Global Warming Mitigation without Harming the Environment

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Concept Summary:

- Mitigate global warming by increasing global cloud reflectivity (albedo) without harming the environment
- Utilize large-scale release of liquid nitrogen or liquefied air to cool very large atmospheric regions in order to create new clouds, enlarge existing clouds or make existing clouds more reflective
- Take advantage of the extreme low temperature of these liquids (below minus 300 degress F) combined with their huge expansion ratio into gas (about 1,000 times at sea level and over 4,000 times at 40,000 feet altitude) to cool "ripe" regions of water vapor into reflective water droplets or increase water droplet density
- Converting water vapor (a highly-warming greenhouse gas) into a reflective medium (water droplets) may increase the effectiveness of this approach
- This approach would be safely controlled due to its naturally dissipative nature, while the desired effect could be maintained using ongoing payload delivery and release
- Effects could be maximized by increasing albedo in equatorial (directly reflective) regions
- Increasing albedo in polar regions could limit the melting of glacial ice and the resulting sea level rise
- The CO2 footprint could be minimized by liquefying air close to delivery regions and by using renewable energy (i.e. wind power) for liquefaction
- This concept may provide several other highly-valuable benefits as well, including mitigating hurricanes and tornado's, fighting large wildfires and enabling cloud moisture to carry into drought-stricken areas

Additional information:

The large-scale release of cryogenic liquid to increase cloud albedo may be an ideal way to mitigate the effects of global warming without harming the environment. Cryogenic liquids such as liquefied air and liquid nitrogen are easily and cheaply produced (costing under 50 cents per gallon) and are currently used for many processes from freezing foods to manufacturing to rocket propulsion. Therefore a large liquefaction production and delivery infrastructure already exists to support these applications, and further scaling to mitigate global warming and/or other severe weather could easily be achieved if necessary.

One aspect of this concept, increasing water droplet density using liquid nitrogen to increase the reflectivity of existing clouds, has already been inadvertently proven by the Chinese government. While trying to reduce precipitation for the 2008 Olympics, the Chinese found that cooling existing clouds with liquid nitrogen made droplets smaller so that they were less likely to fall as rain. This also increased the number of drops per unit volume, which would make the clouds more reflective. In the United States, studies have also determined that a relatively small increase in global cloud cover of 5% would be enough to offset the effect of global warming caused by a doubling of pre-industrial (280ppm) CO2, indicating that increasing cloud albedo could effectively mitigate even a worst-case global warming scenario (from "Policy Implications of Greenhouse Warming", NAS 1992).

Existing technology is all that is needed to prove and implement this approach, minimizing both time and cost needed for its evaluation and development. It may even be possible to use existing KC-135 Stratotanker aircraft for payload delivery, as 500 of these are currently planned for replacement by the Air Force.

The key uncertainty with this approach is its residence time (how quickly would the desired effect dissipate?). Engineering judgment seems to indicate that especially in ideal regions of the atmosphere (cloud periphery and regions with relatively high water vapor content), residence time would be sufficient so that a desired overall albedo increase could be maintained with a small operational CO2 footprint from ongoing payload delivery.

The multi-use potential of this concept, along with its safety to the environment, are reasons to ensure that this approach should take a high priority compared to other global warming mitigation approaches being considered. With hurricanes for example, this approach could be used to cool "hot towers" that are driving the system, or be released into the hurricane eye to both increase eye pressure and cause cooled air on the ocean surface to be pulled vertically up the eye wall, effectively "throttling down" the storm. For large wildfires, a line of liquid nitrogen could be released upwind of a fire line, causing a cold blanket of gaseous nitrogen to cover the fire and dissipate oxygen, eliminating combustion and essentially "snuffing" out the fire.

Finally, the intent of this concept would be to extend the time available to accomplish the multinational effort of adequately reducing greenhouse gases. It is not intended to in any way delay or replace those activities.

This concept is currently patent pending with the US Patent and Trademark Office. Questions can be directed to Mark Massmann of M2 Design LLC, using email m2design@cablespeed.com or by calling 425-208-9798.