

Abstract

Because of the inclined-orbit of GNSS constellations that are not cover the Polar Regions, the polar gaps occur between certain latitudes and therefore in these regions the satellite observations are limited around the zenith direction. In addition, from summer to winter season, the daylight and weather conditions vary tremendously in the Polar Regions. In the context of this study, the PPP accuracy performance was tested as a function of winter and summer seasons, GPS-only and GPS&GLONASS constellations, PPP-AR and PPP-Float solution strategies, static and kinematic processing modes, varying occupation times (1h, 2h, 4h, 8h, 12h and daily), and increasing latitudes towards the South Pole at the OHI3, ROTH, MCM4, and AMU2 GNSS stations in the Antarctica continent. Besides, the effect of the ambiguity solution strategies and the used constellations in the process on PPP convergence time was also examined. In the assessment results of the study, it was revealed that the PPP-AR strategy, additional GLONASS system to GPS constellation, and increased occupation times improved the static and kinematic positioning accuracy. Besides, although similar accuracies were obtained in both seasons, the position accuracy was slightly better in winter. Regarding the investigation on convergence time, the PPP-AR solution using the GPS&GLONASS constellations improved the convergence time by 66% comparing to the GPS-only PPP-Float solution. Finally, according to the assessment of the PPP-AR accuracy performance depending on the increasing latitude towards the South Pole, it has been observed that the 2D position accuracy remained stable for three stations except for AMU2. Besides, the vertical position accuracy decreased as it approaches the South Pole and the GLONASS system contributed to the improvement of the accuracy.

Purpose of the Study

- In the context of this study, the PPP accuracy performance was tested as a function of:
 - Winter and summer seasons,
 - GPS-only and GPS&GLONASS constellations,
 - PPP-AR and PPP-Float solution strategies,
 - Static and kinematic processing modes,
 - Varying occupation times (1h, 2h, 4h, 8h, 12h and daily),
 - Increasing latitudes towards the South Pole.
- Besides, the effect of the ambiguity solution strategies and the used constellations in the process on PPP convergence time was also examined.
- OHI3, ROTH, MCM4, and AMU2 GNSS stations in the Antarctica continent was used in this study. (Figure 1)

GNSS Stations

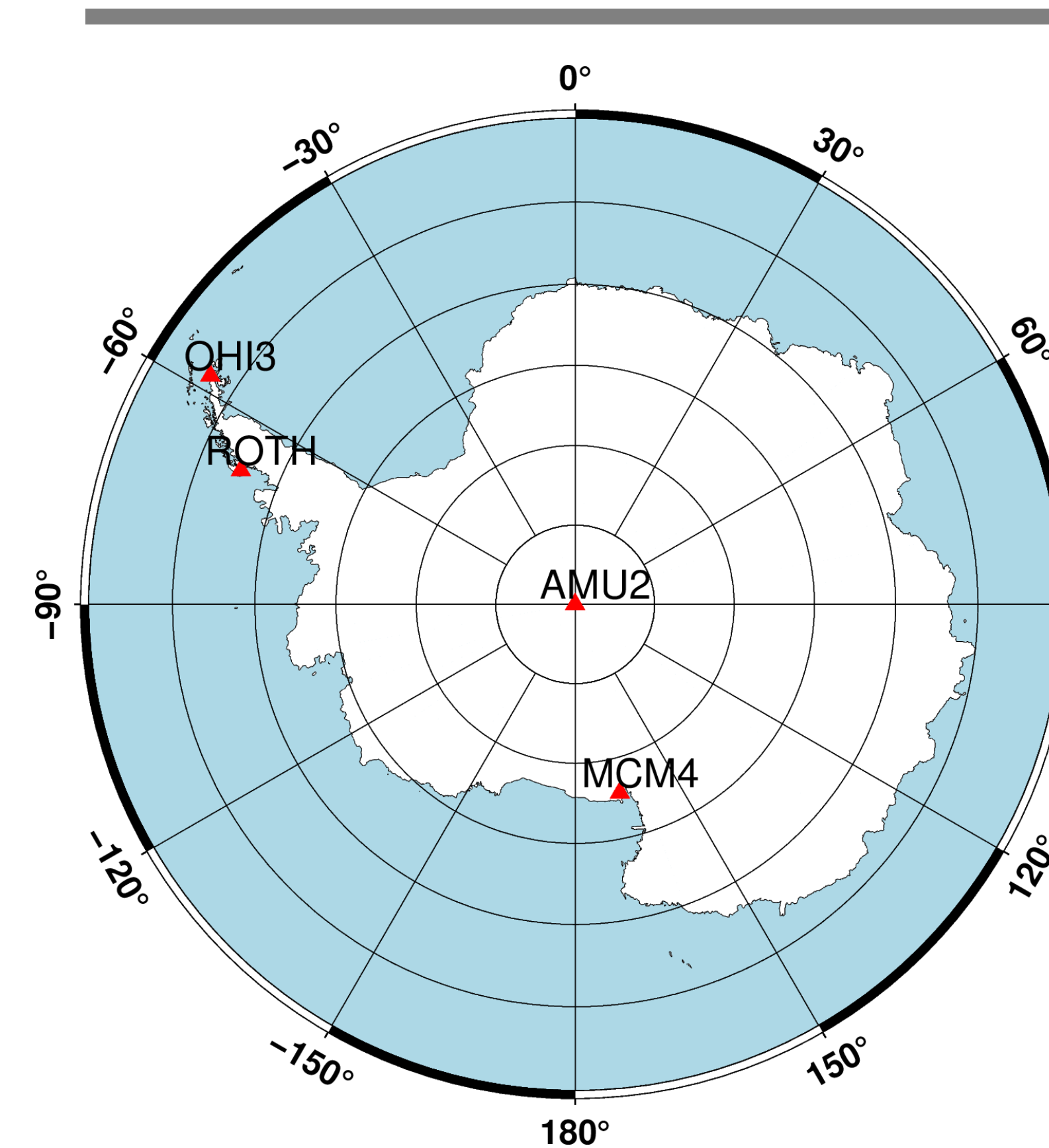


Figure1. Used GNSS stations locations in Antarctica Continent.

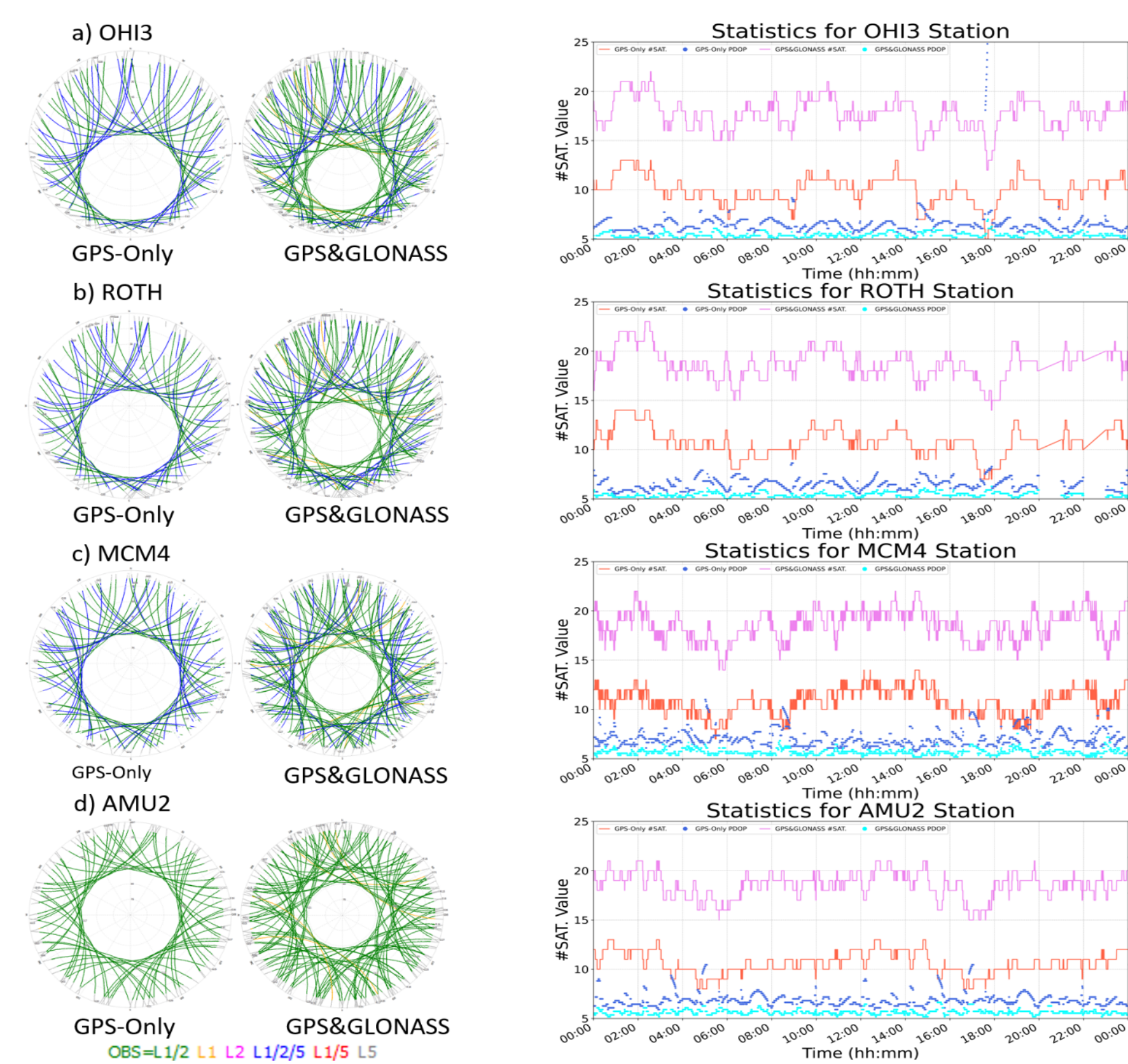


Figure2. Skyplots of GNSS stations.

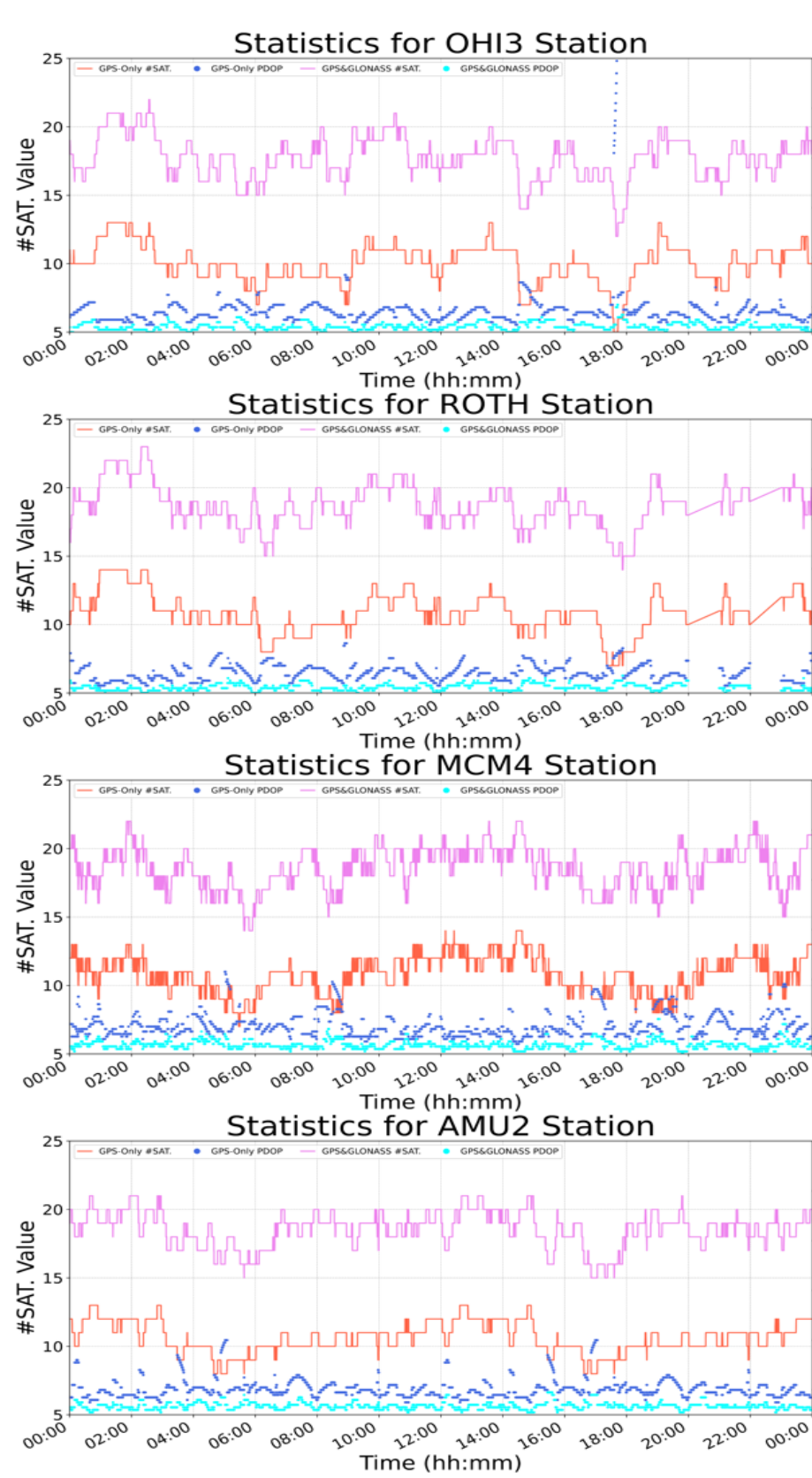


Figure3. Number of observed Satellites and PDOP value graphs.

Analysis on Increasing Latitudes Towards the South Pole

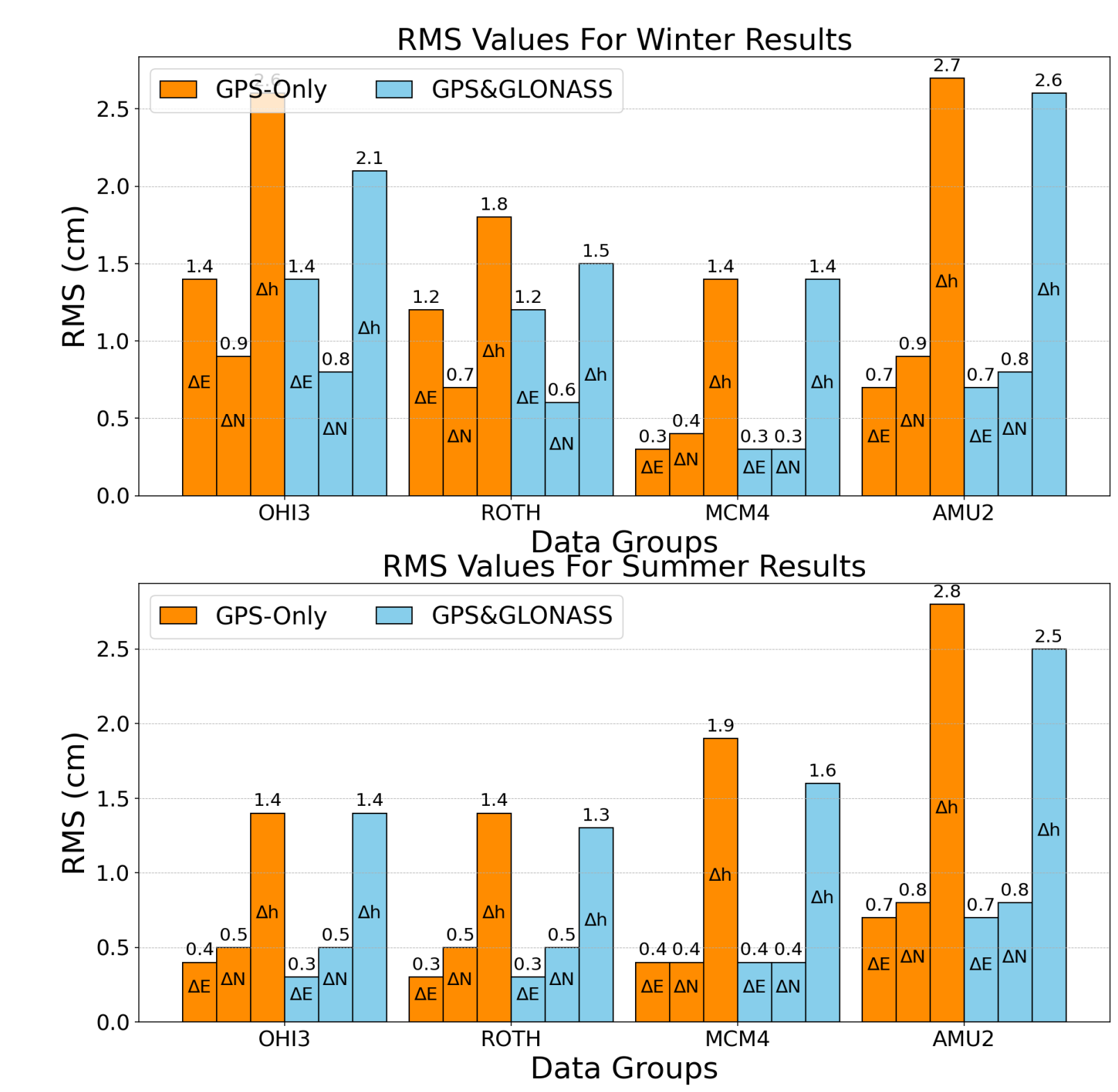


Figure4. RMS values for Kinematic results at OHI3, ROTH, MCM4 and AMU2 stations.

Analysis at MCM4 GNSS Station

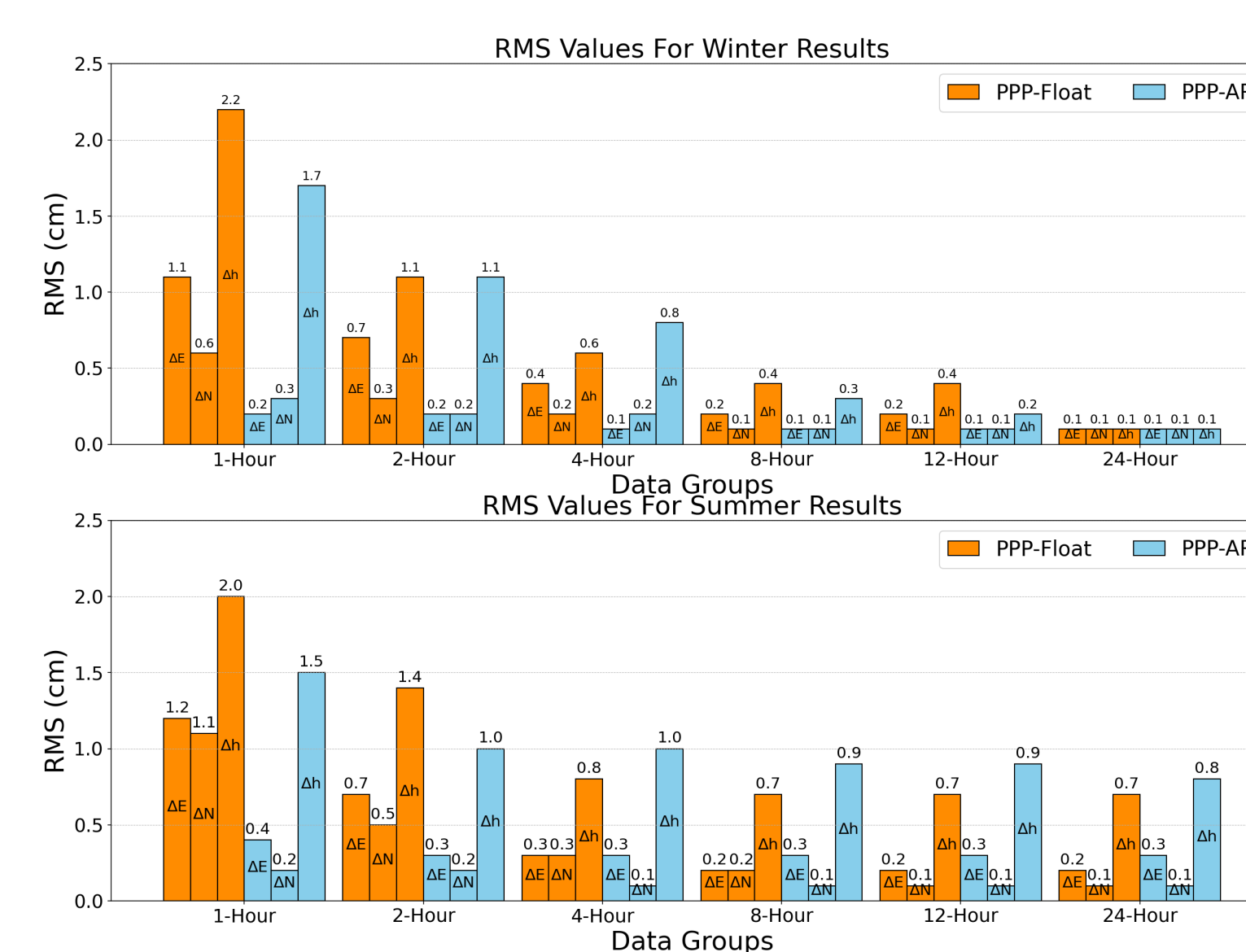


Figure5. GPS-Only RMS values for Static results.

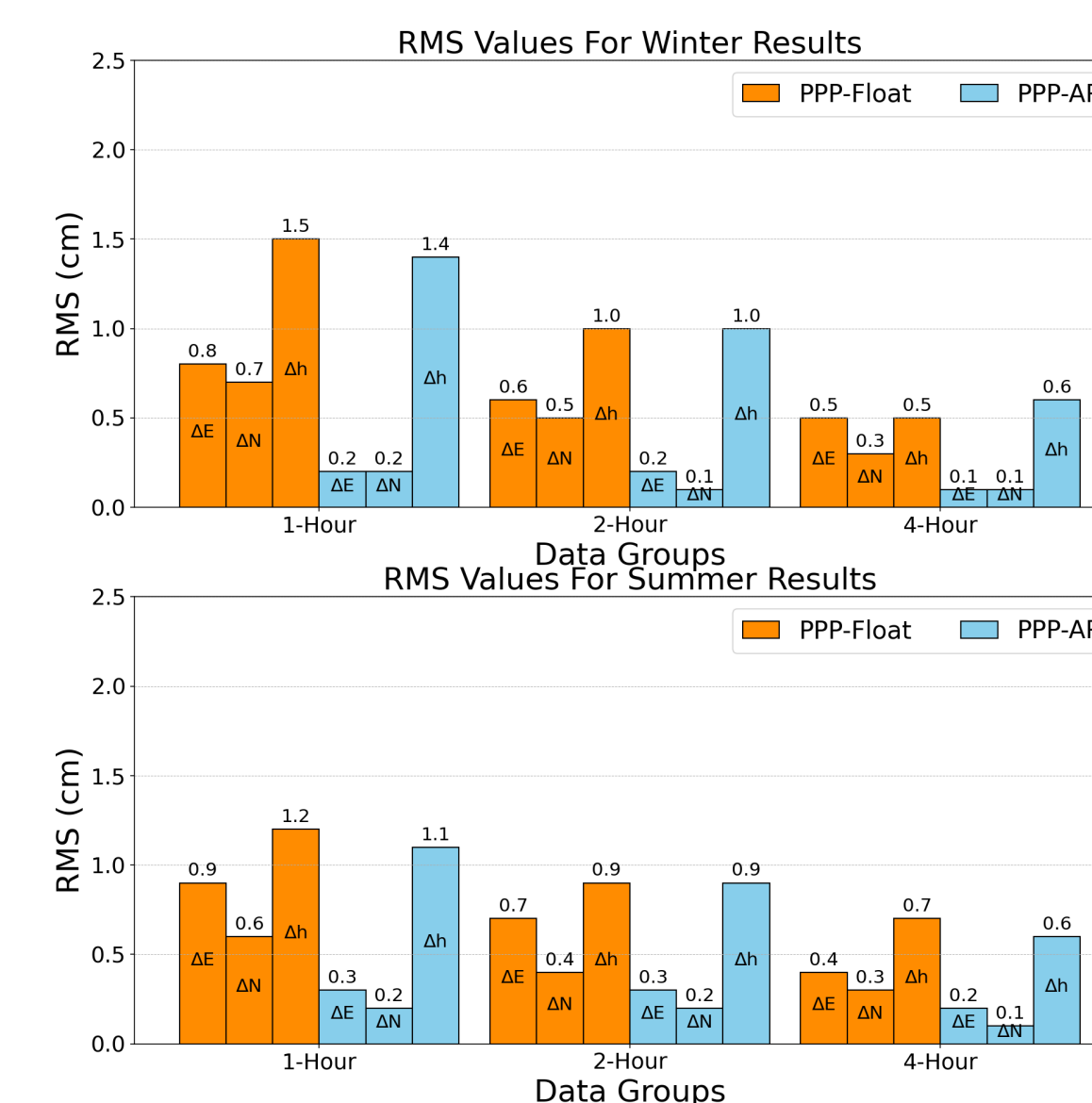


Figure6. GPS&GLONASS RMS values for Static results.

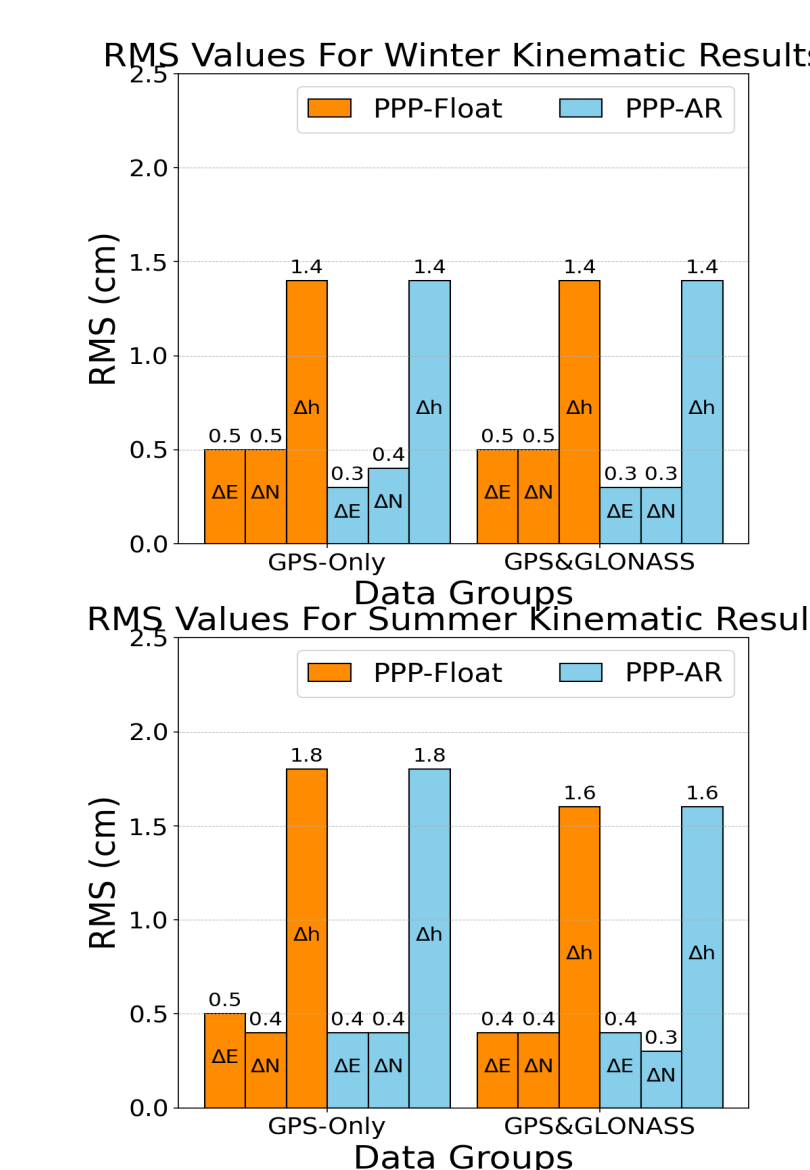


Figure7. RMS values for Kinematic results.

Convergence Time Analysis

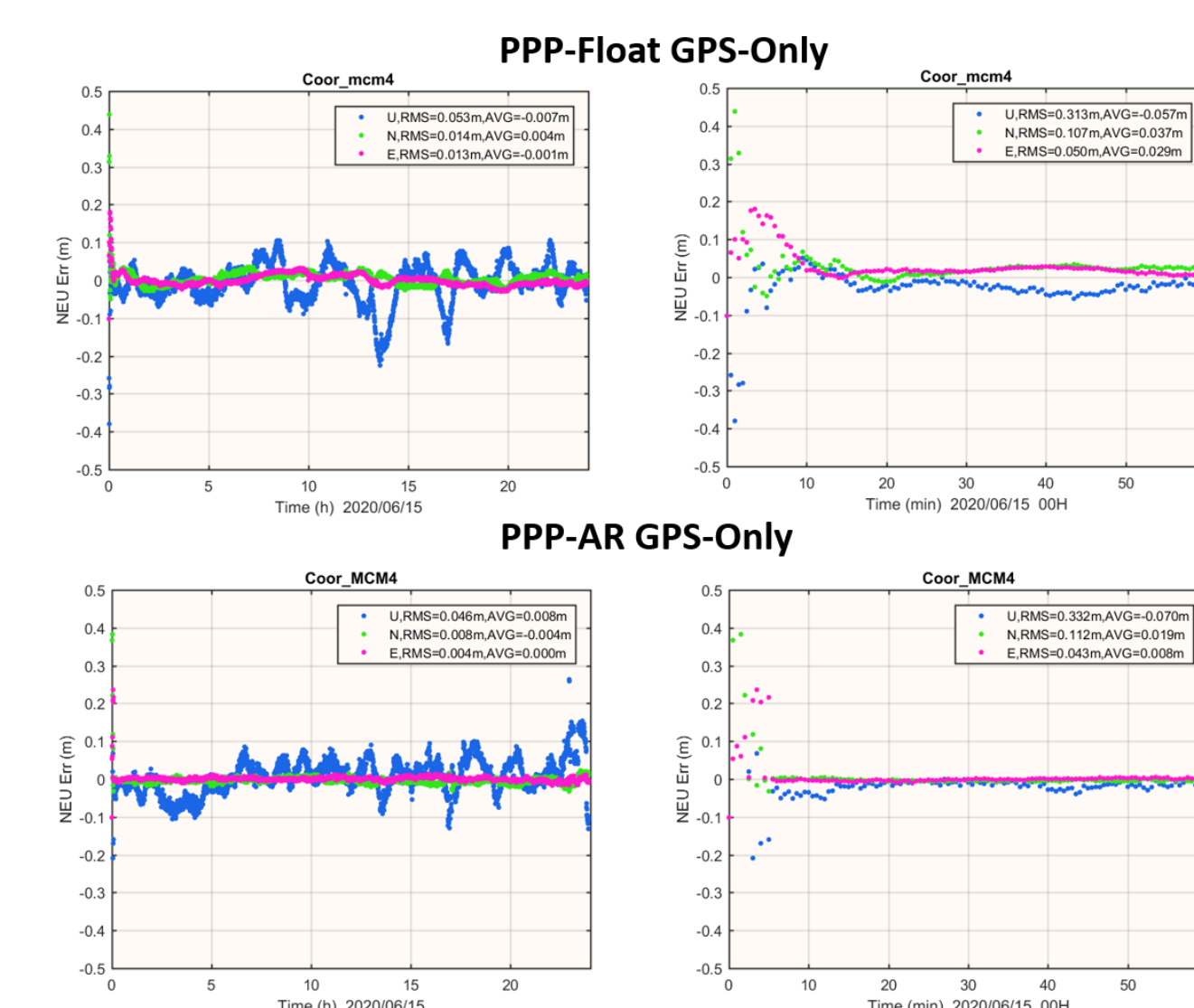


Figure8. GPS-Only Convergence Time analysis.

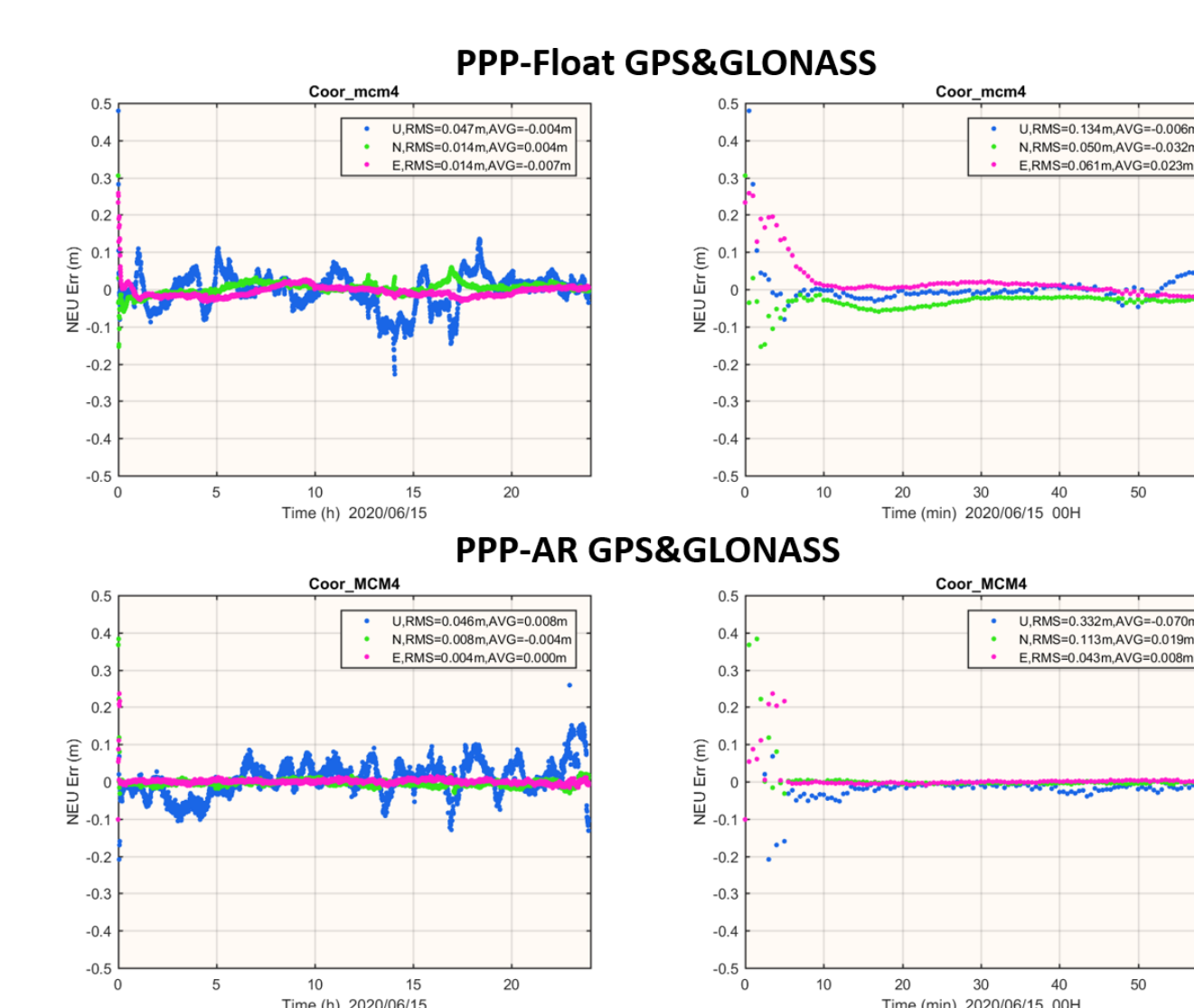


Figure9. GPS&GLONASS Convergence Time analysis.

Conclusion

- For the PPP-Float and PPP-AR Static processing of MCM4 station GPS-Only observations, it was found that 2D and height accuracy values of winter solutions were more accurate than summer season.
- From 1 hourly to daily observations, 2D and height accuracy values were improved from cm to mm level with respect to the observation duration for both seasons.
- The above two situations are the same when using GPS&GLONASS system together. In addition, when the GLONASS system was added to the GPS system, 2D and height accuracies increased for 1h, 2h and 4h observations for both PPP-AR and PPP-Float solutions. However, the effect of the GLONASS system on accuracy has not been observed in longer observation durations.
- PPP-AR technique significantly improved the 2D and height accuracy for all observation time groups and all GNSS combinations, except for 8h, 12h, and 24h GPS solutions in the summer season.
- According to PPP-AR and PPP-Float kinematic solutions of MCM4 station summer and winter observations; PPP-AR solution and GLONASS system have unsatisfactory effect on 2D and height accuracy for both seasons. 2D position accuracy is mm and height accuracy is in cm level for daily kinematic PPP.
- The PPP-AR solution using the GPS&GLONASS constellations improved the convergence time by 66% comparing to the GPS-Only PPP-Float solution.
- Depending on the increasing latitude towards the South Pole, especially for summer results, it has been observed that the 2D position accuracy remained stable for three stations except for AMU2. And, the vertical position accuracy decreased as it approaches the South Pole and the GLONASS system contributed to the improvement of the accuracy.
- As a result of study, it was revealed that the PPP-AR strategy, additional GLONASS system to GPS constellation, and increased occupation times improved the static and kinematic positioning accuracy in the Antarctic region.