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Effect of the Current Military Bombardments on Global Warming and Climate Change

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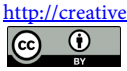

Abstract

This paper explores the relationship between recent military conflicts and their contribution to global warming and climate change. It examines how bombings and explosions emit greenhouse gases, particularly CO_2, and estimates their cumulative impact relative to overall atmospheric concentrations. The analysis highlights those ongoing four conflicts, such as those in Gaza, the Middle East, and Ukraine, have contributed significantly to greenhouse gas emissions, thereby exacerbating global temperature rise. The paper further discusses the broader implications of increased atmospheric heat, including enhanced climate variability and entropy, leading to more extreme weather events and ecological disruption. Our approximate calculations show that the increase in the global temperature (ΔT) will be only 0.0013˚C (13 mK) due to CO_2 emissions from bombings in the four military conflicts. The approximate resulted entropy change (ΔS) is 5.34×10^{15} J/K.

Keywords

Global Warming, Climate Change, Military Conflicts, Entropy in Climate Systems, Warfare and Environment

1. Introduction

Reports on heat conditions leading to well-above-average temperatures are currently impacting many parts of Western Europe, North America, North Africa, the Middle East, and Central Asia. For example, Agencia Estatal de Meteorología (AEMET) recorded a temperature of 46.0˚C in early July 2025 in southern Spain, with nearly identical temperatures in Portugal, Italy, and Greece [1]. It was also reported that 40% of meteorological stations in Europe had recorded temperatures exceeding 40˚C [2]. In Bahrain, April 2025 marked a record since records

began in 1902. The highest temperature recorded in June 2025, at Durrat Al Bahrain, was 48.5˚C (on 16th June), establishing a record in Bahrain's history as the highest temperature recorded for June [3].

Although many factors contribute to these high temperature records, there is significant concern that the intense military bombing in Gaza by Israelis (since 7th October 2023) and the Russia-Ukraine Conflict (since 24th February 2022), along with the extensive U.S. bombing of Iranian nuclear facilities using 14 Massive Ordnance Penetrators (MOPs) - GBU-57 (each weighing 13 tons delivered by 145 US-Israeli military aircraft), had a contribution. Additionally, the mutual rocket bombardment between Israel and Iran, which lasted for 12 days, involved thousands of explosions on both sides. Iran launched around 550 ballistic missiles at Israel during the conflict, while Israel launched about 1700 ballistic missiles at Iran (International Institute for Strategic Studies, 2025). These four military conflicts are expected to result in the release of heat and greenhouse gas (GHG) emissions, exacerbating global warming [4] [5]. The approximate amount of TNT exploded is 700 million tones.

This paper is devoted to proving the influence of military action for the climate due to the formation of CO_2 in the atmosphere resulting from TNT explosions. We presented useful approximate calculations excluding the change caused by debris and areolas from bombing on the atmospheric albedo (due to reflection and absorption of solar radiation with microparticles). This process takes place from eruption of volcano where they are not only absorbers and reflectors, but also, they can be nuclei of condensation and hence change the climate.

2. The Influence of These Four Conflicts on Global Warming

First, we must know that carbon dioxide (CO_2) is formed in bomb explosions as a result of the rapid combustion (oxidation) of carbon-rich organic compounds present in the explosive TNT. These compounds react with oxygen (present inside the explosive or in the air) to form various gases (Nitrogen N_2, Carbon Monoxide CO, and water vapor H_2O—which is a global warming gas), including carbon dioxide, in addition to releasing a huge amount of energy as a result of the sudden rapid reaction and the release of enormous heat in a very short time [6].

Our calculations estimate that the amount of CO_2 Equivalent released from the bombs (exothermic or heat-releasing interactions) from these military strikes is approximately one billion tons (10^9 tons), while the reported current amount of CO_2 in our atmosphere (excluding emissions from war) is 53 billion tons (5.3×10^{10} tons). This means that the CO_2 emissions resulting from these four wars represent 1.8%, which may indicate that the global temperature has increased by nearly 2%, raising Earth's temperature from 15.0˚C to 15.3˚C [5] [7]. This 0.3˚C increase is equivalent to the heat released from the explosion of 2,000 atomic bombs, as a 1˚C increase in Earth's temperature is equivalent to 100,000 nuclear bombs [8]. In fact, the previous calculations are only valid if we do not include other radiative forces and assuming linear relation, which is not the real case. Sec-

tion III shows more approximate calculation which will lead to the conclusion that the increase in the global temperature (ΔT) due to these four wars will be only 0.0013˚C (13 mK).

While the immediate emissions from individual bombardments might seem small compared to global emissions, the cumulative impact of ongoing conflicts, combined with emissions from military activities worldwide, contributes to the overall rise in global temperatures and aggravates global warming and subsequently climate change. Unfortunately, military emissions are often not included in annual national climate reporting or the IPCC National Climate Report [4] [5].

3. Heat Accumulated in Our Atmosphere from the Four Conflicts in Terms of Nuclear Bombs Explosion Equivalent

According to some sources, raising the Earth's temperature by 1˚C requires approximately 5 Exa-joules (5×10^{18} J) of energy. This amount of energy is often compared to the energy released by multiple atomic bombs. It was reported that the Earth's current rate of heat accumulation is equivalent to the energy of 4 or 5 Hiroshima atomic bombs detonating every second [9]. Knowing that the "Little Boy" (Hiroshima) bomb releases approximately 6.3×10^{13} Joules and the "Fat Man" (Nagasaki) bomb releases approximately 8.4×10^{13} Joules, we conclude that a 1˚C increase in Earth's temperature is equivalent to the heat liberated from the explosion of 100,000 nuclear bombs [5] [10].

4. Method of Calculating the Increase of Global Temperature Due to the Four Conflicts

4.1. CO_2 Emission from Explosions (TNT-Based Bombing)

First, we estimate CO_2 produced from combustion of TNT. The approximate combustion equation for TNT ($C_7H_5N_3O_6$):

$$2C_7H_5N_3O_6 + 15O_2 \rightarrow 14CO_2 + 5H_2O + 3N_2$$

This gives approximately 1.356 tons of CO_2 released per ton of TNT exploded., *i.e.* $14 \times 44.012 \times 227.13 = 1.356$ tons CO_2/ton TNT [11].

4.2. Global Contribution of War-Related CO_2

We convert total war-emitted CO_2 into global share. This can be made by assuming the followings:

- Total war CO_2 = 1 billion tons = 10^9 tons.
- Total annual CO_2 in atmosphere (2025 est.): ≈ 53 billion tons [7].
- Relative Share = (10^9 tons/53) × 100 ≈ 1.88%.

4.3. Radiative Forcing from Added CO_2

We use, herein, Myhre formula to calculate additional warming [12]

$$\Delta F = 5.35 \cdot \ln(C/C_0) \quad (1)$$

ΔF is a term that quantifies the change in the Earth's energy balance caused by

a factor like increased CO_2. A positive value indicates a warming effect, while a negative value indicates a cooling effect.

This equation ($\Delta F = 5.35 \ln(C/C_0)$) describes the radiative forcing (ΔF) in W /m^2 due to a change in atmospheric carbon dioxide (CO_2) concentration, according to a site specializing in global warming equations and climate research. Here, "C" represents the final CO_2 concentration, "C_0" is the initial CO_2 concentration, and the constant 5.35 is derived from radiative transfer calculations. Assume:

ΔC Increase in atmospheric CO_2 = 0.128 ppm (from war), then C = 415.123 ($C = C_0 + \Delta C$) and C_0 = 415 pp. Therefore,

$$\Delta F = 5.35 \ln(415.123/415) \approx 0.0016 \text{ W/m}^2$$

This Radiative Forcing ΔF is a measure of the change in the Earth's energy balance caused by factors like greenhouse gas emissions, changes in solar radiation, or volcanic eruptions. Then we convert radiative forcing to temperature change:

$$\Delta T = \lambda \cdot \Delta F, \quad (2)$$

where $\lambda = 0.8^\circ\text{C/Wm}^2$ and therefore $\Delta T \approx 0.0013^\circ\text{C}$.

ΔT is the change in surface temperature, λ is the climate sensitivity parameter, and ΔF is the radiative forcing. It's a simplified way to estimate how much the Earth's surface temperature will change in response to a radiative forcing, like that caused by increased greenhouse gas concentrations. Equation (2) suggests that the temperature change (ΔT) is directly proportional to the radiative forcing (ΔF), with the proportionality constant being the climate sensitivity parameter (λ). A higher λ value means the climate is more sensitive to radiative forcing, and a smaller change in radiative forcing will result in a larger temperature change. This parameter (λ) indicates how sensitive the Earth's climate system is to changes in radiative forcing. It essentially tells you how much the temperature will change for a given change in radiative forcing.

4.4. Total Heat Released by Explosives

E = mass × energy density of TNT and 1 ton TNT releases 4.184×10^9 J, therefore, for 700 million tons $E = 700 \times 10^6 \times 4.184 \times 10^9 = 2.9288 \times 10^{18}$ J [11].

4.5. Equivalent Number of Nuclear Bombs

Use Hiroshima bomb energy for comparison [4] [13]:

Energy per bomb $\approx 6.3 \times 10^{13}$ J.

Total Heat Released by Explosives = 2.9288×10^{18} J.

Equivalent Number of Nuclear Bombs $\approx 2.93 \times 10^{18}/6.3 \times 10^{13} \approx$ 46,500 bombs.

4.6. Energy Required to Raise Global Temperature

First, we calculate the heat capacity of atmosphere using the following equation:

$$Q = m \cdot C \cdot \Delta T \quad (3)$$

$M = 5.1 \times 10^{18}$ kg (mass of atmosphere), C = 1005 J/kg/˚C. For $\Delta T = 0.0013^\circ$C, $Q = 5.1 \times 10^{18} \times 1005 \times 0.0013 = 6.66 \times 10^{18}$ J. However, in taking the very rudely

estimated rise in global temperature (0.3˚C), due to these four wars, it will be ≈ 1.538×10^{21} J. Knowing that the "Little Boy" bomb (Hiroshima) was about 15,000 tons of TNT with energy libated of 6.27×10^{13} J, then 0.0013˚C rise in temperature is equivalent to explosion of 106 k bombs and for the other is 24.5 million bombs [14].

4.7. Entropy and Disorder in Climate

We start with estimating the change in entropy from added heat:

$$\Delta S = TQ \tag{4}$$

- T = 288 K (global mean temperature = 15˚C).
- For Q = 6.66 × 1018 J, $\Delta S = 1.538 \times 10^{18} \times 288 \approx 5.34 \times 10^{15}$ J/K.
- For Q = 1.538×10^{21} J, $\Delta S = 1.538 \times 10^{21} \times 288 \approx 5.34 \times 10^{18}$ J/K.

This links added heat to higher disorder and extreme events (entropy in climate dynamics). $\Delta S = 5.34 \times 10^{15}$ J/K represents a degree of disorder or randomness within the Earth's atmosphere. It suggests that the atmospheric system is highly disordered, with energy distributed in a complex and random manner. This high entropy implies that the atmosphere is in a state of high energy dispersion, with a large number of possible configurations for its molecules and particles. Basically, it means a high entropy value for the atmosphere means there's a lot of mixing, spreading out of energy, and a lack of highly organized structures within the air surrounding the planet, according to some thermodynamics resources. A higher entropy value (like the one provided) indicates a greater level of disorder and a more spread-out distribution of energy within the atmospheric system and therefore more extreme weather events [15] [16].

It follows from NASA and HITRAN (High-resolution Transmission molecular Absorption database), a compilation of spectroscopic parameters that a variety of computer codes use to predict and simulate the transmission and emission of light in the atmosphere data bank for infrared radiative transitions in molecules that CO_2 molecules requires to take into account several hundreds of spectral lines and give that approximately 30% of the annual change in the global temperature is determined by an increase of an amount of atmospheric CO_2 [17]. Therefore, assuming that an increase of an amount of atmospheric CO_2 results from human activity we will have the annual change of the atmospheric CO_2 concentration is 0.6% which results in combustion of 10 billion tons of carbon in the composition of CO_2. This leads to conclude that the annual change in the global temperature is 17 mK (0.017˚C). This figure is close to what has been calculated earlier (0.0013˚C).

5. Global Warming and Climate Change

When heat is accumulated more in the atmosphere (global warming)—due to bombing tons of TNT—the climate change gets more predominance (Entropy). The accumulated heat in the atmosphere leads to increased disorder or randomness in the Earth's climate system, which is related to the concept of Entropy for

the following reasons:

1) Increased Energy Dispersal: As the atmosphere traps more heat (greenhouse gas effect), energy is distributed more unevenly across different parts of the planet. This enhanced energy dispersal results in more frequent and intense weather events, such as storms, droughts, and floods, increasing the overall randomness or "extreme weather events"—*i.e.*, an increase in entropy—in the climate system [18].

2) Disruption of Climate Equilibrium: The Earth's climate tends to stabilize in a balanced state. However, additional heat input disturbs this balance, pushing the system toward a new, less predictable state with a higher degree of disorder [19].

3) Enhanced Climate Variability: More accumulated heat amplifies natural climate fluctuations, making weather patterns less predictable and more chaotic, which is a hallmark of increased Entropy [5].

4) Irreversible Changes: Climate impacts like melting glaciers, rising sea levels, and altered ecosystems are largely irreversible processes that contribute to long-term increases in entropy, representing a move toward greater disorder [20].

6. Conclusions

Conflicts such as those in Gaza, the Israel-Iran mutual bombing, the U.S. strike on nuclear facilities in Iran, and the Russia-Ukraine Conflict do minimally contribute to global warming by releasing significant amounts of GHG, primarily CO_2, from fuel use, explosives, and especially from the massive reconstruction efforts required after destruction [4] [5]. These emissions are substantial compared to the annual emissions of many individual countries.

These conflicts do not directly cause a measurable increase in global atmospheric temperature. The heat released may be localized and dissipates. The impact on global warming derives from cumulative greenhouse gas emissions over time, which contributes to the overall warming trend caused by human activities worldwide [5].

The true climate impact of war extends beyond direct emissions, encompassing environmental degradation, resource depletion, and diverting attention and resources from climate action. However, in terms of immediate, direct atmospheric temperature increase, the effect is negligible.

As heat builds up in the atmosphere, the increased energy and instability lead to more complex, unpredictable, and disordered climate behaviors—manifesting as an increase in the entropy of the Earth's climate system [14].

In order to avoid limiting the scope and generalizability of these findings, we will, in another paper, consider other military activities and not these four specific conflicts.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] AEMET (2025) WMO Global Annual to Decadal Climate Update (2025-2029). Annual Climate Report 2025. https://wmo.int/publication-series/wmo-global-annual-decadal-climate-update-2025-2029

[2] Copernicus Climate Change Service (2025) Copernicus: Monthly Climate Bulletin: Third-Warmest June Globally—Heatwaves in Europe amid Temperature Extremes across both Hemispheres European Heatwave Analysis. https://climate.copernicus.eu/western-europe-and-mediterranean-gripped-major-heatwaves-june

[3] Bahrain Meteorological Directorate (2025) Monthly Reports, Ministry of Communication and Transport, Directorate of Meteorology, Kingdom of Bahrain.

[4] Crawford, N. (2019) Pentagon Fuel Use, Climate Change, and the Costs of War. Watson Institute and Brown University. https://watson.brown.edu/costsofwar/files/cow/imce/papers/Pentagon%20Fuel%20Use%2C%20Climate%20Change%20and%20the%20Costs%20of%20War%20Revised%20November%202019%20Crawford.pdf

[5] IPCC (2025) Seventh Assessment Report (AR6); Scoping of the IPCC Seventh Assessment Report (AR7) Background, Cross-Cutting Issues and the AR7 Synthesis Report, Sixty-Second Session of the IPCC, Hangzhou, China, 24 to 28 February 2025 IPCC Secretariat, WMO and UN Environment Program. https://apps.ipcc.ch/eventmanager/documents/88/290120250857-INF.%207%20-%20Scoping%20of%20the%20AR7.pdf

[6] Bond, T.C., Doherty, S.J., Fahey, D.W., Forster, P.M., Berntsen, T., DeAngelo, B.J., *et al.* (2013) Bounding the Role of Black Carbon in the Climate System: A Scientific Assessment. *Journal of Geophysical Research*: *Atmospheres*, **118**, 5380-5552. https://doi.org/10.1002/jgrd.50171

[7] Friedlingstein, P., O'Sullivan, M., Jones, M.W., Andrew, R.M., Hauck, J., Landschützer, P., *et al.* (2025) Global Carbon Budget 2024. *Earth System Science Data*, **17**, 965-1039. https://doi.org/10.5194/essd-17-965-2025

[8] Li, J., Carlson, B.E., Yung, Y.L., Lv, D., Hansen, J., Penner, J.E., *et al.* (2022) Scattering and Absorbing Aerosols in the Climate System. *Nature Reviews Earth & Environment*, **3**, 363-379. https://doi.org/10.1038/s43017-022-00296-7

[9] Nuccitelli, D. (2020) Earth Is Heating at a Rate Equivalent to Five Atomic Bombs Per Second. Or Two Hurricane Sandys. *Bulletin of the Atomic Scientist.* https://thebulletin.org/2020/02/earth-is-heating-at-a-rate-equivalent-to-five-atomic-bombs-per-second-or-two-hurricane-sandys/

[10] Rhodes, R. (1986) The Making of the Atomic Bomb. Simon & Schuster.

[11] Agrawal, J.P. (2010) High Energy Materials. Wiley. https://doi.org/10.1002/9783527628803

[12] Myhre, G., Highwood, E.J., Shine, K.P. and Stordal, F. (1998) New Estimates of Radiative Forcing Due to Well Mixed Greenhouse Gases. *Geophysical Research Letters*, **25**, 2715-2718. https://doi.org/10.1029/98gl01908

[13] Caldeira, K. and Kasting, J.F. (1993) Insensitivity of Global Warming Potentials to Carbon Dioxide Emission Scenarios. *Nature*, **366**, 251-253. https://doi.org/10.1038/366251a0

[14] Trenberth, K.E. (2008) Climate Change and Extreme Weather Events. In: Epstein, P.,

Ed., *Proceedings of the Catastrophe Modeling Forum*: *Changing Climatic Dynamic and Catast*, The Down Town Association, 7.

[15] Lorenz, E.N. (1963) Deterministic Nonperiodic Flow. *Journal of the Atmospheric Sciences*, **20**, 130-141. https://doi.org/10.1175/1520-0469(1963)020<0130:dnf>2.0.co;2

[16] Hansen, J., Sato, M. and Ruedy, R. (2012) Perception of Climate Change. *Proceedings of the National Academy of Sciences*, **109**, E2415-E2423. https://doi.org/10.1073/pnas.1205276109

[17] Smirnov, B.M. (2021) Introduction. In: Smirnov, B.M., Ed., *Global Energetics of the Atmosphere. Springer Atmospheric Sciences*, Springer, 1-8.

[18] Lenton, T.M., Rockström, J., Gaffney, O., Rahmstorf, S., Richardson, K., Steffen, W., *et al.* (2019) Climate Tipping Points—Too Risky to Bet Against. *Nature*, **575**, 592-595. https://doi.org/10.1038/d41586-019-03595-0

[19] Steffen, W., Rockström, J., Richardson, K., Lenton, T.M., Folke, C., Liverman, D., *et al.* (2018) Trajectories of the Earth System in the Anthropocene. *Proceedings of the National Academy of Sciences*, **115**, 8252-8259. https://doi.org/10.1073/pnas.1810141115

[20] Mach, K.J., Kraan, L., Adger, W.N., Otto, I.M., Siders, A.R., Thaler, K. and Tren-berth, K.E. (2020) Climate as a Risk Factor for Armed Conflict. *Nature Climate Change*, **10**, 918-923.