A I P S L E T T E R

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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*

COVID-19

There is less to say about Covid-19 these days. In-person access to NRAO facilities is now limited to those who are fully vaccinated with at least one booster shot. Mask use inside is determined on a weekly basis and varies from none, to suggested, to required. There is still a lot more work done from home and all meetings have a virtual component.

The Covid status means that your editor would like to find additional, preferably interesting, things to do. If you find any problems with *AIPS* or have any suggestions for new or improved functions, please do not hesitate to e-mail me.

AIPSLetter publication

We have discontinued paper copies of the *AIPSLetter* entirely, at least for this issue. The *AIPSLetter* will be available in PostScript and pdf formats as always from the web site listed above. New issues will be announced in the NRAO eNews mailing and on the `bananas` and `mnj` list servers.

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 (Intel *and* ARM chips), and Linux (32- and 64-bit) systems, but all architectures can do a full installation from the source files. There are no longer binary versions available for Solaris and Mac PPC chip architectures. 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 `31DEC22` 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 2023 to convert your copy of `31DEC22` into the frozen version. However, when patches to `31DEC22` are announced in 2023, 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 `31DEC23`, 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 `31DEC23`, 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 31DEC23 *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 178-Mbyte 31DEC23.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 should 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.

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Installing a new version

If compiling locally, new releases must be installed from the tar ball for that release. 31DEC15, and now 31DEC22 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). A new installation will not change your current *AIPS* data files.

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. 31DEC20 contains a change to the XAS TV server which will cause problems with older versions. Note that the only version which we will patch for major errors is 31DEC22; even 31DEC21 will no longer be changed. **Note that 31DEC21 did get a patch on 30 December 2022 however.**

Improvements of interest to users in 31DEC22

In the latter half of 2022, three new tasks and two new verbs appeared. The tasks are PRRFI to print information from the VLB RFI tests, WXLOD to read a KEYIN-format weather table, and VHCAL to apply Stokes I, Q, and U models to calibrate linear polarization data. The new verbs are UPCASE and DOWNCASE to modify the case of string adverbs. A new RUN file called VHCALIB implements the full procedure needed to calibrate linear polarization data from calibrator source models. Ionospheric Faraday rotation calibration received significant corrections. In the first six months of the year the most significant change was the addition of support for the new Apple ARM chips. That required a very large number of changes to the software, with no changes to the outputs of that software. Closure phase and amplitude received attention, resulting in two new tasks called EVACL to look at closure statistics in continuum data and CLOSE to compute and plot closure statistics as functions of spectral channel. The RFI study software for the VLBA received attention as well. A new task, VLBRF was written to evaluate the median and rms over uncalibrated autocorrelation data. Numerous bug fixes and minor improvements have also been made.

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*. *In 2022, there was a significant misconception which lasted through much of the year before being corrected. It will be described below.* Since a rather large number of sites now install the TST version of *AIPS* during its development, not describing temporary bugs in TST is somewhat of an oversight. We urge you to run the "Midnight Job" at least once after 31DEC22 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). Note that the cgi tools were corrected in 2022 to account for the change from html 4 to 5. 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

From July 20 through December 7, 2022, *AIPS* applied a full 4x4 matrix correction for polarization D terms to the visibilities. This then changed RR and LL differently after they had been initially brought into agreement by CALIB. This is not correct. A proper calibration would determine D terms along with parallel-hand gains simultaneously. If one cannot do this, it is not appropriate to later apply D terms to the parallel-hand visibilities. The code was reverted to the old scheme of applying D terms only to the cross-hand visibilities.

The ionospheric Faraday rotation calibration, which is usually significant only for data below 3 GHz, received considerable attention and correction. A geometry error was discovered at the end of 2022 which caused the IFR values written by TECOR to be in error for positive hour angles. Plots of IFR after TECOR versus hour angle showed clear jumps at 0 hours no matter the source or observatory. These were small sometimes and more significant on occasion. PCAL applies this calibration in order to determine the "D" terms. It was found to apply no correction to the first spectral window ("IF") and to apply the correction appropriate to the first spectral channel of the previous IF after that. It now applies the IFR correction appropriate to the spectral channel which is being solved. The standard procedures that download the appropriate IONEX files with the ionosphere data were given the adverb TECRTYPE to allow the user the choice of IONEX file type. The default remains jplg which has proved reliable. For circular polarizations, the IFR is applied to the cross-hand data when DOPOL is true. For linear polarizations, the IFR is applied, as of the end of 2022, to all polarizations when the data are converted to true Stokes.

There has been considerable confusion over the nomenclature of linear polarizations. X is officially defined as vertical, but the X axis is everywhere the horizontal axis in plots. Therefore, we have changed the nomenclature in *AIPS* to V and H for vertical and horizontal. It turns out that the VLA wrote the P and 4 band data X and Y correctly. MeerKat on the other hand does not. UVLOD and FITLD were changed to do a swap-polarization operation while reading MeerKat data if those data had not already been read into *AIPS*. Task XYDIF was renamed VHDIF.

The right minus left (or vertical minus horizontal) phase of the reference antenna is normally assumed to be constant over time. This is seldom the case in fact although the changes with time are usually modest. RLDIF and VHDIF were changed to offer the option of storing the spectra of phase differences in every SOLINT interval as well as the overall average. When doing so, they also write an SN table, as a function of spectral window, with the average difference of the phase in the time interval and that of the global average. This allows the option of applying an approximate correction for the time variation using CLCAL. POSSM was changed to plot the time samples in the PP table as well as the global average and to correct errors handling the IFs in that table format.

Circular polarization parallel-hand data require only the I polarization flux or model. However, for linear polarization, the Q and U fluxes or models are required. VV is scaled by

$$I + Q\cos(p_1 + p_2) + U\sin(p_1 + p_2)$$

where the p are parallactic angles. HH is similar but with minus signs on Q and U. CALIB was changed to apply point-source models to linear polarization using the Q and U values in the source table. A RUN file called VHCALIB was written to take I, Q, and U model Clean component files in UVSUB to create model visibility files matching data to be calibrated. Then new task VHCAL reads these three files and computes a properly "divided" data set which is then fed to CALIB using its option for a pre-divided file. The resulting SN table is then copied back to the original input data set.

Richard Dodson provided code changes to allow polarization measurements with beam waveguide antennas such as Warkworth and Yamaguchi. This arises from communication antennas repurposed to astronomy.

CLIP has a DOREAL option to clip on real and imaginary parts rather than amplitudes.

UVFND was corrected to test the averaged data when requested rather than some unaveraged values and to label linear polarizations correctly.

VLBI matters

PRRFI is a new task to print those channels and antennas above user-specified cutoffs from VBRFI and VLBRF output text files.

PLRFI was changed to allow more than MAXIF spectral windows (from multiple input files) and to provide the option to plot without dividers between the spectral windows.

VLBRF was changed to support single-polarization data and to offer the option of computing on a scan basis and then averaging.

VLBARFI procedure was changed to handle DOCALIB false more sensibly, ignoring calibration sources and the like.

IANTB was corrected to handle negative parameters in the polynomial, to support any number of IFs correctly, and to fix other format issues.

WXLOD is a new task to read weather data in KEYIN format and write an *AIPS* WX table.

Imaging and Display

IMAGR had multi-scale imaging broken since March 3, 2020 at least for gridded subtraction. The TELL operation was corrected to read NITER and a couple other adverbs correctly. The menu timeout function computed times incorrectly and so did not behave as expected.

MeerKat primary beam parameters are now built in to *AIPS*.

POSSM was changed to space multiple plots on the page even when plot ranges are fully specified. It was given the option to avoid plotting lines between, and labeling, each spectral window, making a much improved labeling for frequency and velocity axes. The source polarization (CP table) is now plotted in polarization angle rather than raw phase.

PCNTR and KNTR now display the length of the polarization vector along with the vector when PVPLOT is not zero.

UVPLT now looks for two possible ranges for all angle types not just phase.

Axis label strings are now allowed to be longer than 8 characters.

General

The file creation routines did not agree among themselves as to the format of the available space parameter. That meant that Linux systems could be confused about the available space and refuse to do file creations that would fit or attempt ones that would not fit. They all agree now on long integers.

UPCASE and `DOWNCASE` are new verbs to change the case of string adverbs.

Y2K master files have been recomputed and the web sites to access the data sets have been simplified, discarding a lot of old files.

Recently revised *AIPS* Memoranda

All *AIPS* Memoranda are available from the *AIPS* home page. *AIPS* Memo 117 was revised to describe changes to the `PP` polarization phase difference table. Memos 114 and 117 were revised for the changed nomenclature for linear polarizations.

114 The FITS Interferometry Data Interchange Convention
Eric W. Greisen, NRAO
July 19, 2022 revision
The FITS Interferometry Data Interchange Convention ("FITS-IDI") is a set of conventions layered upon the standard FITS format to assist in the interchange of data recorded by interferometric telescopes, particularly at radio frequencies and very long baselines. It is in use for the VLBA telescope for data from the current hardware correlator and the future software correlator and has also been used with other correlators such as the JIVE correlator for the EVN. This convention is intended to separate a standard set of conventions from those used within particular software packages such as *AIPS*.

117 *AIPS* FITS File Format
Eric W. Greisen, NRAO
July 19, 2022 revision
AIPS has been writing images and *uv* data in FITS-format files for a very long time. While these files have been used widely in the community, there is a perception that a detailed document in still required. This memo is an attempt to meet that perception. *AIPS* FITS files for *uv* are conventions layered upon the standard FITS format to assist in the interchange of data recorded by interferometric telescopes, particularly by radio telescopes such as the EVLA and VLBA.

Patch Distribution for `31DEC21`

Normally, this section lists the patches that have been released for `31DEC21`. This was based on the assumption that users would want to download individual files to compile them locally. However, the "Midnight Job" (`$HOME/do_daily.`*hostname*) will do this for you on locally-compiled installations. It will also do a proper update for binary installations. Therefore there is no reason to continue the old procedure. Major bug corrections were moved to `31DEC21` as they occur and users should use the MNJ on occasion on both the `NEW` and `TST` versions of *AIPS*. A summary list is provided however.

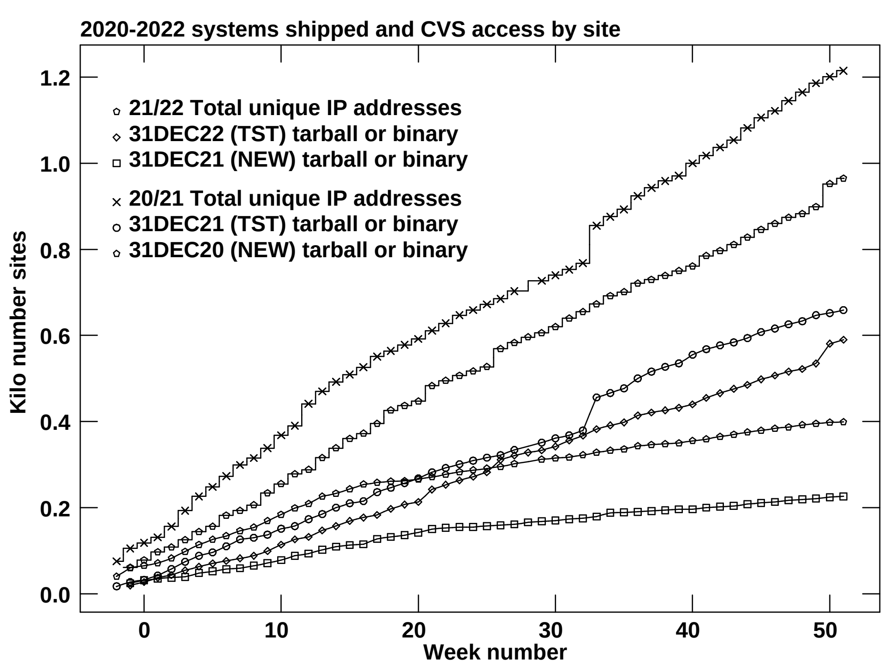
The `31DEC21` release is no longer available for installation and will no longer receive patches even for egregious errors. It had a number of important patches during 2022. They are

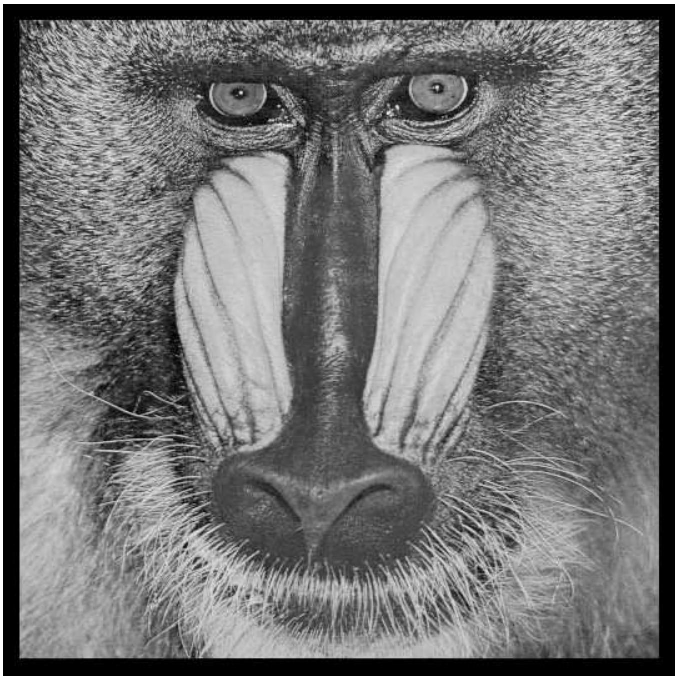
1. Correct "ccdis" to "cddis" in TEC-related help files. *2022-02-01*
2. `FITLD` could not read more than 999 files. *2022-02-07*
3. `APCLN` failed due to limits of `PLNGET`. *2022-02-07*
4. Application of polarization calibration blanked one channel too many at each blanked channel. *2022-03-21*
5. `POSSM` plotted only one polarization when all data are combined into one plot. *2022-04-01*
6. `TRUEP` had a bad formula and the history file had issues. *2022-03-03*
7. Compile procedures depended on the antique computer dave. *2022-06-27*
8. `XAS` changed so that Macs do not allow shared memory. *2022-06-27*
9. `RSPEC` did not set defaults for `BLC(3)` and `TRC(3)`. *2022-06-27*
10. `OFUDG` did not extract antenna numbers in the newer way. *2022-06-27*
11. `PRTAB` could fail to set printing scales. *2022-06-27*
12. `POSSM` had a limit of 50 antennas. *2022-06-27*
13. `UVPLT` did not compute parallactic angles with the correct source ID. *2022-06-29*
14. `XYDIF` did not access the `PP` table properly and that table I/O did not handle blanks properly. *2022-06-29*
15. Minor axis labeling improvements patch made accidentally. *2022-07-06*
16. `CALIB` wrote `DOFIT` into the history file incorrectly. *2022-07-18*
17. TV menu timeouts were computed incorrectly. *2022-07-22*
18. `UVPLT` did not do 3 color properly when plotting individual points (not making an image). *2022-08-12*
19. `NOIFS` did not use the correct header (after calibration) and so could have a source parameter but no file. *2022-09-27*
20. File creation did not access the available disk space correctly on Linux and did not do `FREESPAC` correctly on Macs. *2022-09-28*
21. Multi-scale imaging and calibration with extended Clean components did not work with gridded modeling techniques. *2022-09-30*
22. `MATCH` recorded backwards antenna numbers when the baseline order had to be switched.*2022-10-20*
23. `TECOR` had a geometry error causing bad values for positive hour angles. *2022-12-30*

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 2022, a total of 226 different IP addresses downloaded the frozen form of `31DEC21` and 590 IP addresses downloaded `31DEC22` in tarball or binary form. With the change to the MNJ (rsync only) we are unable even to guess how many sites have run the MNJ. The total number of unique IP addresses in these five lists was 965. The plot of numbers versus time and the table shows that 2022 was substantially behind 2021.

year	`TST` name	`NEW` name	`TST`	`NEW`	`TST` binary	`NEW` binary	Total unique
2004	31DEC04	31DEC03	808	196			1276
2005	31DEC05	31DEC04	832	246	299	48	1460
2006	31DEC06	31DEC05	806	191	402	94	1398
2007	31DEC07	31DEC06	965	277	669	161	1811
2008	31DEC08	31DEC07	1058	246	986	303	2107
2009	31DEC09	31DEC08	1228	307	1082	478	2399
2010	31DEC10	31DEC09	1228	307	1203	477	2416
2011	31DEC11	31DEC10	1105	270	1064	424	2228
2012	31DEC12	31DEC11	940	284	1028	396	1698
2013	31DEC13	31DEC12	1014	307	990	443	1937
2014	31DEC14	31DEC13	1045	333	848	431	1843
2015	31DEC15	31DEC14	1104	309	1001	350	1817
2016	31DEC16	31DEC15	878	222	788	372	1330
2017	31DEC17	31DEC16	874	408	768	386	1383
2018	31DEC18	31DEC17	684	368	603	343	1099
2019	31DEC19	31DEC18	754	406	686	388	1155
2020	31DEC20	31DEC19	796	434	750	470	1230
2021	31DEC21	31DEC20	659	399	604	376	1215
2022	31DEC22	31DEC21	590	226	572	221	965





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