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GPS WATER VAPOUR CONTENT VARIATIONS DURING HEAT WAVE OCCURRED DURING MAY, 2015 OVER SOUTH INDIAN REGION

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ABSTRACT

Water vapour has a great importance in understanding climate change, weather forecasting and also important weather forming elements of the troposphere. A limiting error source in geodetic measurement is unmodelled electrical path delay from atmospheric water vapour. To rebuild a spatially determined humidity fields in the troposphere a GNSS water vapour topography structure is established. GPS has a utility of precise 3-D positioning. With quick growth and widespread use of GPS equipment, developing the perceptible water vapour of troposphere from the information gathered by the GPS which became innovatively noticeable technology. To get precise information and derive perceptible water vapour so as to offer better services, proper operation technique is required. We discussed in this paper about the change in water vapour over the region in South India where heat wave has occurred.

Keywords: water vapour, GPS, perceptible water vapour (PWV), GAMIT.

1. INTRODUCTION

Water vapour is a standout amongst the most critical parameters of the world's air since it has a place with the most vital climate shaping components of the troposphere. In spite of the fact that the water vapour substance is just a little fragment of the environment, however it is the maximum adjustable of the significant ingredients. The circulation of water vapour is closely joined to the circulation of mists and precipitation [1]. Water vapour is a prevailing conservatory gas, as well as the vital variable of the short-run climate rainfall.

The GPS is a satellite triangulation framework generally received for direct situation and the speed at a location anyplace on the shallow of the World in any climate situation. Atmospheric constraints like noticeable water vapour slope of the water vapour, temperature and pressure shows a vital part in climate prediction. The signals are deferred because of ionosphere and troposphere. These interruptions are thought to be the error caused in situating the GPS, yet on another side, these are considered as pointers for atmospheric checking [2].

Propagation Time Delays can be of two sorts. One is the ionosphere delay and other one is the troposphere delay. Troposphere is a neutral standard, which holds air in the higher portion and water vapour in the minor portion. It has been understood that 90% of the water vapour is accessible in the minor level of the troposphere. The deferment is caused because of air and is labelled as hydrostatic and water vapour is termed as wet deferment.

Hydrostatic deferment is because of arid portion of the atmospheric components and can be assessed exactly utilizing ground temperature and weight estimations [2]. By expelling the hydrostatic deferment from the aggregate tropospheric deferment, the leftover signal delay is known as the wet deferment, for the most part because of water vapour in the troposphere.

1.1 Tropospheric delay

The impact of the troposphere on the GNSS pointers shows up as an additional deferment in the estimation of the pointer travelling from the satellite to receiver. This deferment relies on upon the temperature, pressure, humidity and in addition the transmitter and receiver probes position [3].

1.2 Hydrostatic component delay

It is triggered by the arid vapours existing in the troposphere. Its impact contrasts with confined temperature and atmospheric pressure in truly an anticipated way, other than its deviation is less than the 1% in a few hours. The inaccuracy created by this part is around 2.5 meters in the zenith path and 10 meters for minor advancements[3].

1.3 Wet component delay

It is brought on by the water vapour and dense water in type of mists and, thus, it relies on upon climate settings. The overabundance deferment is minor for this situation, just a few several centimetre. However this element show a discrepancy quicker than the hydrostatic module and an arbitrarily mode, being exceptionally hard to demonstrate[3].

1.4 GAMIT

GAMIT is a group of courses to practise phase information of GPS receiver. To evaluate 3-D qualified location of ground stations and satellite orbits, atmospheric zenith delays and globe alignment parameters [4].

2. WATER VAPOUR ESTIMATION

Zenith Wet Delay (ZW_{Delay}) is gained by deducting the Zenith Hydrostatic Delay (ZH_{Delay}) from Zenith Total Delay (ZT_{Delay}) acquired from GPS information,

$$ZW_{Delay} = ZT_{Delay} - ZH_{Delay} \quad (1)$$

The Zenith Hydrostatic Delay (ZH_{Delay}) is

$$ZH_{Delay} = \frac{2,2279 \pm 0.0024)T}{1 - 0.00266\cos(2\lambda) - 0.00028A} \quad (2)$$

where, T_s is the total pressure (hPa) at the earth surface, λ is the latitude, and A is the height above the ellipsoid (in km)

The ZW_{Delay} is gained by deducting the ZH_{Delay} from the ZT_{Delay}. The ZW_{Delay} is subsequently multiplied by a conversion constant C

$$PWV = C * ZW_{Delay} \quad (3)$$

The constant C is defined as follows

$$C = \frac{106}{\rho G_V \left(\frac{C_3}{W_m} + W_m + C'_2 \right)} \quad (4)$$

where, G_V is the gas constant for the water vapour, ρ is the density of water, C'_2 = 22.1K/hPa, C_3 = 3.739 × 105 K^2/hPa, and W_m is the weighted mean temperature of the atmosphere.
The value of W_m as follows

$$W_m = 70.2^\circ + 0.72T_s \quad (5)$$

2.1 Pressure

The sea level pressure is concerning 1013 hPa in average, a worth that's utilized in most traditional atmosphere models. The pressure decreases exponentially with increasing altitude. The layer height is reached at a pressure between 300hPa at the poles and 70 hPa at the equator and a worth of roughly 1 hPa will be declared at the stratopause height.

2.2 Temperature

The temperature shows a linear decrease up to the layer; however note that this linear trend will be significantly disturbed within the initial few hundred meters higher than the surface because of the inversion layers. The supposed temperature lapse rate is within the vary of -5 to -7 K/km below the layer height. At the layer itself, the temperature remains some constant and slowly will increase within the layer.

3. GAMIT OVERVIEW

GAMIT is a far reaching GPS investigation bundle created at MIT and Scripps for the assessment of 3-D comparative spots of base locations and satellite circles. The product is intended to keep running within any UNIX working framework LINUX based Ubuntu 14.04 LS. The greatest number of locations and periods permitted is dictated by measurements fixed at assembling period and could be customized to the appropriate necessities and capacities of the investigator's mathematical surroundings. The essential yield of GAMIT is an inexactly obliged arrangement document constraint of appraisals and covariance which can be gone to GLOBK for mix of information to gauge location points and speeds and orbital and Globe-pivot constraints. So as to determine issues to have the handling, be that as it may, the new client will need to comprehend both the hypothesis and association of each of the GAMIT modules [5].

Toward the begin of handling, the examiner has accessible preparatory arrangement of station directions, that show ephemeris (RINEXnav document) for the satellites watched, a troupe of segment and quasi-array perceptions, and secondary data is accessible from the journal sheets (meteorological information).

This data ought to be sorted out into sessions, characterized as ranges amid which a gathering of stations tracks at the same time the periods of two or more satellites. So as to suit with constantly working locations, periods are currently normally composed into 24-hr traverses wrapping a solitary UTC day. The information and external data are arranged in the best possible organizations, and every term is investigated independently or joined with different periods to return assessments of improved location directs and orbital constraints[6].

Methodology: Establish batch processing and then alter formats to make device records for the group investigation path. Implement the program path FIXDRV to make group records for the investigation. Implement the group to accomplish handling. MODEL registers the hypothetical estimations of the perceptions and fractional subordinates of these perceptions as for the parameters to be evaluated, and keeps in touch with them to a yield document for altering and approximation.The customary preparing arrangement for uncut information incorporates maybe a couple goes through MODEL, AUTCLN [7].

4. RESULTS AND DISCUSSION

4.1 Heat wave

The heat wave was created in substantial part by sparser pre-storm season showers, which conveyed less water vapour than ordinary to the range, leaving huge parts of India dry. The sudden end of pre-rainstorm downpour gives, an extraordinary pattern in India, has added to the heat waves [8][9]. Additionally, the storm season is later and promote south than the ordinary trend. This climate design, coupled with El Niño impact, which frequently increases temperatures in Asia, consolidated to make the record high temperatures. High humidity intensified the impacts of the temperatures on residents. The Loo, a dry wind beginning from Pakistan and northwest India, has added to expanding the temperature. In India, many deceased due to the heat wave in the southeast states of Andhra Pradesh and Telangana.

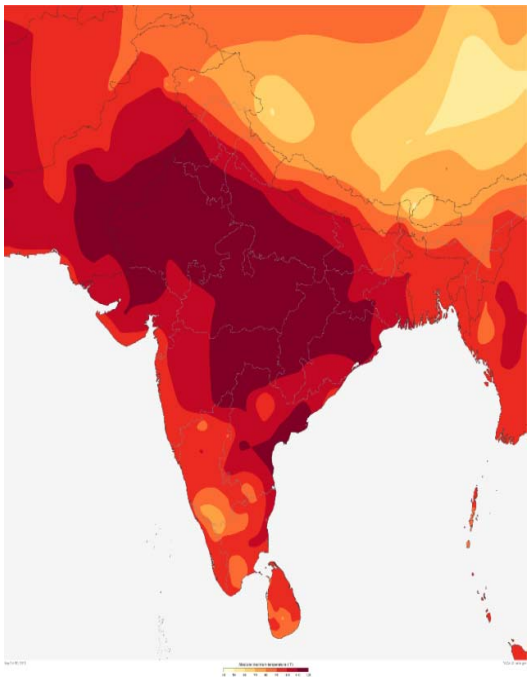

Figure-1. Heat Wave intensity over India.

The intense heat throughout the country is given below in the Figure-1 which has been observed for about 5 successive days with temperatures above (43°C) is the most horrible heat wave incident in several years according to the Indian Meteorological Department. It was further intensified in the states of Andhra Pradesh and Telangana in southeast India which recorded temperatures climbing over 45°C from May 24 to 30 with the average

To observe the water vapour content variation, the skyplots are taken for the days March 8, 2015 and May 26, 2015 at Bangalore International Ground Station (IGS) with code IISC and Hyderabad IGS with code HYDE stations where heat wave is occurred during May 20 to 30, 2015.

The sky plots show the totality of the wet gradients and the residuals for the IISC and HYDE position for a epoch of 4 hours. The black mark shows the mean slope and leaps its concentration (RMS) throughout the equivalent phases. In the given sky plots, anyone can spot the indication of the PWV. Yellow indicates positive delay. Green indicates negative delay.

In Figure-2 less amount of negative delay (green) wet gradient is observed at a particular time than that of Figure-3 at the same time in the HYDE region.In Figure-4 less amount of positive delay (yellow) hydrostatic gradient is observed at a given time than that of Figure-5 at the same time in IISC region.

In conclusion, the facts delivered by the wet gradients are a quasi-direct measure of the water vapour. Hence, the given GPS position is capable of providing the required data of PWV content for troposphere. It can also provide a mathematical estimation of the azimuth deviation of the water vapour circulation.

4.1 Sky plot (HYDE)

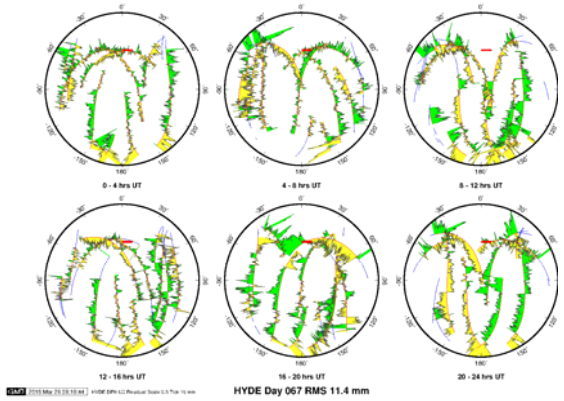

Figure-2. Wet Gradients on March 8, 2015 for HYDE.

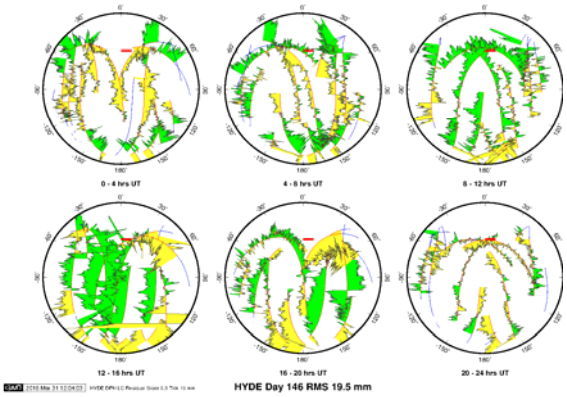

Figure-3. Wet Gradients on May 26, 2015 for HYDE.

4.2 Sky plot (IISC)

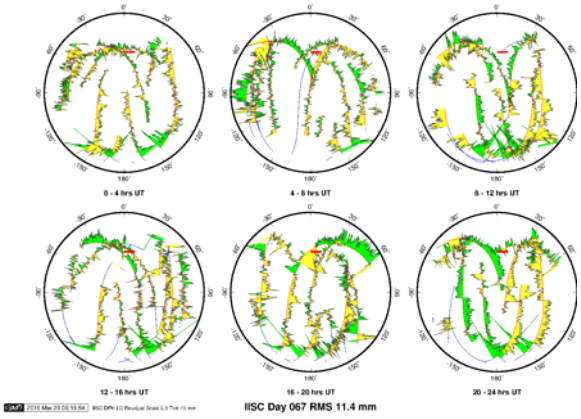

Figure-4. Wet Gradients on March 8, 2015 for IISC.

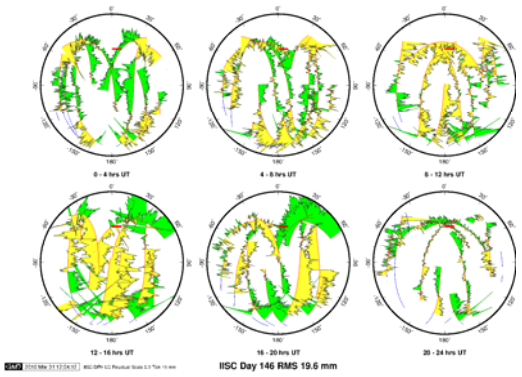

Figure-5. Wet Gradients on May 26, 2015 for IISC.

5. CONCLUSIONS

In this paper, it is understood the fact of the weather variation between two IGS stations. The two IGS stations taken are Hyderabad and Bangalore to check for the water vapour variability based on the GAMIT software. Through this paper it has been analysed that change in water vapour which is due to humidity and also various other factors. It is known that between May 2, 2015 to May 30, 2015 there was a heat wave occurred in South Indian region. Using GAMIT, the amount of change in the water vapour content during those particular days when the heat wave occurred is observed and was compared with the normal day data to check the difference in water vapour.

REFERENCES

[1] M. Bevis, S. Businger, T. A. Herring, C. Rocken, R. A. Anthes, and R. H. Ware, "GPS meteorology: Remote sensing of atmospheric water vapor using the Global Positioning System," Journal of Geophysical Research: Atmospheres, vol. 97, pp. 15787-15801, 1992.

[2] A. Kern, J. Bartholy, É. E. Borbás, Z. Barcza, R. Pongrácz, and C. Ferencz, "Estimation of vertically integrated water vapor in Hungary using MODIS imagery," Advances in Space Research, vol. 41, pp. 1933-1945, 2008.

[3] J. Saastamoinen, "Atmospheric correction for the troposphere and stratosphere in radio ranging satellites," The use of artificial satellites for geodesy, pp. 247-251, 1972.

[4] King R.W. and Bock Y. 2005. Documentation for the GAMIT software analysis, release 10.34 unpublished.

[5] W. Hao, L. Guoping, and C. Jiaona, "Using GAMIT 10.34 to solve GPS precipitation water vapor in Chengdu area," Journal of Chengdu University of Information Technology, vol. 24, pp. 478-483, 2009.

[6] J. Askne and H. Nordius, "Estimation of tropospheric delay for microwaves from surface weather data," Radio Science, vol. 22, pp. 379-386, 1987.

[7] Li, Guoping, and Hao Wang. "Using GAMIT to Derive the Precipitabel Water Vapor." Multimedia Technology (ICMT), 2010 International Conference on. IEEE, 2010.

[8] Harmeet Shah Singh; RishabhPratap; Ravi Agrawal. 26 May 2015. Heat wave kills more than 1,100 in India. CNN. Retrieved.

[9] 2015. Heatwave claims over 1, 100 across country, temperatures soaring. Hindustan times Retrieved.