Limitations to dual frequency ionospheric corrections for frequency switched K-Q observations with the VLBA

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Abstract

- A series of VLBA experiments were carried out at K and Q bands for astrometry and imaging within the K-Q VLBI Survey Collaboration.
- The paired K and Q observations of each source are separated by approximately 3 minutes of time.
- We investigate the delay effect of the ionosphere between K and Q bands involving the interscan separation.
- This differential delay effect is intermixed with the differential fluctuation effect of the troposphere

Limitations to Ionospheric Corrections with Frequency Switching

Dual Frequency Calibration:

- Ionospheric-delay free delay:
  tau = a tau_1 + b tau_2

  a = f_1^2 / (f_1^2 - f_2^2) b = f_2^2 / (f_2^2 - f_1^2)

- It assumes simultaneous dual frequency observations.
- Observations are not simultaneous, consequently we have corrections:

  tau - b dM - b dK/ f_2^2

dM = M_2 -M_1 is the model difference; dK is the ion content difference

- The question is: Are the introduced errors larger than the calibration ?

Limitations to Ionospheric Corrections with Frequency Switching

Problem #1: Q-band system noise

K-band noise, rms = 25 ps

Q-band noise, rms = 40 ps

actual histogram

actual histogram

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Problem #2: Tropospheric fluctuation

- Delay rates are dominated by tropospheric fluctuation
- The average VLBA delay rate fluctuation is appr. 0.08 ps/s
- The temporal separations is nearly 200 s, introducing ~ 16 s delay difference

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Results

K-band residuals, rms = 28 ps

Calibrated K-band residuals, rms = 35 ps

actual histogram

actual histogram

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Conclusion

- Non-simultaneous K-Q band ionospheric calibration is currently not feasible
- We will perform another check with K and S/X bands observations
- The sequence of S/X- K - S/X observations will be used with 3 and 1.5 minutes separation