Strong motion simulation for Osaka plain based on active fault surveys

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Contents

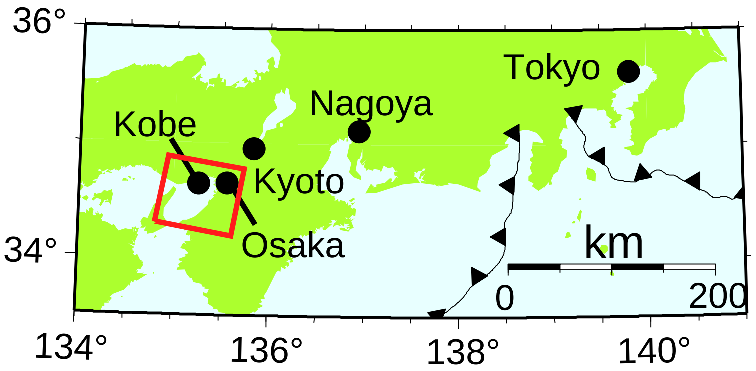
> Evaluate ground motion in Osaka area from a <u>future earthquake</u> with a <u>deterministic approach</u>

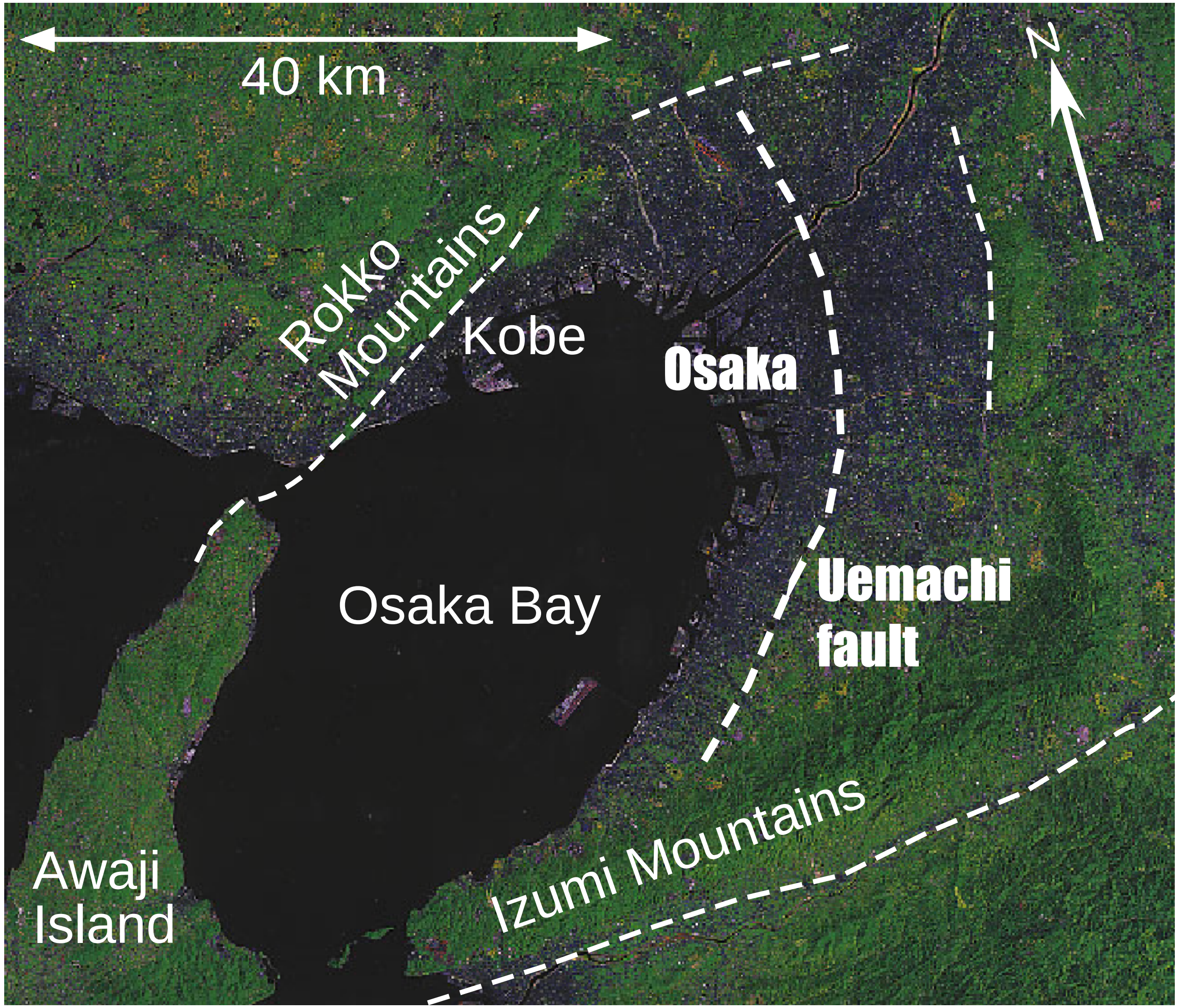
> Consider possible rupture scenarios based on <u>spontaneous rupture model</u> and geological information

> Compare ground motions from different velocity structures

> Discuss the derived peak amplitudes

Where is Osaka?



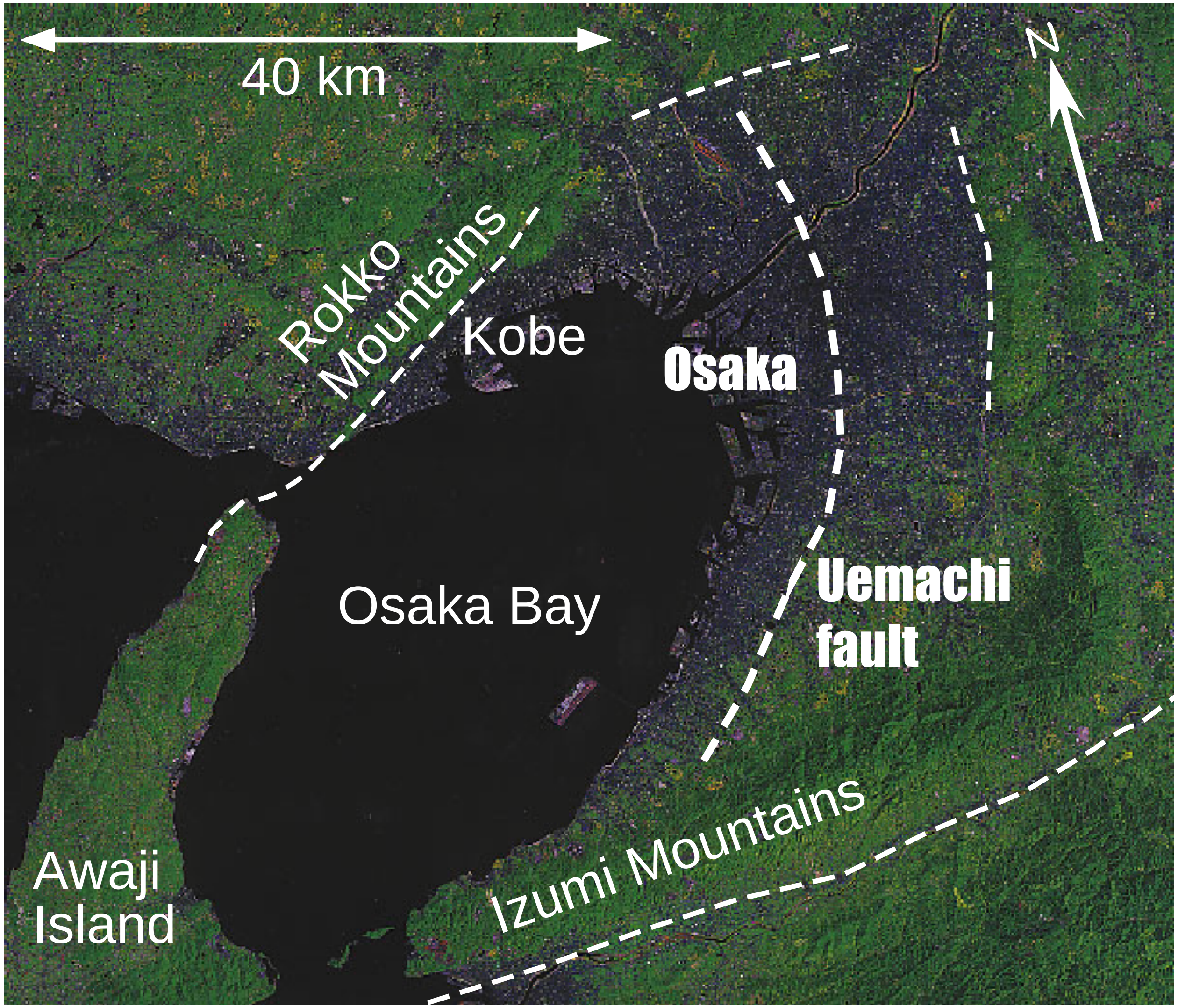


Motivation: Why Osaka?

• Several active faults beneath/close to a urbanized and industrial region

Population of Osaka Prefecture:
> 8.8 million

Gross Product of Osaka Prefecture:
> 3.9 billion yen (US$ 33 million)



Methodology of Ground Motion Estimation

Earthquake Scenario

- spontaneous rupture models
- conditions
  - > fault model
    (e.g., segmentation, strike, dip, length, width)
  - > tectonic stress field
    depth-dependent but laterally homogeneous
  - > frictional constitutive law
    slip-dependent friction law
    (parameters: μs, μd, Dc)
  - > distribution of constitutive parameters
    uniform

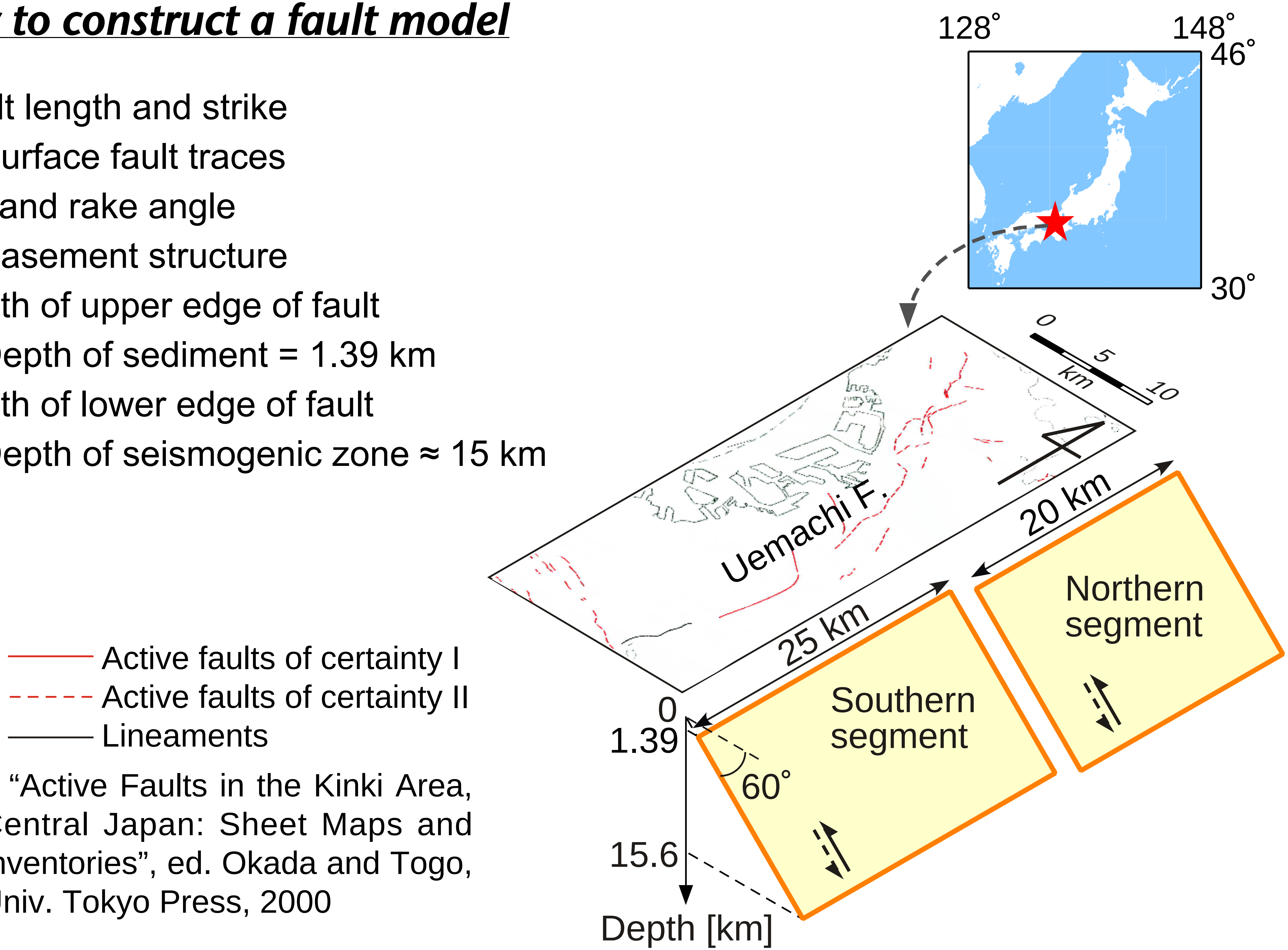
geological information

Calculation of Wave Propagation

Synthetic Ground Motions

How to construct a fault model

- Fault length and strike
  - Surface fault traces
- Dip and rake angle
  - Basement structure
- Depth of upper edge of fault
  - Depth of sediment = 1.39 km
- Depth of lower edge of fault
  - Depth of seismogenic zone ≈ 15 km



After “Active Faults in the Kinki Area, Central Japan: Sheet Maps and Inventories”, ed. Okada and Togo, Univ. Tokyo Press, 2000

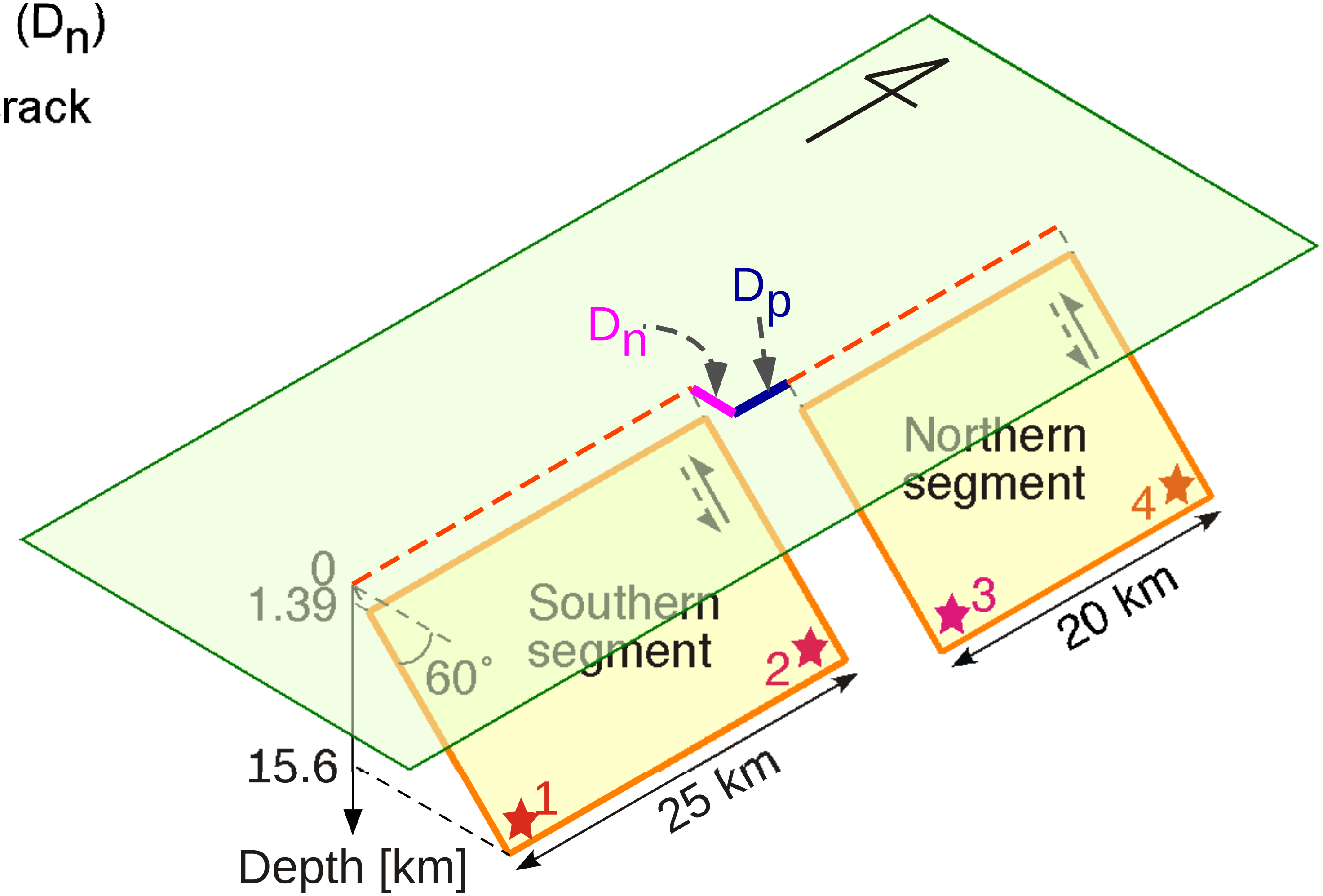
How to construct a fault model

- Fault-parallel distance (D_p)

  Fault-normal distance (D_n)

  Location of an initial crack

    Parameter studies



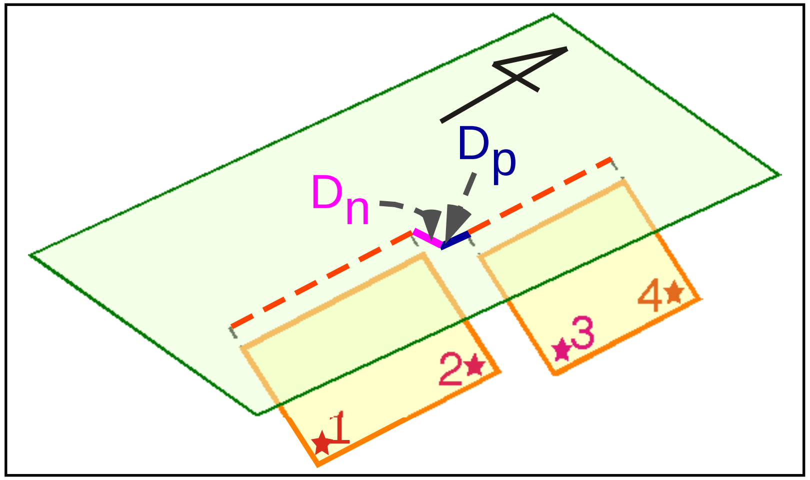
Do ruptures propagate across the jog?

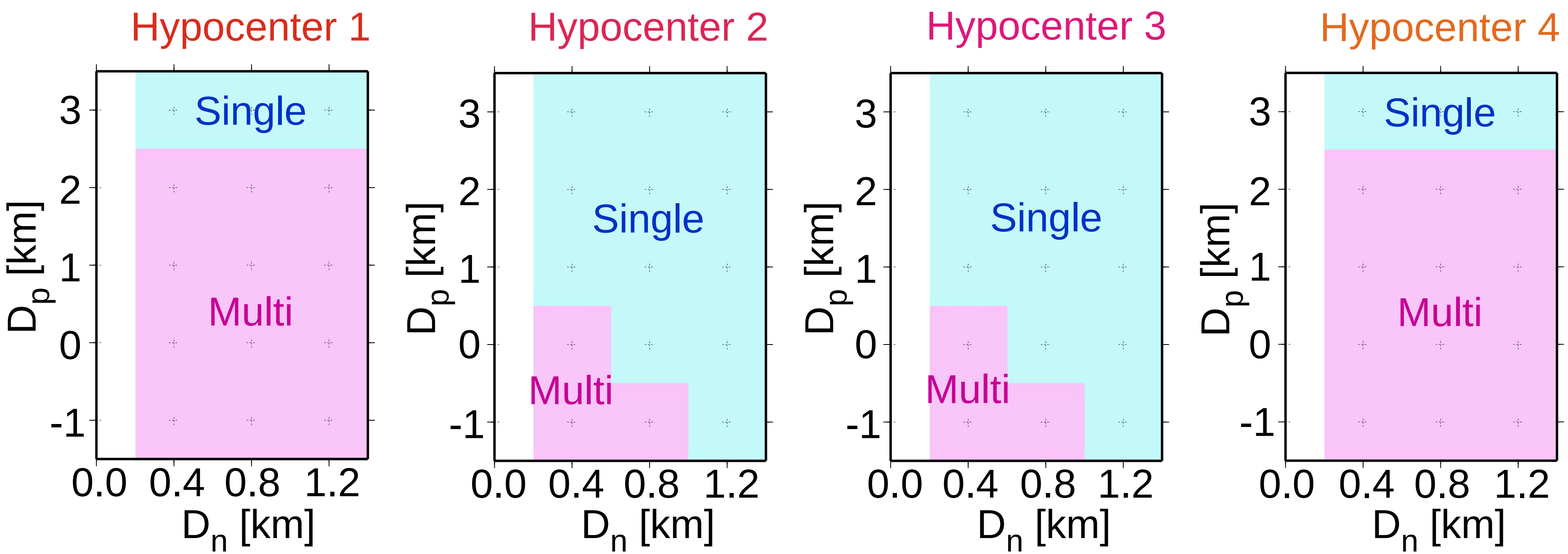
Multi-segment ruptures occur only when

- Hypocenter 1 or 4 ⇒ $D_p \leq 2$ km
- Hypocenter 2 or 3 ⇒ Overlap

Observations: On the Earth's surface

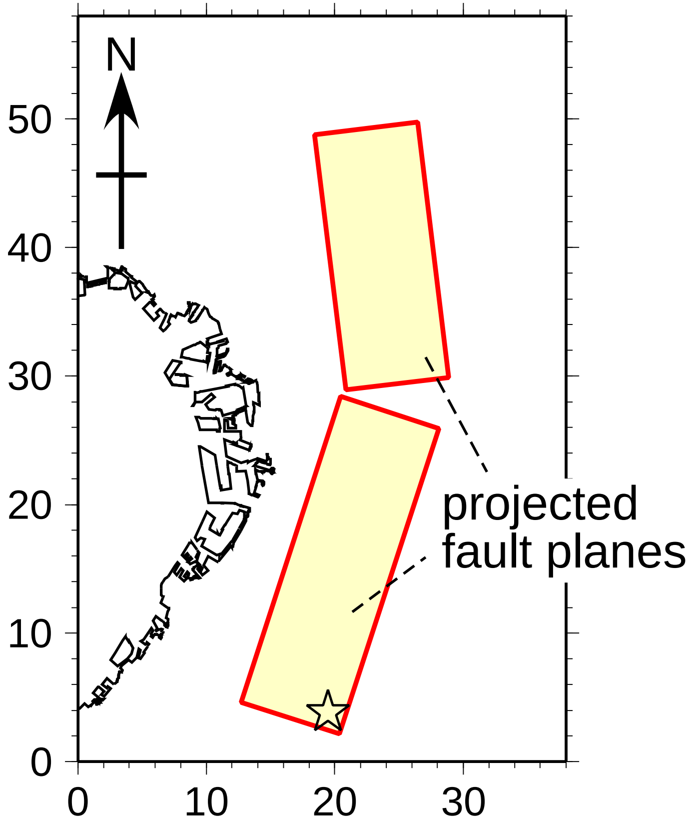
$D_p \approx 3$ km, $D_n \approx 0.4$ km

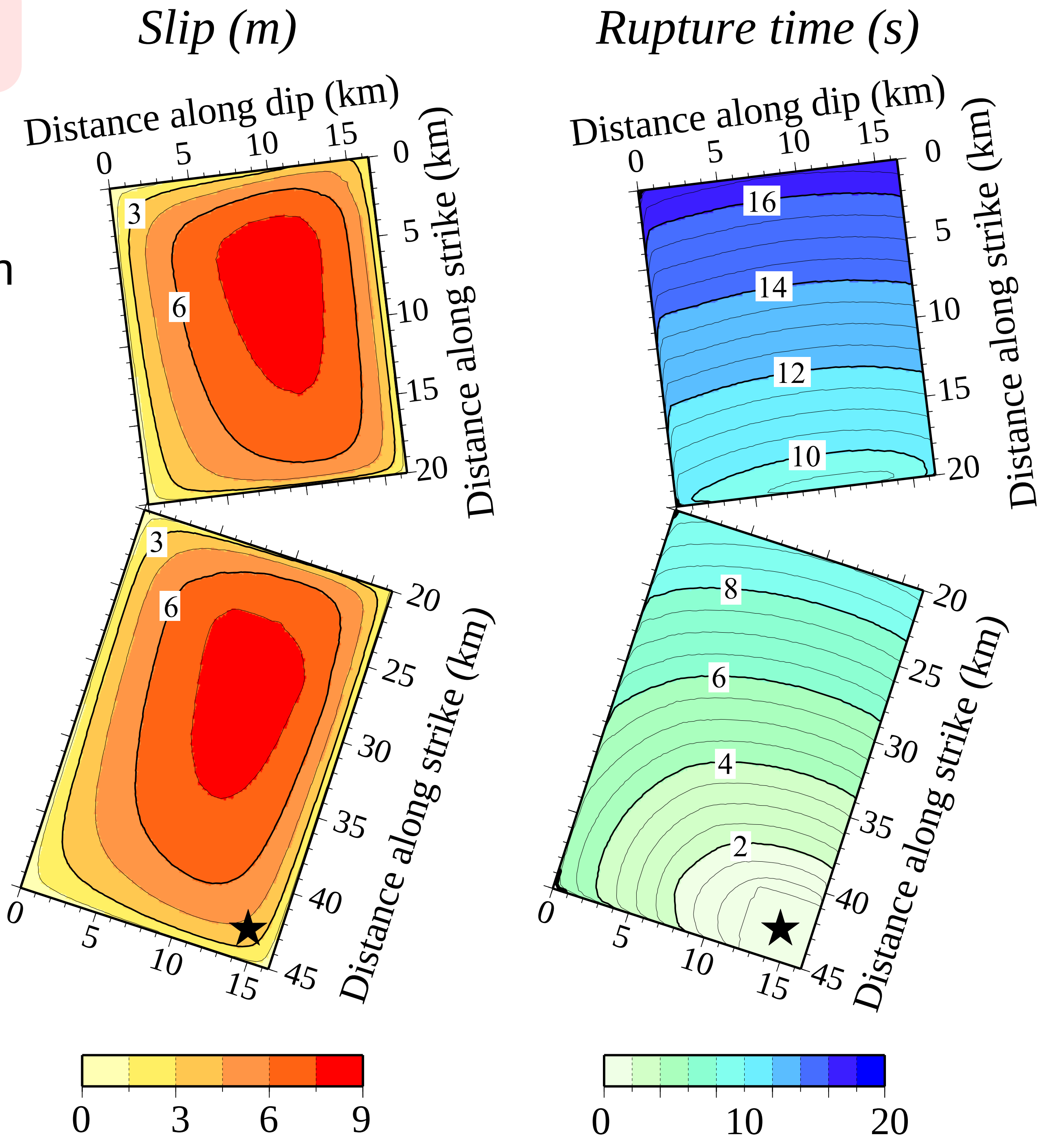




Earthquake Scenario

- Two segments
- Reverse faults dipping to east
- Northward rupture propagation
- Duration: ~ 17 s
- Maximum Slip: ~ 8 m
- 8.0×10^{19} Nm (Mw = 7.2)





Methodology of Ground Motion Estimation

Earthquake Scenario

- spontaneous rupture models

Calculation of Wave Propagation

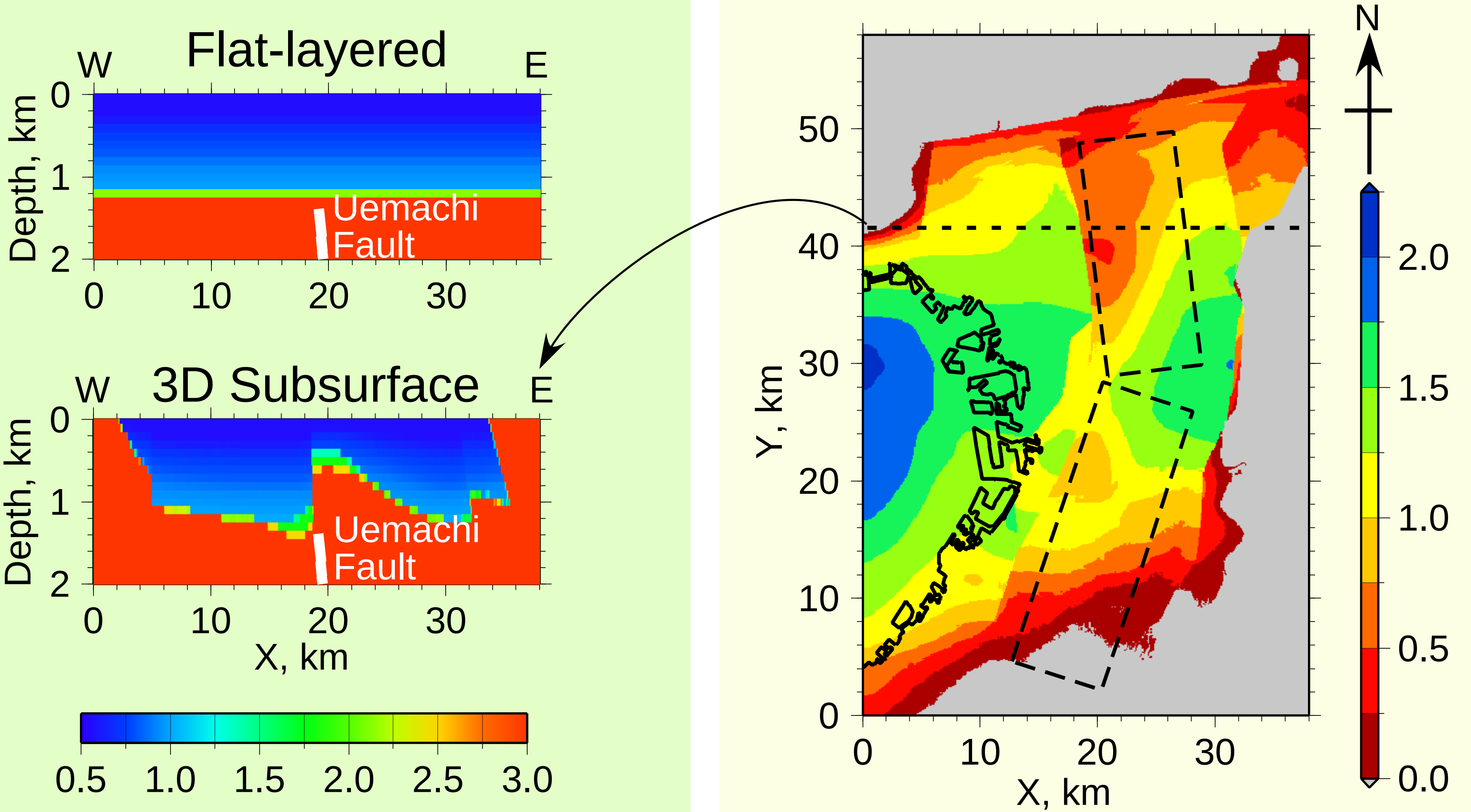
- flat-layered model vs. 3D subsurface structure
- finite difference method (staggered grid)
- velocity field
- frequency range: 0.1- 1 Hz
- neglect of non-linear site effect

Synthetic Ground Motions

Velocity Structure

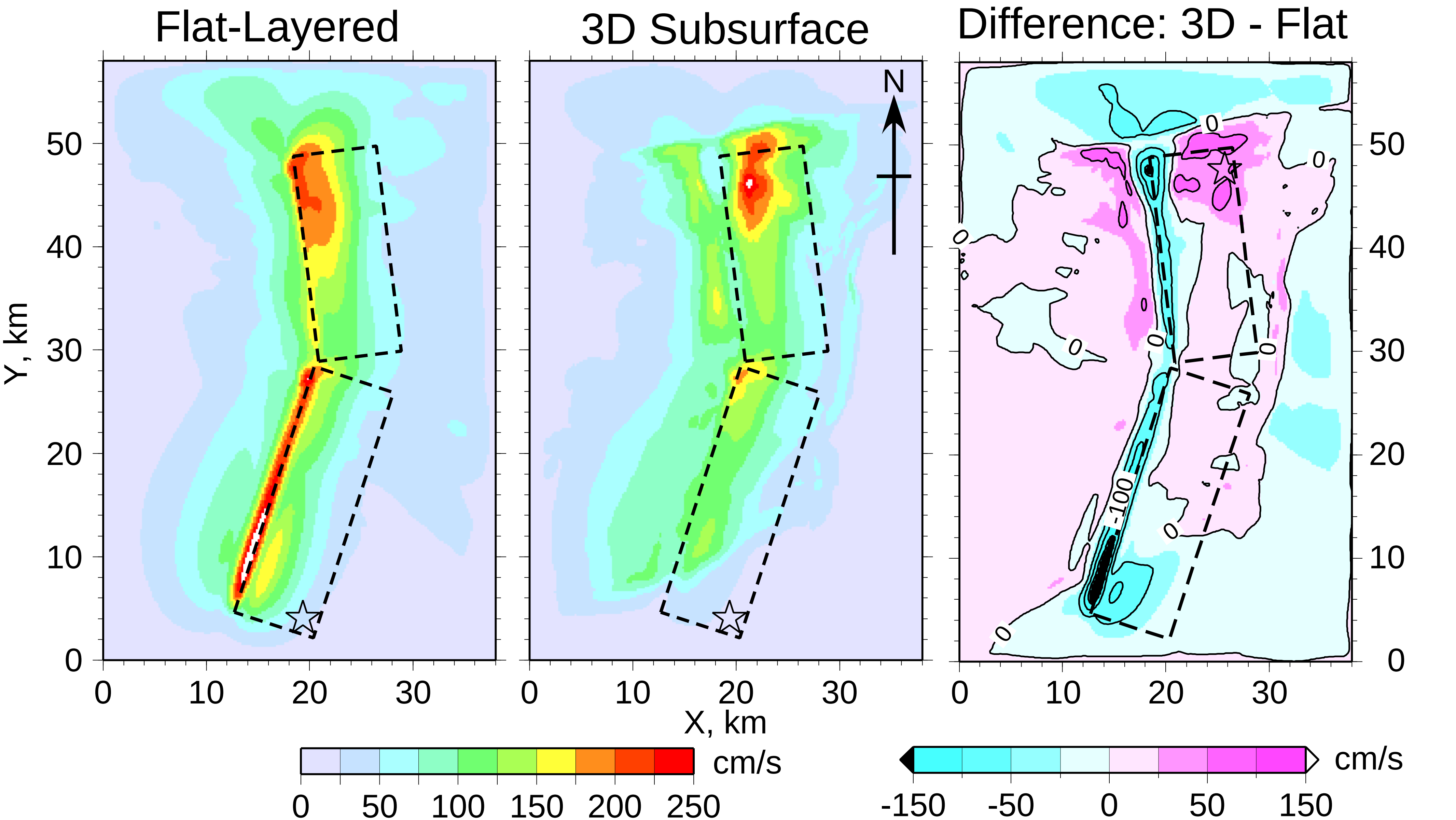
Shear-Wave Velocity (km/s) along Y=41.7 km

Depth to Top of Basement (km) in 3D Subsurface Structure



Peak Amplitude Distribution

Velocity, Horizontal Component
Northward Rupture



Effect of heterogeneity of dynamic source parameters

heterogeneity of dynamic source parameters

↓

incoherent rupture propagation

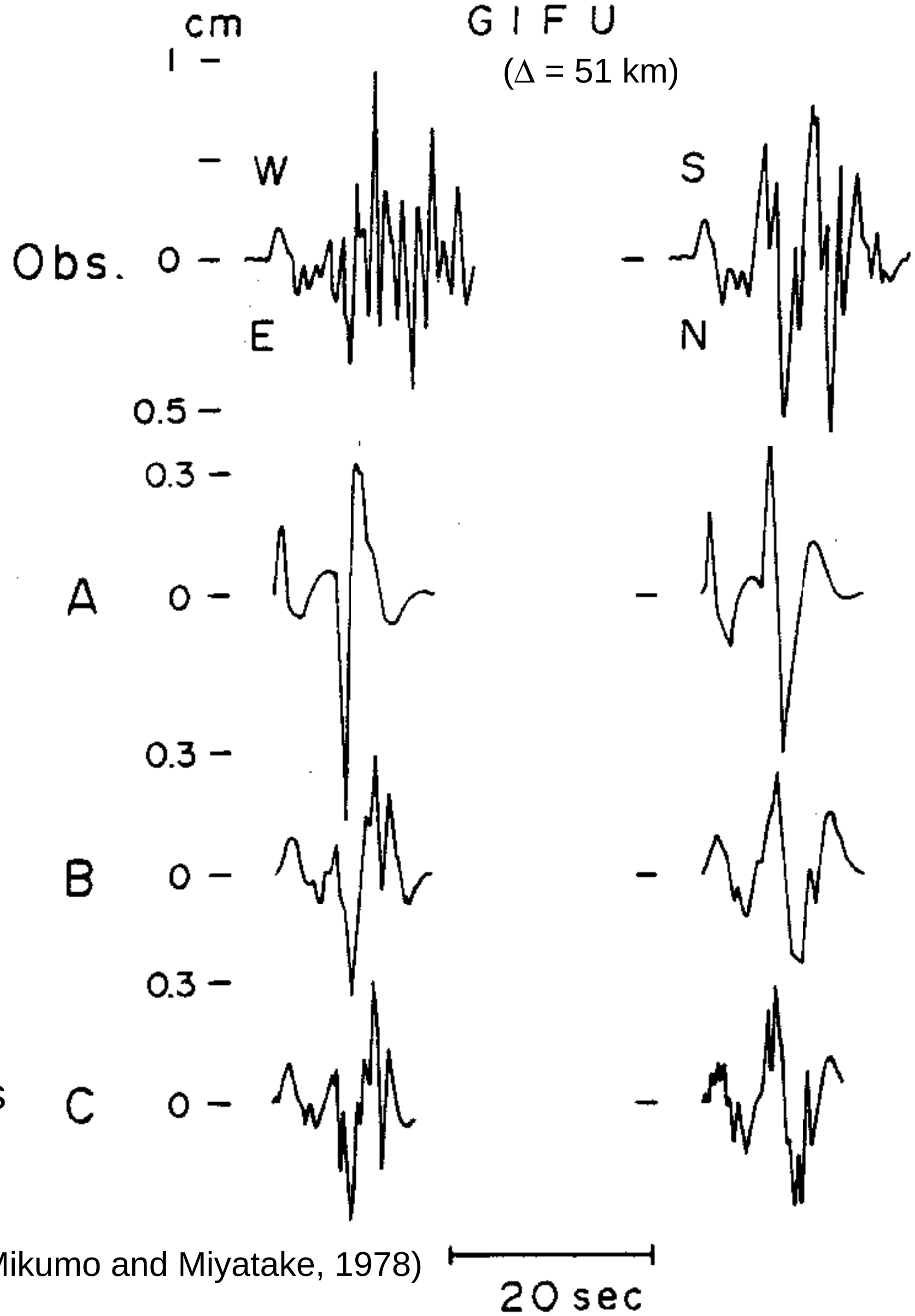
↓

- reduction of peak amplitude
- increase of high frequency components

homogeneous distribution

↕

heterogeneous distribution



(Mikumo and Miyatake, 1978)

Conclusions

Location of hypocenter and geometry of fault jog affect rupture process.

- Location of hypocenter
  - fault end → multi-segment rupture
  - fault jog → single-segment rupture
- Distance between segments
  - short → multi-segment rupture, smooth rupture propagation
  - long → single-segment rupture, rupture jump near the Earth’s surface

Heterogeneity of dynamic source parameters

← Overestimated peak amplitude