Climate change and sustainable use of soils:
How to support land management decisions?

Eckart Priesack

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Decision support for site-specific crop production

Sustainable use of soil, water and air → Site-specific land managment

Decision support systems for precision agriculture based on

site specific geographic information (e.g. on soils and soil parameters)

high resolution weather forecast (regional and local scale)

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Need of site specific information on soils, water and air in high resolution both in space and time

- 1. Methods and procedures to characterize site-specific conditions
- 2. Regionalization of climate and weather conditions
- 3. Methods to provide data in due time for site-specific crop production

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1. Methods of site characterization and parameterization

- **Remote sensing based mapping of plant available water capacity**
- **Spectroscopic and chemo-metric mapping of top soil texture and humus**
- **Yield and relief mapping based on hitch draft sensors and GPS methods**

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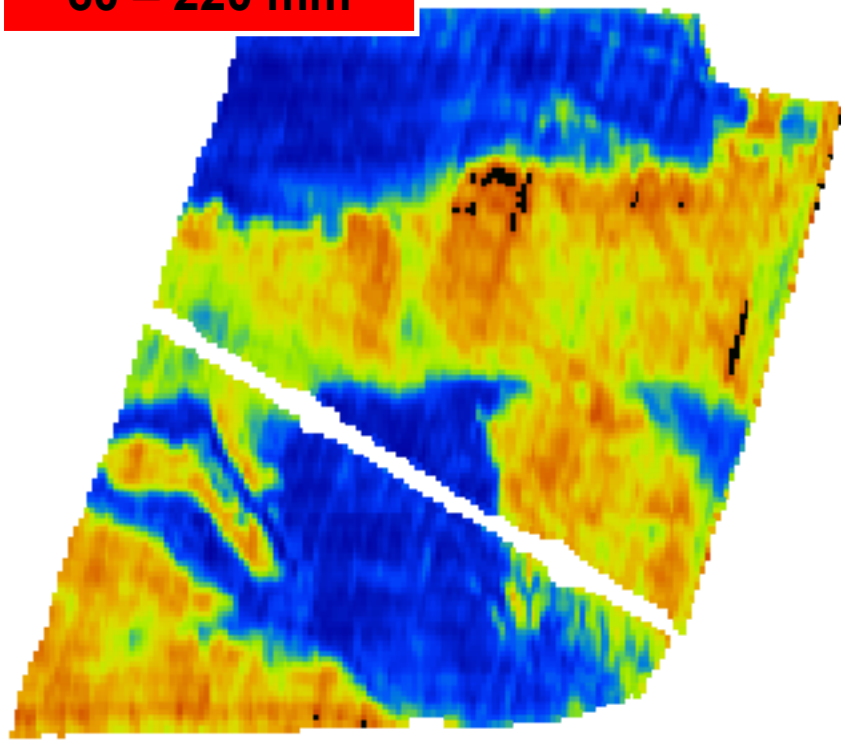
Determination of plant available water capacity (PWC)

- **Remotely sensed growth differences**
- **Assuming plant water availability as main growth limiting factor**

60 – 220 mm



crop	range	RMSE	unit	R^2	n	years
SB	30 - 280	30	mm	0.97	78	5
WW	30 - 240	40	mm	0.94	125	7
WB	20 - 200	50	mm	0.83	57	3
MZ	40 - 260	50	mm	0.85	36	2

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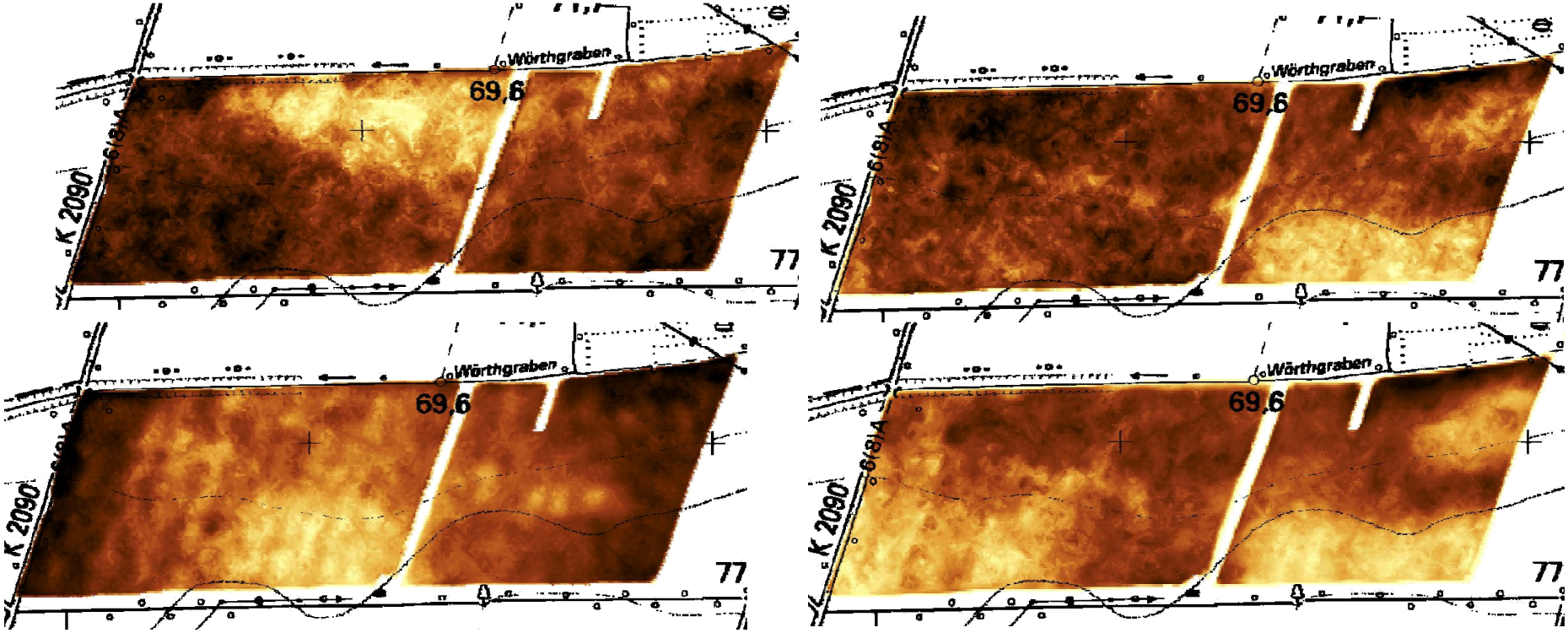
Top soil texture and humus: mapping and validation



parameter	range	RMSE	unit	R^2	n	years
Sand	16 - 88	9.7	%	0.95	46	1
clay	7 - 22	4.2	%	0.71	46	1
Corg	0.7 - 3.85	0.29	%	0.90	46	1
Nt	0.07 - 0.36	0.026	%	0.92	46	1

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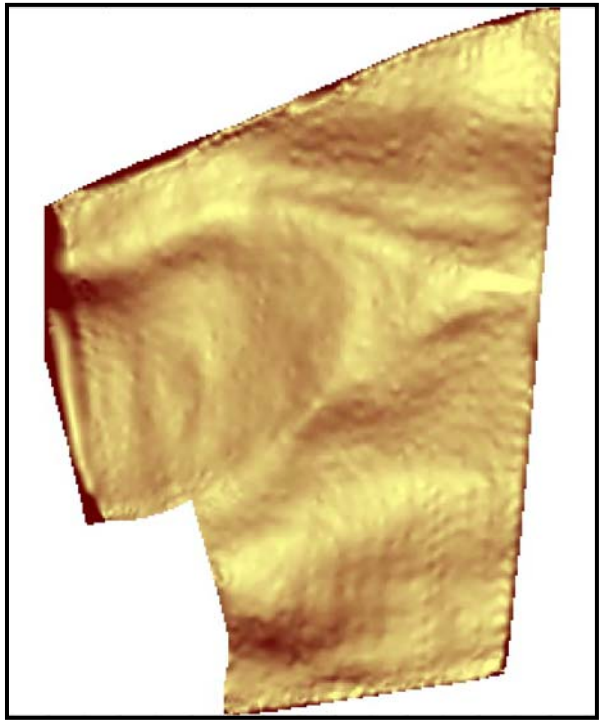
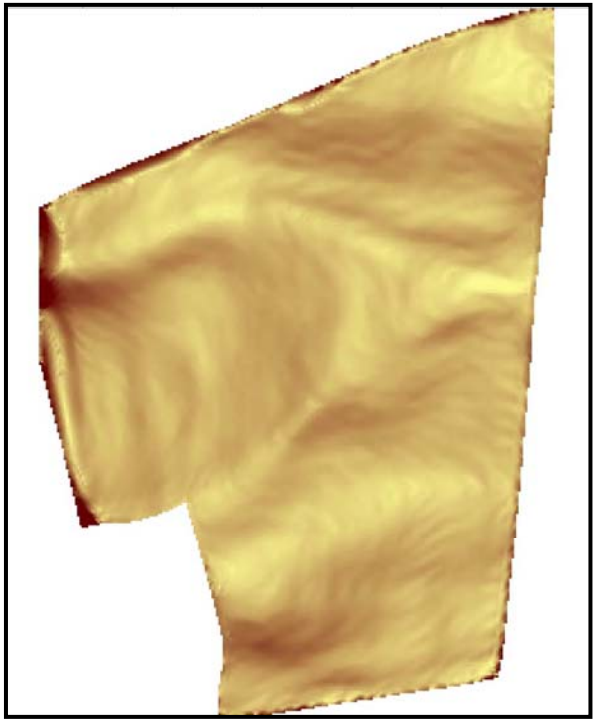
Digital Elevation Model (DEM)

Recording: Real Time Kinematic-GPS (autopilot)

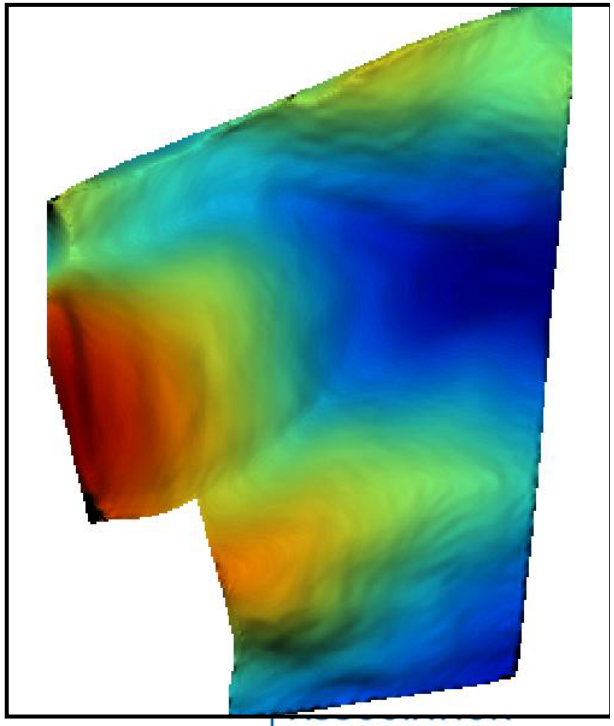
slope
Raw data
IDW Interpolation



slope
Data filtering
anisotropic Interpolation



result: DEM
precision ±7 cm



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2. Regionalisation of climate and weather data

consideration of effects caused by local terrain

- **Adaptation of crop growth plan to local climate risks**
  climatic water balance (April-August)

- **Adaptation of crop growth control to local weather conditions**
  local weather forecast

Use of a complex climate modelling system:

global climate model (circulation data)
regional climate model
process parametrization
downscaling models
96 h forecast model

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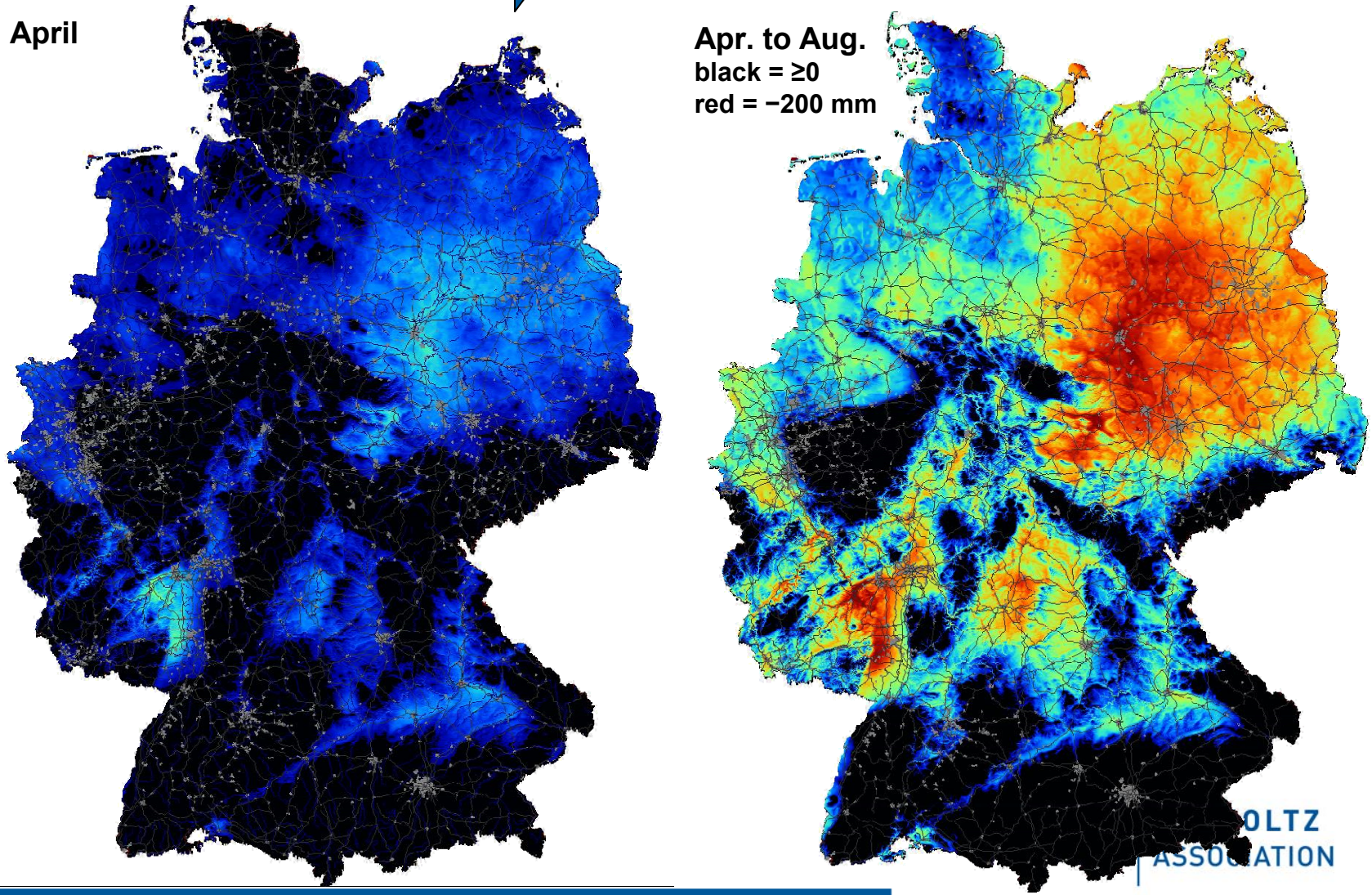
risk for crop growth: water stress

climatic water balance

April

Apr. to Aug.
black = ≥0
red = −200 mm



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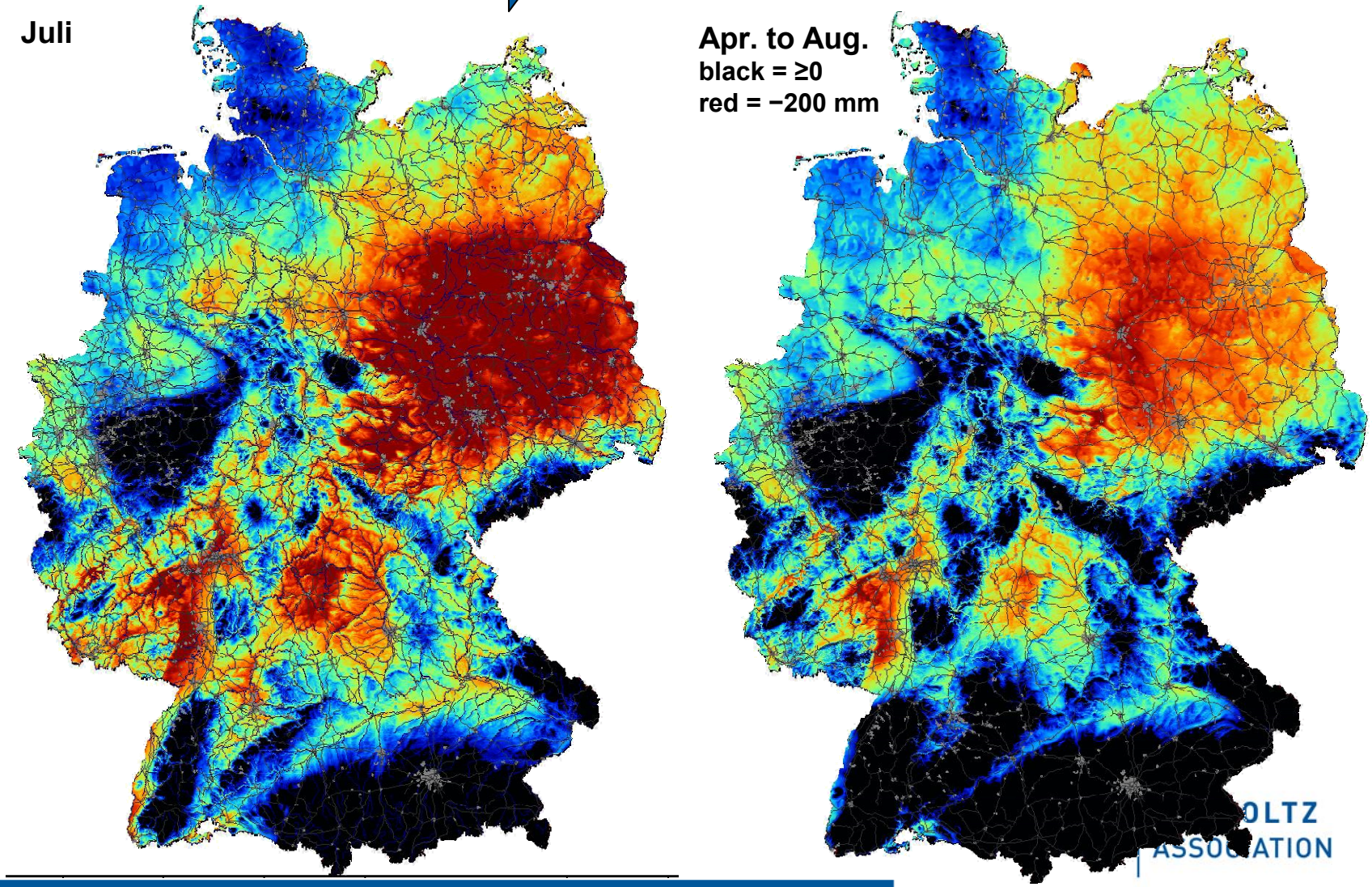
risk for crop growth: water stress

→ *climatic water balance*

Juli

Apr. to Aug.
black = ≥0
red = −200 mm



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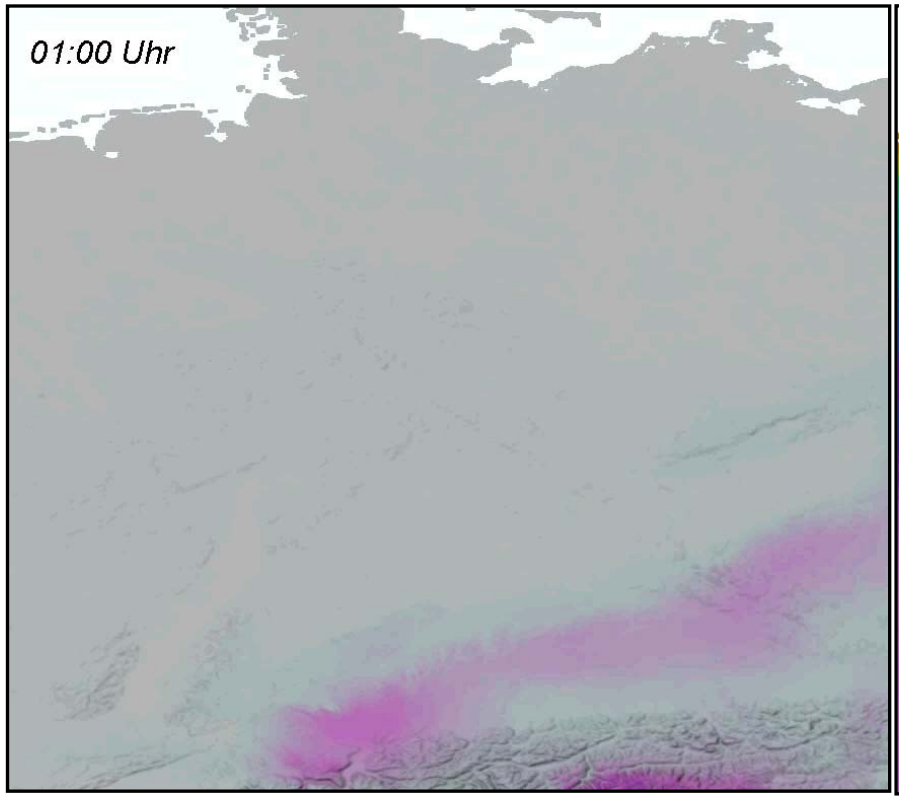
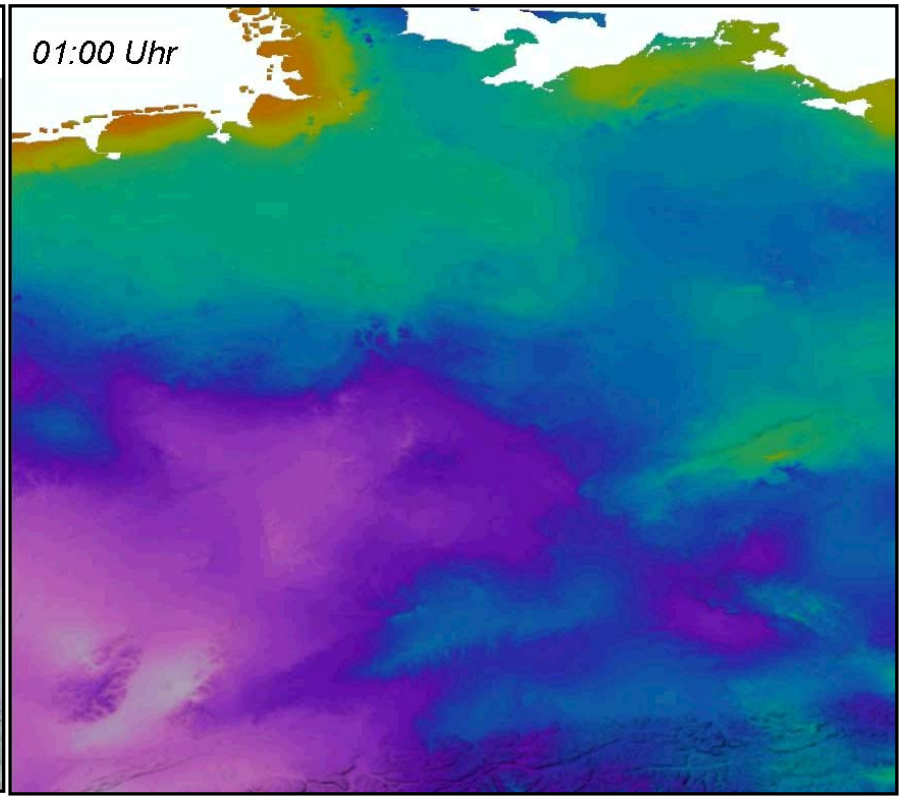
96h weather forecast model

Forecast example from 29.1. for the day 31.1.2008

Precipitation (without snow)



Wind velocity



Continuous input for crop growth control

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3. Methods to provide local site information for plant growth planning and control

Examples:
differentiated sowings / nitrogen fertilisation

- **Adaptation and parameterization of agro-ecosystem models to available data on soils and climate**

- **Integration of adapted agro-ecosystem models into decision support systems and geographical information systems**

to provide sowing and nitrogen fertilizer application maps

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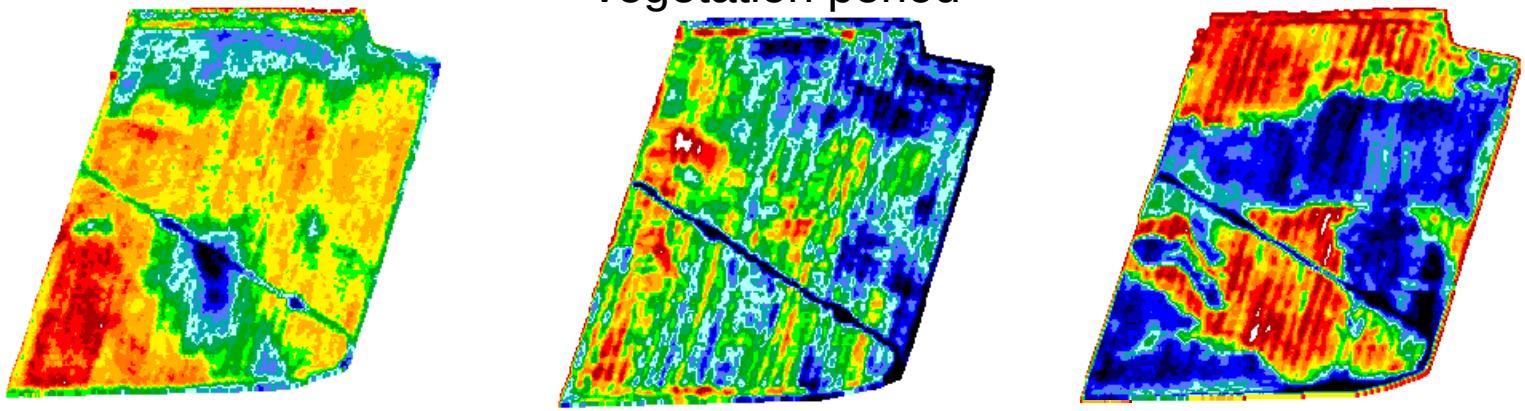
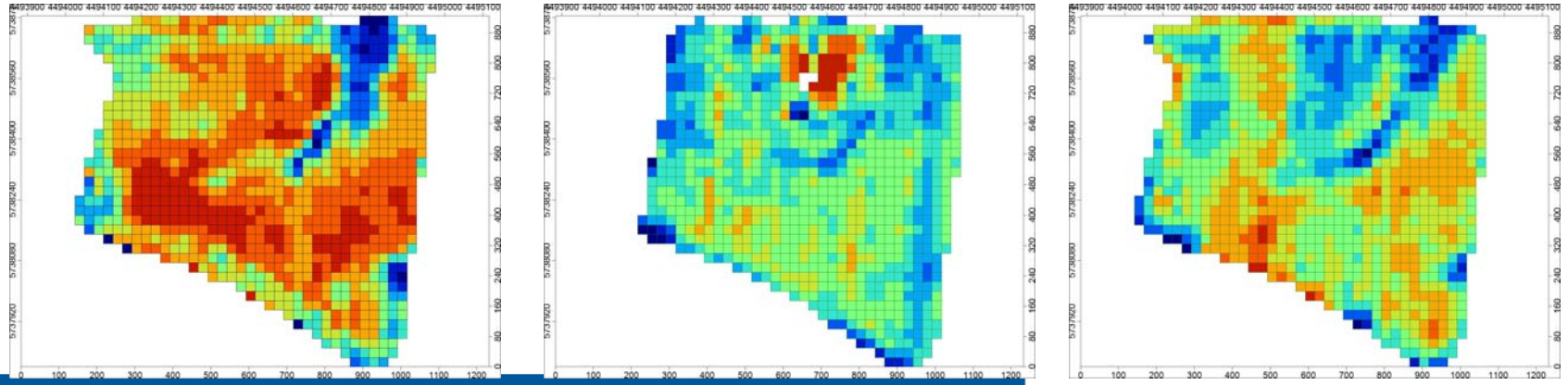
Why agro-ecosystem model based information systems?

Spatial distribution patterns of ontogenesis and biomass change during the vegetation period



Yield and yield patterns change between the different years despite the same crop management and same soils



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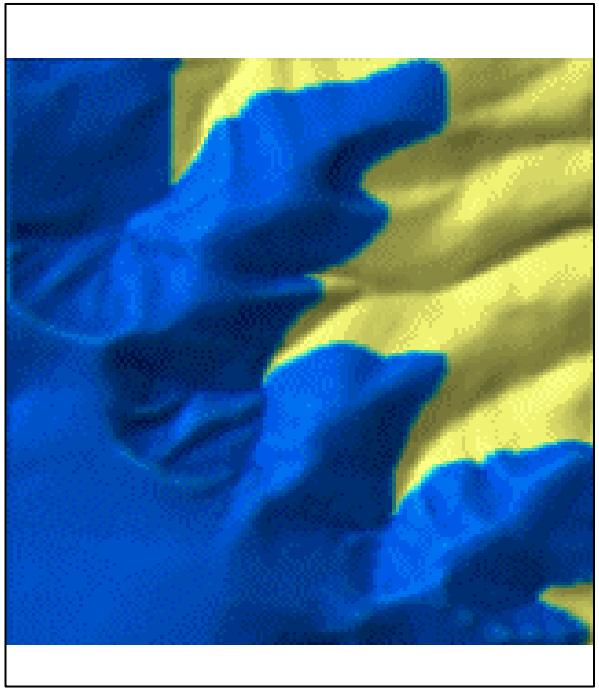
Numerical simulation of soil and crop state variables

- Combination of static and dynamic site factors
- Consideration of coupled processes
- Description of dynamical structures



Example:

lateral water flows during heavy rainfall

- erosion
- water ponding
- nutrient leaching

Simulations to support decisions :

‚Which impact has a certain decision on the actual situation?‘

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Model based nitrogen (N) fertilisation
(flow chart)

Database of site-specific and management data

soils – relief – atmospheric conditions – field records

↓

Agro-ecosystem model system (Expert-N):
soil – growth – feed back

(Interaction between growth and soil status)

↓

Rule based fertilizer application scheme

(updated fertilizer recommendation)

↓

Farm decision – Feed back

(self-determined decision of the farmer)

↓

calculation of final N-application maps

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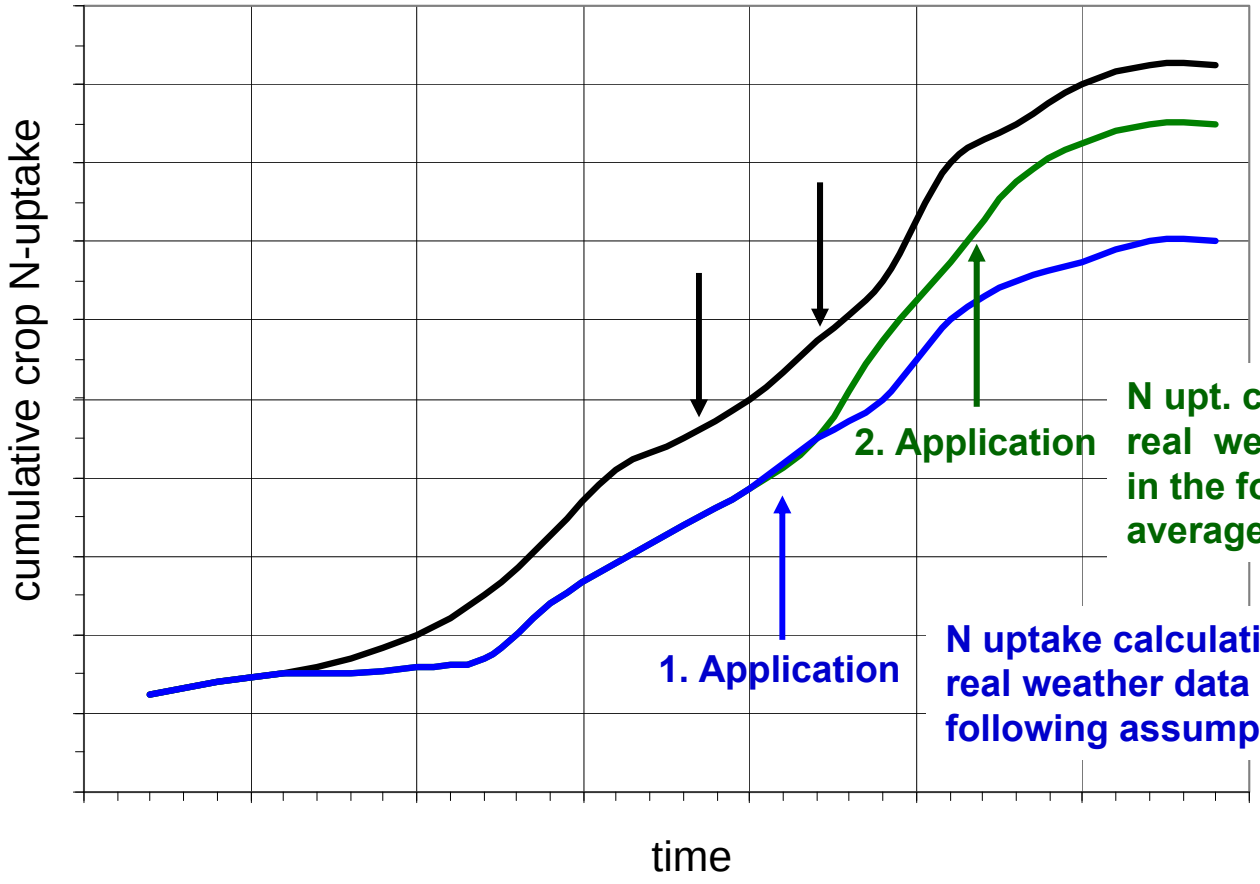
Model based adaptation of N-fertilisation

Adaptation to site-specific conditions, course of the weather and most probable further course of the weather (average climatic conditions)



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Thanks to

Thomas Selige,
Technical University Munich

the partners of the
GEOSTEP team
www.geostep.org

and

the partners of the
TERENO team
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