Wind-related projects and measurements at IMK-IFU of KIT

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Three running projects
WIPAFF
Wind farms in the North Sea (SAR satellite image, Dec 2015)
Wakes: of turbines and entire farms


this turbine was out of service!
SAR-Bild (TERRA-X) von Horns Rev, 16.2.2012

(c) DLR 2012
TerraSar-X
SAR image (TERRA-X) of Horns Rev, 16.2.2012

Horns Rev: wake from SAR image

10 km
Recently started: WIPAFF
(WInd PArk Far Fields)

11.2015 – 02.2019

5 partners: KIT, Institute of Meteorology and Climate Research
Technical University Braunschweig (Astrid Lampert)
Helmholtz Centre Geesthacht (Johannes Schultz-Stellenfleth)
UL International GmbH (ex: DEWI) (Thomas Neumann)
University Tübingen (Jens Bange)

- aircraft observations (Do 128) of wakes
- analysis of SAR satellite images of wakes
- simulation of wind fields with WRF (wave model, farm parameterisation)
- adaptation of analytic and industrial wind farm models
- impact on local and regional climate
Do 128 of TU Braunschweig

(source for these images: IFF, TU Braunschweig)
Wind: simulation (WRF) and observation (Do 128)
Temperature: simulation (WRF) and observation (Do 128)
impact on the regional climate

cloud formation, modification of precipitation
modification of sunshine duration
modification of wind field

...
impact of cut-in (blue) and cut-off (red) Windgeschw.
(own graphics, data source: Tennet, DWD)
WINSENT
Recently started: WINSENT
(WINd Science and ENgineering in complex Terrain)

12.2016 – 06.2020

5 partners: Center for Solar Energy and Hydrogen Research, ZSW
University Stuttgart
Technical University Munich
IMK-IFU, IBF and GPI of KIT
University Tübingen
Univ. of Appl. Sci. Esslingen

- creating and instrumenting a test site for wind turbines in complex terrain
- two turbines, four met masts
- simulation of wind fields with WRF-LES
- putting together a model chain (from regional climate to blade flow)
set up of the WINSENT test site

- mittl. Jahreswindgeschwindigkeit
  5,75 - 6,75 m/s in 80m Höhe

- Hauptwindrichtung

- Höhe H der Stei-stufe (50-200m)

- Abstand zur Stei-stufe
  250 - 1,000m

- für Forschungs-WEA
  Rotor-Ø: max. 60m
  Nabenhöhe: 75m
  Nennleistung: 500-900 kW

- Gesamthöhe
  100m
$[UC]^2$
Recently started: [UC]\(^2\)
(Urban Climate under Climate Change)


23 partners from Germany plus sub-contractors plus three cities

- creating a model chain across scales (street canyon to regional climate)
- evaluating the model chain
- testing the model chain
urban climate model

Module A
model development

Module B
observations

model validation

users from science and applications

Module C
applicability

tests of applications
tests of applications
measurement techniques
Frequencies for atmospheric remote sensing

surface-based remote sensing devices at IMK-IFU

miniSODAR, acoustic backscatter, Doppler Analysis ➔ wind, turbulence

SODAR-RASS (Doppler-RASS), acoustic and electro-magnetic backscatter, determines sound speed ➔ wind and temperature profiles

windlidar, optical backscatter, Doppler Analysis, wave length ~ 1.5 µm ➔ wind and aerosol profiles

ceilometer, optical backscatter, pulsed, wave length ~ 0.9 µm ➔ aerosol profiles
Windlidar - virtual tower

Doppler LiDAR
(Halo Photonics Streamline)

profiles of mean wind and variance of vertical velocity component

Triple Doppler LiDAR
(Halo Photonics Streamline)

profiles of mean wind and variance of all velocity components
airborne in situ measurements at IMK-IFU

drone (hexacopter)

1. Air temperature and humidity sensors
2. Teflon tube
3. Tube extension above hexacopter
Summary

- wind and turbulence fields in different environments (urban, complex terrain, offshore)

- observations and model simulations across scales

- remote sensing techniques (surface-based, airborne, space-borne)

- drones

- urban living conditions (wind climate, thermal comfort, air quality)

- renewable energies (wind, solar, hydro)

- energy meteorology new subject at universities
Thank You for your attention