Extra Credit Homework

Winter Term 2020

Due Date: March 20, 2020

Email to jvanzyl@caltech.edu

The Shuttle Radar Topography Mission (SRTM) flew on the space shuttle Endeavour in January 2000. During its 13-day mission, the SRTM interferometer mapped the entire Earth surface between 54 degrees south and 60 degrees north twice, once using ascending passes, and once using descending passes. The shuttle flew at an altitude of 235 km, the interferometer baseline was 60 meters, and the baseline was tilted at 45 degrees. The requirement was to produce digital elevation maps with an accuracy of 16 meters.

In this problem, you have to derive the requirements for the interferometer system based on the requirement that the height accuracy has to be 16 meters. We shall assume here that we only have four sources of error: uncertainties in the baseline length, the baseline tilt angle, the phase accuracy, and the shuttle height above our reference plane. You now have to calculate how accurately we need to know three of the four quantities: baseline length, baseline tilt angle and SNR. The basic equations are:

$$z = h - R\ \cos\theta$$

$$\delta\phi = -\frac{2\pi B}{\lambda}\sin(\theta - \alpha)$$

When calculating the three quantities, you need to evaluate their contributions to the total error assuming we apportion the total error equally to the three sources. Then make sure that the maximum error from that particular source is less than the apportioned value for the entire angle range between 20 and 50 degrees. Ignore the curvature of the earth.

We also know that the uncertainty in the shuttle height is 1 m, *i.e*

$$\sigma_h = 1$$

Once you calculated the required accuracies, calculate the total error as a function of the incidence angle.