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Center for Coastal Physical Oceanography, Old Dominion University

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Studying Earth's Environment from Space

Typically, the earliest college-level exposure that an undergraduate receives to the earth sciences is in a large lecture class, particularly for non-science majors. Seldom does this static, qualitative format lend insight for introductory-level students into what is means to be a scientist. This spring, students taking CDR Mike Alfultis's Remote Sensing class at the U.S. Coastal Guard Academy had the opportunity to *do science*. By engaging in the process of scientific inquiry of real-world problems, like El Nino, global warming and ozone depletion, students sharpened their skills in critical thinking and the use of technology. From analyzing research quality satellite data of the oceans, land, and atmosphere, students honed their analysis, synthesis, and interpretation skills. Through collaborating in small groups, sharing data, and presenting their results in written reports and oral presentations, they improved their communication and social skills. But, did they learn anything about oceanography as a result of this hands-on approach? CDR Alfultis is convinced they did: "Students think they have mastered an understanding of a complex system such as El Nino through class lectures and discussions. The reality of the situation is that, when faced with interpreting actual data, they find there are gaps in their understanding. When students are actively engaged in a process of inquiry using the satellite data, their understanding deepens and crystallizes."

Satellite images of Earth are proven tools for studying the complexity of Earth's environmental systems. Earth observing satellites are routinely used to monitor rapidly changing weather, El Nino, ocean currents, land and oceanic vegetation, polar sea ice distribution, and stratospheric ozone depletion. Rarely, however, do students have the opportunity to access and use such data for scientific inquiry into Earth Science. Teaching faculty, whether junior or senior, may find incoprorating satellite data into their science curriculum difficult because of the complexity and volume of the data, the computer hardware and software requires to process the data, and little available time during the academic year to develop a new curriculum.

The goal of Studying Earth's Environment From Space (SEES), a NASA Earth Enterprise-funded project headed by CCPO's **ELIZABETH SMITH** and CDR Mike Alfultis of the U.S. Coast Guard Academy, is to improve Earth Science education by increasing the use of satellite data in undergraduate science classes. Their approach is to develop

classroom materials linked to guided inquiry computer exercises which make use of research quality satellite data. SEES consists of four modules on the following topics: Stratospheric Ozone, Global Land Vegetation, Ocean Processes, and Polar Sea Ice Processes. Table 1 shows the available satellite data.

Table 1. AVAILABLE SATELLITE DATA

Module	Satellite Data Variable	Satellite Data Source
Stratospheric Zone	Total Ozone Concentration	Total Ozone Mapping Spectrometer
Global Land Cover	Normalized Difference Vegetation Index	Advanced Very High Resolution Radiometer (AVHRR)
Ocean Processes	Sea Surface Temperature, Chlorophyll Concentration, and Sea Surface Height	AVHRR, Coastal Zone Color Scanner, Sea Wide Field of View Sensor and TOPEX
Polar Sea Ice Processes	Ice Concentration for North and South Polar Regions	Special Sensor Microwave Imager and Scanning Multichannel Microwave Radiometer

Each module contains background material for lecture and discussion in the classroom and computer laboratory resources. The lecture resources are presented as an electronic textbook viewable by a Web browser. The computer lab materials contain public domain software for data display and analysis, tutorials, satellite data, and computer exercises for students. A password secured Instructor's Guide accompanies the exercises. The software is a version of NIH-Image for the Macintosh that was modified by NASA Goddard Space Flight Center especially for SEES. It will work on Windows machines with a Mac emulator. A cross-platform Java version of the software is expected to be available within the next year.

Assessments of students' learning have a powerful influence on education policies and practices. For that reason, Smith and Alfultis are working with a team of experts in Educational Psychology and the Learning Sciences from NASA's Classroom of the Future at Wheeling Jesuit University to assess what students who use these exercises actually learn.

For samples of images available and for further information, please visit SEES' site on the WWW at: http://see.gsfc.hasa.gov/edu/SEES.

Notes from the Director

All organizations go through various phases, and we are certainly going through one now. With the departure of **LOUIS (Lou) A. CODISPOTI**, CCPO research professor; **A. D. (Denny) KIRWAN, JR.**, CCPO professor; their able and enjoyable assistants and postdocs; and **CAROLE BLETT**, CCPO administrato\ r and *CCPO CIRCULATION* Editor, CCPO is certainly going through a change. As puzzle masters and knowledgeable chemists, Lou and Denny would point out this is not a phase change but, at least temporarily, a decrease in CCPO's entropy. Even with replacements, it is doubtful that CCPO will ever return to the former point in phase space. We will miss all of them.

The future here will be different without our departing colleagues, but the spirit and tradition they helped create here will remain. We still enjoy the support of the University, Commonwealth, and community in our endeavor to create a unique research and education center and we will continue.

Larry P. Atkinson
Director, Center for Coastal Physical Oceanography

Student Profile: WILLIAM J. SCHULZ

LCDR WILLIAM (Bill) SCHULZ has been a part-time student at CCPO since August 1996. In real life, he is an active duty Navy METOC (meteorology and oceanography) officer, whose recent duties included serving as the weather officer onboard an aircraft carrier and teaching the tactical applications of meteorology and oceanography. His current assignment involves providing ocean and weather forecasts to ships at sea as part of the watch team at the Naval Atlantic Meteorology and Oceanography Center in Norfolk.

Bill graduated from the U.S. Naval Academy as an oceanography major and headed to San Diego for a three-year assignment as a Surface Warfare Officer on a frigate. Following that tour, he attended the Naval Postgraduate School in Monterey, California. "I started out at Monterey as an Operations Analysis student. That curricular office was next door to the Oceanography curricular office. After six months of walking past the Oceanographers' door, I finally stuck my head in and switched from Surface Warfare to METOC." Bill graduated from Monterey in 1992 with a master's degree in Physical Oceanography and Meteorology, and then he began a string of METOC tours in Norfolk.

While at CCPO, Bill has been working with **Denny Kirwan**, **Bruce Lipphardt** and **Chet Grosch** on developing methods of merging disparate data like buoys and current meters with numerical models to produce detailed surface current maps. Following graduation this year, he will be assigned as the Executive Officer at the Naval Atlantic Meteorology and Oceanography Facility, Jacksonville, Florida.

COMMUNITY OUTREACH: CCPO Scientists Reach Out to K-12 Students

One of the pleasures of academic life is teaching. The most receptive audience seems to be the just pre-teens of late elementary school when nearly everything is interesting and subjects are not constrained by artificial boundaries called history, biology, or mathematics. **JOHN KLINCK**, CCPO professor of oceanography, traveled to New Bern, NC in early March to participate in the "Expanding Horizons" program for the academically gifted students in the 4th and 5th grades of the Craven County (NC) public schools. The day-long program at the Craven County Community College involved exposure to diverse topics (calligraphy, law court, shark internal anatomy, marine aviation, etc.) each taught by a specialist (judge, aviator, artist, scientist, etc.). Each student chose four classes to attend. For his part, John delivered (twice) a class on oceanography with a focus on Antarctica. There was a short slide show of the global ocean and biosphere (courtesy of NASA), ships, places, people, animals, and sampling activities. The class discussed life on ships, who owns Antarctica, how krill and penguins interact, subjects to study to become an oceanographer, the international character of oceanography, the utility of knowing several languages, and many other things.

When talk ran down, the class cocked and released go-flo and Niskin bottles, tried on foul weather gear and boots, and told personal anecdotes. At the end of each class, the students dashed off with great enthusiasm to their next encounter with an expanding horizon.

Also, in Virginia, Norfolk Academy held its first Middle School Career Day on April 21. The event was hosted by its Alumni Association, who recruited local professionals "to stimulate and excite the 8th and 9th graders as they begin to think about their futures." As part of this program, CCPO Director, **LARRY ATKINSON**, described what a career as an oceanographer is like and how students could begin preparing for a future in science. In addition, CCPO research assistant professor, **CATHY LASCARA**, provided the students with an overview of the unlimited career opportunities associated with new developments in computer technology. Both Larry and Cathy emphasized the importance of verbal and oral communication skills, as well as studies in math and science, which surprised some students. The students were extremely attentive and many demonstrated a genuine interest in pursuing a scientific career.

Sabbatical Cowboy and Wannabe Straight Shooter Gang Ride Out of Town!

CCPO CIRCULATION has learned that one of the founding faculty members of the Center for Coastal Physical Oceanography, Professor **A. D. (Denny) KIRWAN, JR.**, is leaving to join the Physical Ocean Science and Engineering faculty in the College of Marine Studies at the University of Delaware in Newark, DE. In Denny's last seminar appearance as a faculty member on April 12, he commented that his tenure at CCPO was the most productive of his career. He chaired more Ph.D. student committees, published more papers, and received more grant and contract support than any other comparable period. He thanked **Larry Atkinson**, Director of CCPO, for his support and praised him for his foresight and leadership in building the Center to one of the premier research institutions focused on the coastal oceans. Denny also praised his long-time CCPO collaborator and friend, **Chet Grosch**, for his scientific acumen and his patience in trying to teach Denny. Denny noted that Chet now succeeds to the coveted position of the "most mature" faculty member of CCPO.

CCPO CIRCULATION has not confirmed rumors that Denny's departure is one step ahead of the posse.

Leaving with Denny, for the Physical Ocean Science and Engineering Program, are the rest of the "Wannabe Straight Shooter Gang," Drs. **BRUCE LIPPHARDT** and **MIKE TONER**. When contacted about the move, Lipphardt asked, "Do I finally get a pay raise and a new officemate?" Toner's comment was, "Hey, I have high standards; I go where the money is."

CCPO will miss Denny and his gang, but we wish them well as they ride into another sunset. Happy Trails!

Good-Bye Monarchs; Hello Terrapins

CCPO CIRCULATION also wants to announce that **LOUIS (Lou) A. CODISPOTI** and his fine group, **CURTIS BROWN**, **STEVE GAURIN**, and **VINCE KELLY**, are moving to the Horn Point Laboratory of the University of Maryland in June. Lou reports that he has spent five enjoyable and productive years at Old Dominion University, during which many colleagues in CCPO and the Department of Ocean, Earth and Atmospheric Sciences (OEAS) have been extremely supportive. Lou adds, ``I want\ to thank them all and to extend an open invitation to visit me at Horn Point." Meanwhile, Lou will be visiting frequently in the next few years as his group continues to pursue joint research on Chesapeake Bay with colleagues at CCPO and OEAS. It is his hope that his move to Horn Point will serve as a catalyst to further enhance the collaborations between Horn Point and Old Dominion University.

Lou extends a special thanks to **Larry Atkinson** for the major role that he played in making his stay at the University possible and for his kindness. He also wants to express his gratitude to the Old Dominion University Research Foundation who made the administrative aspects of running a research program as painless as possible.

CCPO is pleased that Lou will continue his collaboration and friendship with us and wishes him and his group success at their new home.

Puzzler

The purpose of the *Puzzler* is to record thought-provoking questions and problems that have appeared on comprehensive, qualifying, and candidacy exams. Readers are encouraged to submit their own favorites, as well as to attempt to answer all questions. All communications should be directed to: ***Wizzard****@ccpo.odu.edu*. **Wizzard** will acknowledge the sources of all questions/problems used and will publish selected thought-provoking (not necessarily correct) answers to previous submissions.

With considerable regret **Wizzard** announces that this is his/her last *Puzzler*. After considerable soul searching, **Wizzard** has decided to join the "Wannabe Straightshooter Gang" (article this issue) at the University of Delaware. **Wizzard** looks forward to answering challenging problems from the new *Puzzler* editor.

The family spelling of **Wizzard** has been the subject of considerable email discussion. **Wizzard**'s mother said the other

spelling had been preempted by a large unnamed Software Company that she is not particularly fond of. Hence she chose "**Wizzard**" so that her child would have a unique name devoid of any commercial implications.

No answers were submitted to the fall season's *Puzzler* in time for the last publication of CCPO Circulation, Question 98.4, which was posed by **LOU CODISPOTI**. Hence, Lou decided to solicit answers again with an incentive of free lunch to the first five correct answers. For **Question 98.4**, Lou says that an albatross is excellent at soaring flight, and so is a vulture. Why then does the albatross have high aspect ratio wings and the vulture low aspect ratio wings?

Answer to Question 98.4. Four oceanographic graybeards responded to the question about the differences in aspect ratios between albatross and vulture wings. All four respondents (Drs. Charlie Flagg, **Chet Grosch**, Phil Richardson, and Walker Smith) came close enough to earn a meal with wine, collectible the next time that they see **DENNY KIRWAN** or Lou. Where were the young folks? **Wizzard** and Lou wonder if the younger generation of oceanographers are spending too much time glued to their CRTs instead of observing nature.

Here is the official answer gleaned mostly from "Exploring Biomechanics: Animals in Motion" (by R. M. Alexander, *Sci. Americal. Library*, 1992) and supplemented by flying and soaring experiences of *lou@ccpo.odu.edu* vast and respondent Flagg).

First some facts about wings or airfoils. (1) In general, high aspect ratio wings have higher lift/induced drag ratios than low aspect wings, given similar angle of attack, etc. A "long wing" is, in general, more efficient than a "stubby wing." (2) In general, a given foil has higher lift/area at high speeds. All other things being equal (e.g., mass, form drag), if you go fast, you need less wing area. (3) A disadvantage of high speed is that your turning radius increases, unless you increase the angle of attack, which increases induced drag (thereby lowering speed) or unless you lose altitude. (4) High aspect wings have the following disadvantages. They tend to reduce roll-rate, and thus, the ability to quickly initiate turns. Being so long, they present engineering problems with respect to attachment, flexing, and flapping.

With the above in mind, let us turn to the lifestyles of the vulture and the albatross.

It is important for the vulture to be able to gain altitude from the updrafts in thermals. Since thermals are small horizontal scale features, it is advantageous for the vulture to be able to make tight turns at relatively small angles of attack. This means it needs a lightly loaded relatively large area wing. In addition, a vulture eating by roadside or near a pride of lions has a requirement to be able to launch quickly. Thus, a vulture needs to be able to flap its wings powerfully. This would be difficult with a high aspect wing.

Albatross' tend to live in the southern ocean where winds are strong, and to gain lift from widespread more or less continuous wind features (updrafts on the backsides of ocean swells and vertical wind shear). In addition, the albatross needs to be able to fly relatively fast and has little need for making tight low angle of attack turns (although **Wizzard** has seen them make some pretty tight turns on occasion, which were accompanied by a loss of altitude and/or speed that they could easily make up via the widespread lift features). Thus, the albatross needs less wing area than the vulture (of the same mass). Also, the albatross does not normally need to launch quickly in low wind conditions. So an albatross' lifestyle favors the higher lift/induced drag ratios of high aspect wings.

Question 99.1. At sea level on a clear day at noon, the solar irradiance on the "blue" window (425-475 nm) where clean water is most transparent is about 50 W m-2. How much of this irradiance will reach a depth of 1000 m in the clearest ocean water? How does this compare with the irradiance at sea level at night? At what depth would there be only 1 photon m-2s-1 left? If you measure the light at the bottom of the deep ocean (at 4000 m, say), you find that 107 photons m-2s-1. Where does that light come from?

Answer to Question 99.1. This question was posed by Curt Mobley of Sequoia Scientific. *zxd@raptor.ocean.dal.ca* correctly answered all questions. Mobley used an extinction coefficient of 0.0017 (1/m) and got an irradiance at 1000m of 2 X 10-6 W/m2. This is about the same as the irradiance on the sea surface on a cloudy night. The depth at which there is one photon irradiance is 3500 m. Finally, the surprisingly high (to **Wizzard**) photon irradiance at 4000 m is due to bioluminence.

Question 99.2. As a deep water wave moves into shoaling water properties such as wavelength; amplitude; and the

particle, group, and phase velocities all change. However the wave period does not change. Why?

Enhanced Ocean Predictability Through Optimal Observing Strategies

In October 1998, **MIKE TONER**, **BRUCE LIPPHARDT**, **CHET GROSCH**, and **DENNY KIRWAN** started a collaboration with Drs. Chris Jones and Drew Poje at Brown University. The long-term goal of this research is to develop the requisite technology to design effective observation strategies that maximize the capacity to predict mesoscale and submesoscale conditions. This effort brings together the oceanographic expertise at CCPO with the dynamical systems expertise at Brown. The focus of the study is to quantify dynamical information in Lagrangian data so that objective decisions can be made regarding disposition of observational resources.

The first milestone of the project is to determine the extent that velocity fields determined soley from Lagrangian data agree with known flows that include a wide variety of physical processes such as mixing, wind forcing, and nonlinear processes. The benchmark for this are the time varying velocity fields generated by a primitive equation model described in "Geometry of cross-stream mixing in a double-gyre ocean model," which is in press with the Journal of Physical Oceanography. The authors are Drew Poje and G. Haller of Brown University. Not only does this model include the requisite variety of processes, the resulting flow shows highly energetic and complex flows confined to a jet region and a large quiescent region, as well. This latter feature, which is typical of coastal regions and enclosed basins, can bias Lagrangian data since drifters tend to congregate in high velocity regions.

There has been a lot of activity recently on this project. Earlier this year, Mike and Denny visited Brown, and Drew Poje recently spent a week at CCPO. Using technology developed earlier by Bruce and Chet, Mike and Drew have demonstrated that Lagrangian velocities really do represent the large-scale flow characteristics as well as the same number of simulated randomly spaced moorings do. Moreover, the Lagrangian data contains information on small-scale flow features not seen in the mooring data.

This finding makes no use of the dynamical information contained in Lagrangian trajectories; it treats this data as irregularly spaced Eulerian data. The next step in the study will be to see if the trajectory information can be used to improve the accuracy of the velocity fields and reduce the number of Lagrangian probes, as well.

The experience gained in addressing these questions will be put to the test in developing sampling strategies for the Gulf of Mexico, where there is a wealth of drifter data. In that phase of the effort, the CCPO scientists will also collaborate with Drs. Lakshmi Kantha and Jei Choi at the University of Colorado.

Just the *facts* . . .

Graduates

M.S.: J. M. FOUGEROUSSE, non-thesis; May 1999; Advisors: **L. P. Atkinson** and **G. F. Cota**.

Grants/Contracts Awarded

G. F. COTA, "High Latitude Bio-optical Algorithms for GLI," NASDA Earth Observation Center, GLI/ADEOS II, Japan, $40,000.

A. VALLE-LEVINSON, **L. A. CODISPOTI**, and **L. P. ATKINSON**, "Nutrient Fluxes Through the Chesapeake Bay Mouth," Virginia Graduate Marine Science Consortium, $77,764.

G. H. WHELESS and **C. M. LASCARA**, "A CAVE TM for Old Dominion University: Supporting Naval Special Warfare," Office of Naval Research, $275,805.

Presentations

E. E. HOFMANN, "Issues, Concerns, and Progress Towards Linking JGOFS and GLOBEC Modeling Studies," Second IGBP Congress, Shonan Village, Japan, May 7-13, 1999.

E. E. HOFMANN, **J. M. Klinck**, S. E. Ford and E. N. Powell, both of Rutgers University, "Disease Dyanmics: Modeling the Effect of Climate Change on Oyster Disease," National Shellfisheries Association Meeting, Halifax, Nova Scotia, April 18-22, 1999.

E. A. Bochenek, New Jersey Sea Grant Extension Program, Rutgers Cooperative Extension; E. N. Powell, Rutgers University; **E. E. HOFMANN**; and **J. M. KLINCK**, "A Physiologically-based Model of the Growth and Development of *Crassastrea gigas* larvae," National Shellfisheries Association Meeting, Halifax, Nova Scotia, April 18-22, 1999.

K. -H. Hyun, I. -C. Pang, K. -S. Choi, all three of the Cheju University, Korea; E. N. Powell, Rutgers University; **J. M. KLINCK**; and **E. E. HOFMANN**, "Modelling Population Dynamics of Pacific Oyster Crassostrea gigas in Korea," National Shellfisheries Association Meeting, Halifax, Nova Scotia, April 18-22, 1999.

E. N. Powell and S. E. Ford, both of Rutgers University; **E. E. HOFMANN**; and **J. M. KLINCK**, "Modeling the MSX Parasite in Eastern Oyster (*Crassostrea virginica*) Populations," National Shellfisheries Association Meeting, Halifax, Nova Scotia, April 18-22, 1999.

E. E. HOFMANN, "Data Assimilation for Marine Ecosystem Models," Center for Environmental and Applied Fluid Mechanics Seminar Series, The Johns Hopkins University, April 9, 1999.

E. E. HOFMANN, "Mathematical Models as a Framework for Testing Hypotheses About the Dynamics of Oyster Populations," Current Topics in Marine Science Lecture Series, Southampton University, Southampton, NY, March 25, 1999.

E. E. HOFMANN, "Environmental and Biological Interactions and Consequences for Krill Larvae Transport," Department of Marine Sciences Seminar Series, University of South Florida, St. Petersburg, FL, March 19, 1999.

J. M. KLINCK, "Hydrographic Changes on the West Antarctic Peninsula Continental Shelf During 1993," Faculty of Applied Marine Science, Cheju National University, Cheju City, Korea, May 6, 1999.

C. M. LASCARA and **G. H. Wheless**, "Teleimmersive Virtual Environments for Collaborative Knowledge Discovery," Advanced Simulation Technology Conference, San Diego, CA, April 1999.

LI, C.; **A. Valle-Levinson**; K.-C. Wong, University of Delware; and K. M. M. Lwiza, State University of New York-Stony Brook, "Bathymetric Effects of Estuarine Tide and Circulation - From Models to Observations," South China Sea Institute of Oceanology, Gangzhou, China, March 8, 1999.

G. H. WHELESS and **C. M. Lascara**, "The Use of Collaborative Virtual Environments in the Mine Countermeasures Mission," 13th Annual International Symposium on Aerospace/Defense Sensing, Simulations, and Controls, Orlando, FL, April 1999.

Promotions

G. F. COTA, to research professor, April 1999.

G. H. WHELESS, to research associate professor, January 1999.

Publications

L. W. Cooper, Oak Ridge National Laboratory; **G. F. COTA**; L. R. Pomeroy, University of Georgia; J. M. Grebmeier, University of Tennessee; and T. E. Whitledge, University of Alaska, "Modification of NO, PO, and NO/PO during Flow Across the Bering and Chukchi Shelves: Implications for Use as Arctic Water Mass Tracers," *Journal of Geophysical Research*, Vol. 104, 7,827-7,836, 1999.

M. S. DINNIMAN and M. M. Rienecker, NASA/Goddard Space Flight Center, "Frontogenesis in the North Pacific Oceanic Frontal Zones-A Numerical Simulation," *Journal of Physical Oceanography*, Vol. 27(4), 537-559, April 1999.

T. M. Soniat, Nicholls State University; E. N. Powell, Rutgers, The State University of New Jersey; **E. E. HOFMANN**; and **J. M. KLINCK**, "Understanding the Success and Failure of Oyster Populations: The Importance of Sampled Variables and Sample Timing," Journal of Shellfish Research, Vol. 17(4), 1,149-1,165, 1998.

J. Moraga, Facultad de Ciencias del Mar Universidad Catolica del Norte, Chile; **A. VALLE-LEVINSON**; and J. Olivares, Facultad de Ciencias del Mar Universidad Catolica del Norte, Chile, "Hydrography and Geostrophy around Easter Island," *Deep-Sea Research I*, 46, 715-731, 1999.

ADK's Words of Wisdom

Environmental Expertise: "By statured scientists I mean those who collect and analyze the data, build the theoretical models, interpret the results, and publish articles vetted for professional journals by other experts, often including their rivals. I do not mean ... the many journalists, talk-show hosts, and think-tank polemicists who also address the environment, even through their options reach a vastly larger audience. This is not to devalue their professions, which have separate high standards, only to suggest that there are better-qualified sources to consult for factual information about the environment. Seen in this light, the environment is much less a controversial subject than suggested by routine coverage in the media."

Edward O. Wilson
in *Science*, Vol. 281(5383).

Note from the Editor

When it comes down to it, I dislike good-byes. I was not going to write any farewell words in my last issue as editor; I was hoping to quietly slip away. However, I ended up with this leftover space on the page and had to fill it with something. It's not that I don't want to say good-bye, it's just that it seems like my good-byes are never final--I will most likely see everyone again sometime in the future.

I have enjoyed my tenure as editor, and I want ot thank Larry Atkinson for giving me the opportunity to establish this newsletter. Most importantly, I want ot thank the article contributors (without you, there would not be a newsletter). I also want to thank Julie and Kim who are very valuable to me. And as for our faithful readers--please keep reading *CCPO CIRCULATION*!

Good-bye for now, and good luck to the new editor.

--*Carole*

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