



SCHOOL OF SCIENCE AND MATHEMATICS

Student Research

Poster Display

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• BIOLOGY •

• EARTH SCIENCES •

• PHYSICS •

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Note: The names of Millersville University faculty advisors are designated by an asterisk (*) in the abstracts.

Biology

1. Dolphin Mating Behaviors: Dusky Dolphin (*Lagenorhynchus obscurus*) and Bottlenose Dolphin (*Tursiops truncatus*) Comparisons

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Most research on dolphin reproductive patterns has focused on anatomy or physiology, and there is a deficit in mating behavior studies. Dolphin mating systems are usually polygynandrous, with males and females displaying multiple mating tactics and having multiple mates. To better understand dolphin mating behavior, I assessed the mating behavior of dusky dolphins (*Lagenorhynchus obscurus*) that mate in groups (Nov 2011-Jan 2012) and common bottlenose dolphin (*Tursiops truncatus*) that mate in pairs or triads (June 2012-July 2012). We hypothesize that (1) male dusky dolphins employ a wider variety of mating tactics than either female dusky dolphins or male bottlenose dolphins because of the pressures from sperm competition, and (2) female bottlenose dolphins employ a wider variety of mating tactics than male bottlenose dolphins or female dusky dolphins because of the importance of pre-copulatory behavior in controlling paternity. Ethograms were created based on mating video footage (dusky: N=770.77 min; bottlenose: N = 52.61 min), and sex-specific mating behaviors were quantified. Two general (both male and female), 6 male-specific, and 6 female-specific mating behaviors were described; of these, 5 behaviors and 2 additional mating parameters (frequency of intromission and duration of intromission) were used in statistical analyses. Dusky dolphins spent significantly more time at the surface than bottlenose dolphins. Male dusky dolphins showed significantly more inverted swims than male bottlenose dolphins and female dusky dolphins showed significantly more re-entry leaps than female bottlenose dolphins. Intromission was most common in January for dusky dolphins; there was insufficient data to detect a temporal pattern for bottlenose dolphins. Females from both species engaged in a greater proportion of observed mating behaviors than males, suggesting active female choice. Future research comparing dusky dolphin and bottlenose dolphin mating tactics to other species may help explain how mating behaviors emerged and diversified in different mammalian lineages.

2. Characterization of the Bone-Forming Cells of the Turtle Plastron

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Turtle plastron bones develop by intramembranous ossification, suggesting that they are derived, like the facial bones, from neural crest cells. We have previously shown that a wave of cells expressing neural crest markers emerges from the neural tube later than in comparably staged chick or mouse embryos, and appears to migrate ventrally to populate the plastron dermis. This second, later wave of HNK1+ cells can also be observed migrating away from cultured neural tubes from St.17 embryos. These late emerging neural crest cells also express PDGFR α , which is typically expressed by cranial neural crest cells. We have examined the expression pattern of plastron mesenchyme cells by antibody staining and gene expression analysis, and their potential for differentiation by *in vitro* culture. Plastron mesenchyme cells have a gene expression pattern

similar to cranial skeletogenic neural crest cells. They also appear to have functional similarities to cranial neural crest cells, as they differentiate readily in culture to form clusters of collagen I-positive cells. Other types of neural crest derivatives (neurons, melanocytes) are not observed. These data support our hypothesis that the plastron of the turtle is formed by a late emerging population of neural crest cells that collect dorsally in the carapace, migrate ventrally to the plastron, and undergo intramembranous ossification.

3. Genomic Analysis of Terpene Synthase Gene Family in *Medicago* and *Arabidopsis*.

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Terpene synthases (TPS) synthesize the largest class of plant metabolites, terpenes, which are important for plant growth and environmental interaction, and are used extensively in manufacturing medicines and nutritional supplements, pesticides, perfumes, and essential oils. A timely comparative genomic and transcriptomic analysis of the terpene synthase (TPS) gene family in *Medicago truncatula* (bearing glandular and non-glandular trichomes) and *Arabidopsis thaliana* (bearing non-glandular trichomes) was conducted to gain insight into TPS function and phylogenetic relationship and the role of trichomes in terpene biosynthesis and function. This comprehensive in silico analysis has identified 33 (4 new candidates) and 23 (18 new candidates) putative full length TPS genes in *Arabidopsis* (AtTPS) and *Medicago* (MtTPS), respectively. All AtTPS and MtTPS fall into the five established angiosperm TPS subfamilies; lineage-specific expansion of Subfamily A has occurred in *Arabidopsis*, and Subfamily G in *Medicago*. Large amounts of tandem duplications have occurred in both species with one syntenic duplication in *Arabidopsis* and none in *Medicago*. The tissue/organ distribution of TPS expression in the two species is very different with much more trichome-localized TPS expression in *Medicago* than *Arabidopsis*, and in both species TPS genes were expressed in non-glandular trichomes. One trichome-specific gene has been identified in each *Medicago* (MtTPS11) and *Arabidopsis* (AtTPS04) along with some flower-, seed-, stem- and root-specific genes. At least one phylogenetically close paralog has no clustered expression in both species. Non-glandular trichomes appear to play roles in plant chemical defense and/or ecological communication instead of only in physical defense as commonly believed. The general lack of correlation between expression patterns and phylogenetic relationships in both species suggests that phylogenetic analysis alone is insufficient to predict gene function even for phylogenetically close paralogs. These findings provide novel insight into the function and relatedness of the TPS gene family members in *Arabidopsis thaliana* and *Medicago truncatula*, and pave the way for further studies and applications of this important family to enhance biomedical and agricultural production. The discovery of the genes with trichome-specific gene expression in both species provides exciting opportunity for trichome-specific genetic engineering, which could lead to enhanced environmental protection and improved safety of transgenic crops.

4. Insight into the Evolutionary Relationship between Short-chain Isoprenyl Diphosphate Synthases, Terpene Synthases and Triterpene synthases.

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Short-chain isoprenyl diphosphate synthases (IDS), members of prenyltransferases, catalyze the synthesis of the key intermediates for the biosynthesis of various terpenes. Terpene synthases (TPS) catalyze the synthesis of monoterpenes, sesquiterpenes and diterpenes, while triterpene synthases (TTPS) synthesize triterpenes. So far the evolutionary/phylogenetic relationship between these three mechanistically related families remain unclear. Also unclear is the evolutionary relationship of plant and microbial IDS, TPS and TTPS. A genome-wide identification of IDS, TPS and TTPS genes, their detailed structural analysis and chromosomal localization/gene clustering as well as phylogenetic analysis of these three gene families were conducted in both *Arabidopsis* and cyanobacteria. An evolutionary model has been developed as a result of these analyses. Our results suggest that the three gene families appear to have evolved in parallel from a common ancestor in both *Arabidopsis* and cyanobacteria, via tandem duplication and divergence, domain deletion, and domain fusion. Each family appears to have a common proximate ancestor in *Arabidopsis*, as well as in the IDS and TPS (but not TTPS) of cyanobacteria. Cyanobacteria TTPS have likely evolved from two different but related proximate ancestors. *Arabidopsis* and cyanobacteria GGPPS exhibit higher homology to each other than to the other IDS in the same species as the most conserved group among the three families. Most other subfamilies exhibit species-specific homology to each other in this study. Our results provide novel insight into the evolution, relatedness and function of short-chain IDS, TPS and TTPS.

5. Social Tolerance and the Use of Body Brightness for Communication and Camouflage in Gobies (Perciformes: Gobiidae)

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Territoriality is not always beneficial: resources should only be defended when limited and defensible, and the need for territorial displays should be balanced against the risk of predation. Gobies are both strongly territorial and use body brightness for camouflage (e.g. *Coryphopterus nicholsi*) and communication (e.g. *Elacatius spp.*). We predicted that the naked goby (*Gobiosoma bosc* (Lacepède, 1800)) (1) will show territoriality only when shelters are plentiful enough to be defended and (2) will use body brightness to mediate dominance interactions; in addition, we predicted that (3) larger and more dominant individuals control access to shelters and maintain better camouflage than smaller, subordinate individuals. Three experiments were performed, each with five groups of six gobies. In Experiment 1, tanks were provided with 1, 3, 6, 9, and 12 shells, in randomized order; social interactions were recorded. In Experiment 2, each tank was provided with dark and light substrate, with and without dividers, in randomized order, to create grouped and solitary conditions on each type of substrate; body coloration was recorded. In Experiment 3, each tank was provided with three shells and a light substrate;

distance from the nearest shelter and body coloration were recorded, and the length of each individual fish was measured. Results showed that (1) as shelter number increased, overall aggressive behavior increased; (2) body brightness varied with substrate brightness, social context, and individual; and (3) larger individuals remained closer to shelters and showed less contrast in body brightness relative to the substrate than smaller individuals. Together, these experiments show that the territorial behavior of the naked goby responds to both physical factors (shelter number, substrate) and social context (solitary, grouped), and body brightness (contrast with the substrate) is used to signal dominance status.

6. Seasonal Colonization of *Hydra* in a South-Eastern Pennsylvania Pond

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Hydra are well-known freshwater cnidarians but surprisingly, little is known about the parameters that govern population size and habitat specificity. In a previous study we showed that *Hydra viridissima* displayed a strong preference for shallow (~ 1 m) pond water habitats characterized by dense infralittoral vegetation. This study also found increased population densities in early spring sampling as opposed to summer and fall sampling.

In the current study, *Hydra* colonization rates were monitored from mid October 2010 to late December 2011. Six monitoring stations with multiple tiers of settling plates were positioned in a 0.2 hectare pond located in Millersville, PA (Roddy research pond). These stations were assayed every three weeks for colonization of *H. viridissima* and *H. oligactis*. In conjunction with these three week sampling cycles, zooplankton counts and several abiotic factors were measured weekly.

We found a low level (<20 total *Hydra*) of colonization from November to February, whereas in early March colonization had begun to increase (>100) with peak colonization in June (>1000). *Hydra* colonization was significantly correlated ($p < 0.05$) with cladoceran, nauplii, and copepod populations. *H. viridissima* colonization was additionally correlated ($p < 0.05$) with solar radiance while *H. oligactis* was not. A negative correlation ($p < 0.05$) was observed between *Hydra* colonization and protozoan populations.

7. WikiPlantAtlas.org: Phytoinformatics for All

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WikiPlantAtlas is a digital plant atlas that utilizes the Google Maps API in which users can click on a digital map and fill in general information about the plant they've collected/observed and database it. Students enrolled in Millersville University's Plant Systematics course were assigned a project where they were asked to collect, identify, make herbarium specimens, and enter the locations and general information in Wiki-Plant-Atlas for 10 wild flowering plants as 15% of their grade. The traditional component aided in the development of several skills such as plant identification, vouchering, and natural history observation while the digital atlas component provided practical exposure to concepts in biodiversity informatics. Data recorded in WikiPlantAtlas over the course of three semesters and with just 70 students showed that the projects amassed 700 new locality records for 171 species, of which there are 18 new county

records for six Pennsylvania counties. Anonymous, post-project surveys indicated that the students believed the digital atlas component made this otherwise traditional project more enjoyable and more educational regarding the local flora and geography. Although the emphasis on WikiPlantAtlas is for use in the classroom, the public nature of this program opens itself up to a valuable source of citizen scientists. Anyone with an interest in plant identification can create a map of where they've been and what they observed when they were there. Aside from being a complement to plant taxonomy courses and a source for valuable phytoinformatic data, there is also personal value that these citizen scientists may benefit from. There is still a risk for quality issues with public entries, but plants provide a model system for monitoring the accuracy of contributed records and entries can be corrected. We conclude that the undergraduate classroom is a premier place to engage the next generation of professional and citizen biodiversity scientists in the important task of documenting and conserving our natural heritage. Blending the old with the new in the form of Web 2.0 is an effective way to do this.

8. Diversity, Conservation, and Cultivation of Andean Potatoes and Similar Tuber Crops

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Potatoes were first domesticated 7,000 years ago in the Andes of South America and today are cultivated worldwide, in both developed and developing countries. The potato we find in our supermarkets today are several varieties of *Solanum tuberosum* ssp. *tuberosum* (Solanaceae), but there are more than 4,300 varieties, additional subspecies, and even several other species of potatoes cultivated in the Andes. The first author was able to document this diversity on a recent trip to Peru. These include many varieties of *Solanum tuberosum* ssp. *angidena* along with other species in *Solanum*. Whereas in US supermarkets potatoes are all generally globose (e.g., the various red or yellow potatoes) to oblong (e.g., the russet potatoes), the Peruvian Andes harbor a greater variety of potato shapes, including round, oblong, elongate, ovoid, long-oblong, and obovoid. Whereas brown, yellow and red-skinned potatoes predominate in the US, these and additional skin colors such as purple, dark purple-black, pink, and purplish-red are common in Peru. Additionally, whereas white or yellow-fleshed potatoes dominate in the US, there are red, purple, and blue-fleshed potatoes common in Peru. Other tuber crops commonly grown in the Peruvian Andes include oca, *Oxalis tuberosa* (Oxalidaceae), ulluco, *Ullucus tuberosus* (Basellaceae), and mashua, *Tropaeolum tuberosum* (Tropaeolaceae). The International Potato Center (CIP), which is based in Lima but with branches throughout the world, is the primary agency working with farmers to conserve the remarkable diversity of such tuber crops such as the potato and oca.

9. Black Fly Surveillance and Control in Hunterdon County, New Jersey

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Black Flies (Family: Simuliidae) are known to be a nuisance to humans, particularly the species *S. jenningsi*, which are ubiquitous in the summer months in the eastern United States, especially in Pennsylvania and New Jersey. Larval black flies are found in lotic habitats, particularly within the benthos of streams, and it is during this stage that population control is performed. The

purpose of this study was to monitor the species of Simuliidae on four different sites of the Raritan River, in Hunterdon County, New Jersey. Specimens were identified to species level, and enumerations were calculated for each site on a weekly basis. Each of the four sites contained three replicate samples. A pictorial key was developed to aid with the taxonomic identification of species. Although there are more than ten species of Simuliidae found along the Raritan River, data shows that *Simulium jenningsi* is the most common species. The goal of this monitoring program is to aid in the development of efficient methodologies and protocol for the control of black flies in the eastern United States.

10. Impact of Climate Change on Potentially Invasive Exotic Trees of Pennsylvania

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One goal for the Pennsylvania Department of Conservation and Natural Resources (DCNR) and similar agencies is to help protect Pennsylvania's natural resources by identifying and controlling the spread of invasive exotic plants that can harm native ecosystems. The DCNR Watch List, for example, is a list of exotic plants that are now showing invasive tendencies within or near state boundaries, and this list represents an attempt to be more proactive in the fight against the spread of invasive exotics. This list, however, includes only species already showing invasive potential and it does not explicitly take into account the impact of near-future climate change scenarios on the spread or contraction of these species' ranges. Additionally, the Watch List strategy does not attempt to identify currently "well behaved" exotic ornamentals that could become problematic when the near-future climate becomes more favorable to their spread. In order to aid park managers and agencies like the DCNR in controlling the future spread of potential exotic invasives, we used herbarium specimen data with current and future (year 2050) climate models to map and rank the potential spread of commonly cultivated exotic trees in Pennsylvania. We found that *Zelkova serrata* (Japanese zelkova) ranked among the highest increases (46%) in its invasive potential, whereas *Acer griseum* (paperbark maple) is projected to exhibit the lowest increase (actually, a decrease of 6.6%) in its invasive potential in the state. These results demonstrate how specimen data and widely accepted climate change scenarios can be used to predict the threat and quantify the future spread of cultivated exotic species, and that such models can be used as a tool to prioritize control efforts or educational campaigns in order to protect native ecosystems from invasion.

11. The Effect of Stream Restoration on the Biogeochemical Cycling of Nitrogen within the Riparian Interface

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The primary focus of this study is to determine the influence of stream restoration on the nitrogen cycle within the riparian interface by comparing the rate of nitrification before and after the restoration has taken place, focusing on the oxidation of nitrite to nitrate. The study sites are situated within the riparian interfaces of Big Spring Run located in Willow Street, PA. The oxidation of nitrite is determined using a spectrophotometric method based on the reaction of nitrite with *p*-nitroaniline in the presence of diphenylamine to determine the concentration of nitrite in each soil core within a precise time period. *In situ* levels of nitrite in water and soil

samples were below the detection limit of the assay. However, preliminary data and data taken before the restoration show a significant decrease in the added nitrite over a 5, 6.5 and 25 hour time period. The method of using oxygenated soil slurries is also being investigated as compared to the non-oxygenated cores, using fresh, refrigerated and frozen soil samples.

12. The Effect of Hydrogen Sulfide on Recovery from Cardiac Arrhythmia in an Amphibian Model

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Hydrogen sulfide (H_2S) has been shown to act as a novel chemical messenger, a "gasotransmitter," in mammalian systems. H_2S is known to dilate blood vessels and regulate blood pressure in rodents. The present study tested the hypothesis that frogs pretreated with H_2S would recover more quickly and fully from cardiac arrhythmia than controls. Experiments were conducted with two groups of grass frogs (*Rana*, Carolina Science, median mass = 94.2 g). Frogs in the experimental group (n = 11) were pretreated with the H_2S donor, Na_2S , at a concentration of 30 $\mu\text{mol/kg}$ of body weight two days before, one day before, and the day of the experiment. Frogs in the control group (n = 12) were treated with frog Ringer's solution. In both groups, the solutions were administered by injection into the abdominal cavity. At the start of an experiment, a frog was decapitated; its heart was then exposed and connected to a force transducer and ECG leads. Heart activity was recorded using PowerLab® hardware and Chart software® (ADInstruments). To begin, 5 minutes of activity was recorded to establish a baseline. Arrhythmia was then induced by dripping 5% KCl onto the heart until the force recording dropped below 50% of the baseline level. The heart was then rinsed with frog Ringer's solution and its activity was recorded for an additional 25 min. Surprisingly, pretreatment with Na_2S resulted in a decrease in recovery of function after arrhythmia as measured by the force and duration of contraction. There was little effect on the recovery of heart rate. Taken together, the data falsify the hypothesis that H_2S pretreatment aids in recovery of heart function following cardiac arrhythmia in frogs.

13. Macroinvertebrate Community Response to Stream Restoration

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Big Spring Run (BSR), a tributary of the Conestoga River, is a heavily incised, agriculturally-impaired stream located in Lancaster County, PA. Specifically, BSR has been influenced by historic mill dams constructed in the 18th century prompting the restoration effort to remove such legacy sediments that were immobilized within the bank due to this anthropogenic impact. During the summer of 2011, a 300m section of BSR was restored to reflect conditions prior to human impairment. The purpose of this study was to determine the impact of stream channel redesign and riparian buffer rehabilitation on structure. A BACI (Before/After/Control/Impact) sampling design was implemented to sample macroinvertebrates from three control reaches and one impact (restored) reach. Macroinvertebrates were collected using a Surber Sampler and returned to the laboratory for sorting and identification. All invertebrate samples to the generic (Genus) level and a Macroinvertebrate Aggregated Index for Streams (MAIS) was used to determine impact within all study stream reaches.

Earth Sciences

14. Lightning Observations and Tropical Cyclogenesis

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Atlantic tropical disturbance cases (2005-10) are used to evaluate the relationships between lightning strikes and the formation of tropical cyclones (tropical cyclogenesis). The lightning data are gathered from the World Wide Lightning Location Network (WWLLN), and the disturbance information is from an assembly of “best track” data, which includes developing and non-developing cases. Overall, the mean number of lightning strikes for developing systems is higher than that of dissipating systems. Results show that there is a significant difference in radial mean lightning density (MLD) in radial intervals in all but two 6hr time intervals in the 48hr period prior to tropical cyclogenesis (genesis) or disturbance dissipation (DD) and that the significance in 5 of 6 time periods is due to higher MLD in the developing cases. Significantly higher MLD 0-150km from disturbance center in dissipating cases may signal DD within eighteen hours. Conversely, significantly higher MLD 100-300km from disturbance center in developing cases may signal genesis within 6hrs, and significantly higher MLD 500-800km from disturbance center in developing cases may be an indicator of genesis within 24-42hrs. Additionally, it is found that increased lightning to the west of the disturbance center favors genesis. The calculation of MLD over the 0-200km annulus reveals more variance for dissipating cases when compared to developing cases across the time period leading to genesis or DD. Through the analysis of lightning strikes in developing and non-developing tropical disturbances, it appears that the use of such data to better predict tropical cyclogenesis is plausible. The geostationary lightning mapper (GLM) that should be available on GOES-R in late 2016 will provide total lightning measurements with higher detection efficiency than the WWLLN. Plans are underway to develop quantitative algorithms to improve tropical cyclone genesis forecasting, where the WWLLN data is being used as a proxy for the GLM.

15. Thunderstorm Characteristics Correlated with Terrestrial Gamma Ray Flashes Observed by Fermi Gamma-Ray Burst Monitor, RHESSI, and MODIS

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Terrestrial gamma ray flashes (TGFs) are known to be associated with thunderstorms since their discovery and are specifically identified with individual lightning events. While this is known, there remains a multitude of uncertainty in the meteorology of a TGF producing storm. TGFs are observed by the Gamma-ray Burst Monitor (GBM) on the Fermi Gamma-ray Space Telescope (Fermi) and the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI). Characteristics of TGF producing thunderstorms were determined using data from the polar-orbiting Moderate-Resolution Imaging Spectroradiometer (MODIS) meteorological satellite. Because of the association between TGFs and lightning, by examining lightning data we obtain the spatial proximity of the TGF. Out of a possible 230 TGFs observed by GBM and RHESSI

that were geo-located using coincidences with World Wide Lightning Location Network (WWLLN), only three separate events spanning from 13 August 2008 to 13 May 2010 (one GBM and two RHESSI) occurred within seventeen minutes of MODIS passing over the same footprint. Each thunderstorm that produced a TGF during these three events was associated with tropical thunderstorm systems with cloud top heights ranging from 15.9 km to 17.5 km. This indicates that the TGF sources were consistent with models of relativistic runaway electron avalanches causing breakdown near the tops of cumulonimbus clouds. A comparison for each storm at the latitude and longitude by use of the MODIS Cloud Product that corresponds to the TGF-WWLLN correlation was constructed indicating that each storm appeared to be associated with considerably high tropopause altitudes as well as in the vicinity of coastal regions. In a second analysis, a histogram of flash rate as a function of time over a thirty-minute snapshot was prepared to determine what phase of the storm evolution that the TGF occurred. By this, it was found that the TGF does not appear to happen at a preferred spot in the lightning flash rate temporal development close to the TGF.

16. A Comparison of Model Precipitation Forecasts for Hurricane Ida (2009)

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Hurricane Ida (2009) was a long-lived late-season hurricane (4 November – 10 November) that caused substantial amounts of rainfall along the Mid-Atlantic coast. At its peak, Ida was a Category 2 hurricane with maximum sustained wind speeds of 90 knots (~46 m/s), but quickly weakened to a tropical storm due to cold ocean temperatures and strong vertical shear. After making landfall on 10 November as a tropical storm, Ida quickly became an extratropical cyclone, which merged with an occluded front and spawned a new upper-level cyclone. Due to a low-level anticyclone in the northeast US, Ida's remnants stalled, producing large amounts of rainfall along the East coast, with a maximum of 18 inches (~46 cm) in southeast Virginia. As of July 2011, Hurricane Ida is the most recent significant tropical cyclone to have made landfall on the United States, causing \$300+ million in damage from flooding, winds, and storm surge. Ida's genesis probability was not forecast as "medium" (30-50%) until just 18 hours before genesis and only shortly before Ida's landfall did models have reasonably accurate precipitation forecasts. This study looks at precipitation forecasts from 09 November and 11 November from the NAM, GFS, and HWRF out to 72 hours from initialization time. Each models' quantitative precipitation forecast is analyzed and evaluated against each other as well as the actual observed rainfall.

17. Quantifying Diurnal and Seasonal Wind Power at Crystal Cove

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Wind power is a largely untapped renewable energy resource which can alleviate both baseline and peak energy demand in California. Most demand comes from coastal population centers

therefore quantifying availability of coastal and near-offshore wind power availability is crucial to informing future zoning and power-grid decisions. Coastal wind power potential in Orange County is weak to moderate, yet the contribution of the diurnal sea-breezes to this power has not been quantified. UCI operates a meteorology station at nearby Crystal Cove State Park which has recorded about 1 year of coastal weather. This project will analyze the observations to quantify the seasonal and diurnal components of OC coastal wind power resources. The results will be used to evaluate and calibrate the accuracy of mesoscale weather models in OC. Project outcomes will 1) help place OC coastal resources in the context of the broader regional and state-wide renewable resources; 2) document the microclimate of CCSP to complement other ongoing marine and ecological characterizations of this undeveloped slice of the Southern California coast.

18. SAM Global Teleconnection at Multidecadal Time Scales

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This study investigates the global teleconnection of Southern Annular Mode (SAM). Reanalysis-2 data shows that there is a clear link between SAM and zonal and meridional winds in the tropical Indo-Pacific region. The coherent teleconnection pattern repeats for the three extreme SAM events in the instrumental period. The strongest teleconnection occurs in austral summers and during high SAM periods. A spectral analyses of the CMIP5 GISS-R pre-industrial and millennium model runs reveal that extreme SAM events are a natural variability occurring at multidecadal timescales. The GISS-R model, however, does not reproduce the observed teleconnection between SAM and the tropical Indo-Pacific region.

19. Airborne Lidar Data Assessment of Wallops Island, Virginia

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The Virginia eastern shore & Delmarva Peninsula is an ideal test location for developing adaptive conservation approaches, (particularly for migratory birds & their habitats) & strategies for analyzing the effect of sea level rise on coastal ecology & municipal establishment. This work will use existing remote sensing LiDAR data provided by the NASA Wallops Flight Facility to map current distributions of important coastal habitats, develop vegetation specific algorithms for reducing errors in calculation of elevations during LiDAR processing, detail areas likely to experience the greatest impact from sea level rise, quantify the rate of habitat change, & create beach profiles while identifying areas that may become important wetlands as coastal systems attempt to migrate inland. These are essential precursors to effective management / protection of coastal habitat & ecology. We have developed various digital models of the elevation & terrain (surface & bare-earth) of Wallops and the surrounding areas. The models & processes used to develop them are the base for our identification of ecological habitats, terrain composition & adaptation options to mitigate the effects of sea-level rise.

Physics

20. Discreet Markovian Dynamics of a Finite System

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Markov matrices provide a powerful mathematical tool for the analysis of discreet stochastic processes. In this work, we consider two simple dynamical systems. The first is a one dimensional random walk with n transient states and two absorbing states. The random walker can take steps of constant unit length to the left (probability q) or to the right (probability p). The process continues until the random walk is terminated by one of the two absorbing sites. The second dynamical system is a simple model of evaporation. Individual molecules or atoms may occupy a number of surface states, each of different negative energy. Probability transitions among the surface states of different energy are determined by temperature dependent Boltzmann factors. The atoms can also transition to a single absorbing vacuum state of zero energy. Using Markov matrices, we calculate the transition rate of atoms to the vacuum state which is a direct measure of the evaporation rate. We then calculate the temperature dependence of this evaporation rate.

21. Investigation of the Rail Gun

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The rail gun system is simple in design and clearly demonstrates the existence of the Lorentz force through the acceleration of a small object. This investigation will take a look at this rail gun system, specifically some of the interesting physics behind the limitations of the system as well as their effects on the efficiency of its operation. These limiting factors include friction, air resistance, heating within the rails, and melting as a result of a plasma arc traversing the length of the rails. This investigation will also review some design considerations for the rail gun as well as our design that will be used to compare any measured results with our theoretical predictions.

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