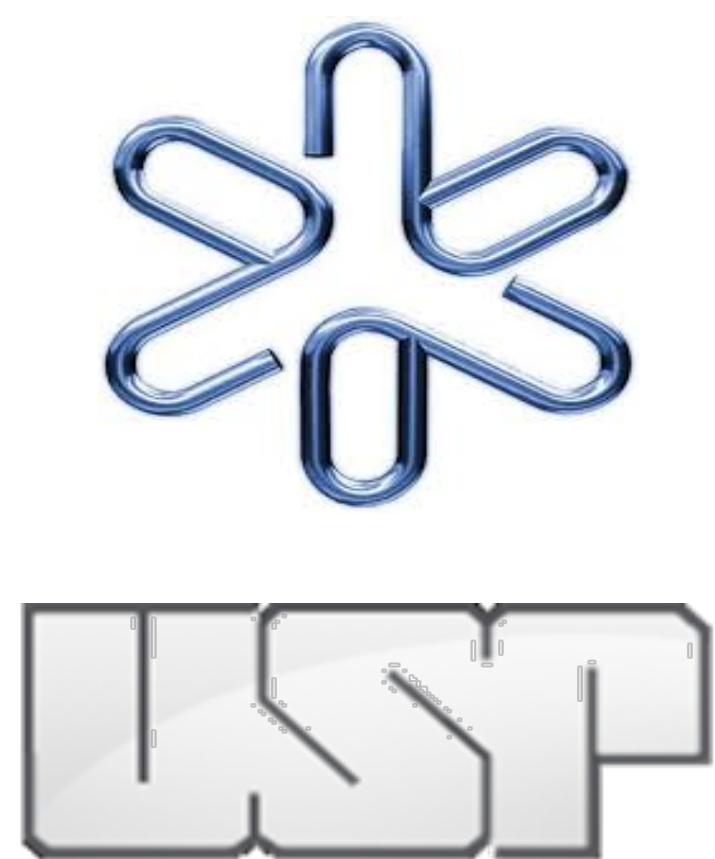




CALIBRATION STABILITY OF A RAMAN LIDAR FOR WATER VAPOR MEASUREMENTS IN THE AMAZON



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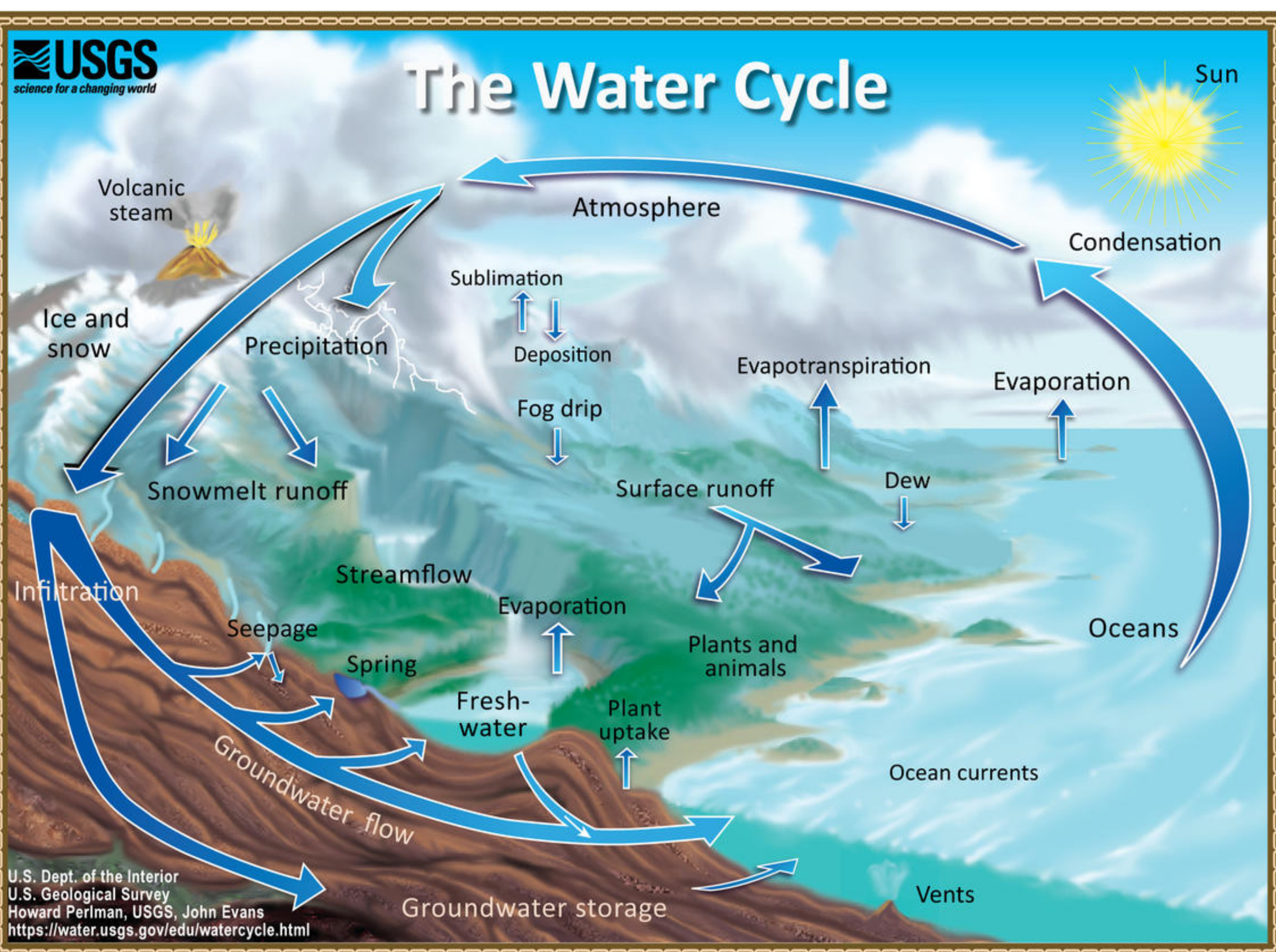
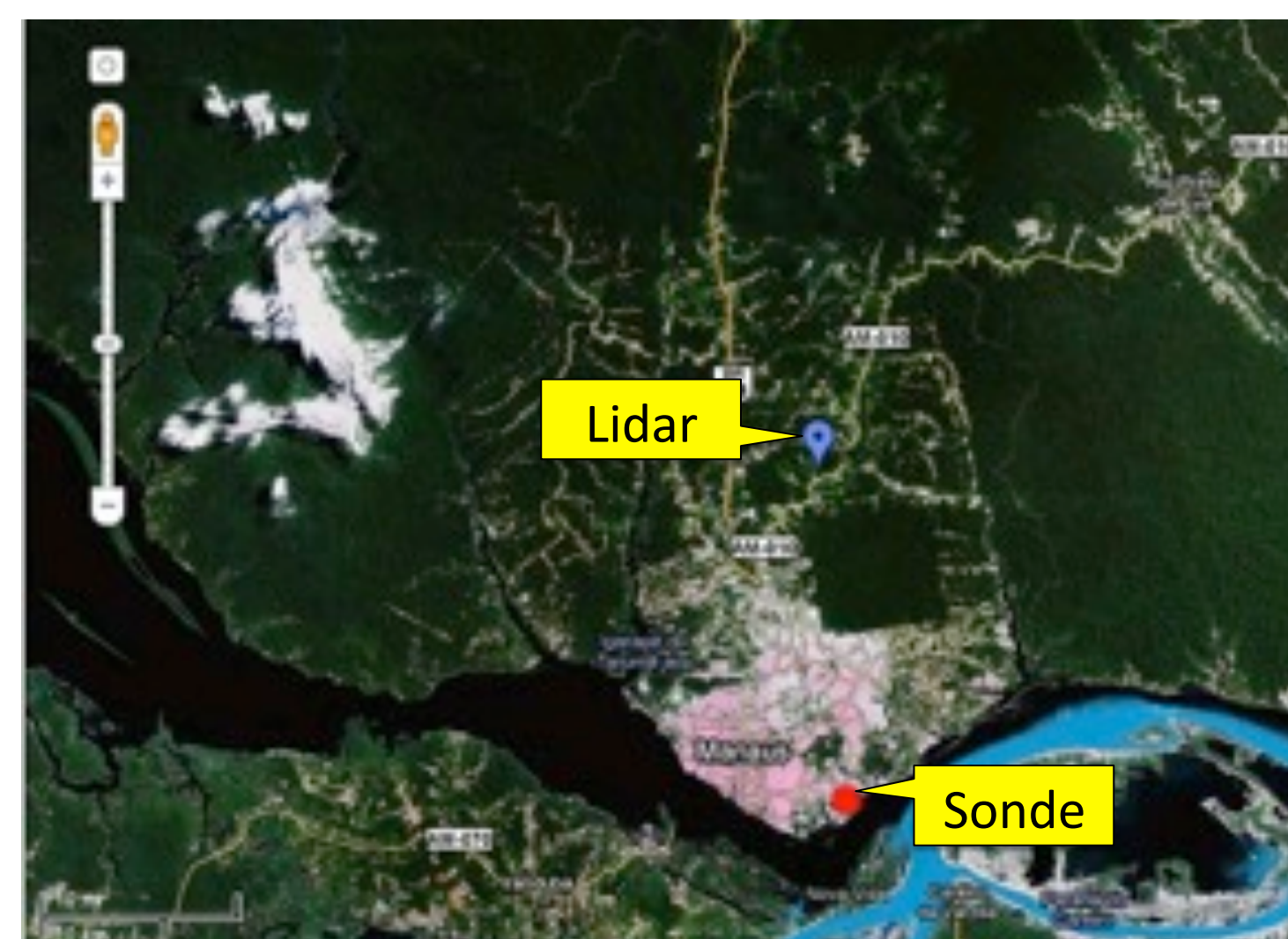
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Overview:

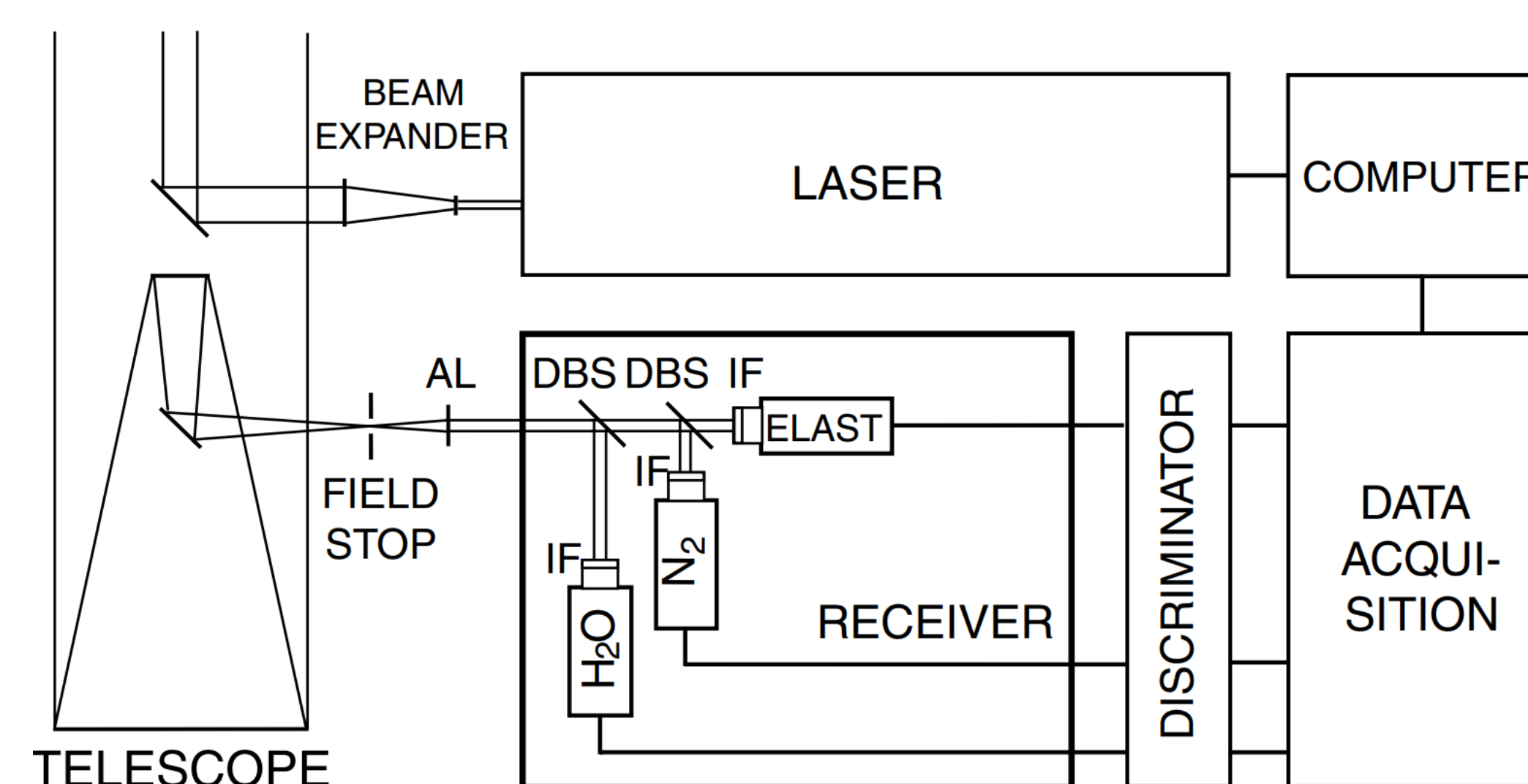
There are several phenomena that depends of water vapor measurements and analysis, mainly in the tropics. That's why in these past year groups of atmospheric studies have installed sites in the Amazon e.g. the ACONVEX (Aerosols, Clouds, Convection Experiment).

This project consists in a study of the Raman lidar equations and technic aiming to write an algorithm to calibrate the water vapor channel using poll data from the military airport of Manaus.

The main objective from the project is to analyze at list 2 months of data per year between 2011 and 2018 and to analyse the stability of these calibrations along these years during the dry and wet seasons.



Raman Lidar setup.



Raman Lidar Equation & H₂O Calibration

The equation for a raman lidar signal is:

$$P(z, \lambda, \lambda') = \underbrace{P_0(\lambda) \frac{c \Delta T}{2} A_{tel} \eta_{eff}(\lambda, \lambda')}_{\text{system/geo.}} \underbrace{\frac{O(z)}{z^2} \beta(z, \lambda, \lambda')}_{\text{back scatter}} \underbrace{\exp\left(-\int_0^z [\alpha(z', \lambda) + \alpha(z', \lambda')] dz'\right)}_{\text{transmission}}$$

The ratio of the H₂O (408nm) and N₂ (387nm) channels, hence, is proportional to the vapor mixing ratio:

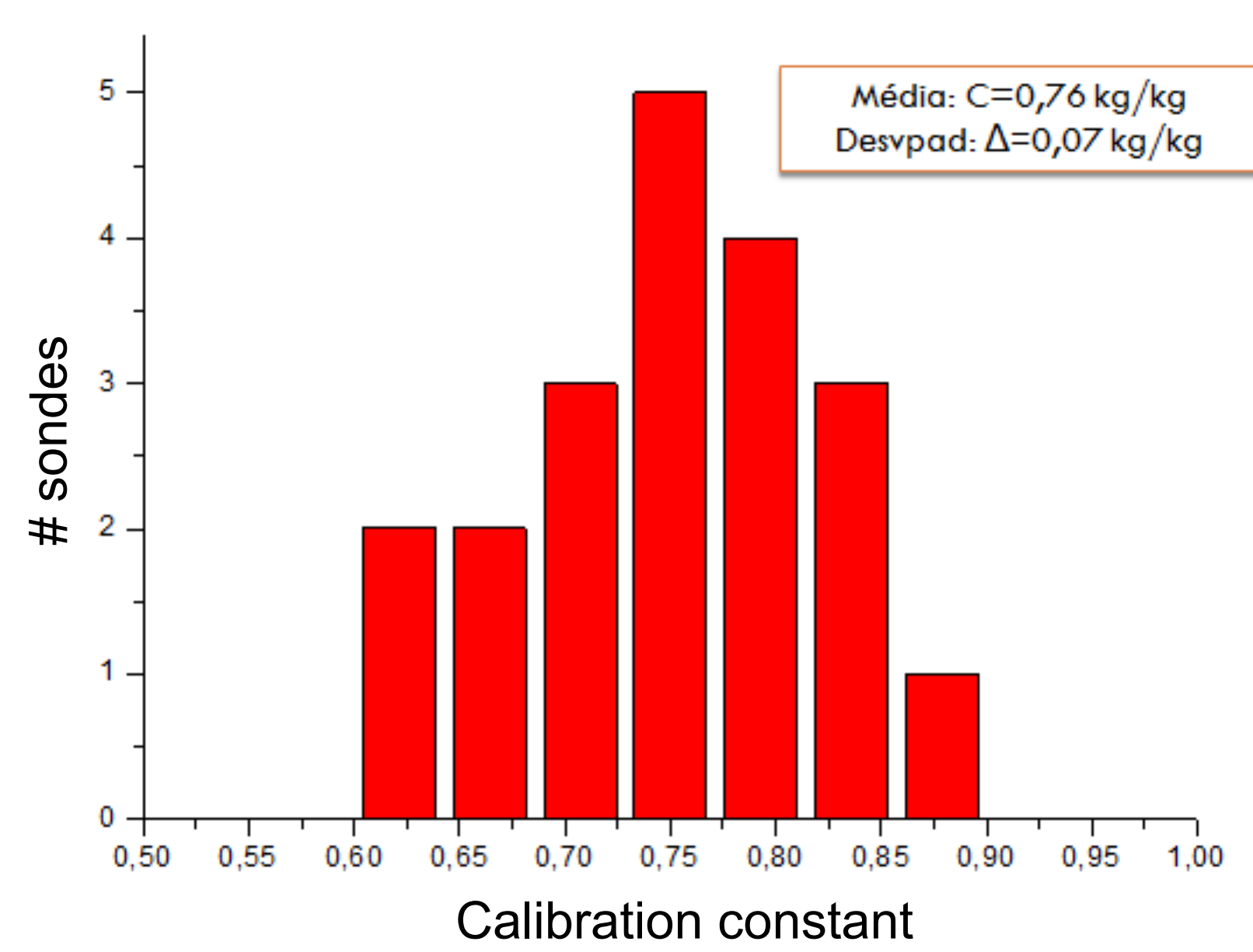
$$\frac{S_{H2O} - BG_{H2O}}{S_{N2} - BG_{N2}} = C''' \frac{\sigma_{H2O}}{\sigma_{N2}} \frac{\omega_{H2O}}{\omega_{N2}} \frac{T_{H2O}^{aer}}{T_{N2}^{aer}} \frac{T_{H2O}^{mol}}{T_{N2}^{mol}}$$

According to Bosser et al. (2010), ignoring the difference in the transmission terms allows as to simplify this equation to:

$$\omega_{H2O} = C Sinal \quad Sinal = \frac{\bar{S}_{H2O} - \bar{BG}_{H2O}}{\bar{S}_{N2} - \bar{BG}_{N2}}$$

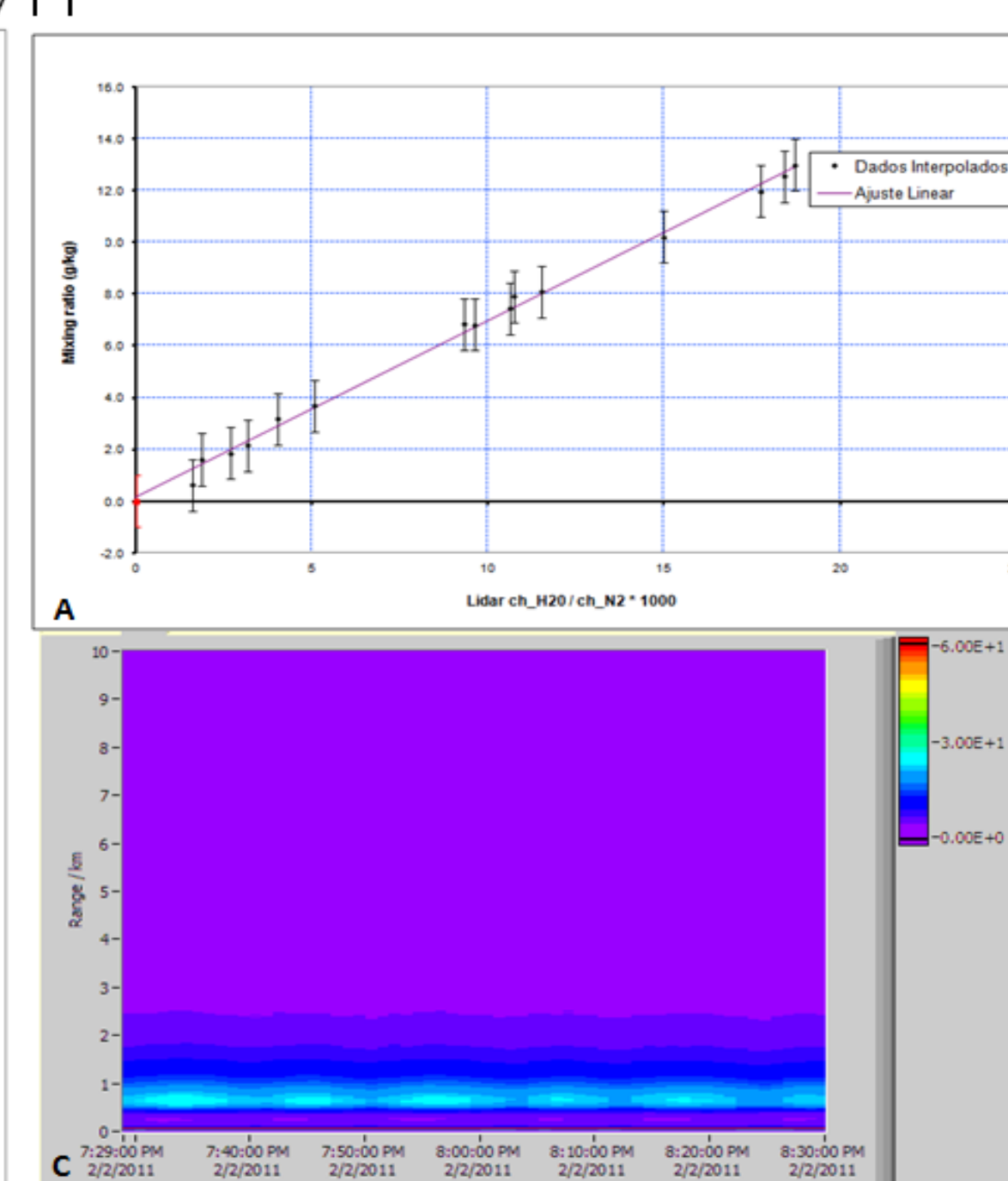
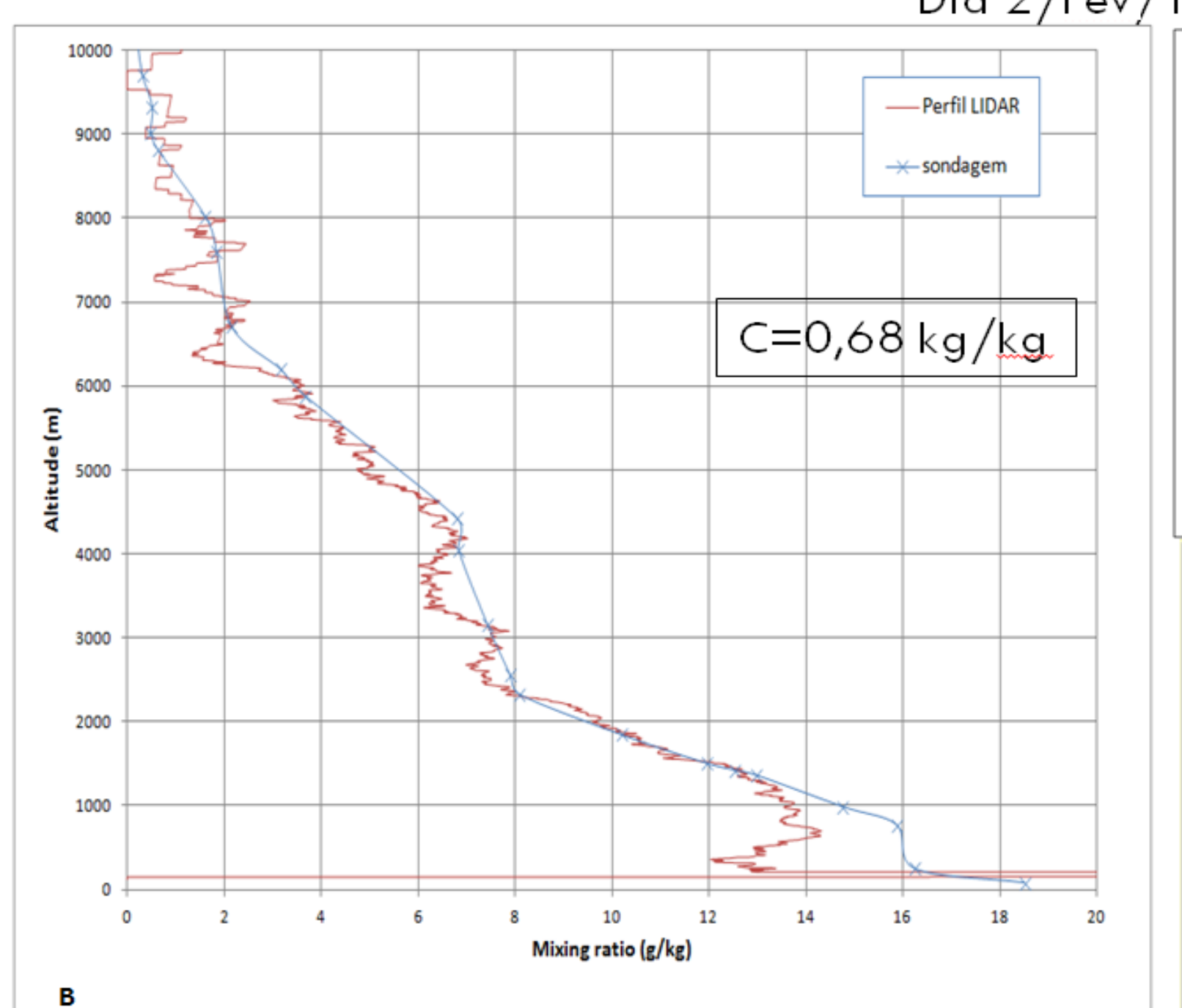
Where the calibration constant is obtained by comparing the *Signal* with a reference measurement of ω_{H2O} , such as from a radiosonde.

Because this simple calibration constant hides information about the aerosols differential absorption, it might have a seasonal dependence. Moreover, as the system ages, changes in the detection efficiency can also make the calibration vary.



Previous Results

Barbosa et al. (2012) analyzed the calibration constant obtained from radiosondes at the airport, from measurements during three weeks in February 2011. The figure on the left shows a histogram of the values found. The figure below shows an example of the calibration procedure.



(A) Linear fit between the lidar signal and the H₂O mixing ratio from the operational sounding at the Military airport in Manaus (Ponta Pelada, ~ 30km), for 2-fev-2011; (B) Vertical profile of water vapor from the sounding and the calibrated lidar; and (C) Time series of the elastic channel for that night.

References:

1. Barbosa et al., 2012: Intercomparison of water vapor calibration constants derived from in-situ and distant soundings for a raman-lidar operating in the amazon forest, In: 26th International Radar Laser Conference, June 2012, Porto Heli, Greece
2. Bosser, P. et al., 2010: A case study of using raman lidar measurements in high-accuracy gps applications. J. Geod., 84, 251–265
3. Raman Lidar, Range-Resolved Optical Remote Sensing of the Atmosphere, Claus Weitkamp, Editora Springer (2005).

Acknowledgments:

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