

ATMOSPHERIC PATTERNS DURING THE STORMS FROM JANUARY 2014 IN BULGARIA AND ROMANIA

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Abstract. Synoptic conditions associated with strong winds and snowfalls on January 2014 in Bulgaria and Romania are investigated in this paper. The Romanian authorities established the orange and red codes while the Bulgarian ones the orange code. A first peak was recorded in northern and especially north-eastern Bulgaria and south-eastern Romania on January 25-26 and a second one on January 29 2014. The purpose is to understand what regulates the duration and intensity of these events. For their study, NCEP-500/700/850 and SLP analyses, different model outputs and soundings as well as data from 12 weather stations have been used.

Introduction

When associated with drifting snow, strong winds have grave consequences on transports, infrastructure, electricity supply etc. in Bulgaria and Romania. Strong winds in the south-eastern parts of Romania and north-eastern parts of Bulgaria occur in winter during synoptic conditions described as “the coupling” continental anticyclone/Mediterranean cyclone arriving over the Black Sea.

Climatological studies showed that more than half of all the storms in the region occur during such synoptic conditions and that the dominant wind direction is north or north-east (Valchev et al., 2012; Chiotoroiu, 1999). Cold air is brought to low latitudes due to an important amplification of the planetary-scale flow waves during the development phase of the Mediterranean cyclones (Georgescu et al., 2009; Maheras et al., 2001; Tayanc et al., 1998). Heavy

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precipitations over Bulgaria and Romania are connected to the observed paths of the cyclones (Apostol, 2008; Bocheva et al., 2007). At 1000 hPa an elongated minimum core distributed between the Aegean and Black seas, beneath the upper-trough was observed using the composites of geopotential height (Trigo, 2002). The south-east part of Romania is generally characterised by the presence of thermal inversions, with the cold air prevailing at ground level (ENE winds) and the warm air at 900-850 hPa (SSE winds), Draghici et al., 1990. Unexpected heavy snowstorms in the western and south-western parts of the Black sea are related with sea-surface 850 hPa temperature differences and with sea-land temperatures differences (Kindap, 2010). Blizzards and cold waves in the eastern and south-eastern parts of Romania and north-eastern Bulgaria are due to this interaction between a continental anticyclone and a Mediterranean cyclone (Chiotoroiu et al., 2013; Ionac et al., 2012; Georgescu et al., 2009; Cordoneanu, 2004; Georgescu et al., 2004; Capsa and Timofte, 2005; Popa and Soci, 2002; Latinov and Nikolov, 2001; Latinov, 2001).

During the period between the 25 and the 30 of January 2014 many local roads were closed and some regions witnessed power outages in the south-east part of Romania. Traffic on highways and sections of 27 national roads was closed. Inhabitants from several villages in the counties of Braila, Buzau, Galati remained isolated due to snowfall. **Over 160 trains were cancelled**, traffic restrictions being introduced for many railway lines. **The maritime ports of Midia, Constanta North, Constanta South Agigea and Mangalia** were closed on 26 January because of the strong wind; also transport activities on the Danube – Black Sea and Sulina – Bara Sulina canals were suspended (<http://www.euronews.com/2014/01/29/...>).

In the Bulgarian regions of Ruse, Silistra, Razgrad, Targovishte and Dobrich many roads were closed between the 24 and 26 of January 2014 when strong winds formed snowdrifts. Roads became icy in Varna and Burgas on January 26 because of the heavy rain and the cold spell. Few villages in the regions of Shabla, Kavarna and Dobrich from the north-eastern part of Bulgaria were without electricity because of icy or broken electrical cables. The maritime ports of Varna and Burgas were closed from the 24 to the 27 of January and again from the 28 to the 30 of January. Bridges over the Danube were also closed during this period.

National committees for emergency situations have been created in Bulgaria and Romania and appropriate regulations have been adopted in order to prevent damages and protect population during natural disasters. The population is informed about the weather phenomena and the risks involved through the mass media, internet or by calling telephone numbers provided by

the national authorities. The main information about the intensity of the phenomena is provided by the meteorological warnings.

The main purpose of this paper is the analysis of the genesis conditions and of the weather characteristics during these storms using GFS and Aladin model outputs, soundings and data from the weather stations.

1. The meteorological warnings.

The storms from January 2014 were considered by the Romanian authorities as dangerous phenomena and orange and red codes* were issued by the meteorological administration.

**Orange and red codes meaning is:*

“dangerous weather phenomena of high intensity are forecast (wind, heavy rainfall, electrical discharges, hail, hot weather, extreme cold). There is a risk of flood on small rivers)” and “extremely violent and dangerous weather phenomena are forecast (wind, heavy rainfall, thunderstorms, hail, hot weather, extreme cold). There is a risk of major floods” respectively.

The orange code was issued starting with the 25 of January, first at 5 a.m. local time only for the northern part of the Olt county (OT on the map) and afterwards for almost all the south-eastern part of Romania (fig. 1). This warning was valid until the 26 of January at 22 p.m., local time. The main weather phenomena forecast were: wind gusts over 70–80 km/h, drifting snow and visibility less than 50 m (<http://www.agerpres.ro/news-of-the-day/2014/01/26/...>).

Issuing a Code Red in Romania requires several cumulative conditions, including the risk of impossible circulation on roads, railways, by air or by water, villages risk being secluded, and the lives of villagers are endangered, as well as possible damages to forests and electrical networks. On January 26 2014 the meteorological phenomena became extremely violent and the Romanian meteorological administration decided to adopt the red code from 3 p.m. to 9 p.m. This warning concerned only a restricted area covering the department of Buzau (BZ), the south part of the Vrancea county (VN) and the north part of the Braila county (BR). The forecast referred to: heavy snowfall, blizzard and drifting snow, visibility almost zero, wind gusts that can exceed 70-80 km/h; at 13 h (on January 26 2014) the snow cover was about 40 cm and the blizzard had a continuous duration of 36 hours (fig. 2). Another orange code was issued on January 29, the warning concerned many counties in the south-east Romania (<http://ercportal.jrc.ec.europa.eu/ECHO-Flash/...>).

In Bulgaria the orange code** was adopted for all the 15 regions from the north and east parts of Bulgaria (fig. 1). The weather phenomena forecast were: snow cover of 15-25 cm, strong east winds, risk of blizzard and snowdrifts; in

the districts of Dobrich, Varna and Burgas east winds will reach 25-30 m/s (over 90 km/h); rainfall amounts could reach 15-20 mm.

***The Bulgarian definitions follow the Metealarm ones (Fuchedziev et al., 1981). The orange code means: “the weather is dangerous. Unusual weather phenomena have been forecast. Damage and casualties are likely to happen. Be very vigilant and keep regularly informed about the detailed expected meteorological conditions. Be aware of the risks that might be unavoidable. Follow any advice given by your authorities”.*

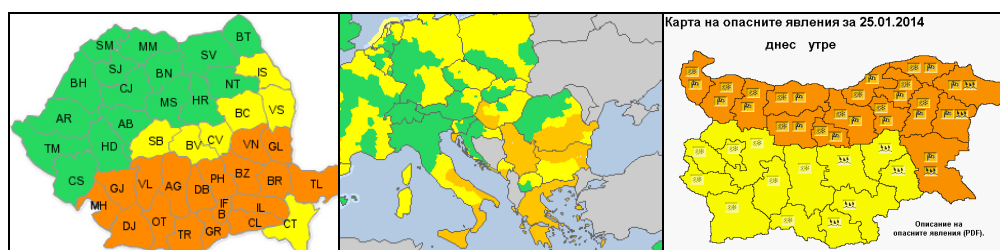


Fig. 1. Warnings of the Romanian Meteorological Administration (left), Metealarm (centre) and of the Bulgarian Institute of Meteorology and Hydrology (right), starting with 25.01.2014

2. The synoptic conditions.

The development of a low pressure area over Italy and the extension of a high pressure field over the north-east of Europe were the main characteristics of the atmospheric circulation in the low troposphere on January 24 2014. The presence of a trough at 500 hPa enhanced the development of the Mediterranean cyclone (fig. 2).

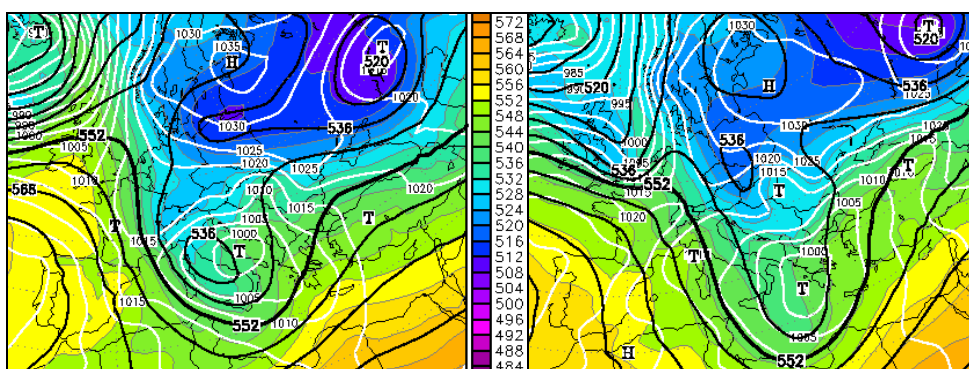


Fig. 2. Sea level pressure, 500 hPa geopotential and relative topography H500-H1000, GFS analysis, January 2014 24, 18 UTC (left) and 25, 18 UTC (right), www.wetter3.de

In the middle troposphere the flow was from southwest the 24 and from south the 25 of January, while surface winds blew from east-northeast on 24 and from north-east the 25 when they became very strong (fig. 3). Their opposite directions explain the cloudiness and precipitations on January 24: snow in the weather stations located on the cold side of the warm front and rain in other stations (including the coastal area).

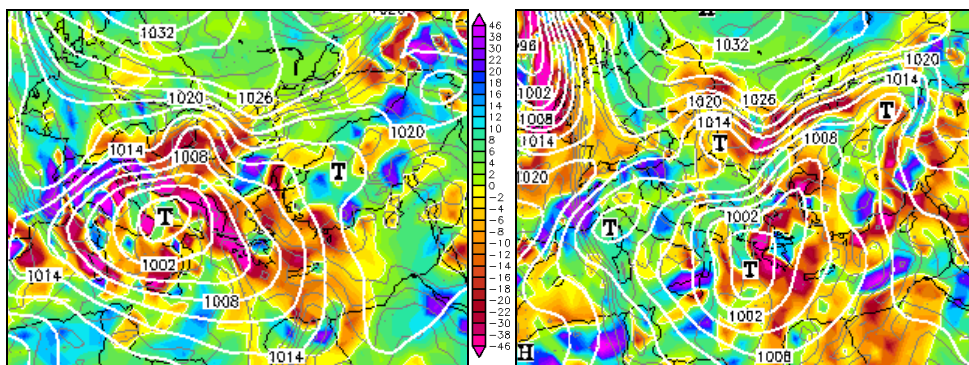


Fig. 3. Sea level pressure (hPa), 700 hPa vertical movements, 850 hPa frontal zones, January 2014 24, 18 UTC (left) and 25, 18 UTC (right), www.wetter3.de

The precipitations' type and intensity can be better observed on the approximate soundings for Dobrich (Bulgaria) and Buzau (Romania), fig. 4. On January 24, at 18 UTC the inversion layer was thicker over Buzau (Romania). Air temperature and dew point lines were on the left side of isotherm zero while for Dobrich they were over it. The air above 700 hPa was not so saturated. Stratus clouds formed so precipitations were slight. Vertical wind shear clearly appears and shows slight warm advection above 850 hPa. At 700 hPa the upward vertical movements became very intense over Macedonia (up to -38 hPa/h). East-northeast winds at ground level became stronger too.

On January 25, 12 UTC the relative humidity recorded high values at 700 hPa over Romania, north Bulgaria and northwestern Black Sea and vertical movements reached ~ -20 hPa/h (fig. 3). Rain and snow falls were more important than the previous day (fig. 4).

Starting with January 26, advection of cold air from the north can be observed at 850 hPa (-10°C over Romania and -12°C over the north-western part of Bulgaria), while the air is warmer over the Black Sea ($+5^{\circ}\text{C}$), fig. 5. The cyclone is now centered over the Peloponnesian peninsula, with pressure decreasing to 995 hPa. The circulation is meridional at 500 hPa, with a trough located over the sea-level low pressure centre. High relative humidity and

strong vertical movements at 700 hPa can be observed over eastern Bulgaria and Romania (fig. 5).

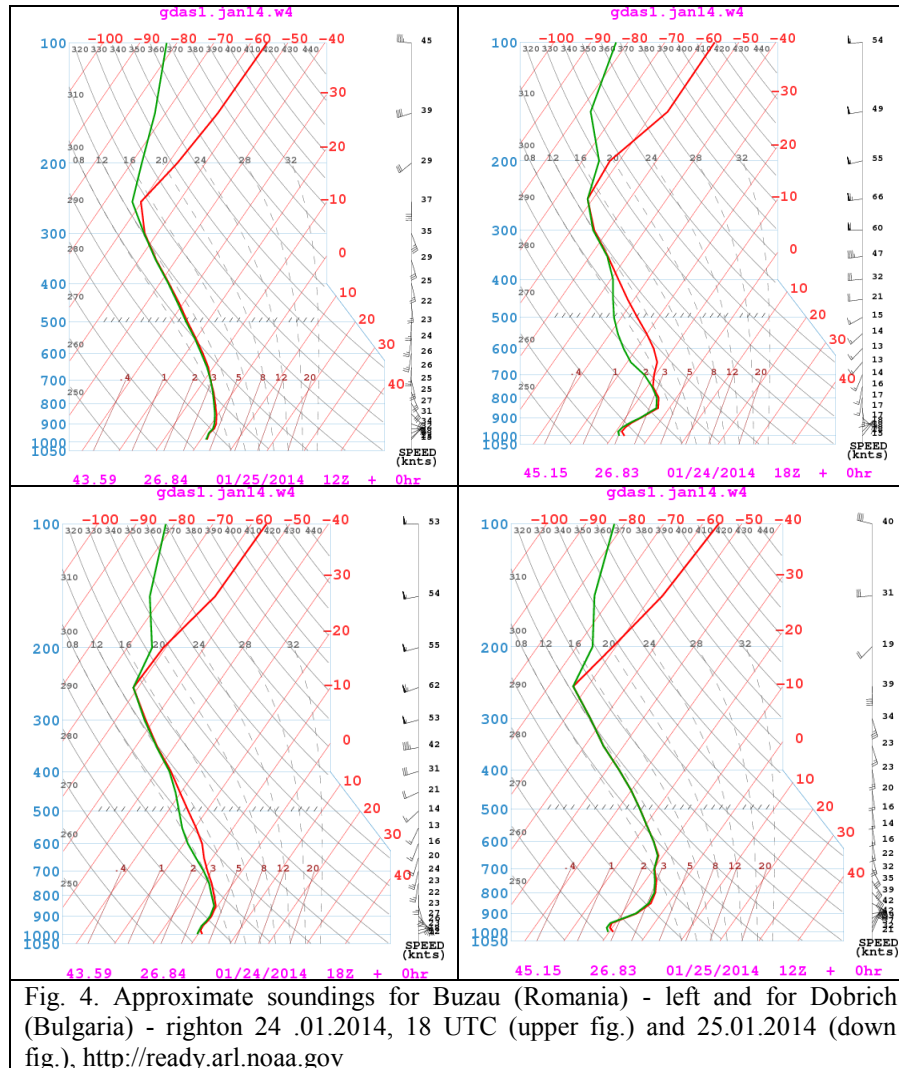


Fig. 4. Approximate soundings for Buzau (Romania) - left and for Dobrich (Bulgaria) - right on 24 .01.2014, 18 UTC (upper fig.) and 25.01.2014 (down fig.), <http://ready.arl.noaa.gov>

Figure 5 also shows heavy snowfalls over a large part of Bulgaria and south-east Romania. Due to the snowfalls, the snow cover quickly rose on January 25 2014 ; it reached more than 40 cm in the Romanian stations of Buzau and Galati and more than 50 cm in the station of Craiova, while in

Bulgaria the maximum height was under 40 cm in Razgrad at the end of the studied period 25 to 30.01.2014 (fig. 6). Snow covers of more than 40 cm height were recorded in other weather stations (not represented in this paper) within an area covering parts of the Romanian counties of Buzau, Vrancea and Braila. Snowdrifts were also very high here, 200 cm near Bucuresti, 260 cm in Focsani and Ramnicu Sarat (Sipos and Manta, 2014).

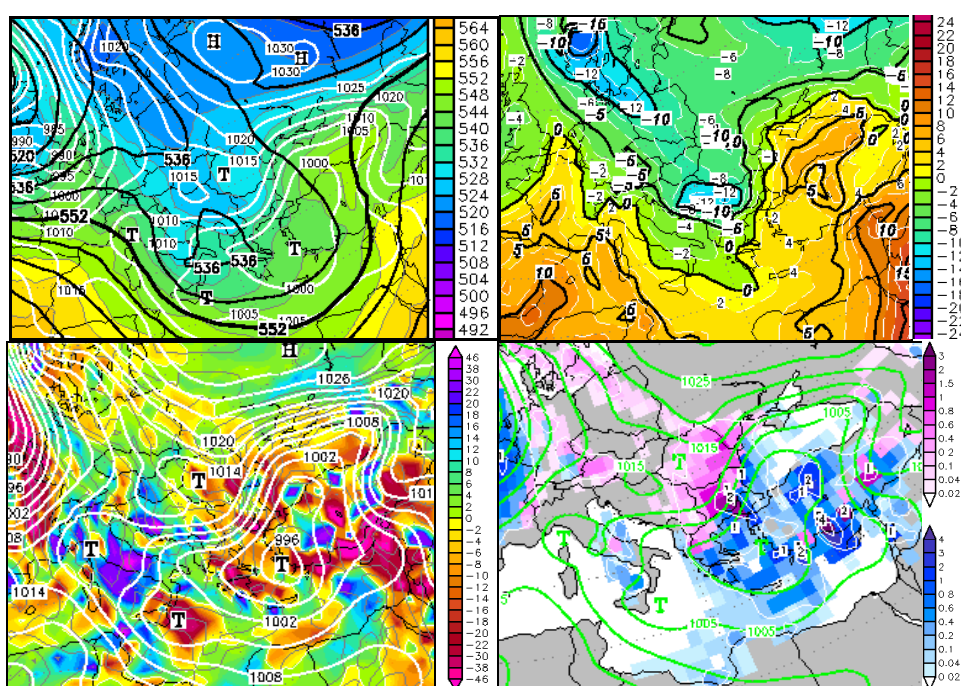


Fig. 5. Upper figures: Sea level pressure, 500 hPa geopotential and relative topography H500-H1000 (left) and temperatures at 850 hPa (right), GFS analysis; Down figures: Sea level pressure, 700 hPa vertical movements, 850 hPa frontal zones (left) and precipitations in mm/h (snow in pink, rain in blue), 6h forecast (right), GFS model; January 2014 26, 18 UTC, www.wetter3.de

Wind gusts reached more than 22.5 m/s (80 km/h) in Buzau and Sulina on January 25/26 and again on 29/30 while in Bulgaria winds over 24 m/s (86.4 km/h) only in Razgrad on January 25 and more than 21 m/s (75.5 km/h) in Shabla (on the coast) on January 29 2014 (fig. 6).

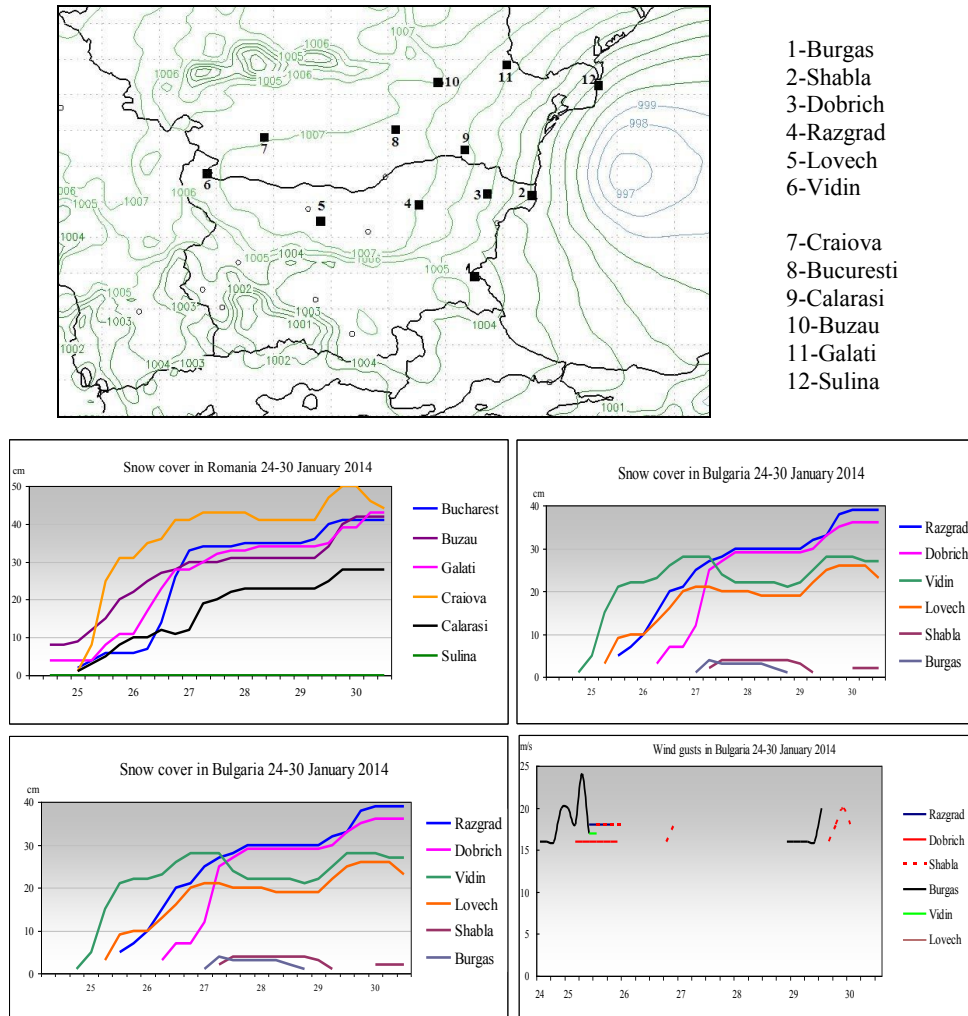


Fig. 6. Location of the weather stations (upper fig.); snow cover (cm) and wind gusts (m/s), (down figs.). The support map is from the ALADIN model output for January 27, 2014, 18 UTC.

Due to its good resolution, the Aladin model has the advantage of considering the particularities of the zone for which it works. For the 25 and 26 of January 2014, the outputs show an increasing wind speed offshore the Bulgarian coasts, over the Black sea, but also in the south-east Romania, at the exterior of the Carpathians curvature (barbs of 22.5 m/s), fig. 7.

On January 27 the cyclone was located over the Black Sea, as it can be observed on the support map in figure 6, from the Aladin output from January 27, 18 UTC. Strong north-west winds blew especially over the coastal area and consequently the sea state became rough (waves height over 4 m). The 28 of January the filling of the cyclone and its movement to the north-west Black Sea, over the gulf of Odessa, can be observed.

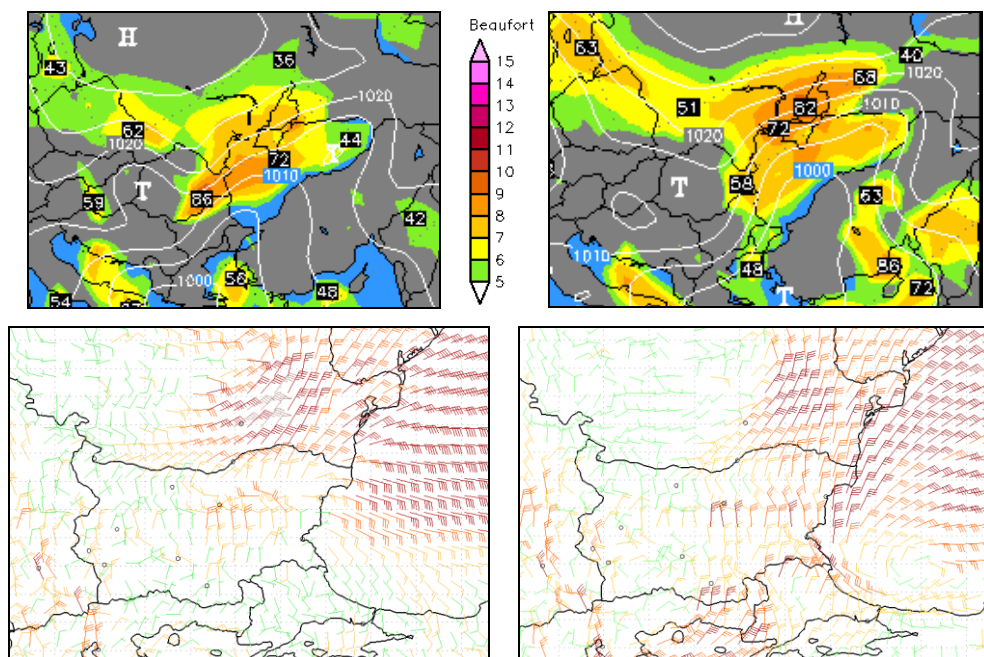


Fig. 7. Wind gusts at 10 m on January 25, 18 UTC (left) and on 26, 18 UTC (right) GFS model (upper figures) and ALADIN Bulgaria (down figures), www.wetter3.de and Bulgaria operational suite

The weather became severe again on January 29 2014 and the orange code was issued in Romania for the south-eastern part of the country. The north-east European anticyclone reinforced (1050 hPa), while a fast moving cyclone can be observed first over the Aegean sea and later on, around 18 UTC, over the Black sea (1008 hPa). Cold advections can be observed at 850 hPa, together with strong vertical movements at 700 hPa (-38 hPa/h). Rain followed by snow fell along the coasts (fig. 8). Air temperature dropped below 0°C around 15 UTC. Wind started to decrease and precipitations stopped on January 30 2014.

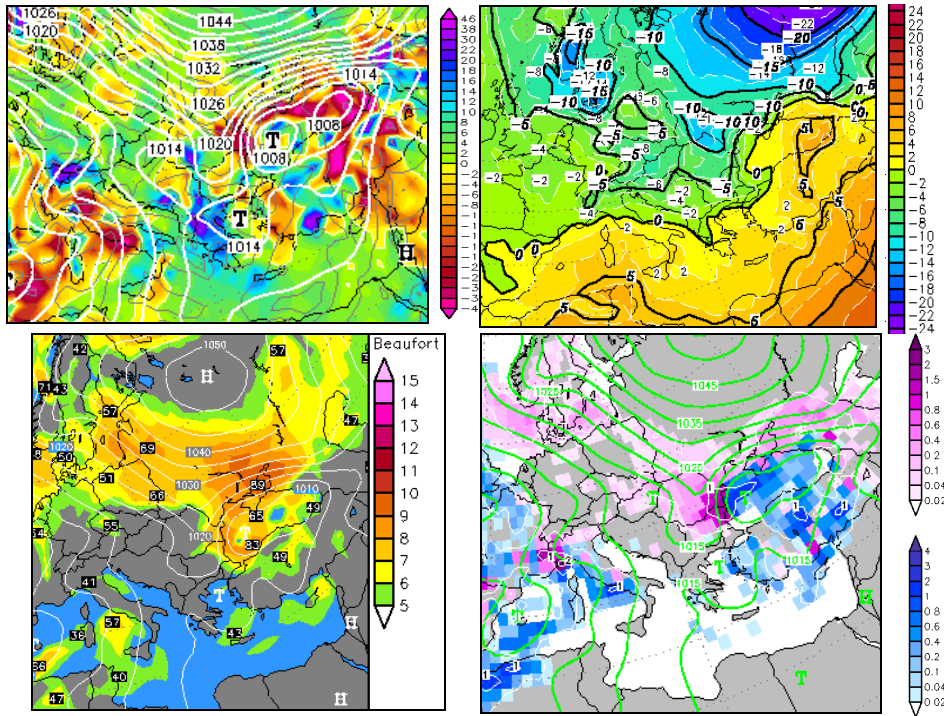


Fig. 8 *Upper figures*: Sea level pressure, 700 hPa vertical movements, 850 hPa frontal zones (left) and temperatures at 850 hPa (right); *Down figures*: Wind gusts Bft at 10 m and precipitations in mm/h (snow in pink), 6h forecast; GFS analysis, 29 Jan. 2014, 18 UTC, www.wetter3.de

Conclusions

Wind and snow storms over the south and south-eastern part of Romania and the north and north-eastern part of Bulgaria had grave consequences on the environment and the economic activities. They were generated by deep cyclones that developed over the Mediterranean Sea and moved to the Black Sea, while continental areas were dominated by high pressure systems. The development and movement of the cyclones depended on the position of the troughs, generally with large meridian extensions. In January 2014 on 25 and 26 the low pressure systems moved slowly to the Black sea, their development being sustained by the upper level trough. On 29, the second peak of strong winds was due to another Mediterranean cyclone that had a rapid movement to the Black sea. Sea-surface 850 hPa temperature differences and sea-land temperatures differences were important during these winter storms.

Acknowledgements: The warning maps are from the meteoalarm.eu website and from media. The GFS analysis and forecast maps were downloaded from www.wetter3.de archive. Wind speed and snow cover data recorded at the weather stations have been extracted from www.ogimet.com. The atmospheric soundings have been downloaded from <http://ready.arl.noaa.gov> and the Aladin model outputs are from the National Bulgarian Institute of Meteorology and Hydrology. Websites were accessed in January 2014.

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