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Tectonic Motions in Western USA from SLR

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OBJECTIVE

The objective of this work is to derive tectonic motion vectors for tracking sites in the Western United States from analysis of LAGEOS Satellite Laser Tracking data.

BACKGROUND

The analysis of laser satellite tracking data utilizes principles from Dynamic Satellite Geodesy. An outcome of this type of analysis yields precise three dimensional laser tracking coordinates. Dynamic analyses have been performed on data accumulated over a six year period (1979-1984) resulting in precise annual tracking station positions. During this six year period, laser systems and data consistency have reached advanced levels of maturity yielding a strong network geometry and better network resolution than in previous years. Our analyses of the data at GSFC yielded the SL6 solution consisting of improved Earth rotation, station coordinates and geodetic constants. In this work, the original SL6 solution was iterated with the introduction of better nutation and ocean tide models. Annual geodesic lengths were computed from the precise final annual station positions in our new SL6 system.

RECENT ACCOMPLISHMENTS

Absolute velocity vectors for the laser tracking stations in the western United States have been computed via a least-squares adjustment model. "Absolute" in this context means that the velocities are referenced with respect to mantle intrusions into the earth's crust, known as hotspots. In this model, two types of stations are defined: "external" stations which have their absolute plate motion defined by a geologic plate motion model (these are shown in Figure 1.); and "internal" stations for which the absolute motion is sought (shown in Figure 2). The Minster & Jordan (1978) AM1-2 model was adopted to describe the absolute motion of the external stations for two reasons; first, it agrees well with the SLR observed rates for these stations and secondly it provides the means to relate the computed velocity vectors to the mantle based reference frame. All the "external" stations have dense tracking data sets and the derived relative rates for these stations are within one standard deviation from the relative rates implied by the geologic model. The methodolgy developed in this work begins by fitting a slope to the time series of geodesics between all pairs of stations which have in common at least two annual geodesic lengths. These slopes, or geodesic rates, are then processed simultaneously in a least-squares algorithm to yield absolute velocity vectors for the "internal" station network. The errors in the station positions, as approximated by the error in the height of the station, are propagated throughout the system. The uncertainties in the geodesic rates are used as "observational" weights in the simultaneous solution.

SIGNIFICANCE

Satellite laser ranging has advanced to the point of providing the capability to monitor tectonic motions. The analysis made in this work guarantees self constency in the solution for absolute motion since all of the constructable geodesic rates enter into the set of simultaneous equations. This is a considerable improvement over the previous methods of analysing the results in a baseline by baseline manner. The resulting tectonic motion model, the SL6 Tectonic Model, have been compared with the geologic models of Minster & Jordan(1978) and Chase (1978). The SL6 computed absolute motions are listed along with motions implied by the geologic models in Table 1. The modeled geodesic rates which traverse the San Andeas Fault indicate that the rate of change (shortening) over these lines has slowed considerably in the last three years (1982-1984). The slower northwesterly absolute motion for the Monument Peak site is largely responsible for this behavior. Using this analysis method, the motion along the SAFE line (San Andreas Fault Experiment line, Monument Peak [7110] to Quincy [7051 & 7109]) now agrees with the rate being obtained from the local survey networks and has slowed over the last decade. This brings into question whether Monument Peak is located on the Pacific Plate or is on some California platlette. The local dynamic behavior of this entire region is a question resolvable by implementing dense regional observation networks and further analysis of surrounding SLR and VLBI station behaviors. Details of this work are described in Christodoulidis et al (1986).

FUTURE

The accuracy and reliability of the SL6 Tectonic Motion Model will be improved as additional data are acquired and processed. The answers to the questions facing the SAFE line and the other regions of interest are expected to gain clearer understanding and greater confidence as more recent data is introduced into the analysis. The least-squares algorithm is being improved to propagate full covariance information and the analysis portions are being supplemented to better locate abberant data. With these improvements, it is expected that these results will have considerable impact among the tectonophysics community.

REFERENCES

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Christodoulidis, D. C., D. E. Smith, S. M. Klosko, and J. W. Robbins, Tectonic Motion in Western U.S.A. from Satellite Laser Ranging, *Proceedings of AAPG Memoir Workshop,* Corvallis, Oregon, in press, 1986.

Minster, J. B. & T. H. Jordan, Present-Day Plate Motions, *J. Geophys. Res.,* V. 83, pp.5331-5354, 1978.

TABLE 1

A COMPARISON OF ABSOLUTED STATION MOTIONS FROM DIFFERING MODELS

	---------MAGNITUDE (CM/Y)-------			-------AZIMUTH (DEG)-------		
	MINJOR	CHASE	SL6	MINJOR	CHASE	SL6
7210	9.68	9.10	9.68	300.40	297.14	300.40
7090	7.97	7.24	7.97	21.71	29.11	21.71
7907	3.12	2.34	3.13	265.76	288.42	265.76
7105	2.69	2.71	2.69	251.53	264.95	251.33
7086	2.67	2.69	2.95	241.14	242.82	239.86
7051	2.41	2.79	3.86	233.86	232.01	229.63
7062	6.38	6.50	4.98	296.64	296.37	307.53
7109	2.41	2.79	1.19	233.86	232.01	251.66
7110	6.31	6.44	4.50	296.62	296.38	301.14
7112	2.55	2.77	3.12	239.39	243.17	346.89
7114	2.49	2.79	3.30	235.46	233.66	174.31
7122	2.72	2.61	4.15	241.06	239.91	201.74

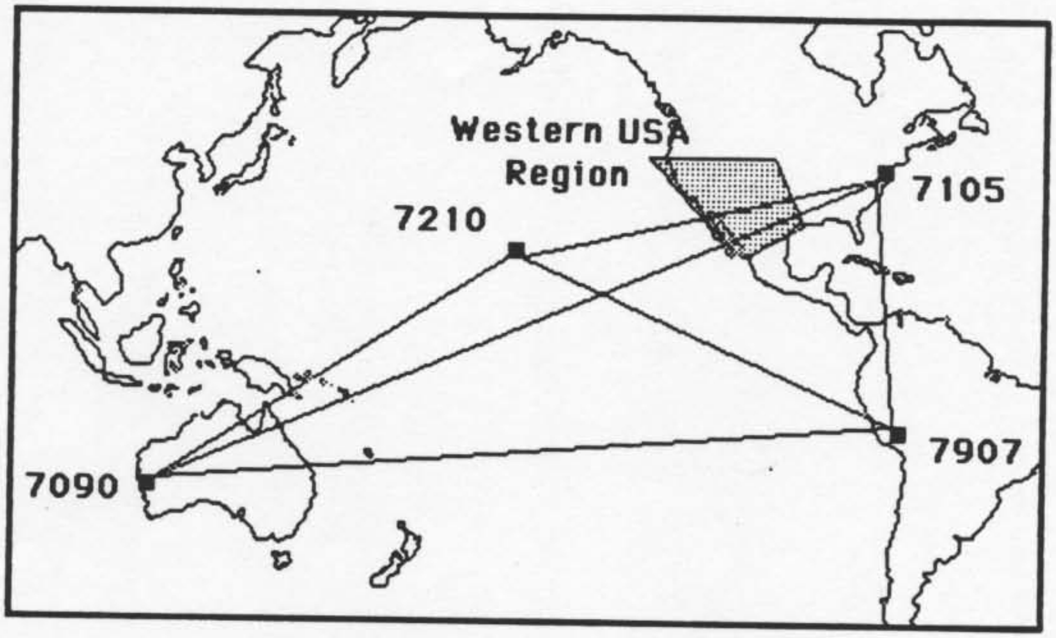

Figure 1. "External" SLR network.

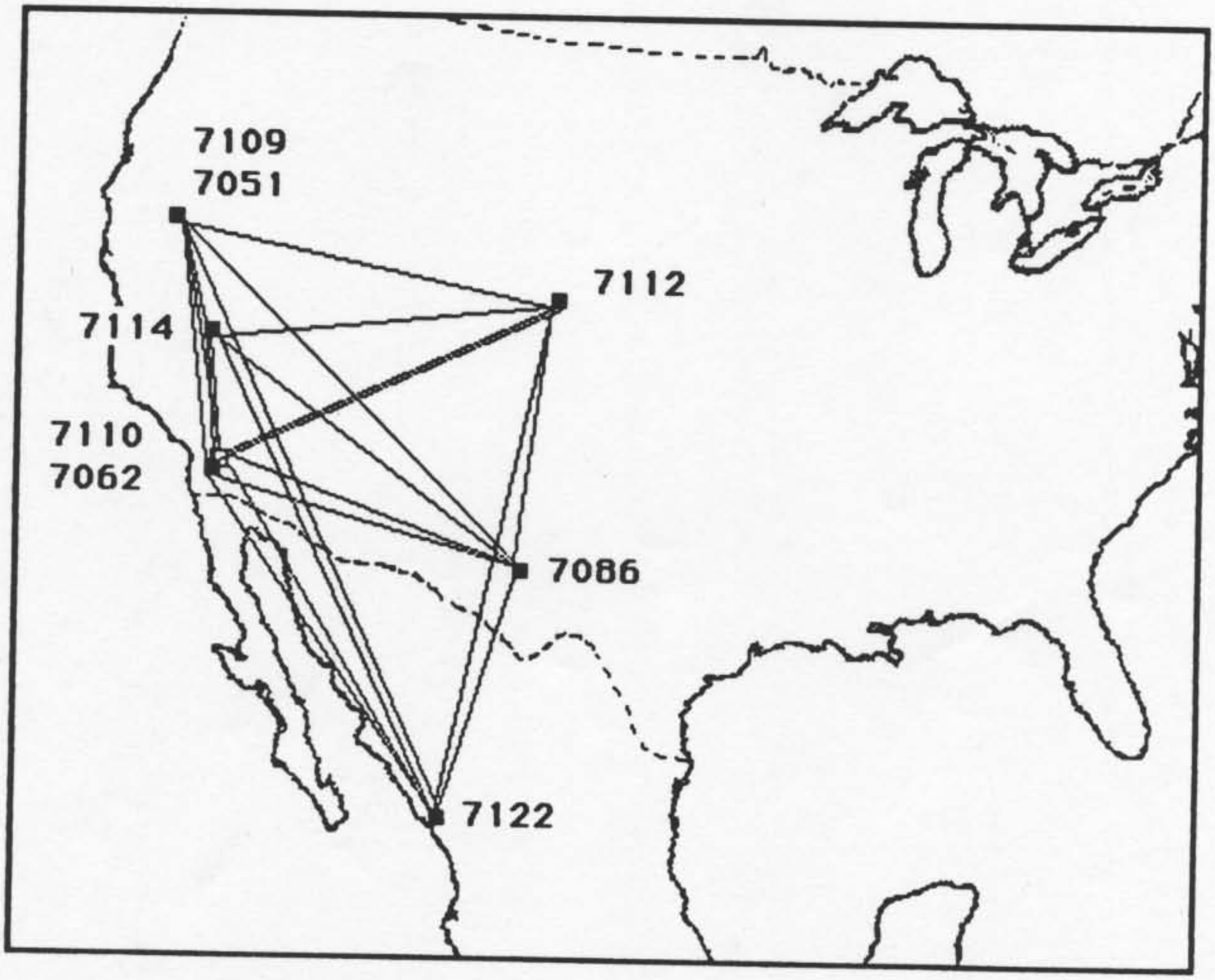

Figure 2. "Internal" SLR network.