NOTES AND CORRESPONDENCE

Comments on “Anthropogenic Heat Release: Estimation of Global Distribution and Possible Climate Effect” by Chen, B. et al.

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Abstract

Chen et al. (2014, *J. Meteor. Soc. Japan*, **92A**, 157–165) estimated the global distribution of anthropogenic heat release (AHR) using satellite observed night lights, and showed a rapid increase of AHR from 2000 to 2009 in many regions, including Europe and North America. From model simulation based on this estimation, they showed a possibility of substantial influence of AHR on the climate over some regions of the world. However, existing data indicate that neither energy consumption nor night lights changed largely from 2000 to 2009. These facts raise serious doubts about the reliability of their results.

Keywords anthropogenic heat release; climate change; night light data

1. Introduction

Chen et al. (2014; hereafter C14) estimated the global distribution of anthropogenic heat release (AHR) for 1992, 2000, and 2009 using night light data obtained from Defense Meteorological Satellite Program (DMSP)/Operational Linescan System (OLS). Their result indicates that AHR in 2009 was considerably larger than that in 2000, possibly by an order of magnitude according to their Figs. 2 and 3, reaching an annual mean value of 20 W m^{-2} in concentrated regions in Europe, North America, and East Asia. Using this estimation and a numerical model, they concluded that “AHR has a significant impact on surface temperature and that it is able to affect global atmospheric circulation, leading to a 1–2

K increase in the high-latitude areas of Eurasia and North America.”

It is believed that AHR can reach 100 W m^{-2} in the central area of large cities, and has some effects on urban temperature (e.g., Aoyagi et al. 2012). However, the area of large AHR is limited, so that contribution of anthropogenic heat to large-scale temperature fields is believed to be negligible, apart from some regions where changes in atmospheric circulation may cause perceivable temperature increase (Zhang et al. 2013). In this respect, the study of C14 may be regarded as presenting a new aspect of the science of global climate. However, there is serious doubt about the validity of their results, as discussed in the following section.

2. Problems in the AHR estimation by C14

Figure 1 shows the trend of energy consumption in the world and regions provided by the Agency for Natural Resources and Energy of Japan (<http://www.enecho.meti.go.jp/about/whitepaper/2014html/2-2-1.html>). There is a marked increase in the Asia–

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Fig. 1. Annual energy consumption in the world and the regions provided by the Agency for Natural Resources and Energy of Japan.

Oceania region, which has a number of rapidly developing countries such as China and India, whereas Europe and North America show little change after 2000. In fact, energy consumption in 2009 was of the same amount as that in 2000 in Europe, and 2 % lesser than in 2000 in North America. For Japan, the energy consumption in 2009 was 8 % lesser than that in 2000 (<http://www.enecho.meti.go.jp/about/whitepaper/2014html/2-1-1.html>).

Data of DMSP/OLS night light can be obtained from NOAA's National Geophysical Data Center (NGDC). The file of "National trends with intercalibrated DMSP stable light" (http://ngdc.noaa.gov/eog/dmsp/download_national_trend.html) provides annual records of "sum of lights (SOL)" in each country since 1992, including "mean SOL" that is an average of SOL from satellites available. Figure 2 shows the trends of mean SOL per unit area for some countries in Europe and East Asia, and USA. It can be seen that SOL does not show a remarkable increase except in China and India. Figure 3 shows the relationship of SOL in 2000 and 2009 for each country. The ratio of SOL in 2009 to that in 2000 is 1.79 in China and 1.29 in India, but is less than 1.1 for other countries except Spain (1.14). In fact, the ratio is less than 1 in USA (0.84), UK (0.87), and Japan (0.93).

Thus, both energy consumption and intensity of night lights are found to have changed little from 2000 to 2009 in European countries and USA, and also in Japan. Since C14's estimation of AHR is based on a linear regression of light intensity and anthropogenic heat flux (Fig.1 of Chen and Shi 2012), AHR should be estimated to be a constant as long as SOL is unchanged. We can therefore conclude that the rapid increase of AHR described by C14 is unreliable, and

Fig. 2. Trends of mean SOL per unit area for each country.

Fig. 3. Comparison of mean SOL in 2000 and 2009 for each country. The dashed line is the $y = x$ line.

so is their model results based on this estimation as to the influence of AHR on the global climate.

3. Supplementary remarks

Flanner (2009) estimated the global distribution of AHR using energy consumption data. His result for 2005 indicates that "regionally-averaged heat fluxes are sufficiently large ($\approx 1 \text{ W m}^{-2}$)" in western Europe and eastern USA (his Fig.1). In comparison, the values of AHR shown in C14 for 2009 appear to be much larger, seemingly by an order of magnitude according to the coloring of their Fig.3. In other words, the results of Flanner (2009) and C14 are incompatible, apart from the difference of four years.

Bennie et al. (2014) analyzed the changes of night light brightness in Europe from 1995 to 2010 using the DMSP/OLS data. They showed that "the continental trend is towards increasing brightness," but the rate of increase is not so large (seemingly of the

order of 10 %), while “some economically developed regions show more complex patterns with large areas decreasing in observed brightness.” The slight increase of brightness in their analysis agrees with the increase of SOL in some countries, as shown in Figs. 2 and 3, such as Spain, Italy, and France.

The results of these studies are consistent with our conclusion that C14’s estimation of AHR in 2009 is unrealistically large.

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