# The *Ihtiman* Flood Event in Bulgaria, 04-07.08.2005

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## Introduction

The *Ihtiman* flood event in Bulgaria in the beginning of August 2005 provoked an outrage of polemics concerning the weather predictions in our country. It actually turned out that our weather service provided the authorities with severe weather warning a couple of days ahead of the event. Apart from that our NWP models' operational forecasts were very good in predicting the exceptional precipitations at least 24 hours in advance. All this excellence has been delivered in conditions of chronic under-funding in which our national civil weather service has functioned for more than a decade. We hope that this sad occasion of severe floods in our country and the misfortune of so many of our compatriots will motivate the government and the public and will be transformed into an opportunity for modernization and upgrade of the Bulgarian civil weather service.
The present material is an attempt to present an analysis of the atmospheric dynamics which lead to the catastrophic weather in West and South Bulgaria on 4, 5, and 6 August 2005. It is illustrated with satellite images, maps of NWP model analysis, and plots of real precipitations data.

## Initial weather situation

The process begins to influence the weather in Bulgaria in the morning on 4 August. The frontal system approaches our country from the west. It is associated with a cyclone positioned over the north-west Balkans: Hungary, Serbia, Croatia, and Slovenia. The upper level low center is positioned over Italy and the Adriatic Sea. It was formed over the western Mediterranean the previous couple of days in the typical birth place for Mediterranean cyclones in between the coasts of France, Italy, and Corsica. Cold air from the north-west sank into the Mediterranean to the west of the Alps and generated the *Ihtiman* cyclone on 2 August. The cyclone then moved along side the Alps which served as a natural boundary and reached the Adriatic Sea on 3 August. During this journey of the *Ihtiman* cyclone through the Mediterranean a significant amount of moist air has been lifted and has joint the cyclonic circulation.
Thus, in the morning of 4 August, the weather situation to the west of Bulgaria can be briefed as follows:

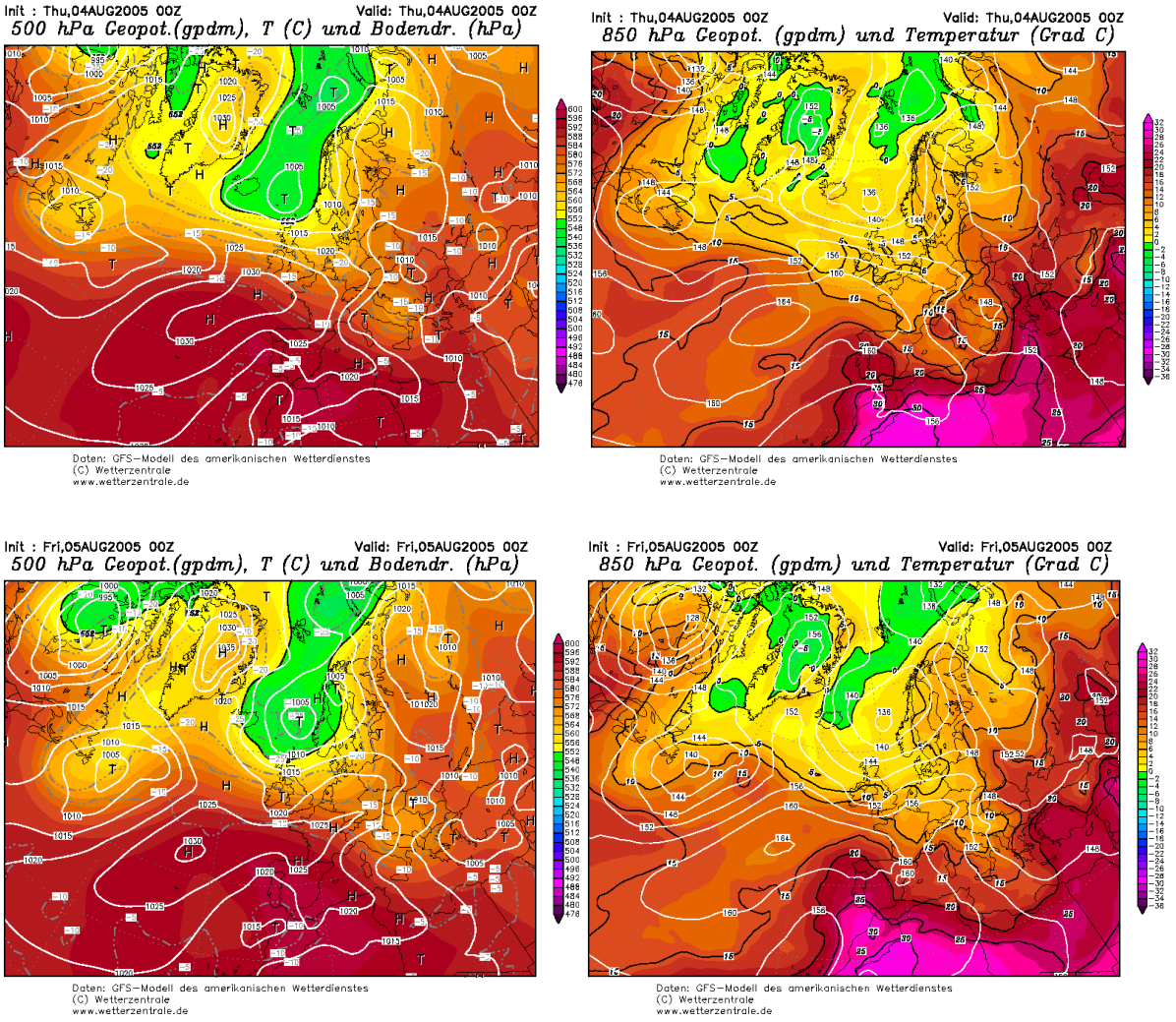
1. A baroclinic Mediterranean cyclonic system is situated to the west of Bulgaria. The upper level low is over Italy and the Adriatic Sea. (see Fig.1a, H500, 04.08).
2. The cold front associated with the *Ihtiman* cyclone is stretched from south to north-west over the West Balkans and propagates slowly to the east towards our western border (see Fig.2a).

## Stationary cold front over West Bulgaria

About 3-6h UTC on 4 August the cold front enters the country from the west. It is very active with convection cells propagating from the south to the north alongside the frontal boundary. The front passes slowly trough West Bulgaria and before the evening reaches the line of Velingrad-Pirdop-Teteven-Oryahovo. In the same time the center of the vortex moves northwards, from the Adriatic to the North-West Balkans, and thus leaves the cold front ahead without momentum to propagate further eastward in Bulgaria. The frontal boundary remains almost stationary for at least 24 hours covering a band about 50km wide to the west of the above given line of towns (see Fig.2). The front however is active. On the synoptic charts Balkan from 3h, 6h, and 9h UTC on 4 August (not shown) the wind convergence along the frontal boundary is easily recognizable. The winds along the western border of the country are

already turned from the north-west while those to the east of the frontal line have direction from the south-east in general. The thermal gradient west-east remains strong as well (see Fig.1b, 1d). All this, combined with the flux of moist air from the south to the north-west along the frontal line, provides conditions for interminable passage of convective systems with abundant precipitations across the same places for about 24 hours. The stationary frontal band of clouds is very well seen in Fig.2c satellite image for 24h UTC, 4 August.

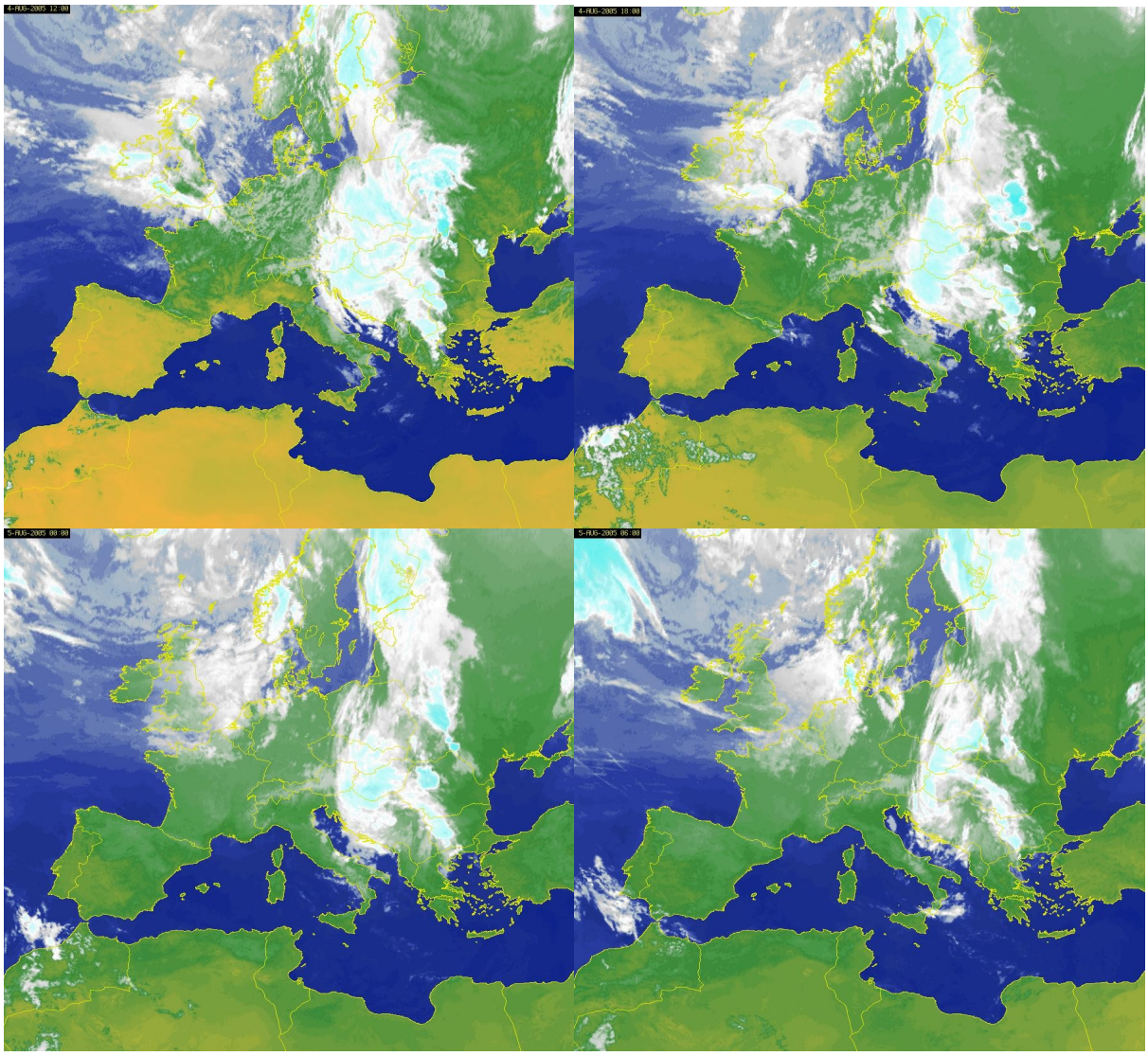
**Figure 1: GFS NWP model analysis, 4 & 5 August 2005. H500+Pres & H850+T850.**




Another factor contributing to the intensity of the precipitations is the orography. Western Bulgaria is mountainous. The frontal band on 4 and 5 August covers the West Rodopi, Rila, West Stara Planina, as well as other smaller scale mountains. At least the Rila Mountain's main chain and the Stara Planina's one are positioned across the flow of convective systems moving from the south to the north. Thus the mountains serve as generators of fresh convection as well as helpers to enhance crossing convective systems which intensify at the arriere side of the mountains. Probably this effect contributed significantly to the intensity of the precipitations in some areas with reported floods and extraordinary amounts of precipitation during the night of 4 to 5 August. These are the towns of Ihtiman and Kostenec, positioned in the valley right behind the Rila Mountain, Botevgrad, which is in the valley right behind the Stara Planina, as well as Velingrad which is in a valley behind the West Rodopi Mountain. This pattern of arriere mountain enhancement of precipitations is recognizable in Fig.3 which shows the accumulated precipitation amount for 24 hours from the beginning of the process on 4 August to 7h30 local

time on 5 August. The spots with maximum amount of precipitation are the Ihtiman-Kostenec domain and Botevgrad. They are coupled with local minimums above the generating mountains as for example above Rila and the mountains to the south of Sofia.

**Figure 2: IR image ATSA, EUMETSAT, 04.08, 12h, 18h, 24h UTC & 05.08, 06h UTC.**



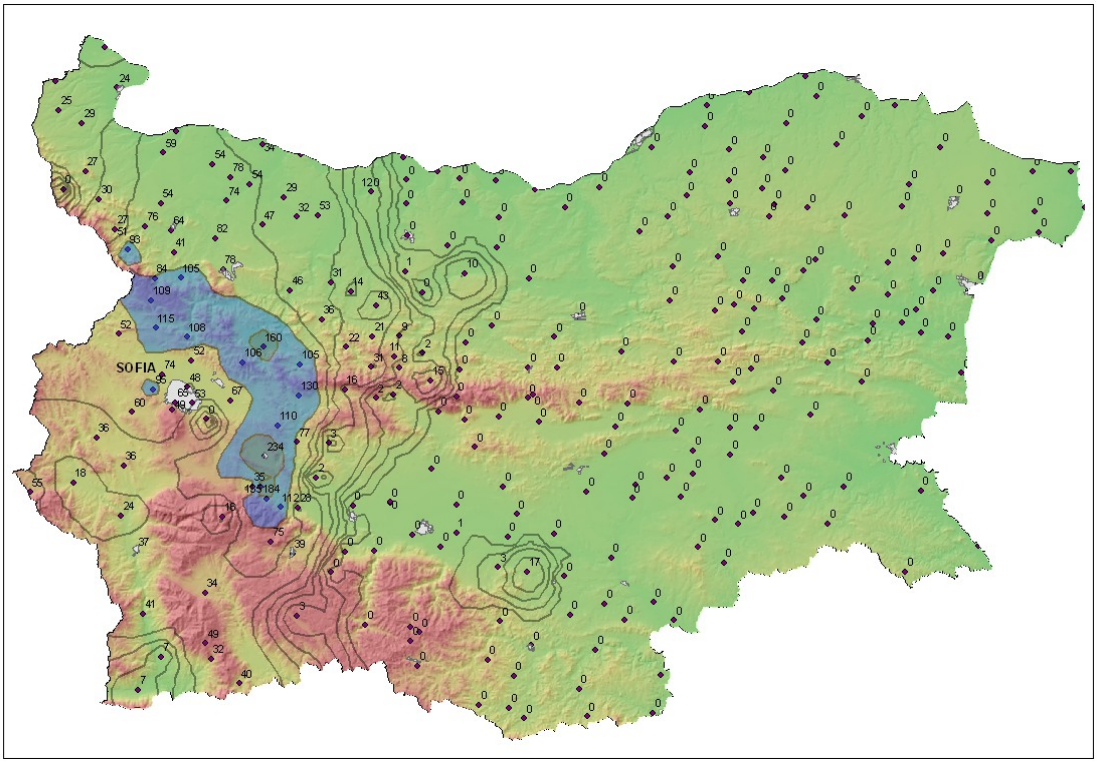
We argue that the extraordinary amounts of precipitation which lead to floods in West Bulgaria on 4-5 August are not due to extraordinary atmospheric phenomena but to the fact that relatively regular and normal, though strong and intensive, cloud systems dominate the weather at the same geographical spot for very long time. In the case of the Ihtiman flood from 4-5 August we can summarize the conditions responsible for the exceptional rain:

1. The cold front is stationary over the region of western Bulgaria for as long as 24 hours (see Fig.2).
2. It is associated with strong temperature gradient (see Fig.1d). There is a pronounced wind convergence along the front line. This two provide excellent conditions for sustained convection.
3. There is available a fair amount of moisture due to the previous evolution of the air masses associated with the *Ihtiman* cyclone in the Mediterranean (see Introduction) as well as local moisture due to the humid summer of 2005 in Bulgaria. The moisture is

rapidly transported from the south to the north-west along the frontal band thanks to the strong southern flow (see Fig.1a,1c).

4. The orographic enhancement of the convection contributes even more to the rain intensity in the arriere mountain zones.

**Figure 3: : 24h cumulative amount of precipitation, 07h30 local time, 05.08.2005.**




## Mesoscale convective system over Rodopi

The convection along side the front line is subdued soon after the sunrise on 5 August. During the day the frontal zone becomes more spread. Actually, with the drift of the upper low from the Adriatic Sea towards the north-west Balkans the cold air retreats in the upper levels from its positions in early 5 August (see Fig.1d and Fig.4b). However, near the surface, the cold air propagates to the east. On the synoptic chart Balkan from 9h UTC on 5 August the wind convergence pattern is recognizable along the line Svilengrad-Chirpan-Kazanluk-V.Turnovo-Russe (all of them synoptic stations). These two facts suggest higher instability for all the West and Central Bulgaria. These conditions lead to strong convection in West and Central Bulgaria in the afternoon on 5 August. First, along the above given convergence line, develops a line of convective clouds which bring severe hail storms in Haskovo and Dimitrovgrad as well as thunderstorms along the line Krumovgrad-Haskovo-Kazanluk. Than, the convection becomes generalized in the West and Central Bulgaria. The convective systems propagate from south-east to north-west. Thus, some of them, generated over the West Rodopi, Rila, and other smaller mountains, pass again across the already flooded regions of Ihtiman and Kostenec as well as the Sofia valley. Plovdiv also reports abundant rain as it is positioned right to the north of the Rodopi.

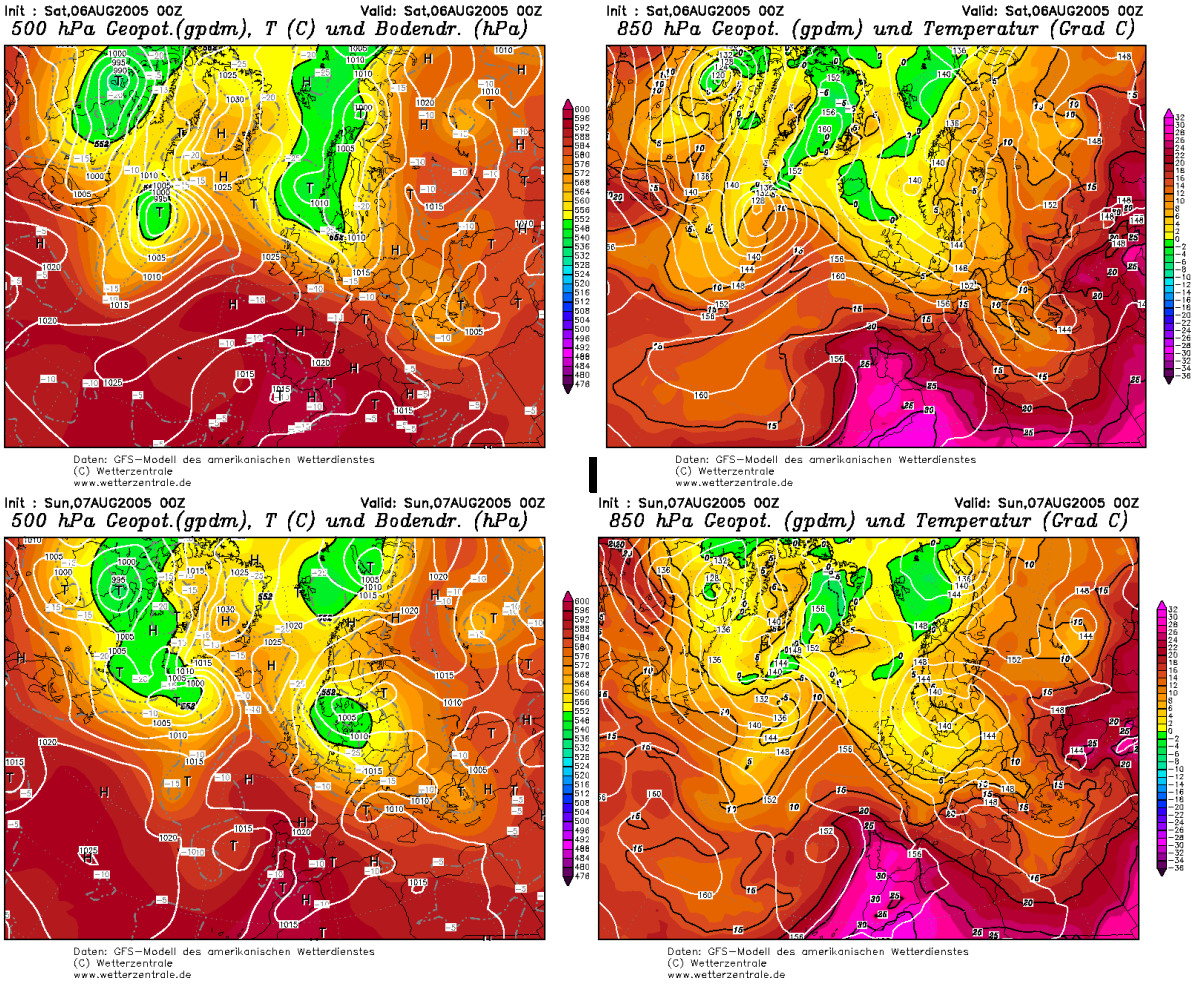
Figure 5 presents the water vapor satellite images from 5 August. One can track on them the trajectory of an upper level vortex rapidly sinking from the Alps through Italy towards North Greece. This mesoscale vortex becomes the core of the *Ihtiman* cyclone late on 5 August.

We can summarize the following conditions over the Rodopi Mountain in the evening on 5 August:

1. There is generalized strong convection in the south-west part of the country due to high instability.
2. The core vortex of the *Ihtiman* cyclone is positioned right to the south of the Rodopi in neighboring Greece.

These two features mutually induce and enhance each other. The vortex facilitates even further the upward motion in the convection and the energy of the heat-of-the-day convection sustains the rotation of the vortex.

**Figure 4: GFS NWP model analysis, 6 & 7 August 2005. H500+Pres & H850+T850.**

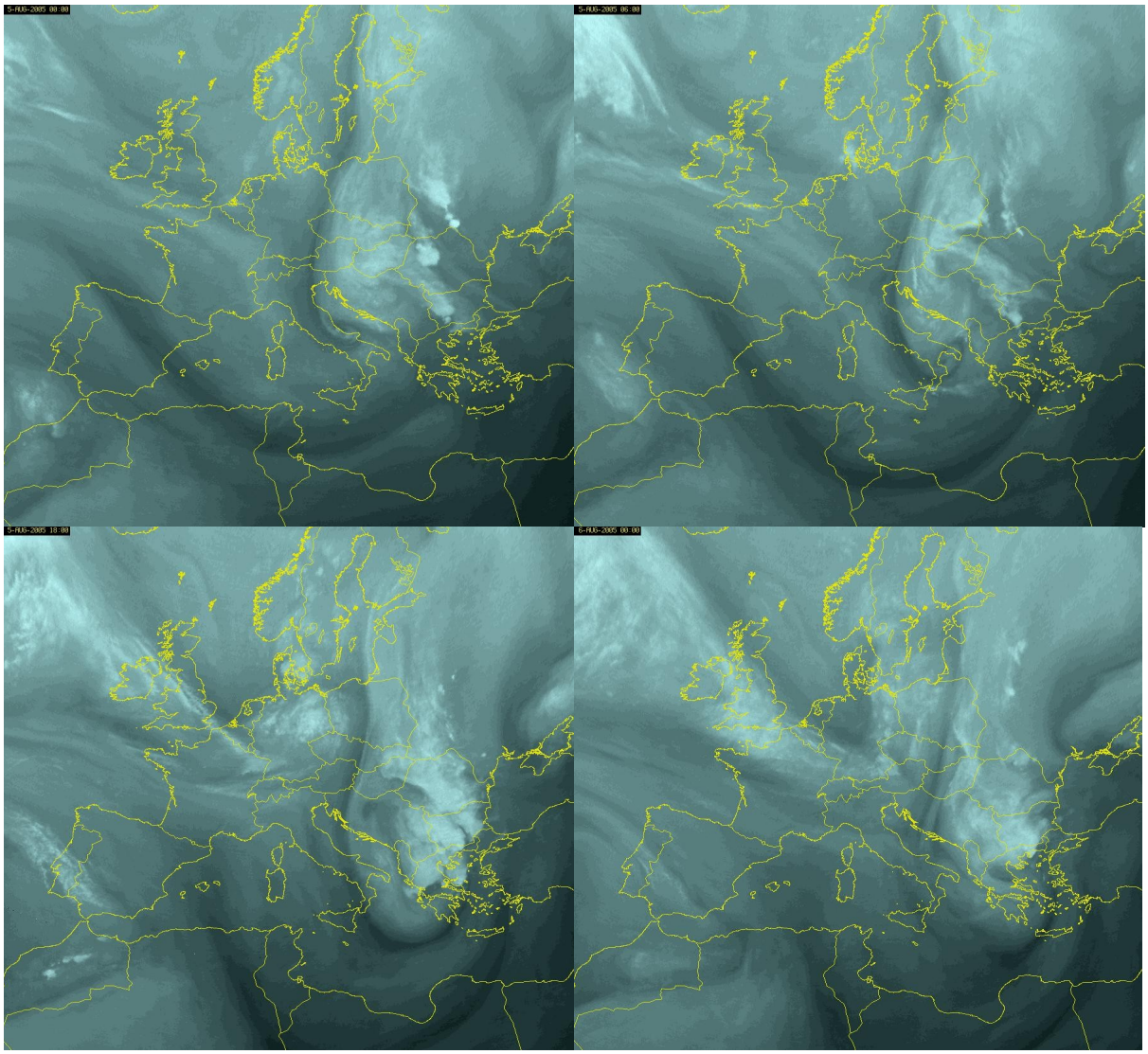



The night from 5 to 6 August is marked by the severity of the weather in the Rodopi Mountain, and particularly in the region of Smolyan. It is very close to the core of the *Ihtiman* cyclone (see Fig.5d). The region of Smolyan is among those reporting highest amount of precipitations for 24 hours at 7h30 local time on 6 August (see Fig.6). There are also severe floods reported.

## Drifting away

On 6 August, after devastating the Smolyan region, the *Ihtiman* cyclone continues slowly its drifting eastwards through North Greece. In fact, it behaves like a winter Mediterranean cyclone. This makes it unusual and rare. With its eastward propagation the *Ihtiman* cyclone is set to dominate the weather on 6 August in East Bulgaria as well. The convective systems generated in the Rodopi Mountains propagate towards north-east in East Bulgaria where there are reported thunderstorms with flush rain and hail.

**Figure 5: WV image, 00h, 06h, 18h, 24h UTC, 05.08.2005.**



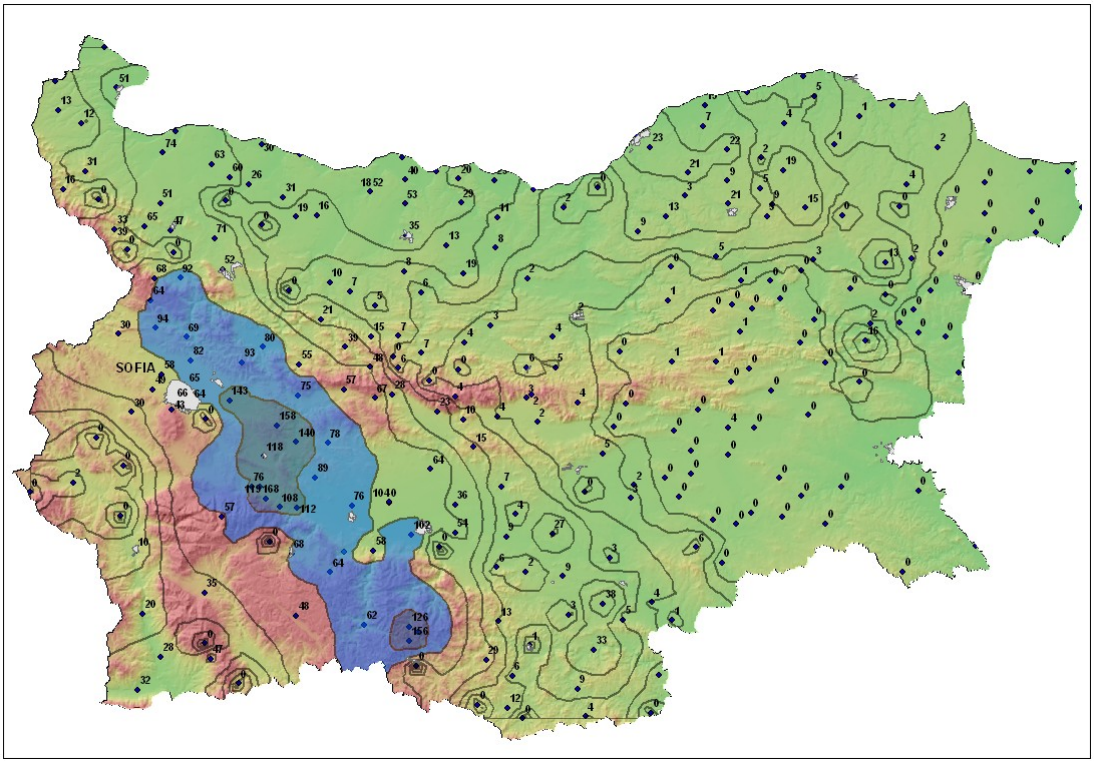
However this convection is not sustained as in the west of the country the day before. The reason is that the frontal system moves rapidly off shore into the Black Sea where it remains until 7 August.
Late on 6 August, in the west of the country, the air flow is oriented from the north and becomes vertically homogeneous (see Fig.4c). It brings cooler air and there are only occasional thunderstorms and rain.
On 7 august the main convective system associated with the *Ihtiman* cyclone and the core vortex itself are in the Black Sea off the Bulgarian coast. They move northwards. There are a few convective clouds only still lingering behind in South-East Bulgaria. The rest of the country is dominated by the cooler air behind the *Ihtiman* cyclone. The weather is stable with moderate westerly winds and a couple of rain showers.

## Final words

The *Ihtiman* cyclone is unusual but not extraordinary meteorological phenomenon. Its vortex trajectory from the Adriatic Sea to North Greece and Black Sea puts it in the class of the winter

Mediterranean cyclones and this is unusual and rare for mid summer. The severity of the weather associated with the *Ihtiman* cyclone therefore can be attributed to this fact as well.

**Figure 6: 24h cumulative amount of precipitation, 07h30 local time, 06.08.2005.**




The extremely high amounts of precipitation registered in West Bulgaria are not due to any extraordinary meteorological phenomena but to the fact that regular, though very active and strong cloud systems, dominate the weather in one and the same area for a very prolonged period of time.

The floods in Ihtiman, Kostenec and Botevgrad on 4-5-6 August are caused by more than 24 hours passage of convective systems siphoning rain over these regions. These convective systems are transported along a stationary cold front and enhanced by the mountain barriers.

The flood in the Smolyan region in the Rodopi Mountain on 5-6 August is caused by the mutual induction of the core of the vortex over North Greece and the strong convection over South-West Bulgaria.

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