used is Least Squares Collocation because of its elegance in handling different kinds of data. Firstly, the gravimetric geoid is computed based on three approaches in gravity anomaly reduction. In the first case the gravity reduction follows the traditional topo-iso approach. The second gravimetric geoid solution is based on the well-known RTM reduction. For the third gravimetric geoid solution the traditional topo-iso approach together with an adapted EGM96 GGM in the gravity reduction is used. The adapted EGM96 GGM is computed using an European topography window. Then these three solutions are compared with the GPS/leveling-derived geoid. In all three solutions, a trend in the pure gravimetric solution is observed, showing the influence of the distant zones on the geoid solutions. This trend is modeled by second order surface polynomials and a transformation of all three solutions is made in order to fit best to the GPS/leveling data. Last but not least, all the three geoid solutions are recomputed again, but this time, in the vector of measurements GPS/leveling data is also included. In the reduction process of the GPS/leveling data, now the trend coming from the distant zones (as computed before) is included, introducing additional reduction term to the reduction process. The accuracy of the thus obtained geoid is studied and explained. Also tests considering the influence of the size of the topography window in the correction of the EGM96 GGM are made.

G51A-0241 0830h POSTER

Multiresolution Analysis of Geopotential and Gravity Data

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Recent advances in the field of signal analysis have provided researchers with new tools for exploring and examining the Earth's crust and upper mantle. Traditional analysis tools employ global basis functions when characterizing measured data. Newer methods provide the opportunity to localize features and signal characteristics. These are exemplified by the use of wavelets for multiresolution analysis. Using symmetric wavelets of arbitrary scale applied to recent models of the geoid, the Earth's crust and upper mantle are examined to identify features that characterize their geological make-up. Two Fourier-based methods are employed in the analysis: filtering on standard rectangular grids, and filtering on the sphere. The results using various datasets and operators are compared in terms of resolution capability, and cost of analysis. With the availability of enormous satellite altimetry and gravity observations from several space missions, the development of new computational tools aims at extracting useful geophysical information from the datasets. Preliminary recommendations are included and ongoing investigations are described.

G51A-0242 0830h POSTER

Potential Problems With the use of Gravimeter Data for GRACE Cal/Val

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The Gravity Recovery and Climate Experiment (GRACE), scheduled for launch in late 2001, will map the Earth's gravity field orders of magnitude more accurately and with considerably higher resolution than any existing satellite. GRACE is expected to deliver estimates of monthly changes in continental water storage averaged over regions of a few hundred km to accuracies of better than a cm of water thickness equivalent. On-land calibration and validation (Cal/Val) of GRACE data will focus on recovery of the negligible surface mass variations expected in dry desert regions of southwest Egypt, but validation of gravity changes by comparison with surface gravity measurements has also been suggested. We examine the feasibility of comparing/combining the GRACE time-variable geoid with continuous measurements of absolute or relative gravity at surface observing stations. Correlation of surface and space-based measurements of gravity depends on the spatial scale at which surface mass density changes are autocorrelated. If mass changes are significantly autocorrelated at scales equal to or greater than the GRACE resolution limits, it may be possible to make meaningful comparisons between network gravity data and GRACE measurements. However, hydrologic signals with correlation length scale of a few km or less would invalidate comparisons of surface and space-based gravity measurements, if those signals are large relative to large-scale mass variations. Preliminary analysis suggests that Antarctic snow accumulations and North American hydrologic mass variations are autocorrelated at length scales of a few hundred km. We present an analysis of the spatial semivariance of various processes, including the hydrology signal from well data and soil moisture measurements, that will contribute to Earth surface mass changes. We also examine the correlation properties of the surface gravity time series from the superconducting gravimeters of the Global Geodynamics Project.

G51A-0243 0830h POSTER

Calibration of GOCE SGG data using high-low SST, terrestrial gravity data, and global gravity field models.

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The GOCE gravity gradients (level 1) are one of the inputs to arrive at level 2 products, for example, geoid heights and gravity anomalies. It is therefore important such level 1 products are free of systematic errors, and that their error has been assessed. The former is called external calibration, the latter error assessment. Systematic errors that might be corrected are, for example, a scale factor and a bias. We will review the possibilities and limitations of using terrestrial gravity and global gravity models for the external calibration of the gravity gradients. In addition, we will explore the possibility to use the GOCE high-low satellite-to-satellite tracking data to calibrate the gravity gradients. The spectral characteristics of the calibration methods will be presented as well as the effect of the external calibration on the level 2 products.

G51A-0244 0830h POSTER

Major Holocene ice sheet signatures in the GRACE data

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A difficulty in the study of post glacial rebound (PGR) arises from the strong coupling between the unknown viscosity structure in the deep interior and the unknown ice history on the surface in virtually all geophysical observables that serve as direct indicators for the evolution of the ice-ocean-earth system. For instance, relative sea level (RSL) are equally sensitive to both unkowns at the peripherals of the ice sheets, and equally less sensitive near the central regions and in the far fields (e.g. Fang & Hager 1996). Our recent analysis using spherical wavelets with a locally support kernel (Fang & Hager, 2001) has revealed that if the viscosity structure has weak lateral heterogenity, as it probably does, the geographic pattern of RSL is relatively sensitive to the ice geometry and less sensative to the viscosity structure. A limitation of the secular changes to be derived from the GRACE is that it only represents the present day rates, some 6 kyr after the completion of deglaciation. In this study, we use spherical wavelets to conduct pattern analysis for the PGR signature in simulated GRACE results. The PGR signature in principle is contained in every harmonic coefficient. Except for a few degrees the signals are, in general, weak. Wavelet is a effective tool for manipulating the global harmonic coefficients to enhance local signals. Wavelet scanning will be performed around the Finoscanndian and Laurentide ice sheets. Quantiative measurements for the gain and loss of the ice history in the GRACE gravity signal will be presented.

G51B MC: Hall D Friday 0830h

The Terrestrial Reference Frame: Definition, Long-Term Stability, and Limitations II *(joint with H, OS, S, T, DI)*

Presiding: **K Larson,** University of Colorado at Boulder**; Z Altamimi,** ENSG/LAREG

G51B-0245 0830h POSTER

Coordinate Time Series of the DORIS Network Stations Since 1993

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LEGOS/GRGS and CLS have been involved in DORIS data processing since the launch of Spot-2 in 1990. They are in charge of the scientific analysis of DORIS data in the field of geodesy, geophysics and space oceanography. LEGOS-GRGS which is a DORIS Analysis Center for IERS, and CLS which has a strong experience as a system operator, have intented to participate tightly to the International DORIS Service star-up, and have proposed their contribution as an Analysis Center in the frame of the IDS Pilot Experiment. The basic products generated with the GINS/DYNAMO software by the Analysis Center are precise ephemerides of all satellites having DORIS onboard, earth rotation parameters, station network coordinates and velocities, geocenter coordinates and low-degree harmonics of the Earth's gravity field, environmental data.

In March 2001, monthly coordinate time series obtained from the analysis of the 1993-1999 Spot-2, -3,-4, and Topex/Poseidon DORIS data have been provided to IDS. Corresponding plots and data files are available on the IDS web site (http://ids.cls.fr). The whole set of data have been re-processed and completed with the data of 2000 and 2001 with a new computation modelling. In particular, the GRIM5-C1 gravity model have been used, as well as the ITRF2000 coordinates and velocities as a priori values. This paper presents the new 9-year time series. We point out the temporal changes observed in the displacement of some stations, and we show the estimate of geocenter motions. For DORIS sites collocated with SLR, we compare the time series obtained from the DORIS and SLR data of Topex/Poseidon.

G51B-0246 0830h POSTER

Determining ITRF2000 Positions and Velocities for the National CORS

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The National Geodetic Survey has determined ITRF2000-compatible positions and velocities for 200+ Continuously Operating Reference Stations (CORS) using every third day of the GPS data collected at these sites through December 2000. This CORS multi-year solution is based on a rigorous least-squares adjustment using the Helmert blocking method in which positions and velocities of selected stations were constrained to ITRF2000 values adopted by the International Earth Rotation Service. A large majority of the CORS exhibit long-term positional stability; however, positions for a handful of primarily Alaskan sites exhibit local anomalies associated with seasonal variations, hydrological loading, and/or other phenomena. We will discuss how our estimates compare with those derived by other organizations and with the NUVEL-1A geophysical model. We will also discuss the transformation of ITRF2000 positions and velocities to the North American Datum of 1983, in which reference frame horizontal velocities are expressed relative to the stable interior of the North American plate.

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URL: http://www.ngs.noaa.gov/

G51B-0247 0830h POSTER

Comparison and Combination of Solutions From the Southern California Integrated GPS Network

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The Southern California Integrated GPS Network (SCIGN) has two independent centers for precise processing of data from 250 stations. The Jet Propulsion Laboratory (JPL) uses the processing software GIPSY-OASIS-II, and the Scripps Institution of Oceanography (SIO) uses the GAMIT/GLOBK/GLORG software. In earlier comparisons of JPL and SIO results, we found discrepancies of several mm in station position and several mm/yr in station velocity and traced these differences to inconsistent antenna heights, different methods of time series analysis, and different reference frames. Current work focussed on correcting antenna heights, comparing baselines, investigating noise models and offset detection, and defining a common reference frame in which to combine JPL and SIO solutions. For baselines, which are relative positions between two stations and hence do not depend on reference frame, the mean difference in JPL and SIO relative position is about 0.1 mm in the horizontal and 0.5 mm in the vertical. Proportional error in baselines is 0.9, 2.5, and 1.0 parts per billion (ppb) for the north, east, and vertical components, respectively, and 1.2 ppb for baseline length. Offset detection and estimation depends on the error model; the best current noise model is a combination of white and flicker noise. Estimated offset uncertainties are then 0.5 mm in the north, 1 mm in the east, and 2 mm in the vertical. To combine JPL and SIO solutions, we defined a preliminary SCIGN reference frame by choosing 16 stations with good geographic distribution and a fairly complete time history back to 1996. The JPL and SIO groups reprocessed data from these stations with loose constraints on station coordinates. We used GLOBK/GLORG to combine the JPL and SIO daily solution and covariance files, aligning to the IGS97 positions of the global stations. These results provide a reference frame (SCIGN97 v.1.) for the entire SCIGN array. For data back to 1996, the mean difference between JPL and SIO solutions in the same reference frame is typically less than 1 mm in the north and east coordinates and 1 to 3 mm in the vertical coordinate. We are combining JPL and SIO solutions from all SCIGN tations in this reference frame.

G51B-0248 0830h POSTER

Analysis of ILRS Site Ties

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By the end of 2000, 94% of ILRS stations had completed station and site information forms (i.e. site logs). These forms contain six types of information. These six categories include site identifiers, contact information, approximate coordinates, system configuration history, system ranging capabilities, and local survey ties. The ILRS Central Bureau, in conjunction with the ILRS Networks and Engineering Working Group, has developed procedures to quality control site log contents. Part of this verification entails data integrity checks of local site ties and is the primary focus of this paper.

Local survey ties are critical to the combination of space geodetic network coordinate solutions (i.e. GPS, SLR, VLBI, DORIS) of the International Terrestrial Reference Frame (ITRF). Approximately 90% of active SLR sites are collocated with at least one other space geodetic technique. The process used to verify these SLR ties, at collocated sites, is identical to the aproach used in ITRF2000.

Local vectors (X, Y, Z) from each ILRS site log are differenced from its corresponding ITRF2000 position vectors (i.e. no transformations). These X, Y, and Z deltas are converted into North, East, and Up. Any deltas, in any component, larger than 5 millimeter is flagged for investigation. In the absence of ITRF2000 SLR positions, CSR positions were used. To further enhance this comparison and to fill gaps in information, local ties contained in site logs from the other space geodetic services (i.e. IGS, IVS, IDS) were used in addition to ITRF2000 ties.

Case studies of two collocated sites (McDonald/Ft. Davis and Hartebeeshtoek) will be explored in-depth. Recommendations on how local site surveys should be conducted and how this information should be managed will also be presented.

G51B-0249 0830h POSTER

A new global plate velocity model using space geodetic data, REVEL

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Our model describes the relative velocities of 19 plates and continental blocks, and is derived from publicly available space geodetic (primarily GPS) data for the period 1993-2000. We include an independent and rigorous estimate for GPS velocity uncertainties in order to assess plate rigidity, and propagate these uncertainties to the velocity predictions. By excluding sites that may be influenced by seismic cycle effects within the plate boundary zone as well sites affected by glacial isostatic adjustment, we believe the plate velocity model is representative of geologically Recent motions (last 10,000 years) and have termed it REVEL, for Recent velocity. Departures from short term rigid plate behaviour due to glacial isostatic adjustment are clearly observed for North America and Eurasia. Australia shows possible differences from rigid plate behavior in a manner consistent with its mapped intraplate stress field. We see statistically significant differences between the velocity predictions of REVEL-2000 and those of the NUVEL-1A geologic model for about one third of tested plate pairs. Pacific-North America motion and motion of the Caribbean plate with respect to North and South America are significantly faster than NUVEL-1A, presumably reflecting systematic errors in the geological model because the relevant rate data do not reflect the full plate rate. Many other differences between the geodetic and geological models appear to reflect real velocity changes over the last few million years. Nubia-Arabia and Arabia-Eurasia appear to be slowing, perhaps related to the collision of Arabia with Eurasia and consequent increased resistance to Arabia's northward motion Several other plate pairs, including Nazca-Pacific, Nazca-South America and Nubia-South America, are experiencing gradual slowing that dates back to about 25 Ma. This is the time of the initiation of the modern Andes mountains, and we speculate that associated crustal thickening on the leading edge of South America may play a role in this deceleration by affecting the balance of plate driving forces.

G51B-0250 0830h POSTER

Apparent Geocenter Variations from IGS Analysis

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Natural Resources Canada's (NRCan) Geodetic Survey Division (GSD), on behalf of the International GPS Service (IGS) and its Reference Frame Working Group, combines a consistent set of station coordinates, velocities, Earth Rotation Parameters (ERP) and apparent geocenter to produce the IGS official station position/ERP solutions in the Software Independent Exchange (SINEX) format The weekly Analysis Centers (AC) solutions include estimates of weekly station coordinates, apparent geocenter positions and daily ERPs. All the AC products are required to be in a consistent reference frame. The combination of station coordinates originating from different ACs involves removing all available constraints and re-scaling the covariance information.

The weekly combination generally includes estimates of coordinates for 120 to 140 globally distributed stations. While the cumulative solution currently includes approximately 280 stations, about 215 of them have complete information and reliable velocity estimates. The IGS combined products are required to be consistent with the most recent realization of ITRF (currently ITRF97, soon in ITRF2000). This is done by transforming the weekly and cumulative solutions, respectively using 7 and 14 Helmert transformation parameters (3 translations, 3 rotations, 1 scale and their respective rates). The transformation parameters are determined from a subset of 51 high quality, globally distributed and generally collocated (with other space techniques) stations, also known as Reference Frame (RF) stations.

The weekly estimated IGS apparent geocenter for the period between 99/08/01 (Wk 1012) and 01/08/04 (Wk 1025) has been analyzed. The apparent X, Y and Z geocenter components were estimated with respect to the realization of ITRF97. The estimated weekly geocenter positions relied on COD, ESA and JPL SINEX solutions for the period of interest. The formal error for the weekly geocenter is about 6-8mm for the XY components and 8-10mm for the Z component. The average geocenter estimate for that period are 2mm, 4mm and -17.5 mm for the X, Y and Z components. A spectral analysis was done on each component of the weekly estimate. A bias and a drift were removed from each component of the time series. The spectral analysis on each axis showed the presence of a significant annual period with amplitude of about 4mm, 6mm and 7mm. Semi annual periods were also found for each axis with amplitude of about 3.5mm 4.5mm and 4.0mm.

The position and velocity of the origin of the proposed IGS realization of ITRF2000 with respect to ITRF97 was also determined. It was estimated from the IGS97 and (proposed) IGS2000 realizations of ITRF using 50 common stations. The results indicate that with IGS2000 the Y and Z components of the IGS apparent geocenter would agree better with the IGS2000 origin. This also suggest an improved agreement between the SLR determination of the geocenter, which defines the origin for ITRF2000 and the IGS combined apparent geocenter. The presentation will show details of the analysis.

G51B-0251 0830h POSTER

Effect of ITRF2000 on TOPEX/POSEIDON Orbit Determination and Mean Sea Level Time Series

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The precision orbits produced by NASA for the TOPEX/POSEIDON altimeter satellite are based on a set of SLR and DORIS station coordinates determined in 1995 (CSR95L01 and CSR95D02). However, it is clear that this terrestrial reference system needs to be updated. In particular, the DORIS station velocities in CSR95D02 are not sufficiently well determined to accurately propagate the positions into the current years, much less into the Jason-1 follow-on mission. The ITRF2000 reference frame is a new solution for the SLR, DORIS and GPS tracking stations which is a significant improvement over previous solutions.

The concern is that artificial trends can be introduced into the sea level observations from changes or errors in the reference system used for orbit determination. ITRF97 has a significant offset (2 cm) and drift (2 mm/yr) relative to the CSR system, so it was not adopted for the NASA orbit production. ITRF2000 has adopted the SLR determination of the terrestrial origin, which has substantially removed this offset and drift. By adopting ITRF2000, NASA and CNES should be able to adopt the same terrestrial reference frame for the transition from TOPEX/POSEIDON to Jason-1. The level of backward compatibility with the CSR95L01/D02 system is examined to determine if any significant artifacts in the sea level time series are introduced in the sea level time series based on the NASA orbits.