Suggestions for improvements to Climate Dynamics by Kerry H. Cook for the next edition

Alan Robock (robock@envsci.rutgers.edu), September 10, 2013

- p. 2 and the rest of the book: The name of our planet is Earth, and not earth or the earth (it is not the mars or the venus). By always capitalizing Earth, we give it respect and make people care about it more, I think.
- p. 3: Why not use IPCC 2007 (AR4) in this book, and AR5 in the next edition?
- Fig. 2.1: missing labels on the contours. And why not make the highest value with the darkest shading?
- p. 6, lines 1-2: Isobar refers to a constant pressure contour on a constant-height surface. A "constant pressure surface" is just that, or perhaps an "isobaric surface," but not an "isobar."
- p. 6: Why not use sea level charts instead of 900 mb? And if you do want to use a constant pressure surface, why not use 850 mb, which is one of the standard levels?
- Figs. 2.3a and 2.4: The 900-mb surface over Antarctica is underground. Why are there "data" there?
- Fig. 2.3 (color): The color bars overlap the x-axis label.
- Fig. 2.4c: Don't use darker shading for both low and high values.
- Fig. 2.4c (color): Shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between positive and negative values clear.
- Fig. 2.5c (color): Shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between positive and negative values clear.
- Fig. 2.7c (color): Shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between positive and negative values clear. [Because the automatic color scheme was used, values that are positive in one panel are negative in another. This is confusing.]
- p. 11: Bullets 2 and 3 refer to "surface air temperature." But this is the 900 mb surface. I recommend actually using a map of surface air temperature, which is more intuitive and would avoid this problem.
- Fig. 2.6: What are that data over Antarctica? 900-mb temperature or surface air temperature?
- p. 14, second paragraph: The thermosphere is also a region of strong absorption.
- Fig. 2.9: Missing y-axis labels of variable and units.

- Fig. 2.9: Data are shown underground in Antarctica.
- p. 15: I would not say that the tropopause in the high latitudes is close to the surface. It is still pretty high.
- p. 16: In discussion of Fig. 2.10, I would add that the easterly and westerly winds balance each other at the surface, and explain why this is (due to angular momentum considerations).
- Fig. 2.10: Y-axis needs labeling with variable and units.
- Fig. 2.10: DJF only goes up to 100 mb, but JJA goes to close to 0 mb. They need to be consistent.
- Fig. 2.10: X-axis has Northern Hemisphere on left. Latitude should increase from left to right to be consistent with other figures and not confuse the readers, and to conform to the usual way these are done.
- Fig. 2.10: What is the bottom level? 1000 mb? Higher? It needs to be labeled.
- Fig. 2.10: There are data underground at the South Pole. Where there are no gridpoints at any longitude with data, they should be plotted as missing with the panels blank.
- Fig. 2.10: Make the shading more intuitive, with darker shading for higher wind speeds for positive values, and use hatching for negative values, darker for higher values.
- Fig. 2.10: Mark the 0 line with a darker contour to distinguish between east and west winds.
- Fig. 2.10: Next to the season in the panel title, include the variable and units, that is, in the blank space along the top of each panel, write: Zonal mean zonal wind (m/s)
- Fig. 2.10 (color): In addition to the above comments, use the same color shading for both panels, so they can be compared.
- Fig. 2.10 (color): In addition to the above comments, shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between easterly and westerly winds clear.
- Fig. 2.10 (color): In addition to the above comments, label all the contours, particularly zero.
- Fig. 2.10 (color): In addition to the above comments, in Grads, after “set gxout shaded,” do “set csmooth on” before “display [variable]” so that the shading exactly matches the contours.
- Fig. 2.11: Y-axis needs labeling with variable and units.
- Fig. 2.12: Y-axis needs labeling with variable and units.
- Fig. 2.13: Caption needs to give units for geopotential height.
- Fig. 2.13 (color): Use more colors to distinguish the different values.
- Fig. 2.14 (color): Use more colors to distinguish the different values.
- Figs. 2.15 and 2.17: Draw lines on Fig. 2.15 to show where the Fig. 2.17 cross-sections are measured.

- Fig. 2.16c (color): Shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between positive and negative values clear.
- Fig. 2.17b: Panel says 40°W, but caption says 30°W. Which is it?
- Fig. 2.17: Y-axis needs labeling with variable and units.
- Fig. 2.18: Y-axis needs labeling with variable and units.
- Fig. 2.20: X-axis has Northern Hemisphere on right, and all the other such plots should be done like this one. In any case, they all need to be the same so as not to confuse readers.
- Fig. 2.22: It is not clear what the shading is.
- p. 31, 3rd paragraph: Mention upwelling as contributing to the temperature patterns.
- p. 31, 5th paragraph, last line: Should be chapter 8 and not chapter 5.
- Fig. 2.23: Why does panel (b) have missing data at the bottom near 60°S, but (c) has shading?
- Figs. 9 and 2.23: Draw lines on Fig. 9 to show where the Fig. 2.23 cross-sections are.
- Fig. 2.26: Caption is wrong. Contour interval is 1 mm/day.
- Fig. 2.27: Use the same contour intervals as Fig. 2.26. And are they really 1 mm/day on this panel, with values at 1, 3, 5, ...? I recommend 2, 4, 6, ... for both figures.
- Fig. 2.29: Use the same contour intervals as Figs. 2.26 and 2.27, so they can be compared.
- Fig. 2.29: Make larger values darker shading.
- Fig. 2.23: The first three values for °F are wrong.
- Table 2.2: What is flux? I can't understand how it is defined and measured.
- Table 2.2: What is residence time?
- p. 42: "Note that" I think that this expression should be banned from scientific writing. If a particular thing should be noted, does this mean that everything else should not? Everything in the text should be noted, and this expression has no information content and just breaks up the flow. [This is a pet peeve of mine, so please ignore it if you want.]
- p. 43, second paragraph: Ice core records from Antarctica now go back to 800,000 years.
- Fig. 2.35: Why not show summer for Antarctica, too?
- p. 47, 3rd paragraph of Gaia: Mention that O_2 allowed the formation of O_3, which then allowed life to move out of the ocean onto land, protected from UV.

Additional comments, September 29, 2013

- p. 50, Table 3.1: Order of rows should be reversed with the Northern Hemisphere at the top.

- p. 51, first bullet: It would be nice to point out that the definition of the Tropics is that the seasonal temperature range is smaller than the diurnal range.

- p. 52, Fig. 3.1: To include the complete seasonal cycle, repeat January on the right side, too. This will give 12 line segments, including the change from December to January. This in general is how I think mean easonal cycles should always be presented.

- p. 53, Fig. 3.2; Give the timing of the periods. Are these 5 days apart? Also explain how the anomalies are calculated. With respect to what? And how large do they have to be to be shaded? [The caption for the color version does this.]

- p. 54, line 4 from bottom: Why 11-month averaging period? Why so long?

- p. 55, Fig. 3.3: Also give Hovmöller diagram of anomalies with respect to the mean seasonal cycle, so that the El Niño and La Niña are clear. With the shading, it is hard to see the La Niña.

- Fig. 3.3b (color): Shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between positive and negative values clear.

- p. 56, Fig. 3.4: Caption says sea surface, but data are plotted over land.

- p. 56, Fig. 3.4: Caption says "during" but it needs to be more explicit about the averaging period. Is it DJF?

- Fig. 3.4b (color): Shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between positive and negative values clear.

- p. 57, Fig. 3.5: Caption needs to be more explicit about the averaging period. Is it DJF?

- Fig. 3.5b (color): Shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between positive and negative values clear.

- p. 57: Definition of SOI needs to explain that it is normalized.

- Fig. 3.7 (color): Shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between positive and negative values clear.

Fig. 11 of Kistler et al. (2001) does this nicely.

Kistler, R., E. Kalnay, W. Collins, S. Saha, G. White, J. Woollen, M. Chelliah, W. Ebisuzaki, M. Kanamitsu, V. Kousky, H. van den Dool, R. Jenne, and M. Fiorino, 2001: The NCEP-NCAR 50-Year Reanalysis: Monthly Means CD-ROM and Documentation. *Bull. Amer. Meteor. Soc.*, **82**, 247-268. doi: http://dx.doi.org/10.1175/1520-0477(2001)082<0247:TNNYRM>2.3.CO;2

- p. 60, Fig. 3.8: Caption needs to be more explicit about the averaging period. Is it DJF?

- p. 61: Include definition of AO and how it is calculated. What is the index?

- p. 61: Include definition of PDO and how it is calculated.

- p. 62: Figure 3.10 caption: The website given has not been updated since 2000. Give a reference to one that is up to date.

- p. 65, second full sentence: I think the temperature difference between a glacial and interglacial climate is closer to 5 K.

- Chapter 3: The South Carolina State Climatologist office has a great set of web pages explaining all these oscillations. Visit http://www.nc-climate.ncsu.edu/climate/patterns/ENSO.html and click on the links to the other oscillations.

- Chapter 3: I was very surprised that there was no section showing the time series of past temperature variations, such as the observational record since 1880, or the hockey-stick diagram, or the longer oxygen or deuterium record from ice cores going back 800,000 years. I supplemented my lectures with such figures (see http://climate.envsci.rutgers.edu/climdyn2013/Slides/ClimDynLecture5.pptx) and I recommend you add them.

- p. 68, equation (4.7): units for luminosity and solar constant are wrong. One of my best students, Sherilyn Graham, found this. The equation should be:

$$S_0 = \frac{L_S}{4\pi r^2} = \frac{3.9\times10^{26}\ \mathrm{W}}{4\pi(1.5\times10^{11}\ \mathrm{m})^2} = 1380\ \mathrm{W/m^2} \qquad (4.7)$$

- p. 85, first paragraph: There is no such thing as "reradiate" or "reemit." Longwave radiation is radiated or emitted. The radiation depends on the temperature and emissivity, but has nothing to do with how the material became the temperature it is. Longwave radiation is not recycled. It is only absorbed, and is one of the terms of the energy balance of a material. Using the terms "reradiate" and "reemit" teaches the wrong physics of radiation and confuses students.

- p. 97, Eq. (5.22): I think it is important to point out the sign convention used for each flux, because some are positive upward and some are positive downward. Here is a table:

	Positive in direction:
S_{INC}	↓
F_{BACK}	↓
$\varepsilon\sigma T_S^4$	↑
H_S	↑
H_L	↑
F_H	→ (out of volume)
F_V	↓ (out of volume)

- p. 99, Fig. 5.4: Nice figure, including the partitioning into direct and diffuse solar, but it is out of date. The most up-to-date one I have seen is at https://climatedataguide.ucar.edu/climate-data/budgets-mass-moisture-energy. It includes data from Trenberth and Fasullo (2011) and points out that there is actually a 0.9 W m^{-2} imbalance at the top, which explains why the planet is warming.

- Fig. 5.5: dark shading for higher values.

- Fig. 5.5 color: Warm colors should be used for higher values. Larger contour interval, and don't allow color scale to end before maximum values, so that values > 300 W m^{-2} have different colors.

- Fig. 5.6 color: Use black contours, not yellow, and only have contours every 10%. The many small contours over the land are hard to understand.

- Fig. 5.8 color: Warm colors should be used for higher values.

- Fig. 5.9 color: Reverse the color scale and shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between positive and negative values clear. Also, the color bar overlaps the bottom contour label.

- Fig. 5.12ab color: Reverse the color scale and shade the positive values with warm colors, starting with yellow for the lowest values and going to red for the highest. Shade the negative values with cold colors, starting with light blue for the smallest negative values and going to dark blue or purple for the largest negative values. This will make the distinction between positive and negative values clear. Use the same scale for both panels.

- p. 107, Fig. 5.13 caption: What does "contribution" mean? Over what depth is the surface layer that is considered?

- Fig. 5.13 color: Nice example of one color scheme for positive and one for negative, but they should be reversed, with warm colors for positive. Also, I would remove the zero contour so that it only shows the significant colored non-zero values.

Additional comments after completing book and semester, January 26, 2014

Fig. 7.2 caption: I don't understand, "vertical p-velocity (hPa/s" when the contour interval is given as 5 x 10^{-3} Pa/s.

Fig. 7.3: Missing units for y-axis

Fig. 7.3: Don't use the confusing construction of "Positive (negative)." See "Parentheses are (are not) for references and clarification (saving space)"
http://climate.envsci.rutgers.edu/robock/Parentheses2010EO450004.pdf

Figs. 7.4 and 7.5: Caption does not have units for wind vectors or height contours

Figs. 7.4 and 7.5: (a) and (b) should have the same units for wind vectors and same shading for height contours, so they can be compared.

Exercise 7.3: Also ask for the SH and LH energy fluxes.

p. 139, line 1: equation is confusing, because the fluxes go in different directions in Fig. 8.3, so the difference so if the second term is negative, then they should add.

Fig. 9.2: (a) and (b) should be labeled, since on the previous page the text refers to 9.2a and 9.2b.

p. 151, end of section 9.1: The atmosphere also has liquid and solid water. The total is precipitable water or water burden.

p. 153: Could include more discussion of history of the atmosphere. Mention the Anthropocene.

Figs. 10.1 (a) and (b) on the same scale for the y-axis.

Fig. 10.1 (c): reverse the x-axis so time increases to the right like the other panels.

p. 155, last paragraph: It is Pg C (not CO_2) and each time Pg is used it should be changed to Pg C.

p. 156, line 4: Data now go back 800,000 years.

p. 156, last sentence of first full paragraph: Explain how much the CO_2 feedback amplifies the temperature change (by about 50%).

p. 158, O_3 section: Mention that O_3 is also a greenhouse gas in the stratosphere.

p.159: Mention how effective the Montreal Protocol was in mitigation of global warming.

p. 165, last line: I don't understand why you would reduce S_0 by 25%.

P. 167, smaller font description of feedback, again don't use this confusing construction. See "Parentheses are (are not) for references and clarification (saving space)" http://climate.envsci.rutgers.edu/robock/Parentheses2010EO450004.pdf

A few lines later you say "T* increase (or decrease)" which is the correct way to use parentheses.

Fig. 11.1: A couple signs are wrong, the two on the bottom of (b). Change + to – and – to +. When snow goes down, the albedo goes down, and absorbed radiation goes up.

p. 168, first full paragraph: But 70% of Earth is covered by an ocean. The actual reason there is not a runaway greenhouse is that there are negative feedbacks at the same time, such as the temperature-radiation feedback.

p. 168: You say there are only two processes responsible for polar amplification, but there are more.

p. 168: The ice-albedo feedback is not important in late fall when there is little Sun. It is important in the spring, when there are still snow and ice, and Sun is strong. See:

Robock, Alan, 1983: Ice and snow feedbacks and the latitudinal and seasonal distribution of climate sensitivity. *J. Atmos. Sci.*, **40**, 986-997. http://climate.envsci.rutgers.edu/pdf/RobockIceSnowJAS1983.pdf

p. 169, line 10: It is incorrect that longwave is reemitted. Longwave is emitted based on the temperature and emissivity of the material. It does not matter how it got to be that temperature.

Fig. 11.2a: There is no such thing as longwave trapping. Draw a + arrow directly from Cloud amount to OLR.

Fig. 11.2b: Bottom two signs are wrong. When cloud amount goes down, planetary albedo goes down and solar absorbed goes up.

Fig. 11.3a: Left two signs are wrong. When cloud top temperature goes down, OLR goes down and T* goes up.

Appendix A: In units section, use brackets [] rather than parentheses for units

Appendix A: There are no degree symbols used with K

Appendix A: Include knot as a unit of wind speed.

Appendix A: The solar constant is 1361 W m^{-2} (see latest work, which is explained in Chapter 8 of the new IPCC Fifth Assessment)

Appendix A: All variable symbols should be in italics

Appendix A: last two lines. I would write the density of water simply as 1000 kg m^{-3} and of sand as 2650 kg m^{-3}