GNSS Verileri ve Yoğuşabilir Su Buharı (*PWV*) Analizi

PhD. Stu. Derya Öztürk Çetni

Ekip...

Prof. Dr. Sacit Özdemir

Doç. Dr. Cahit Yeşilyaprak

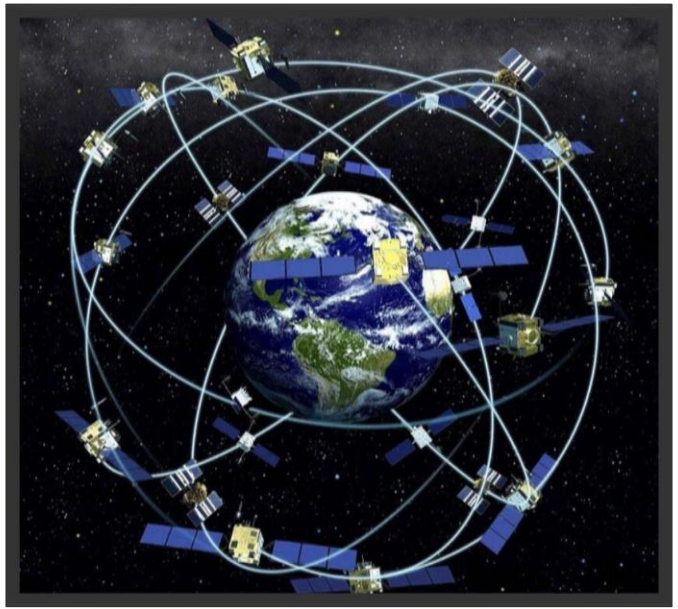
Prof. Dr. Bahadır Aktuğ

Uz. Deniz Çoker

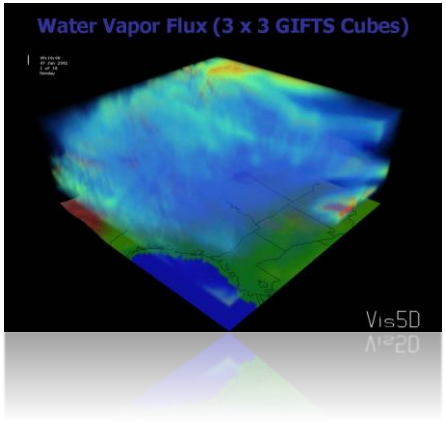
Uz. Recep Balbay

İçerik

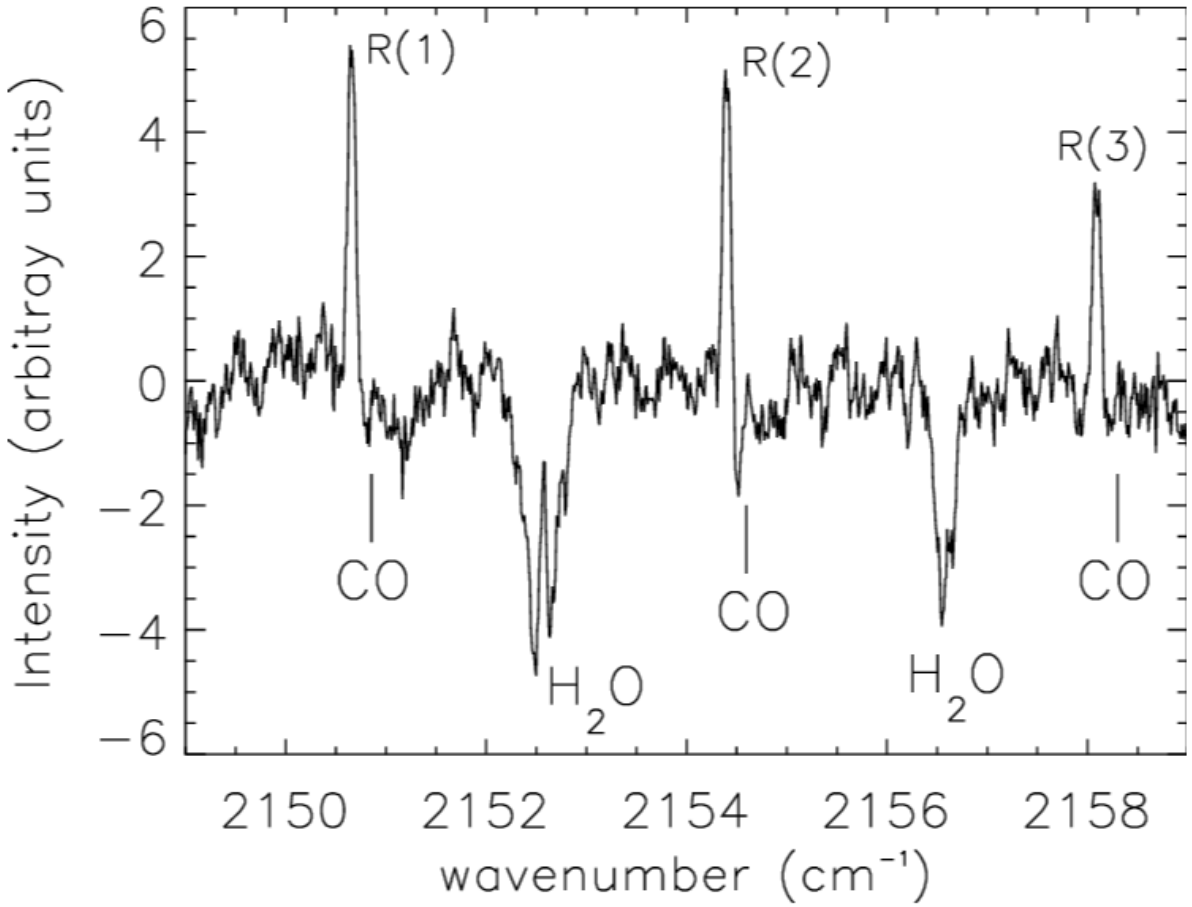
- DAG için neden PWV ölçüyoruz?
- Neden GNSS?
- Diğer bazı gözlemevlerinde durum…
- Ne aşamadayız?
- Yakın zaman planlarımız



Astronomide PWV



N. Ryde et al. 1999

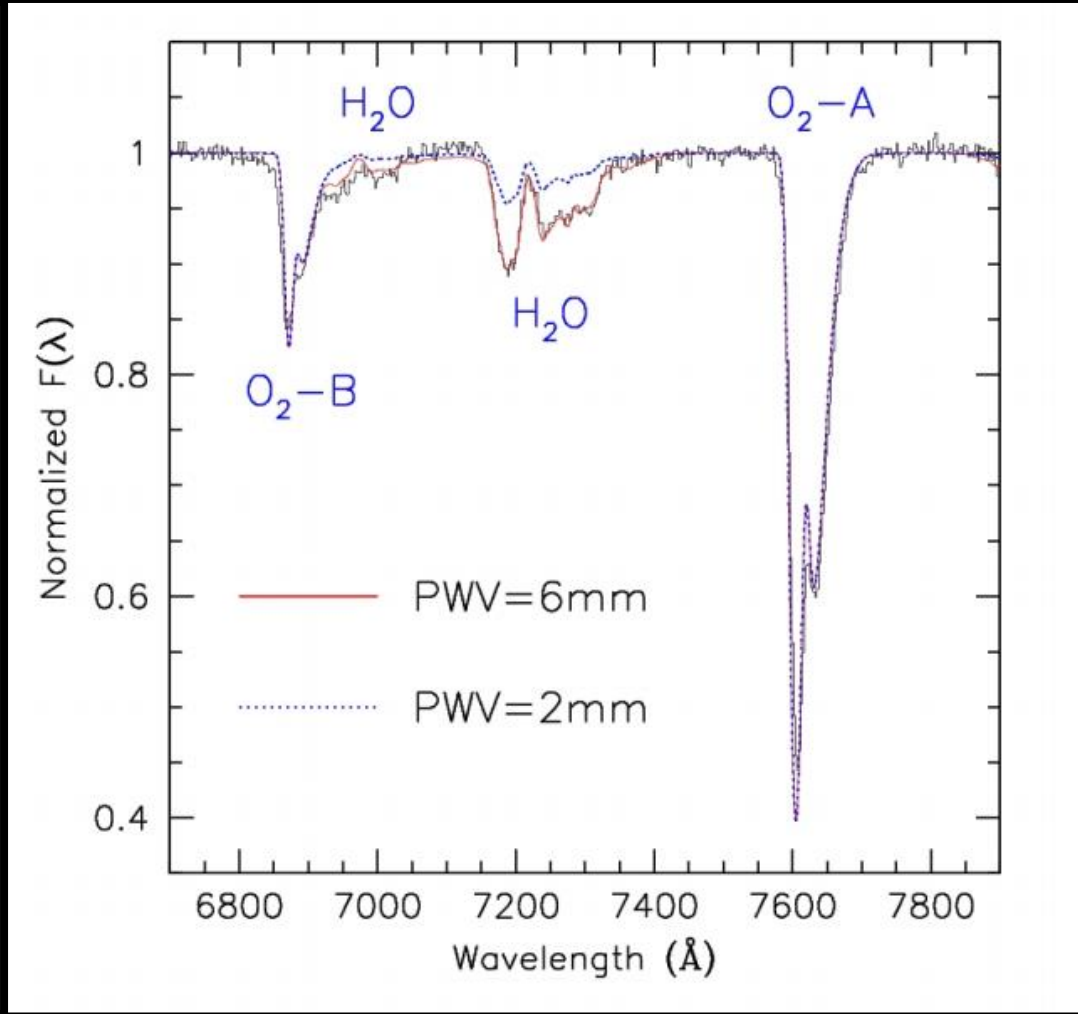


Feige 110 -- Hot subdwarf

Other object types:	* (GJ,AC,...), blu (FB,Feige,...), HS* (Ref),
ICRS coord. *(ep=J2000) :*	23 19 58.3995050606 -05 09 56.170282845 (Op
FK4 coord. *(ep=B1950 eq=1950) :*	23 17 23.5542979182 -05 26 22.263095747 [2
Gal coord. *(ep=J2000) :*	074.0916634737225 -59.0673740882860 [0.078
Proper motions *mas/yr* :	-10.68 0.31 [4.63 3.27 0] A 2007A&A...474..(
Parallaxes *(mas)*:	3.7268 [0.0840] A 2018yCat.1345....0G
Spectral type:	sdO8VIIIHe5 B 2013A&A...551A..31D
Fluxes (9) :	U 10.360 [~] D 2007AJ....133..768L
	B 11.45 [0.09] D 2000A&A...355L..27H
	V 11.50 [0.14] D 2000A&A...355L..27H
	R 11.970 [~] D 2007AJ....133..768L
	I 12.145 [~] D 2007AJ....133..768L
	G 11.7924 [0.0010] C 2018yCat.1345....0G
	J 12.548 [0.026] C 2003yCat.2246....0C
	H 12.663 [0.027] C 2003yCat.2246....0C
	K 12.796 [0.034] C 2003yCat.2246....0C

Fig. 9. Example spectrum of Feige 110 obtained with FORS1 on March 13, 2006 (grism G300I+OG590; airmass X=1.03). The signal-to-noise ratio per pixel on the continuum is ~200. The main molecular absorption bands are marked. Superimposed are two LBLRTM simulations with PWV=2mm (dotted curve), and PWV=6mm (solid curve). In both cases the O_2 column density

Patat F., et al. 2018



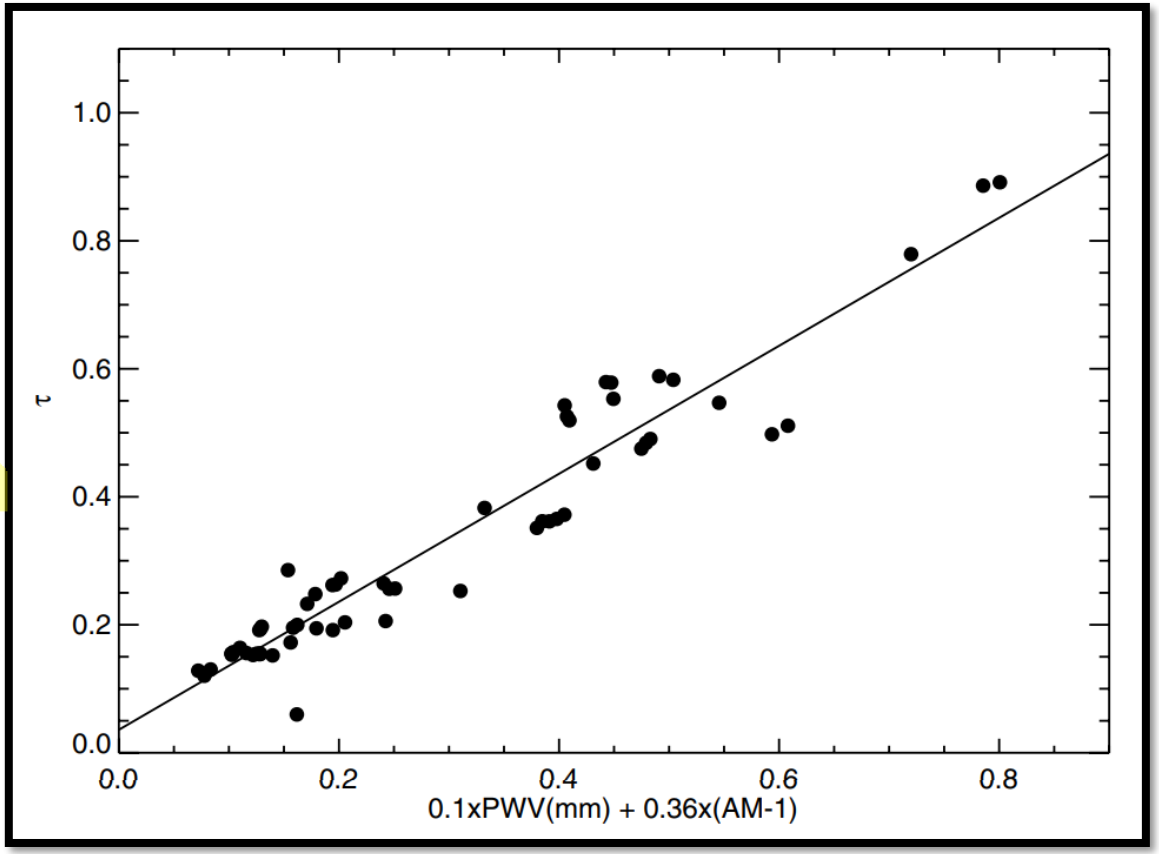
Measuring NIR Atmospheric Extinction Using a Global Positioning System Receiver

CULLEN H. BLAKE AND MARGARET M. SHAW

Princeton University Department of Astrophysical Sciences, Peyton Hall, Ivy Lane, Princeton, NJ 08544

Received 2011 August 24; accepted 2011 September 26; published 2011 October 17

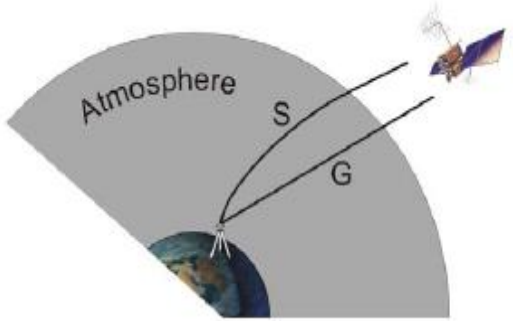
ABSTRACT. Modeling molecular absorption by Earth's atmosphere is important for a wide range of astronomical observations, including broadband NIR photometry and high-resolution NIR spectroscopy. Using a line-by-line radiative transfer approach, we calculate theoretical transmission spectra in the deep red optical ($700 < \lambda < 1050$ nm) for Apache Point Observatory. In this region the spectrum is dominated by H_2O, which is known to be highly variable in concentration on short timescales. We fit our telluric models to high-resolution observations of A stars and estimate the relative optical depth of H_2O absorption under a wide range of observing conditions. We compare these optical depth estimates with simultaneous measurements of precipitable water vapor (PWV) based on data from a Global Positioning System (GPS) receiver located at Apache Point. We find that measured PWV correlates strongly with the scaling of H_2O absorption lines in our spectra, indicating that GPS-based PWV measurements combined with atmospheric models may be a powerful tool for the real-time estimation of total molecular absorption in broad NIR bands



Cullen H., et al. 2011

Atmosfer Katmanlarının Uydu Sinyaline Etkileri;

- Alıcı saat hataları
- Alıcı gürültüsü
- Uydu Saat Hataları
- Yörünge Hataları
- İyonosferik Hatalar
- Troposferik Hatalar
- Çoklu-yansıma (Multipath)



Şekil. ışık doğrusal bir yol kat edemez, ortam yoğunluğuna göre değişen eğri bir yol kat eder. *GPS'in gönderdiği radyodalganın ilerlemesi gereken geometrik yolu ve atmosferin etkisiyle izlediği optik (gerçek) yol temsil edilmiştir.*

Voziakova O.V., 2011

Shatdzhatmaz Dağı için (2112 m) 3 yıl süre ile (λeff = 480nm'lik fotometrik bant aralığında) yapılan gözlemlerin ardından, fotometri için yıllık açık gece oranını %50 olarak ve yıllık ortalama sönümleme 0.21 kadir **ortalama PWV değeri açık gecelerde 7.7 mm olarak ölçülmüş.**

Atmospheric Transparency over Mount Shatdzhatmaz in the Optical and Near-Infrared Ranges

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Sternberg Astronomical Institute, Universitetskii pr. 13, Moscow, 119992 Russia

Received October 23, 2011

Abstract—We present the results of a three-year-long monitoring of atmospheric extinction over Mount Shatdzhatmaz (2112 m) in Northern Caucasus in a photometric band with $\lambda_{eff} = 480$ nm and the results of measurements of precipitable water vapor (PWV), which characterizes the atmospheric transparency in the near infrared. The yearly mean fraction of photometric weather is estimated to be 50% of the clear night time. The yearly median extinction is $0^m.21$; the median PWV on clear nights is 7.7 mm.

Sayısal değer bize ne ifade ediyor?

Infrared astronomical characteristics of the Roque de los Muchachos Observatory: precipitable water vapour statistics

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[3] *Dept. Edafología y Geología, Universidad de La Laguna, C/ Astrofísico Francisco Sánchez, E-38205 Tenerife, Spain*
[4] *NASA Ames Research Center, MS 245-3, Moffet Field, 94035-1000, CA, USA*

Accepted 2010 March 9. Received 2010 March 9; in original form 2010 January 21

ABSTRACT

We present measurements of the atmospheric water vapour content above the Roque de los Muchachos Observatory (ORM) obtained using the Global Positioning System (GPS). The GPS measurements have been evaluated by comparison with 940-nm radiometer observations. A statistical analysis of the GPS measurements points to the ORM as an observing site with suitable conditions for infrared observations, with a median column of precipitable water vapour (PWV) of 3.8 mm. PWV presents a clear seasonal behaviour, with winter and spring being the best seasons for infrared observations. The percentage of nights showing PWV values less than 3 mm is over 60 per cent in February, March and April. We have also estimated the temporal variability of water vapour content at the ORM. We present a summary of PWV statistical results at different astronomical sites, noting that these values are not directly comparable as a result of the differences in the techniques used to recorded the data.

Key words: instrumentation: miscellaneous – site testing – infrared: general.

There are many parameters accounting for the quality of an astronomical site: seeing, cloud cover, ground winds, high-altitude winds, etc. (see Muñoz-Tuñón, Varela & Fuensalida 2007 for a review of the characterization of these parameters at the ORM). The water vapour content is an important parameter affecting the IR quality of astronomical sites. Conditions for IR astronomical observations have been classified in terms of precipitable water vapour (PWV) into four divisions (Kidger et al. 1998): (i) good or excellent, PWV $\leq$ 3 mm; (ii) fair or mediocre, 3 $<$ PWV $\leq$ 6 mm; (iii) poor, 6 $<$ PWV $\leq$ 10 mm; (iv) extremely poor, PWV $\geq$ 10 mm. The development of IR instrumentation and the requirements for current large and future extremely large telescopes demand a proper characterization of PWV and statistical studies of large temporal data bases (covering years). The fraction of nights with good IR

Uydu verisi PWV için tek seçenek mi?

Kullandığımız Yöntem;

- Astronomik anlamda yeterlilik,
- Süreklilik,
- Güvenilirlik, hata aralığı,
- Finansal olarak düşük maliyet
- Uygulanabilirlik
- Yüksek zamansal çözünürlük

Farklı Yöntemler;

- GNSS
- Radyosonda
- Radyometre
- Yer tabanlı meterolojik ölçümler
- Spektrometre

GPS - Radyosonda - MODIS
(Moderate-Resolution Imaging

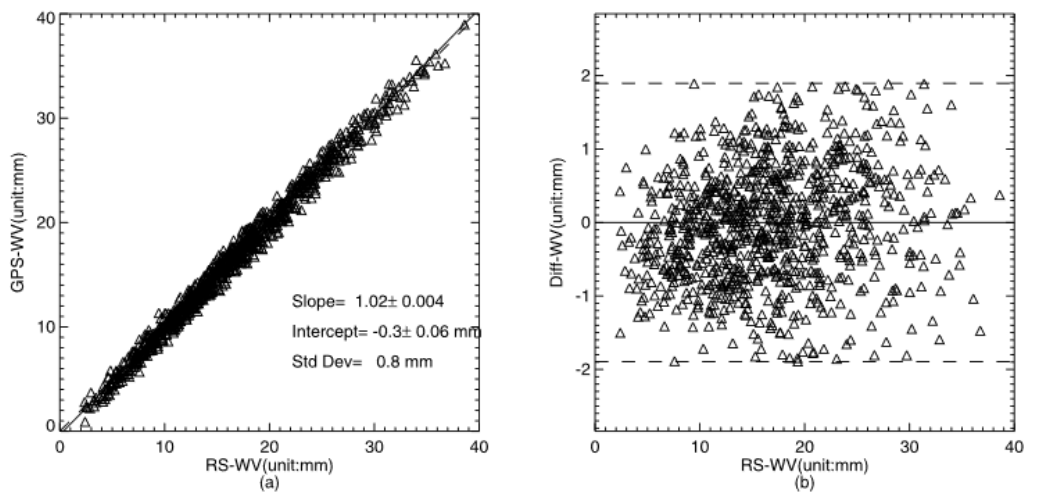


Figure 2. Scatterplots of UKMOHF RS ZWD and GPS ZWD for both daytime and nighttime at the HERS station from 2 December 2001 to 31 October 2002. (a) The line of perfect fit (dashed line) and a least squares regression line (solid line) are plotted. The number of valid samples was 931, and 54 samples were omitted due to the 2σ exclusion; (b) difference in PWV (diff-WV) = GPS PWV − RS PWV. The solid line stands for the zero difference, and the dashed lines stand for the 2σ values.

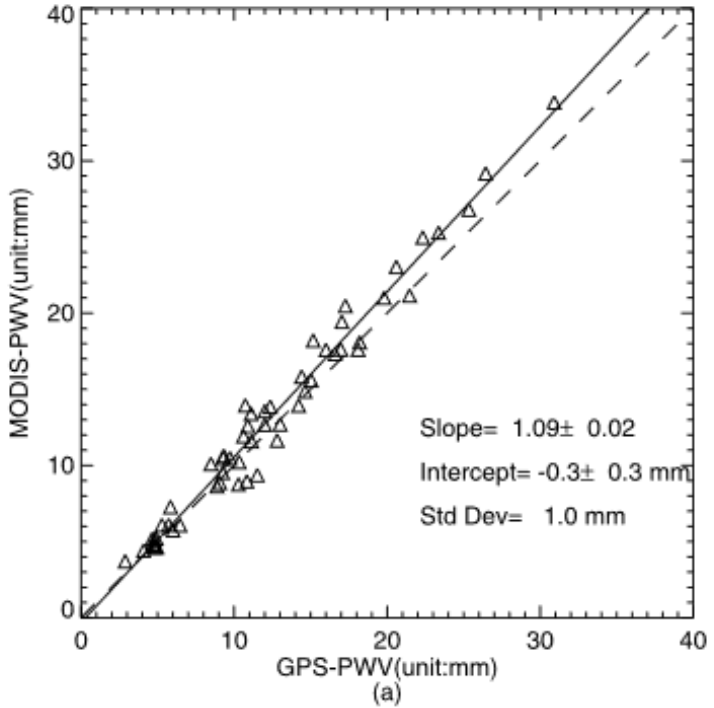
JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 108, NO. D20, 4651, doi:10.1029/2003JD003372, 2003

Comparison of precipitable water vapor derived from radiosonde, GPS, and Moderate-Resolution Imaging Spectroradiometer measurements

Zhenhong Li, Jan-Peter Muller, and Paul Cross
Department of Geomatic Engineering, University College London, London, England, UK

Received 2 January 2003; revised 21 July 2003; accepted 1 August 2003; published 29 October 2003.

[1] Atmospheric water vapor is highly variable in both space and time across the Earth, and knowledge of the distribution of water vapor is essential in understanding weather and



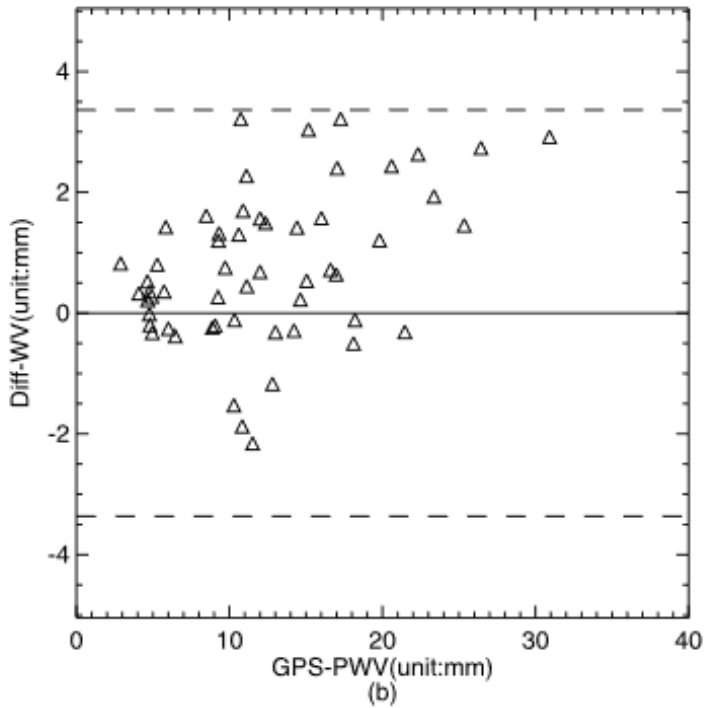


Figure 3. Scatterplots of MODIS PWV and GPS PWV for cloud-free observations at the HERS site from 2 December 2001 to 31 October 2002. (a) The number of valid samples was 66, and 4 samples were omitted due to the 2σ exclusion; (b) difference in PWV (diff-WV) = MODIS PWV − GPS PWV.

Doğu Anadolu Gözlemevi

Geographical coordinates :

39◦ 46’ 50.1” N and 41◦ 13’ 35.6” E, at Karakaya Hills

3170 m

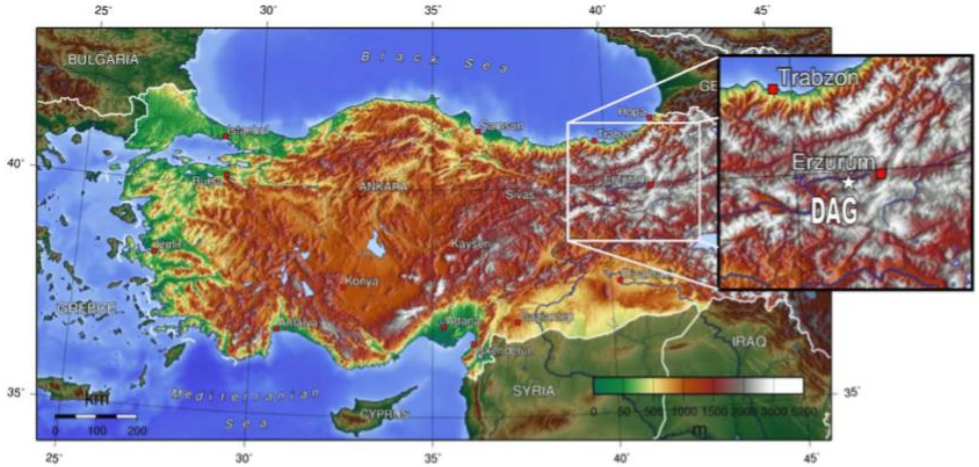


Fig. 1 Topographic map of Turkey showing the location of DAG (inset)

DAG’ın GNSS istasyonu;

Alıcı türü :
STONEX, SC-200

Anten türü :
HAXRON, HX-GG486A

DAG için elde edilen PWV değerleri, sonuçlar

DAG için PWV ;

- **Average : 3.2 mm**
- **Median : 2.7 mm**

Experimental Astronomy
https://doi.org/10.1007/s10686-018-9605-2
ORIGINAL ARTICLE

Precipitable water vapor (PWV) estimations from the site of the Eastern Anatolia Observatory* (DAG), a new astronomical observatory in Turkey

Sacit Özdemir[1,2] · Cahit Yeşilyaprak[3,4] · Bahadır Aktuğ[5] · Derya Öztürk[1,3] · Deniz Çoker[1,3] · Recep Balbay[3,6]

Received: 23 February 2018 / Accepted: 31 August 2018 / Published online: 15 September 2018

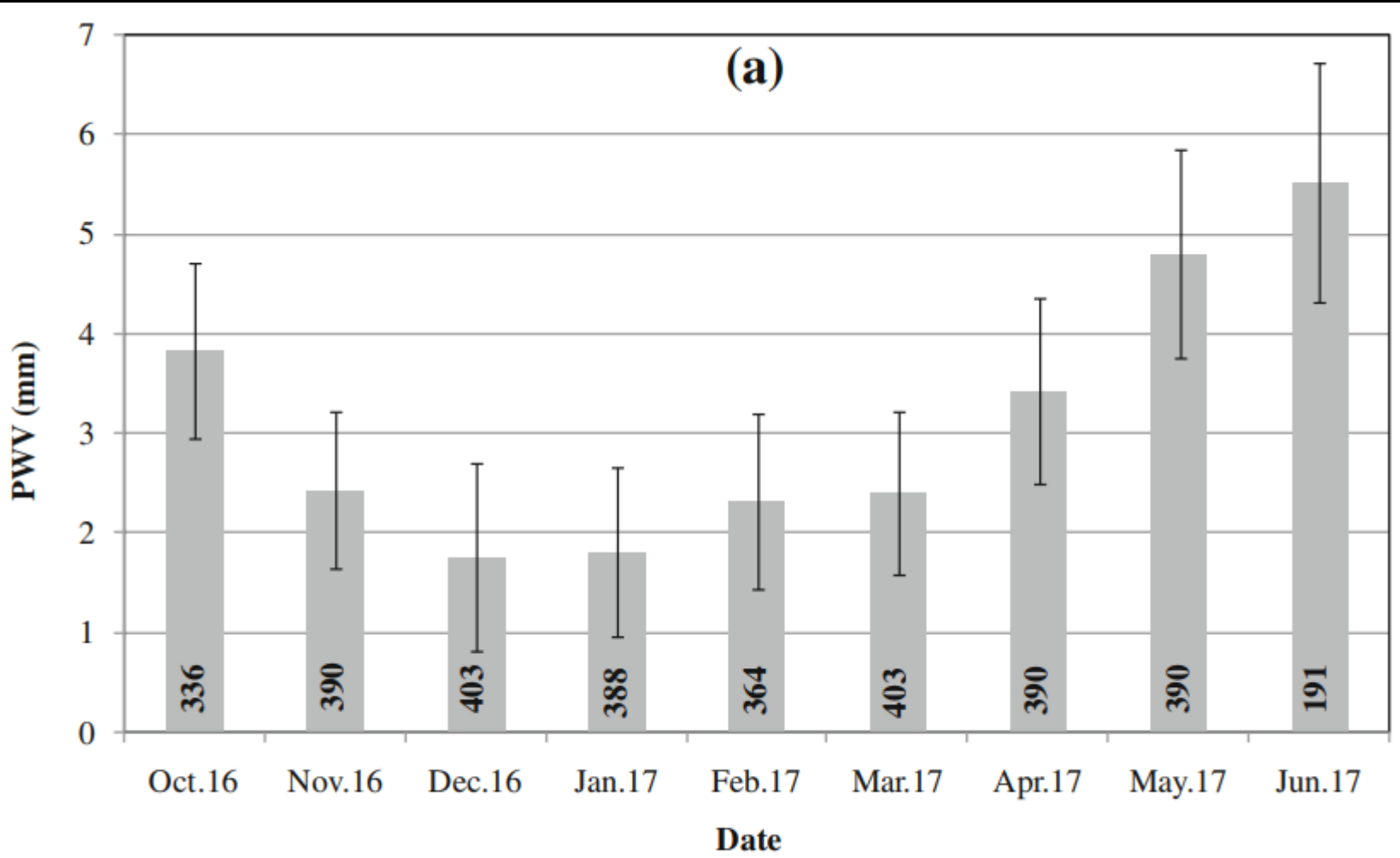
Abstract
We present preliminary statistics on the precipitable water vapor (PWV) content over the Karakaya Hills in Erzurum city, where the largest optical and near-infrared astronomical telescope in Turkey will be operated. Since the observatory will observe in the near-infrared (NIR), it is intended to perform PWV measurements of the atmosphere above the site by using signal delays in Global Positioning System (GPS) communication. The analysis of the GPS data recorded on the summit for almost one year shows that the atmosphere over the site of the observatory, which has an altitude of 3170 m, has favorable conditions for NIR observations. From GPS measurements, we report that the site had an average PWV of 3.2 mm and a median PWV of 2.7 mm between October 6, 2016, and June 15, 2017. We also present the time dependency of the PWV content and the correlations between the amount of PWV and the other meteorological records gathered from radiosonde flights and ground-based measurements.

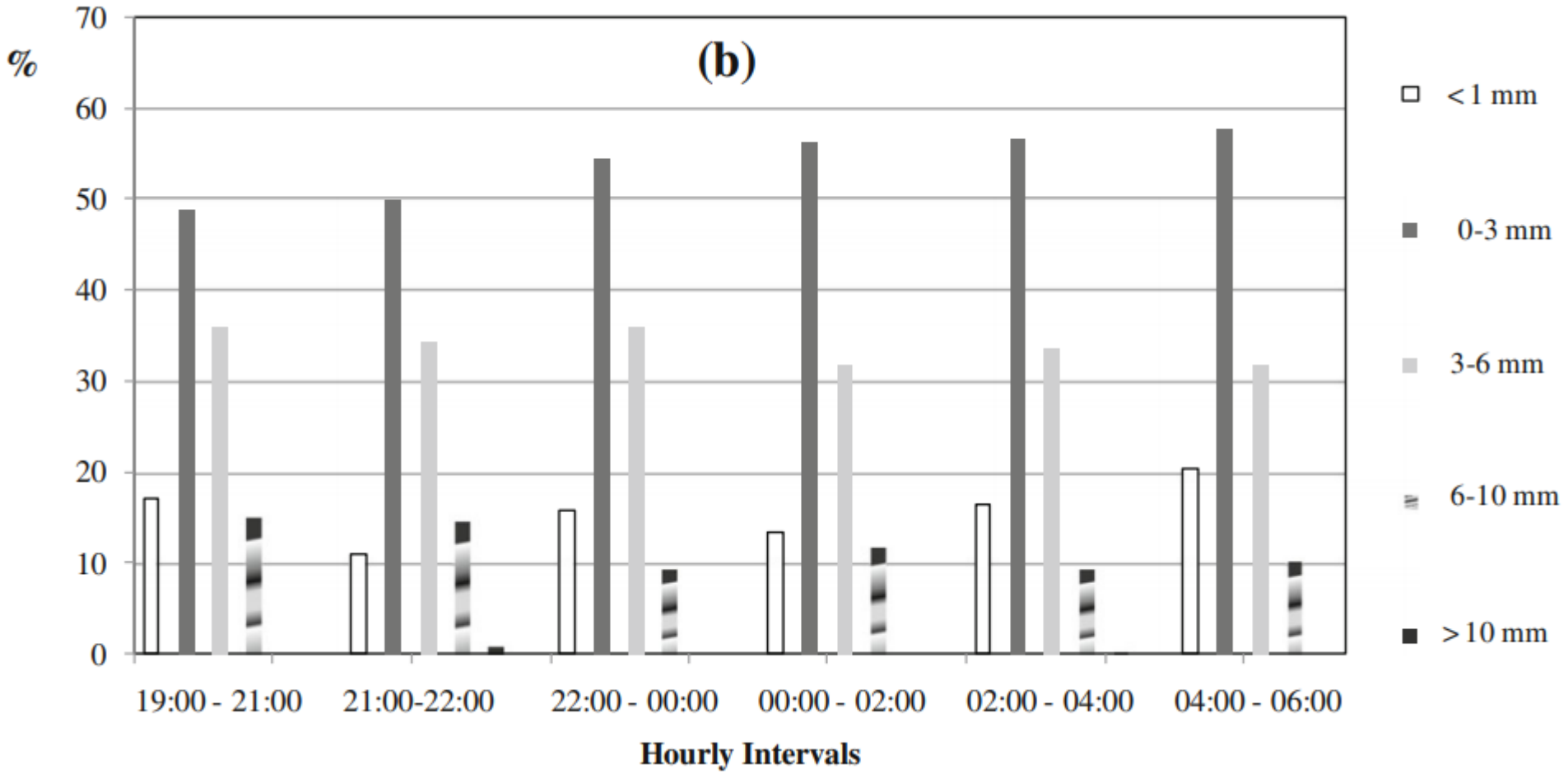
GPS verisi

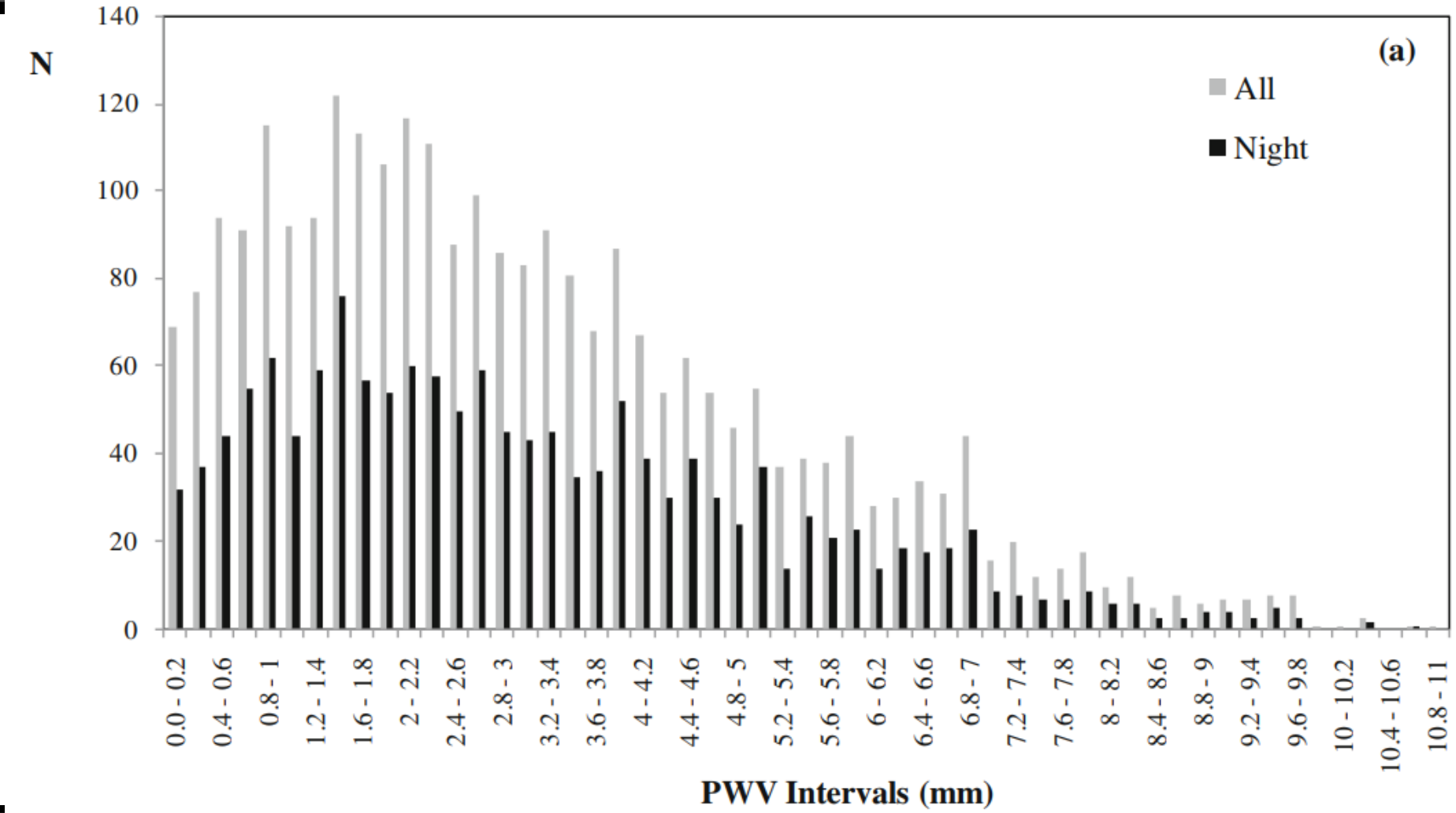
Radyosonda verisi

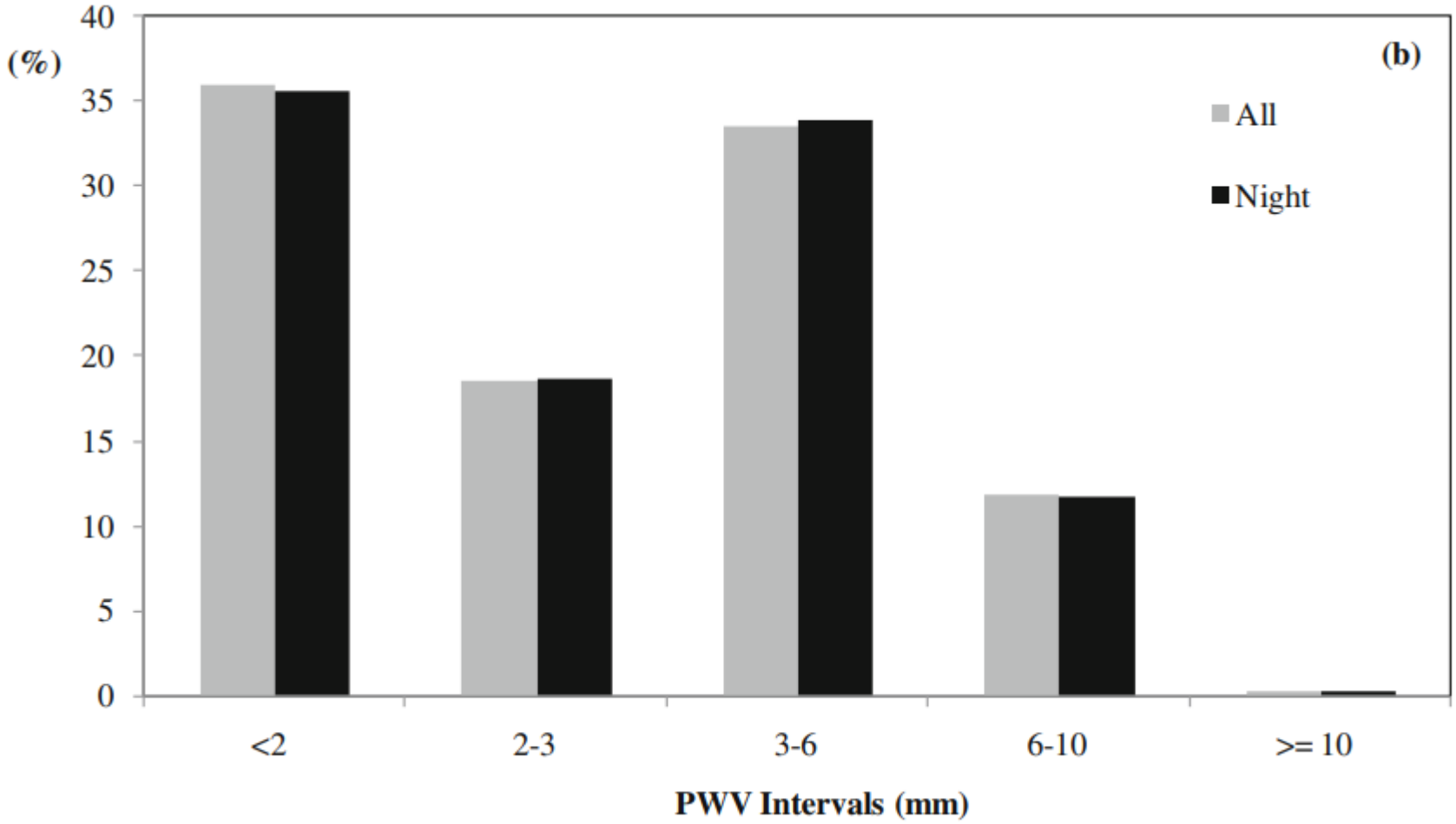
	PWV (mm) (Oct. 6,2016–Jun. 15,2017)				PWV (mm) (Jan. 1, 2016 – Sep. 26, 2017)	
	All	Night	All	Night	All	Night
Average (mm)	3.2	3.2	3.2	3.1	4.5	4.2
Median (mm)	2.7	2.7	2.7	2.6	4.0	3.9
N	2705	1459	500	251	1209	605
< 2 mm (%)	36.6	35.6	36.2	39.0	22.3	24.1
2–3 mm (%)	18.5	18.6	18.6	16.7	14.6	14.5
3–6 mm (%)	33.5	33.9	31.8	32.7	37.6	38.7
6–10 mm (%)	11.8	11.7	13.2	11.6	23	20.8
≥ 10 mm (%)	0.2	0.2	0.2	0.0	2.5	1.8

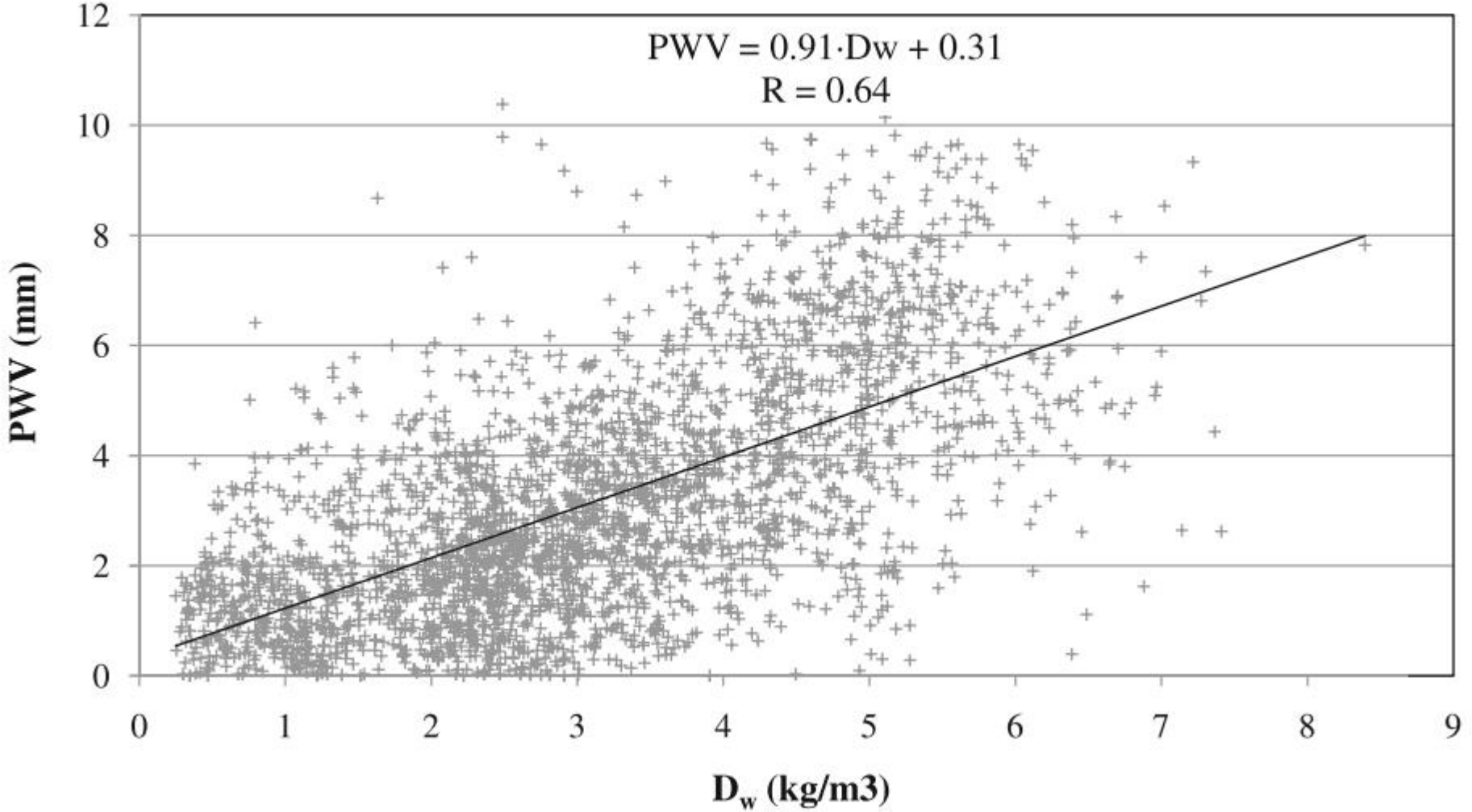
Özdemir S., et al. 2018




(b)
%
70
60
50
40
30
20
10
0
19:00 - 21:00
21:00-22:00
22:00 - 00:00
00:00 - 02:00
02:00 - 04:00
04:00 - 06:00
Hourly Intervals
< 1 mm
0-3 mm
3-6 mm
6-10 mm
> 10 mm


N
140
120
100
80
60
40
20
0
(a)
All
Night
0.0 - 0.2
0.4 - 0.6
0.8 - 1
1.2 - 1.4
1.6 - 1.8
2 - 2.2
2.4 - 2.6
2.8 - 3
3.2 - 3.4
3.6 - 3.8
4 - 4.2
4.4 - 4.6
4.8 - 5
5.2 - 5.4
5.6 - 5.8
6 - 6.2
6.4 - 6.6
6.8 - 7
7.2 - 7.4
7.6 - 7.8
8 - 8.2
8.4 - 8.6
8.8 - 9
9.2 - 9.4
9.6 - 9.8
10 - 10.2
10.4 - 10.6
10.8 - 11
PWV Intervals (mm)


(%)
40
35
30
25
20
15
10
5
0
(b)
All
Night
<2
2-3
3-6
6-10
>= 10
PWV Intervals (mm)


PWV = 0.91·Dw + 0.31
R = 0.64
PWV (mm)
D_w (kg/m3)
0
2
4
6
8
10
12
0
1
2
3
4
5
6
7
8
9

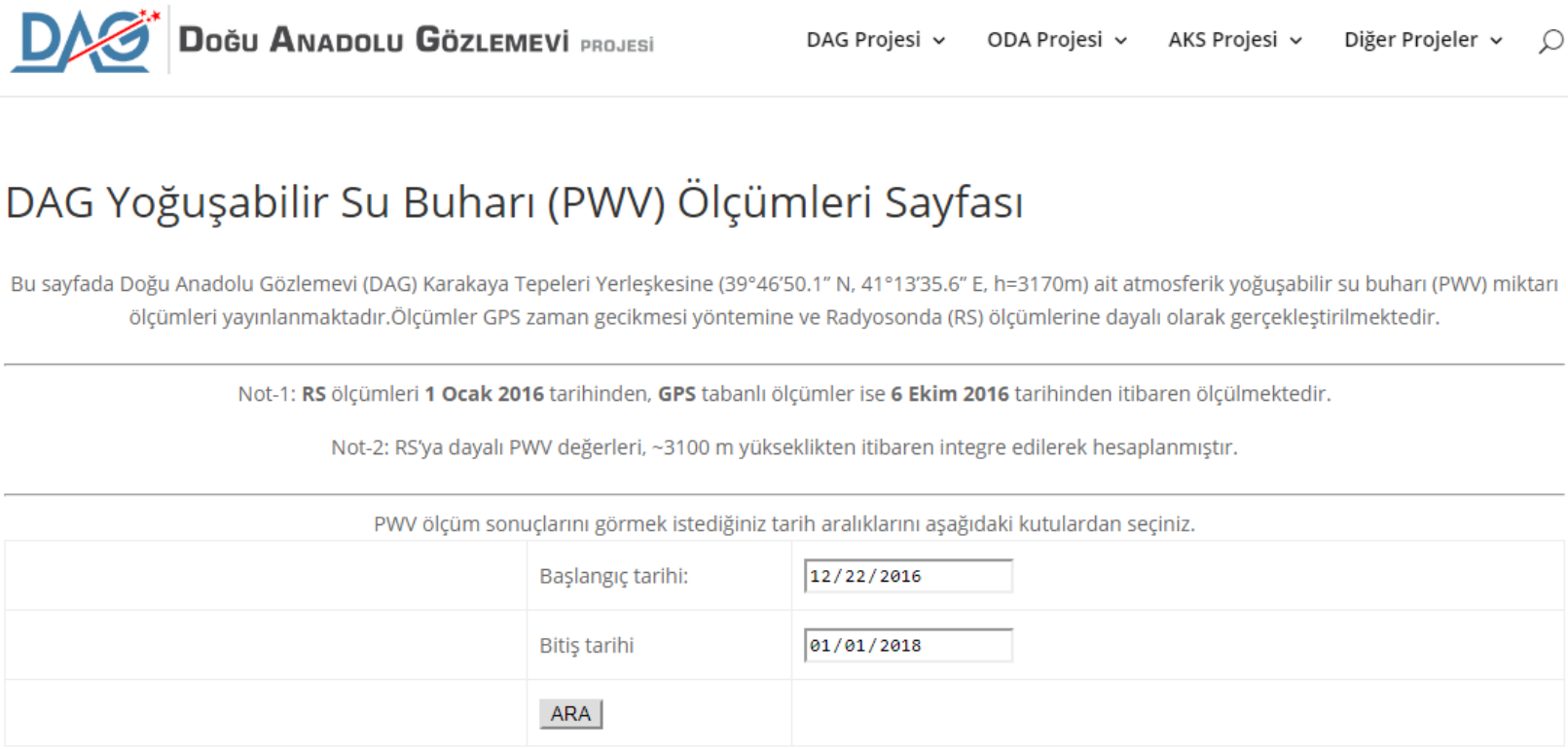
B. Garc´ıa-Lorenzo et al. 2010

DAG için PWV ;

- **Median : 2.7 mm**

Site	Location (latitude, longitude)	Height (m)	Median PWV (mm)	Technique	Temporal range
Las Campanas	29°.01 S, 42°.18 W	2200	2.8	225-GHz radiometer	2005/07–08
Cerro Tolar	21°.96 S, 70°.10 W	2290	4.02	*GOES-8* satellite	1993/06–1996/02
			4.7	Surface PWV data	2004/01–2007/12
ORM	28°.77 N, 17°.88 W	2395	3.9	940-nm radiometer	1996–1998
			3.9	GPS	2001/06–2008/12
			2.6	IR sky radiance	2000–2002
La Silla	29°.25 S, 70°.73 W	2400	3.9	IR sky radiance	1983–1989
Paranal	24°.63 S, 70°.40 W	2635	2.3	IR sky radiance	1983–1989
San Pedro Mártir	31°.04 N, 115°.47 W	2830	2.63	*GOES-8* satellite	1993/06–1996/02
			3.4	210-GHz radiometer	2006
Pico Veleta	37°.07 N, 3°.37 W	2850	2.9	940-nm radiometer	1984–1987
Cerro Armazones	24°.58 S, 70°.18 W	3064	2.87	*GOES-8* satellite	1993/06–1996/02
			3.2	Surface PWV data	2004/01–2007/12
Dome C	75°.06 S, 123°.23 E	3233	0.34	Satellite and model	2008
Mauna Kea	19°.83 N, 155°.47 W	4205	1.7	225-GHz radiometer	2001/06–2008/12
			1.2	Radiosondes	1983
			1.86	*GOES-8* satellite	1993/06–1996/02
			2.1	225-GHz radiometer	2004/01–2007/12
			2.3	GPS	2001/06–2008/12
Ridges A	81°.5 S, 73°.5 E	4053	0.21	Satellite and model	2008
Dome A	80°.73 S, 77°.3 E	4083	0.23	Satellite and model	2008
Cerro Tolonchar	23°.93 S, 67°.97 W	4480	1.7	*GOES-8* satellite	1993/06–1996/02
			1.8	Surface PWV data	2004/01–2007/12
Chajnantor	23°.02 S, 67°.45 W	5080	1.0	Radiosondes	1998/10 and 2000/08
			1.2	225-GHz radiometer	1995/04–2000/04

Ne aşamadayız?

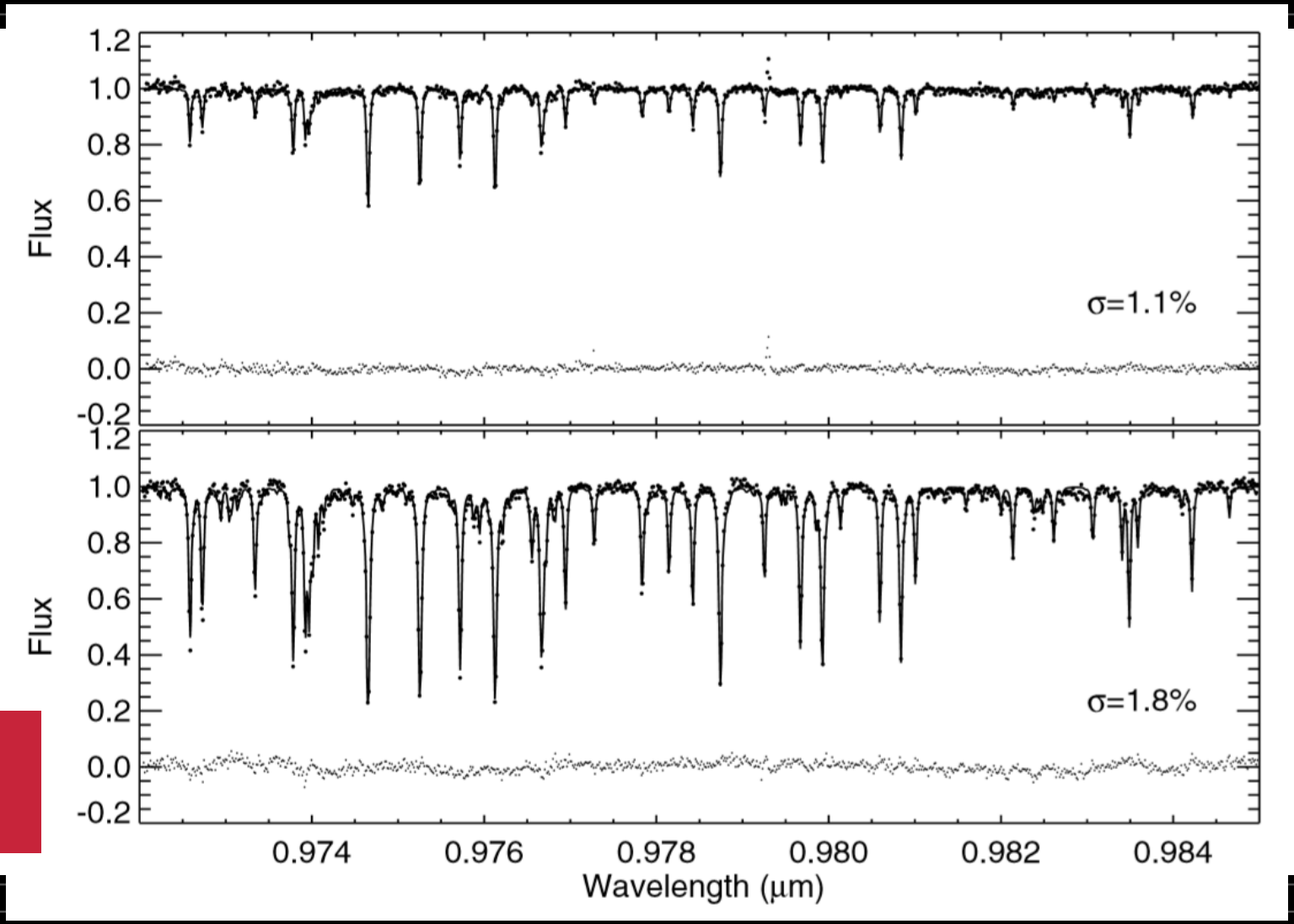


http://dag.atauni.edu.tr/atmosfer/pwv

Yakın zaman planlarımız...

- Kendi model katsayılarımızı üretebilmek
- Slant PWV ve tomografi
- Real-Time Değer Akışı
- Forecasting

Teşekkürler...



Cullen H., et al. 2011