

EGU2020-21943

<https://doi.org/10.5194/egusphere-egu2020-21943>

EGU General Assembly 2020

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Data pre-processing for ionosphere TEC retrieval based on DORIS observations

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DORIS system aims to provide precise orbit determination of low earth orbit satellites, and the dual-frequencies on $S1=2036.25$ MHz and $U2=401.25$ MHz were used on DORIS signals. The ionosphere TEC retrieval on the signal path is possible based on DORIS dual-frequency observations.

Analysis results show that DORIS pseudo-ranges had noise with several kilometers level, hence only the carrier-phase observations could be utilized on TEC retrieval. Moreover, as the DORIS ground stations were thousands kilometers separated with each other, station differential cannot be guaranteed and the data preprocessing can only be done base on the un-difference observations before the TEC could be precisely determined.

In this research, a polynomial function was applied to model the DORIS phase observations, and minimal detectable biases (MDB) of less than one cycle wavelength was used as the index on the cycle-slip detection. And then the geometry free combination of $S1$ and $U2$ phase measurements were calculated for each DORIS LEO satellite passing arc. Finally, the unknown ambiguities bias on $S1$ and $U2$ geometry free observables were shifted to coincide with STEC calculated from the IGS GIM products.

Both the Jason-2 & 3 based DORIS observations were used for the validation, several simulated +5 and -1 cycle-slip events on both DORIS observation could be clearly detected and correctly repaired. And the calculated STEC on one satellite passing arc from the LEO satellite to station show well agreement with IGS STEC on continent area, and the differences on ocean areas could be used to prove that the IGS GIM products were less precise on those areas.