Section 1 Introduction
What Makes Earth's Weather

"The atmosphere is much too near for dreams… It forces us to action. It is close to us. We are in it, and of it. It rouses us both to study and to do. We must know its moods and also its motive forces."
Cleveland Abbe, first chief forecaster for the Signal Service, precursor of the National Weather Service.

Weather is physics in action. Climate is geography and geology (*geo-logos*, knowledge of the Earth) at work over weeks, months, years, decades, centuries and more. How we've come to understand weather and climate is an epic story of men and women grappling with some of the most important and, once, the least understood forces in their lives. It's no accident that the high god and goddess of the ancient Hittites were associated with thunder and lightning. Over the centuries, however, we came to understand what Abbe calls the "motive forces" behind weather and climate in terms of natural laws and scientific principles. (Activity 4.3, Making a Weather and Climate Timeline, will help students appreciate our fascinating journey from superstition to science and embodies many of the science standards relating to invention and discovery as a human enterprise.) Section 1 provides hands-on Activities which bring to life the most important of these principles: temperature, pressure, the hydrologic cycle, heat and pressure gradients, convection and conduction, and differential heating and cooling. These forces shape our world and not so coincidentally they also comprise a large and key portion of the National Science Education Standards. Working through these Activities students can explore fundamental content mandated by most core curriculums. Then they engage in "out of the window" thinking (like "out of the box" but more expansive!) connecting what they've just experienced in class to real world phenomena they can see around them everyday.

Taken together these Activities expose students to the elements of physical and earth science. They provide them with a kit of intellectual parts, synergistically related insights into the most significant of Abbe's motive forces. Activity 1.1, Sun and Seasons, allows students to appreciate how our local star is the single most powerful influence on Earth's weather and how, when and why it makes summer and winter and drives the planetary heat engine. Activity 1.2, Differential Heating and Cooling of Land and Oceans, invites students to experiment with variations in temperature—and has a "cool" "Design a Sports Shirt" extension. Activity 1.3, The Water Cycle, helps students comprehend humble H_2O as a critically important actor in the drama of life on Earth. Activity 1.4, Pressure, Temperature and Wind, offers two related sections: the first explores the interaction of

pressure and temperature, convection and conduction. The second shows why, how and in what direction winds blow in relationship to High and Low pressure. (A sidebar on the Coriolis force invites students to connect to dynamic online demonstrations that make clear this often misunderstood phenomenon.) Activity 1.5, Ocean Currents, Jet Streams and El Niño, also has 2 sections. Avoiding the somewhat risky use of hair dryers around water, a safe and simple straw and student mouth power alternative sets ocean currents in motion. Lastly Activity 1.5.2, A Hands-on El Niño, allows students to see for themselves how warm and cold water interact and why upwelling happens. Many researchers argue that if the Sun is the most important global influence on Earth's weather, then the El Niño/La Niña cycle is the second most significant. Section 1 literally allows your students to get their hands on the two most important and scientifically significant forces. As Abbe urged, students can both "study" and "do".

As in every P2K project, there are also suggestions for extension activities. As you review this section, it will be useful to keep beside you for cross-reference all Student Worksheets co-packaged with this Guide as well as the Standards Correlation sheet.

In our travels to research and record material for the LIVE FROM THE STORM videos and website, we asked researchers at every laboratory and center for their take on the key principles that make Earth's weather. Hugh Willoughby, director of NOAA's Hurricane Research Division, said that air moving horizontally produces normal weather, but that air moving up and down resulted in extreme weather. NASA weather scientists Marshall Shepherd and Jeff Halverson thought that pressure and temperature gradients were key, along with terrain and "circulation" at different scales, from global Coriolis forces to the narrow vortex of a tornado. The LFSTORM videos will show all these forces at work, embodied in dramatic scenes of hurricanes, tornadoes, winter storms and El Niño/La Niña, making both Earth's weather and the science behind the weather come to life.

The Guide is available online in **PDF format**, activity by activity. However as those of you who've used recent PTK projects such as LIVE FROM THE RAINFOREST and LIVE FROM THE SUN know, we try to make the printed Guides superior in design as well as content. "Teachers and students deserve the best." Yes, you can get all the above "free" on the Net, but we think you'll be even happier with your $30.00 order of the Guide, worksheets and an oversize full-color poster! Sometimes people equate "free" with valueless, and we sure hope no-one thinks that about this Guide!

If you have any questions about the Guide, please direct them to ptkinfo@passporttoknowledge.com