The benefit of simple benchmarks to highlight problems in CEM codes

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Computational electromagnetics (CEM) has become an accepted method to help design practical electromagnetic structures. Testing CEM codes is often done using standardized benchmarks. Benchmarks that represent practical problems, yet are simple enough to avoid modelling uncertainties, can often highlight software or formulation errors. Analytical solutions are not always available for benchmark problems that are more complicated than standard canonical problems and measurements come with its own complications. For these types of problems, it is very valuable to compare results obtained through different computational methods both to build confidence in results obtained but also to highlight differences between methods.

In this paper canonical benchmarks such as the multilayer dielectric coated cone-sphere example in JINA2008 will be presented. The particular benchmark shown here is constructed using a sphere joined by a cone. The cone-sphere is defined as in Figure 1 by the angle α and the radius r. Here a central PEC cone-sphere with $r_0 = 0.7\text{m}$ is surrounded by a dielectric cone-sphere with $r_1 = 0.74\text{m}$, $\varepsilon_r = 1.5 - 0.1i$ and $\mu_r = 2.5 - 1.8i$. These two cone-spheres are surrounded by a final cone-sphere with $r_2 = 0.745$ m, $\varepsilon_r = 4$ and $\mu_r = 1$. The monostatic RCS is computed at 1 GHz in the $\theta = 90$ plane for $\phi \in [0,180]$.

For this example reflection is expected from the tip of the cone-sphere, the junction of the cone and the sphere and creeping waves around the sphere. Scattering from the sharp tip is expected to be small, as well as from the smooth junction between the cone and sphere due to the perfect tangent. Creeping waves going around the sphere will be suppressed due to the high dielectric losses. This is particularly true for an incident field on the major x-axis ($\theta = 90, \phi = 0$). It will be shown that simple examples such as these can still lead to valuable insights about code performance and correctness.

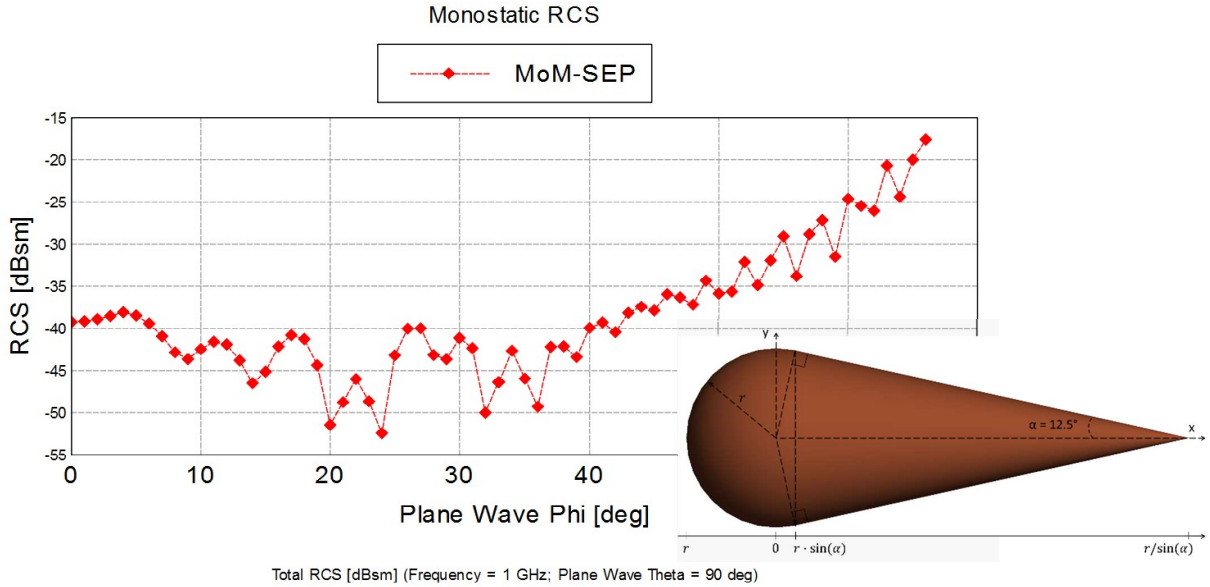

Figure 1: JINA2008 cone-sphere benchmark, geometry and results calculated using Altair FEKO.