P5.26

CORRELATED NOISE MODELING FOR SATELLITE RADIANCE SIMULATION

Thomas J. Kleespies *
David Crosby
NOAA/NESDIS, Camp Springs, Maryland

1. INTRODUCTION

This work is motivated by an Observing Systems Simulation Experiment in which NESDIS is collaborating with NCEP/EMC and the NASA Data Assimilation Office. The immediate goal is to determine the incremental improvement on the forecast of a Doppler Wind Lidar instrument over present day observing systems. In order for the current satellite instruments to be accurately simulated, it is necessary to model instrument noise, both independent and correlated. This paper presents such a method, and notes a high level of correlation in the inter channel noise in one of the High Resolution Infrared Sounder (HIRS) instruments.

2. METHODOLOGY

A number of standard methods of modeling correlated noise are available. We chose one such method presented in Searle (1982). Let S be the sample covariance matrix from the measured noise, then the vector of simulated correlated noise is given by

$$Y = G\sqrt{\Lambda}X \qquad 1)$$

where G is the eigenvectors of S, $\sqrt{\Lambda}$ is a matrix whose diagonal is composed of the square root of the eigenvalues of S, X is a vector of gaussian random numbers with mean 0 and variance 1 .

* *Corresponding author address:* Thomas J. Kleespies, E/RA1 Room 810 WWB, NOAA/NESDIS, 5200 Auth Road, Camp Springs MD 20746; email: Thomas.J.Kleespies@noaa.gov

The sample of the measured noise is from HIRS space calibration observations for an entire day. An example of inter channel noise correlation for NOAA 11 is given in figure 1, which is the scatter diagram of channel 10 versus channel 15 space looks.

The gaussian random numbers are computed using Box and Muller (1958),

$$x = (-2\ln U_1)^{1/2}\cos(2\pi U_2) \qquad 2)$$

where U_1 and U_2 are numbers drawn from a uniform random distribution. We used the FORTRAN RAN function for this purpose. A realization of size 100,000 was applied and the inter channel correlation coefficients were computed. Results for selected channel pairs are presented in Table 1.

3. CONCLUSIONS

We have presented a method for simulating correlated noise and applied it to radiances from the NOAA 11 HIRS instruments. This method accurately reproduces the observed correlation structure. The NOAA 11 HIRS exhibits inter channel noise correlations that approach 0.5 . This fact has implications for the use of off diagonal elements in the observational error covariance matrix used in variational data assimilation.

4. REFERENCES

Box, G. E. P. and M. E. Muller, 1958: A note on the generation of random normal deviates. Annals of Mathematical Statistics, 29, pp 610-611.

Searle, S. R., 1982: Matrix Algebra Useful for Statistics, Ch. 13, Wiley&Sons.

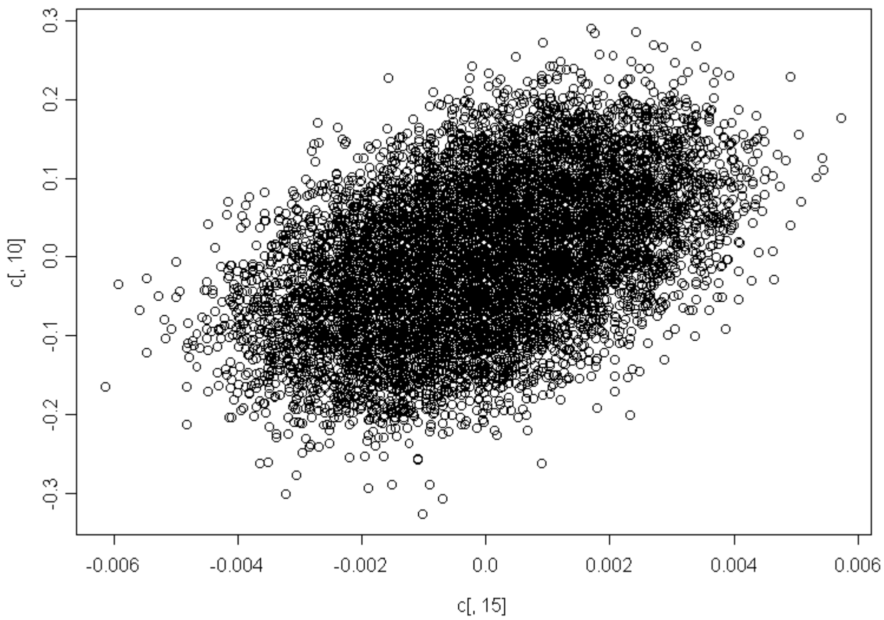

Figure 1. HIRS 11 Space calibration radiances, Ch 10 versus Ch 15, n=16032, r=.492
units are mw /(cm^2 sr cm^{-1})

NOAA 11 N=100000 Chan	Chan	Observed r	Simulated r
6	4	0.487	0.481
9	2	0.408	0.410
9	8	0.428	0.430
11	5	0.483	0.481
11	8	-0.409	-0.413
12	10	-0.434	-0.436
13	4	-0.417	-0.418
14	10	-0.438	-0.438
14	11	0.475	0.474
15	10	0.492	0.495
15	11	-0.417	-0.416
15	14	-0.462	-0.464
17	4	0.416	0.415
17	13	-0.411	-0.411

Table 1. Correlation coefficient for selected channels of NOAA 11 HIRS observed and simulated space calibration observations.