Estimation of the filtering biases in the CDAAC neutral-atmosphere processing

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Filtering biases result from convexity / concavity of the filtered functions; they depend on the shape and width of the filter response function.

Besides the filtering biases, there are filtering end-effects:
- small at the bottom (small filtering window for WO BA)
- truncated at the top (important: RO data must be recorded sufficiently above the max. height where they are used)

Currently applied at CDAAC:
Savitzky-Golay filter (sliding polynomial regression)
3 passes,
polynom power = 2,
analytical calculation of derivative
Impulse response function of the applied filter
**Geometric optics:** filtering with differentiation is applied for the phases; then BA are subject to ionospheric correction

\[ LC = \langle L_1 \rangle - \langle\langle L_4 \rangle\rangle \]

<> half-width \( w_1 = \) diameter of the 1st Fresnel zone (~1.5km)

**Note:** the corresponding time window is different for different occultations (depends on TP ascent / descent rate)

<<>> half-width \( w_4 \) is found individually for each occultation (to suppress the effect of larger noise on \( L_2 \)), in the interval \((w_1, 3^*w_1)\), by minimizing fluctuation of \( LC \)

**Wave optics:** filtering is applied for the \( L_1 \) bending angle

\[ LC = \langle L_1 \rangle - \text{extrapolated} \ L_4 \]

<> half-width \( w = 100, 250, 500 \ m \)

all applied for WO BA at 0 - 22 km; then combined: 0-7 km (100 m); 7-10 km (250 m); 10-20 km (500 m)

**GO is merged with WO at 20 km**
Phase models used for evaluation of the filtering biases (GO)

Neutral atmosphere: \[ LC = A \cdot \exp(-z/H); \quad H = 7 \text{ km} \]
Ionosphere: \[ L4 = B / \sqrt{z_E - z}; \quad z_E = 120 \text{ km} \]
Fractional BA bias for GO processing (applied above 20 km)

\[
\frac{\left( \frac{d<LC+L4>}{dt} - \frac{d<<L4>>}{dt} - \frac{dLC}{dt} \right)}{\frac{dLC}{dt}}
\]
Fractional BA biases for WO processing (applied below 20 km)

Fract. BA bias = ( < LC > - LC ) / LC
For the model of ionospheric BA (slide 5), the absolute BA bias at 60-80 km is about 10 times smaller than the 2nd order ionospheric effect (when RO data are recorded to > 100 km).
Currently applied filterings for L1 Doppler (GO), L1 BA (WO) and for L4 Doppler (GO) (for the ionospheric correction), result in the ionosphere-free BA bias < 0.005% below 60 km (increases above 60 km).