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Evaluation of the diurnal cycle of summertime convection over the Alps and adjacent areas in cloud-resolving models against satellite data

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Diurnal moist convection is an important part of precipitation over Central Europe and the Alps, in particular in summer when the synoptic forcing is weak. This convection is poorly represented in current models using parameterized convection, often leading to large biases in the diurnal cycle, in particular a too early onset and peak of precipitation. Preliminary experience with cloud-resolving models has shown promising results. Here we use COSMO in a cloud-resolving setup with a horizontal grid spacing of 2 km to investigate the diurnal cycle of moist convection and validate the model simulations using a variety of observations with a focus on satellite data. Brightness temperature comes from the SEVIRI sensors and top-of-the-atmosphere thermal flux from the GERB sensors onboard the Meteosat Second Generation geostationary satellites. Cloud optical thickness and cloud top pressure comes from the ESA Cloud CCI project which uses data from the polar orbiting NOAA-18 satellite. SEVIRI provides high temporal and spatial resolution information on fast developing convective cells. The SEVIRI images are compared against model-produced synthetic satellite images using RTTOV. Comparisons with brightness temperature and cloud-top pressure show that COSMO produces too much high clouds in model configurations with the one-moment microphysics scheme. With the change from convection-parameterized setup to cloud-resolving resolutions, and by using a two-moment microphysics scheme with ice sedimentation, high cloud cover is significantly reduced. Also, it is found that the bias in timing of the diurnal cycle of convection in the simulations differs between the Alps and adjacent areas.