OREGON CLIMATE LITERACY EDUCATION INITIATIVE
PRE-PROPOSAL

Overview: *Oregon Climate Literacy Education Initiative* (OCLEI) is an innovative partnership between the University of Oregon Physics Department, Pacific University-Oregon College of Education, and a consortium of rural Oregon school districts. OCLEI will transform climate literacy curriculum in partner middle and high schools by providing a year-long teacher professional development (PD) program consisting of extensive earth systems and climate change science coursework and training in the use of earth observation data and earth system models. In the context of this Call for Proposals, **OCLEI directly targets NOAA Outcomes** 1.2 and 1.3 by vastly increasing the core knowledge of participant teachers in basic climate science and ocean interactions. This will largely be accomplished via an **inquiry** driven approach with an emphasis on regional climate variations, as measured by real climate data. These variations (sometimes strong) are most likely caused by **ocean dynamics** such as El Nino/La Nina as well as the longer timescale cycles of the Pacific Decadal Oscillation (PDO) and the Atlantic Mean Oscillation (AMO). OCLEI project leaders have already developed a simulation based approach to teaching climate science and have successfully deployed it in some previous teacher PD workshops. Increased teacher climate and earth systems science literacy will be achieved by providing district-based teams of middle school math and/or science teachers 12 quarter-hours of challenging coursework on current topics and research in climate change and earth systems science. Operationally, this will entail detailed hands-on workshops in various computer labs involving exercises derived from various ON line data sets and resources. We envision these workshops as **mini-research camps** where we provide easy to use data analysis and visualization tools. Participants will also earn UO graduate level credit for each completed workshop through the UO's continuing education program. Each mini-workshop and associated ON line content will count for 3 credits of continuing education at the "masters" level. OCLEI will directly serve 48 teachers (24 cadre teachers per year) in three rural secondary schools and three associated middle schools, which will impact approximately 4800 students.

OCLEI Professional Development Model: OCCEI builds on *North Coast Teachers Touching the Sky* (NCTTS), a successful three-year ESEA Title IIB Math/Science Partnership project delivered by the PI and Co-I to six rural, high-poverty Oregon coast school districts from 2005-2008 (Carr, et al, 2009). NCTTS trained school-based teams of K-12 teachers to better utilize inquiry-based science instruction models within a comprehensive earth and space science curriculum. NCTTS activities included two week-long summer institutes, a series of on-site Friday-Saturday mini-institutes during the school year, and hands-on mentoring and observation of participant teachers in their classrooms. NCTTS enabled the development of a robust and abiding partnership between PI Bothun and Co-PI Carr, their respective institutions, and the teaching and administrative staff of a number of rural, high-needs, partner school districts. The communication and trust built over several years in comprehensive partnership serves as a strong foundation for OCLEI and most of the NCTTS participant teachers and associated school districts are eager to engage in a similar experience. The **primary reason** for the success of NCTTS was that each cadre of teachers was involved with the project for 12 months instead of just attending "one-off" workshops

Like NCTTS, OCLEI seeks to enhance teacher core content knowledge, build the capacity for inquiry-based science teaching, and develop teacher leadership for sustainable and meaningful

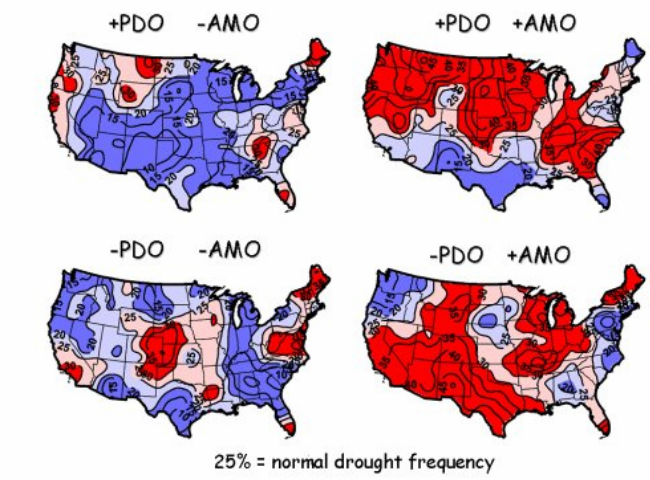
action in schools. This articulated approach between content knowledge, content pedagogy, and a focus on teacher leadership leads to powerful and coherent teacher PD (Penuel, et al, 2007). OCLEI will extend and build on what has been learned in previous work, with content focus on ocean systems science and climate change, and modeling data-driven classroom inquiry using various data resources. Our partnership has had a long history of providing teachers with innovative tools to assist them with data organization and analysis and we generally teach science content via data driven pathways as opposed to just "lecturing about the facts". Example feedback from one participant teacher succinctly encapsulates our approach:

> "This (PD workshop) made me reflect on the way I teach my students science. Before it was a lot of fact learning, learning from books, and just trying to get through the materials. This experience has led me to see that the real key to teaching and leaning science is to know that science is about the moment of discovery."

Climate Change Curriculum Framework: Much of OCLEI course content originates with the wealth of undergraduate curriculum material on both global climate change and global energy production that the PI has produced over the last 5 years. OCLEI course content is consistent with the Climate Literacy Framework set out by the National Oceanic and Atmospheric Administration and the National Science Foundation. It is also intended to introduce the science that underlies much of the policy recommendations of the fourth assessment of the IPCC. The OCLEI curriculum and training are anchored in four *essential questions* of climate change:

1. *What are the physical drivers of the climate system and the dynamics by which they are maintained or altered?* Teachers will learn about jet streams, ocean currents and the various known interaction mechanisms. Short-term fluctuations such as El Nino and La Nina will play a major role in this discussion.
2. *How is data used to measure regional climate and to detect regional climate variations*? Participant teachers will learn how to retrieve extant climate data, how to visualize it, and how to use it to define a given climate in a physically defensible manner. Presently, most teachers (and other policy makers) simply teach the “fact” that climate change is occurring. In order to make physical sense of climate change, teachers will learn to define a regional climate, from actual climate data, to show that the defined climate has actually changed. Since climate data is generally noisy, it is ultimately ambiguous and the same data set may be used to support multiple points of view. One of the main indicators of climate change literacy is the ability to recognize what conclusions the relevant data can and cannot support. **The intrinsic nature of climate data offers an excellent opportunity to improve teacher’s understanding of science as an uncertain process**.
3. *What are the carbon exchange processes between the atmosphere and the ocean, the ocean and the land, and the land and the atmosphere*? The rates of exchange of these processes are determined by planetary energy balance considerations as well as deep ocean mixing. The basic effect of human activities on climate is to alter these rates of exchange thus taking the system out of a state of equilibrium to a more unstable state or volatile state. A fair argument can be made that this leads to increasing climate and weather volatility. The ability for the oceans to act as a buffer then becomes an integral part of understanding climate science and lag times, and also for understanding the general problem of “warming in the pipeline” as a consequence of the high heat capacity of the oceans.

4. *How are climate and climate shifts often driven by processes that operate for decades*? Decadal changes (e.g. the PDO or the AMO) are now well defined by data, but their origins remain a significant puzzle. However, the existence of these climate cycles is very important in terms of choosing a baseline climate if one wishes to assess whether or not climate change has occurred. Indeed, the very existence of these long term fluctuations suggests that there is no representative time period in which one can define an "average climate". This is clearly shown in the figure to the right which shows that the US has basically 4 regional climate patterns depending on the relative phases of the PDO/AMO cycles.



Gulf Oil Spill Component: The PI is already in the process of developing an interactive simulation, based on the real physics of fluid flow through a pipe as a function of viscosity and pressure differential, to both better educate students and to show the egregious nature of BP's PR machine. For instance, their initial estimate of 1000 barrels a day a) is equivalent what 2 household bathtubs would produce, and b) is physically impossible given the 5000 feet of hydrostatic head that would have easily contained such a small flow. The fact that this figured was published, unquestioned, for about one week is an **excellent example of the rampant science illiteracy in this country.** Subsequent "analysis" suggested the flow was actually 50 times higher(!) – coupling that flow to the right fluid dynamic equations directly shows that BP had tapped an internal pressure that greatly exceeds the rated 15,000 PSI of blowout preventers.

OCLEI Team: **Dr. Greg Bothun** (PI) will assume lead responsibility for developing and delivering OCLEI climate change curricula and data tools. Dr. Bothun has been involved in K-12 teacher PD since 1990, primarily in the context of space science but this has now evolved to include earth system science and climate change (see http://theenergycollective.com/TheEnergyCollective/64634 for a recent professional blog article on climate change). Dr. Bothun has developed an extensive series of physics/astronomy/earth system science JAVA/FLASH based visualizations, simulations and virtual experiments to serve as important aids in both data- and inquiry-driven curriculum (many of these tools are visible at http://homework.uoregon.edu/demo). **Dr. Kevin Carr** (Co-PI) will assume lead responsibility for developing and delivering instruction in data-driven pedagogy, and in developing co-teaching partnerships. Dr. Carr has been actively involved since 1998 in PD of both pre-service and in-service science teachers. He is an expert on educational action research, collaborative and inquiry-based learning, and program evaluation and assessment. He currently serves as PI for a NSF Noyce Scholarship Grant for supporting new STEM teachers serving in high-needs schools. Evaluation specialist **Edith Gummer (**from project partner Education Northwest) will carry out a rigorous and comprehensive program evaluation in the manner that was done for NCTTS. Education Northwest provides research and development assistance to education, government, business, and labor as part of a national network of 10 educational laboratories funded by the U.S. Department of Education, Institute of Education Sciences (IES).