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Theoretical background (2) : Data assimilation algorithms, key elements and inputs

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Numerical models provide an almost complete description of the atmosphere, but errors grow rather rapidly in time. Observations provide rather incomplete, but up to date accurate information. Data assimilation is introduced as the process where these two sources of information are combined to produce a best or optimal estimate of the atmospheric state. The state is optimal in the sense that background information from the model is combined with observed information - respecting the uncertainty in both (encapsulated by the background error covariance B and observation error covariance R). This lecture looks in detail at the main elements of the assimilation scheme (such as the chain of observation operators for radiances) and its key statistical inputs. For example it is shown that an incorrect specification observation errors (R) can result in the assimilation process producing an analysis that has larger errors than the background. Also, the importance of vertical correlations of background error is discussed - with respect to the assimilation of low vertical resolution downward looking radiance data. The role of the bias correction system and the data selection / quality control in producing an input population of observations that have statistical properties consistent with R is described.

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