行政院國家科學委員會專題研究計畫 成果報告

利用震波層析推演高解析度的北歐亞板塊上部地函構造 (2/2)

研究成果報告(完整版)

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Summary:

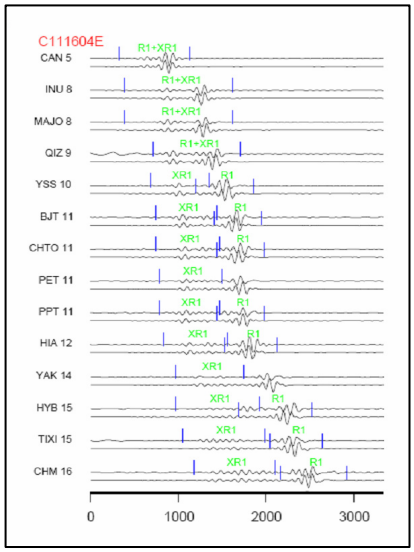
We invert long period Rayleigh waves in the time domain in the framework of normal-mode-based nonlinear asymptotic coupling theory (NACT) [Li and Romanowicz, 1995] for the velocity structure underneath Eurasia. While only Eurasia region, where the sensitivity is the highest in the selected data set, is inverted for its radial anisotropic structure, the effects from global 3D heterogeneous structure are taken into account in the forward stage.

The implementation of regional scale inversion is achieved by converting the partial derivative matrices of the initial model parameters (spherical harmonics) onto nodes of the spherical triangle meshes within the selected region. The regional tomography either in fixed scale or multi-scale can be done with the new matrices. In the scheme of multi-resolution wavelet representation, model parameters are grouped into natural hierarchy of local scales such that the damping regularization acts to sort through successive scales depending on the local data constraints [Chiao and Liang, 2003].

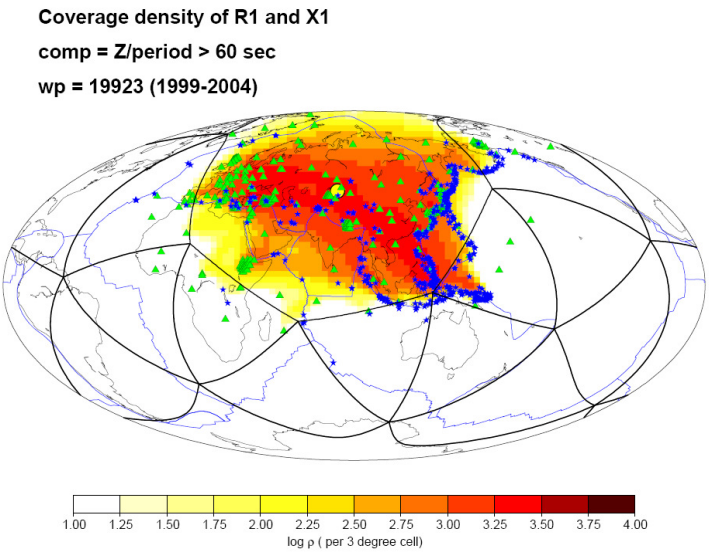
Data:

Data recorded from 412 events that occurred in the period from 1999 to 2004 are used in this preliminary study. Only first orbit of fundamental and overtone phases are used. Tabled details of this data set, sample of wave packets and achieved coverage density are shown below

	Component	Period	Wave packets	data points
1	Z	> 60 s	19,923	541,468
2	Z	> 120 s	17,943	329,486



Samples of Z component seismograms for event C111604E. For each station, the observed seismograms are plot on the top trace, and the PREM synthetics are plotted below for reference. The seismograms are low-pass filtered at 1/60 hz.(Not all the wavepackets shown here are used in this regional study)



The coverage density of the first data set, expressed as the logarithm of the ray length in each 3x3 degree cell, corrected for latitude. Earthquake epicenters and stations are shown in blue stars and green triangles respectively.

Two steps horizontal model parameterization

1. In the forward part, the model is parameterized in terms of spherical harmonics up to degree 48. Spherical harmonics can be simplified to (2smax +1) cosine and sine functions in the great circle path, allowing an efficient analytical solution for the integration along the great circle path. The partial derivatives are computed based on nonlinear asymptotic coupling theory (NACT) [Li and Romanowicz, 1995] .
2. Prior to the inversion, partial derivatives w.r.t spherical harmonics are mapped onto nodes of the spherical triangular meshes used in the study region. For each wave packet, only about 15% of nodes receive effective sensitivities (see the next section for details), which largely reduces the computation cost in the stage of inversion.

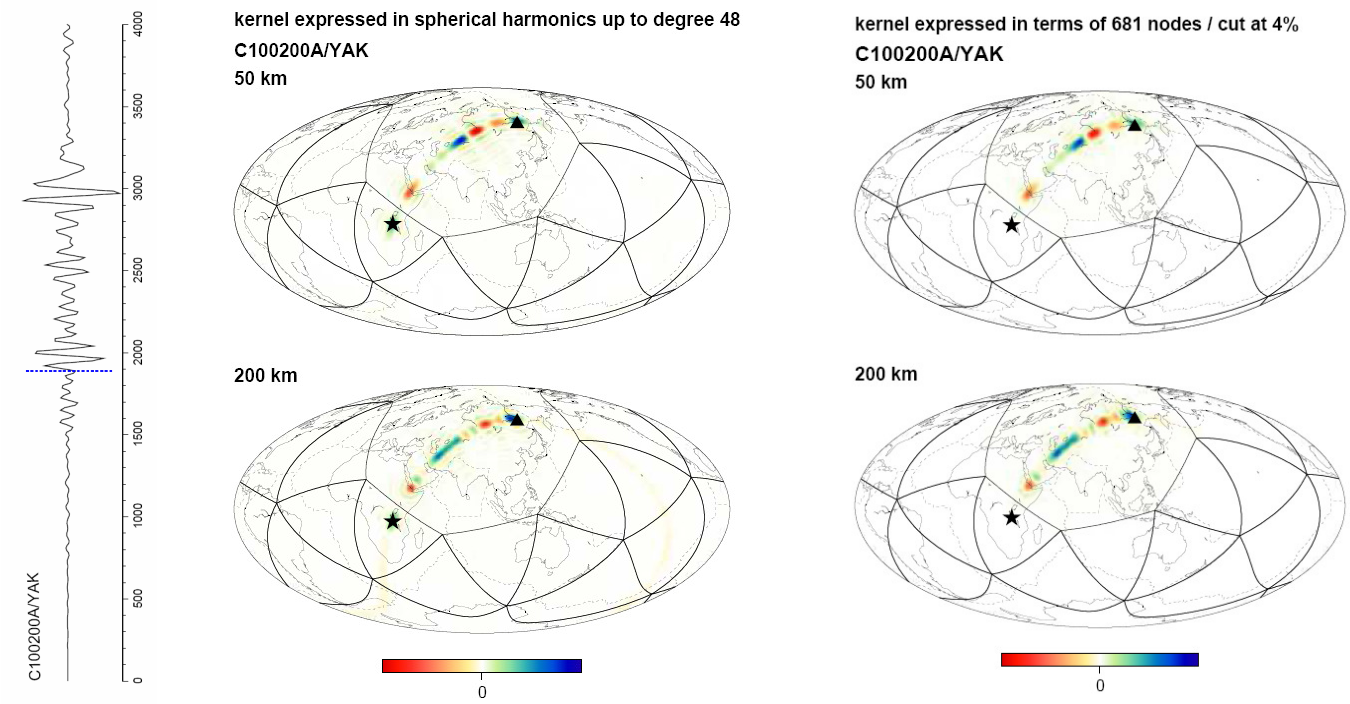
Mapping of kernels

681 nodes resulted from successive divisions up to level 5 on the five base spherical triangular meshes centered at (80, 45) are used as the horizontal model parameters.(see the figure below)

Partial derivatives (kernels) are first computed in the domain of spherical harmonics (bottom middle panel), and then mapped onto the 681 nodes (bottom right panel).

In the vertical part, 7 cubic splines are used in both parameterizations

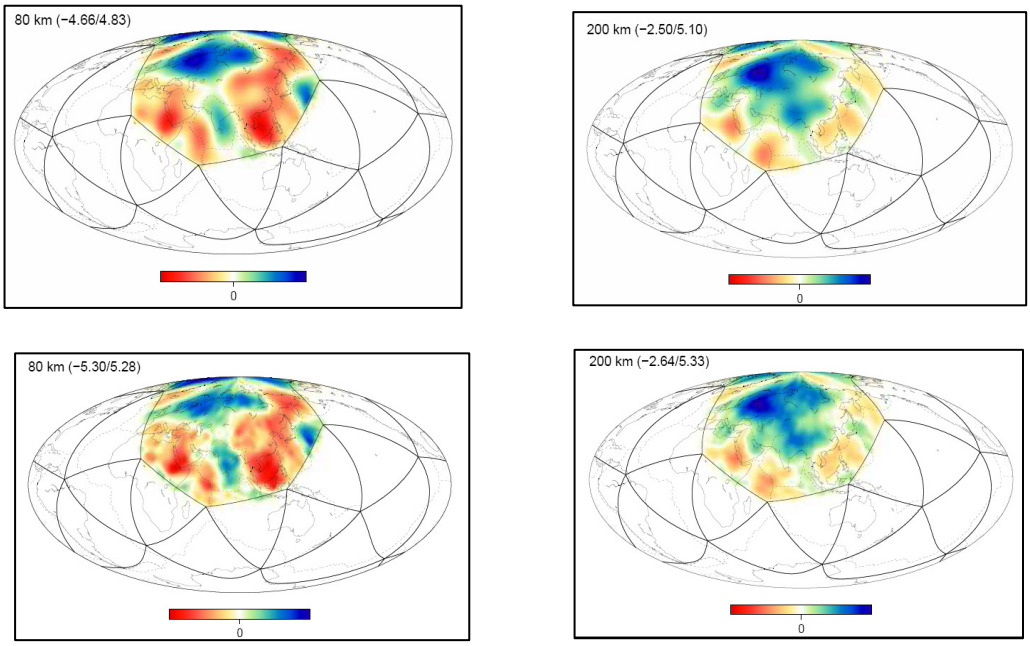
Kernel validations:



Preliminary results:

Starting model (SAW16BV)

Preliminary result



參考文獻

1. Chiao, L.Y. and W.T. Liang (2003) Multiresolution parameterization for geophysical inverse problems: Geophysics, 68, 199-209.
2. Gung, Y. and Chiao L-Y., Multi-scale upper mantle tomography of the Eurasia using surface waveform data, *Eos Trans. AGU, 86*(52), Fall Meet. Suppl., Abstract, S51C-1283,2006.
3. Gung, Y. and B. Gung, Y. and Chiao L-Y., Wavelet-based Multi-scale tomography of the upper mantle using long-period waveform data. (in preparation)
4. Li, X.-D., and B. Romanowicz, Comparison of global waveform inversions with and without considering cross-branch modal coupling, *Geophys. J. Int.*, *121*, 695-709, 1995.
5. Romanowicz, Q tomography of the upper mantle, Geophys. J. Intl. 157, 813-830, 2004

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