# Guided inversion with Bayesian spatial ensemble fusion

Gerhard Visser[1], Hoël Seillé[1], Jelena Markov[1]
[1] *CSIRO, Deep Earth Imaging, Future Science Platform*
gerhard.visser@csiro.au
*ORCID: orcid.org/0000-0001-8752-9828*

Structural constraints and site-specific regularisation can guide inversion towards specific geologically realistic scenarios. When little additional information is available, the range of possibilities can be wide, making it difficult to formulate such informed priors.

We introduce a probabilistic geophysical inversion workflow for developing, visualising and testing multiple interpretations. First, Bayesian ensemble inversion is applied to small subsets of the available data using geometrically simple model parameterisations over small sub-regions with non-informative priors. The results of these separate uncertainty analyses are then used to build many candidate localised interpretations. Simple hypotheses about structures are then be formulated and applied to the sub-region ensembles using segmentation and filtering. Next, constraints for tying these partially processed sub-inversions together are formulated based on the results of the previous step. Bayesian spatial ensemble fusion is then used to combine the localised ensembles to form ensembles of larger 'fused' models. The results are then analysed to further refine the constraints and the process is iterated.

Instead of attempting to define a general-purpose regularisation/prior upfront, data is partially analysed in steps, with constraints being built up along the way where needed. This provides a highly flexible and way to include irregular data or hypothesis into the inversion process and to guide inversion towards realistic solutions. Key to making this possible is our Bayesian spatial ensemble fusion algorithm, which fuses ensembles of small models into ensembles of larger models in a way that approximates what would have been achieved by a more complex probabilistic inversion method. Computational expense was managed by developing various approximations and introducing a method to save and reuse expensive forward calculations. Our workflow is demonstrated with airborne electromagnetic and magnetotelluric data from Cloncurry Queensland. These tests show that our approach is able to shed light on complex posterior multi-modality and to clearly resolve resistivity boundaries.

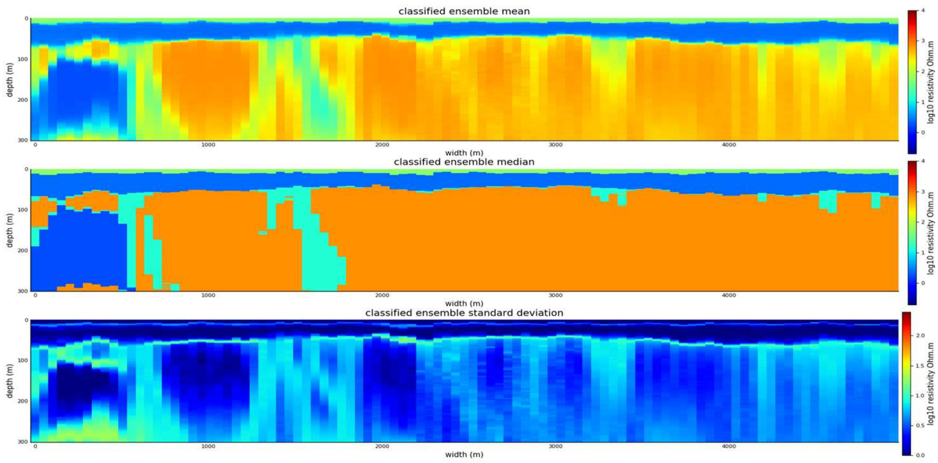


Figure 1. Posterior mean, median and standard deviation of an ensemble of 10000 fused resistivity models. These were derived from VTEM data collected in Cloncurry Queensland.