7 The ICRF2 Solution (DG, DSM)

7.1 Configuration

The solution used for generating ICRF2 is the "gsf008a" solution. It was run by the VLBI group at GSFC using the Calc/Solve analysis package, in its global solution mode. The solution used a total of 4540 VLBI sessions observed between 1979 August 3 and 2009 March 16. The solution used group delays only (no phase delay rates). Parameters were estimated using the arc-parameter elimination method described in Ma et al. [1990], where arc-parameter refers to those parameters that are estimated for each experiment session (arc) in a solution. Global parameter adjustments are based on data from the entire set of VLBI data in the solution. The specific parameters falling into these two general classes are as follows:

1) Arc parameters adjusted for each observing session:

- Station clocks were estimated as quadratic clock polynomials for the slowly varying clock behavior. Short-term behavior was estimated as piecewise linear continuous functions at 60 minute intervals.
- Station wet troposphere zenith delays were estimated as piecewise linear continuous functions at 20 minute intervals.
- Atmosphere gradient residuals in the N-S and E-W directions were estimated at 6 hour intervals. These residuals were adjustments from an *a priori* gradient model [MacMillan & Ma, 1997].
- UT1 and polar motion offsets and rates were estimated at the midpoint of each session.
- Nutation offsets were estimated at the midpoint of each session.
- Source positions were estimated for a set of 39 "special handling" sources whose time series exhibited clear systematic variations (see §4).

2) Global parameters adjusted based on the entire data set:

- Station positions and velocities were estimated, for reference epoch 2000 Jan 01. No-net-rotation and no-net-translation constraints were imposed on a set of 27 stations to align the estimated TRF with VTRF2008 [Nothnagel, 2008].
- Station position harmonic variations were estimated for 41 stations at diurnal, semi-diurnal, annual, and semi-annual frequencies.
- Spline parameter estimation of nonlinear variation was made for sites Gilcreek, Pietown, and HRAS085.
- A discontinuous offset parameter was estimated for 12 stations at epochs corresponding to an identifiable effect, e.g., an earthquake or an antenna repair. These sites were:
  YAKATAGA, SOURDOGH, WHTHORSE, FORTORDS,
  PRESIDIO, MOJAVE12, DSS15, MEDICINA, EFLSBERG,
  DSS65, GGAO7108, and SINTOTU3.
- Source positions were estimated for all sources with three or more good S/X-band observations, except for three gravitational lenses and six radio stars. Positions were estimated globally (for the entire data span) for all but 39 special handling sources. Some 795 sources were excluded from the solution because there were fewer than three good S/X-band observations in at least one session. Most of these were from the VCS sessions. A no-net-rotation constraint was imposed on 205 of the 212 ICRF1 defining sources (seven are special handling sources) to align their positions with the original ICRF1 defining sources.

- Adjustments to the antenna axis offsets were estimated at all fixed sites.

The *a priori* models for geophysical effects and precession/nutation generally followed the IERS Conventions (2003) [McCarthy & Petit, 2004]. Specifically, corrections for solid Earth tides, the pole tide, ocean loading, and high frequency EOP variations were made using the IERS Conventions (2003) [McCarthy & Petit, 2004]. A 5° elevation cutoff was imposed. Other important effects were modeled using:

- Atmosphere pressure loading corrections according to Petrov & Boy [2004].
- The Vienna Mapping Function (VMF1) troposphere model of Böhm, Werl, & Schuh [2006].
- The antenna thermal deformation model of Nothnagel [2008], in which the antenna heights were adjusted in each session using the average temperatures during that session.

The weighting of data in the solution followed the usual procedure for GSFC solutions. For each experiment session, re-weighting noise is calculated for each baseline so that the reduced χ^2 is close to one when the re-weighted noise is added quadratically to the measurement uncertainty determined from the correlation, fringe-fitting, and ionosphere calibration process. Ionosphere corrections were made using the difference of the X-band and S-band group delay observables.

7.2 Statistics

The Solve/Global solution used a total of 4540 VLBI sessions and 6.495553 million observations. The sessions extended from 1979 August 3 to 2009 March 16. The overall wrms post-fit delay residual was 21.856 ps and the χ^2 per degree of freedom was 0.890. "Global" positions were obtained for 3375 sources, and "arc" positions (time series) positions were obtained for the 39 special handling sources. Weighted mean positions of these 39 sources were computed and added to the global catalog. For their formal errors, we assigned the wrms of their RA and Declination positions with respect to the weighted means. Catalog gsf008a thus has positions and formal errors for 3414 sources.