General expectations when preparing for OBAN exams

You should clearly understand the concepts of objectve analysis and assimilation methods covered in this course. You should know the broad types of objective methods that had been developed and used through the history of objective analyses from observational data.

You should know the main characteristics and the strength and weaknesses of different schemes, and be able to compare and contrast them, including solution accuracy, physical meaning, practical implementation issues and associated cost.

For the most commonly used objective analysis schemes, such as the Cressman and Barnes schemes, you are expected to remember the analysis equations, including the analysis weights, and be able to interpret their equations.

For less commonly used schemes, when given their equations, you should be to interpret the meaning of each term and each variable in the equations, and their role and effect in the solutions.

You are not expected to memorize or derive in the exam complete solutions of various analysis schemes in matrix form (this mainly applies to the second part of this course), but you should be able to do so for the equations in scalar form and apply the solution to simple problems.

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 (agin this mainly applies to the later part of this course).

Specifically, in prepration for exam 1, you are expected to:

- Know the several types of commonly used map projections used by weather analysis and numerical weather prediction and their characteristics. Know the meaning of map factor, and be able to perform map projection-related calculations when given equations.
- Know the concept and defintion of objective analysis, sources of errors, multi-variate versus univariate analyses.
- Interpolation methods for obtaining grid point values from observation stations.
- Polynimial fitting to observations, least-squares estimation of polynimal coefficients in 1D and 2D, concept and procedures.
- Relationship between least-squares estimation and maximum likehook estimation, and conditions under which such relationship is valid.
- Error variance of least squares estimation. The role of observation error variances in the least squares analysis.
- Effect of observation bias on least squares esitmation/analysis.
- Least squares estimations in the presence of a background.

- Global function fitting, solution procedure for determining the coefficients of the basis functions, overfitting and underfitting issues.
- Local function fitting versus global function fitting. Influence area.
- Inclusion of equation constraints in least-squares analysis
- Bergthorsson and Doos analysis algorithms, error variance and distance-based weighting. Use of geostrophic relations in the analysis algorithms.
- Cressman method. Cressman weight function, influence radius, the use of multiple analysis passes, characteristics of the Cressman method. Choice of influence radius.
- Iterative procedure of Cressman and desired quality of final analysis. Advantages and disadvantages of the scheme.
- Sucessive correction method (SCM)
- Filtering and response function
- Barnes analysis scheme. Barnes analysis weight, and the choice of scale parameter in the weight. Response function of Barnes analysis and its relation to the scale parameter. Multi-step procedure of Barnes analysis and choice of several analysis parameters and their effects.
- Iterative procedure for obtaining optimal analysis.
- Statistical optimal analysis, derivation procedure for obtaining the optimal analysis, properties of the optimal analysis. Applications of the optimal analysis.