LLNL-G3D-JPS Resolution Kernel Matrix

BASIC INFORMATION

This README document describes the contents of the resolution kernel matrix files for the LLNL-G3D-JPS global model of Vp and Vs in the crust and mantle (Simmons et al. 2015).

We estimated the resolution matrix (**R**) that projects a true model vector of slowness perturbations ($\mathbf{m}^{true}$) to a model vector that would be recovered ($\mathbf{m}^{estimated}$) by the tomographic data and process used to develop LLNL-G3D-JPS (i.e. tomographic filter):

$$\mathbf{R}\mathbf{m}^{true} = \mathbf{m}^{estimated}$$

The **R** matrix dimensions are 1,003,608 x 1,003,608 – representing the number of free parameters in the inversion to construct LLNL-G3D-JPS.

The matrix is broken up into 44 separate ASCII text files, each representing one layer in the inversion ("R_Matrix_TomoFilter_Layer_{*n*}.txt" where *n* is the inversion-layer number). Each file has 3 columns:

[Matrix Row# Matrix Column# Matrix Value]

The full R matrix is sparse, but non-zero entries still use approximately 3 Gbytes of computer memory (all 44 files).

We also include a coordinates file "LLNL_G3D_JPS.Tessellated.Coordinates.txt" which contains 4 columns of coordinates corresponding to the lateral (Latitude/Longitude) locations of the points in the model. The columns in the coordinates file are:

[1-Geodetic(geographic) Latitude, 2-Longitude, 3-Geocentric Latitude, 4-Sealevel Radius (km)]

USING THE R MATRIX

The R matrix can be used to project a hypothesized seismic model vector $\mathbf{m}^{true}$ with the simple equation above. Here we describe the ordering of the model vector (dimensions 1,003,608 x 1).

The model vector is ordered by layer from the crust to the CMB. **The crustal stack layer and upper mantle layers each have 40,962 points (nodes) defined by a spherical tessellation with a nominal resolution of 1 arc degree.** There are 18 inversion layers in the crust and upper mantle; therefore, the first 18*40,962 = 737,316 elements of the model vector represent crust and upper mantle slowness perturbations. The latitude/longitude positions of each of the

40,962 nodes for each crust and upper mantle layer are defined in the coordinates file (LLNL_G3D_JPS.Tessellated.Coordinates.txt) in the same order.

The lower mantle layers each have 10,242 points (nodes) defined by a spherical tessellation with a nominal resolution of 2 arc degrees. There are 26 inversion layers in the lower mantle; therefore, the remaining 26*10,242 = 266,292 elements of the model vector represent lower mantle slowness perturbations. The latitude/longitude positions of each of the 10,242 nodes for each lower mantle layer are defined in the FIRST 10,242 rows of the coordinates file (LLNL_G3D_JPS.Tessellated.Coordinates.txt) in the same order.

The table below outlines the model vector element ordering:

LAYER #	DESCRIPTION	VECTOR ELEMENT #s	LAT/LON ORDER
1	Perturbations in Full Crustal Stack	1-40962	Defined in Coordinates File
2	Top of Upper Mantle – Underside of Moho	40963-81924	"
3	Upper Mantle – Average Depth of 68km	81925-122886	"
4	Upper Mantle – Average Depth of 115km	122887-163848	"
5	Upper Mantle – Average Depth of 150km	163849-204810	"
6	Upper Mantle – Average Depth of 185km	204811-245772	"
7	Upper Mantle – Average Depth of 220km	245773-286734	"
8	Upper Mantle – Average Depth of 265km	286735-327696	"
9	Upper Mantle – Average Depth of 310km	327697-368658	"
10	Upper Mantle – Average Depth of 355km	368659-409620	"
11	Upper Mantle – Topside of 410km Discontinuity	409621-450582	"
12	Transition Zone – Underside of 410km Discontinuity	450583-491544	"
13	Transition Zone – Average Depth of 457km	491545-532506	"
14	Transition Zone – Average Depth of 502km	532507-573468	"
15	Transition Zone – Average Depth of 547km	573469-614430	"
16	Transition Zone – Average Depth of 592km	614431-655392	"
17	Transition Zone – Average Depth of 623km	655393-696354	"
18	Transition Zone -Topside of 660km Discontinuity	696355-737316	"
19	Lower Mantle – Underside of 660km Discontinuity	737317-747558	First 10,242 Points in Coordinates File
20	Lower Mantle – Average Depth of 721km	747559-757800	"
21	Lower Mantle – Average Depth of 771km	757801-768042	"
22	Lower Mantle – Average Depth of 871km	768043-778284	"
23	Lower Mantle – Average Depth of 971km	778285-788526	"
24	Lower Mantle – Average Depth of 1071km	788527-798768	"
25	Lower Mantle – Average Depth of 1171km	798769-809010	"
26	Lower Mantle – Average Depth of 1271km	809011-819252	"
27	Lower Mantle – Average Depth of 1371km	819253-829494	"
28	Lower Mantle – Average Depth of 1471km	829495-839736	"
29	Lower Mantle – Average Depth of 1571km	839737-849978	"
30	Lower Mantle – Average Depth of 1671km	849979-860220	"
31	Lower Mantle – Average Depth of 1771km	860221-870462	"
32	Lower Mantle – Average Depth of 1871km	870463-880704	"
33	Lower Mantle – Average Depth of 1971km	880705-890946	"
34	Lower Mantle – Average Depth of 2071km	890947-901188	"
35	Lower Mantle – Average Depth of 2171km	901189-911430	"
36	Lower Mantle – Average Depth of 2271km	911431-921672	"
37	Lower Mantle – Average Depth of 2371km	921673-931914	"
38	Lower Mantle – Average Depth of 2471km	931915-942156	"
39	Lower Mantle – Average Depth of 2571km	942157-952398	"
40	Lower Mantle – Average Depth of 2671km	952399-962640	"
41	D'' – Average Depth of 2741km	962641-972882	"
42	D'' – Average Depth of 2771km	972883-983124	"
43	D'' – Average Depth of 2871km	983125-993366	"
44	D'' – Top of CMB (2891km)	993367-1003608	"

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