An alternative weather type classification based on spatio-temporal field derivations

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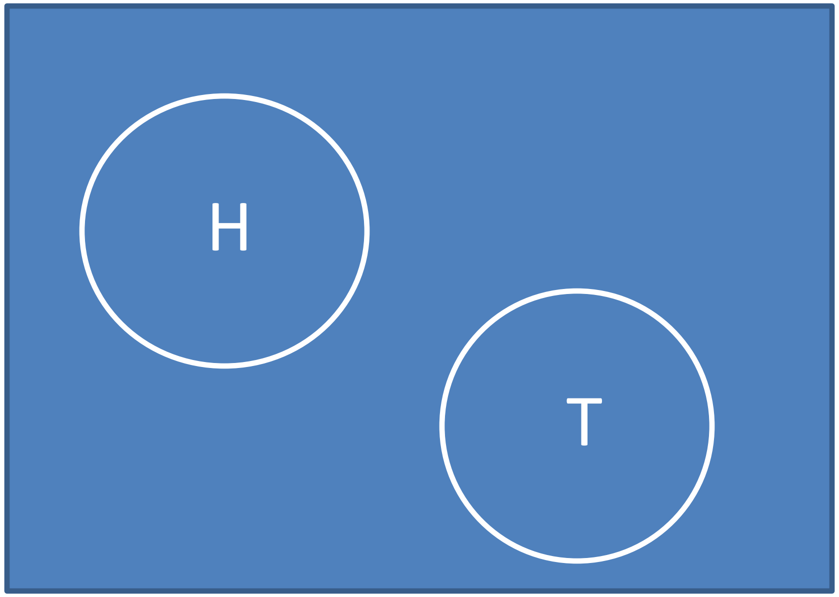
Presented at the workshop:
Classifications in atmospheric sciences and their applications
Present state & future directions
COST 733: Harmonisation and Application of weather type classification in Europe

European Cooperation in Science and Technology

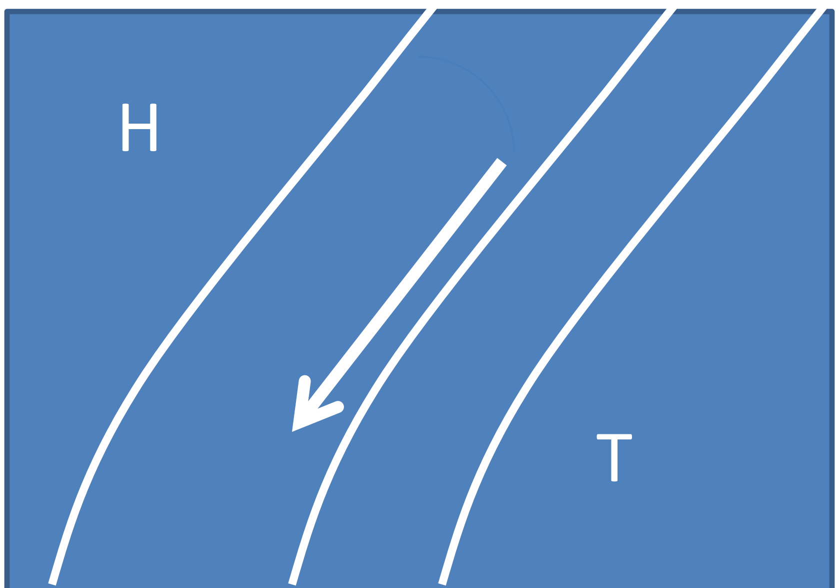
Plan

- standard vs. alternative
- definition of spatio-temporal measures
- application to Alpine gridded time series
- results and conclusion



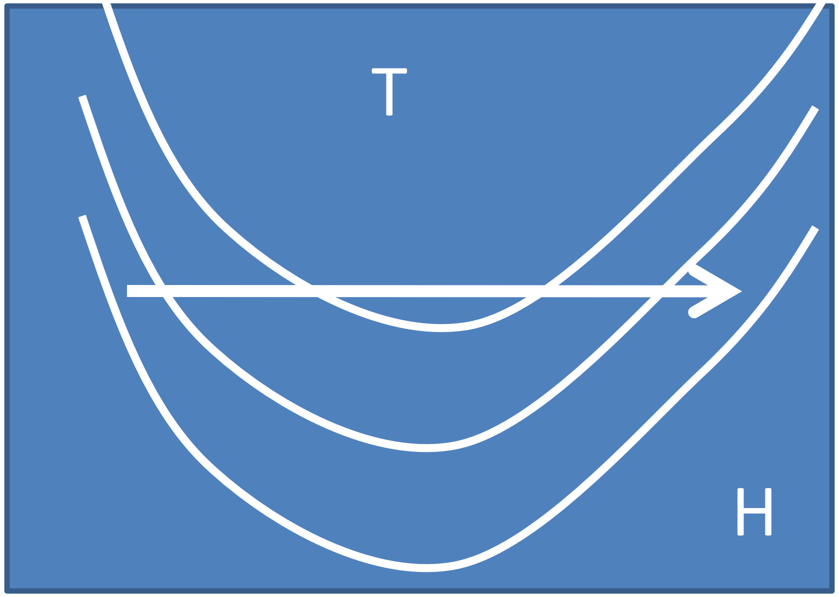
Field distribution/ pattern

e. g. pressure, geopotential, temperature
Ψ(x,y)



Flow direction/speed

e. g. pressure-, geopotential-gradient
(1st directional derivative)
ΔΨ/Δx; ΔΨ/Δy

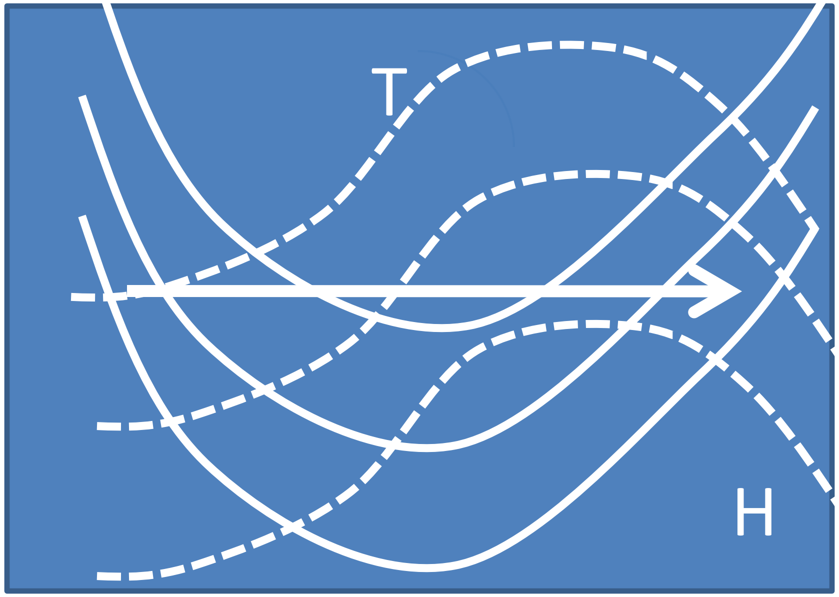


Vorticity (curvature/shear) of the flow field

second spatial derivative

e. g. Laplace of the field (stream function)

$\nabla^2\Psi$



Two-/multilevel approach

Two-/multivariate approach

e. g. 3D field information

e. g. pressure + humidity

Major problem:

Selection of adequate time window; validity

24h – 12h – 6h ?

Alternative:

Additional consideration of temporal derivatives, as most weather events are connected to transient systems

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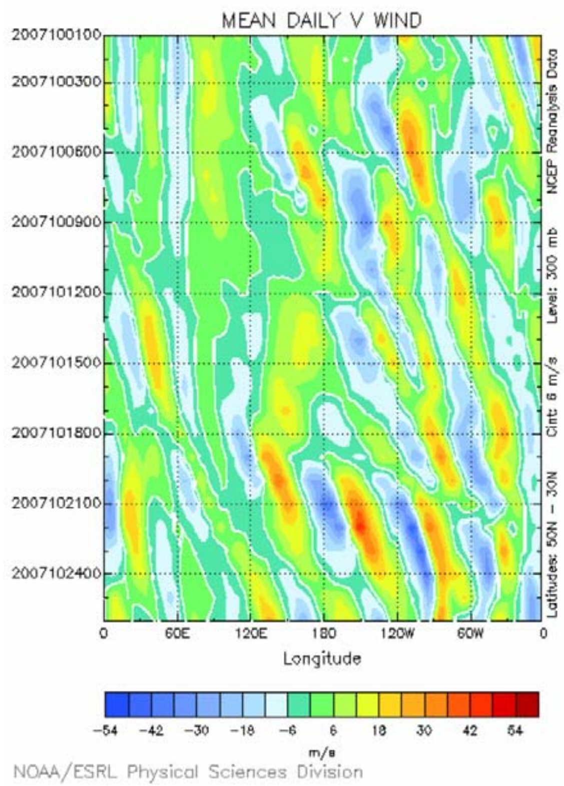
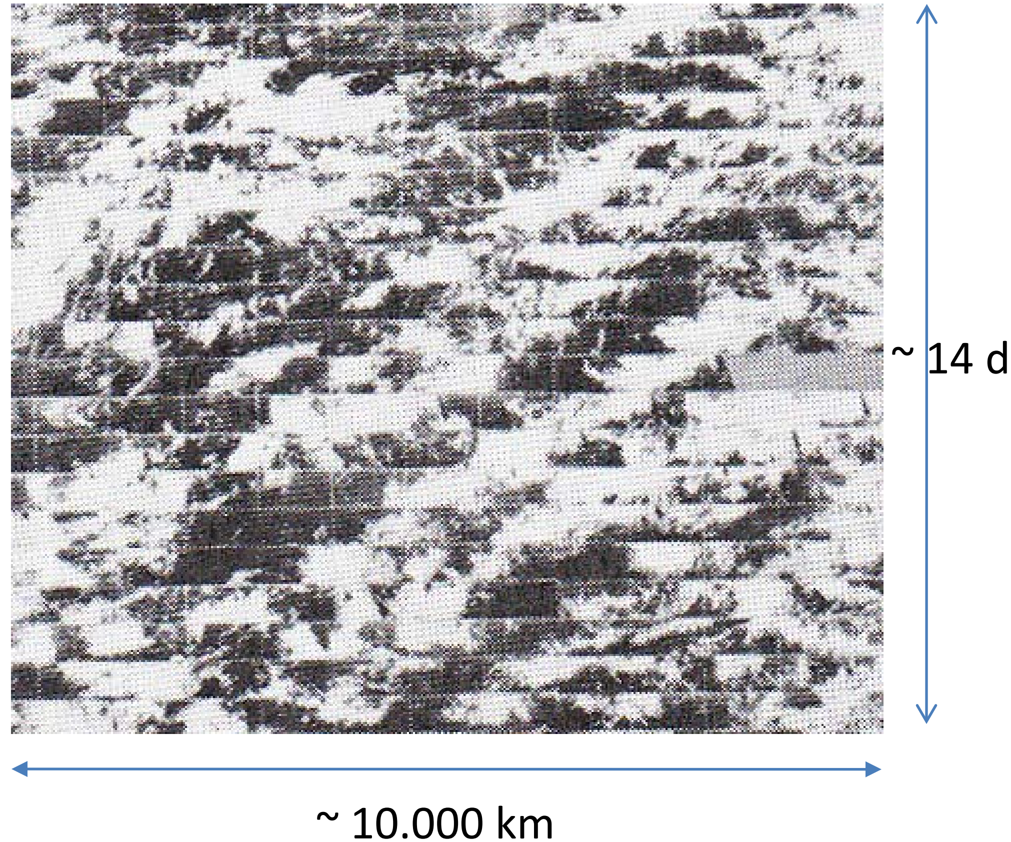
Selection of adequate spatiotemporal scale:
→ Hovmoller diagram (spatio-temporal coherency)





Hovmoller diagram of mean mid latitude daily meridional wind at 300hPa (left) from: http://www.atmos.albany.edu/student/heathera/mapdisc_10-26-07/hov_v_30-50_Oct_2007.gif
and of tropical cloud systems (right), from Wallace and Hobbs, 1977

Selection of adequate spatiotemporal scale:

→ Hovmoller diagram (spatio-temporal coherency)

e. g. to correlate (synoptic/frontal) precipitation events with pressure fields:

$\Delta t \sim 3h$, $\Delta l \sim 100km$ ($c \sim 10\ m/s$)

to avoid influence of meteorological noise and
to allow an application of global scale (climate) models:

$\Delta t \sim 24h$, $\Delta l \sim 500km$

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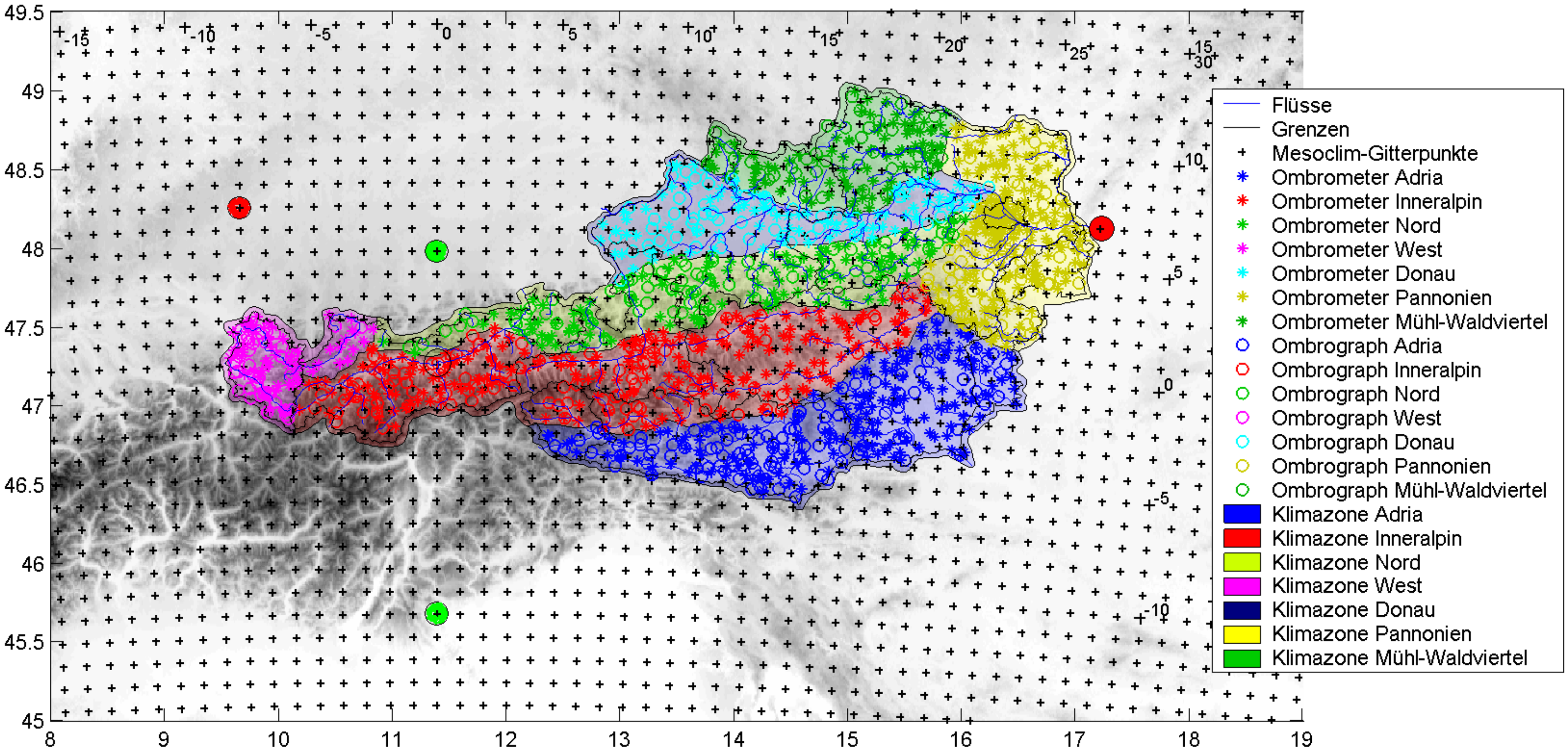
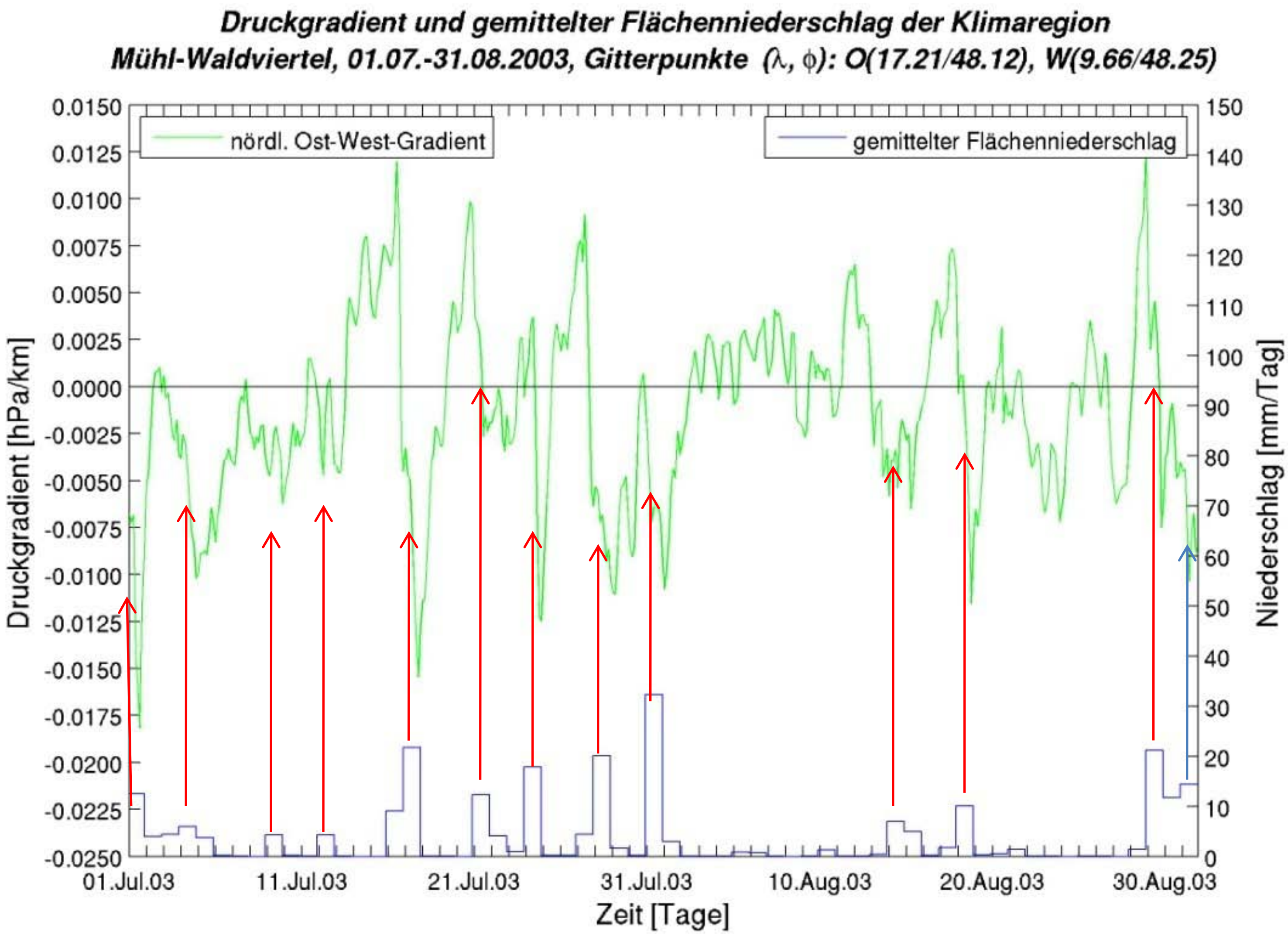


Domain of MESOCLIM pressure grid points around Austria
Red and green dots represent the E/W and N/S extent of Δl
Color points are precipitation stations within certain climatic regions



E/W pressure gradient (green) and 24 hr precipitation (blue) in July/August 2003

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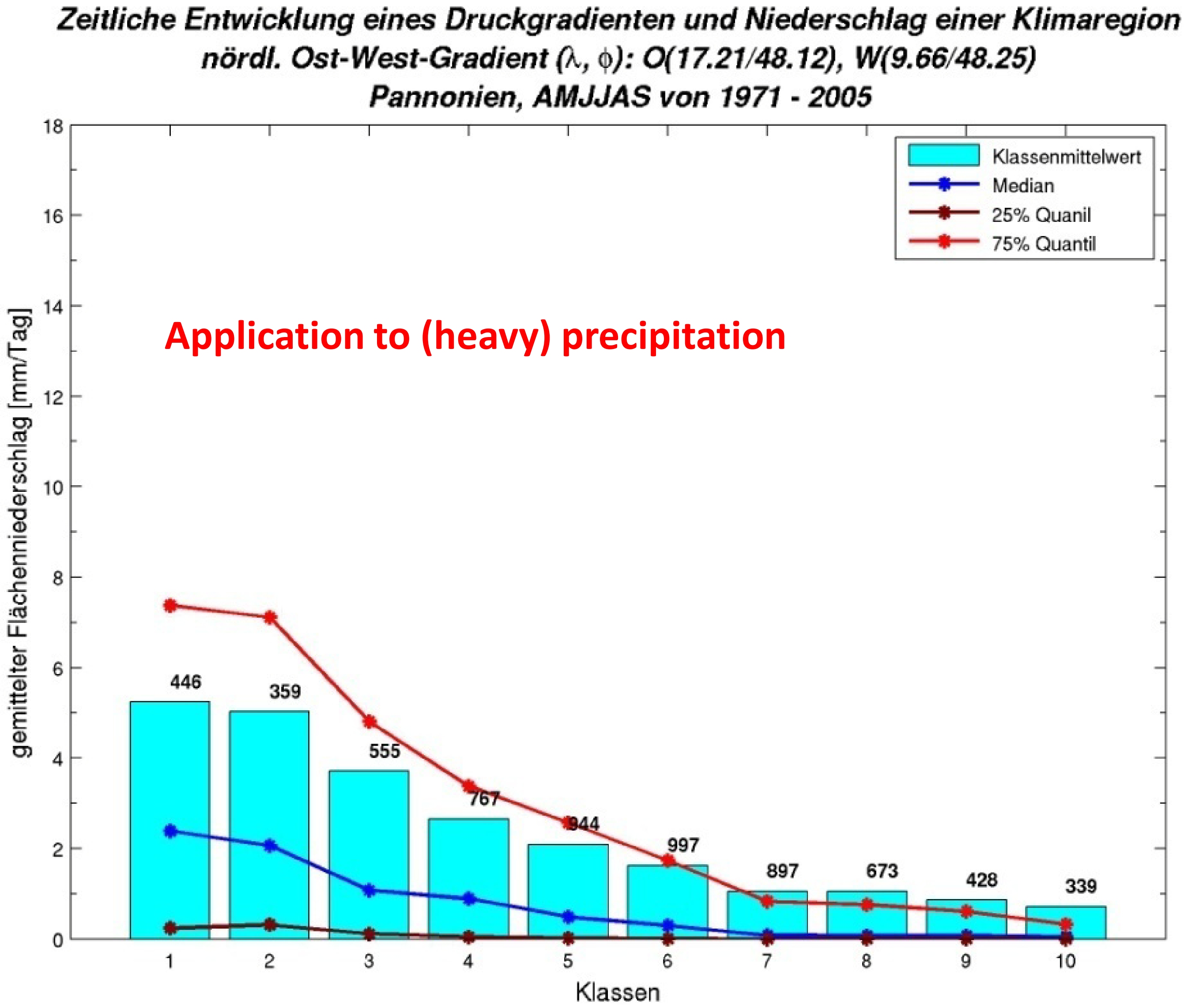
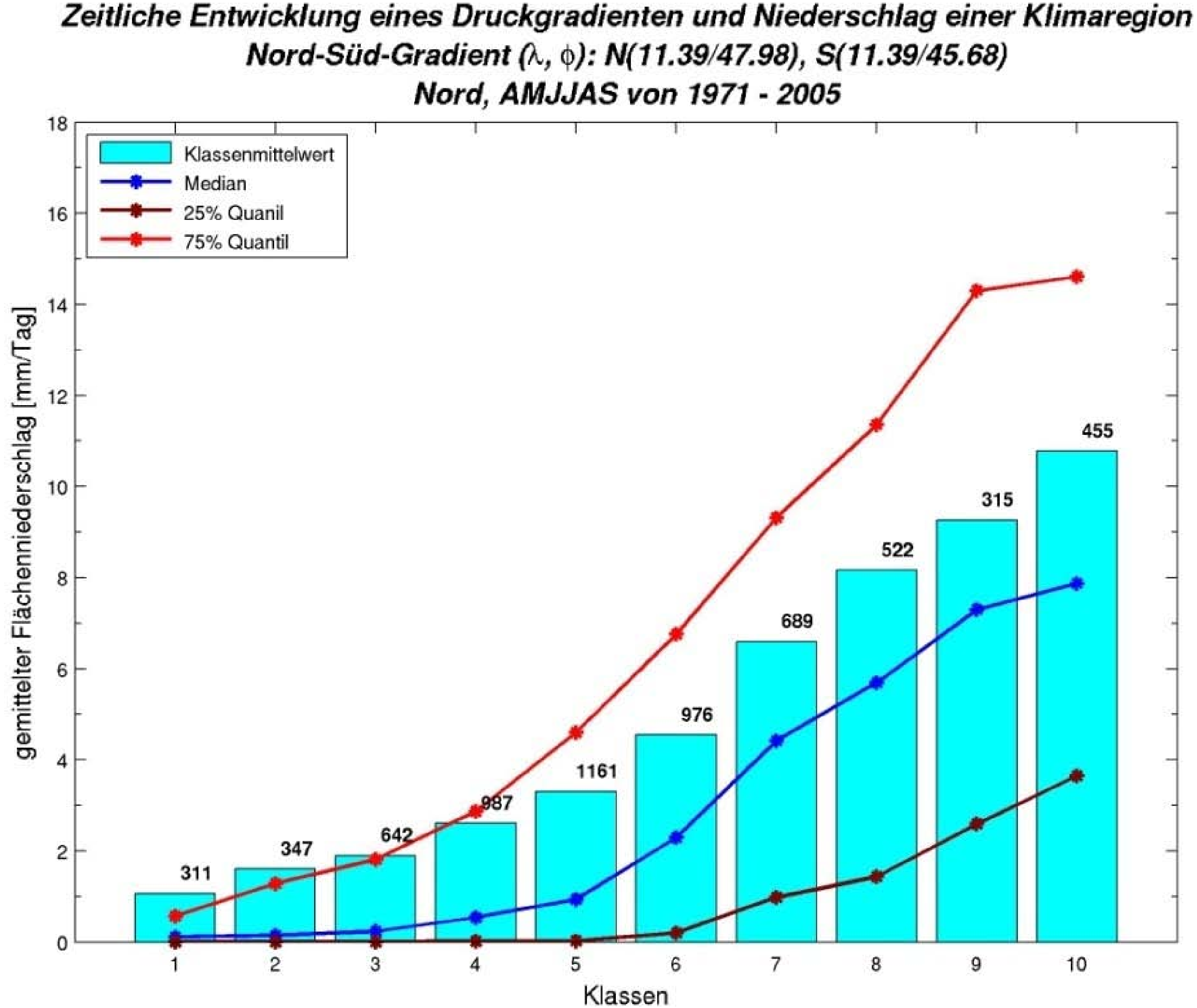
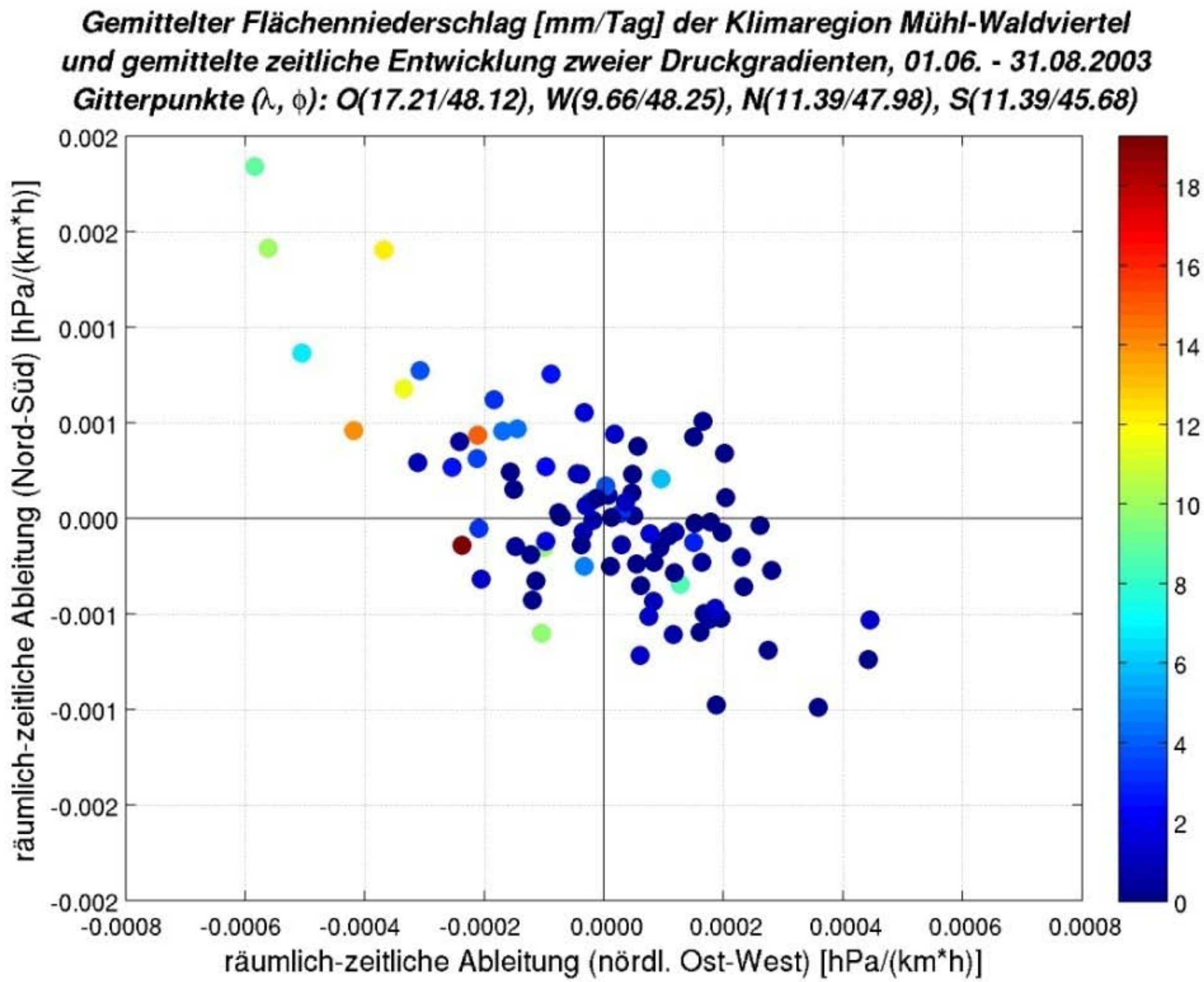


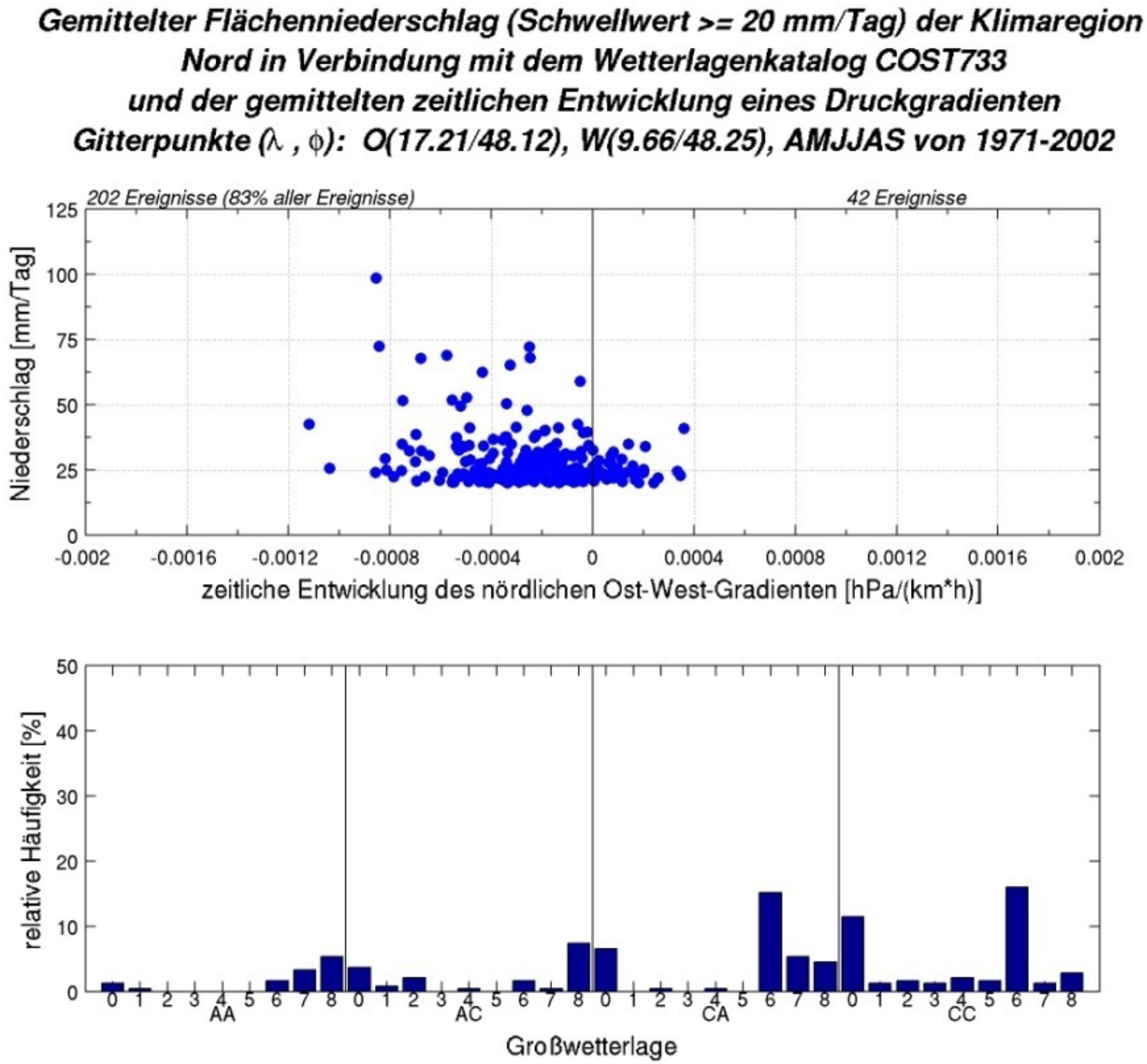
Median and quartiles of 24 hr precipitation with regard to classes of second mixed derivatives $\Delta^2 p/(\Delta x \Delta t)$ for summer season (April – September) 1971 – 2005 for climate region VIENNA



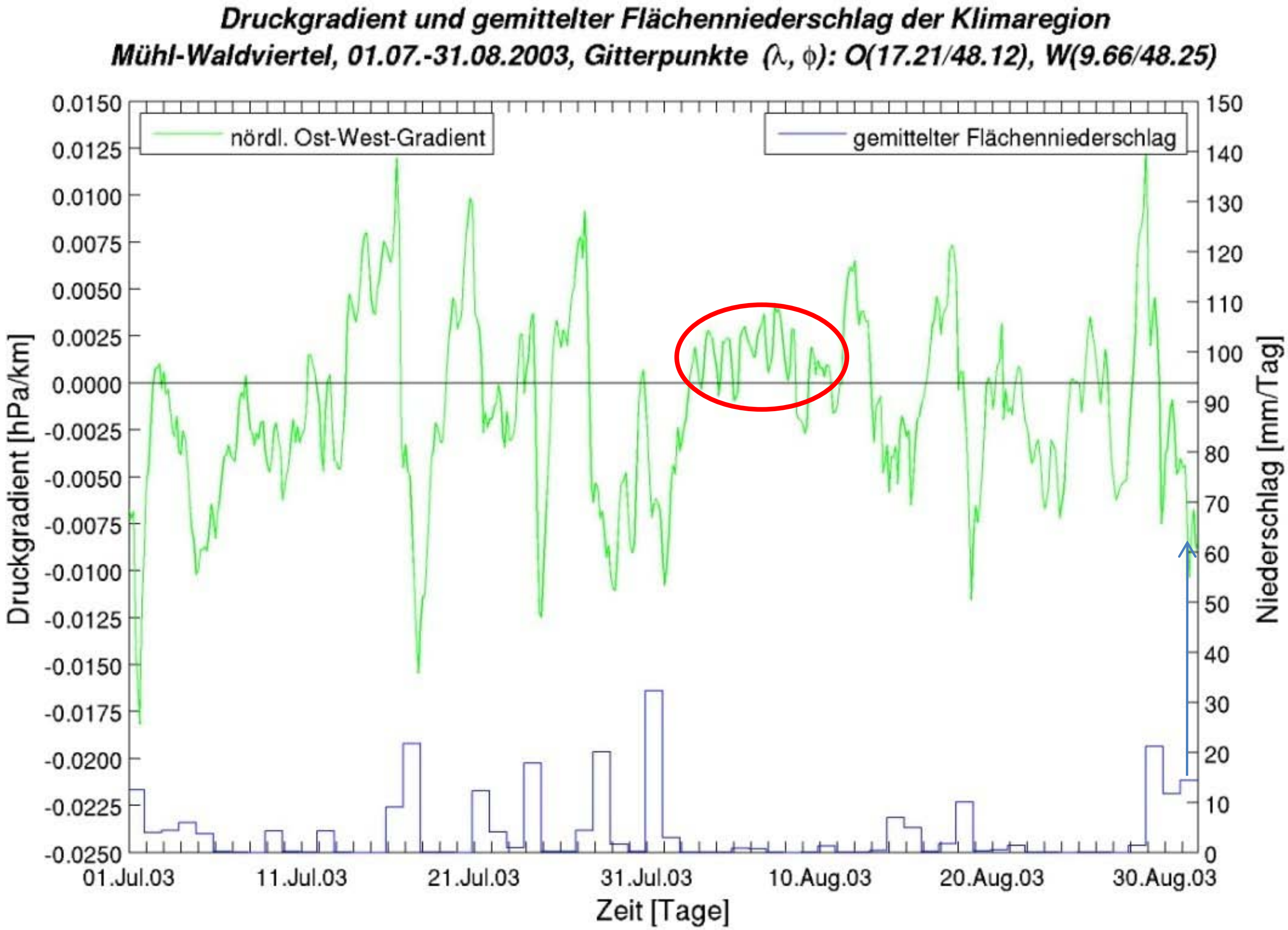
Same as before but for $\Delta^2 p / (\Delta y \Delta t)$ and climate region NORTH



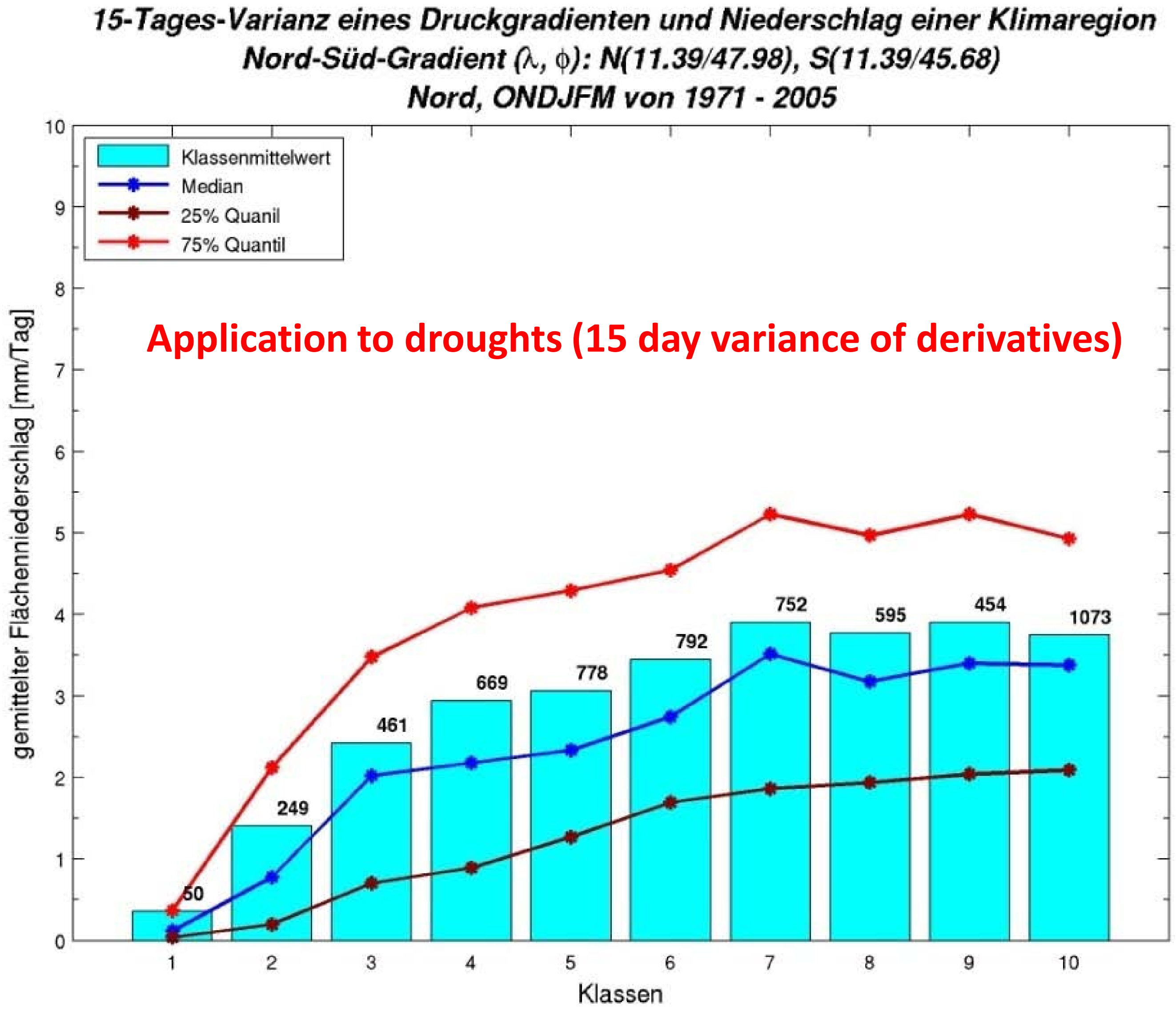
Scatter plot of 24 hr precipitation with regard to the second mixed derivatives of msl pressure for summer 2003; E/W (horizontal axis) and N/S (vertical axis)



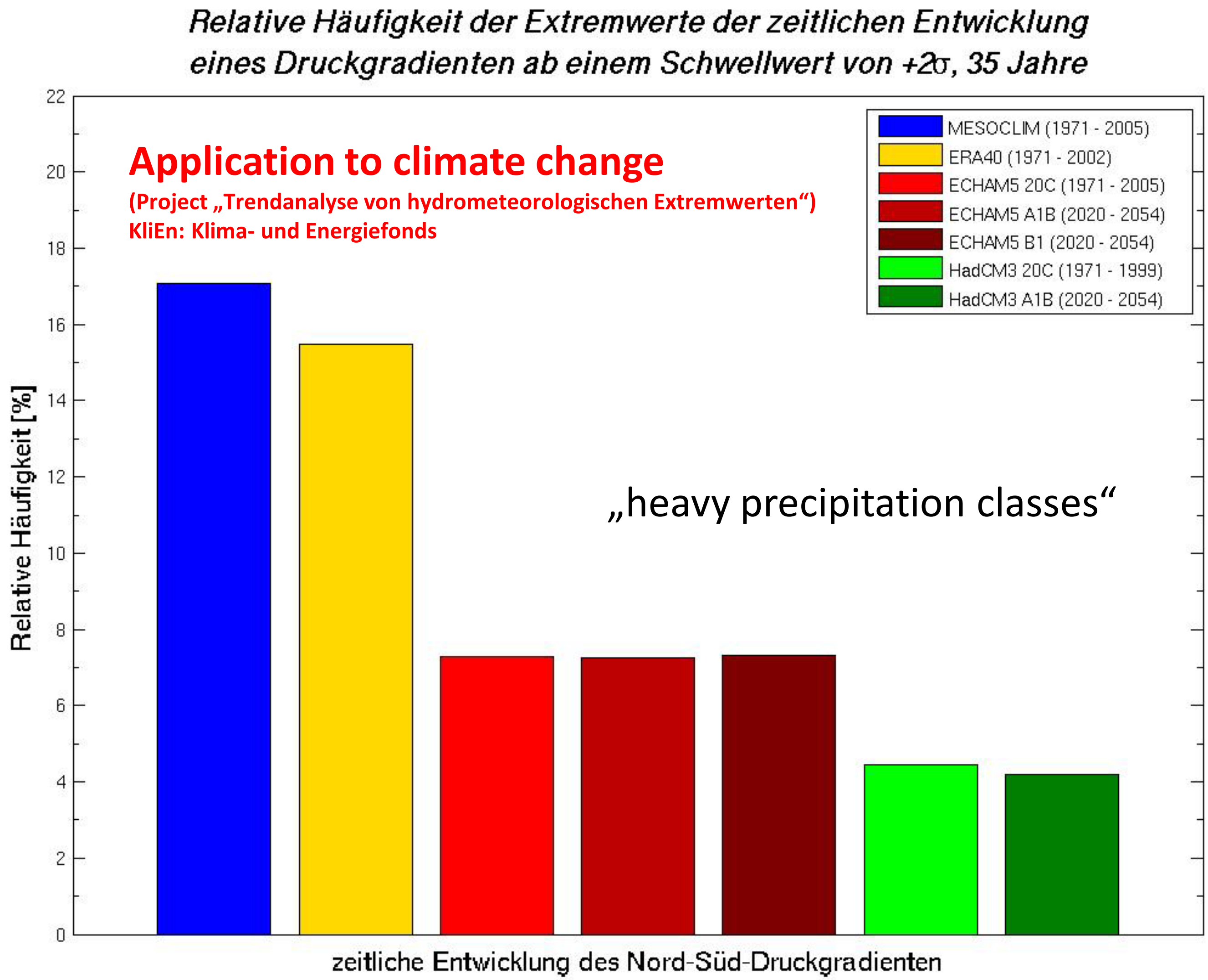
Distribution of the second mixed derivative (top) and the traditional weather pattern Classification of all cases with precipiation above 20mm/24h in summer seasons of 1971 – 2002 for climate region NORTH



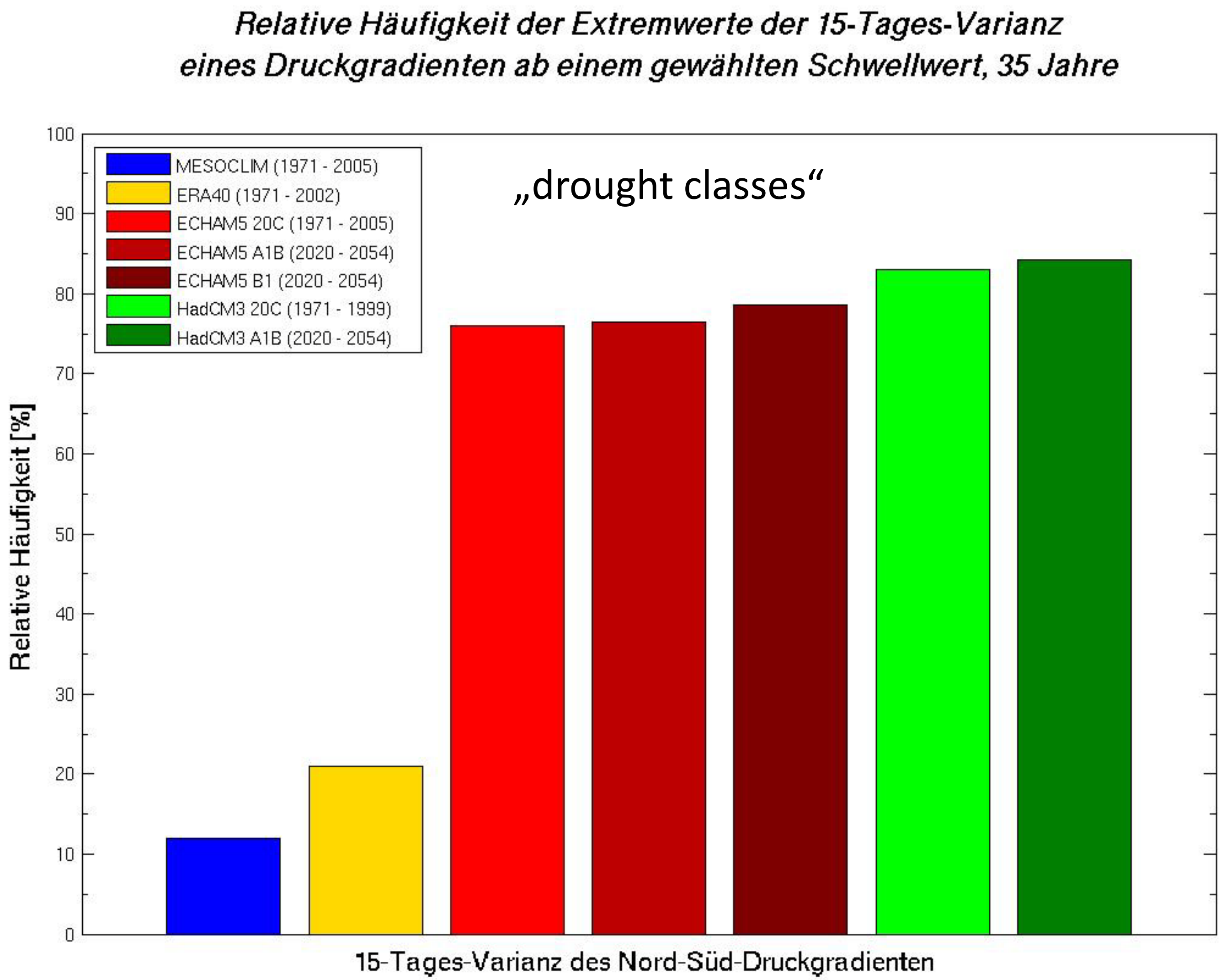
E/W pressure gradient (green) and 24 hr precipitation (blue) in July/August 2003



Median and quartiles of 24 rh precipitation with regard to classes of second mixed derivatives $\Delta^2 p / (\Delta y \Delta t)$ for winter season (October – March) 1971 – 2005 for climate region NORTH



Relative frequencies of extreme values of second mixed derivatives $\Delta^2 p/(\Delta y \Delta t)$
Derived from 35 years of MESOCLIM, ERA40 and climate models (ECHAM5 and HADCM3)



Relative frequencies of extreme low values of the 15 day variance of the second mixed derivatives $\Delta^2 p /(\Delta y \Delta t)$ derived from 35 years of MESOCLIM, ERA40 and climate models (ECHAM5 and HADCM3)

Conclusion:

The spatio-temporal weather pattern classification represents a more dynamical approach and seems to work nicely with precipitation/drought events in mid latitude mountainous terrain.

In contrast to traditional discrete weather pattern classifications it represents a continuous measure for the atmospheric state. Hence it allows an indication of intensity.

The combination of the mixed derivatives and flow direction seems to be a promising extension. It will be tested towards other weather phenomena and other regions in Europe and other parts of the world.

Thank you
for your attention