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## T A B L E  o f  C O N T E N T S



# B I O L O G Y

## 1) Construction of Yeast Strains Deficient in Pseudouridine Synthase (Pus3p) Activity

Arnold-Croop S. E., Harbaugh, D. L. and Hepfer, C. Ely

In the yeast *Saccharomyces cerevisiae* a specific type of genetic exchange known as *HOT1*-associated recombination has been implicated in maintaining homology between repeated ribosomal RNA genes. Deletion of the *DEG1* gene reduces this type of recombination and prevents cell growth at 37$^{o}$C. The mechanism by which *DEG1* impacts these phenotypes is unknown. Pseudouridine synthase 3 (Pus3p), the product of the *DEG1* gene, modifies the anticodon arm of transfer RNA at positions 38 and 39 by catalyzing the conversion of uridine to pseudouridine. These residues enable transfer RNA molecules to achieve the three-dimensional conformation necessary for their transport to the cytoplasm and efficient participation in protein synthesis. No relationship between the pseudouridylation of transfer RNAs and genetic recombination has been established. It is possible that *DEG1*'s effect on recombination is simply a consequence of slowed cellular metabolism due to the impaired functioning of unmodified transfer RNAs. If this is the case, deletion of any gene coding for a pseudouridine synthase should have a similar impact on recombination. In order to test this hypothesis, yeast strains deficient in pseudouridine synthase 3 (Pus3p) were created using Polymerase Chain Reaction (PCR) technology. PCR products that include the *kan$^{r}$* gene, coding for geneticin resistance, and are flanked by sequences lying immediately 5' upstream and 3' downstream of the *DEG1* gene were used to transform wild-type yeast. Successful replacement of the *DEG1* gene with *kan$^{r}$* was verified by PCR analysis. Recombination rates and temperature tolerance will be compared in *pus3* deletion strains and in strains deficient in other pseudouridine synthetases (Pus1p, Pus2p and Pus4p). These results will indicate if Pus3p's effect is specific and will further elucidate recombination mechanisms in yeast cells.

## 2) Contribution of Phytoplankton and Floating Algal Mat Primary Production to Ecosystem Metabolism of a Mangrove Channel

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We studied ecosystem metabolism in a shallow mangrove channel in Belize. Floating algal mats (FAM), which lift off daily from the sediment/water interface, contribute most of the water column primary production. Mean net primary production (NPP) of FAM was 0.83 mg/L/hr, while mean NPP of the water column without FAM was 0.05 mg/L/hr. Swarming zooplankton, epibionts on prop roots and heterotrophs associated with FAM represent numerous grazers on FAM and phytoplankton, and therefore these autotrophs may be major oxygen sources within the ecosystem. Previous studies have considered that mangrove ecosystems are detrital based. To calculate ecosystem metabolism, water column dissolved oxygen concentrations were measured at dawn and dusk for several days in July and August 2002. Daytime ecosystem production (DEP) and nighttime ecosystem respiration (NER) were corrected for air-sea dissolved oxygen flux from or to the atmosphere (g oxygen /$m^2$ /day). Ecosystem metabolism measurements show large variation in DEP and NER. In July, production exceeded respiration, mean of 24.79 g oxygen /$m^2$ /day, and 14.10 g oxygen / $m^2$ /day, respectively. In August, respiration exceeded production, mean of 46.53 g /$m^2$ /day and 23.04 g/ $m^2$ /day, respectively. Ecosystem metabolism of this mangrove channel alternated between autotrophy and heterotrophy.

## 3) Rodent Performance in the Morris Water Maze Under Normothermic and Hypothermic Conditions

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We examined whether hypothermic conditions affect the performance of mice in the Morris water maze (MWM), a commonly used task to study spatial learning and memory in rodents. The task assesses the ability of animals to remember the location of a spatially fixed platform hidden in a large pool of opaque water. An animal's performance in the task is measured as the length of time required to escape from the water by swimming onto the

platform. Equal numbers of adult mice (total n = 36) were randomly assigned to undergo training in the MWM at one of three different water temperatures: 20 C, 28 C, and 36 C. Subjects performed three trials per day (intertrial interval = 30 s) for six consecutive days. The location of the platform was kept constant for each animal while the animal's starting position was varied from trial to trial. Measurements of rectal body temperature were recorded before and after training each day. Statistical analysis (ANOVA) of changes in rectal body temperature before and after training revealed significant differences among the three groups of animals ($p = 0.000$). Mice assigned to the 20 C treatment exhibited an average change in body temperature of -6.78 C, while the average changes for mice in the 28 C and 36 C treatments were -2.7 C and 0.0 C, respectively. Interestingly, analyses of variance revealed no statistically significant differences in the escape latencies of animals randomized to the three water temperature treatments ($p = 0.114$). Over the course of training, subjects in each group learned to escape the water by finding and climbing onto the hidden platform. Thus, although mice required to complete the MWM at water temperatures of 20 or 28 C became hypothermic, their performance in this task was no different than that of normothermic mice.

## 4) The Effects of Liquid Bleach on Pig Decomposition in Southeastern Pennsylvania

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Suspected use of bleach on the victim in a recent homicide trial in San Diego, CA, led the prosecutor to question if bleach on a body would affect a flies reproductive cycle. This case not only exemplified how forensic entomologists were unable to corroborate estimations of a postmortem interval (PMI), but also how the effect of such chemicals may influence arthropod colonization and utilization (if any) of a corpse, thus affecting PMI estimations. To date, empirical studies published on the effect of controlled substances and other chemicals such as pesticides, have examined the effect on particular insects and provided logical implications of the potential impact on a PMI estimate. However, few field studies exist on how decomposition is influenced by any chemical substance. We hypothesized that the topical application via dousing of common household bleach would negatively impact insect colonization of pig carcasses directly, and indirectly slow decomposition.

The objective for our first experiment was to determine the effect of bleach on pig decomposition. In two later experiments, we compared decomposition rates between habitats, each with and without bleach treatments and determining the rate of degradation of bleach between habitats. Stillborn pig carcasses were used in this study. Control pigs (n=3/habitat) i.e. not treated with bleach and experimental pigs (n=3/habitat) i.e. treated topically with a dousing (≈ 4 liters) of Ultra Clorox® liquid bleach, were placed onto individual plastic trays inside separate animal Have-a-Hart® cages. In experiment 1, all cages were placed in an open field exposed to full sunlight.

Five stages of decomposition were easily distinguishable for the control and doused or bleach treated pig: fresh, bloat, decay, post-decay, and dry. Decomposition rates for pigs treated with bleach tended to be similar initially but slowed overtime possibly due to decreased insect activity. Accumulated degree-days estimates were less for control pigs and significantly greater for pigs treated with bleach in full sunlight. We conducted an additional experiment to determine if extraction and detection of the active ingredient in bleach, hypochlorites was possible from carrion flesh. We found that we could extract hypochlorites with a titration technique but were unable to detect the rate of degradation due to logistical errors in the experimental design.

## 5) Stream Restoration on the Small Scale: Impacts on Macroinvertebrate and Fish Communities Before/After Rehabilitation

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Due to the increasing number of non-point source pollutants from runoff into aquatic systems, stream restoration projects have become increasing common throughout the United States. Natural stream designs, i.e., streambank stabilization and/or stream re-location are often used to improve aquatic conditions. Macroinvertebrate and fish abundance and biodiversity were observed to determine the effects of a stream restoration on Hammer Creek. Macroinvertebrate and fish communities were sampled and identified at five sites before and after channel restoration (July, August, December 2002 and April, August 2003) on Hammer Creek in Lancaster County, PA. Biodiversity indices were calculated and statistically compared to determine the difference between pre and post-restoration macroinvertebrate and fish communities. Since the stream channel was re-located in this project such a

traumatic event may have caused macroinvertebrate and fish abundance and diversity in the upper and lower impact areas to decrease post-restoration. However, by August 2003, macroinvertebrate and fish abundance and diversity had recovered and exceeded pre-restoration levels at some sites. We recommend continued management and monitoring of macroinvertebrate and fish populations before and after stream restoration projects in which stream channels are relocated. These projects may positively influence the instream biotic communities and therefore provide rehabilitative opportunities for streams in declining physical and biological conditions.

# C H E M I S T R Y

### 6) Remediation of Contaminated Water Using Nanocrystalline $Tio_2$ as a Catalyst

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The goal of this research was to study the decomposition of organic compounds in a controlled environment using light as the source of energy and nanocrystalline titanium dioxide ($TiO_2$) as a catalyst. $TiO_2$ has a bang gap of ~ 3.2 eV, and absorbs about 5% of incoming solar radiation. This absorbed energy can be used to decompose toxic organic compounds. Since sunlight is the only source of energy, and the nanocrystalline $TiO_2$ is fairly inexpensive, this technique is attractive as a low cost method of pollutant remediation. The high surface area to volume ratio of the nanocrystalline $TiO_2$ provides a large surface area for photocatalysis, improving the rate of decomposition compared to bulk $TiO_2$. We used Congo red dye as a simulated chemical waste and a halogen lamp light source to simulate sunlight indoors. Some experiments were also performed outside using natural sunlight. Over 90% of the starting material was decomposed to carbon dioxide and water and inorganic ions. The results of the research have been used to develop a laboratory experiment in environmental chemistry.

### 7) Stamping Lithography for Making Nanostructures

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Self-assembled monolayers (SAMs) of thiol terminating carboxylic acids were used to print patterns with molecular scale thickness on Au coated glass slides. The functionalized areas showed selective reactivity. The monolayer coated regions were then electrolessly plated with Au, resulting in a replica of the features on the stamp. Such features with very precise dimension are of interest in the development of sensor arrays. This work is part of the development of laboratory course modules for undergraduate courses in Nanoscience and Nanotechnology in the PA SSHE in collaboration with Penn State.

### 8) Baseline Nutrient Data for Several Small Streams in Manor Township, Lancaster County, PA

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Millersville University

This study consists of the sampling of eight local runs in Manor Township that flow directly into the Susquehanna River. The principal reason for this study is to provide some baseline data on the kinds of anion nutrients that are entering the river basin directly from a number of small streams and runs in Manor Township. Such nutrients, such as nitrate and phosphate, could have a cumulatively negative impact on the Chesapeake Bay watershed. The study is being performed over a year's time through February 2005, with samples being collected approximately every two weeks. There are several potential point-sources of discharge of nutrients in this area, including several very large dairy farm complexes in the vicinity, a large dairy product factory, and the Lancaster County Waste Authority landfill. Dry Run is the outflow from a regional wastewater recovery plant. There also are numerous non-point discharge sources, mostly associated with the region's agricultural and livestock industry and with nutrient loads from fertilizers used on domestic lawns and recreational areas. Suppressed Anion

Chromatography (IC) is used for the analysis of fluoride, chloride, bromide, nitrite, nitrate, phosphate, and sulfate ions, and the usual methods are being used for temperature, pH, and alkalinity determinations.

### 9) Micro- And Nanoemulsions as Media for Extracting Persistent Organic Pollutants for Chemical Analysis

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We are studying micro- and nanoemulsions as media for the extraction of persistent organic pollutants (POPs) from environmental samples. The process is of interest in developing new and more efficient techniques for analyzing environmental samples. We prepared SDS microemulsions and characterized the fluids using fluorescence and UV-Vis spectroscopy. Results indicate that the structure of the microemulsion consists of hydrophobic channels with nanometer to micron scale dimensions in pools of water. Solubility of a hydrophobic dye in the nanoemulsion media was found to be up to two orders of magnitude higher than in water. Thus, the dye partitions preferentially into the hydrophobic portions of the nanofluids. This would allow the recovery of compounds after separation from the aqueous medium for analysis.

### 10) Self-Assembly of Polyelectrolytes Gold Surfaces and Nanoparticles

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We have prepared thin films of polyions on Au coated glass slides and Au nanowires one molecular layer at a time, using alternate adsorption of oppositely charged components. Characterization was done using UV-Vis spectroscopy, FT-IR and SEM analysis. The thickness of the films increased with increasing number of layers adsorbed. FT-IR analysis shows peaks at 2800 -3000 $cm^{-1}$, 3400-3500 $cm^{-1}$ and 1500-1600 $cm^{-1}$ which is consistent with the IR absorption pattern of the poly(allyl) amine hydrochloride (PAH) and polystyrene sulfonate (PSS) polyions used to prepare the films. Such films with nanometer scale precision are of interest in fabrication of nanoscale chemical and biosensors, nano reactors and for controlled drug delivery.

## C O M P U T E R  S C I E N C E

### 11) Constructing a Natural Language Parser

Blanchard, Daniel and Elzer, Stephanie

Parsing is the process of taking a string of input and splitting it into categorically labeled pieces, such as parts of speech or clauses. The parsing of natural language is important because it is allows for a more natural interaction with a computer and allows linguistic analysis programs, such as grammar checking software, to exist. Parsing natural language is usually a slow $O(k^n)$ operation, unless one utilizes the Earley parsing algorithm. This famous algorithm outlines a method to reduce the complexity of the problem to $O(n^k)$ time, which drastically increases the number of utterances that can be parsed within a set period of time. This project involved implementing the Earley algorithm and exploring several pruning techniques as to their potential for improving the parsing process.

### 12) Using an Approximation to the Euclidean Skeleton for Faster Collision Detection and Tissue Deformations in Surgical Simulators

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This paper describes a technique for speeding up collision detection and deformation of abdominal organs in surgical simulation using an approximation of the Euclidean skeleton. Many researchers have developed surgical simulators, but one of the most difficult underlying problems is that of organ-instrument collision detection followed by the deformation of the tissue caused by the instrument. Much of the difficulty is due to the vast number of polygons in high resolution complex organ models. A high resolution gall bladder model for instance can number in the tens of thousands of polygons. Our methodology utilizes the reduction power of the skeleton to reduce computations. First, we compute an approximation to the Euclidean skeleton to generate a set of skeletal points for the organ (black line in figures). Then we pre-compute for each vertex in each polygon the associated skeleton point (minimal distance discs). A spring is then connected from each vertex to its associated skeleton point to be used in the deformation algorithm. The data structure for the organ thus stores for each skeletal point its maximum and minimum distances and the list of associated vertices. A heuristic algorithm using the skeleton structure of the instrument and the skeleton of the organ is used to determine if the instrument collides with the organ.

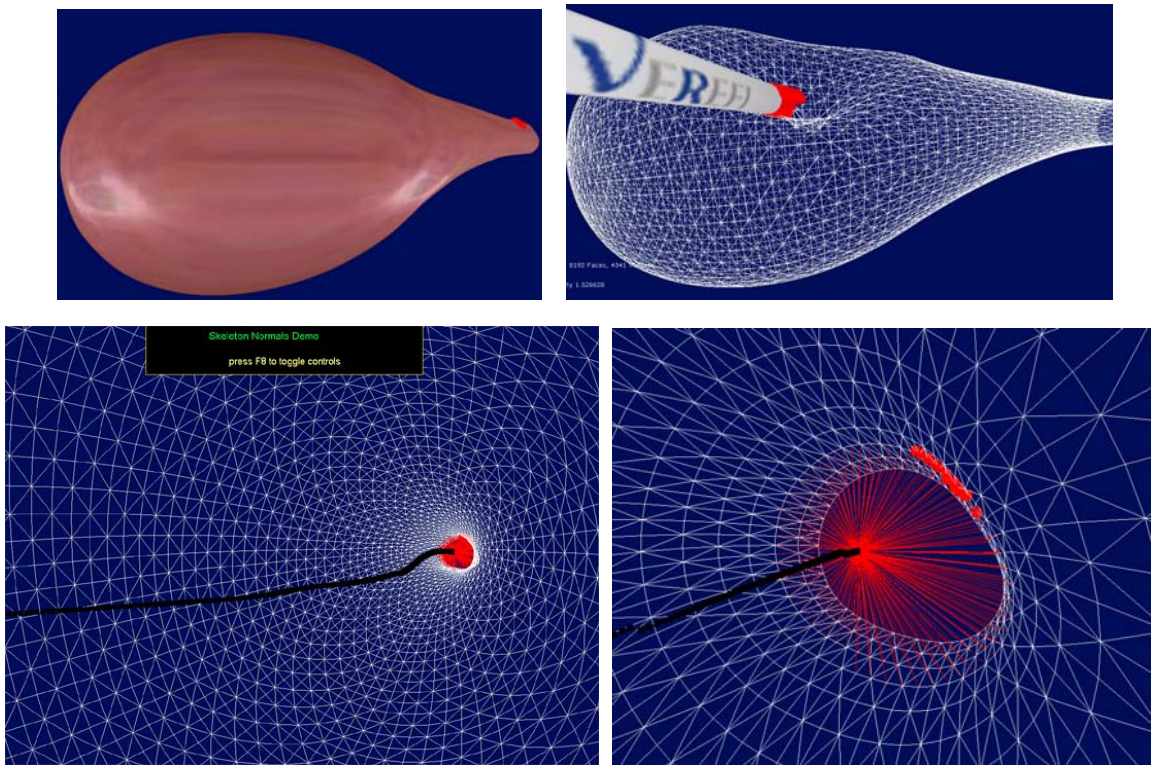


Figure 1. (top left) Gallbladder model (top right) Wireframe showing tool-tissue deformation. (bottom left) Skeleton points in black. (bottom right) Wireframe showing skeleton points in black with connector springs in red attached to all vertices associated with the skeleton point.

## 13) Simulating the Curvilinear Capsulorhexis Cataract Procedure on the EYESI™ System

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This paper describes a technique for simulating the capsulorhexis procedure during cataract surgery on the EYESI™ system. Eye surgery necessitates sub-millimeter precision and demanding hand-eye coordination in a very small workspace, thus making it difficult to simulate. Some researchers have developed eye surgical simulators, but none have attempted to model the capsulorhexis procedure during cataract surgery. The continuous curvilinear capsulorhexis technique can be a difficult procedure for beginning ophthalmology surgeons. In the initial phase of tearing the tissue, the tear vector is tangential to the circumference of the tear circle. However, without the proper re-grasping of the flap of torn tissue

close to the tear point, the tear vector angle quickly runs downhill possibly causing severe damage to the tissue. Novice surgeons tend to try to complete the capsulorhexis without the time consuming re-grasping of the tissue flap. Other factors such as anterior bowing of the lens diaphragm, patient age, and shallow anterior chambers add to the problematic nature of the procedure. The tissue area is modeled as a curvilinear mesh of nodes and springs. Deformation is accomplished via a physically based particle model utilizing a heuristic algorithm to constrain the deformation calculations to the locality of the tear area to speed up computations. The software alerts the user of any potential tear problems before they occur thus instructing the novice surgeon. For example, as the user approaches the 12 o'clock position the tear vector *unintuitively* begins to run peripherally. If the surgeon attempts to redirect it by traction directed in a radial fashion toward the center of the lens, the tear only propagates further peripherally (runs downhill). Continuing to try to redirect the tear can cause severe damage to the tissue in an actual patient. The EYESI™ hardware system (from VRMagic GmbH) provides the user with stereoscopic images thus providing 3D viewing. Our capsulorhexis simulator software models various tear problems and anomalies to provide a useful training environment without the dangers of using live patients.

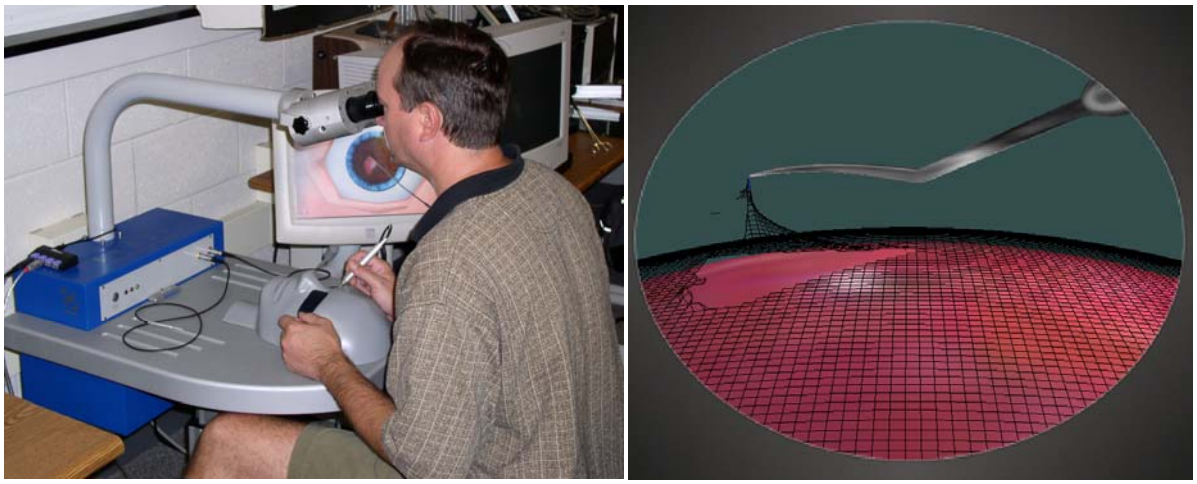

Figure 1. (left) Beginning ophthalmology surgeon using EYESI system (right) tearing the membrane.

# E A R T H  S C I E N C E

### 14) Investigating the Thermodynamic Environment of a Mesoscale Convective System

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A mesoscale convective system (MCS) is a complex of thunderstorms that is organized on a much larger scale than an individual thunderstorm and can persist for several hours. MCS characteristics (intensity, structure, propagation speed) are thought to be influenced by the thermodynamic properties of the environment and vertical wind shear. Past studies have typically characterized MCS environments on the basis of a single sounding, but there are few studies using detailed thermodynamic measurements of the environments of these systems to validate this approach. Data for this study were from the Bow Echo and Mesoscale Convective Vortices Experiment (BAMEX) to investigate the thermodynamic environment a convective system. This research was unique because there were approximately 35 soundings taken within and near this convective system. To quantify the environmental structure, selected parameters were used to estimate the buoyancy of hypothetically lifted parcels at several levels and the vertical wind shear through the lower and middle troposphere. Results suggest that the northern limit of the MCS is determined by environmental stability, not by processes internal to the MCS. There

were significant differences in the intensity of the MCS between the northern and southern halves of the MCS that corresponded to the variation of the lifted index north to south. The variance of soundings in the path of the MCS suggests that it is not possible to characterize the degree of instability in this case. Furthermore, there was nearly a factor of two uncertainties in environmental wind shear. The results of this research further the understanding of the thermodynamic environment of a mesoscale convective system.

## 15) Evaluation of the Downstream Weather Impacts Associated with Atmospheric Blocking Over the Northeast Pacific in the CFS and AMIP Model Simulations

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Episodes of prolonged extreme weather conditions, such as droughts, floods, and heat and cold waves are of considerable importance to society. One feature that is often implicated in these extreme events is the persistent anticyclonic flow anomaly, commonly referred to as an atmospheric blocking episode. Numerous studies have alluded to the inherent problems of numerical weather prediction models in forecasting events of atmospheric blocking. Recently, with the introduction of ensemble forecasting systems at both NCEP and at ECMWF, the forecasting of atmospheric blocking at the medium ranges has improved.

In this study we examine the relationships between atmospheric blocking over the Alaskan region of the Northeast Pacific (162.5$^{o}$W, 62.5$^{o}$N), referred to as Alaskan blocking, and weather extremes over North America during the boreal cold season in the newly implemented NCEP Coupled Forecast System Model (CFS) and an AMIP II simulation with the GFS model. The CFS is a fully coupled system with no flux adjustment, which has demonstrated improved skill in predicting intraseasonal atmospheric variability. It is currently used operationally for seasonal forecasting at NCEP.

Atmospheric blocking events are identified in each model via a threshold crossing procedure. The threshold and duration criteria chosen were 100 m and 8 days. A total of 37 (27) blocking events were identified in the AMIP (CFS) simulation over a 22 year period. For the AMIP blocking events, durations ranged from 8 to 24 days with a mean duration of 11.3 days, while for the CFS events, durations ranged from 8 to 27 days with a longer mean duration of 13.6 days. Using surface temperature and precipitation outputs from both model simulations we plan to examine the changes to the statistical distributions of both variables during the Alaskan blocking regime as compared to the long-term winter climatology. The results will be compared to the findings of a similar study of Alaskan blocking with the NCEP/NCAR global reanalysis.

## 16) A Characterization of the Wintertime Boundary Layer Using Tethered Balloons

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A detailed examination of the structure and evolution of the wintertime boundary layer was conducted from 3 January – 14 February 2004 near Lancaster, PA in support of the research objectives of the Mid-Atlantic/Northeast – Visibility Union. Two tethered balloons were used to deploy meteorological sensors, condensation particle counters, laser-diode scatterometers, and filter samplers to altitudes of 750 m AGL, while a suite of ground-based instruments measured trace gas and particle concentrations and meteorological parameters. January 2004 was characterized by a very active synoptic pattern that frequently brought Arctic air into the mid-Atlantic region and resulted in this being the 10$^{th}$ coldest January on record. Tethered balloon measurements were primarily limited to times when progressive anticyclones moved over the site, bringing clear skies, strong nocturnal radiational cooling, and wind

speeds not in excess of12 $ms^{-1}$. Daytime conditions were marked by the rapid development of the nearly adiabatic mixed layer of uniform winds extending to a depth of 500 – 700 m AGL and capped by a subsidence inversion. The nighttime periods were considerably more interesting with complex stratification embedded in and above the inversion, with significant variability in wind speed and direction, water vapor mixing ratio, particle concentration, and scattering coefficient observed across layers that were often only tens of meters thick. Depending on the atmospheric condition around sunset and the rate of development of the nocturnal inversion, high concentrations of particles were found trapped near the surface and/or in shallow stable layers within the inversion. The tethered balloons were deployed to capture this detail by first performing a vertical profile using the 12 $m^3$ blimp to examine the boundary layer structure. Once potential layers of interest were identified in the profile, a second balloon was parked at that altitude to conduct long-duration (10-12 hour) time series of meteorological variables and particle concentrations. The measurements obtained using the single-site tethered balloons are being integrated into a regional context by incorporating surface and aloft observations from the NWS network, as well as regional profiler data and WRF and Eta model output. Preliminary results suggest that high concentrations of particles (12,000 – 50,000 $cm^{-3}$) are trapped in wintertime stable layers, and are subsequently mixed to the surface the following day. Moreover, black carbon appears to contribute a significant fraction to the total particle count in winter. Finally, tethered balloons provide detailed profiles of meteorological variables (T, p, z, q, and vector wind) with vertical resolution of 0.3 m that show considerable structure and variability in the wintertime boundary layer. These data can be used to validate boundary layer parameterization schemes used in numerical models.

## 17) Correlating Measured Pollutants in Northeast Philadelphia to its Source using ArcGIS

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Pollution today has become both an important social and economic factor in every American's life. It has been linked to both illness and ecological disaster. Yet, little is known about how emissions spreading across the mid-Atlantic and Northeastern states are affected by the weather. For instance, do areas having normally higher levels of $CO_2$, $SO_2$, and $NO_X$ coincide with areas of increased precipitation, health problems, and ecological disasters? In order to discover answers to these and other questions, data from a combination of criteria gas analyzers, small balloon soundings, historical regional emissions data, and back trajectories, were incorporated into advanced modeling software (ArcGIS) to study haze and pollution events in Philadelphia. HYSPLIT 48-hour back trajectories were mapped in hourly intervals giving the location of air parcels terminating at three specific heights. Combined with (EPA) emission data, GIS was used to display air parcels on their way to Philadelphia traveling through weak and intense concentrations of $CO_2$, $NO_2$, and $NO_X$. Our research focuses on the path the air parcel travels through these regions of varying trace gas concentrations, and their affect on the local concentrations observed in Philadelphia. Future plans include the incorporation of precipitation totals at each of the emissions plants, population demographics, National Weather Service observations, and model output, which will be integrated to help us further understand the effect of meteorology on pollution concentrations.

## 18) The Role of Undergraduates in LEAD Learning Communities: Developing LEAD-TO-LEARN Modules

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Each year across the United States, floods, tornadoes, hail, strong winds, lightning, and winter storms – *so-called mesoscale weather events* – cause hundreds of deaths, routinely disrupt transportation and commerce, and result in annual economic losses greater than $13B. Although mitigating the impacts of such events would yield enormous societal and economic benefits, the ability to do so is stifled by

information technology (IT) frameworks that cannot accommodate the *real-time, on-demand, and dynamically-adaptive* needs of mesoscale weather research; its disparate, high volume data sets and streams; and its tremendous computational demands.

In response to this pressing need for a comprehensive national cyberinfrastructure in mesoscale meteorology, LEAD will address the challenges needed to create an integrated, scalable framework for identifying, accessing, preparing, assimilating, predicting, managing, analyzing, mining, and visualizing a broad array of meteorological data and model output, independent of format and physical location. The transforming element of LEAD is *dynamic workflow orchestration and data management*, which will allow use of analysis tools, forecast models, and data repositories as *dynamically-adaptive, on-demand* systems that can a) change configuration rapidly and automatically in response to weather; b) continually be steered by new data; c) respond to decision-driven inputs from users; d) initiate other processes automatically; and e) steer remote observing systems to optimize data collection for the problem at hand.

LEAD will create a series of interconnected, heterogeneous virtual IT "*Grid environments*" to provide a complete framework for mesoscale research. A set of integrated Grid and Web services testbeds will maintain a rolling archive of several months of recent data, provide tools for operating on them, and serve as an infrastructure for developing distributed Web services capabilities. ***Learning Communities are established to ensure that education and outreach are integrated throughout the entire LEAD program, and will help shape LEAD research into applications that are congruent with the needs of the education communities, including access to data and the tools required for analysis and visualization, pedagogical requirements, national and state science and technology standards, and evaluation metrics.***

Millersville Earth Sciences undergraduates are directly involved in the creation of 4-D visualization modules that will be used to enhance undergraduate education in the atmospheric and related sciences nationwide. This presentation will demonstrate some of the modules that have thus far been developed.

# M A T H E M A T I C S

## 19) Periodic Orbits on a Triangular Air Hockey Table

Baxter, Andrew and Umble, Ron

This paper examines the number and types of periodic orbits on a triangular air hockey table. When the table is an equilateral, we use a tessellation of the plane to reveal a countably infinite number of infinite families of periodic orbits. We use techniques from linear algebra to define a coordinate system on the tessellation that yields new distance and angle formulas and allows us to determine the period of an orbit under certain conditions. We classify an orbit is classified as either primitive or with duplicates and discuss the ramifications of this classification.

## 20) Positive Solutions to a Diffusive Logistic Equation with Constant Yield Harvesting

Ladner, Tammy[1], Little, Anna[2], Marks, Ken[3], Russell, Amber[4], and Shivaji, Ratnasingham[4]
Millsaps College[1], Samford University[2], Millersville University[3], Mississippi State University[4]

We consider a reaction diffusion equation which models the constant yield harvesting of a spatially heterogeneous population which satisfies a logistic growth. In particular, we study the existence of positive solutions subject to a class of nonlinear boundary conditions. We obtain our results via a quadrature method and *Mathematica* computations.

### 21) Numerical Simulation of a Wind-Forced Reduced Gravity Ocean Model

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Department of Mathematics, Millersville University
Florida State University

Three linear partial differential equations governing motion and continuity in fluid flow were reduced to their finite difference forms, following appropriate approximations and simplifications. The model simulates the thickness of an 'upper' ocean layer, based on the movement of water in north-south and east-west directions across a region. The model was validated using simulated winds in the equatorial Atlantic Ocean off the coast of Brazil. The geometry of the region was altered to approximate the Gulf of Mexico where the model was forced by an axially-symmetric, moving hurricane. In both scenarios the model produced the expected upwelling events and wave patterns. The upwelling events increase surface nutrient levels available for biological processes, as well as decrease surface temperature reducing the energy available to later hurricanes within the season.

## P H Y S I C S

### 22) The Anisotropic Electrical Properties of Sculptured Thin Films

Schumacher, Matthew and Snyder, Matthew and Gilani, Tariq H.

Chiral Sculptured Thin Films (STFs) exhibit a property of unidirectional nonhomogeneity which is responsible for a subsequent electrical anisotropy in the films. The Montgomery method is used to measure the anisotropic resistivity in the films which is used to map the dimensions of the anisotropic sample to those of an equivalent isotropic sample with a uniform resistivity. The goal of this project is to characterize sculptured thin film and understand the relation of electrical anisotropy to the structural nonhomogeneity of the films. The films under investigation are each deposited onto a silicon substrate with thicknesses ranging from 100-3000 nm. This is ongoing project in collaboration with Penn State University.

### 23) Uncertainty Quantification for a Nonlinear System

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This paper addresses the theoretical aspects of combining uncertainties in a nonlinear system in which statistical data are sparse. Beginning with nominal values and uncertainty measures (means and variances) for the input variable and system function, we derive expressions for the corresponding measures for the output. We start with Markov probability inequalities and derive Bayesian likelihood density functions. Starting with a non-informative prior distribution limited only by the Markov inequality, we then consider encoding additional information, such as unimodal constraints, in the likelihood function. Our results are analytic expressions for the likelihood functions of the mean and variance of the output quantity. Our method of encoding the unimodal constraint is not yet completely self-consistent, which may explain some discrepancies we see in Monte-Carlo numerical simulations aimed at validating our expressions.

# I N D E X