

A Novel Microwave Radiometer for Assessment of Atmospheric Propagation Conditions for 10 and 90 GHz Frequency Bands

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Today's world depends on accurate communication between the Earth and satellites. Communication, navigation and signal transmission are performed by the exchange of electromagnetic radiation between satellites and ground stations. Scientific experiments, performed in outer-space and missions to investigate other planets, are dependent upon high-precision transmission of data to receivers on Earth, passing through the atmosphere which is a big source of disturbance.

Frequency bands between a few GHz and several tens of GHz are frequently used for space transmissions. Propagation and attenuation at these frequency bands are influenced by dry air as well as by water vapour and liquid water. An urgent issue for data transfer by microwave transmissions is the knowledge of these atmospheric parameters. Stable measuring instruments (radiometers), probing water vapour and cloud liquid water, are necessary to measure the wide range of (often turbulent) weather conditions. Passive sensors, which do not influence data transmissions, are preferred. Such a precise and stable microwave radiometer has been developed, it is called *Atmospheric Propagation and Profiling System* ATPROP.

ATPROP is able to detect tropospheric profiles of humidity and temperature as well as the integrated humidity. Using elevation scans, high resolution boundary layer temperature profiles can be measured. The possibility of elevation scans as well as azimuth scans enables the three dimensional detection of inhomogeneities in clouds and water vapour. The beam can also be targeted on every specified satellite position. For the application of satellite ground stations, retrieval algorithms for calculation of dry and wet path delay and attenuation at different frequencies have been developed and implemented.

The radiometer provides 7 channels on the water vapour- (K-Band) and 7 channels on the oxygen line (V-Band) for detection of humidity and temperature profiles (similar to **Humidity and Temperature Profiler** (HATPRO)). Two additional channels have been added within Ku-band (near 15 GHz) and W-band (near 90 GHz). The 90 GHz channel enhances the detection of cloud liquid water and (compared to HATPRO) improves the detection of clouds with lower liquid water path. The 15 GHz channel is favourable for detecting the onset of preprecipitation and quantity of rainfall for most conditions except the heaviest rain events.

The intensity and phase delay of the satellite transmission depends on atmospheric fluctuations as well as technically factors such as orbit instabilities of the spacecraft or thermally driven antenna distortions, etc. These technically related issues extend to time scales of thousands of seconds. Technical and atmospheric causes have to be separated from each other. This demands a radiometer with high stability and low drift on comparable time scales which will be tested by Allan Standard Deviation methods.

During the testing phase the radiometer was checked for stability under laboratory conditions. Under these conditions it obeys the radiometer formula up to 10^4 seconds. Measurements of water vapour, liquid water, path delay and attenuation at different frequencies have been performed under outdoor conditions. At the moment ATPROP is deployed in Cabauw / Netherlands (KNMI). Comprehensive results of the testing phase will be presented as well as the first results from the Cabauw field measurements.