

# Set up of Turbulence Network

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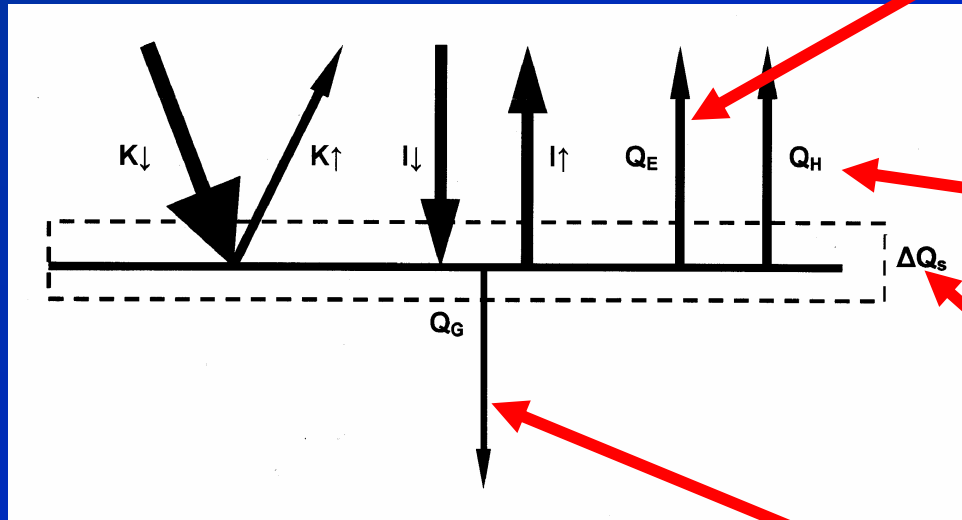
# Content

- 1. Surface fluxes and convection**
- 2. Experimental setup**
- 3. Set up in the Kinzig valley**
- 4. Applicable data**



# Surface fluxes and convection

Net radiation



Latent heat flux  
(moist convection)

Sensible heat flux  
(thermal convection)

Storage

Soil heat flux  
&  
Soil moisture

Furthermore necessary:  
Surface layer Deardorff  
velocity



# Scaling of fluxes and convection

thermal  
scaling

dynamical  
scaling

Surface layer

$$T_* = -\frac{\overline{w'T_v'}}{u_*}$$

$$u_*$$

limit (5-50 m):

$$\frac{z}{L} = \frac{z \cdot \kappa \cdot g \cdot T_*}{T_v \cdot u_*^2} < -1$$

Convective  
layer

$$w_* = \left[ \frac{g \cdot z_i}{\theta_v} \overline{w'\theta_v'} \right]^{1/3}$$

Remark 1: Coherent structures are already generated in the surface layer. There is a connection to such structures in the boundary layer.

Remark 2: There is no remote sensing technique available to determine these parameters.



# Experimental setup

**Building up of at least 3 Main Sites at convection generating area's (2 in the valley, 1 in the mountains and single measurements in between)**

- **Sodar, energy balance and turbulent flux complexes of the Research Centre Karlsruhe**
- **Sodar-RASS, energy balance and turbulent flux complexes of the University of Bayreuth**
- **Permanent stations at Hartheim and Tuttlingen of the University of Freiburg**
- **Probable: 1 complex of an international partner**



# Planned set up

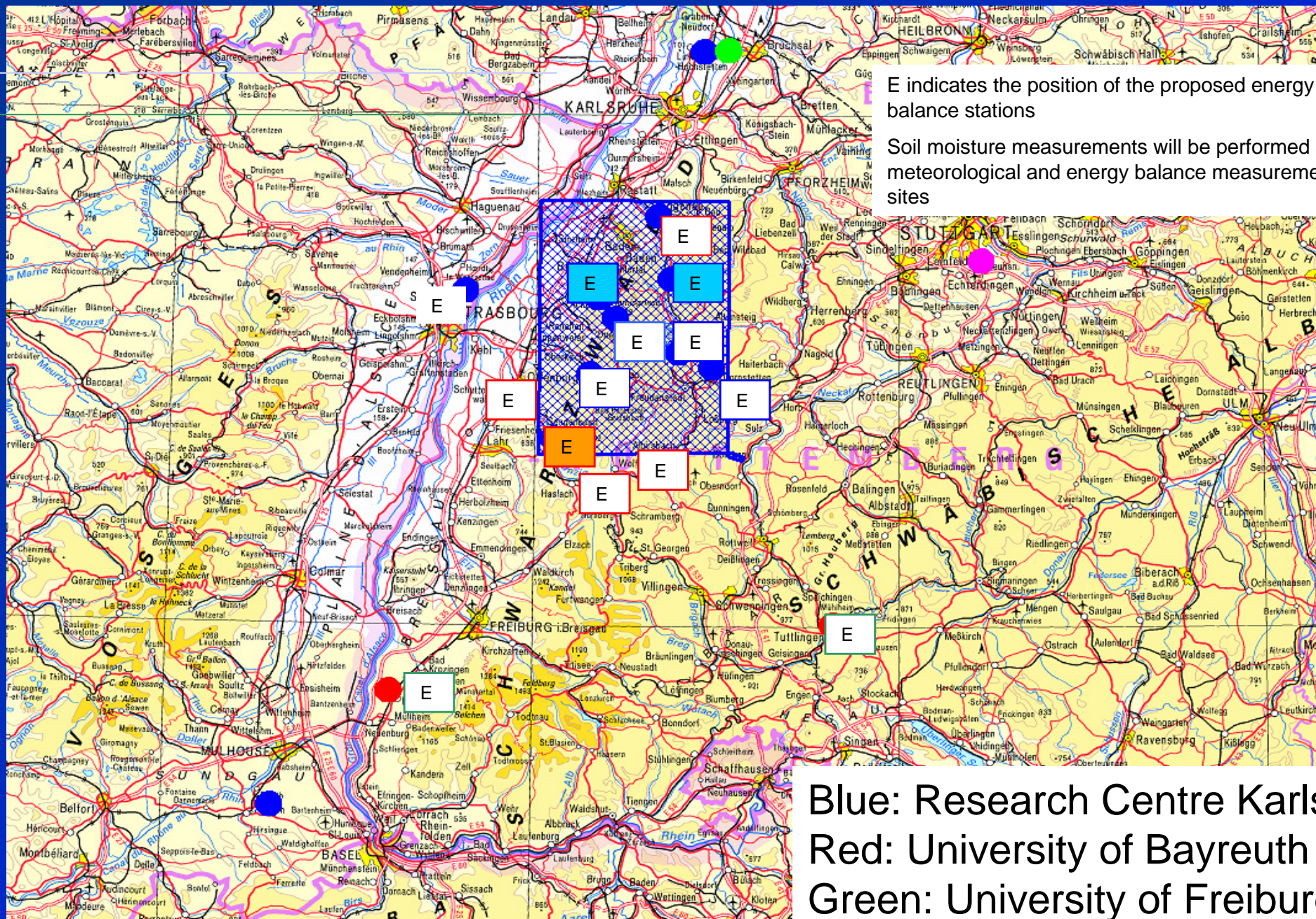
- **Turbulence set up of the Research Centre Karlsruhe in the Northern Schwarzwald (Murg valley) and at the mountains (Hornisgrinde)**
- **Turbulence set up of the University of Bayreuth in the Middle Schwarzwald (Kinzig valley)**
- **Additional tower measurements of the University of Freiburg at Tuttlingen and Hartheim**
- **Additional measurements of an international partners**



# Criteria for the selection of the sites

- **Wide of the valley with uniform land use approx. 300 - 500 m – generation of convection.**
- **Flat area (meadows, agricultural fields) of about 200 m with uniform land use – necessary for eddy-covariance measurements.**
- **No obstacles near the measuring field.**
- **Electric power**
- **For Sodar/RASS: no villages**





E indicates the position of the proposed energy balance stations

Soil moisture measurements will be performed at meteorological and energy balance measurement sites

Blue: Research Centre Karlsruhe  
 Red: University of Bayreuth  
 Green: University of Freiburg



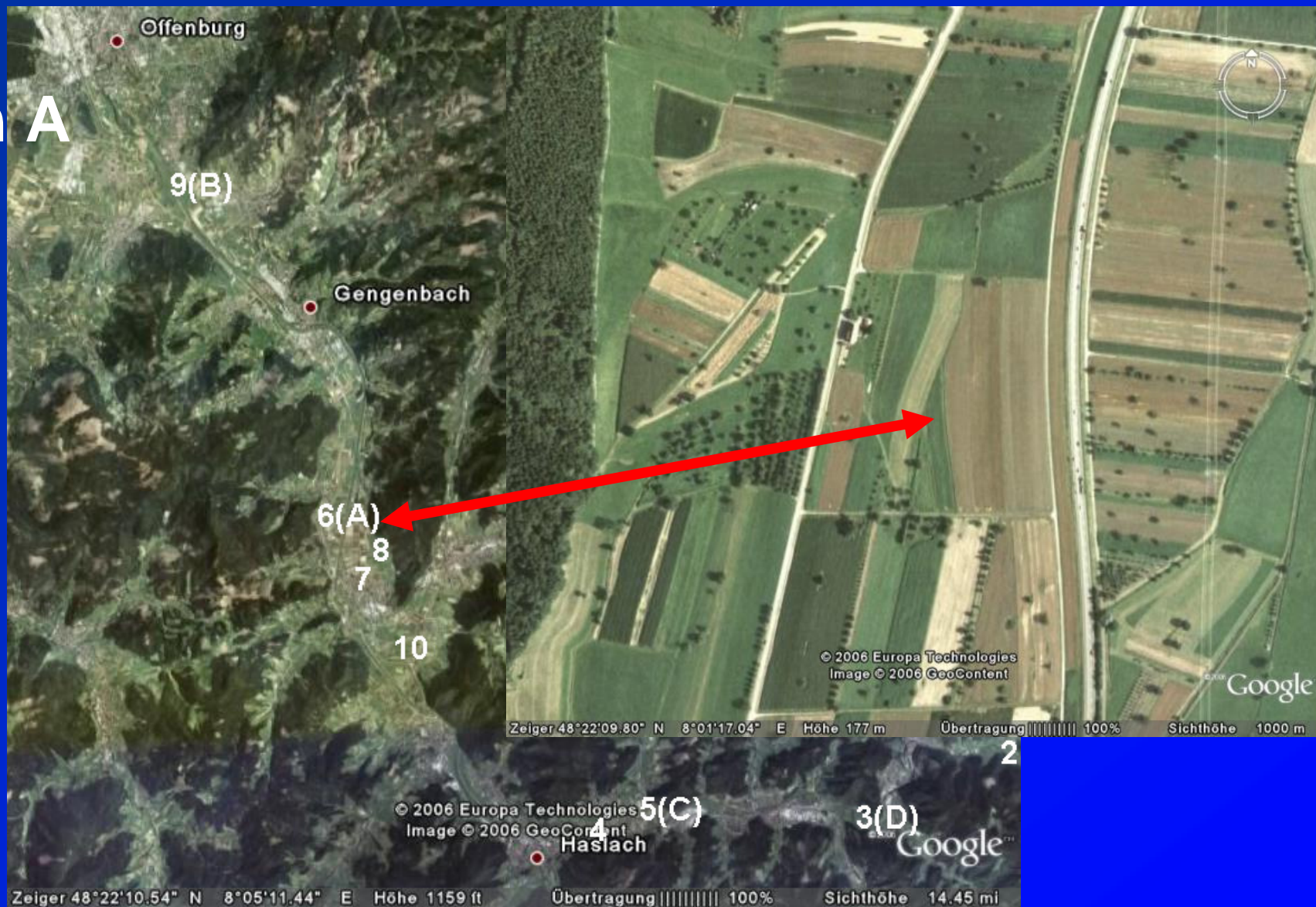


# Turbulence set up in the Kinzig valley



# Turbulence set up in the Kinzig valley

## Station A



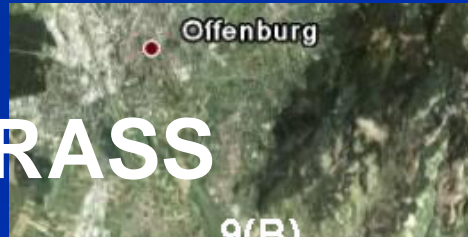
# Turbulence set up in the Kinzig valley

## Station A



# Turbulence set up in the Kinzig valley

## Sodar/RASS



# Turbulence set up in the Kinzig valley

## Turbulence



# Turbulence set up in the Kinzig valley

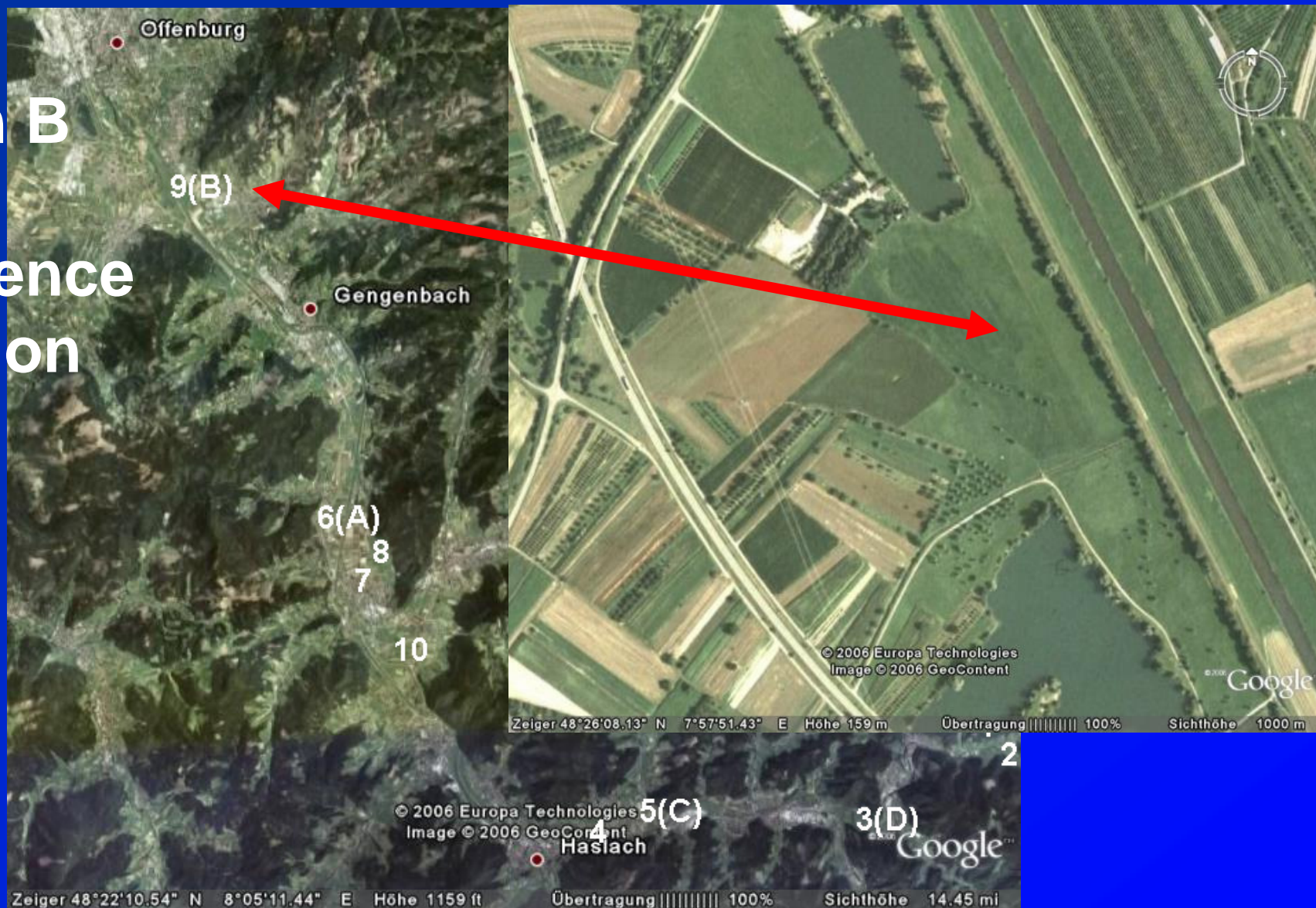
## Radiation



# Turbulence set up in the Kinzig valley

Station B

Turbulence  
Radiation



# Turbulence set up in the Kinzig valley

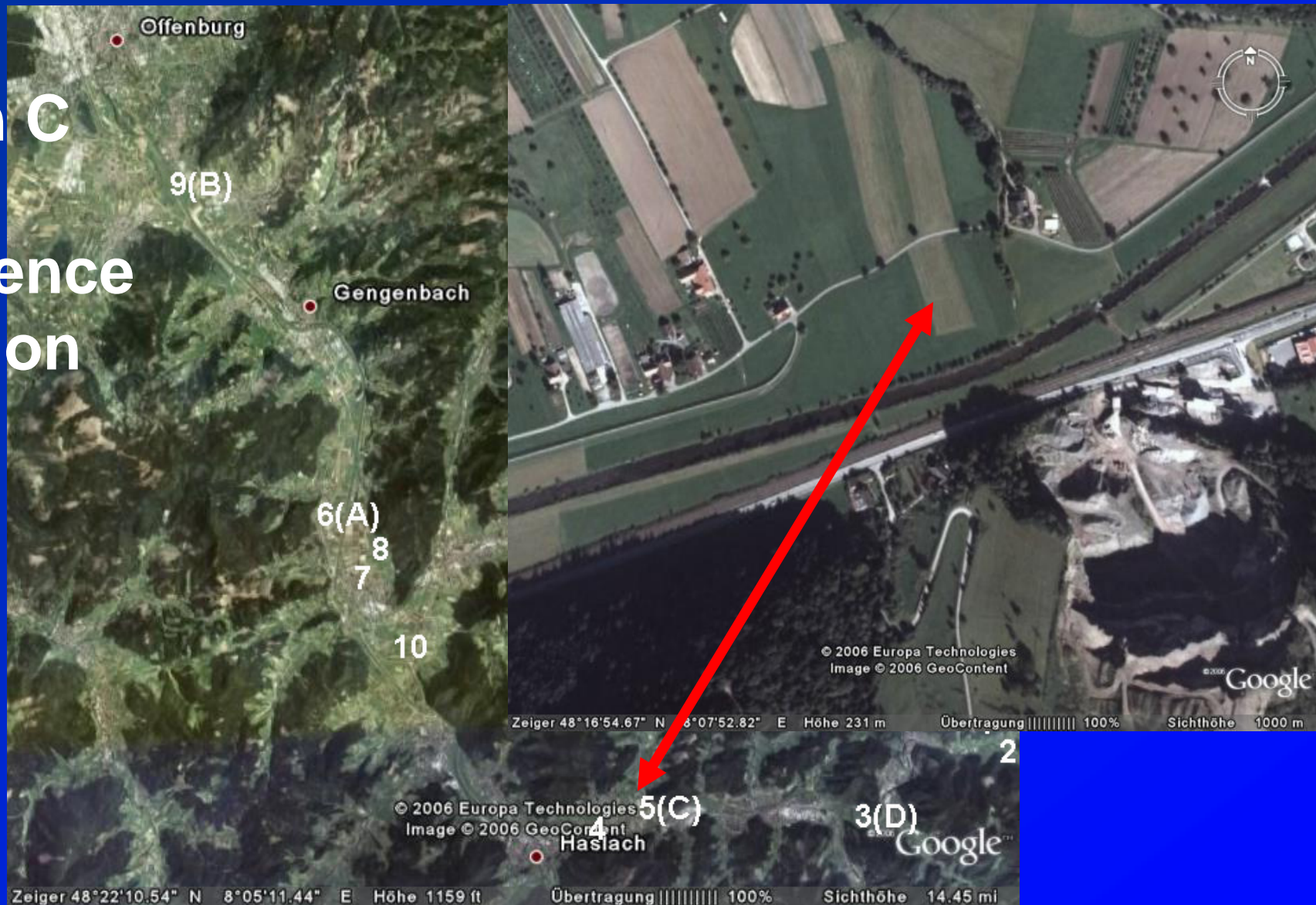
Station B  
Turbulence  
Radiation





# Turbulence set up in the Kinzig valley

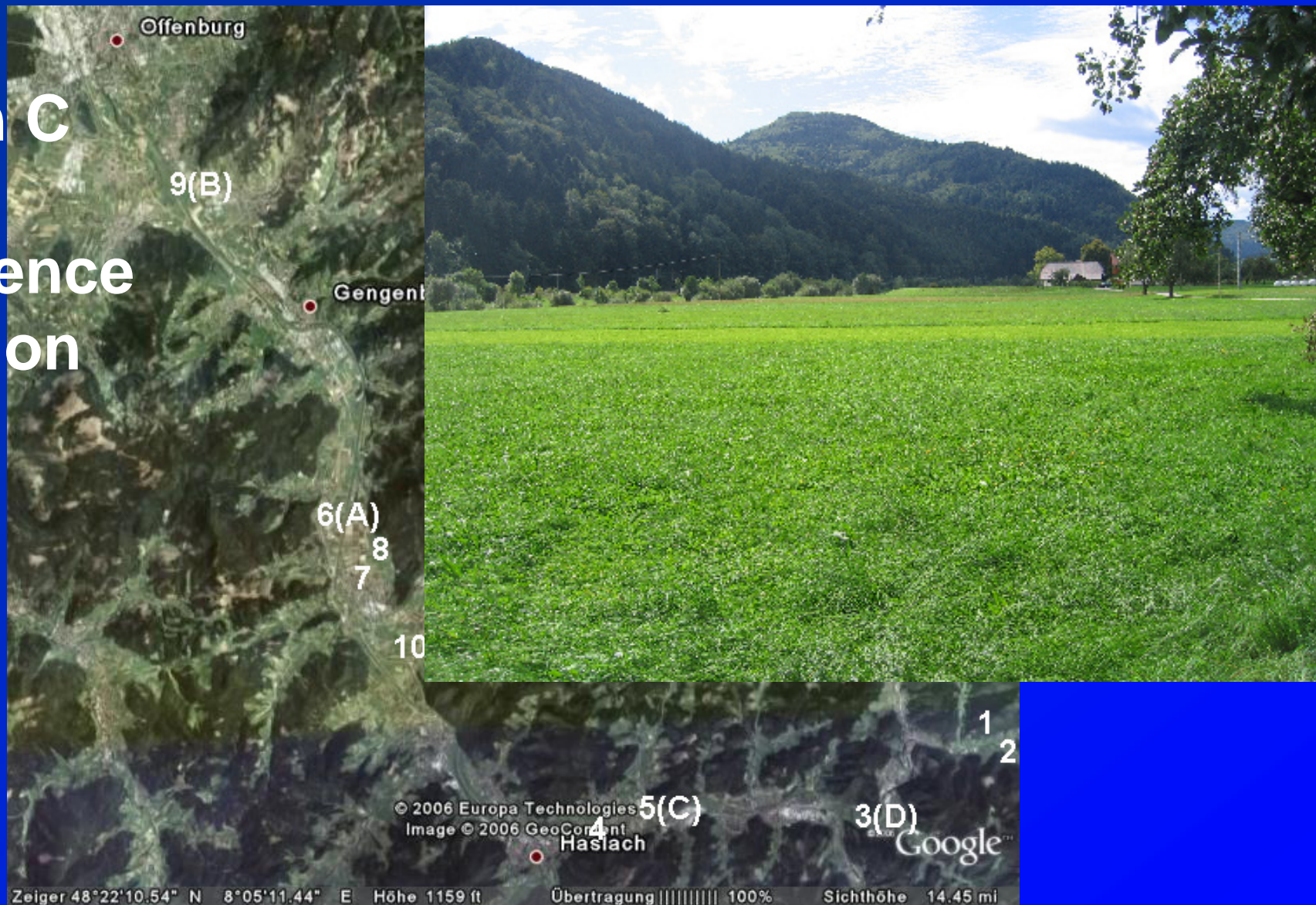
Station C  
Turbulence  
Radiation



# Turbulence set up in the Kinzig valley

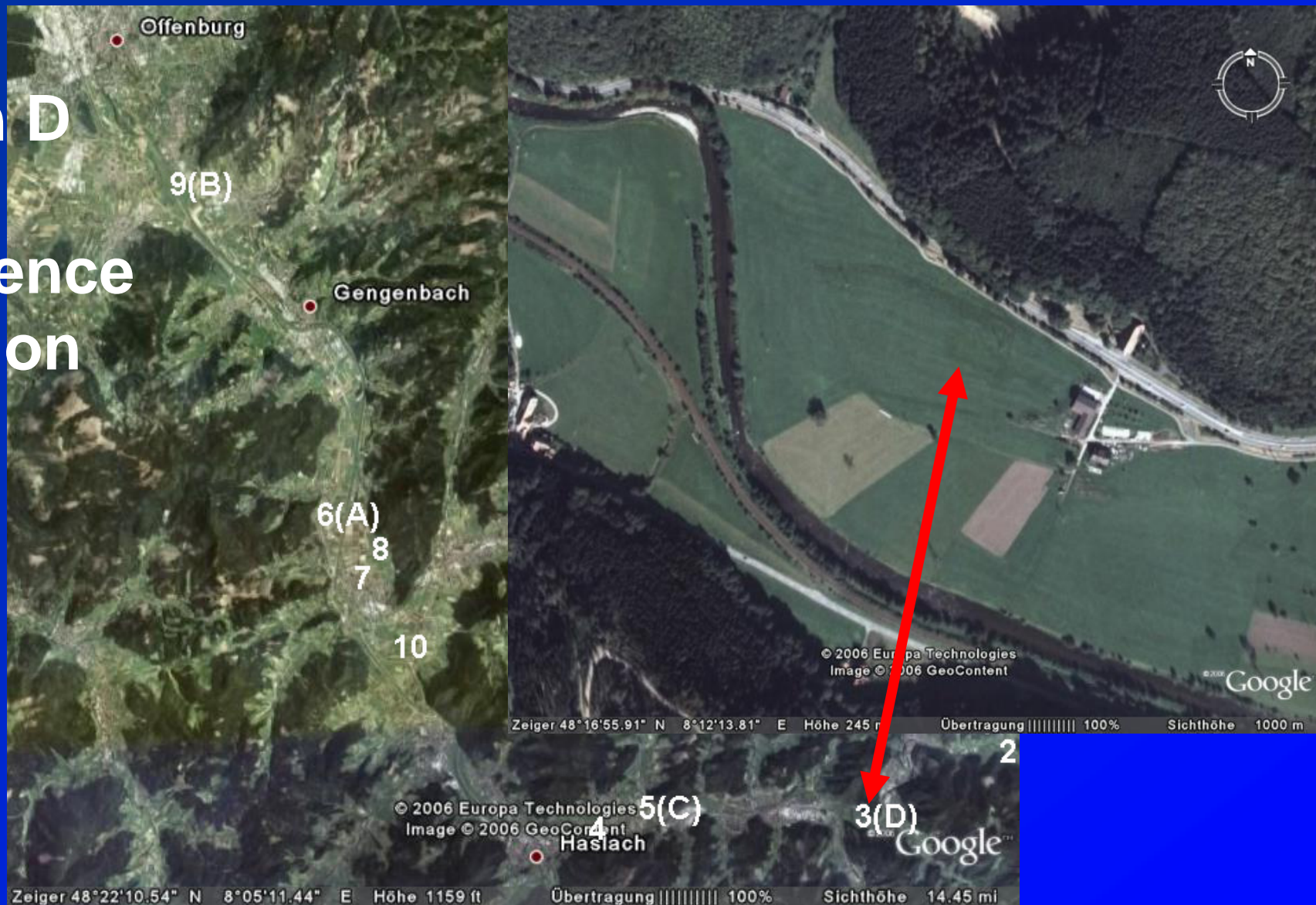
Station C

Turbulence  
Radiation



# Turbulence set up in the Kinzig valley

Station D  
Turbulence  
Radiation



# Turbulence set up in the Kinzig valley

Station D

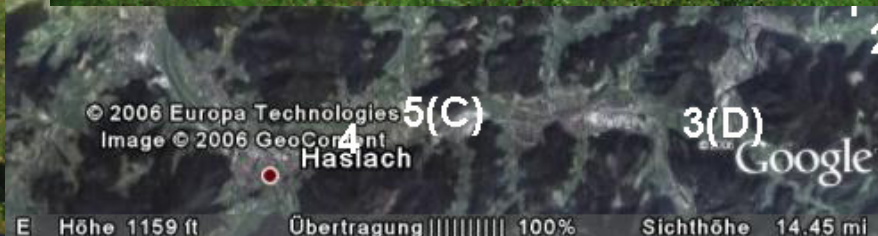
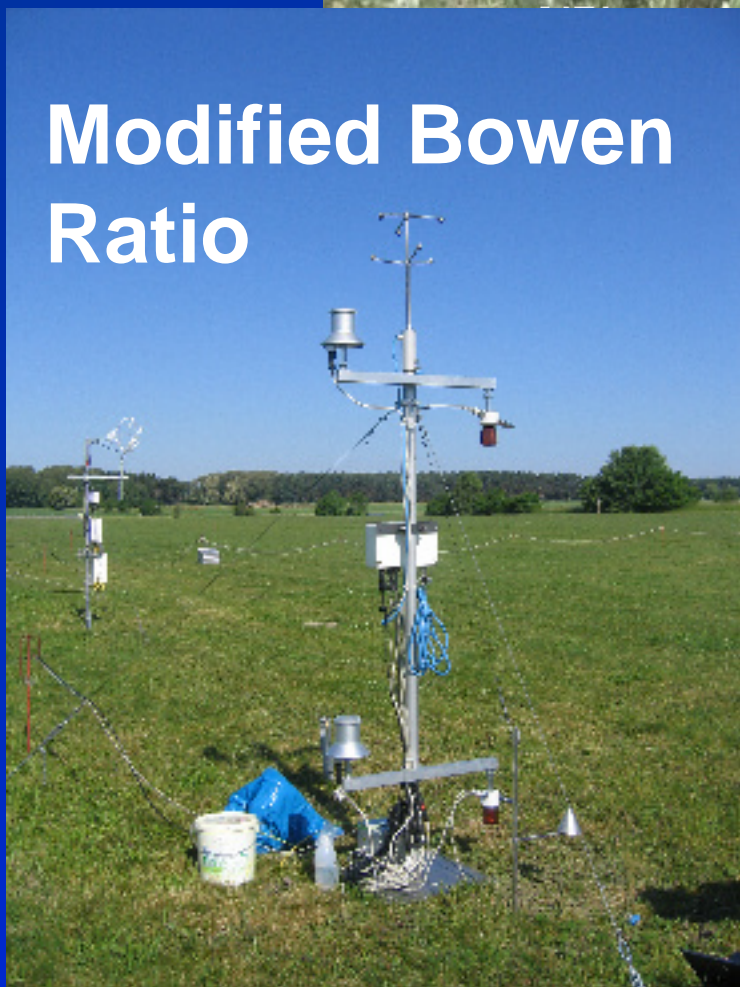
Radiation  
Modified Bowen  
Ratio



# Turbulence set up in the Kinzig valley

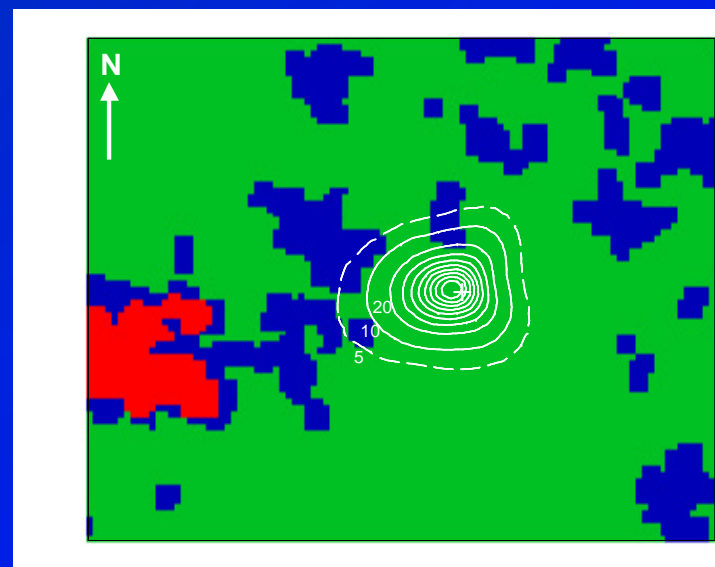
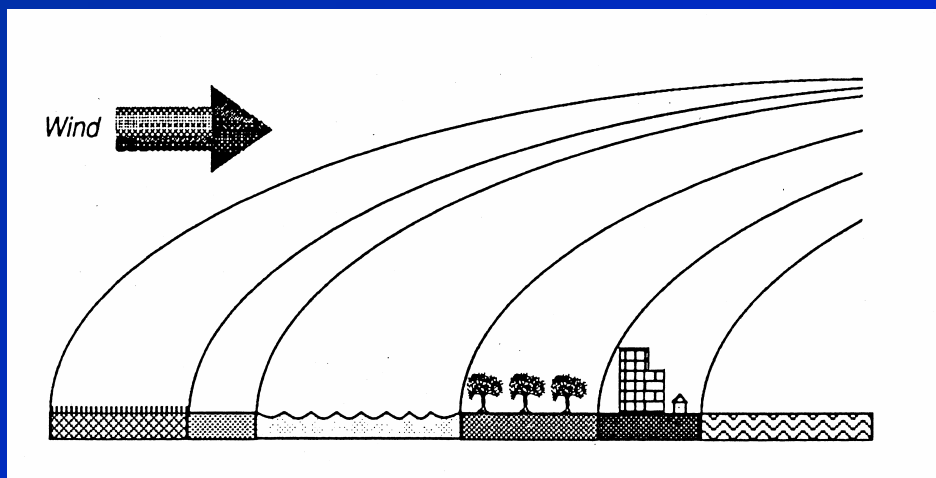
Station D

Modified Bowen Ratio



# Quality Assurance and control

- Quality test according to Foken & Wichura (1996)
- Internal boundary layers
- Simple Footprint



| sector in°   | 30° | 60° | 90° | 120° | 150° | 180° | 210° | 240° | 270° | 300° | 330° | 360° |
|--|-----|-----|-----|------|------|------|------|------|------|------|------|------|
| x in m   | 29  | 41  | 125 | 360  | 265  | 203  | 211  | 159  | 122  | 81   | 36   | 28   |
| δ in m   | 1.6 | 1.9 | 3.4 | 5.7  | 4.9  | 4.3  | 4.4  | 3.8  | 3.3  | 2.7  | 1.8  | 1.6  |
| flux contribution from the target land use area in % |     |     |     |      |      |      |      |      |      |      |      |      |
| stable   | 36  | 49  | 81  | 99   | 96   | 92   | 93   | 88   | 81   | 70   | 44   | 35   |
| neutral  | 51  | 63  | 90  | 100  | 100  | 98   | 98   | 95   | 90   | 82   | 59   | 50   |
| unstable   | 62  | 74  | 98  | 100  | 100  | 100  | 100  | 100  | 98   | 91   | 70   | 61   |



## **Further data analysis (not within the funding period)**

- **Ogive test for longwave contributions of the fluxes (approx. 2-5 % increase of the turbulent fluxes)**
- **Contributions of Turbulent organized Structures and secondary circulations to the turbulent fluxes (approx. 20 % increase of the turbulent fluxes) – Energy balance closure problem**
- **Footprint analysis for each measuring seria**
- **Uniform data analysis for all measuring sites (comparability of the sites)**



# Conclusions

- **The measurement of the surface energy parameters is an important part to understand the generation of convection and to generate initialization parameters for models.**
- **At the present time such measurements and calculation should be done according to the standards of recent experiments and programs.**
- **The data calculation and quality control incl. footprint analysis should be done according to the recent findings (by each group or central).**

