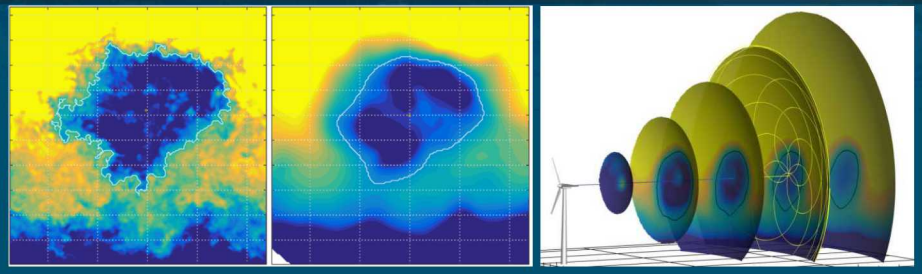
This paper describes objective technical results and analysis. Any subjective views or opinions that might be expressed in the paper do not necessarily represent the views of the U.S. Department of Energy or the United States Government.

SAND2019-6827C

Tutorial on How to Use the SWiFT Facility Data Archive and Portal Data



PRESENTED BY

Alan Hsieh, Tommy Herges,
David Maniaci, and Brian Naughton

Wind Energy Science Conference 2019:
2019-06-20

SAND2019-#### C

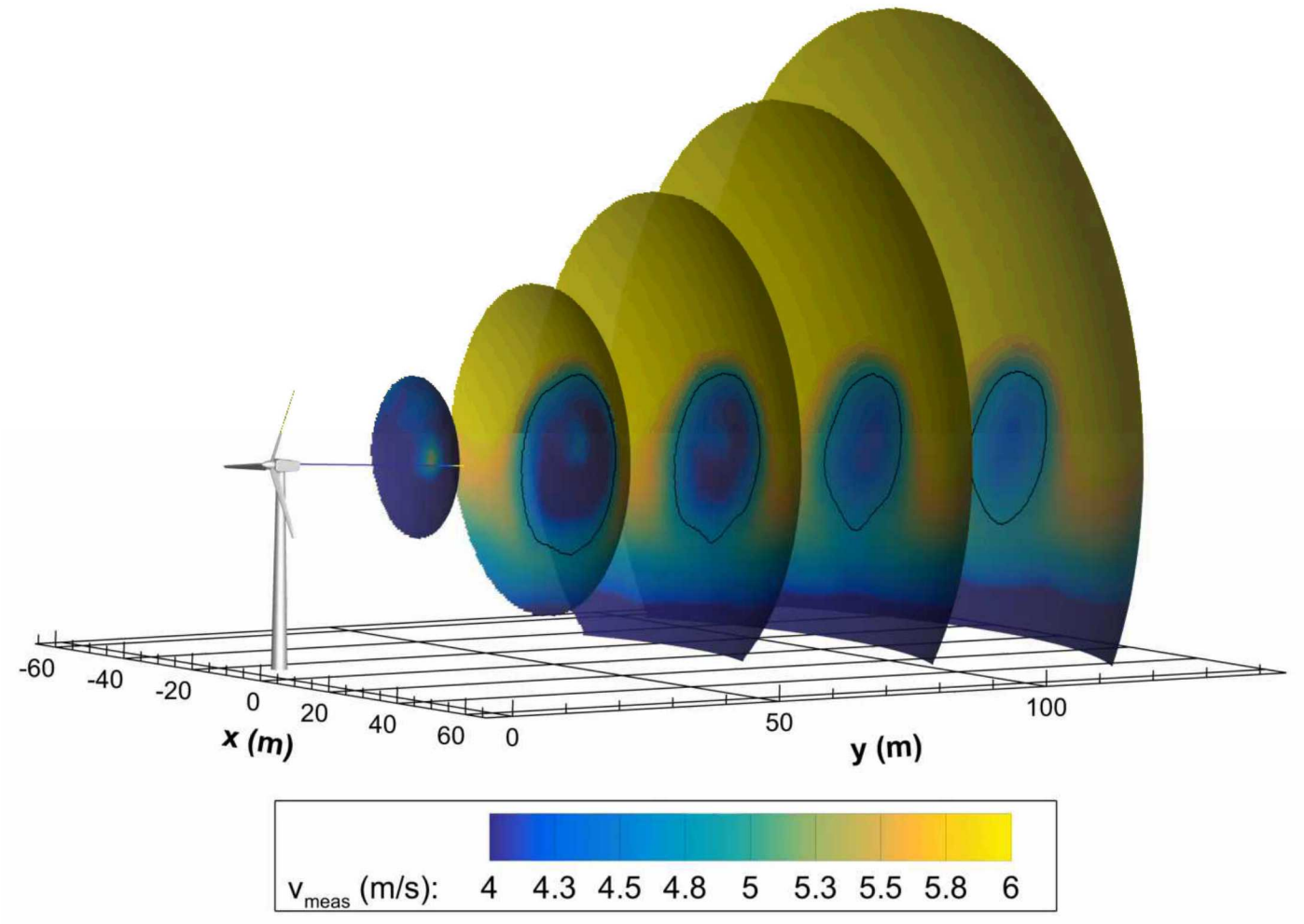
Funded by DOE Wind Energy Technologies Office

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

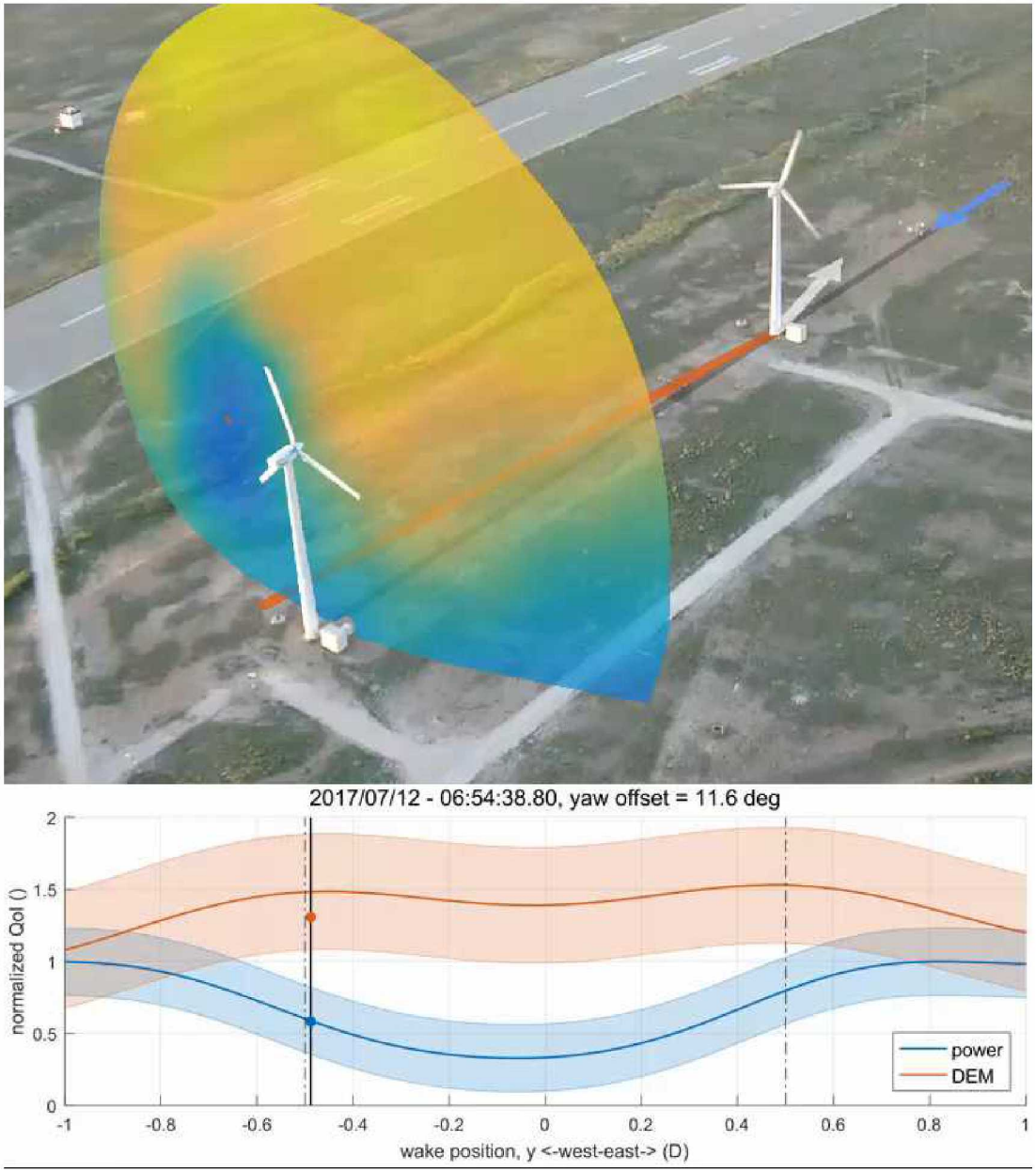
Introduction

- DOE WETO undertaking large verification and validation effort of high-fidelity models to improve modeling of wind turbine wakes
- High-quality measurements of wind turbine wakes required for validation
- DOE SNL/SWiFT facility is a unique open wind plant test site for studying wind turbine wakes and turbine-turbine interactions
- DTU SpinnerLidar capable of capturing wake at high spatial and temporal resolutions
- SpinnerLidar data released on DOE Atmosphere to Electors (A2e) Data Archive Portal (DAP)
- Data was quality controlled and quality assured:
  - Herges, T. and Keyantuo, P., Robust Lidar Data Processing and Quality Control Methods Developed for the SWiFT Wake Steering Experiment, Wake Conference 2019
- Discuss how to navigate DAP, sort lidar data, download
  - Navigate DAP webpage
  - Sort lidar data and download
  - Lidar data structure
  - Examples of what can be done with the data

DTU SpinnerLidar Scan Pattern



DTU SpinnerLidar at SWiFT Facility



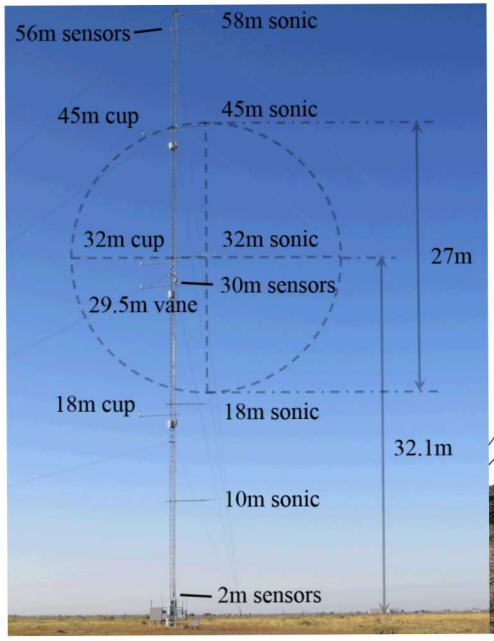
SWiFT Facility Overview

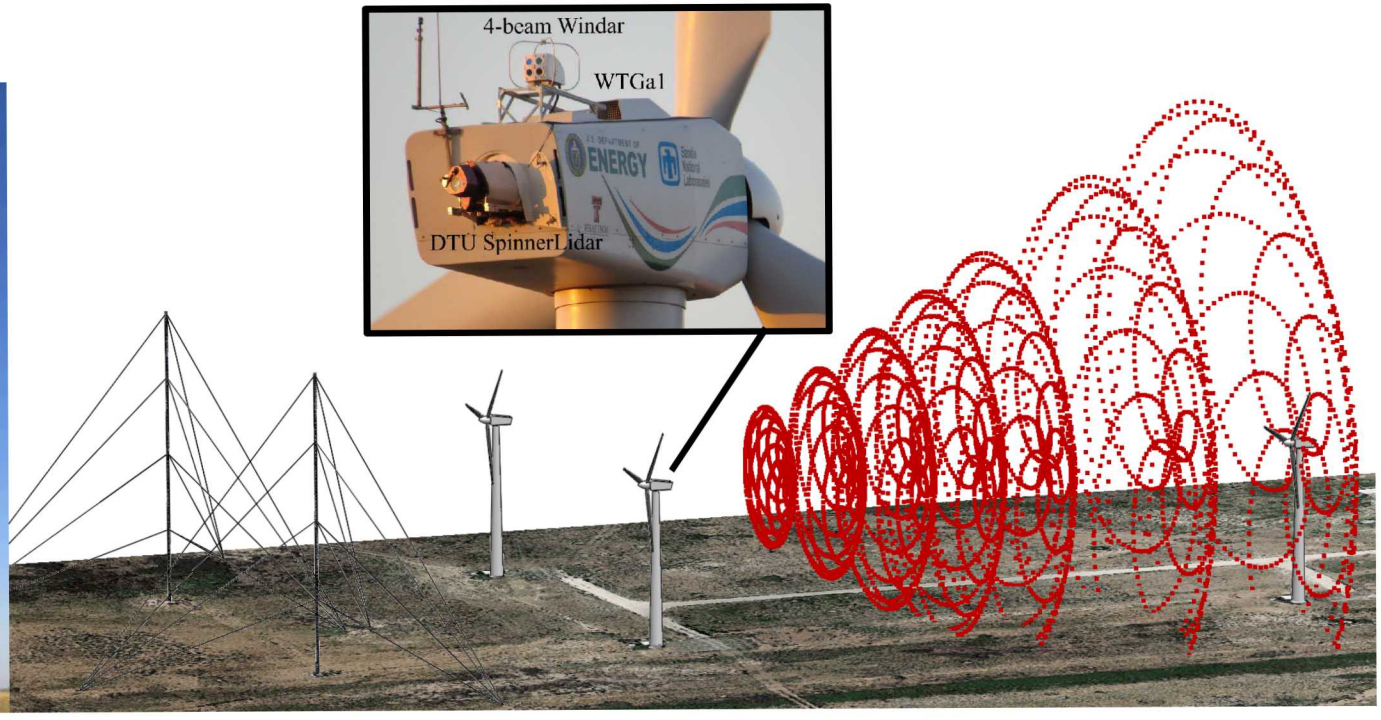
SWiFT facility created to:

- Measure wind plant flows and turbine-turbine interactions
- Perform prototype testing of innovative rotor technology

Wake steering experiment sought to quantify wake deflection vs. yaw offset and the corresponding effects on a two-turbine system

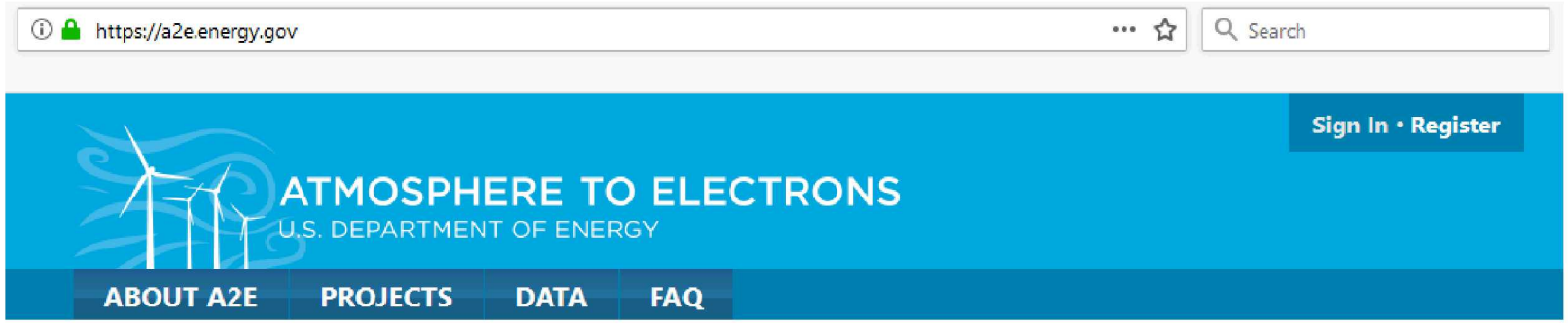
- Characterize wake shape, velocity deficit, turbulence, and dynamics under various conditions





A2e Data Archive Portal

- A2e Data and projects located at:



- Description of different A2e projects located under the Projects tab
  - SWiFT facility wake data is under the Wake project discription

WAKE

Wake Steering Experiment

Planned for May through September 2016, Sandia National Laboratories and the National Renewable Energy Laboratory will execute a joint experimental campaign examining wind farm control at the Scaled Wind Farm Technology (SWiFT) facility, hosted at Texas Tech University in Lubbock, Texas. The experimental campaign will be conducted in two phases. In Phase I, an Offset Controller (OC) will be applied to the upwind wind turbine. This controller applies an offset to a nacelle-based wind direction sensor used for aligning the turbine to the wind direction to achieve a prescribed misalignment to the wind. In Phase II, the controller will be replaced by a Wake Steering Controller (WSC) that uses a look-up table based on the FLOw Redirection and Induction in Steady-state (FLORIS) model to find offsets that produce a desired amount of wake steering. The data collected during both phases will be used to perform initial verification and validation studies on controls-oriented models, such as FLORIS, as well as higher-fidelity wind plant analysis models, such as Simulator fOr Wind Farm Applications (SOWFA). Target data include inflow, wake, and turbine performance and loads.

Read More »

A2e Wake Steering Experiment Project Page

https://a2e.energy.gov/projects/wake

Search

WAKE

Wake Steering Experiment

Overview

Planned for May through September 2016, Sandia National Laboratories and the National Renewable Energy Laboratory will execute a joint experimental campaign examining wind farm control at the Scaled Wind Farm Technology (SWiFT) facility, hosted at Texas Tech University in Lubbock, Texas. The experimental campaign will be conducted in two phases. In Phase I, an Offset Controller (OC) will be applied to the upwind wind turbine. This controller applies an offset to a nacelle-based wind direction sensor used for aligning the turbine to the wind direction to achieve a prescribed misalignment to the wind. In Phase II, the controller will be replaced by a Wake Steering Controller (WSC) that uses a look-up table based on the FLOw Redirection and Induction in Steady-state (FLORIS) model to find offsets that produce a desired amount of wake steering. The data collected during both phases will be used to perform initial verification and validation studies on controls-oriented models, such as FLORIS, as well as higher-fidelity wind plant analysis models, such as Simulator fOr Wind Farm Applications (SOWFA). Target data include inflow, wake, and turbine performance and loads.

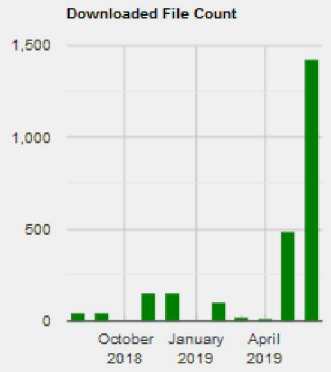
Primary Contact(s)

Brian Naughton
Sandia National Laboratories

Scott Schreck
NREL

3
Datasets

1.5 K
Files Stored



Accessing Data

- Data is located under **Browse Data** or under the **Data** tab at the top of the page next to the Projects tab

Objective

This experimental campaign at SWiFT aims to demonstrate the capability of wake steering control to improve total wind turbine array power production. In addition, the public dataset produced by this project will be available to perform preliminary verification and validation studies on computational models, including FLORIS and SOWFA.

Instruments

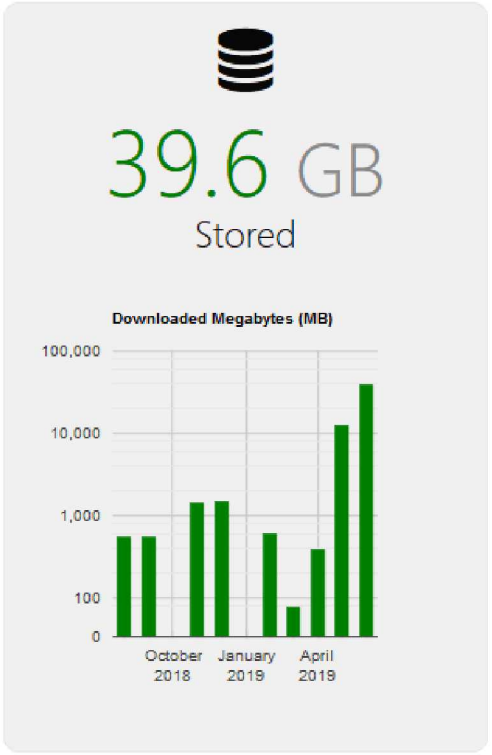
Primary:

SWiFT wind turbine. The upwind SWiFT turbine known as (WTGa1) will be the primary instrumented research turbine to collect power and loads data.

SWiFT met towers. Two upwind SWiFT meteorological towers (METa1 and METb1) will collect inflow data.

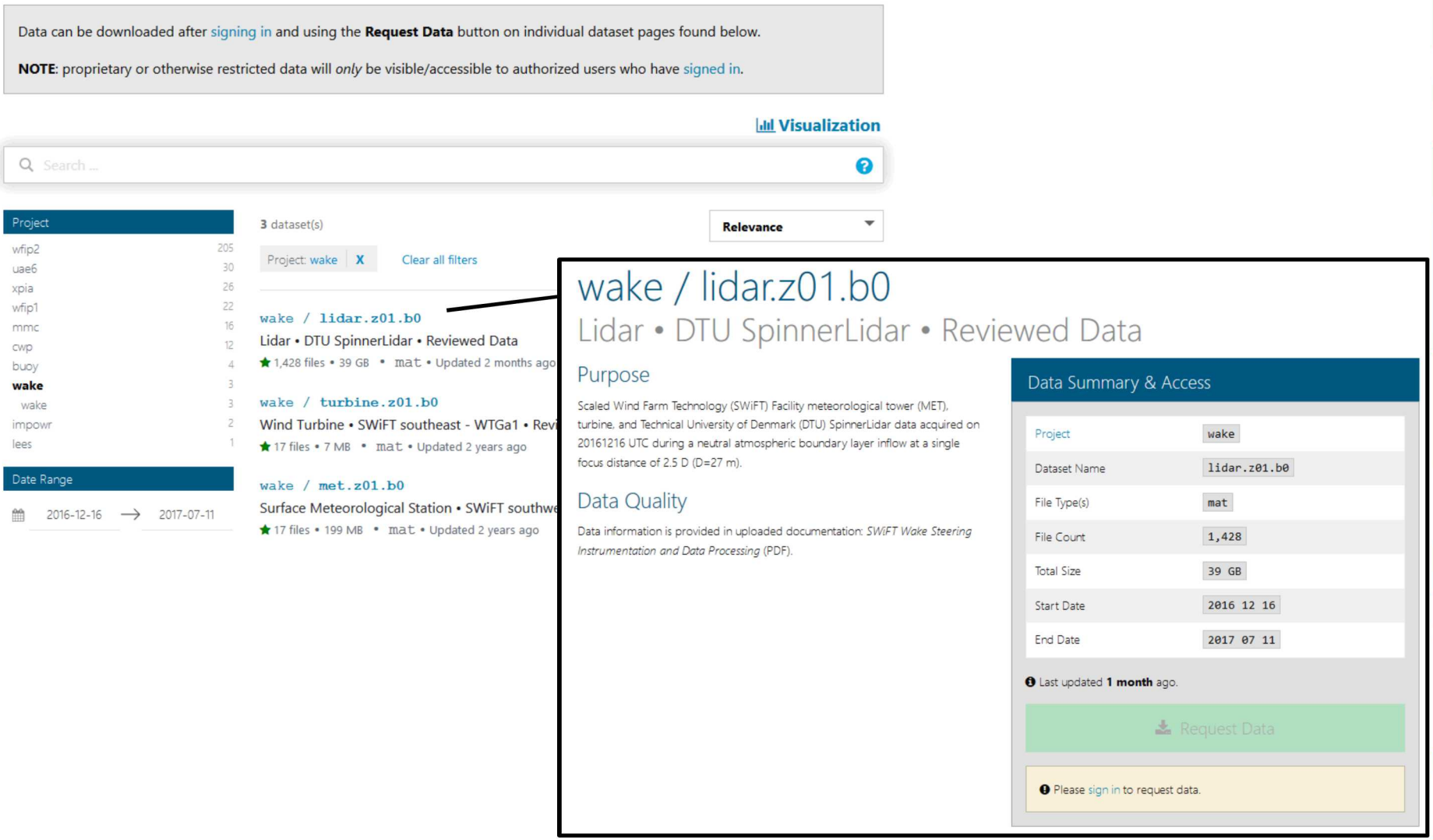
DTU SpinnerLidar. A customized research scanning lidar from the Technical University of Denmark, installed in the upwind turbine nacelle (cover housing the turbine's generating components) and facing downwind, will characterize the wake.

External Resource: http://swift.sandia.gov



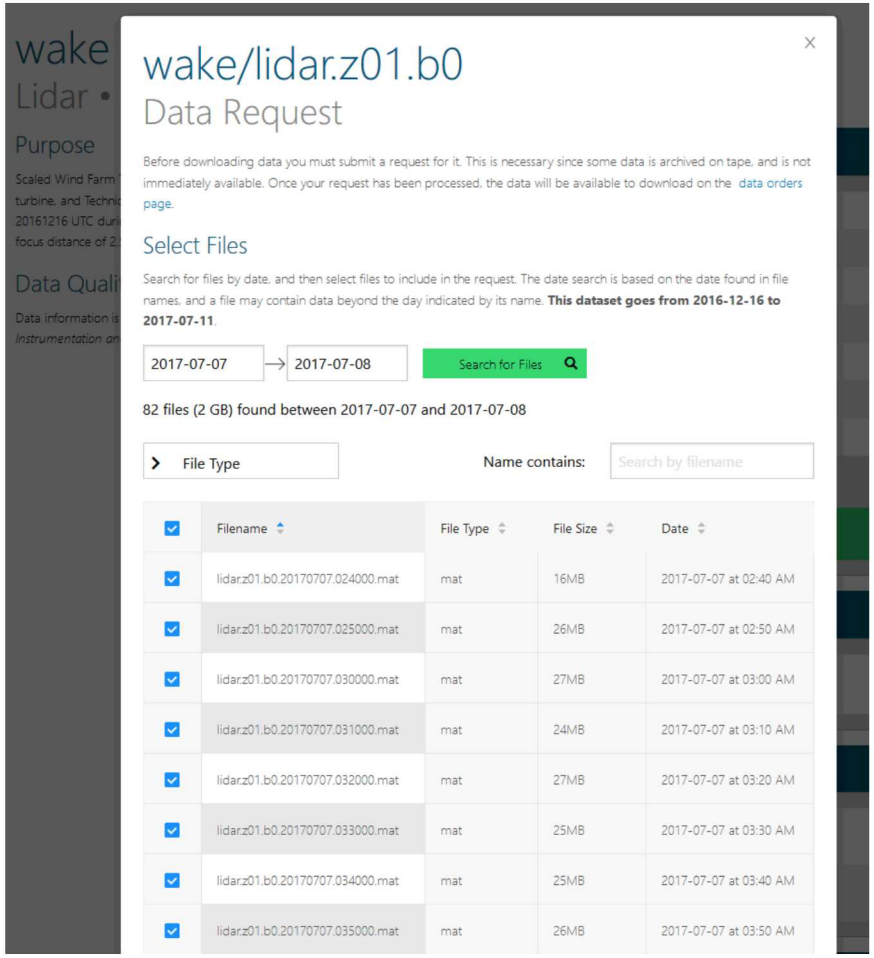
Accessing Data

- Data page shows the three data assets: SpinnerLidar, turbine, and met data
- Must create account and sign in to request data

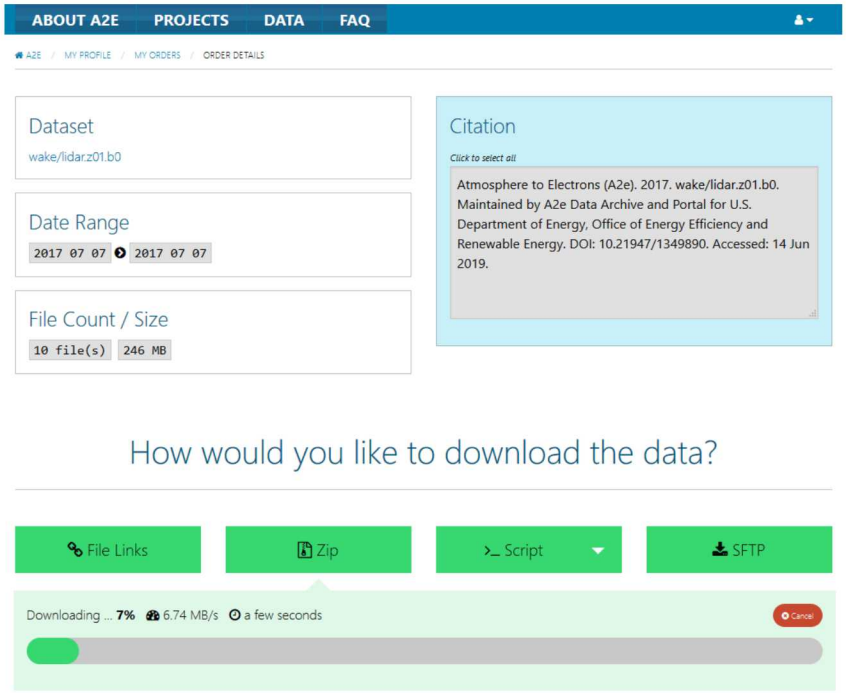


Request Data Range and Download Method

- Specify the date range for data of interest
- Spread sheet of 10 min bin characteristics will be provided to search for data cases of interest

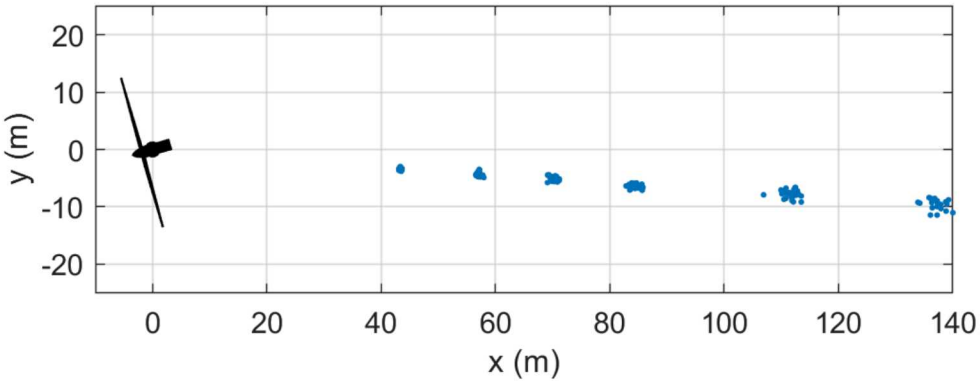


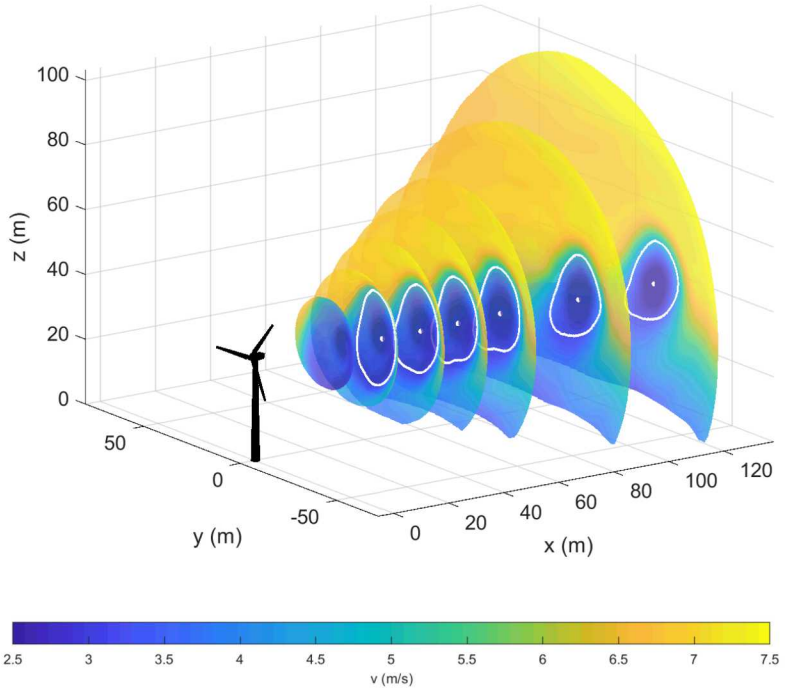
- Check data files for data request
- Follow link to **My Orders**
- Select download method
- Suggested citation provided for use of data



Examples of How the Data Can be Used

- Example file from 2017-07-08 at 07:40:00 UTC
  - 15.9° yaw offset with 6.2 m/s wind speed at low TI of 0.03
  - Shows wake deflection of the wake from 1.5D to 5D
  - Wake position has little fluctuation due to low TI inflow
  - Average wake position over 10 min file
  - Wake outlined to match the area of the rotor

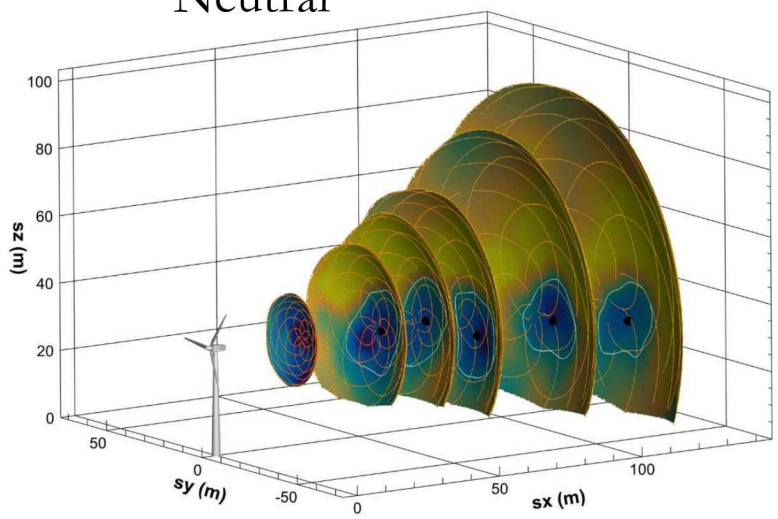




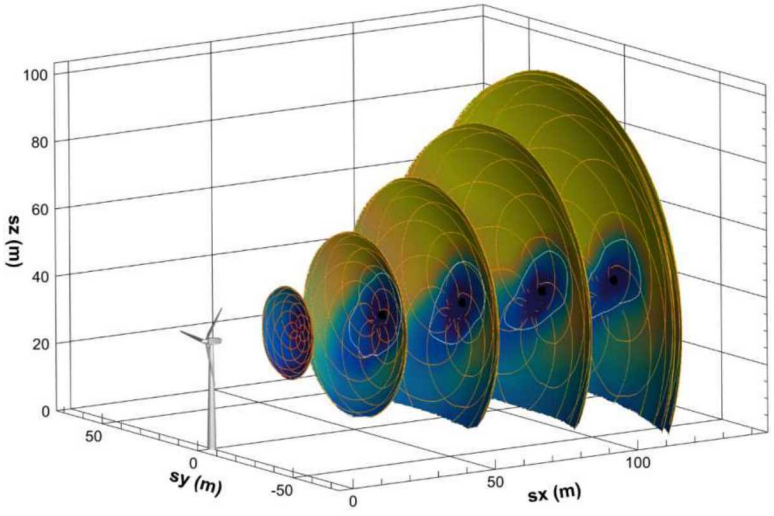
Examples of How the Data Can be Used

- Look at impact of inflow on wake shape

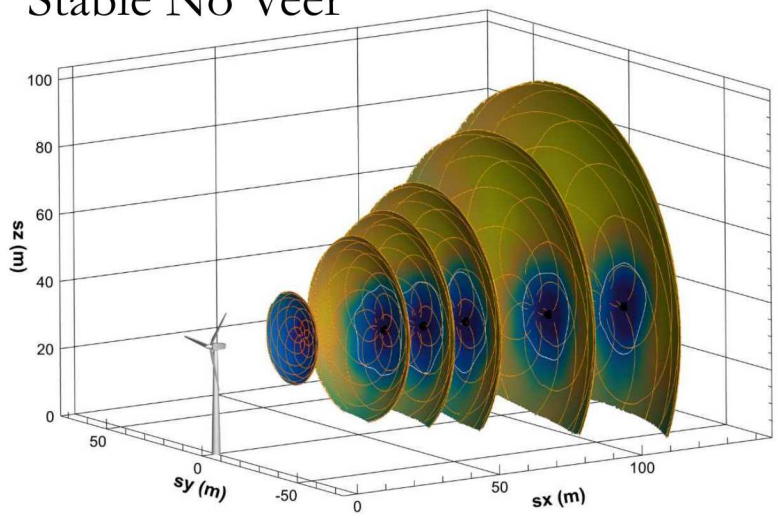
Neutral



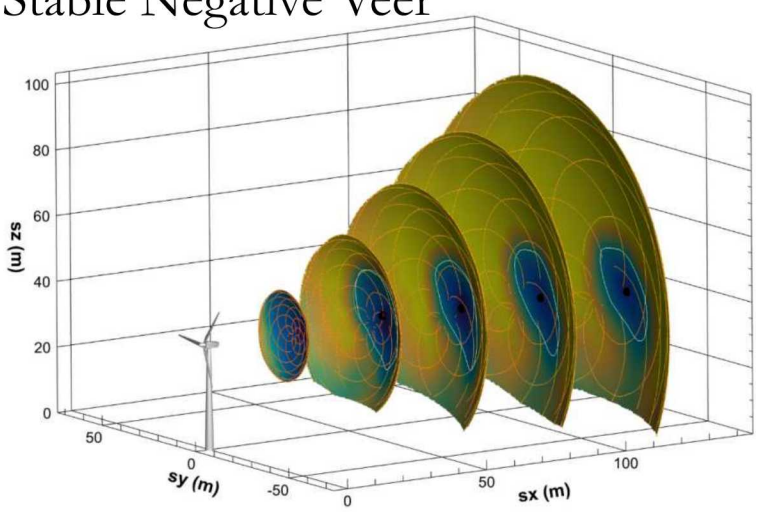
Stable Positive Veer



Stable No Veer

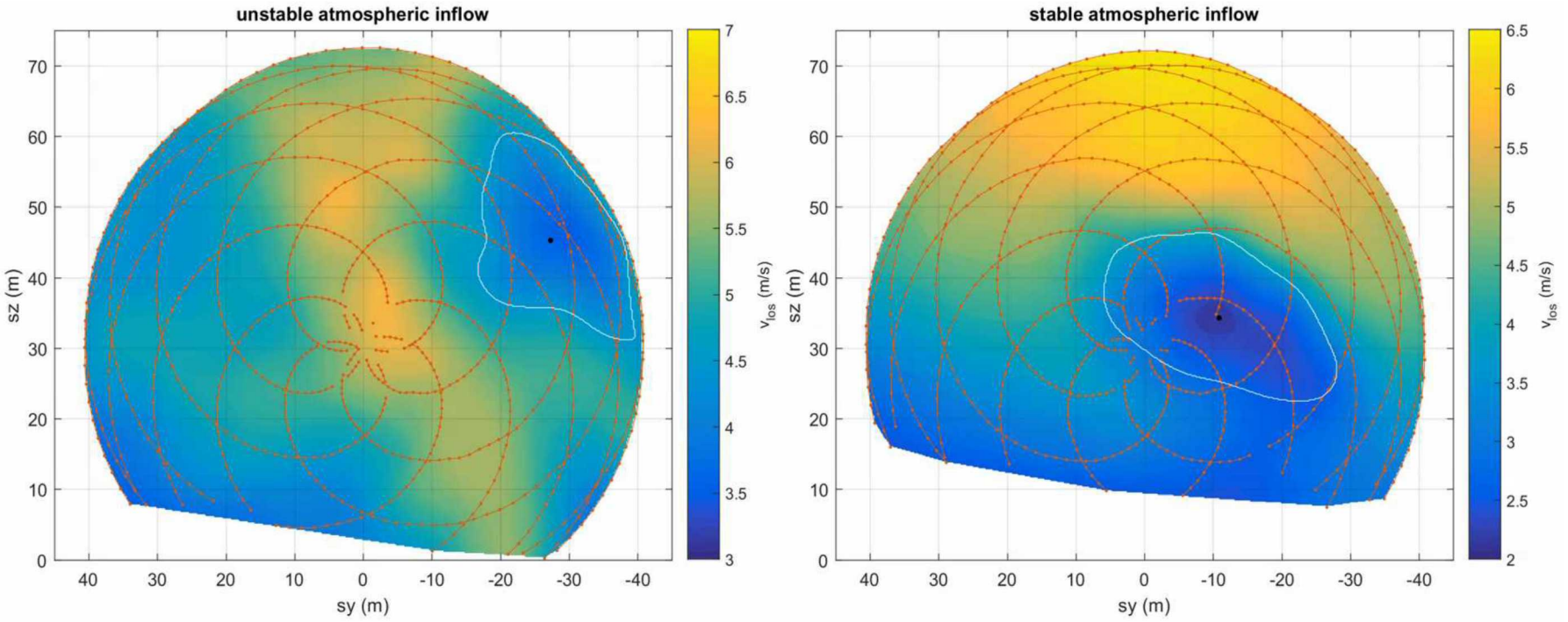


Stable Negative Veer



Examples of How the Data Can be Used

- Look at impact of inflow on wake position fluctations



Conclusion

- SWiFT wake steering experiment complete with quality met, turbine, and lidar wake data
- Data has been quality controlled and quality assured
- Fully open source turbine and Fast models available
- Data released for open use
- Wake data currently being used as part of the IEA Task 31 WakeBench SWiFT benchmark
- All SWiFT facility Wake Steering lidar data is currently available on DAP
  - Additional documentation to be added along with met and turbine data
  - 10 min bin database will be added shortly

The complete Wake Steering SpinnerLidar dataset available for download at **a2e.energy.gov**

Questions?

Thanks!