George Philander – Is the Temperature Rising? The Uncertain Science of Global Warming, Princeton University Press, Princeton New Jersey, 1998 - 3

Chapter 7 dealing with Weather, the music of our sphere, Models of the atmosphere, page 112 to 118; and Chapter 13 dealing with Global Warming, Risky Business, What the models predict and Epilogue, page 201 to 203

Models are useful to simulate the climate changes resulting from greenhouse gases. Furthermore, they are increasing their accuracy of prediction as they become more sophisticated.

Weather patterns appear to be chaotic. But they take place in accord with certain natural laws. Understanding these laws of motion enables us to predict future climate patterns. These laws govern all phenomena and not just changing climate patterns. Thus we should focus only on the questions we want to address and filter out those that we are not interested in. This process describes the construction of a model.

Philander starts with a simple question. What is the average temperature of a planet that absorbs all its incident sunlight? Here the appropriate model is an isolated sphere that obeys the law of the conservation of energy. This means that the planet radiates back to space the same amount of energy that it absorbs. This simple model gives us an average temperature for the planet. It is useful. We can attribute the difference between actual and model temperature to the greenhouse effect.

A model that tries to account for the greenhouse effect must take into account the atmosphere. The simplest model sees the atmosphere as consisting of three layers. We assume a static atmosphere. Each layer must meet the law of conservation of energy. This is still idealised. We need to introduce convection that distributes heat up and down. Philander uses the impact of a mountain on wind to illustrate this. As the wind rises it's temperature and pressure decrease. Expansion of the air cools it. There is condensation of water vapour that produces clouds and rain and snow. A climate model should be able to reproduce climatic zones. Thus it is insufficient to assume a three-layered atmosphere.
We need further to develop the model. This requires that we comprise the atmosphere of many boxes. Within each box we ensure that natural laws come into play. The Law of Conservation of energy and the laws governing mass, moisture and momentum. Like energy none of these factors can be 'destroyed'. But they can take different forms to the ones they took when they moved into a climate zone (box).

Other box events determine specific climate zone 'balancing' of energy, mass, moisture and momentum. The accuracy of the model increases with the increasing number of boxes and balances. The most powerful models in the 1990s used boxes that covered areas 100 km by 100km. Scientists specify intensity and distribution of solar radiation, planetary rotation, and atmospheric chemical composition. They also specify land, water and ice properties beneath the atmosphere. On this basis they simulate climates on other planets or climates in earth's past.

The common predictions are of a range of models that use differing assumptions are as follows. There is consensus that the following is *very probable*. Average surface temperatures will increase by 0,50 to 2 degrees centigrade (1990 and 2050). Globally averaged precipitation will increase. Arctic land areas will experience wintertime warming.

Global sea levels will rise by 5 cm to 40 cm by 2050. It is p*robable* that rainfall will increase over high latitudes of the northern hemisphere. It should decrease in the mid latitudes of the northern hemisphere. This suggests extension of farming farther north in Canada and Siberia. The climate change in smaller regions (of a few thousand kilometers) is *uncertain*. The frequency and intensity of hurricanes, floods, El Nino and prolonged droughts should change.

There is a circumpolar current around the Antarctic. This stops the transport of warm water to high latitudes in the southern hemisphere. This protects the Antarctic continent from melting. The process of melting Antarctic glaciers would increase sea level rises. The deep ocean layers in the northern hemisphere high latitudes traps carbon dioxide. The relative warming of these seas could liberate this carbon dioxide. This will enhance global warming.

(summarised by Paul Hendler)