The Multi-Instrument Intercalibration (MIIC) Framework, a ROSES-2011 ACCESS Project

C. Currey1, A. Bartis2, C. Lukashin3, D. Doelling4, C. M. Rothmayr3, T. Thompson5, D. Johnson1, J. Gallagher1
1) NASA Langley Research Center, 2) Mechdyne, Virginia Beach, VA, 3) OpenNDAF, Inc.

1. MIIC Framework Objectives

A. Goal to access matched measurements within large datasets distributed across multi-agency international data centers
B. Support Inter-calibration & Inter-comparison studies
C. Operate in a distributed collaborative environment
D. Demonstrate feasibility and benefits of distributed services built on top of the OPeNDAP networking middleware and server-side functions

2. MIIC Framework Use Cases

LEO-GEO Inter-calibration

LaRC has a strong inter-calibration heritage with missions such as CERES and CLARREO in support of the Global Space based Inter-Calibration System (GSICS) science community. Climate quality measurements require accurate calibration. Intercalibration ties the calibration of one instrument to more accurate reference instruments by matching measurements in time, space, wavelength, and view angles. Typically < 0.1 % of the instrument data volumes are required for inter-calibration analysis. Software tools and networking middleware are needed to intelligently select and acquire matched samples from instruments on separate spacecraft. The MIIC Framework will demonstrate two use cases, 1) LEO-GEO inter-calibration using MODIS and GOES data, and 2) LEO-LEO inter-calibration using MODIS and SCIAMACHY data in a web-based distributed architecture. Matching measurements requires view angle filtering and spectral and resampling algorithms. For efficiency these algorithms are executed within server-side functions.

3. N-Tier Architecture

The Multi-Instrument Intercalibration (MIIC) Framework is a collection of software designed to work in an N-tier distributed architecture. The system consists of a Client/UI tier, an Application tier, multiple OPeNDAP data tiers, a local data cache, and a Two-Line Element (TLE) Tier (hosted by CERES). The Spring Framework, Tomcat container, and OPeNDAP provide the infrastructure to build the distributed MIIC web services including user interfaces, RESTful APIs, data repositories, and network security.

4. Software Components

MIIC services include event prediction, remote data acquisition, and data analytics. Software components are loosely coupled and configured to support enterprise web services using the Tomcat and Spring frameworks. Implementation uses the Model-View-Controller (MVC) pattern, Hibernate ORM, and open source libraries such as JAIDA, geeg, and JavaDAR.

5. Web Services – Event Prediction

The MIIC Framework provides three main web services: Event Prediction, Data Acquisition, and Analysis. These services, hosted within the main Application tier, support inter-calibration and inter-comparison workflows that access OPeNDAP data tiers located at various DAAC facilities including the Atmospheric Science Data Center at the NASA Langley Research Center. Data transmission between the application tier and the OPeNDAP data tiers adheres to the DAP2 protocol. The Event Prediction service determines locations and times when measurements from instruments on separate spacecraft have matched viewing conditions prior to remote data download. The Event Prediction service uses daily NORAD TLEs from a local web server for orbit propagation. The figures below depict how the event prediction works and typical output for both the LEO-LEO and LEO-GEO use cases.

6. MIIC/OPeNDAP Server-side Functions

A primary objective of the MIIC Framework is to conduct more processing at the remote data tiers responsible for archiving and serving out instrument datasets. This reduces the network traffic and disk storage required by consumers of the data. A number of OPeNDAP Hyrax enhancements including support for HTTP POST have been provided by OPeNDAP, Inc. to support server-side function development. MIIC server-side functions include spatial and spectral convolution, equal-angle gridding, and 1D and 2D histograms are being developed.

7. MIIC Analysis

The focus of the MIIC Framework is on intelligent selection and acquisition of remote data. Analysis on the client side is required to calculate calibration coefficients once matched samples are acquired from remote data servers. Results are saved to a PostgreSQL database. Generic and open source code allow extension of the analysis capabilities.

8. Summary

- The MIIC Framework is a collection of software designed to work in a distributed collaborative environment to support LEO-GEO and LEO-LEO inter-calibration (radiance) and other inter-comparison studies (eg., cloud properties).
- Intelligent subsetting based on orbit modeling significantly reduces the amount of data to access. Typically < 0.1 % of the instrument data volumes are required for inter-calibration.
- The MIIC Framework provides an efficient infrastructure to improve access to L1 and L2 datasets at remote sites.
- GOAL is to deploy MIIC services at the LaRC ASDC and NOAA NCDC archives and generalize software to support additional datasets.