

# Role of **Atmospheric** Convection in Global Warming

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## ABSTRACT

**Aims:** Geophysical convection calculations can potentially obscure details necessary to understand convective-heat-transfer changes caused by changes in the adverse temperature gradient. The objective is to ascertain the functional relationship between adverse temperature gradient and convection efficiency.

**Methodology:** A classroom-demonstration experiment was conducted to illustrate the principle that convection efficiency is a direct function of the adverse temperature gradient.

**Results:** Application of this principle to climate science has profound implications for global warming. A brief period of global warming during **World War II** followed by rapid global cooling afterward is attributable, not to carbon dioxide, but to particulate pollution and its generalization to post-1950 global warming. Rather than simply blocking sunlight and causing global cooling, aerosol particles are radiation absorbers that rapidly transfer heat to the surrounding atmosphere, raising its temperature relative to atmospheric temperature at Earth's surface. Thus the reduction of the adverse temperature gradient between the upper troposphere and the surface reduces atmospheric convection and concomitantly reduces convection-driven surface heat loss, causing global warming, heating the oceans, and reducing CO<sub>2</sub> solubility and releasing dissolved CO<sub>2</sub> to the atmosphere.

**Conclusions:** Increasing levels of atmospheric CO<sub>2</sub>, rather than causing global warming, are symptomatic of particulate-pollution-caused global warming. The Anthropocene idea cannot be justified by anthropogenic CO<sub>2</sub>. Instead the Anthropocene is better characterized by anthropogenic particulate pollution. A drastic reduction in particulate-pollutant emissions will be followed by a rapid and drastic reduction in global warming, as tropospheric pollution-particulates fall to ground in days to weeks, thus increasing atmospheric convection efficiency and potentially providing a radical solution to the global climate crisis. Moreover, reduction of particulate-pollution, the greatest environmental health-threat, will potentially save millions of lives and reduce the suffering of many more.

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*Keywords: global warming, atmospheric convection, particulate pollution, aerosol heating*

## 1. INTRODUCTION

Geophysical atmospheric convection models are generally complex [1,2], typically involving solution of hydrodynamic equations of motion coupled with assumptions [3,4]. Calculations become especially opaque when parameterization is used [5]. Consequently, critical details of the actual physical process of convection may be obscured, details that are necessary to make substantive advances in scientific understanding, and to correct misperceptions.

Thermal convection is an easily visualized process: Add a few tea leaves to a pot of water on the stovetop. Before the water starts to boil, the tea leaves circulate from bottom to top and top to bottom carried along by the motion of the water. This is convection.

27 Chandrasekhar described convection in the following, easy-to-understand way [6]: *The*  
28 *simplest example of thermally induced convection arises when a horizontal layer of fluid is*  
29 *heated from below and an adverse temperature gradient is maintained. The adjective*  
30 *'adverse' is used to qualify the prevailing temperature gradient, since, on account of thermal*  
31 *expansion, the fluid at the bottom becomes lighter than the fluid at the top; and this is a top-*  
32 *heavy arrangement which is potentially unstable. Under these circumstances the fluid will try*  
33 *to redistribute itself to redress this weakness in its arrangement. This is how thermal*  
34 *convection originates: It represents the efforts of the fluid to restore to itself some degree of*  
35 *stability.*

36  
37 Surprisingly, the consequences of the adverse temperature gradient on convection are  
38 rarely, if ever, explicitly considered in geophysical convection calculations [7]. For example,  
39 atmospheric heating by particulate matter has been said to cause "*changes in the*  
40 *atmospheric temperature structure*" [8] without mentioning the consequences on  
41 atmospheric convection and the concomitant surface-heat-transfer reduction that results  
42 from the diminished adverse temperature gradient.

43  
44 Atmospheric convection calculations relating to the consequences of adverse temperature  
45 gradients are necessarily complex, and may not be possible without *ad hoc* assumptions  
46 and simplifications. Nevertheless, a simple classroom-demonstration experiment can serve  
47 as guidance for understanding.

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## 49 **2. METHODOLOGY**

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51 The convection classroom-demonstration experiment was conducted by this author using a  
52 4 liter beaked-beaker, nearly filled with distilled water, and heated on a regulated hot plate.  
53 As an indicator of convection, celery seeds were added to be dragged along by convective  
54 motions in the water. After stable convection was obtained, a ceramic tile was placed atop  
55 the beaker to retard heat loss, thus increasing the temperature at the top relative to that at  
56 the bottom, thus decreasing the adverse temperature gradient. The reduction of the number  
57 of celery seeds in motion indicated the reduction in convection, which was recorded  
58 photographically [9].

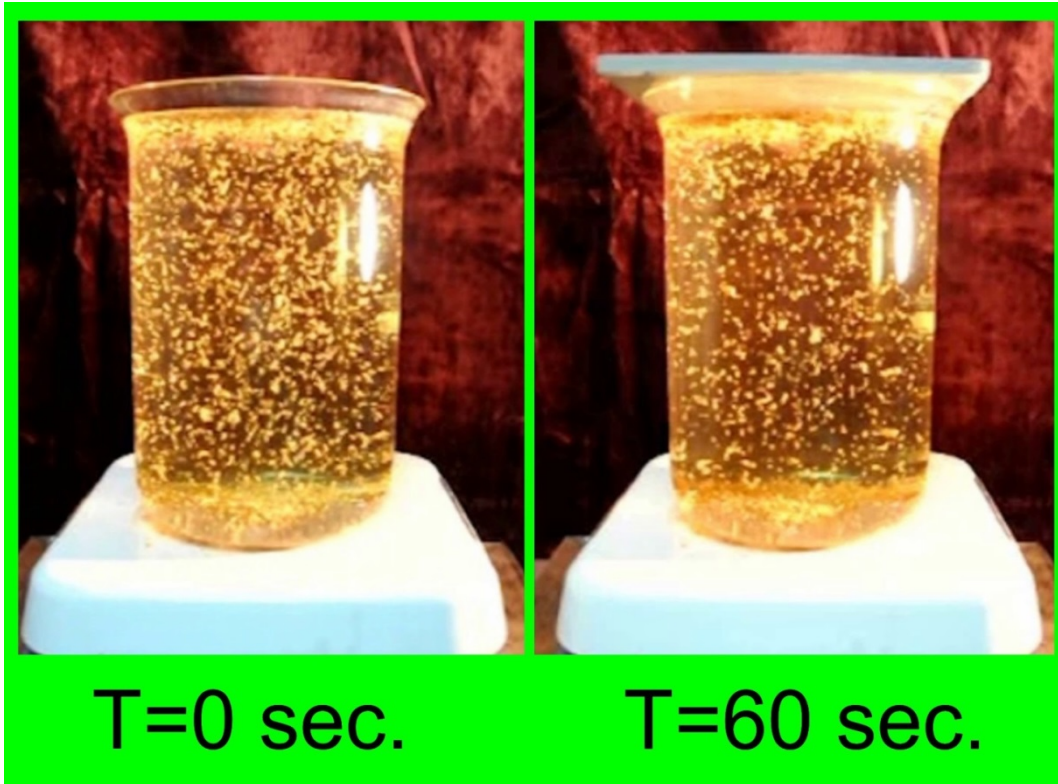
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## 60 **3. RESULTS AND DISCUSSION**

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62 Figure 1 presents images of the beaker on the regulated hot plate taken over a period of one  
63 minute abstracted from a video record [9]. The T=0 image was taken after stable convection  
64 was attained and just before the ceramic tile was placed atop the beaker. Placing the tile  
65 atop the beaker reduced heat-loss from the surface, raising the temperature at the top of the  
66 solution relative to that of the bottom, which reduced the adverse temperature gradient. In  
67 just one minute the number of celery seeds in motion, driven by convection, decreased  
68 markedly, demonstrating that reducing the adverse temperature gradient decreased  
69 convection.

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**Figure 1.** A beaker of water on a regulated hot plate with celery seeds pulled along by the fluid convection motions. Placing a ceramic tile atop the beaker a moment after  $T=0$  reduced heat-loss, effectively warming the upper solution's temperature, thus lowering the adverse temperature gradient, and reducing convection, indicated by the decreased number of celery seeds in motion at  $T=60$  sec. That reduction in convection is reasonable considering zero adverse temperature gradient is by definition zero thermal convection. This simple classroom-demonstration illustrates well the principle that convection efficiency is a direct function of adverse temperature gradient. The application of this principle to climate science has profound implications bearing on global warming.

The climate science community, including the United Nations' Intergovernmental Panel on Climate Change (IPCC), has promulgated the false idea that aerosol particulates cause global cooling by blocking sunlight [7,10-12]. However, it has recently become clear that aerosol particles are efficient absorbers of solar radiation, either separately as large particles or as assemblages of small particles which rapidly transfer that heat to the surrounding atmospheric gases [13-16].

One primary consequence of heating the upper troposphere through heat-absorbing particulate matter can be directly inferred from the experimental observations presented here.

Particles in the troposphere, heated by solar radiation or by radiation from Earth's surface, transfer that heat to the surrounding atmosphere, which raises its temperature relative to atmospheric temperature at Earth's surface. In other words, the adverse temperature gradient between the upper troposphere and the surface is lowered, which reduces atmospheric convection, and concomitantly *reduces convection-driven surface heat loss*.

99 The consequence is increased global warming. The lowering of the adverse temperature  
100 gradient in the lower atmosphere is the primary way global particulate pollution causes  
101 global warming.

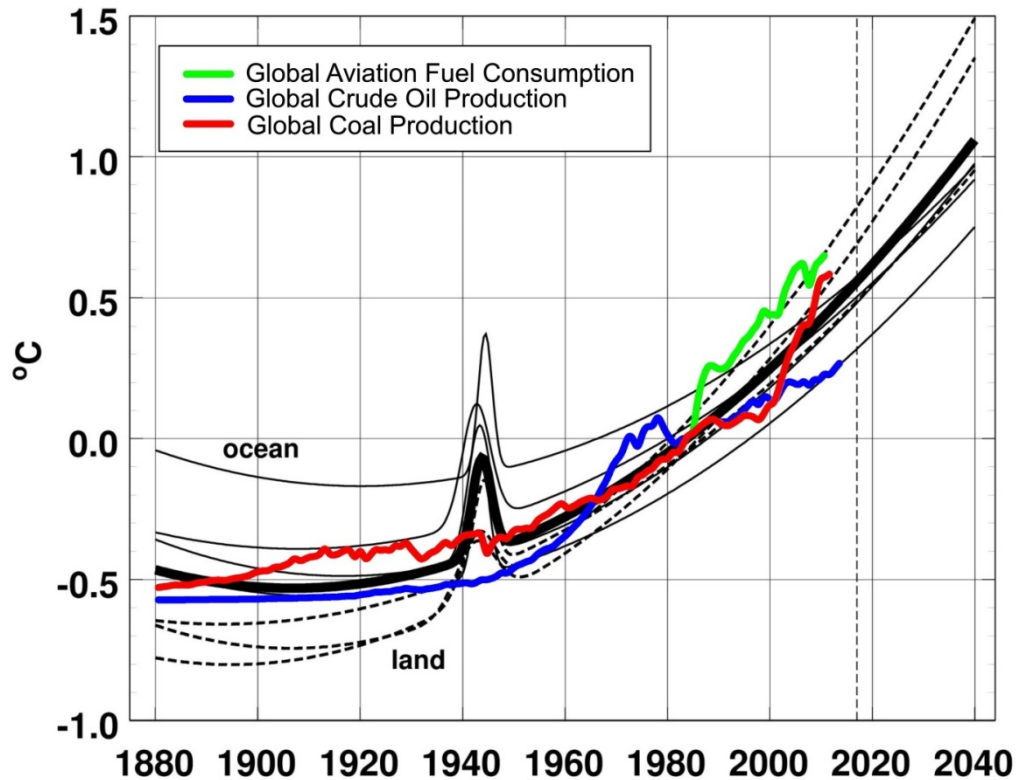
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103 Life on Earth is possible in part because a natural radiation balance exists between our  
104 planet and the sun. The widely promoted perception that anthropogenic greenhouse gases,  
105 mainly carbon dioxide [CO<sub>2</sub>], cause global warming by trapping heat that should otherwise  
106 be radiated into space [7,17,18] is dubious. Further, those who argue that there is no  
107 unnatural global warming are often called “deniers” [19,20], and are also unlikely to be  
108 correct. As described below, it has recently become possible to show that neither of these  
109 perceptions about climate change is correct. Human activity is indeed causing global  
110 warming, but not principally by greenhouse gas emissions. Particulate pollution emissions  
111 are, instead, likely the main cause of ongoing global warming [16,21,22].

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113 The observations that led to this discovery began with an image on the front page of the  
114 January 19, 2017 *New York Times*, a global surface temperature presentation that showed a  
115 bump, an abrupt upward climb in temperatures coincident with **World War II (WW2)**. Inspired  
116 by that image, Harvard physicist Bernard Gottschalk [23,24] applied sophisticated curve-  
117 fitting techniques and demonstrated the bump is a robust feature evident in eight  
118 independent NOAA datasets. The bump in relative temperature, Gottschalk concluded, “is a  
119 consequence of human activity during WW2” [23].

120  
121 Inspired by Gottschalk’s work [23,24], this author [21] realized that two WW2 consequences  
122 were potentially capable of altering the sun-earth radiation balance to cause global warming:  
123 Particulate pollution and carbon dioxide.

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125 Figure 2, from [23] is a copy of Gottschalk’s figure to which has been added three relative-  
126 value proxies which represent major activities that produce particulate pollution [21]. The  
127 proxies are: Global coal production [25,26]; global crude oil production [26,27]; and, global  
128 aviation fuel consumption [26]. Each proxy dataset was normalized to its value at the date  
129 1986 and each relative-value curve was then anchored at 1986 to Gottschalk’s boldface  
130 relative global warming curve. The particulate-proxies track well with the eight NOAA global  
131 datasets used by Gottschalk.

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 134 **Figure 2.** Copy of Gottschalk's fitted curves for eight NOAA data sets showing relative  
 135 temperature profiles over time [23] to which are added proxies for particulate pollution.  
 136 **Dashed line: land; light line: ocean; bold line: weighted average.** From [21].  
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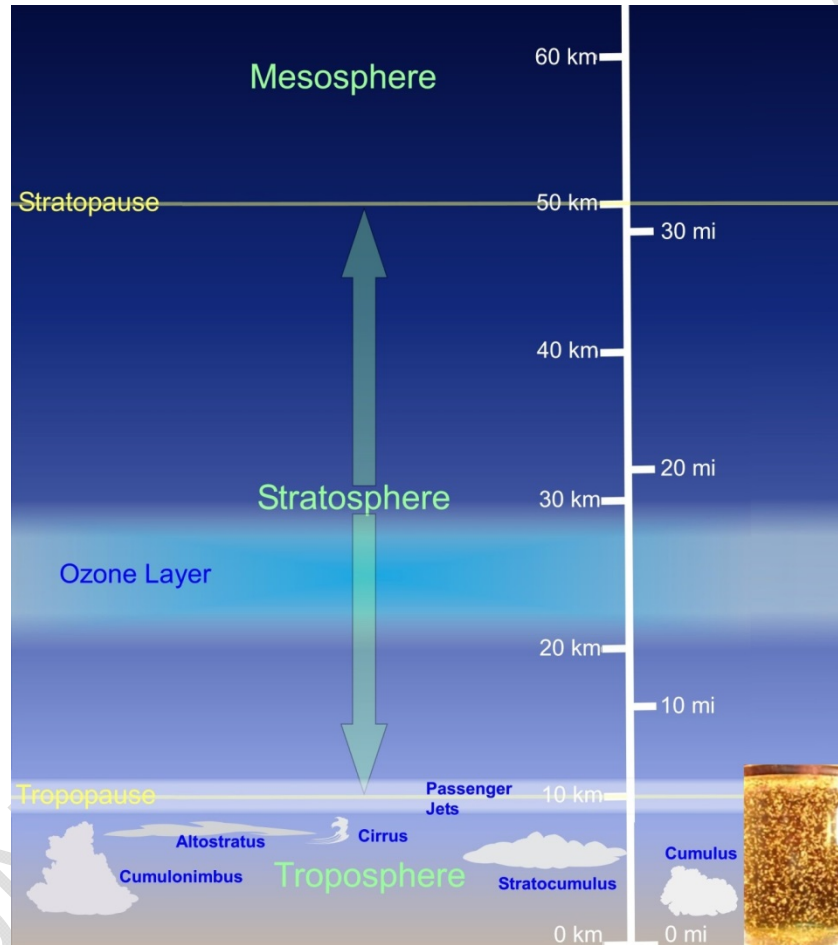
138 During WW2, a great spike in air pollution inevitably occurred from maximized industrial  
 139 production, from smoke and coal fly ash spewing forth from the smokestacks of industries,  
 140 utilities, and locomotive engines, from greatly increased marine and aeronautical transport,  
 141 and from extensive military activities that polluted the air with aircraft, ship, and vehicle  
 142 exhaust and with the consequences of vast numbers of munition detonations, including the  
 143 demolition of entire cities, and their resulting debris and smoke. The implication is that global  
 144 warming during WW2 was caused by the pollution particulates trapping heat that should  
 145 have been returned to space, thus altering Earth's delicate thermal balance [21].  
 146

147 The very activities that cause particulate pollution typically produce massive amounts of  
 148 carbon dioxide. WW2 global warming, however, was not produced by atmospheric CO<sub>2</sub>. The  
 149 extremely-long atmospheric residence time of carbon dioxide (decades or longer) [7]  
 150 eliminates it as the principal cause of WW2 global warming because, just after WW2, the  
 151 global temperature plummeted. Rapid cessation of WW2 global warming is understandable  
 152 as tropospheric pollution-particulates fall to ground in days to weeks [28].  
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154 As the aerosolized particulates settled to ground after the war, Earth radiated its excess  
 155 trapped energy, and global warming abruptly subsided. But only for a brief time, as  
 156 particulate pollution began to rise again from ramped-up post-WW2 industrial growth, initially  
 157 in Europe and Japan, and later in China, India, and the rest of Asia, dramatically increasing  
 158 worldwide aerosol particulate pollution [29].  
 159

160 To maintain thermal balance, Earth must return to space virtually all of the energy it receives  
161 from the sun as well as the energy it produces internally. That complex thermal balance has  
162 been maintained naturally without human intervention for most of Earth's lifetime.

163  
164 Figure 3 is a schematic representation of Earth's atmosphere. The vertical region where  
165 atmospheric convection principally occurs is indicated by the convection-beaker image. In  
166 this region pollution particles absorb solar radiation and radiation from Earth, become  
167 heated, and transfer that heat to the surrounding atmosphere, which reduces the adverse  
168 temperature gradient relative to the surface. The consequence of the reduced adverse  
169 temperature gradient is to reduce atmospheric convection, which in turn reduces convective  
170 heat-loss from the surface, causing global warming.  
171



172 **Figure 3.** Schematic representation of Earth's atmosphere. The convection-beaker image  
173 indicates the vertical region of the atmosphere where convection is a common feature.  
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175  
176 Science progresses by replacing less-precise understanding with more-precise  
177 understanding, a process that necessitates the constant questioning of current ideas. Even  
178 at the highest levels, however, the climate-science community has failed to question the  
179 belief that anthropogenic carbon dioxide is the causal agent of global warming. No one  
180 seems to have asked the basic scientific question, "What could be wrong with this picture?"  
181

182 One thing that is wrong is that global warming unquestioningly warms the oceans, the main  
183 reservoir of CO<sub>2</sub>. Warming the oceans not only lowers the solubility of CO<sub>2</sub>, but also releases

184 dissolved CO<sub>2</sub> into the atmosphere [22,30]. The increasing levels of atmospheric CO<sub>2</sub>, rather  
185 than necessarily causing global warming, are symptomatic of an entirely different,  
186 unrecognized cause of global warming. It appears that the climate-science community took  
187 at face value the erroneous assertion that particulates cool the atmosphere [7,10-12].  
188

189 Steffen, Crutzen, and McNeill [31] have been instrumental in developing the idea of the  
190 Anthropocene, the proposed post-Holocene epoch in which human activity has become a  
191 global geophysical force. They propose that the “Great Acceleration” of this new epoch  
192 happened when carbon dioxide’s “growth rate hit a take-off point around 1950.”  
193

194 The idea of the Anthropocene cannot be justified by anthropogenic CO<sub>2</sub>. The Anthropocene  
195 is better characterized by anthropogenic particulate pollution. The “Great Acceleration” of  
196 particulate pollution was ushered in during WW2, and after a few years pause, by the  
197 massive increase in global industrial growth with its concomitant particulate pollution.  
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199 The good news is that a drastic reduction in particulate-pollutant emissions will be quickly  
200 followed by a drastic reduction in global warming. As tropospheric pollution-particulates fall  
201 to ground in days to weeks [28], the atmospheric adverse temperature gradient relative to  
202 the surface increases, thus increasing convective-driven heat loss from the surface and  
203 concomitantly reducing global warming. Moreover, reduction of particulate-pollution, the  
204 greatest environmental health-threat, will potentially save millions of lives and reduce the  
205 suffering of many more [32].  
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#### 207 **4. CONCLUSION**

208  
209 During WW2 massive quantities of particulate-pollutants and carbon dioxide were released  
210 into the atmosphere. The WW2 “bump” in the relative global thermal profile in eight NOAA  
211 datasets shows abrupt anthropogenic global warming and abrupt global cooling. Because  
212 CO<sub>2</sub> has a long lifetime in the atmosphere, the rapid global cooling at the end of WW2 is  
213 inconsistent with CO<sub>2</sub>-trapped heat. Instead, the sudden global cooling indicates global  
214 warming is caused by aerosolized particulate-pollution that falls to ground in a matter of days  
215 to weeks.  
216

217 Recent scientific papers show that aerosolized particulates absorb incoming solar radiation  
218 as well as outgoing radiation from Earth’s surface. Thus heated, the particles transfer that  
219 heat to the surrounding atmosphere. The consequence of heating the upper troposphere –  
220 illustrated by a classroom-convection demonstration – is to reduce the adverse temperature  
221 gradient between the upper troposphere and Earth’s surface atmosphere; this, in turn,  
222 reduces convective heat loss and causes global warming.  
223

224 Further, particulate-pollution-caused global warming heats the oceans, lowers the solubility  
225 of CO<sub>2</sub>, and thus also acts to release into the atmosphere CO<sub>2</sub> dissolved in the oceans.  
226 Rather than causing global warming, increased levels of atmospheric CO<sub>2</sub> are symptomatic  
227 of an entirely different thermal-trapping process; particulate-pollution caused global warming.  
228 The Anthropocene idea cannot be justified by anthropogenic CO<sub>2</sub>, but is better characterized  
229 by anthropogenic particulate pollution.  
230

231 Trapping and reducing particulates is well within humanity’s present technological and  
232 managerial know-how. The rapidity by which tropospheric pollution-particulates fall to  
233 ground, in days to weeks, assures swift restoration of atmospheric convection efficiency. If a  
234 worldwide effort to reduce aerosol particulate-pollution emissions were adopted, it would be  
235 followed by a rapid and drastic reduction in global warming and a significant improvement in  
236 planetary public health.

237 **COMPETING INTERESTS**

238

239 The author declares no competing interests.

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