Supplemental Materials for: Hurricane impacts in the United States East Coast offshore wind energy lease areas

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This document contains:

- Further details of the NDBC buoy measurements.
- Figs. S1 and S2: Details of the storm tracking for Hurricane Irene and Hurricane Sandy based on output from the outer model domain.
- Figs. S3-S9: Time series of wind speeds, sea surface temperatures, sea level pressure, and significant wave height from observations on NDBC buoys and as simulated with WRF and COAWST for Hurricanes Irene and Sandy without the action of wind turbines.
- Fig. S10: Mean simulated hub-height wind speed and time series of the fraction of WT grid cells with HH WS > 25 m s^{-1} for simulations without the WFP active.
- Fig. S11: Spatial depiction of the mean difference in capacity factor (CF) from the simulations, WRF minus COAWST, for Hurricanes Irene and Sandy.
- Fig. S12: Time series of simulated 10-m wind speed close to the hurricane center.

From https://zenodo.org/records/14895862, the reader can obtain:

- Time lapse videos of HH WS and CF based on simulations with WRF and COAWST (without and with WFP active) for Hurricanes Irene and Sandy.
- The header file for the COAWST simulations, an initial (non-restart) WRF namelist.input file, an initial (non-restart) ROMS ocean.in file, and initial (non-restart) SWAN swan.in files. For more information about the files, refer to https://github.com/DOI-USGS/COAWST.

Further details of the NDBC buoy measurements:

The mixture of 3-meter foam and 3-meter discus buoys have anemometer heights of 4.1 or 3.8 m above site elevation (site elevation is sea level), barometer elevations of 3.4, 2.7, or 2.4 m above sea level, sea temperature depths of 1.5 or 2 m below the water line, and water depths from 24 to 4501 m. Note that buoy 41036, a 3-meter discus buoy, was disestablished in 2015 and its heights, elevations, and depths are not included in the previous discussion. Each of the buoys provide both continuous winds data and standard meteorological data. Continuous winds data include a 10-min average WS value every 10 min and a maximum 5-s peak wind gust once an hour (with the hour starting/ending at 50 min past the top of the hour), with the time of occurrence noted. Standard meteorological data include SST, SLP, and Hs ("the average of the highest one-third of all of the wave heights during the 20-min sampling period"), each provided at 50 min past the top of the hour.
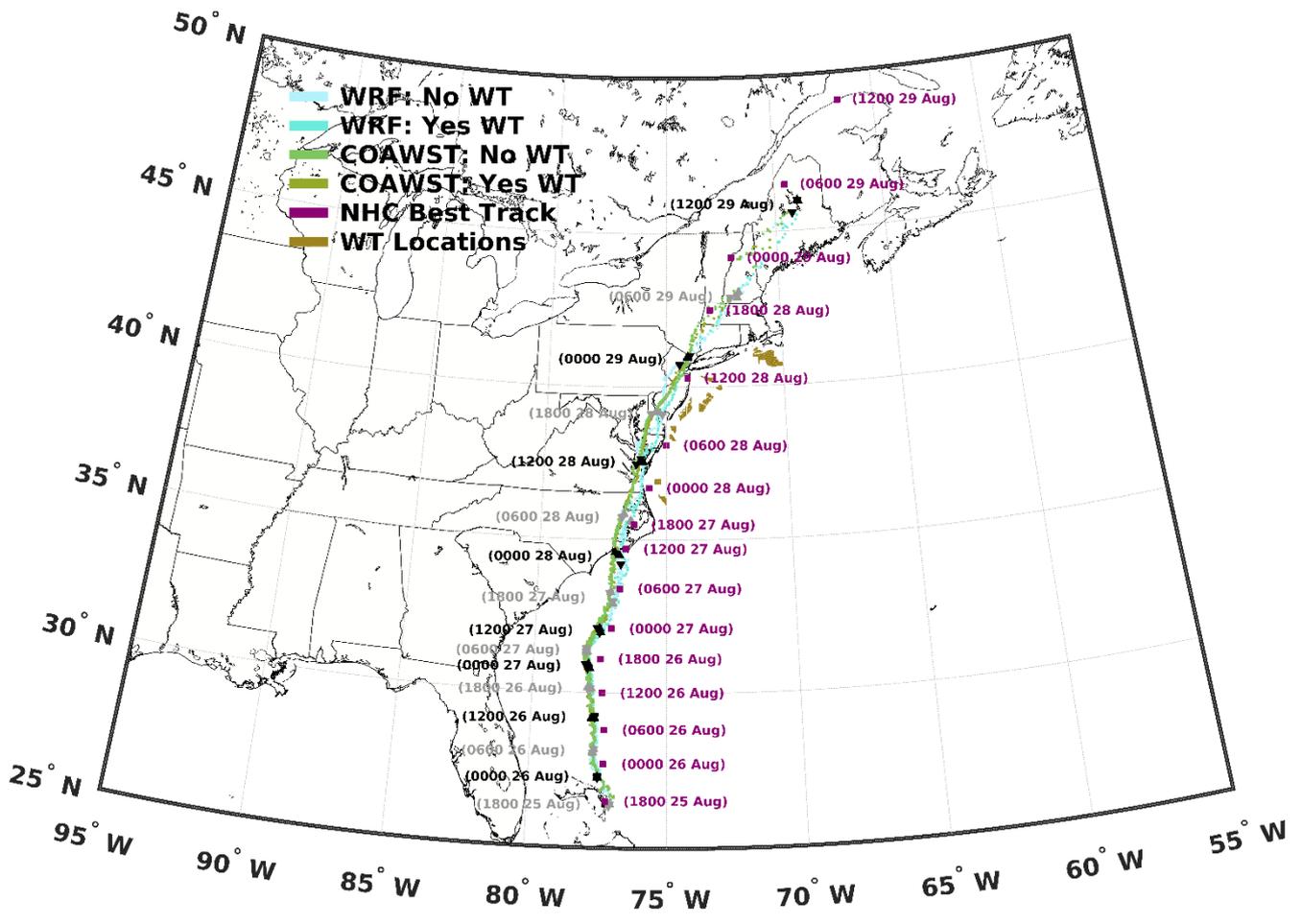
Figure S1: Tracks of Hurricane Irene in d01 based on the minimum SLP every 10 min and the corresponding NHC "best track" locations. Hurricane Irene is tracked from 1800 UTC 25 August 2011 through 1200 UTC 29 August 2011.

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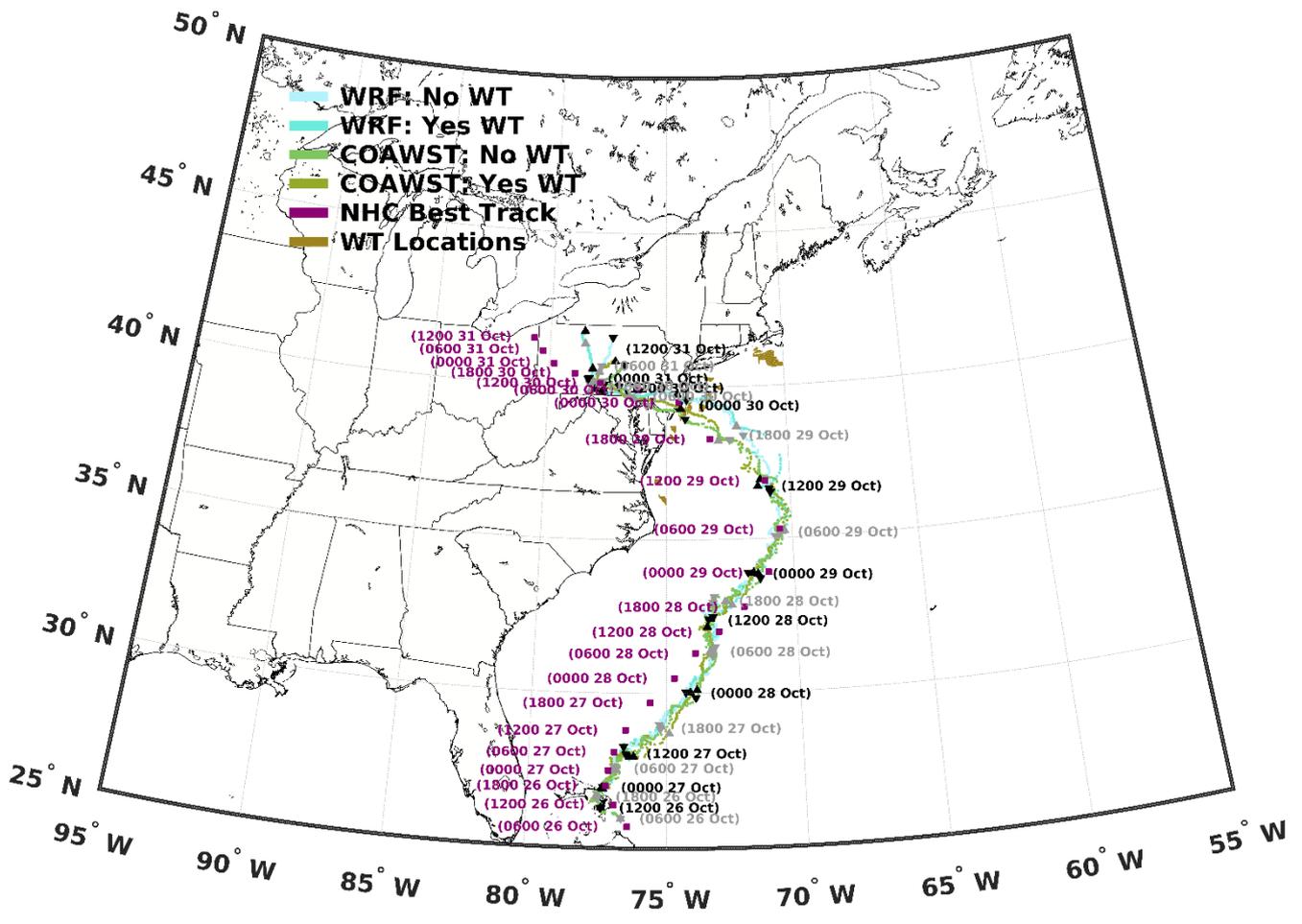
Figure S2: Tracks of Hurricane Sandy in d01 based on the minimum SLP every 10 min and the corresponding NHC "best track" locations. Hurricane Sandy is tracked from 0600 UTC 26 October 2012 through 1200 UTC 31 October 2012.

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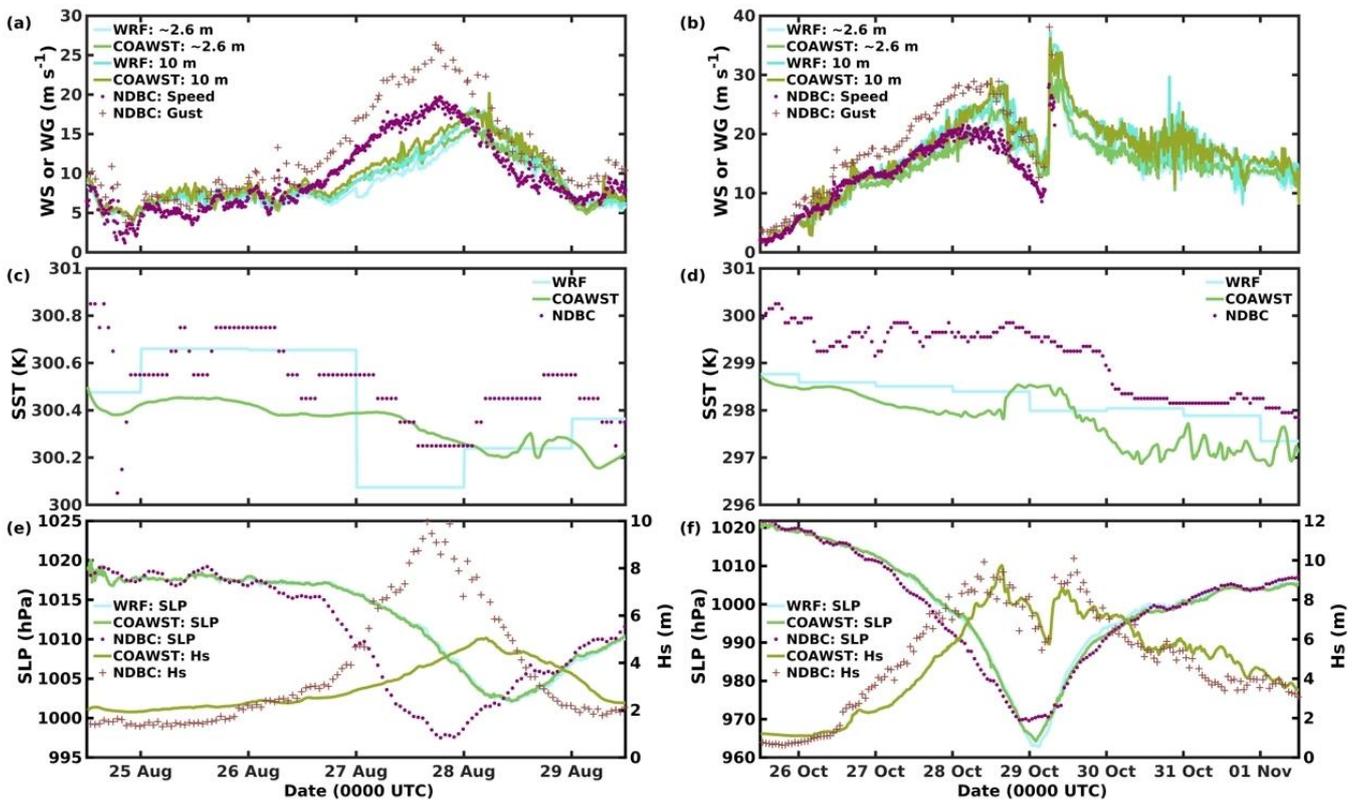
Figure S3: Time series of (a, b) wind speeds and wind gusts (WS or WG [m s⁻¹]), (c, d) sea surface temperatures (SST [K]), and (e, f) sea level pressure (SLP [hPa]) and significant wave height (Hs [m]) from observations and simulations (WRF and COAWST) for Hurricane Irene (a, c, and e) and Hurricane Sandy (b, d, and f) at buoy 41001 (see location in main text Fig. 2a). Simulations performed without the action of wind turbines.
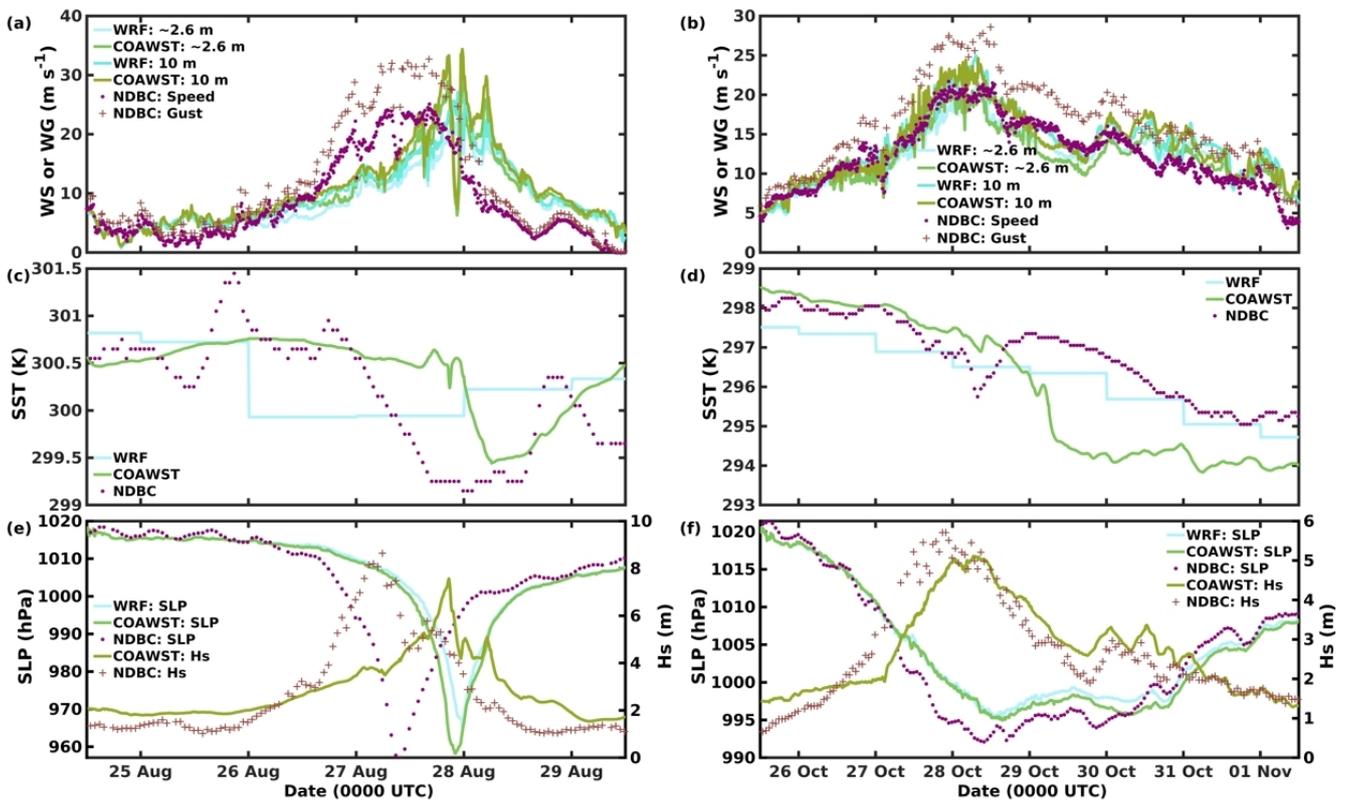
Figure S4: Time series of (a, b) wind speeds and wind gusts (WS or WG [m s⁻¹]), (c, d) sea surface temperatures (SST [K]), and (e, f) sea level pressure (SLP [hPa]) and significant wave height (Hs [m]) from observations and simulations (WRF and COAWST) for Hurricane Irene (a, c, and e) and Hurricane Sandy (b, d, and f) at buoy 41036 (see location in main text Fig. 2a). Simulations performed without the action of wind turbines.
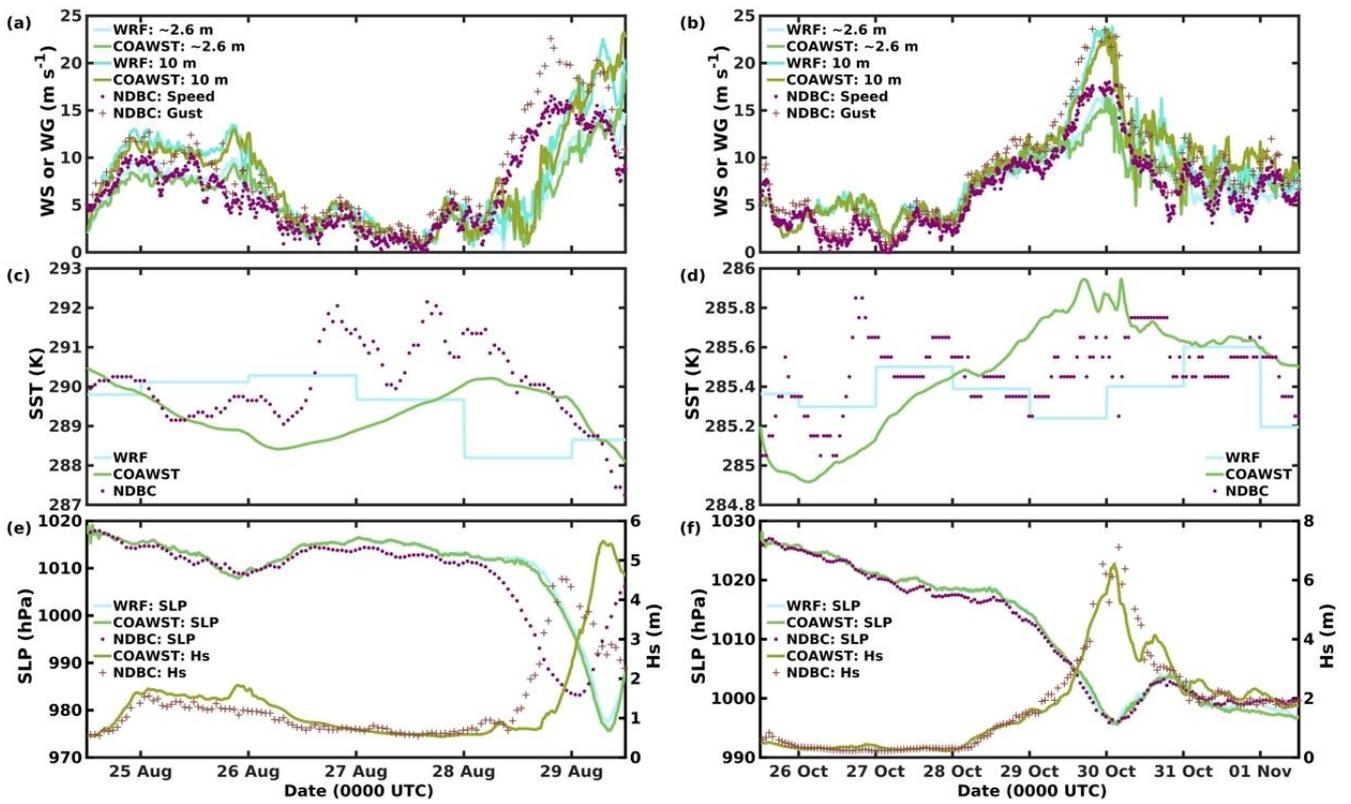
Figure S5: Time series of (a, b) wind speeds and wind gusts (WS or WG [m s⁻¹]), (c, d) sea surface temperatures (SST [K]), and (e, f) sea level pressure (SLP [hPa]) and significant wave height (Hs [m]) from observations and simulations (WRF and COAWST) for Hurricane Irene (a, c, and e) and Hurricane Sandy (b, d, and f) at buoy 44007 (see location in main text Fig. 2a). Simulations performed without the action of wind turbines.
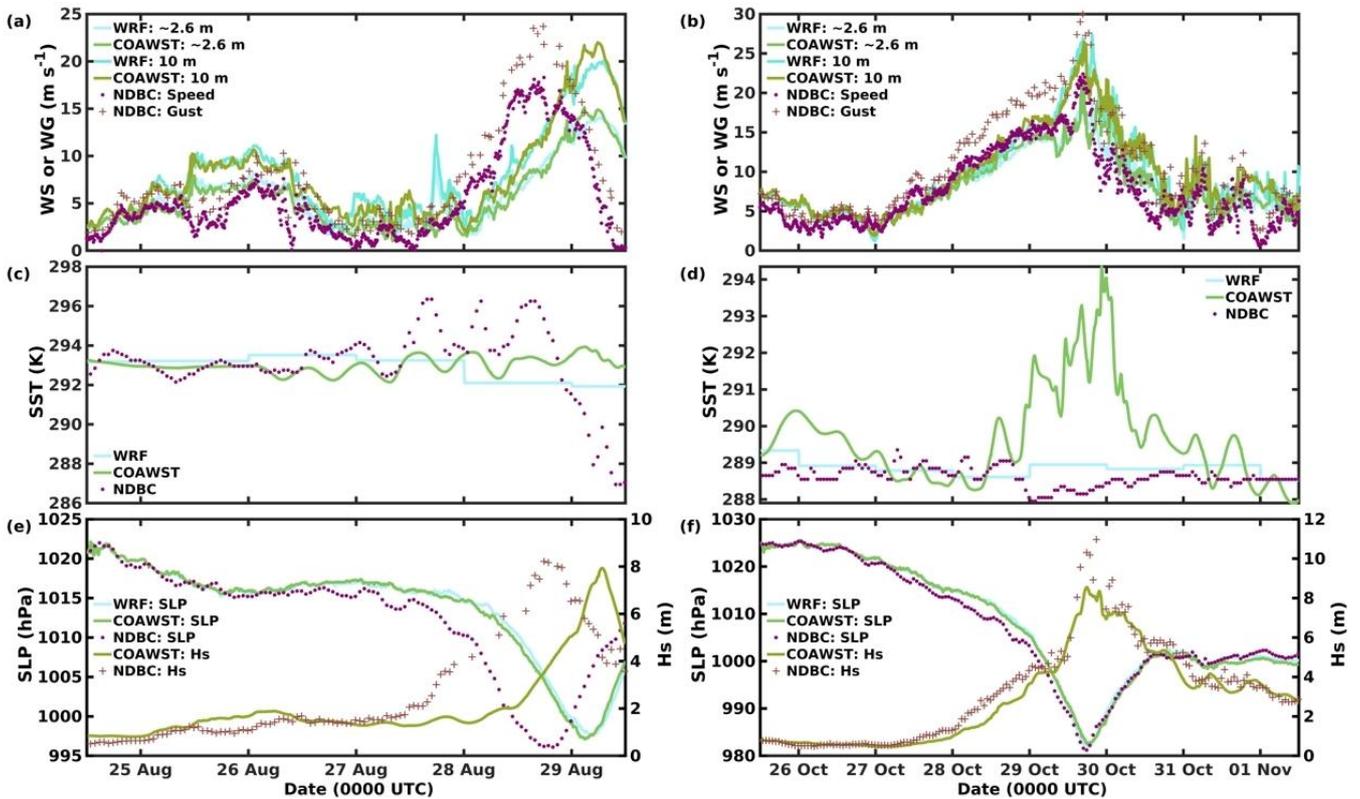
Figure S6: Time series of (a, b) wind speeds and wind gusts (WS or WG [m s⁻¹]), (c, d) sea surface temperatures (SST [K]), and (e, f) sea level pressure (SLP [hPa]) and significant wave height (Hs [m]) from observations and simulations (WRF and COAWST) for Hurricane Irene (a, c, and e) and Hurricane Sandy (b, d, and f) at buoy 44008 (see location in main text Fig. 2a). Simulations performed without the action of wind turbines.
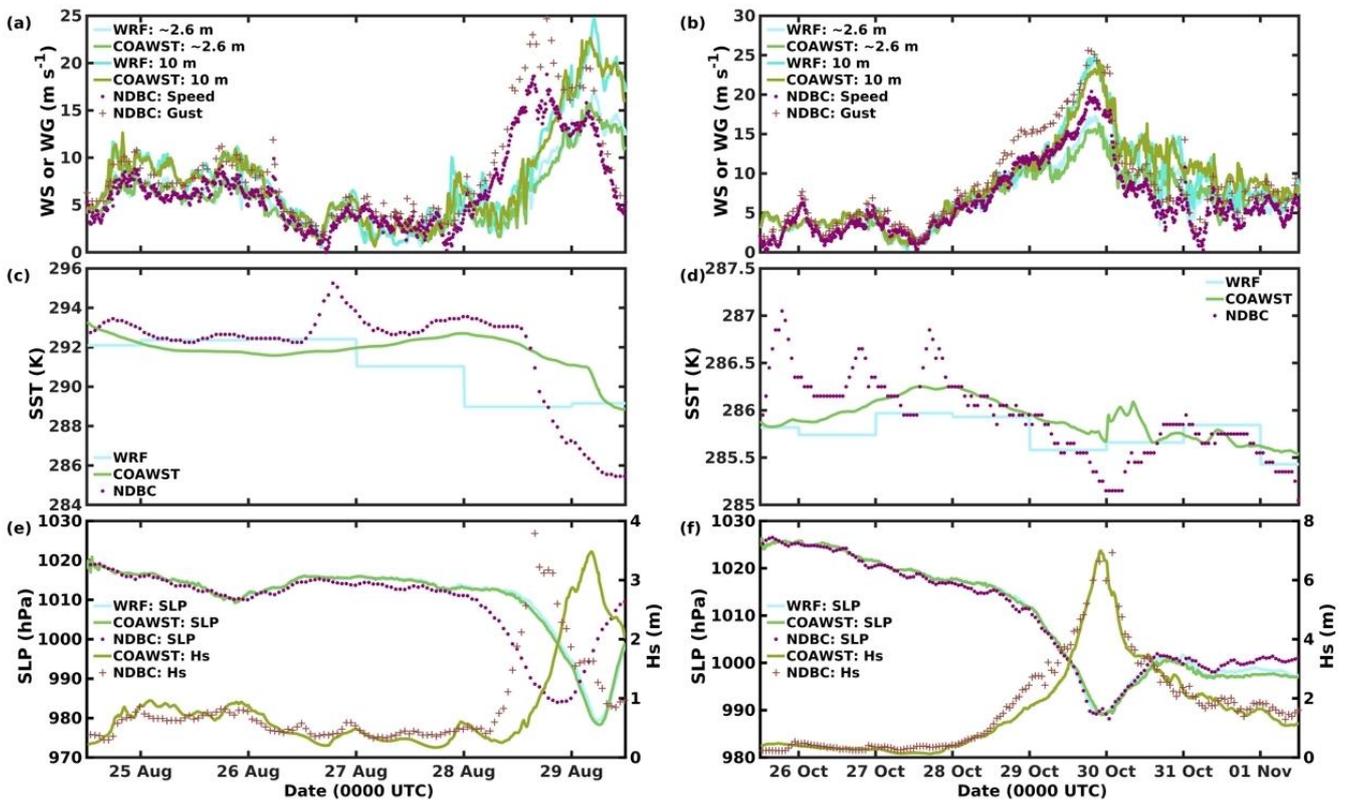
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Figure S7: Time series of (a, b) wind speeds and wind gusts (WS or WG [m s⁻¹]), (c, d) sea surface temperatures (SST [K]), and (e, f) sea level pressure (SLP [hPa]) and significant wave height (Hs [m]) from observations and simulations (WRF and COAWST) for Hurricane Irene (a, c, and e) and Hurricane Sandy (b, d, and f) at buoy 44013 (see location in main text Fig. 2a). Simulations performed without the action of wind turbines.

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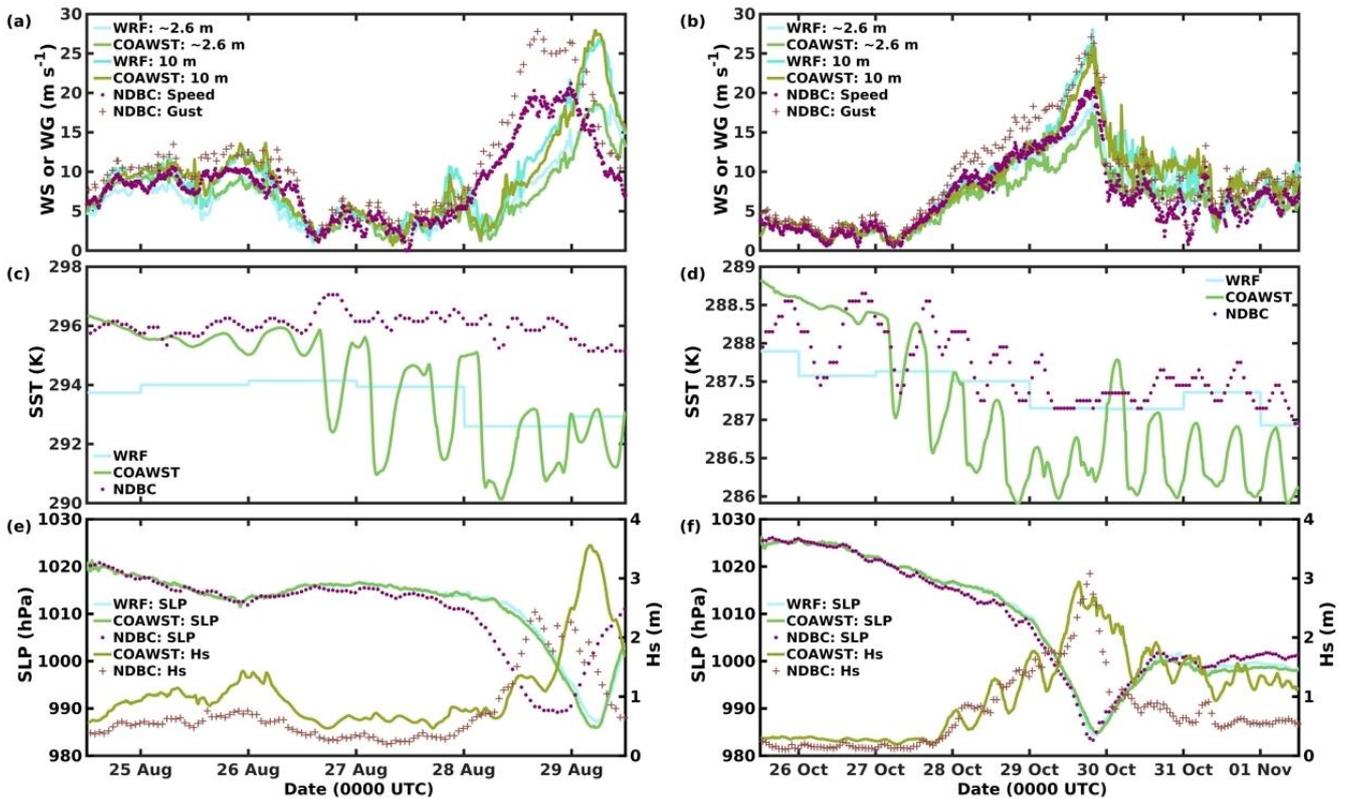
Figure S8: Time series of (a, b) wind speeds and wind gusts (WS or WG [m s⁻¹]), (c, d) sea surface temperatures (SST [K]), and (e, f) sea level pressure (SLP [hPa]) and significant wave height (Hs [m]) from observations and simulations (WRF and COAWST) for Hurricane Irene (a, c, and e) and Hurricane Sandy (b, d, and f) at buoy 44020 (see location in main text Fig. 2a). Simulations

80 performed without the action of wind turbines.
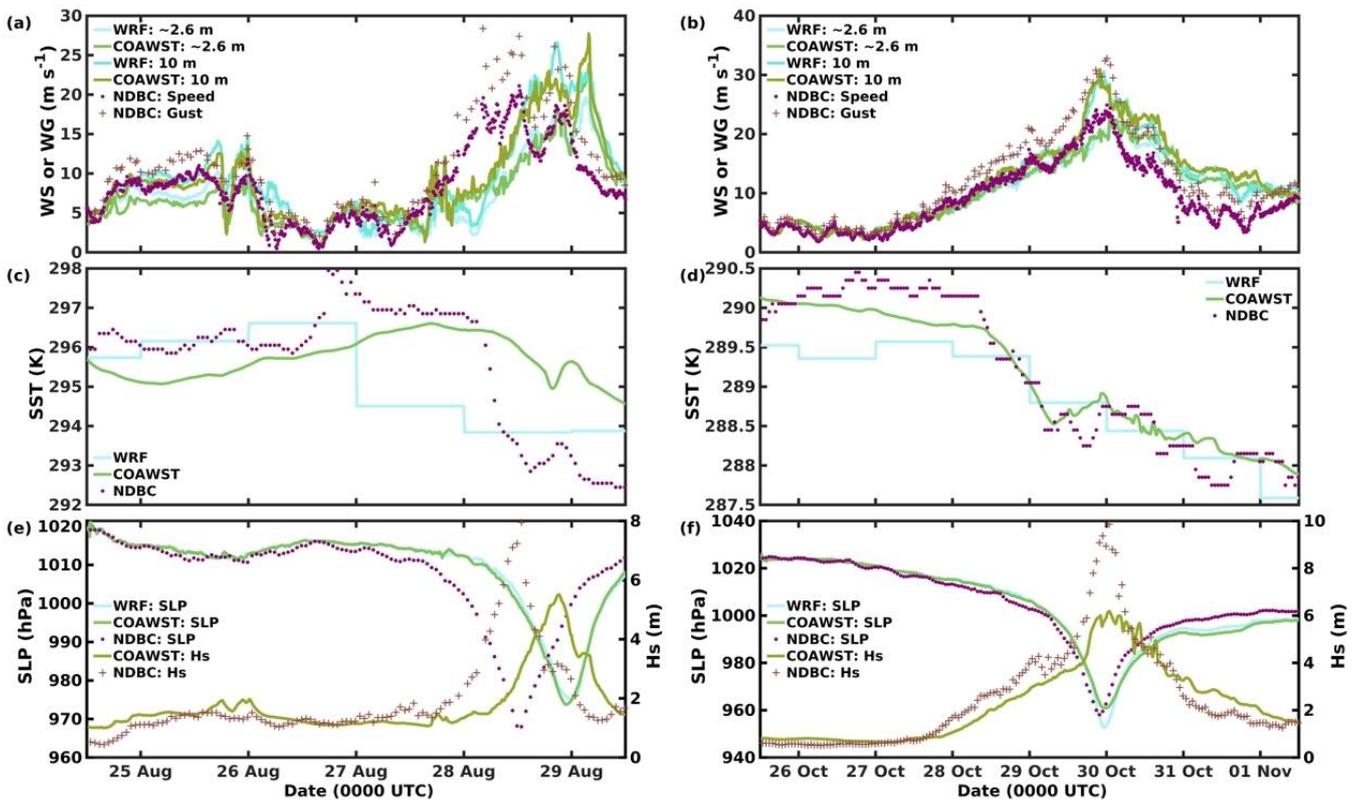
Figure S9: Time series of (a, b) wind speeds and wind gusts (WS or WG [m s^{-1}]), (c, d) sea surface temperatures (SST [K]), and (e, f) sea level pressure (SLP [hPa]) and significant wave height (Hs [m]) from observations and simulations (WRF and COAWST) for Hurricane Irene (a, c, and e) and Hurricane Sandy (b, d, and f) at buoy 44065 (see location in main text Fig. 2a). Simulations performed without the action of wind turbines.
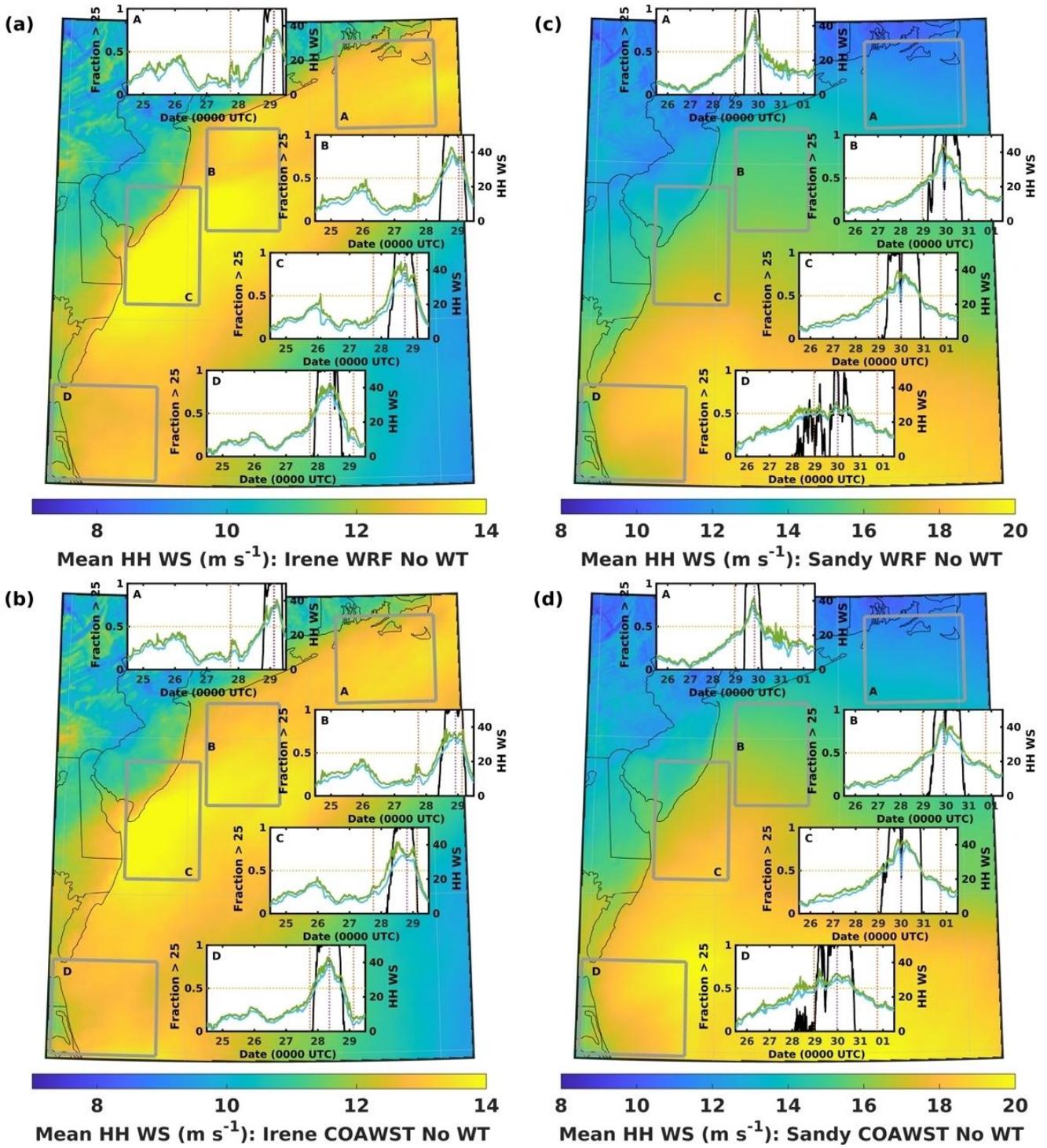
Figure S10: Mean hub-height wind speed (HH WS) and time series of the fraction of wind turbine grid cells with HH WS > 25 m s⁻¹ (left axis) plus the mean (blue) and maximum (green) HH WS in those grid cells (right axis) in simulations with WRF and COAWST without the WFP active. Orange dashed lines indicate the start and end time of storm tracking within d02. The purple dashed line represents the time when the location of the minimum SLP is closest to the cluster center. The yellow line indicates HH WS of 25 m s⁻¹. For simulations with the WFP active, see main text Fig. 7.
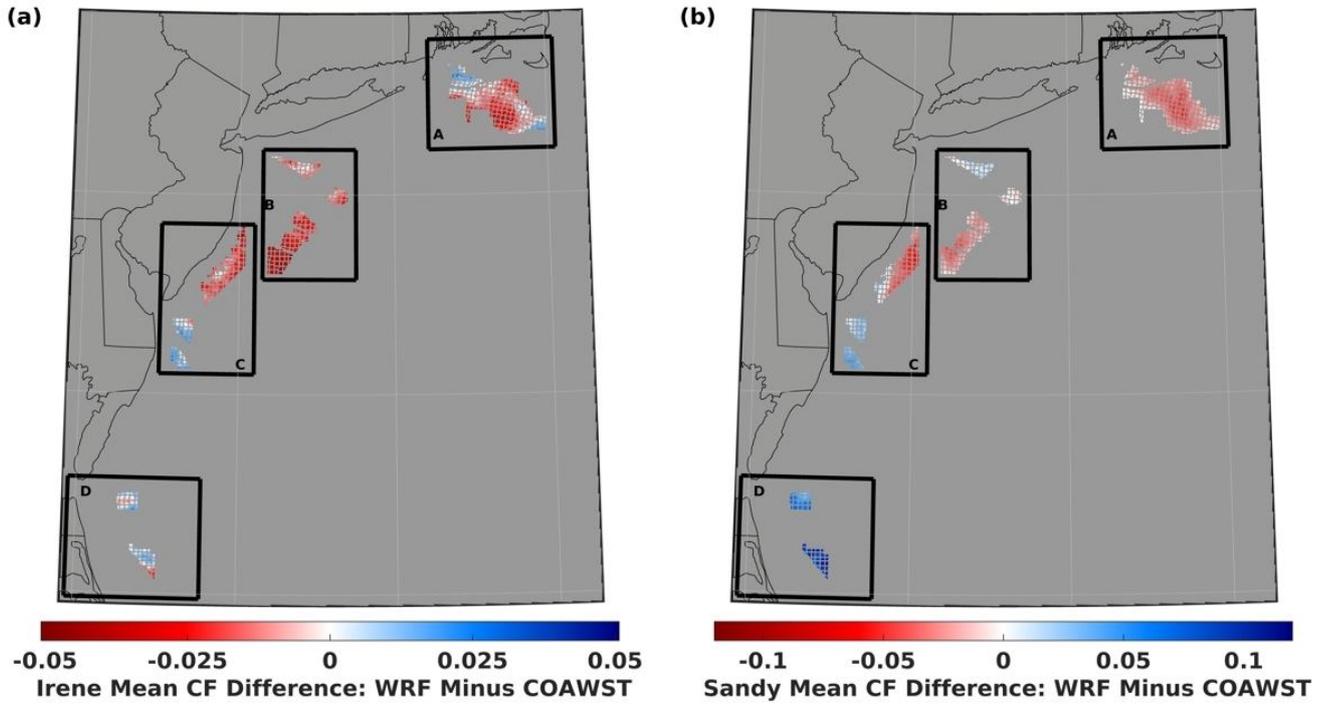
Figure S11: Mean difference in capacity factor (CF) from the simulations, WRF minus COAWST, for Hurricanes (a) Irene and (b) Sandy.
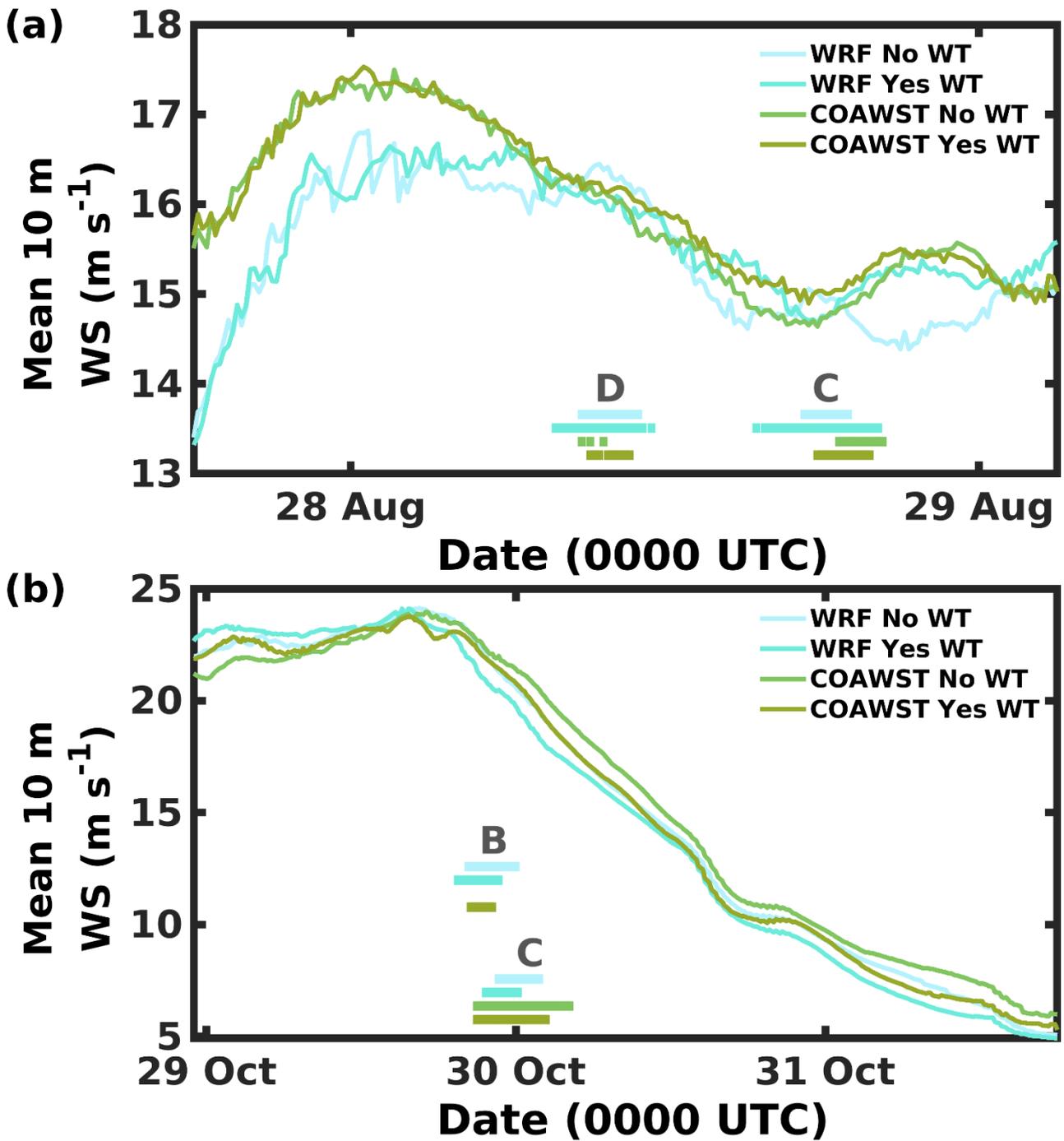
Figure S12: Time series of the mean 10-m WS from 50 to 375 km from the minimum SLP location for Hurricanes (a) Irene and (b) Sandy. The horizontal lines near "D" and "C" for Hurricane Irene and near "B" and "C" for Hurricane Sandy mark the times when the minimum SLP is within 100 km of the center of the specified offshore wind energy LA cluster.