FP-7 CORE-CLIMAX: HOW TO ENSURE SUSTAINABLE, TRANSPARENT, AND TRACEABLE GENERATION OF CLIMATE DATA RECORDS?

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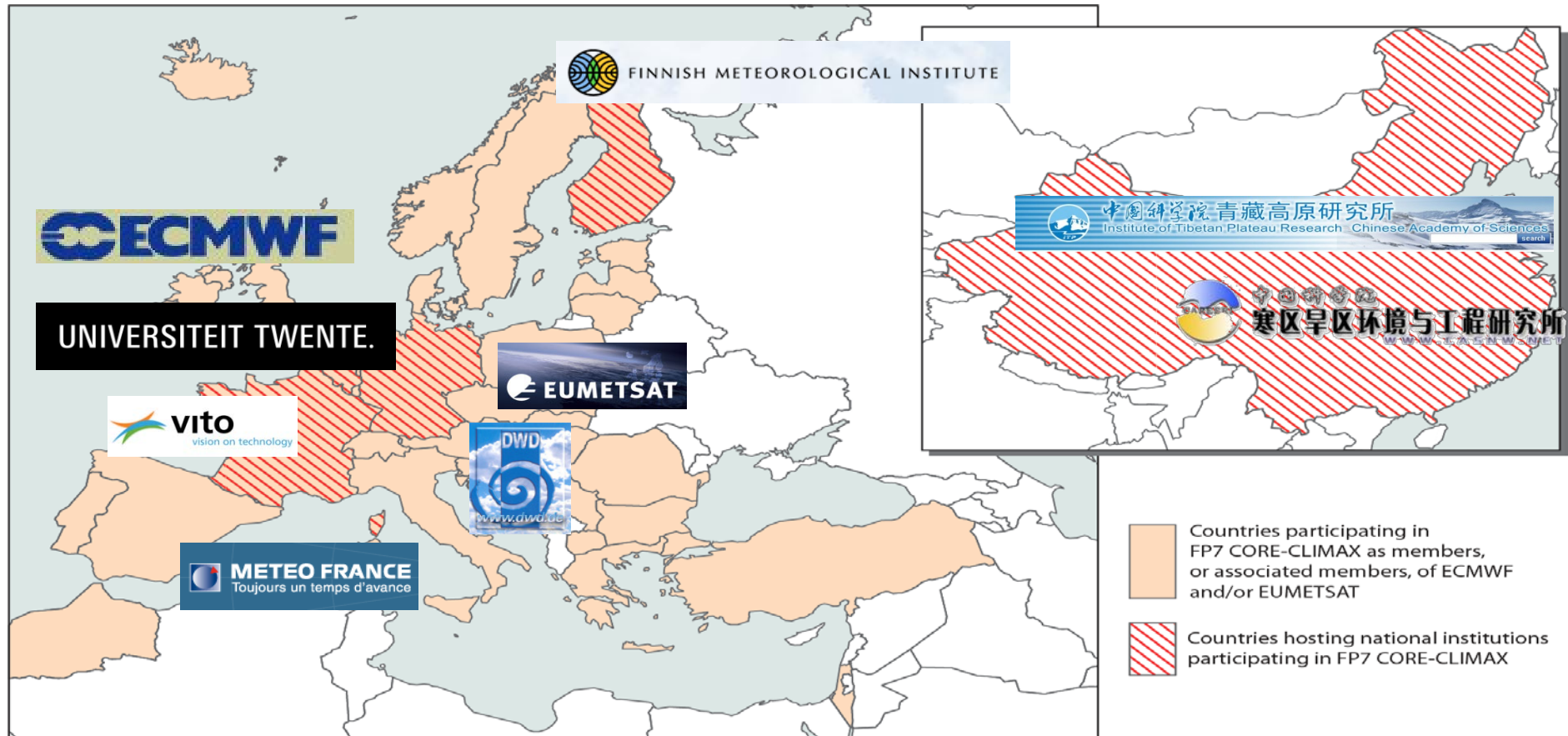
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How it all started ...
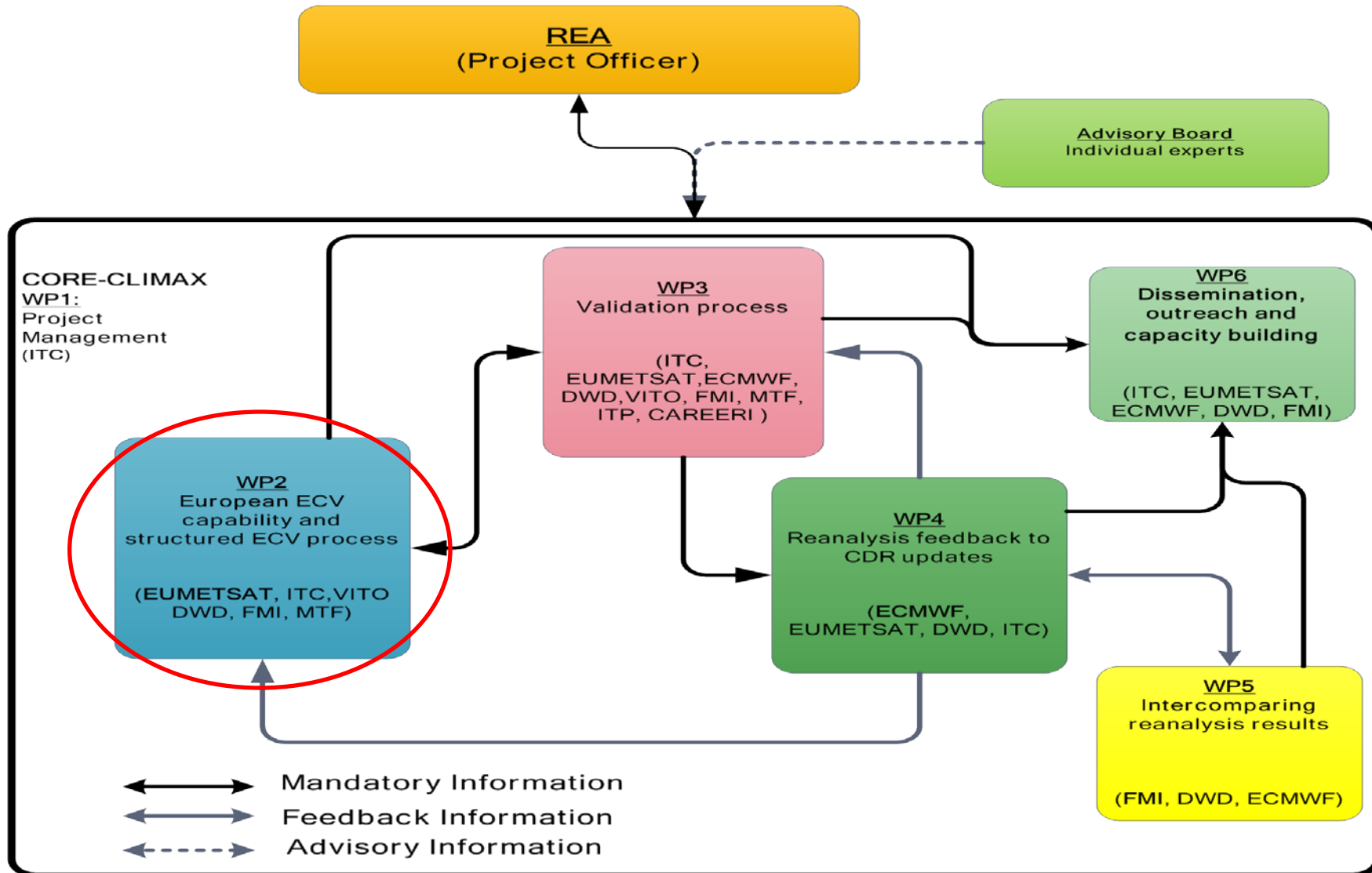
GCOS-WCRP Letter, 12 May 2010 to many agencies:

"However, there is currently no systematic international approach to ensure transparency, traceability and sound scientific judgement in the generation of climate data records across all fields of climate science and related Earth observations, and there are no dedicated sustained resources in place to support such an objective. For example, there are currently eight sea-ice concentration products produced by different organizations globally that differ significantly in providing an estimate of sea-ice extent and concentrations, mostly due to differences in methodology and not the variability or dynamics of underlying phenomenon. It is very confusing and frustrating for the non experts as to which one of these products they can use in their research and analysis, and the necessary documents to describe their attributes in a comparative manner akin to the global model inter-comparisons do not exist."

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CORE-CLIMAX

COordinating Earth observation data validation for RE-analysis for CLIMAte ServiceS

Countries participating in FP7 CORE-CLIMAX as members, or associated members, of ECMWF and/or EUMETSAT

Countries hosting national institutions participating in FP7 CORE-CLIMAX

CORE-CLIMAX work packages

EU FP7 CORE-CLIMAX
Assessment of European Capacity for CDRs

The capacity is assessed using three support tools developed by the project:

- **Data Record Descriptions (DRD)**

  - Contain technical specifications and links to documented information on quality;
  - Provides consistent and coherent information about CDRs produced in Europe (serves as input to CMIP-6 obs4mips activities).

- **System Maturity Matrix (SMM)**

  - Evaluates if the production of a CDR follows best practices for science and engineering and is assessing if data records are used and feedback mechanisms are implemented;
  - The SMM can be used in self assessment mode or in an audit type assessment.

- **Application Performance Metric (APM)**

  - Evaluates the performance of a CDR with respect to a specific application;
  - Might be implemented as an interactive App that convolves user requirements with product specification information in a database.

Maturity Matrix Concept
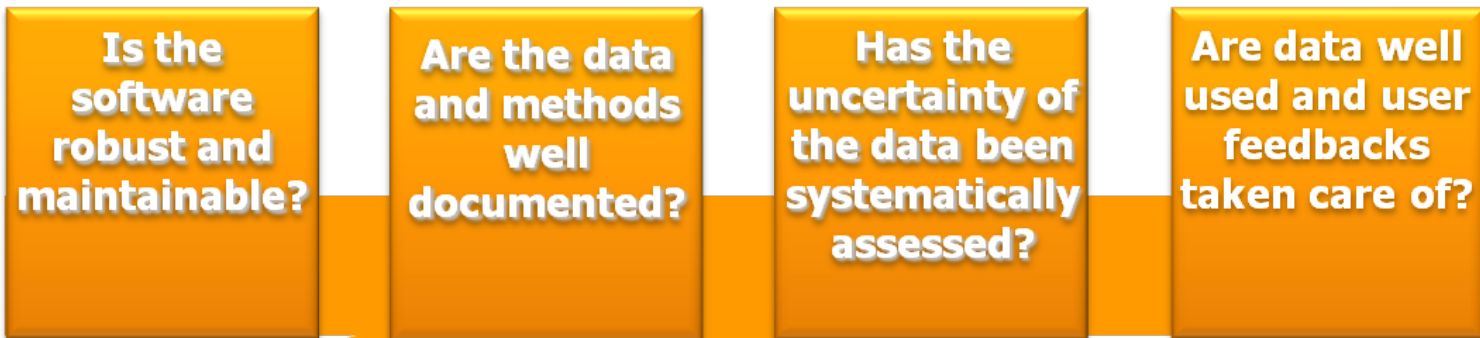
Is the software robust and maintainable?	Are the data and methods well documented?	Has the uncertainty of the data been systematically assessed?	Are data well used and user feedbacks taken care of?

Software readiness	Metadata	User documentation	Uncertainty Characterisation	Public Access, Feedback and Update	Usage
Are the codes compliant with standards, stable, portable and reproducible?	Do the metadata meet international standards, and allow provenance tracking?	Are the formal documents and peer-reviewed papers up-to-date and public?	Are the uncertainties assessed systematically in a standard manner?	Are the data, source code, and documents publicly available and regularly updated?	Are the data widely used in the scientific, and decision and policy making communities?

Core-Climax: System Maturity Matrix

Maturity	SOFTWARE READINESS	METADATA	USER DOCUMENTATION	UNCERTAINTY CHARACTERISATION	PUBLIC ACCESS, FEEDBACK, UPDATE	USAGE
1	Conceptual development	None	Limited scientific description of the methodology available from PI	None	Restricted availability from PI	None
2	Research grade code	Research grade	Comprehensive scientific description of the methodology, report on limited validation, and limited product user guide available from PI; paper on methodology is sumitted for peer-review	Standard uncertainty nomenclature is idenitified or defined; limited validation done; limited information on uncertainty available	Data avaliable from PI, feedback through scientific exchange, irregular updates by PI	Research: Benefits for applications identified DSS: Potential benefits identified
3	Research code with partially applied standards; code contains header and comments, and a README file; PI affirms portability, numerical reproducibility and no security problems	Standards defined or identified; sufficient to use and understand the data and extract discovery metadata	Score 2 + paper on methodology published; comprehensive validation report available from PI and a paper on validation is submitted; comprehensive user guide is available from PI; Limited description of operations concept available from PI	Score 2 + standard nomenclature applied; validation extended to full product data coverage, comprehensive information on uncertainty available; methods for automated monitoring defined	Data and documentation publically available from PI, feedback through scientifc exchange, irregular updates by PI	Research: Benefits for applications demonstrated. DSS: Use occuring and benefits emerging
4	Score 3 + draft software installation/user manual available; 3rd party affirms portability and numerical reproducibility; passes data providers security review	Score 3 + standards systematically applied; meets international standards for the data set; enhanced discovery metadata; limited location level metadata	Score 3 + comprehensive scientific description available from data provider; report on inter comparison available from PI; paper on validation published; user guide available from data provider; comprehensive description of operations concept available from PI	Score 3 + procedures to establish SI traceability are defined; (inter)comparison against corresponding CDRs (other methods, models, etc); quantitative estimates of uncertainty provided within the product characterising more or less uncertain data points; automated monitoring partially implemented	Data record and documentation available from data provider and under data provider's version control; Data provider establishes feedback mechanism; regular updates by PI	Score 3 + Research: Citations on product usage in occuring DSS: societal and economical benefits discussed
5	Score 4 + operational code following standards, actions to achieve full compliance are defined; software installation/user manual complete; 3rd party installs the code operationally	Score 4+ fully compliant with standards; complete discovery metadata; complete location level metadata	Score 4 + comprehensive scientific description maintained by data provider; report on data assessment results exists; user guide is regularly updated with updates on product and validation; description on practical implementation is available from data provider	Score 4 + SI traceability partly established; data provider participated in one inter-national data assessment; comprehensive validation of the quantitative uncertainty estimates; automated quality monitoring fully implemented (all production levels)	Score 4 + source code archived by Data Provider; feedback mechanism and international data quality assessment are considered in periodic data record updates by Data Provider	Score 4+ Research: product becomes reference for certain applications DSS: Societal and economic benefits are demonstrated
6	Score 5 + fully compliant with standards; Turnkey System	Score 5 + regularly updated	Score 5 + journal papers on product updates are and more comprehensive validation and validation of quantitative uncertainty estimates are published; operations concept regularly updated	Score 5 + SI traceability established; data provider participated in multiple inter-national data assessment and incorporating feedbacks into the product development cycle; temporal and spatial error covariance quantified; Automated monitoring in place with results fed back to other accessible information, e.g. meta data or documentation	Score 5 + source code available to the public and capability for continuous data provisions established (ICDR)	Score 5 + Research: Product and its applications becomes references in multiple research field DSS: Influence on decision and policy making demonstrated

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Is the Core-Climax SMM concept generally applicable?
(In-situ, Satellite, and Reanalysis CDRs)

Baseline Surface Radiation Network (BSRN)

NKDZ Precipitation time series

Providers of SMMs for In-Situ CDRs initially indicated that the **Software Readiness** and **User Documentation** categories are not applicable to their data.

ERA-Interim (ECMWF)

ECMWF Interim Reanalysis (ERA-Interim)
CORE-CLIMAX System Maturity Matrix

maturity level as of Jan/14/2014

Self-assessment by D. Tan, ECMWF

Maturity	SOFTWARE READINESS	METADATA	USER DOCUMENTATION	UNCERTAINTY CHARACTERISATION	PUBLIC ACCESS, FEEDBACK, UPDATE	USAGE
1	Conceptual development	None	Limited scientific description of the methodology available from PI	None	Restricted availability from PI	None
2	Research grade code	Research grade	Comprehensive scientific description of the methodology, report on limited validation, and limited product user guide available from PI; paper on methodology is sumitted for peer-review	Standard uncertainty nomenclature is idenitified or defined; limited validation done; limited information on uncertainty available	Data avaliable from PI, feedback through scientific exchange, irregular updates by PI	Research: Benefits for applications identified DSS: Potential benefits identified
3	Research code with partially applied standards; code contains header and comments, and a README file; PI affirms portability, numerical reproducibility and no security problems	Standards defined or identified; sufficient to use and understand the data and extract discovery metadata	Score 2 + paper on methodology published; comprehensive validation report available from PI and a paper on validation is submitted; comprehensive user guide is available from PI; Limited description of operations cocept available from PI	Score 2 + standard nomenclature applied; validation extended to full product data coverage, comprehensive information on uncertainty available; methods for automated monitoring defined	Data and documentation publically available from PI, feedback through scientifc exchange, irregular updates by PI	Research: Benefits for applications demonstrated. DSS: Use occuring and benefits emerging
4	Score 3 + draft software installation/user manual available; 3rd party affirms portability and numerical reproducibility; passes data providers security review	Score 3 + standards systematically applied; meets international standards for the data set; enhanced discovery metadata; limited location level metadata	Score 3 + comprehensive scientific description available from data provider; report on inter comparison available from PI; paper on validation published; user guide available from data provider; comprehensive description of operations concept available from PI	Score 3 + procedures to establish SI traceability are defined; (inter)comparison against corresponding CDRs (other methods, models, etc); quantitative estimates of uncertainty provided within the product characterising more or less uncertain data points; automated monitoring partially implemented	Data record and documentation available from data provider and under data provider's version control; Data provider establishes feedback mechanism; regular updates by PI	Score 3 + Research: Citations on product usage in occuring DSS: societal and economical benefits discussed
5	Score 4 + operational code following standards, actions to achieve full compliance are defined; software installation/user manual complete; 3rd party installs the code operationally	Score 4+ fully compliant with standards; complete discovery metadata; complete location level metadata	Score 4 + comprehensive scientific description maintained by data provider; report on data assessment results exists; user guide is regularly updated with updates on product and validation; description on practical implementation is available from data provider	Score 4 + SI traceability partly established; data provider participated in one inter-national data assessment; comprehensive validation of the quantitative uncertainty estimates; automated quality monitoring fully implemented (all production levels)	Score 4 + soure code archived by Data Provider; feedback mechanism and international data quality assessment are considered in periodic data record updates by Data Provider	Score 4+ Research: product becomes reference for certain applications DSS: Societal and economic benefits are demonstrated
6	Score 5 + fully compliant with standards; Turnkey System	Score 5 + regularly updated	Score 5 + journal papers on product updates are and more comprehensive validation and validation of quantitative uncertainty estimates are published; operations concept regularly updated	Score 5 + SI traceability established; data provider participated in multiple inter-national data assessment and incorporating feedbacks into the product development cycle; temporal and spatial error covariance quantified; Automated monitoring in place with results fed back to other accessible information, e.g. meta data or documentation	Score 5 + source code available to the public and capability for continuous data provisions established (ICDR)	Score 5 + Research: Product and its applications becomes references in multiple research field DSS: Influence on decision and policy making demonstrated

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Fitness for Purpose?
Motivation for Application Performance Metric (APM)

- SMM provides assessment of whether the data set can be sustainable in terms of engineering, science, archive, and usage aspects;

- There is no guarantee that a data set with high System Maturity is suitable for all applications!

- For example, data set X with over all System Maturity FIVE/SIX that provides DAILY mean humidity values is NOT suitable for assessing DIURNAL cycle of humidity in climate models;

- How do we assess the performance of a data set for a particular application?

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Support User's to Select Data

- User requirements collection exercises show a large variability in the stated requirements of users with nominally similar applications;
- But a core set of typical questions may always be isolated:

| Does the coverage of the record suffice ? | Is there sufficient level of detail ? | Are the observations of adequate quality ? | How does the quality vary in time ? |

Coverage	Sampling	Uncertainty	Stability
Are the record length and spatial coverage meeting the application's requirements?	Do the spatial and temporal sampling meet the applications requirements?	Do the random and systematic uncertainties meet the requirements?	Do the temporal and spatial stability meet the requirements?

General Concept of APM

Application Specific User Requirements

User

Database of CDR Product Specification Tables

CDRs matching the URs best

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European Capacity Assessment
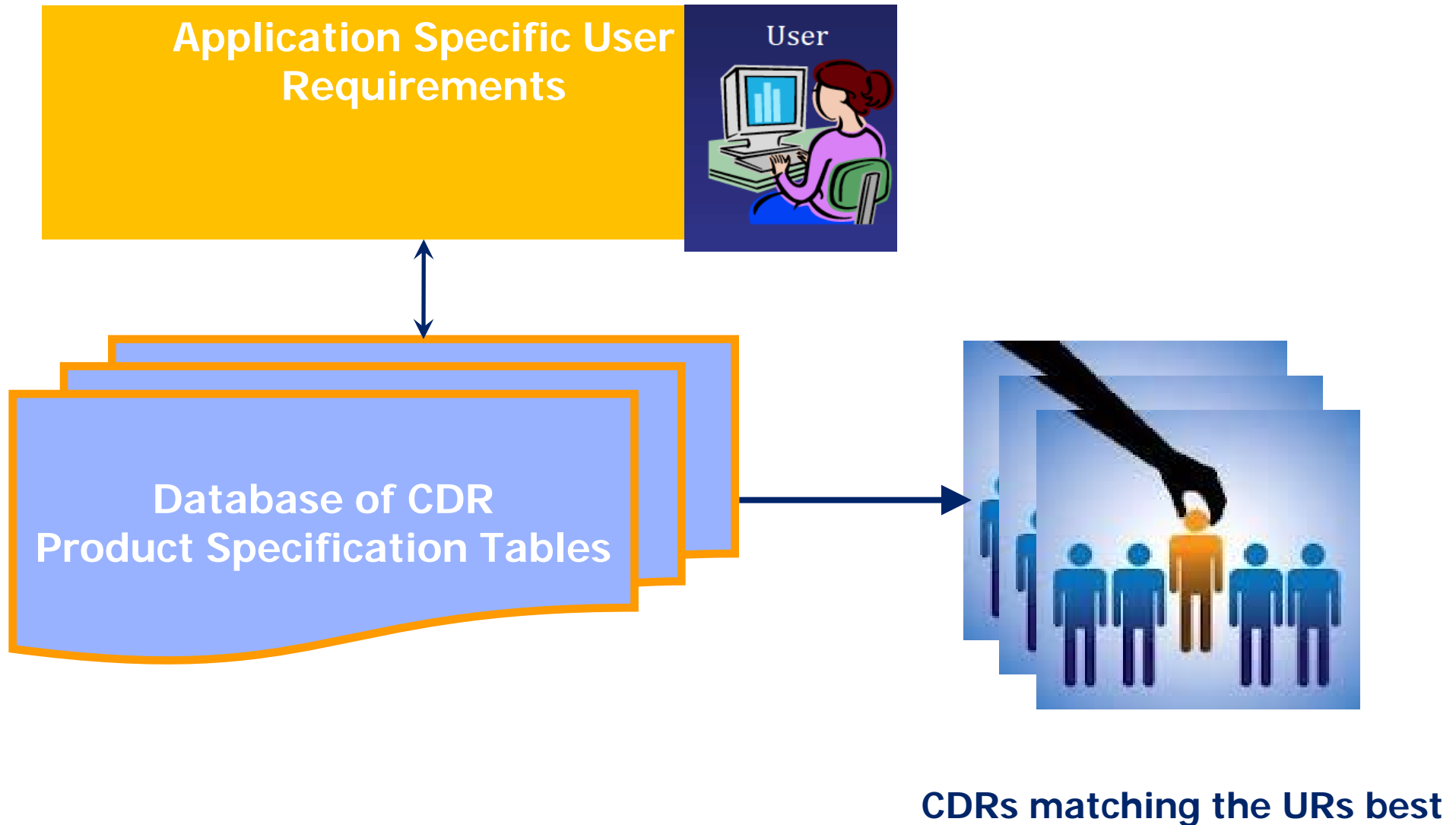
- Data Assessment Workshop was held at EUMETSAT in January 2014;

- All major dataset developers were present and they endorsed the assessment tools (DRD, SMM, and APM);

- 39 data records were assessed (FCDRs and TCDRs for atmosphere, ocean, and land);

- The assessment:

  - Provides consistent view on strengths and weaknesses of the process to generate, preserve and improve CDRs to each individual CDR producer, agencies, and EC;

  - Provides the status of CDRs for the first time across different observing systems (satellite, in situ, and reanalysis);

  - Increases transparency and openness towards the user;

  - Supports selection of CDRs for services and applications;

  - Supports Europe's contribution to the next Obs4Mips activity by providing consistent information on CDRs produced in Europe;

- An assessment report is being prepared, which will be made publicly available .