Propagating uncertainty through temporal and spatial remeshing

Maurice Cox, Xavier Loizeau, Bernardo Mota, Pieter De Vis, Emma Woolliams
xavier.loizeau@npl.co.uk
National Physical Laboratory, Hampton Road, Teddington, Middlesex, TW11 0LW, UK

Motivation

Re-meshing data can be used to:

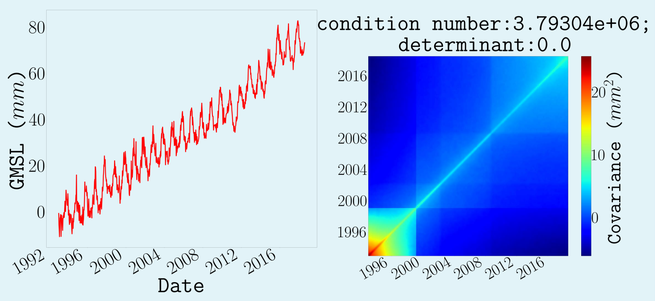
- Fuse datasets (multi-fidelity/resolution/modal)
- Estimate properties such as
$$\max(f(x), x \in \mathcal{H})$$
- Aggregate images in a video or spectra in an hyper spectral-image

Concerns

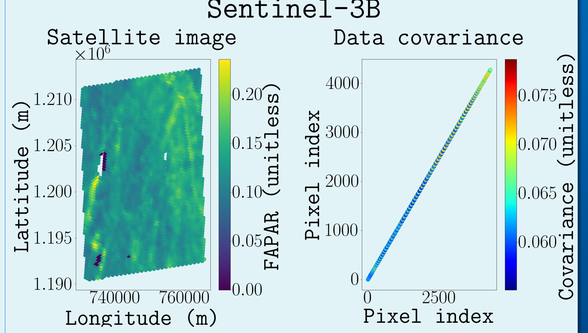
- Reporting uncertainty for individual points is not sufficient;
- Resulting covariance matrix should be reported;
- Data type and end use should dictate the choice of the remeshing method.

Case studies

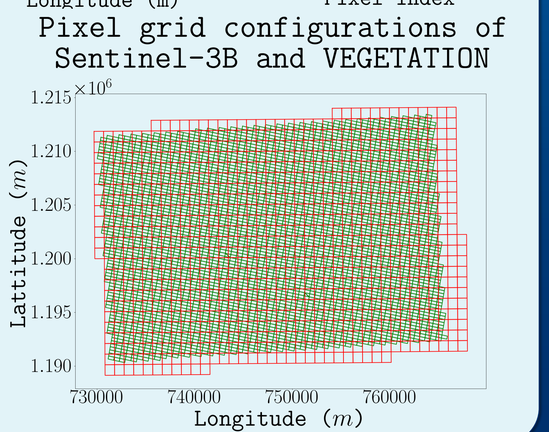
- GMSL smoothing: a time series is smoothed with different bandwidths as a noise filter.



- FAPAR image alignment: a satellite image is projected to a target grid.



- LIME multi-resolution interpolation: a high-resolution, low-fidelity and a low-resolution, high-fidelity spectra are to be aggregated to construct a high-resolution high-fidelity spectrum.



CoMet
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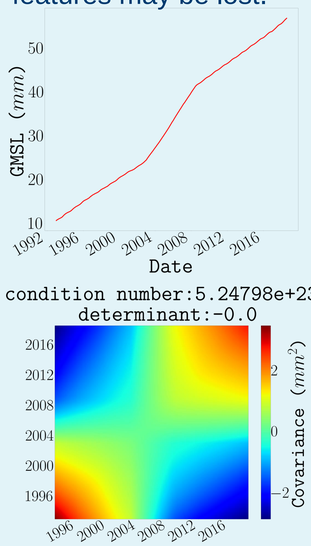
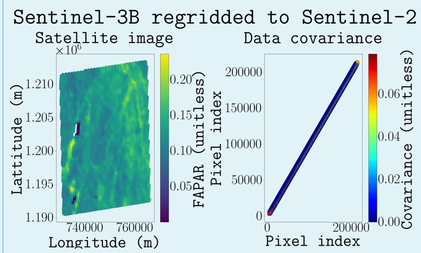
Methodologies and results

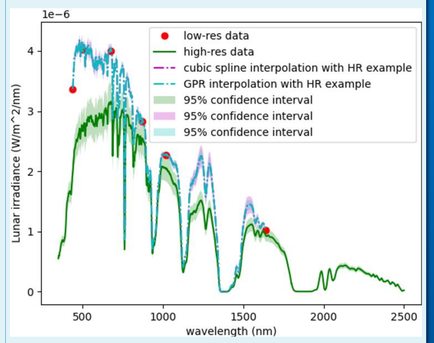
GMSL: a kernel smoothers is applied. As bandwidth increases, uncertainty is reduced, correlations increase, and signal features may be lost.



FAPAR: for each target cell, its overlap with each source cell is computed. The interpolated value is given by the mean of source values weighted by overlap area.



LIME: the high resolution data is scaled to go through the high fidelity data. The scaling factors between the low resolution data are interpolated using either a spline or a Gaussian process regression. Uncertainties and covariances are propagated using Monte Carlo.



Conclusions

- Three case studies for remeshing were considered (temporal, spatial, and spectral);
- Remeshing was performed with different techniques and uncertainty propagated;
- Re-meshed data is correlated, even when source data is un-correlated;
- Parameter (e.g., bandwidth) selection has a strong impact on information loss

Recommendations for next steps

- Systematically propagate covariance through remeshing;
- Tool kits allowing such propagation should be developed for different types of data used in the community, using appropriate methods; **we are keen to work on new problems!**
- Attention should be paid to parameter selection in remeshing.

Department for Business, Energy & Industrial Strategy
FUNDED BY BEIS

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