Gaussian Radial Boundary

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November 24, 2015

1 Introduction

Field solvers often have problems at the simulation radial boundaries, and this can lead to the generation of pseudo-modes. While these are a problem, they are even more of a problem in nonlinear simulations, as they can feed back to particles near the radial boundaries and exacerbate particle loss. Thus, mitigating these effects is important. Here, a Gaussian function is implemented to alleviate this problem.

Let A(i) be any radial mesh defined quantity, where i ranges from 0 to N, and let $nbound$ be the number of radial points where A will be suppressed, in buffer regions, inside of the left and right radial boundaries. Then, for whole number $j = [0 \ \ (nbound - 1)]$,

$$A(j) = A(j) \cdot exp\big[-\frac{1}{2}(\frac{j-(nbound-1)}{\sigma})^2\big], \tag{1}$$

for the inner radial boundary, and

$$A(N-j) = A(N-j) \cdot exp\big[-\frac{1}{2}(\frac{j-(nbound-1)}{\sigma})^2\big], \tag{2}$$

for the outer radial boundary, where

$$\sigma = \frac{(nbound - 1)/2}{2\sqrt{2ln2}}, \tag{3}$$

When, $j = \frac{3}{4}(nbound - 1)$, $A(j)$ becomes $0.5A(j)$. The advantage of using a Gaussian function, is that the radial derivative of A remains continuous.