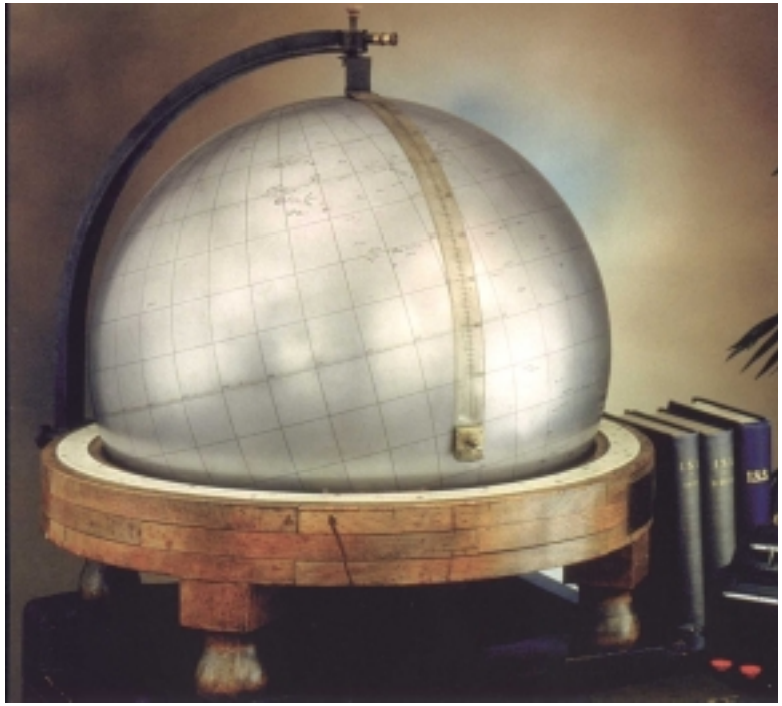
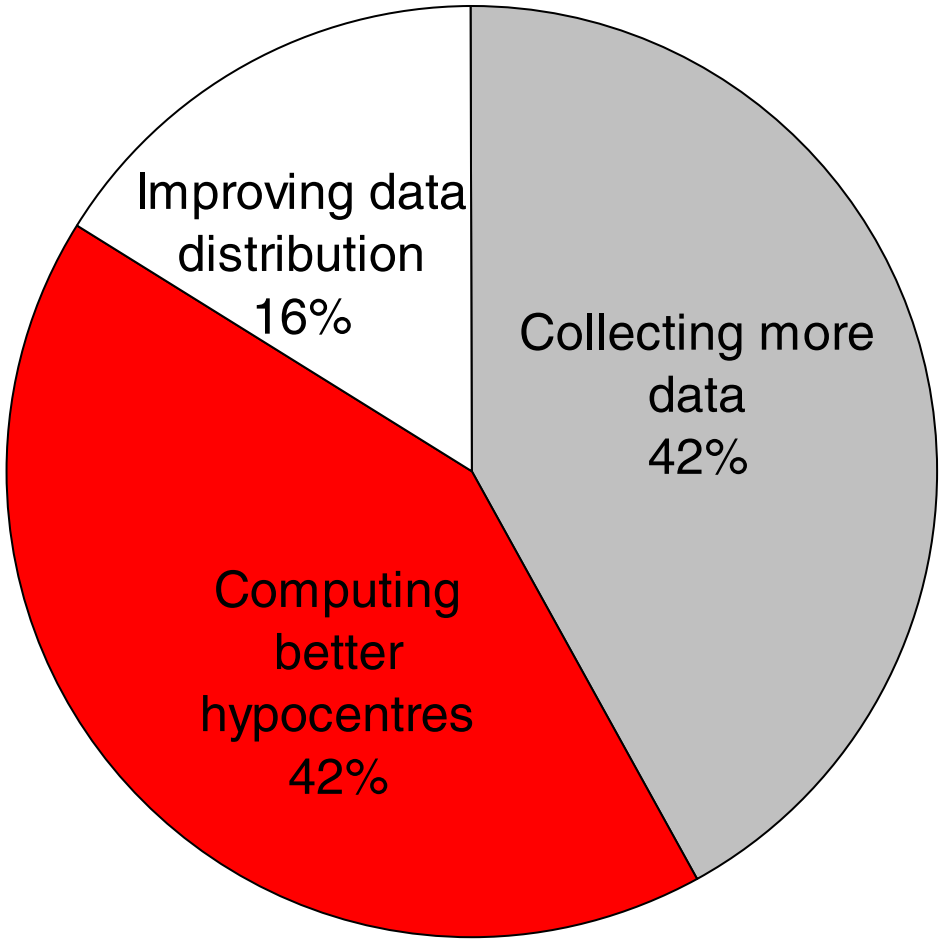
THE RESULTS OF LOCATING THE IASPEI GT(0-5) REFERENCE EVENTS USING STANDARD ISC PROCEDURES



Dmitry A. Storchak

International
Seismological Centre

2003 ISC Web-User's Survey



What has been done at the ISC so far to improve location ? *(I)*

S: M. Andrianirina, R. J. Willemann, Q. F. Chen, D. A. Storchak. Improved Locations for Moderately Small Earthquakes Using Regional and Teleseismic S. AGU 2000.

- use of S phases leads to better constrained solutions.
- additional use of S arrival times increases convergence - allows hypocentres to be determined for a number of events that could not have been previously located using P arrival times only.

PKP: D.A.Storchak, Q.-F. Chen, R. J. Willemann and M. Andrianirina (2000). Improved locations for moderately large earthquakes using regional S and PKP, *EOS Trans. Am. Geophys. U.* **81**, Fall, S71C-01.

- Use of PKP could be beneficial for constraining hypocentres.
- JB PKP travel times are inadequate.

What has been done at the ISC so far to improve location ? *(II)*

3D: Q.F. Chen and R.J. Willemann. Global test of seismic event locations using three dimensional Earth models,BSSA,2001.

- 3D models (KH07,SP12) improve event locations over each of the 1-D models (AK135,PREM,JB) that were tested.
- ISC depths are likely to be improved more by using arrival times of phases that expand the range of vertical slownesses, such as depth, secondary, and core phases (Storchak et al., 2000) , than by use of travel time models better than KH07 or SP12.
- Using local, regional and teleseismic initial arrival times and any travel time model, including JB, gives much better than locations than using initial teleseismic arrival times alone and even the best 3-D models.

What has been done at the ISC so far to improve location ? *(III)*

Crust 2.0 & JB or IASP91: R.Luckett & R.J.Willemann. Would crustal Travel time corrections improve ISC locations? IUGG 2003.

- The absolute residuals of P arrival times increase at more than half of all stations. Mislocations generally became larger.
- Ray tracing through the Crust + upper mantle model (Colorado Uni) produces travel times fitting to real observations of GT-events better than JB.

SSSC: R Luckett, R J Willemann**.** Investigating Alternative Location Methods at the ISC.

- The use of travel time tables, calculated in the form of SSSC for standard 1D model by ray-tracing through detailed upper mantle model (Colorado University) and mantle model (Harvard University), generally improves residuals for both Nevada and Kazakhstan nuclear tests.
- The procedure requires further testing for different regions.
- Non-trivial computer memory arrangements are to be involved.

Relevant developments at NEIC

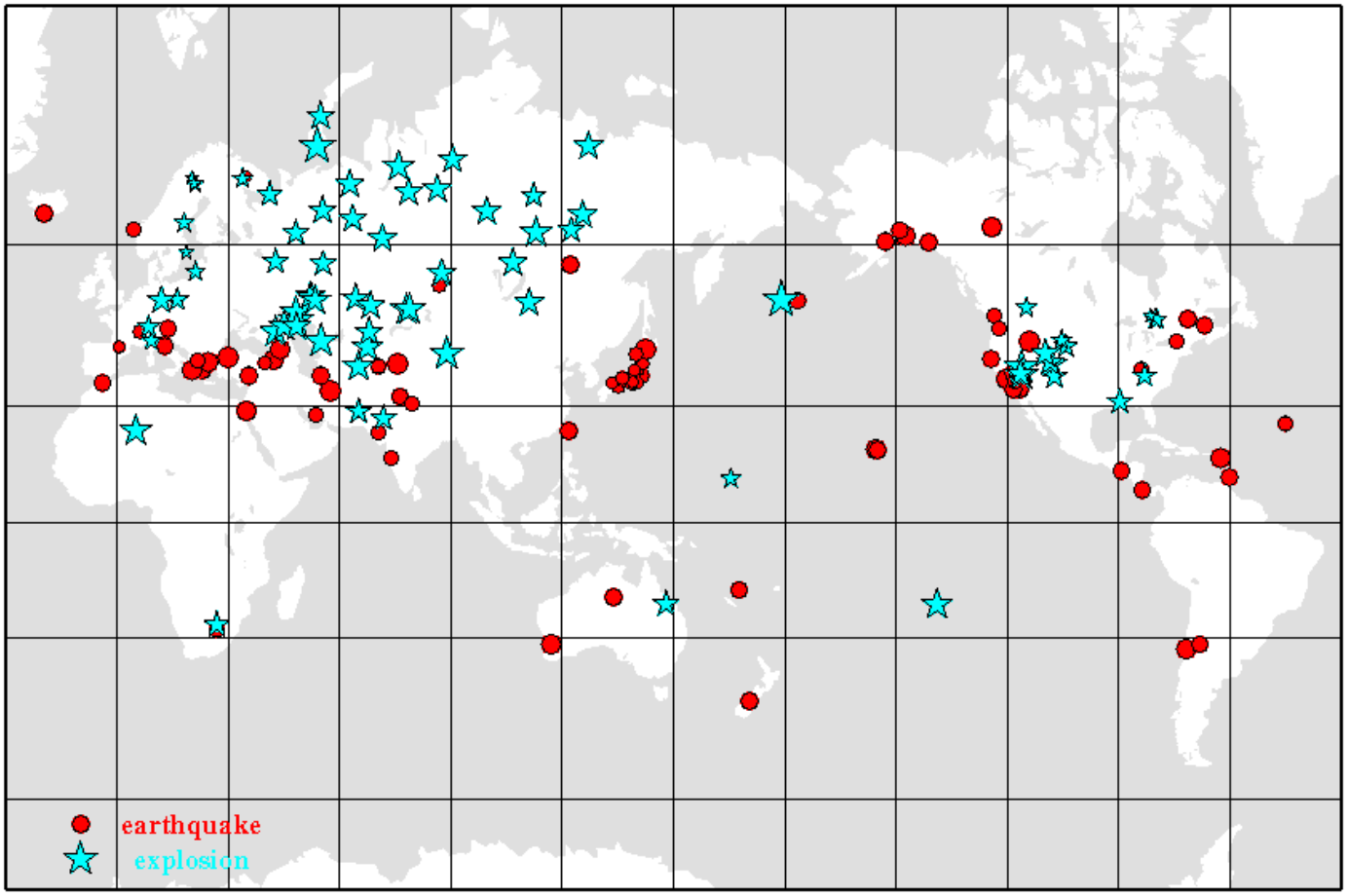
- AK135 is used instead of JB (data year 2004 onwards)
  - Better general fit in continental areas
  - Regional Pn fits better
  - A few additional secondary phases, PKPbc in particular
- Additional procedures available to analyst:
  - Master event location
  - Broad band depth determination

Standard ISC location procedures

Traditionally, from 1964, ISC uses:

- Geiger's least square procedure [Geiger, L. (1912). Probability method for the determination of earthquake epicenters from the arrival time only, *Bull. St. Louis Univ*. **8**, 60-71.];
- Jeffreys's uniform reduction residual weighting scheme[Jeffreys, H. (1939). *Theory of Probability*, Oxford University Press, London.];
- Jeffreys & Bullen travel times[Jeffreys, H. and K. E. Bullen (1940). *Seismological tables*, British Association for the Advancement of Science, London.];
- Phases identified according to the best residual fit;
- P,Pn,Pb,Pg and
- S,Sn,Sb,Sg arrival times (from 2001).

GT(0-5) Reference Event List



A list of 156 well-located reference events (GT0-GT5) was selected by E. R. Engdahl from the IASPEI collection of Ground-Truth (GT) events (Bondar et al., 2004). All events are accompanied by station arrival data from the ISC database.

In This Study:

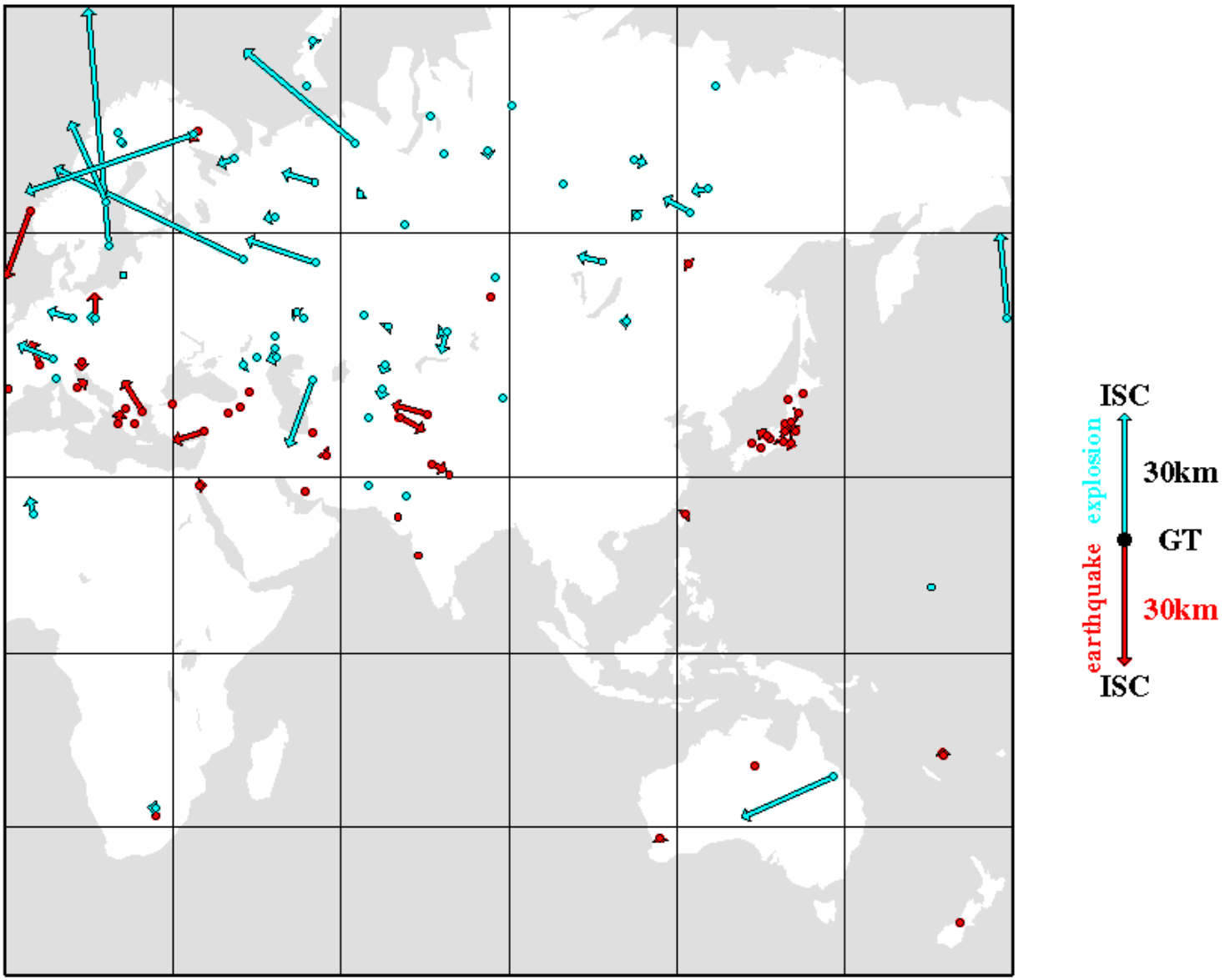
Depth

- We aimed at a free depth if possible; if not -
- we fixed the depth at reported / pP-P / default depth, in that order.

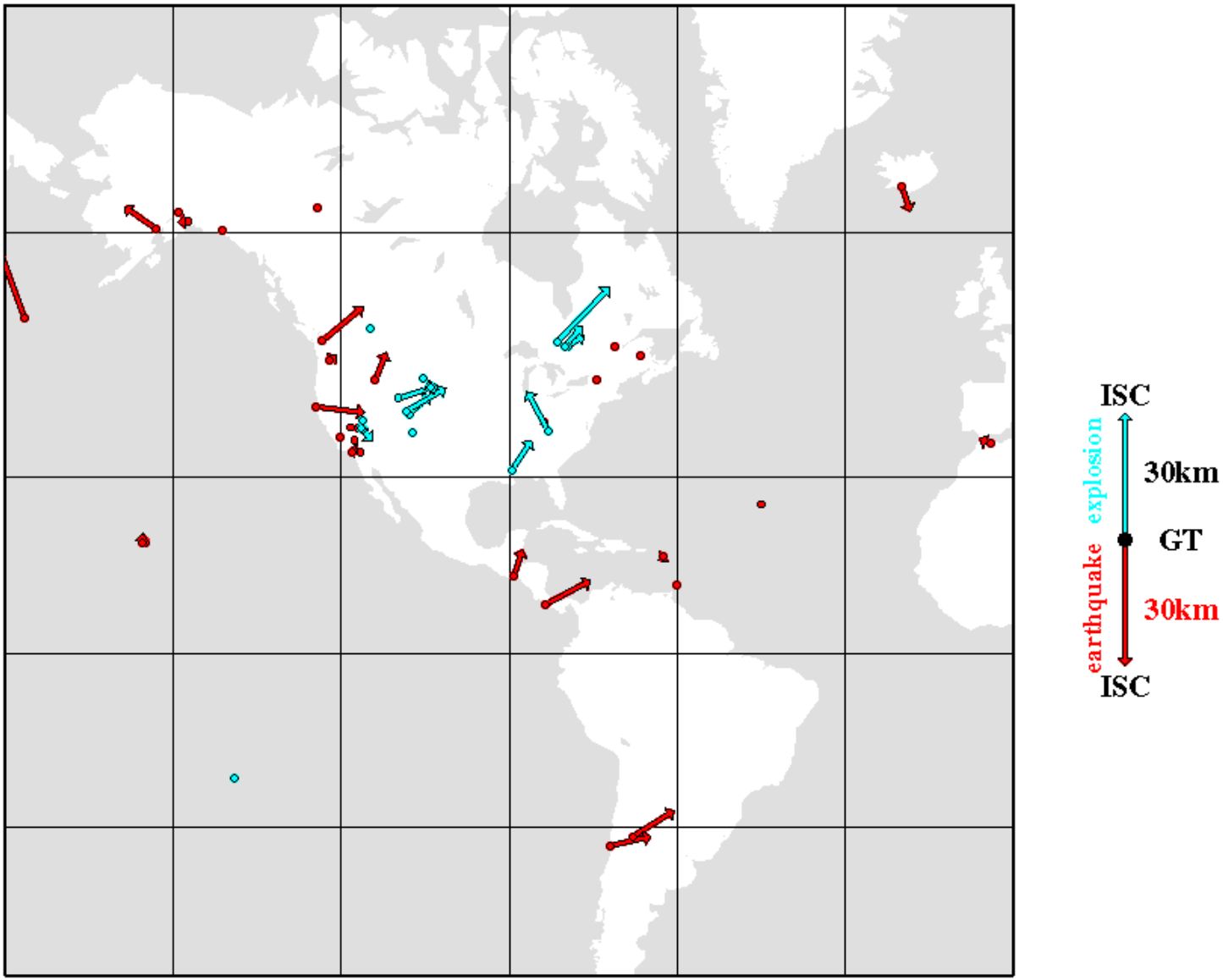
Interpretation of uncertainties

- We know that ISC relocation results by far do not present the state of the location art, so
- we are interested in demonstrating a minimum guaranteed difference between ISC and GT solutions by showing their minimum possible value in view of estimated uncertainties. Therefore, the discrepancies are at least as large as we show them.

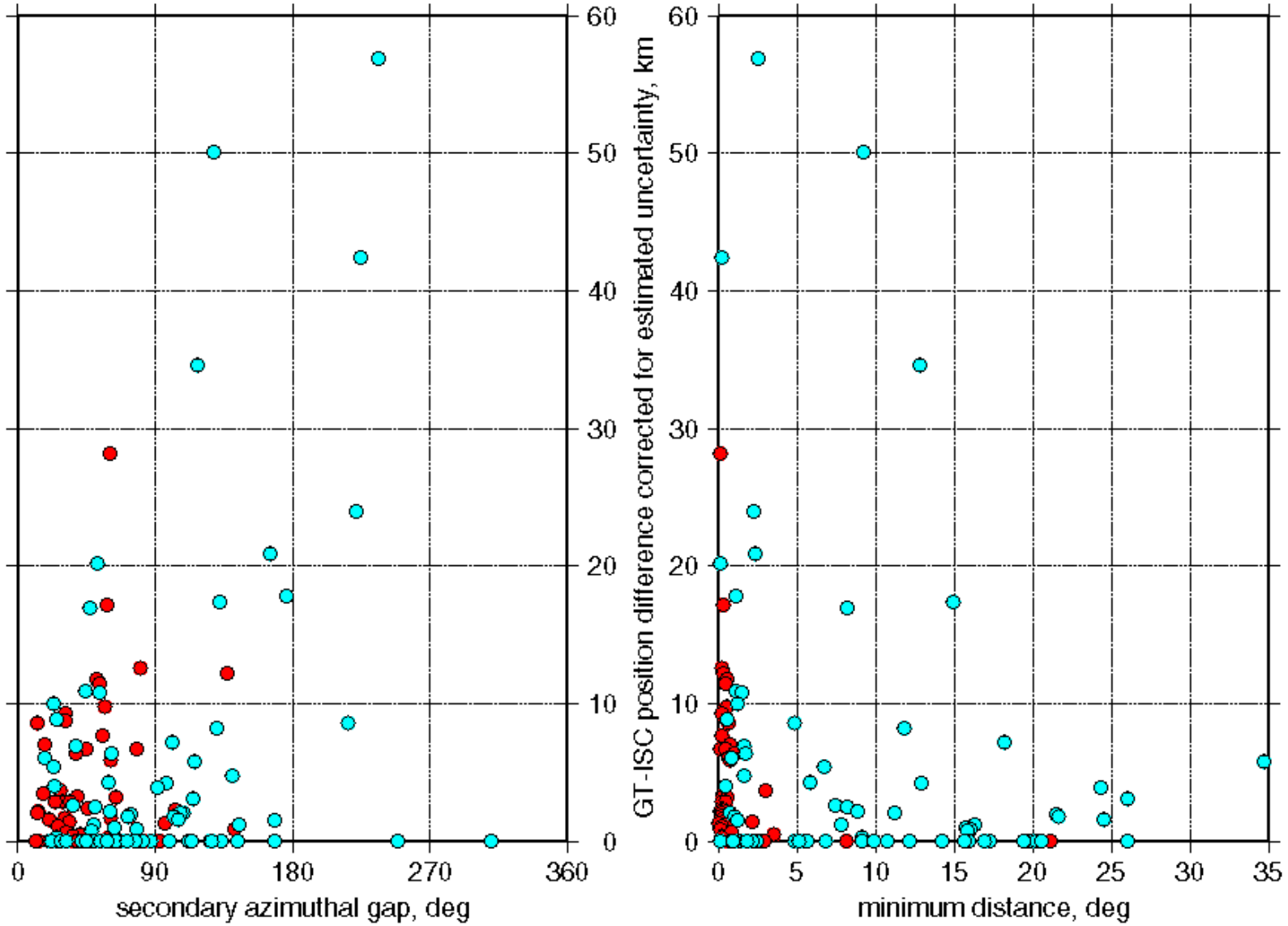
GT → ISC location shift (east)



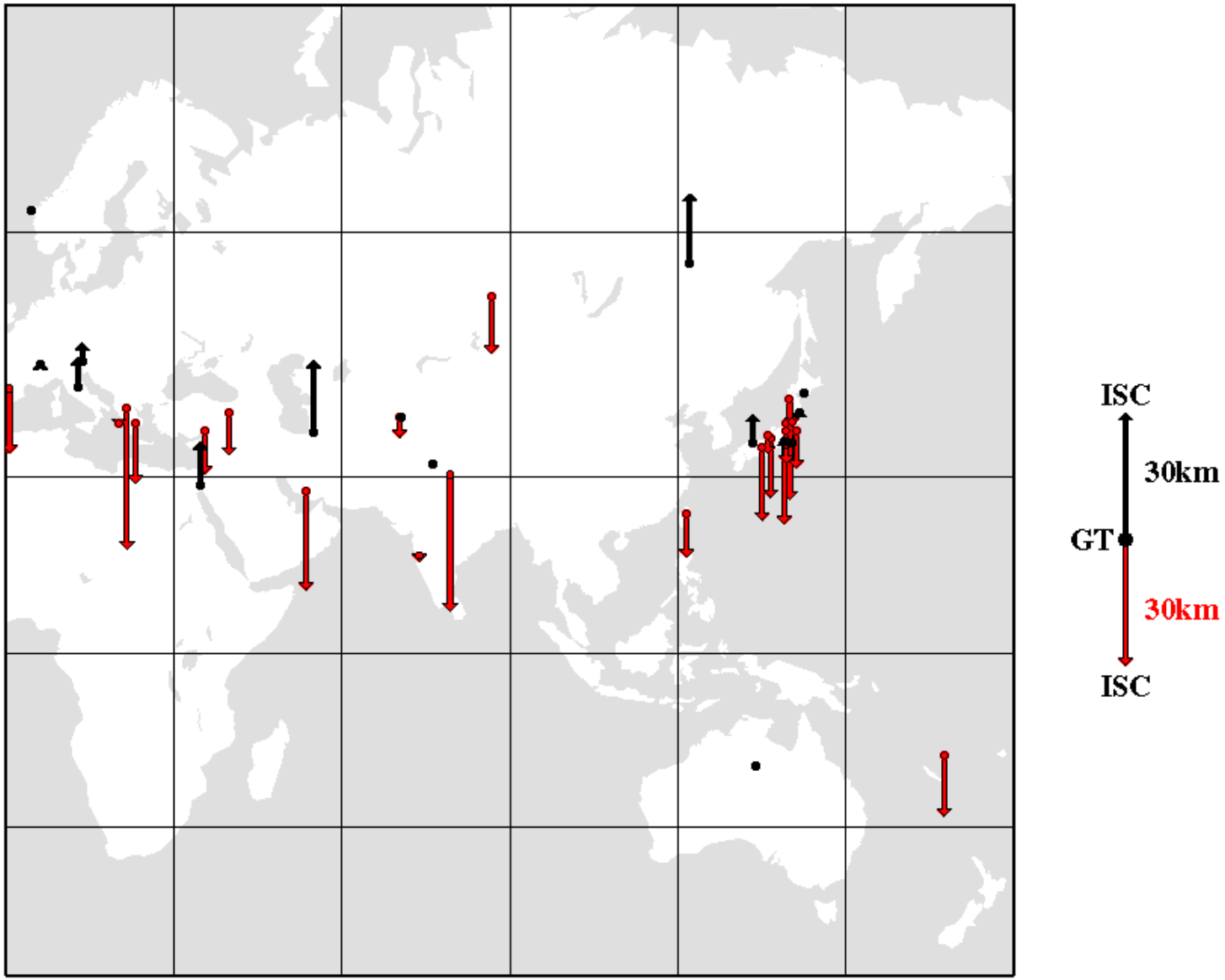
GT → ISC location shift (west)



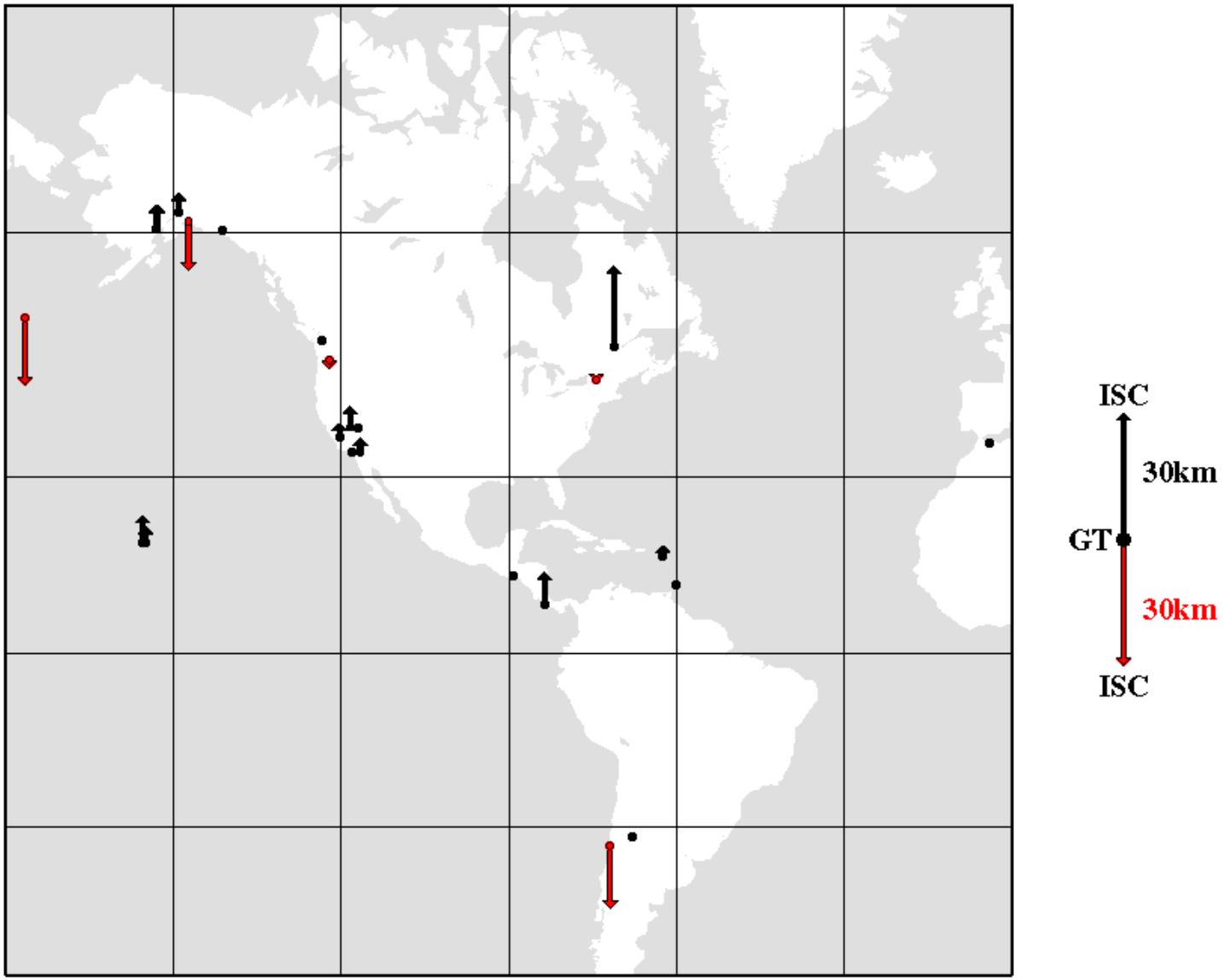
Distribution of GT→ISC location shifts



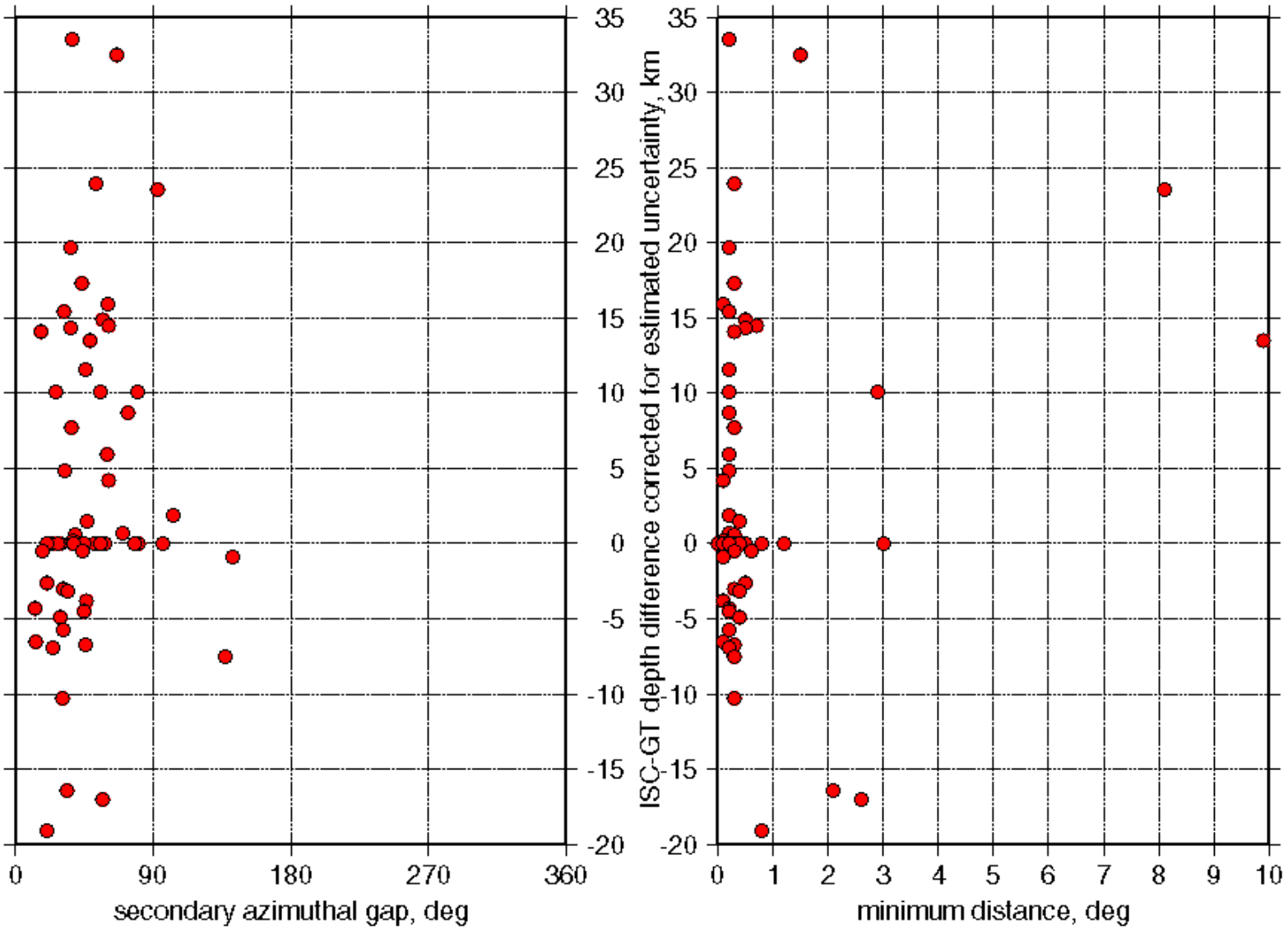
GT → ISC depth shift (east) EQ only



GT → ISC depth shift (west) EQ only



Distribution of GT→ISC depth shifts



ISC relocation results

- 92% earthquakes and 83% explosions had minimum possible shift in ISC location of less than 10 km.
- Largest epicentre shifts, 30-60 km, are found for explosions, and not for earthquakes.
- Largest epicentre shifts for earthquakes can often be attributed to subduction zones.
- ISC hypocentres for earthquakes were more often deeper than reference.
- It is not the network azimuthal coverage and distance to a closest station which are solely responsible for these shifts.

The purpose of this workshop

- Following recent software developments in the ISC Data Management System, it became possible and highly desirable to review and subsequently introduce more up-to-date methods of locating seismic events.
- All proposed improvements in location algorithms should be oriented for daily operation at the ISC, which has to locate globally distributed seismic events based on reported parametric data from local to teleseismic distances.
- The main purpose of the workshop is to discuss possibilities of improving the location capabilities of the ISC by implementing new features/procedures in the ISC software.