

Changing the Climate with White Roofs

For those who are proponents of the idea that humankind is harmfully warming the climate by adding greenhouse gasses to the earth's atmosphere, it is also an article of faith that we can engineer our own solutions through policy prescriptions or burdensome regulations. So it is with Energy Secretary Dr. Steven Chu who claimed that we can offset a large part of the expected human-induced warming by changing roofs to white and urban surfaces to a lighter, more reflective color.

There are many real climate scientists out there who question such silly statements and are not afraid to point out that trying to modify urban areas on such a grand scale would be a very expensive endeavor while delivering a small payoff. Dr. Roy Spencer[1] convincingly demonstrates that such a prescription would offset only a very small portion of the expected CO₂ emissions, and thus probably not make much of a difference in global temperatures. Dr. Lubos Motl[2] also performs some back-of-the-envelope calculations to demonstrate that the impact of Steven Chu's prescription might result in a global temperature change on the order of 0.01° C or less.

My own critique of Dr. Chu's statement has come a bit slower as I am generally a step or two behind many of the skeptics like those cited above. One also might ask the question; what would be the real impact of brightening urban surfaces on the current climate and even the weather. After reading Chu's statement, I was reminded of an experiment that I'd done with a simple climate model some 15 – 20 years ago in a graduate class back at my alma mater. After doing some digging, I found this report and the data, and then reviewed what was done.

In this experiment, a statistical-dynamic climate model (SDM) was used [3]. A statistical-dynamic model is much simpler than the general circulation models (GCMs) used today (see [4] for a discussion of GCMs on this website). The SDM uses the same mathematical core that a GCM uses, but only yields two-dimensional solutions of climate that are steady-state (can be used to diagnostically). The GCM by contrast can yield fully three-dimensional solutions that can vary with time (or be used as a forecast model). Additionally, the SDM has simpler versions of all the critical physics of a GCM, so the advantage is that the computer program is only about 1% as long as a GCM. It can give nearly instantaneous results compared to the GCM. These advantages were big at the time when computer space was at a premium.

In one experiment, the SDM model was used in which the earth's surface albedo, or the amount of reflected radiation, was decreased for all the land on earth by about 2.5%. Keep in mind about 30% of the earth's surface is land-covered. The global temperature was increased by about 0.04° C. These numbers are consistent with the numbers quoted on the two blogs cited above. In fact, using the numbers presented in [1], [2] is the equivalent of reducing the albedo over the entire land surface of the planet by less than 1%. This is less than half the amount of reduction done in the SDM experiment described above.

The implied changes to the earth's general circulation were negligible, in other words, there was no detectable change in the strength or location of the jet-streams, or the storminess in either the Northern or Southern Hemisphere. This was true for both the warm season and cold season. Note that the storminess is a quantity that measures the combined impact of changes in the number and intensity of mid-latitude cyclones.

One experiment was run in which the entire United States was given the same albedo as that of a parking lot (as suggested by a Joni Mitchell song?). In this experiment, the climate of the Northern Hemisphere was changed substantially as the jet stream was pushed farther toward the North Pole, and temperatures were increased appreciably.

It is well known that cities, and therefore people, can have a significant impact on the local climate through the heat-island effect [5]. But their impact on global climate is demonstrably small. Thus, policy-makers should be more careful about proposing solutions that would require substantial costs and drastic changes in lifestyle, when there is no research to back up the solution.

[1] Spencer, R., 2009: <http://www.drroyspencer.com/2009/05/white-roofs-and-global-warming-a-more-realistic-perspective/>

[2] Motl, L., 2009: <http://motls.blogspot.com/2009/05/steven-chu-will-paint-world-white.html>

[3] Oglesby, R.J., and B. Saltzman, 1990: Extending the EBM: the effect of deep ocean temperature on the climate with applications to the cretaceous. *Paleoeco., Paleoclim., Paleoec.*, **82**, 237 – 259.

[4] Lupo, A.R., 2007: *The complexity of Atmospheric modeling.*
<http://icecap.us/images/uploads/complexityatmosmodel2.pdf>

[5] Huff, F.A., and S.A. Changnon, 1973: Precipitation modification by major urban areas. *Bull. Amer. Meteor. Soc.*, **54**, 1220 – 1232.