deformation study, through the connection to international reference frame. Particularly important is the study of for VLNDEF in order to integrated evaluation with other continental and regional networks, as SCAR GPS Epoch and TAMDEF.Some aspects related to the data processing in the Antarctic region and the use of the ITRF2000 as reference frame will be discussed in the paper in addition to the analysis of the deformation in the area.

G33A-11 1620h

Neotectonic Crustal Motions in the Antarctic Interior Measured by the TAMDEF GPS Network

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The Transantarctic Mountain Deformation (TAMDEF) GPS network has been constructed over Victoria Land, Antarctica. After new station deployments in 2003, the TAMDEF network extends 670 km north-south and 400 km east-west. The network crosses gradients in predicted vertical motion due to glacial-isostatic rebound and spans the Terror Rift in the western Ross Sea, where faulting reaches the seafloor and volcanism is active, suggesting modern rift activity. The network now includes 6 remote stations designed to operate continuously, surrounded by 26 campaign sites. The continuous stations will provide strong control for the campaign measurements and will more rigorously constrain vertical bedrock motions. The network of campaign sites allows a broad region to be monitored for horizontal motions. The first campaign sites were installed in 1996 and the continuous stations were added to the network between1999 and 2003. Measurements from the first 7 years of monitoring document east-northeastward horizontal motion of stations on islands within Terror Rift with respect to stations along the inland flank of the Transantarctic Mountains, which are used to approximate a stable 'cratonic' reference frame for interior Antarctica. The rate of extension is about 4mm per year. Although a component of this motion may be due to glacial isostatic adjustment, modeling suggests that the horizontal motion is also due to tectonic opening of the Terror Rift. The horizontal relative motion direction is perpendicular to faults that cut the seafloor mapped from marine seismic data, compatible with modern tectonic activity in the rift.

G33A-12 1635h

Crust and Upper Mantle Seismological Model of Transantarctic Mountains from TAMSEIS

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The large 2-D geometry of the Transantarctic Mountain Seismic Experiment (TAMSEIS) allows for characterizing the East Antarctic crust and upper mantle deep into the interior. This array consists of three sub-arrays that 1) traverse 370km from McMurdo across the Transantarctic Mountains with 20 km spacing, 2) traverse perpendicular to the first sub-array with spacing of 80km running 1400 km inland from Terra Nova, and 3) extend along the coastline at 80km spacing. The 43 seismic stations are used to examine the Antarctic lithosphere with better resolution and extent than any previous experiment. Using a niching genetic algorithm (NGA is a guided search method) we are able to invert both receiver functions and surface wave phase velocities simultaneously. As the two data sets are complimentary they increase the uniqueness of the solutions and reduce need for a priori information. Additionally the NGA allows us to implement ice layers with known thickness and velocity without adversely affecting the inversion. This method produces a variety of 1-D models representing structures underlying TAMSEIS stations. By analyzing these 1-D structures together, we produce 2-D cross sections. From the 2-D cross sections we construct a 3-D model representing the crust and uppermost mantle from the Ross Sea to 1400 km within the East Antarctic plate. The resultant models indicate several structural variations from the Ross Sea to the East Antarctic Ice Plateau. 1) The East Antarctic crust thins through the Transantarctic Mountains from 40 km to 20 km at the Ross Sea, coinciding with uplift. 2) The Ross Sea crust and upper mantle are largely different from those observed beneath East Antarctica. The Ross Sea Moho is not only shallower than that of East Antarctica, but the underlying mantle is seismically much slower. 3) The East Antarctic crust is homogeneous for a large lateral extent. These observations may suggest a buoyant load underlying the West Antarctic Rift System, and a coincident response from the colder, older, and more brittle East Antarctic plate.

URL: http://epsc.wustl.edu/seismology/jfisher/

G33A-13 1650h

Lateral viscosity variations beneath Antarctica and their implications on regional rebound motions and seismotectonics

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In this paper, the potential contributions to present-day crustal motions and seismicity from glacially-induced Pleistocene ice mass changes in Antarctica are assessed by considering different combinations of ice and earth models. Due to the uncertainties in reconstructing the late-Pleistocene ice-sheet distributions in Antarctica, three ice models that encompass a wide range of plausible scenarios are considered. Two different earth models are used to describe the viscoelastic response of the bedrock: In the first one, mantle viscosity varies with depth only. In the second model, three-dimensional viscosity variations inferred from seismic tomography are included, with East Antarctica underlain by a stiff cratonic root and the upper mantle underneath West Antarctica being relatively weak. The results show that predicted present-day crustal motions depend strongly on the ice model chosen, with vertical motions focused around former ice domes. The horizontal motions are greatly affected by earth rheology, as the flow goes from the stiff East Antarctic cratonic root to the weaker West Antarctic mantle. Fault stability is predicted over much of Antarctica today, indicating that the seismically quite state is probably due to the presence of the thick ice. At the site of the 1998 Balleny Island Earthquake (Mw=8.1), the induced fracture stresses are relatively small by comparison, and interestingly become more prone to stress failure when a three-dimensional earth model is assumed.

G34A CC: 519 A Wednesday 1530h

Computations in Geodesy and Geosciences I *(joint with OS, GC)*

Presiding: **R Blais,** University of Calgary**; M Soofi,** University of Calgary

G34A-01 1530h

Modeling Uncertainties in Flood Predictions due to Climate Change

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Classical estimation theory and parametric modeling assume that the hydrologic system structure exhibits stationary behaviour over the entire collection of system observations. However, hydro-meteorological processes are subject to both nonlinear and nonhomogeneous adaptations due to climate change and other variabilities. Previous studies have shown that the variability of daily rainfall causes considerable uncertainty in flood hydrograph simulation. Therefore, in this paper, two approaches, estimation theory and parametric modeling are used to (1) describe the structure of extreme daily rainfall and (2) track error propagation from rainfall data into simulated flood hydrograph. A new approach that uses a Kalman filter to track patterns of hydrologic system behavior under different rainfall inputs and over different periods under greenhouse gas forcings is developed. The methodology incorporates bootstrap resampling and Monte Carlo modeling to simulate different scenarios of hydrologic inputs into HEC-1 flood prediction model to generate potentially realizable flood hydrographs for a medium sized watershed in southwestern Alberta. Preliminary studies indicate that uncertainties in rainfall input can result into about 100% increase or 20% reduction in the 200 year flood.

G34A-02 1545h

Estimating Density Contrast From Global Geopotential Fields

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Each succeeding global geopotential model has provided an increasingly accurate representation of the Earth's potential on the sphere. From these models, the quasi-spherical surface known as the geoid is defined. It is an equipotential surface and represents all mass variations within the Earth. If one could interpret a model's spectrum in terms of plausible depths to anomalous bodies or layers, one could estimate the probable density variations that contribute to that portion of the measured field, and thus to the geoid. It has been known since the early nineteenth century that any Newtonian potential V on an equipotential surface could be represented outside that surface by a layer of density given by the normal derivative of V. Recently, this was used to represent all of the mass within and beneath the mantle to create a realistic model of the Earth's gravity field. This presentation will extend the surface density contrast model by describing a method to use the knowledge of the Earth's potential to estimate possible density contrast variations within the mantle. An indication of why the spectrum has been subdivided, and what density variations will result, will be given.

G34A-03 1600h

Towards Grid-Enabling the Global Geodynamics Project

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The Global Geodynamics Project (GGP) allows Earth scientists to access a network of globally distributed superconducting gravimeters (SGs). By establishing standards around SG instrumentation and data, in concert with various bilateral agreements, the GGP ensures scientific and organizational integrity. Now in its second phase, the GGP is proactively engaging non-traditional disciplines - i.e., those outside the tidal gravimetry community. Although GGP has generated interest with geodynamicists, seismologists, and others, there are practicalities which inhibit engangement by these 'non-specialists'. For example, to geodynamicists and seismologists, tidal, atmospheric, hydrologic and oceanic signals are all unwanted. This means that the processed GGP Data must undergo further, non-trivial reductions before it is useful for geodynamic and seismic purposes. The requirement to correlate data in time and space presents another example. Currently this is a manually intensive process that requires geodynamicists and seismologists to specify temporal (e.g., a period of time, an event in time) and/or spatial (e.g., global, regional, specific instruments) specifics to allow for further analysis. These and other examples suggest infrastructural opportunities for further enabling GGP scientists. With decided emphasis on Virtual Organizations, open standards and qualities of experience, Grid

Computing has the potential to facilitate deeper degrees of collaboration within the context of the GGP. Through use cases which seek to identify core resonance effects at semi-diurnal periods (e.g., Lumb et al., AGU Monograph 72, 51-68, 1993) and earthquake activity, various opportunities for Grid-enabling the GGP are identified and prioritized. Because the High Energy Physics community has figured so significantly in the development of the World Wide Web and The Grid, a Grid-enabled GGP also has the potential to play a role in shaping the ongoing evolution of Grid Computing.

G34A-04 1615h

Numerical Modeling of Fold Structure Evolution

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Tectonic forces along thrust belts deform geological layers to produce folds and later faults when stresses exceed the failure stress. Evolution of such structures is influenced by several factors including composition and strength of geological layers, inhomogeneity in strength (vertical and horizontal), geometry of the layers, and boundary conditions. A comprehensive understanding of the influence of these factors on the development of folds and associated faulting is required to explain evolution of these structures over geological time scale. To achieve this understanding the finite element modeling technique is used. The study focuses on the effect of material strength and geometry of the layers on the development of fold structures and related faults. For a given boundary condition and geometry, it is observed that geological layers with low strength thickens without folding. In the case of high strength geological layers, folding is observed without significant thickening. When the layers and the decollement are horizontal, folding initiates in the middle of the unrestrained part of the layer. When a ramp is included in the decollement folding initiates at the ramp. In all the cases only one fold is produced except when vertical concentrated loads are applied that multiple folds are observed. When basal friction between decollement and the overlying layers is present, the layers thicken more and amplitude of the fold is less than when no friction is present. In the case of extreme folding cracks develop which may later evolve into faults, producing fault-bend folds.

G34A-05 1630h

Geoid determination in mountainous coastal regions from altimetry and gravimetry

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The paper presents numerical results for the solution of the altimetry-gravimetry boundary value problem along a mountainous coastline. The solution uses spherical Shanon wavelets based on the Abel-Poisson kernel and spherical pseudo-diffferential operators. The orthogonality of Shanon wavelets can be used for the numerical solution, overcoming some technical problems with generally non-orthogonal spherical wavelets. A numerical experiment has been conducted in the western coast of Canada and the US and the results have been compared with the geoid heights computed from gravity anomalies by applying 1D FFT spherical Stokes convolution with 50 km integration radius and with the most recent Canadian geoid (CGG2000). Significant effects of compatibility are expected in this mountainous coastal region. The smoothness effects on the solution are discussed and conclusions are drawn about the quality of the numerical solution obtained.

G34A-06 1645h

Error Analysis of Gravity and Bathymetry of the World's Oceans

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The National Geospatial-Intelligence Agency (NGA) has an ongoing massive collection and evaluation effort of terrain and gravimetric data to support navigation. This presentation will concentrate on the methods and findings of the data error analysis in ocean areas. NGA has devised a method of error analysis, which used differences between altimetry-derived gravity anomalies and its marine, submarine, and airborne survey gravity anomalies. Comparisons with both gridded and point gravity anomalies and how the results differ with respect to bathymetry, significant wave height, ice coverage, roughness, coast line variables, and the accuracy of the gravity anomalies will be presented. In recent years NGA has helped other geodesist design, test, and tune their procedures by comparing altimetry derived gravity anomaly sets in development using its data holding and analysis tools. This has resulted in significant overall improvement and dramatic improvement in the reduction of outliers (spikes), in shallow water areas, and in high frequency areas. Overall improvement and improvement in shallow water areas will be discussed. NGA has applied this same method of data analysis to bathymetric depths. It used comparisons of gridded bathymetry files derived from altimetry and ship soundings and from ship soundings alone with point depth soundings. There will be a discussion of how the results differ with respect to such variables as roughness, plus examples of how the analysis can be used to identify bad tracks in the point depth data. The results from the gravity anomaly analysis created certain expectations for the bathymetric results. There were some surprises. The results of using the two bathymetry grids will be discussed as well as the results using the two altimetry-derived grids (i.e. the gravity anomaly and depth grids). NGA is excited about methods of estimating bathymetry from a combination of satellite altimetry and ship depth soundings and in new developments in determining depths in shallow water using LIDAR or motion imagery. NGA looks forward to collaborating on improvements in the methods of computing bathymetry depths, as it did with improvements in methods of computing gravity anomalies. The presentation will conclude with a discussion of the advantages of using comparisons with point data, the complications introduced by using point data of varying quality, and what must be done to resolve the complications.

G34A-07 1700h

Goals and early results of The Princess of Acadia GPS Project

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The Princess of Acadia is an on-going GPS project in which a GPS receiver and meteorological station have been placed on-board the ferry the Princess of Acadia, which crosses the Bay of Fundy, in the Eastern coast of Canada, on a regular basis. A network of static continuous GPS receivers collocated with meteorological stations and tide gauges have also been installed. The project aims at studying high-accuracy GPS carrier phase relative positioning and navigation under variable weather environment, integration of vertical reference frames and local and tidal effects. This presentation will describe the project and its intended goals. Results will be presented coming from preliminary analysis of GPS data sets, tidal records and search for possible multipath signature in the GPS stations.

G41A CC: 220 C-E Thursday 0830h

Pleistocene Ice-Mass Change, Displacement and Gravity Change, and Their Interpretation With 3-D Earth Models I Posters *(joint with H, OS, S, T, C, GC, PP, SEDI)*

Presiding: **A Lambert,** Geological Survey of Canada**; P Wu,** University of Calgary

G41A-01 0830h POSTER

Glacial Isostatic Adjustment Observed using Historical Tide Gauge Records and Precise Relevelling Data in Eastern Canada

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In this paper, we employ historical tide gauge records and precise relevelling data in Eastern Canada to detect the glacial isostatic adjustment (GIA). The study region lies immediately outside of the Laurentide Ice covered area at the last glacial maximum. As the ice sheet began to decay, leading to the postglacial rebound of the crust in the Laurentide region, the forebulge began to collapse to supply the mass required to produce the uplift in the central region. Therefore, the geodetic data in this region primarily show the glacial isostatic submergence. The analysis of the tide gauge data set for the east coast is based upon monthly mean sea level linear trends. These are then treated using differencing method, in which the trend value at one gauge is considered as a point vertical velocity input and the rest of the records are differenced to cancel out the local variations of the sea level. Special attention is also paid to the contribution of other vertical movement effects such as sediment subsidence. Eustatic water rise is then removed from the records to obtain the postglacial rebound signal. Precise relevelled sections in Maritime Provinces are also used to compute the time variations of the regional tilt. We perform a preliminary comparison between the geodetic results and GIA models. The comparison is based on geodynamic interpretation of the observables in terms of the uncertain parameters in the GIA models, such as viscosity and lithospheric thickness. We then fit a vertical velocity surface in the form of a two dimensional algebraic polynomial over the sea level linear trends and levelling height difference differences. The results are presented in the form of a map for Maritime Provinces. We show that it provides useful constraints for the evaluation and/or refinement of postglacial rebound models. Keywords: Glacial isostatic adjustment, vertical crustal movement model, precise levelling data and tide gauges records

G41A-02 0830h POSTER

Glacial isostatic adjustment and recent sea-level change: The influence of Pleistocene ice sheet evolution on tide-gauge measurements

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The solution to the sea-level equation describing the redistribution of glacial melt water in the oceans is implemented in conjunction with the spectral-finite element method (Martinec, 2000) of modelling glacial-isostatic adjustment (GIA). The main feature of this method is that it solves the field equations governing GIA in the time domain, where a radially symmetric, self-gravitating, incompressible earth model consisting of a fluid core, a Maxwell-viscoelastic lower and upper mantle, and an elastic lithosphere has been adopted in the present study. The additional contribution to sea-level caused by the variation of the Earth's rotation due to the ice-water mass redistribution is deter-