Assimilation of Satellite Data Summary – 14 May 2009 – Dan Steinhoff

A technique for assimilation of cloud-affected infrared radiances from advanced infrared sounders (such as AIRS and IASI) is described (Pavelin et al. 2008). Currently, NWP systems are unable to fully utilize cloud-affected soundings, in spite of the large impact that such data could have on forecast accuracy. In this study, assimilation of radiances from cloudy soundings is done by constraining radiative transfer calculations through the use of retrieved cloud parameters. A 1D-Var retrieval method is used to estimate cloud parameters. AIRS profiles are simulated using a radiative transfer model (the same used in construction of the forward operator) from a set of ERA-40 profiles. Model background profiles are also simulated using the same ERA-40 profiles. Only soundings over the ice-free ocean are used. In order to compare retrieved profiles with the original "true" cloud profile, "effective" cloud-top pressure and cloud fraction quantities are computed. The retrieval is found to perform best in dense clouds (high cloud fraction) and at high levels. A 92-channel subset is used, and large biases and RMS errors are found below cloud top. These errors are thought to be caused by the over-simplified cloud model in the 1D-Var scheme, and from errors in cloud parameter retrieval. When a dynamic channel selection scheme is used to filter out channels below cloud top, biases and RMS errors are reduced, and results are comparable with clear-sky radiances. The cloudy 1D-Var analysis is shown to be superior to other methods while utilizing three times the number of radiances in high-peaking channels compared to the other methods.

In Geer et al. (2008), operational assimilation of rain- and cloud-affected SSM/I observations at ECMWF is discussed. ECMWF has assimilated SSM/I data since 2005, and their initial results are described. In this study, SSM/I data is only used over ocean. The 1D-Var retrieval combines SSM/I radiances with the 4D-Var first guess field. Total column water vapor (TCWV) is derived from the humidity profile, which is assimilated in the 4D-Var analysis. The retrievals are compared with measurements from the TRMM precipitation radar (PR) in terms of water content. There is good agreement between PR and the 1D-Var retrievals, especially when compared with the 1D-Var first guess field. When the retrieved TCWV is compared with the 4D-Var TCWV, the correlation is good, indicating that the assimilation is working properly. However, there is almost no correlation when rainwater path is considered, and only weak correlation for cloud liquid water path. Further investigation indicates that TCWV is already properly generated by the model and other observations. The mean effect of SSM/I assimilation is examined next. Biases between the first guess field and observations exist, and propagate into the 4D-Var TCWV field. A positive moisture bias is found in the model first guess field, resulting from changes in the moist physics. These biases are masked by a sampling error, which is caused by not including a subset of cases into the assimilation. Future efforts will involve moving to a direct 4D-Var assimilation of SSM/I observations.