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Variants of meteorological conditions during large-scale rain floods

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Selection of flood events

Assumption

Rain floods on major rivers in Central Europe are caused by widespread and relatively intense rainfalls which often last several days. *Müller et al., NHESS, 2009, 441-450*

Rainfalls are usually linked with circulation conditions in synoptic scale. *Müller and Kaspar, . J. Phys. Chem. Earth., 2010, 484-490*

Selection criterion

- Sum of the products of the areas of affected catchments (>100 km²) and the return periods of respective peak flows
- □ Lower threshold value of the criterion was applied.
- □ 41 events were selected in the period 1951-2010.
- □ Flood events vs. rain events Kaspar and Müller, NHESS, 2008, 1359-1367
 - both sets almost identiacal;
 - rankings of their magnitudes different.



Methods

Anomalies in (thermo)dynamic variables

- □ Anomaly
 - Cavazos, J. of Climate, 1999, 1506-1523
- area of climatologically low or high values
- Meso-alpha scale anomalies
 Müller et al., Atmos. Research, 2009, 308-317
- typical of widespread and steady rains;
- in specific regions and stages of the events.

Divisive clustering of the events

- □ Criterion of similarity
- magnitude (mean **P**) of typical anomalies
- PC analysis
- reduction of considered anomalies (40/238)
- Optimization of clustering
- reduction of considered PCs using cophenet & inconsistency coeffs. & scree test (8/40)

P: probability of not exceeding



30° W – 40° E

Data

- NCEP/NCAR reanalysis, 1951-2010, Europe & N. Atlantic, resolution 2.5°.



Thermobaric conditions



Thermobaric conditions



Thermobaric conditions



Thermobaric conditions



Thermobaric conditions



Thermobaric conditions



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Variants of conditions

Thermobaric conditions



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Thermobaric conditions



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Thermobaric conditions



Thermobaric conditions



Thermobaric conditions

IV



Thermobaric conditions



Conclusions



- □ Selection of flood events
 - 41 events 1951-2010;
 - criterion: area of affected catchments & return period of peak flows.

□ Variants of meteorological conditions

- divisive clustering of the events according to the magnitude of meso-a anomalies;
- 4 consistent clusters of 2nd level.
- 2 cyclonic variants (**I** + **II**):

Anomalies connected with strong baroclinity and conditions favorable for production and orographic enhancement of precipitation.

1 transitional variant (frontal zone & cyclone, **III**) :

Initially, anomalies connected with arriving of warm and moist air.

1 non-cyclonic variant (**IV**) :

Anomalies connected with moist air at lower levels.

- Cyclonic variants (especially **I**) are the most noticeable and dangerous in respect of the magnitude of anomalies, floods and affected area.

Conclusions

□ Selection of flood events

- 41 events 1951-2010;
- criterion: area of affected catchments & return period of peak flows.

□ Variants of meteorological conditions

- divisive clustering of the events according to the magnitude of meso-a anomalies;
- 4 consistent clusters of 2nd level.

Possible outlook

- application of a fuzzy clustering approach;
- confirmation of applicability in other regions;
 - better comparison of various regions in view of circulation causes;
 - detection of past flood events in case of lacking direct data

Thank you !



References

- Cavazos, T., 1999: Large-Scale Circulation Anomalies Conducive to Extreme Precipitation Events and Derivation of Daily Rainfall in Northeastern Mexico and Southeastern Texas. J Climate, 12, 1506–1523.
- Kaspar, M., Müller, M., 2008: Selection of historic heavy large-scale rainfall events in the Czech Republic. NHESS, 8, 1359–1367.
- Müller, M., Kaspar, M., Rezacova, D., Sokol, Z., 2009: Extremeness of meteorological variables as an indicator of extreme precipitation events. Atmos. Research 92, 308–317.
- Müller, M., Kašpar, M., Matschullat, J., 2009: Heavy rains and extreme rainfall-runoff events in Central Europe from 1951 to 2002. NHESS 9, 441–450.
- Müller, M., Kaspar, M., 2010: Quantitative aspect in circulation type classifications
 An example based on evaluation of moisture flux anomalies. J. Phys. Chem. Earth., 484–490.

See also posters A5/151 describing some variants by moisture fluxes and Hovmöller diagrams across Central European catchments and A6/231 containing comparative study of 2010 rain floods.