# **1997-2008: 11 years of European-Mediterranean Regional Centroid Moment Tensors and their dissemination**

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## The Catalog

The European-Mediterranean Regional Centroid Moment Tensor (RCMT) Catalog collects seismic moment tensor solutions that have been routinely computed since 1997 for earthquakes with moderate magnitude (4.5 < M < 5.5) in the Mediterranean region. After more than 10 years we have now a Catalog of centroid moment tensors which includes more than 800 definitive RCMTs and more than 40 Quick RCMTs. representing all together the 1997-to-present timespan.

This database represents an extension to smaller magnitudes of the Global CMT catalog (http://www.globalcmt.org) for this area. RCMT computation is based on analysis of seismograms recorded at regional distances and on modeling of intermediate period surface waves. In the last few years we also inverted simultaneously for body and surface waves, but only when the magnitude is greater than 5.0 – i.e. when the signal-to-noise ratio at 40-100 s of period is significant enough to contribute to the inversion.



The Catalog is regularly updated every few months, and reports are published in Phys. Earth Planet. Int. and on the worldwide web (http://www.bo.ingv.it/RCMT). However, moment tensors can also be computed on the basis of data available in quasi-real time. Such preliminary solutions are available within a few hours after an earthquake occurs, and published as a Quick RCMTs.



seismotectonic studies have been the main applications, but the RCMTs are also used for sea-level change studies to evaluate the amount of tectonic component in the vertical deformation occurred in the Mediterranean in the last centuries.

Deformation and



2008, Tectonophys.)

All seismic moment tensors for this region have been summed over a half degree grid. The cumulative moment tensor obtained for each element is plotted using the Frohlich ternary diagram associated to an RGB representation. This map shows where extensional deformation dominates, as along the Apennines chain, or compression is the main trend, as offshore along the northern coast of Sicily (Pondrelli and Morelli, 2008).

Vertical deformation obtained by cumulative moment tensors (above) and map of predicted rates of present–day sea level change S and vertical deformation of the solid surface U (below, Stocchi and Spada,

## **Recent seismic activity**

In the last year the seismicity of the Mediterranean region shows an activity representative of the seismotectonics and geodynamics of the region. In Italy RCMTs show mainly an extensional deformation along the Apennines, related to several events, with a maximum Mw=4.7 of the earthquakes belonging to the Mugello seismic sequence occurred in March 2008 and a couple of events occurred last month in Sicily and Calabria.



main shocks and other events belonging to these seismic sequences are included in our Catalog in their Quick version.



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January and July 2008. Different label colors are used to underline the change in seismic moment release along time. February has been particularly active.

The New Web Search Page

To provide full search capabilities over the moment tensor solutions, the dataset previously available as static ASCII files had been imported into a MySQL relational database; a web application with advanced user interface (UI) elements allows to perform queries filtered by any combination of date, magnitude, depth and geographic coordinates ranges. Events can further be filtered by 2 flags; one to distinguish between quick and definitive solutions and one for the 'quality' categorization we are using for the solutions.

The web form is based on **open-standards PHP and Javascript routines**, it exploits the Jquery Javascript library/framework to implement an Ajax application that optimizes the client-server communications. While selecting the latitude and longitude ranges with the form's slide-bars, the corresponding area of interest is drawn in real-time on a zoomable map (google Maps), providing precise visual feedback to the user. To guarantee operability even on older browsers, standard input fields elements are also present and kept synched with the slide-bar controls.



JSON also provides a fully semantic structure, integrating the search parameters metadata with the actual records. Given its minimal file-size compared to XML, and the growing list of programming languages supporting it, we consider it as an ideal exchange format for scientific data [see poster IN33A-1159]. The other output formats we currently provide are the **Psmeca** and Psvelomeca GMT formats, a basic CSV (Comma Separated Values), and **KML for Google Earth**. We plan to also include QuakeML and netCDF/HDF5-compatible GIAP. Similarly to the in-page Google Maps view, the KML output uses the moment tensor beachballs as placemarks for the events within the Google Earth 3D interface, and visualizes further details of the solution in dynamic info-boxes. KML would allow to build the beachballs as 3D spheres, but we have chosen to provide the classic two-dimensional inverted projection. Infact, we believe that the information content of the beach ball representation is mostly connected to the classic viewing convention, and further 3D implementation would be more confusing than usefull.



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#### http://www.bo.ingv.it/RCMT





Once the search parameters had been set and the query submitted, the map gets updated with the beach ball representations, positioned at each earthquake location; a mouseover event is defined on each beach ball. generating a dynamic info-box containing the full solution for the event. Immediately below the map, a visual characterization of the resulting dataset is given by means of magnitude, depth and time frequency distributions histograms

sor has a high no-double-component due to low signal-to-noise ratio

Finally the **full dataset** is provided and the user can transform it between various formats, within the web browser; this is made possible by using the **JSON format** as the default representation of the dataset. The JSON notation is natively supported in Javascript, thus assigning the dataset to an object variable is sufficient to access all/any of the records' sub-elements directly by dot and array notations, without a parsing routine.

To further simplify and enhance the readability of the map in Google Earth, we also choose not to position the solutions vertically and we kept them clamped to the ground level; this bypasses Google Earth lack of support for negative altitude values (i.e. depths) that would force us to shift the vertical position of the earthquakes in the atmosphere. In our opinion the real value of supporting Google Earth is not in the 3D functionalities, but in the immediacy with which dataset from different sources and fields of research can be layered and cross-referenced; aside from the search page output we are thus also providing the full export of the dataset as a downladable KMZ file (zip-compressed KML). Given the static nature of such a file, we will soon enhance the web service with an rss feed to notify subscribers each time any record is updated or new ones are made available. Another planned functionality that will soon be integrated in the web search is a cart-like selection of events, allowing users to further personalize and export the datasets obtained form the web form.