Visualizing and Understanding the Science of Climate Change

by Peter Mahaffy

- It's -25º C today in Northern Alberta. Is climate change actually happening? How do we know?
- Our world has gone through ice ages and warm periods in the past—how is this any different?
- Why are CFCs such potent greenhouse gases? I thought they were important in stratospheric ozone depletion, not climate change.
- How does the absorption of infrared radiation by greenhouse gases in our troposphere actually lead to warming?
- Predictions of future climate are just based on models—I need to see data, not models, to believe that climate is changing.
- How do we know what the temperature was a half-million years ago?

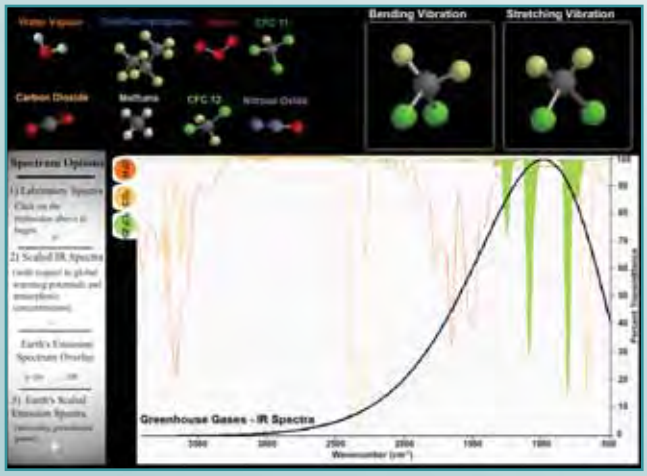
Over the past two years, students, teachers, and the general public have asked these and many other questions of the task group coordinating the project Visualizing and Understanding the Science of Climate Change. People are barraged by contradictory claims in the media about whether our climate is changing, and what is causing the changes that are seen. And at the heart of the answers to many of these questions is a basic understanding of chemistry and physics.

The IUPAC task group is working to produce 13 interactive lessons for global dissemination that will help students visualize and understand the science underlying climate change. The group started by researching common misconceptions that students have about climate change, and also fundamental principles of climate science needed to create climate-literate students and teachers.

A set of critically reviewed interactive lessons for 16–19 year old students is being created by integrating digital learning objects, developed at the King's Centre for Visualization in Science (Canada), with written materials prepared by The Royal Society of Chemistry (UK) and the American Chemical Society (USA). Task group members from IUPAC's Committee on Chemistry Education, UNESCO, and the Federation of African Societies of Chemistry will participate in the review of materials and facilitate dissemination through national and international networks.

To give readers a taste of the project, a screen capture from one of the interactive visualizations is shown to the right:

This interactive flash learning object helps to answer the third question in the list that began this report: Why are CFCs such potent greenhouse gases? Absorption of infrared radiation in the region between 700–1200 cm^{-1} causes excitation of the C-F stretching vibrational modes of CFC molecules. This happens to occur in a region of the IR spectrum where water and carbon dioxide, the two best known greenhouse gases are transparent (a spectral window). And so thinking of the earth as a giant IR source, CFCs absorb energies of IR radiation which have historically escaped into space, thus cooling our planet. This is also in a region of the spectrum close to the peak of earth's emission band (shown in the screen capture as a blue overlay).



This visualization from the King's Centre for Visualization in Science (Canada) shows how the IR signatures of a number of greenhouse gases collectively "close" the "IR window"—a phenomenon that occurs because different greenhouse gases absorb in different parts of the IR window.

When complete, the set of interactive lessons will provide tools for chemistry educators to make important connections in their classrooms to help students understand climate change, one of the defining challenges of the 21st century.

The first lessons will be completed over the next several months—meanwhile some examples of interactive digital learning objects, including the one featured above, can all ready be found at <www.kcvs.ca>.

For more information and comments, contact Task Group Chair Peter Mahaffy <peter.mahaffy@kingsu.ca>.

www.iupac.org/web/ins/2008-043-1-050