

Excerpt of "Earth: Our Changing Planet. Proceedings of IUGG XXIV General Assembly Perugia, Italy 2007" Compiled by Lucio Ubertini, Piergiorgio Manciola, Stefano Casadei, Salvatore Grimaldi

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Organized by Perugia, Italy July 2-13, 2007 IRPI IVGGG XXIV2007 PERUGIA I T A L Y PERUGIA I T A L Y CMANGING PLANET OUR CMANGING PLANET

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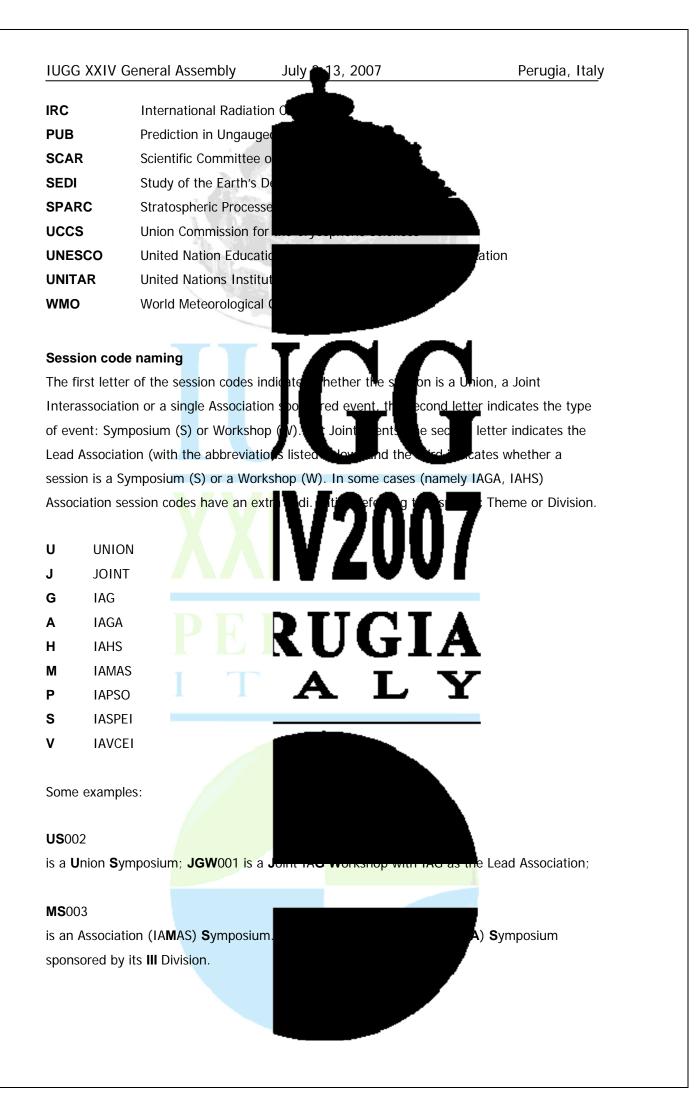
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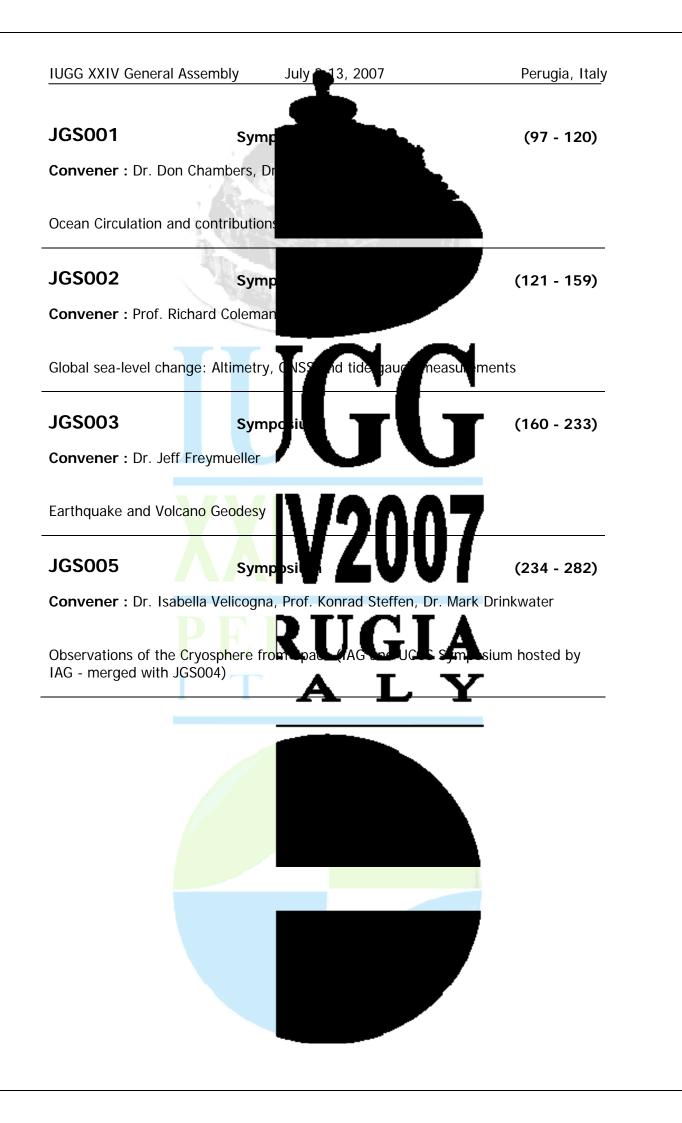
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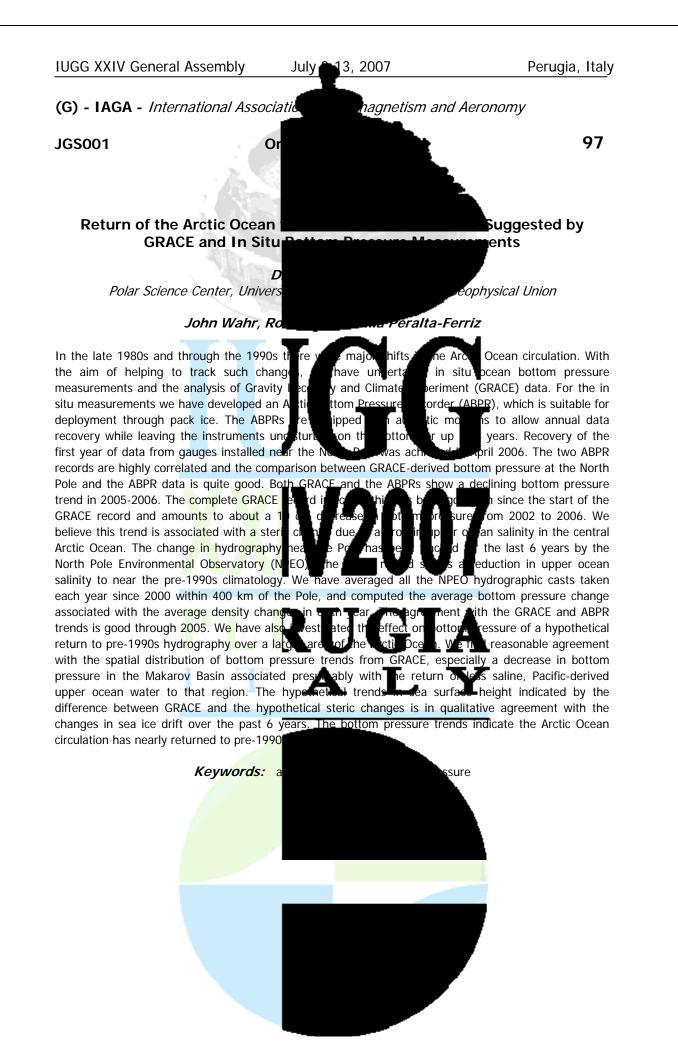
IUGG XXIV General Assembly	July 13, 2007	Perugia, I	taly
SCIENTIF		IITTEE	
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Paola Rizzoli	Ch Pri	Committee	Usa
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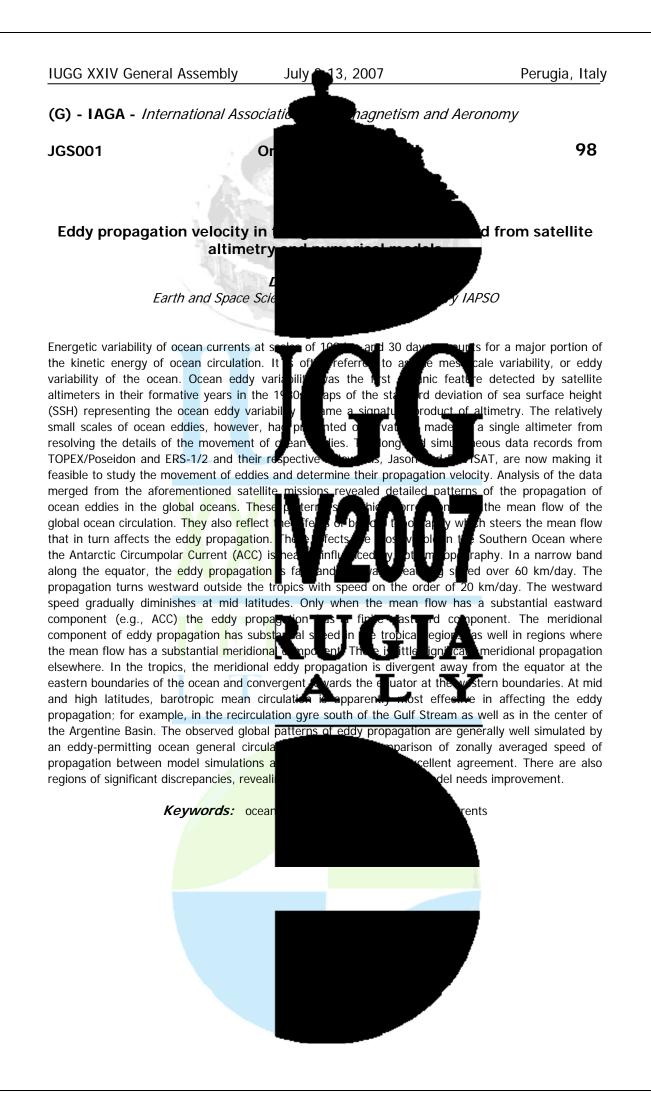
	neral Assembly July 13, 2007	Perugia, Italy
Abbreviations		
AG	International Association	
AGA	International Association	ronomy
AHS	International Association	
AMAS	International Association	Sciences
APSO	International Association	Oceans
ASPEI	International Association	the Earth's Interior
AVCEI	International Associati	stry of the Earth's Interior
CliC	Climate and Cryospher	
Ev-K2-CNR	Everest-K2 CNR Commune	\sim
GEWEX	Global Energy and Wate Experiment	
HKH-FRIEND	Hindu Kush-Himalayan Foveregimes from	ernational Experimental
	and Network Data	
ABO	International Association for the logic	ean raph
ACS	International Association of Cryospheric So	ciences
CACGP	International Commission All nemberic	Shemintry Global Pollution
CASVR	International Commiss on an amospheric	Sill equitation Relations
CCE	International Commission explorite intails	
CCL	International Commission & Clining 1	/VI
CCLAS	International Commission on the Coupled	Land-Atmosphere System
ССР	International Commission on yours and	ecipitation
CDM	International Commission on synamic Me	orongy 🗛
CGW	International Commission on Groundwater	
CIMOD	International Center for International Center for International Center for International Mour	ain Develop tent
СМА	International Commission on the Middle A	tmosphere
CRS	International Celestial Performance	
CSIH	International Commiss	drology
CSW	International Commiss	
СТ	International Commiss	
CWQ	International Commiss	
CWRS	International Commiss	
GAC	International Global Atmospheric Chemistr	у
GS	International Glaciological Society	
LP	International Lithosphe	
NQUA	International Union for	
	International Ocean Ne	

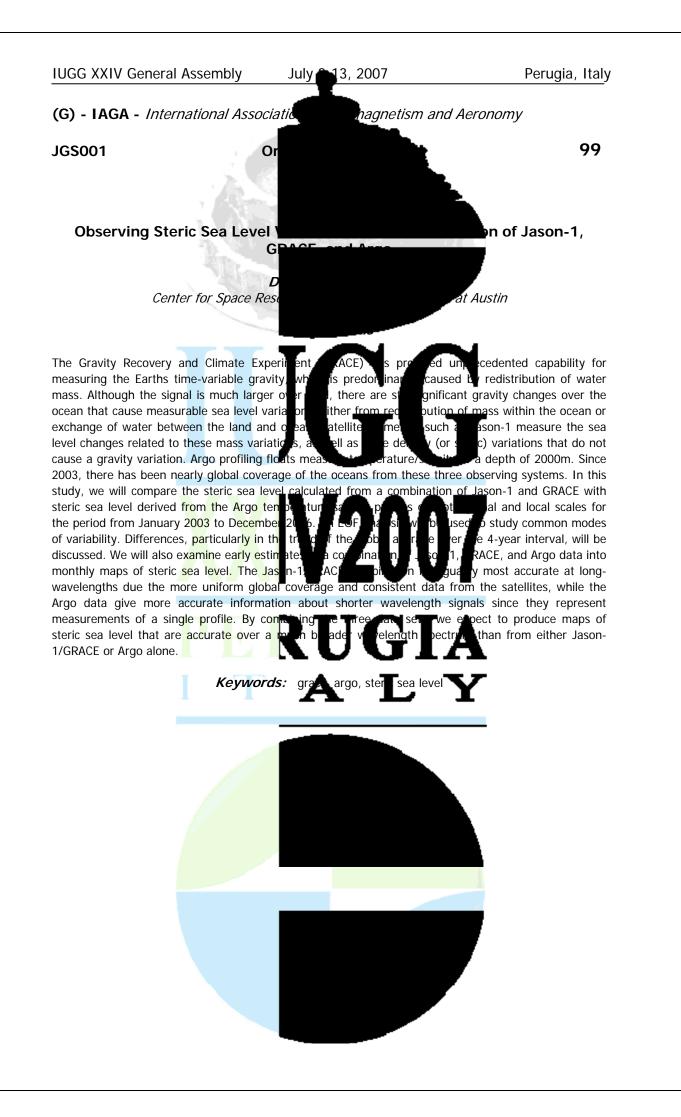


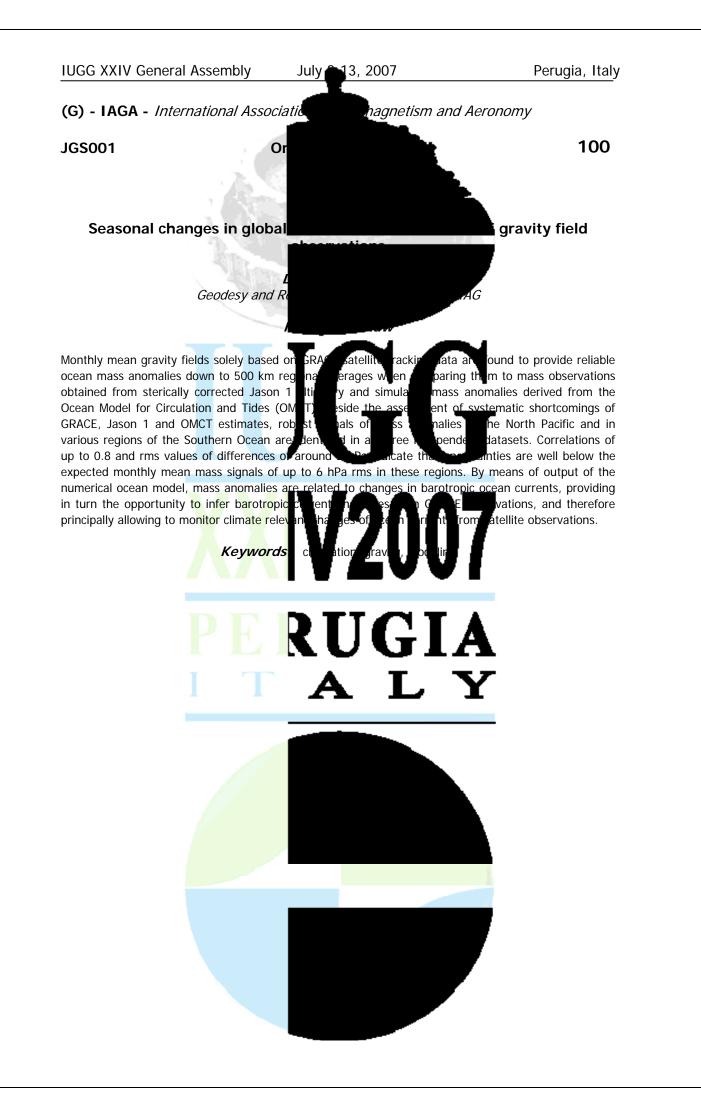


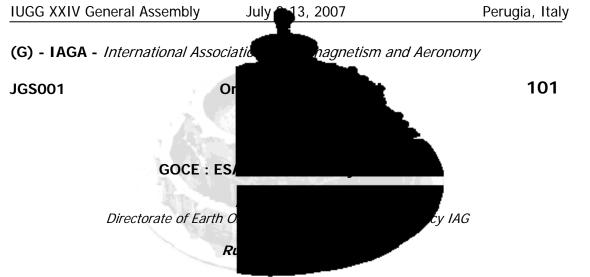












The Gravity field and steady-state Ocean Circulation Explorer Core mission of the Living Plane satellite is scheduled for launch by the end of provide global and regional models of the E surface, with high spatial resolution and gravimetric geoid measured by GOCE will studies of ocean circulation, cryosphere, so this paper we will present the status of the GOC

oloner (GOCE signwill be the first Earth ace Agency (ESA). The ime' he bean[®] jective of the GOCE mission is to . The pima avity field and geoid, its reference equipotential acy. <u>The hi</u>a esolution static gravity field and ide ra of disciplines spanning rese ir azard eodesy and surveying.In physio atu uding the status of the ent ad

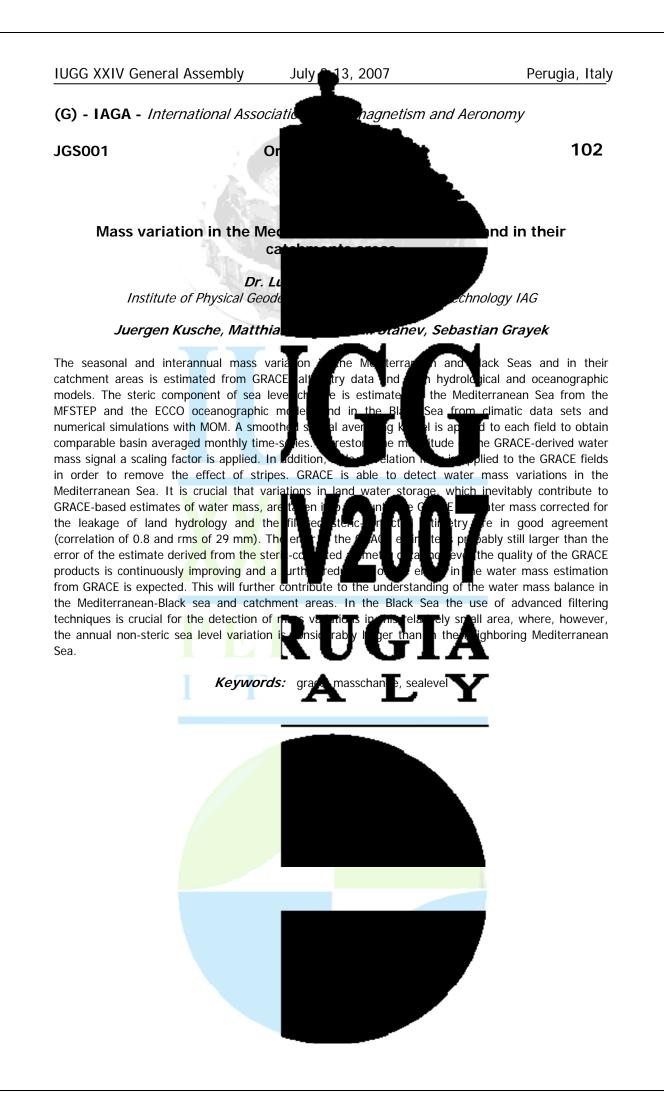
tests of the satellite flight model and payload. Furthermore, the main technical features of the satellite and of the ground segment will be presented.

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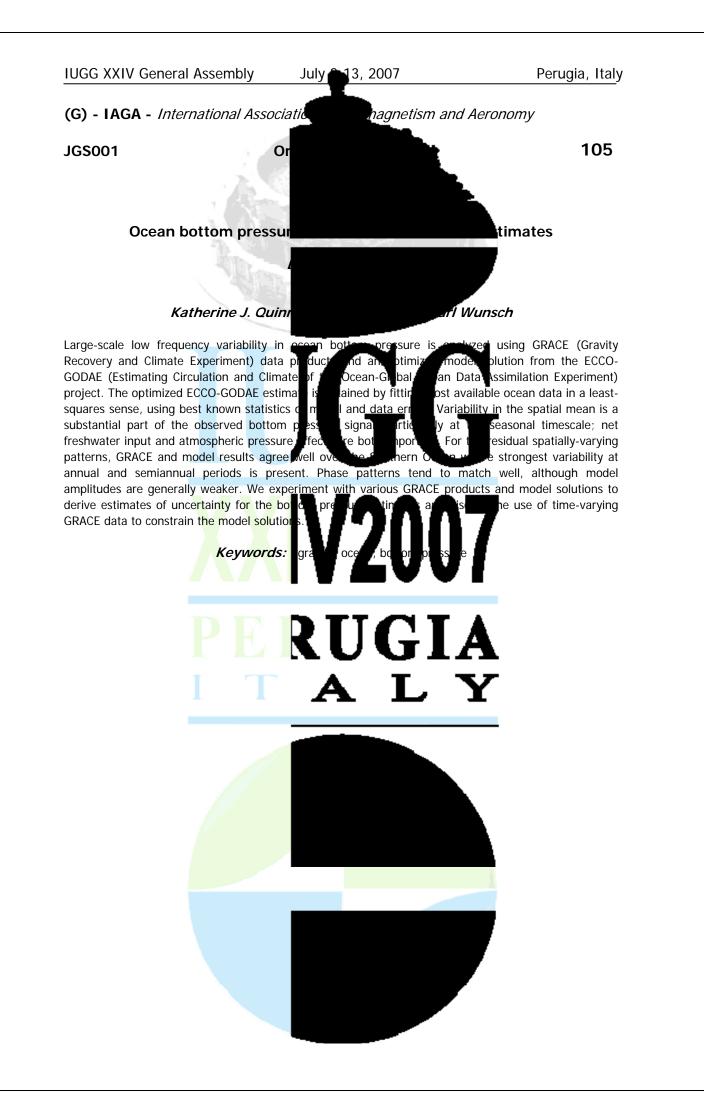
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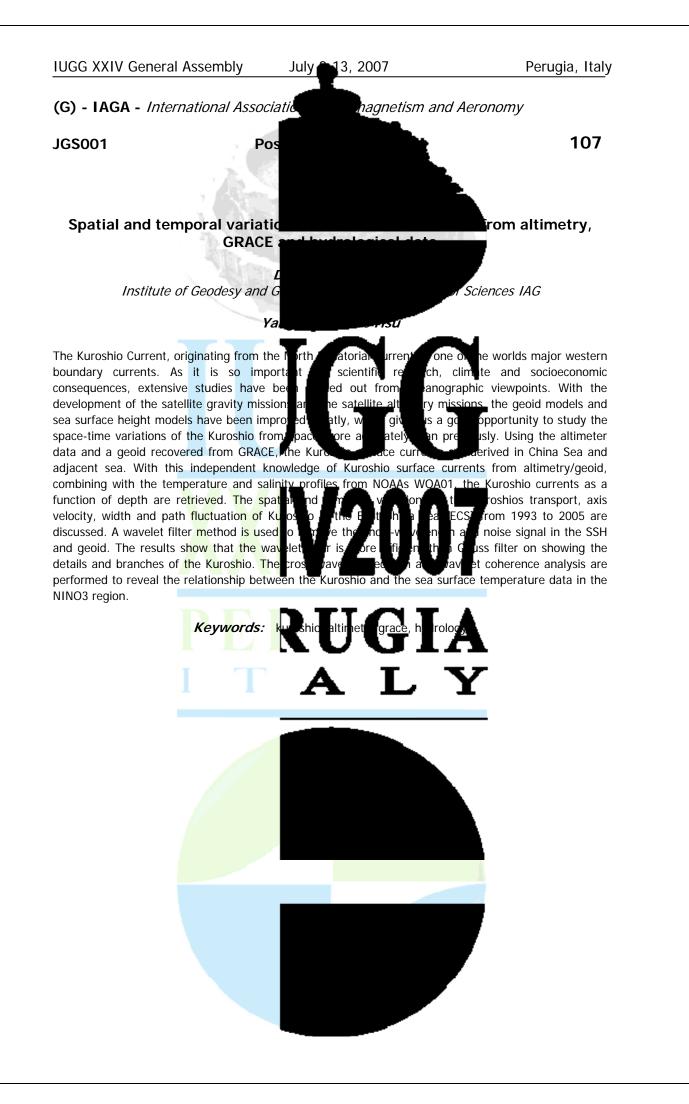


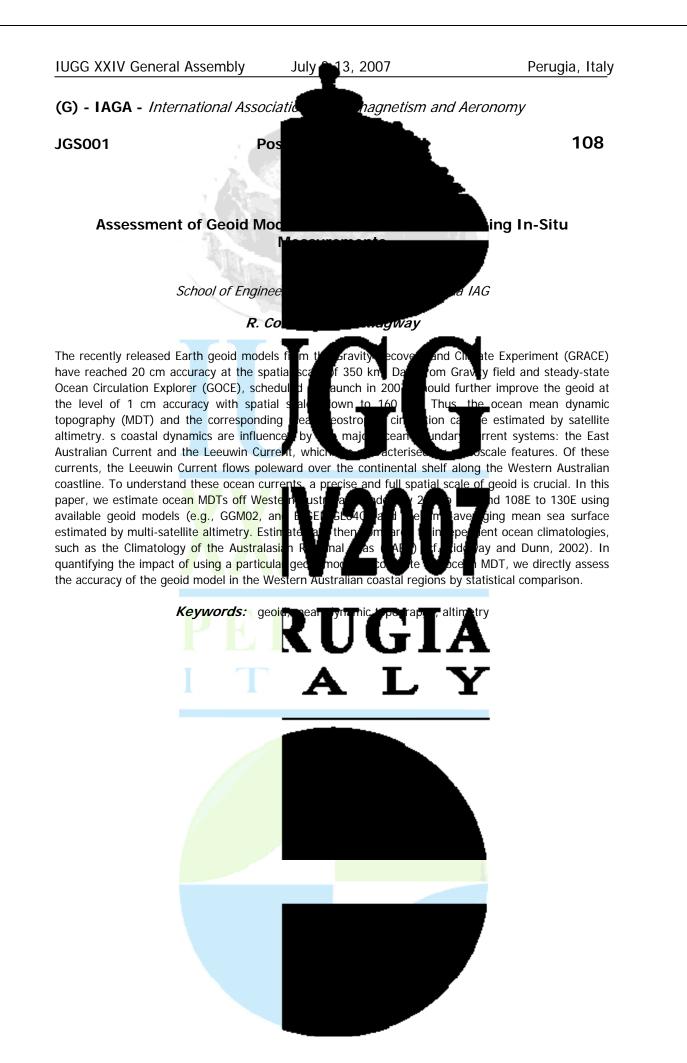


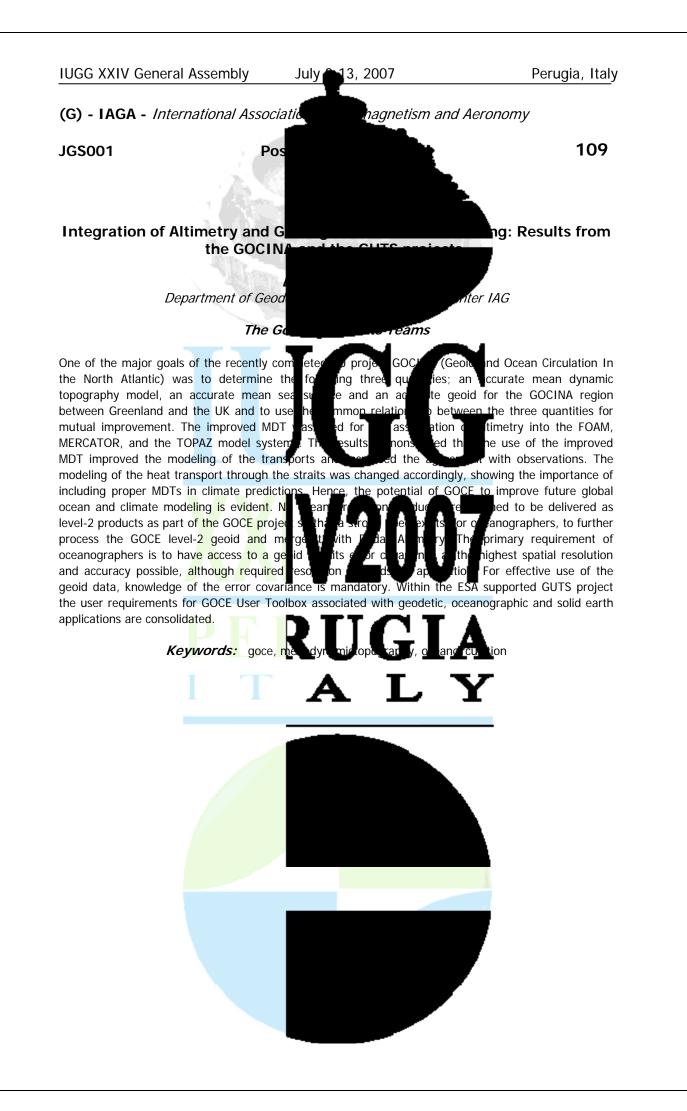


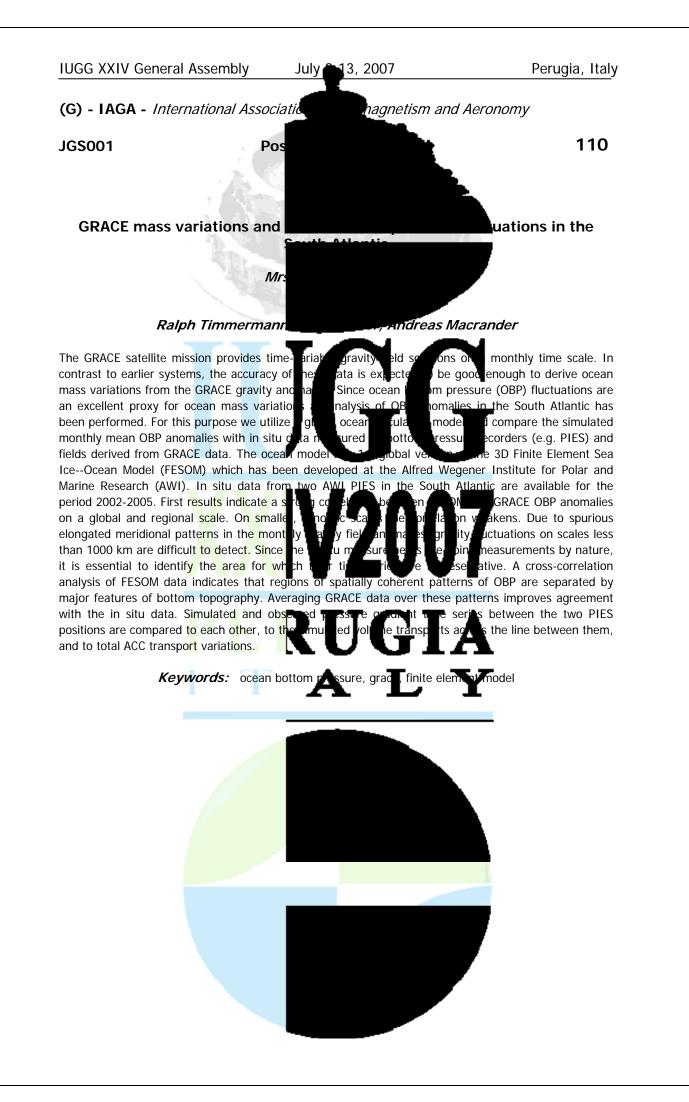


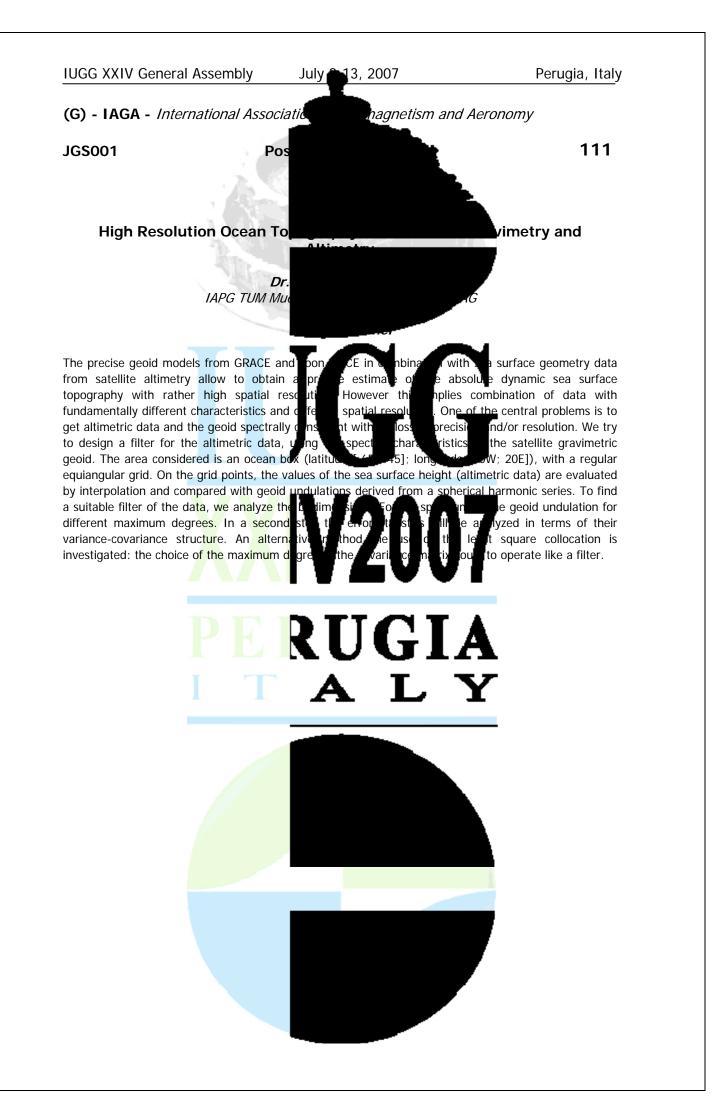


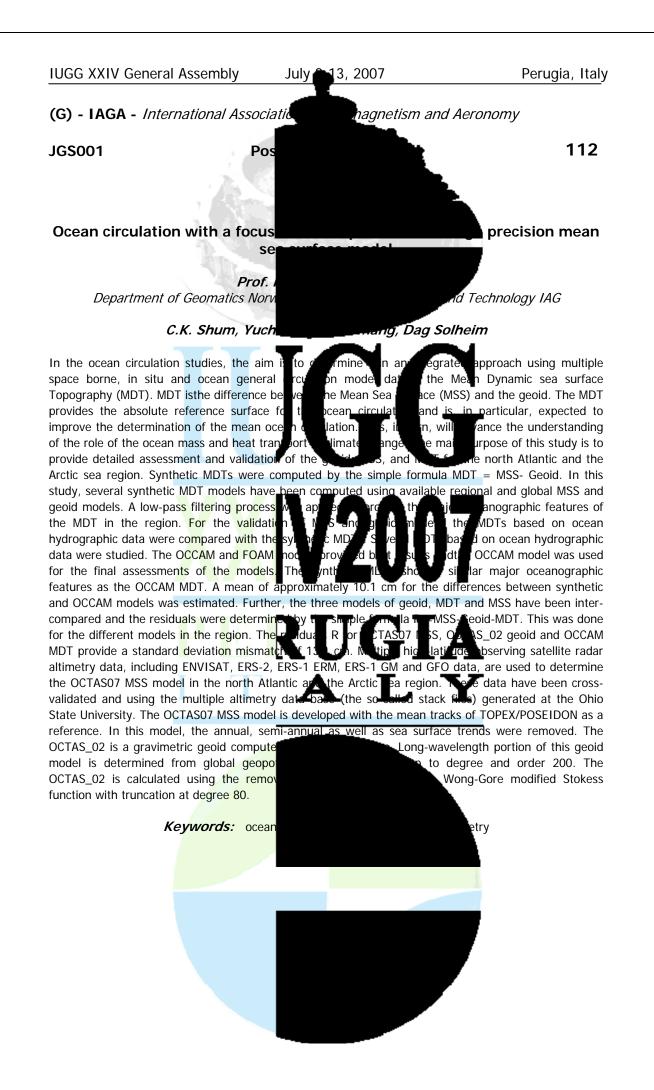


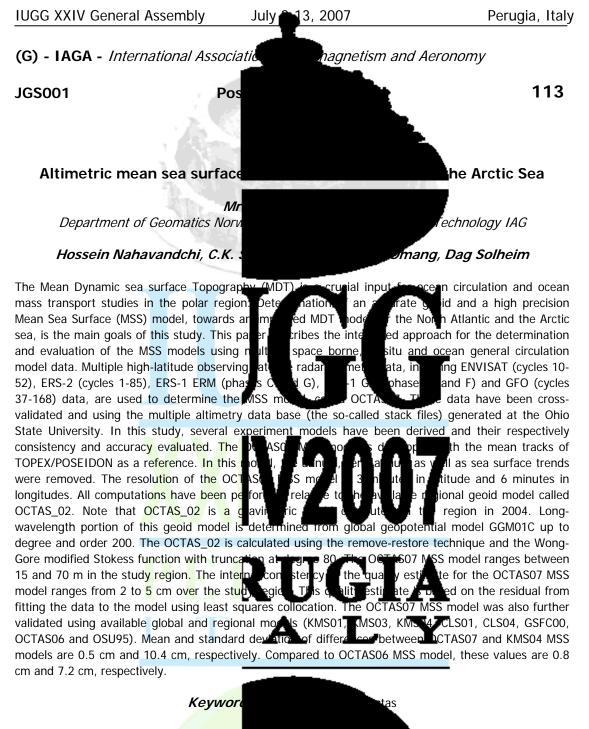


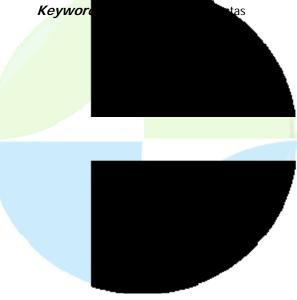


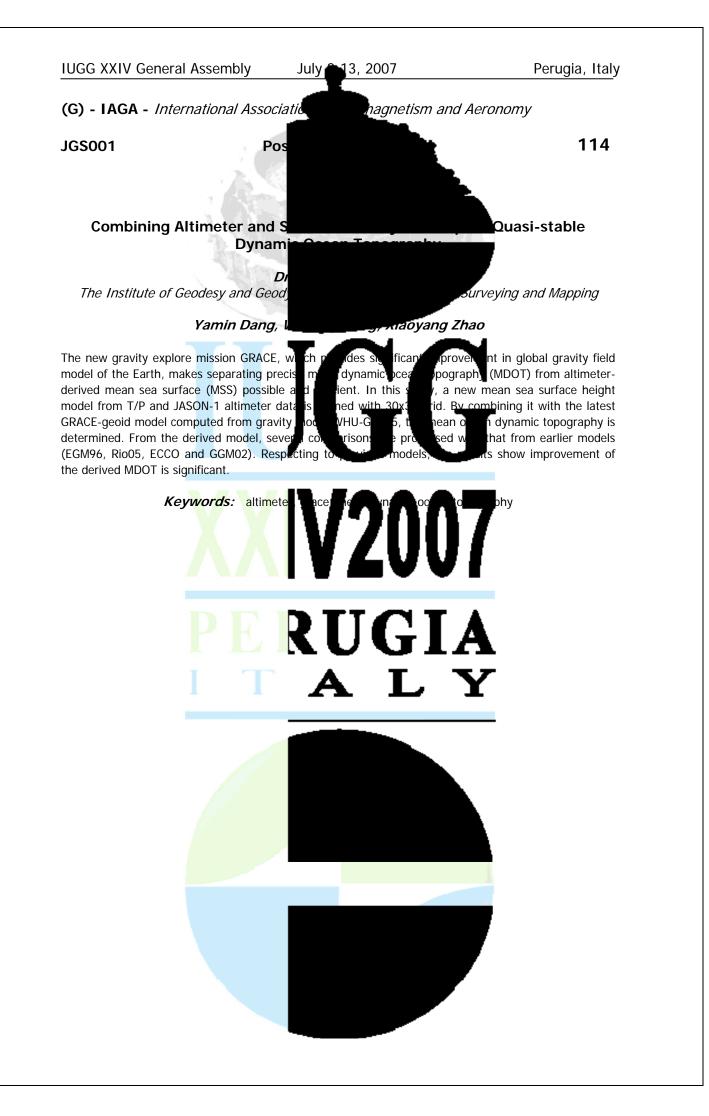




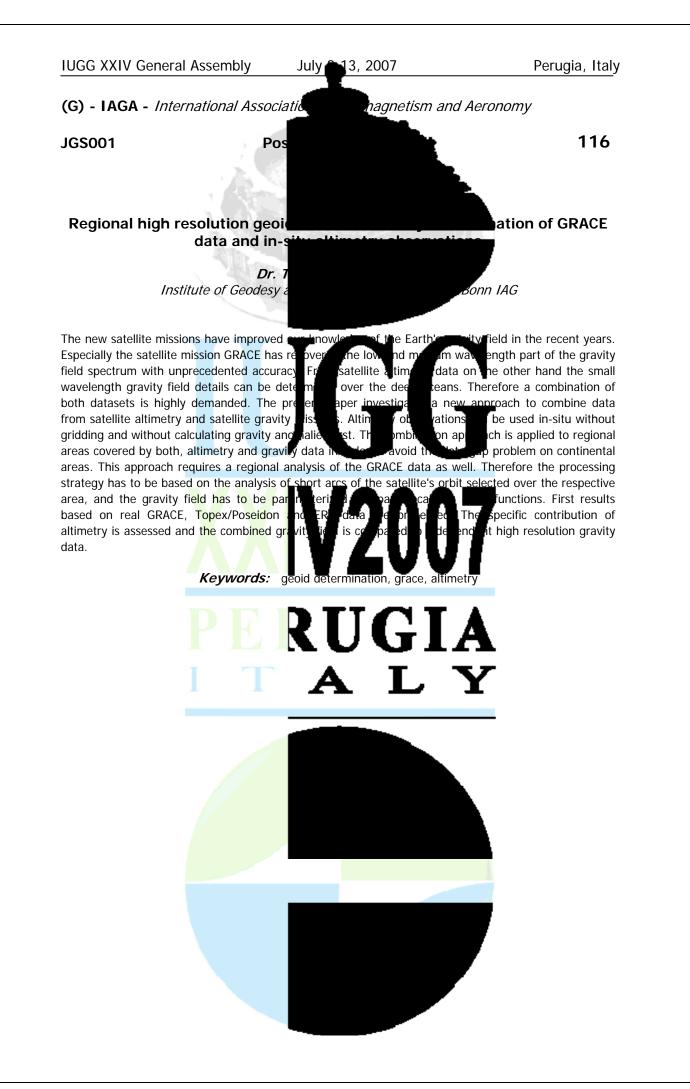


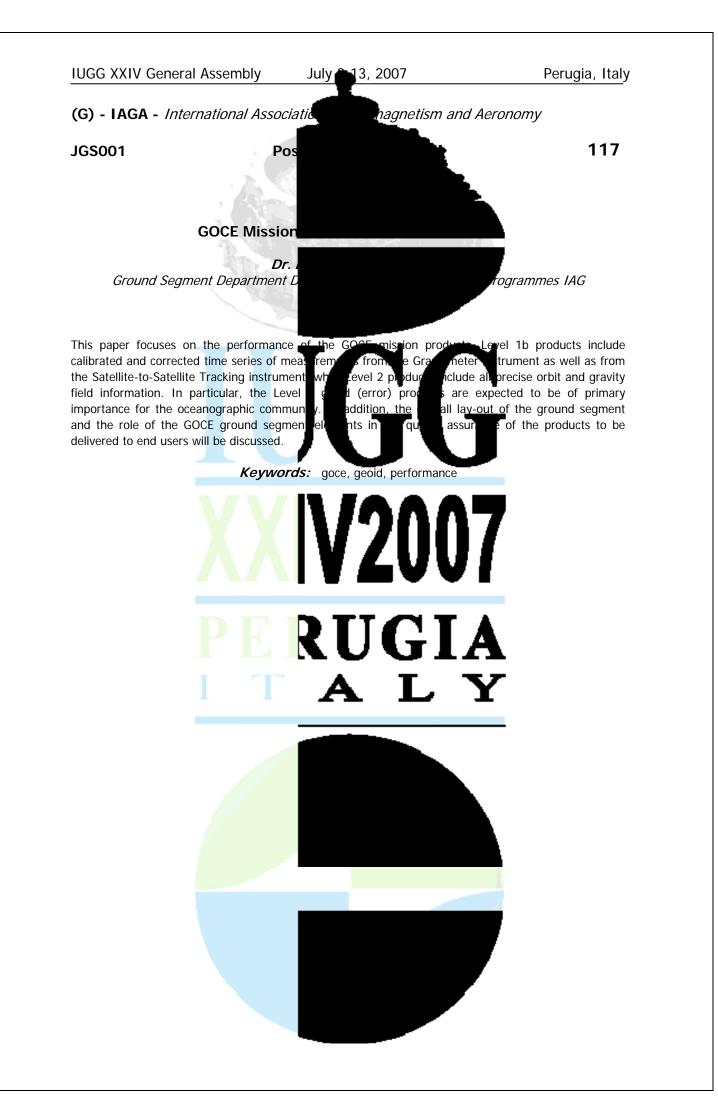






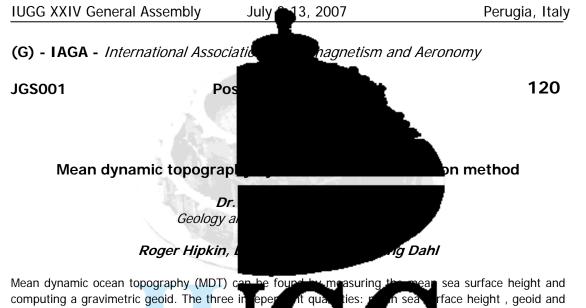












mean dynamic topography, are related by optimal estimation of two quantities from t observable. Computing a geoid involves an integral at sea, gravity must be continuously tracks. We have shown that analytical inte decimetres over the gaps. Thus, data gap make and non-viable. Patching the gaps directly with altimetric 'pseudo-gravity' anomalies is logically inconsistent. Our Iterative Combination Technique (ICM) generates mutually compatible grids of gravity and MDT. The ICM solution converges rap

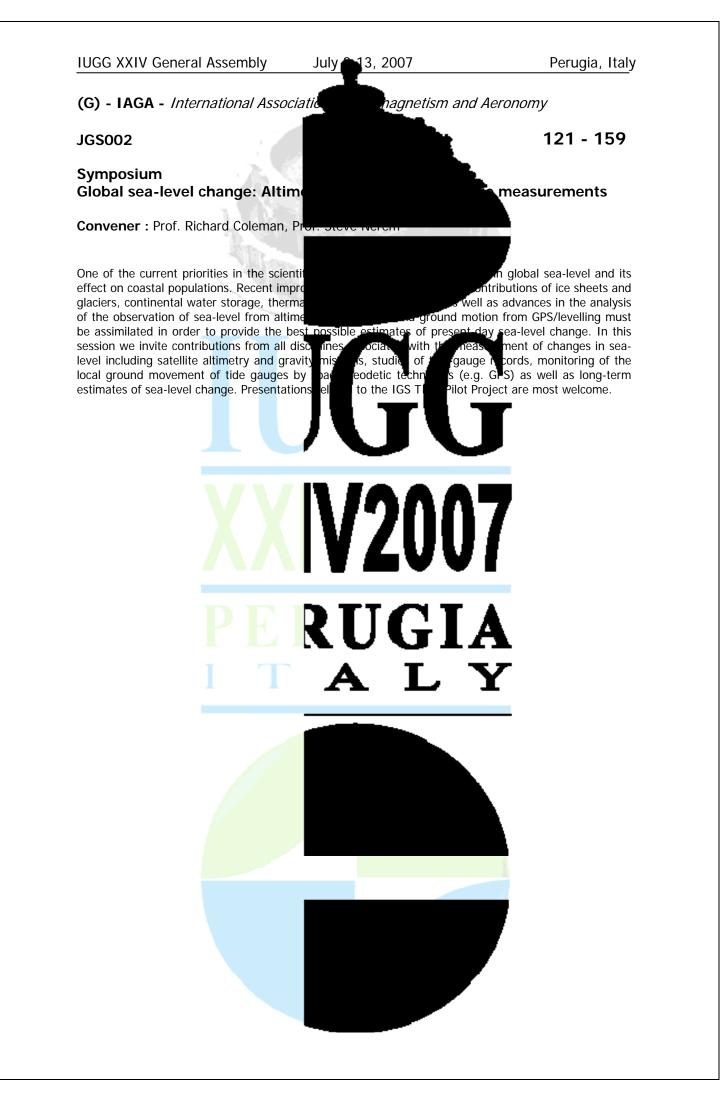
3mm after 10 iterations. We test the I circulation models that assimilate hydrog compatible with the verified part of the G ICM MDT and the composite MDT has a st

ation . H th one constr of gravity ove ple tho ation înt is ins d resu cier

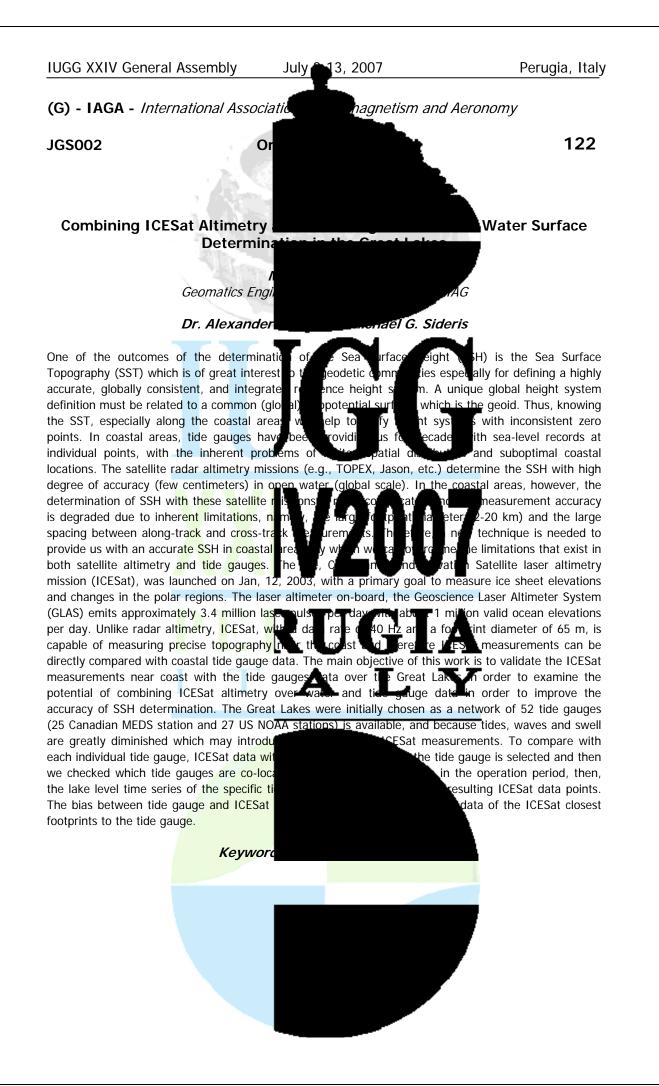
t is misleading to see the task as because the geoid is not directly e Earth's surface. To complete this the gaps between shipin geoid errors of many he three data streams, ,

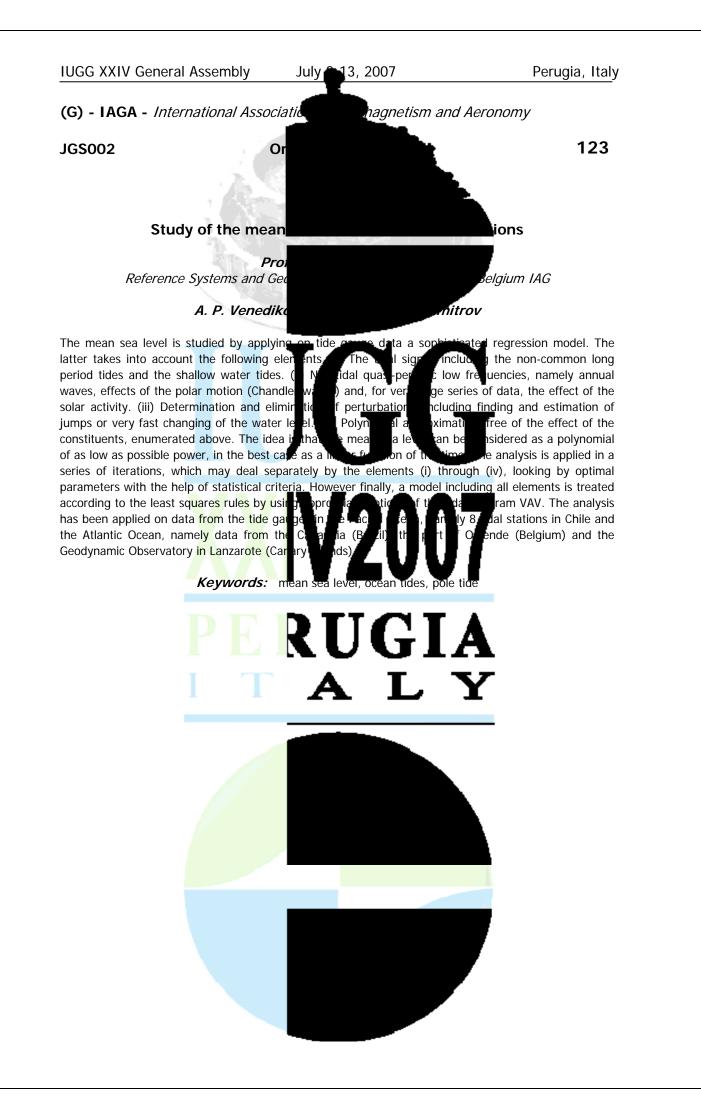
> n iterations falls below high resolution global is composite MDT to a orrection, the difference

Keywords: mean dynamic ocean topography, iterative combination method, geoid



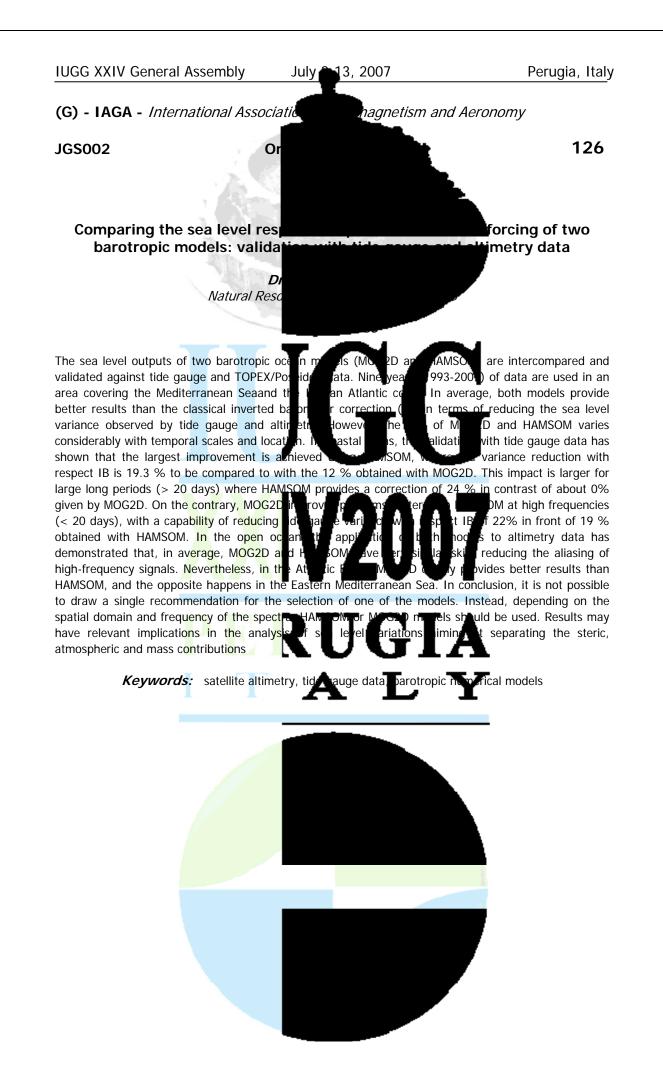


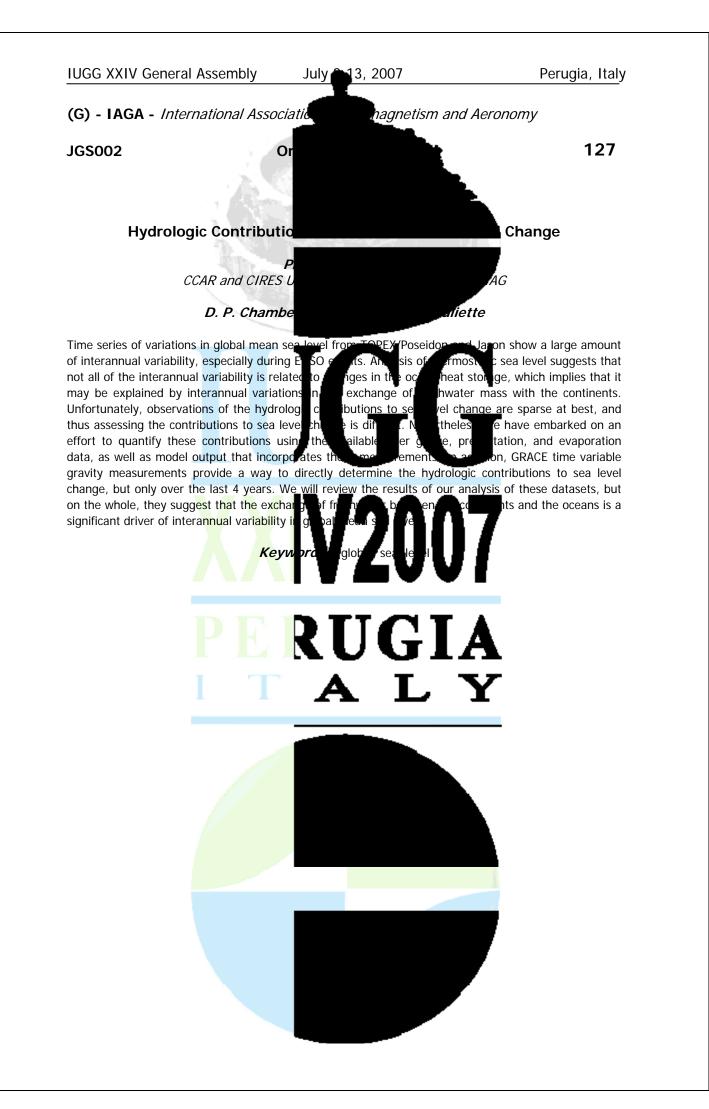


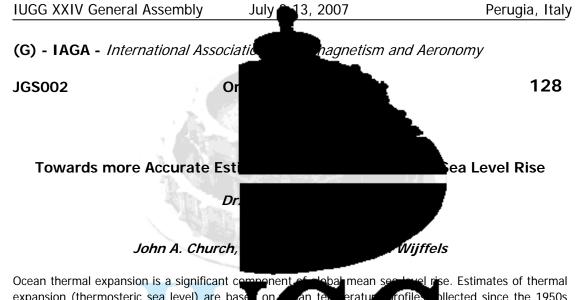












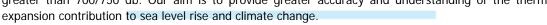
expansion (thermosteric sea level) are base using a variety of instruments with differe floats). Historically, more temperature obse and truly global coverage was only achieved of temperature observations is larger in the with a much smaller number down to 700 sparse. Studies are now reporting systematic biase

both changes in the technology and relative spatial coverage of the observing system. Spatial coverage is especially poor in the Southern Ocean. <u>In this work</u>, we attempt to address the above issues and minimise their impact on our estimates of reconstructed for the 1970-2005 period an using quality-controlled temperature observer reconstruction tests we will be able to exar line investigate the potential of confidently exte hdir greater than 700/750 db. Our aim is to provide greater

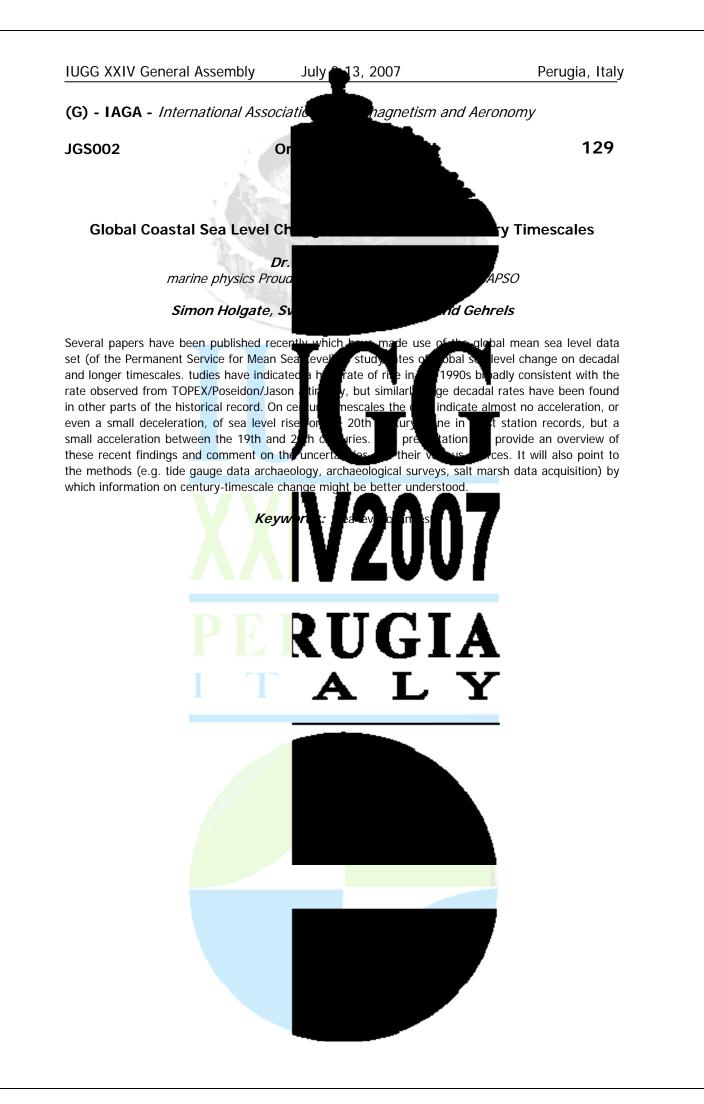


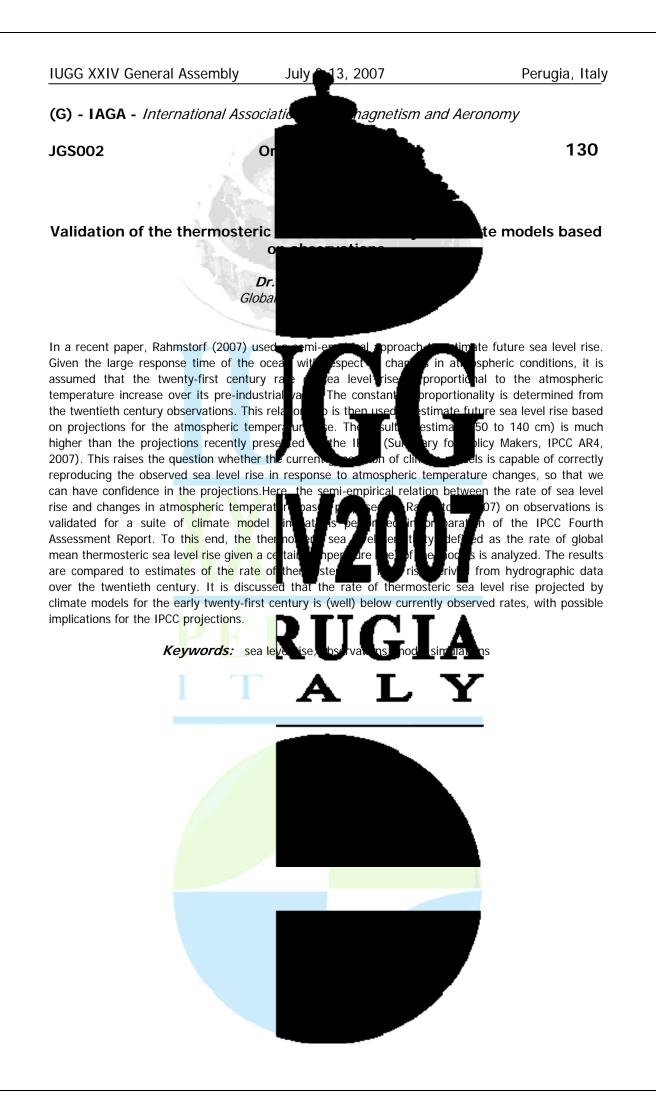
llected since the 1950s les, MB1s, XBTs, CTDs, profiling cted in the Northern Hemisphere, the Argo program. As the number profile e for the upper 300 db, emperature profiles are n leve neasurements related to

pansion estimates are al interpolation scheme t. By performing various rvational biases. We also estimates to depth levels accuracy and understanding of the thermal

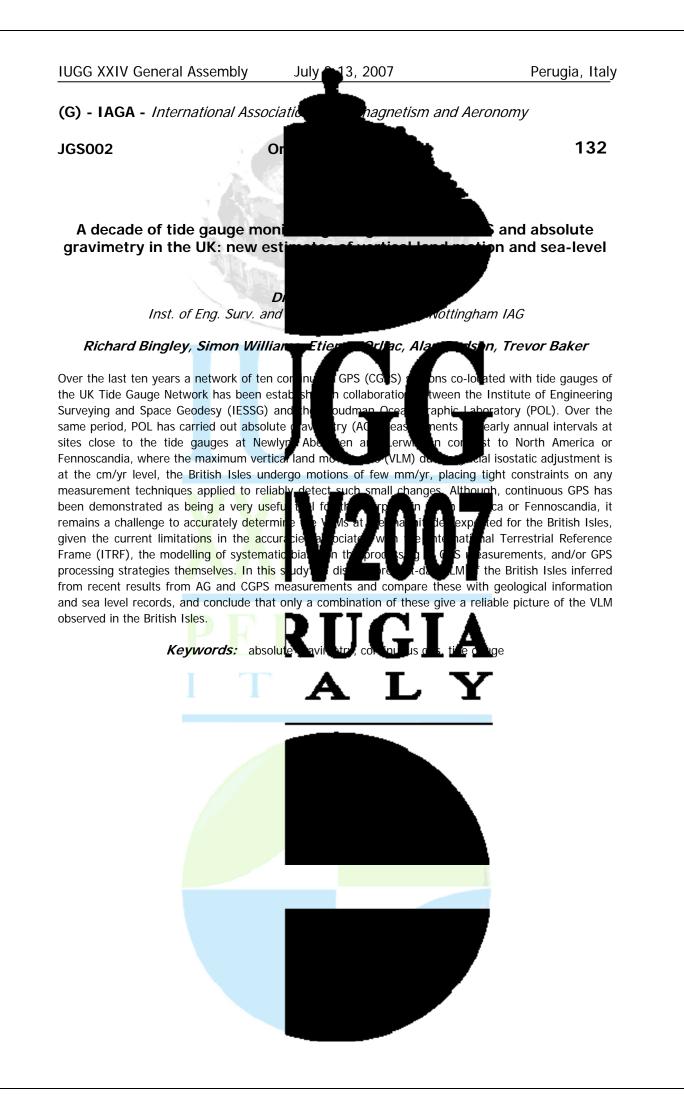


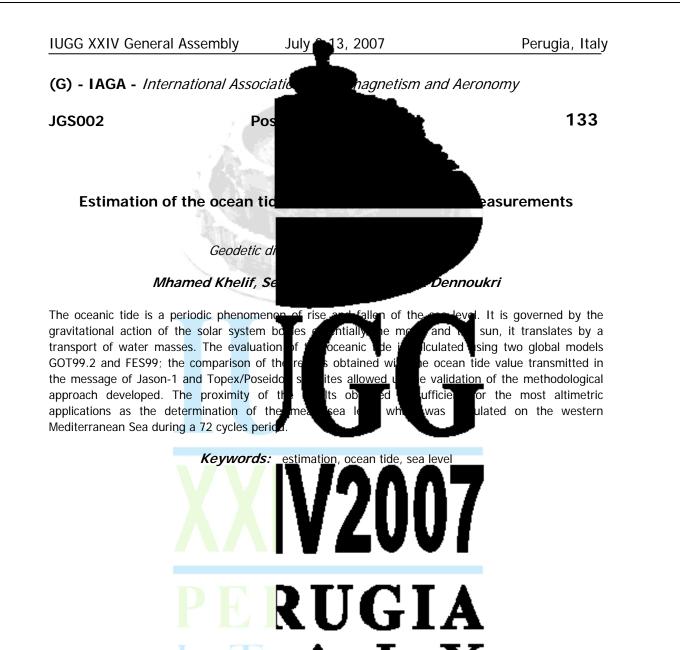


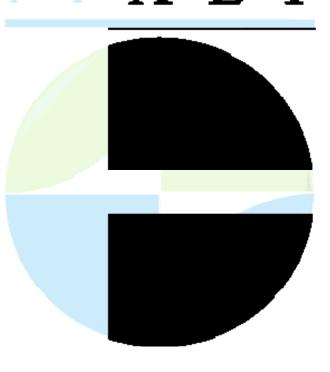


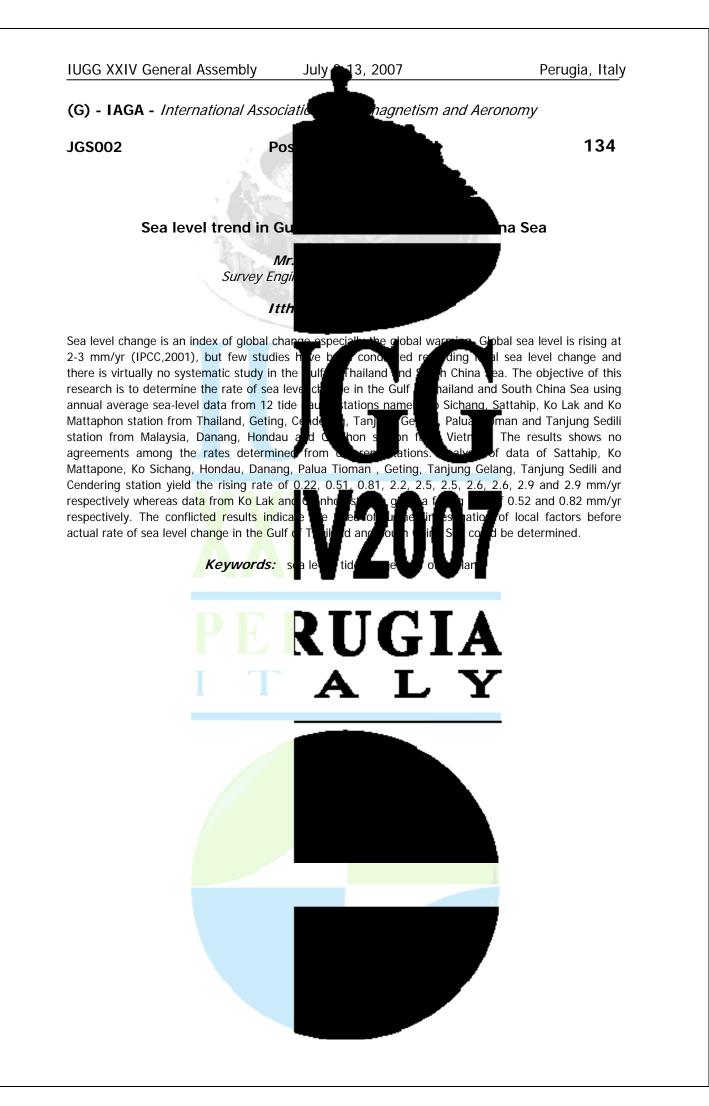




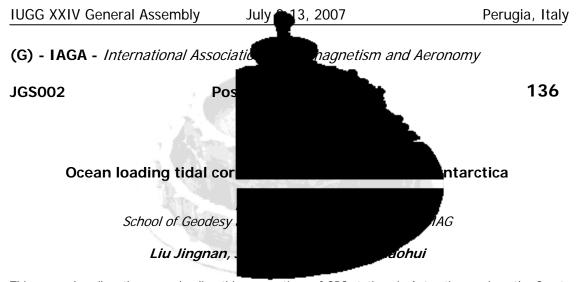










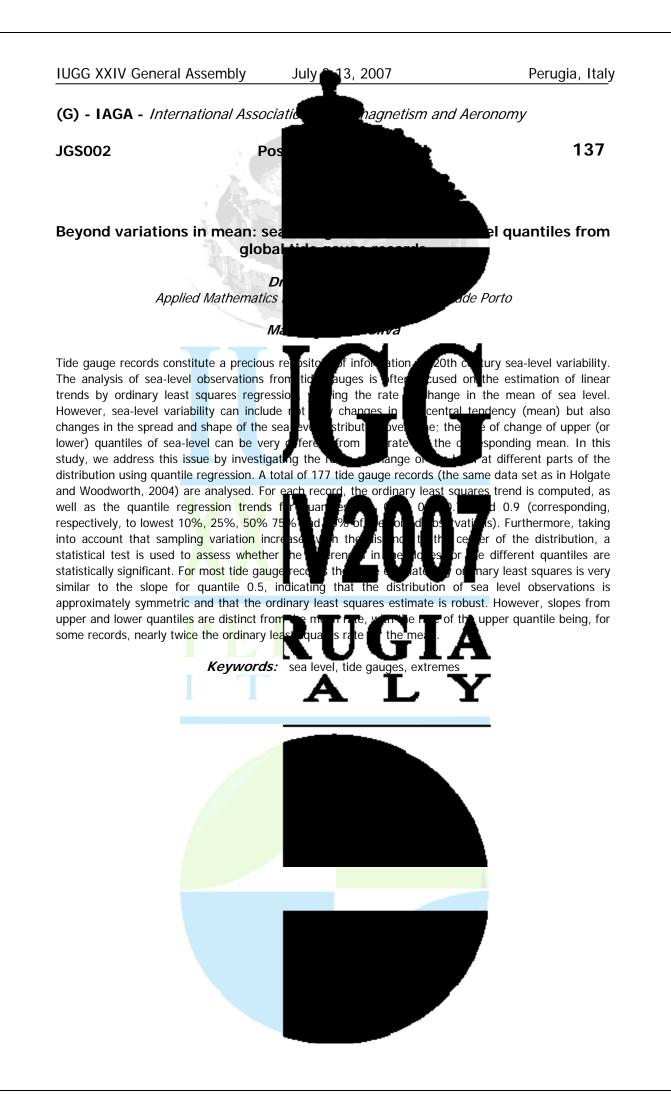


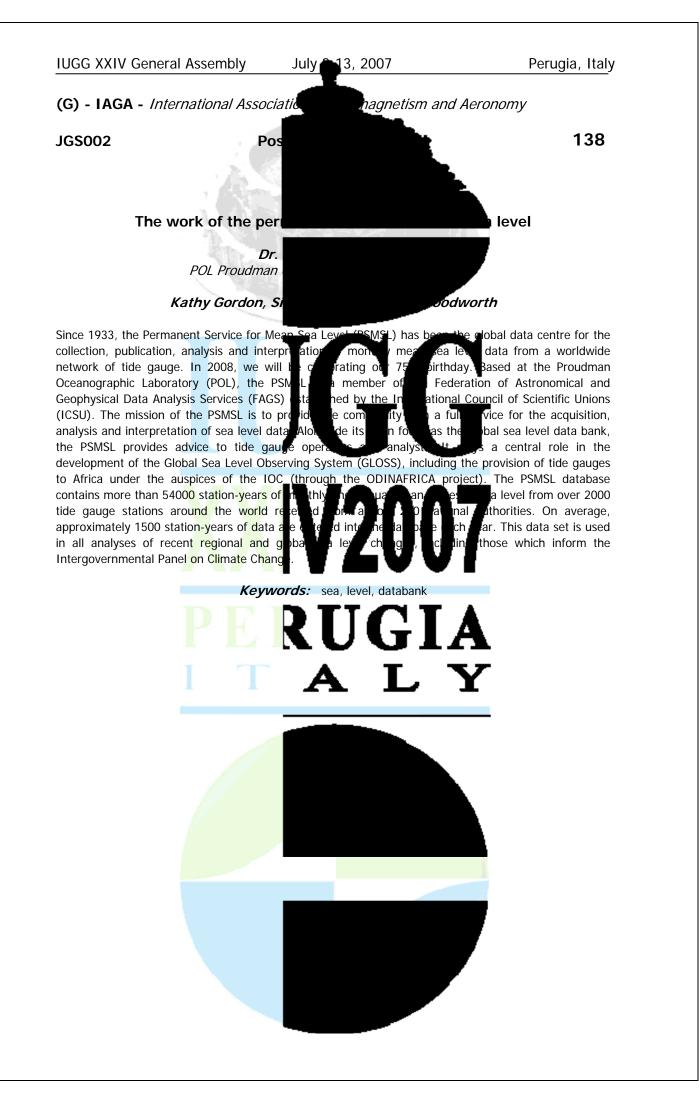
This paper describes the ocean loading tides corrective Wall station, Zhongshan station. Based of the corrections of ocean loading tides on GPS static loading tides model. These corrections are all analyzed by the GAMIT software with and sit GPS baseline components to get the difference corrections have obvious effects upon GPS base. Therefore, we should not ignore the ocean loading obtain precise and reliable results.

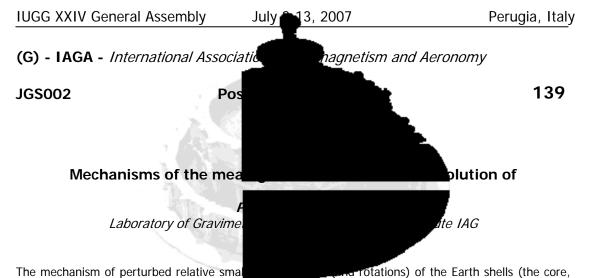
corrections of GPS station the deory ocean atic in Antaro can be also pplied to GPS ta it these corrections and the remains the basis is correction of the basis is correction.

nein Antarctica, such as the Great oading stides, the displacement calculated by using CRS4.0 ocean ta processing. The GPS data are by We compared and analyzed the that the cean tidal displacement he avenue effect is about 6mm.









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The mechanism of perturbed relative smal the mantle etc.) under of a differential gravitational att for formation of qualitatively new oceanic a a displaced core and deformable mantle spectrum of frequencies and various style of in northern and southern). The mentioned r theory and the observations which have bee

global seasonal deformation of the Earl accompanying deformations of the mantle give the load moment and to observable annual oscillation of the Earth centre of mass. On the other hand the gravitational attraction of displaced core_substantially_determines (and organizes) redistribution of atmospheric and oceanic masses between and cyclicity of formation of load on the E of the core (with other frequencies and for phenomena of redistribution of oceanic an mantle, and also the appropriate variatio mean sea level rise on the base of value of velocity of linear trend of the Earth centre of mass in 6.69

mm/yr (Tatevian et al., 2004). The component of this drift caused by the polar trend of the core and by corresponding deformation of the mantle southern hemisphere in northern which lead mm/yr. The velocity of secular increasing of the known value of amplitude of the appropriate load moment making annual oscillation (for atmospheric and oceanic masses). It results in and proportional to the annual mode), but increase South Pole and decreasing with the same velocity on North Pole. On equator radial displacements are

bottom and finally result in rise of mean se in slow change of mean sea level is caused oceanic and atmospheric masses in north Thus, the total effect results in rising of r gives some additional positive arguments mechanism of increasing of mean sea le Oscillations of the Earth core, new oce International Scientific Conference "Str

lestial bodies is responsible d by ravitational attraction of les are haracterized by a wide ispheres of the Earth (in particular explain divergences between the at studying of a style of al. (20 cillatio of the outer core and value of the observable

> e. determines process t any other oscillations ermine also the related etary deformations of the me upper evaluations of

with small velocity 0.33

lated approximately on

of the mantle (similar

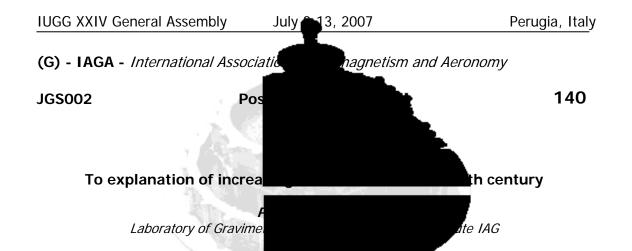
b velocity 1.81 mm/yr on the time w equal to zero. The mentioned displacements of the <u>Earth</u> surface determine deformations of the ocean bout 0.18 mm/yr. One more component of mass, due to linearly increasing uations it makes 0.40 mm/yr. ists about 0.91 mm/yr, that about the unknown (lost) ces Barkin Yu.V. (2005) ences. Materials of XI genetic processes in

ution of water masses from a

lithosphere" (September, 20-22 2005, Syktyvkar, Russia), Publisher of Geology Institute of Komi SC of Ural Section of RAS, Syktyvkar, pp. 26-28. In Russian. Blewitt G., Lavallee D., Clarke P., Nurutdinov K. (2001) New global mode of Earth deformation: seasonal cycle detected. Science, V. 294. pp. 2342-2345. Miller L. and Douglas B. C. (2004) M lieth-century global sea level rise. Nature, v. 428, 25 March 2004, p

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On the basis of geodynamic model of the f mantle (Barkin, 2001, 2002) the secular variations changes of the ocean surface have been **faly** author along geocentric axis OP in direction directed slow redistribution of atmospherid deformations of the elastic mantle) from the axis of the specified hemispheres. In resu changes which have been evaluated by u on masses located at poles of inclined axis OP (Ba 0.179x10 (15) kg/yr (point situated in Northern hemisphere) and 0.043x10 (15) kg /yr (point in Southern hemisphere) at respective change of masses of the top spherical layer. On our geodynamic model the secular drift of a geocenter is a the elastic mantle along axis OP in norther the core by its displacements leads to asymmetric position of continents and incli ed redistribution of masses of the Earth and, hcco As secular variations of a geopotential determine secular changes of a surrace of ocean, as geoid's surface, so on the values of variations of geopotential coefficients we can determine coefficients of development of velocity of increasing of a the basis of offered point model of secular edi second harmonics of secular velocity of char =-1.36 (-0.24 +/-0.52); A11=0.12 (0.12 +/-0.47); B11 =-0.48 (-0.42 +/-0.45); A20 =-1.95 (-1.92 +/-(0.56); A21=0.19 (-0.01 +/0.30); B21 =-0.74 ((0.17 + /-0.14). For comparison the experimental N observations at tidal stations of all world approximately for hundred years are specified in brackets (Nakiboglu, Lambeck, 1991). Secular increasing of the mean sea level has made 1.15 +/-0.39 mm/yr. Formation of a relief surface of ocean a additional increasing of the sea mean leve

the mean sea level according to observ coefficients makes about 1.4 mm/yr. It is l the more high values of velocity of increa 2003). This discrepancy can be explain observations. In reality, the motion of sa Earth. Therefore the drift of the centre of i

test the certain secular poten odel wo points with variable hts vary with velocities Earth core relatively to of superfluous mass of and oceanic tides. The core cause the complex geopotential coefficients. pherical functions. In result, on the fficients of the first and eer ae rmined (in mm/yr): A10 (0.08 +/-0.13); B22=0.07); A22=0.0 figents obtained according to data of

a of the Earth core relatively to the elastic

nd the corresponding slow

t 70.0 , 104.3 E, leads to the

id masses (and to corresponding

the northern hemisphere. OP is an

Earth core predicted by

ntioned solution found above leads to mm/yr. Thus, velocity of change of on variations of geopotential (Topex-Poseidon data) show mm/yr (Cazenave et al., trical effect of satellite center of mass of the formally is reflected in

reduction of distances from the satellite up to the ocean surface in southern hemisphere and to their increase in northern hemisphere. At averaging of measurements on the surface of all ocean there will be an effect of apparent additional increase of the mean sea level. By our estimation this effect makes

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about 0.69 mm/yr at velocity of the drift satellite velocity of increase of the mean se close to the data of observations. So on th in 1990 the rising of the sea level with ve small divergence in the given values of

6.69 mm/yr. Therefore 2.2 mm/yr that is rather Topex-Poseidon satellites azenave et al., 2003). The level can be explained by

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13, 2007 July

Perugia, Italy

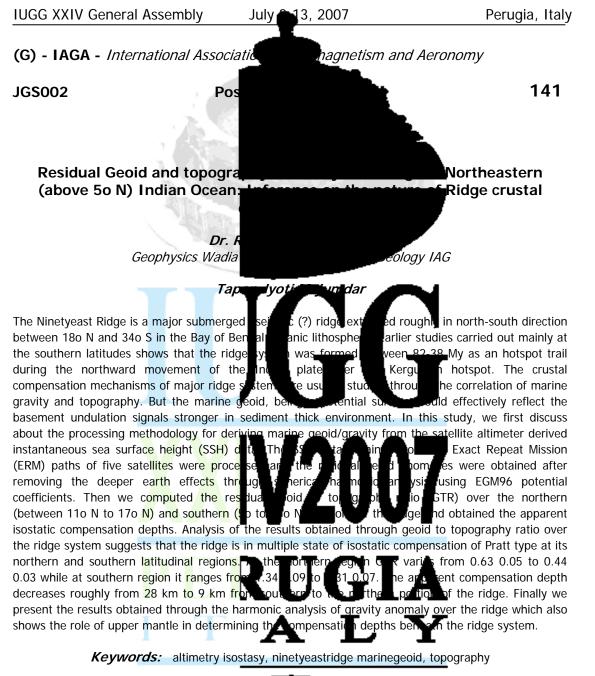
particularities of trajectory measurements. In big component attributed to observed incr K. (1991) "Secular sea-level change". In Sabadini et al.) Kluwer Academic Publi prediction of the secular variations of the drift. Proceedings of International Confe millennium (24-29 September 2001), Kaz Tapley B.D. Variations in the Earth's ob Present-day sea level change: observation 131-144.

ermal and climatic effects can not apply for a ferences Nakiboglu S.M. and Lambeck el and Mantle Rheology (Eds. R. Yu.V. (2001) Explanation and orce of gravity and geocenter omy and geodesy in new pp. 73-79. Cheng M., ournal of geophysical Research, V. 109, B09402 Cazenave A., Cabanes C., Dominh K., Gennero M.C., Le Provost C. (2003) s, V. 108, Issue 1, pp.

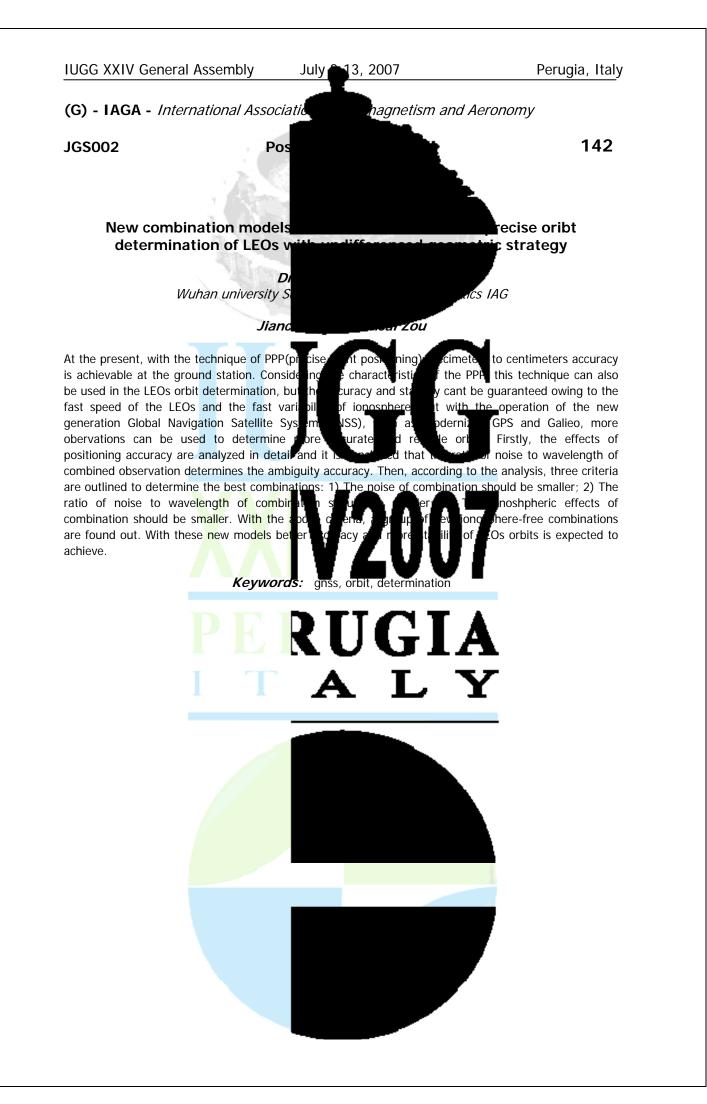
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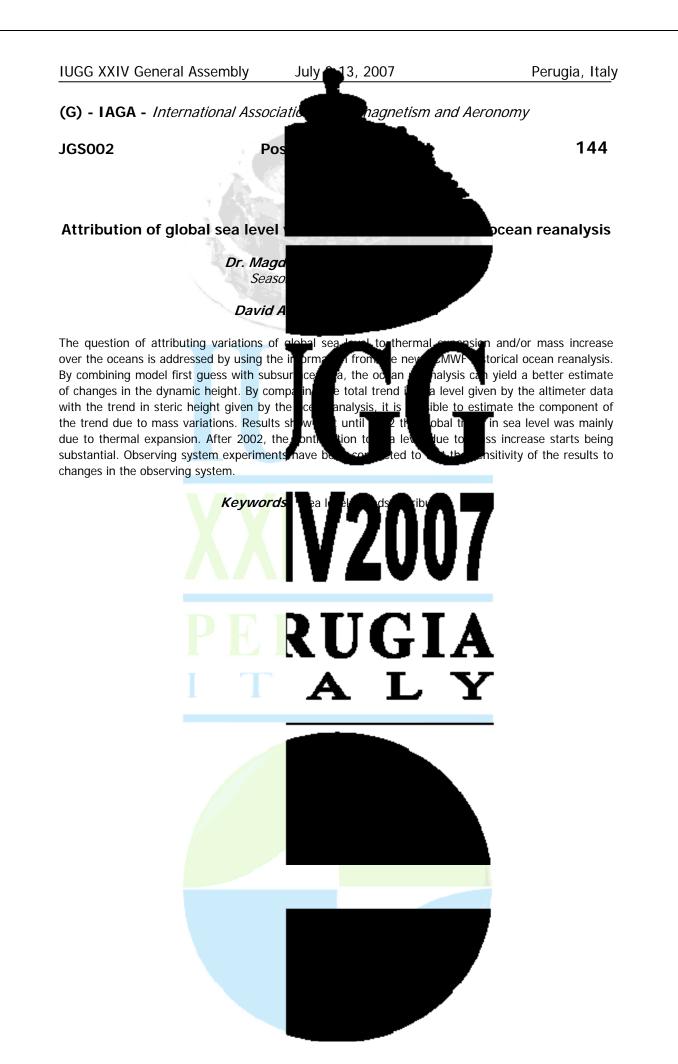


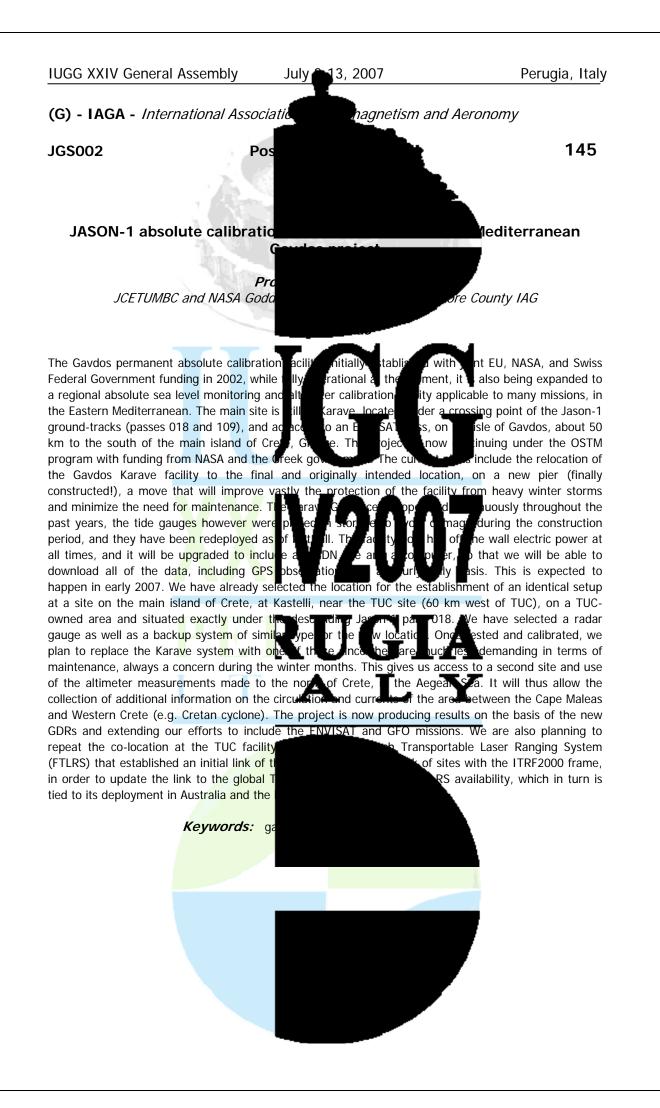


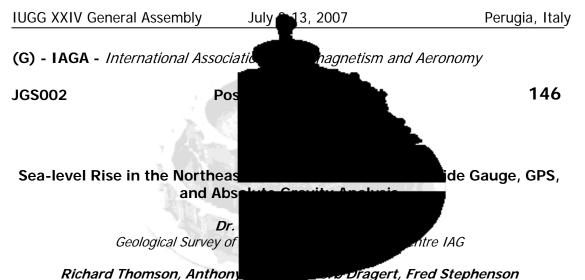












Sea-level rise in the northeast Pacific is a sid ific and infrastructures in the U.S. Pacific North level (RSL), are expected to vary consideral active tectonics and Holocene postglacial re been rejected from most global analyses to recent studies suggesting large spatial vari the issue of applicability of global mean eastatic

this question, we analyze data from a subset of 14 nearby GPS and tide gauge sites. Data from Canadian and tide gauges are guality controlled to derive robust monthly RSL time series. In particular, we estimate linear trends and associated correlated characteristics of the RSL da ITRF2000 reference frame. Alternative refe of the overall uncertainty in the absolute G indicate a 20th Century regional rate of s global average eustatic estimates. As an alternative to the global GPS reference frame alignment, we

haza nd weste g the 2000 k Thus tide e effe he 2 `en the n

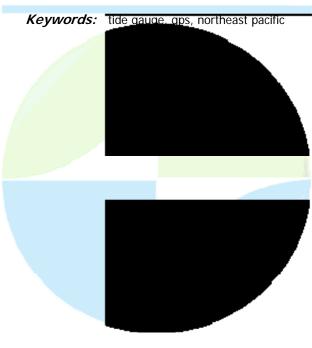
e coastal urban centers tal uplift, and hence relative seang coast as a result of changes in data from this region have so far rected tical motions. In light of rates ea-level rise, this raises acific region. To address

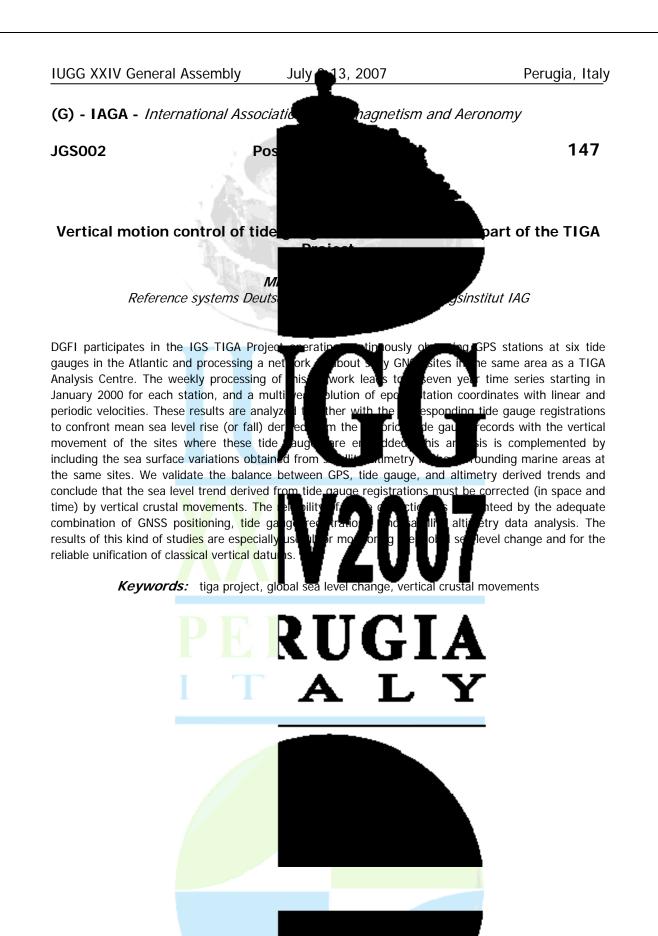
> batially and temporally es are derived in the) are considered as part tide gauge/GPS analyses in good agreement with

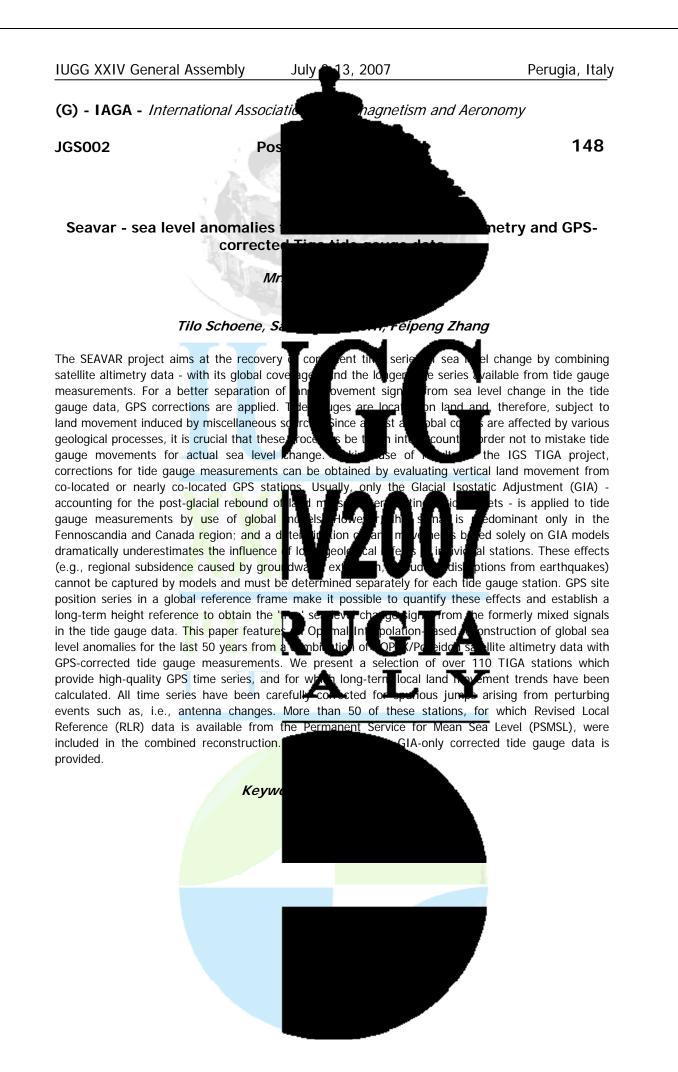
reference. The joint tide gauge/GPS/absol a 20 Century regional rate of sea-level rise of -1.0 to 0.0 mm/yr, inconsi estimates. These results egiq r of mass reference in point to a possible issue in using absolute a rth/cen regions of active tectonics, such as the Cascadia subduction zone. However, the discrepancy between the GPS, absolute gravity, and tide gauge data anot yet res lved, indica That more ground truth work is required to resolve regional uplift and see-le 🕨 rise in ific.

use absolute gravity data at 4 collocated sites to provide an independent tie to the Earth center of mass

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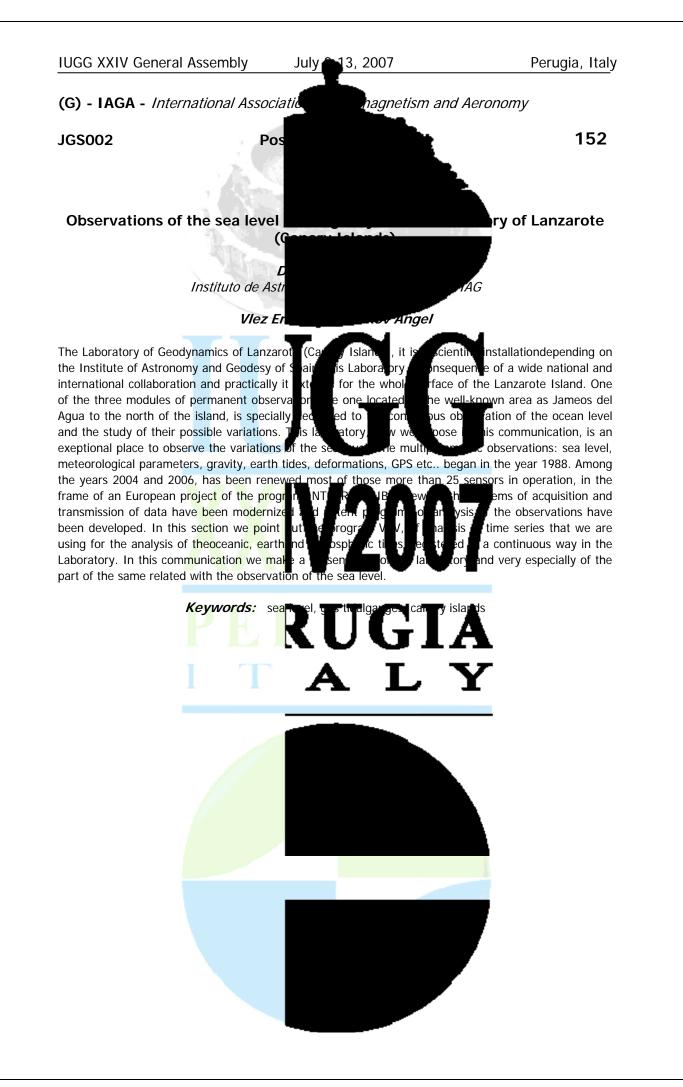


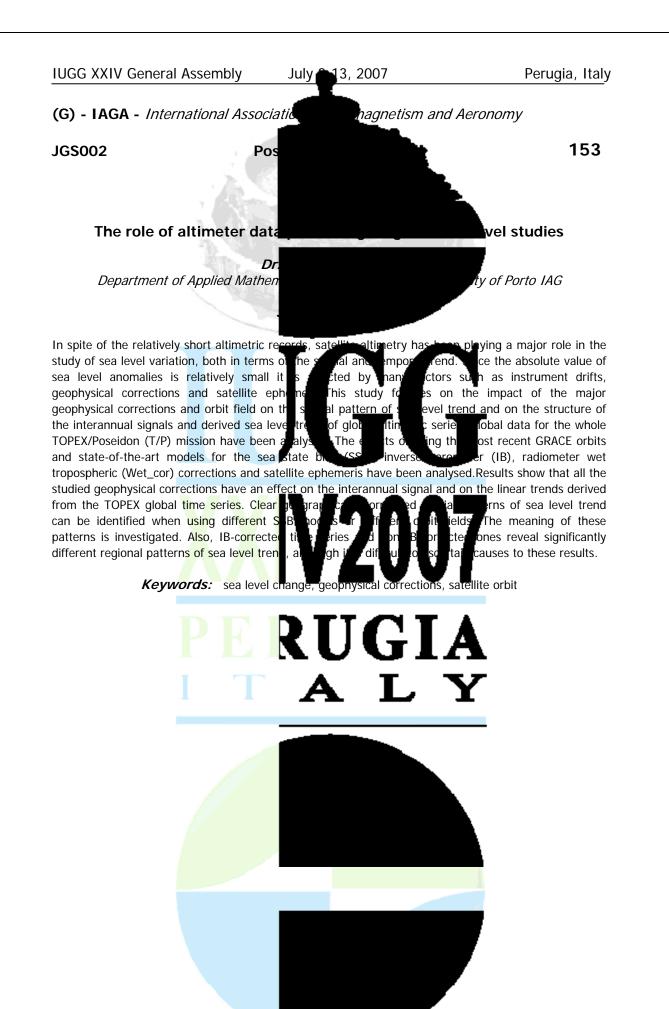


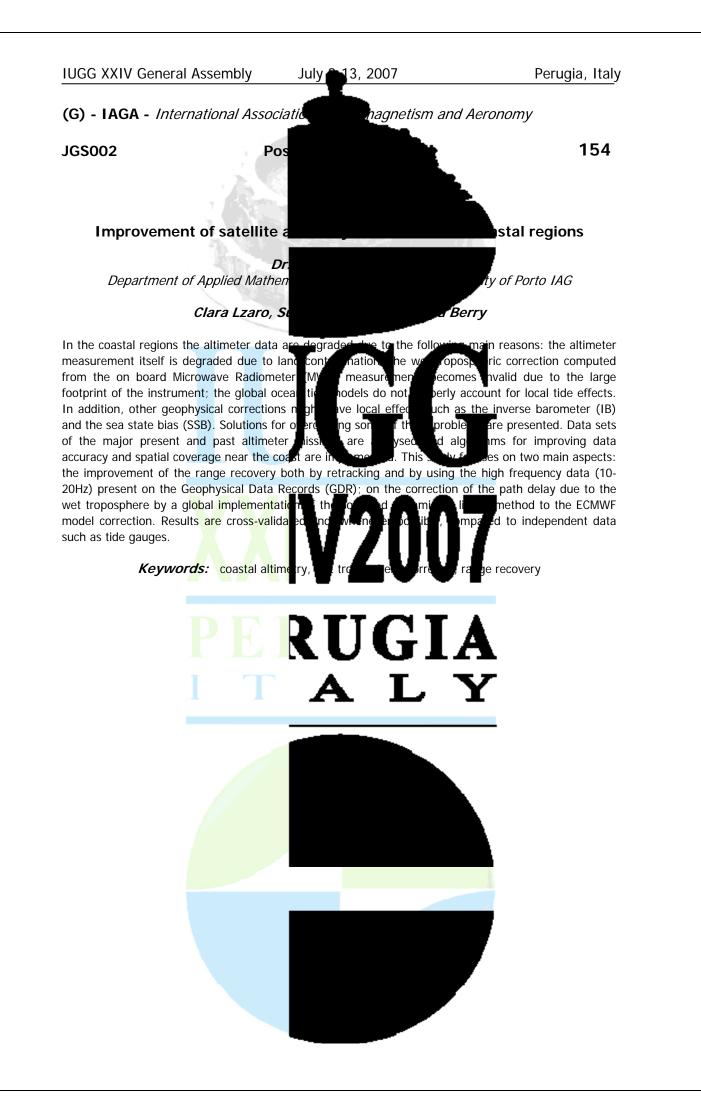


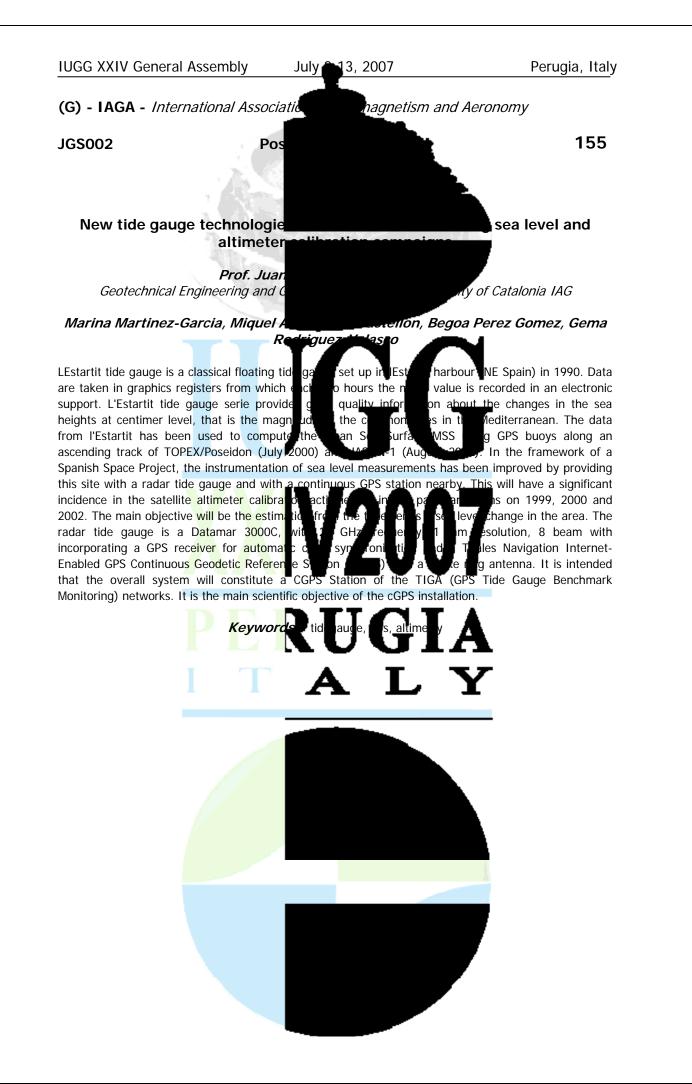


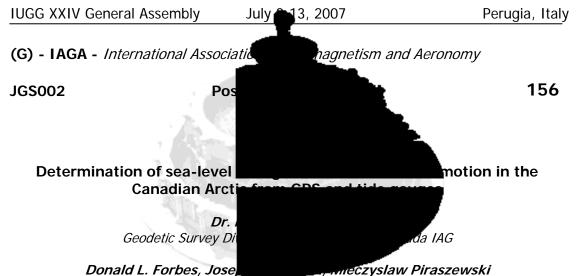












Donald L. Forbes, Jose

Projections of relative sea-level rise and th res good understanding of sea-level change and network of several continuous GPS station Canadian Arctic with the aim of directly mea tide-gauge data provide measurements of tide gauge is anchored while the GPS data crust with respect to a global reference Fame.

reliable estimates from these measurements systematic biases, equipment type and ch We discuss each of these factors in relation based only on three to five years of data sea-level change and compare these to e results. We also make use of older tide-gauge the level of accuracy we might expect with longer time

ated with tid chan<u>ges in s</u>e sea le vit to o mir hat the tw including monumentation, various kinds of noise and

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bastal erosion require a g and consequently, beginning in 2001 a uges has been established in the el and vertical crustal motion. The pect t e crust upon which the e abs e vertical velocity of the to determine absolute s.

changes in Arctic sea level with respect to the global frame. Several factors affect our ability to obtain

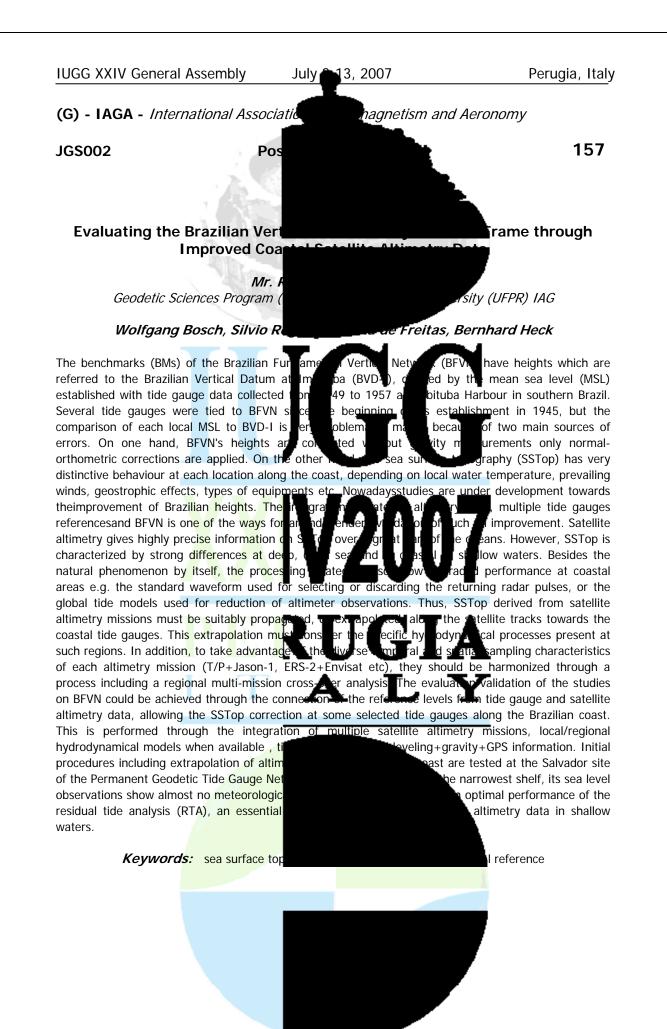
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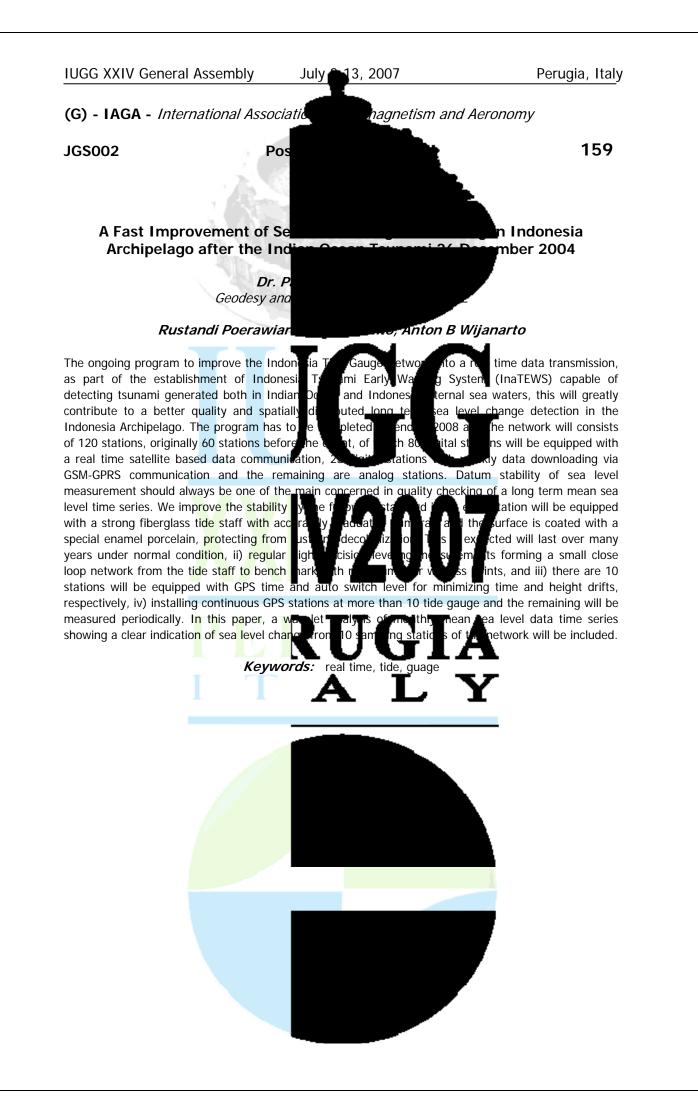
gth of the time series. several years. Although of crustal motion and g geological and model w decades and estimate

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Keyword







Perugia, Italy IUGG XXIV General Assembly July 13, 2007

(G) - IAGA - International Associatio

JGS003

Symposium Earthquake and Volcano Geode

Convener : Dr. Jeff Freymueller

Large earthquakes produce significant stat modern space geodesy. The largest ea earthquake or the much older but eve earthquake, may produce dynamic and

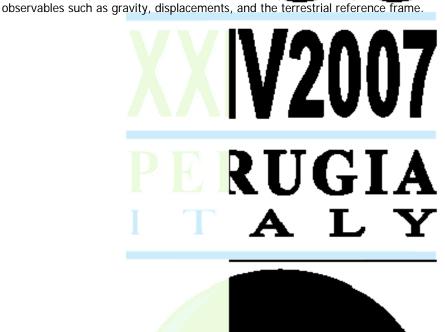
band and the static displacements, for example t High-rate GPS provides a new tool to in esti intrusions cause deformation that is more lo ali be substantial and geodesy can provide cri magma in the subsurface. Volcanoes display a rich array of geodetically observable sign topics ranging from the use of geodetic g ta effects such as postseismic deformation, to the in

an be measured easily by Sumatra-Andaman Islands a earthquake and 1960 Chile

detectable around the entire globe. A particular area of newly-recognized importance is the intermediate range between the seismic frequency postseismic transients. low sl ٦d leno

hagnetism and Aeronomy

volcanic eruptions and a. Whil st earthquakes, displacements can e movement and accumulation of nd va in displacements, with mesca This session will cover nic sources and related and v anic unrest on geodetic



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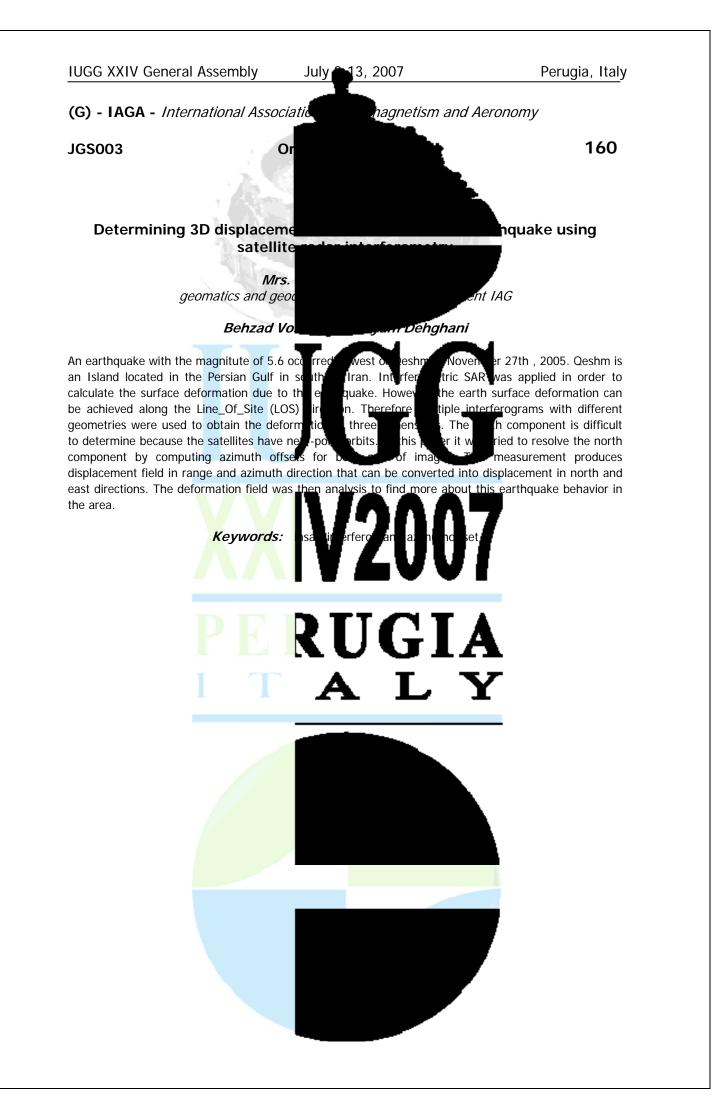
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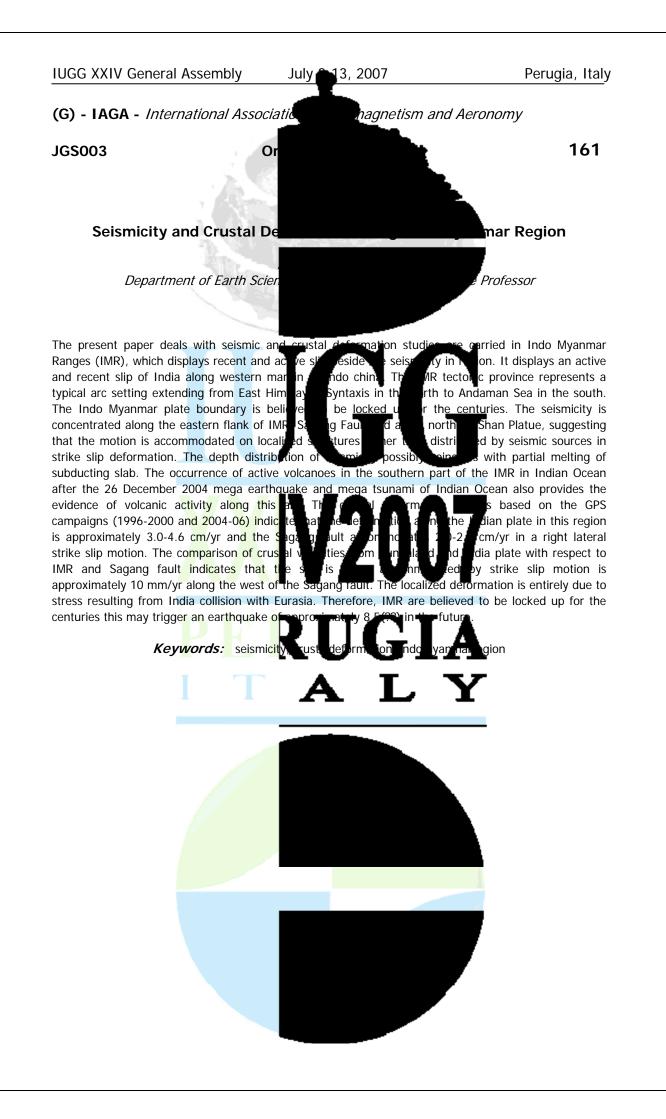
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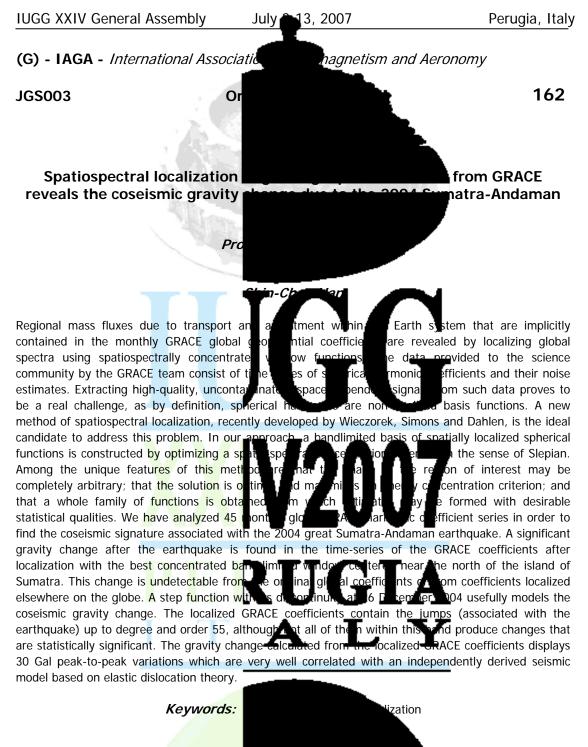
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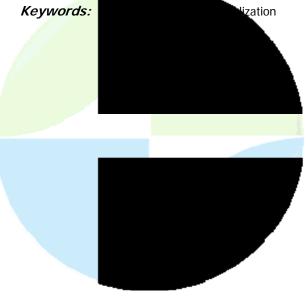
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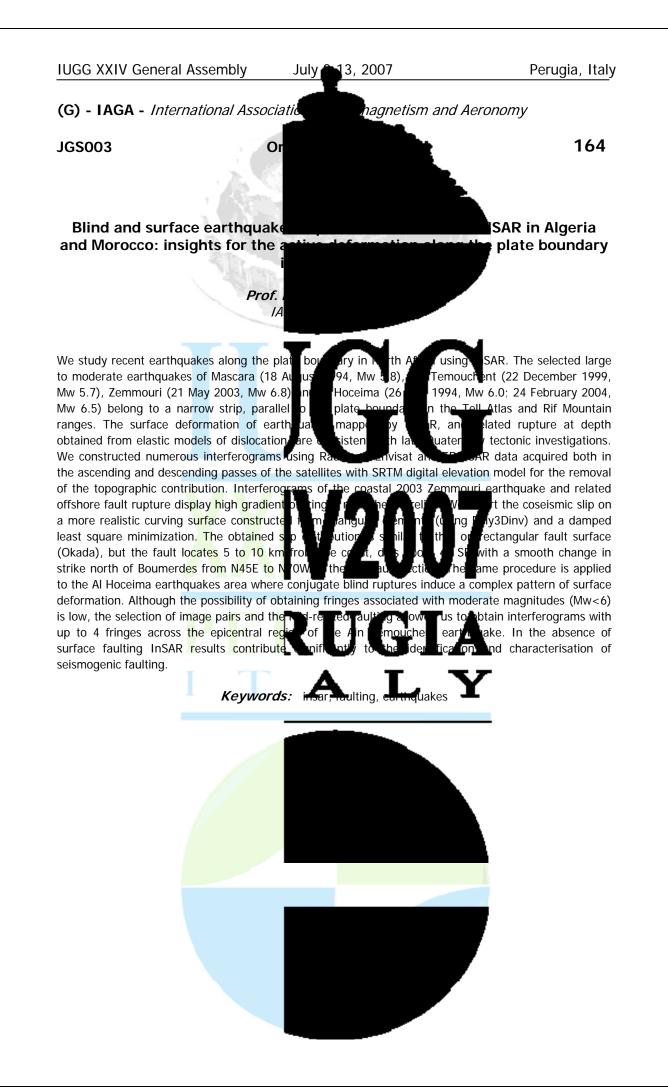


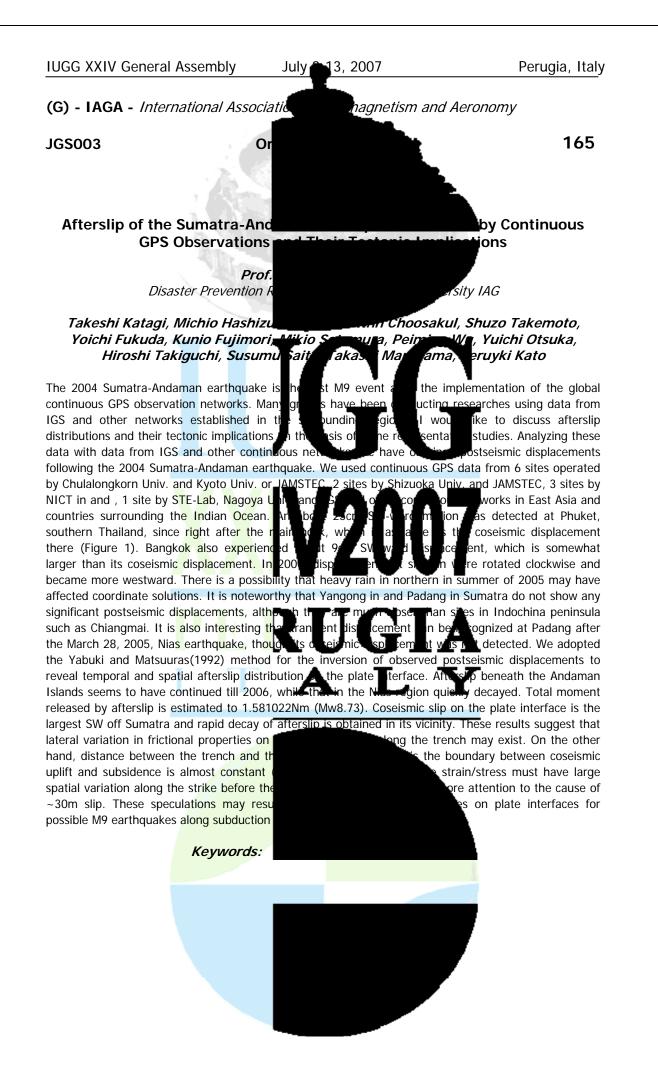


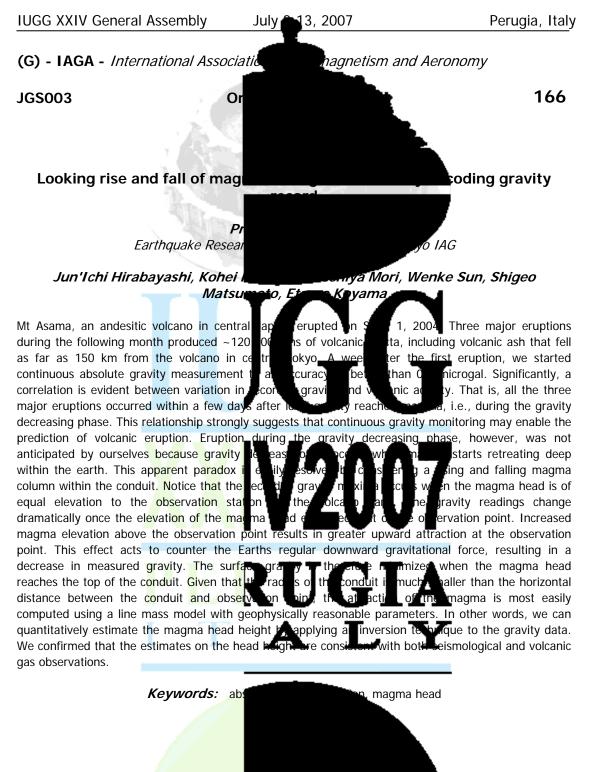




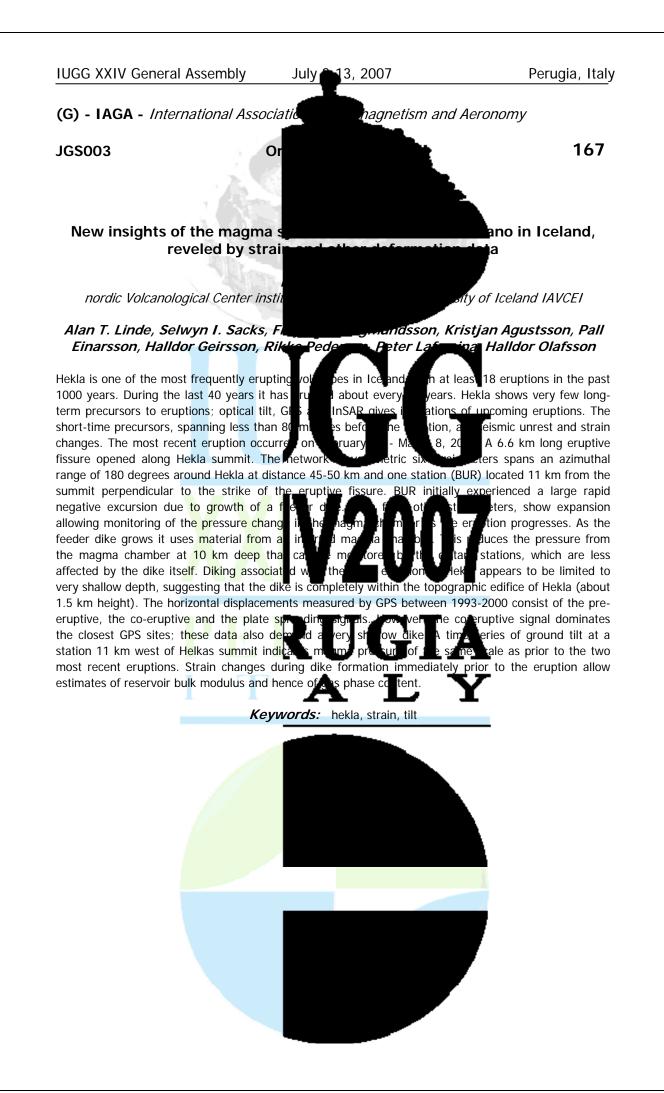




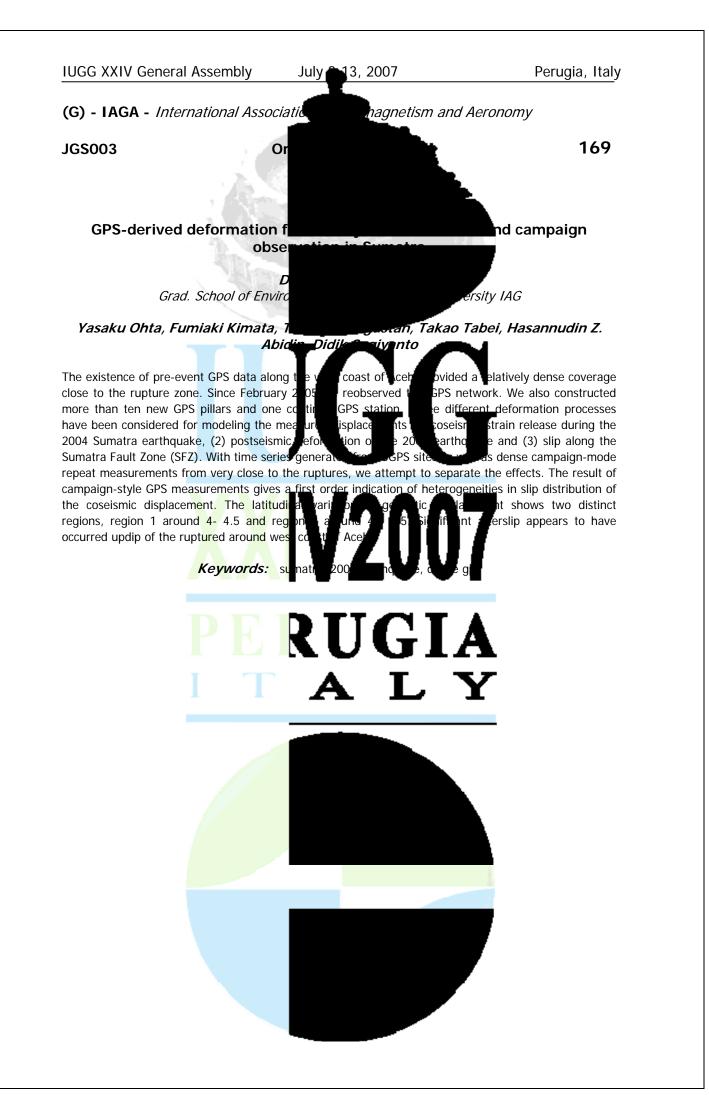


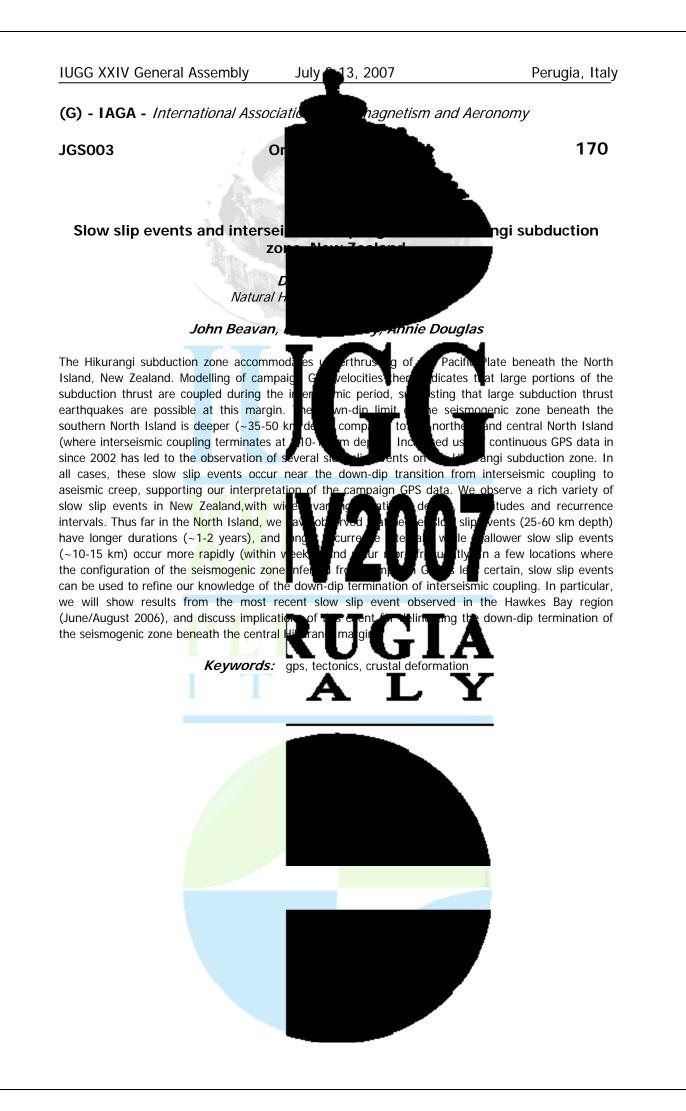


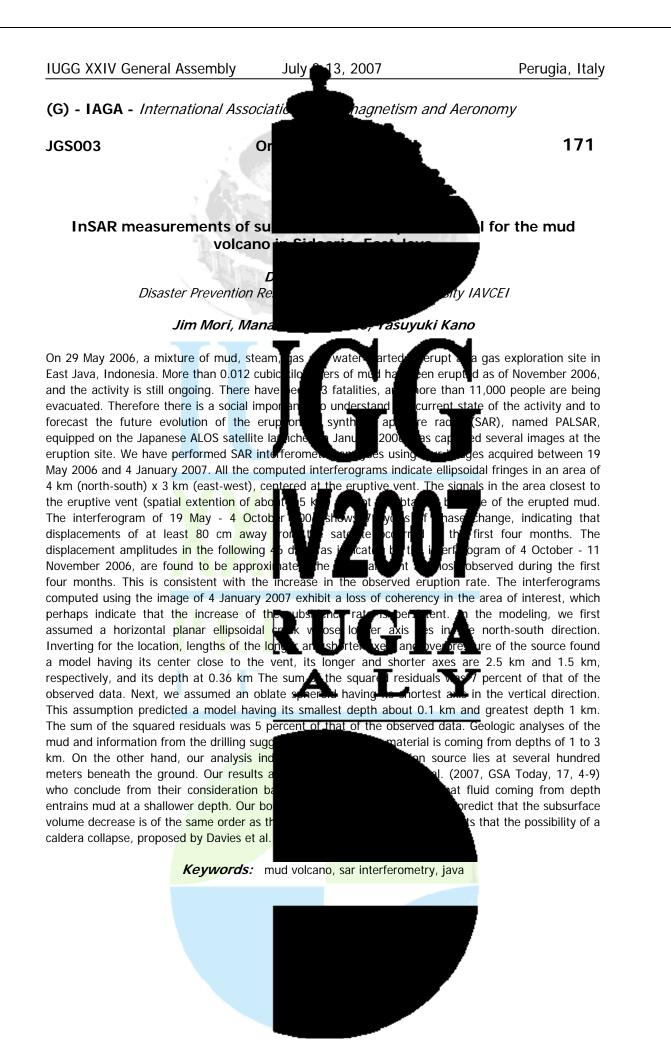


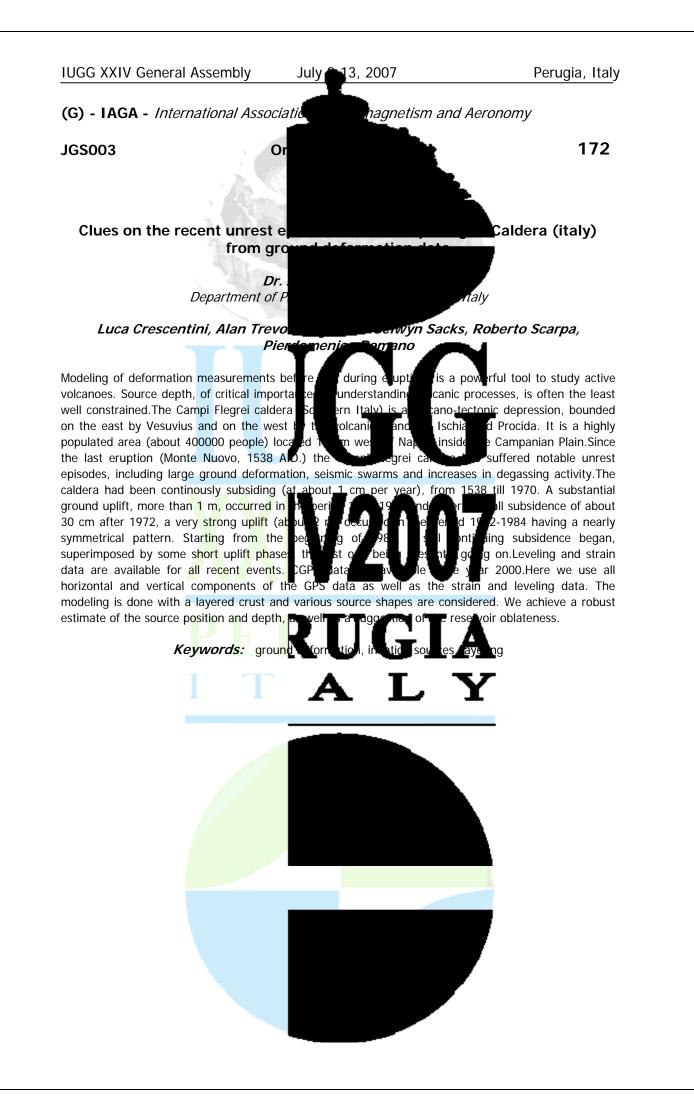


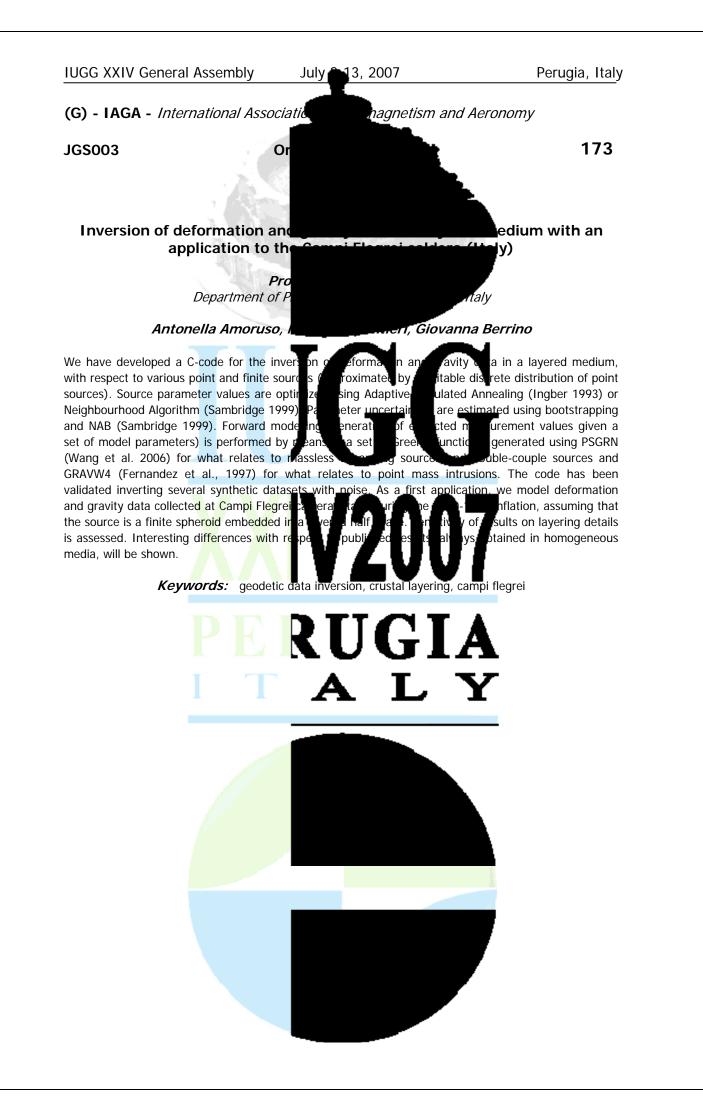




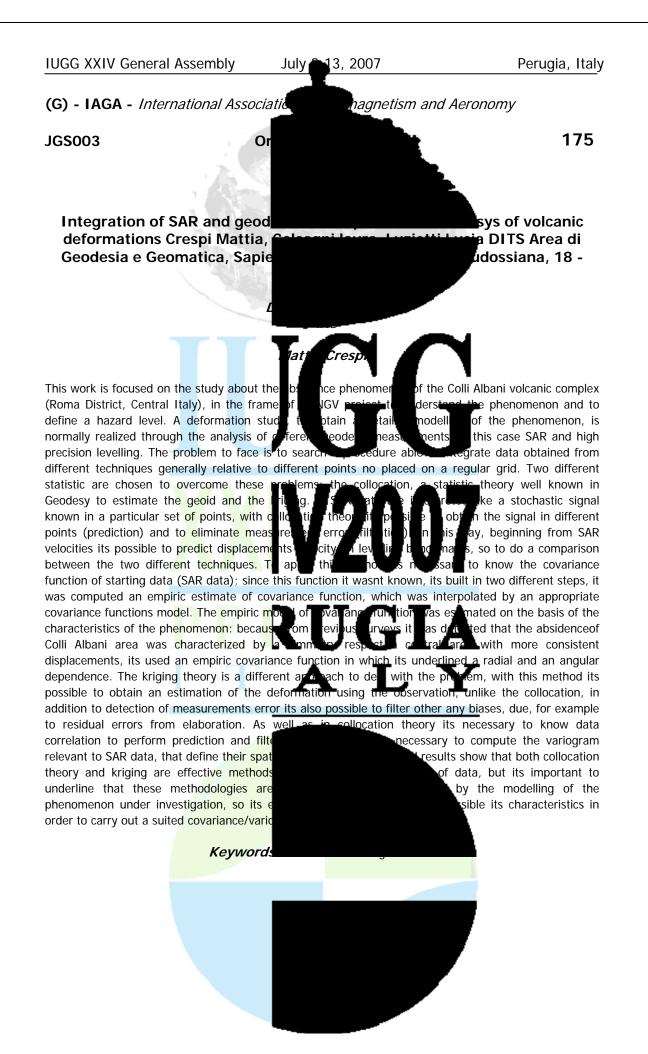






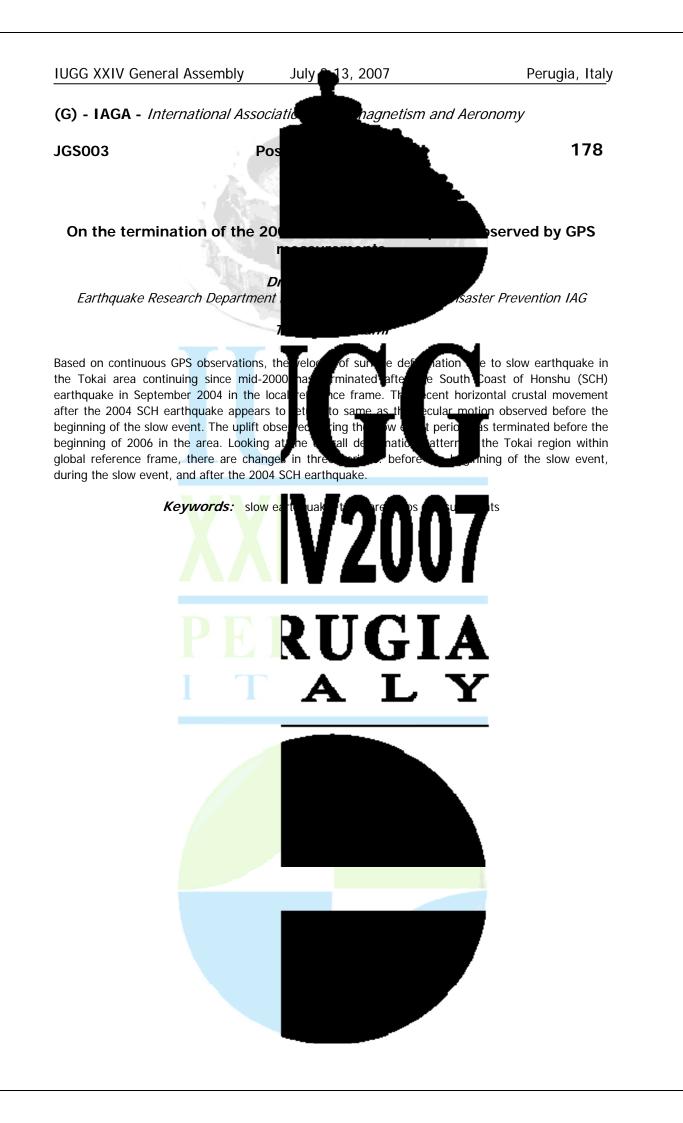




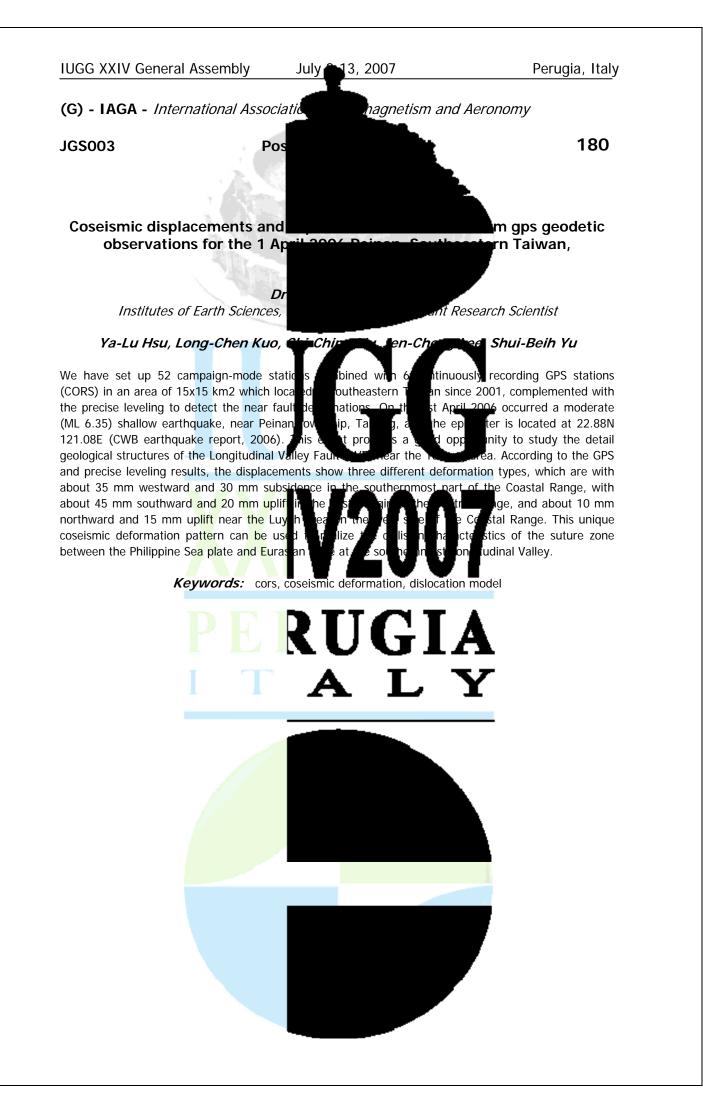




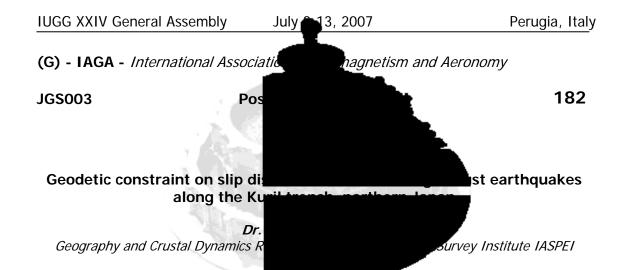












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Geological evidence, historical documents large earthquakes repeated along the Kuril Chis trench is known as one of the most activ subducting beneath Hokkaido with 8 cm/yr 100 years and their segmentation along the Utsu(1972). In Tokachi-oki segment, the 19 In Nemuro-oki segment, the 1894 M~8.0 earthquakes. Although the 1952 and 2005 earthquakes

seismic intensity in Hokkaido, their tsunamis are different on the southeastern coast of Hokkaido (Hirata et al., 2003). Because modern geodetic measurements started in Hokkaido at the end of 19th century, geodetic data can resolve how different collected the geodetic data including tria coseismic slip distribution of the 1952, 19 in Hokkaido in 1890s were used to n respectively. The first measurements near the conducted in 1902-1913. The measurements after the 1952 event were conducted in 1952- 1967. The

trilateration conducted in 1982-84 substituted for triangulation to measure horizontal positions of benchmarks after the 1973 Nemuro-oki ea in 1994. The coseismic and postseismic dis continuous GPS. However, the geodetic mea the difference between preseismic and postseismic measurements include not only the coseismic deformation of the 1952 and 1973 earthquaked but also deformation, deformation associated with other education 1999-2003 is average of interseismic one, I removed the interseismic deformation from observed data.

distance measurements to detect coseisr attribute to slip on the subducting Pacifi boundary is approximated by dozens of opposite to the relative plate motion(N65W estimate. In the inversion, constraint on th amount is applied. The 1952 and 2003 distribution (Fig. 1a and 1c). The location large slip (~8m) east of the Kushiro subm

postseismic one expanded into the eastern

the 2003 events (Mw8.1) is little larger th

attribute of the afterslip and slip of 2004 k

the 2003 events are the recurrence of the

allon manifests couple of kkaido, Japan. The Kuril st off uakes where the Pacific plate is ~8 megathrust earthquakes is 50 ki and Nemuro-oki is proposed by i earthquakes occurred. okacľ eart akes may be the largest ershock distribution and

> are. In this study, I GPS data to estimate tion and leveling started sitions of benchmarks, achi-oki earthquake were

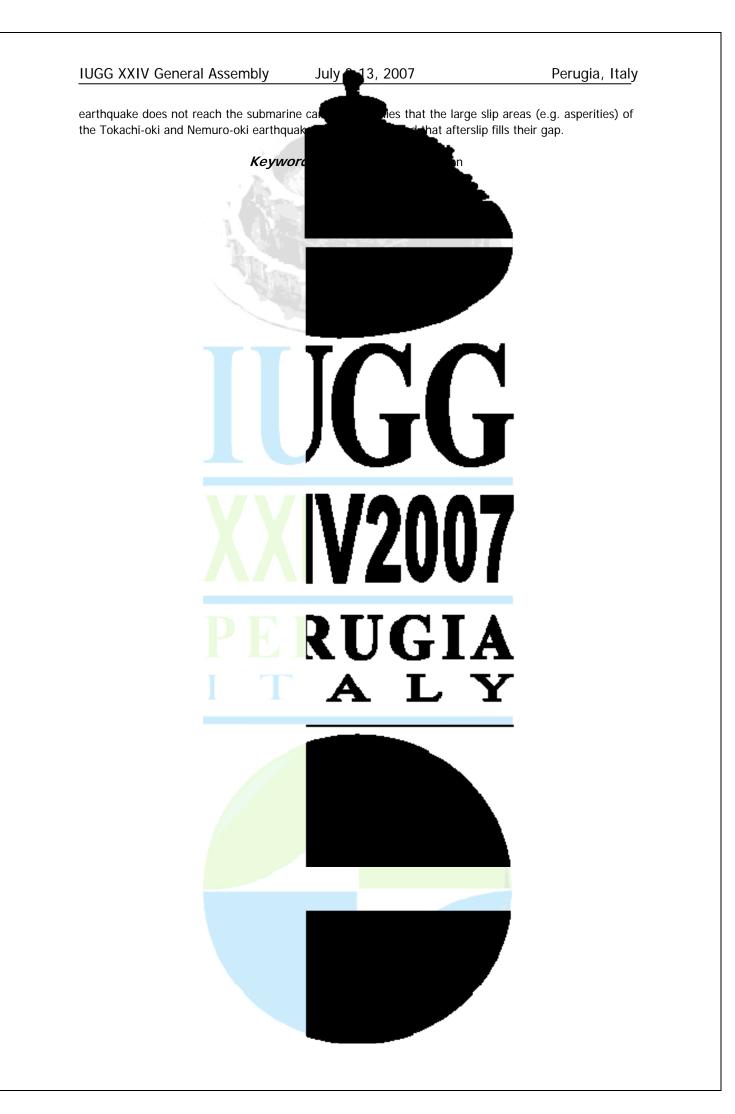
s precisely measured by nqua S are not often so that CO inur us postseism eformation, interseismic duming the GPS site velocity during In addition to triangulation, trilateration, leveling and GPS data, I used data of tide gauge and local observed deformation is assumed to ench. The geometry of the plate slip is fixed to the direction gular fault is a parameter to n and non-negative of slip ted to have similar slip most identical. Although

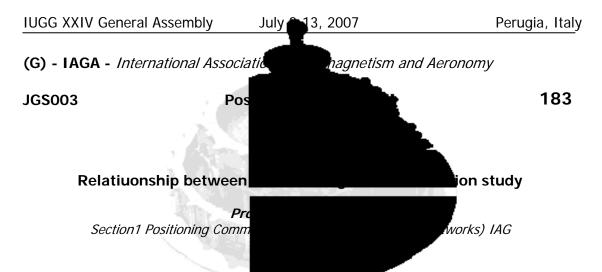
S (GENET) observation started

study of the 1952 event (Hirata et al., 2003), geodetic inversion shows only 1-2m of slip near the coast. Although the resolving power of the geodetic data is poor near the trench, they do not accept large slip such as 8 m. The coseismic slip of the 2003 earthquake is limited west of the submarine canyon and the

> moment magnitude of The postseismic slip is The result suggests that h of the 1973 Nemuro-oki

imated by the tsunami





Currently in many tectonicaly active regi networks with the distances between points of the the study of the general problems of reg between points, have a little information for are required. Amongst them we shall selec the earthquakes, study of the contact zone large faults, where the strong earthquakes economic considerations it is difficult to ex local permanent GPS networks with distances betw

problems will be made. This consideration give justification for searching of analytical description of the relationship between regional and local deformations to convert the first to second ones. The empirical formula was received on the base of the d the Caucasus, Pamiro-Tyanshan, Alpine re data gathered by the laser geodimeters on comparison of real observed and analytica about typical size of blocks in tectonically a 20 km, that well complies with the block size derived using seismic data. It is worse to mention that

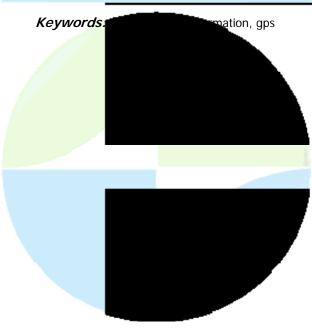
we been developed the permanent GPS 100-500 kilo s, ha Snal dyna /er. of the tasks oblems, conn ent t<u>ectonic</u> mic re en oc Ed. in the the ar 25 K

These networks provide ause of large distances ere the local deformation features d with deformation forerunners of s, detailed study of specific areas me zoning and etc. On elopment on large areas ng the above mentioned

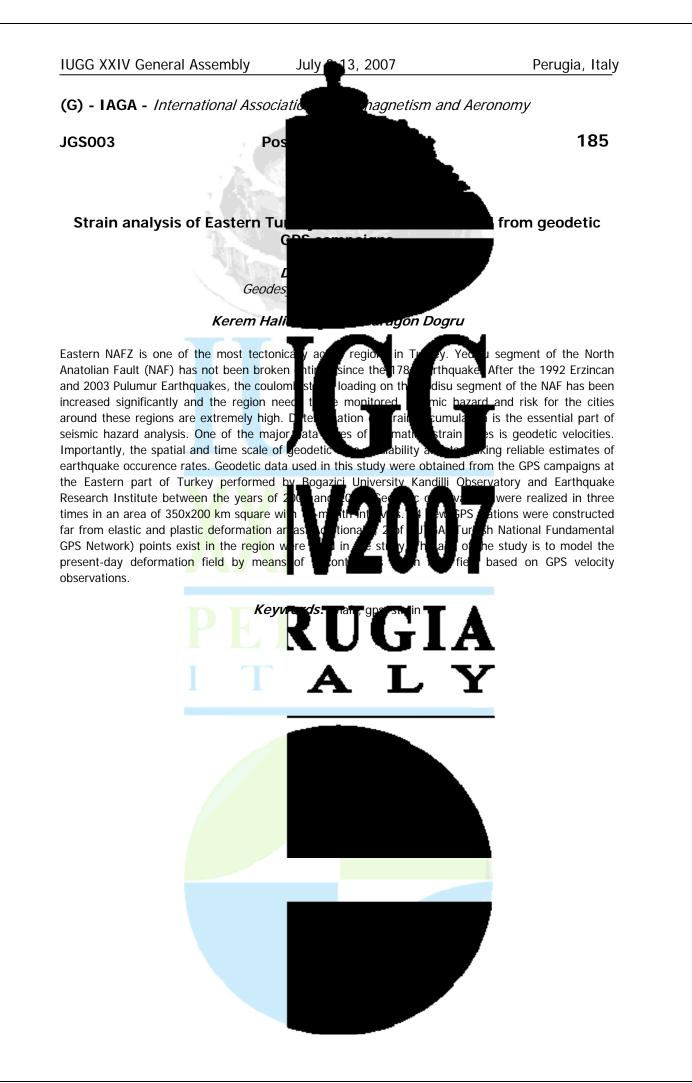
> nically active region of rmation were used the d California regions. The to make the conclusion ng sizes of blocks are 10-

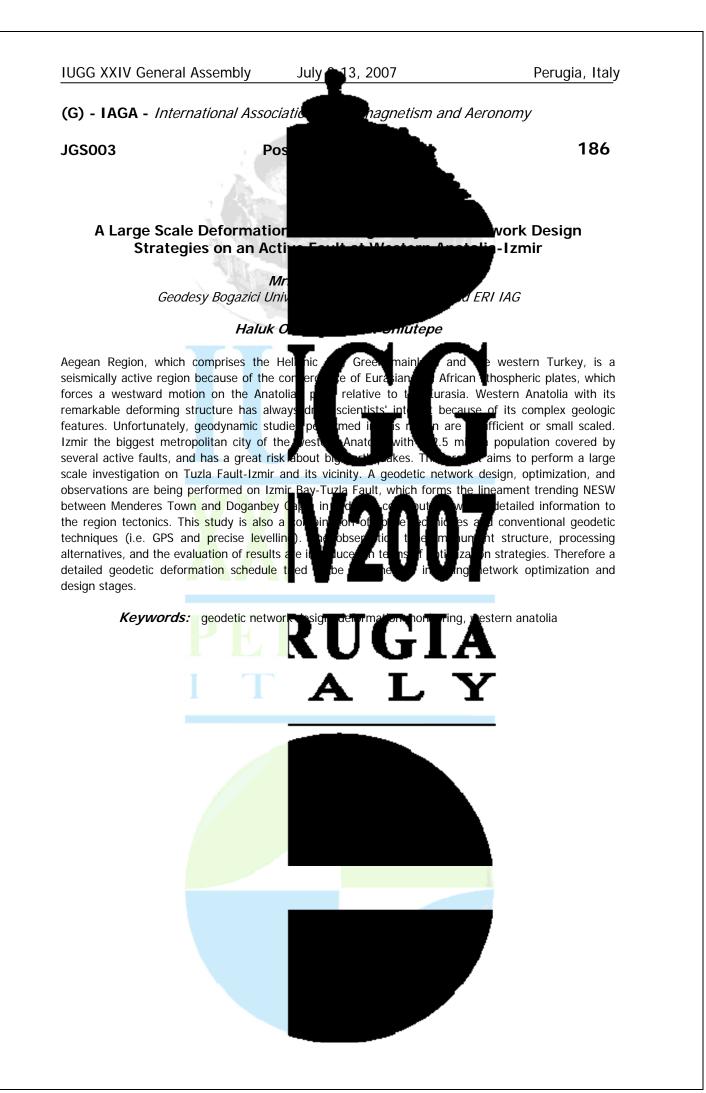
though the main data on deformation is gathered for collision zones, the size of areas with extension and compression approximately equal. used also for analysis of the ricaly covered epicentral deformation processes in regional network svm ation, because of larger area of Izmit earthquake in Turky (M 7.6 1 al d 101 distances between points [300-1500 km,] have an order 1 10-8-5 10-9 and does not characterized at all here as the calculated the deformation condition during the last stages the earth ake prepar match better to usually 2 10-5 local deformation for this region have the val at correspor observed deformation before the seismic events with magnitude 7.5-7.8 on the Richter scale.

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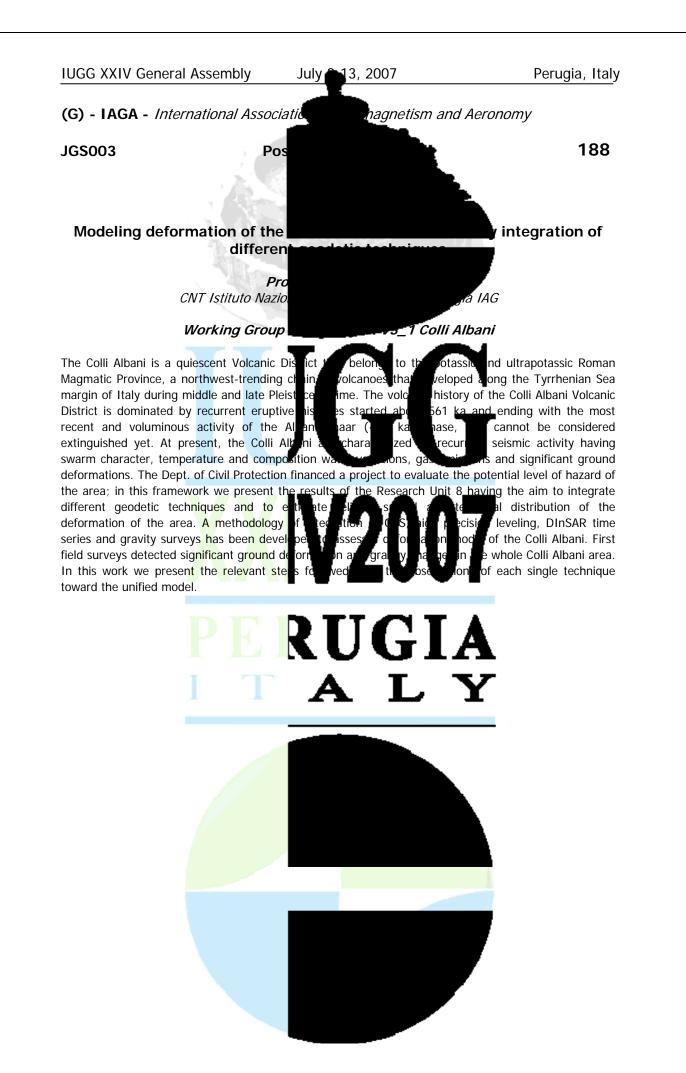


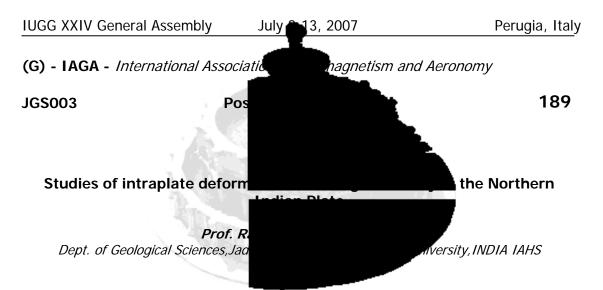












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Abstract: Seismicity map prepared from earth in the Bay of Bengal and adjoining penins seismicity at the eastern plate boundary. Se that the northern Indian plate including extensive deformation.Brief account of va presented and nature of ongoing intrapla Peninsular India is discussed.Fault plane sq the Bay of Bengal and coastal areas of peninsu

consisting north dipping fault and more or less N-S directed pressure or compression axis.Composite plot of pressure and tension axes of focal mechanism of solution of intraplate earthquake of this region also suggest that this region is also exp southern Bay of Bengal also suggest Nsedimentary layer and high angle reverse orientation. The intraplate region of pening lıla response to continuous northward push of

uake ows a in d eophysica e١ of Bengal a auses of sses de dies al ti xhibit

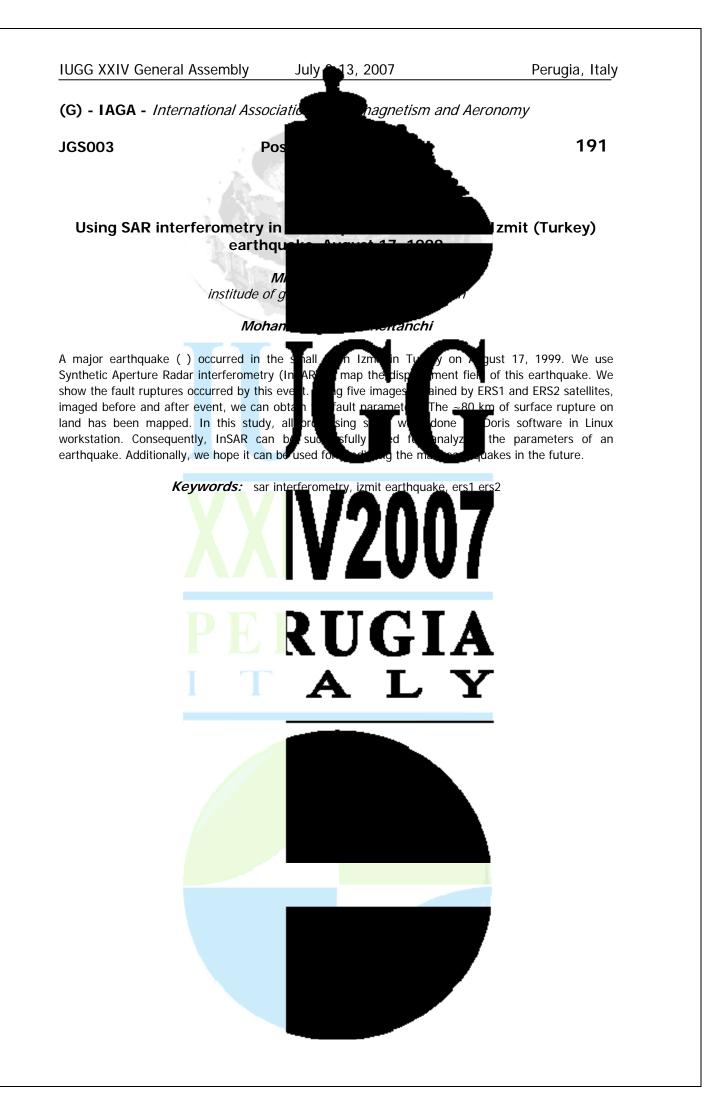
use intraplate seismicity clearly defined higher ์ with es and opservations indicate that peninsular India has experienced ate stresses and deformation is ation he Bay of Bengal and Imost intraplate earthquake in ting mechanism having

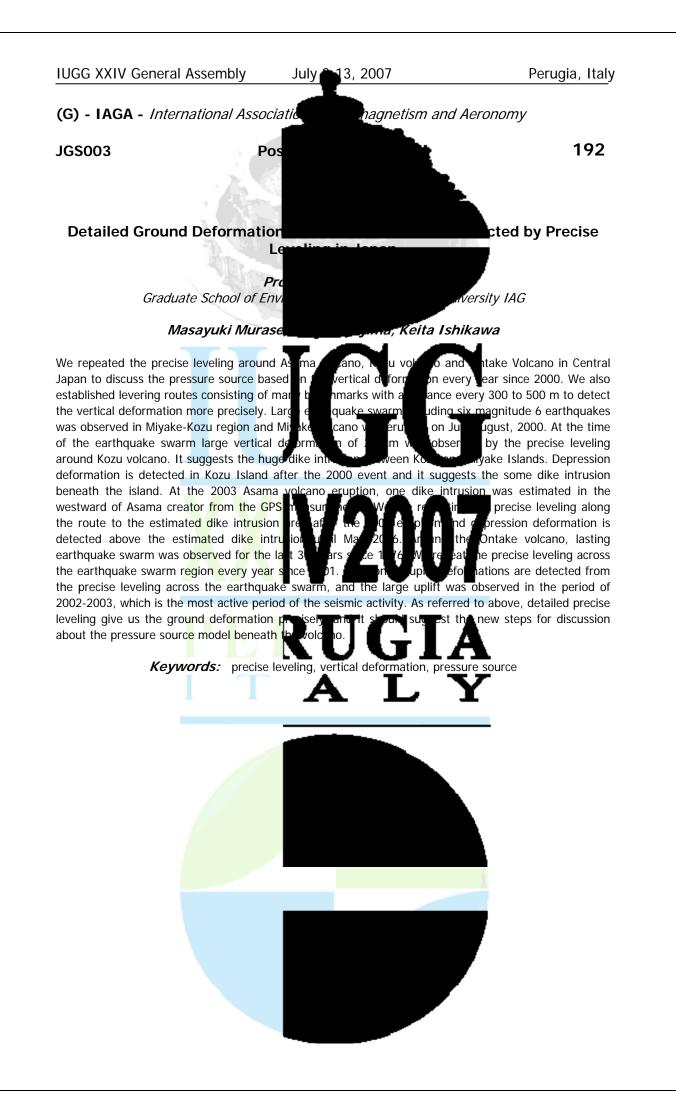
> le seismic profiling in ly by folding of upper eanic crust having E-W nes seismically active in at Carlsberg Ridge.

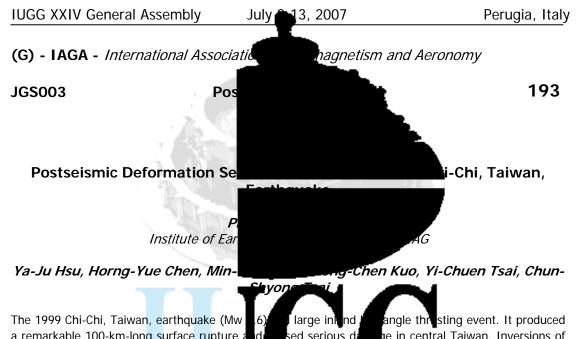
Keywords: seismicity, intraplate deformation, composite plot





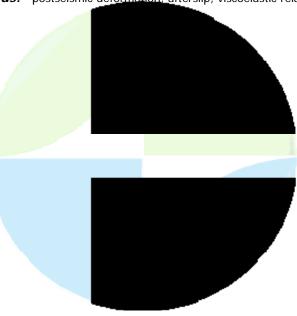


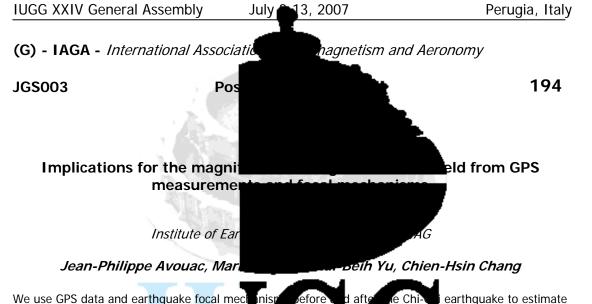




a remarkable 100-km-long surface rupture a sed serious d e in central Taiwan. Inversions of geodetic and seismic data show a maximi eism<u>ic slin</u> out <u>10-15</u> m concentrated at the northern bend of the seismogenic fault, and 0 om the ground surface. ng ab own-d Significant transient postseismic deformat obser by guent S campaign surveys in central Taiwan and a new densely-deployed contin stalled after the Chi-Chi array ii earthquake. The first 15-month (September 1999 to December 2000) postseismic GPS data reveal the postseismic displacement field resembles that due to the main shock, with maximum displacements of 25 and 23 cm in the horizontal and vertical mechanism in the first 15-month period. Based on these data, I ace-time distribution of afterslip, using the Extended Network Inv h slip rates surrounding the region of greatest coseismic slip. The stationary over the 15lindis lutic month period. Maximum afterslip of 0.57 r f the hypocentral region. 0.0 as Afterslip at hypocentral depths is limited to the southern part of the main shock rupture, with little or no slip on the northern section where coseismic slip was greatest. A major part of the postseismic deformation is aseismic. In this study, velocities respectively, from both the campaign-sur-04 to 2006 are estimated, and 2 in central Taiwan. The da /ill 🖌 patterns of postseismic displacement fields e compared with that in the rind b t∖ first 15-month period. These GPS data will also be utilized to study if afterslip is still the dominant mechanism of postseismic deformation seven y Chi-Chi ear after the Take, or the viscoelastic relaxation of the lower crust and upper mantle has

Keywords: postseismic deformation, afterslip, viscoelastic relaxation





the magnitude of deviatoric stress in shallow 15 counter-clockwise rotation relative to vectors suggests that the background stress direction of shear stress is parallel to inferre kinematic slip model, the coseismic stres mechanisms to derive the magnitude of deviatori

Inferred hi seismic slip. ne or<u>der of t</u>l irectio we th lır resi

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ostseisme slip shows a significant rotation of the postseismic slip seismic stress drop. Assuming the We use the interseismic stress field from focal the deviatoric stress is

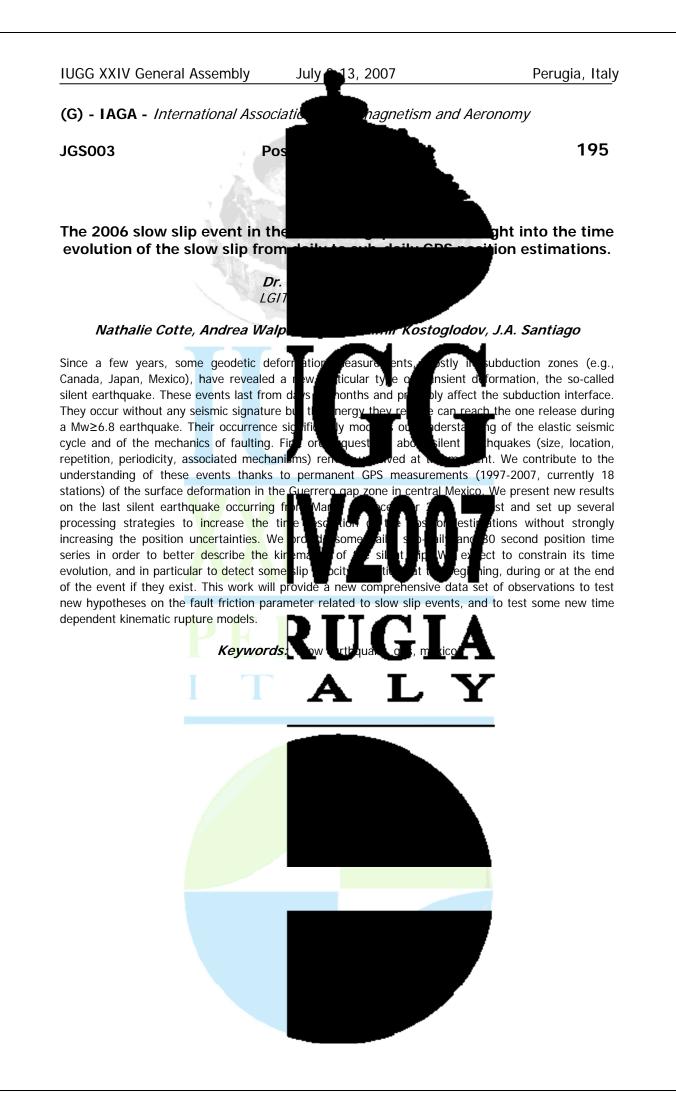
about 5 MPa on the dcollement, implying a low basal shear stress and a low friction of about 0.01. Such a low friction is consistent with the lack of internal deformation in the crustal wedge. In addition, we

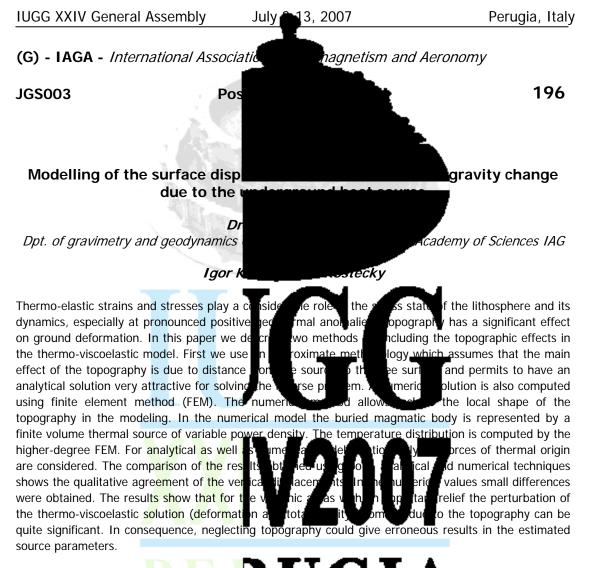
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consider two rheologies including power laboratory estimates of rock flow propertie and may be due to poor constrains of rock more reasonable parameters. Given lithos estimate the frictional parameter (a-b) of a

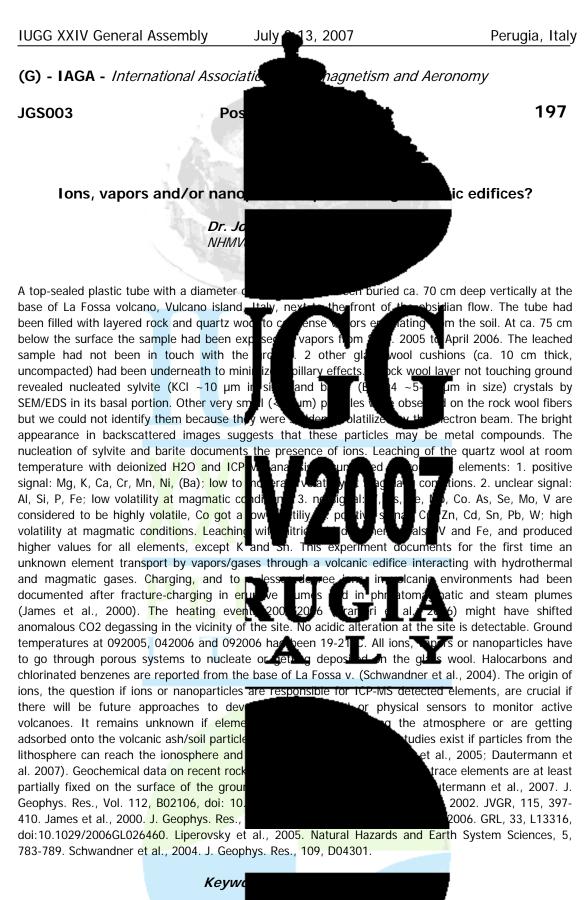
hening friction. Using the shear zone is huge rictional sliding provides on the dcollement, we to laboratory estimates.



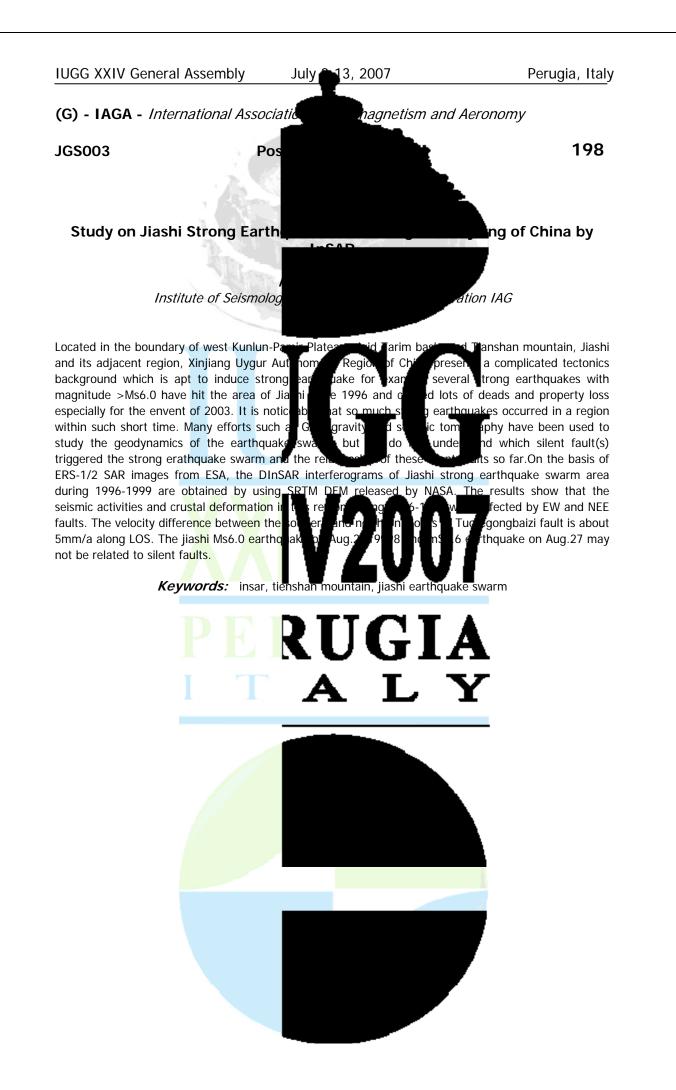


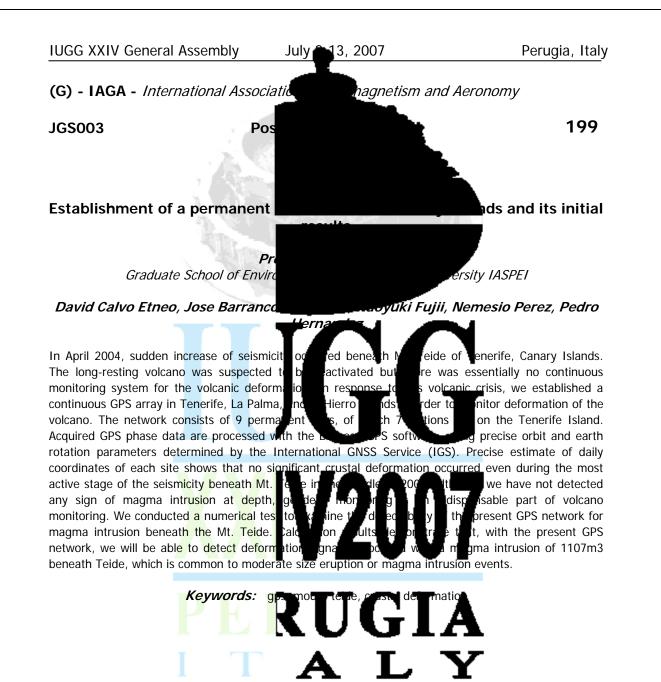


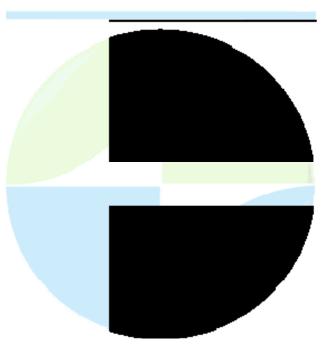


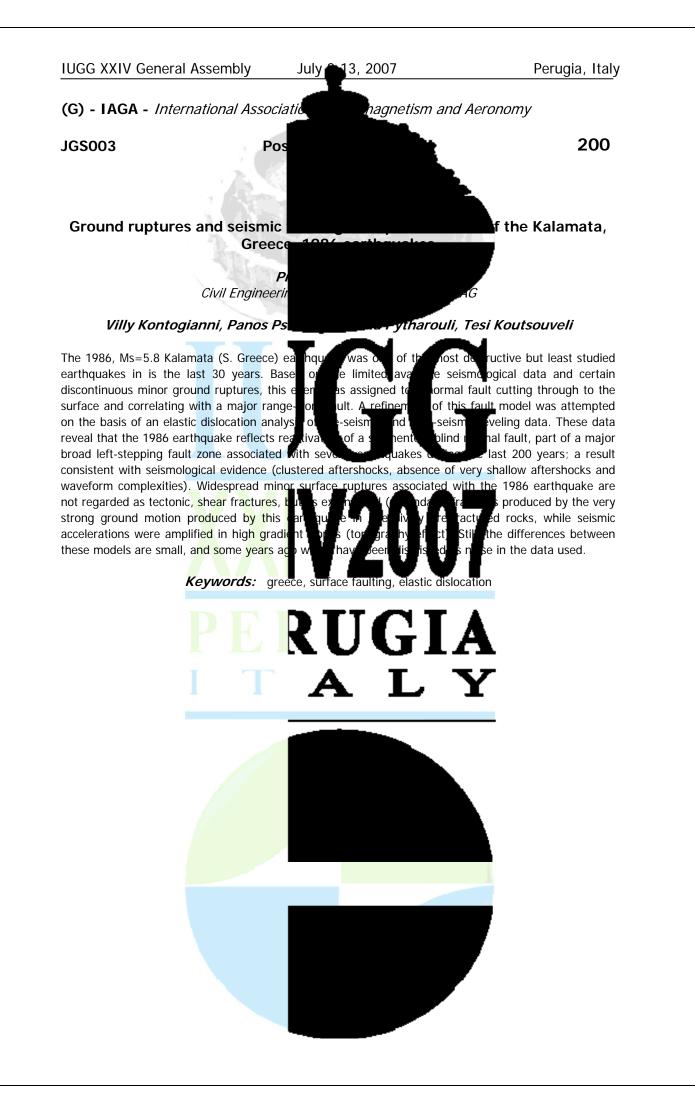


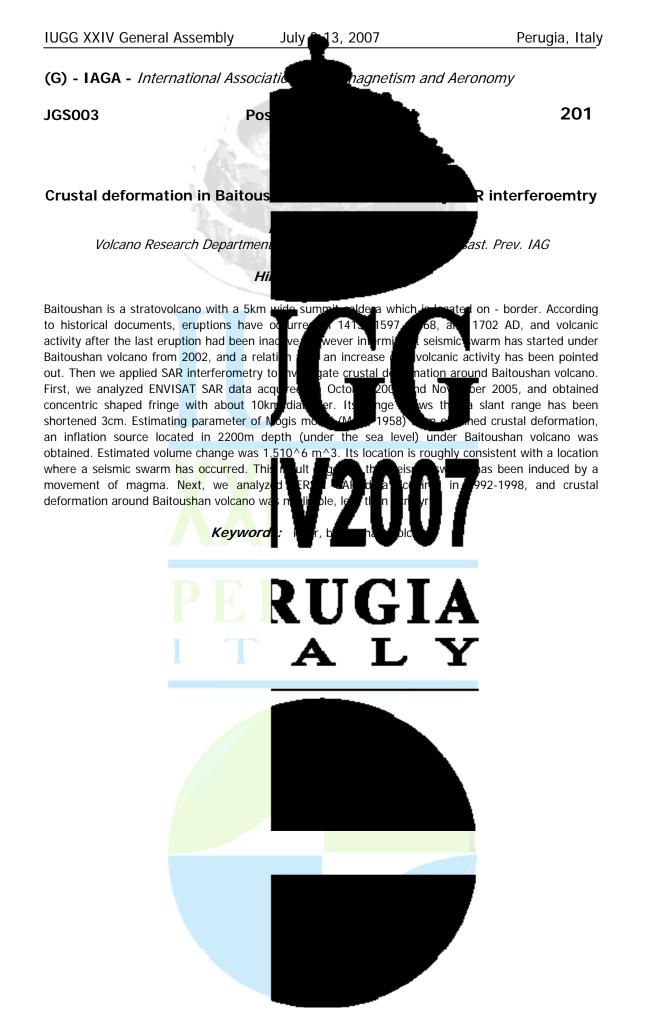


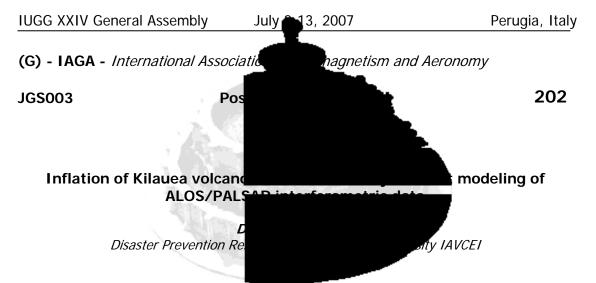












The summit of Kilauea volcano has experient October 2006. The distance between two G sides of Kilaueas caldera increased more website). An L-band synthetic aperture rada that was launched in January 2006, has cap analysis of the pair of 2 May and 2 August the summit area. In order to quantitatively are performed. The summit inflation source is mod

boundary element computation found th

beneath the southwest riftzone.

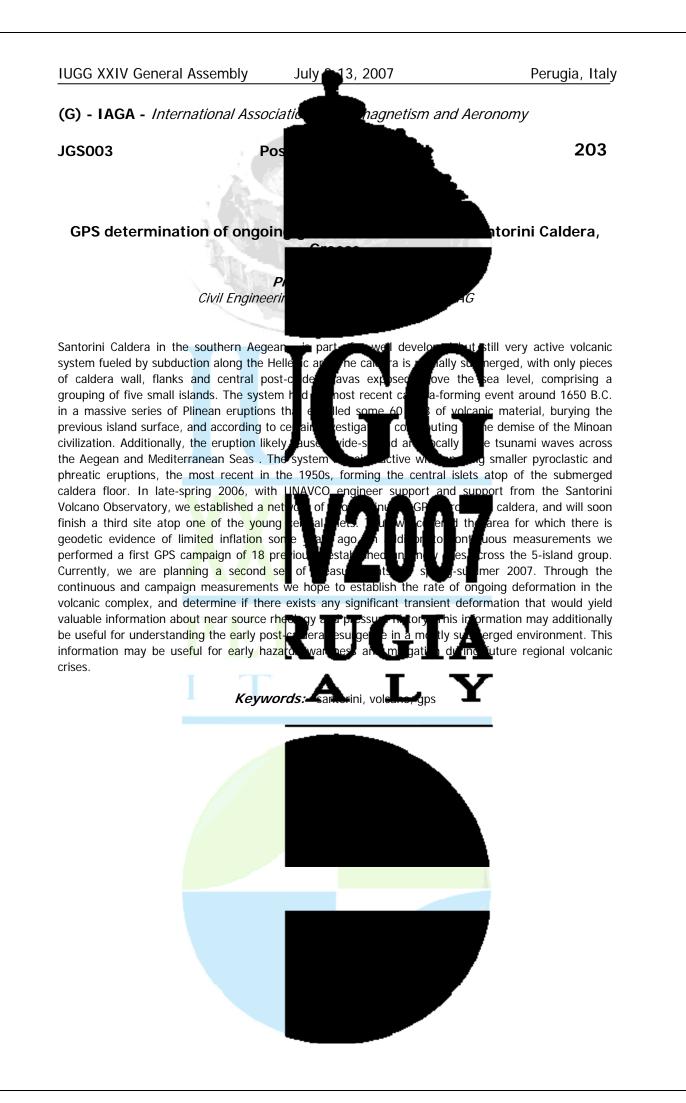
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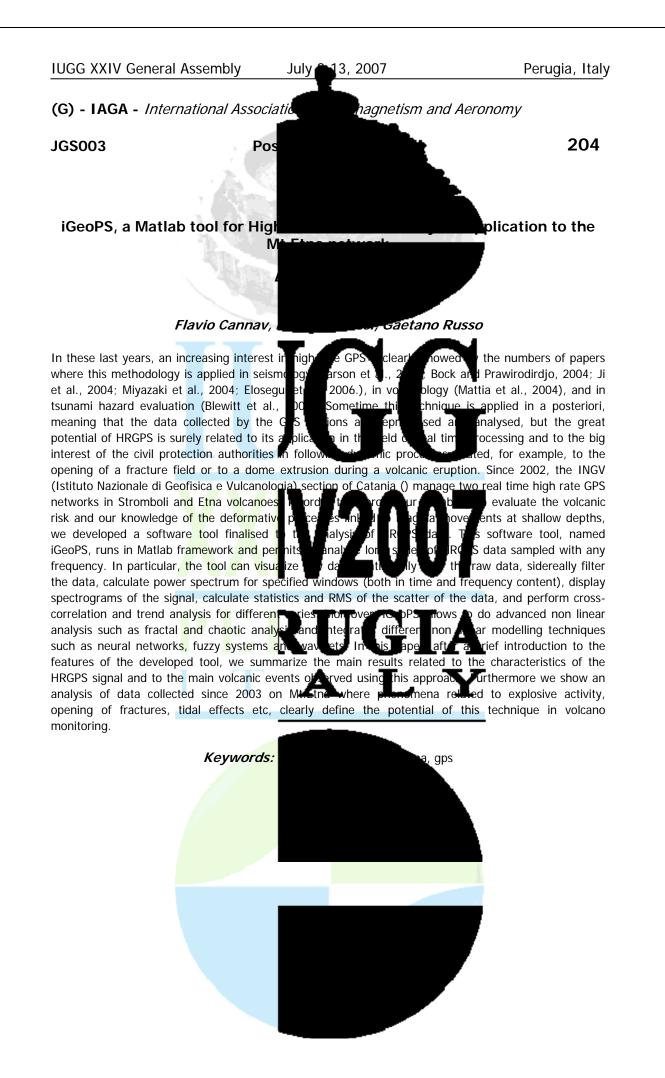
he period of January to ons located on opposite d (Hawahan Volcano Observatory ed on the Japanese ALOS satellite on the volcano. An interferometric nal co tent with an inflation in y element computations bour that inflates in response

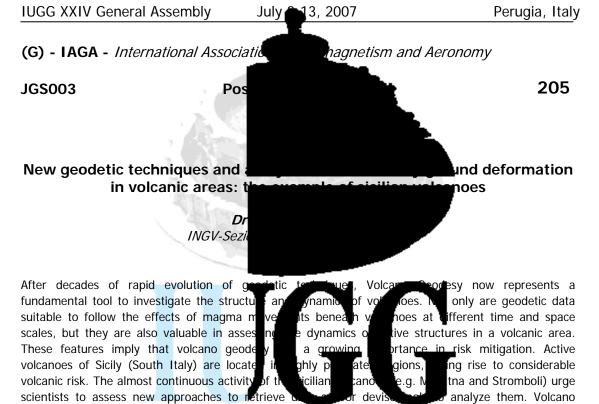
to a constant overpressure. Preliminary results indicate that a vertically elongated spheroid of 1 km height located at about 3.5 km beneath the summit well explains the observed signal. The location of this source is consistent with that of a def before 2003. The interferogram also shows alor of the volcano. While this signal correspon

GPS data for a period the southwest rift zone spheric perturbations, a usion of a vertical dike

Keywords: sar interferometry, kilauea, boundary element modelling



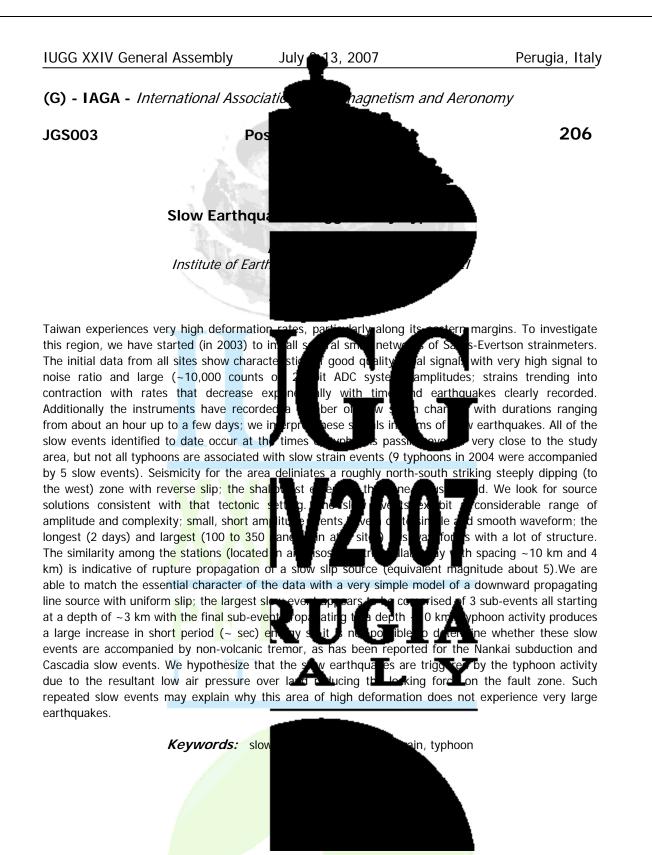




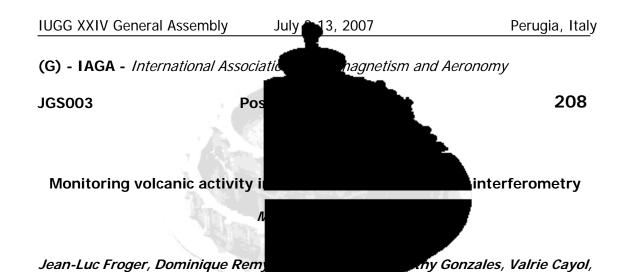
geodesy embraced this challenge and the study of ground deformations on Sicilian volcanoes offers a useful example of applying both new surveying modes and developing mathematical tools to analyze the new data sets. A review of application understanding the current dynamics of devoted to the potential of volcano geode evolving deformations due to deep magi volcanic flank failures or dyke intrusions.

Icanic eruptions or for Particular emphasis is mena from slight slowly movements related to

Keywords: deformations, volcanicrisk, sicilianvolcanoes







Since the year 2002, we carried out an inte fero 28S) using ASAR-ENVISAT data acquired in Cat-1 n 2899). We have produced more th targets of the CVZ (Sabancaya, Ubinas, Mist of the area for the period between the austr from topographic, orbital and atmospheric g ntri displacements. We have detected several Finge pa

the time of our survey. One of the more impressive interferometric signals is a large wavelength (45 x 37 km) elliptical ground inflation localised on the Lastarria Cordon del Azufre volcanic massif at the Chile-Argentina border. Our data show tha Simons from ERS data spanning the 1996 Froger et al. (2007) for the 2003-2005 pe new ASAR images in two different swaths, and to provide new constraints on their sou

of mework interferogran r, La<u>starria,</u> rs 200 ons in ted to

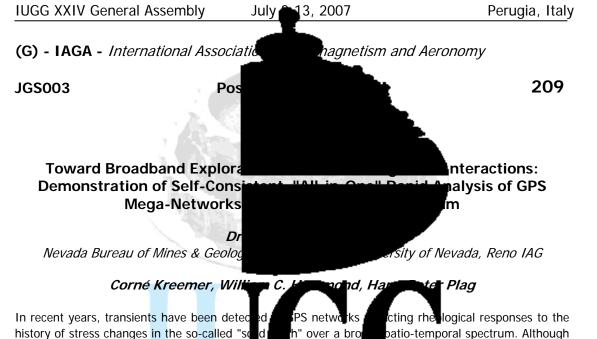
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olcanic Zone (CVZ, 14S project (AO-ENVISAT n 857 & h various active or possibly active nd a <u>alobal</u> interferometric mosaic rograms were corrected the detection of ground tectonic activity during

> 2002 by Pritchard and h, from ASAR data, by ac 2007 period. Thanks to cements characterisation

Keywords: radar interferometry, andes, volcanic deformation



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history of stress changes in the so-called "so rheological responses can be modeled as lir spatio-temporal scales are possible due to q mi events, and due to feedback between such roc geodetic data over different scales have recently

[Smith et al., 2004] and the spatio-temporal pattern of strain spanning the extensional plate boundary of the Great Basin, USA [Davis et al., 2006] geodesy is ideally suited to connect the "broadband exploration" of tectonic-magn scheme that is self-consistent over all sp tid developed an "all-in-one" approach to the ana principle be used to reduce all the world's d temporal resolutions of 0.01-10 years, and spatial resolutions of 1-10,000 km. A major hurdle to GPS network analysis in the past has been the problem that computation time goes as the number of stations to the power 4. This arises from the double-difference carrier phase measure Zumberge et al. [1997] proposed the revol scales linearly with number of stations but only in the case that integer_ambiguities are not resolved.

favor of including data from as many GPS stations a

Our initial tests show that a 98 station net takes using the current GIPSY-OASIS II resulting station coordinates agree to 0.8 for PPP). A block-diagonal covariance is also variances of station and baseline coordin reducing processing time, linear schemes Thus real processing time can be reduc networks. For example, on our 40 cpu clu

batio-temporal spectrum. Although ses, connections between different uch as thquakes and magmatic g cha s in stress. Transients in deep crustal magmatism

asurement_technique to explore such interactions, and geology. Toward evelop a GPS analysis this purpose we have his new capability can in solution, with potential

otstrapping" algorithm.

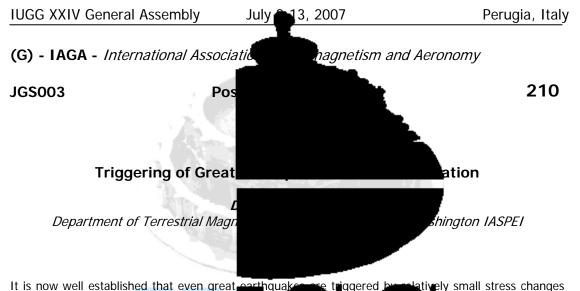
of the integer ambiguities in the

sitic line (PPP) technique, which Here we adopt an approach that augments PPP was ambiguity esolution, bugives up bootstrapping in possible sinsure suce sful ambiguity resolution. The "ambizap" algorithm has a processing time that scales linearly with the number of stations, and gives statistically the same positioning results (<< 1 mm) than when using the full network approach. pu in 7 minutes versus the 22 hours it 200 improvement in speed. The ly repeatability (approx 3 mm mates the rigorously formal n analysis. In addition to ocessor implementation. de for extremely large

an be resolved in ~15 seconds, a factor ~5000 faster than the standard approach. Application of the ambizap algorithm will

greatly assist analysis of crustal movement in regions such as the western North America, which have dense overlapping GPS networks. For example, a network solution from one day of the ~1000 station Plate Boundary Observatory can be produ tes on a 40-cpu cluster (most of which is required by initial PPP).

Keywords:



provided that the stress change increases the Co bars have both advanced and inhibited ear Northeast Japan allowed a ~36 year lag t determined (Rydelek and Sacks, 1990). The from geodetic observations over about 50 y 1940's Nankai trough earthquakes, M ~8, over a 50 year period, resulting in the 1975 Kobe the earthquake record spanning about 12 centuries, the 1940's Nankai trough earthquakes were themselves advanced in time, the interval since the previous event of 1854 being clearly the shortest on record. Strain diffusion from the on-land g but also the two year delay between the ea mechanism was modeled by Rydelek and created stress changes of a fraction to a fe vł modify the occurrence time by a significan lan of more than a century. Here we describe a ation in situ tenth of a bar have governed great earthquake occurrence for more than a thousand years.Continuous

ggered Stre ib fai s.Four c htu subduction e -viscoelastic expla pade m

lag.

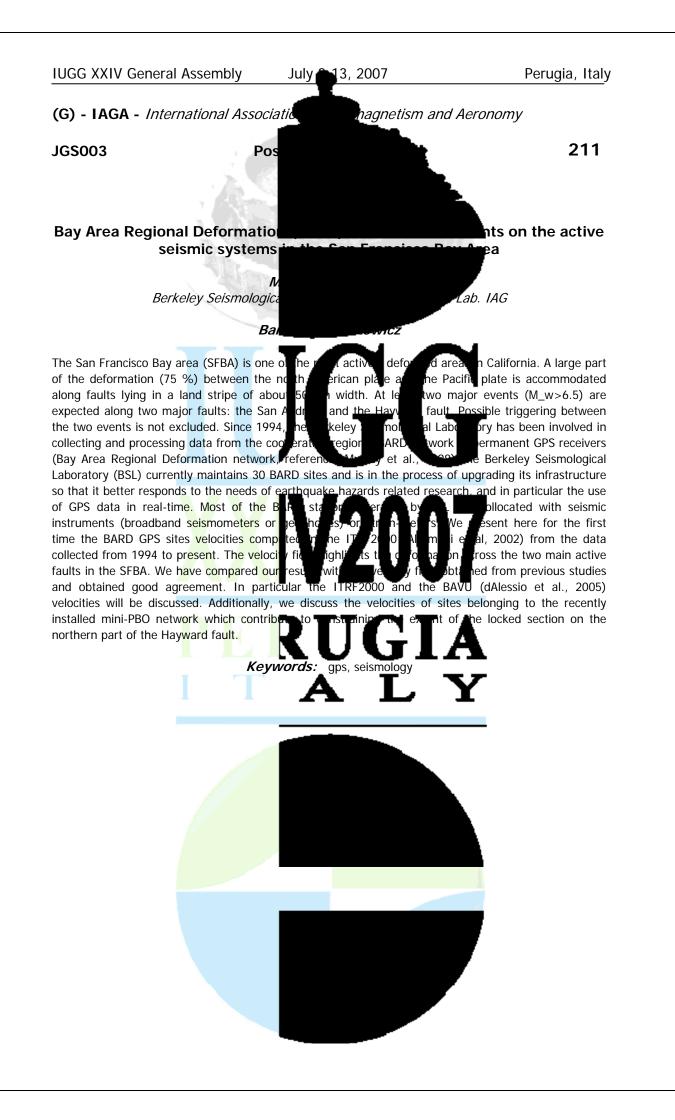
of a few tenths to a few hand of earthouake occurrence data in after on-land earthquakes to be el of the crust-lithosphere derived stress diffusion from the amping the Nojima fault stres and Sacks, 1997). From

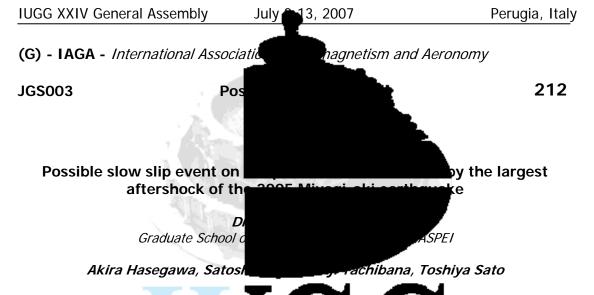
not only the advance, ido) events. The failure the strain diffusion has the Coulomb failure and with recurrence interval which strain changes, even though less than a

GPS observations enable insight into mug greatevents. It has long been recognized that most Nankai trough even ren ntervals of one to two centuries, occur in the winter. A seasonal [pla eki, 2004) overlying the ten on the thrust fault. Even though this stress subducting Philippine sea plate, causes a reduction of stress change is less than 0.1 bar, and the yearly stress fault may 5 to 1 bar, it seems to ading of be sufficient to influence the failure time.

Keywords: coulomb stress, earthquake triggering, great earthquakes







We found possible episodic slow slip event and the overriding continental plate beneath Miyagi-oki Earthquake (M7.2) on 16 August overlapped with the southeast portion of the which is expected to reoccur in the near fut December 2005 and M6.1 on 17 December 00 GPS time series after the largest aftershock sug

dependent inversion analysis based on Yagi and Kikuchi (2003) to the GPS time series to estimate the distribution and evolution of aseismic slip of occurred around the hypocenter of the largest aftershock at a distance of about 4 seismic motion or static stress change due slip event might affect the occurrences of earthquakes which occurred on January aftershock.

ate in ace h th astern Ja an The source a ure a<u>rea of t</u>h e large nd jd po eisn anothe immediately after the largest aftershock at some area north of its hypocenter. Thus, we applied time

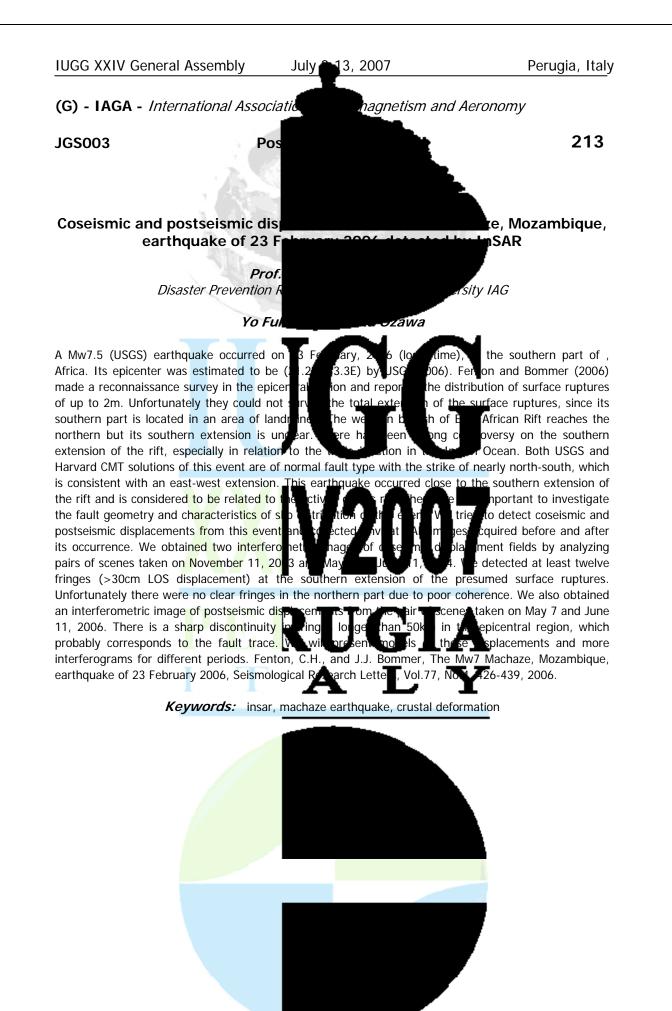
subducting Pacific plate nalyzing PS time series after the of the 2005 Miyagi-oki Earthquake 78 Mivagi-oki Earthquake (M7.5), aftershocks (M6.6 on 2 nd lar p ocd d after the main shock. slip event might start

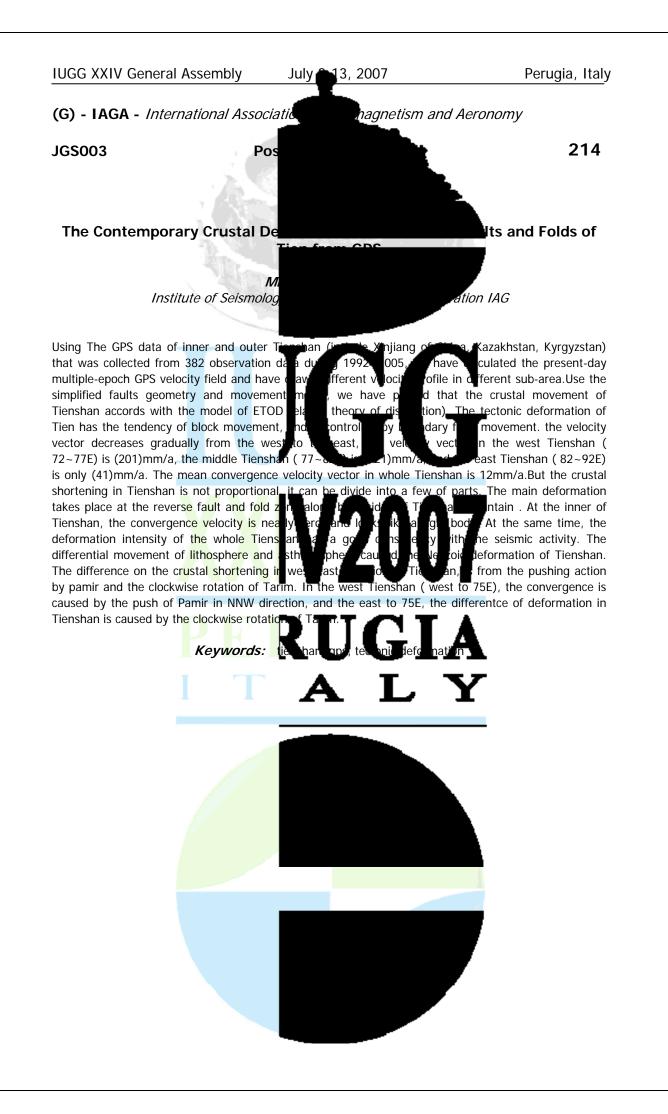
that a slow slip event rred 15 days after the ent might be induced by cumulation by this slow ck and small repeating ypocentral region of the second largest

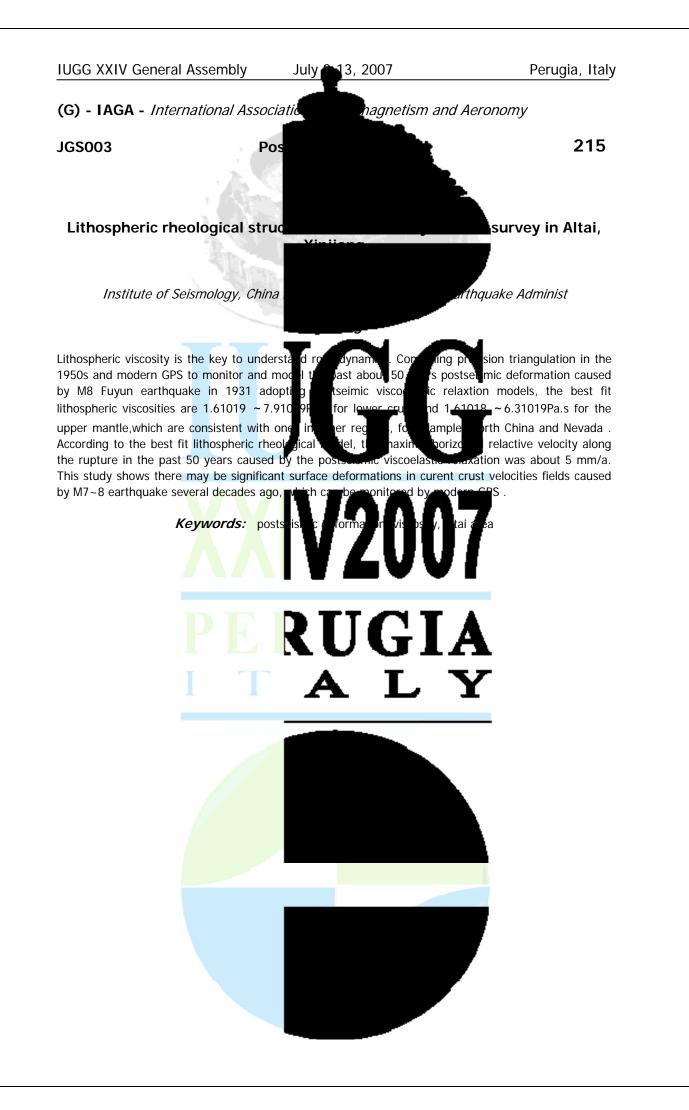


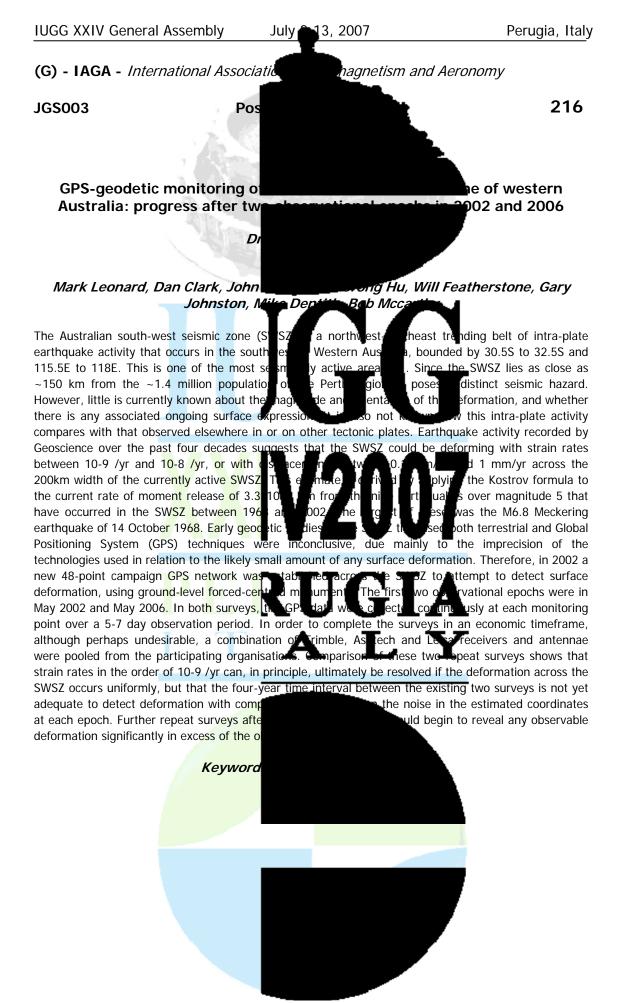
to

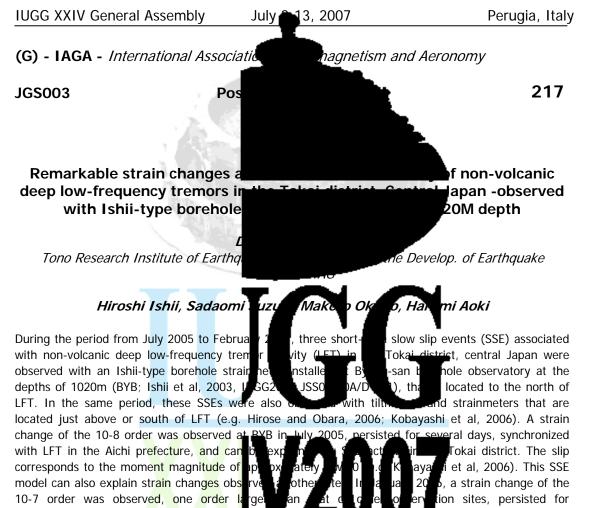
2006



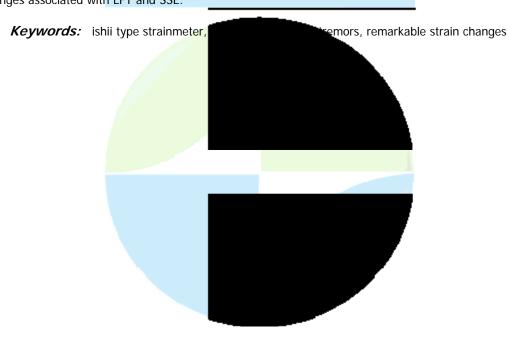








approximately 17 days, and synchronized v ith ble of isodes of LFT and SSE in Tokai district at January, 2006 (National Research Institute for Earth Science and Disaster Prevention; NIED, 2006). But the SSE model of whole episodes (NIED, 2006) can not completely explain the observed strain change at BYB. On the es ob rved at other sites are ha synchronized with only LFT in the Aichi p an be explained by only ar SSE model in the Aichi pref. which is a part of de Herever, this partial model can not explain the observed strain change at BYB. We are trying to clarify the mechanism of observed strain change in January 2006. In February 2007 esently, a train chang milar to that of July 2005 associated with LFT in the Aichi pref. is now from prepresent he details of these strain ress. V **.** . changes associated with LFT and SSE.

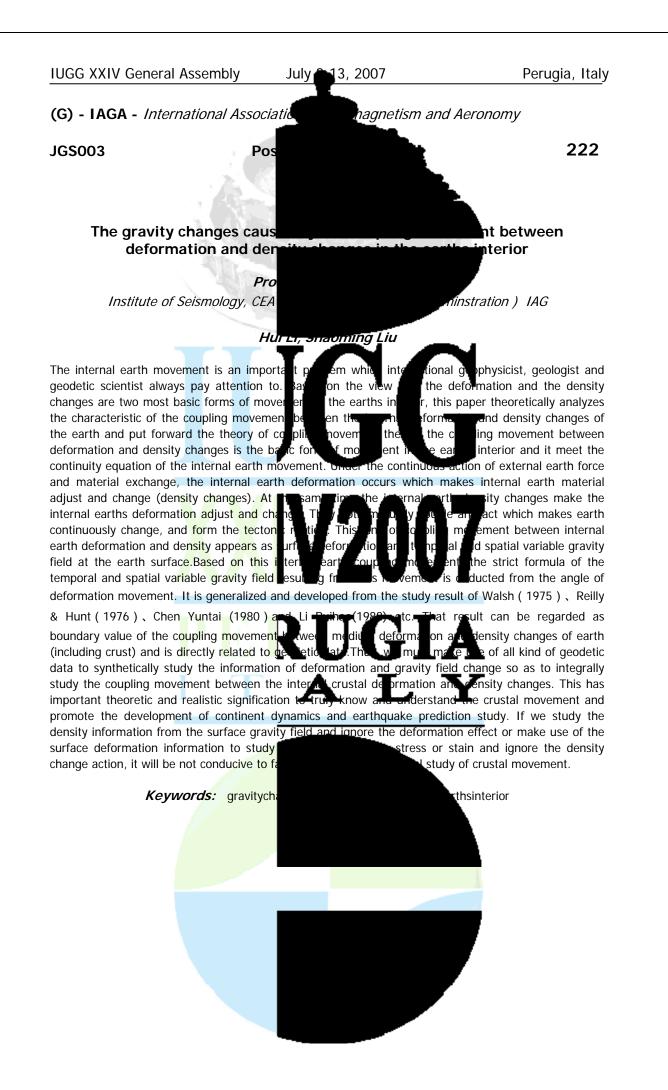


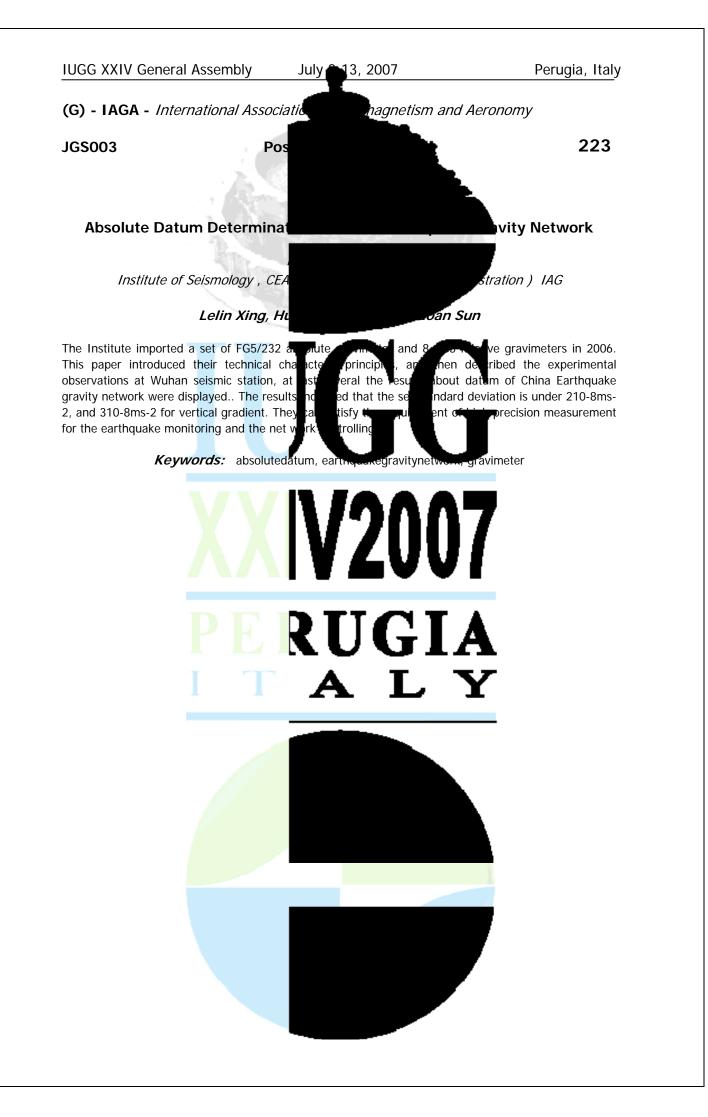


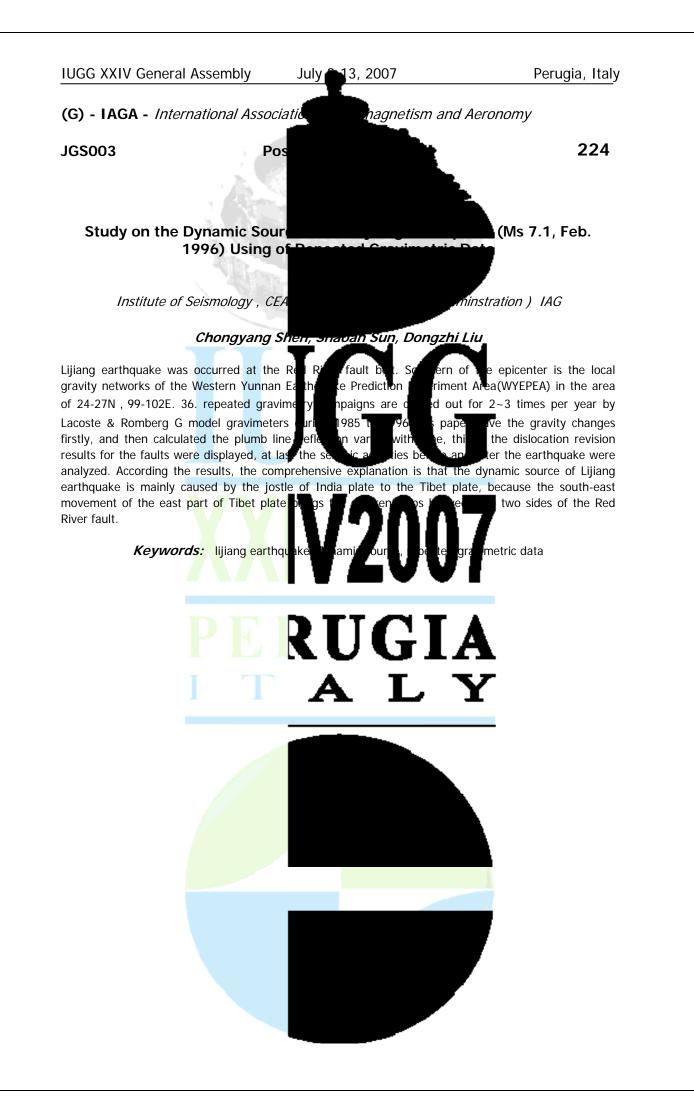


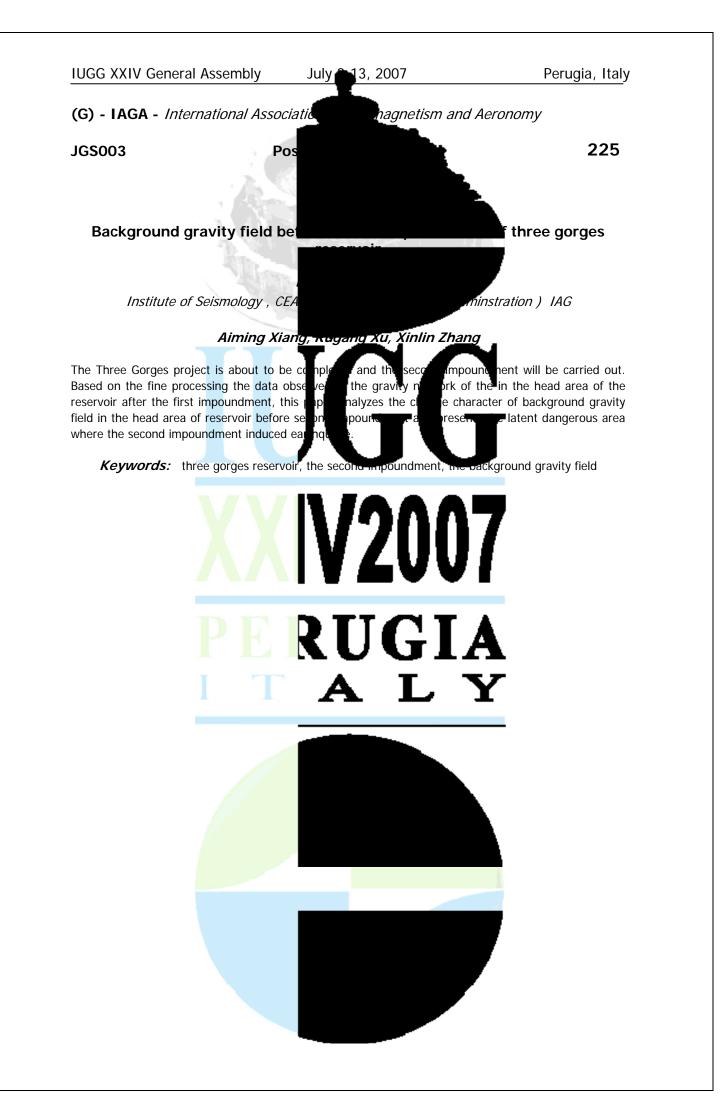


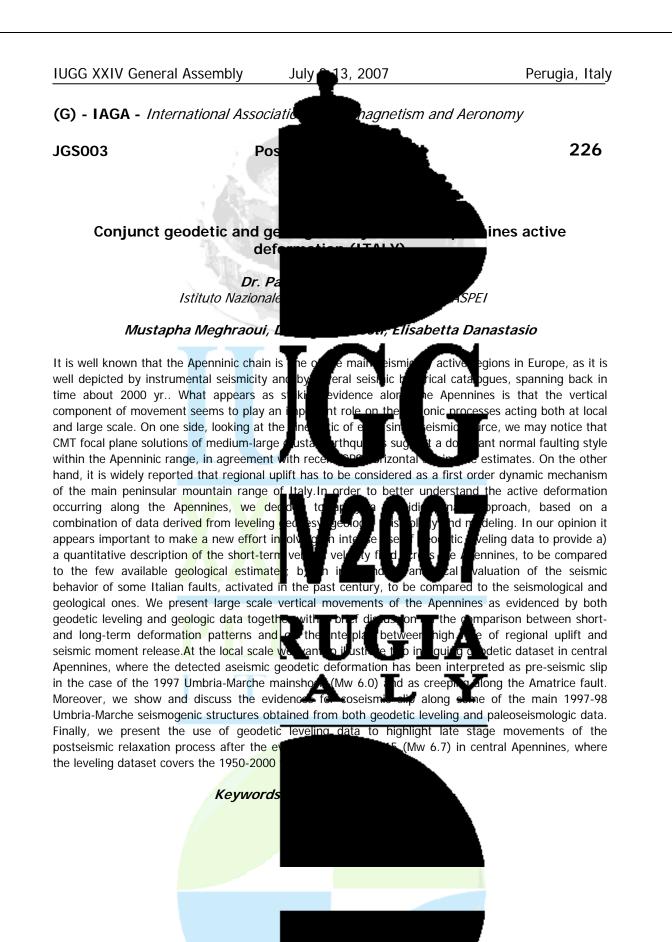


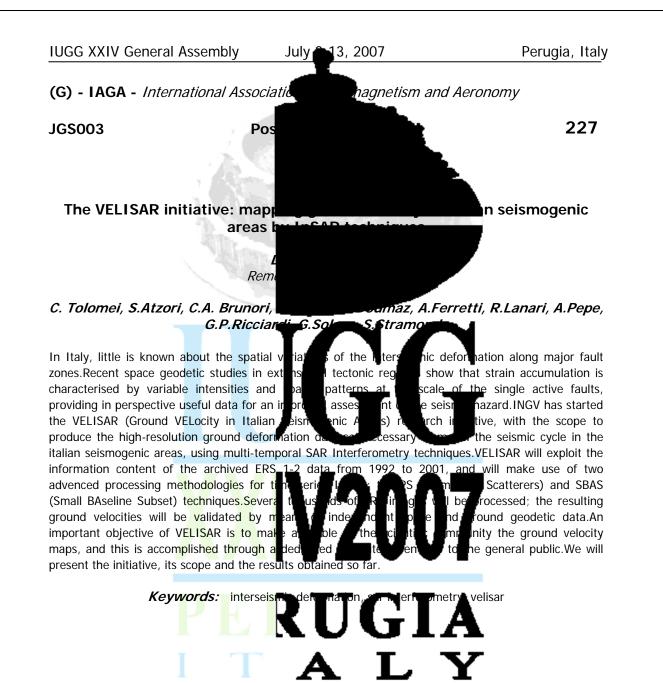


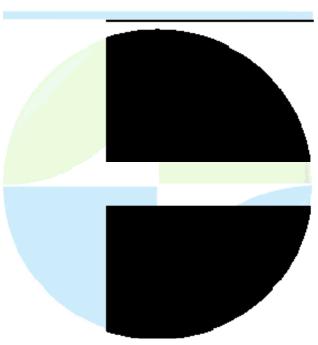


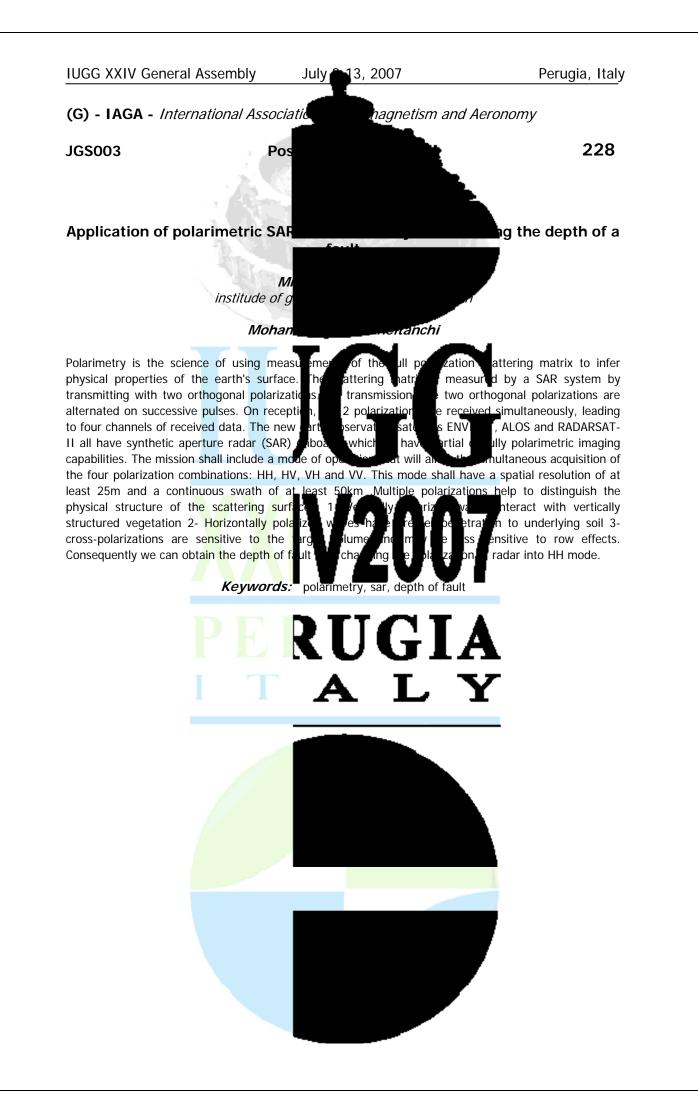


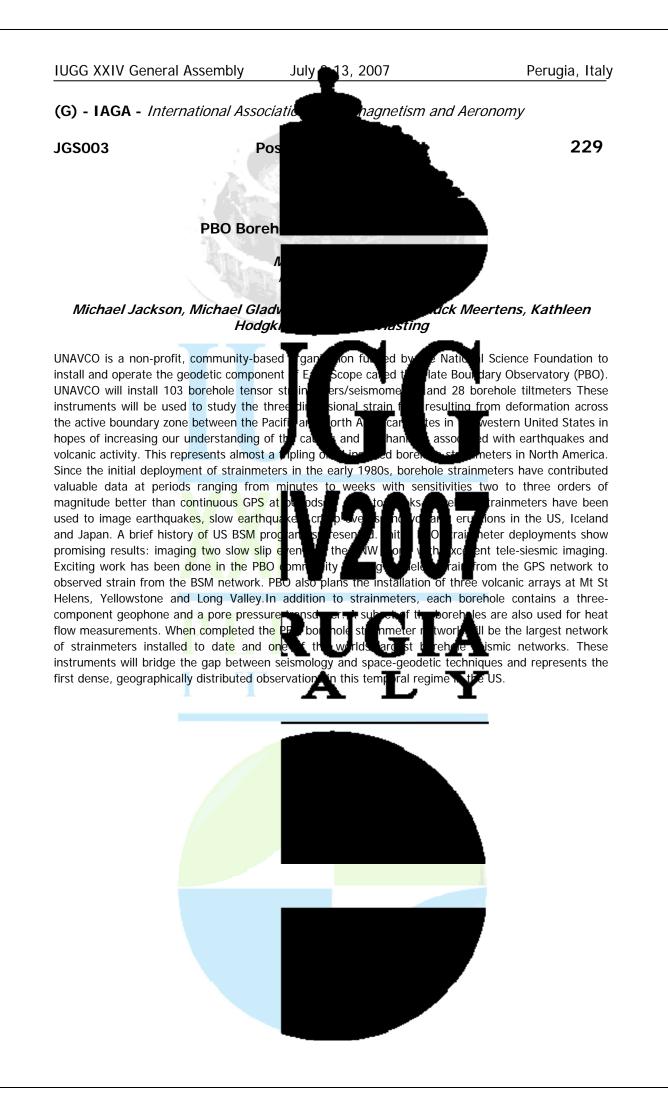


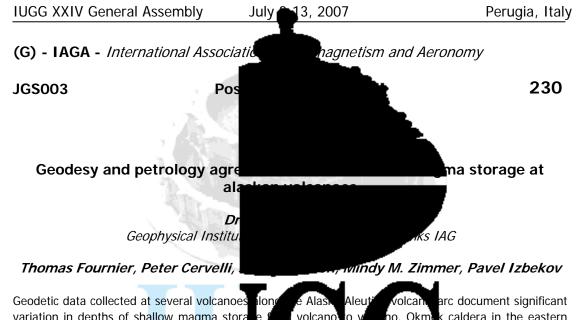












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variation in depths of shallow magma stora Aleutians has undergone substantial inflatio source consistently located ~3 km beneath inflation has varied substantially over this ti <500 meters. Deformation at Westdahl and 5-7 km, and deeper sources are found for Venian

provided a particularly interesting case, as the pre-eruptive inflation suggested a small, shallow (~1.5 km) inflation source, but the deflation in the eruption showed that most erupted magma came from a much greater depth.Petrologic observation magmas experienced before ascent and inferred for the 1997 eruption suggest that from geodesy. Vapor saturation pressures caldera-forming indicate two distinct pressu consistent with current geodetic observations of inflation depth. Vapor saturation pressures from andesitic Akutan melt inclusions indicate entrapment at 4.1 km, and basaltic melt inclusions from Augustine indicate deeper pressures of e

consistent with geodetic data. The uniform each center suggest entrapment occurred petrologic pressure estimates suggest both techniques are recording the same shallow magma storage conditions.

ho. Okmak caldera in the eastern its last eruption, with the inflation the caldera. Although the rate of urce h emained constant within a so at intermediate depths,

ints on the pressure gma storage pressures r depth to that inferred ions from two Holocene km. The latter pressure is epths from both volcanoes are

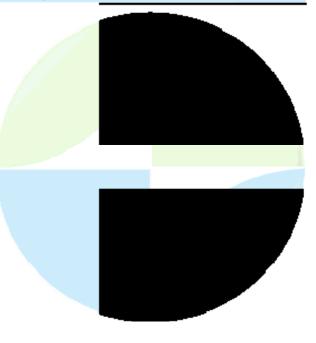
6 eruption of Augustine

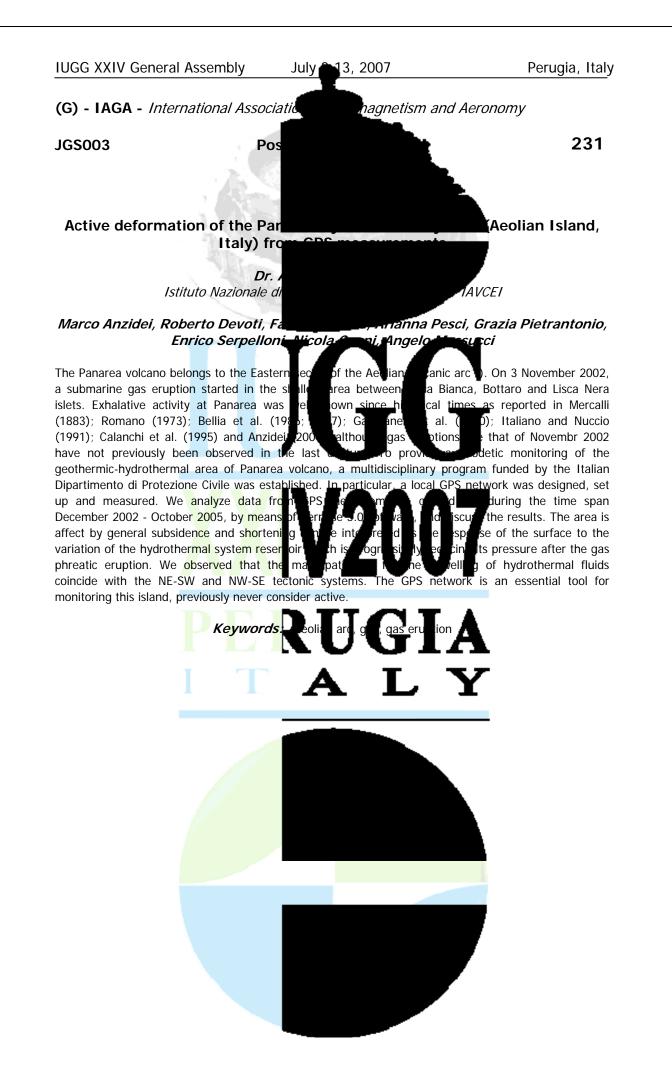
the melt inclusions from host between geodetic and imi aru

Keywords: volcano, deformation, pressure

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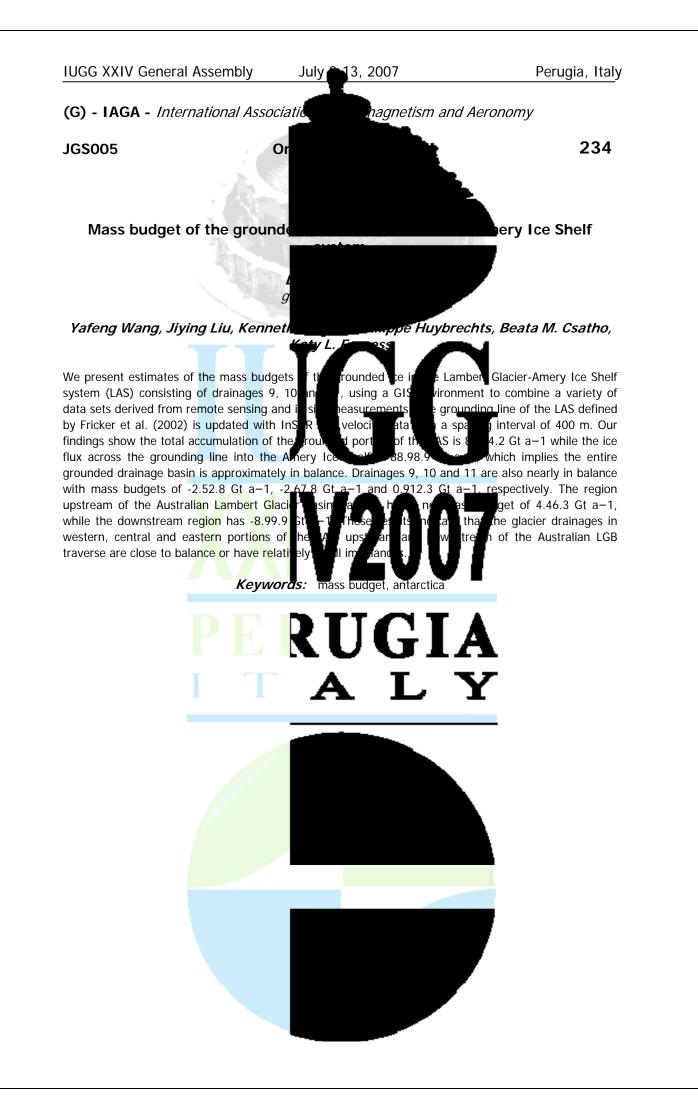




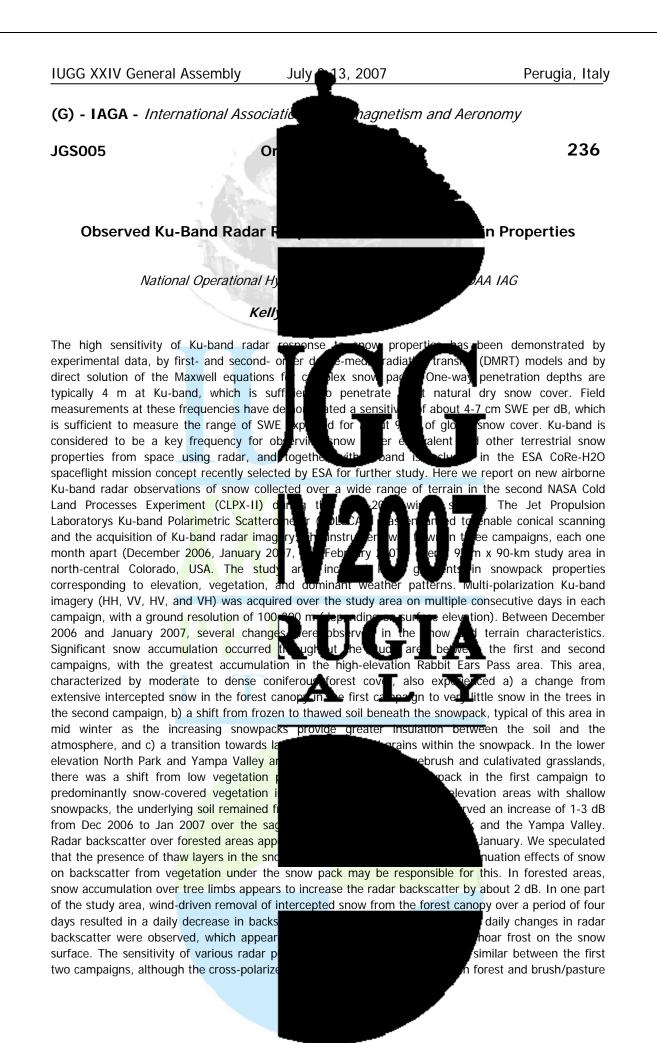


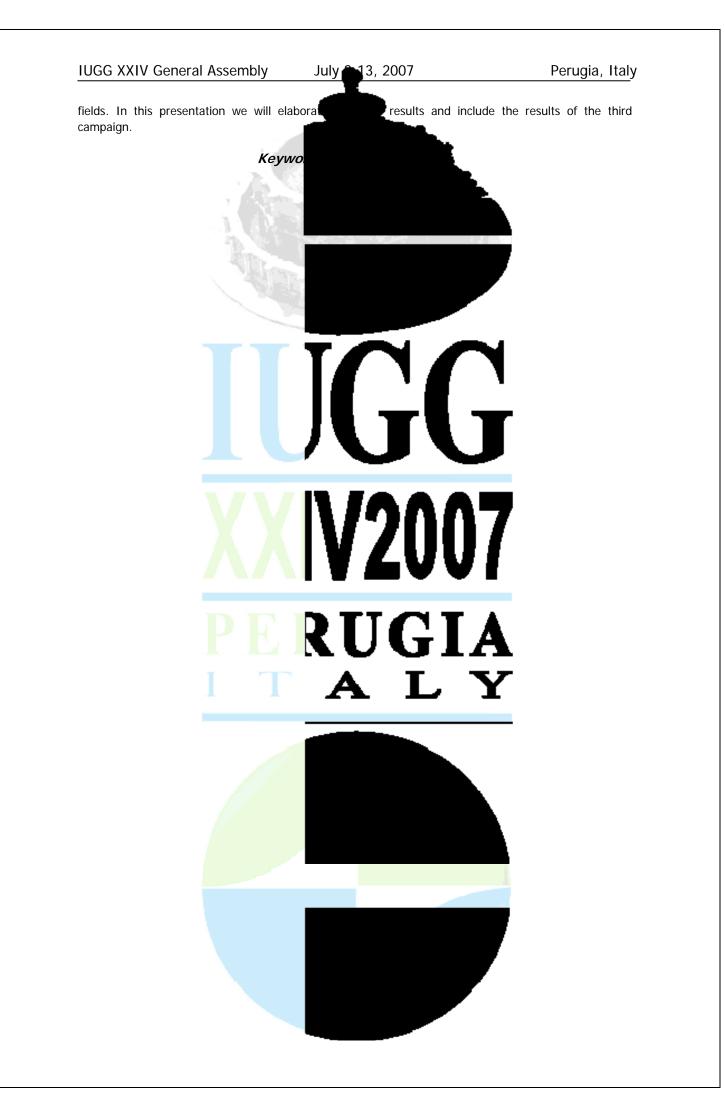




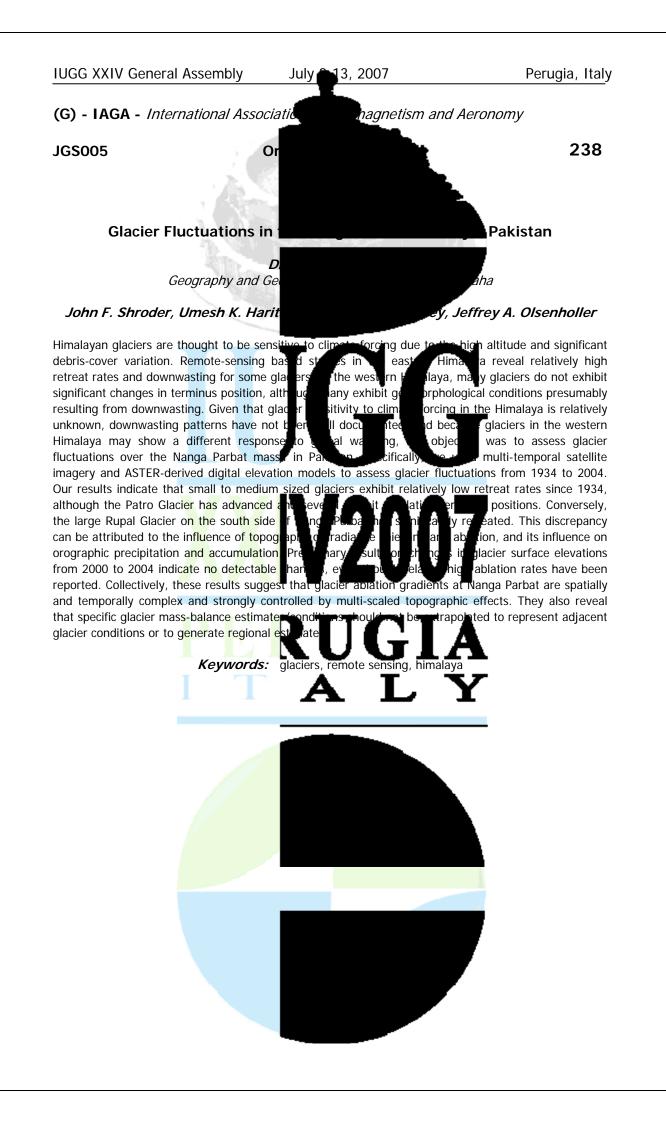




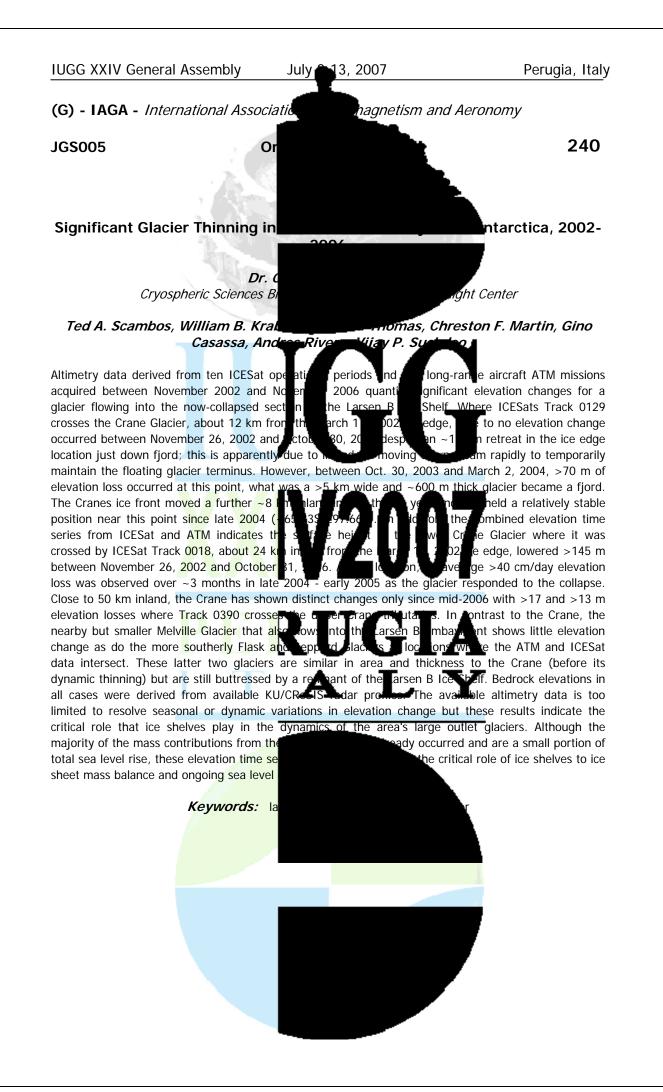


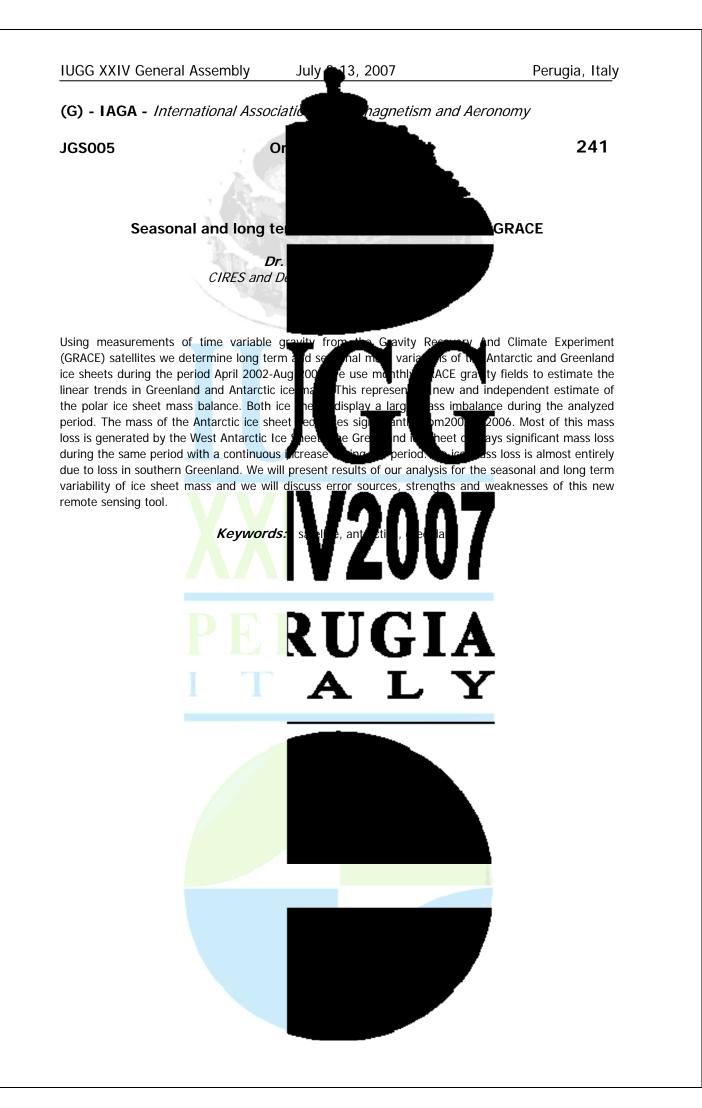


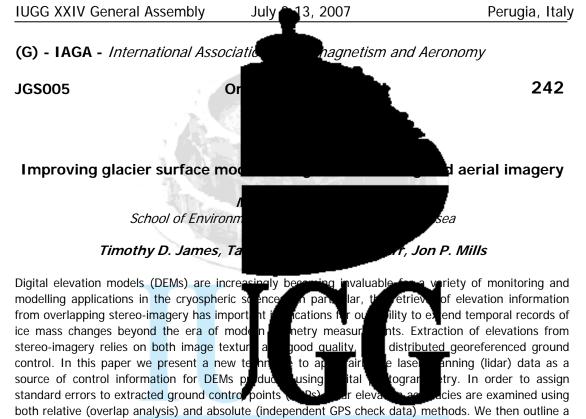












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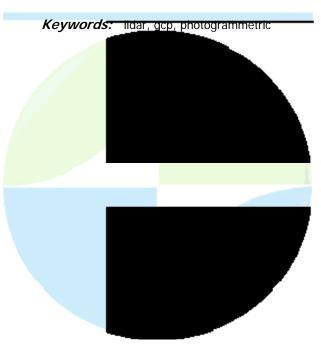
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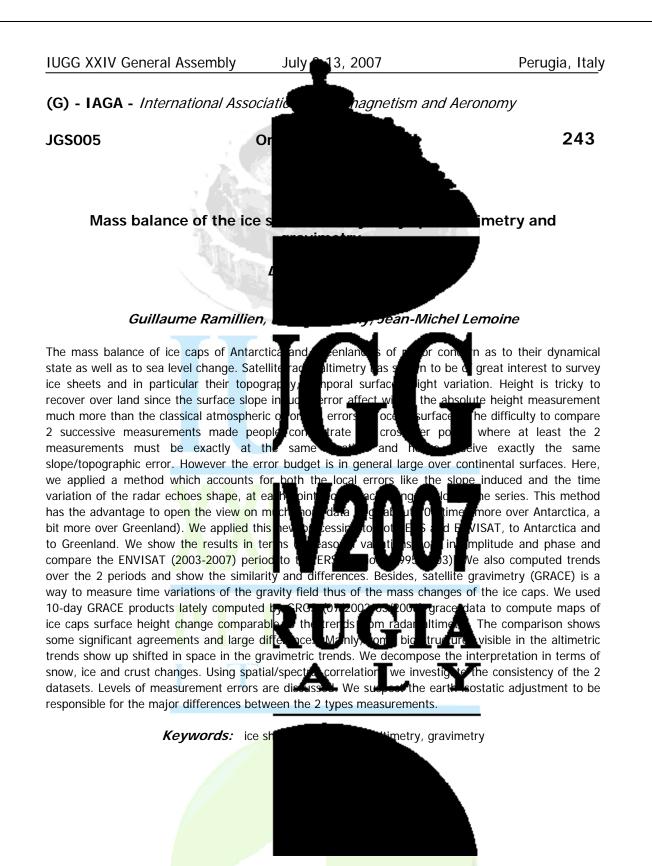
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technique to extract large numbers of GCPs from a raw lidar point cloud and use these to process a series of DEMs of Midtre Lovnbreen, a sm from a 2003 lidar dataset are used to simultaneously with the lidar. We examine and calculations of glacier volume change repeat survey data of the glacier from 20 degraded over steep slopes, has a root mean

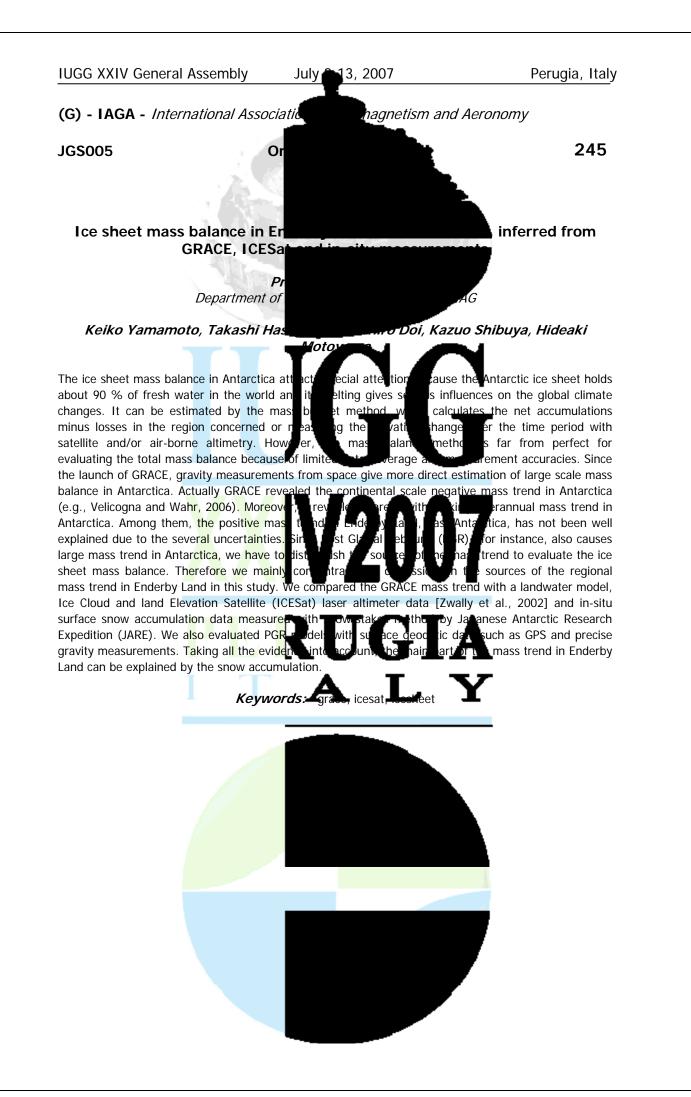
Ibard. GCPs extracted photographs collected on both DEM accuracy our derived models with uracy of lidar data, while (RIVIS) Tesidual of 0.14 m when compared to

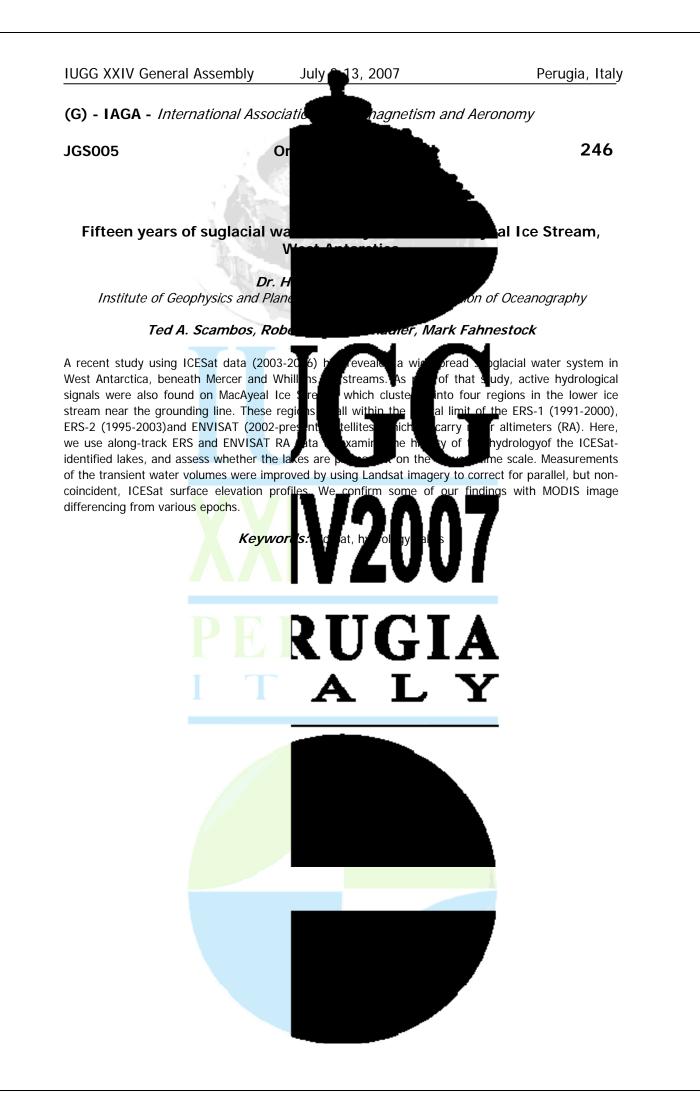
independent check data and may be used to detect elevation changes due to surface melt over a 10 day survey period. Using lidar for ground cont etrieval of high-quality elevation information from image archives and may be surve nd reconnaissance aerial are poking satellite sensors photography, declassified satellite imagery ack ind. d c bd dir such as the VNIR band of the advanced spaceborne thermal emission and reflection radiometer (ASTER). This is particularly important given the ck of both patial and **Toral resolution in global** records of glacier volume change and mass bala

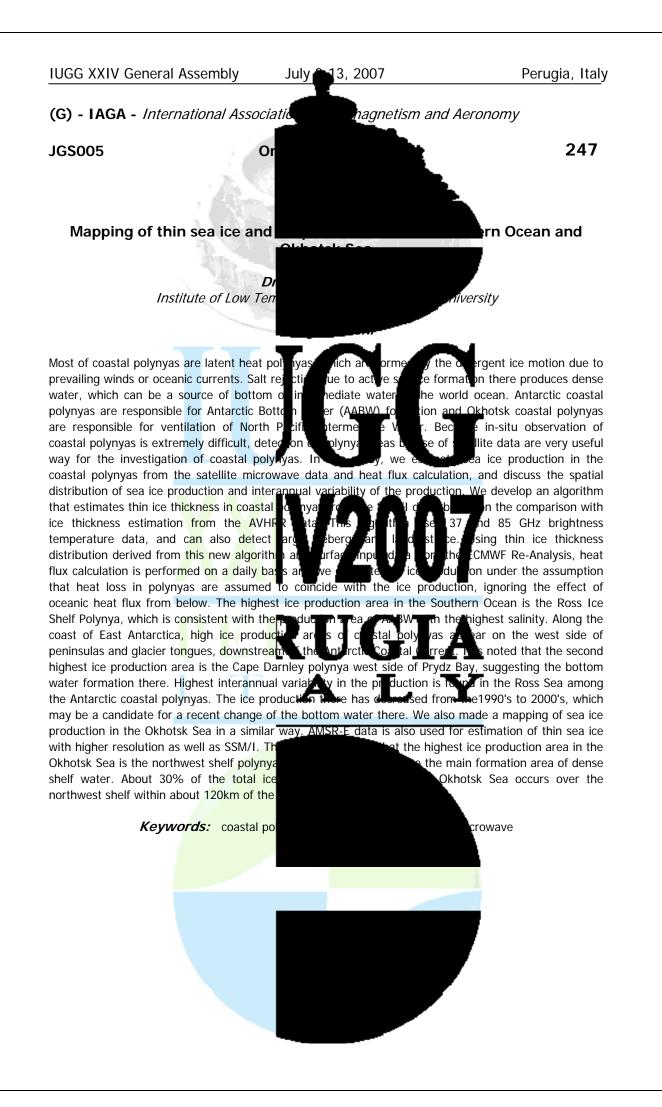




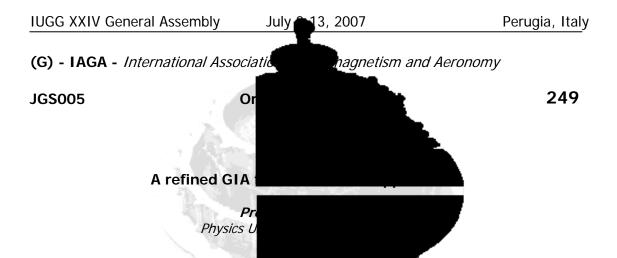












In the application of GRACE derived time-c ongoing rates of loss of land ice from Alaska Green

raw observations to remove the "contamination" ice-age. The quality of the required filter continuing influence of Glacial Isostatic Adju is due to this cause. The most important Canadian sector of the North American con Sheet (LIS), the largest accumulation of lan Maximum approximately 21,000 years age. Initial

good first order fit to the observations in this region. There are nevertheless areas in which misfits do exist to the observed GRACE surface mass the model. In this paper I will describe th this model that are necessary to improve model is then employed in a series of f surface mass loss characteristic of each of

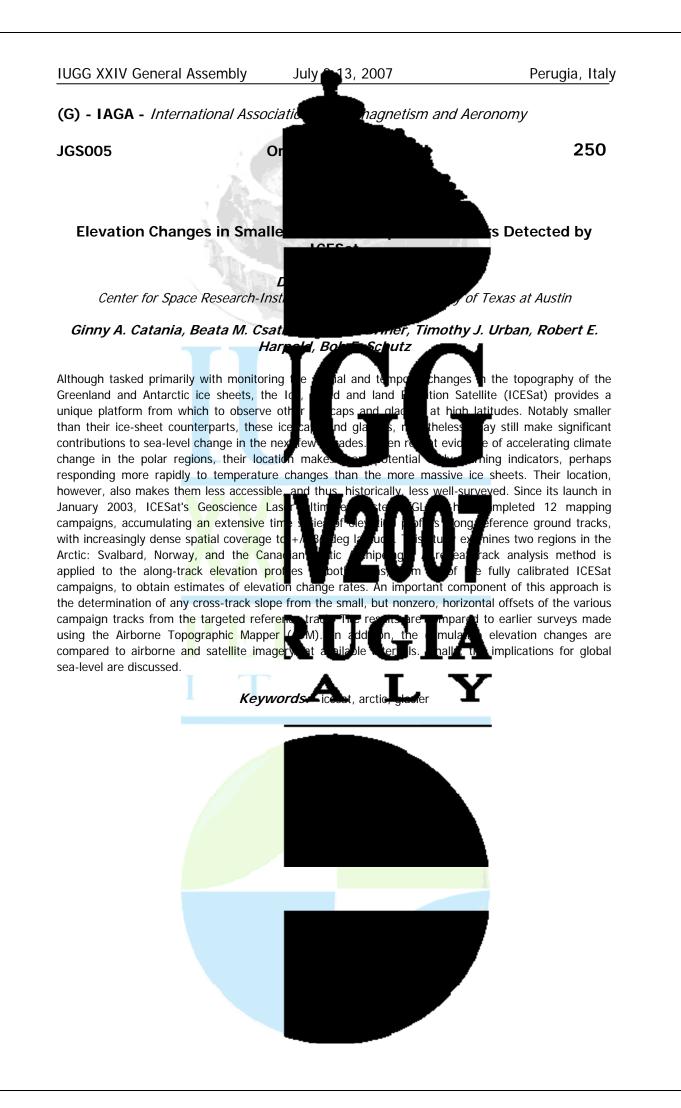
servations to the problem of inferring the nd Antarctic ntinu to the influe tested d tł (GIA) in regid where this /hich vered on rther exis n tł the C

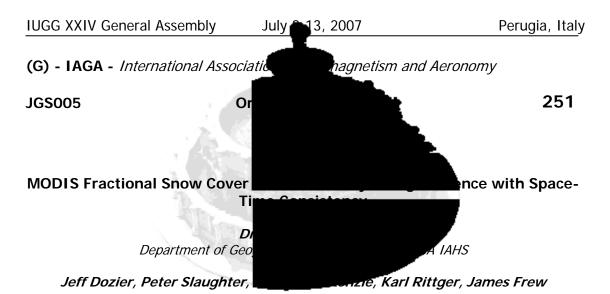
of the Late Quaternary sis of it ability to reconcile the where the only significant influence may be performed involves the the vast Laurentide Ice misphere at Last Glacial set have demonstrated that the ICE-5G(VM2) model of Peltier (2004: Ann. Rev. Earth PLanet. Sci. 32, 111-149) provides a very

first necessary to filter the

ved to further improve has load component of predictions. The refined er the ongoing rates of

Keywords: grace, isostasy, degionlaciat





Melt of seasonal snow cover in mountain r hge resources to over a billion people. These r implications of climate change, drought, an enhanced snow cover products using a mult MODIS surface reflectance products (MOD0 of the fractional snow cover, to more accur lelv Covered Area and Grain Size/Albedo (MODSCAG)

snowcover for regional studies in mountainous areas across the globe but also applicable to polar and grassland regions. The model uses spectral libraries generated with a radiative transfer model for varying grain size snow, adapting the spe MODSCAG improves on extant delivered snowcover with < 10% uncertainty in SCA for VIIRS on NPOESS and the GOES-R A spatially and temporally consistent, physic way incorporating persistence and knowledge of sensor and surface geometry to improve the estimate

the d pro are increasing ation/demang mem<u>ber spe</u>o action ίοv racter alob cificall

minant source of water periencing the pressing, coupled rease. We present here validated, nixture analysis model that inverts e grain size and albedo er, pli ater r urces. The MODIS Snow an accurate estimate of

> scene solar geometry. retrieval of fractional on snow cover mapping de hydrologic users with e series in an intelligent

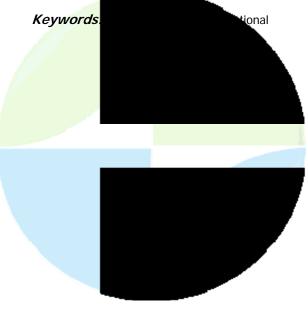
of the measured snow properties for a particular day. We consider two scenarios: one is the forecast mode, whereby we use the past, but not # vered area and albedo on tow-c that day; the other is the retrospective the snow is gone we mer pace-time interpolation reconstruct the history of the snow prop <u>nis '</u> presents both scientific and data management challenges. The scientific question is: how do we use our knowledge of viewing geometry, snow accumulation and ablation, along w available ground data, to devise a scheme that is better than generic mult imensior -terpolatie The data management involves large three-dimensional objects, identification of erroneous data, and keeping track of the lineage of the way a set of pixel values has been interpreted.

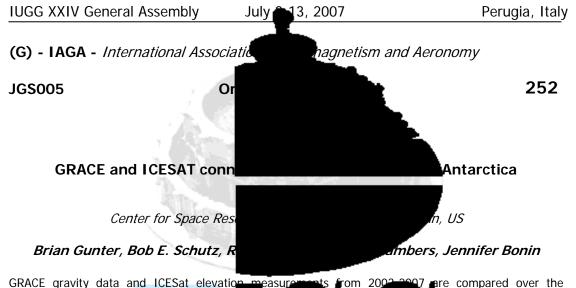
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GRACE gravity data and ICESat elevation Greenland and Antarctic ice sheets. The res solutions created using the newly reproce updated CSR GRACE data sets are a signif greater resolution of the time-variable comp in generating the RL04 data release, the require that some level of spatial filtering interpretation of results, various spatial filtering in

is explored to better characterize the large-scale similarities and differences between the GRACE gravity and ICESat elevation (melt and accumula Climate Experiment (GRACE) satellites pro solutions have been provided since launc gravity field. The time-varying gravity solu of a few 100s of km and may support bette Elevation Satellite (ICESat) was launched

ls to d wil brese SR RL04 data provement o f the gravity are sυ lied. be ež the final surface mass estimates. Spatial filtering and averaging of the high-resolution ICESat altimetry

TCESat laser altimetry captures elevation 2003.

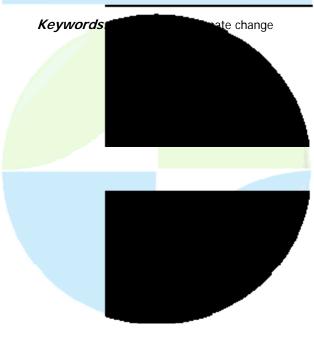
mere compared over the f tailored GRACE gravity ke uš leased in February 2007. These previous releases, providing much I. Despite the improvements made ible to h frequency noise and hoice filter can influence the valuate their impact on

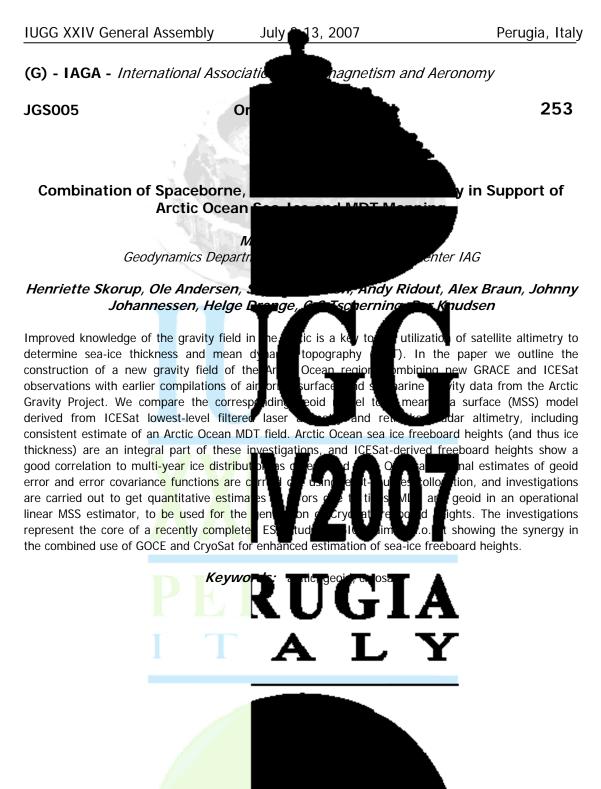
> Gravity Recovery And Monthly GRACE gravity b the mean background have a spatial resolution The Ice, Cloud, and land

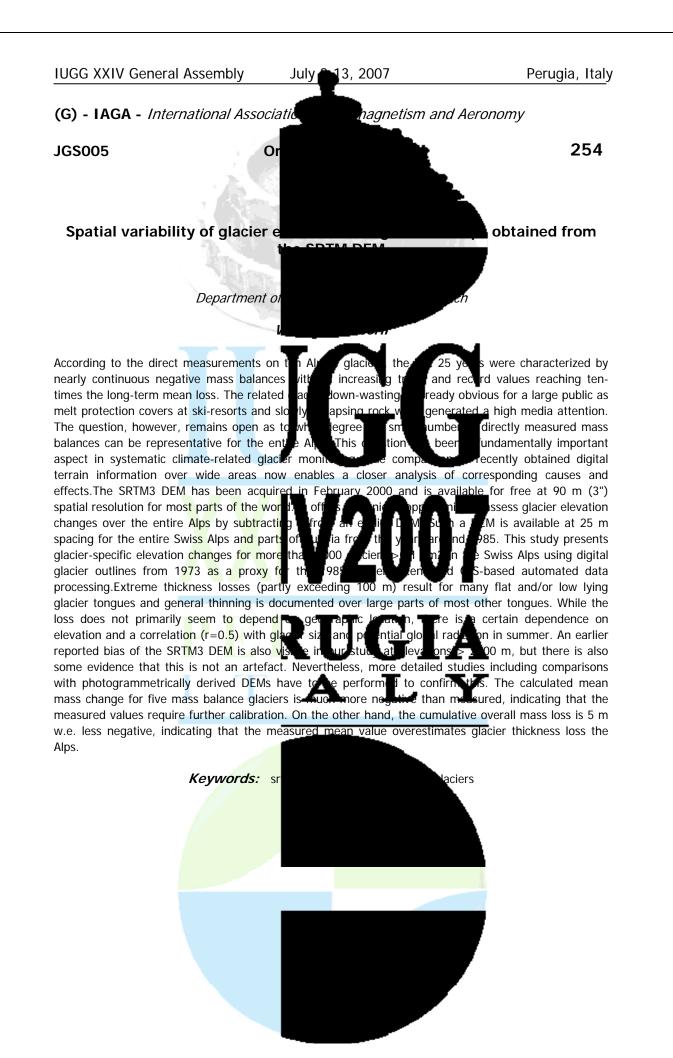
measurements at 40 Hz from an orbit of 600 km altitude, 94 inclination, providing dense ~170 m alongtrack sampling up to 86 latitude. The ICESa bout three 33-day measurement campaigns per year, which have requir sing the precision attitude 00 determination to meet the mission require binting error. Nearly all determination to meet the mission requirement on a signal of a second pointing error. Nearly all ICESat measurement campaigns are now fully calibrated, which provide the precise geolocation for nt а secc cm/year elevation change detection. We have computed coincident with the ICESat measurement campaig. Compa synchronize **GRACE** gravity solutions oducts yields correlation of both between topographic changes observed by ICESat and mass changes observed by GRACE.

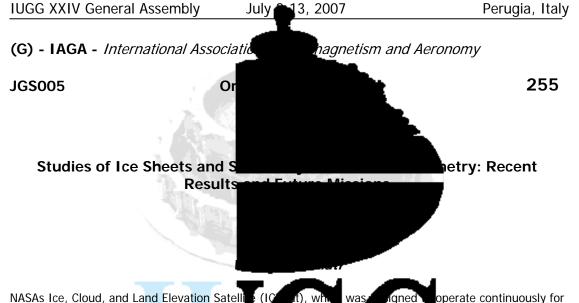
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3 to 5 years, has acquired science data dur days each. The primary purpose of ICESa changes to determine the present-day ma observed ice changes and polar climate, contributions of the ice sheets to global elevation maps of Greenland and Antaroxic ice

from nearly 3 years of intermittent data are showing that some significant changes in the rates of mass input and output have occurred since the being mapped, showing seasonal and inter recent report of the US National Academy recommended extension of these laser alti II follow-on mission. The planning and de /elo instrumentation, in particular to provide continuous long-term

is en topographic features on ice sheet, ice shelves and ice streams. Ice sheet elevation changes derived

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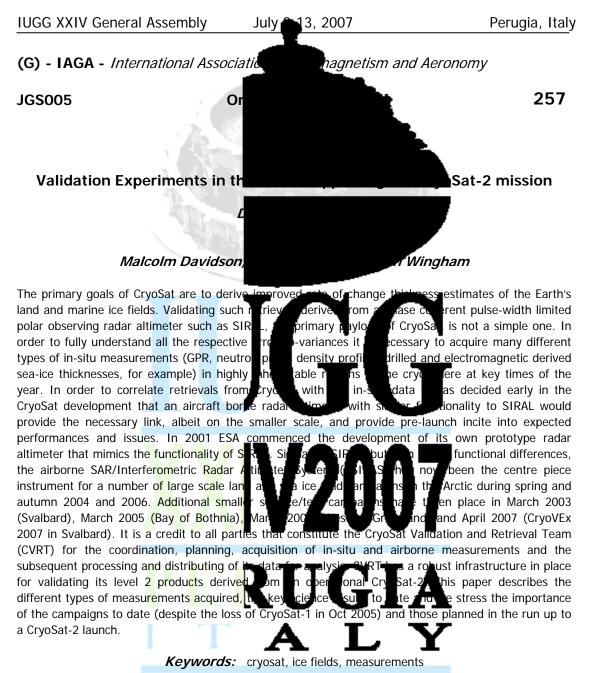
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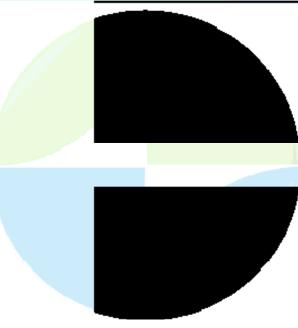
operate continuously for operation ranging from 33 to 54 time-series of ice-sheet elevation study associations between of bo he present and future is p ding the most accurate ailed characterization of

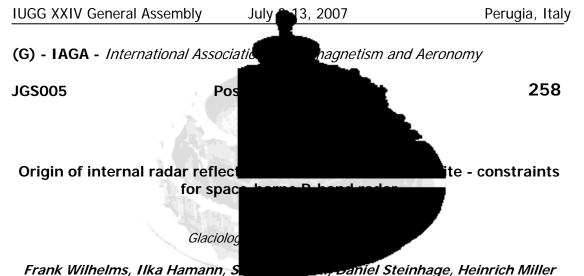
> es of ice thickness are Southern Oceans. The ture Earth observations, nd sea ice with a ICESatmilar but improved laser











Frank Wilhelms, Ilka Hamann, S

Currently, feasibility studies are in progress In addition to determining ice thickness on the internal structure on an ice sheet, and ice-sheet history. Understanding the physic as provided by ice cores, and ground-based results on the origin of internal layers, as drilling site in Dronning Maud Land, Antarctica, wi

ice im fhe là tal scales thi hese to impro of these orne r m with -ec and 6

-band radar from space. uld also be used to map hnique d inderstanding of ice dynamics and es requires in-situ measurements, r reference. We present emen pundi ata at the EPICA deeppulse at a frequency of

150 MHz. Most reflectors can be linked to volcanic peaks, as evident from the conductivity profile of the

in the crystal c-axes, the fabric. It shows maximum orientation. Our observations distributions of the ice, but also to extrap implications for ice-sheet evolution, e.g. a consider detection of such reflectors in the



e to increased singlerate spatial age-depth along the reflector, with We therefore suggest to

Keywords: radar, internal structure, reflector origin



following the approved procurement of th mission reliability SIRAL-2 contains accomme sharing the same interferometric antennas contractor ASTRIUM GmbH. The most cha stability and tracker robustness. CryoSat-2s to measure, via estimates of surface elevation, ra

wo radars ed platform und feati dr pbjec re ge of

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surposes of cold redundancy whilst he r<u>esponsi</u>bility of mission prime in are high instrument as CryoSat which were s on both land and sea

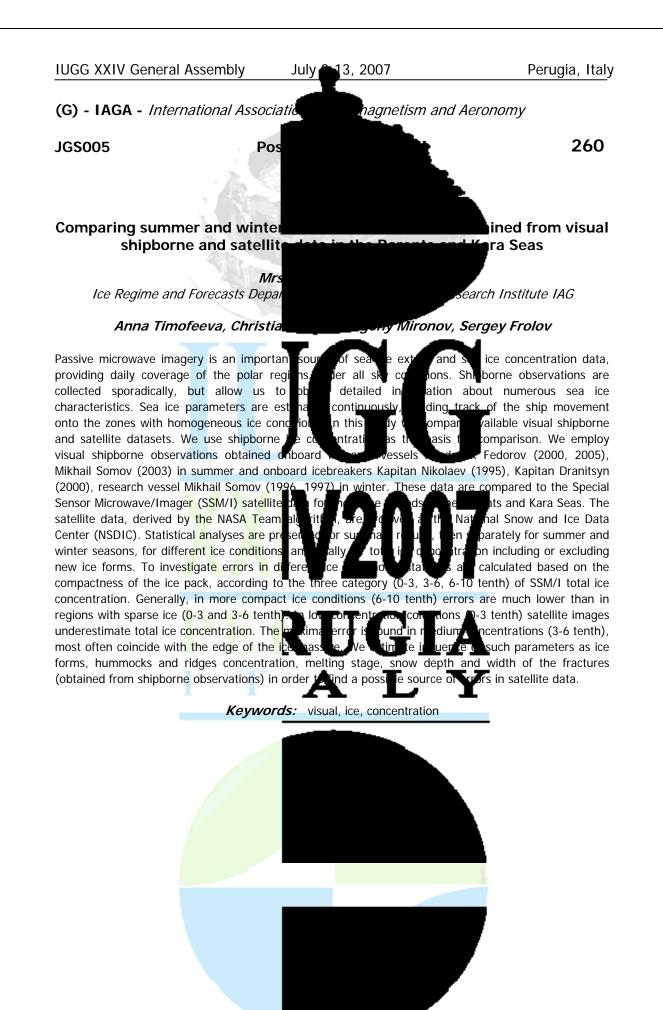
very precisely to reduce uncertainties in the knowledge of the trend towards diminishing polar ice cover and thus furthering our understanding of the relationship between ice and global climate. This paper

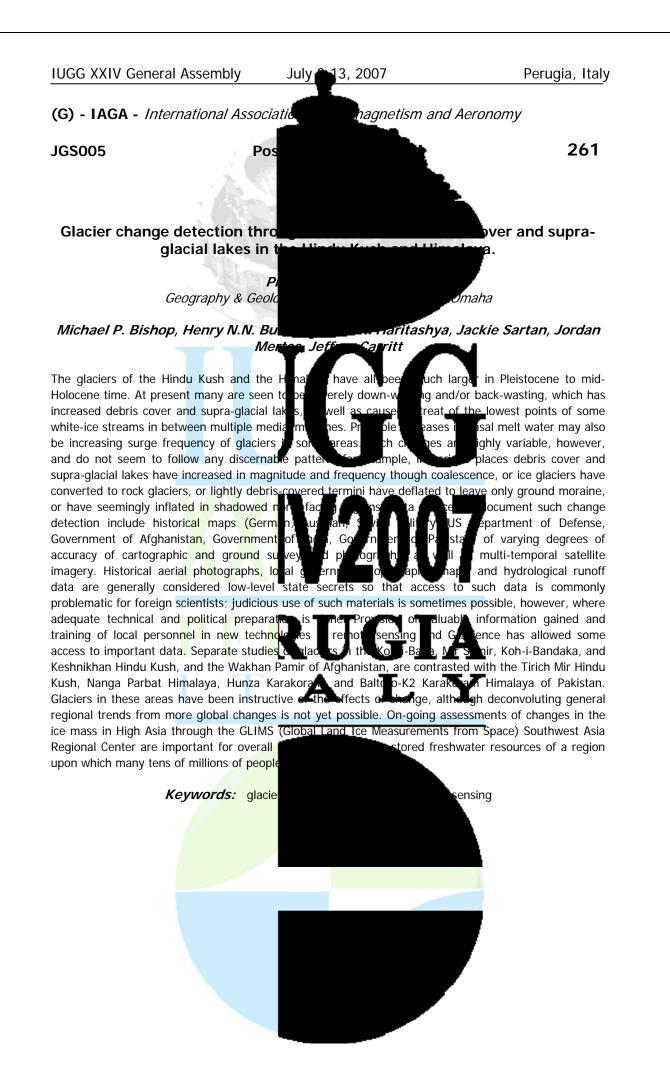
gives a detailed description of the instrume intended surface type, the methods of oninstrument in the measurement budget instrument are in development prior to CryoSat-2 launch in 2009. The next severa a detailed insight of the instrument performa mission.

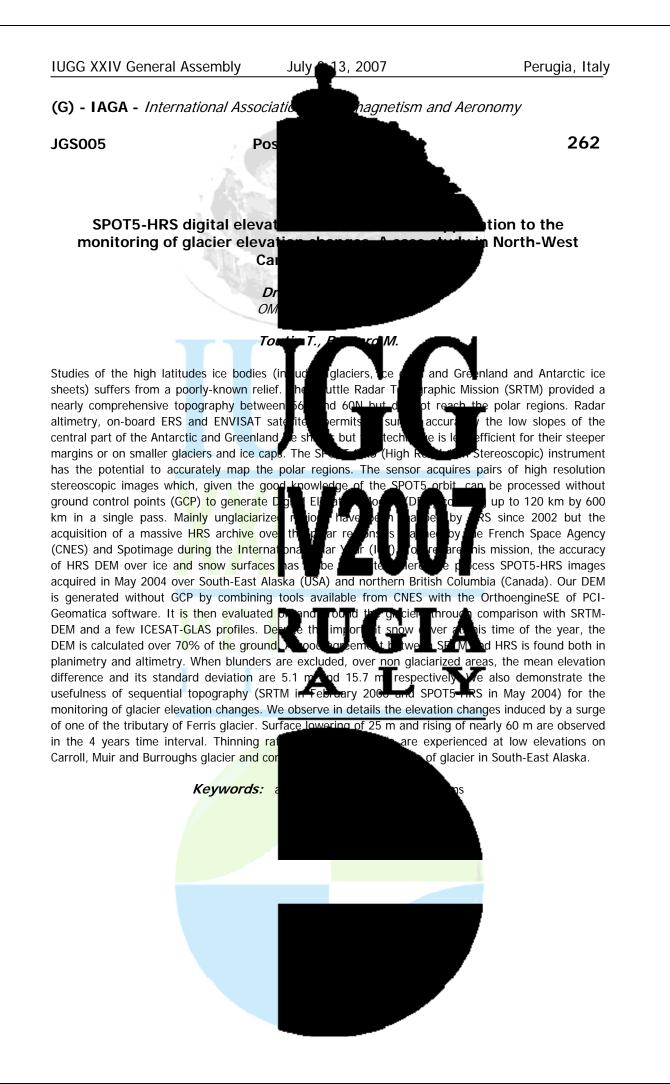


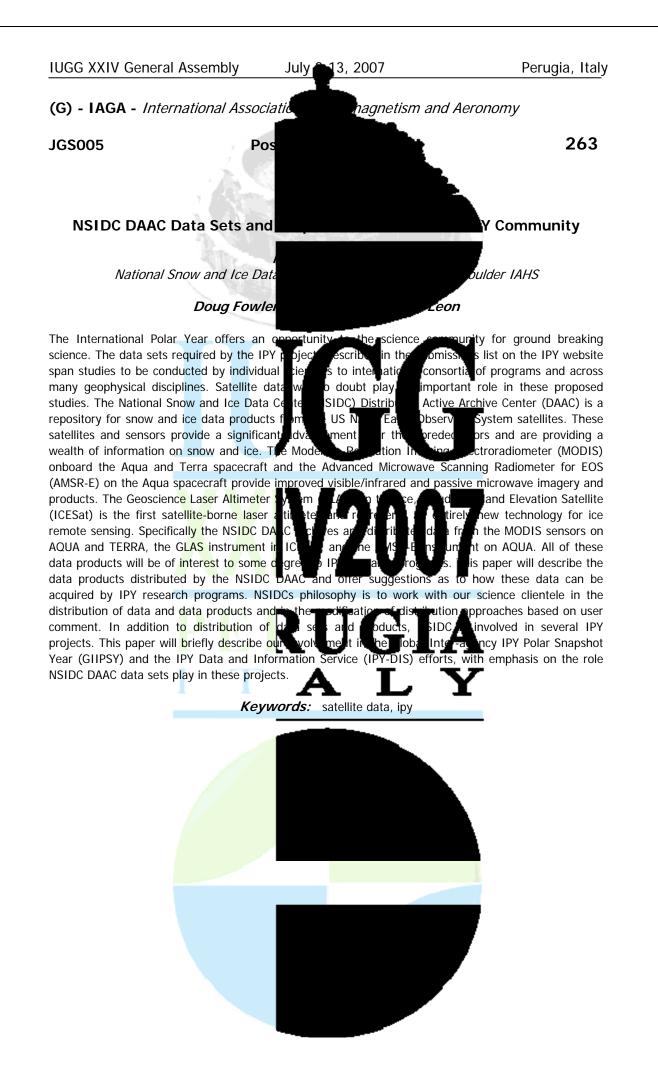
ement modes for each the contribution of the ntly all modules of the 2008 and an expected ve testing which will give sential for the success of the

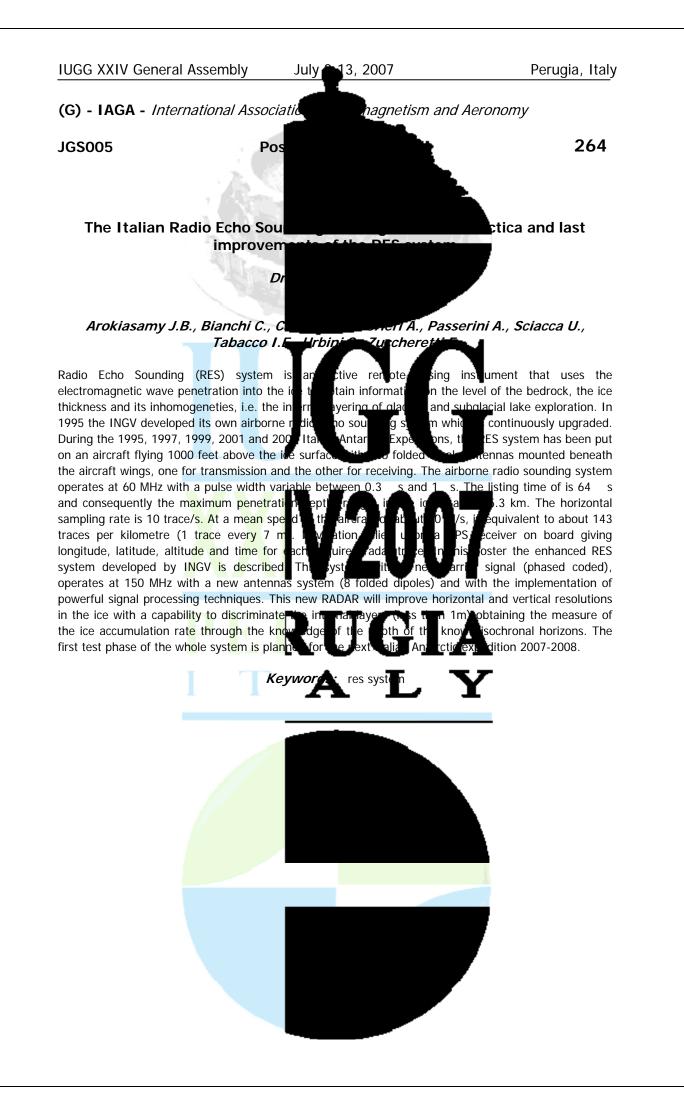




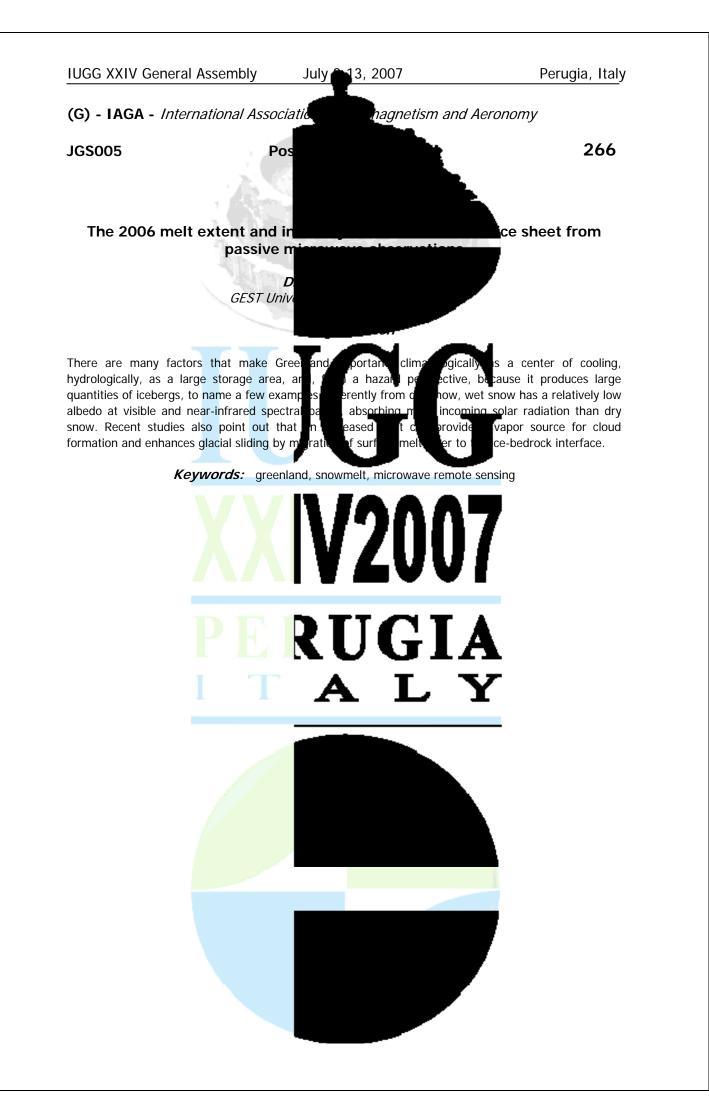


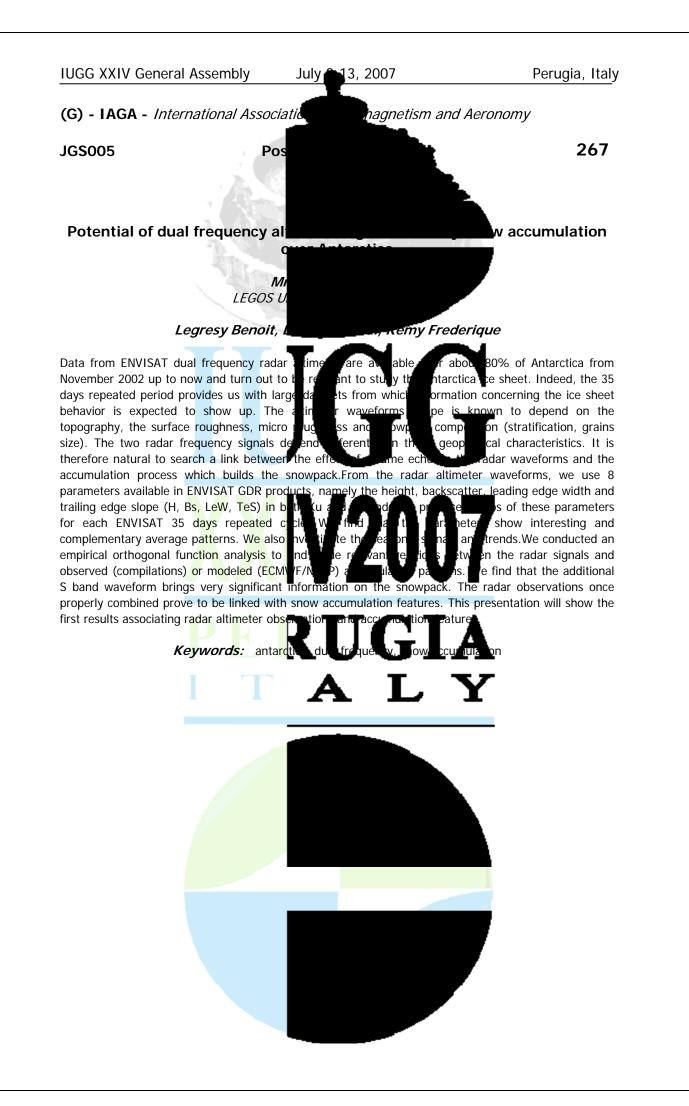


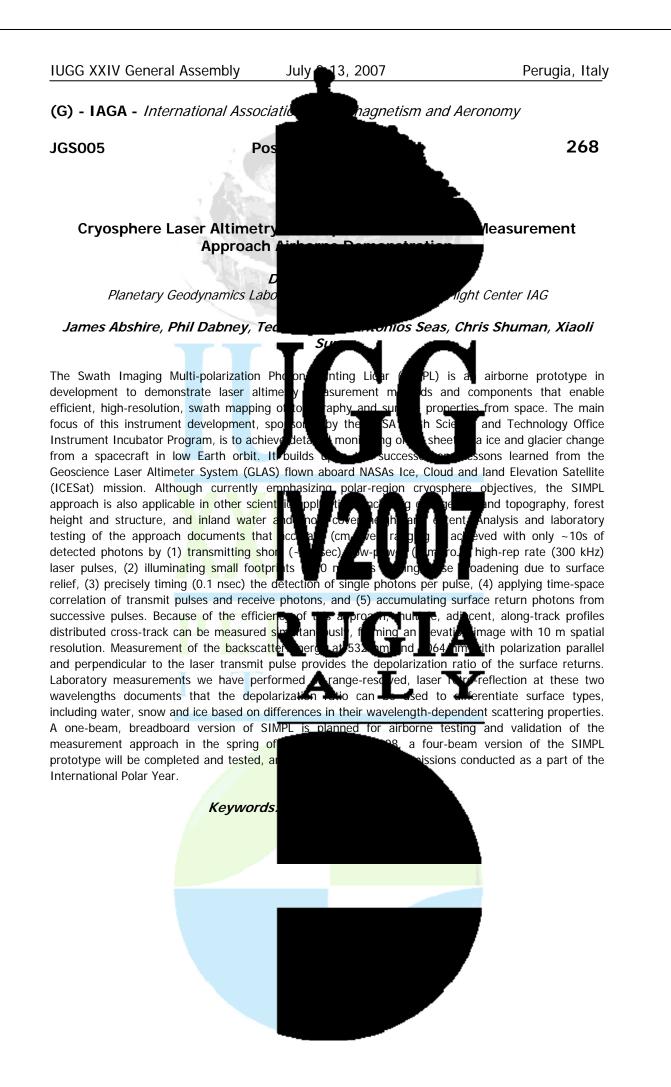


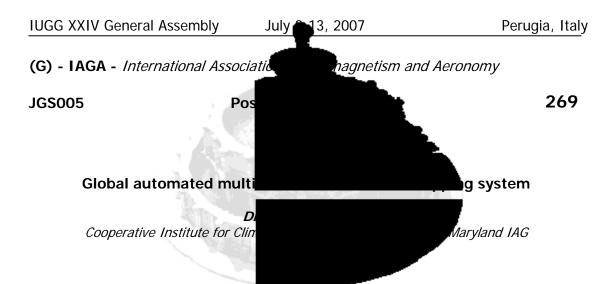












A new global automated snow and ice manning s operations at NOAA/NESDIS. It generates d at a nominal resolution of 4 km. The syst visible/infrared and microwave spectral ba satellites. The idea behind combining obser the all-weather monitoring capability inhere satellite measurements in the visible and MSG SEVIRI, NOAA AVHRR and SSMI/I or board

signatures and temporal variability of the scene response are utilized to identify snow and ice. Climatological data on the snow cover di improve discrimination between snow and give an overview of the developed algorit two winter seasons. To assess the accura ground stations and to results of NOAA Web

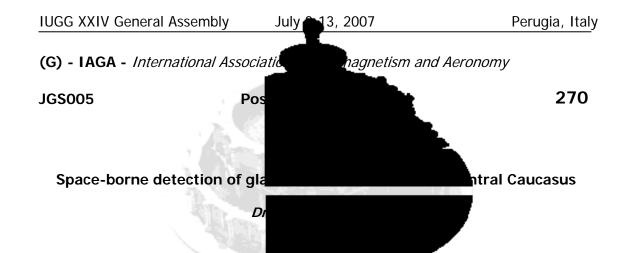
s been ha v co LIOUS p-fre ased on m meteorolo in different icrowa er Curre dat satel

tried to make maximum use of multiple observations from different satellite platforms. Both spectral

and implemented into now and ice distribution laps y of satulite observations in the polar-orbiting and geostationary ral bands was to fully utilize both and th igh spatial resolution of m G East and West Imager, ed. In the algorithm we

> erature are applied to he presentation we will brmance during the last mpared to reports from distribution. The project is

http://www.orbit.nesdis.noaa.gov/smcd/emb/snow/HTML/multisensor_global_snow_ice.html



Space-borne detection of glacial lakes is a near retreating mountain glaciers worldwide GLOFs lake locations and characteristics form a ke risk management. Techniques for glacial lak Swiss Alps and Himalayas. This study appli Russian Central Caucasus where until recer borne glacial lake detection techniques sl reassessment (once every 1-3 years) for th

enough detail and reliably mapped using a uniform only met by medium-resolution multispectral satellite imagery. Of these we assess SPOT XS/XI (20 m), Terra ASTER (15-90 m) and Landsat ETM+(30 m) for an area of active lake development on the northeast slope of Mt. Elbrus in the Central Cau wet glacier ice are illustrated. It is sho previously applied by other researchers for of values for the study area. We also us Caucasusto check variability of NDWI for the the choice of medium- and high-resolution satellite imag

on of glacial lake outburst floods (GLOFs) ten downstr bart égior datas ion have bee de refines existi n th<u>e numb</u>e lfil se egior wł T bgy.

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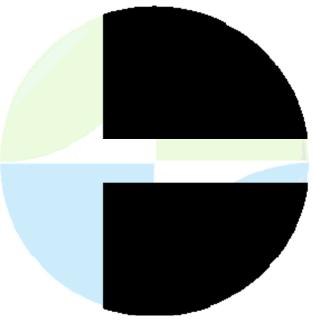
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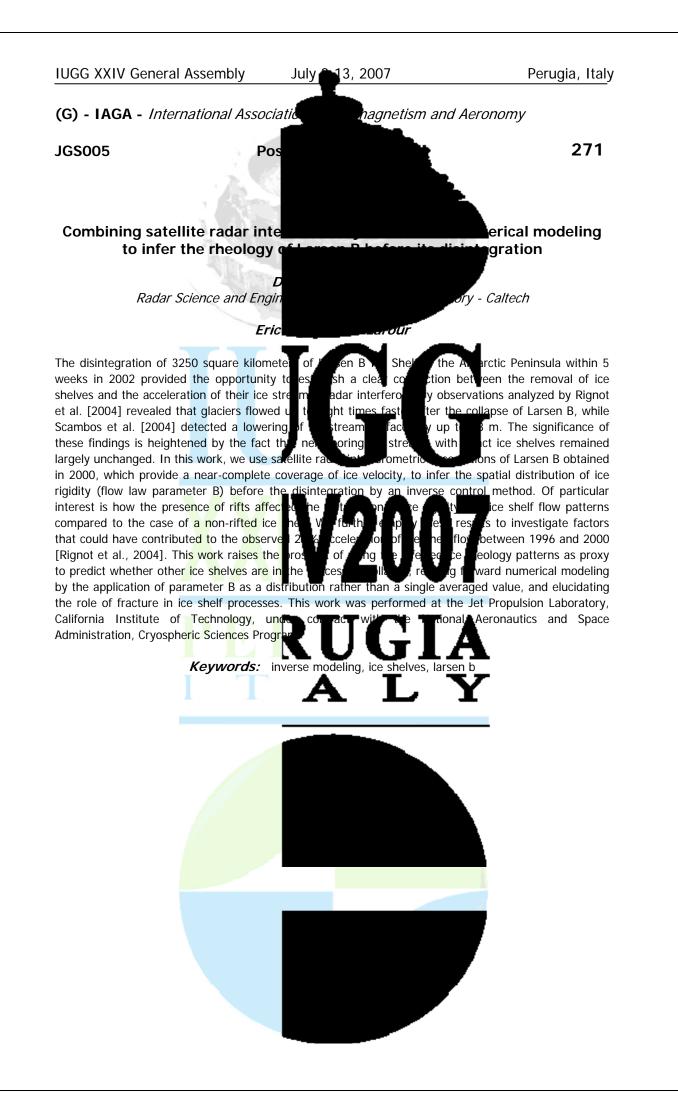
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opulated areas; up-to-date g hazard prediction and gested for several areas, such as echniques for a case study of the glacial lakes was unknown.Spaceere should be frequent should be resolvable in combined are currently

tinguishing lakes from Water Index (NDWI), hd sensor-specific range cial lakes in the Central mendations are made on semi-automated techniques for glacial

lake detection in an arbitrary glaciarized mountain area. Keywords:

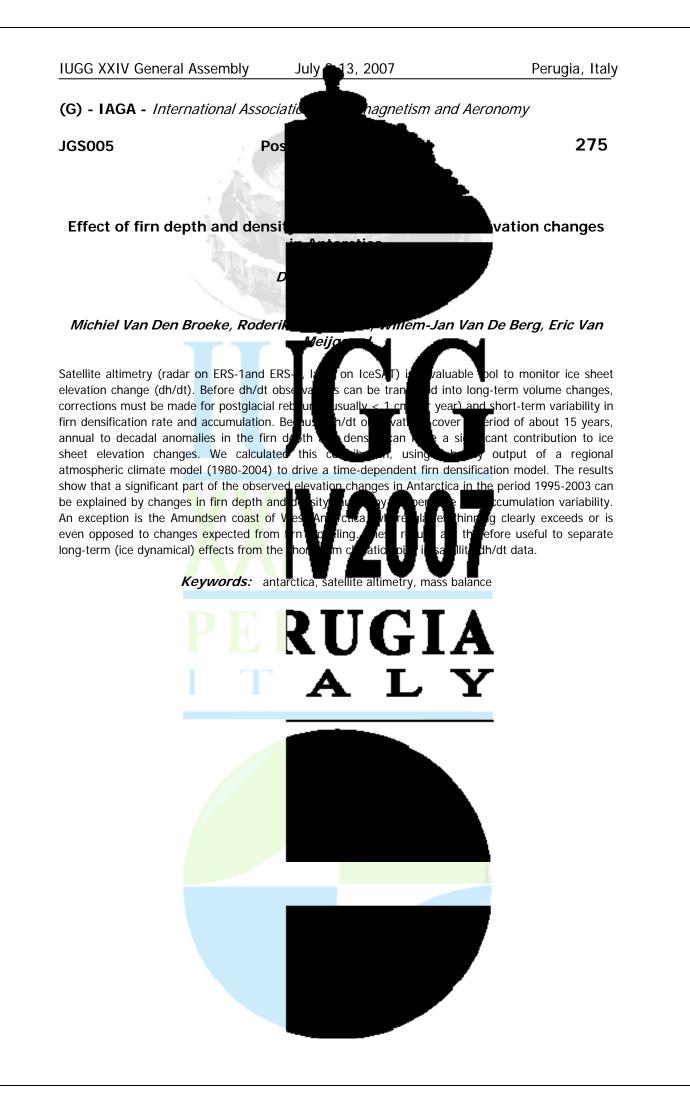






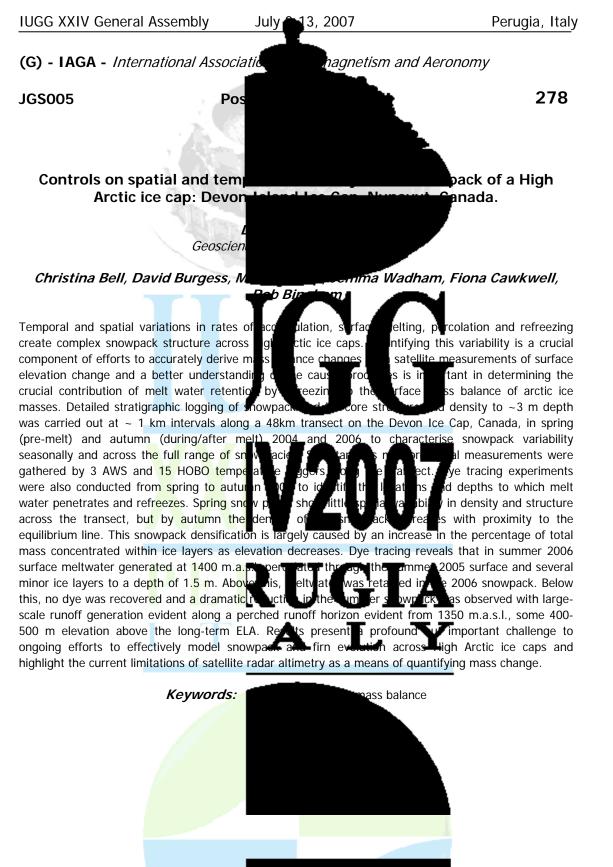




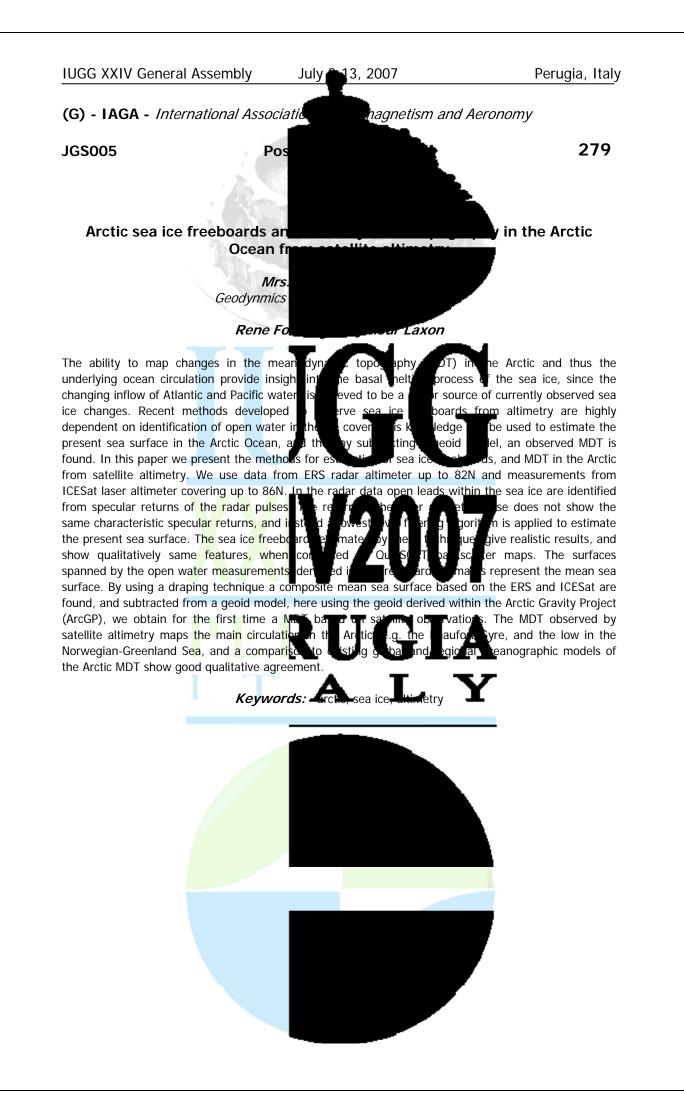


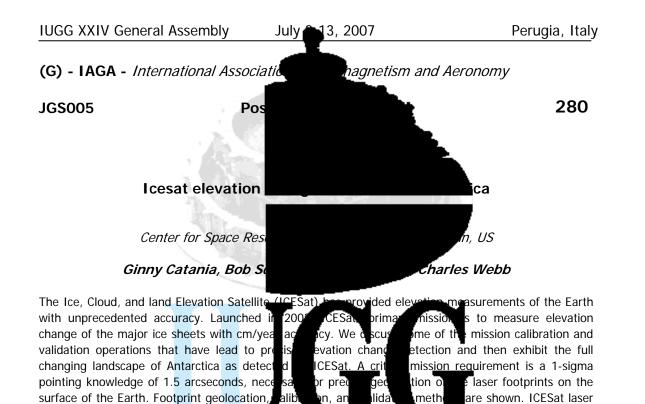












altimetry captures elevation profiles at 40 Hz from 600 providing dense ~170 m along-track sampling up to +/-86 degrees latitude. The ICESat mission

scenario includes about three 33-day measurement campaigns per year since launch in 2003, with nearly all campaigns fully calibrated. ICES surfaces the ICESat measurement precision error sources and the potential for future the Antarctic landscape vary widely in scal ar per year changes in the ice streams lead ha

Antarct

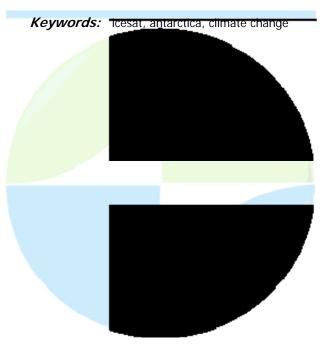
94 degrees inclination, and across flat smooth s ICESat measurement served by ICESat across rgest features are meter in Kamb (C) and fall in

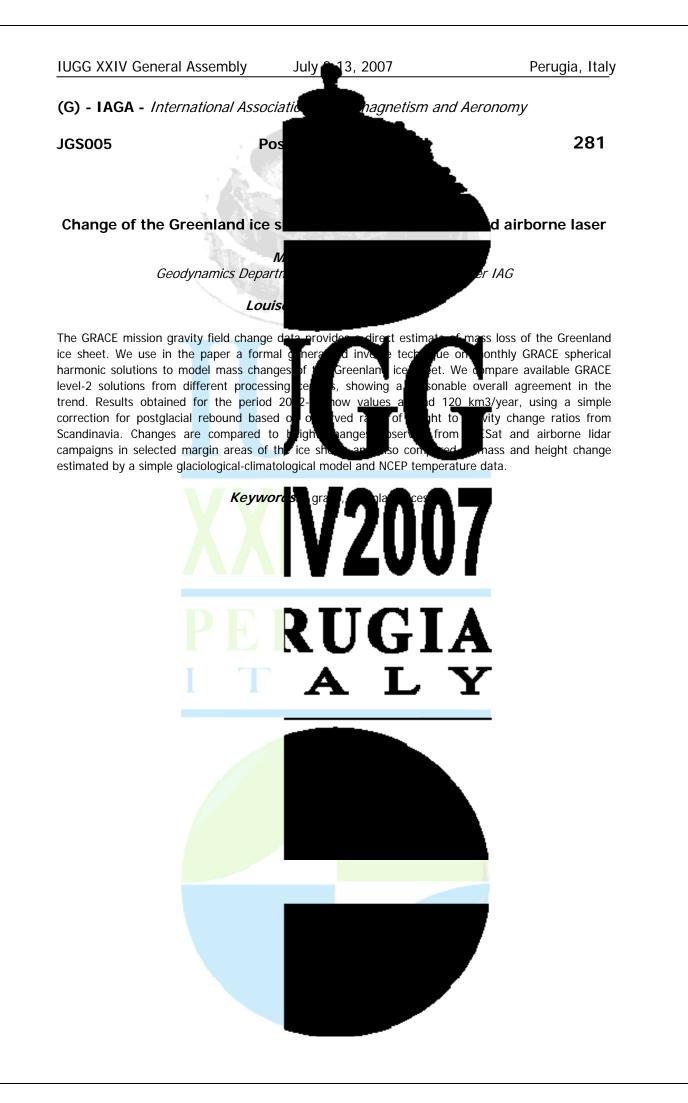
Whillans (B)). ICESats small footprint and high resolution reveal details not previously detectable with large-footprint radar altimetry, such as subglacial lakes and volcanoes; several examples of these ds and making new discoveries. outle laciers, the Scott Coast

d the New Swabia area feeding into the Ross Sea, the East Antarct aci lon. coa LNE ' a near 0 degrees longitude feeding the Larsen and Fimbul ice shelves. In these areas, ICESat detected elevation changes are computed and are compared to ice str **T**or measured velocities. am balance We discuss the climate change implications of these

incredible features are shown, both corrob

Other example areas highlighted are changed







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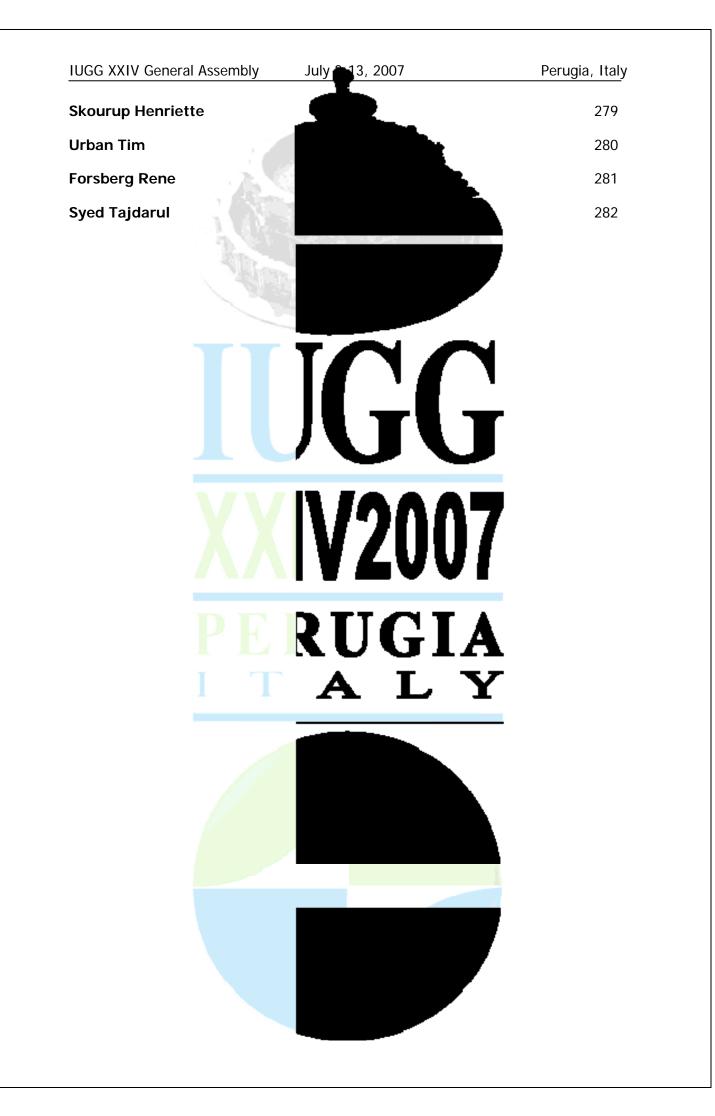
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