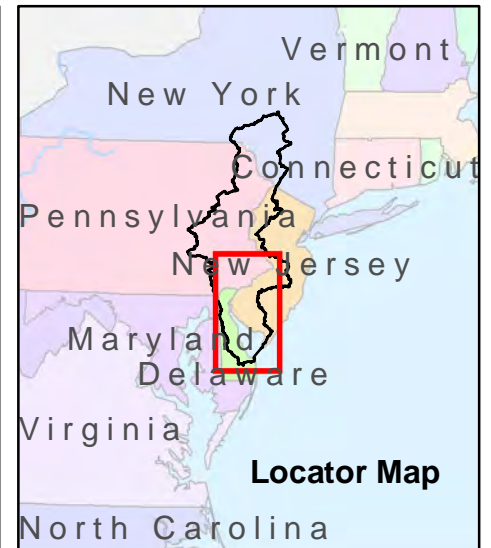
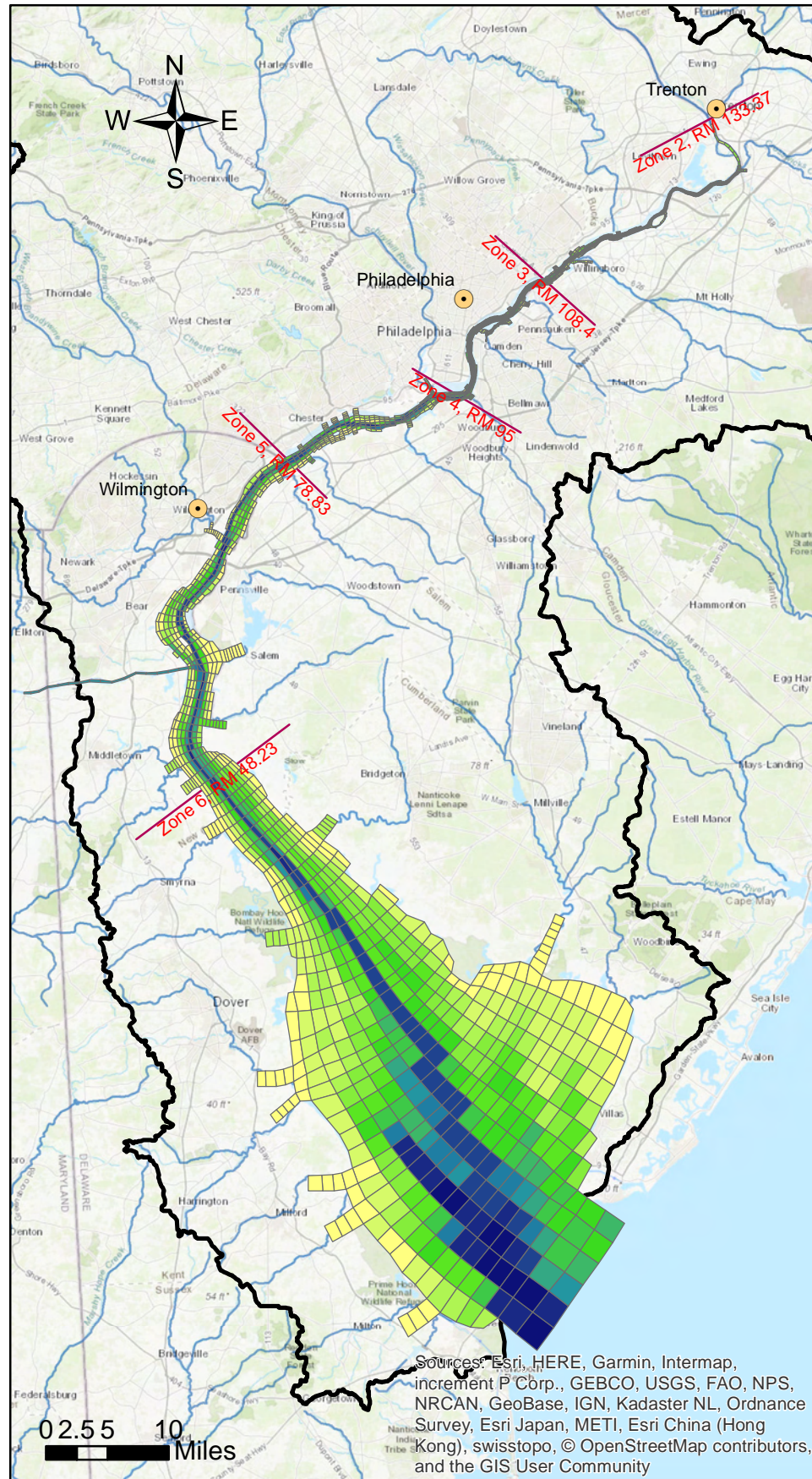


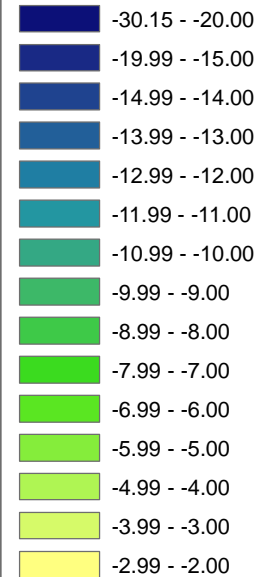
Appendix A: Numerical grid and projected bathymetry



Legend

● Major City

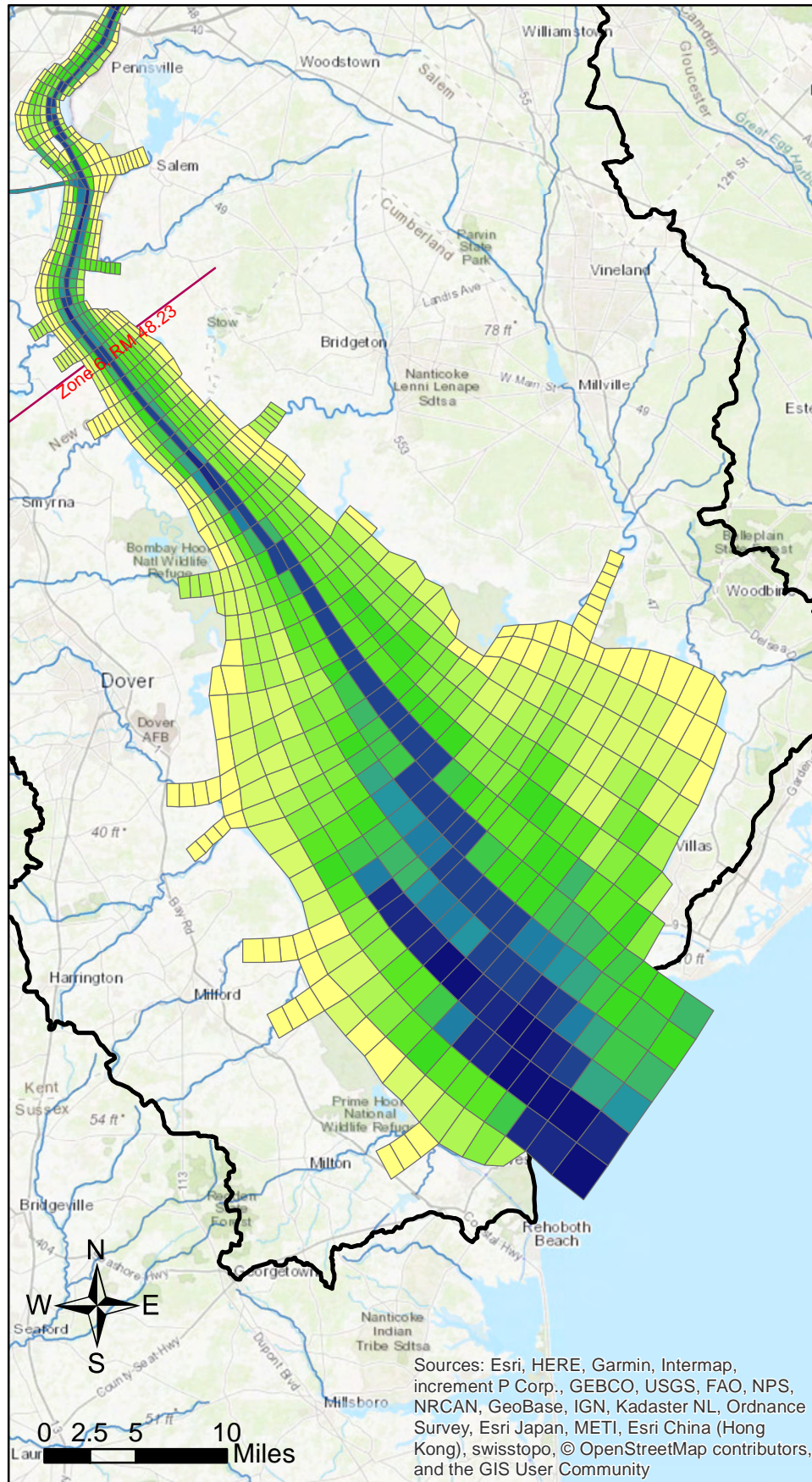
Numerical Grid and Bathymetry
m, NAVD88



— DRBC Water Quality Zones

— Delaware River Basin Boundary

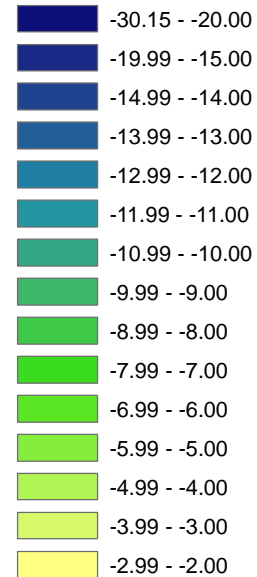
Figure 2.3-1a
Numerical Grid and Projected Bathymetry



Legend

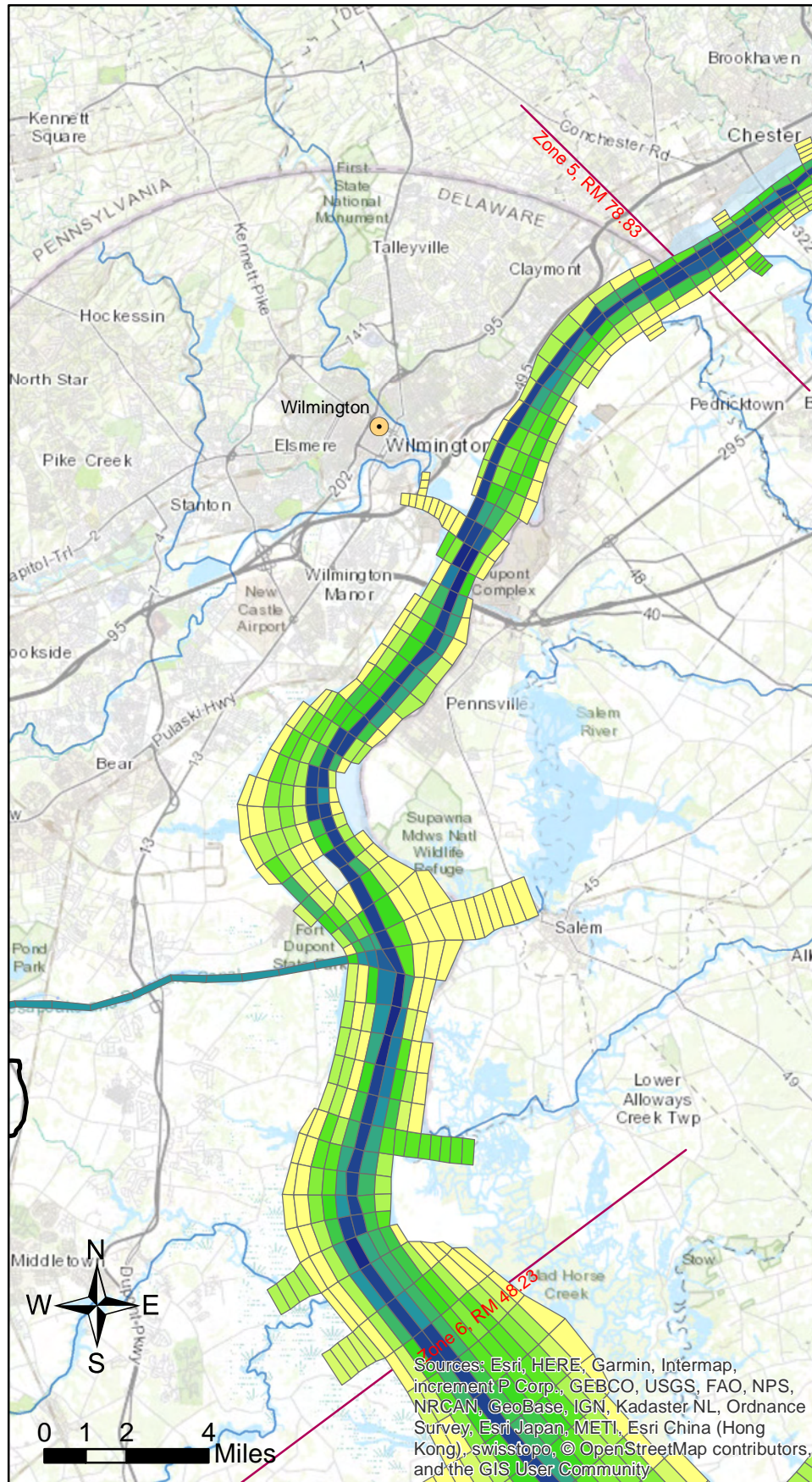
● Major City

Numerical Grid and Bathymetry
m, NAVD88



DRBC Water Quality Zones

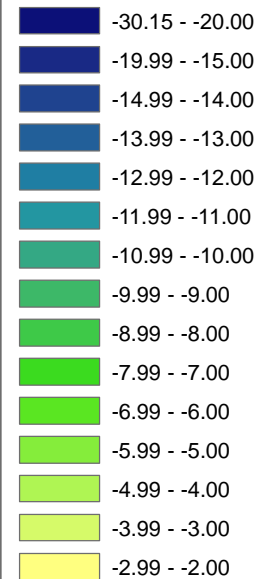
Delaware River Basin Boundary



Legend

● Major City

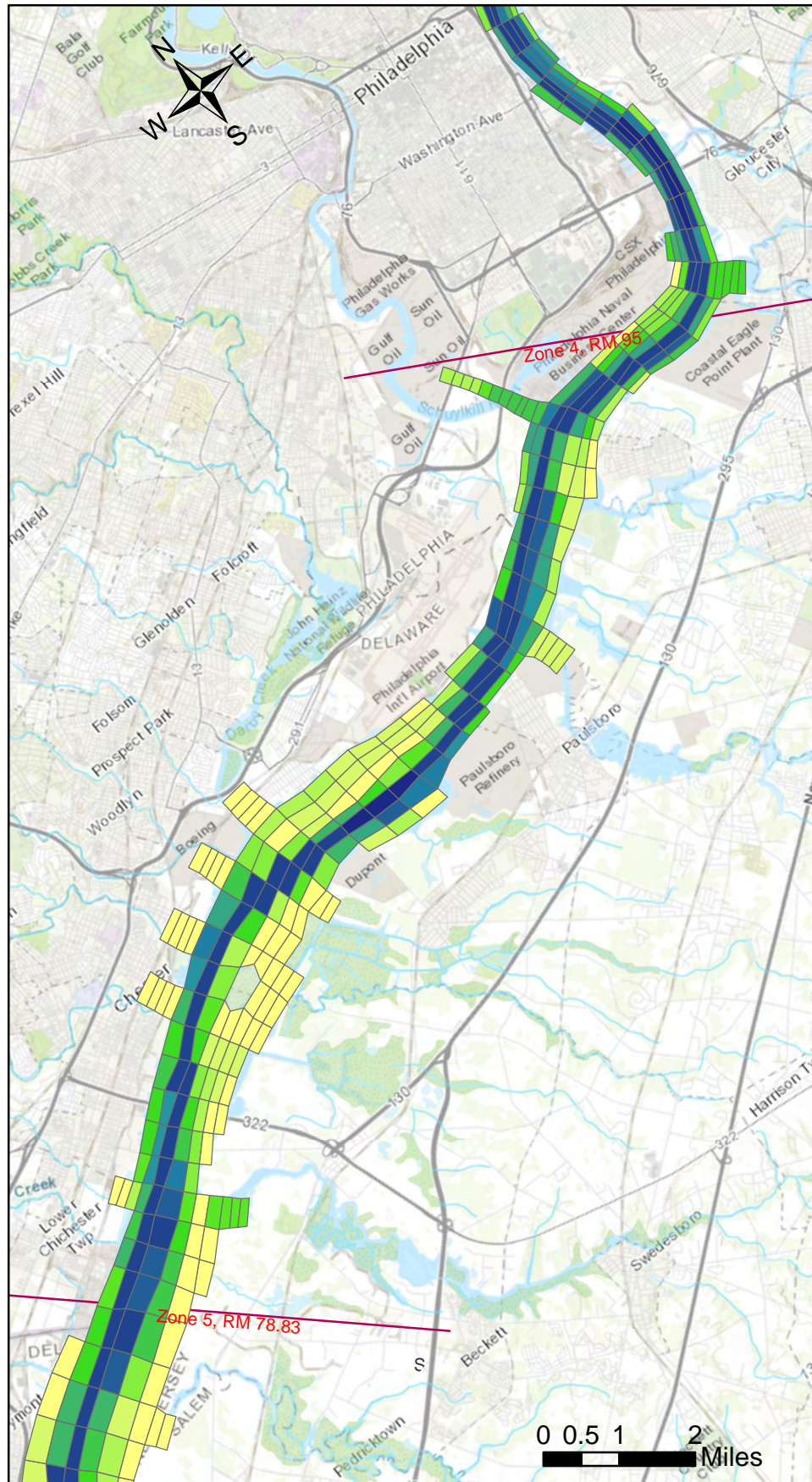
Numerical Grid and Bathymetry
m, NAVD88



— DRBC Water Quality Zones

□ Delaware River Basin Boundary

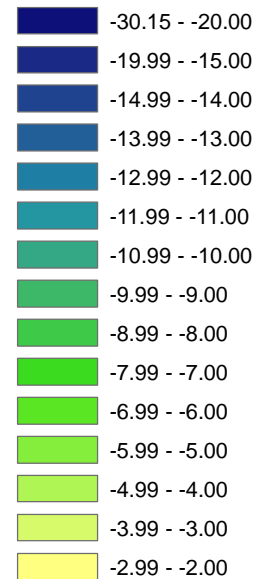
Figure 2.3-1c
Numerical Grid and Projected Bathymetry, Zone 5



Legend

● Major City

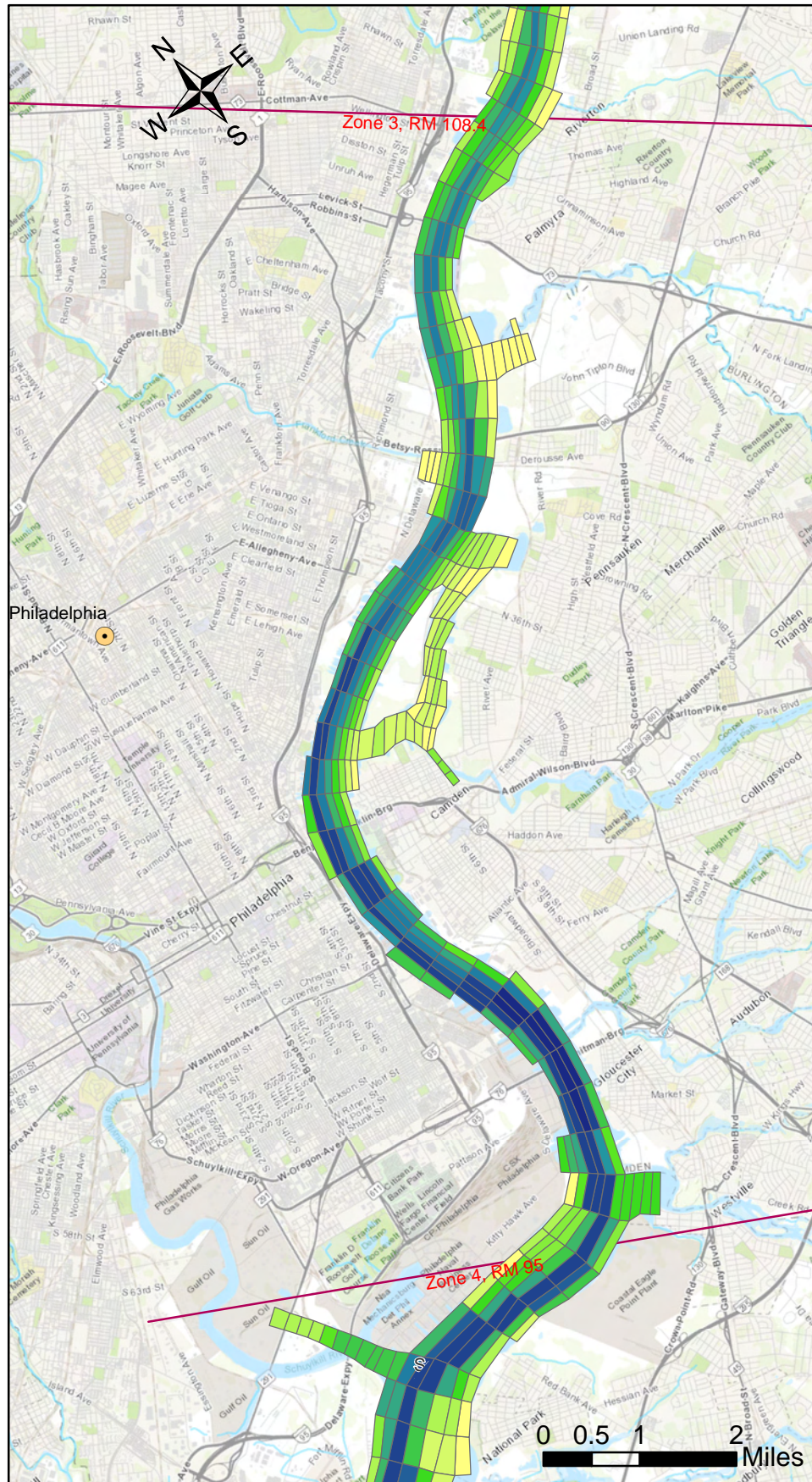
Numerical Grid and Bathymetry
m, NAVD88



— DRBC Water Quality Zones

▭ Delaware River Basin Boundary

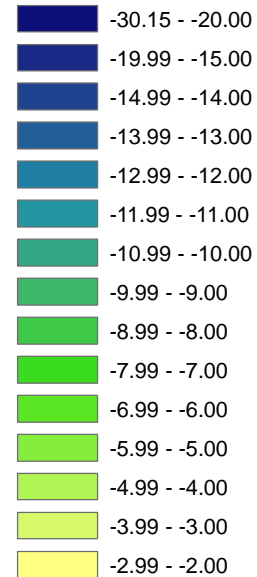
Figure 2.3-1d
Numerical Grid and Projected Bathymetry, Zone 4



Legend

● Major City

Numerical Grid and Bathymetry
m, NAVD88



— DRBC Water Quality Zones

▭ Delaware River Basin Boundary

Figure 2.3-1e
Numerical Grid and Projected Bathymetry, Zone 3

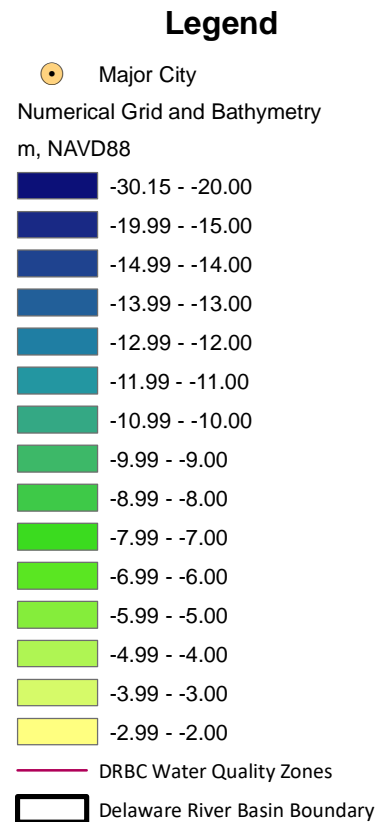
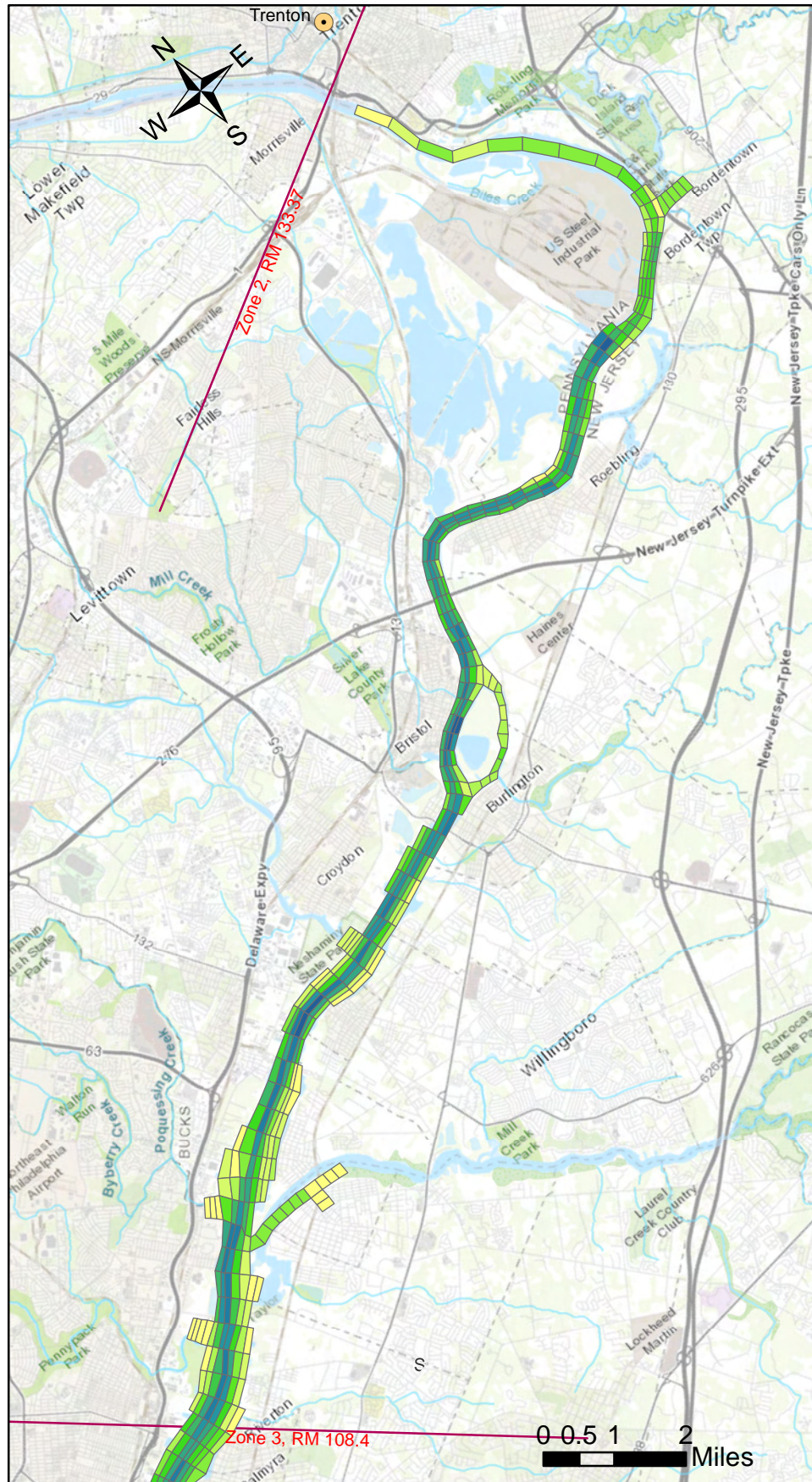


Figure 2.3-1f
Numerical Grid and Projected Bathymetry, Zone 2

Appendix B: Meteorological data

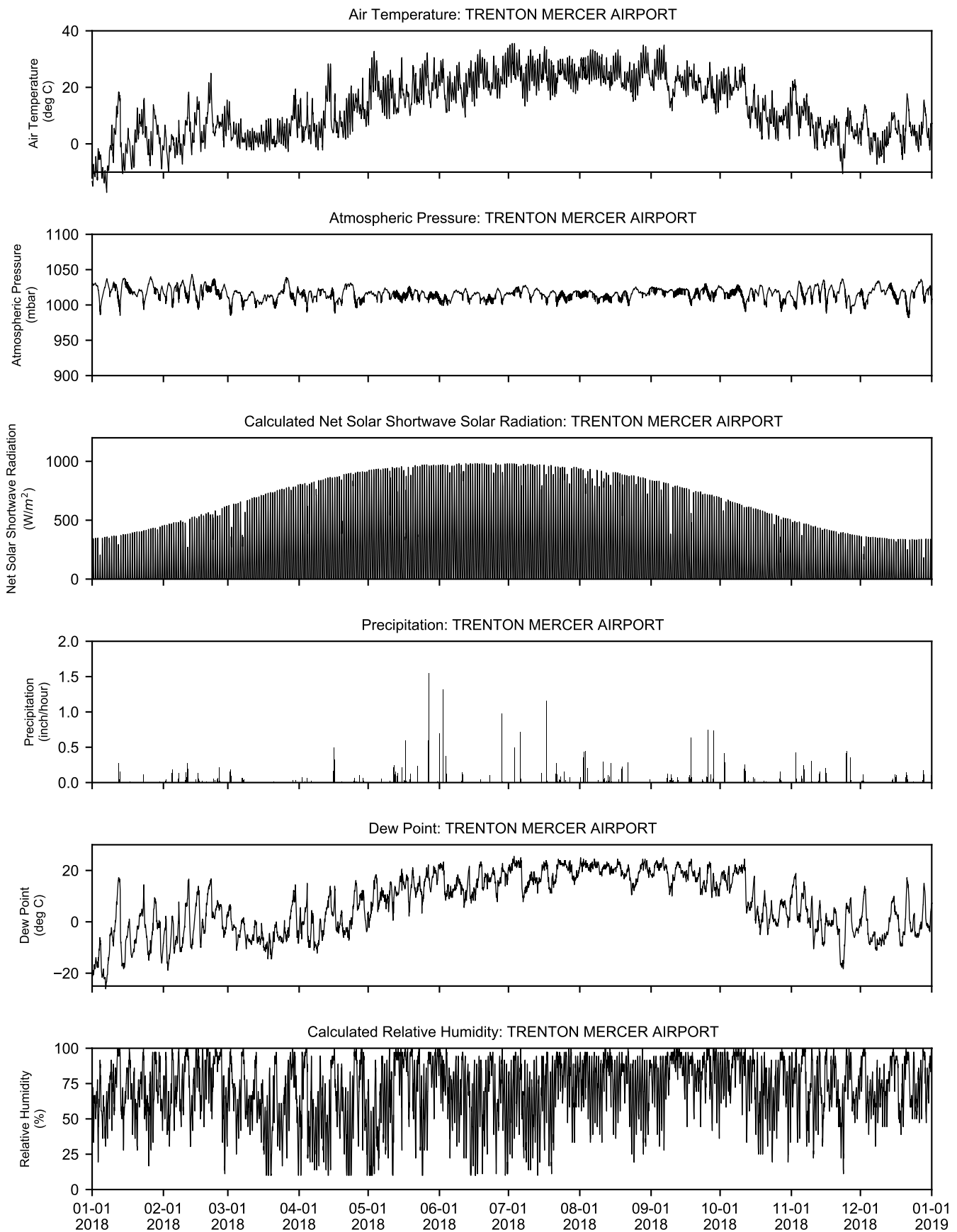


Figure 2.4-7a

Meteorological Data from TRENTON MERCER AIRPORT During 2018

Meteorological data were downloaded from NOAA NCDC website.

<https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>.

Net solar shortwave radiation and relative humidity were calculated as best estimate.

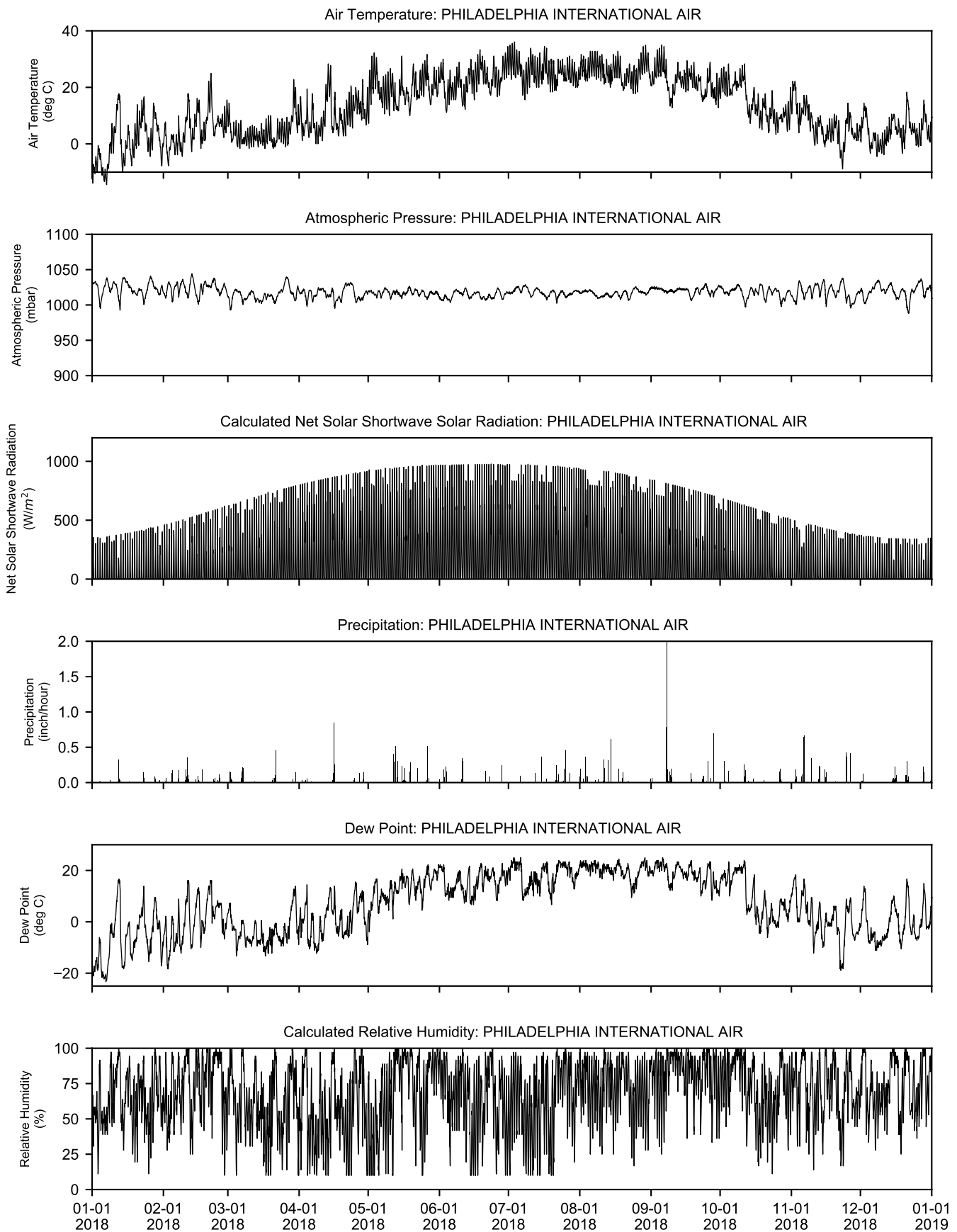


Figure 2.4-7b

Meteorological Data from PHILADELPHIA INTERNATIONAL AIR During 2018

Meteorological data were downloaded from NOAA NCDC website.

<https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>.

Net solar shortwave radiation and relative humidity were calculated as best estimate.

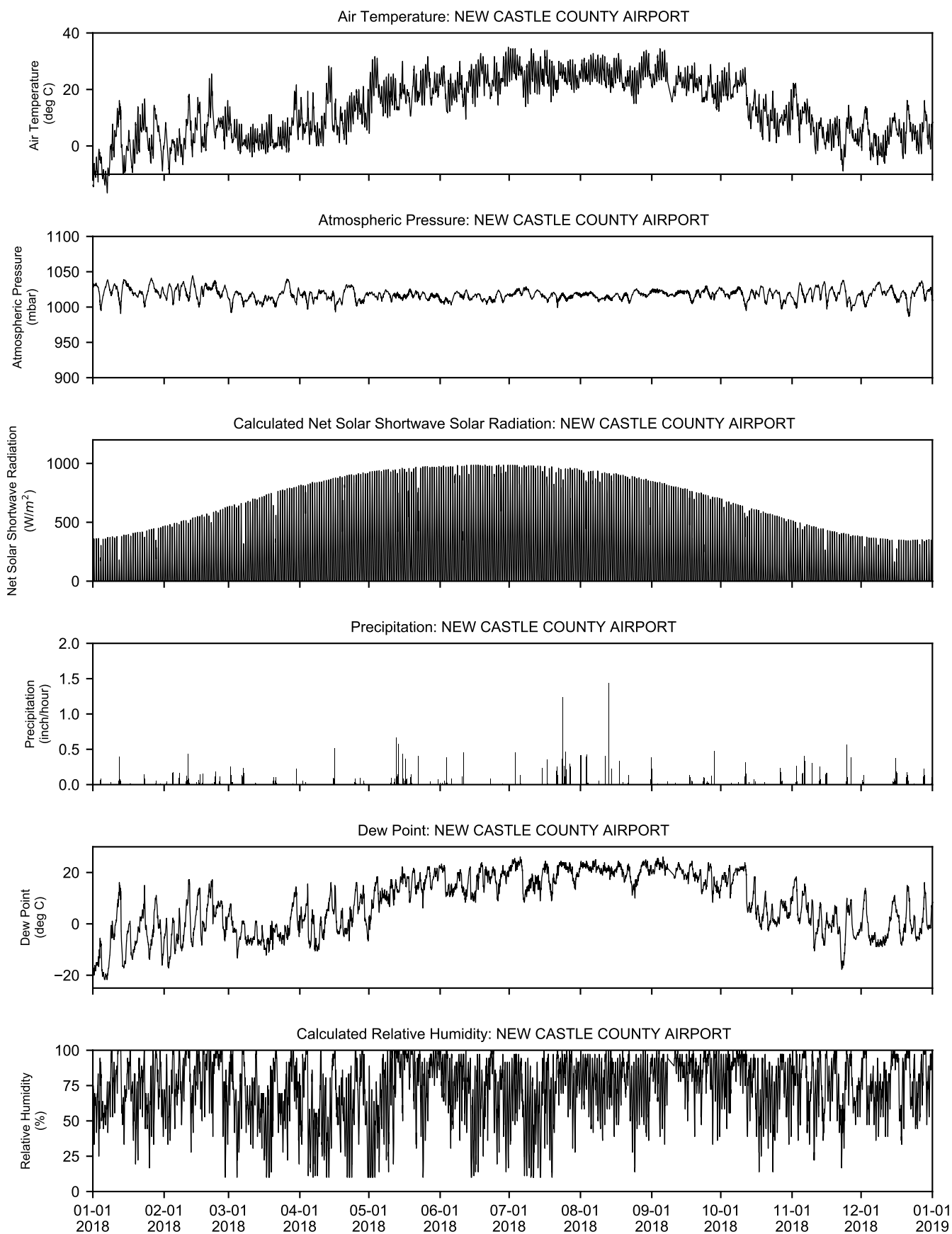


Figure 2.4-7c

Meteorological Data from NEW CASTLE COUNTY AIRPORT During 2018

Meteorological data were downloaded from NOAA NCDC website.

<https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>.

Net solar shortwave radiation and relative humidity were calculated as best estimate.



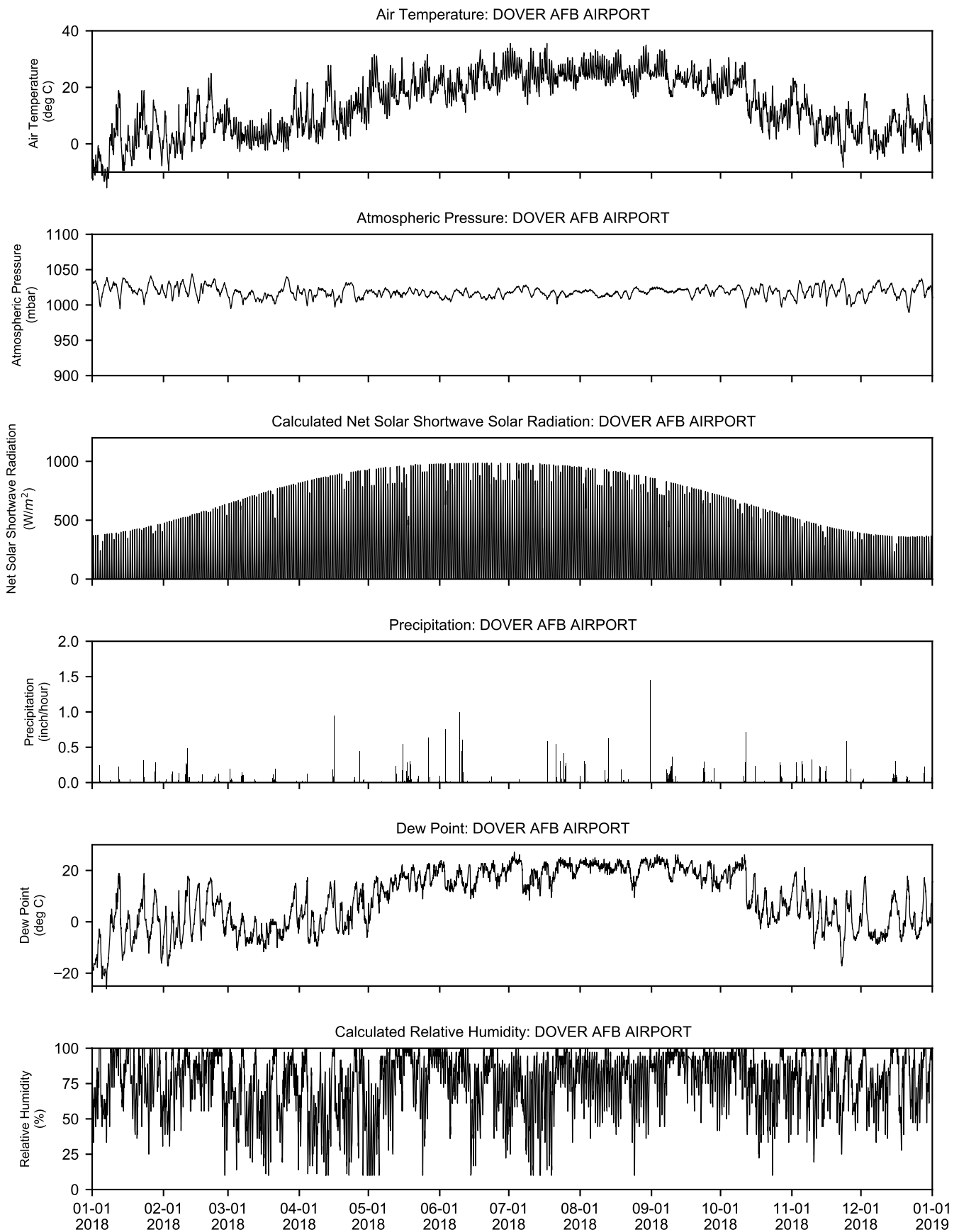


Figure 2.4-7d

Meteorological Data from DOVER AFB AIRPORT During 2018

Meteorological data were downloaded from NOAA NCDC website.

<https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>.

Net solar shortwave radiation and relative humidity were calculated as best estimate.

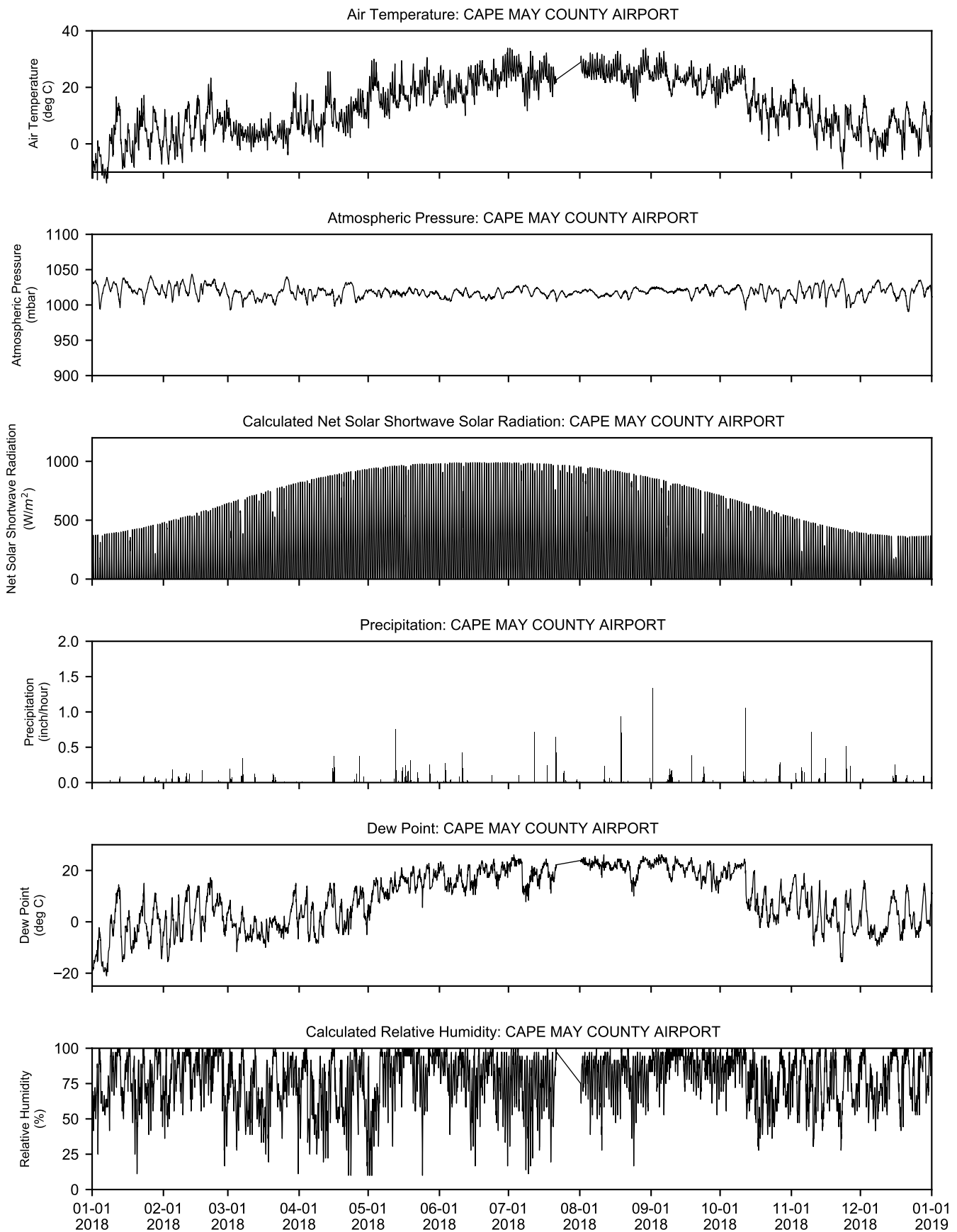


Figure 2.4-7e

Meteorological Data from CAPE MAY COUNTY AIRPORT During 2018

Meteorological data were downloaded from NOAA NCDC website.

<https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>.

Net solar shortwave radiation and relative humidity were calculated as best estimate.



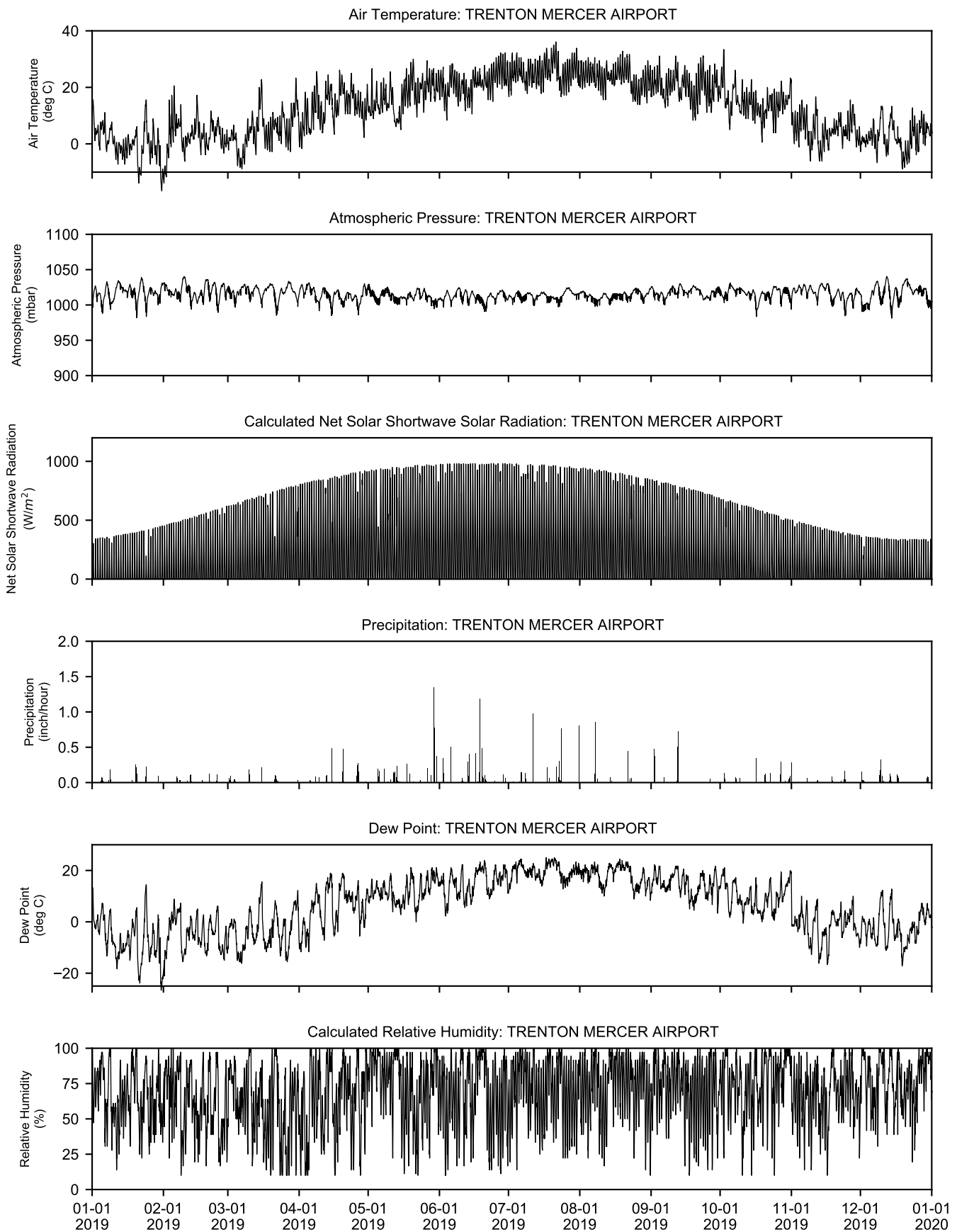


Figure 2.4-8a

Meteorological Data from TRENTON MERCER AIRPORT During 2019

Meteorological data were downloaded from NOAA NCDC website.

<https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>.

Net solar shortwave radiation and relative humidity were calculated as best estimate.



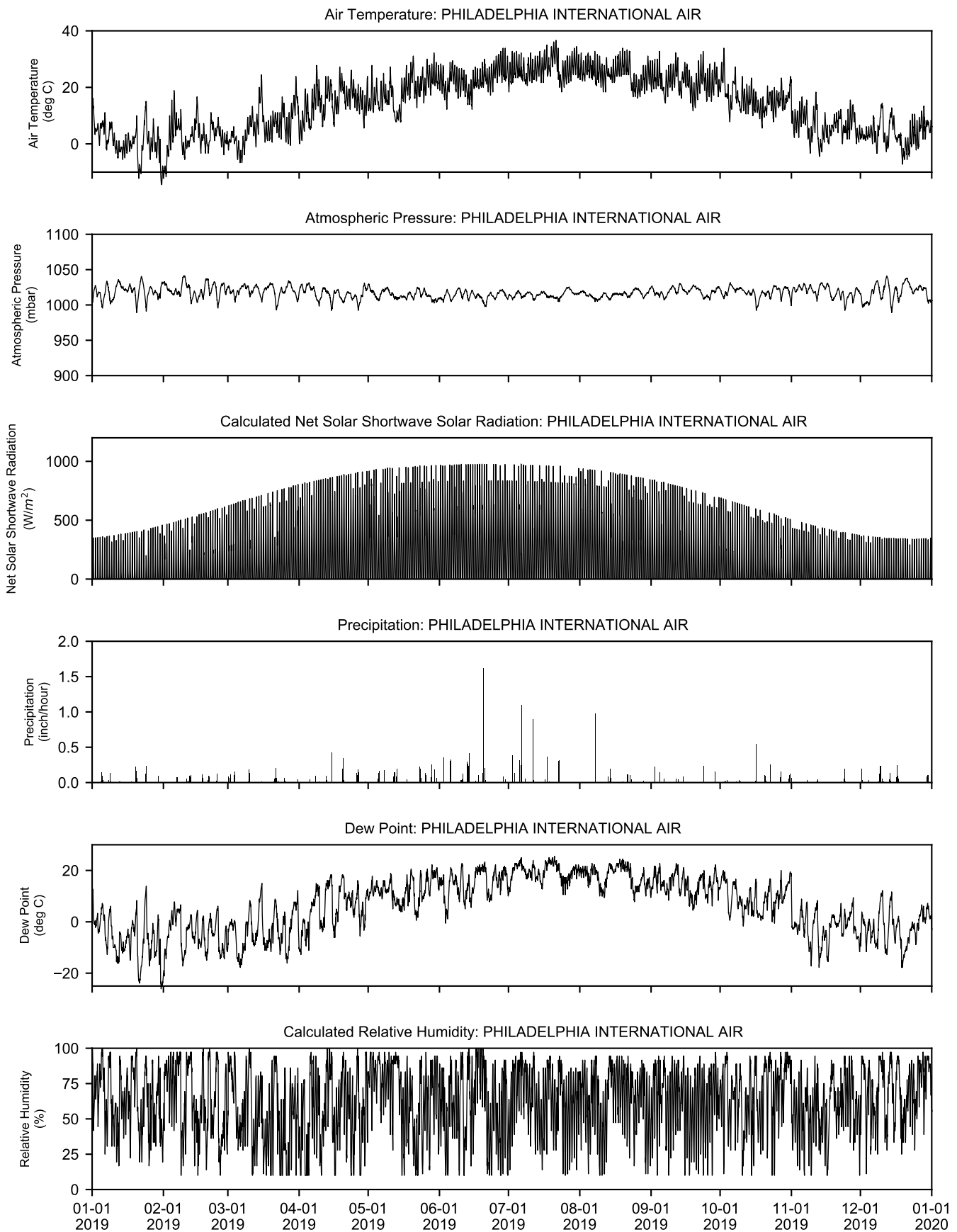


Figure 2.4-8b

Meteorological Data from PHILADELPHIA INTERNATIONAL AIR During 2019



Meteorological data were downloaded from NOAA NCDC website.
<https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>.
 Net solar shortwave radiation and relative humidity were calculated as best estimate.

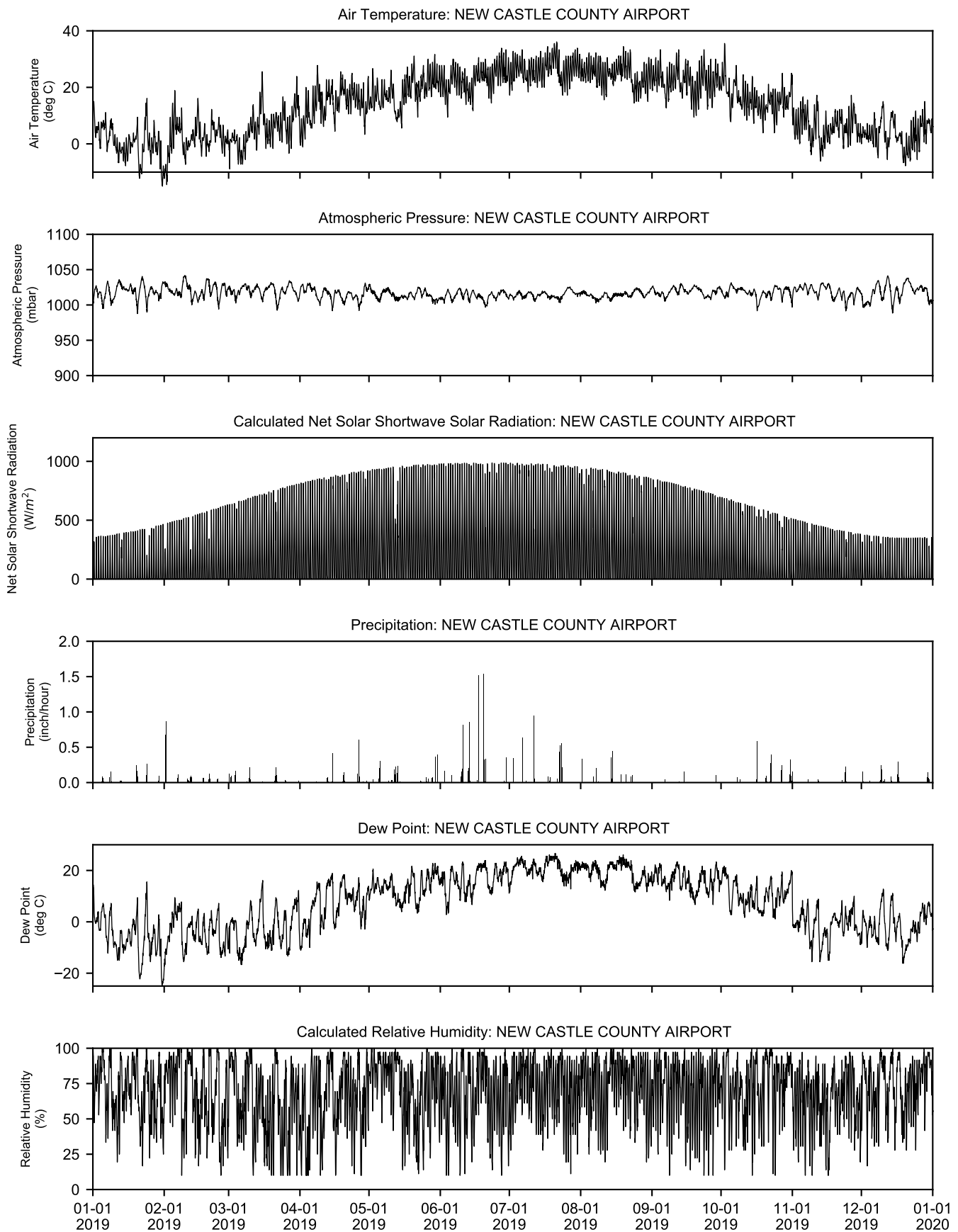


Figure 2.4-8c

Meteorological Data from NEW CASTLE COUNTY AIRPORT During 2019

Meteorological data were downloaded from NOAA NCDC website.

<https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>.

Net solar shortwave radiation and relative humidity were calculated as best estimate.

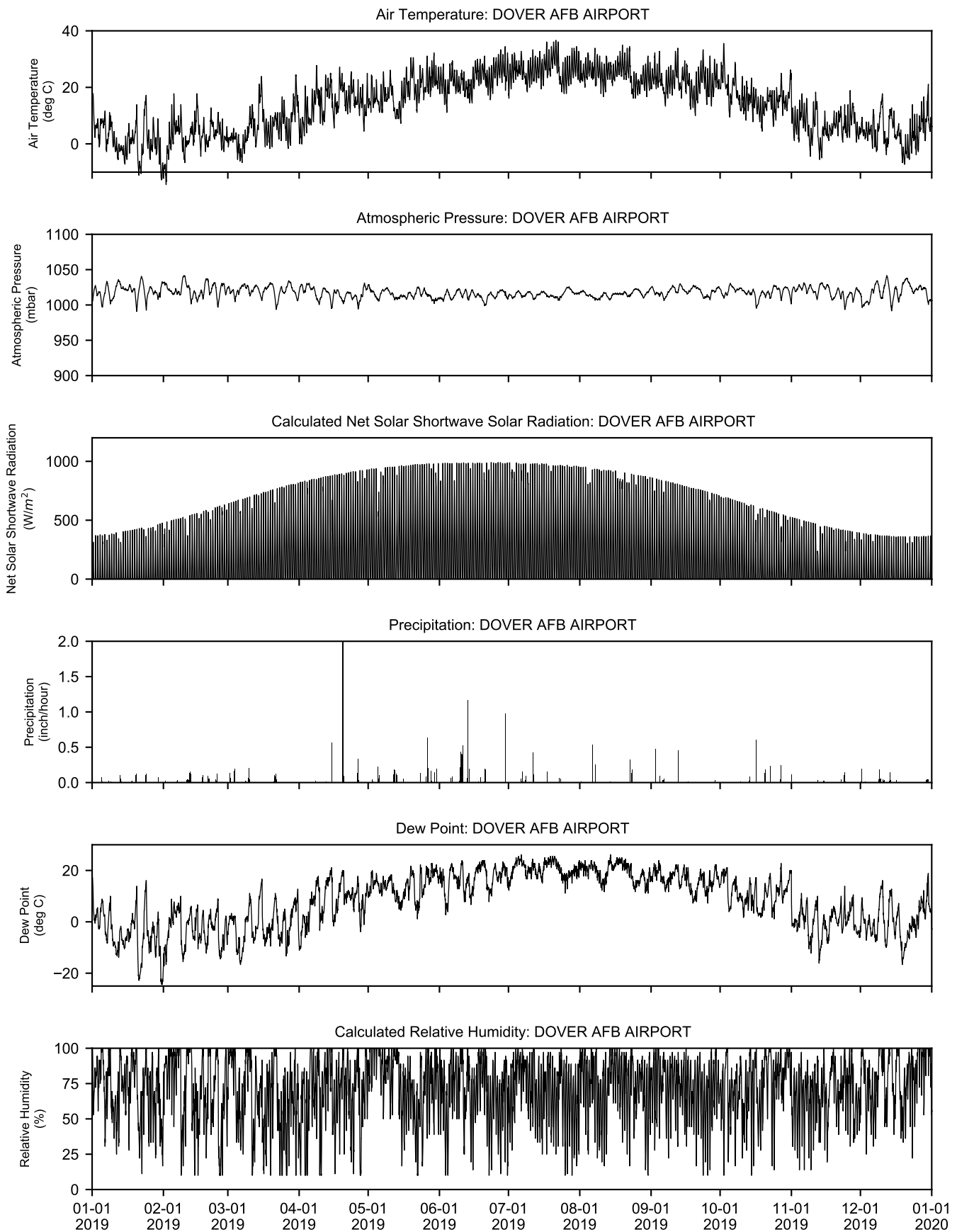


Figure 2.4-8d

Meteorological Data from DOVER AFB AIRPORT During 2019

Meteorological data were downloaded from NOAA NCDC website.

<https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>.

Net solar shortwave radiation and relative humidity were calculated as best estimate.



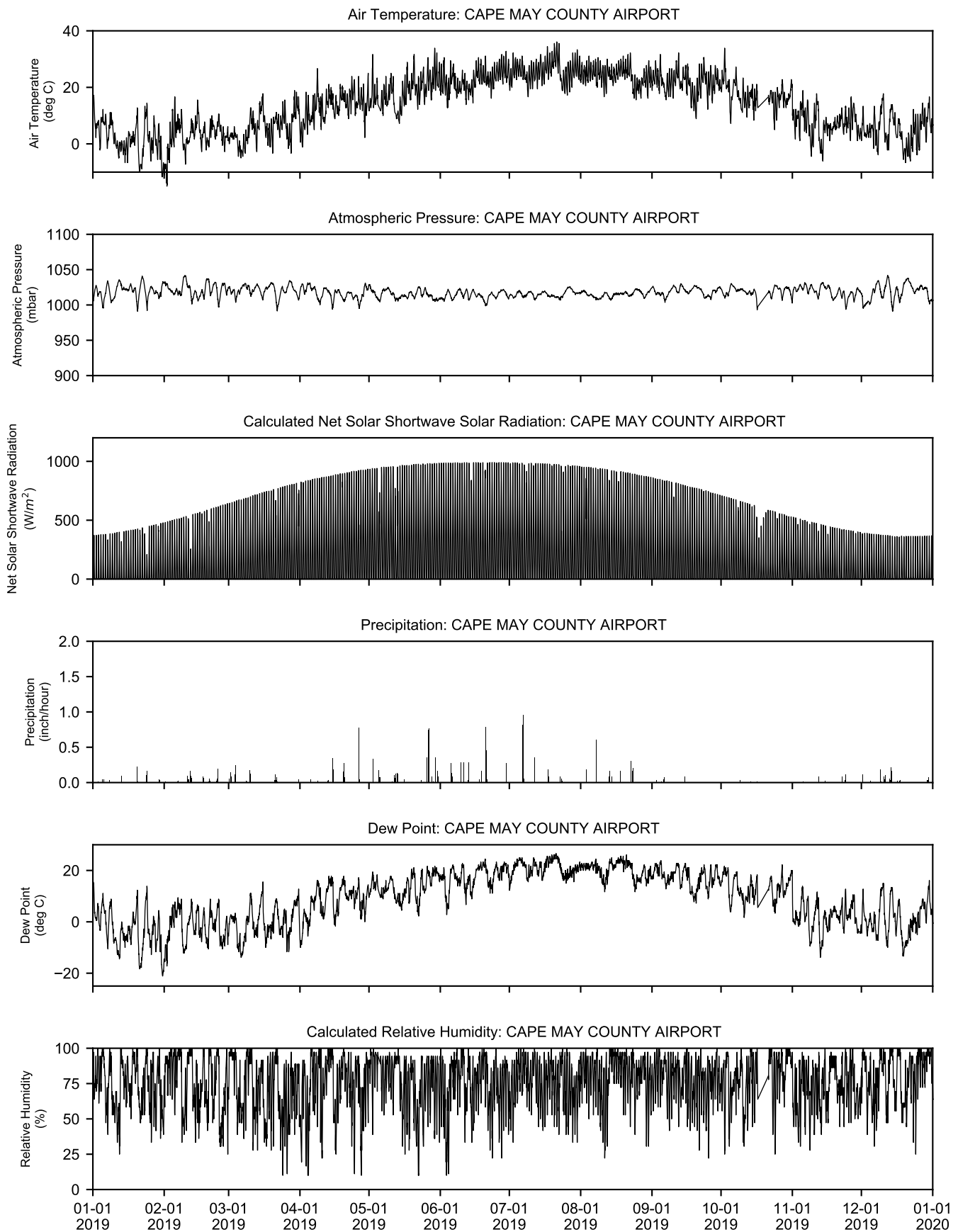


Figure 2.4-8e

Meteorological Data from CAPE MAY COUNTY AIRPORT During 2019

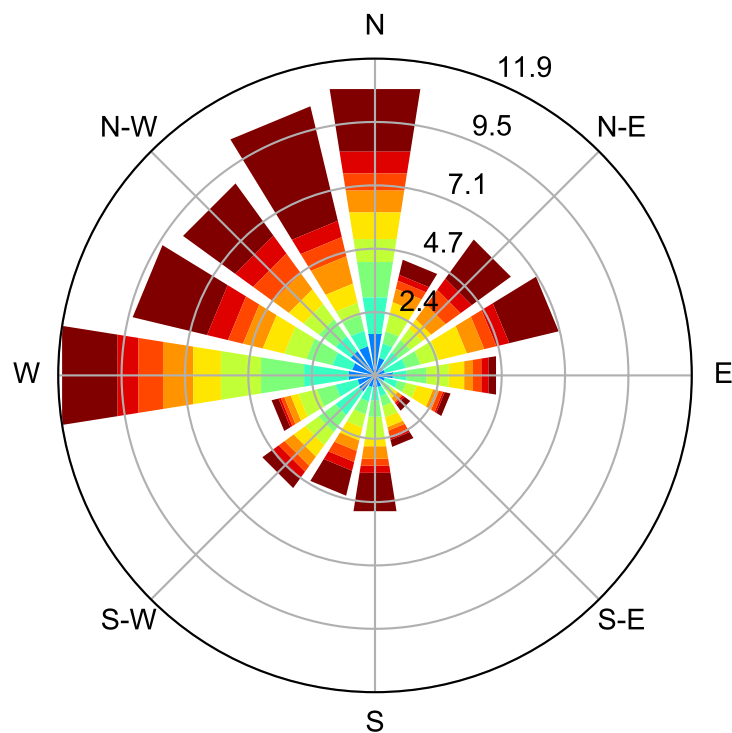
Meteorological data were downloaded from NOAA NCDC website.

<https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>.

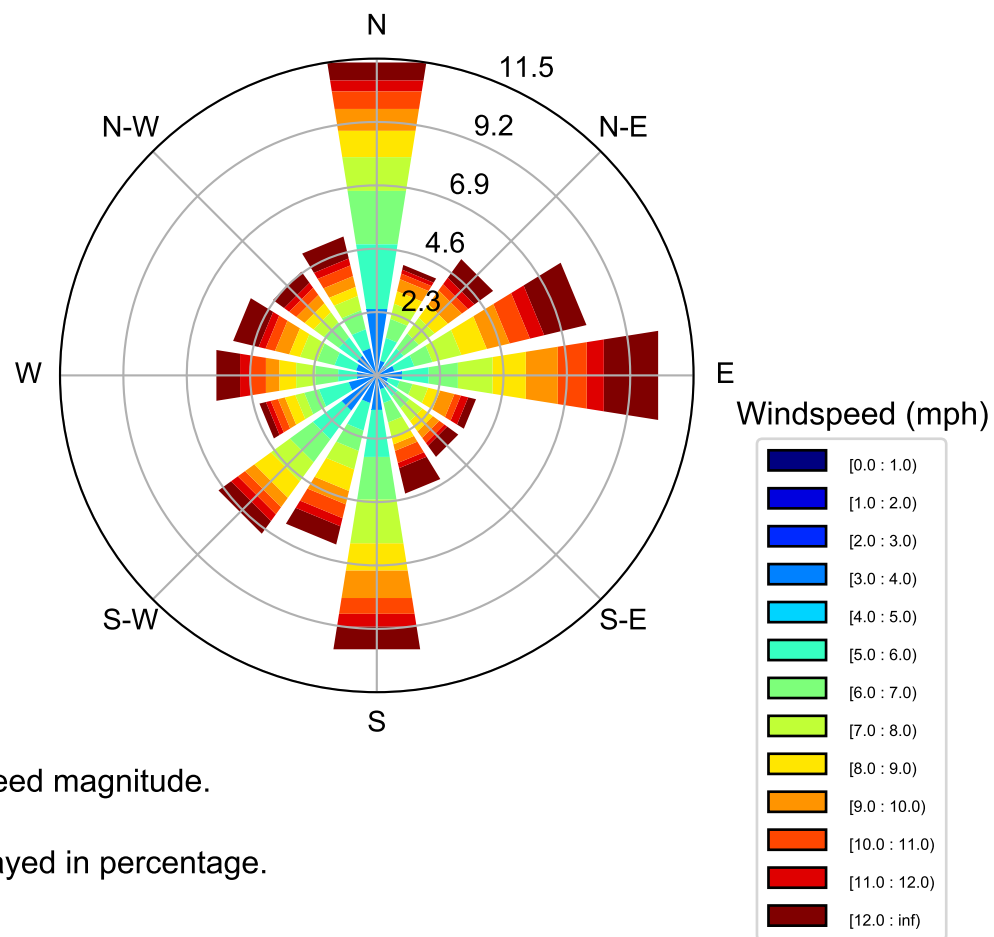
Net solar shortwave radiation and relative humidity were calculated as best estimate.



January to March and November to December
2018



April to October
2018



Color contours = wind speed magnitude.

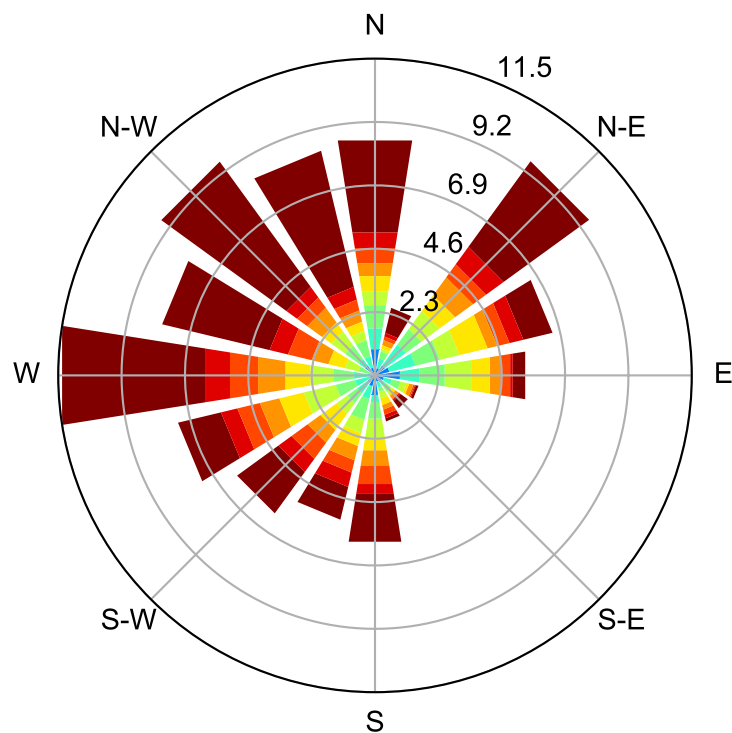
Circles = frequency displayed in percentage.



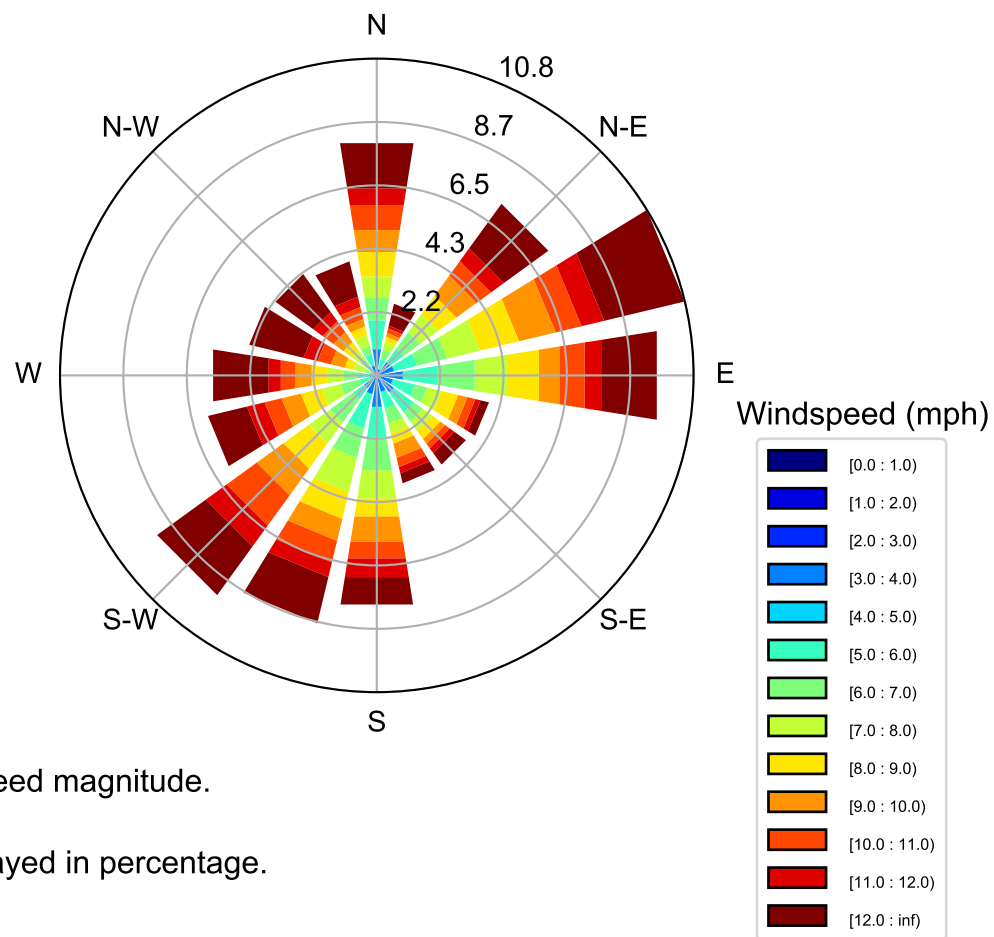
Figure 2.4-9a
Wind Rose Plot Based on 2018 Data Collected at
Station TRENTON MERCER AIRPORT, Station ID: 724095

Notes:
1. Direction angle is measured from true north clockwise to the wind vector (blowing from) in degrees
2. Data were downloaded from NOAA NCDC website, <https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>
FC - D:\Jobs\EFDC\documents\EutroModel_HydroReport\code\p_noaa_wind_rose_rpt.py 9/25/2020 16:42:43

January to March and November to December
2018



April to October
2018



Color contours = wind speed magnitude.

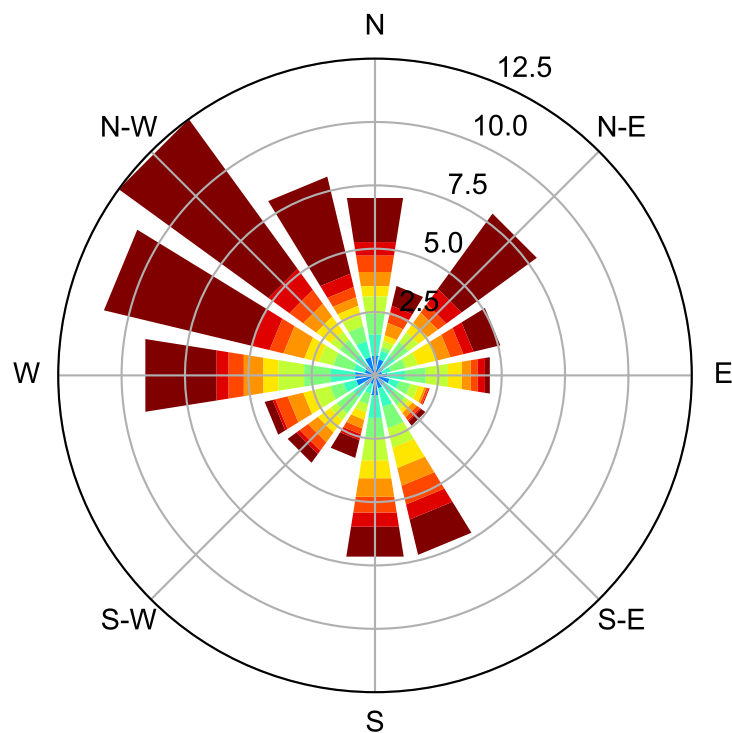
Circles = frequency displayed in percentage.



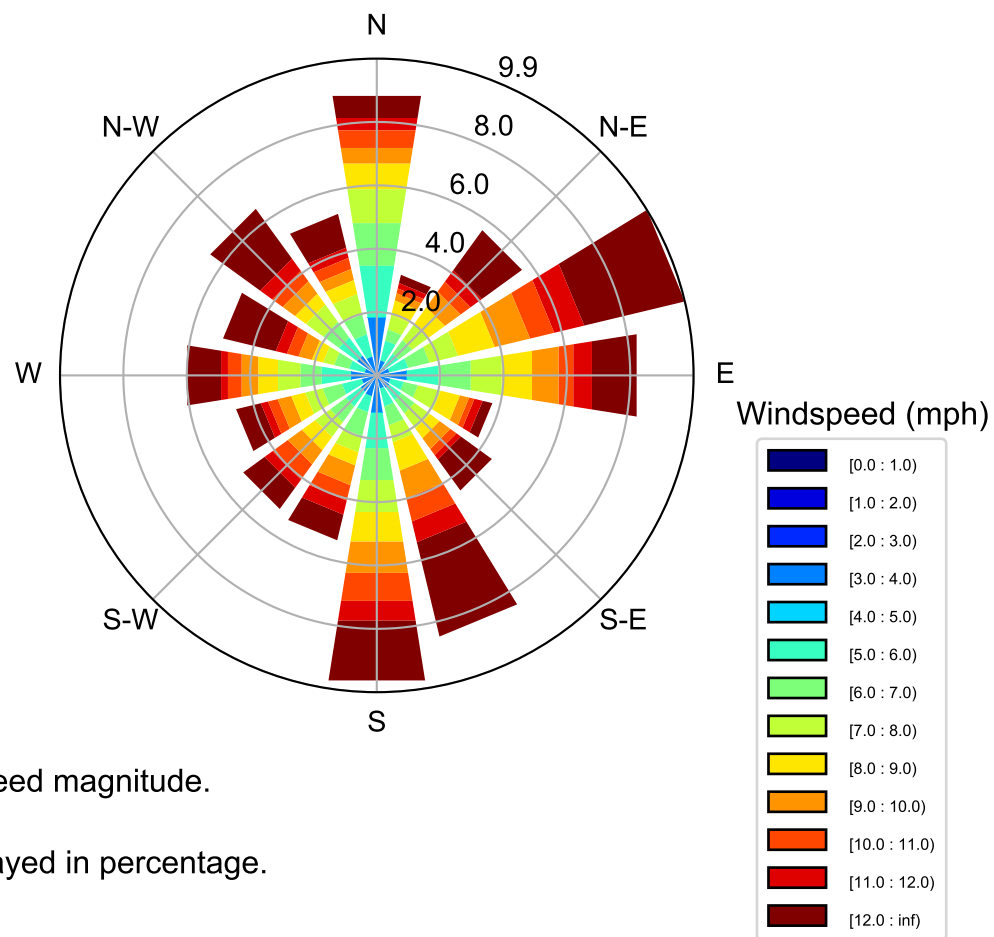
Figure 2.4-9b
Wind Rose Plot Based on 2018 Data Collected at
Station PHILADELPHIA INTERNATIONAL AIR, Station ID: 724080

Notes:
1. Direction angle is measured from true north clockwise to the wind vector (blowing from) in degrees
2. Data were downloaded from NOAA NCDC website, <https://gis.ncdc.noaa.gov/maps/nccei/cdo/hourly>
FC - D:\Jobs\EFDC\documents\EutroModel_HydroReport\code\p_noaa_wind_rose_rpt.py 9/25/2020 16:42:45

January to March and November to December
2018



April to October
2018



Color contours = wind speed magnitude.

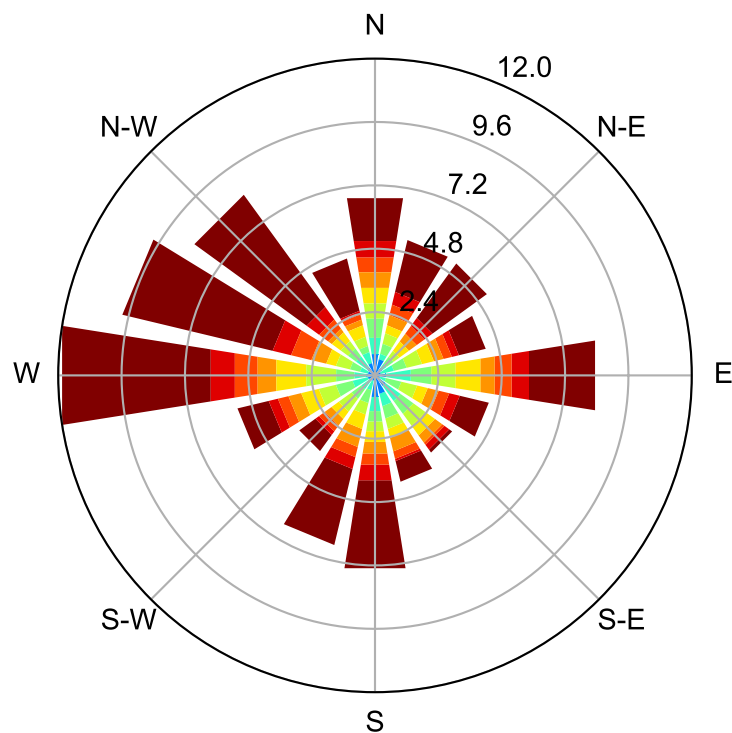
Circles = frequency displayed in percentage.



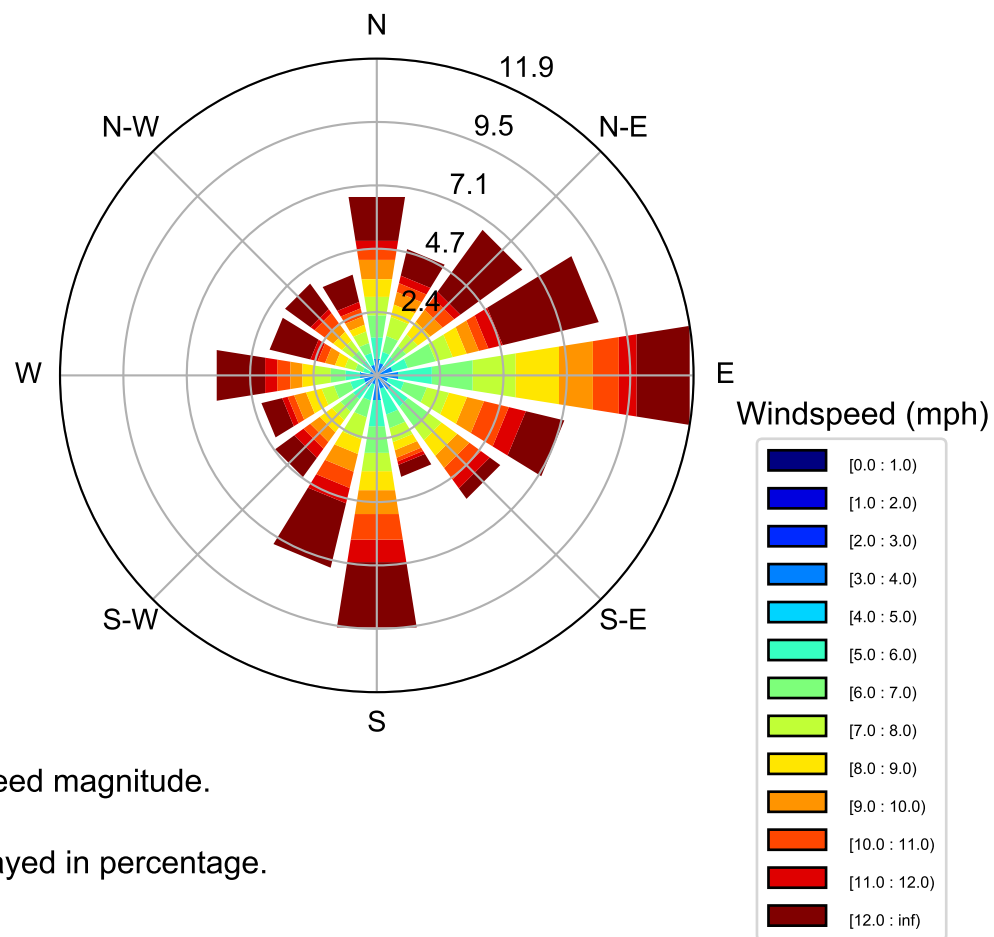
Figure 2.4-9c
Wind Rose Plot Based on 2018 Data Collected at
Station NEW CASTLE COUNTY AIRPORT, Station ID: 724180

Notes:
1. Direction angle is measured from true north clockwise to the wind vector (blowing from) in degrees
2. Data were downloaded from NOAA NCDC website, <https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>
FC - D:\Jobs\EFDC\documents\EutroModel_HydroReport\code\p_noaa_wind_rose_rpt.py 9/25/2020 16:42:46

January to March and November to December
2018



April to October
2018



Color contours = wind speed magnitude.

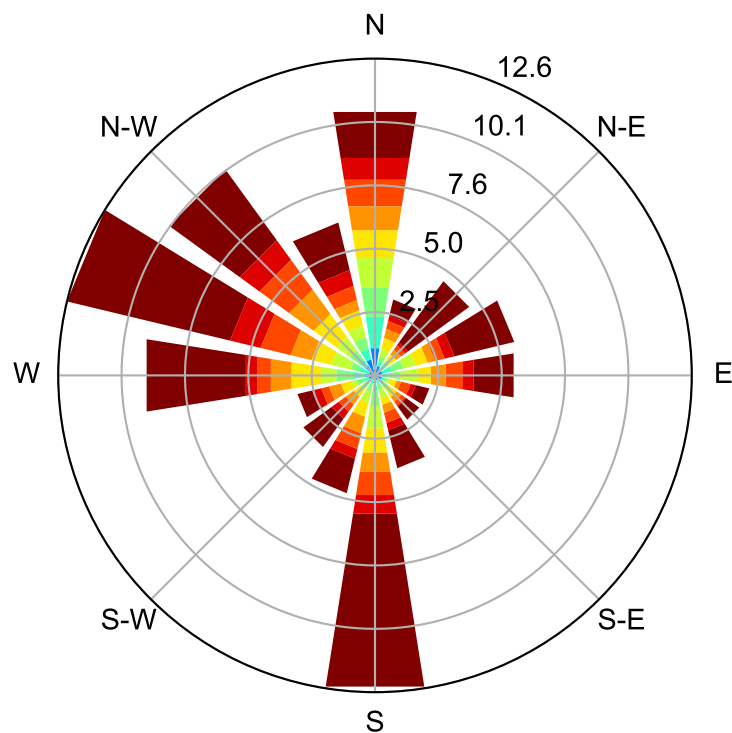
Circles = frequency displayed in percentage.



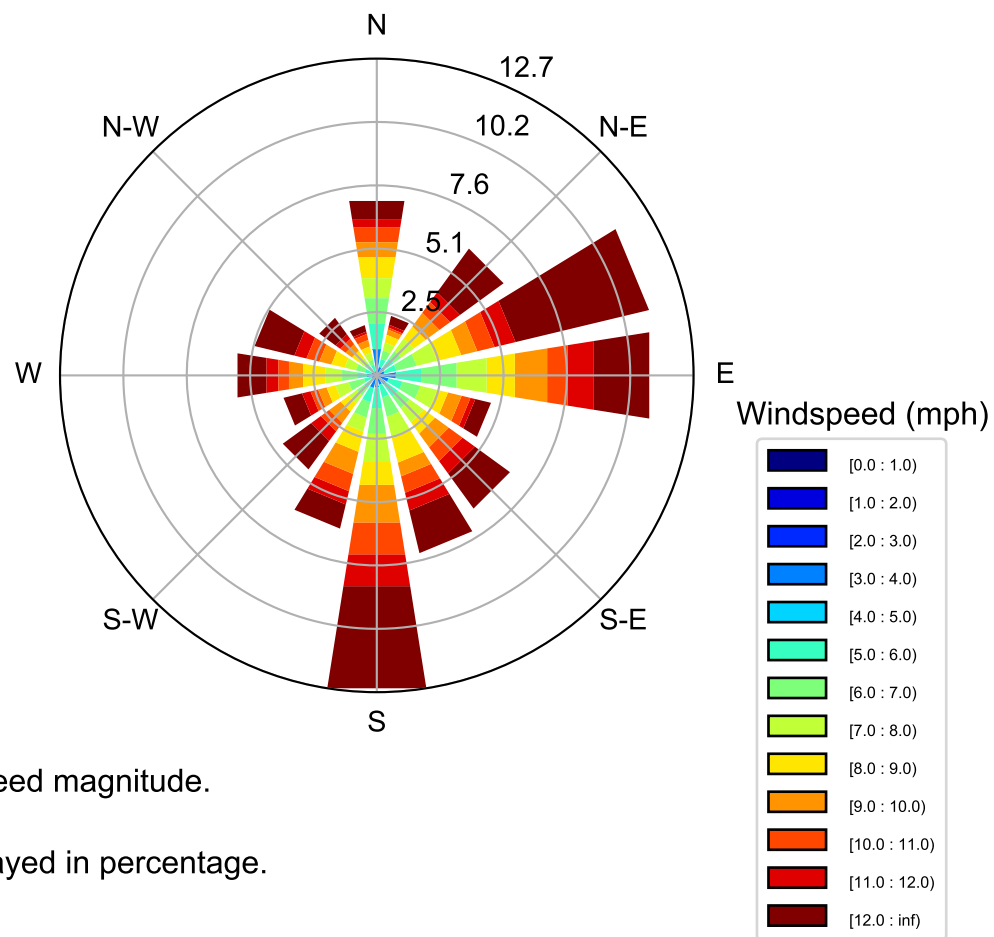
Figure 2.4-9d
Wind Rose Plot Based on 2018 Data Collected at
Station DOVER AFB AIRPORT, Station ID: 724088

Notes:
1. Direction angle is measured from true north clockwise to the wind vector (blowing from) in degrees
2. Data were downloaded from NOAA NCDC website, <https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>
FC - D:\Jobs\EFDC\Documents\EutroModel_HydroReport\code\p_noaa_wind_rose_rpt.py 9/25/2020 16:42:47

January to March and November to December
2018



April to October
2018



Color contours = wind speed magnitude.

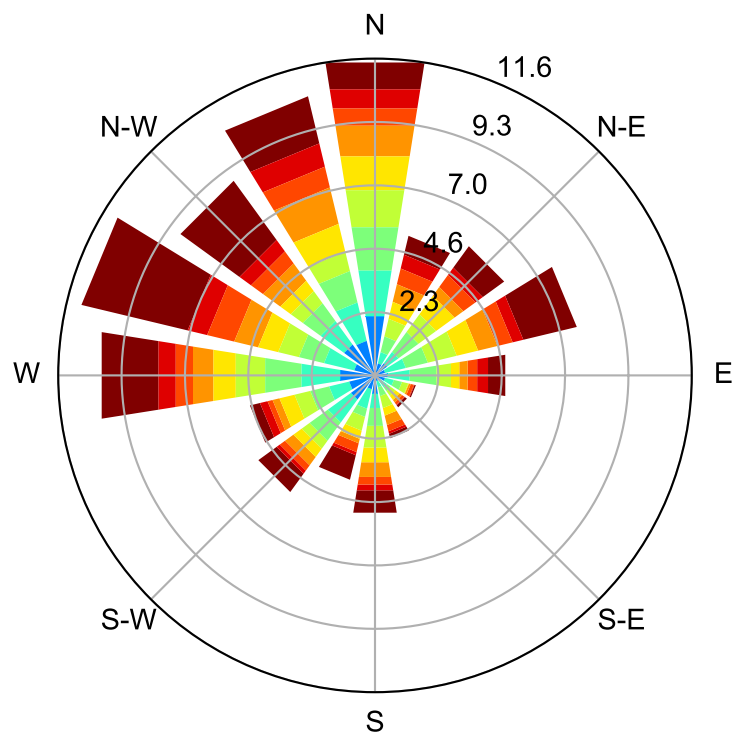
Circles = frequency displayed in percentage.



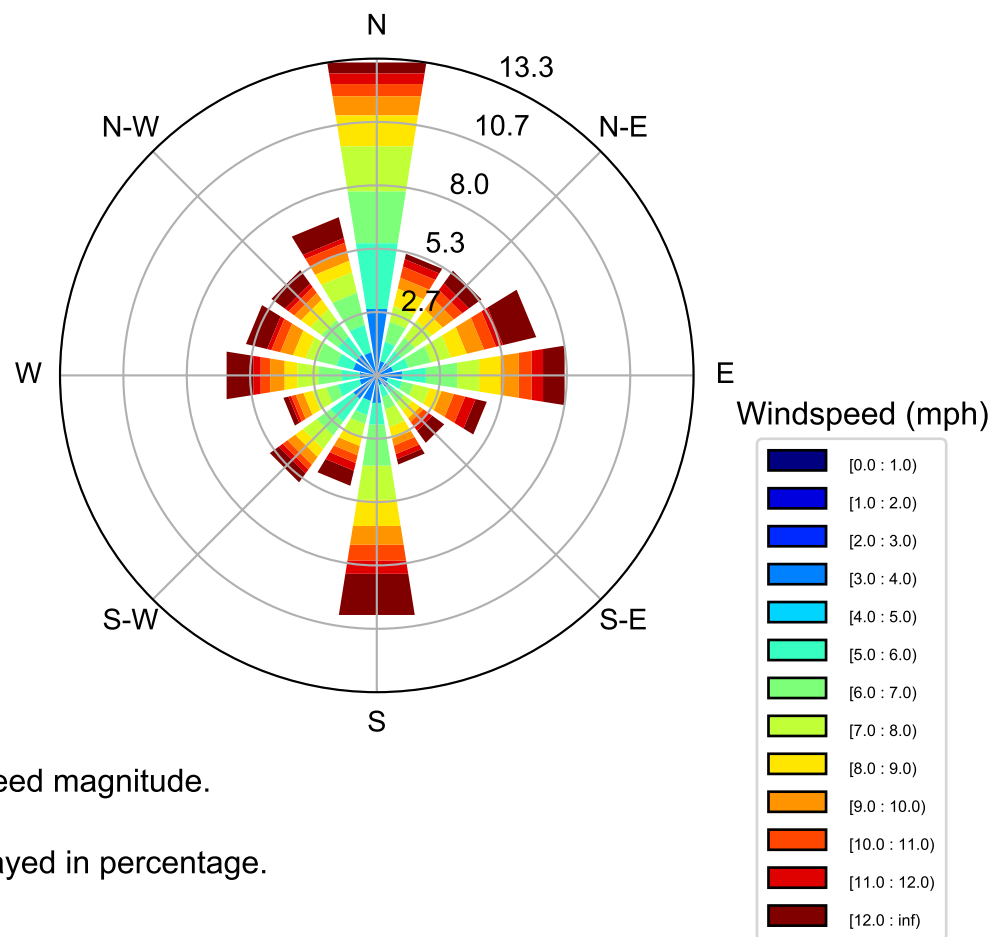
Figure 2.4-9e
Wind Rose Plot Based on 2018 Data Collected at
Station CAPE MAY COUNTY AIRPORT, Station ID: 745966

Notes:
1. Direction angle is measured from true north clockwise to the wind vector (blowing from) in degrees
2. Data were downloaded from NOAA NCDC website, <https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>
FC - D:\GIS\EFDC\documents\EutroModel_HydroReport\code\p_noaa_wind_rose_rpt.py 9/25/2020 16:42:49

January to March and November to December
2019



April to October
2019



Color contours = wind speed magnitude.

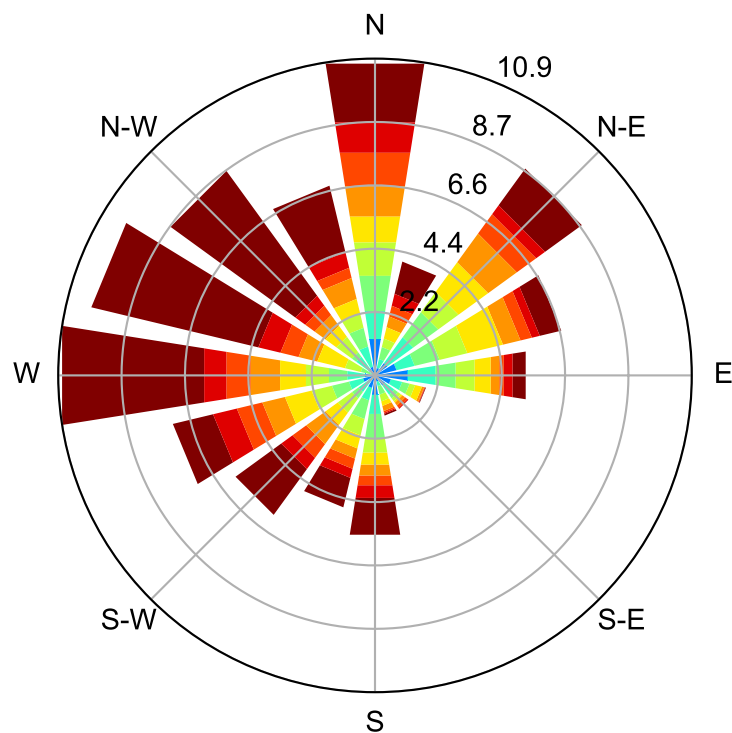
Circles = frequency displayed in percentage.



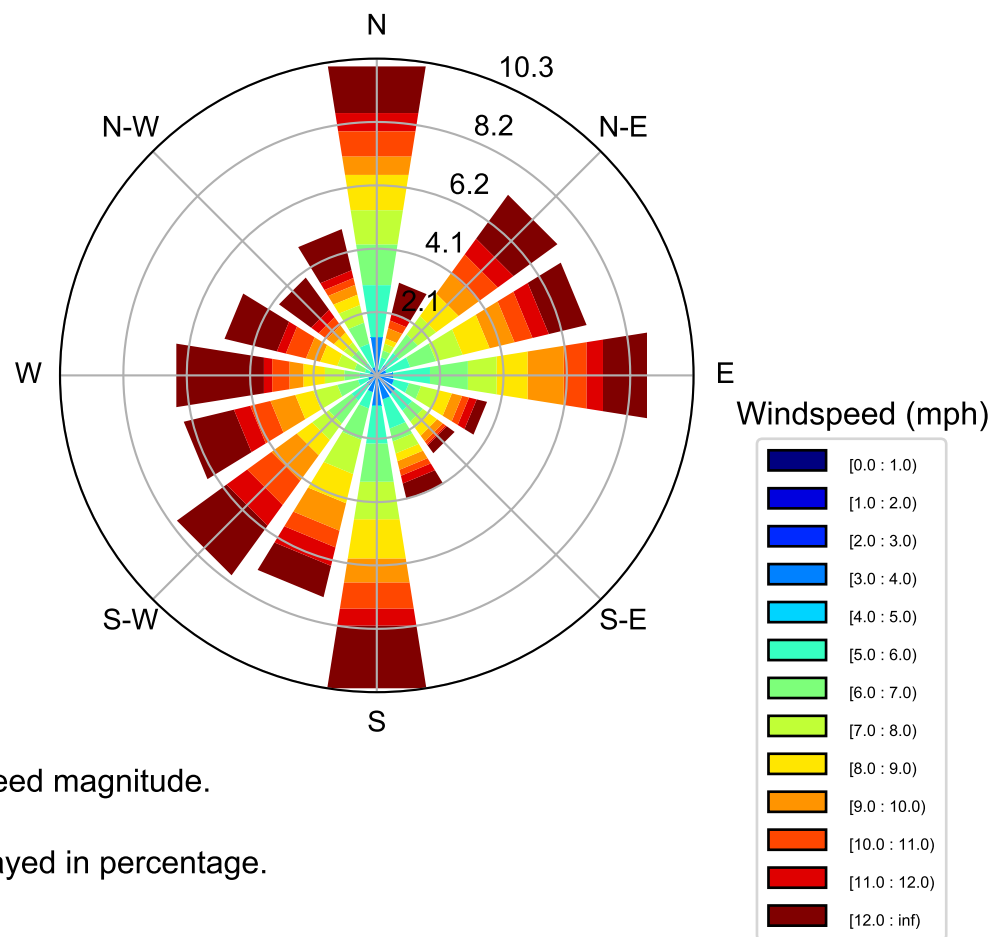
Figure 2.4-10a
Wind Rose Plot Based on 2019 Data Collected at
Station TRENTON MERCER AIRPORT, Station ID: 724095

Notes:
1. Direction angle is measured from true north clockwise to the wind vector (blowing from) in degrees
2. Data were downloaded from NOAA NCDC website, <https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>
FC - D:\Jobs\EFDC\documents\EutroModel_HydroReport\code\p_noaa_wind_rose_rpt.py 9/25/2020 16:42:33

January to March and November to December
2019



April to October
2019



Color contours = wind speed magnitude.

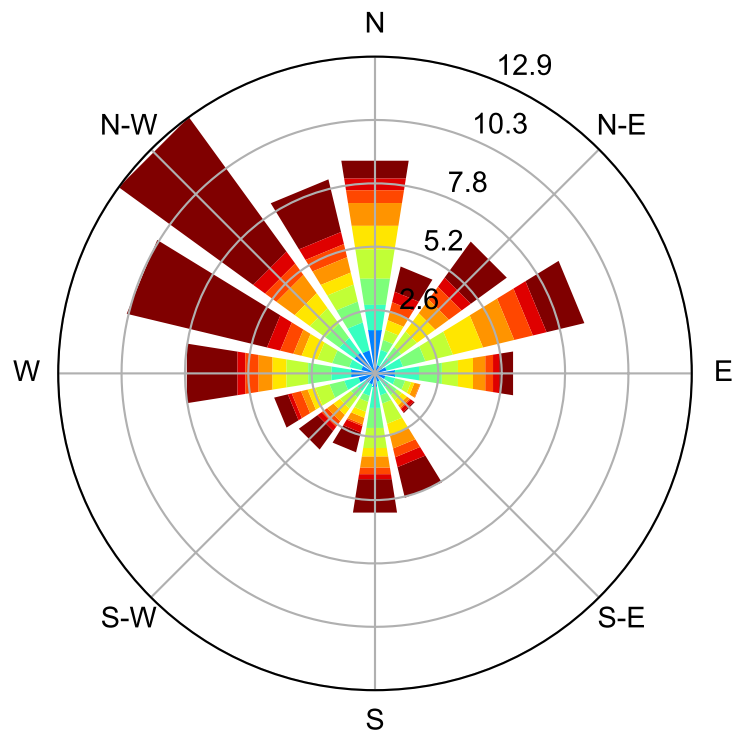
Circles = frequency displayed in percentage.



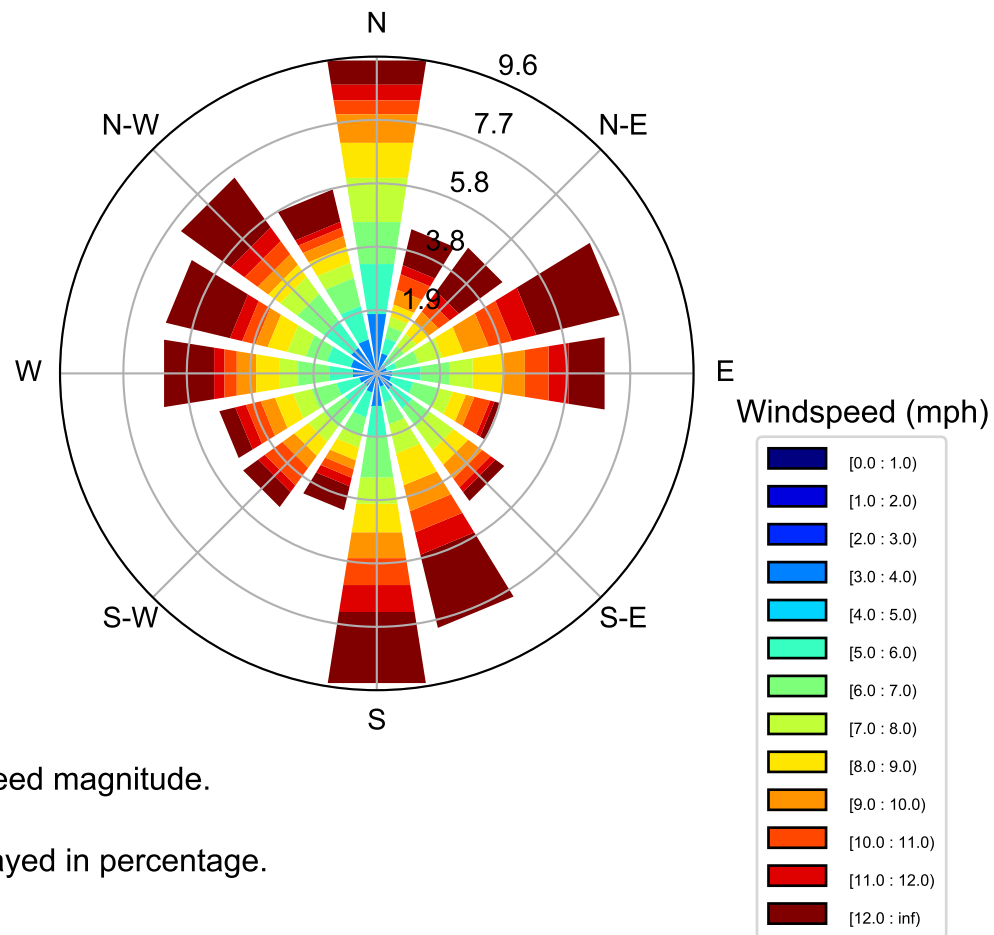
Figure 2.4-10b
Wind Rose Plot Based on 2019 Data Collected at
Station PHILADELPHIA INTERNATIONAL AIR, Station ID: 724080

Notes:
1. Direction angle is measured from true north clockwise to the wind vector (blowing from) in degrees
2. Data were downloaded from NOAA NCDC website, <https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>
FC - D:\JGIS\EFDC\documents\EutroModel_HydroReport\code\p_nobase_wind_rose_rpt.py 9/25/2020 16:42:35

January to March and November to December
2019



April to October
2019



Color contours = wind speed magnitude.

Circles = frequency displayed in percentage.



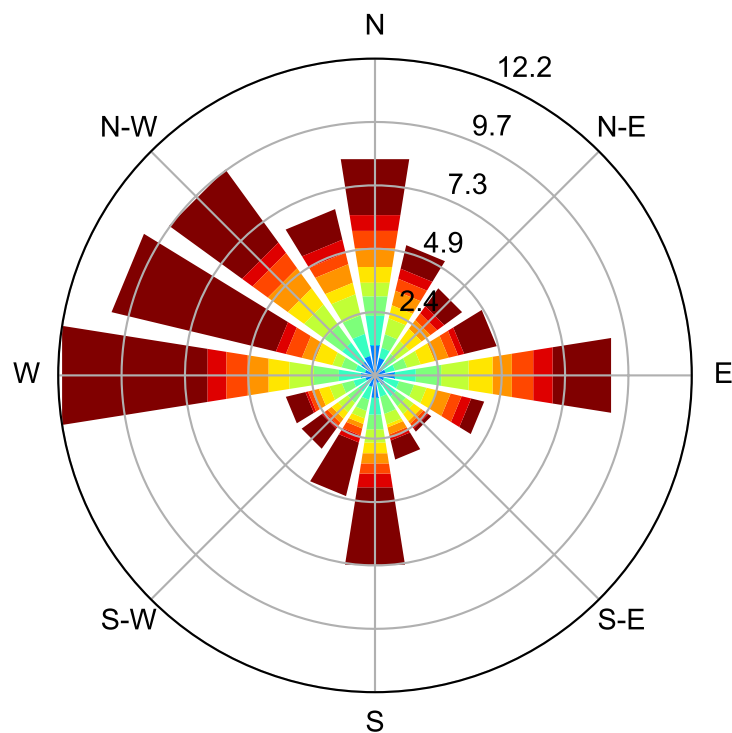
Figure 2.4-10c

Wind Rose Plot Based on 2019 Data Collected at
Station NEW CASTLE COUNTY AIRPORT, Station ID: 724180

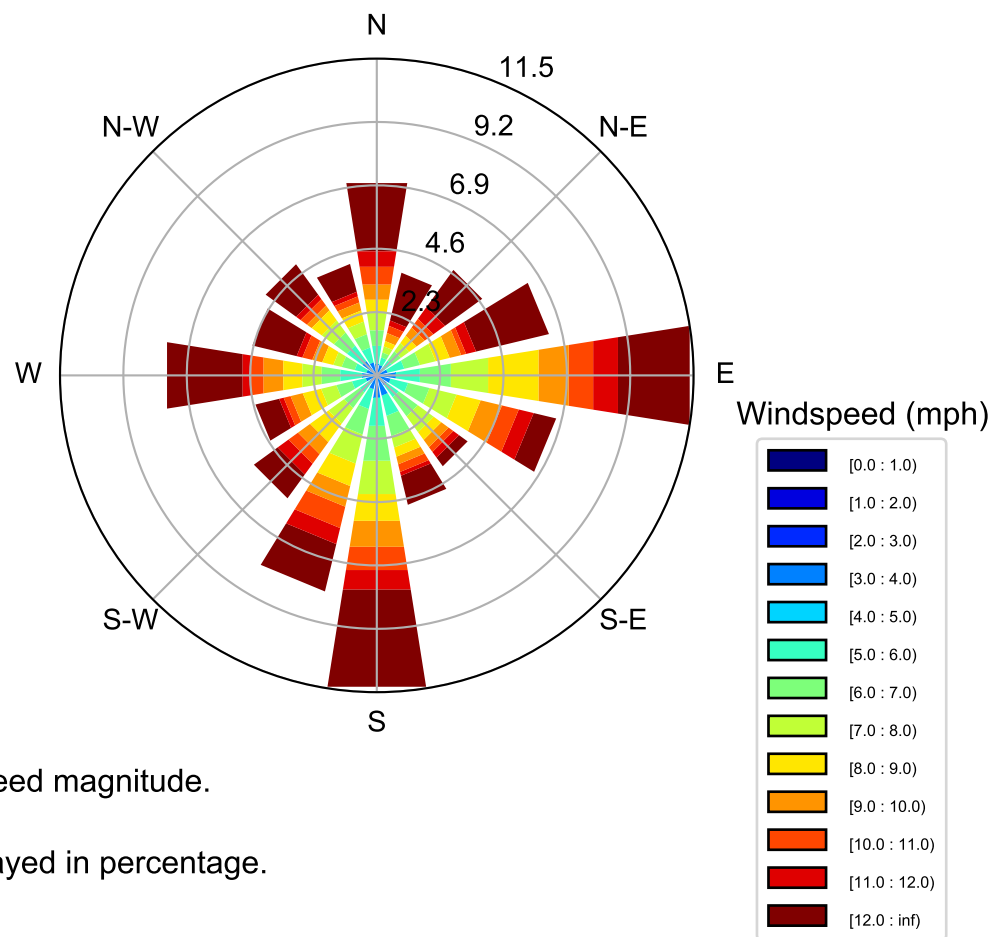
Notes:

1. Direction angle is measured from true north clockwise to the wind vector (blowing from) in degrees
2. Data were downloaded from NOAA NCDC website, <https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>

January to March and November to December
2019



April to October
2019



Color contours = wind speed magnitude.

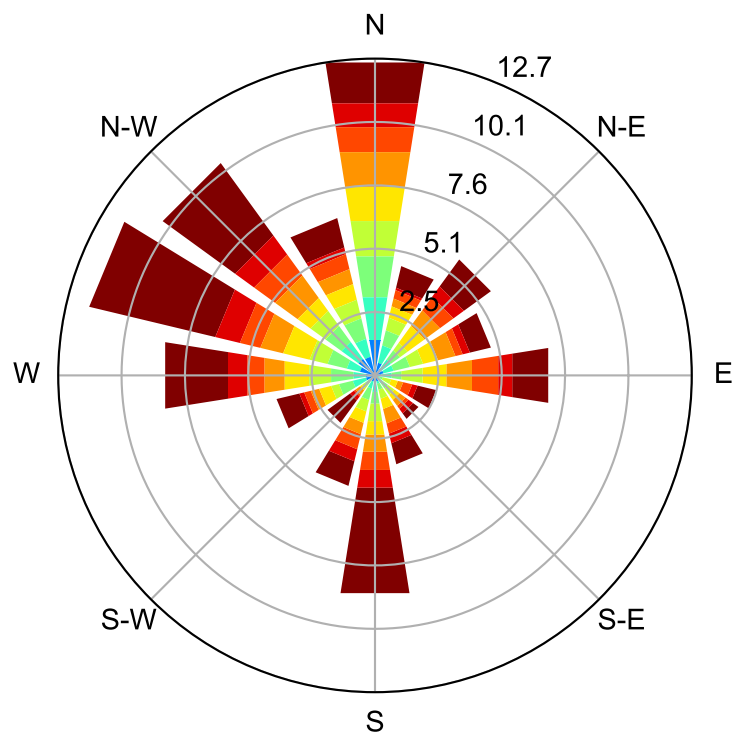
Circles = frequency displayed in percentage.



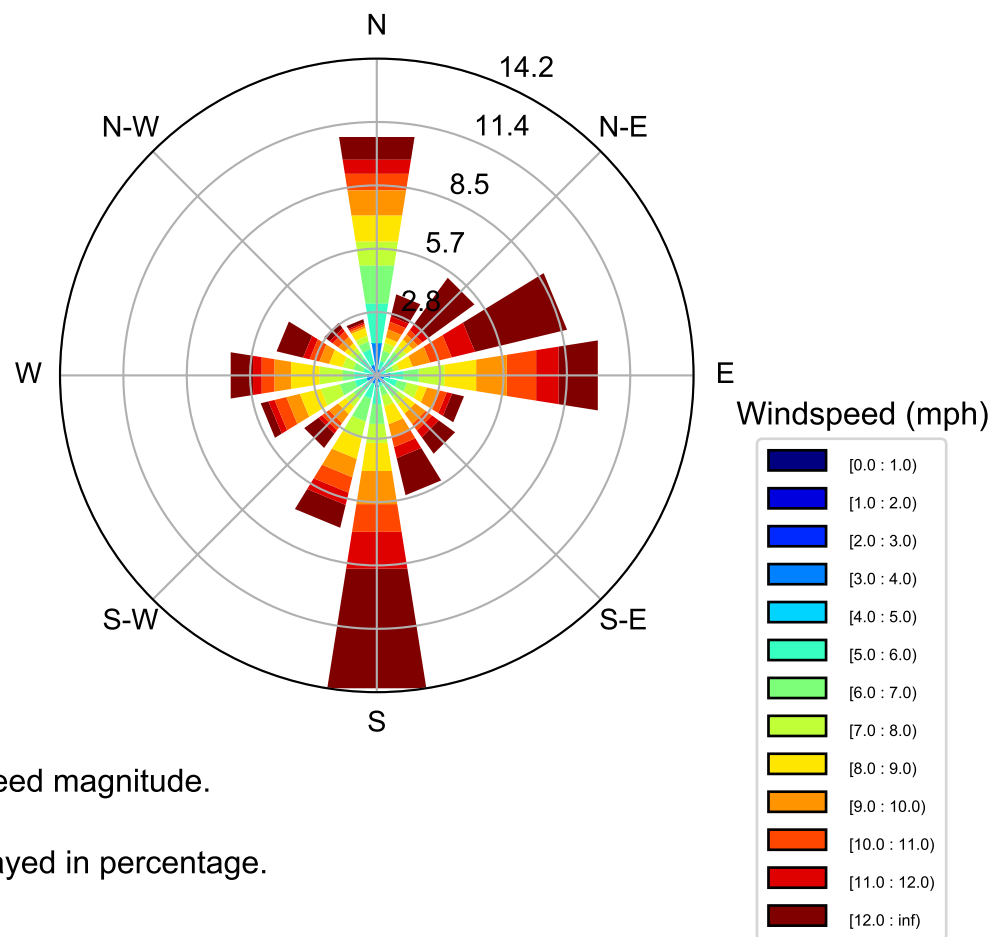
Figure 2.4-10d
Wind Rose Plot Based on 2019 Data Collected at
Station DOVER AFB AIRPORT, Station ID: 724088

Notes:
1. Direction angle is measured from true north clockwise to the wind vector (blowing from) in degrees
2. Data were downloaded from NOAA NCDC website, <https://gis.ncdc.noaa.gov/maps/ncei/cdo/hourly>
FC - D:\Jobs\EFDC\documents\EutroModel_HydroReport\code\p_noaa_wind_rose_rpt.py 9/25/2020 16:42:37

January to March and November to December
2019



April to October
2019



Color contours = wind speed magnitude.

Circles = frequency displayed in percentage.



Figure 2.4-10e
Wind Rose Plot Based on 2019 Data Collected at
Station CAPE MAY COUNTY AIRPORT, Station ID: 745966

Notes:
1. Direction angle is measured from true north clockwise to the wind vector (blowing from) in degrees
2. Data were downloaded from NOAA NCDC website, <https://gis.ncdc.noaa.gov/maps/nccei/cdo/hourly>

Appendix C: Summaries of NOAA and USGS calibration data

Table 3.1-1, Summary of Data from NOAA Stations for Model Calibration						
No.	Station	Station ID	Data Type	Data Inventory for Period Covers Calibration and Validation	DRBC River Mile	Comments
1	Lewes, DE	8557380	Verified Hourly Water Level	1975-02-26 14:00 to Present (2019)	~ 0	Subtidal fluctuations and water temperature were used for specification of tidal forcing and temperature boundary conditions.
			Water Conductivity	2017-04-05 19:48 to Present (2019)		
			Water Temperature	2000-04-10 14:00 to Present (2019)		
2	Cape May, NJ	8536110	Verified Hourly Water Level	1972-04-06 09:00 to 2002-12-10 23:00 2003-04-01 00:00 to Present (2019)	~ 4	The data collected at Cape May were not considered for calibration due to the configuration of the model grid.
			Water Conductivity	2017-04-26 18:18 to Present (2019)		
			Water Temperature	1997-05-22 15:00 to Present (2019)		
3	Brandywine Shoal Light , DE	8555889	Verified Hourly Water Level	2002-07-01 00:00 to 2012-10-29 12:00 2014-11-12 20:00 to 2016-06-23 17:00 2017-06-20 18:00 to Present (2019)	10.0	
			Water Conductivity	2002-06-24 07:00 to 2002-09-09 15:06 2002-12-13 16:00 to 2012-10-29 12:00 2014-11-12 18:24 to 2016-01-23 12:06		
			Water Temperature	2002-11-06 19:54 to 2004-04-30 23:00 2004-08-26 13:42 to 2012-10-29 12:00 2014-11-21 19:30 to 2016-01-23 12:06		
4	Ship John Shoal, NJ	8537121	Verified Hourly Water Level	2002-08-14 19:00 to 2009-05-11 14:00 2009-11-07 16:00 to Present (2019)	37.0	
			Water Conductivity	2002-07-17 21:00 to 2009-05-11 14:42 2009-11-09 17:18 to 2014-09-20 00:30 2015-12-16 18:24 to 2018-02-03 08:54 2018-07-27 15:42 to 2018-10-18 07:36		
			Water Temperature	2002-07-17 21:00 to 2002-07-24 14:00 2002-11-06 19:00 to 2003-10-02 12:54 2004-05-24 01:00 to 2004-05-25 01:00 2006-03-21 20:54 to 2009-05-11 14:42 2009-11-07 15:30 to 2018-02-03 08:54 2018-07-27 13:42 to Present (2019)		
5	Reedy Point, DE	8551910	Verified Hourly Water Level	1980-05-13 17:06 to Present (2019)	~ 58.5 East end of C&D Canal	
			Water Conductivity	N/A		
			Water Temperature	1994-06-22 15:00 to Present (2019)		
6	Chesapeake City, MD	8573927	Verified Hourly Water Level	2003-08-29 19:00 to Present (2019)	West end of C&D Canal	
			Water Conductivity	2017-03-22 13:24 to Present (2019)		
			Water Temperature	2003-08-29 20:24 to Present (2019)		
7	Delaware City, DE	8551762	Verified Hourly Water Level	2001-10-16 15:00 to Present (2019)	60.5	Data were used for specification of model boundary conditions.
			Water Conductivity	N/A		
			Water Temperature	2001-10-16 11:00 to Present (2019)		
8	Marcus Hook, PA	8540433	Verified Hourly Water Level	2002-07-19 22:00 to 2015-07-07 14:00 2017-02-01 23:00 to Present (2019)	79.3	
			Water Conductivity	2002-06-14 20:00 to 2004-03-25 08:48 2004-07-03 08:00 to Present (2019)		
			Water Temperature	2002-09-23 13:18 to 2003-05-21 23:00 2004-05-24 01:00 to 2004-05-25 01:00 2006-03-21 20:54 to 2015-07-07 16:42 2017-02-01 23:00 to Present (2019)		
9	Philadelphia, PA	8545240	Verified Hourly Water Level	1989-03-01 00:00 to Present (2019)	98.5	
			Water Conductivity	N/A		
			Water Temperature	1997-06-06 18:00 to Present (2019)		
10	Bridesburg, PA	8546252	Verified Hourly Water Level	2016-01-04 18:00 tp present (2019)	104.4	Data were not be considered for model calibration.
			Water Conductivity	N/A		
			Water Temperature	2016-01-04 17:24 to Present (2019)		
11	Bur lington, Delaware River, NJ	8539094	Verified Hourly Water Level	2002-06-10 18:00 to Present (2019)	117.5	
			Water Conductivity	2002-08-15 18:48 to 2011-12-30 21:12		
			Water Temperature	2002-08-15 18:48 to 2004-04-01 12:06 2004-08-25 12:54 to Present (2019)		
12	Newbold, PA	8548989	Verified Hourly Water Level	2001-11-14 18:00 to Present (2019)	126.3	
			Water Conductivity	N/A		
			Water Temperature	2001-11-14 20:00 to Present (2019)		
Notes: 1. Bridesburg, PA (8546252) was not considered for model calibration. This location of this station is close to the station at Philadelphia. 2. Model calibration and validation periods are 2018-2019), and 2012 for secondary calibration and validation. 3. Data collected outside model calibration and validation periods may not included in the data inventory in this table and are not used in this study.						

Hydrodynamics Model for the Delaware Estuary

Table 3.1-2 Summary of Data from USGS Stations for Model Calibration

No.	Station	Station ID	Data Type	Data Inventory for Period Covers Calibration and Validation	DRBC River Mile	Comments
1	Delaware River at Trenton, NJ	USGS 01463500	Discharge	1981-10-01 to Present (2019)	134.3	15-min discharge data are available. Hourly discharge, water temperature and specific conductance were used for specification of river inflow boundary conditions.
			Specific conductance	2007-10-01 to Present (2019)		
			Water Temperature	2007-10-01 to Present (2019)		
2	Delaware River at Ben Franklin Bridge at Philadelphia, PA	USGS 01467200	Specific conductance	2007-10-01 to Present (2019)	100.1	
			Water Temperature	2007-10-01 to Present (2019)		
3	Delaware River at Fort Mifflin at Philadelphia, PA	USGS 01474703	Specific conductance	2007-10-01 to Present (2019)	91.9	
			Water Temperature	2007-10-01 to Present (2019)		
4	Delaware River at Chester, PA	USGS 01477050	Specific conductance	2007-10-01 to Present (2019)	83.6	
			Water Temperature	2007-10-01 to Present (2019)		
5	Delaware River at Reedy Island Jetty, DE	USGS 01482800	Specific conductance	2007-10-01 to Present (2019)	54.1	
			Water Temperature	2007-10-01 to Present (2019)		

Notes:

1. There are data gaps within the time period listed in the data inventory column.
2. Model calibration and validation periods are 2017-2018 (may extend to 2019), 2011-2013, and 2001-2003.
3. Data collected outside model calibration and validation periods may not included in the data inventory in this table and are not used in this study.

Hydrodynamics Model for the Delaware Estuary

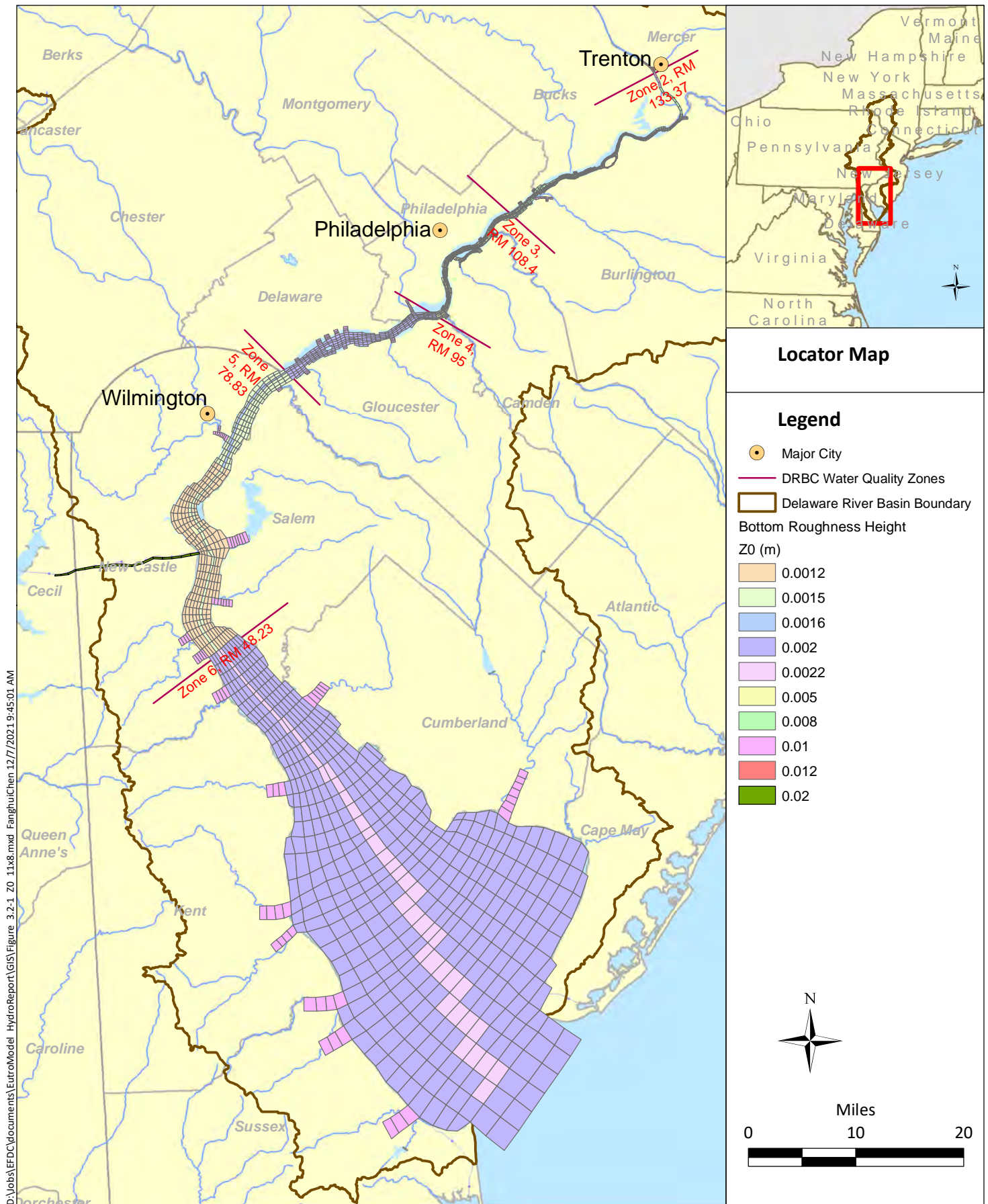
Table 3.1-3, Summary of NOAA Current Velocity Data for Model Calibration

No.	Station	Station ID	Latitude	Longitude	Data Type	Sensor Type	Sensor Orientation	Period of Records for Calibration	DRBC River Mile	Comments
1	Philadelphia	db0301	39.946	-75.140	Current Velocity	Sontek ADP	Side (Shore-Mounted)	2012-05-31 to 2012-06-30	99.5	Approximate Sensor Depth = 4.57 m
2	Reedy Point	db0201	39.559	-75.551	Current Velocity	Workhorse ADCP	up	2012-01-01 to 2012-05-05	58	
3	Brown Shoal Light	db0501	38.922	-75.101	Current Velocity	Sontek ADP	up	2012-05-02 to 2012-07-13	6	
4	Delaware Bay Channel LB 10	db0502	38.939	-75.105	Current Velocity	Nortek ADP	down	2018-09-06 to 2019-02-25	6.5	

Notes:

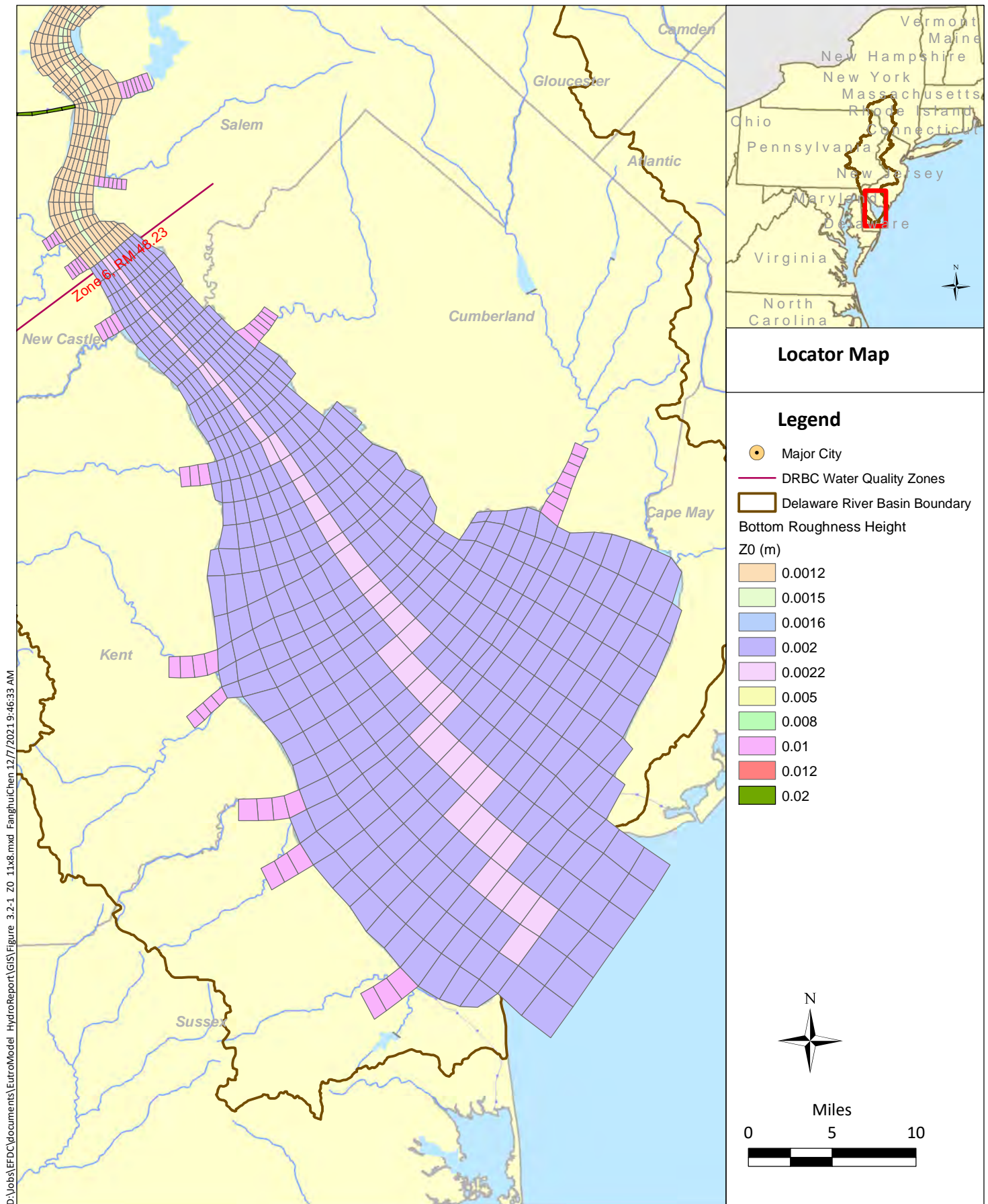
1. Station at Philadelphia has sensor orientated side way at a fixed depth.
2. Model calibration and validation periods are 2018-2019, and 2012 for secondary calibration and validation.
3. Data collected outside model calibration and validation periods may not included in the data inventory in this table and are not used in this study.

Appendix D: Bottom Roughness Height



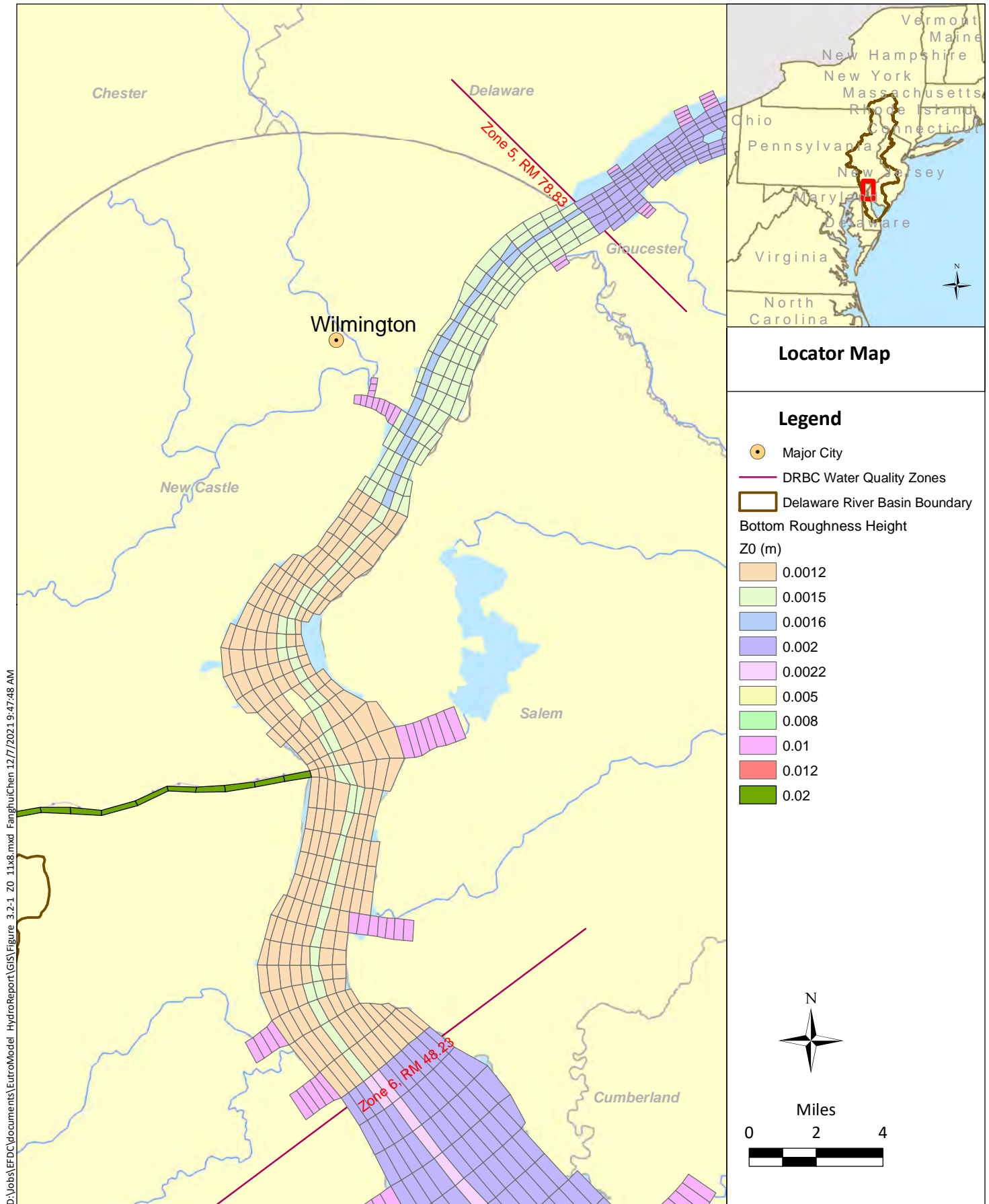
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Figure 3.2-1a
 Bottom Roughness Height

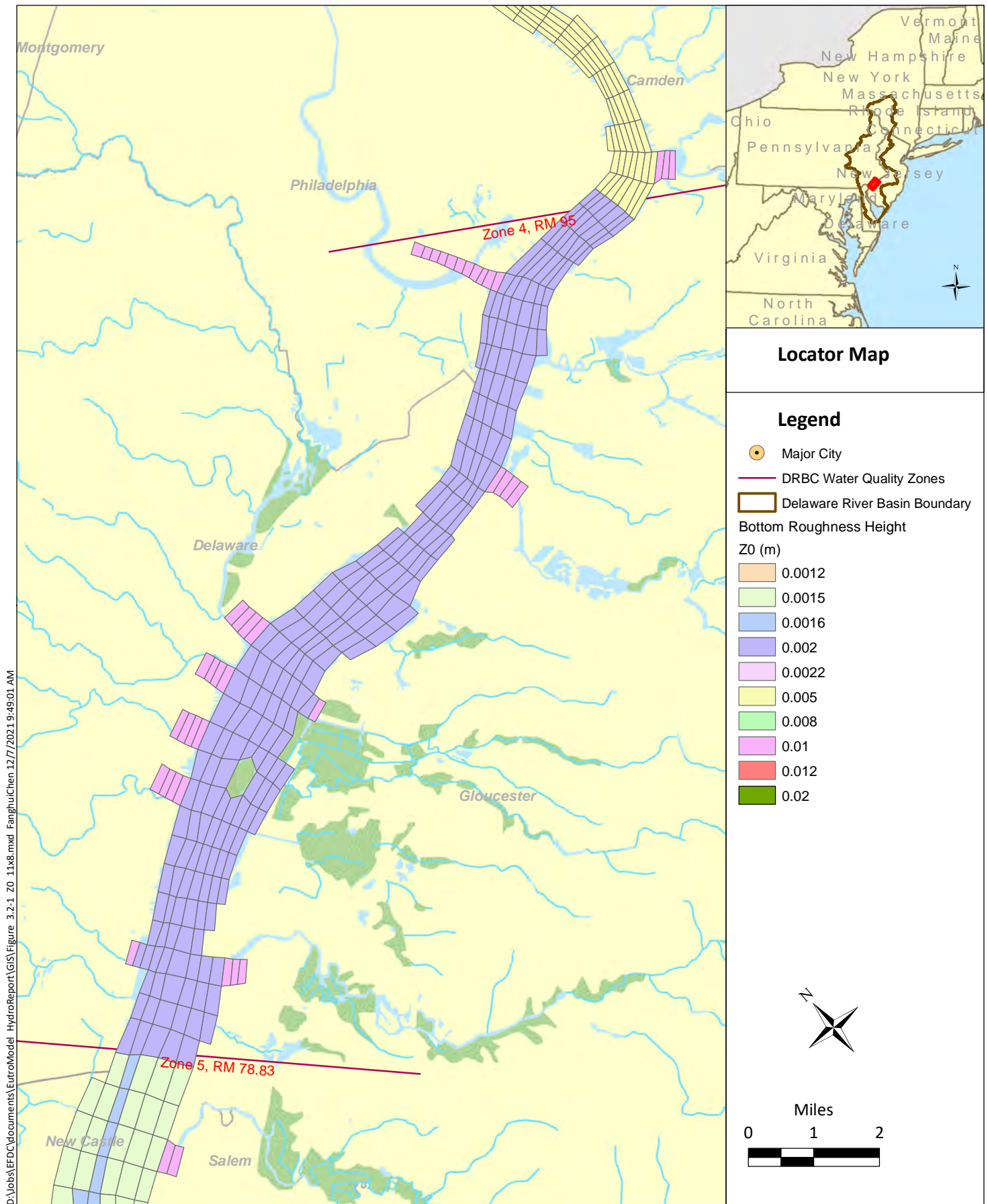


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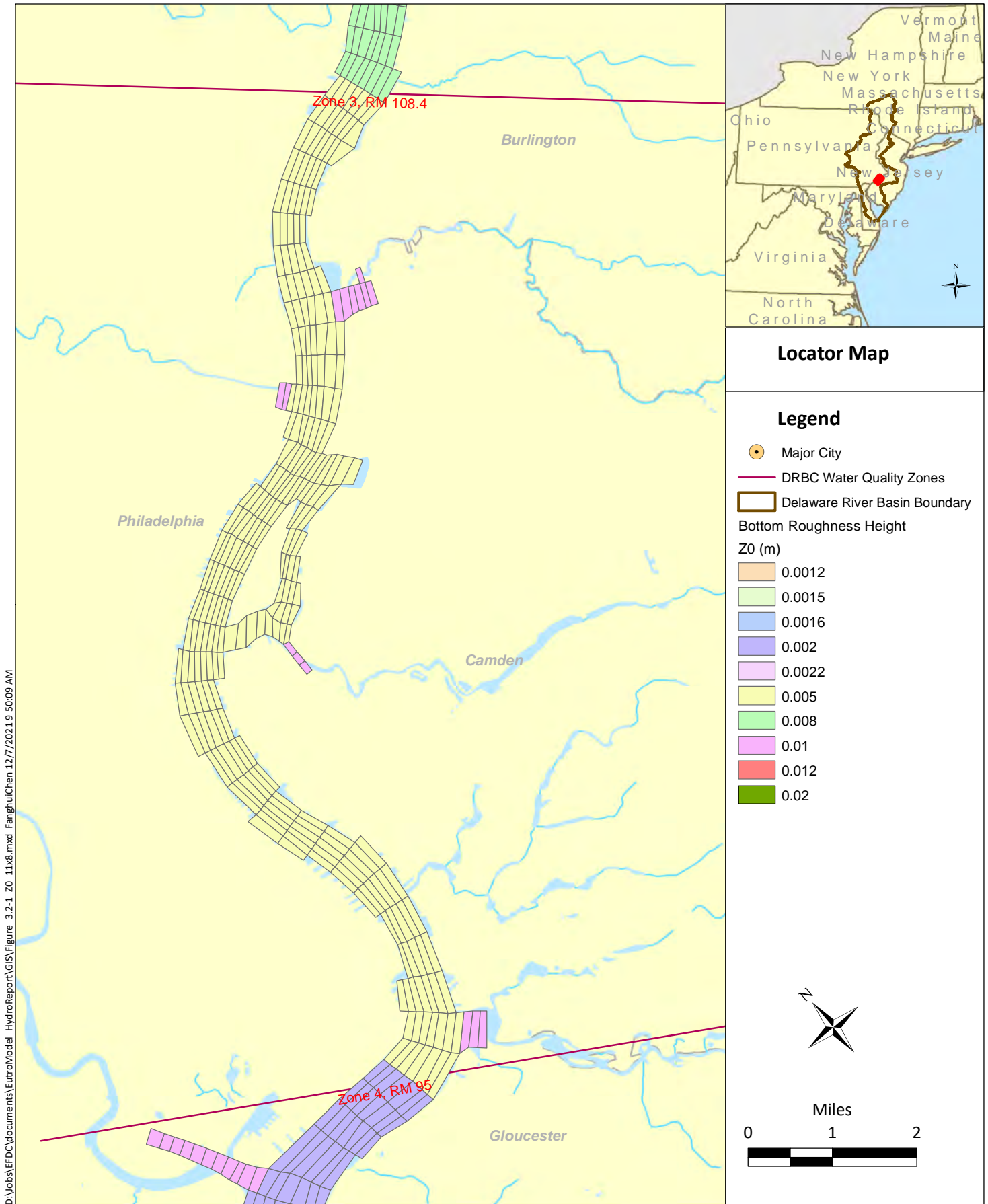
Figure 3.2-1b
 Bottom Roughness Height: Zone 6



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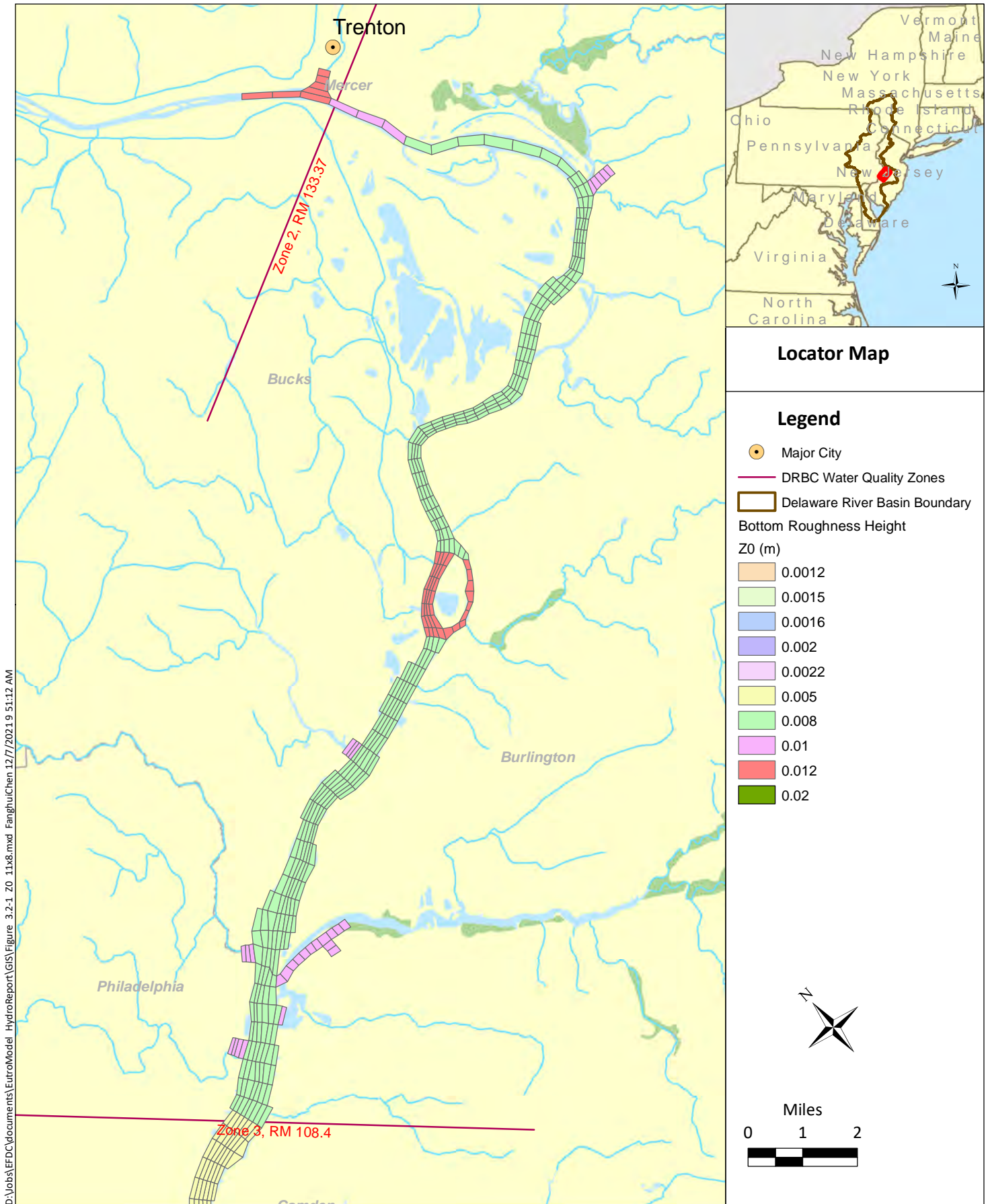


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Figure 3.2-1e
 Bottom Roughness Height: Zone 3



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Figure 3.2-1f
 Bottom Roughness Height: Zone 2