Effects of Climate Change on Radio-Wave Propagation
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Without corrective action, the next 50-100 years will likely see an additional 2-4 degrees Celsius rise in global temperature above current levels (IPCC AR6 2021). This in turn is likely to increase the intensity and frequency of droughts, heatwaves, and flooding. Given their humanitarian impact, these are the most pressing effects to quantify. But there are also "second order" effects that have not yet been examined. Here, we ask whether climate change will have any discernable impact on radio frequency (RF) propagation through the lower atmosphere.

Environmental factors that affect RF propagation include: water vapor content and vertical distribution; rain rate; sea-surface temperature (SST) and its role in evaporation ducting; and aerosol content. Such factors play a role in system design, e.g., in deciding between candidate RF bands. This is especially true of maritime RF systems, and for higher frequencies (mmW) which are more sensitive to environmental factors.

Climate researchers understand the future trajectory of some environmental factors, while others are still uncertain. We avoid uncertain factors here, like rain rate and vertical profiles of moisture, to instead focus on surface-level water vapor content and SST. Hence, this is not a complete picture. It must be updated as climate science improves. In particular, follow-on analysis is required as future rain-rate trends become better understood.

To assess the impacts of changing water-vapor content and SST, we obtained climate-model predictions for various future emission scenarios. 3-hourly time series of meteorological quantities were then run through evaporation duct height (EDH) and transmission loss models to generate time series of RF-propagation-relevant quantities. The resulting time series were then analyzed to obtain trends versus time for the various emission scenarios.

The trends we found are slight. RF systems that perform across geographic, seasonal, and diurnal changes will find climate-induced changes well within their design space. However, the changes are large enough that they should be considered in setting link-budget and detection margins of any new RF system. This was somewhat unexpected. Engineers tend to take the environment as a static factor. Our results jostle that notion, further emphasizing the fact that humanity is impacting earth's climate in unprecedented ways.