Vapor de agua en La Palma y Mauna Kea

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1. WATER VAPOR DATA

The data analized here have been obtained from *The NASA Water Vapor Project (NVAP)* web page. The total column (integrated) water vapor data sets comprise a combination of radiosonde observations, Television and Infrared Operational Satellite (TIROS) Operational Vertical Sounders (TOVS), and Special Sensor Microwave/Imager (SSM/I) data sets. These data sets contain total and layered global water vapor data. The global layered water vapor data set is created by slicing the total water vapor data set using layered information that TOVS and radiosondes data provides. The following list shows the main characteristics of the used data.

- Spatial resolution: Global 1/2 degree grid
- Temporal resolution: Twice daily and daily
- Temporal coverage: **only 2000-2001**
- Data provided: Total column water vapor
- Data provided: Cloid liquid water
- Data provided: 5 layers of water vapor
- Data provided: 5 layers of specific humidity
- Inputs from: SSM/I, ATOVS, AMSU & SSM/T-2, TMI, TOVS pathfinder

We analize here only the data corresponding to 2000. Tables 1 and 2 present the monthly average data corresponding to 5 layers of water vapor and the total column water vapor at grid positions close to Mauna Kea and La Palma observatories, respectively.

Table 1. Monthly average water vapor (in mm) at the indicated layers for a position close to Mauna Kea observatory.

Pressure (mbar)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
200-300	0.05	0.06	0.06	0.07	0.07	0.09	0.10	0.09	0.10	0.10	0.07	0.07
300-500	0.66	0.63	0.51	0.49	1.11	0.79	1.50	0.95	1.16	1.08	0.80	0.53
500-700	2.69	2.88	2.63	2.25	4.27	3.39	5.34	5.11	5.08	3.83	3.74	2.34
700-850	6.78	6.95	7.18	6.33	9.42	9.59	10.83	10.33	10.34	10.28	8.50	7.16
850-1000	16.90	15.73	16.83	16.40	17.59	20.20	21.21	21.19	21.48	21.39	19.96	17.54
Total Column	26.06	24.40	26.15	24.88	29.47	32.32	37.78	35.43	37.24	35.38	32.90	27.46

Table 2. Monthly average water vapor (in mm) at the indicated layers for a position close to La Palma observatory.

Pressure (mbar)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
200-300	0.04	0.05	0.06	0.05	0.06	0.06	0.04	0.07	0.06	0.07	0.06	0.08
300-500	0.32	0.38	0.39	0.33	0.35	0.68	0.64	1.09	0.74	0.47	0.43	0.64
500-700	1.86	1.77	1.75	1.62	2.15	2.35	2.84	4.50	3.34	2.33	2.01	1.98
700-850	4.19	3.59	3.80	4.34	5.65	5.85	6.55	8.12	7.66	6.89	5.97	4.96
850-1000	11.67	10.15	10.94	12.04	13.47	14.38	15.45	15.47	16.56	15.39	14.96	12.96
Total Column	18.11	15.87	16.91	18.35	21.67	23.09	25.48	29.24	28.36	24.68	23.23	20.61

Figure 1 shows the comparison of the monthly average water vapor contain at Mauna Kea and La Palma observatories.

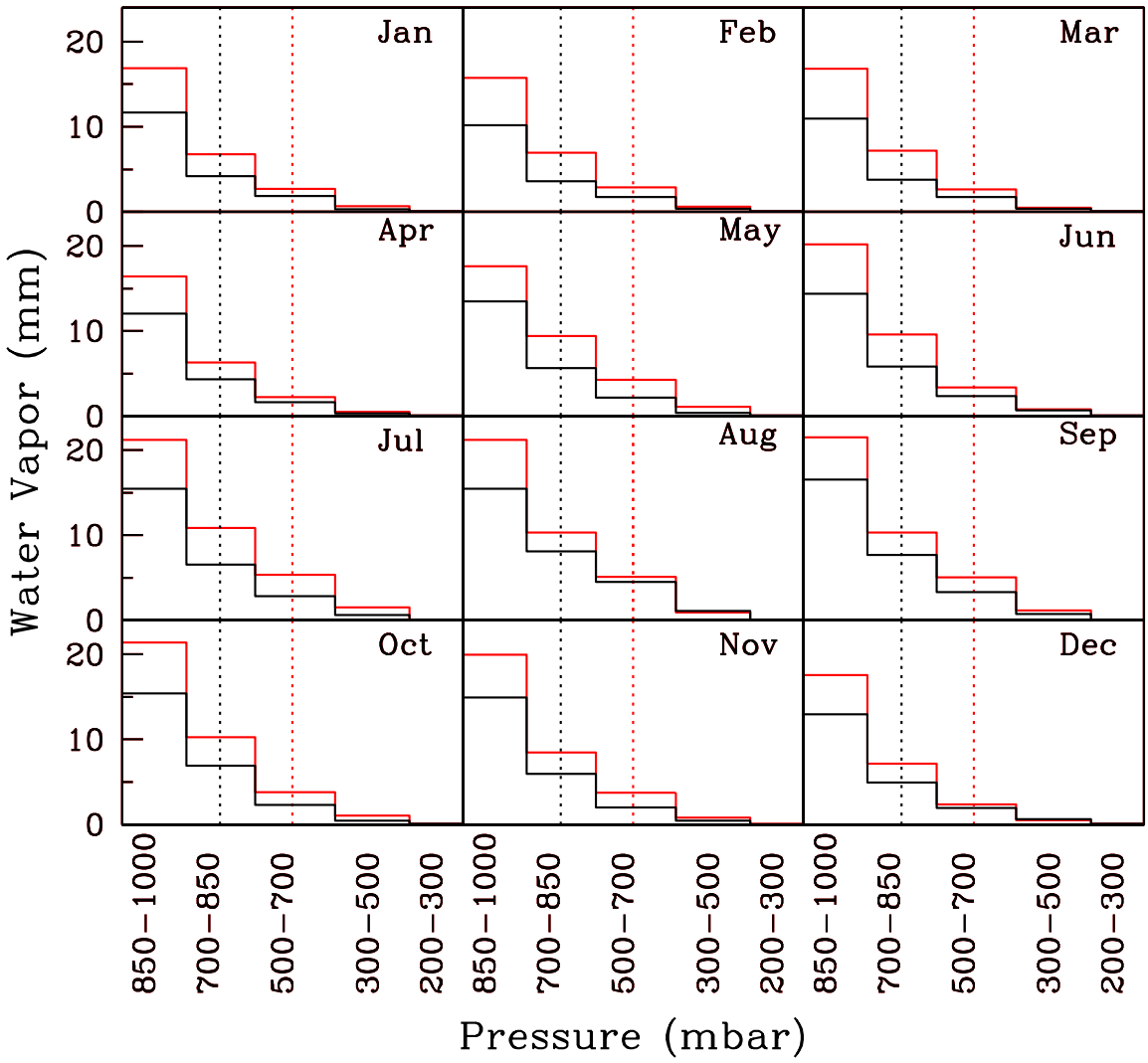

Figure 1. Comparison of the layered water vapor contain at Mauna Kea (red) and La Palma (black). Dotted vertical lines correspond to observatories altitudes (mean pressure level at the observatories).

2. WATER VAPOR ANALYSIS

Based on water vapor data in the previous section, we have calculated the water vapor function, WV(P). We have assumed a linear variation of the WV(P) function with the pressure (P), taking the condition that the integral of WV(P) in the five pressure layers in tables 1 and 2 must be equal to the values in these tables. Based on this idea, we have derived the linear fit AX+B=Y such as for X=P_N, the corresponding Y_N should be the same for the following pressure layer at that pressure. We have assume that WV(P)=0 that the pressure level corresponding to the tropopause layer. In this way:

$$A * X + B]_{P_N} = Y_N \qquad \& \qquad \int_{P_1}^{P_2} (A * X + B) dX = WV_{P1-P2} \tag{1}$$

Playing with these equations, we can obtain the factors A and B of the linear aproximation:

$$B = Y_N - A * P_N \qquad \& \qquad A = \frac{2 * [(\frac{WV_{P1-P2}}{P_2 - P_1}) - Y_N]}{P_2 + P_1 - 2 * P_N} \tag{2}$$

Therefore, the water vapor function across the atmosphere is given by the linear fitting provide by factors in equation 2. Figure 2 shows the derived water vapor function.

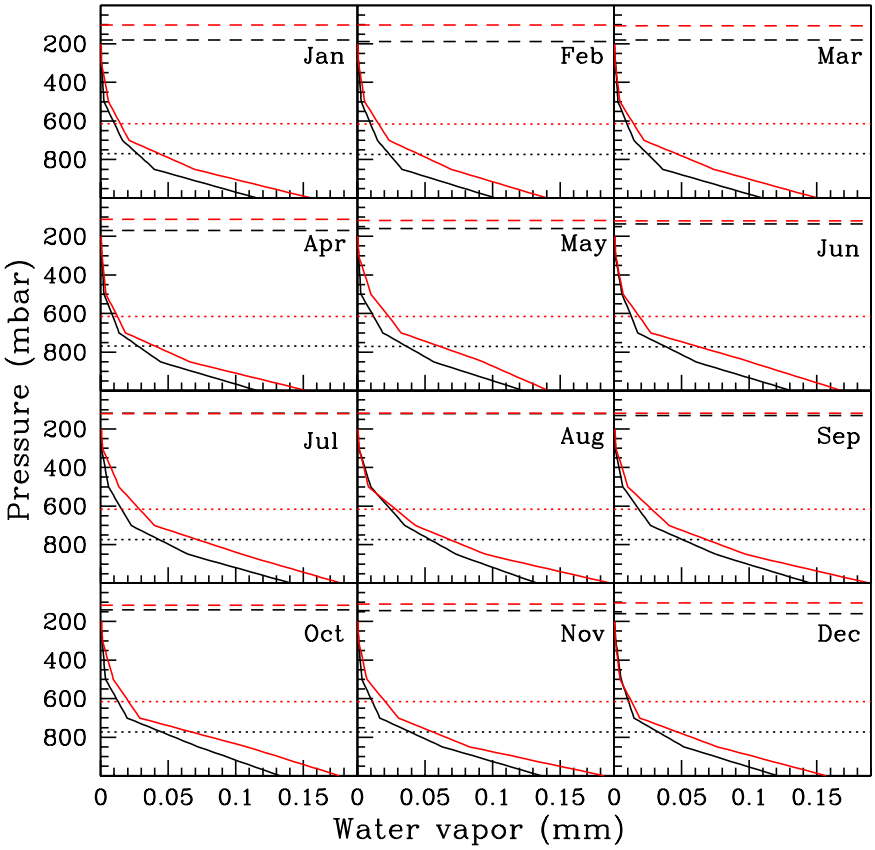

Figure 2. Water vapor function at Mauna Kea (red) and La Palma (black). Dotted horizontal lines correspond to observatories altitudes (mean pressure level at the observatories). Dashed lines corresponds to the monthly average pressure at the tropopause level.

In order to validate the calculation of the water vapor function, we have obtained the total water vapor column integrating the water vapor function from ∼sea level (1000 mbar) to tropopause level at each observatory. Figure 3 presents the comparison of total water vapor column obtained integrating the water vapor function and the data provided in NVAP database. The total water vapor column at Mauna Kea is slightly overstimated to due to topography considerations in the NVAP data. The results show in figure 3 validate the procedure developped.

Integrating the water vapor function from the observatory level to the tropopause level we should obtained the total water vapor contain over the observatories. Figure 4 shows the monthly average water vapor column at

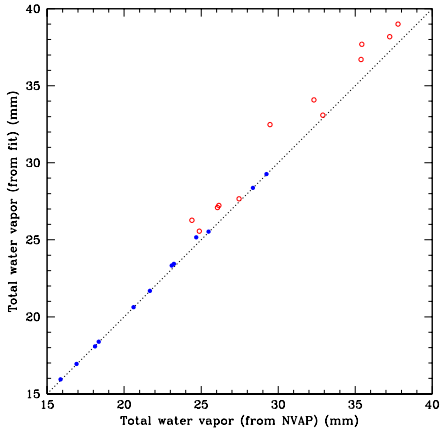

Figure 3. Comparison of direct and integrated water vapor column data. Fill blue circles correspond to La Palma and red open circles to Mauna Kea.

Mauna Kea and La Palma during 2000. **This figure indicates that the worst water vapor conditions at Mauna Kea (March-September with a mean value of 3.25±0.62 mm) are comparable to the best water vapor conditions at La Palma (January-April with a mean value of 3.57**±0.12).

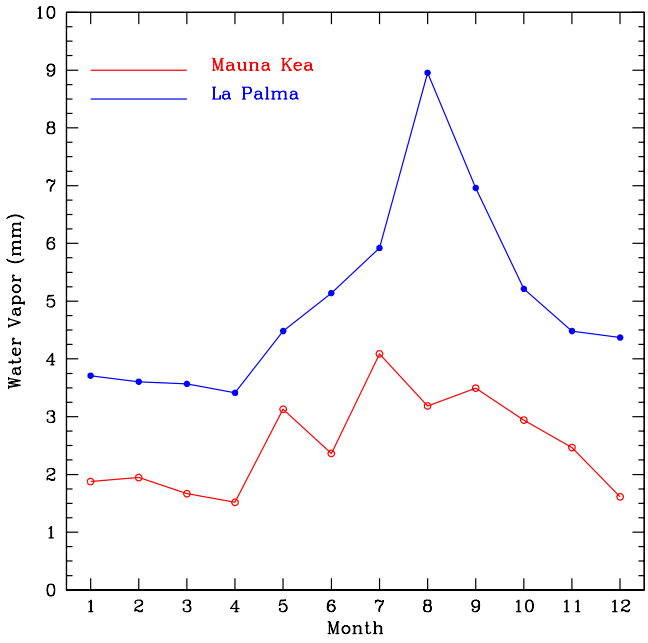

Figure 4. Monthly water vapor column (mm) in Mauna Kea (red) and La PAlma (blue). We have integrated the water vapor function from the observatory level to the tropopause level.