

# **TESTING CLIMATE MODELS USING GNSS OCCULTATION AND INFRARED RADIANCE SPECTRA**

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In the succession of IPCC Scientific Assessments on global warming, the predictions of climate change when subjected to greenhouse forcing has retained about the same level of uncertainty. In business as usual scenarios, surface air temperature is expected to increase by anywhere from 1.5K to 4.5K after a doubling of carbon dioxide. If society is to have a credible tool in climate models to assist in developing strategies to address climate change, the range of uncertainty in decadal scale climate prediction must improve. The only way this can practically be accomplished is in conjunction with testing against data. One way to test against data is to validate trends produced by climate models against measured trends. It takes a significant amount of time for such trends to emerge, and most traditional data types are not sufficiently accurate to produce reliable trends. In answering this problem, climate benchmark data types - wherein the observable is directly traceable via multiple calibration pathways to the international standards on-orbit - are proceeding to the fore in climate sounding. GNSS radio occultation is one such data type. A carefully designed interferometer spectrometer is another such data type. When considered together, the two can be used to constrain radiative forcing of the climate system, the blackbody response of the surface, and longwave feedbacks internal to the climate system. The role of GNSS radio occultation is to constrain the temperature response, and it does so most sensitively by measuring poleward motion of the mid-latitude jets. The role of infrared radiance spectra is to constrain the feedbacks and radiative forcing. In some cases, the first useful tests can be performed with a ten-year timeseries. In other cases, one must wait for several decades. Both GNSS occultation and infrared radiance spectra are two critical components of the Climate Absolute Radiance and Refractivity Earth Observatory (CLARREO), a prototype mission to benchmark the climate system for the purpose of testing climate models by trend detection. It is the highest priority recommendation of the U.S. National Research Council produced as part of its decadal survey of the National Aeronautical and Space Administration and the National Oceanic and Atmospheric Administration.