Priority Program SPP 1167 of the DFG

Quantitative Precipitation Forecast

PQP Praecipitationis Quantitativae Praedictio

Model Evaluation and Predictability Studies Using the COPS/D-PHASE Data Set

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News on COPS 4D data set

- Data analysis of remote sensing systems ongoing
- VERA analyses of European surface stations in preparation
- Unique European precipitation data set collected
- First European precipitation fields with different integration times in preparation (1, 3, 6, 12, 24h)
- Focus on surface, lidar, GPS, and MSG data for model evaluation and process studies

COPS-GOP-D-PHASE data archive

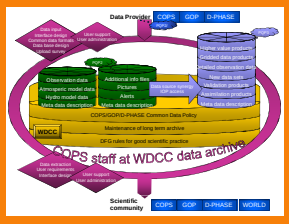
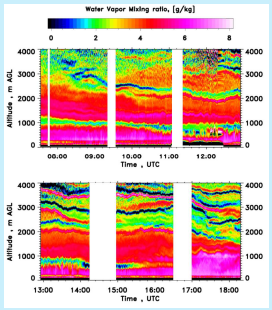


Fig.1: Data management

D-PHASE ensemble evaluation

- Model evaluation with respect to precipitation thresholds using radar data and fuzzy logics
- Spatial distribution of precipitation and diurnal cycles of atmospheric variables at IPM
- GPS slant path delay statistics (also used for data assimilation studies at IPM)
- VERA fields at UniVie

New DIAL results



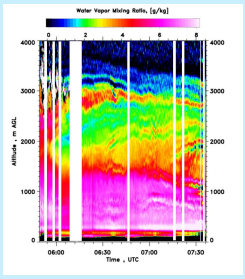


Fig.3: July 16, 2007. Further details are presented on poster B6.

Fig.2: IOP 11b, July 26, 2007.

DIAL reveals complexity of water-vapor field with high accuracy. The ABL usually is very shallow at Supersite H. Indications of mesoscale vortices?

Overlays in COSMO-DE grid

- A common COPS framework is in preparation to overlay key atmospheric measurements using the software IDL
- Extension by VERA fields and D-PHASE model results ongoing

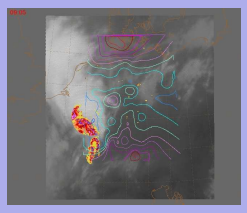
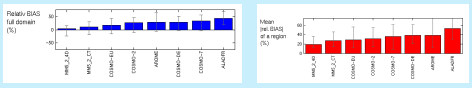


Fig.4: MSG IR, GPS IWV, and DWD radar data during IOP 9c, July , 20, 2007. Further results are shown on poster C4.

Model evaluation at Meteo Swiss



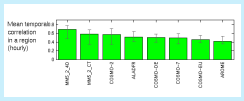


Fig.5: Model evaluation in four catchments with overlap to the COPS domain but edge of radar range.

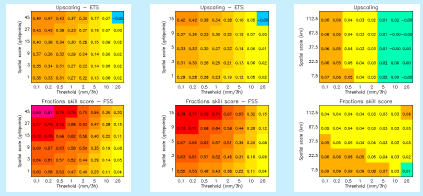


Fig.6: Fuzzy verification during DOP. Left: COSMO-2, center: COSMO-7, right: diff.

The European precipitation data set

Overview over the stations used for the accumulation		
Data Provider\Network	approx. number of stations	Temporal resolution of accumulation
Austria non-gts	220	1h,3h,6h,12h,24h
CH_stations_clim	23	12h,24h
CH_stations_rr	340	1h,3h,6h,12h,24h
CH_stations_synop	74	1h,3h,6h,12h,24h
CZ_stations	44-65	44 stations for 1h,3h,6h, 65 stations for 12h, 24h
DE_stations	630	1h,3h,6h,12h,24h
FR_stations_radomeh	1230	1h,3h,6h,12h,24h
FR_stations_rr6	1200	1h,3h,6h,12h,24h
FR_stations_synop	180	1h,3h,6h,12h,24h
ETS_stations	Italy: 150	1h,3h,24h
	Austria: 135	3h,12h,24h
	Belgium: 17	3h,12h,24h
	Switzerland: 68	3h,12h,24h
	Czech republic: 35	3h,12h,24h
	Germany: 170	3h,12h,24h
	France: 115-150	150 stations for 3h, 115 stations for 6h,12h,24h
	UK: 135-160	135 stations for 6h, 160 stations for 12h,24h
	Croatia: 43	3h,12h,24h
	Hungary: 31	3h,12h,24h
	Italy: 110-180	152 stations for3h, 180 stations for 12h, 110 stations for 24h
	The Netherlands: 34	3h,12h
	Poland: 60	3h,12h,24h
	Slovakia: 19	3h,12h,24h
	Slovenia: 19	3h,12h,24h
T_stations_aosta	90	1h,3h,6h,12h,24h
T_stations_asim_COSMO	290	3h,6h,12h,24h
T_stations_asim_syn	250	1h,3h,6h,12h,24h
T_stations_bozen_COSMO	50	3h,6h,12h,24h
T_stations_bozen_hyd	78	1h,3h,6h,12h,24h
T_stations_fvg_COSMO	25	3h,6h,12h,24h
T_stations_fvg_syn_1	29	1h,3h,6h,12h,24h
T_stations_fvg_syn_2	23	1h,3h,6h,12h,24h
T_stations_liguria_COSMO	72	3h,6h,12h,24h
T_stations_liguria_syn	135	1h,3h,6h,12h,24h
T_stations_lombardia	242	1h,3h,6h,12h,24h
T_stations_marche	59	1h,3h,6h,12h,24h
T_stations_marche_COSMO	12	3h,6h,12h,24h
T_stations_piemonte_COSMO	101	3h,6h,12h,24h
T_stations_trento_COSMO	11	3h,6h,12h,24h
T_stations_trento_syn	59	1h,3h,6h,12h,24h
T_stations_veneto	84	1h,3h,6h,12h,24h
SL_stations	16	1h,3h,6h,12h,24h
HH_Stations	500	24h

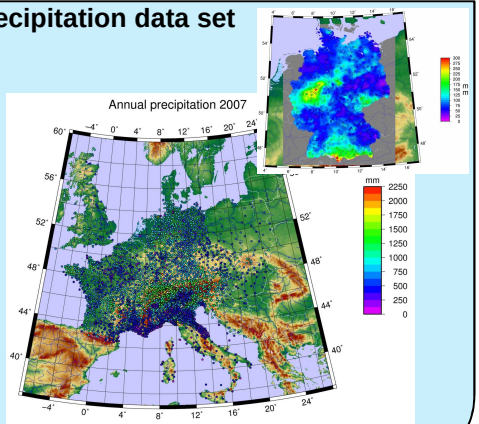


Fig.7: 2007 D-PHASE precipitation data set and comparison with REGNIE for August 2007 (see talk of T. Gorgas).

Model evaluation at IPM

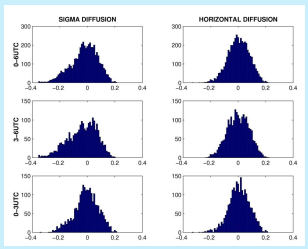


Fig.8: On the importance of horizontal diffusion in complex terrain as analyzed with GPS slant path delay data.

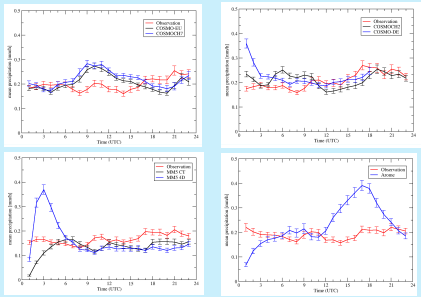


Fig.9: Evaluation of diurnal cycle of precipitation in COPS domain over COPS period.

All model evaluation strategies demonstrate superior performance of convection permitting models with respect to QPF.

Studies of predictability based on Bayesian statistics with NUMEX

- Performance analyses with deterministic and probabilistic skill scores
- Selection of multi-boundary, convection permitting multi-model ensemble

Bayesian factor B: $B_{ir} = \frac{l(\vec{d} \mid M_i)}{l(\vec{d} \mid M_r)}$ I: likelihood, d: data vector, M_i: ith model, M_r: reference model, in this case: observations

If the variable is multivariate normally distributed $l(\vec{d} \mid M_i) = \frac{1}{\sqrt{(2\pi)^q}} \sqrt{\frac{\det \mathbf{G}_i^{-1}}{\det \mathbf{K}_i \det \mathbf{K}_0}} \exp\left(-\frac{1}{2}\Lambda_i\right)$ with $\mathbf{G}_i = \mathbf{K}_i^{-1} + \mathbf{K}_0^{-1}$ and $\Lambda_i = (\vec{d} - \vec{f}_i)^T \mathbf{K}_0^{-1} \mathbf{G}_i^{-1} \mathbf{K}_i^{-1} (\vec{d} - \vec{f}_i)$

$\vec{f}_i$: forecast vector, $\mathbf{K}_i$: model error covariance matrix, $\mathbf{K}_0$: observation error covariance matrix.

A variable d is predictable in dependence of forecast range τ if $P_\tau(d) := B_{ir,\tau}(d) > B_c$ (sign. nonzero).

Consequently, we are proposing a method to quantify predictability of, e.g., precipitation, in dependence of forecast range, resolution, domain, and model physics.

Status

- Model evaluation made good progress, however, more detailed analyses are required with respect to various weather conditions.
- Best performance expected by convection permitting ensemble.
- Bayesian framework will be applied for predictability studies, in preparation.