Impact on wind turbine loads from different down regulation control strategies

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Power down regulation can be done in different ways by adjusting the rotor speed and blade pitch angle on the individual turbines, which affect the fatigue loads on the turbine components. Until now the main focus was on power optimization [7, 8] and there has been limited documentation on the load variations as a result of different down-regulation strategies on wind turbines under wakes.

Main objective: Load impact for three characteristic derating strategies on the upstream WT to the downstream one:

- **Control strategies are directly linked with the deficit strength of the upstream turbine operation.**
- **The load levels for minRS and minT strategies are almost equal when the WTS are aligned with the wind direction (full wake situation).**
- **Above rated wind speed (8 m/s) the downstream WT blade flap loads are minimized when the upfront WT is derated with the minRS and minT strategy.**

### Method

- **High fidelity aerelastic simulations**
  - HAWC2 - Including the Dynamic Wake Meander model (DWM) [3, 4, 5]
  - Generic 2MW Wind Turbine (WT)
  - Two WTs in wind farm configuration
  - Upfront WT-2 is down-regulated, downstream WT-1 normal operation
  - Wind farm derating control strategies
    - minimum/maximum rotor speeds (minRS, maxRS)
    - Minimum thrust (minT)

### Results

- **Equivalent fatigue loads on downstream WT-1**
  - Blade root flapwise BM
  - Tower base fore-aft BM
  - Main bearing yaw moment
  - Wind speed (4D)

### Conclusions

- **Below rated wind speed (8 m/s) the downstream WT blade flap loads are minimized when the upfront WT is derated with the minRS and minT strategy.**
- **The maxRS mode returns always the highest loads variations.**
- **The load levels for minRS and minT strategies are almost equal when the WTS are aligned with the wind direction (full wake situation).**
- **Above rated wind speed (16 m/s) the tendency is the same as at 8 m/s.**
- **Control strategies are directly linked with the deficit strength of the upstream turbine operation.**

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