Visualizing Earth's Radiative Balance:
A Classroom "Jigsaw" Exploration of the Earth's Climate System

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Things to do before starting this jigsaw exercise:
-Explore the difference between shortwave and longwave radiation with your students.
-Make sure your students know how to read latitude and longitude.
-Decide how you want students to make their final presentations: overhead slides? Chalkboard? Dry erase board? This will determine the supplies you will need and the organization of the final phase.

Notes about how to organize the exercise:
-Have the large colored maps posted on the walls of the classroom if possible, this makes it easier for an entire group to look at each map.
-Have the students count off by multiples of three's to create the Data Groups: if you have three sets of maps, have students count off by nines (etc.). Groups of three to six students are best; if you have 30 students, for example, you might create two sets of data maps and have five students in each Data Group.
-The goal is to have one student from each Data Group in each Longitude Group, so one way to create Longitude Groups is to create a number of Longitude Groups that is a multiple of the number of students in each Data Group. For example, if you have five students in each Data Group, you might create five Longitude Groups. In order to create Longitude Groups, have the students count off by the number of Longitude Groups you need *while they are still assembled in Data Groups*. Again, groups of three to six students are best; if you have 30 students, for example, you might select five or ten longitudes. If there are "extra" students, double up on the Data specialists in each Longitude Group.
-When the students meet in their Longitude Groups, it would be easiest for them to work at small tables. Otherwise, as long as they can all sit together it should work.
-The third phase of this exercise will require more group direction from you. There are several ways you can organize this phase, depending on your inclination and available equipment. One way is to create an identical graph on several sheets of overhead transparency film and have each Longitude Group draw their graph on a separate sheet. Each group can nominate one person to present their graph, and after all groups are done you can stack the graphs to see the global trend. You can also draw a common set of axes on a chalk or dry-erase board, and have each group's representative add their plots to the same graph to see the global trend.
-One analogy that may help your discussion of poleward heat transport is describing it in terms of money in checking and savings accounts: say a student earns $100 per week for twelve weeks, and only spends $90 per week. If they transfer the balance into a savings account each week, how much can they spend on a road trip at the end of the semester?

Acknowledgements:
This exercise was inspired and enabled by the work of many other people: grateful thanks go to them all. The "jigsaw" peer-teaching format for the exercise was borrowed from a similar exercise investigating plate tectonics, as described by Sawyer et al., in A Data Rich Exercise for Discovering Plate Boundary Processes, *Journal of Geoscience Education*, v. 53, n.1, January, 2005. I learned of this publication, and great rationales for trying this active-learning approach to teaching earth science, at a workshop for geoscience faculty convened by R. Heather Macdonald in June, 2005, titled "Early Career Faculty Workshop: Teaching, Research, and Managing your Career." The workshop was funded by the National Science Foundation (NSF), the Digital Library for Earth Science Education (DLESE), and the National Association of Geoscience Teachers (NAGT). The content of the exercise was inspired by laboratory exercises developed for V2100: The Climate System, an Earth science course at Columbia University for which I was a teaching assistant while in graduate school. Maps associated with this exercise were created using data collected in the National Aeronautics and Space Administration's Earth Radiation Budget Experiment (ERBE), which was plotted using the online viewer of the Lamont-Doherty Earth Observatory/International Research Institute Climate Data Library: http://iridl.ldeo.columbia.edu/SOURCES/.NASA/.ERBE/.Climatology/. If this exercise proves useful to anyone, it is because of the hard work and vision of all of these people and organizations. I intend to submit a finalized version of this exercise to the Journal of Geoscience Education. Comments for further development and improvement are welcome: please write to me at GEOECF@Hofstra.edu.