WRF WINDFARM EXPERIMENT

WRF EXPERIMENTAL SETUP	
Model Domain	**GRID #1:** 144×160 grid-points, 15 km (15,000 m) resolution **GRID #2:** 301×381 grid-points, 3 km (3,000 m) resolution **GRID #3:** 96×96 grid-points, 0.6 km (600 m) resolution
Model Time-step	60s (**GRID #1**), 12s (**GRID #2**), 4s (**GRID #3**)
# Model (Eta) Levels	60 (see page #5 for schematic of model levels)
Model Top (Pressure)	30hPa
Output Data Frequency	**GRID #1**: 3-Hourly (RAW OUTPUT FILES) **GRID #2**: 1-Hourly (POST-PROCESSED OUTPUT FILES) **GRID #3**: 10-Minutes (POST-PROCESSED OUTPUT FILES)
Interior Nudging	Analysis (Grid) Nudging only applied to **GRID#1** (see page #5)
PHYSICS SCHEMES	
Cloud Microphysics	Goddard Microphysics Scheme [1] [2] [3]
Cumulus/Convection	BMJ Scheme [4] [5] (**GRID #1**) & No Scheme (**GRIDS #2 – 3**)
Radiation	RRTMG Scheme [**RADT = 5min**] [6]
Land Surface	Unified Noah Land-Surface Model [7]
Surface Layer	MM5 Monin-Obukhov Scheme [8]
Planetary Boundary Layer	Mellor-Yamada Nakanishi and Niino (MYNN) Level 2.5 [9]
Sea Surface Temperatures	Time-interpolated SSTs from CFSR + SST Skin Scheme [10]
Wind Farm	Wind Farm scheme [11]
LIST OF OUTPUT FIELDS (TOTAL OF 78)	
2D Output Fields (62)	lat, lon, slp, T2, TH2, rh2, SST, PSFC, PBLH, LH, QFX, HFX, TSK, ZNT, UST, SWDNB, SWUPB, LWDNB, LWUPB, SWDNT, SWUPT, LTDNT, LWUPT, SWDNBC, SWUPBC, LWDNBC, LWUPBC, SWDNTC, SWUPTC, LTDNTC, LWUPTC, ALBEDO, EMISS, GRDFLX, NOAHRES, MICRCLD, CONVCLD, TSLB, SMOIS, SH2O, PRECWT, SR, SFROFF, UDROFF, CANWAT, SNOW, SNOWH, SNOPCX, POTEVP, SWDDIR, SWDDNI, SWDDIF, ICEDEPTH, VDFG, RMOL, MOL, POWER, RAINC, RAINNC, SNOWNC, GRAUPELNC, FGDP
3D Output Fields (16)	ua, va, wa, geopt, pressure, tk, rh, QVAPOR, BR_PBL, QKE, DTKE, qSHEARa, qBUOYa, qDISSa, qWTa, CLDFRA

Output (Height) Levels [m] (GRID #3):

[10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200]

[25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, 500]

Output (Height) Levels [m] (GRID #2):

[50, 100, 150, 200, 300, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000, 2500, 3000, 3500, 4000, 4500, 5000, 5500, 6000, 7000, 8000, 9000, 10000]

2D Output Fields:

lat: latitude, º
lon: longitude, º
slp: Sea Level Pressure, hPa/mb
T2: Temperature at 2-meters, K
TH2: Potential Temperature at 2-meters, K
rh2: Relative Humidity at 2-meters, %
SST: Sea Surface Temperature (input from CFSR), K
PSFC: Surface Pressure, Pa
PBLH: Height of the Planetary Boundary Layer, m
RMOL: Reciprocal of Monin-Obukhov Length, m^{-1}
ZNT: Roughness Length, m
UST: U* in Similarity Theory, $m\,s^{-1}$
MOL: T* in Similarity Theory, K
TSK: Surface Skin Temperature, K
PRECWT: Precipitable Water, $kg\,m^{-2}$
MICRCLD: Microphysics Clouds, $kg\,m^{-2}$
CONVCLD: Convective Clouds, $kg\,m^{-2}$

SR: Fraction of Frozen Precipitation, 0-1
FGDP: Accumulated Fog Deposition between model output steps, mm
RAINNC: Accumulated Precipitation from the Cumulus Scheme between model output steps, mm
RAINNC: Accumulated Precipitation from the Microphysics Scheme between model output steps, mm
SNOWNC: Accumulated Snow and Ice from the Microphysics Scheme between model output steps, mm
GRAUPELNC: Accumulated Graupel from the Microphysics Scheme between model output steps, mm

SRFOFF: Surface Runoff, mm
UDROFF: Underground Runoff, mm
CANWAT: Canopy Water, $kg\,m^{-2}$
SNOWH: Snow Depth, m
SNOW: Snow Water Equivalent, $kg\,m^{-2}$
TSLB: Soil Temperature (4 soil layers), K
SMOIS: Total Soil Moisture Content (4 soil layers), $m^3\,m^{-3}$
SH2O: Unfrozen Soil Moisture Content (4 soil layers), $m^3\,m^{-3}$
SNOPCX: Snow Phase Change Heat Flux, $W\,m^{-2}$
ICEDEPTH: Ice Depth, m
GRDFLX: Ground Heat Flux, $W\,m^{-2}$
POTEVP: Accumulated Potential Evaporation, m
LH: Latent Heat Flux at the Surface, $W\,m^{-2}$
HFX: Upward Heat Flux at the Surface, $W\,m^{-2}$
QFX: Upward Moisture Flux at the Surface, $kg\,m^{-2}\,s^{-1}$
VDFG: Deposition Velocity of Fog, $m\,s^{-1}$
ALBEDO: Albedo, Non-Dimensional
EMISS: Surface Emissivity, Non-Dimensional
NOAHRES: Residual of the Noah Surface Energy Budget, $W\,m^{-2}$
POWER: Power production by wind turbines, W
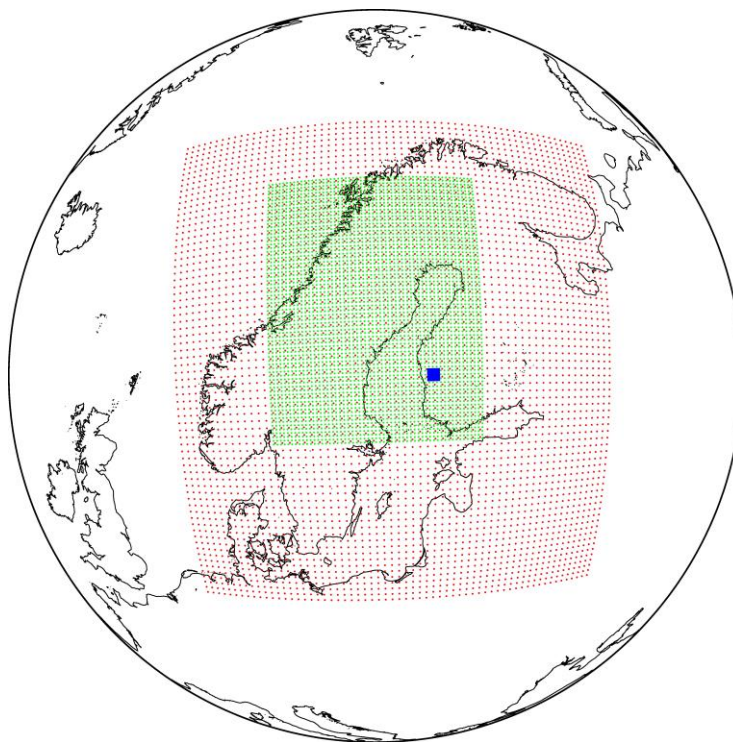
SWDNB: Downward Short-wave Flux at Ground Surface, $W\,m^{-2}$
SWDNBC: Clear-Sky Downward Short-wave Flux at Ground Surface, $W\,m^{-2}$

SWUPB: Upward Short-wave Flux at Ground Surface, W m^{-2}
SWUPBC: Clear-Sky Upward Short-wave Flux at Ground Surface, W m^{-2}
LWDNB: Downward Long-wave Flux at Ground Surface, W m^{-2}
LWDNBC: Clear-Sky Downward Long-wave Flux at Ground Surface, W m^{-2}
LWUPB: Upward Long-wave Flux at Ground Surface, W m^{-2}
LWUPBC: Clear-Sky Upward Long-wave Flux at Ground Surface, W m^{-2}
SWDNT: Downward Short-wave Flux at TOA, W m^{-2}
SWDNTC: Clear-Sky Downward Short-wave Flux at TOA, W m^{-2}
SWUPT: Upward Short-wave Flux at TOA, W m^{-2}
SWUPTC: Clear-Sky Upward Short-wave Flux at TOA, W m^{-2}
LWDNT: Downward Long-wave Flux at TOA, W m^{-2}
LWDNTC: Clear-Sky Downward Long-wave Flux at TOA, W m^{-2}
LWUPT: Upward Long-wave Flux at TOA, W m^{-2}
LWUPTC: Clear-Sky Upward Long-wave Flux at TOA, W m^{-2}
SWDDIR: Downward Short-wave Flux at Ground Surface (Direct), W m^{-2}
SWDDNI: Downward Short-wave Flux at Ground Surface (Normal), W m^{-2}
SWDDIF: Downward Short-wave Flux at Ground Surface (Diffuse), W m^{-2}

3D Output Fields:
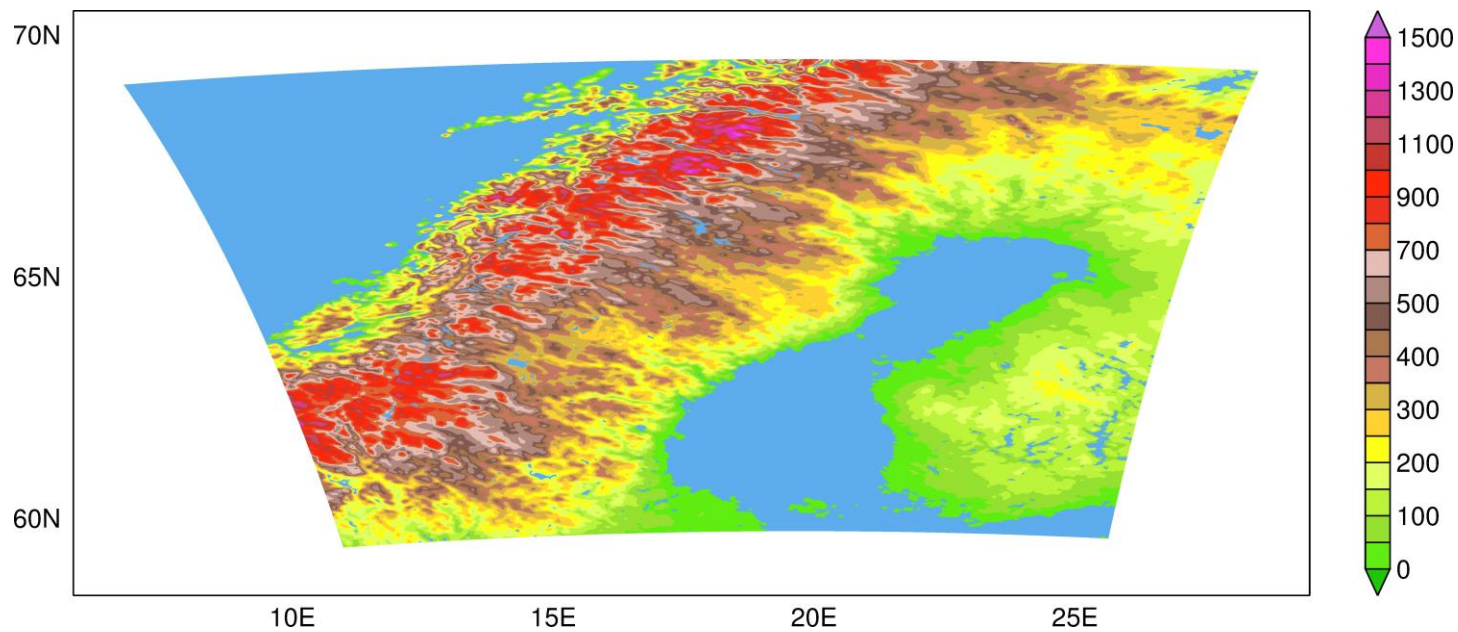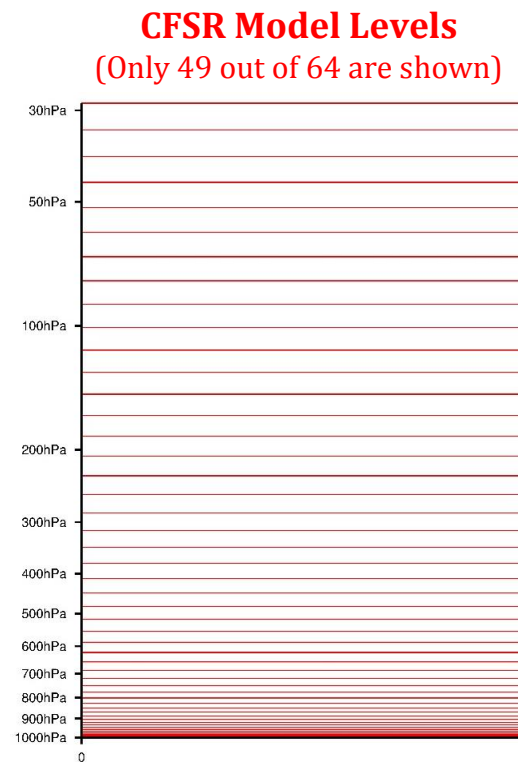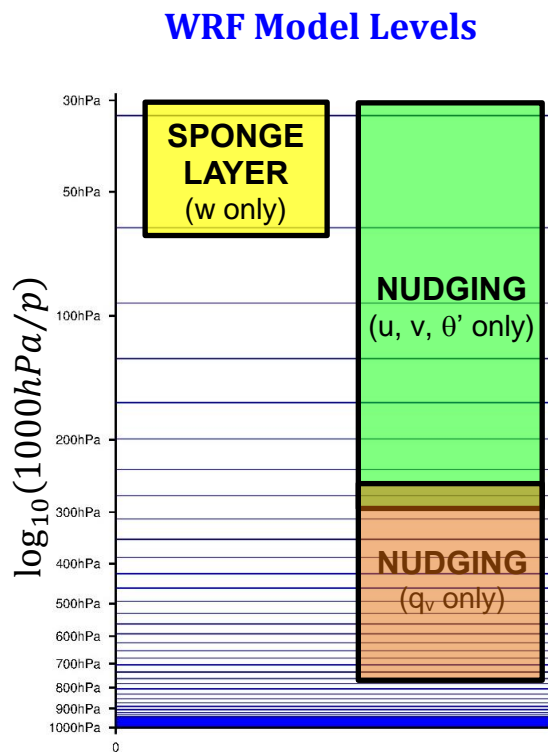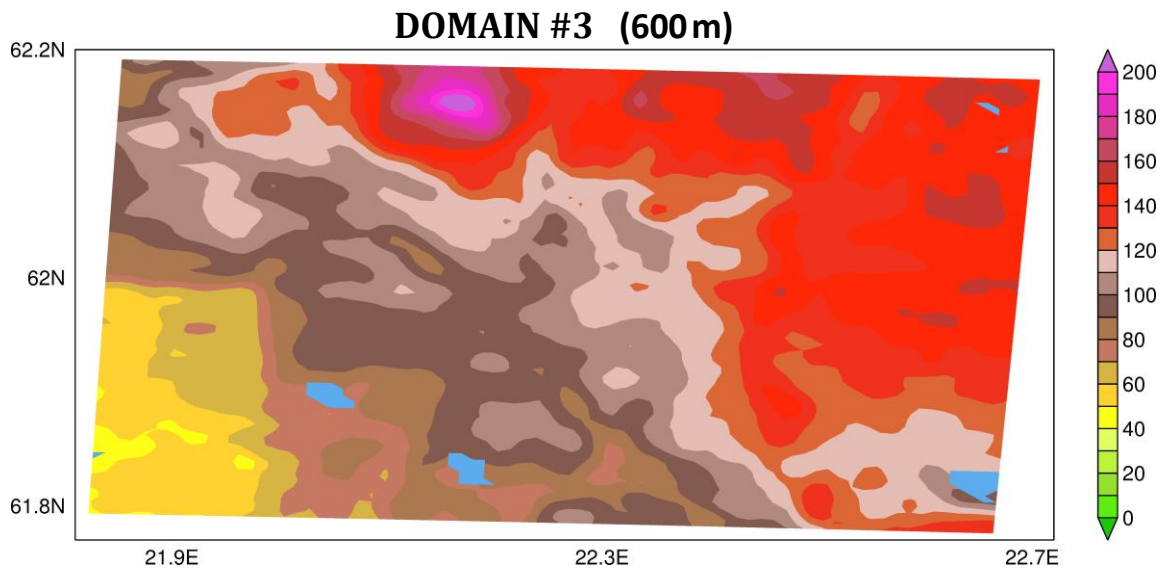
ua: U-Wind Component on Mass Points, m s^{-1}
va: V-Wind Component on Mass Points, m s^{-1}
wa: W-Wind Component on Mass Points, m s^{-1}
tk: Temperature, K
rh: Relative Humidity, %
geopt: Full Model Geopotential, m^2 s^{-2}
pressure: Full Model Pressure, hPa/mb
QVAPOR: Water Vapour Mixing Ratio, kg kg^{-1}
BR_PBL: Bulk Richardson Number from PBL Scheme, Non-Dimensional
QKE: **Twice** Turbulent Kinetic Energy (TKE) from PBL Scheme, m^2 s^{-2}
DTKE: TKE Change, m^2 s^{-2}
qSHEARa: TKE Production (Shear) on Mass Points, m^2 s^{-2}
qBUOYa: TKE Production (Buoyancy) on Mass Points, m^2 s^{-2}
qDISSa: TKE Dissipation on Mass Points, m^2 s^{-2}
qWTa: TKE Vertical Transport on Mass Points, m^2 s^{-2}
CLDFRA: Cloud Fraction from Microphysics Scheme, 0-1

Model Domain Orography (<u>excluding boundary regions</u>; units of meters):

DOMAIN #2   (3 km)

DOMAIN #3 (600 m)

WRF Model Levels

SPONGE LAYER (w only)

NUDGING (u, v, θ' only)

NUDGING (q$_v$ only)

$\log_{10}(1000hPa/p)$

CFSR Model Levels
(Only 49 out of 64 are shown)

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