Xiangdong Zhang wanted to answer a big climate question, and he needed a big computer to do it.

Zhang, a Research Associate Professor of Climatology at the International Arctic Research Center, was responsible for writing the science portion of the PACMAN proposal based on work he had done on the hydrologic cycle in the Pacific Ocean. Now that the proposal has been funded, he and UAF Atmospheric Sciences graduate student Cecilia Borries have been using the Pacman supercomputer to support a study of the influence of the Pacific Decadal Oscillation (PDO) on Pacific water transport.

“80 percent of our effort depends on the machine,” Zhang said. “If there is no supercomputer we cannot do this kind of study.”

Zhang is looking at Pacific moisture transport patterns and parsing out what may be causing them. He explained that there is strong seasonal variability in the system: in the summer, strong Asian monsoons create a warm body of moisture that moves northward. In the winter, circulation reverses direction as dry air moves southward. “The pattern changes, the pathway changes,” Zhang said. “So we want to know how these changes and variability impact the Pacific area and also impact Alaska and Hawaii.”

What isn’t known is to what extent these pathways may be affected by the Pacific Decadal Oscillation (PDO), a long-lived El Nino-like pattern of Pacific ocean temperature variability that shifts phases every 20-30 years. “The PDO is related to ocean dynamics reflected or represented by specific temperature,” explained Zhang. “So there’s a pattern shift of specific temperature in the northwest and central Pacific that’s like a seesaw oscillation structure.”

Zhang and Borries’s task is to see how changes in moisture transport may be specifically linked to PDO temperature changes. Using PACMAN, Zhang and Borries are using surface measurements of ocean temperature to project water transport patterns along a transect of the North Pacific. Their complex mathematical model incorporates humidity, air pressure and other factors and creates a simplified map of projected vectors of moisture transport over time. The finished model will stretch from 1945 to the present, thus incorporating both “warm” and “cool” phases of the PDO in order to see how each phase compares to climatological averages.

“This modeling study is an exercise to isolate PDO’s impacts,” Zhang explained. “If there is a close correlation between PDO and the water cycle, that means there is an implication we can use the PDO to make predictions of changes in future transport.”

Even with PACMAN’s supercomputing power, it’s a hefty task: in March, after months of work, Borries had only completed running the model from 1945-70. “It takes about a day to run a year of the model” she said. “It’s going to take about two months to finish running.”

Zhang said the water cycle is currently a “hot topic” among climate scientists, both because it is generally poorly understood due to insufficient data, and because climate change could lead to widespread changes in water transport. He says modeling efforts like this one can help fill in the blanks; in particular, studying the PDO can help to differentiate between natural cyclical changes and emerging changes in climate.

“In recent years people always talk about dry areas becoming drier and wet areas becoming wetter,” he said. “If these changes continue, our study can contribute some information to decision-makers for use in future planning.”

### Transient Eddy Moisture Transport

**Negative Phase - Winter season during a warm PDO.**

**Positive Phase - Winter season during a cold PDO.**

Moisture transport into Alaska is increased.