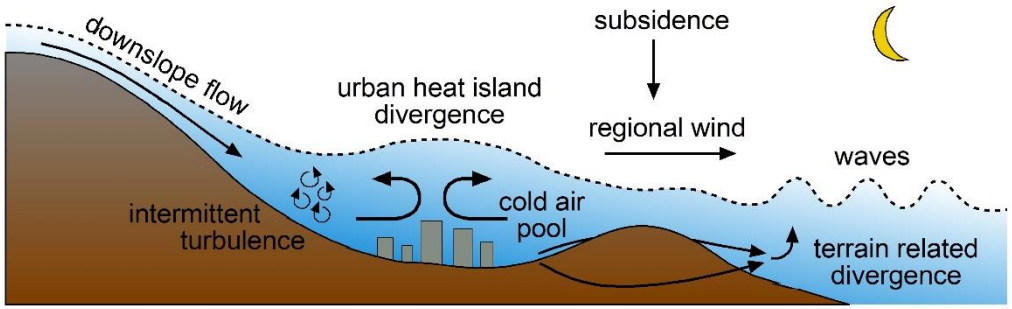


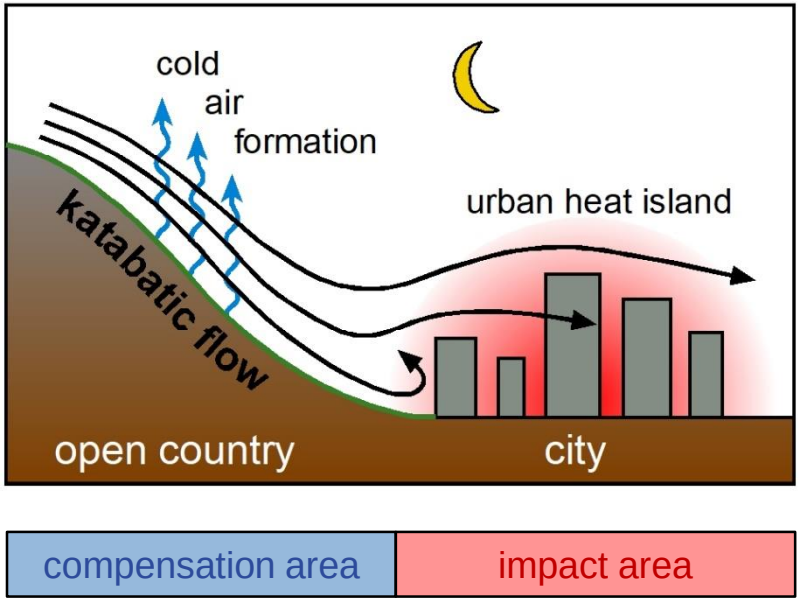
de Wekker et al. (2018)

DWD studies on nocturnal thermally driven flows in hilly and urban terrain

Meinolf Kossmann & Coauthors

Content

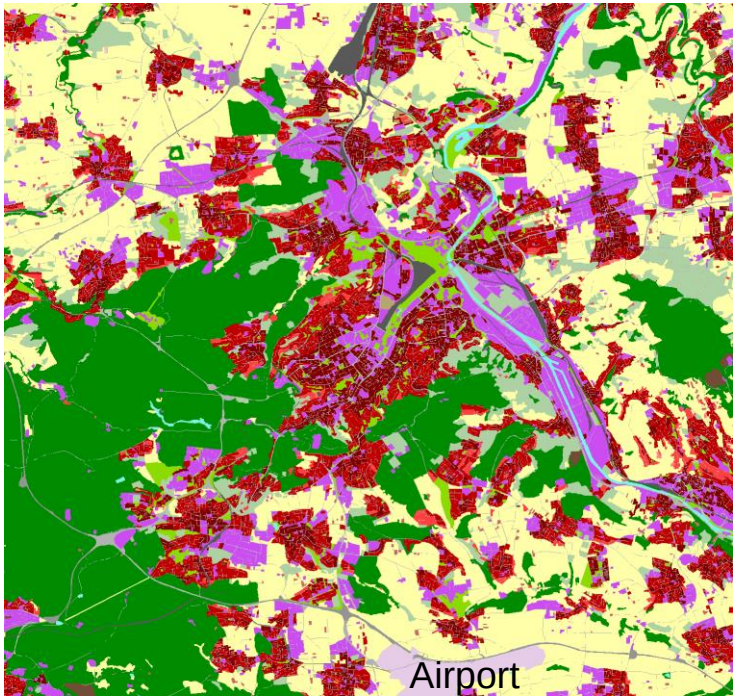
- Observation of nocturnal cooling in the **Stuttgart Basin** by down-valley winds
- Numerical modelling of nocturnal cold air formation and advection into the heat island of **Aschaffenburg**
- Observation of nocturnal **Inn Valley** exit jets (TEAMx)



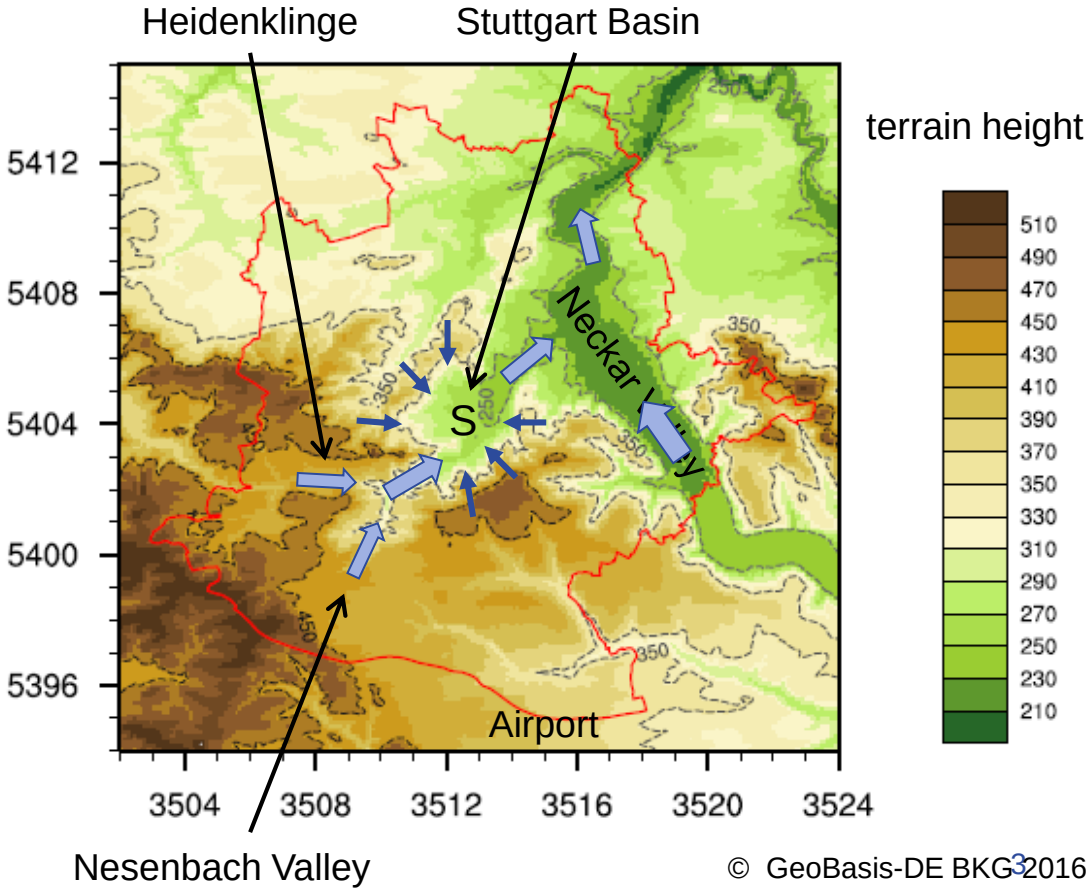
Observations in Stuttgart Basin

640 000 inhabitants, 207 km²

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Land cover (Copernicus Urban Atlas)



Obs. Stuttgart

[UC]²: B-3DO

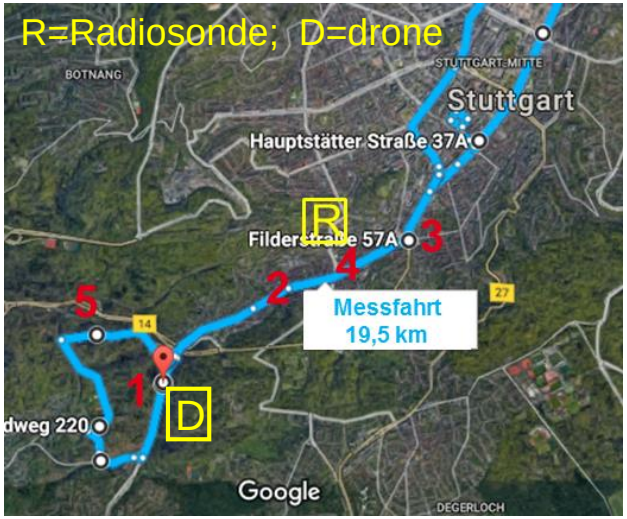
Bundesministerium für Bildung und Forschung

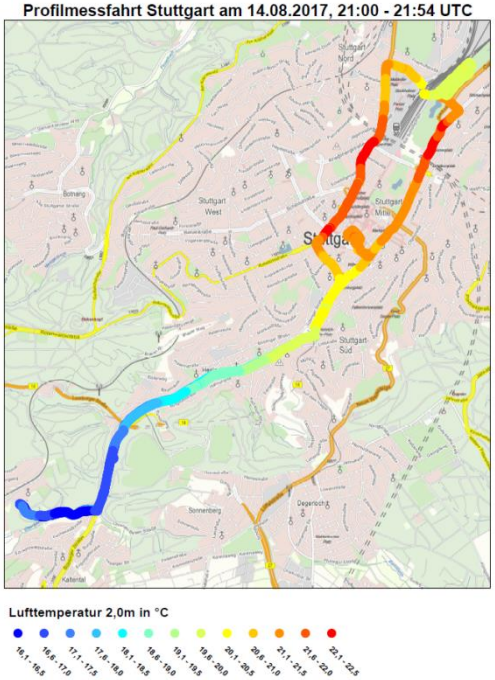
https://uc2-program.org

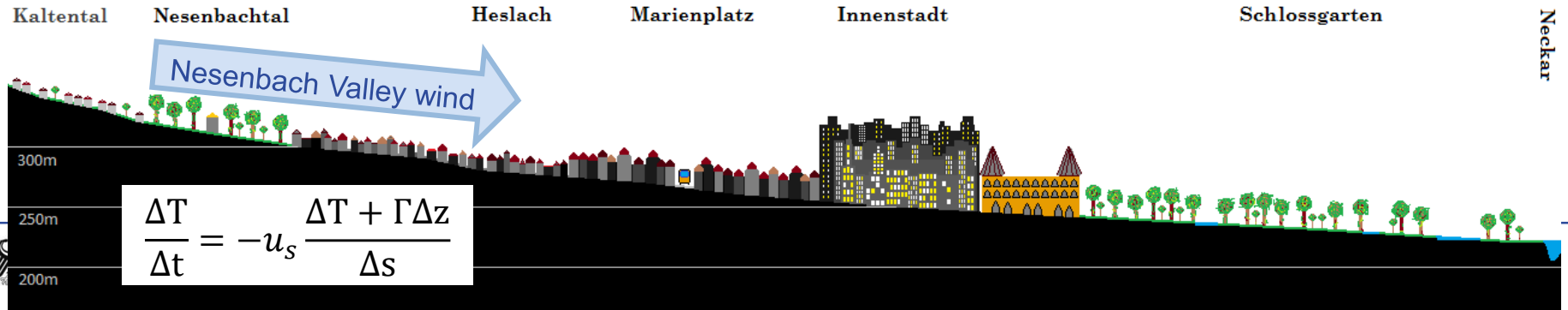
Estimation of advective cooling by along-valley winds (K/h)

Surface stations

1: Nesenbach Valley / Böbl. Str.
2: Möhringer Str.
3: Marienplatz
4: Erwin-Schöttle-Platz
5: Leonberger Str.



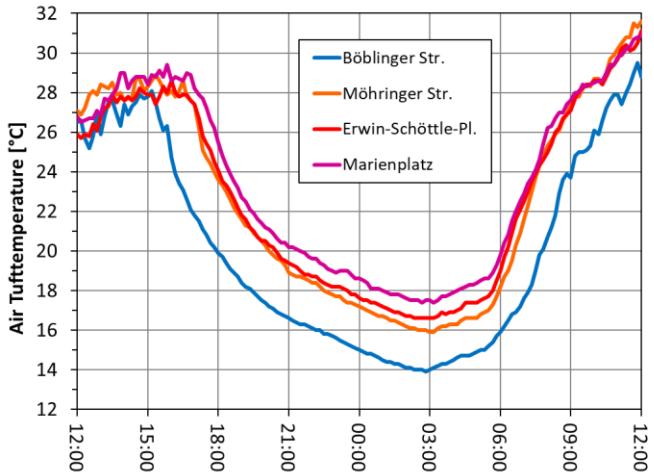


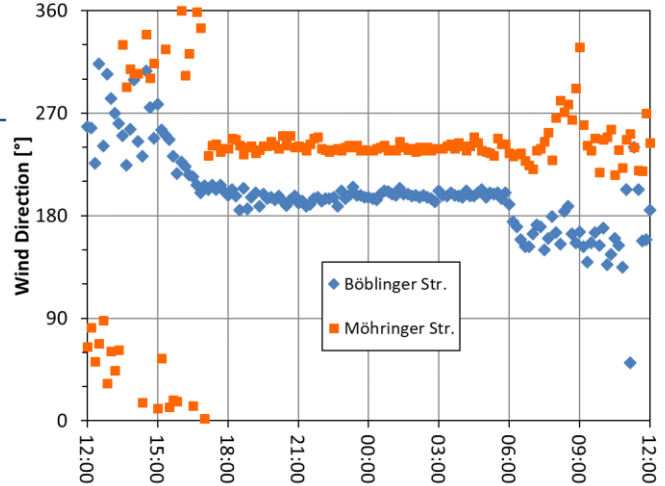


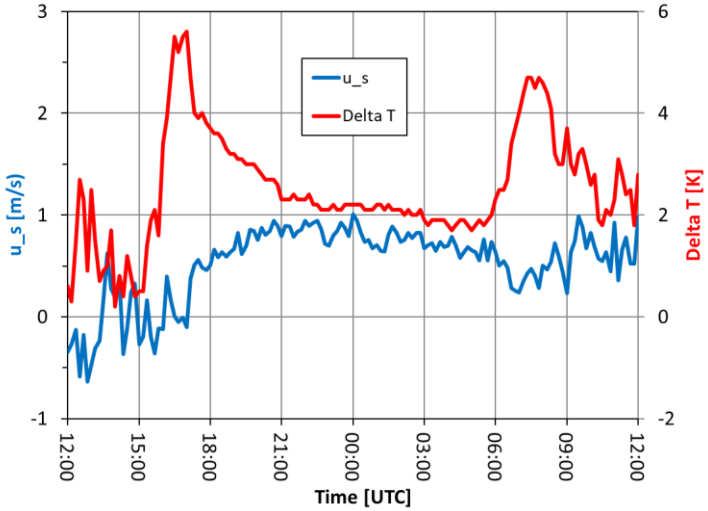
$$\frac{\Delta T}{\Delta t} = -u_s \frac{\Delta T + \Gamma \Delta z}{\Delta s}$$

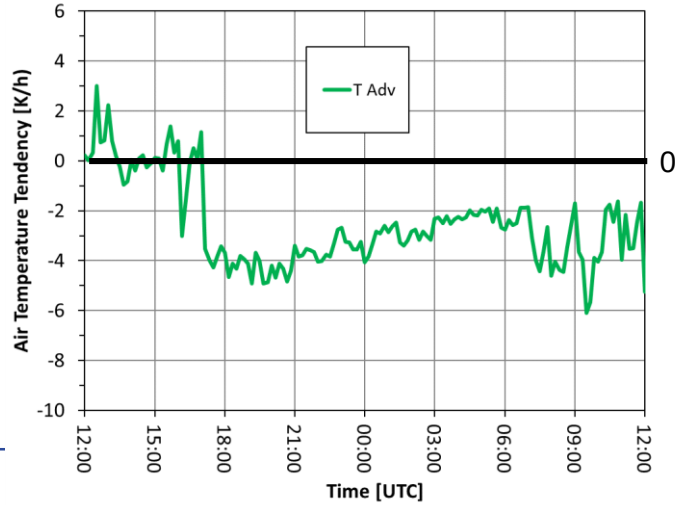
Observations in Stuttgart Basin

14-15/08/2017



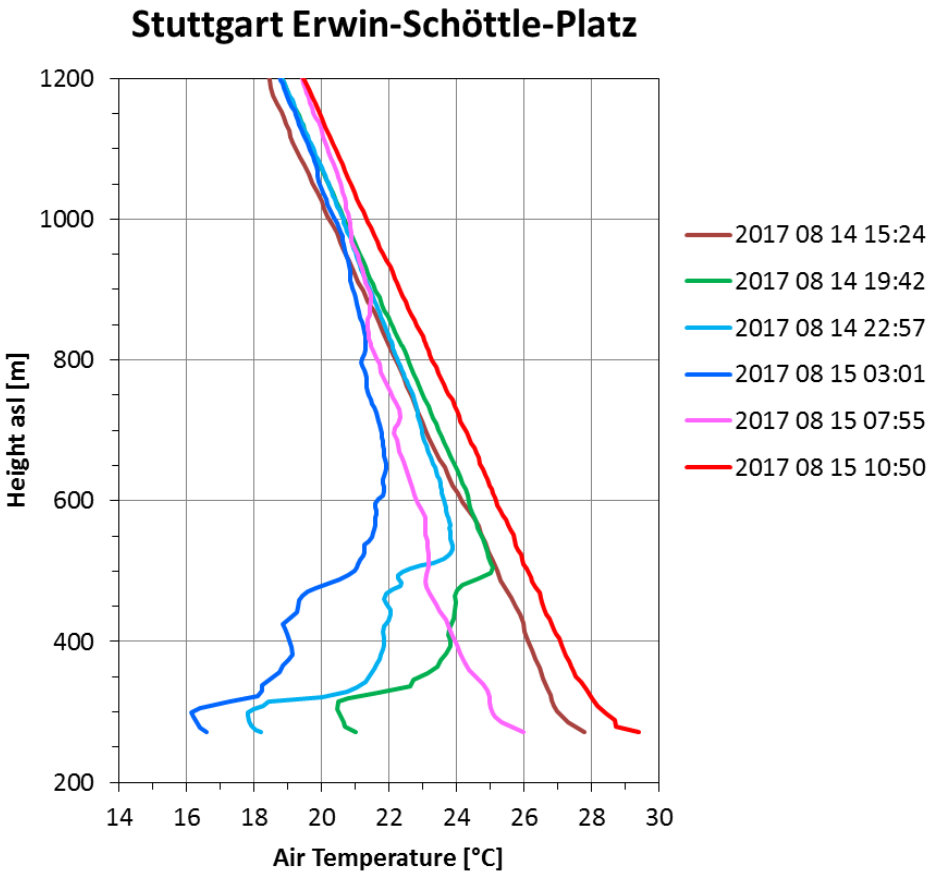


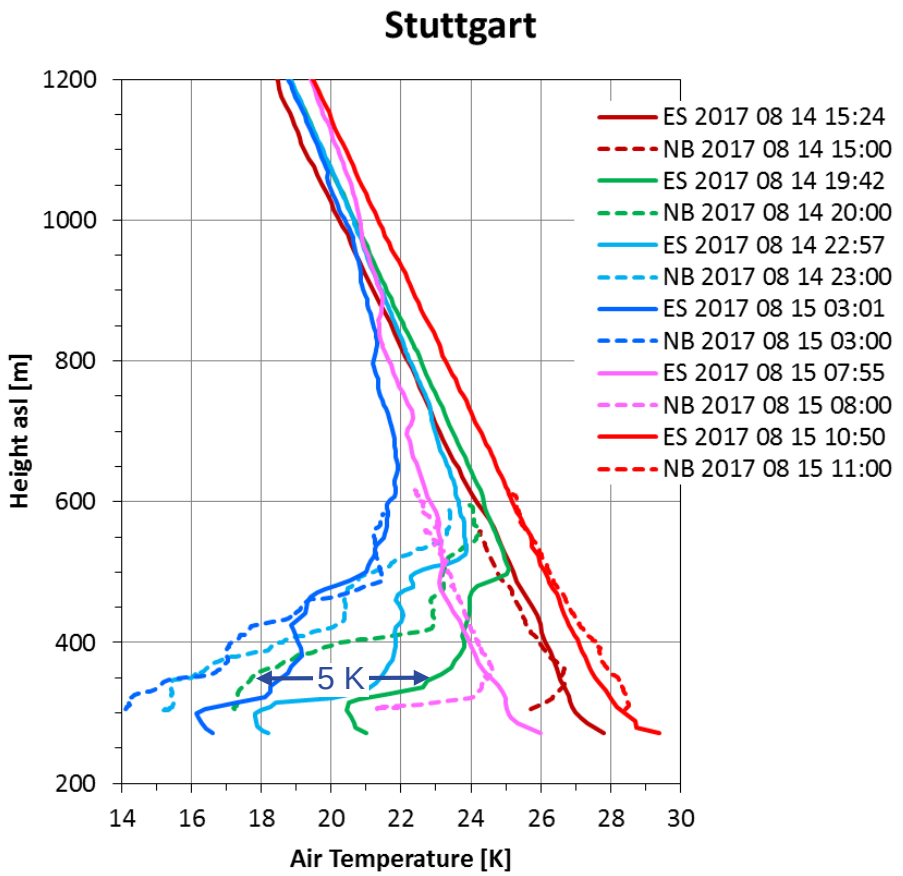




Observations in Stuttgart Basin

Deutscher Wetterdienst
Wetter und Klima aus einer Hand





MUKLIMO_3 simulations Aschaffenburg

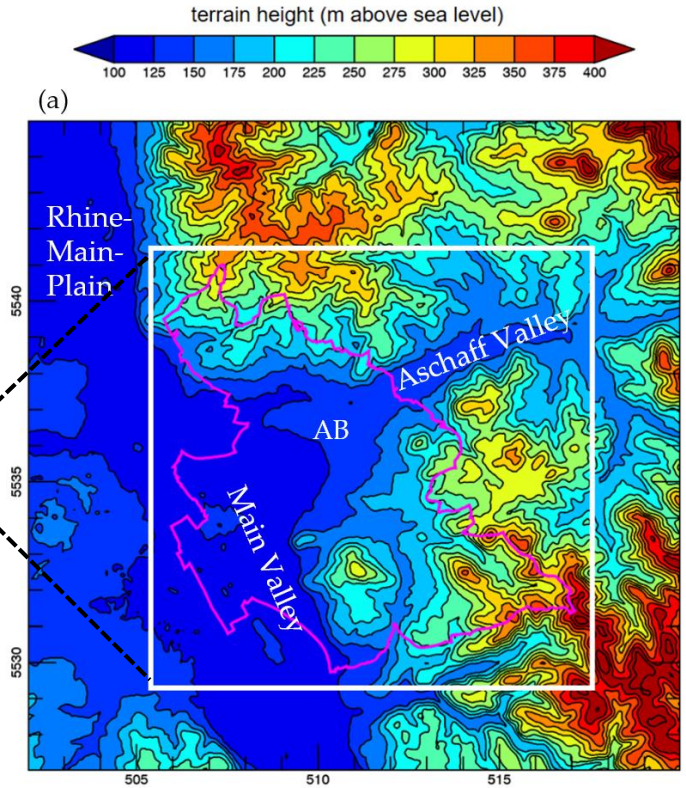
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Core domain

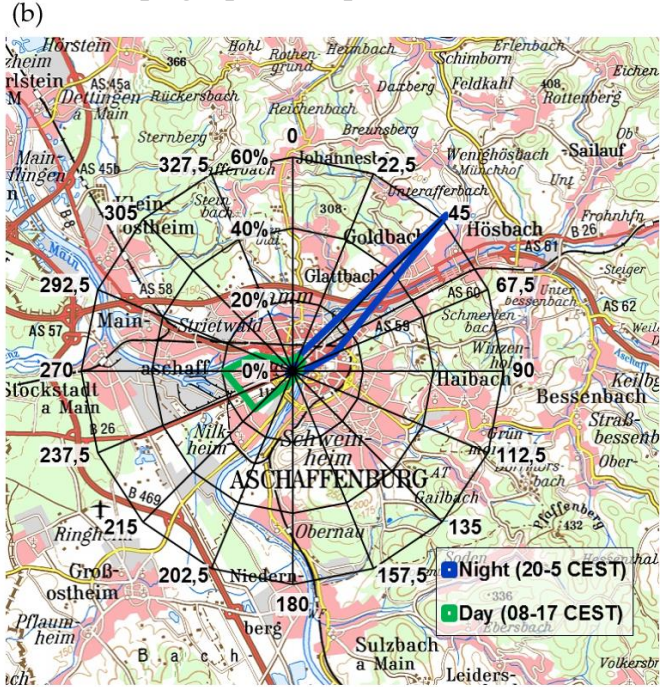
18 km x 18 km

50 m resolution

city domain
12km x 12km



topographic map & wind rose



MUKLIMO_3 simulations Aschaffenburg

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

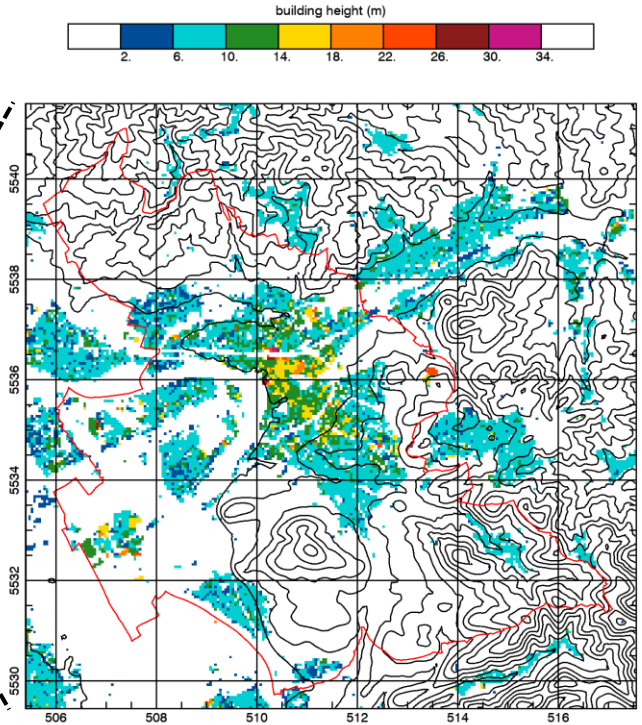
3d building data

(lod1)

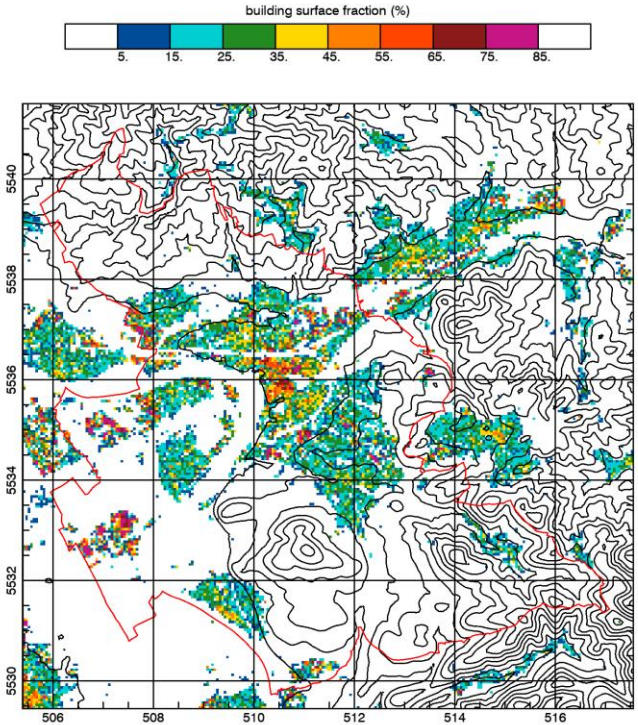
city domain
12km x 12km

© BKG 2020

building height (m)



building surface fraction (%)



MUKLIMO_3 simulations Aschaffenburg

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Nocturnal

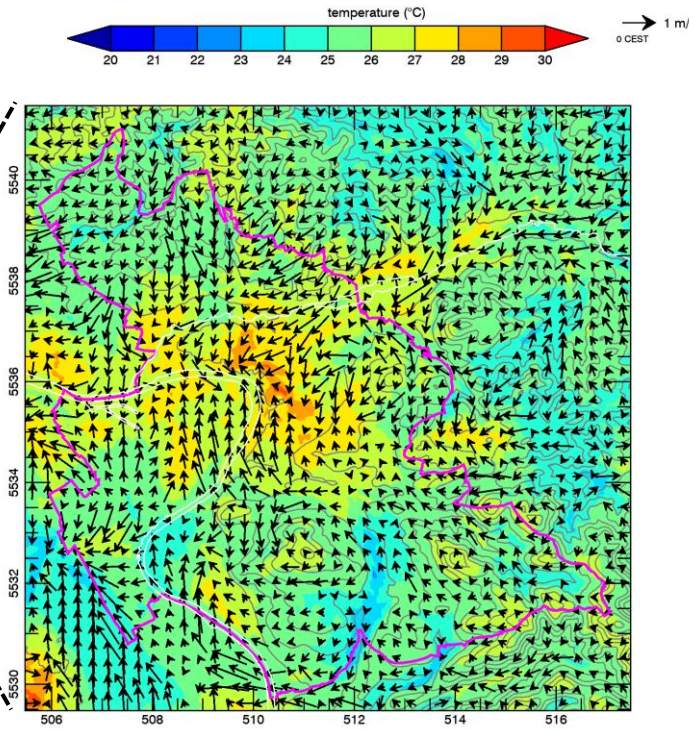
wind vectors &

air temperature

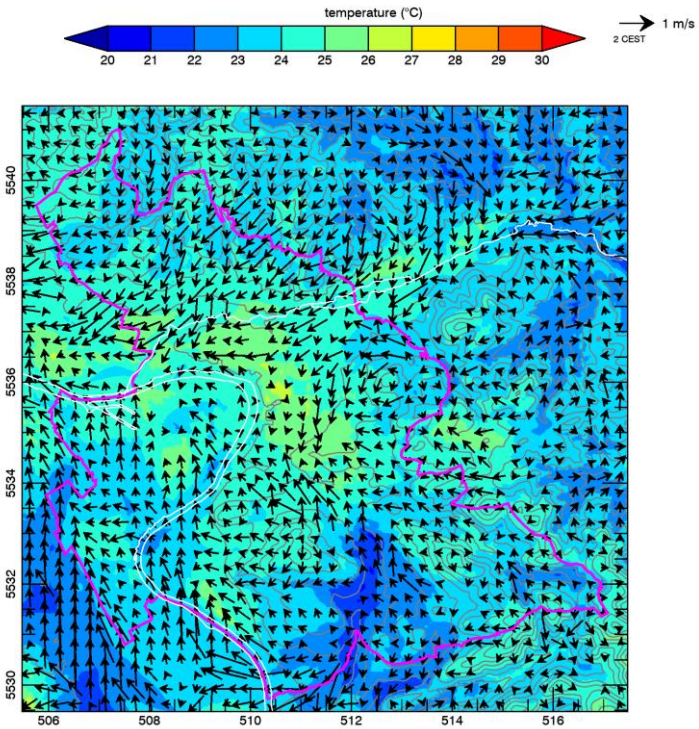
(5m agl)

city domain
12km x 12km

00 CEST 18 July



02 CEST 18 July



z-transformation of spatial variables

$$Z_{var}(x,y) = \frac{var(x,y) - \mu_{var}}{\sigma_{var}}$$

where Z_{var} at the location with spatial coordinates x and y is the normalized value of the variable var. μ_{var} and σ_{var} are the spatial mean value and standard deviation of var for a given domain and time, respectively

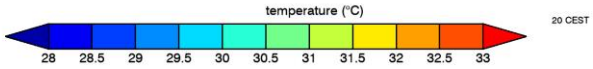
Methods and Presentation of Investigations Relevant for Planning Urban Climate;
Verein Deutscher Ingenieure, VDI Guideline 3785/1;
Beuth Verlag GmbH: Berlin, Germany, 2008.

MUKLIMO_3 simulations Aschaffenburg

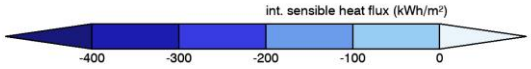
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

red polygons: $Z_T > 1.0$

T_{5m} agl 20 CEST (°C)



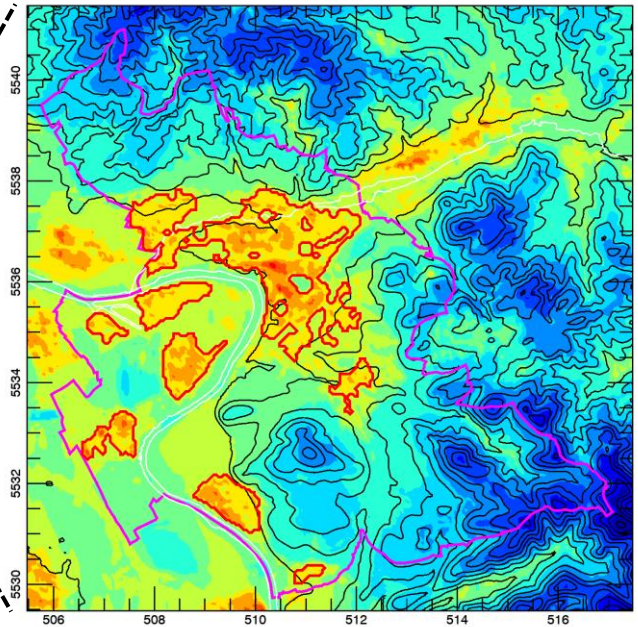
H_{int} 22-04 CEST (kWh/m^2)



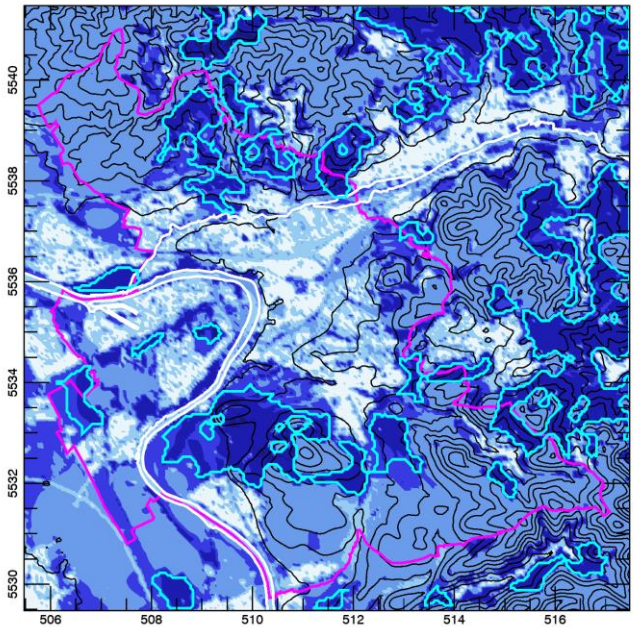
blue polygons: $Z_{hint} < -0.5$

thermal hot spots & cold air formation areas

city domain
12km x 12km



air temperature



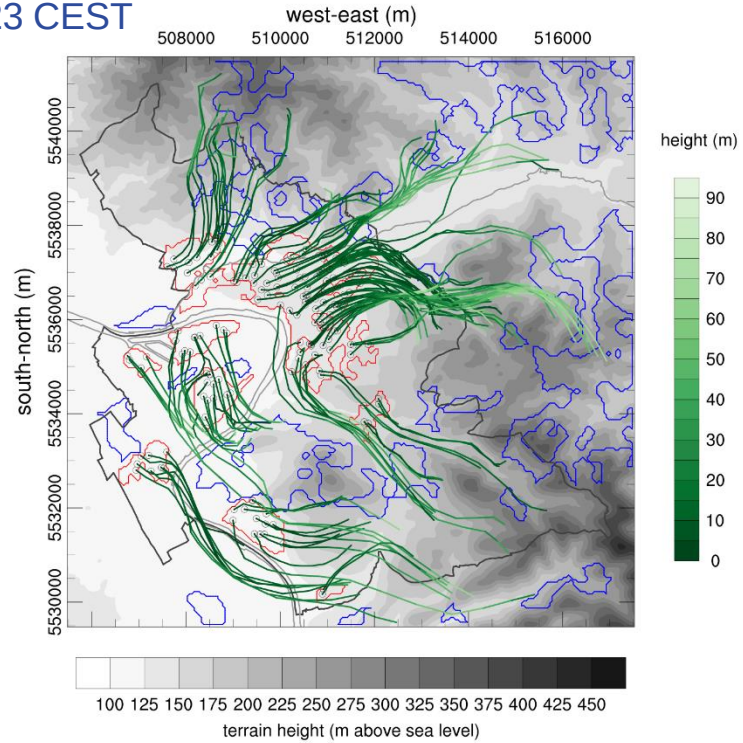
time integrated sensible heat flux

Backward trajectories from THs (red polygons)

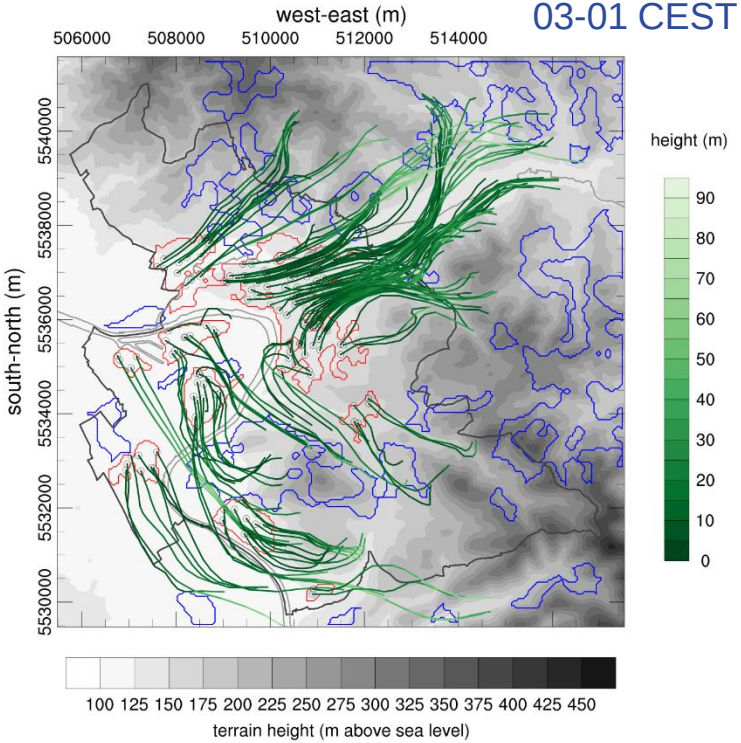
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

16 trajectories per km^2 randomly located in THs, starting at 5 – 15 m agl

01-23 CEST



03-01 CEST

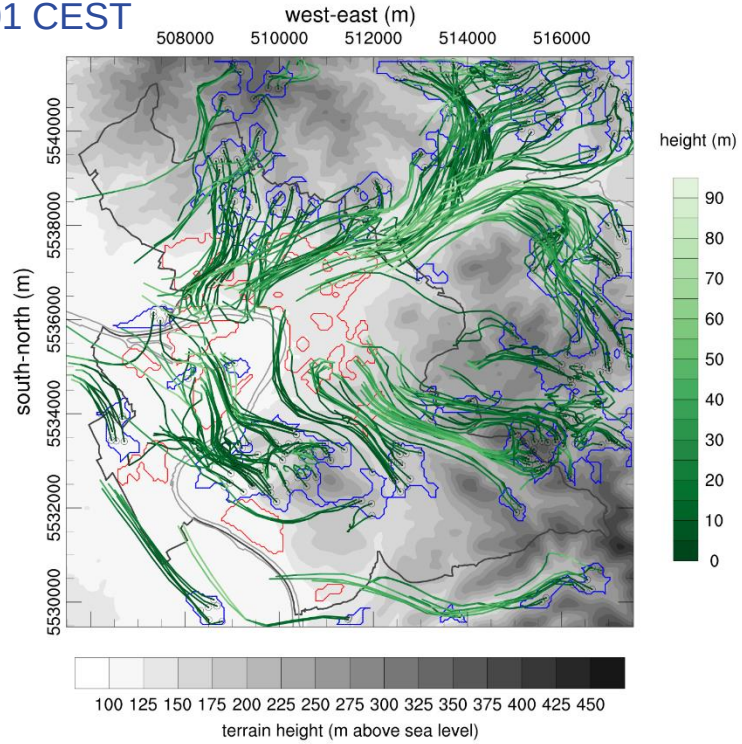


Forward trajectories from CAs (blue polygons)

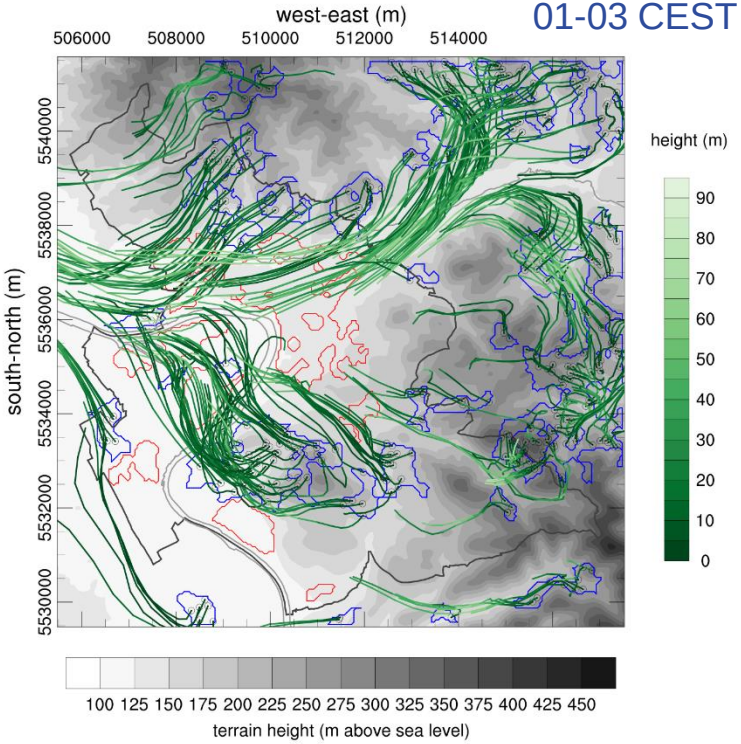
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

16 trajectories per km^2 randomly located in CAs, starting at 5 m agl

23-01 CEST



01-03 CEST



Trajectory connectivity matrix

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

cold air formation areas

urban hot spots

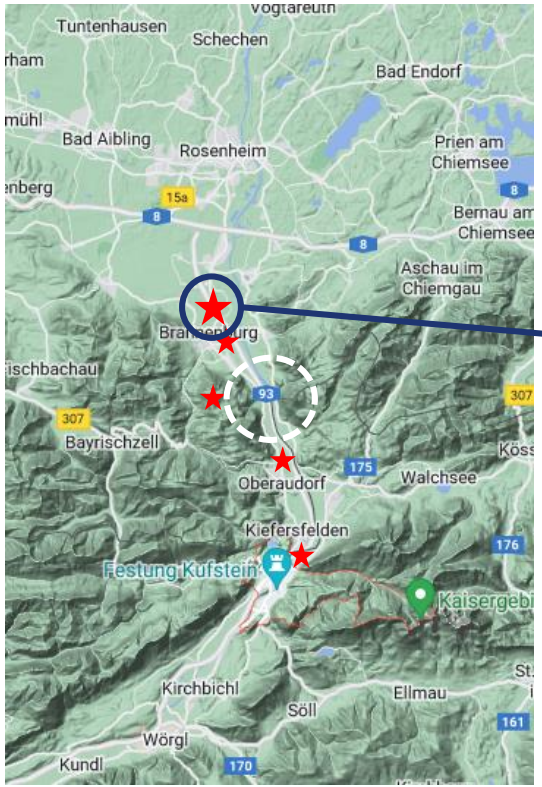
Vorwärts-Trajektorien
V1: 23:00 – 00:00 MESZ
V2: 03:00 – 04:00 MESZ
V3: 23:00 – 01:30 MESZ
VB: V1 & V2

Rückwärts-Trajektorien
R1: 01:30 – 23:00 MESZ
R2: 04:00 – 01:30 MESZ
RB: R1 & R2

Konnektivität
1 2 3 4

	Nr.	Grundgraben / Fahrbach	Glattbach	Klingenbach	Röderbach / Haibach	Naturschutzgebiet	Bischberg / Sternberg	Hösbach
Strietwald	1	V1,R1	V2,R2					
Damm	2	V1	VB,RB	VB,R1	V1,R2			R1
Innenstadt	3			V1	V2,RB	R1	R1	V3
Schweinheim	4					V1,RB	RB	
Nilkheim-West	5						R1	
Nilkheim	6						VB,RB	
Leider / Hafen	7						V2,RB	

Observations nocturnal Inn Valley exit jet



TEAMx Pre-Campaign 2022

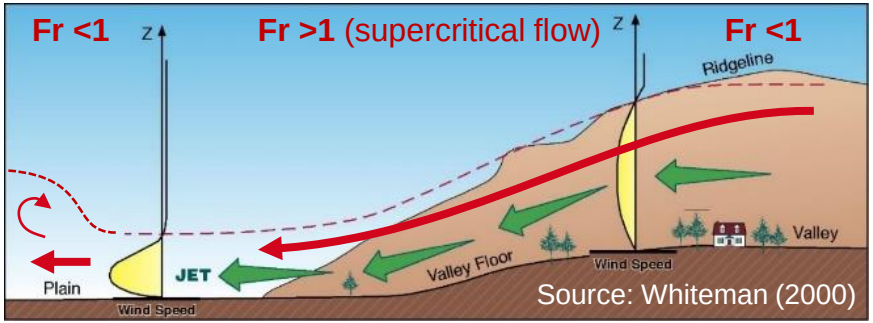
Multi-scale transport and exchange processes in the atmosphere over mountains – programme and experiment

http://www.teamx-programme.org/

Halo Photonics Streamline XR Wind Lidar Brannenburg

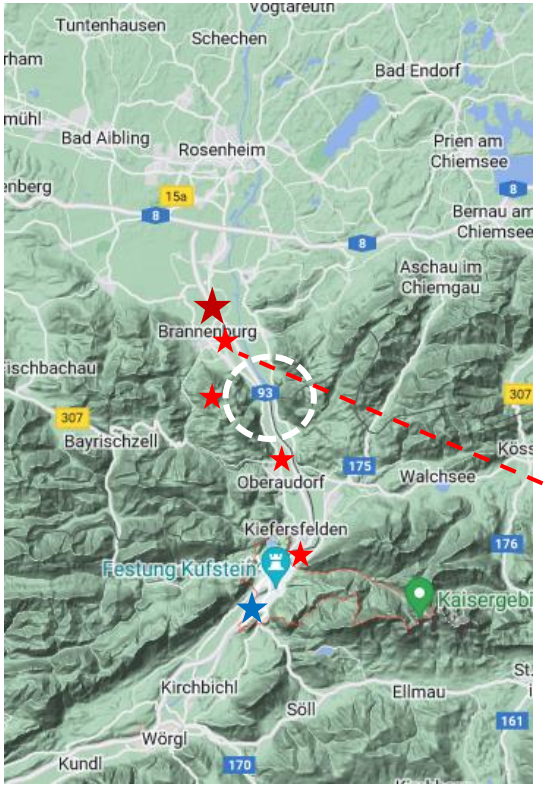
★ surface station

Earlier studies:
- Pamperin & Stilke (1985)
- Zängl (2004)

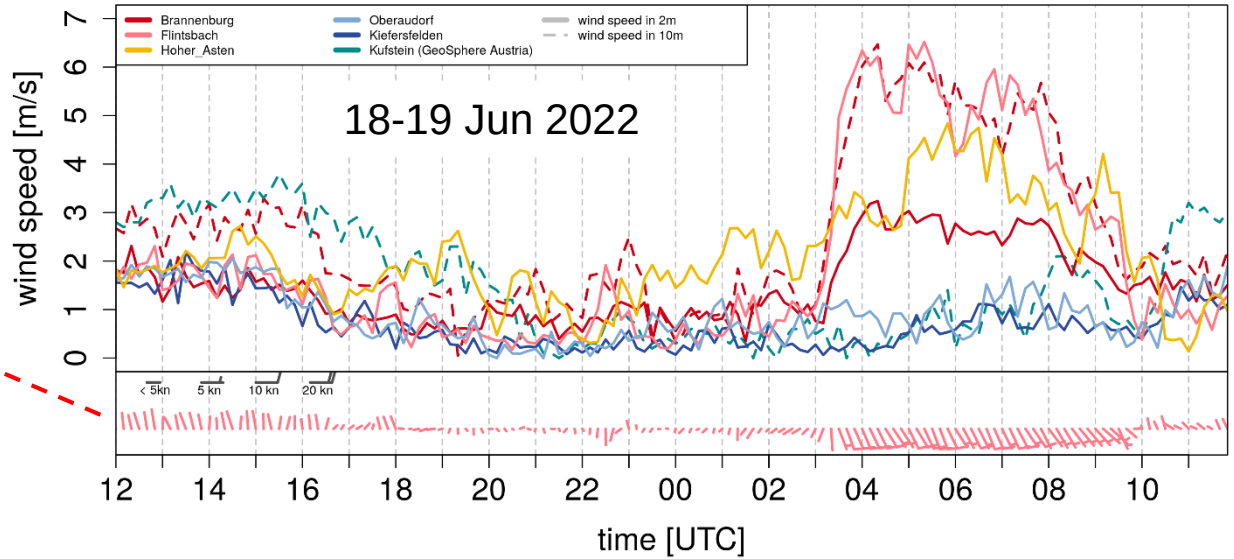


hydraulic jump ?

Observations nocturnal Inn Valley exit jet

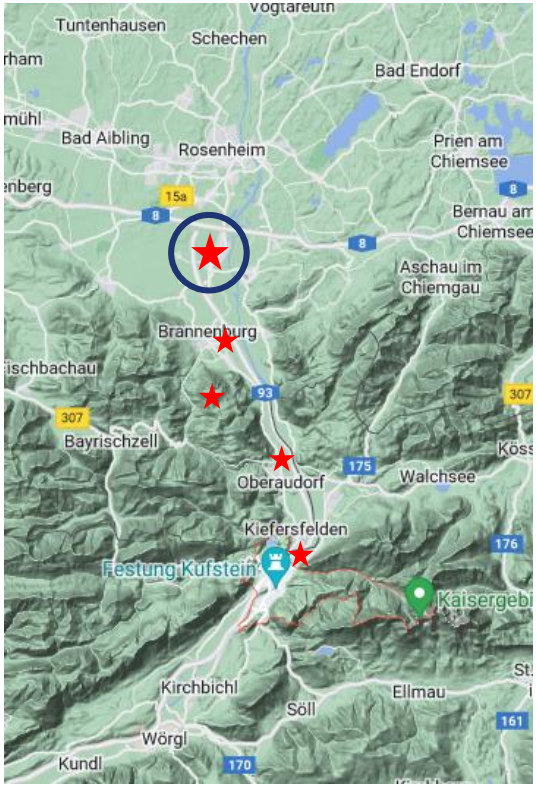


TEAMx Pre-Campaign 2022

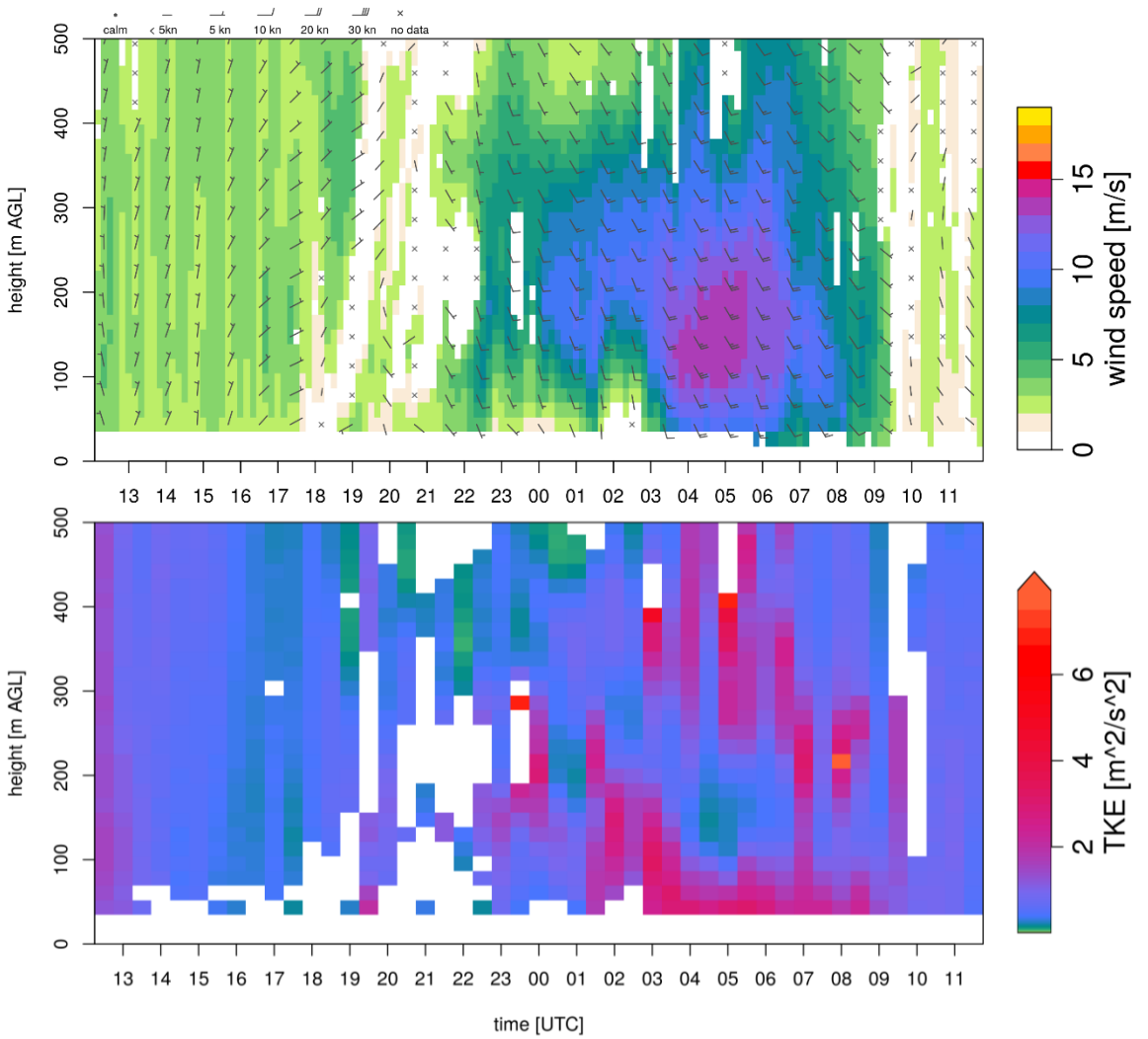


blue: stations south of terrain constriction
red: stations north of terrain constriction
yellow: hilltop station

Lidar Observations



18-19 Jun 2022



The End

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

The presented DWD katabatic flow studies focus on

- ➔ Urban climate model evaluation (PALM-4U)
- ➔ Climate process studies (advective cooling, valley exit jets)
- ➔ Urban climate adaptation (urban and regional planning)

Further reading

- ➔ www.dwd.de/stadtklimaprojekte ; www.dwd.de/lokalklimamodelle
- ➔ https://uc2-program.org (Stuttgart)
- ➔ https://doi.org/10.3390/land11081330 (Aschaffenburg)
- ➔ http://www.teamx-programme.org (Inn Valley)

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