Passive Infrared Retrieval of Tropospheric Refractivity, Temperature, and Water Vapor Profiles

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Passive atmospheric remote sensing is often accomplished in the microwave and millimeter wavebands. The terahertz frontier between millimeter wave and far infrared has not been developed because of technological challenges with detectors and other hardware. Receivers and imagers in the infrared wavebands, however, are quite well developed and offer low NEDT (~30 millikelvins) megapixel images at frame rates of tens of Hz

We present a new method of tropospheric profiling. By processing 8 to 14 micron passive images of the oceanic environment and processing the vertical blackbody temperature structure in the images, resolute refractivity, temperature, and water vapor profiles and the height of the evaporation duct over the ocean can be retrieved. In contrast to the microwave radiometers with antenna beamwidths of several degrees, the IR cameras have pixel widths of several milliradians, allowing ray tracing through the structure of refractivity of the troposphere at a myriad of elevation angles. Electromagnetic fluxes in this IR waveband at atmospheric temperatures are about 10^8 as intense as in the microwave region. This serves to better resolve the complex structure of profiles, especially of water vapor.

We present infrared images of the oceanic horizon over the Persian Gulf and from the coast of Southern California overlain with blackbody isotherms. We also present modeled Artificial Neural Network retrievals of refractivity, temperature, and water vapor based on thousands of radiosondes processed through an artificial neural network approach. These are compared with several typical K-Ka band microwave radiometer retrievals of water vapor profiles.

We also compare performance features of the microwave technologies against this infrared technology for tropospheric thermodynamic profiling.

Refractivity in the sea-atmosphere interface is of high interest to our Navy as it causes ducting of electromagnetic propagation over long distances and can also cause blindness of the horizon, Refractivity is a function of frequency. The retrievals in the above IR waveband do not represent refractivity in other wavebands, but in knowing the temperature and water vapor profiles over the ocean, the refractivity can be modeled into all wavebands.