RRI-EEG Internal

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Simulation results of spherical and conical antennas when placed over lake in Gauribidanur observatory

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Abstract: It is in general known that medium surrounding the antenna if less lossy, the antenna would tend to have more radiation efficiency. In view of this, having water below the antenna is thought to improve the efficiency of a real-earth based antenna. The present report presents the simulation results obtained when antenna is placed over fresh water surface. They results show the effect of water on the return loss and radiation efficiency of spherical and conical monopole antennas in the frequency ranges 50-200 MHz. Simulation has been carried out using WIPL-D electromagnetic simulation software.

1. Introduction:

While using antenna for detecting extremely weak signals, it should be ensured that the medium surrounding it is less lossy. The loss of any medium is governed by the real part of the dielectric constant and the conductivity at a given frequency. Larger the conductivity, less lossy would be the medium. In a similar way, higher conductivity also enhances the loss of the medium. So among two parameters, the equivalent series resistance of the surrounding medium is decided by the factor which is most dominating. So for water, dielectric constant dominates the conductivity. Therefore having water near the antenna instead of real earth would definitely help us minimize the loss of signal due to dissipation The dielectric constant of water is 80 compared 3-5 of dry soil and its conductivity is 0.04 S/m when compared to 0.007 S/m of soil.

$$\mathrm{ESR} = \frac{\sigma}{\varepsilon' \omega^2 C}$$

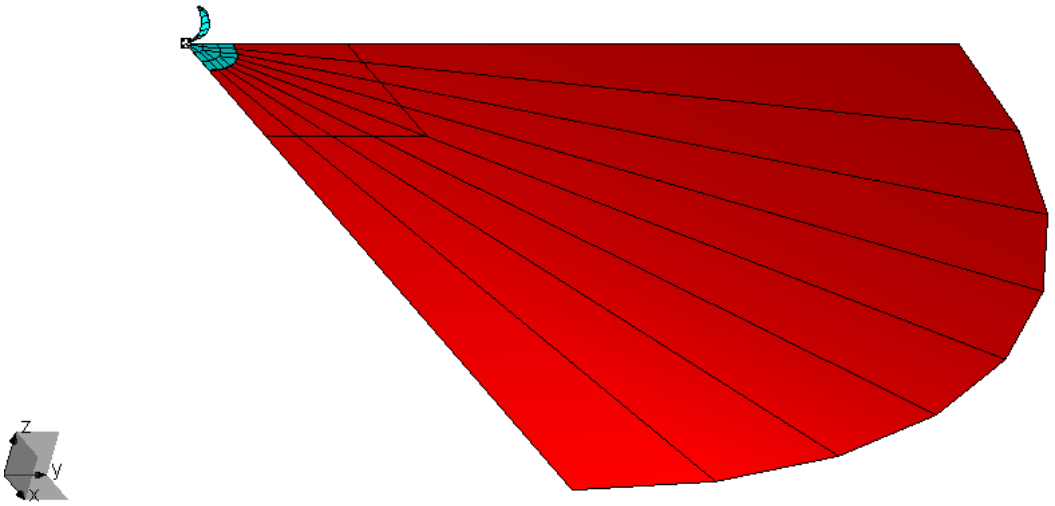
Hence with water beneath the antenna, the radiation efficiency of the antenna could be enhanced. The present report reports simulation results of the radiation and total efficiencies of spherical and conical monopole antennas when placed over fresh water.

2. Motivation:

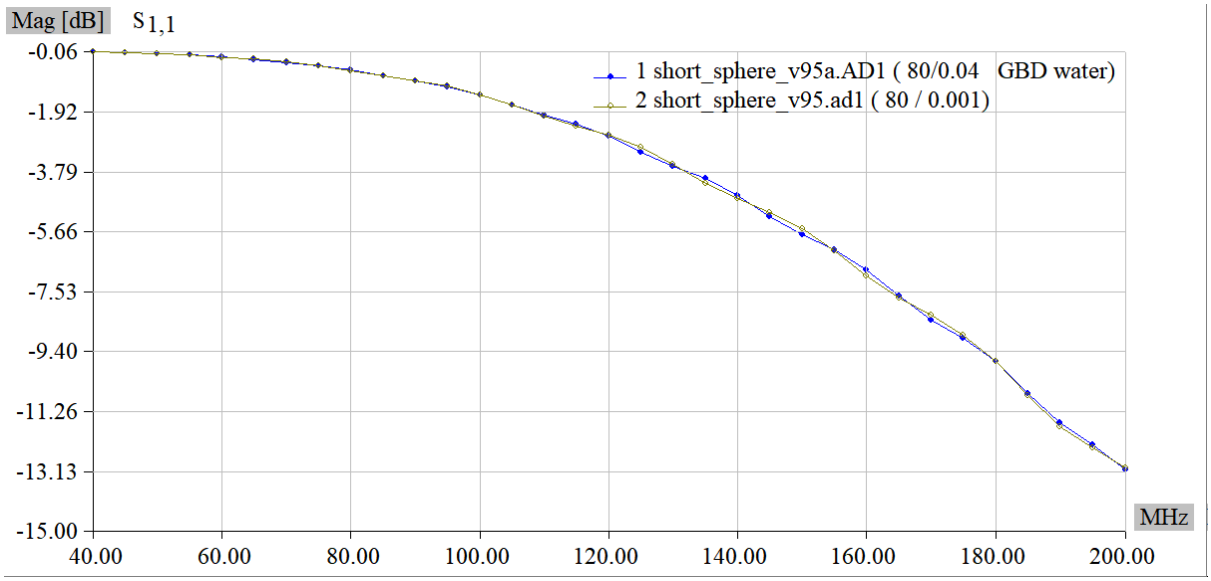
To understand the effect of water on the impedance match and total efficiencies of a given antenna.

3. Simulation of spherical/conical monopole antennas when placed on water having same electrical properties as that found in the Gauribidanur observatory.

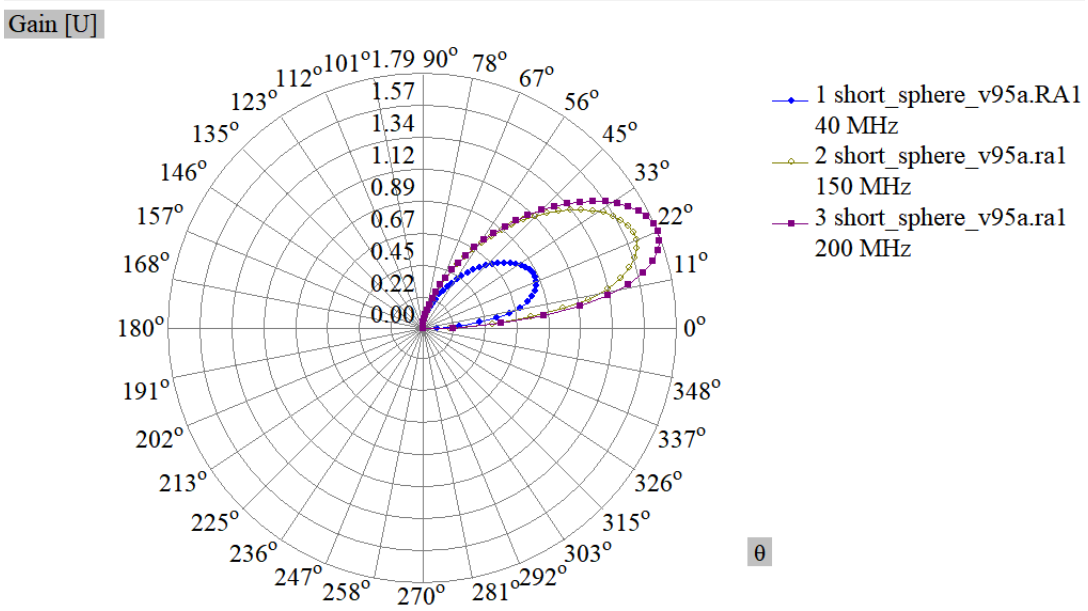
3.1 **Small sphere over GBD ter (ver 95a)**



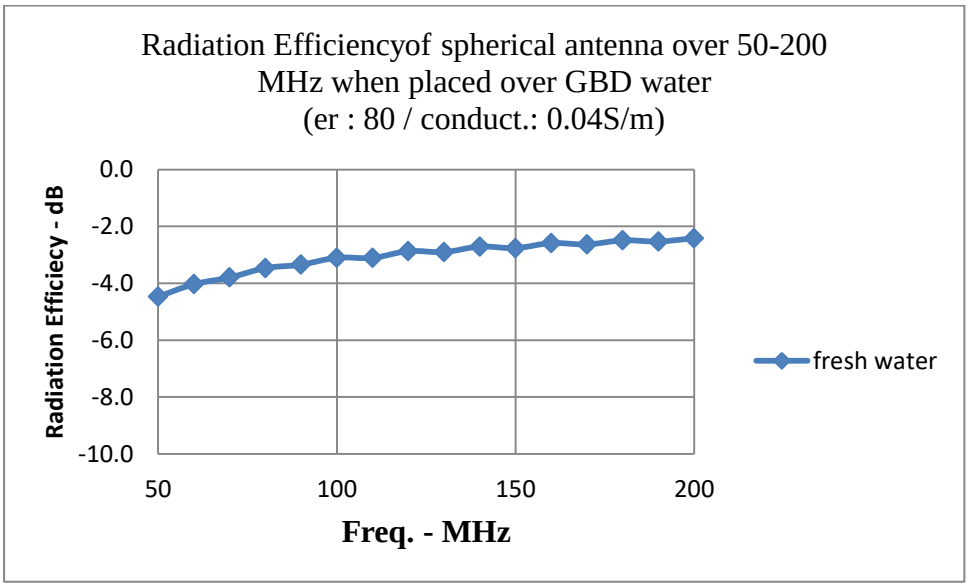
Assumption made about the water below the antenna while carrying out simulation : Radius of water surface : 7200 mm; Radius of reflector : 430 mm; Er = 80, conductivity = 0.04 S/m

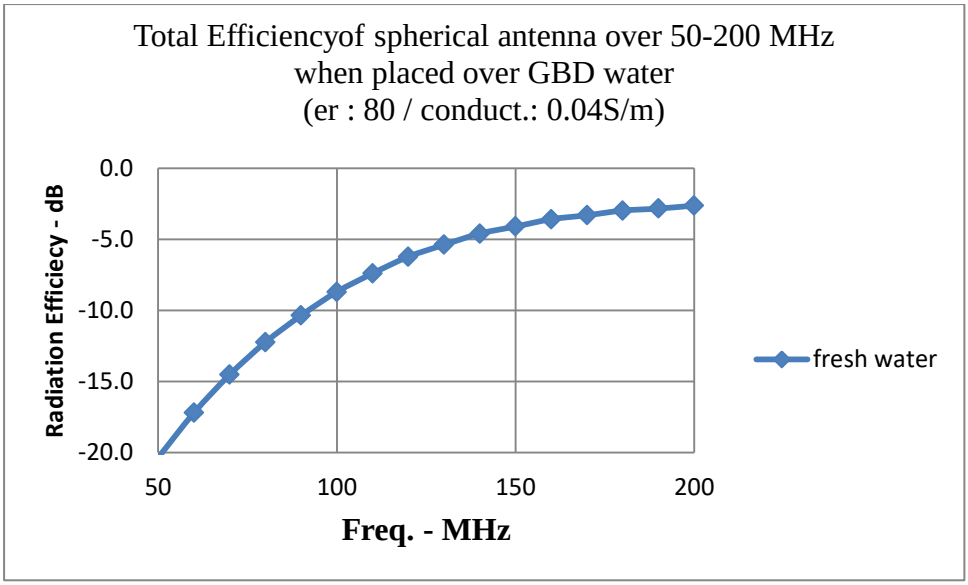


Return loss of antenna

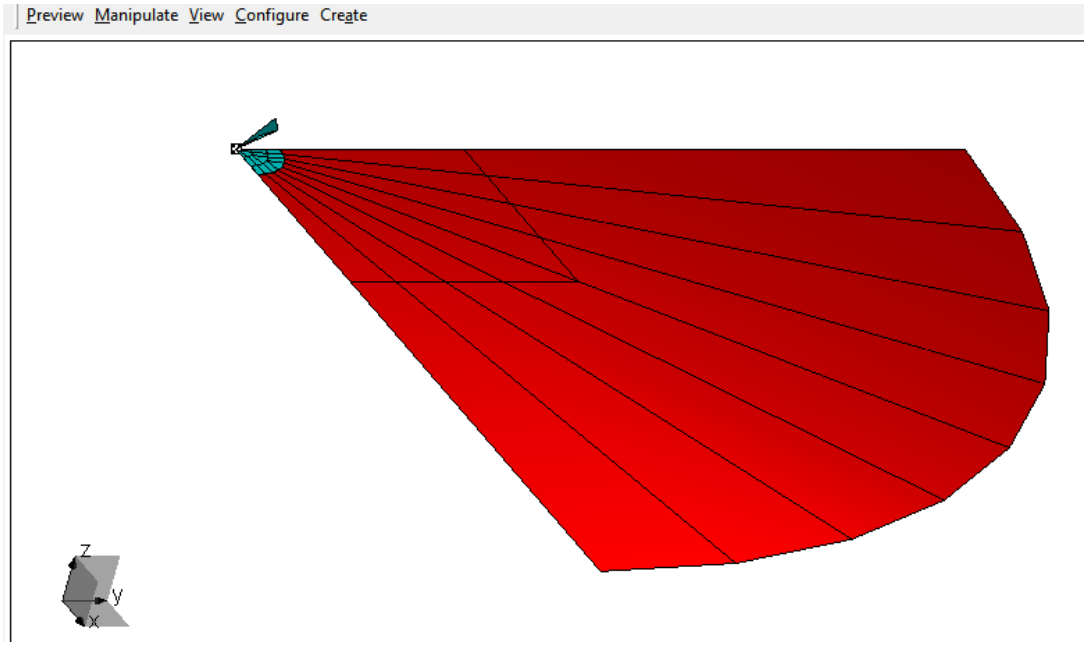


Radiation patterns at various frequencies

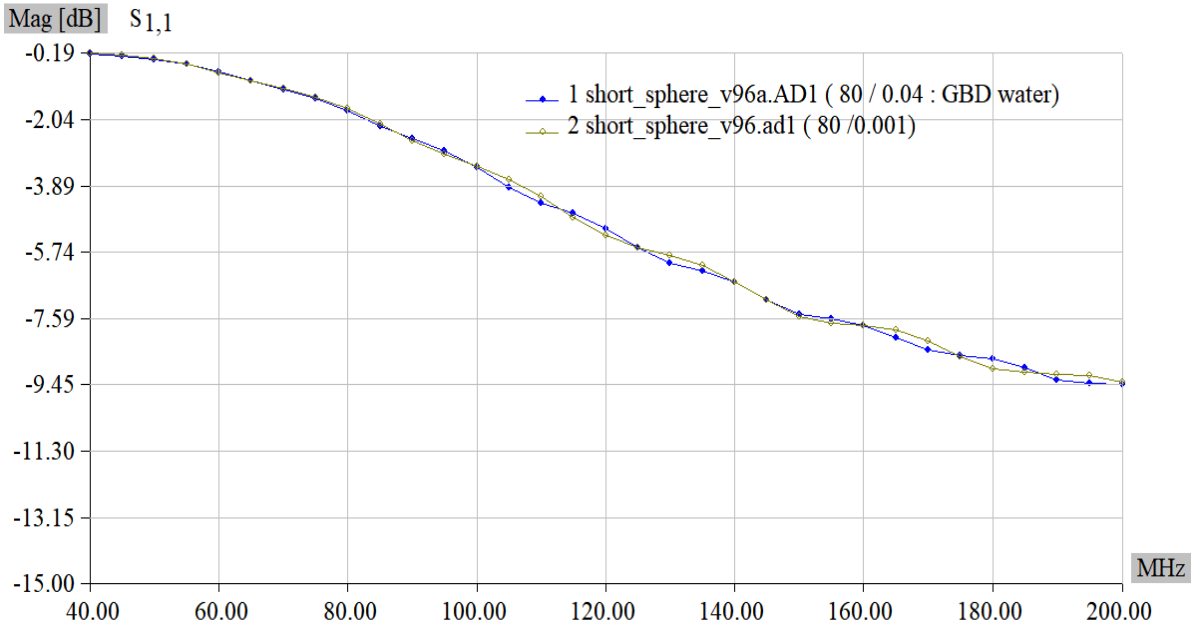


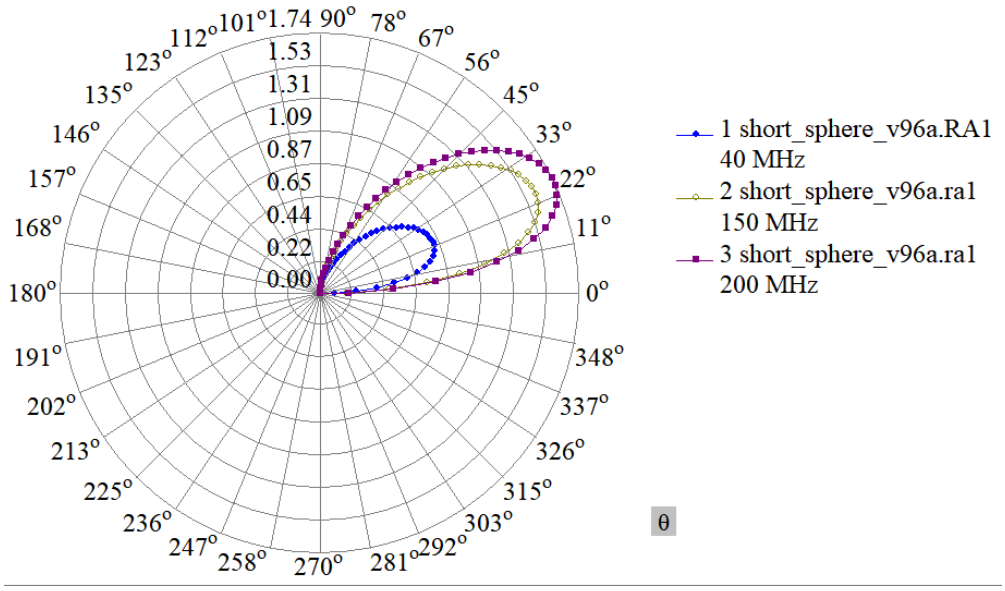


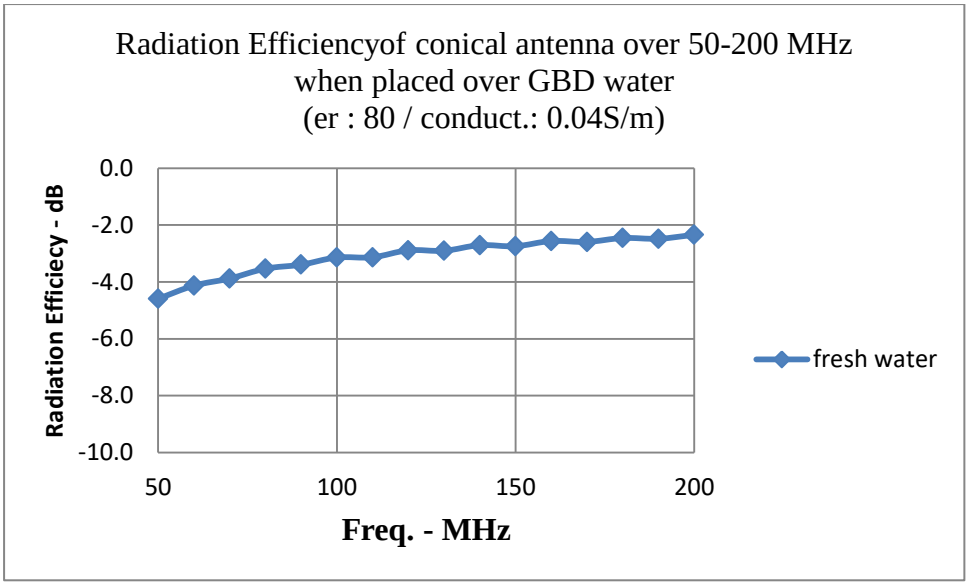
3.2 **Small cone over GBD Water (Ver 96a)**

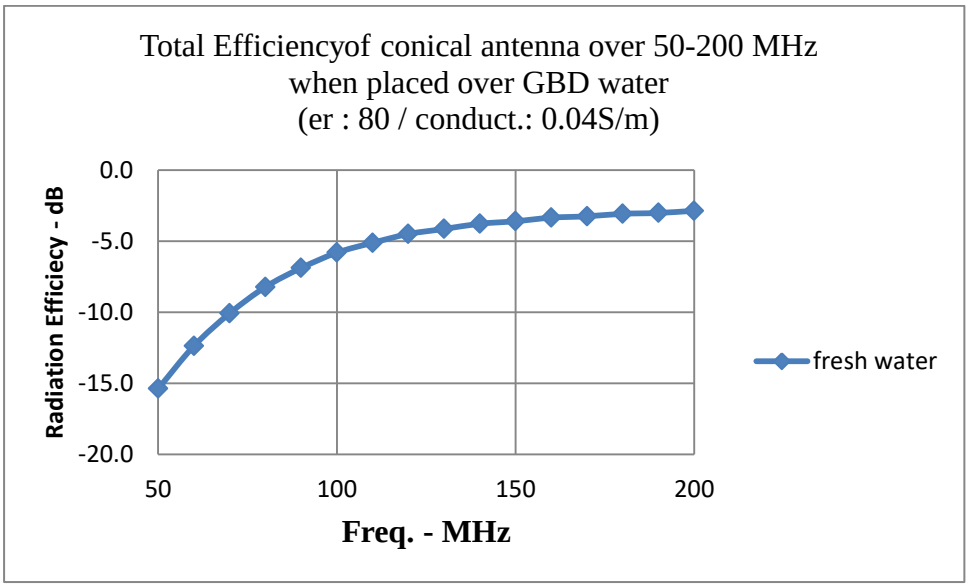


Assumption made about the water below the antenna while carrying out simulation : Radius of water surface : 7200 mm; Radius of reflector : 430 mm; Er = 80, conductivity = 0.04 S/m

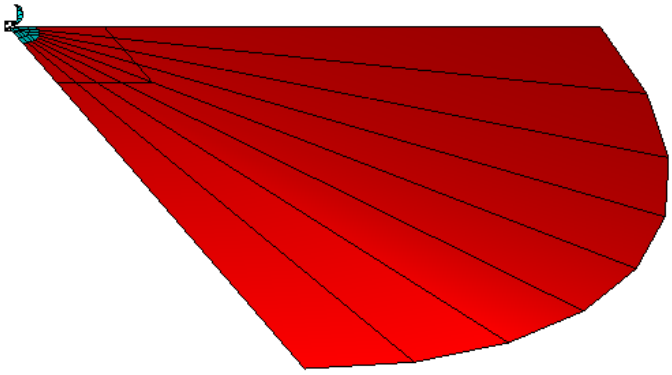

Mag [dB]
S1,1
-0.19
-2.04
-3.89
-5.74
-7.59
-9.45
-11.30
-13.15
-15.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
MHz
1 short_sphere_v96a.AD1 (80 / 0.04 : GBD water)
2 short_sphere_v96.ad1 (80 /0.001)


1.74
1.53
1.31
1.09
0.87
0.65
0.44
0.22
0.00
90°
78°
67°
56°
45°
33°
22°
11°
0°
348°
337°
326°
315°
303°
292°
281°
270°
258°
247°
236°
225°
213°
202°
191°
180°
168°
157°
146°
135°
123°
112°
101°
θ
1 short_sphere_v96a.RA1
40 MHz
2 short_sphere_v96a.ra1
150 MHz
3 short_sphere_v96a.ra1
200 MHz

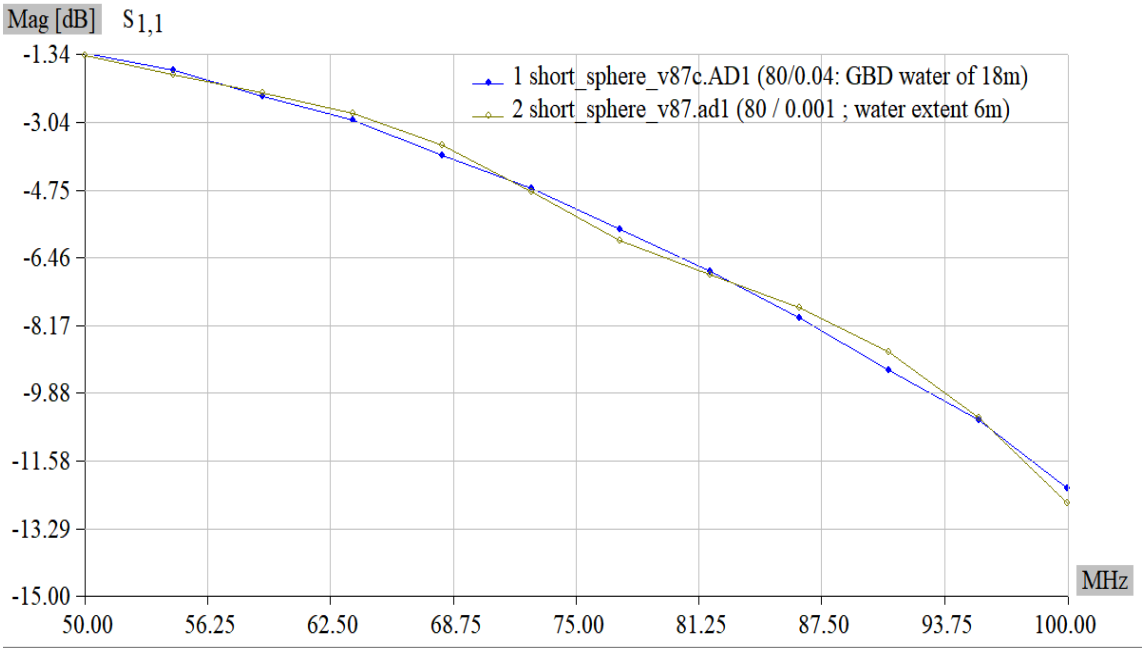


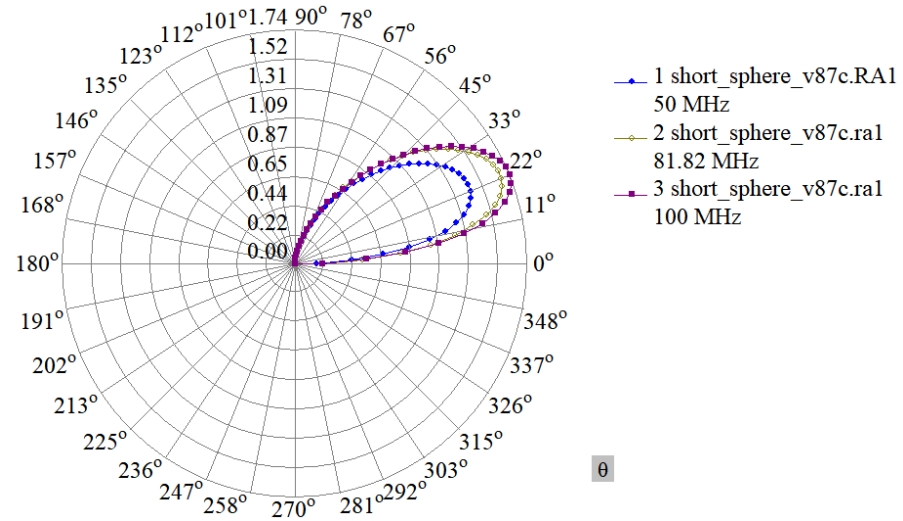


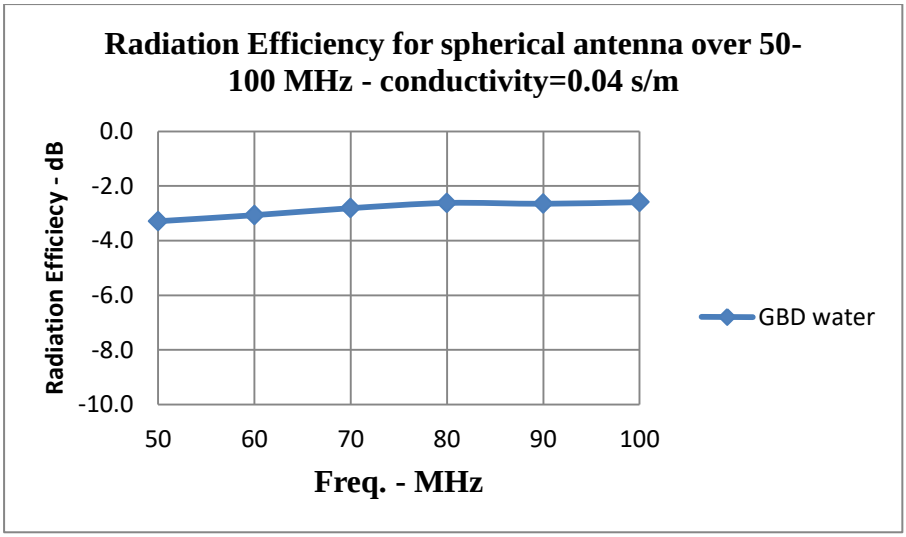
3.3 Big sphere on GBD water (V87c)

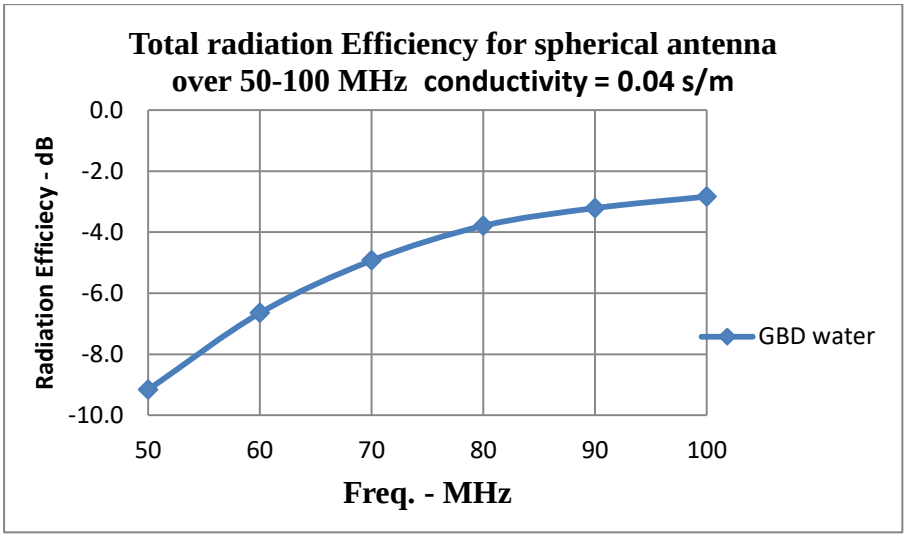


Assumption made about the water below the antenna while carrying out simulation : Radius of water surface : 18000 mm; Radius of reflector : 830 mm; Er = 80, conductivity = 0.04 S/m

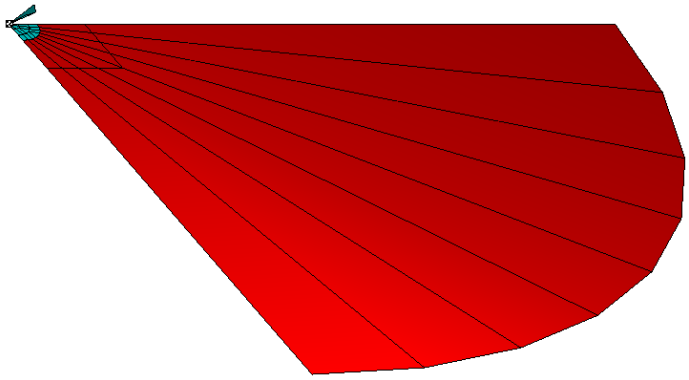

Mag [dB]
S1,1
-1.34
-3.04
-4.75
-6.46
-8.17
-9.88
-11.58
-13.29
-15.00
50.00
56.25
62.50
68.75
75.00
81.25
87.50
93.75
100.00
MHz
1 short_sphere_v87c.AD1 (80/0.04: GBD water of 18m)
2 short_sphere_v87.ad1 (80 / 0.001 ; water extent 6m)


90°
78°
67°
56°
45°
33°
22°
11°
0°
348°
337°
326°
315°
303°
292°
281°
270°
258°
247°
236°
225°
213°
202°
191°
180°
168°
157°
146°
135°
123°
112°
101°
1.74
1.52
1.31
1.09
0.87
0.65
0.44
0.22
0.00
θ
1 short_sphere_v87c.RA1
50 MHz
2 short_sphere_v87c.ra1
81.82 MHz
3 short_sphere_v87c.ra1
100 MHz

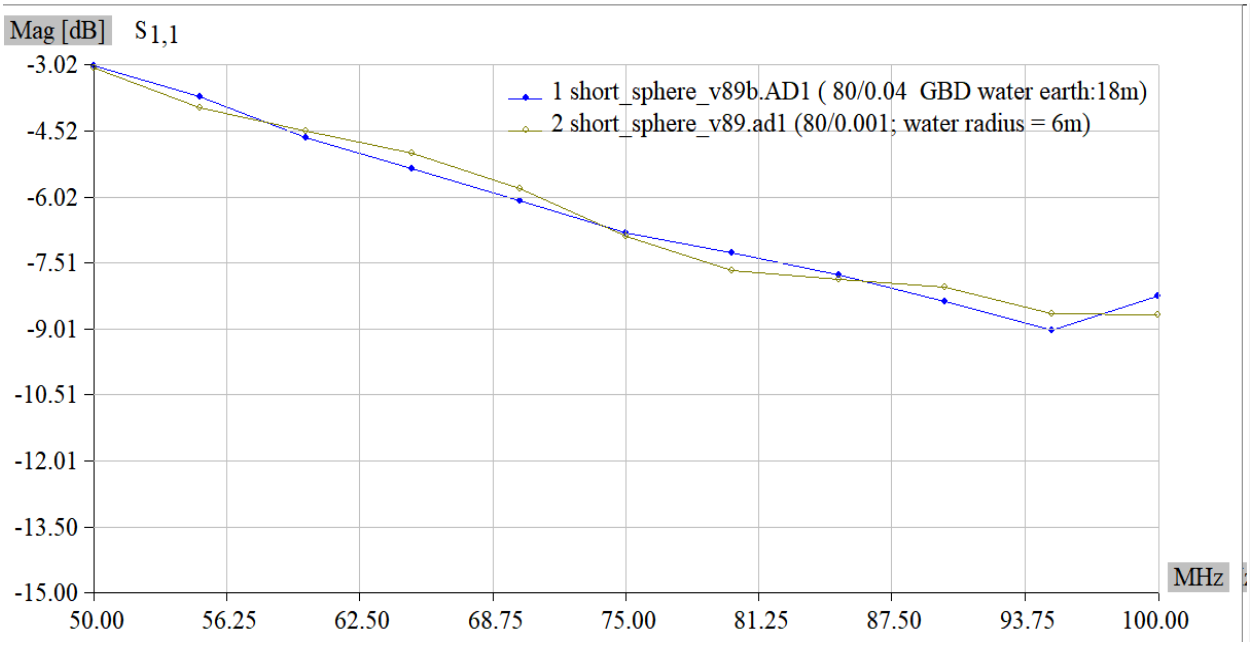


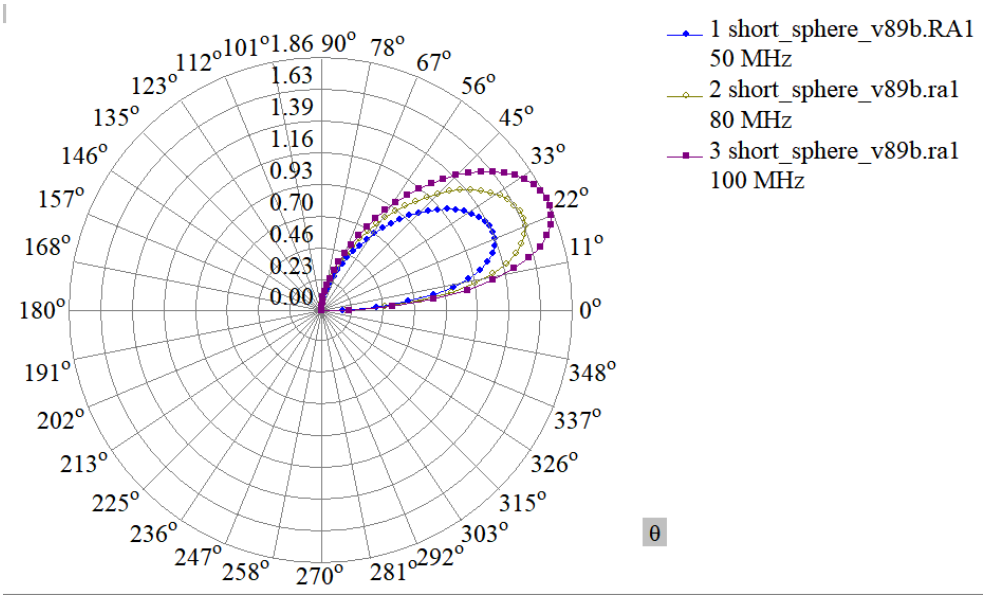


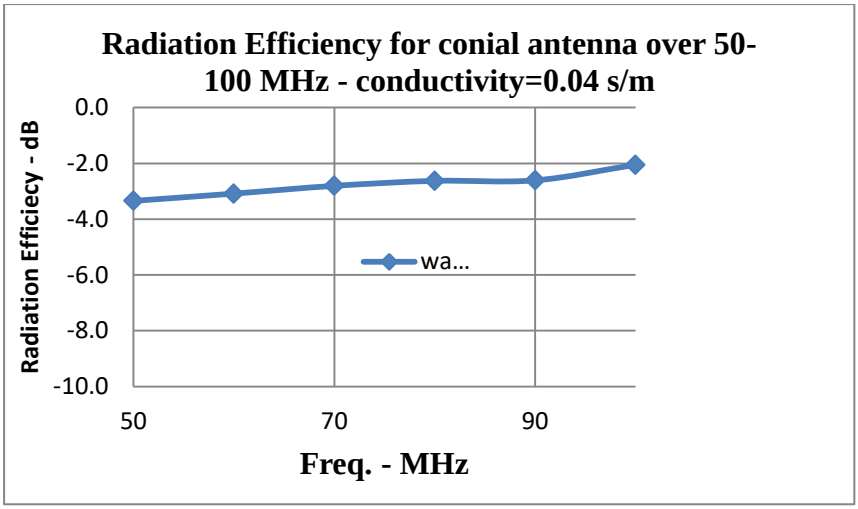
3.4 Big cone on GBD water (ver 89b)



Assumption made about the water below the antenna while carrying out simulation : Radius of water surface : 18000 mm; Radius of reflector : 830 mm; Er = 80, conductivity = 0.04 S/m


Mag [dB]
S1,1
-3.02
-4.52
-6.02
-7.51
-9.01
-10.51
-12.01
-13.50
-15.00
50.00
56.25
62.50
68.75
75.00
81.25
87.50
93.75
100.00
MHz
1 short_sphere_v89b.AD1 (80/0.04 GBD water earth:18m)
2 short_sphere_v89.ad1 (80/0.001; water radius = 6m)


1.86
1.63
1.39
1.16
0.93
0.70
0.46
0.23
0.00
90°
78°
67°
56°
45°
33°
22°
11°
0°
348°
337°
326°
315°
303°
292°
281°
270°
258°
247°
236°
225°
213°
202°
191°
180°
168°
157°
146°
135°
123°
112°
101°
θ
1 short_sphere_v89b.RA1
50 MHz
2 short_sphere_v89b.ra1
80 MHz
3 short_sphere_v89b.ra1
100 MHz



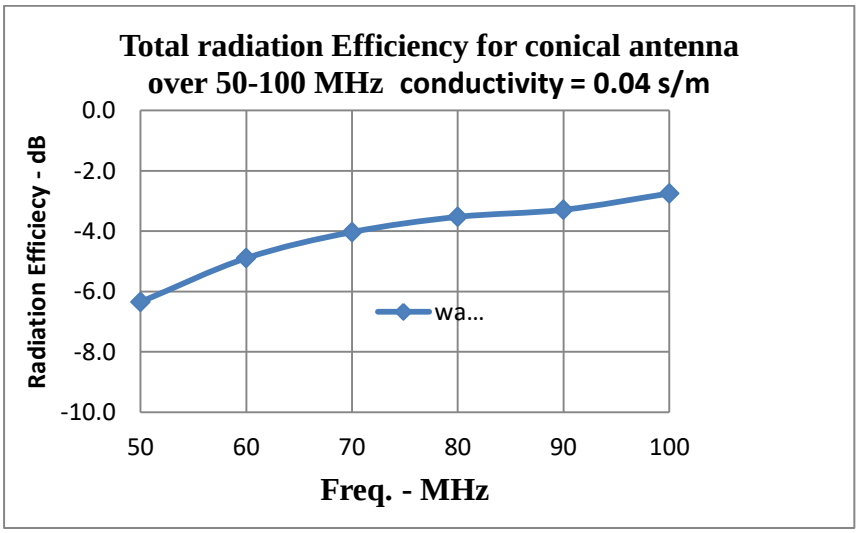


Table :

Sl. No.	Antenna	Rad. Eff. GBD water 80/0.04	Rad. Eff. Fresh water 80/0.001	Tot. Eff. GBD water @ 50 MHz	Tot.Eff. Fresh Water@50MHz
1.	Small sphere	-4.4	-4	-20	-20
2.	Small cone	-4.59	-4	-15	-15
3.	Big sphere	-3.3	-3.5	-9.16	-9
4.	Big cone	-3.3	-3.5	-6.35	-6.5

4. Conclusions

Simulation indicates that keeping the antenna over the water surface definitely improves its radiation efficiency since loss is minimized. For the kind of water found in Gauribidanur, total efficiency spans from -20 dB to -9 dB for the sphere and -15 dB to -6.5 dB for the cone.