

International
Seismological
Centre

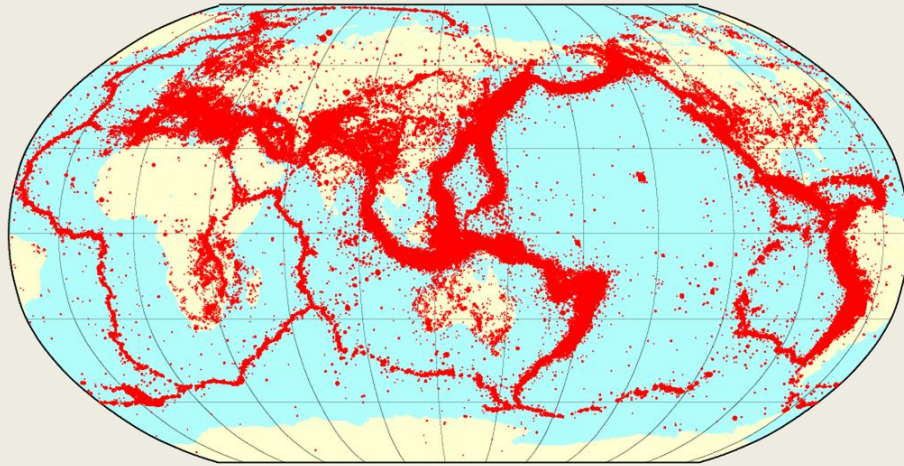
Developments at the **ISC**: new **Locator**, IASPEI **GT** list, Bulletin **Re-Build**, ISC-**GEM** Catalogue and the **CTBTO-Link**

Dmitry A. Storchak, Domenico Di Giacomo, István Bondár & James Harris

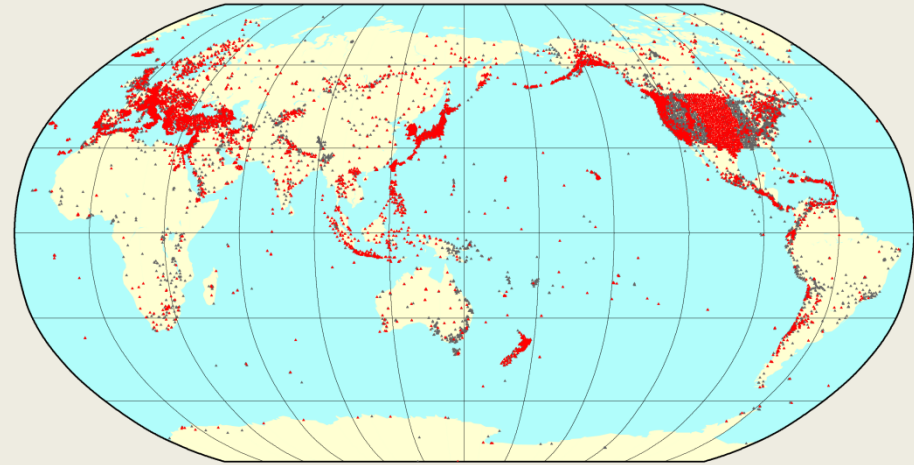
www.isc.ac.uk

Outline: ISC Mission

1: Global definitive earthquake **Bulletin**



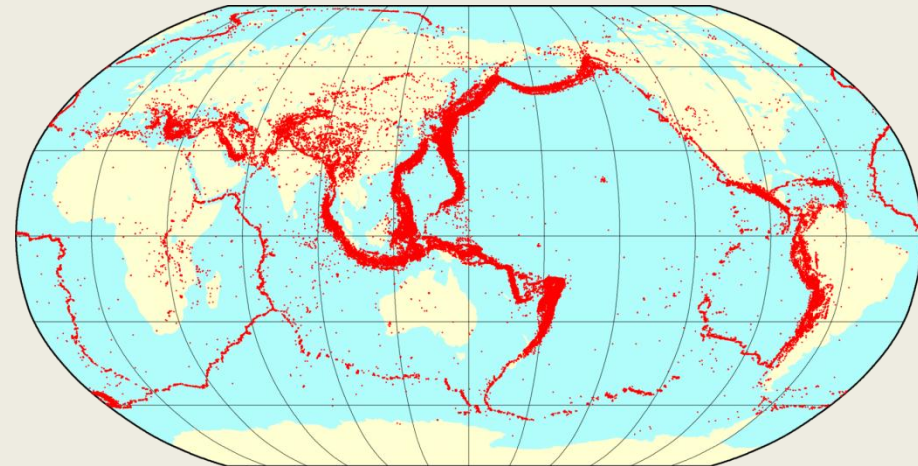
2: International Seismographic **Station Registry**



3: Reference Event (**GT0-5**) List



4: the **EHB**

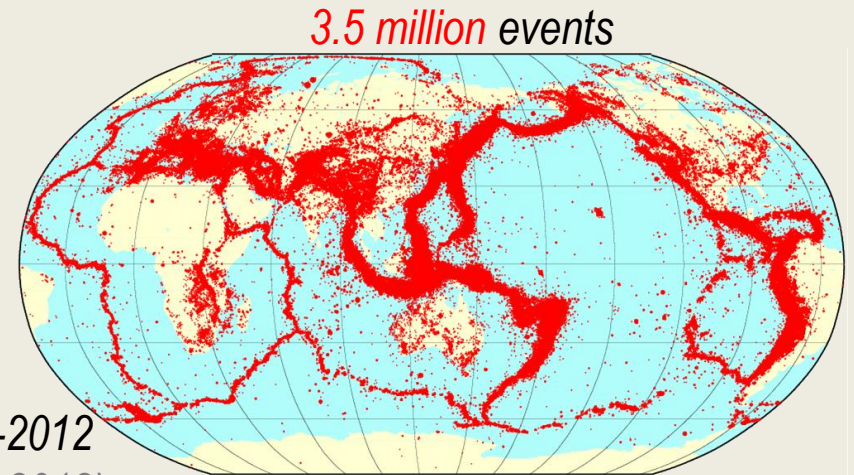
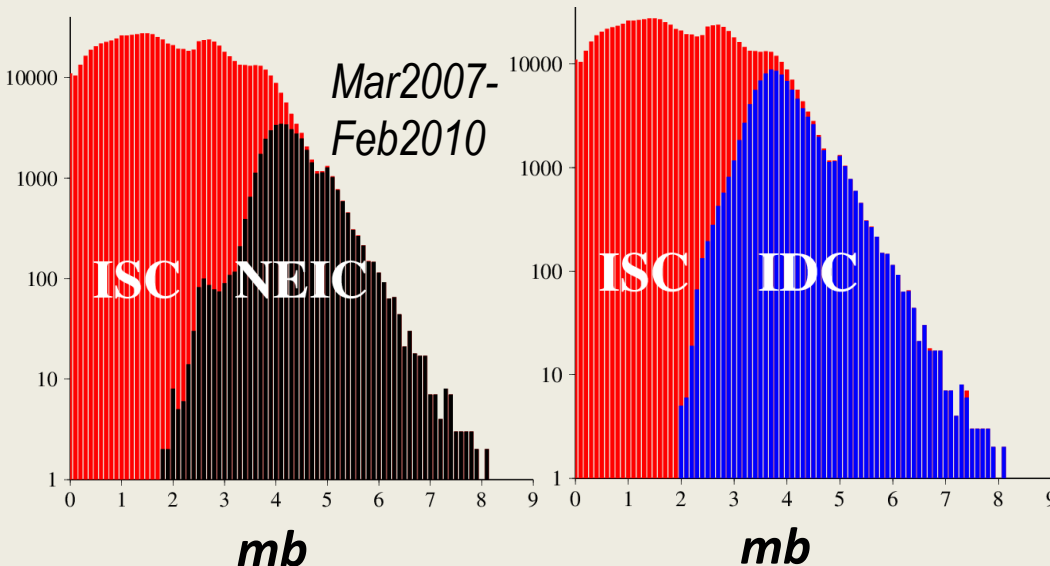


1. Bulletin: the Reviewed ISC Bulletin

The prime mission of the ISC is to compile and distribute the ISC Bulletin - the **definitive** summary of the world seismicity, the longest **continuous & uniform** set of bulletin data.

Preliminary Bulletin is available **soon after events occur**; the **Reviewed** Bulletin is available **24 months** after event occurrence.

The ISC data are **free and open**.



1960-2012
(1904-2012)

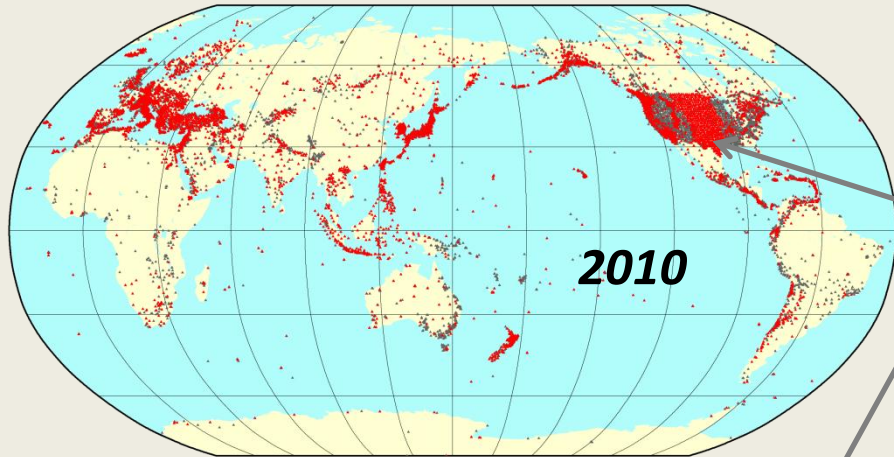
Thanks to its **international and non-governmental status**, the ISC is able to collect seismic bulletins from ~130 institutions worldwide.

The ISC Bulletin **includes** data sets such as:

- ✓ NEIC, GCMT, EMSC, JMA etc
- ✓ ISS (1900-1964)
- ✓ EHB (1960-2007)
- ✓ IASPEI GT (GT0-5 events)
- ✓ US Array phase picks
- ✓ IDC REB (CTBTO)

2. IR: International Seismograph Station Registry

The ISC, jointly with the World Data Center for Seismology, Denver (NEIC/USGS), is responsible for running the International Seismographic Station Registry (IR).



~1650 *US*
Array stations
are part of the
IR.



17,825 stations, open or closed, are currently registered in the IR; **6,700** of those (red) reported seismic arrival data to the ISC in **2010** (above) and **2008** (below).



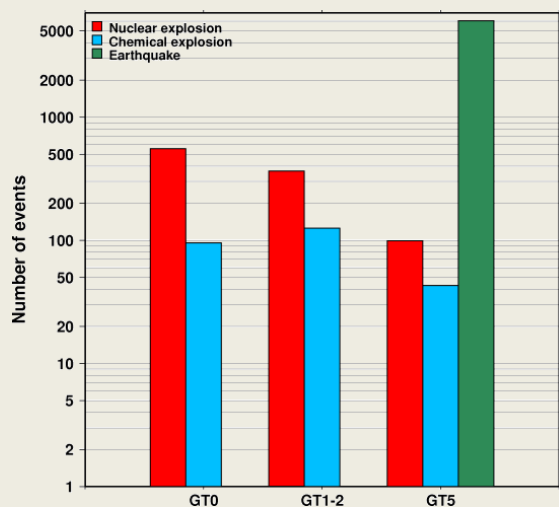
IRIS DMC
archive uses
the IR station
codes

At the ISC web-site one can submit information to register a new station as well as search and obtain information about already registered stations.

3. GT: Maintaining IASPEI Reference Event List (GT)

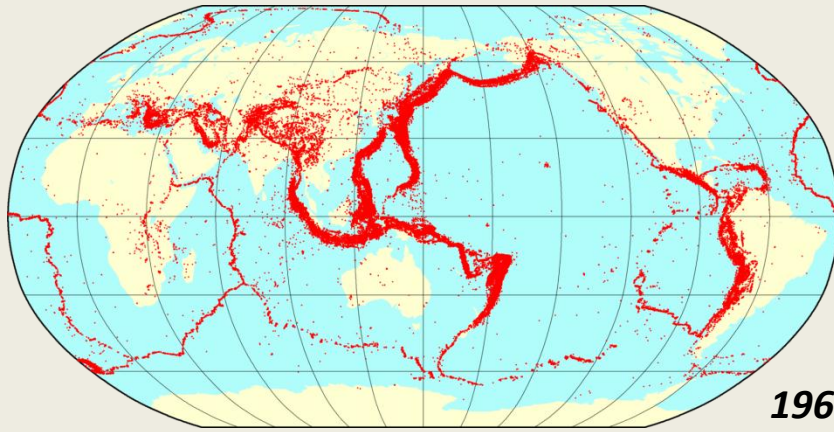


7,412 GT0-5 seismic events
with station arrivals

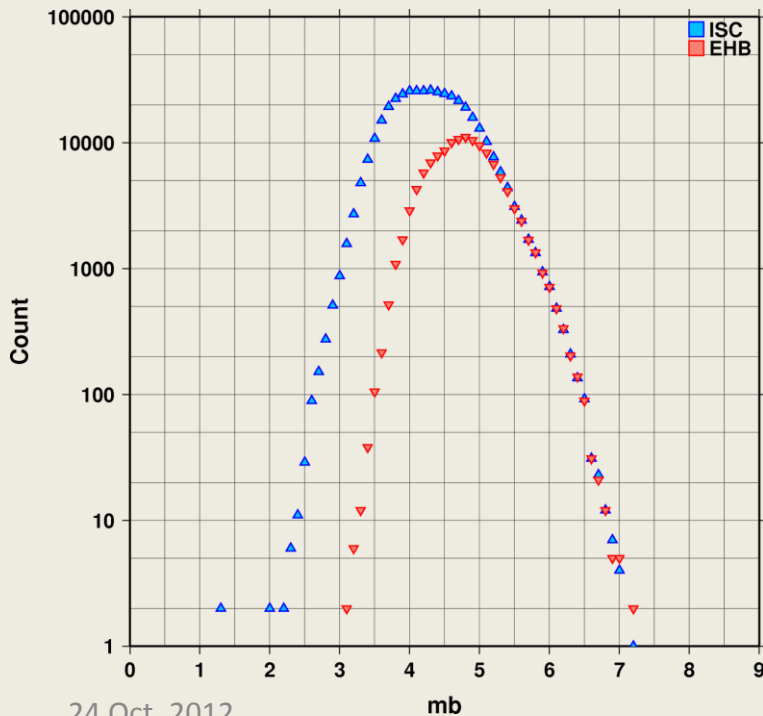


- GT (ground truth): locations known at 95% confidence level
- GT0-5 locations are necessary to
- Validate 3D Earth models against observed travel-times
 - Test new location algorithms
 - Develop empirical path corrections
 - Assess the accuracy of published bulletins
- The effort was coordinated by the CoSOI/IASPEI Working Group on Reference Events for Improved Locations co-chaired by Bob Engdahl and Paul Richards
 - The data set is hosted on the ISC website and currently contains 7,412 GT0-5 events accompanied with ~500,000 arrival data

4. EHB: Hosting and Distribution of the EHB – a groomed ISC Bulletin



1960-2008



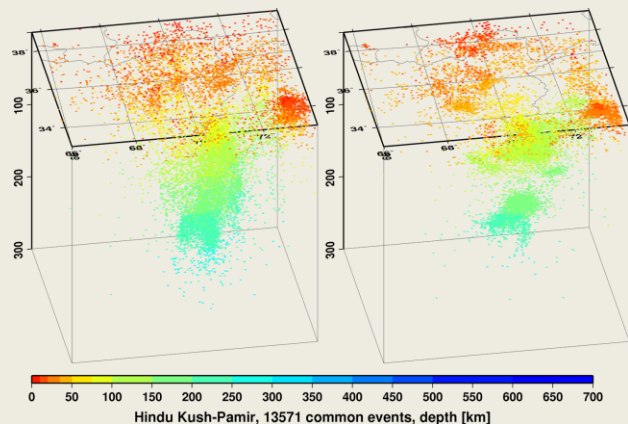
- The **EHB** (E.R. Engdahl, R.D. van der Hilst, R. Buland, 1998) catalogue is **predominantly based on 20% of (larger) events in the ISC Bulletin**. It contains a set of most accurate seismic event locations regularly used in seismic tomography. The EHB algorithm has been used to significantly improve routine hypocenter determinations made by the ISS, ISC and PDE.
- The EHB bulletin is regularly updated by Bob Engdahl as soon as the ISC publishes every next new annual Bulletin
- The EHB is hosted on the ISC website and currently contains ~ 140K events between 1960 and 2008 accompanied with ~20M arrivals

Typical uses of the ISC products: Bulletin, IR, GT, EHB

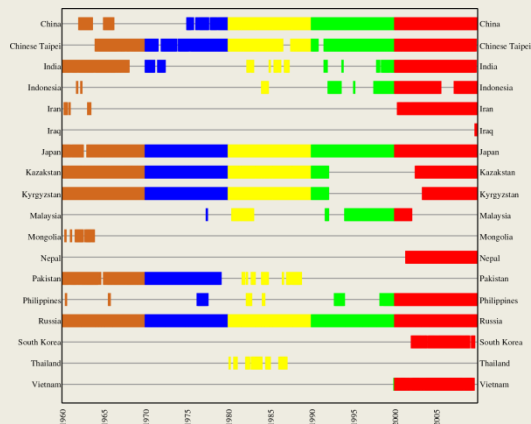
- Starting point to any regional earthquake related study;
- Seismic hazard and risk assessment;
- Studies of inner structure of the Earth;
- Tectonics;
- Monitoring Comprehensive Test Ban Treaty;
- Waveform archival & distribution;
- Testing & validation of:
 - location algorithms;
 - waveform picking algorithms;
 - velocity models.

Outline: ISC Developments

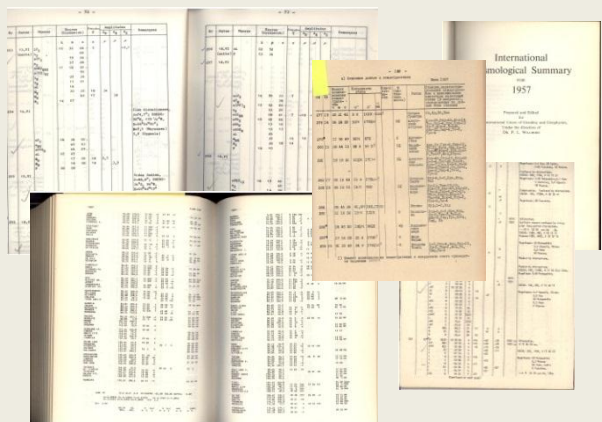
1: New ISC Locator



2: ISC Bulletin Rebuild (1960-2009)



3: ISC-GEM Instrumental Catalogue (1900-2009)



4: CTBTO Link to the ISC database



Area based search

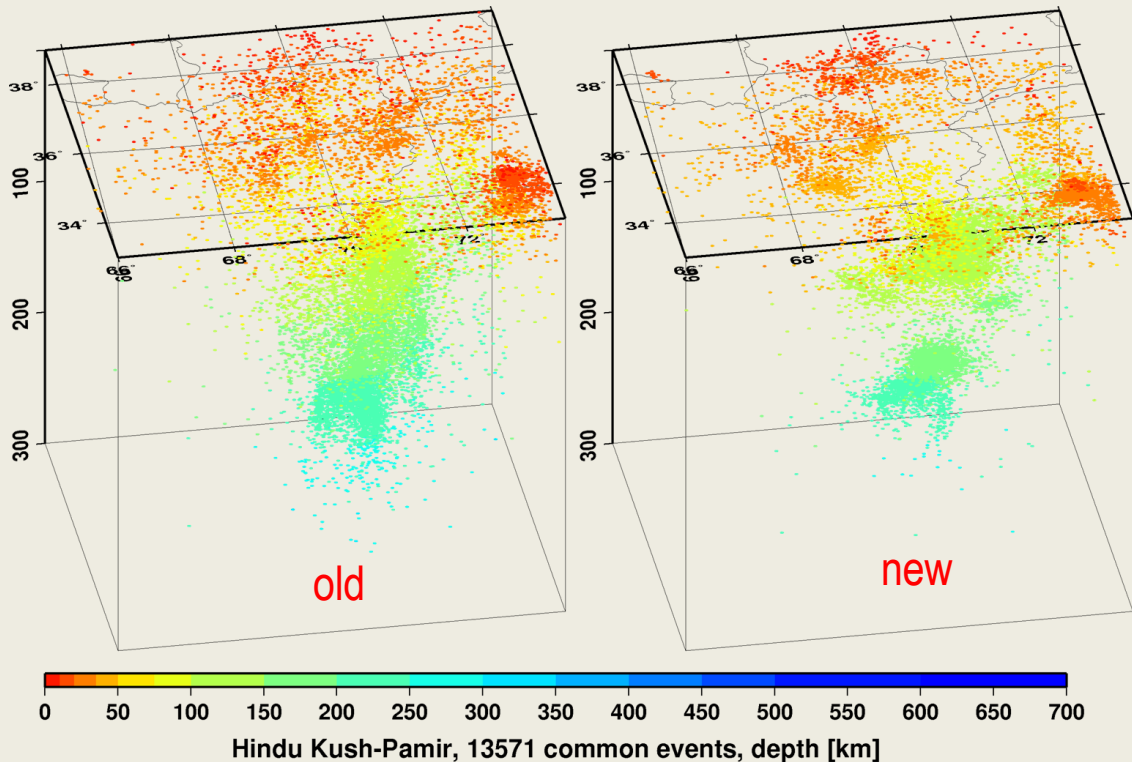


IDC Reviewed Event Bulletin (REB) search



Station based search

1: New ISC Earthquake Location Algorithm



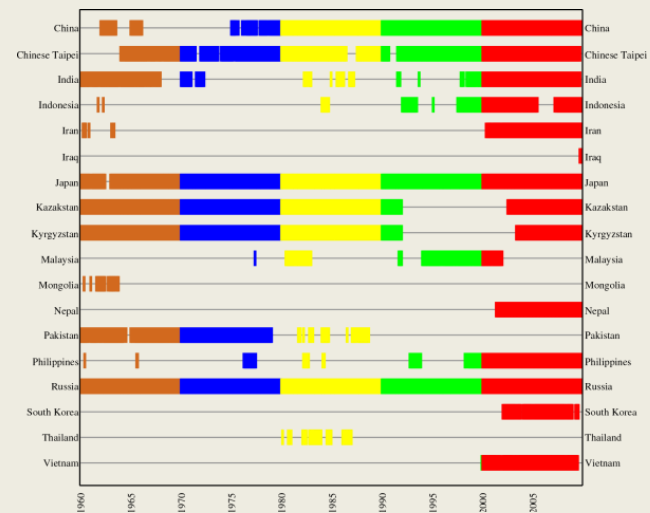
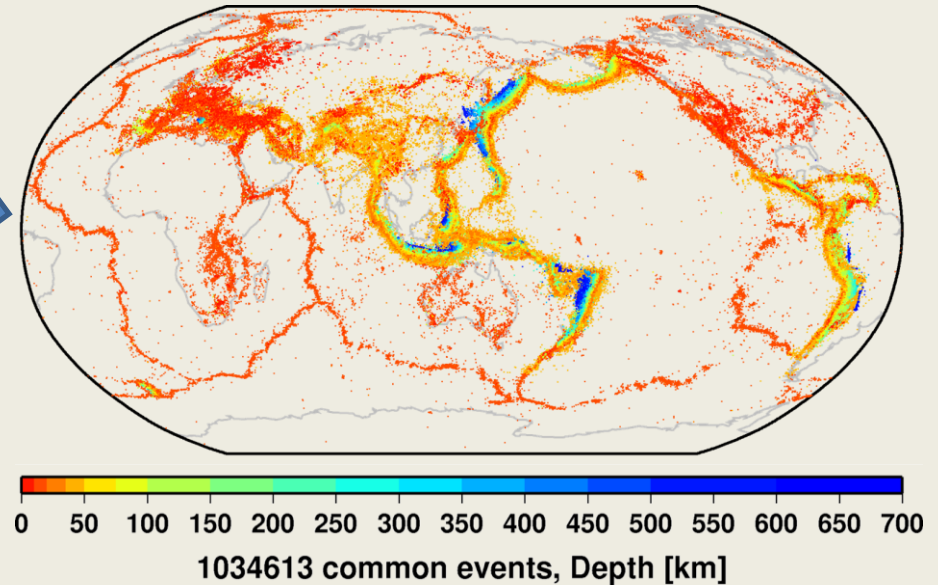
Pamir - Hindu Kush

The new ISC Location program has been put into operations from the beginning of data year 2009.

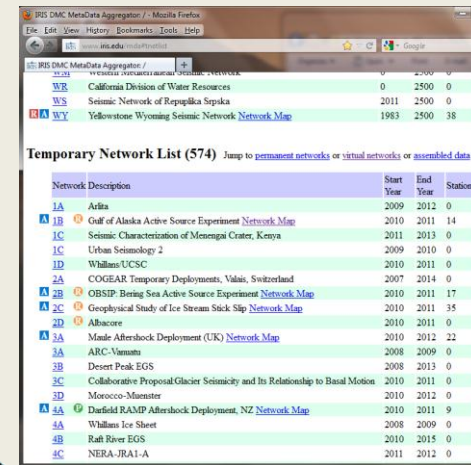
- ✓ uses all ak135 predicted phases;
- ✓ obtains an initial hypocentre via the Neighbourhood Algorithm;
- ✓ accounts for correlated travel-time prediction error structure;
- ✓ performs iterative linearized inversion using *a priori* estimates of the data covariance matrix;
- ✓ obtains depth-phase depth via depth-phase stacking;
- ✓ provides robust network magnitude estimates with uncertainties;
- ✓ attempts free-depth solution only in the presence of local networks or reported depth-sensitive phases;
- ✓ if there is no depth resolution, the depth is fixed to a region-dependent default depth.

2: Rebuild of the entire ISC Bulletin: 1960-2009

1. Re-computing all ISC hypocentres and uncertainties with the **new ISC event locator** and the **ak135** velocity model, using **all available seismic phases**;
2. Re-computing event magnitudes, this time with uncertainties;
3. Introduction and integration of additional essential bulletins that have not been available at the time of original ISC Bulletin production: permanent networks, temporary deployments, OBS installations;
4. Essential quality control and corrections



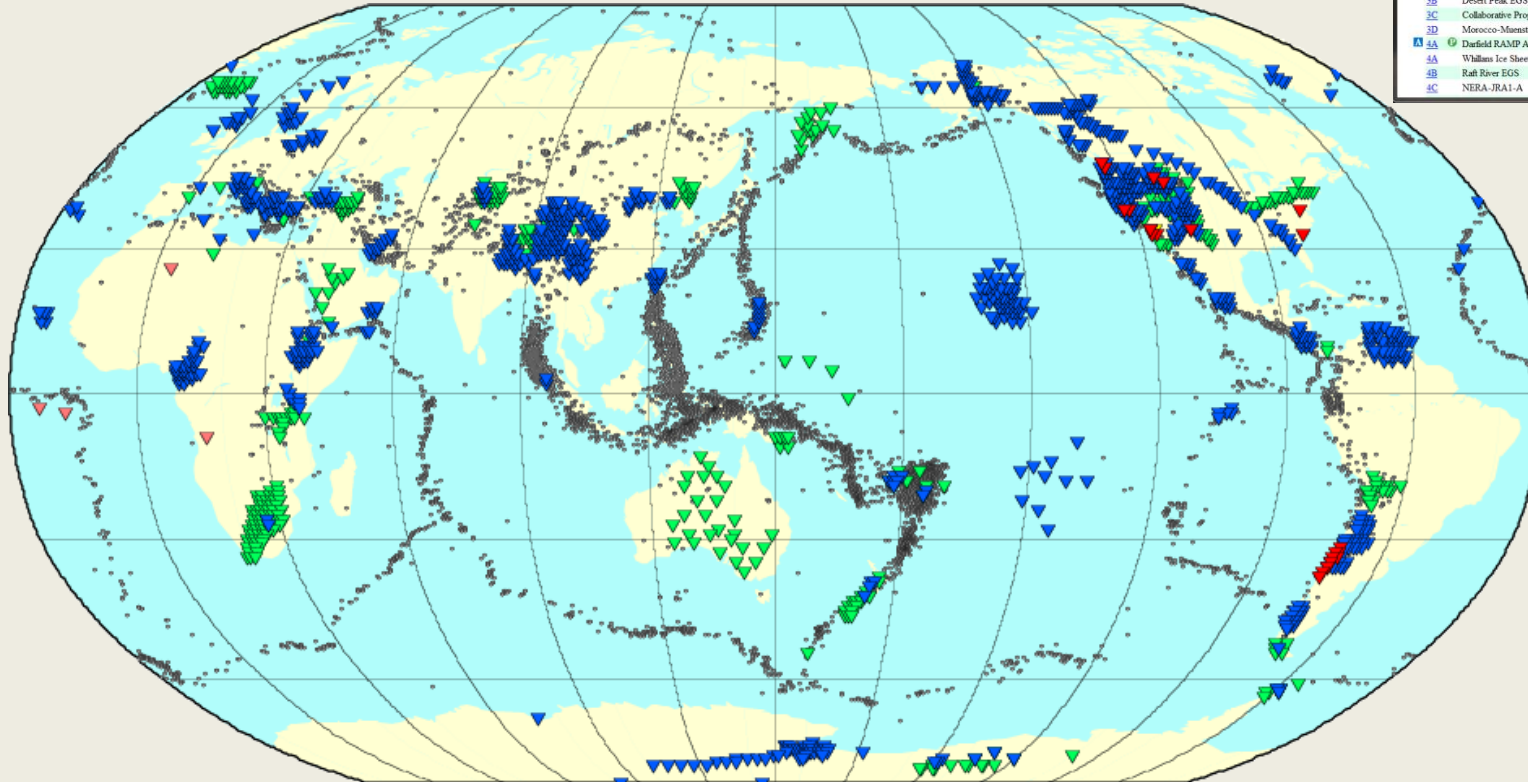
2: Bulletin Rebuild: Temporary Seismic Deployments at IRIS DMC



IRIS DMC Metadata Aggregator / Mozilla Firefox

Temporary Network List (574) Jump to permanent networks or virtual networks or assembled data

Network Description	Start Year	End Year	Stations
1A Africa	2009	2012	0
1B Gulf of Alaska Active Source Experiment Network Map	2010	2011	14
1C Seismic Characterization of Menengai Center, Kenya	2011	2013	0
1C Urban Seismology 2	2009	2010	0
1D Williams/UCSC	2010	2011	0
2A COGEAR Temporary Deployments, Valais, Switzerland	2007	2014	0
2B OBSIP: Beaufort Sea Active Source Experiment Network Map	2010	2011	17
2C Geophysical Study of Ice Stream Stick Slip Network Map	2010	2011	35
2D Albacore	2010	2011	0
3A Maide Aftershock Deployment (UK) Network Map	2010	2012	22
3A AIGC-Vietnam	2008	2009	0
3B Desert Peak EGS	2008	2013	0
3C Collaborative Proposal/Glacier Seismicity and Its Relationship to Basal Motion	2010	2011	0
3D Morocco-Muenster	2010	2012	0
4A Darfield RAMP Aftershock Deployment, NZ Network Map	2010	2011	9
4A Williams Ice Sheet	2008	2009	0
4B Rath River EGS	2010	2015	0
4C NERA-JRA1-A	2011	2012	0



- ▼ 1970–1979
- ▼ 1980–1989
- ▼ 1990–1999
- ▼ 2000–2009
- ▼ 2010–2012

Stations of temporary seismic deployments (coloured triangles) with waveforms freely available from IRIS DMC archive (colours by deployment start date). Some of these projects involved producing a bulletin, some not. We shall try to incorporate these data where possible.

2: Bulletin Rebuild: Request for help

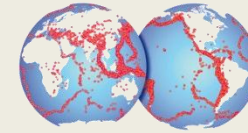
The ISC is asking for **urgent** help
(before mid-2013)
in providing **earthquake bulletins** of
permanent and **temporary deployments**
(1960-present)
that are not part of the ISC Bulletin.

We need event hypocentre solutions along
with station arrival times, especially from
short-term post-aftershock seismic
deployments

3: ISC-GEM Global Instrumental Catalogue (1900-2009)



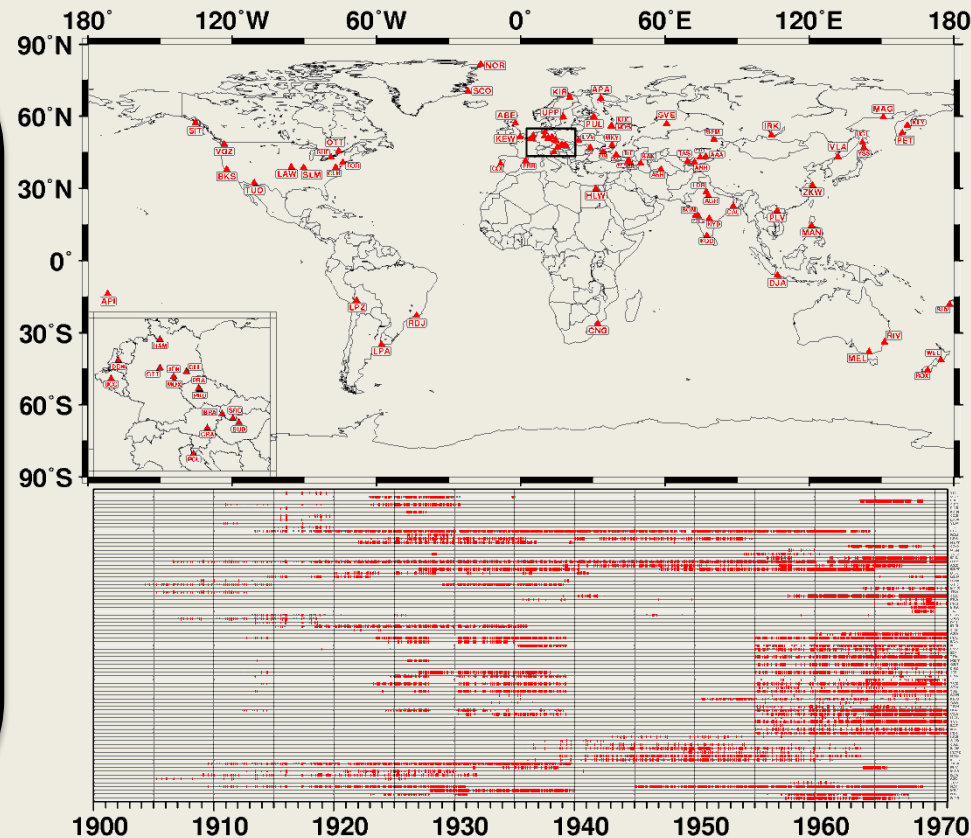
Dedicated talk: Oct 25, 9 am



GEM
GLOBAL EARTHQUAKE MODEL

The ISC-GEM Catalogue is **unique** because we went back to using the original basic parametric data and re-calculated:

- ✓ **homogeneous** locations and magnitudes
- ✓ with the estimates of **uncertainty** and quality flags
- ✓ for the entire period 1900-2009
- ✓ using the same advanced **techniques** to the extent possible.



4: CTBTO Link to the ISC Database: Objectives

The Link run by the ISC based on the IDC/CTBTO Contract.



The objectives are:

- Provide easy access and convenient search tools for the seismological **datasets available at the ISC** and other data centres outside CTBTO
- These searches provide an alternative perspective into current IMS observations based on the wealth of seismological recordings of non-IMS stations for 50 years.



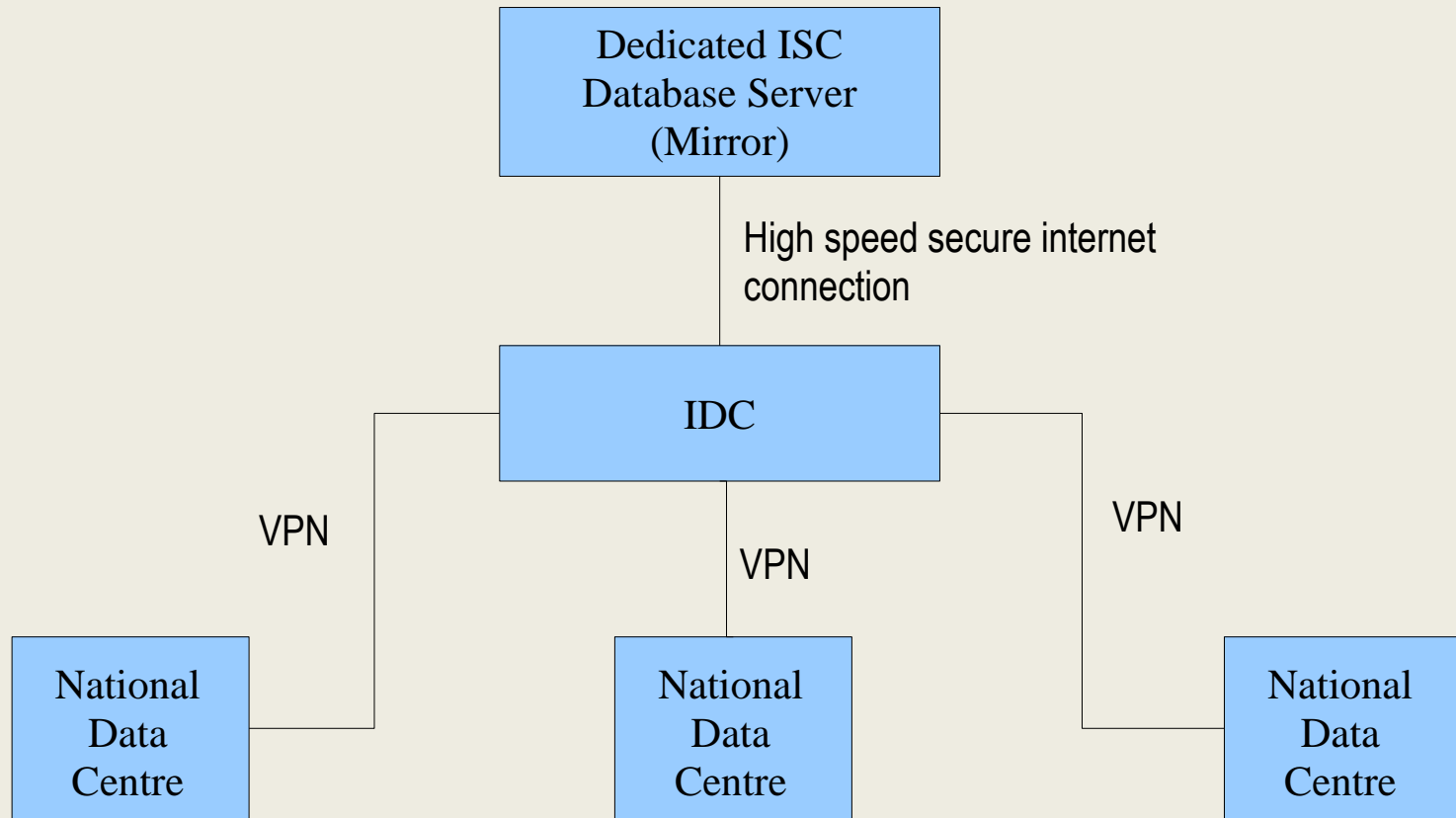
The Link was originally set up with the help of UK Foreign office and Nordic Partners:



NORSAR



4: CTBTO Link to the ISC database: Structure



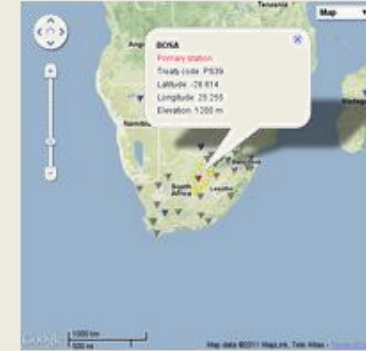
4: CTBTO Link to the ISC database: Overview



Area based search



IDC Reviewed Event Bulletin (REB) search



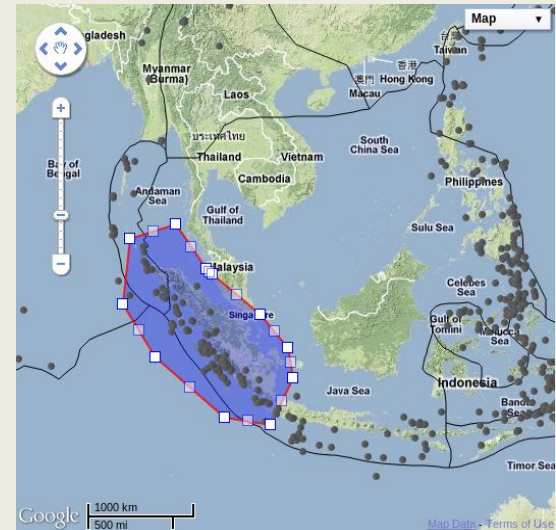
Station based search

Three groups of searches:

- **Area searches** – a spatio-temporal searches within the ISC Bulletin;
- **REB-based searches** – a spatio-temporal searches based on specific events within the IDC Reviewed Event Bulletin; Convenient access to non-IMS waveforms of REB events;
- **IMS station based searches** – searches showing specifics of non-IMS stations in the proximity of selected IMS sites.

CTBTO Link to the ISC Database: Overview of searches

- ❑ Interactive Google Maps based interface;
- ❑ One of the most flexible and sophisticated interactive tools available to the seismological community;
- ❑ Searches can be completed across multiple meridians;
- ❑ Highly customised shapes unavailable on any other seismological site.
- ❑ Customised overlays:
 - ❑ Plate boundaries;
 - ❑ Seismicity (with clickable data);
 - ❑ Station markers (with clickable data).



4: CTBTO Link to the ISC database: Examples

5 categories of events to choose from

Event map

Select specific event categories required:

- Nuclear Explosions
- Ground Truth Events
- EHB Events
- REB Events
- All ISC Events

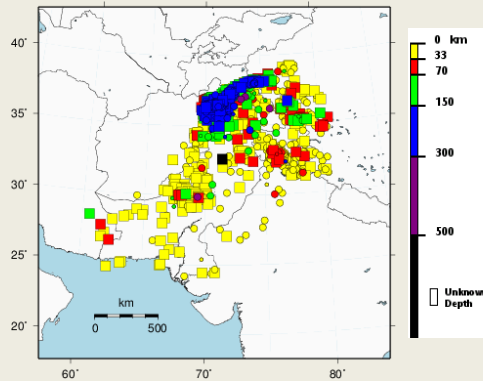
Add different types of events to your search if required:

Check All Choose

- Rock Bursts
- Induced Event
- Mining Explosions
- Chemical Explosions

4 event 'types' to choose from

Results (Pakistan region 1998-01-01 to 2000-01-01):
Map and event 'catalogue' produced for every event type/category



Number	Event Type
1269	ISC Events
765	REB Locations
171	EHB Locations
4	Ground Truth events
3	Nuclear Explosions
0	Chemical Explosions
0	Induced events
0	Mine Explosions
0	Rock Bursts

Sortable columns

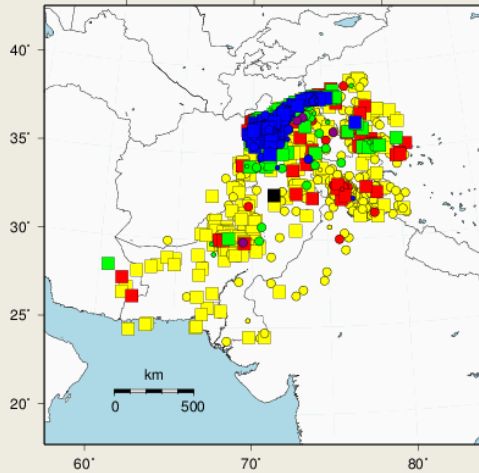
Solution		Hypocentre			Magnitude		ISC Event Type	Preferred magnitude		Bulletin in IMS1.0				
Author	ID	Date - Time	Lon	Lat	Depth	Value	Type	Value	Type	Author	ISC	EHB	GT	REB
ISC	R	1999-06-26 06:54:18	70.847	36.422	67.9	3.8	mb	4.3	ML		✓			✓
NDI	NR	1999-05-10 23:37:11	70.714	36.714	33.0						✓			
ISC	R	1999-07-28 13:17:11	69.466	29.875	33.0	4.9	mb	5.5	Mw	HRVD	✓	✓		✓
ISC	R	1998-09-17 20:49:51	71.714	36.005	172.1	3.7	mb	Unknown			✓			
NDI	NR	1999-09-14 17:14:05	69.073	34.645	33.0						✓			
ISC	R	1998-01-28 23:55:03	69.814	36.064	162.4	3.9	mb	Unknown			✓			
ISC	R	1999-04-22 01:16:48	70.058	35.403	265.5	3.4	mb				✓			✓
ISC	R	1998-05-29 11:43:15	71.216	36.377	33.0	3.6	mb	Unknown			✓			
ISC	R	1999-07-12 05:22:16	76.704	36.173	96.4	4.4	mb	4.4	mb	NEIC	✓	✓		✓
ISC	R	1998-03-24 04:25:43	74.059	32.398	54.3	4.0	mb	Unknown	4.0	mb	NEIC	✓		
NDI	NR	1999-05-02 14:12:06	73.857	34.613	15.0						✓			
NDI	NR	1999-09-01 17:30:57	79.335	35.542	33.0						✓			
ISC	R	1998-11-06 14:59:03	71.640	36.850	150.7	3.8	mb	Unknown	4.0	mb	NEIC	✓		

Links to a full Bulletin for this event

4: CTBTO Link to the ISC database: Examples

Networks reporting

Results (Pakistan region 1998-01-01 to 2000-01-01):



8 Networks reported events within the zone:

BJI	EHB	EIDC	LDG	MOS	NAO
NDI	NEIC				

9 Networks reported other data or less than 5% of the ISC events collected (not shown):

BER	CSEM	DJA	HRVD	IASPEI	MDD
PDG	UNK	ZUR			

- All networks reporting events are listed
- Histograms of events and Frequency-magnitude-distributions are plotted for each network



China Earthquake Administration [BJI]

Address:

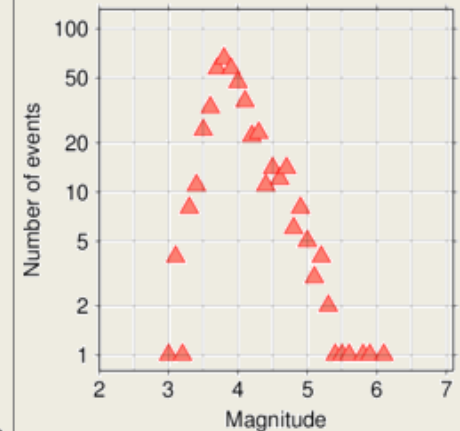
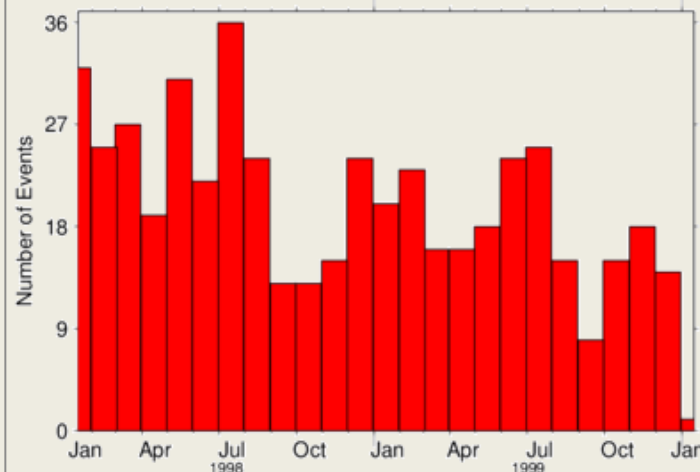
Institute of Geophysics, China Earthquake Administration

P.O. Box 8116, Beijing 100081

Country: China

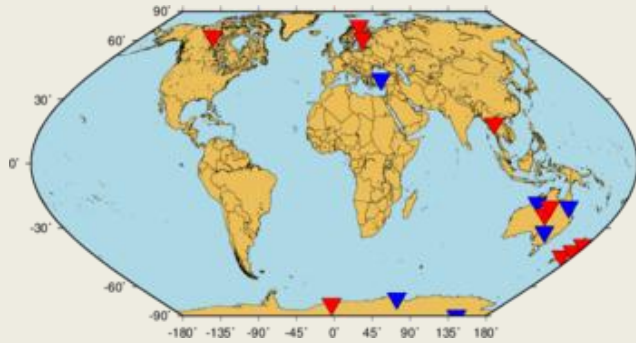
Web site: <http://www.cea-igp.ac.cn/>

[More information](#)



4: CTBTO Link to the ISC database: Examples

Based on a particular selected REB event



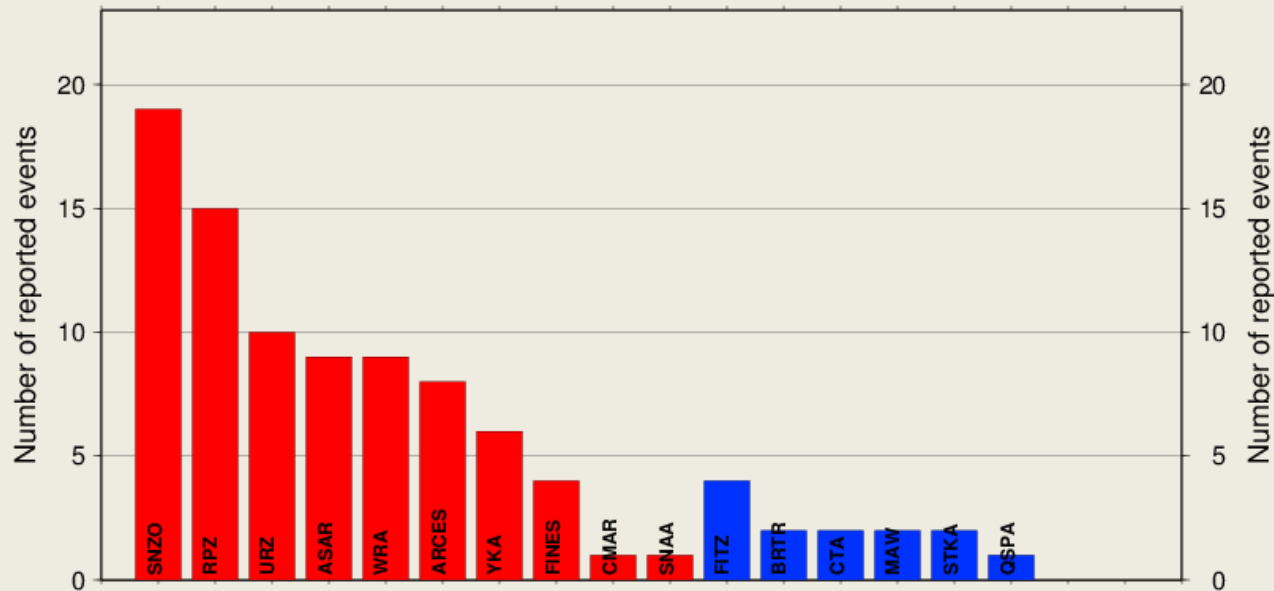
ARCES (8)	ASAR (9)	CMAR (1)
FINES (4)	RPZ (15)	SNAAB (1)
SNZO (19)	URZ (10)	WRA (9)
YKA (6)		

Stations reporting for events within the magnitude tolerance **AND** the selected REB event

BRTR (2)	CTA (2)
FITZ (4)	MAW (2)
QSPA (1)	STKA (2)

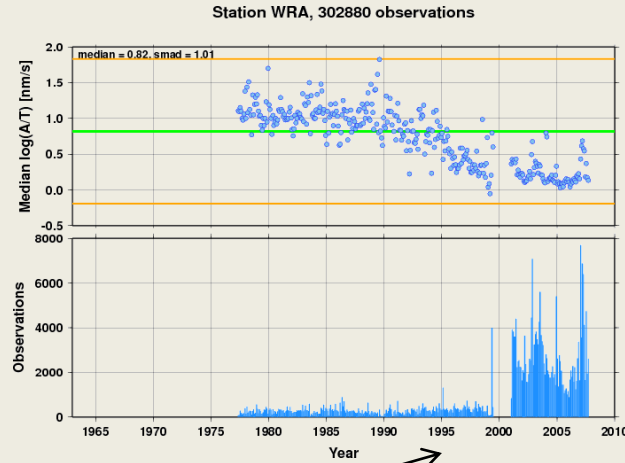
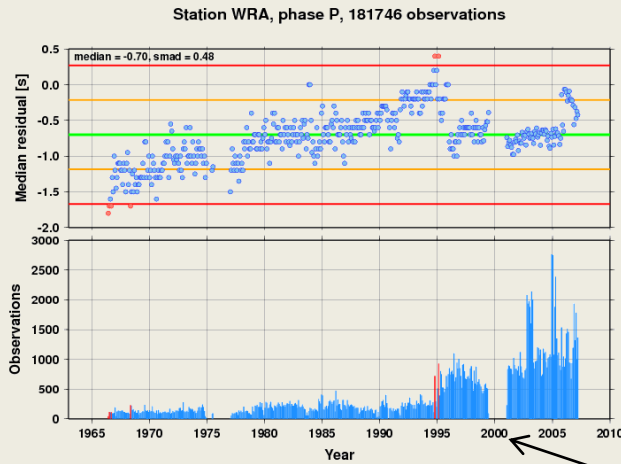
Stations reporting for events within the magnitude tolerance **but NOT** the selected REB event

Stations



4: CTBTO Link to the ISC database: Examples

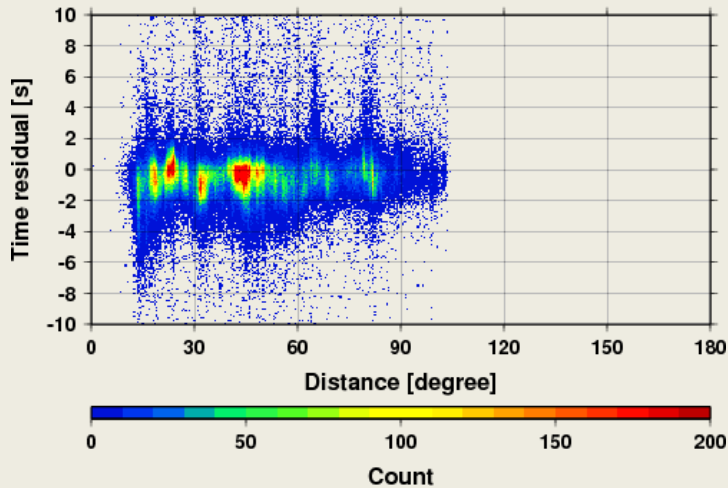
IMS station based: e.g. pre-IMS history of WRA



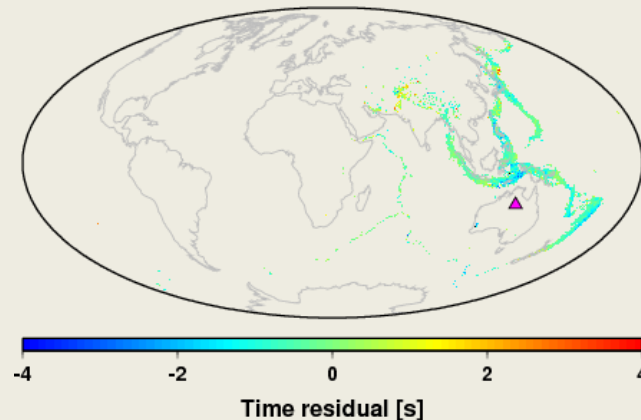
The station search also provides historic data for stations before they became part of the IMS network or stations that were operated for many years close to current IMS sites

IMS upgrade

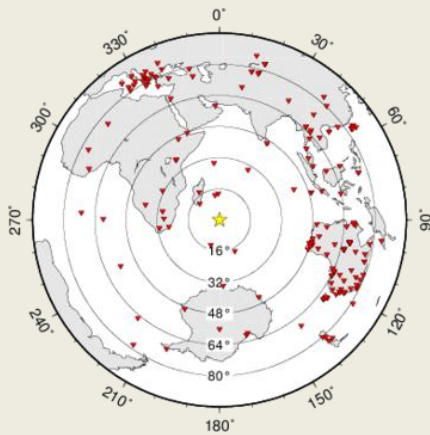
WRA, 229782 first arriving P observations



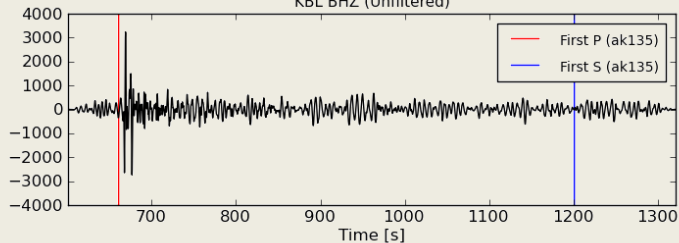
WRA, 6188 first arriving P observations



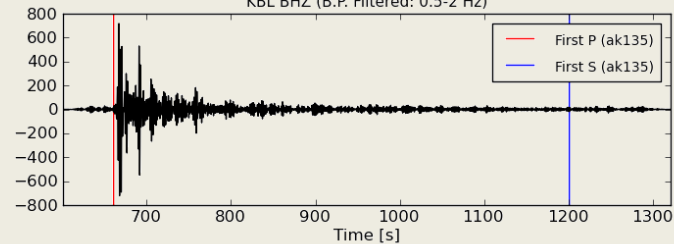
4: CTBTO Link to the ISC database: Waveform requests



REB Origin time: 2011-12-02 00:22:50.570
Distance: 67.98 degrees; Back-azimuth: 9.63 degrees
KBL BHZ (Unfiltered)

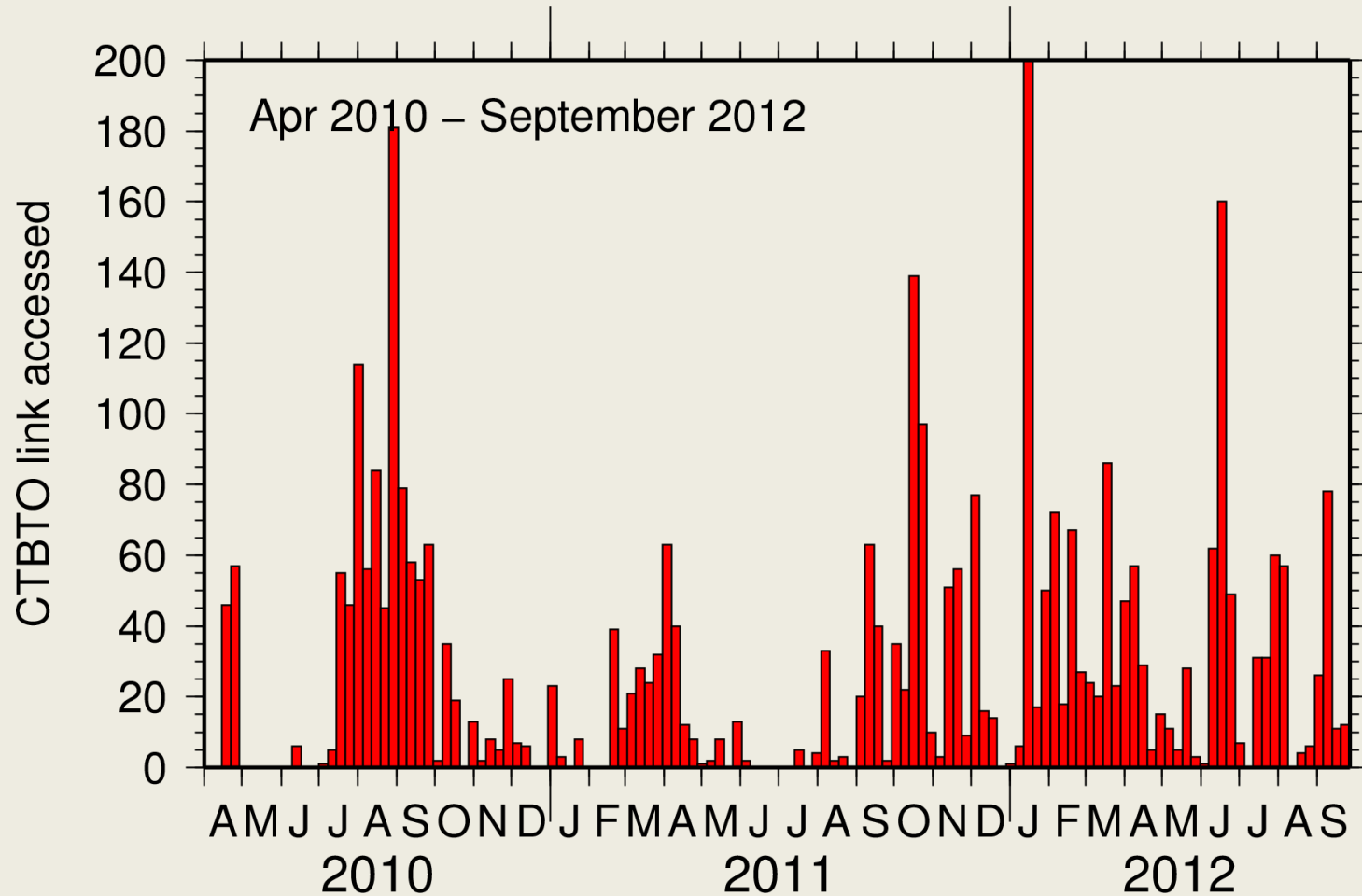


KBL BHZ (B.P. Filtered: 0.5-2 Hz)



- Facility to request waveforms for REB events from non-IMS stations
- With pre-built images of non-IMS waveforms for REB events with predicted P&S picks indicated
- *Currently:* waveform requested from IRIS DMC
- *Soon:* add NZ GeoNet, EIDA, ...

4: CTBTO Link to the ISC database: use by PTS and NDCs



Summary

- ✓ The ISC continues with its **unique international mission**;
- ✓ The ISC products (the Bulletin, the Station Registry (IR), the Reference (GT) list & the EHB) are **free and open**;
- ✓ **Preliminary** ISC Bulletin is available **soon after events occur**; the **Reviewed** ISC Bulletin is available **24** months after event occurrence;
- ✓ **New ISC Locator** has been put into operation and expected to improve the accuracy of locations, depths, magnitudes and their uncertainties.
- ✓ The ISC is engaged in major development projects (**CTBTO-Link, Bulletin Rebuild, ISC-GEM Catalogue**) that will substantially improve the quality of the ISC flagship products.
- ✓ The ISC is asking for **urgent** help (before the mid-2013) in providing **earthquake bulletins** of **permanent** and **temporary deployments** (1960-present) that are not already part of the ISC Bulletin.