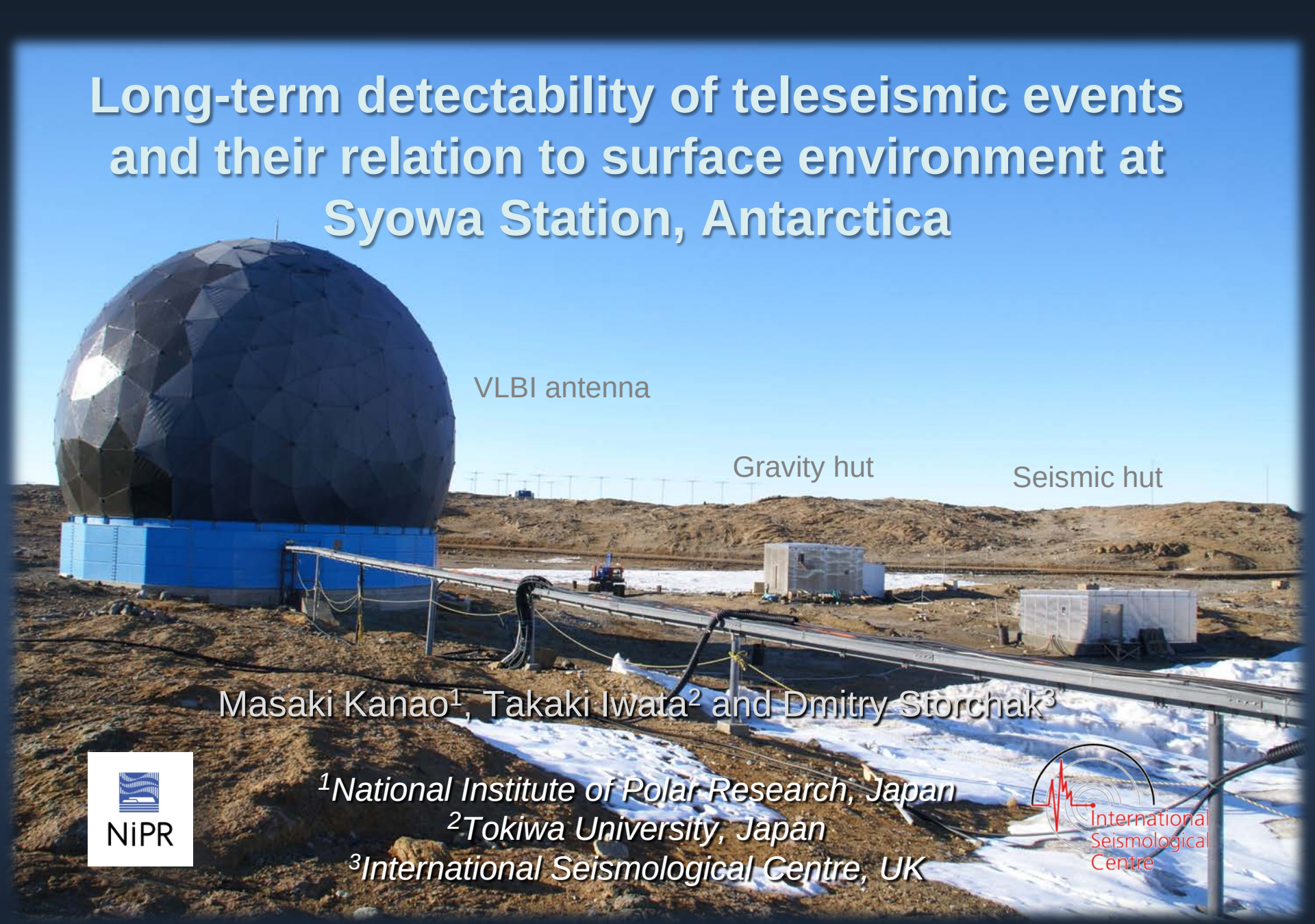
Long-term detectability of teleseismic events and their relation to surface environment at Syowa Station, Antarctica



Masaki Kanao[1], Takaki Iwata[2] and Dmitry Storchak[3]

[1]National Institute of Polar Research, Japan
[2]Tokiwa University, Japan
[3]International Seismological Centre, UK

26th IUGG General Assembly, S02 50 Years of the ISC Service to Seismology

Outline of the presentation

- *Japanese contribution to Global Seismology as viewed from Polar Region, Seismographic Network (GSN, FDSN) & IPY Involved Projects (POLENET, AGAP)*

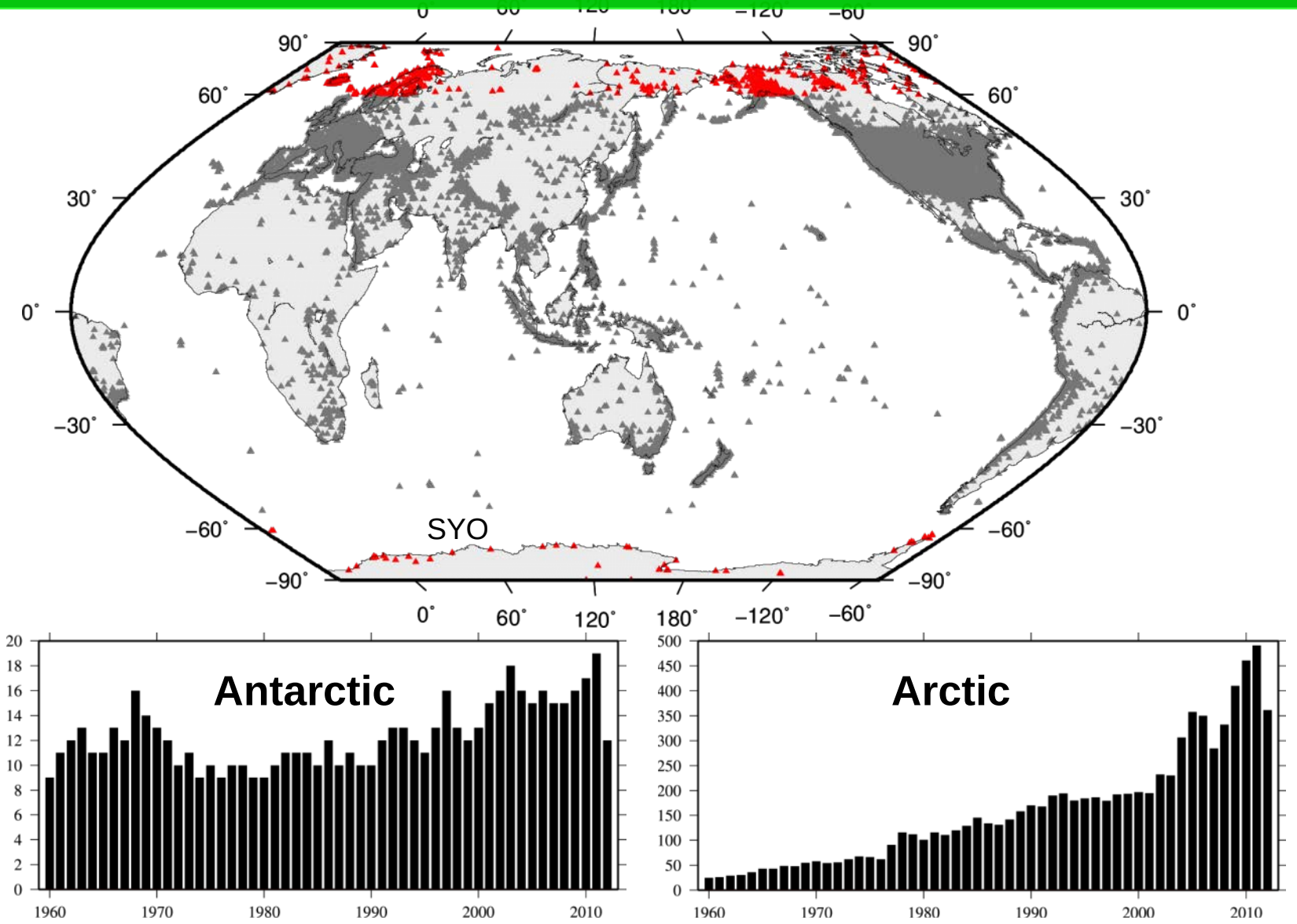
- *Continuous observation system at Syowa Station (SYO), examples of characteristic local & teleseismic events*

- *Teleseismic detection capability at SYO, spacial and temporal variations of the detected events, depth, hypocentral distance, & magnitude dependency*

- *Teleseismic statistics of the reported data to the International Seismological centre (ISC)*

- *Statistic analysis of detection capability associated with environmental data in vicinity of the station*

Timeline of the stations reporting to the ISC



Storchak, D. A., M. Kanao, E. Delahaye and J. Harris, 2015, Long-term accumulation and improvements in seismic event data for the polar regions by the International Seismological Centre, Polar Science, 9, 5-16, 10.1016/j.polar.2014.08.002

Seismographs at Syowa Station (SYO)

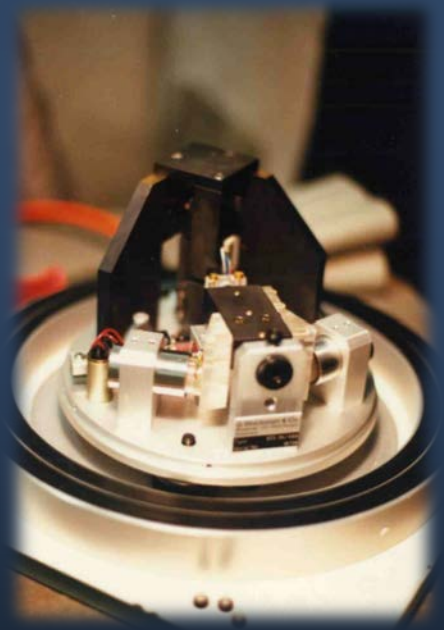
★ short-period seismograph **JARE-3 (1-comp.), JARE-6 (3-comp.)**

(HES; natural period; 1s, 3-comp.; from 1959 to present)

★ broadband seismograph **JARE-30**

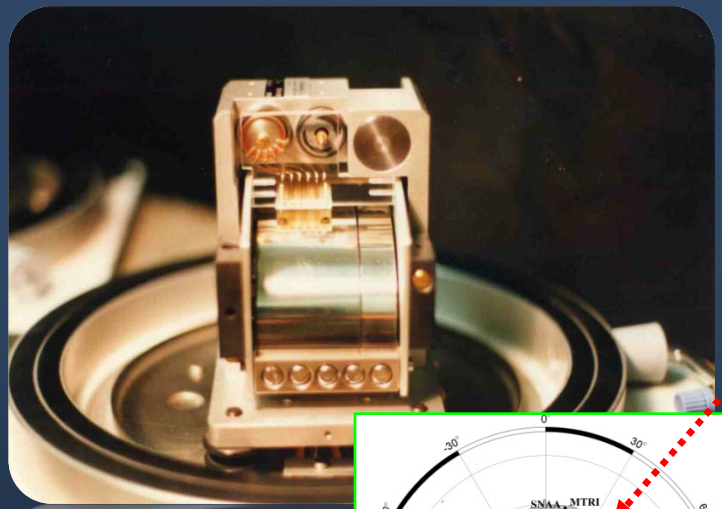
(STS-1V, -1H; flat response; 50Hz-360s, 3-comp.; from 1989 to present)

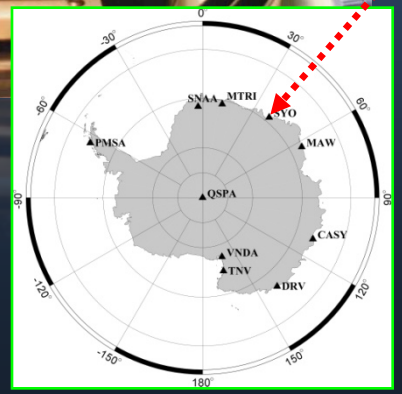
Inside the seismographic hut



STS-1H sensor (inside)

STS-1V sensor (inside)



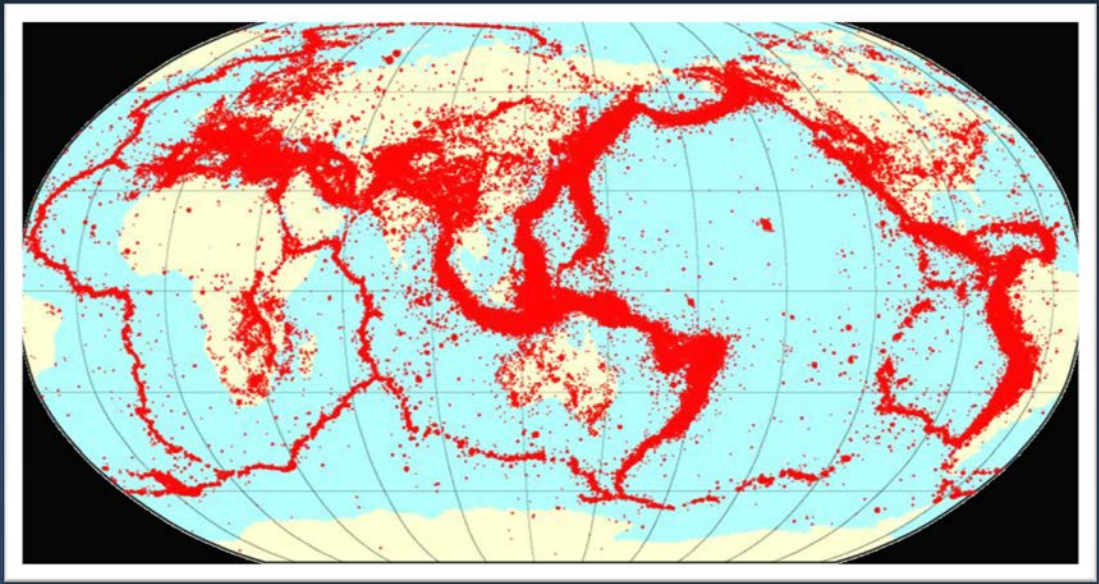


Polar Seismology in Global System

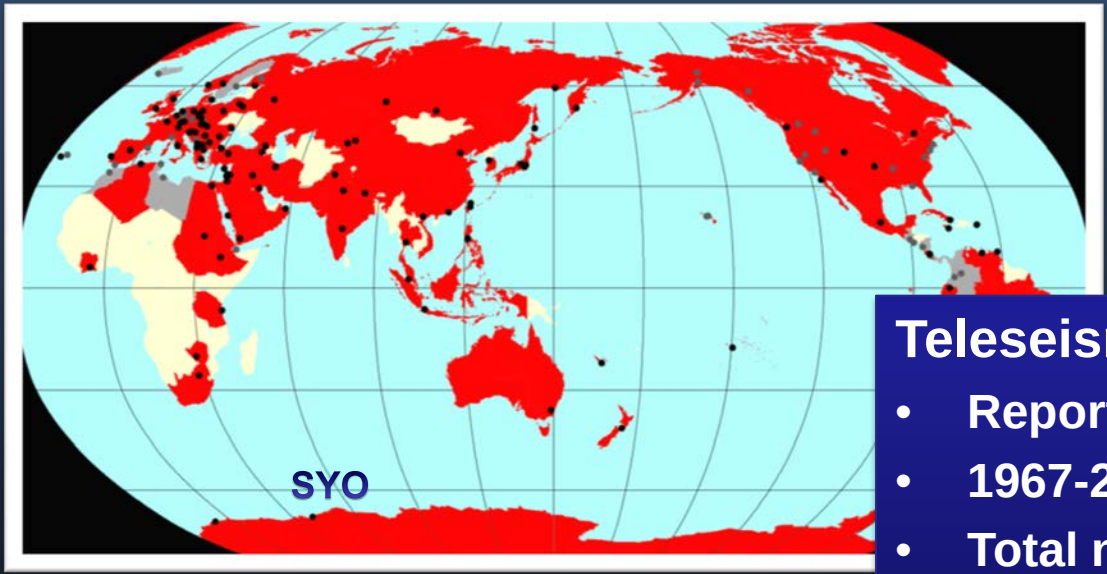
Study on heterogeneous structure and dynamics of the Earth, by using seismic data derived from earthquakes occurred in the whole globe.

- **Whole Earth view:**
  - **Deep structure and dynamics such as the inner and outer Cores and the lower Mantle**
- **Regional view:**
  - **Structure and dynamics of Antarctic/Arctic plate and the upper Mantle**
- **Local view:**
  - **Structure and dynamics of the Crust and lithospheric mantle, Seismicity & Icemicity**
- **Physical interaction (by wave propagation) between Solid Earth and other spheres (Atmosphere, Ocean, Cryosphere)**

Seismic events in the ISC Bulletin for 1900-2012



130 government and research agencies around the world, including those in Australia, China, India, Indonesia, Japan, South Korea, Malaysia, Nepal, New Caledonia, New Zealand, Philippines, Taiwan, Thailand, Vanuatu and Vietnam, report data directly (red) or via other data centres (grey).

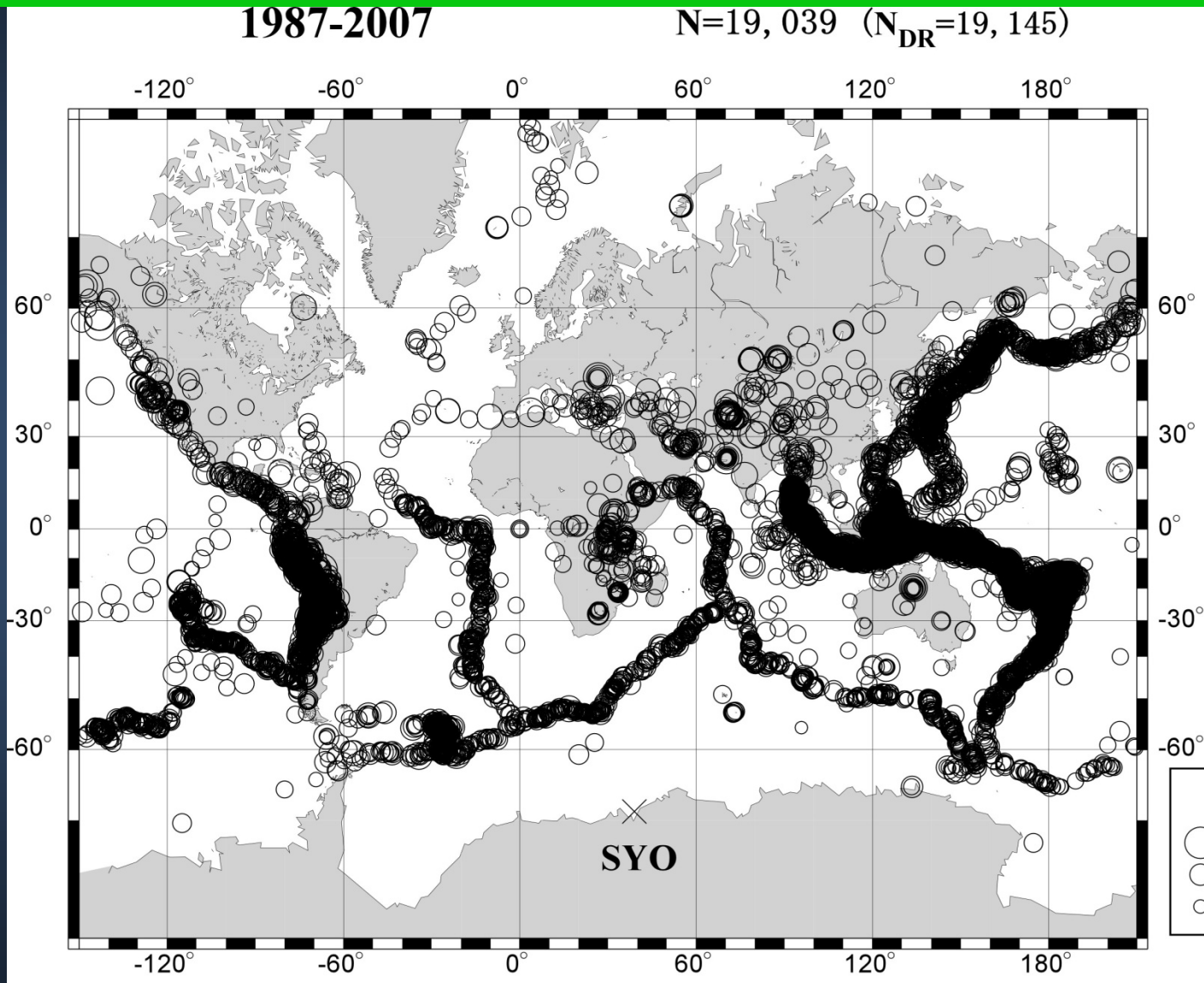


The fact that Antarctica is depicted in red is many ways thanks to the contribution from NIPR for the SYO data.

Teleseismic Data Source: SYO

- **Reported number to ISC**
- **1967-2010; (until present)**
- **Total number of P phases; N=18,021**

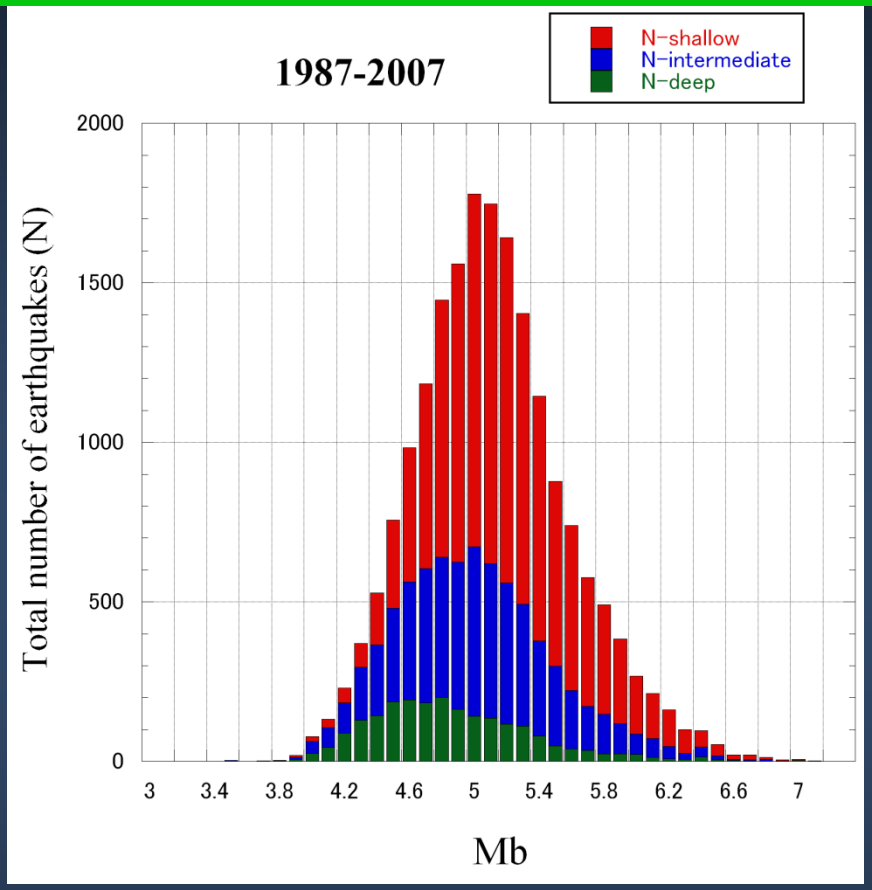
Hypocenters of teleseismic events by SYO

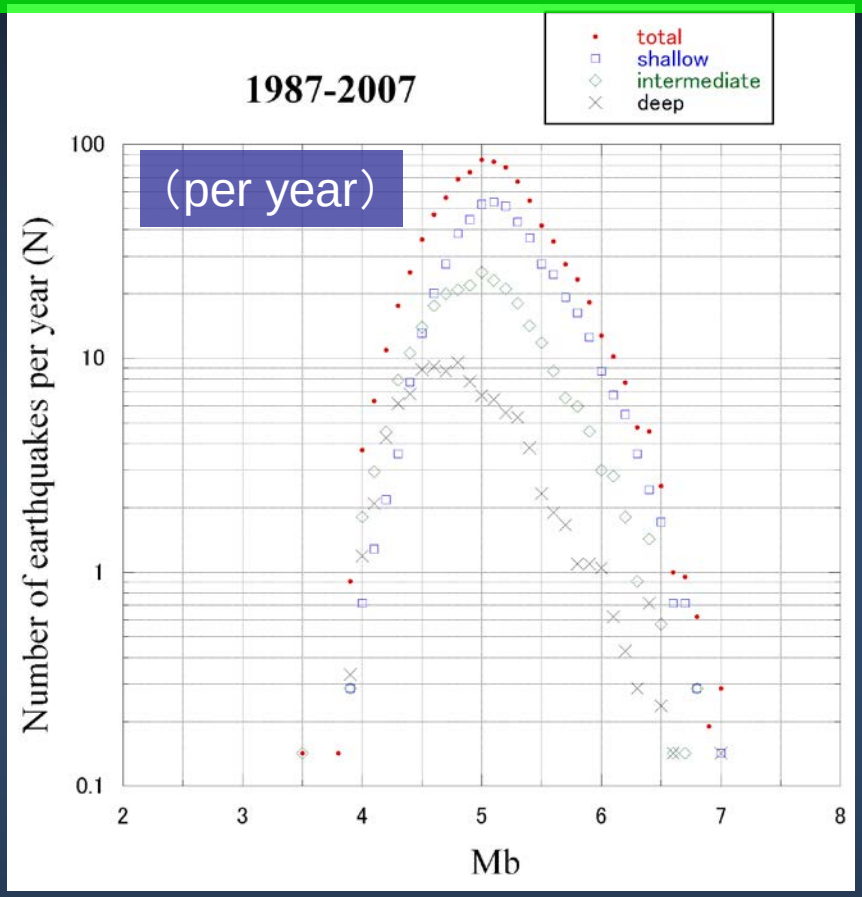


Northern hemisphere:
events more than M > 5 were detectable

Southern hemisphere:
events more than M > 4 were detectable

Magnitude dependency





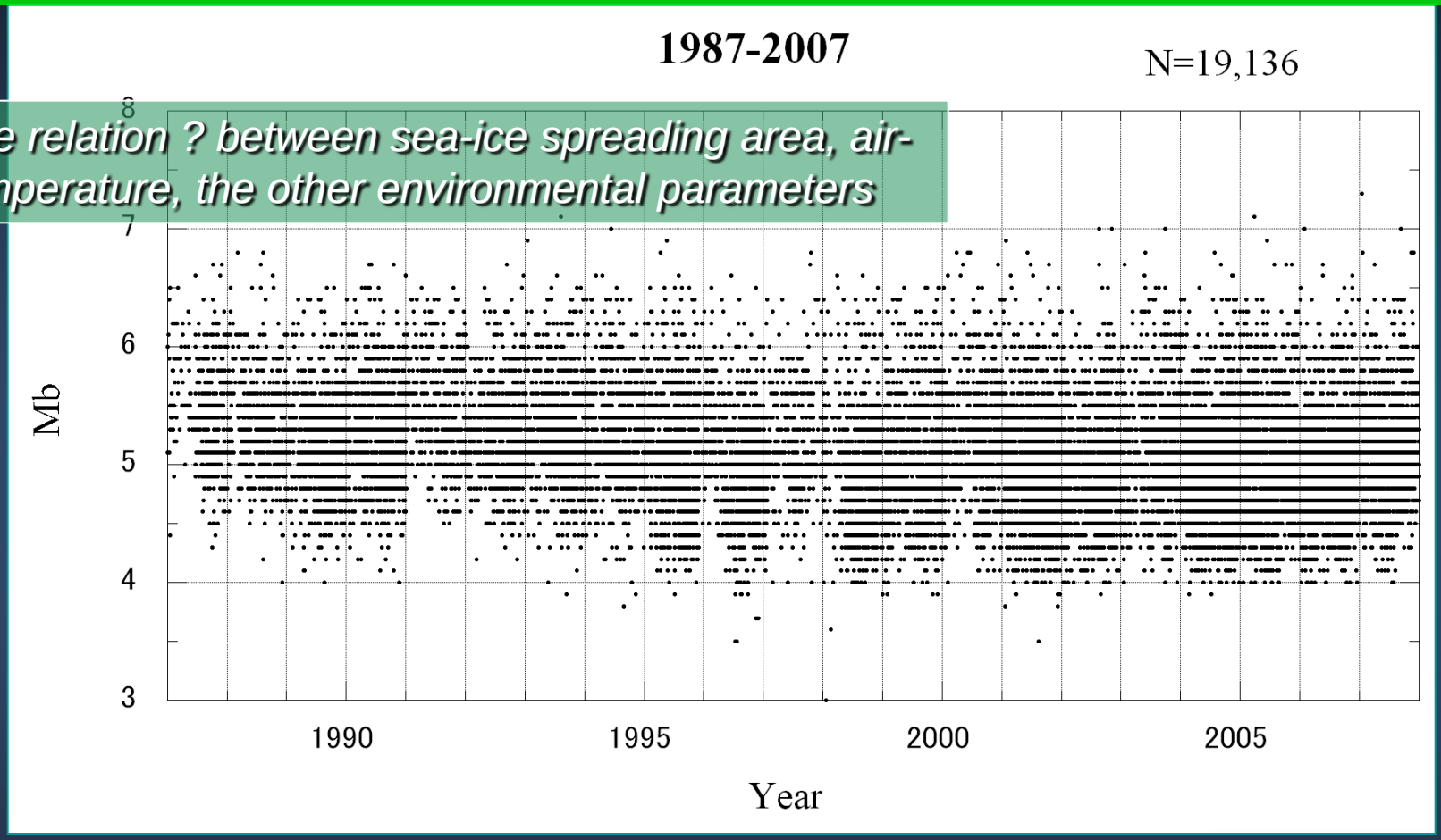
Shallow events; D <= 50km
N=11,156 (58%)
Intermediate events; 50 km < D <=300 km
N=5,776 (30%)
Deep events; D > 300 km
N=2,204 (12%)

Syowa

ISC total

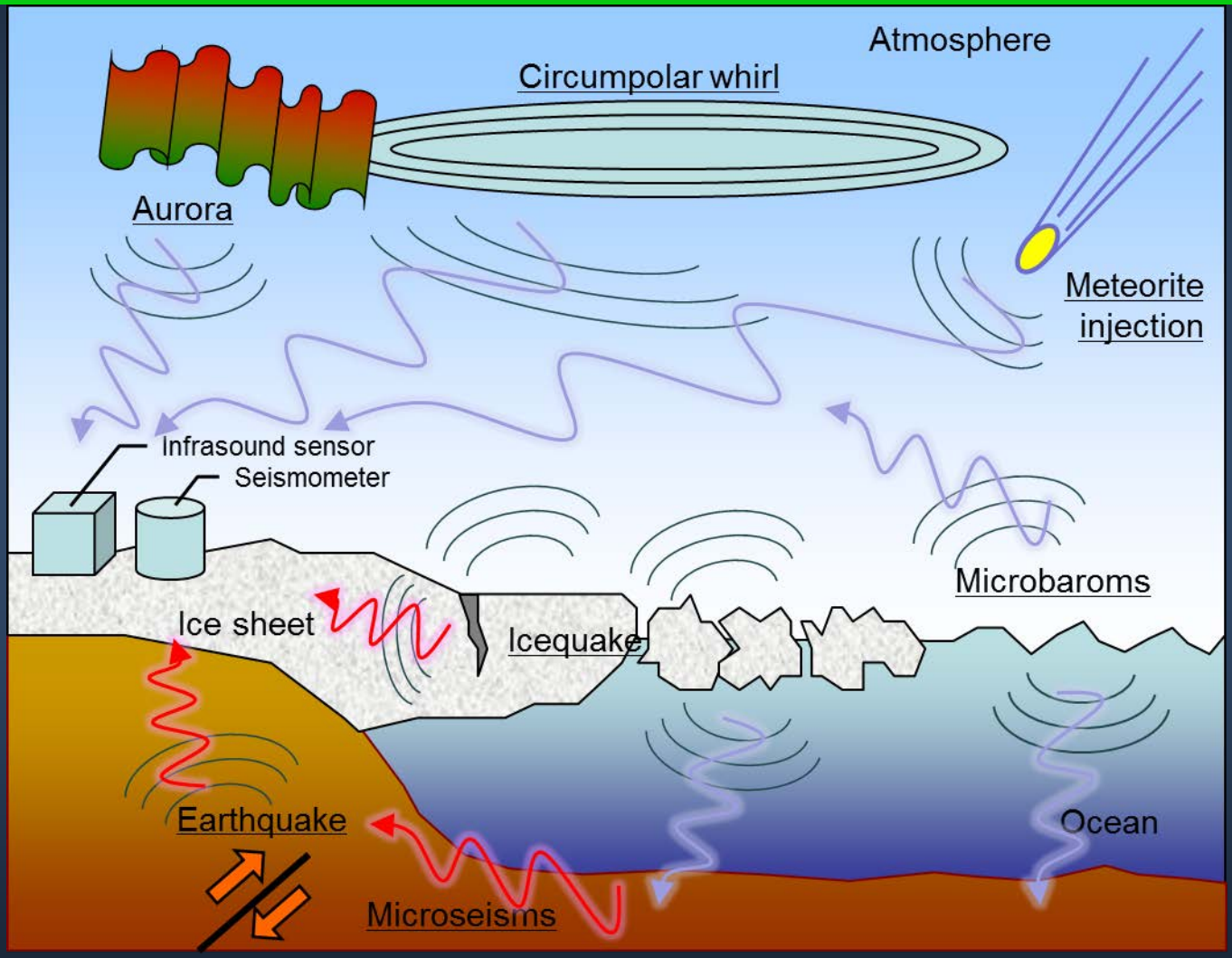
Shallow events; (70%)
Intermediate events; (25%)
Deep events; (5%)

Time variations of Magnitude for 21 year period



Some relation ? between sea-ice spreading area, air-temperature, the other environmental parameters

Physical interaction between Solid Earth & Atmosphere – Ocean – Cryosphere System



- Several kind of seismic & infrasonic waves propagate from various environmental variations and generating sources around Polar regions

JARE Data Report (Seismology), NIPR publication

Teleseismic Data Source:

- JARE Data Report (Seismology)
- 1987-2007; 21 years
- Total number of events; N=19,136

Report of travel-times and hopocenters to ISC

JARE Data Report

NIPR

- NII論文情報ナビゲータ CiNii
- NII学術コンテンツ・ポータル GeNii

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JARE DATA REPORTS: Seismology

ISSN 0075-3343

Seismology (Total-No., Pub.-Year)

1 (No.4, 1969)	2 (No.6, 1970)	3 (No.9, 1970)
4 (No.12, 1971)	5 (No.16, 1972)	6 (No.19, 1973)
7 (No.21, 1974)	8 (No.31, 1976)	9 (No.34, 1976)
10 (No.38, 1977)	11 (No.43, 1978)	12 (No.49, 1979)
13 (No.54, 1980)	14 (No.59, 1981)	15 (No.72, 1982)
16 (No.83, 1983)	17 (No.92, 1984)	18 (No.106, 1985)

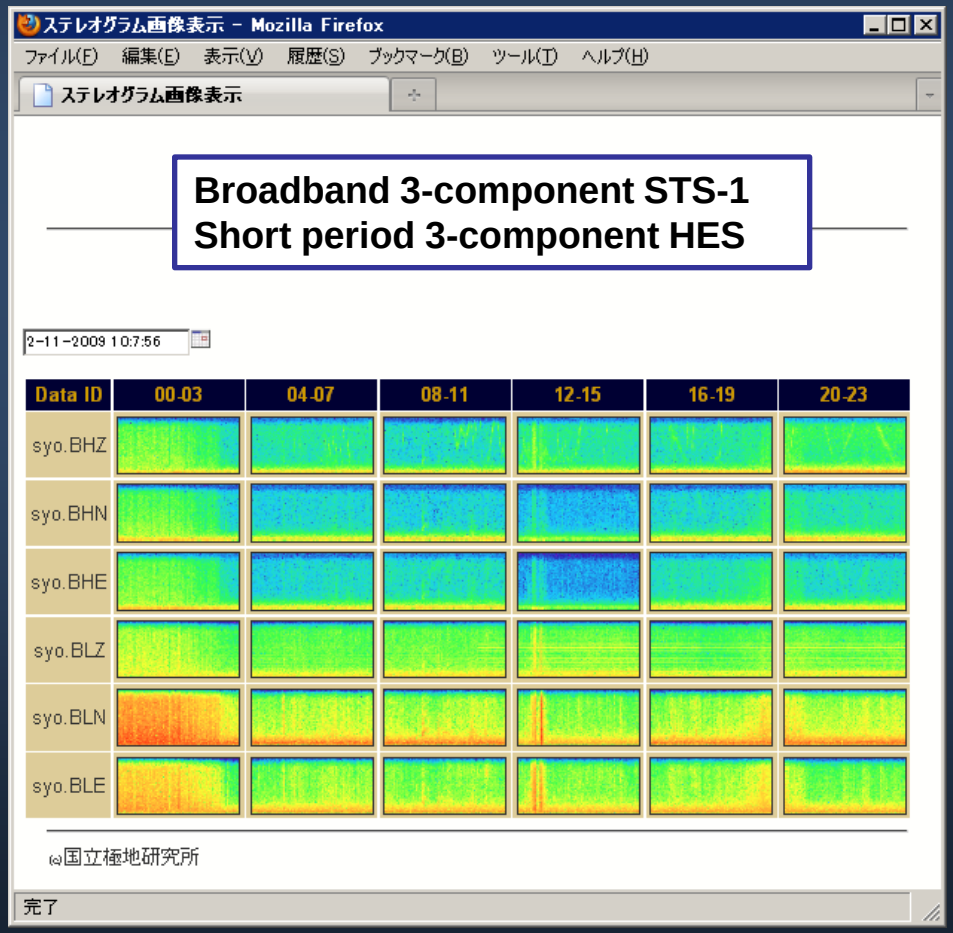
ページが表示されました

インターネット

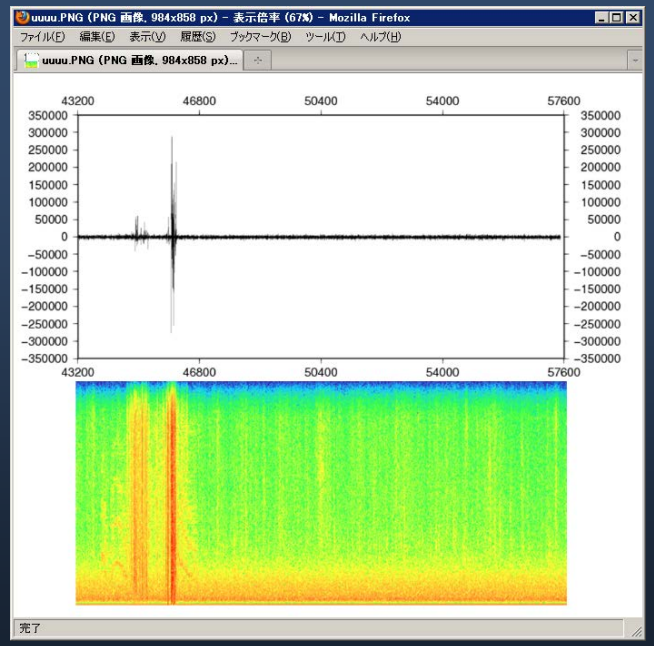
スタート

Continuous monitoring system for seismic waves / spectra at Syowa Station (SYO)

Web-based data publication system
http://geoccs.nipr.ac.jp/



Detection of teleseismic, and local events, ice signals
Compare with data from SCG, Infrasonic, Oceanic tides, etc.

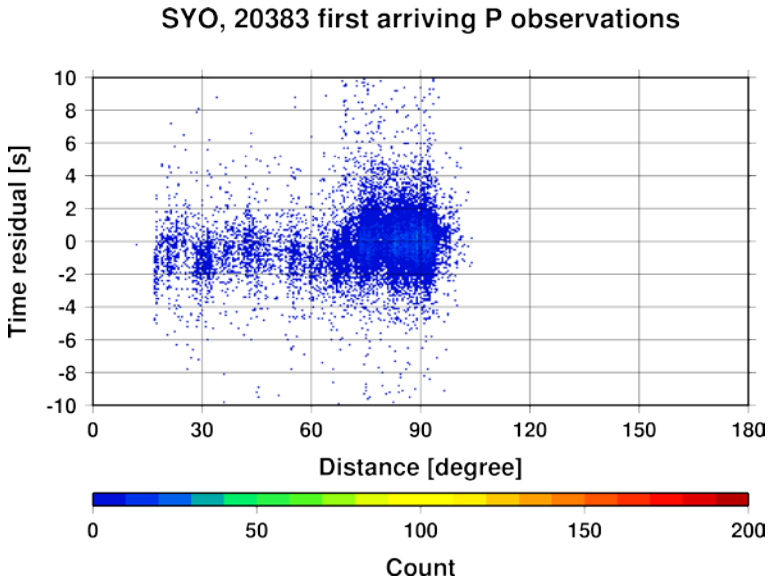


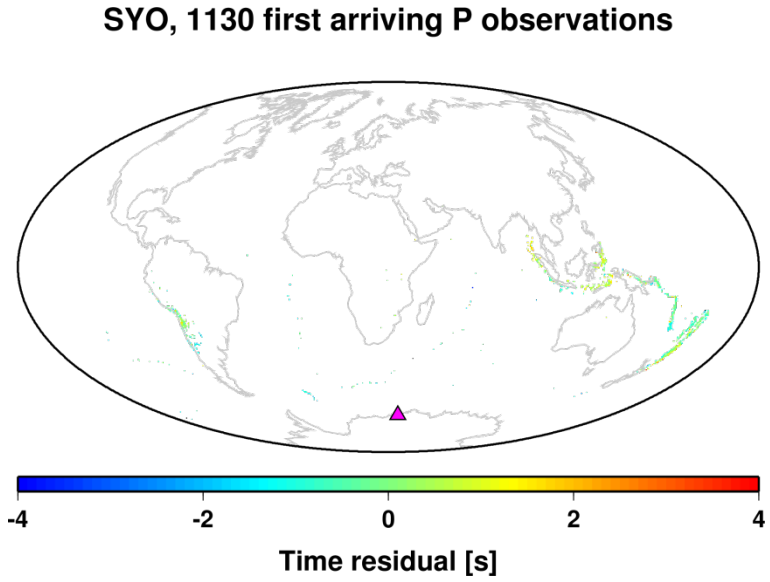
CONTRIBUTION TO GLOBAL DATA CENTERS

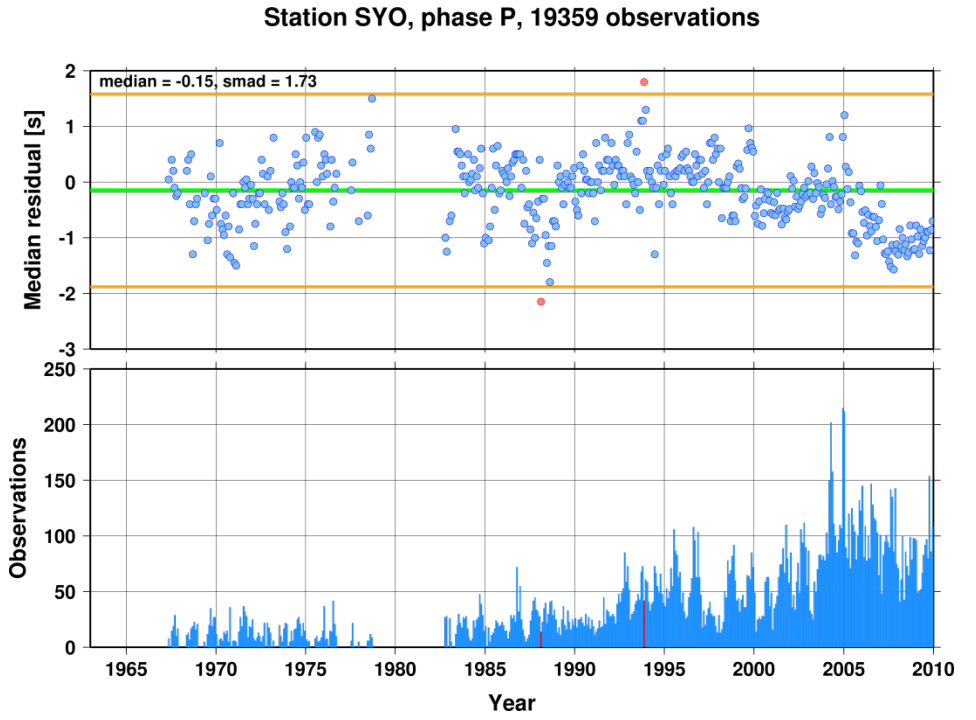
- ***International centers:***
  - United States Geological Survey, National Earthquake Information Center (USGS/NEIC)
  - International Seismological Center (ISC)
  - Federation of Digital Seismographic Networks (FDSN)
  - The Incorporated Research Institutions for Seismology, Data Management System (IRIS/DMS)
  - Antarctic Seismic Web Resource (AnSWeR)

- ***Japanese data centers:***
  - PACIFIC21 (developed from POSEIDON)
  - Ocean Hemisphere Project Data Management Center, Earthquake Research Institute, University of Toyo (OHP/ERI)
  - Institute for Frontier Research on Earth Evolution, Japan Marine Science and Technology Center (IFREE/JAMSTEC)
  - National Institute of Earthquake Prediction and Disaster Prevention (NIED)

ISC Bulletin: Station Histories: SYO (Antarctica)



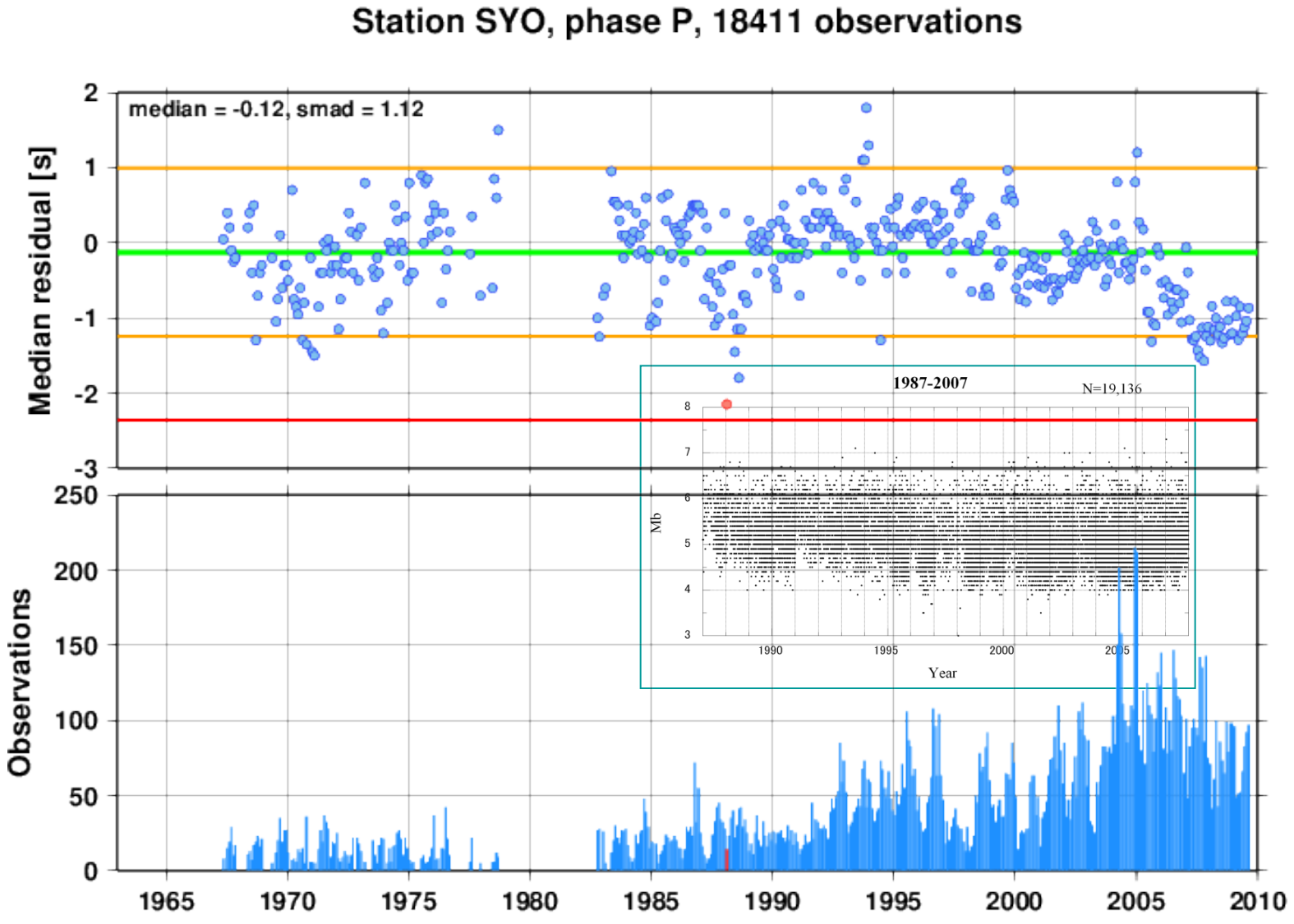




(upper-right) Time variations in travel-time residuals for P-waves at SYO (in totally 19,359 observations). Each dot represents the median residual for one month of data. The green line is the overall median; the orange line shows the standard deviation based on the median absolute deviation, whilst the red line shows twice the standard deviation. The data shown by red color are added by the ISC-GEM catalogue. (lower-right) Reported number of teleseismic events at SYO in 1967-2010 to ISC.

(upper-left) Arrival-time residuals for P-waves against hypocentral distance at SYO. (lower-left) Arrival-time residual map for the first arriving P-waves at SYO, based on the event azimuth and distance. The residuals are binned in a 1x1 degree grid.

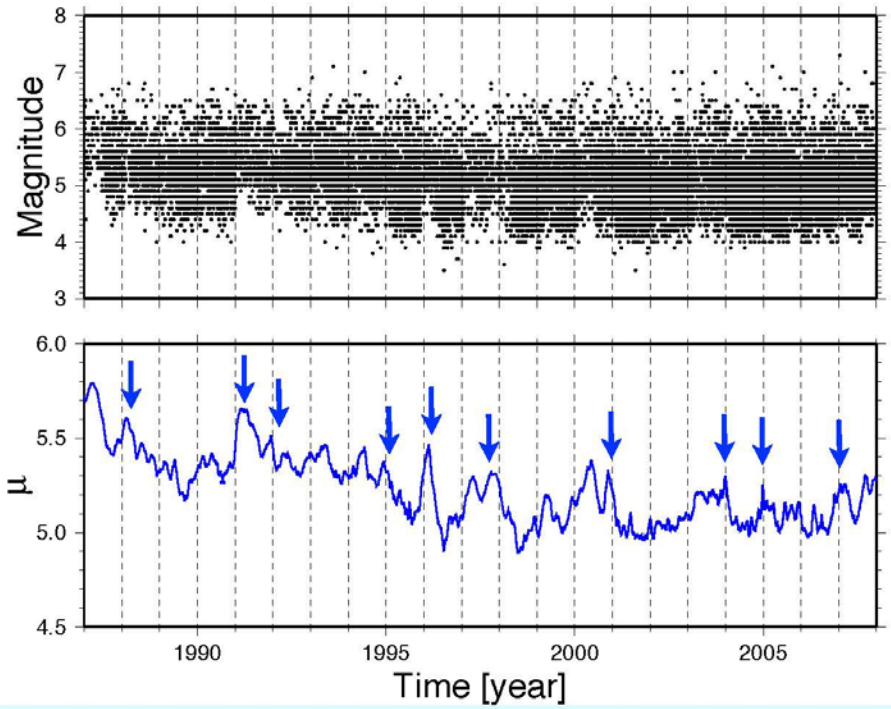
Time variations of P-wave travel-time residuals and event number for 1967-2010 @ SYO



Storchak, D. A., M. Kanao, E. Delahaye and J. Harris, 2015, Long-term accumulation and improvements in seismic event data for the polar regions by the International Seismological Centre, Polar Science, 9, 5-16, 10.1016/j.polar.2014.08.002

Statistic analysis of detection capability

Estimated temporal variation in μ



detectability

worse

better

- Long-term trend: **gradual** **improvement**
  (in particular, 1980's through 1990's)
- **Lowered** detection capability in summer
  (near the dotted lines)

Iwata, T. and M. Kanao, 2015, Statistical analysis on the temporal variation in teleseismic detection capability at Syowa Station, Antarctica, Polar Science, 9, 26-34, 10.1016/j.polar.2014.10.002

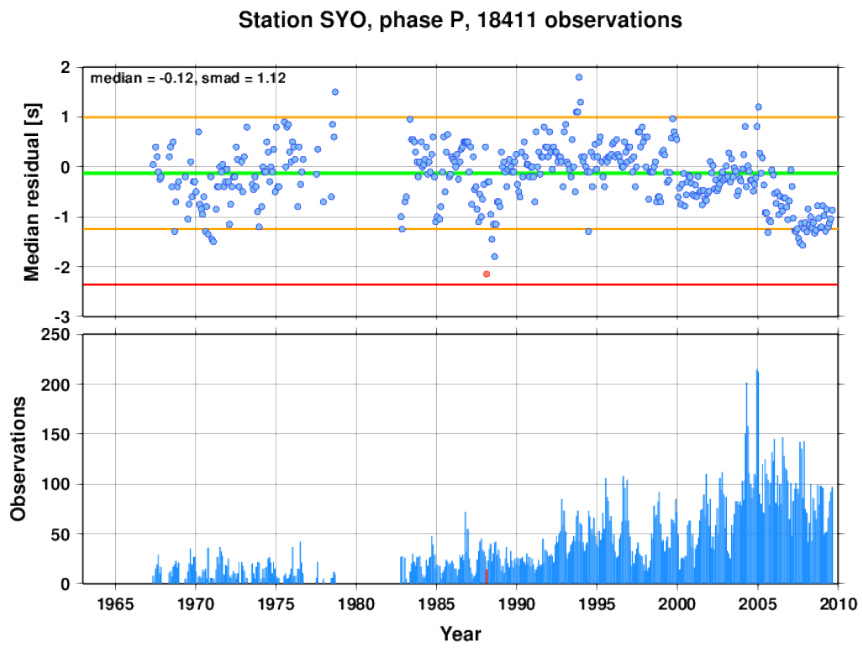
Travel-time Analysis @ SYO v.s. MAW

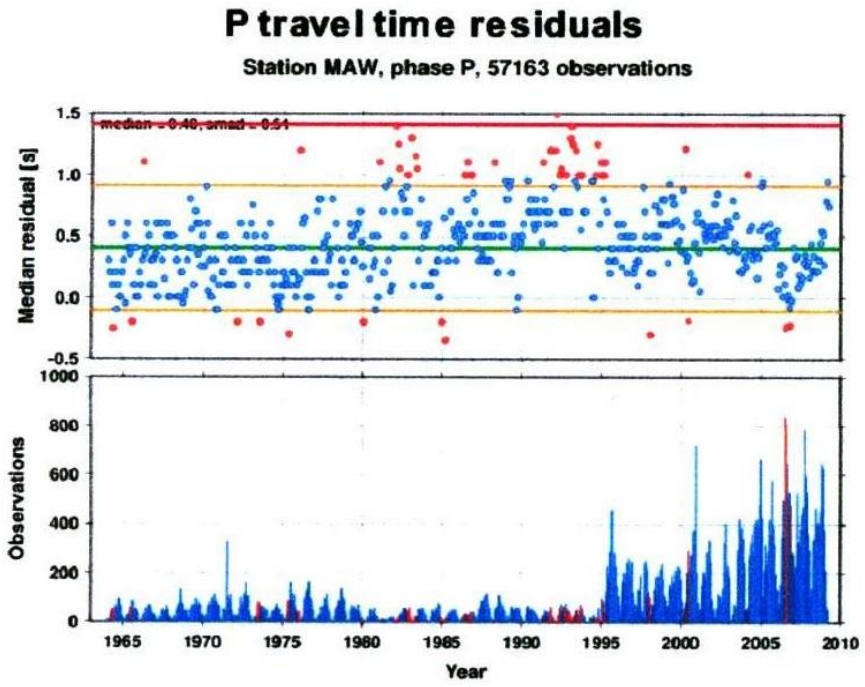
★ P-wave travel-time residuals

Station SYO, phase P, 18,021 observations

★ P-wave travel-time residuals

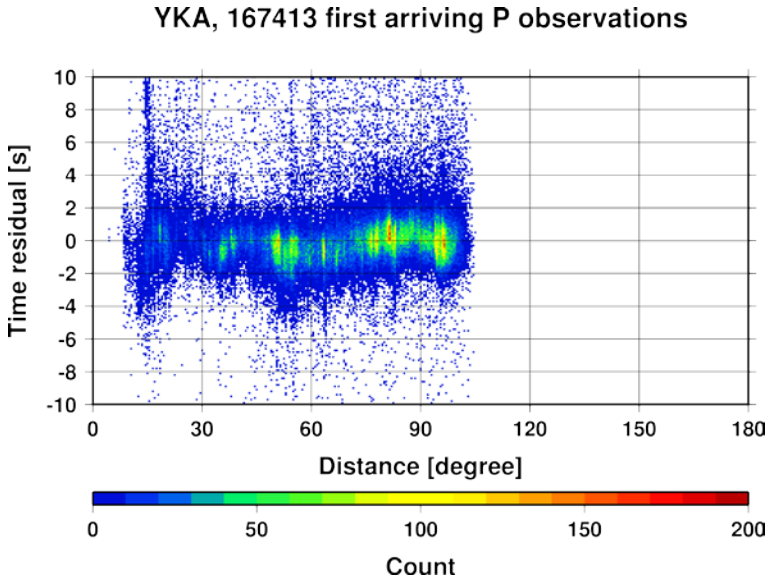
Station MAW, phase P, 57,163 observations

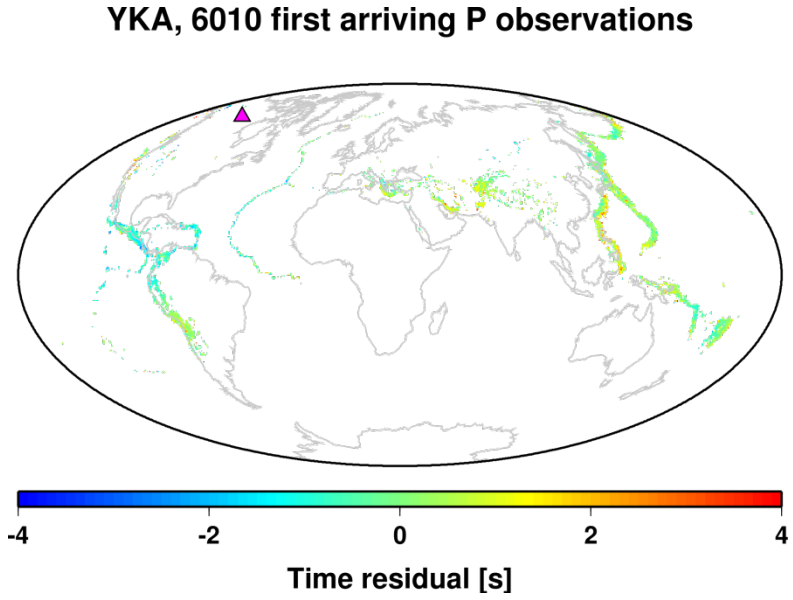


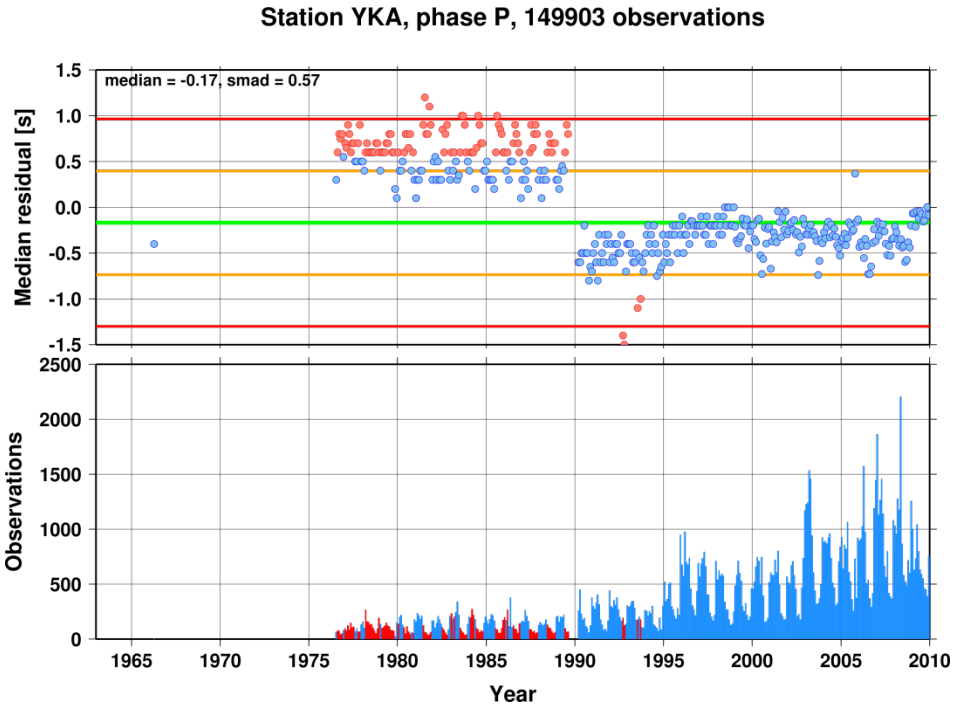


On the top graph, every dot represents the median residual for one month of data. The green line is the overall median; the orange line shows the standard deviation based on the median absolute deviation, whilst the red line shows twice the standard deviation.

ISC Bulletin: Station Histories: YKA (Canada)







(upper-right) Time variations in travel-time residuals for P-waves at YKA (in totally 149,903 observations). Each dot represents the median residual for one month of data. The green line is the overall median; the orange line shows the standard deviation based on the median absolute deviation, whilst the red line shows twice the standard deviation. The data shown by red color are added by the ISC-GEM catalogue. (lower-right) Reported number of teleseismic events at YKA in 1966-2010 to ISC.

(upper-left) Arrival-time residuals for P-waves against hypocentral distance at YKA. (lower-left) Arrival-time residual map for the first arriving P-waves at YKA, based on the event azimuth and distance. The residuals are binned in a 1x1 degree grid.

Summary

- Phase identifying procedure for teleseismic events at Syowa Station (69.0˚ S, 39.6˚ E; SYO), East Antarctica have been carried out since 1967 after the International Geophysical Year (IGY; 1957-1958). From the development of INTELSAT telecommunication link, digital waveform data have been transmitted to the National Institute of Polar Research (NIPR) for utilization of phase identification. Arrival times of teleseismic phases, P, PKP, PP, S, SKS have been reported to the International Seismological Centre (ISC), and published by "JARE Data Reports" from NIPR. In this paper, hypocentral distribution and time variations for detected earthquakes are demonstrated over the last four decades in 1967-2010.
- Characteristics of detected events, magnitude dependency, spatial distributions, seasonal variations, together with classification by focal depth are demonstrated. Besides the natural increase in number for occurrence of teleseismic events on the globe, a technical advance in observing system and station infrastructure, as well as the improvement of procedure for reading seismic phases, could be efficiently combined to produce the increase in detection number in last few decades. Variations in teleseismic detectability for longer terms may possibly by associate with meteorological environment and sea-ice spreading area around the Antarctic continent.
- Recorded teleseismic and local seismic signals have sufficient quality for many analyses on dynamics and structure of the Earth's as viewed from Antarctica. The continuously recorded data are applied not only to lithospheric studies but also to Earths deep interiors, as the significant contribution to the Federation of Digital Seismological Network (FDSN) from high southern latitude.