Integrating seafloor and land-based seismic waveform data at ORFEUS Data Center

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ORFEUS Data Center – mission

The primary purpose of the ORFEUS Data Center (ODC) is to collect and archive high quality seismic broadband waveform data from European and Mediterranean organizations, and to give open and rapid access to the da by the scientific community.

The ODC can fulfill this mission only in strong cooperation with seismic observatories,
seismic network operators and end users from the scientific community.

VEBSN statement of operation
http://www.orfeus-eu.org/Data-info/Statement-of-Operation-VEBSN-update 2009.pdf

Data remains ownership of the contributing network, while the ODC provides a
secure back-up archive of waveform data and offers the means for the academic
research community to access the data.

ORFEUS Data Center - operations structure

RT acquisition

- Antelope 4.11
- SeedLink
- SCREAM

Processing / QC

- Antelope 4.11
- PSD vs. time
- PQLX
- histograms
- manual QC
- [SeisComP3]
- gap management

Storage

- Antelope 4.11
- SCREAM
- MySQL
- GDI

Services

- ftp
- Wilber II
- OWI
- NetDC
- AutoDRM
- Breq_fast
- QuakeExplorer
- ArcLink
- webservices
- Portal

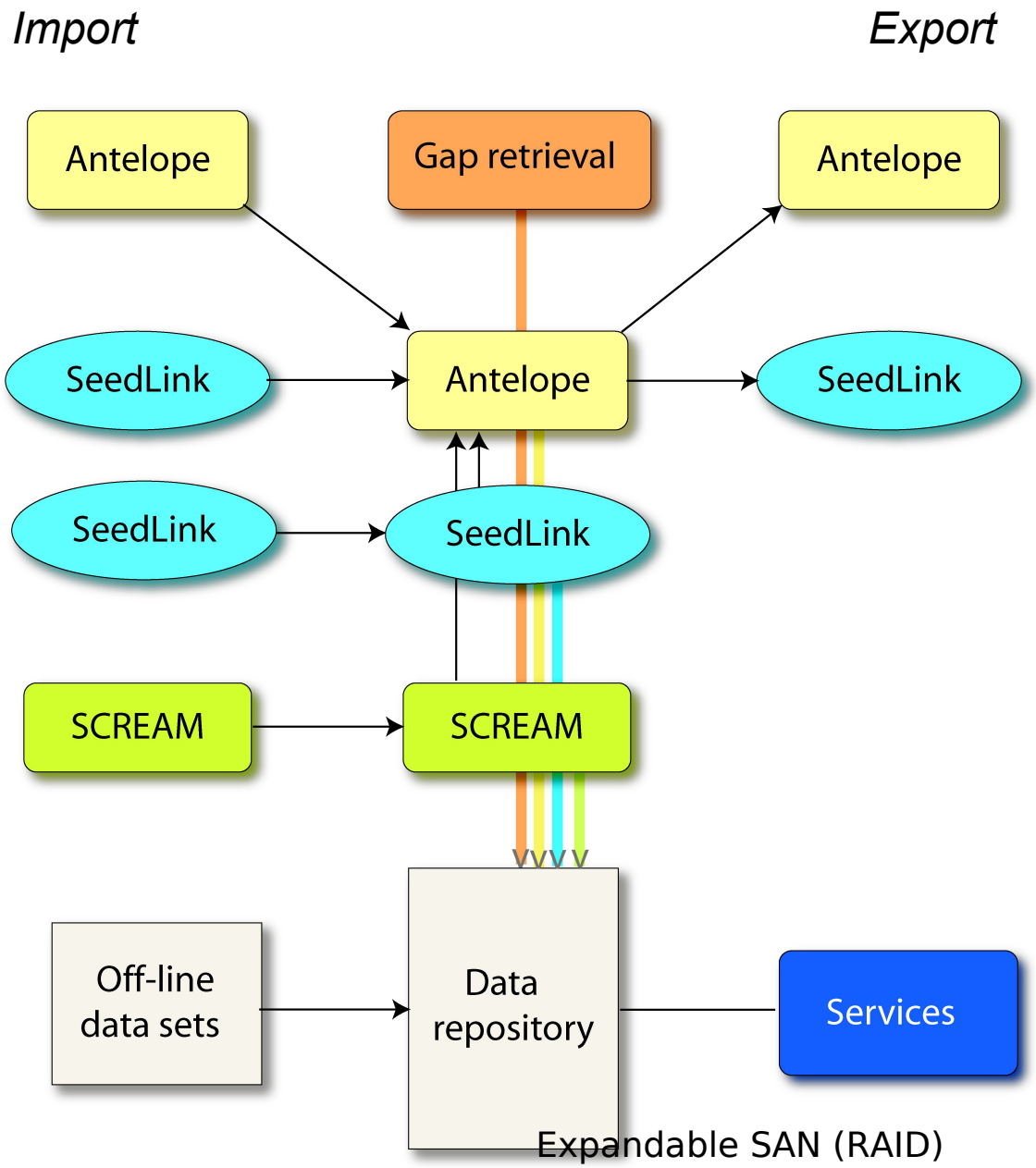
- Linux RH Enterprise 5.1
- HP Blade 64-bit, 16 CPU

- Linux RHE 5.1
- HP Blade 64-bit

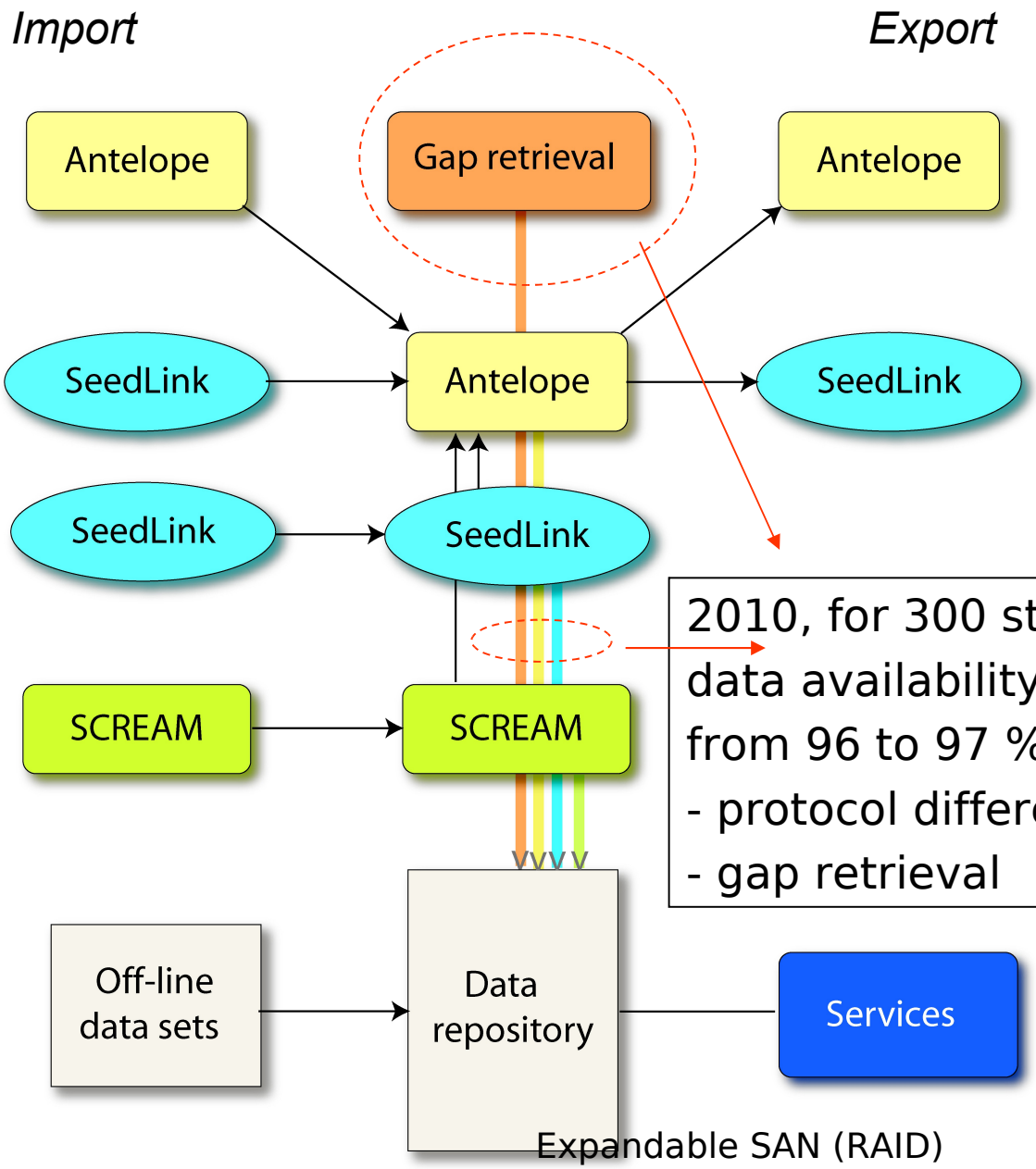
- SAN 10 TB
- RAID

- Linux RHE 5.1
- Cluster software
- HP Blade 64-bit

ORFEUS Data Center - data flow



ORFEUS Data Center - data flow



2010, for 300 stations
data availability increased
from 96 to 97 %;
- protocol differentiation
- gap retrieval

a holdings at ODC:

nuous waveform data (VEBSN): 2000 - present (inc. OBS)

acked event data: 1988 - 2002 (QC), 2003 – p

al data sets

ew absolute arr

Including OBS at ODC:

- **International registry (ISC, FDSN)**
- **Metadata (pref. dataless SEED)**

007 (T. Diehl, E. Kissl

n)

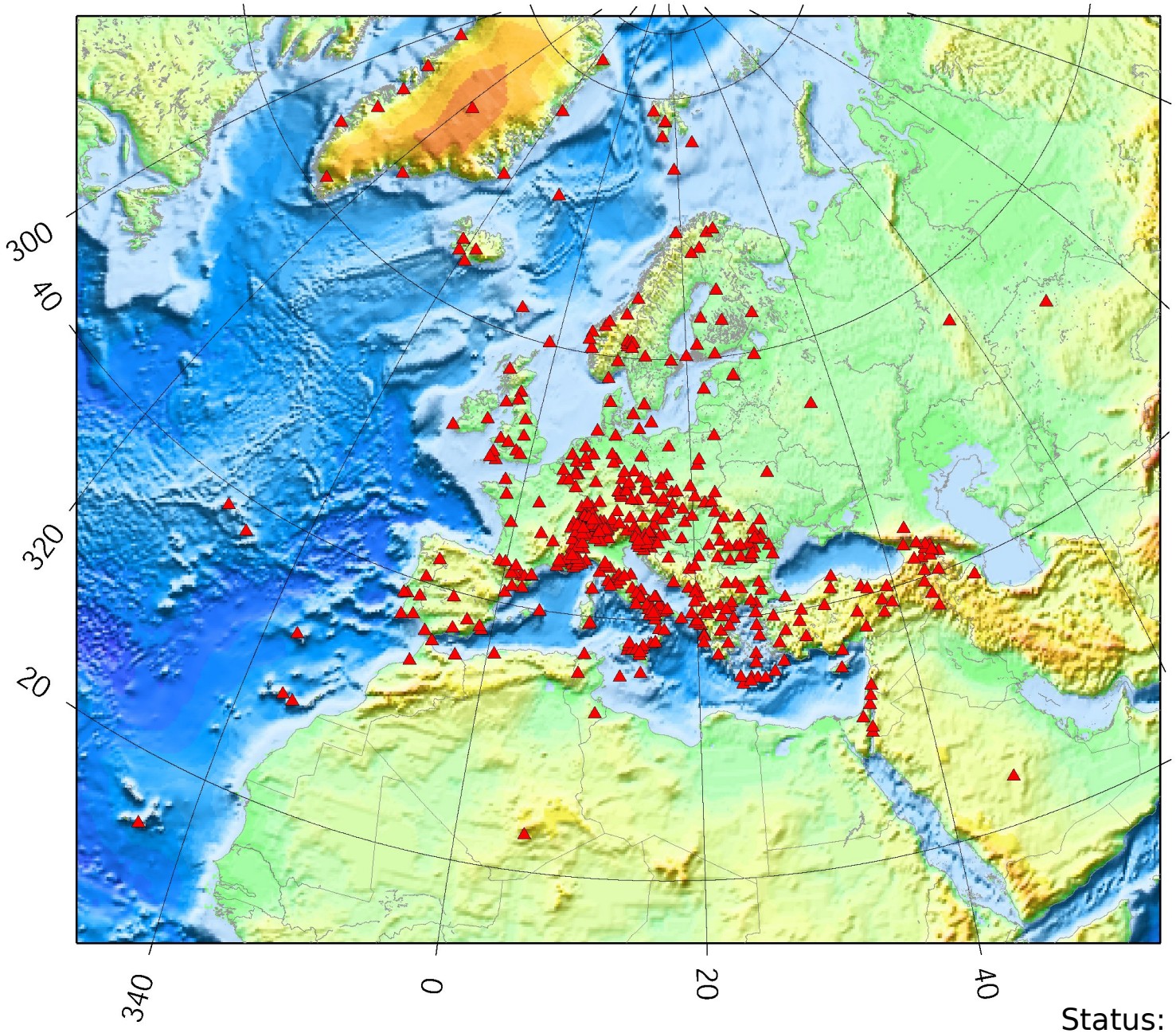
1-2005	11 stations,	Polynesian Lithosphere and Upper Mantle Experiment
1-2005	53 stations,	Tibet/China
3	26 stations,	Mongolia/Russia
4	42 stations,	Tabriz, Iran
4	9 stations,	Bam, Iran

VEBSN – Virtual European Broadband Seismograph Network

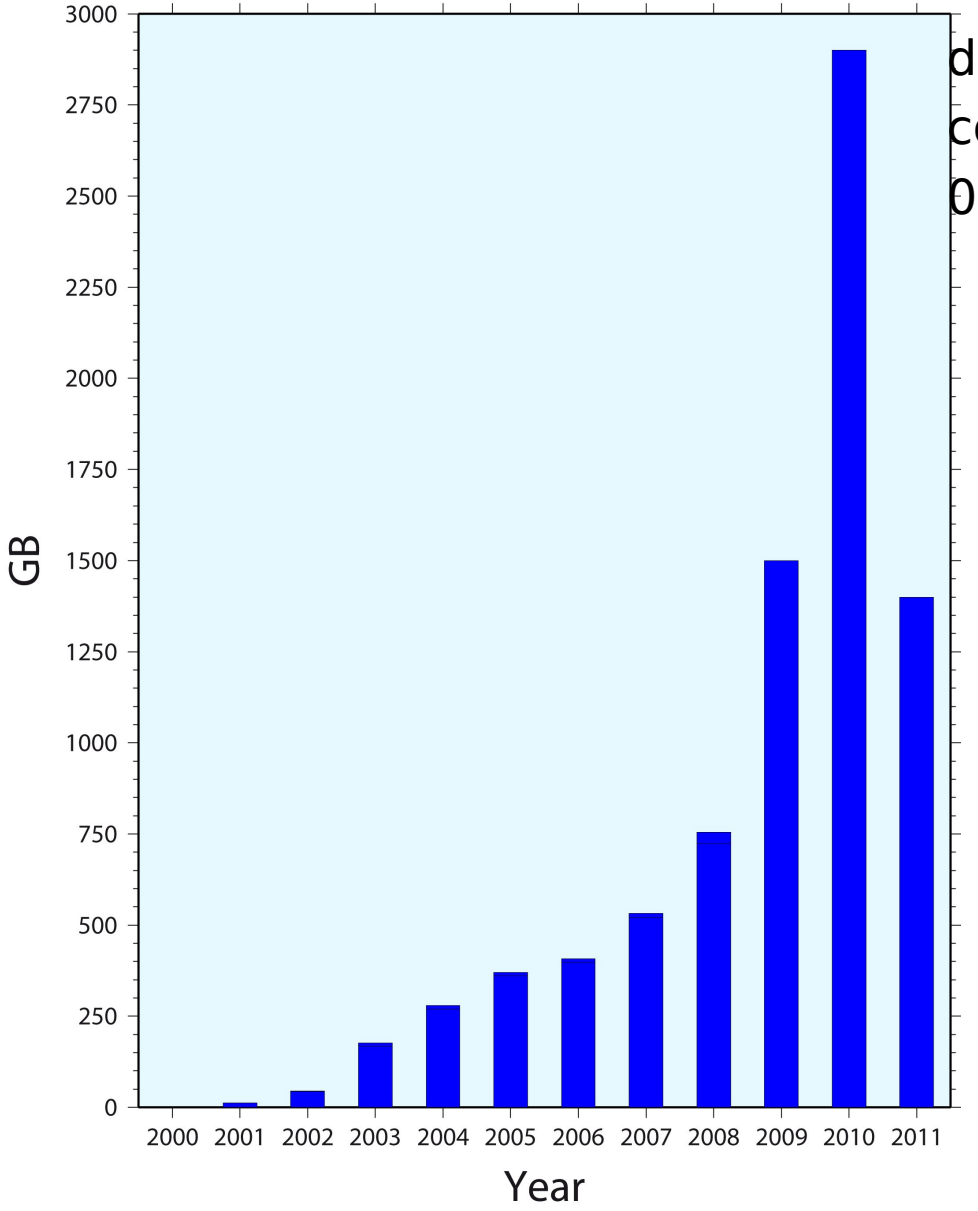
AC	Albanian Seismological Network
AI	Antarctic Seismographic Argentinean Italian Net
BE	Belgian Seismic Network
BN	UK-Net
BS	National Network of Bulgaria
BW	BayernNetz
CA	Catalan Seismic Network **(*)**
CH	Switzerland Seismological Network
CR	Croatian Seismograph Network
CZ	Czech Seismic Network
DK	Danish Seismological Network
DZ	CRAAG, Algeria
EB	Ebro Observatory, Spain
EI	Irish Regional Digital Seismic Network
ES	Spanish Digital Seismic Network
FN	Northen Finland Seismological Network
FR	French Broadband Seismological Network **(*)**
G	GEOSCOPE
GB	Great Britain Seismograph Network
GE	GEOFON
GO	Georgia
GR	German Regional Seismic Network
GU	University of Genua, Italy
HE	Finnish National Seismic Network (HEL)
HF	Swedish Seismic Array Network
HL	National Observatory of Athens Digital Broadband
HP	University of Patras
HT	Aristotle University of Thessaloniki Seismology
HU	Hungarian Seismological Network
IG	Instituto Andaluz de Geofisica
II	IRIS/IDA Network
IP	Instituto Superior Tecnico Broadband Seismic Net
IS	Israel National Seismic Network
IU	IRIS/USGS Network
IV	Italian National Seismic Network
KO	Kandilli Observatory
MN	MEDNET
NA	Netherlands Antilles Seismic Network
NL	Netherlands Seismic Network
NO	Norwegian Seismic Array Network
NR	NARS Array
NS	Norwegian National Seismic Network
OE	Austrian Seismic Network
PL	Polish Seismological Network
PM	Portuguese National Seismograph Network
RO	Romanian Seismic Network
SJ	Serbian National Network
SK	Slovak National Seismic Network
SL	Slovenia Seismic Network
SS	Single Station Network (Coimbra)
SX	Saxon network / Leipzig
TT	Seismic Network of Tunisia, Inst. Nat. de la Meteorologie
TU	National Earthquake Observ. Netw., Ankara, Turkey
UP	University of Uppsala Network
VI	Icelandic National Digital Seismographic Network

VEBSN contributing networks (55) - All stations are ISC registered and have a FDSN network code

VEBSN 2002 - 2011



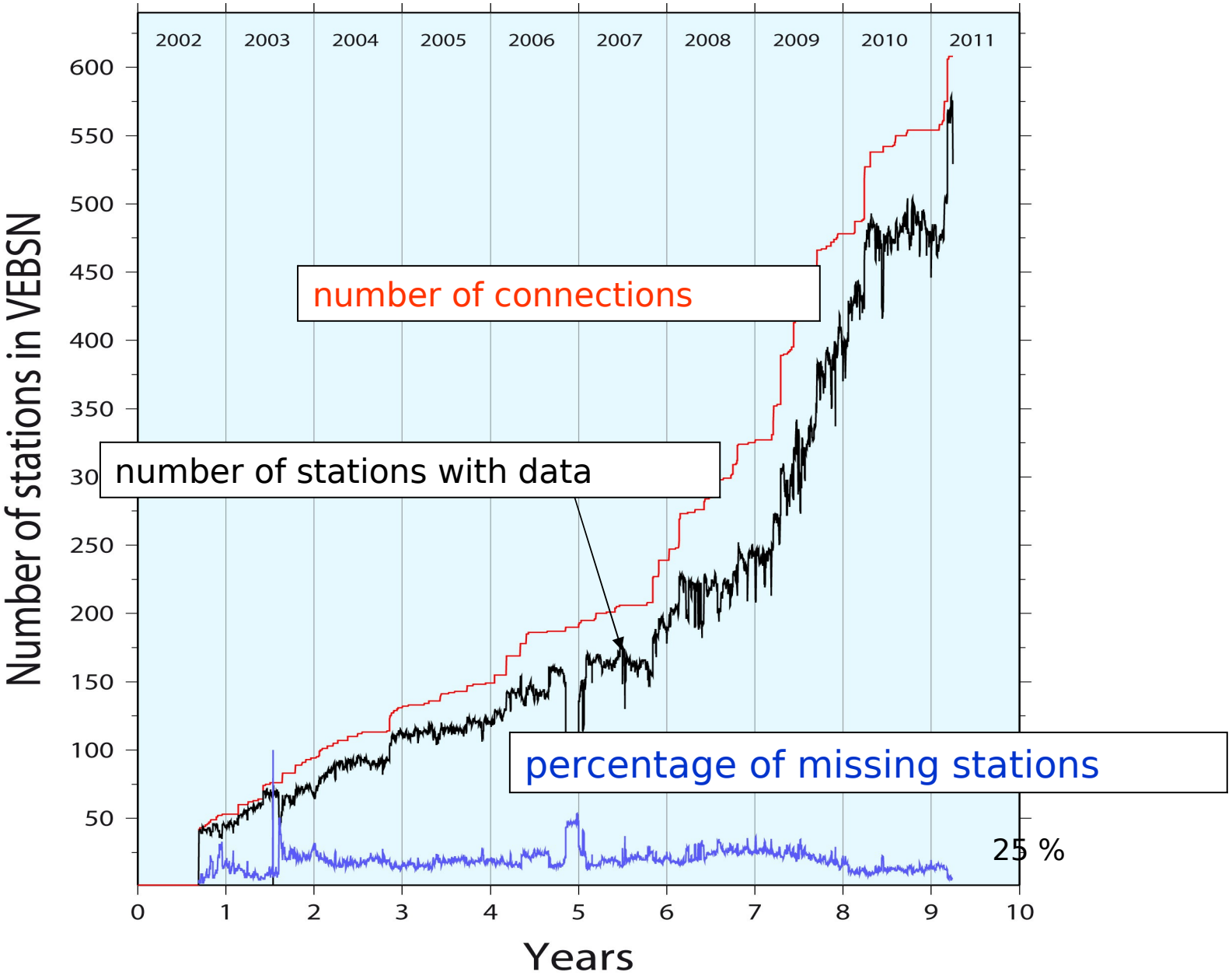
Status: May 2011



data holdings VEBSN
continuous waveform data
01 Jan 2000 – 23 May 2011

- total 9.2 TB
- 12 GB/day
- 4 TB 2011 (expected)

HH, BH, LH, VH
(120 sps – 0.1 sps)


2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
600
550
500
450
400
350
30
250
200
150
100
50
Number of stations in VEBSN
number of connections
number of stations with data
percentage of missing stations
25 %
0
1
2
3
4
5
6
7
8
9
10
Years

ncluding OBS at ODC:

International registry

ISC: www.isc.ac.uk (station code)

FDSN: www.fdsn.org (network code)

Metadata

Dataless building tools:

PDCC (IRIS DMC)

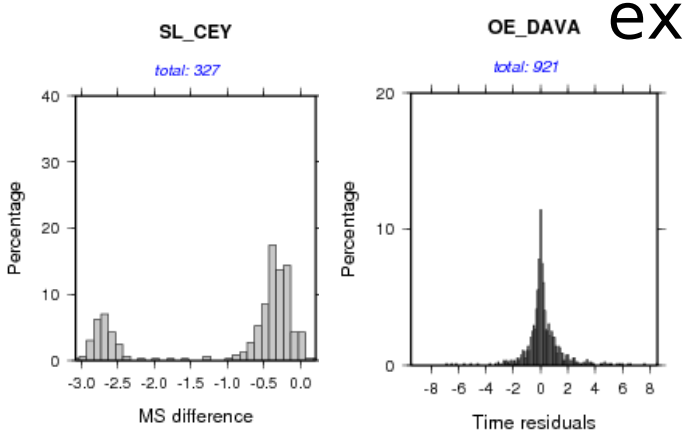
SHAPE (ISTI/ORFEUS)

GSE2SEED (ORFEUS)

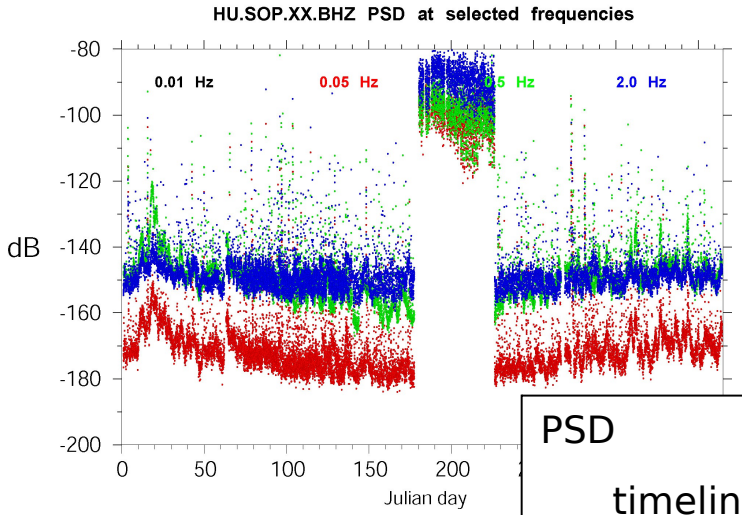
ORFEUS Data Center – Quality Control & Assurance

- system quality parameters: mass position, GPS timing quality, SOH, …
- waveform data quality parameters: overlaps, gaps, availability, RMS, mean, spikes, ….
- waveform and metadata quality control: PSD (vs. time), PDF (PQLX)
- communication (acquisition) parameters: latency, delay
- processing tools Antelope ®: time residuals, magnitude residuals,…
- community tools, e.g. synthetics: gain, sensor orientation, …

QC monitor examples

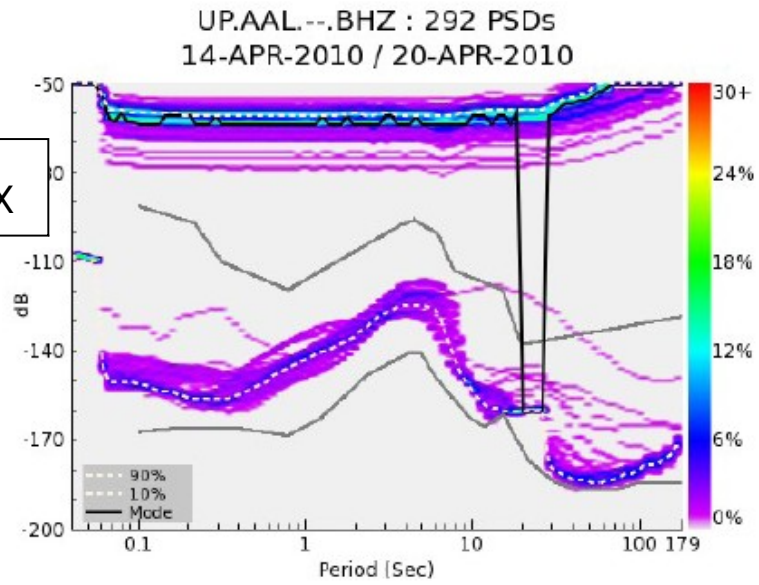


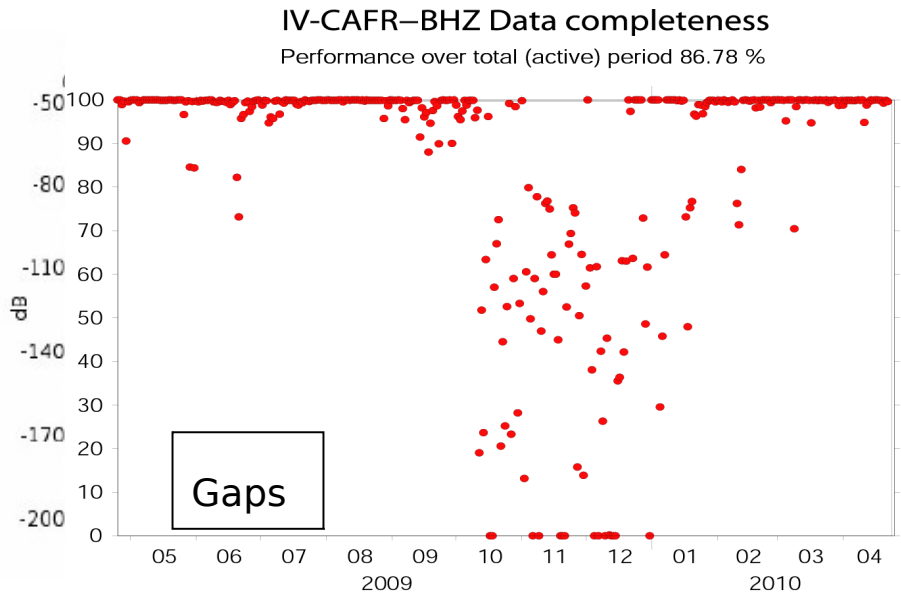
Automatic locations (Antelope) histograms



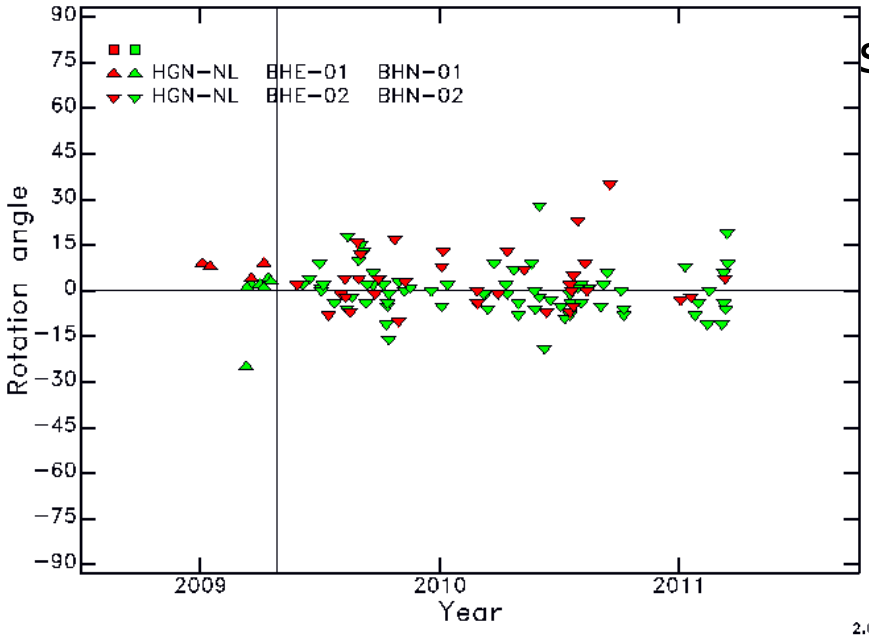
PSD timelines

PQLX





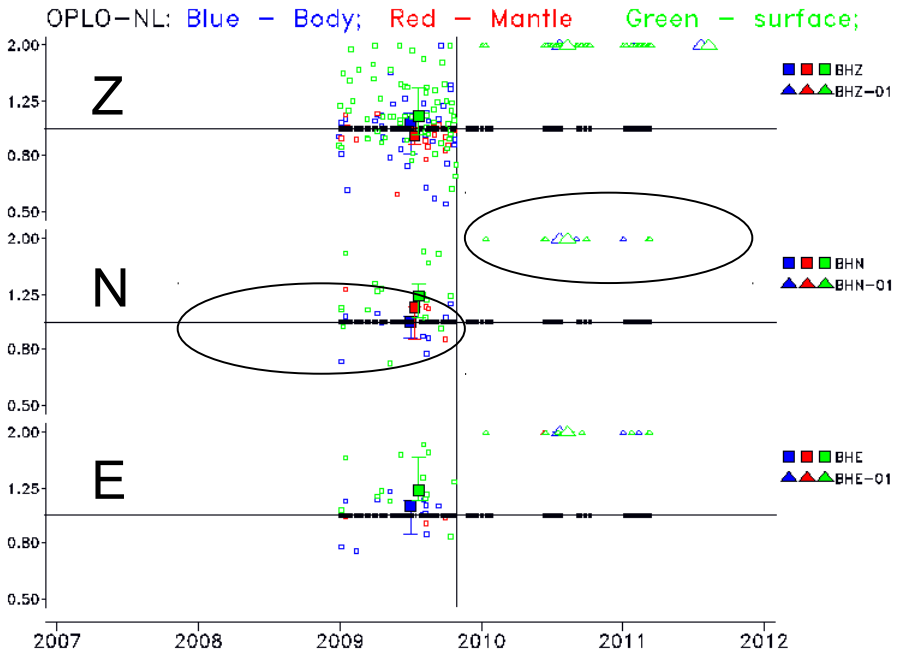
Gaps



sensor orientation

datalogger change

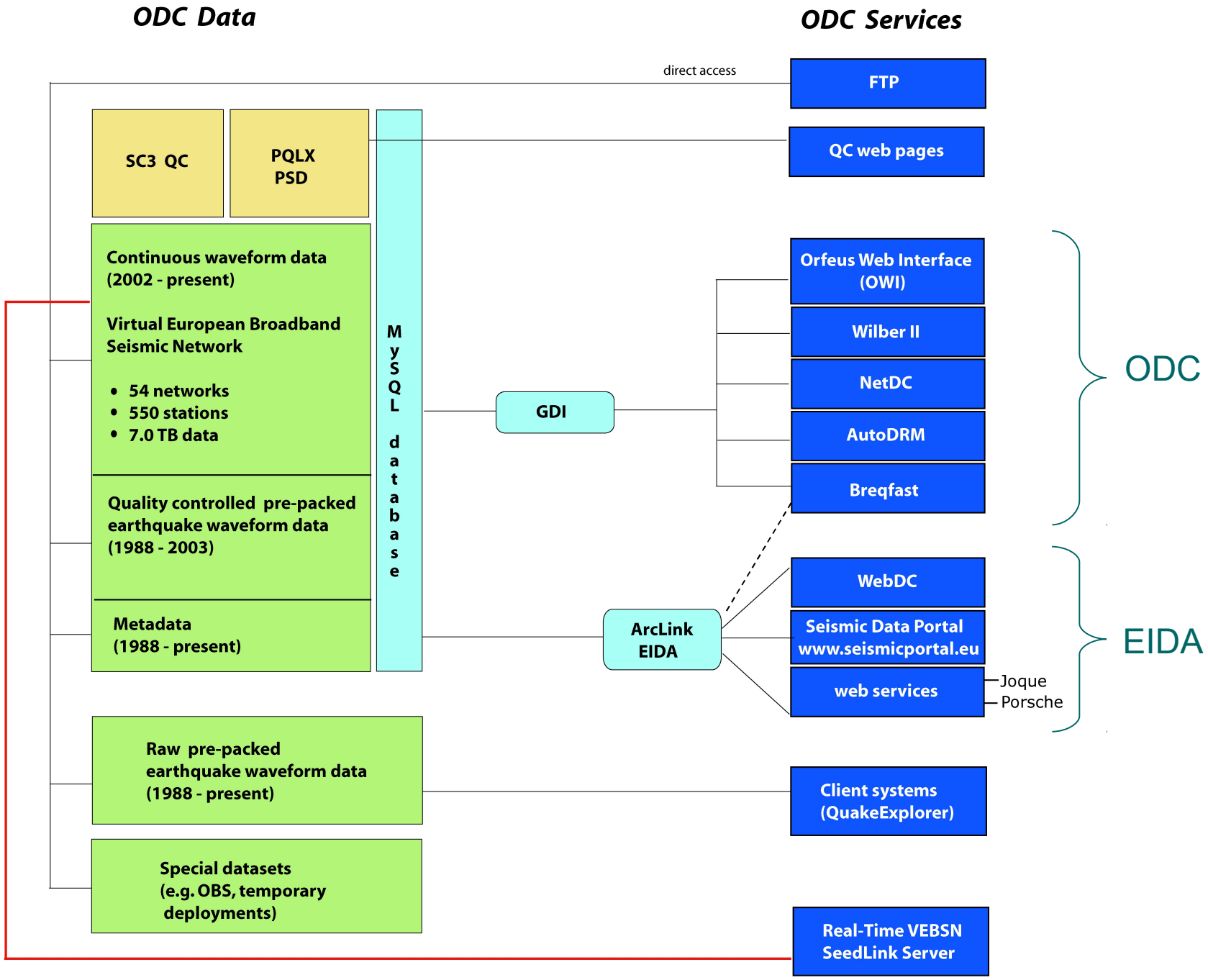
gain



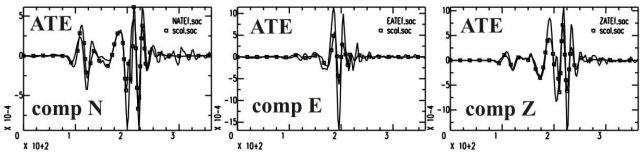
courtesy: G. Ekstrom

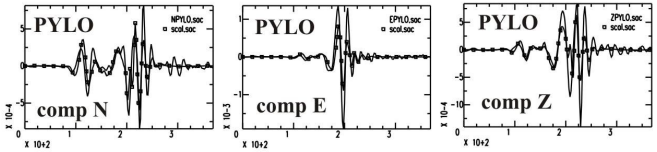
Courtesy: G. Ekstrom

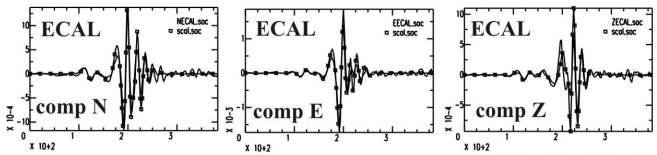
Station	Chan 1	Chan 2	T	min time	max time	# obs.	# used	Azim 1	Azim 2	90-26	25-21	20-16	15-11	10- 8	7- 5	4- 2	1- 1	2- 4	5- 7	8-10	11-15	16-20	21-25	26-90
Station	Chan 1	Chan 2	T	min time	max time	# obs.	# used	Azim 1	Azim 2	90-26	25-21	20-16	15-11	10- 8	7- 5	4- 2	1- 1	2- 4	5- 7	8-10	11-15	16-20	21-25	26-90
MLS-FR	BHE-00	BHN-00	S	20110220	20110315	49	17	90.0	0.0	x	-23		x	x	x	x	x	x	x	x	x	x	x	x
LANU-UP	BHE	BHN	S	20081113	20110118	571	32	90.0	0.0	x	x	x	-11		x	x	x	x	x	x	x	x	x	x
CALF-FR	BHE-00	BHN-00	S	20100318	20110315	290	18	90.0	0.0	x	x	x	x	x	-5			x	x	x	x	x	x	x
CALF-FR	BHE-01	BHN-01	S	20100707	20110222	148	12	90.0	0.0	x	x	x	x	x	-5		x	x	x	x	x	x	x	x
ISO-FR	BHE-00	BHN-00	S	20100922	20110315	116	18	90.0	0.0	x	x	x	x			-3		x	x	x	x	x	x	x
MLYF-FR	BHE-00	BHN-00	S	20110220	20110315	50	1	90.0	0.0	x	x	x	x	x	x	-3	x	x	x	x	x	x	x	x
OUL-FN	BHE	BHN	S	20051212	20110402	1994	351	90.0	0.0	x	x	x	x	x		-3			x	x	x	x	x	x
SMPL-FR	BHE-00	BHN-00	S	20110108	20110315	100	7	90.0	0.0	x	x	x	x			-3				x	x	x	x	x
AAL-UP	BHE	BHN	S	20081113	20110118	565	13	90.0	0.0	x	x	x	x	x		-2		x	x	x	x	x	x	x
HGN-NL	BHE-02	BHN-02	S	20090513	20110402	709	42	90.0	0.0	x	x	x	x	x		-2			x	x	x	x	x	x
UPP-UP	BHE	BHN	S	20081113	20110118	605	42	90.0	0.0	x	x	x	x	x	x		-1	x	x	x	x	x	x	x
HGN-NL	BHE-00	BHN-00	S	20030330	20031023	129	8	90.0	0.0	x	x	x	x	x	x		0	x	x	x	x	x	x	x
HGN-NL	BHE-01	BHN-01	S	20031028	20090421	2323	148	90.0	0.0	x	x	x	x	x			0		x	x	x	x	x	x
ISO-FR	BHE-01	BHN-01	S	20110220	20110222	6	1	90.0	0.0	x	x	x	x	x	x	x	0	x	x	x	x	x	x	x
SAOF-FR	BHE-00	BHN-00	S	20100917	20110315	108	4	90.0	0.0	x	x	x					0	x	x	x	x	x	x	x
OPLO-NL	BHE	BHN	S	20070622	20091027	896	25	90.0	0.0	x	x	x	x	x	x			2		x	x	x	x	x
OPLO-NL	BHE-01	BHN-01	S	20091122	20110402	324	5	90.0	0.0	x	x	x	x	x	x			2			x	x	x	x
WTSB-NL	BHE-00	BHN-00	S	20040109	20070602	1440	90	90.0	0.0	x	x	x	x	x	x			2		x	x	x	x	x
WTSB-NL	BHE-01	BHN-01	S	20070703	20110402	1463	116	90.0	0.0	x	x	x	x	x	x	x		2		x	x	x	x	x
PYLO-FR	BHE-00	BHN-00	S	20100617	20110315	186	13	90.0	0.0	x	x	x	x					3	x	x	x	x	x	x
ATE-FR	BHE-00	BHN-00	S	20100121	20110315	306	16	90.0	0.0	x	x	x	x	x	x	x			6			x	x	x
ATE-FR	BHE-01	BHN-01	S	20100710	20110222	147	7	90.0	0.0	x	x	x	x	x	x	x	x	x	x		12	x	x	x
SJAF-FR	BHE-00	BHN-00	S	20110101	20110315	105	12	90.0	0.0	x	x	x	x	x	x	x	x	x	x		12		x	x
MON-FR	BHE-00	BHN-00	S	20110122	20110315	84	1	90.0	0.0	x	x	x	x	x	x	x	x	x	x	x	x	x	22	x
SMPL-FR	BHE-01	BHN-01	S	20110220	20110222	6	0	90.0	0.0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WIT-NL	BHE	BHN	S	20021203	20110402	3042	0	90.0	0.0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

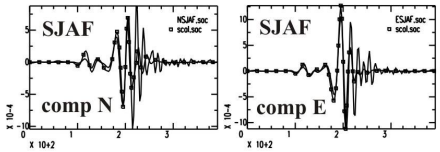

ODC Data
ODC Services
direct access
FTP
QC web pages
SC3 QC
PQLX
PSD
Continuous waveform data
(2002 - present)
Virtual European Broadband
Seismic Network
• 54 networks
• 550 stations
• 7.0 TB data
Quality controlled pre-packed
earthquake waveform data
(1988 - 2003)
Metadata
(1988 - present)
MySQL database
GDI
Orfeus Web Interface
(OWI)
Wilber II
NetDC
AutoDRM
Breqfast
ODC
ArcLink
EIDA
WebDC
Seismic Data Portal
www.seismicportal.eu
web services
Joque
Porsche
EIDA
Raw pre-packed
earthquake waveform data
(1988 - present)
Client systems
(QuakeExplorer)
Special datasets
(e.g. OBS, temporary
deployments)
Real-Time VEBSN
SeedLink Server

Lorca earthquake (Spain) May 11, 2011 16h47 UTC



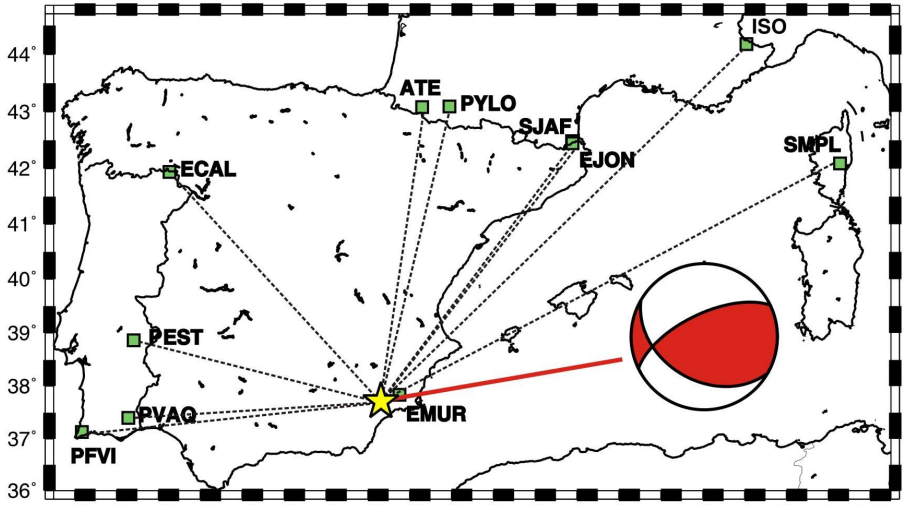




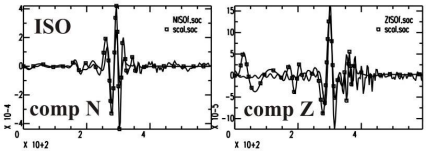


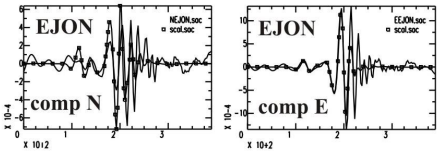
Result:

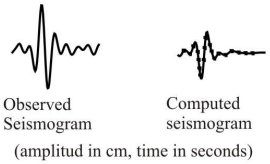
Strike Dip Rake
NP1: 120 40 138
NP2: 245 65 58
Mw 5.1 Depth: 11km
Confidence on focal solution: 77% (good)

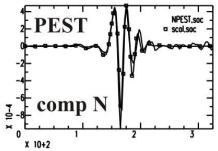


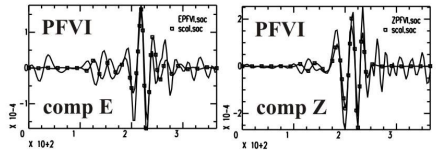
★ : epicenter IGN Spain (37.704°, -1.673°)

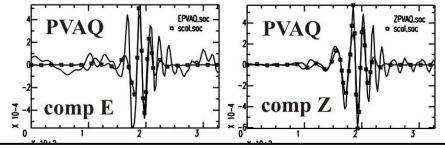


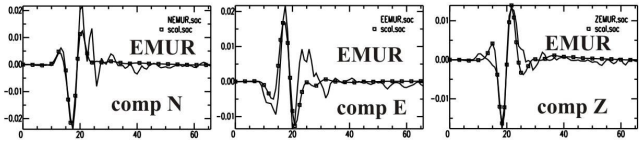




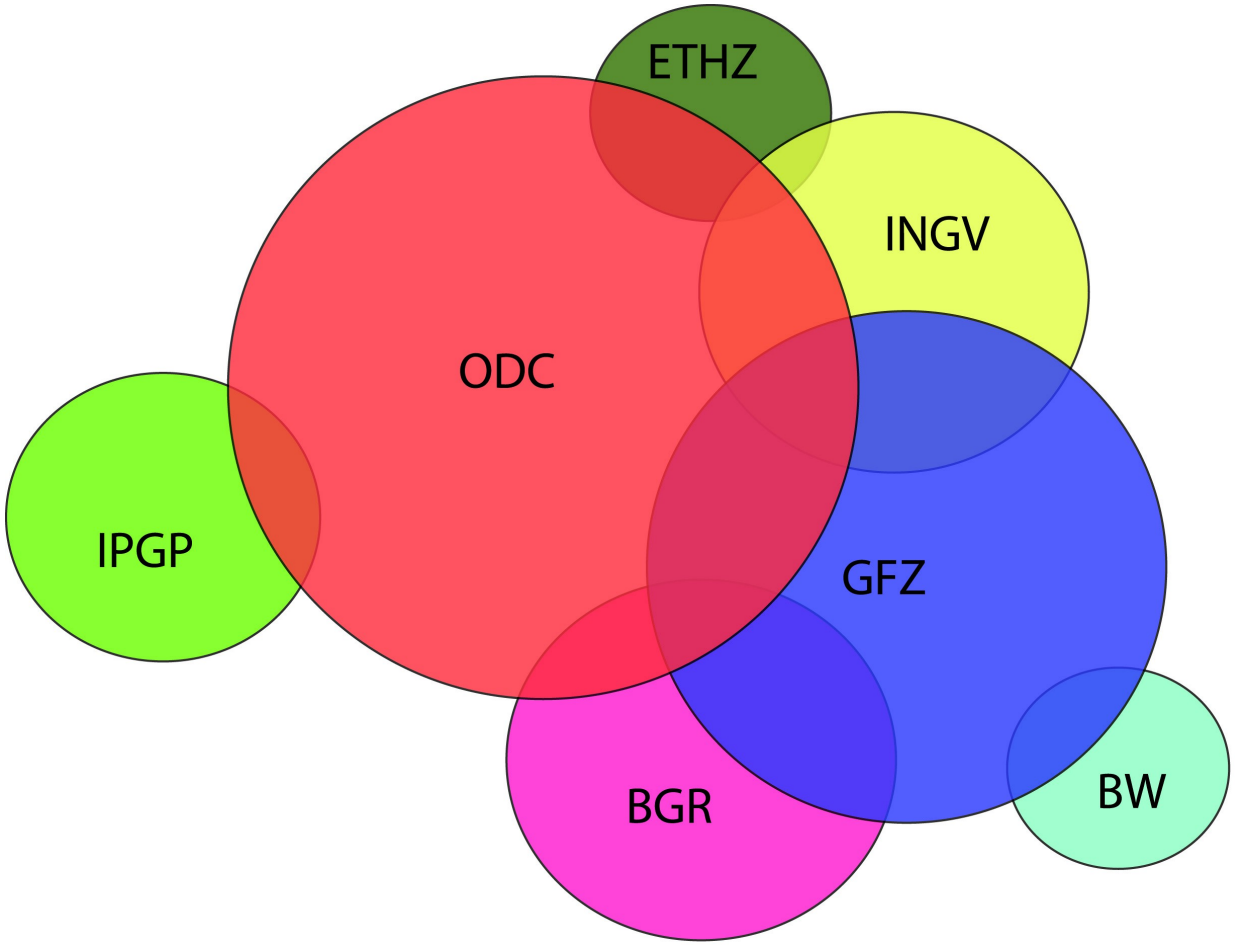








May 12, 2011 B. Delouis **Data retrieved from ORFEUS Data Center (Wilber)**



Distributed, heterogeneous waveform data archives
EIDA - European Integrated Data Archive (ArcLink)

Services

Access to ODC-VEBSN data

- Email based data request services, like NetDC, BreqFast and AutoDRM
- Interactive selection interface, like Wilber II, OWI

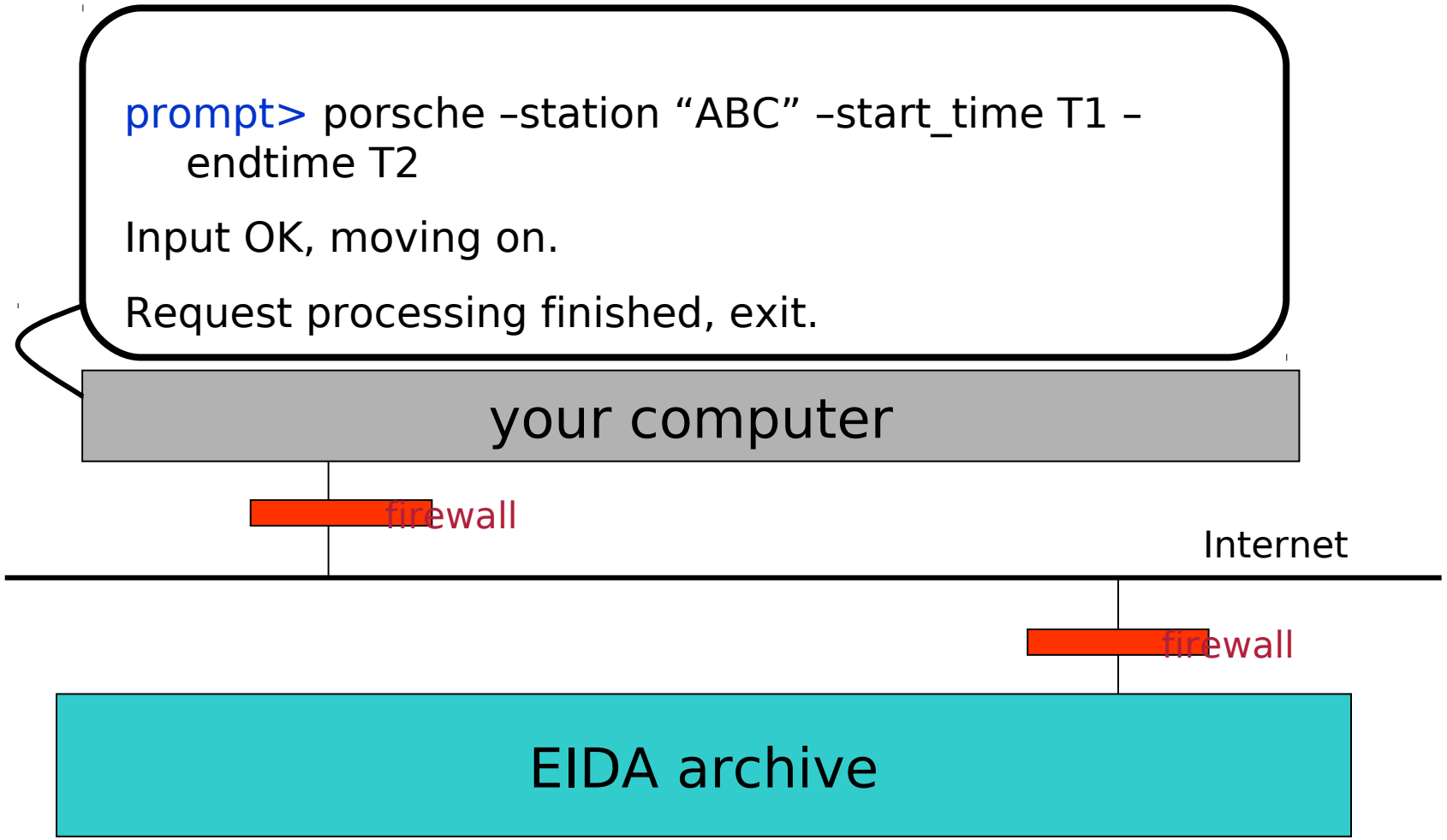
Access to ODC-VEBSN data + other EIDA data

- Web-services: provides access by stand-alone clients on your computer

  to download bulk-data (command line; batch)

- Seismic data portal (www.seismicportal.eu) – earthquake shop

webservice clients – customized data selection and direct download
where (no worries about firewalls !) ; clients available at: **www.seismicportal.e**



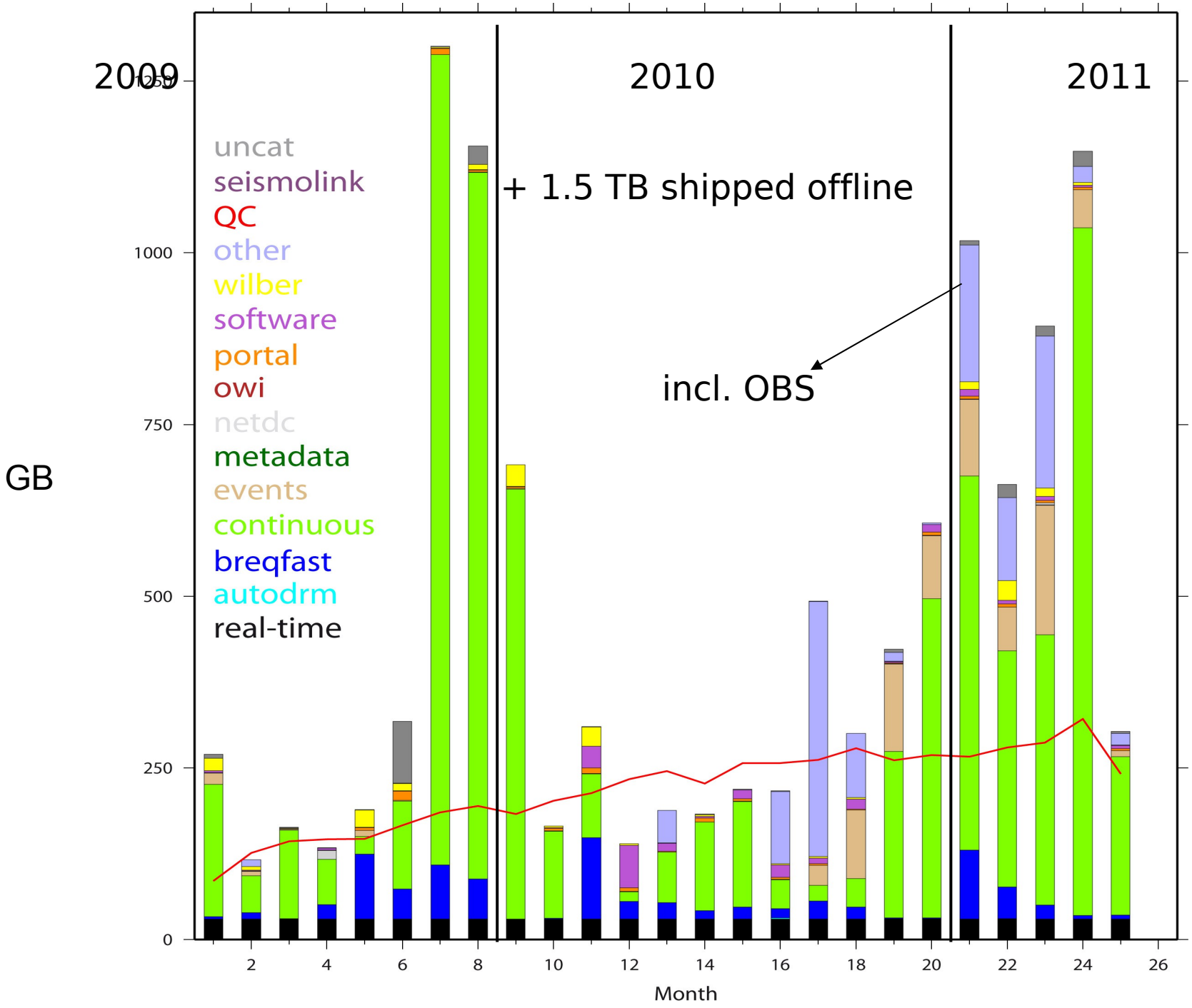
```
porsche --net IP  --stime 2011-04-01T00:00:00 --etime 2011-04-01T00:21
moving on
ventory for requested input
s) found:
g data request for station IP_PACT
olume ID: UNSET, Status: UNSET - - (0% done)
olume ID: ODC, Status: OK - - (100% done)
nsfer complete (264K), output IP_PACT_20110401T000000 can be found
t directory out/
g data request for station IP_PMST
olume ID: UNSET, Status: UNSET - - (0% done)
olume ID: ODC, Status: OK - - (100% done)
nsfer complete (288K), output IP_PMST_20110401T000000 can be found
t directory out/
rocessing finished, exit
```

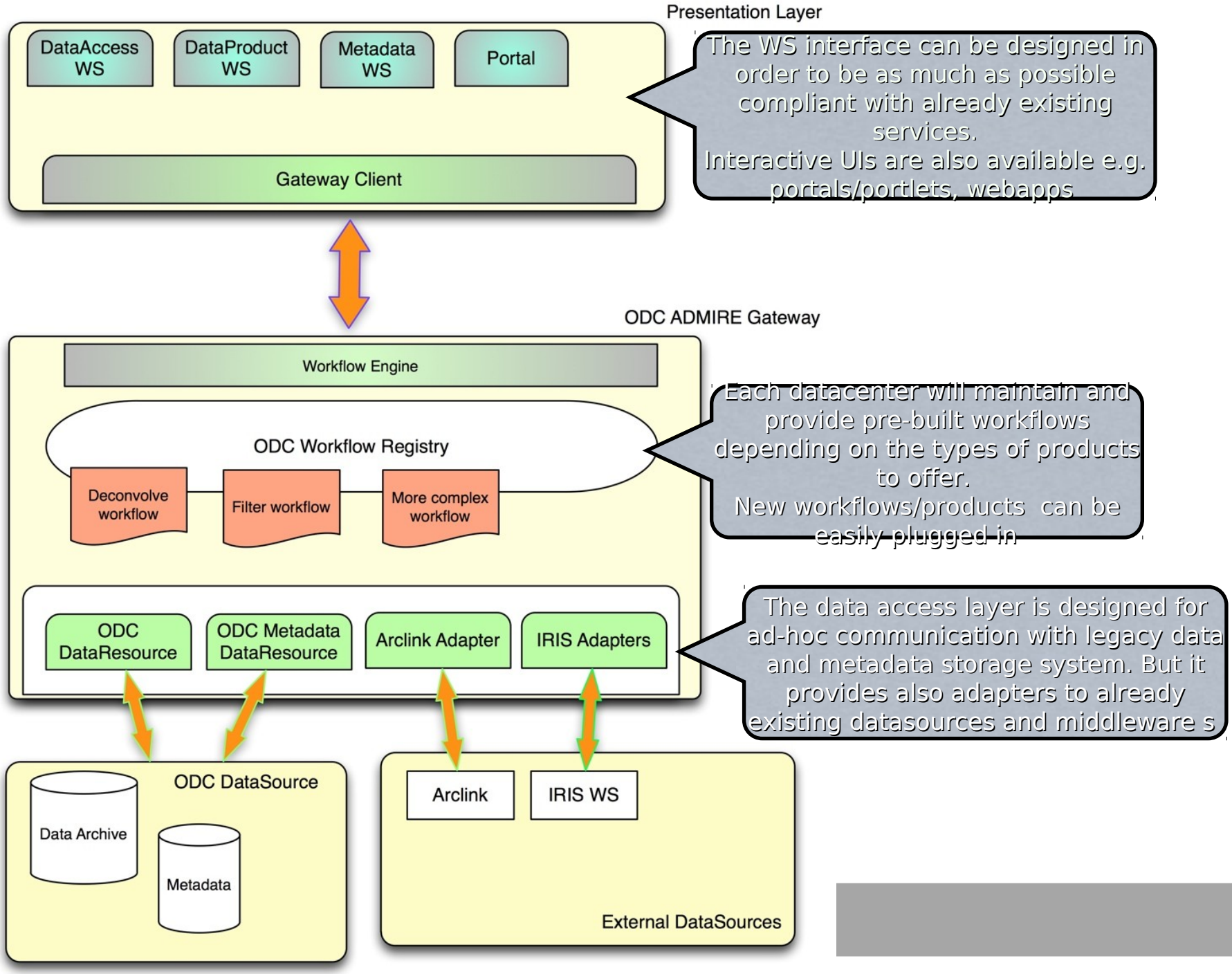
Stand-alone ODC webservice clients

JOQUE: **J**ava **O**RFEUS **Qu**ake **E**xplorer

- Event selection from catalogues in ndk and QuakeML format
  based on user defined regions and/or magnitude thresholds
- Stream selection on network, station and channel level,
  based on geopgraphical region and epicentral distance
- Direct and automatic waveform harvesting (SEED) from EIDA
- Time window adjustment using configurable phase arrival times

PORSCHE: **P**erl **OR**FEUS **S**EED "**C**ontrol & **H**arvest" **E**ngine


2009
2010
2011
uncat
seismolink
QC
other
wilber
software
portal
owi
netdc
metadata
events
continuous
breqfast
autodrm
real-time
+ 1.5 TB shipped offline
incl. OBS
GB
1250
1000
750
500
250
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Month


Presentation Layer
DataAccess WS
DataProduct WS
Metadata WS
Portal
Gateway Client
The WS interface can be designed in order to be as much as possible compliant with already existing services.
Interactive UIs are also available e.g. portals/portlets, webapps
ODC ADMIRE Gateway
Workflow Engine
ODC Workflow Registry
Deconvolve workflow
Filter workflow
More complex workflow
Each datacenter will maintain and provide pre-built workflows depending on the types of products to offer.
New workflows/products can be easily plugged in
ODC DataResource
ODC Metadata DataResource
Arclink Adapter
IRIS Adapters
The data access layer is designed for ad-hoc communication with legacy data and metadata storage system. But it provides also adapters to already existing datasources and middleware s
ODC DataSource
Data Archive
Metadata
Arclink
IRIS WS
External DataSources

Integrating OBS data at ORFEUS Data Center

- increased exposure of your data
- uniform (and possibly extended) QC and verification
- long term archive