NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

SCIENCE ADVISORY BOARD

FINAL REPORT

PEER REVIEW- NEW JERSEY SCIENTIFIC REPORT ON CLIMATE CHANGE

Prepared for:

Commissioner Catherine R. McCabe

Prepared by:

Climate and Atmospheric Sciences Standing Committee*

Approved by:

NJDEP SCIENCE ADVISORY BOARD

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April 22, 2020

Members of the Climate and Atmospheric Sciences Standing Committee:

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***Report Contributors**

Contents

Introduction and Charge:

On October 29, 2019 Governor Phil Murphy issued Executive Order 89 (the Order). In this order the Governor called for the development of "a Scientific Report on Climate Change based on existing data and the best available science regarding the current and anticipated environmental effects of climate change in New Jersey, including but not limited to increased temperatures, sea level rise, increased frequency or severity of rainfall, storms and flooding, increased forest fires, and increased frequency and severity of droughts, anticipated by scientists at least through 2050." This report is to be delivered to the Governor by April 26, 2020, 180 days of the effective date of the Order. The Order also calls for the report to be updated at least every two years in order to reflect the latest available climate change science.

As part of the Order, the Bureau of Climate Resilience Planning (BCRP) was established and charged with managing the development and delivering the climate science report to Governor Murphy and the NJ DEP Commissioner, Catherine R. McCabe. The Division of Science and Research (DSR) was asked to participate in the drafting of the report to provide technical content and support. Multiple Department programs and topic-area experts provided input and guidance by providing various levels of technical support. The report drafting team consisted of five members of BCRP and DSR who worked to draft individual sections of the report as well as edit content provided by topic-area experts. It is our intent that this report provides a review of current scientific information on climate change and potential impacts to New Jersey.

BCRP and DSR have asked the Climate and Atmospheric Sciences Standing Committee (CASSC) of NJ DEP Science Advisory Board (SAB) to peer review and provide comments on the findings of the draft report. The invitation to review and comment was also shared with members of the full SAB. The chairs of each standing committee were encouraged to share the report with members of their respective committees.

A conference call with the CASSC was held February 20, 2020 and the draft report was distributed on February 25, 2020. Comments were requested to be delivered by March 13, 2020 but that deadline was extended to March 20, 2020. Comments were received through March 22, 2020. Nine SAB members ultimately provided comments. The comments from each member are provided below.

Comments from each reviewer:

Anthony J. Broccoli, Ph.D., Chair of the Climate and Atmospheric Sciences Standing Committee.

Professor and Chair, Department of Environmental Sciences; Co-Director, Rutgers Climate Institute, Rutgers University.

Line Number	Section	Comment (1/row)
	General Comments	I've confined my reading to the sections that discuss topics within my expertise, so I've focused on the first four chapters. First and foremost, it must have been an extraordinary amount of work to put this report together in such a short time. You and the other members of your team have obviously had to digest a lot of source material to get to this point. I've offered many specific comments and suggestions in the attached file, but my overall impression is that the report could be substantially improved if there was more time to subject it to a thorough review be experts in each area. I could readily envision a review team in which each member would be chosen for their specific expertise and asked to review a section or set of subsections.
	General Comments	The report contains references to unrefereed websites (Global Change 2020, United Nations 2020, NASA 2020) instead of peer-reviewed publications. Even though the former may be credible, the latter would be better, especially given that they are permanent.
	General Comments	The document is somewhat uneven in style and some information appears more than once or in a section where it doesn't fit best. This is not unexpected if a draft has had multiple authors. Some additional editing could improve the report, if time permits.
164		The second part of the SLR sentence has an error.
166		I wouldn't phrase this as "increases in intensity and frequency of storms," but rather "increases in intensity and frequency of heavy precipitation events." In general meteorological usage, a storm is a weather system, not a precipitation event, although engineers often use the term differently.
481		I assume these are for global mean temperature. The caption should say so
562		$1 billion is wrong. Sandy alone was in the neighborhood of $50-60 billion. Also contradicted in line 564
633		The Lovelock book is a secondary source. The oceans chapter of the NOAA/NCEI State of the Climate Report (https://www.ametsoc.org/index.cfm/ams/publications/bulletin-of-the-american-meteorological-society-bams/state-of-the-climate/) is a better source.
690		Preindustrial CO2 was about 275 ppm, not 250 ppm
698		Should read "expected to result"
702		These are concentrations, not emissions. Clearly distinguishing between the two is crucial. Concentrations will continue to increase even if emissions are reduced. Only a reduction to nearly zero would stop an increase in concentrations.
996		"intensity of weather events" is too vague; climate change is making some weather events (such as cold waves) less intense
1063		What period is used for the long-term average? Is it 1895-2019? The period should be stated
1212		Typo: 219 instead of 2019
1225		Typo: "List of"
1249		"extreme precipitation events" not "extreme weather events"
1350		Why are tornadoes being discussed in a section on precipitation
1433		Typo: Should be Chapter 4, not 3
1450		Should be sea level, not SLR (because the point is the SL is rising faster in NJ)

1024-1037		The presentation of the global SST time series is a strange choice. There are many data sets for global temperatures (NASA-GISS, NOAA, HadCRU, etc.) that are more comprehensive and cover both land and ocean. One of those should be used instead.
1057-1059		Apples and oranges issue with comparison of trends; different time periods, different methods. An alternative would be to go to NCEI website and use their interactive tool to determine trends for the same period (1895-2019). This yields 3.6F for NJ, 2.5F for Northeast, and 1.8F globally
1068-1070		These stats are outdated. Now 38 top-5 warm and still 0 top-5 cold through 2019
1142-1176		This section seems unnecessary. It is background information that is oversimplified and replete with non-sequiturs. I recommend deleting it
1289-1301		Why no references to the Fourth National Climate Assessment (https://science2017.globalchange.gov/)? That would be better than some of the references listed. (BTW, I couldn't find AdaptWest Project in the references.
1302-1303		It's not in line, because the warming under the RCP8.5 scenario would be much more than 2 F. I recommend dropping this sentence.
1317-1319		There is always some uncertainty with regard to the causes of past trends, but robust long-term trends that emerge from future climate simulations are the result of the changes in climate forcing agents that are prescribed in the models. It's not clear why this section should focus on the short-term (especially since some of the period from 2016-2035 is already in the past.
1347-1348		What is the source of this statement? In the 2019 STAP report, we said the following: "Changes in the frequency, intensity (wind speed), precipitation rate, and tracks of extratropical cyclones remain an area of active research, and the STAP concluded that, at this time, there is no definitive consensus regarding such changes."
1459-1462		There is no uncertainty about glacial isostatic adjustment contributing to larger SLR in NJ. Effects of changes in the Gulf Stream and the compaction of coastal sediments have some uncertainty. Also, this sentence contains too much jargon. I would end with something like "continued geologic influences as solid Earth slowly adjusts to the loss of the North American ice sheet and the end of the last ice age.
152-156		Comparison NJ trends vs. regional and global trends apparently mixes methods of trend determination. The temperature trend for the Northeast since 1895 is ~2.5° F if I use the NCEI website and determine it in the same way that yields a NJ trend of 3.5°
540-541		This is an odd sentence. Wouldn't it be simpler to say that increases in greenhouse gases cause other changes in addition to rising temperatures? I assume that's the point of the subsequent paragraph
548-550		I wouldn't include this statement unless there is a reference to the peer-reviewed literature to support it.
5570-5598		IPCC reports are referenced incorrectly. (There also appear to be missing page numbers.) Each report contains instructions on how full reports and individual chapters should be referenced.
571-573		References?
582-591		Reference?
592-655		This section could be better organized if the information was grouped according to climate quantity (i.e., temperature, precipitation, etc.) and observations of past changes and projections were not mixed.
626-627		The increase in frost-free period sounds like a future projection, but it is mixed in with observations of past changes.
645-647		Increasing frequency of intense storms has not been documented, to my knowledge, anecdotes about individual storms notwithstanding. If there is a peer-reviewed reference to support this assertion, it should be included.
658-659		This sentence mixes emissions and concentrations, confusing the distinction between fluxes and stocks
663-677		The description of the greenhouse effect needs to be revised. See p. B1 of the NAS-Royal Society primer (https://royalsociety.org/-/media/Royal_Society_Content/policy/projects/climate-evidence-causes/climate-change-evidence-causes.pdf) for an example of an accurate description designed for a general audience.
707-712		References?

714-727		This paragraph could be misinterpreted. In terms of their effect on atmospheric greenhouse gas concentrations, human-caused emissions are the dominant influence on the present-day carbon cycle, despite the large amounts are carbon stored on land and in the ocean
738-739		This sentence should be moved up into the previous paragraph. That would alleviate the concern raised in my previous comment.
754-756		Should mention that sulfate aerosols exert a cooling effect.
838-840		Caption should indicate that units are for equivalent CO2.
911-913		What is the basis of the statement about 60% of radiative forcing coming from short-lived forcing agents that are not included under Kyoto? This statement is misleading at best because it downplays the importance of CO2. Of the radiative forcing agents that cause heating, CO2 is by far the largest, with methane the second largest. Both of these are included in the Kyoto metrics

Judith S. Weis, Ph.D., Chair of the NJ DEP Science Advisory Board

Professor, Department of Biological Sciences, Rutgers University

Page Num	Line Number	Section	Comment (1/row)
		General Comment	The report is very comprehensive and thorough. It discusses many historical issues that are not essential to the problem, although they are informative and interesting. I notice a general trend of the report - focusing on South Jersey. The northern part of the state is where most of the population live and the part that has greater environmental problems and need for DEP. It deserves more attention in the report and from DEP in general. In my specific comments, I just focus on the parts of the report where I have expertise: biological effects, wetlands, oceans etc. My first couple of comments are English language corrections, but then I mostly stopped doing that in favor of more substantive comments. In the Ocean Acidification section, "Weis et al. 2015," the SAB OA report is referenced, but we did not do the original research on those topics – we were citing the people who did, so are not the primary source.
	3058		productive ecosystem**s**
	3065		complex and **is** not well understood
120	3274		More recent MERI data show all *Spartina* marshes are not keeping up with SLR but *Phragmites*-dominated marshes are. Material from Ildiko Pechmann presented to SAB salt marsh committee
121	3314		reference needed
123	3365		the climate change prediction is for more spring rain in the northeast (which seems to be here already this year!) which will lower the salinity.
126	3467		check the DEP measurements of pH for the past 6(?) years in estuaries. Note that "blue carbon" from sea grasses and marsh plants can reduce coastal acidification
127	3477		Note that the Meadowlands (in the northern part of the state) had been a cedar swamp until the Oradell dam was built to make a reservoir in Bergen County along the Hackensack River, allowing saline water to come up-river.
141	4059		Incorrect use of language. "Toxins" are not anthropogenic poisons. "Toxins" are defined as poisons made by cells of living things such as jellyfish, bees, rattlesnakes etc. Anthropogenic poisons can correctly be called "toxic chemicals," "toxic contaminants," or "toxicants."
144	4171		increased freshwater inflow **directly reduces the pH** since freshwater has a lower pH than saltwater.
144	4177		loss of tidal marshes will reduce fish populations that use the marshes as nursery areas
152	4468		reference? (I could suggest Macdonald, J., Roudez R., Glover T. and Weis JS 2007. The invasive green crab and Japanese shore crab: behavioral interactions with a native crab species, the blue crab. Biol. Invasions 9: 837-848)

	4471		references?
156	4625		what about marine HABs? They haven't been discussed at all!
163	4859		(Urgent Editorial Comment) The state of NJ and all its counties and municipalities should **do everything possible** to move people inland from the shore and prohibit any further development in the flood zone. Spending money now to get people out of harm's way will save a lot more money in the future after hurricanes and other disasters.
112	6241		*Phragmites* dominate**d**
145	4207-4216		A new paper (Clark et al 2020 Ocean acidification does not impair the behavior of coral reef fishes. Nature 577: 370-375) casts some doubt on the earlier behavior papers. (I don't know what you should say about this though…this new paper is clearly not the final word on the subject)
147	4283-4		What about northern NJ coastal ecosystems? (here we go again….)
116		figure 5.16	You should find another figure that is about salt marshes only, one that isn't about living shorelines or oyster reefs etc. There should be plenty of appropriate figures available
117			This geological history is not essential for the report
150			Increased temperatures may produce longer breeding seasons for some resident animals as a result of longer summers. We observed this with fiddler crabs, which in the early 21st century were breeding over a much longer period in the warm weather months than had previously been reported in the 1970s. (Bergey L and Weis JS 2008 Aspects of population ecology in two populations of fiddler crabs, *Uca pugnax*. Mar. Biol. 154:435-442). This phenomenon is probably true for many other species.
		5.4.2.2.8	As a result of our SAB report on OA in 2013(?), DEP is now monitoring pH. Take a look at the data to see what is happening in our estuaries, rather than the ocean itself.
123			it states that the "whole state" was examined – where is information about the Raritan and Meadowlands marshes in the northern half of the state?
136			birds. No discussion about northern part of the state. There is lots of information about birds in the Meadowlands, which has not been included. A good source of information on birds would be Hugh Carolla of the Hackensack Riverkeeper or Nellie Tsipoura of Audubon who is on the Eco Committee of SAB.
		5.4.2.2.4	Entire coast of NJ? Where's information about Meadowlands? If resilience is due to marsh migration, then Raritan is not in good shape either!
		General Comment	The report is very comprehensive and thorough. It discusses many historical issues that are not essential to the problem, although they are informative and interesting. I notice a general trend of the report - focusing on South Jersey. The northern part of the state is where most of the population live and the part that has greater environmental problems and need for DEP. It deserves more attention in the report and from DEP in general.
		General Comment	In my specific comments, I just focus on the parts of the report where I have expertise: biological effects, wetlands, oceans etc. My first couple of comments are English language corrections, but then I mostly stopped doing that in favor of more substantive comments. In the Ocean Acidification section, "Weis et al. 2015," the SAB OA report is referenced, but we did not do the original research on those topics – we were citing the people who did, so are not the primary source.
		5.4.2.2.3	Include the Meadowlands here where there is probably the least available space for marshes to migrate.
		5.4.2.2.3	Phragmites will enable marshes to elevate faster and have a been chance of keeping up with SLR. See the draft write-up I sent about Phrag for the SAB report and its references.
		5.4.2.2.5	Part of the climate predictions for our area is MORE RAINFALL. This would cause reduced salinity.
		5.4.2.2.7	And reduced salinity

Michael Aucott, Ph.D., Member, Climate and Atmospheric Standing Committee

Research Scientist, retired. Division of Science and Research, NJ DEP

Line Number	Section	Comment (1/row)
2501-2511	5.3	Overall, the Report is an impressive work. It appears thorough and up to date. However, there is an important area where more should be said: the ecological impact of elevated carbon dioxide itself. This is discussed to some degree in section 5.3, lines 2501 through 2511. More on this topic has appeared recently in the literature, particularly regarding the impact of elevated carbon dioxide on insect populations, as discussed below. I recommend adding some discussion on this issue; it could perhaps be incorporated to the existing section noted above or perhaps added under a separate sub-heading. Dr. Aucott provided background and references to support this suggestion.

Mark J. Chopping, Ph.D., Member, Climate and Atmospheric Standing Committee

Professor, Earth and Environmental Studies, Montclair State University

Page Num	Line Number	Section	Comment (1/row)
		General Comment	My comments and suggestions are listed sequentially below, with page and line number. The context should be clear from the comment and/or its position in the PDF. Three asterisks (***) indicate what I consider to be the most important of the 164 comments, though I recommend checking all of them. There are no line numbers for the suggested additional references as these are listed sequentially at the end of the document.
4	40		"are"
6	156		Indeed. Question: is C cycle modeling included in calculations of net emissions? It matters whether emitted carbon gases (CH4, CO2) are partof short-or long-term cycles. Will check Chapter 3: yes, C cycle is discussed --OK.
7	178		There should be some mention of ecological shifts that adversely impact forests, and in particular, increased insect outbreaks and vulnerability to pathogens.
7	206		cite: Broccoli et al. 2016 (NJ SAB Climate Change question report).
7	207		...now is the time to plan for adaptation to these problems.
8	212		can
15	354		important
15	377		SAB too?
16	397		This is a strange sentence: it is not a definition of "climate change"; please rewrite.
18	421		interglacial (not "ice age", unless we are OK with slipping completely into the vernacular).
18	422		and allowing the emergence ofcivilization circa 6,000 years ago.
18	424		"absorbs", or "retains" --but not "receives": incident solar radiation at top-of-atmosphere is not affected by orbital cycles; what matters is what parts of the Earth's surface are illuminated.
18	427		...ocean and lake sediments...
18	429		post-glacial (check terminology consistency)
18	429		at the end of the last interglacial (check terminology consistency)
18	446		add something like: but note that unlike the other greenhouse gases, water vapor changes phase in response to temperature (i.e., condenses with cooling and evaporates with warming), meaning that it is primarily considered a climate "feedback" rather than a "forcing".
19	478		CO2 concentration and radiative forcing.
19	481		Average Global Surface Temperature Increase in 2100 (°F)...
21	481		Better to report decadal values, or at least over a longer period: citing values for only two years is odd and does not provide important context.

19	482		Do not split tables across pages, if at all possible (and if you have to, include the column headers on all pages).
21	531		total annual carbon dioxide...
21	540		Replace with: "The changes seen in Earth's climate system are not limited to rising near-surface temperatures." (as it stands, this is misleading: it implies that increased CO2 does not affect ocean temperature).
21	542		These changes are causing...
21	543		"respectively,"
21	544		strike out [see Chopping pdf for more context]
21	545		Because of the size of the ocean and its capacity to store heat, climate change...
21	546		I do not believe that there is any evidence to suggest that climate change already incurred could be undone on the scale of decades, whatever we do (or whatever happens, barring a global conflict involving nuclear weapons, or large asteroid or comet impact). If removing "decades" seems too definitive, please consider adding "in the absence of very extreme events (global nuclear conflict, large meteorite)".
22	560		define all initializations, abbreviations, etc. on first use
22	567		Global Change Research Program
22	578		This material should be in §2.3.
23	604		This is imprecise: it is not clear whether we are referring to the NE, or the subset indicated in parentheses. Please rewrite the sentence; it is also quite vague (i.e., how big of an increase?).
24	634		Strictly speaking, this subsidence _is_ related to climate change: in NJ and along the east coast it is owing to post-glacial isostatic rebound (Laurentide ice sheet melt has led to Canada rising and most of the USA sinking). Rephrase?
24	634		, which (or ...that exists...)
24	636		Add: A further cause of local sea level rise is the gravitational effect related to ice sheet mass loss ("sea-level fingerprints", Larour et al. 2017). Quote: "The melting of ice sheets and glaciers leaves behind a gravitational hollow of lowered sea level, as the water that had been pulled toward the ice mass, no longer captive to its gravitational attraction, migrates away; meanwhile, the additional water mass transferred from the melting ice to the ocean will, at a sufficient distance, raise sealevels." --NASA (https://sealevel.nasa.gov/understanding-sea-level/regional-sea-level/ice-mass-loss last access 3/19/20).
24	650		citation required.
24	657		...one of the reasons...
24	667		Accuracy issue: please do not use "infrared" so broadly, or as shorthand; write "with almost all within the ultraviolet and the near-infrared". It is important to know that almost all solar radiation falls between the ultraviolet and the near-infrared*. EMR in this range is known as "sunlight". The greenhouse effect works because the atmosphere does not attenuate sunlight strongly but it does absorb in the longer infrared wavelengths at which the Earth radiates. *"About 99 percent of solar radiation is contained in a wavelength region from 300 nm(ultraviolet) to 3,000 nm (near-infrared)" --U.S. Energy Information Administration URL: https://www.eia.gov/tools/glossary/index.php?id=Solar%20spectrum See also: https://en.wikipedia.org/wiki/Solar_irradiance#/media/File:Solar_spectrum_en.svg
24	668		...sun (aka "sunlight") hits...
24	671		"heat" is used ambiguously here and is superfluous
24	671		longwave infrared radiation
25	672		reflected
25	673		strike out, longwave [see Chopping pdf comments for more context]
25	691		...extra, long-lived, non-condensing greenhouse gases..
25	698		...expected to result...
26	702		strikeout, Concentration (this curve does not show emissions). We should probably also remove "Global" in the caption title --since the measurements are acquired at one location, Mauna Loa, HI --and indicate that these measurements are considered representative of global increases in CO2.

26	703		(in red), with a moving average of seven adjacent seasonal cycles (in black) that removes the seasonal cycle.
28	755		(sulfur aerosols reflect sunlight, so have a cooling effect overall).
28	758		representing
28	766		(e.g., longer growing seasons)
28	768		and increased moisture retention through shorter stomatal opening periods.
31	822		in CO2e [see Chopping PDF comments for more context]
36	887		Does not exist; correct to Chapter 5.1.1.1 (Ground-Level Ozone).
38	962		_All_ diesel engines. I am astonished that **this is the only mention of diesel engines in the entire report**. We have so many important sources: passenger vehicles and light trucks, vans, semis, buses, rail locomotives, airports (e.g., Newark Liberty International amongst others), ships (e.g., port of Elizabeth).
39	972		*** This is not quite accurate: this path would also require so-called "negative emissions" (i.e., carbon sequestration via BECCS, or some other as-yet-unknown process). Reducing emissions of long-and short-lived species is not adequate. Citation: Hansen et al. (2017).
39	996		important ecological changes and a rise...
40	1007		indicate (data is the plural)
41	1022		over the last 150 years
43	1086		were
46	1146		condenses onto particles, forming the droplets of clouds.
52	1323		direct human-induced radiative forcing.
55	1431		strike out [see Chopping PDF comments for more context]
55	1435		and globally via satellite radar altimetry
55	1439		reduced water supply and quality
55	1448		and gravitational effects related to ice sheet mass loss ("sea-level fingerprints"; Larour et al. 2017), as well as...
55	1450		insert space
55	1450		gravitational effects (Larour et al. 2017) and...
58	1509		strike out [see Chopping PDF comments for more context]
59	1528		Include something here about the economic importance of Atlantic City to NJ? Obvious perhaps --but needs to be said.
59	1530		It would be very useful to include estimates of the area (in acres) of the coastal zone affected with different thresholds (e.g., #flood days yr^-1) in 2050 or 2100.
59	1539		strike out [see Chopping PDF comments for more context]
59	1540		increases the acidity of ocean water
60	1555		Grey literature: There is probably a better or additional citation. I suggest: Gruber, Nicolas, D. Clement, B. R. Carter, R. A. Feely, S. van Heuven, M. Hoppema, M. Ishii, R. M. Key, A. Kozyr, S. K. Lauvset, C. Lo Monaco, J. T. Mathis, A. Murata, A. Olsen, F. F. Perez, C. L. Sabine, T. Tanhua, R. Wanninkhof. The oceanic sink for anthropogenic CO2 from 1994 to 2007. Science 15 Mar 2019: Vol. 363, Issue 6432, pp. 1193-1199 DOI: 10.1126/science.aau5153
61	1570		Grey literature: suggest replacing Union of Concerned Scientists reference (or adding to it) with: Doney et al. (2009) or Orr et al. 2005. References: Doney, S.C., V.J. Fabry, R.A. Feely, and J.A. Kleypas (2009): Ocean acidification: The other CO2 problem. Annu. Rev. Mar. Sci., 1, 169–192, doi: 10.1146/annurev.marine.010908.163834. OR: Orr, J.C., V.J. Fabry, O. Aumont, L. Bopp, S.C. Doney, R.A. Feely, A. Gnanadesikan, N. Gruber, A. Ishida, F. Joos, R.M. Key, K. Lindsay, E. Maier-Reimer, R. Matear, P. Monfray, A. Mouchet, R.G. Najjar, G.-K. Plattner, K.B. Rodgers, C.L. Sabine, J.L. Sarmiento, R. Schlitzer, R.D. Slater, I. Totterdell, M.-F. Weirig, Y. Yamanaka, and A. Yool (2005): Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature, 437(7059), 681–686, doi: 10.1038/nature04095.
62	1623		This sentence repeats NES definition --and we are mixing units (miles?).
64	1681		NRDC citation is to grey literature --but hasadditional supporting reference
65	1688		Grey literature with supporting reference.
66	1737		change [see Chopping PDF comments for more context]
66	1737		on [see Chopping PDF comments for more context]

66	1737		Heading should read: Climate Change Impacts on Resources
67	1742		life. When air is polluted it can cause...
67	1743		and other life. [see Chopping PDF comments for more context]
67	1755		strike out, how
67	1757		This is vague: we should state here the processes that generate the precursors rather than just listing them (viz., nitrogen oxides (NOx) and carbon monoxide (CO) from fossil fuel combustion and volatile organic compounds (VOCs) from solvents and trees). These are discussed below.
68	1764		This diagram downplays and/or conceals the impact of automobiles (cars, SUVs, trucks, vans, buses, semis), one of the largest sources of air pollution in New Jersey. In fact, it obscures the relative importance of each factor: is there a better figure or table?
68	1768		Include material on the impacts on outdoor recreation and associated industries.
69	1786		Change to: motor vehicles that use internal combustion engines (gasoline, diesel), ...
69	1786		(AFAIK, electric vehicles do not release O3 precursors).
69	1805		***Since there is a dearth of measurements noted, add "This is borne out by measurements from the Ozone Monitoring Instrument (OMI) on NASA's Aura satellite (NASA 2014, Paraschiv et al. 2017)."
69	1805		***Also mention that while there has been observed improvements in NO2 in many conurbations, levels are still very high for dense areas (and include the NASA OMI NO2 map for "New York City" on the page at https://www.nasa.gov/content/goddard/new-nasa-images-highlight-us-air-quality-improvement
72	1892		This figure's map of counties and states should be replaced with apopulation density map and/or the NASA OMI NO2 map for "New York City" on the page at https://www.nasa.gov/content/goddard/new-nasa-images-highlight-us-air-quality-improvement
73	1901		***Replace with a population density map and/or the NASA OMI NO2 map for "New York City" on the page at https://www.nasa.gov/content/goddard/new-nasa-images-highlight-us-air-quality-improvement <== this map should go somewhere in this section since it is the only one that shows the spatial distribution of ozone-forming tropospheric NO2.
74	1920		The DEP site says it is 30: "New Jersey operates 30 air monitoring stations throughout the state, keeping track of the quality of our air. This is part of NJDEP's commitment to revitalize our communities and protect human health." Source: https://www.state.nj.us/dep/airmon/--though I can see data for only 16 in the current map.
74	1922		Add: This is consistent with NASA OMI measurements (NASA 2014).
74	1925		Playing devil's advocate: what happened to the data from the other 5 (or more) sites? If these data were excluded, what were the reasons?
75	1938		***Please, please, please: someone expert in this area should be asked to add commentary on particulates from diesel engines. Page 38 has the only mention of diesel engines in the entire report. How is this possible? NJ has so many important sources: passenger vehicles and light trucks, vans, semis, transit and other buses, rail locomotives, airports(e.g., Newark Liberty International amongst others), ships (e.g., port of Elizabeth).
76	1954		***Add: However, this is not true for places where people actually live: localized exposure can be orders of magnitude higher than spatially-averaged values; furthermore, concentrations of PM2.5...
76	1959		...controls and rapidly accelerating electrification of ground transportation (NJDEP 2019e) are expected...
84	2287		add comma
86	2348		Acosta Caraballo et al. 2020
86	2348		Chapter does not exist, please check.
88	2452		***Does this contradict the statements in lines 1222-1225, above: "Both five-year and ten-year averages of annual precipitation show strong statistical increases over the same 125-year period (Office of the New Jersey State

			Climatologist 2020) (see Figure 4.6). This is supported by the observation that annual precipitation over the most recent 10-year period in List of was 8% above the long-term average (Runkle et al. 2017)."?
88	2452		Also, it is not clear if "significantly" is used in the statistical sense here, or as the vernacular for "important".
89	2489		loss in what? sales, revenue, profit?
90	2520		on
90	2525		***In this section I had hoped to see some discussion of 1. implications of increased frequency, severity, and duration of storms with climate change on NJ forests and 2. trees in urban and suburban areas.
90	2526		***The list ignores the utility of urban/suburban trees for shade, mitigation of airborne pollutants, and mental health (note: this is not the same as "aesthetic enjoyment", c.f. §6.6). Add citation: Astell-Burt & Feng 2019.
90	2527		wood products?
91	2533		indicate
92	2542		The list ignores the utility of urban/suburban trees for shade, mitigation of airborne pollutants, and mental health (note: this is not the same as "aesthetic enjoyment", c.f. §6.6). Add citation: Astell-Burt & Feng 2019.
94	2557		***The obvious problem with this map and the one in Figure 5.8 is that they ignore the non-trivial number of trees in urban and suburban areas: these areas are labeled simply "non-forest". This does not seem to be addressed anywhere; perhaps it should at least be acknowledged? It is not as if we do not have the technological capacity to map forest at high resolution (i.e., high resolution remote sensing from NJ state aerial surveys, satellite imagery; computer and network resources) --what we lack is the human capacity (trained analysts).
96	2604		elucidate (the product divided by some fixed divisor)?
96	2619		"Great Lakes"
100	2751		Mention emerald ash borer here too?
103	2870		Merge this section with the previous one?
107	2944		The Y axis should be labeled with these units.
114	3085		mis-numbered
132	3699		and Pueraria spp.?
135	3823		strike out [see Chopping PDF comments for more context]
138	3920		***Do we know if this is supported?
155	4583		Please use italics for journal names.
156	4626		There does not seem to be anything here on impacts on outdoor recreation; insert a new section? The lack is surprising: the Bureau of Economic Analysis found that in 2017, all of the the outdoor recreation goods and services produced in New Jersey were worth more than $11.2 billion —about 1.9% of the Garden State's total GDP —and supported nearly 140,000 jobs (Bureau of Economic Analysis (2019).
156	4626		The breakdown is Conventional Outdoor Recreation Activities (e.g., Walk/Jog/Bike) (29%),Boating / Fishing (5%),RVing (2%),Snow Activities (1%),Other Outdoor Recreation Activities (19%), Amusement Parks / Water Parks (2%),Festivals / Sporting Events / Concerts (4%),Game Areas (including Golf and Tennis) (4%),All Other Supporting Outdoor Recreation (33%).
156	4626		"There were 39 harmful algal blooms confirmed in New Jersey in 2019, according to the New Jersey DEP. That's by far the most since the state started tracking the blooms in 2017. There were 22 blooms confirmed that year, and 20 blooms confirmed in 2018." See also the table at https://www.state.nj.us/dep/wms/bfbm/cyanoHABevents.html HABs caused the cessation of recreation on and major economic hardship at Lake Hopatcong and Greenwood Lake in summer 2019 (NJ.com news 2020).
156	4626		on
157	4671		, Rosenzweig et al. 2005).
160	4780		***All severe air quality events impact outdoor recreation, the physical and mental health of those participating, and associated economic sectors.

162	4845		Extreme weather also impacts mentalhealth by restricting outdoor recreational activities such as walking, jogging, biking, bathing, and fishing.
163	4861		in (PNAS does not author any articles, it publishes them).
163	4883		climate pollution
164	4907		their
164	4908		***Chapter 7. "Research and Data Gaps/Needs" is the least developed section of the entire report and is missing some important components. Given more time, contributors and reviewers would surely be able to both expand and refine this section.
164	4914		Greenhouse (one word!)
164	4918		Why? Is there a lack of data satellite SST observations? Or are we simply not using them for some reason?
164	4934		Nothing on the need for further coastal geomorphology modeling,costs of beach nourishment, coastal armoring (seawalls, groins and jetties), dune maintenance, sacrificial zones, etc...?
164	4935		***Need to provide the rationale for singling out this area (e.g., why not the Newark Bay area?)
165	4949		***Add bullet point: The primary consideration should be filling two important data gaps (1. high spatial and temporal resolution monitoring of all six criteria pollutants, in view of the inadequacy of the current sparse network of monitoring stations; and2. high spatial resolution risk mapping and cumulative risk assessment (Barzyk et al. 2015) to determine vulnerability and exposure of communities at high risk); and research to leverage both these efforts in order to provide meaningful information to decision-makers and the public. The need for greater research in these areas was highlighted in New Jersey Clean Air Council (2015), section III. Research and Collaboration Recommendations, on pages 9 - 10.
165	4950		***Why? No major greenhouse gases have important direct negative human health impacts at current concentrations. Surely there are far more important issues (O3, particulates, VOC; and mapping RISK: vulnerable populations, exposure).
165	4950		***I suggest removing both bullet points: they seem to add nothing and fail to address the obvious larger problem.
165	4952		***Add bullet point: Construct a 21st century monitoring, data analysis, and information system that reflects the needs of all NJ residents --and especially the most at risk --using modern mapping methods (GIS) and leveraging new technologies and approaches (aerial and satellite remote sensing; low cost ground-based sensor networks). Rationale: The Research/Data Gaps" suggestions under "Air Quality" here are missing a major, critical element: MEASUREMENT. The State has a very limited # of AQ stations that are *utterly inadequate* for analysis of AQ impacts on residents. Since there is high frequency spatial variation in both the exposure and vulnerability of communities across the state and in severity of impacts (as well as through time), the State's current measurement capability is a long way from providing useful information, to the administrative, scientific, commercial, industrial, or residential sectors. While modeling is useful, we cannot assess risk purely through modeling exercises.
165	4964		including threats to freshwater systems and public health (e.g., HABs in lakes and reservoirs).
165	4967		How stronger storms, ice storms...
165	4978		Not sure why this is included under "Forest".
166	4982		***Add bullet point:Greater information on trees in urban and suburban areas is needed. The technological capacity to map these is not lacking* but the human capacity --trained and funded geo-spatial analysts --needs to be developed.
166	4982		***i.e., high resolution remote sensing from NJ state aerial surveys, satellite imagery; computer and network resources.
166	4982		***more research is needed on the interactions between climate changes (higher temperatures, more variable precipitation), insect and pathogen outbreaks, and fire risk
166	5014		are
167	5037		Include studies on the impacts of CC on outdoor recreational activities.
167	5041		Yes: also whether reduction in freeze-thaw cycles will improve roadway conditions --or will higher temperatures plus heavier passenger vehicles lead to greater degradation?
167	5041		effect

168	5067		In this case, perhaps more could be included on mitigation in this report --it is very thin on this matter. For example, 2020 state incentives for EV adoption will surely help transition us away from car, trucks, and buses using internal combustion engines)(though much remains to be done, growth is accelerating as EVs become more obvious on our streets). Also, power generation; not much here about the Energy Master Plan. See next comment.
168	5077		should this not include social science, as well as the physical sciences (I write this as a member of the latter community)?
18			receives
18			post ice-age (check terminology consistency)
21			2018
24			strike out, mainly as heat [see Chopping pdf comments for more context]
25			unmarked set by anon
27			Add citation: USGCRP, 2018: Second State of the Carbon Cycle Report (SOCCR2): A Sustained AssessmentReport [Cavallaro, N., G. Shrestha, R. Birdsey, M. A. Mayes, R. G. Najjar, S. C. Reed, P. RomeroLankao, and Z. Zhu (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 878 pp., https://doi.org/10.7930/SOCCR2.2018.
28			Unmarked set by anon
90			strike out, "s" [see Chopping PDF comments for more context]
170			Add: Acosta Caraballo, Y. M. Wu, and S. Domber. (2020). Macroinvertebrate assemblages in selected New Jersey sites. Northeastern Naturalist, in press.
170			Add: Astell-Burt T, Feng X. Association of Urban Green Space With Mental Health and General Health Among Adults in Australia. JAMA Netw Open.2019;2(7):e198209. doi:10.1001/jamanetworkopen.2019.8209
171			Add: Barzyk, T. M., Wilson, S., & Wilson, A. (2015). Community, state,and federal approaches to cumulative risk assessment: challenges and opportunities for integration. International journal of environmental research and public health, 12(5), 4546–4571. https://doi.org/10.3390/ijerph120504546
171			Add: Bureau of Economic Analysis (2019). Outdoor Recreation Satellite Account, U.S. and Prototype for States, 2017. September 2019. https://www.bea.gov/news/2019/outdoor-recreation-satellite-account-us-and-prototype-states-2017 Last access 3/20/20.
172			*** Add: Broccoli, A.J., Aucott, M., Chopping, M.J., Cohen, M.J., Held, J.L., Hopke, P.K., Leichenko, R.M., McMillin, W.E., Pope, G.A., Robinson D.A., Robock, A., Vaccaro, R. (2016). Report of the NJ DEP Science Advisory Board: NJ Climate Change Charge Question (Climate and Atmospheric Sciences Standing Committee). Available at http://www.state.nj.us/dep/sab/
181			Add: Hansen, J., Sato, M., Kharecha, P., von Schuckmann, K., Beerling, D. J., Cao, J., Marcott, S., Masson-Delmotte, V., Prather, M. J., Rohling, E. J., Shakun, J., Smith, P., Lacis, A., Russell, G., and Ruedy, R. (2017). Young people's burden: requirement of negative CO2 emissions, Earth Syst. Dynam., 8, 577–616, https://doi.org/10.5194/esd-8-577-2017, 2017.
186			Add: Larour,E., Ivins, E.R., and Adhikari, S., 2017, Should coastal planners have concern over where land ice is melting? Science Advances, 3, e1700537, doi: 10.1126/sciadv.1700537
190			Add: NASA (2014), New NASA Images Highlight U.S. Air Quality Improvement, June 26, 2014, https://www.nasa.gov/content/goddard/new-nasa-images-highlight-us-air-quality-improvement Last access 3/20/20.
190			Add: New Jersey Clean Air Council (2015), Air Pollution Knows No Bounds Reducing Smog Regionally, Public Hearing April 14, 2015, available at https://www.state.nj.us/dep/cleanair/hearings/pdf/2015HearingReport.pdf, last access 3/20/2020.
190			climate resilience study.

190			Capitalize title and add: March 2019. Available at https://www1.nyc.gov/site/lmcr/background/lower-manhattan-climate-resilience-study.page Last access: 03/20/2020.
191			NJ.com news (2020). N.J.'s largest lake is rid of toxic algae, but 8 others remaincontaminated. Updated Jan 28, 2020; Posted Jan 27, 2020. https://www.nj.com/news/2020/01/njs-largest-lake-is-rid-of-toxic-algae-but-8-others-remain-contaminated.html Last access 3/20/20.
191			Add: NJDEP 2019e. DEP marks National Drive Electric week by hailing increases in electric vehicle sales, expansion of charging infrastructure, NJ DEP news release (19/P073), September 13, 2019. https://www.nj.gov/dep/newsrel/2019/19_0073.htm, last access 3/20/20.
193			Add: Paraschiv, S., Constantin, D. E., Paraschiv, S. L., & Voiculescu, M. (2017). OMI and Ground-Based In-Situ Tropospheric Nitrogen Dioxide Observations over SeveralAdd: Paraschiv, S., Constantin, D. E., Paraschiv, S. L., & Voiculescu, M. (2017). OMI and Ground-Based In-Situ Tropospheric Nitrogen Dioxide Observations over Several Important European Cities during 2005-2014. International Journal of Environmental Research and Public Health, 14(11), 1415. https://doi.org/10.3390/ijerph14111415
195			Important European Cities during 2005-2014. International Journal of Environmental Research and Public Health, 14(11), 1415. https://doi.org/10.3390/ijerph14111415Add: Rosenzweig, C., Solecki, W.D., Parshall, L., Chopping, M., Pope, G., and Goldberg, R. (2005), Characterizing the urban heat island in current and future climates in New Jersey, Global Environ. Change B Environ. Hazards 6: 51-62, doi:10.1016/j.hazards.2004.12.001.
201			Add: USGCRP, 2018: Second State of the Carbon Cycle Report (SOCCR2): A Sustained AssessmentReport [Cavallaro, N., G. Shrestha, R. Birdsey, M. A. Mayes, R. G. Najjar, S. C. Reed, P. RomeroLankao, and Z. Zhu (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 878 pp., https://doi.org/10.7930/SOCCR2.2018.

Philip K. Hopke, Ph.D., Member, Climate and Atmospheric Standing Committee

Bayard D. Clarkson Distinguished Professor Emeritus, Clarkson University

Adjunct Professor, Department of Public Health Sciences, University of Rochester

Section	Comment (1/row)
5.1.1	In section 5.1.1, it needs to be remembered that ozone was chosen as a surrogate for photochemical oxidants since it is easily measured compared to the old wet iodide method used for total photochemical oxidants. The NAAQS is for Ozone and Other Photochemical Oxidants. Thus, although the discussion of ozone is reasonable, it should be noted that there are other gaseous photochemical oxidants like H2O2 and organic peroxides that are important for both human and ecosystem health. The treatment of the ecological effects of ozone is minimal and woefully inadequate. There are likely to be significant effects of increased photochemical oxidants on crop yields and forested ecosystem services that are totally neglected in the one sentence on page 75. (Additional references provided)
5.1	An important consideration of particulate matter is that changing oxidant conditions and sources results in changing PM compositions. These changes in composition may be important in terms of the unit mass toxicity of the PM as seen in recent work in NYS reported by Zhang et al., (2018), Rich et al. (2019), Croft et al. (2019; 2020) and Hopke et al. (2019; 2020). This work along with that of Squizzato et al. (2018) and Masiol et al.(2019) show that spark-ignition vehicle contributions to PM2.5 are increasing along with secondary organic carbon (and thus, secondary organic aerosol) and that the changing composition appears to have increase the per unit mass toxicity of the PM2.5 with respect to a number of cardiovascular and respiratory diseases as well as the rate of viral respiratory infections. The hypothesized mechanism for these changes focus on increased exposure to particle-bound reactive oxygen species or particle-related oxidative potential resulting in increases in oxidative stress and systemic inflammation driving this increased toxicity. Thus, the impact of increased temperature on the composition as well as the concentrations of PM2.5 needs to be adequately discussed particularly in a period with high rates of viral respiratory infections. (Additional references provided)
3	Chapter 3 of the report focuses on greenhouse gases rather than on the full suite of climate forcing atmospheric species that include black (BC) and brown (BrC) carbon particles. Bond et al. (2013) provides a comprehensive review of the role of BC in the climate system and strongly suggests that it is the second most important radiative forcing species. CO2 represents only about 42% of the radiation forcing and the IPCC report figure on page 37 is deliberately misleading with respect to the role of BC and BrC and it should

	be removed. The IPCC is not an independent scientific organization since any country can veto inclusion of material they do not what shown. It is now being recognized that brown carbon (strongly UV absorbing species) such as are found in biomass burning particles such as those coming from wildfires are also important (Zhang et al., 2018) and both play a role in global climate models (Wang et al., 2014). We continue to emit black and brown carbon from anthropogenic sources such as heavy-duty diesel vehicles although as more CRT-equipped heavy-duty diesel vehicles replace older, more emitting vehicles, emissions of BC should continue to be reduced. However, recent studies have suggested a finite lifetime to the CRTs (Bishop and Haugen, 2018). Work in NY found that diesel contributions to the ambient PM2.5 had not been decreasing in recent years (Masiol et al., 2019). The catalysts also result in more of the emitted NOx being NO2 that is light absorbing. Residential wood burning results in local sources of BrC that adds to the burden that is periodically transported from areas of large wildfires. Thus, it is important to include the full set of radiation forcers since local control of some of the particulate species is possible. (Additional references provided)

William E. McMillin Jr., P.E., Member, Climate and Atmospheric Standing Committee

Wet Weather Management Global Technology Leader, Jacobs Civil Engineering

Section	Comment (1/row)
General comment	I didn't have any particular comments on the front end that I'm sure the rest of the committee identified. Although I'm a little concerned with data analyses and conclusions based on the Hayhoe et. al. 2007 reference – only because its 13 years old and there must be more recent analyses that could be referenced
5.2.3.1	fortunately says something about the effects of precipitation and sea level rise changes on CSOs and stormwater, but seems to completely miss the fact that following federal policy and their NJPDES permits, all CSO permit holders in NJ are about to submit CSO Long Term Control Plans to the NJDEP in June that do not account at all for future changes in precipitation or sea level rise. The cumulative costs of the plans across NJ will likely exceed $billion(s) that will be paid by NJ ratepayers and in the end may not achieve the goals because the conditions will change within the 20 to 40 years it will take to implement the plans.
5.2.3.2	Section 5.2.3.2 seemed to pay little attention to the potential effects on drinking water supplies, notably reservoir eutrophication, and the impacts it and the other impacts such as increased turbidity will have on drinking water treatability.
5.4.2.2.3	Also, I found use of phrases such as "as an added bonus" and "On a brighter note" to be inappropriate.

David A. Robinson, Ph.D., Member, Climate and Atmospheric Standing Committee

Distinguished Professor & New Jersey State Climatologist, Department of Geography & NJ Agricultural Experiment Station, Rutgers University

Line Number	Section	Comment (1/row)
	General Comment	The report is clearly a massive effort and so much has been assembled in such a short time. Yes, the latter shows at times, but hopefully with my comments, those of other reviewers, and additional time for you and others at DEP to tackle revisions this will be a notable report. And yes, I hope it will generate some interest in further support for research and monitoring efforts
	General Comment	My review of the climate change report mainly covers the report through section 4.2. The material presented up to that point in the report is more directly linked with my expertise and interest in climate and climate change than later portions of the report. I have also included a comment/recommendation pertaining to Chapter 7. I skimmed through the remainder of the report and found it quite informative but did not dig deeply into weather and climate statements made within the various sectoral contributions.
	General Comment	<<A break from line comments. Here I'd like to make mention of the varying use of degrees F and degrees C throughout the document. At times, only deg F are used (e.g. line 994), other times deg F are followed by deg C shown in parentheses (e.g. line 1041), and in some cases deg C are followed by deg F shown in parentheses (e.g. lines 974-975). This must be standardized prior to the release of the report.>>
	Research Gaps	I'd like to suggest some research and data monitoring that needs to be initiated or maintained to when it comes to NJ's climate system. On the research front, a better understanding is needed as to why NJ is one of the fastest warming states, whether NJ's precipitation regime is changing to one of more of the annual precipitation

		falling in larger events with associated flooding and with periods of "flash" drought perhaps becoming more common, and whether NJ's snow regime has yet to change, and if not, why. These should be empirical and modeling studies. As for model studies, a specific research effort that explores (runs?) model projections of future weather and climate conditions in the coming decades is needed. To date, this has been left to neighboring regional and to national efforts. Regarding monitoring, admitting that I'm bringing this very close to what is presently accomplished within the Office of the NJ State Climatologist, I think this chapter should strongly state that ongoing and enhanced monitoring of atmospheric and surface conditions needs to be maintained or generated. By this I mean variables monitored at National Weather Service stations but in the past two decades greatly enhanced in terms of spatial coverage and variables monitored by the Rutgers New Jersey Weather Network (NJWxNet) (https:njweather.org) (which is partly funded by the NJDEP). The NJWxNet provides five-minute updates on variables that include air temperature, wind speed and direction, precipitation, humidity, barometric pressure, solar radiation, soil moisture and temperature, and snow depth. Over 60 stations are in the network, though not every station records every variable, thus a need to upgrade some stations in the network. Supplementing the NWS and ONJSC networks is the Community Collaborative Rain, Hail, and Snow Network, a national citizen science effort where close to 300 NJ residents provide daily observations of the aforementioned precipitation variables. This effort is coordinated by the ONJSC and helps "fill the gaps" when it comes to precipitation data gathered by the other networks.
159		statewide records date back to 1895, not 1896.
186		remove "likely", as with sea level rise wetlands "will be lost", not "will likely…."
194		what is meant by "shuffled"? I've not heard of the use of this word when discussion change impacts.
206		Why does this sentence begin with "Although"? Suggest it be removed.
354		I strongly suggest replacing "incredible" with another word, such as "substantial". To use incredible demeans the work done in earlier years and is simply not a word to use in a scientific report.
528		Include a quote from the more recent 2013 IPCC report rather than 2007 report. Or even something from more recent IPCC "sub" report.
598		1895, not 1894.
599		Update the 12 inches based on the Kopp 2019 report.
605		Did the Melillo et al report really include just southwestern West Virginia and not the entire state? If so, I might consider just dropping southwestern West Virginia from the text (the SW WV mention appears later in this report too).
690		Carbon dioxide levels were closer to 280 ppm as the industrial era began, not the 250 pp reported here. I'm also not sure I'd peg the start of this era as early as 1820 ("two centuries ago")
747		Change "was occurred" to "what occurred"
1073		heat waves and cold waves should be defined.
1083		figure 4.3 should be updated to include 2019, which had a statewide average temperature of 54.3 deg F.
1202		drop "hail storms" from this sentence. They are rather rare in NJ and any hail adds next to nothing to the annual precipitation.
1212		"2019", not "219".
1360		Drought is not just defined as "a prolonged period of abnormally low rainfall". Rather it is an abnormal period of low precipitation with respect to local and regional averages. In other words, a drought in NJ might occur with 30" of annual precip while that total would be common for some regions and never achieved by many areas that are normally much drier. Not that those areas couldn't experience drought too.
1373		I realize that this sentence speaks of the lack of evidence of a change in NJ precipitation "patterns", but that isn't well defined and isn't it a pattern if more precip is falling in larger events?

6045		the Runkle et al reference is incomplete in the reference section. It should at least include the URL to the report: https://statesummaries.rcics.org/chapter/nj
1000-1001		Update to include 2019. 2019 was the second warmest only behind 2016. The last five years have been the warmest five dating back to 1880.
1003-1006		replace the regional rundown from 2018 with regional anomalies from 2019 or eliminate the section. Also, don't use the word "ever" when discussing records. All must be placed into some specific temporal context or say something such as "on record".
1068-1070		Update the 2015 records of top 5 warmth to read: "Over the period 1990-2019 months with a top-5 average temperature have occurred 43 times while none of the months in that same period have recorded a top-5 coldest temperature. The last top-5 coldest temperature was December 1989". You may cite the Office of the NJ State Climatologist for this information and perhaps include reference to the figure posted on the ONJSC website: https://njclimate.org or the figure itself: https://climate.rutgers.edu/stateclim/NJ_monthly_extremes.pdf (fyi: Jeff Hoffman is involved with this effort, so you may also wish to cite NJDEP)
1107-1108		Thus far, there is no reduction in NJ annual snowfall. Not that this sentence speaks of the past, rather it speaks of the future, just popping up in a paragraph that to this point only speaks of conditions from the past to present.
1206-1208		the reason why annually the Highlands experience more precipitation than lower elevations (especially the coast) is poorly phrased here. Best to say due to the lifting of moist air by the topography of north Jersey air cools and vapor condenses and precipitation is enhanced. Meanwhile, coastal areas experience less precipitation due to the maritime atmosphere being stabilized by the adjacent Atlantic waters.
1216-1217		This sentence should be updated to state that 2018 is the wettest year on record for NJ since record keeping commenced in 1895. At 64.76" it was 18.40" above the 1981-2010 normal.
1391-1399		I'd revise this section and suggest it be reduced in size. Unless you want to explain the National Drought Monitor and how drought is mapped through it, I might just stick to NJDEP actions over this century when it comes to the issuance and duration of drought watch, warning and emergency. This section paints too dire a depiction of drought in NJ over the past 20 years. I don't believe there has been a drought emergency since one early in the century was lifted early in 2003. No warning since then either, just some watches. The "severe" drought mentioned in the report covered part of NJ in the National Drought Monitor in September 2010 and during several months in late 2016 and early 2017. In reality, NJ has been quite drought free during the past almost 20 years.
359-360		I realize the report focuses more on natural systems than human issues and impacts, however along with the mention of "natural resources" in this sentence I suggest adding something regarding the human-focused aspects of the report.
416-418		This sentence needs some work. For instance, greenhouse gases don't prevent the sun's warmth from being "reflected" back to space.
559-560		This sentence must be changed as it currently suggests that the overall costs of the 528 events exceeds $1 billion when in fact each of these events has exceeded that mark (as suggested in the sentence concerning 2019 that follows.
567-581		This section includes a series of random statements that tend to wander.
572-573		The sentence about paleo-temperature records seems to just randomly appear here. Why just mention lipids (and say nothing more about them) when other means of assessing past temperatures exist? I suggest dropping the sentence.
622-623		NJ has an ephemeral snowpack in most winters. Not even the Highlands may retain a season-long snow cover. Thus this sentence doesn't much apply directly to NJ.
626-627		Another example of a "drop in" sentence. If retained, at the least a definition of "frost-free season" should be made. Besides this however, this short paragraph ranges from past observed change to a future frost free projection.
647-648		Another random statement regarding the shore towns experiencing 16-18" of snow in a 2018 storm. While a major event, it pales compared to the December 26, 2010

		snow totals along the coast. But that's really not the point, it just shouldn't be included. More important are the coastal flooding impacts of storms such as these.
979-980		The sentence uses "warming" twice…cut one of them.

Alan Robock, Ph.D., Member, Climate and Atmospheric Standing Committee

Distinguished Professor, Department of Environmental Sciences, Rutgers University

Line Number	Section	Comment (1/row)
130		What does this mean? Change to "the environment"
142		change to "sea level"
142		insert comma after acidity
145		delete "with"
153		"set emission limits for 2020"; Please say how this worked out. Are we on track to meet the 2020 pledges, or will we have to work harder in the near term to reduce emissions?
155		change "total" to "total annual"
164		change "is" to "in"
164		"by 0.9 to 2.1 feet."; as compared to what level? You have to say this is a change from the level in a specific year up to 2050.
172		"indoors"; How does climate change affect indoor air quality? Doesn't this depend more on indoor emissions and how well houses are ventilated?
183		Insert comma after "changes"
191		Insert comma after "change"
212		I think this is completely inappropriate. This implies that the global warming problem is easy to address. I think the best you can say is that in spite of our best attempts, there will still be great damage to NJ from climate change. We can't deal with all the problems sea level rise and more intense storms will bring. How much NJ suffers will depend on global greenhouse gas emissions. Say something like, "With reductions in emissions, to which we are already committed, and plans for adaptation to the climate change to which the world is already committed and that we cannot prevent, NJ is placed to be a leader and model for the rest of the US and the world of how to address climate change."
359		change to "assessment for New Jersey"
393		delete world economic forum reference
395		"A failure to take necessary climate action..." This is a value judgment. Necessary according to what criteria?
406	Figure 1.1	What do the colors mean?
418		capitalize "sun"
446		Insert at end of paragraph: "While water vapor is the most important greenhouse gas, its concentration is controlled by the atmosphere itself (raining when there is too much, evaporation from the surface when there is too little), so scientists consider it a feedback, which amplifies the effects of greenhouse gases emitted by humans."
451		change to "RCPs" instead of "RCP"
463		"The CMIP6 landscape 2019" [delete - titles do not go in references, but in the reference list]
465		"emissions"; emissions as compared to business as usual (RCP8.5)
481	Table 1.1	Specify "Global Average 2100 Temperature"
481	Table 1.1	"increases"; Increases [as compared to what? Current 2020 temperature? Preindustrial temperature?]
501		What does this mean? I have never heard of environmental resources before.
512		Probably should delete "The" from this and all other occurrences. "Earth" is the name of our planet, and other planets are not called The Mars or The Venus.
516		"reductions"; with respect to what?
532		"rose by 1.6%"; as compared to what? 2016?
533		"was projected"; But we now have 2018 data. Why not use the actual data?
547		change "can potentially" to "will"
547		"change"; change as they do any forcings of climate, both those that cause warming and cooling, such as episodic volcanic eruptions.
586		"moderate cuts"; compared to what?
605		"will experience"; What is the subject of this sentence? Should you delete "In terms of?"

626		"can be expected"; When? As compared to what?
640		specify "region" as "region of the ocean"
665		"It has made life as we know it possible"; [delete] This is a repeat, and has been said several times, including in the previous paragraph.
666		Capitalize Sun
666		change "sends" to "emits"
671		"The absorbed energy"; This is absolutely incorrect. Earth emits energy as a function of its temperature and emissivity. It does not matter how it got to be that temperature, which depends on all the energy fluxes in and out. Replace this sentence with "The surface emits infrared radiation in wavelengths that are absorbed by greenhouse gases."
679		"1.86 miles"; no need to be so precise if it is approximate.
686		"data"; Data, except for the most recent data, which are directly measured in the atmosphere.
690		"250"; change to 280
693		"accelerating"; The figure does not show that. The rate of growth is approximately constant.
698		"expected result"; change to "expected to result"
703		"by decade"; Actually these are monthly values that are plotted. It is only the axis labels that are decadal.
709		change to "more than 60"
751		"energy (heat)"; energy [there is no need for (heat) every time.]
753		change "gas" to "gases"
754		"potential"; potential per molecule [but not in total]
754		"emissions"; emissions, which produce aerosol particles that cool Earth by reflecting sunlight,
758		"represents"; represents ??? "and now (2020) represents" or "and the cumulative emissions represent" or what?
771		change "are" to "is"
774	Figure 3.4	for what year or period?
778		Why shaded?
812		"halogenated/fluorinated"; Call them CFCs as discussed earlier, so as not to confuse.
886		But emissions of precursors is more important, and many are blown in from other states. Why emphasize this?
909		"greenhouse gases"; Why not CFCs?
914		"These were excluded..."; First of all, CH4 is a short-lived forcer, as shown in Fig. 3.10 below, as well as long-lived. Why do you not include it in this category? Second, CFCs, as shown in Fig. 3.10, is the third most important anthropogenic gas, but you seem to ignore it.
930		"Earth"; Earth per molecule [NOT IN TOTAL]
948		"phase out of use"; but they still will be around for decades after emission stops.
959		"ozone depleting substances (ODS)"; you should explain which gases these are
974		You use the degree symbol elsewhere. Be consistent.
1016	Figure 4.1	You present this in the previous chapter with the time scale going the other direction. This will be very confusing to put this figure in like this. Furthermore, it is very blurry.
1016		"'C"; [delete] The units are in the axis label.
1036		Why show just SST? Why not air temperature, and air temperature over NJ? You can get the latest data from giss.nasa.gov
1036		"extended"; What does this mean? What does the shading mean?
1083	Figure 4.3	Connect the dots
1083	Figure 4.3	Delete "in `F"
1096	Table 4.1	The table is confusing. Make the annual values in both scales bold or a different colort to distinguish them from the seasonal values.
1104		"1.89"; not correct to use this precision. Use only 1 decimal place for all the values in C.
1128	Figure 4.5	"over 5-year periods"; This cannot be correct. The are plotted for every year.
1131		This is not correct. The water vapor is only one factor. You also need weather to produce upward motion in storms or fronts. If you have downward motion, it does not matter how humid it is - you won't get precipitation.
1139		change "will" to "could"
1143		capitalize sun

1145		"corrective forces"; This is not correct. There is no such thing as "convective forces." Just delete "driven by convective forces."
1147		change "water vapor" to "water"
1148		"does not infiltrate to groundwater"; This is not correct. There are reservoirs in soil moisture and snow cover, as well as vegetation. And most of the water that falls on land evaporates and goes back into the atmosphere. You are only describing some parts of the hydrological cycle.
1172		Extratropical cyclones are only occasionally nor'easters. Again, why include this simplistic statement that has errors?
1185		"A warmer atmosphere will also cause the oceans to warm"; Not correct. The heat balance at the surface of the ocean includes solar radiation.
1193		"emissions"; not the emissions, but the concentrations. Emissions can go down, but concentrations will continue to rise.
1212		change to 2019
1225		"most recent 10 year period"; This is not correct. Look at the figure.
1225		"in list of"; What does this mean?
1230	Figure 4.6	This can't be correct. How can you have calculated it for the most recent 4 years? If you used the Excel function, it plots the moving average not centered on the 5-year period, but on the last year. You need to replot it, or at least explain this.
1241		"nor' easters"; You have to define this. Explain what it is.
1271		change "support" to "supports"
1274		"two to five times more often"; more often than when?
1281		This is not correct. There is no consensus that there will be more tropical storms with a warmer ocean, only that those that do form will be stronger.
1287		delete (heat)
6222		The URL link is wrong. Remove the 6222.
1143-1144		This is not correct. Evaporation takes place when the atmosphere is not saturated (when the relative humidity is less than 100%). It happens at night as well as the day.
1152-1165		This entire description has many errors. The general circulation of the atmosphere is much more complicated than this, and this glossing over the details is not informative and just confusing. Why include it at all?
1206-1208		This does not make any sense as an explanation. Wouldn't that mean that the mountains would get less precipitation?
1222-1223		"strong statistical increase"; What does this mean? When I look at the plot, I see no significant trend. You have to say this.
1234-1235		Yes, this is absolutely true. So you have to remove all the above text claiming there is a trend for NJ.
1291-1294		This makes no sense. If precipitation does not increase, it does not increase.
1294-1295		This completely contradicts the first sentence of the paragraph.
156-157		This is misleading. CO2 has a very long lifetime in the atmosphere. About half of what is emitted is quickly absorbed by the ocean and land cover, but it does not depend on where the CO2 is emitted. Only a tiny fraction of the CO2 absorbed by NJ land cover was emitted in NJ. I would change this sentence to, "About half of these emissions stay in the atmosphere for a long time, causing global warming and its associated impacts."
549-550		This is incorrect. Climate models do the best job they can at the time. Unknowns by definition are unknown. It is just as likely that additional factors will cause more sensitivity and will cause lower sensitivity.
652-655		These forecasts are scenario-dependent. You cannot make forecasts unless you know what the forcing will be. And is this paragraph specific to the ocean, or more general?
704-705		Please use the most recent data. Anyway, why did you take such an old one in December that was 10 months old? The latest chart, accessed Feb. 29, 2020, is inserted as the next page in this document. The source is https://www.esrl.noaa.gov/gmd/webdata/ccgg/trends/co2_data_mlo.pdf
719-720		"biogeochemical processes control atmospheric concentratins of the main greenhouse gases"; This is completely wrong. Anthropogenic emissions overwhelm these processes in producing the observed increasing concentrations.
729-732	Figure 3.3	This is wrongly expressed. You have to say that the thin arrows are the natural background cycles, and that the thick arrows, representing perturbations because of anthropogenic

		emissions, have to be added to the thin arrows to get the total fluxes. But I think it would be much clearer if you just plotted the total for each arrow and not plot them separately.
808, 829		"CO2"; change to CO2e
860, 868	Figure 3.8, 3.9	"2050 emissions reduction goal of 80% decrease from the 2006 baseline"; You need to remind the readers that this actually has to go to zero by 2050, both in NJ and globally, to solve the global warming problem.
	Figure 3.6	Why did the negative values double in 2007? This does not look correct.
	Figure 3.7	Why exclude small-scale solar? Please define what you mean by this and estimate its amount.

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Page Num	Line Number	Section	Comment (1/row)
61	1569	4.4.1	Under Section 4.4.1 Ocean Acidification–The Chemistry, Henry's Law defines the relationship between CO2 in the atmosphere and in sea water. The higher the pressure in the atmosphere the greater the concentration in the aqueous phase; it's an equilibrium condition. Carbonic acid is not unstable; it like any other acid will dissociate, but it is still present at some concentration (or activity) based on the equilibrium pH. I recommend rewriting page 61. For example, beginning on line 1569, I suggest changing the text to "Increased concentrations of acid in seawater due to increased absorption of CO2 increases total acidity, which is referred to as OA. Total acidity is the base neutralizing capacity of a water. The increased concentrations of atmospheric CO2 result in increases in the concentration of dissolved CO2 and carbonic acid. This increase in acid results in a decrease in the equilibrium pH (Figure 4.10)." continuing with the text "Certain projections indicate…(Jewett and Romanou 2017)."
61	1571		Acidity by definition (page 61) is the base neutralizing capacity of a solution and is a concentration-based definition (Benjamin, M. Water Chemistry, 2nd Edition, Waveland Press, IL, 2015). Line 1571 is incorrect. An acid is by definition a proton donor.
	3445		The major buffering system in most natural waters is the carbonate system since it is the only weak acid present. The carbonate system is made up of the following species: $CO_2(g) \leftrightarrow CO_2(aq) \leftrightarrow H_2CO_3 \leftrightarrow HCO_3\text{-} \leftrightarrow CO_3^-$ Analytically it is difficult to distinguish between H_2CO_3 and $CO_2(aq)$ (which predominates) so the combination of the two is called H2CO3*. The equilibrium constants for this system are: $H_2CO_3^* \leftrightarrow H+ + HCO_3^- \; pKa_1 = 6.35$ $HCO_3^- \leftrightarrow H^{++} CO_3^- \; pKa_1 = 10.33$ Line 3445, the sentence should read "the change in pH" not the pH.
	1585-1588		I would remove the sentence starting on line 1585, and on line 1588 beginning with "This lowered" I recommend changing this sentence to "A lower pH results in a lower bicarbonate concentration and a lower calcium carbonate concentration that may dramatically effect a wide range of important species, including …"