Progress Report for Funding Period 2004

Proposal: "Improving the quality and consistency of earthquake catalogs in Southern California"

Project #04010

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Proposal Category: Data Gathering and Products

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For the 2004 funding period, we received a total of $5k in support from SCEC. The funds are being used to pay for travel expenses and a 3 months stay ETH PhD student J. Woessner at the California Institute of Technology, Pasadena (Sept. 2004 – Dec. 2004).

Below, we summarize the work so far accomplished and supported in parts through the 2004 SCEC funding:

1.) Method

Jochen Woessner and Stefan Wiemer have developed a suite of methods to determine the magnitude of completeness in parametric earthquake catalogs based on the assumption of self-similarity in the earthquake process. They have written a review paper on the determination of the magnitude of completeness which introduces a new technique that provides a synthetic model of the entire frequency-magnitude distribution based on a likelihood estimate which has been accepted by BSSA in 2004. The synthetic model has the advantage of being testable using e.g. a Kolmogorov-Smirnov test to verify if it fits the actual observed frequency-magnitude distribution. In a mapping approach, this aids to reveal regions where specific problems in the detection process either related to the network or due to man-made changes might exist. Additionally, a bootstrap technique to estimate the uncertainty of the magnitude of completeness was introduced which can be applied to of the available methods.

The approach as well as results related to other applications has been presented at the SCEC meeting 2004. Figure 1 shows an application to the SCSN dataset for the time period 04/01/2001-10/28/2004, starting at a date where the transition to the TriNet (CISN) era was completed. The magnitude of completeness (Mc) using the synthetic model is mostly accepted, however in the geothermal region of Coso (larger red region in Figure 1B), detailed studies will be pursued in the future.

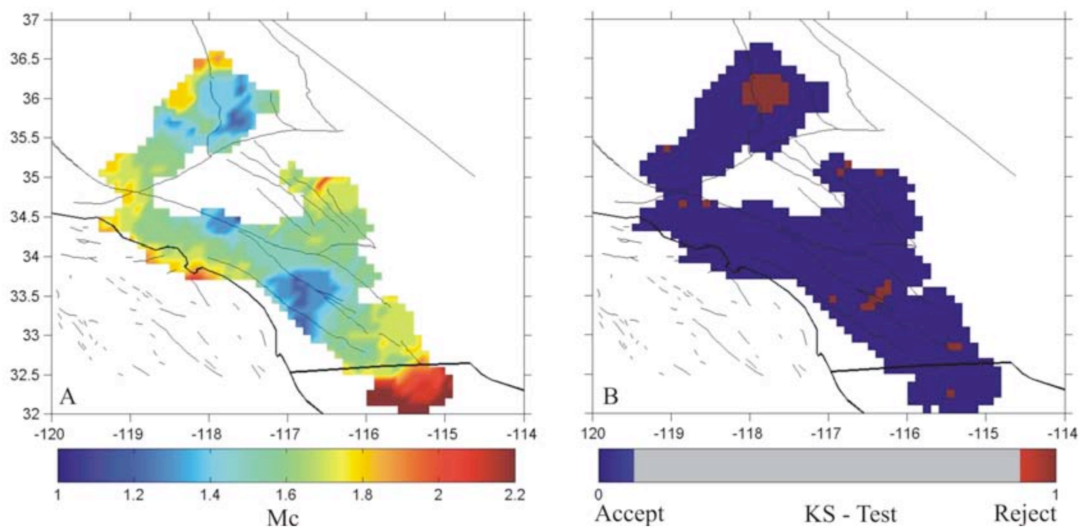

Figure 1: Maps of Southern California showing A) the magnitude of completeness Mc and B) the acceptance level derived for the synthetic model by the Kolmogorov-Smirnov-Test. Maps are calculated for catalog data in the time period of the CISN in the period 04/01/2001-10/28/2004.

2.) Mapping results

Jochen Woessner and Egill Hauksson applied these methods computing a space-time history Mc(x,y,t) using the SCSN data obtained from the SCEC data center. Mislocated events with depths greater than 30 km were excluded. All the maps are computed on a 0.1x0.1 degree grid and events within a radius of r=25km are sampled. Using these parameters, the following maps have been computed:

1) yearly maps from 1984-2004 to analyze short-term changes in the detection level,
2) maps in the time periods between large earthquakes (periods before the Landers 1992, between the 1992 Landers and the 1999 Hector Mine, and after the 1999 Hector Mine event) to analyze the long-term behavior of the detection level,

3) maps for periods that are known to have few changes in the network including the CUSP era and the TriNet SCSN/CISN era, to investigate the detection level and possible changes in b-values.

The computed grids will be available for SCEC scientists who aim to use these magnitude cut-off levels for their research or comparison reasons. The maps will be archived and available either on request or via the scsn.org website. The code is freely available within the Matlab software package ZMAP (http://www.cool.ethz.ch). Figure 2 displays yearly Mc maps of the CISN period (A-C) and for comparison the Mc map of the entire CISN-period (04/01/2001-10/28/2004, panel D).

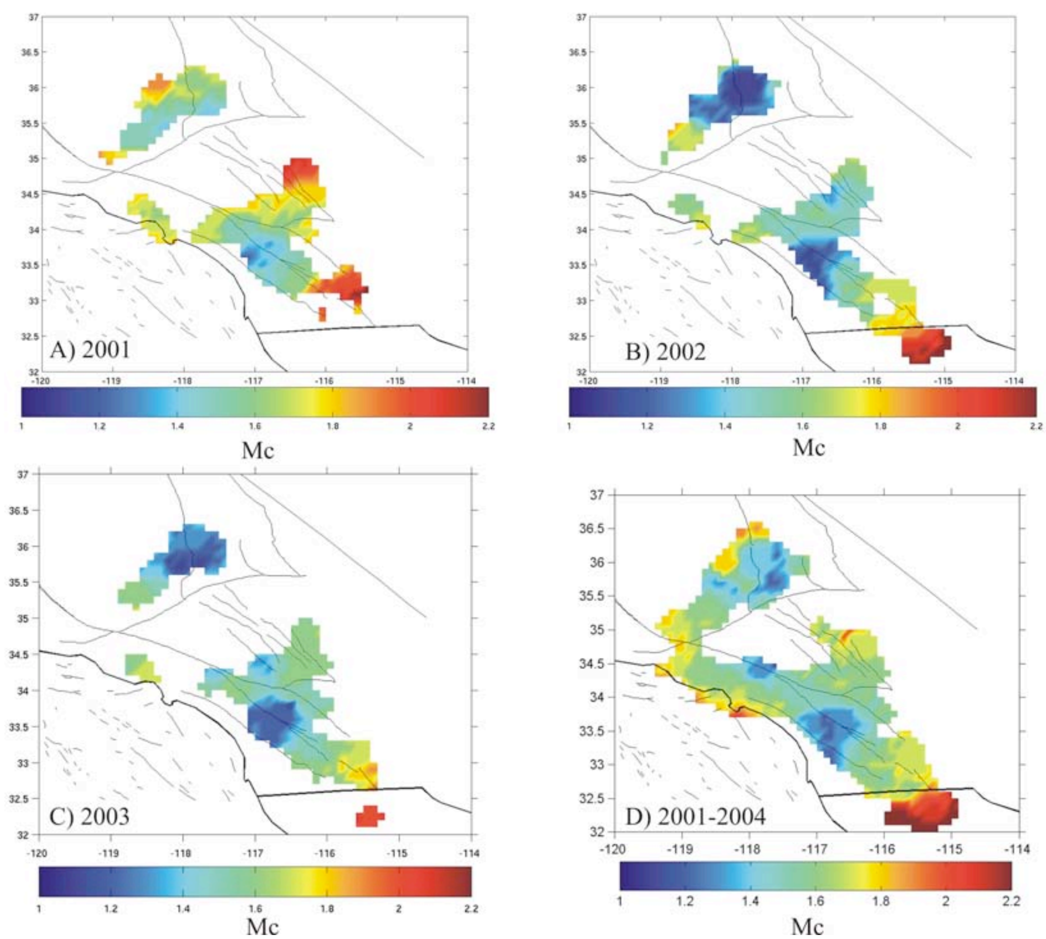

Figure 2: Yearly maps of the magnitude of completeness A-C, the year indicated on the panel. Panel D shows the Mc map for the CISN period (04/01/2001-10/28/2004) for comparison. See text for details on the parameters used.

3) Station configuration studies

To reveal transients in the frequency-magnitude distribution we have correlated the network configurations in time with the detection levels mapped in the yearly magnitude of completeness maps. Figure 3 shows the average distance to the 4 closest stations as a function of the magnitude of completeness for three regions: the San Jacinto / Elsinore fault region covered by the ANZA network, the Los Angeles basin region and the Mojave desert region. The yearly configuration of the network distribution was derived from the SCSN phase picks readily available in the database of the Southern California Earthquake Data Center (SCEDC). The results emphasize that the network density as well as the background micorseismic noise level can influence the detection level significantly. The Los Angeles Basin network is relatively dense compared to the San Jacinto / Elsinore region, however the detection level does not reach the level obtained in the latter region by a difference of 0.2. The relatively poorer performance of the network in the Mojave region as compared with the San Jacinto region may arise from the differences in the geological structure.

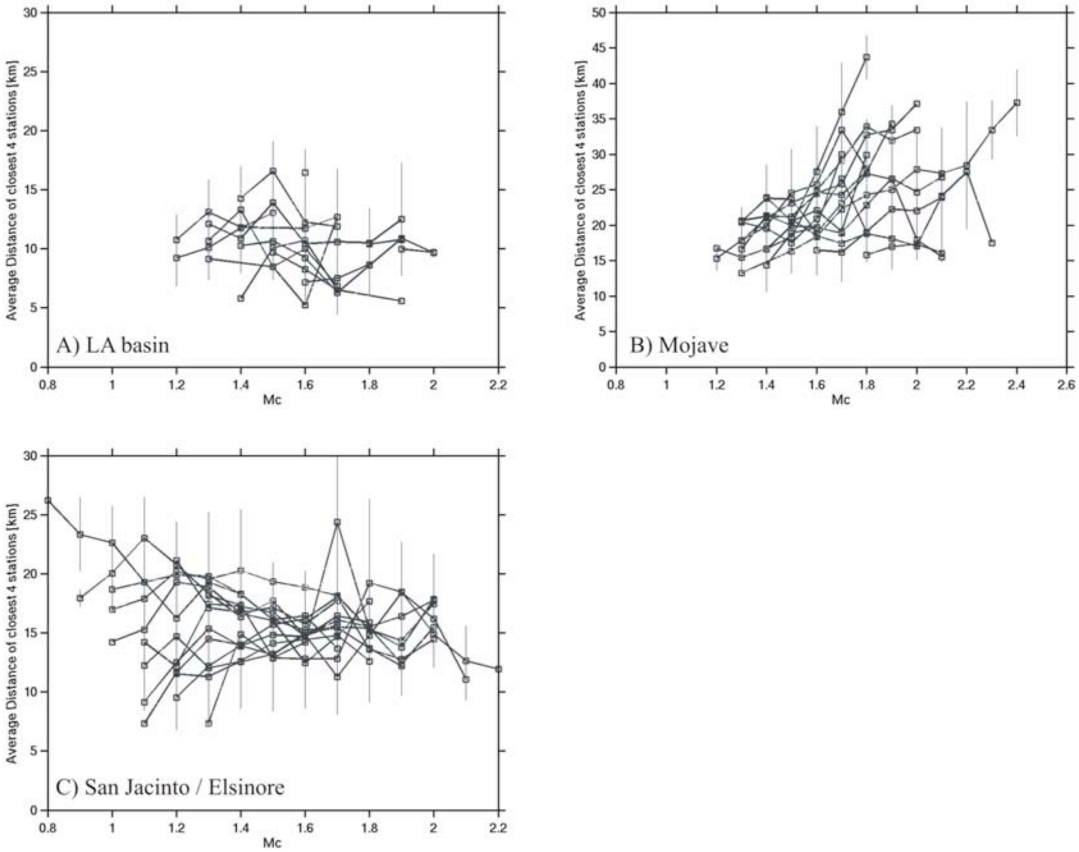

Figure 3: Average distance to 4th station as a function of the magnitude of completeness for three selected regions: A) the Los Angeles basin, B) the Mojave desert region and C) the San Jacinto / Elsinore fault region.