CONSIDERING TEMPERATURE CORRECTIONS FOR AIR TRAFFIC SERVICE

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Considered aspects of taking into account temperature corrections

1. History of accounting for temperature corrections in the Russian Federation
2. The importance of understanding the reasons for accounting for corrections
3. Basic concepts and terms
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1. History of accounting for temperature corrections in the Russian Federation

Development of NASS (MZ US ATM) according to ICAO rules (without corrections) Order of the Ministry of Transport of the Russian Federation No. 305 dated 10/31/2014

Accounting for corrections in accordance with FAFR AS RF No. 136 (included in the schemes)

2014г.

2020г.

Introduction of NASS
Amendment of FR UAS No. 138
Cancellation of FAFR AS RF No. 136

Recommendations to the ATS unit on accounting for temperature corrections

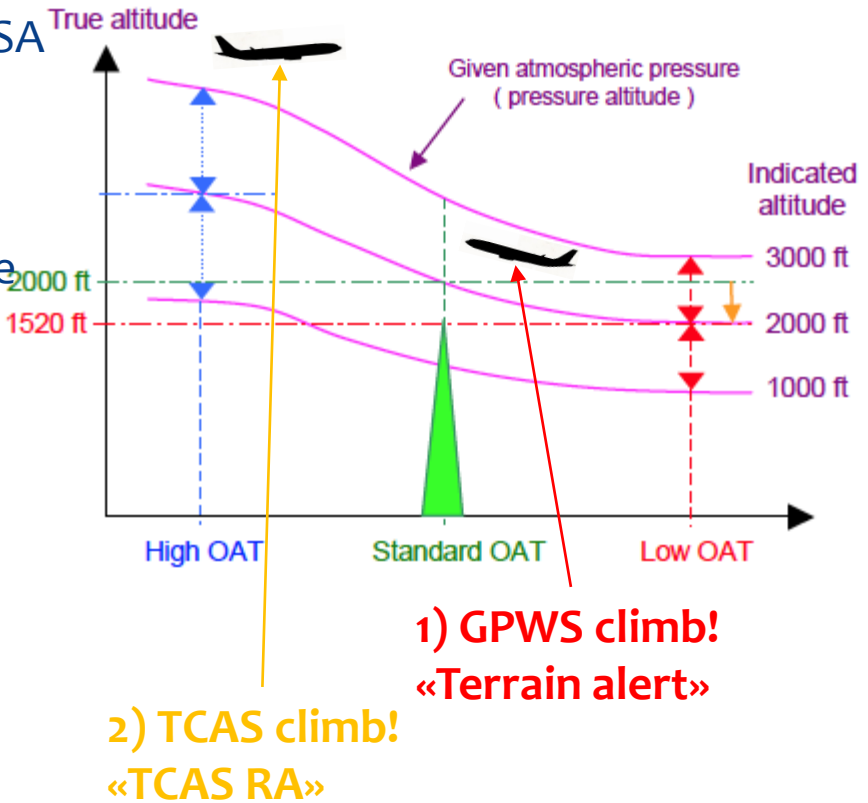
2022г.

Automation of accounting for temperature corrections (MSAW)

2. The importance of understanding the reasons for accounting for corrections

At ΔT > ISA altitude true > barometric	At ΔT = ISA altitude true = barometric	At ΔT < ISA altitude true < barometric

* Pressure altimeters are calibrated to indicate true altitude under international standard atmosphere (ISA) conditions. Any deviation from ISA will therefore result in an erroneous reading on the altimeter. If the temperature is higher than ISA, then the true altitude will be higher than the figure indicated by the altimeter. Similarly, the true altitude will be lower when the temperature is lower then ISA. The altimeter error may be significant in extremely cold temperatures.
* *According to ISA, the temperature at mean sea level is 15°C and its vertical declining gradient is 2°C (1.98°C) per 1000 feet of altitude.*
* Activation of airborne ground proximity warning systems due to insufficiency of the MOC, which will induce aircraft to pull up immediately and climb steeply to avoid hazardous terrain, possibly compromising separation between aircraft.



3. Basic concepts and terms

* **safe flight altitude** – the minimum allowable flight altitude of the aircraft, which guarantees against collision with the ground (water) surface or obstacles on it [FAR 128];
* **MZV** – minimum clearance above the highest obstacle [FR UAS] (true clearance decreases under the influence of low temperatures and requires correction of barometric altitude);
* **MOC** – minimum obstacle clearance [8168] (corresponds to MZV in FR UAS);
* **MOCA** – minimum obstacle clearance altitude [8168] (on the route/procedure leg/section);
* **MNM** – Minimum [AIP RF] (published in AIP RF on route legs/sections similarly to MOCA);
* **MSA** – minimum sector altitude [8168] (does not include correction for minimum temperature in ICAO);
* **MSAAT/MSHAT** – minimum safe flight altitude/height in the terminal area (TMA) (air hub area) [AIP RF] (includes a minimum temperature correction for a particular aerodrome);
* **OCA/OCH** – obstacle clearance altitude/height [8168] (relative to which the operational minima and the minimum descent altitude/height are determined);
* **SMAA** – surveillance minimum altitude area [AIP RF] (on map 57 of section AD AIP, does not include correction for minimum temperature);
* **GRID MORA** – grid minimum off-route altitude [Jeppesen] – an analog of the minimum flight altitude in the area formed by the lines of parallels and meridians of the cartographic grid (according to the FR UAS, does not include correction for the minimum temperature).

3. Basic concepts and terms

BASIC CONDITIONS FOR OBSTACLE CLEARANCE [FAR 128]:

IFR	ATS Route Hqnh≥MNM ALT	SMA/AMA Robst≥8km/Htrue≥300m

* **Minimum altitude/height** [FAR 293, AIP RF];
* **Minimum** Vectoring **altitude/height** [FAR 293] (similarly to MVA - Minimum Vectoring Altitude);
* **Minimum** radar vectoring **altitude** [8168] (similarly to SMA - Surveillance Minimum Altitude);
* **Minimum** sector **altitude/height** [8168, FAR 293, AIP RF];
* **Minimum** flight **altitude** [FAR 293, FAR 128];
* **Minimum** obstacle clearance **altitude** [8168, FAR 128];
* **Minimum altitude** [FAR 128, AIP RF];
* **Minimum** flight **altitude** according to IFR [FAR 128];
* **Minimum** safe flight **altitude** [FAR 128];
* **Minimum** safe **altitude/height** [FAR 128];
* **Minimum** allowable flight **altitude/height** [FAR 128];
* **Minimum** safe flight **altitude** in the aerodrome area (air hub area) [FR UAS, AIP RF];
* **Minimum** safe flight **altitude** in the area formed by the lines of parallels and meridians of the cartographic grid [FR UAS] (similarly to AMA - Area Minimum Altitude).

4. RESPONSIBILITY (Doc 8168)

4.1.1 Pilot's responsibility

The pilot-in-command is responsible for the safety of the operation and the safety of the aeroplane and of all persons on board during flight time (Annex 6, 4.5.1). This includes responsibility for obstacle clearance, except when an IFR flight is being vectored by radar.

4.1.5 Flights outside controlled airspace

4.1.5.1 For IFR flights outside controlled airspace, including flights operating below the lower limit of controlled airspace, the determination of the lowest usable flight level is the responsibility of the pilot-in-command. Current or forecast QNH and temperature values should be taken into account.

4.1.5.2 It is possible that altimeter corrections below controlled airspace may accumulate to the point where the aircraft's position may impinge on a flight level or assigned altitude in controlled airspace. The pilot-in-command must then obtain clearance from the appropriate control agency.

4. RESPONSIBILITY (Doc 8168, AIP RUSSIA)

AIP

4.1.3 State's responsibility

Annex 15, Appendix 1 (Contents of Aeronautical Information Publication), indicates that States should publish in Section GEN 3.3.5, "The criteria used to determine minimum flight altitudes". If nothing is published, it should be assumed that no corrections have been applied by the State.

* *Note. The determination of lowest usable flight levels by air traffic control units within controlled airspace does not relieve the pilot-in-command of the responsibility for ensuring that adequate terrain clearance exists, except when an IFR flight is being vectored by radar.*

GEN 3.3.5 Minimum flight altitude

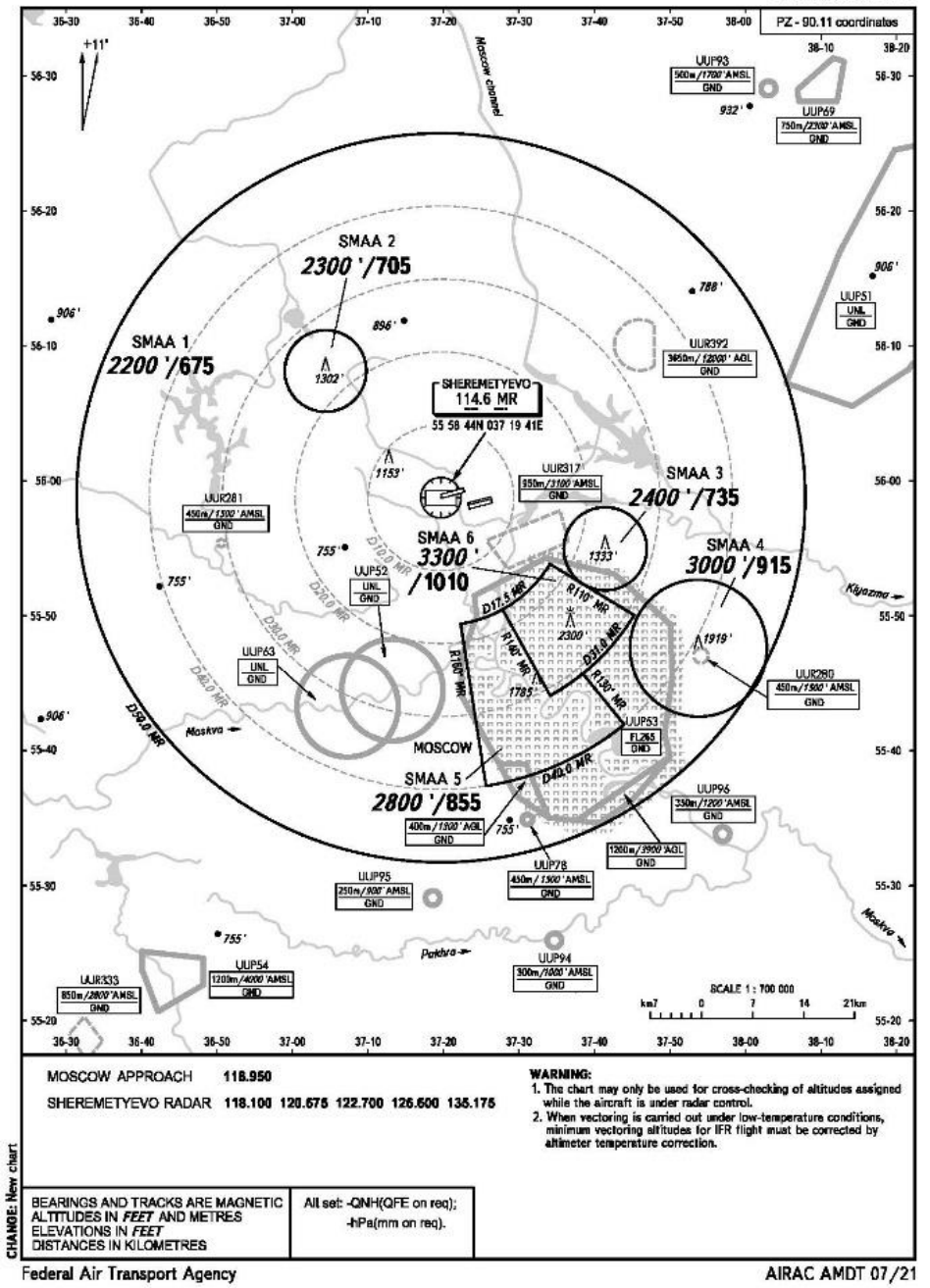
1. The minimum flight altitudes on ATS route segments are published in the ATS Routes tables of ENR 3 section as well as on en-route charts in accordance with the rules in force.

2. The lower (safe) flight level for IFR flights is determined so that to provide a minimum clearance of 2000 feet (600 m) above the highest obstacle within an area of at least 16 km wide (8 km on each side of ATS route centre line) taking into account the temperature correction and the correction for pressure, based upon mean sea level.

The obtained value is increased up to the nearest flight level.

3. For flights in the vicinity of an aerodrome within the radius of not more than 46 km from ARP (in TMA) ATC controller assigns flight heights/altitudes from take-off to transition height/altitude and from transition level to landing in metres with reference to isobaric surface corresponding to the atmospheric pressure at aerodrome level (QFE), or in feet based upon standard atmospheric pressure (QNH).

4. In case ACFT is cleared by the ATS unit to establish at flight altitude, and the pilot-in-command finds the altitude unacceptable due to low temperature, then the pilot-in-command can request a higher altitude. In the absence of such request, ATS unit will consider that the clearance has been accepted and will be complied with.



5. Typical situations and possible crew requests

Responsibility for MOC when flying under IFR

- **PIC**
  - **1. Class C airspace when flying on an ATS route/procedure. Request to occupy a higher altitude (MNM+ΔHt).**
  - **2. Class G airspace (LCU) when flying outside the ATS route/procedure. Request to occupy a higher altitude (AMA+ΔHt) in class C airspace.**
- **ATCO**
  - **3. Class C airspace when flying outside the ATS route/procedure. Providing higher altitude (SMA+ΔHt).**

6. Calculation of corrections for ATS (Doc 8168)

4.3.1 Requirement for temperature correction

The calculated minimum safe altitudes/heights must be adjusted when the ambient temperature on the surface is much lower than that predicted by the standard atmosphere. In such conditions, an approximate correction is 4 per cent height increase for every 10°C below standard temperature as measured at the altimeter setting source. This is safe for all altimeter setting source altitudes for temperatures **above** –15°C.

4.3.2 Tabulated corrections

For colder temperatures, a more accurate correction should be obtained from Tables III-1-4-1 a) and III-1-4-1 b). These tables are calculated for a sea level aerodrome. They are therefore conservative when applied at higher aerodromes. To calculate the corrections for specific aerodromes or altimeter setting sources above sea level, or for values not tabulated, see 4.3.3, "Corrections for specific conditions".

* *Note 1.— The corrections have been rounded up to the next 5 m or 10 ft increment.*
* *Note 2.— Temperature values from the reporting station (normally the aerodrome) nearest to the position of the*
* *aircraft should be used.*

6. Calculation of corrections for ATS (Doc 8168, FR UAS)

4.3.3 Corrections for specific conditions

Tables III-1-4-1 a) and III-1-4-1 b) were calculated assuming a linear variation of temperature with height. They were based on the following equation, which may be used with the appropriate value of t0, H, L0 and Hss to calculate temperature corrections for specific conditions. This equation produces results that are within 5 per cent of the accurate correction for altimeter setting sources up to 3 000 m (10 000 ft) and with minimum heights up to 1 500 m (5 000 ft) above that source.

$$\text{Correction} = H \times \left(\frac{15 - t_0}{273 + t_0 - 0{,}5 \times L_0 \times (H + H_{SS})} \right)$$

The formula from Doc 8168 corresponds to Appendix No. 2 to the FR UAS

Height = altitude – elevation

Altitude = Height + elevation

Hss(setting source) = Haer	- altimeter setting source elevation (the lowest RWY THR)
H = MNM ALT – Hss	- height above the altimeter setting source
to = ta + Lo x Hss	- aerodrome temperature (ta) adjustied to mean sea level;
Lo	- ISA temperature gradient of 0,0065 °C per m (or 0,00198 °C per ft);

6. EUROCONTROL minimum altitude corrections

with specified temperature step

Temperature banding	
Aerodrome Elevation:	26
perature banding interval:	15
CWTC Required after:	200
Unacceptable Max dif:	200

* For a given temperature step, a maximum excess margin is **over 100 feet**

					MSA 1					MSA 2				
				MSA/SMA/MVA:	1600				MSA/SMA/MVA:	2000				
	Temperature bands			Low temp	High - Low	Correction	New	Max	Low temp	High - Low	Correction	New	Max
	High		Low	Correction	Temp Diff.	Rounded up	MSA	Diff	Correction	Temp Diff.	Rounded up	MSA	Diff
Start temperature :	15	to	0	87	87	100	1700	100	109	109	200	2200	200
Temperature bands:	-1	to	-16	191	98	200	1800	107	240	123	300	2300	183
	-17	to	-32	309	111	400	2000	202	388	139	400	2400	152
	-33	to	-48	443	127	500	2100	184	557	159	600	2600	202
	-49	to	-64	599	147	600	2200	148	753	184	800	2800	232
	-65	to	-80	781	171	800	2400	191	981	215	1000	3000	234
	-81	to	-96	995	202	1000	2600	207	1251	255	1300	3300	304
	-97	to	-112	1253	243	1300	2900	290	1575	306	1600	3600	330
	-113	to	-128	1568	297	1600	3200	329	1972	374	2000	4000	402
	-129	to	-144	1963	372	2000	3600	410	2469	469	2500	4500	500
	-145	to	-160	2470	480	2500	4100	509	3109	605	3200	5200	696
	-161	to	-176	3148	641	3200	4800	693	3965	809	4000	6000	845
	-177	to	-192	4099	901	4100	5700	902	5166	1139	5200	7200	1172

NB:

1- The above uses a modifed forumla to that provided in DOC 8168 at Part III, Section 1, Chapter 4, Paragraph 4.3.3

6. Minimum altitude corrections for temperature with a given altitude step (100 feet)

For a given altitude step, the maximum excess margin is not more than 100 feet

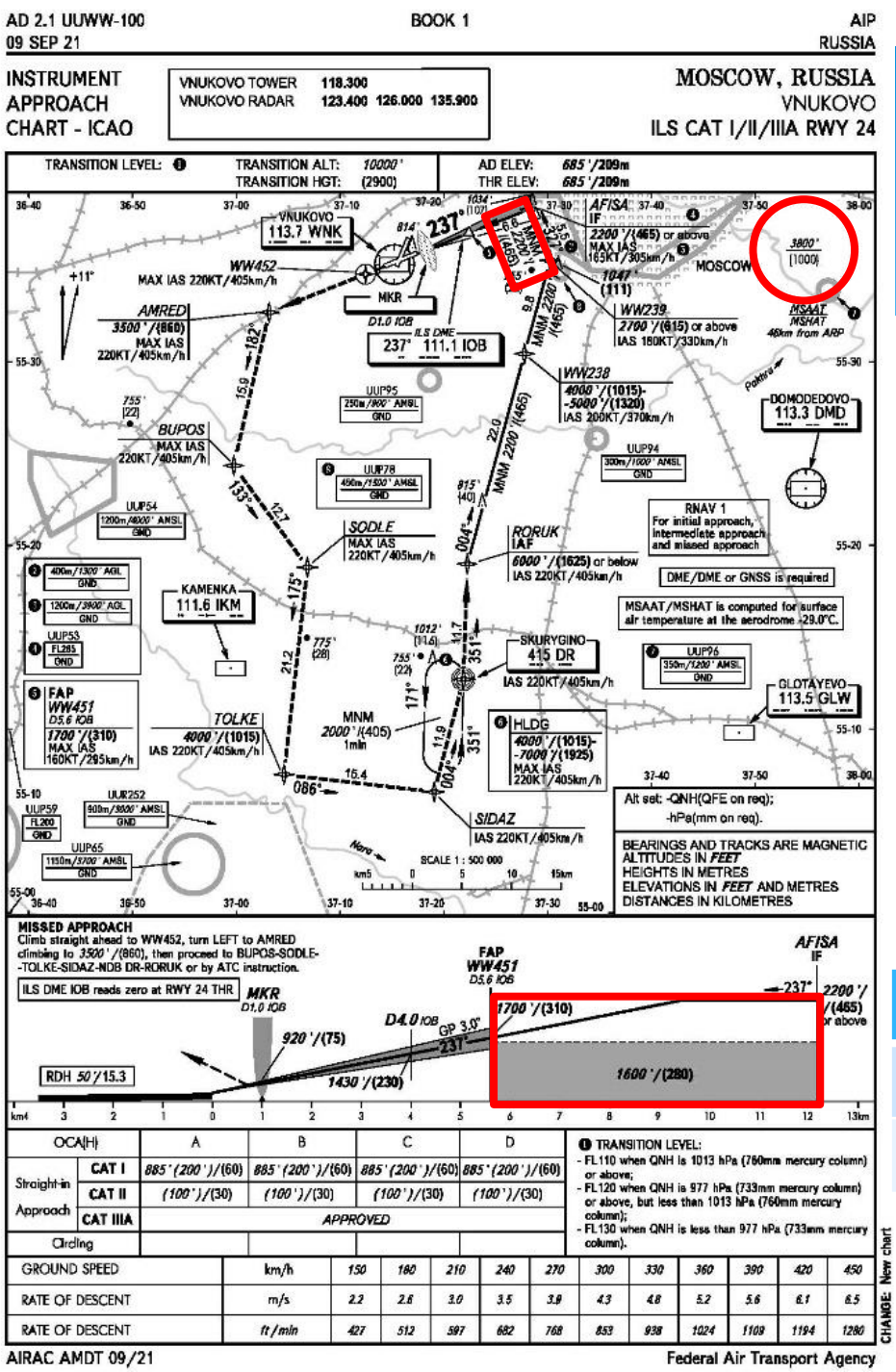
MNM ALT	+100 фут	+200 фут	+300 фут	+400 фут	+500 фут
2000	+14 -5°C	-6 -22°C	-23 -36°C	-37 -49°C	-50 -61°C
2100	+14 -4°C	-5 -19°C	-20 -33°C	-34 -46°C	-47 -57°C
2200	+14 -3°C	-4 -18°C	-19 -31°C	-32 -43°C	-44 -54°C
2300	+14 -2°C	-3 -16°C	-17 -29°C	-30 -40°C	-41 -51°C
2400	+14 -1°C	-2 -14°C	-15 -27°C	-28 -38°C	-39 -48°C
2500	+14 +0°C	-1 -13°C	-14 -25°C	-26 -35°C	-36 -45°C

Note: The table shows an example calculation for elevation 600 feet.

* *The temperature correction calculator chat is available in the VK group:*

7. Recommendations to the ATS unit (tables, NOTAM)

* Calculate minimum altitude corrections (MNM ALT) from temperature in given altitude step (100 feet) for local conditions in tabular form;
* Use the correction table (SMA/AMA+ΔHt) at the workplace for IFR flights outside ATS routes/procedures (vectoring/direction/deviation);
* Consider extra level clearance for separation (+ΔHt);
* Do not inform about taking into account corrections to the cleared altitudes without the request of the PIC;
* Issue NOTAM on altitudes/heights above MSAAT/MSHAT that do not require adjustment to facilitate the use of the airspace structure in TMA;
* Integrate accounting of corrections into the ATC system (MSAW);



7. Recommendations to the ATS unit (flight on the ATS route/procedure)

WW239-AFISA	+100	+200	+300
2200+ 2700+	2300+ 2700+	2400+ 2700+	2500+ 2700+
MNM 2200	+14 -3°C	-4 -18°C	-19 -31°C

- Expect a higher altitude request from the PIC (MNM+ΔHt);
- Take into account extra level clearance for separation (+ΔHt);
- Do not offer to correct the altitude (differences in RFR);
- Note: Above MSAAT/MSHAT no correction is required (but not prohibited).

	+100	+200
FAP 1700	FAP≥MNM	FAP<MNM
MNM 1600	+14 -11°C	-12 -33°C

8. Automation of accounting for temperature corrections (MSAW)

For the ATS unit, integrate into the MSAW function accounting for corrections regarding:

* **SMAA/AMA based on signs of vectoring/direction/deviation during IFR flight**

(MNM on ATS route/procedure segments not to be used)

* **Actual temperature data (METAR, GAMET)**

Vertical criterion from Doc 8168:

4.3.6 Small corrections

For practical operational use, it is appropriate to apply a temperature correction when the value of the correction exceeds 20 per cent of the associated minimum obstacle clearance (MOC).

Note:

for MOC 300 m/1000 ft (basic) corrections over 60 m/200 ft are reasonable

for MOC 600 m/2000 ft (mountainous) corrections over 120 m/400 ft are reasonable

for MOC 150 m/500 ft (from IF to FAF/FAP) corrections over 30 m/100 ft are reasonable

* ***In the Russian Federation, the criteria for starting the practical use of temperature correction at the tactical (operational) level are not explained (which should be an MSP for automation).***

Thank you for your attention

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