Inter-comparaison of integrated water vapor (IWV) derived from numerical weather prediction AROME by IWV issue from global positioning system over Morocco

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Abstract

This work aimed to make an inter-comparaisom between the intergrated water vapor resulting from the Modeled AROME (IWV-AROME) and the integrated water vapor deduced from the 9 permanent GPS (IWV-GPS) installed validated and monitored locally in NWP service (1) . This inter-comparison was made through a statistical study between the 3 hours forecasts of IWV calculated from the AROME model and the IWV from GPS, the result shows a good agreement between (IWV-AROME) and (IWV-GPS], with a correlation of 0,83 associated with a standard deviation of 4,81 mm and a bias of 0,41 mm

Methodology

Estimation IWV-GPS

The zenith Tropospheric delay ZTD is provided from GPS observations by BERNESE processing software, this delay is composed of hydrostatic part (ZHD) and wet part (ZWD)

ZTD=ZWD+ZHD

ZHD = $\frac{0.002277 Ps}{f(\lambda, H)}$ (2)

ZWD is influenced by the distribution water vapor in the atmosphere

IWV-GPS=k ZWD (3)

the k factor depends on the temperature profile and also on the location of the area. (4)

Methodology

calculation of integrator vapor from AROME

AROME :
Coupling model : ALADIN
Coupling frequency : 1h
Time step : 60s
Forecast range : 48h
Horizontal resolution : 2.5km
Number of points : 800x800
Vertical Levels : 90
Cycle : cy41t1

$$IWV - AROME = 1\backslash g_0 \int_{P_{top}}^{P_{ant}} q(P)dP$$

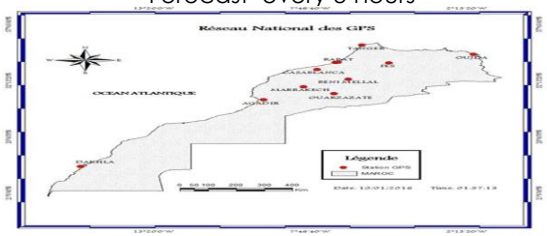
P_ant : pressure at antenna level
P_top : pressure at high level

$$P_{ant} = P_s(1 - 2.26 \times 10^{-5}(H_{ant} - H_s))^{5.225} \quad (5)$$

Where $P_s$is the surface pressure in hPa, $H_{ant}$and Hs are the high of the GPS receiver and the surface

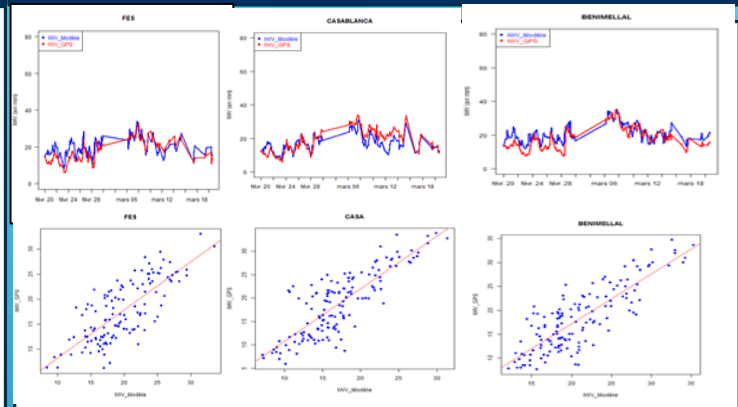
*Bias=(IWV−AROME)- (*IWV-GPS)

Period : February 20 to March 20, 2018
Data: 9 GPS stations
Time resolution:
IWV GPS every 3 hours
Forecast every 3 hours



Fig,1: Permanent GNSS Network in Morocco

Results



Sites	Altitude (m)	Means IWP-GPS(mm)	Means IWV-AROME	RMSE	Biais	Corrélation
Tanger	14	20.73	15.93	6.96	-4.8	0.83
Oujda	465	15.6	17.91	4.23	2.31	0.82
Fès	571	17.58	19.68	4.41	2.09	0.76
Rabat	74	21.02	18.39	5.24	-2.64	0.74
Casablanca	58	18.8	17.13	4.23	-1.67	0.82
Beni Mellal	512	18.11	20.88	4.59	2.75	0.82
Marrakech	464	16.98	19.32	4.07	2.34	0.91
Agadir	75	21.62	17.27	3.54	-2.35	0.91
Dakhla	12	14.72	13.06	2.64	-1.66	0.88
All sites		18.35	17.95	4.34	-0.40	0.83

Fig,2 :Tri-hourly time series (above) related to three GPS locations as examples, the related scatter plots (in the middle) of IWV-GPS and IWV-AROME and Statistics of differences between IWV-GPS and IWV-GPS (below) between February 20th and March 20th 2016

For the means of all GPS stations, the value found for IWV-GPS is around 18.35 mm, while it is 17.9 mm for IWV-AROME, which corresponds to a small difference..

Results

However, for each station alone, we note that there is a good correlation between the IWV- GPS and the IWV-AROME in particular in the stations of Agadir, Marrakech and Dakhla. By analyzing the bias of the stations individually, we note that the minimum is recorded for the city Dakhla with a value of -1.66 mm and an RMSE of 2.64 mm.
The bias for all of the sites is small (around -0.4 mm). The negative sign shows that the model generally underestimates atmospheric water vapor. The scatter plot is generally aligned.

Conclusion

The results show that the IWV values derived from AROME had an agreement with the IWV from GPS with a correlation (all stations) of 0.83 associated with a standard deviation of 4,34 mm and a bias of -0,40 mm
Those results are also promising for the potential use of GPS IWV on nowcasting,

References

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