A I P S L E T T E R

Volume XXXVI, Number 2: December 31, 2016

A newsletter for users of the NRAO
Astronomical Image Processing System

Written by a cast of *AIPS*

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General developments in *AIPS*

Reduction of VLB, VLA and ALMA data in *AIPS*

AIPS continues to be the main software system for the reduction of VLBI data from the VLBA and other telescopes. Since 2010, there have been numerous improvements to *AIPS* that enable full calibration of data from the Karl G. Jansky VLA and most imaging operations as well. The one exception is the wide-band (bandwidth synthesis) deconvolution algorithm ("MSMFS") being developed in CASA by Urvashi Rao Venkata, for which there is no comparable function in *AIPS*. Calibrated *uv* data may be exported from *AIPS* in "UVFITS" format for use in that program. ALMA data may also be reduced in *AIPS*, although the package is not fully qualified to calibrate data from linearly-polarized feeds. See Appendix E of the *AIPS* Cookbook, available via the *AIPS* web site, for details.

AIPSLetter publication

We have discontinued paper copies of the *AIPSLetter* other than for libraries and NRAO staff. The *AIPSLetter* will be available in PostScript and pdf forms as always from the web site listed above and will be shipped with all distributions of *AIPS*. It will be announced on the bananas and MNJ list servers and, usually, in the NRAO e-News mailing.

Current and future releases

We have formal *AIPS* releases on an annual basis. We recommend a full binary installation method for both the frozen and development versions for MacIntosh OS/X (PPC and Intel chips), Solaris, and Linux (32- and 64-bit) systems, but all architectures can do a full installation from the source files. If you develop *AIPS* code locally *or have system managers that forbid the use of* `rsync` or `cvs`, you will need to do a source-level installation. The current release is called `31DEC16` and is now "frozen." If you took a development copy of this version at some earlier date, you should use the "Midnight Job" (MNJ) to bring it up to date. You need to run a MNJ only once in 2017 to convert your copy of `31DEC16` into the frozen version. However, when patches to `31DEC16` are announced in 2017, you may apply them with the MNJ. This *AIPSLetter* is intended to advise you of corrections and improvements in this release.

We have begun a new version, called `31DEC17`, which is now under development by the *AIPS* Group. You may fetch and install a complete copy of this version at any time. Having fetched `31DEC17`, you may update your installation whenever you want by running the MNJ. This uses `cvs`, `rsync`, and/or transaction files to copy all changed text files and then to copy the binary files or to compile the code selectively based on the code changes and compilations we have done. We expect users to take their source-only or binary version of `31DEC17` *AIPS* over the Internet (via *anonymous* ftp). Both versions require you to copy the installation procedure `install.pl` via `ftp`; the source-only version also requires you to ftp the 131-Mbyte `31DEC17.tar.gz` compressed tar file. Binary installations use only `rsync`, while locally compiled versions also use `cvs`. Linux sites will almost certainly have `cvs` installed; other sites may have installed it along with other GNU tools. Secondary MNJs will still be possible using `ssh` or `rcp` or NFS as with previous releases. We have found that `cvs` works very well, although it has one quirk. If a site modifies a file locally, but in an *AIPS*-standard directory, `cvs` will detect the modification and attempt to reconcile the local version with the NRAO-supplied version. This usually produces a file that will not compile or run as intended. Use a new name for the task or put a copy of the task and its help file in a private disk area instead.

Installing a new version

If compiling locally, new releases must be installed from the tar ball for that release. `31DEC15` and later versions contain improvements to the code which should make local compilation more reliable. If using the binary installation, a full new installation must also be done with `rsync`. When installing a new *AIPS* release in a system that already has a previous release, we recommend that `install.pl` be used and that the previous release be left in place, at least until the new installation has been verified. If you do this, then you will not have to re-edit the disk, printer, and tape lists and can simply skip all those pages in the `install.pl` menus. The old `$HOME/.AIPSRC` file may be left in place, but it will need to be edited. The lines giving the `DOWNLOADED` and `UNPACKED` parameters should be cleared and the `CCOMOPT` line should be changed to point to the current release rather than the previous one. If you have made a special version of `do_daily.`*host*, you should preserve it under a new name and restore it after the install. If you have an odd set of *AIPS* versions, the `$AIPS_ROOT/AIPSPATH.*SH` files may need to be edited after the install to set the desired versions. The file `$SYSLOCAL/UPDCONFIG` also needs to be edited to correct your e-mail address(es).

`31DEC09` contains a change in the format of antenna files. Previous releases will not understand the antenna coordinates for arrays that were traditionally left-handed (VLBI primarily). The format change occurs automatically when any `31DEC09` or later antenna-file specific code reads the file, after which older releases will have difficulties. `31DEC15` contains a change in the headers of uv data sets which will not be understood by previous versions. Note that the only version which we patch for major errors is `31DEC16`; even `31DEC15` is no longer changed.

Improvements of interest to users in `31DEC16`

In the first six months of `31DEC16` the "'Midnight Job" was changed so that binary installations use only `rsync`; `cvs` is no longer required. A number of improvements to the MNJ were done in the last six months in support of this change. New tasks in this period include `UFLAG` to edit data interactively on a uv grid, `BPEDT` to flag uv data based on bandpass table problems found interactively, `FGTAB` to prepare fixed frequency flags for input to `UVFLG`, `FGCNT` to compare the effects of two flag tables on the amount of data remaining, and a suite of new tasks to handle pulse-cal data for VLBI observations. These are `PCFLG` to edit a `PC` table with a frequency-time grey-scale display, `PCEDT` to edit a `PC` table with a graphical display, `PCPLT` to plot `PC` table spectra, `PCASS` to compute bandpass correction tables from `PC` table data, and `PCFIT` to write phase and delay calibration information based on the `PC` table phases. Two new verbs, `TVCOMPS` and `TVACOMPS` were added to plot slice model components on the TV. New tasks in in the first six months include especially `TVSPC` to review the contents of spectral cubes interactively plus `SLPRT` to print the contents of slice files and UVGIT to fit models to uv data. The new verb DAYNUMBR returns the day number in the year of the observation of the cataloged file.

Normally, bugs which appear in an AIPS TST version and then are fixed in that same version before its release get little or no discussion in the AIPSLetter. Since a rather large number of sites now install the TST version of AIPS during its development, this is somewhat of an oversight. We urge you to run the "Midnight Job" at least once after 31DEC16 is frozen to bring it up to date and to fix all bugs of this sort. We urge active sites to use the MNJ and, when something odd occurs, to examine CHANGE.DOC using the cgi tool available from the AIPS documentation web page (http://www.aips.nrao.edu/aipsdoc.html). Please do not hesitate to contact us via the NRAO help desk (https://help.nrao.edu) or via e-mail daip@nrao.edu with any questions or suspicions that there are problems.

UV data: Pulse-cal tables for VLBI

The DiFX correlator is now capable of providing pulse-cal tones at every MHz. These complex data are written into text files archived in full at the correlator site and may be written in the FITS-IDI output files. Since these data have very high signal-to-noise ratio, they should be used wherever possible to assist with calibration. Beginning in July 2016, AIPS was changed to support this capability. In fact, AIPS can now handle up to 256 tones per spectral window, which is way more than needed at present. The first task changed for these numerous pulse-cal tones was POSSM which now offers an option to plot pulse-cal spectra with its usual data averaging options. PCLOD was also changed to read the new DiFX pulse-cal text file format, writing a modern PC table.

The pulse-cal spectra show both an amplitude shape resembling the bandpass shape and "bad" channels, *i.e.*, channels with amplitudes and phases differing from those expected from their neighbors. Thus, new tasks were written to edit the PC tables. PCFLG is very similar to SPFLG, showing in gray-scale pulse-cal channel on the X axis and time on the Y axis. Unlike SPFLG, which is used to edit visibility data, PCFLG writes out an edited version of the input PC table. Numerous display types are available including phase corrected for delay and phase fit to the input data ("residual phase"). The fits may be re-done after some editing in case leaving out the bad channels has a significant effect on the fits. PCEDT is a graphical editor to do the same operation. The graphical perspective is good, but if there is a large number of times, editing with PCFLG will be faster. PCEDT does have the capability of computing and re-computing residual phases as well. Another new task, PCPLT, resembles BPLOT in that it can plot pulse-cal spectra for all antennas, one time per page, or for all times, one antenna per page. This is another way to examine your pulse-cal data to look for bad channels in amplitude, phase, or residual phase with a variety of difference options as well. Another new task for pulse-cal data is PCFIT, which does the fitting for delay/phase and then writes out both a PC table with residual phases and an SN table with either the fit delays and phases or with the difference between the fits at time t and the fits at the first time in the PC table. It appears that the delays in the PC table are very large (100's of ns) and quite different between antennas. Thus, the fit delays are probably not suitable to apply to the visibility data directly, but changes to the pulse-cal delays are expected to reflect changes to the delay affecting the visibility data. Finally, another new task is called PCASS to compute bandpass-correction tables from the PC table amplitudes with or without the residual phases.

These new capabilities still need testing with real data, but they offer significant opportunities for more accurate calibration of VLB data.

UV Data: Editing on a uv grid and with bandpass tables

When making images of newly-calibrated data, it is not uncommon to see sine waves in the image particularly when Cleaning down toward the image noise level. Previously, to find the bad data, one had to use tasks FFT plus COMB to make an image of the data on a uv grid. Then the uv coordinates of the peaks in that image had to be found and translated into locations in the visibility data set with UVFND. Finally, UVFLG had to be run multiple times. This was tedious at best and not very reliable.

The whole process has now been replaced with the new task UFLAG. It grids selected visibility data onto a uv grid and displays images of the scalar average amplitude, the vector average amplitude, the difference of these two, and the average phase, all of which may be used to edit the data. One may simply choose to flag a cell which will flag all visibilities contributing to that cell. But one may also examine each of the visibilities contributing to a cell and flag only those that you choose to delete. There are even automated methods to flag all visibilities outside desired ranges from cells selected by various criteria. All of these options are driven via a TV menu plus question and answer sessions for the automated flagging. The task is described fully in *AIPS* Memo 121 (see below).

Another new task is `BPEDT` with resembles `EDITA` and friends. It uses a graphical display of bandpass table data with the X axis being frequency rather than time. The amplitude or phase is displayed in an edit window for the particular antenna and time, with comparison windows of the other parameter for the particular antenna and the same parameter for chosen comparison antennas. Bad channels in the solution may then be marked and used to flag the visibility data for the bandpass calibrator or all sources.

UV data: Fixing a VLA issue

From August 9 until November 15, 2016, the on-line system at the VLA had an error in the atmospheric delay correction. While this correction should probably include elaborate weather models over each antenna, the actual correction that is done is purely geometric. The task `VLANT` was changed to make the correction to the `CL` table for this error for data in the above time range. It was put in `VLANT` so that most users will run it with no new instructions required. The error caused observations at low elevation to have a shifted centroid and, if the elevations varied a lot through the observation, to be rather smeared out. The correction is a tiny change in delay at each antenna, but the phase change between calibrator scans and target scans can be quite significant.

UV data: Miscellaneous

WIPER was changed to keep track of up to 25 baselines per image pixel, to display small (sub)images with pixel replication, to report how much is flagged, and to improve the display of axis labels and other cosmetic items.

FGCNT is a new task that compares the effect of two different flag tables by counting the visibility samples that get through them separately for each source, polarization, and IF.

FGTAB is a new task to extract suitable flags from an existing `FG` table and write them as frequency-range flags in a text file suitable for input to `UVFLG`.

CLCAL was changed to re-reference phases only if they need to be and to correct some issues with reading the input `SN` table.

UVIMG was given an additional adverb to tell it to use the full convolution functions rather than a simple pill-box (which users will almost certainly prefer).

ACSCL was changed to use the `SUBARRAY` adverb and to be able to loop over all subarrays if it is zero. Handling of the last scan was corrected including in `ACCOR`.

Subarrays were limited in the code to no more than 50. The new format allows an unlimited number, so this limit was changed to 512 in numerous places in the code.

IMSCAL and `OOCAL` procedures were changed to write history records in the input file, since all output files in these procedures are temporary and are deleted.

FITLD and `UVLOD` were changed to handle compressed data correctly when `DOKEEP` is false.

UVFLG was changed to compute the flags for shadowing correctly. The choice of which antenna of a pair was the shadowed one used an incorrect variable.

Analysis: Miscellaneous

TVSPC was enhanced to allow axis labeling in channels and to select the display channel range interactively during execution. *AIPS* Memo 120 was updated for the changes.

PBCOR was corrected to tell the truth in the history file about the parameters actually used. All tasks that compute the primary beam now have full information in the help files and will print information about the parameters used during execution. The new VLA P-band parameters were corrected — they require 4 terms while all other bands require only 3.

XGAUS was given the option to plot individual model components and the handling of the `XG` (and `ZE`) tables was improved to guarantee correct coordinates.

XG2PL was changed to display all needed values from the fit, to handle missing `XG` and/or `ZE` files, and to print the chosen axis coordinates in the output text file.

DFTPL now honors all standard data selection and calibration adverbs.

UVHGM was changed to allow more total boxes, to set the default plot range for real, imaginary, and amplitude to match the actual data, and to allow choices in how the histogram is plotted.

PLGET and `EXTLIST` were made current with changes in some plot tasks and support for 5 newer tasks was added.

SLICE was improved to allow non-integer x and y pixel values when constructing a slice along the z axis. A proper interpolation is now done.

TVCOMPS and `TVACOMPS` are new verbs to plot slice model components on the TV display.

Slice fitting was changed to allow fitting of a spectral baseline in `SLFIT` and `TVSPC` and all slice display routines were changed to include any baseline in the display.

RMSD was given two new operations. One returns an image of the median value in the sliding window and the other returns an image of the median absolute deviation from the median (the "`MAD`" statistic) scaled to be like an rms.

General: Miscellaneous

Mac binary distributions are now solely for 64-bit Macs running OS/X version 10.7 or greater. `31DEC15` is the last of the 32-bit binaries since the old machine that computed them will soon be decommissioned.

MNJ procedures for binary installations were updated to insure that essential maintenance operations, such as running `POPSGN` whenever new verbs or adverbs are created, are actually done.

TABED was changed to copy all rows to the output table except when the user explicitly says not to (`APARM(10) > 0`). Previously operations had unexpected actions when writing to a new table.

HINOTE can now pre-pend a user-specified task name rather than simply pre-pending "`HISTORY`".

CookBook was updated for changes noted above.

Recent *AIPS* Memoranda

All *AIPS* Memoranda are available from the *AIPS* home page. *AIPS* Memo 120 describing the new *AIPS* task `TVSPC` has been updated to describe the `SET CHANNELS` option and other changes. Furthermore, *AIPS* Memo 121 describing the new task `UFLAG` has appeared.

120 Exploring Image Cubes in AIPS
Eric W. Greisen, NRAO
October 28, 2016 (revised)
AIPS has recently acquired powerful tasks to fit models to the spectral axis of image cubes. These tasks are easier to run if the user is already familiar with the general structure of the data cube. A new task TVSPC has been written to assist in acquiring this familiarity. This task provides an exploration tool within the AIPS environment, rather than requiring users to export their cubes to one or more of the many excellent visualization tools now available.

121 Editing on a *uv* grid in AIPS
Eric W. Greisen, NRAO
September 12, 2016
Since its beginning, AIPS has offered users methods to identify and delete bad data samples. Modern interferometers observe over wide bandwidths and so must include spectral regions polluted by radio-frequency interference ("RFI"). Numerous tasks, both interactive and automated, have appeared to assist the modern user in this operation. A new one, called UFLAG, has been written to allow the user to explore the data as it appears when gridded in the *uv* plane. This memo is intended to assist users in navigating the new task.

Patch Distribution for 31DEC15

Because of the extensive use of binary installations, we now patch the master copy of the most recently frozen version. Older versions are not corrected even for egregious errors. Thus, 31DEC15 was patched during 2016 and 31DEC16 will be patched as needed during 2017. Your copy of them may be corrected simply by running a Midnight Job. Information about patches and the code may be found using links from the main AIPS web page or by *anonymous* ftp to the NRAO server ftp.aoc.nrao.edu. Documentation about patches to a release is placed on this site at pub/software/aips/*release-name* and the code is placed in suitable sub-directories below this. Patches to older releases are kept here as well, but they will require local compilation.

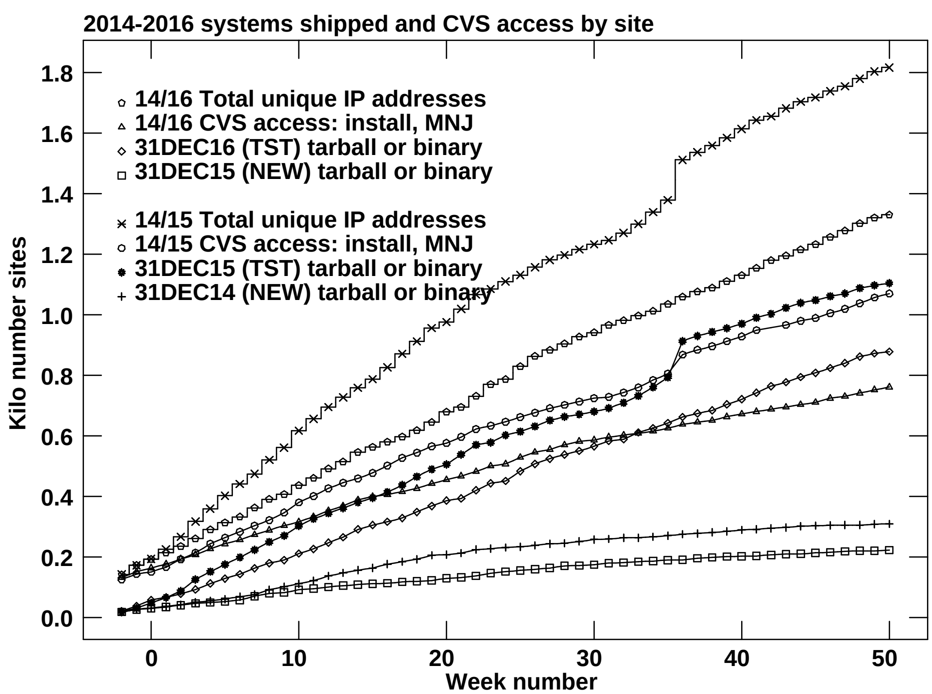
The 31DEC15 release is no longer available for installation and will no longer receive patches even for egregious errors. It had a number of important patches during 2016. They are

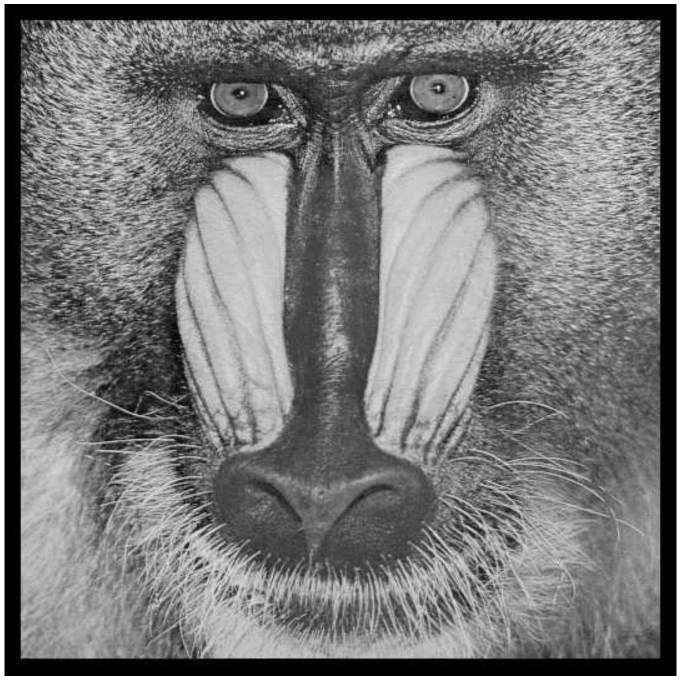
1. GC table used to allow 200 values in the gain curve; restore this limit. *2016-01-07, 2016-01-15*
2. PBEAM scaled Stokes I data incorrectly when adding right and left data files. *2016-01-12*
3. DBCON re-instated flagged table rows. *2016-01-28*
4. DTSUM did not handle the new internal UV format correctly. *2016-02-09*
5. PCAL typo caused errors in antennas used with the new ANTENNA1, ANTENNA2 format. *2016-04-15*
6. PCAL lost Faraday Rotation calibration when doing SPECTRAL solutions. *2016-04-29*
7. IMAGR found automatic boxes in only part of the image when IMSIZE(2) < IMSIZE(1). *2016-05-10*
8. OOP editing had trouble with source number zero sometimes found in tables. *2016-05-19*
9. UVFIX used the actual observing frequency rather than the one in the header to scale *uvw*. *2016-06-20*
10. OOSUB and other model subtraction/division could get the scaling between frequency channels wrong. *2016-06-24*
11. UVLOD, FITLD did not find the subarray value accurately enough. *2016-08-25*
12. SPLIT did not write the correct header frequency when averaging IFs with BIF greater than 1. *2016-08-26*
13. FITLD and UVLOD did not test data flagging correctly when writing and reading UV tables in compressed format. *2016-08-31*

AIPS Distribution

From the NRAO system logs, we count apparent MNJ accesses, downloads of the tar balls, and `rsync` accesses by unique IP address. Since DSL and some university and other connections may be assigned different IP addresses at different times, this will be a bit of an over-estimate of actual sites. However, a single IP address is often used to provide *AIPS* to a number of computers, so these numbers are at the same time an under-estimate of the number of computers running current versions of *AIPS*. In 2016, a total of 222 different IP addresses downloaded the frozen form of `31DEC15` and 878 IP addresses downloaded `31DEC16` in tarball or binary form. Fully 761 IP addresses accessed the NRAO cvs master. Each of these has at least installed some version of *AIPS*, but with the change to the MNJ we are unable even to guess how many sites have run the MNJ. The total number of unique IP addresses in these three lists was 1330. The `31DEC16` numbers are about 80 percent, while others numbers are around 72%, of the previous year. This suggests that CASA has made inroads into our user base. The table below shows these numbers as a function of year since we began recording them. The attached figure shows the cumulative number of unique sites, cvs access sites, and download sites known to us as a function of week in 2016. The numbers for 2015 are also plotted and show a decrease in 2016 in all cases.

year	TST name	NEW name	TST	NEW	TST binary	NEW binary	cvs	Total unique
2004	31DEC04	31DEC03	808	196			797	1276
2005	31DEC05	31DEC04	832	246	299	48	982	1460
2006	31DEC06	31DEC05	806	191	402	94	1050	1398
2007	31DEC07	31DEC06	965	277	669	161	1385	1811
2008	31DEC08	31DEC07	1058	246	986	303	1667	2107
2009	31DEC09	31DEC08	1228	307	1082	478	1855	2399
2010	31DEC10	31DEC09	1228	307	1203	477	1914	2416
2011	31DEC11	31DEC10	1105	270	1064	424	1747	2228
2012	31DEC12	31DEC11	940	284	1028	396	1309	1698
2013	31DEC13	31DEC12	1014	307	990	443	1264	1937
2014	31DEC14	31DEC13	1045	333	848	431	1023	1843
2015	31DEC15	31DEC14	1104	309	1001	350	1070	1817
2016	31DEC16	31DEC15	878	222	788	372	761	1330





December 31, 2016

AIPSLETTER
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