

## **General knowledge expectations for materials taught by Dr. Xue**

### **The following expectations apply to all materials taught by Dr. Xue:**

You should clearly understand the concepts of data assimilation and the analysis/assimilation methods covered in this course. You should know the main characteristics and the strength and weaknesses of these schemes, and be able to compare and contrast them, including solution accuracy, physical meaning, practical implementation issues and cost.

You are not expected to memorize or derive in the exam complete solutions of various analysis schemes in matrix form, but you should be able to do so for the equations in scalar form and apply the solution to simple examples.

You should understand fully the matrix-form equations and solutions, and be able to recognize the terms in standard notations. You should be able to interpret the meaning of each term and each variable in the equations, and their role in and effect on the solutions.

You should know the procedure by which various analysis solutions are obtained and how such solutions are implemented computationally in practical data assimilation systems. You should be able to perform basic matrix operations, and know the general rules of such operations.

### **The following are specific to the materials to be tested in the third exam.**

- Know the 4DVAR formulation and procedures, as well as advantages as compared to simpler schemes such as 3DVAR.
- Understand the role of tangent linear model and joint in 4DVAR systems.
- Know the procedure of incremental 4DVAR.
  
- Know the importance and effects of flow-dependent background error covariances.
- Know the general steps and characteristics of extended Kalman filter (EKF).
- Know the general methodology of ensemble-based data assimilation, in particular, the ensemble Kalman filter (EnKF) and how it calculates flow-dependent error covariances.
- Know two commonly used algorithms of ensemble Kalman filter, their general methodology, though not necessarily memorizing their equations.
- Know main issues with ensemble-based data assimilation, including covariance inflation, covariance localization, the reasons for needing such treatments, and the commonly used procedures and methods.
- Have some general knowledge about hybrid DA methods, and the reason for such algorithms.
  
- For all of the above methods, know their strengths and weaknesses, in terms of both accuracy and cost.