Current issues with time—distance inversions for flows at AsÚ

Michal Švanda

Astronomický ústav Akademie věd ČR, Ondřejov, Czech Republic
Astronomický ústav University Karlovy, Praha, Czech Republic
Motivation

- Time—distance inversions for flows at various depths using Born kernels with combined ridge+phase-speed filtering schemes for Charles's series
- Inversions validated using synthetic data (hence assuming perfect sensitivity kernels)
- Data testing the sanity of the inversion: an average supergranule
  - Failed
Principal method

- **OLA** – *Backus & Gilbert 1968; SOLA (Pijpers & Thompson 1992)* is based on explicitly constructed spatially confined averaging kernels by taking linear combination of the sensitivity kernels, while bounding error magnification.

- *Multichannel* formulation – in Fourier space assuming the translation invariance of the background:
  - *Jackiewicz et al. 2012*
  - *Švanda et al. 2011*

- The code returns the inverted flow map, averaging kernel, and the level of random noise.
• A new MC-SOLA code with the following properties:
  - Born sensitivity kernels
  - Full travel-time noise covariance matrix
  - Control over the random error in the results, amount of cross-talk, and the smoothness of the solution
  - The code is validated for flows using synthetic data
  - Code is embarrassingly parallel
  - Code validated using synthetic data (frozen field, only inversion validated, travel times forward-modelled, consistency between the forward and inverse problem automatically fulfilled)
  - Full pipeline validated for $f$-mode inversions (Švanda et al. 2013) by comparing to direct surface measurements
Inversions

- Depths of 1.9, 2.9, 4.3, 6.2, (and deeper, not discussed here)
- Formal error levels <10 m/s for the statistical sample (inversion cost function is kernels-dominated)
- Two sets of inversion:
  1. combined ridge+phase-speed filters (405 different kernels)
  2. ridge filters only (240 kernels)
Testing sample

- Watershed segmentation of supergranules
- Averaging of all detected supergranules
Results for 1.9 Mm
Results for 2.9 Mm
Results for 4.3 Mm
Results for 6.2 Mm
Origin?

- Forward problem issue?
- Amplified kernel errors? (cf. Ben's talk)
  - Weakly regularised OLA more sensitive?
  - Phase-speed kernels more sensitive?
Forward problem issue?