



# Semantic Oriented Data Access and Storage at MPIM / DKRZ

By

M. Lautenschlager and H. Thiemann

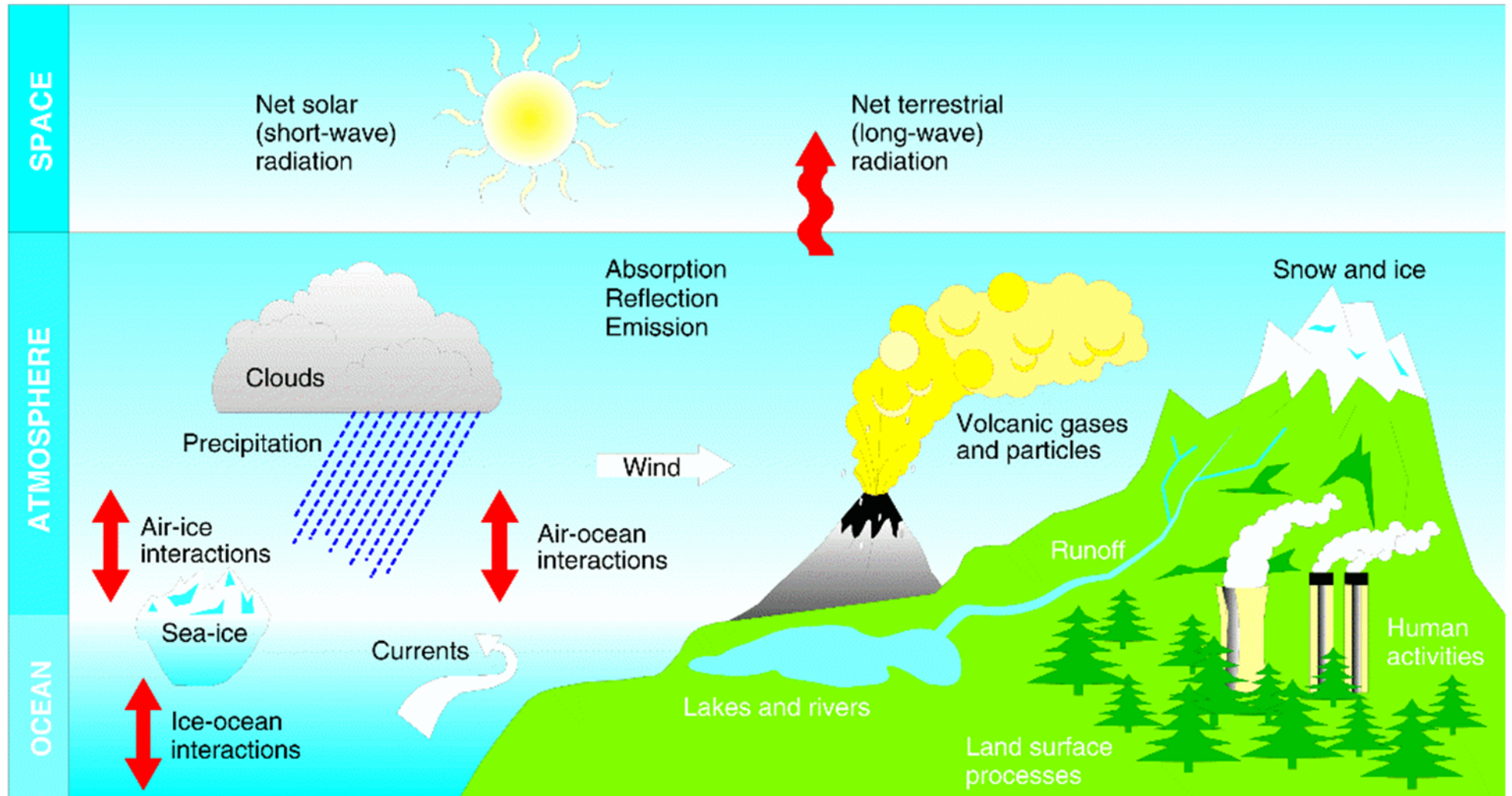
Modelle und Daten / Max-Planck-Institut für Meteorologie  
Hamburg, Germany

18<sup>th</sup> IEEE Symposium on Mass Storage Systems  
April 17-20, 2001, Hyatt Regency Islandia,  
San Diego

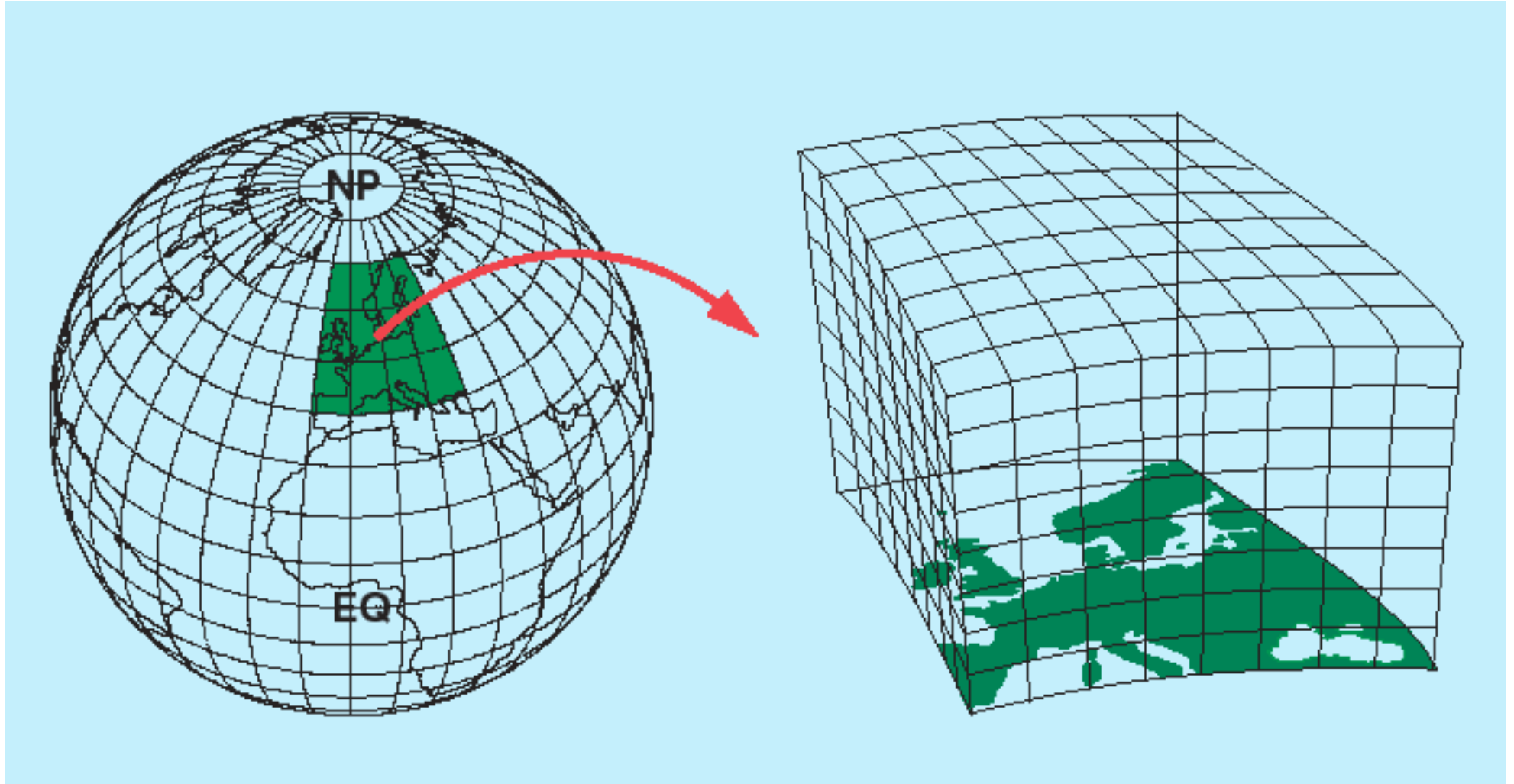
# Contents

- ✂ Archive and Access Problems
- ✂ CERA Database System
- ✂ Tertiary Storage Connection
- ✂ Graphical User Interface

# Climate System

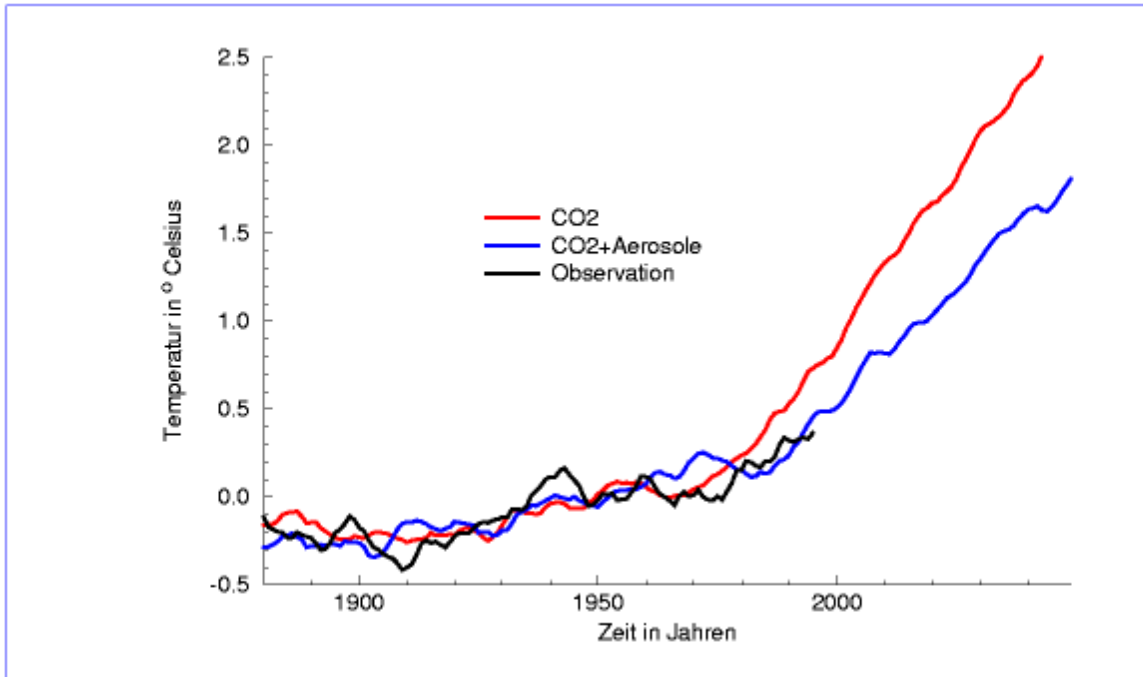


# Climate Model Resolution

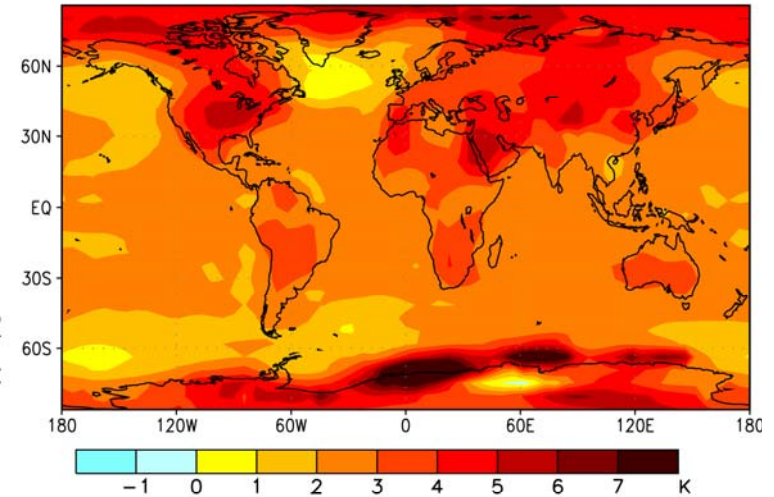


# Climate Model Results

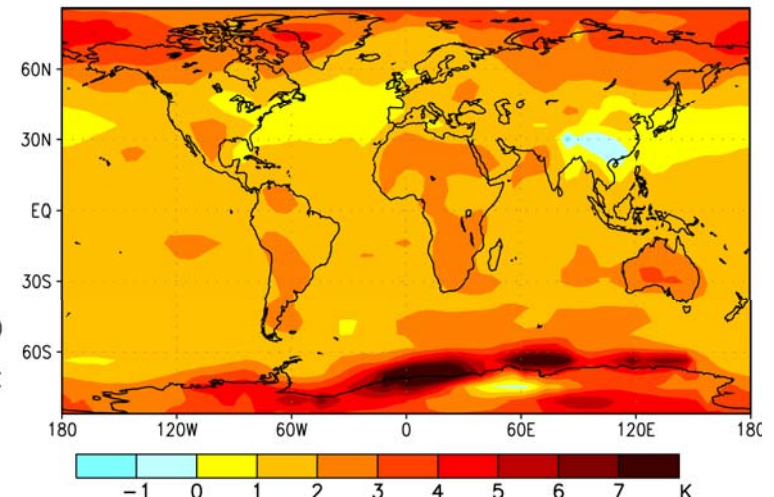
ECHAM3/LSG – 2m Temp.  
 (2040–2049)–(1880–1889)  
 (Mean of both aerosol runs is used)



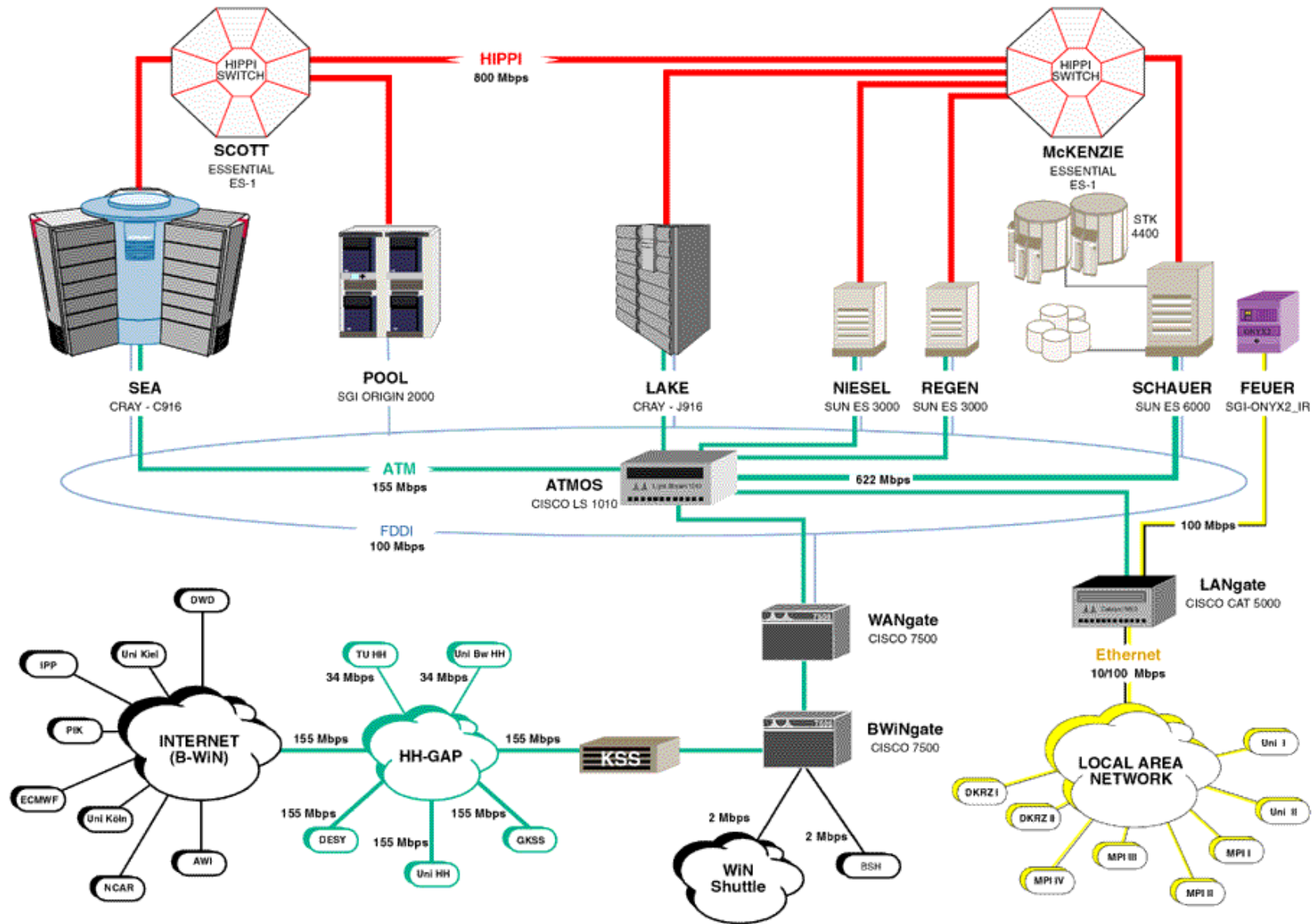
CO2  
 only:



AERO  
 +CO2:

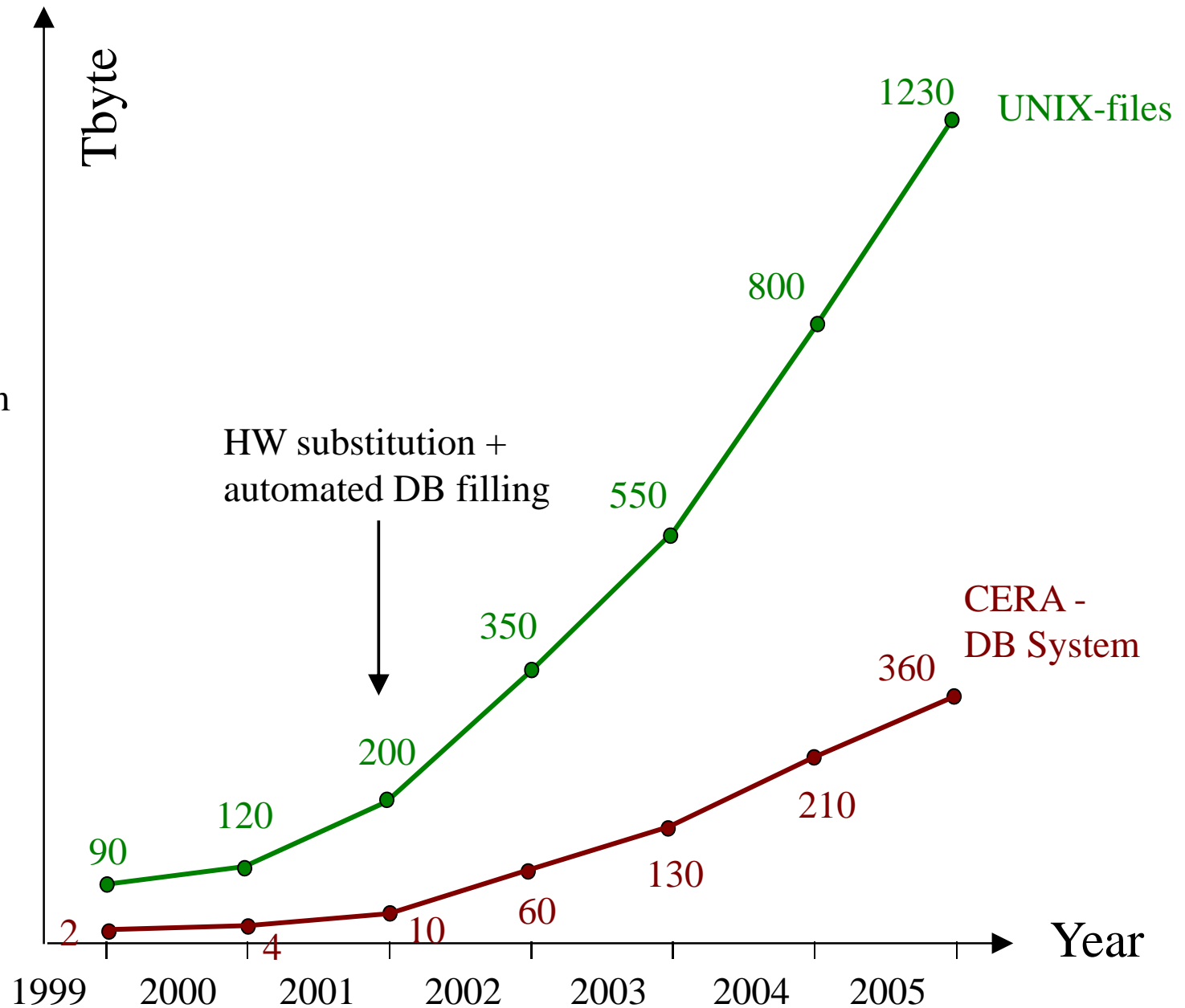


## Rechner und Netze (2Q2000)



## Expected increase of archive and database system

After 2001:  
1/3 of the file  
archive rate will  
be mirrored in the  
CERA DB System



# Climate Model Data Units

✗ Horizontal resolution of global models

✗ **T42**:  $128 * 64 = 8192$  points / del.y= 280 km

✗ **T106**:  $160 * 320 = 51200$  points / del.y= 110 km

✗ ***Required storage amount (GRIB format)***

✗ ***Horizontal field (data access unit):***

**17.1 kB** (T42) / **100.1 kB** (T106)

✗ ***File size of monthly accumulated output (data storage unit):***

**120 MB** (T42) / **750 MB** (T106)

✗ ***100 year model integration (logical data unit):***

**140 GB** (T42) / **880 GB** (T106)



# Unix File Access Problems

- ✘ Storage in **classical file systems** is not sufficient to organise the climate model data. **Descriptive information** about the file content (data catalogue) is widely missing.
- ✘ The **access performance** for primary data is limited due to reload from **magnetic tapes** and the **99% overhead** in data download, only 1% is needed.

# Data Access Example

## ✂ Example:

✂ Extraction of individual time series of **surface climatology** from a 100 year climate model integration

## ✂ Unix file access:

✂ Extracting 1% of data from **1200 raw data files** bears **3000 hours processing** time and **400 hours access** time on a well equipped work station.

✂ In practise: doubling of time due to technical problems (--> **9 months**)

## ✂ CERA DB access:

✂ **Data access improvement** by at least a **factor of 1000** because only one tape mount and no data processing

✂ **Data movement reduction** by a **factor of 100** because only the requested 1% data are transferred.

# CERA Database system

(Climate and Environmental data Retrieval and Archiving system)

## ✘ Semantic oriented data management

☞ **Retrieval:** *Requests are formulated within the semantics of the data model.* The data system then collects and processes the required data and disseminates the extracted information to the user.

☞ **Storage:** Data are stored automatically in the archive within the framework of the data model semantics and data hierarchy. Automatic storage has to be performed before the data are migrated to slow sequential storage devices (tapes).

## ✘ CERA DB system

☞ data model (description, catalogue)

☞ data hierarchy (access optimised data storage)

☞ standard data processing (further data reduction on data server)

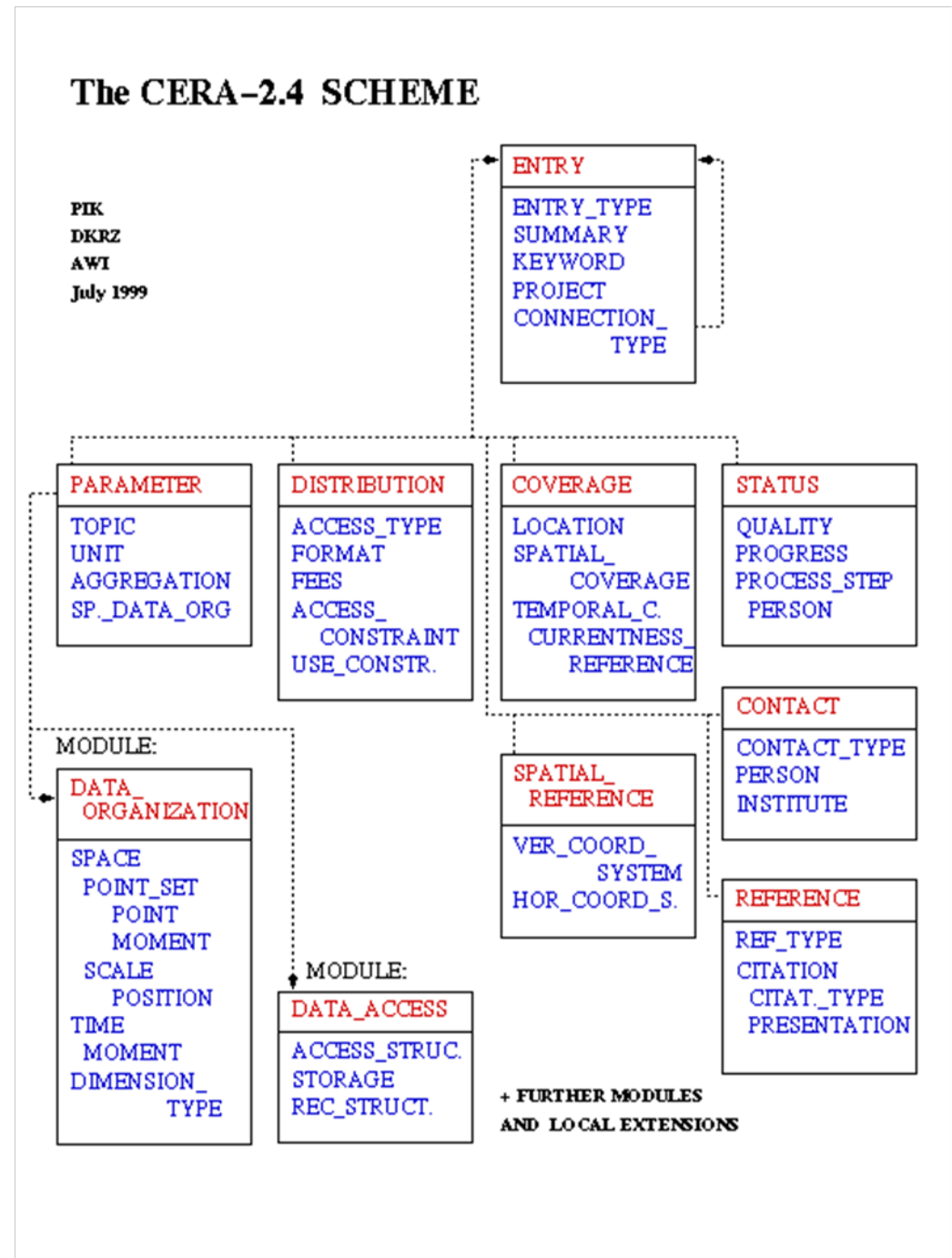
# CERA Data Model

Home page:

[www.pik-potsdam.de/cera](http://www.pik-potsdam.de/cera)

Documentation:

[www.dkrz.de/forschung/reports.html](http://www.dkrz.de/forschung/reports.html)



# CERA Data Hierarchy

## ✂ Metadata

- ✂ Description of the data archive (**data catalogue**)
- ✂ **Access:** as fast as possible

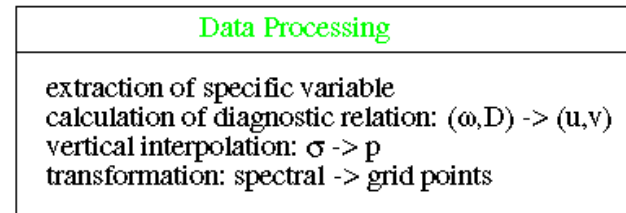
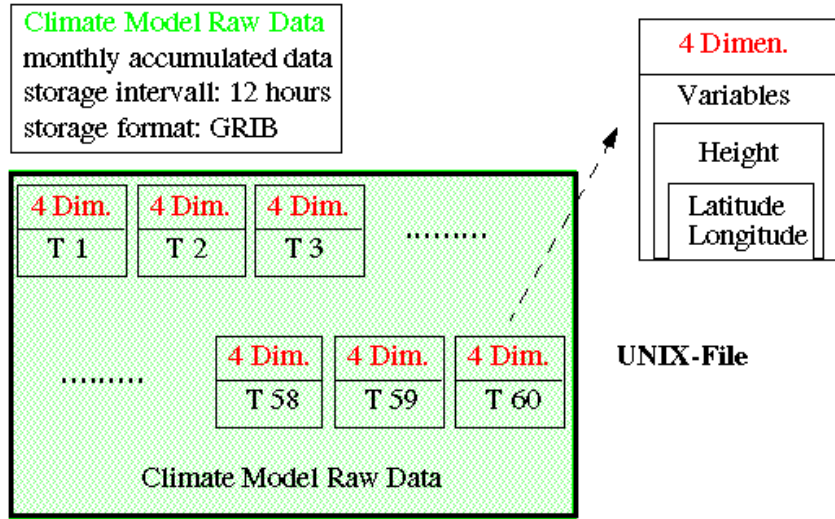
## ✂ Processed climate data

- ✂ **Access optimised** storage
- ✂ 2D time series of the separate model variables as daily data and monthly means as **BLOB table entries**
- ✂ **Access:** preferably on magnetic disks, migration to tapes

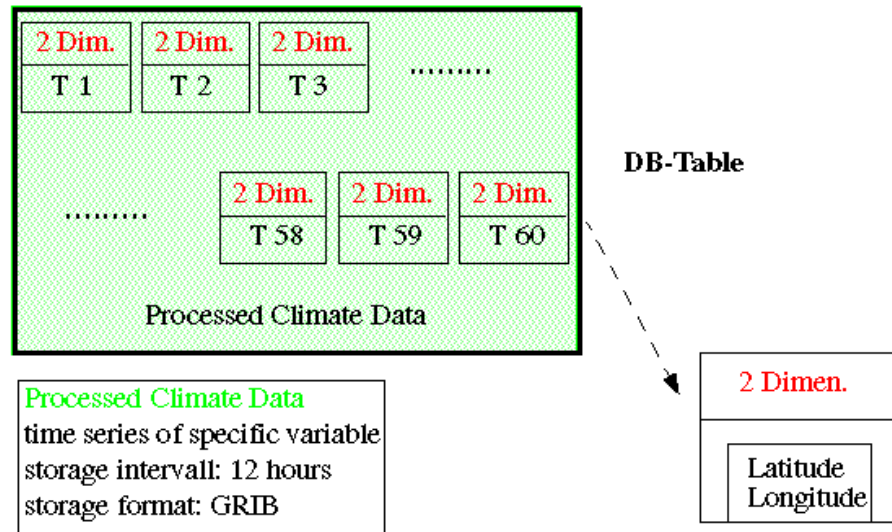
## ✂ Climate model raw data

- ✂ Used for **back-up** and **special evaluations**
- ✂ Monthly accumulated climate model data as **UNIX files** and **Pointer**
- ✂ **Access:** magnetic tapes

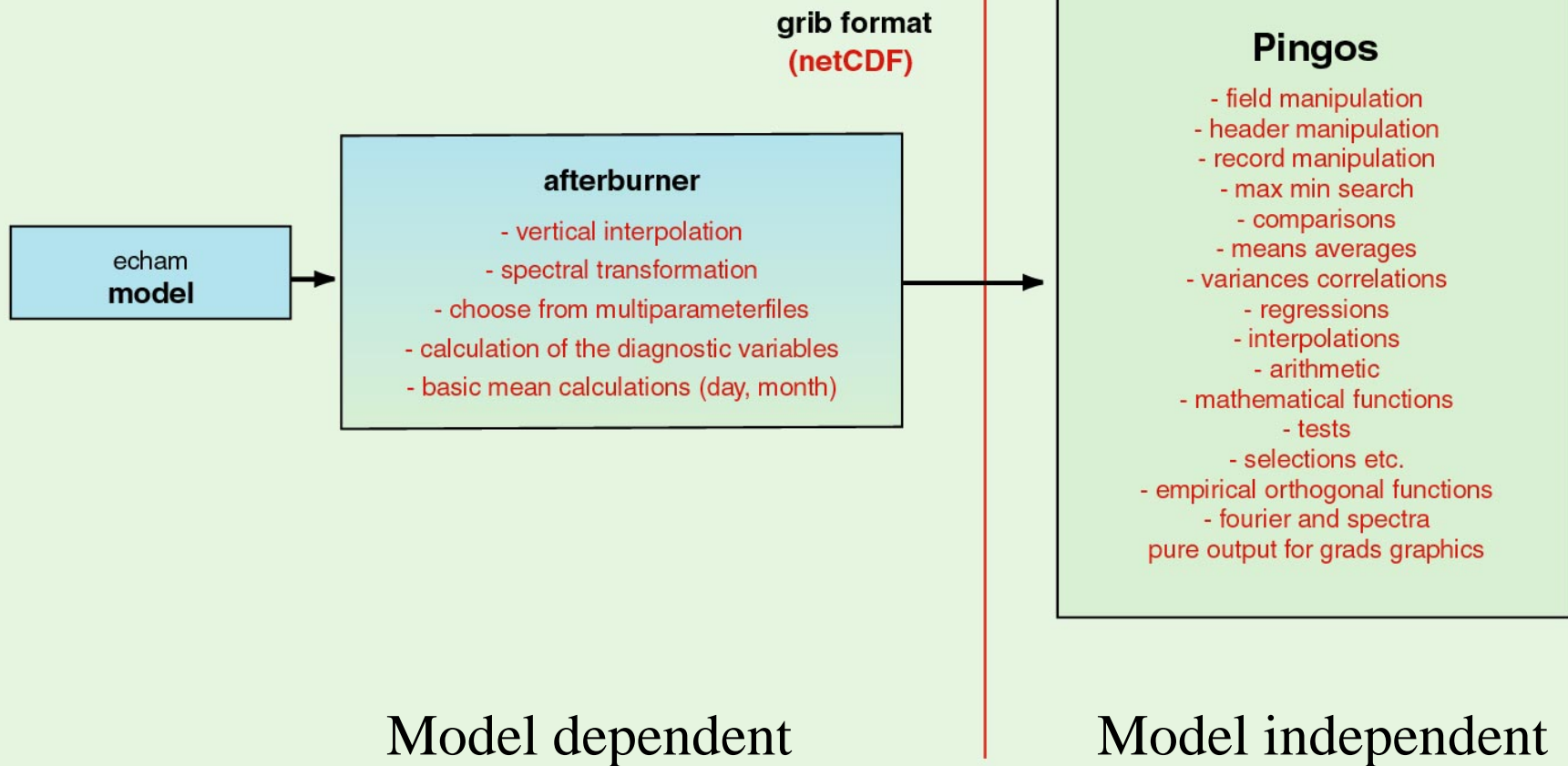
Climate model  
raw data  
(1200 files per  
100 year integration)



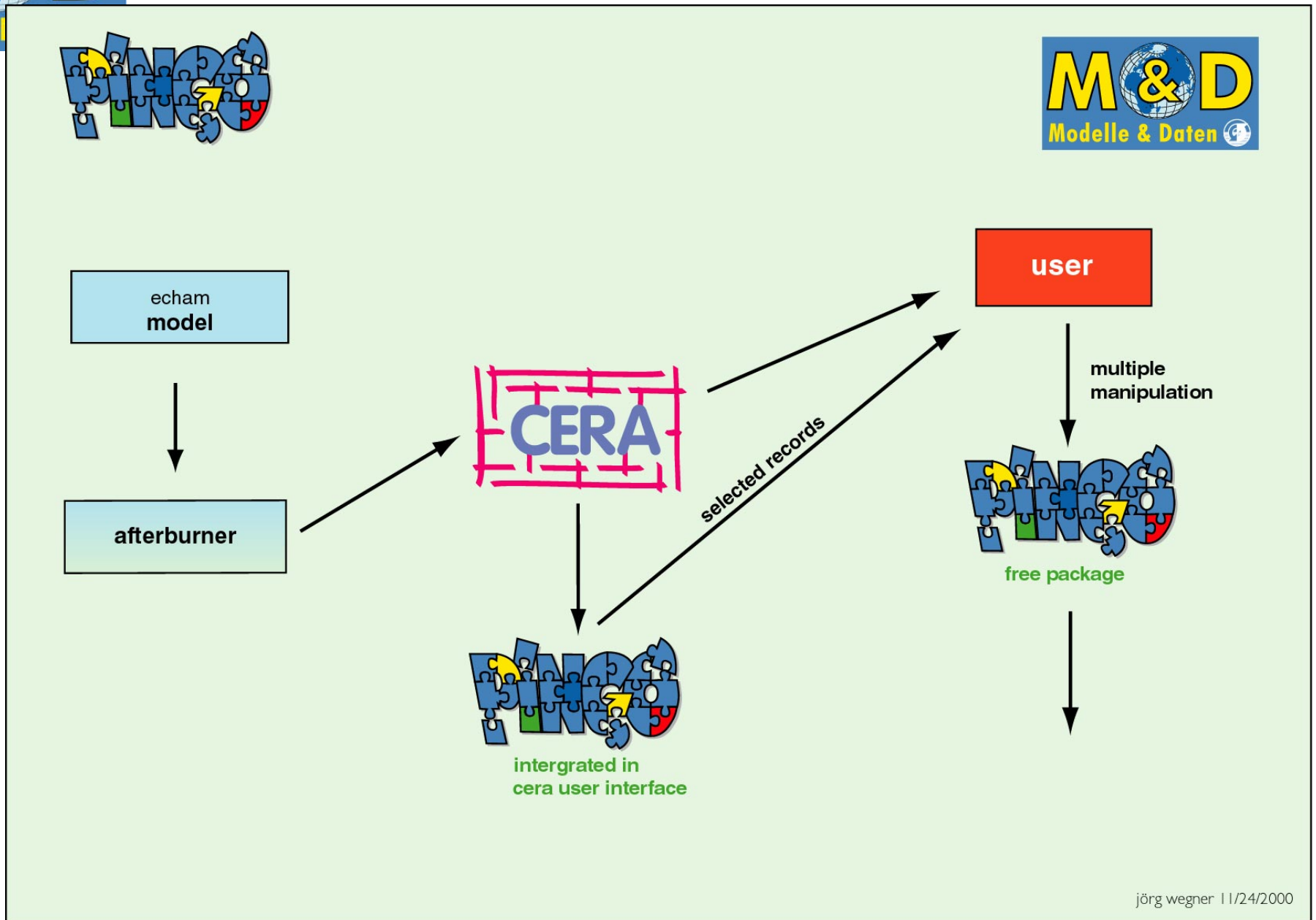
Processed climate  
model data  
(appr. 250 data tables  
per model experiment)



# CERA Data Processing

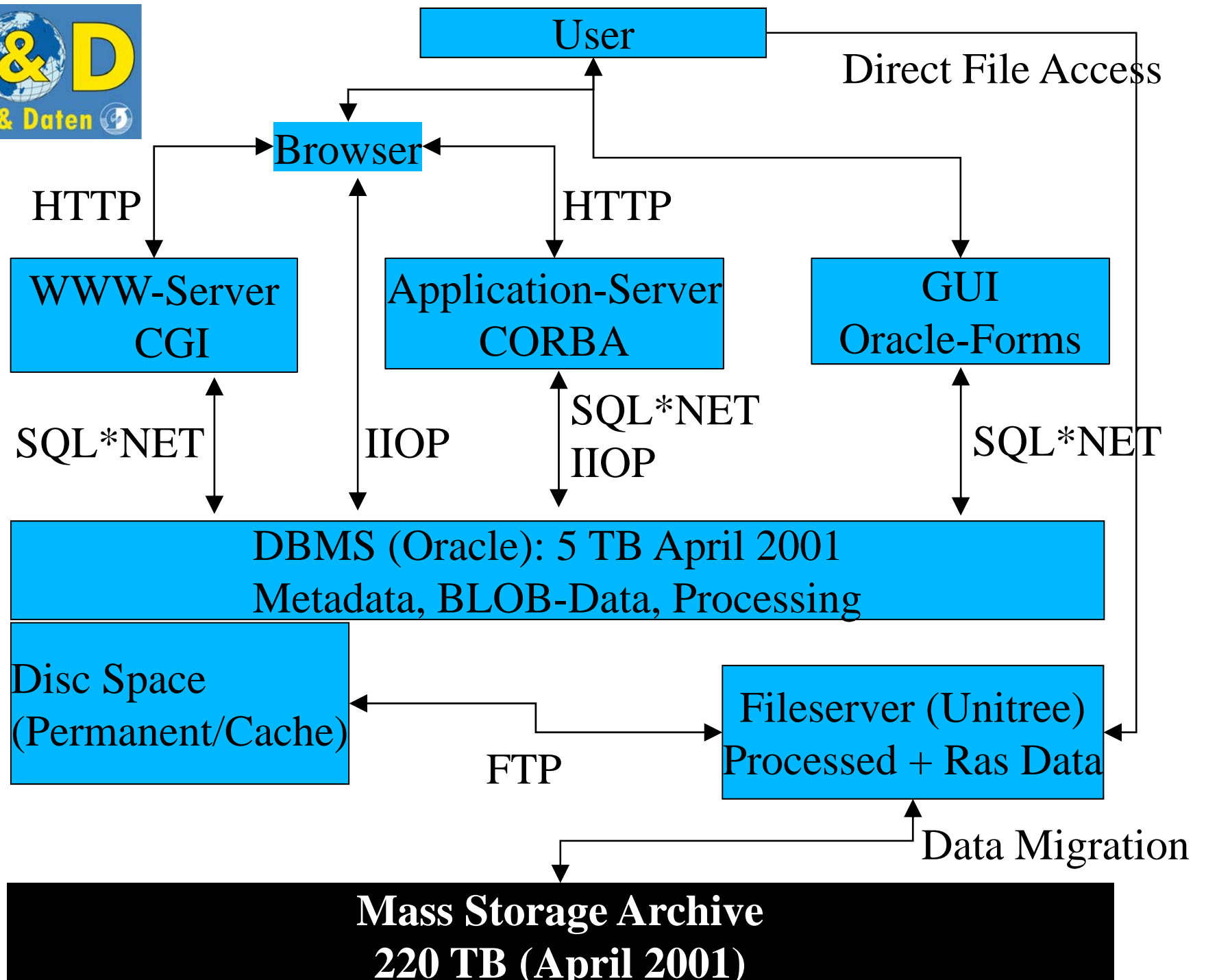


# CERA Data Processing



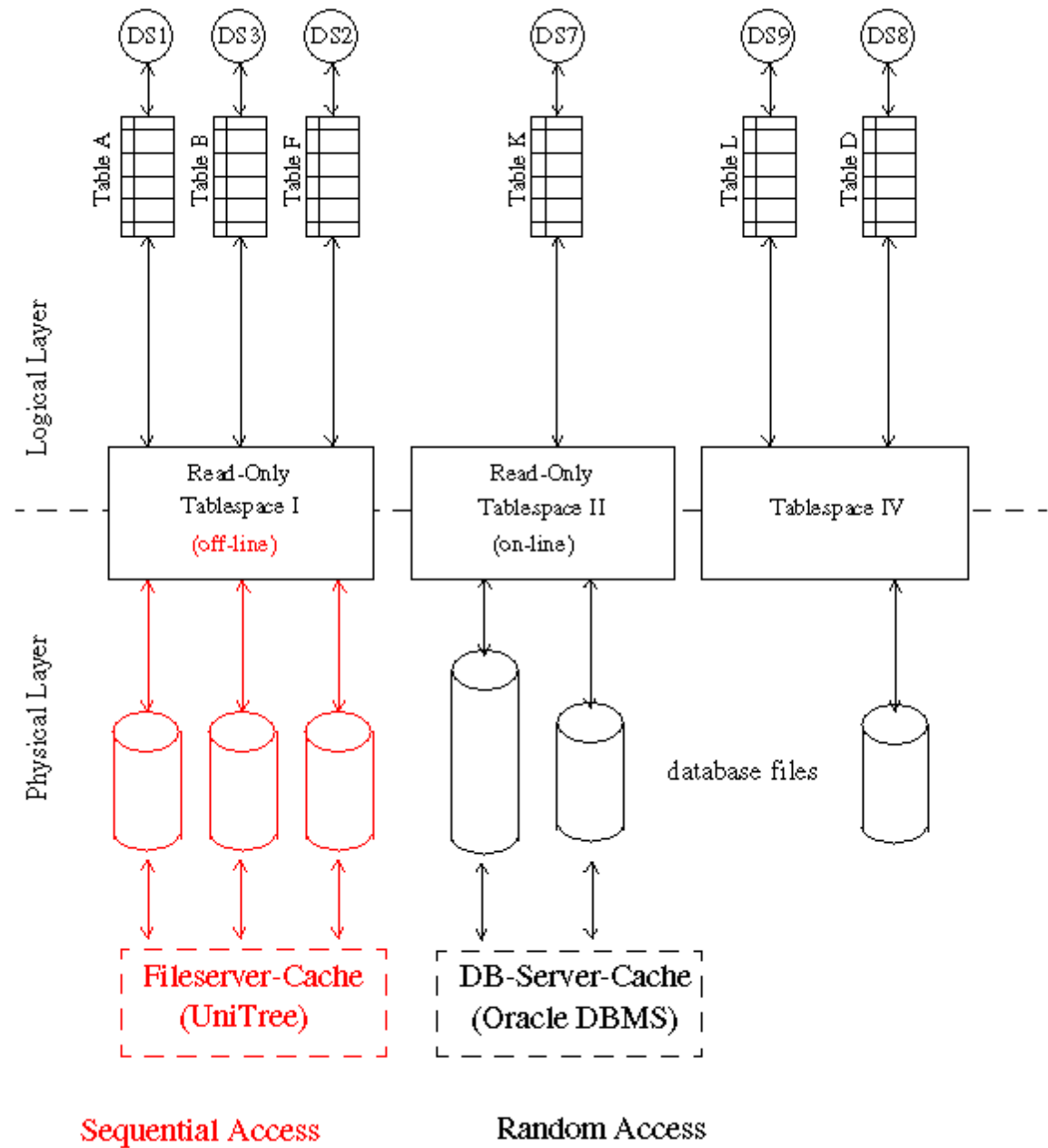
jörg wegner | 1/24/2000



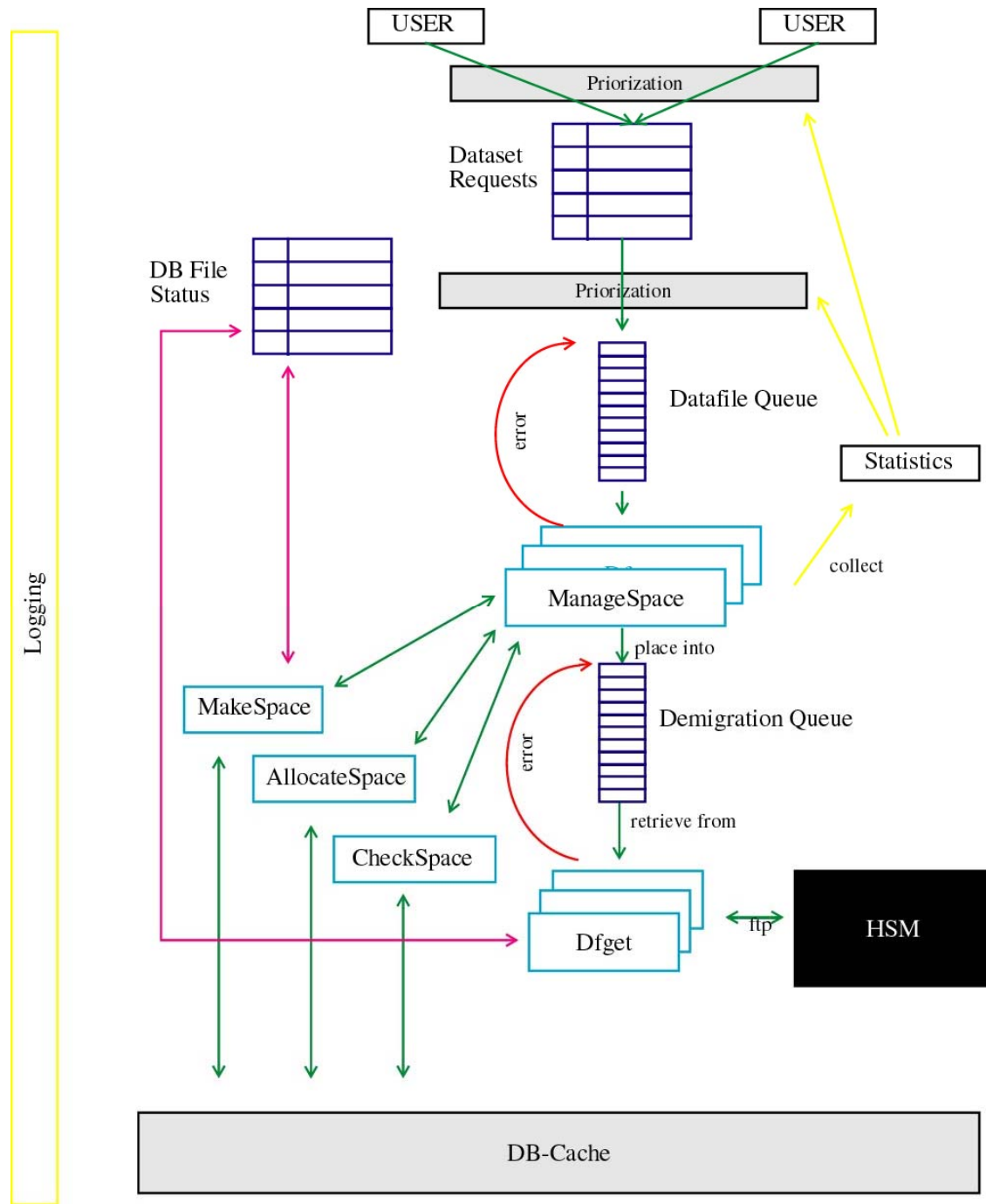


# Tertiary Storage Connection

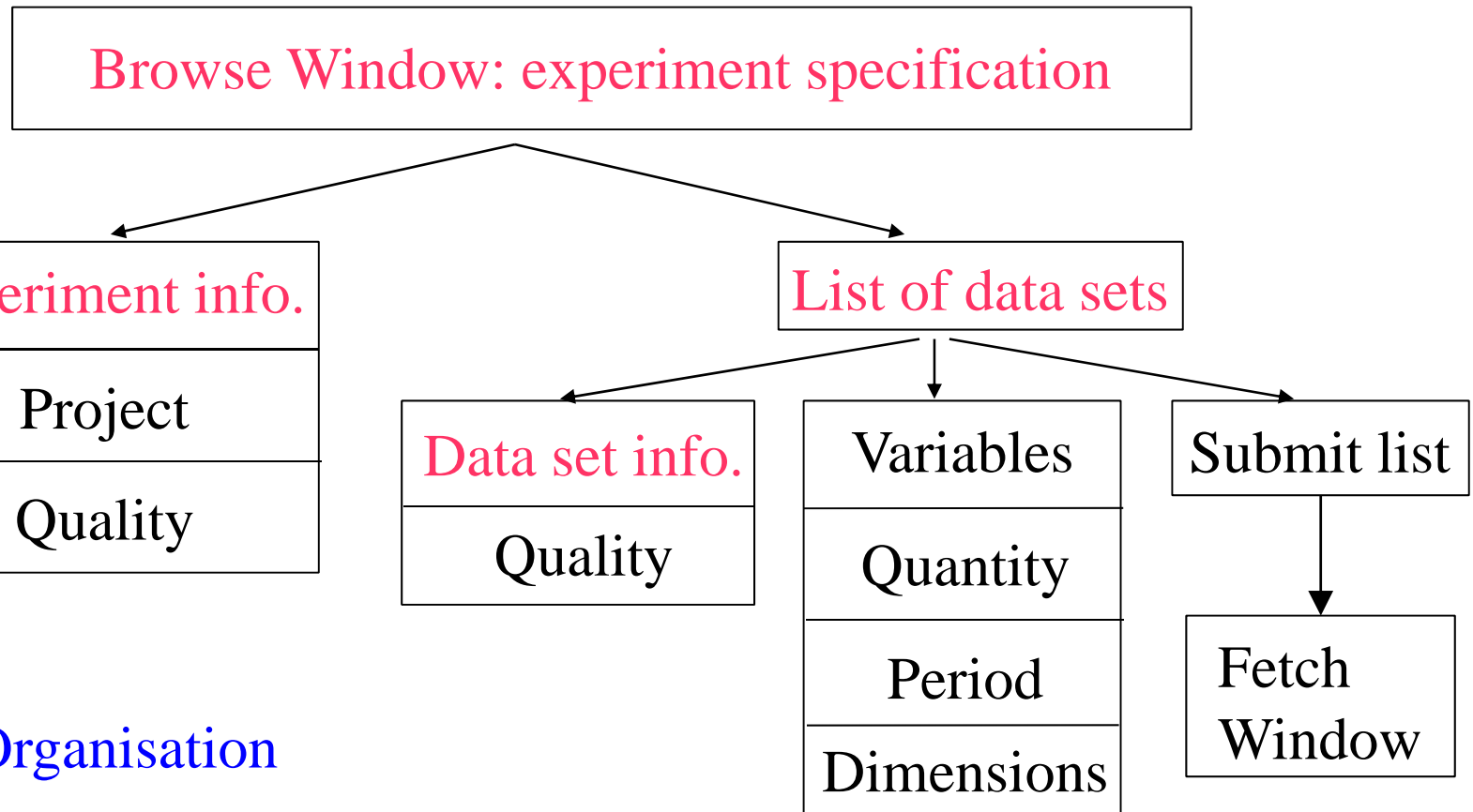
**CERA DB Status 11.04.00:**  
*Current size: 5.2628 Terabyte*  
*Number of experiments: 113*  
*Number of datasets: 10309*



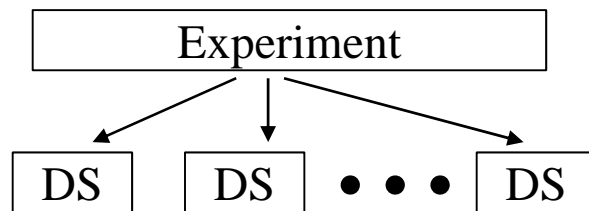
# Tertiary Storage Connection: Oracle process structure



# Java-based User Interface



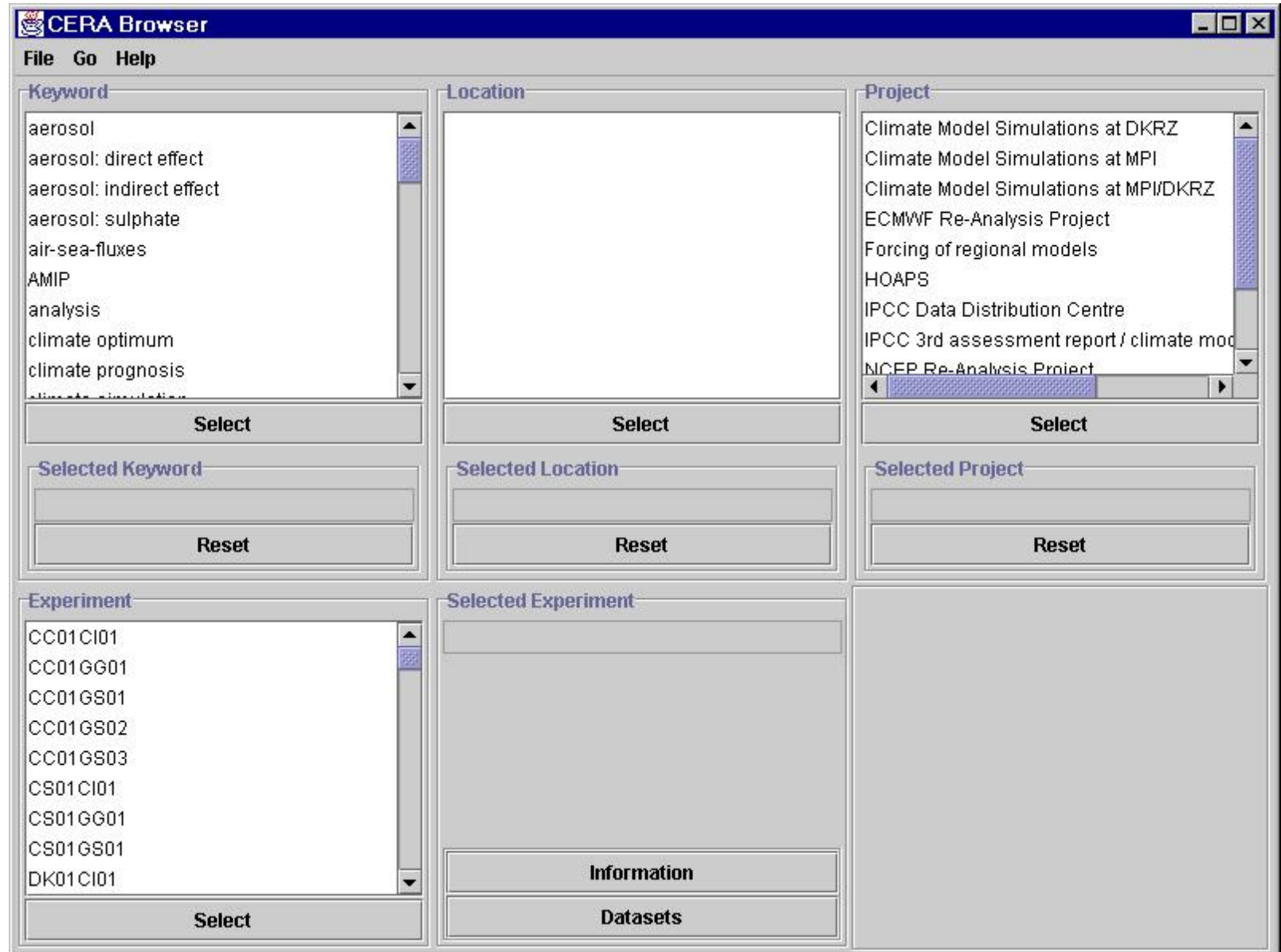
## Data Organisation



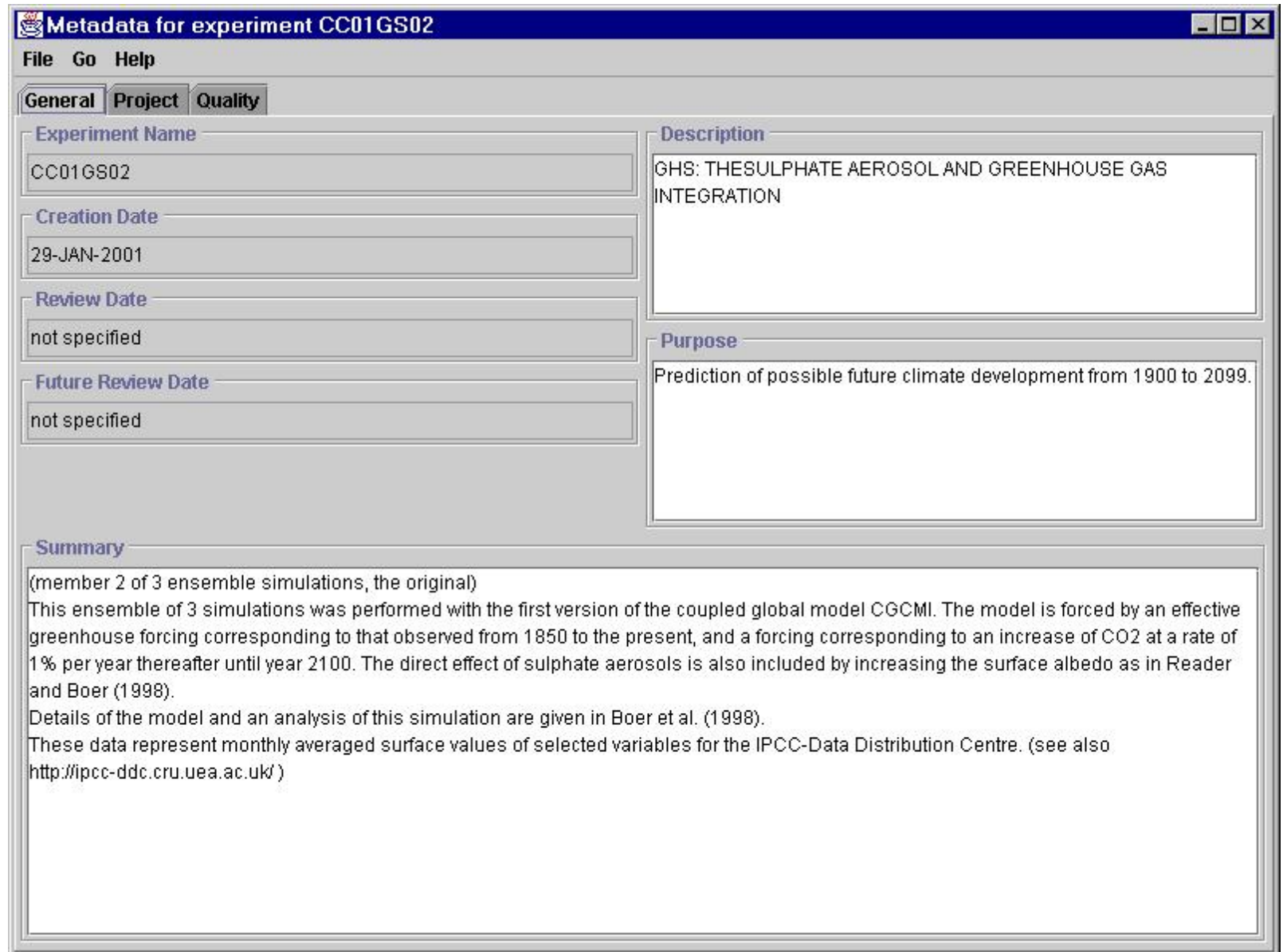
Red mark: more general information

# Java-based User Interface

"Browse"  
window to  
select an  
experiment



## Experiment information



Metadata for experiment CC01GS02

File Go Help

General Project Quality

Experiment Name  
CC01GS02

Creation Date  
29-JAN-2001

Review Date  
not specified

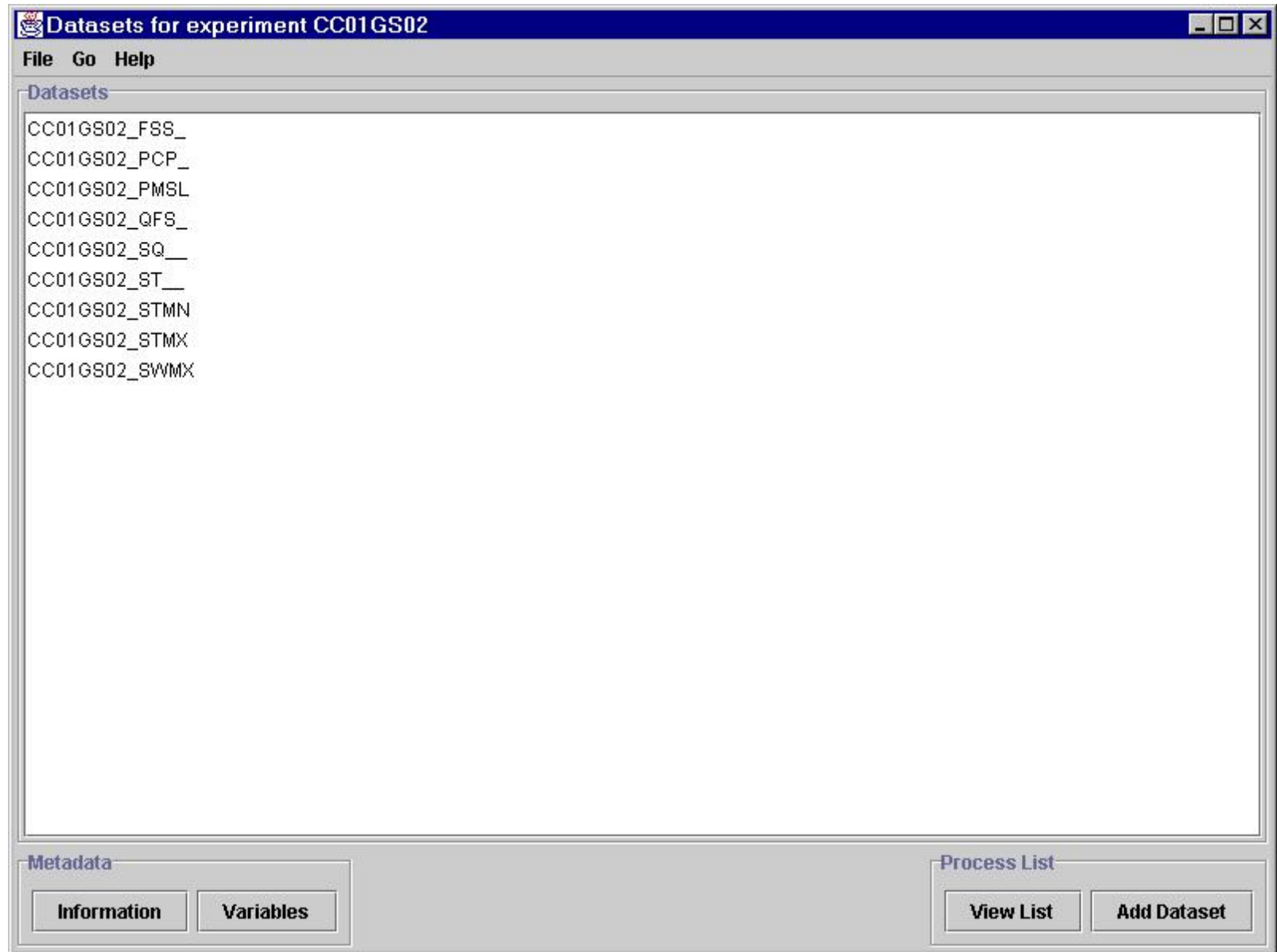
Future Review Date  
not specified

Description  
GHS: THESULPHATE AEROSOL AND GREENHOUSE GAS INTEGRATION

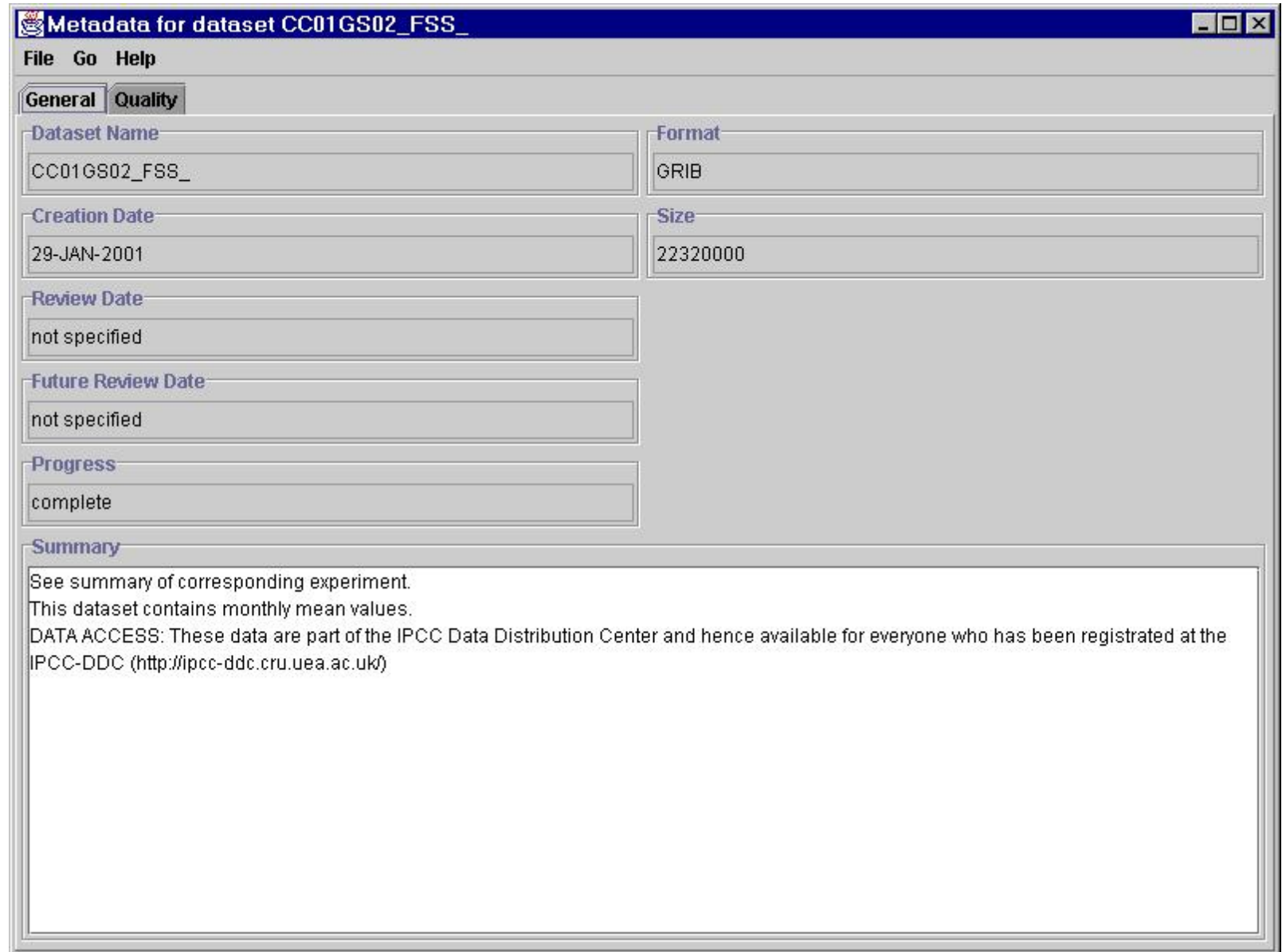
Purpose  
Prediction of possible future climate development from 1900 to 2099.

Summary  
(member 2 of 3 ensemble simulations, the original)  
This ensemble of 3 simulations was performed with the first version of the coupled global model CGCM1. The model is forced by an effective greenhouse forcing corresponding to that observed from 1850 to the present, and a forcing corresponding to an increase of CO<sub>2</sub> at a rate of 1 % per year thereafter until year 2100. The direct effect of sulphate aerosols is also included by increasing the surface albedo as in Reader and Boer (1998).  
Details of the model and an analysis of this simulation are given in Boer et al. (1998).  
These data represent monthly averaged surface values of selected variables for the IPCC-Data Distribution Centre. (see also <http://ipcc-ddc.cru.uea.ac.uk/>)

List of datasets  
of an  
experiment



## Dataset information



The screenshot shows a window titled "Metadata for dataset CC01GS02\_FSS\_". It features a menu bar with "File", "Go", and "Help". Below the menu are two tabs: "General" (selected) and "Quality". The "General" tab contains several fields:

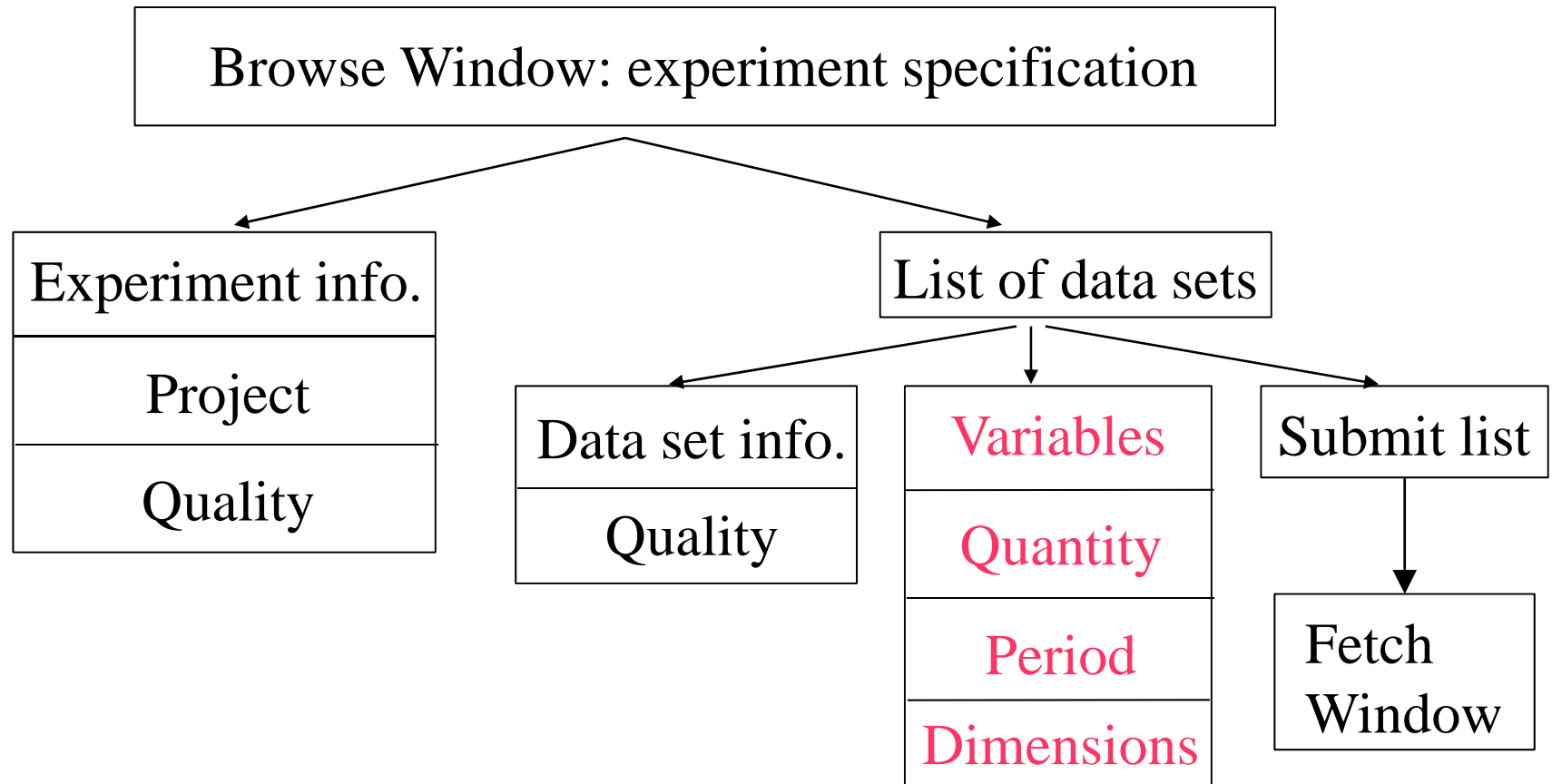
<b>Dataset Name</b> CC01GS02_FSS_	<b>Format</b> GRIB
<b>Creation Date</b> 29-JAN-2001	<b>Size</b> 22320000
<b>Review Date</b> not specified	
<b>Future Review Date</b> not specified	
<b>Progress</b> complete	

At the bottom, there is a "Summary" section with the following text:

See summary of corresponding experiment.  
This dataset contains monthly mean values.  
DATA ACCESS: These data are part of the IPCC Data Distribution Center and hence available for everyone who has been registered at the IPCC-DDC (<http://ipcc-ddc.cru.uea.ac.uk/>)



# Java-based User Interface



Red mark: specific dataset information

# Java-based User Interface

Variables of dataset CC01GS02\_FSS\_

File Go Help

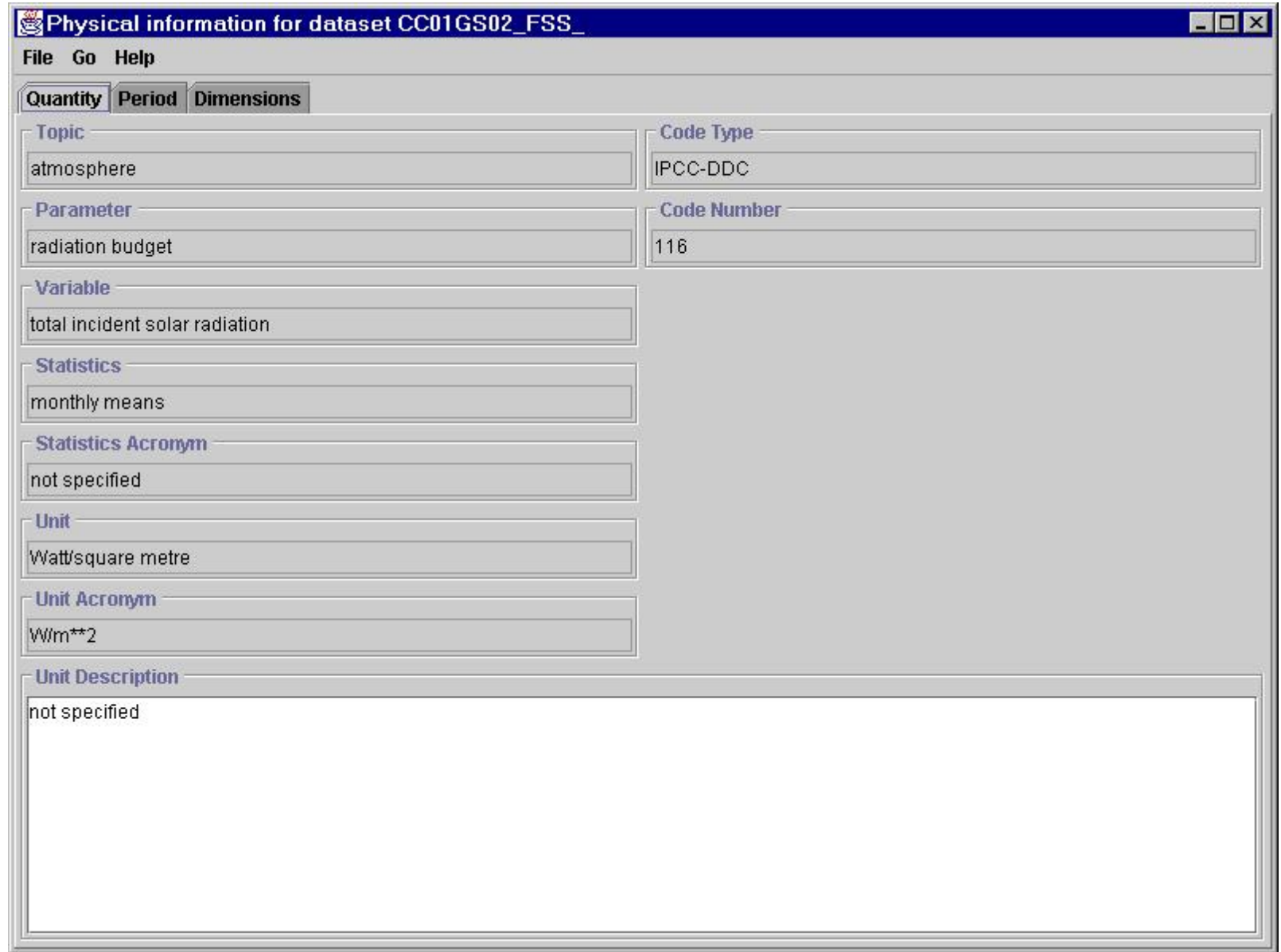
Topic	Parameter	Variable	Ref. Method	Access Type
atmosphere	radiation budget	total incident solar radiation	RASTER	internal stored level data

Metadata

Quantities

Variables of dataset

Quantity  
information  
of one DS  
variable



Physical information for dataset CC01GS02\_FSS\_

File Go Help

Quantity Period Dimensions

Topic  
atmosphere

Code Type  
IPCC-DDC

Parameter  
radiation budget

Code Number  
116

Variable  
total incident solar radiation

Statistics  
monthly means

Statistics Acronym  
not specified

Unit  
Watt/square metre

Unit Acronym  
W/m\*\*2

Unit Description  
not specified

# Java-based User Interface

Period  
information  
of one DS  
variable

Physical information for dataset CC01GS02\_FSS\_

File Go Help

Quantity **Period** Dimensions

**Periods**

Period 1/1

	Start	Increment
Year	1900	0
Month	1	1
Day	1	0
Hour	0	0
Minute	0	0
Second	0	0
Period Length	2400	

**Days per month**

January	31
February	28
March	31
April	30
May	31
June	30
July	31
August	31
September	30
October	31
November	30
December	31

**Additional information**

REAL TIME

**UTC reference time**

Years	0
Months	0
Days	0
Hours	0
Minutes	0
Seconds	0

**Additional information**

not specified

Dimensions  
information  
of one DS  
variable

Physical information for dataset CC01GS02\_FSS\_

File Go Help

Quantity Period **Dimensions**

**1st dimension**

Name of axis: x

Unit: DEGREE

Increment: 3,75

Length of axis: 96

Grid type: regular

**Grid**

Position	Value
1	0

**2nd dimension**

Name of axis: y

Unit: DEGREE

Increment: 0

Length of axis: 48

Grid type: irregular rectangular

**Grid**

Position	Value
1	-87,1591
2	-83,4789
3	-79,777
4	-76,0702
5	-72,3616
6	-68,652
7	-64,9419
8	-61,2316
9	-57,521
10	-53,8103
11	-50,0995
12	-46,3886
13	-42,6776
14	-38,9666
15	-35,2556
16	-31,5445

**3rd dimension**

Name of axis: z

Unit: m

Increment: 0

Length of axis: 1

Grid type: regular

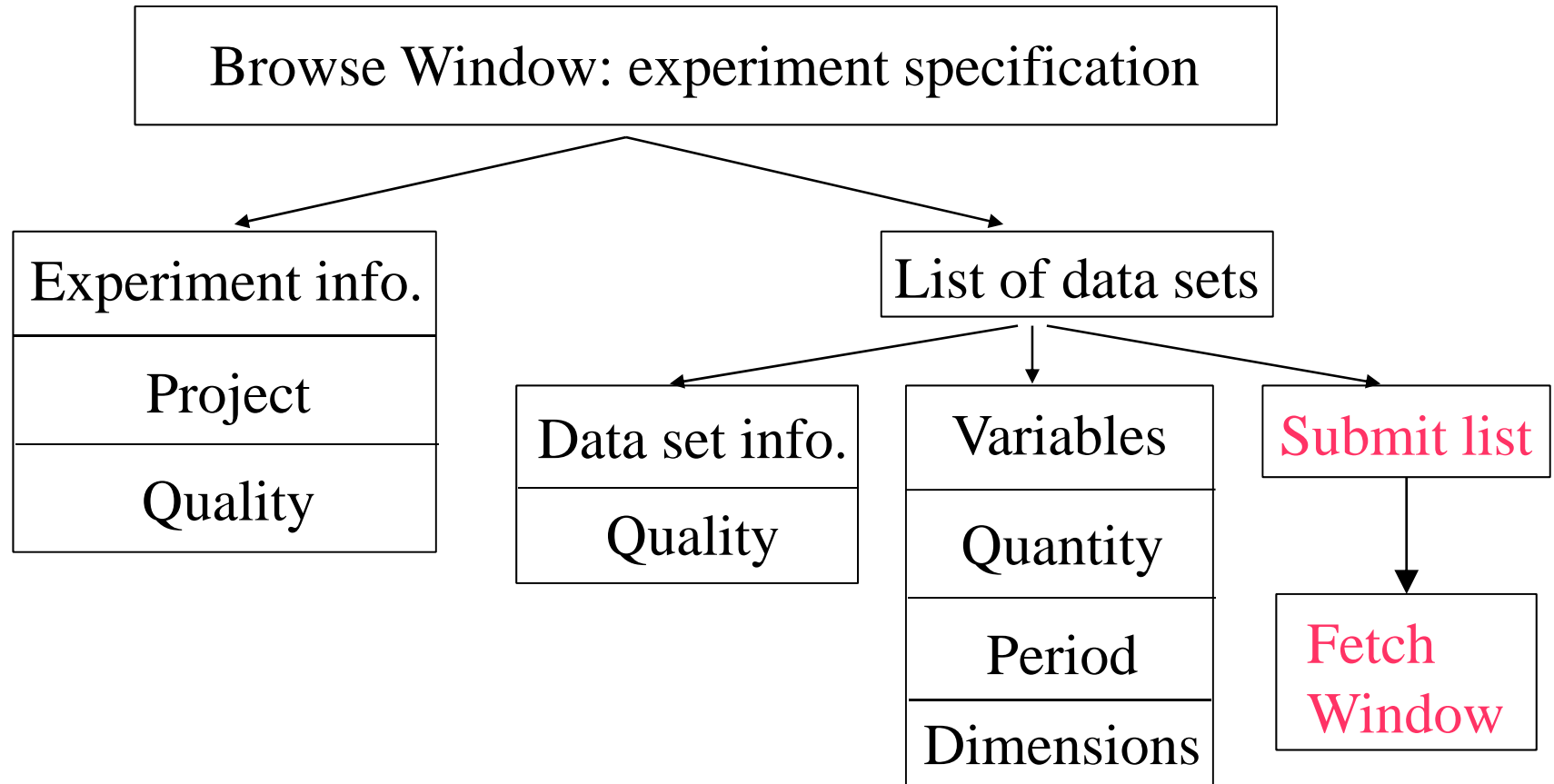
**Grid**

Position	Value
1	0

**Dependence of 3rd dimension**: no dependence

**Description**: horizontal field first vary x then y

# Java-based User Interface



Red mark: enabling retrieval and processing

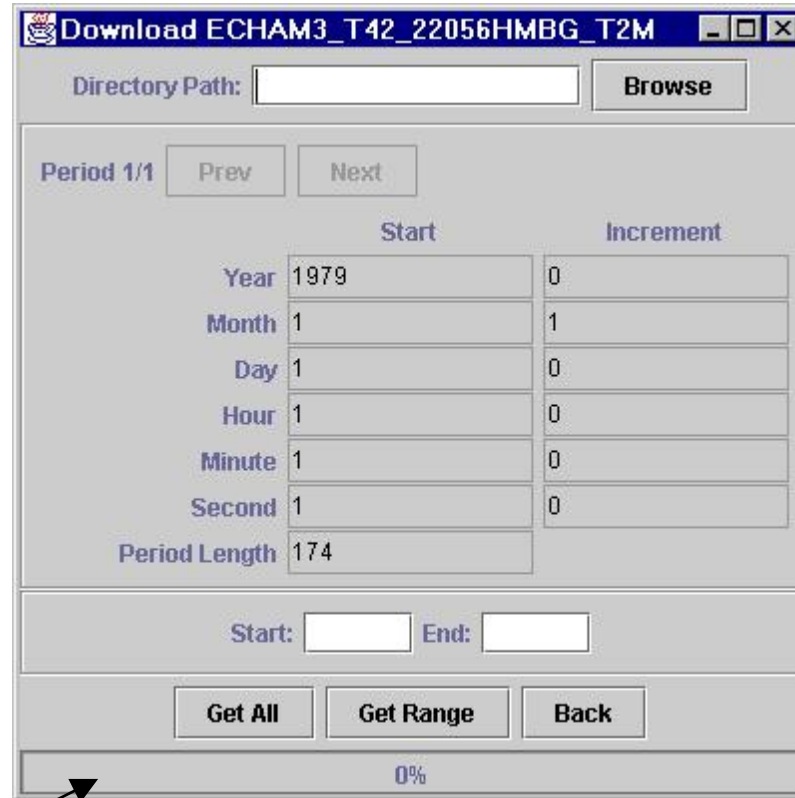
Personalised  
submit list  
of datasets

Submit List				
File Go Help				
Dataset	Size	Status	Request ID	Submit Date
HOAPS_SFCLATE05MONTHLY	58060800	TAPE	16395	05-APR-2001 13:22:32
CC01GS01_FSS_	22320000	TAPE	16275	04-APR-2001 16:13:23
EH4OPYC_71413CTL_U100	3682760400	TAPE	15615	15-MÄR-2001 15:34:03
ECHAM3_T42_22056HMBG_T2M	2864736	DISK	15116	15-FEB-2001 11:31:10
DK01CI01_APRT	12038400	TAPE	15115	15-FEB-2001 11:14:56
EH4OPYC_71413CTL_ALBEDO	3682760400	TAPE	15095	14-FEB-2001 11:46:34
CS01CI01_RSNS	19145280	TAPE	14924	07-FEB-2001 15:47:52
CS01GG01_TMIN	19145280	TAPE	14921	07-FEB-2001 15:47:33
ECHAM3_T42_23103AMIP_GPM300	672336	TAPE	14875	07-FEB-2001 09:04:31
HOAPS_SFCEVAP05DAILY_ASC	1768089600	TAPE	14856	06-FEB-2001 15:07:15
NI01CI01_WNDS	10533600	TAPE	14836	06-FEB-2001 11:12:33
CC01GG01_STMN	22320000	TAPE	14815	02-FEB-2001 15:06:48
HC01GS14_TMAK	18612000	TAPE	14778	01-FEB-2001 13:04:00
ERA15_GGFULLFC00_6H_198701	971617128	TAPE	14777	01-FEB-2001 12:53:23
CC01GG01_PCP_	22320000	TAPE	14776	01-FEB-2001 12:48:57
GF01CI01_SWBO	47088000	TAPE	14712	25-JAN-2001 14:45:34
HC01GG04_TMAK	40608000	TAPE	14575	15-JAN-2001 16:26:54
DK01GG01_MSLP	10282800	TAPE	14574	15-JAN-2001 16:26:29

Entry		Information	
<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Dataset"/>	<input type="button" value="Experiment"/>
Dataset			
<input type="button" value="Fetch"/>	<input type="button" value="Process"/>		

Fetch window for one dataset which allows for the extraction of sub-periods



	Start	Increment
Year	1979	0
Month	1	1
Day	1	0
Hour	1	0
Minute	1	0
Second	1	0
Period Length	174	

Control of data transfer