



# Military Meteorological Support for UAVs

MAJ BÜKI, Richárd

Senior Meteorological Officer

Weather Forecasting and Training Department

Geoinformation Service of HDF



# Military Meteorology and Oceanography (NATO MC 0594/2)



According to the NATO Military Committee MC 594/2, 1. (MC Policy on Meteorological and Oceanographic Support to Allied Forces)

„NATO forces operate in multiple environments and geographical locations, and rely on knowledge of the current and forecast physical environment to enhance the effectiveness of their air, land and maritime military operations and missions.”

As such, **accurate**, **timely**, **relevant**, **consistent** and **reliable** **meteorological** and **oceanographic (METOC)** data, information and products are integral to both the warfighter and the peacekeeper.



# Military Meteorology and Oceanography (NATO MC 0594/2)



METOC data, information and products provide commanders, planners and operators with a portion of the environmental knowledge and situational awareness necessary to anticipate and exploit the best window of opportunity to plan, execute, support and sustain specific operations and missions.

Using METOC data, information and products as the basis of military advice to optimize employment of sensors, weapons, targeting, logistics, equipment and personnel is key to decision superiority and enabling safe, effective and successful operations.



# Military Meteorology (NATO MC 0594/2)



(MC 594/2, 6.a.(1))

Military meteorology is the science concerned with the collection and analysis that results from the understanding of the physical characteristics of the past, current and predicted states of the atmosphere, including space weather effects, and the ability to exploit this information for the planning and conduct of military activities.



# METOC Data, Information and Products (1)



Must be:

- (1) **Coherent** across the joint domain, notwithstanding space, atmospheric or oceanic model variations.
- (2) **Comprehensive**. Covering METOC factors from the ocean floor or ground through any water bodies and the atmosphere, to the factors affecting satellite operations or communications in space.



## METOC Data, Information and Products (2)



- (3) **Consistent** throughout the strategic, operational and tactical levels of both planning and execution.
- (4) **Accurate** to satisfy warfighting requirements.  
Inaccurate data, information and products can cost lives, undermine the successful execution of a mission, waste resources and impair readiness.
- (5) **Relevant**. Irrelevant data, information and products waste resources and detract from higher-level priorities.



## METOC Data, Information and Products (3)



- (6) **Timely** to satisfy warfighting requirements. Meteorological data, information and products must reach the appropriate decision-makers at any level, in time (including a capacity to meet specified levels of readiness).
- (7) **Standardized** in design and format aiming at consistent "look and feel" enhancing interoperability.



# Visualisation of (Weather) Impacts to Operations (1)



- Standardised in NATO AD 080-034, Annex P,
- Operational Commanders combine the following factors:
  - Weapon-system specific guidance,
  - Tactics, Techniques and Procedures,
  - Operational Lessons Learned,
  - Experience/Skill Level of their operators to assess, accept, and manage mission risk,
  - Weather.





## Visualisation of (Weather) Impacts to Operations (2)



- It means that meteorological critical thresholds will **not always be the same** for every mission, even within a single mission set.



# Visualisation of (Weather) Impacts to Operations (3)



- METOC personnel should consider such tables but discuss with their operational customer to capture more specific threshold criteria particular to their operational customers' current mission profiles. When briefing externally, ensure all are aware that impact matrix deviates from AD080-034 Appendix 1 to Annex P.
- Many products are model generated, ensure you are aware of the criterion set for each parameter.



# Traffic Light Visualisation of Weather Impacts to Operations (1)



AD 080-034, Annex P, 1.b

METOC impacts to OPS are commonly provided in a TRAFFIC LIGHT format, which offers a clear and concise indication to COM and Planners:

<b>Colour</b>	<b>Characterization</b>	<b>Operational Impact</b>
<b>GREEN</b>	Favourable	Little or No
<b>YELLOW</b>	Marginal	Moderate
<b>RED</b>	Unfavourable	Severe



# Traffic Light Visualisation of Weather Impacts to Operations (2)



AD 080-034, Annex P, 2.



METOC impact colour criteria:

Colour	METOC impact colour criteria	
<b>GREEN</b>	Favourable	Little or no impact, no restrictions based on METOC conditions.
<b>YELLOW</b>	Marginal	METOC conditions degrade or limit OPS
<b>RED</b>	Unfavourable	Severe impact with significant degradation to OPS; METOC conditions restrict OPS



# Example (1)



		<b>Időjárás-előrejelzés</b>					
		<b>térségére</b>					
Készült: 2020.01.09.	2020.01.10., péntek	2020.01.11., szombat	2020.01.12., vasárnap	2020.01.13., hétfő	2020.01.14., kedd	2020.01.15., szerda	
Időkép							
Csapadék	-	-	-	-	-	-	
Szélirány	Változó	ÉNy-i	DNy-i	Változó	Változó	DK-i	
Szélesség	1-3 MPS	1-3 MPS	1-3 MPS	1-3 MPS	1-3 MPS	1-3 MPS	
Szellökések	-	-	-	-	-	-	
Min./Max. hőm.	(-4)-(-3) °C / 3-4 °C	(-4)-(-3) °C / 3-4 °C	(-4)-(-3) °C / 4-5 °C	(-4)-(-3) °C / 2-3 °C	(-4)-(-3) °C / 2-3 °C	(-5)-(-4) °C / 3-4 °C	
Hatás előerőre	AL	AL	AL	AL	AL	AL	
Hatás UAV-ra	AL, AF	AL, AF	AL, AF	AL, AF	AL, AF	AL, AF	
Várható időjárás	Változóan felhős, csapadékmentes, csendes, téli időre lehet számítani hajnali párássággal, zúzmarás ködfoltokkal.						
Kedvező		Korlátozott			Kedvezőtlen		
CS: Csapadék	HÓ: Havazás	AL: Alacsony látástávolság	AF: Alacsony felhőalap hőérzet	J: Jegesedés	SZ: Szél	T: Turbulencia	AH: Alacsony hőérzet
Az előrejelzés az idő előrehaladtával egyre növekvő bizonytalanságot hordoz magában							
MH GEOSZ Időjárás-előrejelző és Szakkiképzési Osztály; Tel: 06-1-236-5327, HM: 253-40, 252-60, EDR: 4600400							



# Example (2)



A Magyar Honvédség Geoinformációs Szolgálat meteorológiai előrejelzése

Pér térségére

2021. november 09 - 11. közötti időszakra.

2021. november 08-án.



2021.	november 09. kedd		november 10. szerda		november 11. csütörtök	
Várható időjárás	A napsütés lesz a főszerep, csapadék kialakulása nem várható. Eleinte páras lehet a levegő.		A napsütést fátyolfelhők zavarhatják meg, csapadék nem várható. Hajnalban, reggel páras lesz a levegő.		Napos és kissé felhős időszakok váltják egymást, csapadék kialakulása nem várható.	
Összfelhőzet mennyisége	1-4/8		2-5/8		1-5/8	
Várható legalacsonyabb felhőzet alapja, m (AGL)	300-600 m (St reggel)		300-600 m (St reggel)		800-1000 m	
	délelőtt	délután	délelőtt	délután	délelőtt	délután
Csapadék (típus, mm)	-	-	-	-	-	-
Látástávolság (km)	5-30 km, párásságban 1-5 km		5-30 km, párásságban 1-5 km		8-30 km	
Átlagos szélesség (m/s) 10 m-en (AGL)	1-4	1-4	2-5	2-5	2-5	1-4
Átlagos szélesség (m/s) 300 m-en (AGL)	2-4	2-4	2-6	2-6	2-6	2-4
Szellökések, 10 m-en (m/s) (AGL)	-	-	7-9	7-9	7	-
Hőmérséklet (Tmin/Tmax)	1 °C / 11 °C		2 °C / 12 °C		4 °C / 13 °C	
Hatás	AL, AF		AL, AF			

AL: alacsony látástávolság

AF: alacsony felhőalap



# Thresholds for UAV (example)



	Colour Code		
Parameter	Red	Yellow	Green
Precipitation [mm]	> 2	0< and < 2	No
Lightning activity	Expected	N/A	No
Visibility [m]	< 1000	1000 < and < 3000	3000 <
Ceiling (BKN or OVC) [m]	< 300	300 < and < 600	600 <
Icing	SEV or MOD	LGT	None
Wind/Gust [m/s]	10/12	6-10/8-12	< 6/<8
Wind at Operating Altitude [m/s]	>15	10< and <15	10<



# Present

- Providing tailored forecasts and training of meteorology for UAV operators
  - Debrecen (for operators of general military use)
  - Budapest (for operators of mapping)
- Challenge
  - Lower model resolution for forecasting than ideal
  - Higher expectations on behalf of the users than realistically achievable (both in time and space)





# Future



- Enabling the users a better understanding of weather and accepting the limitations of weather forecasting
- Models with higher resolution (both in space and time)
- Training for users of METOC information, including UAV operators
- Co-operation with members of the METOC support field including non-military actors (National Meteorological Service, National University of Public Service)
- Mobile Meteorological Support Group
- Roadmap for Development



# Roadmap for Military Meteorological Development



- 2018 to 2021 Preparation and Adaptation
  - Research and Development Agreement with the National University of Public Service
  - Installing setting up the WRF model
  - Server integration to Military Meteorological Information System
  - Reaching Initial Operational Capability
- 2022 to 2024 Application
  - Establishing the running environment for WRF model
  - Design of Content Providing
  - Verification



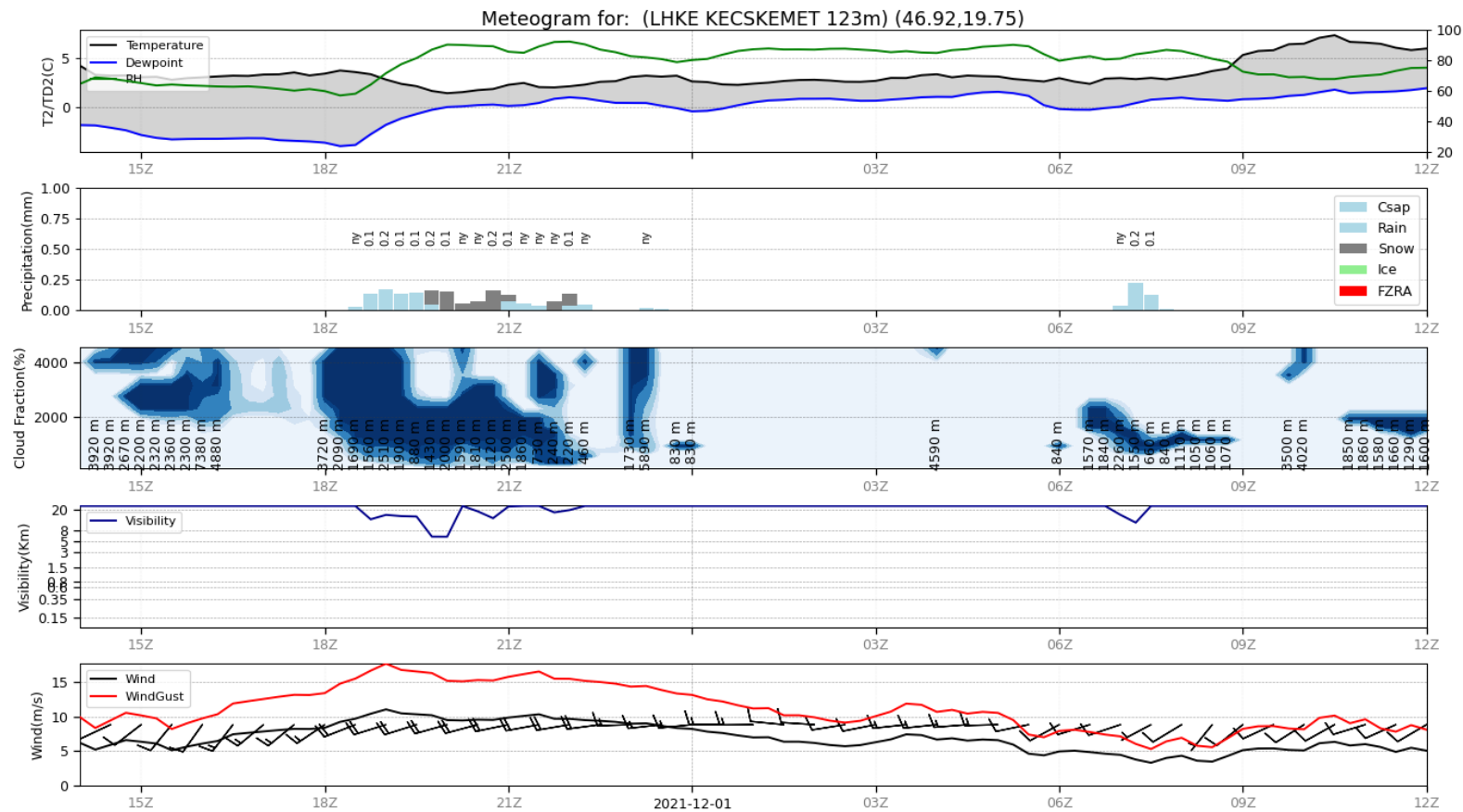
# Roadmap for Military Meteorological Development



- 2024 to 2026 Further Development
  - Forecast for smaller regions
  - Forecast for Missions (abroad)
  - Further parametrization
  - Reaching Final Operational Capability



# Example of own WRF model run (current test run 1 km, 54 layers)





# Questions?



Source: YouTube