Summary of discussion with Bill Cotton, NRAO

Dwingeloo, 4-11-2015

Present Bill, Des, Mark, Ilse

Bread and butter fringe-fitting

* The SNR of baseline fringes in AIPs is based on fitting a function to results of numerical experiments with artificially injected noise, defining 1 radian phase error per unit time to correspond to an SNR of 1. The results are sort of comparable to HOPS signal-to-noise ratios, in that they both increase with goodness, but the numbers don't line up exactly.

* An easy SNR measure for global fits is simply to calculate the RMS of residual phases after correction is applied. This is reported in AIPS; it is robust, algorithm-neutral, easy to calculate and interpret and very unlikely to catch on with mmVLBI people.

* Covariance matrices for the GSL least-squares solvers are related to SNR values, although not in especially convenient ways.

* The global solver in AIPS was by Fred Schwab; Bill is not in a position to comment on the details. (See also note on Obit below).

* For the global solver, units should be chosen to make numbers comparable across dimensions - AIPS has nanoseconds for group delay and
milliherz for delay rate. (Des was doing something similar; the solvers work better that way.)

* Baseline stacking is useful in homogenous arrays, but much less so in arrays dominated by a sensitive antenna. It also requires careful treatment of source models (even for calibrators) as the source structure affects different baseline combinations differently. In the worst case it is necessary to image the source and use the image as a model in a subsequent round of fringe fitting, possibly even iteratively.

Developments in AIPS and elsewhere

* Baseline-based time averaging of data can reduce data size by an order of magnitude; this is implemented in Obit.

* The troposphere becomes dispersive at very high frequencies; we may ultimately need to handle this. AIPS has recently acquired a dispersion term
in its fringe-fitting model.

* Alma will probably end up needing higher-order terms in fringe-fitting solutions.

* In principle it would nice to circumvent considerations of atmospheric coherence time by modelling atmospheric effects as continuous functions of time, exploiting the known (or at least knowable) constraints on derivatives . Cyril Tasse is working on this in the context of LOFAR, but it is a generally applicable concept. This is very desirable in theory, but very hard in practice.

* Obit incorporates a new fringe-fitter in C. It only fits delays - according to Bill, with modern (non-drifting) clocks, good models of sources, and good antenna positions, rates are not required for wavelengths of 7mm or more.

* Fred Schwab favours the use of global solvers using relaxation schemes using Newton's method that change one parameter at a time, using first and second derivatives. They have the advantage that they are fast and parallellize well. (StefCal is in the same broad class of algorithms.) They have the disadvantage that they require a very good applied mathematician (either Fred or possibly one of the StefCal team) to understand and/or implement.

* Alma currently uses a bandpass algorithm as a crude form of fringe-fitting for want of anything better.