

Variable	Unit	Description
X_r	U	state profile of retrieved excess phase/filtered excess phase/retrieved Doppler shift/retrieved geometric optics bending angle/merged GO WO bending angle/filtered bending angle/retrieved bending angle, with $X_r \in \{L_{r,k}(t), L_{F,k}(t), D_{r,k}(t), \alpha_{G,k}(t), \alpha_{G,k}(z_a), \alpha_{M,k}(z_a), \alpha_{F,k}(z_a), \alpha_r(z_a)\}$, $k \in \{1, 2\}$ (frequencies f_{T1}, f_{T2}), and unit $U \in \{m, m, m s^{-1}, rad, rad, rad, rad, rad\}$, comprising elements $X_{r,i}$.
u_X^s	U	estimated systematic uncertainty profile of X (with X and U as defined above), comprising elements $u_{X,i}^s$ (including estimated basic and estimated apparent systematic uncertainties, $u_{X,i}^b$ and $u_{X,i}^a$).
u_X^r	U	estimated random uncertainty profile of X (with X and U as defined above), comprising elements $u_{X,i}^r$.
R_X	1	error correlation matrix of X (with X as defined above), comprising elements $R_{X,ij}$.
C_X	U^2	error covariance matrix of X (with X and U as defined above), comprising elements $C_{X,ij} = u_{X,i}^r \cdot u_{X,j}^r \cdot R_{X,ij}$.
l_X	m	correlation length profile of X (with X as defined above), comprising elements $l_{X,i}$.
τ_X	s	resolution profile of X (with X as defined above) in time domain, comprising elements $\tau_{X,i}$.
w_X	m	resolution profile of X (with X as defined above) in altitude domain (along impact altitude), comprising elements $w_{X,i}$.
X_m	U	model excess phase/Doppler shift/bending angle profiles based on forward modeling of collocated refractivity profiles from ECMWF short-range forecast fields, with $X_m \in \{L_m(t), D_m(t), \alpha_m(z_a)\}$, and $U \in \{m, m s^{-1}, rad\}$, comprising elements $X_{m,i}$.
x_S	U	profiles of Cartesian position/velocity vectors of the receiving/transmitting satellite relative to the center of refraction, with $x_S \in \{r_T(t), r_R(t), v_T(t), v_R(t)\}$, and unit $U \in \{m, m, m s^{-1}, m s^{-1}\}$, comprising elements $x_{S,i}$.
$u_{x_S}^s$	U	estimated (systematic) uncertainty profiles of x_S (with x_S and U as defined above), comprising elements $u_{x_S,i}^s$.
A^{BWS}	1	BWS filter matrix operator, comprising the Blackman windowed sinc (BWS) low-pass filter weights (normalized filter functions) in the form of a band matrix.
A^{L2D}	s^{-1}	Doppler differentiation matrix operator, transforming the filtered excess phase profile to the Doppler shift profile.