Recent advances in GNSS-A observation technology and networks and latest observation results around Japan Islands

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GNSS-A system = “seafloor GNSS”
Target of seafloor geodesy

Macrosopic geodesy

Microscopic geodesy
Target of seafloor geodesy

Coupling condition
- Continental plate
- Ocean plate

Earthquake
- Tsunami
- Earthquake

Postseismic phase
- Afterslip
- Re-coupling
- Viscoelastic deformation

Nankai Trough
- Yokota et al. (2016, Nature)
- Nishimura et al. (2018, Geosphere)
- Yokota & Ishikawa (2020, Sci Adv)

2011 Tohoku-oki earthquake
- Sato et al. (2011, Science)

following to Tohoku-oki earthquake
- Watanabe et al. (2014, GRL)

Next target is “time variation”.

GNSS-A results

Onshore & seafloor data

North American Plate
- KAMN
- KAMS
- Oshika Peninsula
- Miyagi Pref.
- MYGW
- MYGI
- FUKU
- Shimosato
- Pacific Plate

Tsunami
- 15m
- 24m

Earthquake
- Postseismic phase

Continental plate
- Ocean plate
GNSS-A: Accuracy

Gradient field was extracted from upper and lower.

→ shallow SSE detection
Monitoring of slow earthquakes along the Nankai

Around strong coupling regions

Seismometer
Strainmeter/Inclinometer or GNSS

- Deep LFE (tremor)
- Shallow VLF

GNSS

- Deep long-term SSE

Latest results were shown in
Yokota & Ishikawa (2020, Sci Adv)

Continuous monitoring: time variation of postseismic deformation

Watanabe et al., 2014; Iinuma et al., 2012
Continuous monitoring: time variation of postseismic deformation

Watanabe et al., 2014; Iinuma et al., 2012
Continuous monitoring: time variation of postseismic deformation

Watanabe et al., 2014; Iinuma et al., 2012
Observation network density & next-generation platform

2008-2009: only one-site observation

One-site observation cannot determine “SSE model”.

We need “observation density”

Present: 80-100 km >> Ideal: 30 km

In present data, we cannot detect “time-constant”.

Higher Frequency:
We need “next-generation platform” (not vessel?)

Present: 4-8 times/year >> Ideal: everyday
Open data strategy & future works

https://www1.kaiho.mlit.go.jp/KOHO/chikaku/kaitei/sgs/datalist_e.html

- Machine learning
- Output
- Understanding of km-scale ocean
- Time series analysis technique
- Monte Carlo filtering
- Event detection method
- Acoustic analysis
- Machine learning
- Data construction system
- Postseismic effect
- Coupling condition
- Slow slip event
- Expression method
Address list

Pamphlet: [http://sgoi.iis.u-tokyo.ac.jp/figure/pamphlet_190724e.pdf](http://sgoi.iis.u-tokyo.ac.jp/figure/pamphlet_190724e.pdf)

Data site: [https://www1.kaiho.mlit.go.jp/KOHO/chikaku/kaitei/sgs/datalist_e.html](https://www1.kaiho.mlit.go.jp/KOHO/chikaku/kaitei/sgs/datalist_e.html)

Latest papers:

Yokota & Ishikawa (2020, Science Advances)

Yokota, Ishikawa, Watanabe (2018, Scientific Data)

Yokota, Ishikawa, Watanabe (2019, Marine Geophysical Research)

Yokota & Ishikawa (2019, SN Applied Sciences)

Ishikawa, Yokota, Watanabe, Nakamura (2020, Frontiers in Earth Science)

Shallow slow slip event

GNSS-A data paper

GNSS-A analysis method: Ocean structure

GNSS-A analysis method: Interpretation of ocean structure

Review: GNSS-A frequency history