Joint one-dimensional inversion of **Magnetotelluric Data** and **Surface-Wave Dispersion Curves** using **Correspondence Maps**

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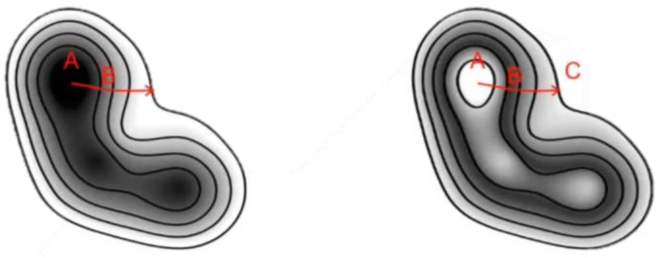
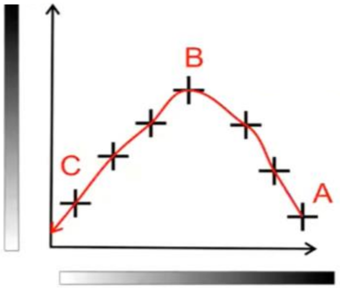
Introduction to joint inversion



$m_1(x,y,z)$ $m_2(x,y,z)$

Correspondence maps

m_2



m_1

The core element of a joint inversion methodology is the proposition of a **link** between different property models.

$$\phi_{joint} = \phi_{data} + \phi_{regularization} + \phi_{coupling}$$

$$g(m_1, m_2, a) = \sum_{i=0}^{q} \sum_{j=0}^{p} a_{ij} m_1^i m_2^j = 0$$

Carrillo and Gallardo 2018

To avoid trivial 0 solution, normalize a_{00}

$$\hat{g} = -1$$

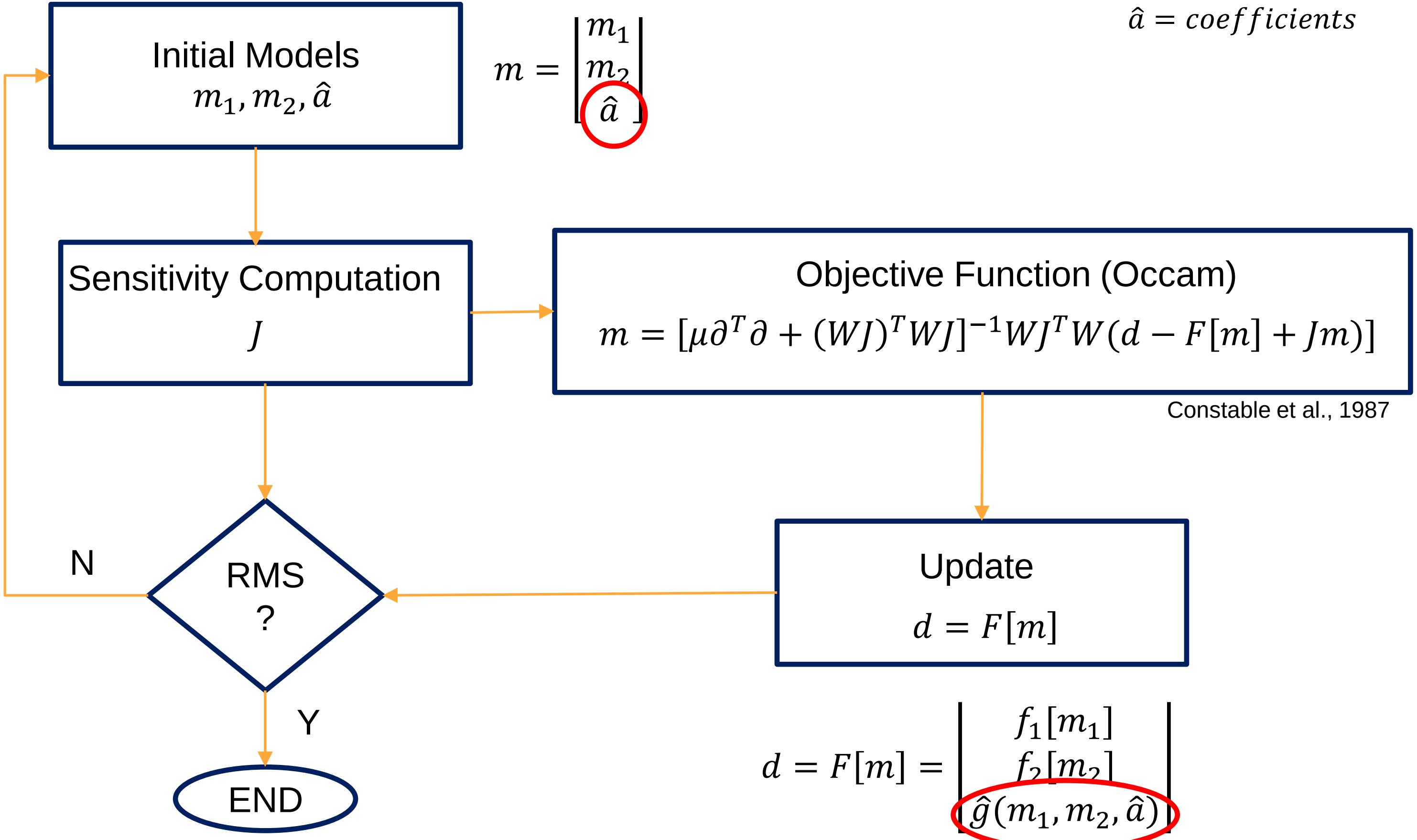
How we implement it?

$m1 = shear\ velocity$

$m2 = resistivity$

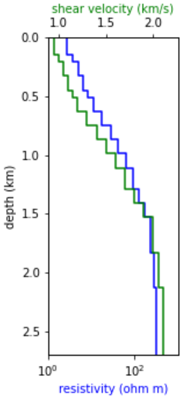
$\hat{a} = coefficients$

$$J = \begin{bmatrix} J_{m11} & 0 & 0 \\ 0 & J_{m22} & 0 \\ J_{gm1} & J_{gm2} & J_{ga} \end{bmatrix}$$



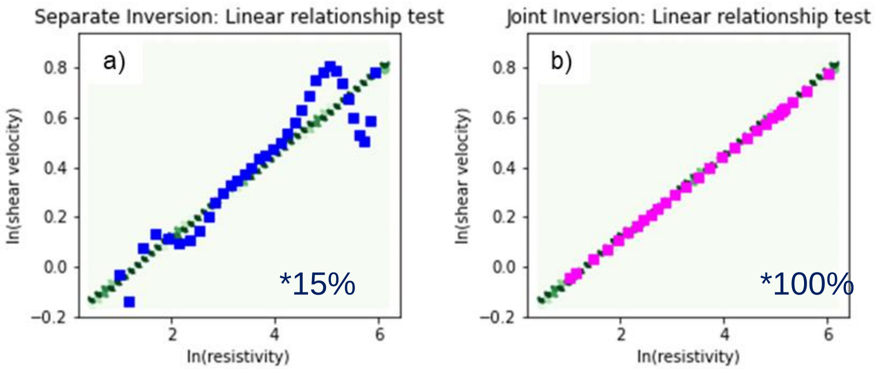
One-dimensional results

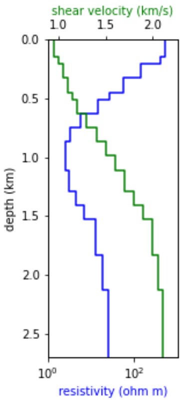
*Percentage of model-pairs that fit $g = -1$ within a 5% error



Example A:
Degree 1 relationship true models

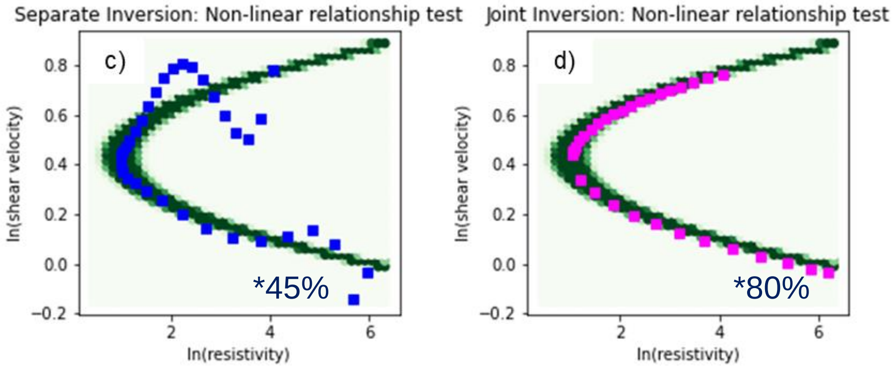
$$m_2 = 6m_1 + 1.3$$

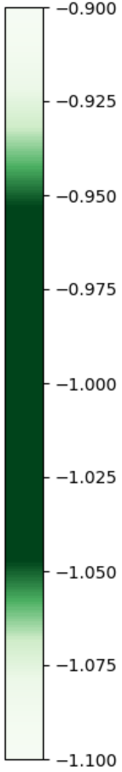




Example B:
Degree 2 relationship true models

$$m_2 = 26m_1^2 - 23m_1 + 6$$



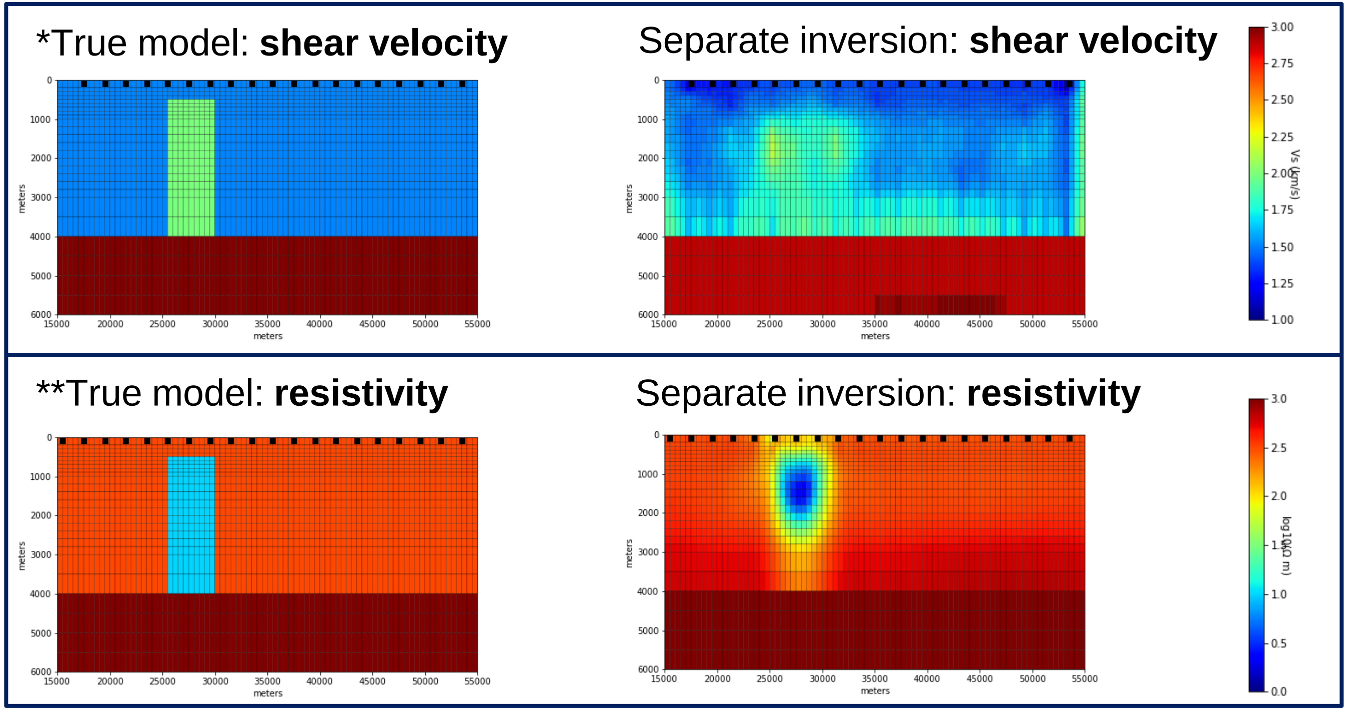


$g(m_1, m_2, a)$

Aquino et al., 2022 (*in press*)

Beyond one-dimensional models

We analyzed the sensitivity of surface wave dispersion curves obtained from ambient seismic noise in order to assess the potential of joint inversion. We observe lower sensitivity of dispersion curves for the periods of interest (0.1-10 sec) compared to MT. Dispersion curves were computed by standard ambient seismic noise workflow i.e. model responses using shots located at each receiver.



*SWD fwd code: Petersson and Sjogreen, *SW4*

**MT fwd code: Wannamaker and Stodt 1987

Conclusions

- We have succesfully applied **1D joint inversion using correspondence maps** between surface-wave dispersion curves and MT data for the first time. It is an effective way to find meaningful physical **parameter relationships** while retrieving the **shear velocity and resisitivity models**. The addition of a proper correspondence maps term has shown not to compromise the fit of the data.

- We obtained, for the **linear relationship test** (degree 1), that **100% of the joint inversion model-pairs** ($v_S - \rho$) had g values, computed using the *true* relationship, between -1.05 and -0.95, vs only **15% of the separate inversion pairs**. In the **non-linear relationship test** (degree 2), it was the case for 80% of the joint inversion pairs but 45% of the separate inversion pairs.

- We have assesed the sensitivity of ambient seismic noise using higher dimensional models and identify its limitations, where MT data can be beneficial in a joint inversion framework.