DOWNLOAD PDF A DYNAMIC ASSIMILATION MODEL

Chapter 1 : Data assimilation - Wikipedia

A dynamic model of cultural assimilation IstvÂ´an KÂ´onya Boston Collegeâˆ— November, Abstract The paper analyzes the population dynamics of a country that has.

The cause of this difficulty is that small changes in initial conditions can lead to large changes in prediction accuracy. This is sometimes known as the butterfly effect - the sensitive dependence on initial conditions in which a small change in one state of a deterministic nonlinear system can result in large differences in a later state. At any update time, data assimilation usually takes a forecast also known as the first guess, or background information and applies a correction to the forecast based on a set of observed data and estimated errors that are present in both the observations and the forecast itself. The difference between the forecast and the observations at that time is called the departure or the innovation as it provides new information to the data assimilation process. A weighting factor is applied to the innovation to determine how much of a correction should be made to the forecast based on the new information from the observations. The best estimate of the state of the system based on the correction to the forecast determined by a weighting factor times the innovation is called the analysis. In one dimension, computing the analysis could be as simple as forming a weighted average of a forecasted and observed value. In multiple dimensions the problem becomes more difficult. Much of the work in data assimilation is focused on adequately estimating the appropriate weighting factor based on intricate knowledge of the errors in the system. Data assimilation as statistical estimation[edit] One of the common mathematical philosophical perspectives is to view data assimilation as a Bayesian estimation problem. However, the probabilistic analysis is usually simplified to a computationally feasible form. Advancing the probability distribution in time would be done exactly in the general case by the Fokker-Planck equation , but that is not feasible for high-dimensional systems, so various approximations operating on simplified representations of the probability distributions are used instead. Often the probability distributions are assumed Gaussian so that they can be represented by their mean and covariance, which gives rise to the Kalman filter. Many methods represent the probability distributions only by the mean and input some pre-calculated covariance. An example of a direct or sequential method to compute this is called optimal statistical interpolation, or simply optimal interpolation OI. An alternative approach is to iteratively solve a cost function that solves an identical problem. These are called variational methods, such as 3D-Var and 4D-Var. Typical minimization algorithms are the Conjugate gradient method or the Generalized minimal residual method. The Ensemble Kalman filter is sequential method that uses a Monte Carlo approach to estimate both the mean and the covariance of a Gaussian probability distribution by an ensemble of simulations. More recently, hybrid combinations of ensemble approaches and variational methods have become more popular e. Weather forecasting applications[edit] In numerical weather prediction applications, data assimilation is most widely known as a method for combining observations of meteorological variables such as temperature and atmospheric pressure with prior forecasts in order to initialize numerical forecast models. Why it is necessary[edit] The atmosphere is a fluid. The idea of numerical weather prediction is to sample the state of the fluid at a given time and use the equations of fluid dynamics and thermodynamics to estimate the state of the fluid at some time in the future. The process of entering observation data into the model to generate initial conditions is called initialization. On land, terrain maps available at resolutions down to 1 kilometer 0. The World Meteorological Organization acts to standardize the instrumentation, observing practices and timing of these observations worldwide. The data are then used in the model as the starting point for a forecast. Sites launch radiosondes in weather balloons which rise through the troposphere and well into the stratosphere. Commerce provides pilot reports along aircraft routes [9] and ship reports along shipping routes. The large error was caused by an imbalance in the pressure and wind velocity fields used as the initial conditions in his analysis, [16] indicating the need for a data assimilation scheme. Originally "subjective analysis" had been used in which NWP forecasts had been adjusted by meteorologists using their operational expertise. Then "objective analysis" e. Cressman algorithm was introduced for automated data assimilation. These objective methods used simple interpolation approaches, and thus were 3DDA methods. They are based

on the simple idea of Newtonian relaxation the 2nd axiom of Newton. They introduce into the right part of dynamical equations of the model a term that is proportional to the difference of the calculated meteorological variable and the observed value. This term that has a negative sign keeps the calculated state vector closer to the observations. Nudging can be interpreted as a variant of the Kalman-Bucy filter a continuous time version of the Kalman filter with the gain matrix prescribed rather than obtained from covariances. Gandin who introduced the "statistical interpolation" or "optimal interpolation" method, which developed earlier ideas of Kolmogorov. This is a 3DDA method and is a type of regression analysis which utilizes information about the spatial distributions of covariance functions of the errors of the "first guess" field previous forecast and "true field". These functions are never known. However, the different approximations were assumed. To overcome this difficulty, approximate or suboptimal Kalman filters were developed. Marchuk, who was the first to apply that theory in the environmental modeling. The significant advantage of the variational approaches is that the meteorological fields satisfy the dynamical equations of the NWP model and at the same time they minimize the functional, characterizing their difference from observations. Thus, the problem of constrained minimization is solved. The 3DDA variational methods were developed for the first time by Sasaki As was shown by Lorenc , all the above-mentioned 4DDA methods are in some limit equivalent, i. However, in practical applications these assumptions are never fulfilled, the different methods perform differently and generally it is not clear what approach Kalman filtering or variational is better. The fundamental questions also arise in application of the advanced DA techniques such as convergence of the computational method to the global minimum of the functional to be minimised. For instance, cost function or the set in which the solution is sought can be not convex. The 4DDA method which is currently most successful [19] [20] is hybrid incremental 4D-Var, where an ensemble is used to augment the climatological background error covariances at the start of the data assimilation time window, but the background error covariances are evolved during the time window by a simplified version of the NWP forecast model. This data assimilation method is used operationally at forecast centres such as the Met Office. A typical cost function would be the sum of the squared deviations of the analysis values from the observations weighted by the accuracy of the observations, plus the sum of the squared deviations of the forecast fields and the analyzed fields weighted by the accuracy of the forecast. This has the effect of making sure that the analysis does not drift too far away from observations and forecasts that are known to usually be reliable.

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data assimilation for dynamic systemsoksana chkrebtii The Model Interested in inference and prediction for large-scale spatio-temporal models de ned implicitly as partial di erential equations (PDE).

Chapter 3 : "A Dynamic Assimilation Model: Selected First-generation Arab-canadian" by Mohammed Sale

The Dynamic Radiation Environment Assimilation Model (DREAM) was developed to provide accurate, global specification of the Earth's radiation belts and to better understand the physical processes.