Introducing HYDRA2 – a Multispectral Data Analysis Toolkit for Suomi NPP and EOS

Tom Rink, W. Paul Menzel, Liam Gumley, and Kathy Strabala

Space Science and Engineering Center
Madison, Wisconsin, 53706 USA

Abstract

A freeware based multispectral data analysis toolkit for satellite data has been developed to assist research and development of remote sensing applications as well as education and training of remote sensing scientists; it is called HYDRA2 - HYper-spectral data viewer for Development of Research Applications version2. HYDRA2 provides a fast and flexible interface that allows users to explore and visualize relationships between sensor measurements (displayed as brightness temperatures for infrared and reflectances for visible and near infrared) and wavelength (or wavenumber) using spectra diagrams, cross sections, scatter plots, multi-band combinations, and color enhancements on a pixel by pixel basis with full access to the underlying metadata of location and time.

HYDRA2 enables interrogation of multispectral (and hyperspectral) fields of data so that (a) pixel location and spectral measurement values can be easily displayed; (b) spectral bands can be combined in linear functions and the resulting images displayed; (c) false color images can be constructed from multiple spectral band combinations; (d) scatter plots of spectral band combinations can be viewed; (e) pixels in images can be found in scatter plots and vice versa; (f) transects of measurements can be displayed, and (g) soundings of temperature and moisture as well as spectra from selected pixels can be compared.

HYDRA2 is a toolkit that can be used with direct broadcast and archived data from Suomi NPP and the EOS Aqua and Terra platforms.

1. Design Philosophy of HYDRA

HYDRA2 (Hyper-spectral data viewer for Development of Research Applications version 2) grew out of the necessity to provide research scientists and educators with freely available software that could display and investigate remotely sensed multispectral and hyperspectral data. HYDRA2 is a fourth generation application produced at the University of Wisconsin's Space Science and Engineering Center (SSEC). The first three were based on commercial packages IDL, Matlab, and Java; they served as a testbed to refine the operations and functionality requested by the users.

When considering the design of HYDRA2, the most important requirements were that the software must be (a) freely available to the global community, (b) computer platform independent, and (c) extendable. Computer platform independence has been elusive in so far as HDF libraries still are required to view the data. To this end the Java-NetCDF

library from Unidata, which provides a platform independent, multi-array access API to a wide range of file storage formats, is employed to provide access to HDF4/5, used for NASA EOS and SuomiNPP. The VisAD (Visualization for Algorithm Development) Java library was selected as the basis for HYDRA2; Hibbard et al (2002) has more information about VisAD. This library allows applications to be written in either Java or Jython, the Java implementation of the popular Python scripting language; more details are available in Bill (2002) and Lutz et al (1996). The core of the VisAD library is a unified Data Model, which allows for the representation of literally any numeric data in a consistent manner. This is very important when integrating data from a variety of sources that may have different sampling topologies in space or time. The Data Model also has built-in metadata for parameters such as units and error estimates. Because these metadata are an integral part of the data, they can be easily used to verify the validity of computations (the software detects invalid combinations, such as adding a temperature to a pressure) and to estimate the reliability of computations.

HYDRA2 is a standalone client application organized into a simple hierarchy of Java classes leveraging the VisAD library, the aforementioned Java-NetCDF library and a higher level, VisAD based library from Unidata for handling map projections and geo navigated displays. HYDRA2's design layout separates classes responsible for generating displays, interactive data interrogation, custom analysis tools and provides a programmatically extendable interface for adapting physical data to VisAD's abstract data model.

The programmatic interface to the data files has been designed so that emerging new file types or formats will be easy to support without changing the core of the applications. The key was to abstract the reading of the files so that the application makes the same function or method calls regardless of the file being read. This same philosophy is used in packages such as OpenDAP and ESML, which have the notion of a plug-in.

2. Getting and Setting Up HYDRA2

The latest stable version of HYDRA2 can be obtaining from the following ftp site:

ftp://ftp.ssec.wisc.edu/pub/CSPP/beta/hydra2/

For Windows Operating Systems (OS) (XP, VISTA 7 and 8) download the 'exe' file for latest version using binary ftp mode, and then run it by double-clicking the file icon. The installer will ask where you wish to install the program. Accept the default, C:\Program Files\HYDRA2. Start the program by selecting Start | All Programs | HYDRA2 | runHYDRA. A window named "HYDRA" will appear (Figure A1); it will indicate the version you are using. A window named "runHYDRA" will also appear (this window may be minimized, but do not close it).

For Mac OSX use the 'dmg' installer and simply double-click to install into the /Applications folder. To start HYDRA2, double-click the icon in that folder. The icon can also be dragged to the applications docking station after which a single click of the icon will start the application.

For the Linux OS (64bit), the 'sh' installer will extract into the directory of choice, or use the 'tar.gz' and install by entering "gzip -cd hydra_v1.5_linux.tar.gz| tar xvf – " at a command prompt. This will create a sub-directory named "hydra" into which everything required to run will be installed. To run HYDRA, first change directory into the 'hydra' directory, and enter "./runHydra" at the command prompt.

Acknowledgements

This paper relied on the active participation in beta testing the HYDRA2 freeware by many students and international colleagues. We thank them for their enthusiasm and useful feedback. Funding from the NASA IMAPP (International MODIS and AIRS Processing Package) and the NOAA CSPP (Community Satellite Processing Package) programs is gratefully acknowledged.

References

Aumann, H.H., M. Chahine, C. Gautier, M. Goldberg, E. Kalnay, L. McMillin, H. Revercomb, P. Rosenkranz, W.L. Smith, D. Staelin, L. Strow and J. Susskind, 2003: AIRS/AMSU/HSB on the Aqua Mission: Design, Science Objectives, Data Products, and Processing Systems. IEEE Transactions on Geoscience and Remote Sensing, **41**, 253-264.

Barnes, W. L., T. S. Pagano, and V. V. Salomonson, 1998: Prelaunch Characteristics of MODIS on EOS-AM1. IEEE Transactions on Geoscience and Remote Sensing, **36**, 1088-1100.

Bill, R. W., 2002: Jython for Java Programmers. New Riders Publishing. ISBN 0-7357-1111-9. Pp. 465.

eoPortal https://directory.eoportal.org/web/eoportal/satellite-missions/a/aqua

eoPortal https://directory.eoportal.org/web/eoportal/satellite-missions/m/metop

eoPortal https://directory.eoportal.org/web/eoportal/satellite-missions/s/suomi-npp

eoPortal https://directory.eoportal.org/web/eoportal/satellite-missions/t/terra

Hibbard, W., C. Rueden, S. Emmerson, T. Rink, D. Glowacki, T. Whittaker, D. Murray, D. Fulker, and J. Anderson, 2002: Java Distributed Objects for Numerical Visualization in VisAD. Communications of the ACM, **45**, 160-170.

Klaes, K. D., and Coauthors, 2007: An introduction to the EUMETSAT polar system. Bull. Amer. Meteor. Soc., **88**, 1085–1096.

Lutz, M., G. Rossum, L. Lewin, and F. Willison, 1996: Programming Python. USENIX. Mark Lutz Programming Python O'Reilly & Associates, 1996. ISBN 1-56592-197-6. Pp. 880.

Murphy, R. P., P. E. Ardanuy, F. DeLuccia, J. E. Clement, and C. Schueler, 2006: The visible infrared imaging radiometer suite. Earth Science Satellite Remote Sensing, vol. 1, 199-223. Springer Verlag, 2006.