



# Convective and Orographically Induced Precipitation Study

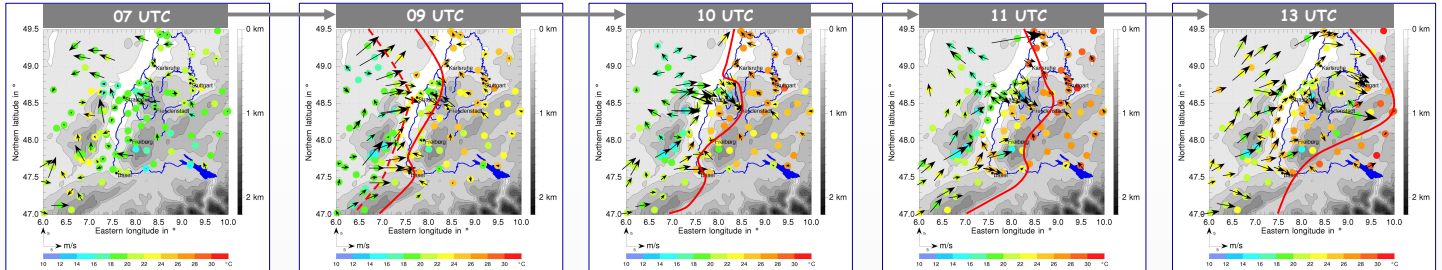
7th COPS Workshop, Strasbourg, France, 27-29 October 2008



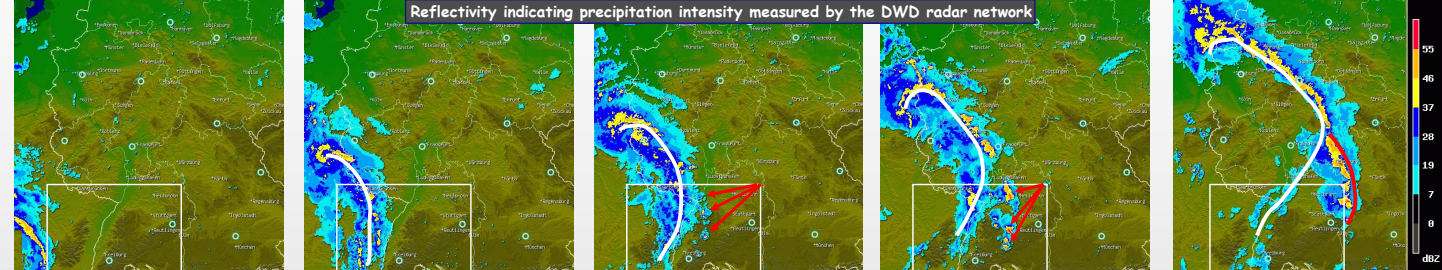
## Driving Processes for Convection Initiation over Complex Terrain: Measurements and Simulations of IOP 9c

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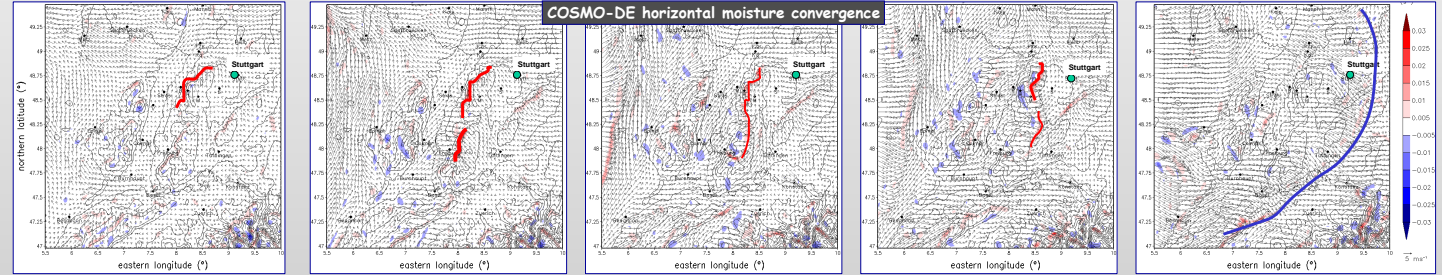
Observations and corresponding COSMO-DE model calculations from COPS IOP 9c (July 20, 2007) between 07 UTC and 13 UTC. The case is governed by local and regional scale CI interacting with processes on the synoptic scale. This causes wrong precipitation forecasts of the COSMO-DE model.



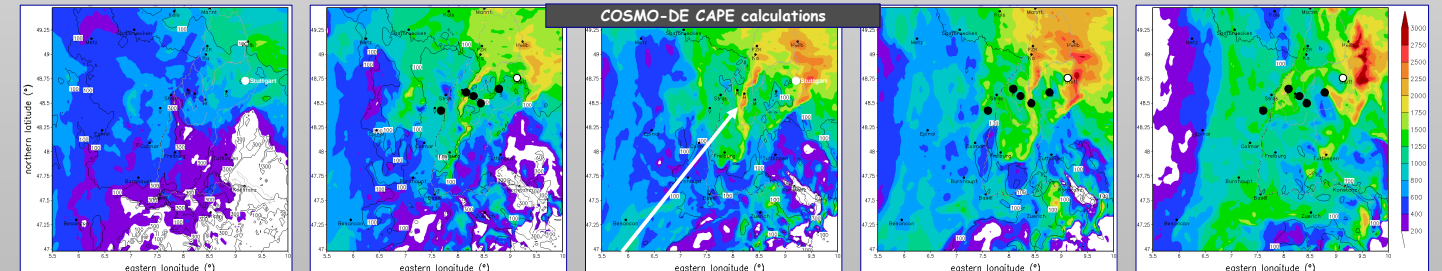
**07 UTC:** In the morning wind between E and S prevailing. High wind on mountain tops ( $8 \text{ ms}^{-1}$ ). Inflow into MSC over France. Low hor. temperature gradient.  
**09 UTC:** Wind turning to W prior to gust front (red line). Outflow of MSC: W to SW with  $10 \text{ ms}^{-1}$  (dashed). Horizontal temperature gradient increasing.  
**10 UTC:** Gust front reaching northern Black Forest. Still easterly winds in the East. Increasing temperature gradient ( $14 \text{ K}$ ). Clouds in the West.  
**11 UTC:** Convergence line developing east of Black Forest. Wind up  $6 \text{ ms}^{-1}$  from opposite directions. Gust front locally enhanced by orography. Temperature gradient increasing. Convection initiated.  
**13 UTC:** Superposition of orographic wind, gust front and convergence line: strong westerly wind and heavy thunderstorms in the Stuttgart area.



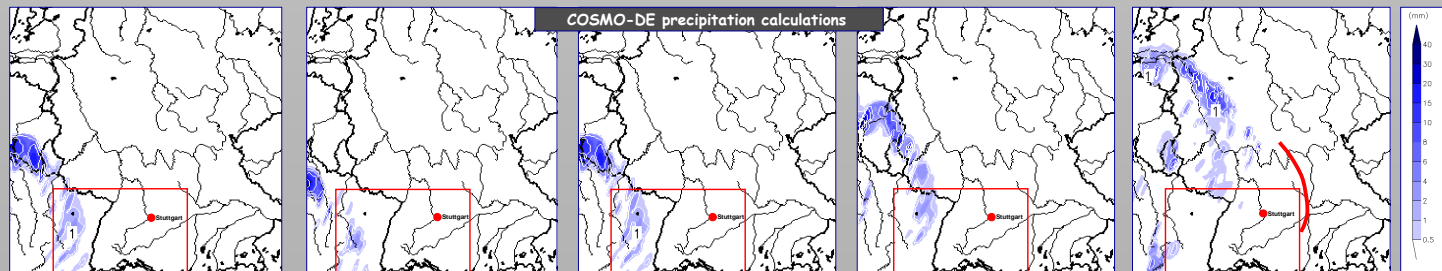
**07 UTC:** Early morning precipitation caused by MCS generated cold front over eastern France. Frontal system developing.  
**09 UTC:** Precipitation coupled with MCS outflow over eastern France. Convective cells along line of highest wind speed (cold front/gust front).  
**10 UTC:** Reduced precipitation during passage of the Rhine Valley. New CI at the leading edge of the gust front. Convective cells along the northern part of the front and in the centre of the Low.  
**11 UTC:** High reflectivity indicating severe convective cells generated by interaction of orographic wind, gust front and convergence line ahead of the front. Convection reduced at southern part of the front.  
**13 UTC:** Southern part of cold front degenerated with respect to convective precipitation and replaced by the convergence line with individual convective cells.



**07 UTC:** Easterly surface wind in the whole COPS area. Channelling in the valleys. Little moisture convergence (red line) over northern Black Forest.  
**09 UTC:** Moisture convergence over northern and southern Black Forest driven by westerly flow over the Rhine valley. Observed maximum and turning of wind over the Vosges not simulated.  
**10 UTC:** Less intensive moisture convergence over the Black Forest. Gust front not resolved. Observed wind maximum over the northern Vosges simulated. New frontal structure west of the Vosges developing.  
**11 UTC:** Moisture convergence over the whole Black Forest still present. Convergence line west of Stuttgart not striking. Frontal structure west of the Vosges moving East.  
**13 UTC:** Moisture convergence no more simulated. Convergence line east of Stuttgart. Reorganisation of a new frontal structure along the line Stuttgart, Tübingen, Basel, Besancon.



**07 UTC:** Low CAPE in the entire COPS area ( $\pm 600 \text{ J kg}^{-1}$ ). Higher values northeast of Stuttgart ( $\sim 1750 \text{ J kg}^{-1}$ ).  
**09 UTC:** High CAPE along simulated moisture convergence and observed gust front ( $\sim 2250 \text{ J kg}^{-1}$ ). High values northeast of Stuttgart ( $\sim 2250 \text{ J kg}^{-1}$ ).  
**10 UTC:** Simulated CAPE increasing along simulated moisture convergence and observed gust front ( $\sim 2500 \text{ J kg}^{-1}$ ). CI detected by radar along line.  
**11 UTC:** Weak convergence causes CAPE line moving east and CAPE maximum (Stuttgart) moving west and increasing. CI in reality but not in the model.  
**13 UTC:** CAPE gap between line and maximum near Stuttgart closed by convergence. Severe convection in reality but not in the model due to missing humidity.



**07 UTC:** Location of synoptic scale precipitation simulated close to reality.  
**09 UTC:** Pattern of synoptic scale precipitation near to reality but to far in the west and to less amount of rain. No embedded convective enhancement.  
**10 UTC:** Synoptic scale precipitation near to reality. No CI and no precipitation along the convergence line with high CAPE over the Black Forest.  
**11 UTC:** Synoptic scale precipitation to far in the west. No CI and no precipitation along the convergence line with high CAPE west of Stuttgart.  
**13 UTC:** Too less synoptic scale precipitation in the north. No CI and no precipitation along the convergence line with high CAPE east of Stuttgart. No reformation of the southern part of the front as seen in observations.