Demonstration of HDF5-DODS Server Prototype with the DODS-Ferret Client

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1. Motivation of the demo

In this document, we will use an example to demonstrate how the HDF5-DODS server prototype can be used in a real scientific application, Ferret [1,2]. The DODS-HDF5 server enables a DODS equipped Web server to provide data from HDF5 files [4]. This allows any DODS client to begin to use data from HDF5 with no changes to the client. We demonstrated this with the Ferret client, which previously used data from HDF4 via DODS, and now can access similar data from HDF5. No change was necessary to Ferret.

2. General Procedures

The Ferret tool [1] can use netCDF data from local files, and also can access remote datasets, netCDF and HDF4 using the Distributed Oceanography Data System (DODS)[2]. Data from any of these sources can be visualized by Ferret. Figure 1 illustrates Ferret's data accesses.

One of the sources for remote data is the Physical Oceanography Distributed Active Archive Center (PODAAC) of Jet Propulsion Laboratory (JPL)[3]. The PODAAC provides remote sensed oceanographic stored in HDF4 and other formats. The PODAAC also has a DODS-HDF4 server, which provides some of its data holdings via DODS. The data used is ocean wind fields observed by NASA SSMI Sensor [8]. The

ocean wind data can be accessed by Ferret across the Internet using DODS, as shown in Figure 1. An example visualization from is shown in Figure 2.

For this demonstration, an HDF4 dataset of ocean wind data was retrieved from PODAAC. The HDF4 file was converted to an equivalent HDF5 dataset using the *h4toh5* utility [7].

The converted HDF5 dataset contains the data and attributes from the HDF4, following the HDF4 to 5 mapping specification [6]. The conversion required a few seconds, and no special post-processing was required, the converted file was used with the default conversion. Figure 3 shows this step.

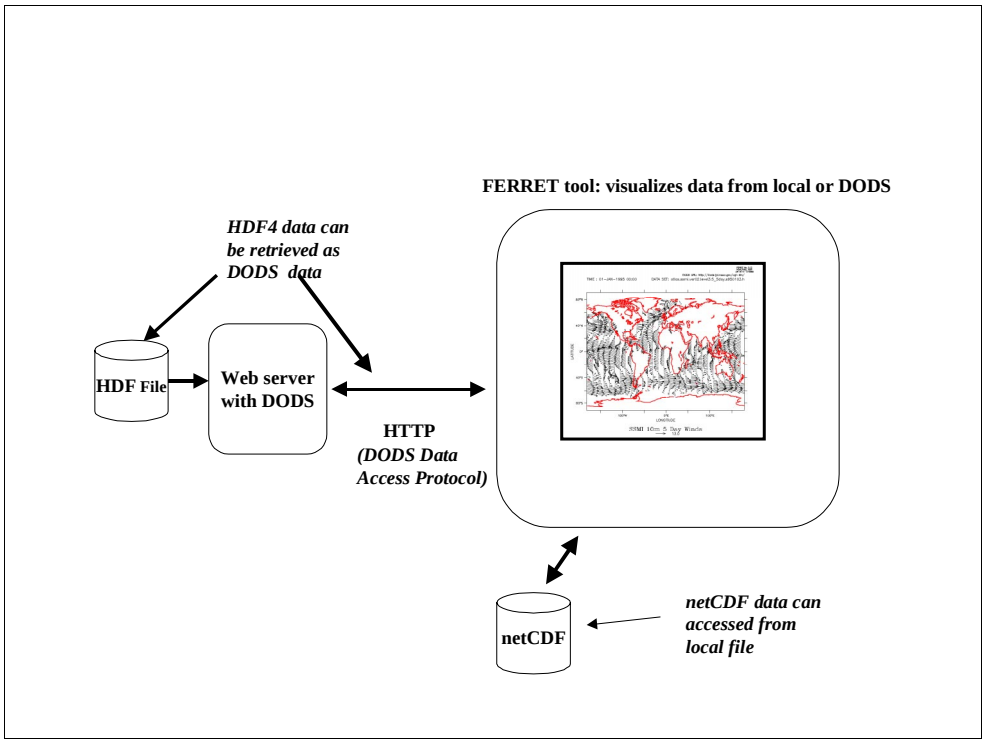

Figure 1. Ferret accesses data from local files or remotely via a DODS enabled Web server.

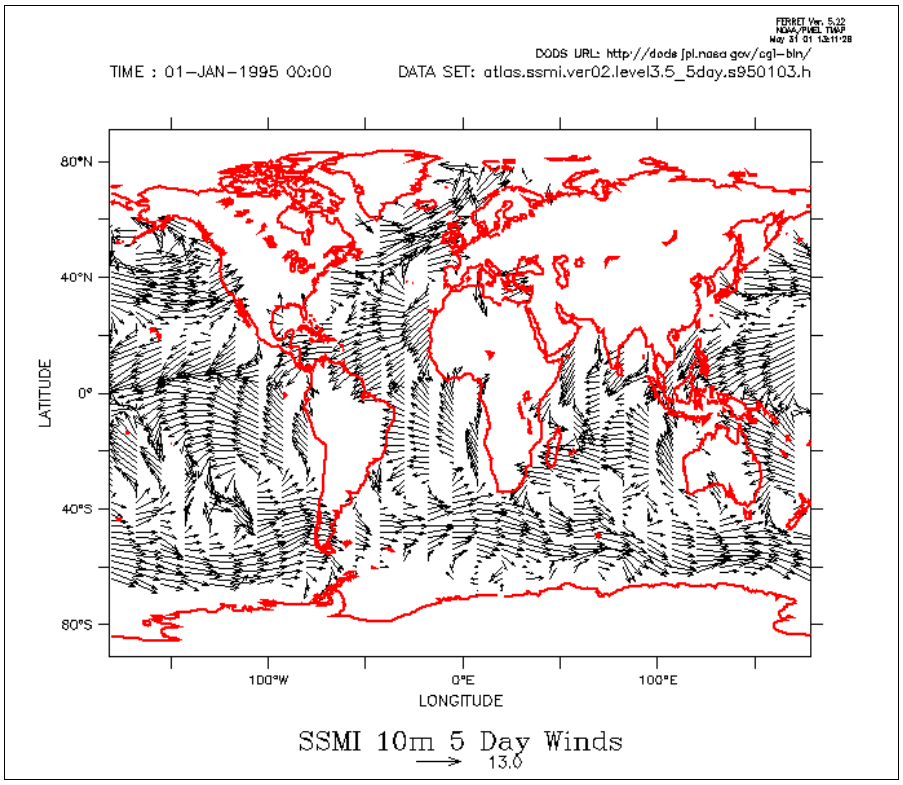

Figure 2. The Ferret visualization of Ocean Winds data obtained from JPL.

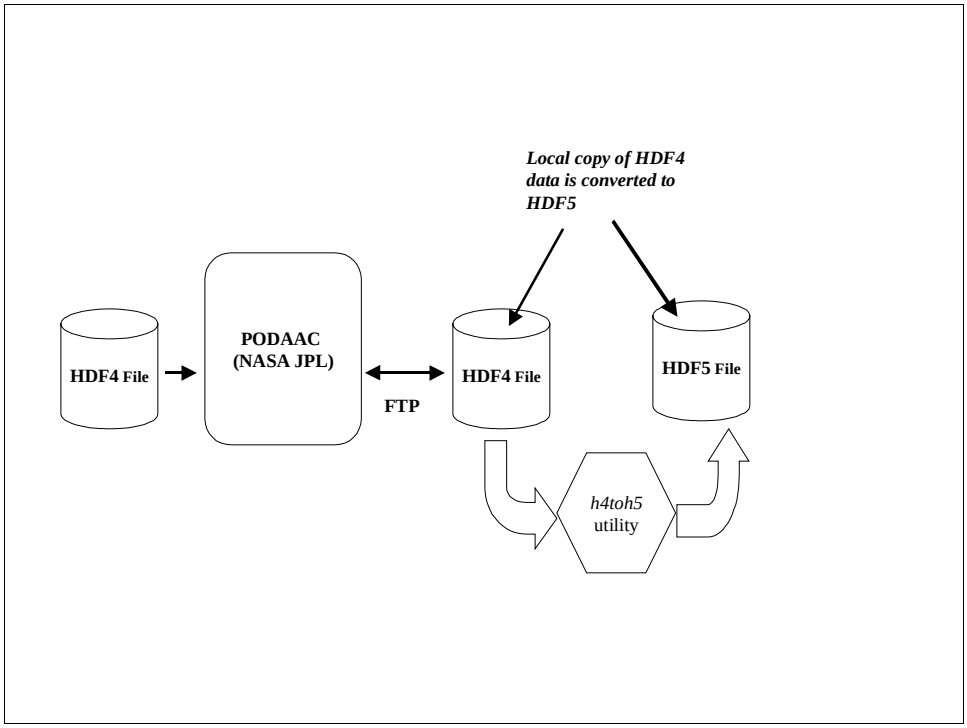

Figure 3. Downloaded HDF4 from PODAAC, converted to HDF5.

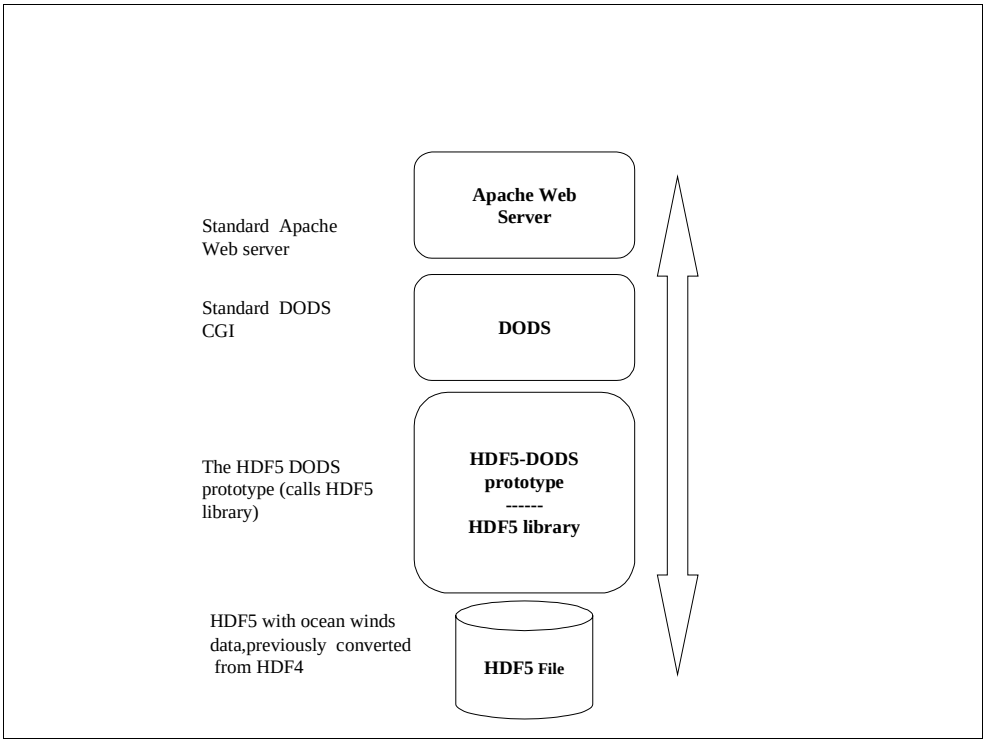

Figure 4. Demonstration server, using Apache, DODS, and the HDF5-DODS prototype.

An Apache Web server was set up on a local Linux system [9]. The HDF5-DODS prototype server was installed as a CGI program on the local Apache Web server. The converted HDF5 file was put on the Web server. Figure 4 shows the components of the server. Table 1 lists the software used.

Table 1. Server software used.

Software	**Source**
Apache Web server, Version 1.3.19	http://www.apache.org
DODS, version DODS-dap-3.1.10	http://www.unidata.ucar.edu/packages/dods/home/sw.shtml
HDF5 DODS prototype	http://hdf.ncsa.uiuc.edu/HDF5/dodshdf5.html
HDF5 Library, V5.1.4.	http://hdf.ncsa.uiuc.edu/HDF5
Linux Red Hat Zoot 6.2, g++ 2.95	

With this configuration, it is now possible for Ferret to access the HDF5 data from the prototype HDF5-DODS server exactly it did with the HDF4 data from PODAAC. The only change that is needed is for the Ferret script to change a URL from PODAAC to the demo server. Thus, the scenario from Figure 1 is repeated, except the Web server is our test server. (Figure 1) The data received by the Ferret tool via DODS is identical in both cases, and Ferret works the same for the HDF4 or converted HDF5. Figure 5

shows the Ferret visualization of the HDF5 data: it is identical to Figure 2 except for the URL in the upper right.

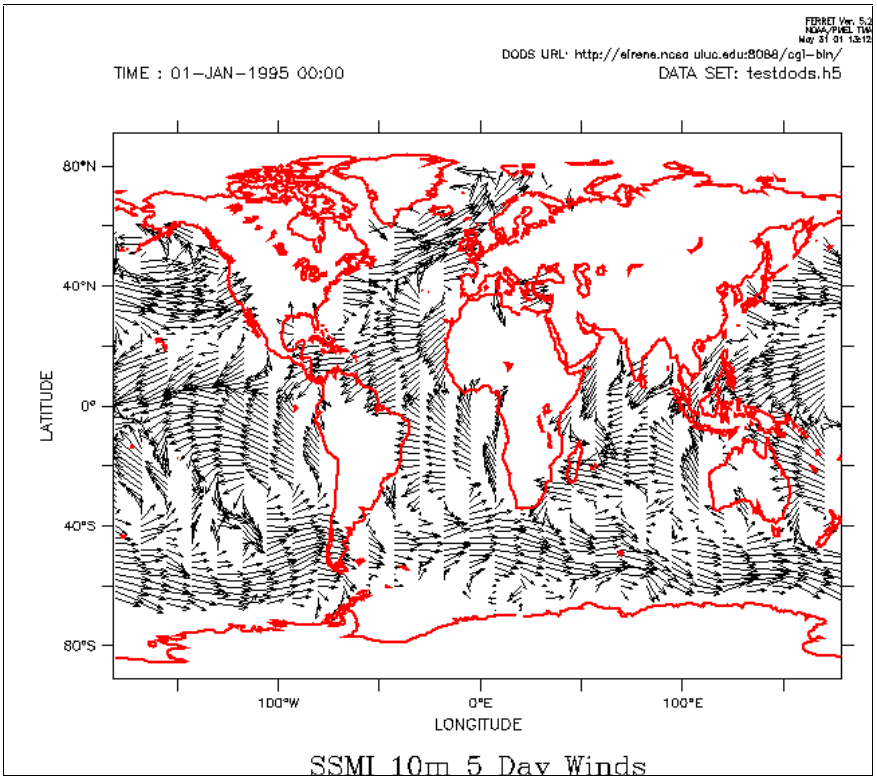

Figure 5. The Ferret visualization of data from HDF5.

DODS-HDF5 server also provides subsetting functionality. With the Ferret one can do hyperslab subsetting of this example, one can refer to Appendix A for more details.

3. Conclusion

This demonstration showed that HDF5-DODS server prototype can be used to work with real scientific applications supported by DODS. The Ferret tool was able to use both HDF4 and HDF5 data transparently, with no modification to the tool. This demonstrates the advantage of using DODS to access data from various formats.

The demonstration also showed that the default conversion by the *h4toh5* utility was sufficient to be used in DODS. Also, the conversion was very efficient, requiring only a few seconds for the SSMI dataset (about 8 MB). This shows that it would be possible to convert the whole contents of the archive to HDF5 in a few hours, or to convert from HDF4 to HDF5 on demand, e.g., extend the DODS HDF5 server to convert HDF4 files into HDF5.

Acknowledgements

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References

1. “DODS”, http://www.unidata.ucar.edu/packages/dods/

2. “Ferret: data Visualization and Analysis”, http://Ferret.wrc.noaa.gov/Ferret/

3. NASA Jet Propulsion Laboratory, “Physical Oceanography Distributed Active Archive Center”, http://podaac.jpl.nasa.gov/

4. M. Yang and R. E. McGrath, DODS white paper: http://hdf.ncsa.uiuc.edu/apps/dods/HDF5-DODS-white-paper.doc

5. The sample data used in this demo was the SSMI data for 3 January 1995: ftp://poseidon.jpl.nasa.gov/pub/ocean_wind/ssmi/atlas_ssmi/hdf/data/level3.5_5day/1995/atlas.ssmi.ver02.level3.5_5day.s950103.hdf

6. Mike Folk, Robert E. McGrath, Kent Yang “Mapping HDF4 Objects to HDF5 Objects”, http://hdf.ncsa.uiuc.edu/HDF5/papers/h4toh5/

7. *h4toh5*, http://hdf.ncsa.uiuc.edu/HDF5/doc/Tools.html#Tools-H4toh5

8. “SSM/I derived global ocean surface-wind components '87-'96 (Atlas et al.)” http://podaac.jpl.nasa.gov/order/order_ocnwind.html#Product079

9. “Apache.org”, http://www.apache.org

Appendix A: Detailed procedure

This appendix gives more detailed instructions for how to set up and run a Ferret demo.

1. Set up the Web server, DODS, and the HDF5-DODS prototype

1) Set up a Web Server

If you have a Web server already, you can use it. If not, then you can set up an Apache Web server. Go to apache web site (http://www.apache.org) to download apache server source code and follow the instruction to set up the apache server.

2) The DODS Server

Install the DODS server as a CGI program. Download DODS and compile it. Go to the directory where DODS is installed, find the document "INSTALL-servers". Follow the instruction of INSTALL-servers, to copy all the third-party files to the *cgi-bin* directory of your web server.

3) Install the HDF5-DODS Prototype

Download the HDF5-DODS prototype ({URL}). Build according to the instructions.

Copy *nph-h5* (HDF5-DODS server CGI program), *h5_dods*, *h5_das*, *h5_dds* (see [4] for details) into the *cgi-bin* directory of your web server.

4) Obtain Sample HDF5 Data

To obtain the sample HDF4 data, go to PODAAC of JPL. The example can be found in the following ftp site:
ftp://poseidon.jpl.nasa.gov/pub/ocean_wind/ssmi/atlas_ssmi/hdf/data/level3.5_5day/1995/atlas.ssmi.ver02.level3.5_5day.s950103.hdf

Use *h4toh5* converter utility implemented at NCSA to convert this HDF file into an HDF5 file. (The *h4toh5* utility is part of the HDF5 distribution.)

Copy the HDF5 file(s) to the Web server, in an appropriate location under *htdocs*.

5) A Manual Check of the Server

You can check that the DODS server is functioning correctly by retrieving the DDS and DAS with a Web browser. Retrieve the data with the following the syntax:

To check the DODS DDS: http://yourhost.net/cgi-bin/nph-h5/testdods.h5.dds

To check the DODS DAS: http://yourhost.net/cgi-bin/nph-h5/testdods.h5.das

2. Set up Ferret

Ferret is an interactive computer visualization and analysis environment for oceanographers and meteorologists analyzing large and complex gridded data sets. Currently it can serve as a DODS client to visualize grid data.

1) Obtain and install Ferret

Go to Ferret's home page [2] to download the freely distributed Ferret software.

2) Install Ferret Demo Scripts

To replicate the demonstration, copy *dods_demo.jnl*, *dods_jpl.jnl* and *dodsnew_jpl.jnl* listed in the Appendix B of this document into the directory where Ferret can open and run them.

3) Run Ferret

1) Select and open the script called *dods_demo.jnl*

2) Click OK when PAUSE appears. You should first see wind vectors over all the oceans. (Figure 3 above) Notice the URL on the top-right corner of the image. It should be from PODAAC.

3) Click OK when PAUSE appears to continue running the script. You should see the same image appear again, this time the URL is from your local HDF5-DODS server. (Figure 5 above).

4) Go to the upper part of the Ferret Main Window, find "select" box, select your own HDF5 data file and wind fields U10M, V10M.

5) Go to the lower part of Window, you should see a global map. Move your mouse to select the desired area, click the plot box just above the box; you should see the subsetting plot of wind vector U10M and V10M. Go to the Main menu of Main Window, find "Scripts" and choose either Land Outline or Solid Land, you can see the land boundary at the plot.

6) You may choose different subsetting options of Ferret to display.

If you prefer, you may open two Ferret windows and compare the image running from PODAAC and your local HDF5-DODS server. The result should be the same.

Appendix B

This Appendix includes listings for three Ferret scripts that run the demo. They are *dods_demo.jnl*, *dods_jpl.jnl* and *dodsnew_jpl.jnl*.

I) script of dods_demo.jnl

```
!-----------------------------------------Cut here ------------------------------------------------------
cancel mode verify

cancel region

! dods_demo.jnl
!
! Description: Demo: how to use Ferret and DODS to access remote HDF5 Datasets
!

set mode verify


!  Go to JPL to grab JPL ocean wind data(an HDF file) from the HDF-server
!  running there


PAUSE
!      ************************************************************


go dods_jpl ocean_wind/ssmi/atlas_ssmi/hdf/data/level3.5_5day/1995/atlas.ssmi.ver02.level3.5_5day.s950103.hdf
!go dodsnew_jpl testdods.h5
show data

! Let's look at the 10m Wind field

PAUSE
!      ************************************************************


vector/xskip=5/yskip=1/l=1 u10m, v10m


! Notice that the plot is not correctly referenced to geophysical or
! time coordinates. (The time label, in fact, is misleading.)
! By consulting the documentation at JPL
! (see http://podaac.jpl.nasa.gov:2031/DAAC_DOCS/catalog.html)
! we are able to define the correct grid and "fix" the data set

PAUSE
!      ************************************************************

define axis/x=-180:177.5:2.5/units=long xjpl
define axis/y=-90:90:2/units=long yjpl
define axis/t="1-jan-1995":"31-dec-1995":5/units=days tjpl
define grid/x=xjpl/y=yjpl/t=tjpl gjpl
vector/title="SSMI 10m 5 Day Winds"/xskip=5/yskip=1/l=1 u10m[g=gjpl@asn], v10m[g=gjpl@asn]go land 8

! Now run another script, go to the local HDF5 server at NCSA to
! retrieve the HDF5 data converted from the previous HDF data at JPL by using HDF4 to
! HDF5 converter.

go dodsnew_jpl testdods.h5
show data

! Let's look at the 10m Wind field

PAUSE
```

```
!      ************************************************************
! You should see the same wind fields as the data from JPL.

vector/xskip=5/yskip=1/l=1 u10m, v10m


! Notice that the plot is not correctly referenced to geophysical or
! time coordinates. (The time label, in fact, is misleading.)
! By consulting the documentation at JPL
! (see http://podaac.jpl.nasa.gov:2031/DAAC_DOCS/catalog.html)
! we are able to define the correct grid and "fix" the data set

PAUSE
!      ************************************************************

define axis/x=-180:177.5:2.5/units=long xjpl
define axis/y=-90:90:2/units=long yjpl
define axis/t="1-jan-1995":"31-dec-1995":5/units=days tjpl
define grid/x=xjpl/y=yjpl/t=tjpl gjpl
vector/title="SSMI 10m 5 Day Winds"/xskip=5/yskip=1/l=1 u10m[g=gjpl@asn], v10m[g=gjpl@asn]go land 8
!--------------------end of dods_demo.jnl ----------------------------------------
```

II) Script of dods_jpl.jnl

```
!cancel mode verify
! dods_pmel.jnl - 4/99 *sh and *kob*

! DESCRIPTION: "Use" a dods data set from JPL

! usage:             arg 1
!       GO dods_pmel data_set

! examples:
!  blah blah

! Set the base DODS URL for this supplier
DEFINE SYMBOL dods_base_url "http://dods.jpl.nasa.gov/cgi-bin/nph-hdf/pub/"

! check if data set argument was given. If not, do a query
IF   $1"True|*>False|"  THEN
  sp netscape ftp://podaac.jpl.nasa.gov/pub &
  SAY ----------------------------------
  SAY "Spawning external viewer to display listings of Available Data"
  SAY " "
  SAY "The base URL is:  ($DODS_base_url)"
  SAY " "
  SAY "Example:"
  SAY "go dods_jpl ocean_wind/ssmi/atlas_ssmi/hdf/data/level3.5_5day/1995/atlas.ssmi.ver02.level3.5_5day.s950103.hdf
"
  QUIT
ENDIF

!!! ==>
! NOTE 1: If a given supplier has a Web site at which the list of data
! sets can be seen, the QUERY option can be used here to bring up a Web
! browser pointing to that site

! NOTE 2: abbreviations for data set names can be created here

! abbreviation examples
IF  $1"|atlas950103>1|*>0|" THEN
  DEFINE SYMBOL DODS_data_set
ocean_wind/ssmi/atlas_ssmi/hdf/data/level3.5_5day/1995/atlas.ssmi.ver02.level3.5_5day.s950103.hdf
  !DEFINE SYMBOL DODS_data_set new.hdf

! all non-abbreviated data set (INCLUDING BLOOPERS!!)
ELSE
  DEFINE SYMBOL DODS_data_set $1
ENDIF

! SET DATA
SET DATA "($DODS_base_url)($DODS_data_set)"

! clean up
SET MODE/LAST verify
!-----------------end of dods_jpl.jnl
```

III) Script of dodsnew_jpl.jnl

```
!----------------------cut here ----------------------------------
cancel mode verify
! dods_pmel.jnl - 4/99 *sh and *kob*

! DESCRIPTION: "Use" a dods data set from JPL

! usage:              arg 1
!       GO dodsnew_jpl data_set

! examples:
!  blah blah

! Set the base DODS URL for this supplier
! You may use your own DODS web server.

DEFINE SYMBOL dods_base_url "http://dodstest.ncsa.uiuc.edu:8088/cgi-bin/nph-h5/"

!!! ==>
! NOTE 1: If a given supplier has a Web site at which the list of data
! sets can be seen, the QUERY option can be used here to bring up a Web
! browser pointing to that site

! NOTE 2: abbreviations for data set names can be created here

! abbreviation examples
! testdods.h5 is the HDF5 file converted from
! atlas.ssmi.ver02.level3.5_5day.s950103.hdf

IF  $1"|atlas950103>1|*>0|" THEN
  DEFINE SYMBOL DODS_data_set testdods.h5

! all non-abbreviated data set (INCLUDING BLOOPERS!!)
ELSE
  DEFINE SYMBOL DODS_data_set $1
ENDIF

! SET DATA
SET DATA "($DODS_base_url)($DODS_data_set)"

! clean up
SET MODE/LAST verify

!--------------end of dodsnew_jpl.jnl--------------------------------
```