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Ministry of Forestry and Water Affairs
Turkish State Meteorological Service

METEOROLOJİ

A Case Study: Analysis of Flash Flood Using FFGS Products on 17 January 2016 in Çeşme, Dikili, Izmir and Manisa.

Presented by
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Black Sea and Middle East Flash Flood Guidance (BSMEFFGS) Second Steering Committee Meeting (SCM2) in Amman, Jordan from 11 to 13 April 2017

Outline of Presentation

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- Synoptic Analysis, 850 hPa chart
- Synoptic Analysis, 500 hPa Chart
- Synoptic Analysis, Maximum Wind Speed at 300 hPa
- ECMWF Operational Analysis and Foracast Map
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- RADAR Image
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- BSMEFFG Products: Average Soil Moisture (ASM-06)
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Introduction

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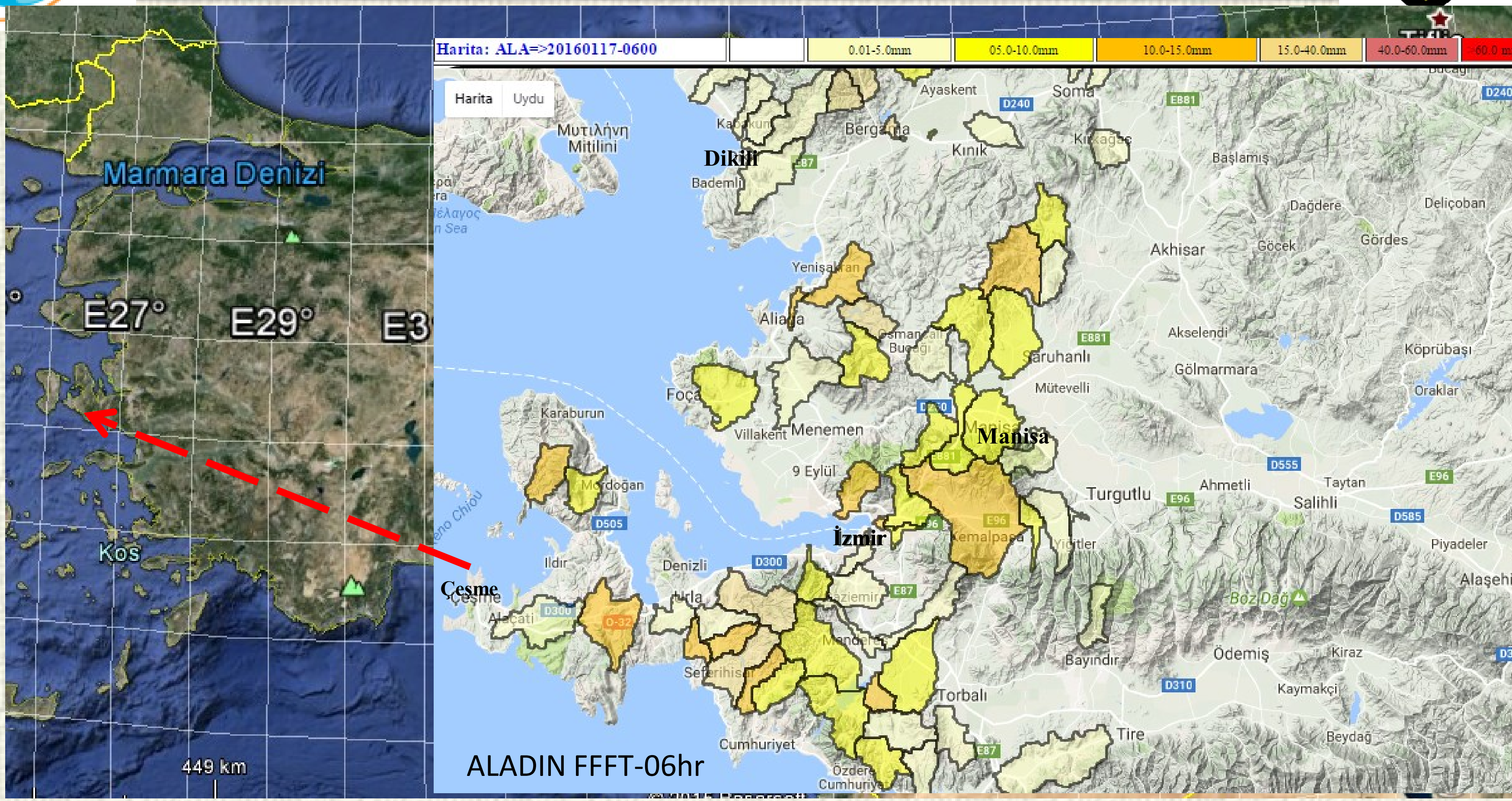
The purpose of this study is:

- to examine meteorological conditions in terms of rainfall intensity, synoptic scale, mesoscale, radar and sounding, that caused the FF event on 17 January 2016 in Çeşme, Dikili, İzmir, and Manisa.
- to take into consideration of the effect of precipitation either increasing or decreasing in the next 24 hours
- to examine this information and knowledge with the support of FFGS products particularly soil moisture saturation (ASM), FFG and FFT products to ensure the success of decision making process on FF occurrence.

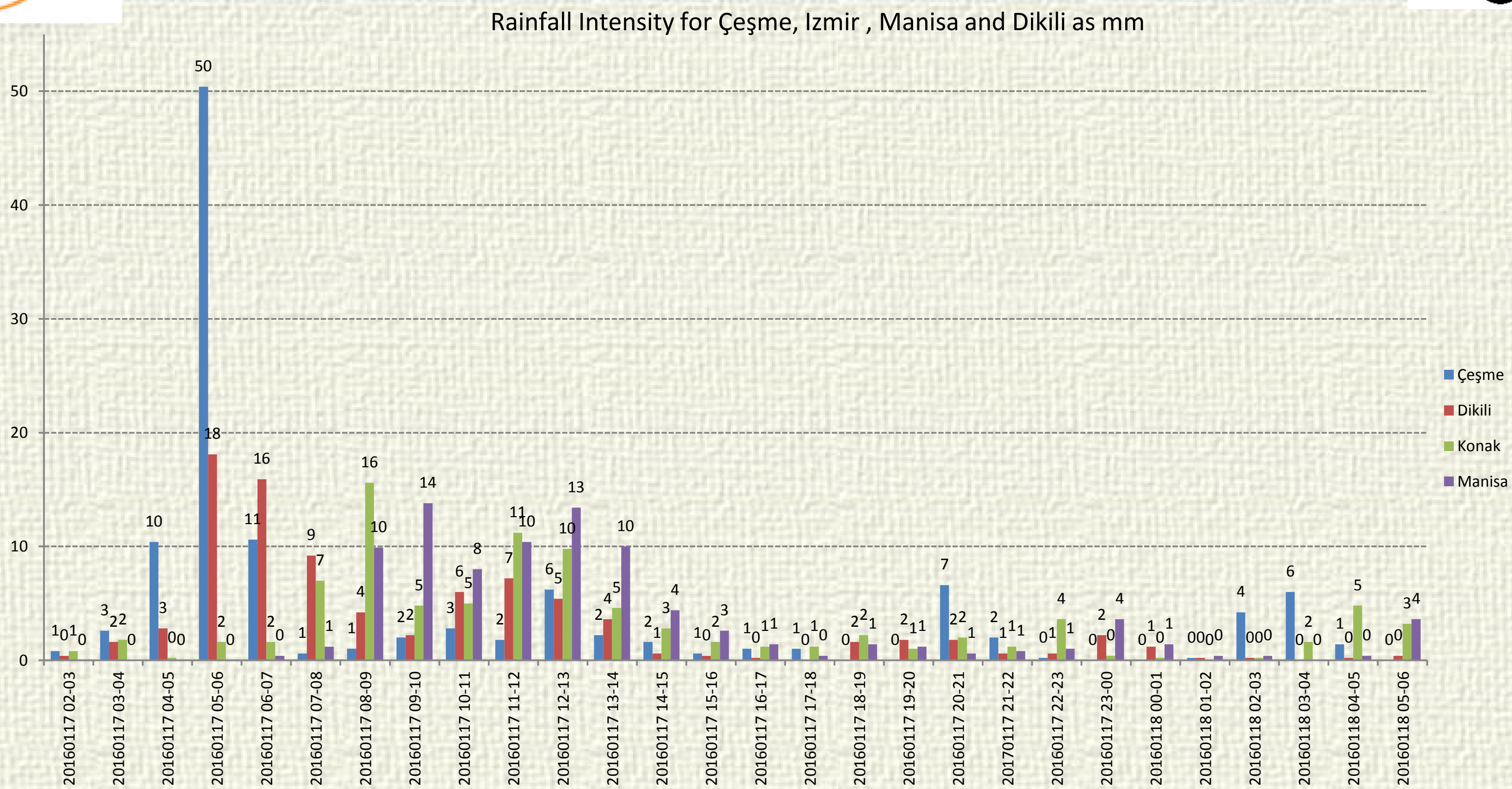
Material and Method (1)

Region of Study, Location of FFGS subbasins over Çeşme, İzmir, Manisa and Dikili



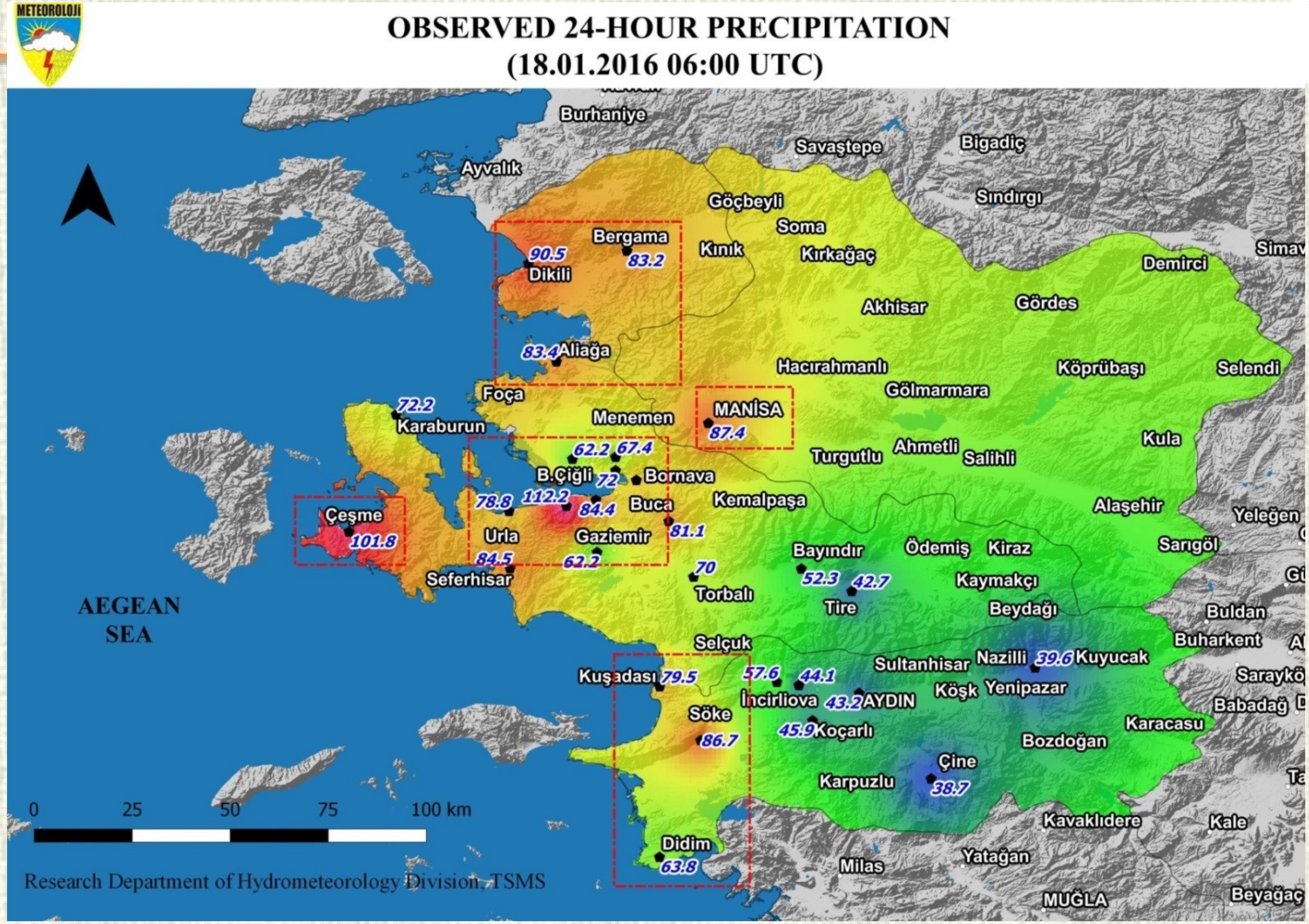
Çeşme:	WMO Synoptic Station No:17221	ICAO Name: CESM	Elevation: 5m	lat:38.3036	lon:26.3724
Dikili:	WMO Synoptic Station No:17180	ICAO Name: DIKL	Elevation: 3m	lat: 39.0737	lon: 26.8880
İzmir(Konak)	WMO Synoptic Station No:17220	ICAO Name: GUZL	Elevation: 29m	lat: 38.3949	lon: 27.0819
Manisa:	WMO Synoptic Station No:17186	ICAO Name: MANS	Elevation: 71m	lat: 38.6153	lon: 27.4049

Material and Method (2)



Rainfall intensity graph shows maximum precipitation (or distinctive peaks) measured at Çeşme between 05-06UTC with **50** mm/hr and at Dikili between 05-06UTC with **18** mm/hr and at İzmir (Konak) between 08-09UTC with **16** mm/hr and at Manisa between 09-10UTC with **14** mm/hr on 17 January 2016. Source:TSMS AWOS

Material and Method (3)
Observed 24 hr Precipitation for Çeşme, Dikili, İzmir and Manisa



- Accumulations of precipitation as measured by AWOS over the last 24 hour ending on 18 January 2016 at 06:00 UTC were **101.8**mm for Çeşme; **90.5**mm for Dikili; **84.4**mm for İzmir and **87.4**mm for Manisa.

Material and Method (4)

Methods used in this study include:

- analysing meteorological conditions that caused flash flood event on 17 January 2016 in Çeşme, Dikili, İzmir and Manisa for synoptic scale weather patterns at surface, 850 hPa, 500 hPa and 300 hPa charts.
- analysing satellite product using ECMWF surface chart for 24 hours precipitation (T+24) valid from 00:00UTC on 17 January 2016.
- analysing radar product using İzmir radar which is the nearest radar to the study region.
- analysing instability product using Skew T and Log P diagramme generated by University of Wyoming.
- evaluating FFGS products (particularly ASM and FFTs) to decide the possibility of flash flood.

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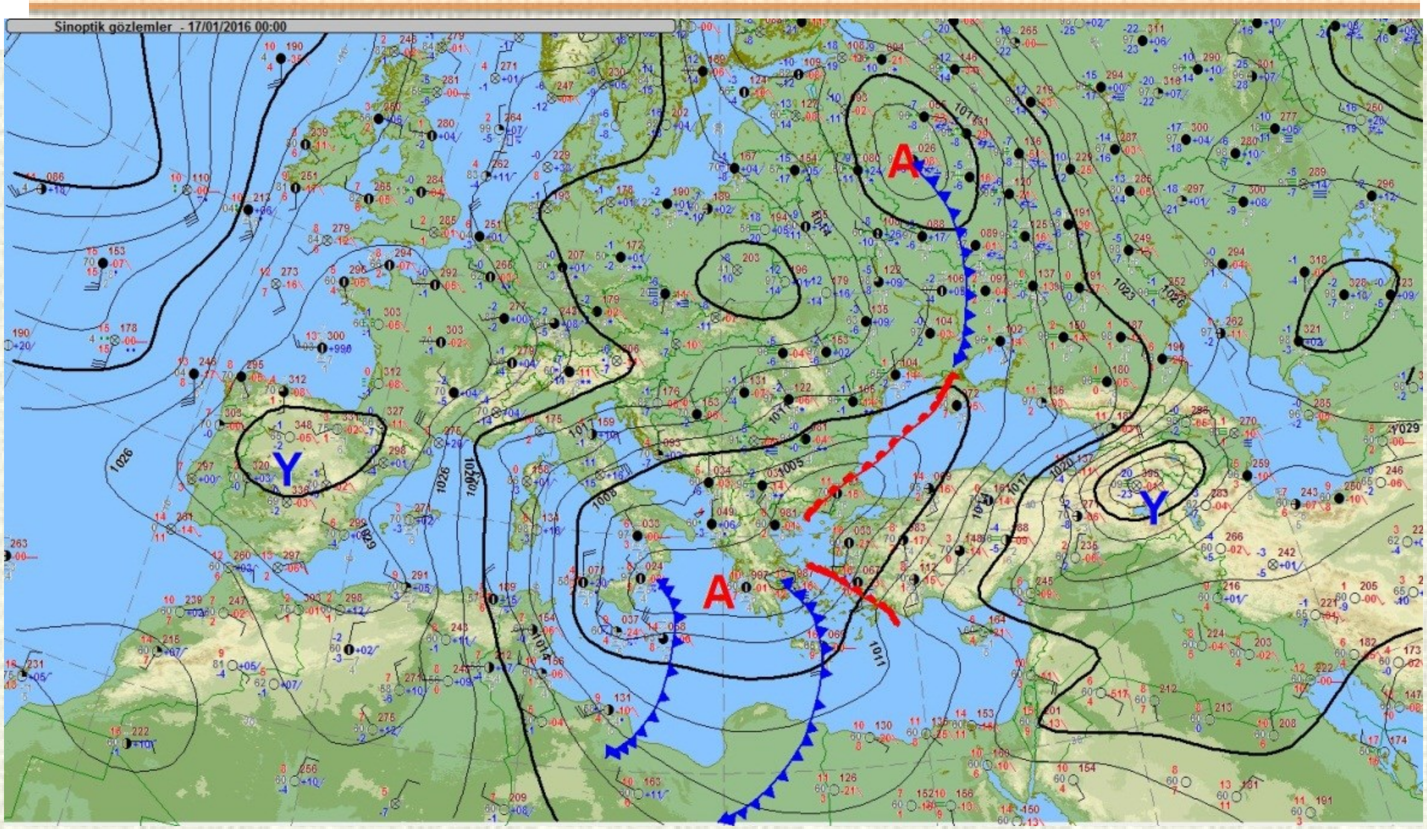
Synoptic Analysis (1)

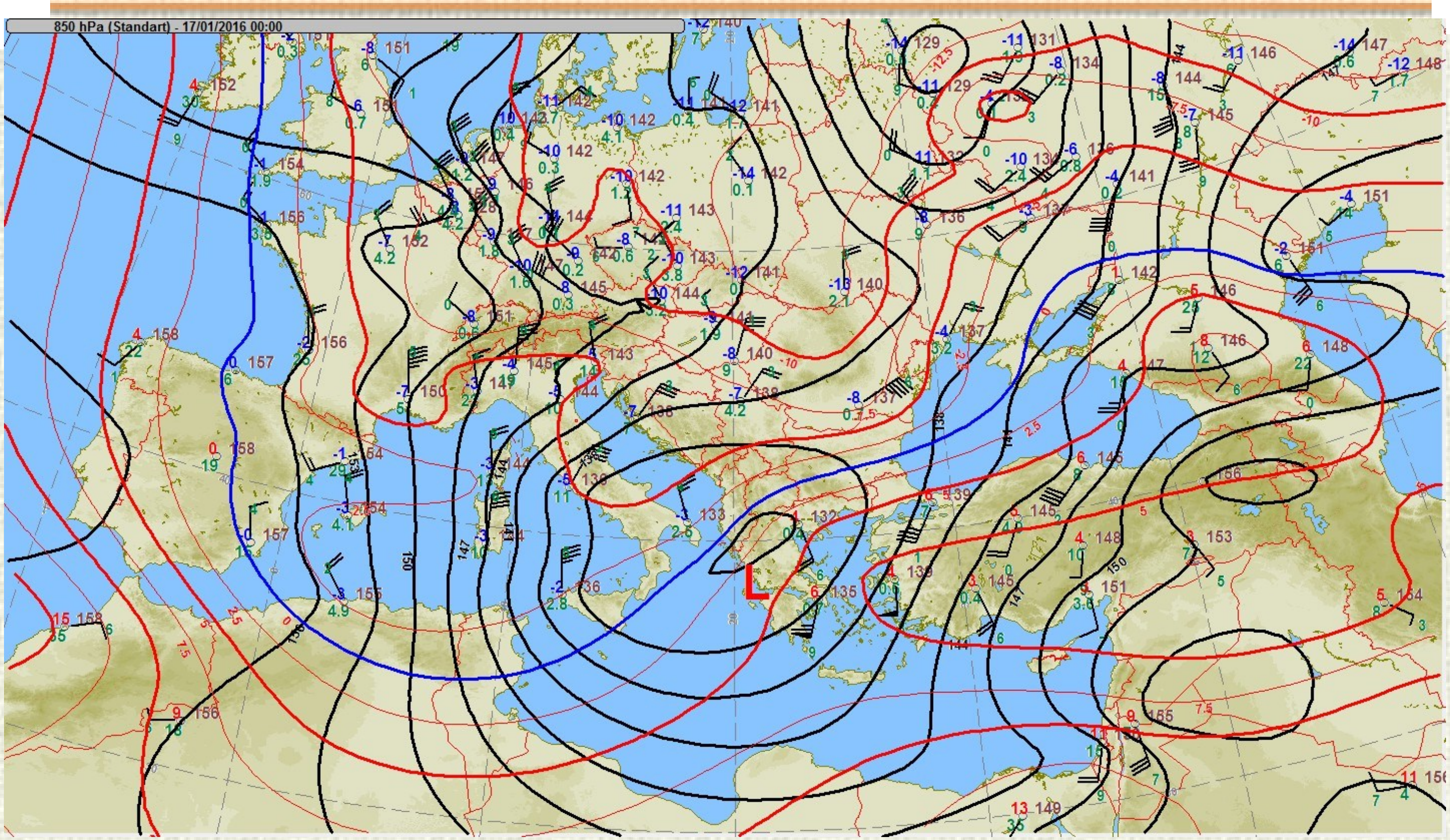
Surface Chart on 17 January 2016 at 00:00 UTC Source:METCAP



On the 17th of January at 00:00UTC, isobars were shown at 3 hPa intervals. There was a deep **Low Pressure Center** (A) with 998 hPa value over Greece. This frontal system associated with (A) affected western Turkey when surface pressure tendencies had negative values toward the northeast and the east of (A).

Synoptic Analysis (2)

850 hPa Chart on 17 January 2016 at 00:00UTC Source:METCAP



- Strong **cold air advection** over Athens from southwest and also Low Level Jet (**LLJ**) from southeast brought high humidity and warm air towards Çeşme. There were strong winds having 50-70 kt between Athens and Çeşme. So, this frontal system generated heavy rainfall.

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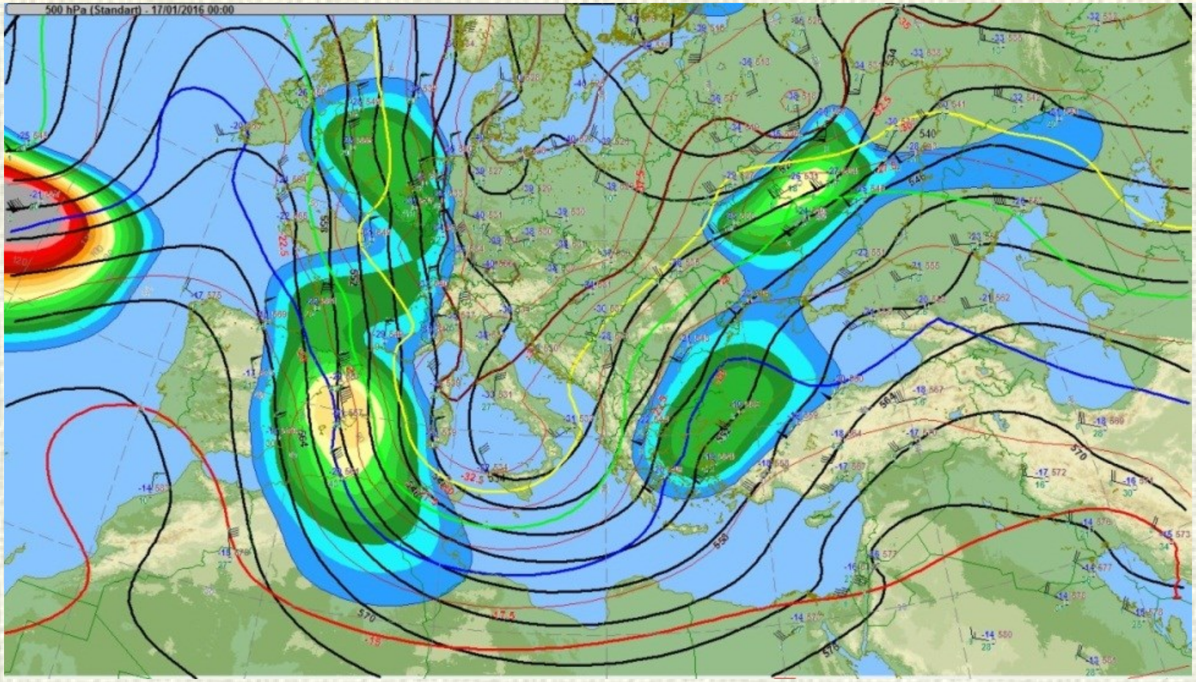
Synoptic Analysis (3)

500 hPa Chart on 17 January 2016 at 00:00 UTC (on the left) ; 17 January 2016 at 00:00UTC Source:METCAP

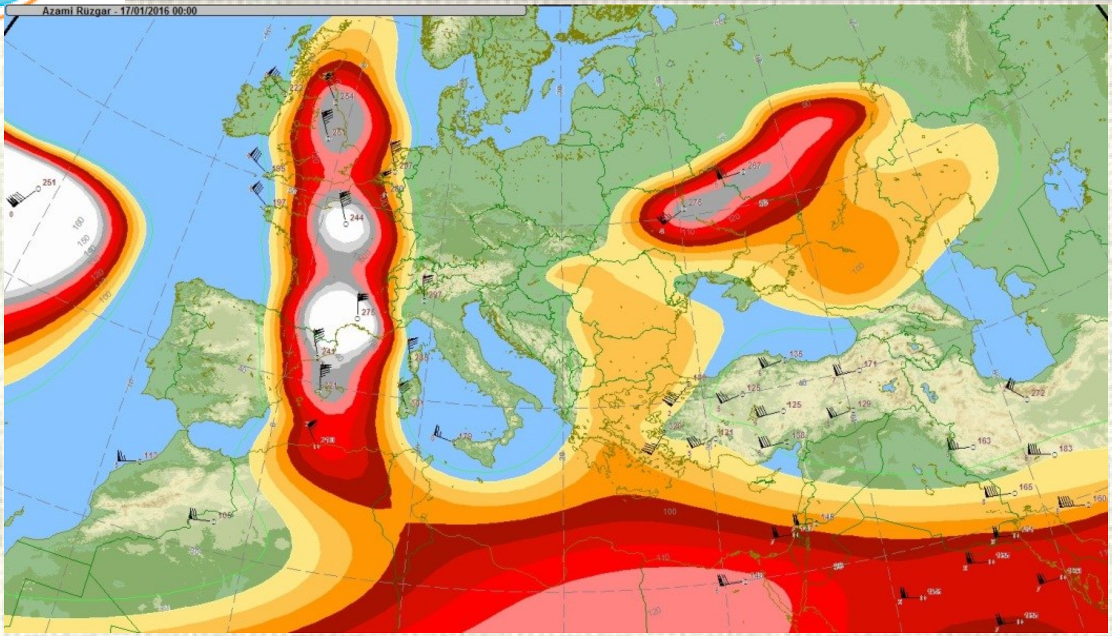
*steering winds

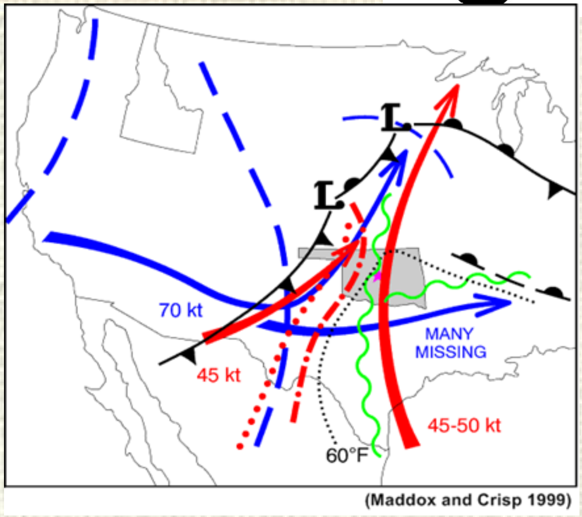


- A trough was expanding over the southern Italy. On the left side of the trough (behind trough), geopotential height contours were very close to each other indicating the presence of very strong winds.Here,the northern and north western wind streams caused subsidence and **convergence space**.
- But, in front of trough, atmospheric upward vertical motion with the south and south western winds were pronounced, which was called **divergence space**. Temperature at the surface chart over Çeşme was 16ºC while -19ºC at 500 hPa level on 17 January 2016 at 00UTC.
- In general, when the wind speed behind the trough is higher than the wind speed in front of the trough, the trough descends further south. Strong winds on divergenge area in front of the trough caused the system to become stronger.

Synoptic Analysis (4)

Maximum Wind Speed at 300 hPa on 17 January 2016 at 00:00UTC (on the left)
Source:METCAP





(Maddox and Crisp 1999)

- The image on the left shows that the Polar Jet Stream, which was associated with the frontal system, stretched down over France was very strong.
- The image on the right shows that the jet stream axis was divided into two over Çeşme. This formation induces heavier precipitation and stronger storm at the separation area (Maddox and Crisp,1999). The composite chart on the right shows **500** hPa features in blue, **850** hPa features in red and green and **surface** frontal analyses in black. This was the important mechanism that determined the heavy precipitation over Çeşme.

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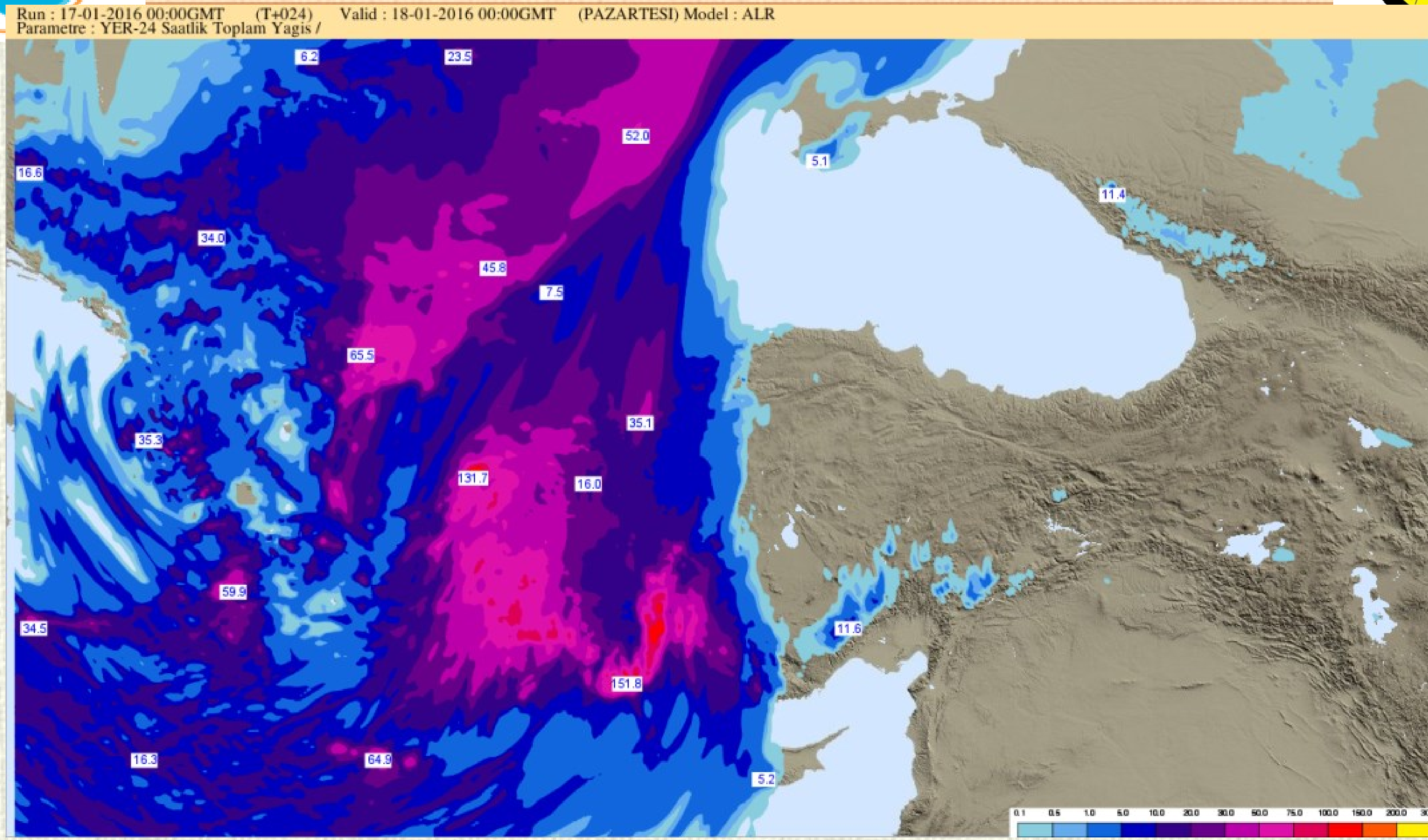
ECMWF Precipitation Forecast

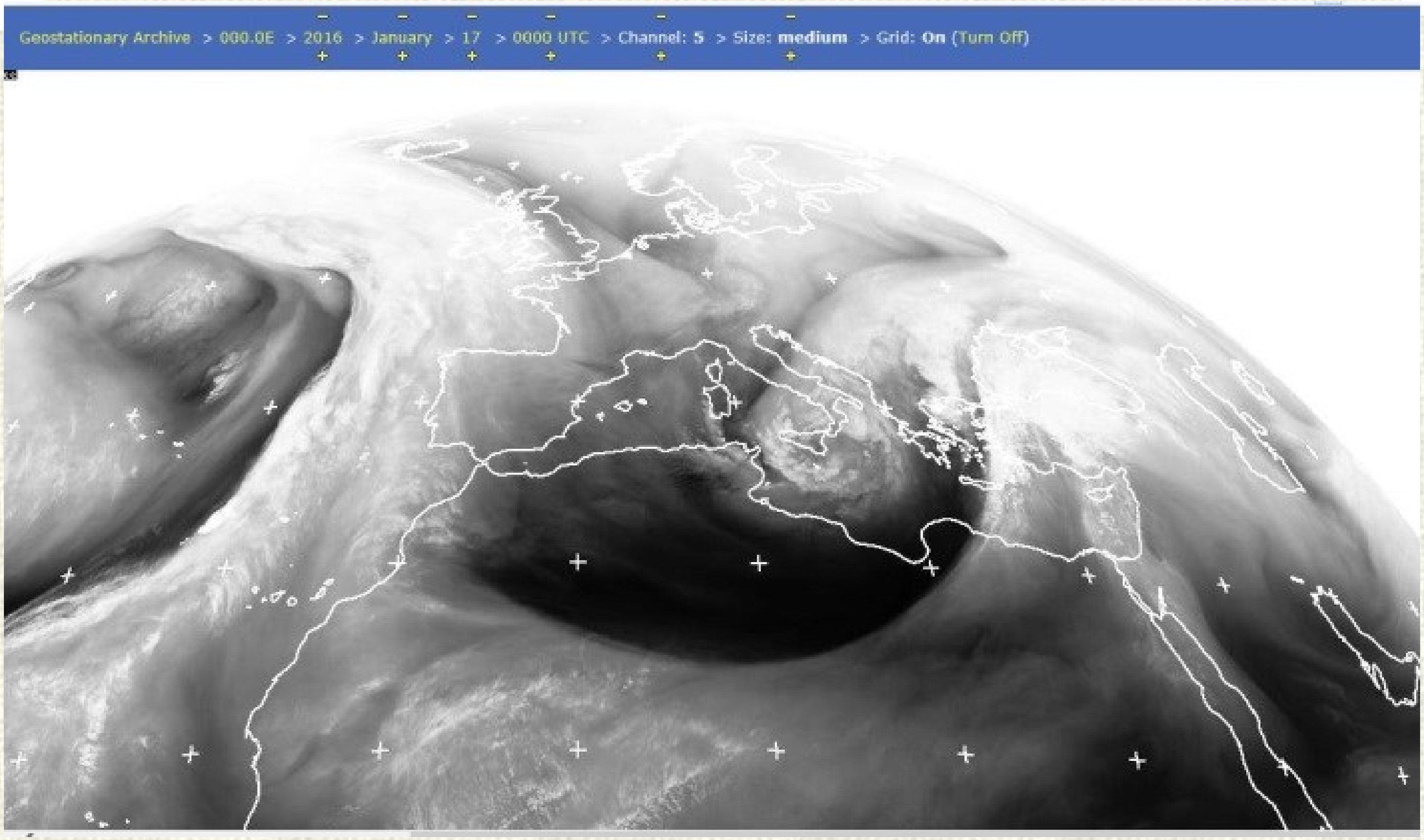
ECMWF Operational Analysis and Foracast Map on 17 January 2016 at 00:00UTC T+24hr (Total precipitation for the next 24 hours).



ECMWF map predicted rainfall of 151 mm/24 hour over Çeşme on 17 January 2016 at 00:00UTC.

Satellite Image

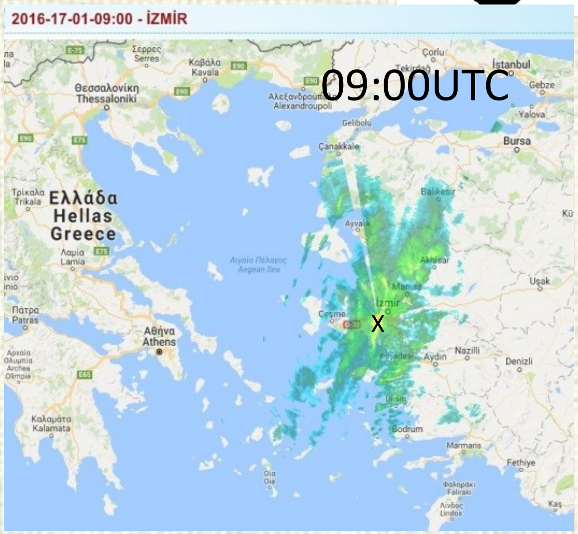
EUMETSAT MSG WV channel 5 on 17 January 2016 at 00:00UTC



- Satellite image shows that the frontal system was more visible and pronounced over Crete island.
- Here, the Water Vapour (WV) absorption band (5.35 to 7.15 µm) is used in determining the amount of water vapour in the upper troposphere.

RADAR Image

IZMIR Radar PPI Reflectivity on 17 January 2016 at 03:00UTC, at 06:00UTC, at 09:00UTC, at 12:00UTC and at 15:00UTC



- The **evolution of precipitation** along a cold front first Çeşme, then Dikili, İzmir and Manisa.
- Radar reflectivity was greater than 40 dBz which indicated heavy precipitation in the winter season,

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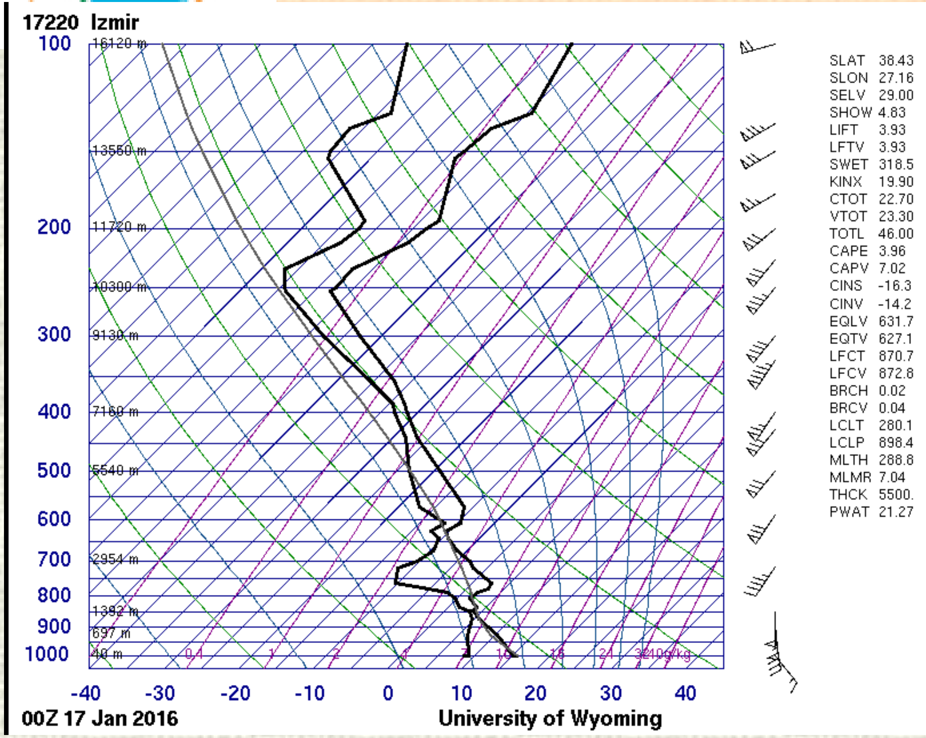
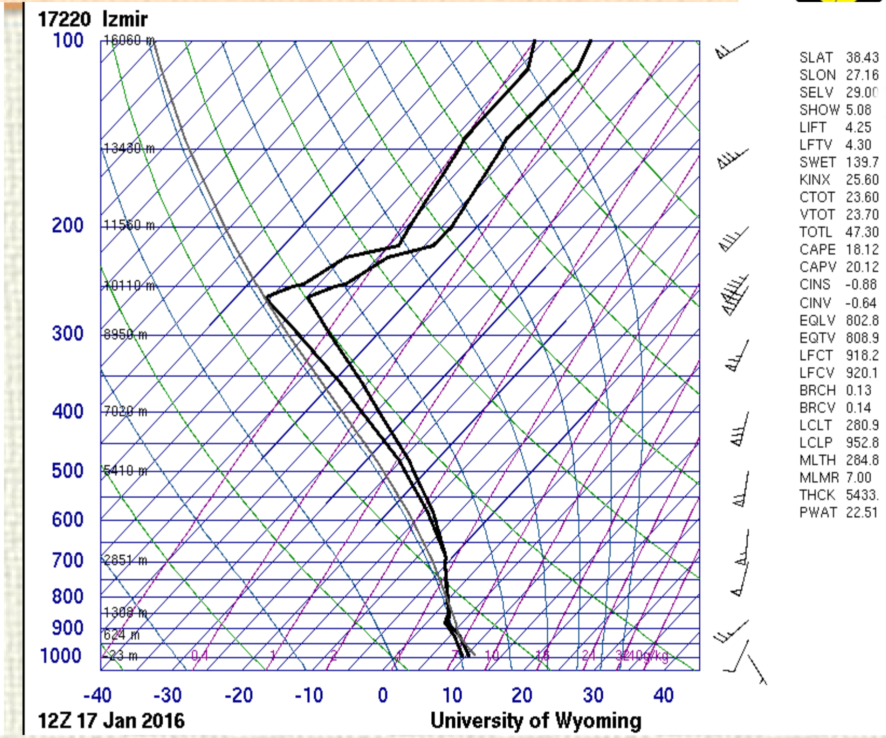
Skew-T Log-P Diagram

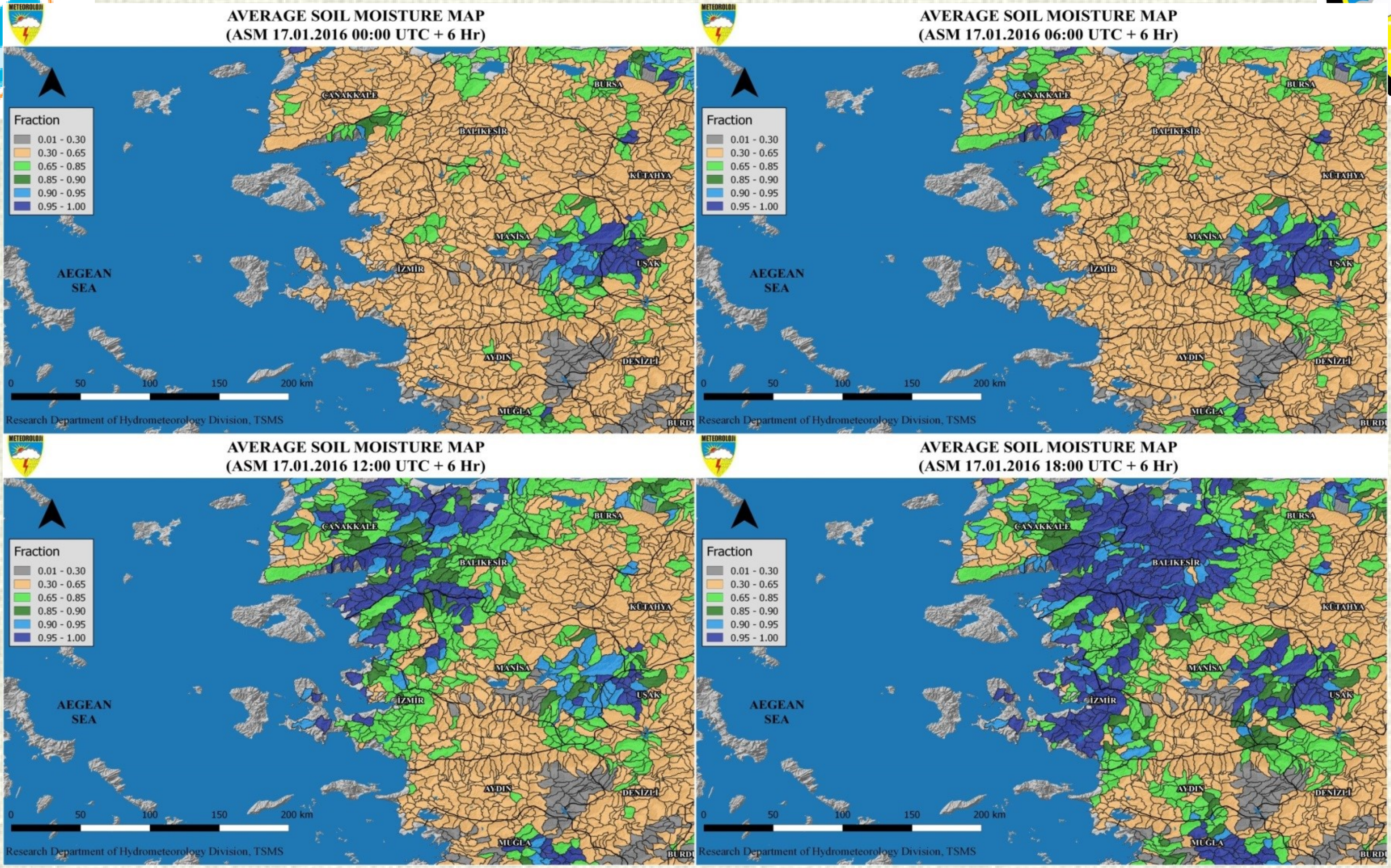
Instability index in the vertical profile of the atmosphere for İzmir 17220 Radiosonde Station Observation on 17 January 2016 at 00UTC(on the left) and 12UTC(on the right).





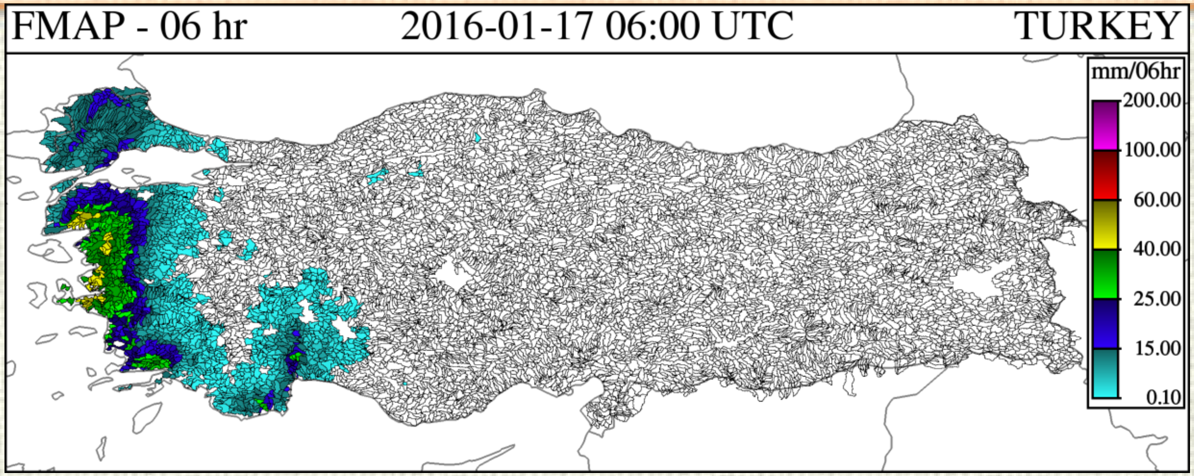
- The sounding image on the left shows a **veering wind** which turns clockwise with height. This veering wind is associated with **warm air advection** and **dynamic lifting**. Furthermore, temperature and dew point temperature lines became closer on the image which refers to a saturated or moist air. South and south east wind associated with warmer and moist air can be seen **up to 850 hPa**.
- The sounding image on the right shows the sounding data indicating up to 100 hPa (approximately 16000 m) geopotential height from the ground as very moist and cloudiness where air temperature and dew point temperature values were very close to each other. Strong south western jet stream was seen above 650 hPa.

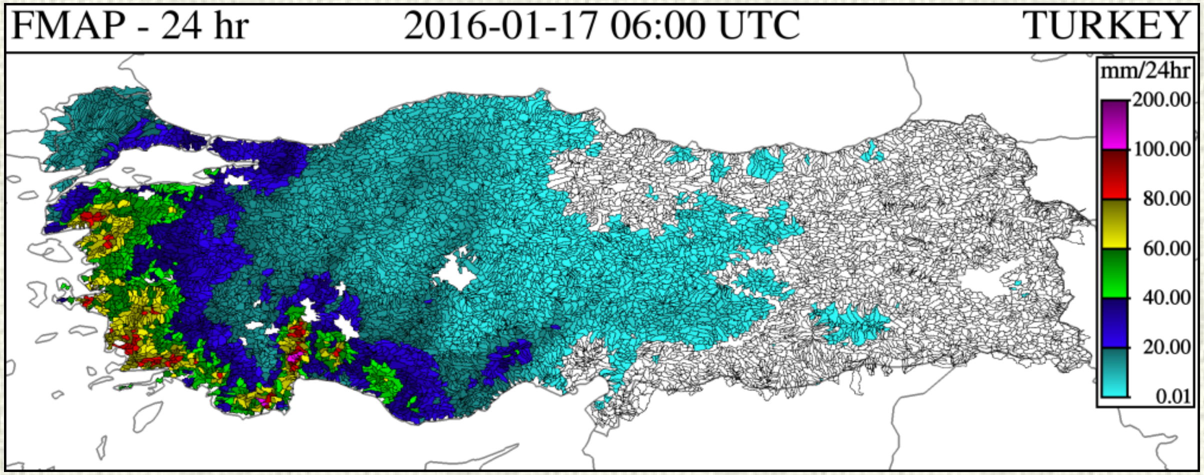
BSMEFFG Products: Average Soil Moisture (ASM-06)



Average Soil Moisture map is changing in time (00-06-12-18UTC) as shown in the images. The color of sub-basins turns from dark yellow to green and finally **blue** on 17 January 2016 at 18:00UTC. Soil becomes more saturated where subbasins are blue thus it can be interpreted as flash flood threat is increasing.

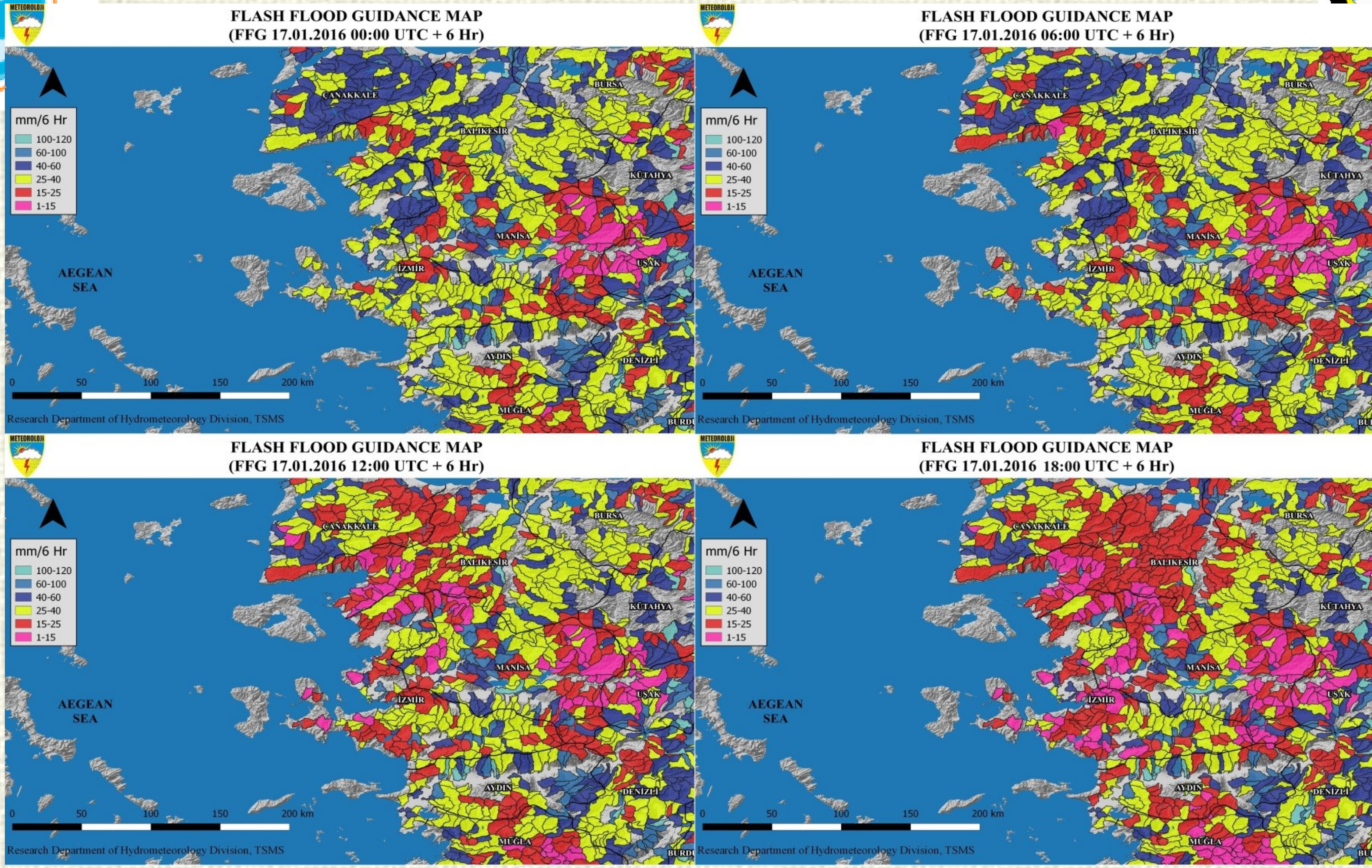
BSMEFFG Products: ALADIN FMAP-06 and FMAP-24





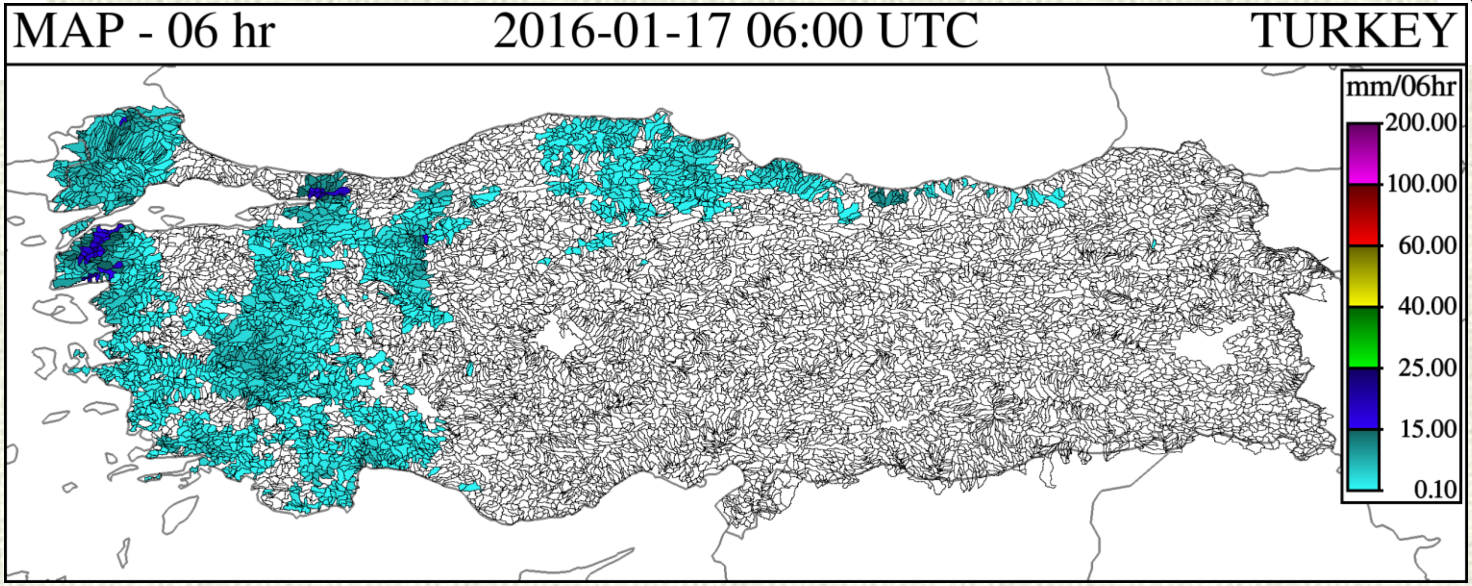
- **FMAP-06hr** (above) and **FMAP-24**hr(below) on 17 January 2016 at 06UTC show that a prolonged and intensifiying precipitation was forecasted in Çeşme, Dikili, İzmir and Manisa.over 6 hr and 24hr beginning from the 06:00UTC.

BSMEFFG Products: FFG-06hr at 00, 06, 12, 18 UTC



FFG value indicates the total volume of rainfall of a given duration (1,3 or 6-hr) over the given sub-basin which is just enough to cause bankfull flow at the outlet of the draining stream. In this case, color of sub-basins gradually turn from blue and **yellow** into **red** and **purple** which means flash flood threat is rising.

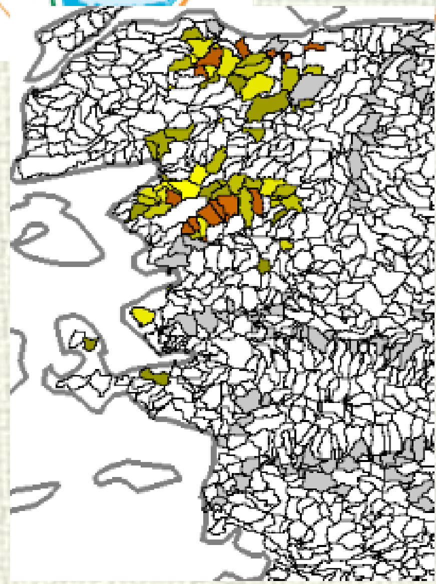
BSMEFFG Products: Merged MAP-06

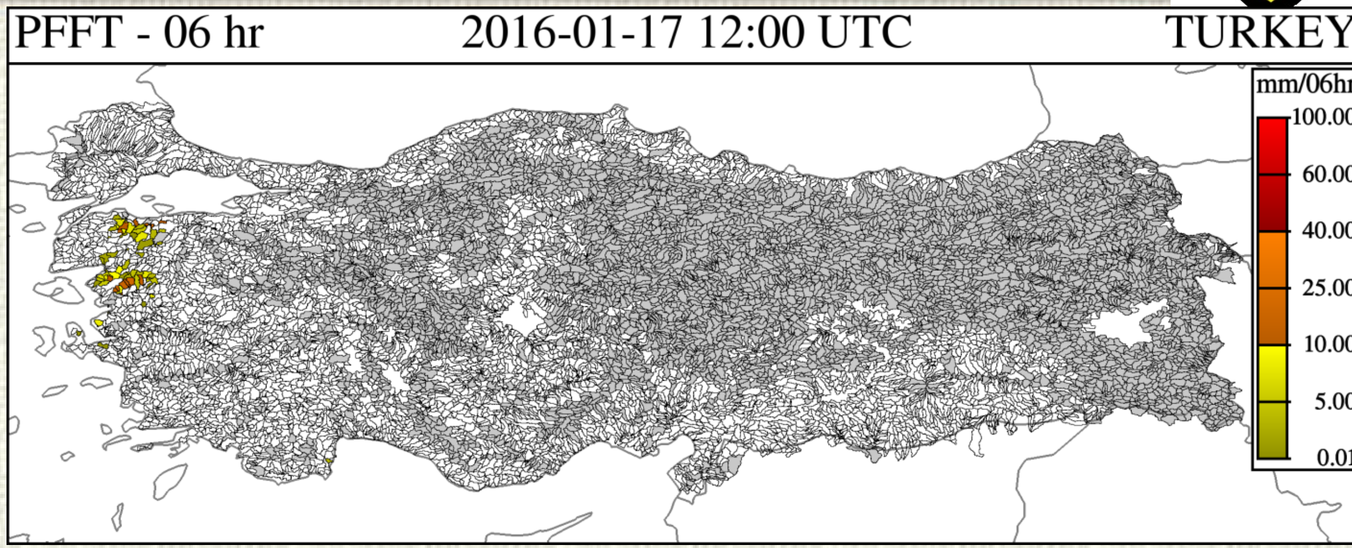


- Merged MAP is main input to the Snow17 and SAC-SMA.
- **Merged MAP** (mm) is derived for each system subbasin based on the best available MAP estimates from
  ** bias-adjusted Radar or
  ** bias-adjusted MWGHE or
  ** bias-adjusted GHE or
  ** gauge interpolations.

- Note that bias is corrected with rain gauge data.

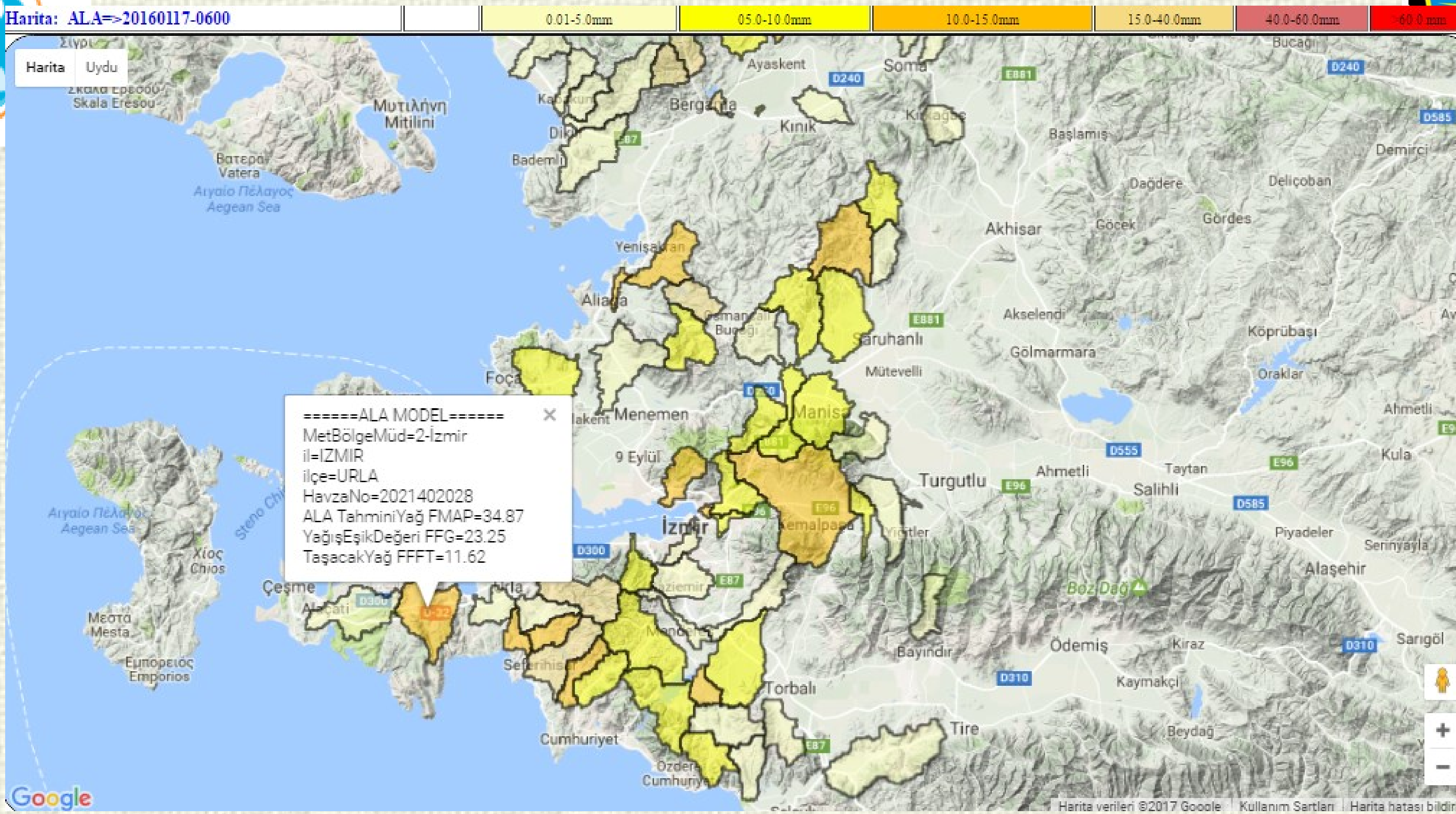
BSMEFFG Products: PFFT-06hr





- PFFT values indicate the difference of recent persisted Merged MAP of the given duration and the corresponding current FFG of the same duration for a given sub-basin.
- PFFT-06 shows yellow coloured sub-basins with the value of approximately 5 mm/6hr as excess water from bankfull level for Çeşme.

BSMEFFG Products: FFFT-06hr



- The FFFT values indicate the difference of the FMAP of the given duration and the corresponding current FFG of the same duration.
- ALADIN FFFT-06 shows orange coloured sub-basins with the value of approximately 60 mm/6 hr as excess water from bankfull level on 17 January 2016 at 06:00UTC for Çeşme.

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FFG Check List for Assessment

Date of Warning: 20160117-0600					ALADIN FFFT	ALADIN FMAP		Gauge MAP	MERGED MAP	ASM	FFG
Model	Region	City	County	BasinID	mm/6sa	mm/6sa	mm/24sa	mm/6sa	mm/6sa	%	mm/6sa
ALA	2-İzmir	IZMIR	CESME	2021402031	0.15	26.93(<-2)	39.48(<-2)	7.46	3.29	0.51	26.78
ALA	2-İzmir	IZMIR	URLA	2021402028	11.62	34.87(3)	52.83(4)	0.42	2.26	0.59	23.25
ALA	2-İzmir	IZMIR	DIKILI	2021401571	0.24	31.52(<-2)	56.41(2)	0.56	3.66	0.55	31.28
ALA	2-İzmir	IZMIR	DIKILI	2021401573	0.83	32.90(<-2)	65.15(4)	0	2.7	0.46	32.07
ALA	2-İzmir	IZMIR	DIKILI	2021401574	4.26	34.80(<-2)	73.45(5)	0	4.65	0.54	30.54
ALA	2-İzmir	IZMIR	DIKILI	2021401579	3.65	34.14(<-2)	68.97(4)	0	4.48	0.51	30.49
ALA	2-İzmir	IZMIR	KONAK	2021402021	3.95	42.27(3)	63.67(3)	1.57	0.97	0.55	38.32
ALA	2-İzmir	IZMIR	KONAK	2021402024	6.62	43.62(3)	72.16(4)	1.26	2.93	0.6	37
ALA	2-İzmir	MANISA	MANISA_M	2021401635	16.34	43.12(4)	63.57(3)	0	1.47	0.54	26.78
ALA	2-İzmir	MANISA	MANISA_M	2021401835	3.23	36.21(<-2)	55.80(2)	0	0.06	0.65	32.98
ALA	2-İzmir	MANISA	MANISA_M	2021401838	5.31	29.63(<-2)	48.38(<-2)	0	0.03	0.66	24.32
ALA	2-İzmir	MANISA	MANISA_M	2021401841	9.75	29.57(<-2)	47.52(<-2)	0	0	0.73	19.82
ALA	2-İzmir	MANISA	MANISA_M	2021401913	2.45	32.59(<-2)	63.24(3)	0	0.38	0.53	30.14
ALA	2-İzmir	MANISA	MANISA_M	2021402005	9.03	33.39(<-2)	62.27(3)	0	0.14	0.56	24.36
ALA	2-İzmir	MANISA	MANISA_M	2021402006	6.87	33.40(<-2)	56.61(2)	0	0.17	0.59	26.53
ALA	2-İzmir	MANISA	MANISA_M	2021402007	6.91	34.53(<-2)	60.42(3)	0.01	0.39	0.54	27.62

Forecaster Opinion: According to check list given above, FF warning is advise for the next 6 hours. In the next 24 hours heavy rainfall was highly expected for Çeşme.

TSMS Extreme Weather Event Observation

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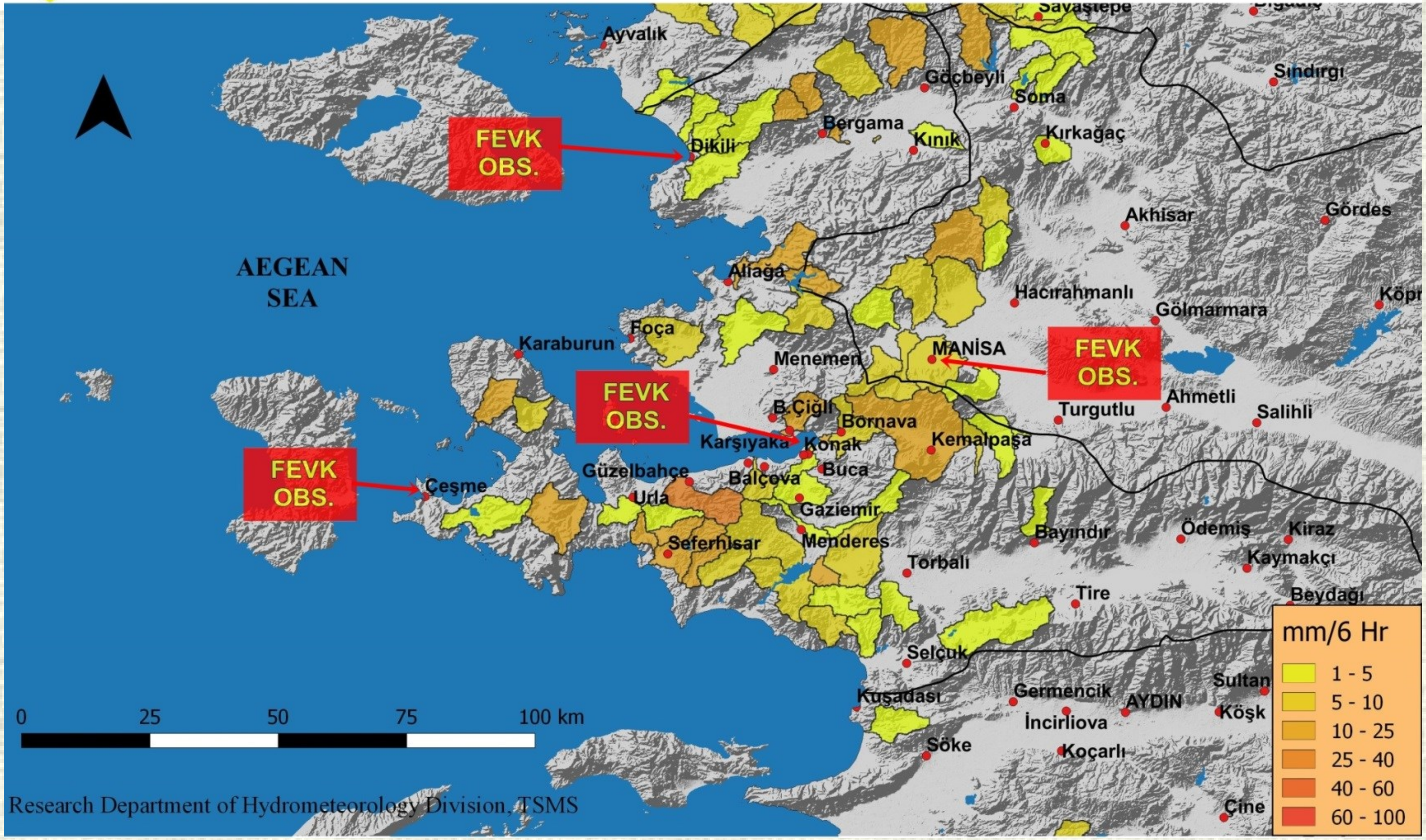
FORECAST FLASH FLOOD THREAT MAP
(FFFT 17.01.2016 06:00 UTC + 6 Hr)



FEVK observations are performed by TSMS for extreme weather events such as flood, hail, storm, high temperature etc. There were four FEVK reports for flash flood as indicated on the map which were prepared for Çeşme, Dikili, Izmir and Manisa.

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RESULTS

Fevk Raporu (ÇESM - 17221) TSMS Extreme Weather Event Report

Başlama Tarihi	17 Ocak 2016 Pazar 04:00		
Bitiş Tarihi	18 Ocak 2016 Pazartesi 01:15		
Olay Tanımı	43- Şiddetli yağış _ Sel _ Su baskını		
Zarar Tanımı	05- Yerleşim yerleri zarar gördü		
Ruzgar Yonu			
Ruzgar Hızı	7777,0		
Yağış Miktarı	109,0		
Yağış Peryodu	24		
Olay Şiddeti	03- Kuvvetli	Olü Var=Hayır	Yaralı Var=Hayır

Damage Report

Hasar Raporu

Meydana gelen kuvvetli yağış neticesinde; Çeşme merkez, Alaçatı, Ilıca ve Ovacık' ta alt yapının yetersiz kalması sonucu yollarda su birikintisi oluştu ev ve işyerlerinin alt katlarını su bastı. Yetkililerden aldığımız bilgilere göre 600.000 TL maddi hasar oluşmuştur. Abdulkerim KARATAŞ

- We have analysed meteorological conditions that caused flash flood event on 17 January 2016 in Çeşme, İzmir, Manisa and Dikili in terms of synoptic scale weather patterns, satellite product, ECMWF surface chart, radar product and sounding analysis.
- A Mediterranean cyclone developed over Greece produced heavy precipitation and caused flash flood event on 17 January 2016 in Çeşme, Dikili, İzmir and Manisa.
- In this study, a top-down approach has been used for the analysis. In other words, We started with synoptic scale, mesoscale and nowcasting analyses and finally FFGS products were investigated and analyzed.
- As a result, the use of FFGS products to issue flash flood watches / warning was shown to be very effective and useful.

THANK YOU FOR YOUR ATTENTION

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