Bayesian multiple rupture plane inversion to assess rupture complexity

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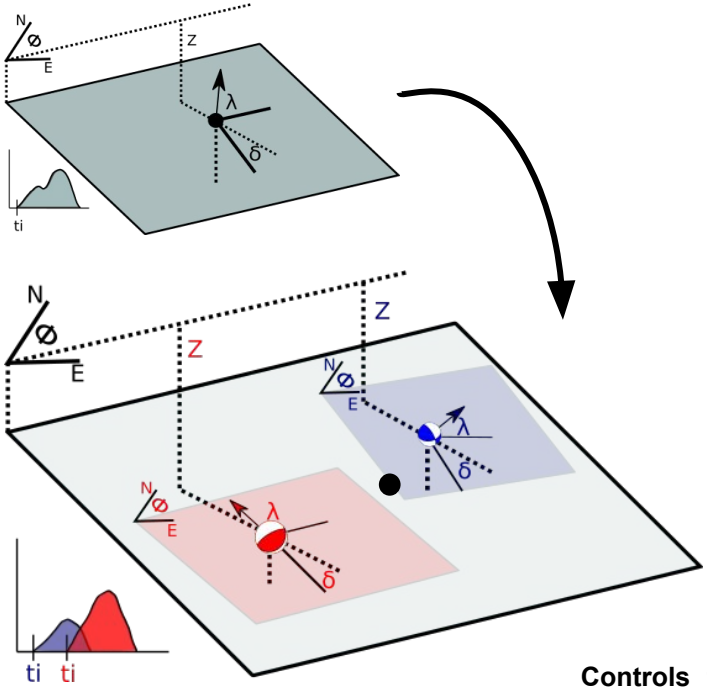
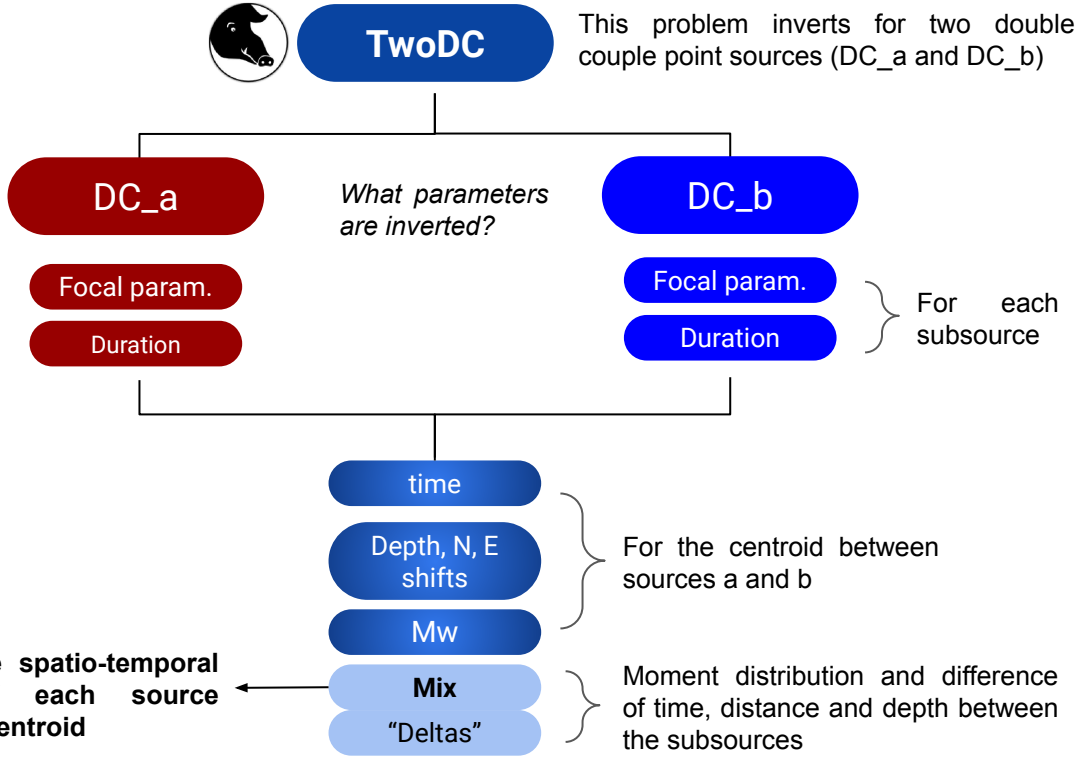
Two double couple source model

To study two prominent rupture phases or a change of mechanism in the rupture plane, it is more suitable to change from the single point source model to a **double point source** model. This method is implemented in Grond, a tool with a bayesian bootstrap-based probabilistic joint inversion scheme included in the Pyrocko software (https://pyrocko.org/grond/).





Application: Can we obtain two subevents in the 2020 Mw 7.0 Samos earthquake ?

Our procedure

1.- Single point source inversion

We get the centroid location

We fix centroid location and mechanisms and we keep both DC at same depth

2DC problem speeds up and works in finding both double couples around the centroid

2.- Double point source inversion

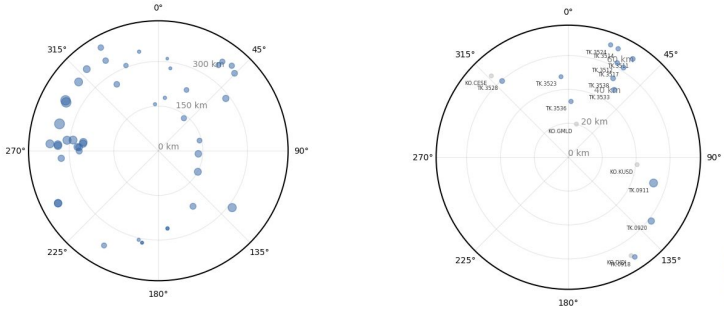
We run this inversion with synthetic and real data

Inversion setup

After testing different configurations, we select:

-Waveforms in displacement and acceleration
-Bandpass: 0.01-0.04 Hz
-Time window: P arrival-50 s, P arrival + 200 s

We use pre-calculated Green's function stores



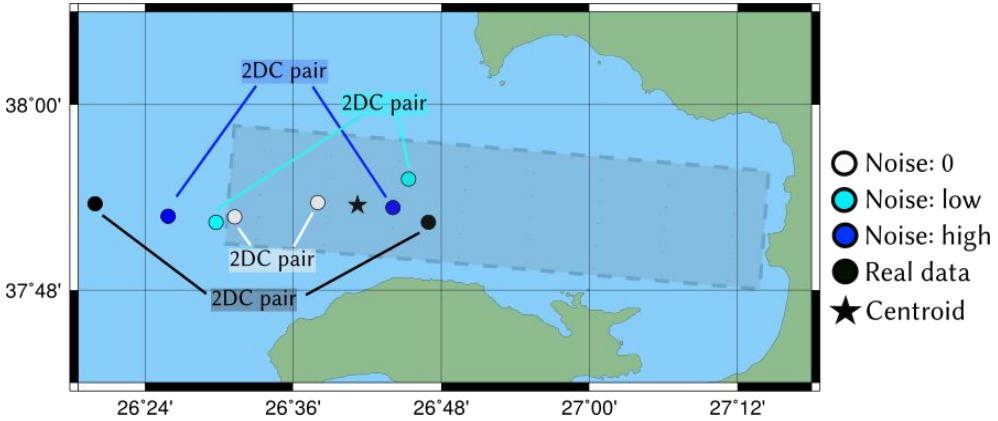
Azimuthal coverage of stations.
(Left: displacement, Right: Acceleration)

Results

The 2DC method is able to find subevents located near the west side of the rupture patch (rectangular grey zone, preliminary result by M. Metz pers. commun, see TS4.4). Each colored pair represents the 2DC location for the different datasets tested.

	Delta time	Dista-nce	Duration 1	Duration 2	Mw1	Mw 2
●	4 s	40 km	15 s	13 s	6.85	6.84

Parameter results of the best solution for real data MT inversion.



Discussion

- Real data MT inversions finds a 2DC pair very similar in size to be separated by 4 s in time and 40 km in distance. The location of 2DC pairs are near the rupture patch but only synthetic data without noise contains both solutions inside the patch. In all cases the stronger DC is located very near to the centroid.
- As we have fixed the mechanisms for each subsource, this preliminary result could correspond to high slip patches present in this earthquake.
- Next steps include improvement in configurations to obtain lower misfits and testing of other earthquakes. This multiple rupture scheme will be implemented in order to get ground displacement for further tsunami simulations.

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I'll be looking forward to your questions, ideas and suggestions in the chat...

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