Mitigation of unmodelled non–tidal atmospheric pressure loading into parameters of a global GNSS solution

R. Dach[1], P. Steigenberger[2], and Johannes Böhm[3]

[1] *Astronomical Institute, University of Bern, Switzerland*
[2] *Institut für Astronomische und Physikalische Geodäsie, TU München, Germany*
[3] *Institute of Geodesy and Geophysics, TU Vienna, Austria*

GGFC workshop
20. April 2012, Vienna, Austria

Outline

Description of the experiment

APL and GNSS–derived coordinates

APL and GNSS–derived troposphere

APL and GNSS–orbits

Summary and Conclusion

Description of the experiment

- Recent CODE reprocessing effort based on existing screened observation files:
  - Time interval:
    January 1996 to May 2003 GPS–only solution
    May 2003 to December 2010 GPS+GLONASS solution
  - fully consistent with IGS08.ATX and IGS08.SNX

Description of the experiment

- Recent CODE reprocessing effort based on existing screened observation files:
  - Time interval:
    January 1996 to May 2003 GPS–only solution
    May 2003 to December 2010 GPS+GLONASS solution
  - fully consistent with IGS08.ATX and IGS08.SNX
- The CODE reprocessing has included the Vienna APL model (Wijaya et al. 2011) with scaling factors allowing to
  - validate the model from GNSS data,
  - easily compute two consistent solutions with/without APL corrections.

Description of the experiment

- Recent CODE reprocessing effort based on existing screened observation files:
  - Time interval:
    January 1996 to May 2003 GPS–only solution
    May 2003 to December 2010 GPS+GLONASS solution
  - fully consistent with IGS08.ATX and IGS08.SNX
- The CODE reprocessing has included the Vienna APL model (Wijaya et al. 2011) with scaling factors allowing to
  - validate the model from GNSS data,
  - easily compute two consistent solutions with/without APL corrections.
- From all days in 2010 two days are selected

  21. January: most active APL in all stations of the network

  29. May: least active APL in all stations of the network

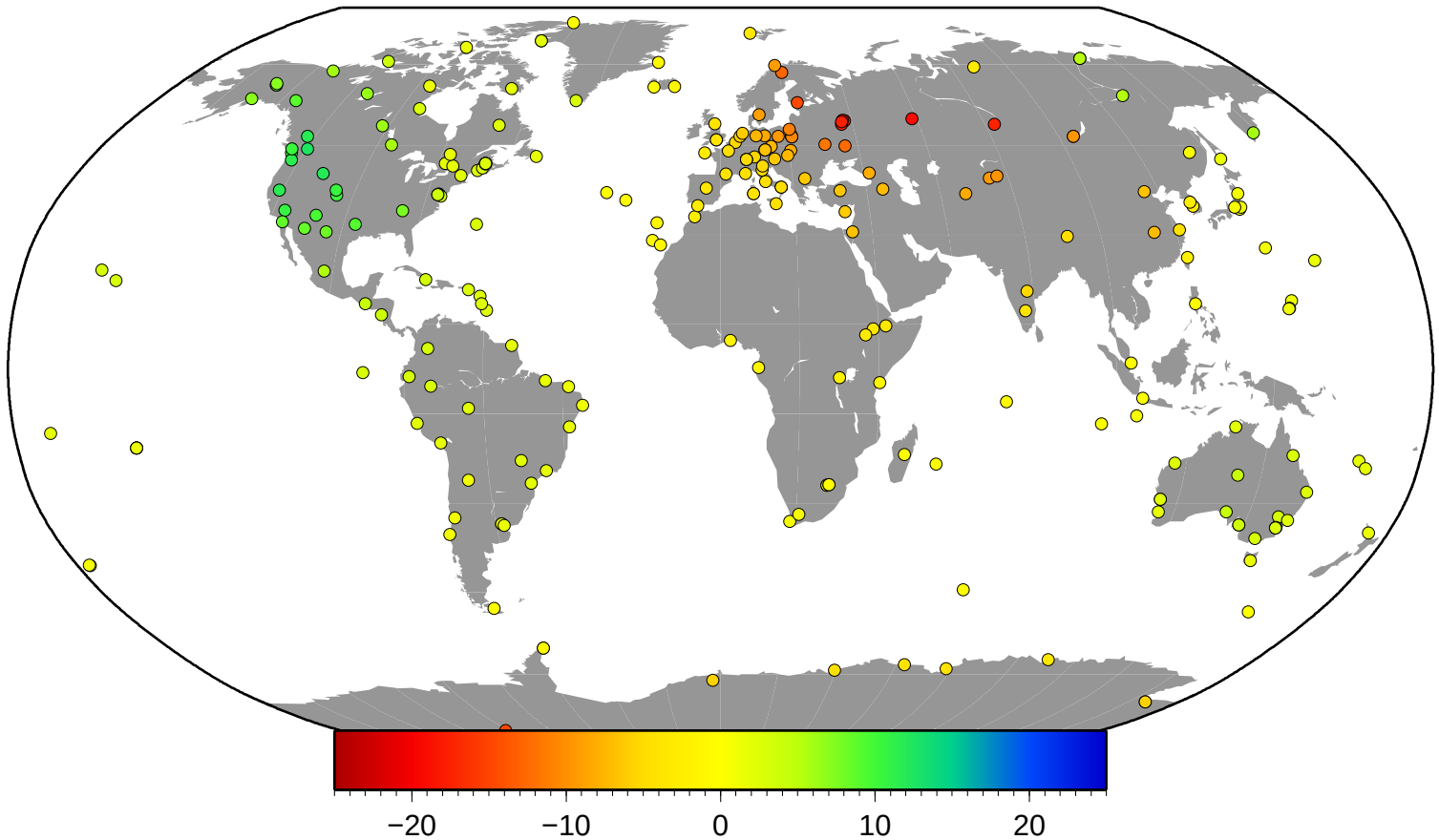
Description of the experiment

- Recent CODE reprocessing effort based on existing screened observation files:
  - Time interval:
    January 1996 to May 2003 GPS–only solution
    May 2003 to December 2010 GPS+GLONASS solution
  - fully consistent with IGS08.ATX and IGS08.SNX
- The CODE reprocessing has included the Vienna APL model (Wijaya et al. 2011) with scaling factors allowing to
  - validate the model from GNSS data,
  - easily compute two consistent solutions with/without APL corrections.
- From all days in 2010 two days are selected

  21. January: most active APL in all stations of the network
  29. May: least active APL in all stations of the network
- For these two days all APL corrections are summed in the processing program for each station.

APL and GNSS–derived coordinates

Mean APL corrections for each station
extracted from Vienna model during data processing

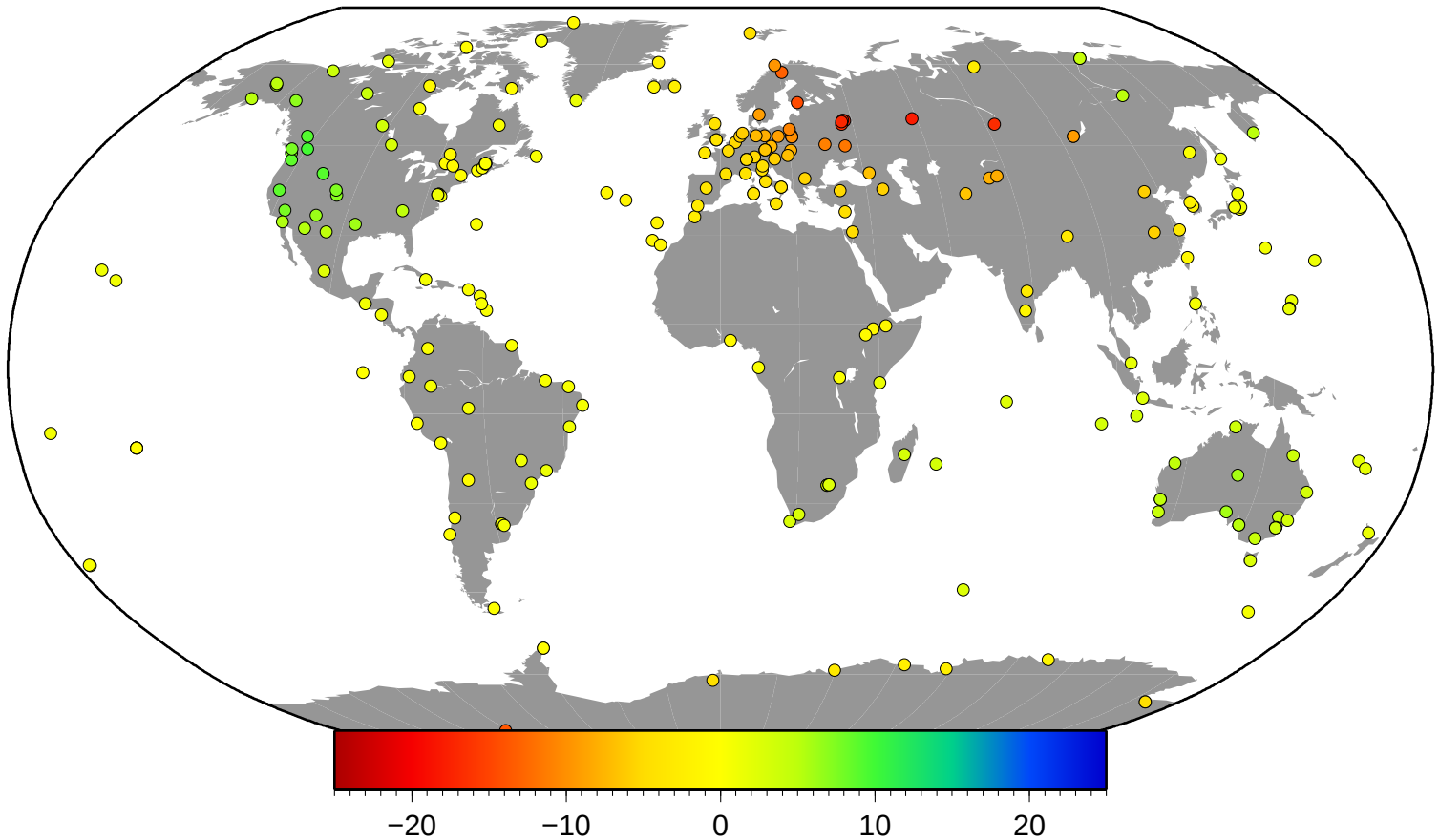


vertical component

21. January 2010

APL and GNSS–derived coordinates

Coordinate difference between solutions
applying/not applying APL corrections

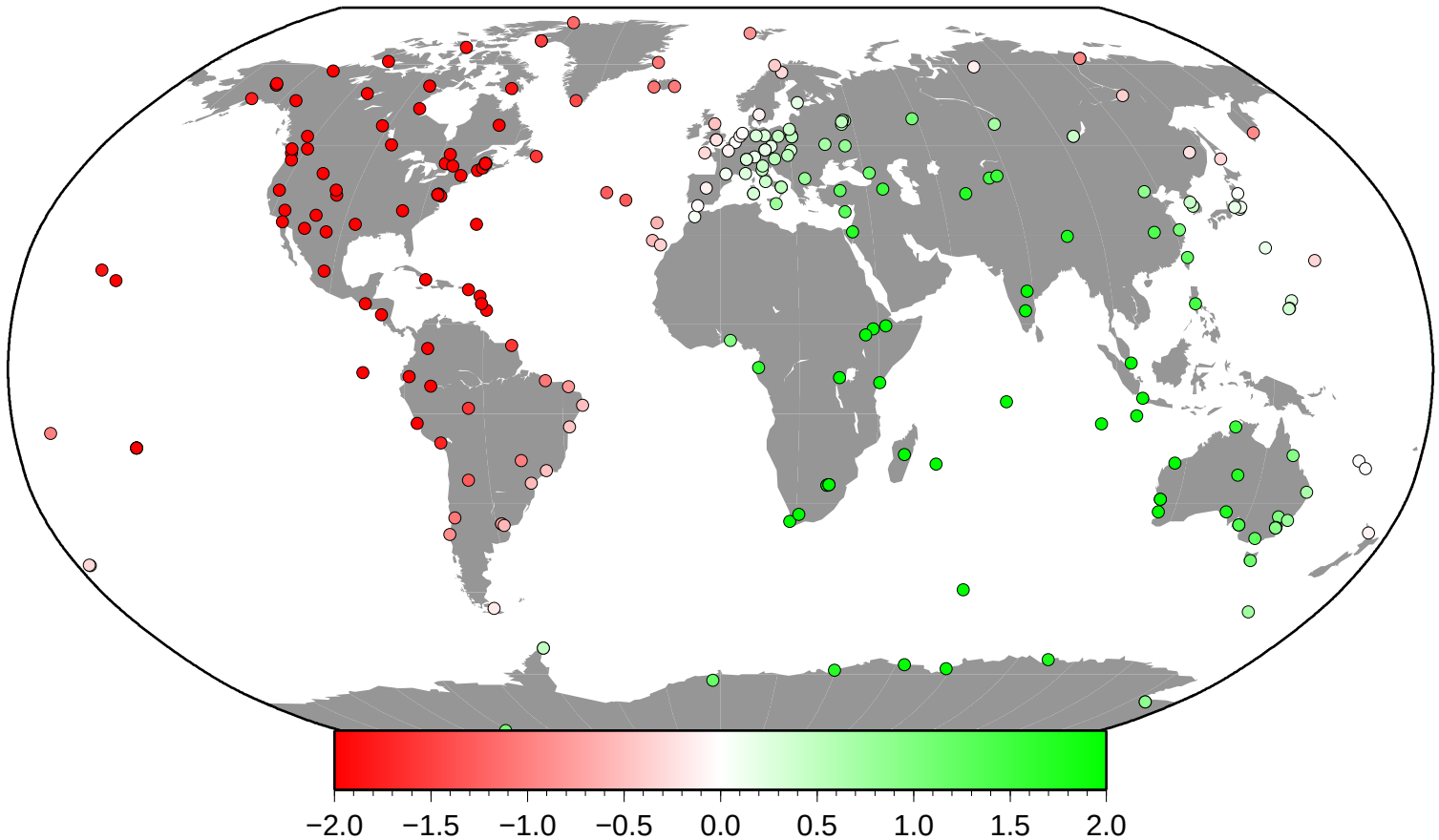


vertical component

21. January 2010

APL and GNSS–derived coordinates

Coordinate difference between solutions
applying/not applying but correcting for APL effect

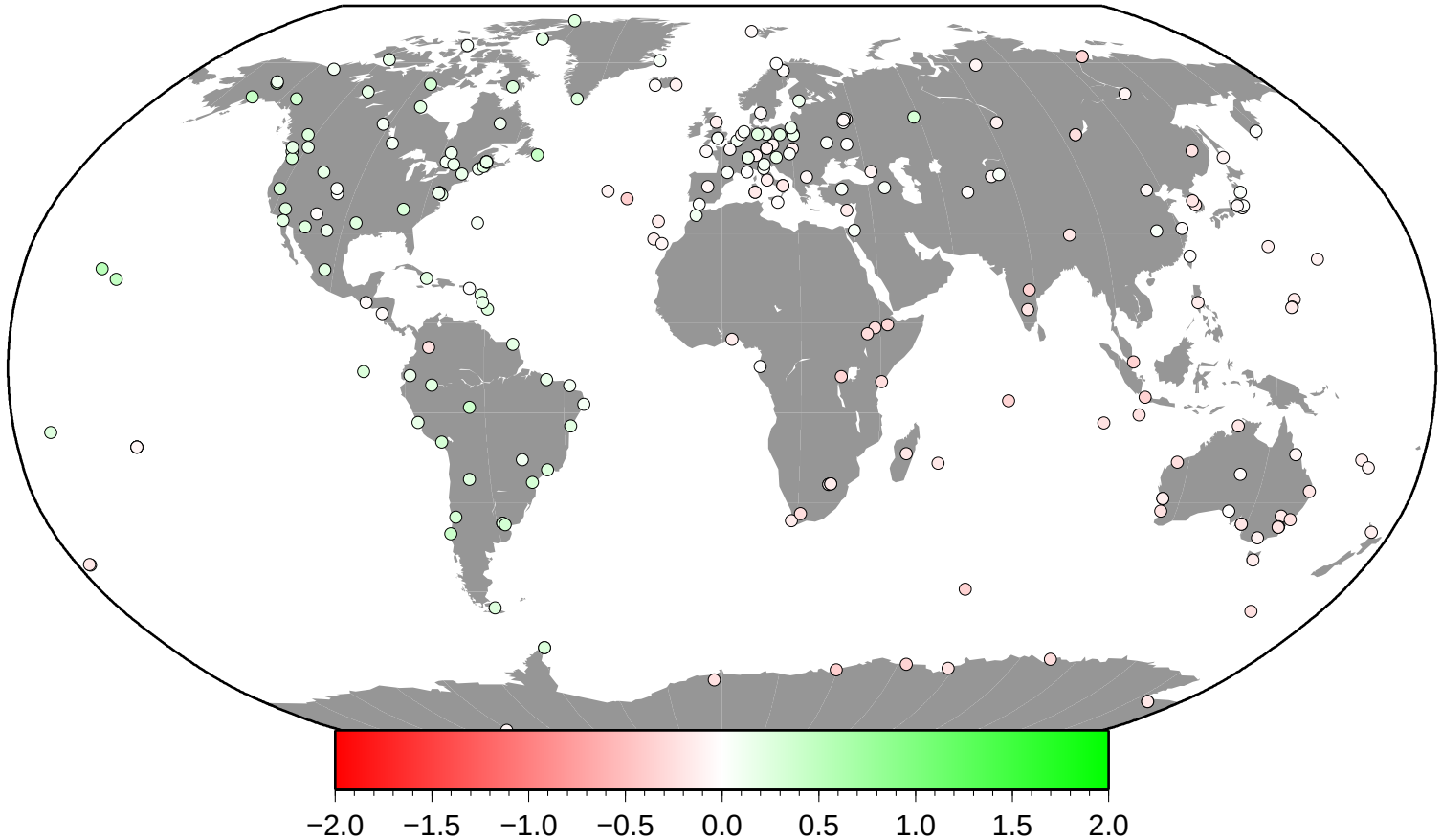


vertical component

21. January 2010

APL and GNSS–derived coordinates

Residuals of a Helmert–transformation between solutions applying/not applying but correcting for APL effect

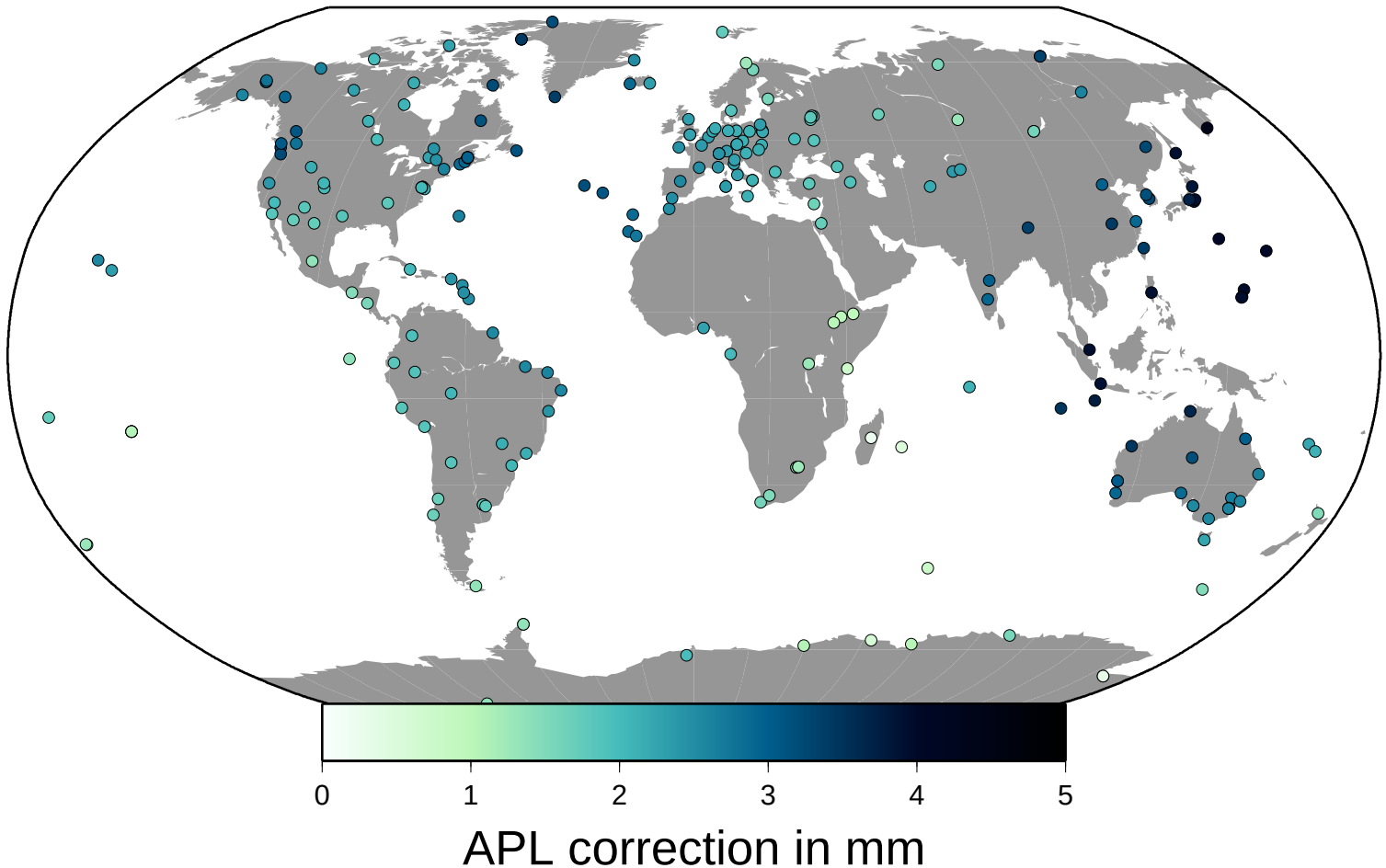


vertical component

21. January 2010

APL and GNSS–derived coordinates

Mean APL corrections for each station
extracted from Vienna model during data processing

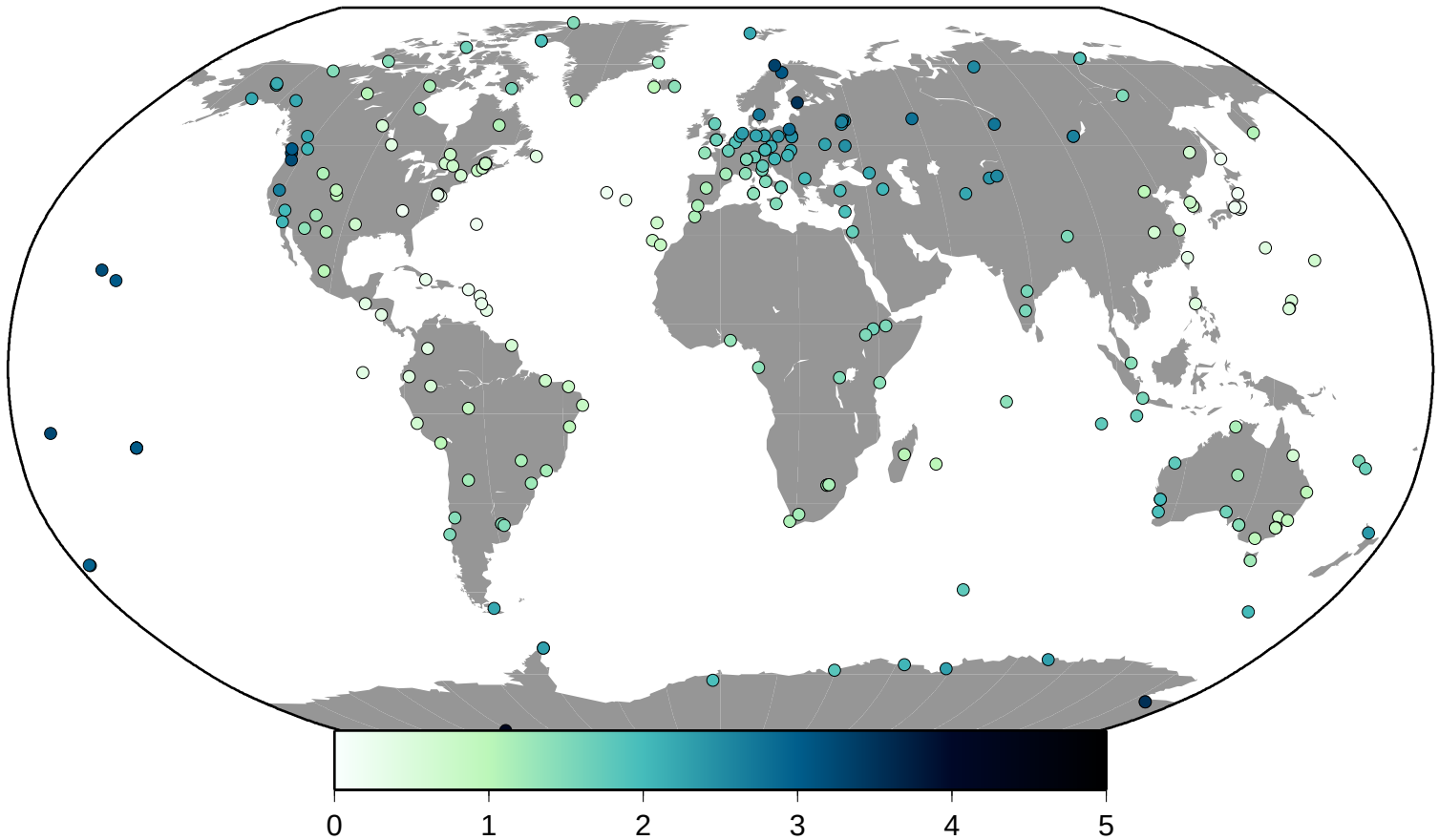


horizontal component

21. January 2010

APL and GNSS–derived coordinates

Coordinate difference between solutions
applying/not applying APL corrections

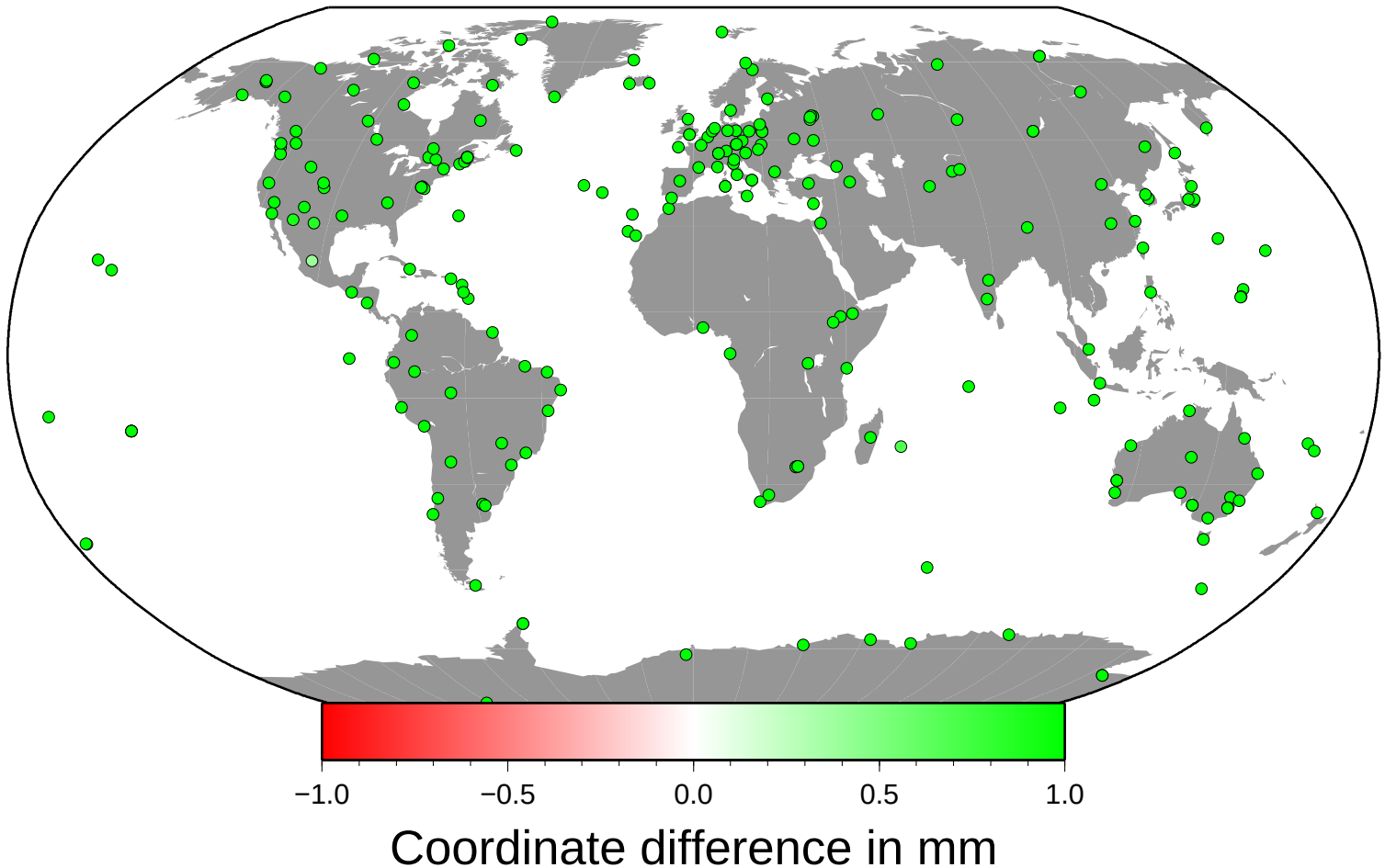


horizontal component

21. January 2010

APL and GNSS–derived coordinates

Coordinate difference between solutions
applying/not applying but correcting for APL effect

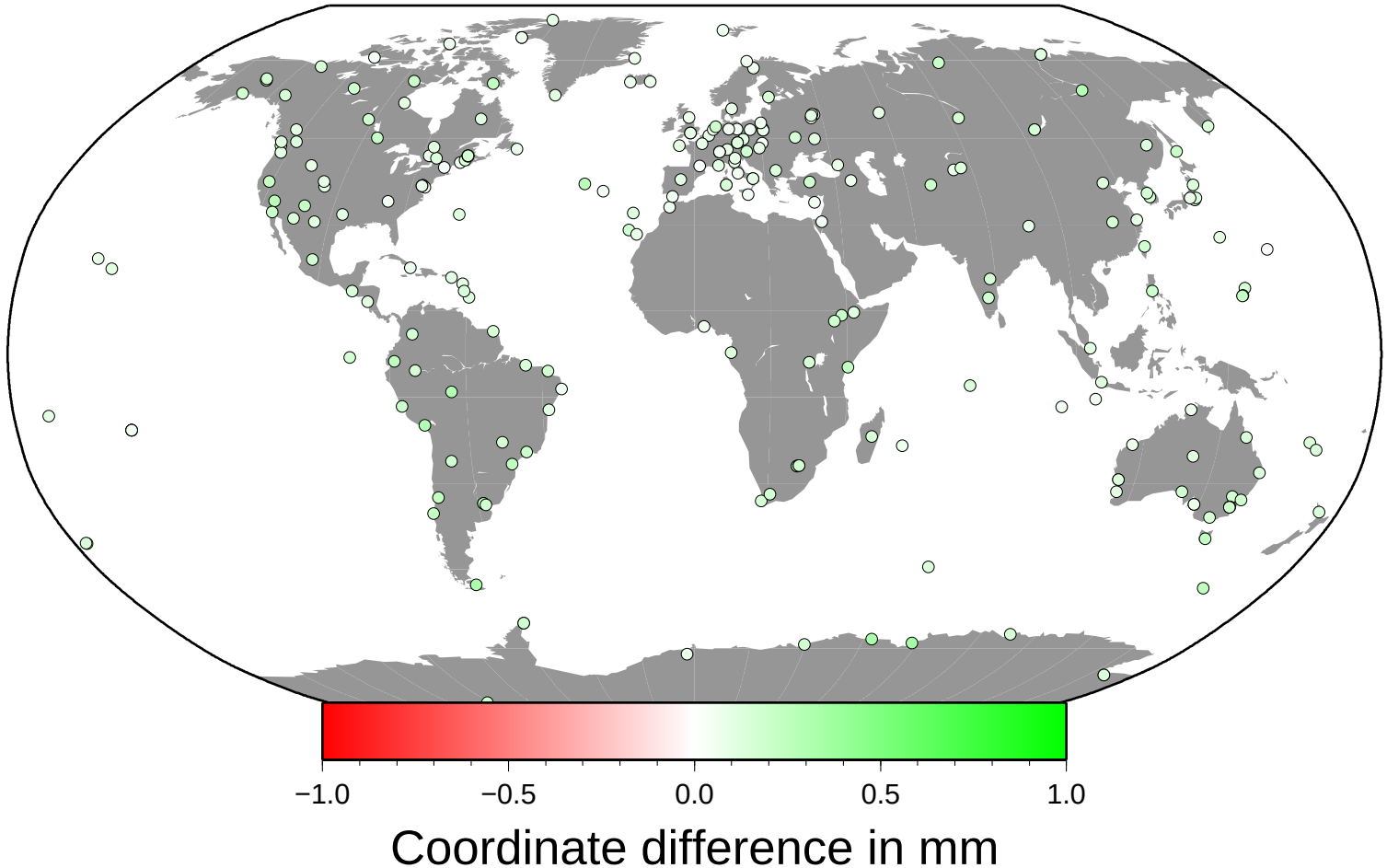


horizontal component

21. January 2010

APL and GNSS–derived coordinates

Residuals of a Helmert–transformation between solutions applying/not applying but correcting for APL effect



horizontal component

21. January 2010

APL and GNSS–derived coordinates

RMS of coordinate comparison

APL and GNSS–derived coordinates

RMS of coordinate comparison

- Difference of the solution without applying APL corrections...

21. January 2010			29. May 2010		
RMS_N	RMS_E	RMS_U	RMS_N	RMS_E	RMS_U
1.1 mm	1.4 mm	5.3 mm	0.6 mm	0.4 mm	1.5 mm

...with respect to the solution applying the APL corrections on observation level.

APL and GNSS–derived coordinates

RMS of coordinate comparison

- Difference of the solution without applying APL corrections...

21. January 2010			29. May 2010		
RMS_N	RMS_E	RMS_U	RMS_N	RMS_E	RMS_U
1.1 mm	1.4 mm	5.3 mm	0.6 mm	0.4 mm	1.5 mm

- Difference of the solution without applying but correcting for the APL effect...

21. January 2010			29. May 2010		
RMS_N	RMS_E	RMS_U	RMS_N	RMS_E	RMS_U
1.8 mm	2.5 mm	1.7 mm	0.5 mm	0.4 mm	0.2 mm

...with respect to the solution applying the APL corrections on observation level.

APL and GNSS–derived coordinates

RMS of coordinate comparison

- Difference of the solution without applying APL corrections...

21. January 2010			29. May 2010		
RMS_N	RMS_E	RMS_U	RMS_N	RMS_E	RMS_U
1.1 mm	1.4 mm	5.3 mm	0.6 mm	0.4 mm	1.5 mm

- Difference of the solution without applying but correcting for the APL effect...

21. January 2010			29. May 2010		
RMS_N	RMS_E	RMS_U	RMS_N	RMS_E	RMS_U
1.8 mm	2.5 mm	1.7 mm	0.5 mm	0.4 mm	0.2 mm

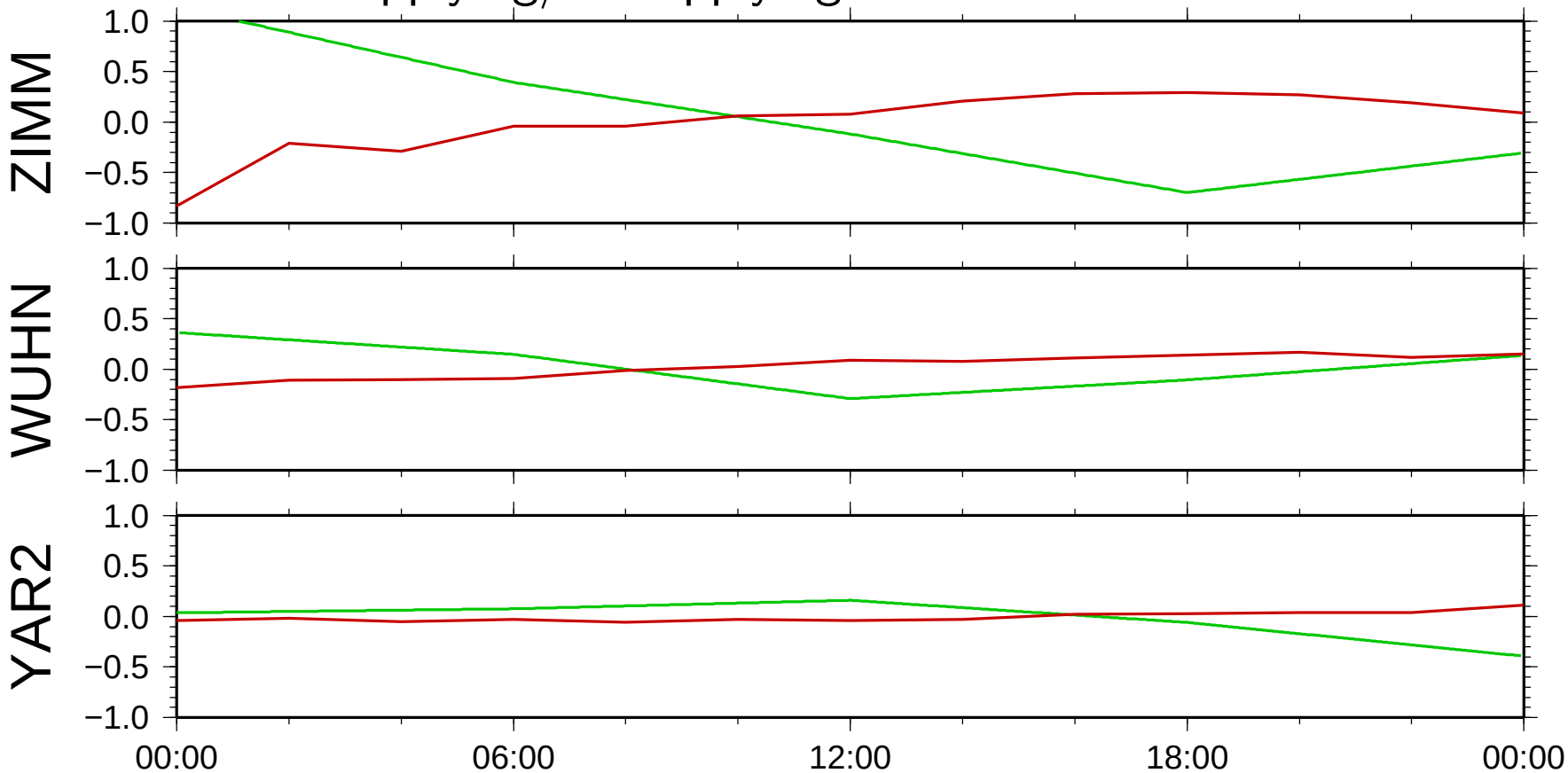
- Residuals of a Helmert–transformation of the solution without applying but correcting for the APL effect...

21. January 2010			29. May 2010		
RMS_N	RMS_E	RMS_U	RMS_N	RMS_E	RMS_U
0.1 mm	0.1 mm	0.2 mm	0.1 mm	0.1 mm	0.1 mm

...with respect to the solution applying the APL corrections on observation level.

APL and GNSS–derived troposphere

Differences between troposphere estimates from solutions applying/not applying APL corrections



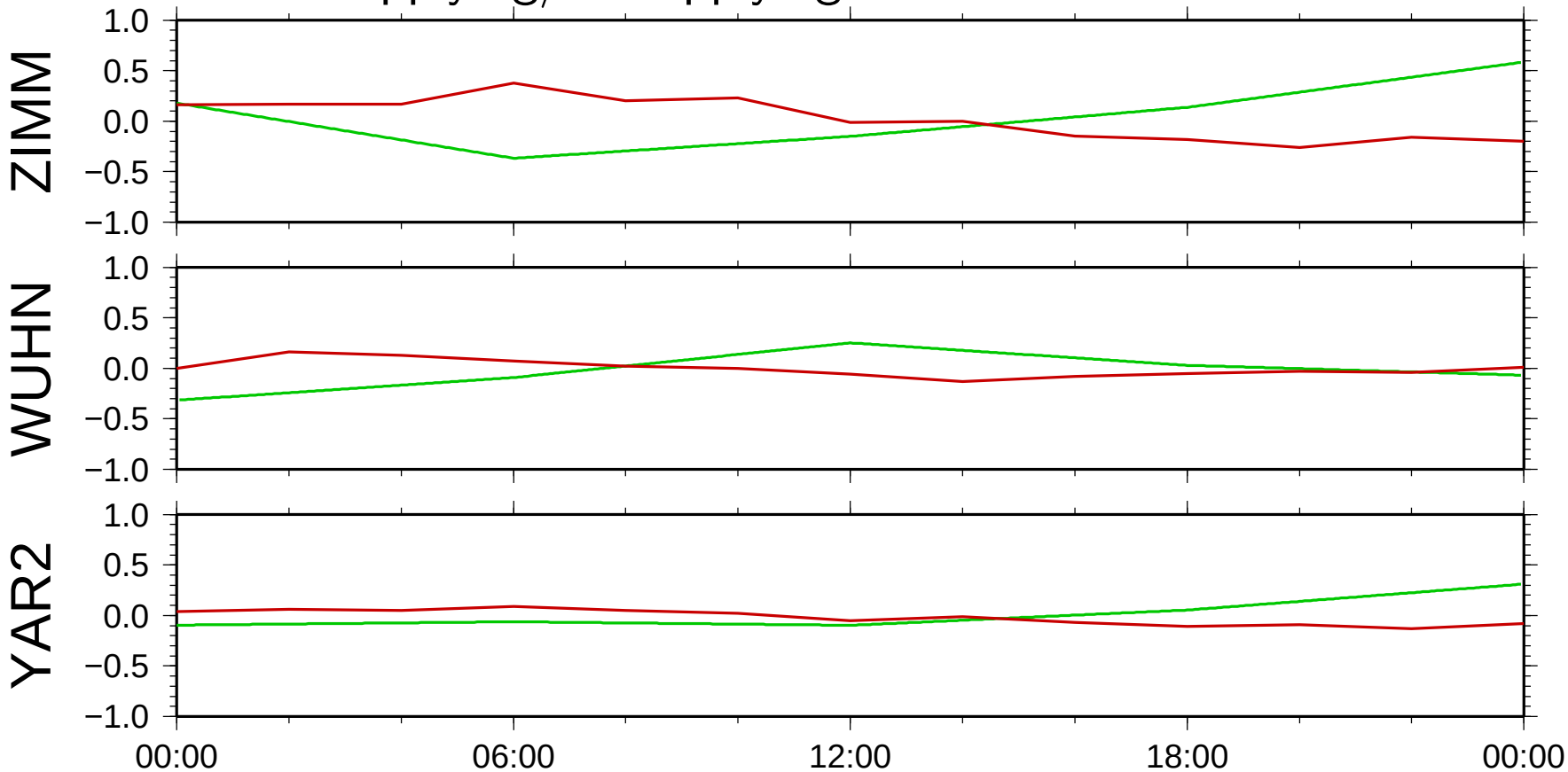
units: mm

red: difference of troposphere estimates, green: APL effect

21. January 2010

APL and GNSS–derived troposphere

Differences between troposphere estimates from solutions applying/not applying APL corrections



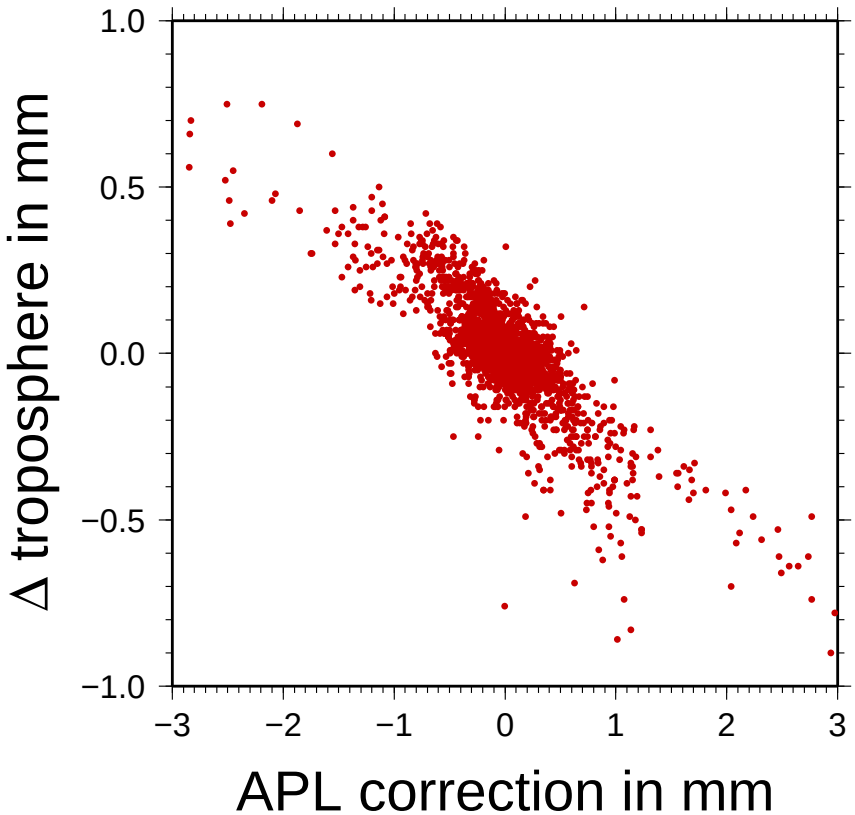
units: mm

red: difference of troposphere estimates, green: APL effect

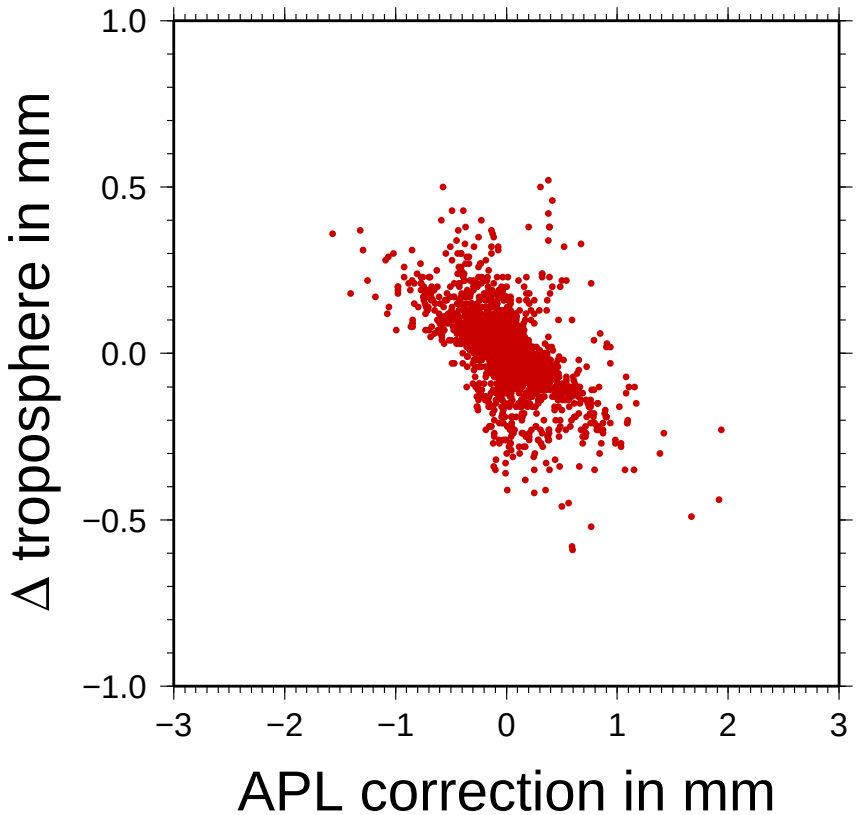
29. May 2010

APL and GNSS–derived troposphere

Differences between troposphere estimates from solutions applying/not applying APL corrections versus APL correction



21. January 2010



29. May 2010

APL and GNSS–orbits

RMS of Earth-fixed satellite positions

- Difference of the solution without applying APL corrections...

21. January 2010			29. May 2010		
RMS_X	RMS_Y	RMS_Z	RMS_X	RMS_Y	RMS_Z
5.2 mm	14.5 mm	13.9 mm	2.0 mm	2.1 mm	2.1 mm

...with respect to the solution applying the APL corrections on observation level.

APL and GNSS–orbits

RMS of Earth-fixed satellite positions

- Difference of the solution without applying APL corrections...

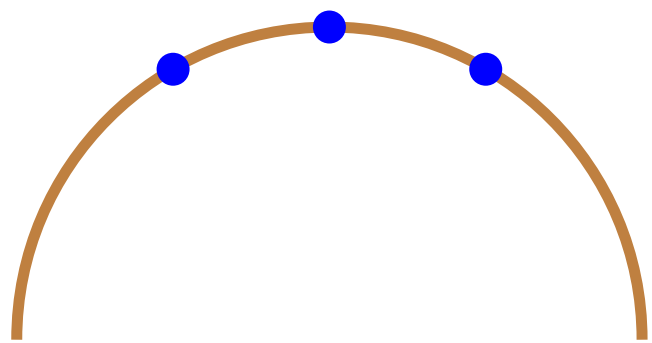
21. January 2010			29. May 2010		
RMS_X	RMS_Y	RMS_Z	RMS_X	RMS_Y	RMS_Z
5.2 mm	14.5 mm	13.9 mm	2.0 mm	2.1 mm	2.1 mm

- Residuals of a Helmert–transformation of the solution without applying APL corrections...

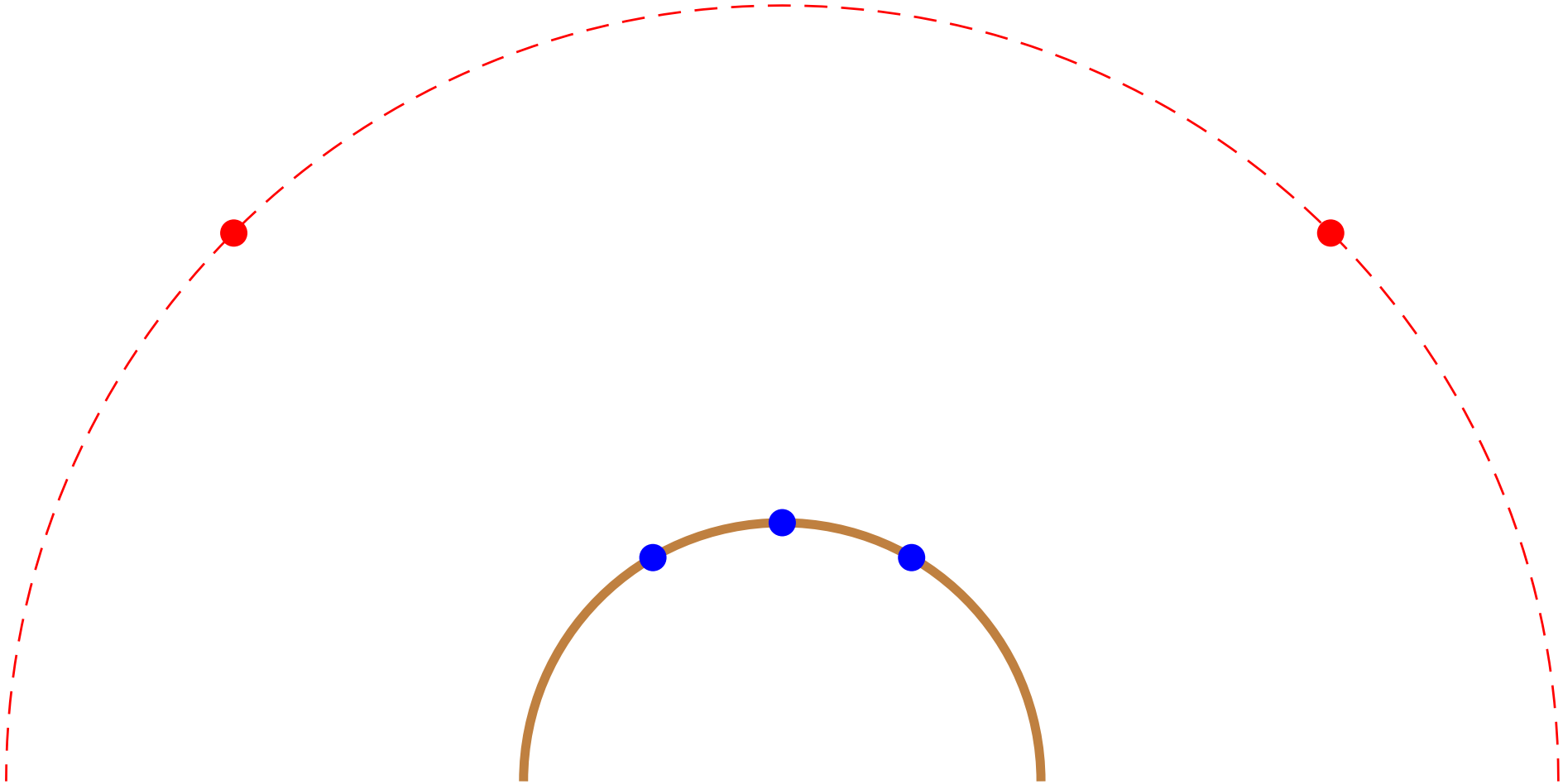
21. January 2010			29. May 2010		
RMS_X	RMS_Y	RMS_Z	RMS_X	RMS_Y	RMS_Z
5.2 mm	14.5 mm	13.9 mm	2.0 mm	2.1 mm	2.1 mm

...with respect to the solution applying the APL corrections on observation level.

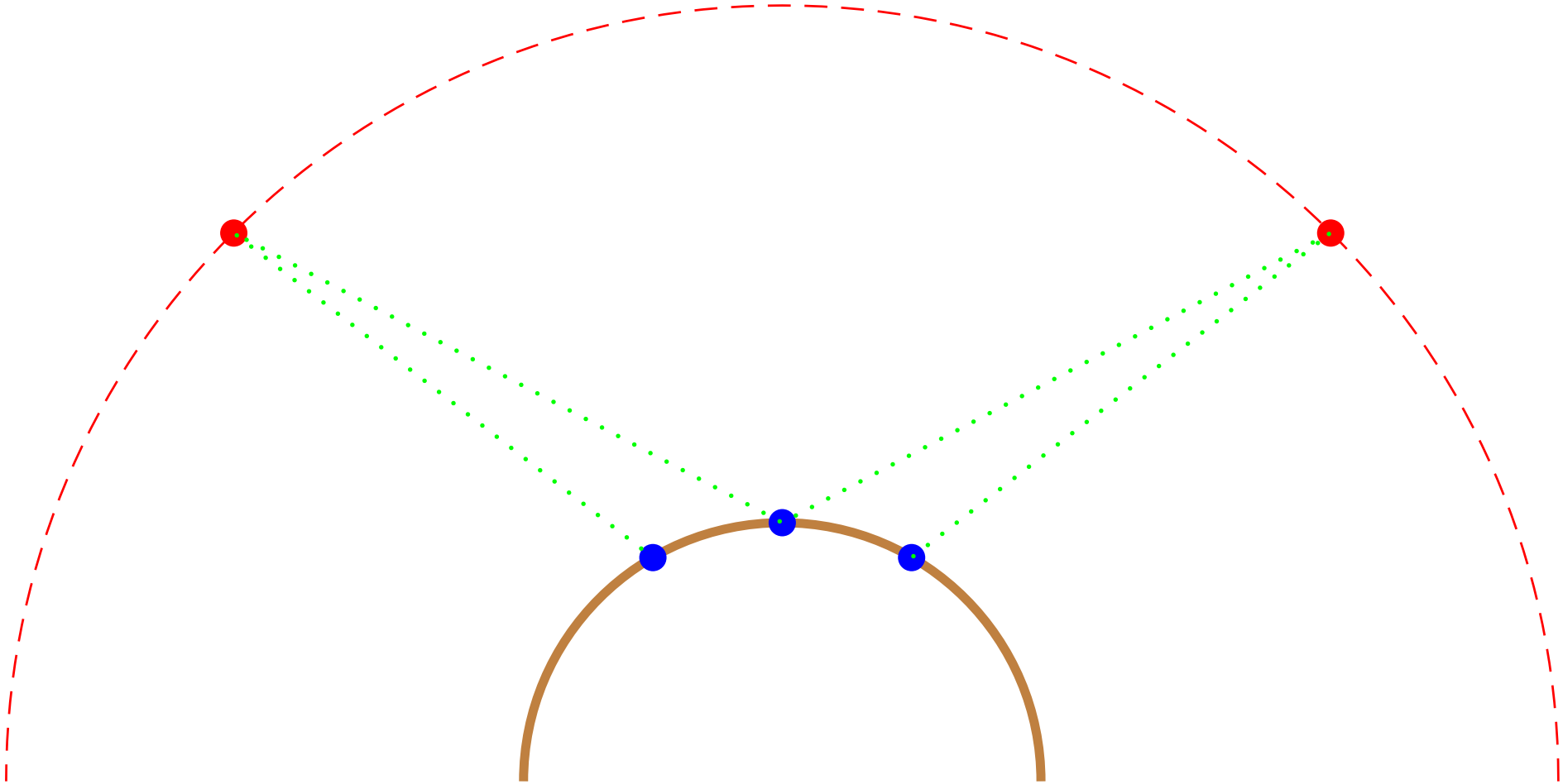
How APL may mitigate into GNSS orbits?



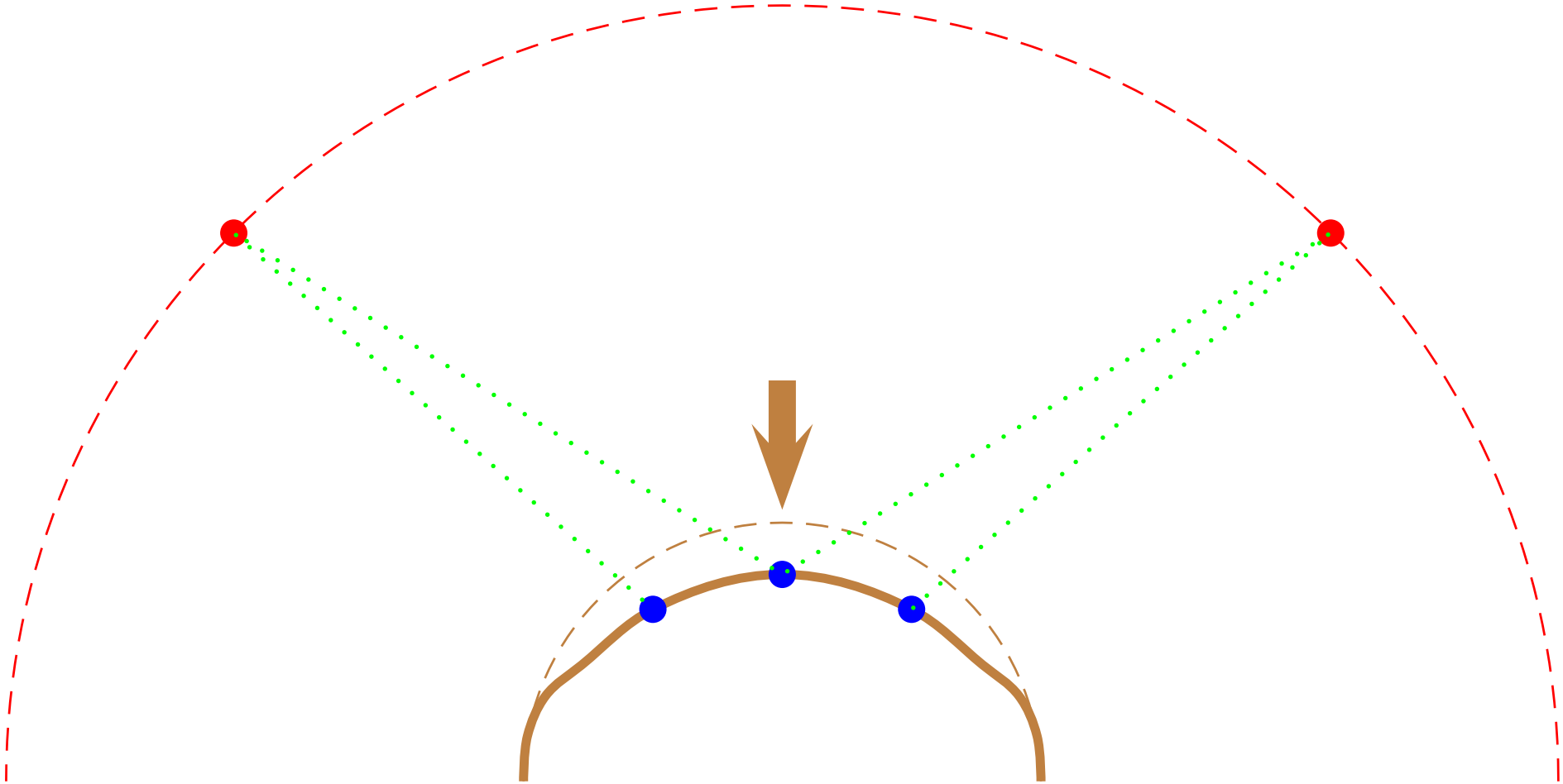
How APL may mitigate into GNSS orbits?



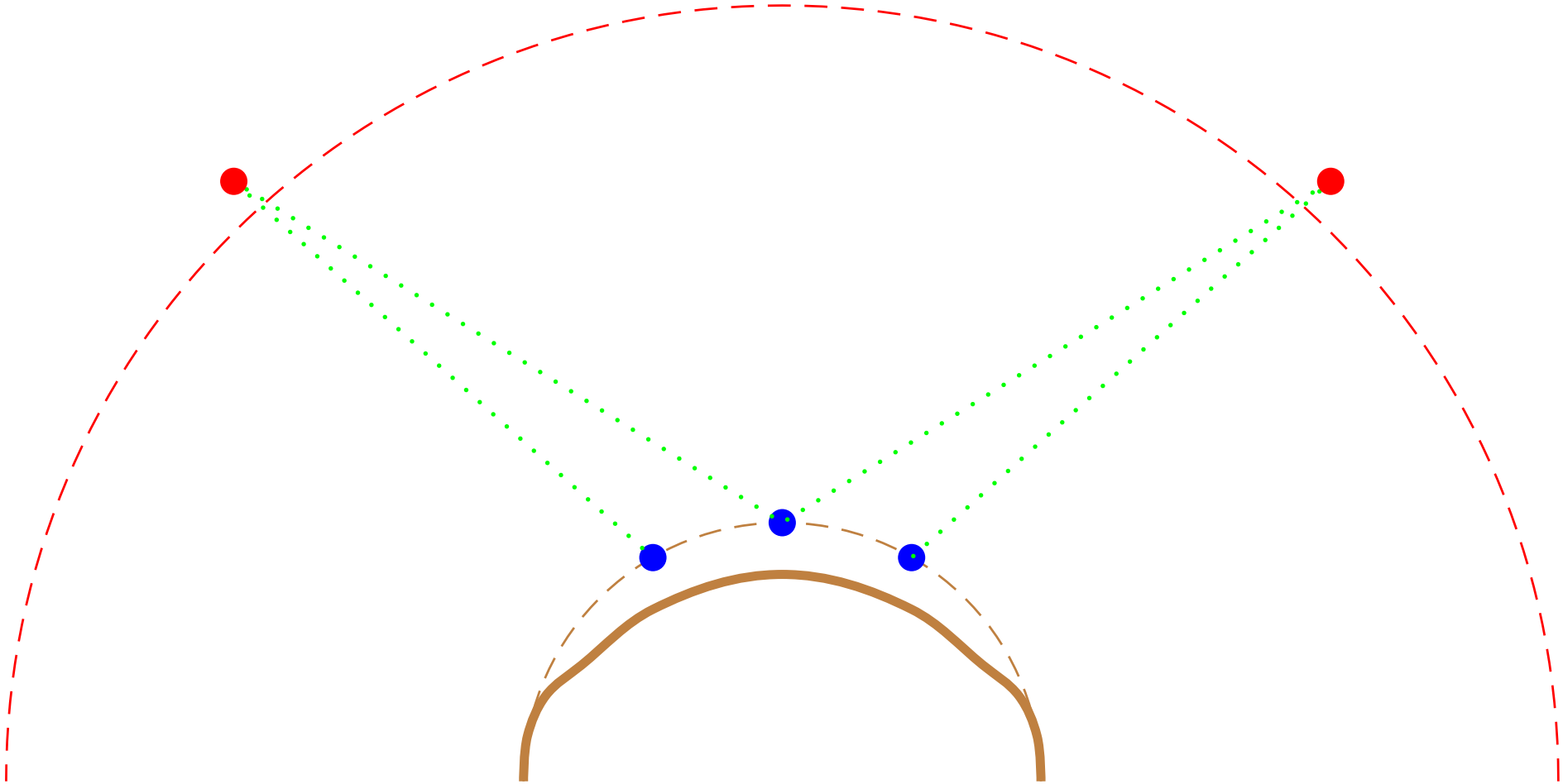
How APL may mitigate into GNSS orbits?



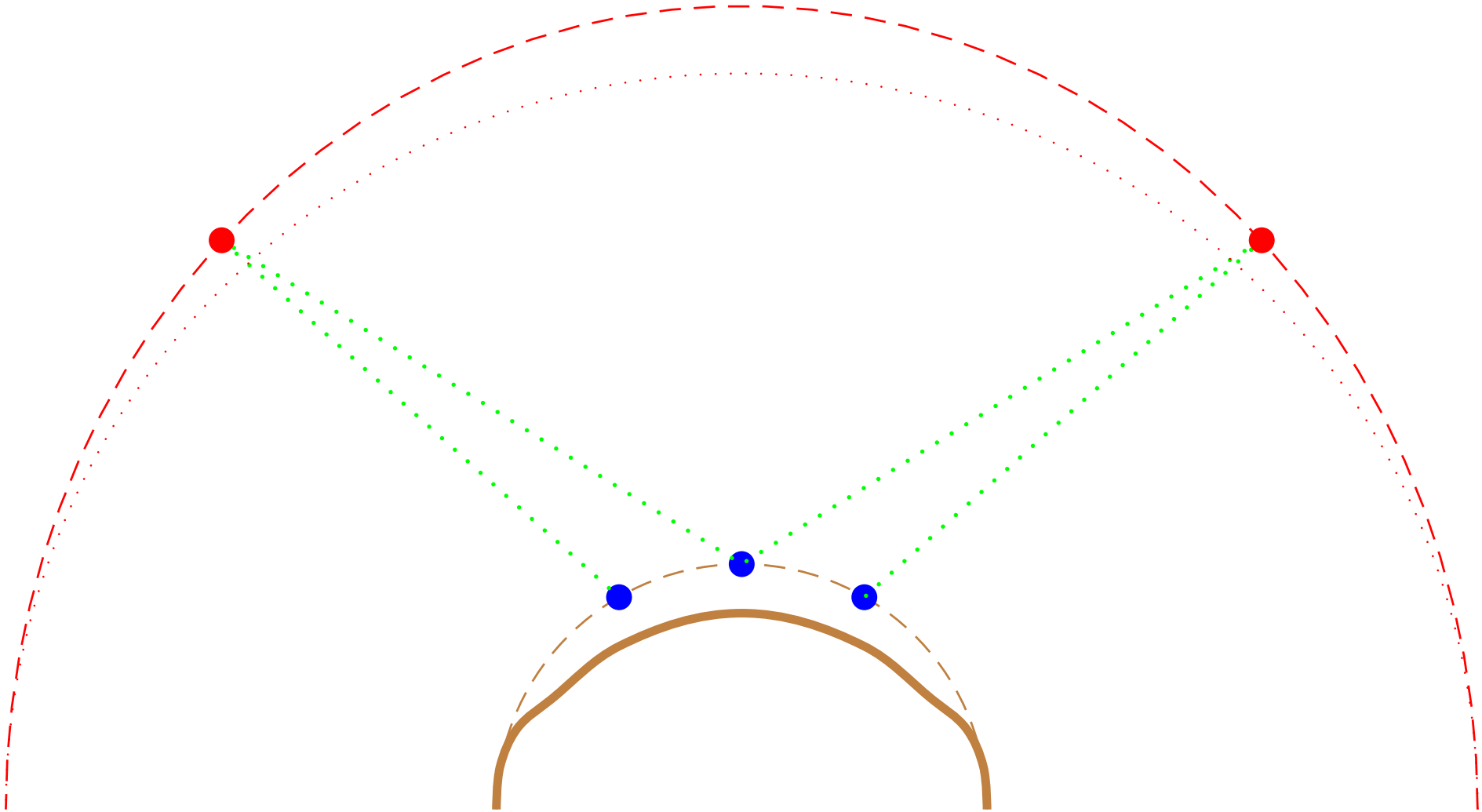
How APL may mitigate into GNSS orbits?



How APL may mitigate into GNSS orbits?



How APL may mitigate into GNSS orbits?



APL model for IGS(–like) processing

Conclusion: APL must be corrected on observation level

because an unmodelled APL-effect mitigates
in different parameters of the GNSS analysis.

APL model for IGS(–like) processing

Conclusion: APL must be corrected on observation level

because an unmodelled APL-effect mitigates
in different parameters of the GNSS analysis.

Resulting requirements:

1. High quality model is needed that corresponds to the quality of the state-of-the-art GNSS processing.
2. The model must consistently cover the time span from 1994 to present.
3. The model must be easily accessable by any user for any station (preferable grids).
4. The model is required at least for the final processing at the analysis centers (three days delay).

Summary and Conclusion

Conclusion: APL must be corrected on observation level
because an unmodelled APL-effect mitigates
in different parameters of the GNSS analysis.

The results can also be interpreted as a general error mitigation study that act in the same way for comparable (unmodelled) effects in the GNSS analysis.

THANK YOU
for your attention

Publications of the satellite geodesy research group:

`http://www.bernese.unibe.ch/publist`