



Long-term Archiving of Climate Model Data at WDC Climate and DKRZ

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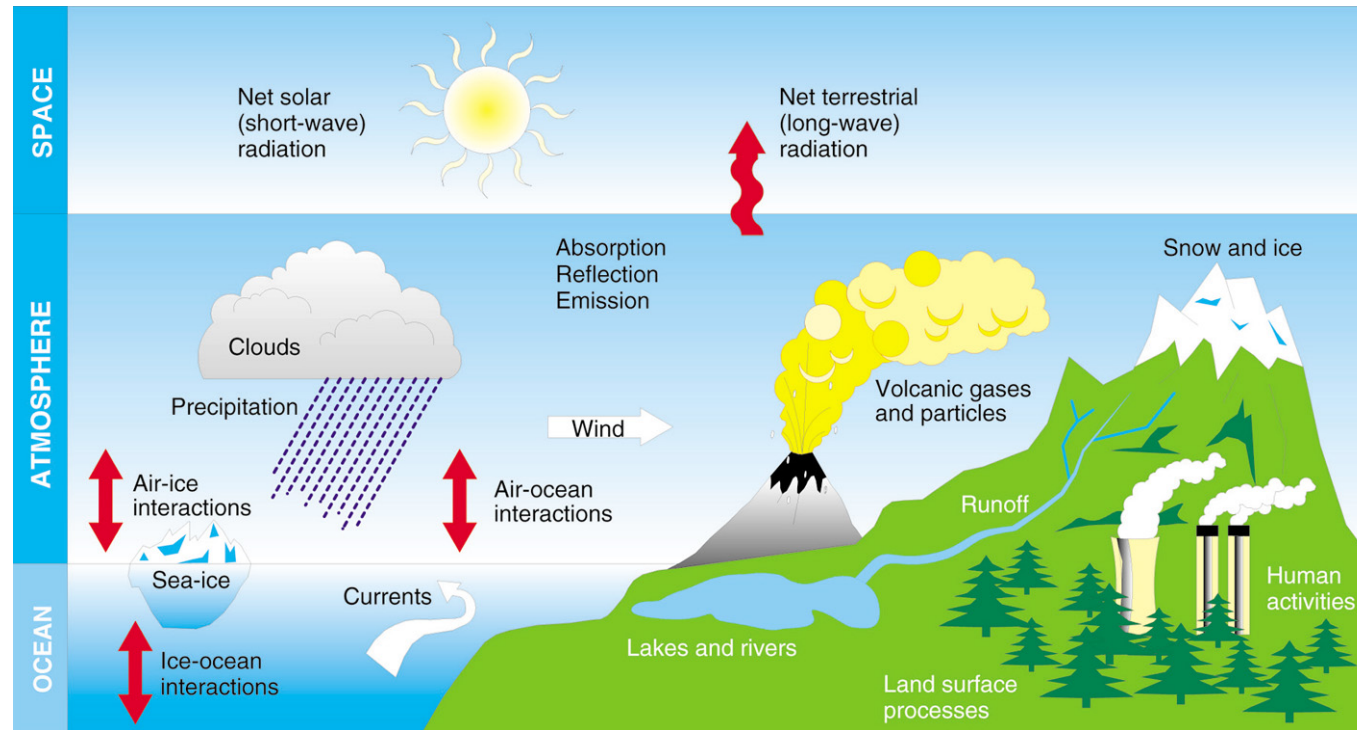
Next generation of compute server and of climate models leads to a problem at DKRZ:

Data production increase with implications for long-term archiving

What is the problem?

What could be the solution?

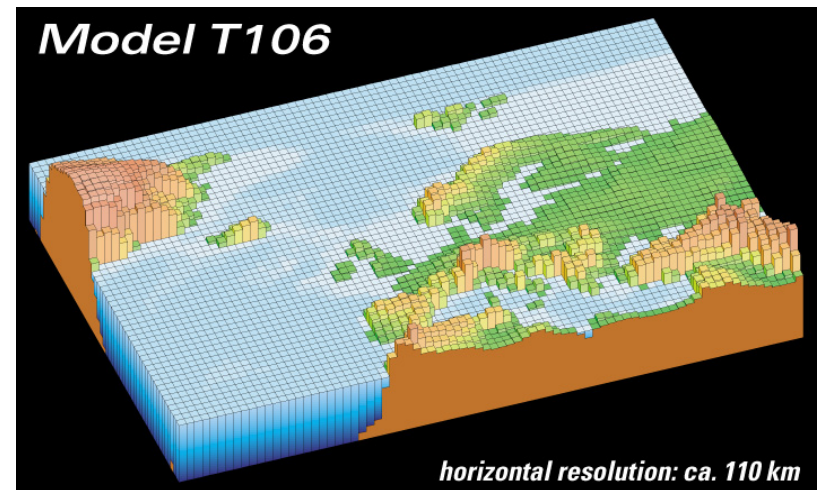
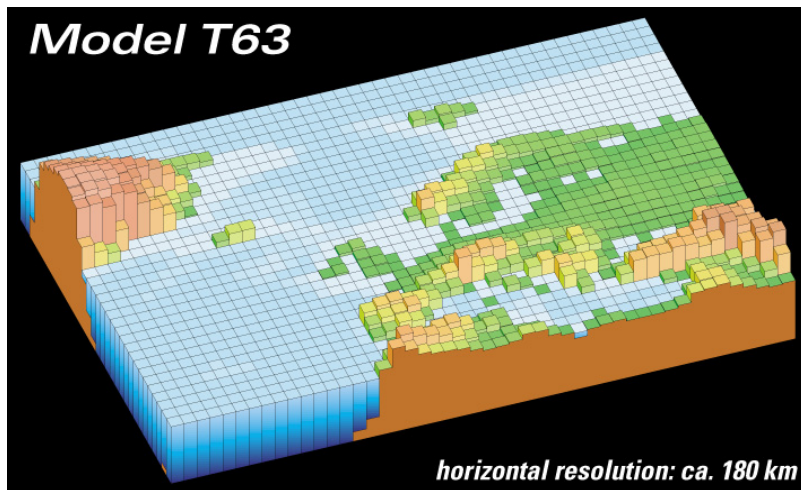
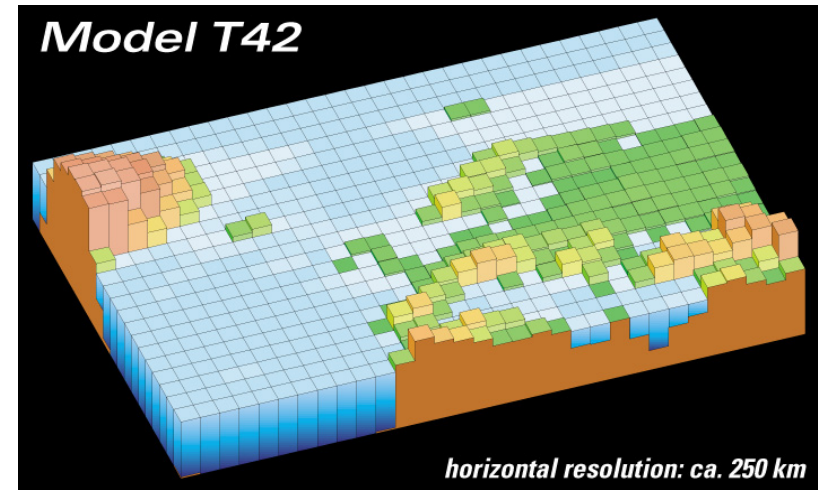
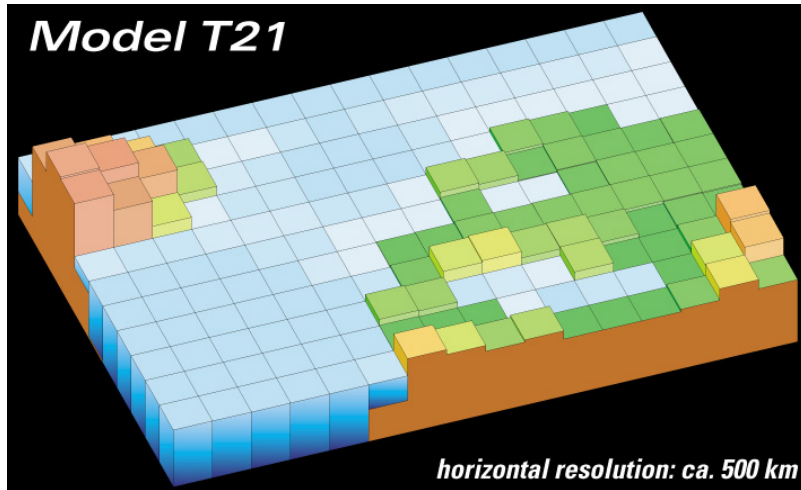




Increase in installed compute power motivates

- finer spatial and temporal model resolution and
- integration of additional physical and chemical processes into climate models.





- Finer spatial (+ temporal) model resolution or
- Execution of climate model ensemble runs



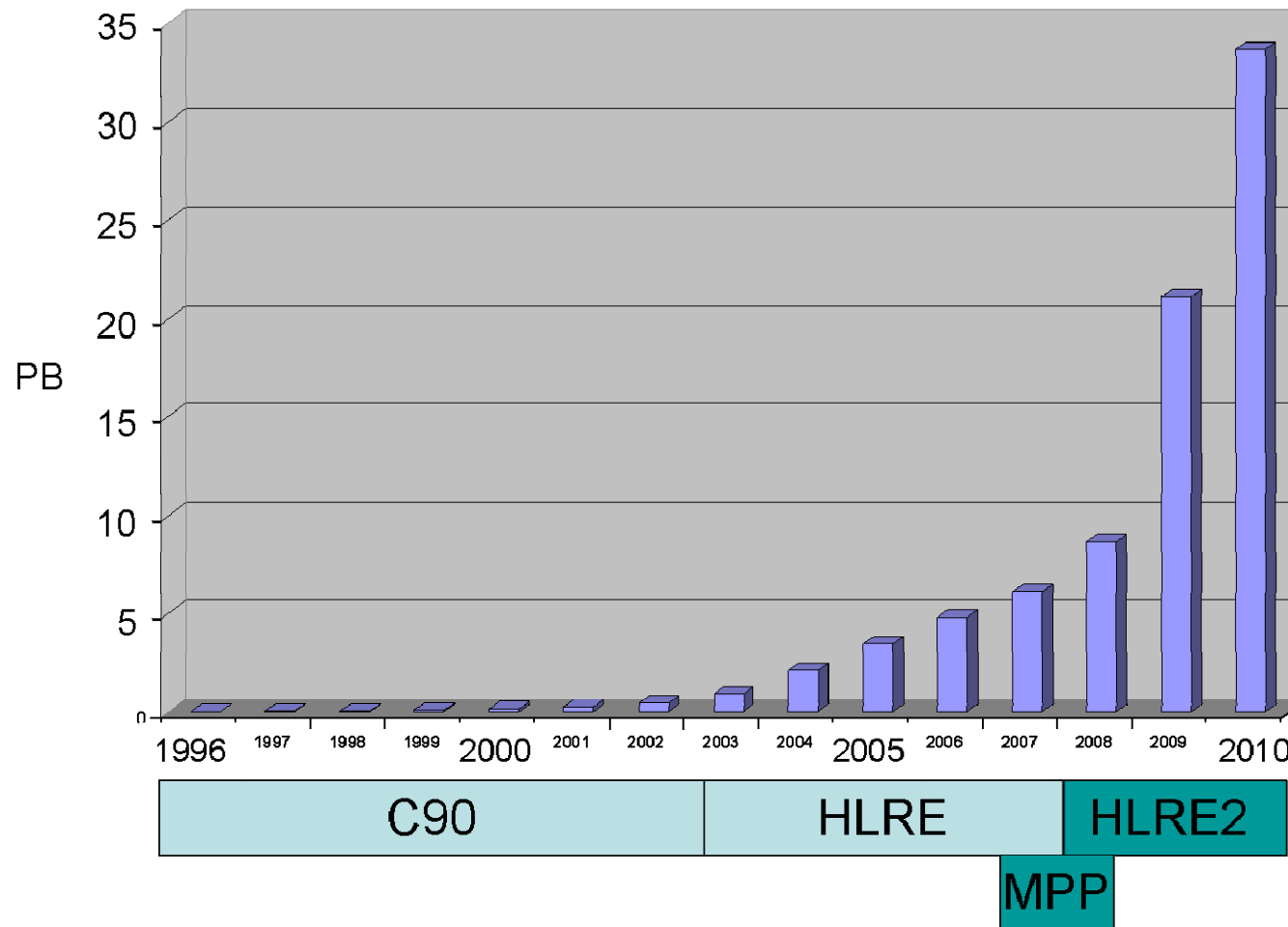


- Experience at DKRZ: **Linear increase in data production** with installed compute power
- Previous data storage strategy: **all data migrated to the long-term mass storage archive** (that means archive increase follows directly the compute power increase)
- Resulting problem: Since the total amount of money for investment and for operations is fixed the **cost relation** between compute service and data service **shifts towards data service** while reducing the compute service fraction
- Example: **archive increase and explosion of media costs** with next generation of compute services assuming $10 * \text{HLRE}$





Data Archive at DKRZ



Extrapolated HLRE2 linear archive increase (**10 times HLRE**)

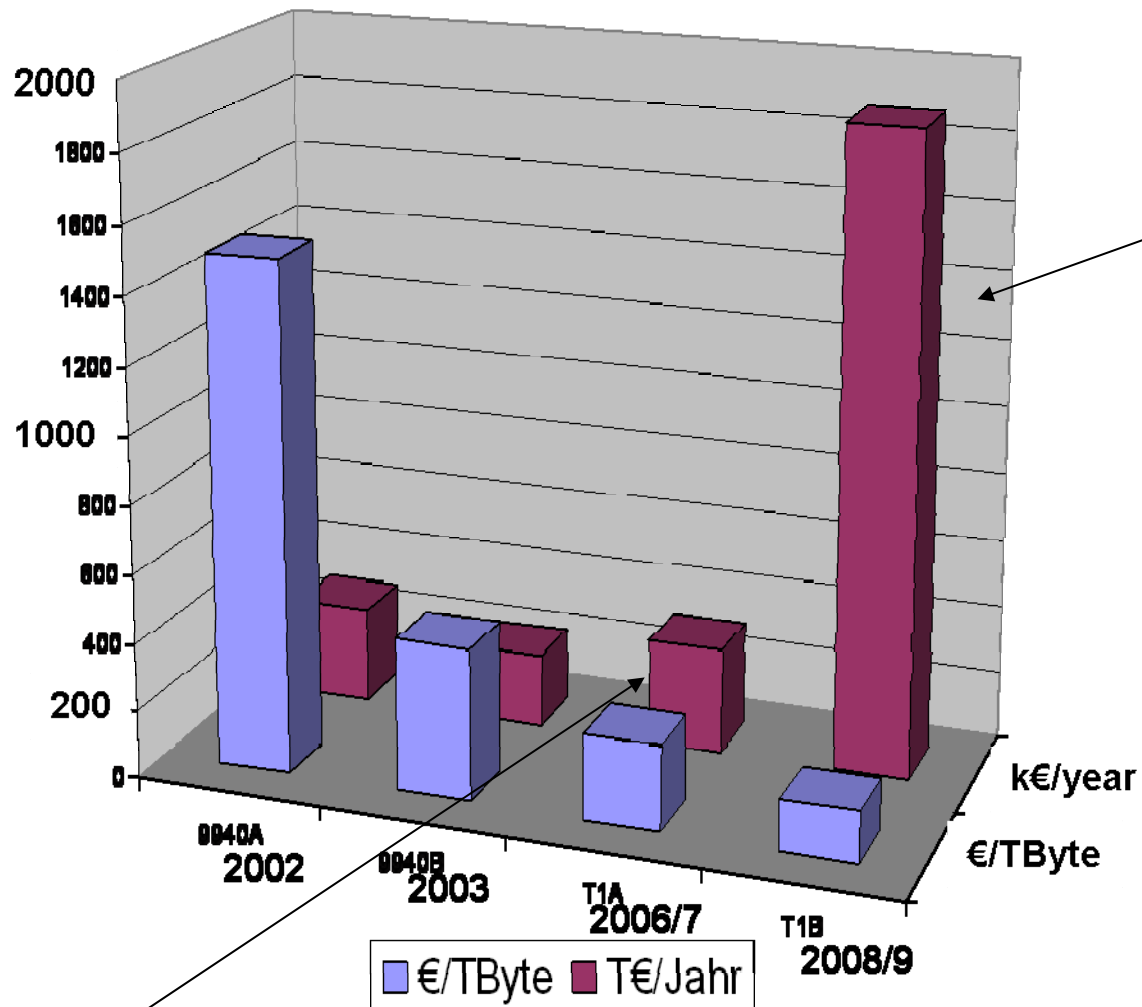
Compute server architectures:

C90: Cray C90 / HLRE: NEC SX-6 / MPP: SUN-Cluster / HLRE2: new system

(HLRE: Höchstleistungsrechnersystem für die Erdsystemforschung)



Development of media costs vs. total costs per year (Feb. 2007)



Not accepted projection

Discussion about total media costs starts

What could be the solution for mass storage cost balancing?



- **Data classes**

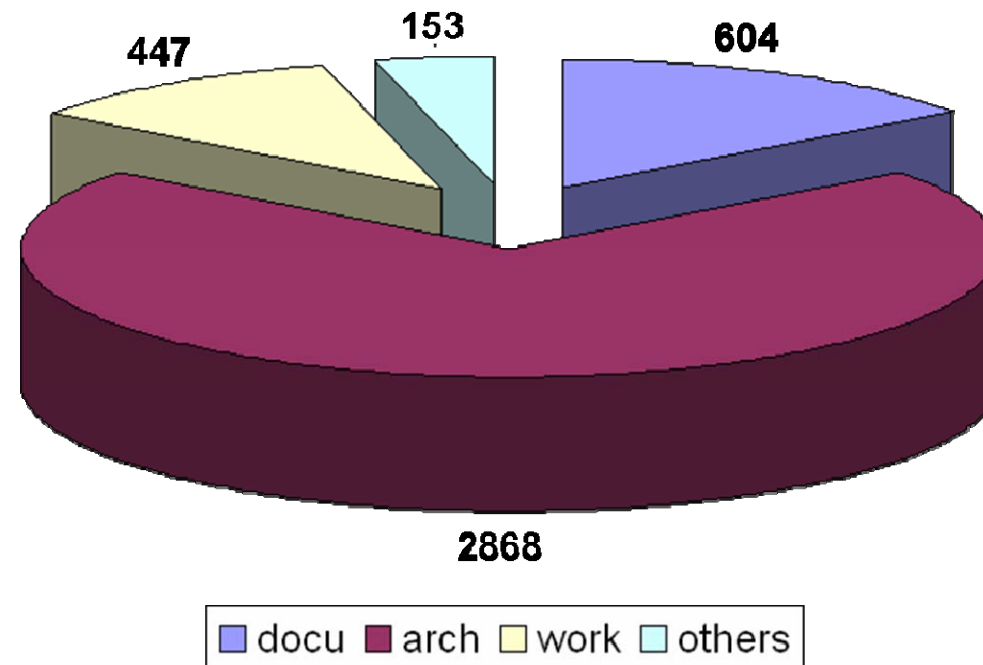
- **Test data** from model code development, life cycle: weeks to months
- **Project data** from scientific model evaluation and research projects (DKRZ resources at project level), life cycle: 3 – 5 years
- **Final results** as data products for international projects (IPCC) and scientific publications, life cycle: 10 years and longer

- **Data hierarchy levels**

- **Temp(orary)**
scratch discs at compute server
- **Work**
fixed disc space at project level for evaluation
- **Arch(ive)**
tape storage space (single copy) with expiration date for project data beyond available disc space
- **Docu(mentation)**
documented, long-term tape archive (security copy) for data products, focus on interdisciplinary data utilisation, data are fixed and no longer matter of change



Archive Classes at DKRZ (in Tbyte)

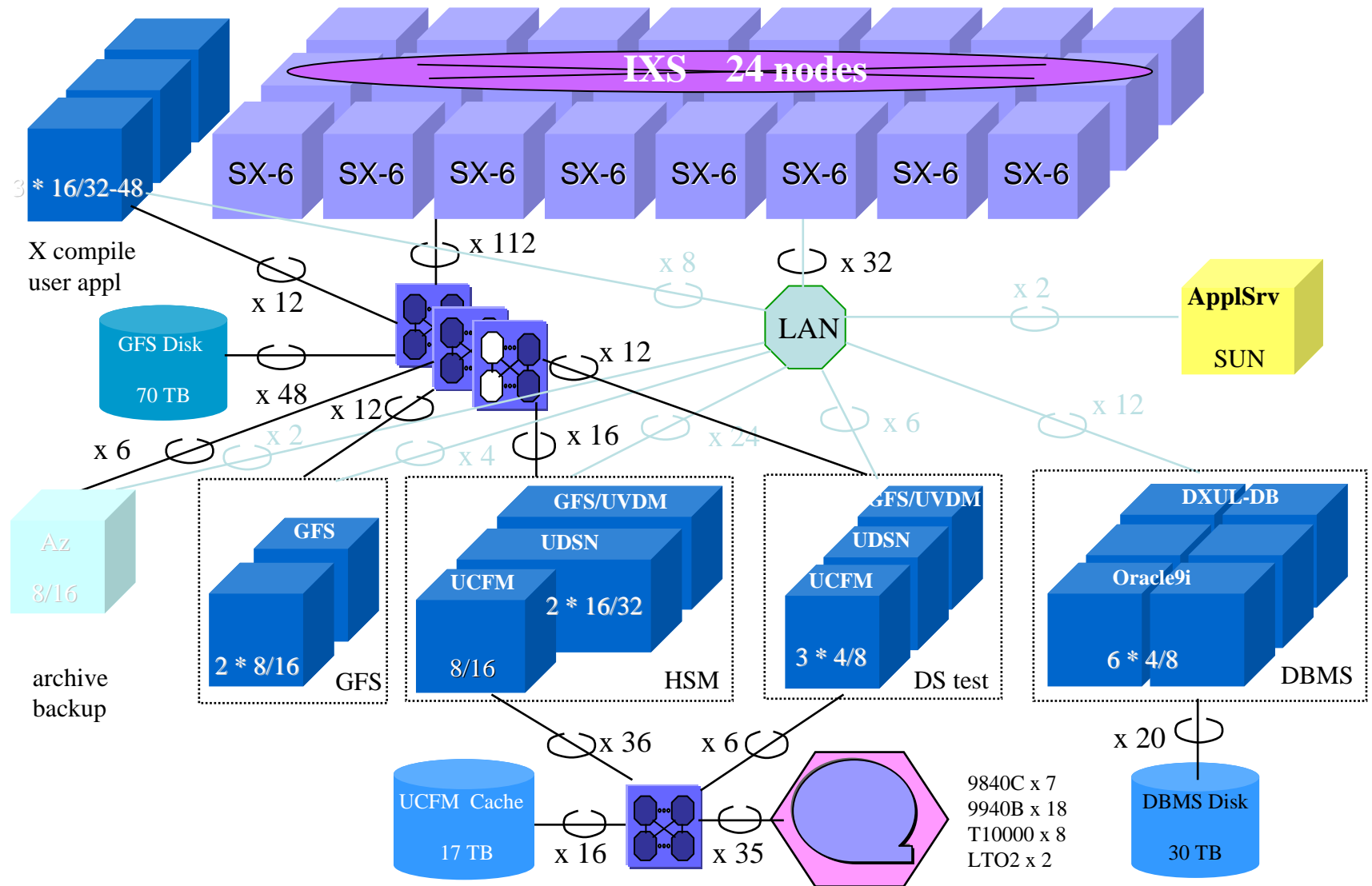


Tape space distributon to archive classes at DKRZ begin of 2007:

- part of the “work” space on tape because GFS too small
- “docu” domain consists of WDCC
- no expiration dates in “arch” domain, parts of “arch” domain belongs to “docu” but not yet documented



HLRE System architecture at DKRZ





- Project based data storage strategy and resource assignment at DKRZ:
 - **Separation** of project data and long-term archive
 - **Expiration date** for project data
 - **Aware, scientific decision** to move data into the long-term archive
 - **Data documentation** requirements for long-term archive
 - Long-term data archive (“docu” hierarchy level) accomplishes the **rules for good scientific practice**





- Data documentation requirements are accomplished by using the WDCC infrastructure
 - CERA-2 metadata model developed in 1999
 - ◆ Catalogue interface: cera.wdc-climate.de
 - ◆ Input interface: input.wdc-climate.de
 - CERA-2 metadata content is **complete with respect to browse, to discover and to use climate data** which are stored in the database system or outside in flat files
 - The WDCC matches international description standards like **ISO 19115, Dublin Core or GCMD** and is integrated in international data federations
 - Data storage structure assembles storage of climate time series per variable in **BLOB data tables**. This allows for web-based data catalogue search and data access in **small data granules**.





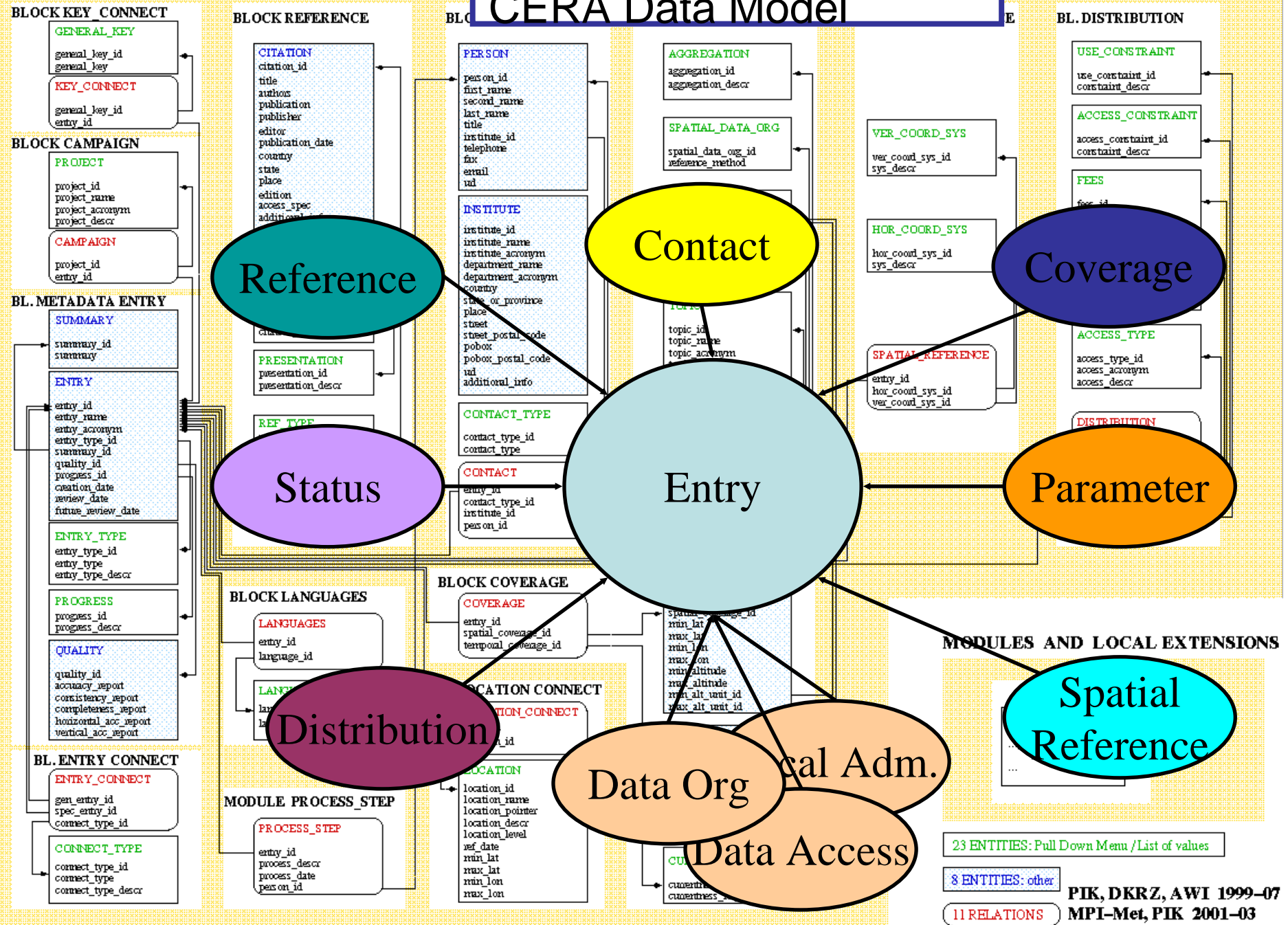
WDCC / CERA: General Statistics at 01-06-2008 00:00:10

- Database Size (TByte): 357
- Number of blobs: 6242417840 (6.2 billion)
- Number of experiments: 1081
- Number of datasets: 136606
- Total size divided by number of BLOBs gives the average size of data access granules: 60 kB/BLOB



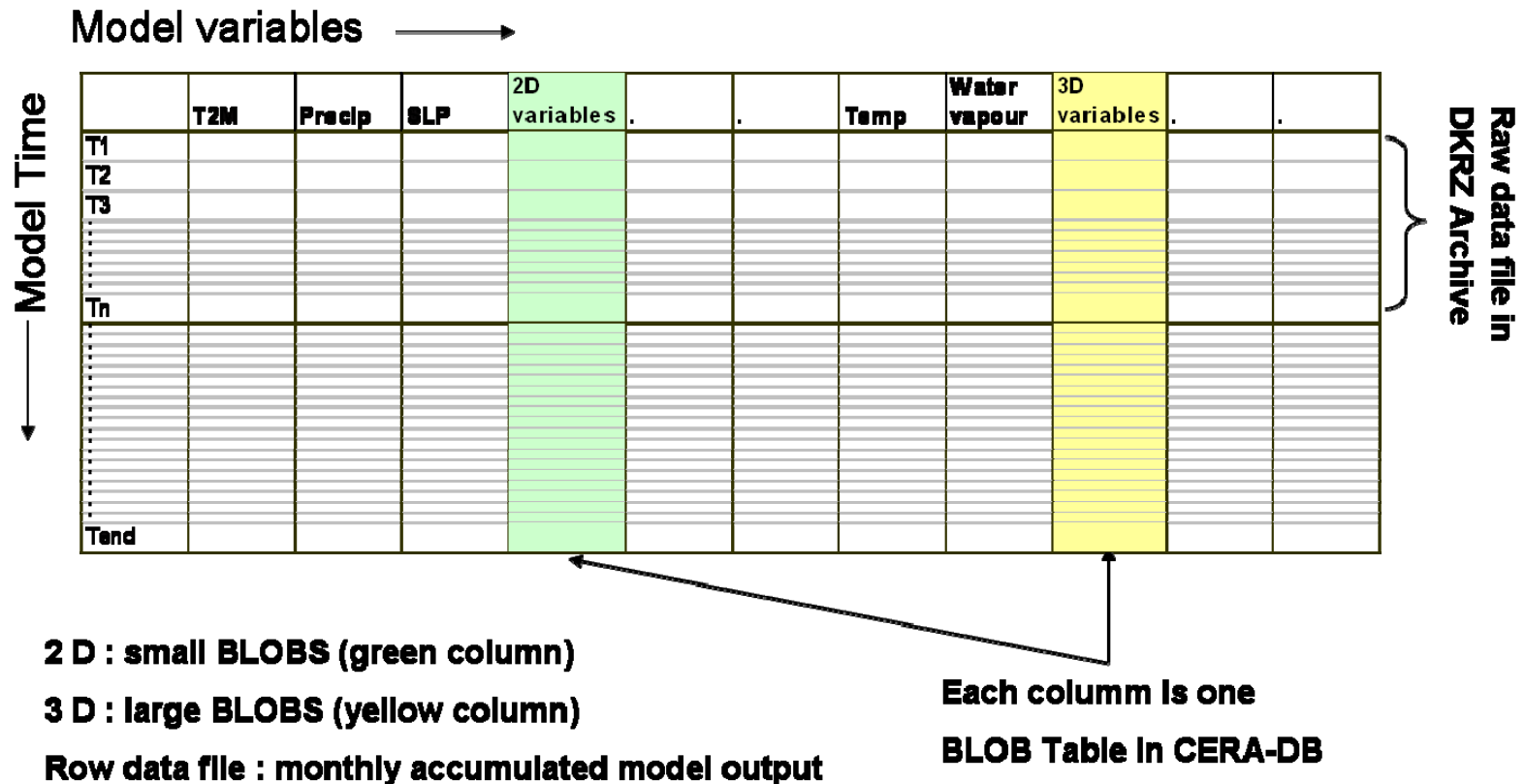
CERA SCHEME 2.5

CERA Data Model





Data matrix of climate model experiment



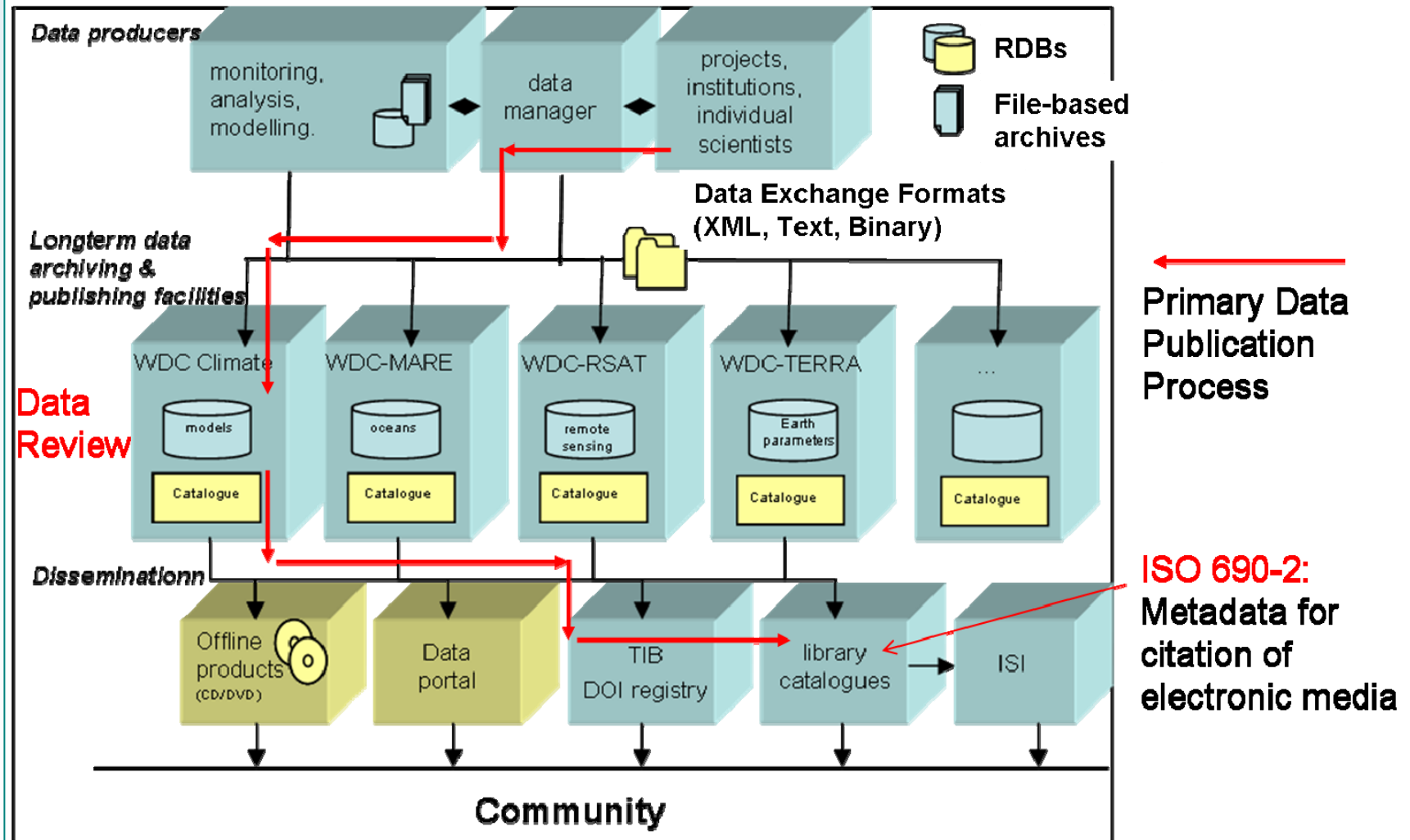
Coloured columns correspond to **BLOB data tables** in WDCC.

Collections of matrix rows represents storage in **model raw data files** (complete model output storage time step by storage time step).





- Additionally WDCC offers the primary data publication service
 - Following the STD-DOI concept (Scientific and Technical Data – Digital Object Identifier, URL: www.std-doi.de)
 - Important aspects of the publication process are
 - ◆ The identification of **independent data entities** which are suitable for publication at the level of scientific literature,
 - ◆ The execution of an elaborated **review process** for metadata and climate data,
 - ◆ The assignment of additional **metadata for electronic publication** (ISO 690-2) and of **persistent identifiers** (DOI / URN) and
 - ◆ The integration of publication metadata and persistent identifiers into the **TIB library catalogue** (Technical Information Library, Hannover) so that primary data entities are searchable and citable together with scientific literature.
 - ◆ Quality characteristic is presently “**approved by author**”, future development should be “**peer reviewed**”.



STD-DOI data publication workflow

URL: <http://tiborder.gbv.de/psi/DB=2.63/LNG=DU/>, keyword: WDCC

TIBORDER - Dokumentlieferdienst der TIB Hannover - results/shortlist - Mozilla Firefox

Suchergebnis sichern
Datenbankauswahl
Bestellung ohne Recherche
Benutzerinfo
TIB Homepage

Suche [und] Alle Wörter sortiert nach Erscheinungsjahr

WDCC

1-19 von 57

Ihre Aktion suchen [und] (Alle Wörter) WDCC

1. Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data - HOAPS II - 5-days mean / Karsten Fenig. - 2006-06-29
2. Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data - HOAPS II - monthly mean / Karsten Fenig. - 2006-06-29
3. IPCC-AR4 MPI-ECHAM5_T63L31 MPI-OM_GRI1.5L40_20C3M run no.1: atmosphere 6 HOUR values MPImet/MaD Germany / Erich Roeckner. - 2006-10-30
4. IPCC-AR4 MPI-ECHAM5_T63L31 MPI-OM_GRI1.5L40 Pinctrl(pre-industrial control experiment): atmosphere 6 HOUR values MPImet/MaD Germany / Erich Roeckner. - 2006-06-29
5. IPCC-AR4 MPI-ECHAM5_T63L31 MPI-OM_GRI1.5L40 1%/year CO2 increase experiment to quadrupling run no.1: atmosphere 6 HOUR values MPImet/MaD Germany / Erich Roeckner. - 2006-09-25
6. IPCC-AR4 MPI-ECHAM5_T63L31 MPI-OM_GRI1.5L40 1%/year CO2 increase experiment to doubling run no.3: atmosphere 6 HOUR values MPImet/MaD Germany / Erich Roeckner. - 2006-09-25
7. IPCC-AR4 MPI-ECHAM5_T63L31 MPI-OM_GRI1.5L40 SRESA2 run no.3: atmosphere 6 HOUR values MPImet/MaD Germany / Erich Roeckner. - 2006-09-25
8. IPCC-AR4 MPI-ECHAM5_T63L31 MPI-OM_GRI1.5L40 SRESA2 run no.2: atmosphere 6 HOUR values MPImet/MaD Germany / Erich Roeckner. - 2006-09-25

TIBORDER - Dokumentlieferdienst der TIB Hannover - results/titledata - Mozilla Firefox

Suchergebnis sichern
Datenbankauswahl
Bestellung ohne Recherche
Benutzerinfo
TIB Homepage

Suche [und] (Alle Wörter) WDCC

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Ihre Aktion suchen [und] (Alle Wörter) WDCC

Titel: IPCC-AR4 MPI-ECHAM5_T63L31 MPI-OM_GRI1.5L40_20C3M run no.1: atmosphere 6 HOUR values MPImet/MaD Germany / World Data Center for Climate (WDCC), Hamburg .Erich@Roekner

Beteiligt: Erich Roeckner; Michael Lautenschlager; Heiko Schneider

Körperschaft: World Data Center for Climate (WDCC)

Erschienen: Hamburg: World Data Center for Climate (WDCC), 2006-10-30

Umfang: Online-Ressource (3987170720028 Bytes).

Anmerkung: Mode: Abstract
StructuralType: Digital
CreationDate: 2004-05-11
The data represent 6 hourly values of a 20th century simulation (including year 2000) with observed anthropogenic forcings(CO2, CH4, N2O, CFCs, O3 and sulfate) initialized in year 2190 of the preindustrial control run. This is followed by a commitment experiment for the 21th century (years 2001-2100) with all concentrations fixed at their levels of the year 2000.
Data Sets with monthly mean values are also available.
Technical data to this experiment:
The experiment is using ECHAM5.2.02a coupled to MPI-OM Vers. 1.0 GRI1.5L40 The output from the model run: humikan.dkrz.de:/ut/k/204076/EXP000/run009
Please note: experiment_name/acronym was renamed (27-JUN-2005, 20C_0 changed to 20C_1)

Inhalt:

Technische Angaben: Format: GRIB

Links: doi: 10.1594/WDCC/EH5-T63L31_OM-GRI1.5L40_20C_1_6H
URN: urn:nbn:de:tib-10.1594/WDCC/EH5-T63L31_OM-GRI1.5L40_20C_1_6H

Bestandsinfo: Anzeigen lizenzfrei

Anmerkung: Primaerdaten

CERA - entry information for EH5-T63L31_OM-GRI1.5L40_20C_1_6H - Mozilla Firefox

http://cera-www.dkrz.de/WDCC/ui/Compact.jsp?acronym=EH5-T63L31_OM-GRI1.5L40_20

World Data Center for Climate, Hamburg

Not logged in (Login) | Process List

CERA UI Home | WDCC Home

Always quote citation when using data!

DOI for Scientific and Technical Data
10.1594/WDCC/EH5-T63L31_OM-GRI1.5L40_20C_1_6H

Title
IPCC-AR4 MPI-ECHAM5_T63L31 MPI-OM_GRI1.5L40_20C3M run no.1: atmosphere 6 HOUR values MPImet/MaD Germany

Citation
Roekner, Erich; Lautenschlager, Michael; Schneider, Heiko 2006; IPCC-AR4 MPI-ECHAM5_T63L31 MPI-OM_GRI1.5L40_20C3M run no.1: atmosphere 6 HOUR values MPImet/MaD Germany. [doi: 10.1594/WDCC/EH5-T63L31_OM-GRI1.5L40_20C_1_6H]

Publication Date
2006-10-30

Author(s)
Roekner, Erich; Lautenschlager, Michael; Schneider, Heiko

Summary
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Data Sets with monthly mean values are also available.

CERA - entry information for EH5-T63L31_OM-GRI1.5L40_20C_1_6H - Mozilla Firefox

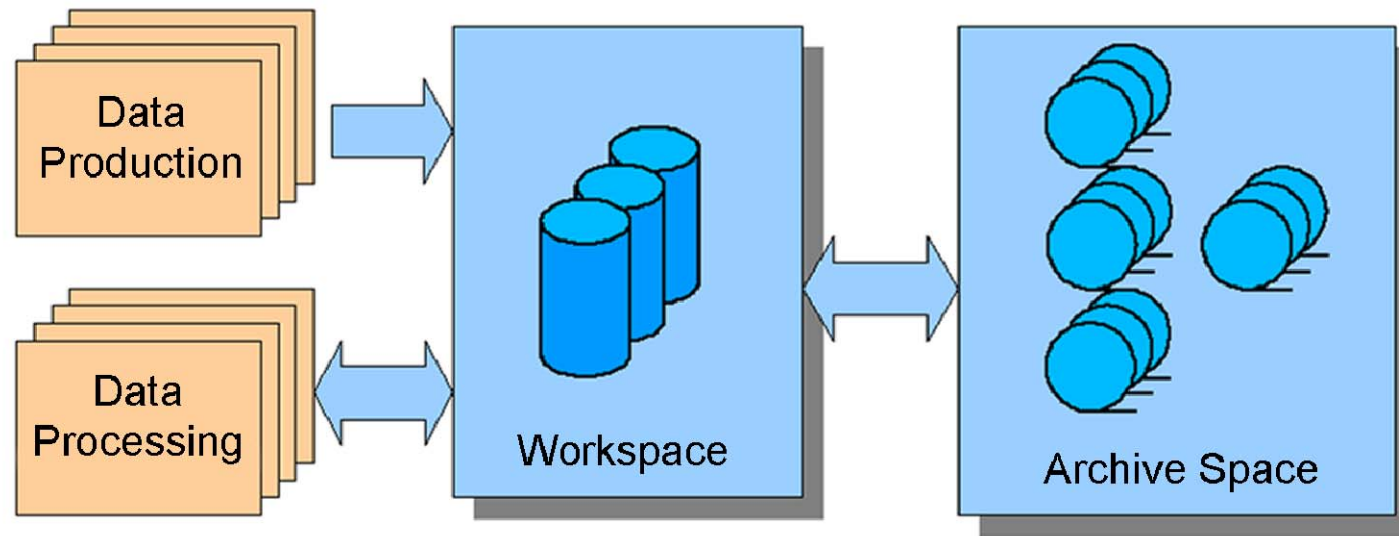
http://cera-www.dkrz.de/WDCC/ui/Compact.jsp?acronym=EH5-T63L31_OM-GRI1.5L40_20

Available Datasets (Page 1 of 13)

Name	Progress
<input type="checkbox"/> EH5_OM_CONST_ALAKE: lake fraction of grid box	complete
<input type="checkbox"/> EH5_OM_CONST_ALB: surface background albedo	complete
<input type="checkbox"/> EH5_OM_CONST_AZOL: roughness length over land	complete
<input type="checkbox"/> EH5_OM_CONST_FAO: FAO data set (soil data flags)	complete
<input type="checkbox"/> EH5_OM_CONST_FOREST: forest fraction	complete
<input type="checkbox"/> EH5_OM_CONST_GEOSP: surface geopotential (orography)	complete
<input type="checkbox"/> EH5_OM_CONST_GLAC: fraction of land covered by glaciers	complete
<input type="checkbox"/> EH5_OM_CONST_OROSTD: orographic standard deviation	complete
<input type="checkbox"/> EH5_OM_CONST_SLF: sea land fraction	complete
<input type="checkbox"/> EH5_OM_CONST_SLM: land sea mask (1. = land, 0. = sea/lakes)	complete
<input type="checkbox"/> EH5_OM_CONST_WSMX: field capacity of soil	complete
<input type="checkbox"/> EH5_OM_20C_1_ACLCOV: total cloud cover	complete
<input type="checkbox"/> EH5_OM_20C_1_AHFCON: conductive heat flux through ice	complete
<input type="checkbox"/> EH5_OM_20C_1_AHFL: latent heat flux	complete
<input type="checkbox"/> EH5_OM_20C_1_AHFLIAC: latent heat flux over ice	complete
<input type="checkbox"/> EH5_OM_20C_1_AHFLIAC: latent heat flux over land	complete



Data Flow at DKRZ



Different architectures for
production and processing

Different tape media for
performance and data
security

Data infrastructure integrates **data stewardship** in the long-term archive

- Bit-stream preservation
- Quality assurance
- Usability enabling





Long-term archive data stewardship

- Bit-stream preservation

- **Secondary tape copies** on different tapes and technology at separate location
- Copy to new tapes after maximum number of tape accesses are reached (**Refreshment**)

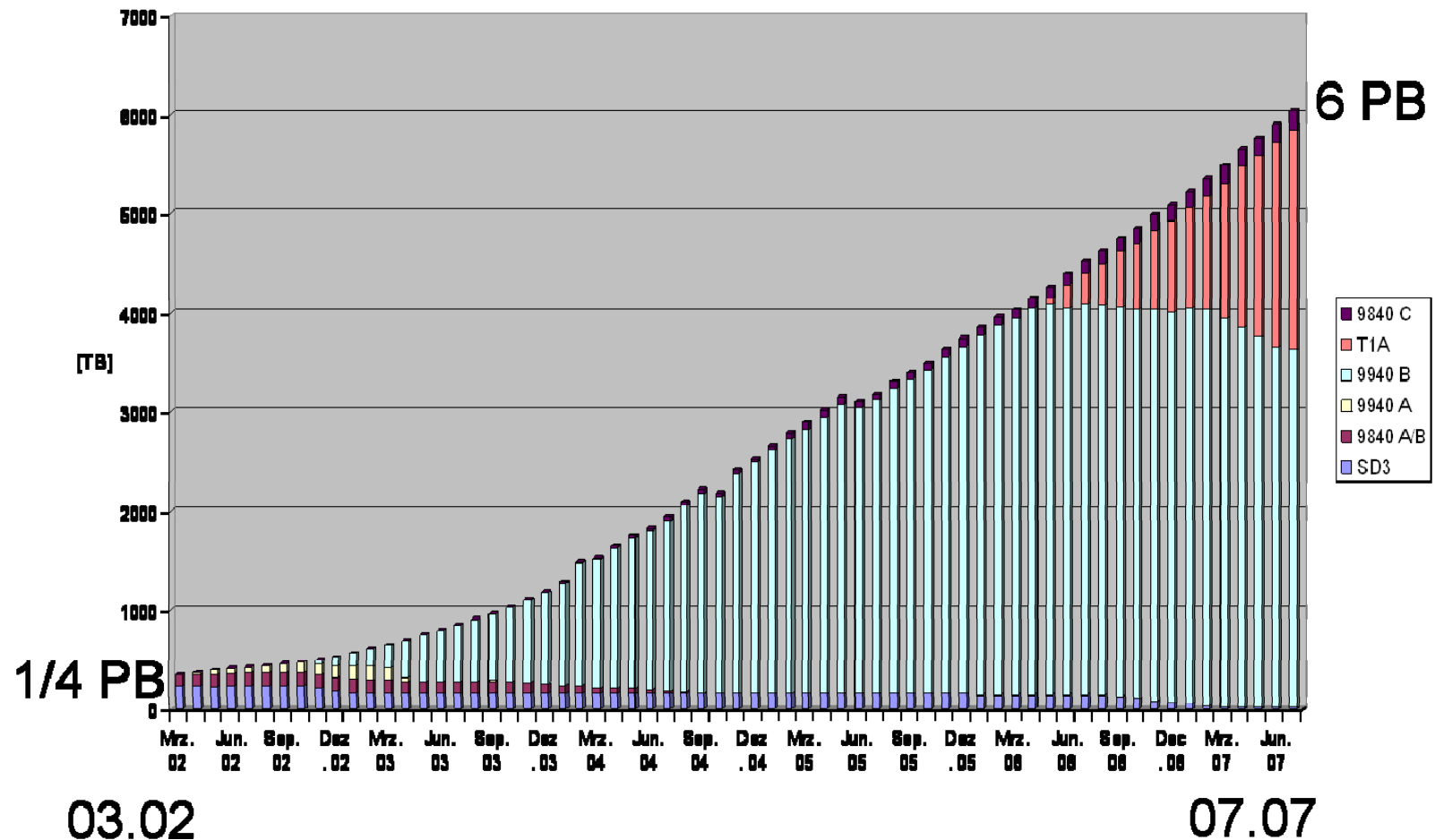
- Quality assurance

- **Semantic examinations:** behavior of a numerical model compared to observations and to other models, part of the scientific evaluation process
- **Syntactic examinations:** formal aspects of data archiving and ensurance that data archiving is free of errors as far as possible
 - ◆ **Consistency** between metadata and climate data
 - ◆ **Completeness** of climate data
 - ◆ **Standard range** of values
 - ◆ Spatial and temporal **data arrangement**



Media Distribution: Capacity

DXUL - data per tape type



History: DKRZ archive increase and transition in tape technology





Long-term archive data stewardship (continued)

- Usability enabling

- Complete and **searchable documentation** of climate data entities (database tables and flat files) in the catalogue system of the WDCC
- WDCC offers **web-based data access** to small data granules (individual entries in BLOB DB tables)
- Archive technology transfer must be **downward compatible** to keep old data technically readable
- Data processing tools and data format access libraries must be **migrated to new architectures**





Summary

- DKRZ long-term **data archive will still grow but slower than linear** with the installed compute power
 - Target increase rates are
10 PB/year for the tape archive,
1 PB/year for the WDCC.
- **Improvement of reliability** of long-term archive because of more emphasis on data stewardship than on technical data service operations
- At the end the new data archive concept will result in a **completely documented and searchable long-term data archive**.
(Data without documentation are only numbers)

