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Advances in space geodesy in the last couple of decades have made two types of precise geophysical data available: (i) tidal signals in the Earth's rotational speed variations and polar motion; and (2) the contribution of ocean tides to the above signals as predicted by satellite altimetry derived tide models. The difference of the two, at all tidal periods (long-periods, diurnals, and semidiurnals), contains contributions of the lateral density heterogeneity of the mantle. We developed an algorithm and conduct the computation using 3-demensional mantle heterogeneity models derived by seismological and gravity means (e.g., the SPRD6 model, Isshii and Tromp, 1999). We discuss the importance of the mantle heterogeneity by comparing with the earth rotation observations conducted by NASA using VLBI networks, and the ocean tides model derived from Topex/Poseidon. In general, the effect from ocean tides accounts for more than 90% of the observed polar motion signals in the tidal frequencies, while the effect from the solid mantle only accounts for less than 10%. Accounting for the effect from the density heterogeneity in the mantle reduced the said discrepancy in the observed tidal signals. Conversely, the latter signals therefore provide global constraints to 3D mantle density models for a better understanding of the internal dynamics of the solid Earth.

G22B MCC: Level 1 Tuesday 1330h

Reference Frame Definition and Modeling and Influence of Geophysical Fluids II Posters *(joint with A, H, OS)*

Presiding: **B F Chao,** NASA Goddard Space Flight Center**; R Noomen,** Delft University of Technology

G22B-0306 1330h POSTER

Analysis of Geocenter Time Series Derived From SLR, GPS and DORIS

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Using various time series of sets of station coordinates derived from satellite geodetic observations, we describe the motion of the Earth's geocenter by the time series of the origin of the individual data sets in a common reference frame. The goal of the analysis of these time series is to extract and compare various components such as trend, seasonal and irregular components. In addition to the comparative analysis of the individual signals, a noise analysis of the series is performed. The geodetic techniques involved are DORIS, SLR and GPS, and the respective time intervals are monthly, weekly and daily.

G22B-0307 1330h POSTER

Excitation of the Chandler wobble by varibale annual oscillation of polar motion

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Analysis of the IERS pole coordinates data in polar coordinate system shows energetic oscillation with a period of 6-7 years in polar motion radius and velocity. This 6-7 years oscillation is a beat period of the Chandler and annul oscillations and it is variable mostly due to variable phase of the annual oscillation of polar motion. It has been found that the increase of the annual oscillation phase is associated with the increase of the envelope of the Chandler oscillation. This may suggest that the Chandler wobble may be excited by the variable annual oscillation of polar motion which is excited by the atmospheric and oceanic angular momentum. Some correlations of this beat period and the annual oscillation phase/amplitude with Nino indices were also detected.

G22B-0308 1330h POSTER

Millimeter QC of the ITRF using SLR

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Using Satellite Laser Ranging (SLR) data, the 3-dimensional quality of the International Laser Ranging Service (ILRS) network coordinates can be objectively evaluated to the few millimeters (mm) level. SLR was used to define the ITRF200 origin and scale and its rate. Certain SLR sites in ITRF2000, which had performance problems or short occupational histories, do have questionable coordinates and velocities (e.g. Riyadh, Beijing). The standard error associated with a coordinate set is one-way to quickly access its quality, but in reality the TRUE' coordinate error could be an order of magnitude larger than the standard error. Another way of performing a site coordinate reality check it by treating any site with a height rate larger than a few mm per year as potentially suspect. For example, Beijing and Riyadh height rates of +23 and -17 mm per year; respectively, immediately raises concern. For a given site, the geometry of the ground tracks from LAGEOS and Jason ranging coupled with pass-by-pass range and time bias estimates from global short arcs (i.e. 1-3 days) can be examined to determine the accuracy of the horizontal components of the coordinates. To determine the accuracy of the vertical component involves simultaneously estimating station positions and range biases every 28-days for a period of at least a few months. Currently, Riyadh ITRF2000 coordinates at epoch 2003 are in error by 10 centimeters (cm) in both North and Up and 5 cm in East. Two SLR analysts groups (ASI and CSR) have computed new Riyadh positions using LAGEOS and a combination of LAGEOS and Jason data, respectively. Their coordinates agree to a 3 cm, 1cm, and 2cm in North, East, and Up, respectively. We will use the global SLR LAGEOS and Jason normal point data sets in 2002 and 2003 to resolve which Riyadh coordinate set is more accurate.

G22B-0309 1330h POSTER

TRF Datum Definition and Geocenter Motion Estimate

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Are satellite geodesy techniques currently able to accurately measure the geocenter motion? We try to discuss this question using the geometric method based on the three translation components of the 7 Helmert transformation parameters under minimum constraints condition. Geocenter motion estimates as results from independent combinations of time series of station postions available in weekly sinex files from SLR, GPS and DORIS techniques will be compared. Expecting a few millimeter variations, care should be paid to the analysis strategy used for geocenter motion estimates, being intimately dependent on the datum definition of the underlying Terrestrial Reference Frame (TRF). The most challenging task is then to be able to de-correlate geocenter motion signal from other computational artefact, being often inherent to the TRF implementation. We concentrate mostly on seasonal variations, more easily detectable by satellite geodesy than the secular part believed to be slow over a time period larger than the available data span. Some conclusions will be drawn and implications for IERS, in particular the next ITRF solution and the Global Geophysical Fluids Product Center, will be addressed.

G22B-0310 1330h POSTER

Realisation of the TRF Origin by Different Satellite Techniques

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The origin of the International Terrestrial Reference System (ITRS) is defined as the center of mass of the Earth, including solid earth, hydrosphere and atmosphere. In order to realize the origin for a TRF it is essential to analyse the contribution of the different space techniques (SLR, DORIS, GPS). This is important to detect systematic differences caused by deficiencies in the modelling of parameters that are correlated with the origin (e.g. orbit errors). Incorrect realisations of the origin cause common errors in the station coordinates of the entire network. Reversely common variations of the station coordinates may be transformed into changes of the origin. The goal of this paper is to analyse those effects. We use weekly network solutions of the different techniques. We processed a SLR solution at DGFI over eleven years using LAGEOS 1 and 2 data and applyied the latest models. GPS solutions were obtained from IGS and weekly DORIS solutions from the joint IGN/JPL analyis center. We investigate common signals in the coordinate time series that can be interpreted either as station position variations or origin variations. We compare these time series of the different techniques regarding offsets, periodic or nonlinear effects. We analyse the strengths and weaknesses of the techniques to realise the origin parameters and the effect of the network distribution. Finally we discuss the impact of these results for a TRF combination from weekly network solutions.

G22B-0311 1330h POSTER

Determination of Forced Diurnal Polar Motion Using Large Ring Lasers Gyroscopes

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In October 2001, a very large ring laser gyroscope with an area of 16 m^2 was inaugurated at the Fundamental Station in Wettzell, Bavaria. Large gyroscopes with areas of 1 m^2, 16 m^2, and 367 m^2 are also operational at the University of Canterbury in Christchurch, New Zealand. These ring lasers, measuring the frequency difference between two counter-rotating laser beams, are now approaching a precision of 10 ppb for geophysical signals with periods of less than 2 days and therefore allow the monitoring of variations in Earth rotation (polar motion and length of day) in the high-frequency spectrum. For the first time, forced diurnal polar motion (also called "Oppolzer terms", caused by the gravitational attraction of Sun and Moon) with variations up to 20 mas (60 cm on the Earth's surface) can directly be measured. This is a novelty, because with the space geodetic techniques like VLBI, GPS, SLR/LLR, and DORIS, nutation and forced diurnal polar motion cannot be separated. With a few months of data stemming from the two most accurate ring lasers, the amplitudes of the largest terms of forced diurnal polar motion have been determined with a precision of about 1 mas. The results are discussed and compared to theoretical models.

URL: http://www.wettzell.ifag.de

G22B-0312 1330h POSTER

Multi-reference Evaluation of Uncertainty in Earth Orientation Parameter Measurements

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The earth orientation parameters including the length of day (LOD) and polar motion (PM) are routinely estimated by measurements from various techniques such as the very long baseline interferometer (VLBI), satellite laser ranging (SLR), and global positioning system (GPS). Objective combination of multiple data sets, such as weighted least-squares or Bayesian statistical (Kalman filter) estimation, requires some quantification of the relative accuracy of these measurements. While statistical sampling of measurement error variances and covariances is usually dependent on some assumed values for the ground-truth earth orientation parameters, we present here the evaluation of these statistics using a technique, referred to as the "three corner hat", that does not require the ground-truth values. We perform such evaluation on as many as eight measurement data sets (4 VLBI, 1 SLR, 3 GPS) as well as two combined products that are based on daily sampling and that, when necessary, have been interpolated to common epochs. Daily variability of some parameters, particularly LOD, can be high enough so that numerical interpolation error can account for a significant fraction of the evaluated variances. This can affect apparent error in measurement sets, such as the VLBI data, that typically have a nominal sampling interval longer than a day.

G22C MCC: Level 1 Tuesday 1330h

Effect of Atmosphere and Ocean on Geodesy and Geodynamics: Observation and Modeling II Posters

(joint with A, OS)

Presiding: **O de Viron,** Royal Observatory of Belgium**; R Gross,** Jet Propulsion Laboratory, California Institute of Technology

G22C-0313 1330h POSTER

Interannual Atmospheric Torque and ENSO: Where is the Polar Motion Signal?

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Climate variability on interannual time scales is dominated by the El Nino / Southern Oscillation (ENSO), an ocean-atmosphere instability originating in the equatorial Pacific. ENSO has a strong signature in length-of-day (LOD), which can be accounted for almost entirely by atmospheric angular momentum (AAM) variations. It has been noted, however, that ENSO effects on polar motion (PM) are much weaker and hard to detect. In this study, we use the torque approach to explore Earth-atmosphere interaction associated with ENSO, and seek to understand why the large atmospheric fluctuations arising from ENSO are not effective in exciting PM variations. PM is affected by atmospheric torques acting in the equatorial plane, which arise largely from gravitational and surface pressure interactions with the Earth's bulge. Using the inverted barometer (IB) approximation for the effect of atmospheric loading on the ocean, we find that the bulge torque exhibits significant coherence with the Southern Oscillation Index (SOI), confirming that the atmosphere acts to force PM in association with ENSO. While the bulge torque is correlated with geodetic excitation at high (sub-annual) frequencies, however, the two series are not coherent at longer (interannual) periods, presumably due to the effects of other excitation sources (e.g. oceans) on these time scales. Local (i.e., non-bulge) torques are also found to be coherent with the SOI, in particular due to the interaction of surface pressure anomalies with the large-scale topography of Antarctica. The local torques can be directly related to wind term anomalies of equatorial AAM, largely associated with extratropical vortices located over the Pacific ocean.

G22C-0314 1330h POSTER

Geodetic effects of global warming.

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The anthropogenic increase of greenhouse gas will probably induce significant changes of the atmospheric and oceanic global circulation. We have evaluated the variation of the Earth's gravity field, geocenter motion and rotational variations using the available atmospheric and oceanic outputs from coupled general circulation models participating to Couple Model Intercomparison Project (CMIP 2+) and the corresponding ice sheets (Antarctica and Greenland) changes according to Huybrechts et al. (2003). We discuss on the possible detection of these geodetic effects, especially with new space gravity missions such as GRACE.

G22C-0315 1330h POSTER

Atmospheric Pressure Loading Service for VLBI and SLR

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Time series of 3D site displacements caused by atmospheric pressure loading are computed for all VLBI and SLR sites from May 1976 using 6-hourly pressure field with a spatial resolution of 2.5x2.5 degrees from NCEP Reanalysis. Atmospheric pressure tides are removed from the NCEP Reanalysis data. Loading due to atmospheric tides is computed separately using Ponte-Ray (2002) model. These series are automatically updated on a daily basis. They are available on the Web at http://gemini.gsfc.nasa.gov/aplo . We have validated our model of atmospheric pressure loading by estimating the admittance factors of the pressure loading time series using the data set of 3.5 millions of VLBI observations. These admittance factors can be interpreted as correlation coefficients between the true (unknown) site displacements and our model. The average admittance factors are 0.95 -+ 0.02 for vertical displacement and 1.00 -+ 0.07 for the horizontal displacements. Closeness of these admittance factors to unity allows us to conclude that our model is adequate at the level of measurements noise.

G22C-0316 1330h POSTER

Evaluating Hydrology Estimated From Atmospheric Models And J2

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There have been many studies that have used atmospheric and oceanic numerical models to indicate the importance of the atmosphere and oceans in explaining temporal variations in Earth's rotation and gravitational field. These studies were also useful in imposing limits on the role of the continental hydrology in these variations. However, modeling the continental hydrology is extremely difficult and most atmospheric models only give estimates of the soil moistures for the upper 200 cm of soil, thus ignoring the deeper ground water variations. This study uses ground water observations from over 100 US Geological Survey wells to examine the usefulness of atmospheric models in estimating ground water recharge. It also shows the effects of the recent drought conditions in the US on ground water and variations in J2.

G22C-0317 1330h POSTER

Excitation of Non-Atmospheric Polar Motion by the Migration of the Pacific Warm Pool

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Changes in the annual variation of the Earth's polar motion are found to be largely caused by the variation of the atmospheric angular momentum (AAM). Recent simulation results of oceanic general circulation models further suggested global oceanic effects on the annual polar motion other than the atmosphere. In parallel to previous model studies of global oceanic effect, this research particularly singles out an active large-scale ocean anomaly and investigates its effect on the annual polar motion, determined from satellite observations of the movement of the Western Pacific Warm Pool (WPWP). Although the scale of the warm pool is much smaller than that of the solid Earth, analysis of the non-atmospheric polar motion excitation has shown that the WPWP does contribute non-negligible effects to the annual polar motion. The analysis consisted of over thirty years of the WPWP data (1970-2000) and shows the polar motion excitation is (2.5mas, -78o) for the x-component and (0.1mas, -14o) for the y-component. Comparing this result with the total geodetic non-atmospheric polar motion excitation of (10.3mas, 59o) for the x-component and (10.6mas, 62o) for the y-component, shows the significance of the WPWP. The difference between the WPWP's excitation on (x, y) components of the polar motion may originate from the WPWP's location and general pattern. Changes in the Earth's polar motion has attracted significant attention, not only because it is an important geodetic issue, but also because it has significant value as a global measure of variations within the hydrosphere, atmosphere, cryosphere, and solid Earth; hence global changes. Key Words. Polar motion - Western Pacific Warm Pool

URL: http://www.ocean.udel.edu/cms/xyan

G

G22C-0318 1330h INVITED POSTER

Fluid Effects on Earth Rotation: What is Next?

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The interaction between the solid Earth and its fluid layers (the liquid core, the ocean, the hydrology and the atmosphere) is the main cause of Earth rotation fluctuations. Recently, significant progress in atmospheric, oceanic and coupled ocean-atmosphere models has been demonstrated; in parallel, associated data sets and quantity continues to advance. Current and future interdisciplinary geodesy missions (such as Jason, GOCE, GRACE and ICESat) will provide synergistic information that enables unique insights into Earth subsystem processes. Together, joint analyses will results in improvement of fluid models, which will result in better Earth rotation models. In this presentation, we will discuss what we can expect for the future of Earth rotation modeling, and the great challenges ahead.