Geophysical Research Abstracts, Vol. 7, 02864, 2005
SRef-ID: 1607-7962/gra/EGU05-A-02864

Short-term instabilities in the IGS reference frame

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Following ITRF, the IGS reference frame is defined in a strictly secular sense by a set of regularized coordinates and linear velocities for about 99 globally distributed stations. The ITRF datum is enforced by a 14-parameter Helmert alignment of the IGS frame. Except for uncertainties in the specification of the datum for rotation rates (the no-net-rotation condition), the long-term stability of the IGS frame is thought to be accurate to $<$1 mm/yr.

Short-duration global GPS coordinate frames are also realized, typically for 1-day and 1-week integrations. The stability of these short-term frames, being subject to greater observational noise and many time-varying effects, is naturally much poorer than for the secular frame. The temporal effects can be considered of two classes: external, geophysical sources that cause individual site motions to be non-linear (after accounting for known and tidal variations); and internal, technique-related errors. There is growing interest in using observed non-linear deviations in the short-term GPS frames to better characterize certain of the geophysical processes, especially transport of fluid mass loads within the Earth system. Doing so reliably, however, requires that the technique errors be reasonably well understood and not too large. We have evaluated global coordinate frames from the International GPS Service (IGS) to assess the significance of technique errors relative to geophysical effects.

Measurement noise in the IGS reference coordinates and velocities imposes a short-term stability floor (precision limit) that increases steadily as observing times move away from the minimum variance epoch. At 2004.0, this floor was about ˜2 mm for station heights but by 2005.0 it reached ˜4 mm. This noise floor compares with the observed RMS scatter in weekly station heights, which has varied from about 4.5 mm to more than 7 mm. For daily frames, realized by precise point positioning using

IGS combined products, the height scatters have varied between about 8 and 12 mm. Trends in the two time series are fairly well correlated.

Atmospheric pressure loading is expected to be the largest source of geophysical height scatter (apart from episodic events which must be recognized and treated individually). Petrov and Boy (2004) estimate an average RMS height scatter of 2.6 mm due to this effect for a globally distributed network. This is too small to explain most of the observed GPS frame instabilities. Among other things, we find that surprisingly large variations in average IGS data quality probably control much of the short-term stability of the GPS coordinate frames.