US-Japan Collaboration on Strong Ground Motion Prediction Techniques

GMSV TAG Meeting

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3 April 2013

Participants

Japan (Kyoto University, funding from MEXT)

- Hiroshi Kawase
- Tomotaka Iwata
- Shinichi Matsushima

California (URS, funding from SCEC/ PG&E)

- Paul Somerville
- Jeff Bayless
- Andreas Skarlatoudis

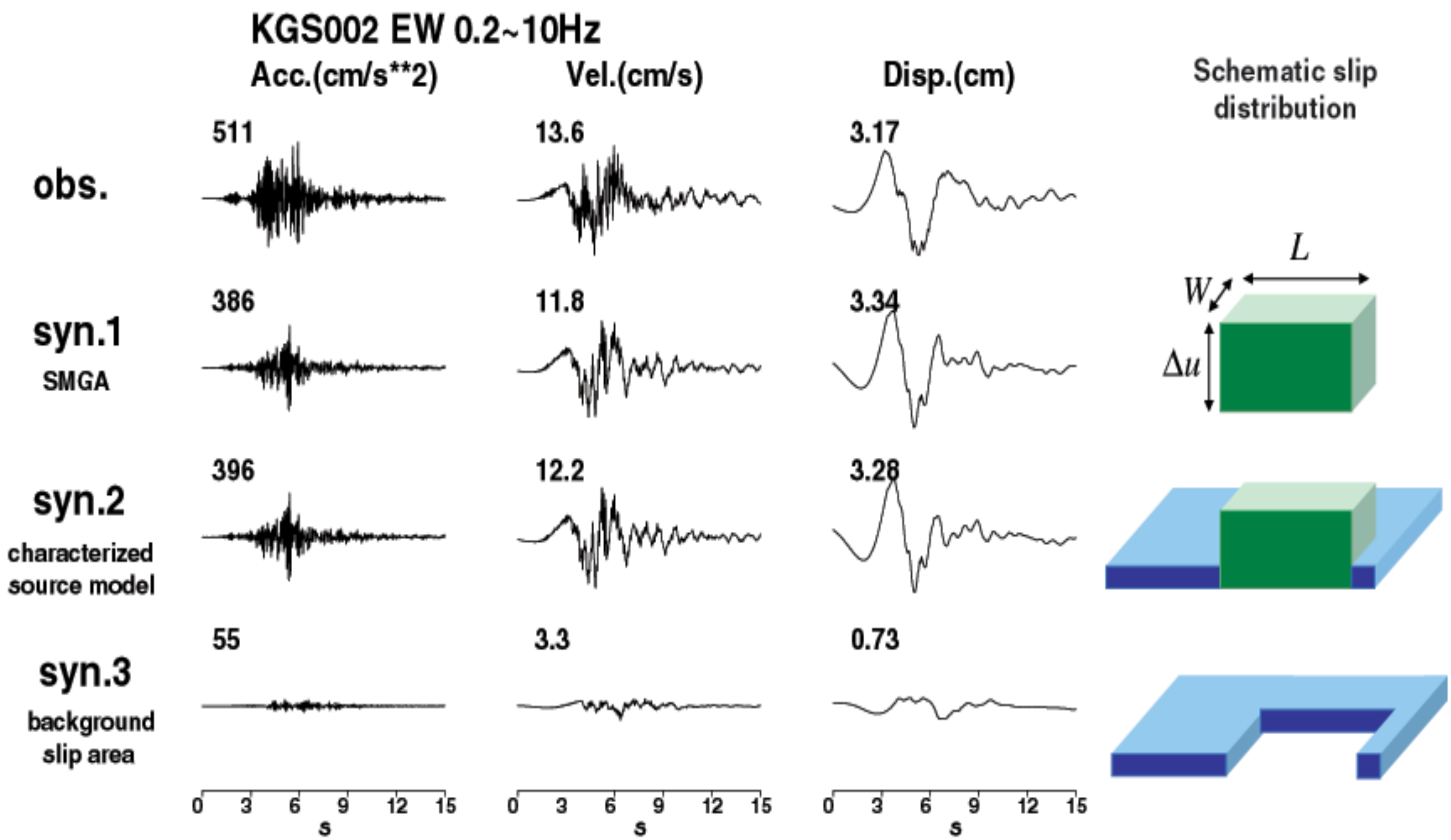
Comparison of Methods

JAPAN

- Irikura Recipe – deterministic asperity model
- Stochastic Green's functions

CALIFORNIA

- Graves-Pitarka stochastic rupture model (SRF file)
- Hybrid wave propagation



Miyake et al. (2003)

Outer Fault Parameters

- **Rupture area S** is given.
- **Seismic moment Mo** from the empirical relation of **Mo-S**.
- **Average static stress-drop** $\Delta\sigma_c$ from appropriate physical model (e.g., circular crack model, tectonic loading model, etc.)

Inner Fault Parameters

- **Combined area of asperities Sa** from the empirical relations of **S-Sa** or **Mo-Ao**.
- **Stress drop** on asperities $\Delta\sigma_a$ based on the multiple asperity model.
- **Number** of asperities from fault segments.
- **Average slip** of asperities **Da** from **dynamic simulations**.
- **Effective stress** for asperities σ_a and background area σ_b are given.
- **Slip velocity time function** given as Kostrov-like function.

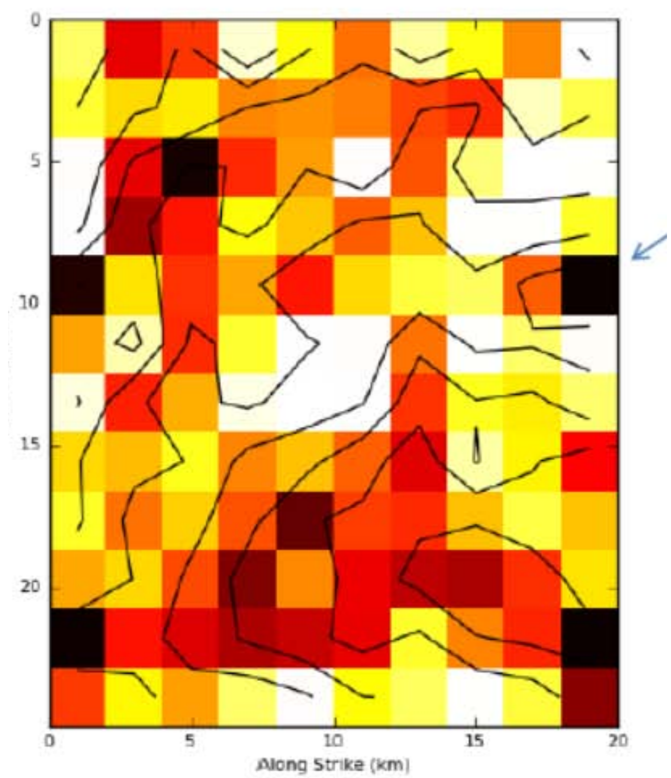
Extra Fault Parameters

- Rupture nucleation and termination are related to **fault geometry**.

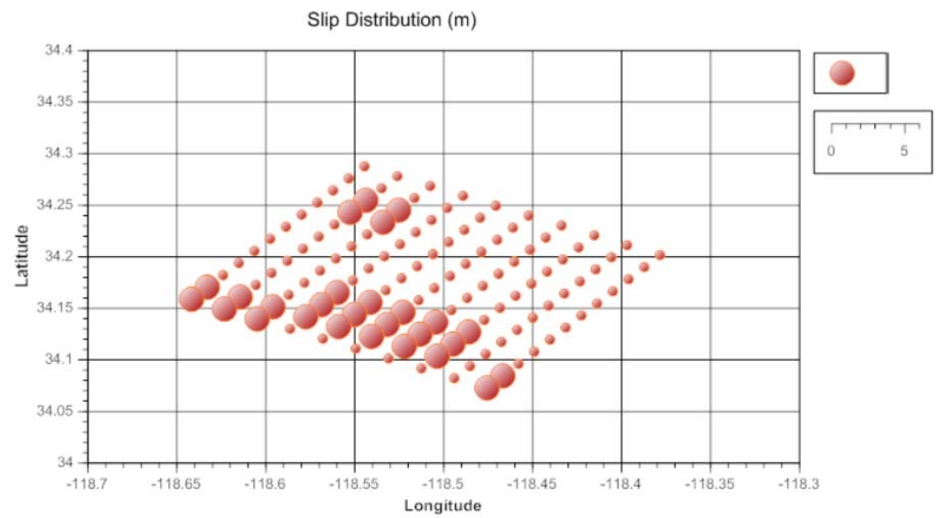
Irikura and Miyake (2001, 2011)

Example - Northridge

SRF Input

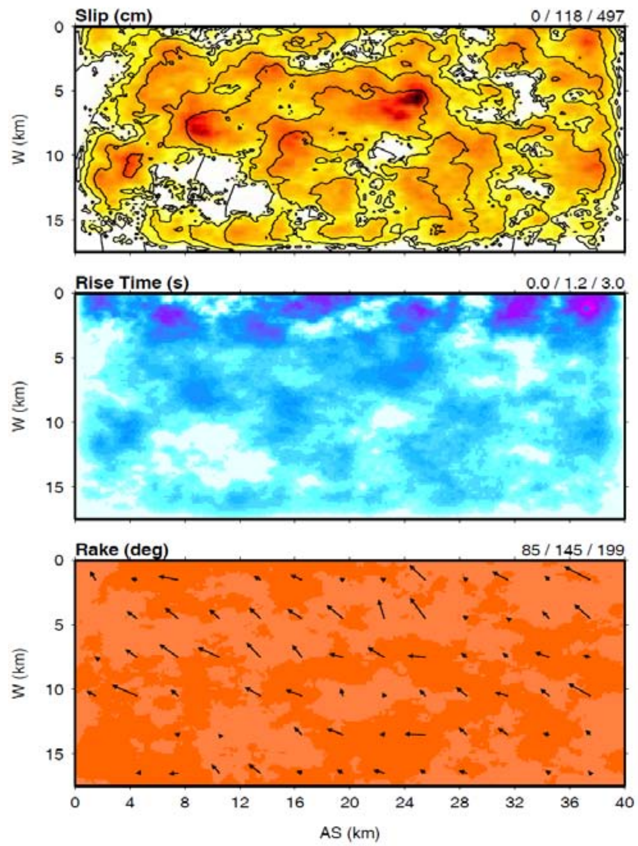


Irikura Asperity Output

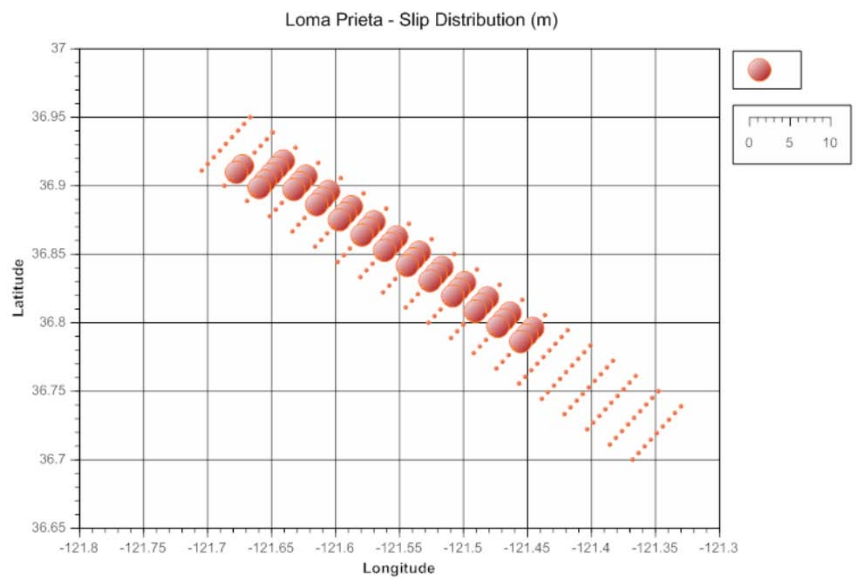


Example – Loma Prieta

SRF Input (Graves & Pitarka)



Irikura Recipe Output



Project Phases

- Method Validation Phase

- Forward Simulation Phase, with Validation against data-based GMPE's

Motivation – Method Validation Phase

- Japanese and California investigators use very different source characterization in strong motion simulations
- Differences in source characterization are thought to be the main causes of differences in ground motion simulations performed using different simulation methods, even within California
- Gain a better understanding of the impact of different source characterization methods on ground motion simulations when there is guidance provided by a historical scenario event

Approach – Method Validation Phase

- Choose two events – Northridge and Fukuoka
- Exchange source models
- Perform simulations using our side's codes with the other side's source model

Source Characterization using Exchanged Source Parameters

Japan Approach

- Use Somerville et al. 1999 asperity picker code to convert Graves & Pitarka SRF file to Irikura asperity model

California Approach

- Convert Irikura asperity model to SRF file
- Also convert Irikura asperity model to NIED Version of the Irikura asperity model

Computational Platforms

Japan

- Various
- SCEC Broadband Strong Motion Simulation Platform is available

California

- SCEC Broadband Strong Motion Simulation Platform

Motivation – Forward Simulation Phase

- Find out how different simulated ground motions are using the Japan and California methods when there is no guidance provided by a historical scenario event
- Find out how well each side's simulations agree with strong motion recordings in their country

Approach – Forward Simulation Phase

- Perform a limited set of forward simulations of future scenario events
- Use a simple regression model to derive simple GMPE's, and compare results
- Perform the same regressions on separate sets of strong motion recordings from Japan and California
- Compare Japan and California GMPE's from both simulations and data

Forward Simulation Events

Mw	Mech	Dip	Depth to Top
6.2*	**SS**	**90**	**4**
6.6*	**RV**	**45**	**3**
6.6*	**SS**	**90**	**0**
7.0	SS	80	0
7.5	SS	80	0
7.5	RV	45	0
8.0	SS	80	0

*Scenarios for SWUS GMPE Comparison

Issues in Data-Based GMPE Comparison

- Selection of consistent magnitude and distance ranges
- Differences in typical Vs profiles between Japan and California cause profiles with the same Vs30 value to have different amplification effects
- Japanese prefer other methods of site characterization, e.g. site period