# Introduction

The earth is a dynamic system in constant movement and subject to continuous change. Continents shift, sea level changes, and the planet’s speed of rotation and its axis is not constant. Water flows downwards with gravity, which then changes the topography and leads to changes in the location of water bodies. Shifting ice masses and changes in groundwater level can influence gravitation and the earth’s gravity field. To measure and evaluate these changes highly accurate and long-term stable, global reference systems are needed. Without the measurements performed at geodetic observatories, it is not possible to realise these reference systems (source: Geodetic Observatory Wettzell (GOW)).

Therefore, the observatory in Wettzell measures the orientation of the earth in space and its shape in collaboration with partner stations all around the globe. Therefore the GOW Wettzell, a VGOS-992, belongs to the European Critical Infrastructure (Gallileo earth station). The start frequency A8 3960,4 MHz (Block A, start frequencies) is referenced in [https://www.itu.int/dms\_pub/itu-r/opb/rep/R-REP-RA.2507-2022-PDF-E.pdf (page 25](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-RA.2507-2022-PDF-E.pdf%20(page%2025)).

This sharing study describes the interference scenarios between Wireless Broadband Low/Medium Power (WBB LMP) systems and the GOW in the band 3800-4200 MHz. While identifying key parameters, interference scenarios, the propagation model and the protection criteria, the needed separation distances for the protection of the GOW from WBB LMP base stations (BS) are calculated via worst case Minimum Coupling Loss (MCL) and these results are analysed.

# INterference Scenario AND KeY PARAMETERS

In this study only outdoor to outdoor propagation is considered. Indoor low power base stations have a reduced transmit power at the outside due to the shielding of buildings etc. Medium power base stations are only used outdoor.

## Parameters OF THE GOW

Table 1: Parameters of the GOW

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Comment |
| [Degree](https://dict.leo.org/englisch-deutsch/degree) [of](https://dict.leo.org/englisch-deutsch/of) [latitude](https://dict.leo.org/englisch-deutsch/latitude) | 49° 8‘ 36,2‘‘ | TTW2 antenna (TWIN Radio Telescope Wettzell) |
| [Degree](https://dict.leo.org/englisch-deutsch/degree) [of](https://dict.leo.org/englisch-deutsch/of) [longitude](https://dict.leo.org/englisch-deutsch/longitude) | 12° 52‘ 41,8‘‘ | TTW2 antenna (TWIN Radio Telescope Wettzell) |
| Antenna height (hGOW) | 11 m | GOW antenna height |
| Antenna gain | 53 dBi | Main lobe |
| Antenna gain (GGow) | 26 dBi | Side lobe (this study considered only the side lobe, because in most cases WBB LMP will not interfere the main lobe) |
| Elevation | 3°-90° | Measurements from 3°onwards possible |
| Azimuth | 0°-360° | All azimuth angles weighted equally |
| Maximum allowed interference | -135 dBm/MHz | This value is used in the procedures of national assignment allocation |
| Maximum allowed interference | -146.1 dBm/MHz | Corresponding to ITU-R RA.769.2 |

In Germany the Bundesnetzagentur (BNetzA) and the GOW have decided to use the protection criterion of - 135 dBm/MHz for the frequency range 3400-3800 MHz. This allows e.g. that this frequency range can also be used for transmitting base stations in Munich. If the transmission of a base station leads to interference within the GOW receiver, the base station parameters could be adjusted as described in section 5.

It is expected that the protection criterion of - 135 dBm/MHz will also be used in the frequency range 3800-4200 MHz. Therefore, the studies based on the protection criterion of - 135 dBm/MHz are conducted initially. The results for the simulation based on a protection criterion of - 146.1 dBm/MHz corresponding to ITU-R RA.769.2 can be found inANNEX 1:.

## WBB LMP Parameters for 3800-4200 MHz

Parameters for the WBB LMP 3800-4200 MHz are based on the UK/NOR approach (see ANNEX 2:).

Table 2: WBB LMP parameters

|  |  |
| --- | --- |
| Base station | Value (P\_WBB) |
| Low power (EIRP) | 18 dBm / 5 MHz for carriers > 20 MHz = 11 dBm/MHz |
| Medium power (EIRP) | 36 dBm / 5 MHz for carriers > 20 MHz = 29 dBm/MHz |

It is assumed that normally carriers greater 20 MHz will be used to enable high datarates.

## Additional parameters for the study

Table 3: Scenario parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Comment |
| f | 3800 MHz | worst case frequency |
| hBS,LP | 10 m | Base station height low power BS scenario |
| hBS,MP | 25 m | Base station height medium power BS scenario |

## Propagation model

For the SEAMCAT simulations Recommendation ITU-R P.452-16 is used to calculate the path loss (PL) between the GOW and WBB LMP BS with a time percentage of 20% to match the long-term protection criterion. The study assumes non-time variant assumptions, e.g. both victim services and interfering services are static.

Clutter is applied on the WBB side for the low power BS scenario, as the maximum antenna height is limited to 10m. ITU-R P.2108-1 section 3.2 with 50 percentage of locations was used to calculate the average clutter loss.

L\_Clutter = 31 dB

No clutter is applied for the medium power BS scenario, as the antenna height is considered above the average clutter level.

For the MATLAB simulations ITU-R P.2108-1 section 3.1 and terrain data from the BKG are used to provide more realistic path loss results than the same Recommendations using section 3.2. It should be noted that this section is only applicable up to 3000 MHz, but since there is no other Recommendation dealing with real clutter above 3000 MHz until now, it is common to use this section for higher frequencies.

The MATLAB simulations uses calculated values between 0 and 26 dB for the clutter.

## MCL – worst case Analysis

Calculating the maximum allowed interference power:

Imax <= P\_WBB + GGow – PL – L\_Clutter

(PL = path loss)

# SIMULATION RESULTS

## SEAMCAT Simulation without terrain profile Data

This scenario analyses the resulting path losses and the necessary separation distances to protect the GOW receiver from harmful interference of the outdoor WBB LMP BS using SEAMCAT and the Test Propagation Model tool with ITU-T P.452-16.

Table 4: Results for the outdoor scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| GOW side lobe (GGow = 26 dBi) | Low power BS (P\_WBB\_LP = 11 dBm/MHz) | | Medium power BS  (P\_WBB\_MP = 29 dBm/MHz) | |
| Needed path loss (PL) | Required separation distance | Needed path loss (PL) | Required separation distance |
| SEAMCAT | 141 dB | 23 km | 190 dB | 72 km |

### SEAMCAT simulation with low power BS

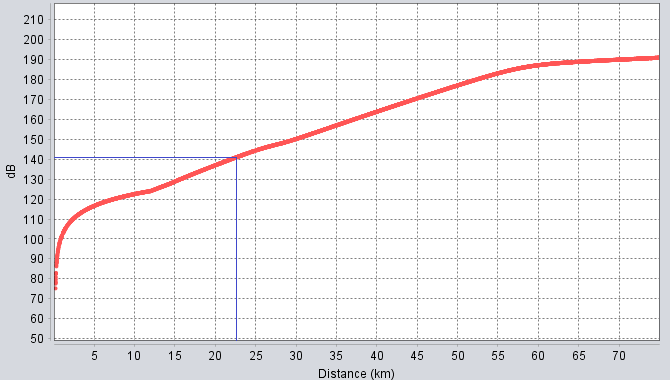


Figure 1: SEAMCAT - low power BS

### SEAMCAT simulation with medium power BS

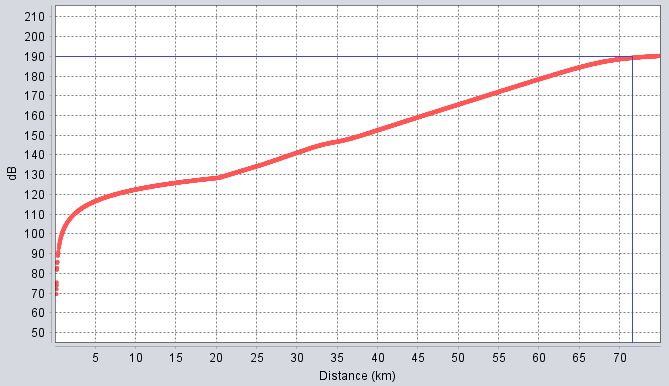


Figure 2: SEAMCAT - medium power BS

## Simulations with terrain profile Data

The area around Wettzell is very mountainous, with the GOW being placed on top of a mountain. Therefore, two further simulations are being carried out. These two simulations consider the terrain profile data in order to achieve more realistic results.

The first simulation is done using MathWorks MATLAB. For the MATLAB simulations and plots, map data from the German “Federal Agency for Cartography and Geodesy” (BKG) is used, including the CLC (CORINE Land Cover) map data from the “European Environment Agency” (EEA) to account for clutter on the terrain.

For the second simulation SEAMCAT Version 5.5.0 alpha is used which includes terrain profile data. The position (angle) of the farthest interferer is needed to start the simulation. This parameter is taken from the MATLAB results.

Slight differences between the two simulation results may arise due to different terrain data used. MATLAB uses the digital terrain model (DTM) with the clutter information from the CLC database while SEAMCAT uses the digital surface model (DSM).

Table 3: Results for the outdoor scenario

|  |  |  |
| --- | --- | --- |
| GOW side lobe (GGow = 26 dBi) | Maximum separation distance for low power BS (P\_WBB\_LP = 11 dBm/MHz) | Maximum separation distance for medium power BS  (P\_WBB\_MP = 29 dBm/MHz) |
| MATLAB | 100 km | 125 km |
| SEAMCAT (with terrain profile data) | 96 km | 125 km |

The results for the SEAMCAT and MATLAB simulation given in Table 3 are comparable and confirm each other. The resulting maximum separation distance of about 100 km could be found for the low power base station and 125 km could be found for the medium power base station. This maximum separation distance is strongly dependent on the terrain around the GOW. Therefore, the plots for separation distances for 360° azimuth around the GOW are given in Figure 4 and Figure 6 below.

### MATLAB simulation with low power BS

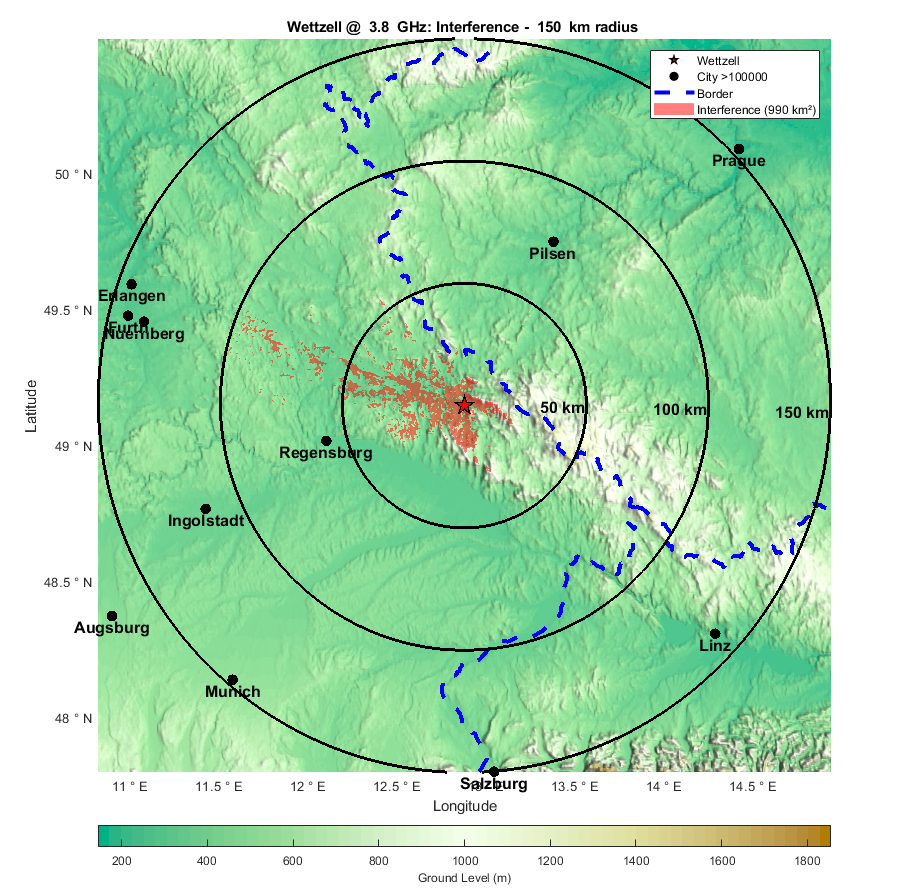


Figure 4: Matlab - low power BS

### SEAMCAT simulation with low power BS

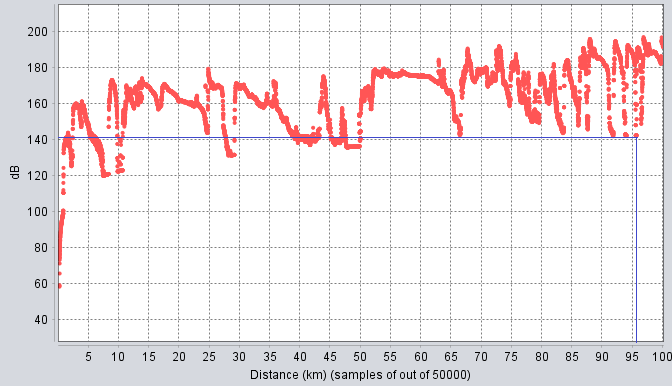


Figure 5: SEAMCAT (with terrain profile data / 289 degree) - low power BS

### MATLAB simulation with medium power BS

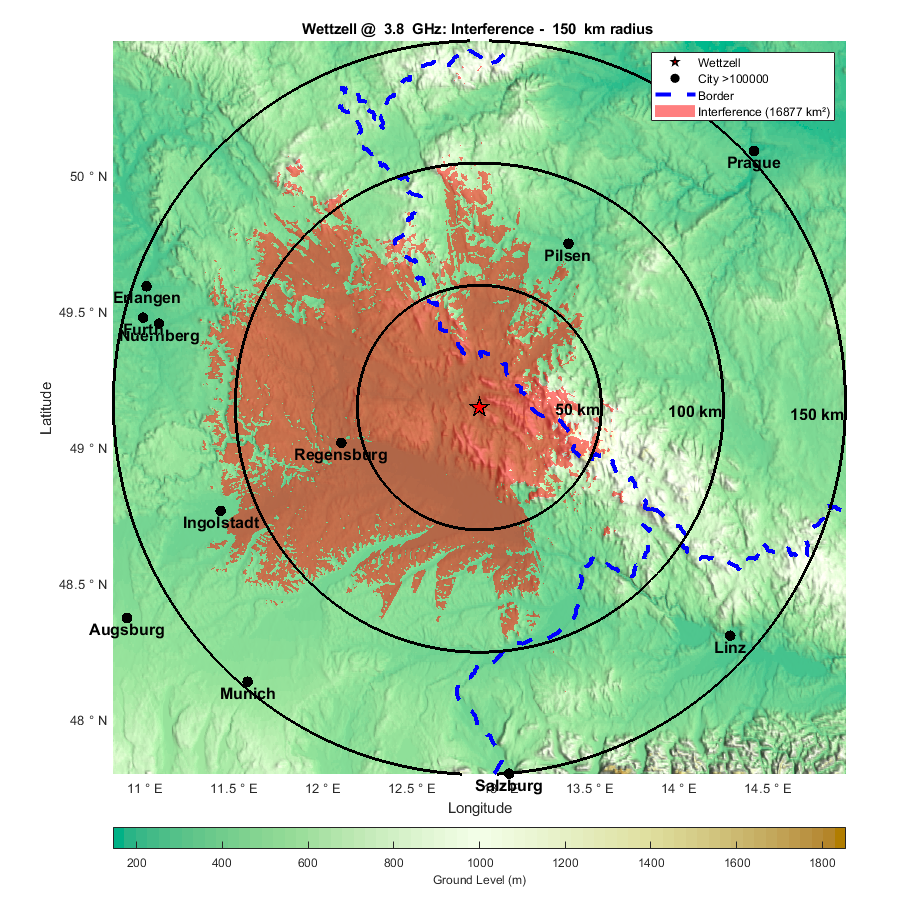


Figure 6: Matlab - medium power BS

### SEAMCAT simulation with medium power BS

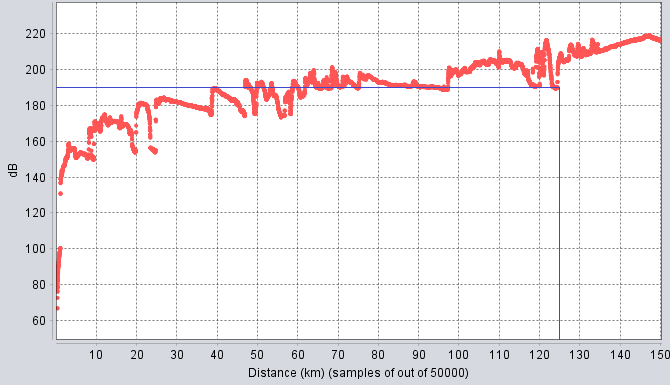


Figure 7: SEAMCAT (with terrain profile data / 319 degree) - medium power BS

# SUMMARY

The results in this sharing study indicate that the maximum required separation distances to protect the GOW from WBB LMP may go up to **125 km for medium power BS** and up to **100 km for low power BS** for a worst-case scenario. The results for the medium power BS also show that a cross-border interference could occur.

# MITIGATION PossiBILITIES

WBB LMP operators could take various measures at their individual sites to minimise restrictions on the observatory, such as:

* restricting the transmitter power;
* reducing the antenna height;
* adjusting the antenna elevation angle;
* adjusting the direction of the antenna (away from Wettzell).

1. Protection Criterion -146.1 dbm/Mhz used in MATLAB SIMULATIONS

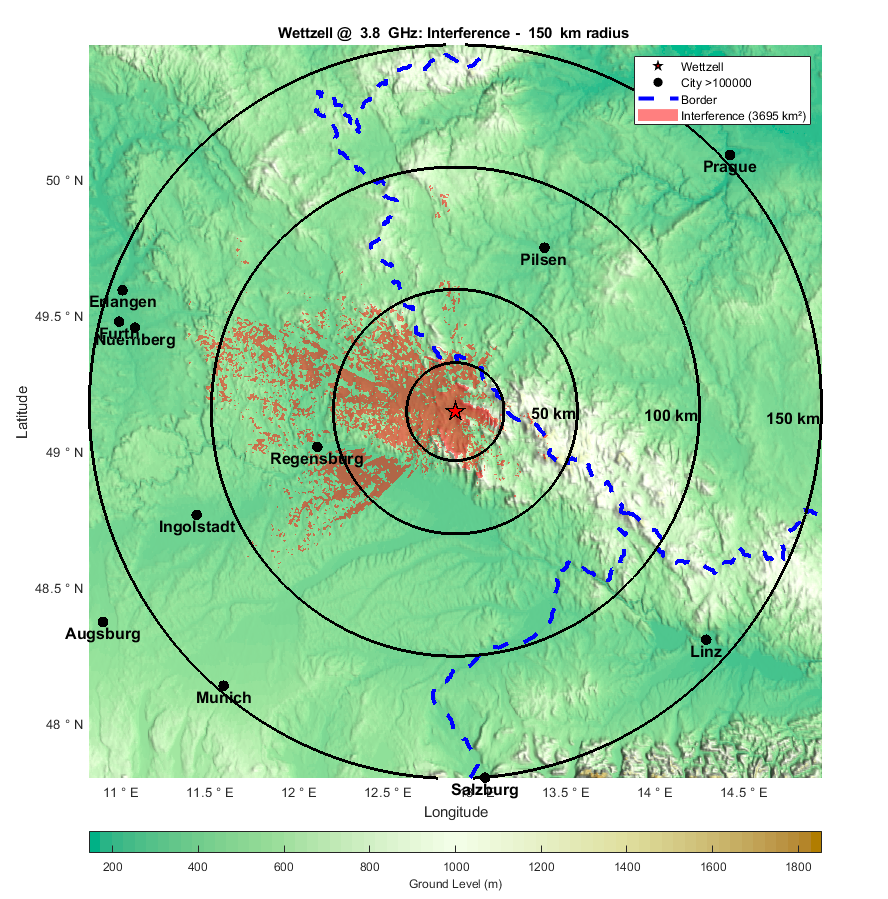


Figure 8: MATLAB - low power BS for maximum allowed interference = -141.6 dBm/MHz

## 

Figure 9: MATLAB – medium power BS for maximum allowed interference = -141.6 dBm/MHz

1. WBB LMP PARAMETERS

Table 4: Parameters of the WBB LMP providing local area network connectivity in 3.8-4.2 GHz from UK/NOR approach

|  |  |  |
| --- | --- | --- |
| Parameter | Low Power BS | Medium Power BS |
| Bandwidth | 10 MHz to 100 MHz | 10 MHz to 100 MHz |
| Antenna height | Outdoor: Limited to a maximum of 10 m above ground  Indoor: Any height within building | No limit |
| Deployment scenario | Outdoor/indoor  or  Indoor-only | Rural areas only |
| BS Tx EIRP limit  (for AAS & non-AAS) | 24 dBm / carrier for carriers ≤ 20 MHz; or  18 dBm / 5 MHz for carriers > 20 MHz | 42 dBm / carrier for carriers ≤ 20 MHz; or  36 dBm / 5 MHz for carriers > 20 MHz |
| Maximum terminal power | Mobile/nomadic: TRP 28 dBm (Note 2)  Fixed: EIRP 28 dBm (Note 2) | Mobile/nomadic: TRP 28 dBm (Note 2)  Fixed: EIRP 35 dBm/5 MHz (Note 1) |
| Note 1: Higher EIRP limit for fixed terminals in the medium power BS case is to account for the use case of Fixed Wireless Access (FWA)  Note 2: The authorisation of 28 dBm includes a 2 dB tolerance consistent with the European harmonisation. | | |