CEOS Database of World-wide Calibration Facilities and Validation Test Sites

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ABSTRACT

Since 1995, the CEOS Calibration/Validation (Cal/Val) Database has provided the international Earth remote sensing science community with a) a central repository for information on current and planned Calibration/Validation activities and b) a means to foster collaboration on common Cal/Val issues. The Cal/Val Database uses an ORACLE relation database management system to store the data and is accessed via the World Wide Web (WWW) using PERL scripts to search and query the database. The search queries are structured such that users can define any combination of fields, either through selection of valids, or by directly typing the information. All query results are displayed in the text form. The text displays are interactive allowing the user to point and click to access more detailed information. System functionality provides an on-line form of all of the three questionnaires for submitting new information and allows a user with the assigned password to edit archived information for their facility. This functionality allows users to update information, as it becomes available.

In 2000, the Cal/Val database was updated through a process of additional surveying of existing and planned Cal/Val capabilities to support the NASA's Earth Science Enterprise (ESE) and other international Earth observing missions. A set of three updated questionnaires was prepared: one for calibration laboratories, one for test sites, and one for field instruments. The information requested included: a description of the facility, instruments available, instrument characteristics, types of measurements performed, programs/projects that have used the facility, etc. These questionnaires with cover letter were mailed to over 250 research groups that included CEOS members and facilities within the USA. The information collected from worldwide facilities was used to construct and update this on-line database for use not only by the CEOS members, but also the broader international Earth science community.

This project has been funded by NASA Headquarters based on the recommendation from the Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation (WGCV6). NASA is maintaining this database on behalf of CEOS. The database can be accessed at the following URL: http://spso.gsfc.nasa.gov/calval/.

Keywords: Calibration, Validation, Test sites, Laboratories, Instruments, Database, World Wide Web, CEOS,

1. INTRODUCTION

The Committee on Earth Observation Satellites (CEOS) is a focal point for the international coordination of space-related Earth observation activities. Its goal is to maximize the benefits of these observations by fostering complementarily and compatibility among the various Earth observation systems and by exchanging policy and technical information. In particular, the CEOS Working Group on Calibration and Validation (WGCV) is responsible for promoting international cooperation in the calibration and validation of satellite-borne sensors to ensure quantitative and compatible Earth observation products.

At the sixth meeting of the CEOS Working Group on Calibration and Validation (WGCV6), the need was identified for a calibration and validation (CAL/VAL) dossier to contain all the available information on test sites, facilities, and activities of the WGCV members. In addition, a need for routine updates of the Cal/Val dossier was recognized. A recommendation from the WGCV was made to the CEOS Plenary in December 1992 to request the commissioning of a first draft of the Cal/Val dossier. In 1993 at WGCV7, the UK presented a 'pilot' Cal/Val dossier prepared by Smith System Engineering Ltd., Surrey, England and offered to complete the 'pilot' version of Cal/Val dossier. The 'pilot' Cal/Val dossier included a Test Site/Field Experiment Database (TFDB) originally developed by the National Aeronautics and Space Administration (NASA) Earth Observing System (EOS) Calibration Scientist. At the WGCV8 meeting in Seattle in 1994, it was recommended that the Cal/Val dossier be commissioned at the earliest opportunity. In 1995 and in response to this recommendation, NASA

Headquarters created a CAL/VAL Database to provide the worldwide science community with a) a central repository for current and planned Cal/Val activities and b) a mean to facilitate collaboration on common Cal/Val activities.

The goal of this activity was to identify and describe laboratory calibration facilities, calibration/validation test sites, and field instruments that are used world-wide in various satellite remote sensing applications and to archive this information in an easily accessible format. CEOS and NASA requested assistance from its members in assembling an international reference database on the calibration and validation of Earth remote sensing instruments. As a result of the 1995 work, the pilot version of the database was augmented and electronically archived.

In 1999, additional work was performed on the database to include new submitted information, update existing information, and improve the overall database functionality. This activity included: a) preparing of questionnaires, b) conducting survey using the questionnaires, c) collecting information, and d) designing a web-based system for collection and dissemination of the information. This information server has administrative function with password protection that allows information provider to periodically update information as necessary. It is hoped that the database will be a reference source for (1) coordinating various calibration and validation activities, (2) sharing available facility resources, and (3) identifying sources of available data. In 2000, a fully operational system was released for users to query the information from the Cal/Val Database. To access this web site visit URL: http://spso.gsfc.nasa.gov/calval/

2. DATA COLLECTION

Important elements in the data collection were to identify people who could provide the relevant information for the database and to decide what relevant information should be collected. First a list people was developed who are members of CEOS Cal/Val Sub-groups of the WGCV. In addition people were included who are involved in Calibration and Validation activities worldwide and who (1) manage calibration laboratories, (2) maintain or use test sites, (3) operate instrumentation at those sites, and/or 4) perform work related directly or indirectly to Earth remote sensing. This list of over 300 people included not only names, but also addresses, phone numbers, affiliations, and the email addresses. Once the list was completed a set of three questionnaires were developed that were mailed with a cover letter providing detailed instructions on how to submit and edit information. Users were instructed to provide responses either through accessing the web server, email, postal mail, or fax. The information collected was used to construct an on-line database for use by the CEOS members, EOS scientists, and the broader Earth science community.

2.1 Cal/Val Questionnaires

A set of three questionnaires was prepared one each for calibration laboratories, test sites, and field instruments as the primary means to collect information. Questionnaires were divided into various sections that collected information such as a description of the facility, contact person with address, instruments available, instrument characteristics, type of measurements performed, references, URL, comments, and programs/projects that has used the facility. The instrument section of all the questionnaires collected information on instrument name, wavelength, parameter measured, measurement accuracy and precision, calibration standard.

Each questionnaire had sections that are relevant to the facility for which questionnaire was applicable. For example, the test site questionnaire requested users to provide information on: test site description and type (e.g. land, ocean, atmosphere), available platform (e.g. tower, vehicle, balloon, ship, aircraft, helicopter, etc.), site occupancy (e.g. personnel availability on the site all the time, seasonally or occasionally), major characteristics, site facilities (e.g. power, communications, accessibility, water source), nearest weather station, altitude, longitude, and latitude. The laboratory questionnaire requested clean-room facility information, clean-room class, thermal vacuum availability, and other facility capabilities (e.g., anechoic chamber, etc.).

3. CAL/VAL DATABASE AND INTERFACES DESIGN

The Cal/Val database is comprised of a few tables that store the information collected through the questionnaires in the ORACLE Relational Database Management System. These tables are queried through special functions using worldwide web interfaces. All the interface programs are written in PERL 5.0 while as ORAPERL, and DB programs are used to provide web-oracle interface.

3.1 Database Design

The database was designed such that the processes of accessing and updating the database are efficient and fast. Links between various tables are established by the unique identification. To accomplish the database layout, the following tables were created:

A) Testsite: This table stores information for all the test sites that is provided by the users through the Test Site Questionnaire. The database table fields and their description are given in Table 1.

B) Instrument: This table archives information for the instrument that is collected through the instrument Questionnaire. The database table fields with their description are listed in Table 2.

C) Laboratory: This table stores the information about laboratories that is collected through the Laboratory Questionnaire. The database fields with their description are given in Table 3.

D) AddInst: This table contains instrument characteristics, parameters measured, wavelengths, and uncertainty of the measurement. This table is common for all three facilities and is linked by the unique identification.

E) AddProj: This table contains information on the projects that were associated with these facilities and has information such as the name of the project and the contact person. This table is common for all three facilities and is linked by the unique identification.

F) UserLog: This table stores information every time any authorized user logs in to perform administrative activities. Information stored includes the person's email address, TCP/IP address, access level, and time of login.

G) User_tbl: This table stores user names, access level, and the passwords for authorized users.

Table 1. Test Site database Table Fields Description

Field Name	Description
SITE_ID	Unique Identification
INFO_BY	Name of the person who is providing information
EMAIL	Email of the person providing information
SITE_NAME	Name of the Facility
CONTACT_NAME	Contact Person's Name
CONTACT_STREET	Contact Person's Street Address
CONTACT_CITY	Contact Person's City Name
CONTACT_STATE	Contact Person's State
CONTACT_ZIP	Contact Person's Zip Code
CONTACT_COUNTRY	Contact Person's Country
CONTACT_PHONE	Contact Person's Phone number
CONTACT_FAX	Contact Person's Fax Number
CONTACT_EMAIL	Contact Person's Email
SITE_DES	Facility Description
FUTURE_PLANS	Description of future plans
PUBLICATIONS	List of publications
URL	Universal Record Locator
SITE_LOCATION	Location of the Test Site
SITE_COUNTRY	Country where Test Site is located
SITE_LATITUDE	Test Site Latitude
SITE_ALTITUDE	Test Site Altitude
PLATFORM_TYPE	Type of Platform Available for experimentation
SITE_OCCUPANCY	Whether Test Site has any help available
WSTATION	Nearest weather station
LAND_TERRAIN	Description of Test Site Terrain
SITE_INFRA	What is the infra-structure at the Test Site (power, water, etc)
COMMENTS	General Comments

3.2 Database Interface

Database interface design consists of three components; one to allow access to the Oracle database, the second is to access the information in the database, and the third to provide the web interface for user information and display of results. The interfaces to the Oracle database constitute login/logout, parsing of the sequential query language (SQL) statement, and results. These interfaces were developed using ORAPERL and DB software packages. In addition DB functions were used to validate the user access and monitor authorized user accessing the server. For the remaining two interface components, PERL programs were used to provide user functions such as accessing questionnaires, querying databases, and revising/updating information. Common library functions were developed that are continuously accessed by various PERL programs. Examples of these library functions include check/conversion of date format, user authentication every time user clicks on a link or function, email notification, and validation of data for its size and data type before data is written into the database. Such library functions protect quality of the data and also notify the administrator of any errors. If the data have errors the interface does not write data into the database but sends all the data to the designated administrator as an email message. Once the administrator rectifies the errors, the administrator writes the data into the database.

A World Wide Web server using an Apache http server and the Unix operating system on a SUN workstation was created. This server is available 24 hours a day 7 days a week

Table 2 Instrument Database Table Fields

Field Name	Description
INSTRU_ID	Unique Identification
INFO_BY	Name of the person who is providing information
EMAIL	Email of the person providing information
INSTRU_NAME	Name of the Facility
CONTACT_NAME	Contact Person's Name
CONTACT_STREET	Contact Person's Street Address
CONTACT_CITY	Contact Person's City Name
CONTACT_STATE	Contact Person's State
CONTACT_ZIP	Contact Person's Zip Code
CONTACT_COUNTRY	Contact Person's Country
CONTACT_PHONE	Contact Person's Phone number
CONTACT_FAX	Contact Person's Fax Number
CONTACT_EMAIL	Contact Person's Email
INSTRU_DES	Facility Description
FUTURE_PLANS	Description of future plans
PUBLICATIONS	List of publications
URL	Universal Record Locator
COMMENTS	General Comments

4. CAL/VAL SERVER FUNCTIONALITY

4.1 Server Access

Server access is largely un-restricted for submitting and browsing information that is in the database. On accessing the information server, the system displays USERID=GUEST and PASSWORD=GUEST as login for general users, while authorized users are required to enter their userid and password allowing those users to perform additional functions. Access to these functions is based on pre-defined access levels that are assigned at the time the userid and password are created. Access levels are created based on the functions to be performed by various users. These include the following: Level 1 users are users who are allowed to browse the information in the database and submit information; Level 2 users are users who have Level 1 access and also can update/revise information in the database and change user passwords; and Level 3 users are

administrators who have super user access, can perform Level 1 and 2 functions, and can create users, change passwords or any other information in the database. User access is controlled through two tables and PERL scripts. The two tables are the USER_TBL table which lists users with user access privilege and the USERLOG table which stores the user accesses log with the access level. Scripts are used to check the user access, to record the user in USERLOG, and to allow appropriate access by dynamically generating a restricted access menu. If a user access is idle for at least 2 hours, the user will be automatically disconnected from the system by a PERL program interface that is running continuously in the background.

4.2 User Functions

Cal/Val Information Server functionality provides a user interface to provide data and store information in the database. These data are then made available to the users through selected query and search capabilities for reviewing, browsing, and generating various reports. In addition those functions with proper authorization can revise, update, and change passwords. All functions are accessible from the World Wide Web and forms are provided for information input as the results are displayed in html table format. These functions are briefly outlined below.

Table 3 Laboratory Database Table Fields

Field Name	Description
LAB_ID	Unique Identification
INFO_BY	Name of the person who is providing information
EMAIL	Email of the person providing information
LAB_NAME	Name of the Facility
CONTACT_NAME	Contact Person's Name
CONTACT_STREET	Contact Person's Street Address
CONTACT_CITY	Contact Person's City Name
CONTACT_STATE	Contact Person's State
CONTACT_ZIP	Contact Person's Zip Code
CONTACT_COUNTRY	Contact Person's Country
CONTACT_PHONE	Contact Person's Phone number
CONTACT_FAX	Contact Person's Fax Number
CONTACT_EMAIL	Contact Person's Email
FACILITY_DES	Facility Description
FUTURE_PLANS	Description of future plans
PUBLICATIONS	List of publications
URL	Universal Record Locator
COMMENTS	General Comments
LAB_STREET	Street Address of the facility
LAB_CITY	Laboratory's City Location
LAB_STATE	Laboratory's State Location
LAB_ZIP	Laboratory's Zip Code
LAB_COUNTRY	Laboratory's Country
CLEANROOM_FAC	Clean room facility description and the Clean room class
THERMAL_VACUUM	Whether Thermal Vacuum is available
MEASURE_DES	Description of measurements that are conducted at the laboratory

4.2.1   Submit: The questionnaire form is accessed by any user to provide information on Test Site, Laboratory, or Instruments to the Cal/Val database using the submit function.. Users are required to provide their name and e-mail address. Such information is mandatory, without which response to the questionnaire will not be accepted. When a response to the questionnaire is submitted, the program automatically performs the following steps in sequence: a) validates the data, b) sends an email to the Cal/Val Administrator with the submitted information, c) writes into the

database, and d) sends an email to the submitter providing the userid and password for future revision or updates. In the case that the user has submitted information before, the system does not assign a new userid and password. This information permits the submitter to review the submitted information or update it at a later date.

4.2.2   Query: The query function provides a selection option for the Test Sites, Instruments, or Laboratories and allows users to browse the information that is in the database for the selected option. A query form allows users to enter desired information in one or more then one field, and the search program will return the list that matches the search criterion. If no fields are filled in, the search will return the full listing for the selected option. The user has the option of choosing to match individual selected fields or to match all selected fields in the database.

4.2.3   Download: The three questionnaires have been stored on the server for users to download and submit as a file or by fax. The download formats are rich text format, postscript and sylk.

4.2.4   Authorized Functions: These functions include Revise, Administrative and Change Password and require a userid and password. Once access is authorized, the user may revise the password or update/revise the information in the database. To change a password, the system requires an old password and a new password. On submitting this information, the program will email confirmation of the change of the password to the user. To revise/update information, the user selects the revise function and the program will display a listing of all the information that the authorized user had submitted. A user can only see his/her submitted information. The user is required to select the item from the list that is to be revised and the program will display all of the information on that item in the form format. Once revisions are made and information is submitted to the database, the program will validate the data, send an email to the Cal/Val Administrator, writes the data to the database, and send an email confirmation to the submitter. The Administrative option allows the Cal/Val Administrator to create accounts, change passwords, and correct any information in the database.

4.2.5   Comments: Users are provided with a feature of submitting on-line comments to report any error or suggestion.

5. RESULTS

Over 300 emails were sent with the three questionnaires attached to people who were identified as possible of information. A letter describing the purpose and containing instructions on how to access the web-based system for submitting information was also mailed with the questionnaires. The distribution of mail to over 23 countries and the number of responses from these countries are shown in Table 4. Approximately 14 percent of the people who received mail responded to the survey. More than 50 percent of the total questionnaires were mailed to USA facilities and a similar percentage of responses were received from the USA. All of the responses except one provided information using the on-line Submit feature of the Cal/Val World Wide Web Server. These responses provided information on a total of 65 Test Sites, 14 Laboratories, and 21 Instruments that are located worldwide. Responses are still being received and, through the auspices of the CEOS WGCV, additional responses are encouraged.

Table 4: Distribution of Questionnaires to Various Countries World Wide

Country	Number Mailed	Responses Received	Country	Number Mailed	Responses Received
AUSTRALIA	8	5	JAPAN	11	2
BELGIUM	1		KENYA	1	
BRAZIL	2	1	MEXICO	1	
BRUSSELS	1		NEW ZEALAND	2	1
CANADA	17	3	RUSSIA	7	
CHINA	10	1	SPAIN	1	
DENMARK	2		SWEDAN	3	
FRANCE	14		SWITZERLAND	5	2
GERMANY	15		NETHERLANDS	2	1
INDIA	4	1	U.K.	26	
ISRAEL	1		UKRAINE	2	
ITALY	9	1	USA	156	24
			Total	**303**	**42**

6. ACKNOWLEDGEMENTS

7. REFERENCES

1. Pilot Cal/Val Dossier 1993, Smith System Engineering, UK. Prepared on behalf of the CEOS working Group on Calibration and Validation
2. Test sites/Field Experiment Database (TFDB) 1993, Goddard Space Flight Center, NASA, Greenbelt, MD. USA