GPS Lessons Learned

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Global geodesy has improved dramatically over the past decade starting with the GPS for IERS and Geodynamics demonstration campaign in 1991 (GIG 91). At that time it took over a week of CPU time to process a network solution based on 21 global receivers and orbit overlaps were in the 40 cm range. Today it is possible to process a network solution based on 80 global receivers in less than one day of CPU time and orbit overlaps are in the 4 cm range. Special methods are under development for efficient processing of increasingly large regional networks which may contain hundreds or thousands of GPS receivers. Along the way there have been many lessons learned about GPS satellites, receivers, monuments, antennas, radomes, analysis, reference frames, error sources, and interpretation. A wide range of scientific disciplines have been impacted including studies of plate motion, post-glacial rebound, seasonal loading, deformation in plate boundary zones, coseismic displacements due to major earthquakes, postseismic relaxation, and interseismic strain accumulation related to assessment of seismic hazards. Lessons learned will be presented in the context of new dense networks such as the Plate Boundary Observatory (PBO).

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GPS Lessons Learned

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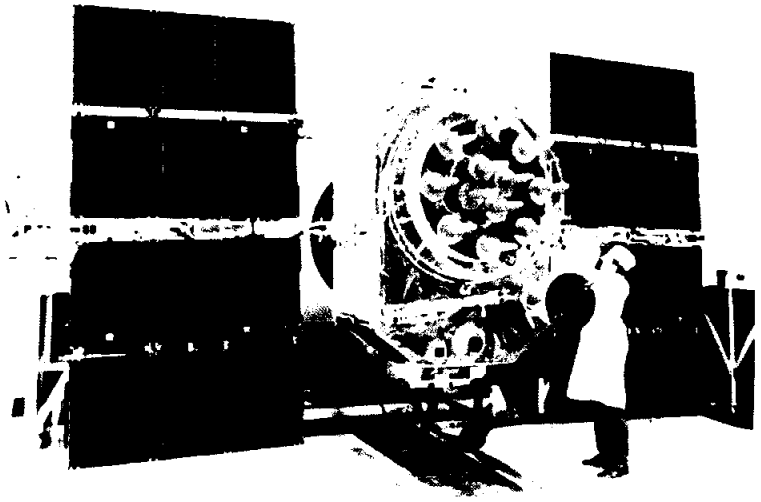
Satellites

Current

II/IIA - 20, Rockwell, 2 Cs + 2Rb, 7.3 yr

IIR - 8, Lockheed, 3 Rb, 7.8 yr



Future

Galileo - 30 satellites with new signals

GPS III - add C2, M1, M2, L5

Lessons

Non-gravitational satellite forces are a limiting error source

Atmospheric delay is a limiting error source

Anti-Spoofing (AS) limits LC range quality to about 50 cm

M code may allow removal of AS

Satellite antenna pattern not well understood

New satellites, new signals, more power will all help

Receivers

Current

Reduced code tracking provides dual-frequency range and phase data

Encrypted Y-code is a slowly modulated version of known P-code

Ashtech and AOA receivers are most common in the global network

Future

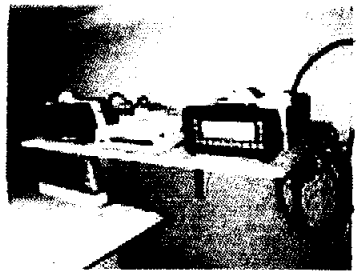
New satellites and signals from Galileo and GPS III

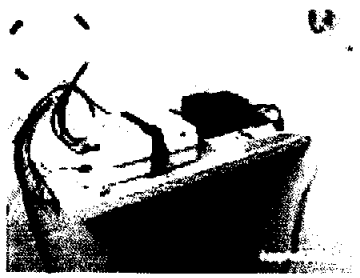
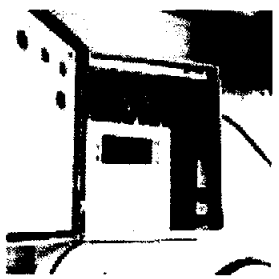
New networks such as the Plate Boundary Observatory (PBO)

Lessons

Buy receivers at last minute to get newest features for lowest price

Budget for receiver upgrades related to Galileo and GPS III



Monuments/Antennas/Radomes

Current

Range of monument designs - stability versus expense

Dorne-Margolin choke ring antenna - multipath reduction

Radome - protection from water and snow

Lessons

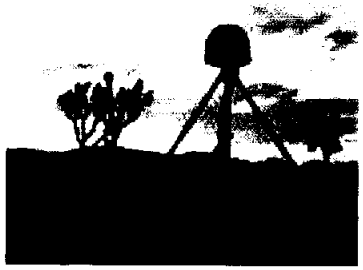
Get permits for monumentation as early as possible

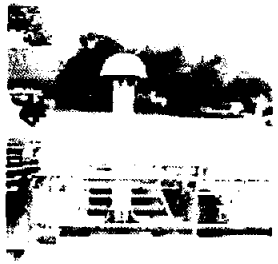
Continue to use a range of monument designs

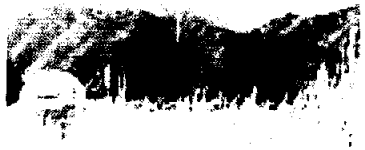
Minimize equipment changes

Elevation mask affected by changing plants and structures

Receiver antenna pattern not well understood







Analysis Strategies/Reference Frame

Undifferenced

LC Range and Phase

GPS Orbits and Clocks

Point positions+Ambiguity Resolution+Regional Filter

Double difference

LC Phase Double Difference

GPS Orbits

Network baselines+Ambiguity Resolution+Regional Filter

Reference Frame

ITRF2000, One Plate Fixed

Lessons

Support 2-3 analysis centers to benefit from competition and diversity

Use of a standard frame simplifies comparisons and combinations

Global Deformation

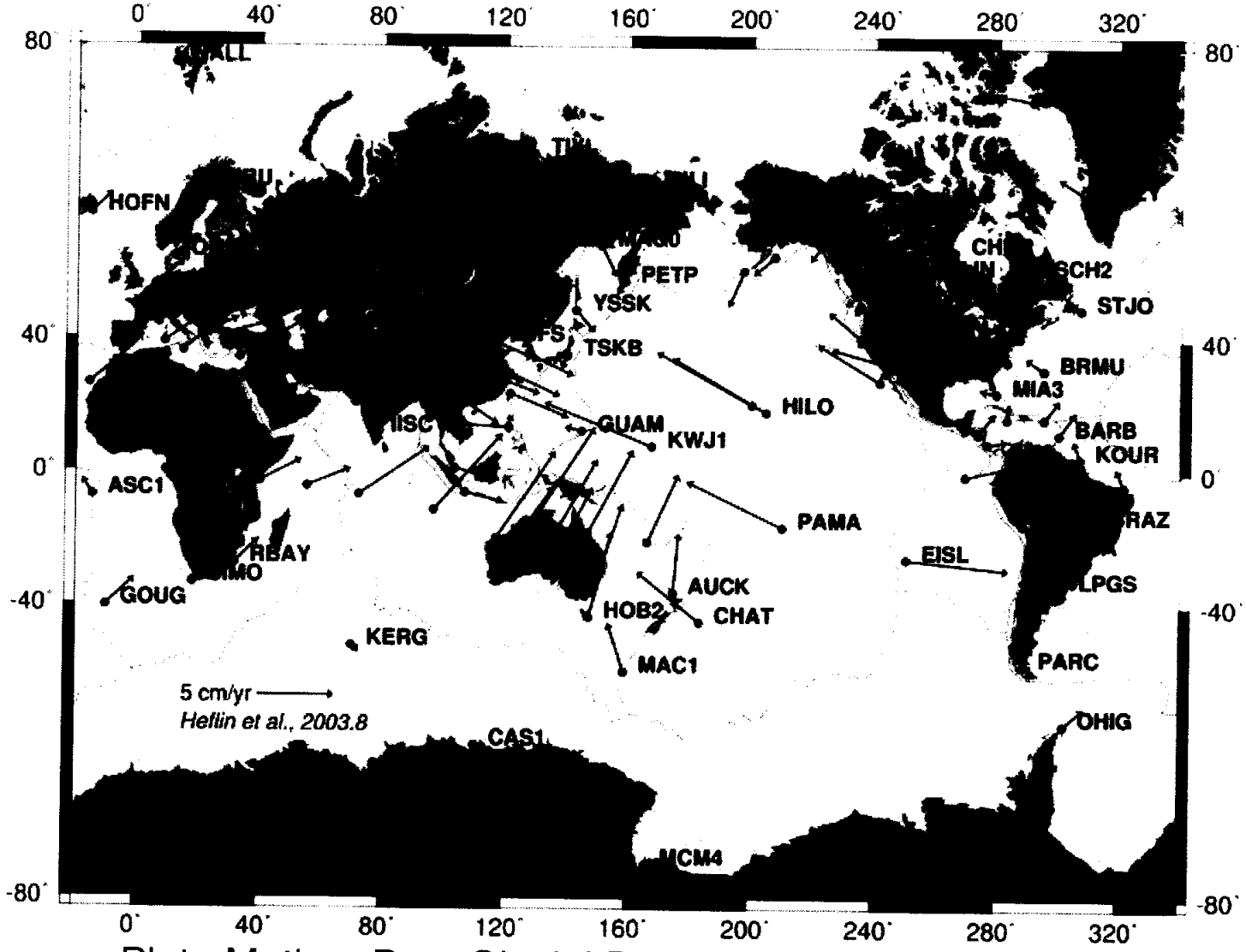
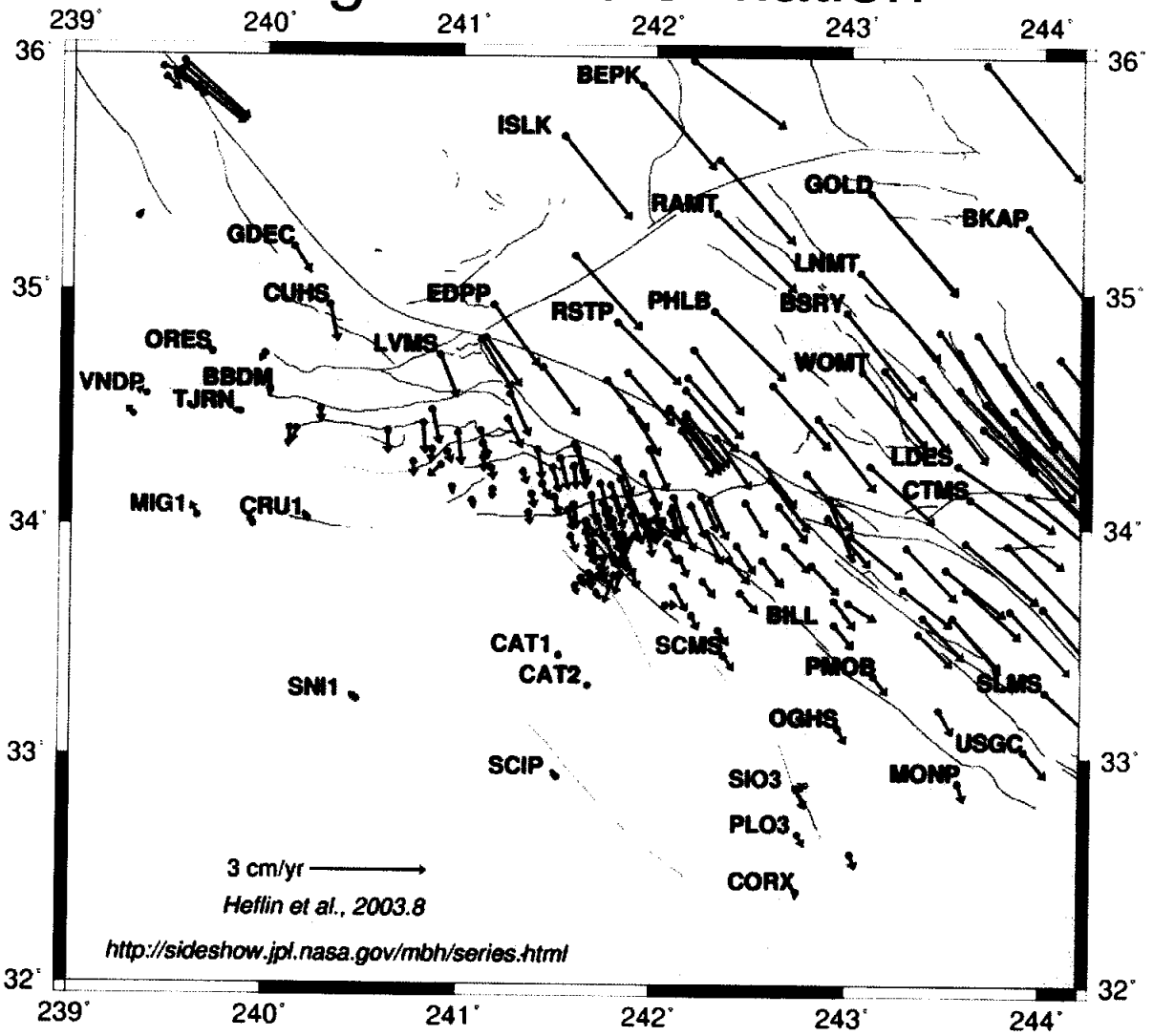


Plate Motion, Post-Glacial Rebound, Seasonal Loading

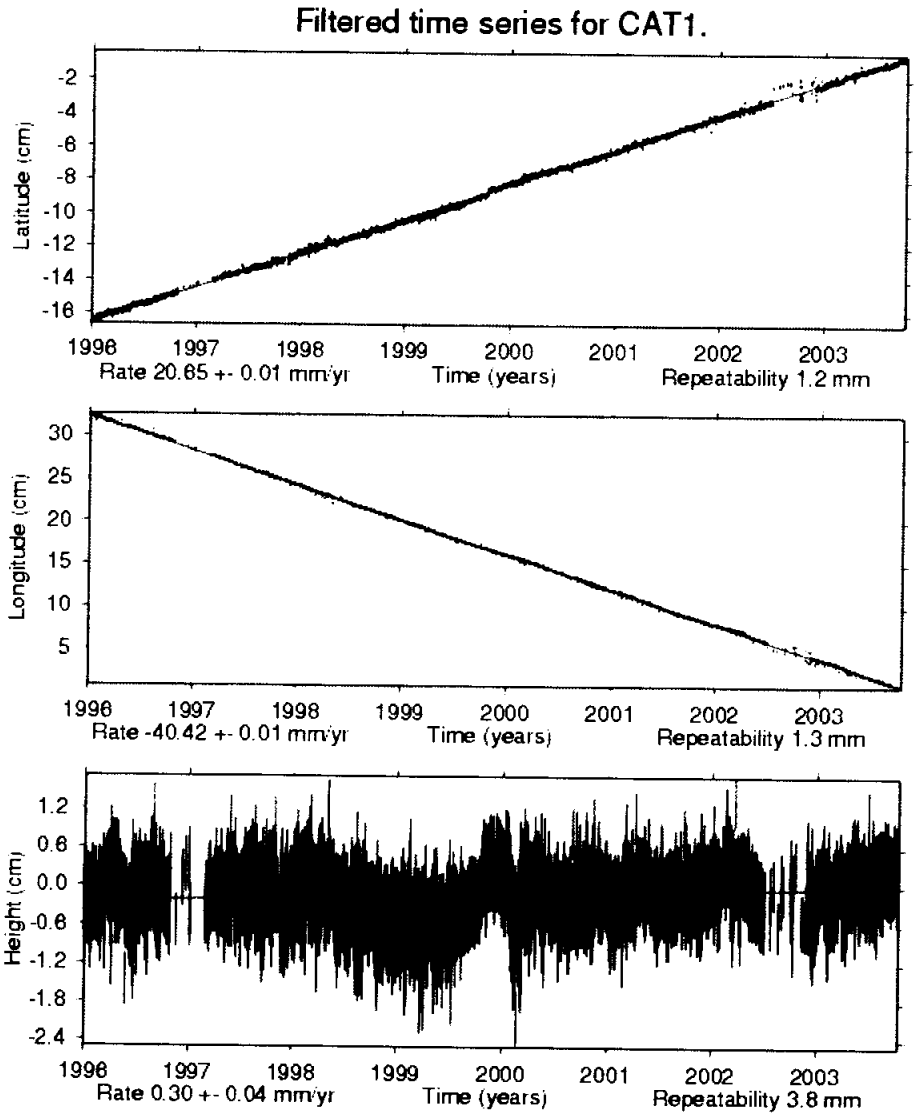
Regional Deformation



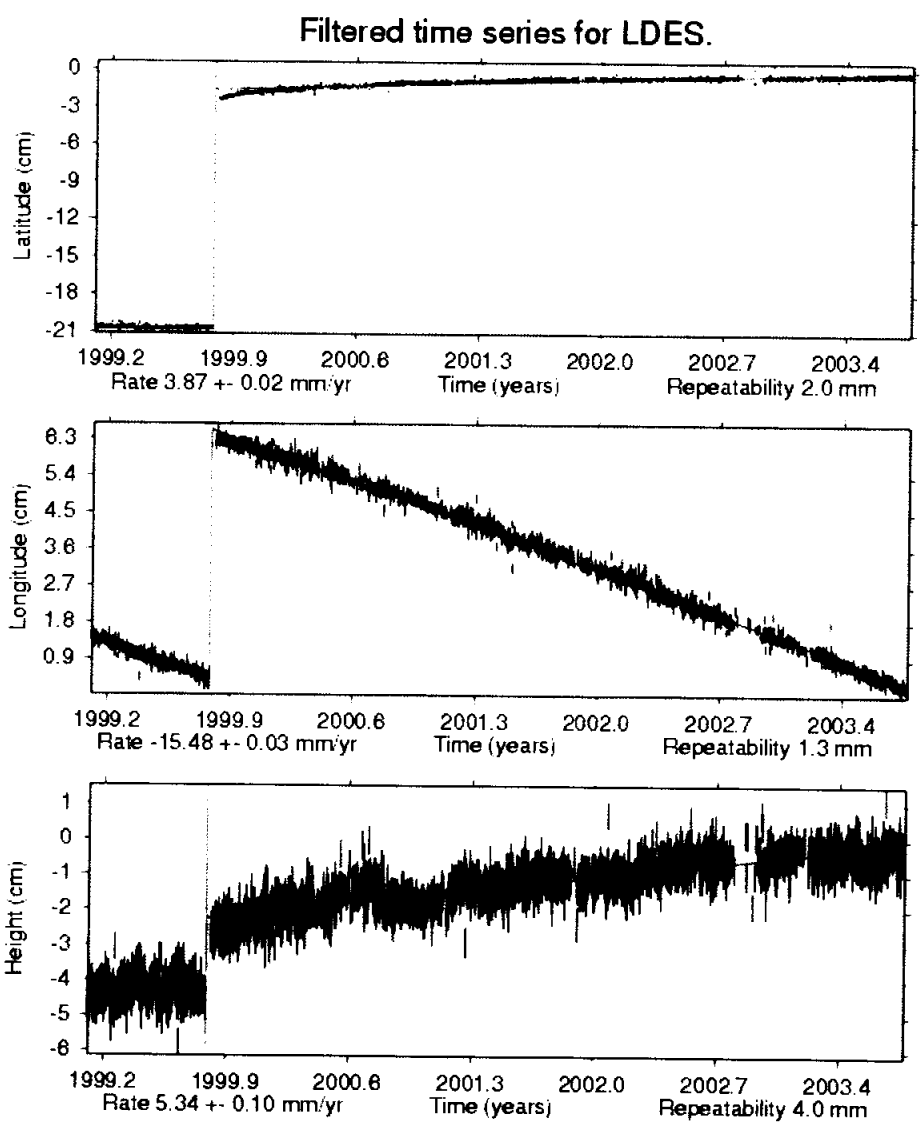
Right Lateral Shear: San Andreas Fault, San Jacinto Fault

Compression: Ventura Basin, Los Angeles Basin

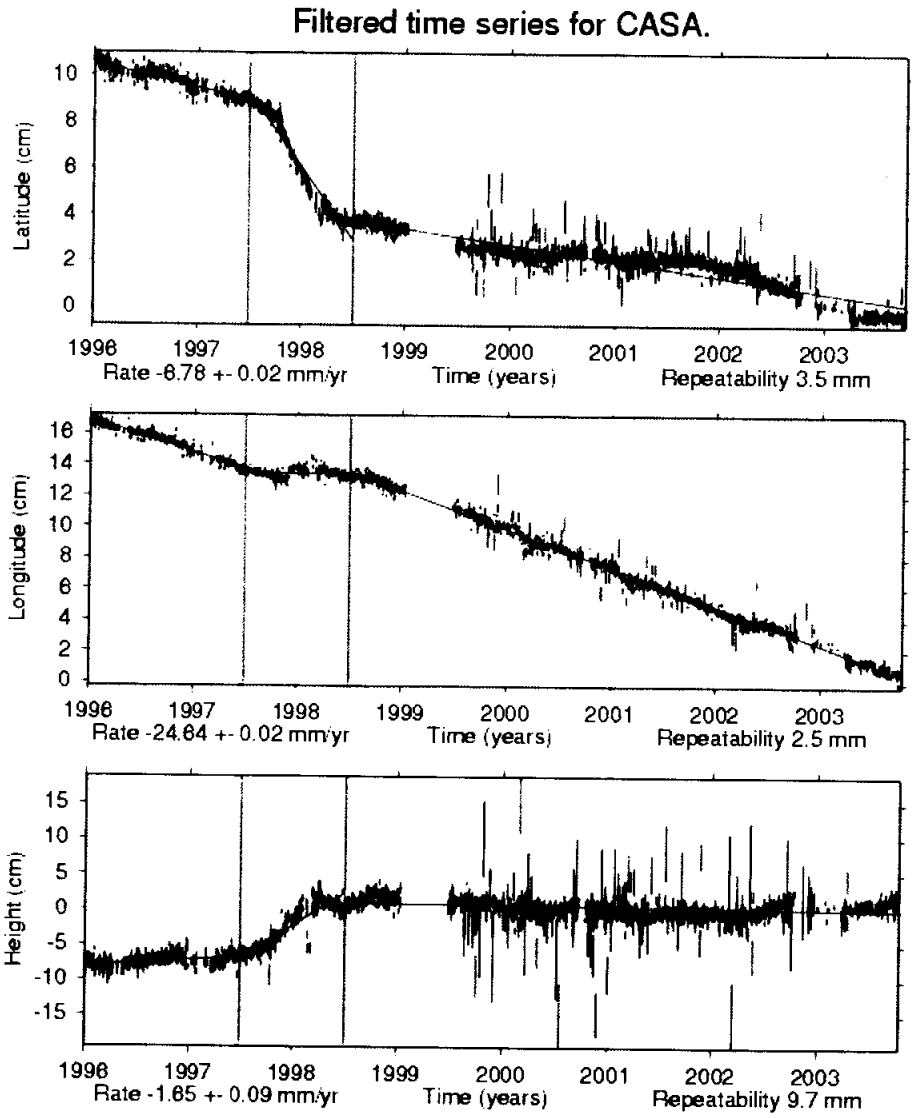
Linear Motion



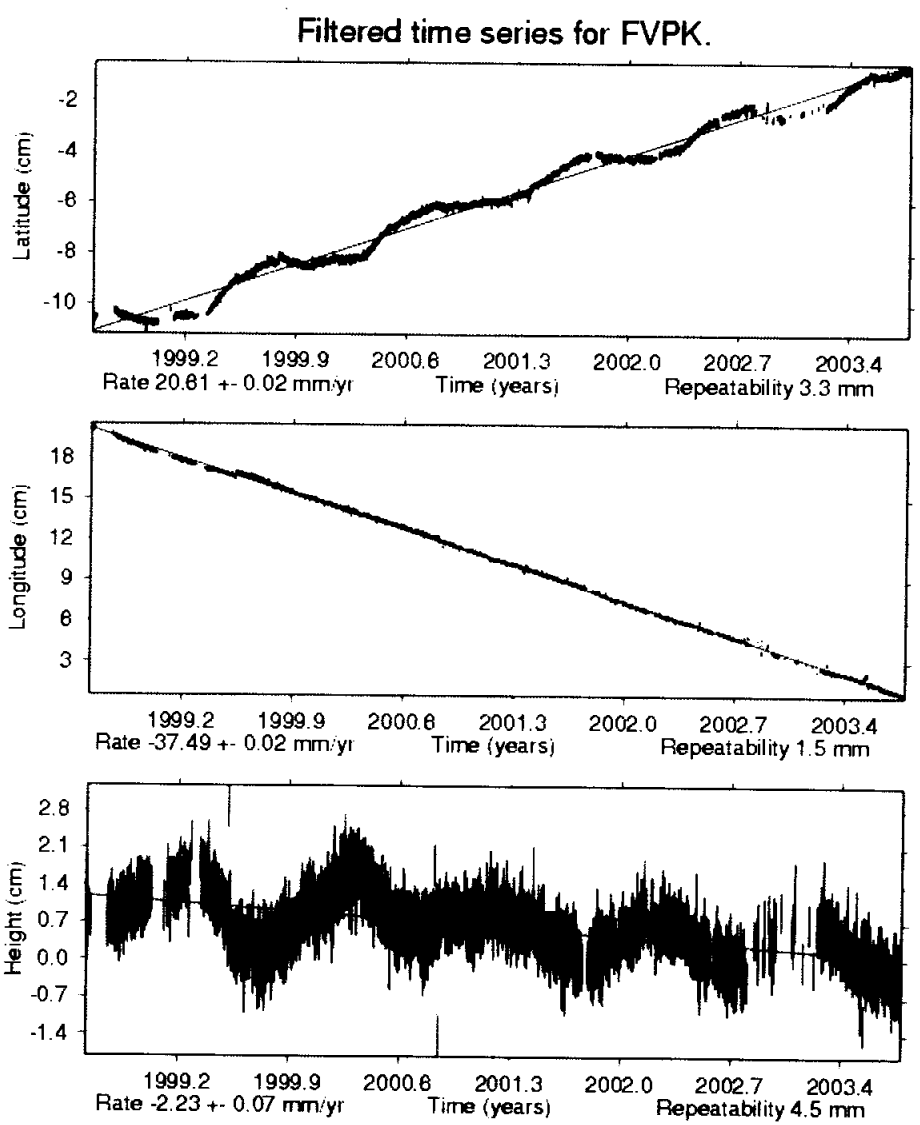
Co- and Post-Seismic



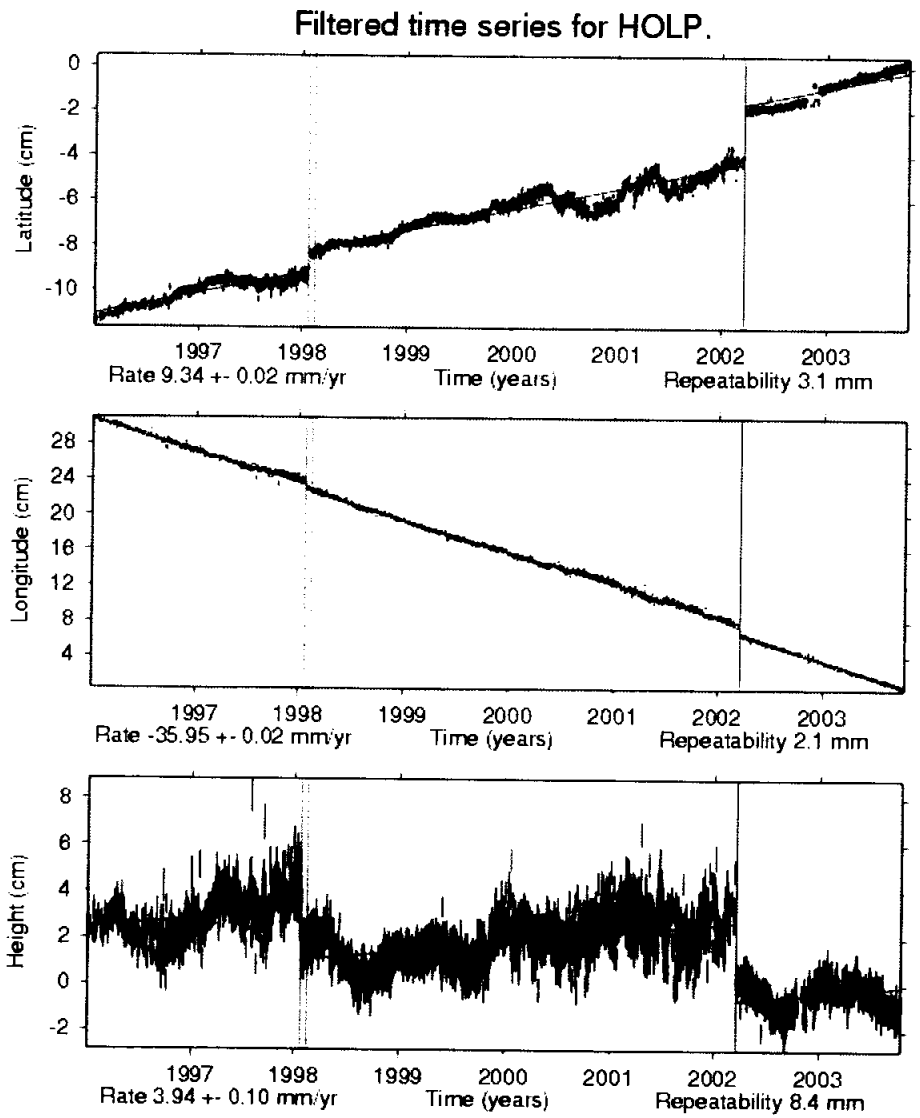
Non-linear Volcanic Deformation



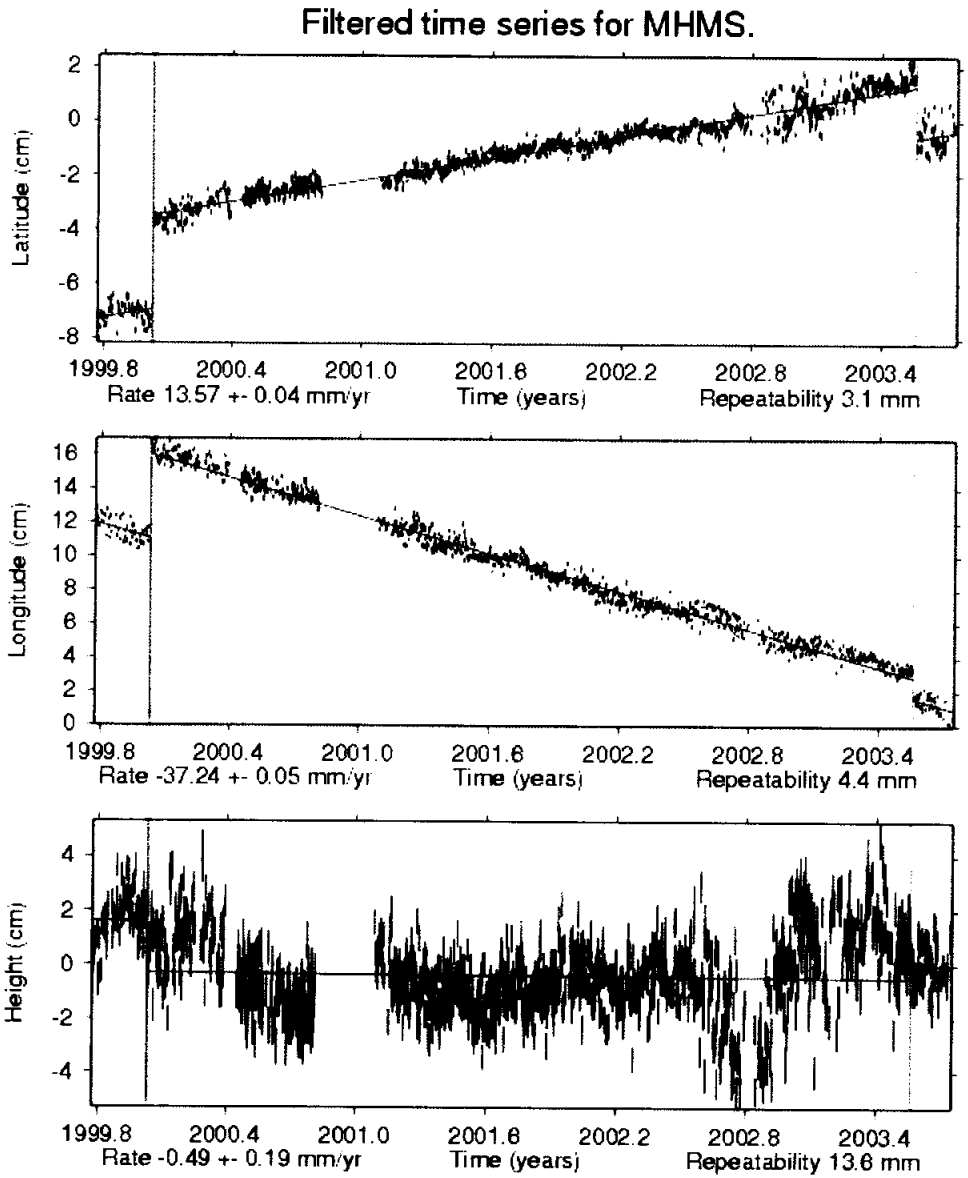
Seasonal Aquifer

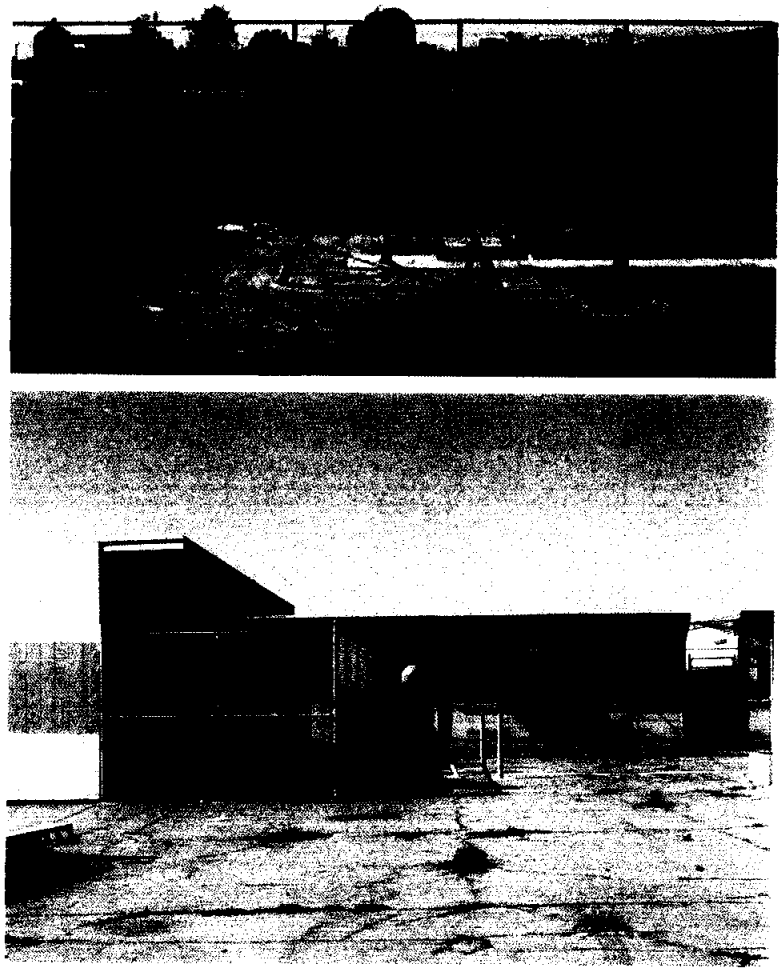


Tree Growth/Trimming



Construction





Summary

Get permits for monumentation as early as possible
Continue to use a range of monument designs
Avoid trees, buildings, and other elevation masking objects

Buy receivers at last minute to get new features and best price
Budget for receiver upgrades related to Galileo and GPS III
Minimize equipment changes

Support 2-3 analysis centers to benefit from competition and diversity
Use a standard reference frame for basic products
Provide time series to handle linear and non-linear signals