File-based Phase-cal Corrections in fourfit

[gbc 9/12/2017] The alignment of AP with time is somewhat problematic as one approaches smaller time intervals. If you are planning to use this technique, you should allow for minor time mis-alignment (at the level of a second or so) given that the time labeling of AP and scan (and so forth) is not fully consistent throughout the entire correlator + HOPS system.

[RJ Cappallo revised 2013.6.10]

For some applications, such as mm-wave VLBI where the atmospheric coherence time scale is short, it is advantageous to be able to make a priori phase corrections in a fringe fit. Typically the phases will be derived through some other avenue, such as other instruments such as WVR's or information from other polarization senses. For full flexibility, one can make corrections for each frequency channel as a function of time within each scan.

The full time-frequency array is specified in a flat 2-dimensional ASCII file, one file per each station. Typically, though not necessarily, a single file would be used for an entire experiment. The file would be given a name that identifies the station whose data it contains.

Each line in the file begins with an epoch, and then has entries for all channels for that epoch, represented by space-delimited phases in degrees. The UT epoch is in decimal days since the beginning of the year. (0300UT on Jan 2 is 1.125). Comments begin with an asterisk, and everything including and beyond an asterisk on each line is stripped prior to reading. Thus an example of a rather short phase file (having only 4 channels, with data points each 10 sec) might appear as:

```
* Westford phases for chans at 221120.0 221152.0 221184.0 221216.0
*
223.041667 13.2 -39.3 57.1 177.0
223.041782 9.7 -36.2 77.0 -176.5
223.041898 8.8 -37.7 92.4 -171.9
```

The new fourfit control file commands to support this capability are

adhoc_phase file   * denotes that file mode pcal will be used

adhoc_file <file_name>   * relative or absolute file name containing
                                    * phases

adhoc_file_chans <channel_list>   * where channel_list is ff chan codes

An example of a block of a fourfit control file might be:

```
if station E
  adhoc_phase file
  adhoc_file pcal_x3970_wf
  adhoc_file_chans abcd
```

Algorithm

The time points are considered to be either instantaneous values, or the result of a linear average of the phase, symmetric about the specified epoch. The algorithm within fourfit performs a linear interpolation between the specified points, and then finds the average value of the piece-wise linear function so derived over each accumulation period in a fringe fit. If the ap data extends beyond the range of the piecewise linear pcal function, then the function is extrapolated linearly (if possible) to cover the ap.

The phase values are considered to be equivalent to measured pcal phase for a station. Thus the value will be *removed* from the data phase prior to the fringe fit. In other words, the data phase will be counter-rotated by the given pcal phase. The ad hoc file-based phases are applied in addition to any extracted phase cal (as invoked by pc_mode multitone, normal, or manual). In order to zero out the extracted pcal, one can simply use pc_mode manual without any phases being specified in a pc_phases command, as the default is 0.

Note that fourfit channel codes (abcde…) have an implied context of the mk4 fileset it is being applied to. It is possible to recorrelate with a changed vex file, and have the resulting channel codes change. This shouldn't present a problem with a modicum of caution on the part of the fringe fitter.