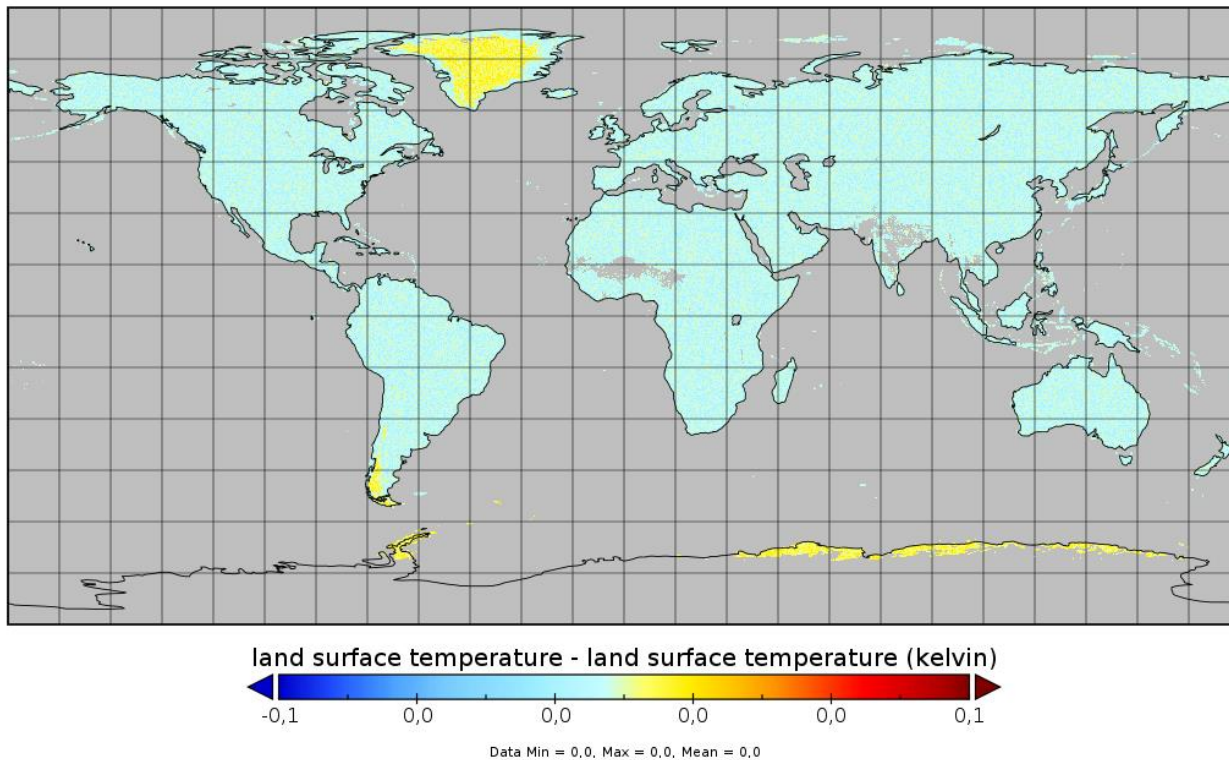


Figure 15: Delta Land Surface Temperature TDS 0.25 – regridded to 0.25

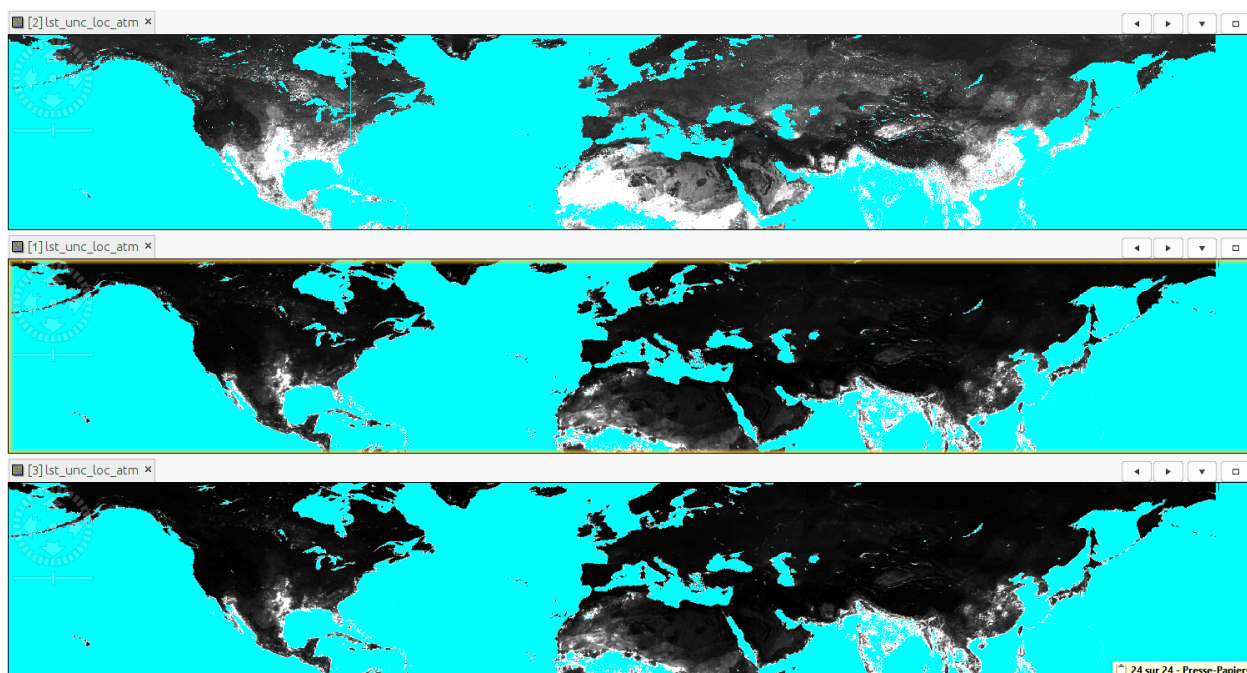
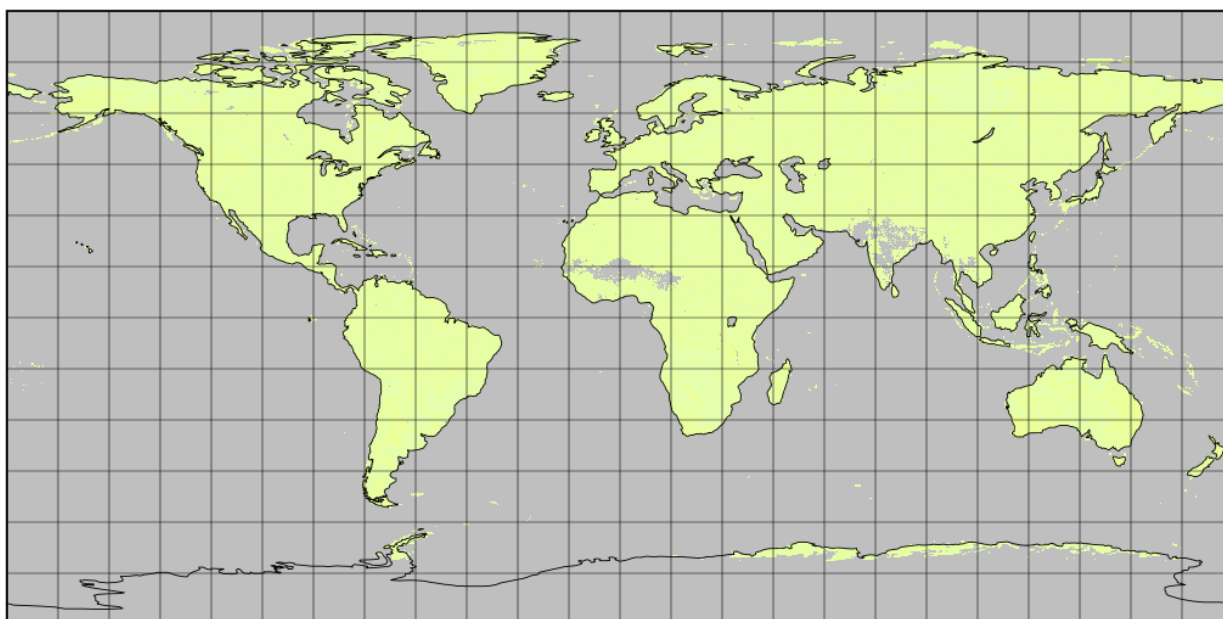


Figure 16: Original 0.05 atmospheric uncertainties, regridded 0.25 product, Reference TDS 0.25

uncertainty from locally correlated errors on atmospheric scales



uncertainty from locally correlated errors on atmospheric scales - uncertainty from locally correlate...



Data Min = 0,0, Max = 0,0, Mean = 0,0

Figure 17: Delta atmospheric uncertainties TDS 0.25 – regridded to 0.25

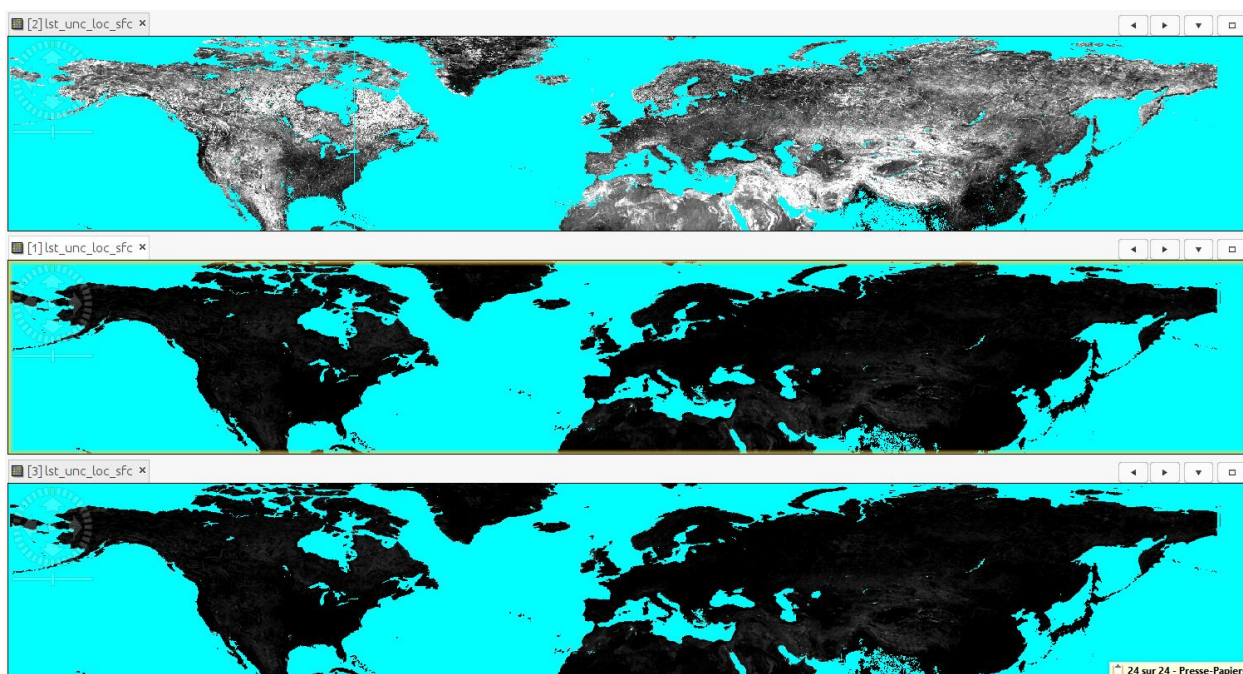
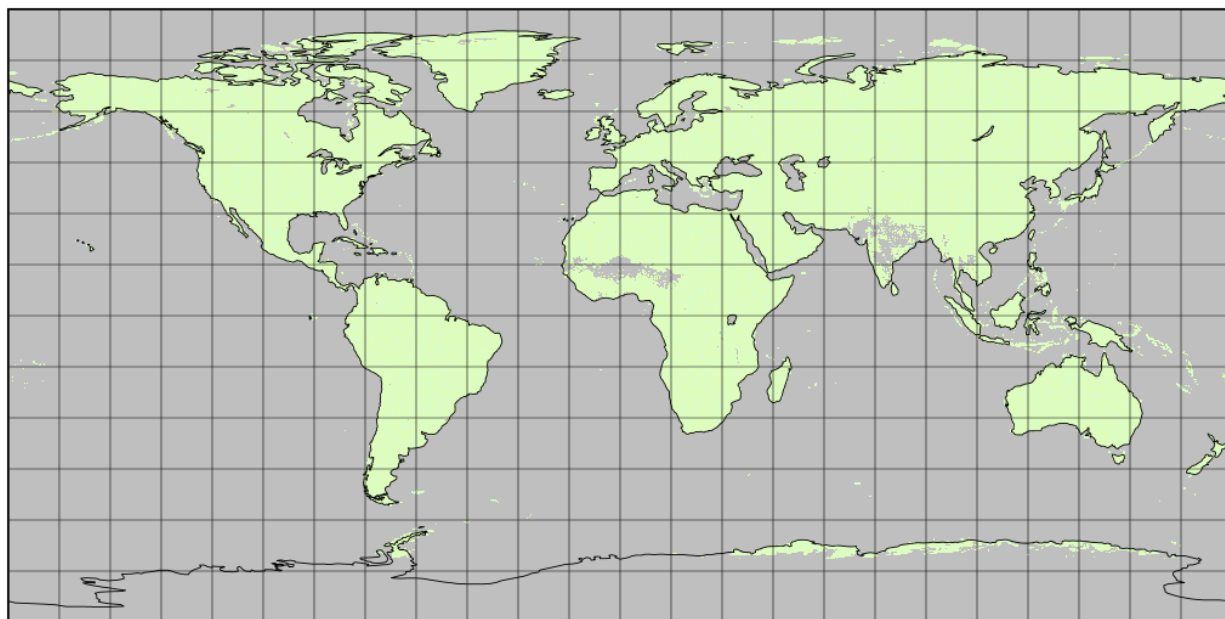


Figure 18: Original surface scales uncertainty 0.05, regridded 0.25 product, Reference TDS 0.25

uncertainty from locally correlated errors on surface scales



uncertainty from locally correlated errors on surface scales - uncertainty from locally correlated erro...



Data Min = 0,0, Max = 0,0, Mean = 0,0

Figure 19 Delta surface scales uncertainty Ref TDS 0.25 - regridded to 0.25

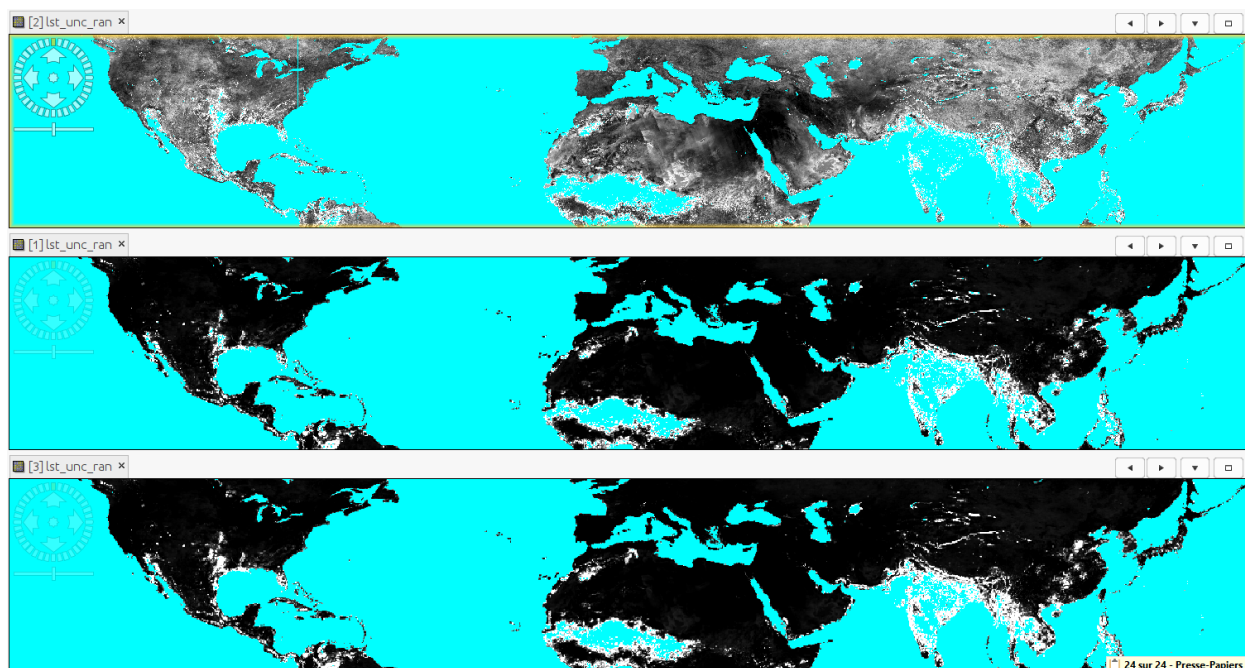


Figure 20: Original 0.05 uncorrelated errors uncertainty, regridded 0.25 product, Reference TDS 0.25

uncertainty from uncorrelated errors

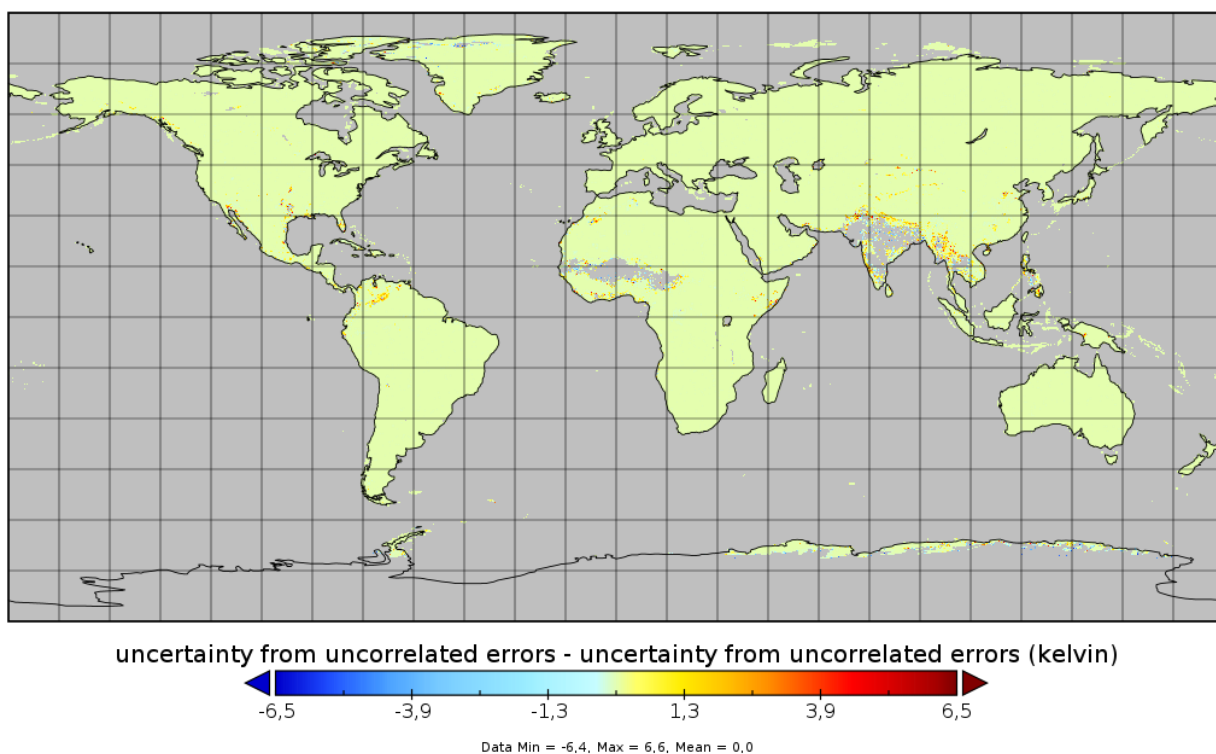


Figure 21: delta uncorrelated errors uncertainty Reference TDS 0.25 - regridded to 0.25

Explanation: See §Global status

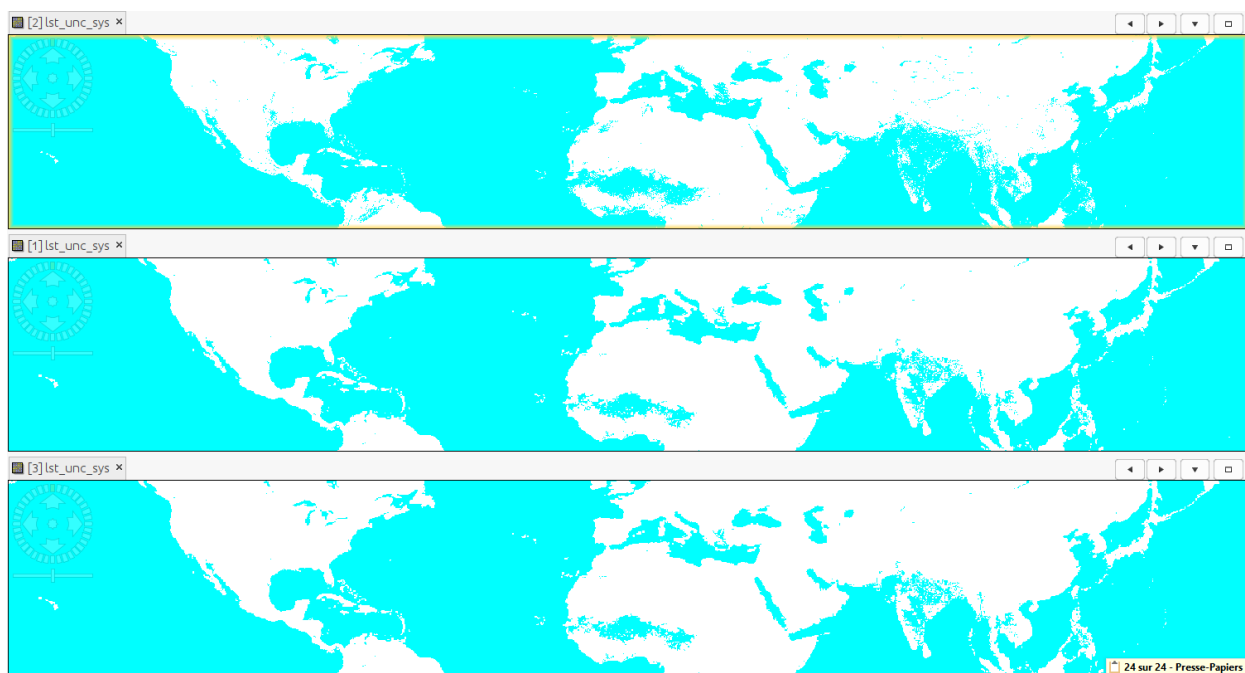
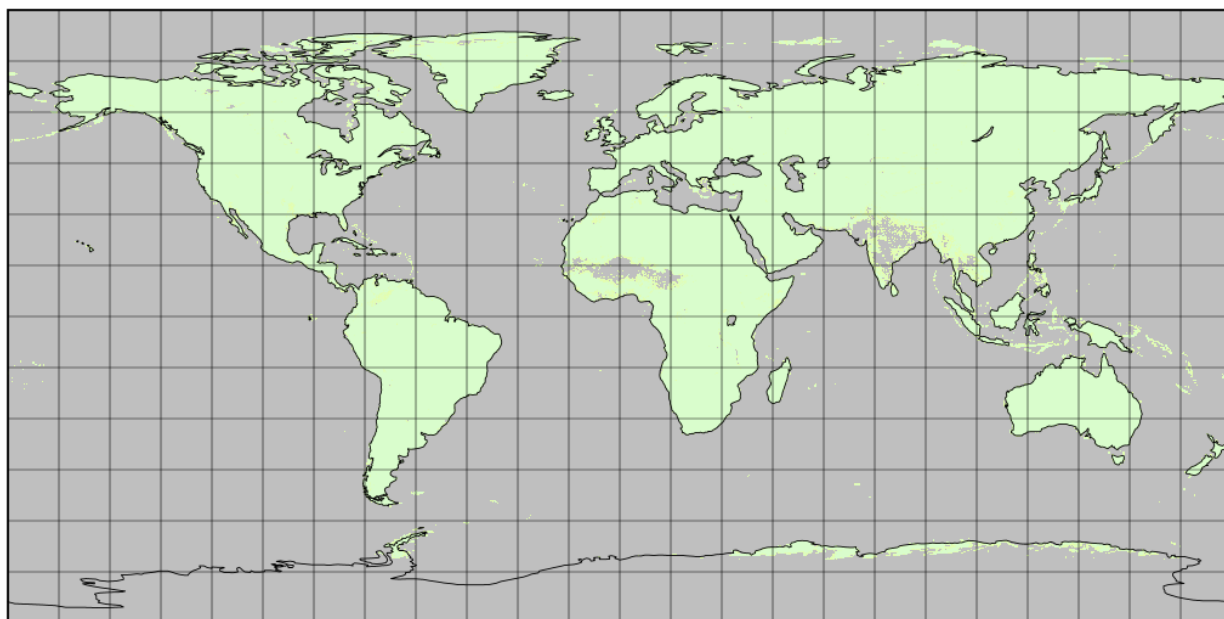
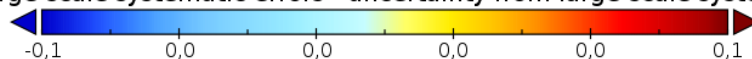


Figure 22: Original large scale systematic error uncertainty 0.05, regridded 0.25 product, Reference TDS 0.25

uncertainty from large-scale systematic errors



uncertainty from large-scale systematic errors - uncertainty from large-scale systematic errors (kelvi...



Data Min = 0,0, Max = 0,0, Mean = 0,0

Figure 23: Delta large scale systematic error uncertainty TDS 0.25 - regridded to 0.25

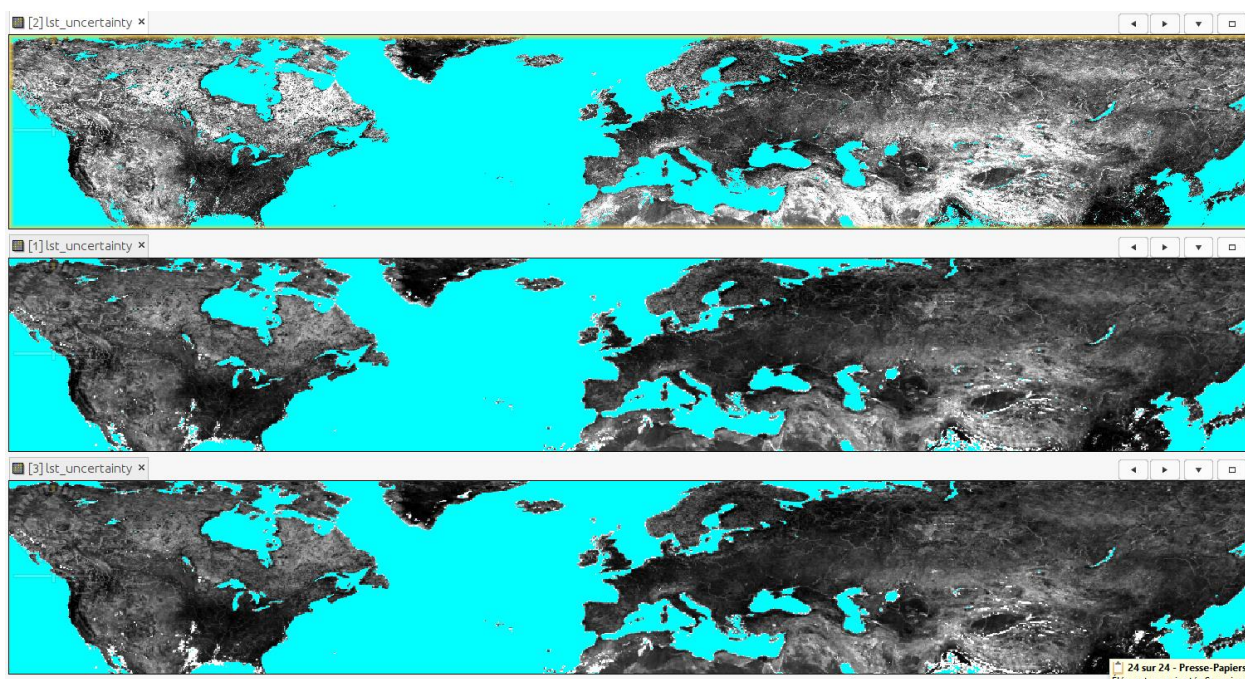
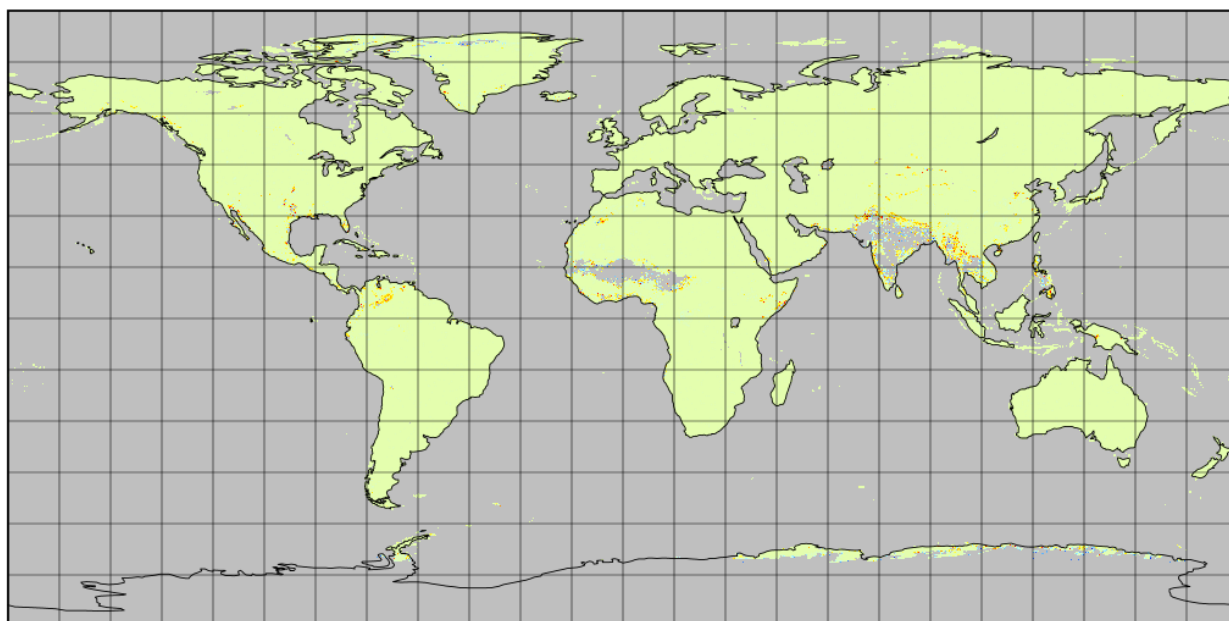


Figure 24: Original 0.05 LST uncertainty, regridded 0.25 product, Reference TDS 0.25

land surface temperature total uncertainty



land surface temperature total uncertainty - land surface temperature total uncertainty (kelvin)



Data Min = -6,3, Max = 6,6, Mean = 0,0

Figure 25: Delta total temperature uncertainty Reference TDS 0.25 - regridded to 0.25

Explanation: See §Global status

Test execution: Regridding in one step. The comparison of the regridded product with the reference TDS shows no difference but on lst_unc_ran and lst_uncertainty: those differences are explained above.

 land surface temperature cci	LST_cci Regridding and Subsetting Tool Verification Report <i>WP3.4 – DEL-D3.4-2</i>	Ref.: LST-CCI-D3.4-2-VR Version: 1.1 Date: 28/11/2022 Page: 32
--	--	---

Conclusion: Test run successfully.

5.2.3. ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.00.nc

5.2.3.1. regriding from 0.01 to 0.05

Scenario: regriding from 0.01 to 0.05: output_resolution = UOL_2_STEPS_RES_LIMIT

```

2022-11-08 14:16:51,873 - INFO - log file: lst_cci_regrid.py_ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.00.nc_to_0.05.log
2022-11-08 14:16:52,172 - INFO - Command: lst_cci_regrid.py TDS/ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.00.nc output_dir --resolution 0.05 --threads 4 --comp_level 1 --keep_1
og false
2022-11-08 14:16:52,297 - INFO - spatial_resolution used is geospatial lat resolution
2022-11-08 14:18:31,563 - INFO - Input file name: ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
2022-11-08 14:18:31,564 - INFO - Use 4 parallel CPU threads
2022-11-08 14:18:31,564 - WARNING - Output file output_dir/ESACCI-LST-L3C-LST-MODISA-0.05deg_1MONTHLY_DAY-20060701000000-fv3.00.nc exists and will be replaced.
2022-11-08 14:18:31,564 - INFO - Input file resolution: 0.01
2022-11-08 14:18:31,564 - INFO - Output file resolution: 0.05
2022-11-08 14:18:31,564 - INFO - -----
2022-11-08 14:19:29,294 - INFO - Use inner loc variable as landmask
2022-11-08 14:19:29,307 - INFO - REGRID 'dtime' Method mean
2022-11-08 14:19:29,380 - INFO - REGRID 'satze' Method mean
2022-11-08 14:19:29,421 - INFO - REGRID 'satze' Method mean
2022-11-08 14:19:29,467 - INFO - REGRID 'solze' Method mean
2022-11-08 14:19:29,504 - INFO - REGRID 'solze' Method mean
2022-11-08 14:19:29,543 - INFO - REGRID 'lst' Method mean
2022-11-08 14:19:29,580 - INFO - REGRID 'lst_uncertainty' Method sqrtmean_lst_uncertainty
2022-11-08 14:19:29,603 - INFO - REGRID 'lst_unc_ran' Method nanmean_uncorrelated_unc
2022-11-08 14:21:51,997 - INFO - lst_unc_loc_atm: Monthly filter: change lst_unc_loc_atm function to nanmean_uncorrelated_loc
2022-11-08 14:21:51,998 - INFO - REGRID 'lst_unc_loc_atm' Method nanmean_uncorrelated_loc
2022-11-08 14:21:52,121 - INFO - REGRID 'lst_unc_loc_sfc' Method nanmean_loc_sys_unc
2022-11-08 14:21:52,344 - INFO - REGRID 'lst_unc_sys' Method nanmean_fullcorr_large_scale_unc
2022-11-08 14:22:53,520 - INFO - IGNORE 'lcc' variable
2022-11-08 14:22:53,582 - INFO - IGNORE 'variance' variable
2022-11-08 14:22:53,585 - INFO - COPY coordinates 'channel'
2022-11-08 14:22:53,587 - INFO - Computing total uncertainties
2022-11-08 14:24:02,745 - INFO - -----
2022-11-08 14:24:02,745 - INFO - Writing output file
2022-11-08 14:30:43,732 - INFO - File output_dir/ESACCI-LST-L3C-LST-MODISA-0.05deg_1MONTHLY_DAY-20060701000000-fv3.00.nc written
2022-11-08 14:30:43,859 - INFO - Regridding successfully ended.
2022-11-08 14:30:43,859 - INFO - Regridding duration: 0:13:51.989271
2022-11-08 14:30:43,859 - INFO - -----

```

Figure 26: console output: regriding from 0.01 to 0.05 degree

Test execution: Regridding in one step, with no error. In the the lst_un_loc_atm mean function is changed as the input file is detected as monthly and output resolution equals 0.05 threshold (as expected).

Conclusion: Test run successfully.

NB: no picture of the regriding is shown here, as the same regriding is done internally in the test 'regridding from 0.01 to 0.25': that regriding is done in two steps, from 0.01 degree to 0.05 degree, then from 0.05 to 0.25 degree. Therefore, the 'regridding from 0.01 to 0.25' test embeds 'regridding from 0.01 to 0.05' scenario and cumulates the possible errors of the two steps: comparison with TDS is done in test 'regridding from 0.05 to 0.25'

5.2.3.2. regriding from 0.01 to 0.25

Scenario: regriding from 0.01 to 0.25: input_resolution < UOL_2_STEPS_RES_LIMIT and output_resolution > UOL_2_STEPS_RES_LIMIT


```

2022-11-08 16:33:14,479 - INFO - log file: lst_cci_regrid.py_ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.00.nc_to_0.25.log
2022-11-08 16:33:14,913 - INFO - Command: lst_cci_regrid.py TDS/ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.00.nc output_dir_025 --resolution 0.25 --threads 4 --comp_level 1 --ke
ep_log false
2022-11-08 16:33:15,029 - INFO - spatial_resolution used is geospatial_lat_resolution
2022-11-08 16:34:45,953 - INFO - Input file name: ESACCI-LST-L3C-LST-MODISA-0.01deg_1MONTHLY_DAY-20060701000000-fv3.00.nc
2022-11-08 16:34:45,989 - INFO - Use 4 parallel CPU threads
2022-11-08 16:34:45,990 - WARNING - Output file output_dir_025/ESACCI-LST-L3C-LST-MODISA-0.25deg_1MONTHLY_DAY-20060701000000-fv3.00.nc exists and will be replaced.
2022-11-08 16:34:45,991 - INFO - 2 steps regridding:
2022-11-08 16:34:45,991 - INFO - Step 1: regrid to a 0.05 grid
2022-11-08 16:34:45,991 - INFO - Input file resolution: 0.01
2022-11-08 16:34:45,991 - INFO - Output file resolution: 0.25
2022-11-08 16:34:45,991 - INFO - -----
2022-11-08 16:35:42,728 - INFO - Use inner lcc variable as landmask
2022-11-08 16:35:42,745 - INFO - REGRID 'dtine' Method mean
2022-11-08 16:35:42,822 - INFO - REGRID 'satze' Method mean
2022-11-08 16:35:42,861 - INFO - REGRID 'sataz' Method mean
2022-11-08 16:35:42,903 - INFO - REGRID 'solze' Method mean
2022-11-08 16:35:42,941 - INFO - REGRID 'solaz' Method mean
2022-11-08 16:35:42,986 - INFO - REGRID 'lst' Method mean
2022-11-08 16:35:43,028 - INFO - REGRID 'lst_uncertainty' Method sqrtmean_lst_uncertainty
2022-11-08 16:35:43,251 - INFO - REGRID 'lst_unc_ran' Method nanmean_uncorrelated_unc
2022-11-08 16:38:01,851 - INFO - lst_unc_loc_atm: Monthly file: change lst_unc_loc_atm function to nanmean_uncorrelated_loc
2022-11-08 16:38:01,851 - INFO - REGRID 'lst_unc_loc_atm' Method nanmean_uncorrelated_loc
2022-11-08 16:38:01,950 - INFO - REGRID 'lst_unc_loc_sfc' Method nanmean_loc_sys_unc
2022-11-08 16:38:02,177 - INFO - REGRID 'lst_unc_sys' Method nanmean_fullcorr_large_scale_unc
2022-11-08 16:38:49,091 - INFO - IGNORE 'lcc' variable
2022-11-08 16:38:49,092 - INFO - REGRID 'n' Method sun
2022-11-08 16:38:49,143 - INFO - IGNORE 'variance' variable
2022-11-08 16:38:49,143 - INFO - COPY coordinates 'channel'
2022-11-08 16:38:49,145 - INFO - Computing total uncertainties
2022-11-08 16:39:58,118 - INFO - -----
2022-11-08 16:39:58,118 - INFO - Step 2: regrid to target grid
2022-11-08 16:39:58,192 - INFO - REGRID 'dtine' Method mean
2022-11-08 16:39:58,275 - INFO - REGRID 'satze' Method mean
2022-11-08 16:39:58,315 - INFO - REGRID 'sataz' Method mean
2022-11-08 16:39:58,359 - INFO - REGRID 'solze' Method mean
2022-11-08 16:39:58,393 - INFO - REGRID 'solaz' Method mean
2022-11-08 16:39:58,428 - INFO - REGRID 'lst' Method mean
2022-11-08 16:39:58,461 - INFO - REGRID 'lst_uncertainty' Method sqrtmean_lst_uncertainty
2022-11-08 16:39:59,489 - INFO - REGRID 'lst_unc_ran' Method nanmean_uncorrelated_unc
2022-11-08 16:40:44,751 - INFO - lst_unc_loc_atm: Output resolution > 0.05: use 'Propagation from 0.05 degree' algorithms
2022-11-08 16:40:44,751 - INFO - REGRID 'lst_unc_loc_atm' Method nanmean_uncorrelated_loc
2022-11-08 16:40:44,853 - INFO - lst_unc_loc_sfc: Output resolution > 0.05: use 'Propagation from 0.05 degree' algorithms
2022-11-08 16:40:44,853 - INFO - REGRID 'lst_unc_loc_sfc' Method nanmean_uncorrelated_loc
2022-11-08 16:40:45,271 - INFO - REGRID 'lst_unc_sys' Method nanmean_fullcorr_large_scale_unc

```

Figure 27: console output: regridding from 0.01 to 0.25 degree (2 steps chaining)

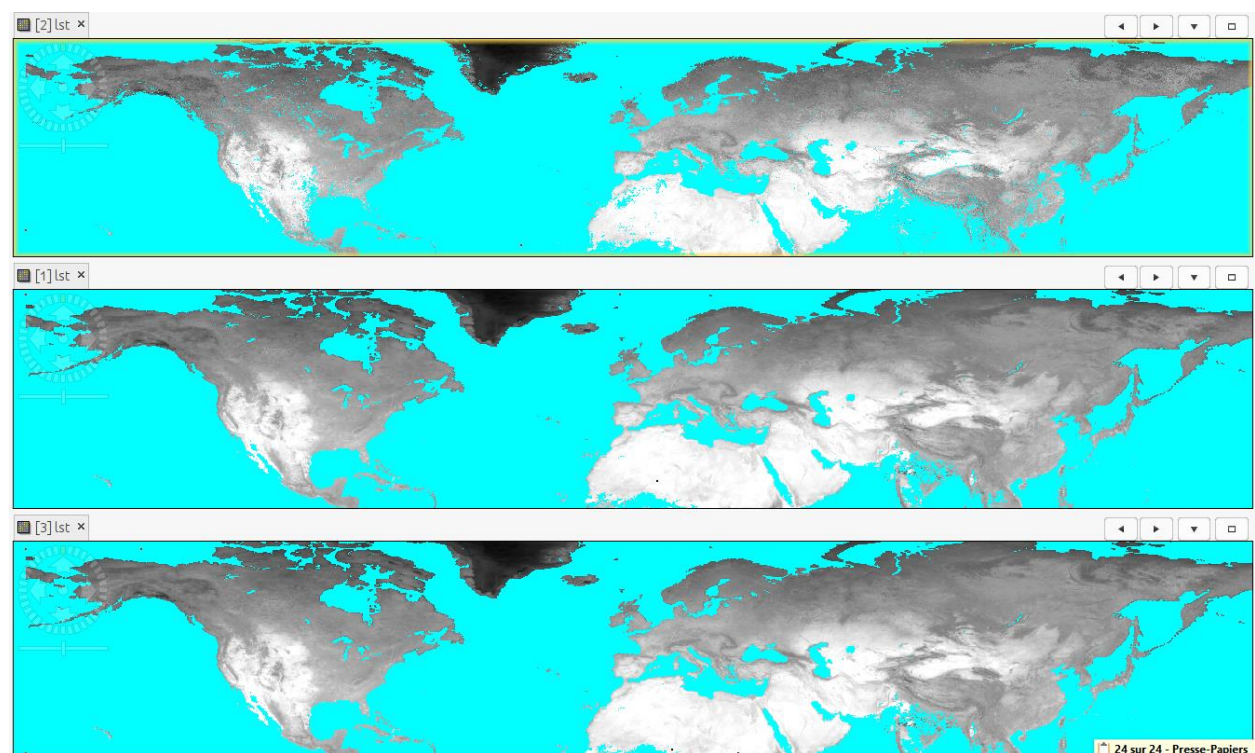


Figure 28: Original 0.01 land surface temperature, regridded 0.25 product, reference TDS 0.25

land surface temperature

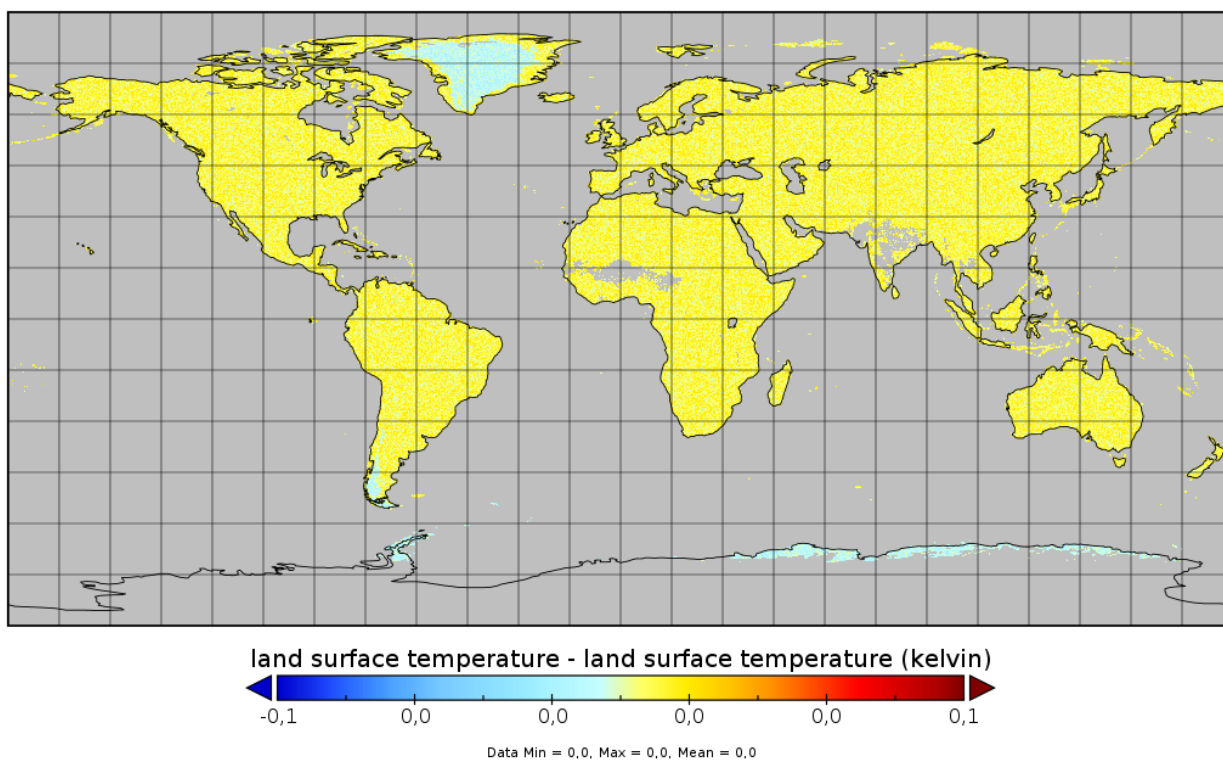


Figure 29: delta LST temperature TDS 0.25 - regrided 0.25

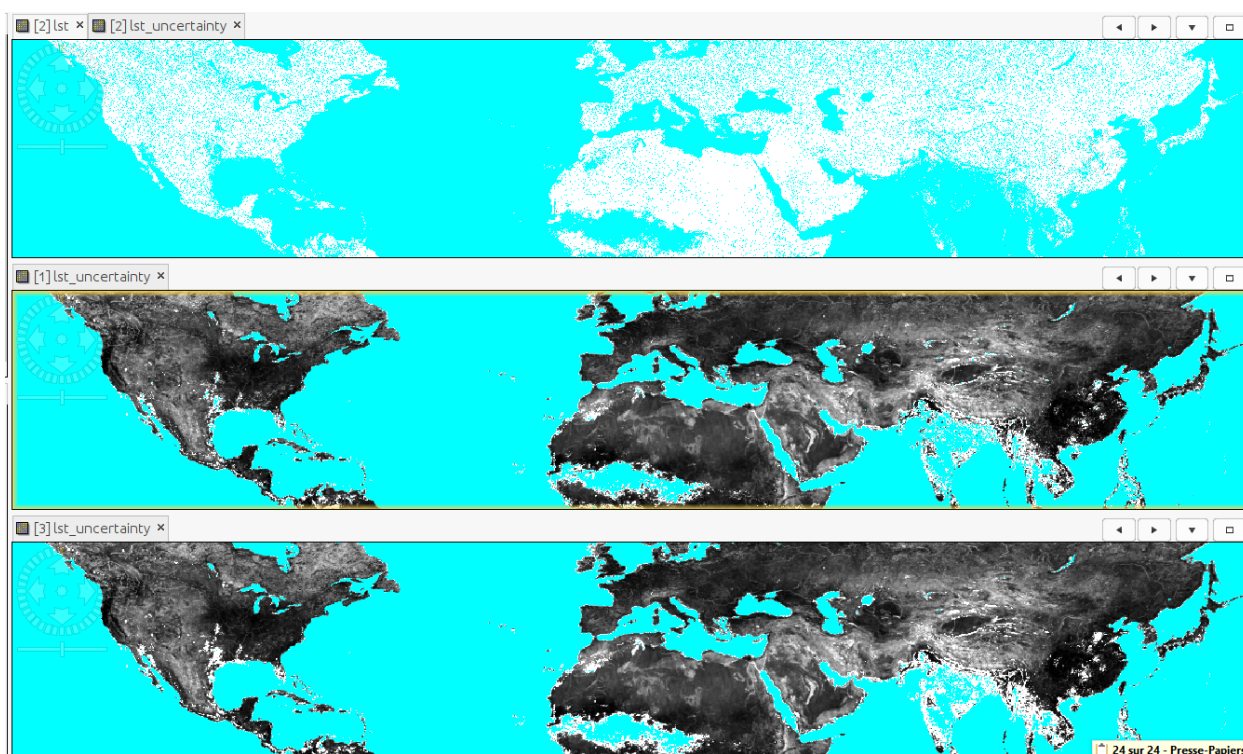
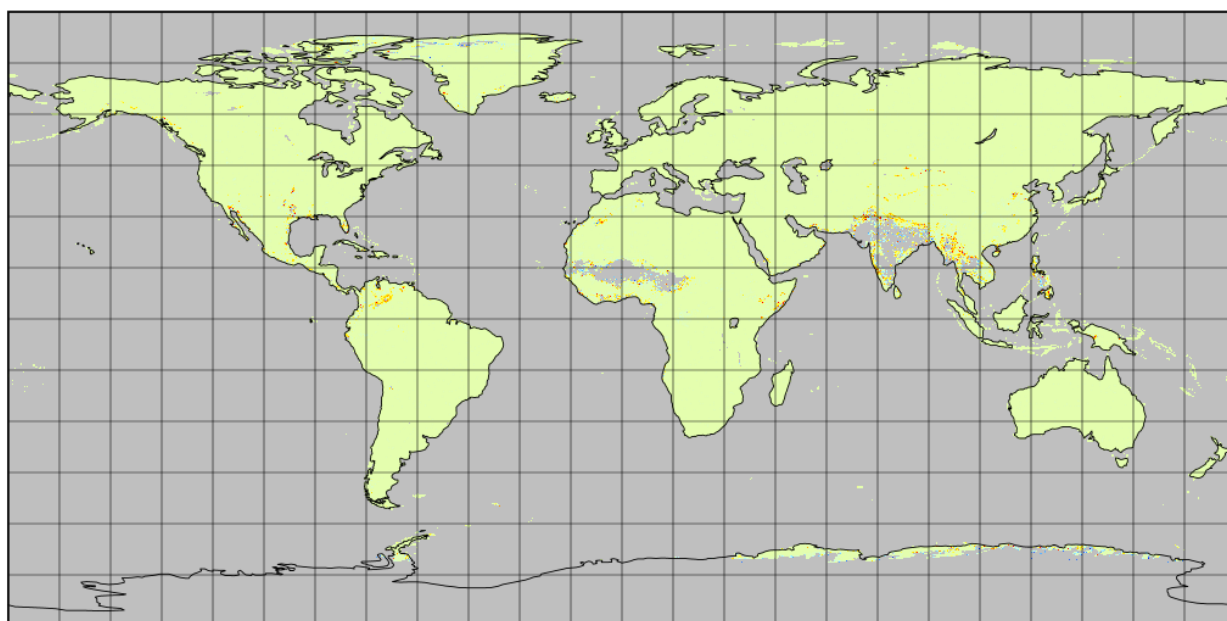


Figure 30: Original 0.01 LST uncertainty, regrided 0.25 product, reference TDS 0.25

land surface temperature total uncertainty



land surface temperature total uncertainty - land surface temperature total uncertainty (kelvin)



Data Min = -6,3, Max = 6,6, Mean = 0,0

Figure 31: Delta LST Uncertainty TDS 0.25– regrided to 0.25

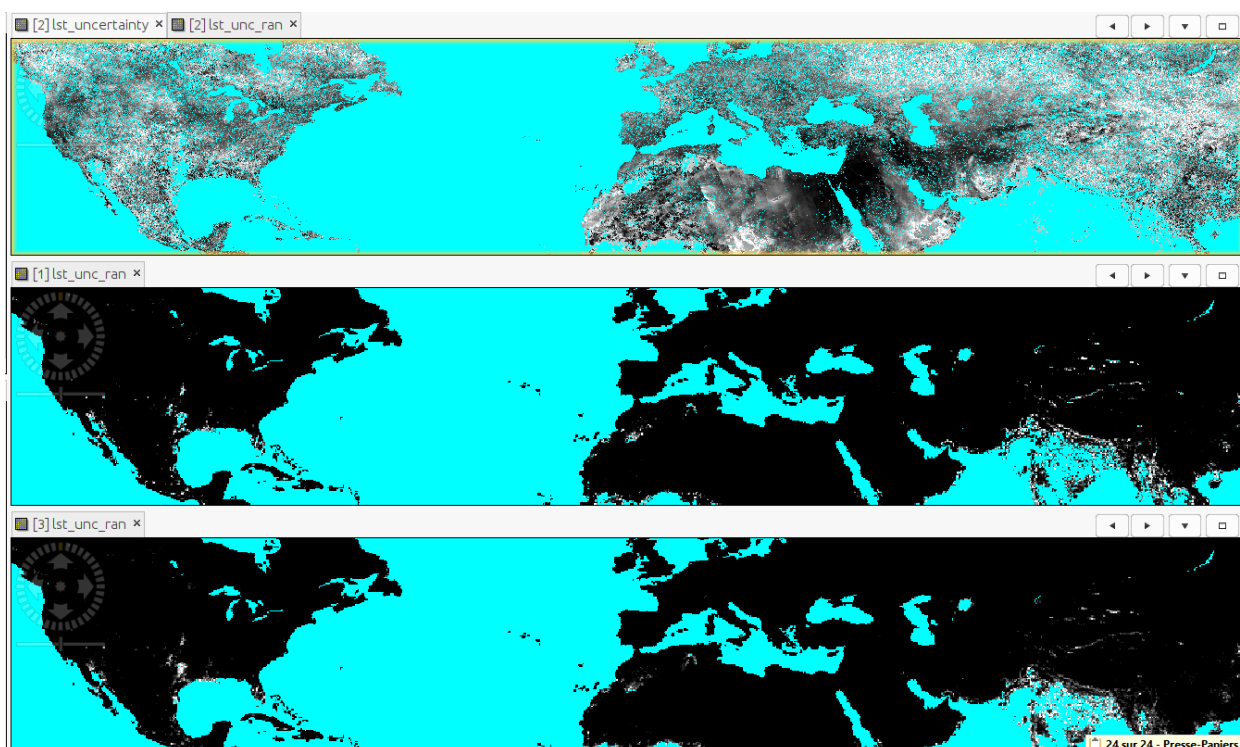
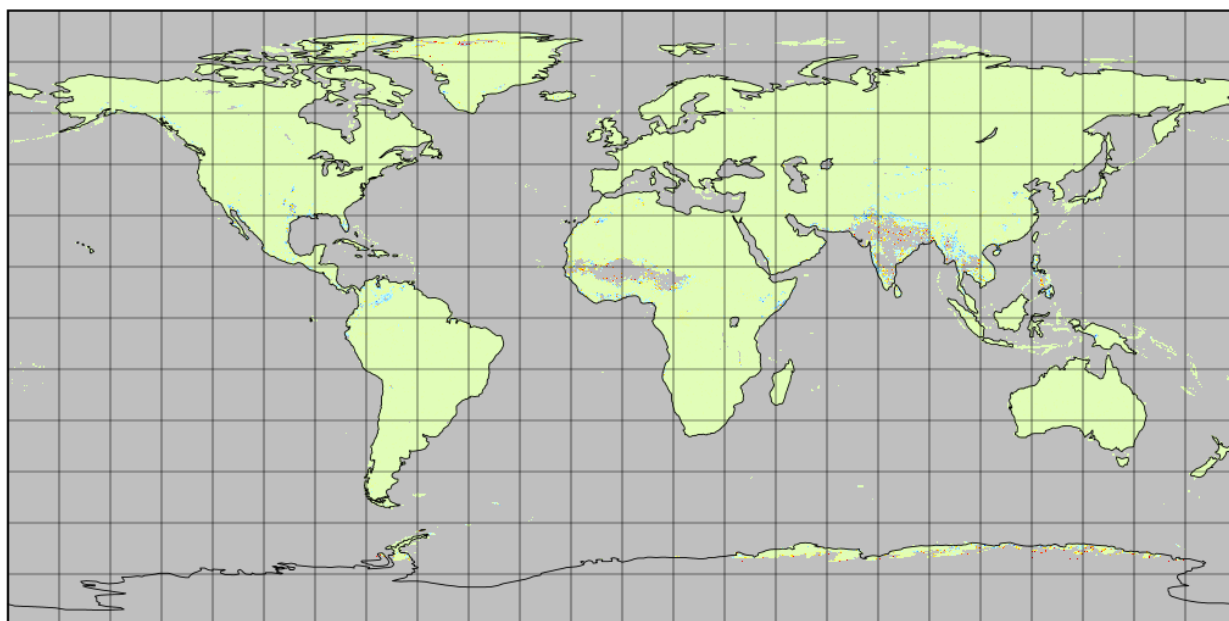


Figure 32: Original 0.01 uncorrelated errors, regrided 0.25 product, reference TDS 0.25

uncertainty from uncorrelated errors



uncertainty from uncorrelated errors - uncertainty from uncorrelated errors (kelvin)



Data Min = -6,6, Max = 6,4, Mean = 0,0

Figure 33: delta uncorrelated errors TDS 0.25 - regridded 0.25

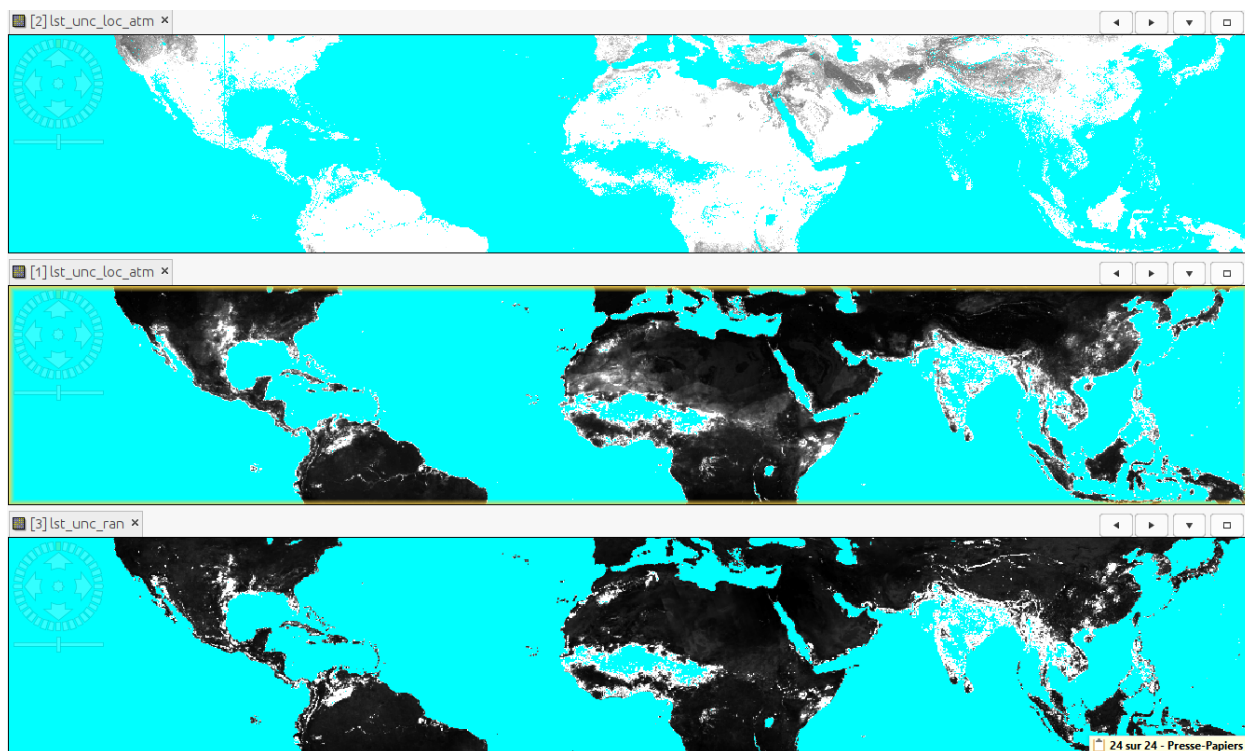
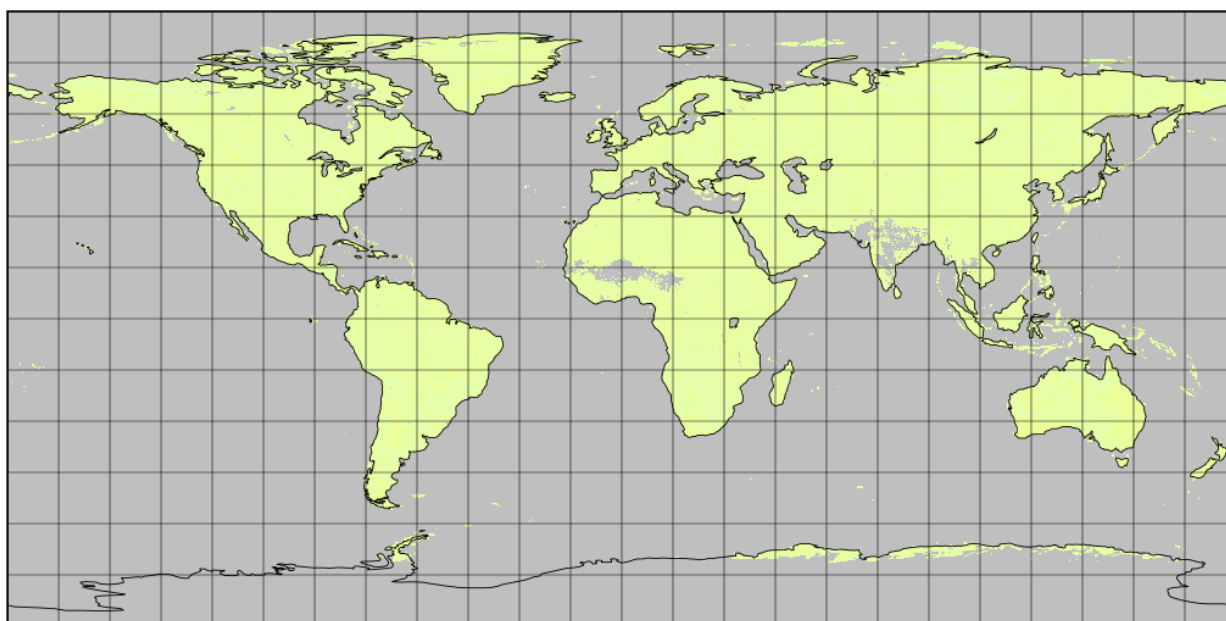


Figure 34: Original 0.01 atmospheric errors uncertainties, regridded 0.25 product, reference TDS 0.25

uncertainty from locally correlated errors on atmospheric scales



uncertainty from locally correlated errors on atmospheric scales - uncertainty from locally correlate...



Data Min = 0,0, Max = 0,0, Mean = 0,0

Figure 35: Delta atmospheric errors uncertainties TDS 0.25 - regridded to 0.25

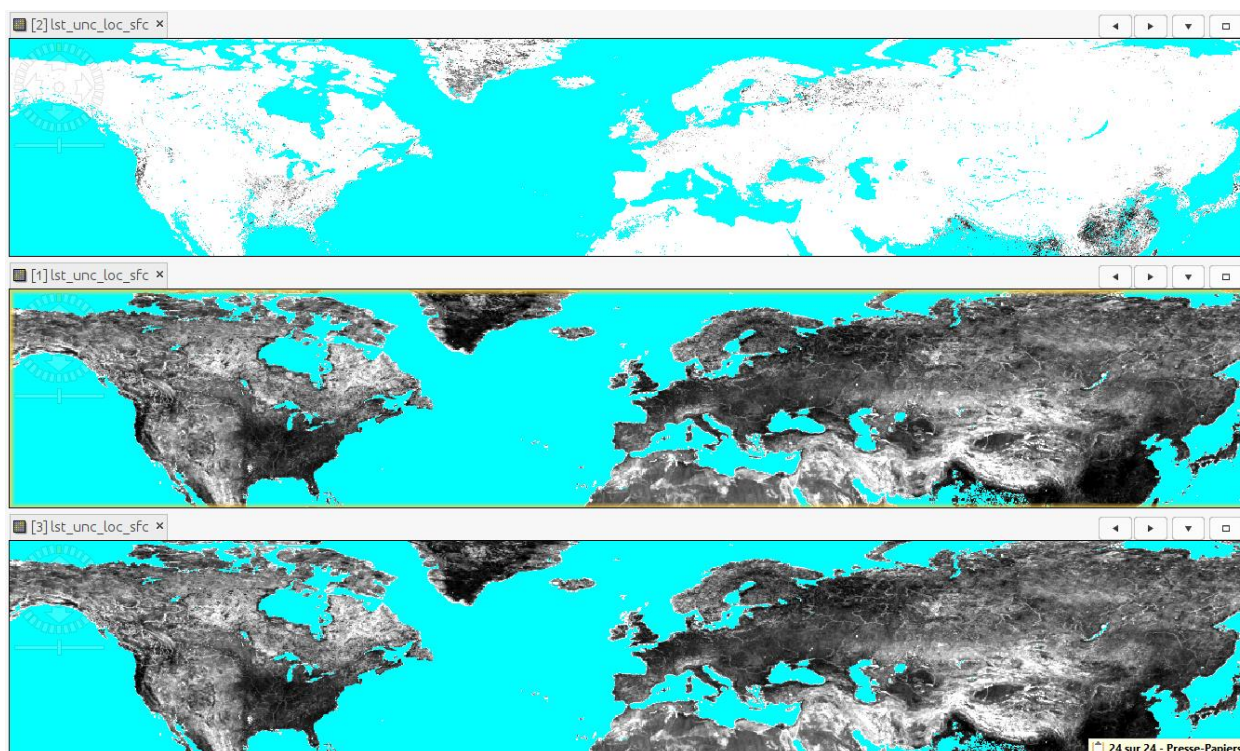


Figure 36: Original 0.01 surface scales uncertainty, regridded 0.25 product, reference TDS 0.25

uncertainty from locally correlated errors on surface scales

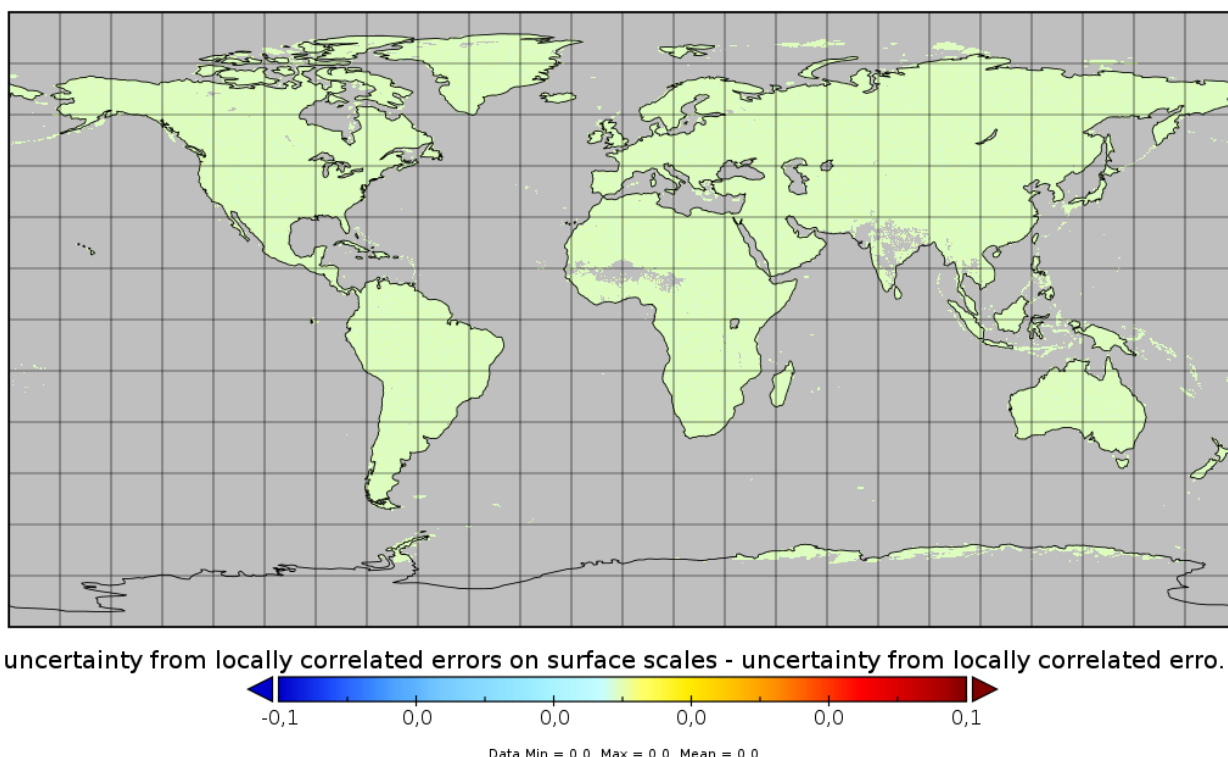


Figure 37: delta surface scales uncertainty TDS 0.25 - regridded 0.25

Test execution: Regridding in two steps. Test ended with no error. Comparison with TDS shows no difference (but on `lst_unc_ran` and `lst_uncertainty`, as explained). In the logs, the mean function for the different variables is selected accordingly to the output resolutions of the different steps: as expected.

Conclusion: Test run successfully.

5.3. Complementary tests

5.3.1. ESACCI-LST-L3S-LST-IRCDR_-0.01deg_1DAILY_DAY-19950801000000-fv2.00.nc

Scenario: Regrid uncertainty from locally correlated errors on LST corrections

This test has been added to complete the test coverage and validate the regridding of CCI LST variables missing in TDS files:

- `lst_unc_loc_cor`

NB: As no reference file exists for a comparison, verification is done visually with snap.

```

2022-09-20 09:20:14,678 - INFO - log file: lst_cci_regrid_ESACCI-LST-L3S-LST-IRCDR_-0.01deg_1DAILY_DAY-19950801000000-fv2.00.nc_to_0.05.log
2022-09-20 09:20:15,656 - INFO - TEST/IR directory not found, creating it.
2022-09-20 09:20:15,827 - INFO - spatial_resolution used is geospatial_lat_resolution
2022-09-20 09:20:15,828 - INFO - 'lcc' variable found in input file;
2022-09-20 09:20:15,832 - INFO - Use 4 parallel CPU threads
2022-09-20 09:20:15,833 - INFO - Output file: TEST/IR/ESACCI-LST-L3S-LST-IRCDR_-0.05deg_1DAILY_DAY-19950801000000-fv2.00.nc
2022-09-20 09:20:15,833 - INFO - Input file resolution: 0.01
2022-09-20 09:20:15,833 - INFO - Output file resolution: 0.05
2022-09-20 09:20:15,833 - INFO - -----
2022-09-20 09:22:32,999 - INFO - REGRID 'dtime' Method mean
2022-09-20 09:22:33,069 - INFO - REGRID 'satze' Method mean
2022-09-20 09:22:33,105 - INFO - REGRID 'sataz' Method mean
2022-09-20 09:22:33,147 - INFO - REGRID 'solze' Method mean
2022-09-20 09:22:33,183 - INFO - REGRID 'solaz' Method mean
2022-09-20 09:22:33,218 - INFO - REGRID 'lst' Method mean
2022-09-20 09:22:33,253 - INFO - REGRID 'lst_uncertainty' Method mean
2022-09-20 09:22:33,519 - INFO - REGRID 'lst_unc_ran' Method nanmean_uncorrelated_unc
2022-09-20 09:24:52,872 - INFO - REGRID 'lst_unc_loc_atm' Method nanmean_loc_sys_unc
2022-09-20 09:24:52,960 - INFO - REGRID 'lst_unc_loc_sfc' Method nanmean_loc_sys_unc
2022-09-20 09:24:53,077 - INFO - REGRID 'lst_unc_sys' Method nanmean_fullcorr_large_scale_unc
2022-09-20 09:25:57,809 - INFO - IGNORE 'lcc' variable
2022-09-20 09:25:57,810 - INFO - REGRID 'lst_unc_loc_cor' Method nanmean_loc_sys_unc
2022-09-20 09:25:57,906 - INFO - COPY coordinates 'channel'
2022-09-20 09:25:57,908 - INFO - Computing total uncertainties
2022-09-20 09:25:58,428 - INFO - Compute sum of uncertainties
2022-09-20 09:27:19,098 - INFO - =====
2022-09-20 09:27:19,098 - INFO - Writing output file
2022-09-20 09:33:18,267 - INFO - File TEST/IR/ESACCI-LST-L3S-LST-IRCDR_-0.05deg_1DAILY_DAY-19950801000000-fv2.00.nc written
2022-09-20 09:33:18,364 - INFO - Regridding successfully ended.
2022-09-20 09:33:18,364 - INFO - Regridding duration: 0:13:03.711776
2022-09-20 09:33:18,364 - INFO - =====

```

Figure 38: Regridding in one step with no error

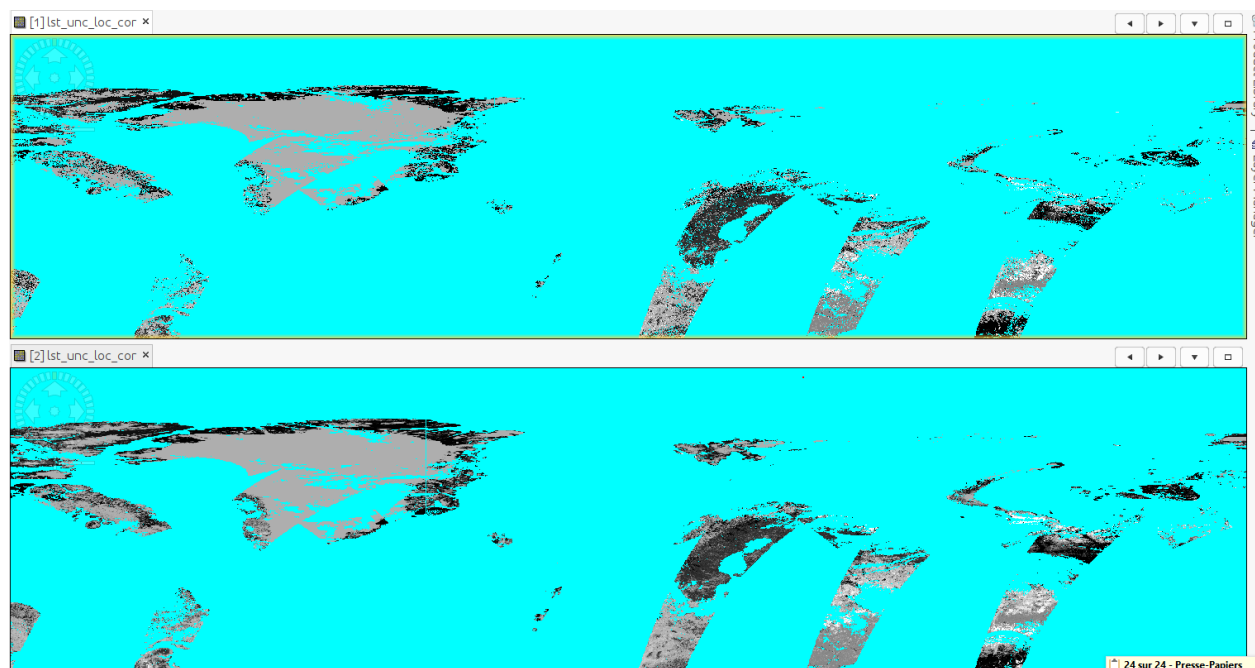


Figure 39: Original 0.01 uncorrelated errors, regrided 0.05

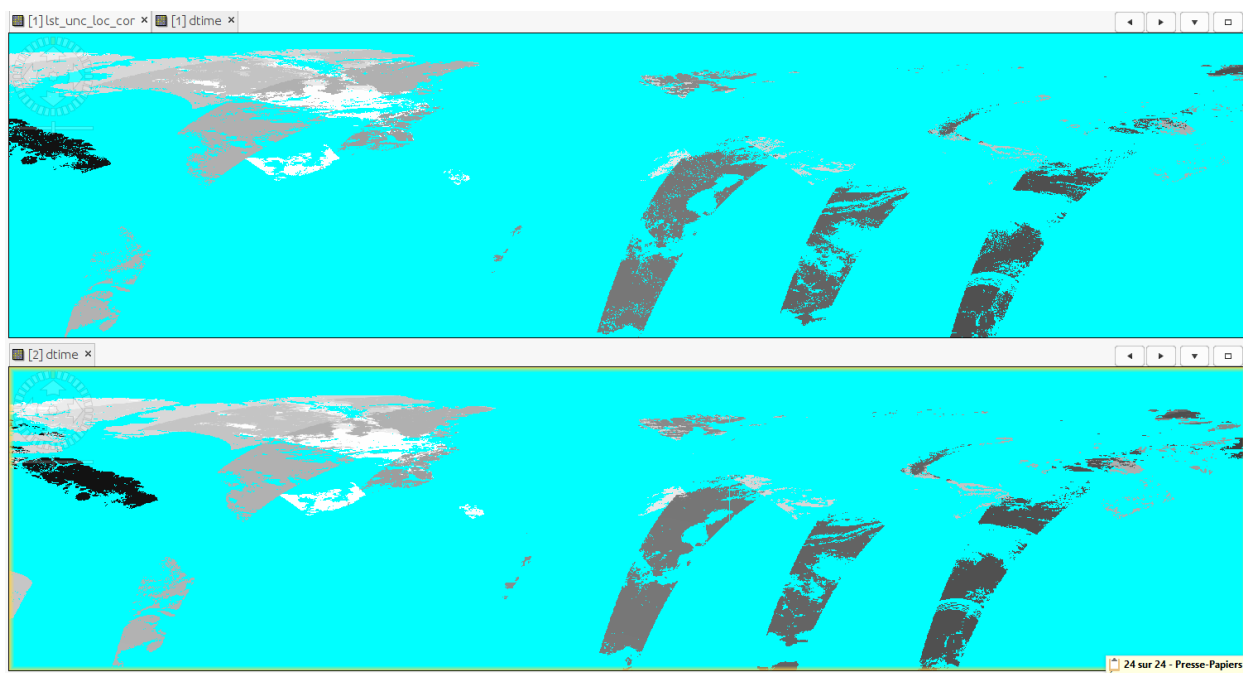


Figure 40: Original 0.01 dtime, regridded 0.05

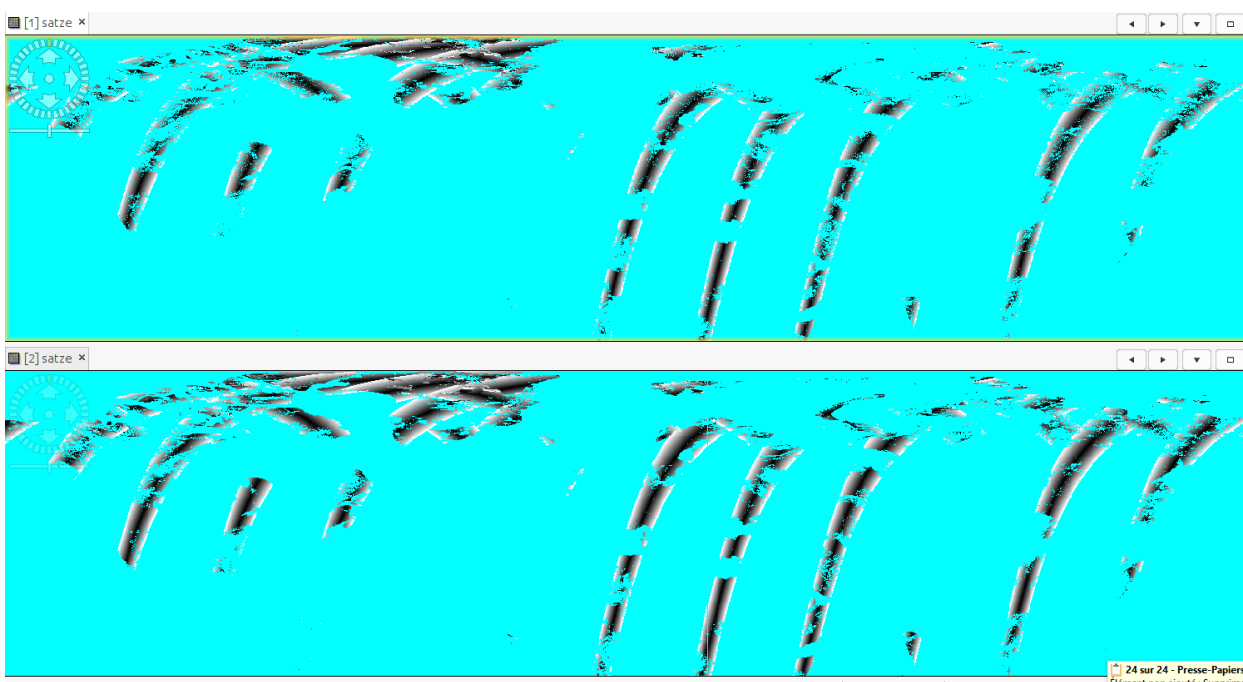


Figure 41: Original 0.01 satellite zenith angle, regridded 0.05

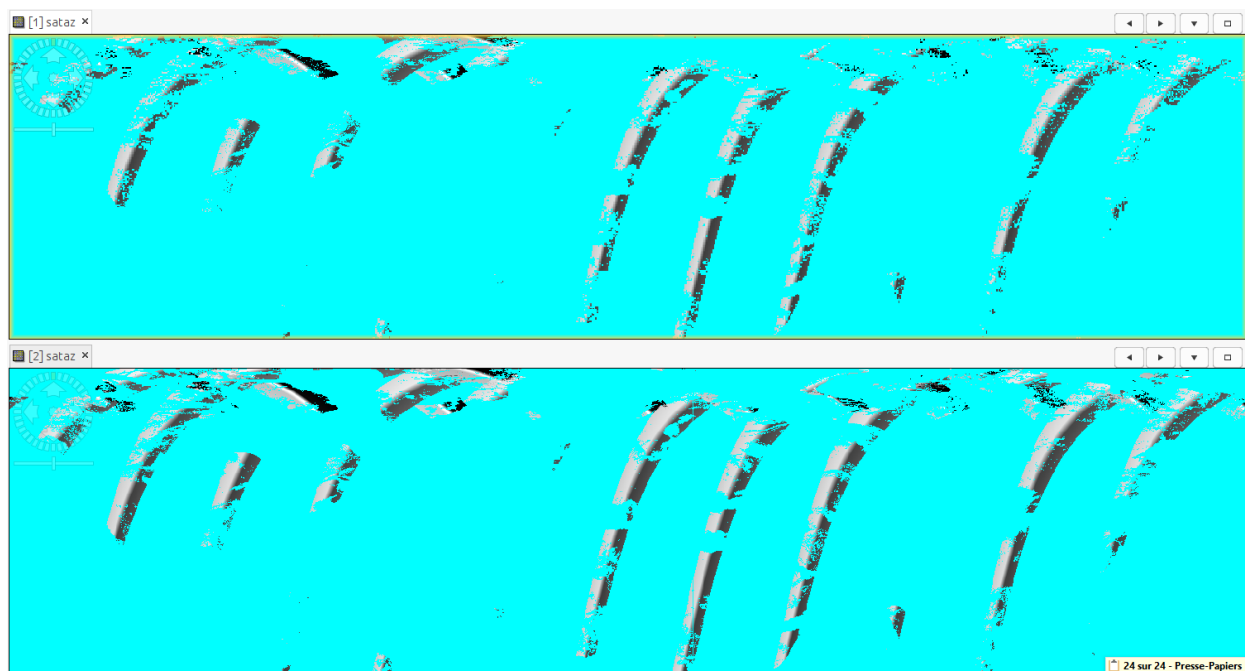


Figure 42: Original 0.01 satellite azimuth angle, regridded 0.05

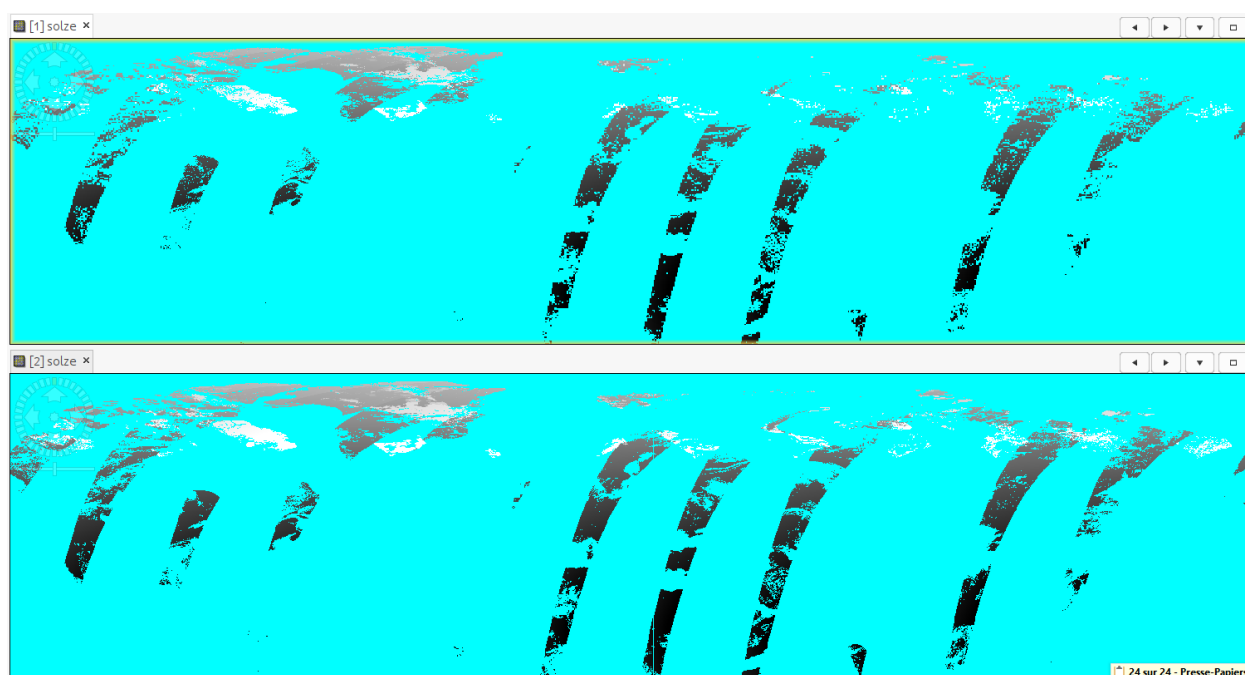


Figure 43: Original 0.01 solar zenith angle, regridded 0.05

Test execution: Regridding in one step with no error. Visualisation shows expected variable coverage without obvious anomaly. The regridding is 'standard', with one single step and no special case: in the logs, the default mean function are used for LST variables.

Conclusion: Test run successfully.

5.3.2. ESACCI-LST-L3C-LST-SSMI17-0.25deg_1DAILY_ASC-20171202000000-fv2.23.nc

Scenario: Regrid time corrections

 land surface temperature cci	LST_cci Regridding and Subsetting Tool Verification Report <i>WP3.4 – DEL-D3.4-2</i>	Ref.: LST-CCI-D3.4-2-VR Version: 1.1 Date: 28/11/2022 Page: 42
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This test has been added to complete the test coverage and validate the regridding of CCI LST variables missing in TDS files:

- lst_unc_time_correction
- lst_time_correction

NB: As no reference file exists for a comparison, verification is done visually with snap.

```

ESACCI-LST-L3C-LST-SSM117-0.25deg_IDAILY_ASC-20171202000000-fv2.23.nc
2022-11-08 15:30:47,901 - INFO - log file: lst_cci_regrid.py_ESACCI-LST-L3C-LST-SSM117-0.25deg_IDAILY_ASC-20171202000000-fv2.23.nc_to_0.5.log
2022-11-08 15:30:48,259 - INFO - Command: lst_cci_regrid.py_TDS/ESACCI-LST-L3C-LST-SSM117-0.25deg_IDAILY_ASC-20171202000000-fv2.23.nc output_dir_025 --resolution 0.5 --threads 4 --comp_level 1 --keep_
log false
2022-11-08 15:30:48,405 - INFO - Input file is a Micro-Wave product
2022-11-08 15:30:48,409 - INFO - Input file name: ESACCI-LST-L3C-LST-SSM117-0.25deg_IDAILY_ASC-20171202000000-fv2.23.nc
2022-11-08 15:30:48,410 - INFO - Use 4 parallel CPU threads
2022-11-08 15:30:48,410 - INFO - Output file: output_dir_025/ESACCI-LST-L3C-LST-SSM117-0.5deg_IDAILY_ASC-20171202000000-fv2.23.nc
2022-11-08 15:30:48,410 - INFO - Input file resolution: 0.25
2022-11-08 15:30:48,410 - INFO - Output file resolution: 0.5
2022-11-08 15:30:48,410 - INFO - -----
2022-11-08 15:30:48,795 - INFO - REGRID 'dtm' Method mean
2022-11-08 15:30:48,818 - INFO - REGRID 'satze' Method mean
2022-11-08 15:30:48,826 - INFO - REGRID 'sataz' Method mean
2022-11-08 15:30:48,834 - INFO - REGRID 'solaz' Method mean
2022-11-08 15:30:48,842 - INFO - REGRID 'solaz' Method mean
2022-11-08 15:30:48,850 - INFO - REGRID 'lst' Method mean
2022-11-08 15:30:48,859 - INFO - REGRID 'lst_uncertainty' Method sqrtmean_lst_uncertainty
2022-11-08 15:30:48,885 - INFO - REGRID 'h' Method sun
2022-11-08 15:30:48,899 - INFO - COPY 'lst_unc_ran' variable
2022-11-08 15:30:49,032 - INFO - lst_unc_loc_atn: Output resolution > 0.05: use 'Propagation from 0.05 degree' algorithms
2022-11-08 15:30:49,044 - INFO - COPY 'lst_unc_loc_atn' variable
2022-11-08 15:30:49,077 - INFO - lst_unc_loc_sfc: Output resolution > 0.05: use 'Propagation from 0.05 degree' algorithms
2022-11-08 15:30:49,077 - INFO - COPY 'lst_unc_loc_sfc' variable
2022-11-08 15:30:49,107 - INFO - COPY 'lst_unc_sys' variable
2022-11-08 15:30:49,113 - INFO - REGRID 'lst_time_correction' Method mean
2022-11-08 15:30:49,133 - INFO - REGRID 'lst_unc_time_correction' Method nanmean_fullcorr_large_scale_unc
2022-11-08 15:30:49,563 - INFO - Writing output file
2022-11-08 15:30:51,747 - INFO - File output_dir_025/ESACCI-LST-L3C-LST-SSM117-0.5deg_IDAILY_ASC-20171202000000-fv2.23.nc written
2022-11-08 15:30:51,824 - INFO - Regridding successfully ended.
2022-11-08 15:30:51,825 - INFO - Regridding duration: 0:00:03.927715
2022-11-08 15:30:51,828 - INFO - =====

```

Figure 44: regridding in one step with no error

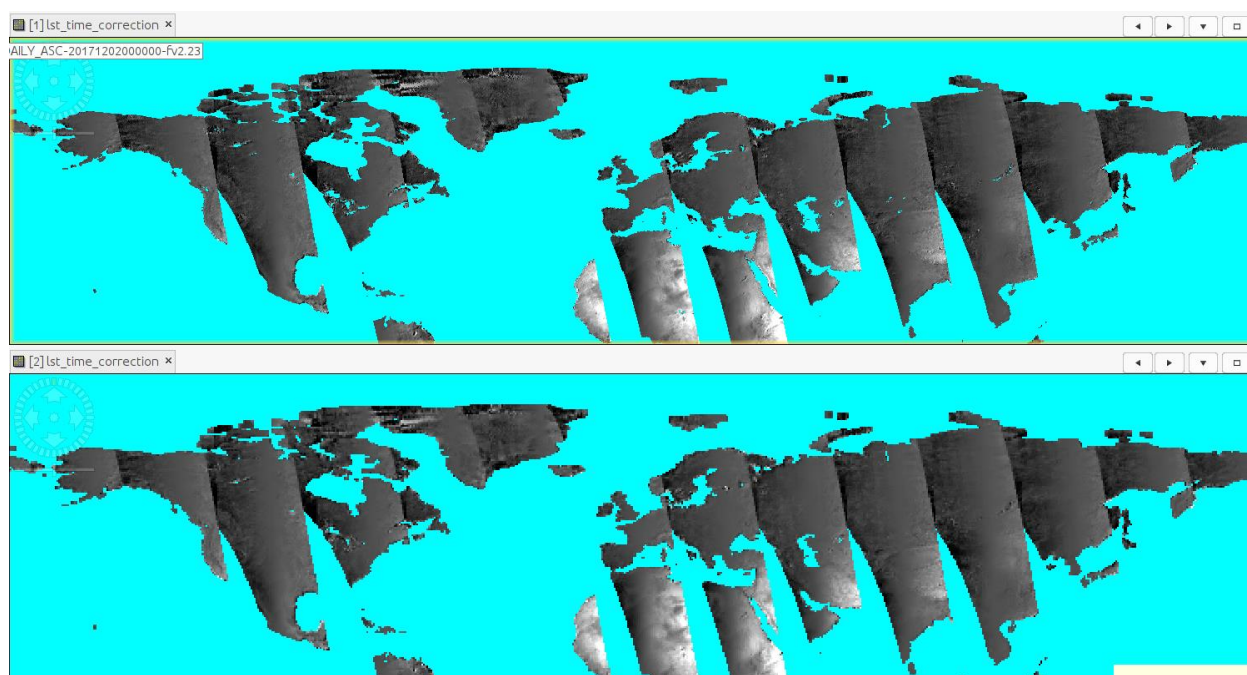


Figure 45: Original 0.25 time correction, regridded 0.5

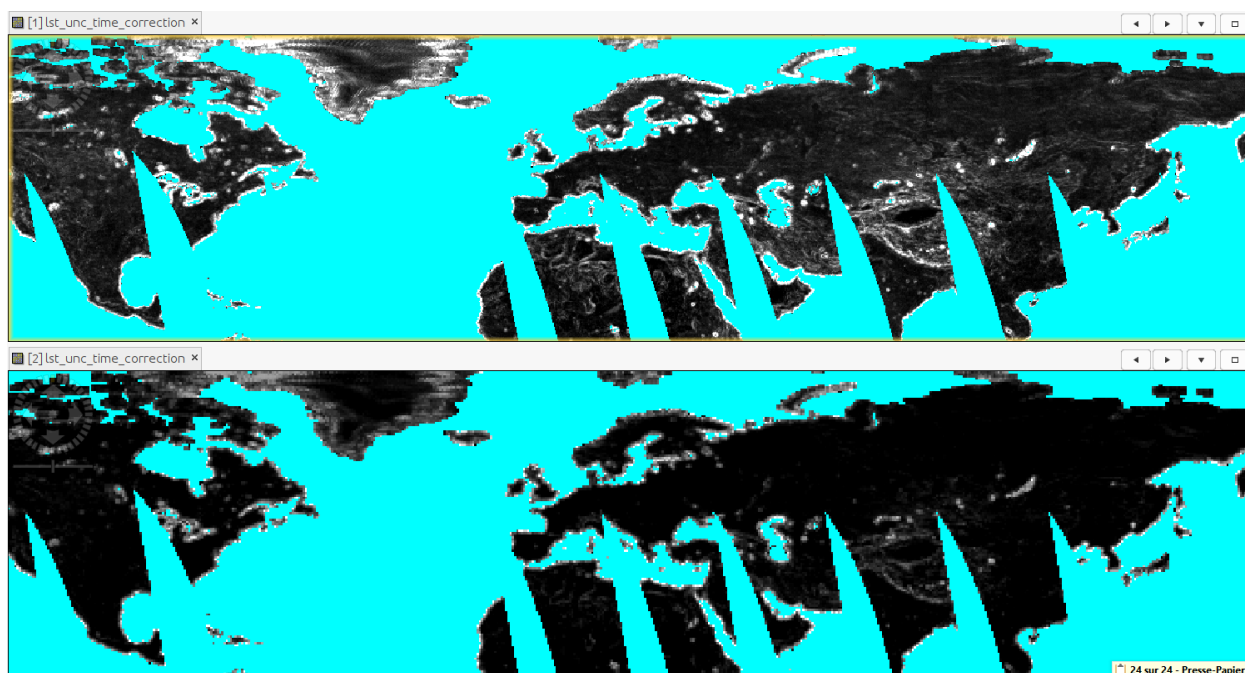


Figure 46: Original 0.25 time correction uncertainty, regridded 0.5

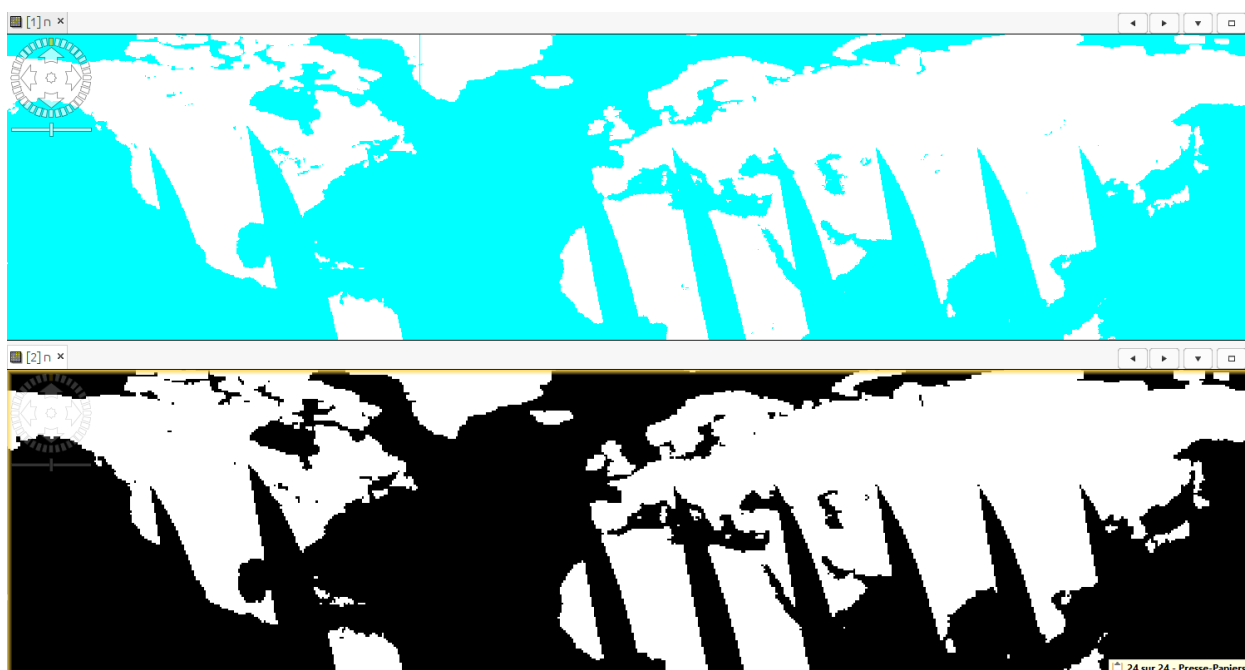


Figure 47: Original 0.01 clear sky pixel, regridded 0.05

Test execution: Regridding in one step with no error. Visualisation shows expected coverage without obvious anomaly.

Conclusion: Test run successfully.

Scenario: Issue 6: MicroWave files uncertainties wrongly handled

This test has been added to verify the correction of issue 6 on MicroWave products:

- Non initialized uncertainties are forwarded to regridded output
- LST total uncertainty is regridded with a square mean function

NB: As no reference file exists for a comparison, verification is done visually with snap.

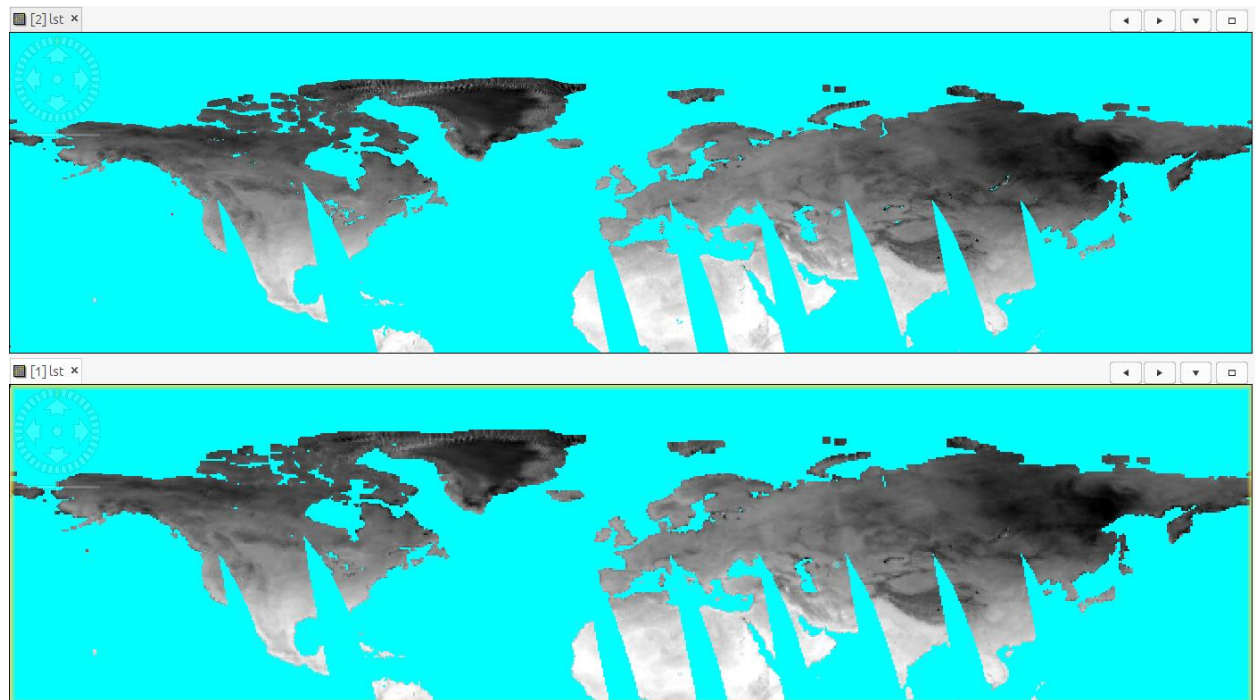


Figure 48: Original 0.25 temperature, regridded 0.5

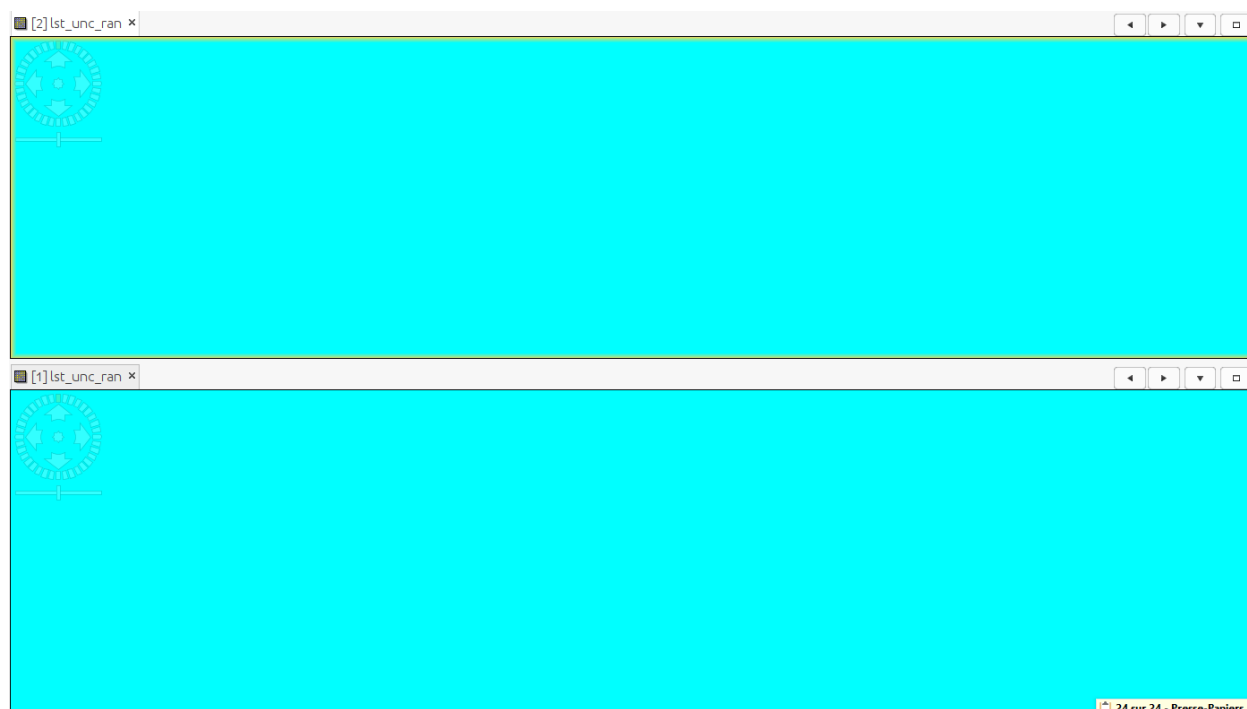


Figure 49: Original 0.25 random uncertainties (NaN), regridded 0.5

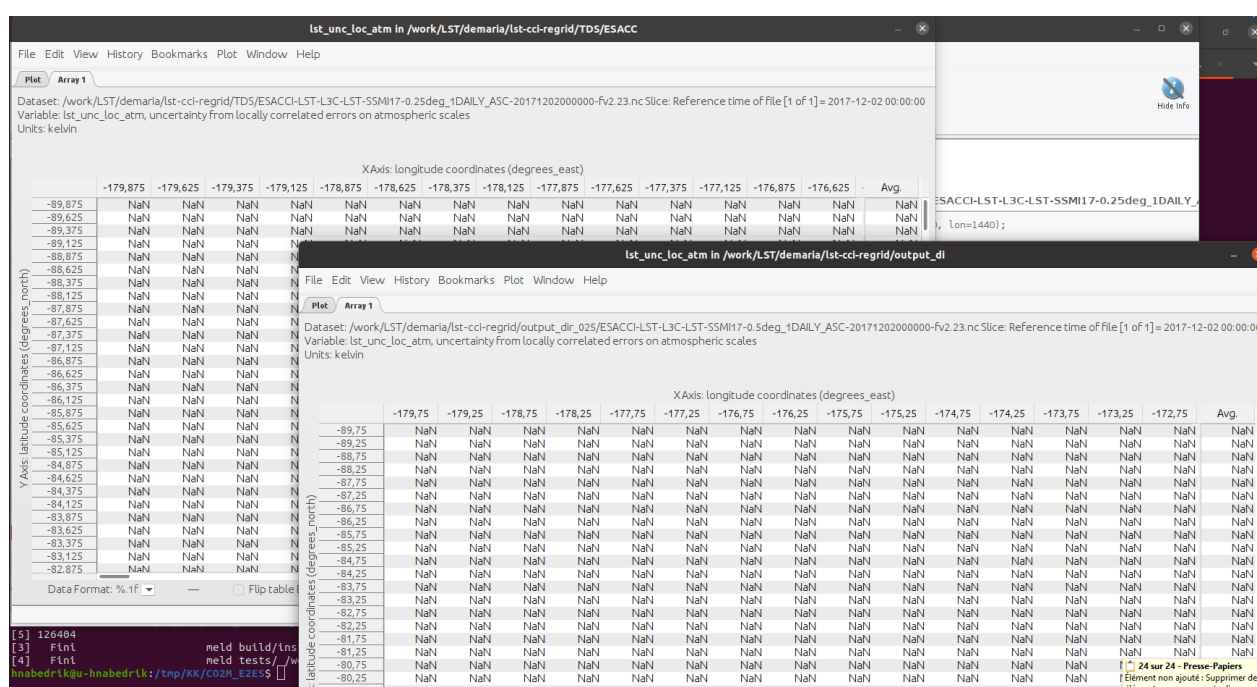
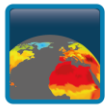


Figure 50: Original 0.25 random uncertainties values, regridded 0.5

NB: other LST uncertainties (lst_unc_loc_atm, lst_unc_loc_sfc) get same values and displayed and are not shown here.

lst_unc_sys is a single NaN value both in original file and regridded product.

Conclusion: Test run successfully.



land surface
temperature
cci

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