Work Plan, January 1, 1997-December 30, 1997

Some New Mathematical Methods for Variational Objective Analysis and Accuracy Estimation, with Emphasis on Adaptive Tuning of Data Assimilation Systems

Grace Wahba, Statistics Dept., University of Wisconsin- Madison

and

Donald R. Johnson, Space Sciences and Engineering Center, University of Wisconsin-Madison

Continuation of NASA Grant NAGW-2961

1. Continue ongoing theoretical work on parameter joint estimability and sensitivity, both when the model is correct and when it is misspecified, and apply the results to a variety of informative examples that arise in atmospheric data assimilation.

2. Continue the development and exploitation of modern and practical methods for representing and tuning slowly varying parameters in data assimilation systems. Important candidates are a slowly spatially varying forecast error variance and slowly varying length scale parameters, as well as distributed physical parameters, and other parameters suggested by the results of 1. and other studies.

3. Continue the development of models for model error correlated in time, that have the potential for being tuned via the present methods. Examine their use as tools for visualizing model error.

4. Complete ongoing work on properties of analysis error covariances obtained by methods involving GCV and UBR, including evaluation of the resulting confidence intervals.

5. Continue the verification and testing of statistical methods and numerical algorithms developed in items 1 through 4 on synthetic data generated via computer model test beds where the 'ground truth' is known, and which are simple, but present some aspect of the problem for realistic testing.

Progress Report, November, 1996

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1. Major effort this year went into the completion of the work Gong, J., Wahba, G., Johnson, D. R., and Tribbia, J. " Adaptive Tuning of Numerical Weather Prediction Models: Simultaneous Estimation of Weighting, Smoothing and Physical Parameters " TR 963, July 1996, submitted. In that work we built a test bed to study and demonstrate feasibility of some of the new mathods under development for adaptively tuning four dimensional data assimilation models. The test bed used an equivalent barotropic vorticity equation on a latitude circle. A high resolution forward integration scheme was used to generate simulated observational data, and a low resolution model was used to analyze the simulated data. The difference between the high resolution scheme and the low resolution scheme was a proxy for model error. Given (simulated) noisy forecast and observations a four dimensional variational problem was solved to get the analysis. We built five tunable parameters into the analysis, two tunable 'distributed' parameters in the equivalent barotropic vorticity equation, two parameters representing tunable relative weights to be given to forecast error relative to observational error and to model error relative to observational error and a fifth parameter which governs the 'smoothness' (a proxy for having energy distribution characteristic of the atmosphere) for the analysis at the final time point. We demonstrated that the numerical method (randomized trace) for computing the traces of large matrices used in the calculation of the GCV tuning criteria is potentially feasible on operational sized systems and that good estimates of the optimal tuning parameters result. The analyzed trajectory was observed to be quite sensitive to four of the (carefully chosen) tunable parameters, and excellent estimates of their optimum values were obtained from the data. A deliberately naive model was used for the model error (white noise), and the true mean square error as a function of the model error parameter had a broad, flat minimum. The estimates of the optimal parameter generally fell in this flat minimum but were variable. These and other results raise a number of questions which merit further investigation.

2. Development of a general theory of the estimability/sensitivity to multiple smoothing, tuning and weighting parameters is continuing, including methods for modeling and tuning spatially slowly varying covariances and distributed parameters.

3. Theoretical work on modeling model errors correlated in time is continuing, in conjunction with 2.

1 January 1997 - 31 December 1997

		Hours	Rate	Cost	
I.	Labor and Fringe Benefits				
	a) Principal Investigator GW	285	96.18	$ 27,411	
	b) Co-Investigator DJ	122	75.12	9,165	
	c) Research Assistant	900	21.07	18,963	
	d) Secretary	48	20.02	961	
	Subtotal				$56,500
II.	Travel				
	a) 4 trips/1person/3days/Wash.DC or mtg				4,000
	(air fare $503 per trip - lodg., meals, etc./day $135 - car rental $34/day)				
III.	Computer system maintenance				2,000
IV.	SSEC Indirect Cost at 44%				27,500
	TOTAL				$90,000

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Cheryl E. Gest

Cheryl E. Gest, Admin. Officer
Research & Sponsored Programs

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