

Interactive comment on “A net decrease in the Earth’s cloud plus aerosol reflectivity during the past 33 yr (1979–2011) and increased solar heating at the surface” by J. R. Herman et al.

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This work is devoted to the 340 nm Lambertian Equivalent Reflectivity (LER) of clouds and aerosols all over the world, derived from NASA satellites, using a common calibration. The results span in a large period of 33 years, from 1979 to 2011, which permits to determine possible (positive or negative) trends.

One of the most important results was the determination of a global net decrease in cloud and aerosol reflectivity, giving rise to a $3.6 \pm 0.2\%$ global change in LER in 33 years. Also, a corresponding increase of 2.7 Wm^{-2} of solar irradiance reaching the Earth’s surface, in the same period. The large decrease in reflectivity was determined

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mostly over land (US, Brazil and Central Europe). Over Ocean, the largest decrease was derived in the central equatorial region of the Pacific Ocean, which is associated with the El Niño Southern Oscillation (ENSO). A strong correlation with this ENSO event has been obtained. Reflectivity increase was also measured mainly at the Pacific Ocean near the west coast of Peru and Chile and parts of Southern Asia (India, China, Indochina and fractions of the Indian and South-West Pacific Oceans).

These results are important for a better knowledge of the cloud and aerosol space-time evolution all over the Earth, of solar power availability and of climate change analysis, among other possible applications.

Some suggestions:

-Item Abstract, page 31992, lines 17-18. Concerning the text: “Based on energy balance partitioning (Trenberth et al., 2009) this corresponds to an increase of 2.7 Wm^{-2} of solar energy reaching the Earth’s surface. . .”, actually the quantity 2.7 Wm^{-2} is an irradiance (energy per time interval and per surface). So, please, change “solar energy” by “solar irradiance” in the text.

-Item 5, page 32005, lines 26-28. Concerning the sentence: “The noon normalization limits the latitude range to $\pm 60^\circ$ in Fig. 5a, whereas the OMI LER (Fig. 5b) is in a near-noon orbit (1330) and can be extended to $\pm 85^\circ$ ”, please, verify if the number 1330 corresponds to a given time. If it is affirmative, change it by: 13:30.

-Item 6, page 32009, lines 12-14. Concerning the text: “we assume as starting values Trenberth et al. (2009) estimate of 341.3 Wm^{-2} average solar energy at the top of the atmosphere”, the same as in the Abstract, replace “solar energy” by “solar irradiance”.

-Item 6, page 32012, lines 9-11. Concerning the sentence: “In the Arctic region, the LER data are entirely from April to August, so that the trends shown near the Arctic in Fig. 11 are representative of the summer months”. Actually, the April-August period corresponds, for the Northern Hemisphere, about half to spring and half to summer.

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-Item 8, page 32013, lines 16-18. Concerning the sentence: “The same multi-year patterns appear in the South American LER time series with opposite trends over the ocean and over land (Fig. 14). The trend over land is similar to those on North America (Table 2).” Actually, “over the ocean” includes a part of Peru land (about 10-20% of all the surface), and “over land” includes a small fraction of the Atlantic Ocean on the Brazil Coast. So a better description would be: “over mainly the ocean (with a small fraction of land) and land (with a small fraction of ocean)”.

-Item 9, Page 32014, line 23 to 32015, line 3. Concerning the sentence: “The 60°S to 60°N change in $\cos^2(\text{Latitude})$ weighted LER, which is used for approximating changes in energy reflected back to space from changes in LER, shows a global average increase in the amount of solar energy reaching the surface of 2.7 Wm^{-2} and, using the energy partitioning from Trenberth et al. (2009), an estimated increase in energy absorbed by the surface and decrease of energy reflected back to space of 2.3 Wm^{-2} or a 1.4 % change”. The same as in the Abstract, replace “solar energy” by “solar irradiance”.

-Legend to Figure 9, page 32030. Concerning the text: “(A) Normalized $\cos^2(\theta)$ weighted zonal average reflectivity for $\theta = 60^{\circ}\text{S}$ to 60°N , (B) Normalized deseasonalized $\text{LER}(\theta, t) \cos^2(\theta)$ for $\theta = 60^{\circ}\text{S}$ to 60°N . The dark solid line is a 365-day low pass filter showing the major multi-year cycles. Normalization $\langle \cos^2(\theta) \rangle = 0.707$. EC = El Chichon and MP = Mt. Pinatubo.” Actually, the dark solid line in B seems to be the red one. Please, verify.

- Legend to Figure 13, page 32034. Concerning the text: “LER time series (black) compared with the offset MEI + 19.47 (grey) for the Pacific region shown in Fig. 8 with large reflectivity change.” Please, verify the reference to Fig. 8, since this figure represents “Zonal average trends (RUyr^{-1}) 1979 to 2011”, the x-axis is Latitude and not a specific region of the World, like the Pacific region. Also, explain the red line.

- Legend to Figure 14, page 32034. Concerning the text: “ $\text{LER}(q, f)$ and $\Delta\text{LER}(q, f)$ for

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the indicated latitude x longitude boxes showing the decrease in LER over land and the increase over a small region Chile and Peru”, actually, the box over land in the figure at the top includes also a part of the Atlantic Ocean near the Coast of Brazil, and “the increase over a small region Chile and Peru” in the figure at the bottom includes a large fraction of the Pacific Ocean. So, it could be changed as: “ $\text{LER}(q, f)$ and $\Delta\text{LER}(q, f)$ for the indicated latitude x longitude boxes showing the decrease in LER over mainly the land (and a small fraction of the Atlantic Ocean near the Coast of Brazil) (figure at the top) and the increase over the Pacific Ocean near the Coast of Peru and Chile (including a small region of Peru) (figure at the bottom)”.

- Legend to Figure 16, page 32037. Concerning the text: “ $\text{LER}(\theta, \varphi)$ and $\Delta\text{LER}(\theta, \varphi)$ for the indicated latitude \times longitude box showing the increase in LER over India, Southern China, and Indochina”, the box also includes a part of the Indian Ocean and a fraction of the South West Pacific Ocean. So, this sentence needs to be modified, for example in the following way: “ $\text{LER}(\theta, \varphi)$ and $\Delta\text{LER}(\theta, \varphi)$ for the indicated latitude \times longitude box showing the increase in LER over India, Southern China, Indochina, a part of the Indian Ocean and a fraction of the South-West Pacific Ocean”.

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