

# Changes in Vb cyclone frequency and rainfall under anthropogenic climate change



Katrin M. Nissen<sup>1</sup>, U. Ulbrich<sup>1</sup>, G.C. Leckebusch<sup>2</sup>, N. Becker<sup>1</sup>

katrin.nissen@met.fu-berlin.de

1: Freie Universität Berlin, Germany, 2: University of Birmingham, UK

## MOTIVATION:

- Cyclones following a track from the Mediterranean region towards central Europe, passing the Alpine mountain range, have been called "Vb cyclones" according to a classification from the 19th century (van Bebber, 1891).
- They are highly relevant for Europe because of their potential to produce extensive precipitation and subsequent flooding, in particular during the warm season.
- An objective detection algorithm is introduced and validated using ERA40 reanalysis data. The climate change signal is analysed in an ensemble of 3 A1B GHG scenario simulations with the ECHAM5 MPIOM model.

## Historic Events

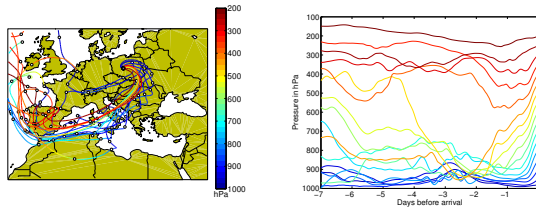
Validation of algorithm using the ERA40 data set (only April-Sept.)

### 1970-2000:

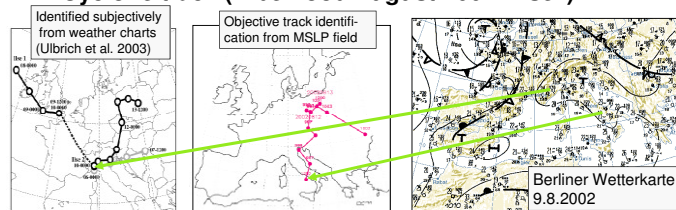
- 37 Vb-events in ERA40 (15 with extreme precipitation)
- Slight increase towards the end of the period (1971-1980: 3, 1981-1990: 5, 1991-2000: 7 events with extreme precipitation)

### Example for backward trajectory (May 1984):

Air is transported from the Mediterranean into Central Europe. The Vb-trajectories reach the low Central European mountain ranges from the North East. The air masses are lifted.



### Cyclone track (Elbe flood August 2002 "Ilse"):



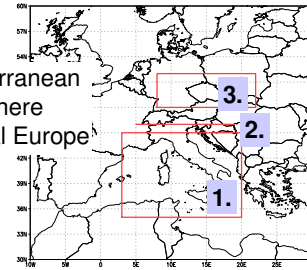
Historic cyclone track is found by the method. Slight differences can be attributed to the synoptic situation.

## Vb Objective Identification

1. Cyclone identification and tracking (Murray und Simmonds 1991)

2. Cyclone path

1. detected in Mediterranean
2. pass Alps or split there
3.  $\geq 12$ hrs in Central Europe

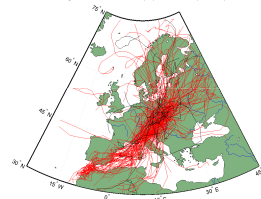


3. Precipitation

distinguish between

- a) all Vb cyclones
- b) Vb cyclones associated with extreme precipitation (daily sum over Central Europe 3 above 95<sup>th</sup> percentile)

## Model Validation



Vb cyclone tracks for events associated with intense precipitation ERA40 (black) 3x ECHAM5 (red)

ERA40	ECHAM5
24,6 km/h	30,3 km/h

Average propagation speed over Central Europe for events associated with intense precipitation

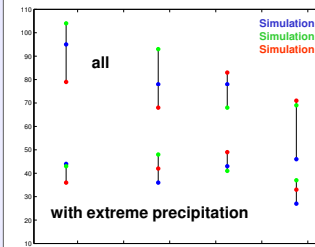
ERA40	ECHAM5
1.3 days	0.9 days

Average residence time over Central Europe for events associated with intense precipitation

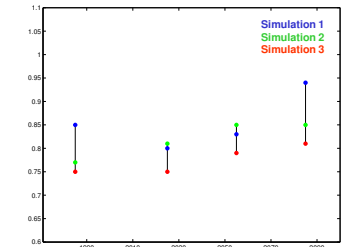
- More Vb tracks in ECHAM5 (average 92) than in ERA40 (37)
- More Vb tracks with intense precipitation in ECHAM5 (average 41) than in ERA40 (15)
- Higher propagation speed of Vb cyclones in ECHAM5
- Lower residence time over Central Europe in ECHAM5
- The tracks are well captured by the objective detection scheme

## Climate Change

- The total number of Vb events is decreasing.
- The number of Vb events associated with extreme precipitation (daily sum over Central Europe above 20C 95<sup>th</sup> percentile) remains stable.
- The mean amount of precipitation associated with the rain intensive Vb events (daily sum over Central Europe above 20C 95<sup>th</sup> percentile) is increasing with time (not statistically significant).



Number of Vb events for 4 30-year long periods in 3 simulations with the ECHAM5 MPIOM model forced with A1B greenhouse gas scenario.



Accumulated precipitation associated with rain intensive Vb events. Mean over 30-year long periods in 3 simulations with the ECHAM5 MPIOM model. In mm/sec

## Summary

### Historic Events:

- Most documented events are captured
- Origin of air masses consistent with Vb situations

### Model validation:

- More Vb events in the model than in ERA40
- Higher propagation speed and lower residence time in the model compared to ERA40.

### Climate Change:

- Reduction in the total number of Vb events
- No change in the number of Vb events associated with extreme precipitation
- Risk of more severe flooding due to Vb situations (not statistically significant)