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BoM Efforts to Improve SSESs for AVHRR SST Level 3 Products

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Point of Use

I'm interested in a typical or representative value

X

I'm interested in a typical or representative bias

- Something that I can safely subtract from the value and get a better result in the long run.
- The supplier should be able to tell me if this will work.

μ

I'm interested in a standard deviation that tells how much uncertainty there might be in the reported value

- Maybe $z=\sqrt{n}.\mu/\sigma$ would give me some useful information ?

σ

If the number of measurements that went into the determination is small, I'm interested to know that number

n

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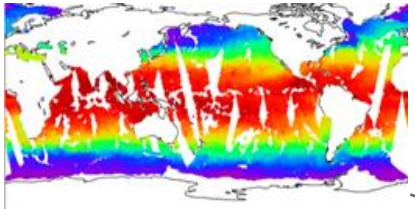
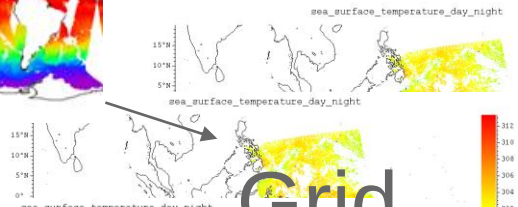
The Processing Chain

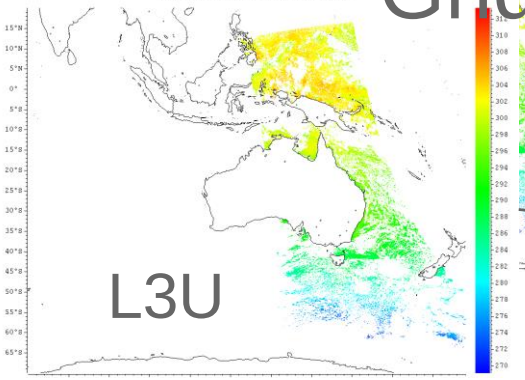
Match



L2



Grid

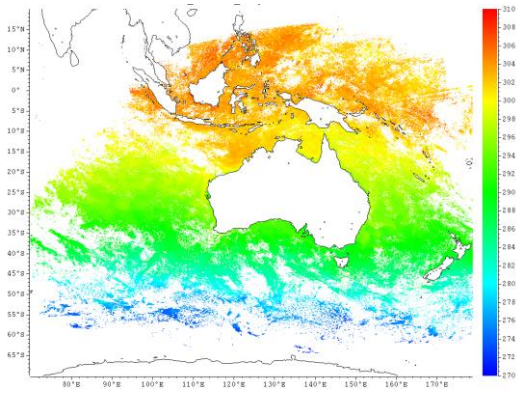


L3U

Merge

3 day, 6 day

"Typical"



L3C / L3S

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SSES L2P

`sses_count` Number of *in situ* matches that contributed to the statistics

`sses_bias` Estimate of the mean of the difference between the *in situ* and satellite measurement of SST

`sses_standard_deviation` Estimate of the standard deviation of the difference between the *in situ* and satellite measurement of SST

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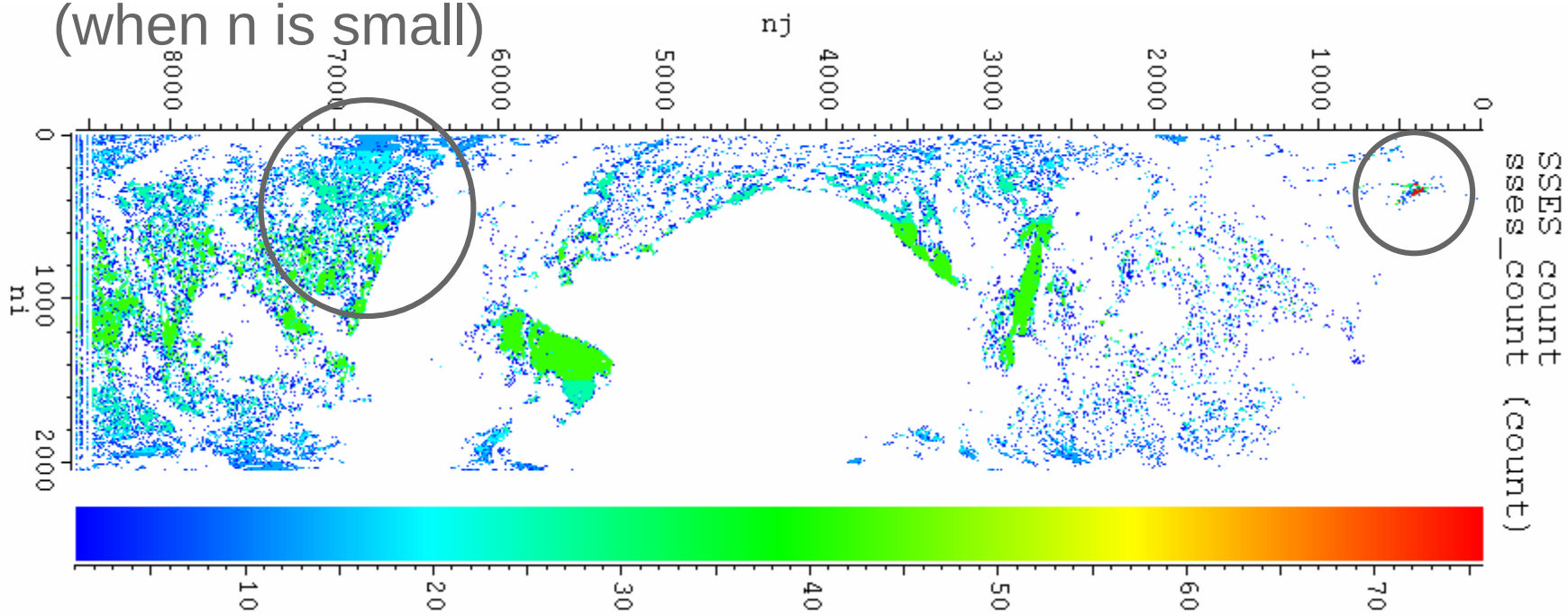
SSES L2P
sses_count

- Still match based on common satellite zenith angle, quality level and day/night
- Use 1 year historical record as the baseline (when n is small)



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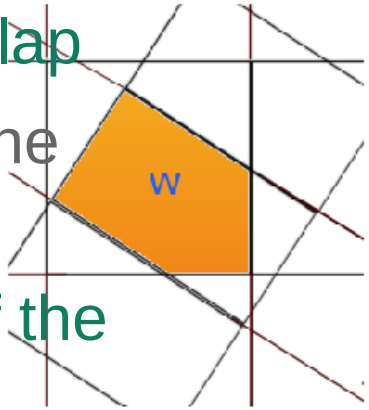
Processing L2P to L3U: Grid

- Grid
  - Choose the *best* quality pixels for the overlap
  - Weight the values, bias, and variance by the likelihood of providing a good estimate
  - The likelihood is proportional to the size of the overlapping region
  - Bias and variance are likelihood weighted
  - A representative number of degrees of freedom is determined by scaling the likelihood



$$n_U = \frac{\sum_i w_i \, n_i}{\max_i w_i \, n_i}$$

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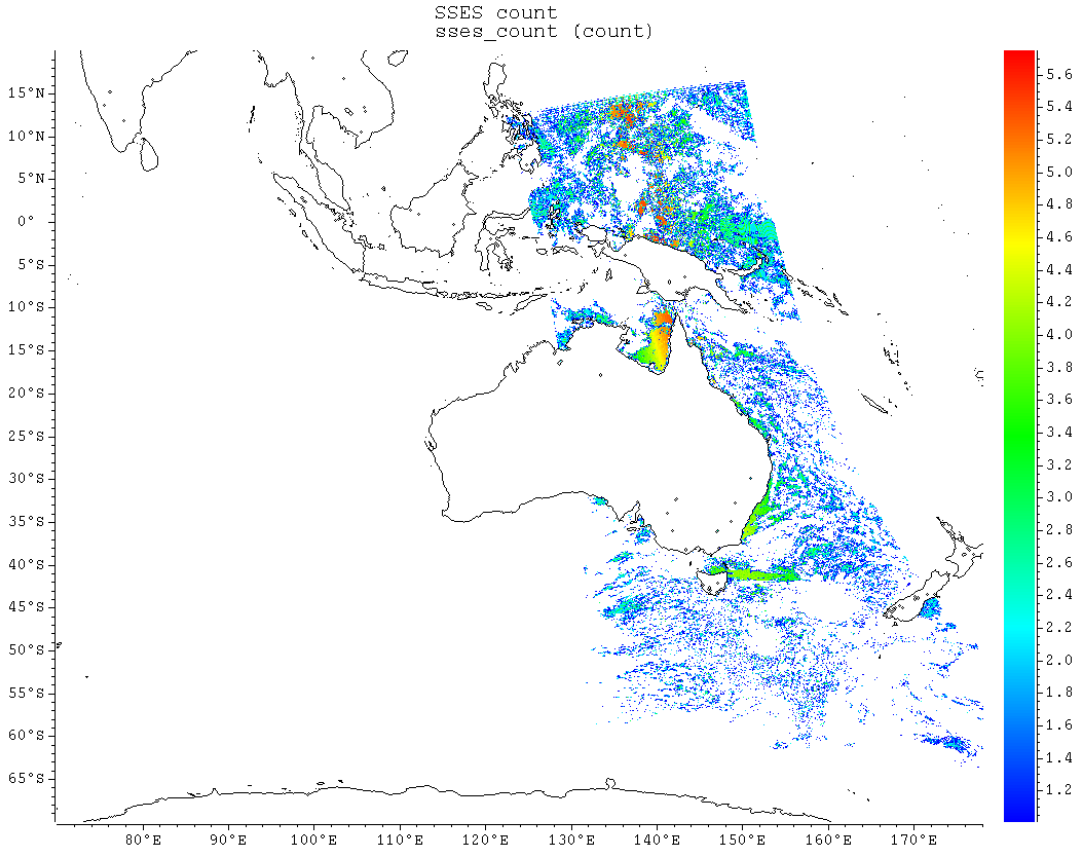
SSES L3U
sses_count



`sses_count` “effective” number of L2P SSTs that contributed to the statistics

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Processing L3U to L3C: Merge

- Merge – combining data from the same sensor
  - *best* quality pixels give a “best typical value” over the time period
  - Weight the values by the likelihood of providing a good estimate
  - The best typical value has the most supporting measurements and the lowest uncertainty (variance)
  - Number of degrees of freedom is scaled by the maximum likelihood (as before)
  - Equally weighted SST allow the standard deviation of the SST over time to be estimated

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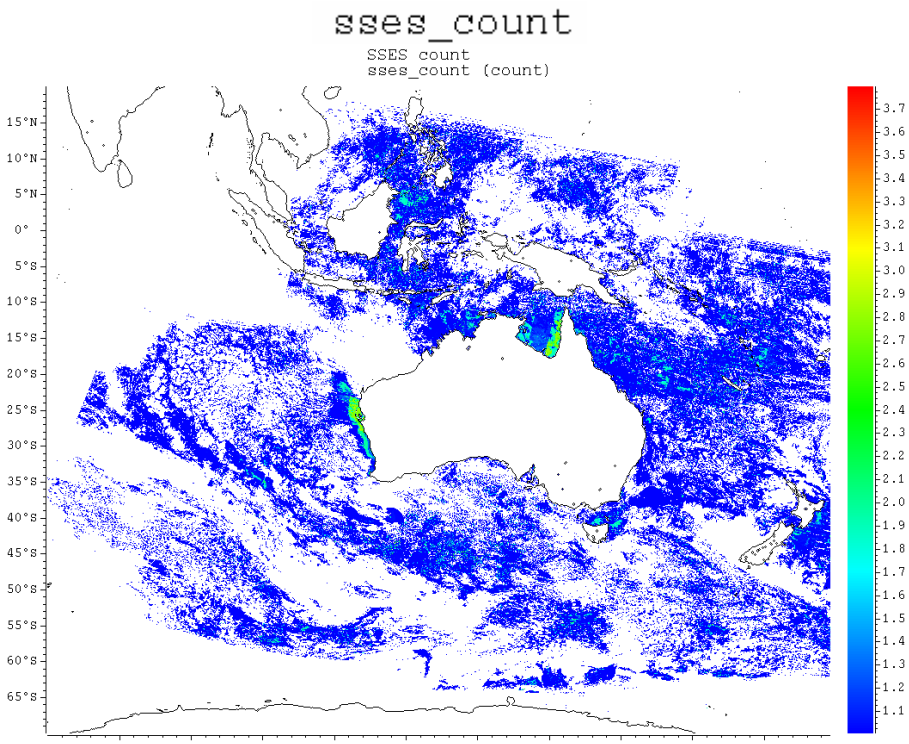
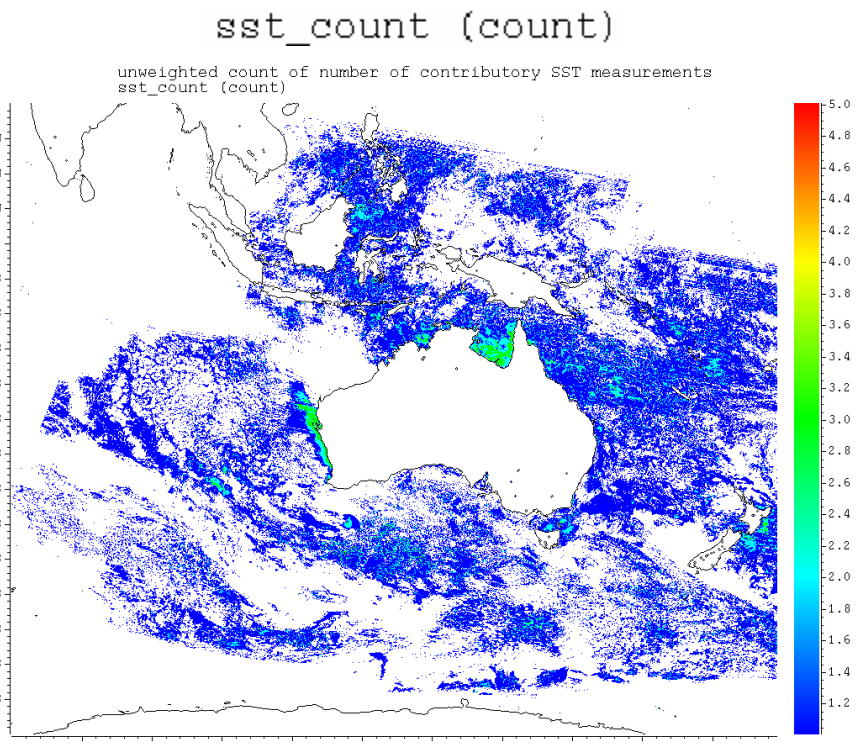
SSES L3C
sses_count and sst_count

1 June 2013, NOAA-19, L3C 3 day (night) “best typical value” contains fewer degrees of freedom. Some measurements were included with lower contribution because of higher variance





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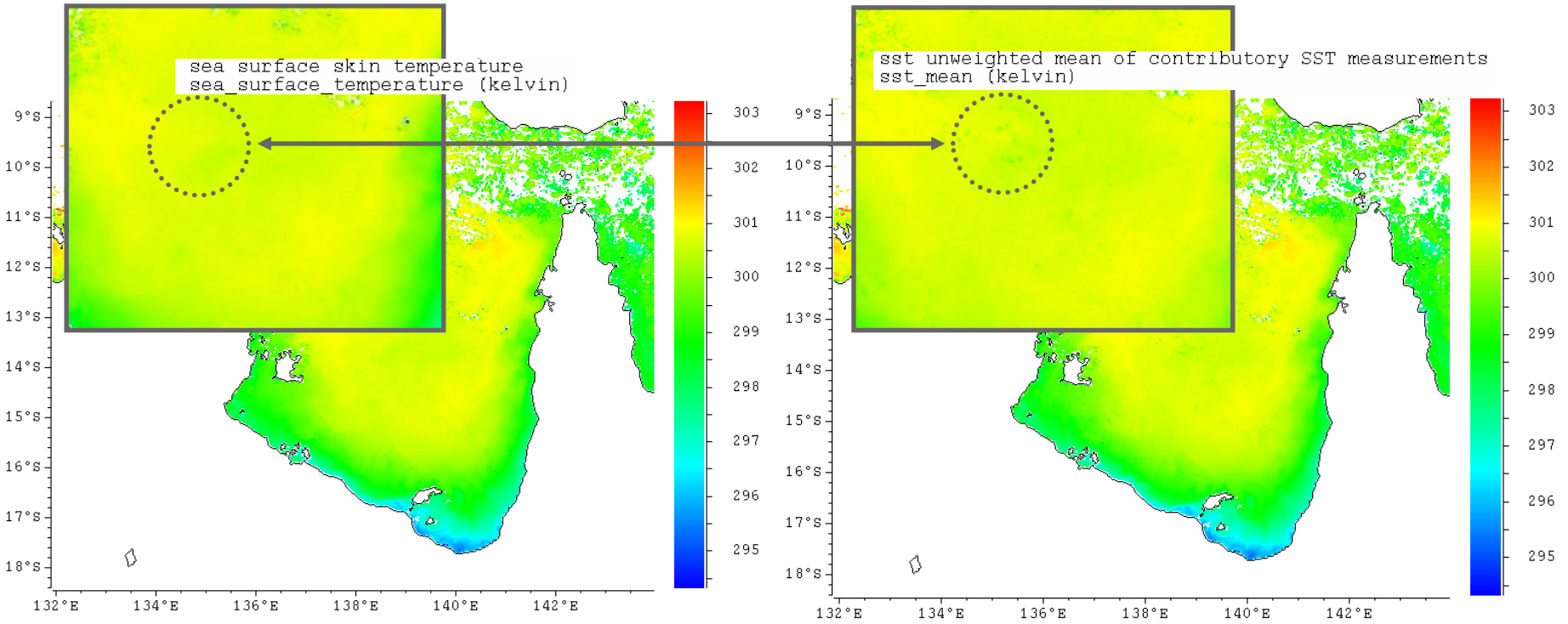
SSES L3C sea_surface_temperature and sst_mean

1 June 2013, NOAA-19, “best typical value” (left) compared to unweighted mean (right) over the 3 day (night) period



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Processing L3C to L3S: Merge

- Merge – combining data from the same sensor
  - When combining multiple L3C, consider all sources of measurement weighted by the count
  - Biases are subtracted before measurements are combined
  - The combined count is recorded

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SSES L3S

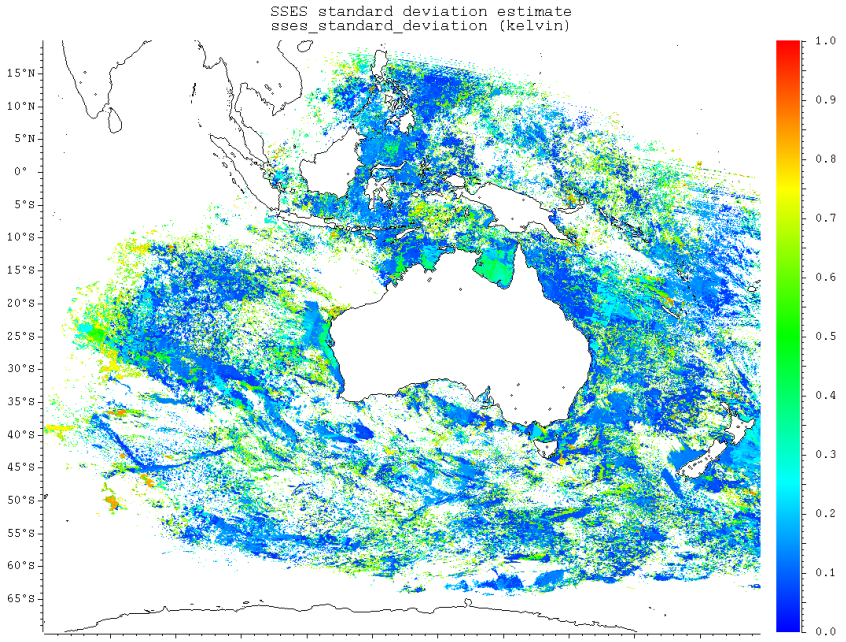
sses_standard_deviation and sst_standard_deviation

1 June 2013, NOAA-19, L3S 6 day (night)

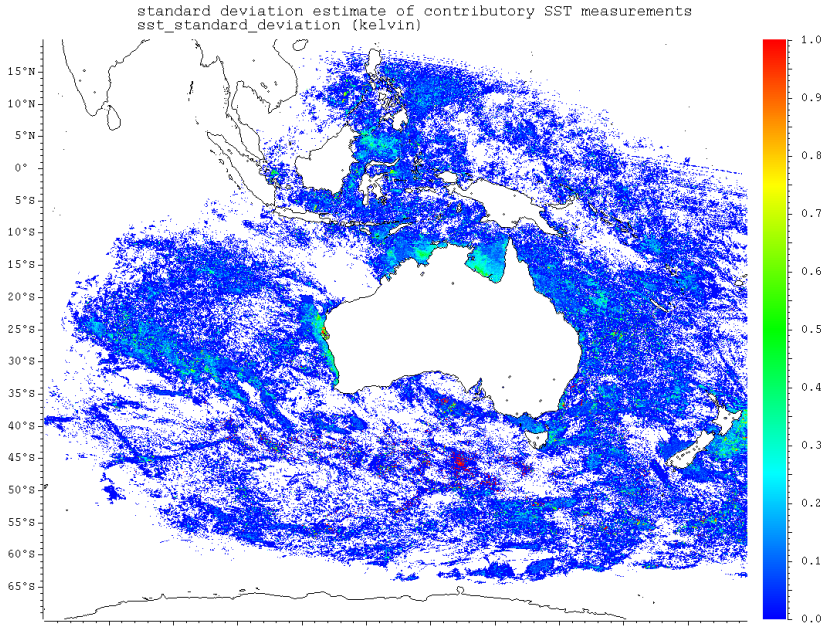
sses_standard_deviation
error relative to *in situ* measurements, of the "best typical" measurement

sst_standard_deviation
satellite measured variability

sses_standard_deviation (kelvin)



sst_standard_deviation (kelvin)



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Processing L3U to L3C/S: “Typical”

- “Typical”
  - Standard error of “best typical” SST scales with $1/\sqrt{n}$
  - *In situ* match up error contributes as before, not decreasing with the number of measurements
  - Keeping equally weighted SST statistics allows these components to be properly accounted for

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SSES L3C/S for multiple days

`sst_count` Number of measurements that contributed to the “best typical” value

`sst_mean` Equally weighted mean SST that contributed to the “best typical” value

`sst_standard_deviation`
Equally weighted standard deviation that contributed to the “best typical” value

Representative of detected diurnal variability if the files contain day and night SST

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What you should be able to do

- Use the **`sea_surface_temperature`** as a “best typical” value over the time scale implied by the data
- Use the bias to correct for deviations from *in situ* measurements
- Use $z = \sqrt{n}.\mu/\sigma$ to give an idea about if the measurement is “unusual” or not
- Use n to inform the accuracy of μ and σ
- Use the unweighted statistics and the “best typical” value to quantify the variation seen over an extended time period

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… and what might be next !

- …. L2P SSES estimates could be more realistic
  - Satellite and Sun zenith angles, Latitude, Longitude…
- …. and L2P to L3U merging could build in the correlation between neighbouring SSES
- …. validation of the approach and the usefulness of bias and standard deviation as a correction to the SST should be done routinely
- …. we can produce long period L3S files which give indications of diurnal variation as well as typical values

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Thank you…

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What this is about

- Rationalizing the current approach to make a little more sense from a *statistical* and *point of use* point of view.
- Respecting the *differences* in the way that data is combined in the formation of GHRSST SST SSES.
- Providing a *essential* set of fields in GHRSST files that may help to understand the uncertainties of measurement.
- Giving information which should be closer to being really usable.

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What this is not about

- A redefinition of SSES within GHRSST SST products.

  We are more interested in better communicating and encouraging the “point(s) of use”.

- A fundamental change to the way L2P SSES are currently estimated within ABOM products.

  We have not considered changes to this apart from extending historical horizons to increase the number of *in situ* matches.

- A major change or “best” statistical solution to the problem.

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Processing L2: Match

- Match
  - Use *in situ* buoy measurements to match SST measurements, look at the differences
  - Bin the differences in critical parameters (satellite zenith angle, quality level, day / night)
  - If we don't have enough data, reference historical information (past year) to make realistic estimates
  - Report the number of measurements used in the estimate