Modelling wake effects using two CFD techniques

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OBJECTIVE: Validation of BEM-CFD coupling through a Moving Reference Frame (MRF) simulation

**CFD approaches to simulate the rotor disks of wind turbines**

**Moving Reference Frame (MRF)**
- Blade geometry explicitly modelled
- Rotation effects taken into account through source terms (Coriolis force and centripetal) in the momentum equations

**Virtual Blade Model (VBM)**
- BEM (Blade Element Theory) - CFD coupling
- Blade geometry implicitly modelled (Cl-α, Cd-α required)
- No need to generate individual meshes over each of the rotor blades -> reduction of cell count
- Momentum sources obtained from BEM as a function of twist, chord and airfoil types along the radius [2] [3]
- VBM replaces rotor systems with the momentum sources on an actuator disk

**Simulation features**
- Dimensions of domain: 5D upstream - > 8D downstream
- Mesh: Non structured
- Turbulence model: kε SST

**Validation data on forces and pressures over the blades for MRF from NREL Phase VI wind tunnel data**

- Accurate estimation for sections near the root and medium sections
- Slight deviation at 80% and 95% due to tip effect (tip effect correction disabled in VBM)

**Results**

- Axial Velocity
- Tangential Velocity
- Radial Velocity
- Static Pressure

- Good representation of radial velocity at sections near the tip
- Similar pressure jump
- Fair description with no important deviations

**REFERENCES**