



**Figure 14.** Wake loss ((a) and (b)), annual energy loss ((c) and (d)), and annual energy improvement ((e) and (f)) in each direction for both the high-TI ((a),(c), and (e)) and low-TI ((b), (d), and (f)) cases for both the base layout (Fig. 6) and the optimized layouts (Fig. 9).

our gradient-based optimization methods, and described the SOWFA setup used to produce the LES results that we used to check the model and optimization results. We found that the individual turbine predictions based on the models had errors up to 28% as compared to our SOWFA simulations. The directional and AEP errors were much less, up to only 7.7% and 6.9%, respectively. The model predicted an improvement in AEP of 7.7% for the high-TI case, while SOWFA predicted 9.3%. For