Weather influence on a different weapons systems

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Abstract: - The paper deals with possible estimation how impact may have meteorological conditions on operations. The paper is focused on human troops, unmanned armed vehicles, artillery, offensive air support, air reconnaissance, helicopter gunship and transport troop carrier. Weather impacts are typically provided in "stoplight" format, i. e. green (in other words Favourable) is used when the meteorological conditions have during mission the minimal operational impacts, amber (Marginal) for moderate operational impact and red (Unfavourable) when the meteorological conditions have severe operational impact or the mission is unrealizable due to meteorological conditions.

Key-Words: - meteorological conditions, colour state, thresholds, operational impact, weapons systems

1 Introduction

The weather influence wide range of human activity (travel, agriculture, tourism etc.) and human health itself. Joint missions are affected by a wide variety of meteorological conditions. Mission planners must be aware of meteorological factors that will affect their operations, ensuring the greatest chance of mission success.

All planners must be familiar with critical meteorological thresholds in order to effectively use weapon systems and to provide maximum safety for friendly personnel. Weather impacts are typically provided in "stoplight" format, i. e. green (in other words Favourable) is used when the meteorological conditions have during mission the minimal operational impacts, amber (Marginal) for moderate operational impact and red (Unfavourable) when the meteorological conditions have severe operational impact or the mission is unrealizable due to meteorological conditions.

2 Weather impact calculations on real data

Calculations were performed with data collected on current used meteorological stations on territory of the Czech Republic. Array of data includes period from August 1997 to the December 2009. All data were taken from main group of meteorological report SYNOP; therefore, data about cloudiness coming from automatic station during the night are missing. Mean annual values were calculated from monthly mean value.

As an evaluation criteria causing impact on personnel were used the humidex and the wind chill. The humidex is a number used by meteorologists to reflect the combined effect of heat and humidity. The humidex of at least 30 causes "some discomfort", at least 40 causes "great discomfort" and above 45 is "dangerous." If the humidex hits 54, heat stroke is imminent, when the temperature is 30 °C and the dew point is 15 °C, the humidex is 34 (humidex is a dimensionless number, but that the number indicates an approximate temperature in °C). If the temperature remains 30 °C and the dew point rises to 25 °C, the humidex rises to 42. The humidex tends to be higher than the U.S. heat index at equal temperature and relative humidity.

Wind chill is the apparent temperature felt on exposed skin due to wind. The degree of this phenomenon depends on both air temperature and wind speed. The wind chill temperature (often popularly called the wind chill factor) is always lower than the air temperature for values where the wind chill formula is valid. In cases where the apparent temperature is higher than the air temperature, the heat index is used instead.
As other an evaluation criteria were chosen visibility, amount and base of cloudiness, wind speed and gusty wind.

In meteorology, visibility is a measure of the distance at which an object or light can be clearly discerned. Meteorological visibility refers to transparency of air: in dark, meteorological visibility is still the same as in daylight for the same air.

Cloud cover (also known as cloudiness or cloud amount) refers to the fraction of the sky obscured by clouds when observed from a particular location. The cloud base (or the base of the cloud) is the lowest altitude of the visible portion of the cloud. It is traditionally expressed either in m or feet above mean sea level (or planetary surface), or as the corresponding pressure level in hectopascal (hPa, equivalent to

millibar). The height of the cloud base can be estimated from surface measurements of air temperature and humidity. Modern automated instruments to measure cloud base include specially designed laser systems called ceilometers. Cloud base is an important meteorological variable for aviation safety, as it determines whether pilots may use Visual Flight Rules (VFR) or must follow Instrument Flight Rules for take-off or landing.

Table 1: Impact thresholds on operations

OPERATION	GREEN	YELLOW	RED
Personnel	HUM < 27 WC > -13 ºC	All other cases	HUM > 32 WC < -31 ºC
UAV/UAS	VIS ≥ 5 km CLB >500m or CLG < 1/8 WND ≤ 14 kt GG ≤ 20 kt	All other cases	VIS < 2 km CLB < 300m and CLG > 4/8 WND > 20 kt GG > 25 kt
Artillery	CLB > 450m	CLB 180 – 450m	CLB < 180m
Offensive Air Support (OAS)	VIS ≥ 8 km CLB > 600m or CLG <1/8	All other cases	VIS < 3 km CLB < 300m and CLG > 4/8
Air Reconnaissanc	VIS ≥ 6 km CLG < 4/8	All other cases	VIS < 3,5 km CLB < 600m and CLG > 4/8
Helicopter Gunship	VIS ≥ 1,6 km CLB > 150m or CLG <1/8	All other cases	VIS < 0,8 km CLB < 100m and CLG > 4/8
Transport Troop Carrier	VIS ≥ 8 km CLB > 300m or CLG <1/8	All other cases	VIS < 0,8 km CLB < 70m and CLG > 4/8
Paratroopers	WND ≤ 11 kt	All other cases	WND > 18 kt

Wind speed is the speed of wind, the movement of air or other gases in an atmosphere. It is a scalar quantity, the magnitude of the vector of motion. Wind speed has always meant the movement of air in an outside environment, but the speed of air movement inside is important in many areas, including weather forecasting, aircraft and maritime operations, building and civil engineering. High wind speeds can cause unpleasant side effects, and strong winds often have special names, including gales, hurricanes, and typhoons. Wind gust is a sudden, brief increase in speed of the wind. Gusts are reported when the peak wind speed reaches at least 16 knots and the variation in wind speed between the peaks and lulls is at least 9 knots. The duration of a gust is usually less than 20 seconds.

Tab. 2: Calculation of CC on real data

Year			
CC	Green	Yellow	Red
Personnel	94,0	5,4	0,6
UAV/S	62,5	16,8	20,7
Artillery	69,9	16,7	13,4
OAS	52,1	29,5	18,4
AR	42,4	29,8	27,8
HG	85,7	5,1	9,2
TTC	65,1	25,7	9,2
PAR	87,5	8,9	3,6
Winter			
Personnel	89,6	10,3	0,1
UAV/S	42,6	22,9	34,5
Artillery	52,4	25,3	22,3
OAS	31,6	36,9	31,5
AR	24,8	29,3	45,9
HG	76,0	8,9	15,1
TTC	45,2	39,7	15,1
PAR	81,0	12,4	6,6
Spring			
Personnel	98,0	1,9	0,1
UAV/S	70,6	14,7	14,7
Artillery	78,2	13,4	8,4
OAS	61,3	26,9	11,8
AR	49,5	31,1	19,4
HG	91,2	3,2	5,6
TTC	74,6	19,8	5,6
PAR	86,6	9,8	3,6
Summer			
Personnel	88,2	9,2	2,6
UAV/S	79,6	11,3	9,1
Artillery	83,4	10,6	6,0
OAS	70,0	22,7	7,3
AR	57,6	30,0	12,4
HG	94,0	2,3	3,7
TTC	82,5	13,8	3,7
PAR	92,5	5,9	1,6
Autumn			
Personnel	98,8	1,2	0,0
UAV/S	56,7	18,4	24,9
Artillery	64,3	18,5	17,2
OAS	45,4	31,5	23,1
AR	37,5	28,7	33,8
HG	81,6	6,2	12,2
TTC	57,7	30,1	12,2
PAR	88,2	8,3	3,5

Legend:

UAV/S – unmanned armed vehicles / system, OAS - offensive air support , AR – air reconnaissance, TTC – transport troop carrier, HG – helicopter gunship, PAR – paratroopers unit, CC – colour code, G – green, R – red, HUM – humidex, WC – wind chill, WND – wind speed, GG – gust wind, CLG – base and amount of cloudiness, VIS – visibility, CLB – base of cloudiness.

The frequency of colour codes is shown in table 2. There is also mentioned the seasonal variability of colour codes on given weapons systems.

3 Reconnaissance environmental picture for personnel

For personnel the meteorological conditions without limitations prevail in 94% of all cases. Unfavourable condition may exist perhaps only in 1% of cases and mainly during summer period in the early afternoon hours. Higher occurrence is favour the lowland station (e.g. Prerov – altitude 212 m above mean sea level pressure, further in text MSLP, Holesov – altitude 234 m above MSLP, c. 1,5%) but unfavourable values of humidex, i.e. higher values, were observed at every locations of all station except Lysa hora station (altitude of meteorological station on this mountain is 1313 m above MSLP).

Average frequency of favourable conditions on personnel over all considered stations is in fig. 1. The frequency is depicted by colour (colour bar on right side) calculated for each month and hour. The difference between lowland station (below 500 m above MSLP) and higher stations are in fig 2 and fig 3. Relation between colour code distribution and altitude for personnel is depicted in fig 4. The altitude is on x axis, the frequency (in %) are on y-axes. All 3 classes of condition are depicted.

In winter season the unfavourable condition occurred only sporadically, especially on higher located stations (Churanov – alt. 1120 m above MSLP, Milesovka – alt. 830 m above MSLP, Pribyslav – alt. 535 m above MSLP - , Svratouch – alt. 735 m above MSLP, Luka – alt. 510 m above MSLP, Serak – alt. 1328 m above MSLP and Lysa hora. Marginal impacts were traced down generally in 5% of all cases and on station of higher altitude it was c. 10%. Deterioration conditions occurred especially from June to August (see Fig. 1-3) in afternoon hours.

On meteorological station Prerov the favourable conditions occurred only in 50% during August in afternoon hours, whereas the maximum of unfavourable conditions (about 25%) is concentrated in July in the afternoon hours. At the station Lysa hora meteorological conditions are deteriorated in winter months (in February morning it is more than 55%), but unfavourable conditions occurred in these cases only to about 1%

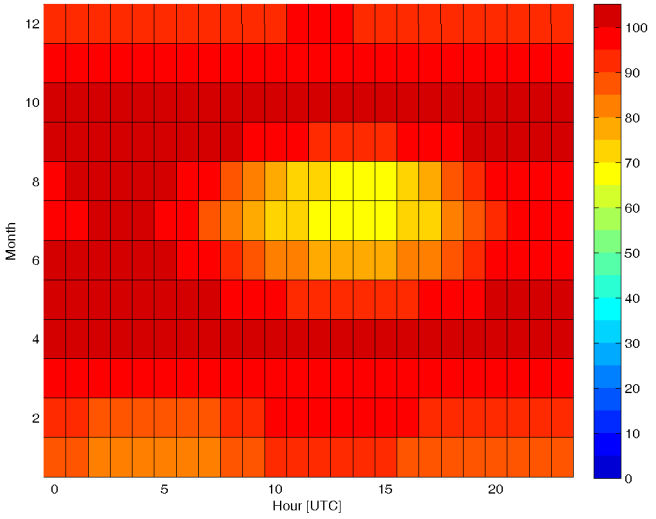

Fig. 1 Frequency of favourable conditions on personnel (all meteorological stations)

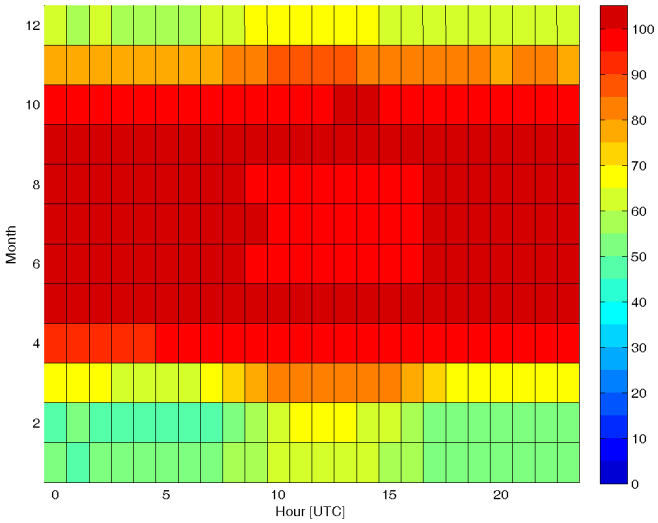

Fig. 2 Frequency of favourable conditions on personnel (altitude more than 500 m above MSLP)

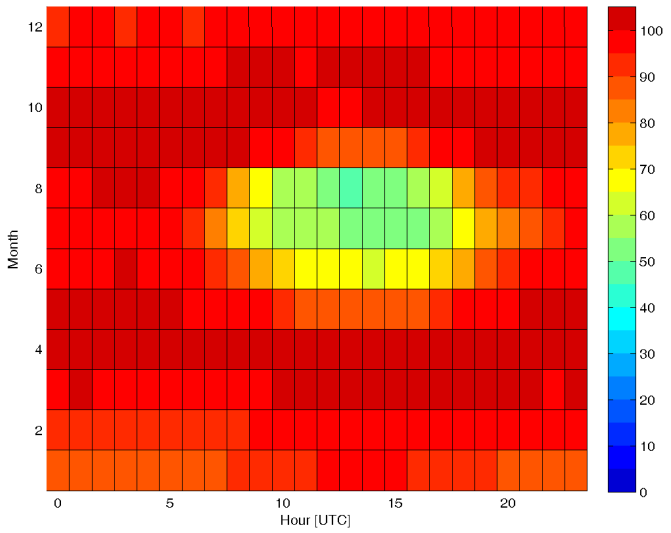

Fig. 3 Frequency of favourable conditions on personnel (altitude less than 500 m above MSLP)

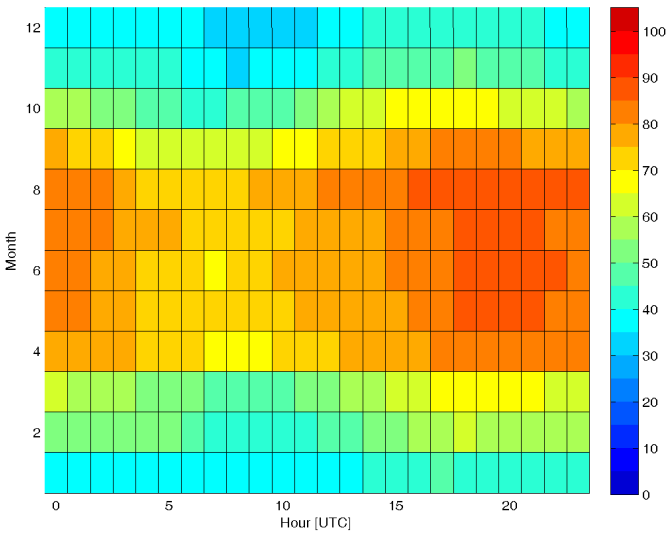

Fig. 5 Frequency of favourable conditions on UAV/S (all meteorological stations)

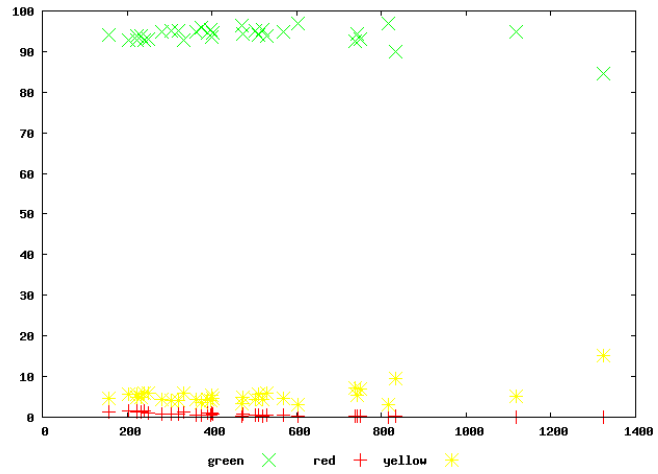

Fig. 4 Relation between colour code distribution and altitude for personnel

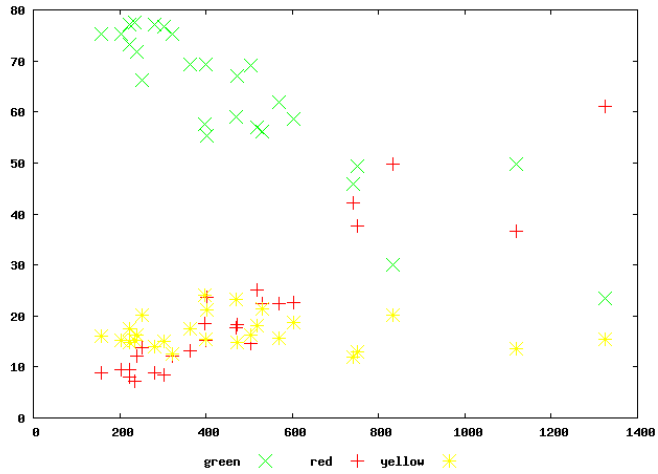

Fig. 6 Relation between colour code distribution and altitude for UAV/S

4 Reconnaissance environmental picture for UAV/UAS

For Unmanned Armed Vehicles / Systems the meteorological conditions without limitations exist in 63% of all cases. Unfavourable conditions are predominant in 21% of cases. The favourable meteorological conditions are slowly decreasing with higher altitude from occurrence 75% to 24%, whereas the unfavourable meteorological conditions increasing (from 10% to 60%).

5 Reconnaissance environmental picture for Artillery

For artillery the meteorological conditions without limitations prevail in 70% of all cases, mainly during summer period (August), especially in the late afternoon hours till midnight (91% of favourable). Unfavourable condition may exist in 14% of cases. Worse conditions occur on higher located stations. The unfavourable meteorological conditions dominate during cool half of the year with maximum in November and December.

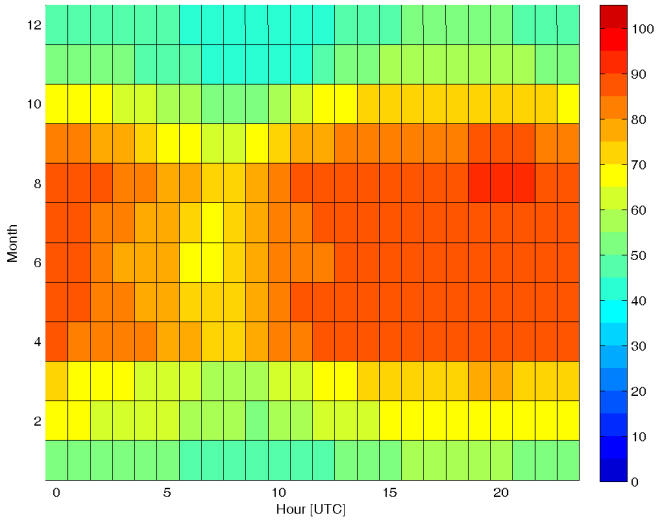

Fig. 7 Frequency of favourable conditions on artillery (all meteorological stations)

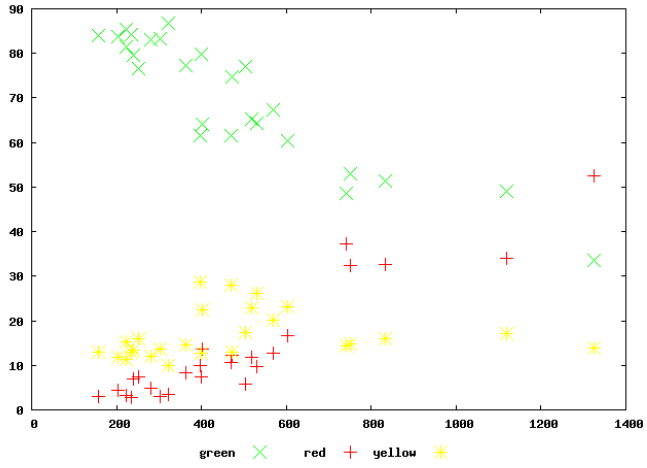

Fig. 8 Relation between colour code distribution and altitude for artillery

6 Reconnaissance environmental picture for Offensive Air Support

For offensive air support the meteorological conditions without limitations preponderate in 52% of all cases. Unfavourable condition may exist in 18% of cases. There is obvious drop of favourable conditions, but even faster increase of unfavourable conditions with higher altitude. On lowland meteorological stations is frequency of red colour ca 10%, on higher located stations it is around 50%. Due to the variable topography in territory of Czech Republic the deterioration of meteorological conditions occurred irregularly both with altitude and season.

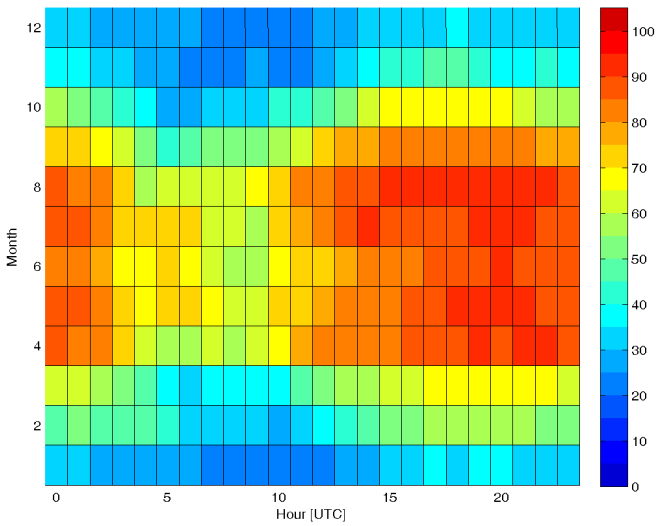

Fig. 9 Frequency of favourable conditions on OAS (all meteorological stations)

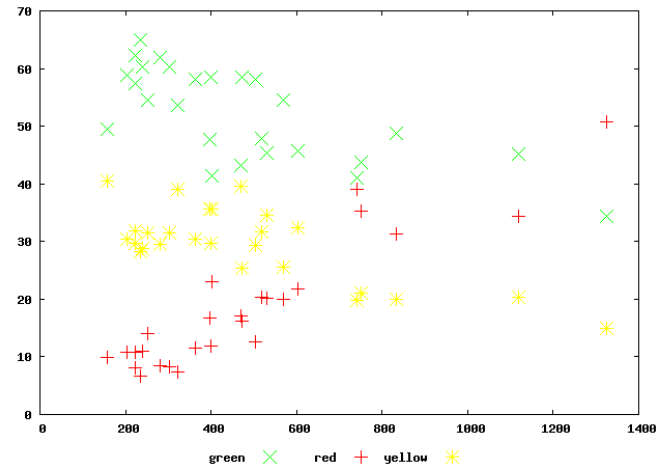

Fig. 10 Relation between colour code distribution and altitude for OAS

7 Reconnaissance environmental picture for Air Reconnaissance

For air reconnaissance offensive air support the meteorological conditions without limitations prevail in 42% of all cases. Unfavourable conditions may exist in 27% of cases. There is no significant dependence on altitude. Seasonal variability is linked with seasonal variability of cloudiness. The worst conditions may exist in winter time during morning hours, i. e. green only 23%, but red colour in 73% of all occurrences. Whilst in summer time, on higher located regions, the worst meteorological conditions have incidence in 57% in the early afternoon hours.

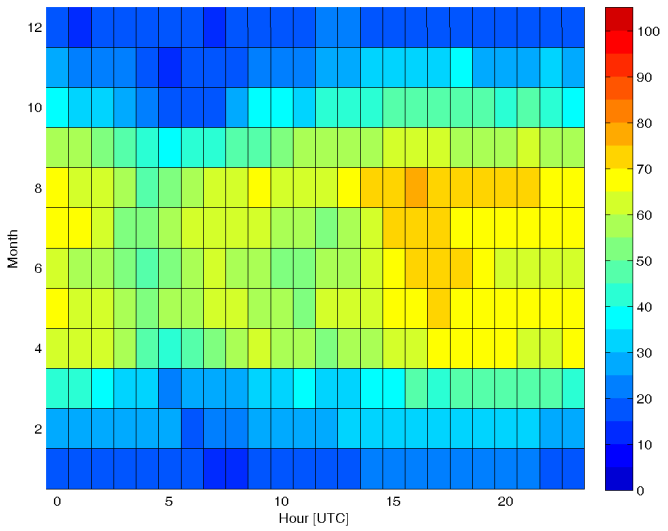

Fig. 11 Frequency of favourable conditions on AR (all meteorological stations)

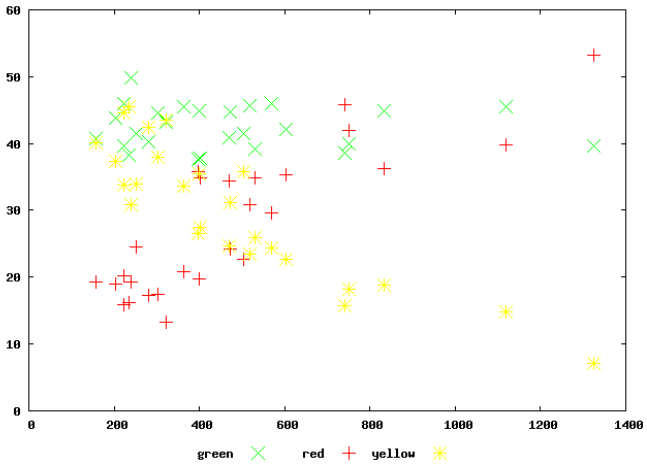

Fig. 12 Relation between colour code distribution and altitude for AR

8 Reconnaissance environmental picture for Helicopters

For helicopters (gunships) the meteorological conditions without limitations prevail in 85% of all cases. Unfavourable condition may exist for long time (more than hours) only in winter season. Pretty obvious is a daily range, when the worst conditions have been observed in early morning hours. There is faster increase of unfavourable conditions with altitude. On lowland meteorological stations is frequency of red colour minimal, only early mornings are reported observations under thresholds, but only in ca 20% of all cases.

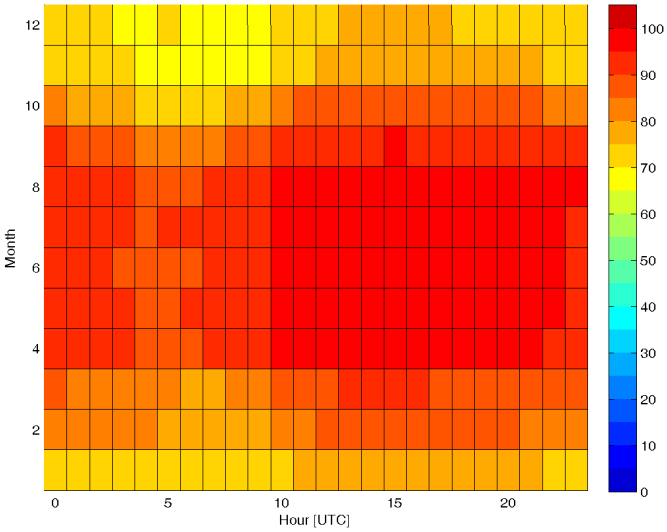

Fig. 13 Frequency of favourable conditions on HG (all meteorological stations)

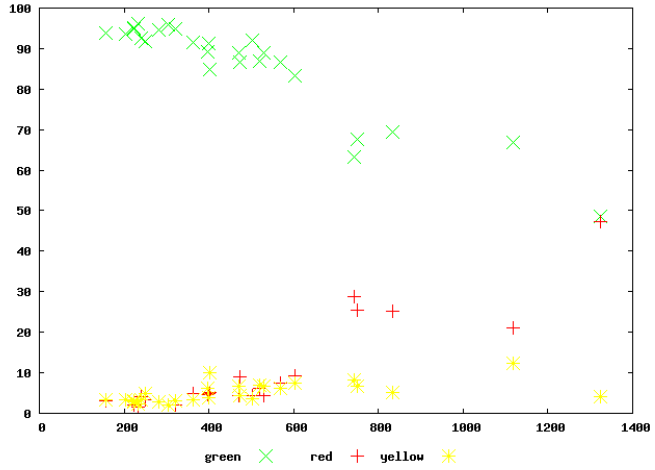

Fig. 14 Relation between colour code distribution and altitude for HG

9 Reconnaissance environmental picture for Transport Troop Carriers

For transport troop carriers the meteorological conditions with unfavourable limitations are mostly the same as for helicopters. Favourable conditions predominate in 65% of cases. There is obvious drop of favourable conditions, but even faster increase of unfavourable meteorological conditions. On lowland meteorological stations is frequency of red colour minimal, only early mornings are reported observations under thresholds, but only in ca 20% of all cases, similar results with helicopters.

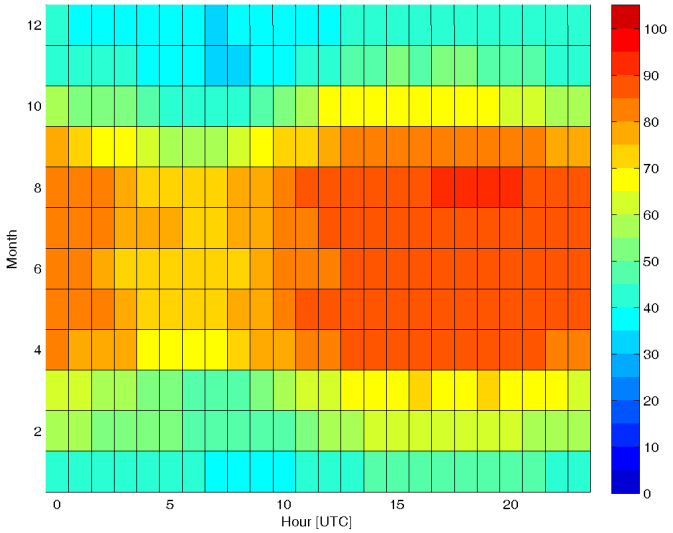

Fig. 15 Frequency of favourable conditions on TTC (all meteorological stations)

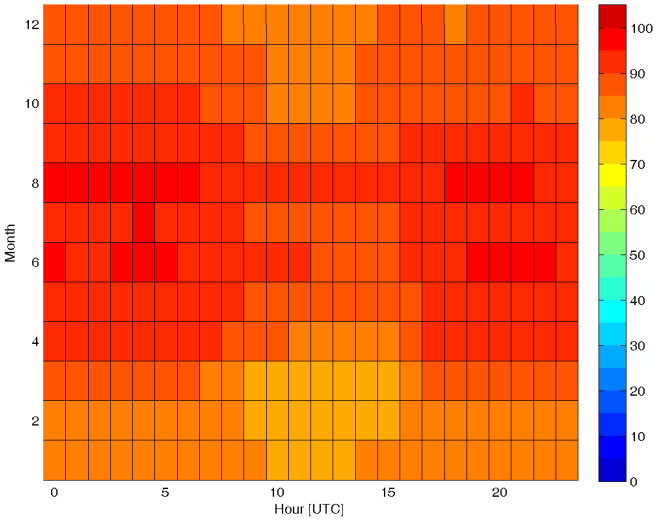

Fig. 17 Frequency of favourable conditions on PAR (all meteorological stations)

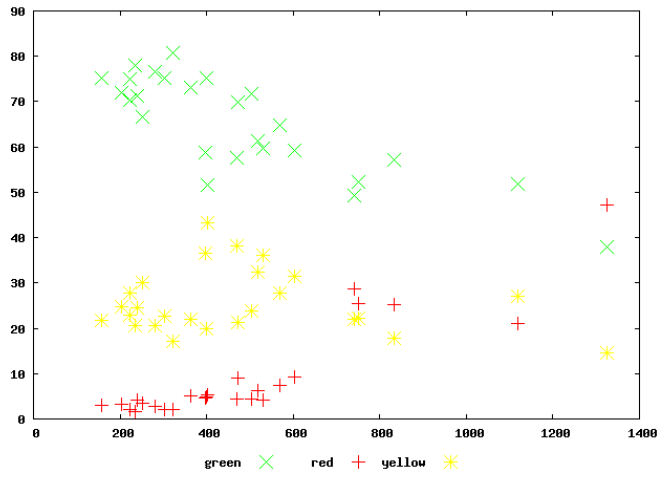

Fig. 16 Relation between colour code distribution and altitude for TTC

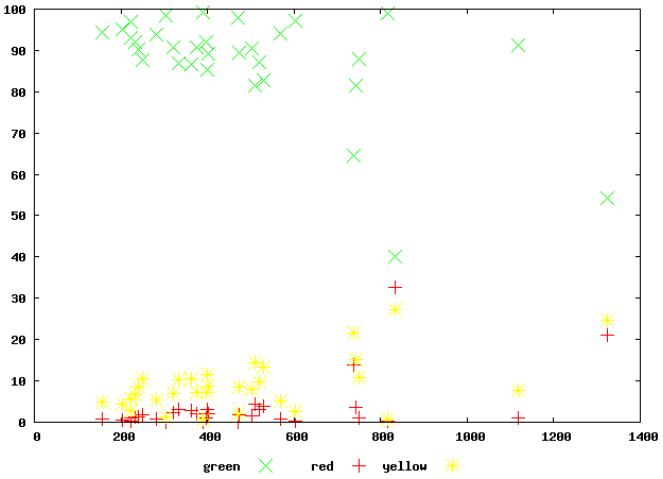

Fig. 18 Relation between colour code distribution and altitude for PAR

10 Reconnaissance environmental picture for Paratroopers

For paratroopers unit the meteorological conditions without limitations acceptable for paradrop prevail in 88% of all cases. Unfavourable condition may exist for long time (more than hours) in about 4 % of all cases and especially over highly located zones due to the windy weather. The best conditions have been observed during summer period and in the time of nights till late mornings. Very significant influence has the diurnal effect.

11 Conclusion

Planners must communicate their mission-specific thresholds to meteorological personnel, so that 'heads-up' alerts can be issued. This paper can be used for future operation planning of mentioned military unit.

Personnel responsible for meteorological support must be knowledgeable about critical meteorological thresholds for the weapon systems they support, to ensure they provide important information required by decision makers.

12 Acknowledgement

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References:

[1] DEJMAL, K. and RÉPAL, V., 2010: Utilization of Minimum Temperature Prediction. WSEAS TRANSACTIONS on ENVIRONMENT and DEVELOPMENT, vol. 6, no. 2, p. 135-144, ISSN: 1790-5079.

[2] PECELJ, M., PECELJ M., MANDIĆ, D., PECELJ, J., MILINČIĆ, M., TOŠIĆ, D., 2010: Informational Technology in Bioclimate analysis of Banja Luka for tourism recreation. In New Aspects TELECOMMUNICATIONS and INFORMATICS. Catania: WSEAS Press, p. 35-39. ISSN: 1790-5117 35 ISBN: 978-954-92600-2-1

[3] MAZILU, M., MARINESCU, R., C., 2008: The Impact of Climate Changes on Tourism. In NEW ASPECTS OF CULTURAL HERITAGE AND TOURISM. Heraklion: WSEAS Press, p. 77-82. ISBN: 978-960-6766-89-3, ISSN 1790-2769.

[4] WEN-ZER LINa, HSIAO-CHUNG TSAI, CHUNG-HO WANG, KUEI-YANG WU, 2005: The Subtropical Urban Heat Island Effect Revealed in Eight Major Cities of Taiwan. In ENVIRONMENT, ECOSYSTEMS and DEVELOPMENT. Venice: WSEAS Press, p. 14-20. ISBN: 960-8457-37-8

[5] U.S. Joint Forces Command Joint Meteorology & Oceanography (METOC) Handbook