



Reference Event List (GT) for monitoring purposes

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IASPEI reference events

- Earthquakes and explosions for which the hypocentral information (*lat, lon, depth*) is known with high confidence (e.g., to 10 km or better, GT10) with seismic signals recorded at regional and/or teleseismic distances.
- Events coded by category GT0, GT1, GT2, or GT5 where the epicentre of a GTx event is known within x km to a 95% confidence level.
- 8969 events from 1959 to 2015.
- 917604 body-wave associated phase arrivals.

IASPEI reference events – Selection criteria (GTx)

Local networks (0°-2.5°)

- GT5 (95% confidence level)
- Azimuthal gap less than 110°
- Secondary azimuthal gap less than 160°
- At least 10 stations within 250 km
- At least one station within 30 km from the epicentre

Teleseismic networks (28°-91°)

- GT25 (90% confidence level)
- Secondary azimuthal gap less than 120°

Near-regional networks (2.5°-10°)

- GT20 (90% confidence level)
- Secondary azimuthal gap less than 120°

Regional networks (2.5°-20°)

- GT25 (90% confidence level)
- Secondary azimuthal gap less than 120°

IASPEI reference events – Selection criteria (GT5)

- Stations up to 150 km
- At least one station within 10 km from the epicentre
- Secondary azimuthal gap less than 160°
- Network geometry ($\Delta U \leq 0.35$)

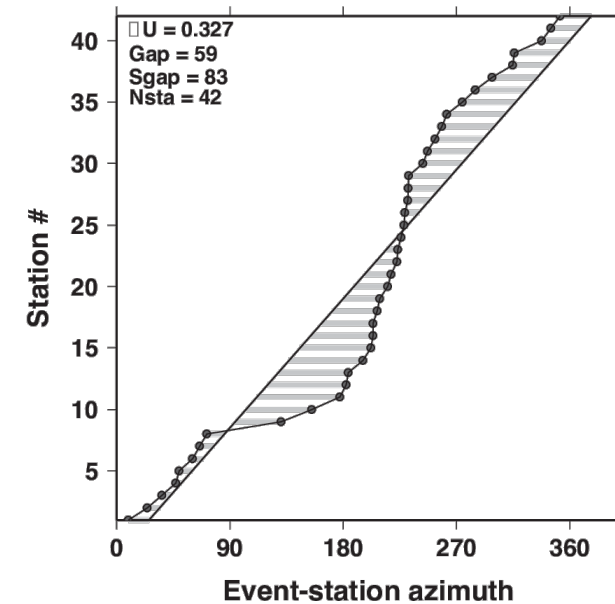
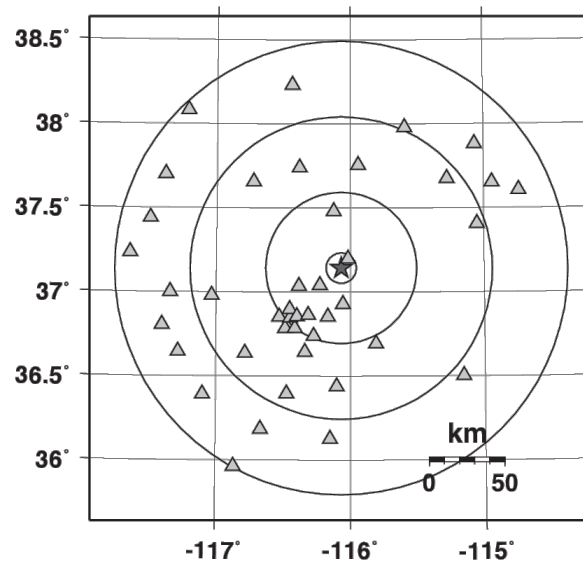
$$\Delta U = \frac{4 \sum |az_i - (unif_i + b)|}{360N}$$

$$\Delta U \in [0,1]$$

$$unif_i = \frac{360i}{N}$$

$$b = \overline{az_i} - \overline{unif_i}$$

N : nb of stations



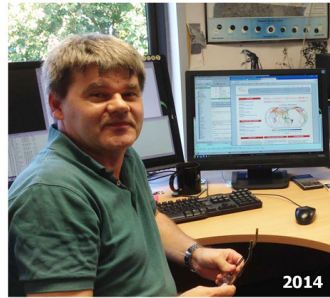
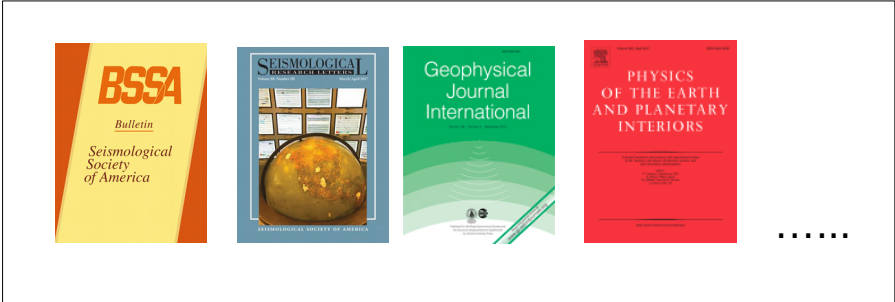
IASPEI reference events – GTx work-flow chart

Bulletin of the International Seismological Centre



Routine review of the ISC bulletin for GT5 candidate events

Search for GT events in publications



2014

Nominate an event



IASPEI GT events

IASPEI Ground Truth (GT) reference events: nominate event

The seismological community is invited to nominate events (including both earthquakes and explosions), for the reference events database, where hypocentre information is known with high confidence (to 2.5 km or better). GT5: Significant earthquakes may be considered for further contribution and for archive time slide. Proper acknowledgement will be given to all contributors.

Please use the following information to complete the nomination form.

Reference Event submission form

Please ensure that sections marked with * must be completed

Date and Origin Time *

2017 03 00 00:00 00:00 Six integers followed by the fraction of a second reported with an appropriate number of significant figures to convey the quality of the origin time parameter. 0, 2, 3, or 7/5.

Coordinates *

Latitude (degrees) Longitude (degrees)

Introduce the coordinates of the event using an appropriate number of significant digits to convey the quality of the hypocentre (down to 0.05 degrees or better).

Focal Depth (km) *

Introduce the depth of the event using an appropriate number of significant digits to convey the quality of the hypocentre.

GT epicentre quality (km) *

GT5 epicentre quality (km) as claimed by contributor. For example, GT5 means that the submitted epicentre estimate has a 95% chance of lying within 2 km of the true epicentre.

Event type *

Earthquake
 Single-line explosion
 Hypocentre explosion
 Rockburst or "mine bump"
 Mine collapse
 Other

Methodology

A brief description of the methodology, e.g.

- Ground survey of known explosion location, with or without information on shot time
- IASPEI
- First-arrival tomographic analysis
- Analysis of seismic data that meet criteria of Bondar et al (2014)
- Special observations (such as slugs)
- Citation of a specific technical report or scientific paper

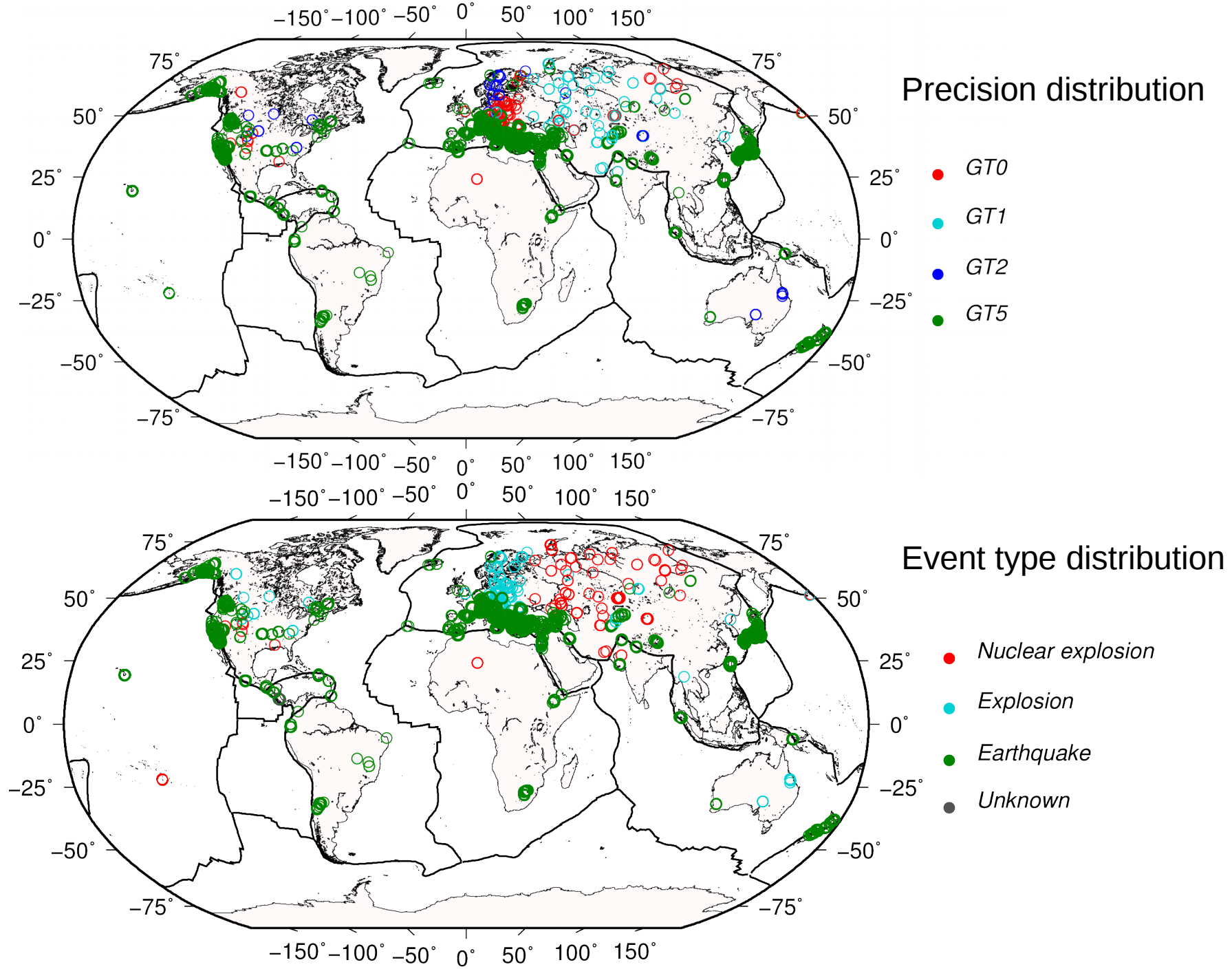
Send GT5 selection for review to the IASPEI working group

Update the GT database

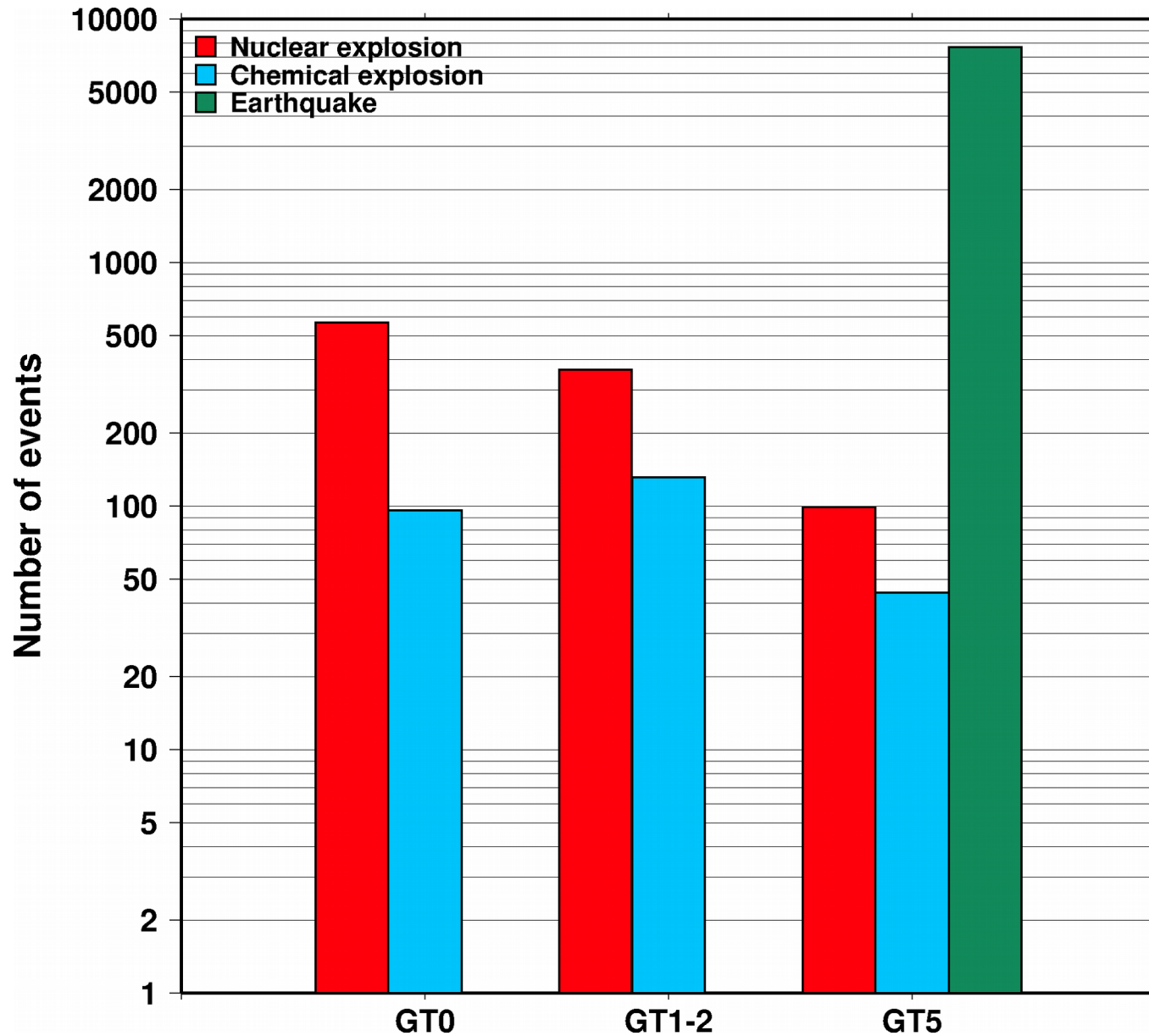


IASPEI Ground Truth (GT) reference events

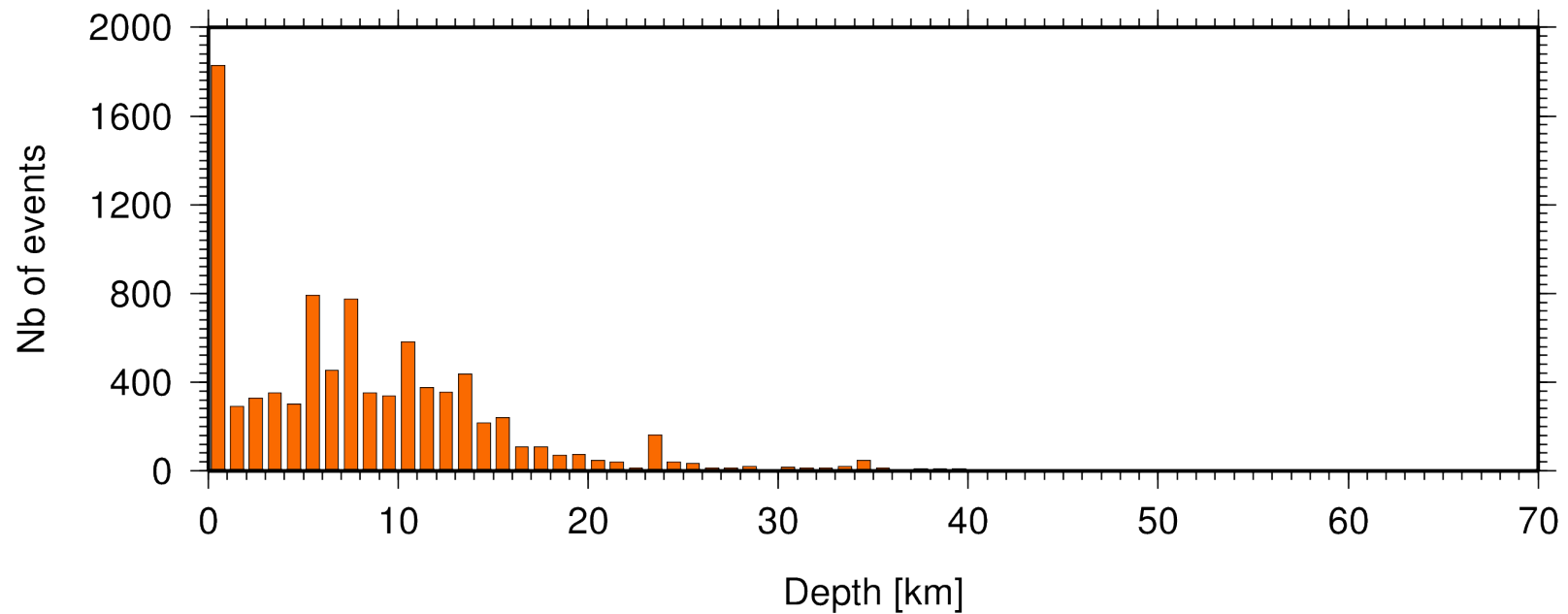
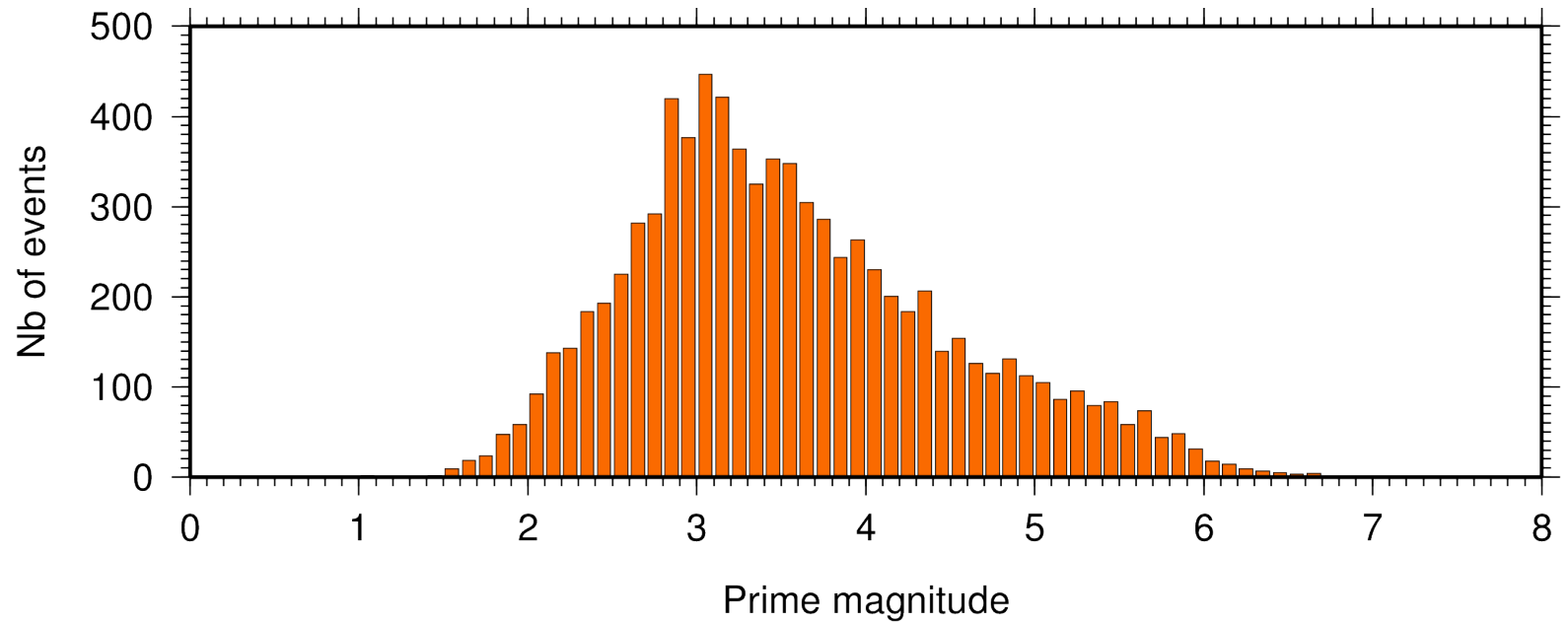
IASPEI reference events – Geographic distribution



IASPEI reference events – Precision & event type distribution



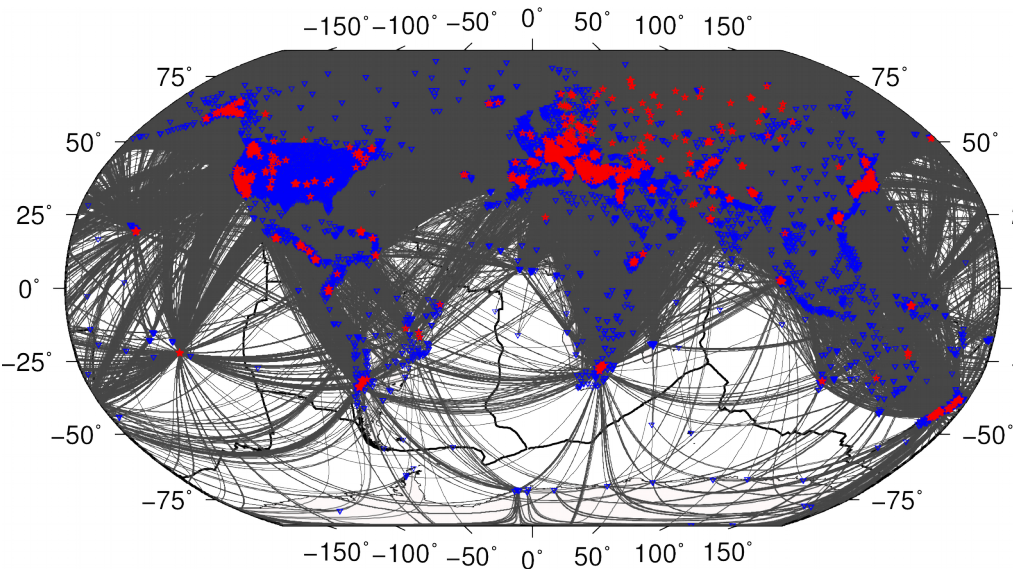
IASPEI reference events – Magnitude & depth distribution



IASPEI reference events – Associated phases

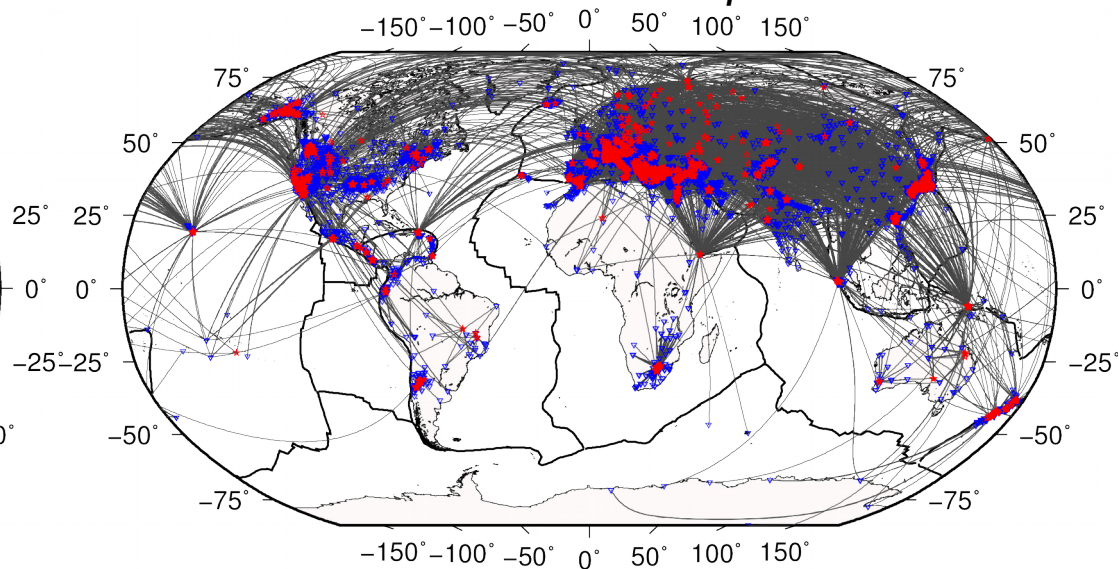
P, P_n, P_b, P_g

nb of phases: 580388



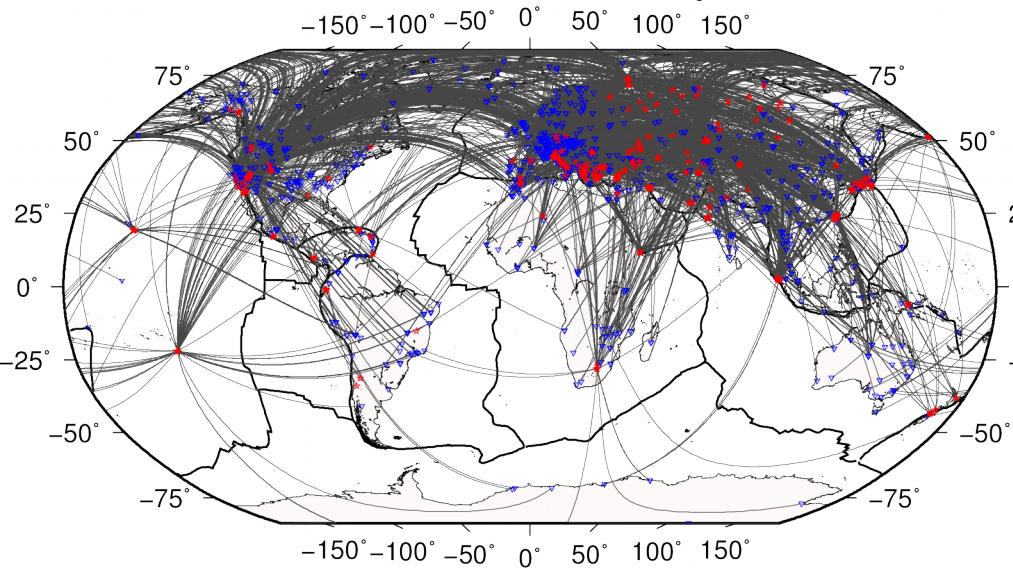
S, S_n, S_b, S_g

nb of phases: 161196



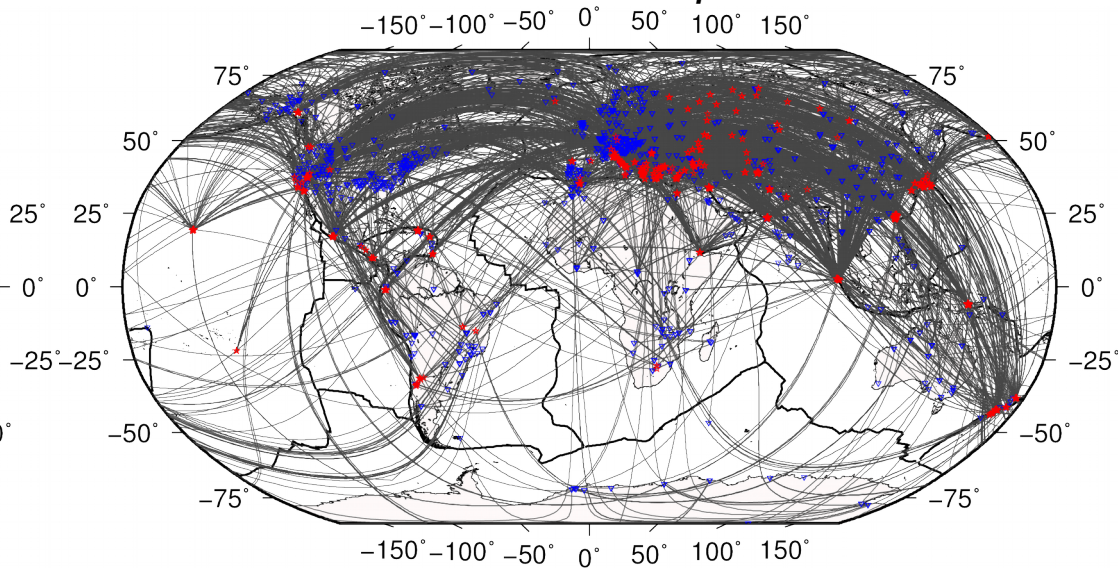
P_cP, S_cS, P_cS, S_cP

nb of phases: 6450

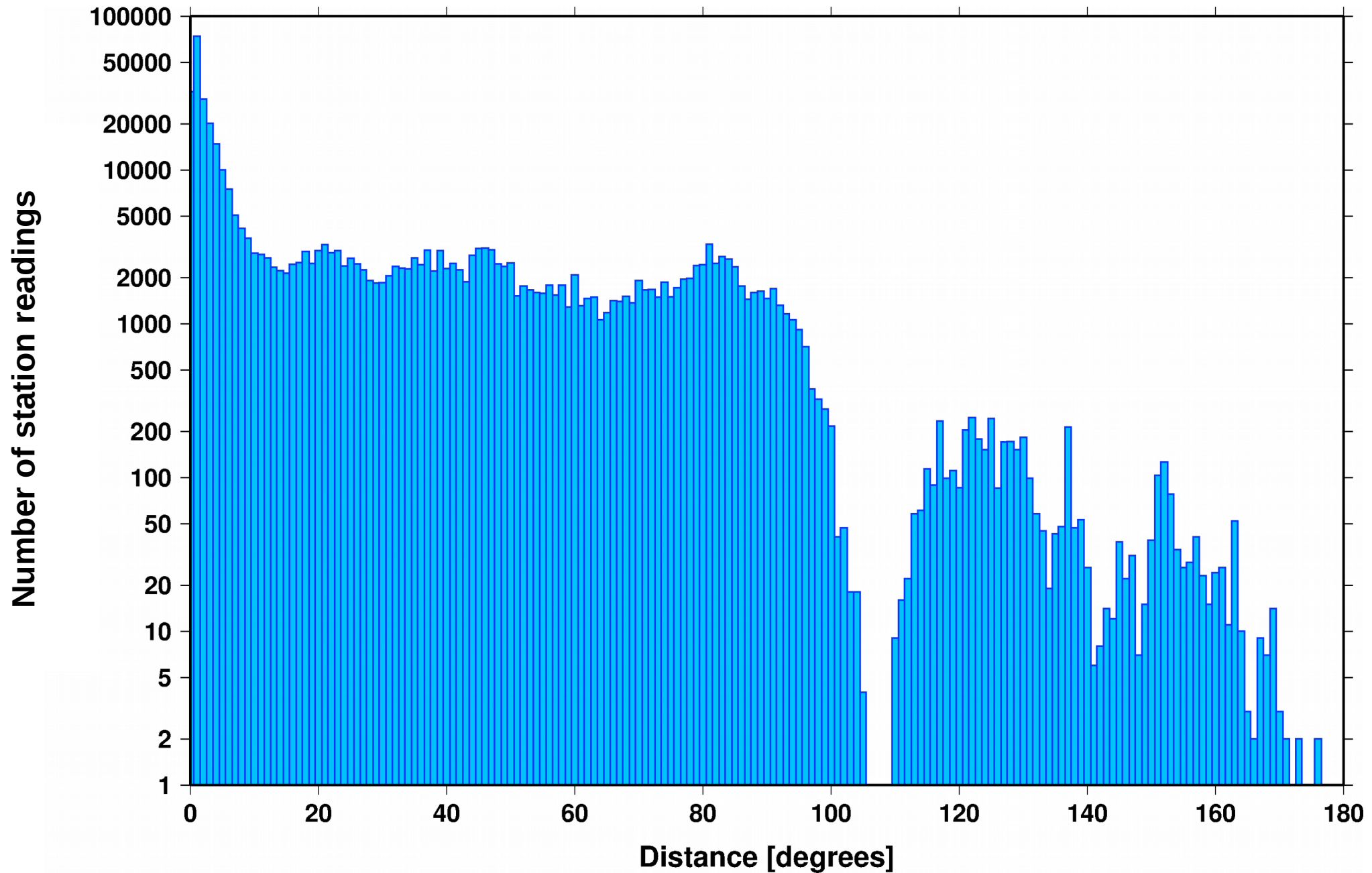


$pP, pS, sP, sP_b, sP_n, sS$

nb of phases: 4900

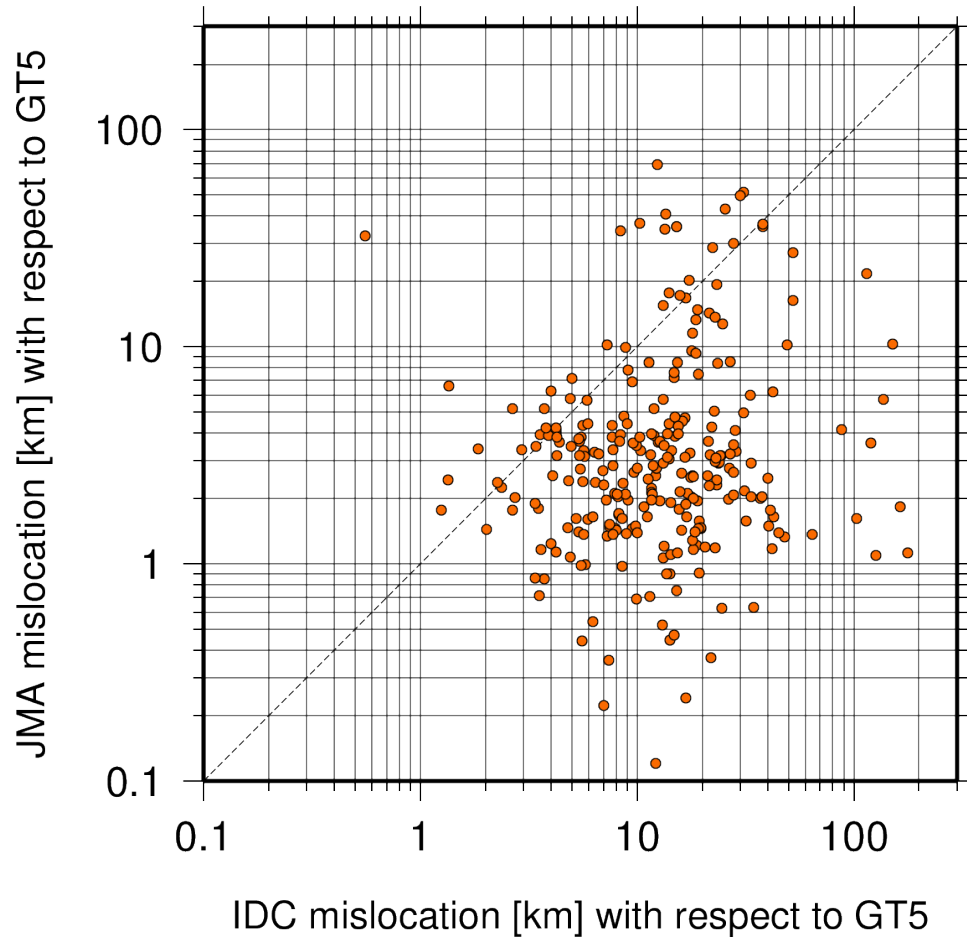


IASPEI reference events – Station readings

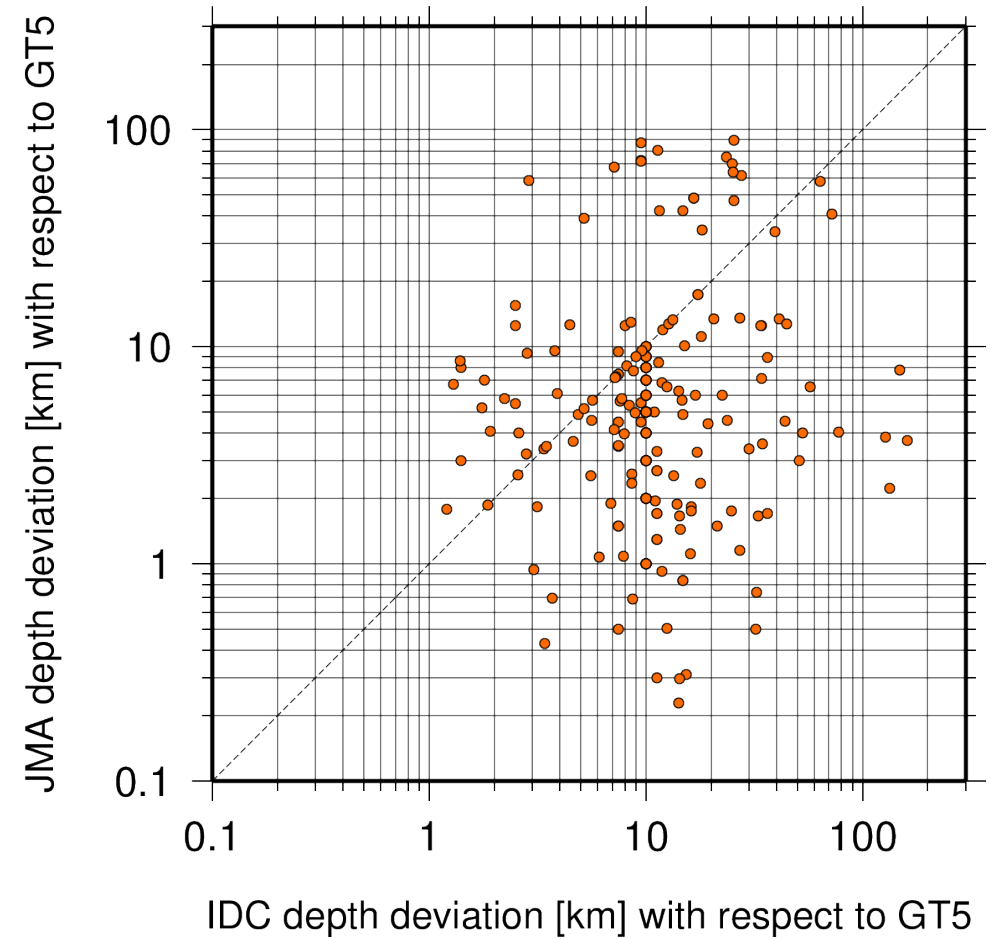


IASPEI reference events – Network comparisons

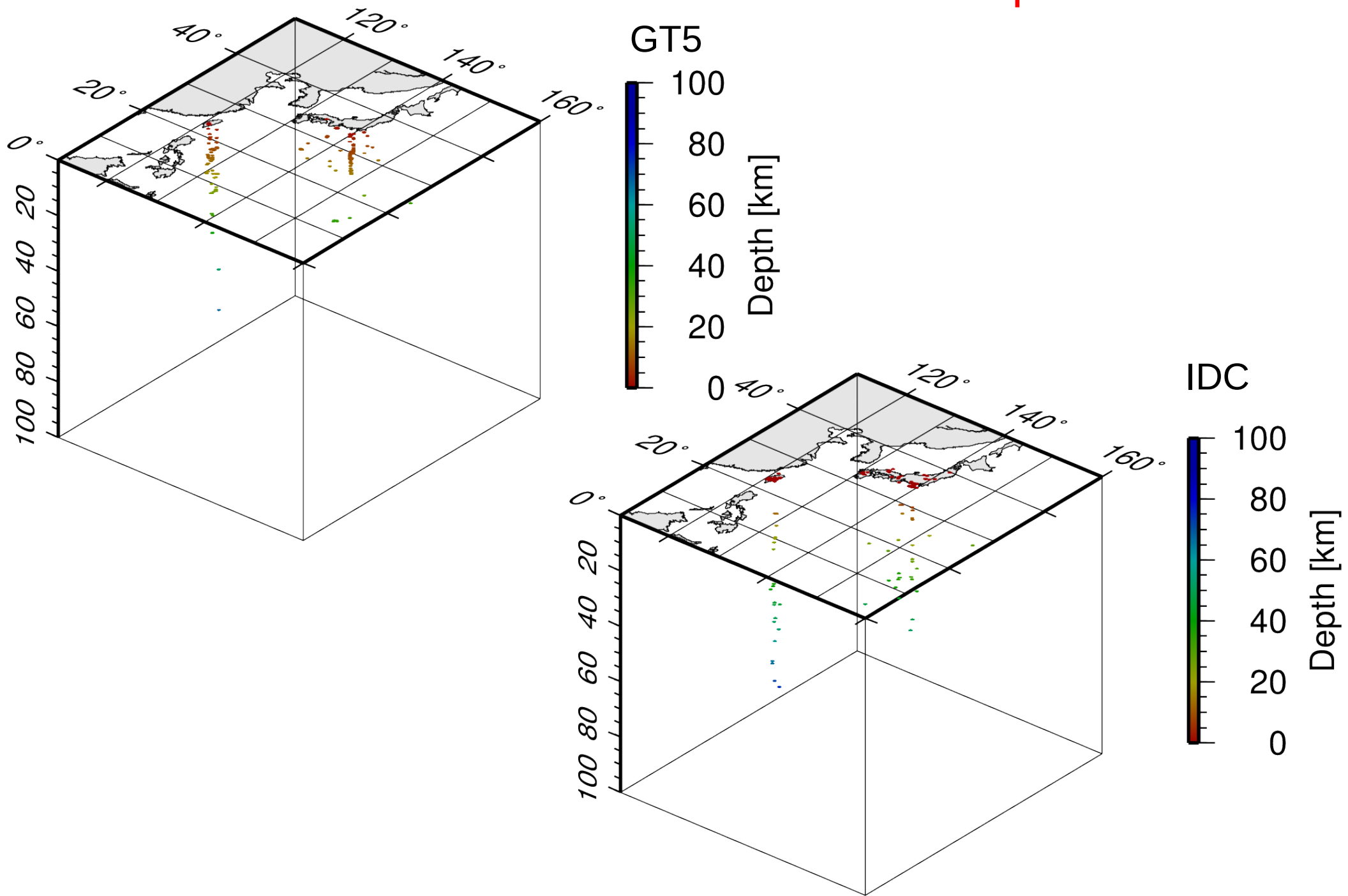
nb of events = 267



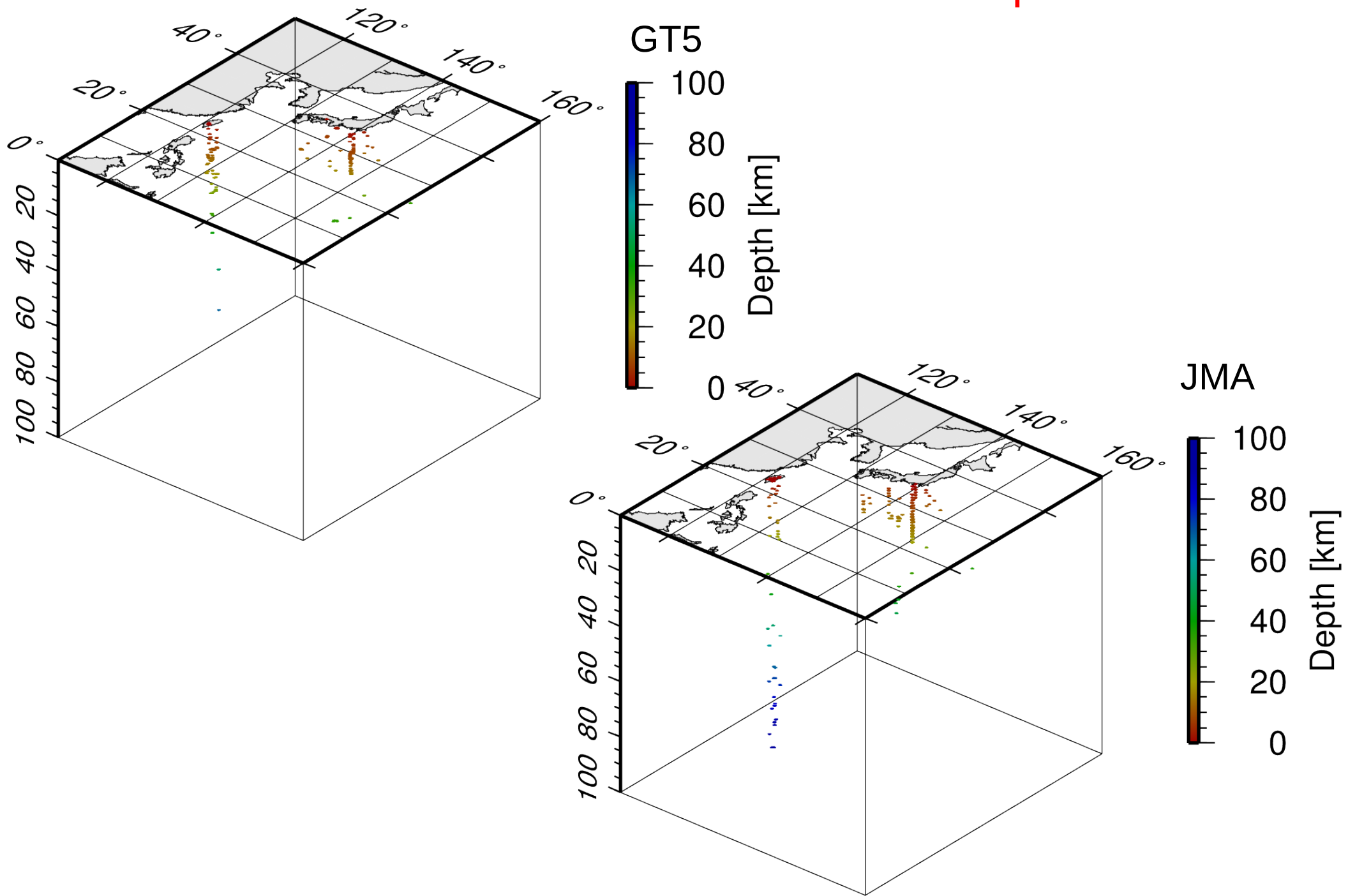
nb of events = 267



IASPEI reference events – Network comparisons



IASPEI reference events – Network comparisons



Conclusions

- The GT database contains a substantial number of reference events for increased accuracy of event locations, better modelling of velocities of seismic waves and more accurate travel time determinations.
- Depth and origin time estimates depend strongly on the velocity structure, thus, the GT network criteria focus on location accuracy only.
- The GT database shows poor raypath coverage in the South hemisphere that can be improved by collecting arrival time data from temporary deployments.
- The ISC will continue to maintain and routinely update the “IASPEI reference events” list.

Acknowledgements

64 Institutions in **48** countries, including the **Royal Society**, **BGS** and **Blacknest** in UK, make the annual **membership** subscriptions to the ISC.

14 international, public or commercial entities sponsor individual ISC **projects**:



CTBTO Link to ISC database



International Station Registry



ISC Event Bibliography



*Aon Benfield,
Lloyd's,
Guy Carpenter,
Catlin.*



ISC-GEM Catalogue