OS51B-0185 0830h POSTER

Performance Comparison Study of Using Gzip and Bzip2 Data Compression Packages to NASA HDF-EOS Data and Other Scientific Data With Different Approaches

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Appropriate data compression algorithm can speed up the process of transferring huge volume of data over the network and can significantly lower data storage costs. NASA EOS data is often in huge data volume and is in need of good data compression algorithm. Gzip and bzip2 are currently two open-source popular data compression packages. In the first part of the poster, we will show the performance comparison results between bzip2 and gzip when applying these two packages to Landsat 7, CERES, ASTER, MODIS, TRIM, TOMS and MISR data. The result shows that generally the data compression ratio through bzip2 is better than that through gzip by 3%-15%; whereas the encoding and decoding time through bzip2 are significantly longer than those through gzip. Neither bzip2 nor gzip can gain good compression ratio for floating point data.

Strong data locality can be found in many NASA EOS dataset and other scientific dataset. However, general data compression packages like gzip and bzip2 may not take advantage of this characteristic of the being compressed data and may end up with poor data compression performance, especially for floating point data. In the second part of this poster, we will introduce a new approach to use gzip and bzip2 data compression packages. A simple shuffling and re-shuffling algorithm is applied before and after the real data compression procedure. The performance comparison study shows that the combination of shuffling and general data compression approach can improve the compression ratio by more than 10% on average for 32-bit floating point EOS data. It can also improve the compression ratio by 5%-8% on average for 16-bit integer EOS data. It always takes less encoding and decoding time when doing data compression with the combination of shuffling algorithm and bzip2 on scientific data of which data type is larger than 8-bit. It generally takes insignificant extra encoding time when using the combination of shuffling and gzip encoding on NASA EOS data and other scientific data.

The emphasis of the poster is to address that the pre and post data processing procedure should be considered when doing scientific data compression. This poster will also show a clear and easy procedure to use the shuffling algorithm with gzip or bzip2 encoding in HDF5.

URL: http://hdf.ncsa.uiuc.edu

OS51B-0186 0830h POSTER

Obtaining information from Case 2 Waters using constraints derived from adjacent Case 1 Waters

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Accurate remote sensing of Case 2 waters is a difficult task. Yet these waters are very important due to their ecological and economic impact. Remote sensing of Case 1 waters is less challenging because their composition is simpler. As a consequence, retrieval algorithms appropriate for Case 1 waters are steadily improving. The logical next step is to base retrievals of marine constituents of the more complex Case 2 waters on information gained from adjacent Case 1 waters. In this way the information about aerosols and chlorophyll concentration derived from a pixel believed to contain Case 1 waters, can be used as a constraint to retrieve information about an adjacent pixel believed to contain Case 2 waters. This approach will improve our ability to retrieve marine constituents such as CDOM and sediments from Case 2 waters. Utilizing a newly developed method for simultaneous retrieval of aerosol properties and chlorophyll concentration of Case 1 waters, we have designed an algorithm to retrieve marine constituents of adjacent Case 2 waters. We report here on our methodology and preliminary results. Our findings so far indicate that this technique can be used not only to retrieve information about Case 2 waters, but also for generating accurate demarcations (boundary masks) between Case 1 and Case 2 waters, and for discriminating between absorbing and non-absorbing aerosols.

OS51C MCC: 274 Friday 0830h

Preliminary Results From the Jason-1 Mission I *(joint with G)*

Presiding: **L Fu,** Jet Propulsion Laboratory**; Y Menard,** Centre National d'Etudes Spatiales

OS51C-01 0830h

The JASON-1 Mission

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On December 7, 2001, Jason-1 was successfully launched by a Boeing Delta 2 rocket from Vandenberg site in USA. This satellite will maintain the high accuracy altimeter service, provided since 1992 by TOPEX/POSEIDON (T/P), ensuring the continuity in observing and monitoring the Ocean Dynamics (intra-seasonal to inter-annual changes, mean sea level, tides...). Despite four times less mass and power, the Jason-1 system has been designed to have the same performances as T/P, measuring sea surface topography at a centimetric level, revisiting every 10 days the same ground tracks. This new CNES/NASA mission, also provides near real-time data for sea state and ocean forecast. Two months after the launch, the Jason-1 satellite was declared operational. The following 8 months were dedicated to the verification of the performances of the system and the cross-calibration with T/P measurements (taking advantage of the tandem flying formation of both satellites). Results of the CalVal investigations, conducted by the Science and Project Teams of the mission, show that in-flight performances are in accordance with pre-launch specifications. Few weeks after the end of the verification phase and the starting of the routine phase, we will make a brief overview of the mission and a status of the first months in orbit.

URL: http://www-aviso.cnes.fr

OS51C-02 0845h

Jason-1 : Geophysical Performance Evaluation

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The CNES/NASA Jason-1 mission has been defined to maintain the high accuracy altimeter service provided since 1992 by TOPEX/POSEIDON (T/P), ensuring the continuity in observing and monitoring the Ocean Dynamics, and achieving the measurement of sea surface topography at a centimeter level of accuracy.

Successfully launched by a Boeing Delta 2 rocket from the Vandenberg site (CA, USA) on December 7, 2001, Jason-1 is a true ocean observatory that supplies accurate sea-surface height and sea-state measurements to an international user community. Designed to follow on from T/P, Jason-1's instruments and data processing systems have drawn extensively on the lessons learned from its predecessor. After completion of a 8-month verification phase which ended in October 2002, Jason-1 entered its "Operational phase". The goal of this paper is to summarize some of the Jason-1 Project Team and Science Working Team's findings about the in-flight performances and error budget of the system and products.

The paper will deal with: (i) the error budget of the Jason-1 mission at geophysical level: altimeter range, significant wave-height, and backscatter coefficient, as well as radiometer brightness temperatures, water vapor content, and cloud liquid content will be addressed; (ii) the characterization of the spectral content of the POSEIDON-2 altimeter measurements onboard Jason-1, (iii) the characterization of the differences between the 2 altimeters onboard T/P (namely, TOPEX and POSEIDON-1) and POSEIDON-2 measurements, (iv) and finally, the cross-calibration of the T/P and Jason-1 microwave radiometers and altimeters that was performed during the Jason-1 verification phase when the T/P and Jason-1 satellites followed each other only 1 minute apart.

OS51C-03 0900h

Results from the TOPEX/Poseidon-Jason Calibration/Verification Mission

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For 210 days (Jan. 15, 2002 - Aug. 15, 2002), the Jason-1 spacecraft followed TOPEX/Poseidon (T/P) along the same groundtrack, separated in time by about 72 seconds. The configuration was designed to measure the sea surface height (SSH) with each altimeter at nearly the same time and location to difference out real sea level variations in order to examine instrument specific errors. The primary goal was to compare the new Jason instrument to the TOPEX instrument, which has been studied, verified, and calibrated for nearly 10 years. For the most part, the Jason measurements appear to be performing as expected. Statistics and maps of the along-track Jason - TOPEX measurement residuals will be presented to demonstrate the performance. An unexpected outcome of the calibration period has also been the discovery of two small, but significant, problems in the TOPEX measurement. One involves the response of the radiometer during certain spacecraft attitude events, and the other involves the sea state bias model used for the TOPEX Side B data. These errors are described, and their effect on the determination of the relative bias between Jason and TOPEX and on the calculation of global mean sea level change is discussed.

OS51C-04 0915h

Jason-1 POD Status and Assessment

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We review the status of the precision orbit determination (POD) activities for Jason-1 and assess the performance relative to the mission requirements and goals. The multiple tracking systems operating on Jason-1 (DORIS, SLR and GPS) provide an opportunity to compare the contribution of the various tracking types to the POD over an extended time interval. In addition to the higher quality two-channel DORIS receiver and more advanced Blackjack GPS receiver, the Jason-1 laser reflector array is much more suitable for high precision calibration work than the array on TOPEX/POSEIDON. Through comparisons of orbits determined by various groups using different combinations of tracking data, we can evaluate the overall quality of orbits. We also review issues affecting the POD accuracy, such as the tracking systems performance and force and measurement modeling choices.

OS51C-05 0930h

Calibrating the Jason-1 Measurement System: Initial Results from the Corsica and Harvest Verification Experiments

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We present calibration results from Jason-1 (2002–) and TOPEX/POSEIDON (1992–) overflights of dedicated verification sites on the Mediterranean island of Corsica and on a California offshore oil platform (Harvest). The *Arguello Inc.* Harvest Oil Platform is located about 10 km off the coast of central California near Point Conception. Attached to the sea floor, the platform sits in about 200 m of water near the western entrance to the Santa Barbara Channel. Harvest served for a decade (1992–2002) as a calibration site for the TOPEX/POSEIDON (T/P) mission, and is serving in a similar capacity for Jason-1. Initiated in 1996, the Corsica experiment features a fiducial reference station near Aspretto, and a primary sub-satellite tide-gauge deployment site 40 km south at Cape Senetosa (where a Jason-1 ascending ground track reaches landfall). Pelagic GPS techniques have been applied to measure the geoid slope between the locations of the open-ocean altimeter measurements and the coastal tide gauges. Both Corsica and Harvest feature carefully designed collocations of space-geodetic and tide-gauge systems to support the absolute calibration of the altimetric sea-surface height.

Early estimates of the SSH bias from Harvest and Corsica are in excellent agreement, indicating that interim SSH measurements from Jason-1 are too high by +5 ± 1 cm (one standard error). By incorporating improved estimates of the Jason-1 sea-state bias and columnar wet path delay, we observe a significant increase in the SSH bias. (Preliminary results suggest a value in the range of 10–12 cm.) Excepting the bias, the high accuracy of the Jason-1 measurements is in evidence from early overflights. In addition to providing important insight on the accuracy of the science data products during the validation phase of the mission, the estimates of the SSH bias and stability from Corsica, Harvest and other calibration programs will be used to link the T/P and Jason-1 sea-level records.

OS51C-06 0945h

Spectral Properties of the Differences Between TOPEX/Poseidon and Jason-1 Altimeter Measurements

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From mid January to mid August 2002, Jason-1 was in a calibration/validation phase in which Jason-1 and TOPEX/Poseidon flew over the same ground tracks and visited the same spot of the ocean only 72 seconds apart. Within such a short period of time, the conditions of the sea state and the overlying atmosphere column remain nearly the same. The differences between the two nearly simultaneous measurements allow the evaluation of the differences in the two altimeter measurements. Ideally, the differences should be white noise. Any "colored signals" should be evaluated as possible systematic measurement errors. Preliminary results indicate that the Jason-1 altimeter measurements have met the mission requirements with only small systematic errors: 0.1 m for significant wave height, 0.1 dB for the normalized backscatter coefficient. The differences in sea surface height measurements were dominated by orbit errors (3 cm rms) at wavelengths longer than 10000 km. At wavelengths 1000-5000 km there is significant coherence between the height difference and wave height, indicating possible systematic instrument errors with a magnitude of 1.5 cm (rms). The ionospheric delay difference also has a systematic error of 0.3 cm (rms) that is coherent with wave height at wavelengths longer than 1000 km. Adjustments of Jason-1 instrument algorithms and re-tracking of TOPEX/Poseidon data are underway to mitigate these systematic errors. Results from these ongoing efforts will be presented in the meeting.

OS51C-07 1020h

The Accuracies of Smoothed SSH Fields and Geostrophic Velocity Estimates from the Tandem TOPEX/POSEIDON and Jason Altimeter Mission

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Jason-1 was launched on 7 December 2001 and the altimeter data record began on 15 January 2002. The Jason altimeter operated in phase with TOPEX/POSEIDON (T/P) for 7 months, sampling the same 10-day exact-repeat ground track 72 seconds ahead of T/P. On 15 August 2002, a series of maneuvers was initiated to shift T/P to a different 10-day exact-repeat orbit with ground tracks half way between the ground track pattern established during the first 10 years of the mission and continued with the Jason mission. The interleaved sampling pattern with evenly spaced ground tracks afforded by this coordinated tandem mission will enable scientific investigations that have not heretofore been possible. Examples include significant improvements in the understanding of the wavenumber-frequency spectral characteristics of sea surface height (SSH) variability and the effects of eddy Reynolds stresses on the slowly varying background currents.

A prerequisite to such scientific studies is a quantitative assessment of the errors of SSH fields and geostrophic velocity estimates obtainable from the coordinated tandem T/P-Jason altimeter mission. The root mean squared (rms) errors of smoothed SSH fields constructed from the tandem dataset are more than a factor of two smaller than those obtainable from T/P or Jason data alone. The rms errors of each geostrophic velocity component estimated by the parallel-track method with this track spacing are larger than 80% of the signal standard deviation between latitudes 10° and 45°, even with residual orbit errors as small as 1 cm. With suitable along-track smoothing, the rms errors of crossover estimates of both geostrophic velocity components are smaller than 30% of the signal standard deviation between latitudes 5° and 60°. The quadrupling of the number of crossovers from the sampling pattern of the tandem T/P-Jason mission compared with what is obtained from a single altimeter will greatly enhance the ability to investigate eddy-mean flow interaction from altimeter data.

OS51C-08 1035h

Accuracy of Altimetric Surface Geostrophic Velocities

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Coordinated orbit phasing of multiple altimetric satellites is expected to lead to significant improvements in resolution and accuracy of sea surface height (SSH) and surface geostrophic velocity fields. This investigation evaluates three methods of velocity estimation which are currently in use, or which have recently been proposed with tandem missions in mind, for several single and two-satellite configurations, in the Gulf Stream (GS) region. Sea surface height measurements are simulated using the output of the 1/10° resolution Los Alamos model of the North Atlantic. Velocities are then evaluated from perfect measurements, as well as from measurements to which realistic instrument noise and orbit errors have been added, and compared with the original model velocities. These two cases identify velocity uncertainties associated with sampling and data errors respectively. The methods will be applied to JASON-TOPEX tandem-mission data once they become available.

OS51C-09 1050h

Results of TOPEX/Poseidon-Jason Calibration to Construct a Continuous Record of Global Mean Sea Level

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The Jason-1 radar altimetry mission was designed to resolve changes in global mean sea level variation to provide for studies of interannual sea level change. We have conducted an evaluation of the Jason1 measurements to determine their readiness for continuing the 10year time series of sea level change measurements compiled by the TOPEX/Poseidon (T/P) mission.

During the calibration/validation phase of the mission (15 January 2002 – 15 August 2002) Jason-1 followed TOPEX/Poseidon (T/P) along the same repeating groundtrack, trailing by about 72 seconds. Preliminary evaluation of sea level change measurements made during the coincident 21 cycles show that the interim data from JASON-1 is of nearly the same quality as T/P, and there is every reason to expect that the final data will be of the same quality or better.

Several data analysis issues have become clear, including the necessity to revisit the calibration of TOPEX side B before evaluating the cross-calibration of T/P and Jason-1. We have completed detailed comparisons of the T/P and Jason-1 sea level measurements, including each of the measurement corrections using the latest instrument and geophysical corrections, including ITRF2000 orbits, and new radiometer and sea-state bias models. We have determined the relative bias and the residuals differences between Jason-1 and T/P and compared the results to the individual tide gauge calibration of each mission. The implications of the remaining issues in the calibration/validation of Jason-1 for long-term sea level monitoring will be detailed.

OS51C-10 1105h

Satellite altimetry and global mean sea level rise

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For now 10 years, global mean sea level variations are routinely measured by the Topex/Poseidon altimeter satellite. Jason-1, launched one year ago, is now taking over from Topex/Poseidon. In this presentation, we first compare sea level measurements from Topex/Poseidon, Jason-1 and a selection of tide gauges. Then we discuss climate-related causes of sea level rise. In particular we quantify thermal expansion and water mass exchange with continental reservoirs during the Topex/Poseidon lifetime and before. Regional analyses as well as EOF decomposition of the steric component over the past few decades allow us to give some insight into the spatio-temporal contribution of thermal expansion to sea level rise.

OS51C-11 1120h

Can salinity variability be monitored with accurate sea level height : a case study in the equatorial Pacific with the Jason-1 observations

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In the context of the Seasonal-to-Interannual prediction problem, it become increasingly clear over the past few years that to properly use satellite observations of sea surface height in a data assimilation system, both temperature and salinity must be considered in oceanic models. This represents a serious problem because salinity is poorly observed in the ocean as compared to temperature. Moreover, the salinity variability in the upper 300 meters of the tropical Pacific Ocean is sufficiently large to generate an associated variability in dynamic height anomalies of several

centimeters. The interannual part of this variability is now believed to be crucial during the onset phase of an El Nino event. The core of the problem is thus to determine whether or not accurate sea level observations can be useful to estimate the salinity variability when the temperature counterpart can be deduced from in-situ measurements. This will be illustrated by considering an independent source of information to evaluate the level of accuracy. By combining temperature observations from the TAO/TRITON array and an estimate of the salinity variability from an indirect approach, dynamic height anomalies are at first used as a basis to validate the measurements of the Jason-1 mission at the scale of the equatorial Pacific Ocean (8N-8S; 137E-80W). Preliminary comparisons show a good agreement in terms of variability with a RMS difference of about 3-4 cm. It is shown moreover that these interim Jason-1 observations present a similar performance compared to the TOPEX/Poseidon products or even better. This gives us confidence to separate the respective contribution of the thermal and salinity fields in the sea level anomalies. By using in situ measurements from a few sites that are instrumented with several salinometers at depth, we expect to study the relationships between the salinity variability such as salinity barrier layer and sea surface salinity and its signature in sea surface height.

OS51C-12 1135h

OSCAR (Ocean Surface Currents Analysis - Real time): An Operational Resource for Various Maritime Applications and El Niño Monitoring in the Tropical Pacific Using Jason-1 Data

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OSCAR is a pilot processing system and data center delivering tropical Pacific Ocean surface velocity fields via the Internet. Surface currents are computed from satellite altimeter and vector wind data using methods developed during the Topex/Poseidon altimeter research mission. OSCAR is a transition to operational oceanographic applications using Jason-1 altimeter data. The various uses include large scale climate diagnostics and prediction, fisheries management and recruitment, monitoring debris drift, larvae drift, oil spills, fronts and eddies, plus opportunities for search and rescue, naval and maritime operations. OSCAR provides velocity maps updated on a weekly basis at 1 degree resolution. This is made possible by (1) the rapid availability of Jason-1 Interim Geophysical Data Records (IGDRs) within 2-3 days delay from the time of satellite measurement, and (2) the fact that Jason-1 IGDR data approach the accuracy of scientific Topex/Poseidon and Jason-1 altimeter Geophysical Data Records (GDRs) which are generally delayed one to two months.

These velocity fields have been particularly useful in monitoring the recent evolution of ENSO conditions. The ten-year Topex/Poseidon record indicates that eastward equatorial surface velocity anomalies lead the Niño SST anomalies by about three months. Monthly maps have been produced for the NOAA/NCEP Climate Diagnostics Bulletin (CDB) using Topex/Poseidon IGDRs from January 2001 through June 2002, and Jason-1 IGDR data thereafter. Eastward current anomalies associated with the recent SST warming have been prevalent much of the time from early summer 2001 to the present. An assessment of the tropical Pacific surface circulation anomalies through November 2002 will be presented using the most recent Jason-1 measurements.

OS51C-13 1150h

Jason-1 Science Data Distribution

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The Jason-1 altimetric satellite, launched December 2001, continues the work of the highly successful, on-going, TOPEX/POSEIDON satellite in mapping the global sea surface topography. These data will extend the high accuracy sea surface height data set, which is used by oceanographers, climatologists and other scientific and commercial users.

The CNES AVISO, the French multi-satellite databank dedicated to space oceanography, and the NASA Physical Oceanography Distributed Active Archive Center will distribute these data to the science community.

We present the following Jason-1 products and distribution methods that will be made available: near-real-time operational sensor data record (OSDR), interim geophysical data record (IGDR), geophysical data record (GDR) and higher level products, such as sea surface height anomaly products and quick-look browse images.

OS51D MCC: 104 Friday 0830h

Quantitative Developments in Coastal Oceanography I

Presiding: **K Brink,** Woods Hole Oceanographic Institution**; E Thornton,** Naval Postgraduate School**; J Barth,** Oregon State University

OS51D-01 0830h INVITED

On the process of upwelling: Progress from Sverdrup to Allen

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Sverdrup (1938), in a paper entitled "On the process of upwelling", described observations made during three cruises off southern California in the spring of 1937 and noted that "it does not seem feasible to make the described conditions the subject of a mathematical analysis". Sverdrup expressed the hope that "in the future it will be possible to undertake special series of observations during periods of upwelling in order to obtain better knowledge of the phenomenon and to answer many questions which now must be left open". It would be more than thirty years before "special series of observations" were made to study coastal upwelling. Some thirty years ago the first session on "Upwelling and coastal oceanography" was scheduled at an AGU meeting: progress in understanding upwelling had finally picked up where Sverdrup had left off and it continues today with GLOBEC and CoOP studies. It is not hyperbole to say that for more than 30 years John Allen has been "instrumental" in our progress in understanding the processes of coastal upwelling in both the mathematical analysis of ideas and the quantitative analyses of observations. We nostalgically recount some steps in the development of our understanding of coastal upwelling: from coastal jets through coastal trapped waves to the coastal transition zone.

OS51D-02 0850h INVITED

Progress in Upwelling Research: Ecosystem Modeling From CUEA to GLOBEC

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Ecosystem modeling of coastal upwelling systems began with a pulse of small but intense effort in the late 1960s, just when John Allens oceanographic career was taking shape. This presentation tracks the remarkable parallel evolution of the physical modeling and food web modeling of coastal upwelling. The Coastal Upwelling Ecosystems Analysis (CUEA) project provided Allen, a physical oceanography purist, with an early and sometimes uncomfortable association with many biologists and fisheries scientists. As the decades unfolded, Allen was more exposed to both biologists and biology in the interdisciplinary milieu that characterizes oceanography at Oregon State University. This exposure helps explain Allens role in the Global Ecosystem Dynamics (GLOBEC) project. Both guarding the flame and encouraging others to be warmed by it, he maintains the rigor of the core physics while enabling other disciplines to use the physical model. We recount some of the intellectual advances that have characterized the parallel and sometimes convergent evolution of physical and biological upwelling modeling.

OS51D-03 0910h INVITED

Coastal Meteorology and Wind-Forced Coastal Ocean Currents

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The work of John S. Allen and others has established that coastal winds are a primary forcing agent for coastal ocean currents. In the last several decades, considerable progress has been made in the observation and analysis of coastal wind fields. For many years, information on coastal winds was limited to point measurements from coastal stations and moored buoys, supplemented by ship and aircraft observations, and products derived from large-scale atmospheric pressure analyses. The limitations of these characterizations for estimating wind stress over the U.S. west-coast shelf have been dramatically illustrated by thorough comparisons of the various estimates, and by the results of focused observational programs in the coastal zone. Recently, wind stress fields measured by satellite scatterometers and derived from mesoscale atmospheric models have become available. The availability of these fields offers exciting new opportunities, and is leading to new advances in understanding, but important challenges and uncertainties remain. These uncertainties have implications for the future of coastal ocean modeling.

OS51D-04 0930h INVITED

Offshore Ekman Transport and Ekman Pumping off Peru During the 1997-1998 El Nino

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Satellite ocean vector wind measurements are used to describe onshore-offshore Ekman transport and Ekman pumping/suction (i.e., downward/upward velocity) in the coastal ocean at 15S off Peru, where upwelling is the dominant physical process. Normal and El Nino conditions are defined for May 1992 - April 1997 and May 1997 - May 1998, respectively. During normal conditions, both Ekman suction and offshore Ekman transport produced upwelling. During the El Nino, the May-August speed of Ekman pumping was nearly 4 times larger than the normal speed of Ekman suction and offshore Ekman transport nearly doubled. The strong Ekman pumping may be the source for the deepened coastal thermocline during El Nino, although the evidence is not conclusive because of the absence of in situ observations.

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The Baroclinic Instability of Time Dependent Zonal Flow.

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The baroclinic instability of a zonal current on the beta plane is studied in the context of the two-layer model on the beta plane when the shear of the basic current is a periodic function of time. The basic shear is contained in a zonal channel and is independent of the meridional direction. The instability properties are studied in the neighborhood of the classical, steady shear, threshold for marginal stability. It is shown that the linear problem shares common features with the behavior of the well-known Mathieu equation. That is, the oscillatory nature of the shear tends to stabilize an otherwise unstable current while; on the contrary, the oscillation is able to destabilize a current whose time-averaged shear is stable. Indeed, this parametric instability can destabilize a flow that at every instant possesses a shear that is sub-critical with respect to the standard stability threshold. This is a new source of growing disturbances. The nonlinear problem is studied in the same near neighborhood of the marginal curve. When the time averaged flow is unstable the presence of the oscillation in the shear produces both periodic finite amplitude motions and aperiodic behavior. Generally speaking, the aperiodic