

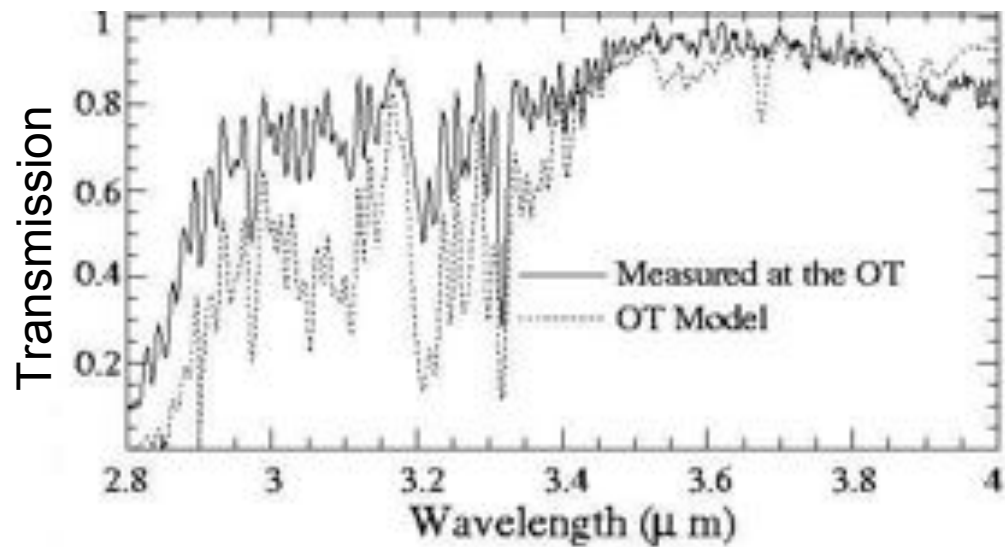
Precipitable water vapor at the Roque de los Muchachos Observatory from GPS measurements

B. García-Lorenzo¹ & I. Romero²

- 1) Instituto de Astrofísica de Canarias
- 2) Soluciones Avanzadas Canarias, SL



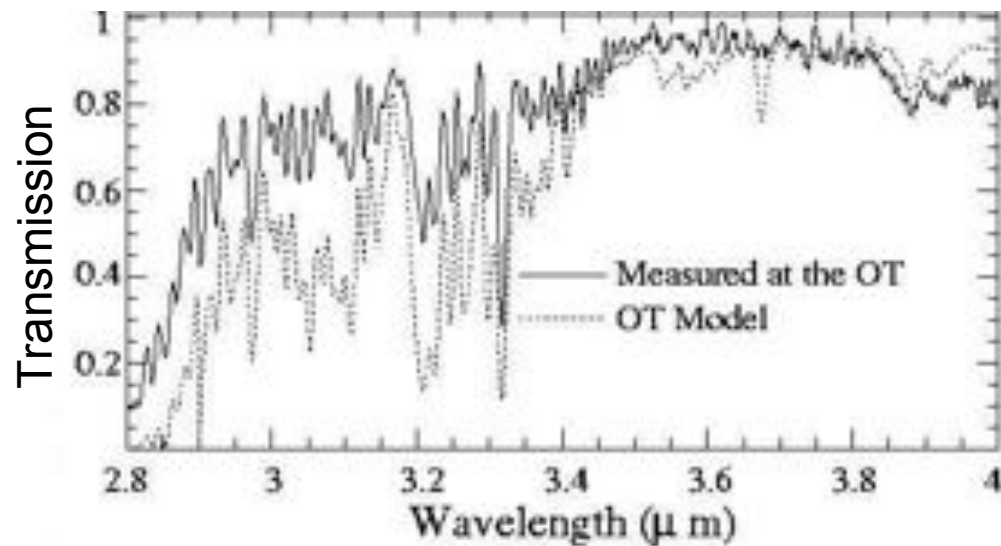
Introduction



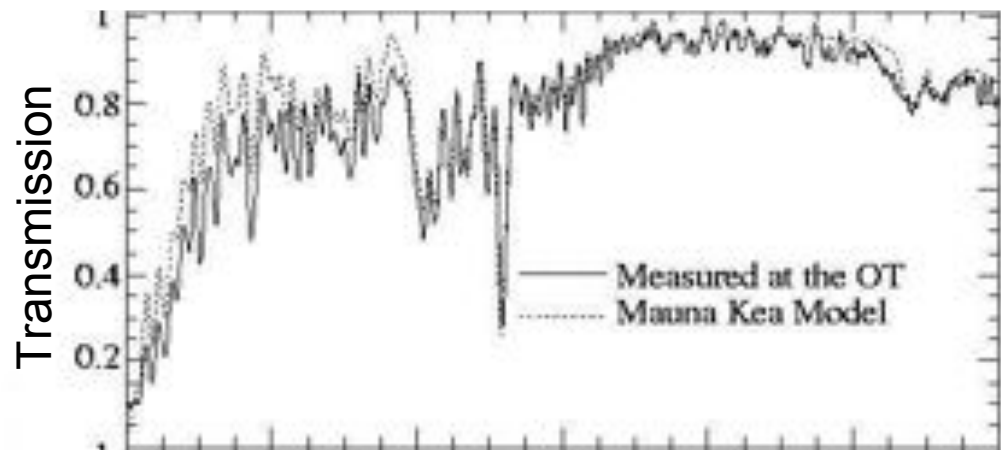
Altitude: 2400 m



Introduction



Altitude: 2400 m

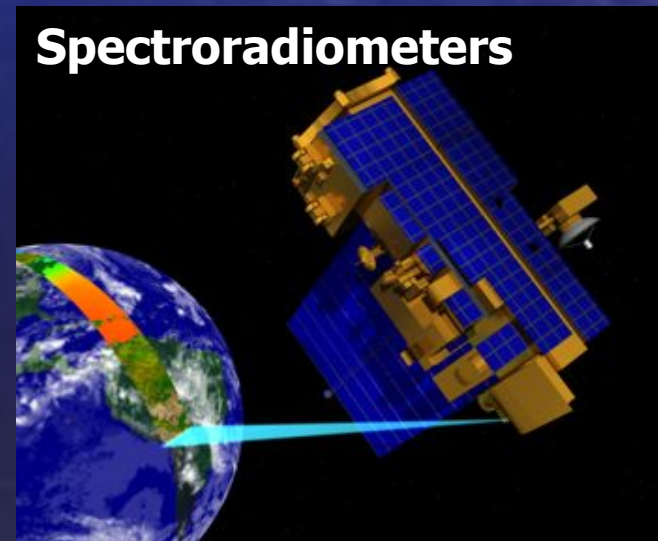
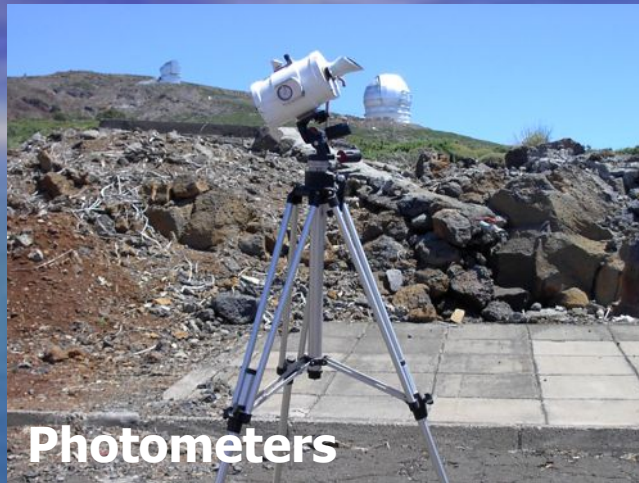


Mauna Kea summit

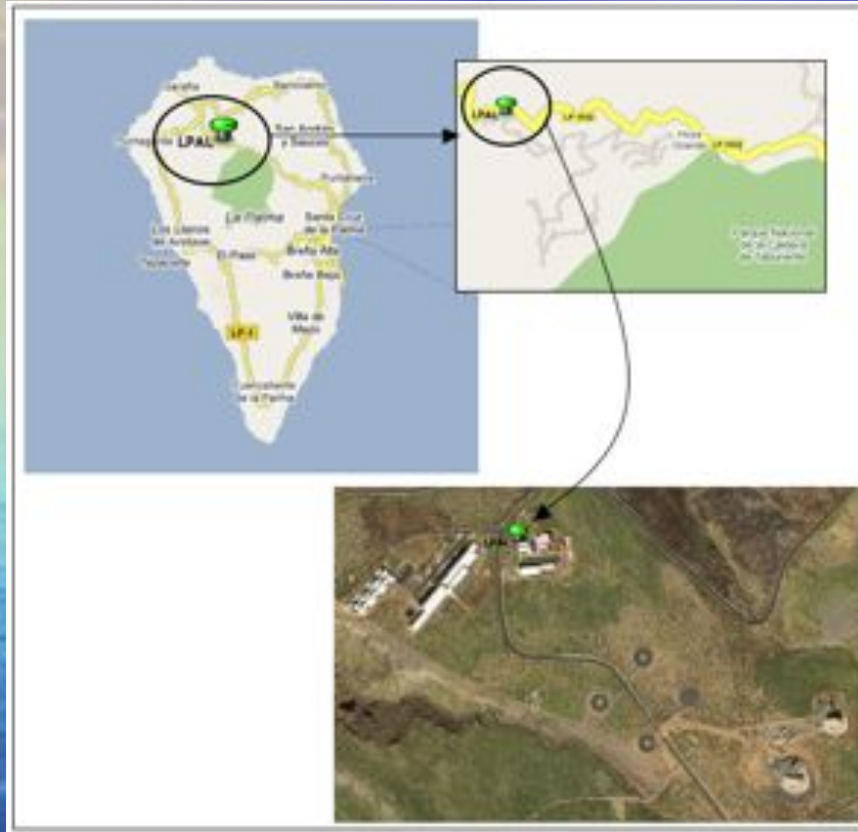


Altitude: 4100 m

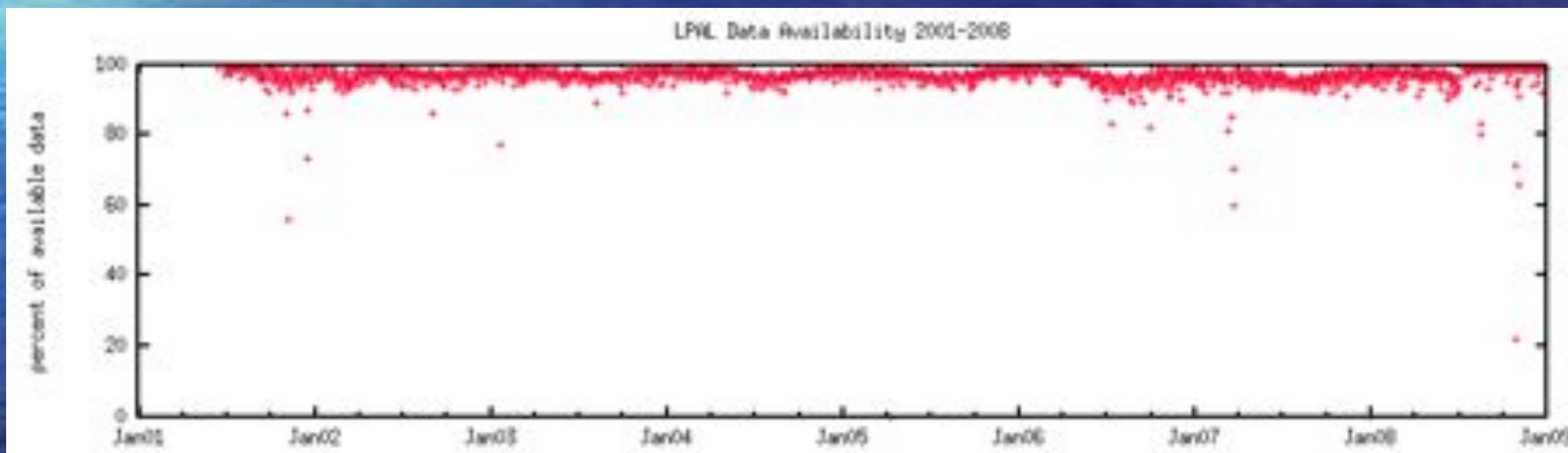
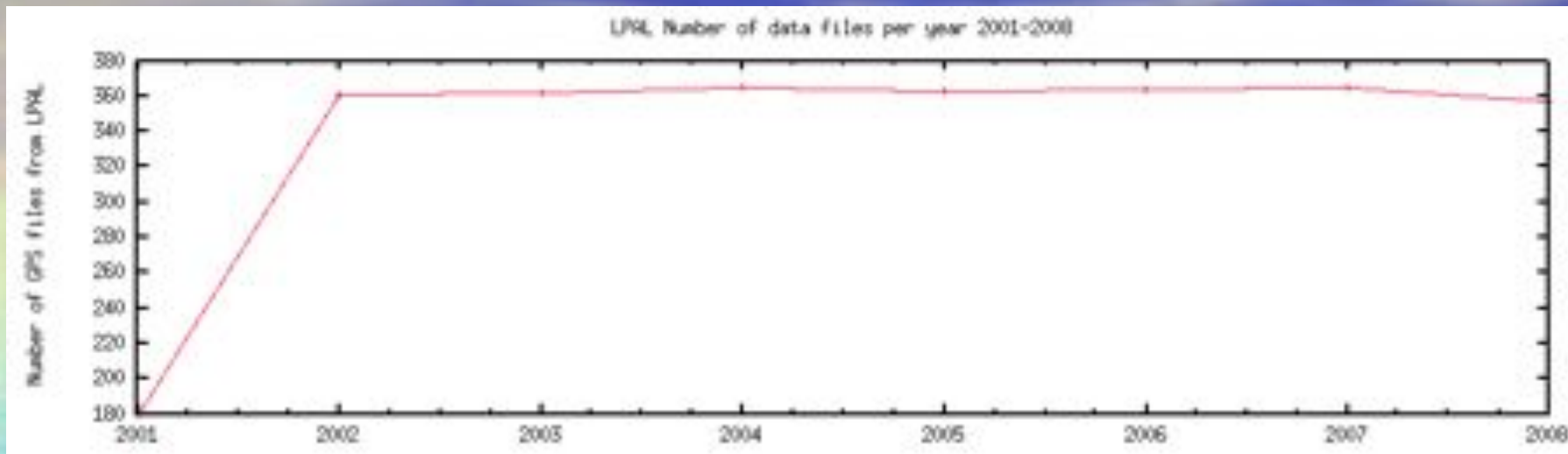
Introduction



GPS station LPAL



GPS station data at LPAL



GPS processing

- Time is distance; $PR_{code} = c(t_r - T_t)$
- Actually times are not synchronized:

$$PR_{code} = c[(t_r + dt_r) - (T_t + dT_t)]$$
- Where: dt_r ; rcvr clock error,
 dT_t ; sat. clock error.
- The PR_{code} is also influenced by atmospheric delay and other errors;

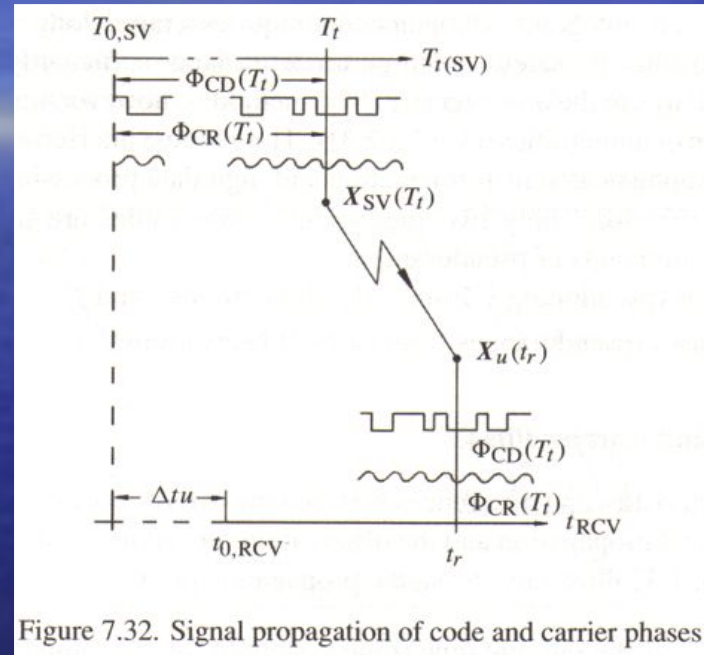


Figure 7.32. Signal propagation of code and carrier phases

(Seeber, 2003)

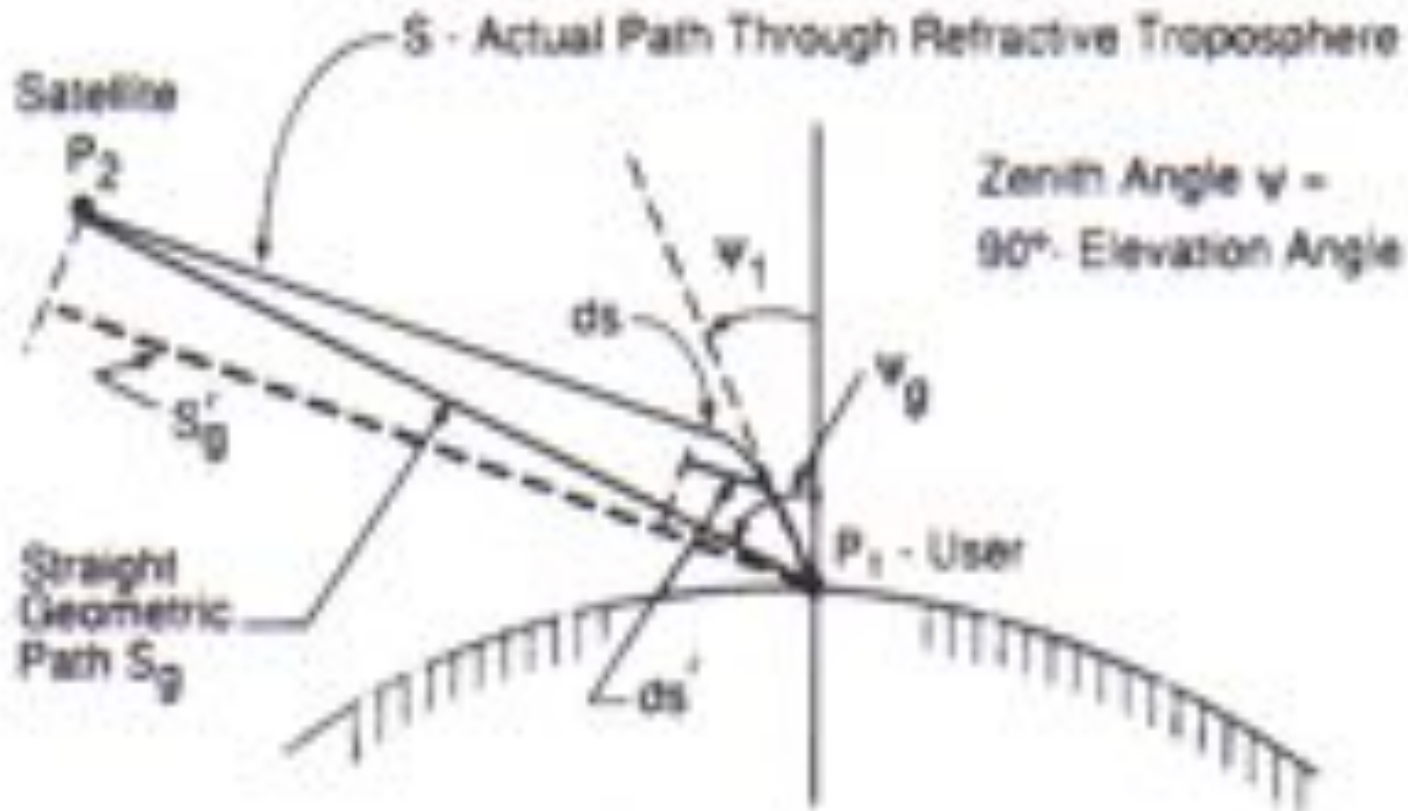
$$PR_{code} = c(t_r - T_t) = R - c \cdot dt_r + c \cdot dT_t + c \cdot dt_{atm} + \epsilon_R$$

- Where: dt_{atm} ; atmospheric propagation delay
 ϵ_R ; observation noise

$$R ; \text{ slant range} = \left| \mathbf{r}_s(T_t) - \mathbf{r}_p(t_r) \right| ; T_t = t_r - \frac{R}{c}$$

GPS processing

TROPOSPHERIC EFFECTS ON GPS



TZD estimation

- The Tropospheric delay is generalized as one estimated parameter (TZD) averaged over 2 hours.
- Elevation dependent mapping function relates all measurements in the estimation 'bin' to the TZD
- All TZD values are initialized to 2.1 m, the parameter is estimated as a step function

PWV estimation

- The TZD values are composed of a Wet component ZWD (water vapor), and a dry component ZHD (inert gases).

$$ZHD = 0.0022768 \frac{Pres(hPa)}{(1 - 0.00266 \cos(2\varphi) - 0.28 \cdot 10^{-6} \cdot H(m))}$$

$$PWV_{gps} = ZWD_{gps} \prod(T_m) \left\{ \begin{array}{l} \prod = \frac{10^6}{\rho R_v [(k_3/T_m) + k_2]} \\ T_m = 70.2 + 0.72T_s \end{array} \right.$$

Precipitable water vapor statistics

