1st Annual Meeting of the Strategic Chinese-Korean-Japanese Cooperative Program

Harbin, 26-28 November 2011

The Global Earthquake Model: hazard component

Marco Pagani | Executive Committee, GEM Foundation

Presentation outline

This presentation provides:

- An introduction to what's GEM and what it does
- A description of GEM pillars:
  - Global Components
  - Model Facility
  - Regional Programmes

THE GLOBAL EARTHQUAKE MODEL (GEM)

"A collaborative effort devised and launched by OECD's Global Science Forum, aimed at **engaging the global community** in the design, development and deployment of uniform open standards and tools for earthquake risk assessment worldwide"

PUBLIC-PRIVATE PARTNERSHIP

13 countries have adhered so far

discussions and negotiations are ongoing with 15+ others

8 private organisations have partnered up with GEM so far

they contribute more than 13 M Euro

the OECD, World Bank, UNESCO, UN/ISDR, IAEE and IASPEI are associate participants

PUBLIC PARTICIPANTS


Australia


Belgium


Ecuador


Germany


Italy

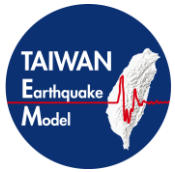

New Zealand


Norway


Singapore


Switzerland

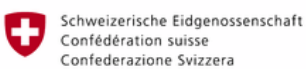

Turkey



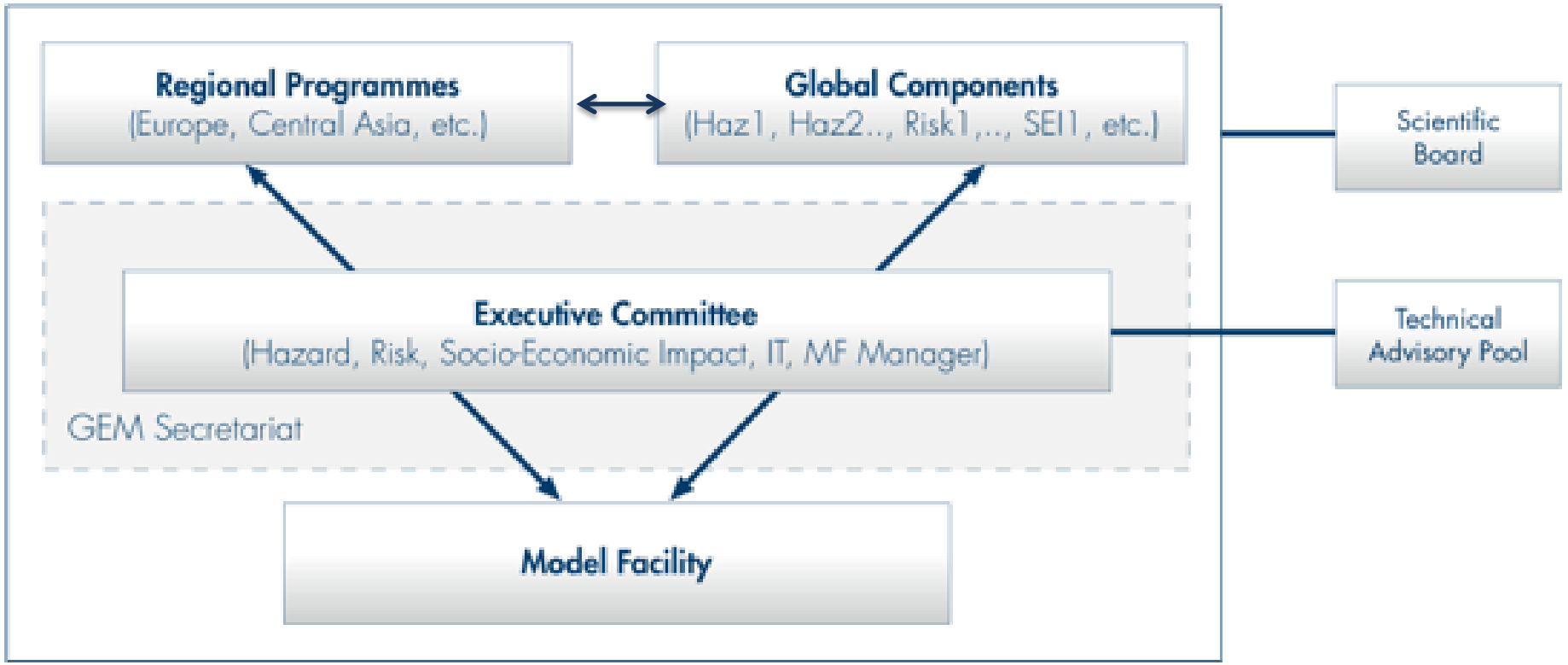
TEM


United Kingdom


United States



GEM MAIN COMPONENTS



GLOBAL COMPONENTS

Introduction

Global components are large projects involving numerous institutions around the world. Their main role is to define data models, create data bases/stores, prepare guidelines and shared methodologies for data acquisition and processing.

In hazard, each global component is dedicated to the creation of a specific data set to be used for PSHA input preparation or calculation:

- Faulted Earth
- Global Earthquake History
- Global Instrumental Catalogue
- Global Geodetic Strain Rate
- Global Ground Motion Prediction Equation

Further information available at:

http://www.globalquakemodel.org/global-components

Global Active Fault and Seismic Source Database

Main products:

An active fault DB resulting from a comprehensive review of DBs available worldwide (e.g. USGS, DISS Italy, AIST RIO Japan, Database of Quaternary Deformation for Andean Countries, GNS Active Fault DB, Taiwan active faults DB)

The new database contains two fundamental layers:

- An active fault layer with site data – primarily the field observational data
- A seismic source layer containing parameters required for PSHA

The fault source layer is considered an initial “strawman” for creating sources in the hazard engine - to be improved via integration and collaboration with other GEM (database) projects.

HAZARD GLOBAL COMPONENTS

Global Earthquake History

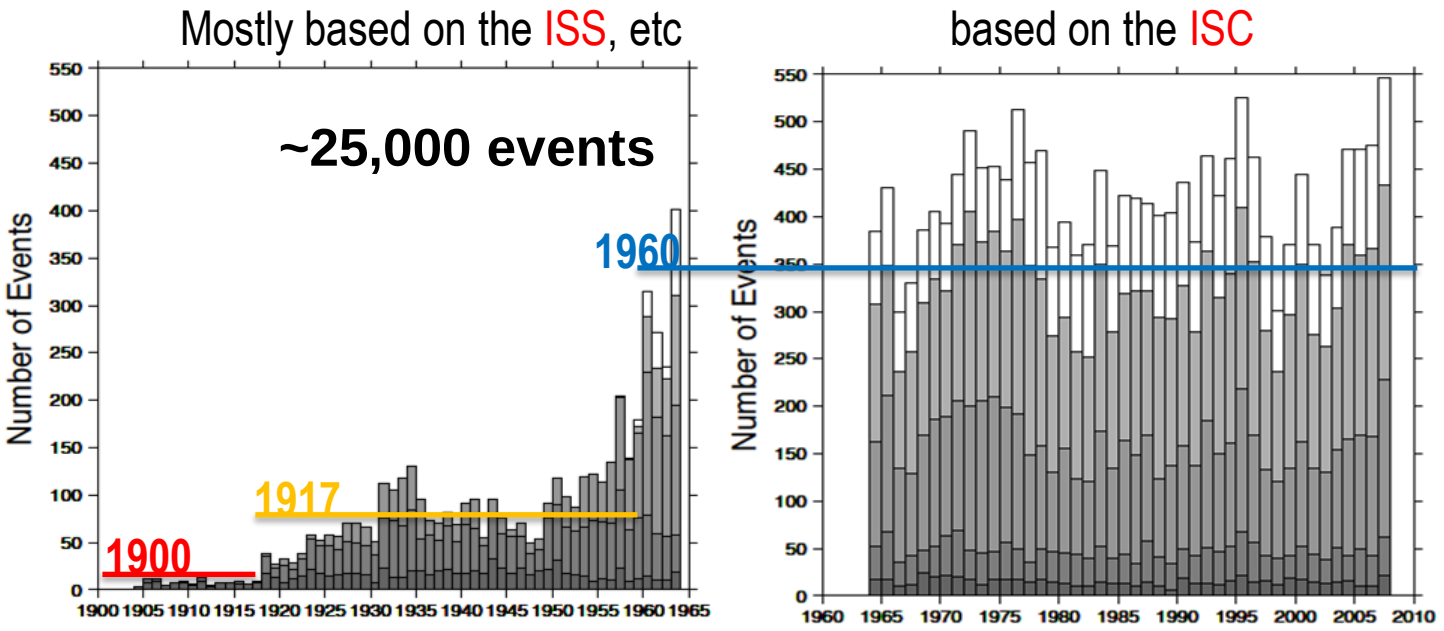
Main products:

- A distributed, online resource, called “Global Archive of Historical Earthquake Studies”, where both reports and macroseismic data points can be uploaded, organized and made available to public (a framework for future development, so that the Global Earthquake History can be updated as new results become available).
- Supplying GEM with the best global parametric earthquake catalogue (covering the period 1000-1900 and M_W>7) compiled from current resources and providing, as far as possible, a link to the background information
- Complementing the catalogue entries with comments and, when possible, with earthquake parameters re-assessed from intensity data points and from historical evidence of length of rupture

Global Instrumental Seismicity Catalogue

Main products:

- A reference Global Instrumental Earthquake Catalogue (1900-2009) for characterization of the spatial distribution of seismicity, the magnitude frequency relation and the maximum magnitude.



Bars (lightest to darkest) indicate the number of events with Mw ≥ 5.5, 5.7, 6.0, 6.5, 7.0

Global Instrumental Seismicity Catalogue

Main products (contd):

Selection windows:

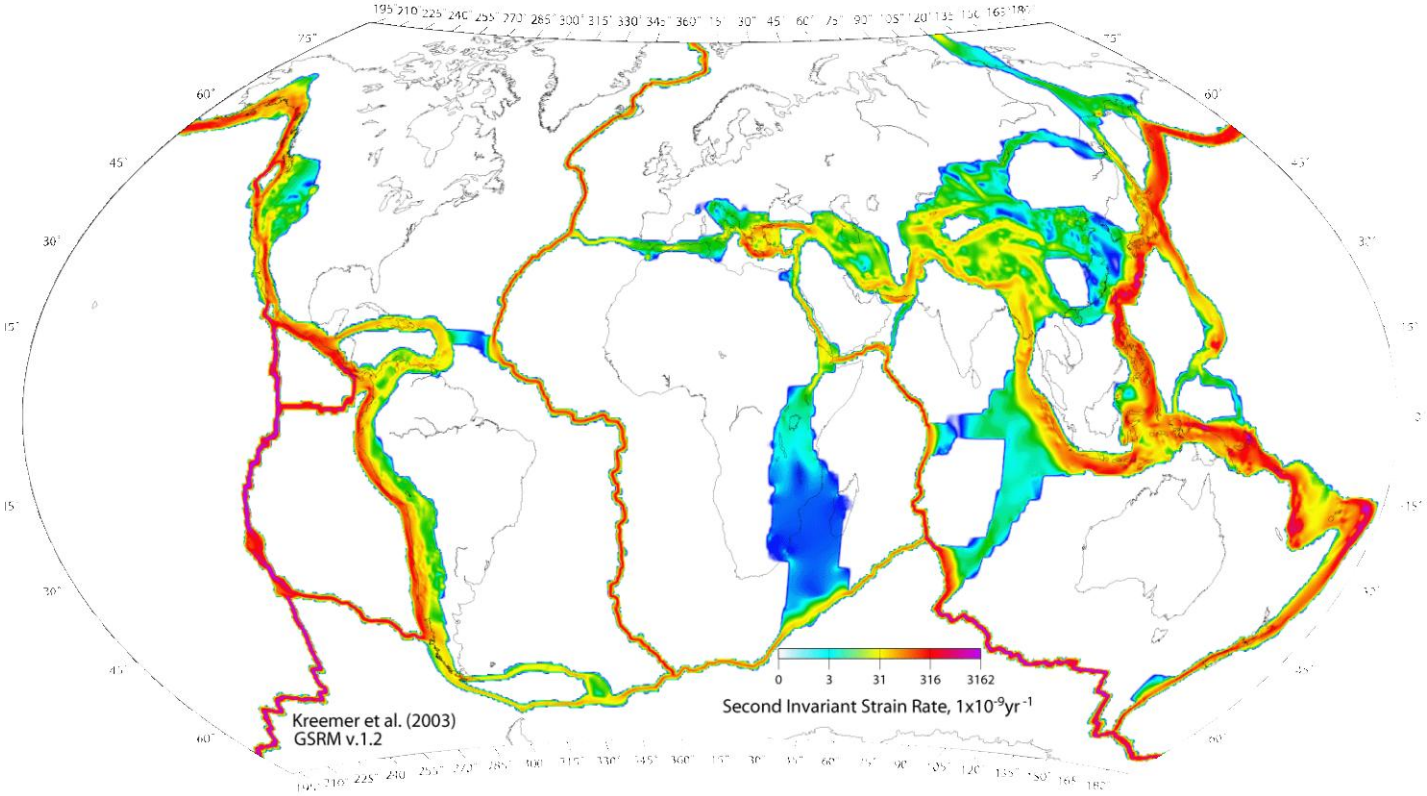
- 1900-1917: $M_S \geq 7.5$ worldwide + smaller shallow events in stable continental areas
- 1918-1959: $M_S \geq 6.25$
- 1960-2009: $M_S \geq 5.5$

HAZARD GLOBAL COMPONENTS

Global Geodetic Strain Rate Model

Main products:

- A high-resolution stain rate model for the entire globe
- GPS velocity field uploading tool



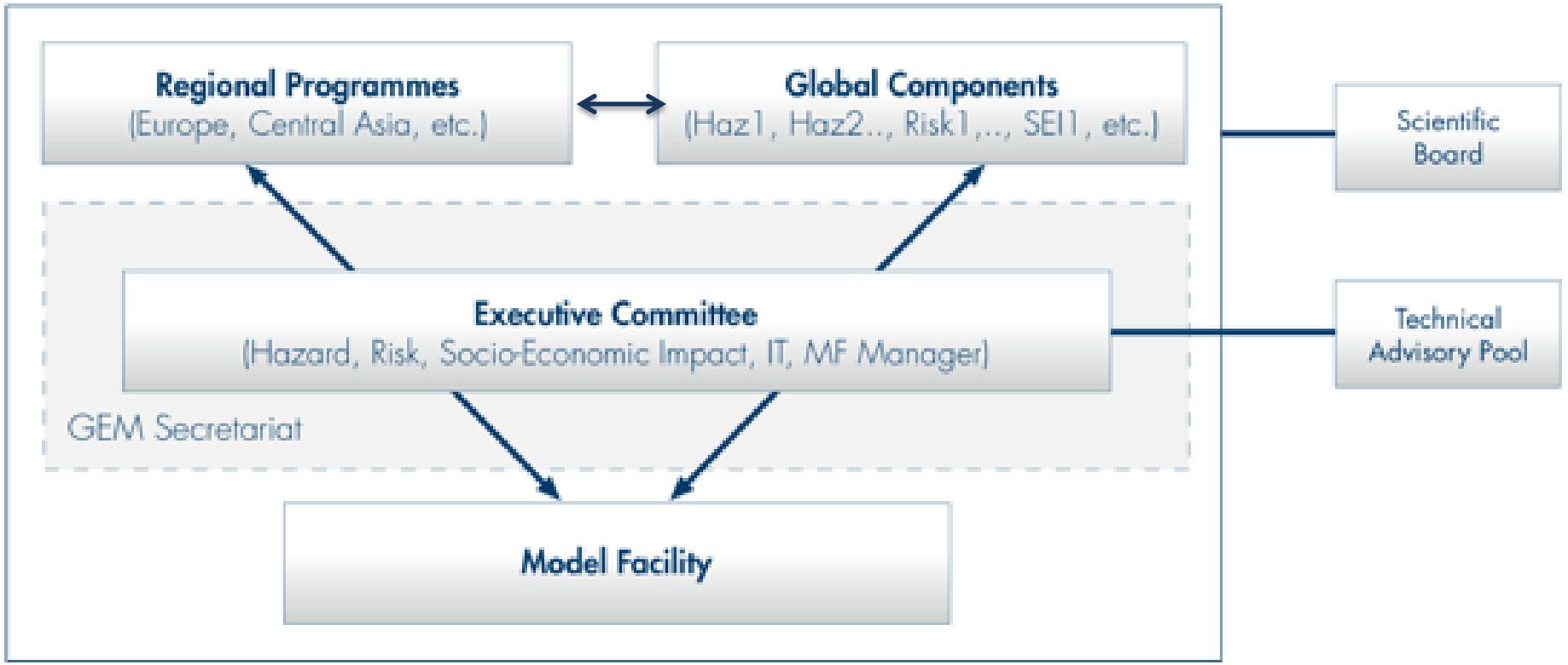
HAZARD GLOBAL COMPONENTS

Global GMPEs

Main products/tasks:

- Consistency in model and ground motion parameters
- Consistency in site conditions parameters
- Compile and overview large sets of GMPEs
- Select or derive sets of GMPEs per tectonic region
- Inclusion of near fault effects
- Database of recorded waveforms
- Design the Specifications to Compile a Global Database of Soil Classification

GEM MAIN COMPONENTS



Main/distinctive properties

- **An Open-Source community effort**
  - Transparency
  - Community participation to the development
  - Largely used/adopted
  - State-of-the-art

  The Code is publicly accessible on a public repository (still a development version) http://www.github.com/gem

  The hazard component of OpenQuake is developed starting from a lite version of OpenSHA http://opensha.org

  
- Extensively tested
  - At a class/module level
  - With smoke tests e.g. PEER Test, Tests on the risk component (currently only some PEER tests)
- Documented
  - For developers
    http://openquake.globalquakemodel.org/docs/
  - For users
    https://github.com/gem/openquake-book
- Flexible and scalable architecture
- Innovative

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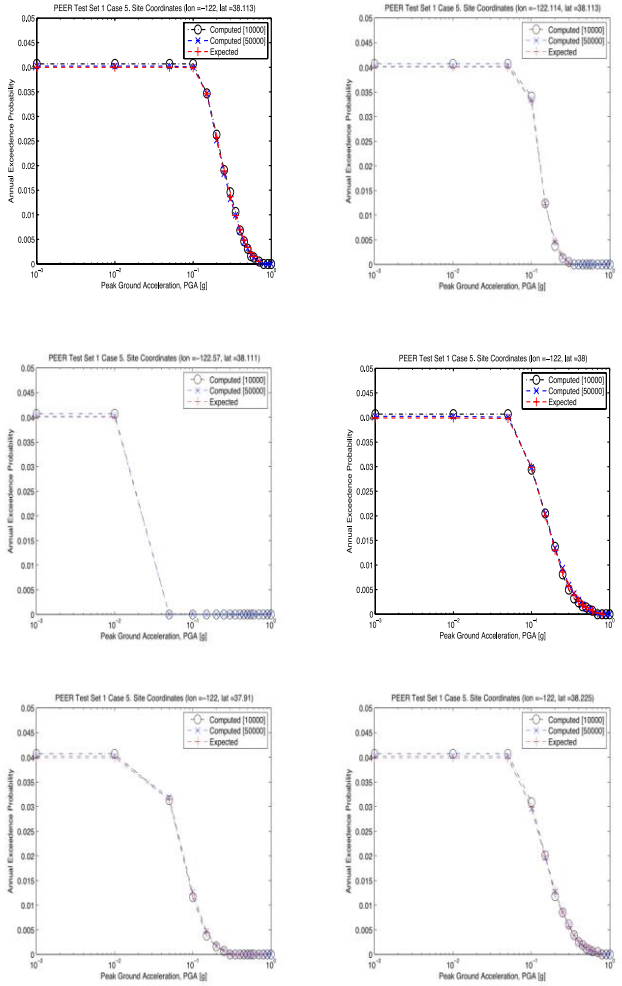

OPENQUAKE

Main/distinctive properties

- An Open-Source community effort
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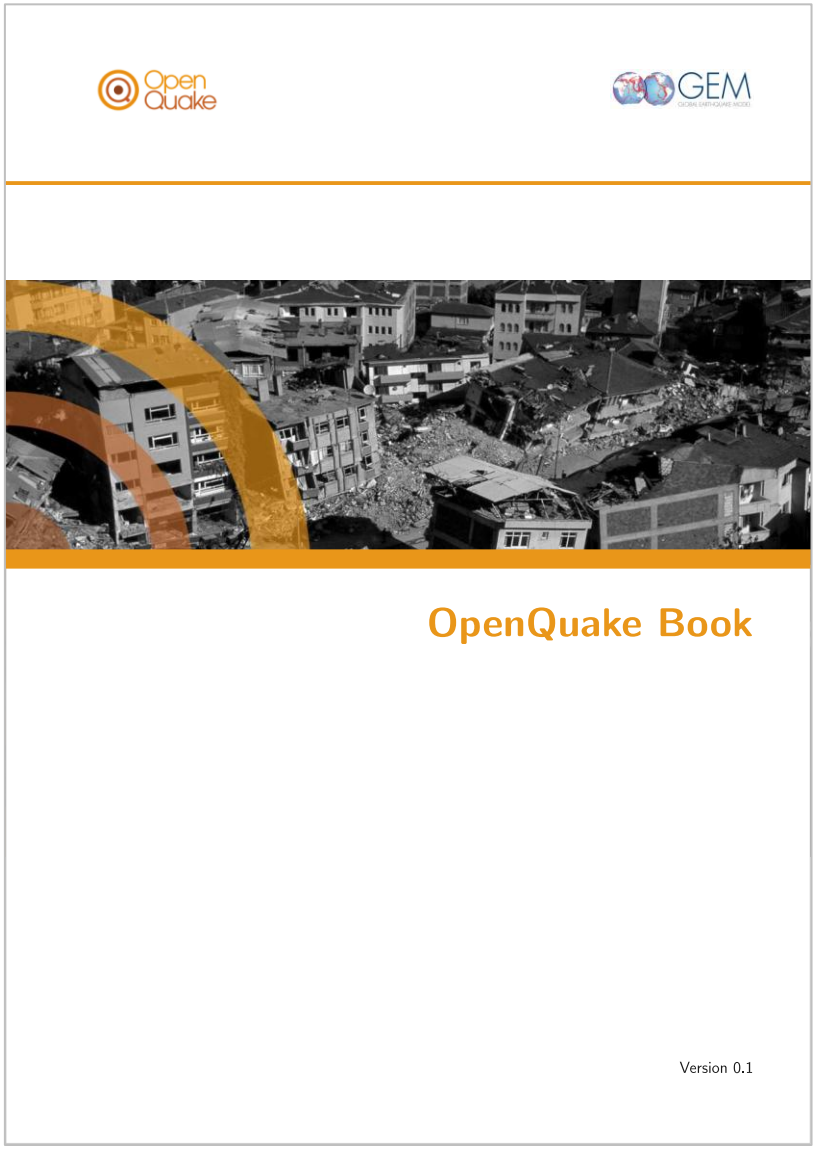

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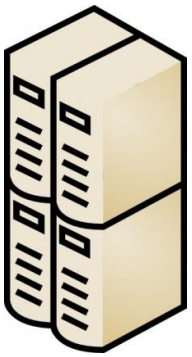
- Innovative

On your own laptop



On your cluster

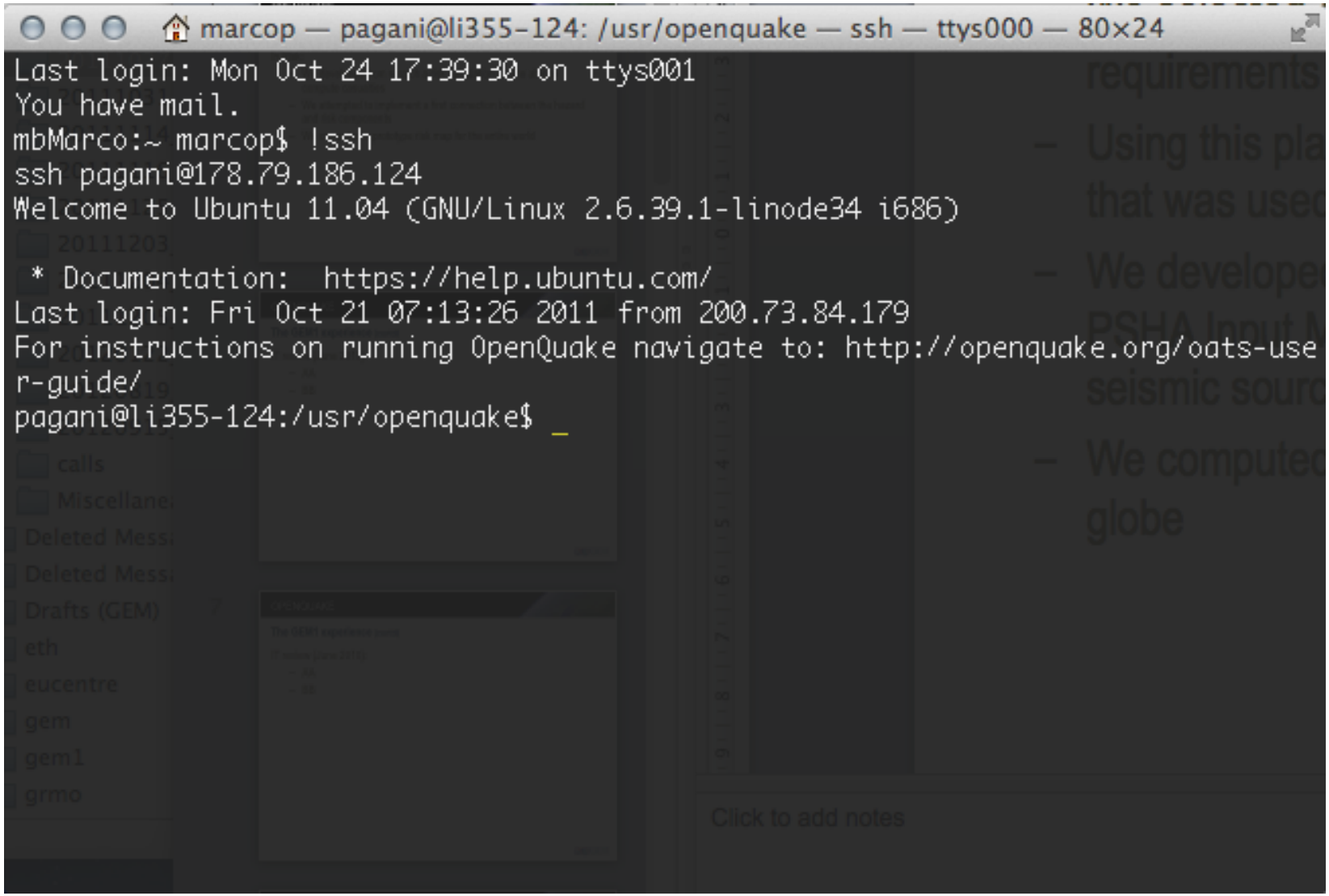
On clouds accessible through the OpenGEM portal

Main/distinctive properties

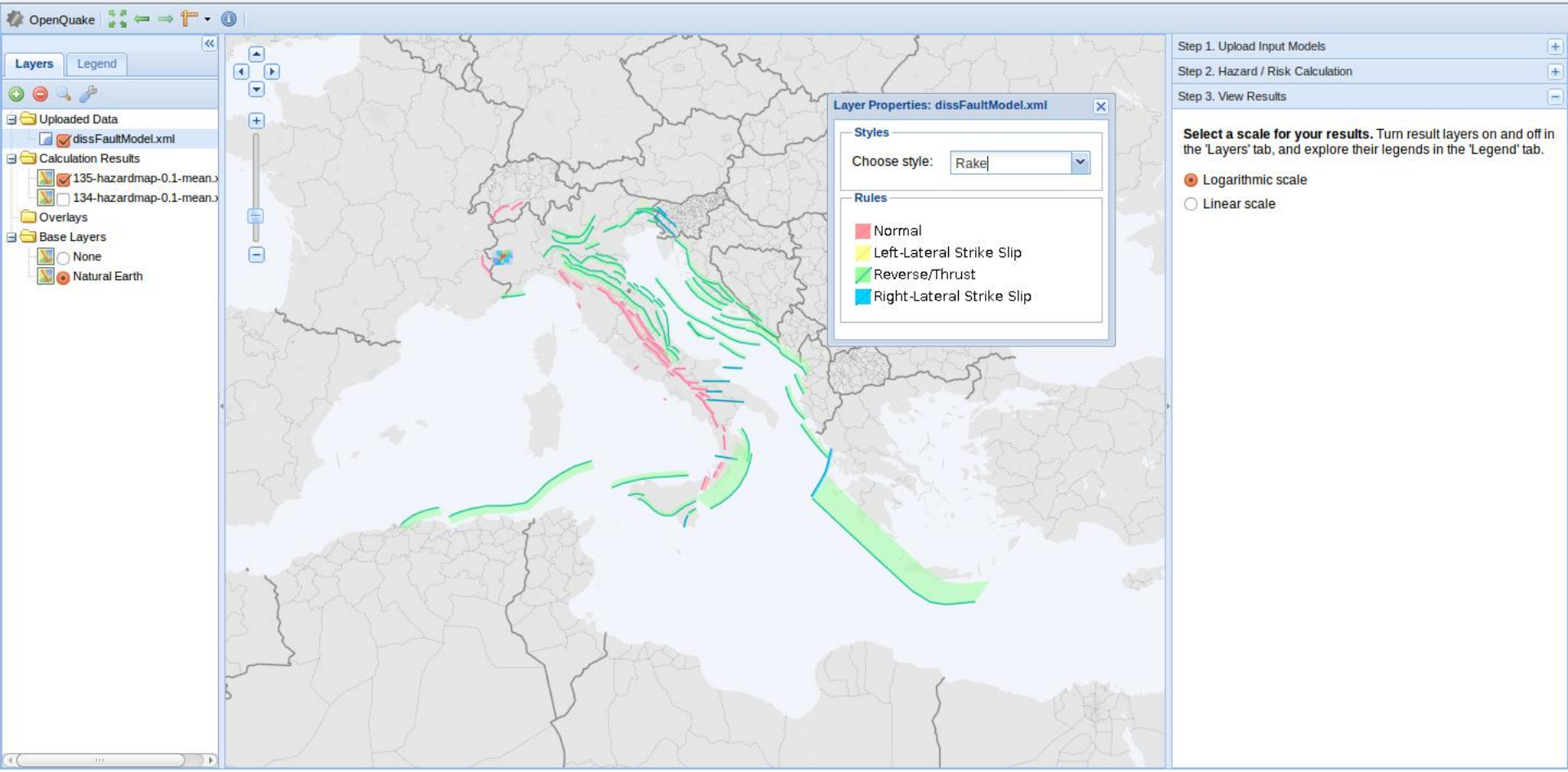
- An Open-Source community effort
- Extensively tested
  - At a class/module level
  - With smoke tests e.g. PEER Test, Tests on the risk component (currently only some PEER tests)
- Documented
  - For developers
    http://openquake.globalquakemodel.org/docs/
  - For users
    https://github.com/gem/openquake-book
- Flexible and scalable architecture
- **Innovative**

- Tight connection with the Modellers' Toolkit
- Extensive test coverage of code and input model
- Capable to flexibly manage whatever logic tree structure
- Adaptable: in GEM1 we modelled hazard using about 15 models around the world
- Offers hazard-risk calculation workflows supporting three methodologies
- The calculation demand implied by OQ is supported by a robust IT infrastructure

OPENQUAKE

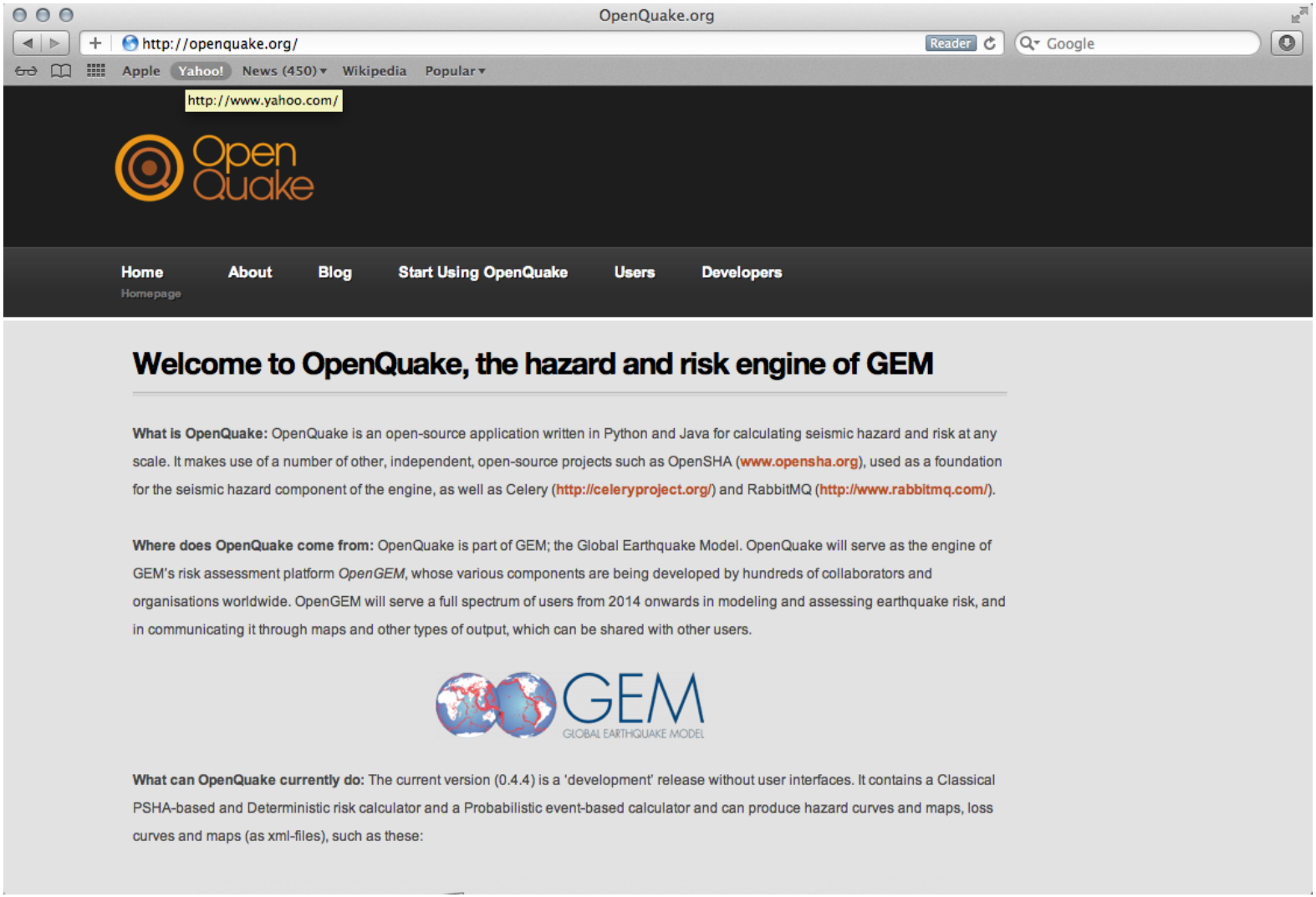

marcop — pagani@li355-124: /usr/openquake — ssh — ttys000 — 80×24
Last login: Mon Oct 24 17:39:30 on ttys001
You have mail.
mbMarco:~ marcop$!ssh
ssh pagani@178.79.186.124
Welcome to Ubuntu 11.04 (GNU/Linux 2.6.39.1-linode34 i686)
* Documentation: https://help.ubuntu.com/
Last login: Fri Oct 21 07:13:26 2011 from 200.73.84.179
For instructions on running OpenQuake navigate to: http://openquake.org/oats-user-guide/
pagani@li355-124:/usr/openquake$ _

Prototype GUI

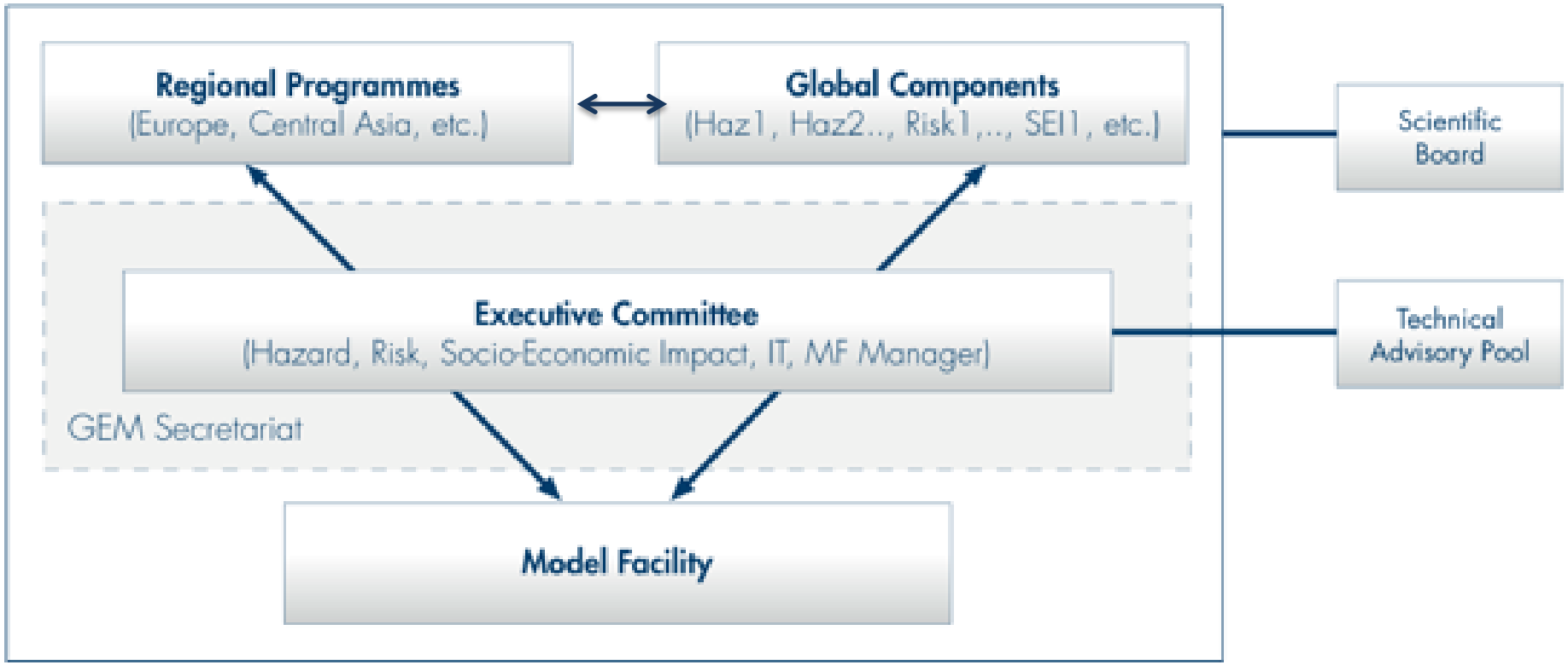


OPENQUAKE

Users, collaborations, contributions



GEM MAIN COMPONENTS



REGIONAL PROGRAMMES

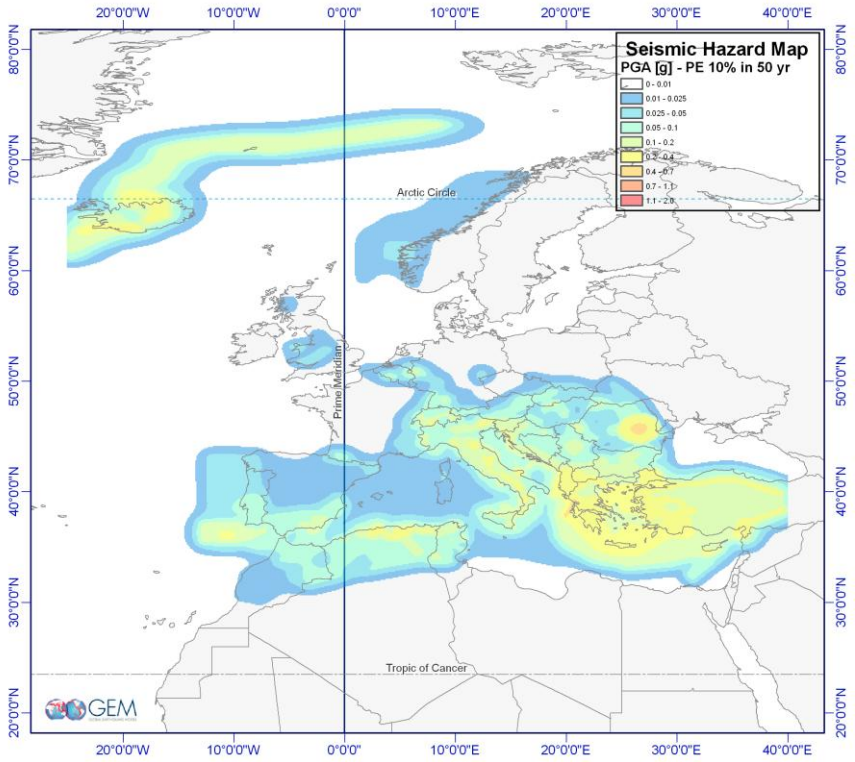
Introduction

- Role
  - RPs are independently founded and managed projects (although a strong interaction with the GEM Model Facility and GCs is welcome and sought)
  - Regional programs have a fundamental role in the GEM framework
    - Work with GCs on creating dataset and standards
    - Collaboratively work with the GEM MF and the ad-hoc working group on producing consensual methodologies for PSHA calculation
- Currently Active (Hazard) Programmes:
  - SHARE (Europe)
  - EMME (Middle East)
  - EMCA (Central Asia)
  - Caribbean
  - North Africa

SHARE - Europe

The first Regional Programme started in GEM. There's a continuous collaboration between the GEM MF and SHARE group.

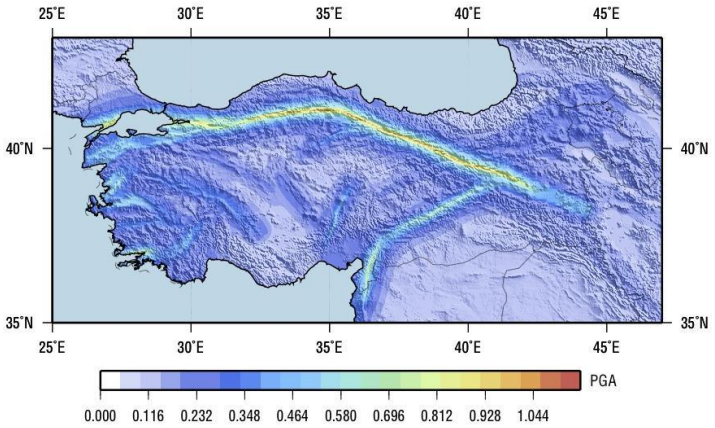
- SHARE is using OpenQuake to compute hazard
- SHARE developed a prototype of the MTK



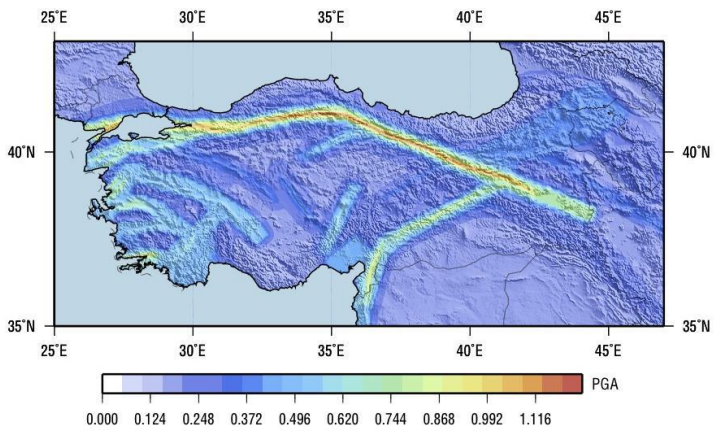
EMME – Middle East

Hazard and Risk calculation on a test area (Turkey and the Marmara Area)

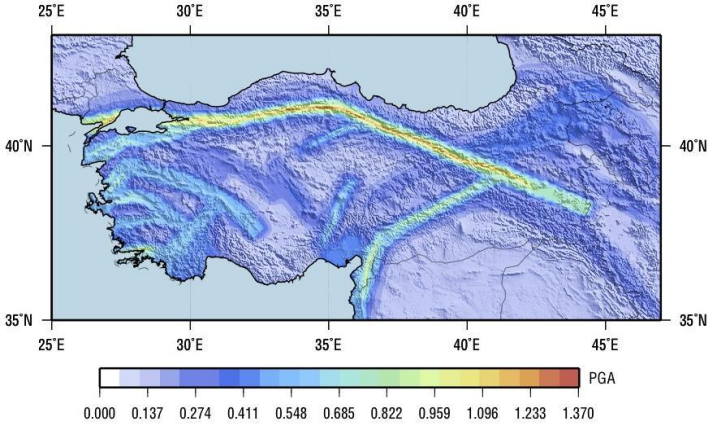
Boore and Atkinson 2008



Campbell and Bozorgnia 2008



Chiou and Youngs 2008



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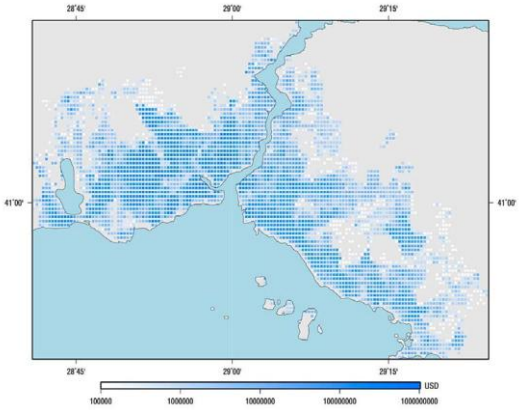


Figure 15 - Distribution of the value of RC frame buildings in the metropolitan area of Istanbul.

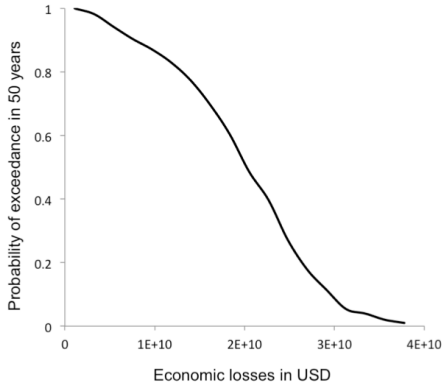


Figure 21 - Aggregate loss exceedance curve for RC buildings in Istanbul.

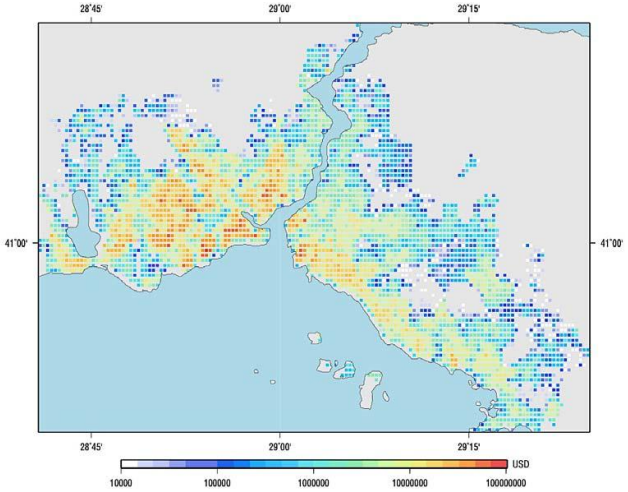


Figure 20 - Loss map with the distribution of mean economic losses for reinforced concrete buildings.

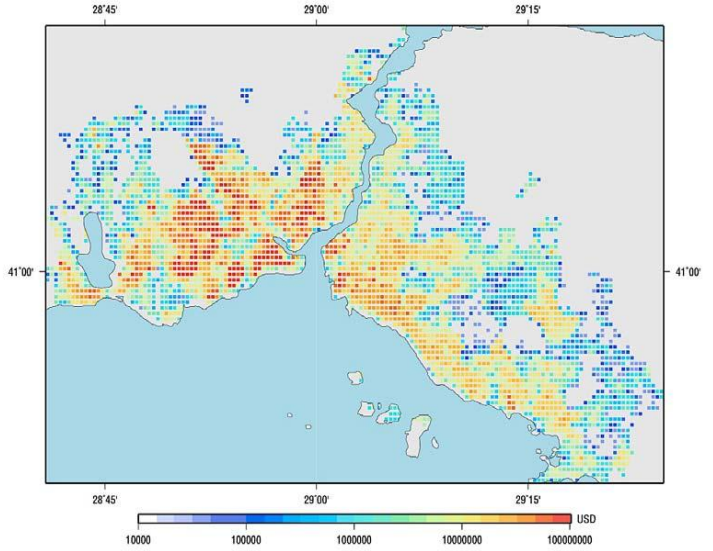
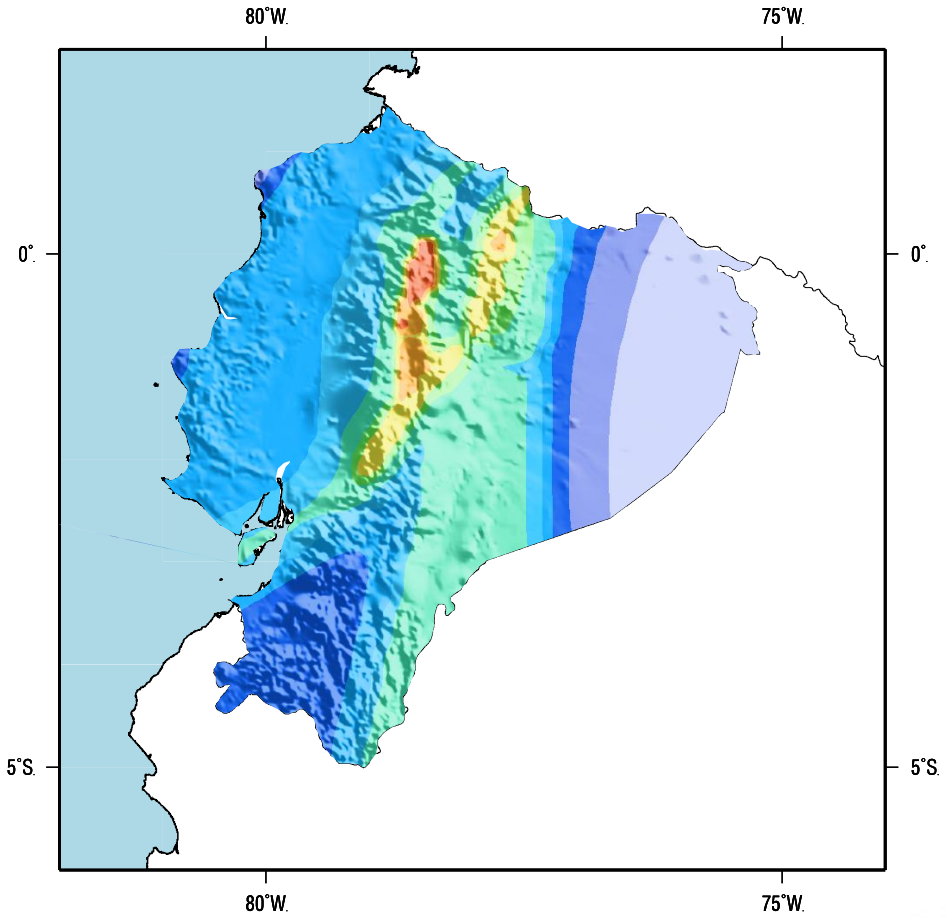


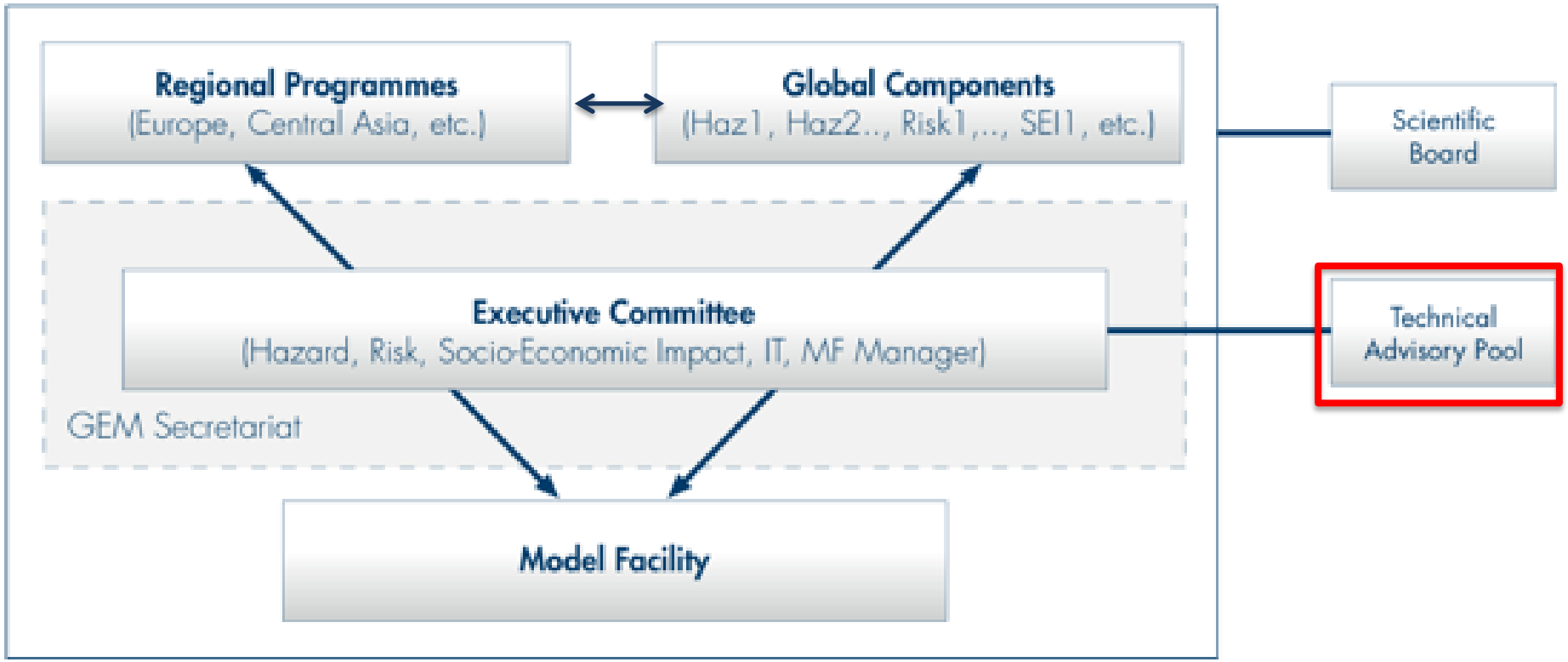
Figure 22 - Loss map for a probability of exceedance of 10% in 50 years.

ECUADOR

Calculation of national seismic hazard maps (a collaboration with Instituto Geofísico EPN, IRD France)



GEM MAIN COMPONENTS



TAP WG on Hazard Integration and Assembling

A group aimed at interacting with the RPs so as to create consensual and homogenised guidelines for PSHA input model preparation and calculation.

Members:

- Mark Stirling – GNS Science, NZ (Chair)
- John Adams – Canada Geological Survey, Canada
- Ned Field and Mark Petersen – USGS, USA
- Laura Peruzza – INOGS, Italy
- Oona Scotti – IRSN, France

TAP WG on Tectonic Regionalisation

A group aimed at defining an objective methodology for the classification of the globe into tectonic regions. This methodology will guide the use of the most appropriate set of GMPEs depending on the tectonic context.

Members:

- John Douglas – BRGM, FR (Chair)
- Fabrice Cotton – ISTerre, FR (Chair)
- Nicola Litchfield – GNS Science, NZ (Chair)
- Kelvin Berryman – GNS Science, NZ (Chair)
- Daniel Garcia – USGS, USA
- Paul Sommerville – URS Corp., USA
- Corné Kreemer – Univ. Nevada, USA
- Willie Lee – USGS, USA
- Roberto Basili – INGV, IT