

ECMWF Observation Feedback Archive

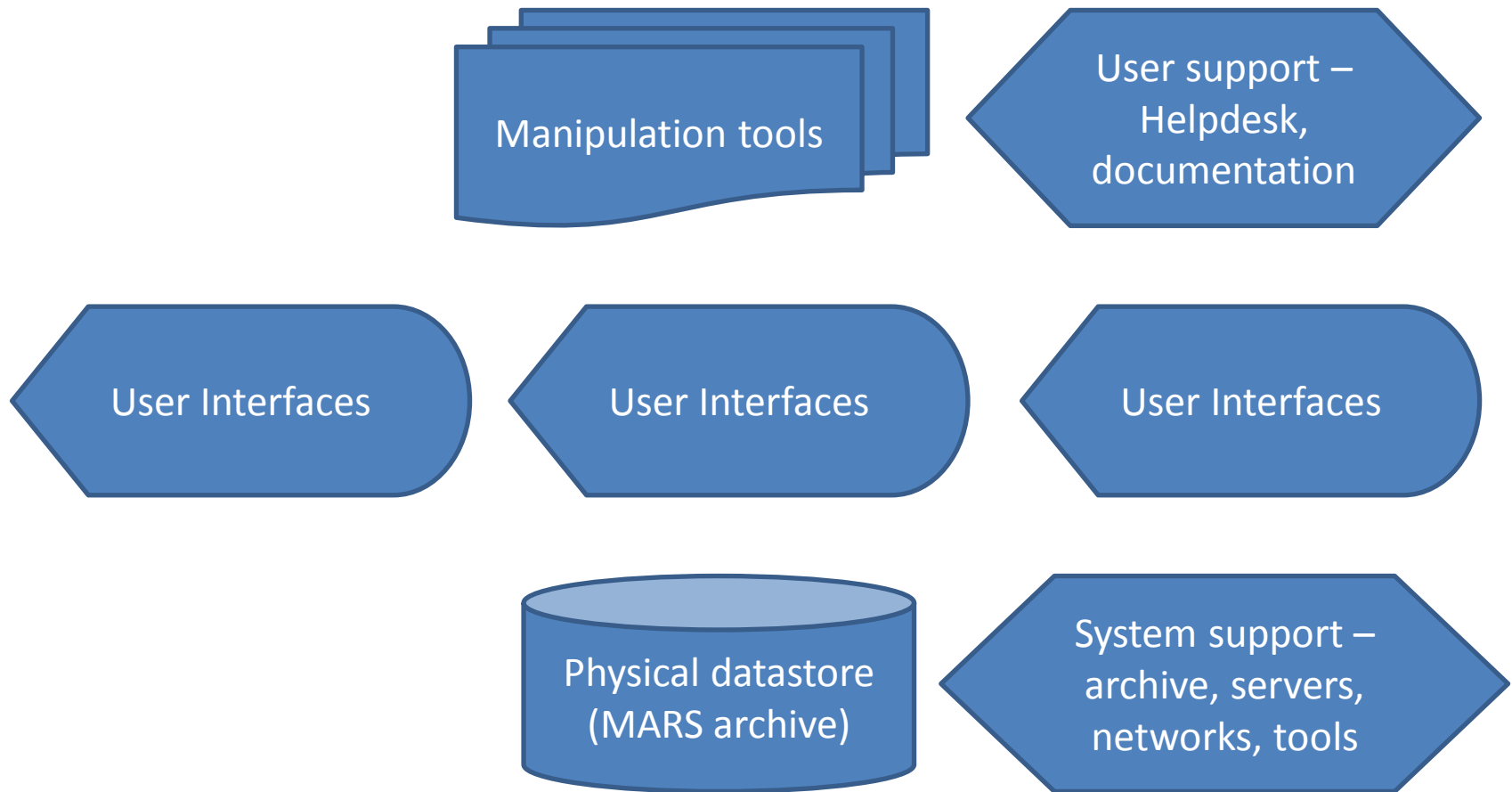
David Tan

Observation Feedback Archive

- A product of ERA-CLIM
- Offers an **open-access web interface**
- Major improvement as it enables users to ‘see’ the observation systems and data locations, without transferring large data amounts across the network
- Still limited by export format (ASCII and ODB2)
- Publicly available ODB2 tools limited, but an ODB2 decoder is in the works
- Needs manual intervention to create the catalogue (not self-made)
- Ongoing developments:
 - Native support for **NetCDF** in MARS (ERA-CLIM2)
 - Searchable metadatabase of events (CHARMe)

Slide from Paul’s talk. To continue – what does it look like in practice?

OFA Infrastructure



Why have multiple interfaces?

- The user base & expertise is increasingly diverse
 - Reanalysis producers
 - CDR providers
 - Satellite agencies & In-situ/ground-based communities
 - Wider than NWP – ESA CCI, GCOS GRUAN, CHUAN, ACRE
 - Third parties
 - Science community - SPARC Reanalysis Intercomparison Project etc
 - Climate service applications - resource management etc
- One-size-fits-all doesn't work (but too many is unmanageable)

User Interface 1

- Direct MARS requests
 - Via ECMWF internal userid and/or MARS server
 - Familiarity with MARS & ODB2 keywords and values

```
linux% emacs mirage_request2b.txt
linux% cat mirage_request2b.txt
retrieve,
class=e2,
date=2010-12-31,
expver=1873,
filter="select reporttype, varno, timeseries_index, \
        date, time, lat, lon, obsvalue, fg_depar, an_depar \
        where (datum_status.active=1) and (source='ISPD3.26') and (varno=110);",
reporttype=16002,
stream=oper,
time=all,
type=ofb,
padding=0,
target=ispd_ps_ManualLandSynop_active_2b.odb

linux% mars mirage_request2b.txt
MARS - INFO - **
MARS - INFO - **
```

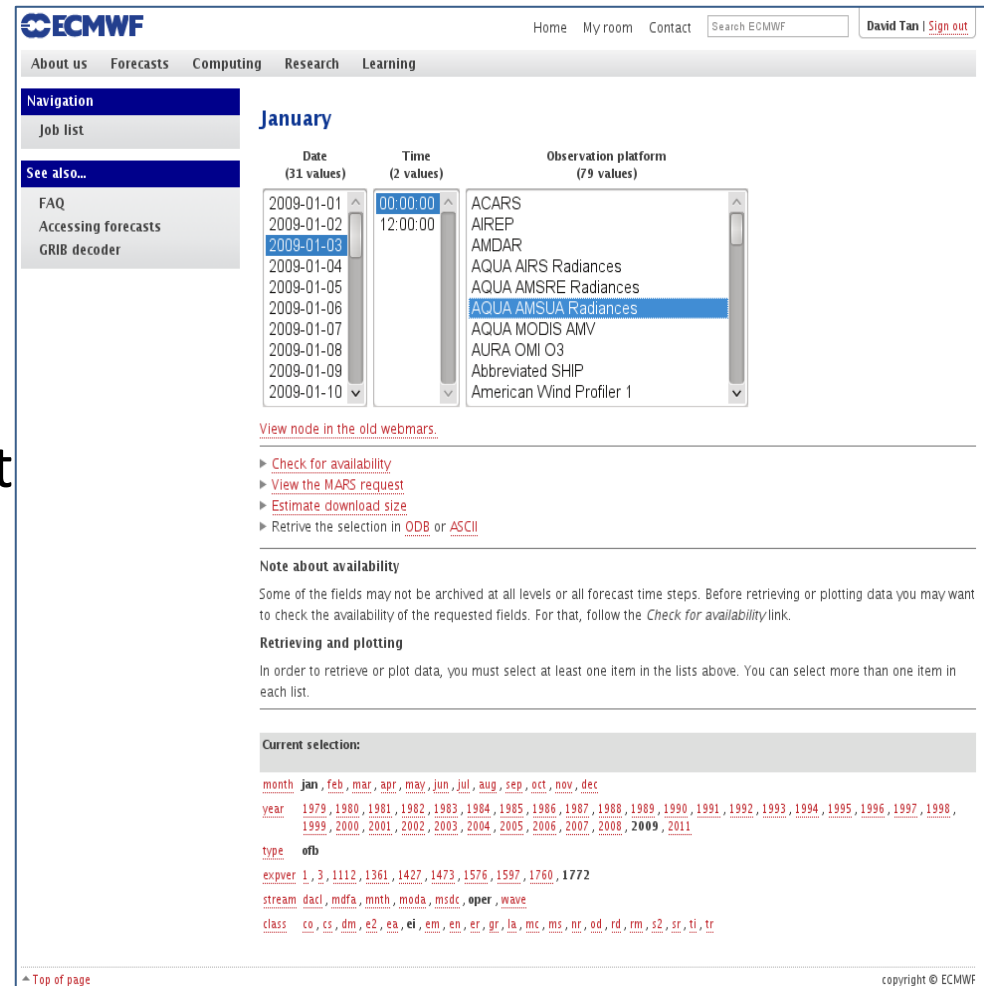
User Interface 1

- Direct MARS requests
 - Maximum control on the request, minimal on data discovery
 - Underlies the GUI & Batch-mode/API/Python interfaces

```
mars - INFO - 20141104.155420 - Calling mars on 'marsr', callback on 54748
mars - INFO - 20141104.155420 - Mars client is on loki.ecmwf.int (136.156.34.102) 54748
mars - INFO - 20141104.155420 - Mars server is on dhs1111.ecmwf.int (136.156.164.31) 42869
mars - INFO - 20141104.155420 - Got connection from dhs1111.ecmwf.int (136.156.164.31) 42869
mars - INFO - 20141104.155420 - Server task is 219 [marsr]
mars - INFO - 20141104.155420 - Got connection from dhs1111.ecmwf.int (136.156.164.31) 54834
mars - INFO - 20141104.155420 - Got connection from dhs1111.ecmwf.int (136.156.164.31) 39765
mars - INFO - 20141104.155420 - Request cost: 1 field, 60.7229 Mbytes online, nodes: mvr01 [marsr]
mars - INFO - 20141104.155420 - Got connection from dhs1111.ecmwf.int (136.156.164.31) 44191
mars - INFO - 20141104.155420 - Got connection from dhs1121.ecmwf.int (136.156.164.61) 50003
mars - INFO - 20141104.155420 - Transferring 63672524 bytes
mars - INFO - 20141104.155420 - odb_filter: sql = "select reporttype, varno, timeseries_index, date, time, lat, lon, obsvalue, fg_depar, an_depar where
) and (varno=110));", total_to_read = 63672524
000 2014-11-04 15:54:20 (I) BitColumnExpression::BitColumnExpression: name=datum_status, field=active, tableReference=: name=datum_status
000 2014-11-04 15:54:20 (I) SQLSelectFactory::create: where = and(and(=(datum_status.active,1),=(source,'ISPD3.26')),=(varno,110))
000 2014-11-04 15:54:21 (I) SelectIterator::parse: SELECT reporttype,varno,timeseries_index,date,time,lat,lon,obsvalue,fg_depar,an_depar FROM input WHERE
3.26')),=(varno,110)) SQLIteratorOutput
000 2014-11-04 15:54:21 (I) WriterBufferingIterator::pass1
000 2014-11-04 15:54:21 (I) WriterBufferingIterator::pass1init
000 2014-11-04 15:54:22 (I) Matching row(s): 87,765 out of 985,591
000 2014-11-04 15:54:22 (I) Skips : 897,826
000 2014-11-04 15:54:22 (I) WriterBufferingIterator::pass1: processed 87765 row(s).
mars - INFO - 20141104.155422 - => odb_filter
mars - INFO - 20141104.155422 - Got connection from dhs1111.ecmwf.int (136.156.164.31) 44905
mars - INFO - 20141104.155422 - Request time: wall: 2 sec cpu: 1 sec
mars - INFO - 20141104.155422 - Visiting marsr: wall: 2 sec
mars - INFO - 20141104.155422 - No errors reported
linux%
```

User Interface 2

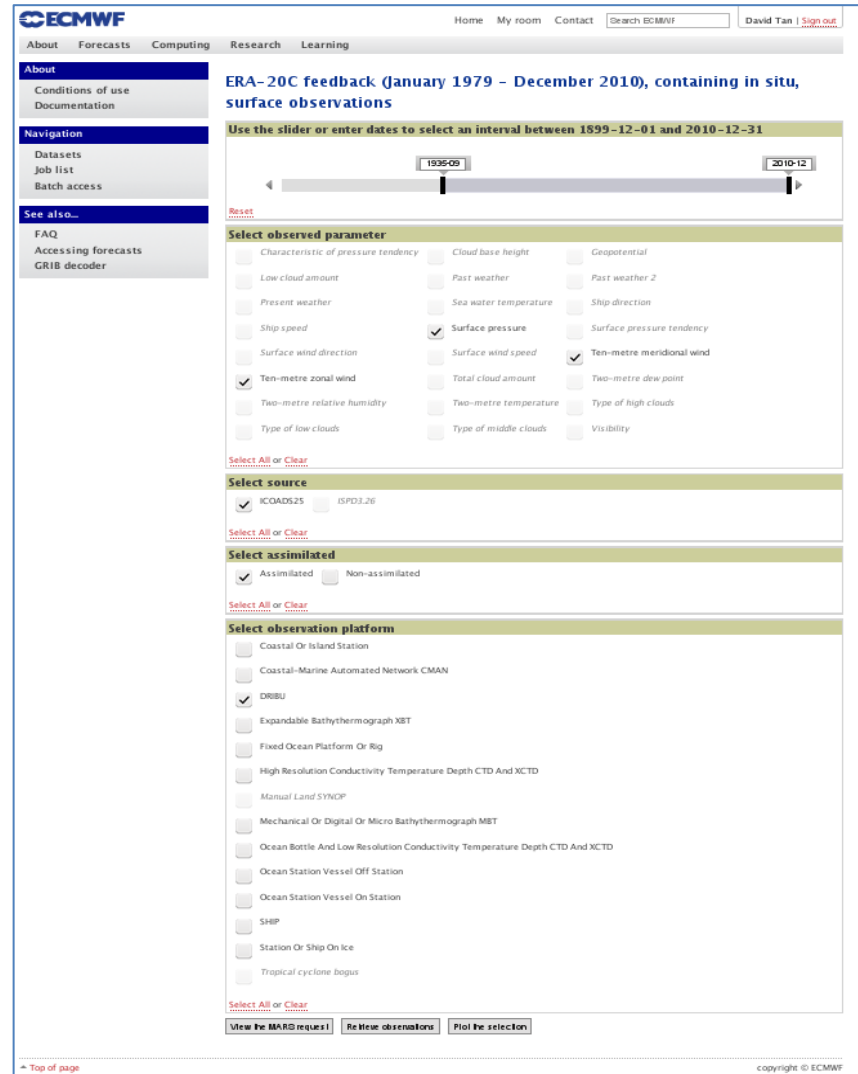
- ECMWF *Internal* Web browser
 - Catalogs allow data navigation/discovery
 - Hierarchy matches underlying MARS layout
 - Less syntactic, more semantic: Reporttype (numerical codes) translated to “Observation platform” (strings)



The screenshot shows the ECMWF Internal Web browser interface. The top navigation bar includes links for Home, My room, Contact, and a search bar. The main content area is titled "January" and features three selection lists: "Date (31 values)", "Time (2 values)", and "Observation platform (79 values)". The "Date" list shows dates from 2009-01-01 to 2009-01-10, with 2009-01-03 selected. The "Time" list shows 00:00:00 and 12:00:00, with 12:00:00 selected. The "Observation platform" list shows various platforms, with AQUA AMSUA Radiances selected. Below the selection lists, there are links for "View node in the old webmars", "Check for availability", "View the MARS request", "Estimate download size", and "Retrieve the selection in ODB or ASCII". A "Note about availability" section explains that some fields may not be archived at all levels or all forecast time steps. A "Retrieving and plotting" section states that at least one item must be selected in the lists. The "Current selection:" section shows the selected date, time, and observation platform. The bottom of the page includes a "Top of page" link and a copyright notice for ECMWF.

User Interface 3

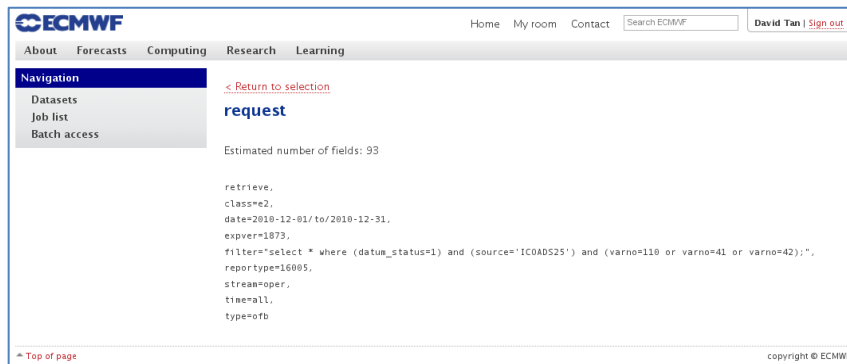
- ECMWF *Public Web* browser apps.ecmwf.int/datasets
 - Increasingly semantic: slider controls date range
 - And dynamic: selection of Surface Pressure restricts Platform, both restrict date range
 - Further customization available under Retrieve



The screenshot shows the ECMWF Public Web browser interface for selecting ERA-20C feedback data. The page title is "ERA-20C feedback (January 1979 - December 2010), containing in situ, surface observations". The interface includes a navigation menu on the left with links to "About", "Conditions of use", "Documentation", "Navigation", "Datasets", "Job list", "Batch access", "See also...", "FAQ", "Accessing forecasts", and "GRIB decoder". The main content area features a date range selector with a slider from 1936-09 to 2010-12. Below this is a "Select observed parameter" section with a grid of checkboxes for various parameters, including "Surface pressure" (checked). The "Select source" section has checkboxes for "ICOADS25" (checked) and "ISPD3.26". The "Select assimilated" section has checkboxes for "Assimilated" (checked) and "Non-assimilated". The "Select observation platform" section has a list of platform types, with "DRBU" (checked) and "Expandable Bathythermograph XBT" (checked). At the bottom, there are buttons for "View the MARO request", "Retrieve observations", and "Plot the selection".

User Interface 3

- ECMWF *Public* Web browser
apps.ecmwf.int/datasets
 - As users gain experience, batch-mode also desirable
 - GUI provides initial templates



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About Forecasts Computing Research Learning

Navigation
Datasets
Job list
Batch access

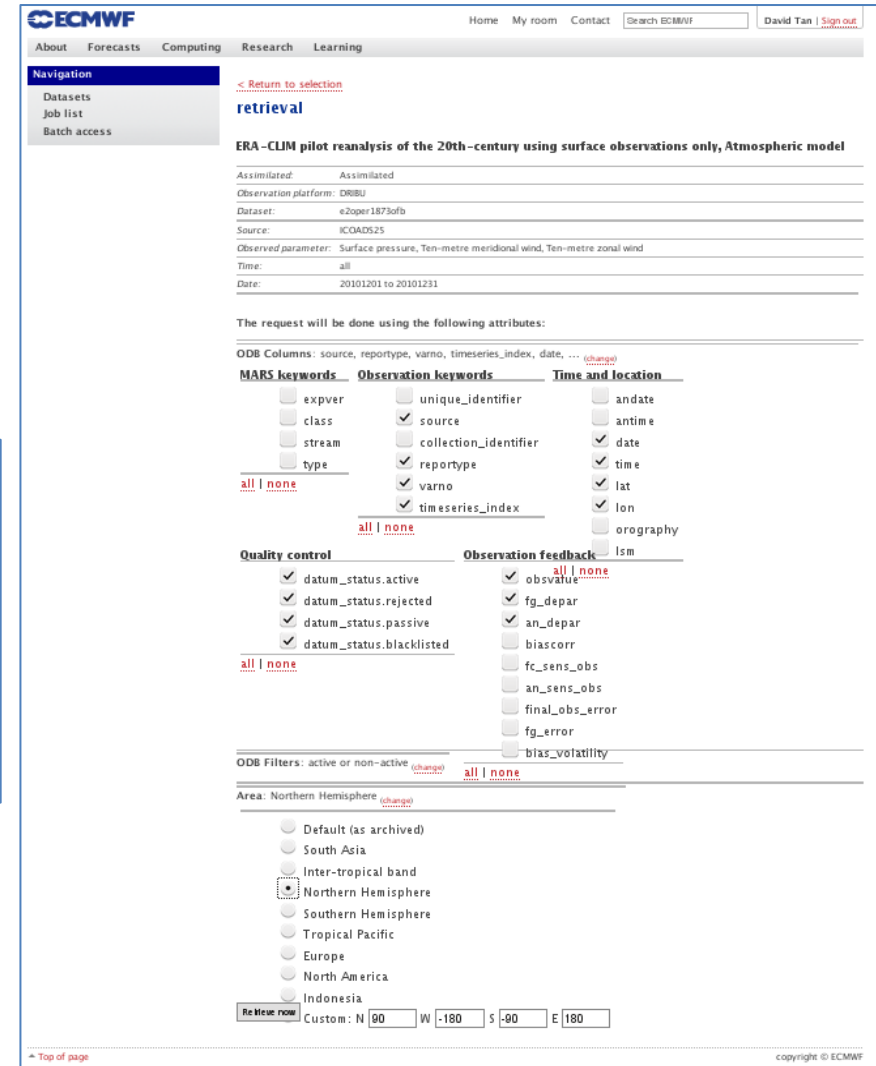
< Return to selection
request

Estimated number of fields: 93

```
retrieve,
class=e2,
date=2010-12-01/to/2010-12-31,
expver=1873,
filter="select * where (datum_status=1) and (source='IC0AD525') and (varno=110 or varno=41 or varno=42);",
reporttype=16005,
stream=oper,
time=all,
type=ofb
```

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- Requests more efficient when physical layout is known



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About Forecasts Computing Research Learning

Navigation
Datasets
Job list
Batch access

< Return to selection
retrieval

ERA-CLIM pilot reanalysis of the 20th-century using surface observations only, Atmospheric model

Assimilated: Assimilated
Observation platform: DRBU
Dataset: e2oper1873ofb
Source: IC0AD525
Observed parameter: Surface pressure, Ten-metre meridional wind, Ten-metre zonal wind
Time: all
Date: 20101201 to 20101231

The request will be done using the following attributes:

ODB Columns: source, reporttype, varno, timeseries_index, date, ... (change)

MARS keywords	Observation keywords	Time and location
<input type="checkbox"/> expver	<input type="checkbox"/> unique_identifier	<input type="checkbox"/> andate
<input type="checkbox"/> class	<input checked="" type="checkbox"/> source	<input type="checkbox"/> antime
<input type="checkbox"/> stream	<input type="checkbox"/> collection_identifier	<input checked="" type="checkbox"/> date
<input type="checkbox"/> type	<input checked="" type="checkbox"/> reporttype	<input checked="" type="checkbox"/> time
<input checked="" type="checkbox"/> varno	<input checked="" type="checkbox"/> timeseries_index	<input checked="" type="checkbox"/> lat
<input checked="" type="checkbox"/> timeseries_index		<input checked="" type="checkbox"/> lon
		<input type="checkbox"/> orography
		<input type="checkbox"/> lsm

all | none

Quality control

<input checked="" type="checkbox"/> datum_status.active	<input checked="" type="checkbox"/> obsvalue
<input checked="" type="checkbox"/> datum_status.rejected	<input checked="" type="checkbox"/> fg_depar
<input checked="" type="checkbox"/> datum_status.passive	<input checked="" type="checkbox"/> an_depar
<input checked="" type="checkbox"/> datum_status.blacklisted	<input type="checkbox"/> biascorr
	<input type="checkbox"/> fc_sens_obs
	<input type="checkbox"/> an_sens_obs
	<input type="checkbox"/> final_obs_error
	<input type="checkbox"/> fg_error
	<input type="checkbox"/> bias_volatility

all | none

ODB Filters: active or non-active (change)

Area: Northern Hemisphere (change)

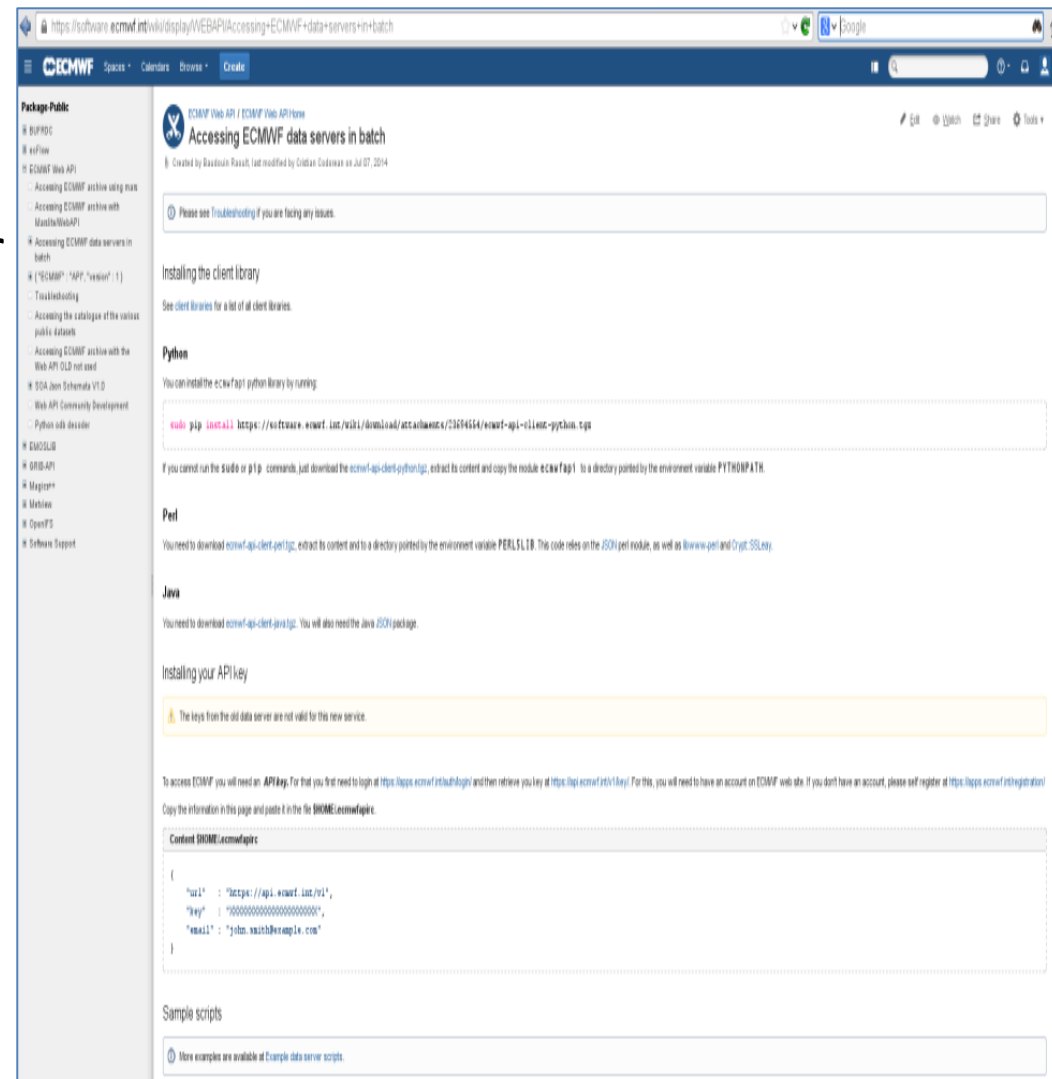
- ☐ Default (as archived)
- ☐ South Asia
- ☐ Inter-tropical band
- ☒ Northern Hemisphere
- ☐ Southern Hemisphere
- ☐ Tropical Pacific
- ☐ Europe
- ☐ North America
- ☐ Indonesia

Re New now Custom: N 90 W -180 S -90 E 180

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User Interface 4

- Batch-mode, APIs, Python
 - Initial use of Public browser
 - Provide syntactic translations of semantic selections
 - Users adapt/embed them within scripts and submit via data servers
 - Control of direct requests without overhead of ECMWF internal usersids



Visualization Tools - Metview

- In-house graphics package
- Permits inspection of data contents at dataset level

Metview - ODB Examiner

File Edit View Settings Help

File: /home/rd/dat/metview/dat/ofa/preSAC2014_demo/Lindenberg_1991010100_1994123112.odb
Permissions: -rw-r----- Owner: dat Group: rd Size: 73MB Modified: 2014-09-23 14:06

Name	Type	Constant	Min	Max	Missing value	Table
an_depar@body	float	n	-1128.53	1784.38	-2.14748e+09	body
andate	int	n	19911101	19911110	N/A	
antime	int	n	0	120000	N/A	
biascorr@body	float	n	-0.939938	1.80614	N/A	body
bufrtype@hdr	int	y	2	2	7.54793e+168	hdr
class	int	y	14	14	N/A	
codetype@hdr	int	y	35	35	4.48563e-311	hdr
date@hdr	int	n	19911031	19911110	N/A	hdr
datum_status@body	bitfield	n	N/A	N/A	N/A	body
active	Pos: 00 Width: 1 bit					
blacklisted	Pos: 03 Width: 1 bit					
passive	Pos: 01 Width: 1 bit					
rejected	Pos: 02 Width: 1 bit					
use_emiskf_only	Pos: 04 Width: 1 bit					
expver	string	y	N/A	N/A	N/A	
fg_depar@body	float	n	-1361.56	1909.58	-2.14748e+09	body
final_obs_error@errstat	float	n	3.02392e-06	392.497	-2.14748e+09	errstat
groupid@hdr	int	y	17	17	N/A	hdr
lat@hdr	float	y	52.22	52.22	N/A	hdr
lon@hdr	float	y	14.12	14.12	5.81217e-317	hdr
lsm@modsurf	float	y	0.974435	0.974435	N/A	modsurf
obstype@hdr	int	y	5	5	N/A	hdr
obsvalue@body	float	n	-850	362340	N/A	body
orography@modsurf	float	n	55.8421	55.8529	N/A	modsurf
reporttype	int	y	16022	16022	5.81217e-317	
seaice@modsurf	float	n	-2.14748e+09	-2.14748e+09	-2.14748e+09	modsurf
seqno@hdr	int	n	128579	803015	2.12455e+183	hdr
stalt@hdr	float	y	115	115	N/A	hdr
statid@hdr	string	y	N/A	N/A	N/A	hdr
stream	int	y	1025	1025	N/A	
subtype@hdr	int	y	101	101	N/A	hdr
time@hdr	int	n	50000	230000	N/A	hdr
timeslot@timeslot_index	int	n	5	19	N/A	timeslot_index
type	int	y	263	263	N/A	
varno@body	int	n	1	112	N/A	body
vertco_reference_1@body	float	n	330	101600	N/A	body
vertco_type@body	int	y	1	1	N/A	body

Visualization Tools - Metview

- Inspection of data values at individual datum level

Metview - ODB Examiner

File Edit View Settings Help

File: /home/rd/dat/metview/dat/ofa/preSAC2014_demoLindenberg_1991010100_1994123112.odb
Permissions: -rw-r----- Owner: dat Group: rd Size: 73MB Modified: 2014-09-23 14:06

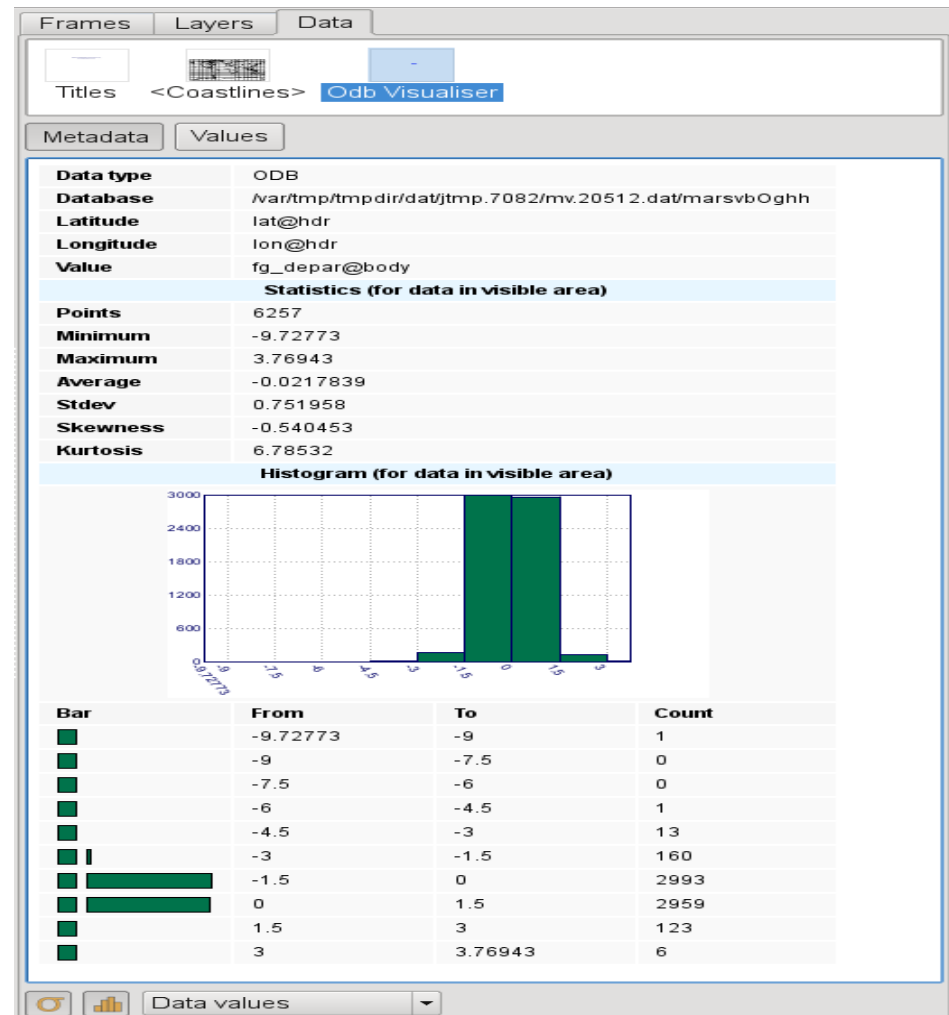
Tables	Columns	SET Variables	Data																						
ie	date	datum_status	expver	fg_depar	final_obs_error	groupid	lat	lon	lsm	obstype	obsvalue	orography	reporttype	seaiice	seqno	stalt	statid	stream	subtype	time	timeslot	type	varno	vertco_reference_1	vertco_type
19911031	12	1772	-18.9258	42.1882		17	52.22	14.12	0.974435	5	1130	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	1	101600	1
19911031	12	1772	-2.14748e+09	0.980087		17	52.22	14.12	0.974435	5	271.3	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	39	101600	1
19911031	12	1772	-2.14748e+09	-2.14748e+09		17	52.22	14.12	0.974435	5	267.7	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	40	101600	1
19911031	12	1772	0.0804787	0.133155		17	52.22	14.12	0.974435	5	0.763672	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	58	101600	1
19911031	1	1772	-0.000133877	0.000436014		17	52.22	14.12	0.974435	5	0.00249754	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	7	101600	1
19911031	12	1772	-2.14748e+09	-2.14748e+09		17	52.22	14.12	0.974435	5	120	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	111	101600	1
19911031	12	1772	-3.70159	2		17	52.22	14.12	0.974435	5	4	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	112	101600	1
19911031	12	1772	1.4205	1.8018		17	52.22	14.12	0.974435	5	-3.4641	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	41	101600	1
19911031	12	1772	-3.95532	1.8018		17	52.22	14.12	0.974435	5	2	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	42	101600	1
19911031	12	1772	-86.9804	42.1882		17	52.22	14.12	0.974435	5	2310	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	1	100000	1
19911031	1	1772	-2.68913	0.980087		17	52.22	14.12	0.974435	5	270.5	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	2	100000	1
19911031	12	1772	-2.14748e+09	-2.14748e+09		17	52.22	14.12	0.974435	5	266	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	59	100000	1
19911031	12	1772	0.0249518	0.134374		17	52.22	14.12	0.974435	5	0.711336	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	29	100000	1
19911031	1	1772	-0.000391751	0.000421151		17	52.22	14.12	0.974435	5	0.00222735	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	7	100000	1
19911031	12	1772	-2.14748e+09	-2.14748e+09		17	52.22	14.12	0.974435	5	120	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	111	100000	1
19911031	12	1772	-6.71215	2		17	52.22	14.12	0.974435	5	4	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	112	100000	1
19911031	1	1772	2.65619	1.8018		17	52.22	14.12	0.974435	5	-3.4641	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	3	100000	1
19911031	1	1772	-6.79266	1.8018		17	52.22	14.12	0.974435	5	2	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	4	100000	1
19911031	12	1772	-93.0186	42.6511		17	52.22	14.12	0.974435	5	8420	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	1	92500	1
19911031	1	1772	-0.199382	0.929651		17	52.22	14.12	0.974435	5	273.8	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	2	92500	1
19911031	12	1772	-2.14748e+09	-2.14748e+09		17	52.22	14.12	0.974435	5	262.8	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	59	92500	1
19911031	12	1772	0.00775267	0.129501		17	52.22	14.12	0.974435	5	0.434905	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	29	92500	1
19911031	1	1772	2.12679e-05	0.000558083		17	52.22	14.12	0.974435	5	0.00187434	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	7	92500	1
19911031	12	1772	-2.14748e+09	-2.14748e+09		17	52.22	14.12	0.974435	5	130	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	111	92500	1
19911031	12	1772	-7.67582	2		17	52.22	14.12	0.974435	5	6	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	112	92500	1
19911031	1	1772	-0.813151	1.8018		17	52.22	14.12	0.974435	5	-4.59627	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	3	92500	1
19911031	1	1772	-9.22623	1.8018		17	52.22	14.12	0.974435	5	3.85673	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	4	92500	1
19911031	12	1772	-2.14748e+09	-2.14748e+09		17	52.22	14.12	0.974435	5	135	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	111	90800	1
19911031	12	1772	-6.11443	2		17	52.22	14.12	0.974435	5	7	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	112	90800	1
19911031	1	1772	-0.815888	1.8018		17	52.22	14.12	0.974435	5	-4.94975	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	3	90800	1
19911031	1	1772	-7.49651	1.8018		17	52.22	14.12	0.974435	5	4.94975	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	4	90800	1
19911031	12	1772	-43.4323	42.9679		17	52.22	14.12	0.974435	5	12680	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	1	87700	1
19911031	1	1772	0.312461	0.895296		17	52.22	14.12	0.974435	5	275.792	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	2	87700	1
19911031	12	1772	-2.14748e+09	-2.14748e+09		17	52.22	14.12	0.974435	5	258	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	59	87700	1
19911031	12	1772	0.0205054	0.126333		17	52.22	14.12	0.974435	5	0.255606	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	29	87700	1
19911031	1	1772	0.000182061	0.000682609		17	52.22	14.12	0.974435	5	0.00133973	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	7	87700	1
19911031	12	1772	-118.018	43.1628		17	52.22	14.12	0.974435	5	15080	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	1	85000	1
19911031	1	1772	-0.0770144	0.875073		17	52.22	14.12	0.974435	5	275.27	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	2	85000	1
19911031	12	1772	-2.14748e+09	-2.14748e+09		17	52.22	14.12	0.974435	5	252.6	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	59	85000	1
19911031	12	1772	0.000505317	0.127308		17	52.22	14.12	0.974435	5	0.167877	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	29	85000	1
19911031	1	1772	2.18168e-05	0.000682609		17	52.22	14.12	0.974435	5	0.000874481	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	7	85000	1
19911031	12	1772	-2.14748e+09	-2.14748e+09		17	52.22	14.12	0.974435	5	140	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	111	85000	1
19911031	12	1772	-5.13978	2		17	52.22	14.12	0.974435	5	8	55.8421	16022	-2.14748e+09	760012	115	10393	1025	101	230000	17	263	112	85000	1

Total number of rows: 1598218

Data block size: 200000 rows Data block: 1 / 8

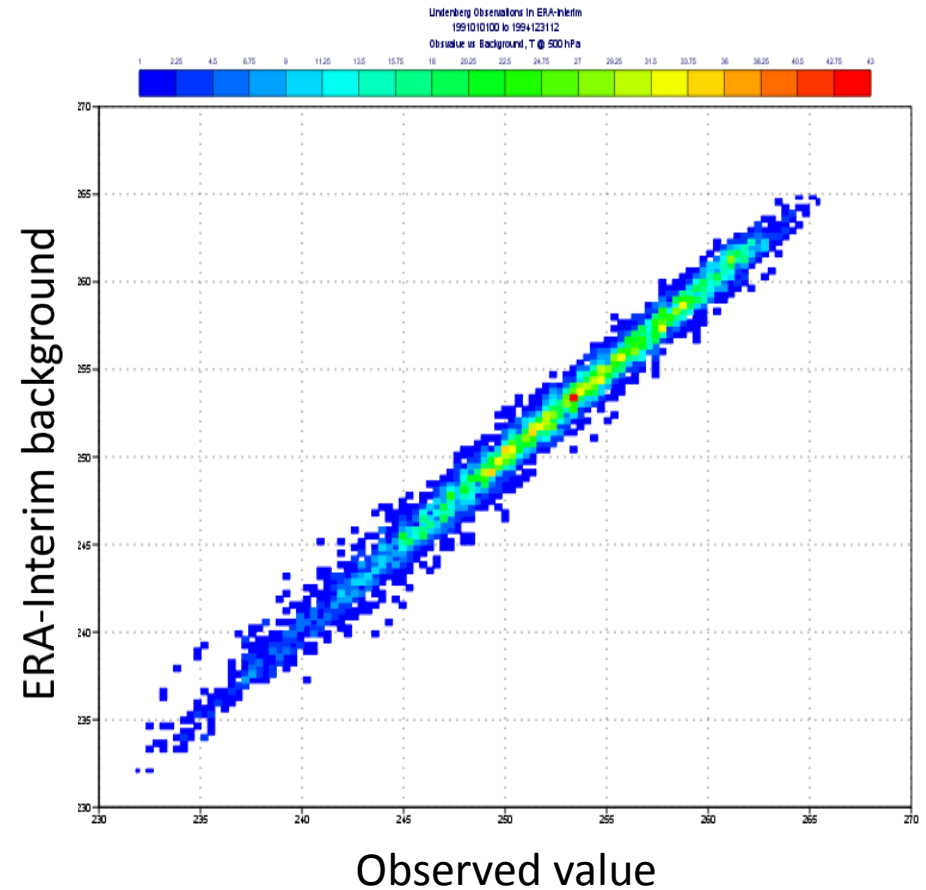
Visualization Tools - Metview

- Statistical summaries



Visualization Tools - Metview

- Filtering of data
- Plots for scientific analysis



Manipulation Tools – odb_api

- SQL-based interrogation
- Underlies Metview and data retrievals

```
linux% module load odb_api
load odb_api 0.9.24 Library (PATH, PYTHONPATH, ODB_API_MODE, ODB_API_VERSION, ODB_API_INCLUDE, ODB_API_LIB,
LAGS, EC_CXXFLAGS, EC_FLDFLAGS, EC_CLDFLAGS, EC_CXXLDFLAGS)
linux% odb sql -q "select distinct reporttype, count(obsvalue)" -i ispd_ps_ManualLandSynop_active_2b.odb
000 2014-11-04 16:58:15 (I) Executing 'select distinct reporttype, count(obsvalue) ;'
000 2014-11-04 16:58:15 (I) FileHandle::open ispd_ps_ManualLandSynop_active_2b.odb r 5
      reporttype  count(obsvalue)
000 2014-11-04 16:58:16 (I) SELECT has aggregated and non-aggregated results
      16002      87765.000000
000 2014-11-04 16:58:16 (I) Matching row(s): 1 out of 87,765
000 2014-11-04 16:58:16 (I) Skips : 0
000 2014-11-04 16:58:16 (I) Execute: 0.025198 second elapsed, 0.02 second cpu
linux% █
```

Concluding remarks

- Infrastructure needs are substantial
- Implementation well-advanced but still maturing
- Co-ordination would help to address:
 - Architecture: central or distributed/brokerage systems?
 - Common contents/formats?
 - Mappings, convertors, governance?
 - Community toolboxes?
 - Capacity building
 - Technical systems
 - Training users to access/interpret Observation Feedback
 - Providers of training and other services

Tools, by format

- BUFR: for linux and HPC
 - ‘dump’ and (linux:) ‘viewer’
 - spaghetti Fortran programs that need tailoring for each type of BUFR message
- ODB1: for linux and HPC (preferred)
 - Fortran interface (quite heavy to implement)
 - SQL command-line (dump, search, sort, aggregate functions...)
 - Linux: viewer in metview/Magics++
- ODB2: for linux and HPC
 - API with Fortran, C++, and python bindings
 - SQL command-line (dump, search, sort, aggregate functions...)
 - Several wrappers at command-line for sub-setting, merging (adding blocks or attributes), comparing (attributes and numerical contents)
 - Linux: viewer in metview/Magics++

Observation identification tables at ECMWF

- Reporttype:
 - Examples: **16002** indicates Manual Land SYNOP, **1005** indicates NOAA 19 AMSUA Radiances, ...
 - <http://data-portal.ecmwf.int/odbgov/ReportType/>
- Geophysical variable numbers:
 - Examples: **7** indicates Specific humidity, **119** indicates Brightness temperature, ...
 - <http://data-portal.ecmwf.int/odbgov/Varno/>