1. Convective and Orographically-induced Precipitation Study

**WHY**
- Heavy orographic precipitation – flooding / flash flooding
- Poor skill at Quantitative Precipitation Forecasting (QPF)
- Lack of intensive observations of flow over complex orography
- Forcing mechanisms poorly understood & modelled
- Systematic error to orosystemic leeward & underestimate precipitation
- Systematic error to make early prediction of precipitation

**GOAL**
- “To advance the quality of forecasts of orographically-induced convective precipitation by 4-dimensional observations & modelling of it’s lifetime”

**HOW**
- Novel setup of multi-platform observation network to measure all spatial & temporal scales
- Allow extensive instrument intercomparison
- Detailed observations – improved orographic flow understanding
- Verify atmospheric models & identify key failures

**CONVECTION**

- Heavy orographic precipitation → flooding / flash flooding
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**Radar observations** indicate the intensity of precipitation over the COPs region. They show abatement of the precipitation & convective cells as the system descends & passes over the Rhine valley. Intense precipitation is then observed in the lee of the Black Forest at the leading edge of the MCS, after it has passed over the COPs region. It is suggested, therefore, that CI is related to the interaction of the MCS with the complex COPs orography.

**WRF modelling** of IOP9c

- Weather Research & Forecasting (WRF) version 3.0.1.1
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- Three nested grids are used, with resolutions of 2.7km, 900m & 300m (see fig.3)
- ECMWF analyses & started at 00Z on 20th July

**Discussion & Conclusions**

- Good overall simulation of mesoscale features of IOP9c by WRF
- Location of precipitation further west than observations - attributed to analyses & simulation start time because simulations (not shown) began at 06Z represented locations better.
- Longer spin-up time resulted in > vertical velocities aloft orography, thus precipitation was initiated earlier than observations
- The 0927 plot from fig.12 shows high theta in the Rhine valley, preventing the MCS outflow from reaching the valley floor
- Temperature of the outflow air was still warmer than the night-time residual fog layer in the RV
- Upon reaching the Black Forest, the orographic barrier forced a steepening & intensification of the outflow bore, resulting in a line of high vertical velocity – development of the observed gust front ahead of the MCS frontal zone.
- Structure of the deformation of the gust front by orography captured well
- The SuperSonde R profiles in Fig.14 show a region of high between Z = 1-2km, after the passage of the frontal zone. This instability explains one mechanism for the subsequent CI aloft the COPS orography.
- Orographic forcing & convergence from thermally-driven easterly flows (from other observations not shown), provide a further 2 mechanisms for the CI in both the simulations & observations
- Channeling of flows out of the COPs region along the valleys, not well represented by WRF

- Larger, convective & meso-scale flows govern the surface wind regime, thus, suggesting further explanation why the precipitating cells form further upstream in WRF than in reality.