Abstract

In this study the Weather Research Forecast Model is used to analyze the sensitivity of convective precipitation to cumulus convection parameterization and soil moisture content. Soil moisture content affects the surface energy budget and moisture exchange between the atmosphere and the land surface. The amount of energy and moisture supplied by the surface affects the buoyancy available for convection cloud development. Compared to satellite and in-situ measurements the model initial soil moisture content can deviate with about 40%. Creating simulations in which the soil moisture content is changed with 15% and 30% the effect of such differences on summer convective precipitation is investigated. However prediction of convective precipitation is highly dependent on the application of cumulus parameterization schemes. Simulations are carried out over the Carpathian Basin, using 5 km horizontal resolution for 33 summer days with convective precipitation applying both explicit and parameterized convection. Initial results show that the latent heat flux is about 10% and the convective available potential energy is about 20% lower in case of explicit cumulus cloud development description, however vertical velocities are higher. Considering precipitation, the decrease of soil moisture results an increment in precipitation area but lowered the amount in both cumulus convection cases. Soil moisture increment increased the amount of precipitation but decreased the area. When cumulus parameterization is chosen, the weaker updraft results less precipitation compared to explicit cumulus convection. Also irrespective of soil moisture condition, the spatial distribution of precipitation is significantly different comparing explicit and parameterized cases over plains.

Methods

1. Databases:
   - Weatherinput:
     - GFS (Global Forecast System), 0.5° resolution analysis, every 6 hours
     - Surface:
     - DWD: (German Weather Service): soil moisture, 2010: soil texture
     - DWD: SML database
     - Soil moisture:
     - European Space Agency: soil moisture database (Owe et al., 2006)
     - In-situ measurements at Szeged, Hungary

2. WRF V3.5:
   - Resolution: 15 km, 0.5 km inner domain, 60 x 20 x 3 level step, 44 vertical levels (dashed in PBL)
   - Main parameterizations: PPTIM/Duuth scheme, Thompson microphysics, RRTM/MacCcrum PBL, Noah surface

3. Simulations:
   - Period of analysis: Summer of 2012, 31 days with convective precipitation
   - Area of interest: 43°–51°N and 12°–27°E
   - 24 hours simulations, with cumulus parameterization

![Convection vs. soil moisture](image)

Convection vs. soil moisture

Dependence of maximum vertical velocity in PBL, CAPE and precipitation on initial soil moisture and cumulus parameterization (vertical dotted lines denote average soil moisture amount for simulations).

![Precipitation vs. soil moisture](image)

Precipitation vs. soil moisture

Sum of precipitation differences between soil moisture initialization cases for 31 days, precipitation spatial distribution

Conclusions

- Soil moisture uncertainty is high in GFS.
- The behaviour of explicit convection sensitivity to soil moisture was similar to parameterized convection.
- According to simulations soil moisture has a positive feedback to precipitation in presented cases.
- CAPE is higher for parameterization though it is an artefact from CAPE closure.
- Dry runs showed more intense precipitation but altogether lower amount.
- Area of cloudiness was higher for dry runs.
- Explicit deep convection resulted more clouds and slightly more precipitation.

Verification

- Precipitation from MSG satellite – only daytime
- Skill of parameterized convection is better
- Dry runs are slightly better

References
