

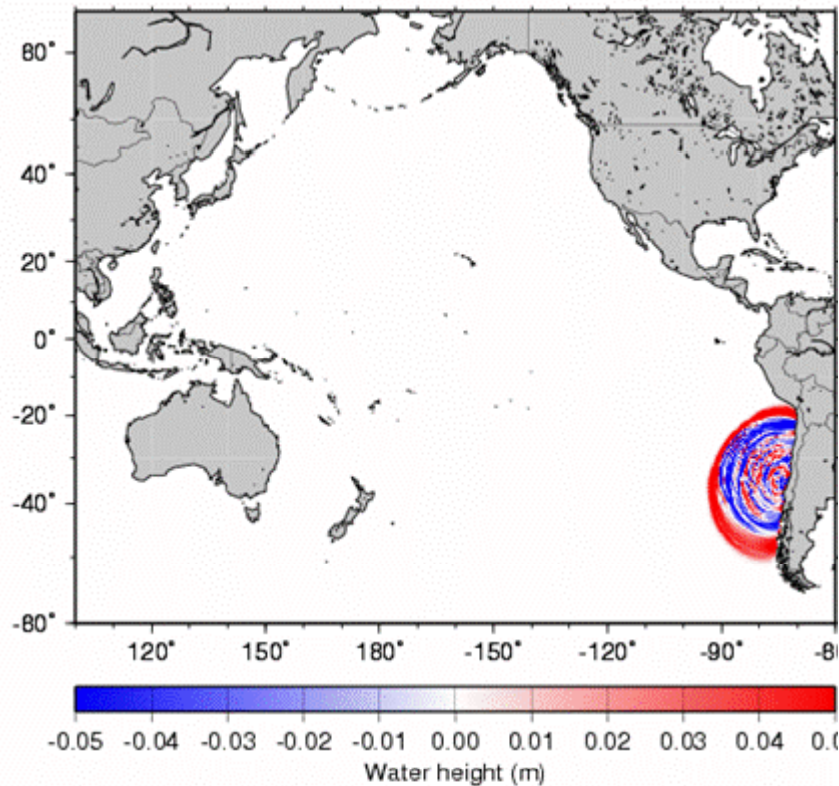
# **Towards Real-Time Detection of Tsunami in Deep Sea Waters for Early Warning Using GNSS Buoys**

Oscar L. Colombo, UMBC/NASA  
Goddard SFC, Code 698

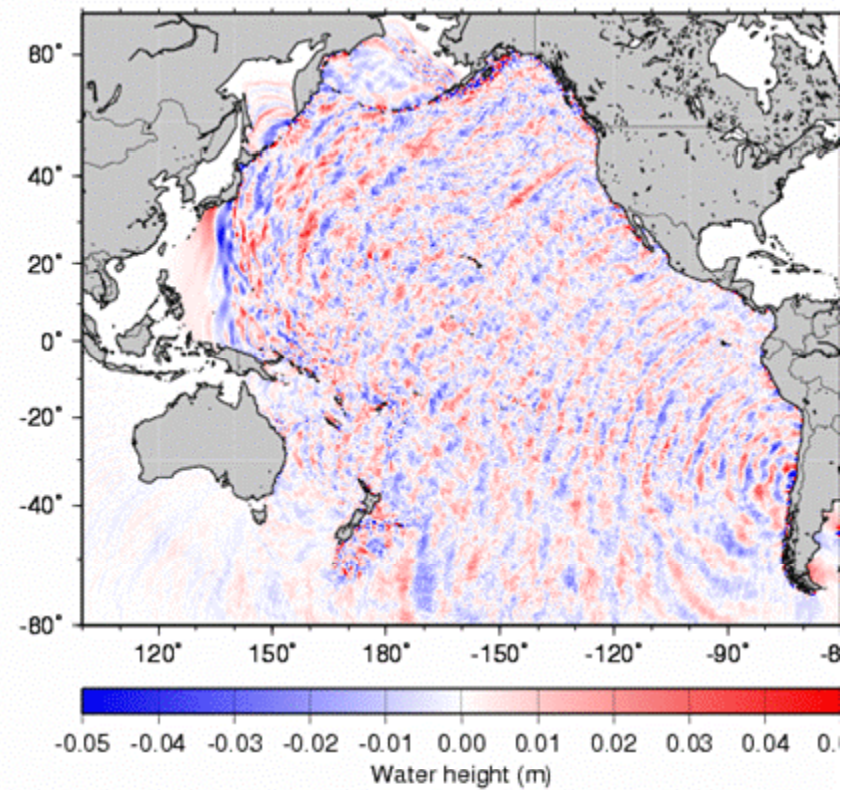
# Tsunami Caused by the M 8.8 Chilean Earthquake of 27 February 2010

(Modeled by Earth Research Institute, University of Tokyo)

2 hour 40 min



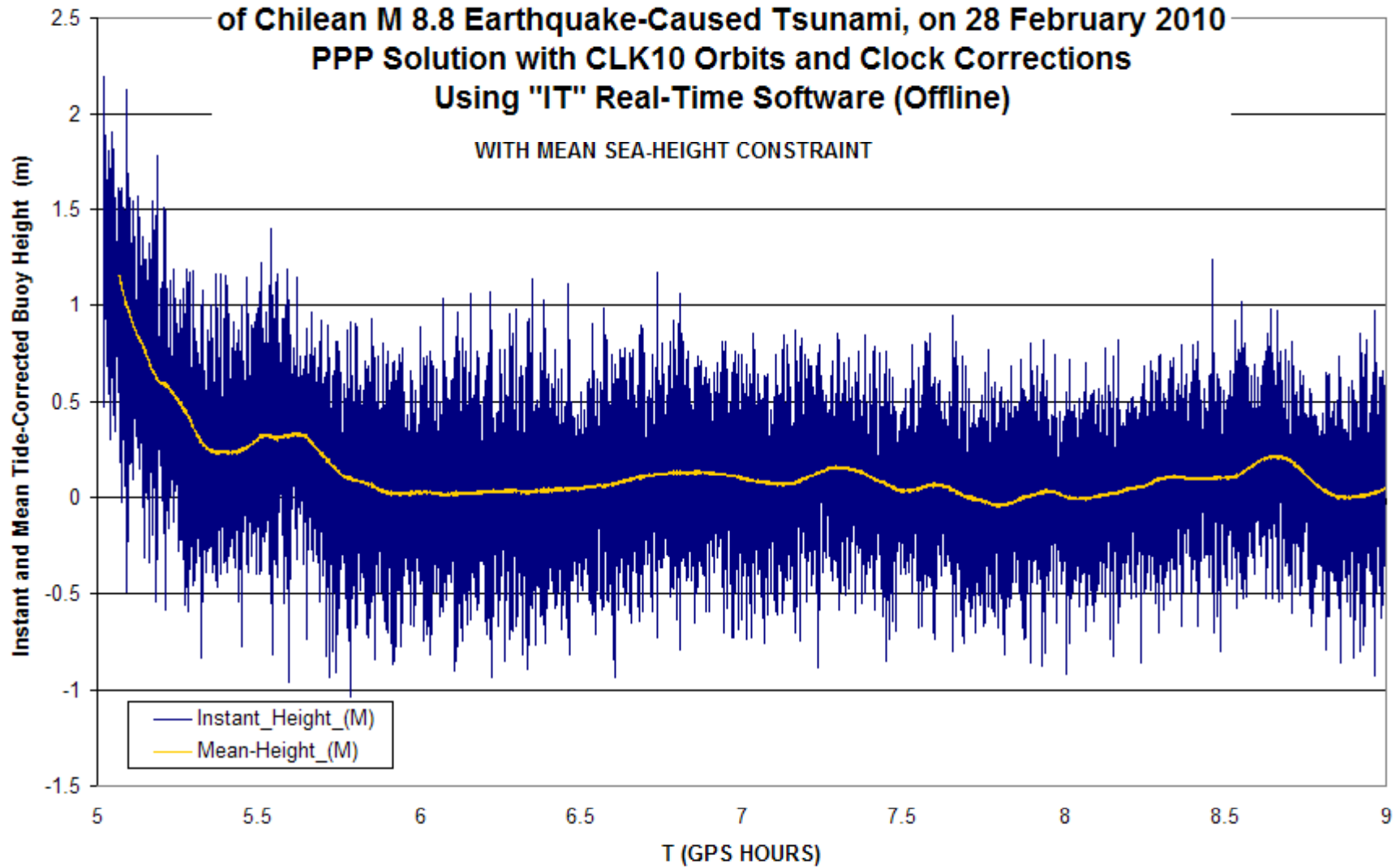
23 hour 40 min



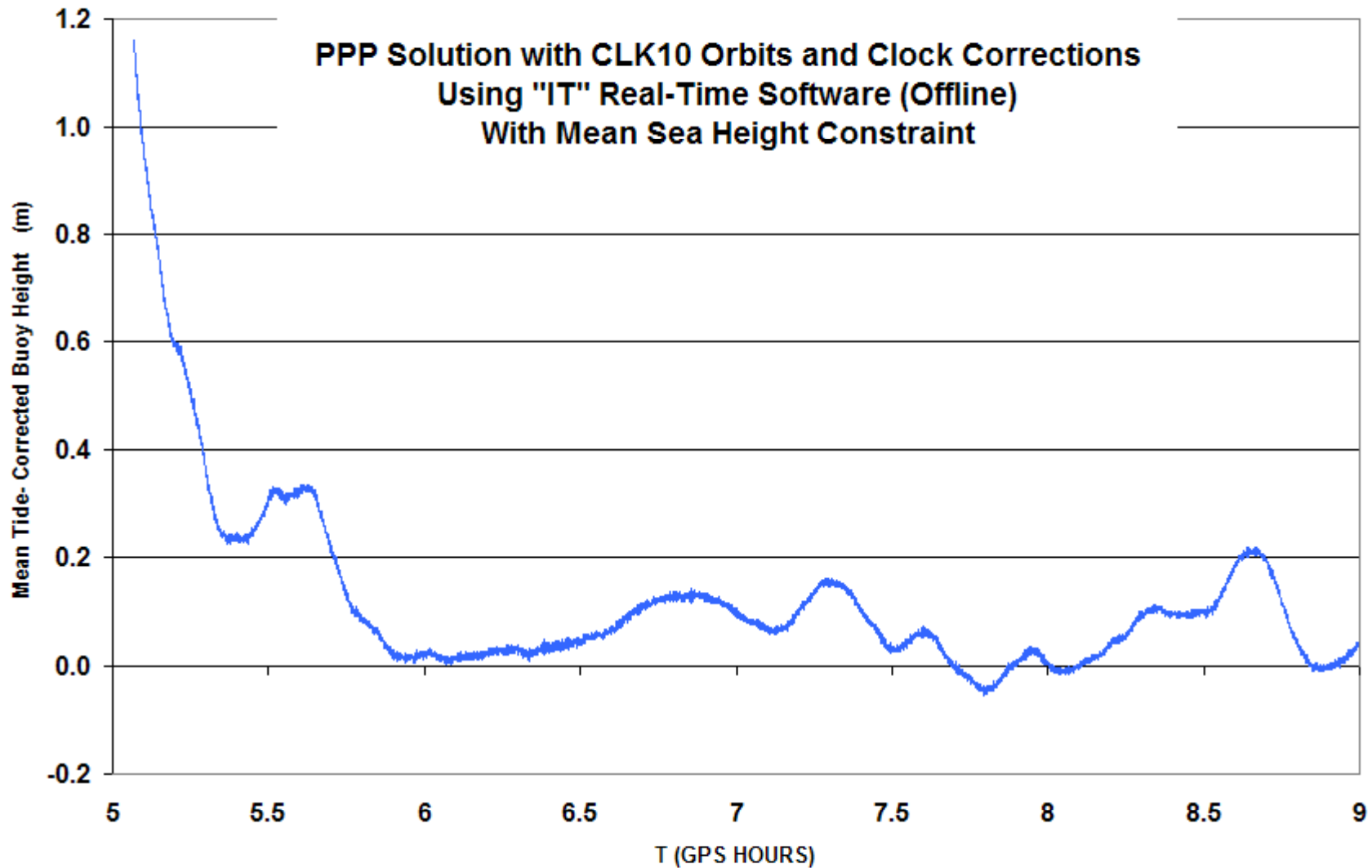


**Tide-Corrected, Instantaneous and Mean Height of Buoy  
During Arrival in Muroto, Japan  
of Chilean M 8.8 Earthquake-Caused Tsunami, on 28 February 2010  
PPP Solution with CLK10 Orbits and Clock Corrections  
Using "IT" Real-Time Software (Offline)**

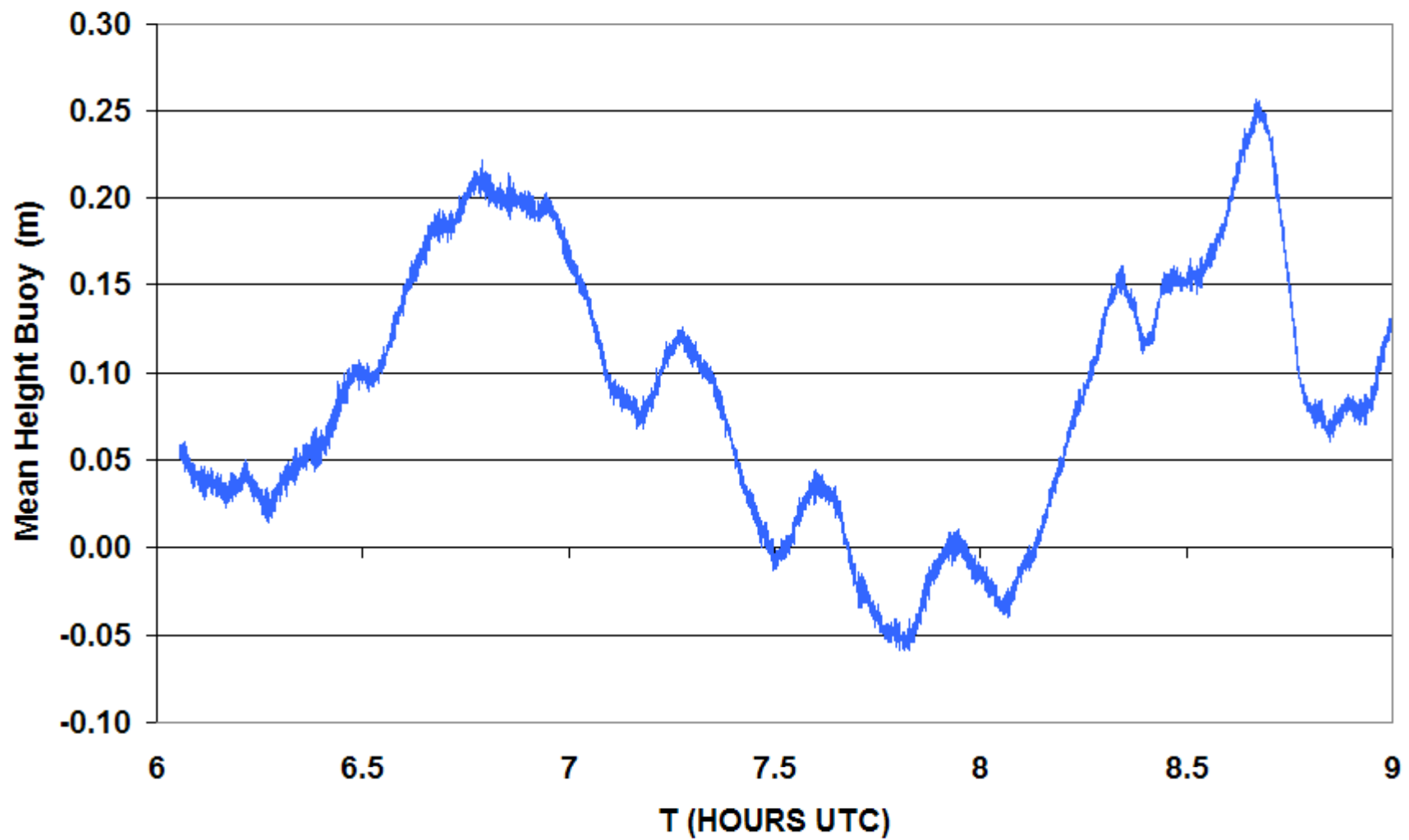
WITH MEAN SEA-HEIGHT CONSTRAINT



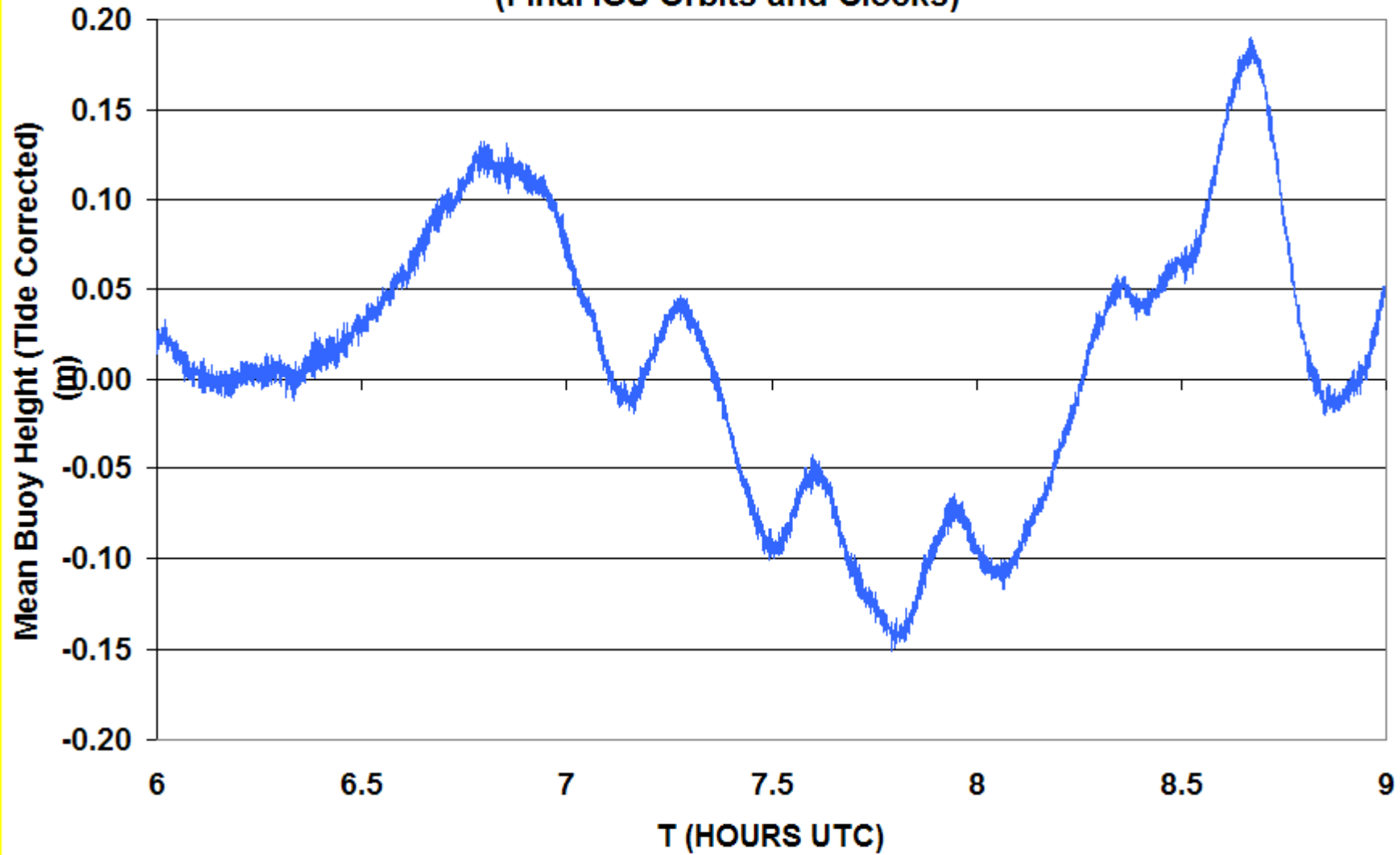
**Mean Height of Buoy During Arrival in Muroto, Japan  
of Chilean M 8.8 Earthquake Tsunami, on 28 February 2010**



**Mean Height Buoy (Base 13km-Buoy, Post-Processed), with Tsunami  
(3-Minute Running Average, Tides Corrected)**

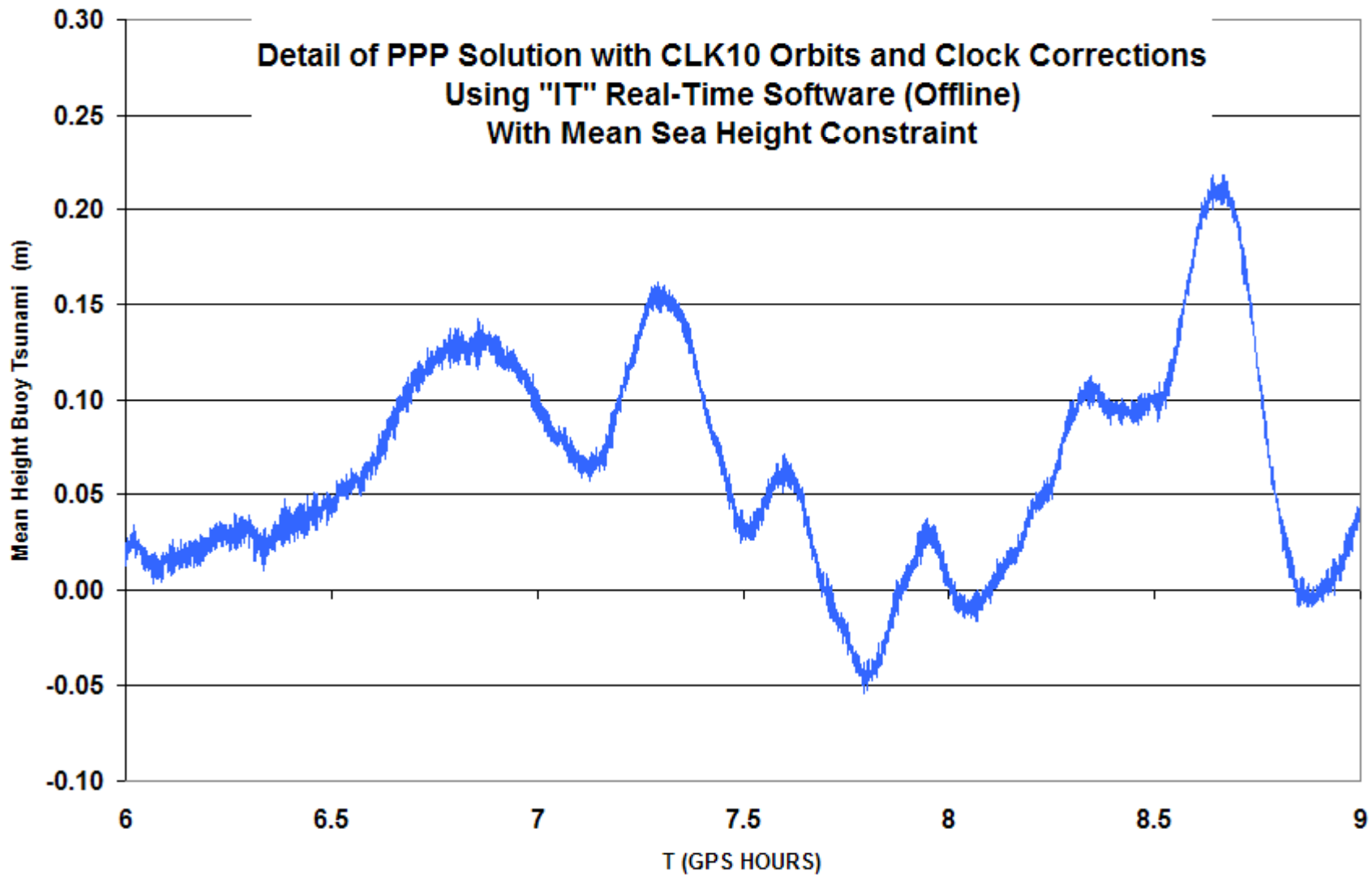


**Mean Buoy Height (Real Time PPP with Mean Sea Height Constraint)  
around the Time of the Tsunami: Converged Part  
(Final IGS Orbits and Clocks)**



**Mean Height of Buoy During Arrival in Muroto, Japan  
of Chilean M 8.8 Earthquake Tsunami, on 28 February 2010**

**Detail of PPP Solution with CLK10 Orbits and Clock Corrections  
Using "IT" Real-Time Software (Offline)  
With Mean Sea Height Constraint**



# Conclusions

- **The February 2010 tsunami is clearly recognizable in the solutions shown here.**
- **Very dangerous > 20 cm tsunami waves should be easily detectable with Real-Time Kinematic PPP in deep waters, far from the coast.**
- **Real Time Pilot Project SSR orbits and clocks seem adequate for tsunami detection.**