Session 3

Sea Level Change and Ocean

03-01

Asia-Pacific Space Geodynamics (APSG) Program Sea Level Project: Status

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03-02

Determination of 20th Century Global Sea Level Rise

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ABSTRACT

Global sea level rise during the last two centuries has been widely recognized as a measurable signal as one of the consequences of possible anthropogenic (human-induced) effect on global climate change. The small rate of sea level rise signal, at 1-2 mm/yr during the last century, may be partially explained by a number of competing geophysical processes, each of which is a complex process within the Earth-atmosphere-ocean-cryosphere-hydrosphere system. They include plate tectonics; the redistribution of atmosphere masses and water from ice sheet and glacier melt; the rebound of the lithosphere and the mantle from deglaciation; the resulting gravity changes; the thermal expansion of the ocean; the extraction of ground water and storage of water in man-made reservoirs; astronomical and atmospheric tides; and changes in coastal sedimentation and erosion. Among these signals, the trend of the thermal expansion variations [Levitus et al., 2000] and recent ice sheet melt [Mitrovica et al., 2001] exhibit basin scale spatial variations with the longest temporal scale at least at several decades. These variations have to be quantified with adequate accuracy for the possible detection of the climate signal in the sea level. The goal is to isolate and accurately measure and possibly predict the climate signal in the observed sea level rise associated with the mass change of the ocean. The contemporary estimate of global sea level rise during the last century primarily used island and coastal tide gauges and correcting for the vertical motion of the tide gauge datum due to the postglacial rebound effect [Peltier, 1988, Peltier and Jiang, 1997; Trupin and Wahr, 1990; Douglas, 1991; 1995, 1997, Mitrovica and Davis, 1995; IPCC studies, Warrick et al., 1996]. Recent estimates of the mean sea level trend are arguably ranging from 1.4 to 2.o mm/yr [e.g., Mitrovica and Davis; 1995; Peltier and Jiang, 1997; Douglas, 1997; Shum et al., 2000; Mitrovica et al., 2000; Cabane et al., 2001; Plag et al., 2001]. Although there are more than 1000 operating tide gauges, less than 100 of the gauges have data record longer than 50 years and are located mostly in the Northern hemisphere. Use of tide gauges for measuring sea level has the limitations of inadequate knowledge of the vertical motion of the tide gauge datum and non-global coverage of the gauges. Satellite radar altimeters have the potential to definitively measure the long-term (decades) global sea level change with a spatial scale of 50 km and with an accuracy approaching 1-2 mm/yr [e.g., Nerem, 1999; Urban et al. 1999; Cazenave et al. 1999; Shum et al., 2000; 2001]. The limitation of using altimeters for measuring sea level change is the knowledge of the biases for the altimeter instrument, their corrections to infer the data

to sea level, their drifts, and the links between different altimeter systems. This paper addresses the recent results of estimation of global sea level rise in the 20th century using satellite radar altimeter, tide gauges, and measurements and models associated with vertical motion of the tide gauge datum. Results include the analysis and quantification of the uncertainties associated with the estimate of the observed sea level rise.

03-03

SEAL: Sea Level Change – An Intergrated Approach to its Quantification

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ABSTRACT

SEAL is a large-scale strategic programme of the German Helmholtz Association aiming at an integrated approach for quantifying sea level on various space and time scales. It is based on new observing techniques and recent high resolution models of the processes governing the system ocean-ice-earthand covers the following interdisciplinary tasks.
(1) Space and ground control of sea level, (2) Ice mass transfer investigations, (3) Ocean modelling and (4) Glacial isostasy investigations. The presentation will describe the project goals and investigations started so far in areas (1) and (4).

03-04

Global Mean Sea Level Change from Satellite Altimetry and Model Estimation

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ABSTRACT

We estimate the global mean sea level change using TOPEX/Poseidon satellite radar altimeter measurements and investigate possible contributions from water mass redistribution within the global hydrological cycle using a few numerical models. We examine the global mean sea level change at seasonal, interannual, and long term time scales. The atmospheric and hydrological models include the ECMWF operational atmospheric model and the NCEP/NCAR reanalysis system. The World Ocean Atlas 1998 and over 19 years¡¯ satellite sea surface temperature observations are used to evaluate steric mean sea level change at different time scales. Both hydrological cycle and steric change provide important contribution to seasonal global mean sea level change. Preliminary results show that steric change is not a dominant contributor to long term sea level rise, indicating that snow and ice melting associated with global warming may play an important role in driving global mean sea level rise.

03-05

Sea Level Change Observed by Satellite Altimetry at Global and Regional Scales

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ABSTRACT

We present interannual sea level variations observed by Topex-Poseidon between january 1993 and december 2000 at global and regional scales, in particular the mediterranean and the Chiana sea. We also compare altimetry-derived sea level with tide-gauges data when available.

03-06

The South Pacific Climate Monitoring Project Phase 111.

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ABSTRACT

AUSAID is funding a five year extension of the South Pacific Climate Monitoring Project. This Phase will include precision tide gauges and continuous GPS at each of fourteen locations to monitor sea level changes.

Results from the Australian National Tidal Facility over the past ten years are discussed and plans for the next five years outlined.

03-07

Interannual variation of sea level of South China Sea and its relationship with ENSO

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ABSTRACT

Six years of TOPEX/Poseidon altimeter data were used to form time series of sea level anomaly (SLA) over the South China Sea (SCS). Continuous and multiresolution wavelet analyses show that the SLA of the SCS has monthly to interannual components of time-varying amplitudes, and the regional slope of SLA is 8.9 mm yr^{-1}, which may be caused by secular climate change. Coherences of SLA with wind stress anomalies (WSA) and sea surface temperature anomalies (STA) are significant at the annual and semi-annual time scales. At periods of 2-5 years the wavelet coefficients of SLA, WSA, and STA have the same pattern, but WSA leads SLA, and STA follows SLA. The zero crossing of SLA in spring is highly correlated with the onset of the summer monsoon. The interannual variation of SCS SLA is correlated with El Niño-Southern Oscillation, and most important is that when the El Niño-like wavelet coefficients of SCS SLA change curvature from negative

to positive, an El Niño is likely to develop. Thus wavelet coefficients of SCS SLA, together with other data, may be used to predict the occurrence of an El Niño.

03-09

GPS Buoy for Indonesian Waters

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ABSTRACT

The Assessment and Development of Sea Survey Technology Group (Kajibang Teksurla) in Baruna Jaya Technical Services Unit (UPT Baruna Jaya) is responsible for providing fast, efficient and reliable techniques of sea surveys to customers. UPT Baruna Jaya has 4 (four) research vessels, which should have sophisticated techniques and equipments for sea surveying in order to fulfill costumer needs. One of typical works is for the UPT Baruna Jaya to perform a hydrographic survey to identify to the contractor characteristics of sea level in the area of interest. In the past, UPT Baruna Jaya used conventional tide gauges, wave rider buoys or even by modeling of existing data.

Recent development of "On-The Fly" (OTF) ambiguity resolution techniques with Global Positioning System (GPS) observations has created a powerful tool for the study of dynamic time series such as the tidal motion of the body of water, accurate measurement of sea level using GPS equipped buoys and many others

The ability to measure and locate precisely the secular, seasonal, annual, inter-annual and longer time scale variations of the sea level, are critical to enhance our understanding of various processes of climate change and to conduct potential mitigation of natural hazards as a result of the sea level change. This is the motivation for assessing and applying of using GPS technology for sea level measurement to improve our understanding of the mechanism of the variations beside of its capability for positioning and navigation which is an essential and typical tool for our research and survey activity in understanding our vast marine environment.

03-10

Sea Level Change in Shanghai from Tide Gauge Records

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ABSTRACT

The monthly mean tide gauge data from January 1945 to December 2001 at Wusong station is adopted to study the sea level change in the East China Sea. The tide gauge data has been adjusted for the land subsidence by the Station. The rising rate of sea level in the region estimated from 1945 – 2001 is about 1.8±0.2 mm per year. There are the multiple oscillation signals ranging from seasonal to interdecadal time scales in the tide gauge records and the amplitude of annual oscillation with 25 cm is the strongest of them. The interannual variations of sea level in Shanghai area seem to have some opposite relations with SOI and the phases of SOI seems to lead that of sea level. The further research project on the sea level change of Shanghai from the historical tide gauge records at Wusong station concerning with the local meteorological data will make some contribution to the climate changes in the eastern part of China and East China Sea.

03-11

Sea Level Change in Hong Kong from Tide Gauge Records

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ABSTRACT

Nearly five decades of tide gauge records and leveling measurements collected at two tide gauge stations in Hong Kong are analyzed to study the tendency and the frequency features in the sea level. The results from the research show that there has been a long-term rise of 1.9 mm per year in the sea level and a downward trend of over 4 mm per year in the vertical ground movement at the tide gauge stations. The variations in the sea level from seasonal through to decadal time scales are detected by the use of time-frequency spectrum of wavelet transform. The annual, semiannual and the 18.6-year variations are most significant and exhibit stable periodicity. The local atmospheric pressure variations mainly influence the annual sea level change. It is found that the interannual fluctuations in the sea level are affected by the interactions between the atmosphere and the ocean in the tropical Pacific accompanying the ENSO events.

03-14

Inter-annual Variation of the Earth Rotation and El Nino Event

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ABSTRACT

El Nino event is a kind of important phenomenon for the environment and disaster. In this paper, the relationship between the inter-annual variation of the earth rotation, atmospheric angular momentum, sunspot number and the El Nino event is analyzed. By the inter-annual variation, we mean the variation of the residuals that the components with periods are less than 1.5 years and more than 8 years have been eliminated from the original data by a band-pass filter. The analyzed result shows that the inter-annual variation of the atmospheric angular momentum and El Nino events are closely related to the inter-annual variation of the earth rotation. El Nino event will appear after the inter-annual variation of the earth rotation rate became slow dawn, that is the inter-annual variation of length of the day (LOD) increasingly became plus extreme value from the minus extreme value, by about half year and more. The inter-annual variation of the LOD reached the minus extreme value in August of 2000, and it will be near zero in March of 2001 according to the prediction of the LOD. According to the result, the authors consider that the initial stage of a new El Nino event will appear in the later part of 2001 possibly. And the analysis of this paper shows that the solar activity can exert certain influence on the appearance of El Nino events perhaps.