

J. Robbins  
May 16, 1990

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# THE MEASUREMENT OF THE VERTICAL POSITION FROM LASER RANGING AND VLBI DATA

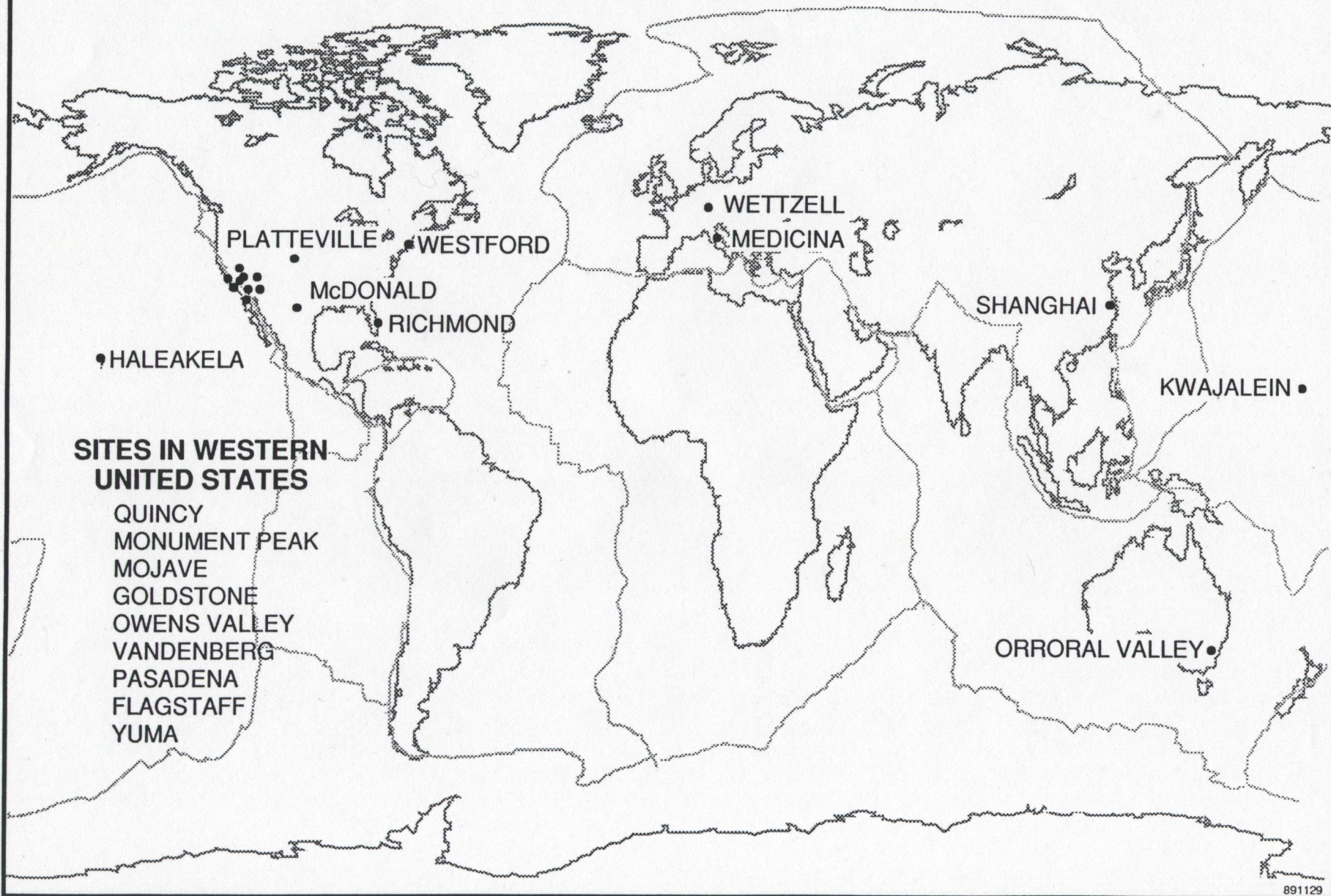
David E. Smith  
Laboratory for Terrestrial Physics  
Goodard Space Flight Center

presented to  
The Fall American Geophysical Union Meeting  
December 5, 1989  
San Fransisco, CA

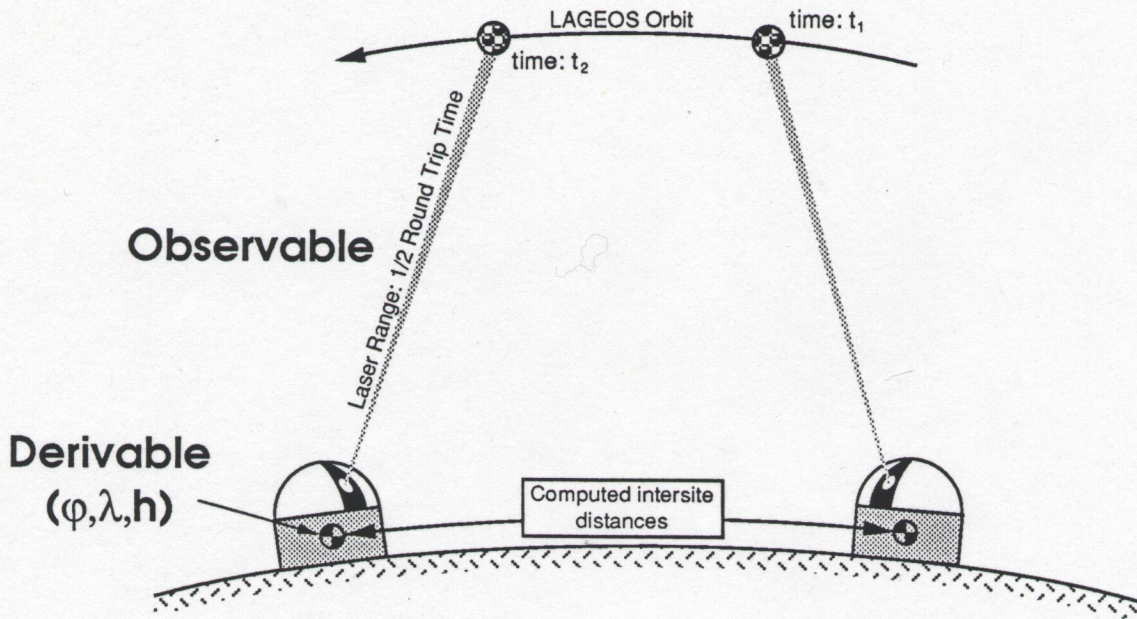
# OVERVIEW

- SLR AND VLBI TECHNIQUES
- COORDINATE SYSTEMS
- ALIGNING OF SLR AND VLBI NETWORKS
- DETERMINING HEIGHTS
- EXAMPLES OF SLR AND VLBI HEIGHT DISPLACEMENTS

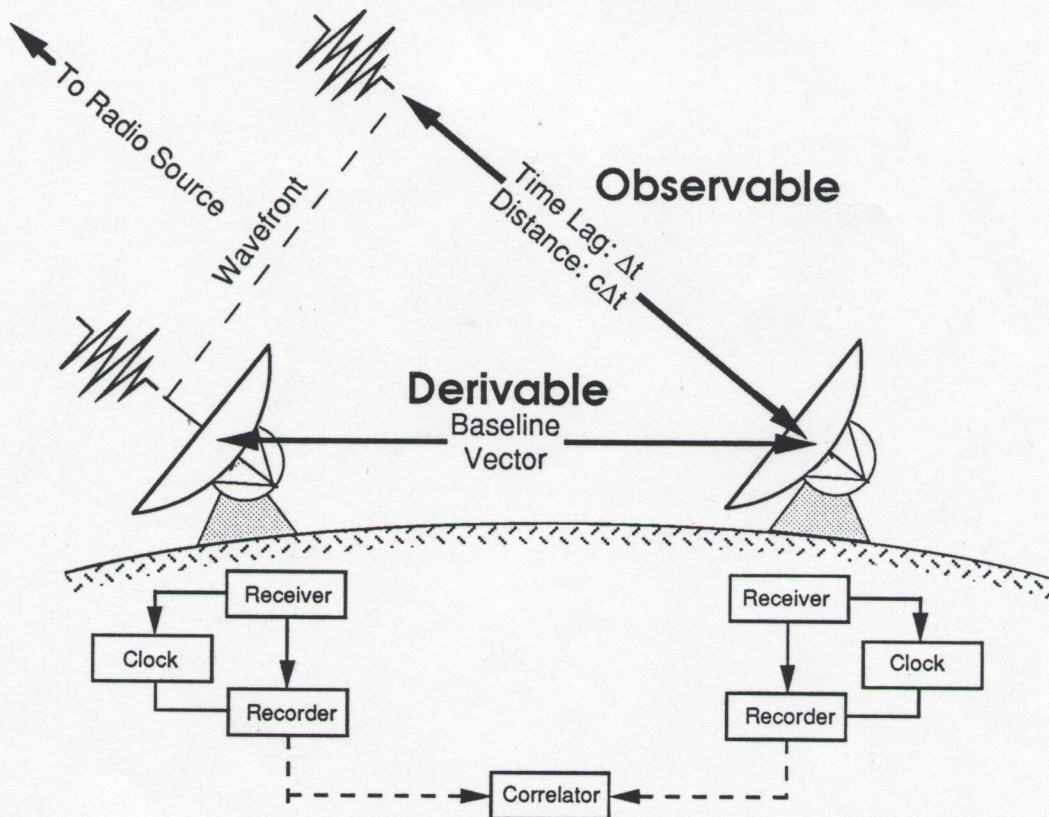
# LOCATIONS OF COLLOCATED SLR AND VLBI SITES



# Satellite Laser Ranging: SLR



# Very Long Baseline Interferometry: VLBI



# METHODOLOGY

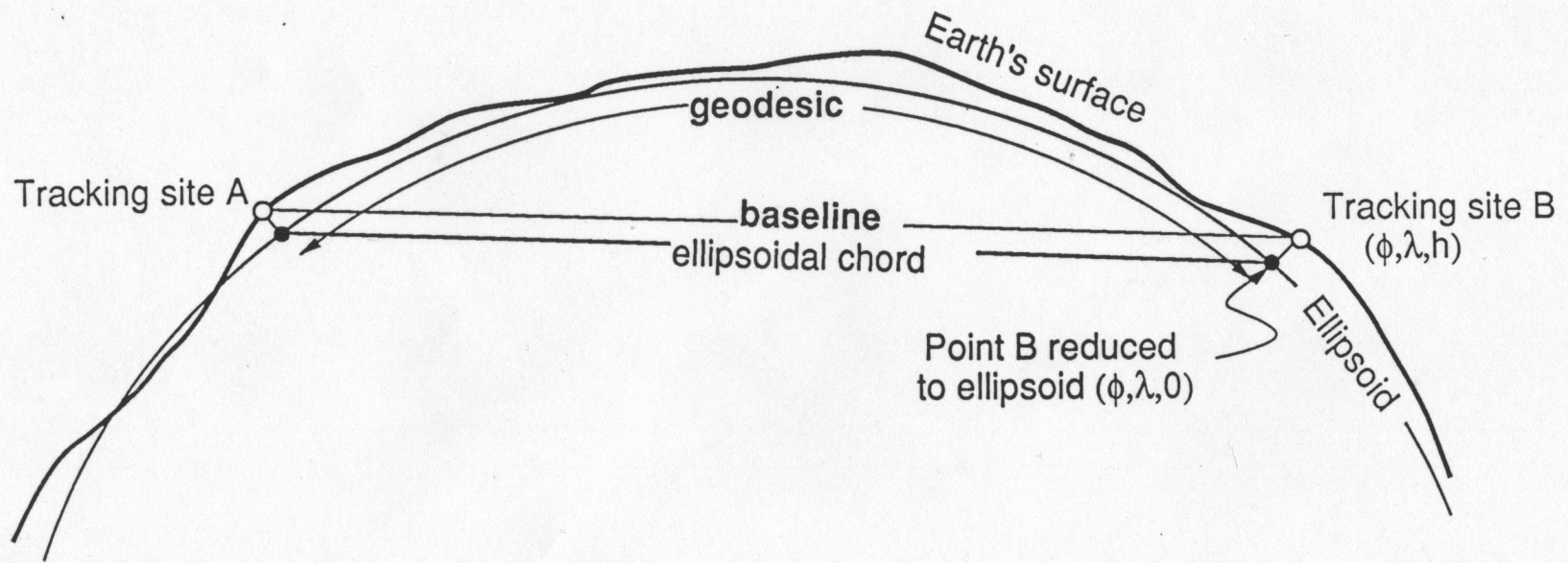
## **SATELLITE LASER RANGING**

- **Solution based on equations of motion for near-Earth orbits**
- **Coordinate system defined by the Earth's center of mass and orbit plane of the satellite**

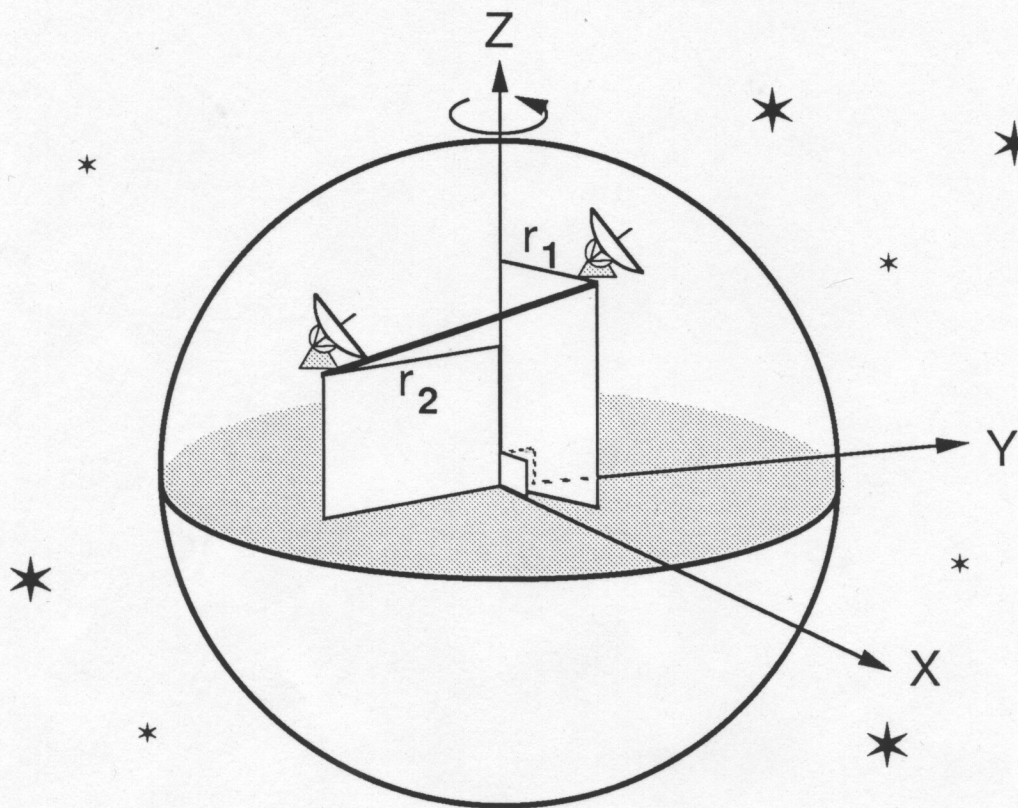
## **VERY LONG BASELINE INTERFEROMETRY**

- **Geometric solution correlating phase delay and delay rates of received intergalactic signal**
- **Coordinate system defined by celestial source locations of quasars**

# GEODESIC & BASELINE

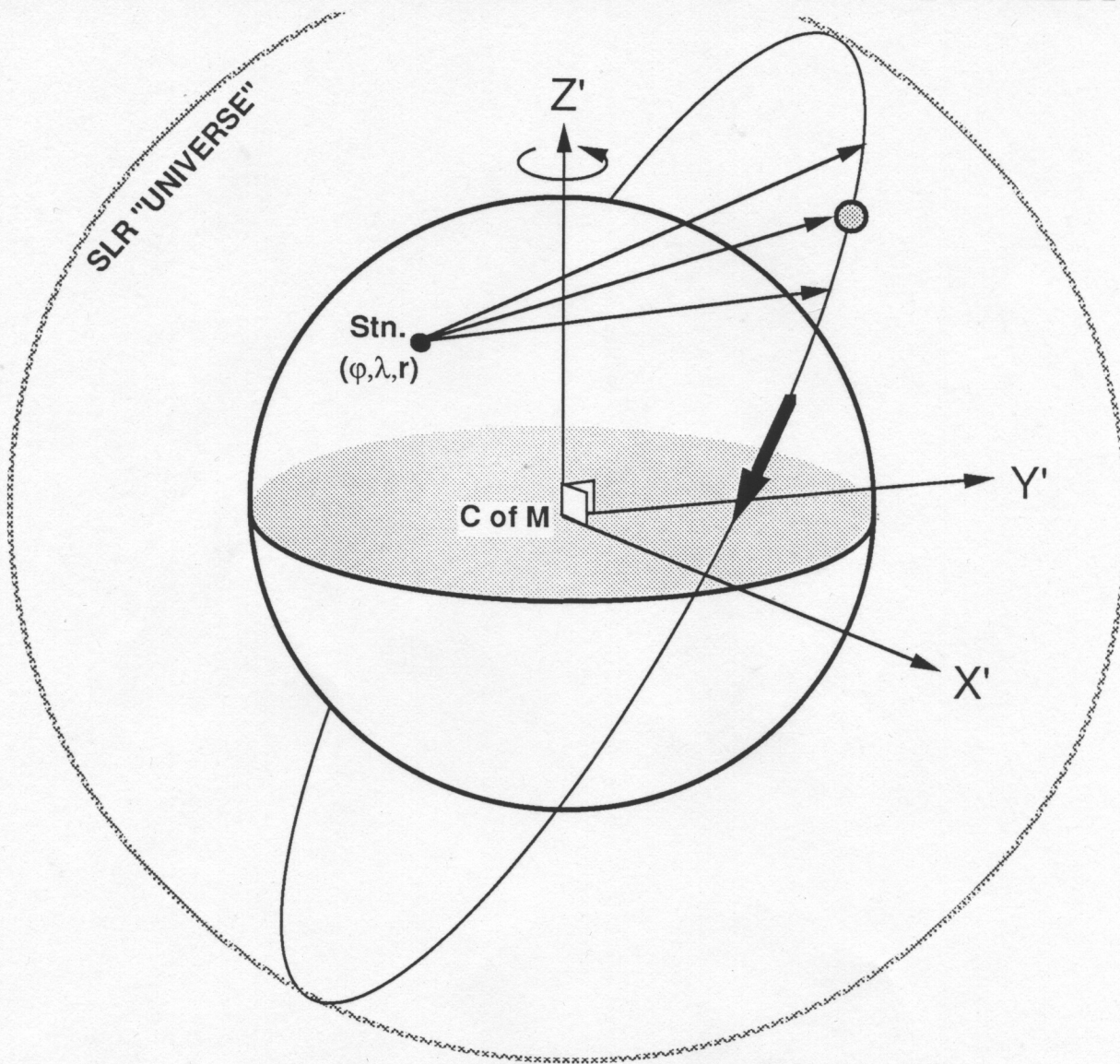


# VLBI COORDINATE SYSTEM



- OBSERVATIONS OVER TIME ( $\sim 1$  DAY) PROVIDE SPIN AXIS DISTANCES (and other parameters)
- INFORMATION ON X, Y COORDINATES OF STATIONS, NO INFORMATION ON Z
- NO FIXED ORIGIN. COORDINATES IN INERTIAL REFERENCE FRAME
- NOT SENSITIVE TO GRAVITY, OR DIRECTION OF THE VERTICAL

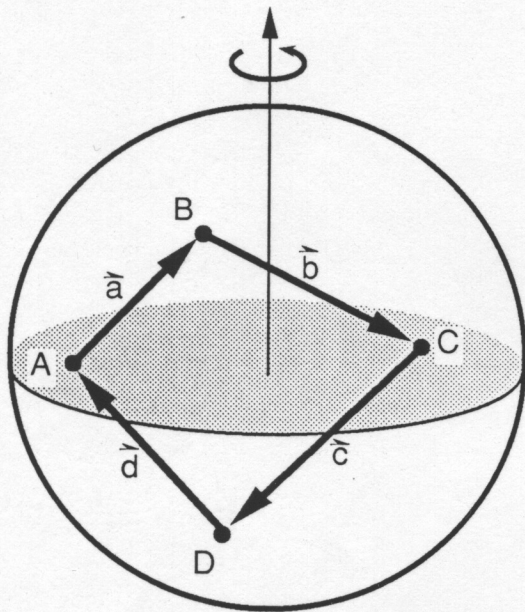
# SLR COORDINATE SYSTEM



- OBSERVATIONS OVER TIME PROVIDE POSITION OF STATION WITH RESPECT TO EARTH'S CENTER OF MASS (and other parameters)
- INFORMATION ON  $X'$ ,  $Y'$ ,  $Z'$  COORDINATES OF STATIONS
- NO INERTIAL COORDINATE SYSTEM COORDINATES IN EARTH CENTERED FRAME
- NOT SENSITIVE TO GRAVITY, OR DIRECTION OF THE VERTICAL

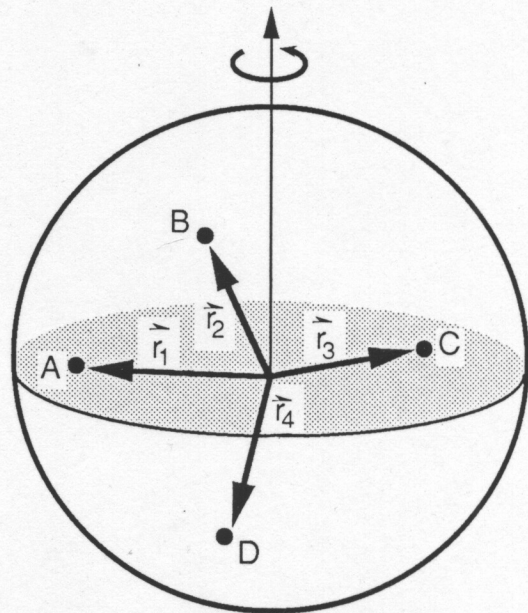


# COMBINING NETWORKS



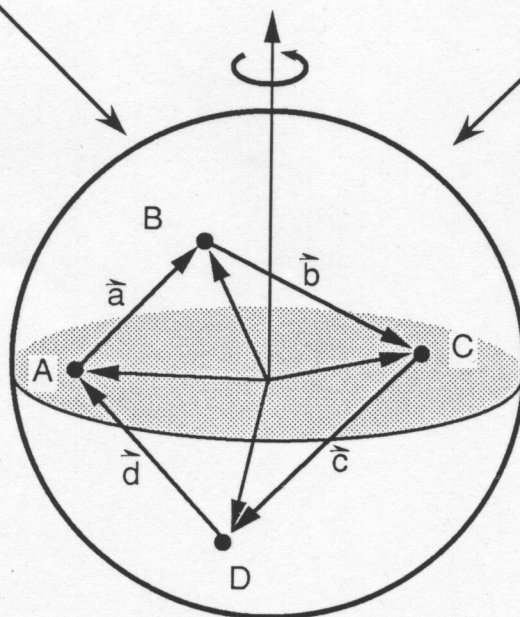
## VLBI

MEASURES  
MOTIONS/POSITIONS w.r.t.  
POINT ON SURFACE



## SLR

MEASURES  
MOTIONS/POSITIONS w.r.t.  
CENTER OF MASS

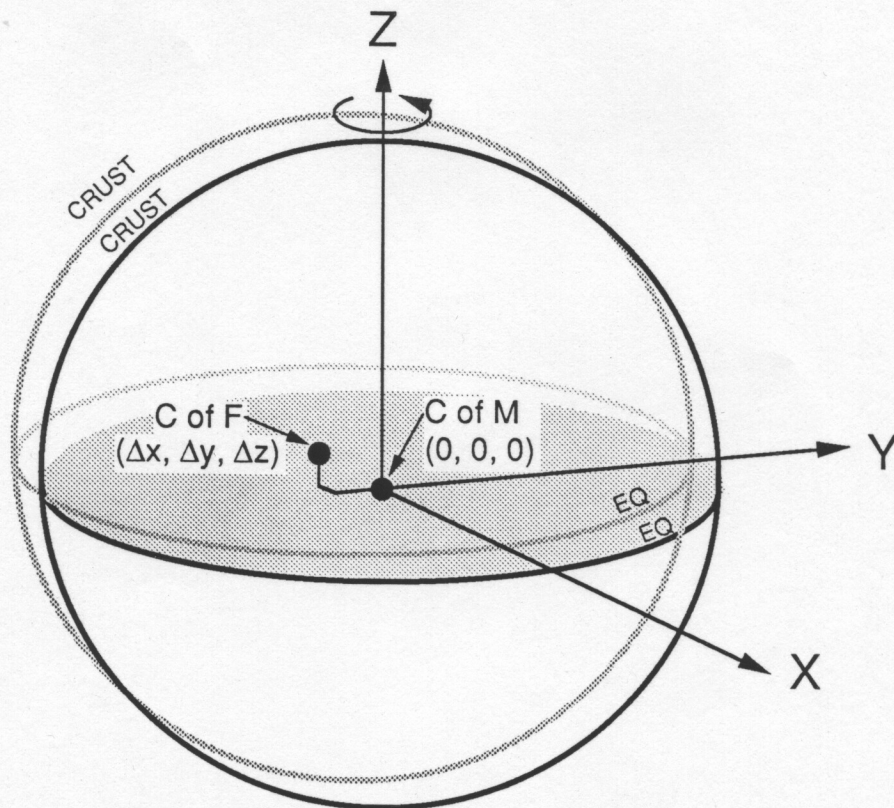


## COMBINED NETWORKS

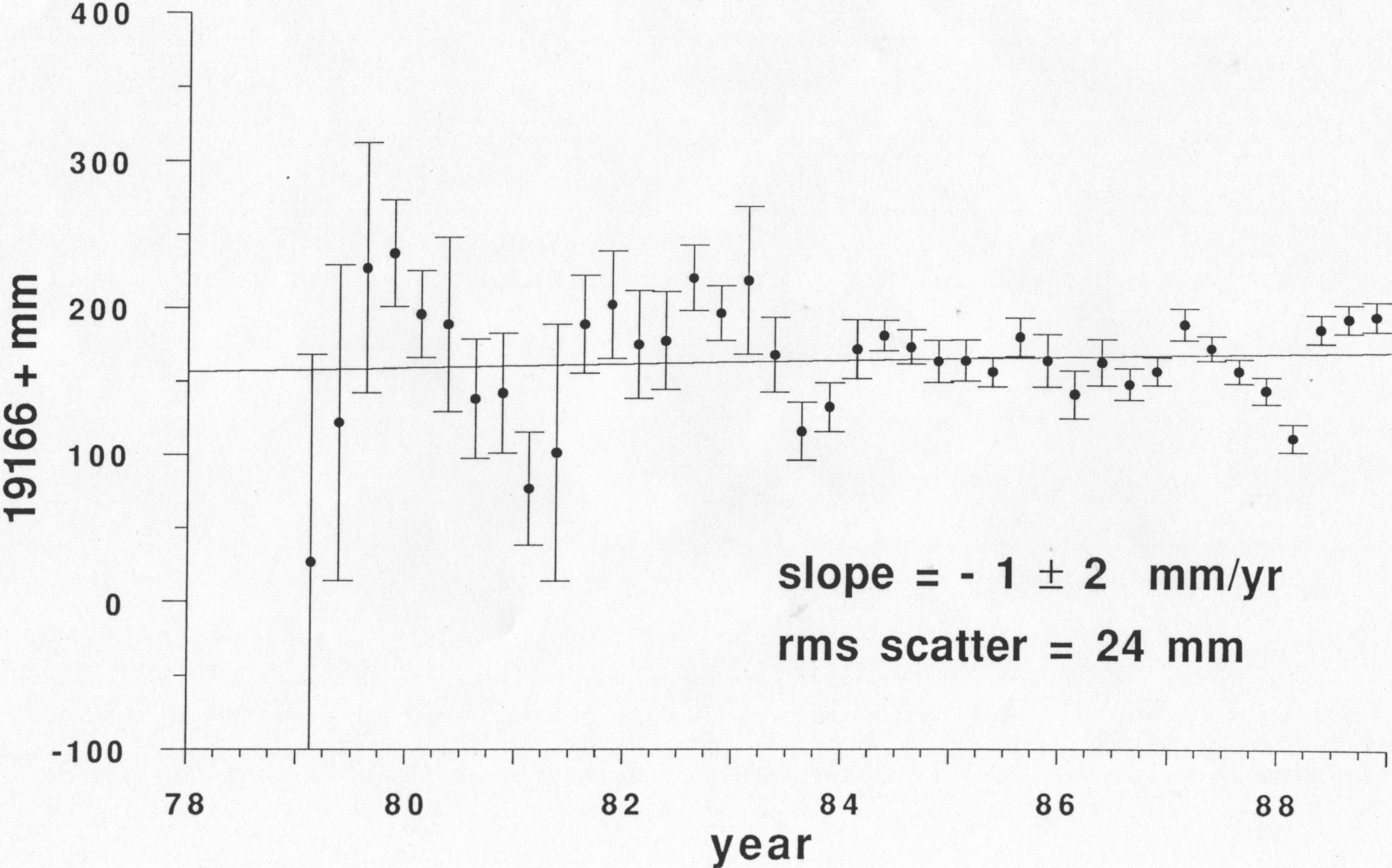
# EARTH'S CENTER OF MASS AND CENTER OF FIGURE

- THE CENTER OF MASS OF THE EARTH DEFINES THE EARTH'S ORBIT IN SPACE
- THE CENTER OF FIGURE IS NOT FIXED WITH RESPECT TO THE CENTER OF MASS OF THE EARTH

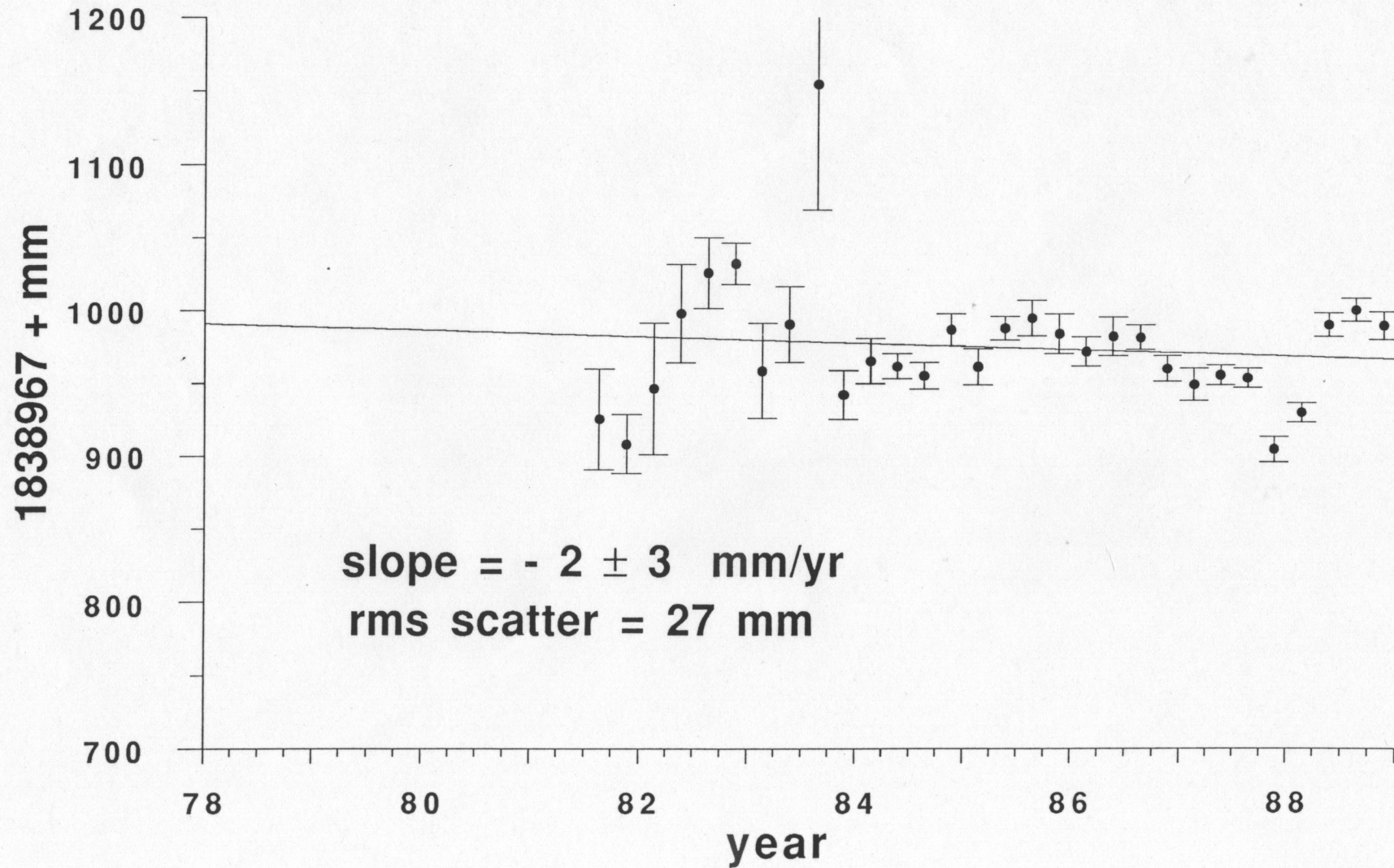
Atmospheric and oceanic movements cause periodic motion of the Earth's shell at the several centimeter level with respect to the center of mass.



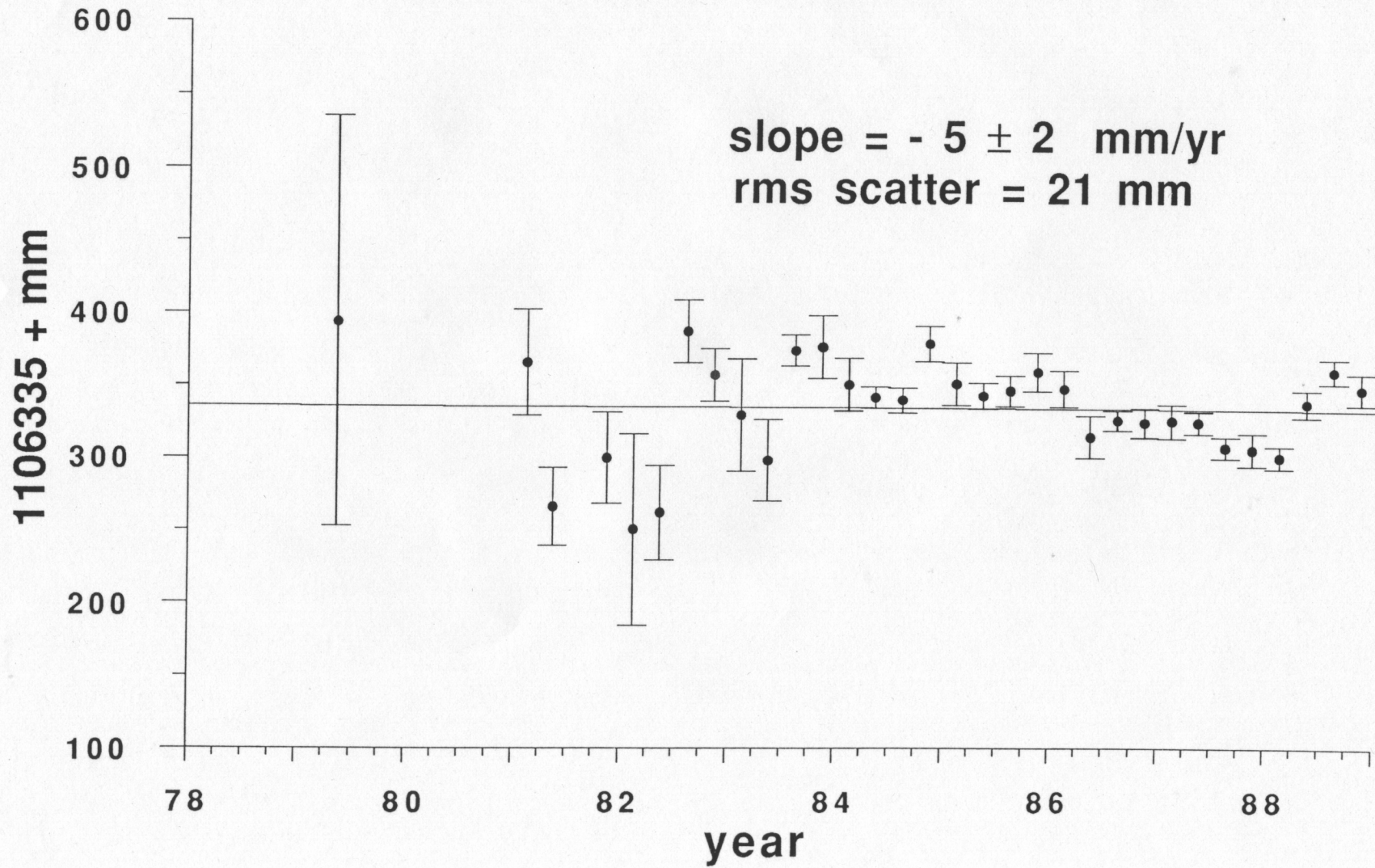
# GREENBELT HEIGHT



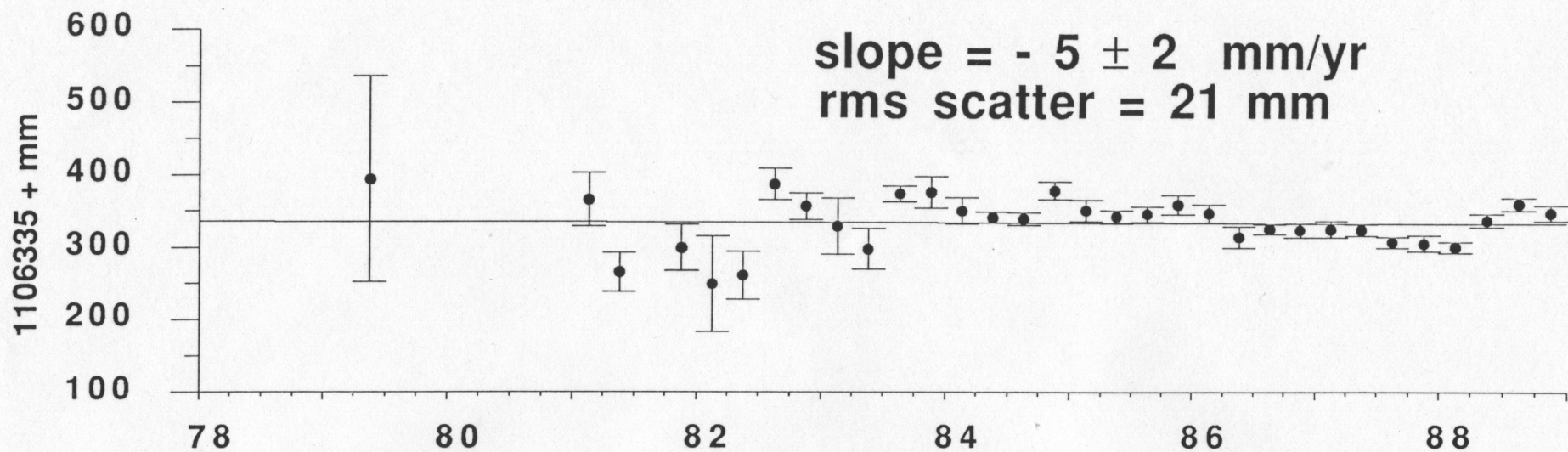
# MONUMENT PEAK HEIGHT



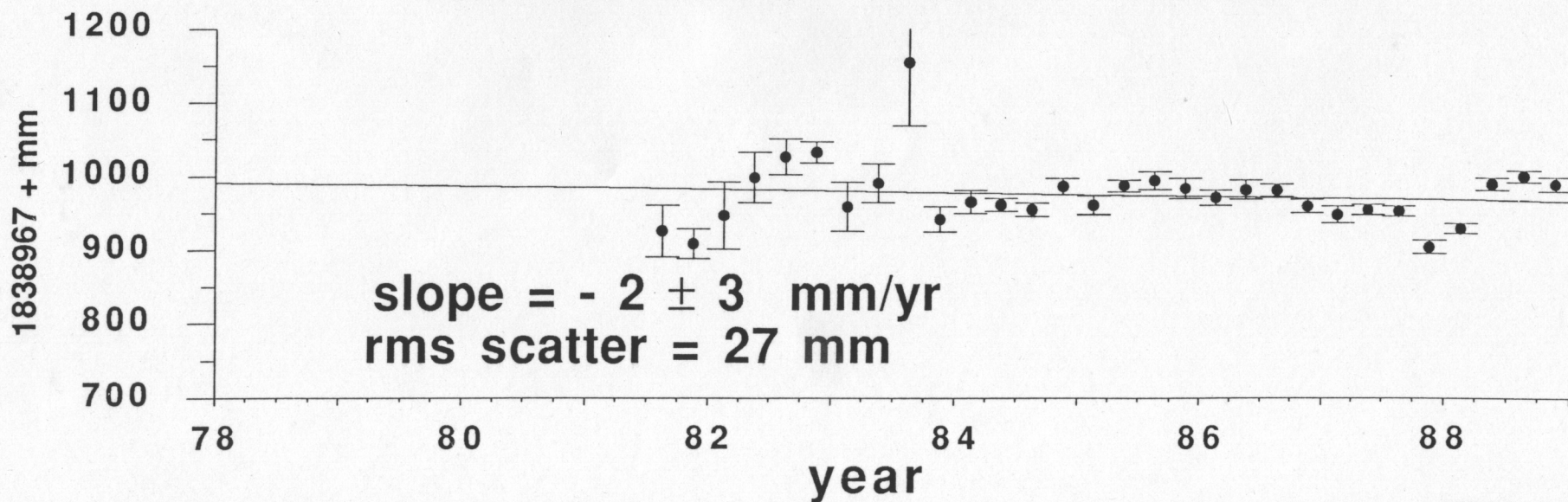
# QUINCY HEIGHT



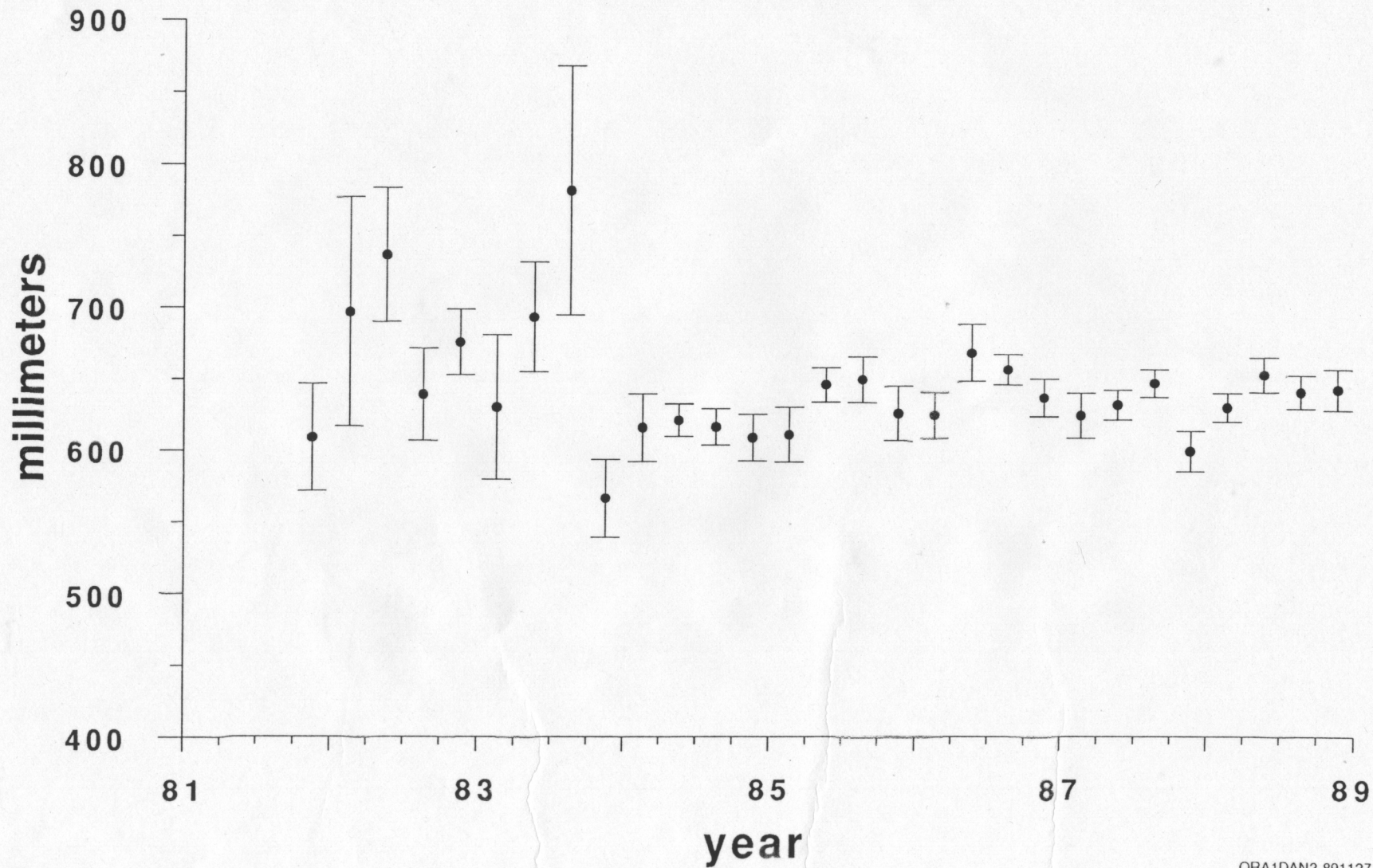
# QUINCY HEIGHT



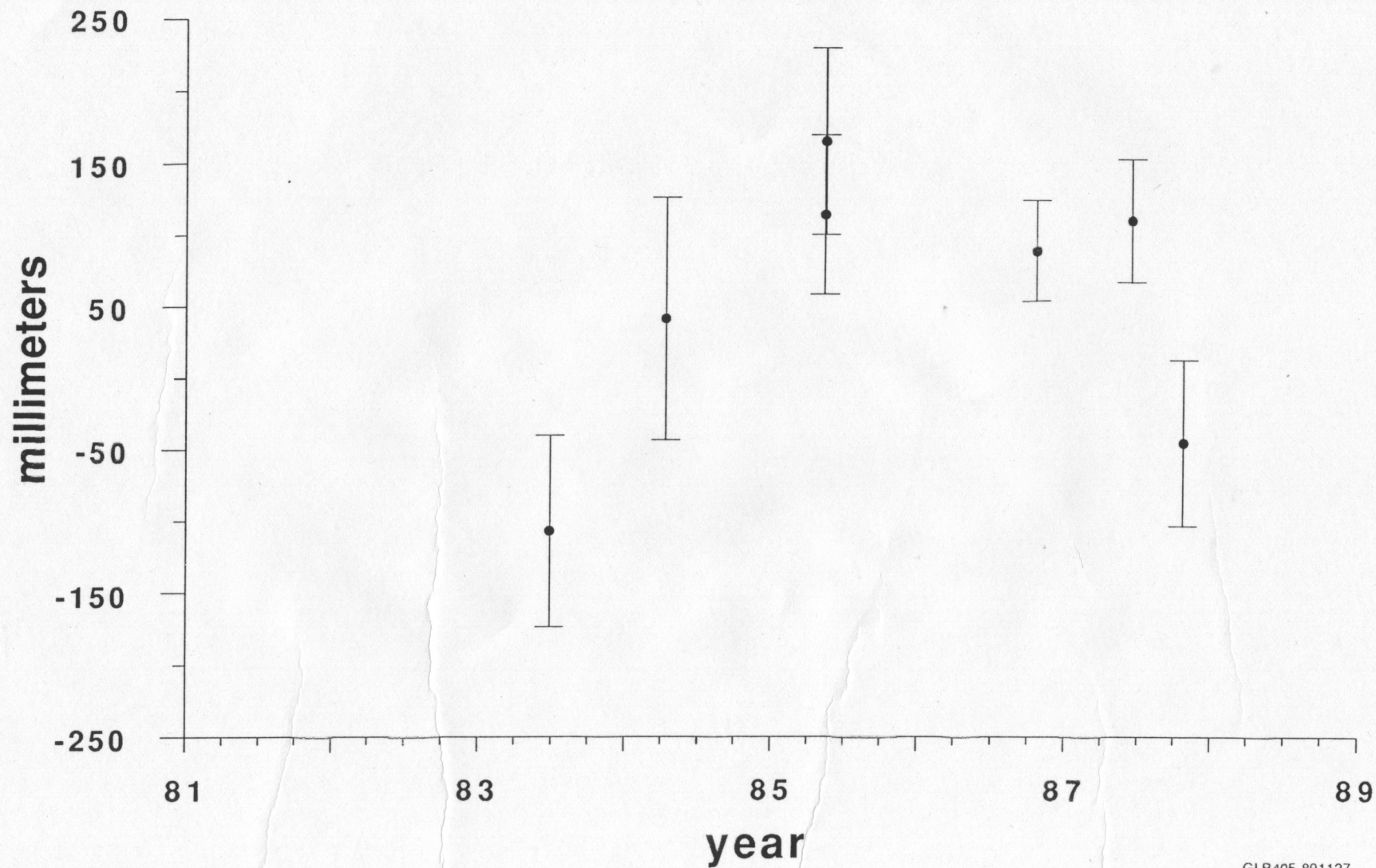
# MONUMENT PEAK HEIGHT



# MONUMENT PEAK minus QUINCY HEIGHT from SLR data

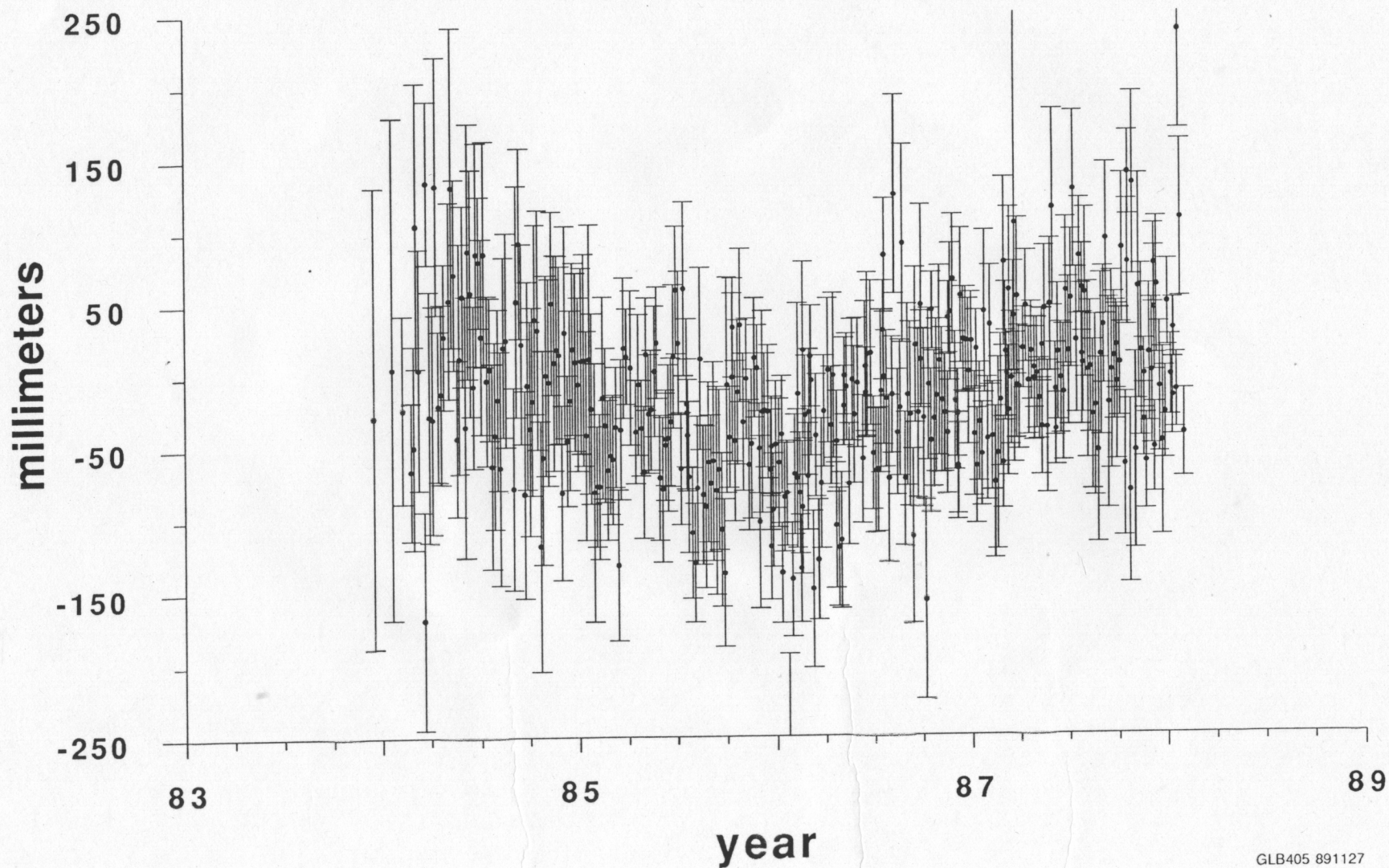


# MONUMENT PEAK to QUINCY VERTICAL from VLBI data





# WESTFORD TO WETTZELL VERTICAL from VLBI data



# WESTFORD TO WETTZELL VERTICAL from VLBI data

