In order for well informed decisions on future climate policy to be be made, it is necessary to simulate the future behaviour of the climate system for a wide range of future emissions scenarios covering the full range of uncertainty in future anthropogenic emissions. While much recent attention has been devoted to very low emissions future, the potential for very high emissions has not been thoroughly explored. We specify a range of illustrative emissions scenarios that are significantly higher than the A1FI scenario, the highest scenario considered in past IPCC reports, and simulate them in the Community Earth System Model. Our analysis finds that the effective climate sensitivity of the model is greater at very large carbon dioxide concentrations, and that patterns of regional change cannot be linearly scaled for some extreme scenarios. Relative to the A1FI scenario, our highest scenario results in an additional 2K of global mean warming above A1FI levels by 2100, a complete loss of arctic summer sea ice by 2070 and an additional 43% sea level rise due to thermal expansion above A1FI levels by 2100. Regional maximum temperature increases from late 20th century values are 50-100% greater than A1FI increases, with some regions such as the Central US, the Tibetan plateau and Alaska showing 300-400% increase above A1FI levels.