saqarTvelos teqnikuri
universitetis
hidrometeorologiis
instituti

saqarTveloSi setyvasTan da zvavebTan brZolis samuSaoTa ganaxlebis sakiTxisaTvis

ON THE RESTORATION OF HAIL SUPPRESSION AND ANTI-AVALANCHE ACTIVITIES IN GEORGIA

К ВОПРОСУ О ВОЗОБНОВЛЕНИИ ПРОТИВОГРАДОВЫХ И ПРОТИВОЛАВИННЫХ РАБОТ В ГРУЗИИ

Tbilisi
2013

1

mimoxilvis avtorebi

Tengiz cincaZe
hidrometeorologiis institutis direqtori,
teqnikis mecn. akad. doqtori, saqarTvelos sainJinro
akademiis wevr-korespodenti
bakur beritaSvili
hidrometeorologiis institutis mTavari mecnieri
TanamSromeli, geogr.mecn. doqtori
naili kapanaZe
hidrometeorologiis institutis ufr.mecnieri
TanamSromeli, geogr.mecn.akad.doqtori
manana saluqvaZe
hidrometeorologiis institutis ufr.mecnieri
TanamSromeli, geogr.mecn.akad.doqtori

**Tengiz Tsintsadze, Bakur Beritashvili,
Naili Kapanadze Manana Saluqvadze**

**Цинцадзе Т.Н., Бериташвили Б.Ш.,
Капанадзе Н.И., Салуквадзе М.Е**

3

uak 551.576:538.978

naSromis pirvel TavSi ganxil ul ia saqarTvel oSi setyvasTan
brZol is adre warmoebul samuSaoTa istoria, organizacia, ga-
moyenebul i teqnol ogia. mocemul ia bul gareTSi amJamad warmo-
ebul i setyvasTan brZol is samuSaoebis struqtura, koncefcia,
samuSaoebSi gamoyenebul i konveqciuri Rrubl isa da reagentis
gavrcel ebis model ebi. ganxil ul ia setyvasaSiSi uj redebisa
da setyviani Rrubl ebis kategoriebi da maTi gansazRvris kri-
teriumebi, zemoqmedebis strategia, teqnikuri saSual ebebi da
kompiuterul i uzrunvel yofa, sacecxl e wertil is teqnikuri
aRWurvil oba. Catarebul ia kaxeTsa da bul gareTSi setyvasTan
brZol is samuSaoTa warmoebis SedarebiTi anal izi.

naSromis meore TavSi warmodgenil ia saqarTvel os zvavsaSiSi
teritoriebi, ganxil ul ia zvavsawinaaRmdego RonisZiebebi da
Tovl is zvavebis dacvis Tanamedrove meTodebi.

УДК 551.576:338.978

В первой главе работы рассмотрены история, организация и технология
работ по борьбе с градом, которые велись ранее в Грузии. Приведены
структура, концепция, используемые модели конвективных облаков и
распространения реагента в ныне ведущихся работах по борьбе с градом в
Болгарии. Рассмотрены категории градоопасных ячеек и градовых облаков,
критерии их определения, стратегия воздействия, технические средства и
компьютерное обеспечение, техническое оснащение огневой точки.
Проведен сравнительный анализ ведения противоградовых работ в Кахетии
и Болгарии.

Во второй главе представлены лавиноопасные районы Грузии, рассмотрены
противолавинные мероприятия и современные методы защиты от снежных
лавин.

UDC 551.576:338.978

In the first part the history, organizational structure and applied technology of hail
suppression activities conducted earlier in Georgia are reviewed. The structure,
concept, convective cloud and agent diffusion models used in ongoing hail
suppression works in Bulgaria are discussed. Categories of hail-dangerous cells
and hailstorms, criteria for their definition are considered along with the seeding
strategy, technical means and software, and rocket launching site equipment. The
comparative analysis of hail suppression activities undertaken in Georgia and
currently being carried out in Bulgaria is performed.

In the second part the avalanche prone territories of Georgia are presented, anti-
avalanche measures and modern methods of avalanche protection are described.

teqstSi gamoyenebul i special uri terminebis
gl osariumi

aerol ogiuri zondireba - atmosferoSi 40 km simaRl emde
meteorol ogiuri el ementebis (haeris temperatura da
sinotive, qari, atmosferul i wneva) vertikal uri ga-
nawil ebis gazomva radiozondis saSual ebiT.

aerosinoptikuri monacemebi - atmosferoSi didi terito-
riis (regioni, kontinenti, naxevarsfero) Tavze mete-
orol ogiuri el ementebis sivrcul i ganawil eba, ro-
mel ic saSual ebs iZl eva 40 km simaRl emde dadgenil
iqnas ZiriTadi bariul i warmonaqmnebis (cikl oni, an-
ticikl oni, atmosferul i frontebi, tropikul i qa-
riSxl ebi da sxv.) konfiguracia da moZraobis siCqa-
re, agreTve mocemul teritoriaze cal keul i Rrubl-
l ebisa da saRrubl o sistemebis ganviTarebis SesaZ-
l ebl oba. aRniSnul i monacemebis misaRebad saWiroa
sxvadasxva. punqtebidan Catarebul i aerol ogiuri
zondirebis masal ebis erTobl ivi anal izi.

amrekl adoba (radiol okaciuri) — Rrubel Si wyl is Txe-
vadi da myari nawil akebis Semcvel obisa da zomebis
ganmsazRvrel i fizikuri sidide, romel ic gaizomeba
sxvadasxva. tal Ris sigrZeze momuSave radiol okat-
orebis saSual ebiT. misi ganzomil ebaa decibel i
(dBz). es sidide saSual ebas iZl eva raodenobrivad
Sefasdes Rrubl is struqtura da misi setyvasaSiS-
roeba.

gadametcivebul i (wyal i, wveTi) - uaryofiT temperaturaze
Txevad fazaSi myofi wyal i. minarevebis gareSe wyl is
mcire wveTebi atmosferoSi xSirad arseboben -20 ℃
temperaturamde. minarevebis Setanisas wveTebi iwyeben
gayinvas -5℃ da ufro dabal temperaturaze.

gazrdil i amrekl adobis zona - Rrubel Si radiol okaci-
uri amrekl adobis are, romel ic SemosazRvrul ia ama-
ve Rrubel Si maqsimal ur amrekl adobaze erTi rigiT
nakl ebi amrekl adobis izokonturiT.

5

grdeml i - setyvasaSiS stadiaSi gadasul i mZl avri kon-
veqciuri Rrubl is grdeml is formis mqone zeda nawi-
l i, romel ic yinul is kristal ebisgan Sedgeba.

decibel i - radiol okaciuri amrekl adobis sazomi erTe-
ul i (saerTaSoriso aRniSvna dBz).

difuziuri Rrubel i - Rrubel Si Setanil i reagentis ga-
vrcel ebis Sedegad warmoqmnil i are, romel Sic sub-
l imaciisa da Rrubl is wveTebTan urTierTqmedebis
Sedegad, agreTve atmosferul i turbul entobis zega-
vl eniT reagentis koncentracia droSi swrafad kl e-
bul obs.

zvavi – ferdobidan simZimis Zal is gavl eniT mowyvetil i
garkveul i mocul obisa da siCqaris Tovl is masaa;

zvavSemkrebi – ferdobis, xevis an xeobis nawil ia, ro-
mel zedac warmoiqmneba, moZraobs da Cerdeba zvavi;

zvavis konusi – zvavis mier xeobaSi, an gzis saval na-
wil ze Camotanil i Tovl is masa, roml is simaRl e
zogj er aTeul obiT metrs aRwevs;

Termiki – atmosferoSi konveqciuri moZraobis ZiriTadi
Semqmnel i el ementi, romel ic warmoadgens garemos-
Tan SedarebiT ufro Tbil i haeriT dakavebul sferu-
l i formis mocul obas. kondensaciis donis miRwevis
Semdeg Termiki, roml is diametri Cveul ebriv ramde-
nime km-s Seadgens, iqceva konveqciuri Rrubl is Sem-
qmnel el ementad. atmosferoSi Rrubel Ta ganviTare-
bisTvis xel Semwyobi pirobebis arsebobisas Termike-
bis erTobl ioba qmnis haeris aRmaval nakadebs, ris
Sedegadac warmoiqmneba konveqciuri Rrubl ebi.

katastroful i zvavi – rogorc sporadul i, ise
sistematuri zvavi, romel ic scil deba Tavis Cveul
sazRvrebs. misTvis damaxasiaTebel ia ngreva,
dazianeba da adamianTa msxverpl i. saqarTvel oSi
aseTi zvavebi teritoriis 36% -ze vrcel deba.

koagul acia - Rrubel Si wyl is wveTebis an yinul is kris-
tal ebis urTierTSerwymis procesi, romel sac Tan
sdevs saRrubl o nawil akebis zomebis zrda da, sabo-
l oo j amSi maTi gamoyofa nal eqebis saxiT.

6

kondensacia - atmosferoSi arsebul aerozol ur minare-
vebze wyl is wveTebis warmoqmnis meqanizmi. am aeroz-
ol ur nawil akebs Cveul ebriv kondensaciis gul ebs
an kondensaciis birTvebs uwodeben.

konveqciuri ujredi - aRmaval TermikebSi wyl is or-
Tql is kondensaciis Sedegad warmoqmnil i konveqciu-
ri Rrubl is ZiriTadi struqturul i el ementi, rome-
l ic saTanado pirobebSi SeiZl eba gardaiqmnas wvimis
an setyvis momcem mZl avr konveqciur Rrubl ad.

meteograma - mocemul i adgil mdebareobisTvis atmosfe-
roSi meteorol ogiuri el ementebis ganviTarebis sap-
rognozo grafiki, romel ic Seicavs uaxl oesi 5-10
dRis ganmavl obaSi temperaturis, Rrubl ebisa da na-
l eqebis sxvadasxva. saprognozo model ebiT gaTvl il
mosal odnel mniSvnel obebs.

momwifebul i/simwifis stadiaSi myofi konveqciuri ujre-
di - maqsimal uri ganviTarebis stadiaSi myofi ujre-
di, romel ic xasiaTdeba haeris mZl avri aRmaval i na-
kadebisa da nal eqTa mzardi el ementebis — wyl is wve-
Tebisa da setyvis marcvl ebis arsebobiT. nal eqebis
gamoyofasTan erTad momwifebul i ujredi iwyebs di-
sipaciis stadiaSi gadasvl as.

mraval ujrediani konveqciuri Rrubel i - ramdenime uj-
redisgan Semdgari kompl eqsuri konveqciuri Rrube-
l i, romel Sic ujredebi, SesaZl ebel ia ganviTarebis
sxvadasxva. stadiaSi imyofebodnen. aseTi tipis kon-
veqciuri Rrubel i SeiZl eba damoukidebl adac viTar-
debodes da SeiZl eba superujrediani Rrubl is fron-
tal ur nawil sac warmoadgendes.

nal eqTa xel ovnuri gazrda - samuSaoTa kompl eqsi, ro-
mel ic miznad isaxavs SerCeul teritoriaze drois
garkveul monakveTSi (Tve, sezoni, wel i) Sesaferisi
teqnol ogiis gamoyenebiT nal eqTa raodenobis gazr-
das.

nukl eacia - wyl is orTql is fazuri gadasvl is procesi,
roml is drosac atmosferoSi arsebul minarevebze,

7

rogorc Canasaxebze, warmoiqmneba wyl is wveTebi an yinul is kristal ebi.

reagenti - qimiuri nivTiereba, roml is Setana Rrubel Si iwvevs misi fazuri an kol oiduri mdgomareobis dar-Rvevas. pirvel SemTxvevaSi es aris makristal ebel i reagenti (umetes SemTxvevaSi iodovani vercxl is AgI Semcvel i nivTiereba), roml is nawil akebi uaryofiT temperaturaze iwvevs yinul is kristal ebis gaCenas saRrubl o wveTebis gayinvis an wyl is orTql is maTze subl imaciis gziT. meore SemTxvevaSi es aris hig-roskopul i reagenti (umeteswil ad sufris maril i NaCl), roml is nawil akebi iwvevs maTze kondensaciis gziT wyl is wveTebis warmoqmnas da am wveTebis Semdgom koagul aciur zrdas.

satel ituri informacia - dedamiwis meteorol ogiuri xel ovnuri Tanamgzavridan miRebul i satel evizio gamosaxul ebebi, roml ebic sxva informaciasTan erTad Seicavs monacemebs saRrubl o sistemebis tipis, geometriul i zomebisa da gadaadgil ebis mimarTul ebisa da siCqaris Sesaxeb.

sistematuri zvavi – yovel wl urad Camosul i zvavi. saqarTvel oSi aseT zvavebs teritoriis 20% ukaviaT;

sporadul i zvavi – iSviaTi ganmeoradobis zvavi, romel ic SesaZl ebel ia 2-3 wel iwadSi erTxel, an aTeul wel iwadSi erTxel Camovides;

subl imacia - atmosferoSi arsebul aerozol ur minarevebze yinul is kristal ebis warmoqmnis meqanizmi. am aerozol ur nawil akebs Cveul ebriv subl imaciis gul ebs an yinul warmomqmnel birTvebs uwodeben.

superuj rediani konveqciuri Rrubel i - atmosferoSi ar-sebul i yvel aze mZl avri tipis konveqciuri Rrubel i, romel ic Cveul ebriv, gansxv.vebul i haeris masebis Se-revis/konvergenciis zonaSi viTardeba. am Rrubel s, rogorc wesi, Tan axl avs wwimisa da setyvis mosvl a, agreTve haeris mZl avri vertikal uri nakadis (tornado an Skval i) gaCena. misi simaRl e SeiZl eba aRwev-des 1517 km, xol o horizontal uri zomebi – ramdenime

8

aTeul kilometers. Rrubel ma SeiZleba iarsebos ram-
denime saaTs da gaiaros ramdenime aseuli kilomet-
ri.

yinulianoba - Rrublis erTeulovan moculobaSi yinu-
lis kristalebisa da gayinuli wveTebis jamuri masa.
 misi ganzomilebaa g/m^3.

wylianoba - Rrublis erTeulovan moculobaSi Txevad
fazaSi myofi wylis wveTbis jamuri masa. misi ganzo-
milebaa g/m^3.

<div align="center">Semoklebebi</div>

gaz – gazrdili amrekladobis zona.

nxg – naleqTa xelovnuri gazrda.

r/l – radiolokaciuri.

LED - sinaTlis gamasxivebeli diodi.

RAPIRA - radiolokaciuri da aerologiuri informaciis
real ur droSi analizis sistema.

WMO - msoflio meteorologiuri organizacia.

Sinaarsi

11

winasityvaoba

klimatis globaluri daTbobis zegavleniT gavlili 20 wlis manZilze msoflios yvela regionSi aSkarad gamovlinda amindis eqstremaluri movlenebis gamZafreba, rac did zarals da msxverpls iwvevs. saqarTveloSi am movlenebma Tavi iCina wyalmovardnebis, Zlieri Stormebis, mewyerebis, zvavebis da setyvianobis gaxSirebiT. es Sesabamis reagirebas moiTxovs qveynis mTavrobis mxridan, romelic valdebulia gaataros am stiqiuri movlenebiT miyenebuli zaralis Semarbilebeli RonisZiebebi.

kaxeTi, romelic sasoflo-sameurneo warmoebis da mevenaxeobis erT-erT wamyvan regions warmoadgens, bolo wlebSi yovel wliurad aRiniSneba Zlieri setyvis mosvlis SemTxvevebi, rac mniSvnelovnad azaralebs soflis mosaxleobas da iwvevs mis ukmayofilebas gasul i saukunis 60-ian — 80-ian wlebSi aq warmoebul setyvasTan brZolis samuSaoTa Sewyvetis gamo. sagulisxmoa, rom anal ogiuri samuSaoebi romlebic saqarTvelos gamocdilebaze dayrdnobiT, mogvianebiT daiwyo sxva yofil sabWoTa respublikebSi, agreTve bul gareTSi, 1990-iani wlebidan ar Sewyvetila da Tanamedrove teqnologiebis gamoyenebiT amJamadac grZeldeba. setyvasTan brZolis samuSaoebi cal keuli proeqtebis saxiT mimdinareobs agreTve aSS-Si, kanadaSi, argentinaSi, samxreT afrikaSi, safrangeTSi da sxv. yovelive aman ganapiroba saqarTvelos mTavrobaSi sakiTxis dasma kaxeTis regionSi setyvasTan brZolis samuSaoebis aRdgenis Taobaze, ramac garkveuli wvlili unda Seitanos qveynis ekonomikis prioritetul dargis — soflis meurneobis efeqtianobis gazrdaSi da Seqmnas regionis fermerebisaTvis amindis Wirveulobisgan ufro daculi Sromis pirobebi. imis gaTval iswinebiT, rom setyvasawinaaRmdego, nal eqebze aqtiuri zemoqmedebis da zvavsawinaaRmdego samuSaoebi dakavSirebulia garkveuli tipis sabrZolo teqnikis gamoyenebasTan, aRniSnuli amocanis gadaWra daeval a saqarTvelos Tavdacvis saministros ssip saxel mwifo samxedro samecnieroteqnikur centr "deltas", romel mac 2013 wels daiwyo

mosamzadebel i saqmianoba aRniSnul i mimarTul ebiT samu-SaoTa gasaSl el ad. gasul i ori aTeul i wl is manZil ze am dargSi daSvebul i CamorCenis dasaZl evad miRebul iq-na gadawyvetil eba bul gareTis setyvasTan brZol is sam-saxurTan saTanado kontaqtebis damyarebis Sesaxeb, rac ganpirobebul ia am qveynis geografiul i da kl imaturi pirobebis msgavsebiT saqarTvel os pirobebTan, agreTve setyvis sawinaaRmdego samuSaoTa warmoebis maRal i do-niT.

aranakl eb did zians ayenebs saqarTvel os mTian regionebs Tovl is zvavebic, roml ebTan brZol is didi tradiciebi gaaCnia svaneTisa da sxva kuTxeebis mosaxl eobas. uxvi nal eqebis gaxSirebis gamo amJamad am mimarTul ebis aqtual obac gaizarda.

amasTan dakavSirebiT saqarTvel os teqnikuri univer-sitetis hidrometeorol ogiis instituts, romel ic gasu-l i saukunis meore naxevarSi aqtiurad monawil eobda samxreT kavkasiaSi setyvasTan brZol isa da nal eqTa re-gul irebis, agreTve zvavsawinaaRmdego samuSaoebSi, daev-al a mokl e mimoxil vis momzadeba saqarTvel oSi, da ker-Zod kaxeTSi, 1980-ian wl ebSi setyvasTan brZol is samuSa-oTa organizebisa da amJamad am samuSaoTa bul gareTSi warmoebis, zvavsawinaaRmdego RonisZiebebis Tanamedrove mdgomareobis Sesaxeb.

winamdebare mimoxil va miznad isaxavs zogadad gaac-nos qarTvel eqspertebs aRniSnul dargSi adre da amJa-mad gamoyenebul i teqnol ogiebi da moamzados niadagi saqarTvel oSi setyvasTan brZol is da zvavsawinaaRmdego samuSaoTa Tvisobrivad axal doneze aRsadgenad.

13

Tavi I.setyvasTan brZolis samuSaoTa ganaxlebis
sakiTxisaTvis

1.setyvasTan brZolis samuSaoTa istoria
saqarTvelOSi

bolo ori saukunis manZilze setyvasTan brZola aq-
tualur problemad iqca kaxeTSi. gasuli saukunis da-
sawyisSi am mizniT ukve gamoiyeneboda mortirebi, romel-
Ta gasrolisas warmoqmnil akustikur talRas, maSinde-
li warmodgeniT, xeli unda SeeSala setyvis warmoqmnis
procesisaTvis. nax.1-ze 1970-iani wlebis monacemebiT war-
modgenilia setyvianobis sixSiris ganawileba kaxeTis
teritoriaze.
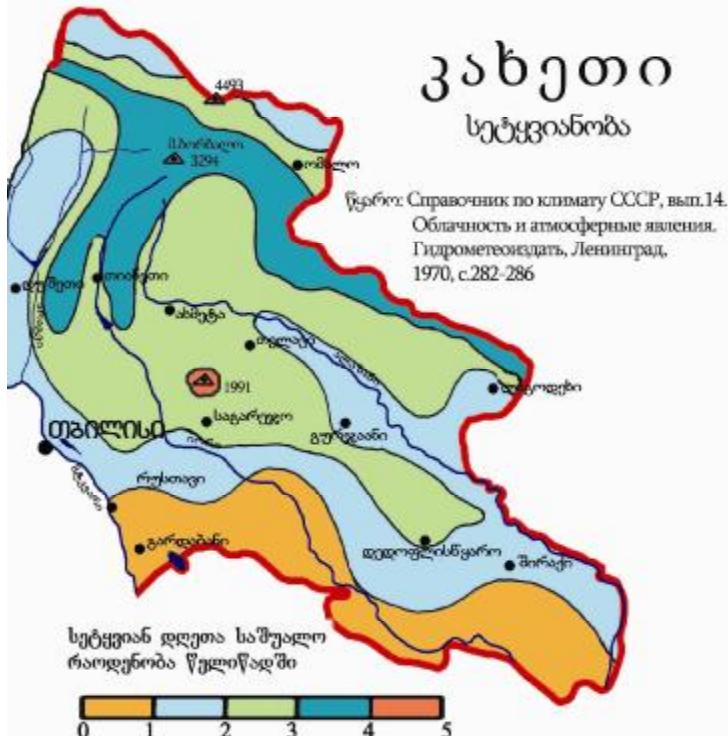
nax.1. setyvianobis ganawileba kaxeTis teritoriaze 1970-
iani wlebis monacemebiT.

14

am naxazidan Cans, rom kaxeTis umetes nawilSi weli-
wadSi erT punqtSi mosuli setyvis sixSire saSualod
icvleboda 1-dan 3-mde. kavkasionis ferdobebze da civ-
gomboris qedis maRal zonaSi es sidide izrdeba 45-mde,
setyvian dReTa raodenobis maqsimumi weliwadSi SeiZle-
ba aRwevdes 8-10, kavkasionis maRal mTian zonaSi ki 20-s
(nax.2).
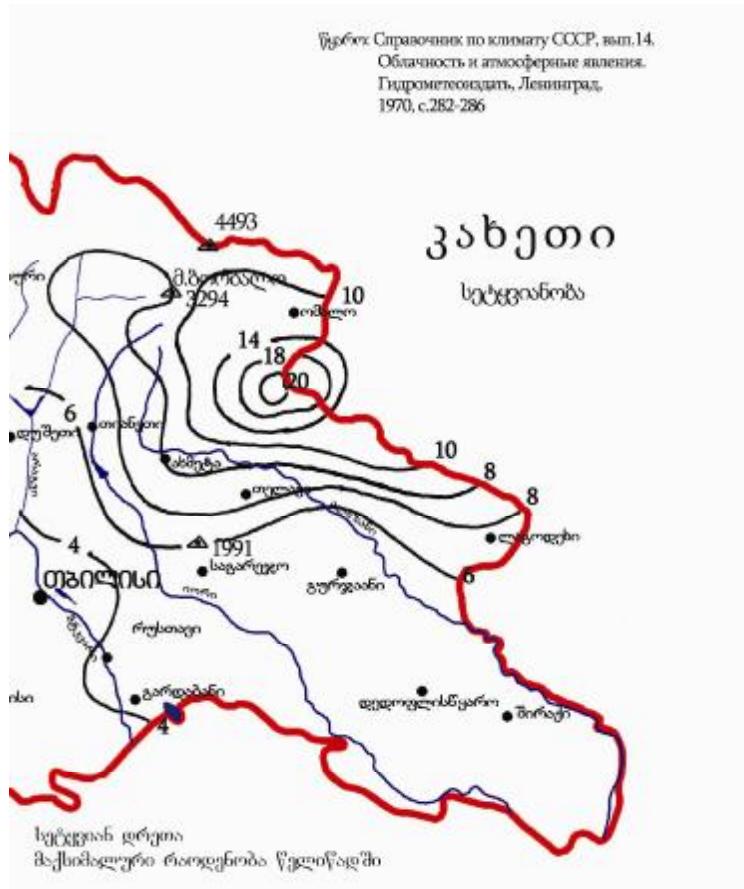
nax.2. setyvian dReTa maqsimaluri raodenobis ganawileba
kaxeTis teritoriaze (1983).

15

1.1. savel e samuSaoebi

konveqciuri Rrubl ebisa da maTTan dakavSirebul i nal eqebis (TqeSi wvima, setyva) Seswavl a saqarTvel oSi daiwyo gasul i saukunis 50-ian wl ebSi geofizikis insti-tutsa (a. qarcivaZe, a. buxnikaSvil i, a. bal abuevi) da hid-rometeorol ogiis institutSi (v. l ominaZe, v. gigineiSvi-l i, i. barTiSvil i). 50-iani wl ebis dasasrul isaTvis sab-WoTa kavSirSi Seiqmna setyvasTan brZol is special uri teqnikuri saSual ebebi (setyvasawinaaRmdego raketebi `pgi~, `obl ako~, mogvianebiT sazenito Wurvebi `el bru-si~). Rrubl ebze dakvirvebisa da zemoqmedebis operacieb-is Casatarebl ad gamoiyeneboda samxedro daniSnul ebis radiol okatorebi, ars-3 (λ=3.2 sm) da son-4 (λ=10 sm).

setyvasTan brZol is sacdel -sawarmoo samuSaoTa pir-vel i samsaxuri geofizikis institutis xel mZRvanel obiT Seiqmna 1959 wel s al aznis vel ze (a. qarcivaZe, a. buxni-kaSvil i), xol o 1960 wel s hidrometeorol ogiis insti-tutma anal ogiuri sacdel i samuSaoebi daiwyo faravnis tbis auzSi (v. l ominaZe, i. barTiSvil i). 1964 wl idan sa-warmoo samuSaoebi geofizikis institutis xel mZRvane-l obiT gaiSal a kaxeTis raionebSi da hidrometeorol og-iis institutis xel mZRvanel obiT _ qvemo qarTl is rai-onebSi. kaxeTSi reagentis (**AgI, PbI₂**) Setana Rrubl ebSi warmoebda raketebis saSual ebiT, xol o qvemo qarTl Si _ saartil erio WurvebiT. 60-iani wl ebis Sua periodidan hidrometinstitutSi SemuSavda setyvasTan brZol is or-iginal uri meTodika, romel ic gul isxmobda Rrubl is er-Tdroul damuSavebas sazenito Wurvebis gamoyenebiT ro-gorc makristal ebel i (**AgI**), ise higroskopul i (**NaCl**) re-agentiT.

1980-ian wl ebSi dasacavi teritoriebis farTobma ka-xeTSi 650 aTasi ha-s miaRwia, xol o qvemo qarTl Si 350 aTas ha-s (nax.3.). kaxeTSi zemoqmedeba warmoebda erT da orsafexuriani `al aznis- tipis raketebis gamoyenebiT, roml ebic mzaddeboda ruseTSi, q. CapaevskSi.

16

КАРТА РАЙОНА РАБОТ ВС Груз УГКС

М-1:600000

УСЛОВНЫЕ ОБОЗНАЧЕНИЯ

Граница защищаемой территории благазированных частей:
1-Телавской, 2-Гурджаанской, 3-Сагарейджойкой,
4-Цителицкаройской, 7-Тетрицкаройской, 6-Марнеульской
★-Командные пункты благазированных частей
● - Пункты выгрузки.

Границы районов работ безмотированных отрядов по
базовым водам:
8- Иорское, 7-Храмо-Парабанское
● - Районные , ... Границы республики
— — Граница Администрративных районов

1985

nax.3. setyvasTan brZol is gasamxedroebul i samsaxu-
ris samoqmedo teritoriis sqema. setyvasTan brZol is ga-
samxedroebul i nawil ebis dasacavi teritoriebi: 1-Te-
l avis, 2-gurj aanis, 3-sagarej os, 4-dedofl iswyaros, 5-
TeTriwyaros, 6-marneul is. nal eqTa xel ovnuri gazrdis
pol igonebi: 7-faravnis, 8-ioris

maTi fasi Sesabamisad Seadgenda 100 da 150 maneTs. se-
zonze daaxl oebiT ixarj eboda 10-dan 30 aTasamde raketa,
roml ebic aRWurvil i iyo 16.8 g makristal ebel i reagen-
tiT (1980 wl amde PbI_2, SemdegSi AgI). erTsafexuriani ra-
ketebis moqmedebis radiusi Seadgenda 5 km, orsafexuri-
anisa ki 10 km.

17

1970-ian wlebSi operaciebis Casatareblad gamoiyeneb-
oda meteorologiuri radiolokatorebi mrl-2, xolo
SemdgomSi mrl-5 (nax. 4), romlebic mzaddeboda q.gorkSi
(niJni novgorodi) da maTi Rirebuleba 600-800 aTas ma-
neTs Seadgenda.

nax. 4 meteorologiuri radiolokaciuri sadguri mrl-5

kaxeTis dasacav teritoriaze funqcionirebda 4 ga-
samxedroebuli nawili sakomando punqtebiT ruispirSi
(Tel avis raioni), gurjaanSi, badiaurSi (sagarejos raio-
ni) da dedofliswyaroSi. samuSao sezoni grZeldeboda 1
aprilidan 30 oqtombramde. teritoriaze moqmedebda 100-
mde sacecxle wertili, romlebic xeliT asrulebda sa-
komando punqtidan miRebul brZanebebs. yvela sacecxle

18

wertil i uzrunvel yofil i iyo sayofacxovrebo pirobe-
biTa da misasvl el i gzebiT. ramdenime maRal mTian wer-
til s Sveul mfreni emsaxureboda.

qvemo qarTl Si zemoqmedeba warmoebda sazenito qveme-
xebis `ks~ gamoyenebiT. sakomando punqti TeTriwyaroSi
iyo ganTavsebul i. sazenito Wurvi `el brusi~ Seicavda
16.5 gramamde iodovan vercxl s, an 240 g sufris maril s.
TiToeul i Wurvis moqmedebis radiusi 12 km-mde aRwevda,
xol o Rirebul eba 120 maneTs Seadgenda. operaciebis Ca-
satarebl ad aqac gamoiyeneboda mrl -2 da mrl -5 radiol -
okatorebi. sacecxl e wertil ebi xel iT imarTeboda.

80-ian wl ebSi iyo mcdel oba zemoqmedebis operaciebi
avtomatur reJimSi Catarebul iyo, magram teqnikuri mize-
zebis gamo es mcdel oba uSedegod dasrul da.

setyvasTan brZol is samuSaoebis paral el urad 1980-
ian wl ebSi gasamxedroebul i samsaxuri 2 pol igonze aw-
armoebda agreTve nal eqTa xel ovnuri gazrdis (nxg) sac-
del   sawarmoo samuSaoebsac. ioris pol igonze, hidrome-
teorol ogiis institutis samecniero-meToduri   xel -
mZRvanel obiT, es samuSaoebi tardeboda Tel avis gasam-
xedroebul nawil Si Semaval i cal ke razmis mier, xol o
faravnis pol igonze — TeTriwyaros nawil Si Semaval i
razmis mier.

1.2. samecniero gamokvl evebi

setyvasTan brZol is operatiul samuSaoebTan erTad
1960-iani wl ebidan saqarTvel oSi intensiurad mimdinare-
obda Rrubel Ta fizikisa da nal eqTa regul irebis dar-
gSi Teoriul i da l aboratoriul i samuSaoebic. geofiz-
ikis institutSi Teoriul i gamokvl evebi ZiriTadad kon-
centrirebul i iyo setyvis warmoqmnis procesebze makris-
tal ebel i reagentis zemoqmedebis Seswavl aze, xol o hid-
rometeorol ogiis institutSi _ nal eqwarmomqmnel   pro-
cesebze higroskopul i reagentis gavl enis dadgenaze.
1970-ian wl ebSi orive institutSi Rrubl ebSi mimdinare
procesebis eqsperimentul i model irebisTvis agebul iqna
saRrubl o kamerebi.

19

geofizikis institutis 40 m simaRl is kameraSi -30°C-
mde temperaturis pirobebSi Seiswavl eboda setyvis mar-
cvl ebis zrdis Taviseburebebi xol o hidrometeorol og-
iis institutis 250 m mocul obis kameraSi — dadebiT tem-
peraturaze mimdinare nal eqwarmoqmnis procesebi. am kame-
rebSive da ufro mcire danadgarebSi gamoicdeboda sxva-
dasxva tipis reagentebi.

setyvasTan brZol is dargSi saqarTvel oSi warmoebu-
l samuSaoTa pionerul i xasiaTis aRiarebas mowmobda
is faqti, rom 1962 da 1969 wl ebSi Tbil isSi Catarda
Rrubel Ta fizikisa da aqtiuri zemoqmedebis maRal i do-
nis saerTaSoriso konferenciebi, xol o Semdgom wl ebSi
qarTvel i mecnierebi farTod monawil eobdnen sxvadasxva
qveynebSi Catarebul am mimarTul ebis mraval Sexvedreb-
Si.

1.3. arsebul i mdgomareoba

1990 wl idan dawyebul ma pol itikurma procesebma da-
mangrevel i zemoqmedeba moaxdina setyvasTan brZol is sa-
muSaoebze: finansirebis Sewyvetis gamo gapartaxda sako-
mando punqtebi, ganadgurda radiol okaciuri teqnika, sa-
raketo da saartil erio danadgarebi gamoyenebul iqna
samoqal aqo dapirispirebis sabrZol o moqmedebebSi, gaif-
anta zemoqmedebis kval ificiuri kadrebi, romel Tagan am-
Jamad mxol od 10 special istamdea SemorCenil i. amrigad,
aRniSnul dargSi savel e samuSaoTa aRdgena Tanamedrove
teqnol ogiebis gamoyenebiT faqtobrivad nul idan iqneba
sawarmoebel i.

rac Seexeba samecniero gamokvl evebs, isini SezRudu-
l i saxiT grZel deba geofizikisa da hidrometeorol o-
giis institutebSi. pirvel maTganSi es samuSaoebi moi-
cavs, ZiriTadad, kaxeTis regionSi Catarebul i samuSaoeb-
is Sedegebis anal izs da setyvis zrdis procesebis cal -
keul i aspeqtebis Seswavl as, xol o meoreSi — konveqciu-
ri Rrubl ebis model irebis sakiTxebs.

2.kaxeTSi warmoebul setyvasTan brZolis samuSaoTa organizacia

1960 wlidan kaxeTSi setyvasTan brZolis samuSaoebs awarmoebda saqarTvelos soflis meurneobis saminist-ros sistemaSi Semavali setyvasTan brZolis gasamxedro-ebuli samsaxuri. mis operatiul saqmianobas samecniero-meTodur xel mZRvanelobas uwevda saqarTvelos mecnier-ebaTa akademiis geofizikis instituti. daarsebis dRi-dan 1986 wl amde samsaxurs xel mZRvanelobda geofizikis institutis Rrubel Ta fizikis ganyofilebis gamge a.qar-civaZe. 1986 wlidan gasamxedroebuli samsaxuri Sevida saqarTvelos hidrometeorologiisa da garemos kontro-lis sammarTvelos daqvemdebarebaSi, rac gamowveuli iyo ssrk teritoriaze setyvasTan brZolis yvela qvedanayo-febis erTiani meTodikiT muSaobis moTxovniT.

1980—iani wlebisTvis kaxeTis teritoriaze moqmedi setyvasTan brZolis gasamxedroebuli samsaxuri (sbgs), romelic awarmoebda 650 aTas ha farTobze setyvisagan dacvis samuSaoebs, Sedgeboda 4 gasamxedroebuli nawi-lisagan, romelTa sakomando punqtebi mdebareobda ruis-pirSi (Telavi), gurjaanSi, badiaurSi (sagarejo) da qo-CebSi (dedofliswyaro). nawilebis SeTanxmebul muSaob-as saerTo xel mZRvanelobas uwevda ruispirSi ganTavse-buli sbgs centraluri sammarTvelo, romelic Sedgebo-da Semdegi ganyofilebebisagan: administracia, zemoqmede-bis, radiolokaciis, saraketo teqnikis, kavSirgabmulobi-sa da sameurneo ganyofilebebi.

• administracia xel mZRvanelobda samsaxuris saqmianobas yvela sferoSi: sakadro, safinanso, materialur-teqniku-ri momaragebis, agreTve samecniero-meTodur sakiTxebSi. Sesabamisad, masSi Sedioda kadrebis seqtori da buRal - teria.

• zemoqmedebis ganyofileba uzrunvelyofda oTxive ga-samxedroebul nawilSi zemoqmedebis samuSaoTa erTiani meTodikiT warmoebas, dRis ganmavlobaSi Catarebuli ze-moqmedebis Sesaxeb, angariSebis Sedgenas da maT detal-ur ganxilvas, sezonis dasrulebis Semdeg samsaxurSi

21

Catarebuli zemoqmedebis operaciebis Sejamebas, anal iz-
sa da jamuri angariSis Sedgenas.
• radiolokaciis ganyofileba uzrunvelyofda gasamxed-
roebul nawilebSi moqmedi radiolokaciuri sadgurebis
gamarTul muSaobas, sadgurebis parametrebis Sesabamiso-
bas miRebul standartebTan.
• saraketo teqnikis ganyofilebis moval eobaSi Sedioda
sacecxle wertilebze (zemoqmedebis punqtebze) moqmedi
saraketo gamSvebi danadgarebis gamarTuli muSaobis uz-
runvelyofa, sakomando punqtidan miRebuli brZanebebis
operatiuli Sesruleba, raketebis Senaxvisa da punqtebze
disciplinis wesebis dacva.
• kavSirgabmulobis ganyofileba uzrunvelyofda centra-
luri sakomando punqtis kavSirs xel mZRvanel organoeb-
Tan da sahaero moZraobis marTvis centrTan, kavSirs ga-
samxedroebuli nawilebis sakamando punqtebsa da sacec-
xle wertilebs Soris.
• sameurneo ganyofileba axorcielebda samsaxuris moma-
ragebas sabrZolo teqnikiT (radiolokatorebiT, rakete-
biTa da gamSvebi danadgarebiT), avtotransportiTa da
sawvaviT, formis tansacmliT, sakomando punqtebisa da
sacecxle wertilebis funqcionirebisaTvis saWiro masa-
lebiT da sxv.
        TiToeul gasamxedroebul nawilSi Sedioda daaxlo-
ebiT 20-25 zemoqmedebis punqti, romlebzedac momsaxure
personali uzrunvelyofili iyo minimaluri sayofacxov-
rebo pirobebiT (mcire zomis martivi saxli, maRal mTian
punqtebze-karavi), gazquriT, eleqtromomaragebiTa da mi-
sasvleli gziT. maRal mTian punqtebze raketebisa da sxva
masalebis misawodeblad gamoiyeneboda vertmfreni, rome-
lic samuSao sezonze mimagrebuli iyo gasamxedroebul
samsaxurze.
        TiToeuli gasamxedroebuli nawilis baza warmoad-
genda misasvleli gziT, eleqtro - da wyal momaragebiT
uzrunvelyofil Semofargluli teritorias, romel zedac
ganTavsebuli iyo erTi an ramdenime radiolokaciuri
sadguri, standartuli tipis sakomando punqti sruli

22

wriul i xil vadobiT, administraciul i Senoba, momsaxure personal is sacxovrebel i korpusebi, saxel osnoebi da damxmare saTavsoebi.

gasamxedroebul i samsaxuris central uri baza moic- avda central uri sakomando punqtis samsarTul ian Seno- bas, romel Sic damontaJebul i iyo 2 radiol okaciuri sadguri, ganTavsebul i iyo zemoqmedebisa da kavSirgabmu- l obis centrebi, samsaxuris administracia da ganyofi- l ebebi, saaqto darbazi da sxva saTavsoebi. central ur bazaze cal ke Senoba ekava aerosinoptikur j gufs, rome- l ic special uri arxebiT Rebul obda Tanamgzavrul da aerosinoptikur informacias atmosferoSi 20 km simaR- l emde kavkasiis regionis fargl ebSi mimdinare procese- bis Sesaxeb da miRebul i monacemebis safuZvel ze iZl eo- da dRe-Ramis ganmavl obaSi mosal odnel i movl enebis prognozs. central ur bazaze funqcionirebda agreTve sastumro, sasadil o da bibl ioTeka. aqve ganTavsebul i iyo samsaxuris central uri sawyobi, avtofarexi, saxe- l osnoebi da momsaxure personal is 2 mraval biniani sac- xovrebel i korpusi. baza uzrunvel yofil i iyo special - uri dadubl irebul i el eqtro momaragebiT, sakuTari wyal momaragebiT da wyl is gamwmendi nagebobiT. bazidan 1 km moSorebiT agebul i iyo raketebis special urad dap- roeqtebul i sawyobi, roml idanac maragdebodnen cal keu- l i gasamxedroebul i nawil ebi.

gasamxedroebul samsaxurSi zemoqmedebis sezoni grZel deboda april is dasawyisidan oqtombris bol omde. noember-dekemberSi mimdinareobda Catarebul i samuSaoeb- is Sej ameba, anal izi da angariSebis gaformeba, xol o Teberval -martSi tardeboda zemoqmedebis, radiol okaci- is, saraketo teqnikisa da kavSirgabmul obis ganyofil e- baTa momsaxure personal is treiningebi.

zemoqmedebis sezonis ganmavl obaSi TiToeul gasam- xedroebul nawil Si axal i samuSao dRe iwyeboda 12 sa- aTze, rodesac special istebis saerTo krebaze j amdebo- da gasul i dRe-Ramis Sedegebi da igegmeboda momaval i dRe-Ramis saqmianoba. ruispiris central ur sakomando

23

punqtze TaTbirs (Stabis sxdomas) eswreboda samsaxuris mTel i xel mZRvanel oba. moxsenebas gavl il dRe-RameSi Catarebul i saqmianobis Sesaxeb akeTebda gavl il i dRis samsaxuris morige xel mZRvanel i, romel ic, rogorc wesi, iniSneboda samsaxuris xel mZRvanel i personal idan. zemoqmedebis Catarebis SemTxvevaSi samuSao dRis anal izisas detal urad ixil eboda zemoqmedebis Catarebul i operaciebi da fasdeboda maTi efeqturoba. Tu dasacav teritoriaze adgil i hqonda setyvis mosvl is SemTxvevas, ganixil eboda dasetyvil i teritoriis Semowmebis Sedegebi, romel sac operatiul ad atarebda special urad momzadebul i jgufi. amis Semdeg ganixil eboda sxva gasamxedroebul nawil ebSi Catarebul i samuSaoebis Sedegebi.

Catarebul i operatiul i muSaobis Sejamebis Semdeg moismineboda aerosinoptikuri jgufis xel mZRvanel is informacia, romel ic Seicavda gavl il i dRis aerosinoptikuri situaciis diagnozs da momaval i dRis prognozs. am informaciis safuZvel ze miiReboda gadawyvetil eba momaval i dRis ganmavl obaSi operatiul i saqmianobis Sesaxeb, agreTve iniSneboda dRis morige Semadgenl oba. TaTbiris Catareba 12 saaTze ganpirobebul i iyo imiT, rom am droisTvis unda moswrebul iyo wina dRes Catarebul i zemoqmedebis operaciebis Sesaxeb angariSis Sedgena, rac Zl ieri procesebis SemTxvevaSi sakmaod Sromatevad proceduras warmoadgenda. amave dros mxedvel obaSi miiReboda isic, rom kaxeTis regionSi adgil obrivi Zl ieri konveqciuri procesebi, umeteswil ad, dRis meore naxevarSi viTardeba, xol o frontal ur procesebs, ZiriTadad, saRamosa da Ramis saaTebSi aqvs adgil i.

daaxl oebiT anal ogiuri wesiT tardeboda yovel dRiuri TaTbir-garCevebi regionis sxva gasamxedroebul nawil ebSic. gasamxedroebul i samsaxuris muSaoba da misi Sedegebi mudmivad imyofeboda respubl ikis umaRl esi xel mZRvanel obis yuradRebis qveS, rac uzrunvel yofda mis saqmianobaSi sistematuri daxmarebis gawevas.

warmoebul samuSaoTa garemoze ekol ogiuri zemoqmedebis Sesafasebl ad Tbil isis saxel mwifo universite-

tis, geofizikis da hidrometeorologiis institutebis specializebuli jgufebis mier kaxeTis teritoriaze sistematurad warmoebda Sesabamisi gamokvlevebi.

1970-iani wlebis dasasruls setyvasTan brZolis gasamxedroebul samsaxurSi Seiqmna naleqTa xelovnuri gazrdis (nxg) specializebuli qvedanayofi, romelsac daeval a naleqTa xelovnuri gazrdis mizniT sacdel- sawarmoo samuSaoebis Catareba sionis wyal sacavis auz- Si. 2 radiolokaciuri sadguriT aRWurvili am razmis sakomando punqti imyofeboda gorSevirdenis serze Tian- eTis raionSi da 1990 wl amde atarebda zemoqmedebis op- eraciebs hidrometeorologiis institutis samecniero- meToduri xel mZRvanel obis qveS. razmis Semadgenl obaSi Sedioda 5 sacecxl e wertili da samoqmedo teritoria Seadgenda 100 aTas ha-s. sakomando punqts emsaxureboda aerosinoptikuri jgufi, punqti uzrunvel yofili iyo sa- Tanado sayofacxovrebo pirobebiT.

gasamxedroebul samsaxurSi saTanado yuradReba eq- ceoda axali kadrebis momzadebas. 1970-iani wlebis meore naxevarSi Tel avis i.gogebaSvilis sax. pedagogiuri in- stitutis saswavlo programaSi Setanil iqna setyvasTan brZolis praqtikasTan dakavSirebul i sagnebis swavl eba (zogadi meteorologia, Rrubel Ta fizika, aqtiuri ze- moqmedebis safuZvlebi, sinoptikuri meteorologia da sxva), rac uzrunvel yofda setyvasTan brZolis samsaxu- risTvis regionis mosaxl eobidan saSual o rgol is spe- cial istTa momzadebas.

1991 wlidan Sewyda setyvasTan brZolis samuSaoTa dafinanseba, moiSal a misi organizaciul i struqtura da ganiavda misi material ur-teqnikuri baza. amJamad Semor- Cenil ia sakomando punqtebis cal keul i el ementebi ruis- pirsa da badiaurSi.

3. kaxeTis regionSi setyvasTan brZolis gamoyenebu- l i teqnol ogia

1960 wl idan kaxeTSi setyvasTan brZolis praqtikul gamocdil ebaze dayrdnobiT, agreTve sabWoTa kavSirsa da ucxoeTis qveynebSi warmoebul samuSaoebSi dagrovili

codnis gaTval iswinebiT, 1980-iani wl ebisTvis setyvasTan brZol is gasamxedroebul samsaxurSi setyvasTan brZol is teqnol iogia moicavda Semdeg ZiriTad el ementebs:

1. aerosinoptikuri situaciis gaTval iswinebiT sakomando punqtidan wriul i radiol okaciuri (r/l) mimoxil vis periodul ad Catareba. mimoxil vis radiusi, Cveul ebriv, $\mathbf{R}$=100 km Seadgenda da tardeboda mrl sadguris λ=3.2 sm tal Ris sigrZis diapazonSi. imis gaTval iswinebiT, rom kaxeTis regionSi setyvasaSiSi Rrubl ebis gadaadgil ebis siCqare saSual od 30km/sT Seadgens, dakvirvebis es radiusi sakmaris dros iZl eoda dasacavi teritoriidan sakmaod daSorebul i Rrubl ebis (koveqciuri uj redebis) an maTi sistemebis aRmosaCenad da maTze zemoqmedebisTvis mosamzadebl ad. miRebul i informaciis dasazustebl ad mimoxil vebi tardeboda $\mathbf{R}$=300 da 50 km radiusebSic. interval ebi mimoxil vebs Soris SeirCeoda aerosinoptikuri situaciis gaTval iswinebiT da, rogorc wesi, 1 sT ar aRemat.eboda.

2. r/l dakvirvebis radiusSi ($\mathbf{R}$=100 km) mZl avri konveqciuri Rrubl ebis ($\mathbf{Cu\ cong.\ Cb}$) radioeqos aRmoCenisas dakvirvebebi uwyvet reJimze gadadioda, izomeboda da dakvirvebis Jurnal Si fiqsirdeboda maTi parametrebi: Rrubl is simaRl e, maqsimal uri amrekl adobis azimuti da manZil i, gazrdil i amrekl adobis zonis (gaz) geometriul i zomebi (sigrZe/sigane, diametri, zeda da qveda sazRvris simaRl eebi), maqsimal uri r/l amrekl adoba. gaz aRniSnavda Rrubl is im mocul obas, roml is r/l amrekl adoba erTi rigiT nakl ebi iyo Rrubl is maqsimal ur amrekl adobaze. am monacemebiT ganisazRvreboda Rrubl is (an maTi sistemis) moZraobis siCqare da setyvasaSiSroeba.

3. aRmoCenil i konveqciuri Rrubl ebis setyvasaSiS stadiaSi gadazrdisa da dasacavi teritoriisken moZraobis dadgenis SemTxvevaSi sahaero moZraobis marTvis centrSi gadaecemoda nebarTvis moTxovna sahaero sivrcis aviaciisTvis gadasaketad samoqmedo teritoriisa da zemoqmedebis xangrZl ivobis savaraudo miTiTebiT. moT-

26

xovna unda gadacemul iyo saTanado winwaswrebiT (daax-
l oebiT 1 saaTiT adre), raTa am droSi moswrebul iyo
frenebSi saTanado koreqtivebis Setana. aRsaniSnavia,
rom sbgs praqtikaSi yofil a SemTxvevebi, rodesac sxvad-
sxva mizezebiT nebarTvis miuRebl obis Sedegad dasacav
teritoriaze Semosul a, an mis Tavze ganviTarebul a set-
yviani Rrubel i da, zemoqmedebis gareSe darCenil s, mo-
ucia setyva.

4. zemoqmedebis Casatarebl ad nebarTvis moTxovnis
gadacemasTan erTad sacecxl e wertil ebi srul i sabrZo-
l o mzadyofnisa da uwyveti radiokavSiris reJimSi gada-
dioda.

5. setyvasaSiSi/setyviani Rrubl is dasacav teritori-
asTan miaxl oebisas an mis sazRvrebSi Semosvl isas/mis
Tavze ganviTarebisas zemoqmedebis xel mZRvanel is mier
gaicemoda brZaneba zemoqmedebis dawyebis Sesaxeb. ze-
moqmedebis procedura moicavda Semdeg operaciebs:

zemoqmedebis parametrebis gansazRvra setyvasaSiSi
Rrubl is/uj redis radiol okaciuri monacemebis safuZ-
vel ze. zemoT dasaxel ebul i monacemebi radiol okatoris
ekranze aiTvl eboda da gazrdil i amrekl adobis zonis
konturebi xel iT daitaneboda dasacavi teritoriis
pl anSetze. (setyvasaSiSi Rrubl is moaxl oebisas r/l
dakvirvebebi λ=10 sm tal Ris sigrZis diapazonSi gadadi-
oda). paral el urad, gazrdil i r/l amrekl adobis zonis,
misi geometriul i zomebis da maqsimal uri amrekl adobis
mixedviT special uri cxril is mixedviT ganisazRvreboda
Rrubl is setyvasaSiSroeba da masze erTj eradi zemoqme-
debis Casatarebl ad saWiro raketebis raodenoba.

gaz konturebisa da maqsimal uri r/l amrekl adobis
aris pl anSetze datanis Semdeg special uri SimSis dax-
marebiT SeirCeoda zemoqmedebis Casatarebl ad optimal u-
rad ganl agebul i sacecxl e wertil i/wertil ebi da gaic-
emoda brZaneba aqedan Sesabamisi tipis (moqmedebis radi-
usis, anu erT-Tu orsafexuriani „al aznis") da raodenob-
is raketebis mocemul i azimutiTa da vertikal uri kuT-
xiT gaSvebis Sesaxeb. zemoqmedebaze gaxarj ul i rakete-

27

bis raodenoba sbgs praqtikaSi did diapazonSi icvl ebo-
da susti setyvasaSiSi Rrubl is sawvimar stadiaSi gada-
sayvanad zogj er 2-3 raketac ki yofil a sakmarisi, maSin
radesac ganviTarebis stadiaSi myofi mraval uj rediani
frontal uri Rrubl is TiToeul uj redze xandaxan 100-
ze meti raketac ki gaxarj ul a. gansakuTrebiT mZime viTa-
reba iqmneboda dasacav tiritoriaze erTdroul ad bevri
seryvasaSiSi Rrubl is SemoWris/warmoqmnis SemTxvevaSi.
am dros zemoqmedebas dasacavi teritoriis sxvadasxva
nawil Si/seqtorSi erTdroul ad ramdenime piri xel mZRva-
nel obda da sacecxl e wertil ebs anomal uri datvirTviT
uwevdaT muSaoba. Tu zemoqmedebis Sedegad ar SeimCneoda
konkretul i uj redis setyvasaSiSroebis Semcireba, ze-
moqmedebis procedura Sesabamisi dozirebiT unda game-
orebul iyo da es grZel deboda manamde, sanam Rrubel i
ar daiwyebda Sesustebas an gasvl as dasacavi teritori-
is gareT. interval ebi zemoqmedebis gameorebas Soris Se-
irCeoda zemoqmedebis xel mZRvanel is mier radiol okaci-
uri parametrebis cvl il ebis trendisa da Seqmnil i situ-
aciis mixedviT.

6. zemoqmedebis Catarebis procesSi uwyvetad grZel -
deboda r/l dakvirvebebi rogorc zemoqmedebaqmnil , ase-
ve axal konveqciur uj redebze, roml ebic uaxl ovdeboda
dasacav teritorias, an warmoiqmneboda mis Tavze. dak-
virvebebi wydeboda mxol od maSin, rodesac Rrubl ebi
wamyvani nakadis mimarTul ebiT stovebda dasacav terito-
rias da mis SemogarenSi R=100 km radiusiT aRar daikvir-
veboda konveqciis axal i kerebis gaCena. amave dros ixsne-
boda nebarTvis moTxovna sahaero moZraobis marTvis cen-
tridan.

7. dasacav teritoriaze Rrubl is setyvasaSiS stadia-
Si didi xniT (12 sT) yofnis SemTxvevaSi an setyvis mos-
vl is Sesaxeb informaciis miRebisas savaraudod daset-
yvil teritoriaze igzavneboda special istTa j gufi Se-
saZl o zaral is (farTobi, dazianebis xarisxi) dasadge-
nad.

28

8. konkretul i samuSao dRis ganmavl obaSi Catarebul i zemoqmedebis operaciebis Sesaxeb dgeboda srul i dokumentacia, romel ic moicavda Semdeg informacias:

- gasamxedroebul nawil Si am dRes morige Semadgenl o-bis srul i sia;

- informacia gasul i dRis aerosinoptikuri situaciisa da samuSao dRis amindis prognozis Sesaxeb;

- dRis ganmavl obaSi Catarebul i r/l dakvirvebebis srul i cxril i cal keul i ujredebis/Rrubl ebis r/l parametrebis droSi cvl il ebis miTiTebiT;

- TiToeul ujredze Catarebul i zemoqmedebis srul i aRweril oba gaxarjul i raketebis tipisa da raoden-obis miTiTebiT, dasacavi teritoriis rukaze/pl anSet-ze maTi gaz da maqsimal uri amrekl adobis aris tra-eqtoriis CvenebiT;

- samuSao dRis srul i angariSi zemoT CamoTvl il i do-kumentaciis anal iziTa da jamuri Sedegebis CvenebiT, agreTve dRis ganmavl obaSi morige Semadgenl obis saq-mianobasTan dakavSirebul i faqtorebis aRweriT (Se-ferxebebi radiol okatorebis, zemoqmedebis teqnikisa da kavSirgabmul obis muSaobaSi, zemoqmedebis nebar-Tvis miRebaSi, zemoqmedebis dagvianeba, raketebis mara-gis amowurva sacecxl e wertil ebze da sxv.).

samuSao dRis angariSebi aRniSnul i formiT dgebo-da yvel a gasamxedroebul nawil Si, sezonis dasrul ebis Semdeg ikribeboda ruispiris central ur bazaze da maT safuZvel ze xdeboda sbgs Catarebul i zemoqmedebis oper-aciebis srul i wl iuri angariSis Sedgena.

miuxedavad imisa, rom 1980-iani wl ebisTvis ucxoeTis ganviTarebul qveynebSi kompiuterul i teqnikis gamoyene-biT ukve avtomatizebul i iyo Rrubl ebze r/l dakvirve-bis Sedegad miRebul i informaciis safuZvel ze zemoqme-debis parametrebis dadgena, sabWoTa kavSirSi es midgoma jer ar iyo danergil i. amitom setyvasTan brZol is teq-nol ogia moicavda monacemebis xel iT damuSavebis proce-durebs, rac sagrZnobl ad arTul ebda da anel ebda ze-moqmedebis Catarebas. es ki atmosferoSi swrafad mimdi-

29

nare procesebis dros xSirad amcirebda zemoqmedebis efeqturobas.

setyvasaSiSi Rrubl is operatiul i model isa da kom- piuterul i teqnikis uqonl obis gamo setyvasaSiSi Rrub- l ebis mosal odnel i ganviTarebis prognozi dgeboda ka- xeTis regionisagan moSorebiT (Tbil isSi). Catarebul i radiozondirebis monacemebis gamoyenebiT, Cveul ebriv em- agramaze atmosferos Termul i aramdgradobis pirobebis gaTvl is gziT. es garemoeba ar iZl eoda regionSi mZl av- ri konveqciis ganviTarebis pirobebis real uri Sefasebis SesaZl ebl obas. garda amisa, saimedo model uri gamoT- vl ebis Sedegebis uqonl oba SeuZl ebel s xdida radiol - okaciur monacemTa saSual ebiT zemoqmedebis efeqtis sarwmuno doneze dadgenas. amasTan erTad, dasacavi teri- toria ar iyo aRWurvil i nal eqmzomi xel sawyoebis adeq- vaturi qsel iT.

zemoqmedebis efeqturobis dadgenas arTul ebda ag- reTve msgavs fizikur-geografiul pirobebSi myofi sa- kontrol o teritoriis ararseboba, amitom efeqturobis kontrol isaTvis ZiriTadad gamoiyeneboda setyvasTan brZol is samuSaoTa dawyebamde arsebul i mosavl is sa- xel mwifo dazRvevis monacemebi da iSviaTad Rrubl ebze r/l dakvirvebis masal ebi. es monacemebi sezonis dasru- l ebis Semdeg safuZvl ad edeboda Catarebul samuSaoTa ekonomikuri efeqturobis j amur Sefasebas, risTvisac se- zonze gaweul i saerTo xarj ebi dardeboda setyvisgan hi- poTeturad gadarCenil mosavl is Rirebul ebas.

sacecxl e wertil ebze sakomando punqtidan miRebul i brZanebebis Sesrul eba warmoebda xel iT, rac gansakuT- rebiT Ramis saaTebSi da intensiuri muSaobis pirobebSi, Secdomis did al baTobas Seicavda. 80-ian wl ebSi iyo mcdel oba raketebis gamSvebi danadgarebis sakomando punqtidan avtomatur marTvaze gadayvanisa, Tumca teqni- kuri mizezebis gamo es proeqti ver ganxorciel da.

kompiuterul i teqnikis uqonl obis gamo zemoqmedebis masal ebis arqivireba qaRal dze warmoebda da es monace- mebi geofizikis institutSi inaxeboda. monacemTa anal i-

30

zi da ganzogadeba periodul ad tardeboda geofizikis institutis TanamSromel Ta mier.

4. setyvasTan brZol is samuSaoebi bul gareTSi

saxel mwifo pol itikis rangSi ayvanil i setyvasTan brZol is samuSaoebi bul gareTSi daiwyo 1968 wel s, rodesac pl ovdivis raionSi gaixsna setyvasTan brZol is pirvel i qvedanayofi. 2001 wl amde setyvasTan sabrZol vel ad gamoiyeneboda rusul i warmoebis raketebi "pgim", "obl ako", "al azani"-1 da "al azani"-2 . 1994 wl idan daiwyo agreTve "al aznis' modificirebul i raketebis gamoyeneba, roml ebic aRWurvil ia iodovani vercxl is (AgI) Semcvel i reagentiT.

amJamad Rrubl ebze zemoqmedeba warmoebs 9 sakomando punqtidan. dasacavi teritoriis farTobi Seadgens 17257 kv.km anu 1ml n 725.7 aTas ha-s da igi moicavs 4 raions dunais vakeze da 4 raions Trakiis dabl obze.

4.1. setyvasTan brZol is samsaxuris struqtura

setyvasTan brZol is sakomando punqtebis ganl ageba bul gareTis teritoriaze da maTi saerTo xedebi moyvanil ia nax.5-ze. *saTanado masStabis gamoyenebiT am naxazidan miiReba, rom saSual o manZil i sakomando punqtebs Soris daaxl oebiT tol ia 60km. TiToeul i sakomando punqtis dasacavi teritoria sakmaod farTo diapazonSi icvl eba 150-dan 300 aTas ha-mde da saSual od Seadgens 220 aTas ha-s. sagul isxmoa, rom samxreTiT Trakiis seqtorSi erT dasacav teritorias ori sakomando punqti icavs.**

TiToeul i sakomando punqti aRWurvil ia λ=3.2 da 10 sm tal Ris sigrZeze momuSave ortal Riani dopl eris meteorol ogiuri radiol okatoriT, roml ebic gamoiyeneba zemoqmedebis operaciebis Casatarebl ad. amasTan erTad, 3 sakomando punqtze ganTavsebul ia mrl -5 tipis 3 radiol -

----

- SeniSvna: xazgasmul i daxril i SriftiT mocemul ia teqstis qarTul i versiis Semdgenel Ta komentarebi.
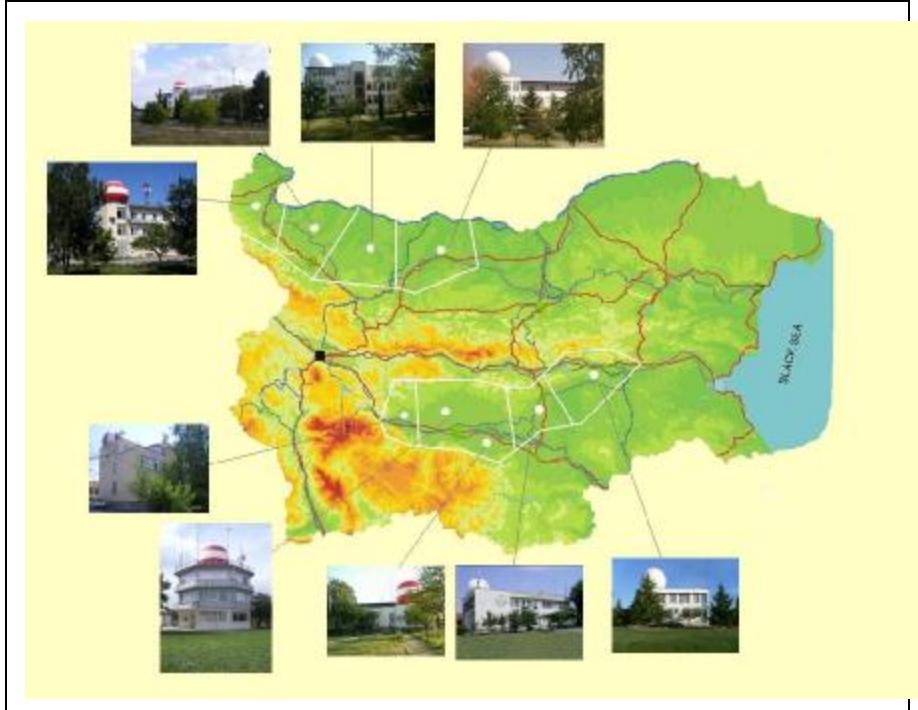
nax.5 bul gareTis setyvasTan brZol is samsaxuris dasaca-
vi teritoriebisa da sakomando punqtebis ganl agebis sqe-
ma.

okaciuri sadguri (nax.6), roml ebic 150 km radiusSi sis-
tematurad awarmoebs dakvirvebas saRrubl o sistemebze
da real ur droSi gadascemen meteorol ogiur informa-
cias amindis movl enebis ganviTarebis Sesaxeb sofiaSi
mdebare sainformacio centrs da zemoqmedebis punqtebs
(sacecxl e wertil ebs) zemoqmedebis operaciebisTvis ma-
Ti mzadyofnis uzrunvel sayofad. aRniSnul i informacia
Seicavs monacemebs dakvirvebis radiusSi wvimis zonebis,
Rrubel Ta maqsimal uri simaRl isa da radiol okaciuri
(r/l) amrekl adobis, Rrubel Ta gadaadgil ebisa da maTi
siCqaris Sesaxeb, agreTve raodenobriv monacemebs wvimis

32

intensivobisa da raodenobis, qaris mimarTul ebisa da
siCqaris Sesaxeb.

**Network for transfer of real time radar meteorological information**

The three radars MRL-5 transfer real time radar data to informative center-Sofia and to remote posts IRIS Display, where hail suppression operations carry out.

nax.6 meteorol ogiuri informaciis mimRebi mrl -5 radi-
ol okatorebis ganl ageba dasacav teritoriaze.

4.2.samuSaoTa organizacia

   bul gareTis setyvasTan brZol is samsaxuris organi-
zaciul i struqtura naCvenebia nax.7-ze. moyvanil i sqemis
marcxena nawil Si pirvel /zeda adgil ze ganTavsebul ia
sahaero moZraobis marTvis centri, romel ic uzrunvel -
yofs samoqal aqo da samxedro aviaciisgan sahaero sivr-
cis gaxsnas zemoqmedebis operaciebis Casatarebl ad. misi

33
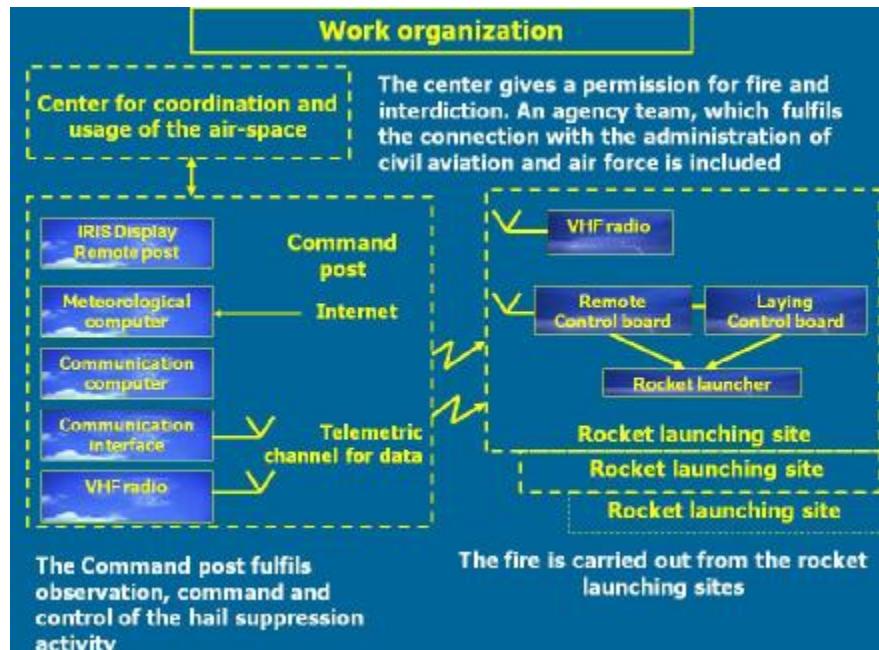
nax.7 bul gareTis setyvasTan brZol is samsaxuris organi-
zaciul i struqtura

nebarTvis gareSe zemoqmedeba Rrubl ebze akrZal ul ia.
sahaero moZraobis marTvis centris qveS ganTavsebul ia
sakomando punqtis bl oki, romel ic Seicavs wriul i mimo-
xil visa da zemoqmedebis operaciebis samarTav radiol -
okatorebs, internetTan dakavSirebul Sesabamis meteor-
ol ogiur kompiuters, sakomunikacio kompiuters, radio-
kavSirisa da kavSirgabmul obis sxva saSual ebebs. sako-
mando punqtidan warmoebs dakvirvebebi saRrubl o siste-
mebze, setyvasaSiSi Rrubl ebis SerCeva, maTze zemoqmede-
bis xel mZRvanel oba da zemoqmedebis operaciebis kon-
trol i. am programiT momuSave TiToeul i sakomando pun-
qti mWidro kavSirSi imyofeba danarCen sakomando pun-
qtebTan, agreTve maT dasacav teritoriaze masze mimagre-
bul sacecxl e wertil ebTan, roml ebic gaerTianebul ia
sqemis marj vena nawil Si moTavsebul bl okSi. radiol ok-

34

aciuri informaciis safuZvel ze sakomando punqtze gamo-muSavebul i brZanebis Sesabamisad am wertil ebidan war-moebs raketebis gaSveba.

4.3. setyvasTan brZol is koncefcia

bul gareTSi setyvasTan brZol is samuSaoebi eyrdno-ba zemoqmedebis Sedegad setyvasaSiS Rrubel Si setyvis warmomSobi makonkuririrebel i birTvebis koncentraciis xel ovnuri gazrdis koncefcias, ramac unda uzrunvel-yos ganviTarebis adreul fazaSi myofi Rrubl is ga-dazrda sawvimian stadiaSi, an setyvis marcvl ebis zrda mcire zomebamde. am miznis misaRwevad Rrubl is gadamet-civebul i nawil is minus 10°C-dan minus 20°C-mde gazrdi-l i r/l amrekl adobis areSi Setanil i unda iqnas sakma-risi raodenobis makristal ebel i reagenti, romel ic ga-moiwvevs mcire wveTebis gayinvas da maT konkurencias Rrubel Si arsebul i wyl is orTql is misaTvisebl ad. Se-degad warmoqmnil i setyvis mraval ricxovani mcire nawi-l akebi Rrubl idan vardnisas aswreben gadnobas da miwam-de aRweven wvimis wveTebis saxiT

es_koncefcia_samarTl iania_im_SemTxvevaSi,_Tu_Rru-bel Si_Setanil i_reagentis_raodenoba_sakmarisia_Rru-bel Si_arsebul i_gadametcivebul i_mcire_wveTebis_dasak-ristal ebl ad._Tuki_Rrubl is_gadametcivebul_areSi_uk-ve_arsebobs_didi_raodenobiT_setyvis_marcvl ebi_an_msxvil i_wveTebi,_maSin_Setanil _reagents_SeuZl ia_mxo-l od_maTi_Semdgomi_zrdis_Seferxeba_da_ara_setyvis_mos-vl is_Tavidan_acil eba._koncefcia_samarTl iania_agreTve_im_SemTxvevaSi,_rodesac_Rrubel Si_wyl is_orTql is_miwo-deba_l imitirebul ia,_rac_ganapirobebs_xel ovnurad_war-moqmnil _birTvebs_Soris_konkurencias._Tumca,_Tu_Rrube-l i_viTardeba_iseT_pirobebSi,_rodesac_wyl is_orTql is_miwodeba_praqtikul ad_SeuzRudavia (mag._mZl avri_fron-tal uri_procesebis_dros),_maSin_konkurenciis_meqanizmi_kargavs_azrs_da_setyvis_warmoSobis_procesi_SeiZl eba_umarTavad_mimdinareobdes.

setyvasaSiSi Rrubl is model ad SerCeul iqna msof-
l io meteorol ogiuri organizaciis (**WMO**) mier 1996
wel s SemoTavazebul i setyvis mraval uj rediani Rrub-
l is sqema (nax.8), roml is zeda sazRvari e.w. "grdeml is"
saxiT SeiZl eba aRwevdes 17km simaRl es -55°C temperatu-
raze. Rrubl is marj vena nawil Si gamosaxul ia mZl avri
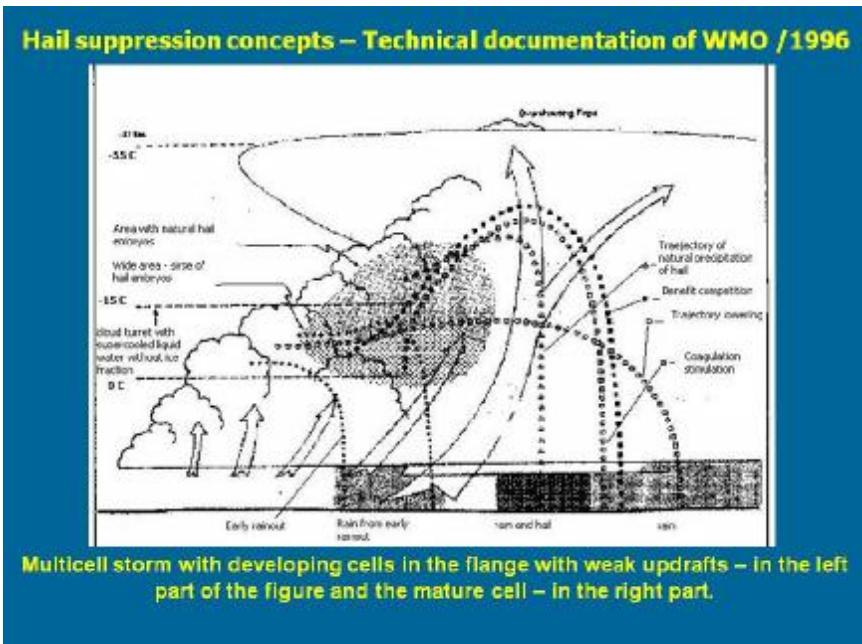
nax.8. setyvis mraval uj rediani Rrubl is sqema.

aRmaval i nakadebiT mkvebavi Rrubl is simwifis stadiaSi
myofi uj redi, romel ic iZl eva wvimasa da setyvas. Rrub-
l is gamuqebul i are Seesabameba gazrdil i amrekl adobis
aris mdebareobas, sadac Tavmoyril ia Rrubel Si arsebu-
l i, samive fazaSi myofi wyl is umetesi nawil i da ro-
mel Siac warmoebs wvimis wveTebisa da setyvis marcvl e-
bis zrda. Rrubl is marcxena nawil Si warmoebs haeris Se-
darebiT susti aRmaval i nakadebiT mkvebavi axal i uj re-
debis warmoqmna, roml ebic Sesaferisi aerosinoptikuri
pirobebis arsebobis SemTxvevaSi SeiZl eba gaZl ierdes da

36

SemdgomSi miaRwios agreTve simwifis stadias. sqemaze
gamosaxuli Rrubeli, rogorc wesi, viTardeba moZravi
atmosferuli frontis pirobebSi. axali ujredebis Ca-
saxva xdeba frontTan erTad moZravi Rrublis wina na-
wilSi, xolo wimisa da setyvis gamoyofa– mis Sua da
ukana nawilSi. konveqciis ganviTarebisTvis gansakuTre-
biT xel Semwyobi pirobebis arsebobisas SesaZlebelia
moxdes ramdenime mraval ujrediani Rrublis Serwyma,
ris Sedegadac warmoiqmneba e.w. superujrediani Rrube-
li. am tipis Rrublis horizontaluri zomebi Cveul eb-
riv ramdenime aTeul km-s aRwevs da arsebobis xangrZl i-
voba –ramdenime saaTs. zemoqmedeba aseT Rrubel ze Zal ze
garTulebulia misi didi zomebis, masSi Tavmoyrili
wylis maragisa da metad mZlavri aRmaval i nakadebis ar-
sebobis gamo, roml ebsac SeuZlia RrublSi Setanili
reagentis swrafi gatana Rrublis grdemlSi da mis ga-
reT ise, rom igi ver aswrebs urTierTqmedebas gazrdil i
amrekl adobis areSi arsebul nawil akebTan.

4.4. atmosferuli pirobebis aerosinoptikuri anal izi

Rrubel Ta ganviTarebis pirobebis dasadgenad da maTi
prognozirebisaTvis saWiro aerosinoptikuri monacemebi
moicavs miwispira amindis da aerosinoptikur rukebs 850,
700 da 500 heqtopaskal (hpa) bariul simaRl eebze, saprog-
nozo model ebs, meteogramebs da meteorol ogiuri Tanam-
gzavrebidan miRebul satel itur informacias.

atmosferos fizikuri mdgomareobis anal izisaTvis
gamoiyeneba aerol ogiuri zondirebis monacemebi, romel -
Ta safuZvel ze aigeba konveqciuri Rrublis erTganzomil-
l ebiani model i.

4.5. konveqciuri Rrublis erTganzomil ebiani model i mik-
rofizikis parametrizaciiT

atmosferos mocemul i stratifikaciis pirobebSi kon-
veqciuri Rrublis ganviTarebisa da misgan miRebul i na-
l eqis prognozirebisTvis gamoyenebul ia sofias univer-
sitetSi damuSavebul i Rrublis erTganzomil ebiani mo-
del i. igi eyrdnoba Semdeg ZiriTad principebs:

37

- Rrubel Si mimdinare mikrofizikuri da dinamikuri procesebi urTierTdamokidebulia;
- model Si mikrofizikuri procesebis parametriza-ciis bloki ganixilavs wylis Semcvelobis 5 klass (wylis orTqli, Rrubel Si arsebuli wyali, wvima, Rrubel Si arsebuli yinulovani fraqcia, myarinaleqebi);
- Rrublis maxasiaTeblebi simaRlis funqcias war-moadgens;
- naleqTa tipis (setyva Tu wvima) saprognozo kla-sifikaciis funqciebi miiReba safexuriani diskri-minantuli analizis gamoyenebiT.

Rrubel Si mimdinare mikrofizikuri procesebis gan-xiluli sqema mocemulia nax.9-ze.
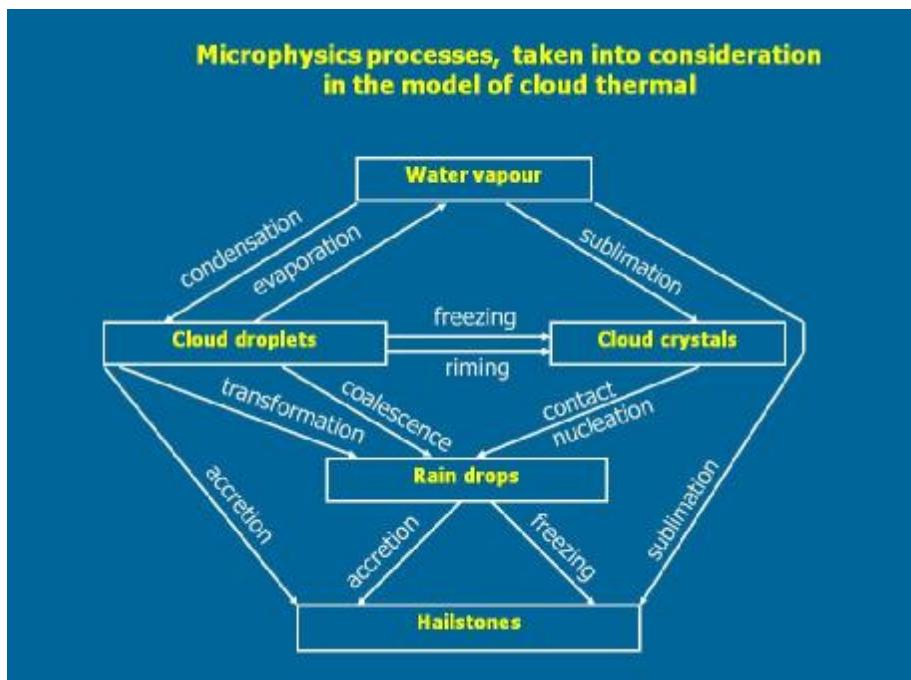
nax.9. Rrubel Si mimdinare mikrofizikuri procesebis ur-TierTkavSiris sqema.

38

sqemis mixedviT aRmaval i nakadebidan da wveTebis aor-
Tql ebis Sedegad miRebul i wyl is orTql i ixarjeba kon-
densaciasa da subl imaciaze. kondensaciis Sedegad miRe-
bul i Rrubl is wveTebi ganicdian koagul acias da war-
moqmnian wvimis wveTebs, xol o subl imaciisa da Rrubl is
wveTebis gayinvis Sedegad warmoqmnil i Rrubl is krista-
l ebi sakontaqto nukl eaciis gziT agreTve warmoqmnian
wvimis wveTebs. am wveTebis koagul aciisa da gayinvis Se-
degad miiReba setyvis marcvl ebi, roml ebzedac damate-
biT kidev xdeba Rrubl is wveTebis dal eqva (akrecia) da
wyl is orTql is subl imacia.

gamoTvl ebis Casatarebl ad sawyis pirobebad miiCneva:
– Rrubl is warmomqmnel i sabaziso el ementis, Termikis
radiusi Rrubl is fuZis doneze R_0=5km, xol o misi saw-
yisi aRmaval i siCqare W_0=5m/wm.
–   gamoTvl ebSi gamoyenebul i mudmivebis, sawyisi da
zRvrul i sidideebis mniSvnel obebi miRebul ia eqsperi-
mentul i gamokvl evebis Sedegad.

model is Semaval i monacemebi:
• atmosferos radiozondirebis /aerol ogiuri zondi-
rebis monacemebi;
• miwispirul i meteorol ogiuri monacemebi temperatu-
ra da fardobiTi sinotive, dRis maqsimal uri tempe-
ratura;
• setyvasaSiSi Rrubl is tipi: frontal uri (konvergen-
ciul i) an Sidamasiuri, gansazRvrul i sinoptikuri
anal izis safuZvel ze.

model uri gamoTvl ebis Sedegad miiReba Rrubl is
Semdegi maxasiaTebl ebi:
• Sesabamis simaRl eze temperaturis sxvaoba Rrubl is
SigniT da mis gareT;
• Sesabamis simaRl eze aRmaval i nakadis maqsimal uri
siCqare;
• Sesabamis simaRl esa da temperaturaze Rrubl is maq-
simal uri wyl ianoba;

39

- Sesabamis simaRl esa da temperaturaze Rrubl is maqsimal uri yinul ianoba;
- fenebis sisqe aRmaval i nakadebis maqsimal uri siCqareebiT 20, 25, 30m/wm;
- Rrubl is Sida temperaturis vertikal uri ganawil eba, rac saWiroa Rrubel Si Setanil i reagentis difuziis gamosaTvl el ad;
- mosul i nal eqis prognozirebul i kategoria (setyva Tu wvima).

4.6. Rrubel Si reagentis gavrcel ebis model i.

zemoqmedebis procesSi reagentis optimal uri dozirebis mizniT damuSavda reagentis difuziis model i, romel ic eyrdnoba Semdeg ZiriTad principebs:

- Rrubel Si reagenti vrcel deba turbul enturi difuziis gziT;
- yinul warmomqmnel i birTvebis yinul is Canasaxebad gardaqmnis procesSi wyarodan garkveul manZil ze warmoiqmneba yinul is Canasaxebis fiqsirebul i koncentracia;
- mcire zomebis gamo reagentis nawil akebi gaitaneba gareT konveqciuri nakadebis mier, roml ebic daikvirveba reagentis Setanis areSi, ris Semdegac xdeba maTi gavrcel eba turbul enturi difuziis meqanizmiT.

model is Semaval i monacemebia:

- raketebis traeqtoriis aqtiuri nawil i;
- frenis dros generatoris mier yinul warmomqmnel i birTvebis warmoqmnis intensivoba;
- raketis efeqturobis koeficienti;
- Rrubel Si temperaturis vertikal uri ganawil eba;
- aRmaval i nakadi reagentis Setanis areSi;
- reagentis gavrcel ebis dro da masStabi;
- yinul warmomqmnel i birTvebis koncentracia difuziuri Rrubl is sazRvarze;
- turbul enturi energiis disipaciis vertikal uri siCqare;

40

- turbulenturi energiis disipaciis horizontaluri siCqare;
  difuziuri modelis gamoyenebiT xdeba Semdegi para-metrebis gaangariSeba:
- difuziis aris mocul oba yinul warmomqmneli birTve-bis mocemuli koncentraciiT;
- raketis gaSvebis vertikaluri kuTxe sxvadasxva si-maRleze myofi sacecxle wertilebisTvis.

4.7. setyvasaSiSi ujredebisa da setyviani Rrublebis ka-tegoriebi da maTi gansazRvris kriteriumebi

bul gareTis setyvasTan brZolis samsaxurSi miRebu-lia setyvasaSiSi da setyviani Rrublebis dayofa xuT kategoriad (cxrili 1).

cxrili 1. setyvasaSiSi da setyviani Rrublebis katego-riebi

Categories of hail-dangerous cells and hailstorms. Criteria				
	Zmax dBz	ΔH dBz	Development of cells	Seeding
I	45 ≤ Z ≤ 50	ΔH45 ≥1.5км	Slowly growing, with Zmax 15-25dBZ, reaching slowly Zmax 35-40dBZ, H₁₅ᵈᵇᵤ≥H-10℃. Small gradient of radar reflectivity. Zmax 45dBz arises at a height ≤H-10℃ and grows slowly in height	Continuous observation. If ΔH45dBz grows more than 2 км, the cells are seeded
II	40 ≤ Z < 45	ΔH40 ≥3км	Rapidly growing, with Zmax 15-25dBZ. Zmax reaching 35-40dBZ for 1-2 minutes. High gradient of radar reflectivity and growth of the cell in all directions. H₁₅ᵈᵇᵤ≥H-20℃	The cells are seeded with the purpose of early rainout
III	45 ≤ Z < 50	ΔH45 ≥2км	High formation of an area with 45dBz H₄₅ᵈᵇᵤ≥H-10℃	The cells are seeded when 45dBz shows
IV	50 ≤ Z ≤ 55	ΔH45 ≥3км	Hailstorms	The seeding starts immediately
V	Z ≥ 55	ΔH45 ≥4км	Hailstorms	The seeding starts immediately

41

pirvel (I) kategorias miekuTvneba SedarebiT susti da nel a ganviTarebadi konveqciuri ujredebi, romel Ta maqsimal uri r/l amrekl adoba Z_{max} moTavsebul ia 45-dan 50 decibel amde (db) Sual edSi. ujredi nel -nel a izrdeba 15-25db-dan 35-40db-mde. maqsimal uri amrekl ebadoba 45 db-s aRwevs -10℃ izoTermis simaRl eze da agrZel ebs simaRl eSi mdored zrdas. ganviTarebis sawyis stadiaSi ujredze unda warmoebdes uwyveti r/l dakvirvebebi, xol o Tu 45 db-mde miRweul i gazrdil i amrekl adobis zonis (gaz) vertikal uri simZl avre ΔH45 db 1.5 km-dan 2 km-mde miaRwevs, saWiroa masze zemoqmedebis Catareba

meore (II) kategoriaSi Sedis swrafad mzardi konveqciuri ujredebi, romel Ta Z_{max} 15-25db-dan 12 wT-is ganmavl obaSi izrdeba 35-45 db-mde. ujredis 40db-mde miRweul i gaz vertikal uri simZl avre ΔH40 db unda aRematebodes 3km-s da misi zomebi unda izrdebodes yvel a mimarTul ebiT. 15 db amrekl adobis zona unda aRwevdes minus 20℃ izoTermis simaRl es. aseTi tipis ujredebze zemoqmedeba tardeba wvimis mosvl is daCqarebis mizniT. _aRniSnul SemTxvevaSi zemoqmedeba or mizans emsaxureba. pirvel i maTgani iTval iswinebs ujredSi/RrubelSi haeris daRmaval i nakadebis xel ovnurad Seqmnas, rac Tan sdevs Rrubl idan nal eqis gamoyofas. Seqmnil i daRmaval i nakadi asustebs Rrubl is zrdis ganmapirobebel aRmaval nakads da amiT aferxebs setyvasaSiSi Rrubl is setyvian fazaSi gadasvl as. garda amisa, Rrubl idan SesaZl o setyvis nacvl ad damatebiTi wvimis miReba, rogorc wesi, sasikeTod adgeba sasofl o-sameurneo kul turebis zrda-ganviTarebas. amasTan erTad, Tu zemoqmedeba tardeba raime wyal -sacavis wyal Semkrebis fargl ebSi, Rrubl idan miRebul i damatebiTi wvima zrdis am wyal sacavis sairigacio da hidroenergetikul potencial s._

mesame (III) kategoriaSi gaerTianebul ia 45-dan 50 db-mde maqsimal uri amrekl adobis mqone ujredebi, romel Ta 45db amrekl adobis mqone gaz-is vertikal uri simZl avre aRemateba 2km-s da 45 db amrekl adobis mqone are imyofeba -10℃ izoTermis simaRl is zeviT. zemoqmedeba aseT uj-

42

redebze iwyeba maSin, rodesac Z_{max} aWarbebs 45db far-
gl ebs.

meoTxe (IV) kategoriaSi moqceul ia setyvian stadiaSi
gadasul i konveqciuri uj redebi, romel Ta Z_{max} icvl eba
50-55db fargl ebSi. 45 db-mde miRweul i gaz-is vertikal u-
ri simZl avre ΔH45 db aRemateba 3km-s da maTze dauyov-
nebl iv unda daiwyos zemoqmedeba.

mexuTe (V) kategoriaSi Sedis 55db-ze maRal i maqsima-
l uri r/l amrekl adobis mqone uj redebi, romel Ta 45db-
iani gazis vertikal uri simZl avre 4 km aRemateba. aseTi
uj redebi, umeteswil ad ukve Seicavs setyvis marcvl ebs
da maTze aseve dauyovnebl iv unda daiwyos zemoqmedeba.

_setyvasTan brZol is samsaxuris gamarTul i muSaobis
pirobebSi bol o ori kategoriis setyviani Rrubl ebi,
rogorc wesi, dasacav teritoriaze mis fargl ebs gare-
dan unda Semodiodes da maTze zemoqmedeba miznad isax-
avs setyvis marcvl ebis raodenobisa da zomebis Semdgo-
mi zrdis pirobebis minimumamde dayvanas_.

4.8.zemoqmedebis strategia

setyvasaSiS Rrubl ebze zemoqmedebis strategia eyr-
dnoba or ZiriTad princips:
I. zemoqmedebisas reagenti Setanil i unda iqnas im are-
ebSi, sadac Tavmoyril ia gadametcivebul i wyl is di-
di raodenoba da sustia aRmaval i nakadi. yinul war-
momqmnel i birTvebis Setana Rrubl ebSi unda warmoeb-
des regul arul i interval ebiT uwyvetad, uj re-
dis/Rrubl is setyvasaSiS stadiaSi yofnis mTel i pe-
riodis ganmavl obaSi.
II. reagentis gafrqvevis momentidan nawil akebis makonku-
rirebel i zomebis miRwevamde saWiroa daaxl oebiT 3
wuTi. amitom reagentis Setanis done unda iyos Ser-
Ceul i imgvarad, rom difuziuri Rrubl is horizonta-
l urma kveTam miaRwios -10^{0}C izoTermis dones im
dros, rodesac nawil akebis zomebi miaRweven makonku-
rirebel zomebs.

<u>* izolirebuli erTujrediani (Sidamasiuri) Rrublebi</u>

muSavdeba 2 sqemiT (nax. 10). umoZraod ganviTarebadi Rrublis/ujredis SemTxvevaSi (**A**) reagenti SehyavT gazr-dili amrekvl adobis zonis (45 db) Sua nawilSi -10^{0}C izo-oTermis doneze; moZravi ujredis SemTxvevaSi (**B**) reagen-tis Setana unda moxdes igive doneze gaz-is moZraobis mimarT frontalur nawilSi, raTa uzrunvel yofil iqnas difuziuri Rrublis sruli Secvla gaz-Si.
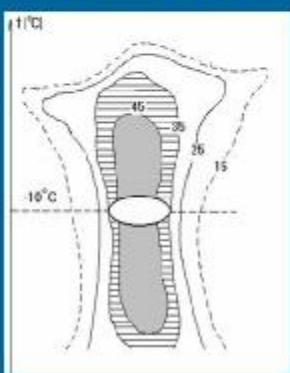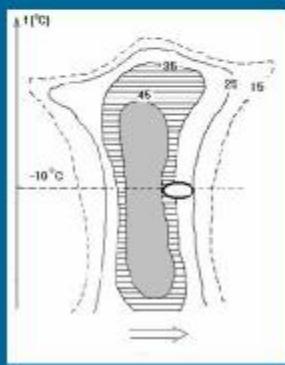
nax.10 erTujrediani konveqciuri Rrublis damuSavebis sqemebi: (**A**) uZravi, (**B**) moZravi

* <u>mraval ujrediani Rrublis SemTxvevaSi </u>(nax.11) ze-moqmedebis, anu Rrublis damuSavebis mizans Seadgens mi-si ganviTarebis stabilurobis darRveva Rrublis fron-talur nawilSi mzardi, e.w."Svilobili" ujredebidan wvimis gamowveviT, rac xels SeuSlis simwifis stadiaSi

44

myof ujredSi setyvis formirebas. iseve, rogorc wina SemTxvevebSi, reagentis Setana unda moxdes -10^{0}C izoTermis areSi. naxazis marcxena suraTze, anal ogiurad nax.4-ze mocemul i sqemisa, axal i mzardi ujredebi viTardeba marcxniv moZravi Rrubl is wina nawil Si, e.w. grdeml is qveS, xol o marjvena suraTze aRbeWdil ia radiol okatoris ekranidan gadaRebul i mraval ujrediani Rrubl is vertikal uri Wril i, sadac kargad Cans marcxnidan marjvniv moZravi Rrubl is ukana mxareSi muqi momwifebis ujredi da wina nawil Si ganviTarebadi, SedarebiT nakl ebi amrekl adobis mqone baci ujredebi. naxazis Sua nawil Si mocemul ia radiol okatoris wriul i mimoxil vis indikatoridan (ekranidan) miRebul i Sesabamisi suraTi.
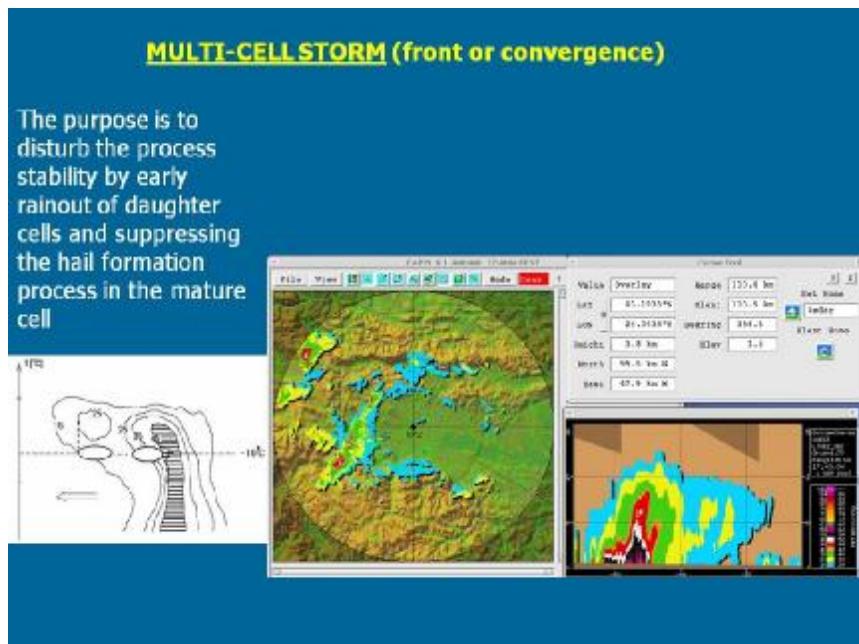
nax.11. mraval ujrediani konveqciuri Rrubl is damuSavebis sqema

    * zemZl avr konveqciur, e.w. superujredian Rrubel ze (nax.12) zemoqmedeba miznad isaxavs misi kveazistacionaru-

45

l i mdgomareobis darRvevas Rrubl is frontal ur nawil -
Si e.w. "xorTumis" qveS ganviTarebis stadiaSi myof uj -
redebSi reagentis SetaniT, ramac unda SeaCeros setyvis
axal i Canasaxebis zrda.
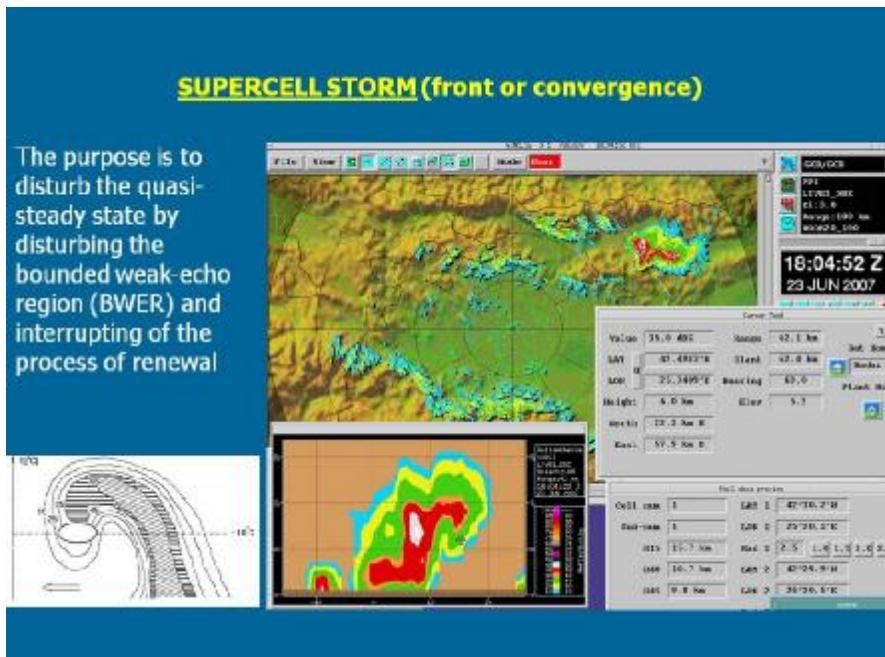
nax.12. superuj rediani konveqciuri Rrubl is damuSavebis
sqema

naxazis marcxena nawil Si sqematurad asaxul supe-
ruj redian Rrubel Si reagentis Setanas moZraobis mimar-
Tul ebiT mis ukana nawil Si azri ara aqvs, radgan igi ga-
moirecxeba Rrubl idan gamoyofil i nal eqebiT, xol o Sua
nawil Si Setanil i reagenti, haeris mZl avri aRmaval i na-
kadebiT, myisierad atanil i iqneba Rrubl is grdeml Si da
gadatanil i iqneba Tavisufal atmosferoSi. naxazis qve-
da Sua nawil Si gamosaxul ia radiol okatoris ekranidan
miRebul i superuj rediani Rrubl is vertikal uri Wril i,
romel zedac jvriT aRniSnul ia reagentis Sesatani are.
sqemaze naCvenebi Rrubl isagan gansxvavebiT l okatoris

46

ekranze asaxuli Rrubeli mopirispire mimarTul ebiT, marcxnidan marjvniv moZraobs. superujrediani Rrubl e-bi, rogorc wesi, frontaluri konvergenciis pirobebSi viTardeba. *saqarTvel oSi_superujrediani_Rrublebis_ho-rizontaluri_zomebi,_Cveulebriv,_orjer_da_metad_aRem-ateba_maT_vertikalur_simZlavres.*

4.9.teqnikuri saSualebebi da kompiuteruli uzrun-vel yofa

bul gareTis setyvasTan brZolis samsaxurSi zemoqme-debis operaciebis sruli ciklis Casatarebl ad Seqmni-lia radiolokaciuri da aerologiuri informaciis re-aluri droSi analizis sistema, romlis abreviaturaa RAPIRA.

MRL 5 – IRIS meteorologiur movlenebze dakvirve-bis, maTi monitoringisa da prognozirebis mZlavri qve-sistema, romelic uzrunvelyofs real ur droSi infor-maciis miRebas;

FIRE HAIL kompiuteruli programa Rrubl ebze ze-moqmedebisTvis saWiro monacemTa mosamzadebl ad, rome-lic gamoimuSavebs zemoqmedebis brZanebebs;

FIRE W sakomunikacio da sainformacio qvesistema setyvis sawinaaRmdego raketebis kontrolisa da gaSvebis special izebul i kompiuterul programiT.

pirvel i maTgani **MRL 5 IRIS** (λ=10 sm) qvesistema uz-runvelyofs saRrubl o sistemis displeize gamosaxul e-bis miRebas da setyvasaSiSi ujredebis SerCevas, rac sa-Sual ebas iZleva dadgenil iqnas Rrublis struqtura, reagentis Sesatani aris adgil mdebareoba da radiusi, zemoqmedebis proceduris dasawyisi da dasasruli, ag-reTve sxvadasxva r/l amrekl adobis areebis simaRl e. es monacemebi gadaecema **FIRE HAIL** qvesistemas (modul s). **MRL 5 – IRIS** qvesistemis mier gamomuSavebul saiformacio monacemTa nimuSi moyvanil ia naxazze 13, romel zedac naC-venebia wriuli mimoxilvis indikatorze dafiqsirebul i saRrubl o sistemebi (zemoT) da SerCeul i setyvasaSiSi Rrubl is vertikaluri Wril i (qvemoT). aqve mocemul ia

47

radiol okatoriT gazomil i sidideebis cifrul i amonab-
eWdebi.
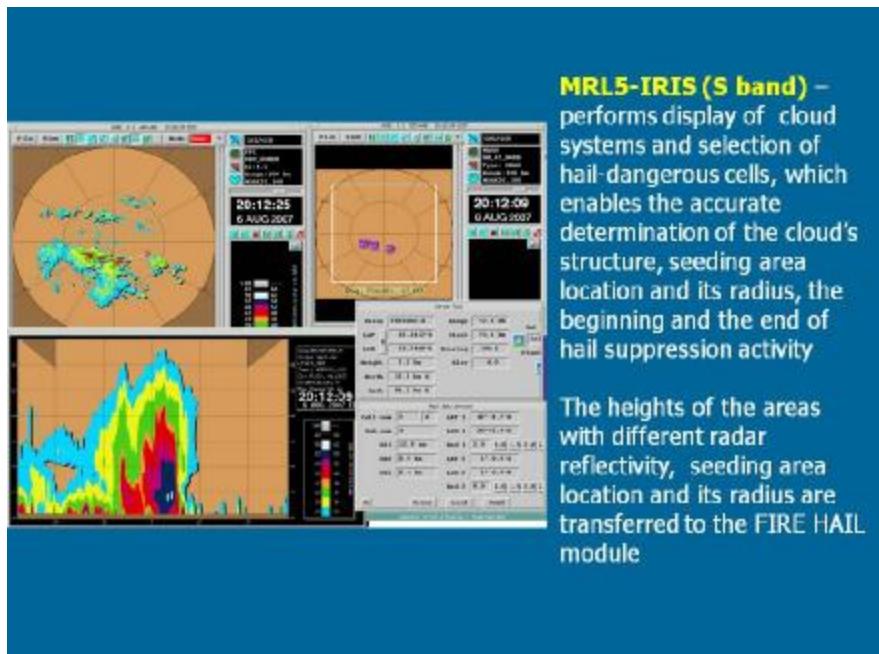
nax.13. MRL5 – IRIS sainformacio qvesistemebis saSual ebiT
miRebul monacemTa warmodgenis magal iTi

meore qvesistema **FIRE HAIL** modul i eyrdnoba atmos-
feros radiozondirebis monacemebs, romel Ta safuZvel -
ze xdeba atmosferos Termodinamikuri maxasiaTebl ebis
gamoTvl a, Rrubel Ta ganviTarebis pirobebis Sefaseba,
mosal odnel i nal eqebis tipis prognozireba da Rrubel -
Si Setanil i reagentis gavrcel ebis parametrebis dadge-
na. atmosferos vertikal uri zondirebis Sedegad miRebu-
l i aerol ogiuri diagramisa da mis safuZvel ze kompiut-
erul i programis saSual ebiT gamoTvl il i maxasiaTebl e-
bis cifrul i saxiT warmodgenis magal iTi moyvanil ia na-
xazze 14.

48
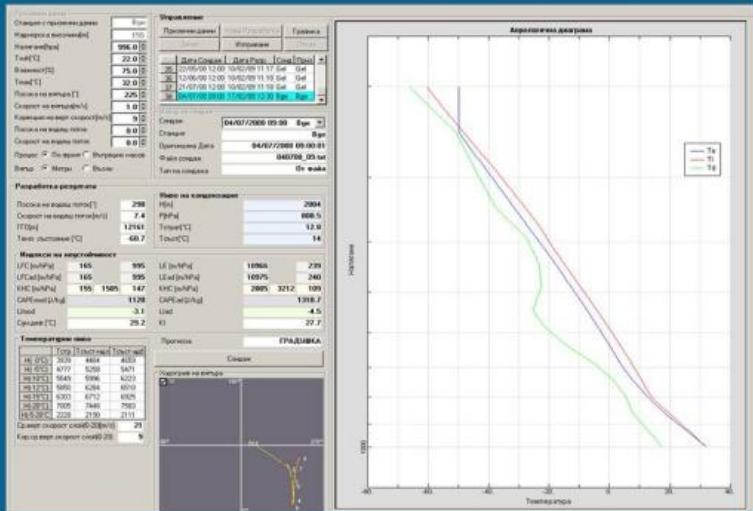
nax.14. **FIRE HAIL** modulis saSualebiT gamoTvlili atmosferos Termodinamikuri maxasiaTeblebis warmodgenis magaliTi

aRniSnuli monacemebis safuZvelze, agreTve **MRL 5 – IRIS** qvesistemidan miRebuli konveqciuri Rrublebis maxasiaTeblebis gaTvaliswinebiT **FIRE HAIL** kompiuteruli programa gansazRvravs zemoqmedebisaTvis Sesaferis sacecxle wertilebs, raketebis gamSveb azimutebsa da vertikalur kuTxeebs, agreTve reagentis Sesatani aris moculobas. Sesabamisi brZanebebi gadaecema **FIRE W** qvesistemas/modul s. cifruli formiT warmodgenili, zemoqmedebis Casatarebl ad sakomando punqtidan gacemuli brZanebebis nimuSi warmodgenilia naxazze 15. aqve naCvenebia dasacav teritoriaze sacecxle wertilebis ganlagebis sqema (planSeti), romel zedac muqi wreebiT datanilia agreTve reagentis Setanis areebi.

49
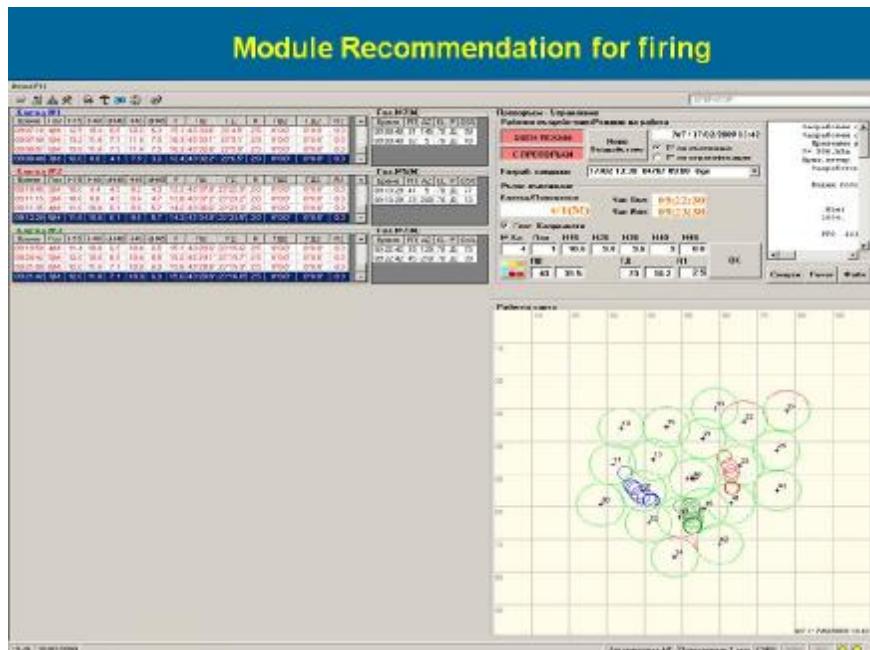
nax.15. . FIRE HAIL modulis saSualebiT gamoTvlili i ze-
moqmedebis Catarebis brZanebebi

*naxazidan_Cans,_rom_sakomando_punqtidan_zemoqmedebis
operaciebis_Catarebas_emsaxureba_daaxloebiT_20_sacec-
xle_wertili,_rac_axlosaa_kaxeTis_regionSi_sacecxle
wertilebis_ganlagebis_simWidrovesTan._bul_gareTSi__9
sakomando_punqtis_moqmedebis_areSi_sacecxle_wertile-
bis_saerTo_raodenoba_daaxloebiT_180_unda_iyos.*

FIRE HAIL modulidan miRebuli brZanebebis Se-
sabamisad **FIRE W** modulis saSualebiT Catarebuli
zemoqmedebis kompiuteruli formiT warmodgenili
Semajamebeli dokumentaciis nimuSi moyvanilia na-
xazze 16.

nax.16. sakomando punqtebidan Catarebul i zemoqmedebis dokumentaciis nimuSi

sakomunikacio da sainformacio qvesistema **FIRE W**, rogorc mraval funqciuri kompiuterul i progra-ma, uzrunvel yofs Semdegi operaciebis Catarebas:

* kodirebul i telemetrul i sistemis saSual eb-iT sakomando punqtidan sacecxl e wertil ebze rake-tebis gaSvebis kontrol i;

* sakomando punqtidan gadacemul i informaciis saimedoobis kontrol i;

* raketebis gaSvebis brZanebebis zusti da drou-l i Sesrul ebis kontrol i;

* sacecxl e wertil ebTan saimedo kavSirisa da raketebis gamSvebi danadgarebis gamarTul i mdgoma-reobis kontrol i;

51

* zemoqmedebis Casatarebl ad gacemul i brZanebe-
bisa da maTi Sesrul ebis arqivireba;

* sacecxl e wertil ebze raketebis xarj visa da
maTi miwodebis raodenobis, TiToeul wertil ze mo-
cemul i momentisaTvis maTi maragis kontrol i;

* meteorol ogiur monacemTa avtomaturi Segro-
vebisa da damuSavebis SesaZl ebl oba Semdegi el emen-
tebisaTvis: haeris temperatura da sinotive, atmos-
ferul i wneva, qaris siCqare da mimarTul eba, wvimi-
sa da Tovl is j amuri raodenoba, wvimis intensivoba.

4.10. sacecxl e wertil is teqnikuri aRWurvil oba

raketebis gamSvebi punqtis teqnikuri aRWurvi-
l obis sqema mocemul ia naxazze 17. es aRWurvil oba
Sedgeba Semdegi el ementebisagan:

nax.17. raketebis gasaSvebi punqtis teqnikuri aRWurvil o-
bis sqema

52

1 – mzis fotoeleqtruli paneli, romelic suf-
Ta ganaxlebadi energiiT uzrunvelyofs miudgomel
adgilas myof daSorebul sacecxle wertilebs, sa-
dac ar arsebobs eleqtrul qselTan mierTebis Se-
saZlebloba;

2 – fotovoltaikuri sistemis sakontrolo pane-
li, romlis daniSnulebaa, **MPPT** teqnologiis gamo-
yenebiT, mzidan miRebuli eleqtroenergiiT akumul-
atorebis damuxtvis procesis kontroli, maTi mdgo-
mareobis kontroli da ganaTebisa da sxva miznebi-
saTvis sacecxle wertilis eleqtroenergiiT uz-
runvelyofa;

3 – sacecxle wertilis gasanaTeblad gamiznu-
li, sinaTlis gamasxivebeli diodebiT (**LED**) aRWur-
vili proJeqtori, romelic 10-jer nakleb energias
moixmars Cveulebrivi varvarebis naTurebiT aRWur-
vil proJeqtorTan SedarebiT;

4 – akumulatorebis batarea, romelic uwyvetad
miawodebs eleqtroenergias sacecxle wertilis yve-
la sistemas;

5 – distanciuri kontrolis paneli, romelic sa-
komando punqtTan uzrunvelyofs sainformacio kav-
Sirs sacecxle wertilze arsebul mdgomareobis,
raketebis gaSvebisa da am procesis fiqsirebis Sesa-
xeb kodirebuli telemetruli sistemis gamoyenebiT;

6 – raketebis avtomatizebuli gamSvebi danadga-
ri, romlis daniSnulebaa special uri kompiuteruli
programis **FIREW** mier gamomuSavebuli brZanebis Se-
sabamisad avtomaturad daayenos danadgari azimut-
ebis diapazonSi 0-360⁰ da vertikaluri kuTxeebis
diapazonSi 45-dan 85⁰-mde da uzrunvelyos 6 raketis
rig-rigobiT gaSveba. danadgarSi gaTval iswinebulia
agreTve xeliT marTvis SesaZlebloba;

53

7 – raketebis gamSvebi danadgaris distanciuri kontrolis paneli, romelic gamoiyeneba sakomando punqtidan srolis azimutisa da vertikaluri kuT-xis Semcveli brZanebis Sesrulebis Sesamowmeblad.

sacecxle wertilis aRWurvil obaSi Sedis set-yvis sawinaaRmdego raketa, romlis amJamad gamoyene-buli tipis teqnikuri parametrebi moyvanilia naxaz-ze 18. rogorc am naxazidan Cans, raketis diamet-ri/kalibri Seadgens 55 mm, xolo sigrZe 910 mm. rake-taSi moTavsebulia 400 g makristal ebeli reagenti, romlis gabneva Rrubel Si warmoebs 34 wamis ganmav-l obaSi. raketis gaSvebis adgilze haeris temperatu-ra SeiZl eba icvl ebodes -5dan +50^0-mde. Senaxvis sa-garantio vadaa 3 weli.

Technical parameters

Length of the container, mm	1045
Outside diameter of the container, mm	60
Length of the rocket, mm	910
Diameter of the rocket, mm	55
Total weight of the rocket with the container, kg	3,45
Weight of the agent, kg	0,4
Initial velocity, m/sec	80
Working time of the engine, sec	4
Time of dispersion, sec	34
Time of self-destruction, sec	41
Working temperature range, T°C	from −5 to +50
Temperature range for storage, T°C	from −30 to +50
Warranty, years	3

nax.18. bul gareTis setyvasTan brZol is samsaxurSi amJa-mad gamoyenebul i raketis **MTT9M** teqnikuri parametrebi

54

raketis traeqtoriebi zRvis donidan 250 m simaR-
l eze mdebare gamSvebi danadgaris sxvadasxva. verti-
kal uri kuTxeebisaTvis naCvenebia naxazze 19.

Trajectories of anti-hail rocket MTT-9M

Altitude of
rocket
launching site
- 250m
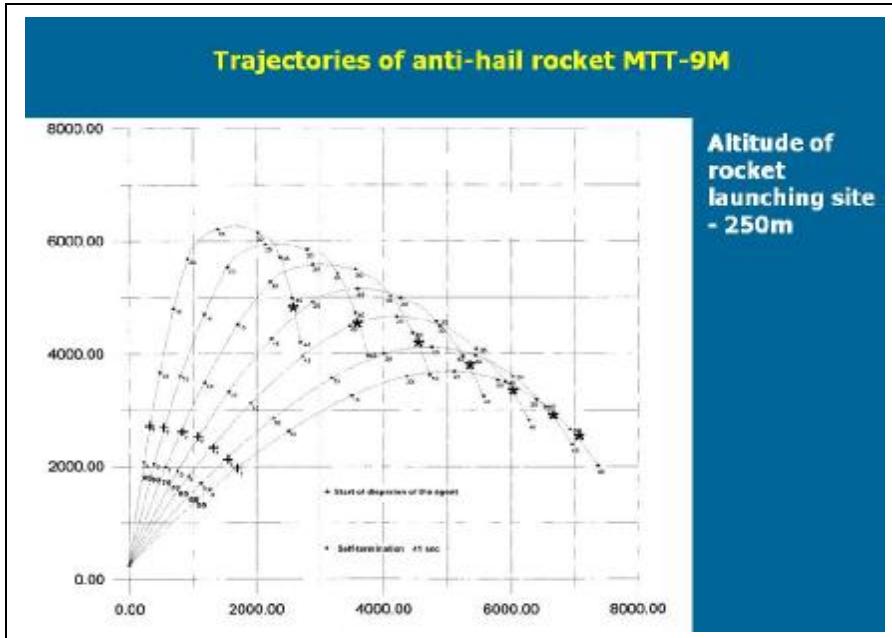
nax.19. setyvis sawinaaRmdego raketis mtt-9m traeqtorie-
bi.

masze muqi j vrebiT aRniSnul ia raketidan reag-
entis gamoyofis sawyisi (7wm) da sabol oo (41 wm)
momentebi, xol o patara varskvl aviT (*) — raketis
TviTl ikvidaciis momenti gaSvebidan 45-e wamze. naxa-
zidan Cans, rom raketis moqmedebis maqsimal uri si-
maRl e icvl eba Sual edSi zRvis donidan 4.0-6,2 km,
xol o moqmedebis radiusi 2,5-dan 7 km-mde. amrigad,
dasacav teritoriaze sacecxl e wertil ebis moqmede-
bis radiusis minimal uri gadafarvis pirobebSi man-
Zil i maT Soris unda Seadgendes ara umetes 12-13 km.

55

5.kaxeTsa da bul gareTSi setyvasTan brZol is samuSao-
Ta warmoebis SedarebiTi anal izi

bul gareTSi 1960–iani wl ebis Sua periodSi dawyebul i
setyvasTan brZol is sacdel –sawarmoo samuSaoebi mniSvne-
l ovanwil ad eyrdnoboda saqarTvel oSi, da kerZod kaxeT-
Si, warmoebul i samuSaoebis gamocdil ebas. bul gareTSi
setyvasTan brZol is samsaxurSi 1970–ian wl ebSi gamoyenebu-
l i radiol okatorebi, saraketo teqnika, zemoqmedebis meTo-
l ogia da misi efeqrurobis dadgenis principebi TiTqmis
mTl ianad gadmotanil i iyo kaxeTSi setyvasTan brZol is
praqtikidan, rac aixsneboda dasacavi teritoriebis fizi-
kur–geografiul i pirobebis didi msgavsebiT. bul garel i
kol egebi xSirad stumrobdnen Tel avisa da sxva gasamxed-
roebul nawil ebs, special istebs Soris mimdinareobda ga-
mocdil ebis nayofieri gaziareba.

es garemoeba ganapirobebda imas, rom kaxeTis regionSi
1980–ian wl ebSi ganviTarebul i setyvasTan brZol is Cvens
mier zemoT ganxil ul i teqnol ogia TiTqmis anal ogiuri
iyo bul gareTis setyvasTan brZol is samsaxurSi danergil i
teqnol ogiisa, Tumca zemoqmedebis Casatarebl ad saWiro in-
formaciis damuSaveba da operaciebis avtomatizacia j er
kidev im wl ebSi iq ufro Tanamedrove doneze warmoebda,
vidre saqarTvel oSi.

1990–iani wl ebidan bul gareTSi setyvasTan brZol is sa-
muSaoebi ar Sewyvetil a. piriqiT, gasul 20 wel iwadSi es sa-
muSaoebi, dasavl eTis ganviTarebul qveynebSi gamoyenebul i
axal i teqnol ogiebis gaTval iswinebiT, ufro maRal done-
ze iqna ayvanil i, rasac mowmobs bul gareTis setyvasTan
brZol is samuSaoebis zemoT moyvanil i mimoxil va. amitom,
saqarTvel oSi setyvasTan brZol is samuSaoTa aRdgenis gza-
ze erT–erT mTavar amocanas warmoadgens im teqnol ogiuri
siaxl eebis gamovl ena, roml ebic miRebul iqna bul garet-

TSi 20 wlis manZilze da saqarTveloSi maTi danergvis Se-
saZleblobaTa garkveva.

kaxeTis regionSi 1980—ian wlebSi da bul gareTSi amJa-
mad gamoyenebuli setyvasTan brZolis zemoTaRwerili teq-
nologiebis Sedareba saSualebas iZleva gamovitanoT Sem-
degi ZiriTadi daskvnaebi:

1. setyvasTan brZolis konceptualuri modeli, rome-
lic 1980—iani wlebisTvis damuSavda mravali qveynis special-
istTa mier da romelic eyrdnoboda mzardi konveqciuri
ujredis gadametcivebul areSi makonkurirebeli Canasaxe-
bis koncentraciis xel ovnurad gazrdis gziT setyvis
zrdis procesis SeCerebis ideas, kvl avac warmoadgens set-
yvasTan brZolis samuSaoTa safuZvels.

2. setyvasaSiS konveqciur ujredSi makristalebel i re-
gentis Setanis saukeTeso saSualebas warmoadgens setyvis
sawinaaRmdego raketa, romlis teqnikuri parametrebi uz-
runvel yofs radiolokatoris saSualebiT Rrubeli Si Ser-
Ceuli gadametcivebuli areebis dedamiwis zedapiridan dis-
tanciur damuSavebas.

3. setyvasTan brZolis samuSaoebi kvl avac eyrdnoba
setyvasaSiSi da setyviani Rrublebis 1980—ian wlebSi Semu-
Savebul klasifikacias, romlis mixedviT gamoiyofa er-
Tujrediani, mraval ujrediani da superujrediani Rrubl e-
bi maTTvis damaxasiaTebeli struqturiTa da ganviTarebis
Taviseburebebi T.

4. setyvasTan brZolis operaciebis dasagegmad da Casa-
tarebl ad aucilebel pirobas warmoadgens aerosinoptiku-
ri monacemebis arseboba, roml ebic konveqciuri Rrubl is
saTanado maTematikuri modelis gamoyenebiT kompiuterul -
ad unda damuSavdes. miRebuli Sedegi unda gaanal izdes ra-
diolokaciuri da Tanamgzavruli dakvirvebebis monacemeb-
TanerTad.

5. radiolokaciuri dakvirvebebis monacemebi kompiut-
eruli programiT unda muSavdebodes, real ur droSi xel -
misawvdomi iyos zemoqmedebis xel mZRvanel isTvis da cif-

57

rul i formiT inaxebodes arqivSi. setyvasaSiS an setyvian Rrubl ebze dakvirvebisas kompiuterul i programa unda iTval iswinebdes aerosinoptikuri da radiol okaciuri monacemebis safuZvel ze rekomendaciebis gamomuSavebas konkretul uj redSi Sesatani reagentis raodenobisa da zemoqmedebis gansaxorciel ebl ad SerCeul i sacecxl e wertil is Sesaxeb.

6. sacecxl e wertil ze sakomando punqtidan miRebul i zemoqmedebis Casatarebel i brZanebis Sesrul eba avtomatur reJimSi unda warmoebdes, rac gamoricxavs raketebis gaSvebaSi subieqturi Secdomebis daSvebas. yvel a gaSveba da misi Sesrul eba kompiuterul ad unda fiqsirdebodes da inaxebodes arqivSi. principul ad gansxvavdeba sacecxl e wertil i is bul gareTSi gamoyenebul i sxva teqnikuri aRWurvil obac. mzis panel i uzrunvel yofs saakumul atoro batareis saimedo moqmedebas, rac adre moqmed sistemebSi moiTxovda benzinze momuSave el eqtrogeneratorebis gamoyenebas. amasTan dakavSirebiT, ar aris gamoricxul i saqarTvel os pirobebSi qarian maRal mTian sacecxl e wertil ebze paral el urad gamoyenebul i iqnas qaris el eqtrogeneratorebic.

7. setyvasTan bZol is operaciebis Casatarebl ad bul gareTSi gamoiyeneba erT sistemad gaerTianebul i sami qvesistema:

* **MRL5 IRIS** radiol okaciuri dakvirvebis qvesistema, romel ic real ur droSi uzrunvel yofs sakomando punqtze informaciis miwodebas meteorol ogiur movl enebze dakvirvebisa da maTi prognozirebis Sesaxeb;

* **FIRE HAIL** kompiuterul i programa, romel ic uzrunvel yofs monacemTa momzadebas Rrubl ebze zemoqmedebis Casatarebl ad da iZl eva rekomendaciebs sacecxl e wertil ebis SesarCevad;

* **FIRE W** – sakomunikacio da sainformacio qvesistemaa, romel Sic Sedis raketebis gaSvebisa da misi kontrol is special uri kompiuterul i programa.

58

8. zemoT CamoTvl il i samive qvesistemis mier gamomuSave-
bul i informacia da brZanebebi Tavs iyris sakomando pun-
qtis central ur kompiuterSi, romel ic uzrunvel yofs ze-
moqmedebis operaciebis detal uri dokumentaciis Sedgenas.

ganxil ul i 8 punqtidan pirvel i sami kaxeTSi warmoebu-
l i setyvasTan brZol is samuSaoebSic iyo miRebul i, rac
mowmobs imas, rom bol o 20 wl is manZil ze bul gareTSi set-
yvasTan brZol is strategia principul ad ar Secvl il a. me-
oTxe punqtSi ukve Semovida aerosinoptikur monacemTa kom-
piuterul i damuSavebis faqtori, roml is maRal doneze re-
al izeba damokidebul ia konveqciuri Rrubl is maTematiku-
ri model is SerCevaze da gamoTvl ebis Sedgenis saTanado
formiT warmodgenaze. saqarTvel oSi setyvasTan brZol is
samuSaoTa aRdgenis SemTxvevaSi mizanSewonil ad unda CaiT-
val os model uri gamoTvl ebis Casatarebl ad Rrubl is sak-
maod srul i model is gamoyeneba, romel ic SesaZl ebel s gax-
dis sandoobis maRal doneze radiol okaciuri monacemebis
gamoyenebiT Sefasdes cal keul setyvasaSiS Rrubel ze ze-
moqmedebis efeqturoba.

me–5 punqti mTl ianad moicavs radiol okaciuri dakvir-
vebebis kompiuterizacias, rac principul ad axal safexur-
ze aiyvans monacemTa damuSavebisa da warmodgenis sistemas.
rogorc zemoT iyo naTqvami, kaxeTSi warmoebul samuSaoeb-
Si l okatoris ekranze vizual urad aTvl il i monacemebi xe-
l iT registrirdeboda Jurnal Si, gazrdil i amrekl adobis
zonis parametrebis mixedviT Rrubel Si Sesatani reagentis
raodenoba isazRvreboda tipiuri pirobebisaTvis Sedgeni-
l i cxril ebiT, xol o sacecxl e wertil ebis SerCeva xdebo-
da zonis konturebis pl anSetze dataniT. yvel a am procedu-
ris kompiuterizaciis Sedegad zemoqmedebis operacia mniS-
vnel ovnad Cqardeba da gamoiricxeba gadawyvetil ebis miRe-
baSi subieqturi faqtori. zemoqmedebis xel mZRvanel s meti
dro rCeba kompiuteris mier rekomendebul i brZanebebis Se-
safasebl ad da, sabol ood, zemoqmedebis optimal uri vari-
antis SesarCevad.

me–6 punqti agreTve iTval iswinebs sacecxl e wertil ze warmoebul i samuSaos srul modernizacias. cecxl is warmoebis anu raketebis gaSvebis avtomatizebul i sistema gamoricxavs subieqturi Secdomebis daSvebas, agreTve iTval iswinebs am procesis detal ur registracias da kontrol s, rac gansakuTrebul mniSvnel obas iZens sagangebo SemTxvevis pirobebSi (saraketo sistemis avariul i funqcionireba, raketis TviTgasvl a el Weqis dros da sxv.)

me–7 punqtSi ganxil ul i qvesistemebis saqarTvel os pirobebSi danergva faqtobrivad zemoT ganxil ul i modernizaciis principebis Sej amebas warmoadgens, rac uzrunvel - yofs saqarTvel oSi gavl il i 20 wl is manZil ze dagrovil i CamorCenis daZl evas da setyvasTan brZol is samuSaoTa Tanamedrove doneze warmoebas.

garda amisa, saWiro iqneba kaxeTSi adre warmoebul i ekol ogiuri monitoringis ganaxl eba setyvasTan brZol is samuSaoTa garemoze zemoqmedebis Sesafasebl ad.

Tavi II. zvavsawinaaRmdego RonisZiebebi

saqarTvelos bunebrivi pirobebi xels uwyobs Tov-
lis zvavebis gavrcelebas. zvavsaSiSia ara mxolod cal-
keuli dasaxlebuli punqti, aramed saavtomobilo magis-
tralebi, eleqtrogadamcemi xazebi, rekreaciuli daniS-
nulebis sxvadasxva obieqti. Tu imasac gaviTval iswinebT.
rom, saqarTvelos teritoriis 56% zvavsaSiS zonaSi mde-
bareobs da teritoriis 20%-ze zvavi yovel wliurad Ca-
modis, cxadi gaxdeba zvavebis Seswavlis aucilebloba
da zvavsawinaaRmdego rekomendaciebis SemuSaveba.

6. zvavsawinaaRmdego RonisZiebebis klasifikacia

arsebuli literaturuli wyaroebis analizi da mra-
val wliuri kvlevebi, romelic hidrometeorologiis in-
stitutSi warmoebda, SesaZleblobas iZleva Catardes
zvavsawinaaRmdego RonisZiebebis klasifikacia, romel sac
safuZvlad edeba zvavsawinaaRmdego RonisZiebebis kate-
goriebi (profil aqtikuri, sainJinro, zvavSemakavebeli da
zvavdamcavi). zvavsawinaaRmdego RonisZiebebi SeiZleba da-
iyos or jgufad: pasiur da aqtiur RonisZiebebad
(cxr.2).

cxrili 2. zvavsawinaaRmdego RonisZiebebis klasifikacia

| #	pasiuri	#	aqtiuri
1	zvavsaSiSi teritori- is gamokvleva, usafr- Txo adgilis SerCeva	4	RonisZiebebi zvavis keraSi (droebiTi, kapitaluri, sa- inJinro nagebobebi, gatyi- aneba)
2	zvavis prognozis me- Todebis damuSaveba (cal keuli zvavSemkre- bisaTvis, mTiani regi- onisaTvis)	5	RonisZiebebi zvavsadenSi (zvavis amcilebeli, obieq- tis Tavze gamSvebi, dam- SIeli nagebobis mowyoba)
3	zvavsawinaaRmdego sa- meTval yuro samsaxu- ris Seqmna (saguSago- ebis mowyoba, samaSve- lo razmebis Seqmna)	6	RonisZiebebi zvavis gamozidvis konusSi (zvavis amcilebeli, damSIeli, damamuxruWebeli da gamaCerebeli nagebobebis mowyoba)

61

pasiuri zvavsawinaaRmdego RonisZiebebi ar iTval is-
winebs zvavSemkrebis teritoriaze raime special uri sa-
muSaos Catarebas (sainJinro, gatyianeba, dateraseba da
sxv.), Tovl is safarze zemoqmedebas (Tovl is moZraobaSi
mosvl is xel SemSl el i farebi, Robeebi, badeebi, Tovl ze
qimiuri zemoqmedeba, datkepnva da sxv.), Tovl is safaris
moZraobaSi moyvanas (afeTqeba, karnizebis moxerxva da
sxv.), zvavebis bunebriv procesebSi Carevas (mimarTul ebis
Secvl a, damuxruWeba, gaCereba da sxv.). pasiuri RonisZi-
ebebidan hidrometeorol ogiis institutSi dReisaTvis
SemuSavebul i zvavebis prognozis meTodebi iyofa or
jgufad: 1. cal keul i zvavSemkrebebis an mcire farTobis
mqone teritoriebze zvavsaSiSi periodis dadgomis prog-
nozirebis meTodebi; 2. SedarebiT did teritorize fonu-
ri prognozis meTodebi. saqarTvel oSi Camosul i zvavebis
saerTo raodenobis 80% axal mosul i Tovl isagan warmo-
iqmneba. institutis mecnierTa mier SemuSavebul ia yvel a
genezisis zvavis Camosvl is prognozirebis meTodi, rome-
l ic danergil ia saqarTvel os garemosa da bunebrivi re-
sursebis dacvis saministros monitoringisa da progno-
zirebis centrSi, saidanac mosaxl eobas da dainterese-
bul organizaciebs droul ad miewodebaT informacia mo-
sal odnel i zvavsaSiSroebis Sesaxeb.

aqtiur zvavsawinaaRmdego RonisZiebebSi mTavari ro-
l i adamians miekuTvneba. igi cdil obs zvavis keris ze-
dapiris formis Secvl as, gamoiwvios zvavis profil aqti-
kuri Camosvl a an xel i SeuSal os mis warmoqmnas. aqtiu-
ri zvavsawinaaRmdego RonisZiebebis Catareba SesaZl ebe-
l ia zvavsadenSi, zvavis gamozidvis konusSi da zvavis
keraSi.

7. saqarTvel os zvavsaSiSi teritoriebi
saqarTvel os zvavsaSiSi teritoriebi detal urad ar-
is Seswavl il i da Sedgenil ia zvavsaSiSroebis rukebi.
Tval saCinoebisaTvis warmovadgenT teritoriis zvavaqti-
urobis rukas (nax.20), romel ic gviCvenebs Tu teritoriis
ra nawil ze SeiZl eba warmoiqmnas zvavi, anu teritoriis

62

ra nawilia aqtiuri zvavebis warmoqmnis Tval sazrisiT.
rukaze warmodgenilia nulovani, < 20-ze, 20-dan - 40-mde,
40-dan 60-mde da >60 –ze zvavaqtiuri teritoriebi;
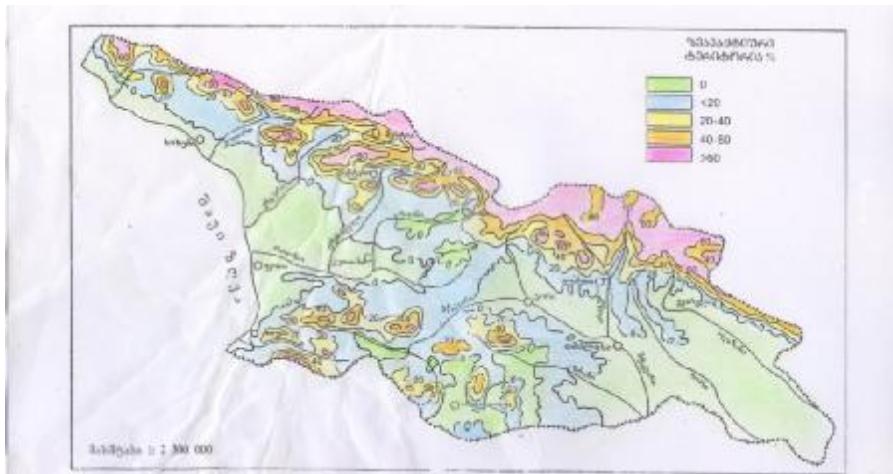
nax.20. saqarTvelos teritoriis zvavaqtiurobis ruka

zvavsaSiSroebis oTxi ZiriTadi raodenobrivi maxasi-
aTebl is (teritoriis zvavaqtiuroba, zvavSemkrebebis six-
Sire, zvavebis Camosvlis sixSire da zvavsaSiSi periodis
xangrZlivoba) mixedviT Sedgenilia saqarTvelos teri-
toriis zvavsaSiSroebis ruka, sadac gamoiyo gansakuTre-
biT Zlieri, Zlieri, saSualo, susti da arazvavsaSiSi
raionebi (nax.21). zemoT CamoTvlil raionebs ukaviaT sa-
qarTvelos teritoriis 12, 33, 8 da 3% Sesabamisad.

Sedgenilia agreTve katastrofuli da sistematuri
zvavebis gavrcelebis ruka (nax. 22).

rogorc ukve aRvniSneT, saqarTvelos teritoriis
56% zvavsaSiS zonaSi mdebareobs da amasTan teritoriis
20%-ze, miuxedavad imisa uxvTovliania Tu ara zamTari,
zvavi yovel wliurad Camodis. rac Seexeba teritoriis
36%-s, swored aq xdeba rogorc sporaduli (2-3 weliwad-
Si erTxel an aTeul weliwadSi erTxel), ise sistematu-
ri (rodesac zvavis parametrebi scildeba Tavis Cveul
sazRvrebs) zvavebis Camosvla, romelebic gamoirCeva di-
di damangreveli ZaliTa da msxverpliT.

63
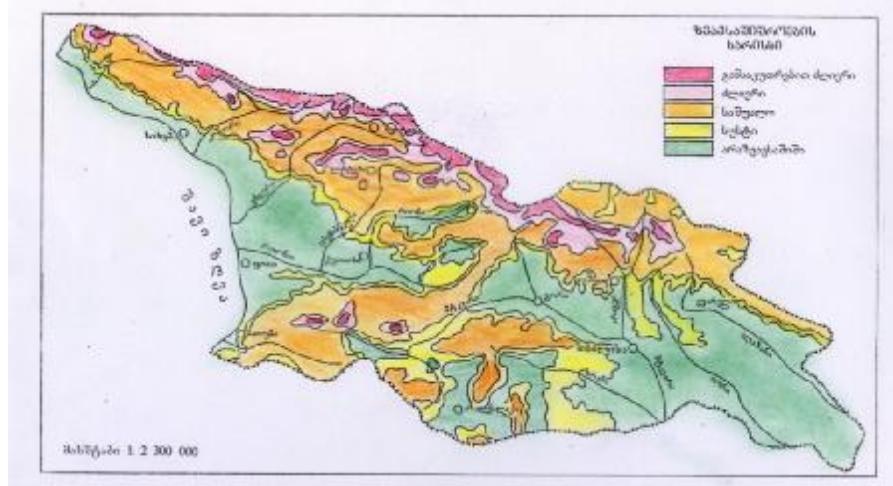
nax.21. saqarTvelos zvavsaSiSi raionebis ruka
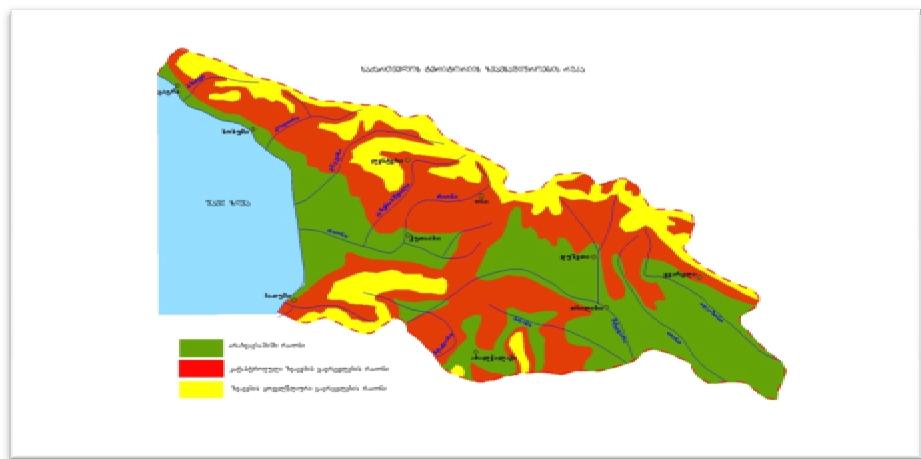
nax.22. saqarTveloSi katastrofuli da sistematuri
zvavebis gavrcelebis ruka

8. zvavsawinaaRmdego RonisZiebebis kategoriebi
msoflios mTian raionebSi zvavsawinaaRmdego brZo-
lis mravali meTodi arsebobs. maTi ganxorcieleba upir-

64

vel esad iwyeba teritoriis zvavsaSiSroebis SefasebiT, tyis masivebis dacviTa da maTi aRdgeniT, mosaxleobis usafrTxoebis uzrunvel yofiT. zvavsaSiSi raionis usafrTxoebis uzrunvel sayofiT aucilebelia:

1. adgil mdebareobis analizi:
2. amindis prognozi. maT Soris zvavsaSiSroebis prognozi;
3. saSiSroebis klasifikacia;
4. moqmedebis gegma.

zvavsawinaaRmdego nagebobebis daproeqtebisa da sxvadasxva RonisZiebebis gatarebisas gasaTvaliswinebelia zvavebis reJimi da maTi xasiaTi, aseve Tovlis safaris simaRle, landSaftis morfologia, Tavad dasacavi obieqtisaTvis Sesabamisi zvavsawinaaRmdego konstruqciebisa da RonisZiebebis SerCeva (cxr.3).

9. zvavsawinaaRmdego nagebobebi

zvavebisagan dacvis strategia iseT zvavsawinaaRmdego nagebobebis mSeneblobas gulisxmobs, romelic adamianebis usafrTxo cxovrebasTan aris dakavSirebuli. uxsovari droidan alpebsa da kavkasiaSi saxlebs ise aSenebdnen, rom saxlis ukana kedeli ferdobze yofiliyo mibjenili, xolo saxlis saxuravs iseTi daxris kuTxe unda hqonoda, rom Tovlis masas masze dacurebis saSualeba miscemoda an ukana kedels unda hqonoda iseTi forma, rom Seesrulebina zvavis mWrelis funqcia (nax.23). aseTi principiT aris agebuli RvTismSoblis eklesia davosSi, romelic Tavdapirvel ad agebisTanave 1602 wels 70 saxlTan erTad daingra. aRdgenis Semdeg 1817 wels Camosul ma zvavma mxolod eklesiis gumbaTi dafara da swored zvavismWrelis formiT agebuli kedlis wyalobiT gadarCa, 1968 wlis 25 ianvars Camosul ma zvavma ki mxolod galavnis gverdiTi kedeli daaziana (nax.24).

PDF created with pdfFactory Pro trial version www.pdffactory.com

cxril i 3. zvavsawinaaRmdego RonisZiebebis kategoriebi

#	RonisZiebis kategoria	RonisZiebis mizani
I. profil aqtikuri		
1	zvavsawinaaRmdego sam-saxuris organizeba, dakvirveba, prognozi da informaciis gavrce-leba	zvavebis Camosvl is prognozi. mosaxl eobis droul i infor-mireba da zvavsaSiSi zonidan gayvana
2	zvavebis xel ovnuri gamowveva	Tovl is safaris mdgradobis prognozis safuZvel ze zvave-bis regul arul i CamoSveba srol iT, afeTqebiT, karnizis moxerxviT da sxva.
II. zvavis amacil ebel i sistemebi		
1	Tovl Semakavebel i nage-bobebis mowyoba (Robe, kedel i, damcavi fari, xidi, mavTul xl arTi). ferdobis dateraseba da gatyianeba	Tovl is safaris mdgradobis miRweva zvavebis warmoqmnis zonebSi, maT Soris ferdobe-bis daterasebisa da ganaSeni-anebis gziT, riTac moxdeba Tovl dagrovebis regul ireba
2	Tovl Semakavebel i Ro-beebis da farebis sis-temis mowyoba	Tovl dagrovebis acil eba zvavebis warmoqmnis zonebSi
III. zvavebisagan dacva		
1	mimarTul ebis Semcvl e-l i nagebobebis Seqmna kedel i, xel ovnuri zvavsadeni, zvavismWre-l i	zvavis mimarTul ebis Secvl a, zvavsaSiSi obieqtis dacva
2	SemaCerebel i da Sema-ferxebel i nagebobebis mowyoba: damba, borcvi, tranSea	zvavis SeCereba da misi gada-adgil ebis Seferxeba
3	zvavgamSvebi nagebobe-bis ageba: gal erea, es-takada, fardul i	zvavebis gaCereba obieqtis Tavze an maT qvemoT

66

<center>(a)   (b)</center>
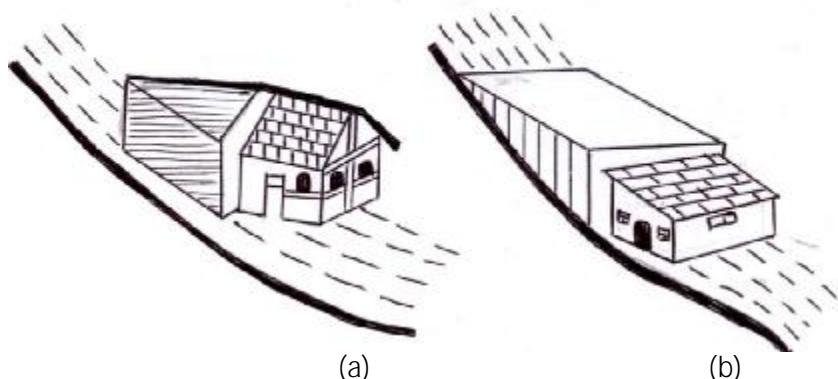
nax.23. Sesabamisi konstruqciebiT sacxovrebel i
saxl ebis dacva zvavebisagan
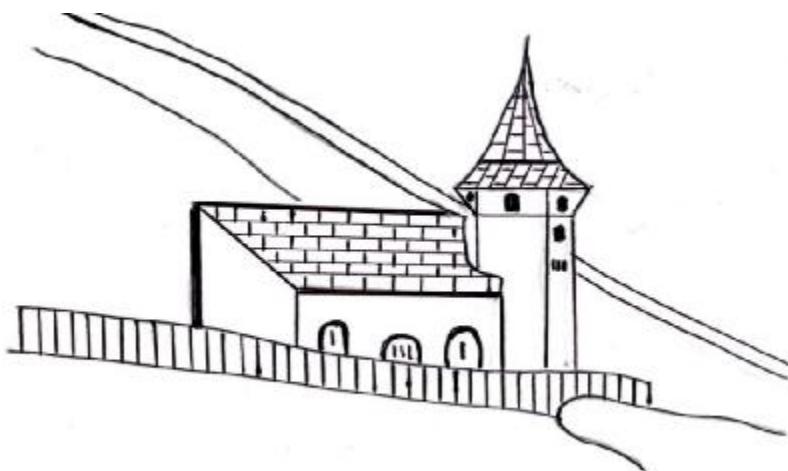
nax.24. RvTismSobl is taZari davosSi (Sveicaria)

saqarTvel oSi zvavsaSiSroebis gauTval iswinebl obis
mraval i saval al o magal iTis moyvana SeiZl eba. aseTia
1987 wel s svaneTSi, sofel JamuSSi zvavis Sedegad dan-
greul i axal i nagebobebisa da 26 adamianis tragikul i
bedi, roca mxol od svanuri koSki gadarCa, radgan swo-

<center>67</center>

red misma kedel ma Seasrul a zvavismWrel is funqcia (nax. 25)

nax. 25. 1987 wel s sof JamuSSi (mestiis municipal iteti) zvavs gadarCenil i svanuri koSki

mTiani raionebis mosaxl eoba zvavebisagan dasacavad miwurebsa da fardul ebs afarebda Tavs. 1805 wel s al -pebSi simpl onis uRel texil ze napol eonis brZanebiT yvel aze zvavsaSiS monakveTebze pirvel i gal erea aSenda. gal erea rkinigzisa da saavtomobil o gzebis erT-erTi saimedo dacvis saSual ebaa. aseTi gal ereebi gvxvdeba yirgizeTSi, kavkasiaSi, kerZod ki saqarTvel os samxedro gzaze (nax..26).

me-18 saukunidan fiqrobdnen Tu rogor SeekavebinaT Tovl i ferdobze: iTxreboda ferdobebi, zvavis mowyvetis adgil as xdeboda boZebis Casma da es martivi konstruqciebi Robeebs mogvagonebdnen. zvavsaSiSi ferdobebis pirvel i sainJinro ganaSenianeba 1868 wel s graubiudenSi (Sveicaria) moxda. zvavsaSiS ferdobze 19 qvis Robe 17 rigad aSenda, romel Ta j amuri sigrZe 412 metrs Seadgenda. mas Semdeg am ferdobze zvavi ar Camosul a. dReisaTvis qvis Robeebi rkina-betonis, xis, al uminis, fol adis, pl astmasis martivi konstruqciebiT icvl eba. pl as-

68

tmasisa da neilonisagan amzadeben Tovlis Semakavebel badeebs (nax.27,28).

nax.26. zvavsawinaaRmdego galerea saqarTvelos samxedro gzaze

nax. 27 Tovlis Semakavebeli plastmasis bade

69

nax. 28 Tovlis Semakavebeli rkinis bade

Tanamedrove zvavsawinaaRmdego Robeebis erTi metris Rirebuleba 500 dolars Seadgens. magaliTad, Sveicariis erT-erTi dasaxlebul i punqtis - sen-antonionis 150 adgil obrivi mosaxlis dasacavad milion naxevari dolari gamoiyofa. arsebobs sxvadasxva saxeobis zvavSemakavebeli nagebobebi. mag. sanatorium "saxalinis" dasacavad xis Tovl Semakavebeli farebi gamoiyeneba, romlebic msxvili fol adis trosebiT aris mimagrebul i mTis Txemze. es farebi aTeul i wel ia icavs sanatoriums zvavebisagan

rig qveynebSi zvavis mimarTulebis Semcvlel dambebs zvavis siCqaris Sesasustebl ad da Sesakavebl ad ageben. aseTi nagebobebi bevria al pur qveynebSi, magal iTad ol impiur sofels insbruks didi zvavsawinaaRmdego damba icavs. aseTi nagebobebi bevria agreTve xibinebSi qal aq kirovskis raionSi.

zvavis amcilebeli nageboba Tovl is zvavis mimarTul ebis Sesacvlel adaa gamiznul i. SesaZl ebel ia rkinabetonisagan an sxva masal isagan agebul i dambis, kedl is, qvayril is an miwayril is gamoyeneba, aseve zvavis mimarTulebis Secvla xel ovnuri zvavsadenis gayvaniTac SeiZl eba. erT-erT magal iTad ganvixil avT sof.Rurtas (xu-

70

l os raioni), sadac 1971 wel s Camosul ma zvavma daangria sacxovrebel i saxl ebi da 22 adamiani imsxverpl a. insti-tutis TanamSroml ebis mier, adgil obrivi mikrorel ief-is, zvavSemkrebebis morfometriul i da dinamikuri maxasi-aTebl ebis dadgenis safuZvel ze 1984 wel s SemuSavda sofl is dacvis zvavsawinaaRmdego RonisZieba (nax.29).


nax. 29. xel ovnuri zvavsadenis magal iTi (sof.Rurta)

damrec ferdobze, sadac xdeboda zvavis gaSl a, aSen-da zvavis mimarTul ebis Semcvl el i ori damba. 7m simaRl isa da 50-55 m sigrZis pirvel i dambis daniSnul e-bas zvavis siCqarisa da dartymis Zal is Semcireba da, na-wil obriv, mimarTul ebis Secvl a warmoadgenda, xol o me-ore dambis (simaRl e 10 m, sigrZe 190-200 m) daniSnul ebas uSual od zvavis mimarTul ebis Secvl a. am meore dambis gaswvriv xel ovnuri zvavsadeni iqna gayvanil i. garda am RonisZiebisa, gaTval iswinebul i iqna isic, rom herima-Rardos ferdobze, sadac es sofel i aris gaSenebul i, aucil ebel i iyo utyeo monakveTebis wiwvovani jiSis xe-ebiT gatyianeba da arsebul i tyis gaCexvis akrZal va. am

71

RonisZiebebis Semdeg sofl isTvis zvavs zaral i aRar mi-
uyenebia.

1885 wel s pirvel i betonis kedel i saqarTvel os sam-
xedro gzaze zvav "bodosagan" dasacavad aSenda.

zvavis moZraobis Seferxeba an SeCereba xdeba zigza-
govani monakveTebis SeqmniT, rac SesaZl ebel ia mizanmi-
marTul i afeTqebebis gziT. aseTi meTodi espaneTis piri-
neis mTebSi gamoiyeneba. zvavsawinaaRmdego nagebobebis
simtkices da saimedoobas Tavad zvavi gansazRvravs. xibi-
nebSi, al pebSi, iaponiis mTebSi Catarebul i RonisZiebebi
miuTiTebs, rom aucil ebl ad gasaTval iswinebel ia adgi-
l obrivi pirobebi da zvavis xasiaTi.

aqm principis gansaxorciel ebl ad zogj er gasaTva-
l iswinebel ia kompl eqsur RonisZiebaTa gatareba (nax. 30).
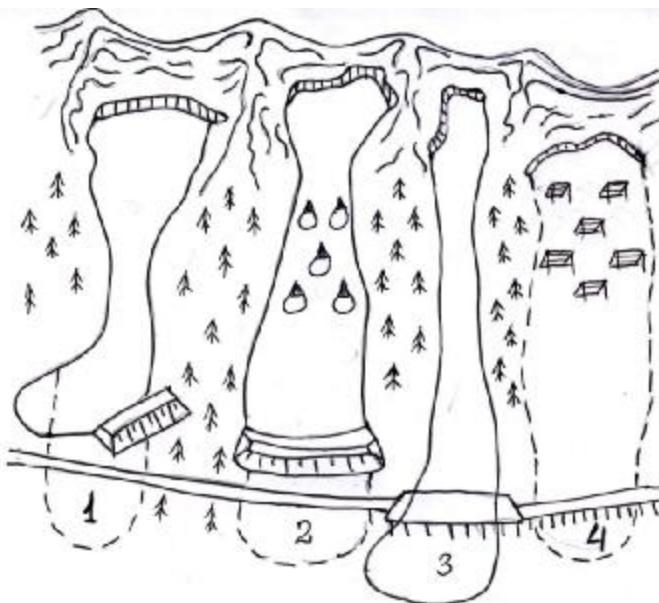
nax. 30. zvavebisagan dacvis kompl eqsuri sistema. 1. zvavis
mimarTul ebis Semcvl el i damba; 2. zvavis Semaferxebel i
borcvebi da zvavSemakavebel i damba; 3. zvavsawinaaRmdego
gal erea. 4. Tovl Semakavebel i nageboba.

72

10.asafeTqebel i nivTierebebisa da artileriis gamo-yeneba

aSS-Si zvavebis profil aqtikuri CamoSvebisaTvis ga-moiyeneba naRmebi da satyorcni yumbarebi. satyorcni yum-barebis gamoyenebis SemTxvevaSi ramdenime sacecxle po-ziciidan aris SesaZlebeli didi raionis kontrolireba. aRniSnuli meTodi gamiyenes olimpiuri TamaSebis dros skvo-veliSi, gasuli saukunis 60-ian wlebSi, roca ori saaTis ganmavlobaSi ocdaaTamde zvavSemkrebidan Camovi-da zvavi.

zvavsaSiS zonaSi afeTqeba SesaZlebelia Semdeg Sem-TxvevebSi:

1.   erTi ferdobidan zvavis Camosvlis dros aucileb-lad unda Semowmdes sxva ferdobebic;
2.   zogjer, afeTqebis Semdeg Tovli isev rCeba ferdob-ze an SesaZlebelia mcire zomis zvavis Camosvla.

ferdobebidan zvavebis CamosaSvebad gamoiyeneba:

1.   tetritrolis sabrZolo fugasuri Wurvebi $C - 3$ da trotili;
2.   seismografiuli denTi;
3.   105 mm-ze naklebi kalibris sabrZolo Wurvebi;
4.   gamonaklis SemTxvevaSi — dinamiti.

Tovlis karnizebis CamosaSleblad gamoiyeneba:

1.   teqnikuri 40%-iani Jelatin-dinamiti, romelic ar iy-ineba;
2.   samxedro fugasuri Wurvebi an seismografiuli den-Ti;
3.   karnizis warmoqmnamde SesaZlebelia winaswar gaT-xril ormoebSi fugasuri Wurvebis ganlageba;
4.   SesaZlebelia detonarorebis gamoyeneba, kerZod: a) eleqtronuli da cecxlovani kafsula detonatorebi an detonatoris zonari; b) detonatori fugasuri WurvisaTvs unda iyos #8 an meti.

aucileblad gasaTvaliswinebelia asafeTqebeli niv-Tierebebis Senaxvis wesebi.

qvemexs, naRmtyorcns, saraketo mowyobilobebs unda gaaCndes sizuste da Sor manZilze srolis unari, unda

iyos mobiluri, saimedo da gamoirCeodes marTvis simar-
tiviT. sxvadasxva iaraRebs Soris aRsaniSnavia 75 da 105
mm-is kalibris qvemexebi, aseve 75 mm-is haubicebi. 105 mm-ze
meti kalibris iaraRis gamoyeneba rekomendebuli ar ar-
is.

105 mm-iani e.w. ukugorebis armqone qvemexi TiTqmis ar
gansxvavdeba 75 mm-iani qvemexisagan rogorc srolis si-
zustiT, ise eqspluataciiTa da sandoobiT. srolis si-
Sore misi ufro didia, aseve didia dartymis Zalac,
Tovl ze advilad gadaadgileba, misi ganTavseba SesaZ-
lebelia rogorc avtomobilze, ise romelime platfor-
maze. es iaraRi SesaZlebelia gamoyenebuli iqnas saavto-
mobilo gzebis dacvis mizniT. naRmtyorcnebis gamoyeneba
SeuZlebelia im adgilebSi, sadac nagebobebi da dasax-
lebuli punqtebia, radgan maTi dazianeba SesaZlebelia
yumbaris namsxvrevebiT. aseve zemoqmedebis dros aucil-
ebelia gzebis gadaketva da gadaadgilebis SezRudva.
gaTval iswinebuli unda iyos usafrTxoebis teqnikis Zi-
riTadi principebi.

gasuli saukunis 70-ian wlebSi saqarTveloSi saavto-
mobilo magistralebze zvavebis profil aqtikuri gamow-
veva dabombvisa da afeTqebis gziT (eqsperimentis saxiT)
saqarTvelos samxedro gzaze tardeboda. instituti aq-
tiur monawileobas iRebda zvavsaSiSi ubnebis gansaz-
RvraSi, zvavebis dinamikuri parametrebis (zvavis siCqa-
ris, dartymis Zalis, moZravi zvavis simaRlis da konu-
sis maqsimaluri simaRlis) gamoTvlebSi.

11. Tovlis zvavebisagan dacvis Tanamedrove meTo-
debi

zvavebisagan dasacavad aucilebelia rogorc aqtiuri
(zvavebTan brZola), ise pasiuri (zvavebisagan dacva) zvav-
sawinaaRmdego meTodebis gamoyeneba.

aqtiur RonisZiebebs miekuTvneba Tovlis safarze ze-
moqmedebis Tanamedrove sistemis **GAZEX**, **AVALANCHE** (pnev-
maturi qvemexi) da **DAISYBELL** kompleqsebis gamoyeneba.

1989 wels frangulma firmam 15-wliani eqsperimen-
tis Catarebis Semdeg daapatenta **GAZEX** sistema, romlis

74

daxmarebiT Jangbadisa da propanis narevis saSualebiT xdeba zvavebis xelovnurad gamowveva. aseTi sistema msoflioSi gamoiyeneba rogorc zamTris kurortebis, aseve gzebis, gvirabebis da sacxovrebeli kompleqsebis dasacavad. 2002 wels es sistema gamoiyenes ruseTis federaciaSi krasnodaris mxaris "krasnaia polianasa" da 2008 wels kurort "roza xutorSi" (nax. 31).

am sistemas sammagi moqmedeba gaaCnia:

1. iwvevs Tovlis masis rRvevas gazebis wvis Sedegad;
2. iwvevs Tovlis safaris gamkvrivebas;
3. seismuri talRa, romelic sistemis amoqmedebisas warmoiqmneba, iwvevs Tovlis masis Camosvlas.
4.

nax.31. zvavsawinaaRmdego sistema **GAZEX**

sistema Sedgeba ori nawlisagan: **SHELTER** marTvis punqtisagan, sadac Jangbadisa da propanis rezervuari, eleqtronuli marTvis sistema, radiosignalebis mimRebi mowyobiloba, Tovlis safaris parametrebis ganmsazRvre-

75

l i xel sawyoa moTavsebul i (suraTis marj vena nawil i)
da aqtiuri zemoqmedebis ramdenime **EXPLODER** danadgari-
sagan. naxazze gamosaxul i erTi aseTi rezervuari momsa-
xurebas uwevs 5 **EXPLODER-**s (suraTis marcxena nawil i).
es aqtiuri zemoqmedebis danadgari warmoadgens metal is
mil s, romel ic Tavsdeba zvavSemkrebSi da romel Tanac
mierTebul ia gazgamtari mil ebi. Tavad mil ebi ZiriTad
punqtSi ganTavsebul rezervuarTan aris mierTebul i.
EXPLODER- is SigniT xdeba Jangbadisa da propanis (1:6
wil iT) SeerTeba. es sistema muSaobs zamTris mTel i se-
zonis ganmavl obaSi nebismieri amindis pirobebSi da zva-
vebis gamowveva SeuZl ia manam, sanam zvavi miaRwevs daman-
grevel masas da Zal as. mag. kurort "roza xutor"-Si
cirkSi ganTavsebul ia 34 **EXPLODER** danadgari (nax.32).
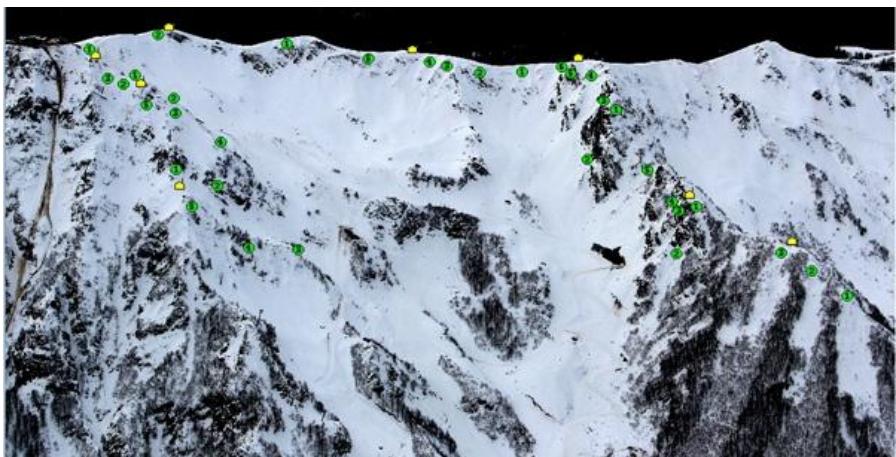
nax. .32. kurort "roza xutorSi" ganTavsebul i
EXPLODER-ebi

Tanamedrove zemoqmedebis kidev erT saxeobas warmo-
adgens pnevmaturi qvemexi **AVALANCHE**, romel mac saarti-
l erio iaraRi Secval a. Wurvi-raketa special uri Txeva-
di (usafrTxo) komponentebisagan da detonatorisagan
Sedgeba. qvemexi SeiZl eba ganTavsdes rogorc stacionar-
ul ad erT garkveul adgil ze, ise SesaZl ebel ia misi ga-

76

datana muxl uxiani transportiT. misi gasrol is manZil i 2 km-ia (sur.33).

nax.33. pnevmaturi qvemexi **AVALAUNCHE.**

    DAISYBELL (e.w.„zari) zvavebze aqtiuri zemoqmedebis mesame uaxl esi teqnol ogiaa, romel ic Znel admisawvdomi zvavSemkrebebis cal keul ubnebze zemoqmedebis SesaZl eb- l obas iZl eva. sistema warmoadgens metal is konuss spe- cial uri mowyobil obiT, romel ic trosiT aris mimagre- bul i vertmfrenze. **DAISYBELL** – is muSaobis principi mdgomareobs imaSi, rom distanciuri inicirebiT xdeba metal is konusSi moTavsebul i Jangbadisa da wyal badis narevis afeTqeba. konusi damzadebul ia maRal i mdgrado- bis fol adisagan, rac saSual ebas iZl eva daikavos gaze- bis narevi aal ebamde da mimarTos Tovl is safarisaken asafeTqebl ad. (nax.34).

    DAISYBELL – is eqspl uatacia damokidebul ia frenis pirobebze, misi gamoyeneba SesaZl ebel ia mxol od dRis

77

saaTebSi kargi xil vadobis pirobebSi da miCneul ia, rom es warmoadgens am sisitemis nakl s.

garda zemoqmedebis aRniSnul i sistemebisa, zvavebTan sabrZol vel ad amJamad sxvadasxva qveynebSi gamoiyeneba Semdegi tipis zvavsawinaaRmdego raketebi:

1. ПРЛ -2,5 H . kal ibri 60 mm, sigrZe – araumetes 850 mm, masa -3 kg, moqmedebis radiusi – 2500 m.
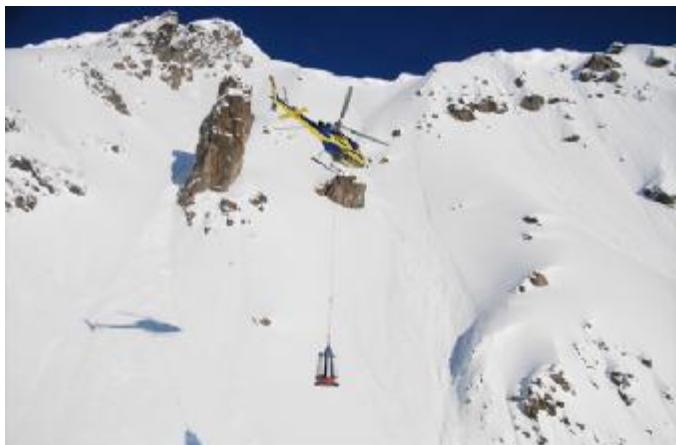
nax.34. zvavSemkrebze **DAISYBELL** sistemiTzemoqmedeba.

2. "КИЗИЛ –T " reaqtiul zvavsawinaaRmdego kompl eqss gaaCnia 650-7000 m-mde gasrol is siSore. gamoiyeneba Znel admisawvdom raionebSi, misi daniSnul ebis adgil ze gadatana xorciel deba vertmfreniT an avtotransportiT Sesabamisi usafrTxoebis teqnikis dacviT.

kompl eqsi Sedgeba: 80 mm-iani C-8 sistemis raketebis gamSvebi pul tis mqone mraval l ul iani danadgaris, MK – 52 tipis mikrokal kuratorisa da l azerul i samiznebel i – manZil mzomisagan. misi teqnikuri maxasiaTebl ebia: kal ibri -80mm, gasrol is maqsimal uri manZil i 7000 m, minimal uri – 650 m; raketis masa 11,6 kg; gamSvebi danadgaris ПУ mimmarTvel ebis raodenoba – 5, ПУ- s masa araumetes 150 kg, ПУ savel e mdgomareobidan sabrZol o mdgomareobaSi gadasvl is dro 8-10 wT.

78