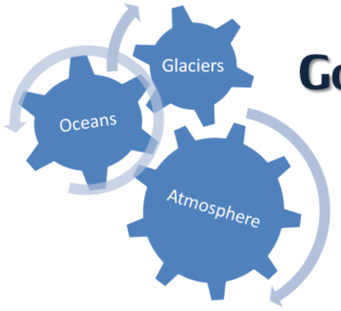
I use this background image to engage students in (leaving behind the various arguments surrounding the causes of our climate problems and) considering the impacts of climate change on humans and how we might best face them. This line of inquiry is a segue to Unit 6 of the Climate of Change InTeGrate module. The image also visually connects the issue of melting ice from Unit 4 with human concerns. You could also discuss these at greater length as an introduction.

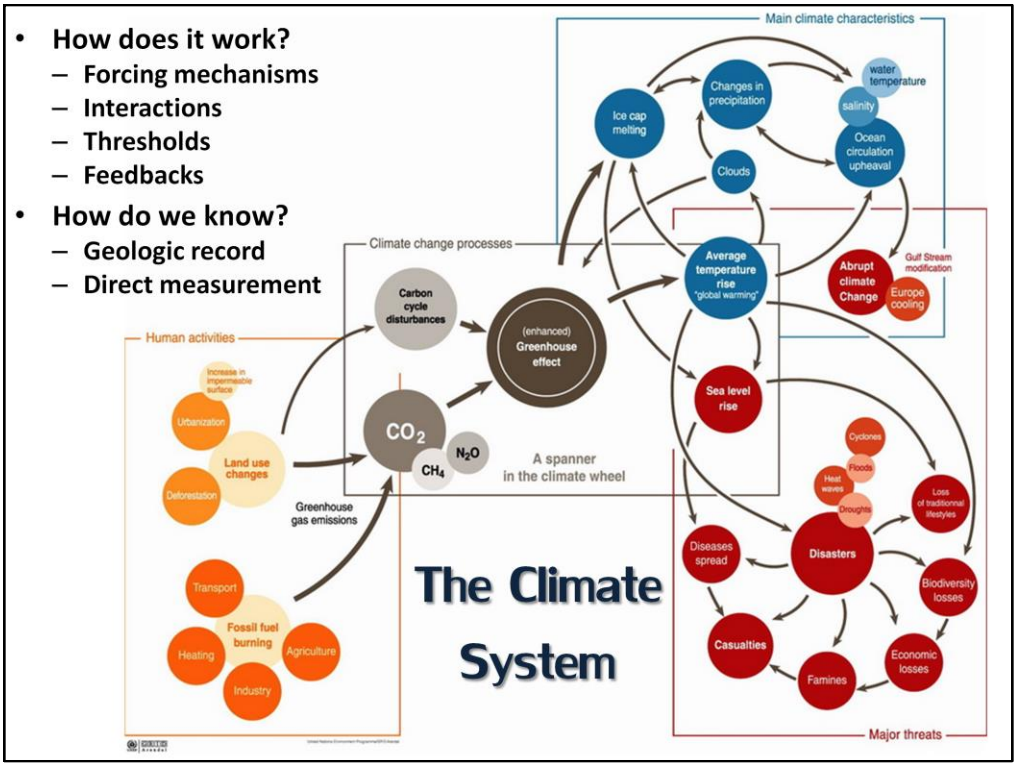
In order to raise awareness of the possible consequences of climate change, Greenpeace China organized a display of melting ice sculptures in Beijing in August 2009. The water for the sculptures came from melting glaciers in the Himalayas.

http://www.greenpeace.org/international/en/multimedia/photos/in-beijing-melting-ice-sculptu/, last accessed June 19, 2014
Image credit: Greenpeace / Lu Guang



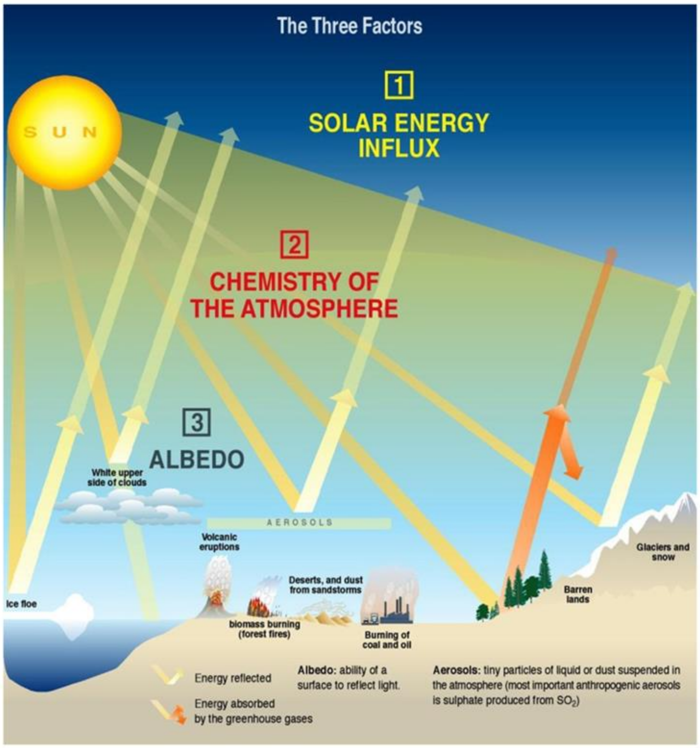
Goals

- List and describe climate system processes that complicate its interpretation.
- Explain the connection between climate records, human choices, & climate projections.
- Interpret a graph of atmospheric greenhouse gas concentration.
- Describe the structure of a climate model, & the connection between the climate system we know & our possible futures.



Here I begin a discussion of the complexity of prediction, which carries through to the end of class: that the nature of the system itself (or the way we currently understand it) makes it difficult to predict. Students don't necessarily have to understand the way feedbacks and thresholds work at this point (that comes mostly during the activity during which they work with them), but that they exist and create relationships between system components that aren't 1:1.

Credit: UNEP/GRID-Arendal
Source: UNEP/GRID-Arendal (2005). Vital Climate Change Graphics - Update. UNEP/GRID-Arendal. http://www.grida.no/publications/vg/climate2/, last accessed 31 July 2012.

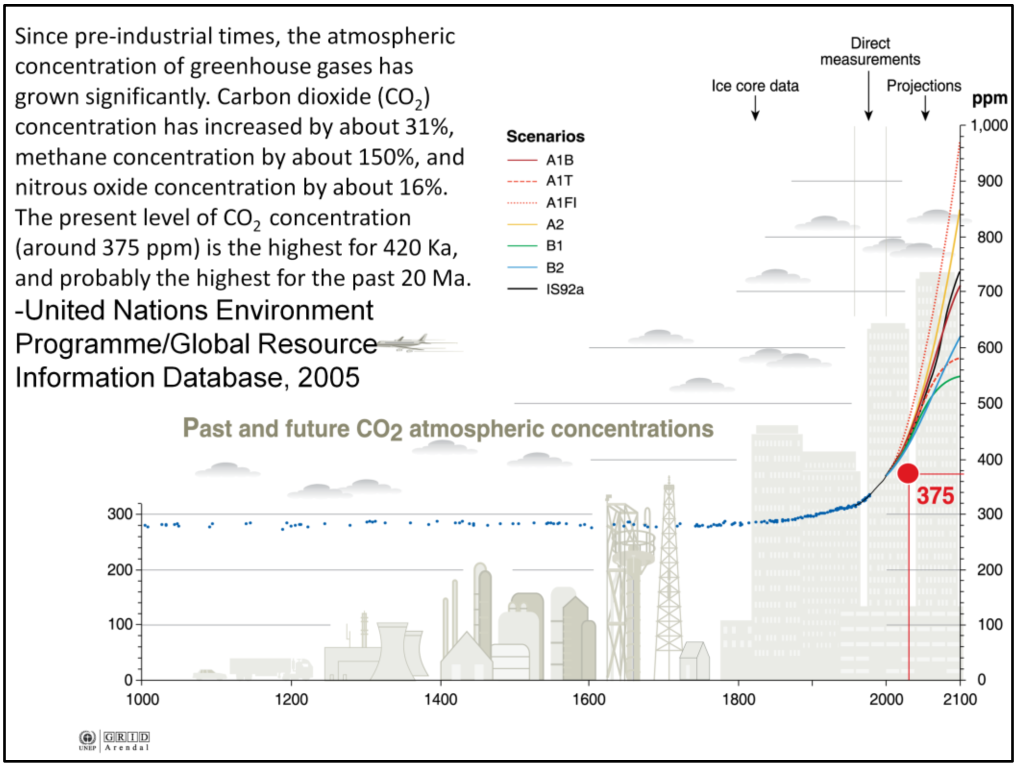


Influencing our Energy Balance

Source: UNEP/GRID Arendal (http://www.grida.no/publications/vg/africa/page/3111.aspx)

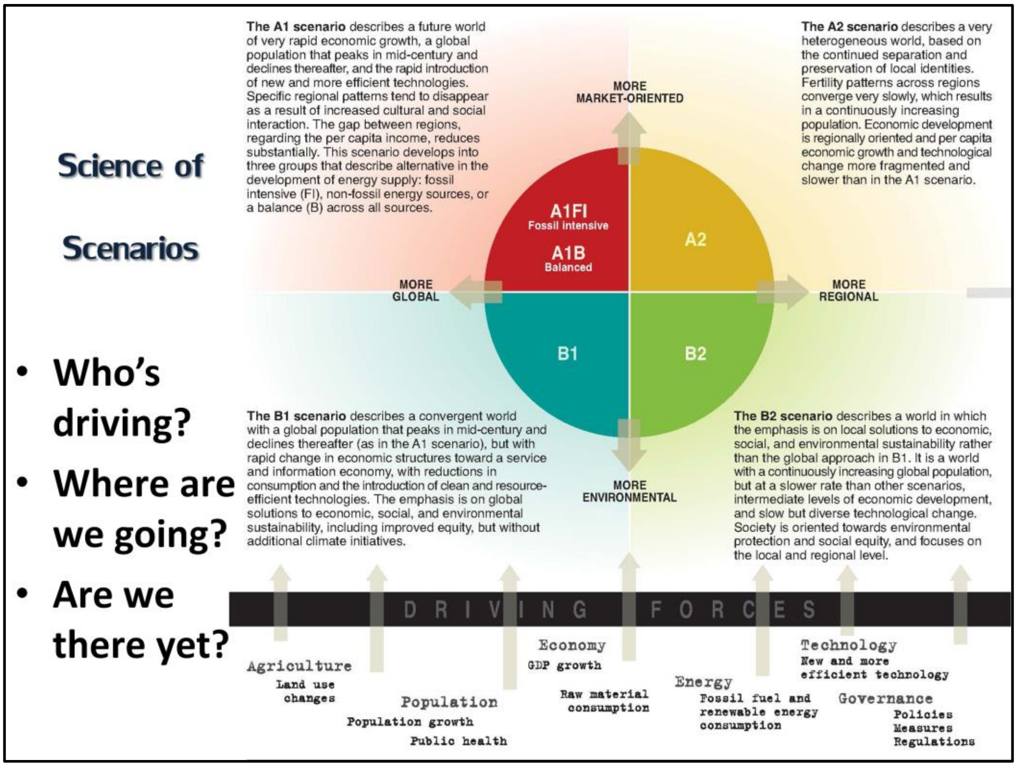
The 3 factors: sun, albedo and atmospheric chemistry.
There are three main factors directly influencing the energy balance of our planet:
1) The total solar influx, depending on distance from the sun and solar activity
2) Albedo, or reflections of solar rays from the Earth and back into space.
3) The chemical composition of the atmosphere.
The earth system is continually changing. Temperatures on our planet have changed much before. These changes can be regional: a temperature increase in the northern hemisphere can have a corresponding lower temperature in the southern part of the world. The global temperature may vary due to solar activity, like the temperature rise during the first part of last century. The rapid temperature rise during the last decades cannot be explained by increased solar activity. The only factor of the three mentioned above where we have clear evidence of change is the atmospheric chemical composition. During the last 200 years, the amount of CO2 in the atmosphere has increased by more than 30%, atmospheric methane has increased by more than 150% while atmospheric N2O has increased by 17% and tropospheric ozone by 35%.

"For the last half of the century the positive forcing due to well-mixed greenhouse gases has increased rapidly over the last four decades, while in contrast the sum of natural forcings has been negative over the past two and possibly even four decades." (IPCC: Climate Change 2001- Synthesis report)



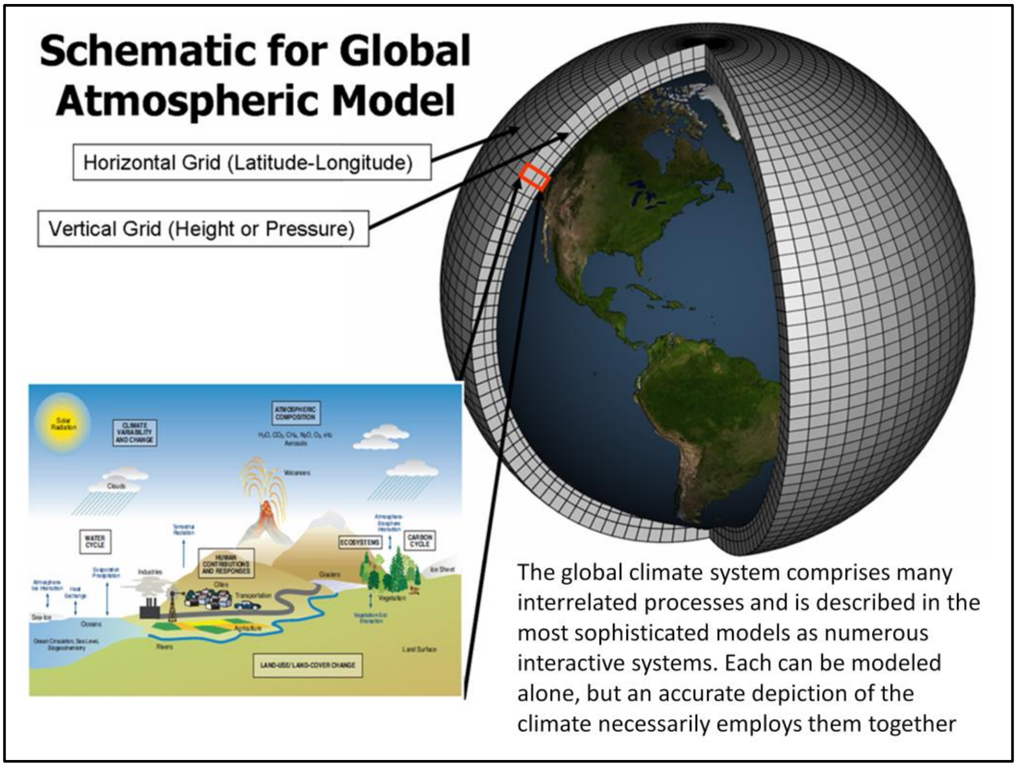
I use this graph to discuss trends in ghg, the connection between past and present measurements that relate irrefutably to our climate, and how these - in turn - relate to our possible futures. It also presages the work students do in case study 5.2 if you choose to assign it.

Credit: Philippe Rekacewicz, Emmanuelle Bournay, UNEP/GRID-Arendal
Source: Rekacewicz, P., and Bournay, E. (2005). Past and future CO2 concentrations. Vital Climate Change Graphics Update. UNEP/GRID-Arendal. http://www.grida.no/graphicslib/detail/past-and-future-co2-concentrations_a92d, last accessed 31 July 2012.



This slide deals with the IPCC scenarios (as does the previous slide). As these come up so much even in cursory examinations of climate data, you may want your students to have some familiarity with what they are and how they came to be. I use this slide to discuss the interaction of human choice and climate future, something that further complicates climate prediction and modeling.

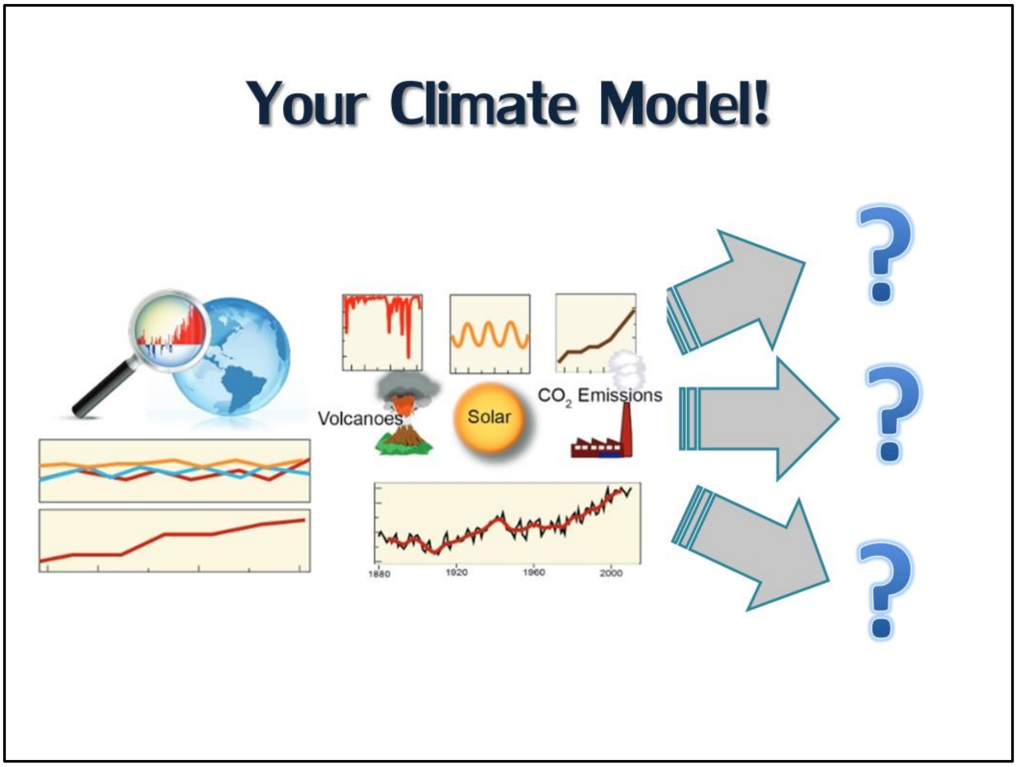
Credit: UNEP/GRID-Arendal
Source: “We cannot anticipate everything, but we try to assemble as many of the pieces as possible in order to predict the future. The science – or the art – of building scenarios requires a degree of control over a wide range of factors, all intricately linked. It is like a game, where we have to guess how changing one thing will affect the whole. Some elements appear simple – it is easy to imagine that rising atmospheric temperatures will melt the sea ice and cause sea level to rise, perhaps threatening coastal populations – but at what speed and what intensity and will this start a chain reaction of new calamities?” UNEP/GRID-Arendal (2005). Back to the future: The science of building scenarios. Vital Climate Change Graphics - Update. UNEP/GRID-Arendal. http://www.grida.no/graphicslib/detail/back-to-the-future-the-science-of-building-scenarios_b43f#, last accessed June 18, 2014.



Before bringing up this slide, I ask students how they would create a model of the climate system, what components they would include, and how they would deal with uncertainties and unknowns. This slide presents an example of an implemented model for them to examine - you can also ask them what they might change about it.

Climate models are systems of differential equations based on the basic laws of physics, fluid motion, and chemistry. To “run” a model, scientists divide the planet into a 3-dimensional grid, apply the basic equations, and evaluate the results. Atmospheric models calculate winds, heat transfer, radiation, relative humidity, and surface hydrology within each grid and evaluate interactions with neighboring points.

Source:
http://en.wikipedia.org/wiki/Climate_model#mediaviewer/File:Global_Climate_Model.png



I use this slide as the jumping off point for the in-class role-playing activity, case study 5.1. They each have this figure in their activity materials to help them diagram their interactions. They will each become individual components in climate models and be able to present their model outcome(s) to the class.

Source: National Climate Assessment and Development Advisory Committee, (http://www.globalchange.gov/ncadac) Draft for Public Review of the National Climate Assessment Report, Appendix: The science of Climate Change (p.1139) http://www.globalchange.gov/sites/globalchange/files/NCAJan11-2013-publicreviewdraft-appendix2-climateprimer.pdf, last accessed June 18, 2014.