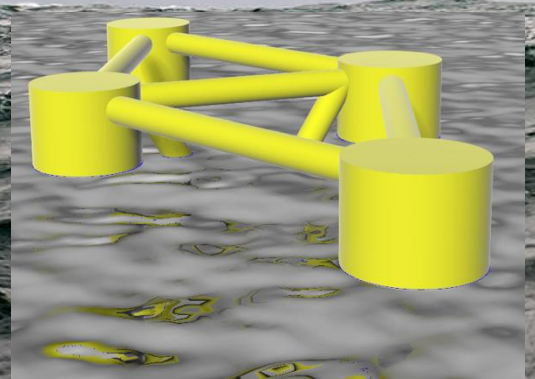
NREL
Transforming ENERGY

UMERC 2024 – OpenFAST Workshop
Installation and Running

August 7, 2024



Installation

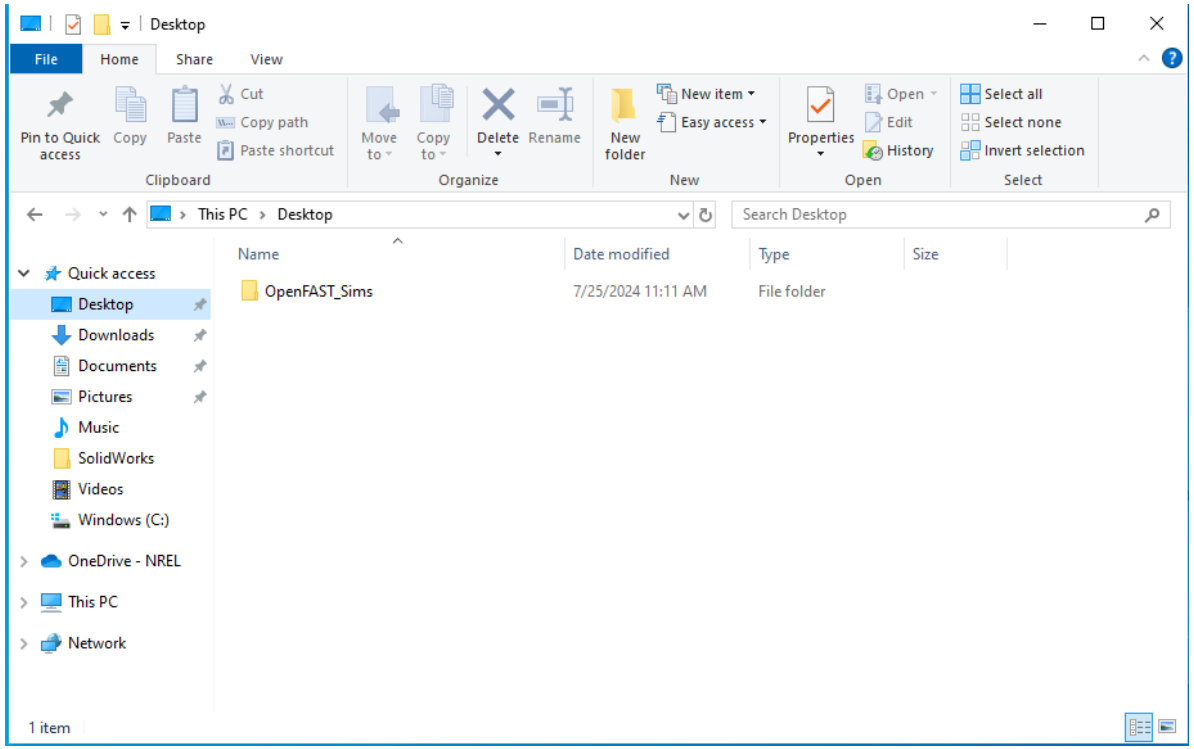
Instructions at: https://openfast.readthedocs.io/en/main/source/install/index.html

- Options for precompiled binaries:
  - Conda installation
  - Homebrew installation
  - Download releases on Github (Windows only)

- Compile from source - https://github.com/OpenFAST

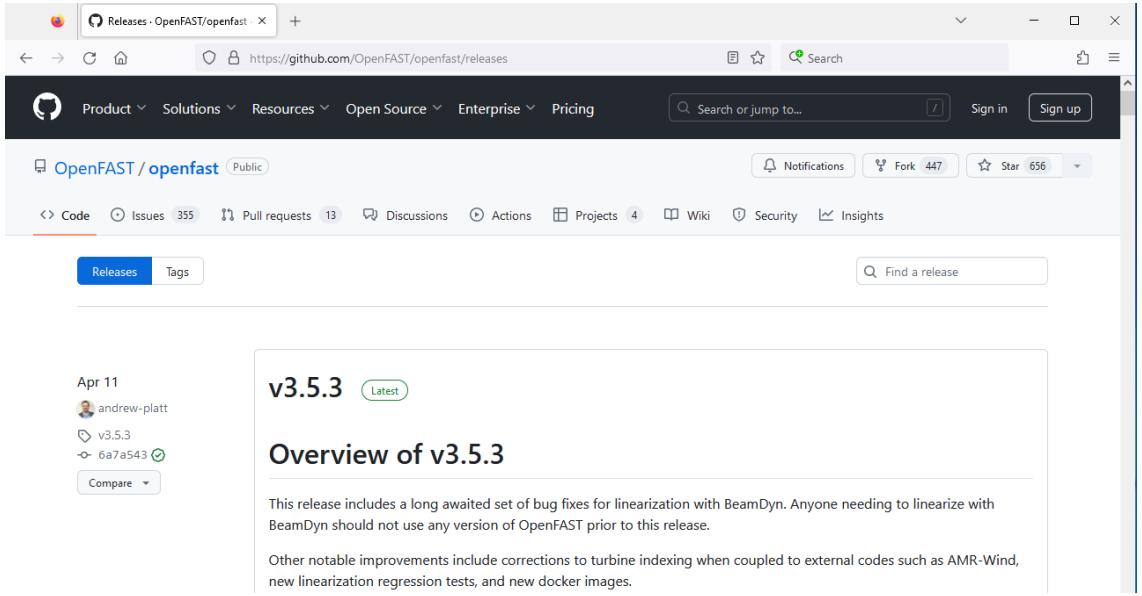
Windows

1. Create a new folder for your OpenFAST simulations. I've created a folder on the desktop called "OpenFAST_Sims", but you may want to create the folder in a different location.



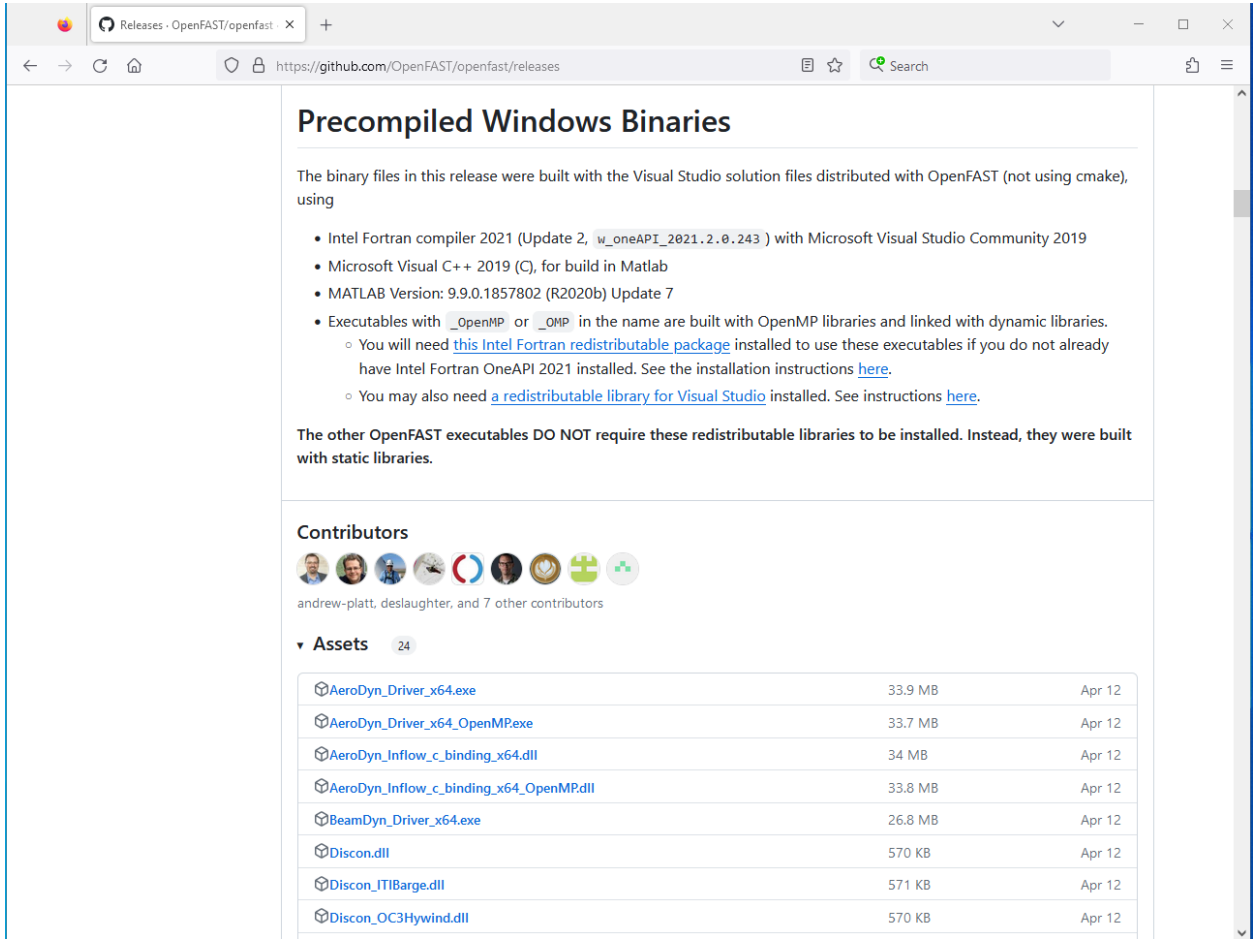
Windows

2. Go to the OpenFAST releases GitHub page: https://github.com/OpenFAST/openfast/releases. The latest release will be shown at the top of the page.



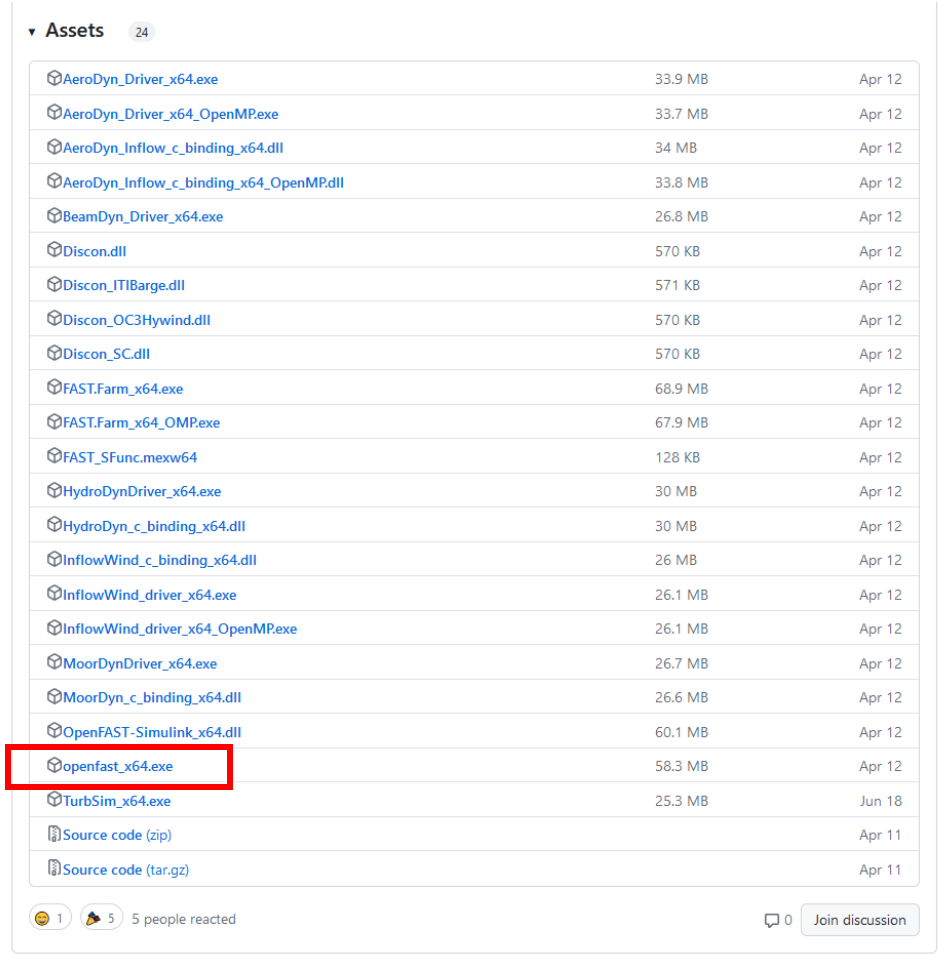
Windows

3. Scroll down to the “Assets” header. Note that each version has it own set of Assets, so make sure to select the most recent version, unless you intentionally want to use an older release.



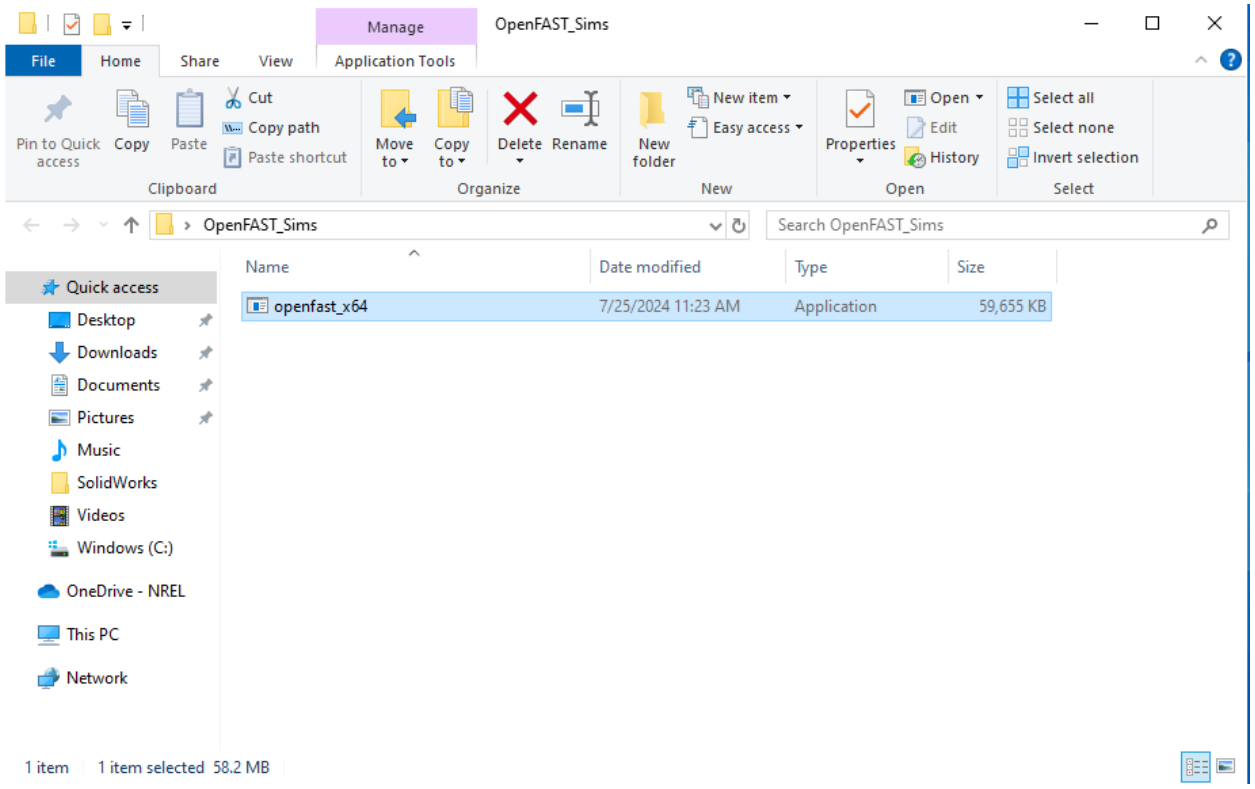
Windows

4. There is a list of executables corresponding to the different ways you can run OpenFAST or the individual modules. Here, we will install only the main OpenFAST program (openfast_x64.exe).



Windows

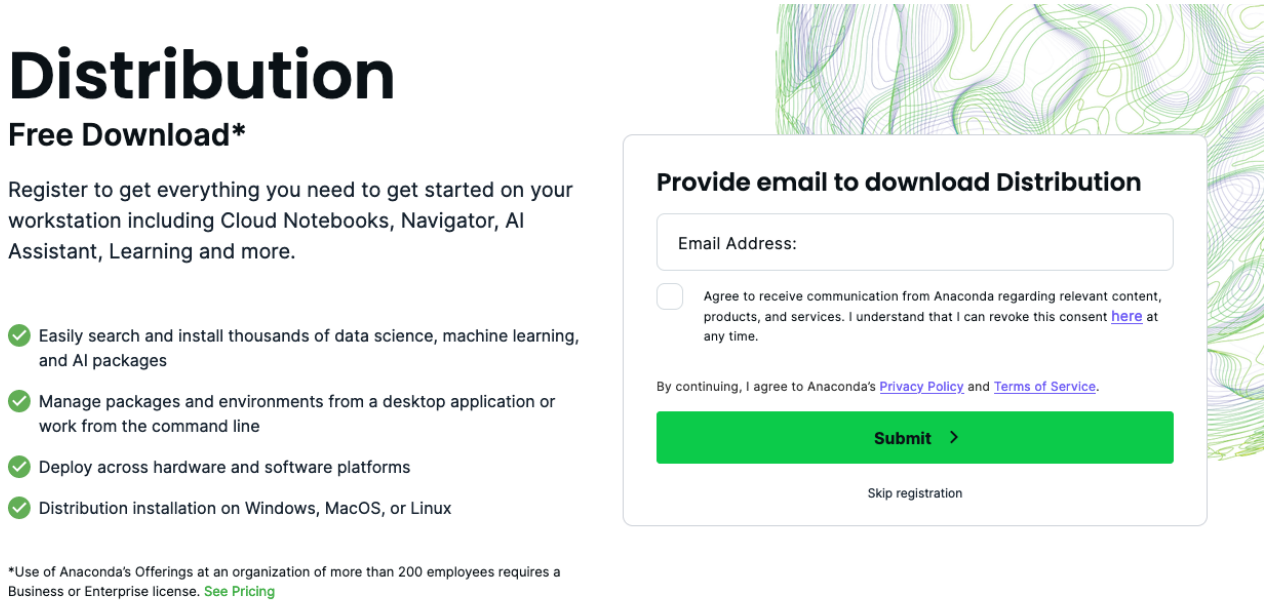
5. Click on “openfast_x64.exe” and find the downloaded file (most likely in your Downloads folder). Move this file to the folder you created to host your OpenFAST simulations.



6. This is all that is required to install OpenFAST on Windows.

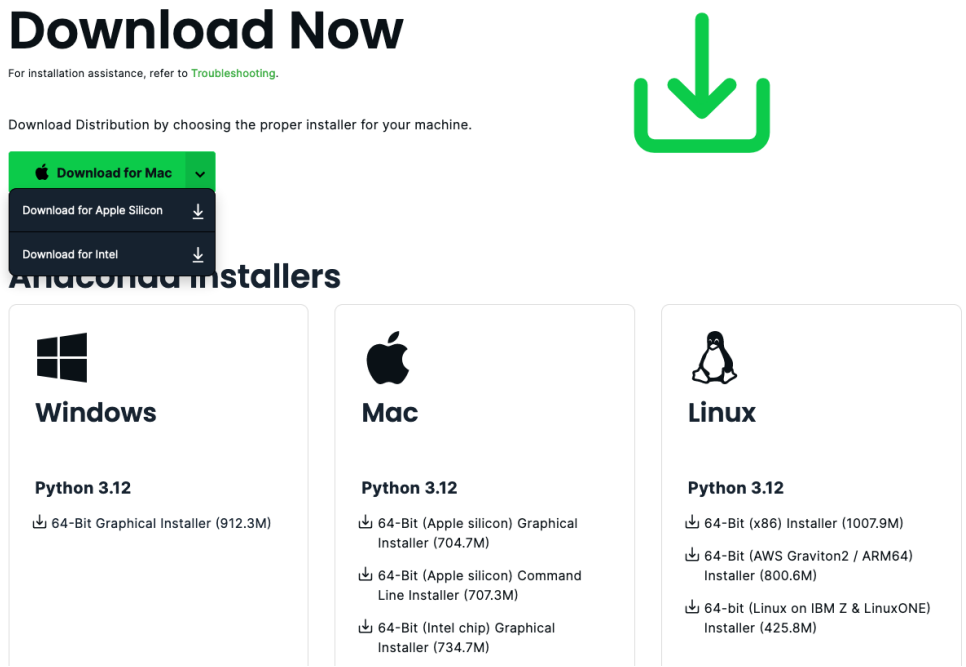
Mac

1. OpenFAST can be installed through conda, which requires an Anaconda installation. If Anaconda is already installed on your system, you can skip to step 3. There are several different ways to install Anaconda. One option is directly through the Anaconda website (https://www.anaconda.com/download). You can hit “skip registration” if you prefer not to provide your email address.



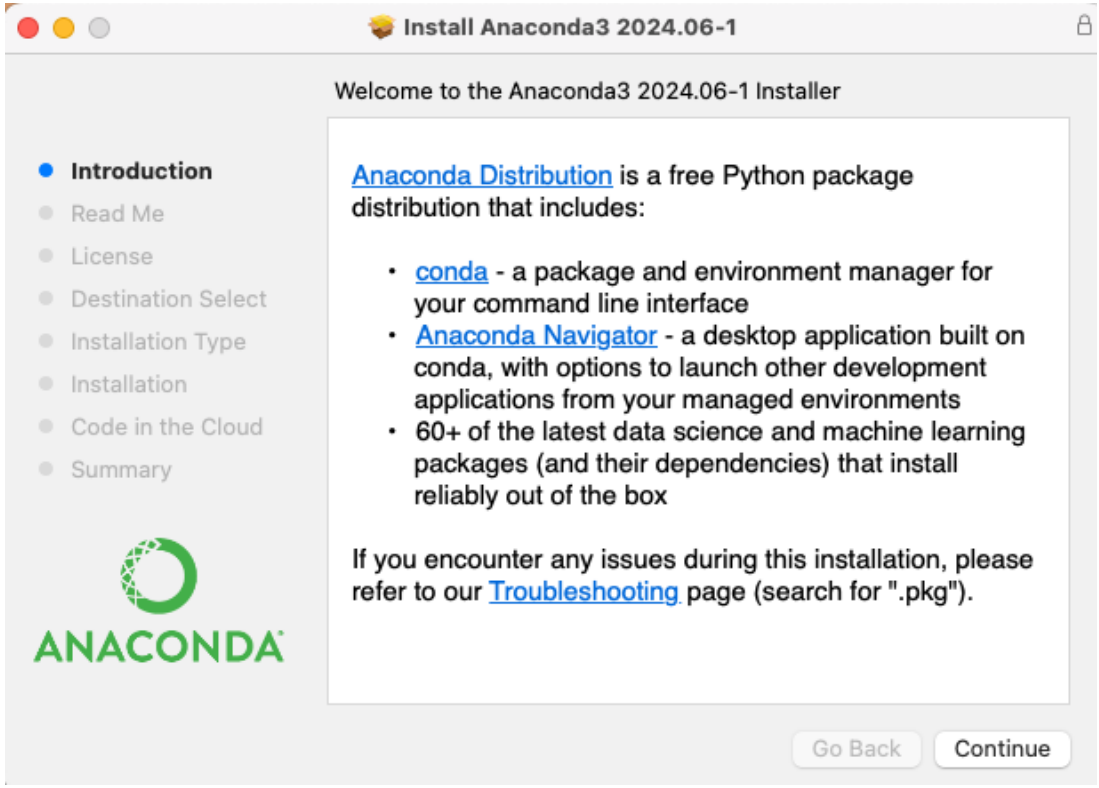
Mac

1b. Then, choose the “Mac” download and select either “Download for Apple Silicon” or “Download for Intel”, depending on your processor. Instructions for determining your processor type can be found here: https://support.xtool.com/article/643.



Mac

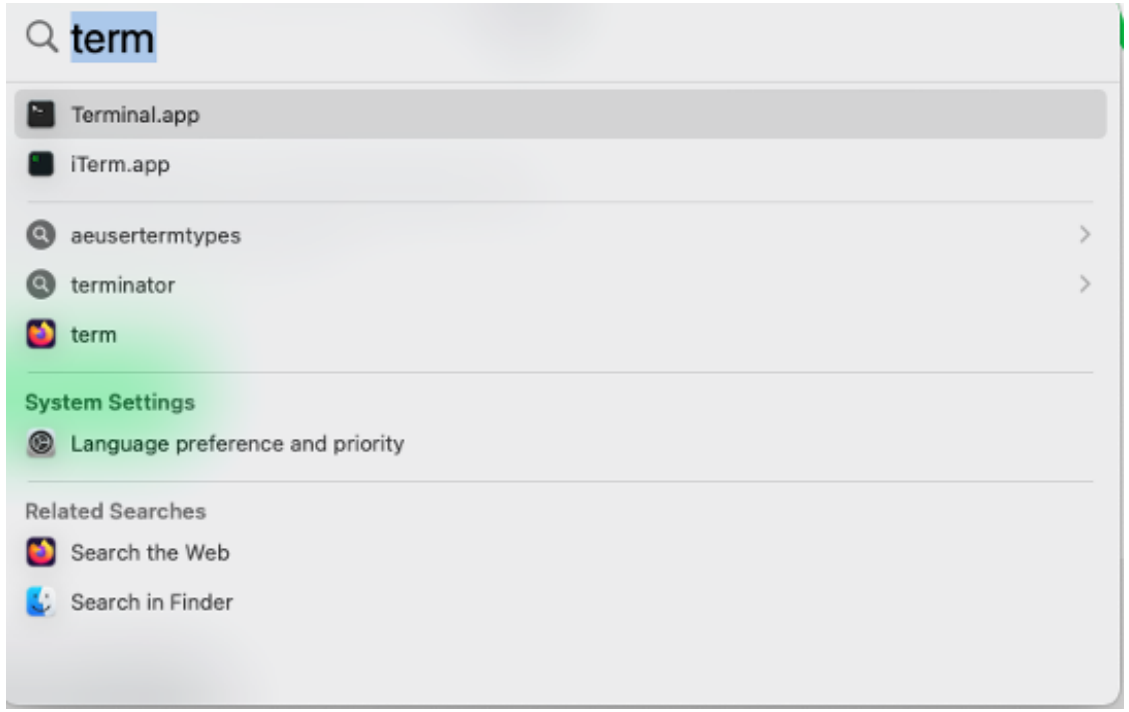
1c. Find the installer download in your Downloads folder, and double click on it. Follow the prompts to install Anaconda. Selecting the default install options when relevant should be sufficient.



* Another option to install Anaconda is through the Homebrew package manager. Detailed instructions for this method will not be covered in this video but can be found here: https://medium.com/ayuth/install-anaconda-on-macos-with-homebrew-c94437d63a37.

Mac

2. Now test that your Anaconda installation is successful. Open a terminal by searching for and opening “Terminal.app” (the default Mac terminal), or your preferred terminal if others are installed.



Mac

2b. Type `conda list` into the terminal. This command displays a list of packages installed in your active environment and their versions and will only execute if your Anaconda installation is successful.

Mac

3. Now, create a new conda environment for OpenFAST:
`conda create -n openfast_env`

Mac

3b. Run `conda init zsh`

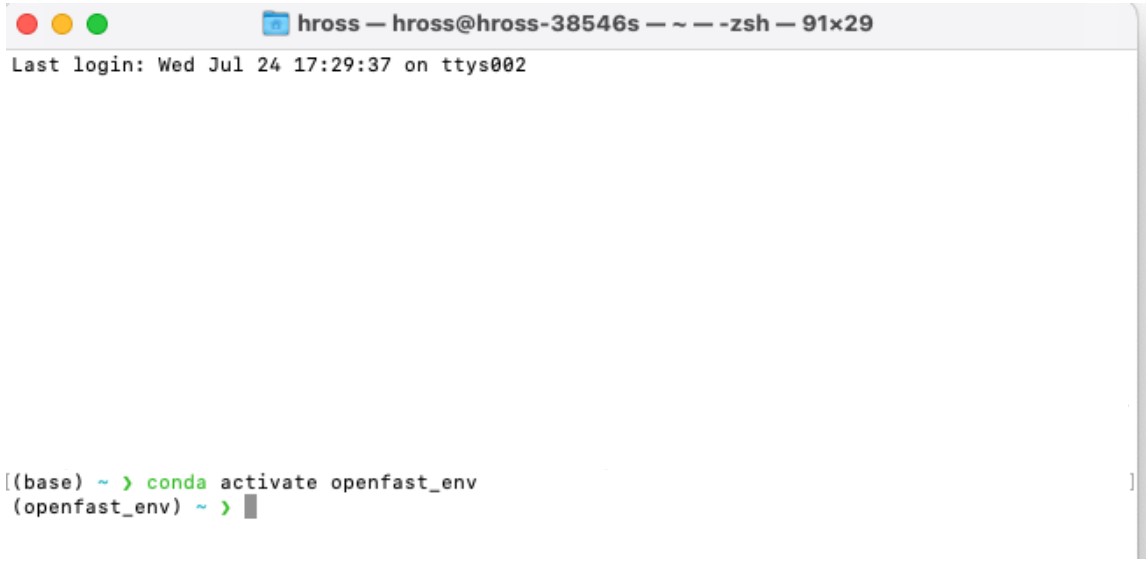
* Note that `zsh` may need to be replaced by your shell name, which should be displayed at the top of your terminal.

Mac

4. Close and reopen your terminal

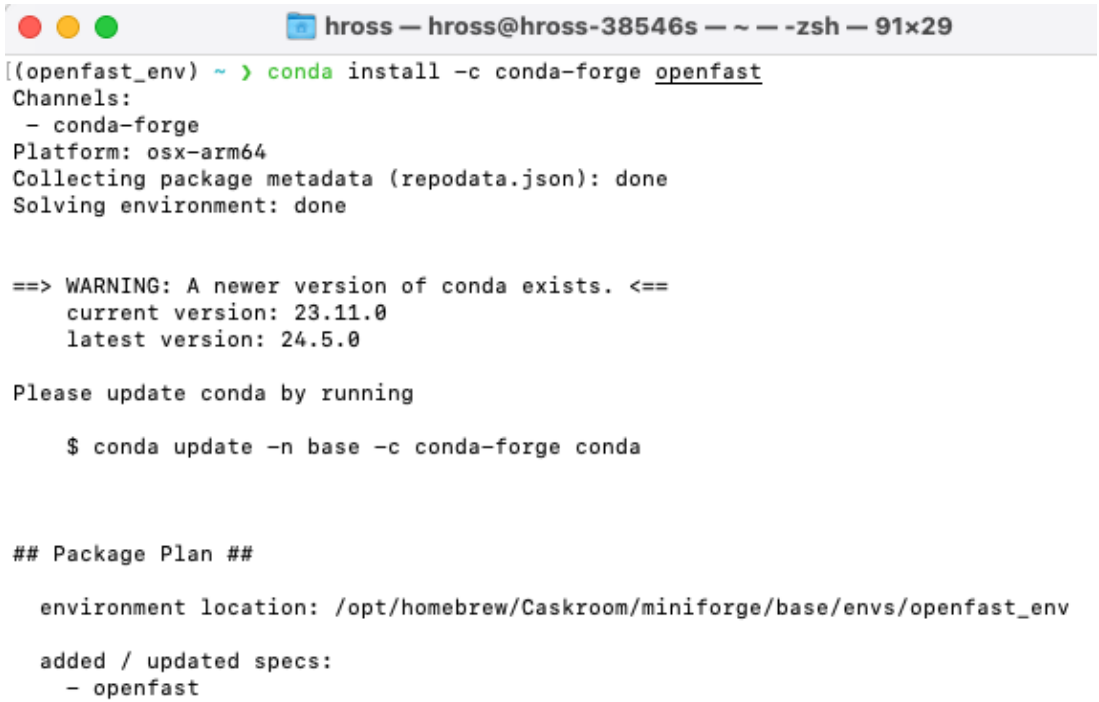
Mac

5. Activate the environment: `conda activate openfast_env`



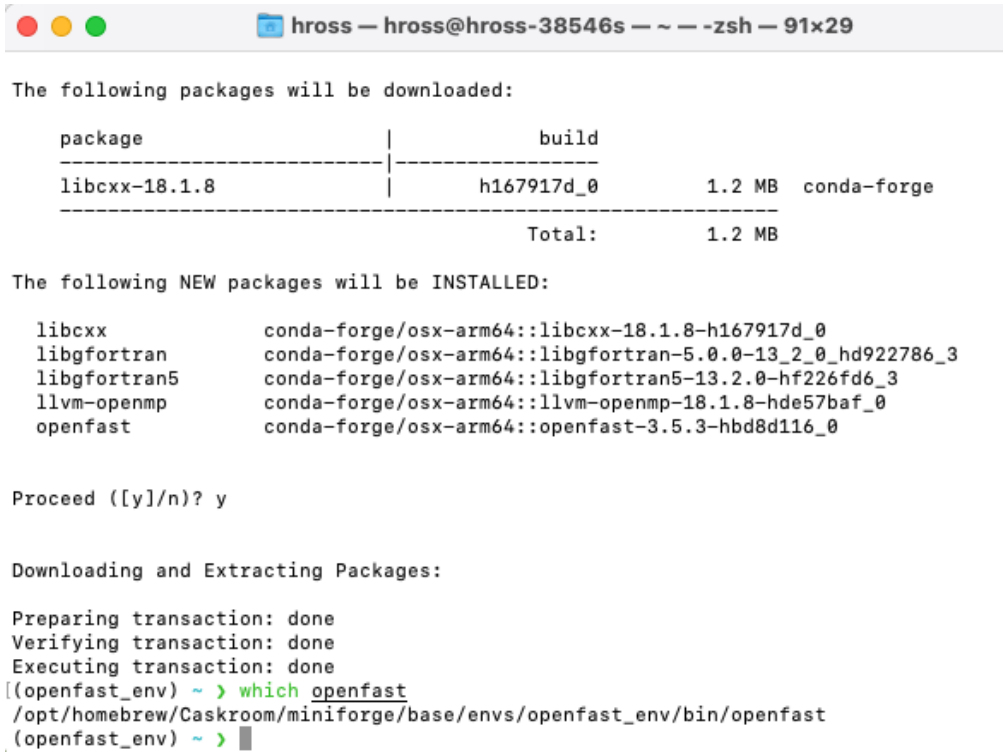
Mac

6. Install OpenFAST: `conda install -c conda-forge openfast`. This will install the most recent version of OpenFAST.



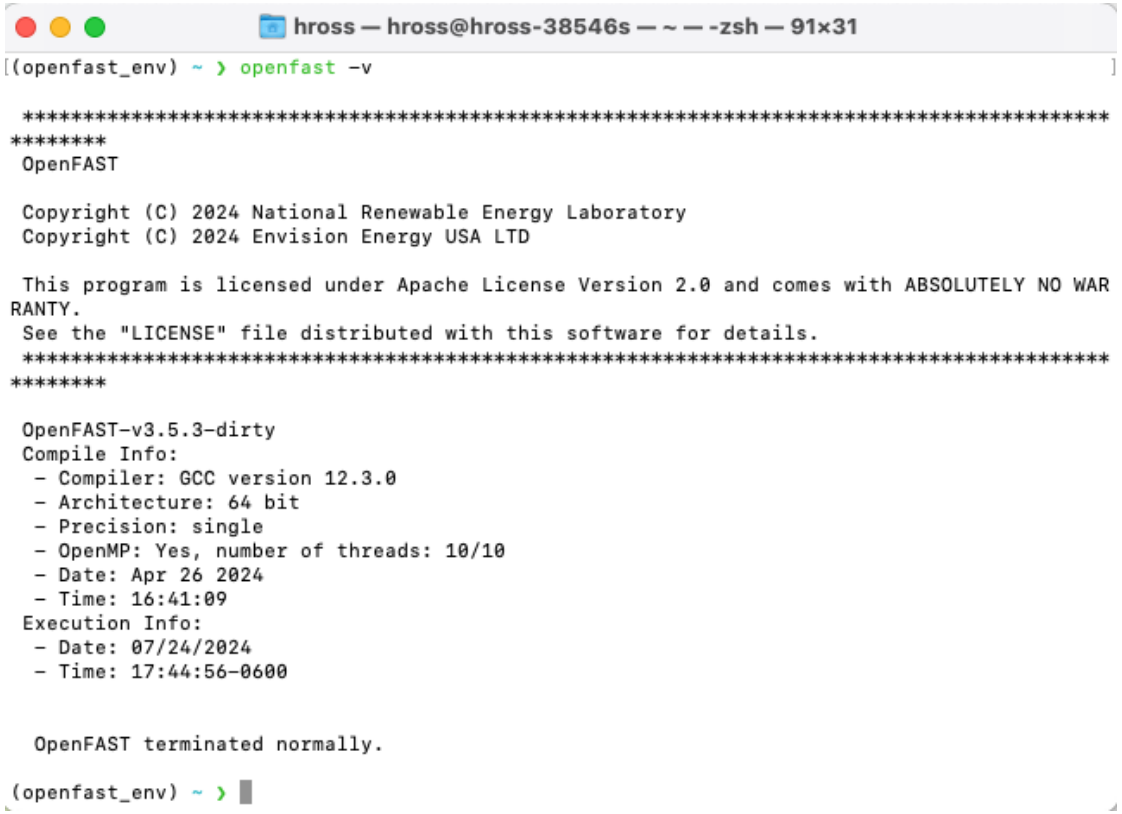
Mac

7. Test that OpenFAST was installed correctly: `which openfast`. This will display the installation location.



Mac

7b. You can also run openfast -v, which will display version information. Successful running of these commands indicates that OpenFAST was installed.



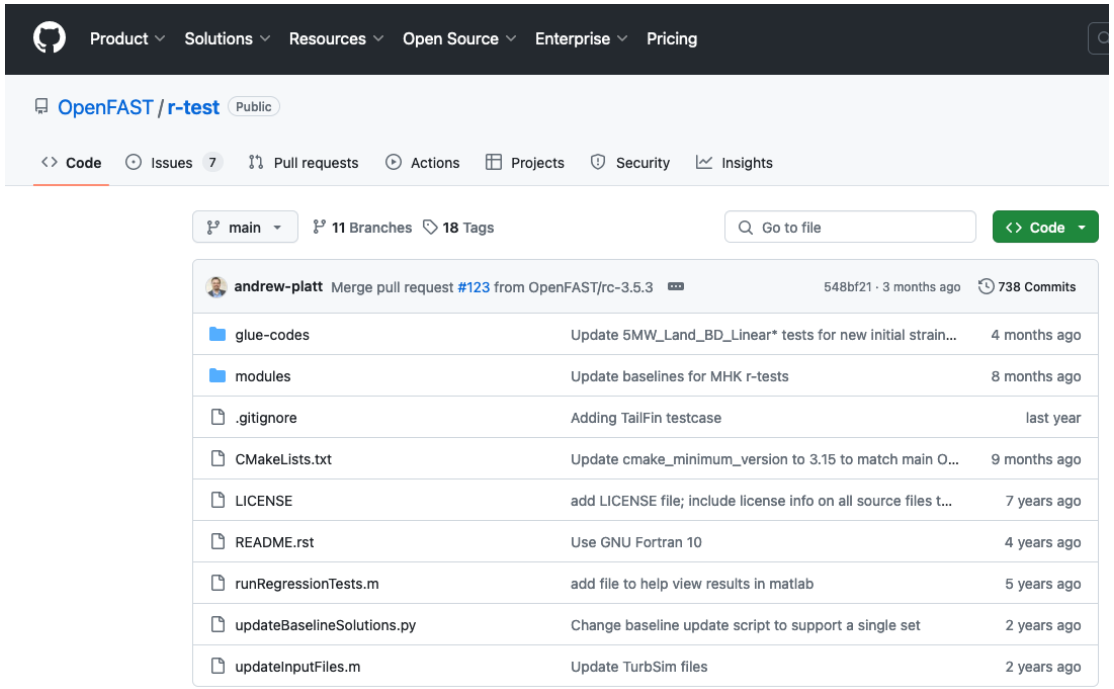
Mac

8. After working with OpenFAST, you can simply close the terminal.

Note that this method will also install module drivers, if available. These allow you to run individual modules (i.e., AeroDyn, HydroDyn) on their own.

Running OpenFAST

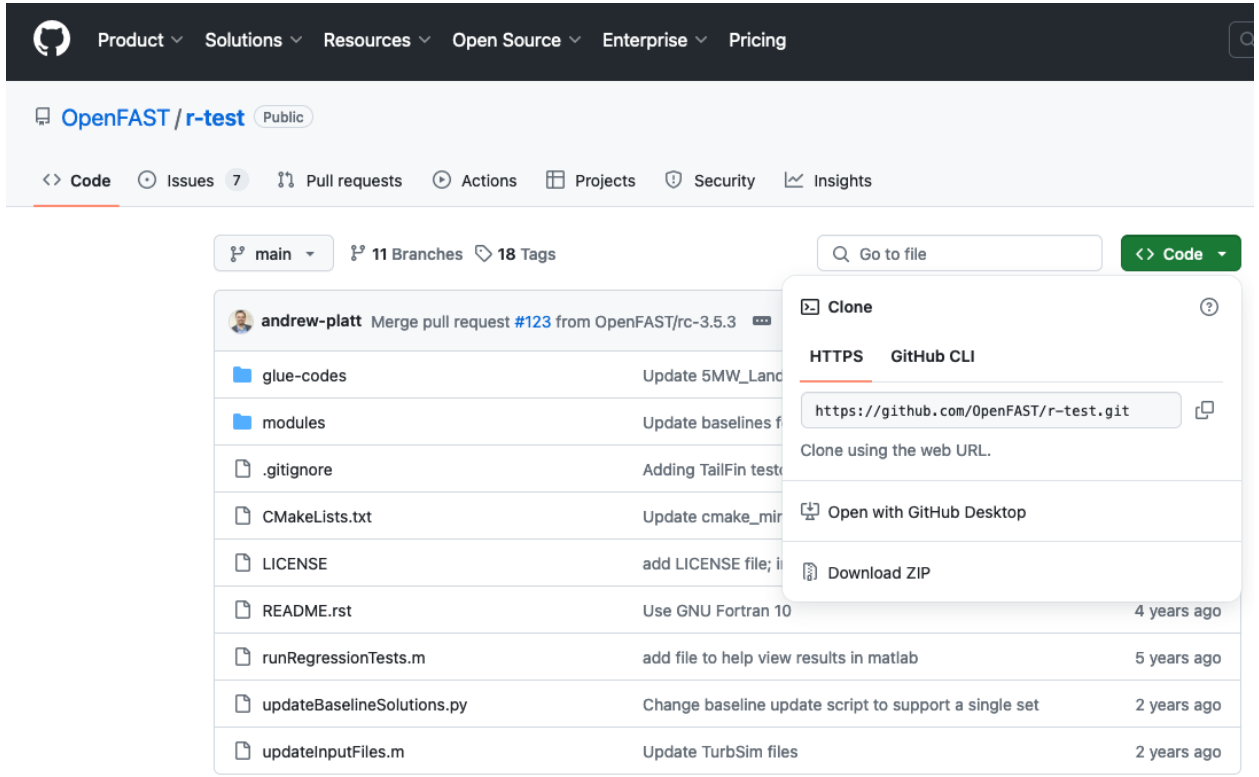
1. OpenFAST uses regression test to ensure that developers do not unintentionally change the code when adding new features. These tests are mostly used by developers, but they can also serve as example cases. We will use them here to make sure OpenFAST was installed correctly and to demonstrate running the code. Regression tests are hosted on the OpenFAST GitHub page: https://github.com/OpenFAST/r-test/tree/main.



MHK directory for this demo here:
https://github.com/hkross/OpenFAST_UMERC_Demo

Running OpenFAST

2. We will be using files from this repository, so we need to download the files to our local machine. This is done by clicking on the green “<> Code” button in the upper right corner of the screen and selecting “Download ZIP”.



This will download a zip folder of all the files in this repository.

Running OpenFAST

1. Find the zip file, which will most likely be in your downloads folder, and extract it.
2. We will now copy specific files to the location where you will be running simulations. For Windows users, this should be the folder where the openfast_x64.exe file is located. Mac and Linux users can create a new folder in a preferred location. My folder is named "OpenFAST_Sims".
3. We will be working with MHK_RM1_Floating

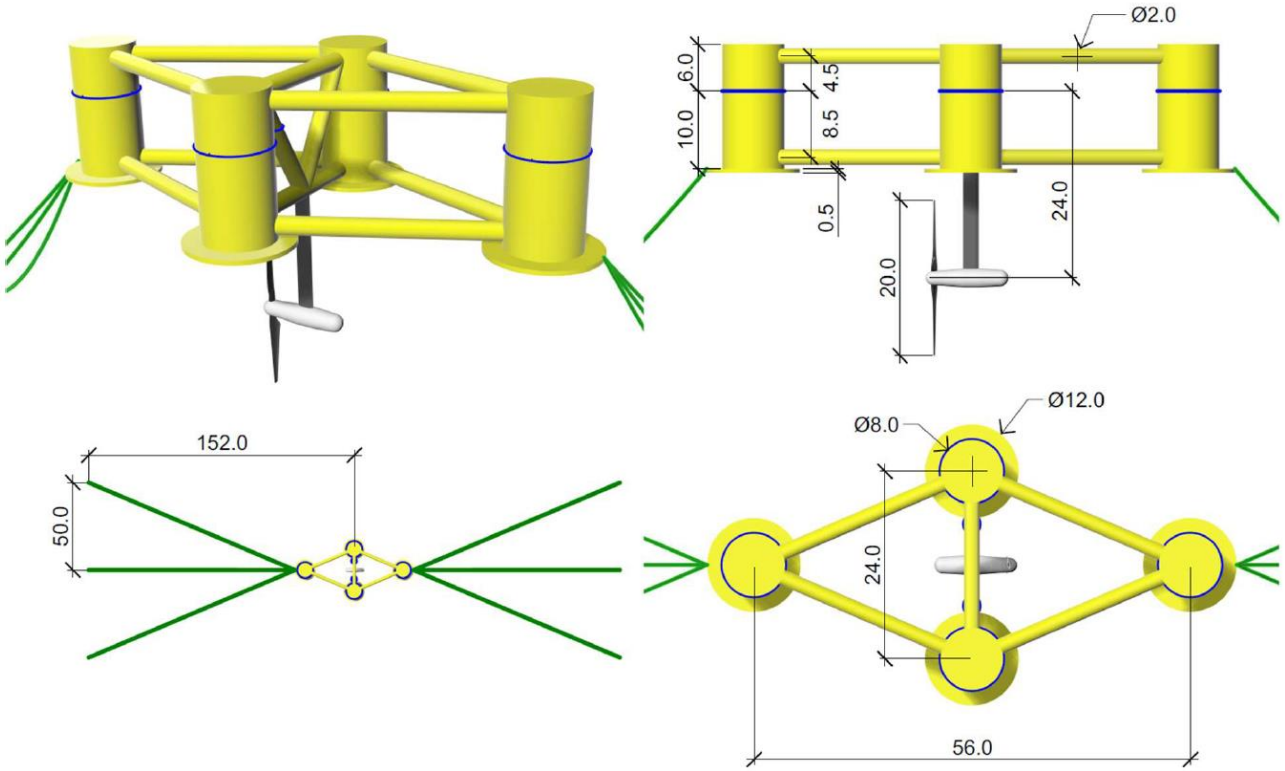
Floating RM1 Quad

RM1 Turbine

- 500 kW reference turbine designed by national labs in 2011
- 2-bladed
- Variable speed – variable pitch
- 20 m rotor diameter
- 1.9 m/s rated speed
- Specifications include:
  - Blade structural + aerodynamic properties
  - Nacelle and hub
  - Drivetrain
  - Operating profile

Floating Quad Platform

- Robust test platform designed by NREL in 2023
- Similar elements to typical FOWT semisubmersible
  - Large diameter columns
  - Heave plates
  - Catenary mooring system
- Faired tower



	Platform Structure	Platform Structure + Ballast	Platform Structure + Ballast + Tower & RNA
Mass [kg]	1.050e6	2.525e6	2.588e6
COG [m]	[0.0, 0.0, -5.63]	[0.0, 0.0, -6.09]	[-0.02, 0.0, -6.52]
Ixx [kg-m^2]	8.866e7	1.952e8	2.155e8
Iyy [kg-m^2]	3.408e8	9.194e8	9.403e8
Izz kg-m^2]	3.691e8	1.054e9	1.054e9

https://github.com/OpenFAST/r-test/tree/dev/glue-codes/openfast/MHK_RM1_Floating

Running OpenFAST

- ElastoDyn — Structural dynamics
- BeamDyn
- AeroDyn — Turbine hydrodynamics
- InflowWind — Current inflow
- SeaState — Wave and current field
- ServoDyn
- HydroDyn — Platform hydrodynamics
- SubDyn
- MoorDyn — Dynamic mooring
- MAP++
- FEAMooring
- OrcaFlexInterface
- IceFloe
- IceDyn

- Steady, 1.9 m/s current
- Power law shear
- No control
- Fixed rotational speed
- Blade, tower, and drivetrain DOFs

Running OpenFAST

- In a terminal, navigate to the folder containing the relevant OpenFAST executable for your system and the simulation input files
  - For Mac users, run OpenFAST using the following command for the example
    - ./openfast_Mac “Onshore/ MHK_RM1_Floating.fst”
  - For Windows users, run OpenFAST using the following command for the example
    - openfast_Windows.exe Onshore\ MHK_RM1_Floating.fst
  - For Linux users, run OpenFAST using the following command for the example
    - ./openfast_Linux Onshore/MHK_RM1_Floating.fst

* Just need full relative path of executable and input files

Running OpenFAST – Input Files

Key input files to look at:

- Primary glue-code input:
  - MHK_RM1_Floating.fst
- AeroDyn
  - MHK_RM1_Floating_AeroDyn15.dat
- ElastoDyn
  - MHK_RM1_Floating_ElastoDyn.dat
- HydroDyn
  - MHK_RM1_Floating_HydroDyn.dat

Running OpenFAST – View Outputs

Summary files

- OpenFAST (MHK_RM1_Floating.sum)
- ElastoDyn (MHK_RM1_Floating.sum)
- AeroDyn (MHK_RM1_Floating.sum)

Output file

- MHK_RM1_Floating.out

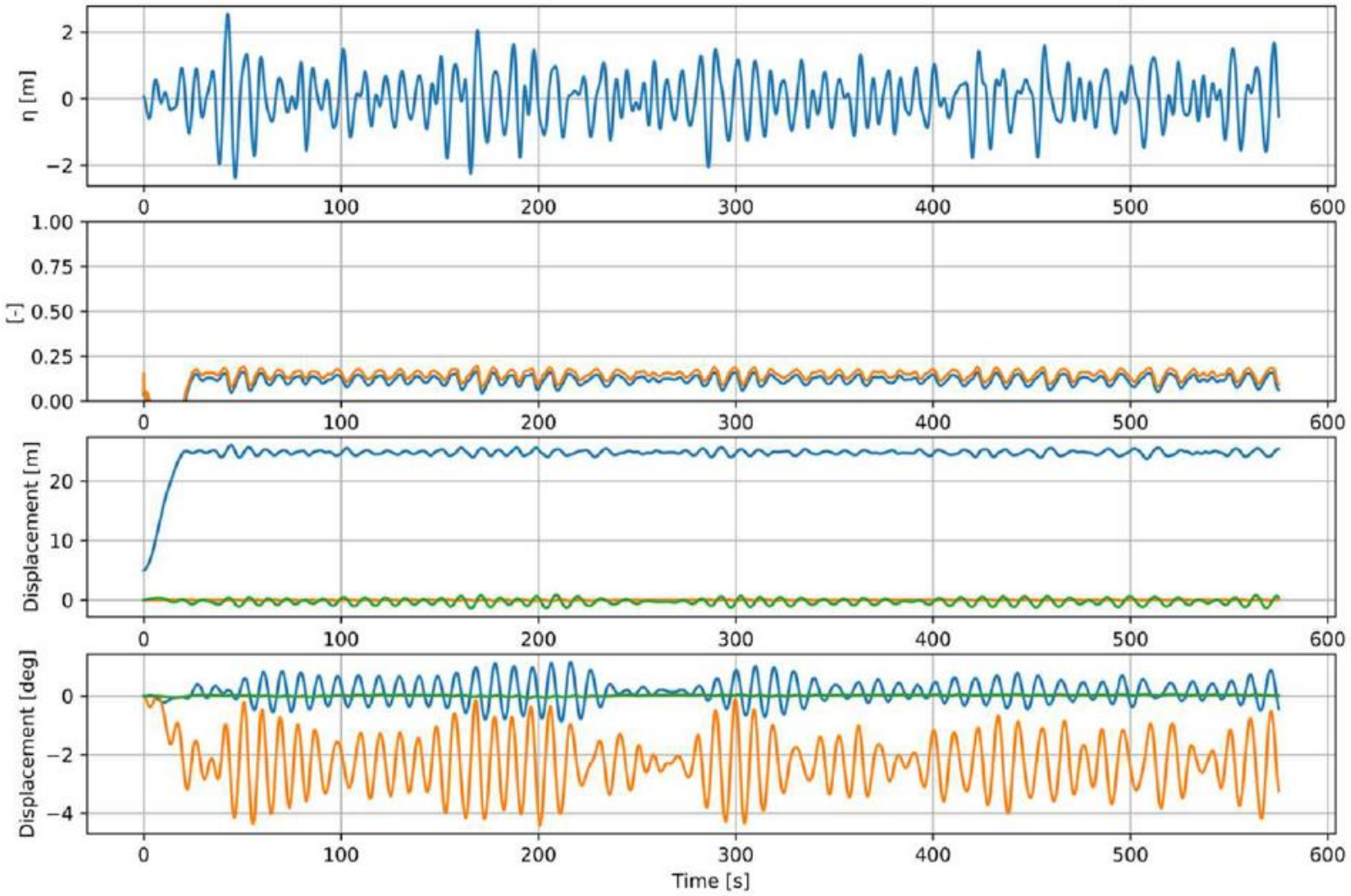
Full list of possible outputs: https://github.com/OpenFAST/openfast/tree/main/docs/OtherSupporting/OutListParameters.xlsx

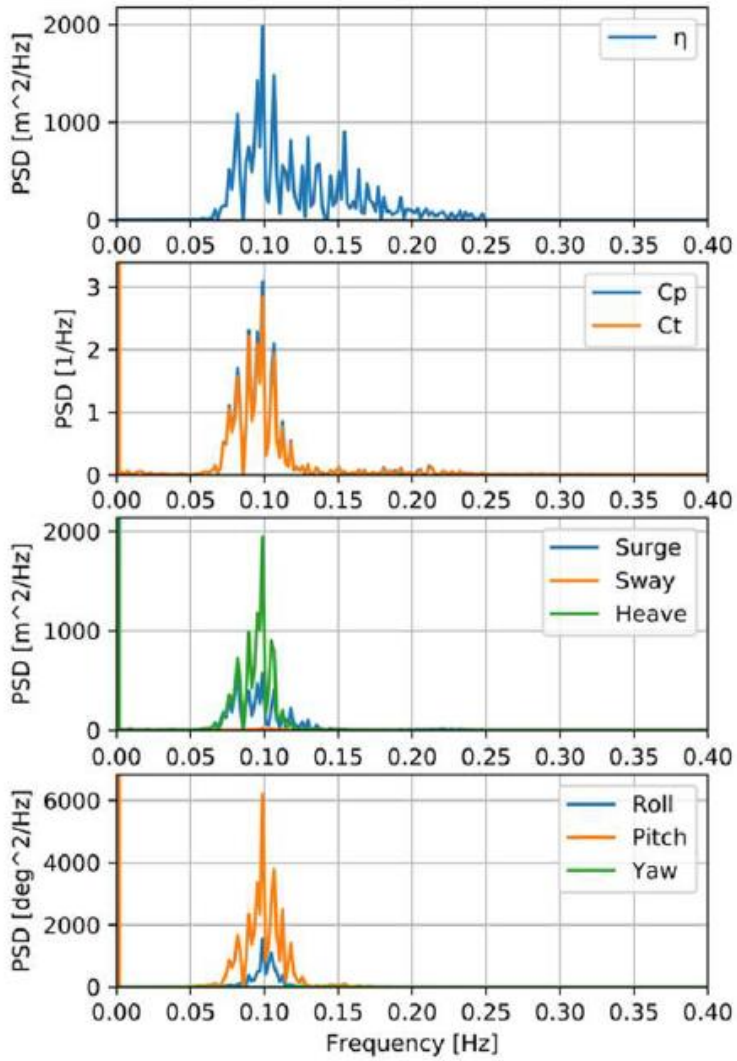
```
Predictions were generated on 16-Jan-2022 at 20:07:40 using OpenFAST, compiled as a 64-bit application using double precision at commit v3.0.0
 linked with  NWTC Subroutine Library; ElastoDyn; InflowWind; AeroDyn

Description from the FAST input file: MECC OpenFAST Webinar: NREL 5.0 MW Baseline Wind Turbine (Onshore)

Time     Wind1VelX   Wind1VelY   Wind1VelZ   OoPDefl1    IPDefl1 TwstDefl1   BldPitch1   Azimuth RotSpeed    GenSpeed    TTDspFA TTDspSS TTDspTwst   Spn2MLxb1   Spn2MLyb1   RootFxb1    RootFyb1
(s) (m/s)    (m/s)    (m/s)    (m) (m) (deg)    (deg)    (deg)    (rpm)    (rpm)    (m) (m) (deg)    (kN-m)  (kN-m)  (kN)     (kN)     (kN)     (kN-m)  (kN-m)  (kN-m)  (kN-m)  (kN-m)  (kN)     (kN)
    0.0000   8.000E+00  -0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   9.000E+00   8.730E+02   0.000E+00  -0.000E+00   0.000E+00   3.179E+00  -8.463E+00
    0.0125   8.000E+00  -0.000E+00   0.000E+00   4.536E-03  -7.934E-05   0.000E+00   0.000E+00   6.752E-01   9.005E+00   8.730E+02  -6.648E-06  -9.360E-08   0.000E+00   2.637E+00  -1.772E+01
    0.0250   8.000E+00  -0.000E+00   0.000E+00   1.753E-02  -2.317E-04   0.000E+00   0.000E+00   1.351E+00   9.010E+00   8.730E+02  -2.619E-05  -1.031E-06   0.000E+00  -4.740E+00  -1.089E+01
    0.0375   8.000E+00  -0.000E+00   0.000E+00   3.791E-02  -3.428E-04   0.000E+00   0.000E+00   2.027E+00   9.014E+00   8.730E+02  -5.740E-05  -3.834E-06   0.000E+00  -1.259E+01  -1.121E+00
    0.0500   8.000E+00  -0.000E+00   0.000E+00   6.530E-02  -5.111E-04   0.000E+00   0.000E+00   2.703E+00   9.018E+00   8.730E+02  -9.823E-05  -9.546E-06   0.000E+00  -2.322E+01   1.254E+01
    0.0625   8.000E+00  -0.000E+00   0.000E+00   9.902E-02  -8.166E-04   0.000E+00   0.000E+00   3.379E+00   9.020E+00   8.730E+02  -1.460E-04  -1.920E-05   0.000E+00  -3.524E+01   2.920E+01
    0.0750   8.000E+00  -0.000E+00   0.000E+00   1.385E-01  -1.409E-03   0.000E+00   0.000E+00   4.056E+00   9.021E+00   8.730E+02  -1.973E-04  -3.379E-05   0.000E+00  -4.819E+01   4.890E+01
    0.0875   8.000E+00  -0.000E+00   0.000E+00   1.833E-01  -2.459E-03   0.000E+00   0.000E+00   4.732E+00   9.020E+00   8.730E+02  -2.481E-04  -5.421E-05   0.000E+00  -6.136E+01   7.130E+01
    0.1000   8.000E+00  -0.000E+00   0.000E+00   2.329E-01  -4.153E-03   0.000E+00   0.000E+00   5.409E+00   9.018E+00   8.730E+02  -2.940E-04  -8.127E-05   0.000E+00  -7.405E+01   9.622E+01
    0.1125   8.000E+00  -0.000E+00   0.000E+00   2.869E-01  -6.672E-03   0.000E+00   0.000E+00   6.085E+00   9.014E+00   8.730E+02  -3.300E-04  -1.156E-04   0.000E+00  -8.555E+01   1.235E+02
    0.1250   8.000E+00  -0.000E+00   0.000E+00   3.448E-01  -1.018E-02   0.000E+00   0.000E+00   6.761E+00   9.010E+00   8.730E+02  -3.508E-04  -1.577E-04   0.000E+00  -9.529E+01   1.529E+02
    0.1375   8.000E+00  -0.000E+00   0.000E+00   4.063E-01  -1.481E-02   0.000E+00   0.000E+00   7.436E+00   9.004E+00   8.730E+02  -3.510E-04  -2.078E-04   0.000E+00  -1.028E+02   1.843E+02
    0.1500   8.000E+00  -0.000E+00   0.000E+00   4.711E-01  -2.066E-02   0.000E+00   0.000E+00   8.112E+00   8.999E+00   8.730E+02  -3.249E-04  -2.660E-04   0.000E+00  -1.083E+02   2.174E+02
    0.1625   8.000E+00  -0.000E+00   0.000E+00   5.388E-01  -2.777E-02   0.000E+00   0.000E+00   8.786E+00   8.994E+00   8.730E+02  -2.670E-04  -3.322E-04   0.000E+00  -1.102E+02   2.520E+02
    0.1750   8.000E+00  -0.000E+00   0.000E+00   6.086E-01  -3.611E-02   0.000E+00   0.000E+00   9.461E+00   8.989E+00   8.730E+02  -1.719E-04  -4.059E-04   0.000E+00  -1.085E+02   3.070E+02
    0.1875   8.000E+00  -0.000E+00   0.000E+00   6.799E-01  -4.561E-02   0.000E+00   0.000E+00   1.013E+01   8.985E+00   8.730E+02  -3.381E-05  -4.866E-04   0.000E+00  -1.063E+02   3.219E+02
    0.2000   8.000E+00  -0.000E+00   0.000E+00   7.532E-01  -5.617E-02   0.000E+00   0.000E+00   1.081E+01   8.983E+00   8.730E+02   1.537E-04  -5.737E-04   0.000E+00  -1.006E+02   3.656E+02
    0.2125   8.000E+00  -0.000E+00   0.000E+00   8.280E-01  -6.764E-02   0.000E+00   0.000E+00   1.148E+01   8.983E+00   8.730E+02   3.964E-04  -6.664E-04   0.000E+00  -9.368E+01   4.036E+02
    0.2250   8.000E+00  -0.000E+00   0.000E+00   9.044E-01  -7.987E-02   0.000E+00   0.000E+00   1.216E+01   8.984E+00   8.730E+02   6.999E-04  -7.639E-04   0.000E+00  -8.589E+01   4.420E+02
    0.2375   8.000E+00  -0.000E+00   0.000E+00   9.823E-01  -9.269E-02   0.000E+00   0.000E+00   1.283E+01   8.986E+00   8.730E+02   1.069E-03  -8.651E-04   0.000E+00  -7.733E+01   4.803E+02
    0.2500   8.000E+00  -0.000E+00   0.000E+00   1.061E+00  -1.059E-01   0.000E+00   0.000E+00   1.350E+01   8.990E+00   8.730E+02   1.510E-03  -9.692E-04   0.000E+00  -6.742E+01   5.224E+02
```

Running OpenFAST – View Outputs





Running OpenFAST – View Outputs

https://github.com/ebranlard/pyDatView

pyDatView

A crossplatform GUI to display tabulated data from files or python pandas dataframes. It's compatible Windows, Linux and MacOS, with python 3. Some of its features are: multiples plots, FFT plots, probability plots, export of figures... The file formats supported, are: CSV files and other formats present in the weio library. Additional file formats can easily be added.

Running OpenFAST – View Outputs

Install pyDatView

QuickStart

For **Windows** users, an installer executable is available here (look for the latest pyDatView*.exe)

Linux users can use the command lines below, but first they'll need to install the package python-wxgtk* (e.g. `python-gtk3.0`) from their distribution:

```
git clone https://github.com/ebranlard/pyDatView
cd pyDatView
python -m pip install --user -r requirements.txt
make                                          # will run python pyDatView.py
echo "alias pydat='make -C `pwd`'" >> ~/.bashrc
```

MacOS users can use a `brew`, `anaconda` or `virtualenv` version of python and pip, but the final version of python that calls the script needs to have access to the screen (for instance using `pythonw`) (see details for MacOS). We recommend using conda, in the base environment, for which the following commands should work:

```
conda install -c conda-forge wxpython            # install wxpython
git clone https://github.com/ebranlard/pyDatView -b dev
cd pyDatView
python -m pip install --user -r requirements.txt
make                          # will run ./pythonmac pyDatView.py
# OR try
#pythonw pyDatView.py         # NOTE: using pythonw not python
echo "alias pydat='make -C `pwd`'" >> ~/.bashrc   # add an alias for quicklaunch
```

If this fails using the Mac terminal, try the zsh terminal from VSCode or iterm2. More information about the download, requirements and installation is provided further down this page

Running OpenFAST – Input Files

Changes for demonstration:

Run # 1

1. ElastoDyn

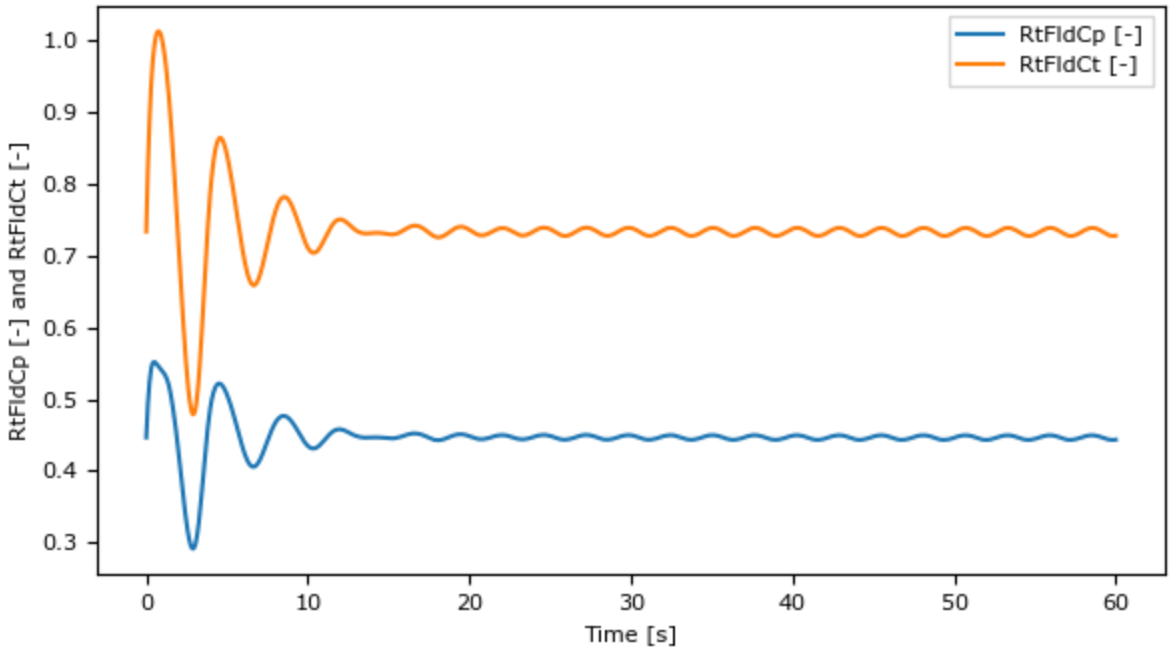
    a) Turn off all blade DOF's
    b) Turn off all tower DOF's
    c) Turn off all platform DOF's

2. Glue-code (.fst)

    a) Increase dt – 0.025 s
    b) Increase tmax – 60.0 s
    c) Set CompMooring to 0
    d) Dt_Out – 0.05 s

3. Aerodyn

    a) Add outputs: "RtFldCp" and "RtFldCt"

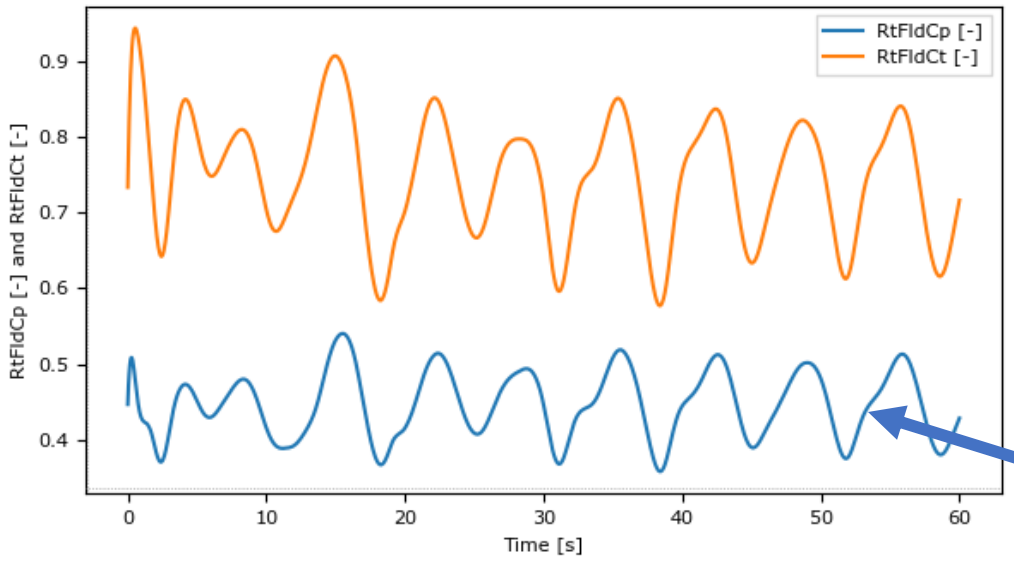


Running OpenFAST – Input Files

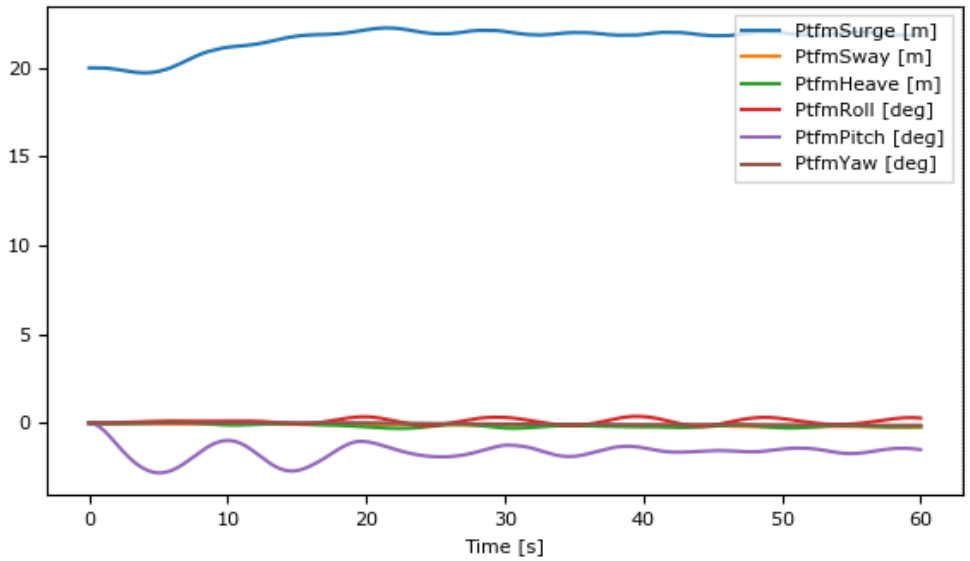
Changes for demonstration:

Run # 2

1. ElastoDyn
    a) Turn on all platform DOF's
2. Glue-code (.fst)
    a) Set CompMooring to 3



Oscillation with surge frequency



Thank You

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will.wiley@nrel.gov

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NREL
Transforming ENERGY

OpenFAST Input File Format

```
------- OpenFAST EXAMPLE INPUT FILE -------------------------------------------
Floating MHK turbine, based on the RM1 tidal current rotor
---------------------- SIMULATION CONTROL --------------------------------------
False          Echo          - Echo input data to <RootName>.ech (flag)
"FATAL"        AbortLevel    - Error level when simulation should abort (string) {"WARNING", "SEVERE", "FATAL"}
      6        TMax          - Total run time (s)
  0.003        DT            - Recommended module time step (s)
      2        InterpOrder   - Interpolation order for input/output time history (-) {1=linear, 2=quadratic}
      5        NumCrctn      - Number of correction iterations (-) {0=explicit calculation, i.e., no corrections}
  99999        DT_UJac       - Time between calls to get Jacobians (s)
1000000        UJacSclFact   - Scaling factor used in Jacobians (-)
```

- **Description**
  - Brief description, including options/units
- **Keyword**
  - Variable name/identifier
- **Value**
  - Numerical, logical, flag, or string

OpenFAST Driver Input File

```
------- OpenFAST EXAMPLE INPUT FILE -------------------------------------------
Floating MHK turbine, based on the RM1 tidal current rotor
---------------------- SIMULATION CONTROL --------------------------------------
False         Echo            - Echo input data to <RootName>.ech (flag)
"FATAL"       AbortLevel      - Error level when simulation should abort (string) {"WARNING", "SEVERE", "FATAL"}
        6     TMax            - Total run time (s)
    0.003     DT              - Recommended module time step (s)
        2     InterpOrder     - Interpolation order for input/output time history (-) {1=linear, 2=quadratic}
        5     NumCrctn        - Number of correction iterations (-) {0=explicit calculation, i.e., no corrections}
    99999     DT_UJac         - Time between calls to get Jacobians (s)
  1000000     UJacSclFact     - Scaling factor used in Jacobians (-)
---------------------- FEATURE SWITCHES AND FLAGS ------------------------------
        1     CompElast       - Compute structural dynamics (switch) {1=ElastoDyn; 2=ElastoDyn + BeamDyn for blades}
        1     CompInflow      - Compute inflow wind velocities (switch) {0=still air; 1=InflowWind; 2=external from OpenFOAM
        2     CompAero        - Compute aerodynamic loads (switch) {0=None; 1=AeroDyn v14; 2=AeroDyn v15}
        0     CompServo       - Compute control and electrical-drive dynamics (switch) {0=None; 1=ServoDyn}
        1     CompSeaSt       - Compute
        1     CompHydro       - Compute
        0     CompSub         - Compute
        3     CompMooring     - Compute
        0     CompIce         - Compute
        2     MHK             - MHK turbi                                                                    ine
---------------------- ENVIRONMENTAL CONDITIONS --------------------------------
  9.80665     Gravity         - Gravitational acceleration (m/s^2)
    1.225     AirDens         - Air density (kg/m^3)
     1025     WtrDens         - Water density (kg/m^3)
 1.06E-06     KinVisc         - Kinematic viscosity of working fluid (m^2/s)
     1500     SpdSound        - Speed of sound in working fluid (m/s)
   101325     Patm            - Atmospheric pressure (Pa) [used only for an MHK turbine cavitation check]
     2500     Pvap            - Vapour pressure of working fluid (Pa) [used only for an MHK turbine cavitation check]
       50     WtrDpth         - Water depth (m)
        0     MSL2SWL         - Offset between still-water level and mean sea level (m) [positive upward]
```

- **TMax** should allow convergence
- **DT** should resolve structural frequencies (≤ 1/10 of the highest frequency DOF)

OpenFAST Driver Input File

```
------- OpenFAST EXAMPLE INPUT FILE -------------------------------------------
Floating MHK turbine, based on the RM1 tidal current rotor
---------------------- SIMULATION CONTROL --------------------------------------
False         Echo            - Echo input data to <RootName>.ech (flag)
"FATAL"       AbortLevel      - Error level when simulation should abort (string) {"WARNING", "SEVERE", "FATAL"}
        6     TMax            - Total run time (s)
    0.003     DT              - Recommended module time step (s)
        2     InterpOrder     - Interpolation order for input/output time history (-) {1=linear, 2=quadratic}
        5     NumCrctn        - Number of correction iterations (-) {0=explicit calculation, i.e., no corrections}
    99999     DT_UJac         - Time between calls to get Jacobians (s)
  1000000     UJacSclFact     - Scaling factor used in Jacobians (-)
---------------------- FEATURE SWITCHES AND FLAGS ------------------------------
        1     CompElast       - Compu
        1     CompInflow      - Compu
        2     CompAero        - Compu
        0     CompServo       - Compu
        1     CompSeaSt       - Compu
        1     CompHydro       - Compu
        0     CompSub         - Compu
        3     CompMooring     - Compu
        0     CompIce         - Compu
        2     MHK             - MHK t
---------------------- ENVIRONMENTAL
  9.80665     Gravity         - Gravi
    1.225     AirDens         - Air density (kg/m^3)
     1025     WtrDens         - Water density (kg/m^3)
 1.06E-06     KinVisc         - Kinematic viscosity of working fluid (m^2/s)
     1500     SpdSound        - Speed of sound in working fluid (m/s)
   101325     Patm            - Atmospheric pressure (Pa) [used only for an MHK turbine cavitation check]
     2500     Pvap            - Vapour pressure of working fluid (Pa) [used only for an MHK turbine cavitation check]
       50     WtrDpth         - Water depth (m)
        0     MSL2SWL         - Offset between still-water level and mean sea level (m) [positive upward]
```

- **CompElast=1**: ElastoDyn without BeamDyn
- **CompInflow=1**: Inflow set by InflowWind
- **CompAero=2**: Aerodynamics computed by AeroDyn15
- **CompSeaSt=1**: Full grid wave field with SeaState
- **CompHydro=1**: Hydrodynamic platform forces
- **CompMooring=3**: Dynamic mooring with MoorDyn
- **MHK=2**: Floating marine turbine

OpenFAST Driver Input File

```
---------------------- FEATURE SWITCHES AND FLAGS ------------------------------
          1   CompElast       - Compute structural dynamics (switch) {1=ElastoDyn; 2=ElastoDyn + BeamDyn for blades}
          1   CompInflow      - Compute inflow wind velocities (switch) {0=still air; 1=InflowWind; 2=external from OpenFOAM
          2   CompAero        - Compute aerodynamic loads (switch) {0=None; 1=AeroDyn v14; 2=AeroDyn v15}
          0   CompServo       - Compute control and electrical-drive dynamics (switch) {0=None; 1=ServoDyn}
          1   CompSeaSt       - Compute sea state information (switch) {0=None; 1=SeaState}
          1   CompHydro       - Compute hydrodynamic loads (switch) {0=None; 1=HydroDyn}
          0   CompSub         - Compute sub-structural dynamics (switch) {0=None; 1=SubDyn; 2=External Platform MCKF}
          3   CompMooring     - Compute mooring system (switch) {0=None; 1=MAP++; 2=FEAMooring; 3=MoorDyn; 4=OrcaFlex}
          0   CompIce         - Compute ice loads (switch) {0=None; 1=IceFloe; 2=IceDyn}
          2   MHK             - MHK turbine type (switch) {0=Not an MHK turbine; 1=Fixed MHK turbine; 2=Floating MHK turbine
---------------------- ENVIRONMENTAL CONDITIONS --------------------------------
    9.80665   Gravity         - Gravitational acceleration (m/s^2)
      1.225   AirDens         - Air density (kg/m^3)
       1025   WtrDens         - Water density (kg/m^3)
   1.06E-06   KinVisc         - Kinematic viscosity of working fluid (m^2/s)
       1500   SpdSound        - Speed of
     101325   Patm            - Atmosphe
       2500   Pvap            - Vapour p
         50   WtrDpth         - Water de
          0   MSL2SWL         - Offset b
---------------------- INPUT FILES ---------
"MHK_RM1_Floating_ElastoDyn.dat"    EDFile          - Name of file containing ElastoDyn input parameters (quoted string)
"unused"      BDBldFile(1)    - Name of file containing BeamDyn input parameters for blade 1 (quoted string)
"unused"      BDBldFile(2)    - Name of file containing BeamDyn input parameters for blade 2 (quoted string)
"unused"      BDBldFile(3)    - Name of file containing BeamDyn input parameters for blade 3 (quoted string)
"MHK_RM1_Floating_InflowWind.dat"    InflowFile      - Name of file containing inflow wind input parameters (quoted string)
"MHK_RM1_Floating_AeroDyn15.dat"    AeroFile        - Name of file containing aerodynamic input parameters (quoted string)
"unused"      ServoFile       - Name of file containing control and electrical-drive input parameters (quoted string)
"SeaState.dat"    SeaStFile       - Name of file containing sea state input parameters (quoted string)
"MHK_RM1_Floating_HydroDyn.dat"    HydroFile       - Name of file containing hydrodynamic input parameters (quoted string)
"unused"      SubFile         - Name of file containing sub-structural input parameters (quoted string)
"MHK_RM1_Floating_MoorDyn.dat"    MooringFile     - Name of file containing mooring system input parameters (quoted string)
"unused"      IceFile         - Name of file containing ice input parameters (quoted string)
```

- Specify module primary input files
  - Path relative to folder containing .fst file
- Unused modules not specified

OpenFAST Driver Input File

```
---------------------- OUTPUT --------------------------------------------------
True          SumPrint        - Print summary data to "<RootName>.sum" (flag)
           5  SttsTime        - Amount of time between screen status messages (s)
       99999  ChkptTime       - Amount of time between creating checkpoint files for potential restart (s)
        0.03  DT_Out          - Time step for tabular output (s) (or "default")
           0  TStart          - Time to begin tabular output (s)
           3  OutFileFmt      - Format for tabular (time-marching) output file (switch) {1: text file [<RootName>.out], 2: binary file
True          TabDelim        - Use tab delimiters in text tabular output file? (flag) {uses spaces if false}
"ES10.3E2"    OutFmt          - Format used for text tabular output, excluding the time channel.  Resulting field should be 10 charact
---------------------- LINEARIZATION -------------------------------------------
False         Linearize       - Linear
False         CalcSteady      - Calcu                                                    inearize=False] (f
           1  TrimCase        - Contro                                                   dy=True] (-)
        0.01  TrimTol         - Tolera
        0.01  TrimGain        - Propor                                                   (rad/(rad/s) for
           0  Twr_Kdmp        - Dampi
           0  Bld_Kdmp        - Dampi
           0  NLinTimes       - Numbe
           0  LinTimes        - List                                                     ue and CalcSteady
           0  LinInputs       - Input                                                    debug)} [unused if
           0  LinOutputs      - Output                                                   utputs (debug)} [
False         LinOutJac       - Includ                                                   e=False; used onl
False         LinOutMod       - Write module-level linearization output files in addition to output for full system? (flag) [unused if
---------------------- VISUALIZATION -------------------------------------------
           0  WrVTK           - VTK visualization data output: (switch) {0=none; 1=initialization data only; 2=animation; 3=mode shape
           1  VTK_type        - Type of VTK visualization data: (switch) {1=surfaces; 2=basic meshes (lines/points); 3=all meshes (deb
False         VTK_fields      - Write mesh fields to VTK data files? (flag) {true/false} [unused if WrVTK=0]
           0  VTK_fps         - Frame rate for VTK output (frames per second){will use closest integer multiple of DT} [used only if W
```

- Summary file prints inputs as read by the code
  - Useful for debugging inputs
- **SttsTime** should balance screen updates with time required to write to screen
- **DT_Out** can downsample calculated values when writing to file

OpenFAST Driver Input File

```
---------------------- OUTPUT --------------------------------------------------
True          SumPrint        - Print summary data to "<RootName>.sum" (flag)
           5  SttsTime        - Amount of time between screen status messages (s)
       99999  ChkptTime       - Amount of time between creating checkpoint files for potential restart (s)
        0.03  DT_Out          - Time step for tabular output (s) (or "default")
           0  TStart          - Time to begin tabular output (s)
           3  OutFileFmt      - Format for tabular (time-marching) output file (switch) {1: text file [<RootName>.out], 2: binary file
True          TabDelim        - Use tab delimiters in text tabular output file? (flag) {uses spaces if false}
"ES10.3E2"    OutFmt          - Format used for text tabular output, excluding the time channel.  Resulting field should be 10 charact
---------------------- LINEARIZATION -----------------------------------------
False         Linearize       - Linearization analysis (flag)
False         CalcSteady      - Calculate a steady-state periodic operating point before linearization? [unused if Linearize=False] (f
           1  TrimCase        - Controller parameter to be trimmed {1:yaw; 2:torque; 3:pitch} [used only if CalcSteady=True] (-)
        0.01  TrimTol         - Tolerance for the rotational speed convergence [used only if CalcSteady=True] (-)
        0.01  TrimGain        - Proporti                                                                    rad/(rad/s) for
           0  Twr_Kdmp        - Damping
           0  Bld_Kdmp        - Damping
           0  NLinTimes       - Number
           0  LinTimes        - List of                                                                     e and CalcSteady
           0  LinInputs       - Inputs i                                                                    bug)} [unused if
           0  LinOutputs      - Outputs                                                                     tputs (debug)} [
False         LinOutJac       - Include                                                                     =False; used onl
False         LinOutMod       - Write module-level linearization output files in addition to output for full system? (flag) [unused if
---------------------- VISUALIZATION -----------------------------------------
           0  WrVTK           - VTK visualization data output: (switch) {0=none; 1=initialization data only; 2=animation; 3=mode shape
           1  VTK_type        - Type of VTK visualization data: (switch) {1=surfaces; 2=basic meshes (lines/points); 3=all meshes (deb
False         VTK_fields      - Write mesh fields to VTK data files? (flag) {true/false} [unused if WrVTK=0]
           0  VTK_fps         - Frame rate for VTK output (frames per second){will use closest integer multiple of DT} [used only if W
```

- **Linearization=True** enables linearization of the full coupled solution
  - Linearized equations can be output for use in other models

OpenFAST Driver Input File

```
---------------------- OUTPUT --------------------------------------------------
True          SumPrint        - Print summary data to "<RootName>.sum" (flag)
           5  SttsTime        - Amount of time between screen status messages (s)
       99999  ChkptTime       - Amount of time between creating checkpoint files for potential restart (s)
        0.03  DT_Out          - Time step for tabular output (s) (or "default")
           0  TStart          - Time to begin tabular output (s)
           3  OutFileFmt      - Format for tabular (time-marching) output file (switch) {1: text file [<RootName>.out], 2: binary file
True          TabDelim        - Use tab delimiters in text tabular output file? (flag) {uses spaces if false}
"ES10.3E2"    OutFmt          - Format used for text tabular output, excluding the time channel.  Resulting field should be 10 charact
---------------------- LINEARIZATION -----------------------------------------
False         Linearize       - Linearization analysis (flag)
False         CalcSteady      - Calculate a steady-state periodic operating point before linearization? [unused if Linearize=False] (f
           1  TrimCase        - Controller parameter to be trimmed {1:yaw; 2:torque; 3:pitch} [used only if CalcSteady=True] (-)
        0.01  TrimTol         - Tolerance for the rotational speed convergence [used only if CalcSteady=True] (-)
        0.01  TrimGain        - Proportional gain for the rotational speed error (>0) [used only if CalcSteady=True] (rad/(rad/s) for
           0  Twr_Kdmp        - Damping factor for the tower [used only if CalcSteady=True] (N/(m/s))
           0  Bld_Kdmp        - Damping factor for the blades [used only if CalcSteady=True] (N/(m/s))
           0  NLinTimes       - Number of times to linearize (-) [>=1] [unused if Linearize=False]
           0  LinTimes        - List of times at which to linearize (s) [1 to NLinTimes] [used only when Linearize=True and CalcSteady
           0  LinInputs       - Inputs included in linearization (switch) {0=none; 1=standard; 2=all module inputs (debug)} [unused if
           0  LinOutputs      - Outputs                                                                    puts (debug)} [
False         LinOutJac       - Include                                                                   False; used onl
False         LinOutMod       - Write module-level linearization output files in addition to output for full system? (flag) [unused if
---------------------- VISUALIZATION -----------------------------------------
           0  WrVTK           - VTK visualization data output: (switch) {0=none; 1=initialization data only; 2=animation; 3=mode shape
           1  VTK_type        - Type of VTK visualization data: (switch) {1=surfaces; 2=basic meshes (lines/points); 3=all meshes (deb
False         VTK_fields      - Write mesh fields to VTK data files? (flag) {true/false} [unused if WrVTK=0]
           0  VTK_fps         - Frame rate for VTK output (frames per second){will use closest integer multiple of DT} [used only if W
```

- Visualization using VTK (Visualization ToolKit)

ElastoDyn Primary Input File

- Blade and tower bending DOFs enabled
- Platform 6 DOFs enabled
- Generator and yaw DOFs disabled
  - Fixed RPM specified
- Teeter and platform DOFs not applicable

```
------- ELASTODYN for OpenFAST I
Floating MHK turbine structural
---------------------- SIMULATIO
False          Echo        - Echo
|||||  3       Method      - Inte
"default"      DT          - Inte
---------------------- DEGREES OF FREEDOM --------------------------------------
True           FlapDOF1    - First flapwise blade mode DOF (flag)
True           FlapDOF2    - Second flapwise blade mode DOF (flag)
True           EdgeDOF     - First edgewise blade mode DOF (flag)
False          TeetDOF     - Rotor-teeter DOF (flag) [unused for 3 blades]
True           DrTrDOF     - Drivetrain rotational-flexibility DOF (flag)
False          GenDOF      - Generator DOF (flag)
False          YawDOF      - Yaw DOF (flag)
True           TwFADOF1    - First fore-aft tower bending-mode DOF (flag)
True           TwFADOF2    - Second fore-aft tower bending-mode DOF (flag)
True           TwSSDOF1    - First side-to-side tower bending-mode DOF (flag)
True           TwSSDOF2    - Second side-to-side tower bending-mode DOF (flag)
True           PtfmSgDOF   - Platform horizontal surge translation DOF (flag)
True           PtfmSwDOF   - Platform horizontal sway translation DOF (flag)
True           PtfmHvDOF   - Platform vertical heave translation DOF (flag)
True           PtfmRDOF    - Platform roll tilt rotation DOF (flag)
True           PtfmPDOF    - Platform pitch tilt rotation DOF (flag)
True           PtfmYDOF    - Platform yaw rotation DOF (flag)
```

ElastoDyn Primary Input File

```
---------------------- INITIAL CONDITIONS -------------------------------------
      0   OoPDefl     - Initial out-of-plane blade-tip displacement (meters)
      0   IPDefl      - Initial in-plane blade-tip deflection (meters)
      0   BlPitch(1)  - Blade 1 initial pitch (degrees)
      0   BlPitch(2)  - Blade 2 initial pitch (degrees)
      0   BlPitch(3)  - Blade 3 initial pitch (degrees) [unused for 2 blades]
      0   TeetDefl    - Initial or fixed teeter angle (degrees) [unused for 3 blades]
      0   Azimuth     - Initial azimuth angle for blade 1 (degrees)
   11.5   RotSpeed    - Initial or fixed rotor speed (rpm)
      0   NacYaw      - Initial or fixed nacelle-yaw angle (degrees)
      0   TTDspFA     - Initial fore-aft tower-top displacement (meters)
      0   TTDspSS     - Initial side-to-side tower-top displacement (meters)
     20   PtfmSurge   - Initial or fixed horizontal surge translational displacement of platform (meters)
      0   PtfmSway    - Initial or fixed horizontal sway translational displacement of platform (meters)
      0   PtfmHeave   - Initial or fixed vertical heave translational displacement of platform (meters)
      0   PtfmRoll    - Initial or fixed roll tilt rotational displacement of platform (degrees)
      0   PtfmPitch   - Initial or fixed pitch tilt rotational displacement of platform (degrees)
      0   PtfmYaw     - Initial or fixed yaw rotational displacement of platform (degrees)
```

- Specify initial angles, displacements, and motions
- Fixed rotor speed of rated 11.5 rpm
- Initial surge based on rated thrust

ElastoDyn Primary Input File

```
---------------------- TURBINE CONFIGURATION -------------------------------------
         2   NumBl        - Number of blades (-)
        10   TipRad       - The distance from the rotor apex to the blade tip (meters)
         1   HubRad       - The distance from the rotor apex to the blade root (meters)
         0   PreCone(1)   - Blade 1 cone angle (degrees)
         0   PreCone(2)   - Blade 2 cone angle (degrees)
         0   PreCone(3)   - Blade 3 cone angle (degrees) [unused for 2 blades]
    0.2222   HubCM        - Distance from rotor apex to hub mass [positive downwind] (meters)
         0   UndSling     - Undersling length [distance from teeter pin to the rotor apex] (meters) [unused for 3 blades]
         0   Delta3       - Delta-3 angle for teetering rotors (degrees) [unused for 3 blades]
         0   AzimB1Up     - Azimuth value to use for I/O when blade 1 points up (degrees)
     -4.91   OverHang     - Distance from yaw axis to rotor apex [3 blades] or teeter pin [2 blades] (meters)
         0   ShftGagL     - Distance from rotor apex [3 blades] or teeter pin [2 blades] to shaft strain gages [positive for upwin
         0   ShftTilt     - Rotor shaft tilt angle (degrees)
      0.43   NacCMxn       - Downwind distance from the tower-top to the nacelle CM (meters)
         0   NacCMyn       - Lateral  distance from the tower-top to the nacelle CM (meters)
      -1.2   NacCMzn       - Vertical distance from the tower-top to the nacelle CM (meters)
         0   NcIMUxn       - Downwind distance from the tower-top to the nacelle IMU (meters)
         0   NcIMUyn       - Lateral  distance from the tower-top to the nacelle IMU (meters)
      -1.2   NcIMUzn       - Vertical distance from the tower-top to the nacelle IMU (meters)
      -1.2   Twr2Shft      - Vertical distance from the tower-top to the rotor shaft (meters)
       -24   TowerHt       - Height of tower relative to ground level [onshore], MSL [offshore wind or floating MHK], or seabed [fi
        -9   TowerBsHt     - Height of tower base relative to ground level [onshore], MSL [offshore wind or floating MHK], or seabe
         0   PtfmCMxt      - Downwind distance from the ground level [onshore], MSL [offshore wind or floating MHK], or seabed [fix
         0   PtfmCMyt      - Lateral distance from the ground level [onshore], MSL [offshore wind or floating MHK], or seabed [fixe
     -6.09   PtfmCMzt      - Vertical distance from the ground level [onshore], MSL [offshore wind or floating MHK], or seabed [fix
         0   PtfmRefzt     - Vertical distance from the ground level [onshore], MSL [offshore wind or floating MHK], or seabed [fix
```

- Specify turbine geometry
- Platform COG

ElastoDyn Primary Input File

```
---------------------- MASS AND INERTIA ---------------------------------------
          0   TipMass(1)  - Tip-brake mass, blade 1 (kg)
          0   TipMass(2)  - Tip-brake mass, blade 2 (kg)
          0   TipMass(3)  - Tip-brake mass, blade 3 (kg) [unused for 2 blades]
        140   HubMass     - Hub mass (kg)
       79.6   HubIner     - Hub inertia about rotor axis [3 blades] or teeter axis [2 blades] (kg m^2)
      139.5   GenIner     - Generator inertia about HSS (kg m^2)
      40100   NacMass     - Nacelle mass (kg)
     244643   NacYIner    - Nacelle inertia about yaw axis (kg m^2)
          0   YawBrMass   - Yaw bearing mass (kg)
    2525214   PtfmMass    - Platform mass (kg)
  195242474   PtfmRIner   - Platform inertia for roll tilt rotation about the platform CM (kg m^2)
  919435755   PtfmPIner   - Platform inertia for pitch tilt rotation about the platform CM (kg m^2)
 1053535885   PtfmYIner   - Platform inertia for yaw rotation about the platform CM (kg m^2)
```

- Specify turbine mass and inertia
- Specify platform mass and inertia

ElastoDyn Primary Input File

- Specify blade structural input files
- **BldFile(3)** ignored for 2-bladed rotor

```
---------------------- BLADE -----------------------------------------------
        8   BldNodes    - Number of blade nodes (per blade) used for analysis (-)
"MHK_RM1_ElastoDyn_Blade.dat"    BldFile(1)   - Name of file containing properties for blade 1 (quoted string)
"MHK_RM1_ElastoDyn_Blade.dat"    BldFile(2)   - Name of file containing properties for blade 2 (quoted string)
"unused"         BldFile(3)   - Name of file containing properties for blade 3 (quoted string) [unused for 2 blades]
```

ElastoDyn Primary Input File

```
---------------------- BLADE -------------------------------------------------
         8   BldNodes    - Number of blade nodes (per blade) used for analysis (-)
"MHK_RM1_ElastoDyn_Blade.dat"    BldFile(1)  - Name of file containing properties for blade 1 (quoted string)
"MHK_RM1_ElastoDyn_Blade.dat"    BldFile(2)  - Name of file containing properties for blade 2 (quoted string)
"unused"         BldFile(3)  - Name of file containing properties for blade 3 (quoted string) [unused for 2 blades]
---------------------- ROTOR-TEETER ------------------------------------------
         0   TeetMod     - Rotor-teeter spring/damper model {0: none, 1: standard, 2: user-defined from routine UserTeet} (switch) [u
         0   TeetDmpP    - Rotor-teeter damper position (degrees) [used only for 2 blades and when TeetMod=1]
         0   TeetDmp     - Rotor-teeter damping constant (N-m/(rad/s)) [used only for 2 blades and when TeetMod=1]
         0   TeetCDmp    - Rotor-teeter rate-independent Coulomb-damping moment (N-m) [used only for 2 blades and when TeetMod=1]
         0   TeetSStP    - Rotor-teeter soft-stop position (degrees) [used only for 2 blades and when TeetMod=1]
         0   TeetHStP    - Rotor-teeter hard-stop position (degrees) [used only for 2 blades and when TeetMod=1]
         0   TeetSSSp    - Rotor-teeter soft-stop linear-spring constant (N-m/rad) [used only for 2 blades and when TeetMod=1]
         0   TeetHSSp    - Rotor-teeter hard-stop linear-spring constant (N-m/rad) [used only for 2 blades and when TeetMod=1]
---------------------- DRIVETRAIN --------------------------------------------
        92   GBoxEff     - Gearbox efficiency (%)
        53   GBRatio     - Gearbox ratio (-)
    600000   DTTorSpr    - Drivetrain torsional spring (N-m/rad)
    100000   DTTorDmp    - Drivetrain torsional damper (N-m/(rad/s))
```

- Specifications for teetering rotors

ElastoDyn Primary Input File

```
---------------------- BLADE -----------------------------------------------
         8   BldNodes     - Number of blade nodes (per blade) used for analysis (-)
"MHK_RM1_ElastoDyn_Blade.dat"    BldFile(1)   - Name of file containing properties for blade 1 (quoted string)
"MHK_RM1_ElastoDyn_Blade.dat"    BldFile(2)   - Name of file containing properties for blade 2 (quoted string)
"unused"         BldFile(3)   - Name of file containing properties for blade 3 (quoted string) [unused for 2 blades]
---------------------- ROTOR-TEETER ----------------------------------------
         0   TeetMod      - Rotor-teeter spring/damper model {0: none, 1: standard, 2: user-defined from routine UserTeet} (switch) [u
         0   TeetDmpP     - Rotor-teeter damper position (degrees) [used only for 2 blades and when TeetMod=1]
         0   TeetDmp      - Rotor-teeter damping constant (N-m/(rad/s)) [used only for 2 blades and when TeetMod=1]
         0   TeetCDmp     - Rotor-teeter rate-independent Coulomb-damping moment (N-m) [used only for 2 blades and when TeetMod=1]
         0   TeetSStP     - Rotor-teeter soft-stop position (degrees) [used only for 2 blades and when TeetMod=1]
         0   TeetHStP     - Rotor-teeter hard-stop position (degrees) [used only for 2 blades and when TeetMod=1]
         0   TeetSSSp     - Rotor-teeter soft-stop linear-spring constant (N-m/rad) [used only for 2 blades and when TeetMod=1]
         0   TeetHSSp     - Rotor-teeter hard-stop linear-spring constant (N-m/rad) [used only for 2 blades and when TeetMod=1]
---------------------- DRIVETRAIN ------------------------------------------
        92   GBoxEff      - Gearbox efficiency (%)
        53   GBRatio      - Gearbox ratio (-)
    600000   DTTorSpr     - Drivetrain torsional spring (N-m/rad)
    100000   DTTorDmp     - Drivetrain torsional damper (N-m/(rad/s))
```

- Gearbox and drivetrain specifications, including drivetrain rotational flexibility

ElastoDyn Primary Input File

```
---------- FURLING ---------------------------------------------------
False          Furling     - Read in additional model properties for furling turbine (flag) [must currently be FALSE)
"unused"       FurlFile    - Name of file containing furling properties (quoted string) [unused when Furling=False]
---------- TOWER -----------------------------------------------------
          2    TwrNodes    - Number of tower nodes used for analysis (-)
"MHK_RM1_Floating_ElastoDyn_Tower.dat"    TwrFile     - Name of file containing tower properties (quoted string)
---------- OUTPUT ----------------------------------------------------
True           SumPrint    - Print summary data to "<RootName>.sum" (flag)
          1    OutFile     - Switch to determine where output will be placed: {1: in module output file only; 2: in glue code
True           TabDelim    - Use tab delimiters in text tabular output file? (flag) (currently unused)
"ES10.3E2"     OutFmt      - Format used f                                                              10 characters. (qu
          0    TStart      - Time to begin
          1    DecFact     - Decimation factor for tabular output {1: output every time step} (-) (currently unused)
          0    NTwGages    - Number of tower nodes that have strain gages for output [0 to 9] (-)
          0    TwrGagNd    - List of tower nodes that have strain gages [1 to TwrNodes] (-) [unused if NTwGages=0]
          0    NBlGages    - Number of blade nodes that have strain gages for output [0 to 9] (-)
          0    BldGagNd    - List of blade nodes that have strain gages [1 to BldNodes] (-) [unused if NBlGages=0]
               OutList     - The next line(s) contains a list of output parameters.  See OutListParameters.xlsx for a listing
"PtfmSurge"
"PtfmSway"
"PtfmHeave"
"PtfmRoll"
"PtfmPitch"
"PtfmYaw"
"TwrTpTDxi"
"TwrTpTDyi"
"TwrTpTDzi"
"OoPDefl1"
END of OutList section (the word "END" must appear in the first 3 columns of the last OutList line)
```

- Furling properties (currently unused)

ElastoDyn Primary Input File

```
---------------------- FURLING ---------------------------------------------------
False          Furling     - Read in additional model properties for furling turbine (flag) [must currently be FALSE)
"unused"       FurlFile    - Name of file containing furling properties (quoted string) [unused when Furling=False]
---------------------- TOWER -----------------------------------------------------
           2   TwrNodes    - Number of tower nodes used for analysis (-)
"MHK_RM1_Floating_ElastoDyn_Tower.dat"    TwrFile     - Name of file containing tower properties (quoted string)
---------------------- OUTPUT ----------------------------------------------------
True           SumPrint    - Print summary data to "<RootName>.sum" (flag)
           1   OutFile     - Switch to determine where output will be placed: {1: in module output file only; 2: in glue code
True           TabDelim    - Use tab delimiters in text tabular output file? (flag) (currently unused)
"ES10.3E2"     OutFmt      - Format used for text tabular output (except time).  Resulting field should be 10 characters. (qu
           0   TStart      - Time to begin tabular output (s) (currently unused)
           1   DecFact     - Decimation facto                                    rrently unused)
           0   NTwGages    - Number of tower
           0   TwrGagNd    - List of tower nodes that have strain gages [1 to TwrNodes] (-) [unused if NTwGages=0]
           0   NBlGages    - Number of blade nodes that have strain gages for output [0 to 9] (-)
           0   BldGagNd    - List of blade nodes that have strain gages [1 to BldNodes] (-) [unused if NBlGages=0]
               OutList     - The next line(s) contains a list of output parameters.  See OutListParameters.xlsx for a listing
"PtfmSurge"
"PtfmSway"
"PtfmHeave"
"PtfmRoll"
"PtfmPitch"
"PtfmYaw"
"TwrTpTDxi"
"TwrTpTDyi"
"TwrTpTDzi"
"OoPDefl1"
END of OutList section (the word "END" must appear in the first 3 columns of the last OutList line)
```

- Specify tower structural input file

ElastoDyn Primary Input File

```
---------------------- FURLING -----------------------------------------------
False          Furling     - Read in additional model properties for furling turbine (flag) [must currently be FALSE)
"unused"       FurlFile    - Name of file containing furling properties (quoted string) [unused when Furling=False]
---------------------- TOWER -------------------------------------------------
           2   TwrNodes    - Number of tower nodes used for analysis (-)
"MHK_RM1_Floating_ElastoDyn_Tower.dat"    TwrFile     - Name of file containing tower properties (quoted string)
---------------------- OUTPUT ------------------------------------------------
True           SumPrint    - Print summary data to "<RootName>.sum" (flag)
           1   OutFile     - Switch t                                utput file only; 2: in glue code
True           TabDelim    - Use tab                                 y unused)
"ES10.3E2"     OutFmt      - Format u                                eld should be 10 characters. (qu
           0   TStart      - Time to
           1   DecFact     - Decimation factor for tabular output {1: output every time step} (-) (currently unused)
           0   NTwGages    - Number of tower nodes that have strain gages for output [0 to 9] (-)
           0   TwrGagNd    - List of tower nodes that have strain gages [1 to TwrNodes] (-) [unused if NTwGages=0]
           0   NBlGages    - Number of blade nodes that have strain gages for output [0 to 9] (-)
           0   BldGagNd    - List of blade nodes that have strain gages [1 to BldNodes] (-) [unused if NBlGages=0]
               OutList     - The next line(s) contains a list of output parameters.  See OutListParameters.xlsx for a listing
"PtfmSurge"
"PtfmSway"
"PtfmHeave"
"PtfmRoll"
"PtfmPitch"
"PtfmYaw"
"TwrTpTDxi"
"TwrTpTDyi"
"TwrTpTDzi"
"OoPDefl1"
END of OutList section (the word "END" must appear in the first 3 columns of the last OutList line)
```

- Specify formatting of outputs written to file

ElastoDyn Primary Input File

```
---------------------- FURLING -----------------------------------------------
False          Furling     - Read in additional model properties for furling turbine (flag) [must currently be FALSE)
"unused"       FurlFile    - Name of file containing furling properties (quoted string) [unused when Furling=False]
---------------------- TOWER -------------------------------------------------
           2   TwrNodes    - Number of tower nodes used for analysis (-)
"MHK_RM1_Floating_ElastoDyn_Tower.dat"    TwrFile     - Name of file containing tower properties (quoted string)
---------------------- OUTPUT ------------------------------------------------
True           SumPrint    - Print summary data to "<RootName>.sum" (flag)
           1   OutFile     - Switch to determine where output will be placed: {1: in module output file only; 2: in glue code
True           TabDelim    - Use tab delimiters in text tabular output file? (flag) (currently unused)
"ES10.3E2"     OutFmt      - Format used for text tabular output (except time).  Resulting field should be 10 characters. (qu
           0   TStart      - Time to begin tabular output (s) (currently unused)
           1   DecFact     - Decimation factor for tabular output {1: output every time step} (-) (currently unused)
           0   NTwGages    - Number of tower nodes that have strain gages for output [0 to 9] (-)
           0   TwrGagNd    - List of tower nodes that have strain gages [1 to TwrNodes] (-) [unused if NTwGages=0]
           0   NBlGages    - Number of blade nodes that have strain gages for output [0 to 9] (-)
           0   BldGagNd    - List of blade nodes that have strain gages [1 to BldNodes] (-) [unused if NBlGages=0]
               OutList     - The next line(s) contains a list of output parameters.  See OutListParameters.xlsx for a listing
"PtfmSurge"
"PtfmSway"
"PtfmHeave"
"PtfmRoll"
"PtfmPitch"
"PtfmYaw"
"TwrTpTDxi"
"TwrTpTDyi"
"TwrTpTDzi"
"OoPDefl1"
END of OutList section (the word "END" must appear in the first 3 columns of the last OutList line)
```

- List of user-selectable outputs (not comprehensive)

AeroDyn Primary Input File

```
------- AERODYN v15 for OpenFAST INPUT FILE ------------------------------------------------
Floating MHK turbine hydrodynamic input properties, based on the RM1 tidal current rotor
======  General Options  ============================================================================
False         Echo                - Echo the input to "<rootname>.AD.ech"?  (flag)
"default"     DTAero              - Time interval for aerodynamic calculations {or "default"} (s)
          2   WakeMod             - Type of wake/induction model (switch) {0=none, 1=BEMT, 2=DBEMT, 3=OLAF} [WakeMod cannot be 2 or
          1   AFAeroMod           - Type of blade airfoil aerodynamics model (switch) {1=steady model, 2=Beddoes-Leishman unsteady m
          1   TwrPotent           -                                                                                  1=baseli
          0   TwrShadow           -                                                                                  =Powles m
True          TwrAero             -
False         FrozenWake          -                                                                                  arizing]
True          CavitCheck          -
True          Buoyancy            -
False         CompAA              -
"unused"      AA_InputFile        -
======  Environmental Conditions  ===================================================================
"default"     AirDens             - Air density (kg/m^3)
"default"     KinVisc             - Kinematic viscosity of working fluid (m^2/s)
"default"     SpdSound            - Speed of sound in working fluid (m/s)
"default"     Patm                - Atmospheric pressure (Pa) [used only when CavitCheck=True]
"default"     Pvap                - Vapour pressure of working fluid (Pa) [used only when CavitCheck=True]
======  Blade-Element/Momentum Theory Options  ========================================== [unused when WakeMod=0 or 3]
          2   SkewMod             - Type of skewed-wake correction model (switch) {1=uncoupled, 2=Pitt/Peters, 3=coupled} [unused wh
"default"     SkewModFactor       - Constant used in Pitt/Peters skewed wake model {or "default" is 15/32*pi} (-) [used only when Sk
True          TipLoss             - Use the Prandtl tip-loss model? (flag) [unused when WakeMod=0 or 3]
True          HubLoss             - Use the Prandtl hub-loss model? (flag) [unused when WakeMod=0 or 3]
True          TanInd              - Include tangential induction in BEMT calculations? (flag) [unused when WakeMod=0 or 3]
True          AIDrag              - Include the drag term in the axial-induction calculation? (flag) [unused when WakeMod=0 or 3]
True          TIDrag              - Include the drag term in the tangential-induction calculation? (flag) [unused when WakeMod=0,3 c
"default"     IndToler            - Convergence tolerance for BEMT nonlinear solve residual equation {or "default"} (-) [unused when
       1000   MaxIter             - Maximum number of iteration steps (-) [unused when WakeMod=0]
```

- **WakeMod** options include steady and dynamic BEM and OLAF (vortex model)
- **AFAeroMod** options include steady and unsteady aerodynamics models

AeroDyn Primary Input File

```
------- AERODYN v15 for OpenFAST INPUT FILE ----------------------------------------------
Floating MHK turbine hydrodynamic input properties, based on the RM1 tidal current rotor
======  General Options  ============================================================================
False         Echo                - Echo the input to "<rootname>.AD.ech"?  (flag)
"default"     DTAero              - Time interval for aerodynamic calculations {or "default"} (s)
          2   WakeMod             - Type of wake/induction model (switch) {0=none, 1=BEMT, 2=DBEMT, 3=OLAF} [WakeMod cannot be 2 or
          1   AFAeroMod           - Type of blade airfoil aerodynamics model (switch) {1=steady model, 2=Beddoes-Leishman unsteady m
          1   TwrPotent           - Type tower influence on wind based on potential flow around the tower (switch) {0=none, 1=baseli
          0   TwrShadow           - Calculate tower influence on wind based on downstream tower shadow? (switch) {0=none, 1=Powles m
True          TwrAero             - Calculate tower aerodynamic loads? (flag)
False         FrozenWake          - Ass                                                    n linearizing]
True          CavitCheck          - Per
True          Buoyancy            - Include buoyancy effects? (flag)
False         CompAA              - Flag to compute AeroAcoustics calculation [used only when WakeMod = 1 or 2]
"unused"      AA_InputFile        - AeroAcoustics input file [used only when CompAA=true]
======  Environmental Conditions  ===================================================================
"default"     AirDens             - Air density (kg/m^3)
"default"     KinVisc             - Kinematic viscosity of working fluid (m^2/s)
"default"     SpdSound            - Speed of sound in working fluid (m/s)
"default"     Patm                - Atmospheric pressure (Pa) [used only when CavitCheck=True]
"default"     Pvap                - Vapour pressure of working fluid (Pa) [used only when CavitCheck=True]
======  Blade-Element/Momentum Theory Options  ================================================== [unused when WakeMod=0 or 3]
          2   SkewMod             - Type of skewed-wake correction model (switch) {1=uncoupled, 2=Pitt/Peters, 3=coupled} [unused wh
"default"     SkewModFactor       - Constant used in Pitt/Peters skewed wake model {or "default" is 15/32*pi} (-) [used only when Sk
True          TipLoss             - Use the Prandtl tip-loss model? (flag) [unused when WakeMod=0 or 3]
True          HubLoss             - Use the Prandtl hub-loss model? (flag) [unused when WakeMod=0 or 3]
True          TanInd              - Include tangential induction in BEMT calculations? (flag) [unused when WakeMod=0 or 3]
True          AIDrag              - Include the drag term in the axial-induction calculation? (flag) [unused when WakeMod=0 or 3]
True          TIDrag              - Include the drag term in the tangential-induction calculation? (flag) [unused when WakeMod=0,3 c
"default"     IndToler            - Convergence tolerance for BEMT nonlinear solve residual equation {or "default"} (-) [unused when
       1000   MaxIter             - Maximum number of iteration steps (-) [unused when WakeMod=0]
```

- Options to calculate tower influence and loads

AeroDyn Primary Input File

```
------- AERODYN v15 for OpenFAST INPUT FILE ------------------------------------------------
Floating MHK turbine hydrodynamic input properties, based on the RM1 tidal current rotor
======  General Options  ============================================================================
False         Echo               - Echo the input to "<rootname>.AD.ech"?  (flag)
"default"     DTAero             - Time interval for aerodynamic calculations {or "default"} (s)
          2   WakeMod            - Type of wake/induction model (switch) {0=none, 1=BEMT, 2=DBEMT, 3=OLAF} [WakeMod cannot be 2 or
          1   AFAeroMod          - Type of blade airfoil aerodynamics model (switch) {1=steady model, 2=Beddoes-Leishman unsteady m
          1   TwrPotent          - Type tower influence on wind based on potential flow around the tower (switch) {0=none, 1=baseli
          0   TwrShadow          - Calculate tower influence on wind based on downstream tower shadow? (switch) {0=none, 1=Powles m
True          TwrAero            - Calculate tower aerodynamic loads? (flag)
False         FrozenWake         - Assume frozen wake during linearization? (flag) [used only when WakeMod=1 and when linearizing]
True          CavitCheck         - Perform cavitation check? (flag) [AFAeroMod must be 1 when CavitCheck=true]
True          Buoyancy           - Include buoyancy effects? (flag)
False         CompAA             - Flag to compute AeroAcoustics calculation [used only when WakeMod = 1 or 2]
"unused"      AA_InputFile       - AeroA
======  Environmental Conditions  ======
"default"     AirDens            - Air
"default"     KinVisc            - Kine
"default"     SpdSound           - Speed
"default"     Patm               - Atmos
"default"     Pvap               - Vapou
======  Blade-Element/Momentum Theory Op                                                  =0 or 3]
          2   SkewMod            - Type of skewed-wake correction model (switch) {1=uncoupled, 2=Pitt/Peters, 3=coupled} [unused wh
"default"     SkewModFactor      - Constant used in Pitt/Peters skewed wake model {or "default" is 15/32*pi} (-) [used only when Sk
True          TipLoss            - Use the Prandtl tip-loss model? (flag) [unused when WakeMod=0 or 3]
True          HubLoss            - Use the Prandtl hub-loss model? (flag) [unused when WakeMod=0 or 3]
True          TanInd             - Include tangential induction in BEMT calculations? (flag) [unused when WakeMod=0 or 3]
True          AIDrag             - Include the drag term in the axial-induction calculation? (flag) [unused when WakeMod=0 or 3]
True          TIDrag             - Include the drag term in the tangential-induction calculation? (flag) [unused when WakeMod=0,3 c
"default"     IndToler           - Convergence tolerance for BEMT nonlinear solve residual equation {or "default"} (-) [unused when
       1000   MaxIter            - Maximum number of iteration steps (-) [unused when WakeMod=0]
```

- Cavitation check for MHK turbines
- Buoyancy for MHK turbines
- Future releases will include options to calculate added mass

AeroDyn Primary Input File

```
------- AERODYN v15 for OpenFAST INPUT FILE ------------------------------------------------
Floating MHK turbine hydrodynamic input properties, based on the RM1 tidal current rotor
======  General Options  ============================================================================
False         Echo                - Echo the input to "<rootname>.AD.ech"?  (flag)
"default"     DTAero              - Time interval for aerodynamic calculations {or "default"} (s)
          2   WakeMod             - Type of wake/induction model (switch) {0=none, 1=BEMT, 2=DBEMT, 3=OLAF} [WakeMod cannot be 2 or
          1   AFAeroMod           - Type of blade airfoil aerodynamics model (switch) {1=steady model, 2=Beddoes-Leishman unsteady m
          1   TwrPotent           - Type tower influence on wind based on potential flow around the tower (switch) {0=none, 1=baseli
          0   TwrShadow           - Calculate tower influence on wind based on downstream tower shadow? (switch) {0=none, 1=Powles m
True          TwrAero             - Calculate tower aerodynamic loads? (flag)
False         FrozenWake          - Assume frozen wake during linearization? (flag) [used only when WakeMod=1 and when linearizing]
True          CavitCheck          - Perform cavitation check? (flag) [AFAeroMod must be 1 when CavitCheck=true]
True          Buoyancy            - Include buoyancy effects? (flag)
False         CompAA              -
"unused"      AA_InputFile        -
======  Environmental Conditions  ===================================================================
"default"     AirDens             - Air density (kg/m^3)
"default"     KinVisc             - Kinematic viscosity of working fluid (m^2/s)
"default"     SpdSound            - Speed of sound in working fluid (m/s)
"default"     Patm                - Atmospheric pressure (Pa) [used only when CavitCheck=True]
"default"     Pvap                - Vapour pressure of working fluid (Pa) [used only when CavitCheck=True]
======  Blade-Element/Momentum Theory Options  ========================================== [unused when WakeMod=0 or 3]
          2   SkewMod             - Type of skewed-wake correction model (switch) {1=uncoupled, 2=Pitt/Peters, 3=coupled} [unused wh
"default"     SkewModFactor       - Constant used in Pitt/Peters skewed wake model {or "default" is 15/32*pi} (-) [used only when Sk
True          TipLoss             - Use the Prandtl tip-loss model? (flag) [unused when WakeMod=0 or 3]
True          HubLoss             - Use the Prandtl hub-loss model? (flag) [unused when WakeMod=0 or 3]
True          TanInd              - Include tangential induction in BEMT calculations? (flag) [unused when WakeMod=0 or 3]
True          AIDrag              - Include the drag term in the axial-induction calculation? (flag) [unused when WakeMod=0 or 3]
True          TIDrag              - Include the drag term in the tangential-induction calculation? (flag) [unused when WakeMod=0,3 c
"default"     IndToler            - Convergence tolerance for BEMT nonlinear solve residual equation {or "default"} (-) [unused when
       1000   MaxIter             - Maximum number of iteration steps (-) [unused when WakeMod=0]
```

- Environmental conditions in driver input files

AeroDyn Primary Input File

```
------- AERODYN v15 for OpenFAST INPUT FILE ------------------------------------------------
Floating MHK turbine hydrodynamic input properties, based on the RM1 tidal current rotor
======  General Options  ============================================================================
False         Echo                - Echo the input to "<rootname>.AD.ech"?  (flag)
"default"     DTAero              - Time interval for aerodynamic calculations {or "default"} (s)
          2   WakeMod             - Type of wake/induction model (switch) {0=none, 1=BEMT, 2=DBEMT, 3=OLAF} [WakeMod cannot be 2 or
          1   AFAeroMod           - Type of blade airfoil aerodynamics model (switch) {1=steady model, 2=Beddoes-Leishman unsteady m
          1   TwrPotent           - Type tower influence on wind based on potential flow around the tower (switch) {0=none, 1=baseli
          0   TwrShadow           - Calculate tower influence on wind based on downstream tower shadow? (switch) {0=none, 1=Powles m
True          TwrAero             - Calculate tower aerodynamic loads? (flag)
False         FrozenWake          - Assume frozen wake during linearization? (flag) [used only when WakeMod=1 and when linearizing]
True          CavitCheck          - Perform cavitation check? (flag) [AFAeroMod must be 1 when CavitCheck=true]
True          Buoyancy            - Include buoyancy effects? (flag)
False         CompAA                                                                          2]
"unused"      AA_InputFile
======  Environmental Conditi
"default"     AirDens
"default"     KinVisc             - Kinematic viscosity of working fluid (m^2/s)
"default"     SpdSound            - Speed of sound in working fluid (m/s)
"default"     Patm                - Atmospheric pressure (Pa) [used only when CavitCheck=True]
"default"     Pvap                - Vapour pressure of working fluid (Pa) [used only when CavitCheck=True]
======  Blade-Element/Momentum Theory Options  ================================================== [unused when WakeMod=0 or 3]
          2   SkewMod             - Type of skewed-wake correction model (switch) {1=uncoupled, 2=Pitt/Peters, 3=coupled} [unused wh
"default"     SkewModFactor       - Constant used in Pitt/Peters skewed wake model {or "default" is 15/32*pi} (-) [used only when Sk
True          TipLoss             - Use the Prandtl tip-loss model? (flag) [unused when WakeMod=0 or 3]
True          HubLoss             - Use the Prandtl hub-loss model? (flag) [unused when WakeMod=0 or 3]
True          TanInd              - Include tangential induction in BEMT calculations? (flag) [unused when WakeMod=0 or 3]
True          AIDrag              - Include the drag term in the axial-induction calculation? (flag) [unused when WakeMod=0 or 3]
True          TIDrag              - Include the drag term in the tangential-induction calculation? (flag) [unused when WakeMod=0,3 c
"default"     IndToler            - Convergence tolerance for BEMT nonlinear solve residual equation {or "default"} (-) [unused wher
       1000   MaxIter             - Maximum number of iteration steps (-) [unused when WakeMod=0]
```

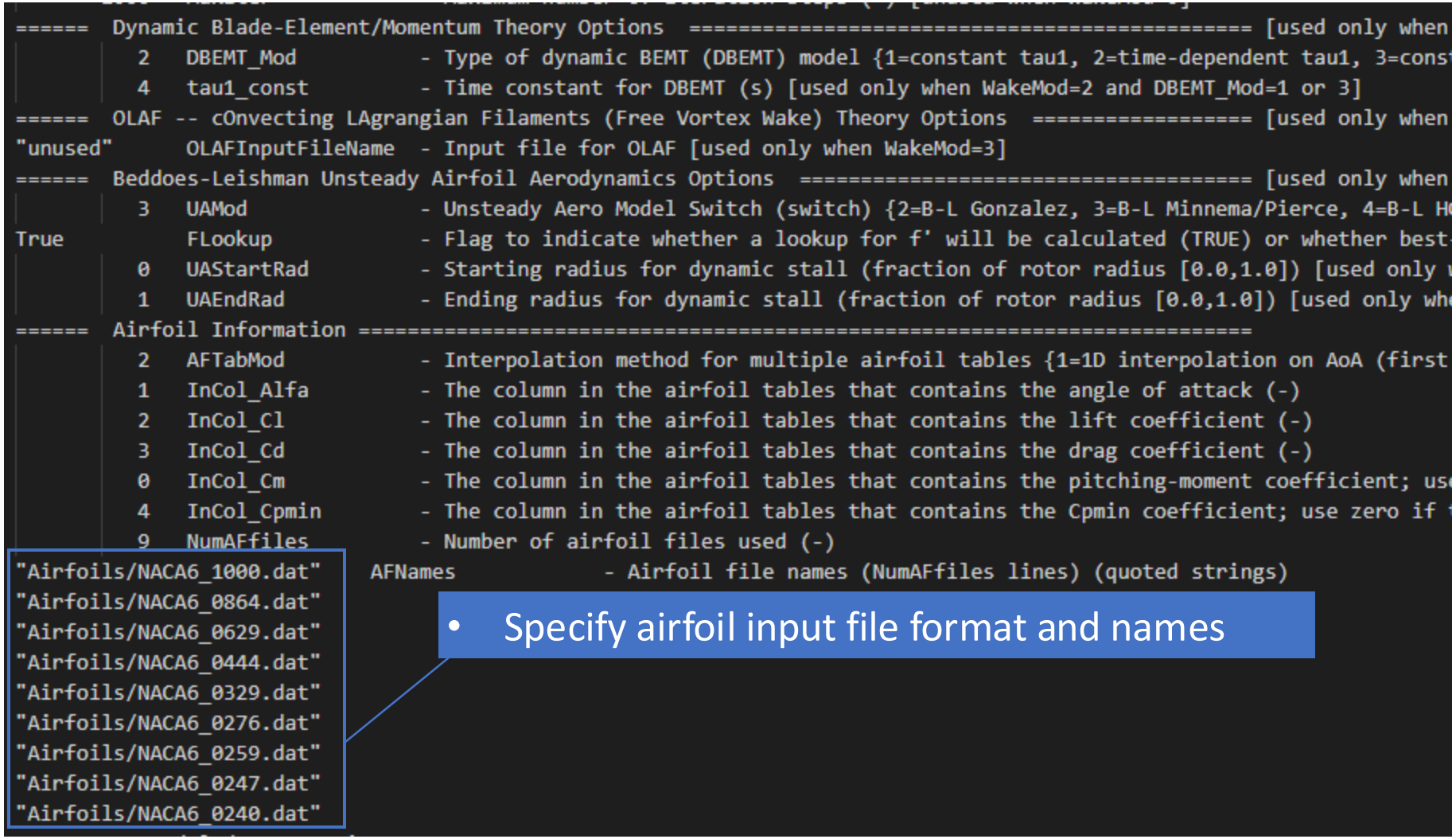
- BEM options, including optional correction models

AeroDyn Primary Input File

- Dynamic BEM, OLAF, and unsteady aerodynamics model options

```
======  Dynamic Blade-Element/Momentur                                                  nly when
          2   DBEMT_Mod           - Typ                                                , 3=const
          4   tau1_const          - Ti                                                 ]
======  OLAF -- cOnvecting LAgrangian Filaments (Free Vortex Wake) Theory Options  ================== [used only when
"unused"      OLAFInputFileName   - Input file for OLAF [used only when WakeMod=3]
======  Beddoes-Leishman Unsteady Airfoil Aerodynamics Options  ==================================== [used only when
          3   UAMod               - Unsteady Aero Model Switch (switch) {2=B-L Gonzalez, 3=B-L Minnema/Pierce, 4=B-L H
True          FLookup             - Flag to indicate whether a lookup for f' will be calculated (TRUE) or whether best
          0   UAStartRad          - Starting radius for dynamic stall (fraction of rotor radius [0.0,1.0]) [used only
          1   UAEndRad            - Ending radius for dynamic stall (fraction of rotor radius [0.0,1.0]) [used only wh
======  Airfoil Information ========================================================================
          2   AFTabMod            - Interpolation method for multiple airfoil tables {1=1D interpolation on AoA (first
          1   InCol_Alfa          - The column in the airfoil tables that contains the angle of attack (-)
          2   InCol_Cl            - The column in the airfoil tables that contains the lift coefficient (-)
          3   InCol_Cd            - The column in the airfoil tables that contains the drag coefficient (-)
          0   InCol_Cm            - The column in the airfoil tables that contains the pitching-moment coefficient; us
          4   InCol_Cpmin         - The column in the airfoil tables that contains the Cpmin coefficient; use zero if
          9   NumAFfiles          - Number of airfoil files used (-)
"Airfoils/NACA6_1000.dat"    AFNames             - Airfoil file names (NumAFfiles lines) (quoted strings)
"Airfoils/NACA6_0864.dat"
"Airfoils/NACA6_0629.dat"
"Airfoils/NACA6_0444.dat"
"Airfoils/NACA6_0329.dat"
"Airfoils/NACA6_0276.dat"
"Airfoils/NACA6_0259.dat"
"Airfoils/NACA6_0247.dat"
"Airfoils/NACA6_0240.dat"
```

AeroDyn Primary Input File



AeroDyn Primary Input File

- Specify blade input files

```
======  Rotor/Blade Properties  ===========================================================
False         UseBlCm             - Include aerodynamic pitching moment in calculations?  (flag)
"MHK_RM1_AeroDyn15_Blade.dat"    ADBlFile(1)         - Name of file containing distributed aerodynamic properties
"MHK_RM1_AeroDyn15_Blade.dat"    ADBlFile(2)         - Name of file containing distributed aerodynamic properties
"unused"      ADBlFile(3)         - Name of file containing distributed aerodynamic properties for Blade #3 (-) [
======  Hub Properties ======================================================================== [used only
       7.2   VolHub              - Hub volume (m^3)
    0.2222   HubCenBx            - Hub center of buoyancy x direction offset (m)
======  Nacelle Properties ==================================================================== [used only
      38.6   VolNac              - Nacelle volume (m^3)
      0.43,          0,          0    NacCenB             - Position of nacelle center of buoyancy from yaw bear
======  Tail Fin Aerodynamics ================================================================
False         TFinAero            - Calculate tail fin aerodynamics model (flag)
"unused"      TFinFile            - Input file for tail fin aerodynamics [used only when TFinAero=True]
======  Tower Influence and Aerodynamics ======================================================== [used only
         4   NumTwrNds           - Number of tower nodes used in the analysis  (-) [used only when TwrPotent/=0,
TwrElev         TwrDiam         TwrCd           TwrTI           TwrCb  ! TwrTI used only when TwrShadow=2; TwrCb us
(m)               (m)            (-)             (-)             (-)
-9.0000000E+00  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
-1.4000000E+01  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
-1.9000000E+01  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
-2.4000000E+01  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
```

AeroDyn Primary Input File

```
======  Rotor/Blade Properties  ===========================================================================
False         UseBlCm             - Include aero
"MHK_RM1_AeroDyn15_Blade.dat"     ADBlFile(1)
"MHK_RM1_AeroDyn15_Blade.dat"     ADBlFile(2)
"unused"      ADBlFile(3)         - Name of file
======  Hub Properties ========================
      7.2   VolHub               - Hub volume (
   0.2222   HubCenBx             - Hub center of buoyancy x direction offset (m)
======  Nacelle Properties ========================================================================== [used only
     38.6   VolNac              - Nacelle volu
     0.43,          0,          0    NacCenB
======  Tail Fin Aerodynamics ==========
False         TFinAero            - Calculate tail fin aerodynamics model (flag)
"unused"      TFinFile            - Input file for tail fin aerodynamics [used only when TFinAero=True]
======  Tower Influence and Aerodynamics ============================================================ [used only
        4   NumTwrNds           - Number of tower nodes used in the analysis  (-) [used only when TwrPotent/=0,
TwrElev         TwrDiam         TwrCd           TwrTI           TwrCb  ! TwrTI used only when TwrShadow=2; TwrCb us
(m)               (m)           (-)              (-)            (-)
-9.0000000E+00  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
-1.4000000E+01  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
-1.9000000E+01  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
-2.4000000E+01  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
```

- Specify hub buoyant properties
- Note that VolHub must ≠ 0 or blade root forces will be incorrect

- Specify nacelle buoyant properties

AeroDyn Primary Input File

```
======  Rotor/Blade Properties  ====================================================================
False         UseBlCm             - Include aerodynamic pitching moment in calculations?  (flag)
"MHK_RM1_AeroDyn15_Blade.dat"    ADBlFile(1)         - Name of file containing distributed aerodynamic properties
"MHK_RM1_AeroDyn15_Blade.dat"    ADBlFile(2)         - Name of file containing distributed aerodynamic properties
"unused"      ADBlFile(3)         - Name of file containing distributed aerodynamic properties for Blade #3 (-) [
======  Hub Properties ============================================================================== [used only
       7.2   VolHub              - Hub volume (m^3)
    0.2222   HubCenBx            - Hub center of buoyancy x direction offset (m)
======  Nacelle Properties ========================================================================== [used only
      38.6   VolNac              - Nacelle volume (m^3)
      0.43,          0,          0    NacCenB             - Position of nacelle center of buoyancy from yaw bear
======  Tail Fin Aerodynamics =====================================================================
False         TFinAero            - Calculate tail fin aerodynamics model (flag)
"unused"      TFinFile            - Input file for tail fin aerodynamics [used only when TFinAero=True]
======  Tower Influence and Aerodynamics ============================================================ [used only
         4   NumTwrNds           - Number of tower nodes used in the analysis  (-) [used only when TwrPotent/=0,
TwrElev         TwrDiam         TwrCd           TwrTI           TwrCb  ! TwrTI used only when TwrShadow=2; TwrCb us
(m)               (m)           (-)              (-)            (-)
-9.0000000E+00  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
-1.4000000E+01  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
-1.9000000E+01  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
-2.4000000E+01  3.2530000E-01  2.0000000E-01  0.0000000E+00  1.0000000E+00
```

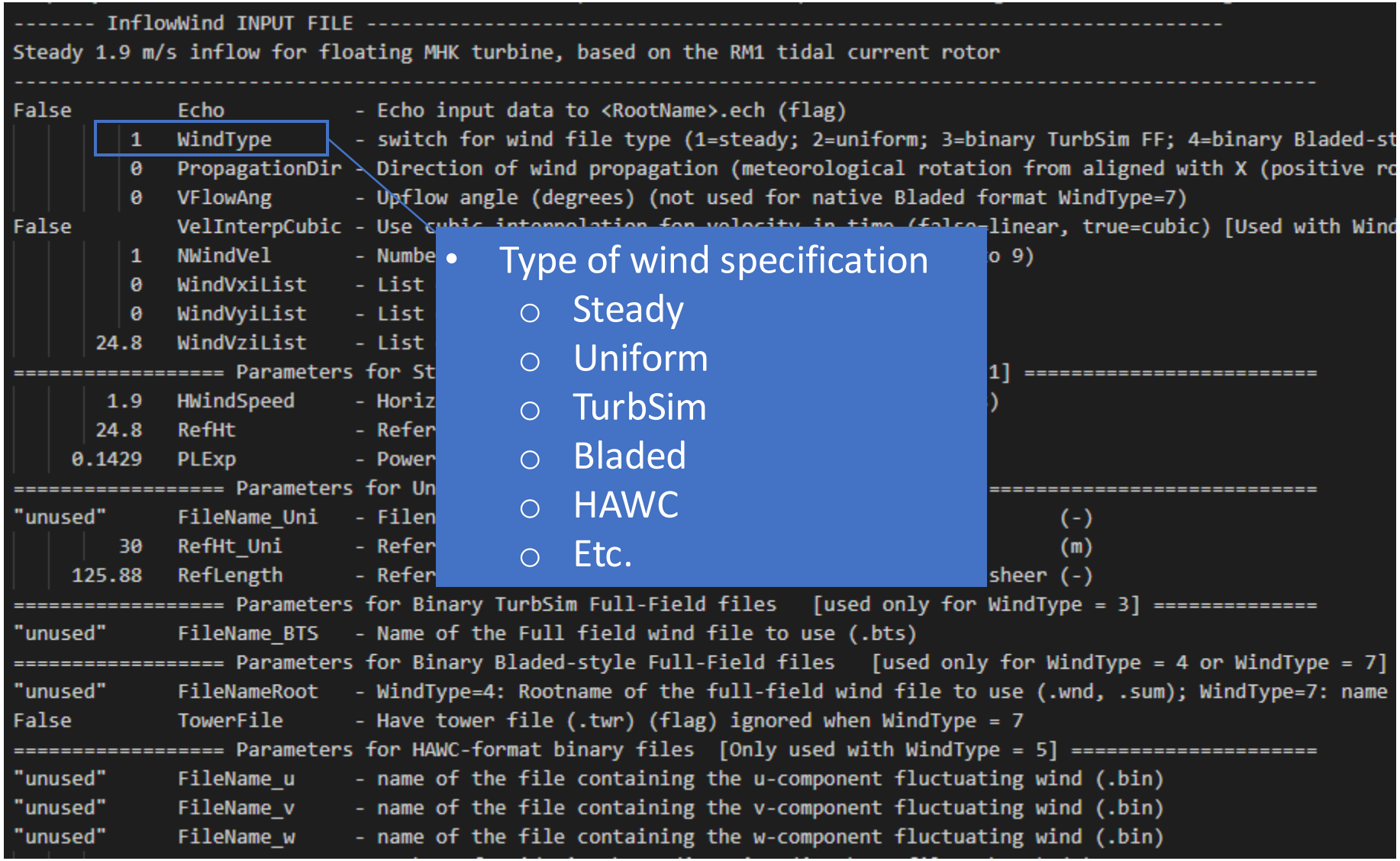
- Tower geometric, hydrodynamic, and buoyant properties

AeroDyn Primary Input File

```
======  Outputs  ========================================================================
True          SumPrint            - Generate a summary file listing input options and interpolated properties to "<root
          9   NBlOuts             - Number of blade node outputs [0 - 9] (-)
          1,         5,         9,         13,         17,         21,         25,         27,         30    BlOutNd
          4   NTwOuts             - Number of tower node outputs [0 - 9]  (-)
          1,         2,         3,          4    TwOutNd             - Tower nodes whose values will be output  (-)
              OutList             - The next line(s) contains a list of output parameters.  See OutListParameters.xlsx
"TwN1Fbx"                - x-component of buoyant force per unit length at Tw node 1
"TwN3Fby"                - y-component of buoyant force per unit length at Tw node 3
"TwN4Fbz"                - z-component of buoyant force per unit length at Tw node 4
"TwN1Mbx"                - x-component of buoyant moment per unit length at Tw node 6
"TwN2Mby"                - y-component of buoyant moment per unit length at Tw node 5
"TwN3Mbz"                - z-component of buoyant moment per unit length at Tw node 2
"B2N4Fbn"                - Buoyant force normal to chord per unit length at blade 2 node 4
"B1N7Fbt"                - Buoyant force tangential to chord per unit length at blade 1 node 7
"B2N8Fbs"                - Buoyant spanwise force per unit length at blade 2 node 8
"B1N2Mbn"                - Buoyant moment normal to chord per unit length at blade 1 node 2
"B2N3Mbt"                - Buoyant moment tangential to chord per unit length at blade 2 node 3
"B1N6Mbs"                - Buoyant spanwise mo
"B1FldFz"                - Total blade aerodyn
"B2FldMx"                - Total blade aerodyn
"HbFbx"                  - x-component of buoy
"HbFby"                  - y-component of buoy
"HbFbz"                  - z-component of buoy
"HbMbx"                  - x-component of buoy
"HbMby"                  - y-component of buoyant moment at hub node
"HbMbz"                  - z-component of buoyant moment at hub node
"NcFbx"                  - x-component of buoyant force at nacelle node
"NcFby"                  - y-component of buoyant force at nacelle node
"NcFbz"                  - z-component of buoyant force at nacelle node
"NcMbx"                  - x-component of buoyant moment at nacelle node
"NcMby"                  - y-component of buoyant moment at nacelle node
"NcMbz"                  - z-component of buoyant moment at nacelle node
"RtFldFxh"               - Total rotor aerodynamic/hydrodynamic and buoyant load (force in x direction)
"RtFldFyh"               - Total rotor aerodynamic/hydrodynamic and buoyant load (force in y direction)
"RtFldFzg"               - Total rotor aerodynamic/hydrodynamic and buoyant load (force in global z direction)
"RtFldMxh"               - Total rotor aerodynamic/hydrodynamic and buoyant load (moment in x direction)
"RtFldMyg"               - Total rotor aerodynamic/hydrodynamic and buoyant load (moment in global y direction)
"RtFldMzh"               - Total rotor aerodynamic/hydrodynamic and buoyant load (moment in z direction)
"B1N3SigCr"              - Critical cavitation number blade 1 node 3
"B2N5SigCr"              - Critical cavitation number blade 2 node 5
"B1N2SgCav"              - Cavitation number blade 1 node 2
"B2N6SgCav"              - Cavitation number blade 2 node 6
```

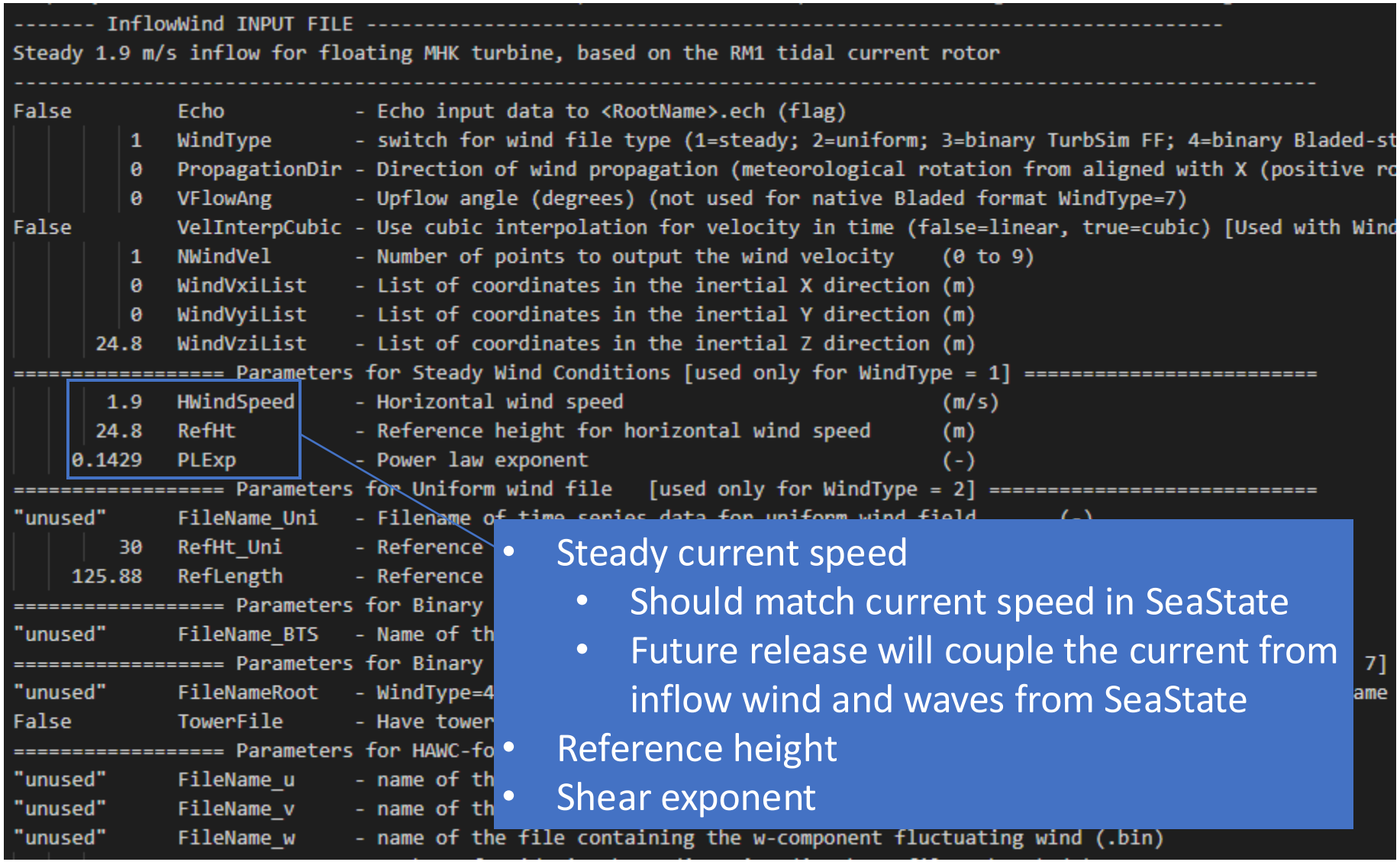
- Specify formatting of outputs written to file
- Select blade/tower nodes for output

InflowWind Primary Input File



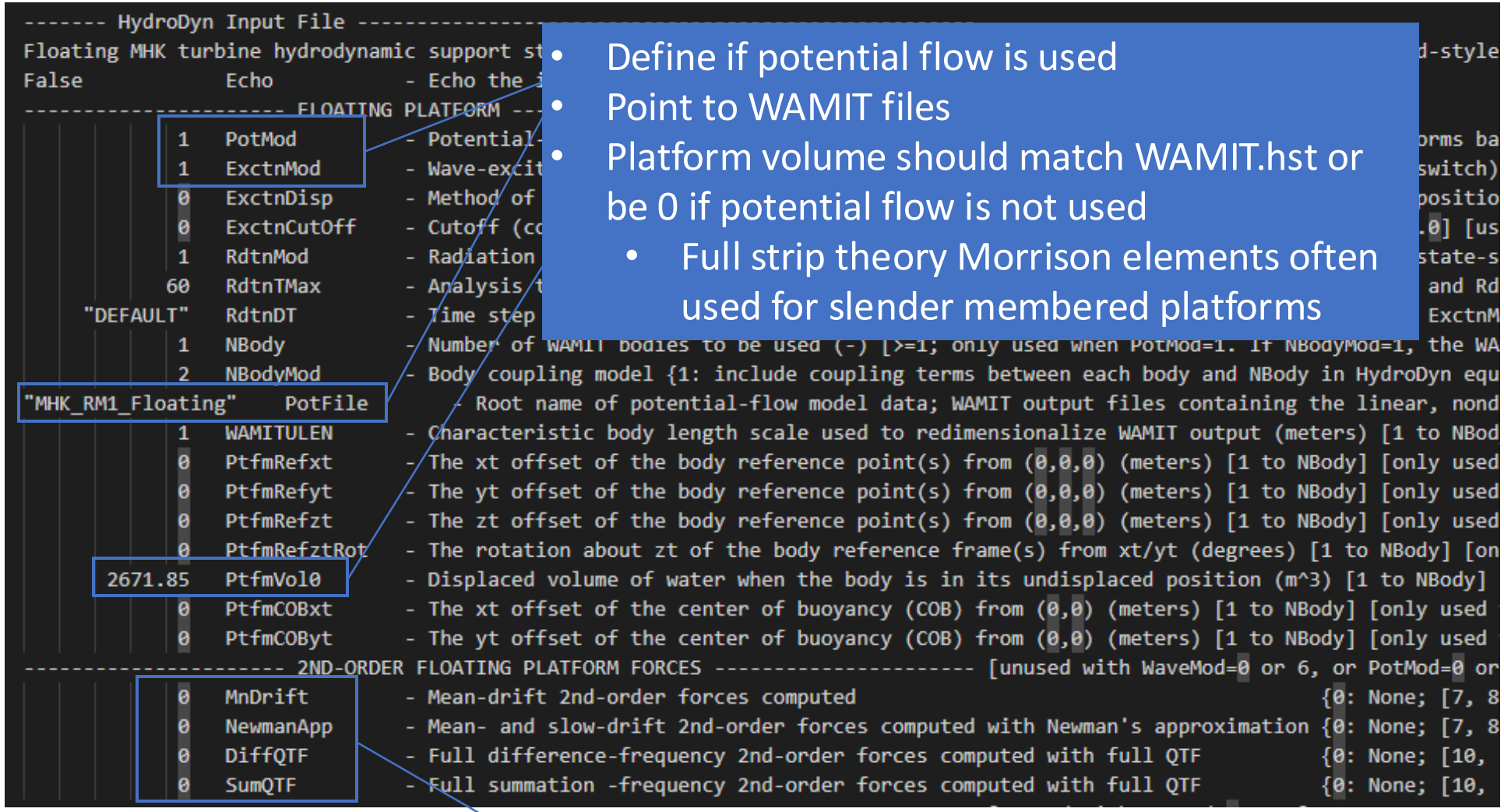
- Type of wind specification
  - Steady
  - Uniform
  - TurbSim
  - Bladed
  - HAWC
  - Etc.

InflowWind Primary Input File



- Steady current speed
  - Should match current speed in SeaState
  - Future release will couple the current from inflow wind and waves from SeaState
- Reference height
- Shear exponent

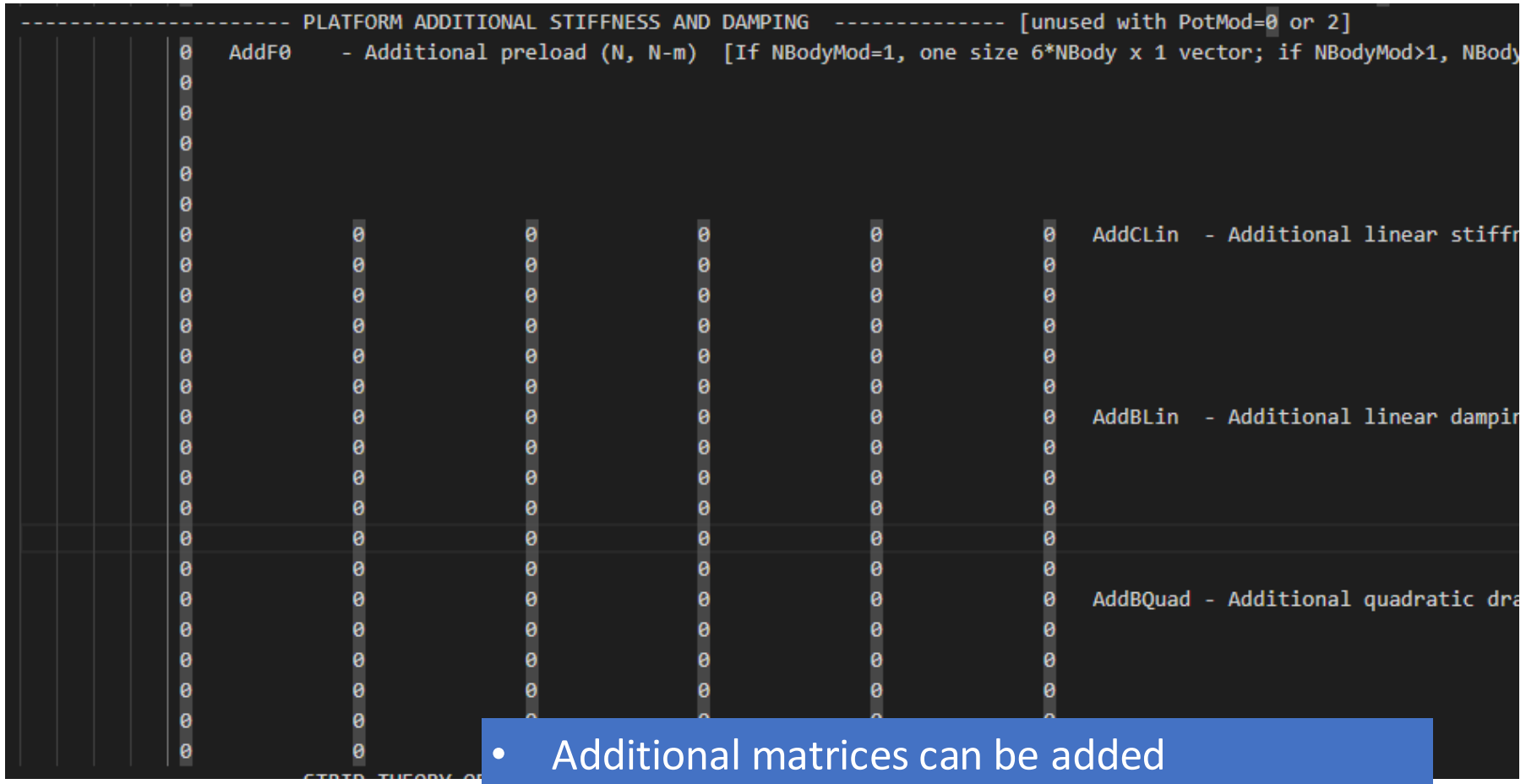
HydroDyn Primary Input File



- Define if potential flow is used
- Point to WAMIT files
- Platform volume should match WAMIT.hst or be 0 if potential flow is not used
  - Full strip theory Morrison elements often used for slender membered platforms

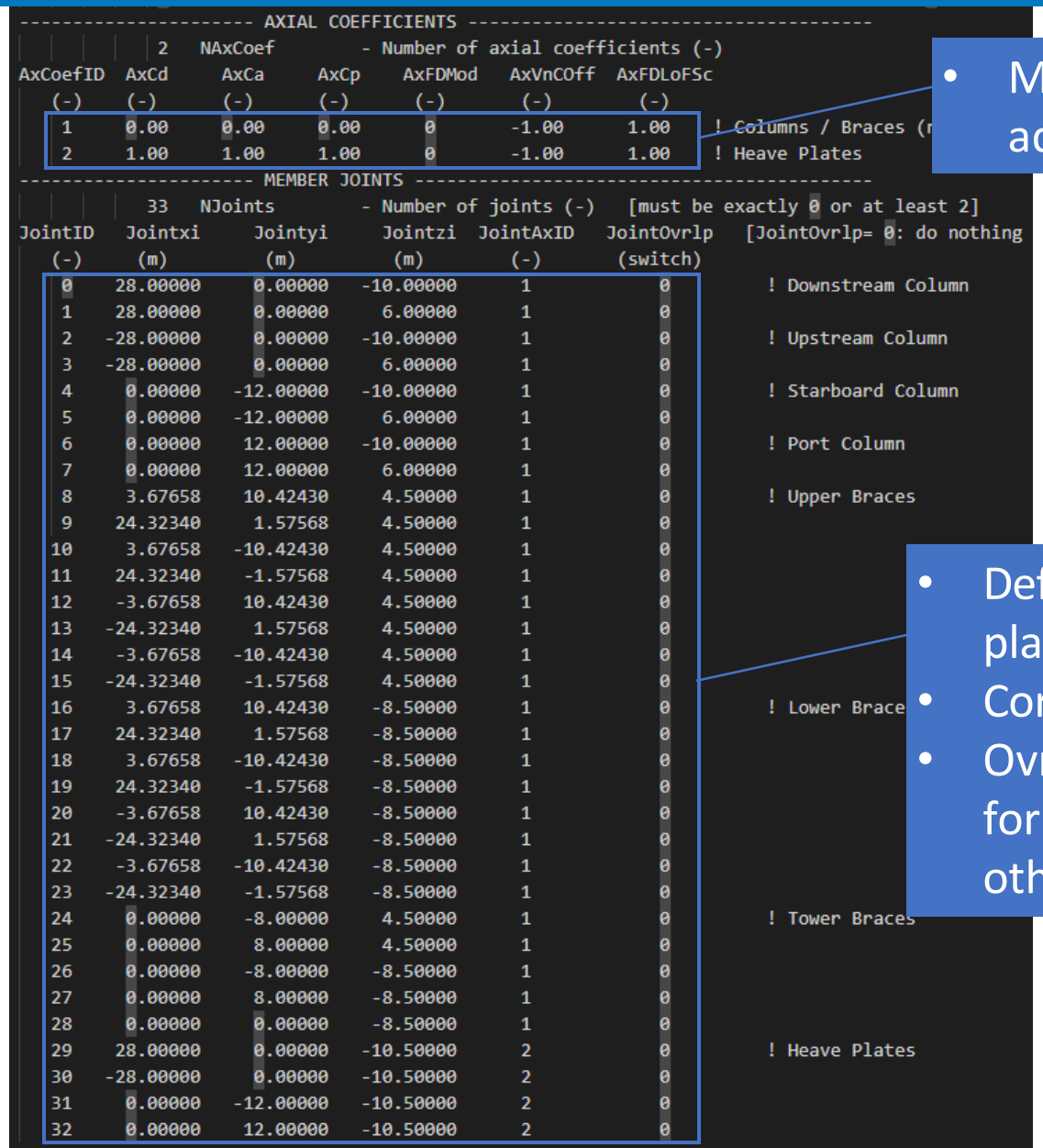
- 2nd order potential flow forces available

HydroDyn Primary Input File



- Additional matrices can be added
  - Often used to tune to free decays
- Only applied if potential flow files are present
- Dummy files can be used if additional matrices are desired with full strip theory elements

HydroDyn Primary Input File



```
---------------------- AXIAL COEFFICIENTS -------------------------------------
           2   NAxCoef        - Number of axial coefficients (-)
AxCoefID  AxCd     AxCa     AxCp     AxFDMod   AxVnCOff  AxFDLoFSc
   (-)    (-)      (-)      (-)       (-)       (-)       (-)
    1     0.00     0.00     0.00       0        -1.00     1.00     ! Columns / Braces (r
    2     1.00     1.00     1.00       0        -1.00     1.00     ! Heave Plates
---------------------- MEMBER JOINTS ------------------------------------------
          33   NJoints        - Number of joints (-)   [must be exactly 0 or at least 2]
JointID   Jointxi     Jointyi     Jointzi   JointAxID   JointOvrlp   [JointOvrlp= 0: do nothing
   (-)     (m)         (m)         (m)       (-)       (switch)
    0    28.00000     0.00000   -10.00000     1            0        ! Downstream Column
    1    28.00000     0.00000     6.00000     1            0
    2   -28.00000     0.00000   -10.00000     1            0        ! Upstream Column
    3   -28.00000     0.00000     6.00000     1            0
    4     0.00000   -12.00000   -10.00000     1            0        ! Starboard Column
    5     0.00000   -12.00000     6.00000     1            0
    6     0.00000    12.00000   -10.00000     1            0        ! Port Column
    7     0.00000    12.00000     6.00000     1            0
    8     3.67658    10.42430     4.50000     1            0        ! Upper Braces
    9    24.32340     1.57568     4.50000     1            0
   10     3.67658   -10.42430     4.50000     1            0
   11    24.32340    -1.57568     4.50000     1            0
   12    -3.67658    10.42430     4.50000     1            0
   13   -24.32340     1.57568     4.50000     1            0
   14    -3.67658   -10.42430     4.50000     1            0
   15   -24.32340    -1.57568     4.50000     1            0
   16     3.67658    10.42430    -8.50000     1            0        ! Lower Brace
   17    24.32340     1.57568    -8.50000     1            0
   18     3.67658   -10.42430    -8.50000     1            0
   19    24.32340    -1.57568    -8.50000     1            0
   20    -3.67658    10.42430    -8.50000     1            0
   21   -24.32340     1.57568    -8.50000     1            0
   22    -3.67658   -10.42430    -8.50000     1            0
   23   -24.32340    -1.57568    -8.50000     1            0
   24     0.00000    -8.00000     4.50000     1            0        ! Tower Braces
   25     0.00000     8.00000     4.50000     1            0
   26     0.00000    -8.00000    -8.50000     1            0
   27     0.00000     8.00000    -8.50000     1            0
   28     0.00000     0.00000    -8.50000     1            0
   29    28.00000     0.00000   -10.50000     2            0        ! Heave Plates
   30   -28.00000     0.00000   -10.50000     2            0
   31     0.00000   -12.00000   -10.50000     2            0
   32     0.00000    12.00000   -10.50000     2            0
```

- Member axial drag and added mass forces

- Define location of all platform joints
- Corresponding axial force ID
- Ovrlp turns off axial forces for members that intersect other members

HydroDyn Primary Input File

```
---------------------- MEMBER CROSS-SECTION PROPERTIES ------------------------
           4   NPropSets       - Number of member property sets (-)
PropSetID     PropD          PropThck
   (-)         (m)             (m)
    0        8.00000         0.02000    ! Columns
    1        2.00000         0.02000    ! Braces
    2        2.00000         0.08100    ! Flooded Braces (not flooded in hydrodyn)
    3       12.00000         0.39250 ! Flooded Heave Plates (not flooded in hydrodyn)
---------------------- SIMPLE HYDRODYNAMIC COEFFICIENTS (model 1) --------------
    SimplCd    SimplCdMG    SimplCa    SimplCaMG    SimplCp    SimplCpMG    SimplAxCd  SimplAxCdMG   SimplAxCa  SimplAxCaMG  SimplAxCp  SimplAxCpMG
      (-)         (-)         (-)         (-)         (-)         (-)         (-)         (-)         (-)         (-)         (-)         (-)
     1.20        0.00        1.00        0.00        1.00        1.00        0.00        0.00        0.00        0.00        1.00        1.00
---------------------- DEPTH-BASED HYDRODYNAMIC COEFFICIENTS (model 2) ---------
           0   NCoefDpth       - Number of depth-dependent coefficients (-)
Dpth       DpthCd    DpthCdMG    DpthCa    DpthCaMG       DpthCp    DpthCpMG    DpthAxCd    DpthAxCdMG    DpthAxCa    DpthAxCaMG    DpthAxCp    DpthAxCpMG    Dp
(m)        (-)       (-)         (-)       (-)            (-)       (-)         (-)         (-)           (-)         (-)           (-)         (-)           (
---------------------- MEMBER-BASED HYDRODYNAMIC COEFFICIENTS (model 3) --------
           0   NCoefMembers       - Number of member-based coefficients (-)
MemberID    MemberCd1     MemberCd2     MemberCdMG1    MemberCdMG2     MemberCa1     MemberCa2     MemberCaMG1    MemberCaMG2     MemberCp1     MemberCp2
   (-)         (-)           (-)           (-)            (-)           (-)           (-)           (-)            (-)           (-)           (-)
                    MEMBERS
```

- Member ID with diameter

- Member hydrodynamic coefficients
- Can apply to all members
- Can be grouped by member ID or by depth

HydroDyn Primary Input File

---------- MEMBERS ----------

20	NMembers	- Number of members (-)						
MemberID	MJointID1	MJointID2	MPropSetID1	MPropSetID2	MDivSize	MCoefMod	MHstLMod	PropPot	[MCoefMod=1: use simp
(-)	(-)	(-)	(-)	(-)	(m)	(switch)	(switch)	(flag)	
0	0	1	0	0	0.1000	1	1	TRUE	! Columns
1	2	3	0	0	0.1000	1	1	TRUE	
2	4	5	0	0	0.1000	1	1	TRUE	
3	6	7	0	0	0.1000	1	1	TRUE	
4	8	9	1	1	0.1000	1	1	TRUE	! Upper Braces
5	10	11	1	1	0.1000	1	1	TRUE	
6	12	13	1	1	0.1000	1	1	TRUE	
7	14	15	1	1	0.1000	1	1	TRUE	
8	16	17	2	2	0.1000	1	1	TRUE	! Lower Braces
9	18	19	2	2	0.1000	1	1	TRUE	
10	20	21	2	2	0.1000	1	1	TRUE	
11	22	23	2	2	0.1000	1	1	TRUE	
12	24	25	1	1	0.1000	1	1	TRUE	! Tower Braces
13	26	27	1	1	0.1000	1	1	TRUE	
14	24	28	1	1	0.1000	1	1	TRUE	
15	25	28	1	1	0.1000	1	1	TRUE	
16	0	29	3	3	0.1000	1	1	TRUE	! Heave Plates
17	2	30	3	3	0.1000	1	1	TRUE	
18	4	31	3	3	0.1000	1	1	TRUE	
19	6	32	3						

- Members connect between defined joints
- Assign property ID

HydroDyn Primary Input File

```
---------------------- FILLED MEMBERS ------------------------------------------
          0   NFillGroups      - Number of filled member groups (-) [If FillDens = DEFAULT, then FillDens = WtrDens;
FillNumM FillMList            FillFSLoc     FillDens
(-)      (-)                  (m)           (kg/m^3)
---------------------- MARINE GROWTH -------------------------------------------
          0   NMGDepths       - Number of marine-growth depths specified (-)
MGDpth     MGThck       MGDens
(m)        (m)          (kg/m^3)
---------------------- MEMBER OUTPUT LIST --------------------------------------
          0   NMOutputs       - Number of member ou
MemberID   NOutLoc    NodeLocs [NOutLoc < 10; node locations are normalized distance from the start of the member; and
  (-)        (-)        (-)
---------------------- JOINT OUTPUT LIST ---------------------------------------
          0   NJOutputs       - Number of joint outputs [Must be < 10]
          0   JOutLst         - List of JointIDs which are to be output (-)[unused if NJOutputs=0]
---------------------- OUTPUT --------------------------------------------------
True              HDSum           - Output a summary file [flag]
False             OutAll          - Output all user-specified member and joint loads (only at each member end, not inter
          2   OutSwtch        - Output requested channels to: [1=Hydrodyn.out, 2=GlueCode.out, 3=both files]
"E15.7e2"         OutFmt          - Output format for numerical results (quoted string) [not checked for validity!]
"A11"             OutSFmt         - Output format for header strings (quoted string) [not checked for validity!]
---------------------- OUTPUT CHANNELS -----------------------------------------
Wave1Elev                 - Wave elevation at the platform reference point (0,  0)
HydroFxi                  - Buoyancy force [N
HydroFyi                  - Buoyancy force [N
HydroFzi                  - Buoyancy force [N] in the vertical direction (Z).
END of output channels and end of file. (the word "END" must appear in the first 3 columns of this line)
```

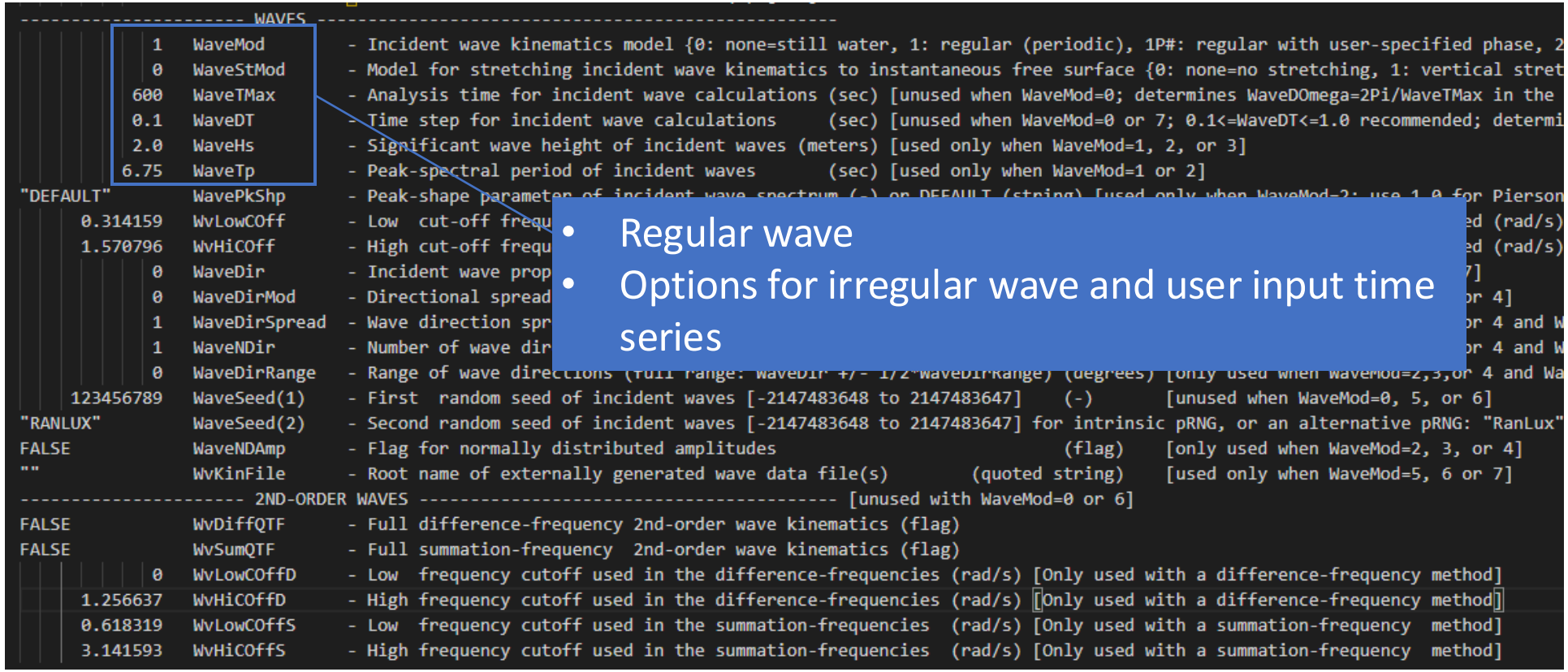
- Ballast included in platform mass and inertia instead of filled members
- List outputs

SeaState Primary Input File

```
------- SeaState Input File ----------------------------------------------------
Floating MHK turbine hydrodynamic support structure input properties, based on the RM1 tidal current rotor with a
False            Echo           - Echo the input file data (flag)
---------------------- ENVIRONMENTAL CONDITIONS -------------------------------
"DEFAULT"        WtrDens        - Water density (kg/m^3)
"DEFAULT"        WtrDpth        - Water depth (meters) relative to MSL
"DEFAULT"        MSL2SWL        - Offset between still-water level and mean sea level (meters) [positive upward;
---------------------- SPATIAL DISCRETIZATION ---------------------------------
          30   X_HalfWidth      - Half-width of the domain in the X direction (m) [>0, NOTE: X[nX] = nX*dX, where
          30   Y_HalfWidth      - Half-width of the domain in the Y direction (m) [>0, NOTE: Y[nY] = nY*dY, where
          50   Z_Depth          - Depth of the domain the Z direction (m) relative to SWL [0 < Z_Depth <= WtrDpth
          11   NX               - Number of nodes in half of the X-direction domain (-) [>=2]
          11   NY               - Number of nodes in half of the Y-direction domain (-) [>=2]
          10   NZ               - Number of nodes in the Z direction (-) [>=2]
```

- Define grid for wave generation
- Should cover full expected range of displacements

SeaState Primary Input File



- Regular wave
- Options for irregular wave and user input time series

SeaState Primary Input File

```
---------------------- CURRENT ------------------------------------------------ [unused with WaveMod=6]
           1   CurrMod         - Current profile model {0: none=no current, 1: standard, 2: user-defined from routine User
           0   CurrSSV0        - Sub-surface current velocity at still water level  (m/s) [used only when CurrMod=1]
           0   CurrSSDir       - Sub-surface current heading direction (degrees) or DEFAULT (string) [used only when CurrM
        12.2   CurrNSRef       - Near-surface current reference depth           (meters) [used only when CurrMod=1]
           0   CurrNSV0        - Near-surface current velocity at still water level (m/s) [used only when CurrMod=1]
           0   CurrNSDir       - Near-surface current heading direction        (degrees) [used only when CurrMod=1]
         1.9   CurrDIV         - Depth-independent current velocity                (m/s) [used only when CurrMod=1]
           0   CurrDIDir       - Depth-independent current heading direction    (degrees) [used only when CurrMod=1]
---------------------- MacCamy-Fuchs diffraction model ------------------------
           0   MCFD            - MacCamy-Fuchs member radius (ignored if radius <= 0) [must be 0 when WaveMod 0 or 6]
---------------------- OUTPUT -------------
True           SeaStSum        - Output a s
           2   OutSwtch        - Output rec
"E15.7e2"      OutFmt          - Output for
"A11"          OutSFmt         - Output for
           1   NWaveElev       - Number of                                                              imum of
           0   WaveElevxi      - List of xi-coordinates for points where the incident wave elevations can be output (meter
           0   WaveElevyi      - List of yi-coordinates for points where the incident wave elevations can be output (meter
           2   NWaveKin        - Number of points where the wave kinematics can be output (-)       [maximum of 9 output l
    14.43376,      -18.4752    WaveKinxi - List of xi-coordinates for points where the wave kinematics can be output (met
          25,            -6    WaveKinyi - List of yi-coordinates for points where the wave kinematics can be output (met
         -14,           -17    WaveKinzi - List of zi-coordinates for points where the wave kinematics can be output (met
---------------------- OUTPUT CHANNELS -----------------------------------------
"Wave1Elev"                - Wave elevation at the platform reference point
END of output channels and end of file. (the word "END" must appear in the first 3 columns of this line)
```

- Current speed
  - Should match inflow wind
- Future release will couple to inflow wind

MoorDyn Primary Input File

```
---------------------- MoorDyn Input File ------------------------------------
Floating MHK turbine mooring input properties, based on the RM1 tidal current rotor with a quad-sty
FALSE    Echo      - echo the input file data (flag)
---------------------- LINE TYPES Chain studless 0.018m ----------------------
Name     Diam     MassDen     EA        BA/-zeta   EI    Cd   Ca   CdAx   CaAx
(-)      (m)      (kg/m)      (N)       (N-s/-)    (-)   (-)  (-)  (-)    (-)
main     0.324    644.8       85.4e8    -0.8       0.8   2.4  1.0  1.15   0.5
---------------------- POINTS ------------------------------------------------
Node     Type     X        Y        Z        M     V       CdA     CA
(-)      (-)      (m)      (m)      (m)      (kg)  (m^3)   (m^2)   (-)
1        Fixed    -152.0   -50.0    -50.0    0     0       0       0
2        Fixed    -152.0   0.0      -50.0    0     0       0       0
3        Fixed    -152.0   50.0     -50.0    0     0       0       0
4        Fixed    152.0    -50.0    -50.0    0     0       0       0
5        Fixed    152.0    0.0      -50.0    0     0       0       0
6        Fixed    152.0    50.0     -50.0    0     0       0       0
7        Vessel   -34.0    0.0      -10.0    0     0       0       0
8        Vessel   -34.0    0.0      -10.0    0     0       0       0
9        Vessel   -34.0    0.0      -10.0    0     0       0       0
10       Vessel   34.0     0.0      -10.0    0     0       0       0
11       Vessel   34.0     0.0      -10.0    0     0       0       0
12       Vessel   34.0     0.0      -10.0    0     0       0       0
```

- Define line properties
- New release includes bending

- Define fairlead and anchor locations
- If multiple line types or mooring components are used – define initial location

MoorDyn Primary Input File

```
---------------------- LINES ---------------------------------------------
Line     LineType  AttachA  AttachB   UnstrLen   NumSegs   Outputs
(-)      (-)       (-)      (-)       (m)        (-)       (-)
1        main      1        7         160.0      30        -
2        main      2        8         152.0      30        -
3        main      3        9         160.0      30        -
4        main      4        10        160.0      30        -
5        main      5        11        152.0      30        -
6        main      6        12        160.0      30        -
---------------------- SOLVER OPTIONS ---------------------------------------
0.5e-4   dtM       - time step to use in mooring integration (s)
3.0e6    kbot      - bottom stiffness (Pa/m)
3.0e5    cbot      - bottom damping (Pa-s/m)
1.0      dtIC      - time interval for analyzing convergence during IC gen (s)
10.0     TmaxIC    - max time for ic gen (s)
4.0      CdScaleIC - factor by which to scale drag coefficients during dynamic relaxation (-)
0.1      threshIC  - threshold for IC convergence (-)
```

- Lines connect between defined points

- Bottom stiffness must support chain
- Time and time step used in initialization convergence

Supporting Files

- ElastoDyn blade structural properties
  - Pre-calculated mode shapes
- ElastoDyn tower structural properties
  - Pre-calculated mode shapes
- AeroDyn blade geometric properties
- AeroDyn blade aerodynamic properties
- Foil polars

Running OpenFAST

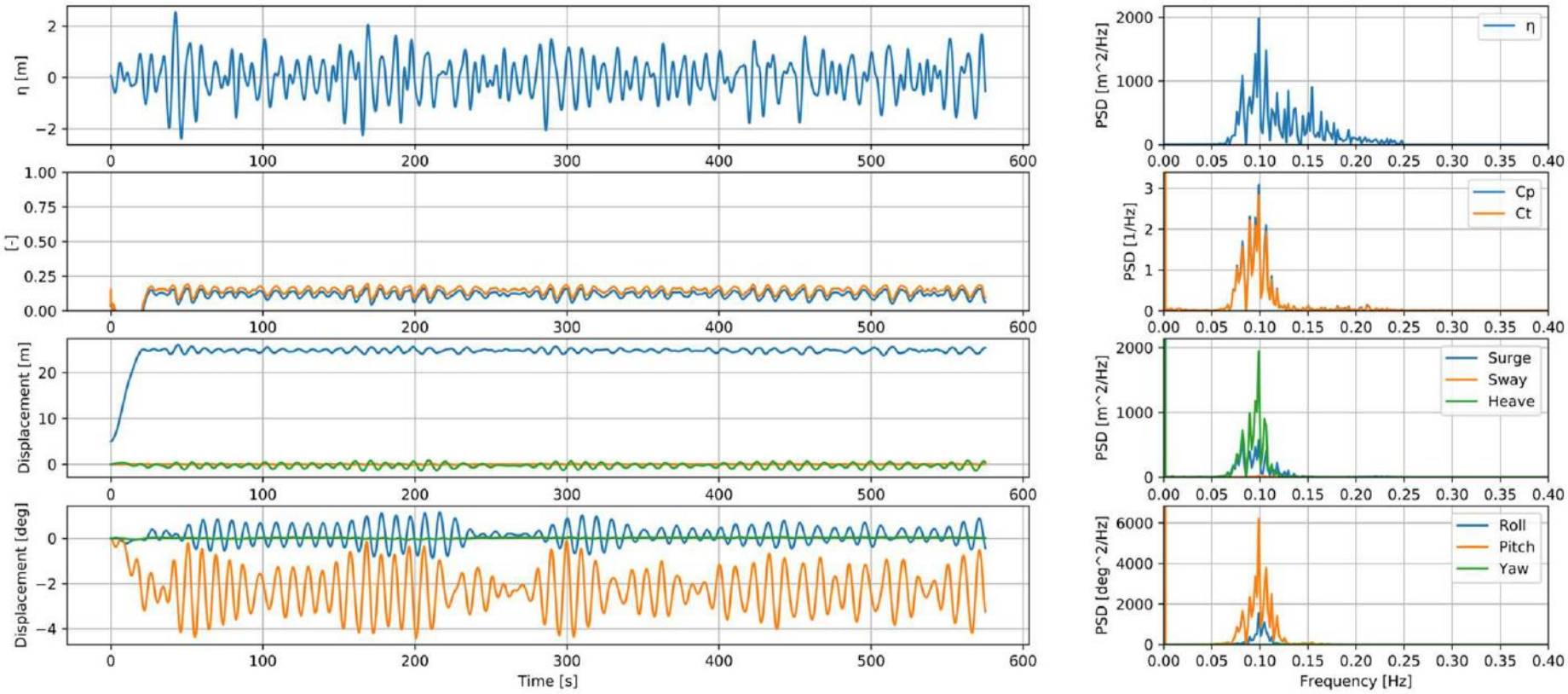
- In a terminal, navigate to the folder containing the relevant OpenFAST executable for your system and the simulation input files
- For Mac users, run OpenFAST using the following command for the example
  - ./openfast_Mac “Onshore/ MHK_RM1_Floating.fst”
- For Windows users, run OpenFAST using the following command for the example
  - openfast_Windows.exe Onshore\ MHK_RM1_Floating.fst
- For Linux users, run OpenFAST using the following command for the example
  - ./openfast_Linux Onshore/MHK_RM1_Floating.fst

OpenFAST Outputs

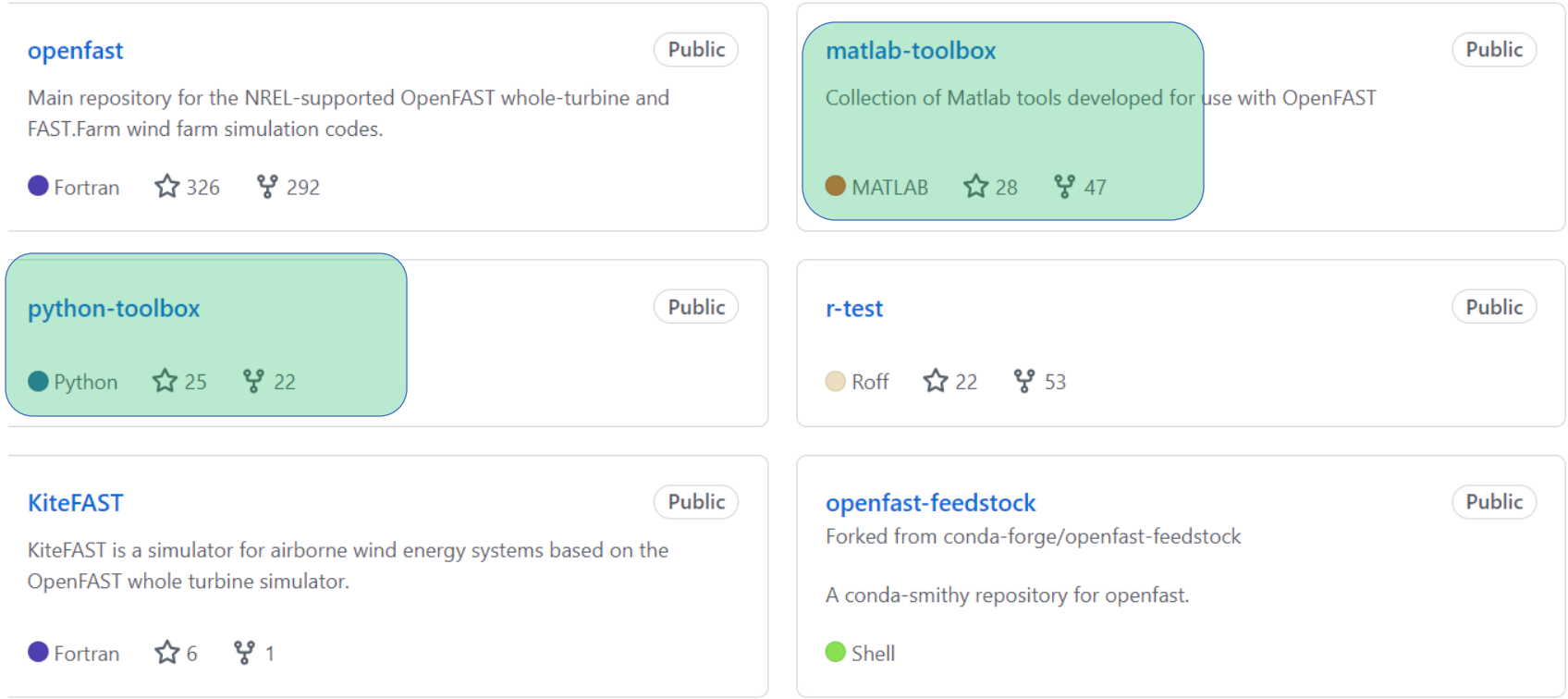
- Summary files
  - OpenFAST (MHK_RM1_Floating.sum)
  - ElastoDyn (MHK_RM1_Floating.sum)
  - AeroDyn (MHK_RM1_Floating.sum)
- Output file
  - MHK_RM1_Floating.out

```
Predictions were generated on 16-Jan-2022 at 20:07:40 using OpenFAST, compiled as a 64-bit application using double precision at commit v3.0.0
 linked with  NWTC Subroutine Library; ElastoDyn; InflowWind; AeroDyn

Description from the FAST input file: MECC OpenFAST Webinar: NREL 5.0 MW Baseline Wind Turbine (Onshore)

Time    Wind1VelX   Wind1VelY   Wind1VelZ    OoPDefl1    IPDefl1 TwstDefl1   BldPitch1   Azimuth RotSpeed    GenSpeed    TTDspFA TTDspSS TTDspTwst   Spn2MLxb1   Spn2MLyb1   RootFxb1    RootFyb1
(s) (m/s)    (m/s)    (m/s)    (m) (m) (deg)    (deg)    (deg)    (rpm)    (rpm)    (m) (m) (deg)    (kN-m)   (kN-m)   (kN)     (kN)     (kN)     (kN-m)   (kN-m)   (kN-m)   (kN-m)   (kN-m)   (kN)     (kN)
    0.0000   8.000E+00  -0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   9.000E+00   8.730E+02   0.000E+00  -0.000E+00   0.000E+00   3.179E+00  -8.463E+00
    0.0125   8.000E+00  -0.000E+00   0.000E+00   4.536E-03  -7.934E-05   0.000E+00   0.000E+00   6.752E-01   9.005E+00   8.730E+02  -6.648E-06  -9.360E-08   0.000E+00   2.637E+00  -1.772E+01
    0.0250   8.000E+00  -0.000E+00   0.000E+00   1.753E-02  -2.317E-04   0.000E+00   0.000E+00   1.351E+00   9.010E+00   8.730E+02  -2.619E-05  -1.031E-06   0.000E+00  -4.740E+00  -1.089E+01
    0.0375   8.000E+00  -0.000E+00   0.000E+00   3.791E-02  -3.428E-04   0.000E+00   0.000E+00   2.027E+00   9.014E+00   8.730E+02  -5.740E-05  -3.834E-06   0.000E+00  -1.259E+01  -1.121E+00
    0.0500   8.000E+00  -0.000E+00   0.000E+00   6.530E-02  -5.111E-04   0.000E+00   0.000E+00   2.703E+00   9.018E+00   8.730E+02  -9.823E-05  -9.546E-06   0.000E+00  -2.322E+01   1.254E+01
    0.0625   8.000E+00  -0.000E+00   0.000E+00   9.902E-02  -8.166E-04   0.000E+00   0.000E+00   3.379E+00   9.020E+00   8.730E+02  -1.460E-04  -1.920E-05   0.000E+00  -3.524E+01   2.920E+01
    0.0750   8.000E+00  -0.000E+00   0.000E+00   1.385E-01  -1.409E-03   0.000E+00   0.000E+00   4.056E+00   9.021E+00   8.730E+02  -1.973E-04  -3.379E-05   0.000E+00  -4.819E+01   4.890E+01
    0.0875   8.000E+00  -0.000E+00   0.000E+00   1.833E-01  -2.459E-03   0.000E+00   0.000E+00   4.732E+00   9.020E+00   8.730E+02  -2.481E-04  -5.421E-05   0.000E+00  -6.136E+01   7.130E+01
    0.1000   8.000E+00  -0.000E+00   0.000E+00   2.329E-01  -4.153E-03   0.000E+00   0.000E+00   5.409E+00   9.018E+00   8.730E+02  -2.940E-04  -8.127E-05   0.000E+00  -7.405E+01   9.622E+01
    0.1125   8.000E+00  -0.000E+00   0.000E+00   2.869E-01  -6.672E-03   0.000E+00   0.000E+00   6.085E+00   9.014E+00   8.730E+02  -3.300E-04  -1.156E-04   0.000E+00  -8.555E+01   1.235E+02
    0.1250   8.000E+00  -0.000E+00   0.000E+00   3.448E-01  -1.018E-02   0.000E+00   0.000E+00   6.761E+00   9.010E+00   8.730E+02  -3.508E-04  -1.577E-04   0.000E+00  -9.529E+01   1.529E+02
    0.1375   8.000E+00  -0.000E+00   0.000E+00   4.063E-01  -1.481E-02   0.000E+00   0.000E+00   7.436E+00   9.004E+00   8.730E+02  -3.510E-04  -2.078E-04   0.000E+00  -1.028E+02   1.843E+02
    0.1500   8.000E+00  -0.000E+00   0.000E+00   4.711E-01  -2.066E-02   0.000E+00   0.000E+00   8.112E+00   8.999E+00   8.730E+02  -3.249E-04  -2.660E-04   0.000E+00  -1.083E+02   2.174E+02
    0.1625   8.000E+00  -0.000E+00   0.000E+00   5.388E-01  -2.777E-02   0.000E+00   0.000E+00   8.786E+00   8.994E+00   8.730E+02  -2.670E-04  -3.322E-04   0.000E+00  -1.102E+02   2.520E+02
    0.1750   8.000E+00  -0.000E+00   0.000E+00   6.086E-01  -3.611E-02   0.000E+00   0.000E+00   9.461E+00   8.989E+00   8.730E+02  -1.719E-04  -4.059E-04   0.000E+00  -1.085E+02   3.070E+02
    0.1875   8.000E+00  -0.000E+00   0.000E+00   6.799E-01  -4.561E-02   0.000E+00   0.000E+00   1.013E+01   8.985E+00   8.730E+02  -3.381E-05  -4.866E-04   0.000E+00  -1.063E+02   3.219E+02
    0.2000   8.000E+00  -0.000E+00   0.000E+00   7.532E-01  -5.617E-02   0.000E+00   0.000E+00   1.081E+01   8.983E+00   8.730E+02   1.537E-04  -5.737E-04   0.000E+00  -1.006E+02   3.656E+02
    0.2125   8.000E+00  -0.000E+00   0.000E+00   8.280E-01  -6.764E-02   0.000E+00   0.000E+00   1.148E+01   8.983E+00   8.730E+02   3.964E-04  -6.664E-04   0.000E+00  -9.368E+01   4.036E+02
    0.2250   8.000E+00  -0.000E+00   0.000E+00   9.044E-01  -7.987E-02   0.000E+00   0.000E+00   1.216E+01   8.984E+00   8.730E+02   6.999E-04  -7.639E-04   0.000E+00  -8.589E+01   4.420E+02
    0.2375   8.000E+00  -0.000E+00   0.000E+00   9.823E-01  -9.269E-02   0.000E+00   0.000E+00   1.283E+01   8.986E+00   8.730E+02   1.069E-03  -8.651E-04   0.000E+00  -7.733E+01   4.803E+02
    0.2500   8.000E+00  -0.000E+00   0.000E+00   1.061E+00  -1.059E-01   0.000E+00   0.000E+00   1.350E+01   8.990E+00   8.730E+02   1.510E-03  -9.692E-04   0.000E+00  -6.742E+01   5.224E+02
```

OpenFAST Outputs



OpenFAST Post Processing

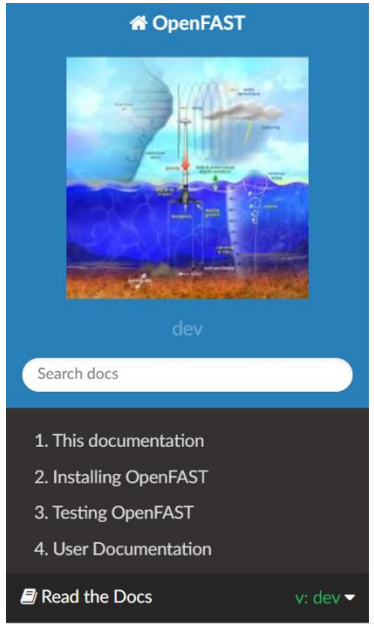


Two post-processing tools using Matlab and Python languages are being actively developed and supported.

https://github.com/OpenFAST

OpenFAST GitHub Resources

OpenFAST Documentation https://openfast.readthedocs.io/en/main/index.html



Docs » OpenFAST Documentation

Edit on GitHub

OpenFAST Documentation

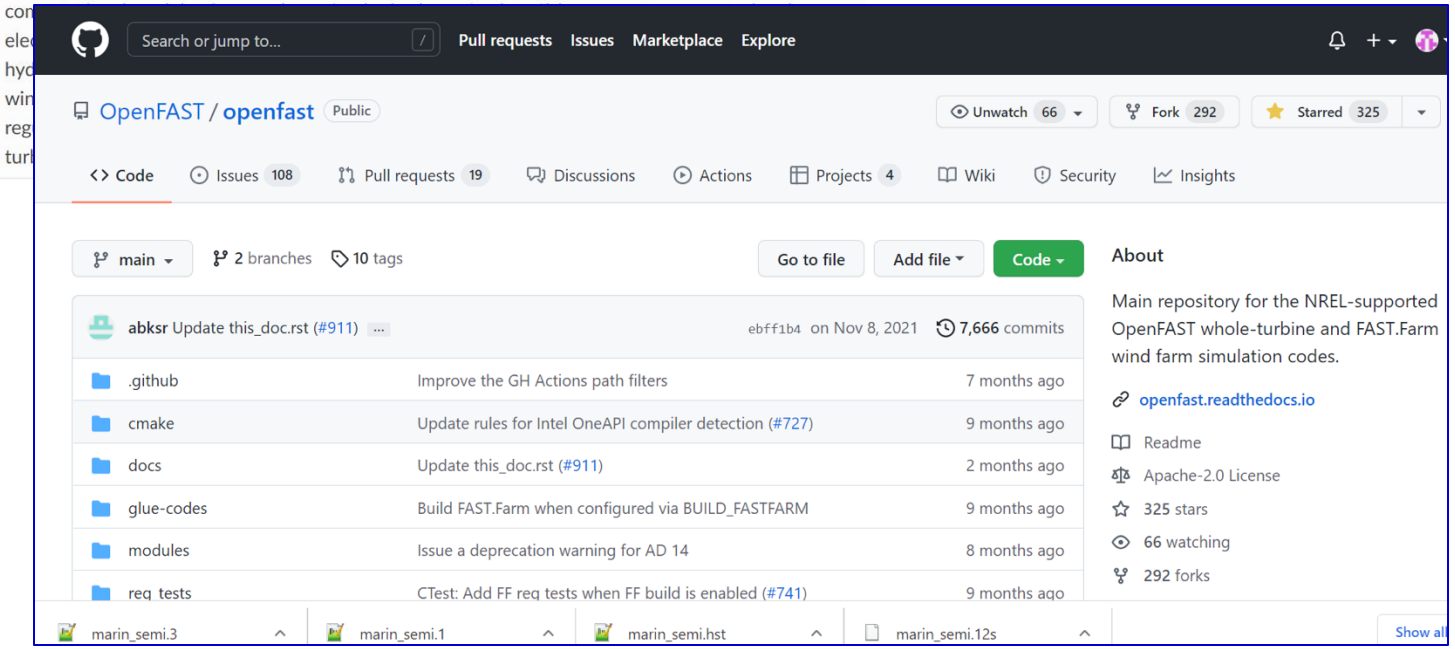
Version

v3.0.0

Date

Dec 29, 2021

OpenFAST is a multi-physics, multi-fidelity tool for simulating the coupled dynamic response of wind turbines. Practically speaking, OpenFAST is the framework (or "glue code") that couples



OpenFAST GitHub repository https://github.com/OpenFAST/openfast

OpenFAST GitHub Resources

Discussion Forum: https://wind.nrel.gov/forum/wind/index.php

Highly recommended to find useful information before posting questions on GitHub or this forum?