

**The improvement on quantitative precipitation forecast by implementing ice phase microphysics into a four-dimensional Variational Doppler Radar Analysis System (VDRAS)**

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An ice phase microphysical process is implemented in a four-dimensional Variational Doppler Radar Analysis System (VDRAS). A series of observation system simulation experiments (OSSEs) and real-case experiments are conducted to explore the influence of the ice phase process on the radar data assimilation and quantitative precipitation forecast (QPF). The forward simulations show that implementing ice phase process can produce strong heating and upward vertical velocity in upper-level. Results from OSSEs demonstrate that the retrieved water content would be underestimated if all radar reflectivities are assumed to be in the form of liquid phase. This underestimation can be improved when the ice phase process is implemented in VDRAS. While using environmental sounding to estimate the freezing level in the 4DVar cycle, the precipitation water content is seriously overestimated. Moreover, using predicted temperature field from forecast can provide relatively accurate estimation of the freezing level and further produce better retrieved result. A real case study from Intensive Operation Period (IOP) #8 of the 2008 Southwest Monsoon Experiment (SoWMEX) indicates that implementing ice phase process in VDRAS can produce wider precipitation distribution than only including original liquid phase does and obviously improve the QPF skill.