

## Increasing Testability, Expanding Possibilities. Some CSEP Future Developments

\*Danijel Schorlemmer<sup>1</sup>, Naoshi Hirata<sup>2</sup>, Fabrice Cotton<sup>1</sup>, Matt Gerstenberger<sup>3</sup>, Warner Marzocchi<sup>4</sup>, Maximilian Werner<sup>5</sup>, Stefan Wiemer<sup>6</sup>, Thomas Jordan<sup>7</sup>, Thomas Beutin<sup>1</sup>, David D Jackson<sup>8</sup>, Sum Mak<sup>1</sup>, Kazuyoshi Nanjo<sup>9</sup>, Yoshihiko Ogata<sup>10</sup>, David Rhoades<sup>3</sup>, Hiroshi Tsuruoka<sup>2</sup>, Jiancang Zhuang<sup>10</sup>

1. GFZ German Research Centre for Geosciences, Potsdam, Germany, 2. Earthquake Research Institute, University of Tokyo, Tokyo, Japan, 3. GNS Science, Lower Hutt, New Zealand, 4. Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy, 5. University of Bristol, Bristol, UK, 6. Swiss Seismological Service, ETH Zurich, Zurich, Switzerland, 7. University of Southern California, Los Angeles, USA, 8. University of California Los Angeles, Los Angeles, USA, 9. University of Shizuoka, Shizuoka, Japan, 10. Institute of Statistical Mathematics, Tachikawa. Japan

The Collaboratory for the Study of Earthquake Predictability (CSEP) has expanded over the years to many different testing areas hosted at multiple testing centers. Hundreds of earthquake forecast models have been submitted to CSEP and are being tested. New testing metrics were implemented and a lot of progress was made to establish CSEP as an institution that cannot be ignored when issuing earthquake forecasts. Its rigor and independence became the standard in evaluating earthquake forecasts and in reporting on the results.

In the framework of the testing activities of the Global Earthquake Model, one line of expanding the capabilities of CSEP was developed. The mechanisms that CSEP introduced to earthquake forecast models were applied to the area of intensity prediction equations (IPEs) and ground-motion prediction equations (GMPEs). First truly prospective tests were carried out on IPEs for Italy and also on GMPEs for Japan and New Zealand. These tests helped CSEP move into the hazard domain and increase the relevance of its results to the hazard community. Finally, first prospective test of the US national seismic hazard maps were conducted. Although these tests have been successful and well-received, they have also shown the limitations of the CSEP approach. Many aspects of seismic hazard or earthquake forecasting remain inherently untestable if only the model forecasts are tested and not the model ingredients.

We will continue along the lines of these developments and create new areas of activity for CSEP, namely targeted experiments that currently cannot be conducted with the current CSEP software system. This includes the predictive power of b-values, discrimination of foreshocks for short-term forecasting, as well as a deeper look into precursory phenomena applying CSEP-style rigorous testing. To further support model testing for hazard assessment, CSEP will introduce testing of models forecasting finite ruptures. During the next years, the CSEP system will be expanded to cover these new experiments and simultaneously simplified to increase accessibility for researchers to become an integral part of model development. As part of the EFEHR-EPOS ground-shaking models service, we will introduce permanent testing of IPEs and GMPEs to the testing center to establish strong performance records to be used in European hazard models. We support including testability in future hazard models or their components to move to better testable seismic hazard models. Finally, to expand into the risk domain, we will test exposure models against new and independent data.

We report on the achievements of CSEP over the past decade, the plans for future experiments, the directions of future development of CSEP, and the scientific challenges that CSEP addresses.

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