1 Supplementary material for 'GNSS-IR Measurements of Inter Annual Sea Level Variations in Thule, Greenland from 2008-2019'

This supplementary information is comprised of multiple plots of the sea level data discussed in the paper. While the paper focus on annual average sea levels, here monthly averages and individual measurements is plottet.

1.1 Monthly sea level anomalies

Figure 1 illustrates the monthly sea level estimated by tide gauge (TG), GNSS Interferometric Reflectometry (GNSS-IR) and altimetry. The data used is the same as for figure 3 in the paper. The only difference is that averages are taken over a month in stead of a year. The gravimetry is not shown here since the data used to estimate this is annual. There are considerable differences between TG and GNSS-IR results but no clear seasonal pattern.

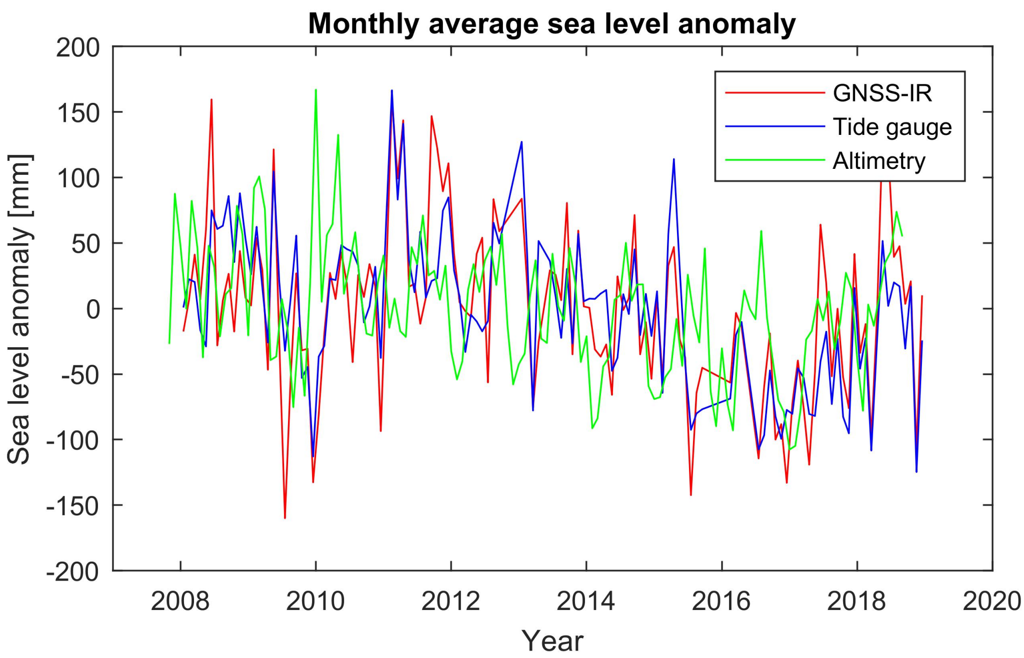

Figure 1: Monthly sea level from GNSS-IR, tide gauge and altimetry

1.2 Individual sea level measurements

Figure 2 compares individual measurements of sea level by GNSS-IR and TG before filtering tides and annual and biannual variations. Note that the figure compares variations not absolute values (mean has been subtracted from both time series). There is a tendency that GNSS-IR is higher than TG during late winter and spring and lower during summer. This is an expected result of sea ice in the fjord. The RMSE between the two calculated over all of 2018 is 20 cm which is higher than the RMSE for August of 13 cm used the estimate errors in the paper, but not high enough to explain the differences in the annual sea level measurements.

Figures 3 to 14 show the monthly comparisons of individual measurements of sea level by GNSS-IR and TG before filtering tides and annual and biannual variations. A for S2 the figures compare variations not absolute values.

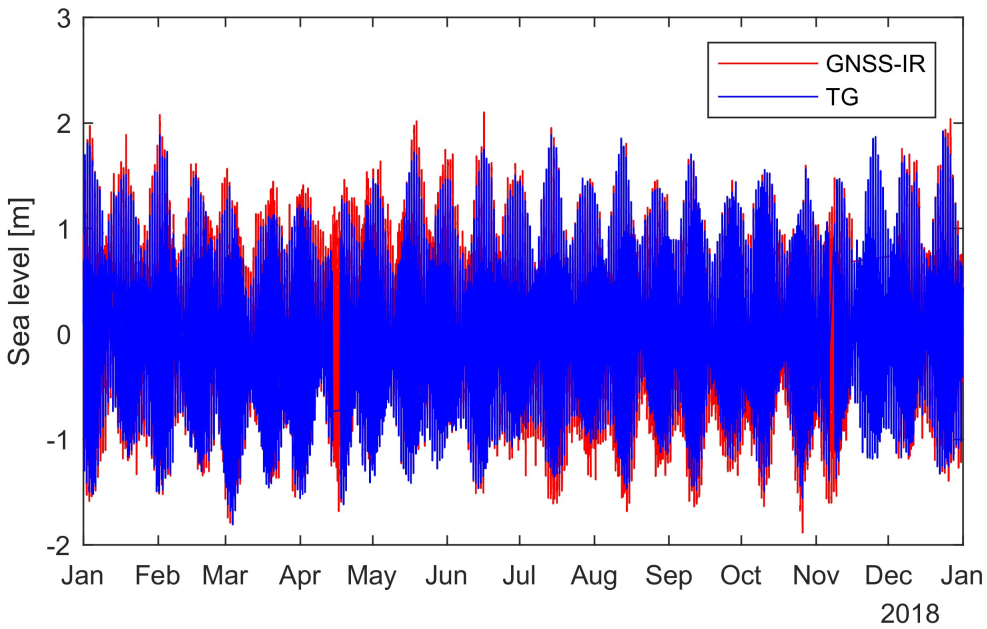

Figure 2: Comparison of individual sea level measurements by tide gauge and GNSS-IR for 2018

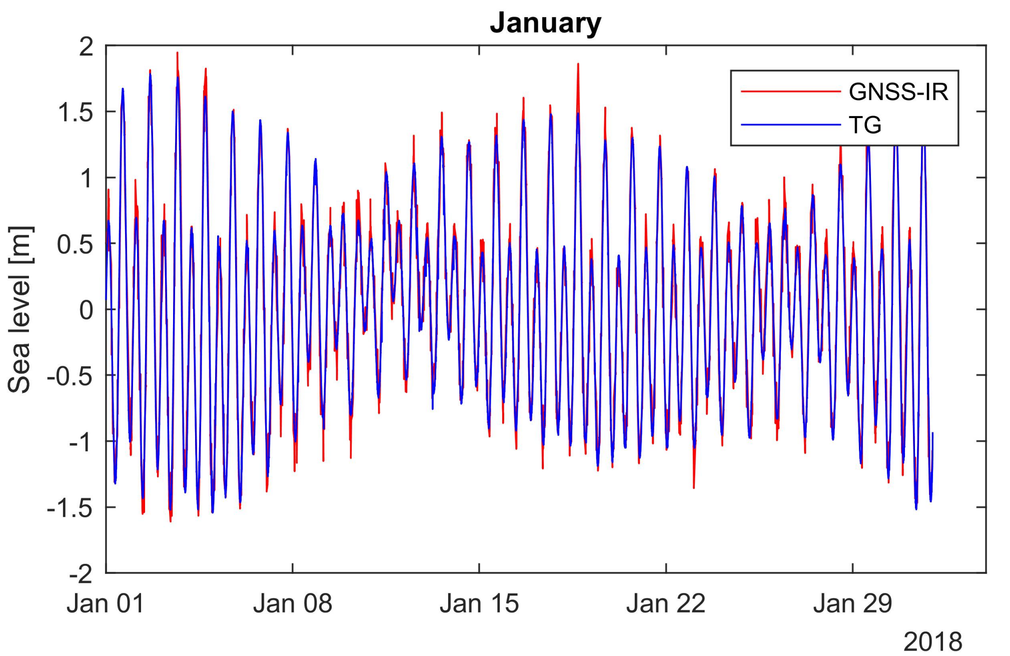

Figure 3: Comparison of individual sea level measurements by tide gauge and GNSS-IR for Janunary 2018

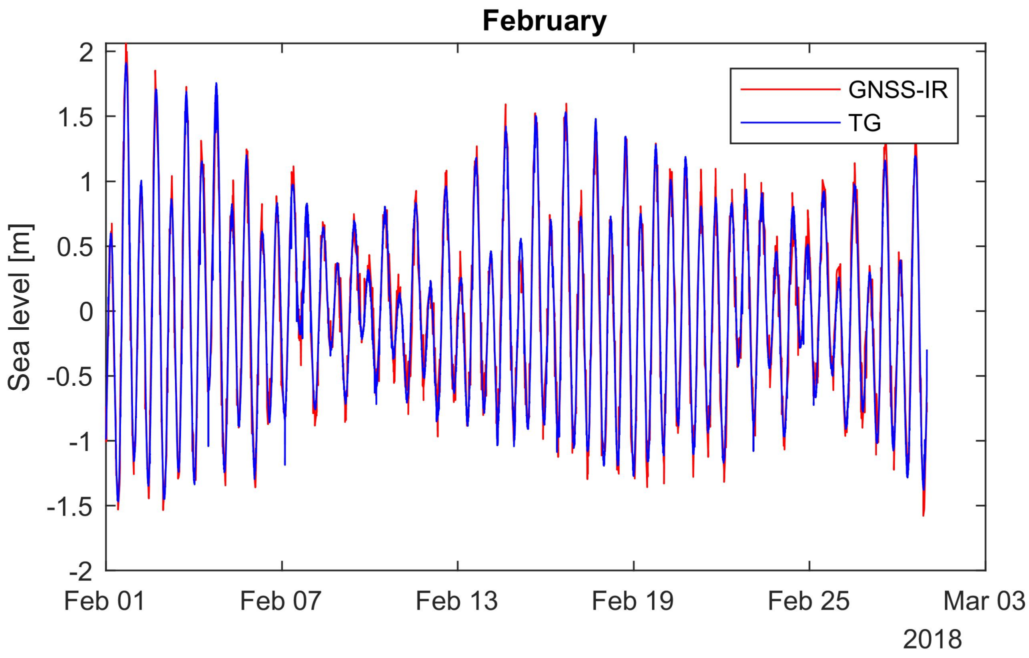

Figure 4: Comparison of individual sea level measurements by tide gauge and GNSS-IR for February 2018

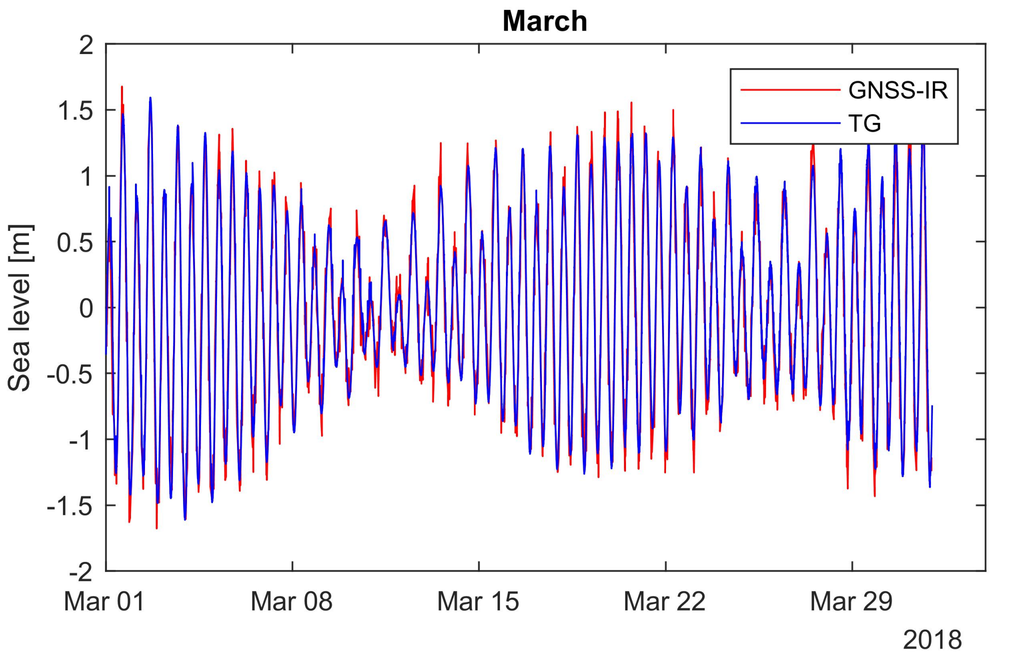

Figure 5: Comparison of individual sea level measurements by tide gauge and GNSS-IR for March 2018

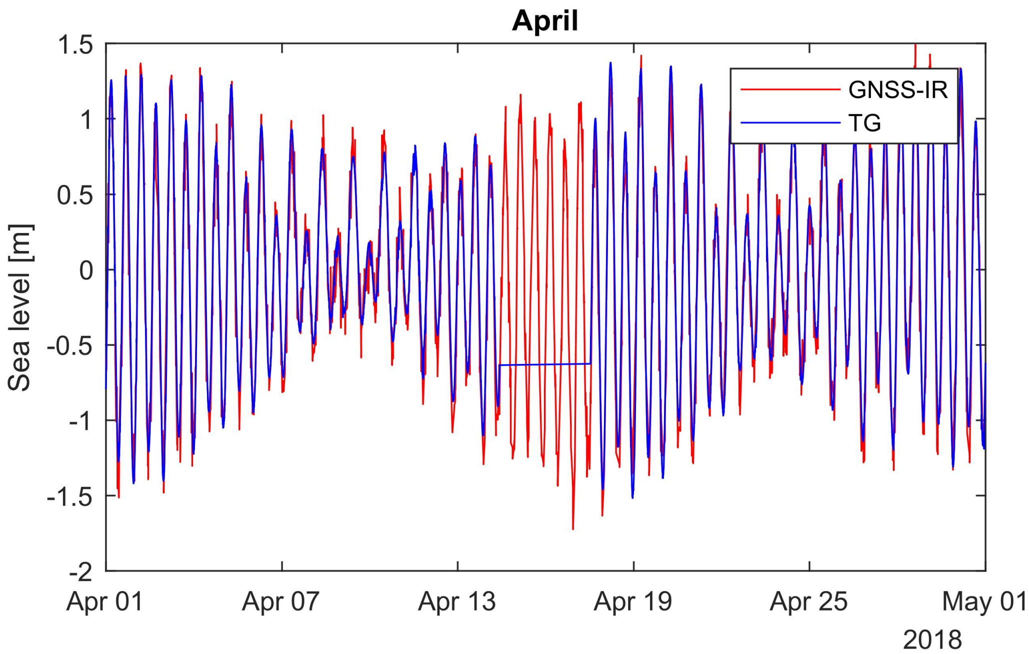

Figure 6: Comparison of individual sea level measurements by tide gauge and GNSS-IR for April 2018

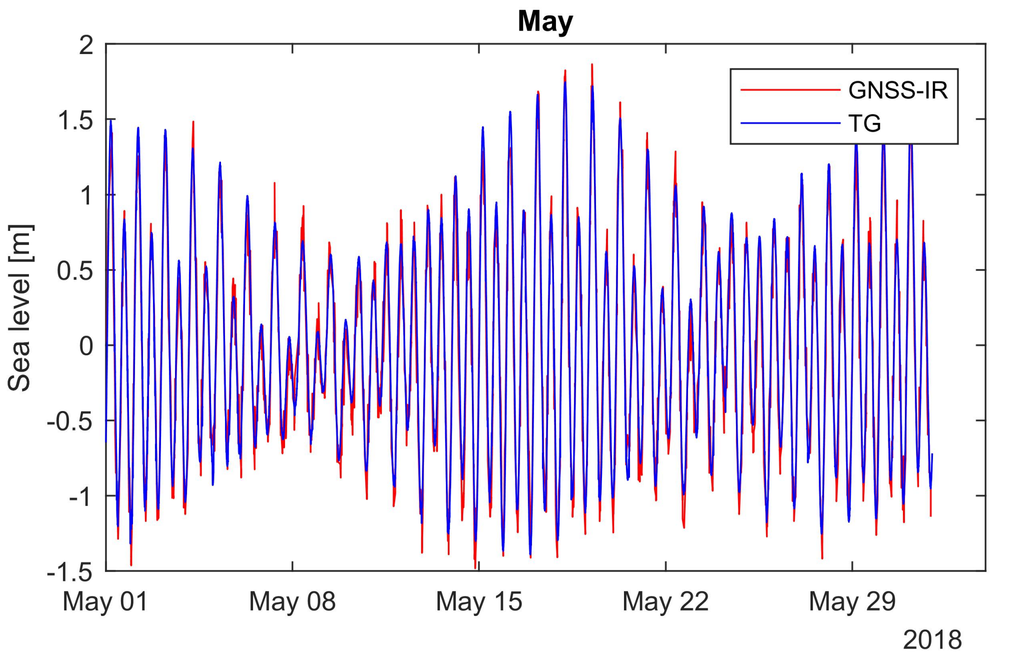

Figure 7: Comparison of individual sea level measurements by tide gauge and GNSS-IR for May 2018

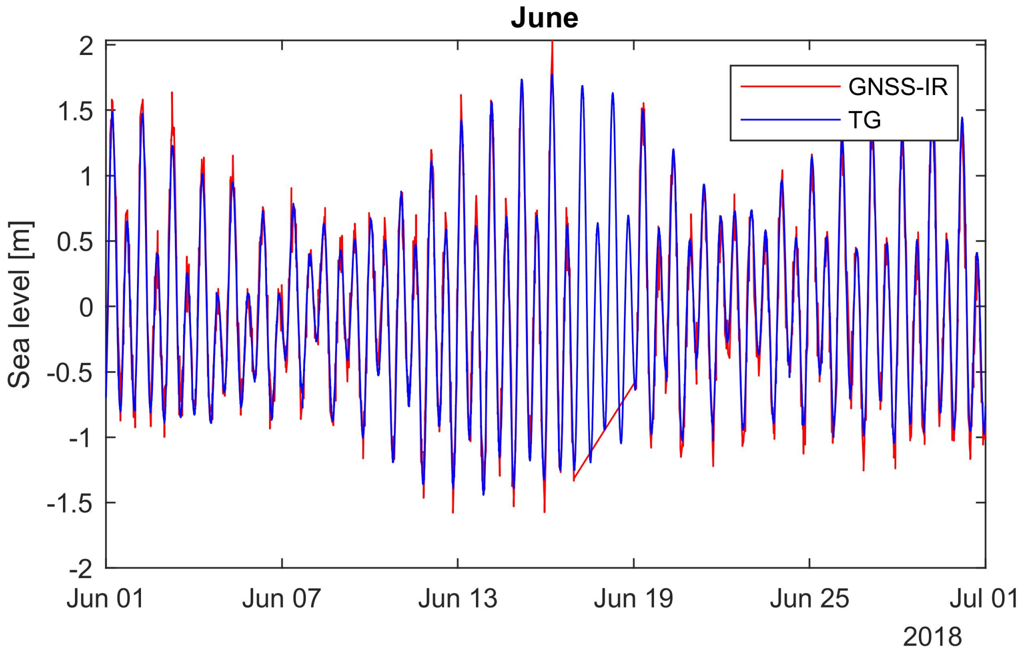

Figure 8: Comparison of individual sea level measurements by tide gauge and GNSS-IR for June 2018

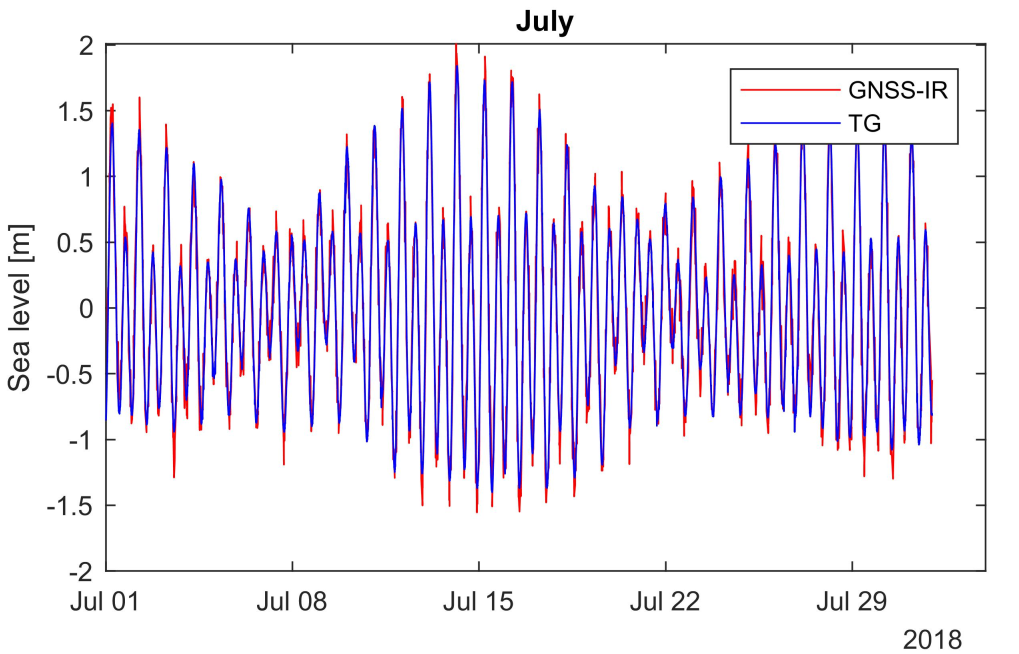

Figure 9: Comparison of individual sea level measurements by tide gauge and GNSS-IR for July 2018

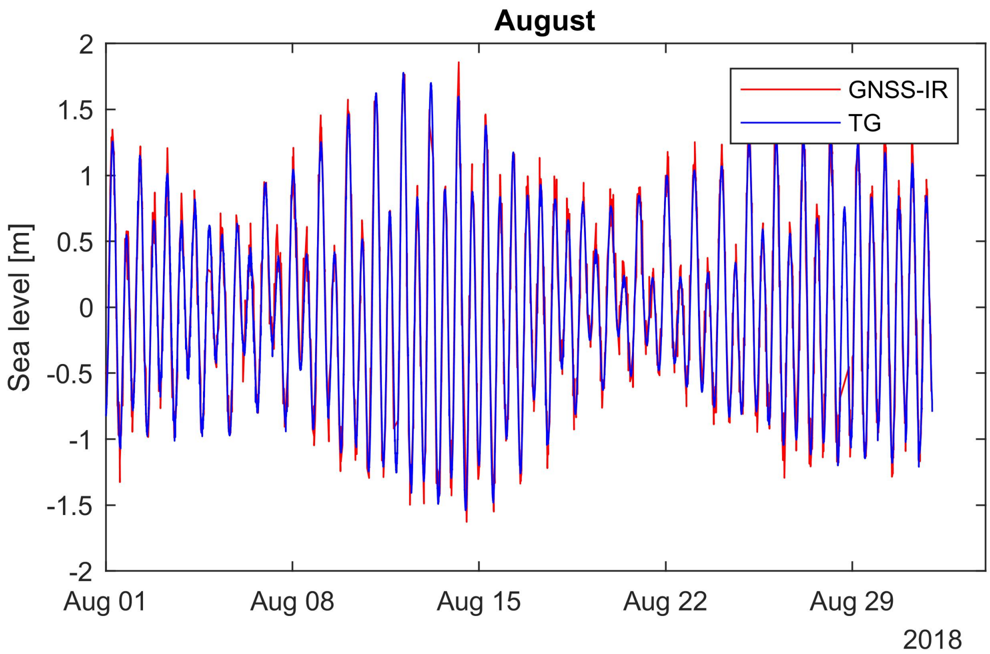

Figure 10: Comparison of individual sea level measurements by tide gauge and GNSS-IR for August 2018

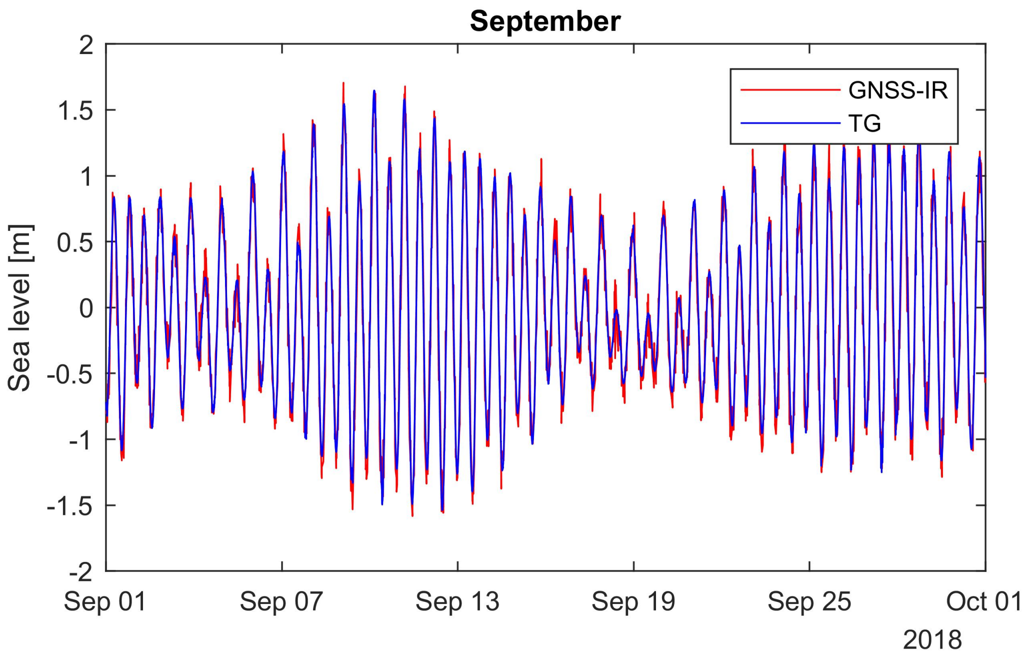

Figure 11: Comparison of individual sea level measurements by tide gauge and GNSS-IR for September 2018

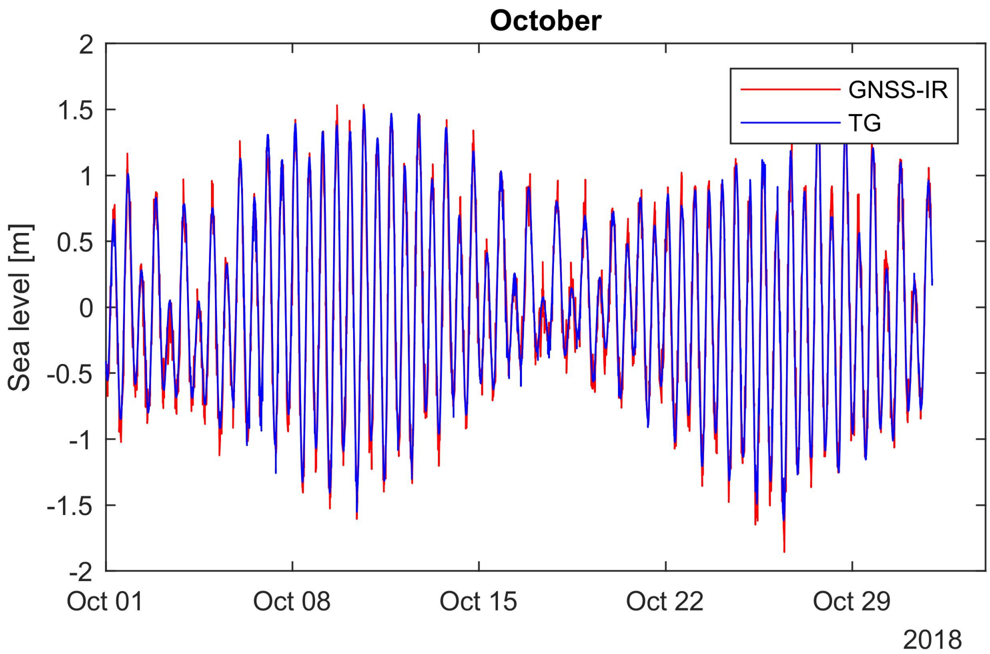

Figure 12: Comparison of individual sea level measurements by tide gauge and GNSS-IR for October 2018

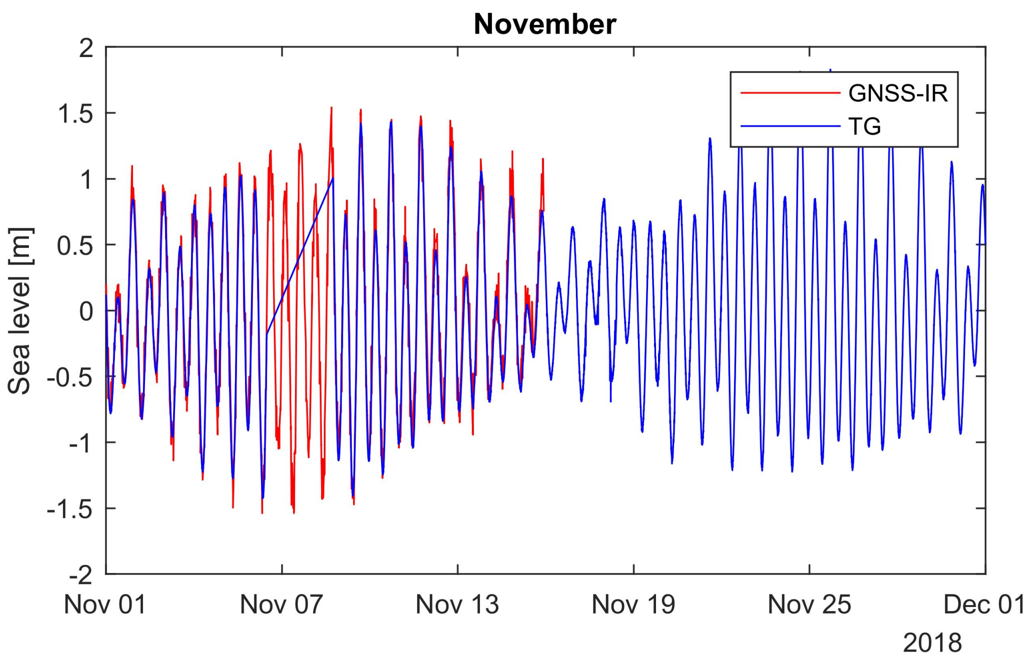

Figure 13: Comparison of individual sea level measurements by tide gauge and GNSS-IR for November 2018

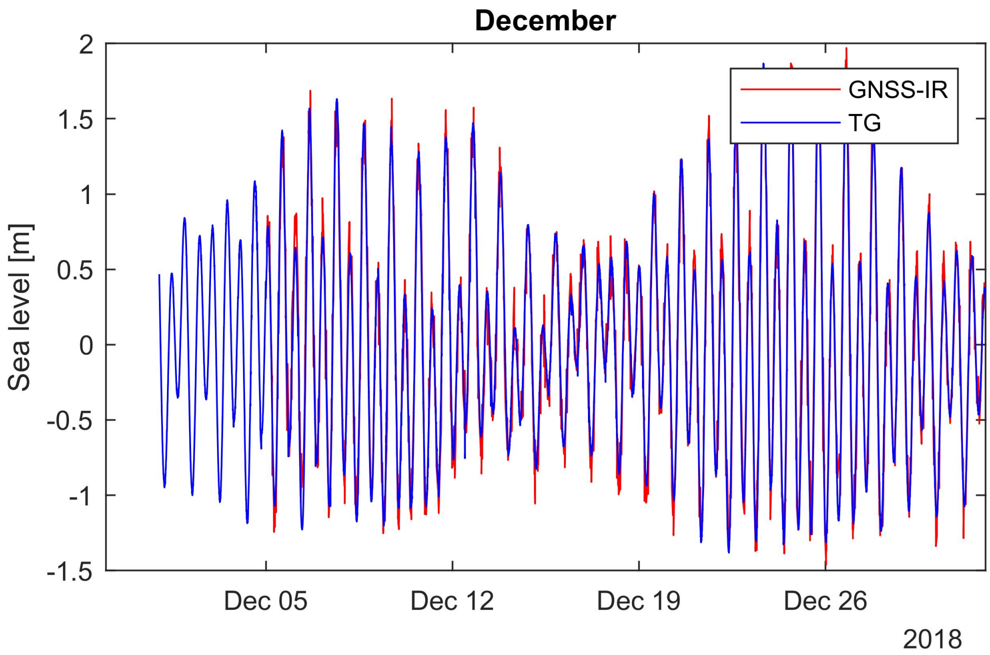

Figure 14: Comparison of individual sea level measurements by tide gauge and GNSS-IR for December 2018

1.3 Uplift at THU2

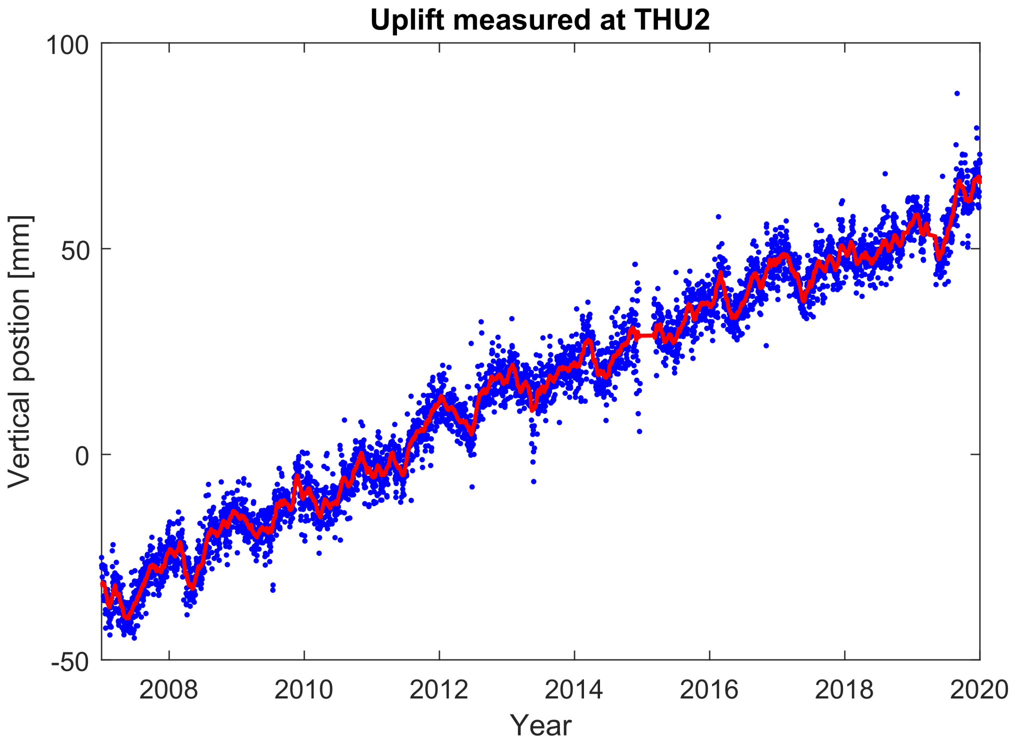

Figure 15: Variations in measured vertical position at THU2 during the study period. Blue dots are daily values and the red line is a 30 day running average of the daily values.

1.4 Fresnelzones

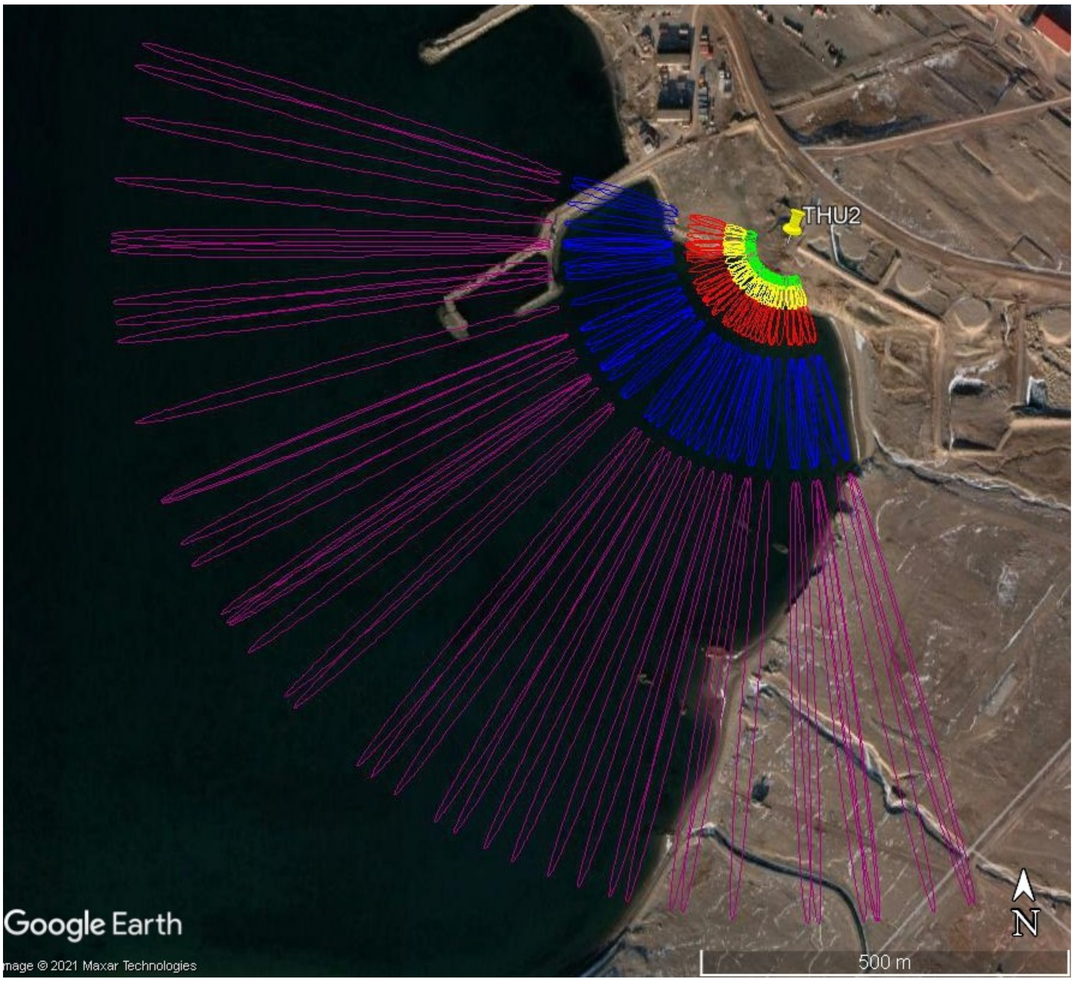

Figure 16: Fresnel-zones for azimuth 160-290 for elevation angles: 2, 5, 10, 15, 20.

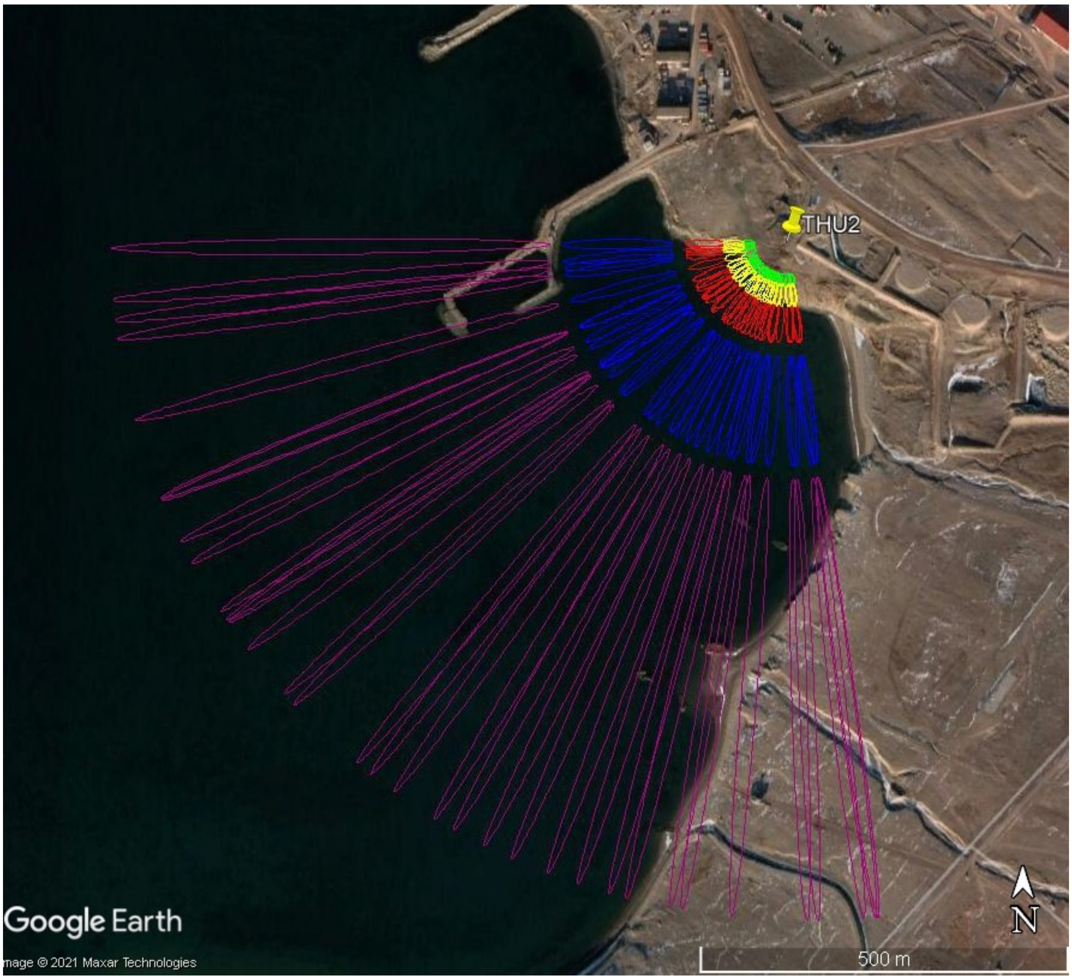

Figure 17: Fresnel-zones for azimuth 170-270 for elevation angles: 2, 5, 10, 15, 20.