Response to third referee's comments on "Understanding Spatiotemporal Development of Human Settlement in Hurricane-prone Areas on U.S. Atlantic and Gulf Coasts using Nighttime Remote Sensing"

By Xiao Huang, Cuizhen Wang and Junyu Lu

"The topic is as interesting as important, and is dealt with by the Authors using modern data (remote sensing) and techniques. However, I have some major concerns that should be clarified and fixed before the paper can be accepted for publication."

Our response: We appreciate your encouragement and comments. We will address all your concerns in the following response. Please find our point-by-point response below.

"The goals of the study are not always declared clearly, and sometimes they are overstated. For example, in the last paragraph of the introduction (p.3, l. 14) the Authors state that the goal of the paper is "to monitor urbanization process and hurricane impact". First, NTL is only a proxy for (some features of) urbanization, and "monitoring urbanization process" goes far beyond what is presented in this paper. Second, "hurricane impact" can be ascribed to a variety of factors (storm duration, exposure, vulnerability, etc.) that are not accounted for either by NTL or the wind speed only. To sum up, the paper draws a comparison between i) an urbanization index based on NTL (and not directly between urbanization) and ii) the storm proneness, unless the link between VANUI and real urbanization (or, better, exposure to storms) is validated quantitatively."

Our response: Thanks for your comments on the general goal of this study. We apologize for the overstatement in the last paragraph of the Introduction section. In this revision, we modified this paragraph to make it more suitable.

"The goal of this paper is to illustrate the use of DMSP/OLS NTL data in 1992-2013 to monitor urbanization process and hurricane impacts on the U.S. Atlantic and Gulf coasts **using nighttime artificial lights as proxy**…….. The spatiotemporal changes of human settlement **revealed from nighttime remote sensing** in **hurricane-prone zones** provide valuable information to evaluate damage and to support decision making of urban development."

We believe our modified version is more suitable given the context of this study. We appreciate your suggestion on our Introduction section.

"I have some doubts on the significance of the linkage between satellite-derived indexes such as VANUI and urbanization of an area. First, the use of NTL-derive indexes as a proxy of urbanization intensities and exposure to storms should be validated against urban maps and census data, at least for some significant regions/cities of the study area."

Our response: We totally understand your concerns regarding the satellite derived index and the exposure of storms. Please allow us to explain our insights on this one.

Firstly, we believe the focus of our article is not to prove/validate the linkage between satellite-derived indexes and urbanization. Rather, this study applies well established satellite-derived urban index. To make our approach convincing, we did a detailed review on the application of satellites, especially nighttime satellite (DMSP/OLS series). We illustrated "Extensive attempts have been made to harvest the NTL observations from DMSP/OLS in applications including urban expansion and decay (Lu et al., 2018), settlement dynamics (Elvidge et al., 1999; Yu et al., 2014), socioeconomic development (Doll et al., 2000) and energy consumption (Chand et al., 2009)". Further, in the newly added section 2 "Intercalibration and desaturation of DMSP/OLS NTL series", we did another review on the applications of nighttime satellite – derived activity index:

"A commonly used vegetation index, NDVI, is a useful indicator to reduce the saturation effect in DMSP/OLS data. Its practicality has been confirmed by many studies (Zhou et al., 2014; Liu et al., 2015). Lu et al. (2008) proposed a human settlement index (HSI) by merging normalized DMSP/OLS NTL data with the maximum NDVI in growing season derived from Moderate Resolution Imaging Spectroradiometer (MODIS). HSI has been proved rather efficient for settlement mapping in several testing sites in southeastern China. Zhang et al. (2013) develop a vegetation-adjusted NTL urban index (VANUI), which captures the inverse correlation between vegetation and luminosity. This simple index efficiently reveals the heterogeneity in regions with saturated DN values, which has been recognized by other study (Shao and Liu, 2014). Following the original design of NDVI that characterizes the inverse relationship between the near-infrared band and red band in vegetation, Zhang et al. (2015) designed a normalized difference urban index (NDUI) that characterizes the inverse relationship between vegetation and luminosity in a similar way. NDUI was evaluated in five testing sites in U.S and proved to be effective in desaturating DN values in DMSP/OLS."

We believe those aforementioned, widely recognized applications and the popularity of DMSP/OLS in long-term urban monitoring provide sufficient validity of our approach.

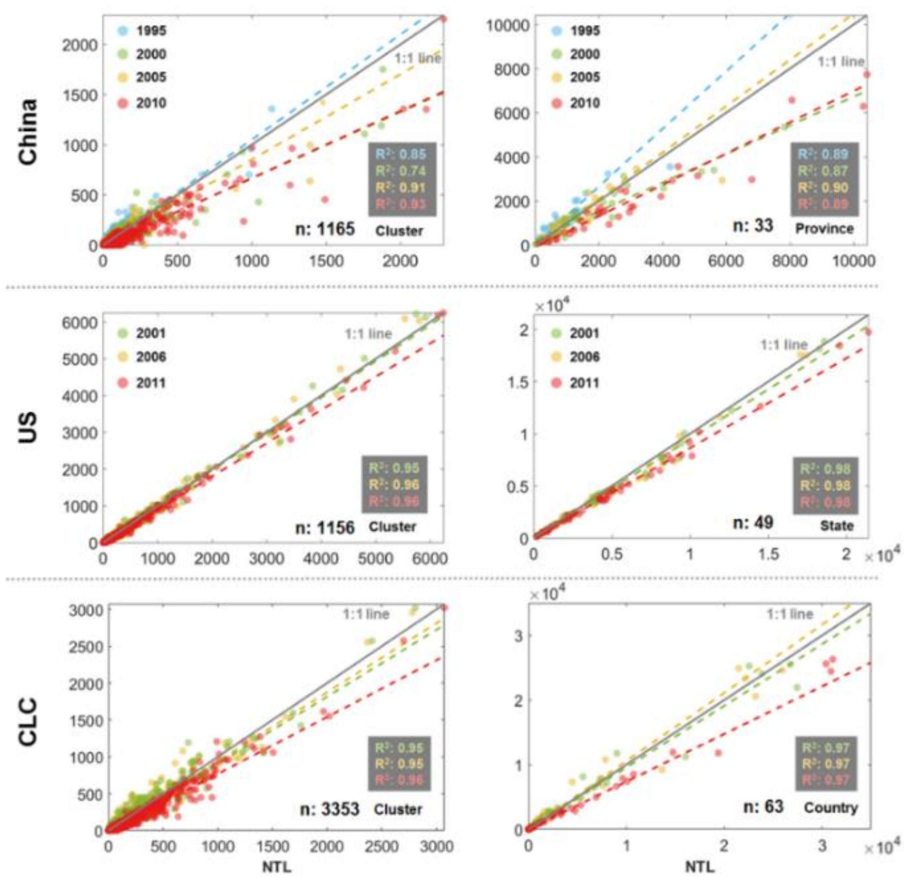


Fig. 9. A comparison of NTL based urban extents with high-resolution land cover products in China (top), US (middle), and Europe (bottom) at the cluster (left) and state/province/country (right) levels.

(Comparison of NTL based urban extents with high-resolution land cover products by Zhou et al. 2018)

As our study doesn't focus on proving the validity of satellite derived indices, we believe our approach has a great amount references as support for an application purpose. We sincerely appreciate your understanding.

In our manuscript, we did compare our observed trend (decrease of VANUI in the north) to the U.S Census Bureau. We illustrate in our manuscript:

"Similar trends of population decrease have been observed in other big northeastern cities such as Pittsburgh, in which its population dramatically decrease -9.5% during 1990-2000 and -8.6% during 2000-2010 (U.S Census Bureau, 2018). The population loss is also recorded in a large number of small cities in the northeast region including Johnstown and Rochester in NY, Weirton in WV and Harrisburg in PA (U.S Census Bureau, 2018)……In general, the opposite trends of human settlement between north and south of study area match well with the "Snow Belt-to-Sun Belt" population shift trend in the last decades that has been documented in past studies (Hogan, 1987; Iceland et al., 2013)."

In terms of quantifying storm exposure, we used the official storm tracks documented from 1851-2016. We didn't invent an exposure index in our study. Rather, we simply calculated the density of those officially documented tracks. Our explanation on the "wind speed weighting" is presented in latter comments. We thank you for your valuable comments and suggestions.

Additional references:

Zhou, Y., Li, X., Asrar, G. R., Smith, S. J., & Imhoff, M. (2018). A global record of annual urban dynamics (1992–2013) from nighttime lights. *Remote Sensing of Environment*, *219*, 206-220.

"Second, while it is evident that urbanization of rural areas produces an increased spatial extent of NTL, it is difficult for me to believe that a (moderate) decrease of population in an already urbanized area would reflect in a reduction of NTL. To put it simply, the streetlights are not kept off because some apartments become uninhabited, and the NTL differences linked to small population reductions are probably lower than uncertainties in the NTL data/calibration; buildings are rarely destroyed to restore cultivated fields. Rather, I see a very different resolution between 1992 and 2002 scenarios, which probably descends from the resolution of the NDVI. I think that substantial difference in the estimated extent of the urban area could descend from a sensibly different resolution of the processed data."

Our response: Thanks for pointing out the decrease of NTL observed in our study. We well understand you concerns. In this response, we'd like to offer some evidence from other sources to back up the claim in our study. Firstly, we'd like to point out the existence of urban decay that has been stated in many studies:

1) "*Shrinking Cities in the United States of America*" by Pallagst (2009)
2) "*Viewing urban decay from the sky: a multi-scale analysis of residential vacancy in a shrinking U.S city*" by Deng and Ma (2015)
3) "*Shrinking Cities: Urban Challenges of Globalization*" by Martinez-Fernandez et al. (2012)
4) "*Ghost cities identification using multi-source remote sensing datasets: a case study in Yangtze River Delta*" by Zheng et al. (2017)
5) "*Ghost City Extraction and Rate Estimation in China Based on NPP-VIIRS Night-Time Light Data*" by Ge et al. (2018)

Some of those studies above documented the reduce of artificial lights in cities and they believe the decreasing of light in cities is partly due to the migration pattern and the suburbanization process. Secondly, to statistically investigate pixels that have a decreasing trend, we utilized Mann-Kendall test at a significant level of 0.05. We believe that trend test with this level of significance reduces the impact of the uncertainties in the calibration process and is able to extract pixels with significant decrease of VANUI value.

We acknowledge the difference of resolution between AVHRR (1 km) and MODIS (250 m). In this study, we resampled both of them to the same pixel size (1 km), carefully calibrated both of them in their 3 overlapping years using a total of 90,000 samples, and achieved an R^2 of 0.934. Based on the references that gave very promising NDVI calibration results between AVHRR and

MODIS (Tucker et al., 2005; Fensholt et al., 2009), and our very high R^2, we believe we have built a stable enough NDVI time series to be fused with our nighttime series. However, we do recognize the different sensitivity of those two sensors and we believe it inevitably leads to some uncertainties in our VANUI series. In our manuscript, we claim this potential uncertainty as:

"It could be noted that the VANUI maps in 2013 provide much finer details than those in 1992 and 2002. Given the unaltered spatial resolution of DMSP/OLS sensors, it can be explained by the different resolutions of the raw NDVI products from AVHRR (1km) and MODIS (250m). Although images have been resampled to the same pixel size (1km) and carefully calibrated in their time series, the intrinsic sensitivity of those two sensors still affect the VANUI outputs."

We thank you for your valuable comments.

References used:

Pallagst, K. (2009). Shrinking cities in the United States of America. *The Future of Shrinking Cities: Problems, Patterns and Strategies of Urban Transformation in a Global Context. Los Angeles (University of California)*, 81-88.

Deng, C., & Ma, J. (2015). Viewing urban decay from the sky: A multi-scale analysis of residential vacancy in a shrinking US city. *Landscape and Urban Planning*, *141*, 88-99.

Martinez-Fernandez, C., Audirac, I., Fol, S., & Cunningham-Sabot, E. (2012). Shrinking cities: Urban challenges of globalization. *International journal of urban and regional research*, *36*(2), 213-225.

Zheng, Q., Zeng, Y., Deng, J., Wang, K., Jiang, R., & Ye, Z. (2017). "Ghost cities" identification using multi-source remote sensing datasets: A case study in Yangtze River Delta. *Applied Geography*, *80*, 112-121.

Ge, W., Yang, H., Zhu, X., Ma, M., & Yang, Y. (2018). Ghost City Extraction and Rate Estimation in China Based on NPP-VIIRS Night-Time Light Data. *ISPRS International Journal of Geo-Information*, *7*(6), 219.

Frey, W. H. (2018). US population disperses to suburbs, exurbs, rural areas, and "middle of the country" metros,". *Brookings Institution*.

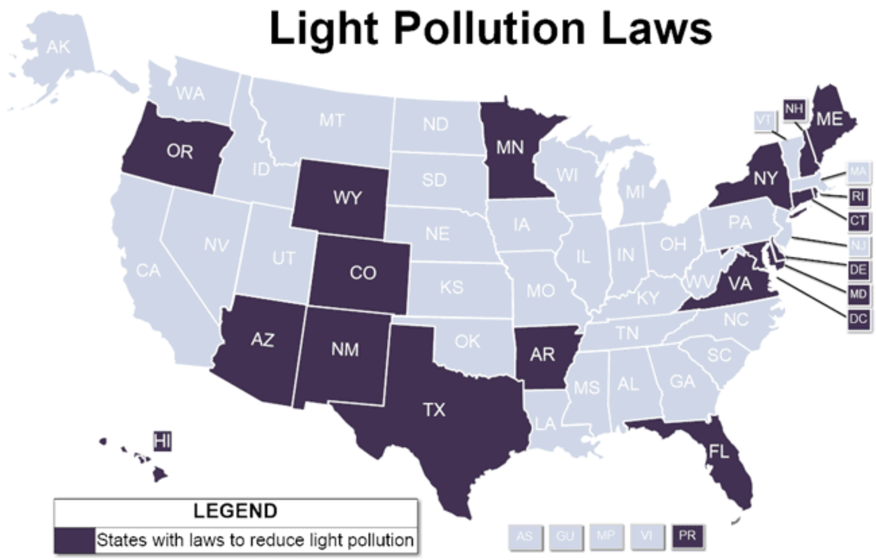
Kolko, J. (2017). Americans' Shift to the Suburbs Sped Up Last Year. *FiveThirtyEight*.

Tucker, C. J., Pinzon, J. E., Brown, M. E., Slayback, D. A., Pak, E. W., Mahoney, R., ... & El Saleous, N. (2005). An extended AVHRR 8-km NDVI dataset compatible with MODIS and SPOT vegetation NDVI data. *International Journal of Remote Sensing*, *26*(20), 4485-4498.

Fensholt, R., Rasmussen, K., Nielsen, T. T., & Mbow, C. (2009). Evaluation of earth observation based long term vegetation trends—Intercomparing NDVI time series trend analysis consistency of Sahel from AVHRR GIMMS, Terra MODIS and SPOT VGT data. *Remote Sensing of Environment*, *113*(9), 1886-1898.

"Again about NTL. How can NTL be influenced by differences in how cities are illuminated? For example, have policies been put in place to combat light pollution in the study area? (e.g., by forbidding upward oriented spots) How can these policies affect the NTL?"

Our response: Thanks for pointing out this issue. We acknowledge that there are many different ways in which cities are illuminated. In this study, however, we are not comparing one city to another. We are comparing the same pixel (1 km by 1km) within its time series (1992-2013). We are aware that changes of policy regarding nighttime lights might affect the NTL. Since you pointed out the light pollution laws, we did a detailed research on all the policies regarding lights in U.S.



(Source: http://www.ncsl.org/research/environment-and-natural-resources/states-shut-out-light-pollution.aspx)

In our study area, TX, AR, FL, VA, DC, MD, DE, CT, RI, NY, NH, ME have established laws to combat light pollution. However, we noticed that during the investigated period (1992-2013), there is no significant change of policy for those states. As we have discussed in our manuscript, DMSP/OLS data is saturated at DN value of 63. Even if there is a sudden change of policy, we believe it won't significantly affect the urban core as it will still be capped as 63. We believe the popularity of DMSP/OLS in long-term urban studies in U.S has proved its effectiveness (Small et al., 2005; Zhang and Seto, 2011; Li et al., 2016).

Additional references used:

Small, C., Pozzi, F., & Elvidge, C. D. (2005). Spatial analysis of global urban extent from DMSP-OLS night lights. *Remote Sensing of Environment*, *96*(3-4), 277-291.

Zhang, Q., & Seto, K. C. (2011). Mapping urbanization dynamics at regional and global scales using multi-temporal DMSP/OLS nighttime light data. *Remote Sensing of Environment*, *115*(9), 2320-2329.

Li, Q., Lu, L., Weng, Q., Xie, Y., & Guo, H. (2016). Monitoring urban dynamics in the southeast USA using time-series DMSP/OLS nightlight imagery. *Remote Sensing*, *8*(7), 578.

"Page 8, l. 18-20: what does "per unit" mean? What is the sense of summing slopes?"

Our response: Please let us explain our methodology (Mann-Kendall + Theil-Sen slope) in this study. Mann-Kendall identifies pixels with significant trend, and Theil-Sen further calculates the slope of those pixels that have been identified. After the identification of pixels (1 km by 1 km area) with a significant increasing trend, we calculated the percentage of those pixels in each zone (Table 3). However, in our logic, this statistic only explores the "coverage" of areas with significant increase. Each pixel identified as significant has a "Theil-Sen" slope, representing how strong this increasing trend is. The sum of Theil-Sen slope calculates the entire increasing intensity in each zone. As you may notice, this summation is proportional to the size of different zones. To solve this, we simply normalized the summation of slope by dividing it by the size of each zone. This is why (in Table 3) we added the column "Sum of Theil-Sen slope per 100,000 $km2$". As we expected, Zone 1 have not only the highest percentage of significant pixels but also the highest intensity of this increase.

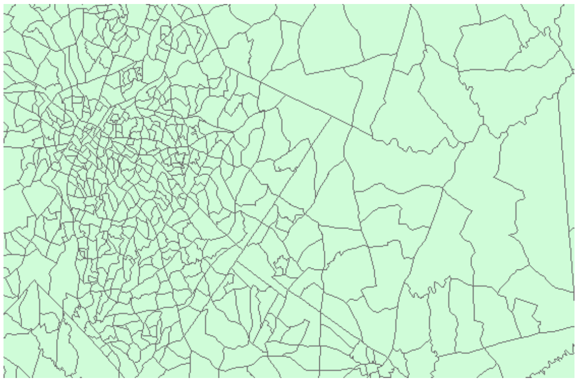
"Note that urbanization process and exposure to storms can be monitored using census data. Such a way is undoubtedly more burdensome than using NTL, but far more precise and accurate."

Our response: We'd like to provide our insight on this issue. Firstly, census data is based on samples, meaning that the quality of census data depends on the sample size and sampling period. As for American Community Survey (ACS), their 1-year estimates only survey areas with population larger than 65,000 and their 3-year estimates only survey areas with population larger than 20,000. The only product from ACS that covers all areas is their 5-year estimates, which is the estimation after 5 years of sampling. As for U.S Decennial Census, it provides surveyed results every 10 years based on sampling method. We believe nighttime remote sensing provides a better temporal explicit monitoring (yearly or even monthly) compared to traditional census data.

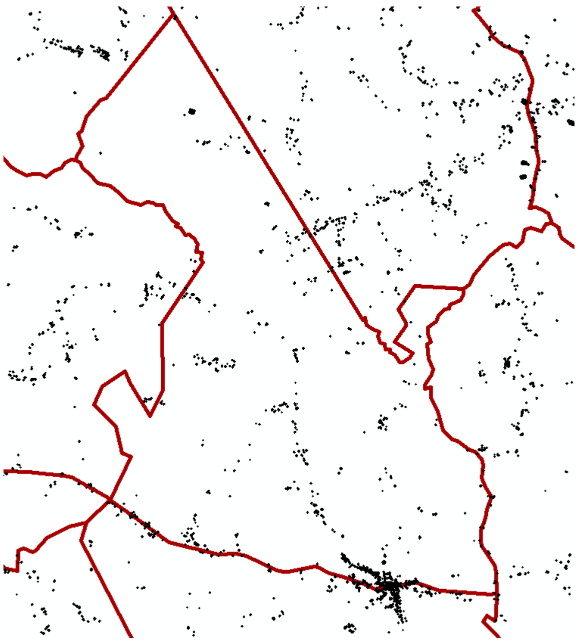
(Source: https://www.census.gov/programs-surveys/acs/guidance/estimates.html)

Secondly, census data tend to suffer from MAUP (Modified Areal Unit Problem) as the size of their unit varies a lot. Within each unit, however, we have to assume an uniform distribution of attributes from census data, which is not often the case. To some degree, nighttime remote sensing provides a better spatial explicit representation of human activity.

Here, we present blockgroups for a certain area in city of Atlanta to demonstrate the size difference of blockgroup as unit. We also present the distribution of buildings in blockgroups to demonstrate the great heterogeneity of buildings within this very small geographical level.



Blockgroups in City of Atlanta



Buildings within blockgroups

As you mentioned in your previous comments, in this study, NTL is just a proxy of monitoring human activity. We totally agree with your comments. We modified the last paragraph in our introduction section to better explain our goal.

"The goal of this paper is to illustrate the use of DMSP/OLS NTL data in 1992-2013 to monitor urbanization process and hurricane impacts on the U.S. Atlantic and Gulf coasts **using nighttime artificial lights as proxy**. Hurricane-prone areas were first derived by calculating the track density from historical storm tracks in the North Atlantic Basin. An intercalibrated DMSP/OLS NTL time series was built in a yearly interval. Assisted with the NDVI data, the Vegetation Adjusted NTL Urban Index (VANUI) was used to characterize human settlement intensities in the study area. After that, a trend analysis was conducted to identify areas with a significant increase of human settlement intensity in different zones. The spatiotemporal changes of human settlement **revealed from nighttime remote sensing** in hurricane-prone zones provide valuable information to evaluate damage and to support decision making of urban development."

"The paper contains a huge number of abbreviations, which sensibly hinder the text readability particularly for not-familiar readers. I ask the Authors to limit the number of abbreviations to the minimum necessary (for example, NAB, CONUS, EPB, DN are of course not necessary."

Our response: We agree that a large number of abbreviations might hinder the readability of our manuscript. Following your suggestion, we replaced "CONUS" to "the conterminous U.S", "NAB" to "North Atlantic Basin", "EPB" to "Eastern Pacific Basin". In terms of DN, we decided to keep the short form so that it can be consistent with the notation in our calibration functions. The aforementioned abbreviations in the figures and captions have been replaced as well:

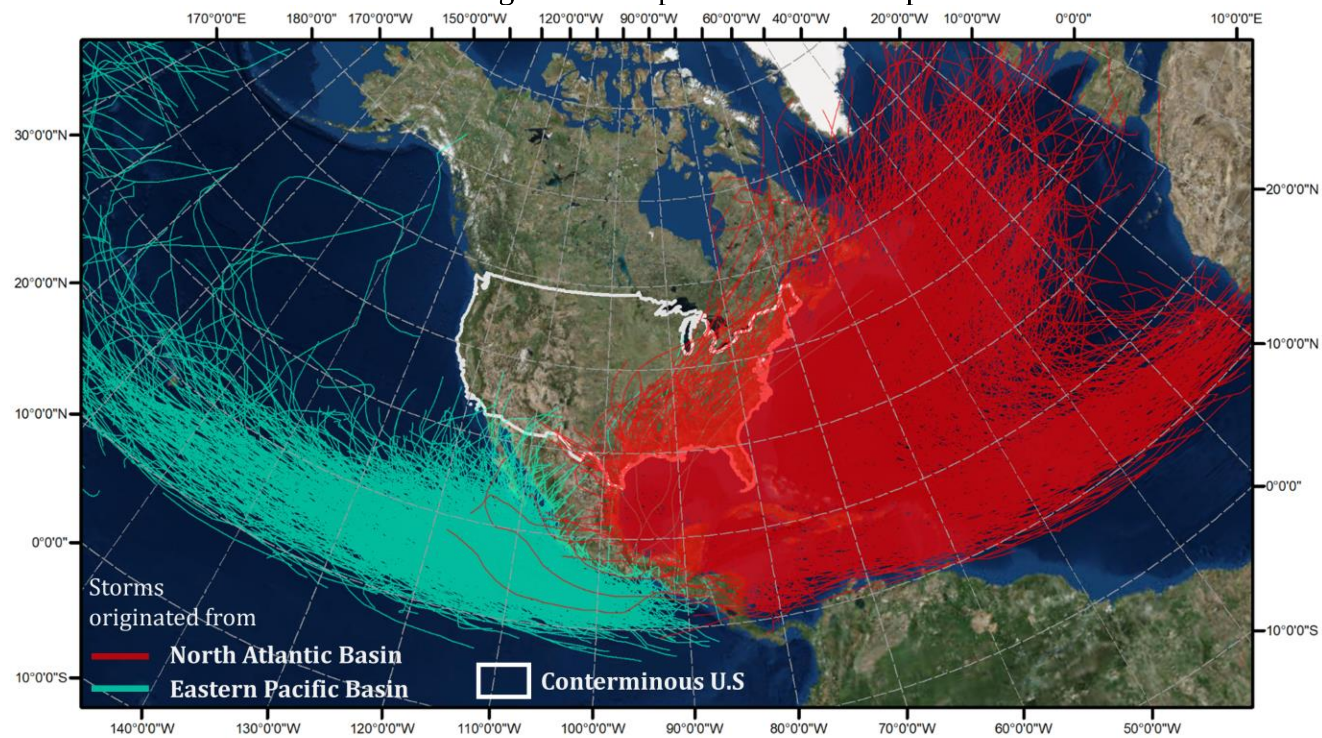


Figure 1: Historical storm tracks from the North Atlantic Basin (in red) and from the Eastern Pacific Basin (in green).

"The quality of the English should be significantly improved."

Our response: Thanks for pointing out the language issue. In our revision, we performed spelling/grammatical check for the entire document. The revised manuscript has been carefully proofread multiple times and refined by native English speakers.

"p.3, l. 6-9: applications of DMSP/OLS NTL data also encompass exposure to floods (Ceola et al., 2014, 2015)."

Our response: Thanks for providing this relevant reference. We added those two references to our Introduction section as "In comparison, satellite-derived nighttime light (NTL) data provides a unique and direct observation of human settlement via night lights **(Ceola et al., 2014; Ceola et al., 2015)**."

References used:

1. Ceola, S., Laio, F., and Montanari, A.: Human-impacted waters: New perspectives from global high-resolution monitoring, Water Resour. Res., 51, 7064-7079, 2015.
2. Ceola, S., Laio, F., and Montanari, A.: Satellite nighttime lights reveal increasing human exposure to floods worldwide, Geophys. Res. Lett., 41, 7184-7190, 2014.

"p.3, l. 20: what is "disaster migration"? Furthermore, an analysis of storm proneness can undoubtedly provide valuable information to support urban planning. The spatiotemporal changes of human settlement is what we need to influence, not an input data to allow disaster mitigation."

Our response: We agree with your comment on disaster mitigation and we do not think disaster mitigation fits well in this context. This sentence has been revised as "The spatiotemporal changes of human settlement **revealed from nighttime remote sensing** in hurricane-prone zones provide valuable information to evaluate damage and to support decision making of urban development."

"Section 2 should be merged with the following sections into a "Material and methods" section."

Our response: Thanks for your suggestion on the organization of Section 2. We agree that some information in Section 2 can be merged to Section 3. In this revised manuscript, we reorganized the structure by merging information regarding the DMSP/OLS dataset to Section 3. We changed the title of Section 2 to "Intercalibration and desaturation of DMSP/OLS NTL series". In this new Section 2, we mainly focus on illustrating the limitations of DMSP/OLS series, explaining why we need to perform intercalibration and desaturation, and presenting the methods we choose to adopt. We believe a stand-alone section benefits the readers' understanding of this problem. This stand-alone section also helps to keep "Methods" section more focused and concise. In addition, we expanded section 2 to provide a better background of some famous efforts in addressing intercalibration and saturation of DMSP/OLS data. The newly expanded section is attached:

2 Intercalibration and desaturation of DMSP/OLS NTL series

Due to the absence of on-board calibration and intercalibration, the annual DMSP/OLS NTL composites derived from multiple satellites in a span of 22 years were not comparable directly (Li and Zhou, 2017; Liu et al., 2012). This lack of continuity and comparability has posed great challenges in DMSP/OLS NTL based trend analysis (Tan, 2016). Elvidge et al. (2009) designed a three-step framework to intercalibrate the DMSP/OLS NTL composites. Those three steps are: 1) selecting a reference region; 2) selecting a reference satellite year; 3) performing a 2nd-order polynomial regression against the NTL reference data. This simple framework has been proven efficient in reducing discrepancies in digital number (DN) values of the DMSP/OLS NTL time series (Pandey et al., 2013) and has been adopted in many studies (Liu and Leung, 2015; Huang et al., 2016).

Another notable limitation of DMSP/OLS NTL is the saturation of luminosity in the 6-bit (DN in a range of 0-63) imagery (Letu et al., 2010). Numerous attempts have been made to mitigate the saturation effect to retrieve the heterogeneity in areas with high intensity of human settlement. A commonly used vegetation index, NDVI, is a useful indicator to reduce the saturation effect in DMSP/OLS data. Its practicality has been confirmed by many studies (Zhou et al., 2014; Liu et al., 2015). Lu et al. (2008) proposed a human settlement index (HSI) by merging normalized DMSP/OLS NTL data with the maximum NDVI in growing season derived from Moderate Resolution Imaging Spectroradiometer (MODIS). HSI has been proved rather efficient for settlement mapping in several testing sites in southeastern China. Zhang et al. (2013) develop a vegetation-adjusted NTL urban index (VANUI), which captures the inverse correlation between vegetation and luminosity. This simple index efficiently reveals the heterogeneity in regions with saturated DN values, which has been recognized by other studies (Shao and Liu). Following the original design of NDVI that characterizes the inverse relationship between the near-infrared band and red band in vegetation, Zhang et al. (2015) designed a normalized difference urban index (NDUI) that characterizes the inverse relationship between vegetation and luminosity in a similar way. NDUI was evaluated in five testing sites in U.S and proved to be effective in desaturating DN values in DMSP/OLS.

In this study, the intercalibration of DMSP/OLS data follows the method proposed by Elvidge et al. (2009) and the desaturation of DMSP/OLS data is achieved by using VANUI (Zhang et al., 2013).

Additional references added:

1. Liu, Z., He, C., Zhang, Q., Huang, Q. and Yang, Y.: Extracting the dynamics of urban expansion in China using DMSP-OLS nighttime light data from 1992 to 2008, Landscape Urban Plann., 106, 62-72, 2012.
2. Li, X., and Zhou, Y.: Urban mapping using DMSP/OLS stable night-time light: a review. Int. J. Remote Sens., 38, 6030-6046, 2017.

3. Shao, Z. and Liu, C.: The integrated use of DMSP-OLS nighttime light and MODIS data for monitoring large-scale impervious surface dynamics: A case study in the Yangtze River Delta. Remote Sens., 6(10), 9359-9378, 2014.
4. Zhang, Q., Li, B., Thau, D., and Moore, R.: Building a better urban picture: Combining day and night remote sensing imagery, Remote Sens., 7, 11887-11913, 2015.

"p.5, l. 3: "were downloaded": : : and also used? Or not??"

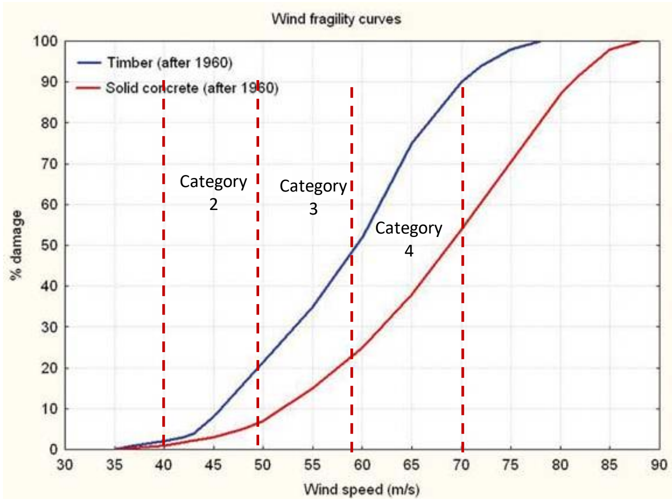
Our response: We replaced word "downloaded" with word "used" in this revision.

"of radius R"

Our response: We apologize that we didn't give enough information for the setting of circular neighborhood (R). In this case, R represents a **circular domain** and its radius (one of its attributes) defines the size of this domain. We adopted the idea from the tool in ArcGIS called "Line Density" which calculates a magnitude-per-unit area from polyline features that fall within a radius around each cell. Here, we adopted the default setting of radius of R in that function: "The default is the shortest of the width or height of the output extent in the output spatial reference, divided by 30". Per our calculation, the circular neighborhood R in our research area is 100 km. We added the setting of R in the revised manuscript as "The radius of R is set as 100 km in this study". We apologize for not specifying this parameter in the previous manuscript.

"why using the wind speed and not the square of the speed? Consider that wind drag goes with the speed squared."

Our response: The reason of introducing "wind speed weighted track density" in our study is to generally categorize the severity of hurricane exposure. We understand that our weighting scheme may not be the only option. It is our assumption. The relationship between wind speed and damage is never fixed and we acknowledge that it depends on many factors. Besides, damage resulting from wind only consists part of the total damage introduced from hurricanes. Since wind speed is the best attribute in the dataset to distinguish different levels of the storm, and given the generally positive relationship between wind speed and hurricane impact, we assume a simple linear function in this study. In some studies, the relationship between wind speed and damage is conceptualized as:



(“Dealing to wind hazards in New Zealand” from https://www.niwa.co.nz/sites/niwa.co.nz/files/import/attachments/wind2.pdf)

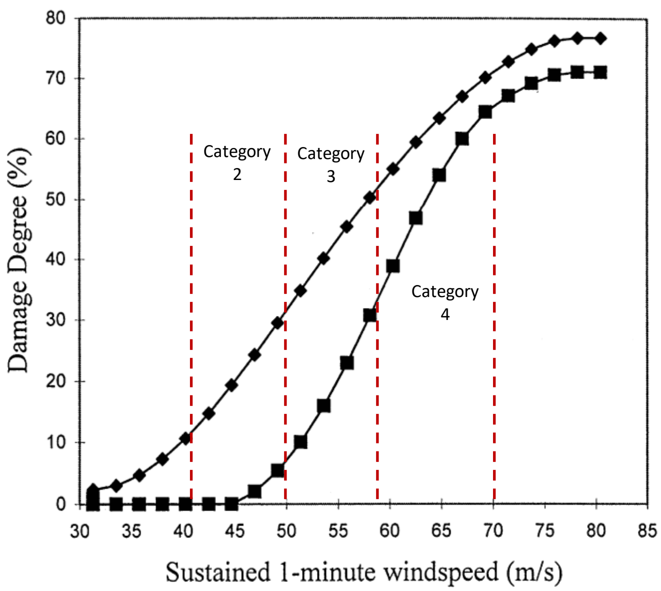


Fig. 11. Wind damage band for 1–3 story residential buildings. ♦ Upper, ■ lower.

(Unanwa et al., 2000)

From those figures, we can observe that for three most common hurricane types (Cat 2, 3, and 4), their wind speed and damage relations can be assumed linear. We appreciate your understanding.

“p.19, l. 3: start a new paragraph after “the Atlantic Gulf coasts.”

Our response: A new paragraph was started in the revision. We appreciate your suggestion.

“I note that, in a recent study by Viero et al. (2019), similar trends have been identified (and conclusions drawn) for a large coastal lowland in Italy, where population has been found to resettle in areas at high(er) risk of flooding. Interesting comparisons could be drawn.”

Our response: Thanks for providing this reference. We acknowledge the close relationship between this reference and our study. In their article, they pointed out that anthropogenic landscape modifications can significantly affect flood hazard. We found this statement extremely helpful in backing up one of our statements. In this revision, we added this reference in the following context: "Additionally, intensification of human settlement always couples with anthropogenic environmental changes (deforestation, wetland destruction, etc.), potentially resulting in more severe impacts during hurricanes and floods (Viero et al., 2019)."

"In the bibliography, cited references should be ordered alphabetically. Please check all the bibliographic references throughout the text. For example, line 6 at page 2 should read "(Goldenberg et al., 2001)".

Our response: We apologize for the mistake of the intext citation you pointed out. We have checked all the references and the references in the revised manuscript have been listed in alphabetical order.

"ADDITIONAL REFERENCES"

Our response: All the additional references have been added per your suggestion. The references added in the revision include:

1. Ceola, S., Laio, F., & Montanari, A. (2014). Satellite nighttime lights reveal increasing human exposure to floods worldwide. Geophysical Research Letters, 41(20), 7184-7190.

2. Ceola, S., Laio, F., & Montanari, A. (2015). Human-impacted waters: New perspectives from global high-resolution monitoring. Water Resources Research, 51(9), 7064-7079.

3. Viero, D. P., Roder, G., Matticchio, B., Defina, A., & Tarolli, P. (2019). Floods, landscape modifications and population dynamics in anthropogenic coastal lowlands: The Polesine (northern Italy) case study. Science of The Total Environment, 651, 1435-1450.

Other references used in this response:

Unanwa, C. O., McDonald, J. R., Mehta, K. C., & Smith, D. A. (2000). The development of wind damage bands for buildings. *Journal of Wind Engineering and Industrial Aerodynamics*, *84*(1), 119-149.

"Dealing to wind hazards in New Zealand" from https://www.niwa.co.nz/sites/niwa.co.nz/files/import/attachments/wind2.pdf