

r-wave eigenfunction update

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Harvest data from transient events

- Get radial-vertical phase information for station “i” (and then average across events and stations at each depth):

$$\rho(f; t) = \overbrace{\tilde{R}^*(f; t)}^{\text{radial}} \times \overbrace{\tilde{Z}(f; t)}^{\text{vertical}}$$
$$\phi(f; t) = \arctan \left(\frac{\text{Im } \rho(f; t)}{\text{Re } \rho(f; t)} \right)$$

- Get amplitude information for station “i”:
 - Take mean across events, time segments, and channels at each depth
 - Normalize by mean of vertical channels for all surface stations.

Combine phase + amplitude

$$\mathcal{R}(f, z) = R(f, z) \operatorname{sgn} \left(\operatorname{Re} \left[e^{i\left(\frac{\pi}{2} + \phi(f, z)\right)} \right] \right)$$

Events used: (all events are mine blasts)

latitude	longitude	time	evID	win_start	taper_start	win_end	taper_end
44.3627	-106.0725	2015-05-20T23:03:02.234300Z	5.0	60.0	10.0	140.0	20.0
43.9408	-105.4559	2015-05-22T20:23:43.930540Z	18.0	30.0	10.0	130.0	10.0
43.815	-105.5652	2015-05-23T21:23:46.031030Z	24.0	40.0	5.0	150.0	10.0
44.1964	-105.3649	2015-05-25T19:11:20.937630Z	34.0	40.0	10.0	120.0	10.0
43.8249	-105.4232	2015-05-25T20:13:26.627470Z	38.0	45.0	10.0	140.0	10.0
43.6702	-105.4549	2015-05-26T20:03:36.492510Z	44.0	55.0	10.0	150.0	10.0
43.9628	-105.5024	2015-05-27T20:35:49.542810Z	47.0	50.0	10.0	140.0	10.0
43.9059	-105.4762	2015-05-28T00:27:59.720410Z	50.0	60.0	10.0	130.0	10.0

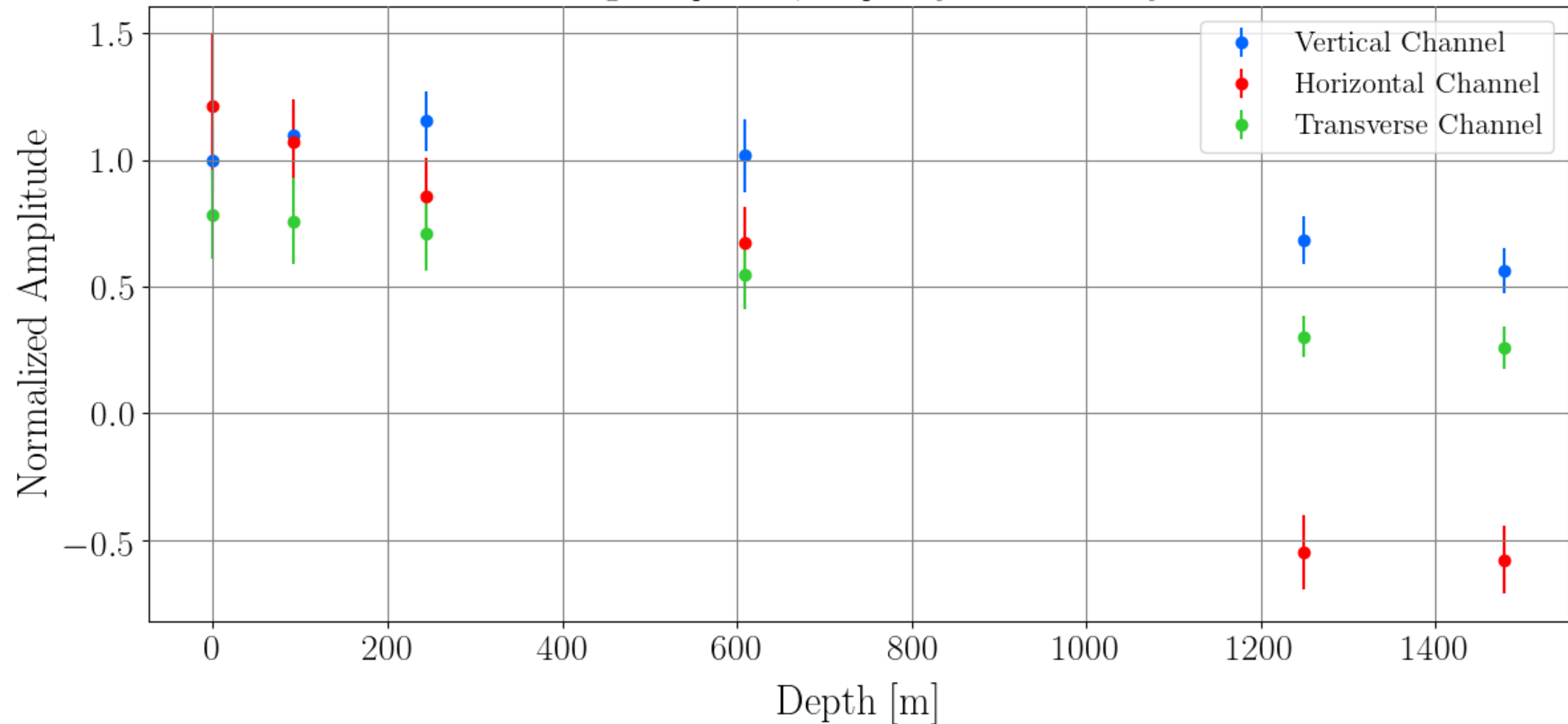
Stations used:

- ['A2000', 'B2000', 'C2000', 'D2000', 'YATES', 'ROSS', 'WTP', 'ORO', 'A4850', 'B4850', 'C4850', 'D4850', 'A4100', 'C4100', 'D4100', '300', '800', 'E2000']
- 1700, RRDG, and far stations had zeros in them

Results

0.9 Hz

Average amplitude; frequency domain analysis



Bi-exponential fit

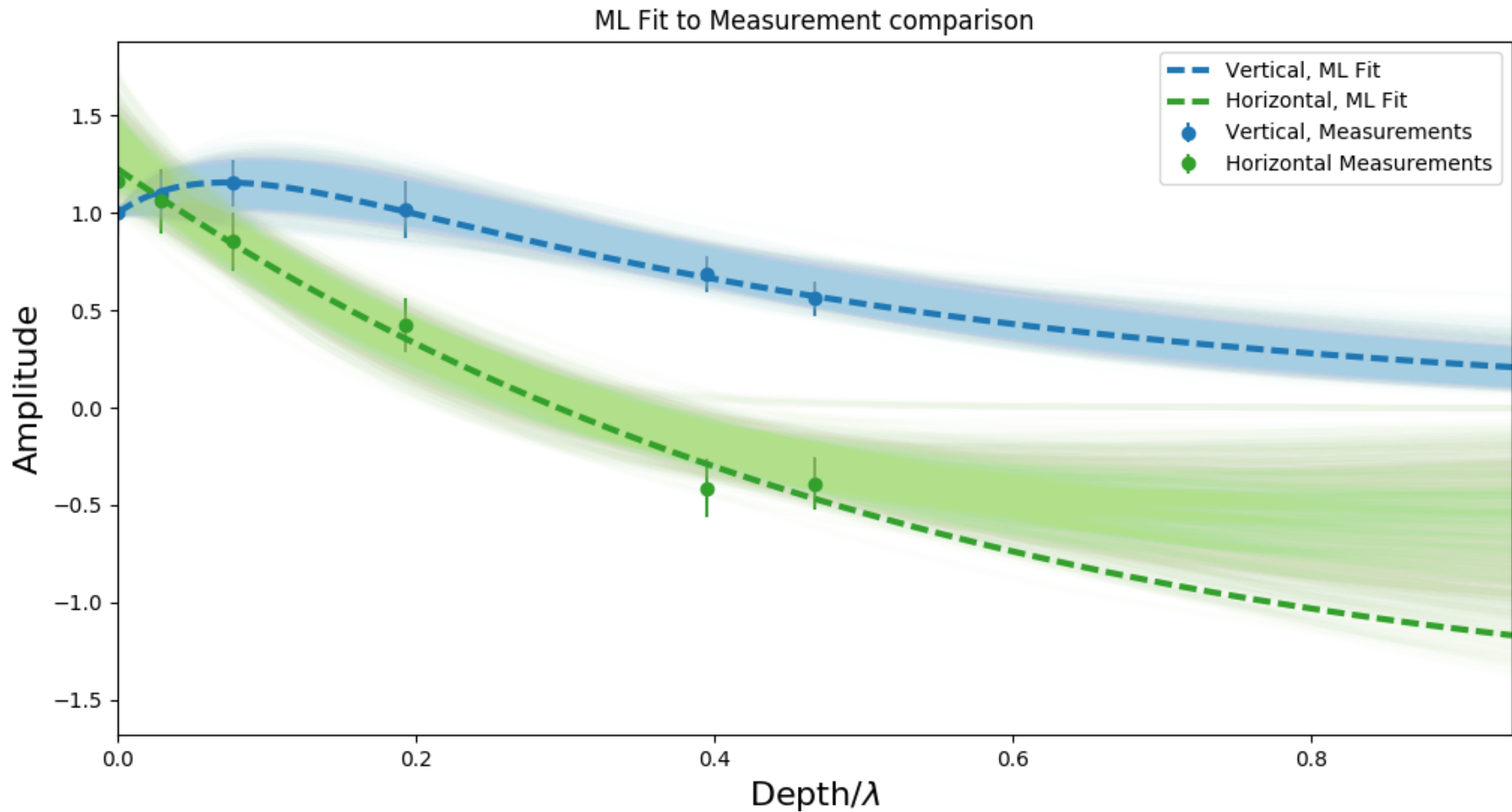
- Fit a bi-exponential with 7 parameters:

$$r_z(z) = c_1 e^{-a_1 k z} + (1 - c_1) e^{-a_2 k z}$$

$$r_h(z) = c_3 e^{-a_3 k z} + (N_h - c_3) e^{-a_4 k z}$$

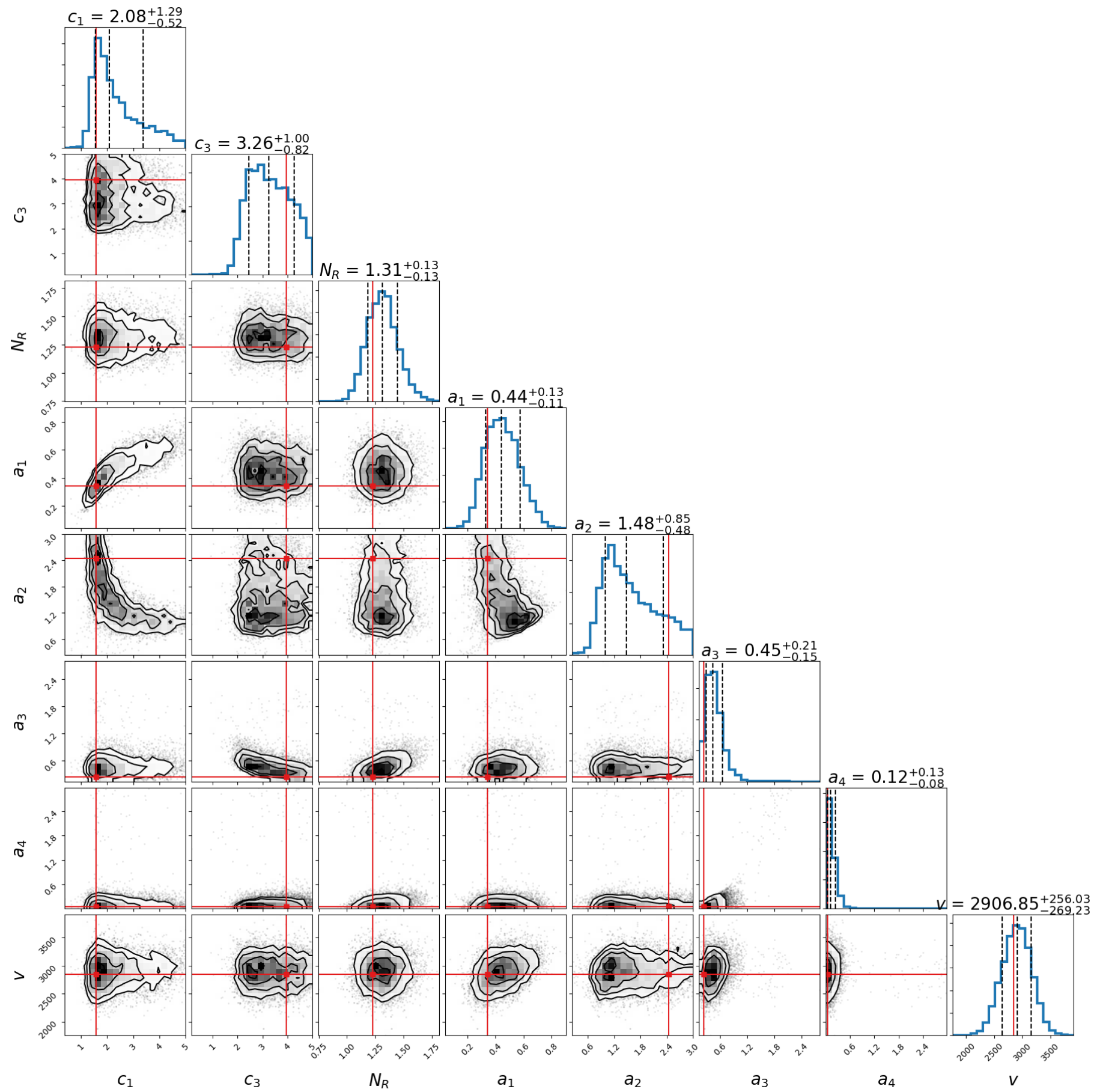
- Use MultiNest MCMC nest sampler to perform parameter estimation

Best fits



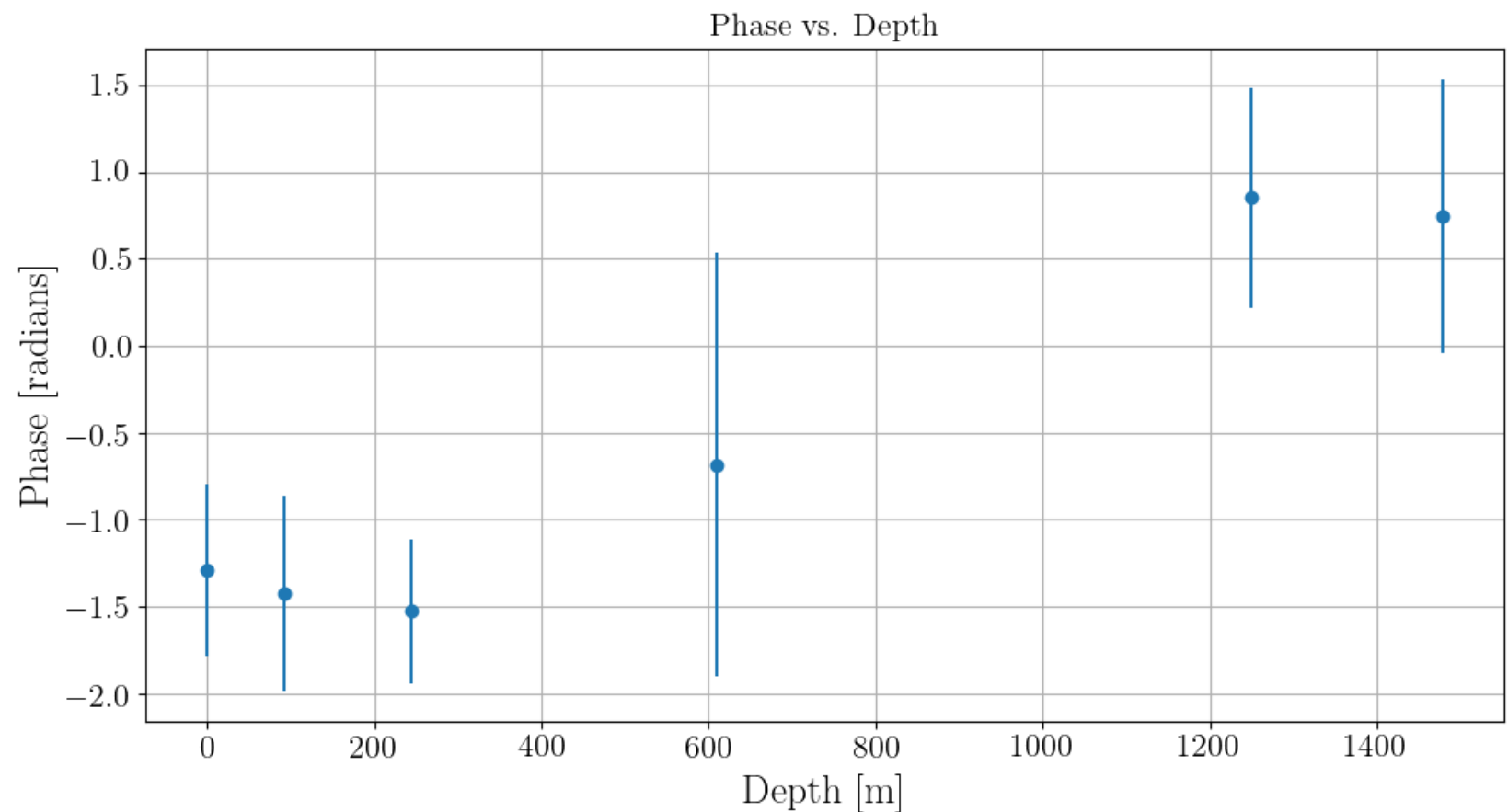
- Shaded region are 1000 points pulled from the equal-weighted posteriors

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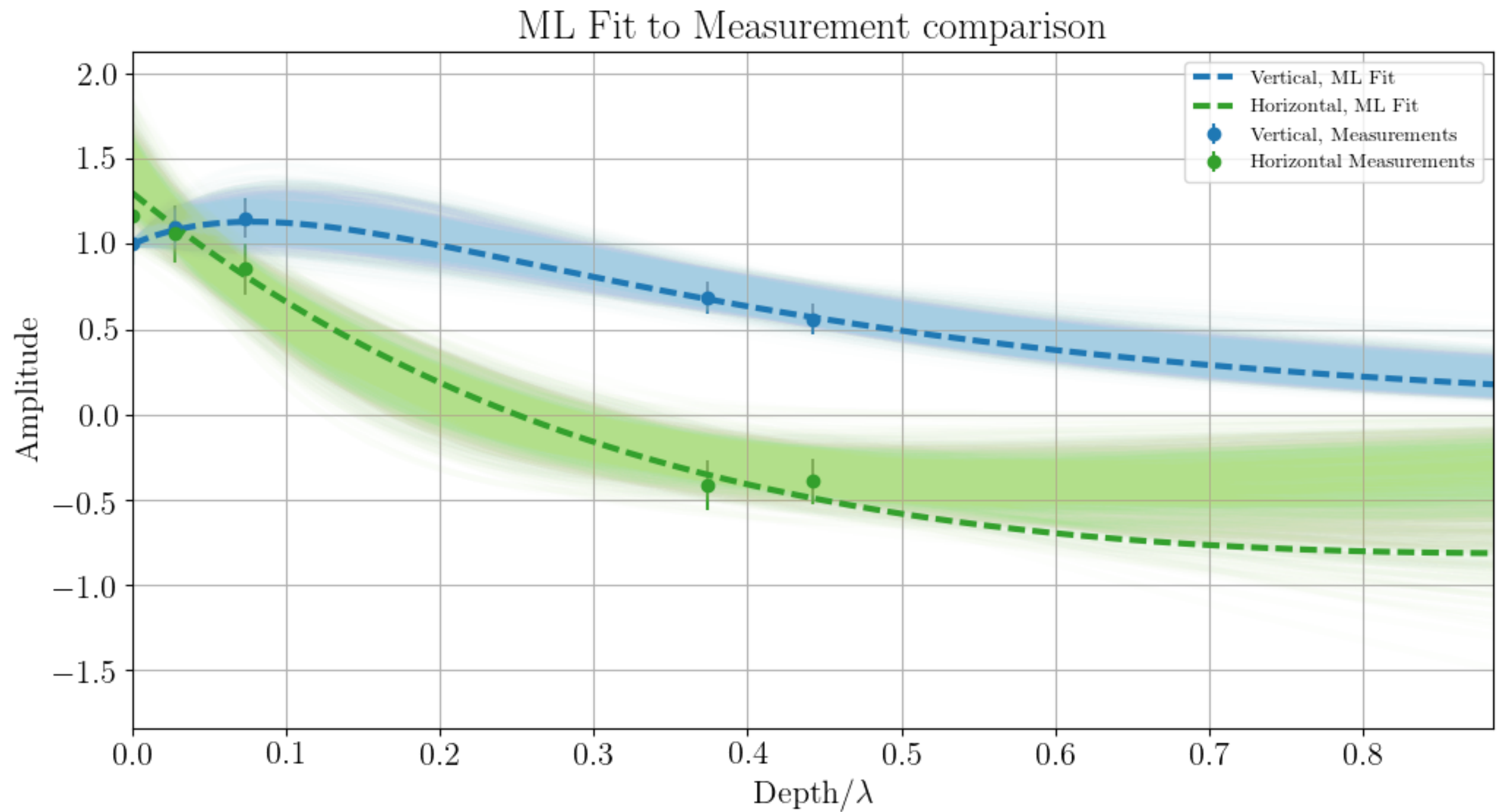


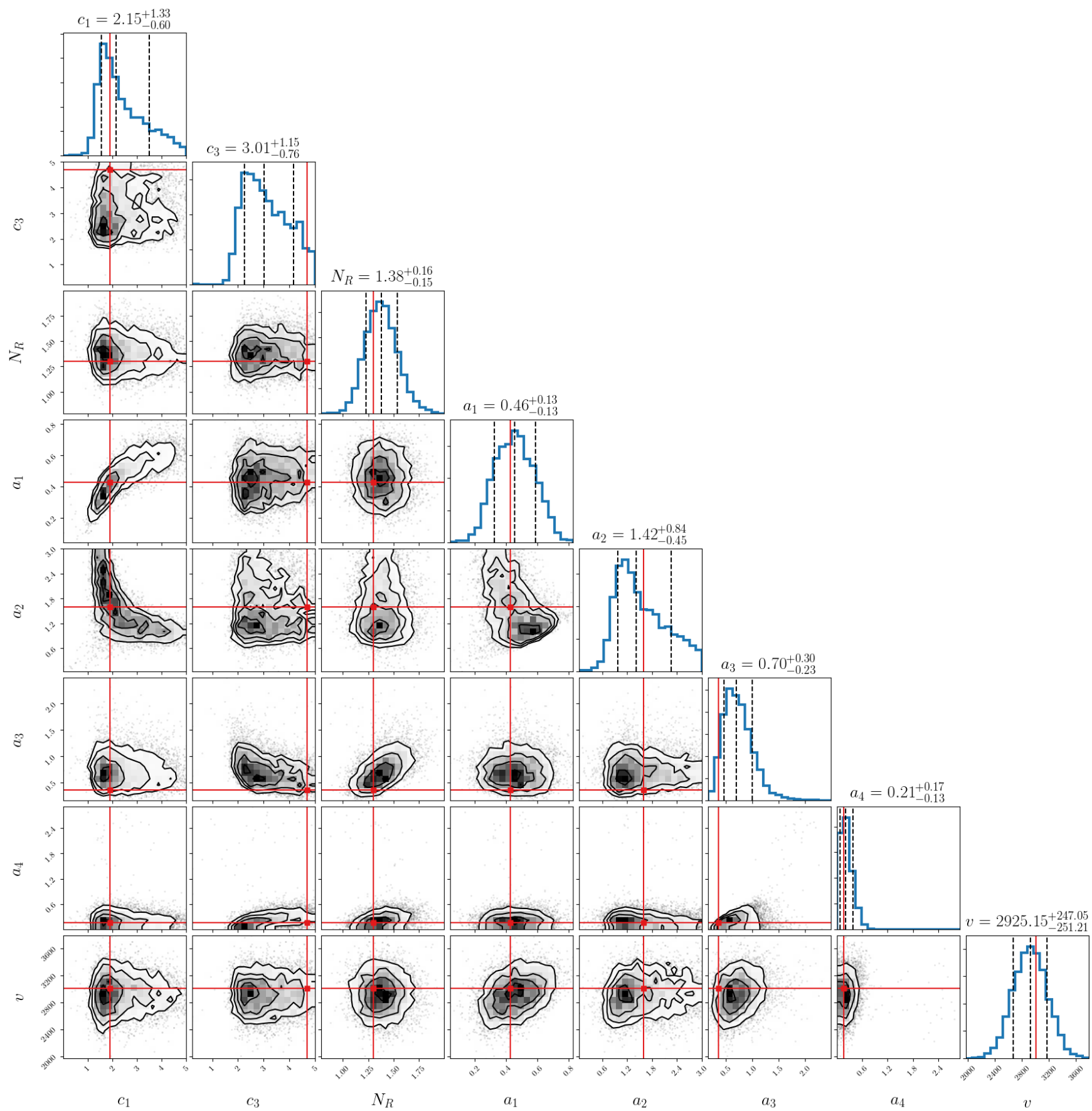
2000 is the weird one

- The data Radial to Vertical data for 2000 stations do not appear to have the phase we expect for r-waves, and removing it gives more reasonable looking biexponential fits in general.



Fits without 2000 station





Future

- Would like to include events that have data for 1700 station. I think that would be ideal
- Right now I combine data across many events into one single data point for each depth
 - I can use `*each*` event and `*each*` station as a data point...
- Try using earthquakes instead of just mine blasts