

EUROMECH Colloquium 576 “Wind Farms in Complex Terrains”

KTH Royal Institute of Technology, Stockholm, June 8-10, 2016

## Colloquium program

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<http://576.euomech.org/>

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We gratefully acknowledge the Sponsors of the EUROMECH Colloquium 576:

- Linné FLOW Centre
- Vetenskapsrådet (The Swedish Research Council)
- STandUP for WIND
- EUROMECH (the European Mechanics Society)



# Practical Information

## Room location & Registration

The room D2 (Lindstedtsvägen 5, 3<sup>rd</sup> floor) is located within the main building of KTH. One can easily find it in the figure 1 or by typing “KTH D2” in Google, where a path from your actual position and the room location will be highlighted.

A registration desk will be present at the entrance of the D building (Lindstedtsvägen 5) during the mornings of 8<sup>th</sup> and 9<sup>th</sup> between 08:00 and 09:00 for the registration of the conference participants.

## Social Events

Lunches and coffee breaks are planned during the conference according to the time plan. Lunches will be served at the “Q Restaurang” located at Osquldas vägen 4, 100 44 Stockholm (see map in figure 2).

Furthermore, two social events are planned:

- **Wednesday, the 8<sup>th</sup> of June** (from 17:30): The Conference participants are invited to the Fluid Physics Laboratory for a lab tour where drinks and snacks will be served.
- **Thursday, the 9<sup>th</sup> of June** (from 19:30 until 23:00): The Conference Dinner in the Solliden restaurant (Sollidenbacken, 115 21 Stockholm) inside the Skansen park. A bus will leave KTH at 18:00 directed to Skansen where the participants will be able to visit the park. Public transportation is available to reach the restaurant location.

## How to get to the conference venue from the airport?

Stockholm is situated at the heart of Scandinavia, and most of Europe is reachable within three hours. There are 4 international airports in Stockholm.

1. Stockholm-Arlanda Airport - [www.arlanda.se](http://www.arlanda.se). Key hub for flights to major destinations in Europe as well as the rest of the world. It is situated 40km (25mi) north of the city. The fastest way to go to the city center is the Arlanda express train which takes you from Arlanda Airport to the city center in 20 minutes (with trains every 15 minutes for most of the day). There is also a coach service departing every 10-15 minutes between Arlanda Airport and the City Terminal (located next to the Central Station). The bus travel time is approximately 35-40 minutes.
2. Stockholm-Bromma Airport - [www.brommaairport.se](http://www.brommaairport.se). Stockholm-Bromma Airport is a small city-airport offering both scheduled (mainly domestic) and charter flights. It is located conveniently close to central Stockholm (20 minutes by bus).
3. Stockholm-Skavsta Airport - [www.skavsta.se](http://www.skavsta.se). Stockholm Skavsta Airport is located 100 km south west of central Stockholm. The airport is a hub for Ryanair and other low cost airlines and offers direct flights to several destinations in Europe (80 minutes by bus from central Stockholm).
4. Stockholm-Västerås Airport - [www.vst.nu](http://www.vst.nu). Stockholm Västerås Airport is located 100 km north west of central Stockholm. The airport is served chiefly by the low-fare airline Ryanair.

All above airports offer coach services with departures timed with arrivals and departures at the airports. The travel time is 15-20 minutes (from Bromma), 80 minutes (from Skavsta) and 75 minutes (from Västerås).

## Public transport

The public transportation system in Stockholm is punctual and efficient so that visitors can quickly travel between different locations. The conference participants can find details about the transportation in the website [www.sl.se/en](http://www.sl.se/en). A single-journey ticket can be bought for 36 SEK (valid within 1 hour), but we recommend to buy the SL cards (those can be found in many shops, like Pressbyrån, 7-eleven, or the SL offices) and to charge them according to your plans. Each used ticket will cost 25 SEK. It is also possible

to buy tickets for 1, 3 or 7 days with the cost of 115 SEK, 230 SEK and 300 SEK, respectively (please keep in mind that the ticket starts from the day of the purchase).

### **Taxi**

There are many taxi companies to choose from in Stockholm. Approved taxis with metered fares always bear yellow number plates. Credit cards are readily accepted. Taxi prices are not regulated in Sweden; they may vary greatly. It is the customers responsibility to check prices beforehand. Check the price on the yellow-and-white label (as per the picture below), which is usually on the rear door window, before entering the vehicle. The highest unit price of most taxis is between SEK 350 - 440. The price on the yellow label is based on a 10 km, 15-minute journey. The price indicated on the taximeter is in Swedish kronor. For trips to and from Stockholm Arlanda Airport the major taxi companies have fixed prices of between SEK 550-600. Always ask the driver beforehand. In addition to the major taxi companies there are several independent firms; caution is advised.

Recommended taxi companies:

- Taxi Stockholm [www.taxistockholm.se](http://www.taxistockholm.se)
- Taxi Kurir [www.taxikurir.se](http://www.taxikurir.se)
- Taxi 020 [www.taxi020.se](http://www.taxi020.se)

### **Currency and credit cards**

Sweden is one of three EU countries (along with Denmark and the UK) that opted to keep their currency and not use the Euro. The currency in Sweden is called the Swedish crown, or the krona (SEK). Credit and debit cards are accepted almost everywhere in Stockholm. Forex is the place to exchange money or buy SEK. They are found throughout the city at 17 locations, including Arlanda, the train station, NK department store and the Old Town. They have good exchange rates there and do money transfers as well.

### **Electricity**

Electrical sockets (outlets) in Sweden are one of the two European standard electrical socket types, and usually supply electricity at between 220 and 240 volts AC.

### **Telephone**

- Conference Organizer (Dr. A. Segalini): +46 (0)73-359 33 70

### **Emergency numbers**

- Swedish Police, Fire, Ambulance: 112
- Hospital Karolinska: 08-517 700 00
- Hospital Södersjukhuset: 08-616 10 00

### **Tourist information point**

Most of the events in Stockholm are reported in the website <http://www.visitstockholm.com/en/> while the main tourist-information desk is located in the Kulturhuset, Sergels Torg 5, 103 27 Stockholm (email address: [touristinfo@stockholm.se](mailto:touristinfo@stockholm.se))

### **Wi-Fi**

All the campus is covered by the Wi-Fi network, where the access points are located mostly in the conference rooms and public places like the KTH library. The account associated to the conference is **KTH-Conference**. Another Wi-Fi network is *Eduroam*.

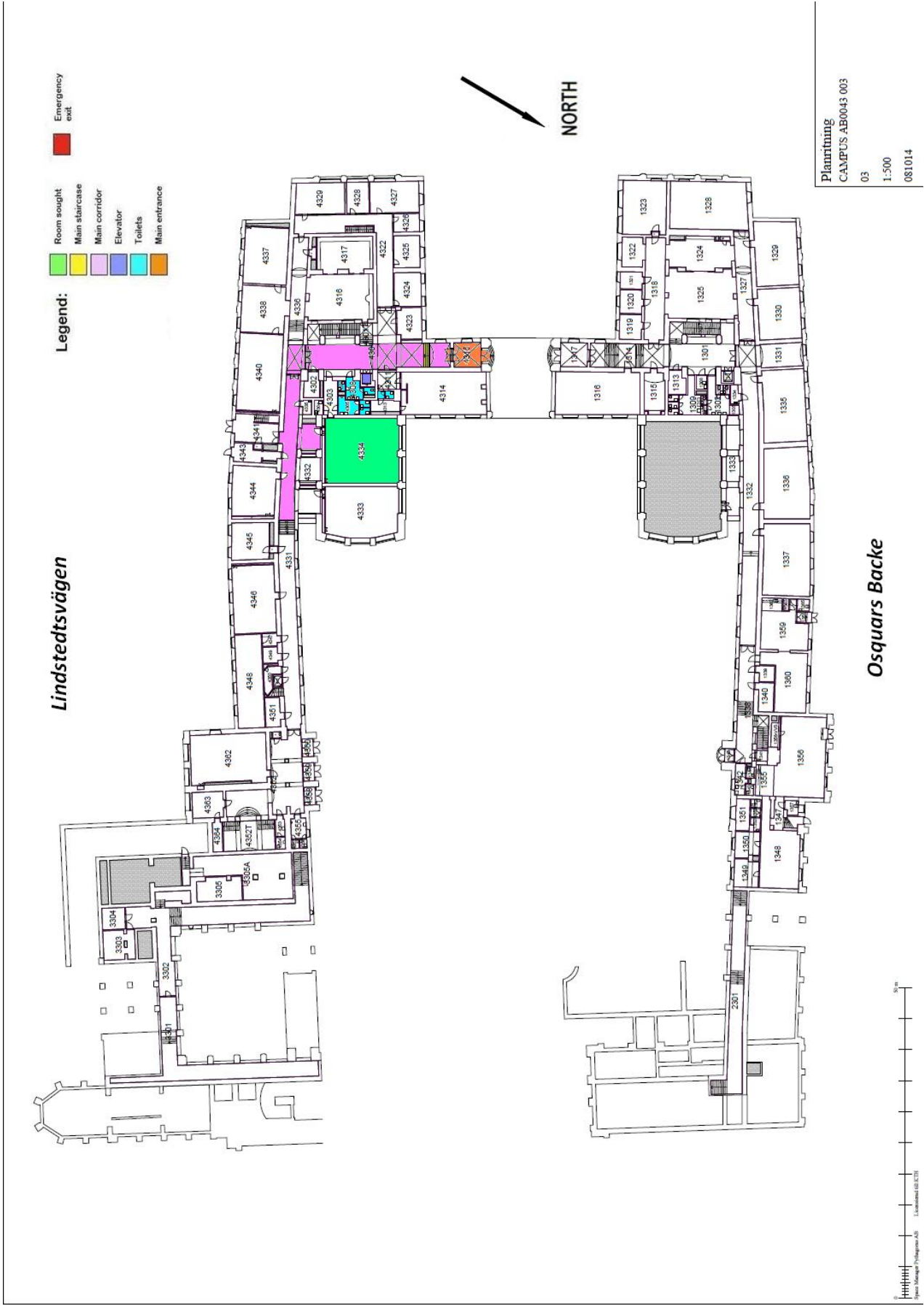


Figure 1: Map of the room D2

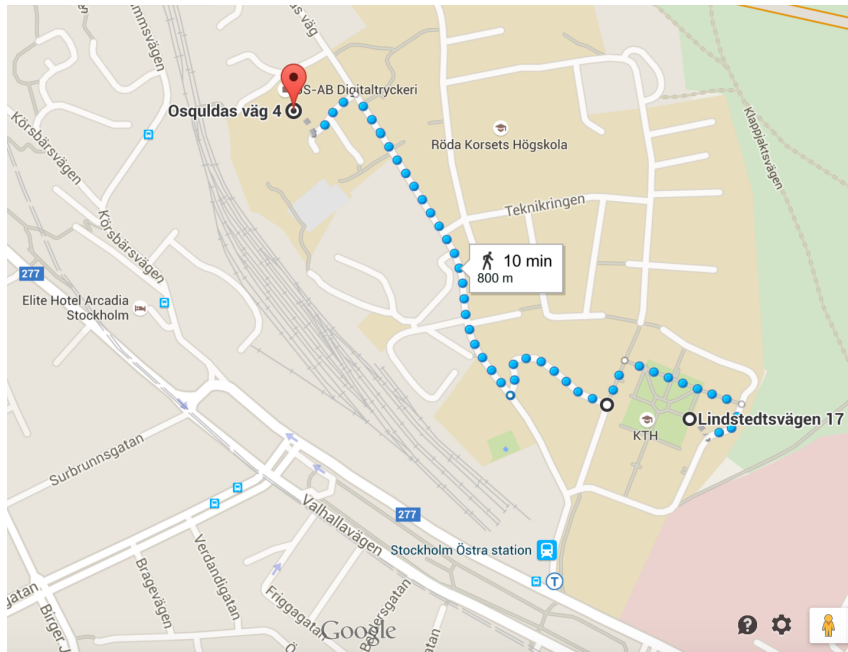


Figure 2: Path to reach the restaurant Q.

## Wednesday, June 8

Conference opening (08:45-09:00) with Prof. Dan Henningson

- 09:00 INVITED TALK **Optimal control and optimization of wind farms using large-eddy simulations**, Meyers, Munters and Bokharaie. Chair: D. S. Henningson
- 09:40 **Long-wave instabilities in the wake of a two-bladed rotor**, Brynjell-Rahkola, Quaranta, Leweke and Henningson
- 10:00 **Measurements and large eddy simulations of the atmospheric boundary layer over complex terrain**, Stoellinger, Han, Welch and Naughton
- 10:20 **Field superresolution measurements of turbulence in a complex terrain with access to the tensor of velocity derivatives**, Borisenkov, Gulitski, Kholmyansky and Tsinober

Coffee break (10:40-11:10)

- 11:10 **Wind turbine wake measurement in complex terrain**, Hansen, Larsen, Menke, Vasiljevic, Angelou, Feng, Vignaroli, Liu, Xu and Shen. Chair: D. Gayme
- 11:30 **Wind farm operation in complex terrain: numerical and experimental wind flow analysis**, Castellani, Astolfi, Mana, Piccioni and Terzi
- 11:50 **Wind measurements by cup anemometers in turbulent flow**, Dahlberg
- 12:10 **Large wind farm wakes, a CFD approach in conjunction with stable boundary layer and WindFarmer**, Medici and Digraskar

Lunch break (12:30-14:00)

- 14:00 INVITED TALK **Characterization of turbulence intermittency in the SABL through observations**, Arnqvist and Bergström. Chair: J. N. Sørensen
- 14:40 **Using LES to develop and validate model-based wind farm control**, Gayme, Shapiro, Meyers and Meneveau
- 15:00 **Synthesis of divergence-free turbulent wind profiles with prescribed statistics**, Kröger and Kornev
- 15:20 **Reduced order model for prediction of dynamics of the intra wind farm wind field**, Iungo, Debnath, Santoni and Leonardi

Coffee break (15:40-16:10)

- 16:10 **A fast reduced order method for computing the flow in offshore wind farms**, Heggelund, Khalil and Jarvis. Chair: S. Leonardi

- 16:30 **Reconstruction of volumetric wind turbine wakes in complex terrain by long range-lidar measurements**, Beck, Rott, Trabucchi and Kühn
- 16:50 **The maximum speed-up velocity of the flow over multiply hills**, Al Sam, Szasz and Revstedt
- 17:10 **Wind turbine power curves in complex terrain**, Mohr, Arnqvist and Berström

Reception at the Fluid Physics Laboratory (17:30-20:00)



## Thursday, June 9

- 09:00 INVITED TALK **Nonsteady forcing of the wind turbine drivetrain by the passage of daytime atmospheric turbulence eddies**, Brasseur, Nandi, Lavelly and Vijayakumar. Chair: J. M. L. M. Palma
- 09:40 **Large eddy simulation of flow in complex terrain: challenges with a pseudo-spectral model**, Berg, Sullivan and Patton
- 10:00 **LES studies of wind farms including wide turbine spacings and comparisons with the CWBL engineering model**, Stevens, Gayme, Meyers and Meneveau
- 10:20 **The effect of heterogeneous land-use on the land-sea transition and power production of offshore wind farms**, Witha, Dörenkämper, Steinfeld and Heinemann

Coffee break (10:40-11:10)

- 11:10 **Inflow turbulence generation methods**, Wu. Chair: B. Ganapathisubramani
- 11:30 **Generation of a synthetic turbulent inflow and its application to flow over complex terrain**, Kim, Schulz, Weihing and Lutz
- 11:50 **Entrainment models for turbine wakes, wind farms and vegetation canopies in complex terrain**, Luzzatto-Fegiz and Sadri
- 12:10 **Model scale experiments of wind conditions on top of a former waste dump**, Kaltenbach and Hopf

Lunch break (12:30-14:00)

- 14:00 INVITED TALK **Modeling boundary layer flow over fractal-like multiscale terrain in large eddy simulations**, Meneveau and Yang. Chair: J. G. Brasseur
- 14:40 **Flow field past a wind turbine over a wavy terrain**, Santoni, Ciri and Leonardi
- 15:00 **Development of a LES model for ABL flow simulations over forested terrain**, Olivares-Espinosa, Nilsson, Arnqvist and Ivanell
- 15:20 **Immersed boundary method for complex terrains: issues and progress**, Senocak, DeLeon and Sandusky

Coffee break (15:40-16:10)

- 16:10 INVITED TALK **Turbulent flow over heterogeneous terrain**, Ganapathisubramani, Placidi and Vanderwel. Chair: P. H. Alfredsson
- 16:50 **Lidar-based maps for flow modeling in complex forested terrain**, Dellwik and van der Laan
- 17:10 **Verification measurements for wind models in complex terrain**, Arnqvist and Bergström

Bus to Skansen (18:00)

Conference Dinner (19:30-)

## Friday, June 10

- 09:00 INVITED TALK **Methods to characterize the dynamical power performance of a wind park and possibilities for monitoring**, Peinke, Milan, Anvari and Wächter. Chair: C. Meneveau
- 09:40 **Southern German wind energy test site in complex terrain and associated research opportunities**, Rettenmeier, Anger and Cheng
- 10:00 **Long-distance sound propagation from a ridge wind turbine across a valley**, Van Renterghem
- 10:20 **Sound propagation from wind turbines in complex terrain**, Bolin and Karasalo

Coffee break (10:40-11:10)

- 11:10 INVITED TALK **Turbulence and entrainment length scales in large wind farms**, Andersen, Sørensen and Mikkelsen. Chair: S. Ivanell
- 11:50 **Application and validation of an adaptive lattice Boltzmann method for high-resolution wind turbine wake simulation**, Deiterding and Wood
- 12:10 **Modelling the flow within canopies based on weak turbulence assumptions**, Palma, Viana Lopes and Silva Lopes

Lunch break (12:30-14:00)

- 14:00 INVITED TALK **Complex terrain experiments in the new european wind atlas**, Mann. Chair: H. Bergström

Concluding remarks (14:40-15:00)