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The dynamical properties of forecasts corrected using linear MOS schemes are explored, with emphasis on the respective role of model and initial condition uncertainties. Analytical and numerical investigations of low-order systems displaying chaos indicate that MOS schemes are able to partly correct the impact of both initial and model errors on model forecasting. Nevertheless the amplitude of the correction is much more sensitive to the presence of (state-dependent) model errors and if initial condition errors are much larger than model uncertainties, MOS schemes become less effective. Furthermore, the amplitude of the MOS correction depends strongly on the statistical properties of the phase space velocity difference between the model and reference systems, such as its mean and its covariance with the model predictors in the MOS scheme. Large corrections are expected when the predictors are closely related to the sources of model error.

The dynamical properties of ECMWF operational forecasts corrected by a (linear) Model Output Statistics (MOS) technique are then investigated, in the light of the above results. For the temperature forecasted by the ECMWF model over Belgium, it is found that: (i) The error amplification arising from the presence of uncertainties in the initial conditions dominates the error dynamics of the 'free' atmosphere; (ii) the temperature at 2 meters can be partly corrected by the use of the (linear) MOS technique (as expected from earlier works), suggesting that model errors and systematic initial condition biases dominate at the surface. In the latter case, the respective amplitudes of model errors and systematic initial condition biases corrected by MOS depend on the location of the synoptic station. The origin of the differences will be discussed, as well as the potential improvement of higher resolution models.

Data assimilation schemes are confronted with the presence of model errors arising from the imperfect description of atmospheric dynamics. These errors are usually modeled on the basis of simple assumptions such as bias, white noise, first order Markov process. In the present work, a formulation of the sequential extended Kalman filter is proposed, based on recent findings on the universal deterministic behavior of model errors in deep contrast with previous approaches (Nicolis, 2004). This new scheme is applied in the context of a spatially distributed system proposed by Lorenz (1996). It is found that (i) for short times, the estimation error is accurately approximated by an evolution law in which the variance of the model error (assumed to be a deterministic process) evolves according to a quadratic law, in agreement with the theory. Moreover, the correlation with the initial condition error appears to play a secondary role in the short time dynamics of the estimation error covariance. (ii) The deterministic description of the model error evolution, incorporated into the classical extended Kalman filter equations, reveals that substantial improvements of the filter accuracy can be gained as compared with the classical white noise assumption. The universal, short time, quadratic law for the evolution of the model error covariance matrix seems very promising for modeling estimation error dynamics in sequential data assimilation.