Optimum Retrieval Techniques in Remote Sensing of Atmospheric Temperature, Liquid Water, and Water Vapor

by

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ABSTRACT

In recent years a number of satellite platform remote sensors have been launched for the purpose of inferring atmospheric temperature, liquid water, and water vapor. One problem in the area of remote sensing of these parameters is the method of parameter retrieval because of the non-linear effects of the physics involved and the non-stationary nature of the data fields. This thesis applies the techniques of modern recursive estimation theory (Kalman-Bucy filtering) to the problem of estimating these parameters from data produced by the SCAnning Microwave Spectrometer (SCAMS) carried on the NIMBUS 6 satellite. Two primary experiments were conducted in this thesis. The first was the design and implementation of an extended Kalman-Bucy filter for estimation of vertical temperature profiles. The filter of this experiment was operated in three modes: a causal mode, a non-causal mode and a precomputed parameter mode. The second experiment was the design and implementation of an extended Kalman-Bucy filter for estimation of liquid water and water vapor columns in the atmosphere.

The conclusions reached from the results of these experiments are: The Kalman-Bucy filter is a valuable method for estimation of the state of the earth's atmosphere based on passive remote observations. The estimates of temperature profiles obtained with a causal filter show an improvement in accuracy over those obtained with a regression inversion technique. This improvement is greater with a non-causal filter. The use of either precomputed gain or error covariance matrices in the Kalman filter produces little degradation in the accuracy of the retrieved profiles, but produces a substantial reduction in the computation burden of the filter. The use of an extended Kalman filter in retrievals of liquid water and water vapor shows a factor of three improvement over a regression inversion in a simulation of the data observed by SCAMS.

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