Clouds provide a major link between the water and energy cycles. Betts and Viterbo (JGR, 2005) demonstrated that link in detail including an astonishing relationship of soil moisture, low cloud cover and surface net long-wave radiation over the Amazon.

Recent work at ECMWF on the cloud model error illustrates the complex feedbacks involved. Three examples are presented focused on deep, shallow convection and stratus at the CEOP sites LBA, ARM SGP and Lindenberg.

(1) The diurnal cycle of convection over Amazonia has been a well recognised problem in many models. A comparison of high resolution cloud resolving model (CRM) runs with the ECMWF single column model (SCM) of the build-up of convection at the LBA observational experiment has been performed. The SCM qualitatively replicates the CRM results going from a shallow convection phase to deep convection later. Yet two quantitative SCM problems were revealed which are crucial to the diurnal cycle of convection: (i) shallow mass fluxes are too strong early on and (ii) convection goes too quickly to the deep phase.

(2) Shallow convection over the ARM Southern Great Plain (SGP) site is lacking in the ECMWF model. Back trajectories showed moisture fluxes at 950hPa (PBL) to be dominated by the low level jet originating from the Gulf of Mexico. Fluxes at 600hPa (top of shallow convection) are coming from the North-West bring in dry air. Attention therefore focused on the moist low level jet which in the model slows too much and therefore doesn't accomplish the necessary moisture transport to SGP. Interestingly, when switching to a stable boundary layer parameterization with less mixing, the nocturnal low level jet becomes stronger providing more moisture to SGP and helping the shallow convection there. This link illustrates the power of using point data together with gridded data in the analysis of complex model errors.

(3) Stratus decks over Europe can be a dominant feature in winter during high pressure conditions with boundary layers capped by strong inversions. The coupling of cloud with radiation and the land surface is complex and instable. It is therefore no surprise that global and regional models have difficulties predicting winter stratus. Low clouds over Hungary in December 2004 provided such a case with a blocking situation leading to 10 days of persistent clouds, while the ECWMF model produced little to no cloud. A comprehensive upgrade of the parameterisation of PBL clouds was implemented in April 2005, which included a conceptual unification of cloud and PBL processes. This upgrade effectively improved the Hungary December 2004 case but occasional problems remain. To make use of the comprehensive observations at the CEOP site Lindenberg we will identify stratus periods there to identify and solve the remaining problems.

ECMWF has supplied point (MOLTS) and gridded data to CEOP. The combination of the two provides a powerful tool to disentangle model error as has been shown in the three presented examples. Yet to understand feedbacks that include clouds or even non-cloudy interactions require a knowledge of at the minimum total cloud cover and better cloud profile information. It is therefore proposed to include total cloud cover from the ISCCP DX dataset for all MOLTS

points and additionally cloud profile data for the super sites Lindenberg, Cabauw and ARM SGP from algorithms using lidar and radar data (e.g. CLOUDNET).