Using RtStatic to Monitor Movement of the San-Andreas Fault

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Background

Presented here are results from a 252-day run (March 29, 2001 to December 5, 2001) of RtStatic between the IGS stations POMM and MIDA. POMM and MIDA were chosen due to their proximity to each other (1.8 km), their data availability and because they lie on opposite sites of the San-Andreas Fault.

The baseline data was obtained by downloading RINEX files from the SOPAC site (http://sopac.ucsd.edu/). We gratefully acknowledge the Southern California Integrated GPS Network and its sponsors, the W.M. Keck Foundation, NASA, NSF, USGS, SCEC, for providing data used in this study.

To simulate real-time processing, the RINEX data was read from disk by a utility program and converted to NovAtel GPS binary data format. This binary GPS measurement data was piped with appropriate time delays through MULTICAST network ports over a local computer network. As RtStatic can be configured to process real-time data either through serial or network ports, this configuration is equivalent to processing real-time data from two NovAtel receivers.

Results

RtStatic processed a single frequency fixed solution every hour. In total, 3304 solutions were processed. Out of the total number of fixed solutions attempted, only 33 failures occurred (1% failure rate). These solutions are filtered with a 24-hour time constant and plotted in real time. The static plot produced in RtStatic is shown below, which shows the filtered latitude, longitude and height values.

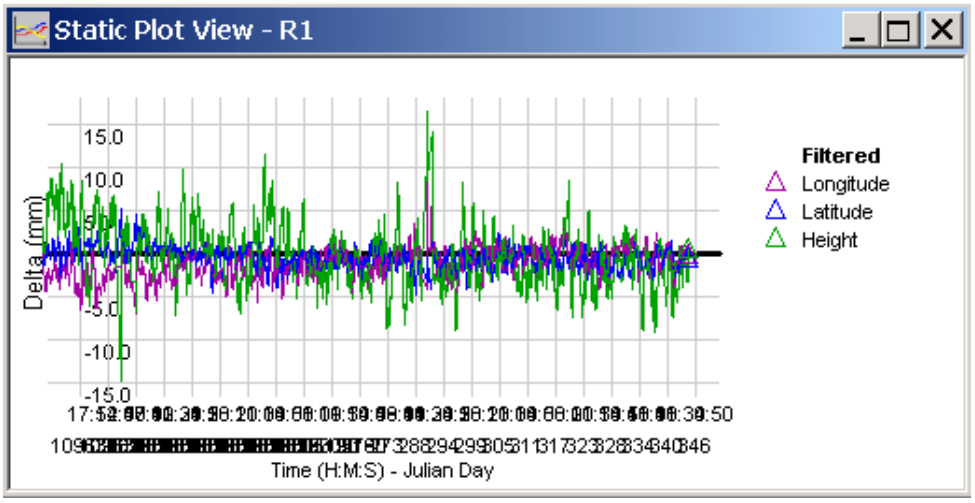

Figure 1: Static Plot of R1 (MIDA) in RtStatic

For clarity, latitude, longitude and height can be exported and plotted externally to RtStatic. The following graphs show each component plotted separately in Microsoft Excel.

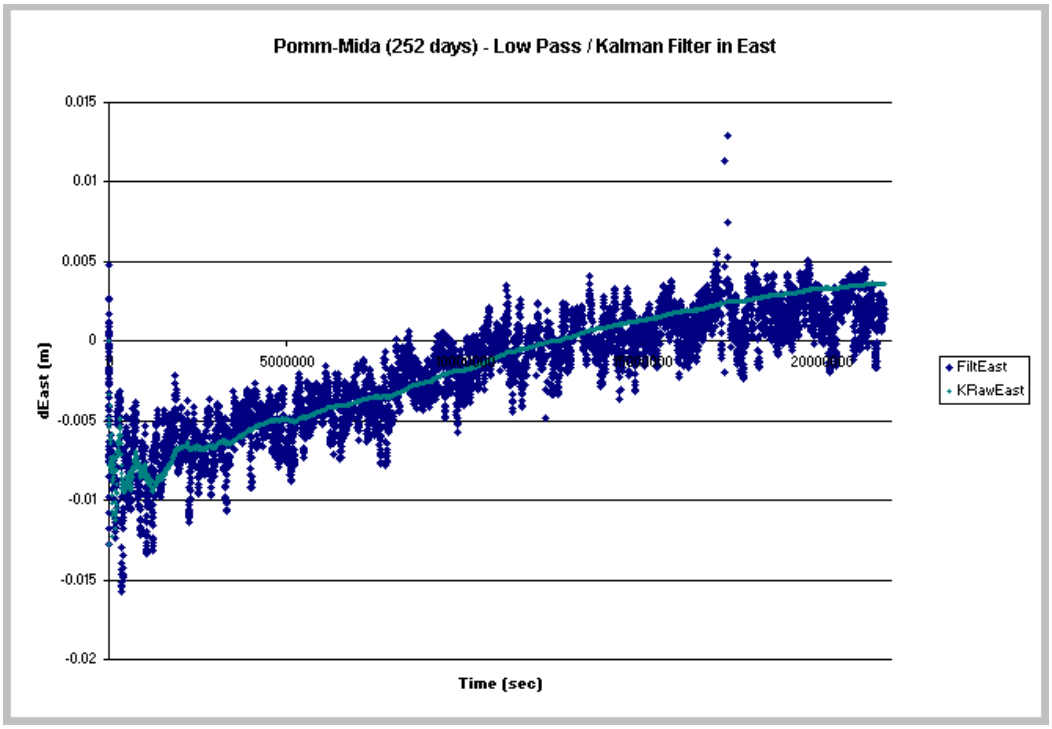

Figure 2: Low Pass/Kalman Filtered East coordinates over 252 days

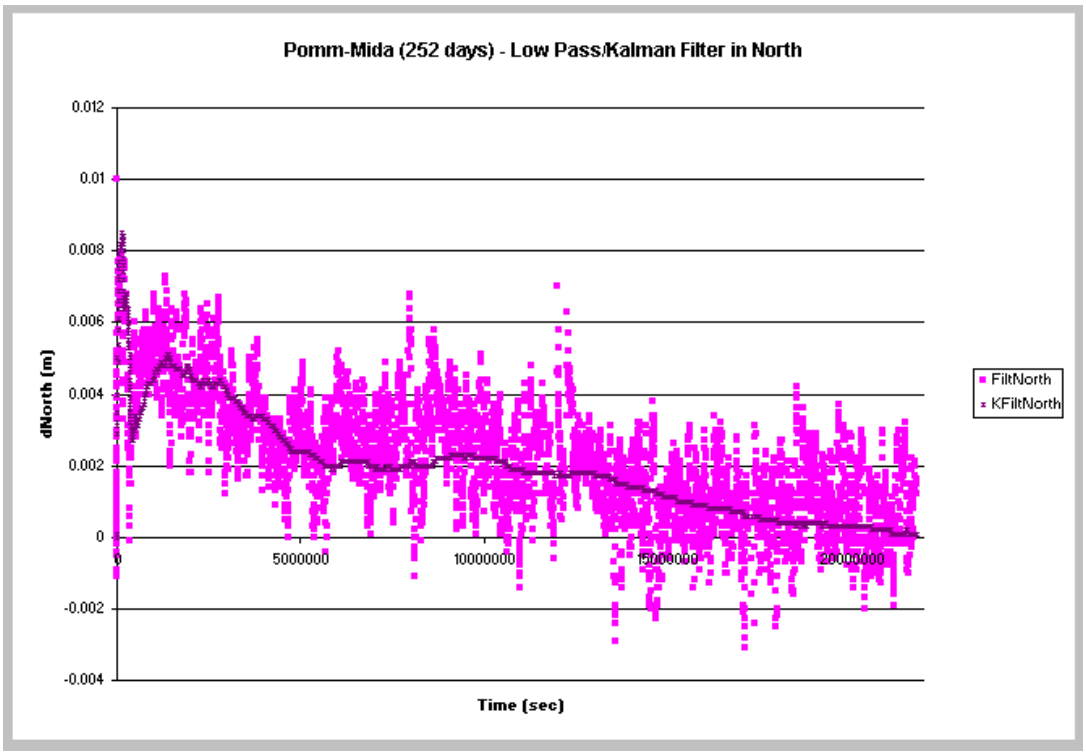

Figure 3: Low Pass/Kalman Filtered North coordinates over 252 days

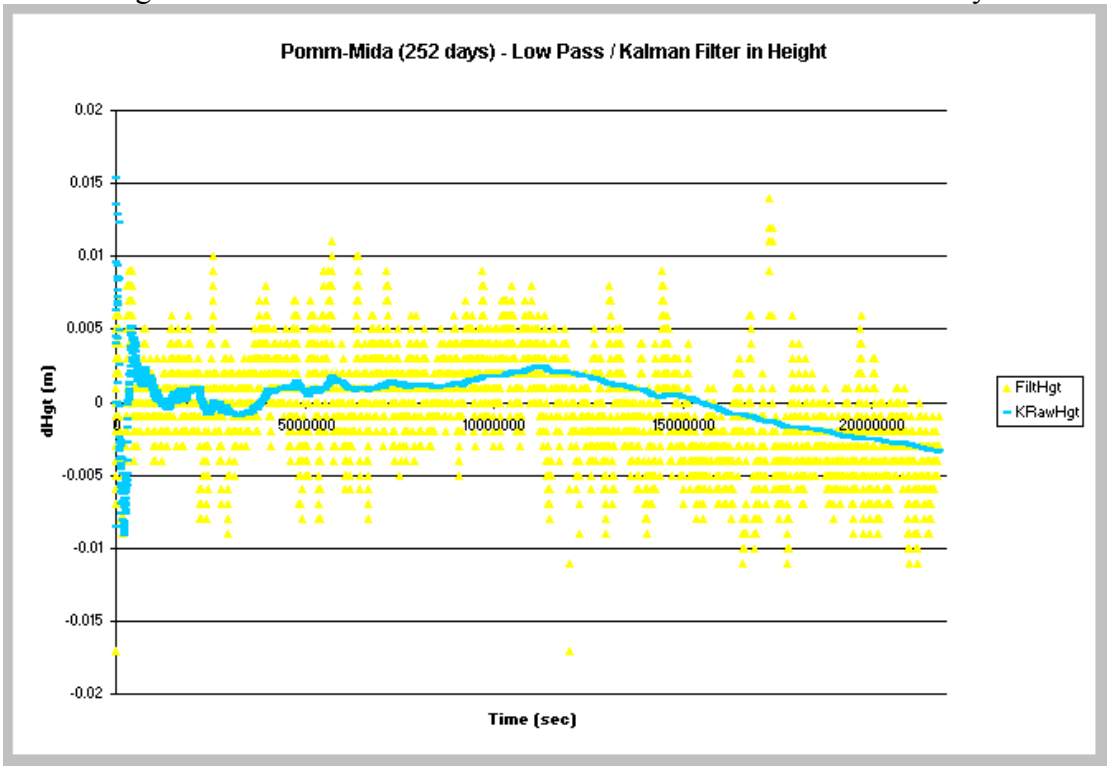

Figure 4: Low Pass/Kalman Filtered Height coordinates over 252 days

The plots shown in Figures 2, 3, and 4 represent two sets of coordinate differences filtered from the one hour series of Fixed Static solutions provided by RtStatic over the 252 day period of the survey. The coordinate differences are with respect to an arbitrary position for MIDA as obtained on day 252. The low pass filtered coordinate differences are represented by the noise-like data pattern. These are the results of a low pass filter in the coordinate domain with a 24-hour data window. The solid line in the center of the low pass results is the Kalman filtered representation of the coordinate difference s obtained by solving for the relative component velocities of MIDA with respect to POMM.

Absolute velocity values for POMM and MIDA for the same time period are available from the SOPAC website. These "truth" values were used to compare against RtStatic results. SOPAC reports the absolute velocity of POMM to be 13.5 ±0.2 mm, -36.3 ±0.2 mm, and 2.4 ±1.5 mm in the North, East, and up components respectively. For the same period, MIDA is reported to have absolute velocity values of 6.8 ±0.2 mm, -24.7 ±0.2 mm, and –1.0 ±1.6 mm in the north, east and height components respectively.

From the above-mentioned velocities of POMM and MIDA, the relative movement of MIDA with respect to POMM (as calculated in RtStatic) is expected to be –6.7 mm in North, 11.6 mm in East, and –3.4 mm in height. No strong movement is expected to be detected in height, however, as the individual absolute velocities are close to the noise level. This is seen given the small absolute velocities and the relatively large standard deviations reported by SOPAC for each site.

From the above plots, it is clear that a positive trend exists in the east and a negative trend in the north. No strong trend is shown in height. The Kalman filtered results seem to indicate an approximate movement of about -5 mm north and 13 mm east. The low pass filtered results seem to indicate a more conservative movement of approximately -4 mm North and 11 mm east.

Overall, the relative movements reported by RtStatic agree well with the absolute coordinate differences detailed by SOPAC and other monitoring agencies.