

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*

Edited by

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General developments in *AIPS*

Happy birthday AIPS, changes in the *AIPS*Letter

We started work on the software system now known as *AIPS* on July 1, 1979, making it 30 years old. Had we realized its longevity, would we have had the nerve to start it?

With this issue, we have decided to discontinue paper copies of the *AIPS*Letter other than for libraries and NRAO staff. The *AIPS*Letter will be available in PostScript and pdf forms as always from the web site listed above. It will be announced in the NRAO e-News mailing and on the bananas list server.

Current and future releases

We have formal *AIPS* releases on an annual basis. While all architectures can do a full installation from the source files, Linux (32- and 64-bit), Solaris, and Macintosh OS/X (PPC and Intel) systems may install binary versions of recent releases. The last, frozen release is called 31DEC08 while 31DEC09 remains under active development. You may fetch and install a copy of these versions at any time using *anonymous ftp* for source-only copies and *rsync* for binary copies. This *AIPS*Letter is intended to advise you of improvements to date in 31DEC09. Having fetched 31DEC09, you may update your installation whenever you want by running the so-called “Midnight Job” (MNJ) which copies and compiles the code selectively based on the changes and compilations we have done. The MNJ will also update sites that have done a binary installation. There is a guide to the install script and an *AIPS* Manager FAQ page on the *AIPS* web site.

The MNJ serves up *AIPS* incrementally using the Unix tool *cvs* running with anonymous ftp. The binary MNJ also uses the tool *rsync* as does the binary installation. 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.

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Patch Distribution for 31DEC08

Important bug fixes and selected improvements in 31DEC08 can be downloaded via the Web beginning at:

<http://www.aoc.nrao.edu/aips/patch.html>

Alternatively one can use *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. As bugs in 31DEC09 are found, they are simply corrected since 31DEC09 remains under development. Corrections and additions are made with a midnight job rather than with manual patches. Since we now have many binary installations, the patch system has changed. We now actually patch the master version of 31DEC08, which means that a MNJ run on 31DEC08 after the patch will fetch the corrected code and/or binaries rather than failing. Also, installations of 31DEC08 after the patch date will contain the corrected code.

The 31DEC08 release has had a number of important patches:

1. CALIB could go into an infinite loop if the first NX record was of 0 length *2009-01-27*
2. TYAPL would apply the highest flag table without permission when it should just be copied *2009-02-04*
3. OFM files were not adjusted to the new TV intensity ranges *2009-04-02*
4. IMAGR TV option `FORCE A FIELD` caused all facets to be re-imaged; scratch files were way too large under some circumstances *2009-04-22*
5. DBCON copied keyword `MAXBLINE` which confused later imaging routines *2009-04-27*
6. IMAGR had a limit test that was too small affecting restoration of large numbers of CCs from one facet to another *2009-05-18*
7. IMAGR had a tendency to sort input data sets when it did not really have to do so *2009-06-19*

Improvements of interest in 31DEC09

We expect to continue publishing the *AIPSLetter* approximately every six months along with the annual releases. Henceforth, this publication will be primarily electronic. There have been several significant changes in 31DEC09 in the last six months. The most significant of these are new tasks and options in IMAGR to assist in boxing of sources. New task `SABOX` will prepare a list of boxes by using a SAD-like search over a set of facet images. New task `FILIT` simplifies the interactive checking and setting of boxes for a set of facet images, even those larger than the TV display window. IMAGR now has the ability to add to the `OBOXFILE` list of Clean boxes automatically. A new verb `ROAMOFF` was written to convert a TV display in `TVROAM` mode into a simple display which other *AIPS* tasks and verbs can handle. Another new verb `DELAY` will let users put measured pauses into scripts and procedures. The new task `RLCOR` will correct a single- or multi-source data set directly for the RL phase difference. (`CLCOR` will do this but only for multi-source data sets.) Support for 64-bit Linux operating systems was added since it was discovered that Intel-compiled load modules had a performance improvement over those computed for 32-bit systems.

31DEC08 contains major changes to the display software. Older versions may use the 31DEC08 display (`XAS`), but 31DEC08 code may not use older versions of `XAS`. 31DEC04 through 31DEC09 use a new numbering scheme for magnetic tape logical unit numbers that is incompatible with previous versions. Thus all tape tasks and the server `TPMON` must be from one of these six releases. Other than these issues, 31DEC09 is compatible in all major ways with the with the 15OCT98 and later releases. There are significant incompatibilities with older versions.

Imaging

Leonia Kogan noticed a clever way in which the “W” problem could be recast allowing multiple facets to be imaged accurately while remaining in the same coordinate system as the central tangent plane. The mathematics of this method are described in *AIPS* Memo 113 by Kogan and Greisen available from the *AIPS* web site. The “new” mathematics have been implemented in **IMAGR** when the adverb **D03DIMAG** = **FALSE**. The previous imaging done with this parameter set to false was known to be incorrect for significant shifts from the center, but the present imaging is believed to be nearly as good as that done with **D03DIMAG** = **TRUE**. The latter produces facets on different geometries, each tangent to the center of the facet. The implementation of both values of **D03DIMAG** is now very similar and means that u, v depend on facet. This violates fundamental structures in a variety of old software, causing tasks **MX** and **HORUS** to be removed from *AIPS*.

Although **FLATN** will be needed in both cases to deal with overlapping facets, bad corners, and the like, the regridding done with **D03D FALSE** will be much simpler. **FLATN** was revised recently to weight the corners of images — actually all pixels outside an inscribed ellipse — much lower than those pixels inside the ellipse. These pixels are much less reliable in synthesis imaging due to aliasing and accumulated mathematical error which is emphasized in the corners of images. The revised **FLATN** provides a method to avoid this down-weighting when the input images are reliable all the way to the edge.

Boxing — limiting Clean to portions of the input image only — has been well established as a method to reduce the problem of Clean taking noise bumps as sources. A completely unconstrained Clean often finds 10-40% more flux than is actually present in an image. If short spacings are missing, it is also capable of finding rather less flux than is present. However, in large imaging problems it is very time consuming to create the list of Clean boxes by hand using interactive verbs like **TVBOX**, **REBOX**, and **FILEBOX** OR their equivalents available with the TV display while **IMAGR** IS running. **IMAGR** has been given yet another array of parameters **IM2PARM**, the first of which are used to request and control a new auto-boxing capability. Each image facet is examined to find “islands” of emission above $n\sigma$. Those islands with a peak greater than F , where $F = \max(m\sigma, fP)$, $m \geq n$, P is the current peak residual, and $f = 0.1$ by default, may become a new Clean box if the peak is not already within a box. Only the strongest of these are actually taken as boxes at any one time. The maximum number of new boxes at any one time per facet, n , m , and f are set by **IM2PARM**, along with the number of pixels by which each box is extended outward and the diameter of the ellipse within the facet image which is examined for the rms and the islands.

To assist with the boxing, two new tasks were also written. **SABOX** uses the algorithm described above on a set of facets to make a list of boxes. One might do a preliminary image of a field with no boxing (*e.g.*, using the circles output by **SETFC**) and then run **SABOX** to produce a more accurate list of boxes for a deeper, more careful Clean. **FILIT** is an interactive task that allows the user to modify the list of boxes for a set of facet images. It uses a menu on the TV display to allow creation of new boxes, editing of existing boxes, and auto-boxing. It handles images larger than the TV display with a **TVROAM**-like function always followed by a **ROAMOFF** capture of the current sub-image. There is a full set of image enhancement functions and a way to alter the auto-boxing parameters while running the task. **FILIT** should be more efficient than the **FILEBOX** verb in *AIPS*, which functions only on a single sub-image of one facet at a time.

All interactive boxing routines were corrected to allow the display of the inscribed ellipse. Previously, they only understood circles, but rectangular images call for ellipses as do images loaded with **TXINC** not the same as **TYINC**. The creation of circular Clean boxes will now display ellipses when the display increments are not equal.

Three other changes were made to **IMAGR** as well. During Clean with **OVERLAP=2**, more than one facet is imaged at each cycle in an attempt to reduce the number of times it has to cycle through the uv work file looking for the strongest facet. This is useful some of the time, but has proved costly at other times. The parameter **IMAGRPRM(18)** was added to allow users to limit the number of facets imaged at each cycle. During testing with very large data sets (100 Gbyte uncompressed), it was found that **IMAGR** insisted on sorting the data when an **XY** sort was not required. Bugs in handling the sort test were found in two places and corrected to avoid excessive and time consuming sorts. The automatic restart of Cleaning after a “final” filtering was made an option, with the default being not to do this. The restart may be a good idea if the filtering (using **IMAGRPRM(8)** and **IMAGRPRM(9)**) changes the residual images significantly.

UV-data calibration and handling

- CALIB** continued to get corrections to the algorithm sub-dividing scans after the previous *AIPS Letter*. These made it into 31DEC08 directly and as patches. The 31DEC09 version only was changed to avoid counting fully flagged data as “failed” solutions.
- FRING** was corrected to remove a few spots that assumed the frequencies were in ascending order, after which it worked well on data in either order.
- VLANT** has had difficulties on some but not all Mac computers which were traced to a mysterious abort when the first record in a text file is null. We will avoid that in the VLA data files henceforth.
- RLDIF** was changed in the order of averaging and the reported sigmas which are now reasonable.
- PCAL** now allows the user control over the updating of the source table with the source polarization solutions.
- RLCOR** is a new task to apply the POLR corrections from RLDIF directly to a data set; the CLCOR route requires multi-source data.
- CLCOR** will now allow the POLR OP CODE on data which have not had PCAL run although it cannot correct the solutions in that case.
- CLCOR** has a new OP CODE = ' IONO' to correct delays for the ionosphere using data from an input text file.
- SPLIT** and SPLAT were corrected to deal smoothly with sources for which no data are found.
- FITLD** was corrected to handle files written by FITAB better. Multi-file tapes had trouble retaining the original file name/class and the DOCONCAT operation is no longer possible on such files. They are now written correctly which means that information needed to decide about concatenation is not available until well past the point where it would be required.
- FILLM** was changed to use, by default, the system shadowing bit in those format versions for which it was correct and 25m for the other versions. Shadowing is now correctly computed — except for sub-arrays — when the user specifies a shadowing diameter in the inputs. On-line FILLM should now actually stop when requested and the observation code changes.

Other UV-data matters

- POLARXY** the pole position will be tabulated in the usual arc seconds rather than the meters which was erroneously declared for *AIPS*. It is possible to tell the two units apart in the period 1979-2008 and all usages are checked and the units corrected if necessary.
- FLOPM** has a new option to reverse the IFs as well as the spectral channels.
- DIFUV** has a new OPTYPE = 'DIV' that will divide one data set into another, making a gains file which can be plotted with UVPLT and VPLT, et al.
- UVMOD** will now read in a text file with up to 9999 source components, allowing more general models including components of all types and spectral index.
- UVCON** was changed to use the W term with the same sign as used in UVMOD and IMAGR. It was enhanced to allow multiple IFs with frequencies specified in the inputs.
- LISTR** was changed in a variety of ways to improve the LIST and MATX displays, including avoiding missing antennas and controlling whether a baseline is shown both as $n - m$ and $m - n$.
- CMODEL** was added to numerous tasks that compute models and the defaults were changed so that an error occurs on missing CC tables only when they are required by the user.
- PRTAN** was corrected to stop confusing row number with antenna number and was changed to recognize the new EVLA station names from the Widar correlator.

Display and image analysis matters

SNPLT was given the option of plotting the locations of failed (blanked) solutions.

TVROAM creates a scrolled, split screen display that baffles most *AIPS* TV functions. Added defenses to those functions so that they don't do bad things if they encounter such a display.

ROAMOFF is a new verb to take a display left by TVROAM and convert it into a single-plane image of the selected sub-image.

OFM files were updated to the new range of TV intensities. They worked when used in plotting but not when loaded to the TV.

ISPEC and **BLSUM** were given the option to save their results in SLice extension files and all slice plotting and fitting routines were adjusted to use them.

XBASL was improved in its defaults, in its behavior when not writing output images of the parameters, and in its setting of windows. More information is now available in the **EXPLAIN** section.

WIPER was changed to display during editing the x, y coordinates in the scaled units of the display and the menu was re-arranged to reduce the chance of inadvertent **ABORTs** and **EXITs**.

EDITR **EDITA**, **SNEDT**, and the edits in **SCMAP** and **SCIMG** had a blank menu item added before **ABORT** and **EXIT** to avoid inadvertent use.

System-wide matters

LNx64 is a new "operating system" supported by *AIPS*; it uses Intel-compiled tasks for 64-bit Linux computers and achieves some performance enhancement.

DELAY is a new verb to delay *AIPS* by a specified number of seconds; it should be useful in scripts.

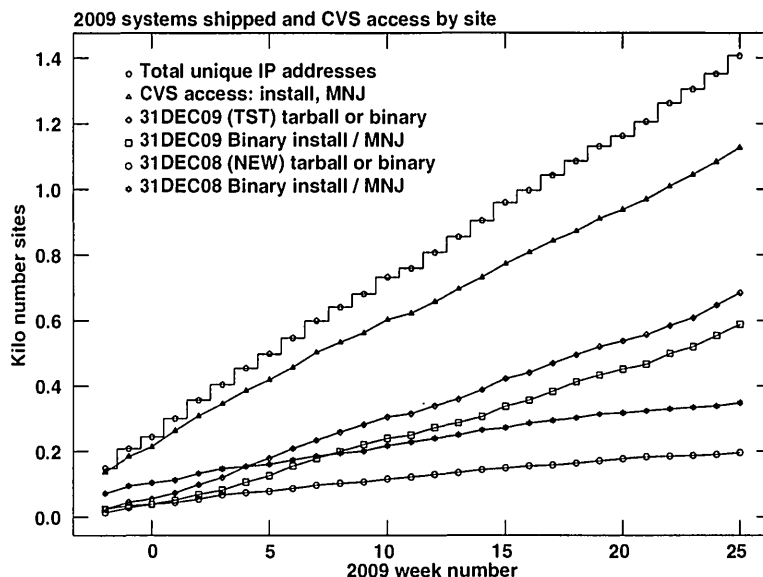
RENUMBER verb can now renumber an image or data set to slot numbers larger than those currently on the disk.

TIMDEST verb has been rendered inaccessible — it is really dangerous.

USERID adverb has been removed from all tasks and verbs except those that require it (**DISKU**, **MOVE**, and **PRAC**). It was left in all plot-file tasks to avoid breaking **PLGET** and **EXTLIST**, but those tasks now ignore the **USERID** value entirely.

AIPS Distribution

We are now able to log apparent MNJ accesses and downloads of the tar balls. We count these by unique IP address. Since some systems assign the same computer different IP addresses at different times, this will be a bit of an over-estimate of actual sites/computers. However, a single IP address is often used to provide *AIPS* to a number of computers, so these numbers are probably an under-estimate of the number of computers running current versions of *AIPS*. In 2009, there have been a total of 1406 IP addresses so far that have accessed the NRAO cvs master. Each of these has at least installed *AIPS* and **310** appear to have run the MNJ on 31DEC09 at least occasionally. During 2009 more than 196 IP addresses have downloaded the frozen form of 31DEC08, while more than 685 IP addresses have downloaded 31DEC09. The binary version was accessed for installation or MNJs by 348 sites in 31DEC08 and 588 sites in 31DEC09. The attached figure shows the cumulative number of unique sites, cvs access sites, and binary and tar-ball download sites known to us as a function of week — so far — in 2009. These numbers are more than 12% greater than those reported one year ago for last year's releases.



Recent *AIPS* and related Memoranda

All *AIPS* Memoranda are available from the *AIPS* home page. There are three new memoranda in the last six months. In addition, a paper entitled "Aperture Synthesis Observations of the Nearby Spiral NGC 6503: Modeling the Thin and Thick Disks" by Greisen, E. W., Spekkens, K., & van Moorsel, G. A. has appeared in the *Astronomical Journal*, volume 137, pages 4718-4733. It contains an appendix which is a good description of imaging in *AIPS* and may be useful as a reference.

113 Faceted imaging in *AIPS*

Leonid Kogan & Eric W. Greisen (NRAO)

May 22, 2009

"Image-plane faceting," in which each small image plane or facet is computed as tangent to the celestial sphere, has been the solution to the "W problem" in *AIPS* for some time. This memo describes another approach in which the facets are all in the same plane which is tangent to the sphere at the center of the field of view. This "uv-plane faceting" method may have some computational advantages and has replaced the `D03DIMAG = FALSE` methods in *AIPS*.

114 The FITS Interferometry Data Interchange Convention

Eric W. Greisen (NRAO)

June 25, 2009

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*.

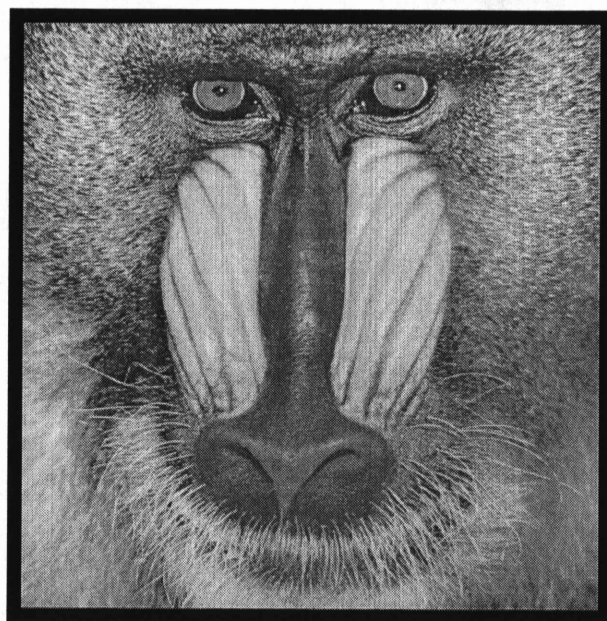
115 Auto-boxing for Clean in *AIPS*

Eric W. Greisen (NRAO)

June 29, 2009

Cotton (EVLA Memo 116) has demonstrated the importance of constraining the Clean deconvolution to search for model components only within restricted regions ("Clean boxes") of the dirty image. An option to create such boxes in an unbiased and automatic fashion has been added to the *AIPS* task `IMAGR` and two new tasks have been written to find these boxes in images which have already undergone a preliminary Clean. This memo describes the implementation of auto-boxing in *AIPS*.

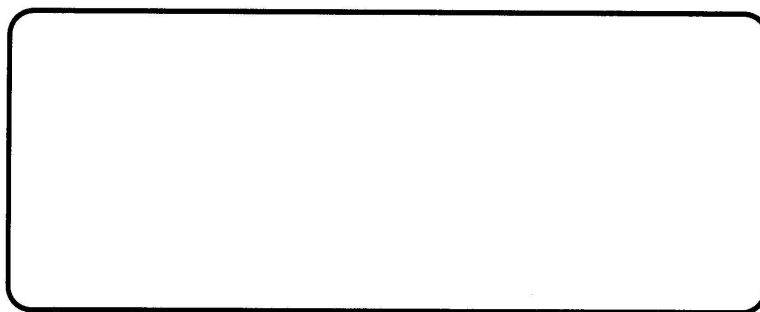
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General developments in *AIPS*

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, you will need to do a source-level installation. The current release is called 31DEC09 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 2010 to convert your copy of 31DEC09 into the frozen version. When patches to 31DEC09 are announced, you may apply them with the MNJ. This *AIPS*Letter is intended to advise you of corrections and improvements in this release.

We have begun a new version, called 31DEC10, 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 31DEC10, you may update your installation whenever you want by running the MNJ. This uses cvs, rsync, and/or transaction files to copy and 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 31DEC10 *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 97-Mbyte 31DEC10.tar.gz compressed tar file. 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.

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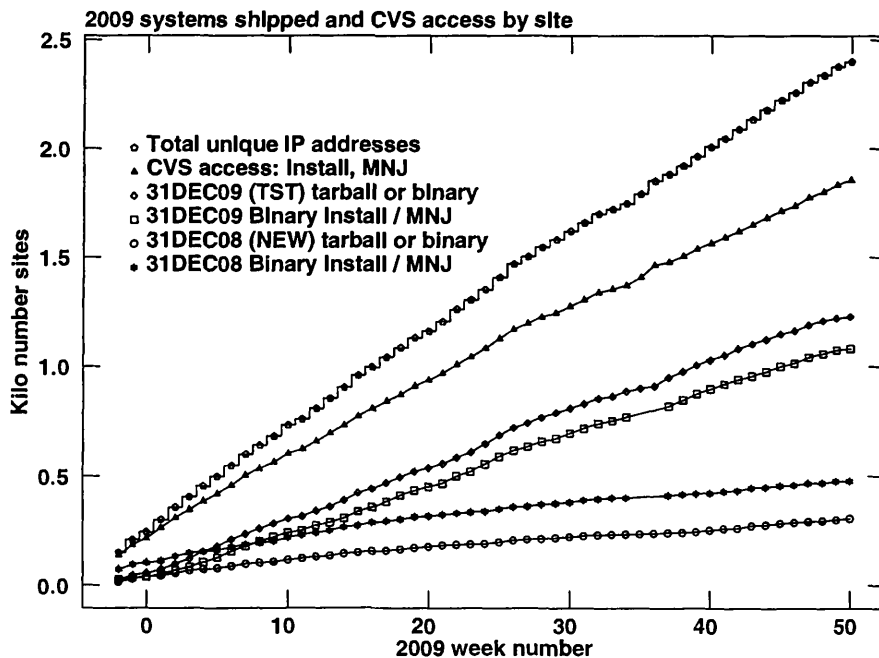
Installing a new version

If compiling locally, new releases must be installed from the tar ball for that release. If using the binary installation, a full new installation must also be done with `rsync`. The `cvs` system requires this. 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 seen to work. 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 `$HOME/.AIPSRC` file may be left in place, but it will need to be edited. The lines giving the `DOWNLOADED` and `UNPACKED` parameters should be cleared and the `CCOMOPT` line should be changed to point to the current release rather than the previous one — the `-I` parameter really should be `-I$INC` but it gets its full path name instead. This forces a re-edit with each release. If you have made special versions of `UPDCONFIG` and `do_daily.host`, you should preserve them under new names and restore them 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.

For Linux, Solaris Ultra, and Macintosh systems, a binary installation could be available from DVD, supported by `install.pl`. Alternatively, the frozen version may be installed with the binary installation method now present in `install.pl`. The ftp site for downloading files directly has been eliminated.

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 2009, a total of 307 different IP addresses downloaded the frozen form of 31DEC08 and 1228 IP addresses downloaded 31DEC09 in tarball or binary form. Fully 1855 IP addresses accessed the NRAO `cvs` master. Each of these has at least installed some version of *AIPS* and 507 appear to have run the MNJ at least occasionally. The total number of unique IP addresses in these three lists was 2399. 478 sites accessed 31DEC08 in binary form, while 1082 sites used the binary form of 31DEC09. The attached figure shows the cumulative number of unique sites, `cvs` access sites, tar-ball/binary download sites and binary access sites known to us as a function of week in 2009. These numbers represent substantial increases (more than 10%) over those for 2008.



Since the registration system, always under-utilized, has now been abandoned, we are left with analysis by IP address. The table below lists the IP addresses for 2009 by the final qualifier for shipments of 31DEC09, 31DEC08, and access to the cvs site. The numbers in the cvs column include those sites that install or run a midnight job for these releases. The comments come from what appears to be a semi-official list of Internet codes. Sorting is on the “unique” column, which counts unique IP addresses over the other three columns:

Code	31DEC08	31DEC09	cvs site	unique	Comments
net	22	130	490	554	Network
edu	34	213	344	401	US Educational
uk	12	102	85	132	United Kingdom
jp	16	73	50	87	Japan
com	15	43	51	74	US Commercial
de	5	29	61	73	Germany
org	6	30	50	57	Non-Profit Organization
in	16	29	38	56	India
es	9	33	36	50	Spain
pl	1	32	29	42	Poland
it	2	28	25	34	Italy
br	20	13	16	30	Brazil
nl	3	20	25	29	Netherlands
au	2	12	22	28	Australia
ca	5	15	24	26	Canada
fr	3	21	16	23	France
ru	2	21	13	22	Russian Federation
za	3	10	7	19	South Africa
mx	4	12	6	14	Mexico
gov	1	9	6	12	US Government
se	0	4	10	10	Sweden
ie	4	6	6	8	Ireland
mil	2	2	6	7	US Military
tw	0	6	6	7	Taiwan
ar	4	3	3	6	Argentina
fi	1	4	5	6	Finland
be	3	2	3	5	Belgium
cl	1	3	4	5	Chile
pt	1	1	4	4	Portugal
dk	1	0	2	3	Denmark
arpa	0	3	2	3	Old style Arpanet
at	0	2	3	3	Austria
yu	0	3	2	3	Yugoslavia
hu	0	3	1	3	Hungary
nz	1	1	1	2	New Zealand (Aotearoa)
ae	1	2	0	2	United Arab Emirates
lv	1	2	1	2	Latvia
ch	1	1	2	2	Switzerland
gr	0	2	1	2	Greece
cn	0	2	0	2	China
kr	1	1	1	1	Korea (South)
il	0	1	1	1	Israel
bg	0	1	1	1	Bulgaria
sa	0	1	0	1	Saudi Arabia
ro	0	0	1	1	Romania
tr	0	0	1	1	Turkey
Unknown	104	297	394	545	
Total	307	1228	1855	2399	

Preview of coming attractions

The 31DEC10 release already contains a few changes that we decided were a bit risky or not needed in 31DEC09. UVRFI is a new task that implements two methods for excising RFI from data without flagging the data samples. It shows some real promise in cases which are suited to the algorithm. The old task RM has already been revised to read image cubes with FQID axes (as now produced by FQUBE and MCUBE) and to have an additional method for searching for the best fit rotation measures. New tasks are being developed to evaluate tables and *uv*/image data left behind by pipelines. The installation procedure has been given code to avoid common problems when the site name or architecture changes at a site installing a new version of *AIPS*.

Improvements of interest to users in 31DEC09

We expect to continue publishing the *AIPS Letter* every six months along with the annual releases. There are a number of new tasks released in the last 6 months along with a variety of improvements to IMAGR and other tasks. The new tasks include FQUBE to build image cubes with an FQID axis to describe irregularly distributed frequencies, FARS to determine best estimates of rotation measure by the Faraday rotation synthesis algorithm, CAPLT to plot closure amplitudes with source models, SNCOP to average IFs within an SN table and copy the averages to an SN table of another data set, BLCHN to perform channel-dependent baseline corrections, ATLOD to translate ATNF and ATLBA data into *AIPS*, and SUFIX to correct source assignments in *uv* data sets. The new verb FILEZAP allows one to delete an external file from within *AIPS*. IMAGR now can do baseline-length dependent time averaging on input, can switch from OVERLAP 2 mode to OVERLAP 1 mode automatically, and can delete boxes which overlap in more than one facet. In the first half of 2009, IMAGR learned how to create Clean boxes automatically supported by new tasks SABOX and FILIT. The latter task was improved in recent months as well.

Normally, bugs which are created in an *AIPS* TST version and then fixed in that same version before its release get little or no discussion in the *AIPS Letter*. 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 31DEC09 is frozen to bring it up to date and to fix all bugs of this sort. We will discuss below a particular set of errors that accompanied the change in antenna file format and have set up a web page <http://www.aips.nrao.edu/problems.shtml> which we hope to maintain to emphasize such matters. It is linked from the main *AIPS* web page so it is not necessary to remember the above URL. Other bugs of this sort are mentioned below for IMAGR, FILIT, and EDITR. 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* web page under documentation. Please do not hesitate to e-mail daip@nrao.edu with any questions or suspicions that there are problems.

31DEC09 contains a change in the format of antenna files which will be discussed in detail below. 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 antenna-file specific code reads the file, after which older releases will have difficulties. Major changes were made to the display software last year in 31DEC08. Older versions may use the 31DEC08 display (XAS), but 31DEC08 code may not use older versions of XAS. FITS-IDI data from the DiFX correlator, now in use for the VLBA, requires 31DEC08 or later. 31DEC04 through 31DEC10 use a new numbering scheme for magnetic tape logical unit numbers that is incompatible with previous versions. Thus all tape tasks and the server TPMON must be from a recent release. Other than these issues, 31DEC08 is compatible in all major ways with the with the 15OCT98 and later releases. There are significant incompatibilities with older versions. Note that the only version which we patch for major errors is 31DEC09; even 31DEC08 is no longer changed.

Imaging

FARS

FARS is a new task to perform Faraday rotation synthesis on images of Q and U made at a variety of

frequencies. The user prepares two cubes of these images using FQUBE and TRANS. The task determines the Faraday rotation free ($\lambda = 0$) brightness and the Faraday depth of the media on the way from the source to the observer. The main ideas of the algorithm are described by M. A. Brentjens and A. G. de Bruyn in *Astronomy & Astrophysics*, 441, 1217-1228 (2005). The task Fourier transforms the data at each spatial pixel along the λ^2 axis. A simple version of Hogbom Clean is used to find a small number (usually 1 or 2) of complex components. The position of these components on the transformed axis corresponds to the rotation measure of that component while the real and imaginary values correspond to the Q and U of the component. The task then produces images of Q, U, and rotation measure for each of the allowed components. This task is new and experimental and will undoubtedly require improvements in the algorithm, in user controls, and in documentation. Nonetheless, it offers a significant step up from the rather simple algorithms in, for example, AIPS task RM.

IMAGR

IMAGR has acquired yet more capabilities. Perhaps of greatest interest, is the new capability to average a time-sorted input file in time with an averaging interval that depends upon projected baseline length. The input parameters are the size of the overall image and the maximum allowed averaging interval, with the default to do no averaging. This should make the task run faster since it can reduce the size of the work file considerably. It will, however, change the image some since it will have preferentially averaged short spacing data, thereby changing the cell sampling seen in uniform weighting. A modest taper could be used to compensate.

In high-dynamic range imaging with multiple facets, it is recommended to begin in `OVERLAP = 2` ; `ONEBEAM FALSE` mode for the most accurate beam pattern and to avoid sidelobes of the strongest sources. However, when the dynamic range of the residual images is reduced, the need for this accuracy is very much less. At that stage, Cleaning all the facets in each round, perhaps with only one beam, would be rather faster and of sufficient accuracy. The new adverb `OVRSWTCH` has been added to IMAGR to have the task itself perform this switch at an appropriate moment. This puts the task in `OVERLAP=1` mode in which overlapping Clean boxes cause instabilities. Therefore, a new routine was added to check for overlapping Clean boxes and to drop the smaller one in each overlap when in this mode. In `OVERLAP=2` mode, this clean-up operation is not automatic but is available from the TV menu.

Another new user option is one that controls whether the Clean of the next spectral channel starts with all the boxes used for the previous spectral channel or starts over with whatever boxes were specified in the inputs and input `BOXFILE`.

A number of internal matters were also improved. IMAGR will now append keywords for average zenith and parallactic angle only for observations that cover a small time range for which these averages are then meaningful. The auto-boxing routine would refuse to make boxes around single bright pixels, so the routine that finds the maximum in the residual changed to use the average of adjacent pixels in pairs for the maximum. Infinite loops may have been seen by users until this was fixed. The Clean Components are now restored to all resolutions in multi-resolution Clean. This allows the output images to be used in `FILIT` and `SABOX` for all resolutions. `OVERLAP = 1` mode seemed to have trouble stopping at a `FLUX` cutoff. It would Clean all facets below `FLUX` and then re-image them finding several very slightly above `FLUX` and so on and so forth. The test for "is there anything to Clean now" was changed to use `1.05 * FLUX` to avoid this useless extra computation.

IMAGR is now very much more careful about using a pre-existing work file. It did not seem able to confirm that such a file was actually appropriate for the current input adverbs and so would use ones that did not have the new parameters. Pre-existing workfiles are now deleted unless `ALLOKAY = 2`, which tells the task that the contents of the workfile are current and useful. The tests on the data to determine if sorting to *uv*-plane order had errors which caused IMAGR to sort data rather often when the data did not need to be sorted. These are corrected and avoid a potentially lengthy sort operation. The code that found a list of model facets which could be subtracted at the same time had an error that caused the list making to stop at any facet with no components. All components were eventually subtracted, but the data were read more times than necessary.

Miscellaneous

FQUBE is a new task to build image cubes with an irregular frequency ID (“FQID”) axis for which the correct frequencies of each plane are determined by a table look up. It is meant to simplify the serious complexities of MCUBE. MCUBE was corrected for a bug limiting the output axis to 2048.

FILIT was corrected for bad errors when OBOXFILE was the same as BOXFILE. It has new options to check boxes for overlap between facets, to enter the next facet number directly (rather than jumping by ± 1), and to delete all boxes in the current facet.

IMAGE extensions in FITS are a standard form which *AIPS* has not previously recognized. IMLOD and FITLD were changed to recognize this form of FITS file and to make one or more images in the *AIPS* catalog from them.

COMB was changed to copy attached tables other than Clean Components. This enables the FQ table to be preserved.

SAD and IMFIT and JMFIT did incorrect things with the image rotation on the deconvolved component parameters when one or both widths were indeterminate.

UV data

Antenna tables

The format of the *AIPS* antenna tables was changed. The main purpose of the change was to take control of the geometry of the antenna locations quoted in the file. Previously, *AIPS* and other packages had to know whether right-handed or left-handed geometries were used according to the array name in the file — and that was sometimes uncertain. Now there are two new header keywords TFRAME to define the terrestrial frame for the antenna locations (*e.g.*, ITRF) and XYZHAND to define the handedness (now always RIGHT). An automatic translation occurs using the array or station names to determine what handedness is used and to force it to right-handed. Two columns were added to the antenna file itself, DIAMETER of the antenna in meters and BEAMFWHM of the antenna as a function of IF in degrees per meter wavelength. At present these columns are little used, but there are several heterogeneous arrays (such as CARMA and ALMA) which have come into operation or soon will be in use.

This change was introduced into 31DEC09 en masse on September 20, 2009. This change will produce errors when the new antenna files are used by software that does not understand the new handedness, such as 31DEC08 and earlier versions of *AIPS* and other software packages. These errors will not produce messages in most cases. When 31DEC09 (or later) touches an antenna file it fixes its format if needed. But then, when an older version reads a “fixed” VLBI file it will make a wrong assumption about handedness. This includes UVFIX, plot routines doing elevation or parallactic angle, CLCOR ‘POLR’, ‘PANG’, ‘ANTP’, ‘IONS’, ‘ATMO’, *et al.* corrections, UVFLG elevation flagging, CALIB elevation cutoff for gain normalization, TECOR, ANTAB with opacity corrections, DELZN, CAL, LPCAL, CVEL, and probably others. Negative elevations are a common symptom of this error; use UVPLT to plot the elevations in your data to test for the problem. A RUN file named ANFIX8 was patched into 31DEC08 to correct “fixed” antenna files. Note that VLBA data pre-processed into the NRAO archive will have the new convention, causing old *AIPS* versions to have trouble with the latest archive data. Archive files in FITS-IDI format are safe, but more numerous and bothersome.

Unfortunately, the change also contained a number of outright errors. FITLD was left able to record some antennas with the wrong B_y coordinate if they did not occur in the first FITS-IDI file. A large number of archive files affected by this bug are being corrected, but a procedure ANCHECK is available as a RUN file to check your VLBA pre-processed data for this error.

The application of polarization calibration was completely broken in 31DEC09 from September 20 to November 17. The results of PCAL and friends were probably fine, but the application of those D terms was badly messed up. The POLR option in CLCOR corrected the CL table properly but only corrected the first IF in the polarization solutions in the antenna table. That error was fixed November 26.

The executive summary of the above is that you should use 31DEC09 or 31DEC10 and make sure that your version is up to date.

Other changes

CLCOR was changed so that 'ANTP' and 'ANTC' operations compute delays internally with respect to antenna one. The absolute delays for the EVLA which uses Earth-centered antenna coordinates were way too large for storage in single-precision. Note that the CL table is in single precision which limits the accuracy of large shifts for VLBI and other long baselines.

FRING was changed to handle time intervals with only one sample and, similarly, to force a delay-only form of solution if requested. The output frequency increment and reference pixel were corrected.

CALIB was changed to use ICHANSEL rather than BCHAN and ECHAN to define the spectral channels to be averaged.

BPASS had an egregious error causing it to average all channels rather than use ICHANSEL correctly in those modes that use that adverb.

BLCAL was changed to use ICHANSEL; previously it averaged all channels.

BLCHN is an experimental, channel-dependent version of BLCAL. It produces a BD table but applies its corrections directly to an output file. The BD table can be displayed by POSSM and BPLOTT.

TVFLG was corrected for a memory error which caused it to die when more than six spectral channels were used. TVFLG and SPFLG now offer an option of TV transfer functions which will be useful for high dynamic range data (or RFI). Reading of the antenna file for baseline lengths was corrected.

SPLAT was corrected to clean up empty output files, to write a correct index table with the output (source numbers became confused sometimes), to write a null CL table with output multi-source files, to avoid difficulties in unusual data sets with random parameters that change on output, to handle removing the polarization calibration from the output files, and to avoid the header alternate reference pixel which is often incorrect.

SPLIT was corrected to clean up empty output files, to handle the new antenna file format when removing polarization calibration from output antenna files after application, and to avoid the header alternate reference pixel which is often incorrect.

FO tables are a new kind of table to carry the frequency offset applied to the data as a function of time. It is hoped that these may be used by other software to tell AIPS about Doppler tracking if any. SPLIT and SPLAT copy the frequency information (if there is any) in the CL table to an output FO table. CVEL and others will use an FO table in preference to a CL table if possible.

CVEL was corrected to use the proper sub-array number, to create an index table for the output file, and, most importantly, to write an output FO table containing the sum of the frequency offsets now applied to the data.

SNFLG can now flag data based on discrepant gains in an SN table.

UVFLG now offers the option to flag antennas for shadowing and baselines for being too short. This will work well only if the antenna file contains all of the antennas, not just those currently being used.

VBGLU was changed to not require index tables with the input data sets (it did not use them), to make an output index table, to avoid excess error messages, and to get correct start and stop times for the input data sets.

ATLOD is a task to translate Australian "RPFITS" format into AIPS. It is now updated and shipped with AIPS instead of having to come from the ATNF.

TACOP was changed to allow dropping of flagged table rows.

UVFND will now examine phase as well as amplitude to find questionable samples.

- GETJY** now uses “robust” averaging methods which should make its results a bit more reliable.
- CLIP** was given the option to flag a number of spectral channels surrounding the offending data sample.
- FILLM** was changed to adjust the requested stop time so that the test is effectively on the center of the integration rather than the end.
- EDITR** had an error from Jan. 31 to June 30 in transferring “flag above and below for one antenna” commands to the output flag table.
- SUFFIX** is a new task which allows the source number to be changed for ranges of times. It may be needed when the on-line system confuses source IDs in fast switching.
- SNCOP** is a new task that will average specified IFs in an SN table and then write that average to an SN table of another data set. This may be used to apply delay solutions from good IFs to those damaged by RFI or to transfer gains from a single IF subset to the parent multi-IF data set as when a spectral feature is used to determine delays or gains.

Display of *uv* data

- CLPLT** was changed to plot symbols correctly and to plot models preferably at the location of the input data samples or at a regular grid of time samples (which will be less accurate).
- CAPLT** is a new task which is a variation on CLPLT to plot closure amplitudes around sets of four baselines. Plotting of models with multiple plots per page is supported.
- PRTUV** was changed to use a fixed format by default. The reading of the data to determine the best format is too expensive with the new volumes of data. The user may still control the formats with adverbs.
- UVPLT** and **WIPER** were given the **NCHAV** adverb to display multiple channels with some averaging for improved signal to noise.
- FRPLT** was changed to accept **DOACOR**, to plot phase or amplitude only solutions when requested, to do fixed scale plotting correctly when requested and for a few other minor matters.

Miscellaneous

- FREESPAC** now reports disk space in Mega-bytes because disks are getting larger and larger.
- FILEZAP** is a new verb to delete external files from within AIPS if, for example, the task you are to use will not over-write an existing file and you want to do so.
- CookBook** files were updated to drop **TIMDEST** and **MX**, add **FILEZAP** and **ATLOD**, describe multiple new **IMAGR** options, **SABOX**, **FILIT**, Slice files from **ISPEC** and **BLSUM**, **UVMOD** allowing 999 components, and **FRING** no-rate change.

Recent *AIPS* and related Memoranda

All *AIPS* Memoranda are available from the *AIPS* home page. There are two newly revised memoranda in the last six months.

110 Strategy for Removing Tropospheric and Clock Errors using DELZN, Version 2.0

Amy J. Mioduszewski & Leonid Kogan (NRAO)

August 31, 2004; Revised October 21, 2009

This memo provides a guide to scheduling and reducing phase reference experiments in order to improve the astrometric accuracy and image quality of a target source. The recommended procedure includes occasional short periods of observations of calibrator sources around the sky, interspersed with the desired phase reference observations, from which the troposphere modeling errors can be determined using a new *ATPS* task DELZN. The recommended observing procedure, data reduction, running of DELZN and application of corrections to the phase reference data are covered.

114 The FITS Interferometry Data Interchange Convention

Eric W. Greisen (NRAO)

June 25, 2009; Revised December 15, 2009

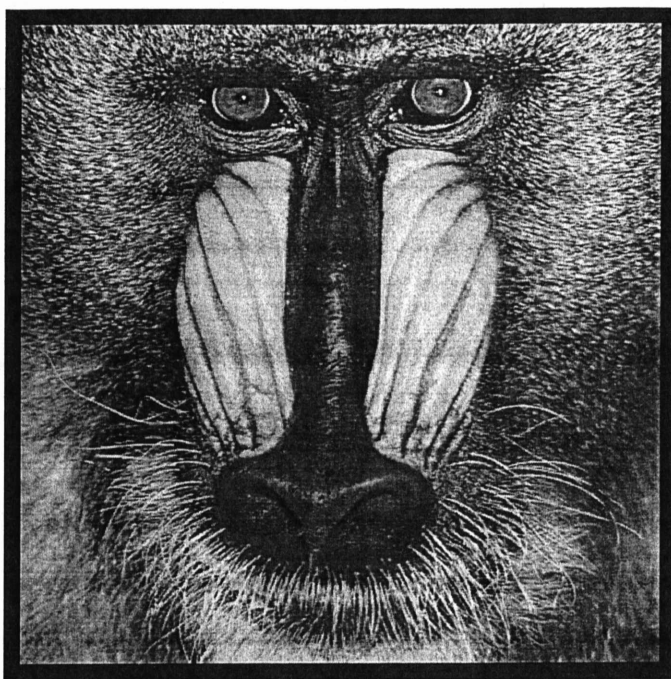
The FITS Interferometry Data Interchange Convention ("FITS-IDI") is a set of conventions layered upon the standard FITS format to assist in the interchange of data recorded by interferometric telescopes, particularly at radio frequencies and very long baselines. It is in use for the VLBA telescope for 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 *ATPS*.

Patch Distribution for 31DEC08

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, 31DEC08 was patched during 2009 and 31DEC09 will be patched as needed during 2010. 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 *ATPS* 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 31DEC08 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 2009. They are

1. CALIB could infinite loop if the first NX record was of 0 length *2009-01-27*
2. TYAPL would apply the highest flag table without permission when it should just be copied *2009-02-04*
3. OFM files were not adjusted to the new TV intensity ranges *2009-04-02*
4. IMAGR TV option "FORCE A FIELD" caused all facets to be re-imaged; scratch files were way too large sometimes *2009-04-22*
5. DBCON copied keyword MAXBLINE which confused later imaging routines *2009-04-27*
6. IMAGR had a limit test that was too small affecting restoration of large numbers of CCs from one facet to another *2009-05-18*
7. IMAGR had a tendency to sort input data sets when it did not really have to do so *2009-06-19*
8. `install.pl` skipped the automatic tarball download when one was missing *2009-07-26*
9. FITLD did not correct the AN table frequency when rearranging frequency order for IDI-format data *2009-08-18*
10. BPASS did not translate the ICHANSEL adverb correctly, causing all channels to be averaged *2009-11-11*
11. ANFIX8 is a new RUN file and procedure to correct antenna files back to 31DEC08 geometry *2009-11-30*



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