Optimal Control of a Floating Wind Farm Based on Turbine Repositioning

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Introduction

The effect of **floating turbine repositioning** is currently primarily assessed by finding optimal **steady-state yaw values** using **steady-state wake models**. This work uses the **dynamic wake model** FLORIDyn to find optimal **time-varying yaw signals.**

A preliminary conclusion from steady-state analysis is that mooring line tension needs to be reduced to allow for a sufficient range of movement for steady-state turbine repositioning to significantly increase wind farm efficiency.

By allowing yaw signals to be time-varying, this work shows that for stiffer mooring configurations turbine repositioning can also increase wind farm efficiency, and that in such cases the optimal yaw control signal is periodic in nature.

Methodology

An optimization problem formulated as

$$\max_{\gamma_{1,1}\cdots\gamma_{N,T}} \frac{1}{T}\sum_{i=1}^{N}\sum_{j=1}^{T} P_{i,j} \quad \text{(MW)}$$

$$\text{s.t} \quad \begin{cases} |\gamma_{i,j}| \leq \phi & \forall i,j \\ |\gamma_{i,j+1} - \gamma_{i,j}| \leq \theta & \forall i,j \end{cases}$$

is solved to find yaw signals that **optimize the total power output of a two-turbine wind farm** over a time horizon, given constraints on the yaw angle and the yaw rate.

This problem is solved for **different settings for the anchor to fairlead distance of the mooring lines.**

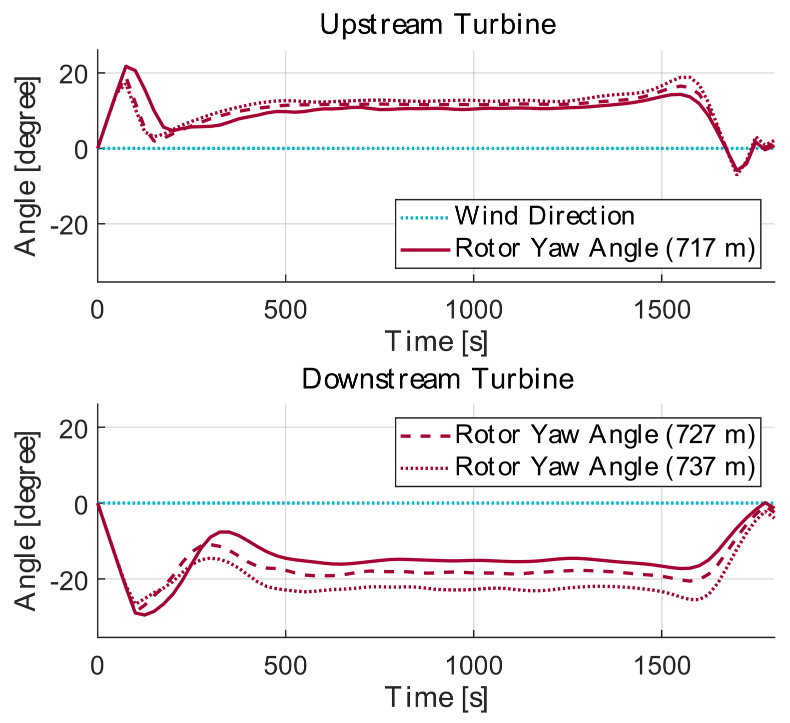
Results

The main result of this work is that:

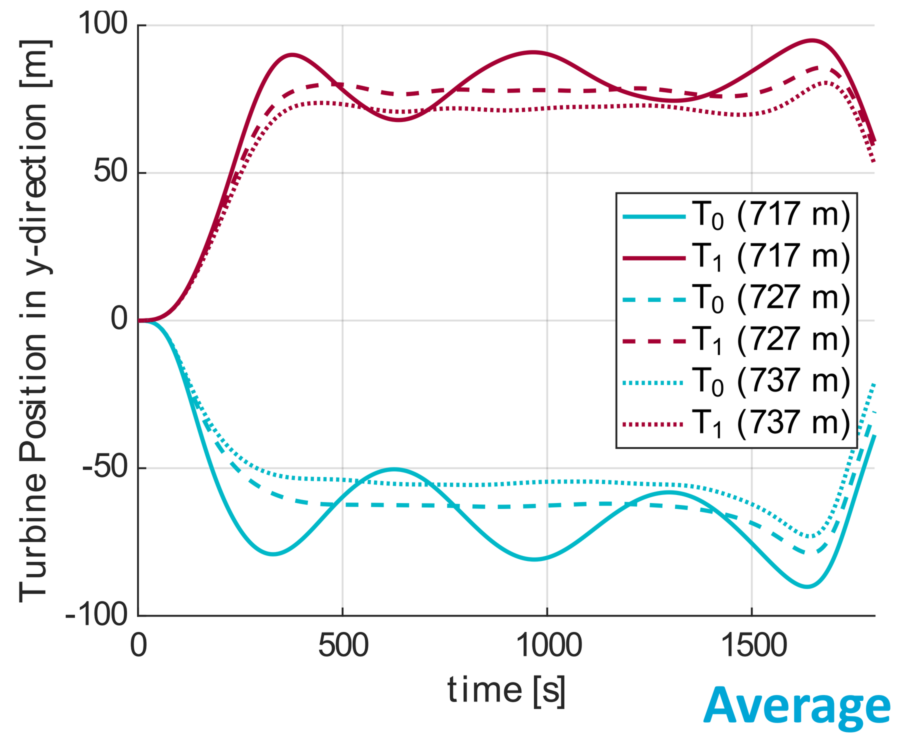
- ❑ **For slack mooring systems**, the range of movement in crosswind direction is sufficient for **steady-state** yaw angles to be optimal.
- ❑ **For stiffer mooring systems,** the optimal solution is to apply **dynamic** yaw signals because this minimizes the average wake overlap over time.

Steady-state Repositioning

Optimal yaw signal

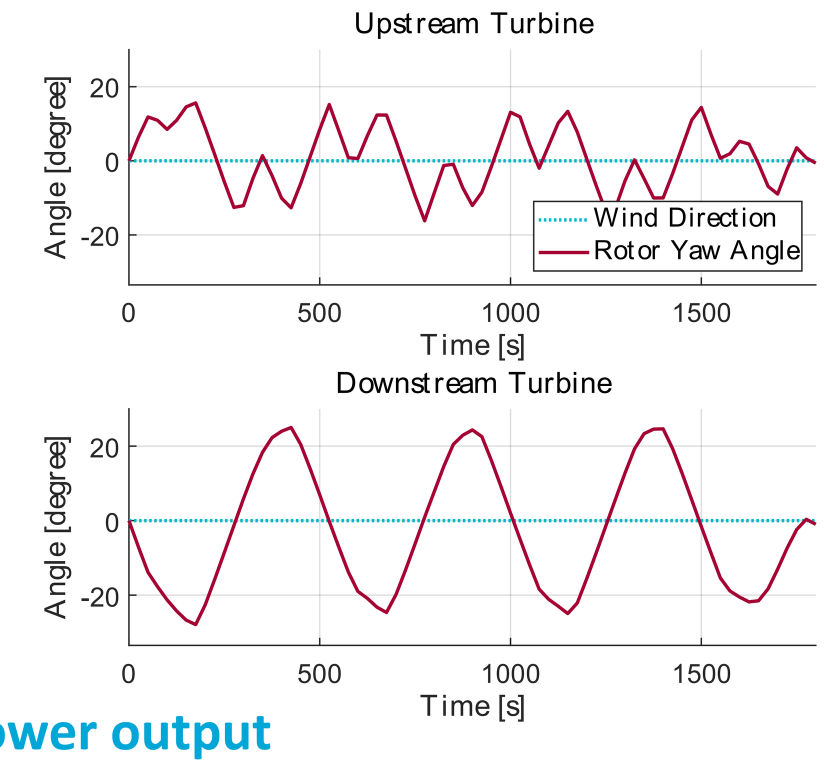


Optimal crosswind trajectory

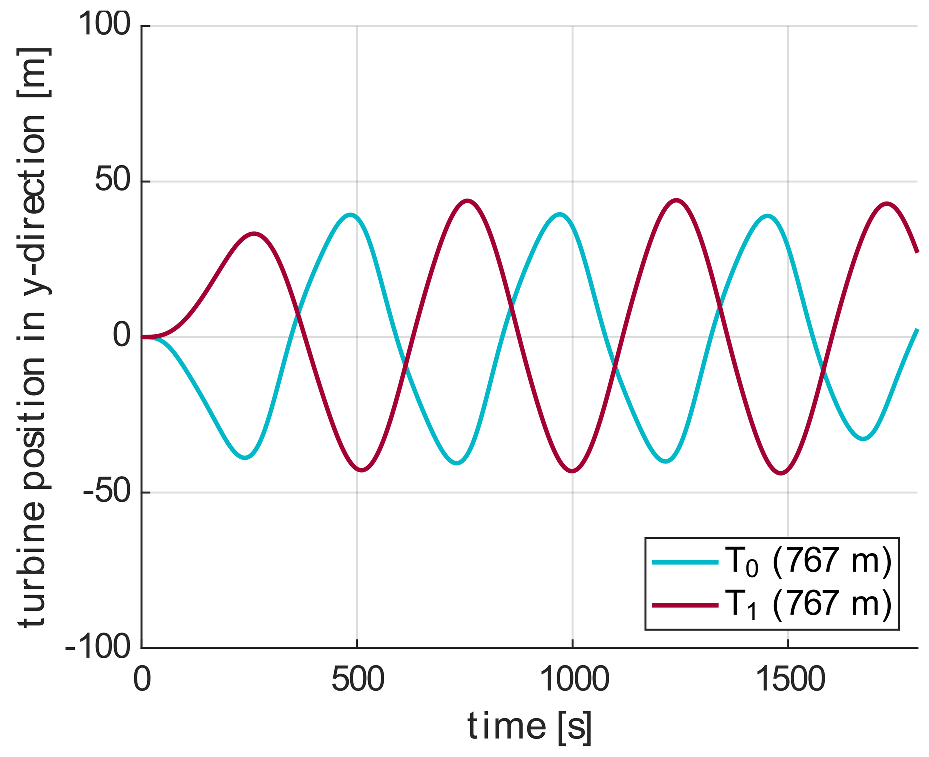


Dynamic Repositioning

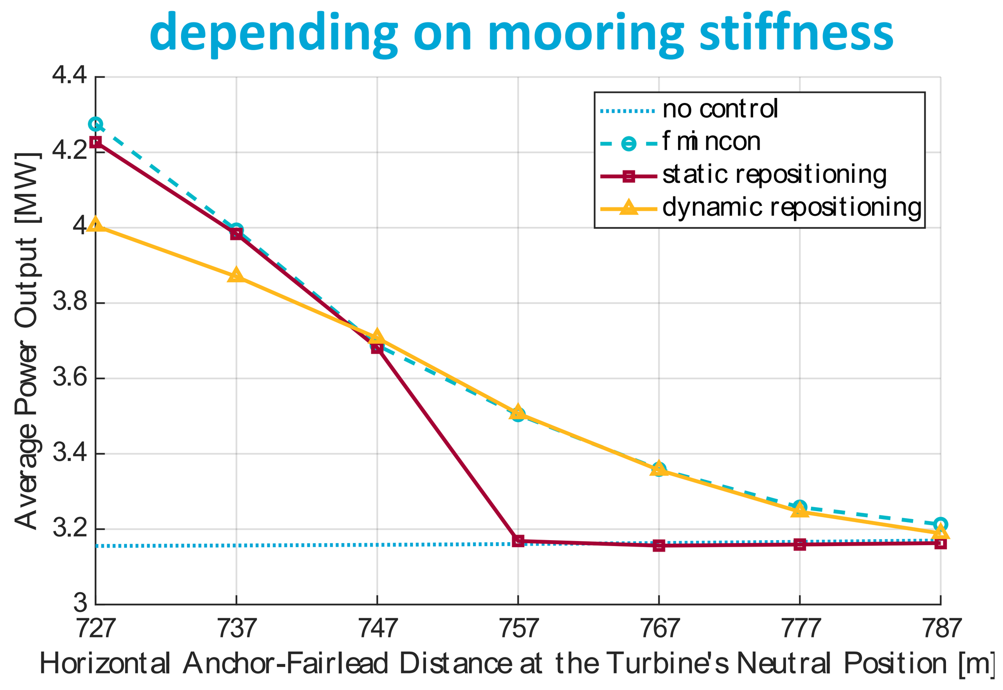
Optimal yaw signal



Optimal crosswind trajectory



Average power output depending on mooring stiffness



References

[1] A.C. Kheirabadi and R. Nagamune. A low-fidelity dynamic wind farm model for simulating time-varying wind conditions and floating platform motion. *Ocean Engineering*, 234:109 313, 2021.

[2] M Becker, D Allaerts, and JW Van Wingerden. Floridyn-a dynamic and flexible framework for real-time wind farm control. In *Journal of Physics: Conference Series*, volume 2265, page 032103. IOP Publishing, 2022.

QR-Codes

To the thesis:

To a dynamic repositioning gif: