ESA Climate Change Initiative Phase-II

Sea Surface Temperature (SST)

www.esa-sst-cci.org

Modelled SST Uncertainties vs Empirical SSES

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Error and Uncertainty

- Error and uncertainty are two different concepts:

Error – the concept of 'wrongness'

- Concept: How different is the measured value from the true value?

Uncertainty – the concept of 'doubtfulness'

- Concept: To what degree is the measured value in doubt?
- Quantification: "Standard Uncertainty" is the standard deviation of the (estimated) error distribution.

Objective for uncertainty information provision:

Users to have access to a standard uncertainty estimate….

- For every SST value given.
- At all levels (L2, L3, L4 and Obs4MIPS).
- At all spatial resolutions.
- For all types of SST provided (skin, 20 cm depth, daily mean values).
- That is realistic for the context in which the SST is derived.
- That is validated so that users have confidence that it is realistic.

We consider how we might achieve this for:

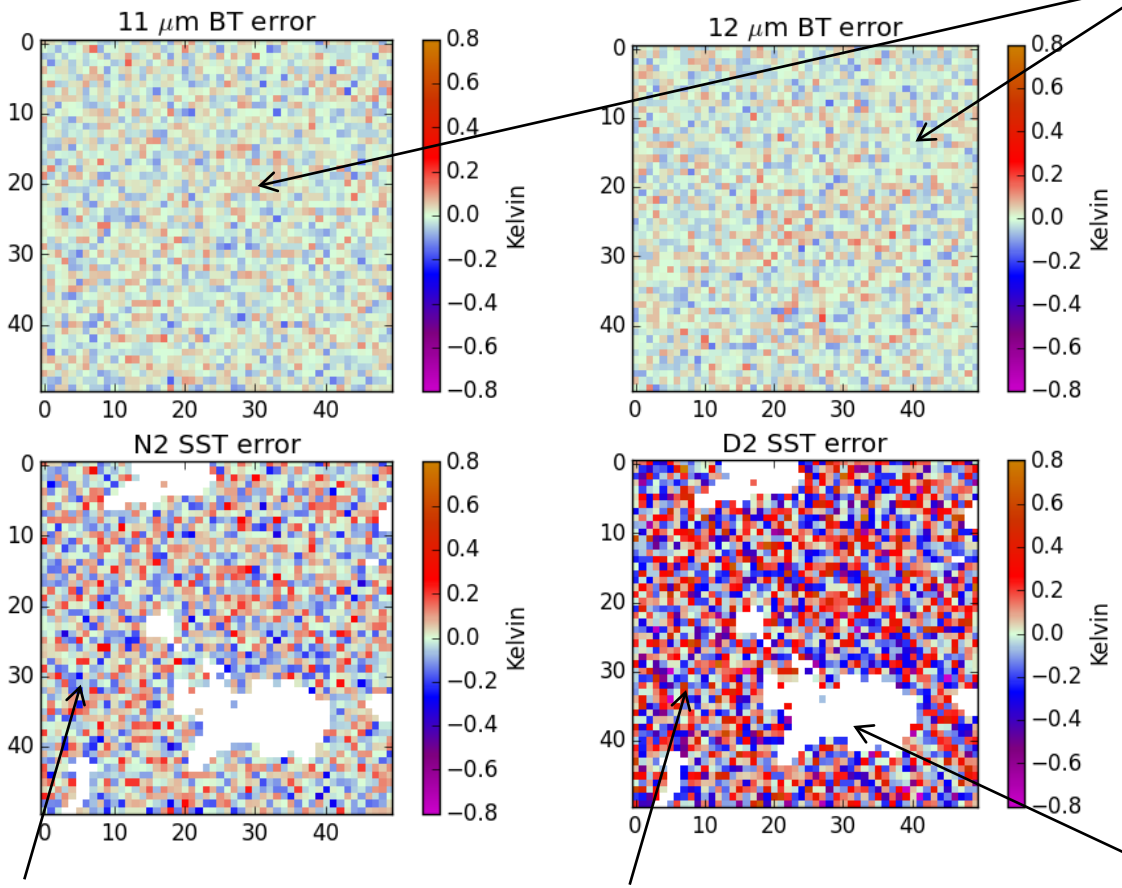
- Coefficient based retrievals (giving examples from AATSR retrievals).

Level 1 Products

Sources of Uncertainty

- Errors from random effects.
  - Errors from radiometric noise (propagated using NEdT estimates).
- Locally systematic effects.
  - Eg. Intermittently determined calibration parameters.
  - Retrieval errors.
- Systematic effects.
  - Eg. Spectral response function error.
  - Eg. Emissivity error.

Level 2 Products: Noise propagation



Simulated error in the 11 and 12 µm channels.

Error propagation:

$e_{ret}=\Sigma(a_i e_{yi})$

Where:

e = error

a = coefficient

y = brightness temperature

Nadir 2-channel retrieval simulated error.

Dual-view 2-channel retrieval simulated error.

Cloud fields overlaid.

Level 2 Products: Retrieval uncertainty

Ambiguity in / limitations of the retrieval mean that there is a further error which varies with the state of the atmosphere, therefore:

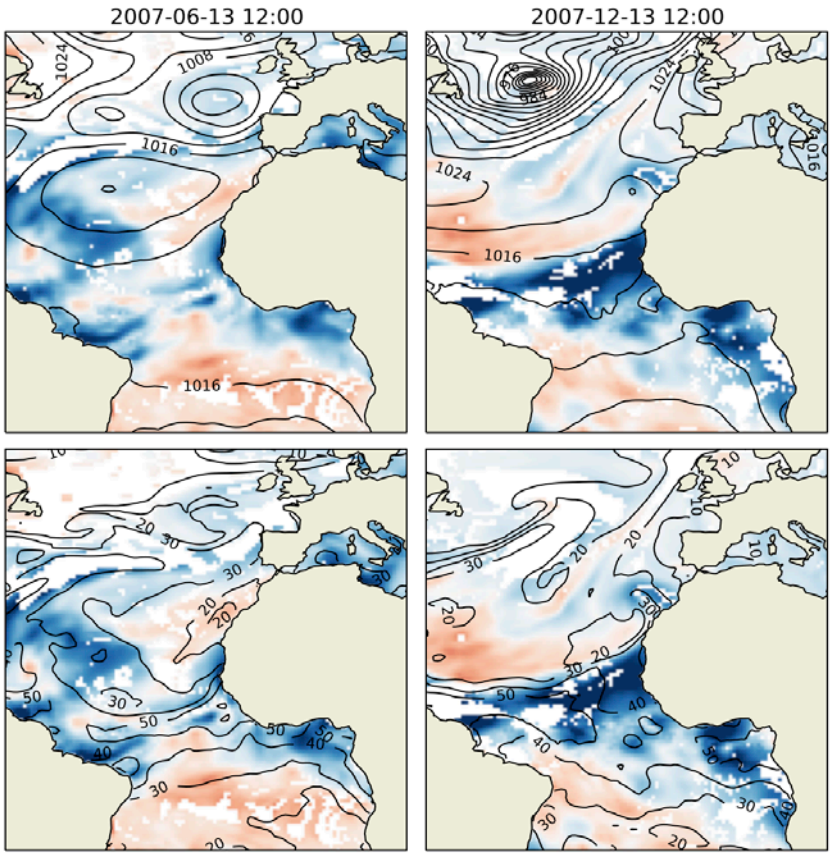
- It is correlated in space.
- It is correlated in time.
- Space/time correlations are on synoptic scales.

The magnitude of these uncertainties can be evaluated on the basis of a simulation study of the retrieval process.

- ‘True’ SST field and simulated brightness temperatures.
- Retrieve SST using the simulated brightness temperatures as input.
- Retrieval algorithm uncertainty is the difference between the retrieved and ‘true’ SST.

Calibration of the sensor means that there is also a systematic error (on larger spatial scales).

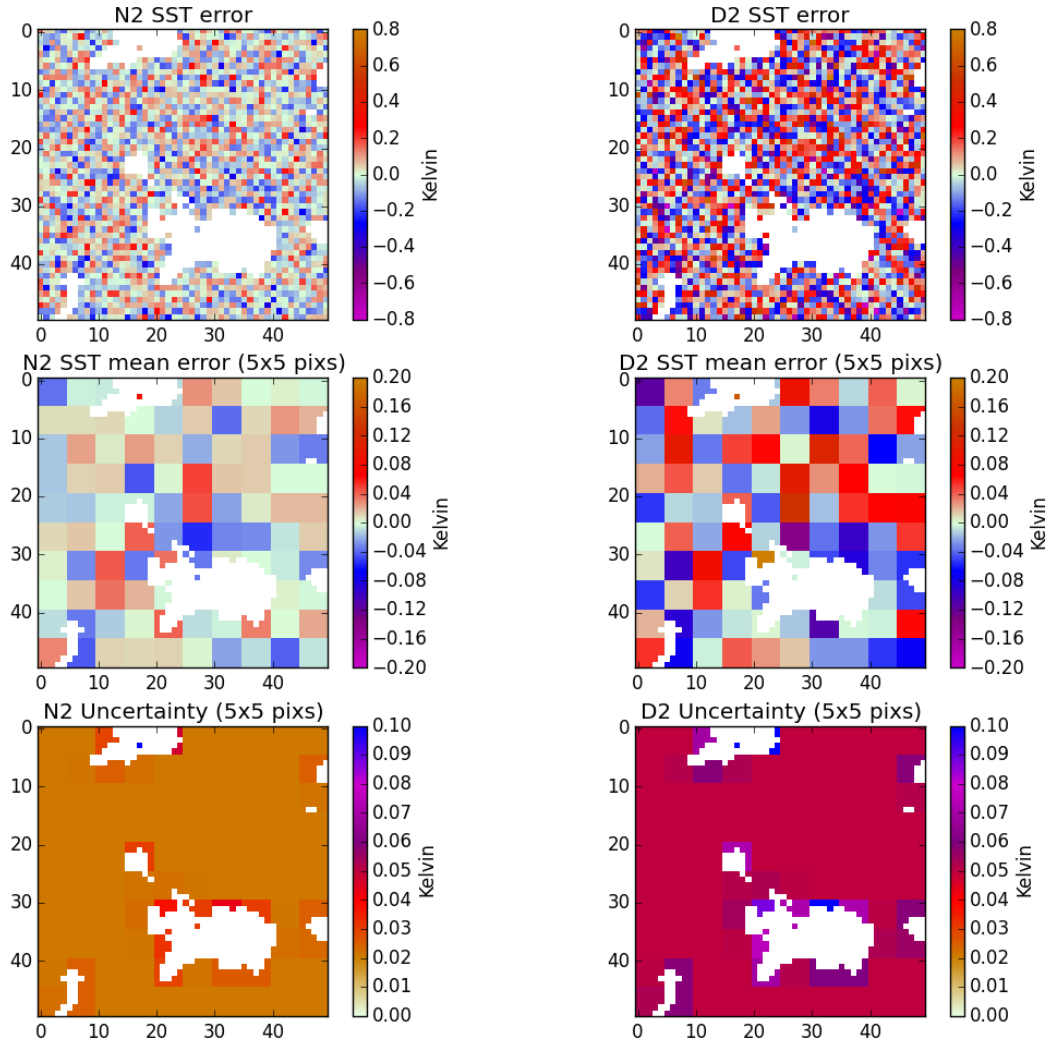
Simulated Retrieval Errors



- Differences between ‘true’ and retrieved SST on two different days from simulation studies.
  - Upper panels show pressure contours.
  - Lower panels show TCWV contours.

Bulgin, C. E., Embury, O., Corlett, G. and Merchant, C. J. (2015), Independent uncertainty estimates for coefficient based sea surface temperature retrieval from the Along-Track Scanning Radiometer instruments (in press).

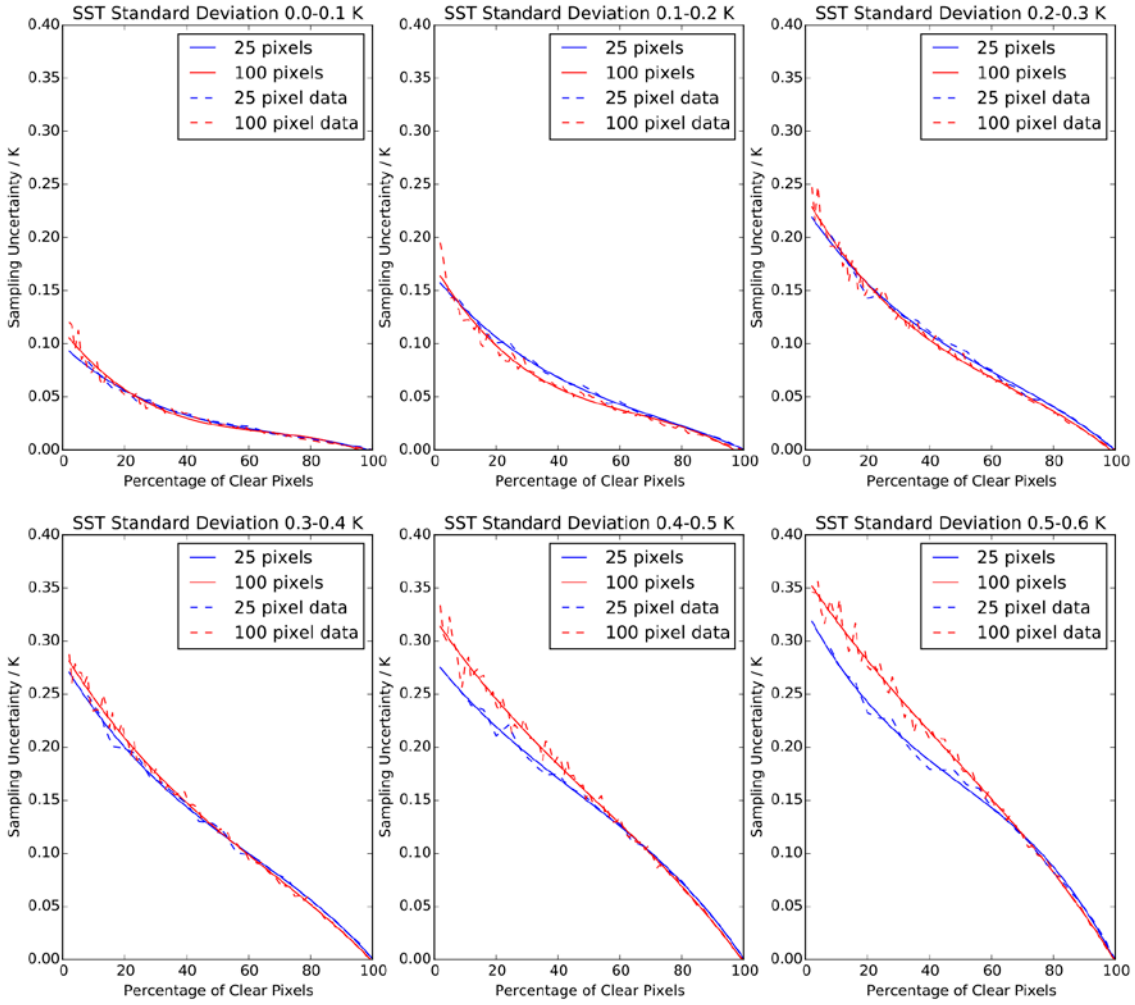
Noise propagation to L3 Gridded Products



Many SST users want data at 0.05 degrees or coarser so we generate gridded products:

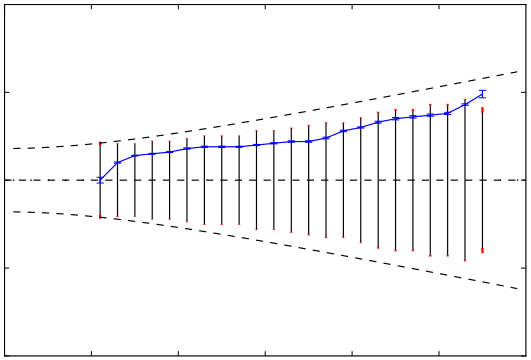
- Mean errors over gridded products do not average down.
- Uncertainty from random effects reduces as $1/\sqrt{n}$.

Sampling Uncertainties in L3 Products



- Sampling uncertainties are introduced where the gridded domain is not fully observed (eg. due to partial cloud cover).
- These uncertainties can be modeled as a function of domain size, clear-sky percentage and SST variability.

Validation of uncertainties

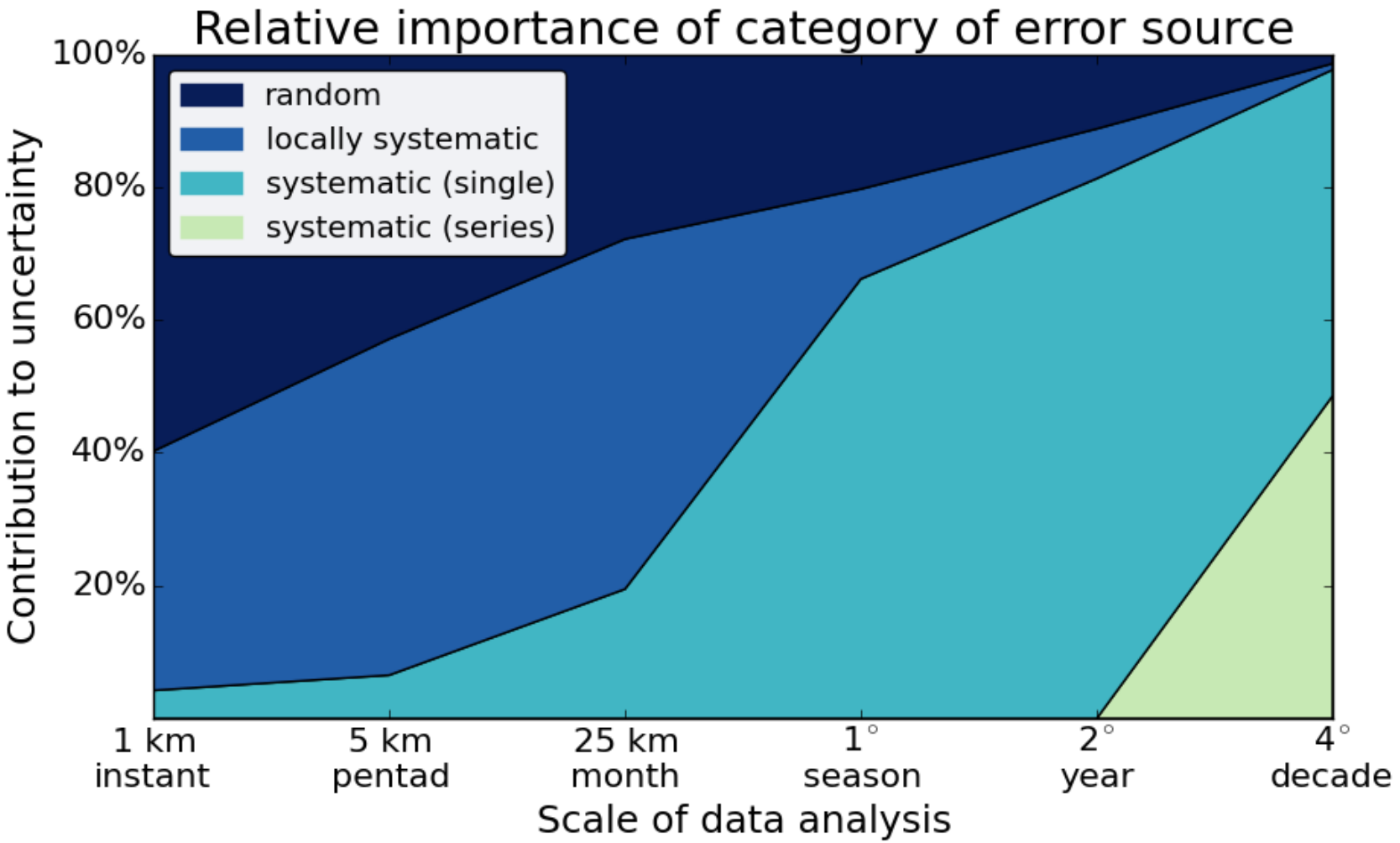


D2 Grid

STD Dev (retrieval minus drifter SST)

- Where uncertainties are calculated independently of in-situ data, these can be used to validate both SST and the associated uncertainty.
- We do this for both L2 and L3 data.
- Dashed lines show buoy and geophysical uncertainties in matched data.

Errors at different scales



Extending the uncertainty budget

Uncertainties from the following sources of error are not presented in this analysis:

- Undetected cloud
- Aerosol variability
- Undetected ice
- Sensor drift (systematic error)
- Adjustment uncertainty (skin to depth) – will be in SST CCI products.

Further work:

- Ideally uncertainties should be traceable back to SI through the entire processing chain.
- Work undertaken within the FIDUCEO project will take this approach, tracing to a reference and characterise systematic errors for AVHRRs, HIRS, MVIRI (vis chan) and microwave humidity sounders.