APNEP Air Resources Indicator Report

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US EPA Office of Research and Development

Proposed Indicators and Metrics

(Blue = Indicator, Green = Associated metric; 2012 = Metrics included in the last ecosystem assessment)

Ecosystem Stressors

4 indicators, 7 metrics

- Nutrient Deposition (draft completed)
  - Total (inorganic + organic) nitrogen deposition (2012)
- Ambient Ozone (draft completed)
  - Ground-level ozone concentration (2012)
- Metals Deposition
  - Mercury deposition
- Regional Climate (draft in prep)
  - Ambient air temperature (2012)
  - Precipitation (2012)
  - Storm frequency and severity (2012)
  - Photosynthetically active radiation (PAR)

Air MAT Report Development Process

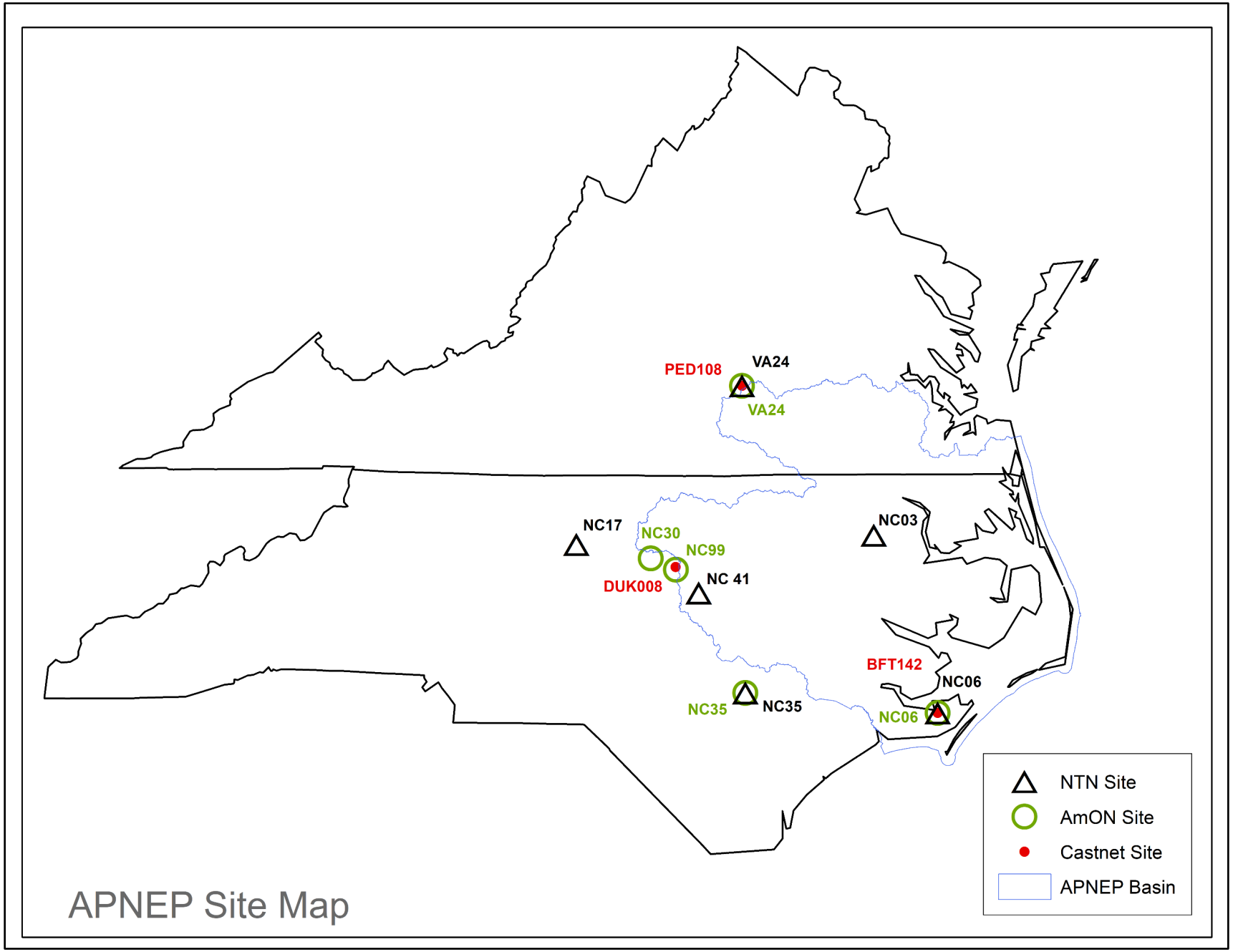
- Air MAT Meeting March 2017
- Webinars (Jan, July 2018) to revisit/discuss metrics
  - What do we have the data to support?
  - Do we have the people we need to develop the report?
- “Refresh” Air MAT membership
  - Expand technical expertise and numbers
  - Leverage support from different agencies – helpful if MAT members have support from management to work on APNEP
- Solicit “champions” for each indicator
- Champions pull together team to work on indicator
  - Look for new data; approaches
- Draft prepared for indicator and circulated to Air MAT team for comment

Air MAT Member “Refresh”

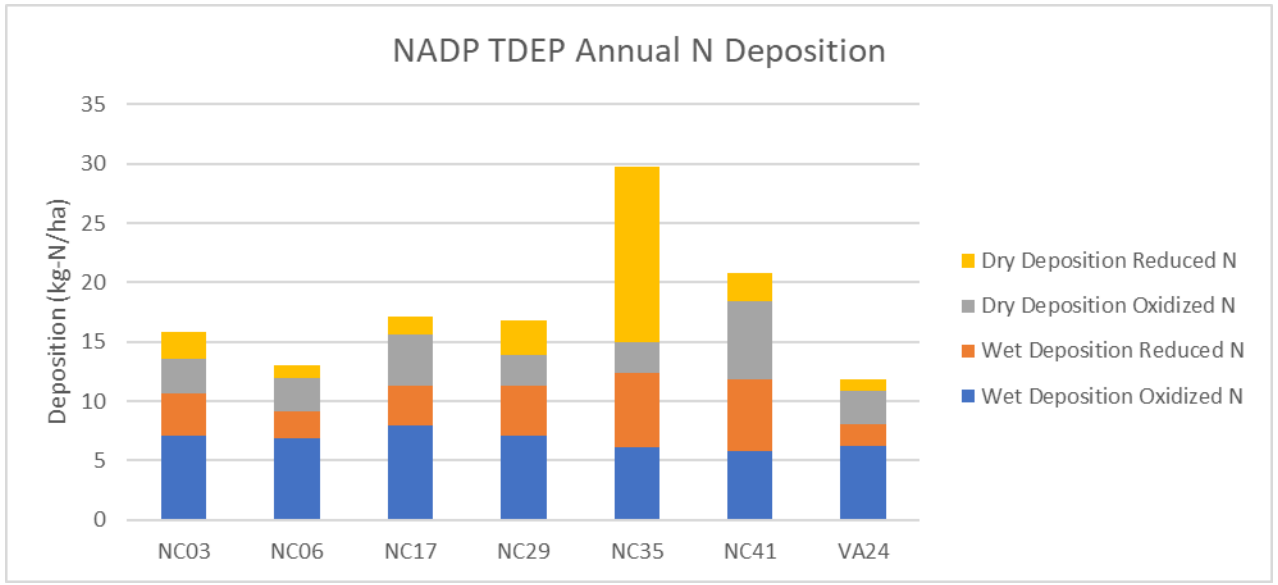
Name	Affiliation
Jared Bowden	North Carolina State University, Department of Applied Ecology
Corey Davis	North Carolina Climate Office
Robin Dennis	U.S. Environmental Protection Agency (Ret.)
Cari Furiness	North Carolina State University, DOI Southeast Climate Adaptation Science Center
David Glenn	U.S. National Weather Service
Jim Hawhee	North Carolina Division of Water Resources
Heather Murphy	North Carolina Division of Air Quality
Donna Schwede	U.S. Environmental Protection Agency, National Research Exposure Laboratory
Richard Smith	University of North Carolina at Chapel Hill, Department of Statistics and Operations Research
John T. Walker	U.S. Environmental Protection Agency, National Research Exposure Laboratory
Jessica Whitehead	North Carolina Sea Grant

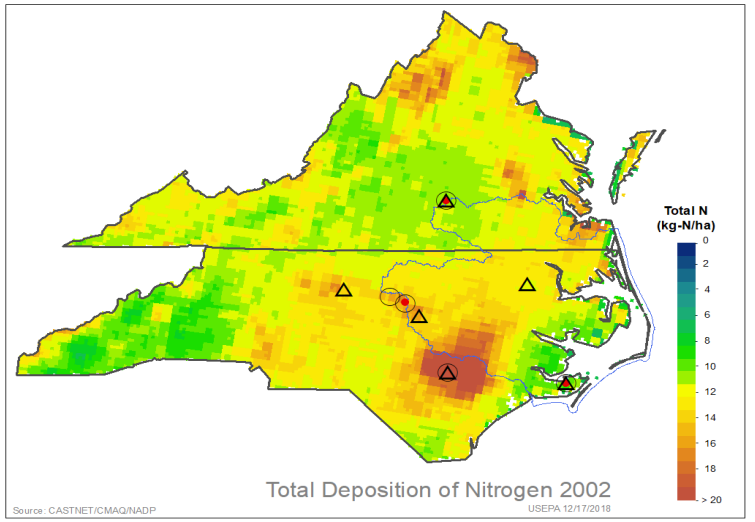
Nitrogen Metrics for 2020 Report

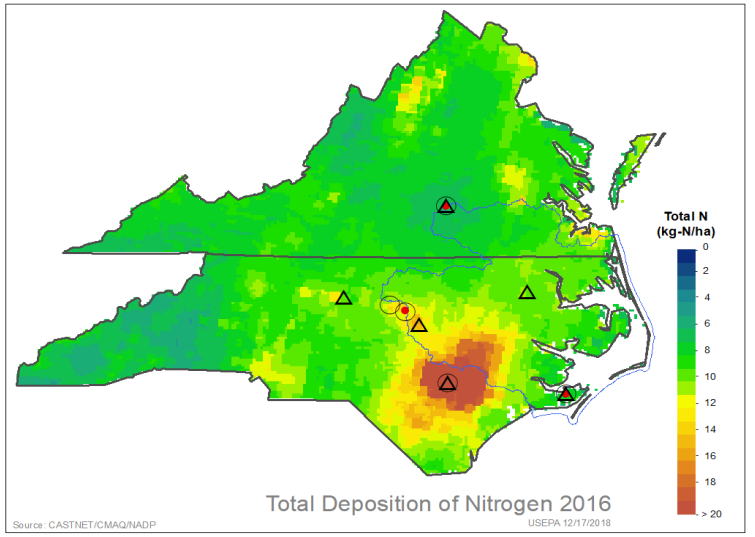
- Measured Annual Wet N Deposition
  - 7 NADP/NTN sites
  - 3 sites 1980 – present
- Measured Annual Rainwater N Concentration
  - 7 NADP/NTN sites
  - 3 sites 1980 – present
- Modeled Total N Deposition
  - NADP/TDEP data at 4 km
  - Spatial pattern as well as budget of oxidized/reduced
- Measured Annual Average Concentration of N Aerosols and Gases
  - 2 CASTNET sites
  - 1990 - present
- Measured Ammonia concentrations
  - 4 AMoN sites
  - 2016-2017


PED108
VA24
VA24
NC17
NC30
NC99
DUK008
NC 41
NC03
BFT142
NC06
NC35
NC35
NC06
NTN Site
AmON Site
Castnet Site
APNEP Basin
APNEP Site Map

Total N Deposition – NADP TDEP Data

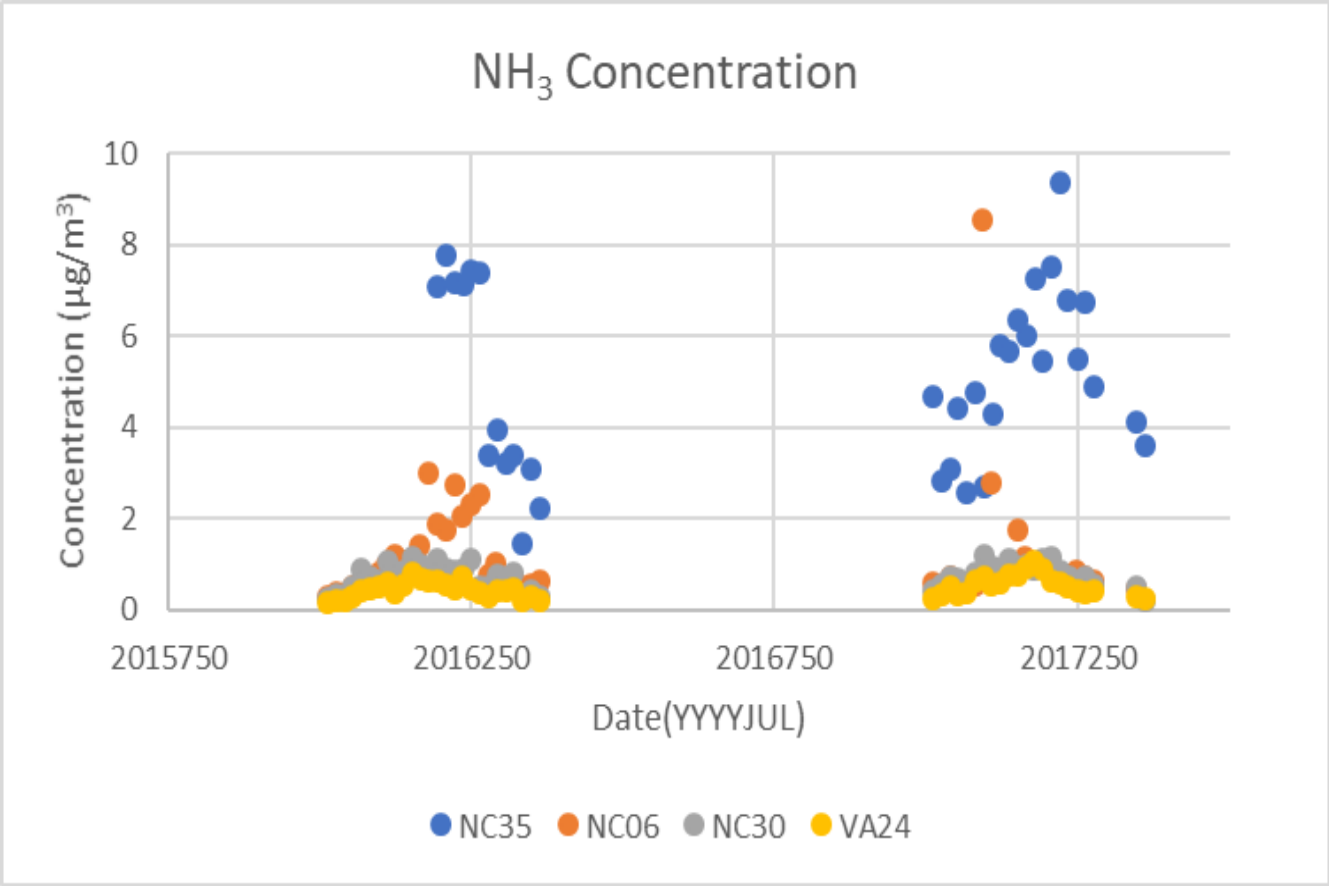






http://nadp.slh.wisc.edu/committees/tdep/tdepmaps/

NH_3 Concentration – NADP/AMoN data



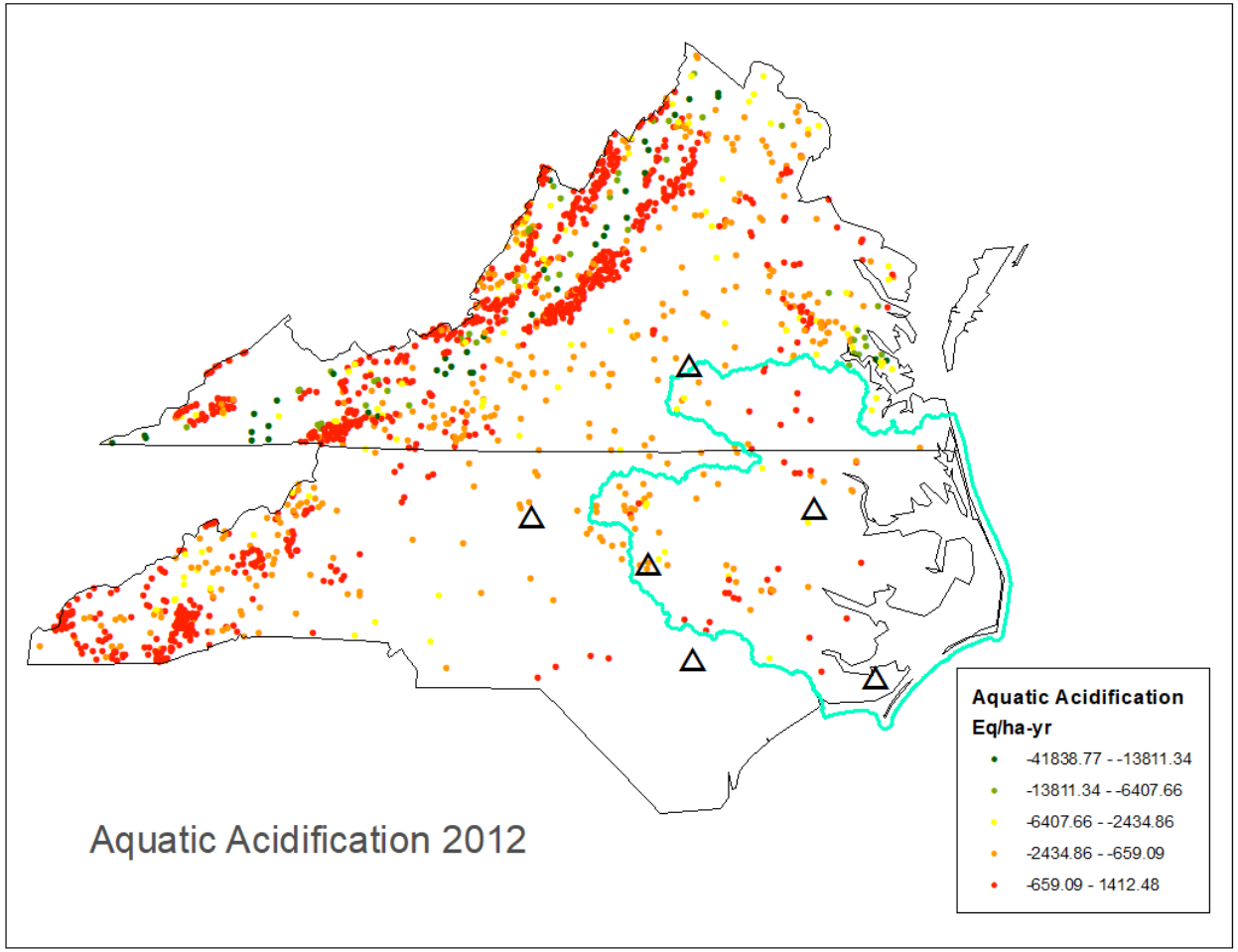
- High spatial variability
- NH3 exchanges bidirectionally
- Need modeling to get fluxes
- Expand monitoring?

http://nadp.slh.wisc.edu/AMoN/

Include critical loads exceedance information

- Looking beyond the deposition value alone
  - Critical load – deposition level below which harmful effects are not thought to occur
- New EPA Tool – Critical Loads Data Mapper
  - https://clmapper.epa.gov
- Deposition data from multiple sources
  - CMAQ
  - CMAQ – NADP/NTN fusion
  - NADP TDEP
  - Climate simulations
- National Critical Loads Database (NCLD)
  - http://nadp.slh.wisc.edu/committees/clad/db/
  - Steady state forest ecosystem and surface water critical loads values

Example: Aquatic Acidification Exceedance

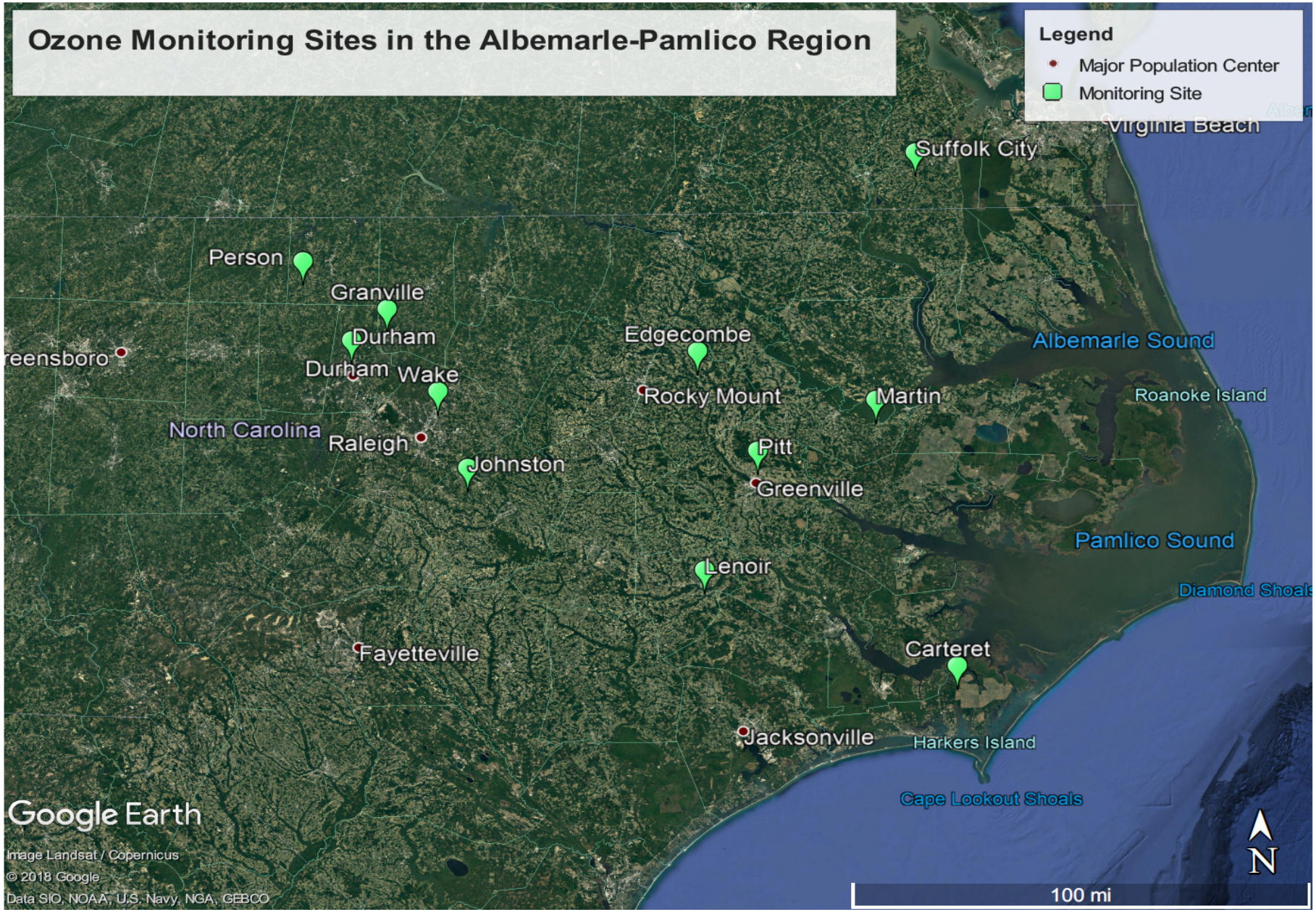


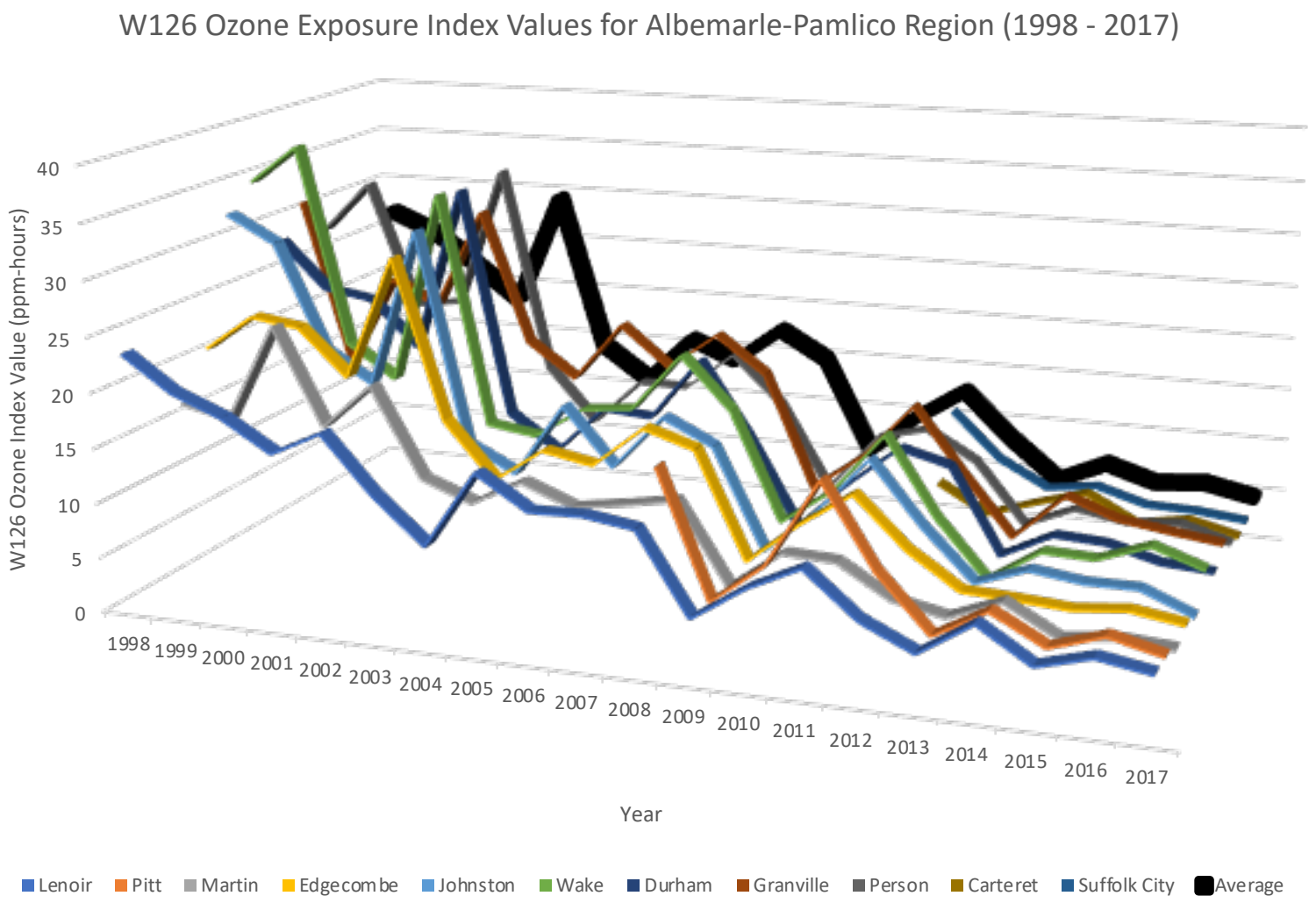
Plots show deposition in excess of critical load

- Positive values are exceedances
- Are these useful?
- How do we set goals for reduction of exceedances?

Ground-level Ozone

- Metric: Ozone Cumulative Concentration-weighted Index (W126)
  - cumulative, biologically-relevant exposure to ozone concentrations that is associated with plant damage during the April – October growing season
  - assigns greater weight to high hourly ozone concentrations over low- or mid-level concentrations.
  - Only average hourly concentrations for daylight hours (8am – 8pm) are used to calculate W126 values. Units are parts per million-hours (ppm-hours). Lower values are more stringent or protective than higher values.
  - 10 ozone monitoring stations in North Carolina within the Albemarle-Pamlico region that have sufficient data to be included in the assessment analysis and are currently in operation


Ozone Monitoring Sites in the Albemarle-Pamlico Region
Legend
Major Population Center
Monitoring Site
Virginia Beach
Suffolk City
Person
Granville
Durham
Durham
Wake
Edgecombe
Albemarle Sound
Rocky Mount
Martin
Roanoke Island
North Carolina
Raleigh
Johnston
Pitt
Greenville
Pamlico Sound
Lenoir
Diamond Shoals
Fayetteville
Carteret
Jacksonville
Harkers Island
Cape Lookout Shoals
Google Earth
Image Landsat / Copernicus
© 2018 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
N
100 mi


W126 Ozone Exposure Index Values for Albemarle-Pamlico Region (1998 - 2017)
W126 Ozone Index Value (ppm-hours)
0
5
10
15
20
25
30
35
40
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Lenoir
Pitt
Martin
Edgecombe
Johnston
Wake
Durham
Granville
Person
Carteret
Suffolk City
Average

Background on climate indicators

The World Meteorological Organization includes expert teams on the extreme event definitions, monitoring, climate change detection, and development of climate indices.

- Task Team on the Definition of Extreme Weather and Climate Events (TT- DEWCE)
  - Goal is to list the existing definition of hazards and develop a catalogue of extreme weather and climate events for easy reference (globally)
  - Will develop a global portal for extreme weather and climate events (not currently available)
- Task Team on National Climate Monitoring Products (TT-NCMP)
  - Develop national climate monitoring products - allows easier direct comparison from country to country for global modeling
  - Standard practices such as defining base period of calculating anomalies for comparisons
  - Mostly consists of area averages and not as helpful for regional to local monitoring
- **Expert Team on Climate Change Detection and Indices (ETCCDI)**
  - **Determined a set of climate indices for temperature and precipitation to diagnose and describe the state of the climate**

ETCCDI
27 Core Indices

ID	Indicator name	Definitions	UNITS
FD0	Frost days	Annual count when TN(daily minimum)<0ºC	Days
SU25	Summer days	Annual count when TX(daily maximum)>25ºC	Days
ID0	Ice days	Annual count when TX(daily maximum)<0ºC	Days
TR20	Tropical nights	Annual count when TN(daily minimum)>20ºC	Days
GSL	Growing season Length	Annual (1st Jan to 31st Dec in NH, 1st July to 30th June in SH) count between first span of at least 6 days with TG>5ºC and first span after July 1 (January 1 in SH) of 6 days with TG<5ºC	Days
TXx	Max Tmax	Monthly maximum value of daily maximum temp	ºC
TNx	Max Tmin	Monthly maximum value of daily minimum temp	ºC
TXn	Min Tmax	Monthly minimum value of daily maximum temp	ºC
TNn	Min Tmin	Monthly minimum value of daily minimum temp	ºC
TN10p	Cool nights	Percentage of days when TN<10th percentile	Days
TX10p	Cool days	Percentage of days when TX<10th percentile	Days
TN90p	Warm nights	Percentage of days when TN>90th percentile	Days
TX90p	Warm days	Percentage of days when TX>90th percentile	Days
WSDI	Warm spell duration indicator	Annual count of days with at least 6 consecutive days when TX>90th percentile	Days
CSDI	Cold spell duration indicator	Annual count of days with at least 6 consecutive days when TN<10th percentile	Days
DTR	Diurnal temperature range	Monthly mean difference between TX and TN	ºC
RX1day	Max 1-day precipitation amount	Monthly maximum 1-day precipitation	Mm
Rx5day	Max 5-day precipitation amount	Monthly maximum consecutive 5-day precipitation	Mm
SDII	Simple daily intensity index	Annual total precipitation divided by the number of wet days (defined as PRCP>=1.0mm) in the year	Mm/day
R10	Number of heavy precipitation days	Annual count of days when PRCP>=10mm	Days
R20	Number of very heavy precipitation days	Annual count of days when PRCP>=20mm	Days
Rnn	Number of days above nn mm	Annual count of days when PRCP>=nn mm, nn is user defined threshold	Days
CDD	Consecutive dry days	Maximum number of consecutive days with RR<1mm	Days
CWD	Consecutive wet days	Maximum number of consecutive days with RR>=1mm	Days
R95p	Very wet days	Annual total PRCP when RR>95th percentile	Mm
R99p	Extremely wet days	Annual total PRCP when RR>99th percentile	mm
PRCPTOT	Annual total wet-day precipitation	Annual total PRCP in wet days (RR>=1mm)	mm

Survey for 27 ETCCDI core climate indices

- 21 total participants
- Request no more than 3 temperature and 3 precipitation indices from list
- There are 16 temperature indices
  - 53 responses
- A total of 11 precipitation indices
  - 52 responses

- Responses from
  - Aquatic Fauna
  - Submerged Aquatic Vegetation
  - Terrestrial
  - Water
  - Wetlands

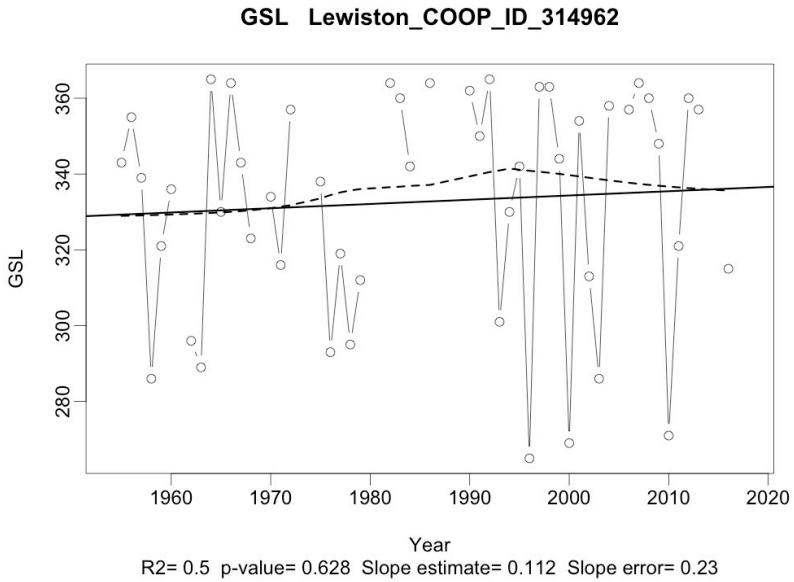
Survey Results for Temperature Indices

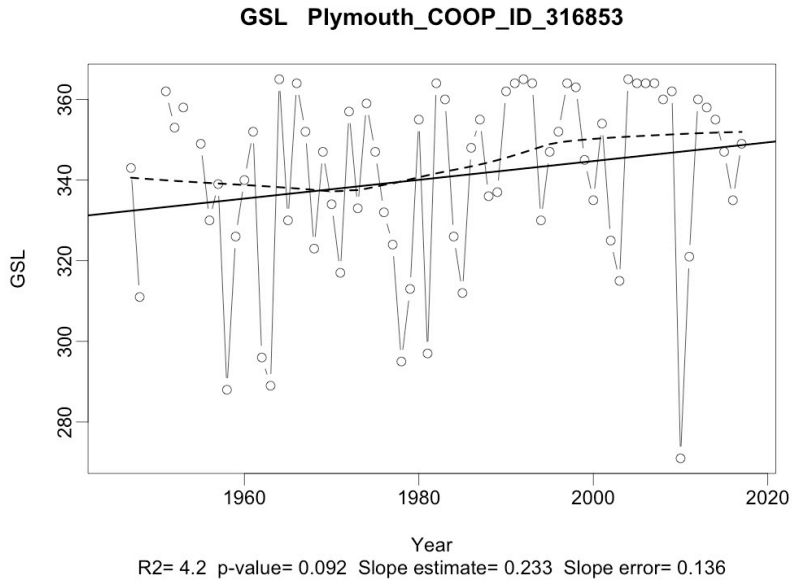
- Growing Season Length (34%) : 6 days daily mean temp. above 5°C to start and below 5 ° C to end (41F)
- Frost Days (13%) : count daily min below 0 ° C (32F)
- Summer Days (13%) : count daily max above 25 ° C (77F)
- Percentage of Days when Daily Max. Temperature > 90^{th} Percentile (9%)
- Number of tropical nights (8%): count min. temperature >20 ° C (68F)
- Number of icing days (6%): count max. temperature < 0 ° C
- Warm Spell Duration Index (6%): 6 consecutive days max temperature > 90^{th} percentile
- Monthly maximum value of daily min. temperature (4%)
- Monthly minimum value of daily min. temperature (4%)
- Percentage of days when maximum temperature < 10^{th} percentile (1%)
- Daily temperature range(1%): monthly mean difference

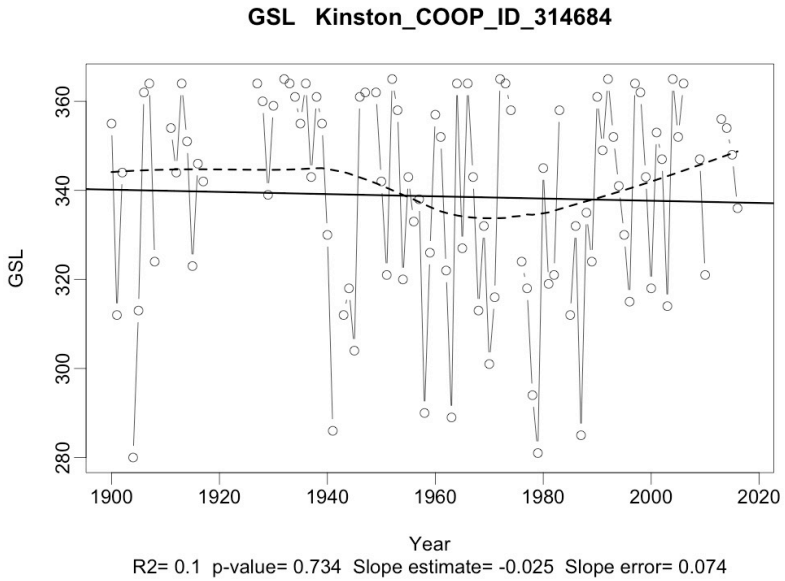
Survey Results for Precipitation Indices

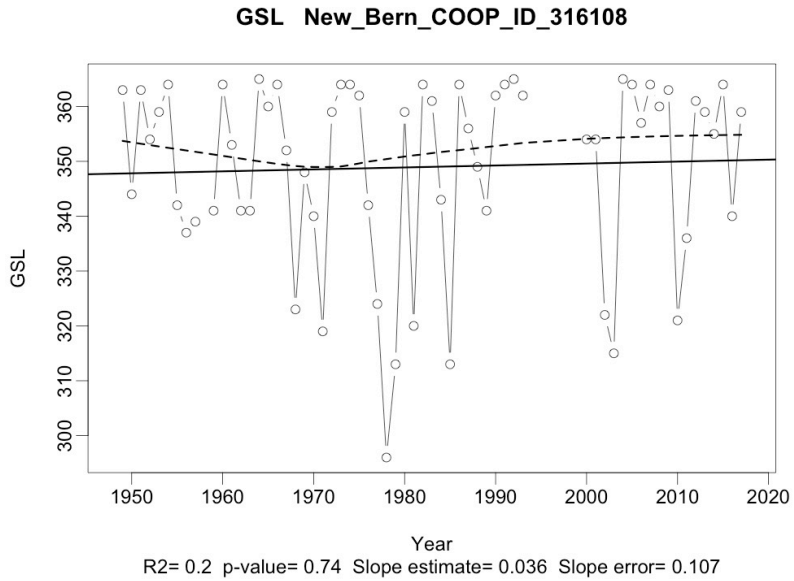
- Maximum length of dry spell (30%) : Number of consecutive days precipitation < 1mm per year/period
- Simple daily precipitation intensity (15%) : average precipitation intensity on wet days per year/period
- Maximum length of wet spell (13%) : max number of consecutive days precipitation > 1mm in year/period
- Annual total precipitation in wet days (10%)
- Monthly maximum consecutive 5-day precipitation in year/period (10%)
- Monthly Maximum 1-day precipitation in year/period (8%)
- Annual count of days when precipitation >10 mm in year/period (4%)
- Annual count of days when precipitation > 20mm in year/period (4%)
- Annual count of days when precipitation > user defined (4%)
- Annual total precipitation when precipitation > 95^{th} Percentile (2%)

Growing Season Length – definition issue for NC





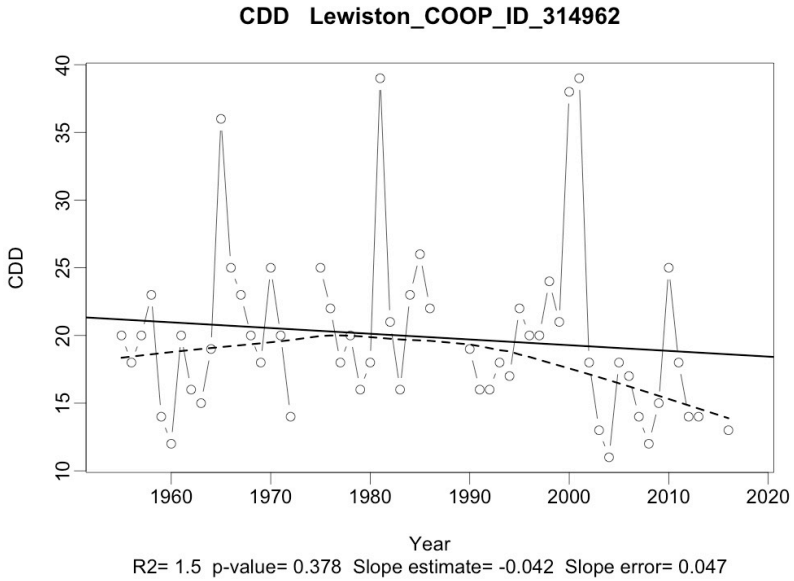




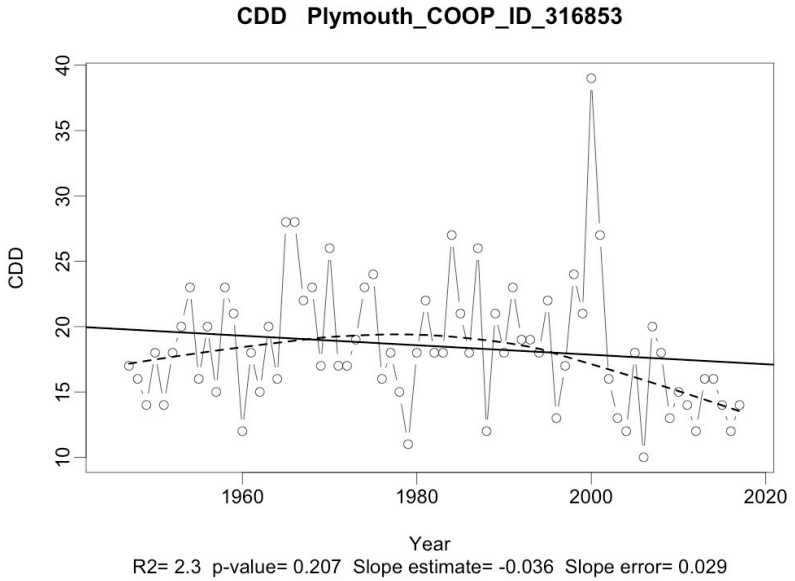
In NC the horticulture definition
growing season is defined as the number of days without an air temperature of 32°F
https://content.ces.ncsu.edu/average-growing-season-for-selected-north-carolina-locations

	GSL (Days)	**Annual Standard Deviation (Days)**
Plymouth	195	15
Lewiston	N/A	N/A
New Bern	232	18
Kinston	214	21

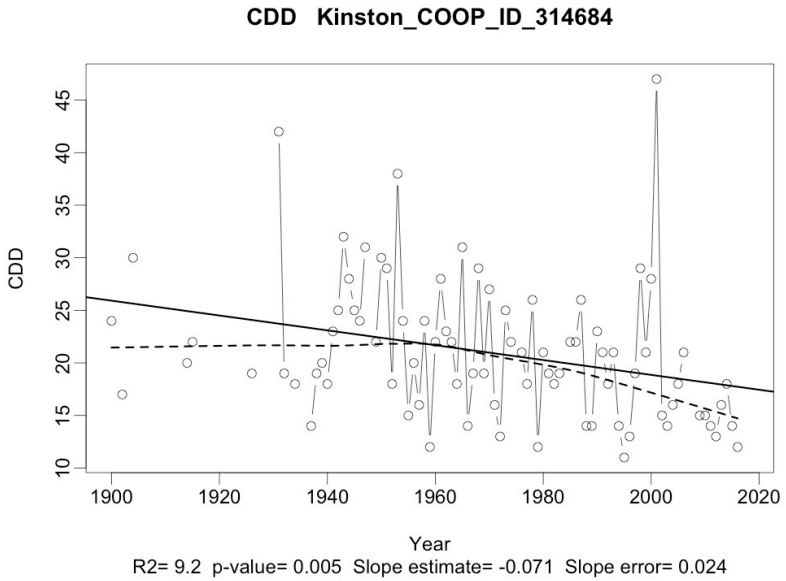
Consecutive Dry Days



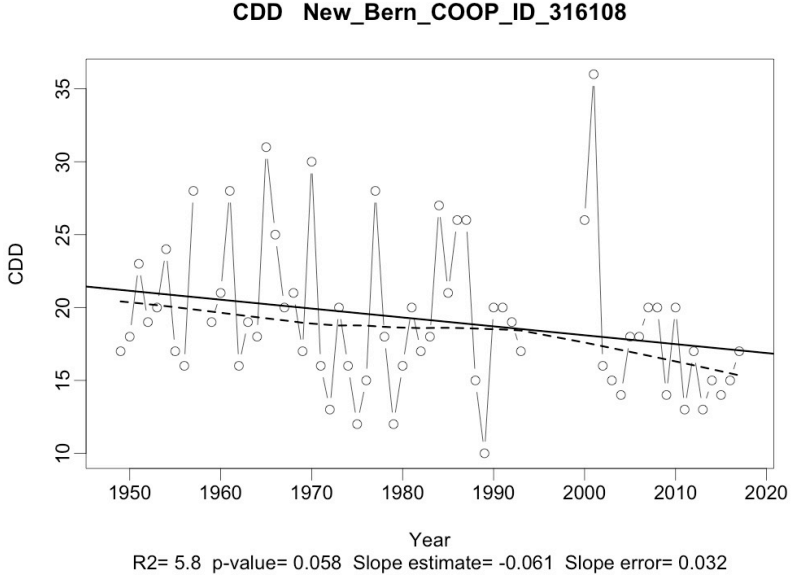
R2= 1.5 p-value= 0.378 Slope estimate= -0.042 Slope error= 0.047



R2= 2.3 p-value= 0.207 Slope estimate= -0.036 Slope error= 0.029



R2= 9.2 p-value= 0.005 Slope estimate= -0.071 Slope error= 0.024



R2= 5.8 p-value= 0.058 Slope estimate= -0.061 Slope error= 0.032

Next Steps

- More frequent MAT meetings (quarterly?) – keep momentum going
- Indicator reports
  - Finalize reports for Nitrogen and Ozone
  - Develop draft for Regional Climate
  - Develop draft for Mercury
- Build support for APNEP work in agencies
  - EPA – set up meetings with ORD and APNEP; APNEP is not on the radar like other NEPs (e.g. Chesapeake Bay, Narragansett)
- What additional monitoring or measurements are needed?
  - Organic N
  - Flux measurements