The demonstration of the HB NS technology for the rapid prediction is based on the simulation of the periodic flow of a 5 MW HAWT rotor (left plot of Fig. 5) subject to a 20° yaw error with a freestream velocity of 13 m/s. The blade sector grid used for the HB simulations has 3 million cells, whereas that of the complete rotor for the TD simulation is 3 times larger. A time-independent solution is obtained using at least 720 intervals per period. The middle and right plots of Fig. 5 compare thrust and torque coefficients of the TD 720 solution and the HB analyses using 1,2,3 and 4 harmonics. The TD 720 and HB 3 analyses present negligible differences.

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The ratios between runtimes of the HB and the TD 720 analyses are reported in the table at right, which shows that the HB 3 analysis accurately determined the sought periodic flow nearly 50 times faster. Rotor thrust and torque over one period predicted by the TD 720 and HB3 simulations are depicted in Fig. 6. Fluctuations are smaller than those on each blade, but shaft torque fluctuations yield electrical power flickering.

Conclusions

- HB NS analysis resolves HAWT periodic flows with the same accuracy but much more rapidly than the conventional TD approach.
- Approach can be used to study turbine/wake interaction.

Bibliography

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