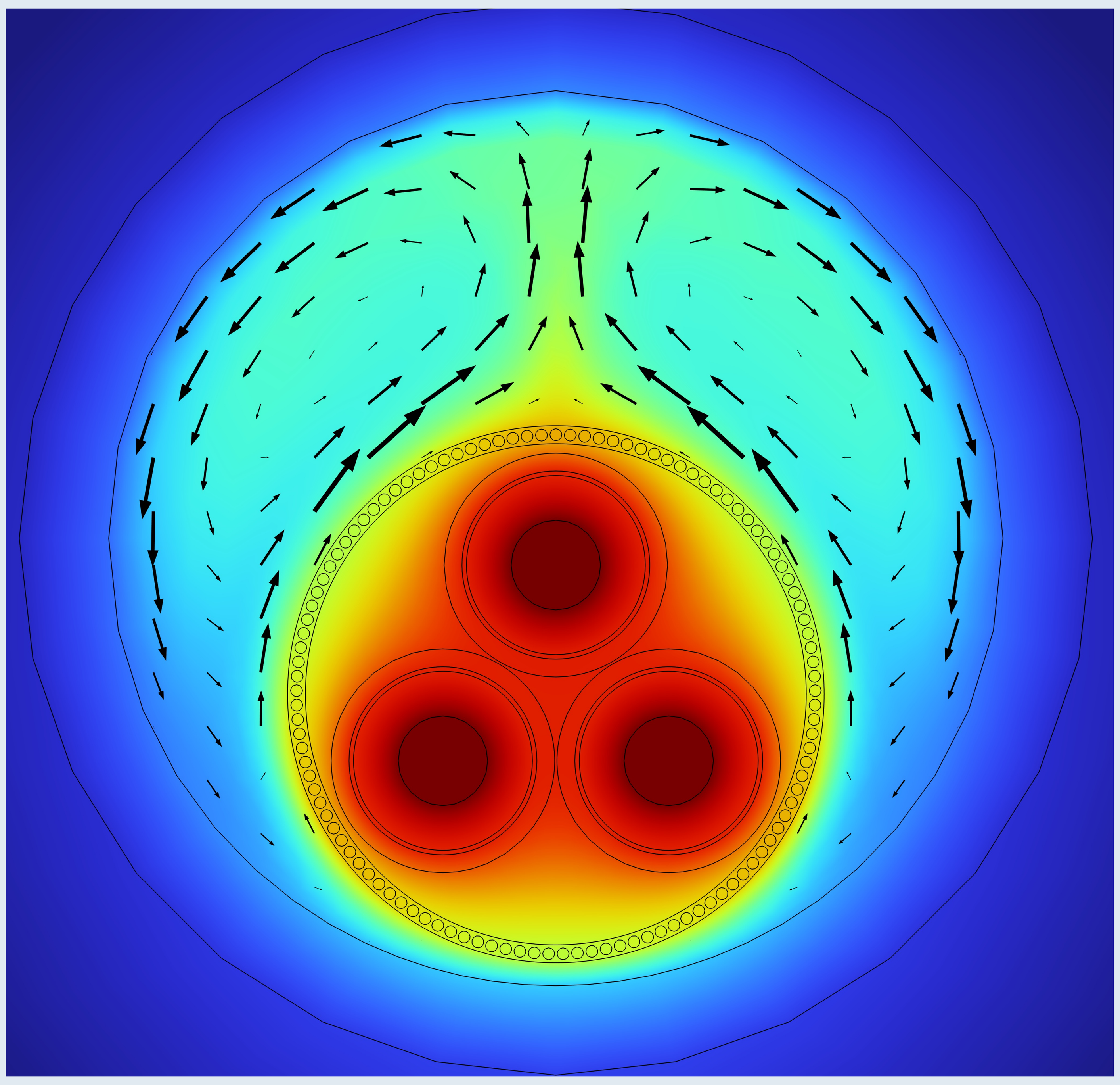

Taking a Detailed Cross Section out of a 3D Model

Increase performance and accuracy by simulating the cross section in a separate 2D model and couple it to the remaining 3D model.

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Abstract

Splitting a 3D model into two coupled components can increase performance. (Ref. 1). Two offshore applications are presented, but the approach is general: crossing of cable ducts in ground and a cable in a J-tube. The hot spot temperature in the power cables should not damage the insulation.

The detailed cross section is simulated in a separate 2D model. A similar approach for a straight twisted cable splits the cable itself into a 3D model and a detailed 2D cross section. (Ref. 2). Our method works for any routing of a constant cross section in a 3D environment.

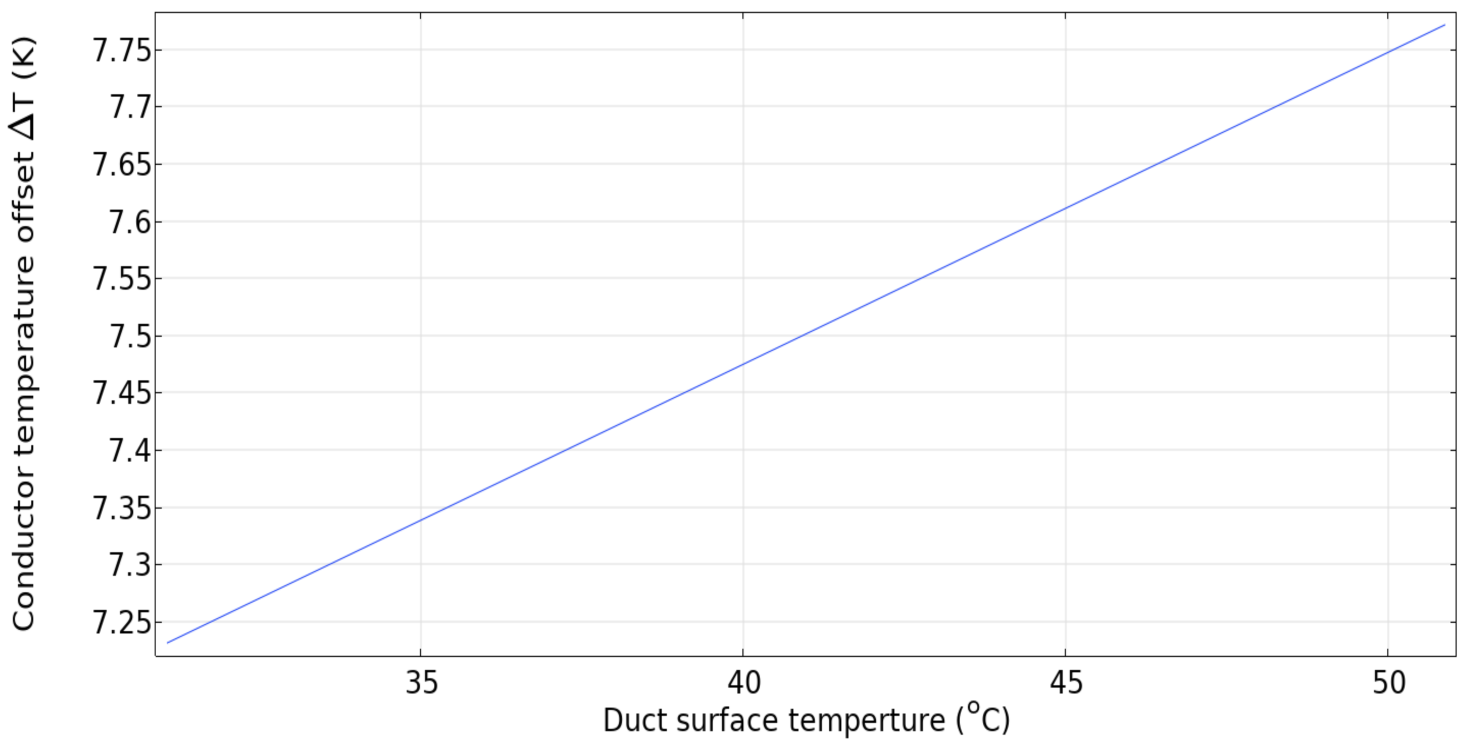

FIGURE 1. Temperature offset of conductor compared to duct surface.

Methodology

A temperature sweep on the constant 2D cross-section yields the offset ΔT of the conductors compared to the duct surface temperature that varies in 3D. The temperature coefficient of copper α_{Cu} increases the losses q. In the 3D model the cable ducts are replaced by a surface boundary condition for the heat flux:

$$q = q_0\left(1 + \alpha_{Cu}(T_{duct} + \Delta T - 20°\mathrm{C})\right)$$

The J-tube geometry is simple enough to allow for direct coupling of temperature and heat flux by probes.

Results

Figure 2 shows the simulated temperature in ground and the hot spot in the cable. The results of the conventional 3D model are 1 K to 2 K lower because of axial heat flux. The segregated model consumes about 2.5% of the memory and is 20 times faster. As opposed to the single 3D model, it can be simulated in full multiphysics, which is more reliable. The title image was done by the segregated model with electromagnetic heat losses and natural convection of air.

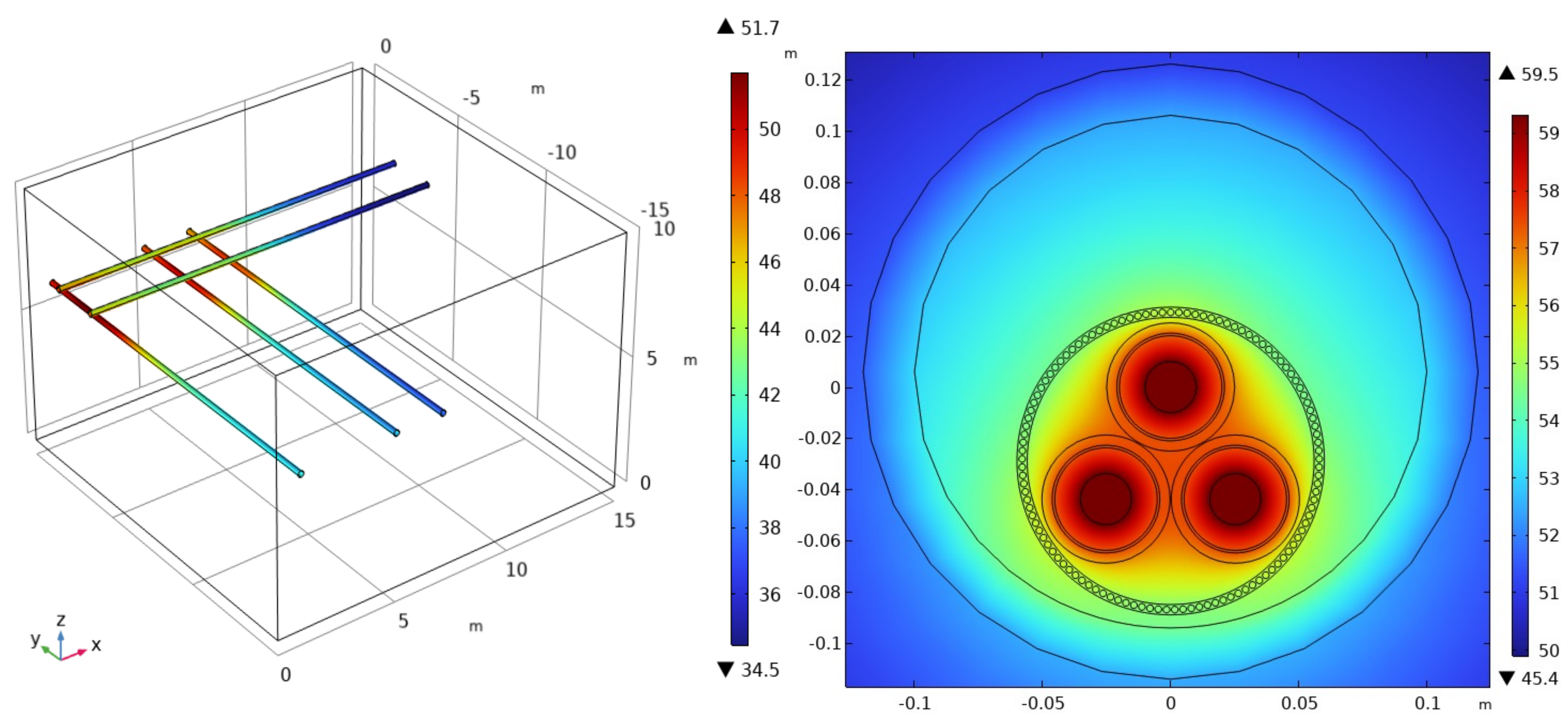

FIGURE 2. Left: Ducts temperature. Right: Cable hot spot temperature at (1 m, -2 m, 6 m) .

REFERENCES

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