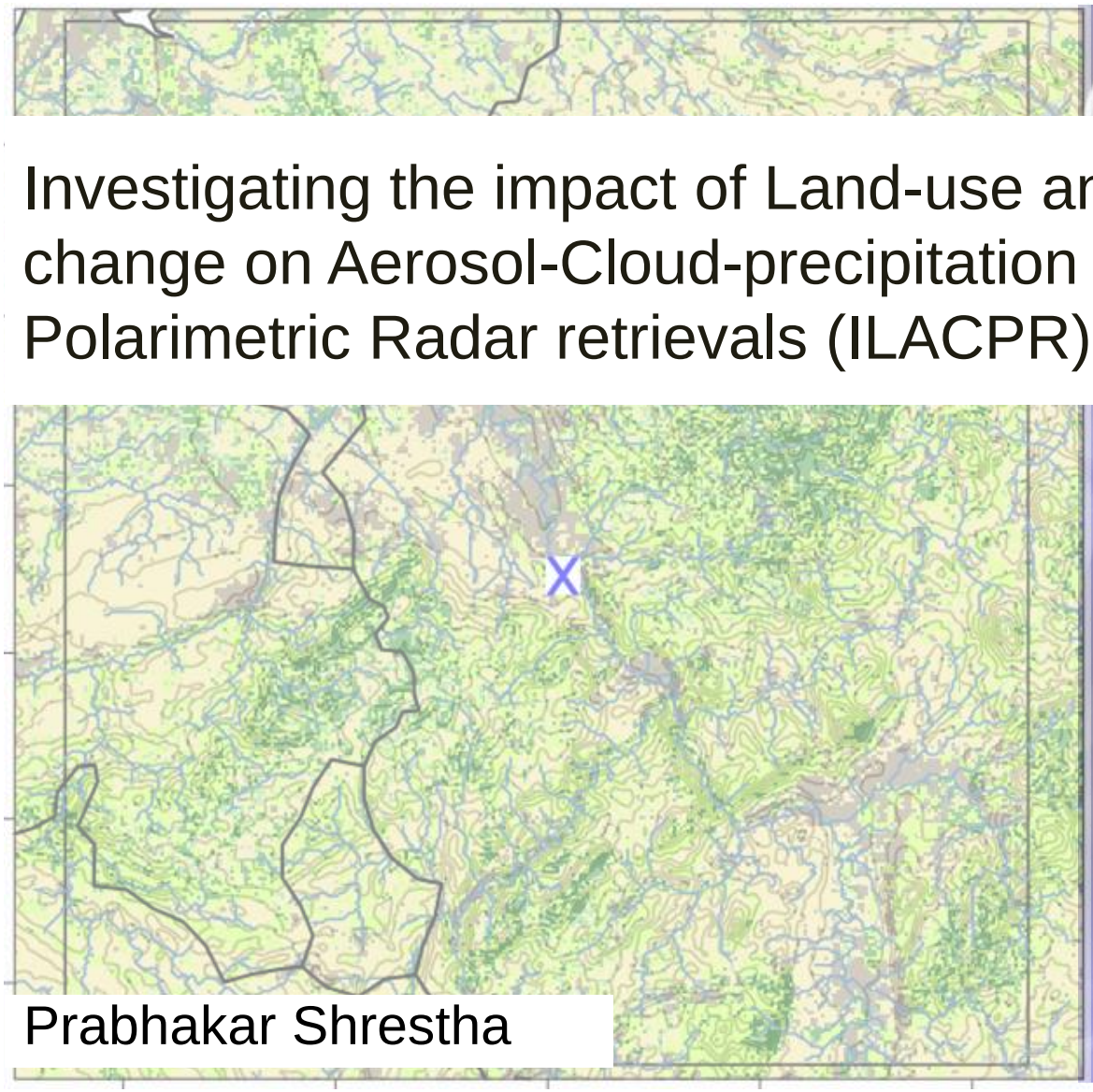
Investigating the impact of Land-use and land-cover change on Aerosol-Cloud-precipitation interactions using Polarimetric Radar retrievals (ILACPR)



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About ILACPR/PROM - Phase 1

- ILACPR contributes to objective one of PROM -- exploitation of radar polarimetry for quantitative process and model evaluation
- It will provide new insights on the impact of anthropogenic land-use and land-cover changes on cloud microphysical and macrophysical (dynamical) mechanisms.

Preliminary work

- Numerical modeling study of summertime convective storm with large-scale perturbation of aerosols and change in LULC

Findings

- Response of the system in terms of surface precipitation to this external forcing is weak.
- Microphysical/Macrophysical pathways acting as a buffered system to the changes in forcing differs.
- Polarimetric radar measurements and numerical model scenarios allow investigation of the buffering mechanisms, arising from interactions between land, aerosols, clouds and precipitation processes.

Hypothesis - ILACPR

- LULC change are among the main sources for the variability in the distribution and hygroscopic properties of aerosols, which can directly/indirectly affect the lifetime evolution of convective precipitating cloud systems.
- Combined availability of synthetic and observed polarimetric fingerprints, makes the problem more tractable by allowing for the investigation of the processes and their variability, that buffer the precipitation response of the system to the external forcing.

Science Questions - ILACPR

1) How does LUCC affect the local aerosol compositions under different meteorological settings?
2) How do LULC change and aerosol-cloud-precipitation interactions together affect cloud microphysical/macrophysical processes?
3) How sensitive are the cloud microphysical/macrophysical buffers to the inclusion of the coupling between LULC and a CTM?

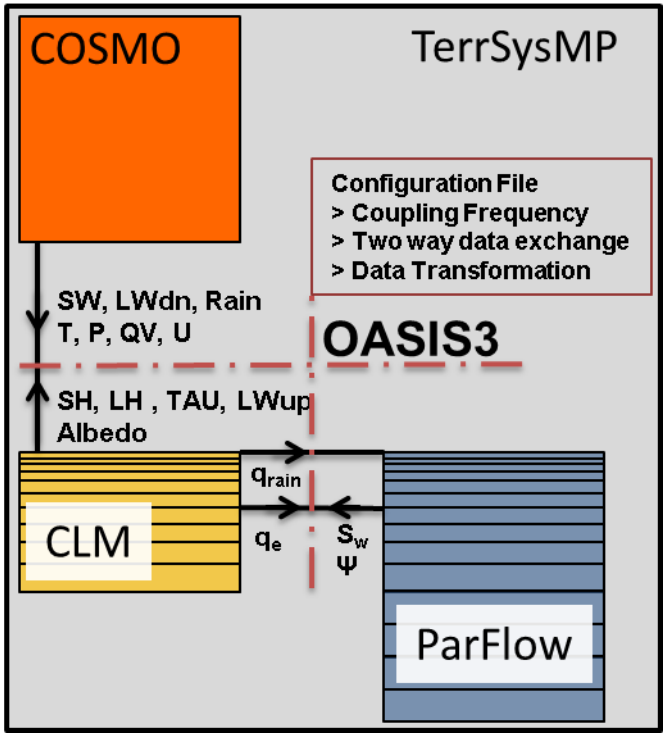
How do we investigate such complex interactions?

Polarimetric Radar Observations

X-Band research radar in Bonn (**BoxPol**), Germany.
C-Band operational polarimetric radar network of DWD

BoxPol

Terrestrial Systems Modeling Platform

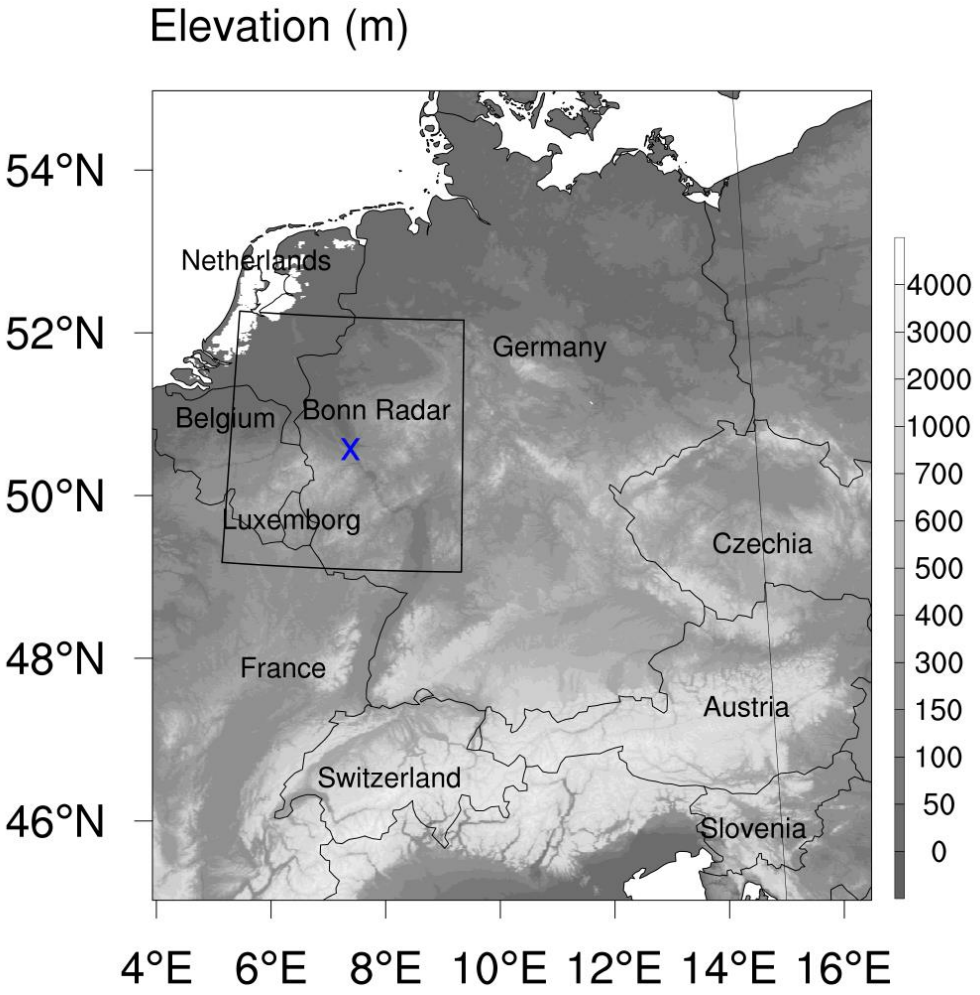


Schematic adopted from Shrestha et al. 2014, MWR

Extension to OASIS3-MCT (Gasper et al. 2014)
Extension for agricultural PFTs (Sulis et al. 2015)
Extension to PDAF (Kurtz et al. 2016)
CO2 coupling (Uebel et al. 2017)

Bonn Radar Domain

- 340 x 340 km^2 covers entire range of the polarimetric X-Band research radar in Bonn (**BoxPol**), Germany.
- Heterogeneous features of forests, agricultural land and urban area
- Twin polarimetric X-Band research radars (Bonn and Jülich)
- Four polarimetric C-Band radars of the German Weather Service
- Measurement platform for cloud research (JOYCE).



Work Programme – Phase 1

Work packages/Milestones	Year 1				Year 2				Year 3			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
WP1 Evaluation of TerrSysMP with radar polarimetry				1								
WP2 Integration of CTM in TerrSysMP						2						
WP3 Evaluation of TerrSysMP-CTM with radar polarimetry.									3			
WP4 Exploring critical linkages between land-aerosol-cloud-precipitation interaction in TerrSysMP and TerrSysMP-CTM												4

WP1 Evaluation of TerrSysMP with radar polarimetry

- Ensemble runs with large scale aerosol perturbation and LULC change for multiple convective precipitation events will be evaluated using polarimetric radar retrievals.
- Synthetic radar variables will be used to investigate its impact on process fingerprints:
  - changes in microphysical compositions
  - changes in microphysical/macrophysical processes
- Lifecycle statistics of the precipitating cloud systems (collaboration with Roel Neggers and Daisuke Sakurai)

WP2 Integration of CTM in TerrSysMP

- CTM will be integrated in TerrSysMP
- Benchmark study with actual, reduced and enhanced human disturbances will be developed.
- Simulated ensemble aerosol compositions will provide valuable insight in the coupling between LULC and atmospheric chemistry.
- Model data will be evaluated for diurnal cycle and the spatial pattern of different aerosol compositions.

WP3 Evaluation of TerrSysMP-CTM with radar polarimetry.

- TerrSysMP-CTM runs will be used to examine the impact of LULC change and aerosol chemistry on clouds and precipitations with the help of radar polarimetry.
- Synthetic radar variables will be used to investigate its impact on process fingerprints:
  - changes in microphysical compositions
  - changes in microphysical/macrophysical processes
- Lifecycle statistics of the precipitating cloud systems (collaboration with Roel Neggers and Daisuke Sakurai)

WP4 Explore critical linkages between land-aerosol-cloud-precipitation interaction

- Based on WP1 and WP3, critical linkages between the land-aerosol-cloud-precipitation interaction and the associated uncertainty in the model with and without the CTM coupling will be derived.
- Changes in the impact of reduced, actual and enhanced human disturbances on buffering mechanisms of summertime precipitating cloud systems with the inclusion of a CTM will be statistically examined by exploiting the simulated synthetic polarimetric radar variables.

Phase 2

- Improve the prediction of summertime convective precipitation events by directly assimilating the polarimetric variables.
- Data assimilation will be initially conducted using TerrSysMP-DART over the Bonn radar domain, followed by extension to TerrSysMP-CTM.

Thank you.

Current Collaborators:

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