TEMPERATURE PROFILE RETRIEVALS WITH EXTENDED KALMAN - BUCY FILTERS

W. H. Ledsham and D. H. Staelin

Research Laboratory of Electronics and the Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, U.S.A.

ABSTRACT

The Extended Kalman-Bucy Filter is a powerful technique for estimating non-stationary random parameters in situations where the received signal is a noisy non-linear function of those parameters. A practical causal filter for retrieving atmospheric temperature profiles from radiances observed at a single scan angle by the Scanning Microwave Spectrometer (SCAMS) carried on the Nimbus 6 satellite typically shows ∿ 10-30% reduction in rms error about the mean at almost all levels below 70 mb when compared with a regression inversion.

DISCUSSION

Over the years, the field of passive remote sensing has seen the introduction of many techniques for retrieval of a set of geophysical parameters given a set of observed radiances. These methods have included various statistical and non-statistical approaches such as the statistical D method [1], the minimum information technique [2], the empirical eigenfunction method [3], and various relaxation techniques.

One common aspect of all these approaches is that they are point methods. That is, they produce estimates of the parameters based on data taken at only one space/time instant. Since many geophysical parameters exhibit coherence in both space and time, observations that are "close" to the point being inverted contain significant information about the geophysical state of that point. One method for utilizing such information is that of Kalman-Bucy filtering.

The purpose of this paper is to describe the experimental application of Kalman-Bucy filtering to remote sensing of atmospheric temperature and humidity fields by means of an orbiting passive remote sensor. This algorithm provides statistically optimum processing of a sequence of linear observations of a field of Gauss-Markov variables. Forms of the algorithm which account for non-linear observations include the Extended Kalman Filter or the Iterated-Extended Kalman Filter. The general theory of the Kalman filter is well represented in the literature [4]-[7]. A specific exposition of the theory in the context of passive remote sensing is given in [8].

The flow of the Extended Kalman Filter is diagrammed in Fig. 1. The algorithm begins by requiring an *a priori* value for the vector of parameters to be estimated, $X_i(-)$, and an error covariance, $P_i(-)$, of this prior at the current time i when