Completeness and Consistency of Different IGS RINEX Products

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Introduction

With the release of the RINEX 3 format, a considerable number of IGS stations is submitting not only RINEX 2 but also RINEX 3 formatted observation files to the IGS. Completeness and consistency of the observation data is essential as all IGS analysis products rely on the submitted RINEX files.
The still widely used RINEX 2 format will be in the future by the newer version. Therefore, we compare the observation files of both formats in terms of completeness and consistency. The quality of the various RINEX files will be assessed by computing phase-only GPS/GLONASS PPP solutions.

Mapping of RINEX 2 to RINEX 3 observation types

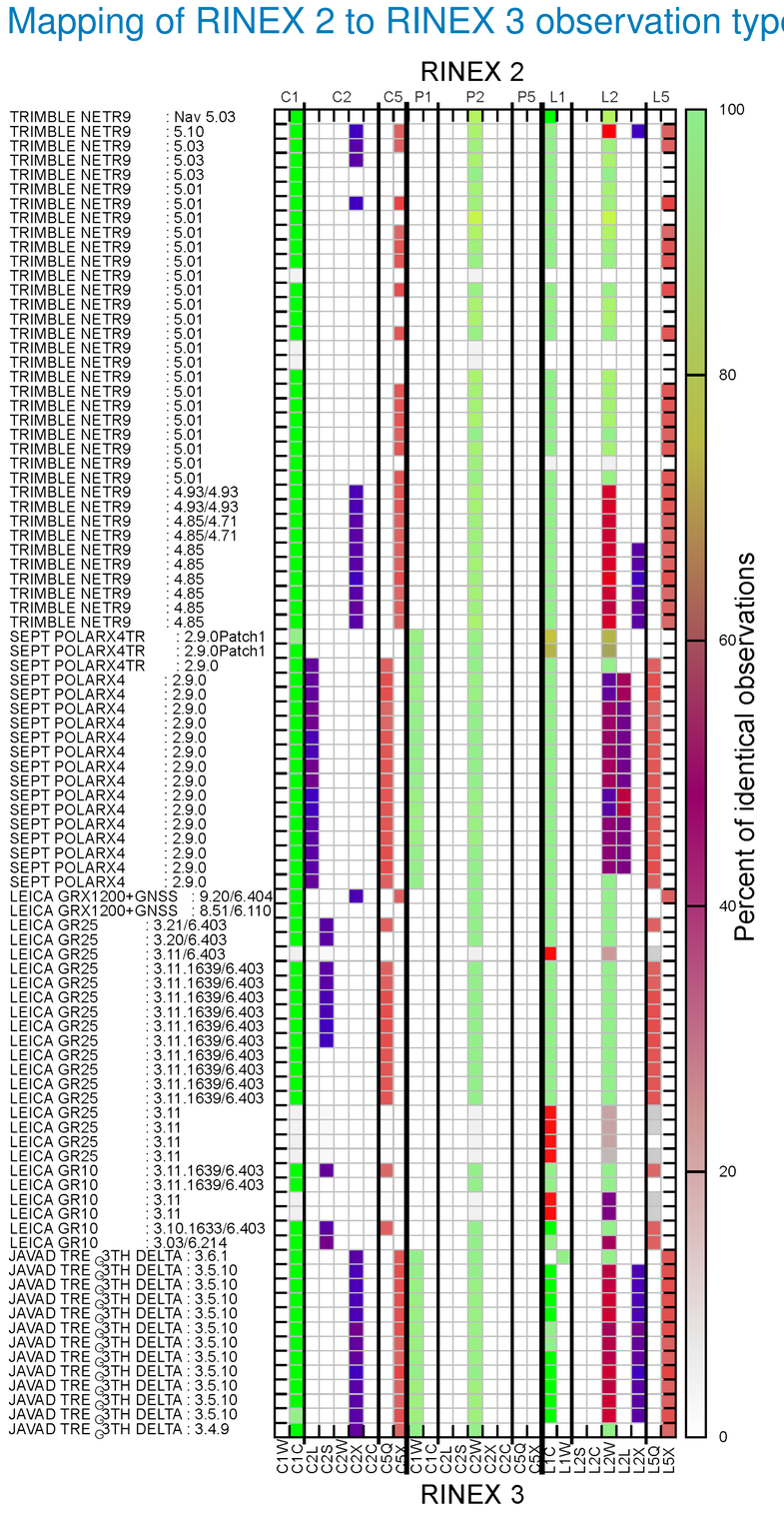

Figure 1: Percentage of observations between RINEX 2 and RINEX 3 observation types with identical values for day 280 pf year 2015. Only observations available in the RINEX 2 and the RINEX 3 data are used.

RINEX 3 PPP solution

The comparison is done with a Precise Point Processing (PPP) (GPS or GLONASS phase-only) approach. The outcome of the RINEX 3 processing is then compared to the solution using the legacy RINEX 2 solution. As it can be seen in Figure 1 the RINEX 3 data contains a variety of different signals for each code and phase measurement. Therefore, for the PPP approach a pair of L1 and L2 signals has to be chosen in order to form the usual ionosphere-free linear combination. We have chosen three different priority lists for the observation selection when processing GPS and two when processing GLONASS data. The observation type with the highest priority (and completeness) is then used during the processing Using different priority list definitions (as shown in the listing) the PPP processing was performed and compared to the RINEX 2 solution. The selection is made for each satellite individually, if two different observation types have been chosen it is indicated in the result plots by an additional entry in brackets L1W/L2W(L2C) where the second observation type L2C was chosen for the GPS satellites from block IIR-M and IIF (1, 3, 5, 6, 7, 8, 9, 12, 15, 17, 24, 25, 26, 27, 29, 30, and 31).
The phase-only solution is run without ambiguity resolution. Therefore, the solution could be run for all different phase combination without knowledge of the corresponding code biases. The PPP strategy was applied for following GPS-only and GLONASS-only phase solutions:

- GPS: Priority on L1W and L2W (Figure 2 and 7)
- GPS: Priority on L1C and L2C (Figure 3 and 8)
- GPS: Receiver dependent selection (Figure 4 and 9))
- GLONASS: Priority on L1P and L2P (Figure 5 and 10)
- GLONASS: Priority on L1C and L2P (Figure 6 and 11)

Difference of number of observations used

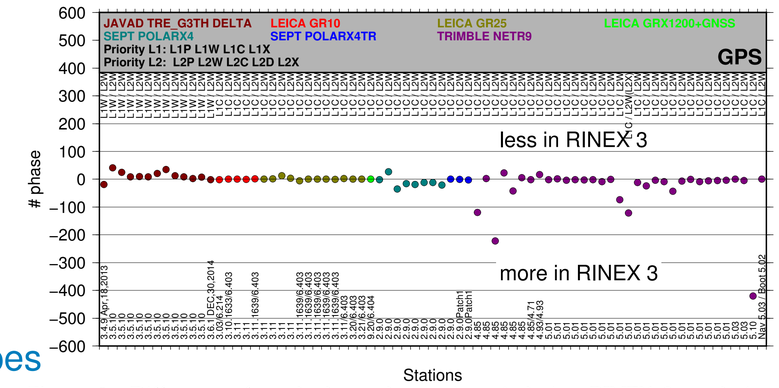

Figure 2: Difference of used phase observations (solution RINEX 2 - solution RINEX 3). Priority on L1W and L2W.

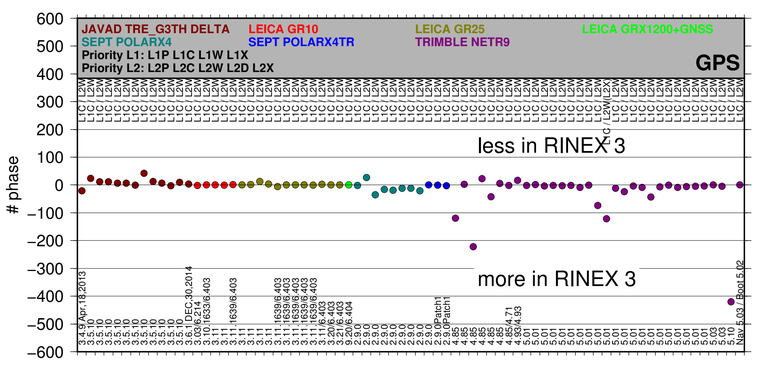

Figure 3: Difference of used phase observations (solution RINEX 2 - solution RINEX 3). Priority on L1C and L2C.

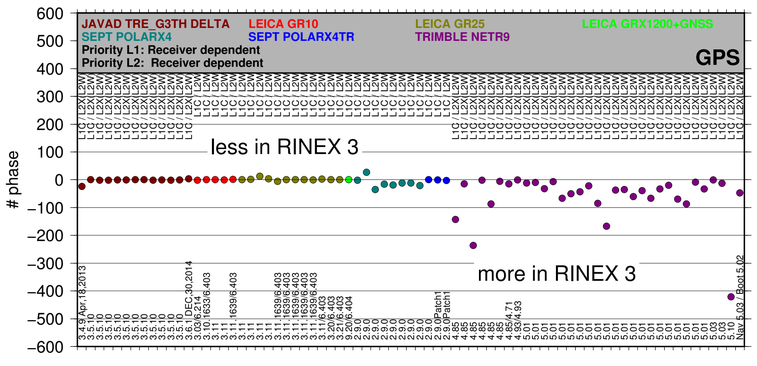

Figure 4: Difference of used phase observations (solution RINEX 2 - solution RINEX 3). Receiver dependent selection.

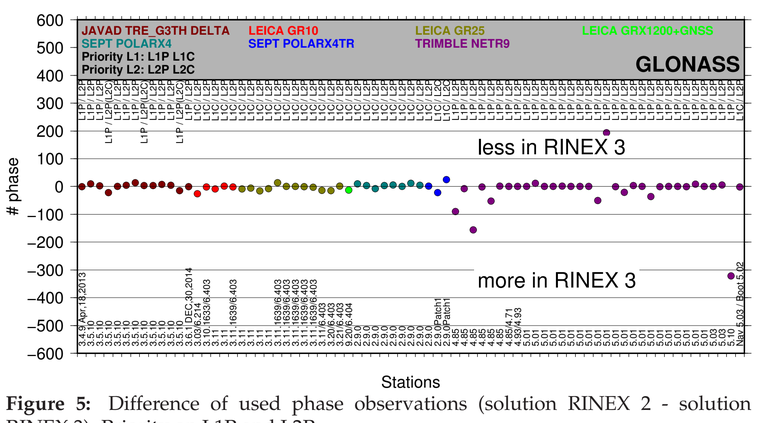

Figure 5: Difference of used phase observations (solution RINEX 2 - solution RINEX 3). Priority on L1P and L2P.

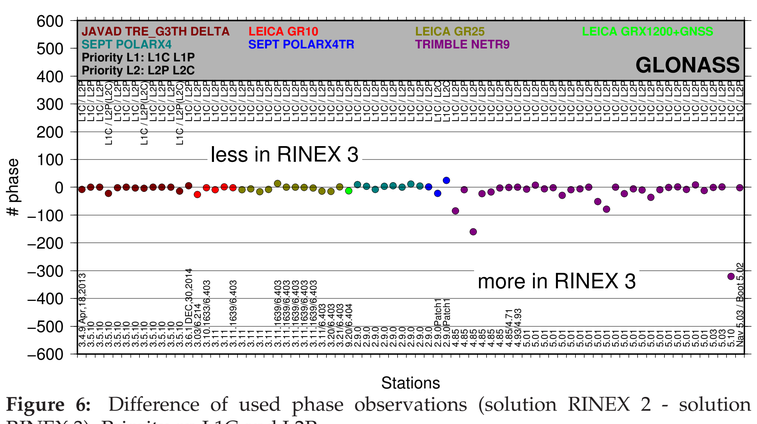

Figure 6: Difference of used phase observations (solution RINEX 2 - solution RINEX 3). Priority on L1C and L2P.

Difference of χ^2/dof

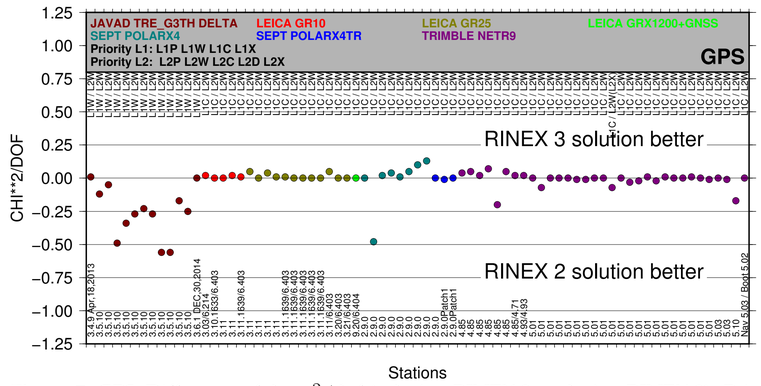

Figure 7: GPS: Difference of the χ^2/dof (solution RINEX 2 - solution RINEX 3). Priority on L1W and L2W.

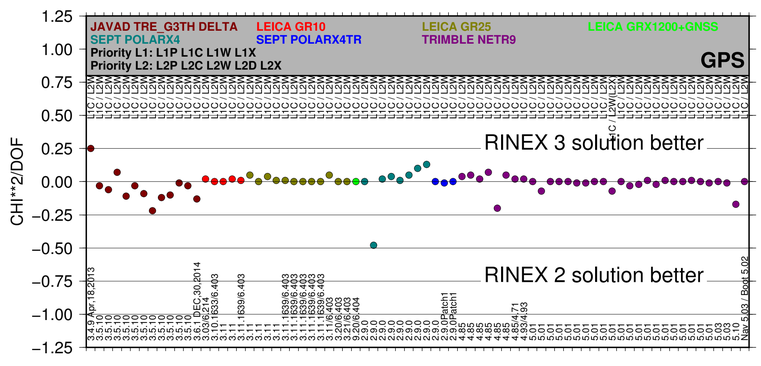

Figure 8: GPS: Difference of the χ^2/dof (solution RINEX 2 - solution RINEX 3). Priority on L1C and L2C.

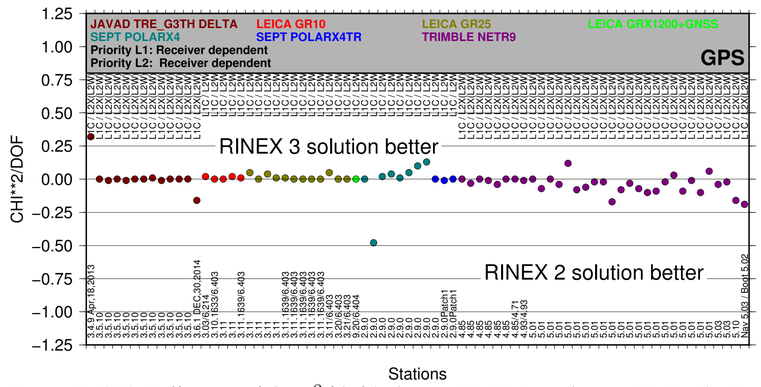

Figure 9: GPS: Difference of the χ^2/dof (solution RINEX 2 - solution RINEX 3). Receiver dependent selection.

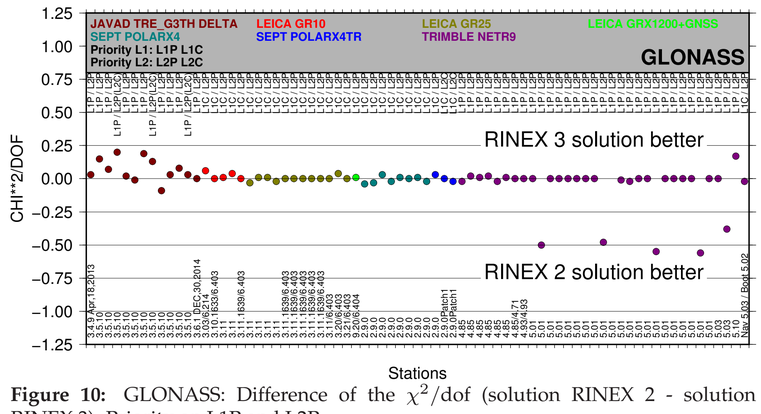

Figure 10: GLONASS: Difference of the χ^2/dof (solution RINEX 2 - solution RINEX 3). Priority on L1P and L2P.

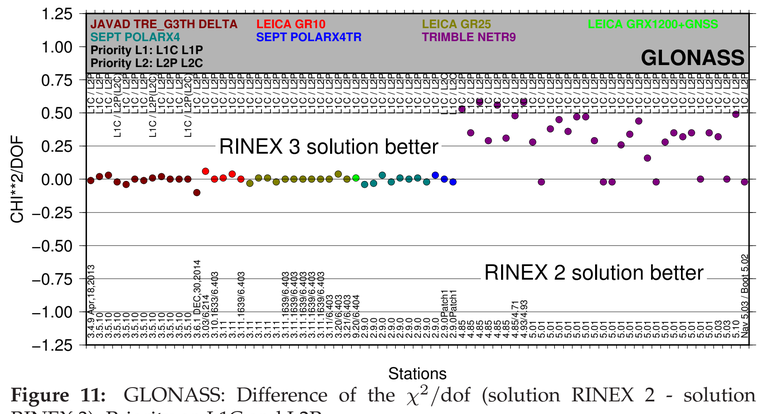

Figure 11: GLONASS: Difference of the χ^2/dof (solution RINEX 2 - solution RINEX 3). Priority on L1C and L2P.

Conclusion

In comparison to RINEX 2, the RINEX 3 data format has an explicit observation type definition. Commonly RINEX 3 data files contain more observation types per frequency (code and phase). Therefore, when processing RINEX 3 data the observation type selection is essential for the PPP. In order to achieve a similar solution from RINEX 3 data, compared to the one using the old RINEX 2 format, the selection criteria has to be chosen accordingly.
From the PPP comparison we may draw following conclusions:

- The assignment of phase measurement from RINEX 2 (L1/L2) to the RIENX 3 observation types is receiver dependent.
- The assignment may also depend on the installed firmware.
- GLONASS observations have less observation types. However, the L1 and L2 assignment may vary between L1P or L1C.
- As more observation types are available, it might be useful to switch to a different observation type pair than those stored in RINEX 2 files.
- If a correct assignment between RINEX 2 and RINEX 3 observation types is done, consistent solutions are possible. However, for station KIRU (SEPT POLARX4, 2.9.0) we could not get a similar result and needs further analysis.

Another specific issue is the assignment of L2 GPS RINEX 2 observations to the corresponding RINEX 3 type. The L2 observations are mostly identical with the L2W signals for the older GPS satellite blocks before the IIR-M series. The L2 observations of newer GPS satellites, for which C2 receivers are recording the corresponding signals, it can vary between L2W, L2C, or L2X. It does depend on the receiver type and firmware dependent.

Poster compiled by A. Villiger, February 2016
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