Quantitative Precipitation Forecasts in the Alpine Region – First Results from the Forecast Demonstration Project MAP D-PHASE

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(Lyss-Hochwasser, 29.8.2007)
MAP D-PHASE
Demonstration of Probabilistic Hydrological and Atmospheric Simulation of flood Events in the Alpine region

• 2nd WWRP FDP (Forecast Demonstration Project) after Sydney 2000 and before Beijing 2008 and Vancouver 2010.
• Focuses on heavy precipitation, hydrology, high-resolution numerical modeling and ensembles.
• Huge number of participants: 30 atmospheric models, 7 hydrological models and more than 50 end users.
• Establishes an end-to-end forecasting system, which was operated from June until November 2007.

www.d-phase.info
Real-time
• warnings of all models
• forecast charts

Data archive
• 13 TB model data
• in a unified GRIB format for scientific evaluation
First results of D-PHASE | COSMO User Seminar, 3-4 March 2008, Langen
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D-PHASE data processing

Model output

65 target regions:

domain averages

RR time series

Yellow alert level, 24h accumulation

3 types of alerts:

- No alert
- 6 times a year
- Twice a year
- Every 10 years

(Accumulation times: 03h, 06h, 12h, 24h, 48h, 72h)

apply warnlevels

Alert time series
Verification – rules of the game

Models

Observations

domain averages

Verification of RR time series

apply warnlevels

Verification of alert time series

- **Period:** Summer 2007 (June, July, and August)
- **Spatial resolution:** 18 target regions in Switzerland
- **Temporal resolution:** 3 hour intervals
- **Forecast range:** Use most recent forecast, but ignore a certain cut-off time at the beginning of each forecast (default cut-off: 3h)
Observational data

Swiss Radar composite
- 3 Radar stations
- 5 min scans accumulated to hourly estimates
- 1km resolution

Gridded rain gauge data
- Statistical interpolation + elevation correction
- Daily accumulations

RADAR time series
- Warn regions averages
- Hourly accumulations

RADAR_CAL time series
- Warn regions averages
- Hourly accumulations
- Daily sums equivalent to gridded gauge data

Spatial average
Multiplicative correction to achieve match of daily accumulations
Verification of precipitation amount I

Whole Switzerland, summer 2007, relative BIAS

Single target region, summer 2007, relative BIAS

Single target region, 3 hourly resolution, correlation

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Verification of precipitation amount II
(RADAR_CAL reference)

Whole Switzerland, summer 2007, relative BIAS

Single target region, summer 2007, relative BIAS

Single target region, 3 hourly resolution, correlation
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Fuzzy Verification

Verification on coarser scales than model scale: “Do not require a point wise match!”

<table>
<thead>
<tr>
<th>Method</th>
<th>Raw Data</th>
<th>Fuzzyfication</th>
<th>Score</th>
<th>Example result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upscaling</td>
<td>![Upscaling Diagram]</td>
<td>Average</td>
<td>Equitable threat score</td>
<td>![Upscaling ETS Graph]</td>
</tr>
<tr>
<td>Fraction Skill Score (Roberts and Lean, 2005)</td>
<td>![Fractional Coverage Diagram]</td>
<td>Fractional coverage</td>
<td>Skill score with reference to worst forecast</td>
<td>![Fractional Coverage Graph]</td>
</tr>
</tbody>
</table>
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### Fuzzy Verification cosmo-2 – cosmo-7

JJA 2007, Verification against Swiss Radar Composite, 3 hourly accumulations

<table>
<thead>
<tr>
<th>Spatial scale (km)</th>
<th>upscaling</th>
<th>COSMO-2 (2.2km)</th>
<th>COSMO-7 (7km)</th>
<th>difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>0.53</td>
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<td>0.75</td>
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<td>0.18</td>
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<td>0.52</td>
<td>0.49</td>
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<td>0.54</td>
<td>0.45</td>
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</table>

<table>
<thead>
<tr>
<th>Threshold (mm/3h)</th>
<th>0.1</th>
<th>0.25</th>
<th>0.5</th>
<th>1</th>
<th>2.5</th>
<th>5</th>
<th>10</th>
<th>25</th>
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</thead>
<tbody>
<tr>
<td>bad</td>
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<td>0.25</td>
<td>0.5</td>
<td>1</td>
<td>2.5</td>
<td>5</td>
<td>10</td>
<td>25</td>
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<tr>
<td>good</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>1</td>
<td>2.5</td>
<td>5</td>
<td>10</td>
<td>25</td>
</tr>
</tbody>
</table>

COSMO-7 better | COSMO-2 better
Fuzzy Verification COSMO-DE – COSMO-EU

JJA 2007, Verification against Swiss Radar Composite, 3 hourly accumulations

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Alerts – level „yellow“, 3h intervals

(Alert level yellow = return frequency of 6 times per year)

Relative frequency of an alert (frequency bias)

Probability to detect an event (probability of detection)

Probability to issue a false alarm (false alarm ratio)

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Concept of “Relative Value”

Economic point of view:

Precautions causes Costs

Having no protection results in Losses

Event

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>L</td>
<td>0</td>
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</table>

Precaution

Yes  
No

Relative Value

- useless

useful

<table>
<thead>
<tr>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>no forecast</td>
</tr>
<tr>
<td>1.0</td>
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</table>
Relative value – Alert level „yellow“
(03h, 06h and 12h accumulations, cut-off +03h)

+ useful

- useless

... insensitive ... sensitive ... against false alarms
Advantage of convection resolving models

(03h, 06h and 12h accumulations, cut-off +03h)

+ useful

- useless

Insensitive … sensitive …

… against false alarms

param. conv.
resolved conv.
RADAR
global model
Impact of rapid update cycle
(03h, 06h and 12h accumulations, cut-off +03h)
Model Calibration - BIAS correction

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Simple calibration of COSMO-2

Multiply COSMO-2 precipitation forecasts by a factor of

- 2.0
- 1.25
- 1.0
- 0.8
- 0.5

D-PHASE poor-men's ensemble

Issue an alert, if a certain fraction of models gives a warning:

- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
Conclusions

- Quantitative precipitation verification is a delicate task: Observational uncertainties are not significantly smaller than forecast errors!

- Quality of precipitation warnings certainly does not satisfy all demands (~50% POD, ~50% FAR).

- However most COSMO models give good results compared to other D-PHASE models.

- In particular, most COSMO models outperform the IFS.

- Rapid update cycle (even without latent heat nudging) is beneficial.

- Probabilistic forecasts are useful for customers. Simple static recalibration and an uncalibrated ensemble forecasting system perform equally!