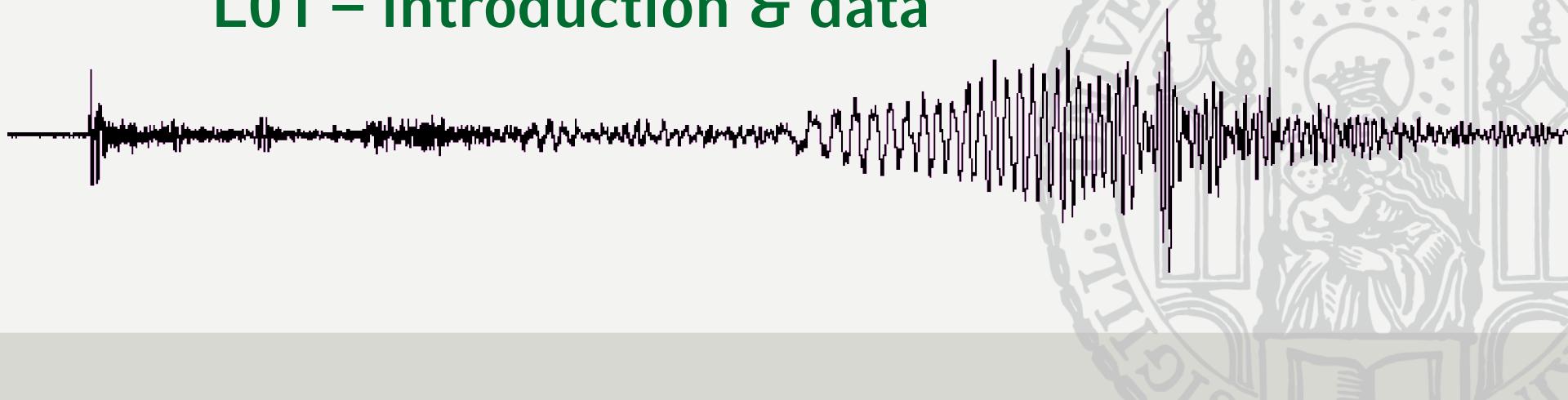


Stefanie Donner

# Geophysical Data Analysis

## L01 – introduction & data





# Introduction



## What is GDA?

“Data processing is about extracting a few nuggets from the raw data.”

Gubbins (2000) Time Series Analyses and Inverse Theory for Geophysicists

“Many of the fundamental questions in Earth Sciences rest on the results from the analysis of seismograms.”

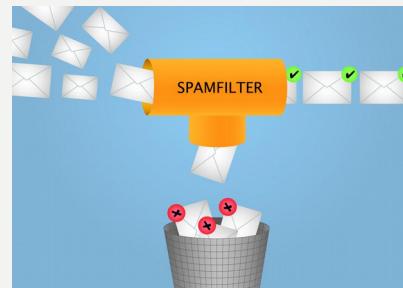
from lecture “Seismology”

# What is GDA?

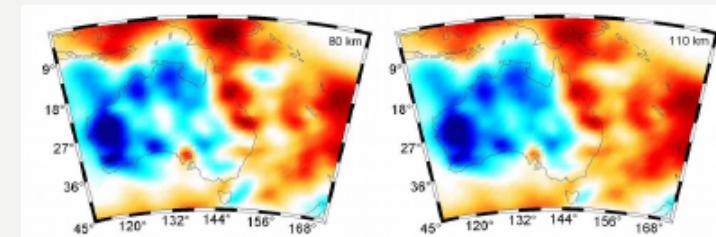
## 1. Collecting data



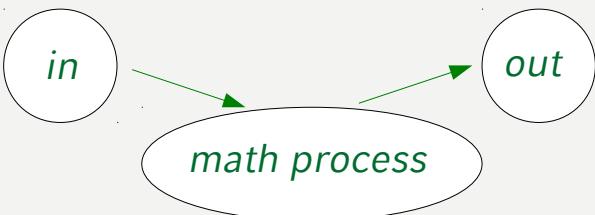
## 2. Pre-processing data



## 5. Visualizing data



### *3. Processing data*



The logo consists of the word "reftek" in a green sans-serif font to the left of a circular arrow icon. The arrow is composed of two interlocking arcs, one green and one blue, forming a continuous loop.

A cartoon illustration of a person with orange hair sitting at a desk, looking at a computer monitor. The monitor displays the word "ERROR". The person has their arms raised in a gesture of frustration or despair.

## *4. Analysing data*

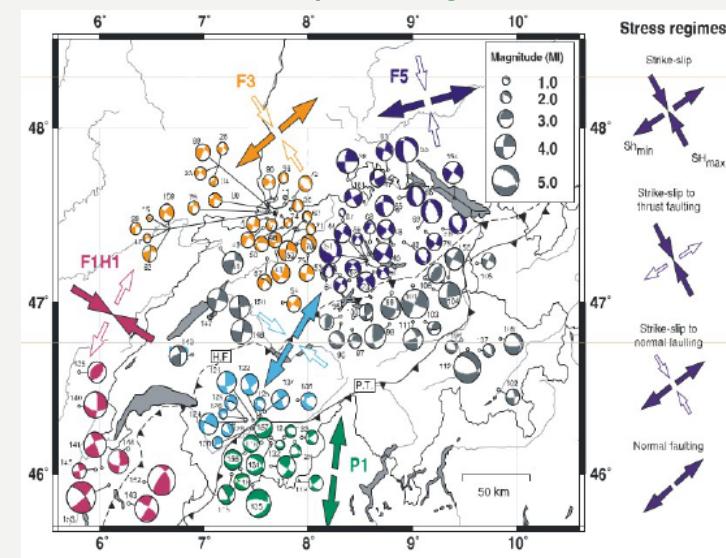
### *observed data*

*physical model*

$$d = G(m)$$

## *operator*

## 6. Interpreting data



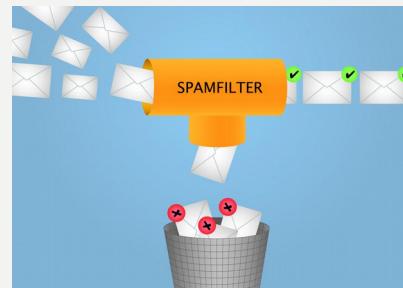
Courtesy N. Deichmann, SED, ETHZ

# What is GDA?

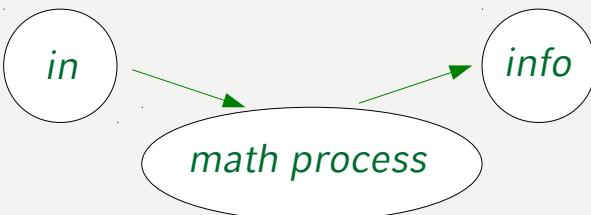
## 1. Collecting data



## 2. Pre-processing data



## 3. Processing data



## 4. Analysing data

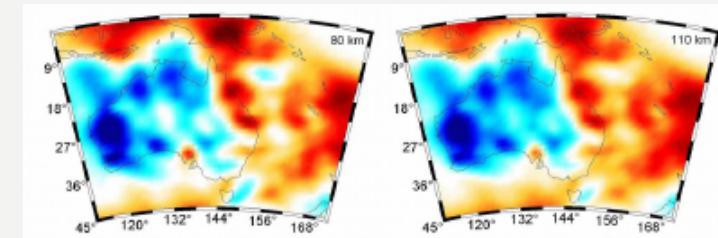
*observed data*

$$d = G(m)$$

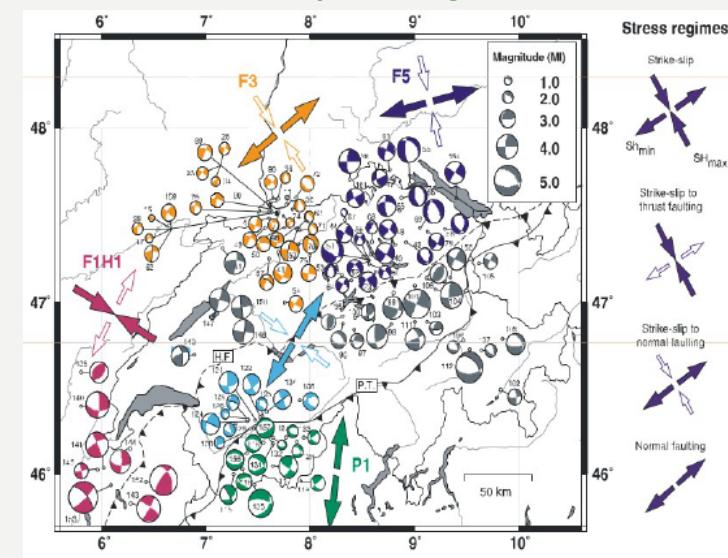
*operator*

*physical model*

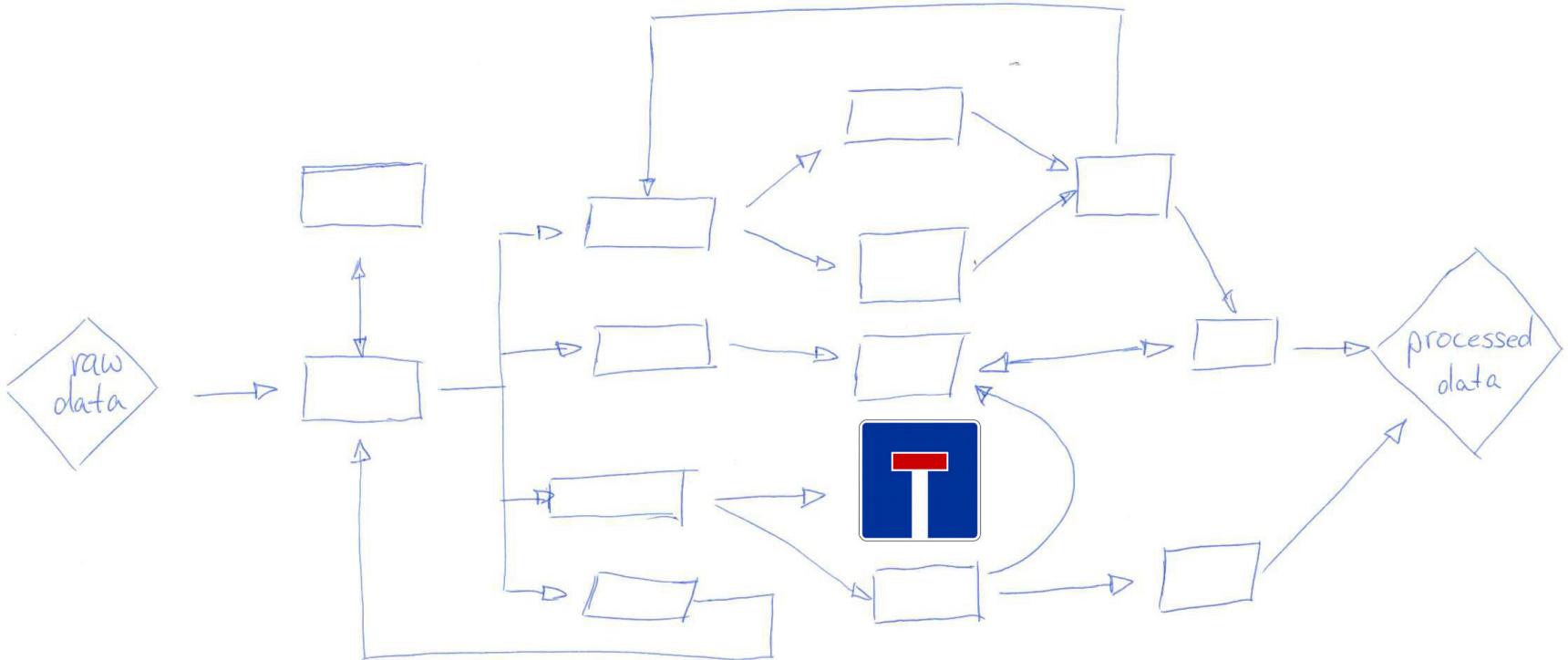
## 5. Visualizing data



## 6. Interpreting data

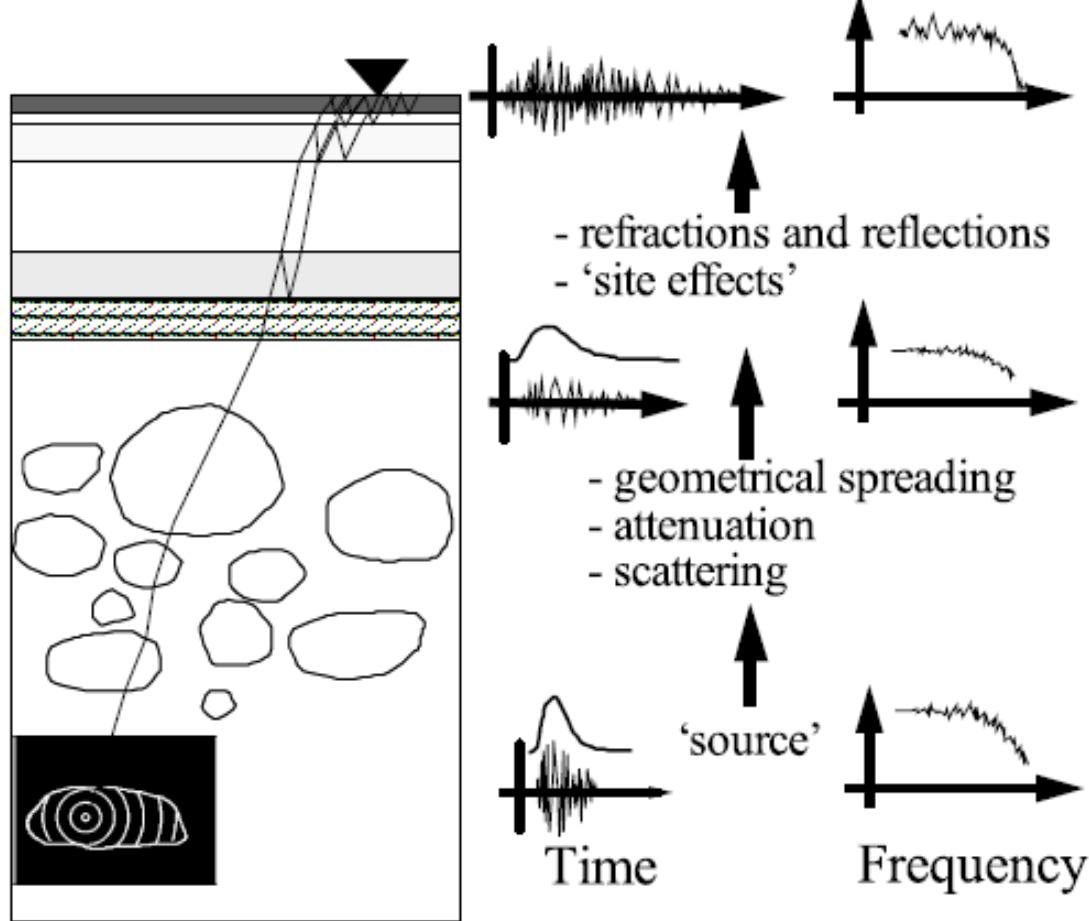


Courtesy N. Deichmann, SED, ETHZ



*Some steps change the data irreversibly !!!*

# Major problem ...



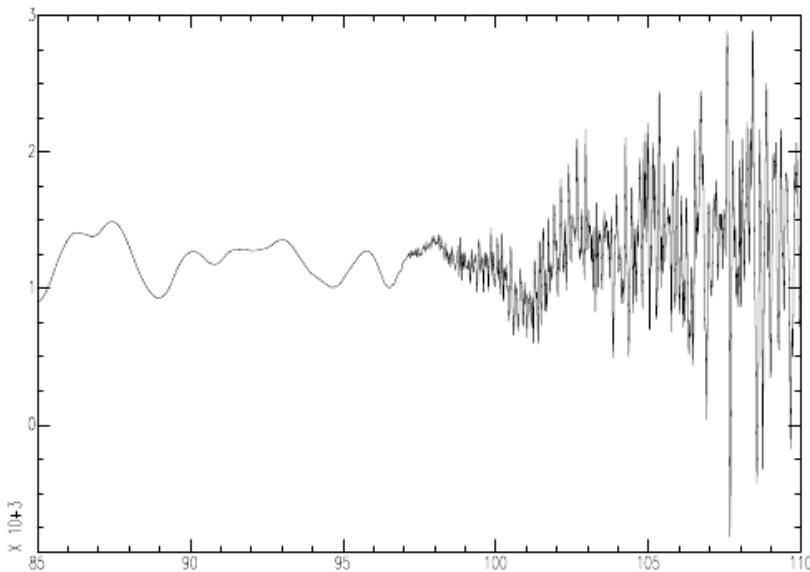
*... separating the original source signal from other effects.*

F. Scherbaum (2001) Of Poles and Zeros

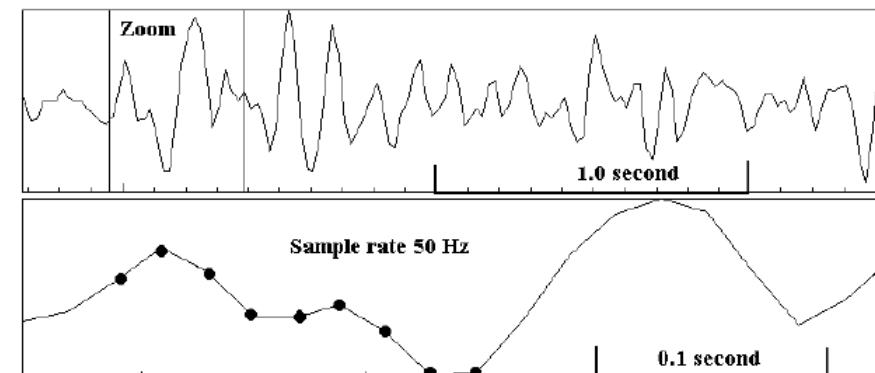
# A problem with two aspects ...



*Understand and model natural effects*

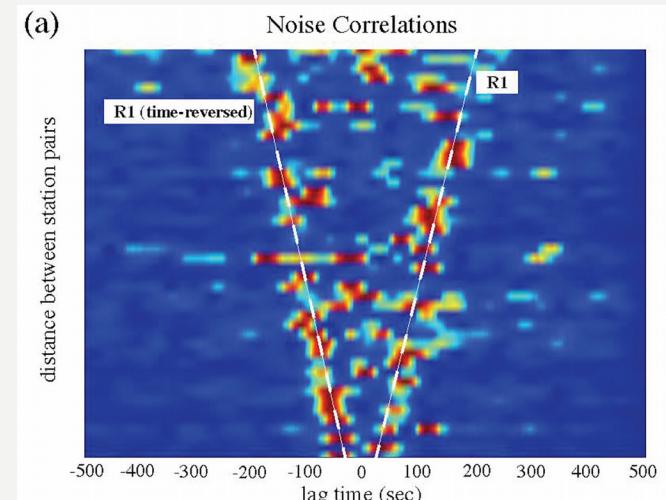
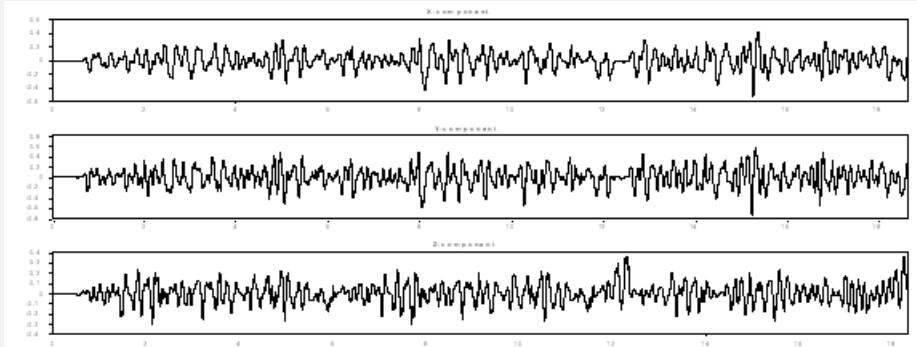
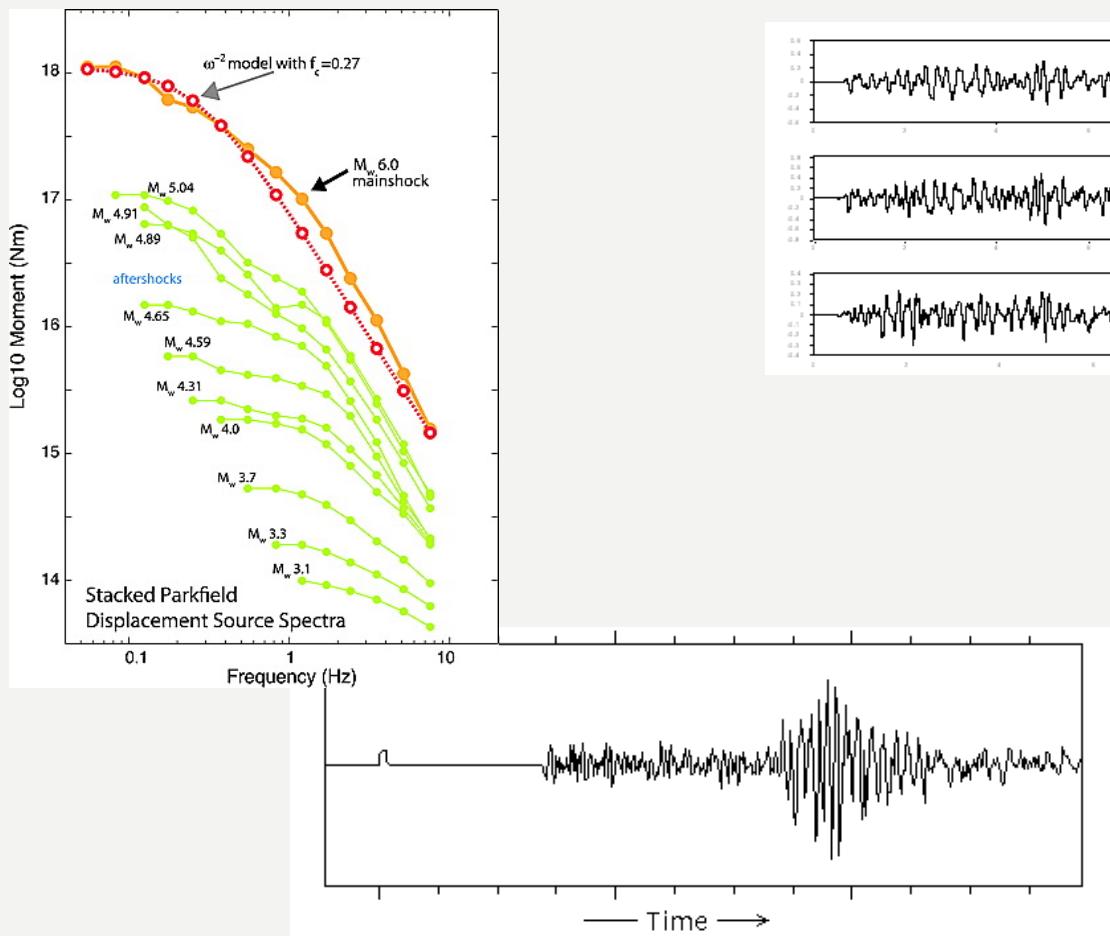


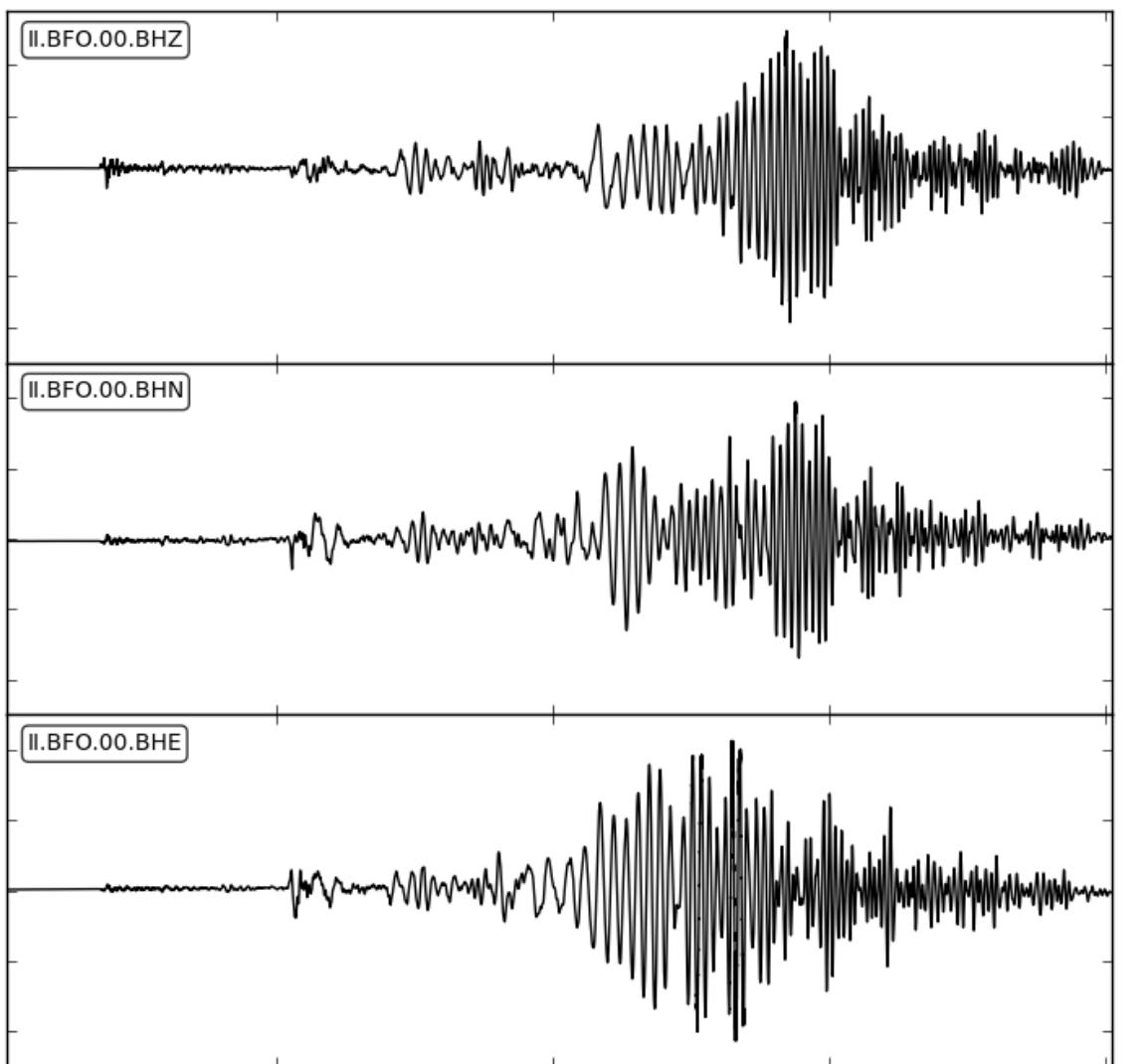
*Understand the limitations & work-arounds of signal processing*



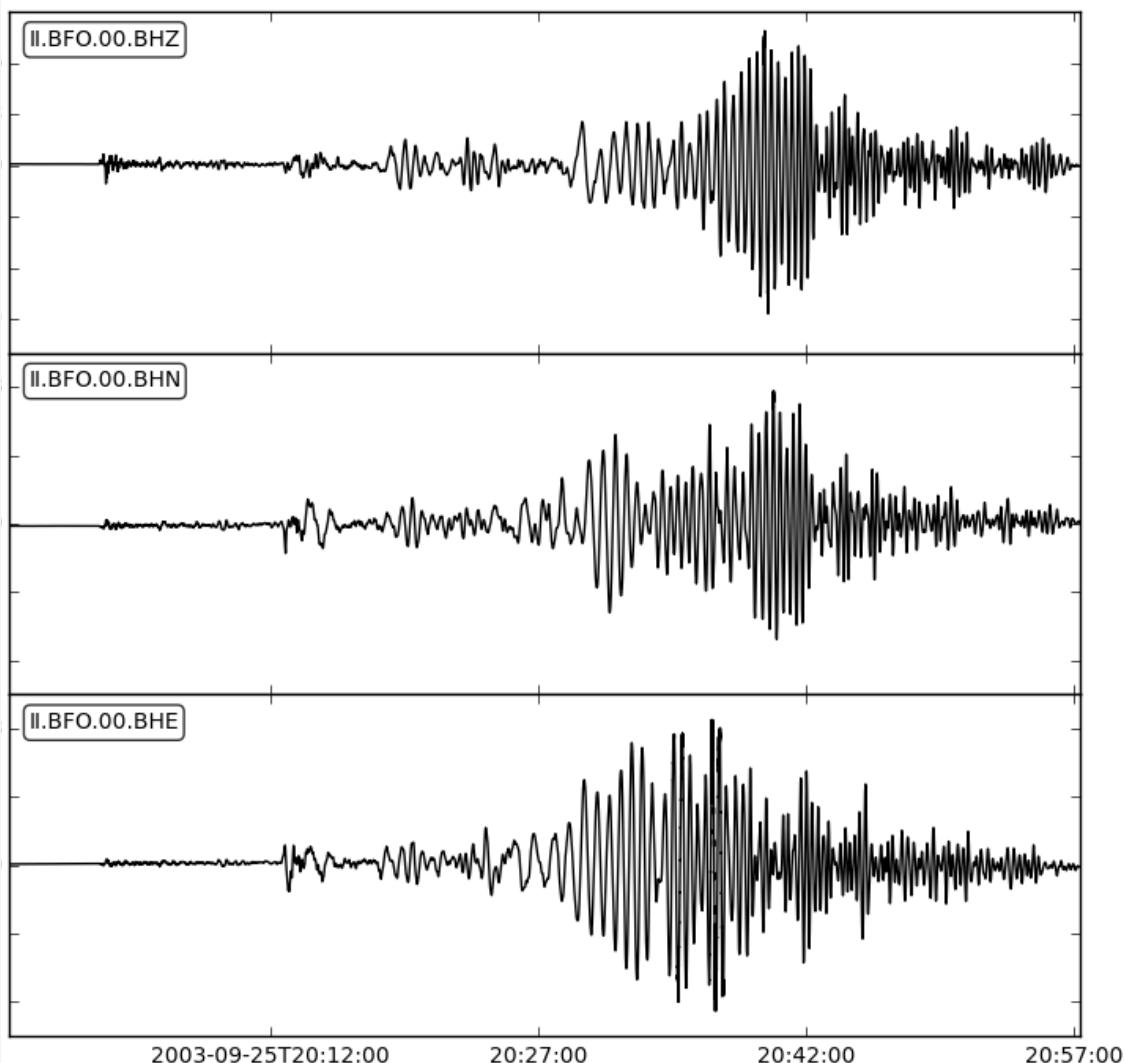


*... one man's signal is the other man's noise ...*





*Guess!*  
*Length:*  
*Distance:*  
*Magnitud:*  
*Amplitud:*  
*Phases:*



Guess!

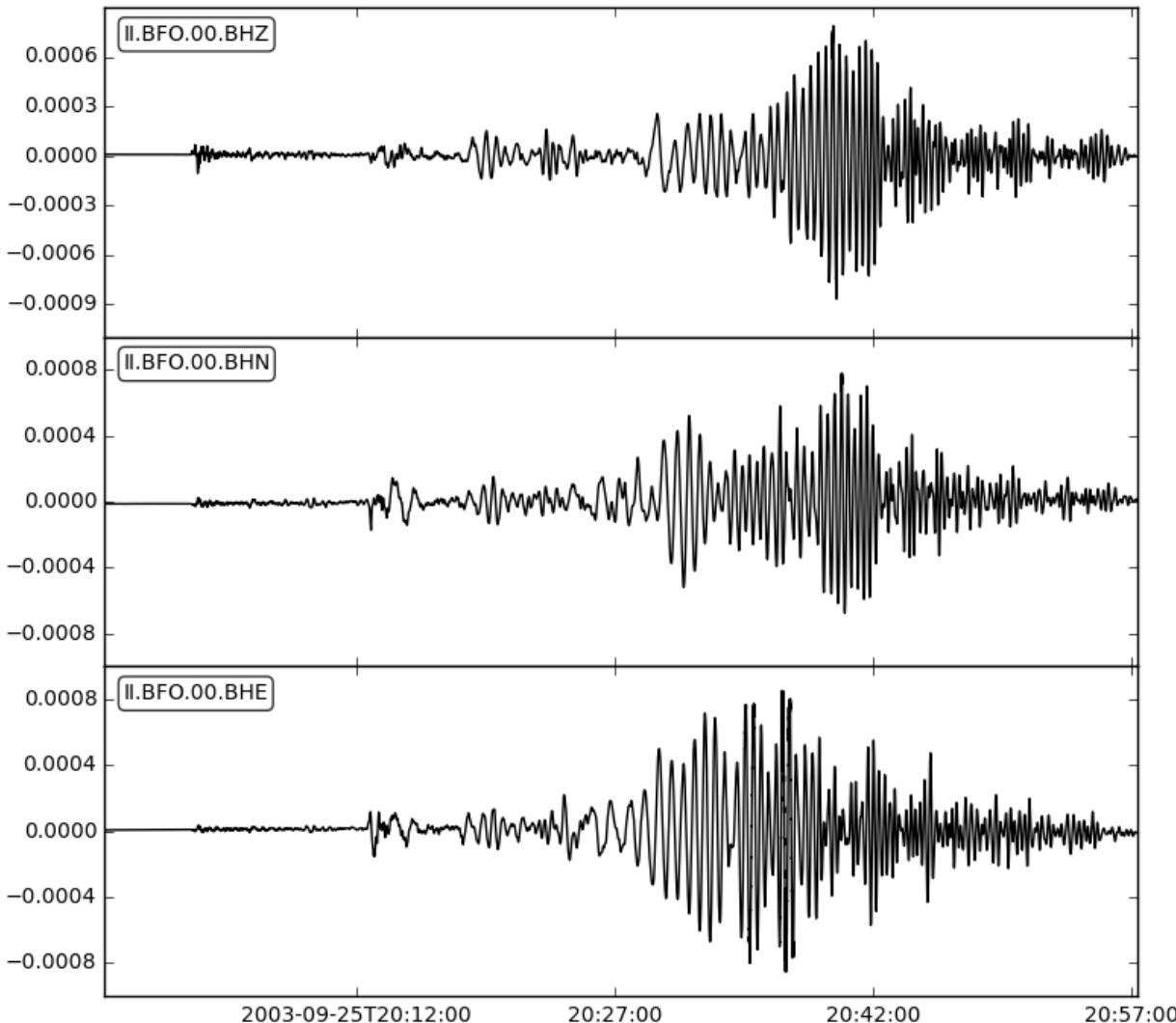
Length: 60 min

Distance:

Magnitude:

Amplitude:

Phases:



Guess!

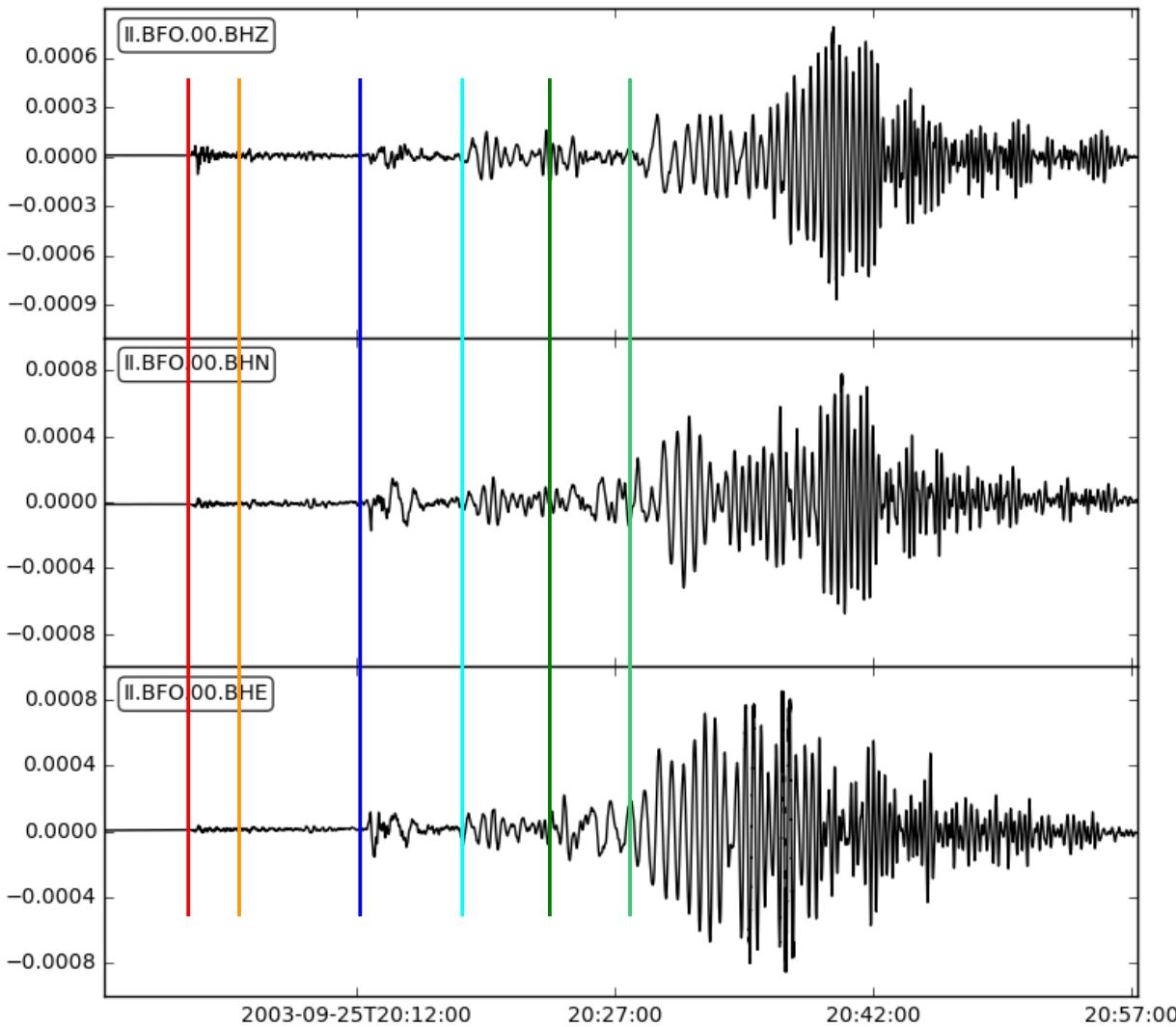
Length: 60 min

Distance:

Magnitude:

Amplitude:  $1.6e-2$  m/s

Phases:



Guess!

Length: 60 min

Distance: 81.7°

Magnitude: Mw 8.1

Amplitude: 1.6e-2 m/s

Phases:

P PP S SS

Love Rayleigh

Hokkaido, Japan

25<sup>th</sup> September 2003

19:50:07 UTC

depth: 33 km

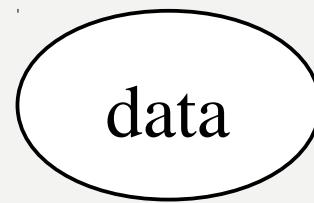


# Data



# What are data?

Brainstorming ...



... on the board.



What are data?

Great!

But what are data?

# Numbers!

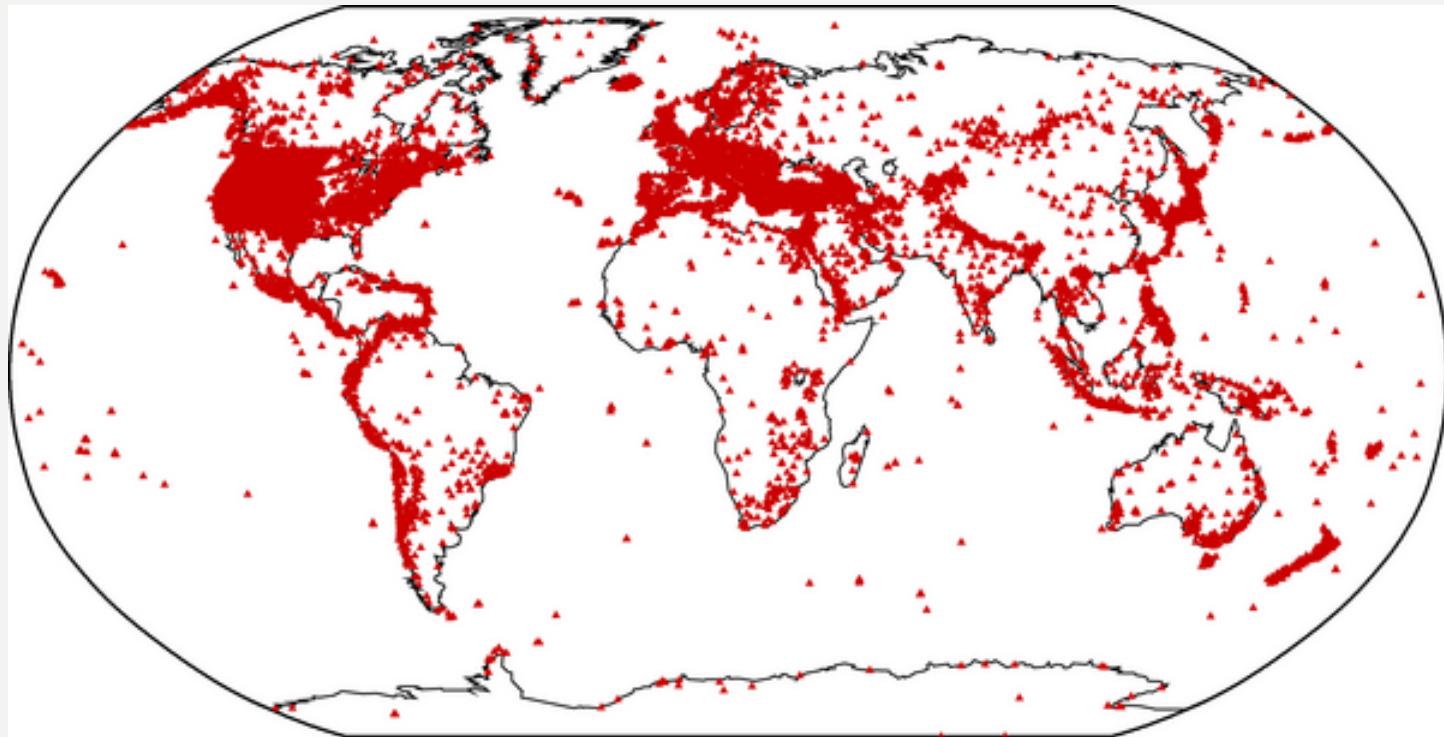
Out[4]:

```
array([ 18.41965412, 15.22472427, 15.22472427, ..., 7.66450017,  
       7.66450017, 7.83758004])
```

# Global Seismic Networks



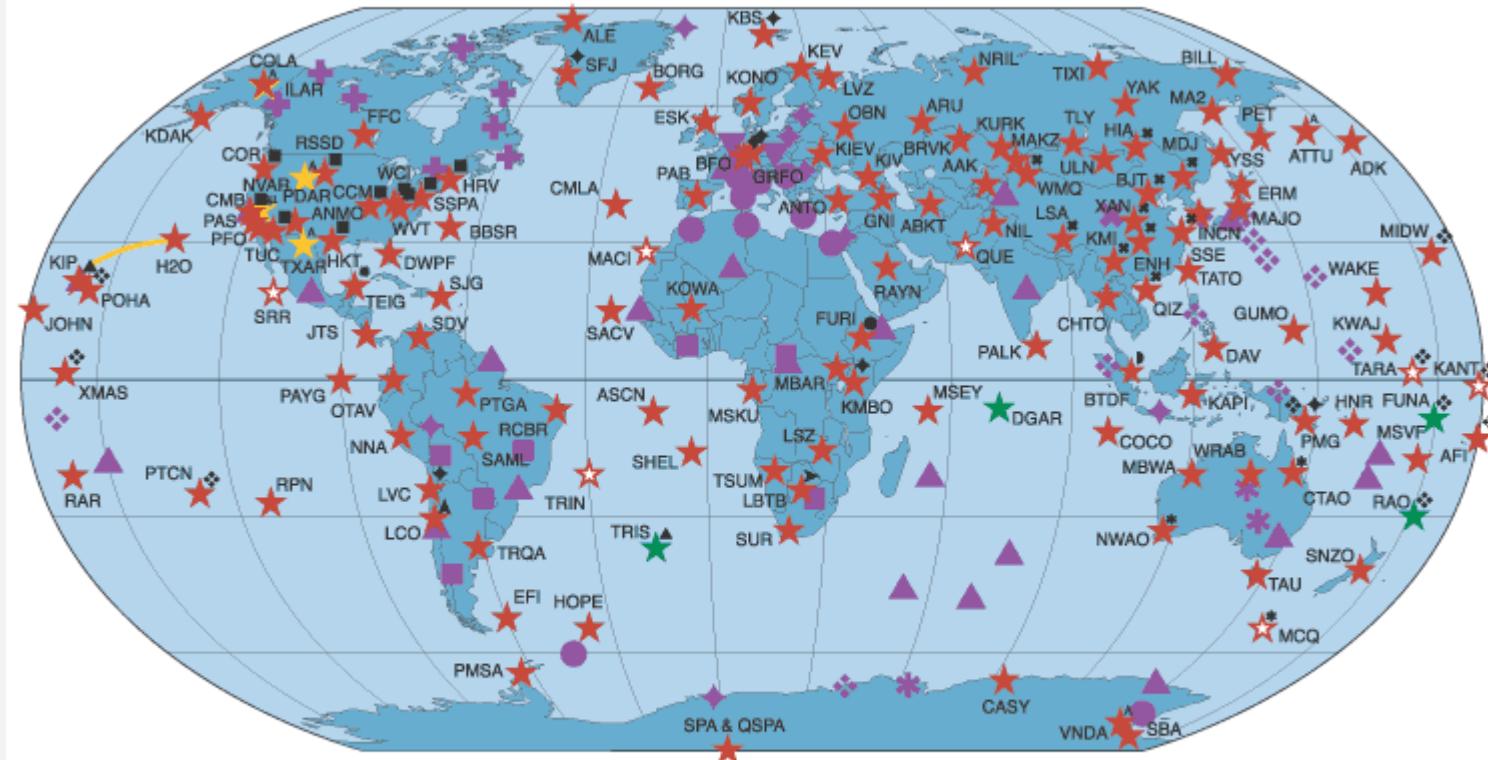
*at present more than 22.000 stations worldwide*



*ISC webpage*

# Global Seismic Network

## GSN Stations



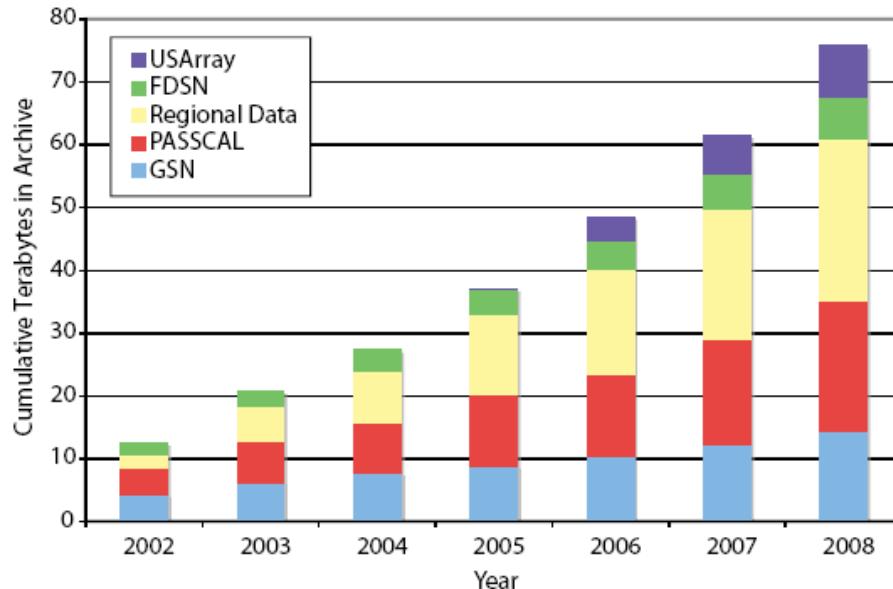
IRIS International & National Cooperative Sites

IRIS Affiliate Current Array Geoscope Japan Mednet Geofon/AWI/BGR/BFO China/USGS Mexico Singapore Botswana Andes Australia USNSN AFTAC SMU

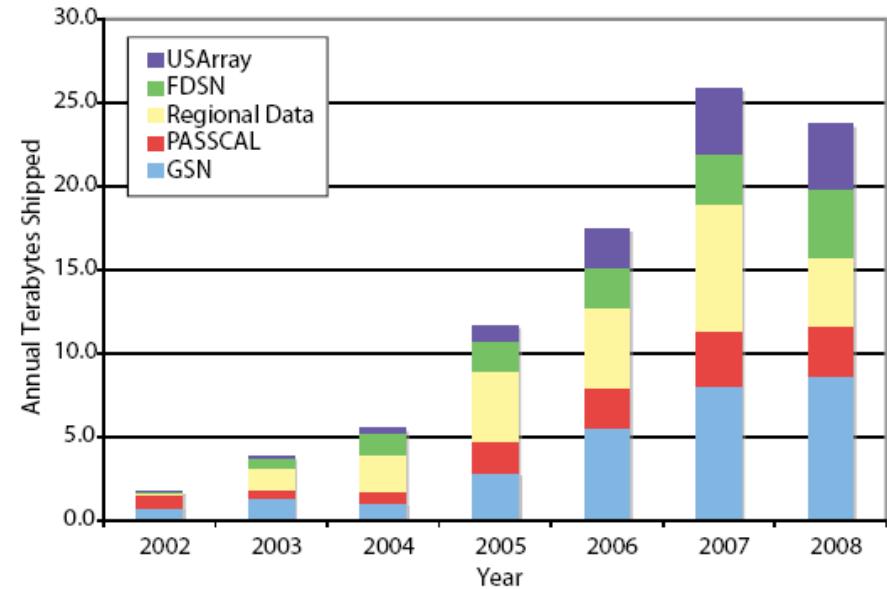


# Seismic data volumes

Cumulative Terabytes Archived by Network Type through August 31, 2008

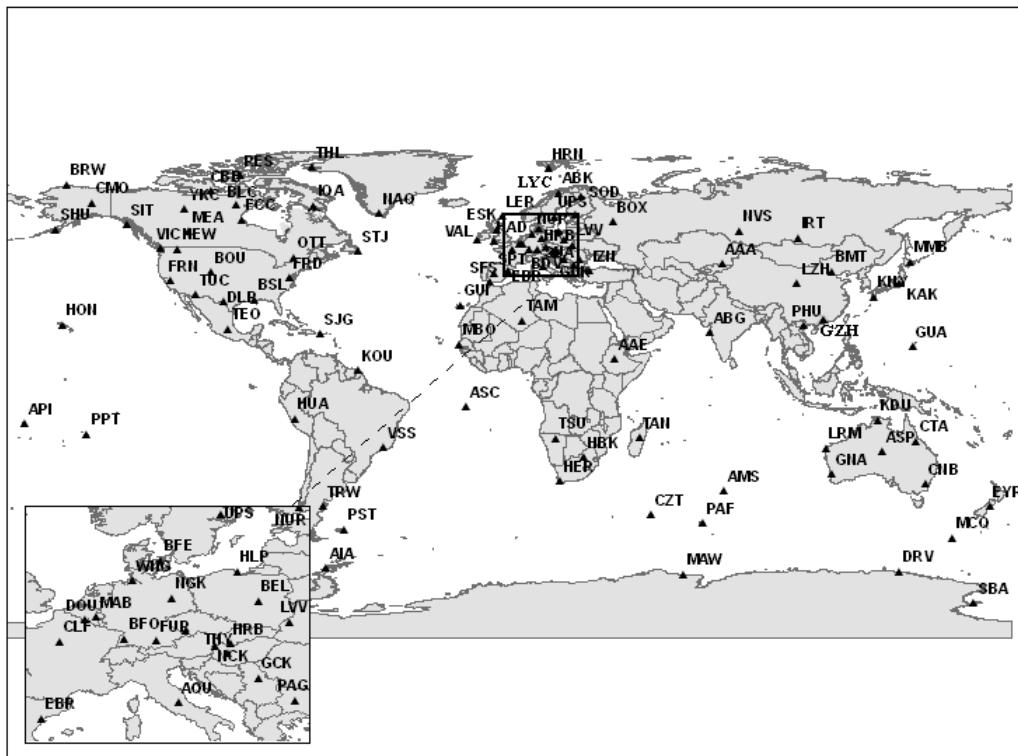


Terabytes Shipped by Network Type through August 31, 2008

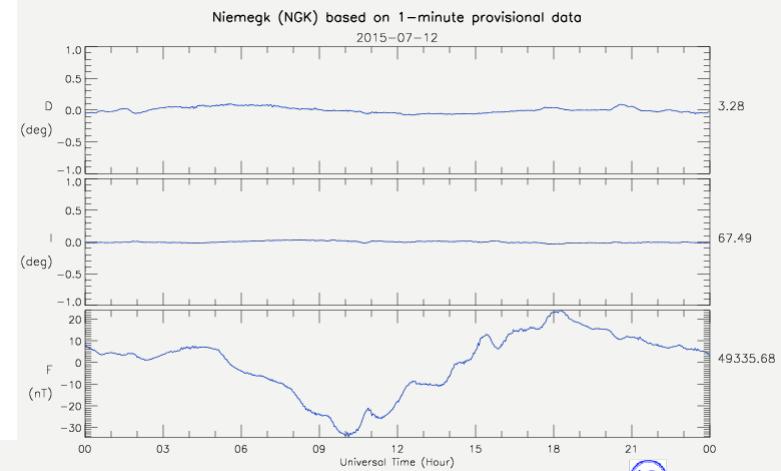


The cumulative volume of seismic data archived at the IRIS Data Management Center (left) for major seismic networks totals 81.3 terabytes as of August 2008. The annual number of terabytes shipped from the IRIS DMC (right) for the same seismic network types is twice as much data as new data arriving at the DMC, and will total more than 35 terabytes to end users in 2008. (Image courtesy of T. Ahern.)

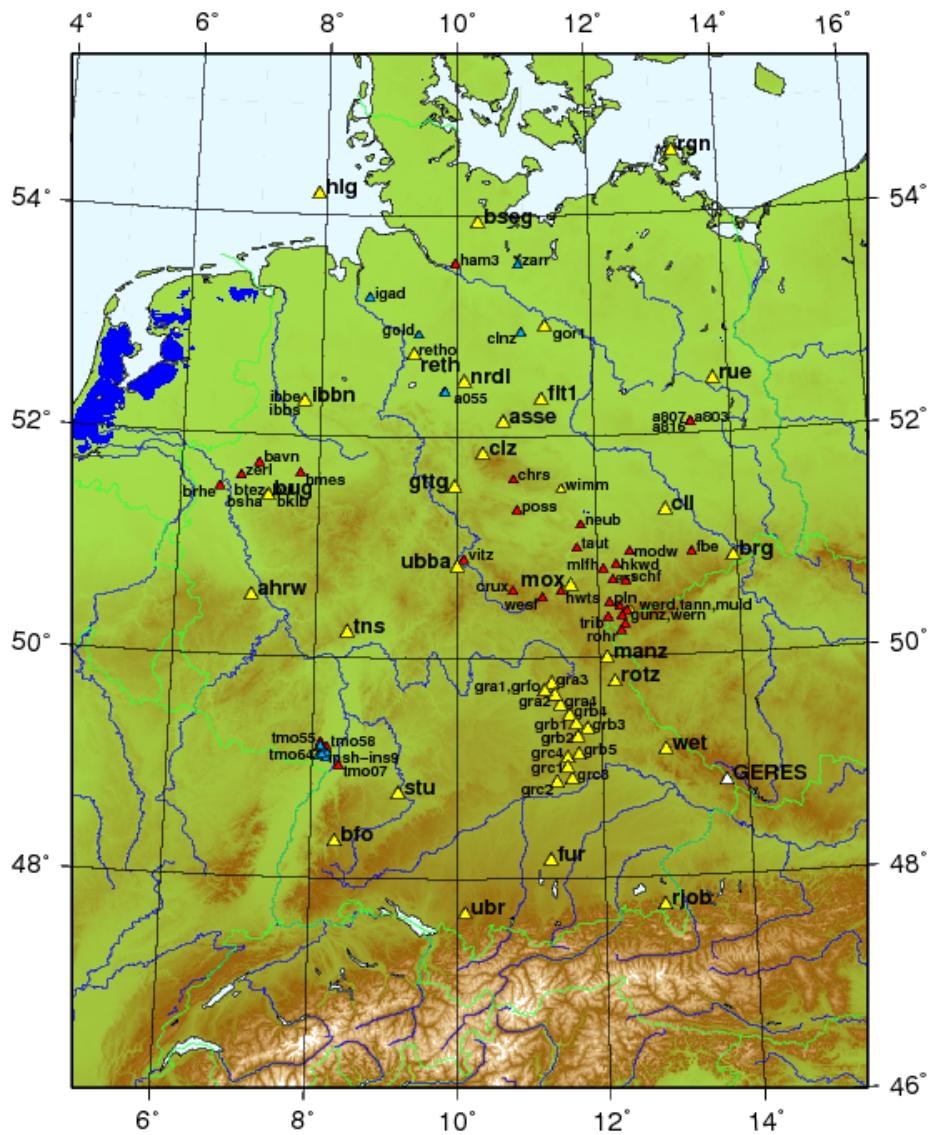
# Magnetic observatories



## INTERMAGNET



# Regional networks



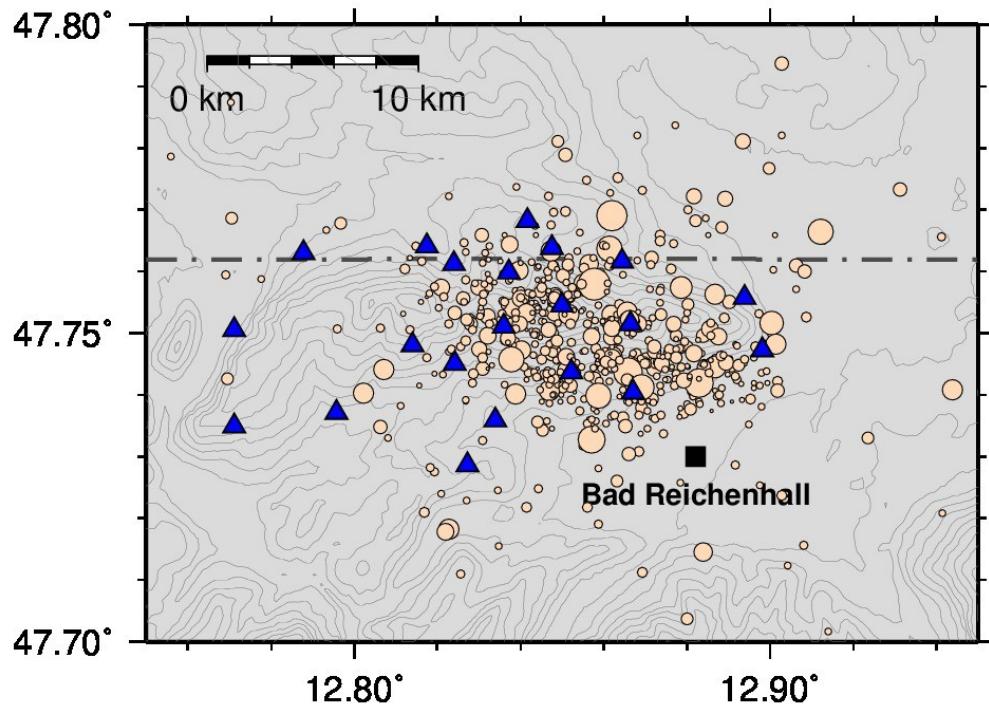
*distance ranges between 100 km  
and 1500 km (roughly!)*

# Regional networks

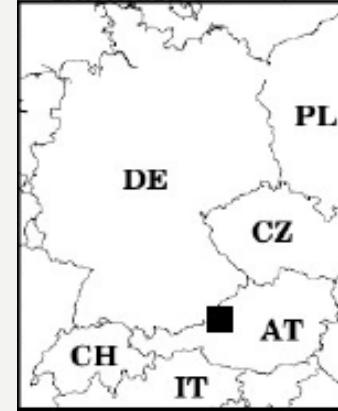


*The German Gravity Reference Network*

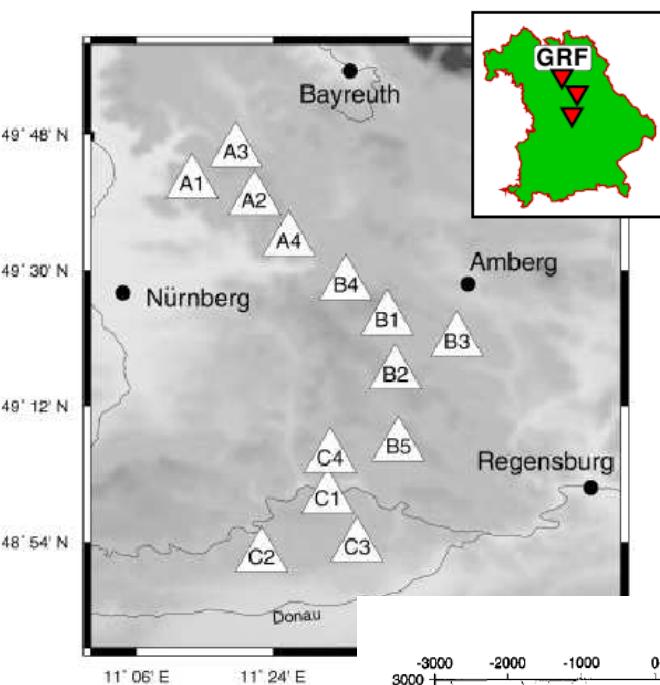
# Local networks



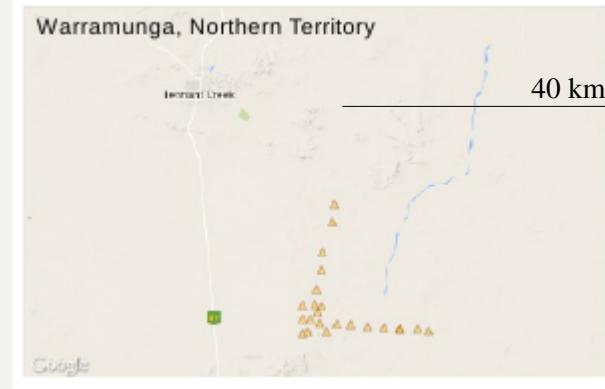
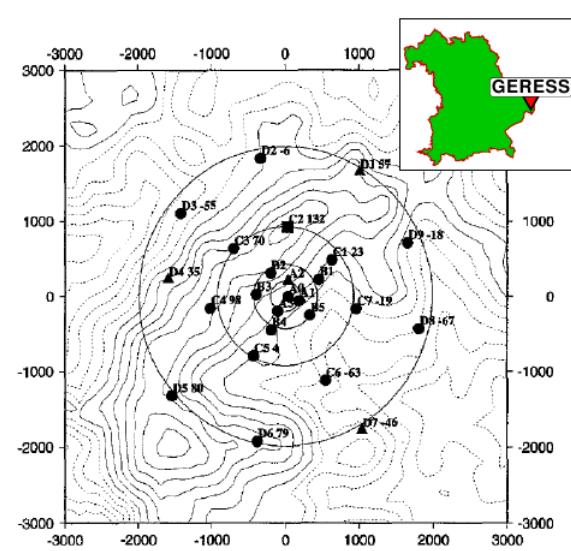
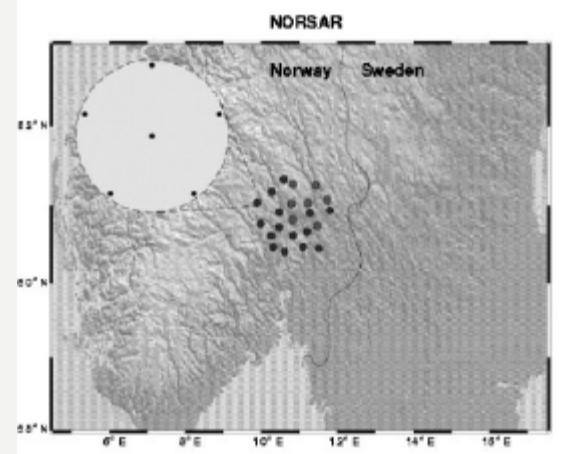
distances below 200 km (roughly!!!)



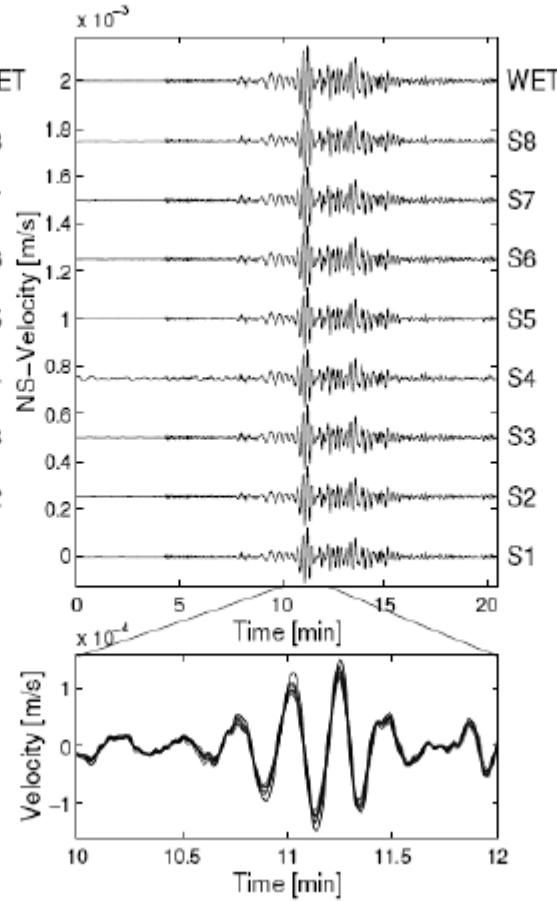
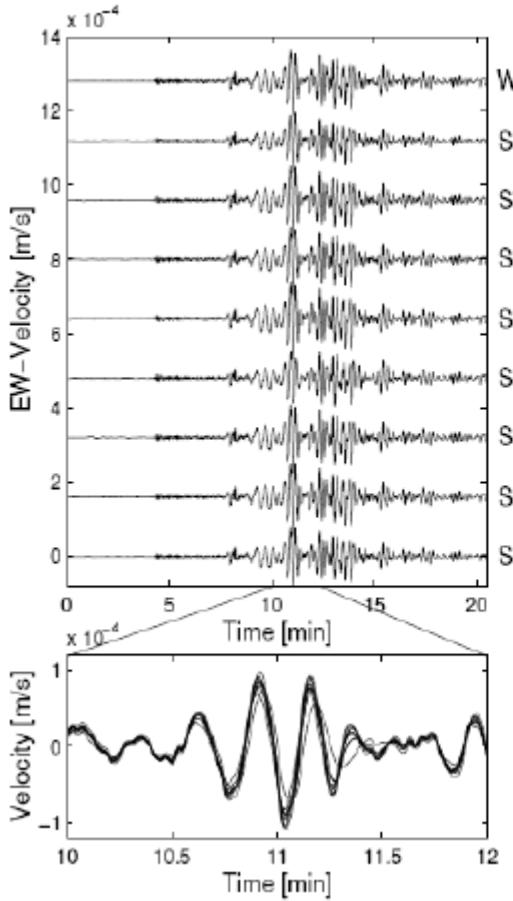
# Seismic arrays



- *distance ranges between a few meters to hundreds of kilometres;*
- *“arrays of arrays”*



# Seismic array



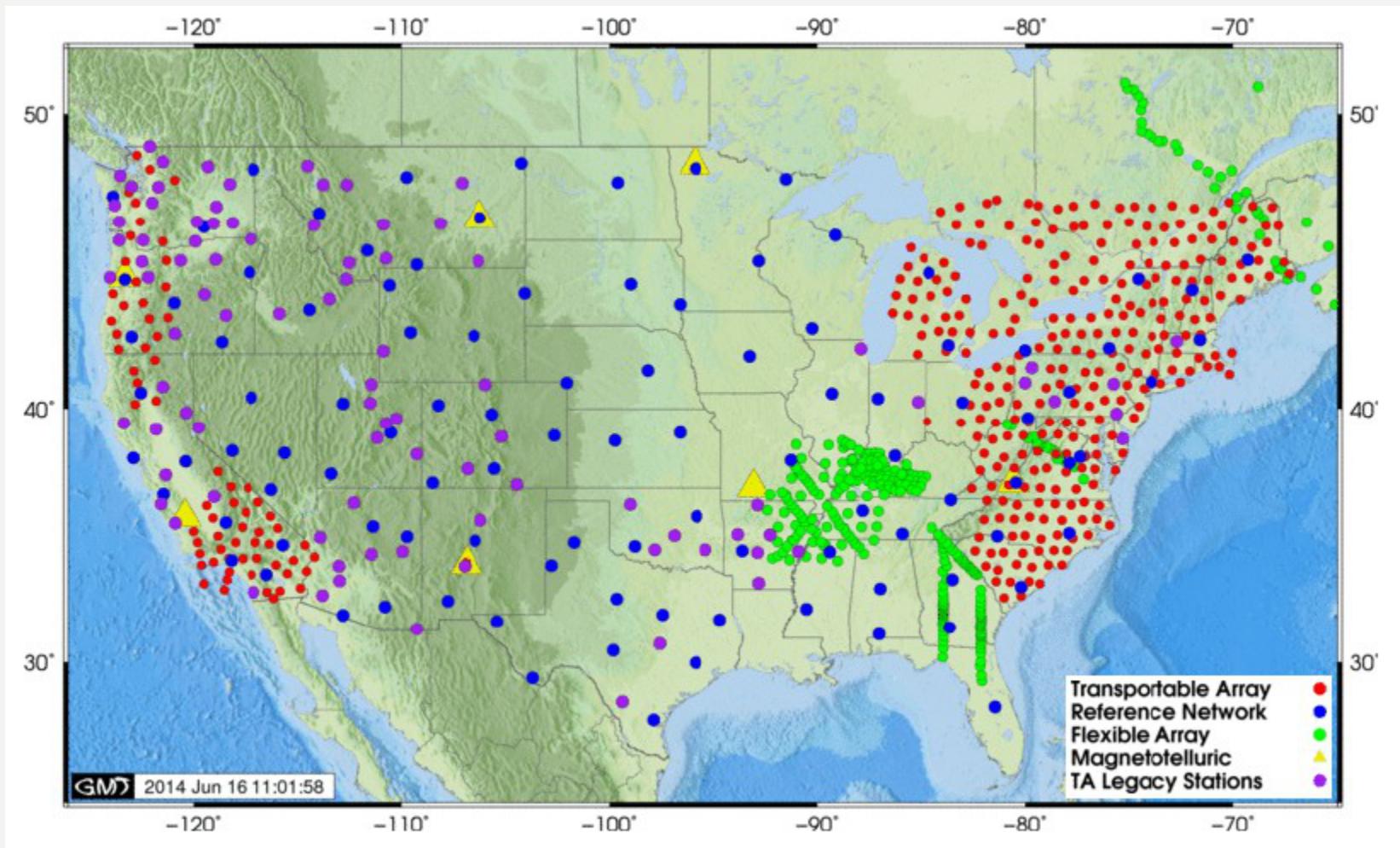
- Improving SNR ratio
- Obtain apparent velocity of wave
- Retrieve localisation from one 3C station

# Temporary (campaign) networks



[www.eartscope.org](http://www.eartscope.org)

[www.usarray.org](http://www.usarray.org)





- **Parameterized data:**

- EQ catalogue
- Travel time picks
- Focal mechanisms ...

- **Waveform data:**

- Raw data
- Quality controlled data
- Archive vs. Real-time data
- Station data
- Instrument data





SZGRF - [www.szgrf.bgr.de](http://www.szgrf.bgr.de)



You are here: SZO Home

---

This is a web page for seismologists. For general information please visit <http://www.seismologie.bgr.de>

---

[General Info](#) | [Waveform Data](#) | [Links to other data sources](#)

---

## Earthquake Lists and Bulletins

- [Recent Earthquake List](#)
  - [Earthquakes located with GRF- and GRSN-stations](#)
  - [Earthquake Bulletins \(monthly listings\)](#)
  - [Preliminary list of stronger seismic events \( \$M\_l > 3.0\$ \) in Germany and adjacent areas \(as pdf, since 1994\)](#)
  - [Earthquakes with at GRF/GRSN visible teleseismic phases of a given type](#)
- 

## Waveform Data and Station Information

- [Which data are available at the SZGRF ?](#)
  - [Requests via WWW](#)
  - [Using the Automatic Data Request Manager \(AutoDRM\)](#)
  - [Requests via Operator](#)
  - [Station map and Station Information](#)
  - [Longperiod/Shortperiod Dayplots of Stations](#)
-



## GEOFON Earthquake Information Service

Rapid global earthquake information is a major task of the GEOFON Program of GFZ Potsdam. As a key node of the European Mediterranean Seismological Centre (EMSC), GFZ has the responsibility for rapid global earthquake notifications. GFZ has also become a driving force in earthquake monitoring for tsunami warning in the Mediterranean and the north-east Atlantic as well as for the Indian Ocean.

The **GEOFON Earthquake Information Service** is

- one of the fastest sources for earthquake information worldwide,
- at first fully automatic (type A solutions), **therefore errors may occur**,
- only later verified by GEOFON seismologists on an *ad hoc* (non 24/7) basis (type M solutions, or type C confirmed automatic solutions)
- based on a virtual seismic network ([GEVN: GEOFON Extended Virtual Network](#), > 700 stations) composed of GEOFON real-time stations as well as from compatible stations from partner networks (in Europe mostly from the [VEBSN: Virtual European Broadband Seismic Network](#)).
- issuing notification e-mail and RSS feeds.

## Global Seismic Monitor

The GEOFON **Global Seismic Monitor** is a world map of global seismicity located automatically using the global virtual seismic network. Detailed information including hypocenter coordinates and a location map are displayed for the last major earthquake. There is also a [large version](#) suitable for display on a 1280x1024 screen, e.g. by using a web browser in full-screen mode.

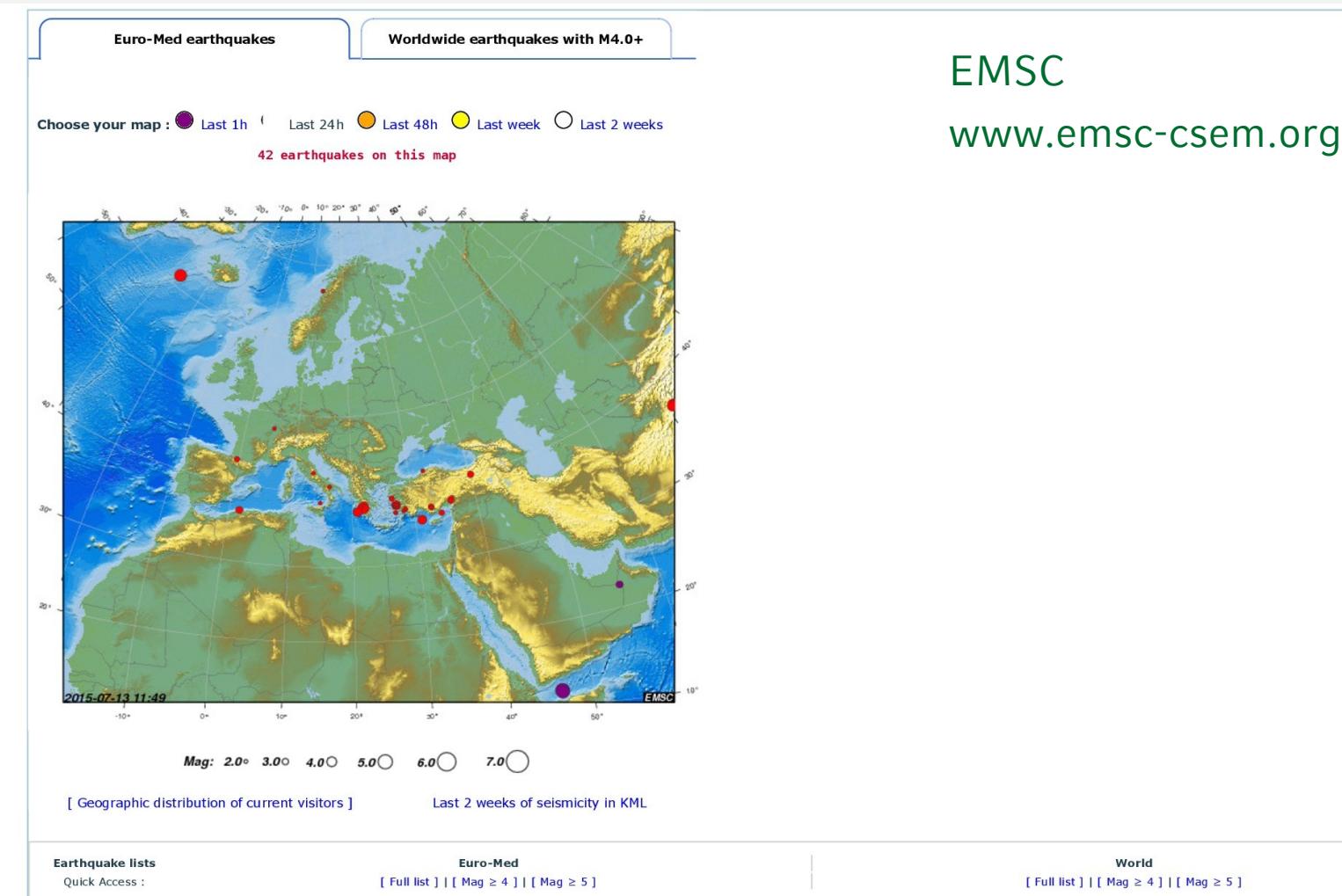
## Earthquake Bulletin

- Recent earthquakes
- Search in earthquake catalogue
- Moment tensor catalogue

## Event classification criteria

- **Normal**
  - All events which are located automatically by a sufficient number of stations ( $\geq 25$ ) or manually revised events.
- **BIG**
  - all events with  $M \geq 4.5$  in Central Europe, or
  - $\geq 5.0$  in the wider Europe/Mediterranean area, or
  - $\geq 5.5$  in the rest of the world.
- **XXL**
  - All events with  $M \geq 5.0$  in Central Europe, or
  - $\geq 5.5$  in the wider Europe/Mediterranean area, or
  - $\geq 6.5$  in the rest of the world.

**GEOFON**  
[geofon.gfz-potsdam.de](http://geofon.gfz-potsdam.de)



EMSC

[www.emsc-csem.org](http://www.emsc-csem.org)

# Centres for parameter data



**International Seismological Centre**

Home About ISC Staff Contact us Site Map

About ISC ISC Bulletin International Station Registry IASPEI GT Events EHB Bulletin

Event Bibliography Bibliography of Seismology Seismological Contacts

**ISC-GEM Catalogue**

**ISC News**

**2015-07-10**  
[Jobs at the ISC](#)

**2015-06-12**  
[Newsletter July-Dec 2014](#)

**2015-01-13**  
[ISC-50 Scientific Session at IUGG, Prague, 2015](#)

**2014-08-20**  
[ISC-GEM papers in PEPI](#)

**2014-05-21**  
[Summary of the Bulletin of the ISC is available online](#)

**News for / from data contributors**

**2015-06-10**  
[Seismic Network and Routine Data Processing - Japan Meteorological Agency](#)

**2015-06-10**  
[Geological Survey of Canada: Canadian National Seismic Network](#)

[Past news](#)

**What we do**

The main purpose of the ISC is to compile the [ISC Bulletin](#), regarded as the definitive record of the Earth's seismicity. Data is collected from over 130 [agencies](#) worldwide and is available online soon after being received. The Reviewed ISC Bulletin is typically available 24 months behind real-time and is manually checked by ISC analysts. With sufficient data events in the Reviewed ISC Bulletin are relocated using the ISC location algorithm

**ISC Membership**

Membership of the ISC is open to any scientific academy, governmental agency, research institution or other non-profit organisation. All members are represented on the [Governing Council](#), which determines the general policies of the Centre. Any commercial organisation with an interest in the objectives and/or output of the Centre may become an associate member (sponsor). Please [contact us](#) if you are interested in ISC membership.

**Projects**

The ISC is involved in the following projects:

- **Extension of the ISC-GEM Catalogue** - complementing the 1904-1959 period with data on moderate earthquakes.
- **Rebuild of the ISC Bulletin** - recomputing the entire ISC Bulletin using ak135 with the updated [ISClon](#). The rebuilt bulletin will also include many additional data.
- **CTBTO link to the ISC database** - only

ISC locations: 1960 to present

Depth (km)

ISC  
www.isc.ac.uk



USGS Home

Contact USGS

Search USGS

## Earthquake Hazards Program

[Home](#)[About Us](#)[Contact Us](#)[Search](#)[EARTHQUAKES](#)[HAZARDS](#)[DATA & PRODUCTS](#)[LEARN](#)[MONITORING](#)[RESEARCH](#)

## National Earthquake Information Center (NEIC)

### NEIC Tour Information

The National Earthquake Information Center is located in Golden, CO at:

1711 Illinois Street  
(on the Colorado School of Mines Campus).

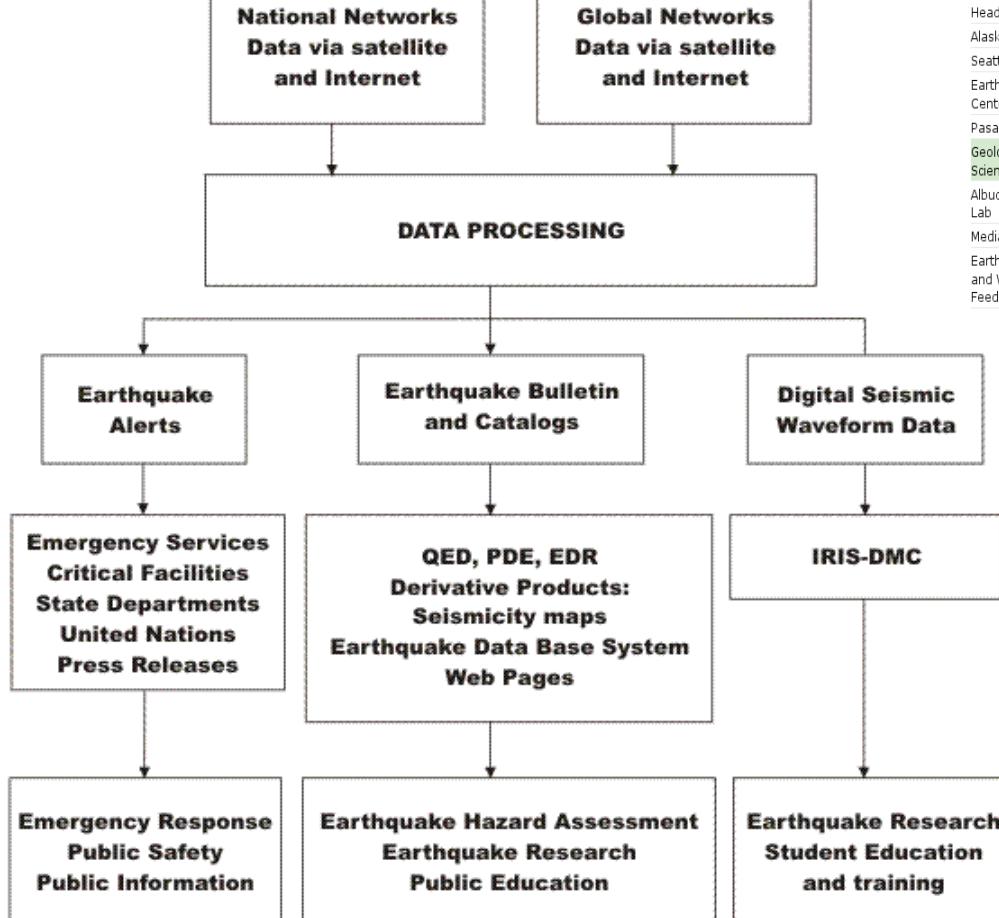
Our mailing address is:  
U.S. Geological Survey  
National Earthquake Information Center  
Box 25046 MS 966  
Denver Federal Center  
Denver, Colorado 80225-0046



## NEIC

[earthquake.usgs.gov/contactus/golden/neic.php](http://earthquake.usgs.gov/contactus/golden/neic.php)

Data Sources



Products

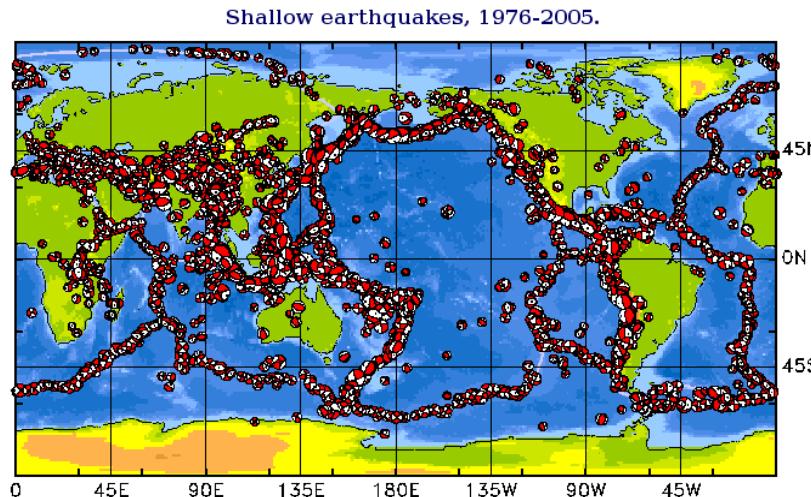
Applications



## Global CMT Web Page

### Introduction and Explanation

The Global Centroid-Moment-Tensor (CMT) Project is overseen by Principal Investigator Göran Ekström and Co-Principal Investigator Meredith Nettles at the Lamont-Doherty Earth Observatory (LDEO) of Columbia University. The project was founded by Adam Dziewonski at Harvard University and operated there as the Harvard CMT Project from 1982-2006, led first by Prof. Dziewonski and later by Prof. Ekström. During the summer of 2006, the activities of the CMT Project moved with Prof. Ekström to LDEO. This research effort is moving forward under the name "The Global CMT Project". The main dissemination point for information and results from the project is the web site [www.globalcmt.org](http://www.globalcmt.org). The CMT project has been continuously funded by the National Science Foundation since its inception, and is currently supported by award EAR-0824694.



GCMT  
[www.globalcmt.org](http://www.globalcmt.org)

The Global CMT Project involves four main activites:

1. Systematic determination, with a three-to-four-month delay, of moment tensors for earthquakes with  $M>5$  globally, and accumulation of the results in the CMT catalog.
2. Rapid determination of moment tensors for earthquakes with  $M>5.5$  globally and quick dissemination of results ("quick CMTs").
3. Curation of the CMT catalog, which contains more than 25,000 moment tensors for earthquakes since 1976.
4. Development and implementation of improved methods for the quantification of earthquake source characteristics on a global scale.



## Orfeus

Observatories and Research Facilities for European Seismology

[HOME](#) [DATA](#) [EARTHQUAKES](#) [WORKING GROUPS](#) [SOFTWARE](#) [LINKS](#) [ORGANIZATION](#)

### Organization

announcements

documents

news

participation

projects

structure

contact

### Get Data

direct data access (ftp)

tools and services

### Earthquakes

google maps monitor

recent earthquakes list

### In Memoriam

Torild van Eck  
1949 - 2014

[Condolences](#)

### ORFEUS

ORFEUS (Observatories and Research Facilities for European Seismology), is the non-profit foundation that aims at co-ordinating and promoting digital, broadband (BB) seismology in the European-Mediterranean area.

#### More information

**2015 ORFEUS Annual Observatory Coordination meeting**

**21-24 September, 2015, Bucharest, Romania**

#### Information

**Registration is open**

### News

#### 29-05-2015: European Strong-Motion database (ESM)

The European Strong-Motion database (ESM) is an archive of accelerometric waveforms from events with magnitude  $\geq 4.0$  recorded in Europe and middle-East since 1969. It provides unprocessed acceleration time-series, manually processed acceleration, velocity and displacement time-series, acceleration and displacement response spectra, and relevant engineering parameters.

- Waveforms are either downloaded from the the ORFEUS European Integrated Data Archive (EIDA) or provided by data providers joining the ORFEUS Working Group 5.
- Near realtime earthquake information is provided by the EMSC, although earthquake locations and magnitudes are periodically revised.
- The ESM was developed within the NERA project.

FIRUZABAD 1994-06-20 09:09:03 - 11.A3297 - Iranian Strong Motion Network [\[i\]](#)



ORFEUS

[www.orfeus-eu.org](http://www.orfeus-eu.org)

# Centres for waveform data



INCORPORATED RESEARCH INSTITUTIONS FOR SEISMOLOGY

Resources/Search



**RESEARCH**  
Data, derived products,  
software, web services

**EDUCATION**  
Lessons, lectures,  
videos, public displays

**FACILITIES**  
Directories, programs,  
networks, centers

**EARTHQUAKES**  
Recent earthquakes,  
teachable moments

**ABOUT IRIS**  
Organization, governance,  
news, jobs, publications

**RESOURCES**  
Publications, webinars, posters,  
newsletters, proposals



**FACILITATE**

**COLLABORATE**

**EDUCATE**

Latest Major Earthquake Information > Magnitude 7.0 - Southern Mid-Atlantic Ridge 2015-06-17

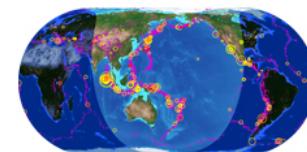
## RECENT NEWS

- ★ Geophysics Community Seeks Comments on Draft Report by July 20 2015-07-07
- IRIS and Latin American Network Operators Meet in Chile 2015-06-30
- The San Andreas Movie - Perspectives from Seismologists 2015-06-01
- Hundreds of Sensors Deployed to Image Socorro Magma Body 2015-05-12
- USArray Featured in Canada's Leading Newspaper 2015-05-05

## UPCOMING WORKSHOPS

- Ocean Bottom Seismology Symposium 2015  
Vancouver Washington, Vancouver , WA , USA  
2015-10-05 — 2015-10-06
- Managing Data from Seismic Networks  
Silk Path Hotel, Hanoi , Vietnam  
2015-09-09 — 2015-09-15

All workshops



Seismic Monitor

Other Major Earthquakes

IRIS

[www.iris.edu](http://www.iris.edu)



[HOME](#) [ABOUT](#) [CONTRIBUTE DATA](#) [SERVICES](#) [DATA COLLECTIONS](#) [COMMUNITY](#) [NEWS](#) [HELP](#) [CONTACT US](#)

**IEDA Data Browser**

Explore our global data holdings through an interactive map interface. [IEDA Data Browser](#) uses our [GMRT Synthesis](#) as a backdrop, and allows you to quickly zoom to areas of interest to discover data available from [EarthChem Portal](#), [Geochron](#), and [MGDS](#).

• • • • • • • • • • • •
▶ ||

**Quick Links**

- [IEDA Data Browser](#)
- [Data Mgmt Plan Tool](#)
- [EarthChem Systems](#)
- [GeoMapApp](#)
- [Geosamples \(SESAR\)](#)
- [GMRT](#)
- [Marine-Geo \(MGDS\)](#)
- [MediaBank](#)
- [PetDB](#)

**Welcome to IEDA**

IEDA or **Interdisciplinary Earth Data Alliance** is a community-based data facility funded by the US National Science Foundation (NSF) to support, sustain, and advance the geosciences by providing data services for observational solid earth data from the Ocean, Earth, and Polar Sciences. IEDA systems enable these data to be discovered and reused by a diverse community now and in the future.

Funding for IEDA's services is provided by the [Ocean Sciences](#) and [Earth Sciences](#) Divisions in the [Geoscience Directorate](#) and by the [Office of Polar Programs](#) of the [US National Science Foundation](#).

IEDA is a partnership between [EarthChem](#) and the [Marine Geoscience Data System](#). [Read more >>](#)

**Recent News**

- IEDA Newsletter, March 2016, No. 6**  
Mar 2016. This newsletter summarizes new features and improvements in the Interdisciplinary Earth Data Alliance (IEDA) ...
- IEDA at AGU 2015**  
Nov 2015. A selection of events, presentations, and sessions by IEDA team members at the upcoming AGU Fall Meeting 2015 in San...
- IEDA Newsletter, December 2015, No. 15**  
Dec 2015. This newsletter summarizes new features and improvements in the Interdisciplinary Earth Data Alliance (IEDA) ...
- Geoscience Paper of the Future Training Session: Learning best practices for scholarly publication**  
Aug 2015. IEDA will be hosting a Geoscience Paper

[www.iedadata.org](http://www.iedadata.org)

- **Geochronology**
- **Thermochronology**
- **Geochemistry**
- **Petrology**
- **Marine geoscience**

# National data centers



For example:

- <http://www.bgs.ac.uk/services/ngdc/>
- <https://www.ngdc.noaa.gov/>
- <http://www.ngii.go.kr/en>  
(Korea)



**British Geological Survey**  
NATIONAL ENVIRONMENT RESEARCH COUNCIL



**NOAA** NATIONAL CENTERS FOR  
ENVIRONMENTAL INFORMATION  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



National Geographic  
Information Institute



- ... for recording
  - compact/compressed, often instrument specific
  - e.g. Guralp gcf, reftek, ...
- ... for exchange
  - contain additional information in header, e.g. instrument characteristic
  - e.g. gse, seed, miniseed, ...
- ... for processing
  - almost every code has its own working format
  - e.g. Q, sac, seisan, ...



ObsPy

GitHub Documentation ▾

### Waveform Import/Export Plug-ins

<a href="#">obspy.io.ah</a>	obspy.io.ah - AH (Ad Hoc) read support for ObsPy
<a href="#">obspy.io.ascii</a>	
<a href="#">obspy.io.css</a>	obspy.io.css - CSS read support for ObsPy
<a href="#">obspy.io.datamark</a>	obspy.io.datamark - DataMark read support for ObsPy
<a href="#">obspy.io.gse2</a>	obspy.io.gse2 - GSE2/GSE1 read and write support for ObsPy
<a href="#">obspy.io.kinemetrics</a>	obspy.io.kinemetrics - Evt format support for ObsPy
<a href="#">obspy.io.mseed</a>	obspy.io.mseed - MiniSEED read and write support
<a href="#">obspy.io.nied.knet</a>	Reading of the K-NET and KiK-net ASCII format as defined on
<a href="#">obspy.io.pdas</a>	obspy.io.pdas - PDAS file read support for ObsPy
<a href="#">obspy.io.sac</a>	obspy.io.sac - SAC read and write support for ObsPy
<a href="#">obspy.io.seisan</a>	obspy.io.seisan - SEISAN read support for ObsPy
<a href="#">obspy.io.seg2</a>	obspy.io.seg2 - SEG-2 read support for ObsPy
<a href="#">obspy.io.segy</a>	obspy.io.segy - SEGY and SU read and write support for ObsPy
<a href="#">obspy.io.sh</a>	obspy.io.sh - Q and ASC (Seismic Handler) read and write support for ObsPy
<a href="#">obspy.io.wav</a>	obspy.io.wav - WAV(audio) read and write support for ObsPy
<a href="#">obspy.io.y</a>	obspy.io.y - Nanometrics Y file read support for ObsPy

### Event Data Import/Export Plug-ins

<a href="#">obspy.io.cmtsolution</a>	obspy.io.cmtsolution - CMTSOLUTION file format support for ObsPy
<a href="#">obspy.io.cnv</a>	obspy.io.cnv - CNV file format support for ObsPy
<a href="#">obspy.io.json</a>	JSON write support
<a href="#">obspy.io.kml</a>	obspy.io.kml - Keyhole Markup Language (KML) write support
<a href="#">obspy.io.ndk</a>	obspy.io.ndk - NDK file support for ObsPy
<a href="#">obspy.io.nied.fnetmt</a>	F-net moment tensor file format support for ObsPy.
<a href="#">obspy.io.nlloc</a>	obspy.io.nlloc - NonLinLoc file format support for ObsPy
<a href="#">obspy.io.pde</a>	obspy.io.pde - NEIC PDE Bulletin read support for ObsPy
<a href="#">obspy.io.shapefile</a>	obspy.io.shapefile - ESRI shapefile write support
<a href="#">obspy.io.quakeml</a>	
<a href="#">obspy.io.zmap</a>	obspy.io.zmap - ZMAP read/write support.

### Inventory Data Import/Export Plug-ins

<a href="#">obspy.io.css</a>	obspy.io.css - CSS read support for ObsPy
<a href="#">obspy.io.kml</a>	obspy.io.kml - Keyhole Markup Language (KML) write support
<a href="#">obspy.io.sac.sacpz</a>	Module for SAC poles and zero (SACPZ) file I/O.
<a href="#">obspy.io.seiscomp</a>	obspy.io.seiscomp - SeisComp3 Inventory Files
<a href="#">obspy.io.shapefile</a>	obspy.io.shapefile - ESRI shapefile write support
<a href="#">obspy.io.stationtxt</a>	obspy.io.stationtxt - Read support for the FDSNWS station text files
<a href="#">obspy.io.stationxml</a>	

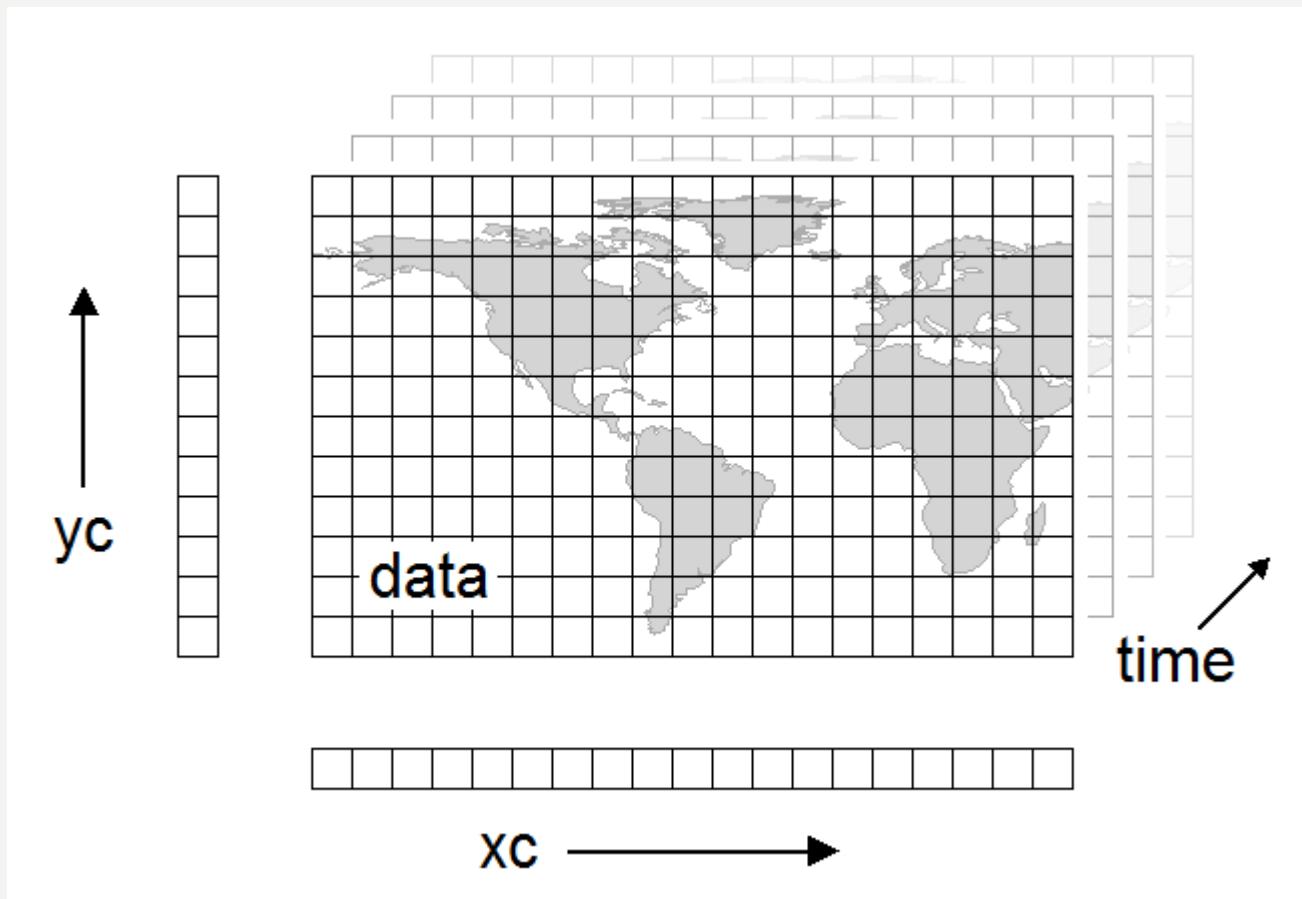
Geophysical Data Analysis

25/07/15

11/39

# Data formats

- Up to four dimensions ...





# gse and gse2

- developed in connection with the Comprehensive Nuclear-Test-Ban Treaty in late 1980s
- pure ascii format

XW01

```
WID2 2014/01/01 00:00: 0.000 GRA1 BHZ GRA1 CM6   6000  20.000000  0.17E+00  1.000      -1.0 -1.0
STA2      49.69190 11.22170          0.500 -.999
DAT2
h8wG+-59OL-HLUF1S6J3+T53+-OMAMO5M23kMJ+F2L4KG1-NJBK1G06Q34MJ2G15H-GKFK21HFNOF71
THA0HI32LF894I2+0DLG9549+L021I5UM+P+47PH6JDGL0K0JO26LkF24-MkGDUhkFkIJ690OkFH67RS
F6UKNKH-28GL27QH5K6+N--M+IFBL+5NKAUIQkF065GQkF0C7IQ-C2MFIF6FF2UEFR01BUG2N1308kLS
7DCkIHAlIQOK2UKNkI6-A1QPF41GkFUF8kFI8UIHJTL28-kEDUE-5RK29DHG+FJKI7HNSGUGPTI6CQ
IGPA0Q098JN0K00QQ+D6kGN0H5KQ017LkEQ3UGJJ1K8GkJUI22CkG2UL0F7SAUO10kGUMD3-TG0UGHN9
8MkH+5C4kEO+76kJRUF90GkNPUG5NkFI423FM4KSJQ2CIkH-2++kHG65HkN3D9MOUNJ31ks4A25J3UKK
I1kLAUESI96A6KTkG31F010IKT0H1UIQRUHGkQ7A34P3D-HJP9B0-SD7M-GB+QQGBB0I5+UKN8O+7JIk
H3UI-L+1JF1LTB8PI-+II+0031GKJFH2G10kE02J4-I1724+JMFAUE60UEKI9kE0C5F14MT20+UkLkSA
BNMH30+8JSFFFJH2H-HPFLIIKUIGP4-++K1UE25B-PQD-JCL28MNH8KK1J+13PNDJNGQA-kNA6kO8GPU
IPNG+UFQM5MA8IGR9F22MBkFF9PUG1MG+27NGUKM0B89kE7AQ6UE43JLGJ+3GOkE0247SkIMFC3kEkGU
EUS-TP-9LH418JI3271SkF88PJGGUH2HOPC4NPB9G6LM-0RP4kFF1S480TQH0UENKEGUAKg1-ABHPKU
...
F7H-3K1G-J06G+GFJGBLK0JIP+-F2J4LN00-5FS3IG6J1HI3K60K0HH08+N0F-++10FGH3HMA1K1-FHF
1100+60O4+K19HI7NK9HHFF+L3+JF2M-BN1GJ3H3+03L30+UFI+01I2420I+2IJ9+-FIHHG-1F-0NIL
M7H-0PG1Q16J--Q1-H-L3+H+F-I-M-AI1-M3IL1I49K1+N132GM22M-2FH6HI2I58JF5LJ6022G5HI+G
76-0IH4FG-F+80I81J1
CHK2 2651083
```

STOP



- complex, mixed binary/ascii format
- claim to include all necessary information for waveform processing

```
000001V 010005102.3122014,001~2014,001,00:05~1990,001,02~~~0110153013GRA1 000003GRA2 000004GRA3  
000005GRA4 000006GRB1 000007GRB2 000008GRB3 000009GRB4 000010GRB5 000011GRC1 000012GRC2  
000013GRC3 000014GRC4 000015012004100012014,001~2014,001,00:05~000016
```

*binary*

```
000002A 0340023001M/S~VELOCITY~0340024002COUNTS~COUNTS~0330040001STS-2  
STRECKEISEN SEISMOMETER~0330061002FED. INSTITUTE FOR GEOSCIENCES AND NAT. RES.  
(BGR)~0300232STEIM INTEGER COMPRESSION FORMAT~000105006F1 P4 W4 D0-31 C2 R1 P8 W4 D0-31 C2~P0 W4  
N15 S2,0,1~T0 X N0 W4 D0-31 C2~T1 N0 W1 D0-7 C2 N1 W1 D0-7 C2 N2 W1 D0-7 C2 N3 W1 D0-7 C2~T2 N0 W2 D0-15  
C2 N1 W2 D0-15 C2~T3 N0 W4 D0-31 C2~
```

*binary*

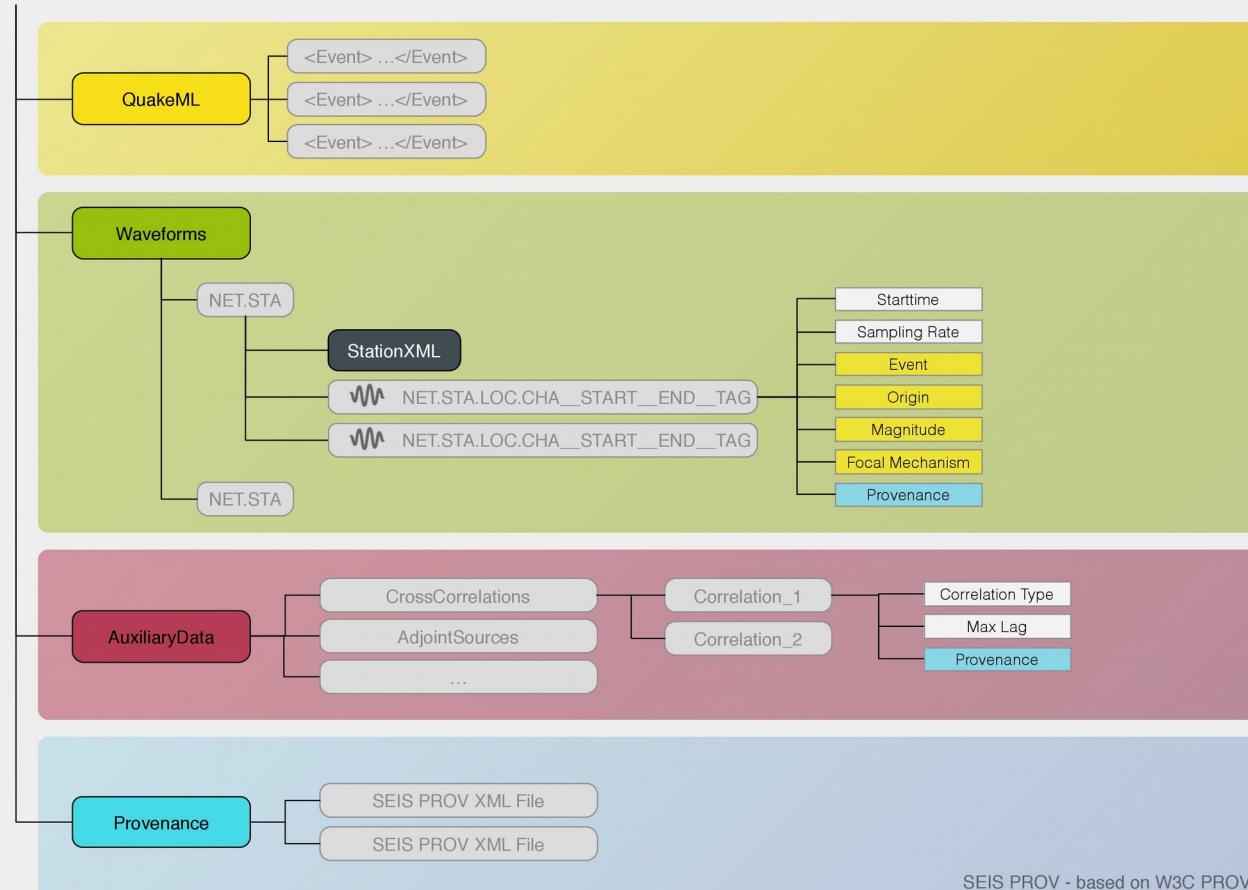
...



Format conversion is complex, error-prone, and annoying.

→ developments of solutions are necessary

CONTAINER (HDF5) => broad tool support, works on essentially all platforms of interest



ASDF

a new **Adaptable Data Format for seismology**

suitable for large-scale workflows

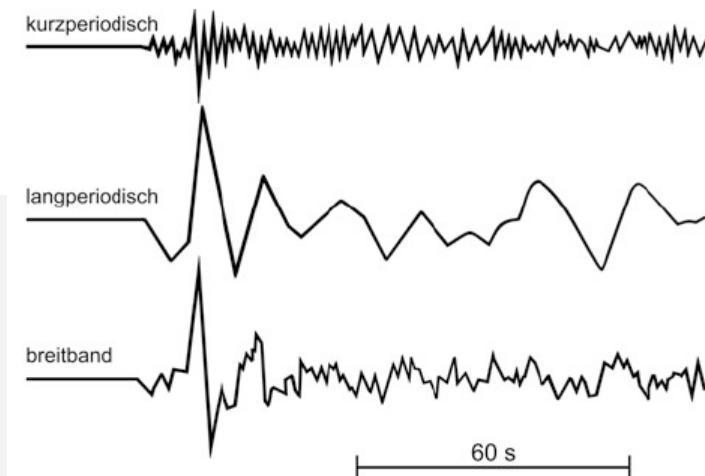
developed inhouse by Lion Krischer



Typical naming of waveform file: **BW.HROE.00.EHZ**

**Table 3.3** The most common band codes for channel naming. There is no corner period specified in the SEED manual for sample rates lower than 1 Hz, however it is assumed to be more than 10 s

Band code	Band type	Sample rate	Corner period (s)
E	Extremely short period	$\geq 80$ to $< 250$	$< 10$
S	Short period	$\geq 10$ to $< 80$	$< 10$
H	High broadband	$\geq 80$ to $< 250$	$\geq 10$
B	Broad band	$\geq 10$ to $< 80$	$\geq 10$
M	Mid period	$> 1$ to $< 10$	
L	Long period	$\approx 1$	
V	Very long period	$\approx 1$	
U	Very long period	$\approx 0.01$	





Typical naming of waveform file:

BW.HROE.00.EHZ

**Table 3.4** The most common instrument and orientation codes used for channel naming

*Instrument code*

H	High gain seismometer
L	Low gain seismometer
G	Gravimeter
M	Mass position seismometer
N	Accelerometer

*Orientation code*

Z N E	Traditional (Vertical, north–south, east–west)
A B C	Triaxial (Along the edges of a cube turned up on a corner)
T R	For formed beams (Transverse, Radial)