FORECASTING HEAVY PRECIPITATION EVENTS IN WINTER IN HUNGARY USING ECMWF ENSEMBLE FORECASTS AND INFORMATION BASED ON ERA-40

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OVERVIEW OF THE FORECASTING PROCESS

Original way of making weather forecasts

NWP Models

Direct Model Output

Post-processed Model Output (MOS, Kalman filter, PP, etc.)

Automated Forecasts (using algorithms)

Forecasts made by the forecaster (using own experiences)

Often problems about rare/extreme events…

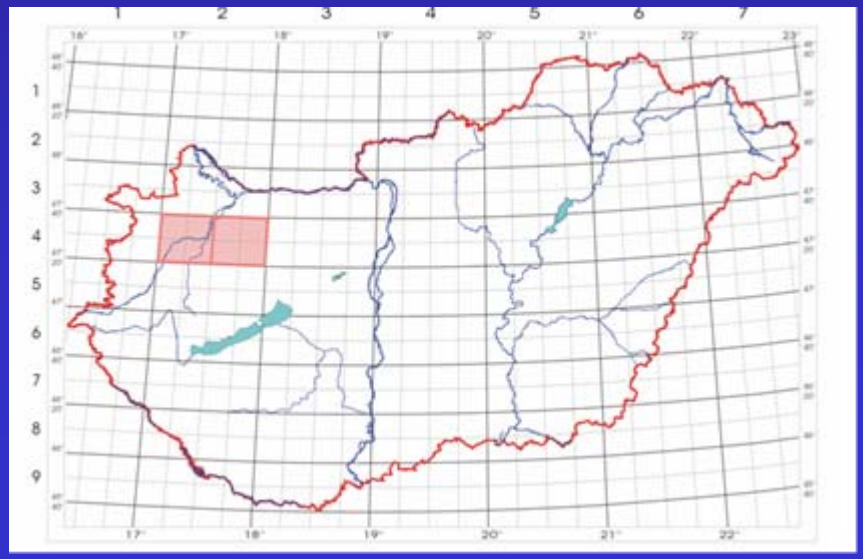
NWP Models + **Using additional information about special meteorological events (obtained from comprehensive investigations)**

Increasing forecast skill of rare events (?)

HEAVY PRECIPITATION EVENTS IN WINTER

Special meteorological events in this investigation → **Heavy Precipitation Events in winter**

Defined as: Cases during the winter period (Nov, Dec, Jan, Feb and March) with the area average of 24-hour accumulated precipitation exceeding 10 mm in more than 10% of the area of Hungary



- **High Resolution Observation Network (600 – 800 stations) used**
- **Precipitation average for grid boxes**
- **24-hour accumulated precipitation: 06 – 06 UTC**

INVESTIGATED PERIODS

Basic (learning) period → **Learning about HPEs**

- 1981/1982 – 2001/2002 (21 winter periods)
- 276 HPEs found ~ relative frequency of 8.7%

→ **Selected cases are quite rare and can be regarded as heavy precipitation events considering winter precipitation in Hungary**

Test period → **Using information about HPEs to test whether forecasts can be improved**

- 2002/2003 – 2006/2007 (5 independent winter periods)
- 61 HPEs found

SYNOPTIC CLASSIFICATION OF HPEs: ERA-40

Classification (subjective and objective) of synoptic-scale weather systems

- **Based on ERA-40 reanalysis fields**
- **Fields of 1.5° x 1.5° horizontal resolution used**
- **Area: 70°N, 30°N, 10°W, 50°E (~Europe)**
- **For each HPE, averaging 06, 12, 18, 00 and 06 UTC fields**

one single field containing information on the whole 24-hour period

Parameters used

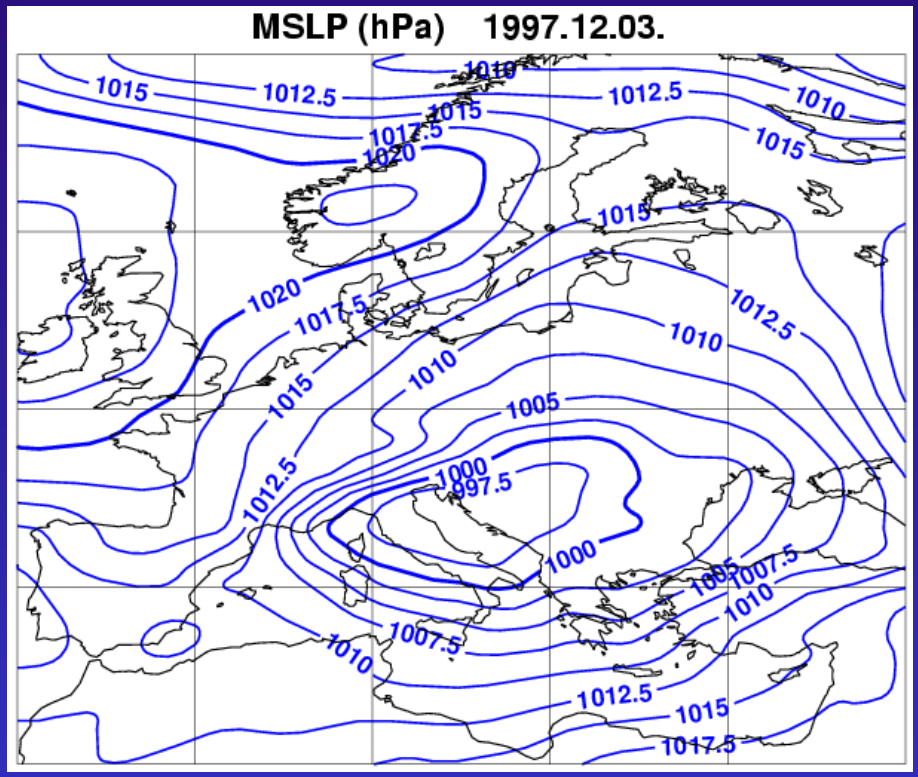
MSLP/G1000/G925/G850/G700/G500

T925/T850/T500

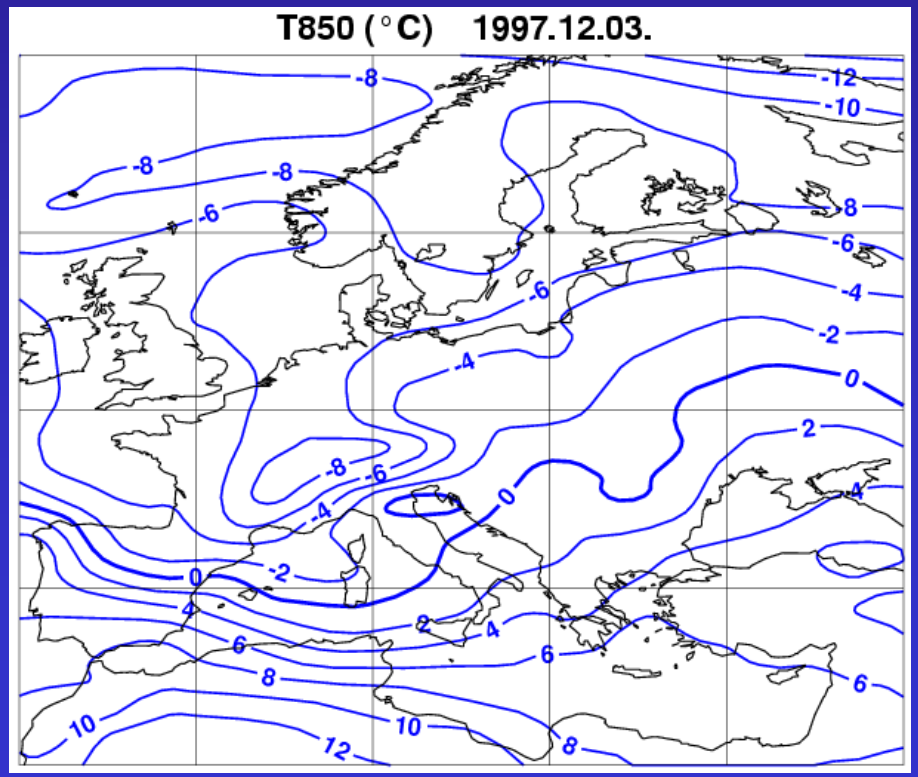
RHU700

PW - Precipitable water SD500/1000 – Saturation deficit

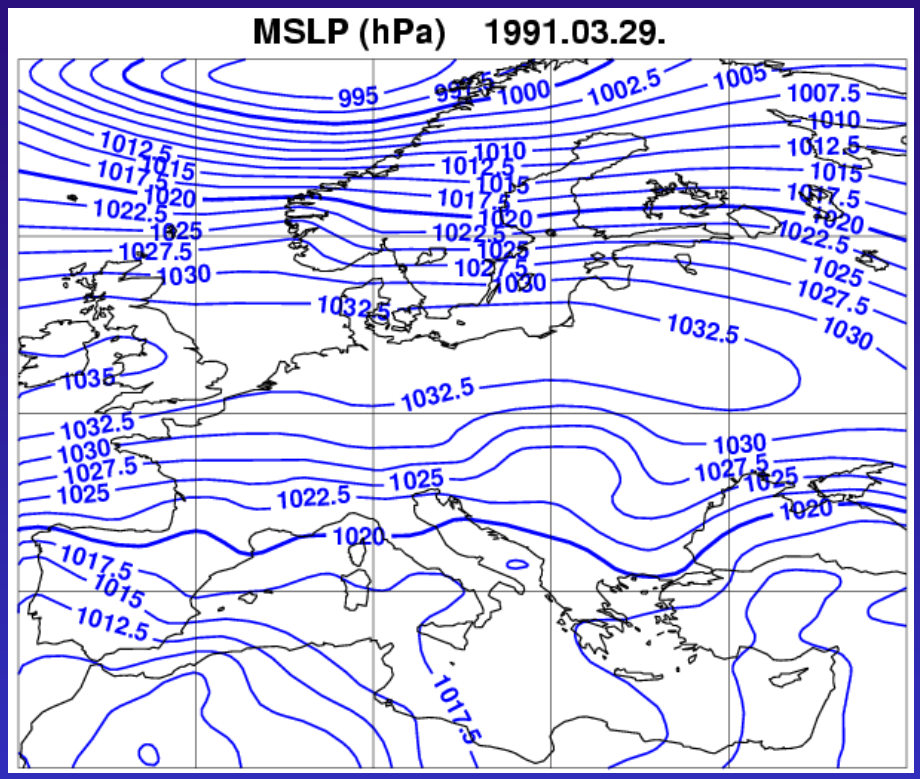
Mediterranean cyclone moving over the Carpathian Basin



One of the 9 weather types classified suitable for HPEs



Cyclonic curvature on the southern edge of an anticyclone



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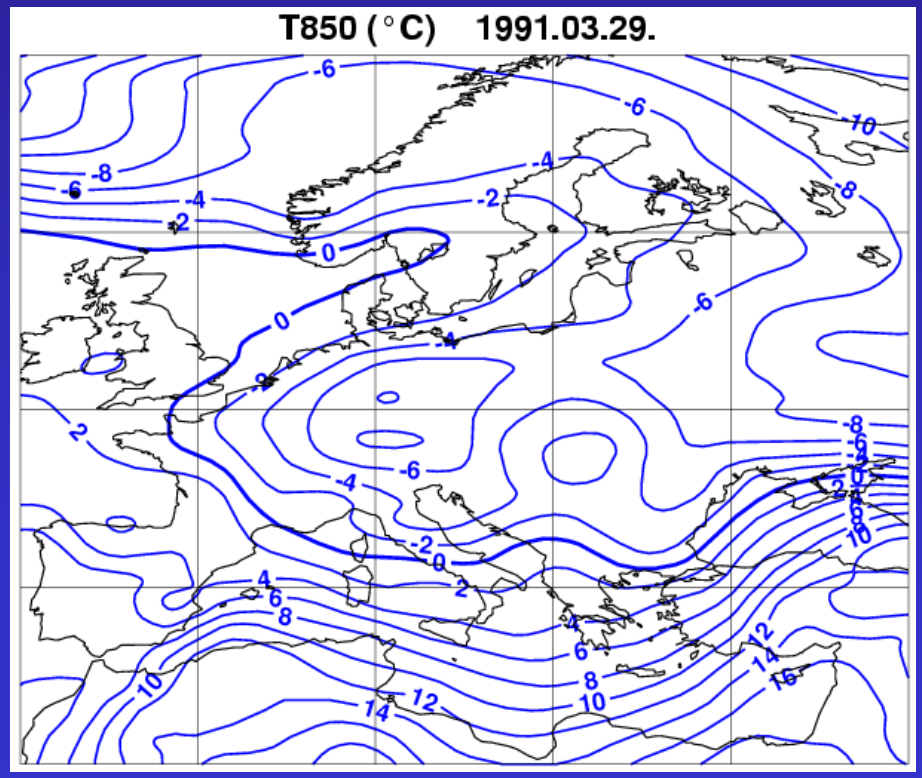
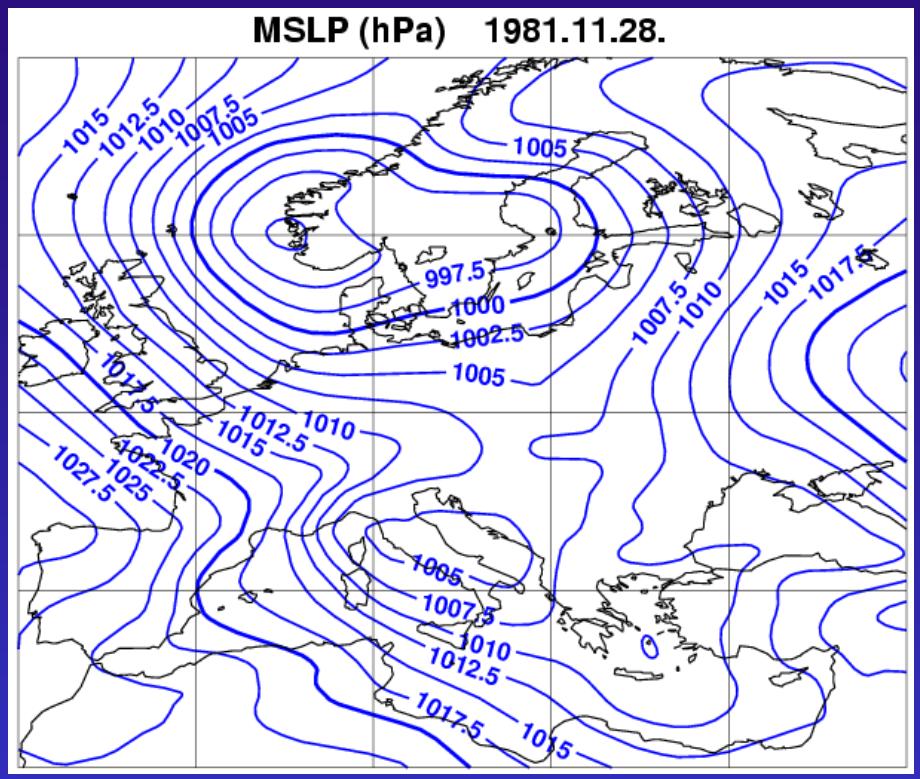


Frontal wave on the forward side of an upper level trough



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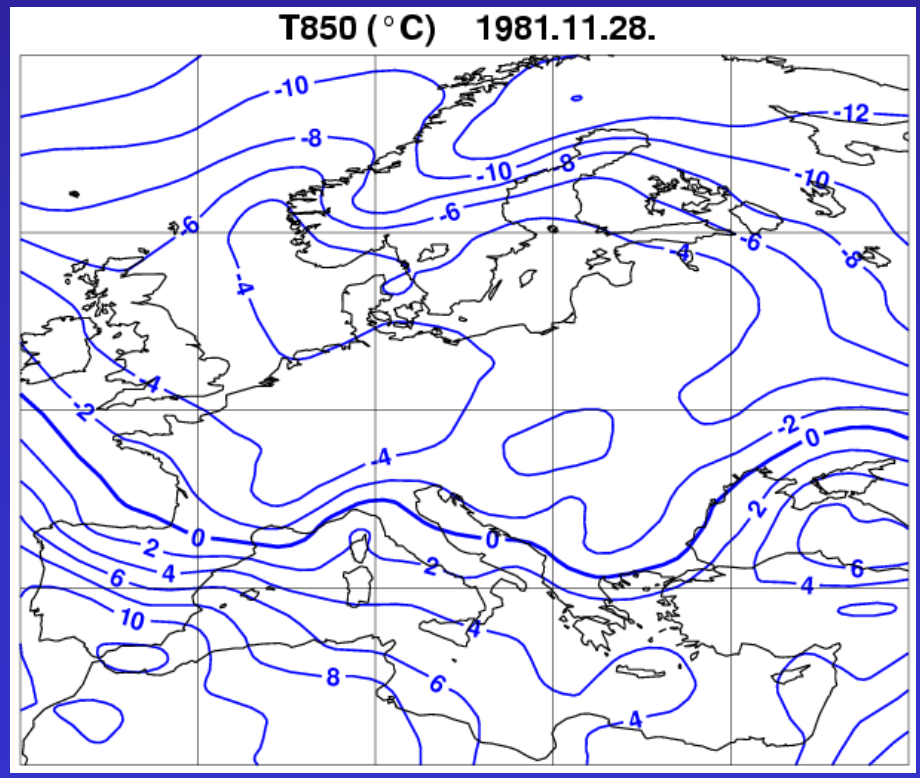


RESULTS OF SYNOPTIC CLASSIFICATION OF HPEs

9 weather types found

Quite different characteristics e.g:

- **Typical occurrence within the winter period**
- **Characteristic precipitation type and intensity**
- **Spatial extent and distribution of precipitation**

This information can be used efficiently when forecasting precipitation

FORECASTING HPEs: precipitation vs weather type

Original way

Using model precipitation forecasts and possibly modifying it according to (subjective) synoptic experience

New way

Using model forecast fields to predict weather types that can lead to heavy precipitation in winter in Hungary

Thereby combining model forecast results with information based on events from the past

FORECASTING HPEs: precipitation vs weather type

”Precipitation method”

Find out whether the predicted precipitation amount meets the criteria required for a HPE

”Weather type method”

Find out whether the predicted meteorological fields describe one of the weather types needed for heavy precipitation

Can the predicted weather pattern clustered as one of the heavy precipitation weather types?

FORECASTING HPEs: precipitation vs weather type

- Verification made for the 61 HPEs of the Test period (2002/03 – 2006/07)
- Deterministic, Control and EPS members all involved
- 9 different forecast ranges (D+2 … D+10)

Time step	18 - 42	42 - 66	66 - 90	90 - 114	114 - 138	138 - 162	162 - 186	186 - 210	210 - 234
Days	D+2	D+3	D+4	D+5	D+6	D+7	D+8	D+9	D+10

Precipitation → Direct model output (total precipitation)

Weather types → MSLP / T850 / RHU700 (not used: PW, SD, as model levels not archived in MARS for EPS members)

- Use of relative fields (MSLP and T850)

CLUSTERING FORECASTS FIELDS

Relative fields → **Relative value of each grid point compared to its environment is more important than its absolute value**

Relative field = Field – Spatial Average(Field)

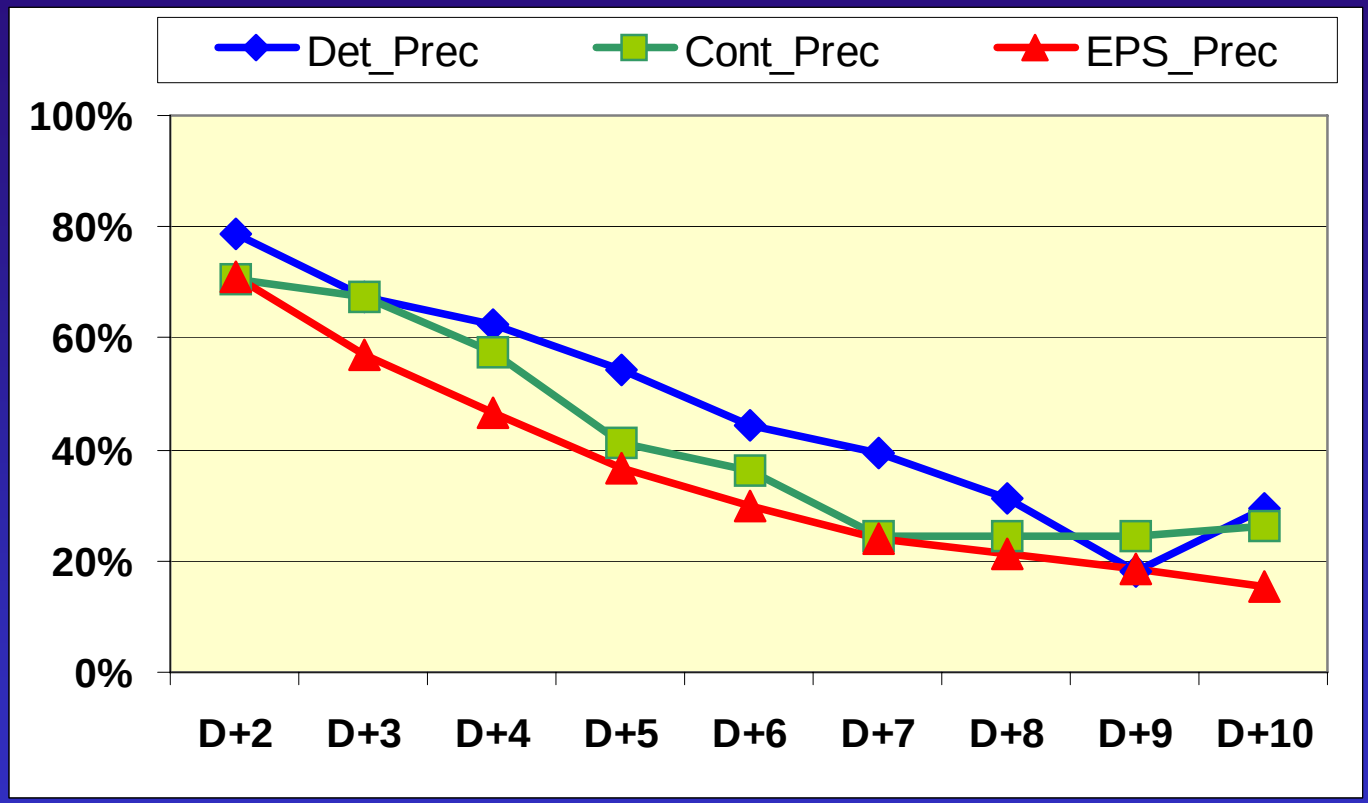
Temporally averaging (06/12/18/00/06 UTC) → **One single field containing information on the whole 24-hour period**

Forecasts fields classified as a HPE weather type if: (for MSLP/T850/RHU700) →

1, Sum of grid point differences from the HPE type average below the limit for this type

2, Grid point values within possible range for this type

VERIFICATION RESULTS – ”Precipitation method”

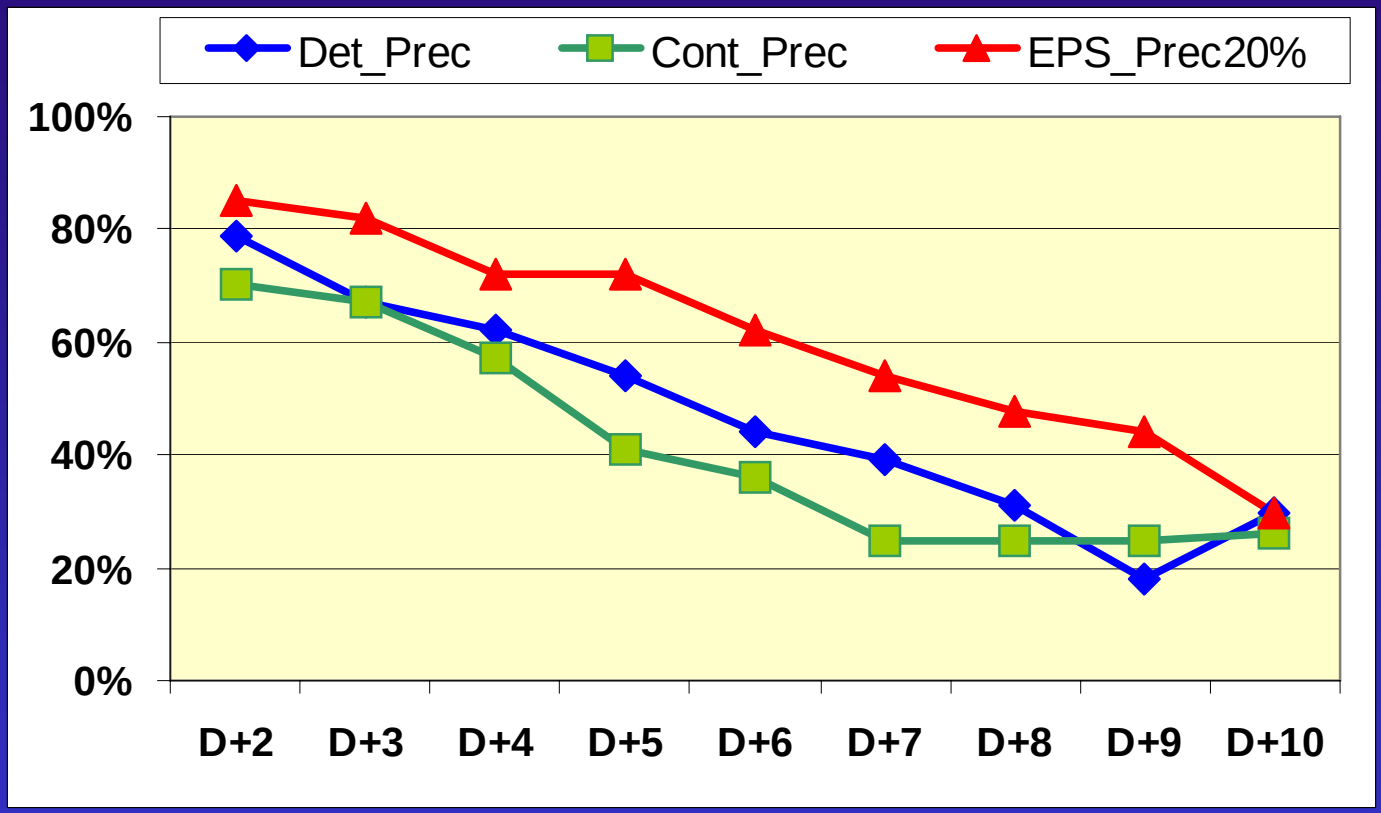


Deterministic best

Det, Cont: Percentage of cases with HPE forecast

EPS: Average percentage of EPS members forecasting HPE

VERIFICATION RESULTS – ”Precipitation method”

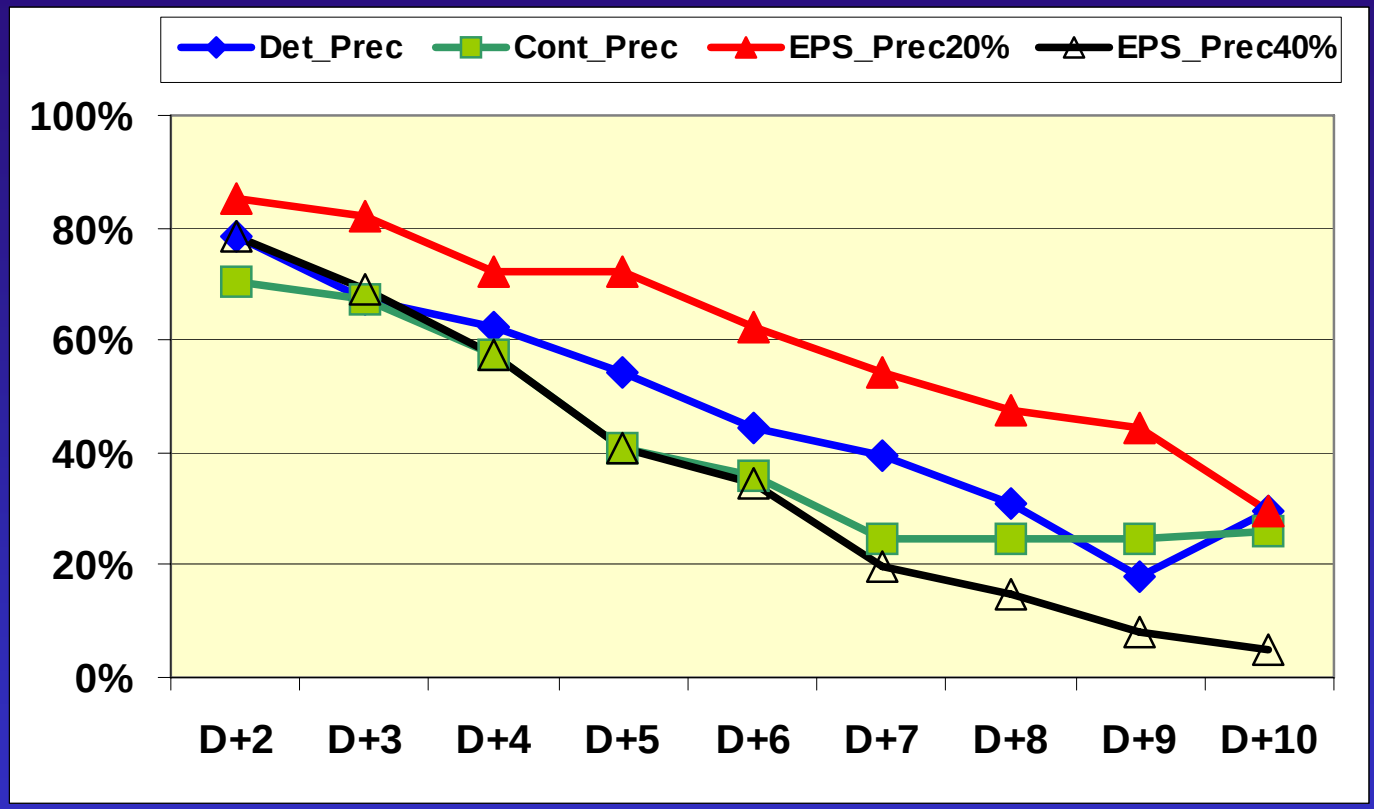


EPS best

Det, Cont: Percentage of cases with HPE forecast

EPS: Percentage of cases with at least 20% of EPS members forecasting HPE

VERIFICATION RESULTS – ”Precipitation method”

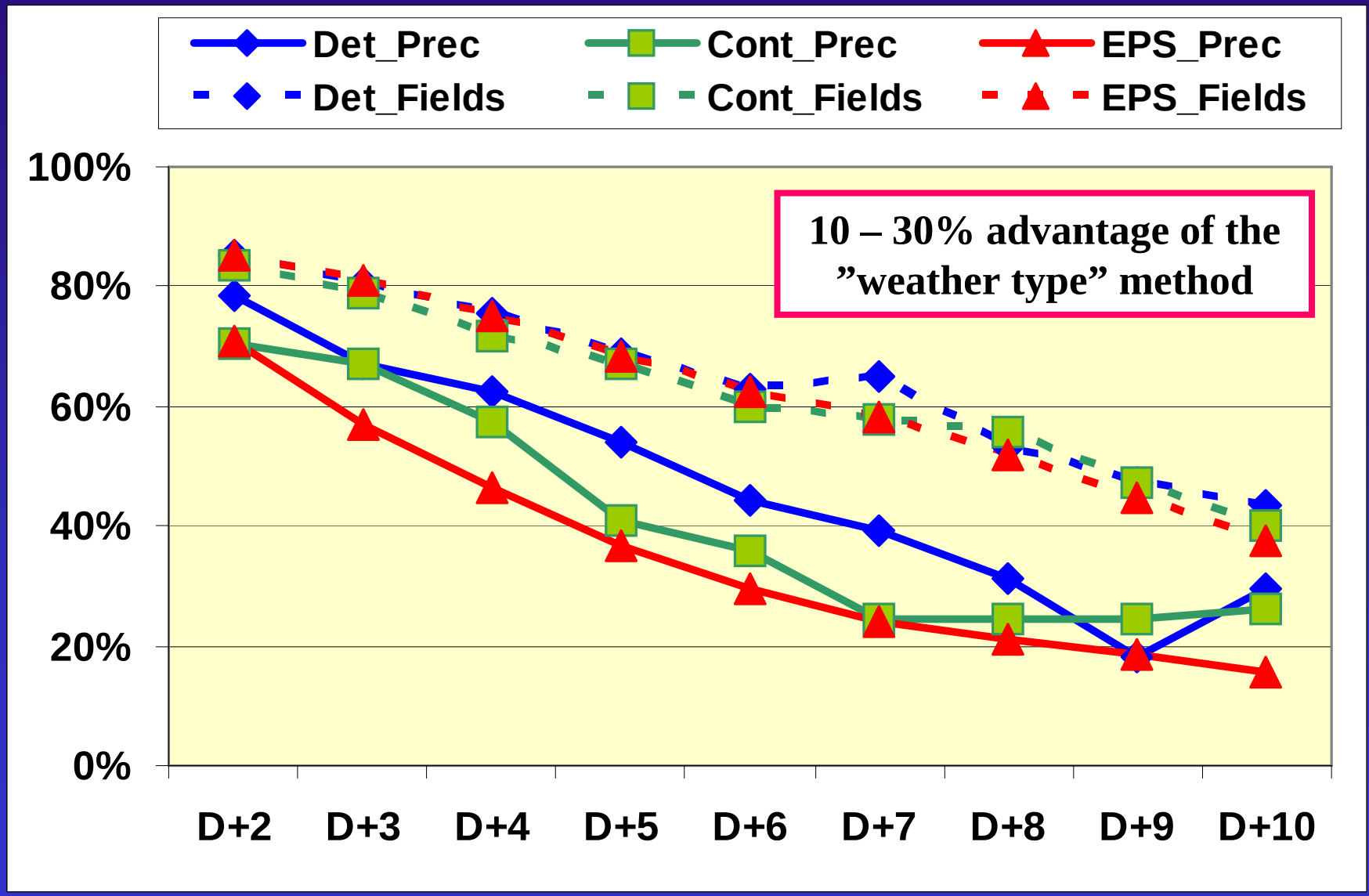


EPS best & worst

Det, Cont: Percentage of cases with HPE forecast

EPS: Percentage of cases with at least 20% or 40% of EPS members forecasting HPE

VERIFICATION RESULTS: precipitation vs weather type



CONCLUSION

- **It was shown that combining NWP output with relevant information based on comprehensive investigations, methods can be developed to considerably improve the forecast of rare events (HPEs in winter in Hungary) in the medium range**

- **However, using only MSLP, T850 and RHU700 to cluster forecast fields might not be enough to adequately identify HPE weather types and might possibly lead to high false alarm rate by specifying only some of the criteria needed for the formation of a weather system causing heavy precipitation**

- **High false alarm rate can only be decreased by using more sophisticated parameters like Precipitable water or Saturation Deficit500/1000, which, however, means more computation, and currently not possible for EPS fields due to the lack of necessary data in MARS (available operationally?)**