Doris phase measurement and ionospheric effects

Flavien Mercier [1] , Luca Cerri [1]
[1] *CNES, 18 Avenue Edouard Belin*

Abstract

The new Doris instruments (DGXX) beginning with Jason 2 satellite produce directly a phase measurement instead of a Doppler measurement (defined as phase variations between consecutive epochs). This new observable may be used directly for ionosphere studies, but there are some limitations which must be taken into account. The frequencies of the system are $f_1 = 2036.25$ MHz (wavelength $\lambda_1 = 14.7$ cm) and $f_2 = 401.25$ MHz (wavelength $\lambda_2 = 74.7$ cm). The lowest frequency of Doris is about 400 MHz, and this may produce important $1/f^3$ ionosphere delays effects.

The new Doris instruments have also up to six channels producing measurements, and this gives a much better coverage at low elevations than the previous two-channels instruments.

The theoretical model is very close to the GPS dual frequency model (two phase measurements and two pseudo-range measurements at each epoch). The main difference for Doris case is that the pseudo-range is not usable for precise studies. The purpose of the pseudo-range measurement is only the instrument synchronization. The pseudo-range noise is very important (typically 1000 meters). This means that the remaining ambiguity present in the phase ionosphere combination cannot be estimated using the pseudo-range data. This ambiguity must be adjusted using an external ionospheric model in order to obtain the complete slant ionospheric delay.

The important ratio between the two frequencies (close to 5) leads to specific properties for the various phase combinations (ionosphere-free phase combination, geometry-free phase combination used to observe the ionosphere propagation delays, combination $5L1 - L2$ used to detect some cycle slips).

The objective is here to establish the relevant equations and the necessary corrections terms for a correct estimation the ionospheric propagation effect using directly the Doris phase measurements (geometry and synchronization corrections for example).