COST734 Final Conference

Climate Change Impacts on Agriculture and Forestry in Europe

COST734 in cooperation with COST FP0703C and OPAG III of CAgM of WMO

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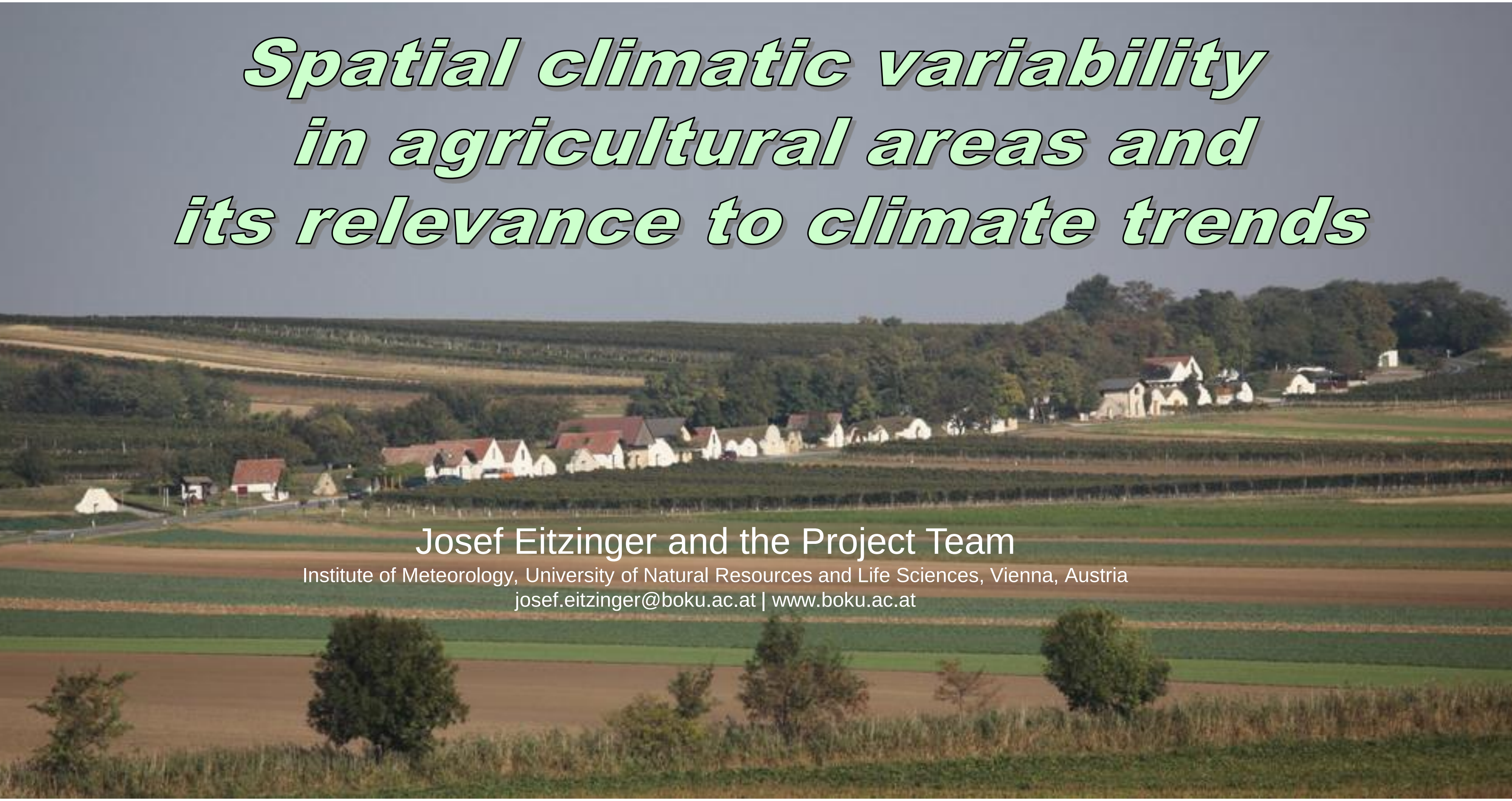

Spatial climatic variability in agricultural areas and its relevance to climate trends

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Introduction

- Local climatic conditions determine agricultural production to a great extent
- Local climate conditions can vary depending on
  - orography (altitude, slope, aspect)
  - landscape structures
  - canoy and surface conditions
- Significant shifts in local climate conditions are expected due to climate change
- Investigation of spatio-temporal variability

→ Importance of estimation methods under a high spatial resolution to detect relevant spatial gradients in climatic parameters for spatial agrometeorological modelling of related climate shifts or climate change impacts on crops

→ some (intermediate) results of two projects

The projects were financed by several Austrian Federal Ministries (Agriculture, Forestry, Environment and Water Management; Science and Research; Economy, Family and Youth), the Austrian Federal Forests and the Austrian Hail Insurance. The Carnuthum Study is co-financed by the Rubin Carnuntum winemakers with financial support of the Leader program of the European Commission.

Investigation area: Rutzendorf, Göttlesbrunn

Met

located in the north-eastern part of Austria

- Marchfeld is one of the major field crop production areas of Austria (900km²)
- geologically part of the Vienna Basin
- a flat area with minor variations in elevation,
- influenced by a semi-arid climate:

  winters are usually cold, frequently strong frosts

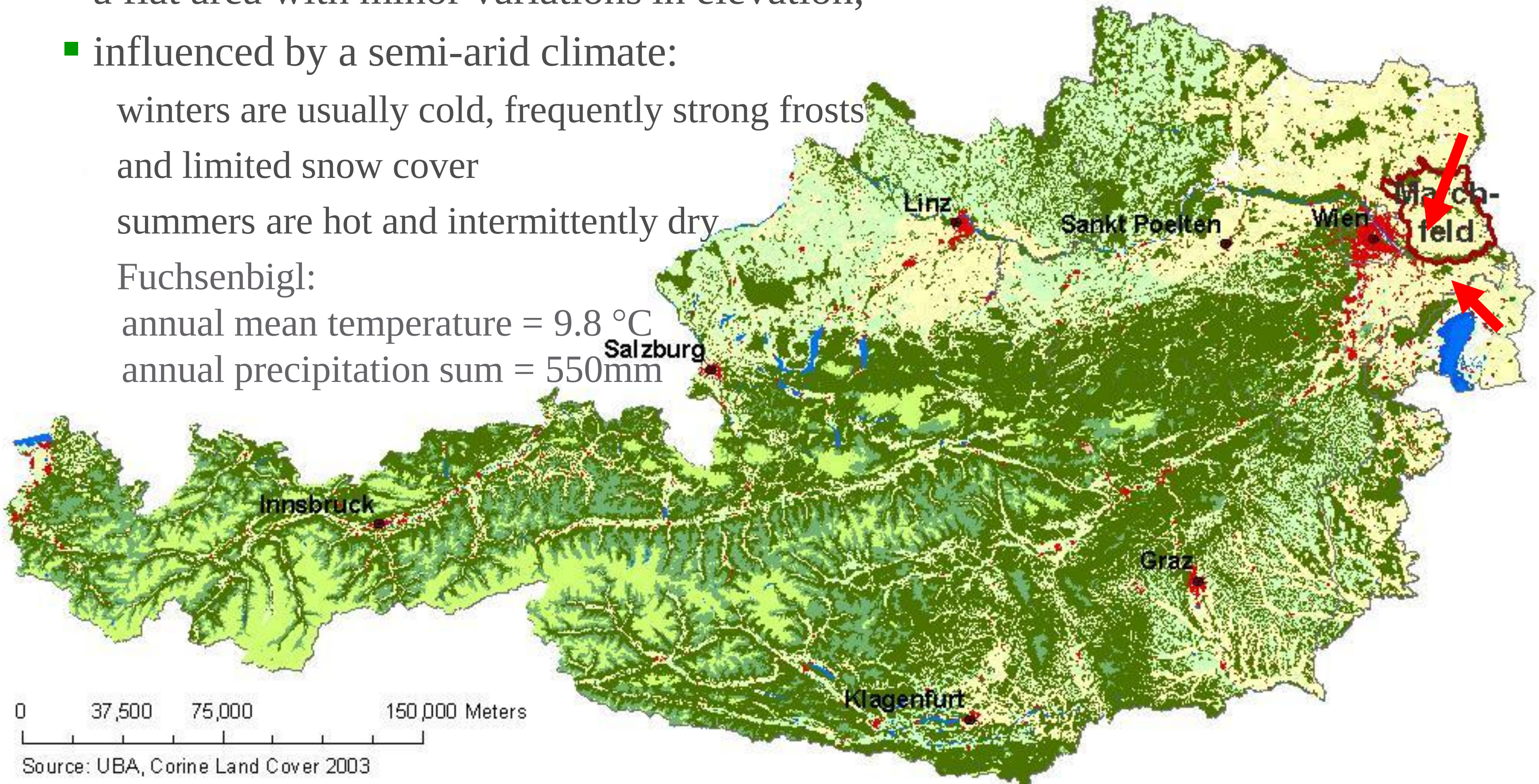
  and limited snow cover

  summers are hot and intermittently dry

  Fuchsenbigl:

  annual mean temperature = 9.8 °C

  annual precipitation sum = 550mm



MUBIL: Hedgerows – modification of microclimate of neighbouring fields

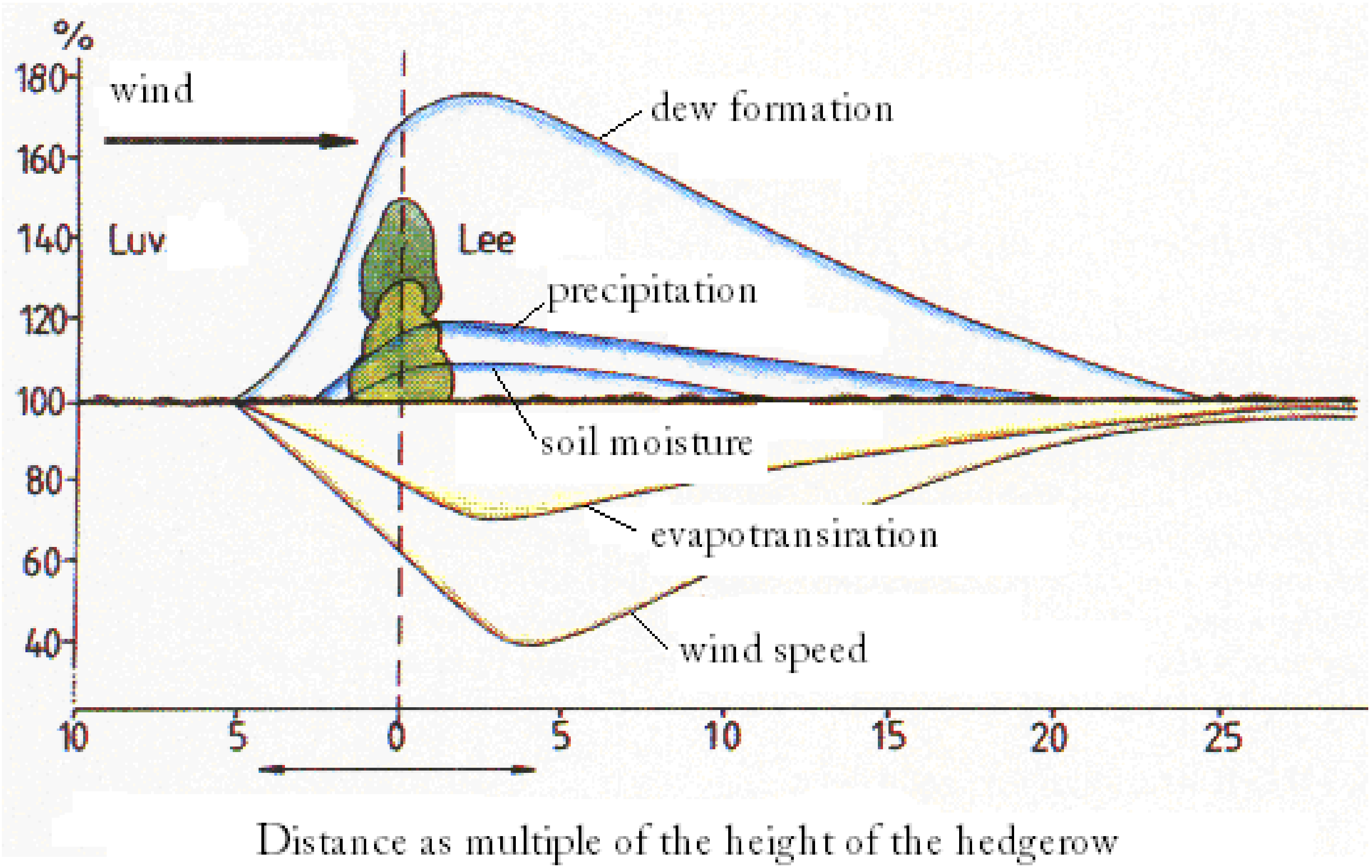
Multiple effects of hedgerows on microclimate

- wind speed reduction
- higher amounts of precipitation
- promoting dew formation
- reducing evapotranspiration
- reducing soil erosion

→Significant effects on crop water balance, drought damage and crop yield

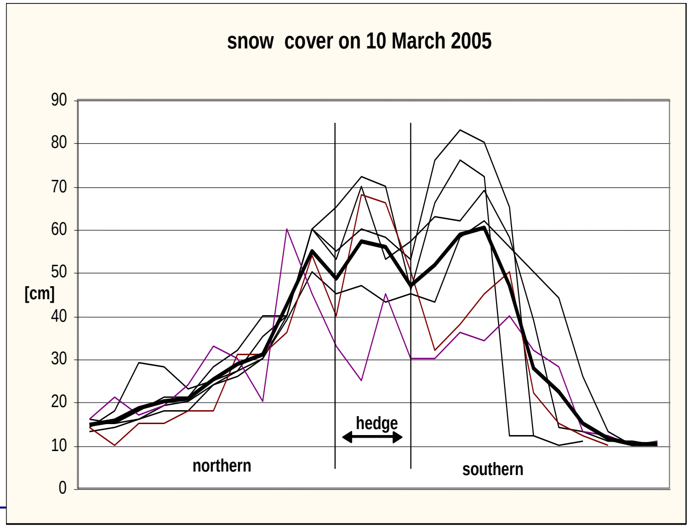
→Optimization of microclimatological conditions

Sphere of influence

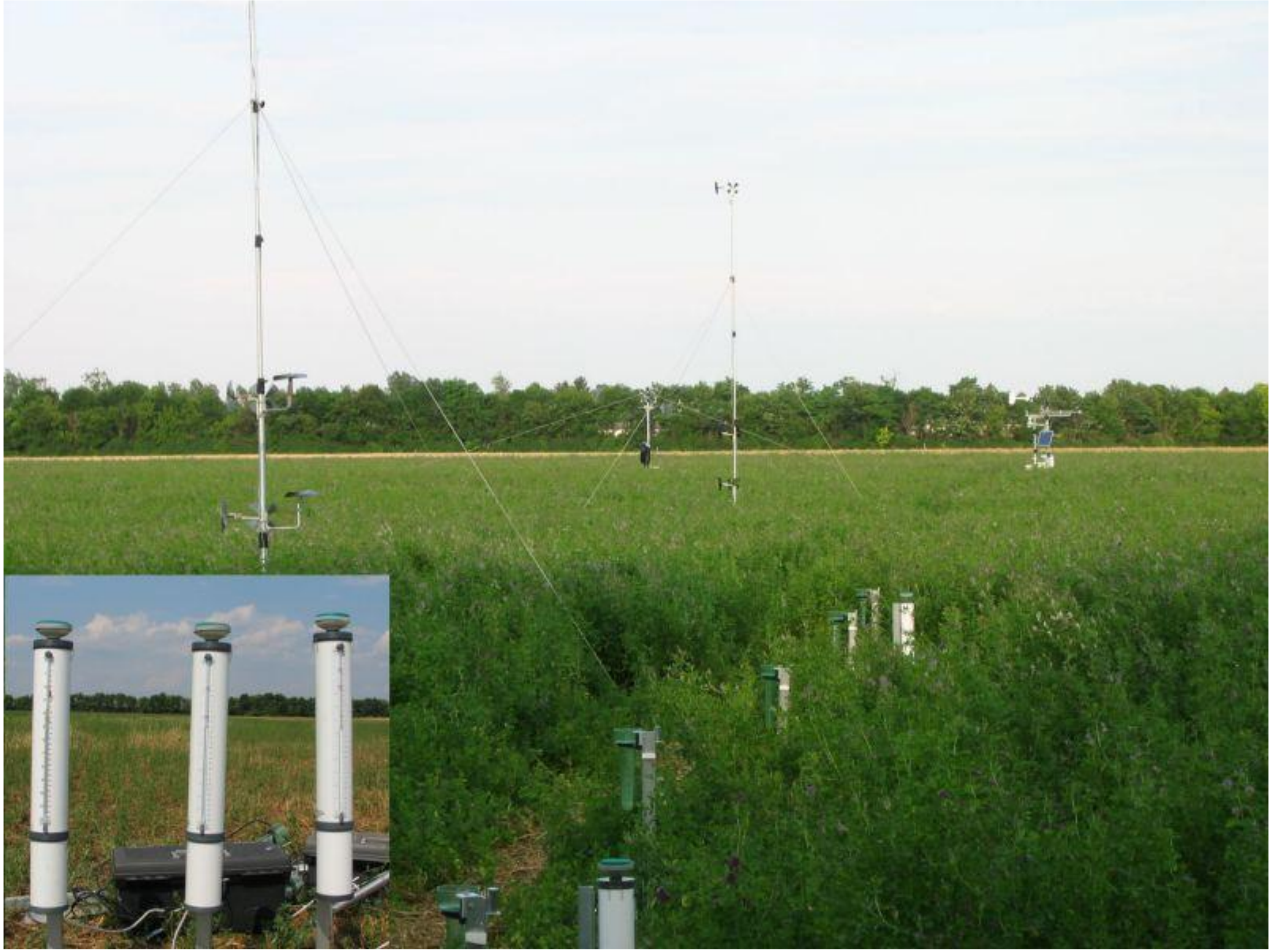


Source: Frielinghaus et al.,1997, modified

Additional Snow Accumulation Effects



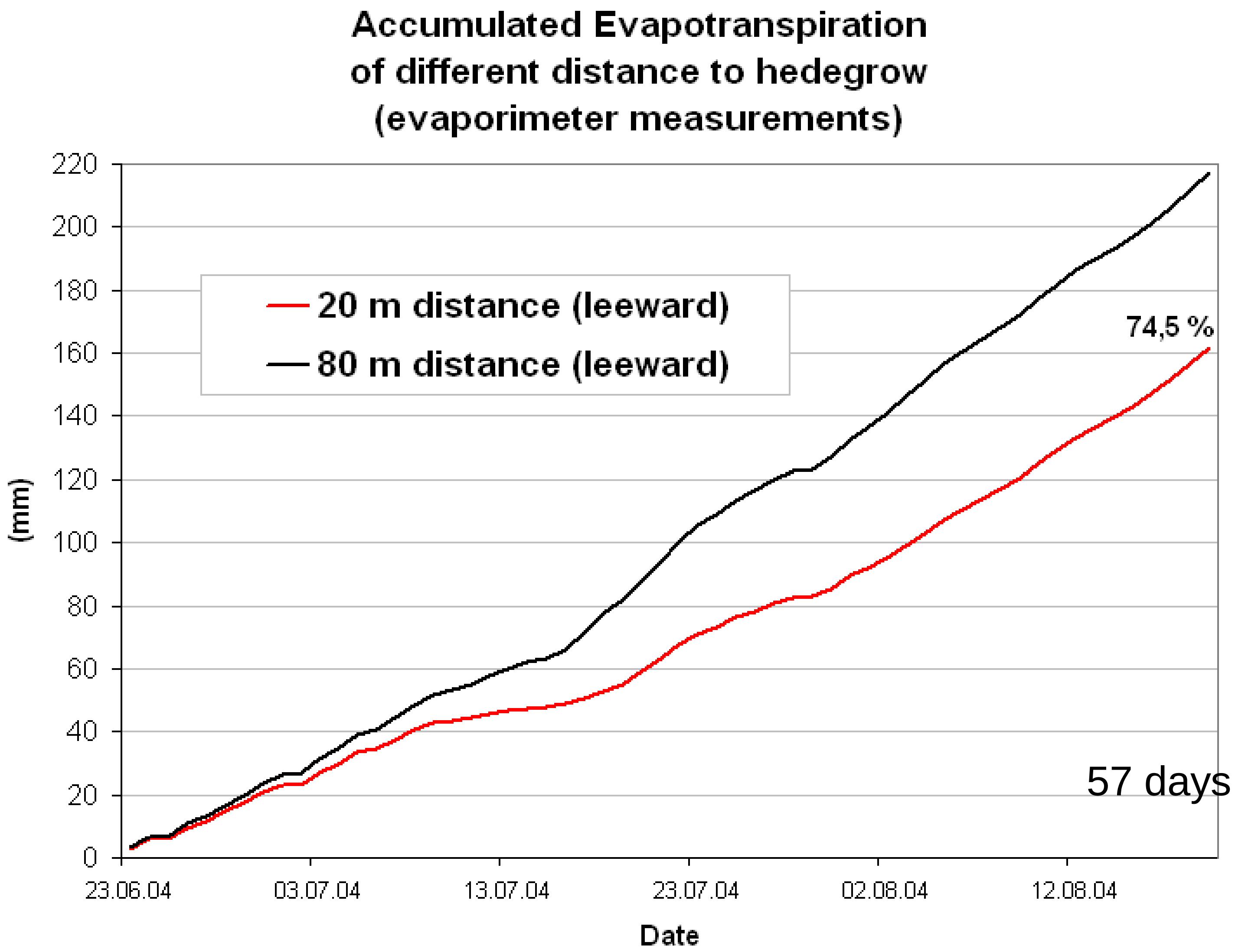
Transect measurements to detect the influence of hedgerows on evapotranspiration



ETgages:

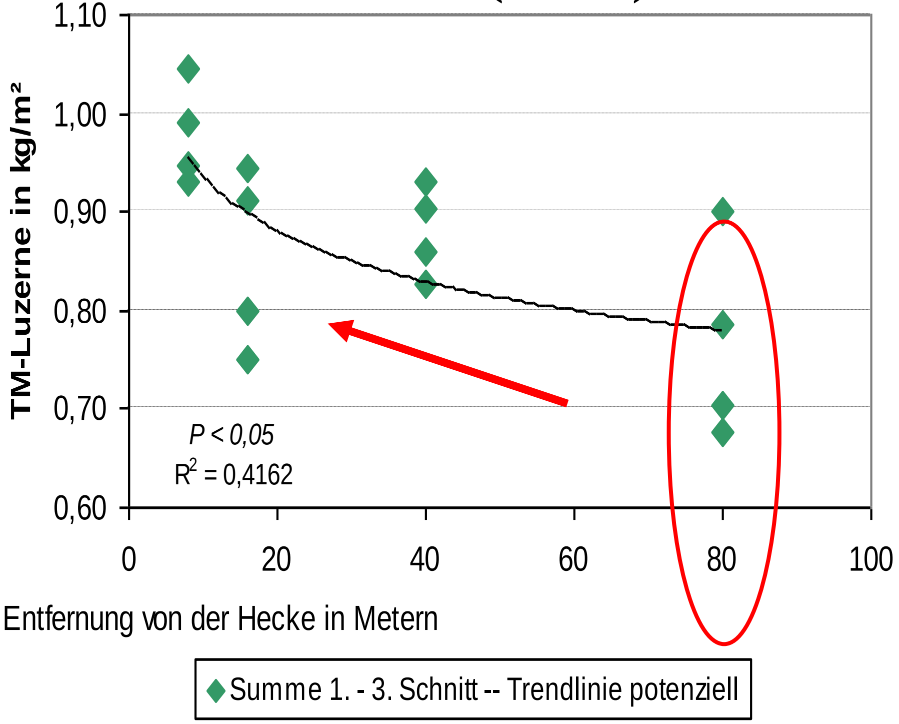
placed in 20m and 80 m distance from the hedgerow (lee side)

Hedgerow effects on evapotranspiration

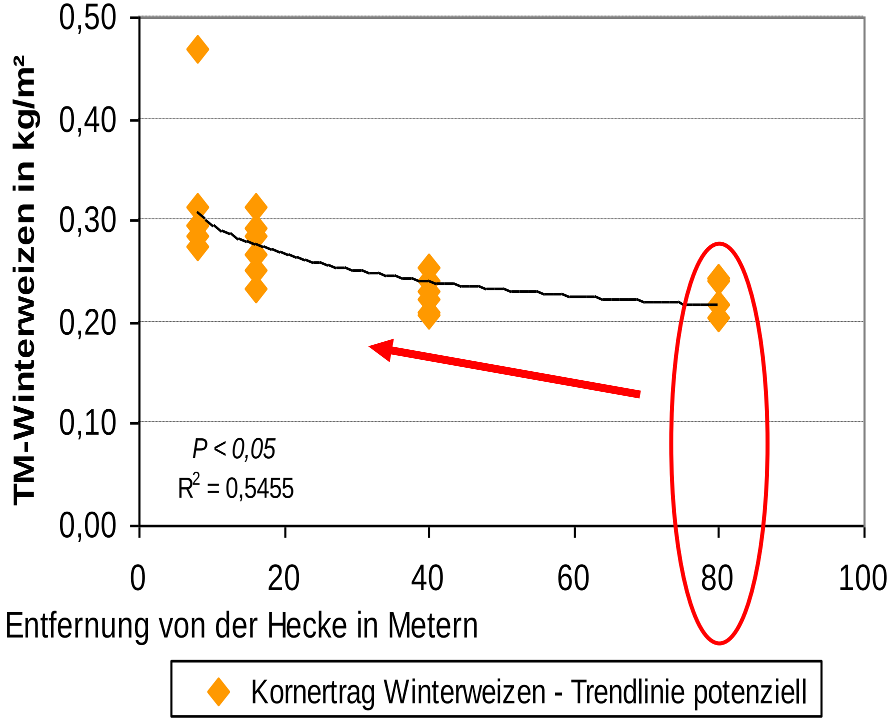


Impact on measured crop yields due to hedgerow effects on microclimate
(Location: Marchfeld, NE-Austria)

Alfalfa (2004)



Winter wheat (2005)



distance [m]	yield dm [kg/ha] averaged
8 m	3220
16 m	2730
24 m	2500
40 m	2270
80 m	2270

(Surböck, Schaupenlehner et al., 2008)

Summary Tables - Hedgerow Effects and Climate Change Signal

Crop Simulation; Year 2005 (CERES Wheat)			Simulated Crop yield (measured) (kg/ha)	Seasonal precip. (mm)	Seasonal Evapotransp. (mm)	Water Stress factor
Scenario	Distance	Conditions				
S1	80m	Open field (no hedgerow effect)	2193 (2270) 100 %	348	345	1.56
S2	8m	Wind speed reduction 50%	2983 136 %	348	348	1.25
S3	8m	Wind speed reduction 75%	3653 166 %	348	348	0.79
S4	8m	considering snow accumulation	3048 138 %	498	412	0.91
S5	8m	Wind speed reduction 50% + snow accumulation effect	3054 (3220) 139 %	498	412	0.69

Crop: Winter Wheat	0-80m (avg.)	20m	80m	Scenario Echam5 A2-2050s A1B-2035s	Scenario HadCM3 A2-2050s A1B-2035s	Scenario Echam5 A2-2050s	Scenario HadCM3 A2-2050s	
Parameter	Measured 2005 (ecological production)			Simulated 100 years (conventional, medium soil, plough, open area) Reference : 1971-2000		Simulated 100 years (as left but minimum tillage) Reference : 1971-2000		
Yield (kg/h)	2452	2615	2270	-				
Yield (rel)	108 %	115 %	100 %	+ 15.4 % -15 %	+ 16.2 % - 11 %	+ 18.4 %	+ 19 %	
Wind (m/s)	?	0.56	1.3	-	-	-	-	
Wind (rel)	?	42 %	100 %	-	-	-	-	
Etp (mm/d)	?	2.8	3.8	-	-	-	-	
Etp (rel)	?	74.5 %	100 %	-	-	-	-	

Carnuntum - Agrometeorological aspects

Vineyards of the Carnuntum wine district are investigated for their terroir characteristics and dominating viticulture functions

Grapevines depend on climatic conditions to a high extent →

- Climatic variability within the Carnuntum wine-growing region is investigated
- microclimatic variations are influenced by soil type and by canopy management.
- the variability is a result of the topoclimate (altitude, aspect and slope) and therefore relief is a major terroir factor.

Focus of agrometeorological research

- local climatology (micro-meteorology) in complex terrain
- measurement of variations in time and space in a high resolution
- relationship between relief, structure of the vineyards and the climatic conditions
- detection of the influence of topoclimate (altitude, aspect, slope) and of soil

Measured parameters since April 2009

- 3 basic stations:

  air temperature (2m), air humidity, radiation, wind, leaf wetness, precipitation, soil temperature and soil humidity

- Additional stations for the measurement of precipitation (GBA, Petzenkirchen)

- 35 transect ministations:
  air temperature and air humidity (0,5m)
  soil temperature (5 cm depth)

- Temporal transects for evapotranspiration measurements (Göttlesbrunn)

- Time intervall of measurements: 10 min

Orth an der Donau
Hainburg an der Donau
Fischamend
T4-1
T2-1
T7-4
T8-3
T8-2
T6-2
T7-3
T7-2
T7-1
T3-1
T6-1
Haslau-Maria Ellend
T5-3
StPel G1
Kittsee
T5-1
Enzersdorf an der Fischa
T1-8
T9-1
T1-5
T9-4
T1-3
T1-2
Prellenkirchen
Rohrau
T10-1
T1-1
Bruck an der Leitha
Trautmannsdorf an der Leitha
Bruckneudorf
Parndorf
Zurndorf
Sommerein
Mannersdorf am Leithagebirge
Neusiedl am See
Breitenbrunn
Nickelsdorf
Image © 2010 DigitalGlobe
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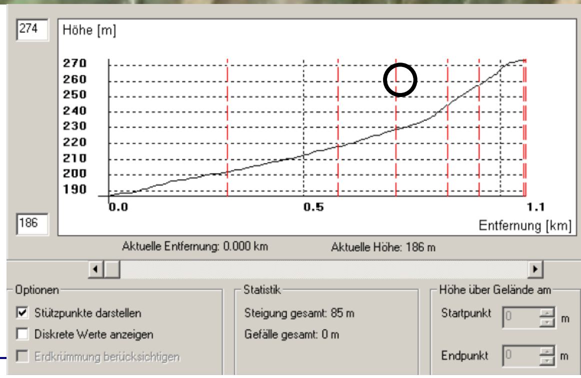
Image © 2010 GeoEye
Image © 2010 Geoimage Austria
©2009
10.0 km
Bildaufnahmedatum: 31. Mrz. 2008
Breite 48.040741° Länge 16.869836° Höhe 0 m

Transect Göttlesbrunn



Atmometer (evaporimeter): evapotranspiration
Hobo (down): air and soil temperature, air humidity

Procedure of the analysis

- **Data of the Austrian Weather Service (stations Schwechat, Groß-Enzersdorf (wind, temperature, air humidity) and stations of the Austrian Hydrographic Service (precipitation)**

- **Transsect-analysis**

Step 1: analysis of the transect measurements (data check)

Step2: correlation to data of ZAMG station Schwechat (daily data 2009-2010)

Step 3: recalculation to 30-year means from Schwechat to the transect stations (1980-2009) on a monthly basis

Step 4: detection of the influence of sea level, aspect and orientation on the measured transect station data (mulitple regressions)

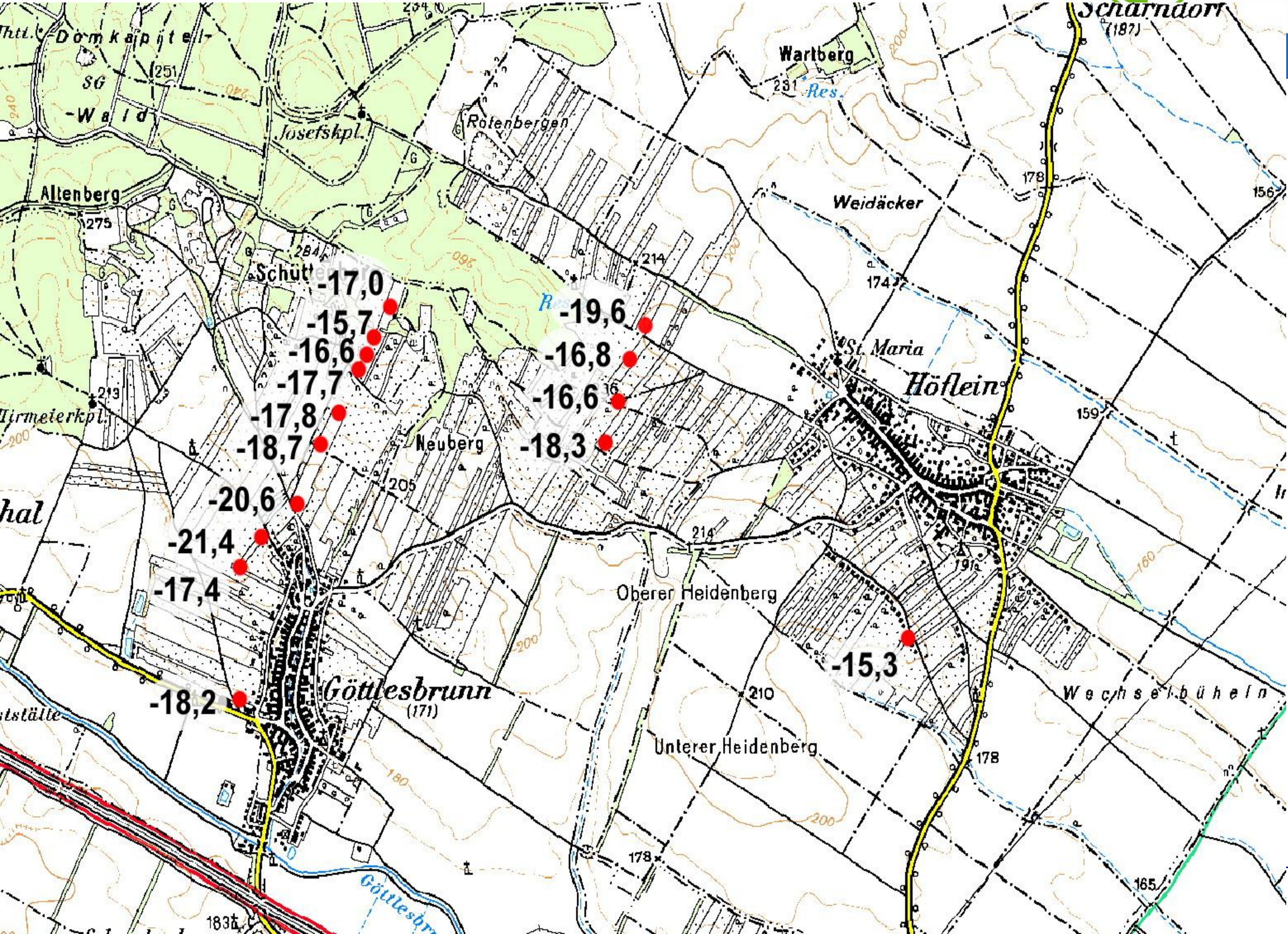
Step 5: Extrapolation of results to high resolution (10m) GIS-maps

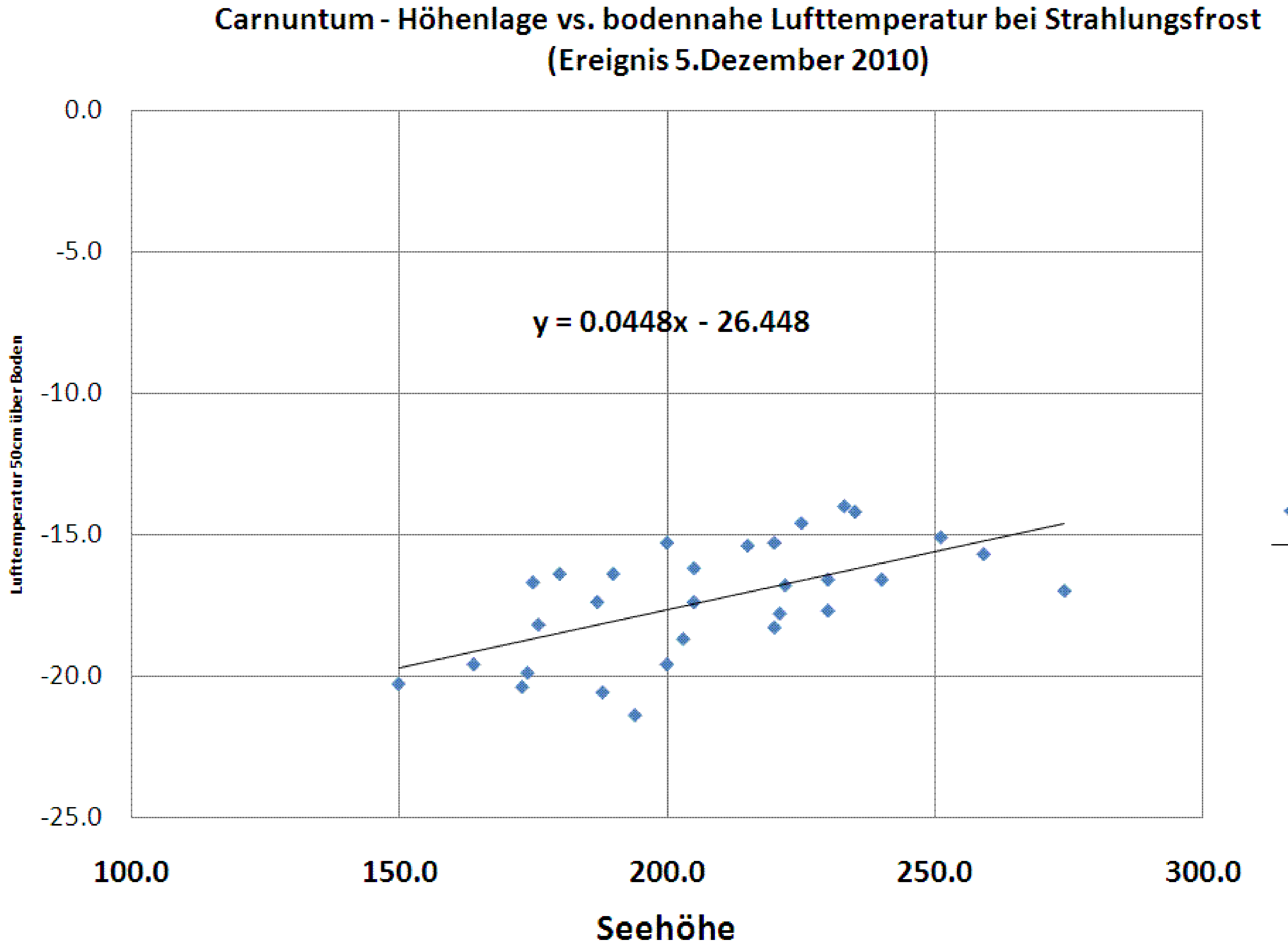
Effects of slope, aspect and sea level on microclimatic parameters - (microclimatic variability)

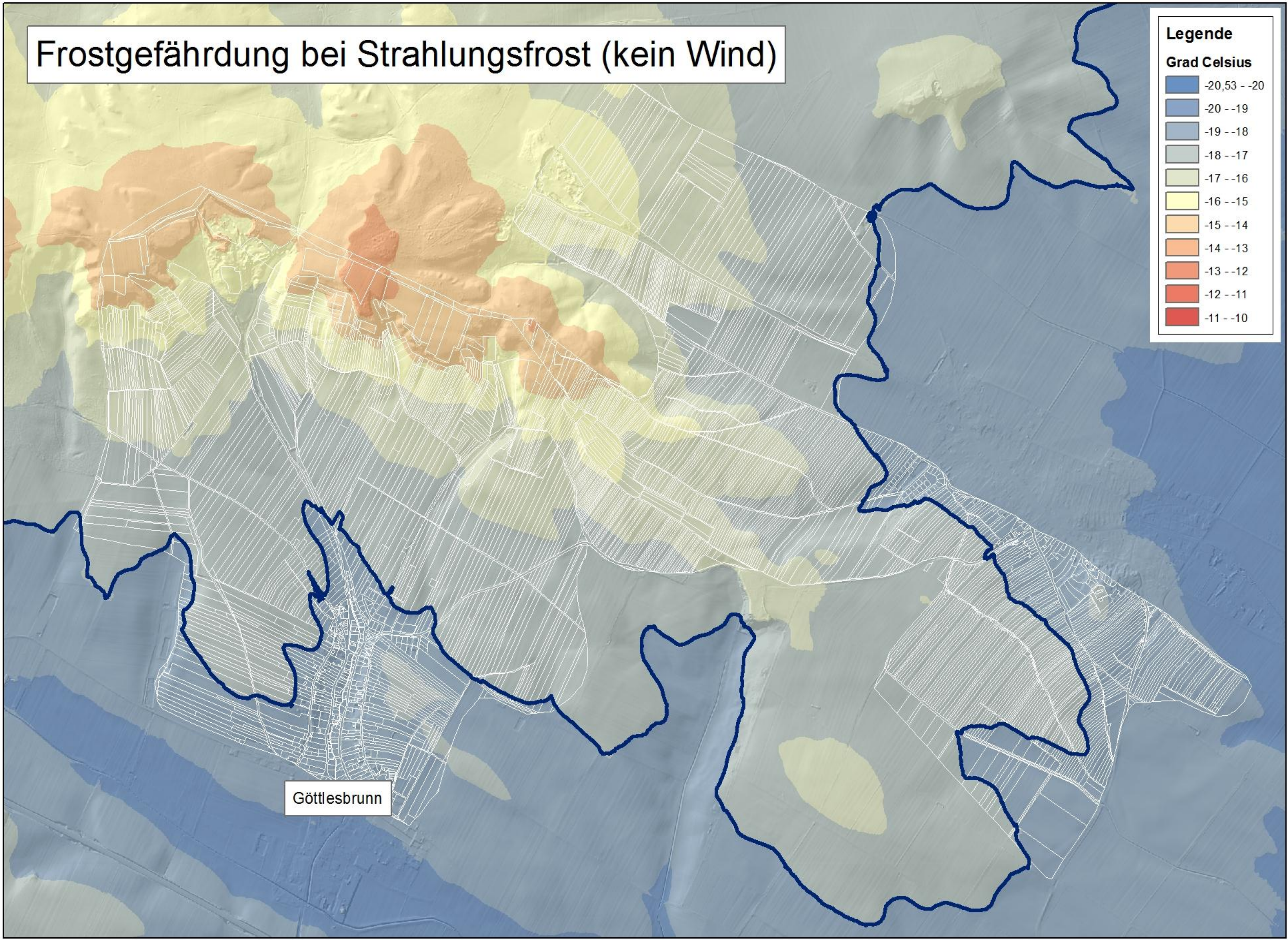
Met

	sea level	slope	aspect	transect
T1-1	176,10	3,26	194,20	Göttlesbrunn
T5-2	173,15	0,77	213,39	Spitzerberg
T8-2	174,92	1,46	132,65	Berg
T5-5	233,18	9,25	175,73	Spitzerberg
T8-4	214,71	13,63	173,61	Berg
T8-3	189,50	6,16	173,15	Berg
T1-6	221,07	6,41	221,03	Göttlesbrunn
T5-3	205,21	5,61	172,20	Spitzerberg
T8-3	189,50	6,16	173,15	Berg
Göttlesbrunn	221,07	6,41	221,03	Göttlesbrunn
Berg	187,45	3,72	175,17	Berg

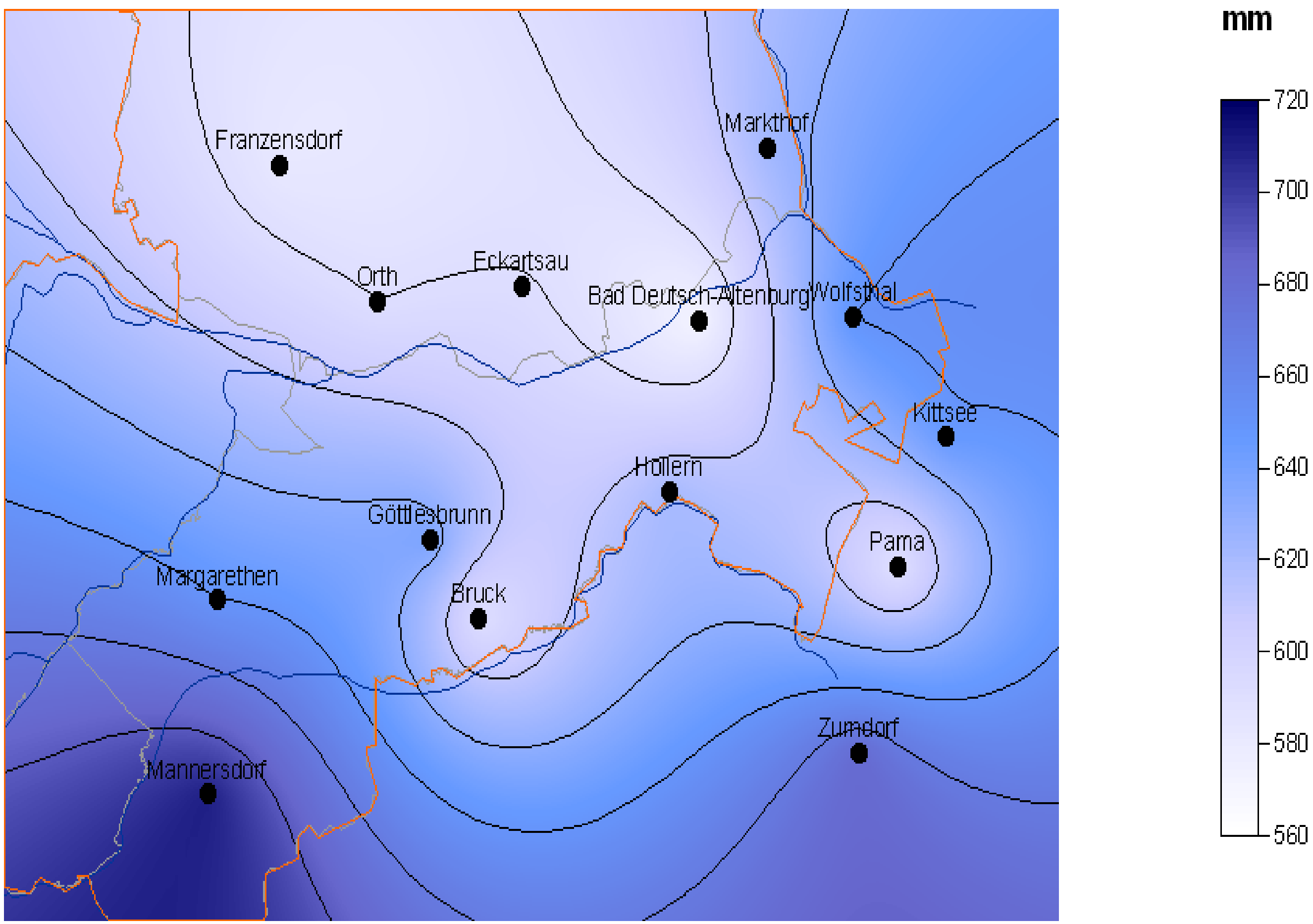
Minimum temperature 5/6 Dezember 2011



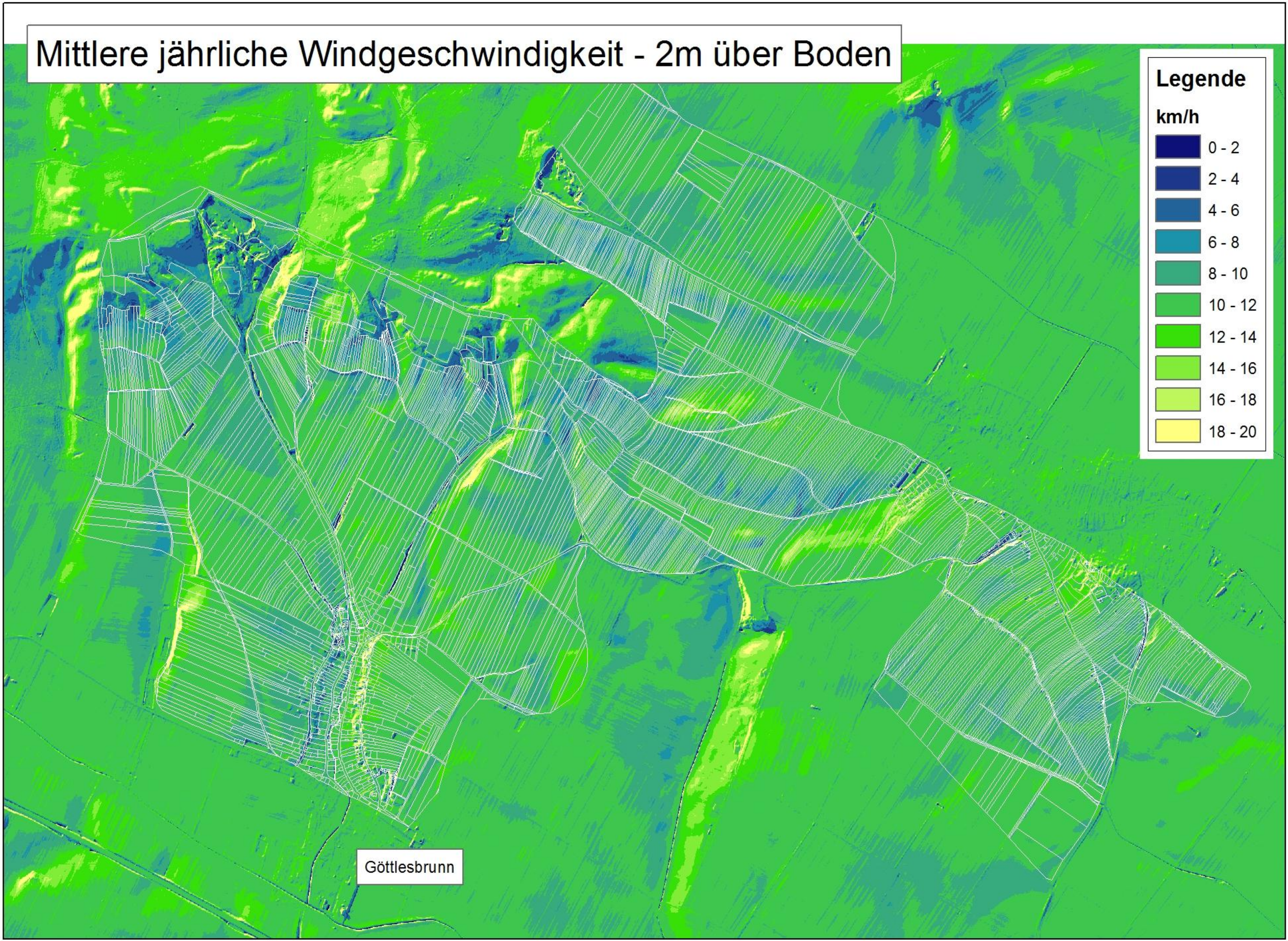

Carnuntum - Höhenlage vs. bodennahe Lufttemperatur bei Strahlungsfrost
(Ereignis 5.Dezember 2010)
y = 0.0448x - 26.448
Lufttemperatur 50cm über Boden
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
100.0
150.0
200.0
250.0
300.0
Seehöhe

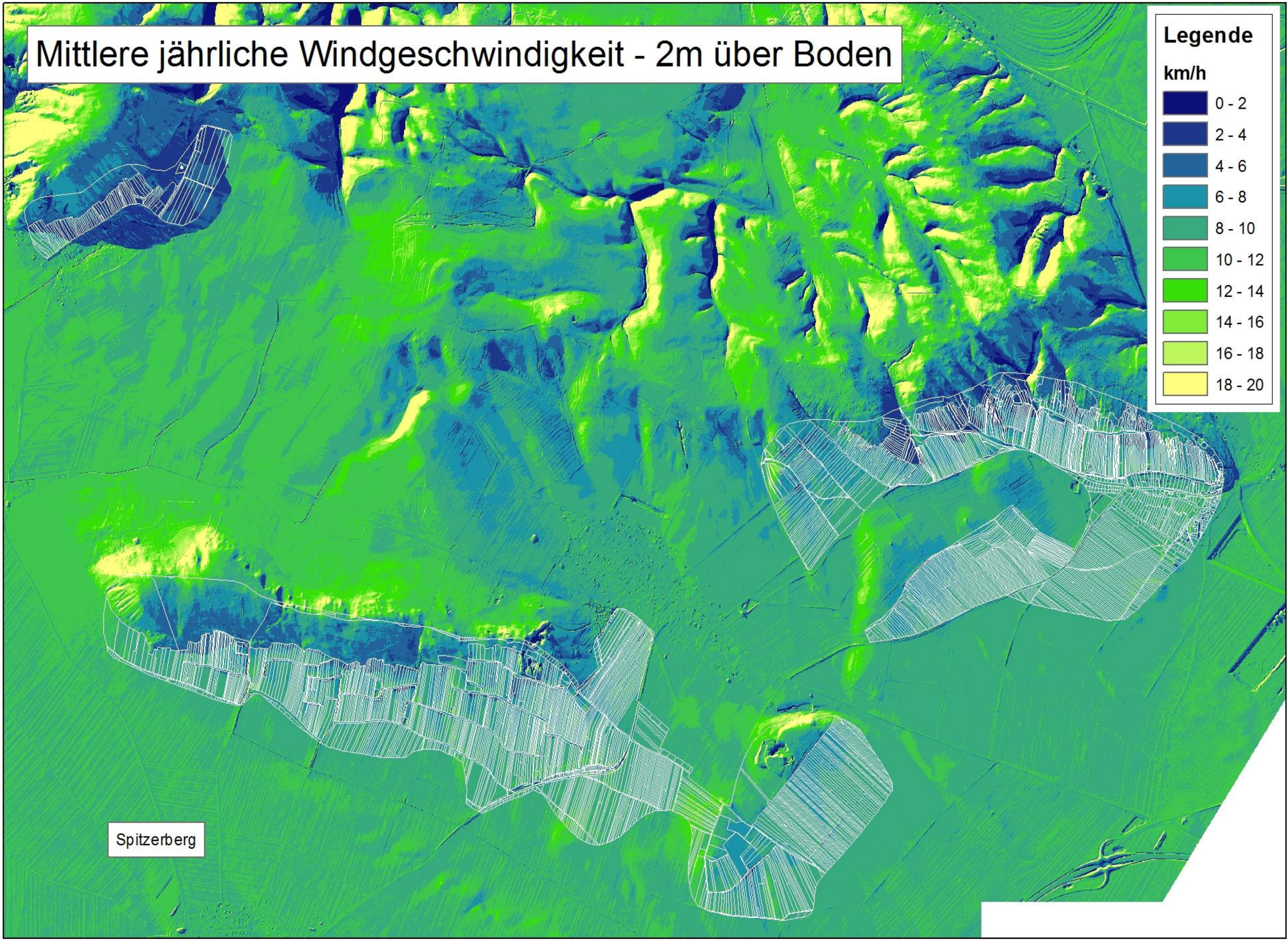

Frostgefährdung bei Strahlungsfrost (kein Wind)
Legende
Grad Celsius
-20,53 - -20
-20 - -19
-19 - -18
-18 - -17
-17 - -16
-16 - -15
-15 - -14
-14 - -13
-13 - -12
-12 - -11
-11 - -10
Göttlesbrunn

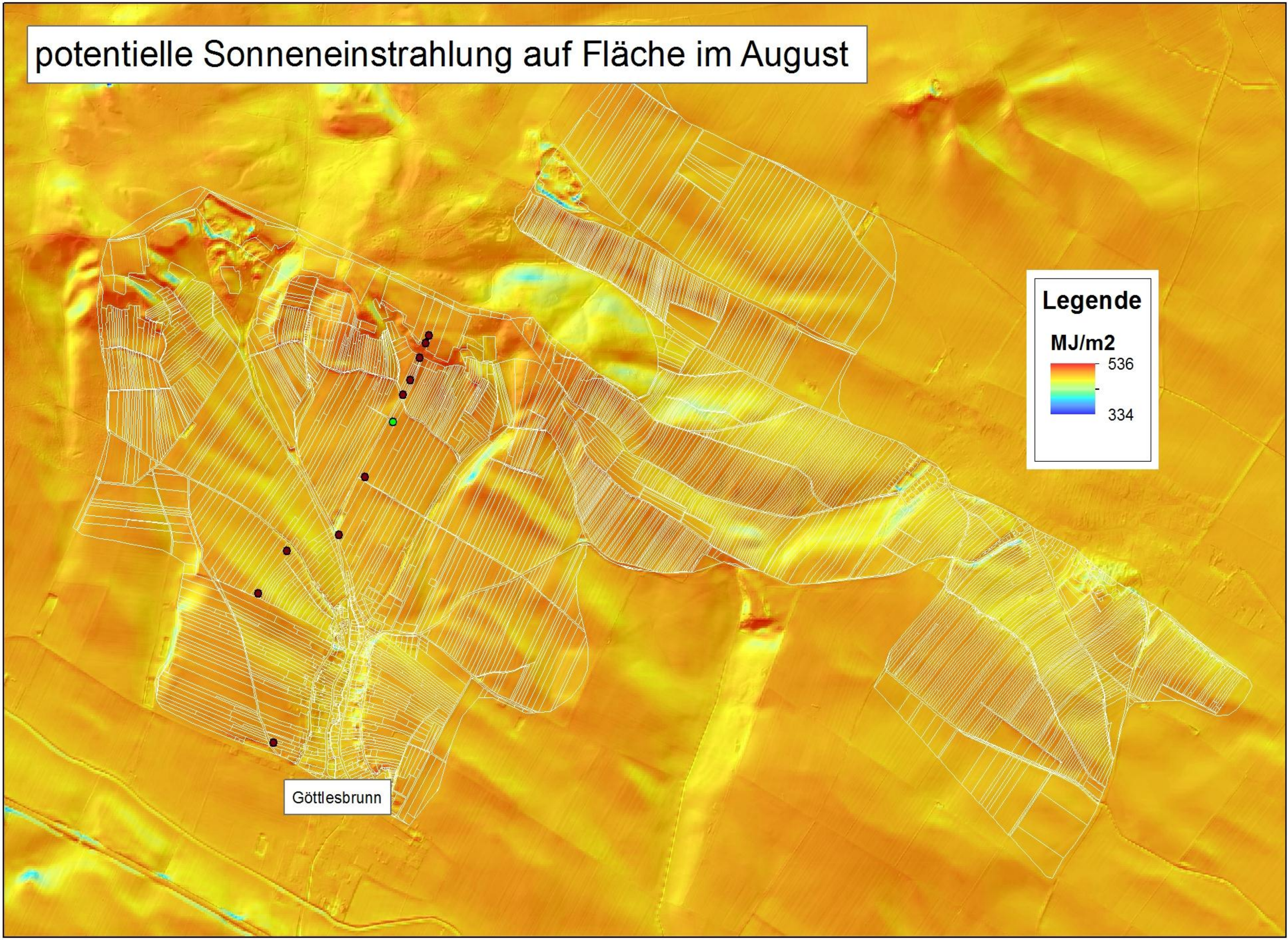
Mean annual precipitation 1999-2010
Region Carnuntum

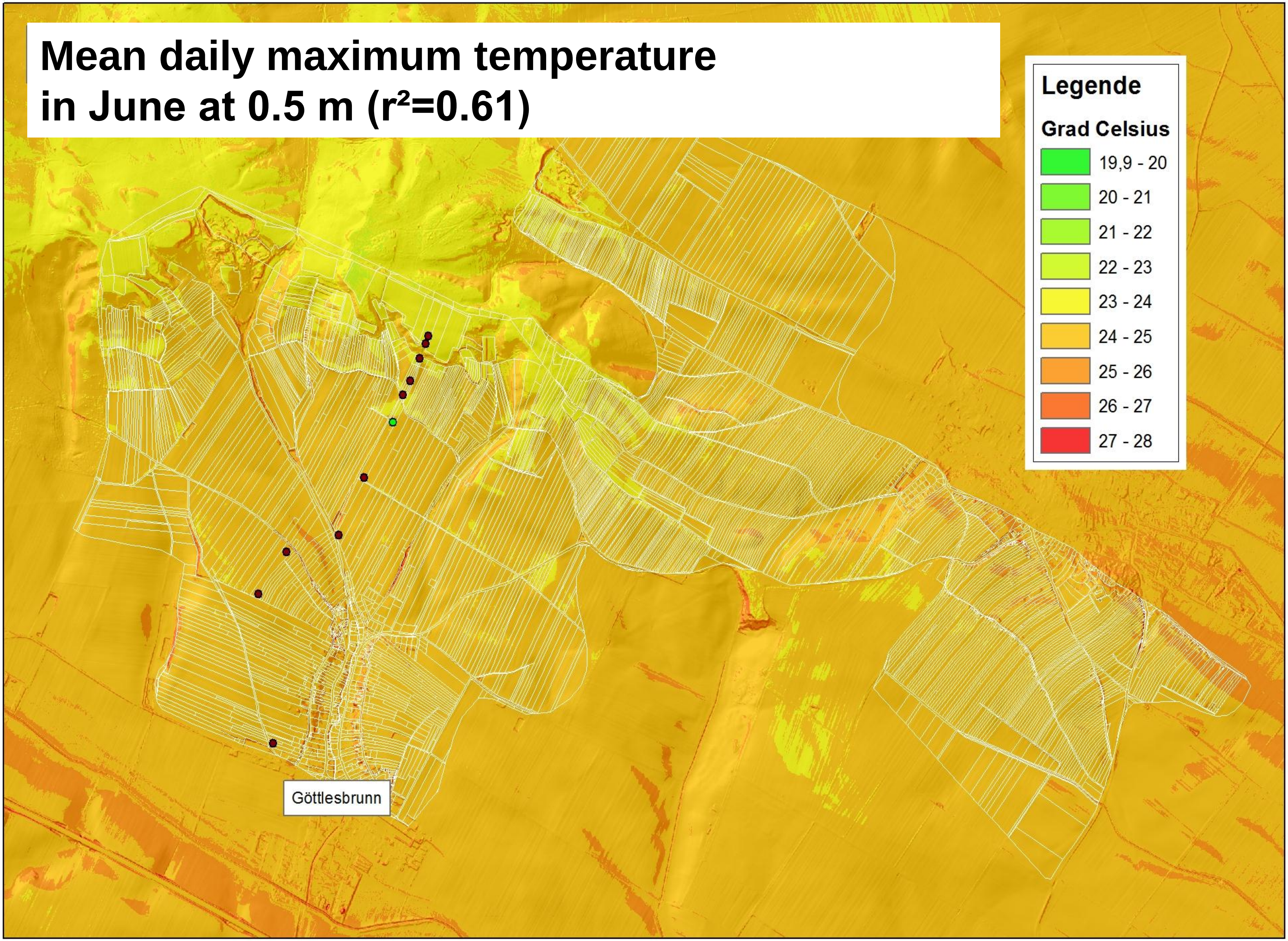


Interpolation: Kriging

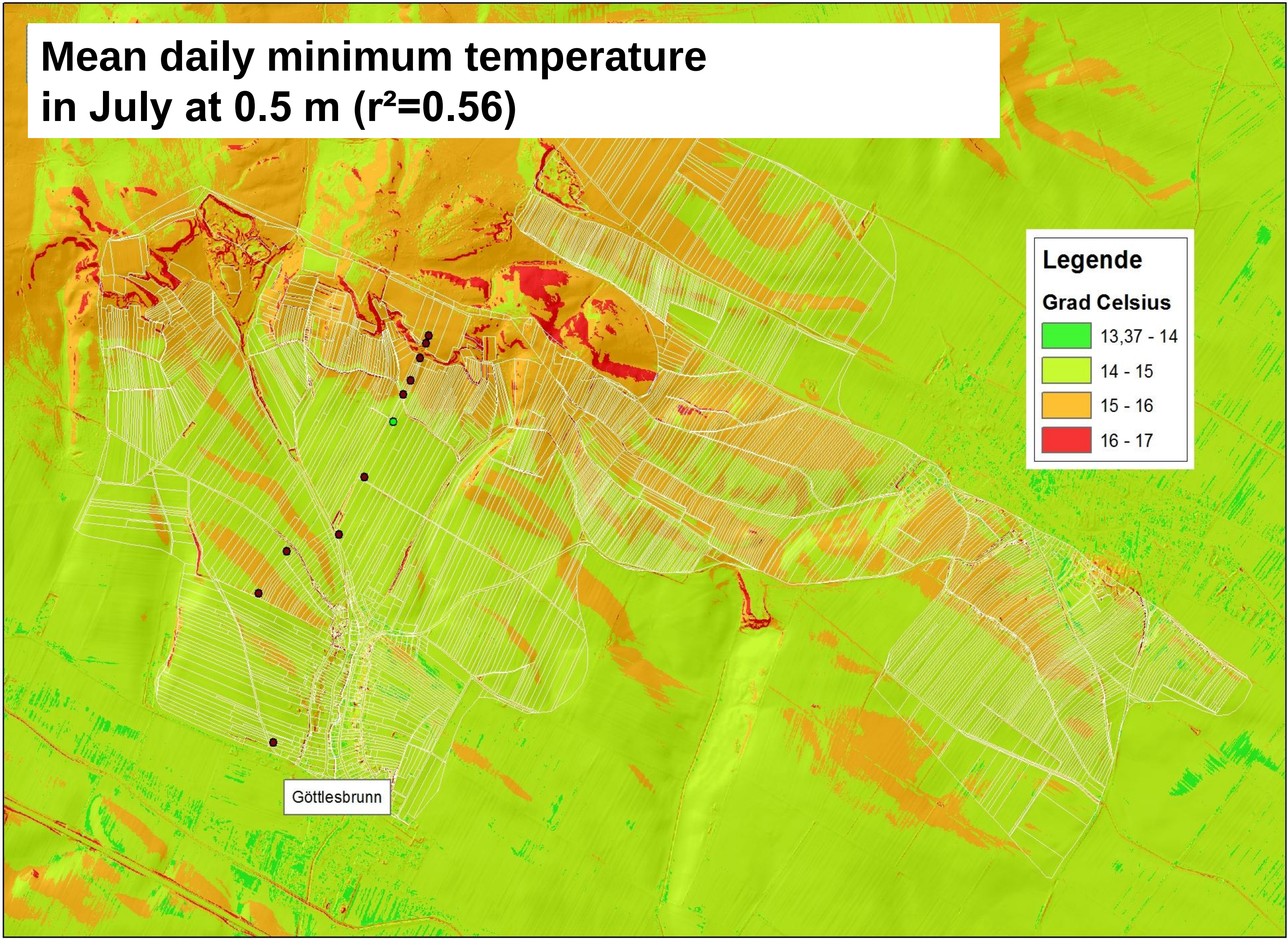

Mittlere jährliche Windgeschwindigkeit - 2m über Boden
Legende
km/h
0 - 2
2 - 4
4 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
Göttlesbrunn

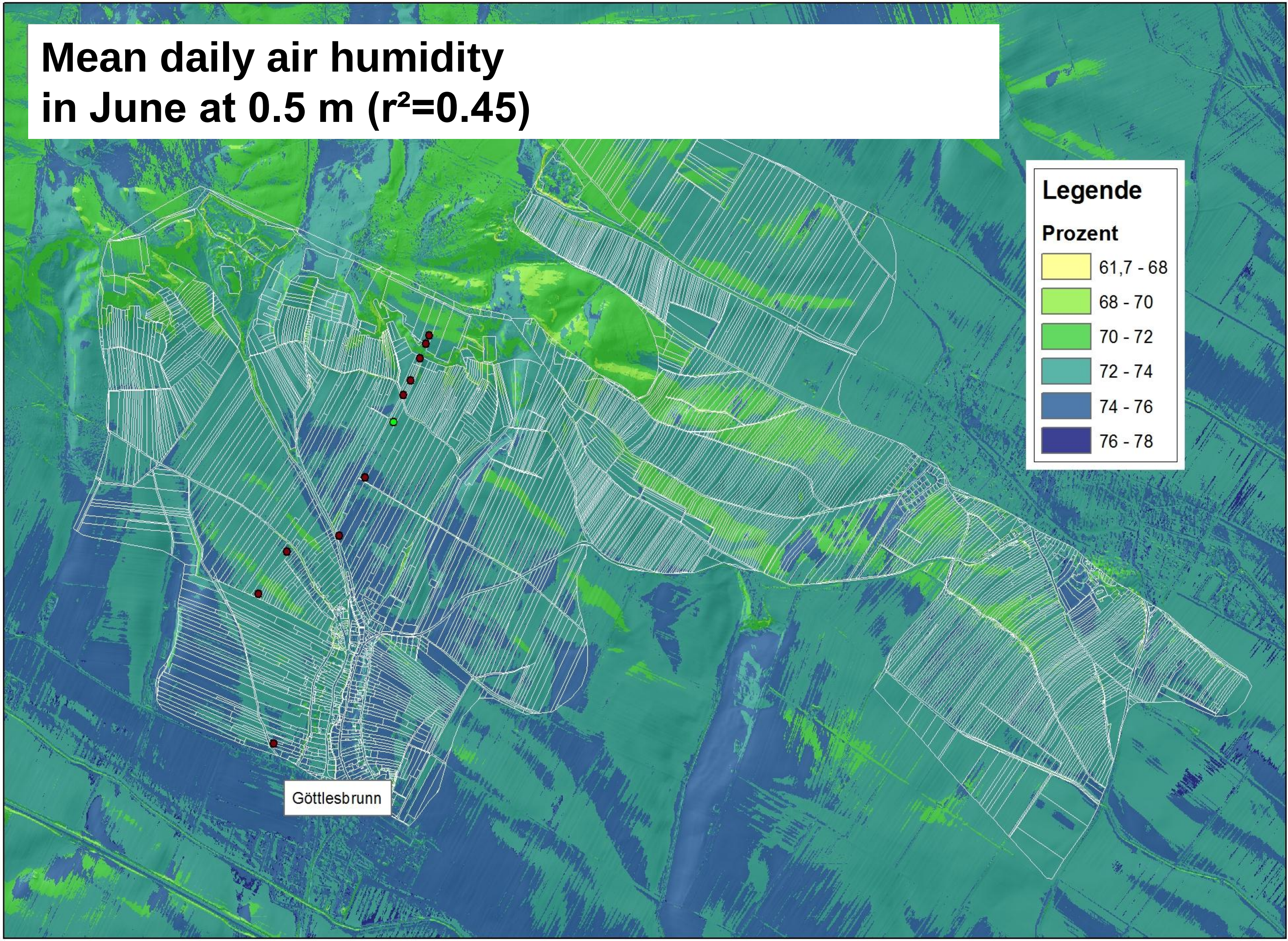

Mittlere jährliche Windgeschwindigkeit - 2m über Boden
Legende
km/h
0 - 2
2 - 4
4 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
Spitzerberg

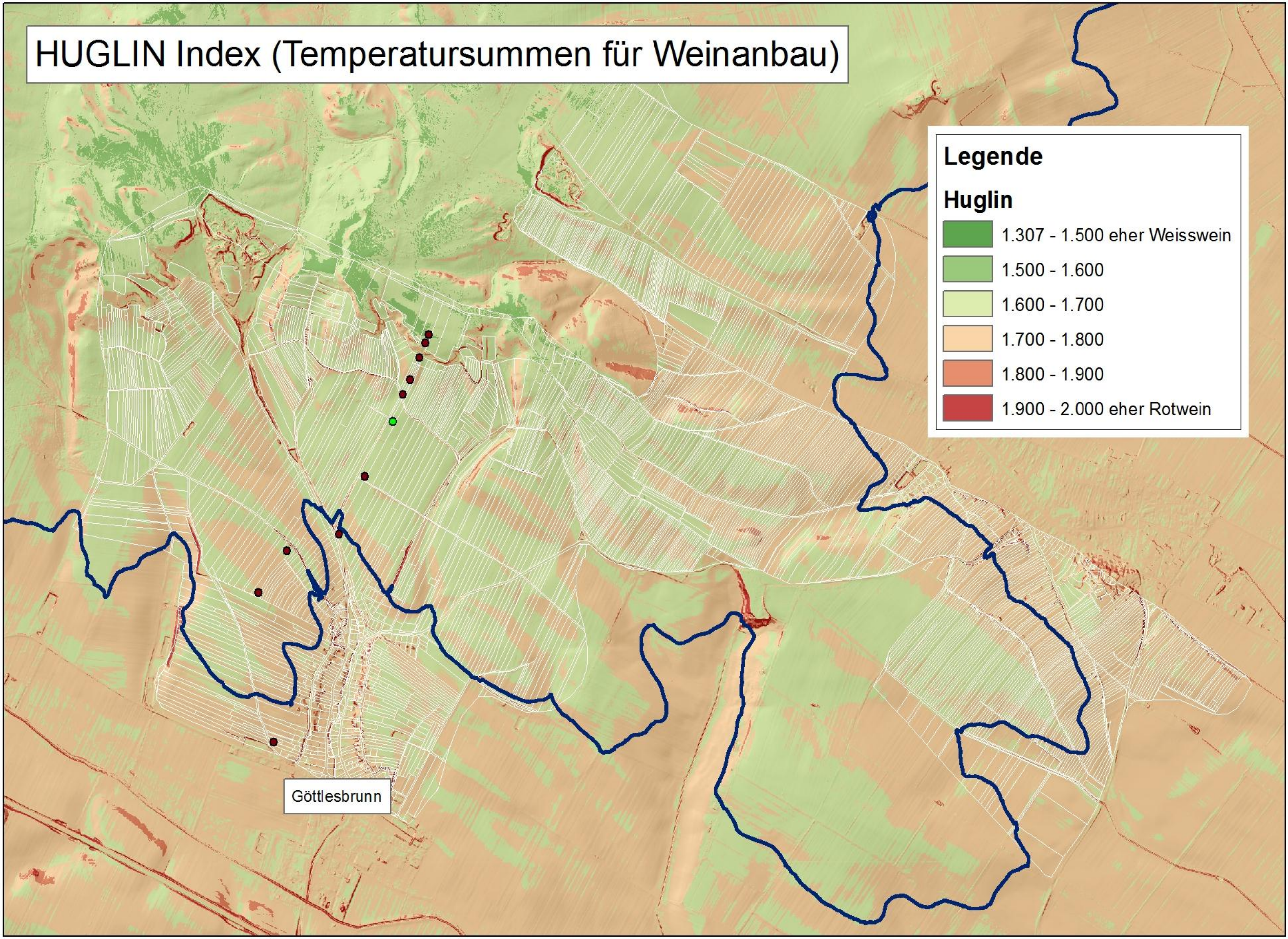

potentielle Sonneneinstrahlung auf Fläche im August
Legende
MJ/m2
536
334
Göttlesbrunn


Mean daily maximum temperature
in June at 0.5 m (r²=0.61)
Legende
Grad Celsius
19,9 - 20
20 - 21
21 - 22
22 - 23
23 - 24
24 - 25
25 - 26
26 - 27
27 - 28
Göttlesbrunn

Mean daily minimum temperature in July at 0.5 m (r^2=0.56)




Mean daily air humidity
in June at 0.5 m (r²=0.45)
Legende
Prozent
61,7 - 68
68 - 70
70 - 72
72 - 74
74 - 76
76 - 78
Göttlesbrunn


HUGLIN Index (Temperatursummen für Weinanbau)
Legende
Huglin
1.307 - 1.500 eher Weisswein
1.500 - 1.600
1.600 - 1.700
1.700 - 1.800
1.800 - 1.900
1.900 - 2.000 eher Rotwein
Göttlesbrunn

Conclusions / 12

- The impact of orography on evaporation and air humidity becomes clearly evident due to the spatial variation of the wind field.
- Nearly everywhere, summer soil temperatures at 5 cm depth are higher than air temperature at ground level by 0.5 – 1.9°C depending on soil texture, slope and aspect.
- The effect of cooling at higher altitudes is small (0.0 – 0.6°C) since the relief is modest, but there is an impact from the soil type and its impact on moisture status.
- Precipitation may differ significantly due to local rainfall or thunderstorms

Conclusions / 2

- remarkable effect of wind-shadowing on air humidity and evapotranspiration
- distinctive spatio-temporal variations of temperature parameters in the terrain
- spatio-temporal variations within the range or even higher than possible shifts in climate scenarios


Thank you for your attention!