CALIBRATION OF WSRT DATA WITH AIPS: THE TASKS LINPO, REMOB, TESTP

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SUMMARY

The AIPS package has been integrated with tasks which perform fixed amplitude and phase corrections to individual UV polarization channels. This kind of corrections is particularly useful for WSRT data if one needs to correct the crossed polarization channels, which are not handled by the standard calibration task ASCAL. To correct WSRT data, one has first to convert the circular polarization components to the linear ones; this performance has also been included.

1. INTRODUCTION

The AIPS package for radio astronomical data reduction (Fomalont and Bridle, 1983) is now definitely used for WSRT data. This is possible thanks to an interface program (Stirpe 1984), that reads a WSRT tape and writes an EXPORT tape, which can be managed by AIPS.

The main difference between WSRT and VLA format is that visibilities are recorded in a different way: WSRT data contain the linear polarization channels (XX, XY, YX, YY), while VLA data are expressed as circular polarization components (RR, RL, LR, LL). The translation from one expression to the other is obtained by standard formulae (Stirpe 1984), which give each term RR, RL, LR and LL as a linear combination of XX, XY, YX, YY. These last values are the actual output of WSRT correlators; therefore after conversion to circular polarization channels, the original information connected with the recorded channels is lost and possible errors or malfunctioning of one of the correlators

is spread on all 4 channels RR, RL, LR, LL. The kind of errors connected with the polarization channels cannot be corrected by ASCAL, which performs a selfcalibration on RR and LL only.

Therefore, for WSRT data it may be useful in some cases, when observations are bad and no obvious error is found in the UV data, to re-establish the original situation recorded at the WSRT, in order to correct possible errors related with the single polarization channels. To this aim the programs LINPO, REMOB and TESTP were added to AIPS.

More generally, these tasks can be used on VLA or VLBI UV data to shift the phase center and/or to subtract point sources in the UV plane (LINPO), or when fixed phase and amplitude corrections are to be applied (REMOB).

2.GOING AIPS

There are in AIPS two modification tasks for the two types of data files, UV data (FUDGE) and images (TAFFY). The basic structures of these two tasks are very similar and consist of calls to routines which do the basic functions, i.e. initialize COMMONS get ADVERB values, restart AIPS, find input file catalogue, create and catalogue output file. The user supplies a subroutine which does some operation on the logical record and returns the result.

The task FUDGE sends UV data records to the subroutine DIDDLE, whose content must be supplied by the user. Visibilities are sent to the subroutine one at a time, together with NUMVIS (visibility number), U V W (baseline components), T (time), IA1

IA2 (antenna numbers). These are the data which are returned to the main program after modification. The parameters RA, DEC (center coordinates), FREQ, NCOR (number of Stokes parameters) are sent to the subroutine DIDDLE via COMMON, therefore can be used in the subroutine but cannot be modified. The arrays APARM(10), BPARM(10) and BOX(4,10) are used as input parameters supplied by the user. The modified parameters are returned to the main program, together with a return code, which contains the information of possible errors. Moreover, it is possible to write messages on the terminal and in the history file of the output data set, using ENCODE and, respectively, the arrays MSGTXT and HISCRD.

The procedure for creating a new task is as follows:

1 - create in the directory [AIPS.LOCAL.PGM] the source program (PROG.FOR) by using the main FUDGE.FOR and adding to it the content of the subroutine DIDDLE;

2 - create in the directory [AIPS.reldate.HELP] (where reldate is the current release date) the file PROG.HLP for the management of inputs and help, having as an example the file FUDGE.HLP

3 - compile and link the source program. This is easily done with the following commands:

```
SET DEF [AIPS]
@NEW:CDNEW          (makes the process logical assignments
                     needed to compile and link programs)
@LCOMLNK PROG       (creates the load module PROG.EXE in
                     the area [AIPS.LOCAL.LOAD])
```

The load module is further copied in the area [AIPS.reldate.LOAD], in order to be available simultaneously with the other AIPS tasks.

3.PRESENTATION OF THE PROGRAMS

The use of individual programs is described in the HELP file contained in AIPS and enclosed at the end of this report. It is useful to mention here the logic sequence of UV data processing, which can be followed for WSRT data. This procedure is quite similar to the selfcalibration tecnique, known as REMOBS program, of the Leiden reduction library (Brouw 1970).

1 - Convert visibilities from circular to linear polarization components by mean of task LINPO. If the conversion is performed correctly, a message is written in the history file of the output data set, but nothing is changed in the header of the data set. Therefore the programs which further handle this data set (which contains linear polarization channels) always think to deal with circular polarization components. This is not a problem since the standard AIPS programs one may wish to use at this stage are those which do not perform any computation on polarization channels (UVPLT, PRTUV, UVFND, etc.). The convention is: R means X and L means Y. In case of confusion, the program TESTP allows one to check the type of polarization components.

2 - Plot visibilities, by mean of standard AIPS programs, for different polarization channels and/or interferometers, in order to find out possible phase and/or amplitude errors (remember that RR means XX, etc). These can be better seen if a strong pointlike source is present at the fringe stopping center and no other strong sources are present in the field. By mean of task LINPO it is possible to produce as good as possible this optimal situation, by shifting the phase center to a new position (that of the strongest source in the field) and subtracting pointlike

weaker sources. A message of the operation made on data is written in the history file; remember that in the case of center shift, the center position written in the header of the output data set remains the old one (parameters RA and DEC cannot be modified, as mentioned above).

3 - Correct amplitude and/or phase errors in different polarization channels and/or interferometers and/or time intervals by mean of task REMOB.

4 - Reconvert to circular polarization channels, by means of task LINPO , before making the map (via UVMAP). This step must not be forgotten, otherwise the resulting map will be a mess.

4.HELP FILES OF THE NEW PROGRAMS

LINPO Task to convert circ to lin polarization and reverse

Task: *This task reads a UV data file and converts visibilities from circular to linear polarization components, or reverse. One must specify a polarization code, which refers to the original dipole position written in the WSRT tape (output of WSRT_AIPS).
The output data set contains linear polarization channels in following order: XX, YY, XY, YX.
The AIPS display programs, however, always refer to channels RR, LL, RL, LR (therefore one should keep in mind that R ==> X and L ==> Y).
Use TESTP to check the type of polarization channels.
Moreover it is possible with this task to
*shift the phase center to a given position

*subtract up to 10 point sources of given flux and position

Adverbs:

INNAME.....Input UV file name (name).

INCLASS....Input UV file name (class).

INSEQ......Input UV file name (seq.).

INDISK.....Disk drive of input UV file. 0 => user pack

OUTNAME....Output UV file name (name). blank => INNAME

OUTCLASS...Output UV file name (class). blank => INCLASS

OUTSEQ.....Output UV file name (seq.). 0 => lowest unique

OUTDISK....Disk drive of output UV file. 0 => INDISK

APARM......APARM(1) is the polarization code, which refers to WSRT dipole position. It is +1 or -1 for crossed dipoles (sky position Xw=90 and Xw=0, respectively) and =2 for parallel dipoles (and Xw=90). This parameter can be taken from the output of WSRT_ AIPS. No default value when change of polarization channels is requested.

APARM(2) = 1 for conversion circular to linear pol.

-1 for conversion linear to circular pol.

0 no conversion

BPARM......BPARM(1)=1 if a shift to a new phase center is desired. Remember that in this case the header of the dataset reports the old field center; the new position is only restored in the history file

BPARM(2,3,4,5,6,7)=new center position(h m s o ' ")

BOX........parameter to be used for source subtraction. Give in the order flux (Jy), RA, DEC, values for each source (maximum of 10 sources)

NOTE: RA and DEC should be given without blank between h m s and o ' " (Ex: 012324.5 352009.1)

REMOB Applies fixed amp-phase correction to UV data

Task: This task applies fixed corrections to the amplitude and/or the phase of UV data and writes the modified data onto a new file. It allows only two sets of corrections to be applied at a time. Therefore if many intervals of time or groups of interferometers have to be corrected it is necessary to run REMOB several times.

Adverbs:

INNAME.....Input UV file name (name).

INCLASS....Input UV file name (class).

INSEQ......Input UV file name (seq.).

INDISK.....Disk drive of input UV file. 0 => user pack

OUTNAME....Output UV file name (name). blank => INNAME

OUTCLASS...Output UV file name (class). blank => INCLASS

OUTSEQ.....Output UV file name (seq.). 0 => lowest unique

OUTDISK....Disk drive of output UV file. 0 => INDISK

APARM......Parameters of the corrections to be applied.

APARM(1)=1 correct amplitude; =2 correct phase

APARM(2)=value of correction, to be multiplied by the amplitude if APARM(1)=1 or added to the phase if APARM(1)=2

APARM(3)=Start APARM(4)=end time in mIAT of the interval where the correction has to be applied

APARM(5)=100ant1*ant2 :antenna numbers to which

apply correction; 0=all

APARM(6)=polarization channels to which apply

correction: 0=all 1=XX/RR 2=YY/LL 3=XY/RL

4=YX/LR

BPARM.....Same as APARM if another correction of amplitude

or phase must be applied

TESTP Task to check the type of polarization channels

Task: This task checks the type of polarization components

and writes it on the screen.

Adverbs:

INNAME.....Input UV file name (name).

INCLASS....Input UV file name (class).

INSEQ......Input UV file name (seq.).

INDISK.....Disk drive of input UV file. 0 => user pack

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