

TIGGE and the EU Funded BRIDGE project

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ECMWF

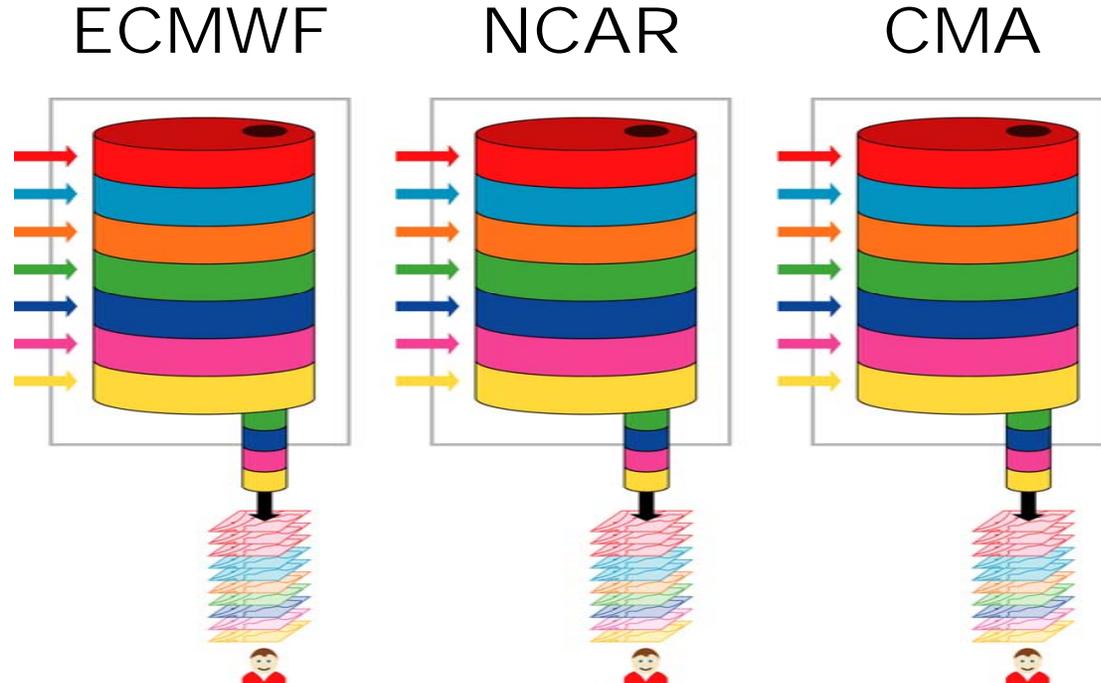
The TIGGE core dataset

- **THORPEX Interactive Grand Global Ensemble**
- **Global ensemble forecasts to around 14 days generated routinely at different centres around the world**
- **Outputs collected in near real time and stored in a common format for access by the research community**
- **Easy access to long series of data is necessary for applications such as bias correction and the optimal combination of ensembles from different sources**

Phased implementation of the archive

- **Phase 1: multiple instances, low development effort**

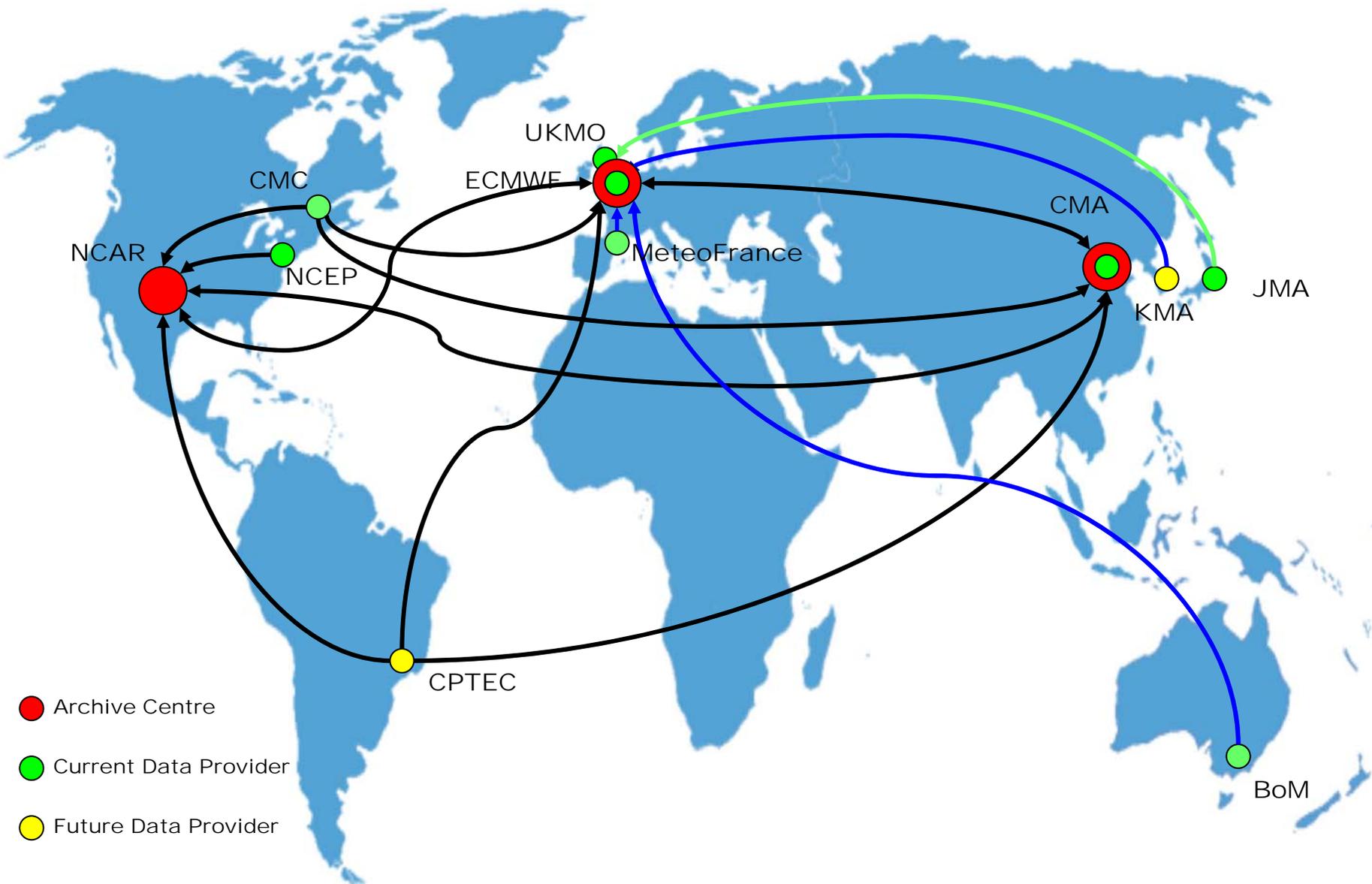
**Phase 1
Archive
Centres**



Building the TIGGE database

- **Three archive centres: CMA, NCAR and ECMWF**
- **Ten data providers:**
 - **Already sending data routinely: ECMWF, JMA (Japan), UK Met Office (UK), CMA (China), NCEP (USA), MSC (Canada), Météo-France (France), BOM (Australia),**
 - **Coming soon: CPTEC (Brazil), KMA (Korea)**
- **Exchanges using UNIDATA LDM, HTTP and FTP**
- **Operational since 1st of October 2006**
- **77 TB, growing by ~ 1 TB/week**

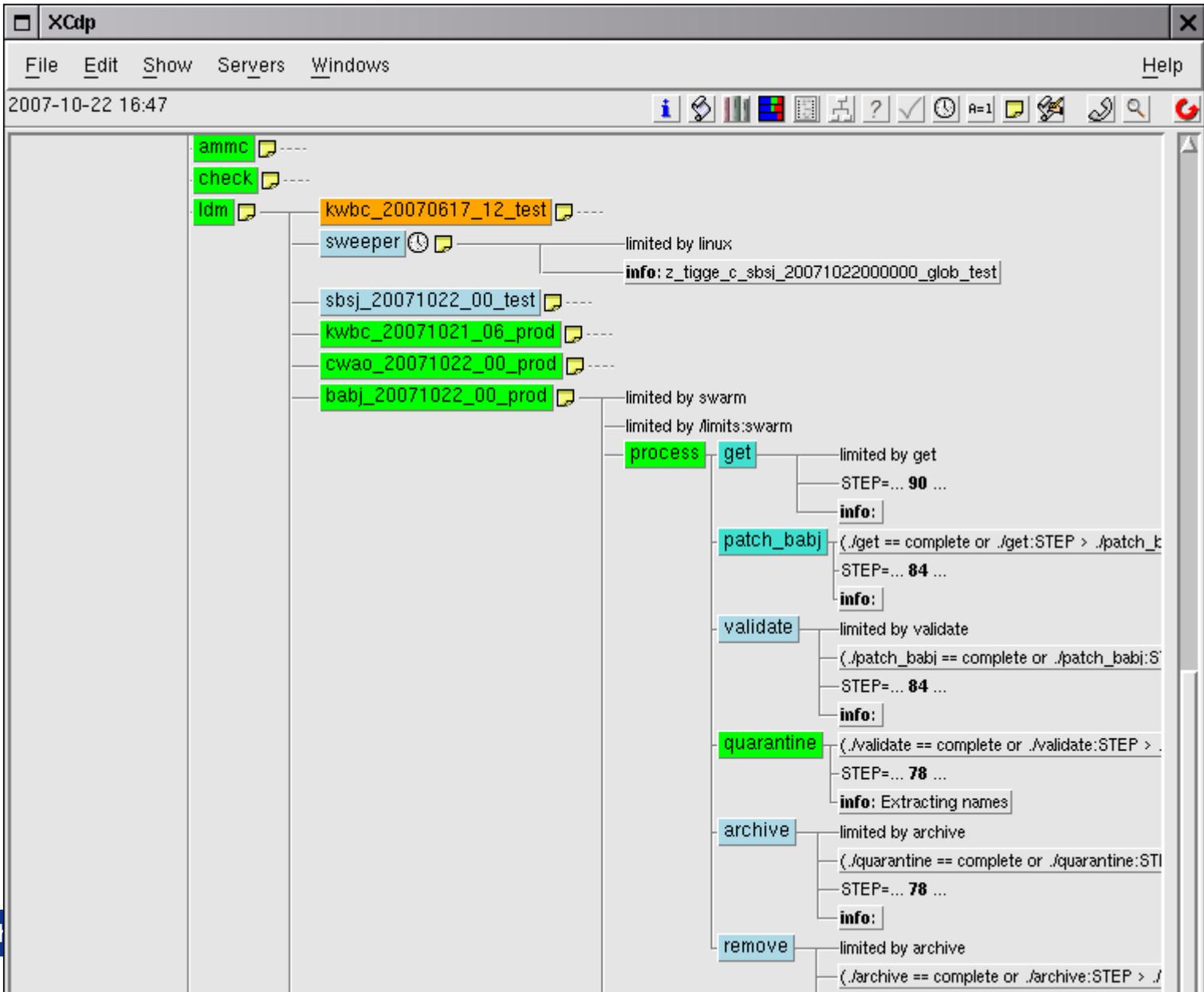
TIGGE Archive Centres and Data Providers



Strong governance

- **Precise definition of:**
 - Which products: list of parameters, levels, steps, units,...
 - Which format: GRIB2
 - Which transport protocol: UNIDATA's LDM
 - Which naming convention: WMO file name convention
- **Only exception: the grid and resolution**
 - Choice of the data provider
 - Best possible model output
- **Many tools and examples:**
 - Sample dataset available
 - Various GRIB2 tools, "tigge_check" validator, ...
 - Scripts that implement exchange protocol

Using SMS to handle TIGGE flow

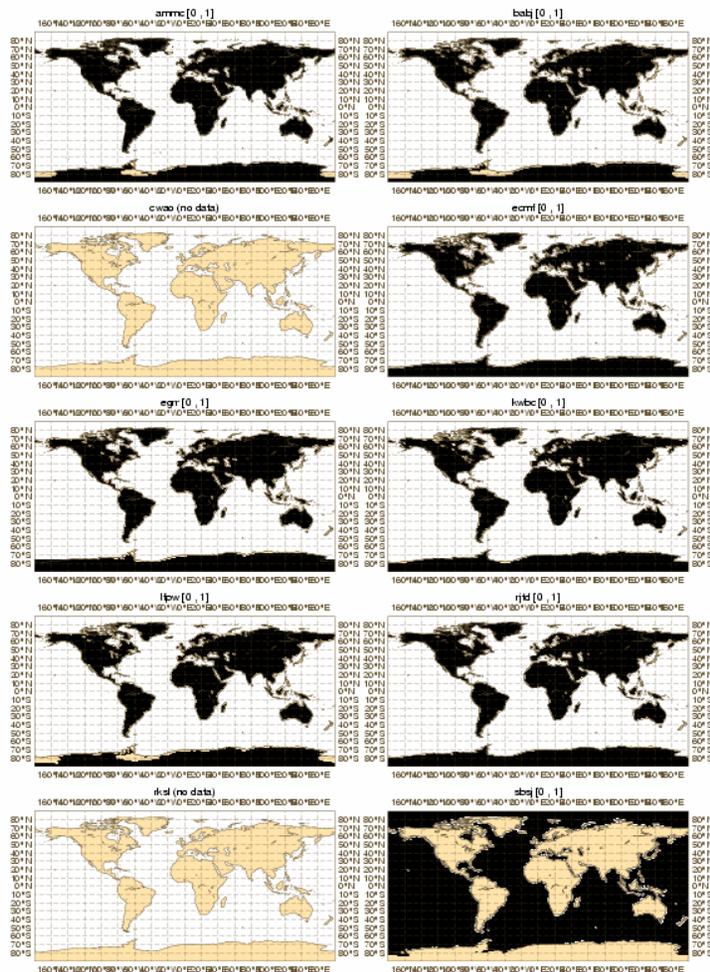


Quality assurance: homogeneity

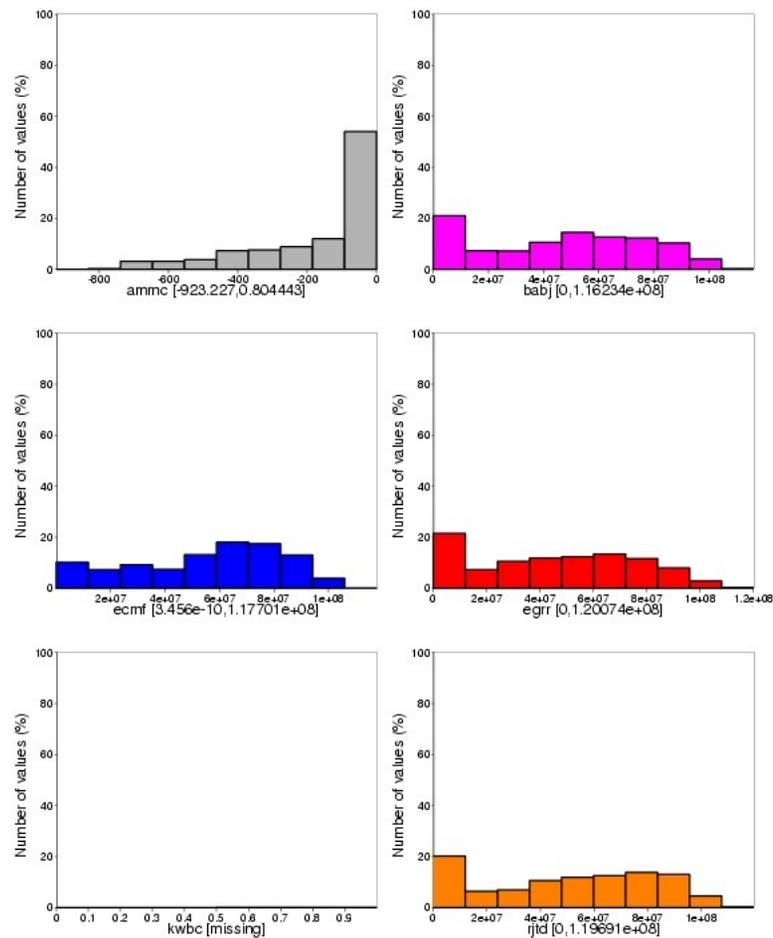
- **Homogeneity is paramount for TIGGE to succeed**
 - The more consistent the archive the easier it will be to develop applications
- **There are three aspects to homogeneity:**
 - Common terminology (parameters names, file names,...)
 - Common data format (format, units, ...)
 - Definition of an agreed list of products (Parameters, Steps, levels, ...)
- **What is not homogeneous:**
 - Resolution
 - Base time (although most provider have a run a 12 UTC)
 - Forecast length
 - Number of ensemble

QA: Checking for homogeneity

Land sea mask (sfc), step 48, 20071107



Time integrated surface net solar radiation (sfc), step 96, 20070608



QA: Completeness

- **The objective is to have 100% complete datasets at the Archive Centres**
- **Completeness may not be achieved for two reasons:**
 - **The transfer of the data to the Archive Centre fails**
 - **Operational activities at a data provider are interrupted and back filling past runs is impractical**
- **Incomplete datasets are often very difficult to use**
- **Most of the current tools (e.g. epsgrams) used for ensemble forecasts assume a fixed number of members from day to day**
 - **These tools will have to be adapted**

Accessing TIGGE

- **Data is available to Research and Education after 48 hours**
 - Self registration by agreeing to the terms and conditions
- **Portals at CMA, NCAR and ECMWF.**
- **ECMWF portal offers:**
 - Access to offline data
 - Aggregation along any axis (date, level, parameter, origin, ensemble, ...)
 - Provision of multi-model data on a single grid (regridding to any lat/lon grid)
 - Sub-area selection
 - Reduces volumes to be downloaded by many order of magnitude

TIGGE portal at ECMWF

TIGGE Data Retrieval - Mozilla Firefox

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TIGGE Data Retrieval

Type of level

[Potential temperature level](#)

[Potential vorticity level](#)

[Pressure level](#)

[Single level](#)

Select date

Select a date range between 2006-10-01 and 2007-10-20:

Start date: End date:

Select a list of month:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2006						<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2007						<input type="checkbox"/>									
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	

[Select All](#) **OR** [Clear](#)

Type of forecast

[Control](#)

[Deterministic](#)

[Perturbed](#)

Personal

[Your Requests](#)

Data usage

[Conditions](#)

See also...

[GRIB decoder](#)

[Other datasets](#)

[Data Services](#)

Select Origin and Base time

	BoM (Australia)	CMA (China)	CMC (Canada)	ECMWF (Europe)	JMA (Japan)	NCEP (USA)	UKMO (United Kingdom)
00:00:00	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
06:00:00						<input type="checkbox"/>	
12:00:00	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18:00:00						<input type="checkbox"/>	
	BoM (Australia)	CMA (China)	CMC (Canada)	ECMWF (Europe)	JMA (Japan)	NCEP (USA)	UKMO (United Kingdom)

[Select All](#) **OR** [Clear](#)

TIGGE portal at ECMWF (using Ajax)

TIGGE Data Retrieval - Mozilla Firefox

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TIGGE Data Retrieval

Type of level

Potential temperature level
Potential vorticity level
Pressure level
Single level

Type of forecast

Control
Deterministic
Perturbed

Personal

Your Requests

Data usage

Conditions

See also...

GRIB decoder
Other datasets
Data Services

Select date

Select a date range between 2007-03-05 and 2007-10-20:

Start date: 2007-03-05 End date: 2007-10-20

Select a list of month:

2006 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 2007 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Select All OF Clear

Select Origin and Base time

	BOM (Australia)	CMA (China)	CMC (Canada)	ECMWF (Europe)	JMA (Japan)	NCEP (USA)	UKMO (United Kingdom)
00:00:00	<input type="checkbox"/>	<input type="checkbox"/>					
06:00:00	<input type="checkbox"/>	<input type="checkbox"/>					
12:00:00	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>				
18:00:00	<input type="checkbox"/>	<input type="checkbox"/>					

Select All OF Clear

Select Time step

0 6 12 18 24 30 36 42 48 54 60 66 72

78 84 90 96 102 108 114 120 126 132 138 144 150

156 162 168 174 180 186 192 198 204 210 216 222 228

234 240 246 252 258 264 270 276 282 288 294 300 306

312 318 324 330 336 342 348 354 360 366 372 378 384

Select All OF Clear

Select parameters

10 Meter U Velocity 10 Meter V Velocity

Convective Available Potential Energy Convective Inhibition

Field Capacity Land Sea Mask

Mean Sea Level Pressure Orography

Skin Temperature Snow Depth Water Equivalent

Snow Fall Water Equivalent Soil Moisture

Soil Temperature Sunshine Duration

Surface Air Dew Point Temperature Surface Air Maximum Temperature

TIGGE Portal: based on WebMARS

retrieval105 - Mozilla Firefox

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retrieval105

Warning: This request represents about 79300 fields.

Version: Production
Type of forecast: Control
Type of level: Single level
Date: 2007-06-01 to 2007-06-30, 2007-08-01 to 2007-08-31
Parameter: Convective Inhibition, Skin Temperature, Soil Moisture, Surface Air Minimum Temperature, Surface Pressure
Time step: 0 to 384 by 6

Base time: 00:00:00
Origin: ECMWF (Europe)

Base time: 12:00:00
Origin: ECMWF (Europe), JMA (Japan), NCEP (USA)

The retrieval will be done using the following attributes:

Area:  Grid: 

Inter-tropical band *2x2*

Retrieve:

[Now](#)

TIGGE Portal: grid selection

retrieval105 - Mozilla Firefox

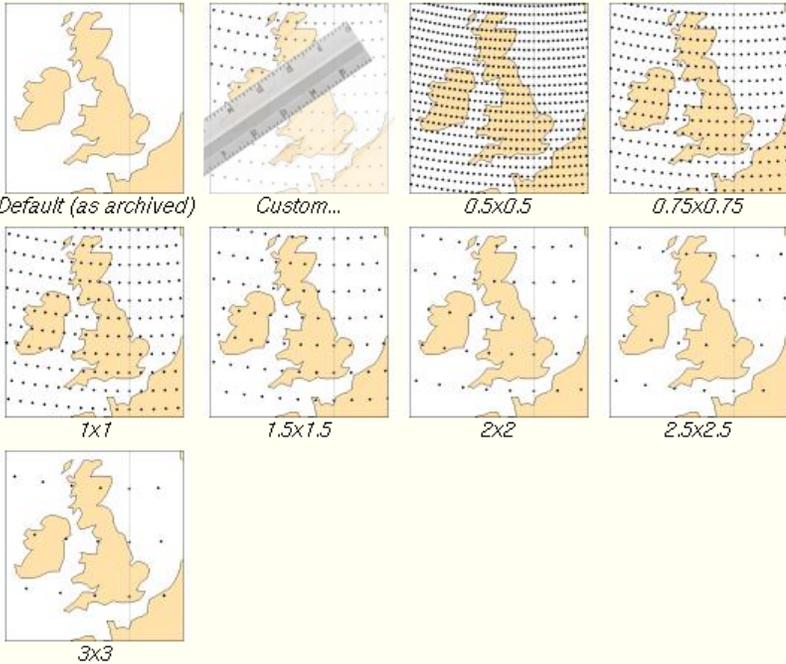
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Grid for retrieval105



The grid selection interface displays seven maps of the United Kingdom, each with a different grid resolution. The maps are arranged in two rows. The first row contains four maps: 'Default (as archived)', 'Custom...' (with a ruler overlay), '0.5x0.5', and '0.75x0.75'. The second row contains four maps: '1x1', '1.5x1.5', '2x2', and '2.5x2.5'. A third map, '3x3', is positioned below the '1x1' map. The grid resolutions increase from left to right and top to bottom.

22-10-2007 © ECMWF

TIGGE Portal: area selection

retrieval105 - Mozilla Firefox

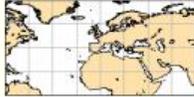
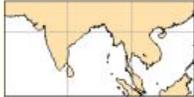
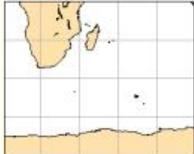
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Area for retrieval105

 <i>Default (as archived)</i>	 <i>Custom...</i>	 <i>Northern Hemisphere</i>	 <i>80°N 80°W 0°S 80°E</i>
 <i>Europe</i>	 <i>North America</i>	 <i>South Asia</i>	 <i>Inter-tropical band</i>
 <i>Tropical Pacific</i>	 <i>Indonesia</i>	 <i>0°S 1°E 80°S 100°E</i>	 <i>Southern Hemisphere</i>

22-10-2007 © ECMWF

TIGGE Portal: based on WEBMARS

retrieval105 - Mozilla Firefox

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retrieval105

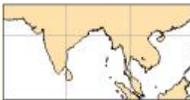
Warning: This request represents about 79300 fields.

Version: Production
Type of forecast: Control
Type of level: Single level
Date: 2007-06-01 to 2007-06-30, 2007-08-01 to 2007-08-31
Parameter: Convective Inhibition, Skin Temperature, Soil Moisture, Surface Air Minimum Temperature, Surface Pressure
Time step: 0 to 384 by 6

Base time: 00:00:00
Origin: ECMWF (Europe)

Base time: 12:00:00
Origin: ECMWF (Europe), JMA (Japan), NCEP (USA)

The retrieval will be done using the following attributes:

Area:  Grid: 

South Asia *2.5x2.5*

Retrieve:

[Now](#)

11th



TIGGE Portal: use SMS for scheduling users' requests

- **Monitoring**
- **Per user limits**
- **Global limits**

The screenshot displays the TIGGE Portal interface, showing a tree view of user requests and their associated limits. The top section lists global limits for various resources, each with a progress indicator (a green dot and a bar of small squares):

- users: 1/30
- retrieval: 1/30
- netcdf: 0/30
- thumbs: 0/30
- plot: 0/30
- cost: 0/30
- availability: 0/30

Below these are several user requests, each with a unique ID and a status icon (a small square with a checkmark or an 'X'). The requests are:

- dummy
- 00000046_95_mimatsue_95_mri_95_jma_95_go_95_jp
- 00000016_95_yonehara_95_met_95_kishou_95_go_95_jp
- 00000032_95_taiwei0214_95_sina_95_com
- 00000001_95_baudouin_95_raouil_95_ecmwf_95_int

The '00000001_95_baudouin_95_raouil_95_ecmwf_95_int' request is highlighted in green. To its right, a detailed view of its limits is shown:

- work: 1/3
- personal: 0/1
- limited by users
- dummy
- personal209
- personal211
- personal213
- personal215
- personal217
- personal219
- personal221
- personal223
- personal225
- personal227
- personal229
- personal231
- personal232

Below this list, a tree view shows the request's status and associated limits:

- 1 - work (limited by work)
- status (limited by status)
- retrieval (limited by retrieval)
- status: 0/1
- active (..work == act, ..work == cor, name: persor)
- aborted (..work == abc, ..work == cor)
- complete (..work == cor)
- remove

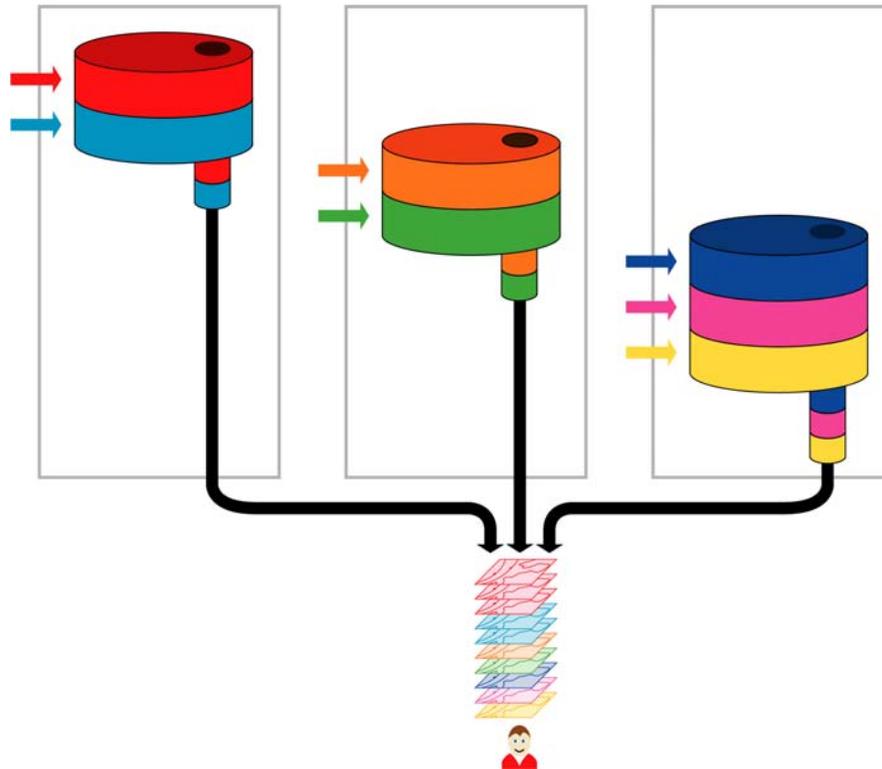
TIGGE Portal: direct access to MARS

- Most of the data is on tape: access to long timeseries
- Even finer control of resource usage

name	Idle	Pid	Task	ID	Info	Request
cleaner	2	94546	547	0	-	-
flusher	4	68598	599	0	-	Waiting for connection
hpss	10:53	68598	878	0	-	-
httpsvr	9	44498	36	0	-	Idle
mars	7	72778	778	0	-	Waiting for connection
queue	7	72778	282	0	-	-
queue	0:06	68118	118	0	-	-
mars	30	72778	314	0	-	-
mars	0:01	43156	692	0	-	-
mars	15	72778	322	0	-	RETRIEVE 00000001_baudouin_raoult_ecmwf_int web03 TI ECMF CF SFC 20070601 0000
mars	7	87224	224	3586081	-	Retrieving 19420 fields from 61 layouts 0%
queue	7	72778	570	0	-	-
queue	7	64812	348	0	-	-
mars	7	72778	618	0	-	-
mars	0:02	81798	798	0	-	-
mars	6	72778	842	0	-	-
mars	6	105786	788	0	-	-
marsadm	3:34	69510	510	0	-	Executing 'ps'
marsadm	28days	97532	532	0	-	Idle...
marsadm	2days	86642	642	0	-	Executing 'ps'
newops	10days	62814	350	0	-	Executing 'ps'
newops	10days	92438	438	0	-	Executing 'ps'
newops	40days	57080	616	0	-	Executing 'df'
newops	12days	61458	994	0	-	Executing 'ps'
reader	7	84546	546	0	-	Waiting for connection
hpss	14	84546	146	0	-	Waiting for reader.t
reader	13 H	74148	148	3586081	Read 0	Reading 70,1765 Mbytes from hpss 0%
reader	13	74148	164	0	Wait 0	Double buffering 70,1765 Mbytes 0%
hpss	0	84546	258	0	-	59 requests queued
hpss	12	84546	930	0	-	Waiting for reader.t
reader	12 H	78432	432	3586081	Read 0	Reading 70,1765 Mbytes from hpss 0%
reader	12	78432	448	0	Wait 0	Double buffering 70,1765 Mbytes 0%

TIGGE Phase 2

- Phase 2: distributed approach, higher development effort



BRIDGE

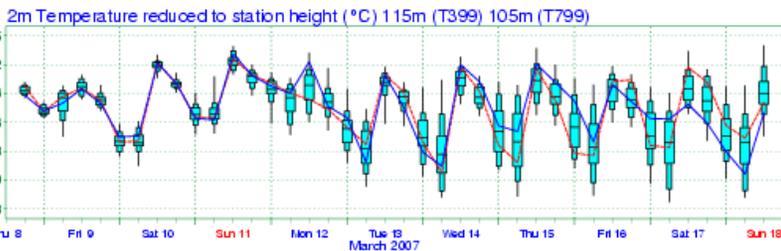
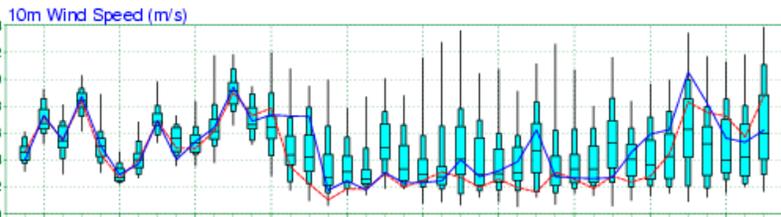
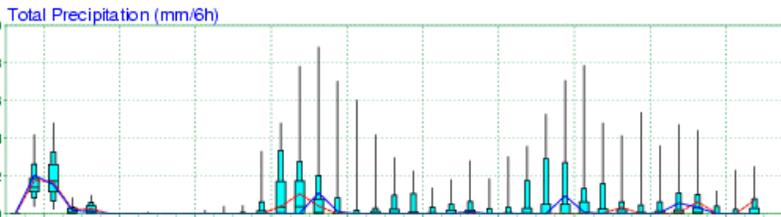
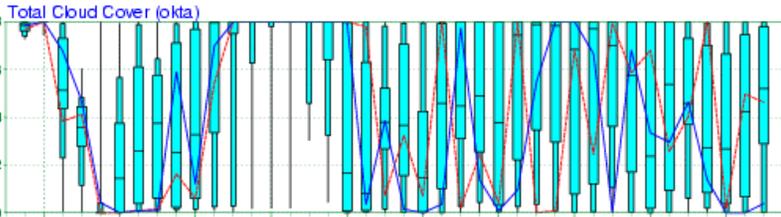
- **Bridge is a 2 years project funded by the EC under the FP6-IST programme.**
- **It will demonstrate the benefits of GRID technology for international cooperation, in particular between Europe and China**
- **This work focuses on the development of interoperable Grid infrastructures (CNGrid, GRIA)**
- **Three applications: Aircraft Design, Meteorology, Drug Design**

BRIDGE meteorology application

- **BRIDGE project gives us the funding to explore how to implement TIGGE Phase 2**
 - Partners: ECMWF, DWD, CMA and CNIC (Computer Network Information Center, Chinese Academy of Sciences)
- **Creation of probabilistic weather forecasts products from the TIGGE dataset in a distributed fashion**
 - Each site hosts only part of the TIGGE data
 - Each site offers basic operations on the data (e.g. computing an average)
- **Strategy: minimize data transfers**
 - Run operations at data location
 - Decompose operations in simpler ones
 - Most of the time intermediate results are much smaller

Example: EPSGram

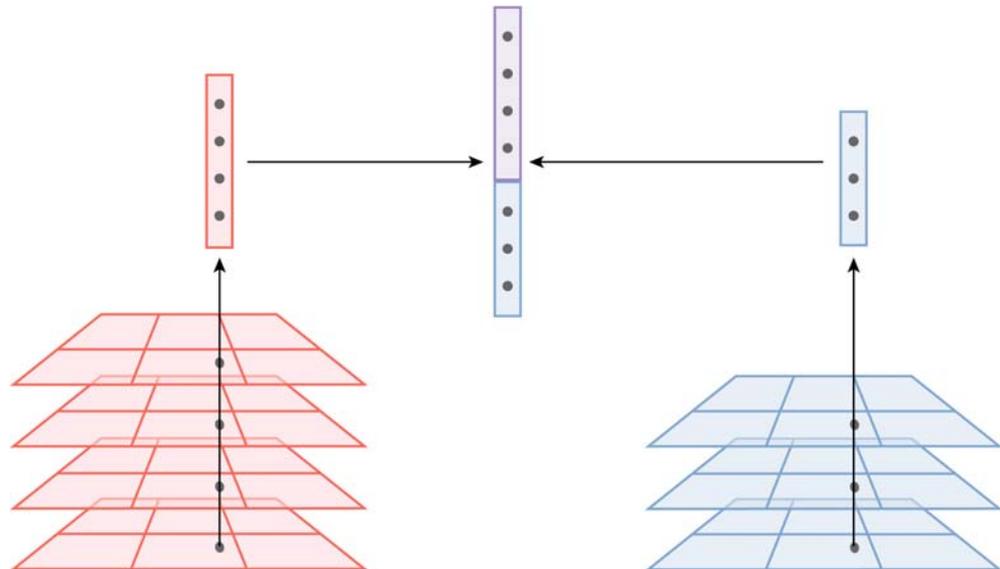
EPS Meteogram
Reading (48m) 51.46 °N 1.33 °W
Deterministic Forecast and EPS Distribution Thursday 8 March 2007 12 UTC



max
95%
75%
median
25%
10%
min

— T799 OPS — T399 CTRL

- Send lat/lon location at each sites
- Receive list of values back
- Compute distributions
- Generate plot



EPS Products

- **Examples**

- Ensemble mean
- Standard deviation
- Clustering
- Probability of weather events
- Extreme Forecast Index
- EPSgram

- **Some products can be decomposed in simpler operations on a subset of members**

- Ensemble means

- **Some products need all the members**

- Clustering

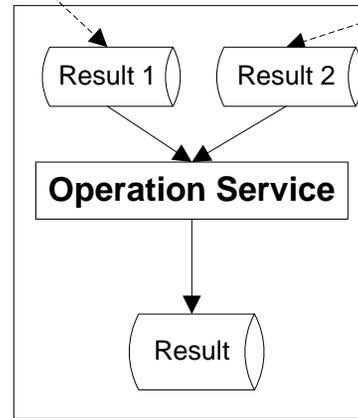
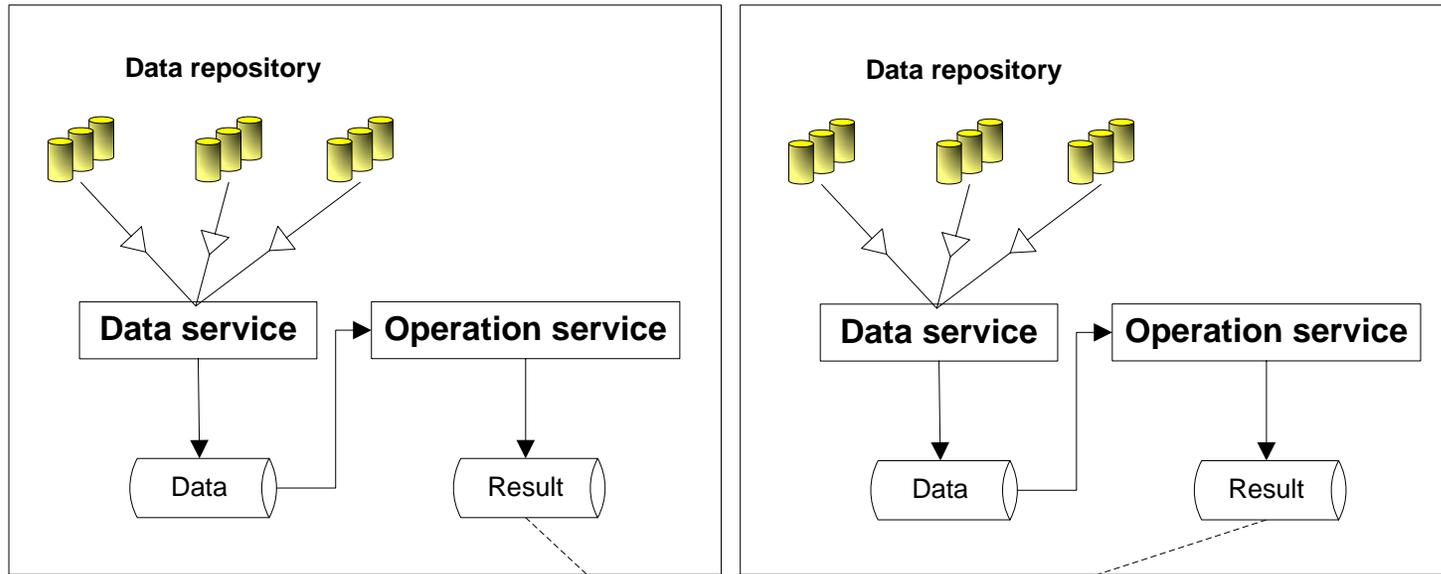
Example: Ensemble mean

- Data requests describes 10 fields
- 6 are available from ECMWF
- 4 are available from CMA
- $S1 = \text{sum}(6 \text{ ECMWF fields})$ performed at ECMWF
- $S2 = \text{sum}(4 \text{ CMA fields})$ performed at CMA
- Intermediate results and associated metadata moved to site where user invoked request: $(S1,6)$ and $(S2,4)$
- Final result $A = (S1 + S2)/(6+4)$ computed locally and returned to user

Decomposable operation

ECMWF/GRIA

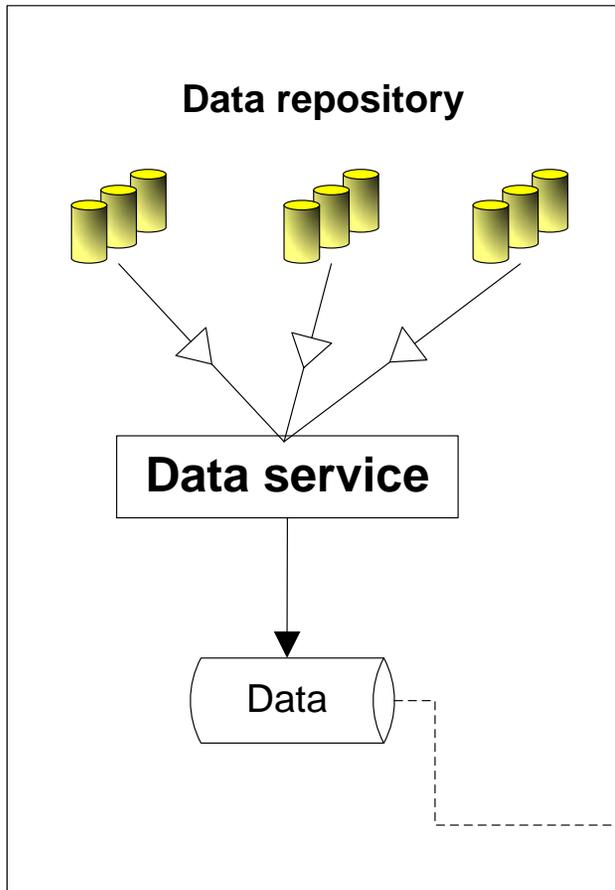
CMA/GOS



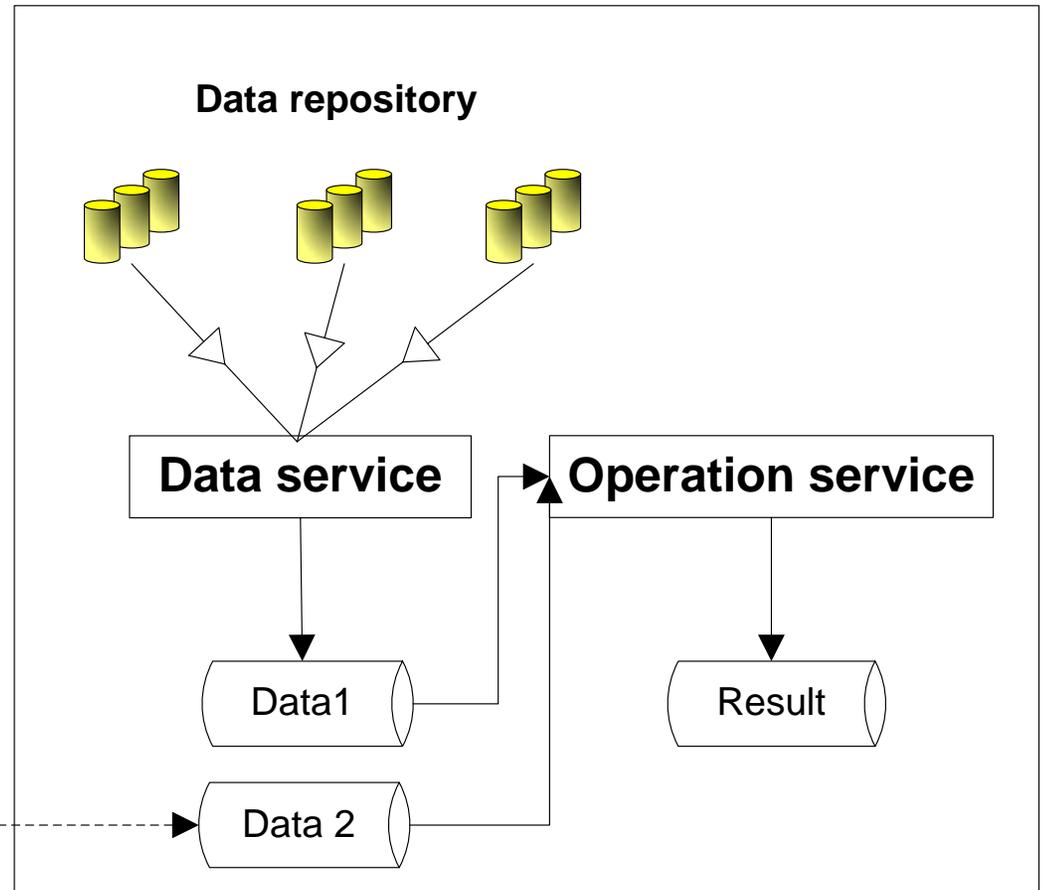
DWD/GRIA

Non-decomposable operation

ECMWF/GRIA



CMA/GOS



Products description

- **At ECMWF, most EPS products are computed using the MARS/Metview macro languages**

- Notion of fieldsets: A variable contains many fields
- Computations are expressed as high level formulas:

$$\text{speed} = \text{sqrt}(u*u+v*v)$$

- **In BRIDGE we will express the computations using a similar syntax**

- High level formulas...

$$\text{epsmean}(\text{date:20070101}, \text{param:total_precipitation})$$

- ... translate into low level formulas

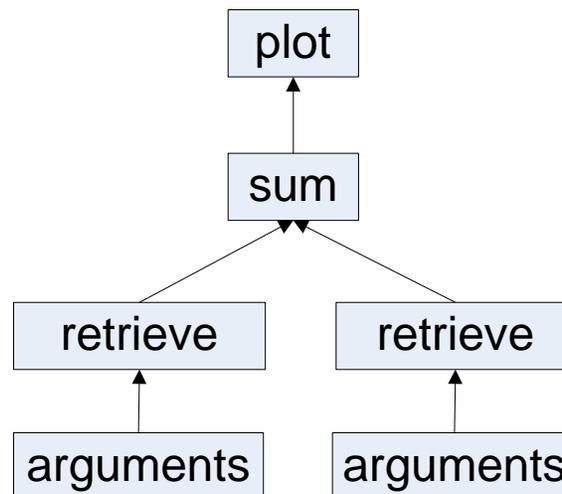
$$A = \text{retrieve_ecmwf}(\text{date:20070101}, \text{param:total_precipitation})$$

$$B = \text{retrieve_cma}(\text{date:20070101}, \text{param:total_precipitation})$$

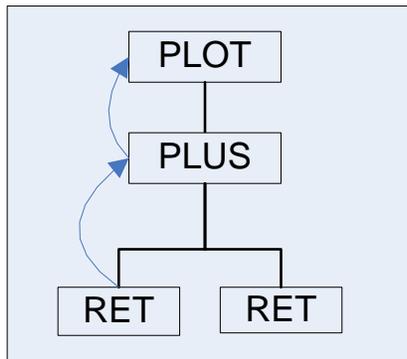
$$E = (\text{sum}(A) + \text{sum}(B)) / (\text{count}(A) + \text{count}(B))$$

Example

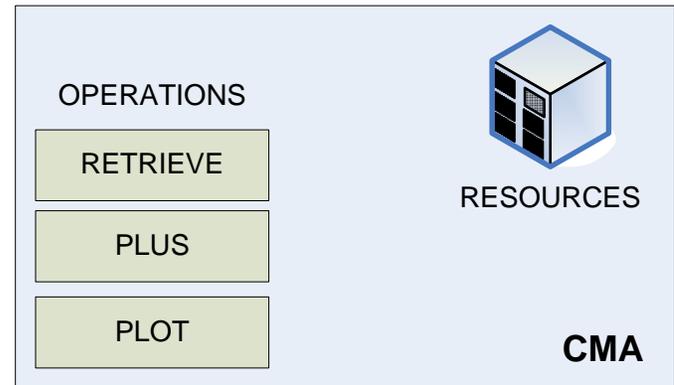
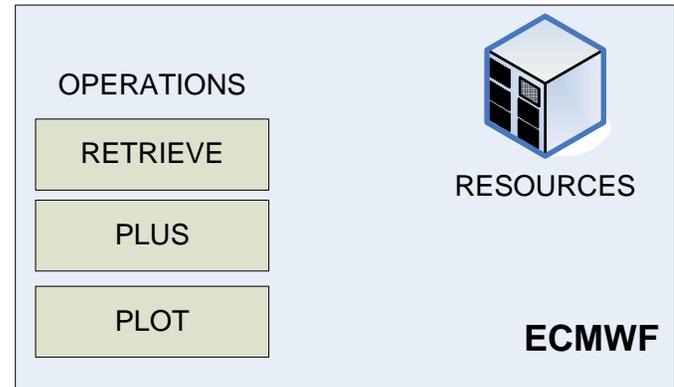
plot(retrieve(origin:babj,...) + retrieve(origin:ecmf,...))



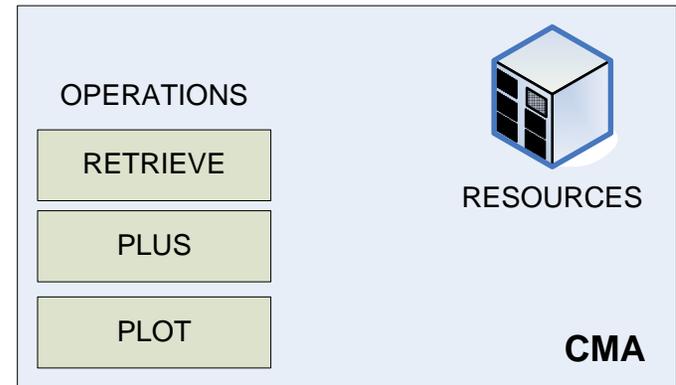
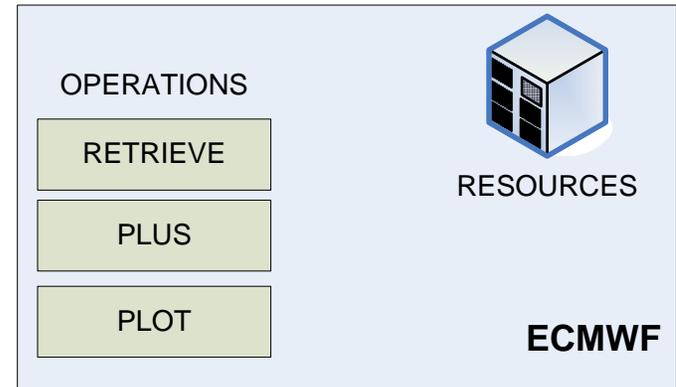
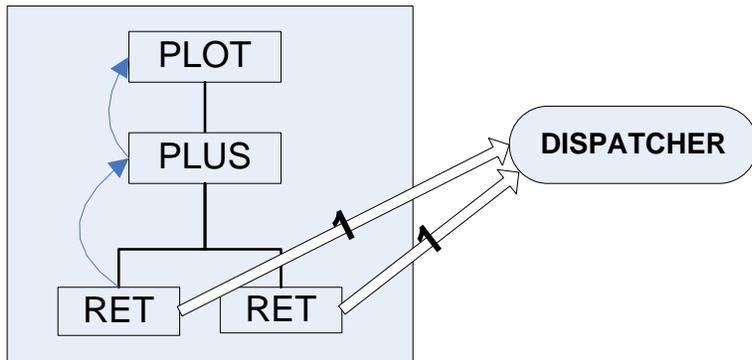
Example (cont.)



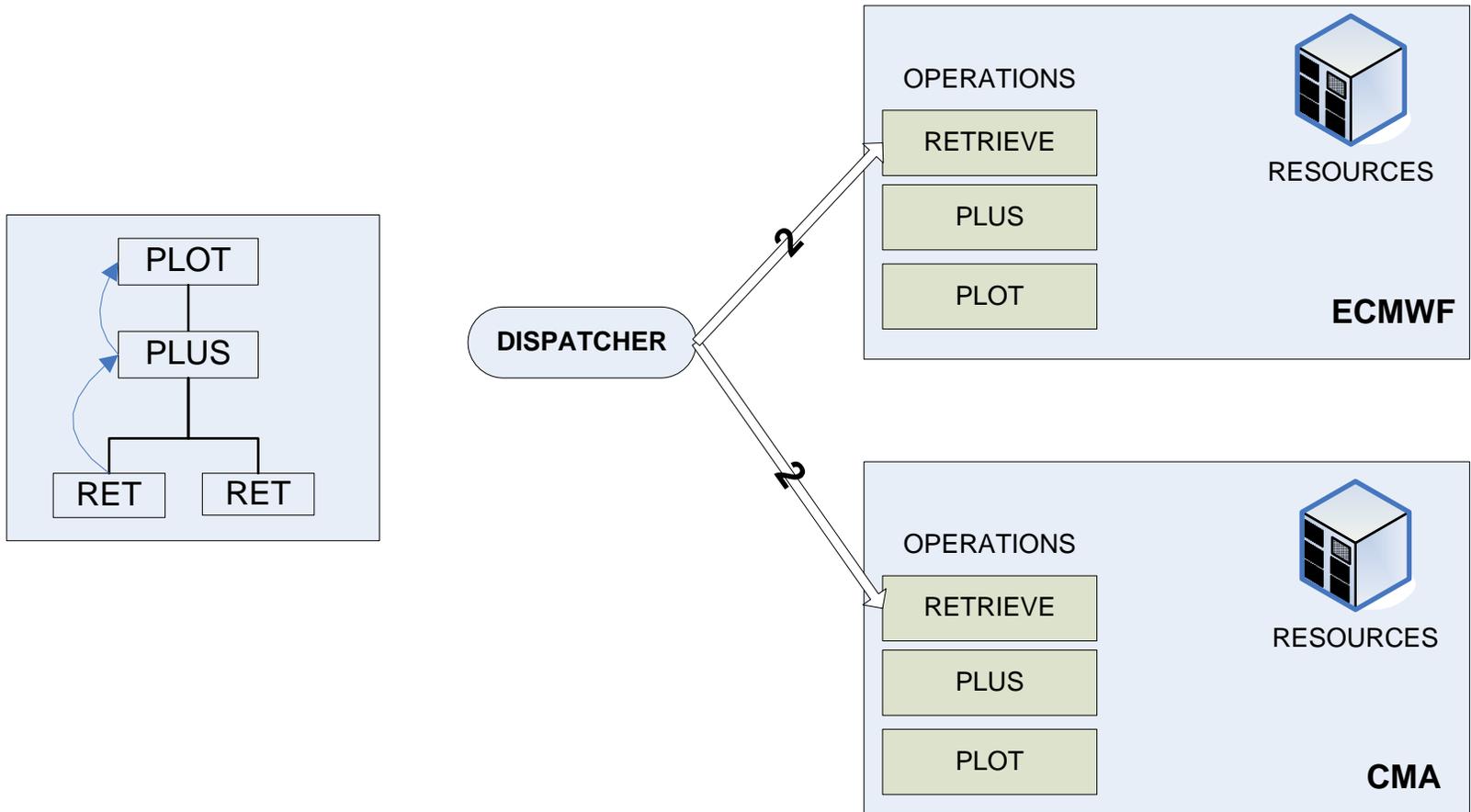
DISPATCHER



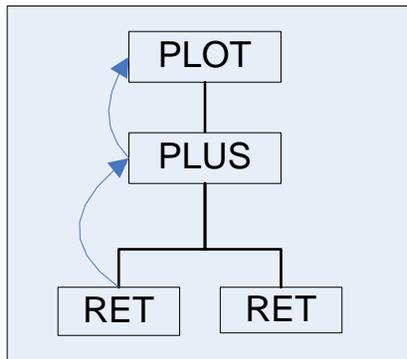
Example (cont.)



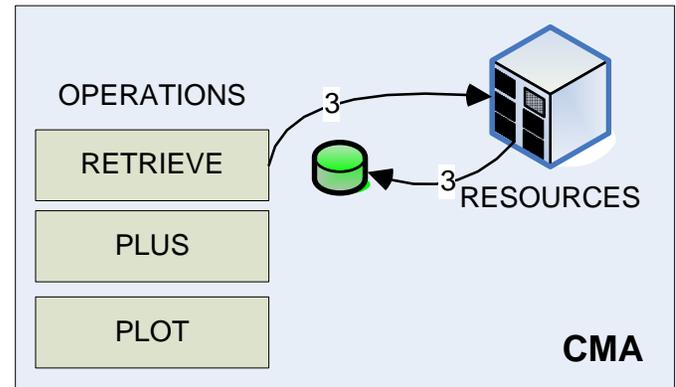
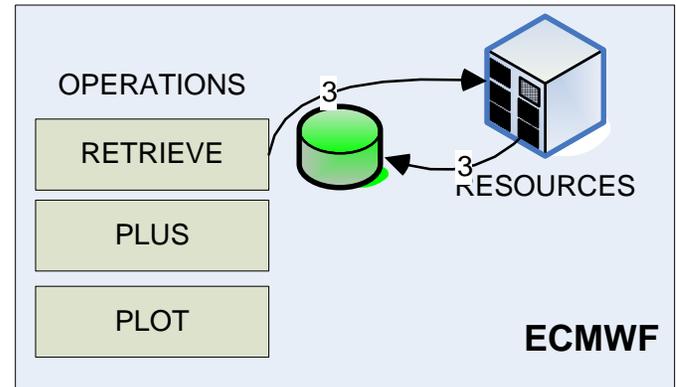
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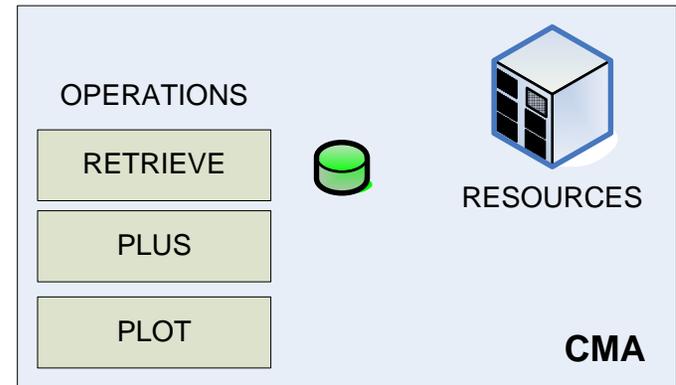
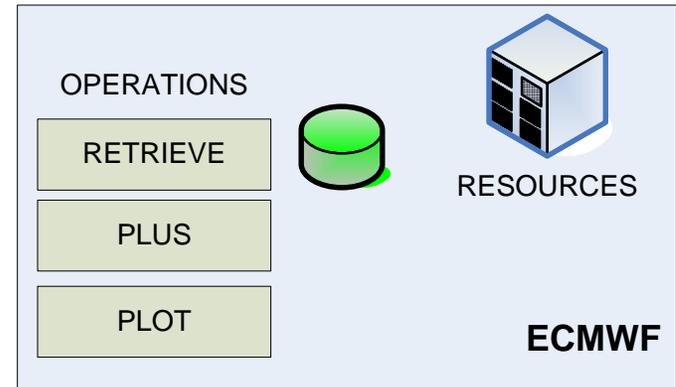
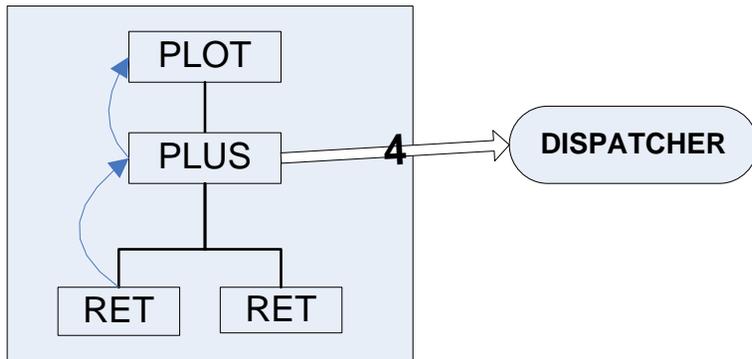
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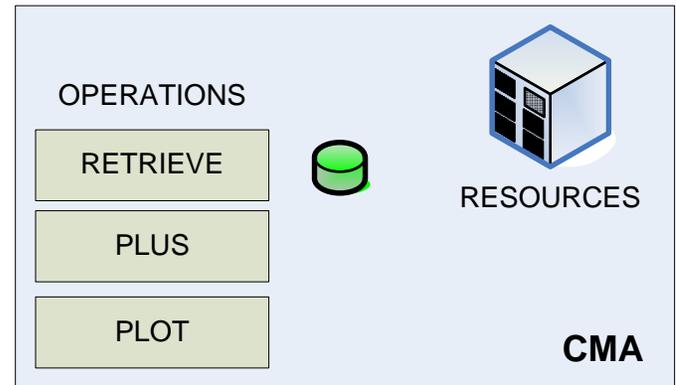
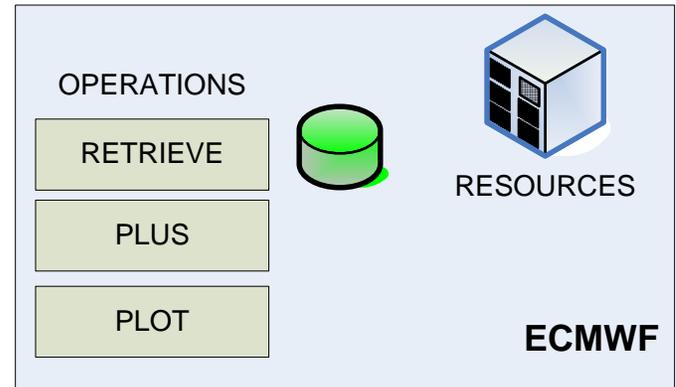
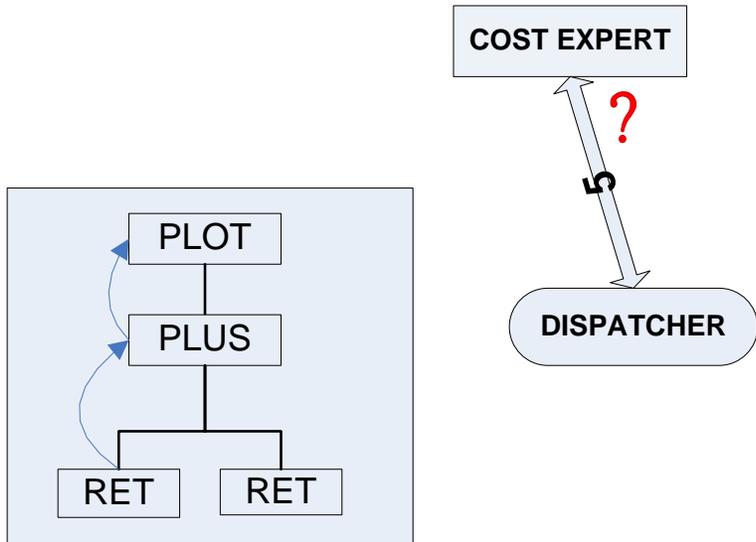
DISPATCHER



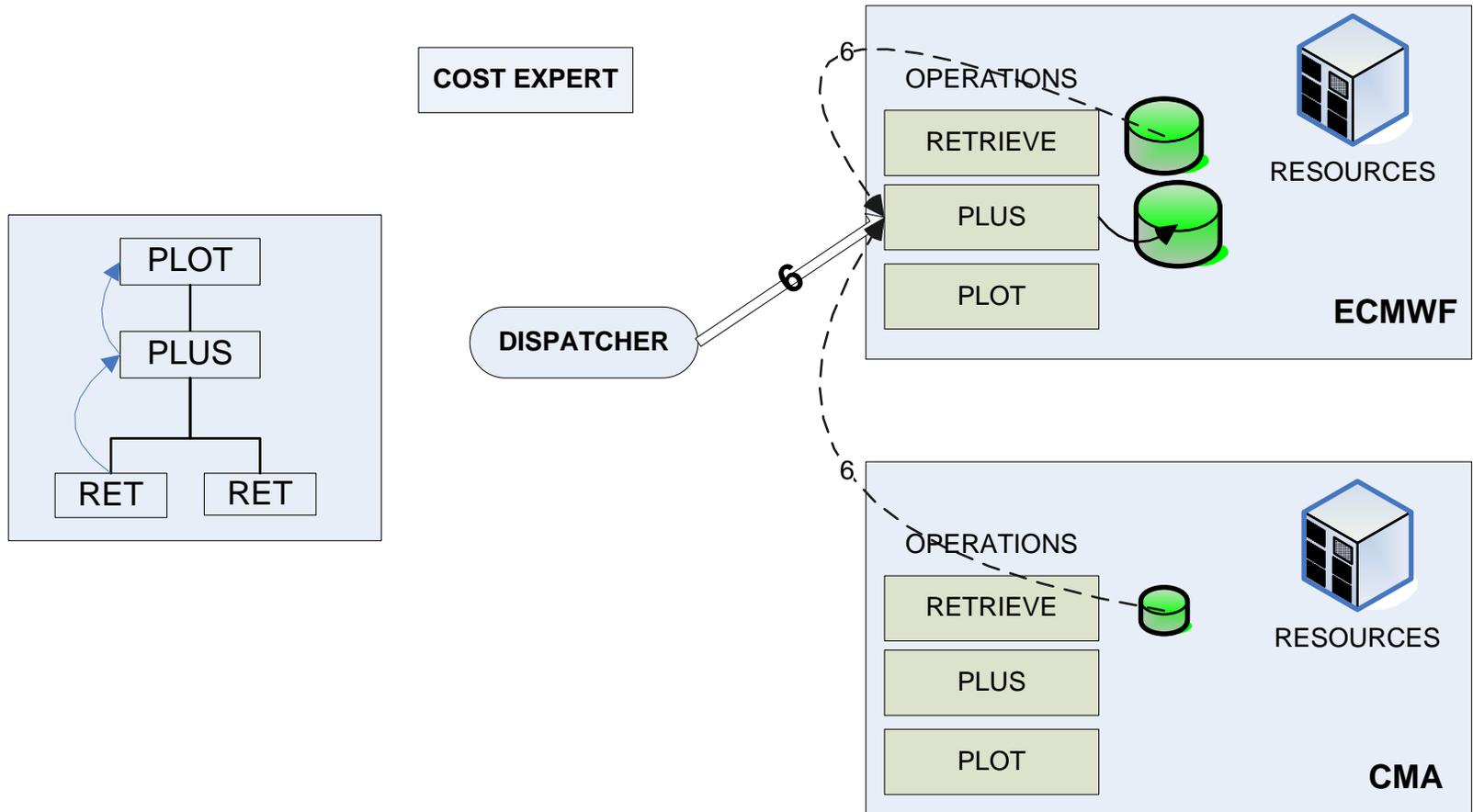
Example (cont.)



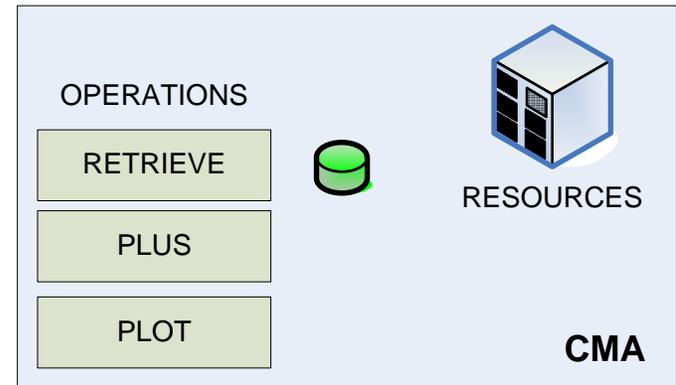
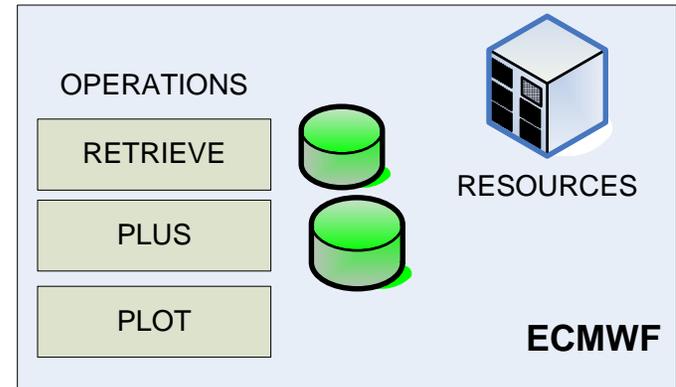
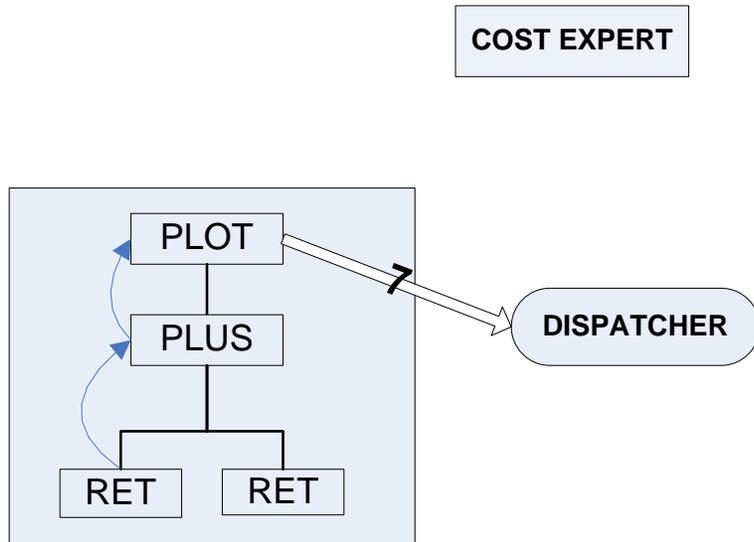
Example (cont.)



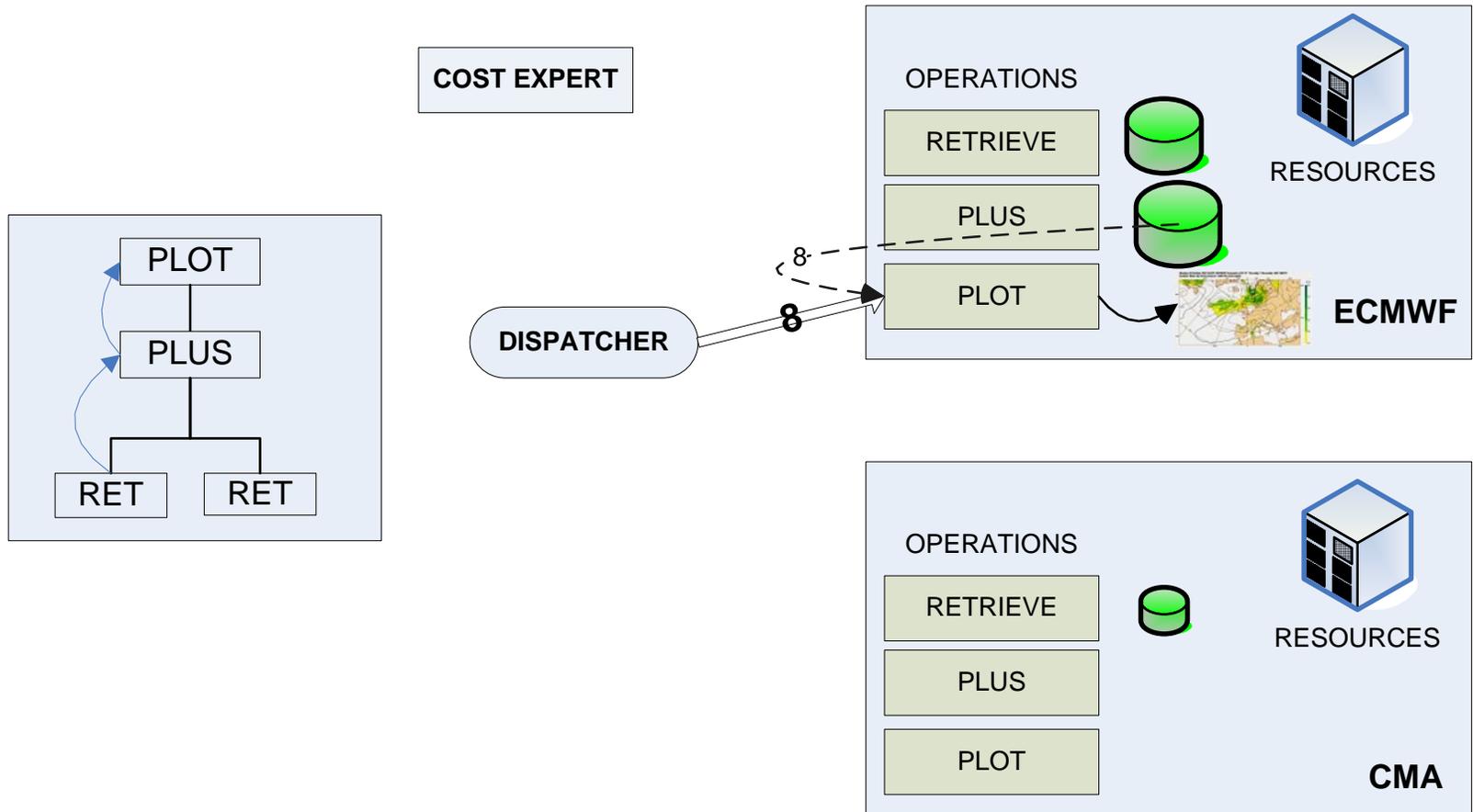
Example (cont.)



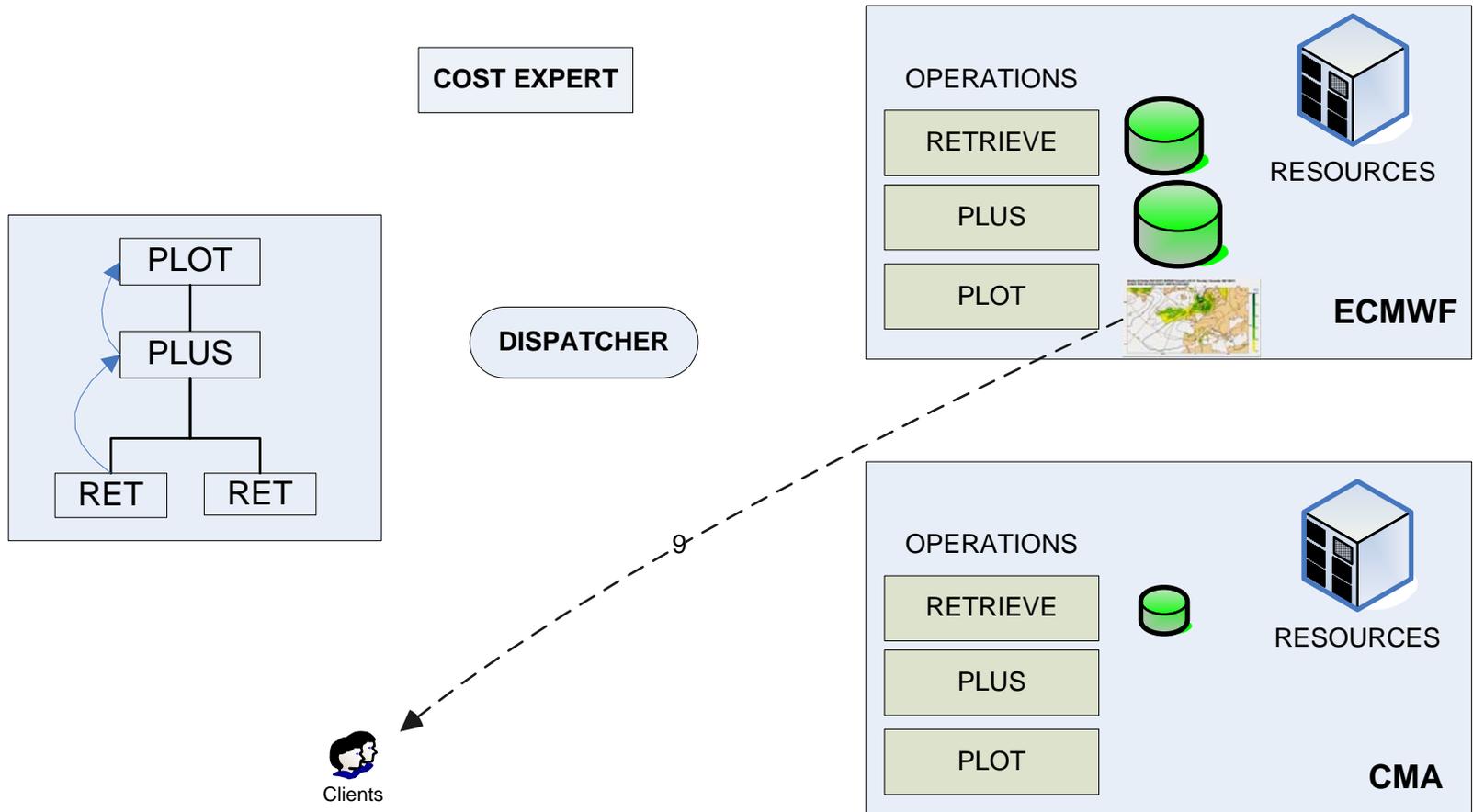
Example (cont.)



Example (cont.)



Example (cont.)



Conclusion

- **TIGGE Phase 1 is progressing well**
 - Strong governance
 - Very good working relationship between CMA, NCAR and ECMWF
- **BRIDGE project gives us the funding to explore how to implement TIGGE Phase 2**
 - Study how to create EPS products in a distributed environment