Progress Report

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Project: T-RELM: Testing Regional Earthquake Likelihood Models in Southern California
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Proposal Category: B, A

1 RELM testing procedure

At the RELM workshop 2004, held in San Francisco December 12th, the concept of a testing center was introduced to the participants, mainly modelers. This idea has been developed in the months before as a response of the needs of the modelers as well as to guarantee transparency and reproducibility of the tests and their results.

For preparing this meeting, Danijel Schorlemmer discussed many open issues together with Matt Gerstenberger, Ned Field, Lucy Jones, and David Jackson. These issues include the definition of classes of models in which models will be tested against each other. We attempted to define the classes as close to the characteristics of participating models to ensure easy adoption for testing.

Danijel Schorlemmer became the leader of the RELM testing effort. Matt Gerstenberger the co-leader. RELM also formed an advisory committee: Ned Field, Thomas Jordan, Lucy Jones, Stefan Wiemer, and David Jackson. During a workshop at the USGS office in December 2004, the testing procedure was finalized and presented by Danijel Schorlemmer to the modelers at a RELM workshop held the day before the AGU Fall Meeting 2004. Also at this workshop, Danijel Schorlemmer presented the concept of a T-RELM Testing Center for the first time.

The participants of this workshop decided that a last workshop around the SSA 2005 meeting at Lake Tahoe should be held in oder to inform more people and to collect their commitments to the proposed testing procedure and the Testing Center. This workshop was held a day before the SSA meeting and the participants defined the so called testing classes (Table 1). The submission deadline for stationary models (classes I and II) was set to September 1st and later prolonged to December 31st, 2005.

All necessary details for model submission have been prepared, assembled, and sent out by Danijel Schorlemmer. The full description of the testing procedure was submitted as a paper to the RELM special volume [*Schorlemmer et al.*, submitted].

Class	Forecast period	Aftershocks	Magnitude range	Submission
I	5 years	Not included	$M \in [5; 9]$	Numbers
II	5 years	Included	$M \in [5; 9]$	Numbers
III	24 hours	Included	$M \in [4; 9]$	Code
IV	1 year	Not included	$M \in [5; 9]$	Code
V	1 year	Included	$M \in [5; 9]$	Code

Table 1: Classes of models. The magnitude range's upper limit of 9 means that the last bin covers the magnitude range $8.95 \leq M < 10$. Any other magnitude bins are of the size of $\Delta M = 0.1$.

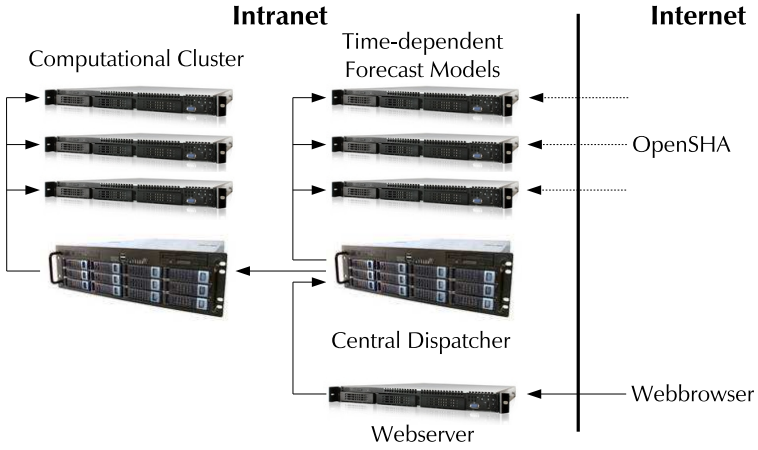

Figure 1: Schema of the computer setup for the Testing Center. The Central Dispatcher is conducting the tests and storing the results. Each time-dependent model runs on a model computer, additionally accessible from the internet via OpenSHA. All results will be presented on the webserver.

2 RELM Testing Center

Danijel Schorlemmer designed the Testing Center (Figure 1). The necessary computer infrastructure was purchased by ETH in Zurich. The computer cluster is operational and the first model computer was set up. The Central Dispatcher is under development and will soon start operating.

Over the next month, several time-dependent models will be installed at the Testing Center, which will accordingly be extended by more model computers.

During the RELM workshop at Lake Tahoe, the ANSS catalog was chosen as authorized data source for testing. In several discussions, Danijel Schorlemmer explored additional potential autorized data sources in oder to extend the variety of models testable in the Testing Center. The most promising candidate are automatic slip distribution provided by the USGS.

For integrating the Testing Center with OpenSHA, Danijel Schorlemmer and Silvio Maraini (ETH) visited the USGS office in Pasadena in June/July 2005. Silvio Maraini set up a model computer in the Testing Center in Zurich to interface with the OpenSHA framework. One test model has been installed during this collaboration.

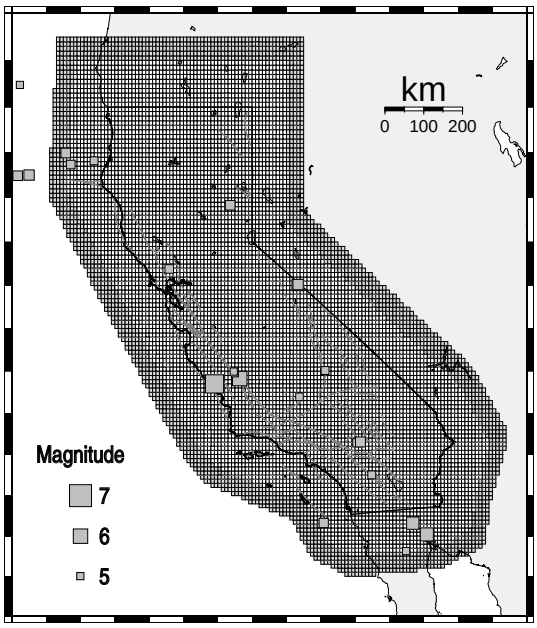

Figure 2: Testing and collection area. The white squares indicate spatial cells of the testing area. The cells extending the testing area to the collection area are drawn in gray. Main faults are indicated with gray lines. The squares mark earthquakes of magnitude $M \geq 5$ of the ANSS catalog in the period 2000–2005.

The only open question which remained after the multiple RELM workshops was the declustering algorithm to be used in testing stationary models. During the aforementioned visit, Matt Gerstenberger and Danijel Schorlemmer developed a probabilistic approach to the declustering algorithm designed by *Reasenberg* [1985]. The probabiilistic approach is necessary for assigning each event in the catalog an independence probability p_I of being an independent event (not part of an aftershock sequence). There probabilisites allow for including the uncertainty in independence into the testing. Because the direct approach developed was to computationaly intensive, Matt Gerstenberger and Danijel Schorlemmer decided to Monte Carlo simulate the algorithm by *Reasenberg* [1985] with changing input parameters. They also generated an example catalog which is provided at the testing website.

During this visit, also the testing area grid was defined together with the network operators, namely David Oppenheimer and Egill Hauksson. The grid is shown in Figure 2. Danijel Schorlemmer together with Silvio Maraini started the development of the testing website which will be linked from the official RELM website (`www.relm.org`).

The complete specifications of the testing classes (choice of free parameters) and the Testing Center has been submitted as a paper to the RELM special issue [*Schorlemmer and Gerstenberger*, submitted].

3 Asperity Likelihood Models for California

Many progress has been achieved with the Asperity Likelihood Model (ALM), also a participant of the RELM testing effort. ALM was initially proposed after discovering the large b-value contrasts at Parkfield [*Wiemer and Wyss*, 1997]. In 2004, *Schorlemmer et al.* [2004a] quantified the stationarity of b-values and *Schorlemmer et al.* [2004b] investigated their predictive power. The Parkfield 2004 event showed that the expectation that the low b-value volume corresponds to the asperity and is likely to rupture in the anticipated event was justified [*Schorlemmer and Wiemer*, 2005]. Furthermore, *Schorlemmer et al.* [2005] have shown, that b-values are inversely correlating with stresses in the Earth.

Taking all these observations into account, *Wiemer and Schorlemmer* formulated the Asperity Likelihood Model, generated the forecast (Figure 3), and submitted its description to the RELM special issue.

References

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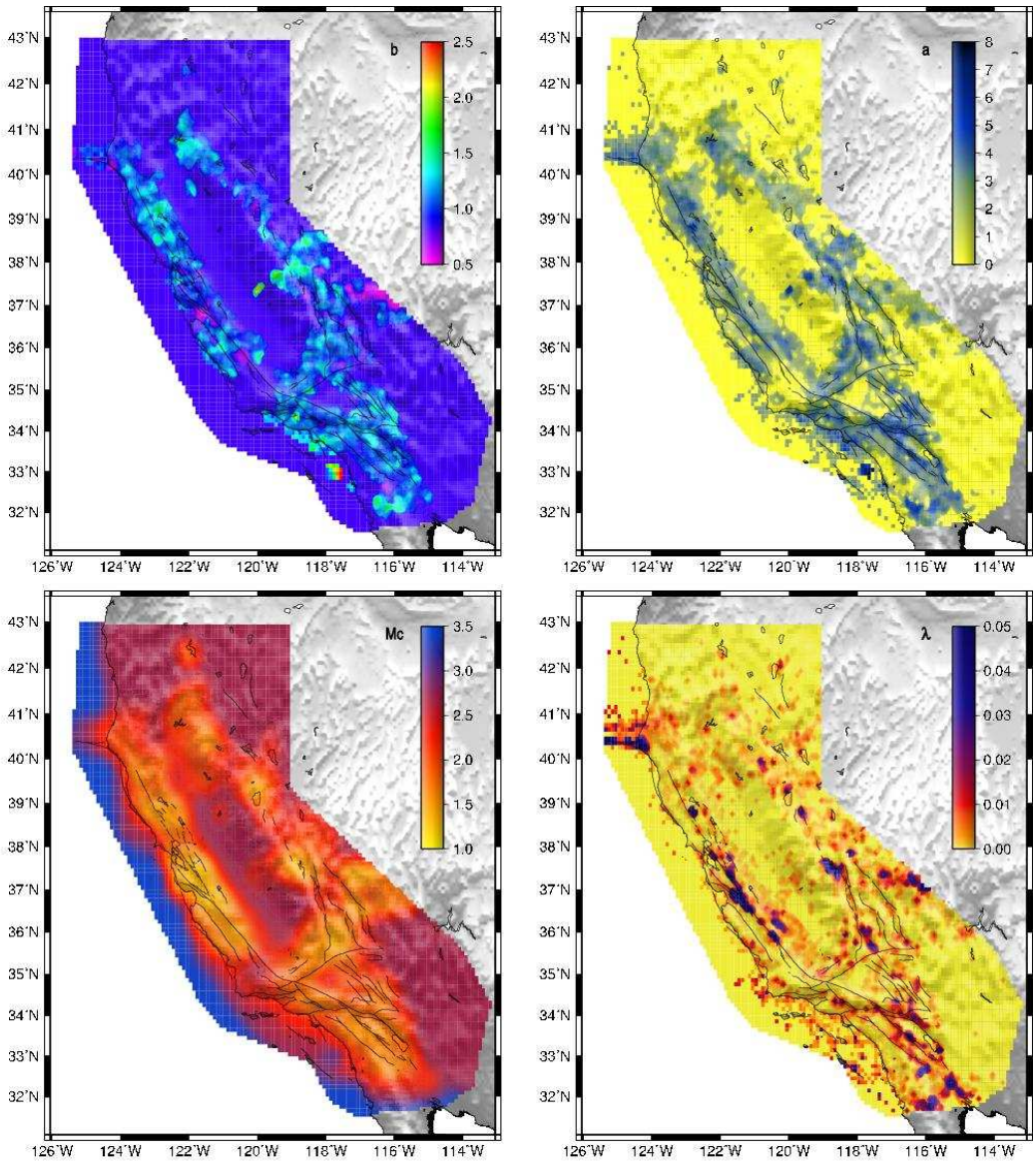

Figure 3: Maps of (top left) b-values, (top right) a-values, (bottom left) magnitude of completeness, M_c, and (bottom right) the forecast for $M \geq 5$ events of our model.