TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное
образовательное учреждение высшего образования
«Национальный исследовательский Томский политехнический университет» (ТПУ)

Школа инженерная школа ядерных технологий
Направление подготовки 14.03.02 Ядерные физика и технологии
Отделение школы отделение ядерно-топливного цикла

БАКАЛАВРСКАЯ РАБОТА

Тема работы
Исследование сезонных зависимостей динамики гамма-фона приземной атмосферы

УДК 539.122.16:551.510

Студент

Группа	ФИО	Подпись	Дата
0А7А	Каштакова Ульяна Валерьевна		

Руководитель ВКР

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Доцент ОЯТЦ	Яковлева Валентина Станиславовна	д.т.н.		

Консультант

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Старший преподаватель	Побережников Андрей Дмитриевич	-		

КОНСУЛЬТАНТЫ ПО РАЗДЕЛАМ:

По разделу «Финансовый менеджмент, ресурсоэффективность и ресурсосбережение»

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Профессор ОСГН	Гасанов М.А.	д.э.н.		

По разделу «Социальная ответственность»

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Доцент ОЯТЦ	Передерин Ю.В.	к.т.н.		

ДОПУСТИТЬ К ЗАЩИТЕ:

Руководитель ООП	ФИО	Ученая степень, звание	Подпись	Дата
Доцент ОЯТЦ	Бычков П.Н.	к.т.н.		

Томск – 2021 г.

TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

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образовательное учреждение высшего образования
«Национальный исследовательский Томский политехнический университет» (ТПУ)

School School of Nuclear Science & Engineering
Field of training (specialty) 14.03.02 Nuclear Science and Technology
Department Nuclear Fuel Cycle Division

BACHELOR THESIS

Topic of research work
Investigation of seasonal dependences of the dynamics of the gamma background of the surface atmosphere

UDC 539.122.16:551.510

Student

Group	Full name	Signature	Date
0A7A	Kashtakova Ulyana Valerevna		

Scientific supervisor

Position	Full name	Academic degree, academic rank	Signature	Date
Professor of NFCF	Yakovleva Valentina Stanislavovna			

Consultant

Position	Full name	Academic degree, academic rank	Signature	Date
Senior lecturer of NFCF	Poberezhnikov Andrey Dmitrievich	-		

ASVISERS:

Section "Financial Management, Resource Efficiency and Resource Saving"

Position	Full name	Academic degree, academic rank	Signature	Date
Professor	Hasanov Maharram Ali oglu	PhD		

Section “Social Responsibility”

Position	Full name	Academic degree, academic rank	Signature	Date
Associate Professor	Perederin Yuri Vladimirovich	PhD		

ADMITTED TO DEFENSE:

Position	Full name	Academic degree, academic rank	Signature	Date
Associate Professor	Bychkov Petr Nikolaevich	PhD		

Tomsk – 2021

ПЛАНИРУЕМЫЕ РЕЗУЛЬТАТЫ ОСВОЕНИЯ ООП

Код компетенции	Наименование компетенции
Универсальные компетенции	
УК(У)-1	Способен осуществлять поиск, критический анализ и синтез информации, применять системный подход для решения поставленных задач
УК(У)-2	Способен определять круг задач в рамках поставленной цели и выбирать оптимальные способы их решения, исходя из действующих правовых норм, имеющихся ресурсов и ограничений
УК(У)-3	Способен осуществлять социальное взаимодействие и реализовывать свою роль в команде
УК(У)-4	Способен осуществлять деловую коммуникацию в устной и письменной формах на государственном и иностранном (-ых) языке
УК(У)-5	Способен воспринимать межкультурное разнообразие общества в социально-историческом, этическом и философском контекстах
УК(У)-6	Способен управлять своим временем, выстраивать и реализовывать траекторию саморазвития на основе принципов образования в течение всей жизни
УК(У)-7	Способен поддерживать должный уровень физической подготовленности для обеспечения полноценной социальной и профессиональной деятельности
УК(У)-8	Способен создавать и поддерживать безопасные условия жизнедеятельности, в том числе при возникновении чрезвычайных ситуаций
Общепрофессиональные компетенции	
ОПК(У)-1	способностью использовать основные законы естественнонаучных дисциплин в профессиональной деятельности, применять методы математического анализа и моделирования, теоретического и экспериментального исследования
ОПК(У)-2	способностью понимать сущность и значение информации в развитии современного информационного общества, сознавать опасности и угрозы, возникающие в этом процессе, соблюдать основные требования информационной безопасности, в том числе защиты государственной тайны
ОПК(У)-3	владением основными методами защиты производственного персонала и населения от возможных последствий аварий, катастроф, стихийных бедствий
Профессиональные компетенции	
ПК(У)-1	способностью использовать научно-техническую информацию, отечественный и зарубежный опыт по тематике исследования, современные компьютерные технологии и информационные ресурсы в своей предметной области
ПК(У)-2	способностью проводить математическое моделирование процессов и объектов на базе стандартных пакетов автоматизированного проектирования и исследований
ПК(У)-3	готовностью к проведению физических экспериментов по заданной методике, составлению описания проводимых исследований и анализу результатов

ПК(У)-4	способностью использовать технические средства для измерения основных параметров объектов исследования, к подготовке данных для составления обзоров, отчетов и научных публикаций
ПК(У)-5	готовностью к составлению отчета по выполненному заданию, к участию во внедрении результатов исследований и разработок
ПК(У)-6	способностью использовать информационные технологии при разработке новых установок, материалов и приборов, к сбору и анализу исходных данных для проектирования приборов и установок
ПК(У)-7	способностью к расчету и проектированию деталей и узлов приборов и установок в соответствии с техническим заданием с использованием стандартных средств автоматизации проектирования
ПК(У)-8	готовностью к разработке проектной и рабочей технической документации, оформлению законченных проектно-конструкторских работ
ПК(У)-9	способностью к контролю соответствия разрабатываемых проектов и технической документации стандартам, техническим условиям, требованиям безопасности и другим нормативным документам
ПК(У)-10	готовностью к проведению предварительного технико-экономического обоснования проектных решений при разработке установок и приборов
ПК(У)-12	способностью к контролю за соблюдением технологической дисциплины и обслуживанию технологического оборудования
ПК(У)-13	способностью к организации метрологического обеспечения технологических процессов, к использованию типовых методов контроля качества выпускаемой продукции
ПК(У)-14	готовностью к эксплуатации современного физического оборудования и приборов, к освоению технологических процессов в ходе подготовки производства новых материалов, приборов, установок и систем
ПК(У)-15	способностью к монтажу, наладке, настройке, регулировке, испытанию и сдаче в эксплуатацию оборудования и программных средств
ПК(У)-17	способностью к оценке ядерной и радиационной безопасности, к оценке воздействия на окружающую среду, к контролю за соблюдением экологической безопасности, техники безопасности, норм и правил производственной санитарии, пожарной, радиационной и ядерной безопасности, норм охраны труда
ПК(У)-18	готовностью разрабатывать способы применения ядерно-энергетических, плазменных, лазерных, сверхвысокочастотных и мощных импульсных установок, электронных, нейтронных и протонных пучков, методов экспериментальной физики в решении технических, технологических и медицинских проблем
ПК(У)-20	способностью к составлению технической документации (графиков работ, инструкций, планов, смет, заявок на материалы, оборудование), а также установленной отчетности по утвержденным формам

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Министерство науки и высшего образования Российской Федерации
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«Национальный исследовательский Томский политехнический университет» (ТПУ)

Школа инженерная школа ядерных технологий
Направление подготовки 14.03.02 Ядерные физика и технологии
Отделение школы отделение ядерно-топливного цикла

УТВЕРЖДАЮ:
Руководитель ООП
Бычков П.Н.
(Подпись) (Дата) (Ф.И.О.)

ЗАДАНИЕ
на выполнение выпускной квалификационной работы

В форме:

бакалаврской работы

Студенту:

Группа	ФИО
0А7А	Каштакова Ульяна Валерьевна

Тема работы:

Исследование сезонных зависимостей динамики гамма-фона приземной атмосферы	
Утверждена приказом директора (дата, номер)	28.04.2021 г., №118-33/с

Срок сдачи студентом выполненной работы:	09.06.2021

ТЕХНИЧЕСКОЕ ЗАДАНИЕ:

Исходные данные к работе	Экспериментальные данные по гамма-фону приземной атмосферы, экспериментальные данные по метеорологическим величинам.

Перечень подлежащих исследованию, проектированию и разработке вопросов	- обзор литературных источников; - методы и приборы измерения гамма-фона в приземной атмосфере; - суточные и сезонные особенности в динамике гамма-фона; - корреляционный и регрессионный анализ радиационных и метеорологических величин; - анализ полученных результатов; - финансовый менеджмент, ресурсоэффективность и ресурсосбережение; - социальная ответственность; - заключение по работе.
Перечень графического материала	Презентация для защиты ВКР

Консультанты по разделам выпускной квалификационной работы

Раздел	Консультант
Финансовый менеджмент, ресурсоэффективность и ресурсосбережение	Гасанов М.А.
Социальная ответственность	Передерин Ю.В.

Дата выдачи задания на выполнение выпускной квалификационной работы по линейному графику	26.04.2021

Задание выдал руководитель:

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Профессор ОЯТЦ	Яковлева Валентина Станиславовна	д.т.н		
Старший преподаватель ОЯТЦ	Побережников Андрей Дмитриевич	-		

Задание принял к исполнению студент:

Группа	ФИО	Подпись	Дата
0А7А	Каштакова Ульяна Валерьевна		

TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

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образовательное учреждение высшего образования
«Национальный исследовательский Томский политехнический университет» (ТПУ)

School School of Nuclear Science & Engineering
Field of training (specialty) 14.03.02 Nuclear Science and Technology
Department Nuclear Fuel Cycle Division

APPROVED BY:
Programme Director
Bychkov P.N.
«____» _____ 2021

ASSIGNMENT

for the Graduation Thesis completion

In the form:

Bachelor Thesis

For a student:

Group	**Full name**
0A7A	Kashtakova Ulyana Valerevna

Topic of research work:

Investigation of seasonal dependences of the dynamics of the gamma background of the surface atmosphere	
Approved by the order of the Director of School of Nuclear Science & Engineering (date, number):	28.04.2021 г., №118-33/с

Deadline for completion of Bachelor Thesis:	09.06.2021

TERMS OF REFERENCE:

Initial date for research work	Experimental data on the gamma background of the surface atmosphere, experimental data on meteorological values.

List of the issues to be investigated, designed and developed	- review of literature sources; - methods and instruments for measuring gamma background in the surface atmosphere; - diurnal and seasonal features in the dynamics of the gamma background; - correlation and regression analysis of radiation and meteorological quantities; - analysis of the results; - financial management, resource efficiency and resource conservation; - social responsibility; - conclusion.
List of graphic material	Presentation for the defense of the FQP

Advisors to the sections of the Bachelor Thesis

Section	Advisor
Financial management, resource efficiency and resource saving	M.A. Gasanov
Social responsibility	Yu. V. Perederin

Date of issuance of the assignment for Bachelor Thesis completion according to the schedule	26.04.2021

Assignment issued by a scientific supervisor / advisor (if any):

Position	Full name	Academic degree, academic status	Signature	Date
Professor of NFCF	Yakovleva Valentina Stanislavovna	DSc		
Senior lecturer of NFCF	Poberezhnikov Andrey Dmitrievich	-		

Assignment accepted for execution by a student:

Group	Full name	Signature	Date
0A7A	Kashtakova Ulyana Valerevna		

ЗАДАНИЕ ДЛЯ РАЗДЕЛА
«ФИНАНСОВЫЙ МЕНЕДЖМЕНТ, РЕСУРСОЭФФЕКТИВНОСТЬ И РЕСУРСОСБЕРЕЖЕНИЕ»

Студенту:

Группа	ФИО
0А7А	Каштакова Ульяна Валерьевна

Школа	ИЯТШ	**Отделение школы (НОЦ)**	ОЯТЦ
Уровень образования	Бакалавриат	**Направление/специальность**	14.03.02 Ядерные физика и технологии

Исходные данные к разделу «Финансовый менеджмент, ресурсоэффективность и ресурсосбережение»:	
1. Стоимость ресурсов научного исследования (НИ): материально-технических, энергетических, финансовых, информационных и человеческих	*Затраты на специальное оборудование 3025 руб.* *Заработная плата исполнителей 274036 руб.* *Отчисления во внебюджетные фонды 32883 руб.* *Накладные расходы 92076 руб.* *Прочие прямые затраты 348 руб.*
2. Нормы и нормативы расходования ресурсов	*Районный коэффициент города Томска – 1,3*
3. Используемая система налогообложения, ставки налогов, отчислений, дисконтирования и Кредитования	*Размер отчислений во внебюджетные фонды – 30,2 %*
Перечень вопросов, подлежащих исследованию, проектированию и разработке:	
1. Оценка коммерческого и инновационного потенциала НТИ	*Оценочная карта конкурентных технических решений. SWOT-анализ.*
2. Планирование процесса управления НТИ: структура и график проведения, бюджет, риски и организация закупок	*Составление календарного плана проекта.* *Определение бюджета НТИ.*
3. Определение ресурсной, финансовой, экономической эффективности	*Интегральный финансовый показатель.* *Интегральный показатель ресурсоэффективности.* *Интегральный показатель эффективности.*
Перечень графического материала *(с точным указанием обязательных чертежей):*	
1. Оценка конкурентоспособности технических решений *2. Матрица SWOT* *3. График проведения НТИ* *4. Бюджет НТИ* *5. Оценка ресурсной, финансовой и экономической эффективности НТИ*	

Дата выдачи задания для раздела по линейному графику	

Задание выдал консультант:

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Профессор ОСГН	Гасанов М.А.	д.э.н.		

Задание принял к исполнению студент:

Группа	ФИО	Подпись	Дата
0А7А	Каштакова Ульяна Валерьевна		

TASK FOR SECTION
«FINANCIAL MANAGEMENT, RESOURCE EFFICIENCY AND RESOURCE SAVING»

To the student:

Group	Full name
0A7A	Kashtakova Ulyana Valerievna

School	Nuclear Science and Engineering	**Division**	Nuclear Fuel Cycle
Degree	Bachelor	**Educational Program**	Nuclear physics and technologies

Input data to the section «Financial management, resource efficiency and resource saving»:	
1. *Resource cost of scientific and technical research (STR): material and technical, energetic, financial and human*	*Special equipment costs 3025 rub.* *Basic salary of STR performers 274036 rub.* *Additional salary for theme performers 32883 rub.* *Contributions to extrabudgetary funds 92690 rub.* *Overhead costs 92076 rub.* *Other direct costs 348 rub.*
2. *Expenditure rates and expenditure standards for resources*	*Regional coefficient of the city of Tomsk -1,3*
3. *Current tax system, tax rates, charges rates, discounting rates and interest rates*	*Amount of contributions to extrabudgetary funds – 30%.*
The list of subjects to study, design and develop:	
1. *Assessment of commercial and innovative potential of STR*	*Competitive technical solutions scorecard*
2. *Scheduling of STR management process: structure and timeline, budget, risk management and organization of purchases*	*Creation of the time schedule of the project. Calculation of STR budget.*
3. *Determination of resource, financial, economic efficiency*	*Assessing the economic efficiency of using all three types of visualization to control the effectiveness of the method*
A list of graphic material *(with list of mandatory blueprints):*	
1. *"Portrait" of the consumer of STR results* 2. *Assessment of the competitiveness of technical solutions* 3. *SWOT Matrix* 4. *Schedule and budget of STR* 5. *Assessment of resource, financial and economic efficiency of STR*	

Date of issue of the task for the section according to the schedule	

Task issued by adviser:

Position	Full name	Scientific degree, rank	Signature	Date
Professor	M.A. Gasanov	DSc		

The task was accepted by the student:

Group	Full name	Signature	Date
0A7A	Kashtakova Ulyana Valerievna		

ЗАДАНИЕ ДЛЯ РАЗДЕЛА
«СОЦИАЛЬНАЯ ОТВЕТСТВЕННОСТЬ»

Студенту:

Группа	ФИО
0А7А	Каштакова Ульяна Валерьевна

Институт	ИЯТШ	**Отделение (НОЦ)**	ОЯТЦ
Уровень образования	Бакалавриат	**Направление/специальность**	14.03.02 Ядерные физика и технологии

Тема ВКР:

Исследование сезонных зависимостей динамики гамма-фона приземной атмосферы	
Исходные данные к разделу «Социальная ответственность»:	
1. Характеристика объекта исследования (вещество, материал, прибор, алгоритм, методика, рабочая зона) и области его применения	Объектом исследования является радиационный гамма-фон приземной атмосферы
Перечень вопросов, подлежащих исследованию, проектированию и разработке:	
1. Правовые и организационные вопросы обеспечения безопасности	Трудовой кодекс Российской Федерации от 30.12.2001 № 197-ФЗ (ред. от 30.04.2021).
2. Производственная безопасность: – Анализ выявленных вредных и опасных факторов – Обоснование мероприятий по снижению воздействия	Вредные и опасные факторы: – параметры микроклимата; – повышенный уровень ионизирующих излучений; – вредные вещества; – вентиляция; – шум; – недостаток естественного и искусственного освещения; – электрический ток; – электромагнитные поля; – пожароопасность.
3. Безопасность в чрезвычайных ситуациях	– падение с высоты собственного роста; – удар электрическим током; – пожар.

Дата выдачи задания для раздела по линейному графику	

Задание выдал консультант:

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Доцент ОЯТЦ	Передерин Ю.В.	к.т.н.		

Задание принял к исполнению студент:

Группа	ФИО	Подпись	Дата
0А7А	Каштакова Ульяна Валерьевна		

Task for section
«Social responsibility»

To student:

Group	Full name
0A7A	Kashtakova Ulyana Valerievna

School	Nuclear Science and Engineering	**Division**	Nuclear Fuel Cycle
Degree	Bachelor	**Educational Program**	14.03.02 Nuclear physics and technologies/ Radiation safety of humans and the environment

Topic of research work:

Investigation of seasonal dependences of the dynamics of the gamma background of the surface atmosphere	
Initial data for section «Social Responsibility»:	
1. Information about object of investigation (matter, material, device, algorithm, procedure, workplace) and area of its application	Measurement of the radiation background of the surface atmosphere and carrying out various types of analysis.
List of items to be investigated and to be developed:	
1. Legal and organizational issues to provide safety: - Special (specific for operation of objects of investigation, designed workplace) legal rules of labor legislation; - Organizational activities for layout of workplace.	- GOST 12.2.032-78 SSBT. Workplace when performing work while sitting. General ergonomic requirements; - GOST R 50923-96. Displays. Operator's workplace. General ergonomic and working environment requirements. Measurement methods; - PND F 12.13.1-03. Guidelines. Safety precautions when working in analytical laboratories (general provisions).
2. Work Safety: 2.1.Analysis of identified harmful and dangerous factors 2.2.Justification of measures to reduce probability of harmful and dangerous factors	– deviation of microclimate parameters; – increased noise level; – increased vibration level; – insufficient light – electromagnetic fields; – psychophysiological stress; – electric current.
3. Ecological safety:	– environmental impact of research;
4. Safety in emergency situations:	- selection and description of a typical emergency - fire in the working room; - preventive measures and procedures in case of emergency.

Assignment date for section according to schedule	

The task was issued by consultant:

Position	Full name	Scientific degree, rank	Signature	Date
Assistant professor	Yu. V. Perederin	Cand.of Sc.		

The task was accepted by the student:

Group	Full name	Signature	Date
0A7A	Kashtakova Ulyana Valerievna		

TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное
образовательное учреждение высшего образования
«Национальный исследовательский Томский политехнический университет» (ТПУ)

Школа инженерная школа ядерных технологий
Направление подготовки 14.03.02 Ядерные физика и технологии
Уровень образования бакалавриат
Отделение школы отделение ядерно-топливного цикла
Период выполнения весенний семестр 2020 /2021 учебного года

Форма представления работы:

бакалаврская работа

КАЛЕНДАРНЫЙ РЕЙТИНГ-ПЛАН
выполнения выпускной квалификационной работы

Срок сдачи студентом выполненной работы:	09.06.2021

Дата контроля	Название раздела (модуля) / вид работы (исследования)	Максимальный балл раздела (модуля)
14.02.2021	Формирование целей и задач ВКР, задания на ВКР, плана-графика выполнения ВКР и титульного листа;	10
28.02.2021	Обзор литературных источников;	10
14.03.2021	Обьекты и методы исследования;	10
31.03.2021	Выявление суточных и сезонных особенностей в динамике гамма-фона приземной атмосферы;	10
21.04.2021	Корреляционный и регрессионный анализ радиационных и метеорологических величин;	10
04.05.2021	Финансовый менеджмент, ресурсоэффективность и ресурсосбережение;	15
11.05.2021	Социальная ответственность;	15
18.05.2021	Заключение по работе	10
10.06.2021	Представление итогового варианта пояснительной записки к ВКР	10

СОСТАВИЛ:
Руководитель ВКР

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Профессор ОЯТЦ	Яковлева В.С.	д.т.н.		

СОГЛАСОВАНО:
Руководитель ООП

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Доцент ОЯТЦ	Бычков П.Н.	к.т.н.		

TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Министерство науки и высшего образования Российской Федерации
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«Национальный исследовательский Томский политехнический университет» (ТПУ)

School School of Nuclear Science and Engineering
Field of training (specialty) 14.03.02 Nuclear Physics and Technology
Level of education Bachelor degree programme
Department Nuclear Fuel Cycle Division
Period of completion spring semester 2020/2021 academic year

Form of presenting the work:

Bachelor Thesis

SCHEDULED ASSESSMENT CALENDAR
for the Bachelor Thesis completion

Deadline for completion of Bachelor's Graduation Thesis:	09.06.2021

Assessment date	**Title of section (module) / type of work (research)**	**Maximum score for the section (module)**
14.02.2021	Formation of the goals and objectives of the FQP, assignments for the FQP, the schedule for the implementation of the FQP and the title page;	10
28.02.2021	Review of literary sources;	10
14.03.2021	Objects and research methods;	10
31.03.2021	Revealing diurnal and seasonal features in the dynamics of the gamma background of the surface atmosphere;	10
21.04.2021	Correlation and regression analysis of radiation and meteorological quantities;	10
04.05.2021	Financial management, resource efficiency and resource conservation;	15
11.05.2021	Social responsibility;	15
18.05.2021	Conclusion on work	10
10.06.2021	Presentation of the final version of the explanatory FQP Notes	10

COMPILED BY:
Scientific supervisor:

Position	Full name	Academic degree, academic status	Signature	Date
Professor of NFCF	V.S. Yakovleva	Professor, PhD		

AGREED BY:

Programme Director	Full name	Academic degree, academic status	Signature	Date
Associate Professor of NFCF	P.N. Bychkov	PhD		

Abstract

Final qualifying work 76 p., 21 figures, 25 tables, 15 sources, 1 app.

Key words: gamma background, surface atmosphere, dynamics, precipitation, meteorological parameters, regression analysis, correlation analysis.

The object of the study is the gamma background of the surface atmosphere of the city of Tomsk.

The objective of this work is to study the seasonal features of the gamma background of the surface atmosphere.

In the course of the research, the software code was developed in the MATLAB package for visualizing the dynamics of the gamma background, precipitation intensity and meteorological parameters. Also, a correlation and regression relationship was carried out between the gamma background and parameters.

The result of the study is the regression dependences of the gamma background and meteorological values with the corresponding regression and correlation coefficients.

Implementation degree: high, the project can be used at the present time and to continue research.

Applications: atmospheric physics, geophysics, radiation ecology.

Economic efficiency / value of work is high.

In the future, it is planned: the obtained results will be used in the creation of a new or improvement of the technology of radiation monitoring of the urban environment, which will allow obtaining new data on the structure and dynamics of the fields of ionizing radiation in the surface atmosphere, revealing the features and patterns in their behavior, as well as the relationship with the meteorological processes of daily and synoptic scales.

Definitions

Ionizing radiation is a flow of elementary particles, quanta or waves of electromagnetic energy, which directly or indirectly causes the formation of electric charges when interacting with matter.

Gamma radiation (γ-radiation) - electromagnetic radiation, radiation dose (absorbed dose) - the energy of ionizing radiation absorbed by the irradiated object and calculated per unit mass of this object.

Background radiation - radioactive radiation present on the Earth from natural and man-made sources, in the conditions of which a person is constantly present.

Table of Contents

Introduction

The entire population of the planet and all living nature as a whole are exposed to the radiation background. The radiation background is considered to be radioactive radiation, which is formed by three components, namely: radiation of technogenic or artificial radionuclides, cosmic radiation and radiation of natural radionuclides scattered in the earth's crust, air or other objects of the environment.

Monitoring of the background radiation is carried out constantly, not only because its effect on humans and the environment can be negative and even dangerous, but also because it can be used to predict various atmospheric and geological processes, and the indicators are the radioactive substances themselves in the soil or in the atmosphere.

The objective of this work is to study the seasonal dependences of the dynamics of the gamma background of the surface atmosphere.

Tasks:

- Review of the literature on the research topic;
- Study of the meteorological situation in the city of Tomsk from 2011 to 2020, to find the most appropriate time period for analysis;
- Development of software code in MatLab software for data visualization and analysis;
- Revealing the relationships between the values of the ambient dose equivalent rate of gamma radiation and meteorological values;
- Analysis of the obtained results.

1 Literature review

1.1 Features of the radiation gamma background of the surface atmosphere

Monitoring the background radiation is widely used as an early warning of nuclear emergencies, since air is the fastest "transporter" of radionuclides. In the event of an emergency, the radioactivity in the air will be higher than the natural background - this will happen due to radon, which will be released into the air from thorium-232 and uranium-238. However, the measurement of the radioactive background for timely detection and prevention is a rather difficult task, since the concentration of radioactivity has low values [1].

A large number of scientific studies have shown that some meteorological parameters and factors can significantly affect the change in the ambient dose equivalent rate. For example, air temperature, relative humidity, absolute pressure, wind speed, earthquake, etc. [1]:

The intensity of radiation has a maximum value at a pressure of 750-760 mm Hg. and minimum at 740 and 770 mm Hg.;

The main drop in the intensity of the radiation background falls on 75-90% of the relative air humidity and does not change within 55-75% and 95-100%;

The highest background values are achieved at a wind speed of 4 to 12 m / s, while calm and storms lead to low background radiation values.

Also, according to [2], it is believed that the gamma background changes in direct proportion to the air temperature and inversely proportional to the relative humidity and absolute pressure. However, deeper and more detailed studies have shown that at different times of the year the intensity of the gamma background increases with an increase in a certain meteorological parameter, then it practically does not correlate with it. Therefore, the study of the influence of the relationship between gamma background and meteorological parameters requires a longer and more thorough study.

The relationship between the gamma background and the intensity of precipitation was discovered by a group of researchers from the Polar Geophysical Institute of the KSC RAS, who studied the increase in the gamma background of the surface atmosphere during precipitation in Apatity and Svalbard. Having obtained the energy spectra of gamma radiation in good weather and during precipitation, it turned out that they lack the spectral lines characteristic of atmospheric radionuclides. Therefore, the main reason for the "bursts" of gamma background during precipitation is considered to be the bremsstrahlung X-ray radiation of energetic electrons, which are accelerated by electric fields inside rain clouds. [2].

Measurement of radionuclide concentrations is usually carried out in the field with further laboratory analysis. Not every device is capable of satisfying all research goals and measuring specific necessary parameters, therefore the choice of devices requires an assessment of the geographical location and certain conditions and radionuclide parameters: devices must be compatible with the intended application, comply with environmental and geographical parameters and be reliable and stable. Companies producing devices, always provide information about the performance characteristics, limitations and capabilities of the product. [1].

1.2 Regression and correlation analysis

To identify the relationship between the gamma background of the surface atmosphere and meteorological parameters, it is necessary to conduct a regression and correlation analysis between them.

Regression analysis describes how the independent variable is numerically related to the dependent variable and shows the effect of changing one in a known variable on the estimated variable.

Assuming that the relationship between the variables is linear, the regression model takes the form:

$$y = \beta_0 + \beta_1 x$$

Parameters β_0, β_1 are called regression coefficients.

Correlation analysis shows the relationship of two variables.

Variables are called correlated if a single change in one variable is reacted by a change in another variable. If the variables are uncorrelated, then the movement in one variable is not equivalent to the movement of another variable in a certain direction.

Correlation analysis is defined by the correlation coefficient, which shows the degree to which two variables move together. Correlation is weak if the correlation coefficient is in the range from 0 to 0.5, and strong from 0.7 and above [4].

1.3 Chapter Conclusions

This chapter reviewed the literature on the research topic.Determination of the relationship between the gamma background and meteorological parameters has been studied for a long time and requires further careful study, since the gamma background is not a constant value and depends on many factors, for example, geographic location.

2 Objects and research methods

2.1. Radiation detectors

A portable germanium detector or gamma ray spectrometer is used to assess the concentration of gamma radionuclides in the field. A calibrated detector measures the flux density of primary photons at a specific energy specific to a specific radionuclide. Further, the energy density indicator is converted into concentration units, and under certain conditions, the energy density indicator can be dosed. Since the indicator of energy density is a directly measurable physical quantity, it should be considered the main parameter for assessing the level of ionizing radiation [3].

The specific capabilities of a radiation detector will determine its potential application for a particular type of survey.

Based on the material and application, the detectors are divided into several classes.:

- Gas-filled detectors;
- Scintillation detectors;
- Solid state detectors;
- Passive-integrating detectors.

2.2 Tomsk Observatory of Radioactivity and Ionizing Radiation

The Tomsk Observatory of Radioactivity and Ionizing Radiation (TORIR) was established to monitor radiation fields. It includes two experimental sites located on the territory of IMCES SB RAS and a dosimetry laboratory located in building 10 of TPU.

Monitoring of the characteristics of ionizing fields (alpha, beta and gamma radiation) is carried out at heights of 10 cm, 1, 5, 10, 25, 30 and 35 m in the surface layer of the atmosphere and at depths of 10, 20, 50 cm, 1 and 5 m in the ground (Figure 2).

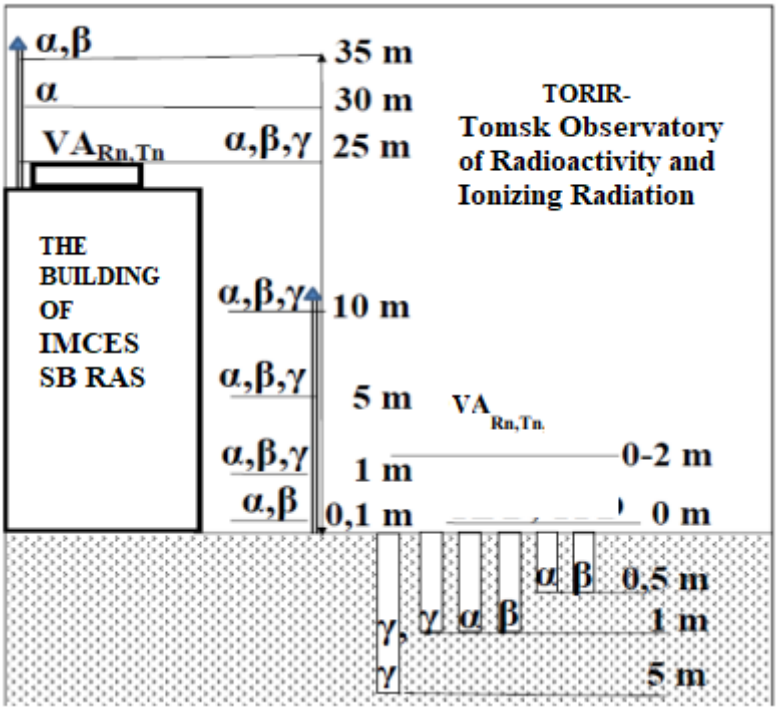

Figure 2. - Diagram of an algorithm for monitoring the structure and dynamics of fields of ionizing radiation and natural radioactivity in the surface atmosphere and surface layer of the soil

The research complex includes a laboratory stand "ATRad", which consists of a meteorological mast 10 m high and attached gas-discharge counters of beta and gamma radiation and scintillation detectors of ionizing radiation.

Each counter that detects beta and gamma radiation has the same type, covered with aluminum and plastic cases, a counter that detects only gamma radiation. This makes it possible to isolate the "pure" beta background, since the pulse count rates between paired counters at the same height are different.

Gas-discharge counters of gamma and hard beta radiation STS-6 and SBM-19, high-sensitivity scintillation intelligent detecting units BDPB-01, BDPA-01 at altitudes of 10 cm, 1, are used at the experimental sites for monitoring the flux density of beta and gamma radiation. 5, 25, 30 and 35 m and at depths of 0.1; 0.2; 0.5 and 1 m, high-sensitivity scintillation units for detecting gamma radiation BDKG-03.

Along with monitoring the fields of ionizing radiation, monitoring of meteorological parameters is carried out: air temperature of the surface layer of the

atmosphere, absolute pressure, relative humidity, wind direction and speed.

Measurements of the main meteorological parameters and characteristics of turbulence with a cycle of 1 minute are carried out using the ultrasonic meteorological station AMK-3, which is a new generation of meteorological instruments (developed by IMCES SB RAS). The incoming solar radiation is measured with a Kipp & Zonen CM-11 pyranometer and a NILU-UV-6T photometer.

The measuring meteorological booth is located at a height of 25 m; two SBM-19 detectors are installed inside, one of which is placed in an aluminum and plastic casing. BNV-30 power supply and VEKTOR standard power supply provide high-voltage power supply to the detectors.

2.3 Chapter Conclusions

The radiation background (alpha, beta and gamma radiation) is measured at the Tomsk Observatory of Radioactivity and Ionizing Radiation using gas-discharge counters of the STS-6 and SBM-19 type and scintillation detectors of the BDKG-03, BDPB-01, BDPB-01 types.

3 Study of the dynamics of the radiation background of the near-ground atmosphere

3.1 Analysis of interannual features of precipitation

To study the seasonal dependences of the gamma background of the surface atmosphere, it was necessary to choose the year with the least amount of liquid atmospheric precipitation. This is due to the fact that precipitation strongly affects the dynamics of the gamma background, causing sharp bursts up to 2.5-3 times, which interferes with the conduct of regression and correlation analysis to identify the relationship with meteorological values.

An array of data was obtained from the site rp5.ru, which represented the values of air temperature (ºC), atmospheric pressure (mm Hg), relative humidity (%), wind speed (m / s), precipitation (mm) from May to September 2011-2020.

Below is the dynamics of precipitation for the selected time period.

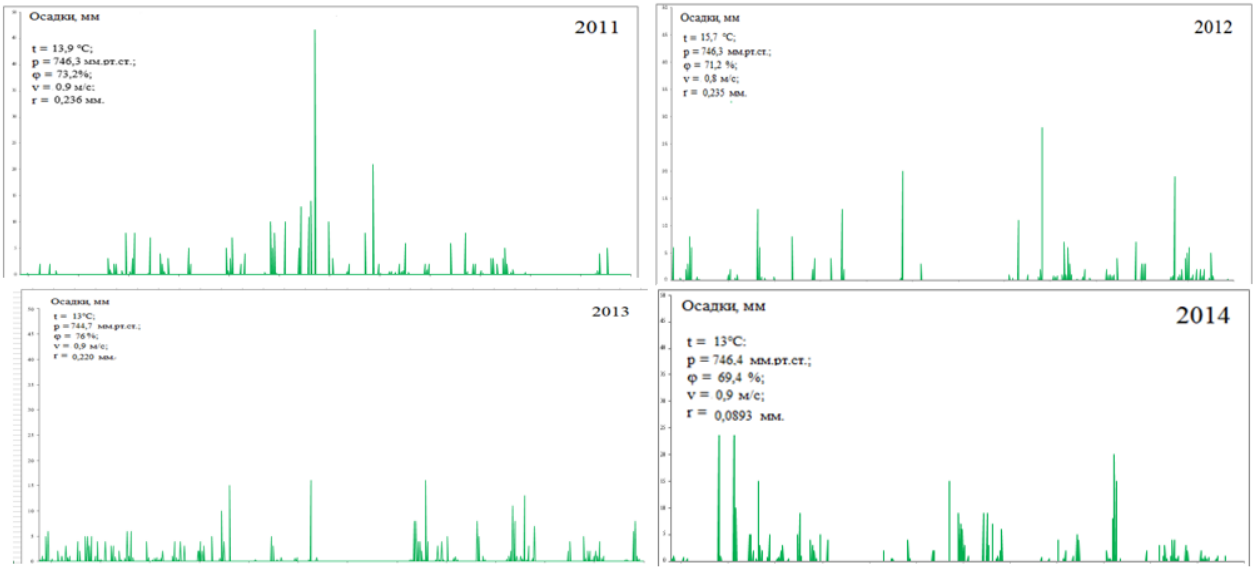

Figure 3.1 - Dynamics of precipitation intensity for 2011-2014

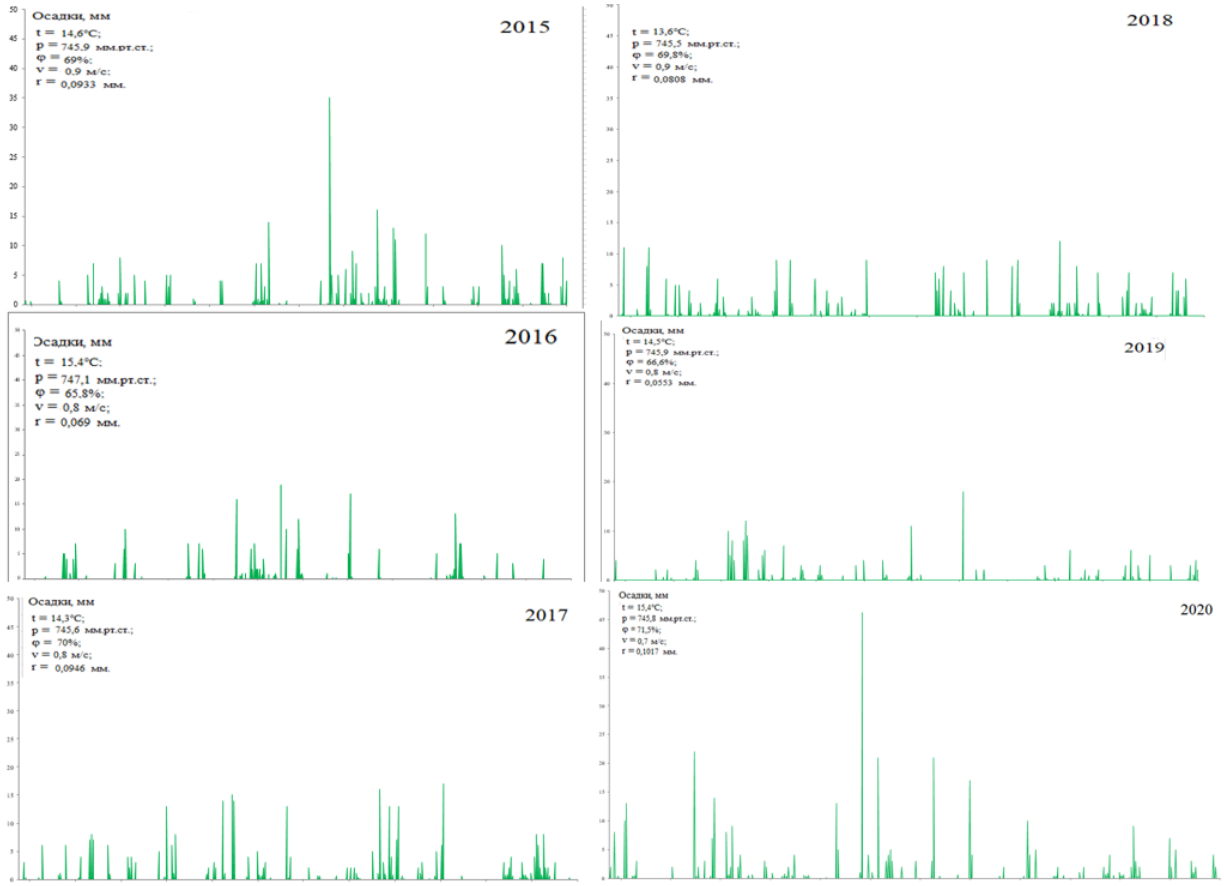

Figure 3.2 - Dynamics of precipitation intensity for 2015-2020

According to the dynamics of the total amount of liquid precipitation in Figure 3.2, it can be seen that the year with the least precipitation is 2019, therefore this year was chosen for further analysis.

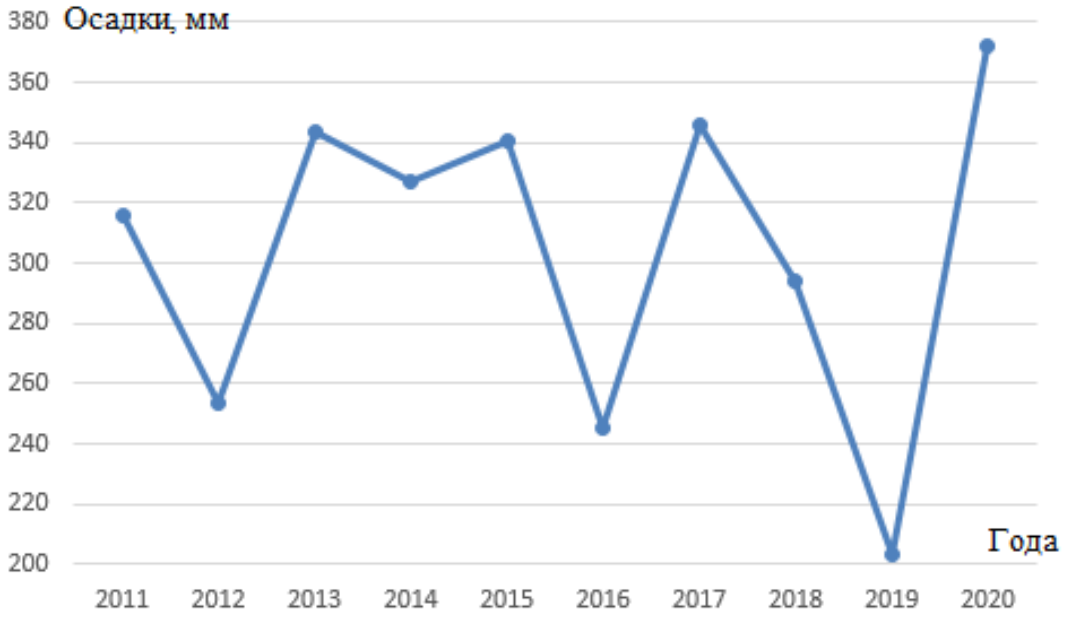

Figure 3.3 - The amount of liquid precipitation by years

3.2 Study of the influence of meteorological parameters on the gamma background of the surface atmosphere in the warm season of the year

Gamma background data for the warm period of 2019 were obtained in μSv / h. To visualize the dynamics of precipitation intensity, gamma background and meteorological values, a simple code was developed in MATLAB software.

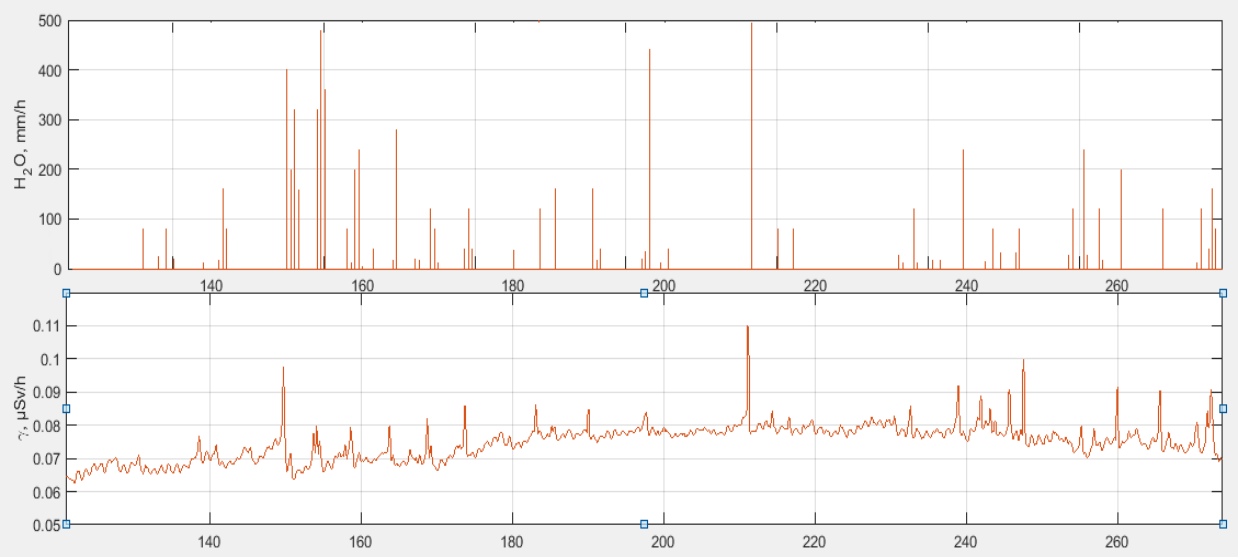

Figure 3.4 - Dynamics of precipitation intensity and gamma background taking into account precipitation from May to September 2019

The dynamics in Figure 3.4 visually shows that the bursts of the intensity of liquid precipitation coincide with bursts of the gamma background. In order for the outbursts not to interfere with further analysis, the days on which precipitation was observed were manually removed from the data set.

Further, the dynamics of the gamma background and meteorological parameters were constructed with and without precipitation..

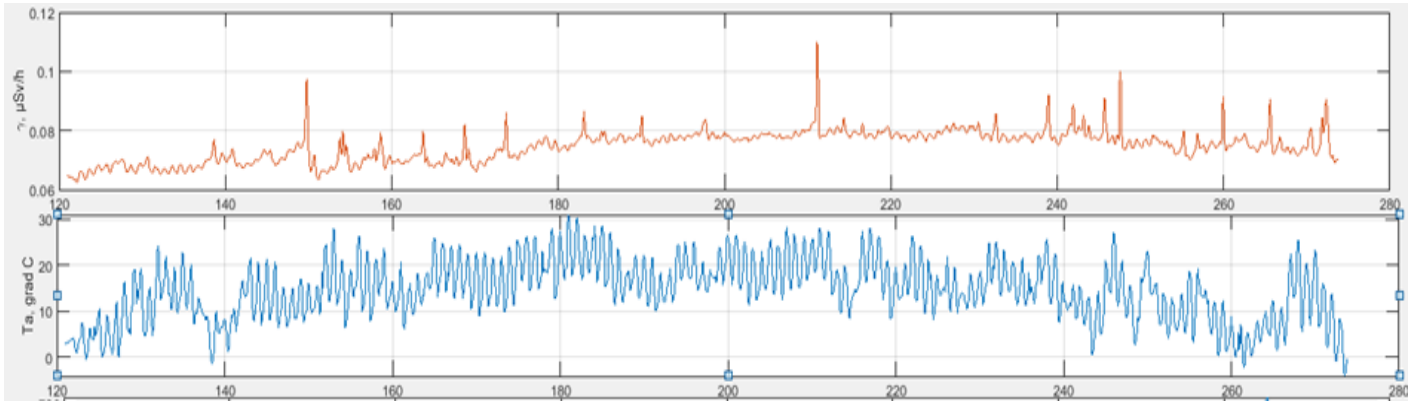

Figure 3.5 - Dynamics of gamma background and temperature taking into account precipitation

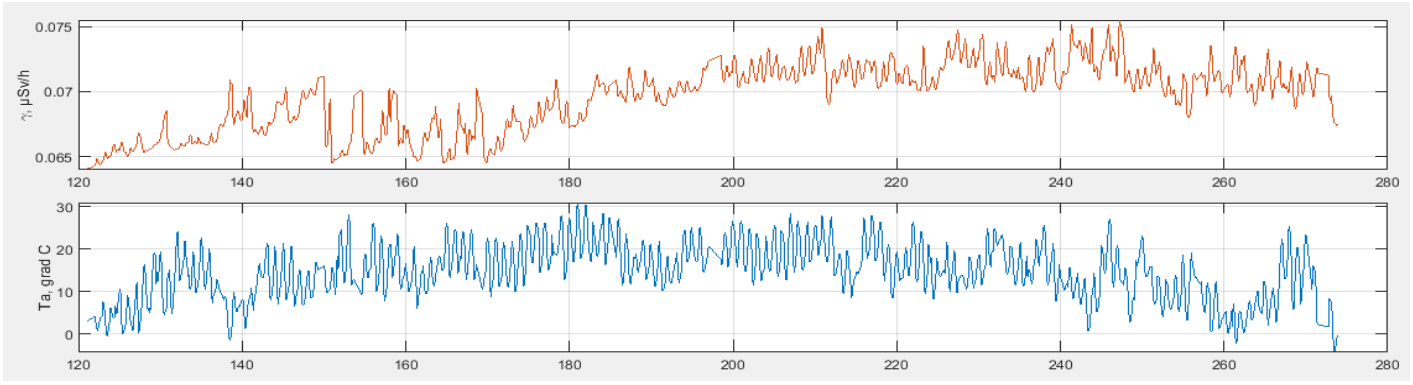

Figure 3.6 - Dynamics of gamma background and temperature without taking into account precipitation

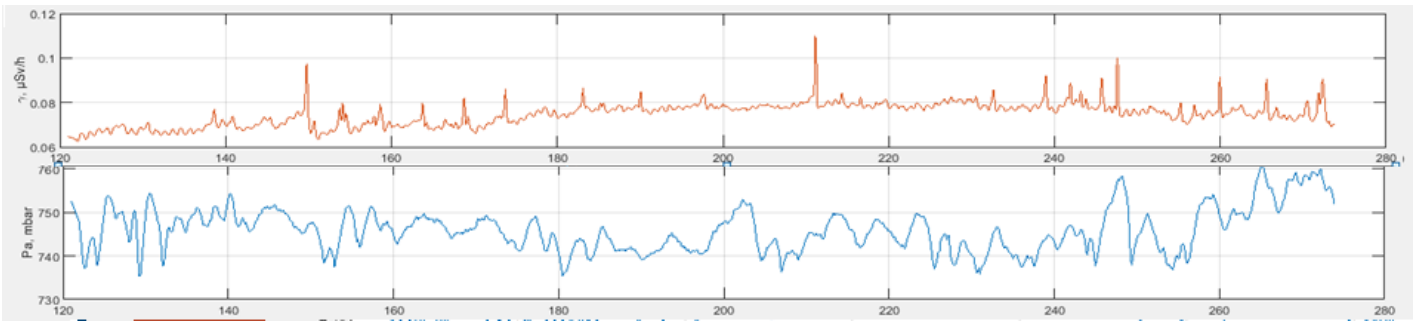

Figure 3.7 - Dynamics of gamma background and pressure taking into account precipitation

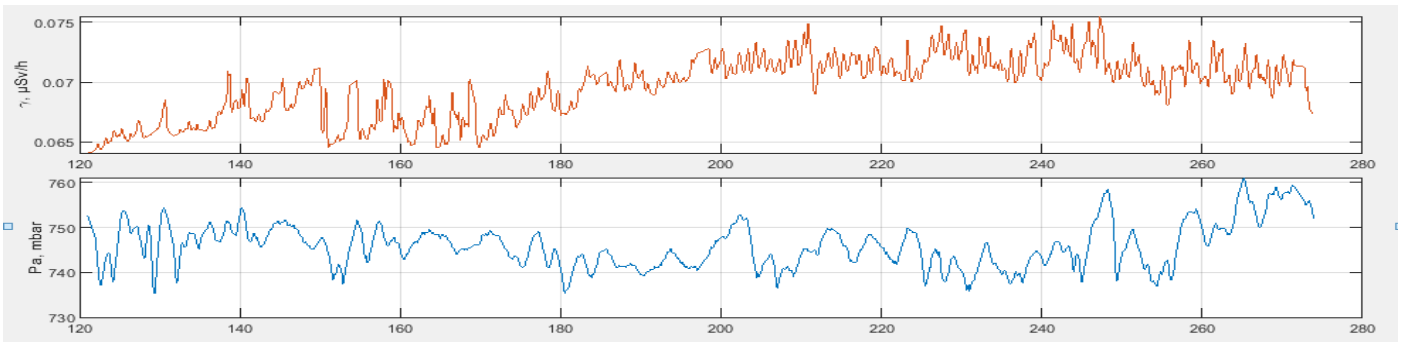

Figure 3.8 - Dynamics of gamma background and pressure without taking into account precipitation

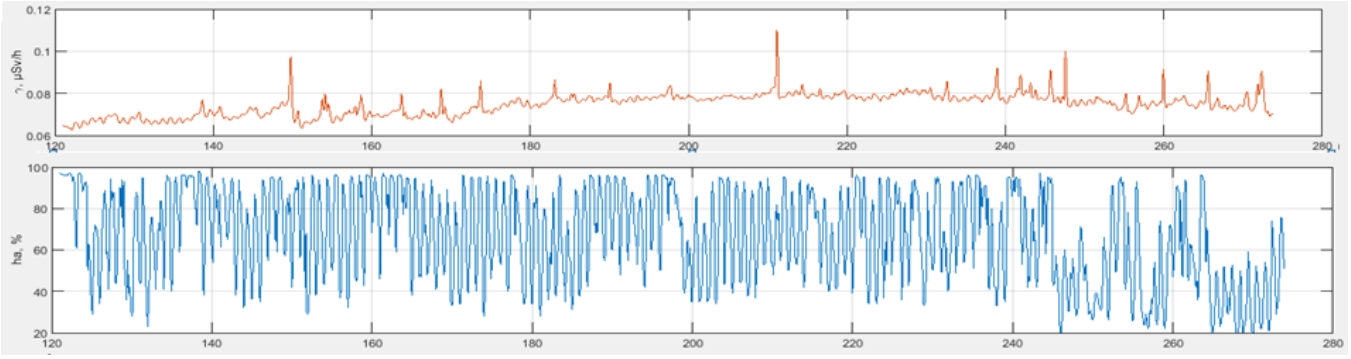

Figure 3.9 - Dynamics of gamma background and humidity, taking into account precipitation

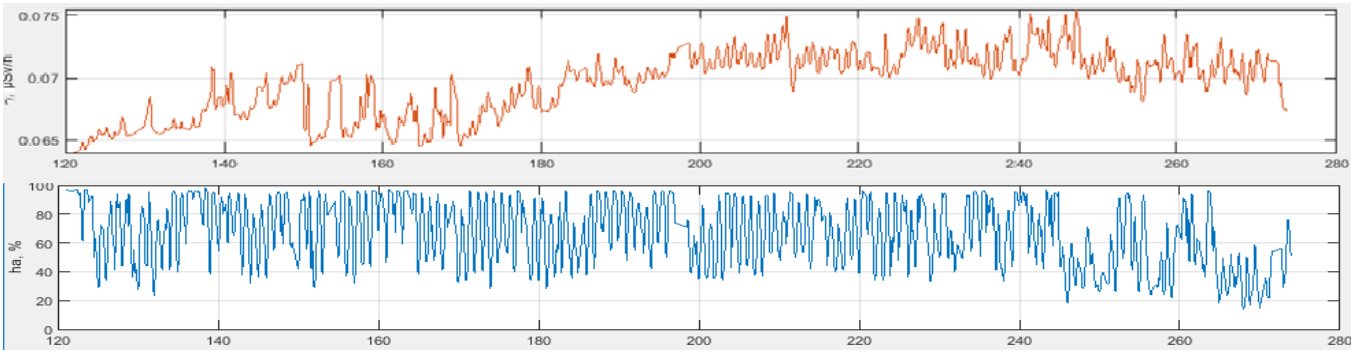

Figure 3.10 - Dynamics of gamma background and humidity without taking into account precipitation

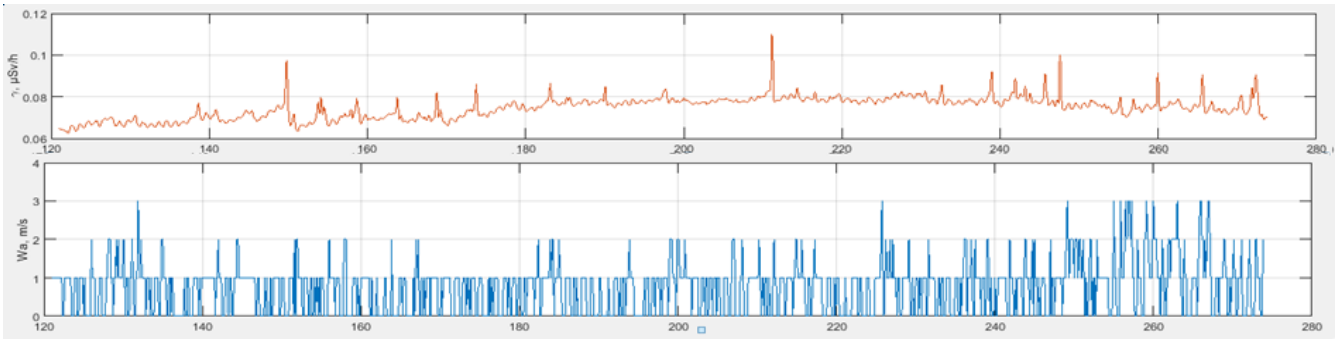

Figure 3.11 - Dynamics of gamma background and wind speed taking into account precipitation

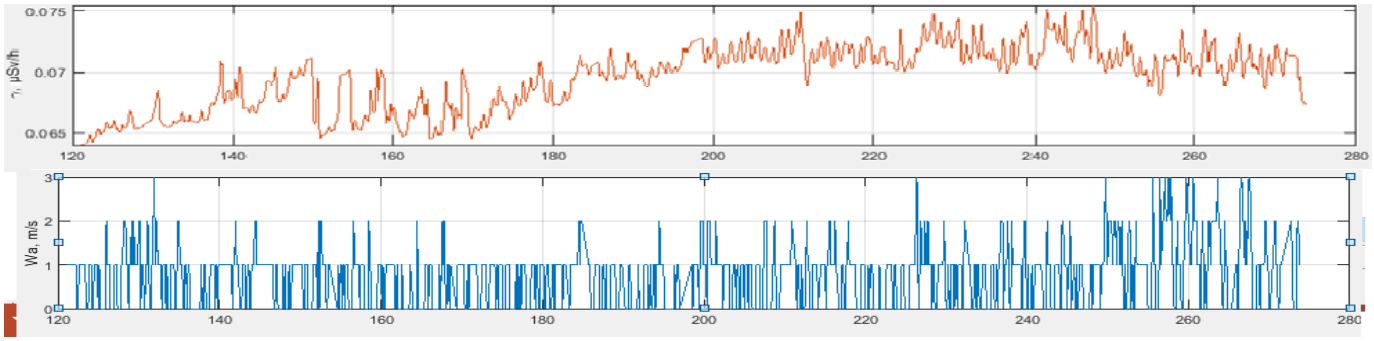

Figure 3.12 - Dynamics of the gamma background and wind speed without taking into account precipitation

According to the dynamics of the gamma background and meteorological parameters with and without precipitation (Figures 3.4-3.12), it is difficult to say something about their relationship, since there is no correlation in both cases.

Further, regression dependencies are also built in MATLAB software.

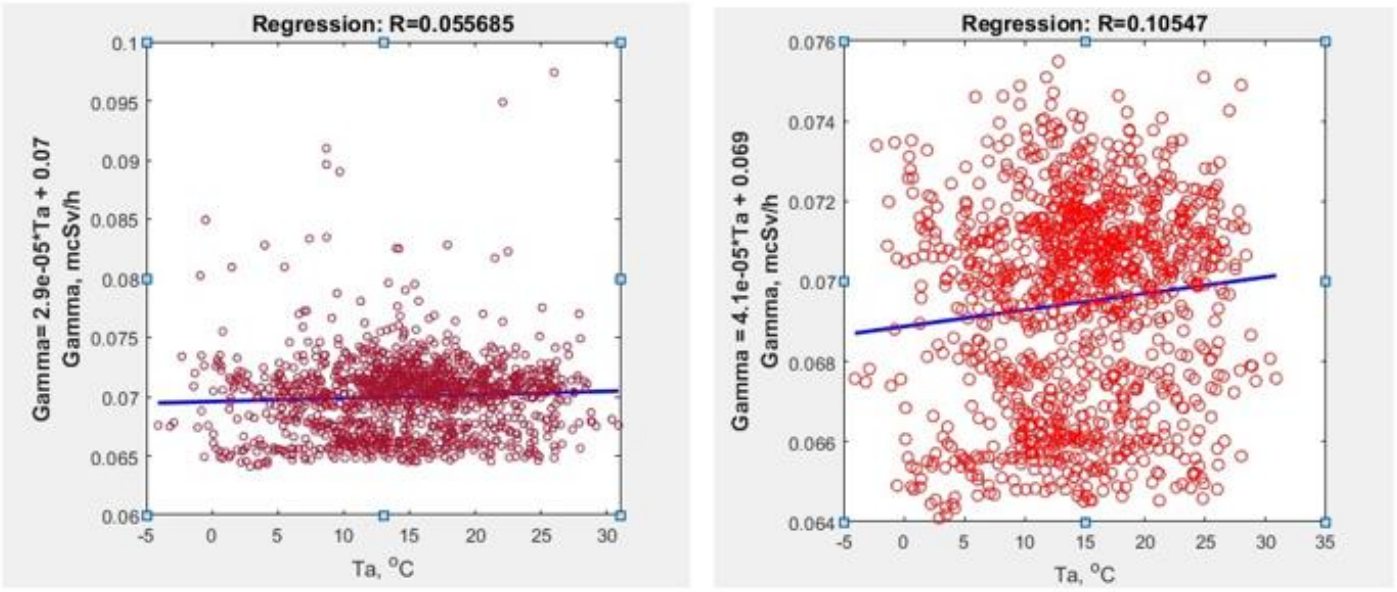

Figure 3.13 - Regression relationship between gamma background and temperature with and without precipitation

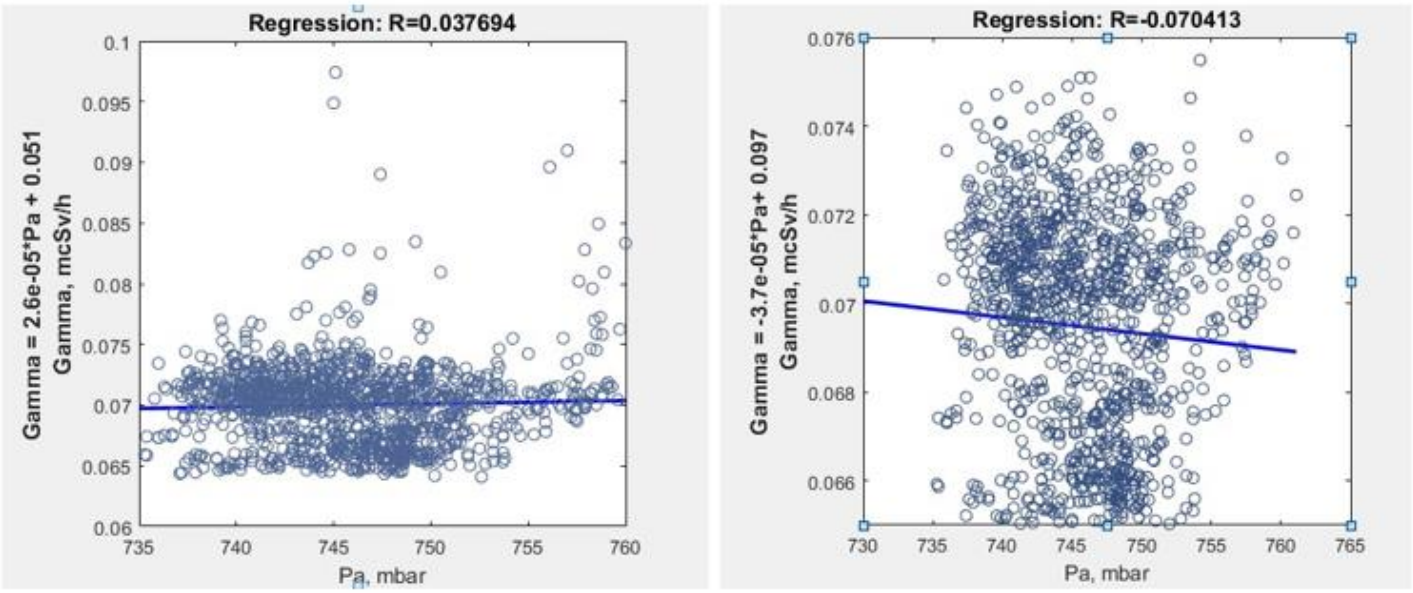

Figure 3.14 - Regression relationship between gamma background and pressure with and without precipitation

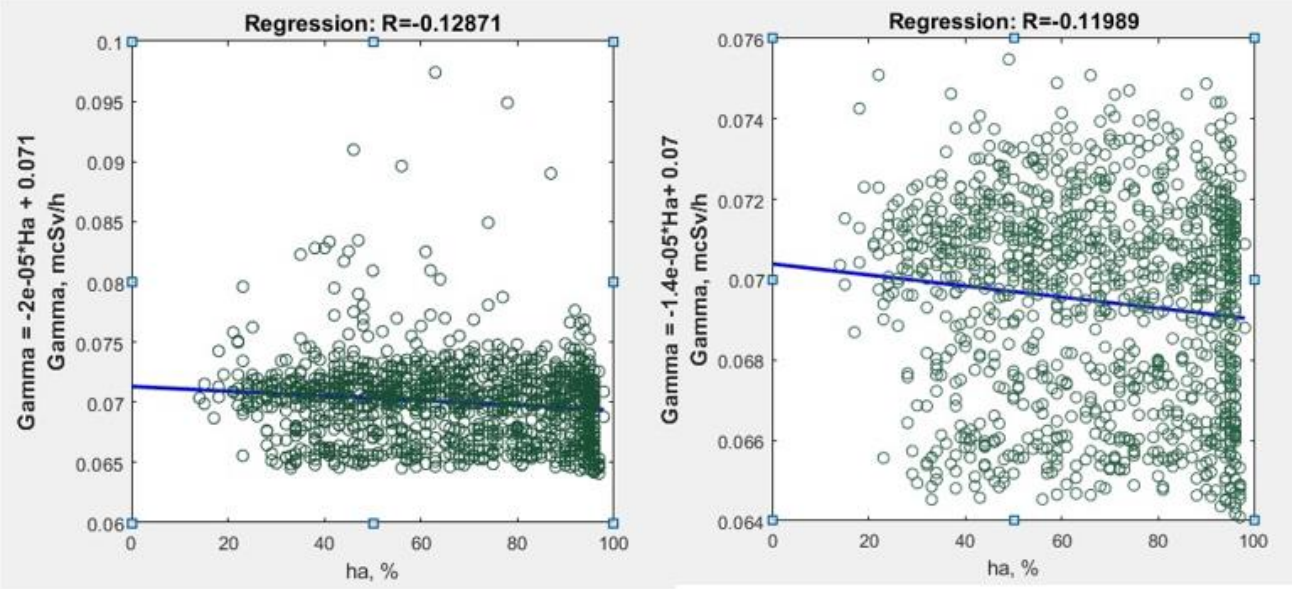

Figure 3.15 - Regression relationship between gamma background and humidity with and without precipitation

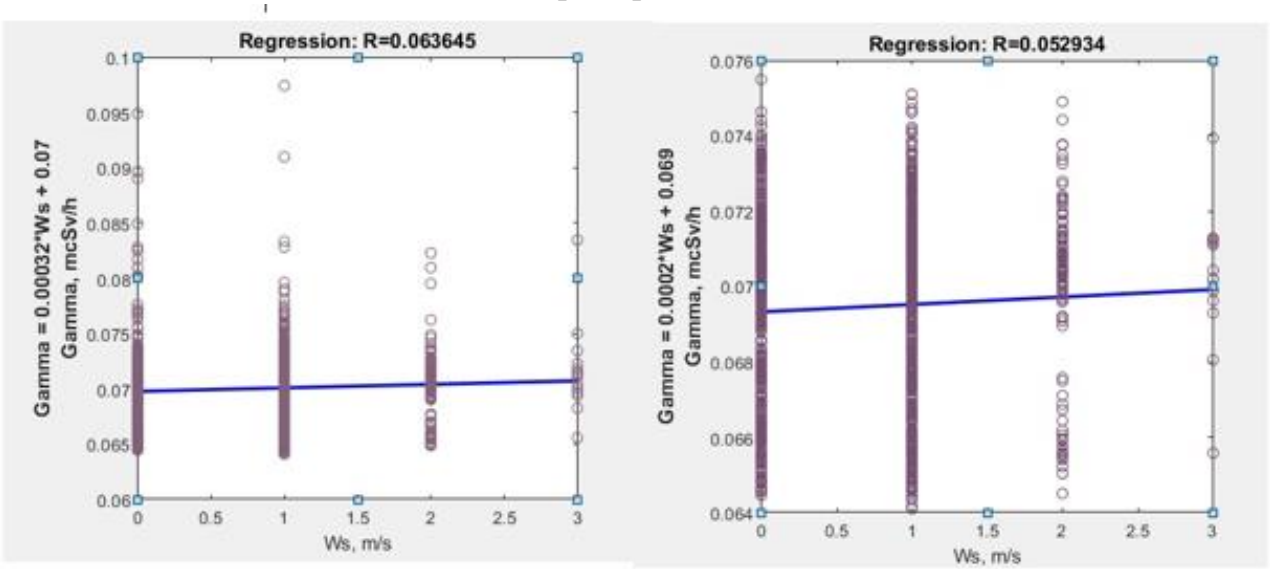

Figure 3.16 - Regression relationship between gamma background and wind speed with and without precipitation

The correlation coefficients between the gamma background, temperature, relative humidity, wind speed, taking into account precipitation, turned out to be insignificant (0.056, 0.037 and -0.149, 0.06, respectively).

Even with the removal of all precipitation for May-September 2019, it is difficult to draw conclusions about the relationship between the gamma background and meteorological values (the correlation coefficients between the gamma background, temperature, relative humidity, pressure and wind speed are 0.105, -0.07 and -0.12, 0.05, respectively).

3.3 Study of the influence of meteorological parameters on the gamma background of the surface atmosphere on a synaptic scale

For a more thorough analysis, a short period of time was taken, which fell on a long time without rain (August 12-16, 2019).

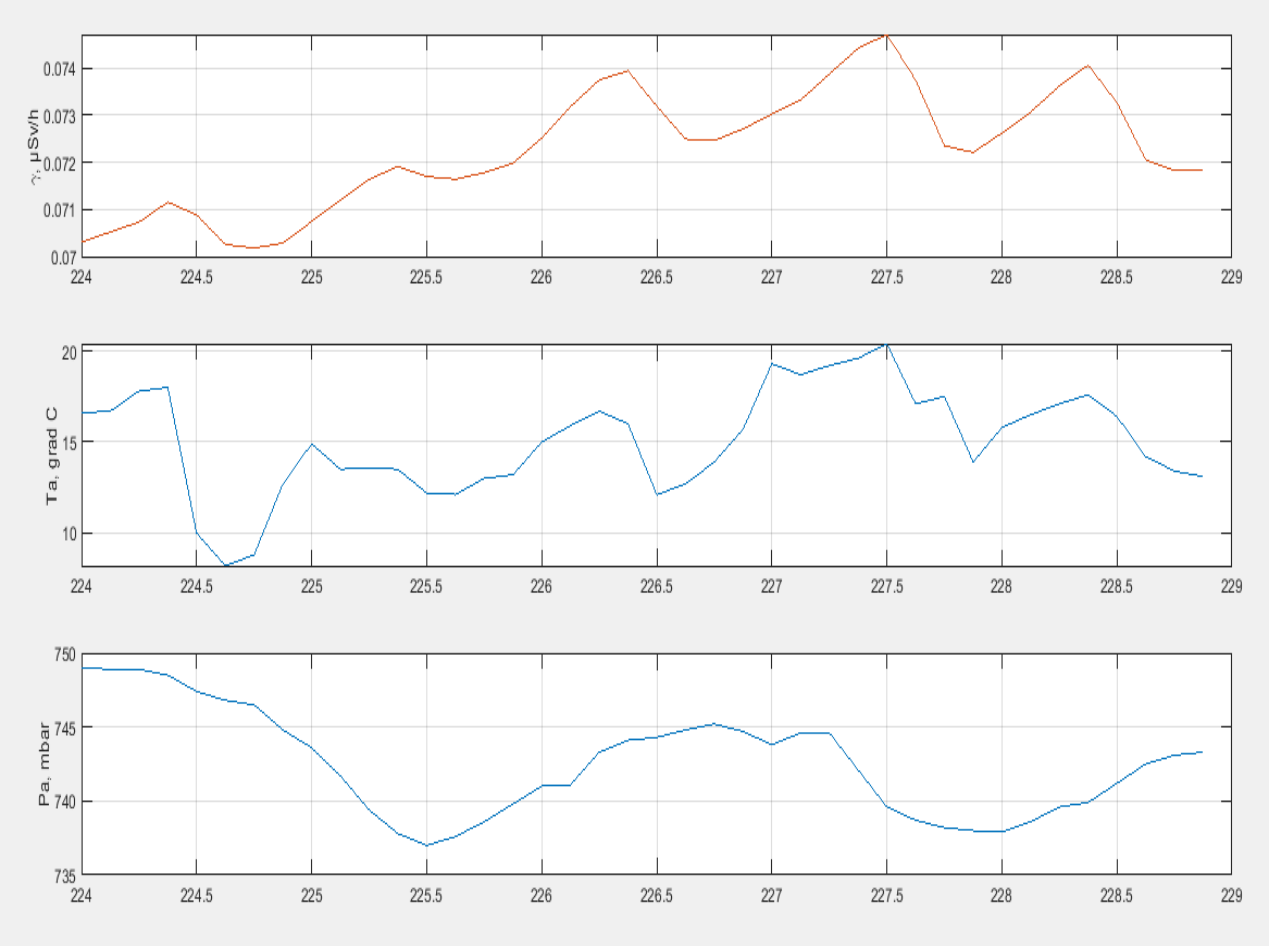

Figure 3.17 - Dynamics of gamma background, temperature and pressure for August 12-16, 2019

Figure 3.17 shows a significant positive correlation between gamma background and temperature.

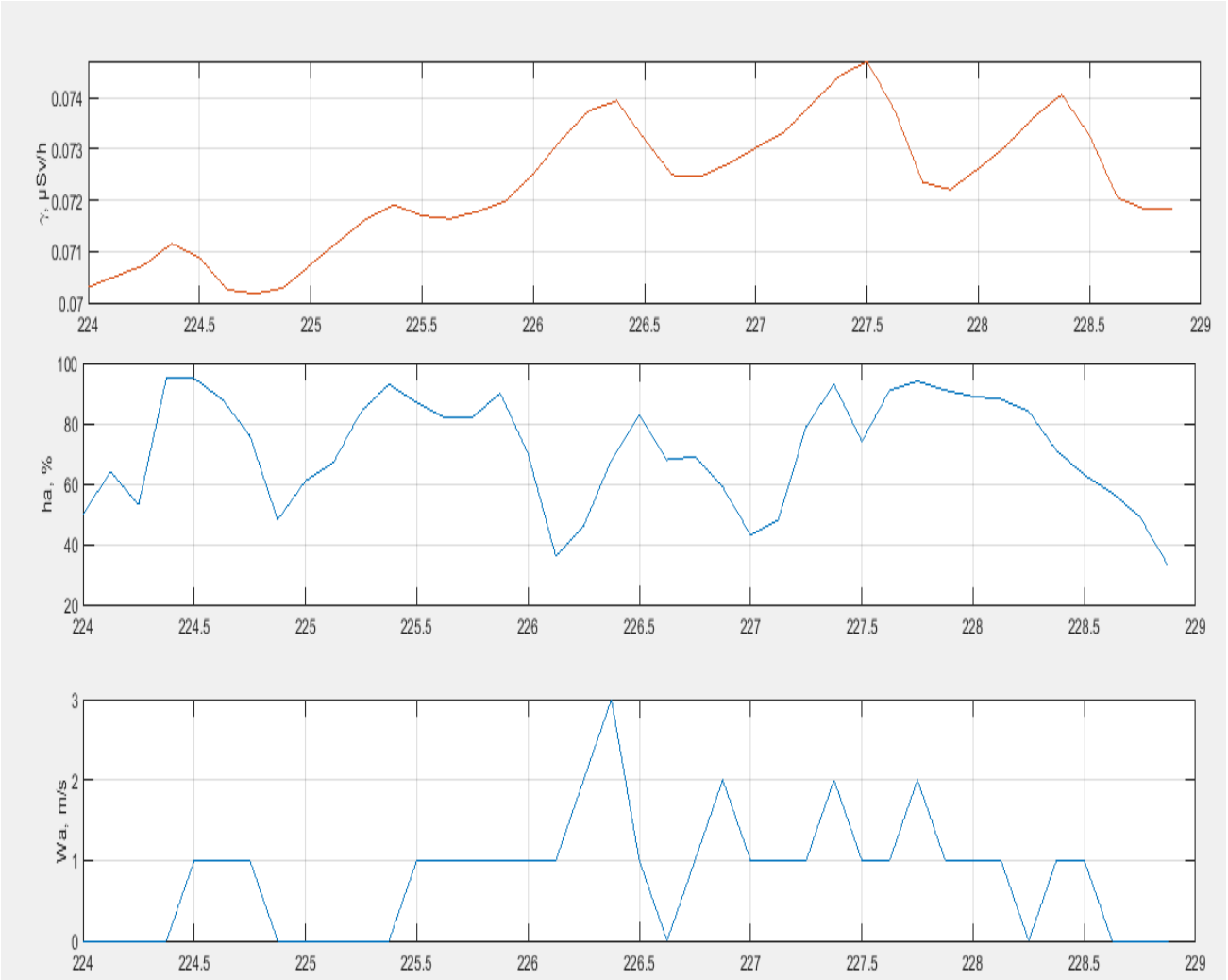

Figure 3.18 - Dynamics of gamma background, humidity and wind speed for August 12-16, 2019

In Fig. 3.18, you can also see that the dynamics of the gamma background is similar to the dynamics of wind speed, which already allows us to say about a significant positive correlation.

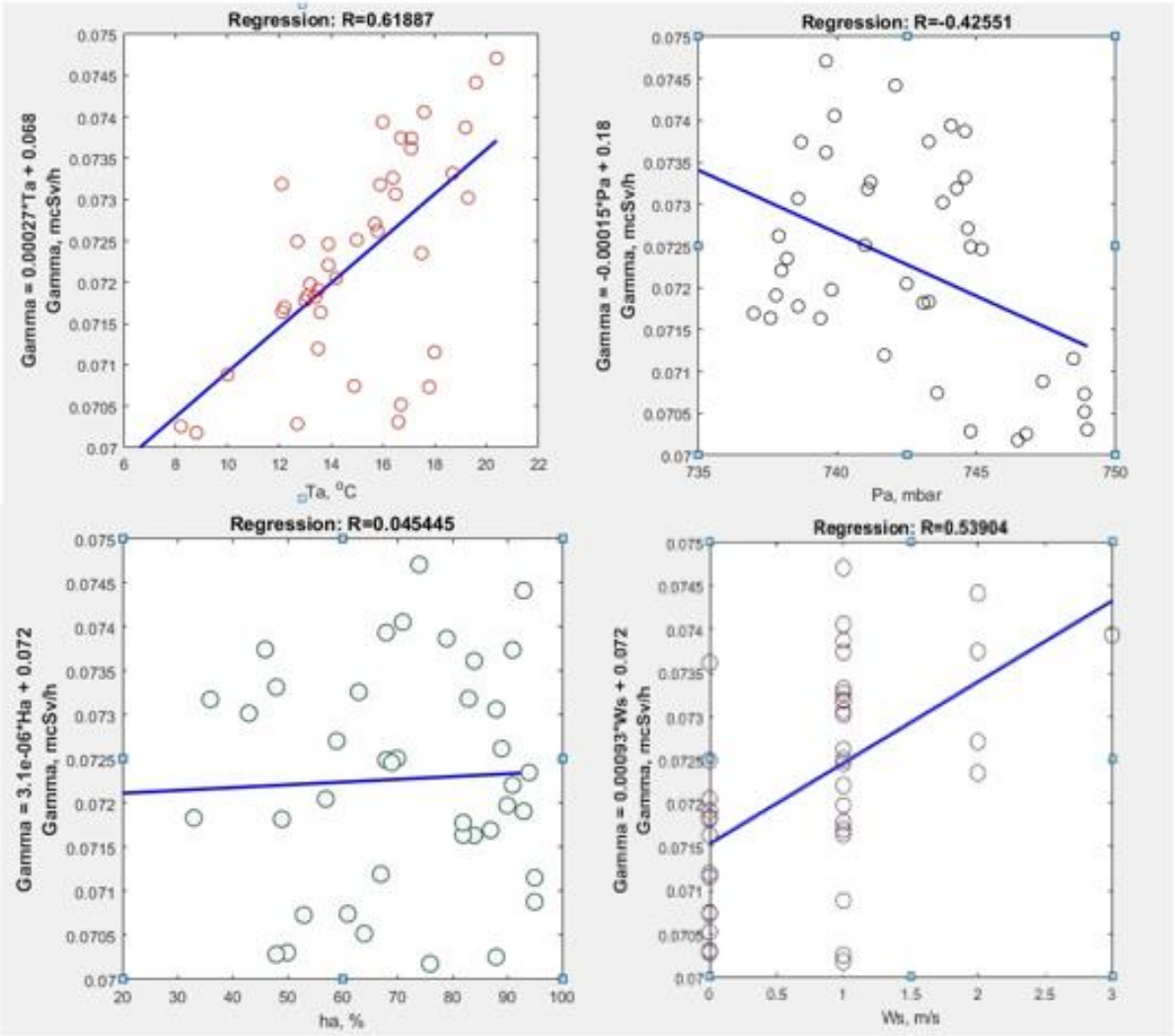

Figure 3.19 - Regression relationships between the gamma background and meteorological values for the period 12-16 August 2019

As you can see from Figure 3.19, the gamma background indeed has a positive significant correlation with air temperature and wind speed (correlation coefficients are 0.61887 and 0.53904, respectively), and also negatively correlates with absolute pressure (correlation coefficient -0.42551).

3.4 Chapter Conclusions

1. The analysis of the features of the average annual liquid precipitation from May to September 2011-2020 was carried out. The largest amount of liquid precipitation fell in 2017 (346.2 mm) and 2020 (372.4 mm). The least amount of precipitation fell in 2016 (245.6 mm) and 2019 (203 mm).

2. The program code in MATLAB was developed, the dynamics of the gamma background and meteorological parameters were visualized with and without precipitation, and regression dependencies were built and the regression and correlation coefficients were obtained between the gamma background and parameters.

3. During the analysis, it was found that the removal of all precipitation for the warm period of 2019 did not affect the result - the regression and correlation coefficients remained insignificant.

4. Considering a short period of time (on a synaptic scale), there is a significant correlation between the gamma background and pressure (-0.41), temperature (0.65), wind speed (0.57)

4 Financial management, resource efficiency and resource saving

Today, the prospects of scientific research are determined not so much by the scale of the discovery, which can be quite difficult to assess at the first stages of the life cycle of a high-tech and resource-efficient product, as by the commercial value of the development. Assessment of the commercial value of a development is a prerequisite for finding sources of funding for research and commercialization of its results. This is important for developers, who must represent the state and prospects of ongoing scientific research.

This section provides for the consideration of the following tasks:

- assessment of commercial potential and prospects for scientific research;
- identification of possible alternatives for conducting scientific research that meet modern requirements in the field of resource efficiency and resource conservation;
- research planning;
- determination of resource (resource-saving), financial, budgetary, social and economic efficiency of research.

4.1 Assessment of the commercial potential and the prospects for conducting scientific research from the standpoint of resource efficiency and resource conservation

This section presents a description of the study of the gamma background of the surface atmosphere depending on the season of the year and meteorological parameters.

4.1.1 Objectives and relevance of the project

The objective of the design work is to investigate the seasonal dependences of the dynamics of the gamma background of the surface atmosphere using the MatLab software package. For more than a decade, scientists have been conducting both experimental and theoretical studies of the dynamics of the fields of ionizing gamma radiation in the surface layer of the atmosphere. Among them, there are studies of the influence of various meteorological quantities on gamma radiation fields to identify their relationship.

In order to find out in which direction to conduct research, a consumer analysis was carried out.

Various meteorological and geological organizations, research institutes, as well as operational radiological services can show interest in the project.

Table 4.1 - Project stakeholders

Project stakeholders	**Stakeholder expectations**
Research institutes	The possibility of continuing research work for a deeper study of the relationship between meteorological parameters and gamma background
Operational radiological services	Obtaining up-to-date data on the state of the gamma background of the surface atmosphere to prevent emergencies

Table 4.2 - Objective and results of the project

Objectives of the project:	Investigation of the seasonal dependences of the dynamics of the gamma background of the surface atmosphere
Expected results of the project:	1. Obtaining data on the current state of the gamma background of the surface atmosphere 2. Revealing the relationship between meteorological parameters and gamma background through Fourier, Wavelet and regression analysis.
Acceptance criteria of the project result:	1. Correctness of data array processing 2. Availability of graphs with their description and analysis.
Requirements for the project result:	1. The project must be completed by May 31, 2021. 2. The results obtained must meet the criteria for the acceptance of the project result. 3. Availability of a conclusion on the state of the surface atmosphere

Project constraints and assumptions:

1. Funding source: government funding.
2. Project completion date: until 31.05.2021.
3. Time limit for TPU employees.

4.1.2 Analysis of competitive technical solutions

To analyze competitive technical solutions, experimental measurements were taken with detectors. The position of the development and competitors is assessed for each indicator by an expert way on a five-point scale, where 1 is the weakest position, and 5 is the strongest. The weights of the indicators, determined by expert, should add up to one.

The analysis of competitive technical solutions is determined by the

formula:

$$К = \sum В_i \cdot Б_i ,$$

Where К – competitiveness of a scientific development or a competitor; $В_i$ – indicator weight (in fractions of a unit); $Б_i$ – weighted average of the *i*-th indicator, $Бк_i$ – detector measurements.

Table 4.3 - Scorecard for comparing competitive technical solutions (developments)

Criteria for evaluation	Criterion weight	Points	Competitiveness	
		$Б_{к1}$	$К_ф$	$К_{к1}$
Technical criteria for assessing resource efficiency				
1. Reliability of the received data	0,3	4	1,2	1,2
2. No influence of atmospheric conditions on the experiment	0,15	3	0,75	0,45
3. Experiment safety	0,1	3	0,4	0,3
4. Ease of experimenting	0,12	4	0,6	0,48
5. Time of data production	0,1	3	0,3	0,3
6. Availability of expensive equipment	0,05	3	0,25	0,15

Table 4.4 - Economic criteria for assessing efficiency

1. Funding for scientific development	0,05	2	0,25	0,1
2. Cost of materials	0,1	2	0,5	0,2
3. Competitiveness	0,03	4	0,12	0,12
Total	1	40	4,37	3,3

During the analysis of competitive technical solutions, a table was compiled (a scorecard for comparing competitive technical solutions).

4.2 SWOT analysis

SWOT- analysis – Strengths, Weaknesses, Opportunities and Threats – is a comprehensive analysis of a research project.

SWOT- analysis consists in describing the strengths and weaknesses of the project, in identifying opportunities and threats for the implementation of the project, which have manifested or may appear in its external environment.

Strengths are factors that characterize the competitive side of a research project. Strengths indicate that the project has a distinctive advantage or special resources that are special in terms of competition. In other words, strengths are the resources or capabilities that project management has and that can be effectively used to achieve the goals.

Weaknesses are a flaw, omission or limitation of a research project that hinders the achievement of its objectives. This is something that does not work well within the project or where it has insufficient capabilities or resources compared to competitors.

Opportunities include any preferable present or future situation that arises in the project's environment, such as a trend, change, or perceived need, that sustains demand for project outcomes and allows the project management to improve its competitive position. A threat is any undesirable situation, trend or change in the environmental conditions of a project that is destructive or threatening to its competitiveness in the present or future. The threat can be a barrier, restriction or anything else that can lead to problems, destruction, harm or damage to the project.

The table presents a SWOT analysis in the form of a table, also shows the results of the intersections of sides, opportunities and threats.

Table 4.5 - SWOT analysis

	Strengths of the research project: −С1. Reliability of the received data; −С2.Scientific novelty; −С3. Expanding the boundaries of applicability; –С4. Security of conducting research.	Weaknesses of the research project: − Сл1. Lack of funding; − Сл2. Long term for processing results; −Сл3. Lack of awareness of this type of research.
Capabilities: –В1. Using the innovative infrastructure of TPU. –В2. The novelty of the research will lead to the emergence of stakeholders.	Results of the analysis of the interactive matrix of the project fields "Strengths and Capabilities ": 1. Growth in demand for this type of research due to the spread among various organizations and universities. 2. Priority to this research in comparison with competitors due to the implementation of proper reliability and safety.	Results of the analysis of the interactive matrix of the project fields "Weaknesses and Capabilities ": 1. Lack of a large number of orders for research. 2. Improvement of γ-detectors will lead to a decrease in the measurement error.
Threats: − У1. High competition due to modernization of other devices; − У2. Lack of funding	1. High reliability coupled with low data cost significantly increases competitiveness; 2. Advantage over competitors due to the novelty of the idea.	1. Research stagnation due to lack of funding; 2. A decrease in the cost of γ-detectors will allow the purchase of an additional number of detectors to expand the area of dose rate measurement, which will lead to an increase in demand for this technique.

To identify the degree of need for strategic changes, an interactive matrix was built, presented in Table 4.6.

Table 4.6 - Interactive matrix

Strengths of the research project					
Capabilities		C1	C2	C3	C4
	B1	+	+	0	+
	B2	-	+	+	-

Based on the data of the interactive matrix, we can conclude that the strengths of the project are associated with the capabilities of the external environment and thanks to them the project can be implemented and in demand on the market.

4.3.1 Research planning

4.3 The structure of work in the framework of scientific research

Table 4.7 - List of stages, works and distribution of performers

Main stages	№	Content of work	Duration days	Position of the performer
Development of technical specifications	1	Preparation and approval of technical specifications	5	Scientific supervisor, consultant of FM, SR, bachelor
Choosing a direction of research	2	Development of a research methodology	3	Supervisor, bachelor
	3	Choosing a direction of research	20	Supervisor, bachelor
	4	Scheduling of works by topics	7	Supervisor, bachelor
Theoretical and experimental research	5	Analysis of literary sources	10	Bachelor
	6	Practical calculation	12	Bachelor
Summarizing and Evaluating Results	7	Evaluation of the effectiveness of the results obtained	6	Supervisor, bachelor
	8	Determination of the feasibility of holding a FQP	3	Supervisor, bachelor
Carrying out the FQP				
Development of technical documentation and design	9	Calculations and their analysis	30	Bachelor
	10	Evaluation of production efficiency and development application	9	Bachelor, FM Consultant
	11	Developing social responsibility on the topic	8	Bachelor, SR consultant
Registration of a set of documentation for FQP	12	Drawing up an explanatory note	25	Bachelor
Total: 138 days				

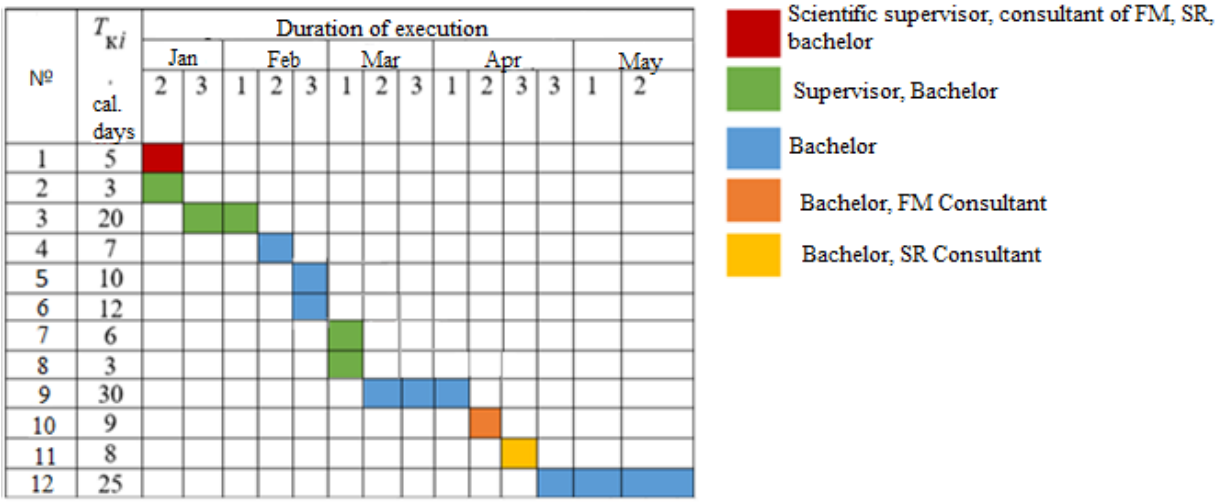

Figure 4- Gantt chart

4.4 Project budget

When planning the project budget, a complete and reliable reflection of all types of costs associated with its implementation must be ensured.In the process of forming the project budget, the following grouping of costs by item is used:

1. Materials.
2. The cost of wages of employees.
3. Contributions to extrabudgetary funds.
4. Works performed by third parties.
5. Special equipment for scientific and experimental work.
6. Other direct costs.
7. Overhead costs.

Groups 1-7 relate to direct costs, the amount of direct costs, as a rule, should be determined by direct account, these are costs associated directly with the implementation of a specific scientific and technical research, the remaining costs are calculated indirectly, these are the costs of maintaining the administrative apparatus, general technical and general economic services, they are grouped together in the Overhead group.

Material costs

The special equipment required for experimental work includes a laptop.

Laptop cost: 40,000 rubles. Service life: 5 years.

Depreciation deductions for the duration of the project:

$$A = \frac{40000 * 138}{1825} = 3025 \text{ rub.}$$

Table 4.8 - Calculation of costs for the item "Special equipment for scientific work"

№	Equipment	Days of operation	Life time	Cost	Depreciation deductions
1	Computing technology, laptop	138	5 лет	40000	3025 rub.
	Total				**3025 rub.**

Basic salary

The amount of wage costs is determined based on the labor intensity of the work performed and the current remuneration system. The basic salary includes a bonus paid monthly from the payroll (the amount is determined by the Regulations on Labor Remuneration).

The salary of the project performer is calculated by the formula:

$$С_{зп} = З_{осн} + З_{доп}$$

where $З_{осн}$ – basic salary; $З_{доп}$ – additional wages.

Basic salary ($З_{осн}$) of the project performer is calculated by the following formula:

$$З_{осн} = З_{дн} \cdot Т_{раб}$$

where $З_{осн}$ – basic salary of one employee;

$Т_{раб}$ – duration of work performed by a scientific and technical worker, working days.;

$З_{дн}$ – average daily wage of an employee, rub.

Average daily wages are calculated using the formula:

$$З_{дн} \frac{З_{м} \times М}{F_{д}}$$

where $З_м$ – employee's monthly salary, rub.;

M – the number of months of work without vacation during the year: with a vacation of 48 work. days M = 10.4 months, 6-day week;

$F_д$– actual annual fund of working time of scientific and technical personnel, working days .

Table 4.9 - Balance of working hours

Working time indicators	**Scientific adviser**	**Student**
Calendar number of days	365	365
Number of non-working days - weekends - holidays	 19 6	 19 6
Lost working time - vacation - sick absence	48	48
Valid annual working time fund	251	251

Employee's monthly salary:

$$З_м = З_б \cdot (1 + k_{пр} + k_д) \cdot k_р,$$

where $З_б$ – base salary, rub.;

$k_{пр}$ – premium coefficient equal to 0.3;

$k_д$ – the coefficient of surcharges and allowances is approximately 0.2 - 0.5;

$k_р$ – regional coefficient equal to 1.3 (for Tomsk).

4.10 - The calculation of the basic salary

Performers	**Salary, rub**	***k*р**	**Зм, руб**	**Здн,руб.**	**Тр,раб.дн.**	**Зосн,руб.**
Scientific adviser	30847	1,3	40101,1	1 662	86	142932
Student (engineer)	17890		23257	964	136	131104
Total:						**274036**

Additional salary

This group includes the amount of payments provided for by labor legislation, for example, payment of regular and additional vacations; payment of time associated with the performance of state and public duties; payment of remuneration for seniority, etc. (on average - 12% of the basic salary).

Additional salary is calculated on the basis of 10-15% of the basic salary of employees directly involved in the performing of threads:

$$З_{доп} = k_{доп} \cdot З_{осн}$$

where $З_{доп}$ – additional salary, rub.;

$k_{доп}$ – additional salary coefficient equal to 0.12;

$З_{осн}$ – basic salary, rub.

Table 4.11 - Salaries of project performers

Salary	Scientific adviser	Student
Basic salary, rub.	142932	131104
Additional salary, rub.	17152	15733
Total, rub:	**306921**	

Contributions to extrabudgetary funds

This group reflects the obligatory deductions according to the norms established by the legislation of the Russian Federation to the state social insurance bodies (FSS), the pension fund (PF) and medical insurance (FFOMS) from the costs of salary of employees.

The amount of contributions to extrabudgetary funds is determined based on the following formula:

$$C_{\text{внеб}} = k_{\text{внеб}} \cdot (З_{\text{осн}} + З_{\text{доп}})$$

where $k_{\text{внеб}}$ – coefficient of deductions for payment to extra-budgetary funds equal to 30.2%.

The amount of contributions to extrabudgetary funds is determined based on the following formula:

$$З_{\text{внеб}} = k_{\text{внеб}} * \sum(З_{\text{осн}} + З_{\text{доп}}) = 0{,}302 * 306921 = 92690 \text{ руб.}$$

Overheads

This group includes management and maintenance costs. In addition, this includes the costs of maintaining, operating and repairing equipment, production tools and inventory, buildings, structures, etc.

Overhead costs are 30% of the amount of basic and additional salary of employees directly involved in the implementation of scientific research.

$$C_{\text{накл}} = k_{\text{накл}} * (З_{\text{осн}} + З_{\text{доп}}) = 0{,}3 * 306921 = 92076 \text{ руб,}$$

where $k_{\text{накл}}$ – overhead coefficient.

Other direct costs

This group of expenditure considers the cost of electricity consumed by the equipment, which is calculated by the formula:

$$C = T_{эл} \cdot P \cdot t_{об}$$

where $T_{эл}$ – electricity tariff (5.8 rubles per 1 kWh);

P – equipment power, kW;

$t_{об}$ – time of equipment use, h.

Table 4.12 - Calculation of other direct costs

Equipment	**Working time, h**	**Power consumption of electricity, kW**	**Price for 1 kW, rub.**	**Electricity costs (Зэ), rub.**
Computer	276	0,5	5,8	348
Total:				**348 руб.**

The calculated amount of research costs is the basis for the formation of the project cost budget. Determination of the cost budget for a research project for each implementation option is shown in the table.

Table 4.13 - Project cost budget

Article title	**Amount, rub.**
Special equipment costs	3025
Costs for the basic salary of performers	274036
Costs of additional salaries of performers	32883
Contributions to extrabudgetary funds	92690
Overheads	92076
Other direct costs	348
Project cost budget	**495057**

The planned cost of the project is 495057 rubles.

4.5 Determination of the resource (resource-saving), financial, budgetary, social and economic efficiency of the research

Determination of efficiency is based on the calculation of the integral indicator of the effectiveness of scientific research. Its finding is associated with the determination of two weighted averages: financial efficiency and resource efficiency.

The integral financial development indicator is defined as:

$$I_{\text{фин}}^{\text{испi}} = \frac{\Phi_{pi}}{\Phi_{max}},$$

where $I_{\text{фин}}^{\text{испi}}$ – integral financial development indicator;

Φ_{pi} – cost of the *i*-th version;

Φ_{max} – maximum cost of performing of a research project (including analogues).

The resulting value of the integral financial development indicator reflects the corresponding numerical increase in the development cost budget in times (the value is greater than one), or the corresponding numerical reduction in the development cost in times (the value is less than one, but greater than zero).

Since the development has one version, then:

$$I^{\text{исп}}_{\text{фин}} = 1$$

The integral indicator of resource efficiency of variants of the research object can be determined as follows:

$$I_{pi} = \sum a_i \cdot b_i,$$

where I_{pi} – integral indicator of resource efficiency for the *i*-th development option;

a_i – weighting factor of the *i*-th design option;

b_i – the point estimate of the *i*-th variant of the development, is established by an expert according to the selected rating scale.

The calculation of the integral indicator of resource efficiency is presented in the form of a table.

Table 4.14 - Assessment of the characteristics of project performing

Criteria	Parameter weighting factor	Evaluation
1. Promotes increased user productivity	0,23	5
2. Ease of use	0,10	5
3. Interference immunity	0,20	4
4. Energy saving	0,20	3
5. Reliability	0,12	4
6. Material consumption	0,15	4
Total	1	

$$I_{pi} = 5 \cdot 0{,}23 + 5 \cdot 0{,}1 + 4 \cdot 0{,}2 + 3 \cdot 0{,}2 + 4 \cdot 0{,}12 + 4 \cdot 0{,}15 = 4{,}13$$

Integral indicator of the effectiveness of development options ($I_{испi}$) is determined on the basis of the integral indicator of resource efficiency and the integral financial indicator according to the formula:

$$I_{испi} = \frac{I_{р-испi}}{I_{финр}^{испi}},$$

Comparative project effectiveness ($Э_{ср}$):

$$Э_{ср} = \frac{I_{исп1}}{I_{исп2}},$$

Table 4.15 - Development efficiency

№	Indicators	Evaluation
1	Integral financial development indicator	1
2	Integral indicator of resource efficiency	4,13
3	Integral efficiency indicator	0,24

Comparison of the values of integral performance indicators allows us to understand and choose a more effective solution to the technical problem posed

from the standpoint of financial and resource efficiency. In this case, it has only one solution to the problem. Therefore, the option provided is assumed to be the best.

4.6 Chapter Conclusions

As a result of fulfilling the objectives of the section, the following conclusions can be drawn:

- the market in which the provided service is in demand has been determined.
- an analysis of competitors was carried out
- in the course of planning, a schedule for the implementation of the work stage was developed for the manager and the engineer, which allows you to estimate and plan the working hours of the performers. The days from the schedule are determined, when and how much the manager and engineer work.
- to estimate the costs of the project, a project budget has been developed, which is 306921 rubles.

In the completed final qualifying work, economic and technical criteria of efficiency were achieved due to the functional capabilities of development, as well as social due to the demand for research in the market.

5 Social responsibility

Labor protection is a system of legislative, socio-economic, organizational, technological, hygienic and treatment-and-prophylactic measures and means that ensure safety, preservation of human health and performance in the labor process.

Safety and labor protection rules are necessary to prevent accidents (at work, for example) and to ensure the availability of safe working conditions for workers. They are mandatory for both workers and management [7].

A production factor, the impact of which on a worker in certain conditions leads to illness or a decrease in working capacity is called a harmful production factor. Hazardous production factor - a production factor, the impact of which, under certain conditions, lead to injury or other sudden sharp deterioration in health.

FQP is a study of the radiation background of the surface atmosphere depending on the season, analysis of the relationship between meteorological quantities and gamma background, processing, sampling of a data array, which implies the use of a PC. The work used a personal computer 122 classroom 10 TPU building.

A person working on a PC is affected by the following harmful factors: physical (temperature and humidity of the air; noise; static electricity; electromagnetic field of low frequency; illumination; presence of radiation) and psychophysiological.

Psychophysiological hazardous and harmful production factors are divided into: physical overload (static, dynamic) and neuropsychic overload (mental overstrain, monotony of work, emotional overload). A harmful production factor that arises when performing work on a PC is electric shock; they are divided into: physical overload (static, dynamic) and neuropsychic overload (mental overstrain, monotony of work, emotional overload) [6].

5.1 Legal and organizational security issues

The Labor Code of the Russian Federation regulates relations between an employee and an employer, which relate to the length of the working day, the provision of vacations, salary, etc.

The length of the working day is established according to the employment contract, but should not exceed 40 hours per week. When working with harmful or hazardous working conditions, the duration of the working day is 8 hours (with a 36-hour working week) and 6 hours (with a 30-hour working week). At night, the duration of the shift is reduced by 1 hour. Each employee must be given a break during the working day of at least 30 minutes, but not more than 2 hours, which is not included in working hours [6].

5.1.1 Organizational activities

Personnel training in safety and industrial sanitation consists of induction and on-the-job briefing by the responsible person.

The knowledge of safety regulations is tested by the qualification commission after training at the workplace. The auditee is assigned a safety qualification group corresponding to his knowledge and work experience and a special certificate is issued.

Persons serving electrical installations should not have injuries and diseases that interfere with production work. Health status is established by medical examination [7].

5.1.2 Technical activities

The rational layout of the workplace provides for a clear order and consistency in the placement of objects, labor tools and documentation. What is required to perform work should often be located in the easy reach of the workspace, as shown in Figure 5 [10].

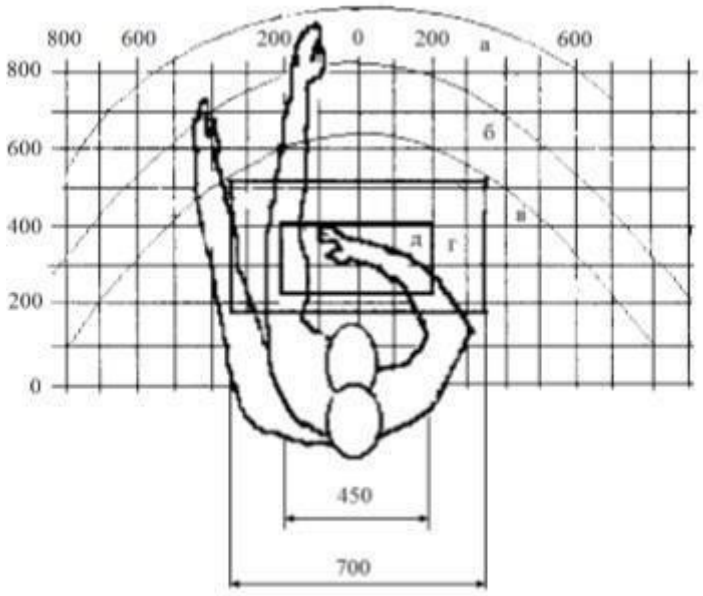

Figure 5 - Zones of reach of hands in the horizontal plane:

a - zone of maximum reach of hands;

b - the reach of the fingers when the arm is outstretched;

c - zone of easy palm reach;

d - optimal space for rough manual work;

f - optimal space for delicate handwork.

Optimal placement of objects of work and documentation in the reach of the hands:

- the display is located in zone a (in the center);
- keyboard - in zone d or f;
- the system unit is located in zone b (left);
- the printer is in area a (right);
- the documentation is placed in the easy reach of the palm - c (left): literature and documentation required for work;
- in drawers of the table, literature not used constantly.

When designing a writing desk, it is necessary that:

1) The height of the working surface on which the keyboard is installed must be 650 mm. The working table must be at least 700 mm wide and at least 1400 mm long.

2) There must be legroom at least 600 mm high, at least 500 mm wide, at least 450 mm deep at the knee and at least 650 mm at the extended legs.

3) The work chair must be lifting and turning and adjustable in height and angles of inclination of the seat and backrest, as well as the distance of the backrest to the front edge of the seat. The recommended seat height above floor level is 420 - 550 mm. The design of the working chair should provide: width and depth of the seat surface not less than 400 mm; seat surface with recessed front edge.

4) The monitor should be located at eye level of the operator at a distance of 500 - 600 mm. According to the standards, the viewing angle in the horizontal plane should be no more than 45º to the screen normal. Better if the viewing angle is 30º. In addition, it should be possible to select the level of contrast and brightness of the image on the screen.

5) It must be possible to adjust the screen:

- in height + 3 cm;
- tilt from 10 to 20 degrees relative to the vertical;
- in the left and right directions.

6) The keyboard should be placed on the table surface at a distance of 100 - 300 mm from the edge. The normal position of the keyboard is to place it at the level of the operator's elbow with an angle of inclination to the horizontal plane of 15º. It is more convenient to work with keys that have a concave surface, a rectangular shape with rounded corners. Key design should provide the operator with a clickable feel [10].

5.2 Industrial safety

A harmful production factor is such a production factor, the impact of which on a worker in certain conditions leads to illness or a decrease in working capacity. A hazardous production factor is a production factor, the impact of which, under certain conditions, leads to injury or other sudden, sharp deterioration in health. [9].

When working on a PC, the following harmful factors affect the researcher: physical (temperature and humidity of the air; noise; static electricity; electromagnetic field of low purity; illumination; presence of radiation) and psychophysiological. Psychophysiological hazardous and harmful production factors are divided into: physical overload (static, dynamic) and neuropsychic overload (mental overstrain, monotony of work, emotional overload). A hazardous production factor arising during the performance of work is electric shock [8].

The identified harmful and dangerous factors are considered below, and measures to protect the researcher from their effects are given.

5.2.1 Microclimate

The main indicators characterizing the microclimate in industrial premises are: air temperature; surface temperature; relative humidity; air speed; heat radiation intensity.

PC, auxiliary equipment, as well as lighting devices generate heat during operation. High temperature contributes to rapid fatigue and overheating of the body when being in close proximity to heat sources. Humidity also has a significant effect on human thermoregulation, so low humidity can lead to drying out of the skin, mucous membranes and general dehydration of the body, and high humidity can lead to increased heat release and possible overheating of the body [11].

To maintain these sanitary standards, it is necessary to have a local air conditioner of a full air conditioning installation, which ensures constant temperature, relative humidity, speed and air purity. A central hot water heating

system is required to ensure the desired temperature level in winter. When installing a ventilation and air conditioning system in the laboratory, certain fire safety requirements must be observed [11].

Table 5.1 shows the optimal values of the microclimate at workplaces, which are established by sanitary standards for various categories of work in different periods of the year. When working on a PC, the category of work is easy (Ia), since there is no systematic physical exertion [11].

Table 5.1 - Optimal values of microclimate indicators at workplaces of industrial premises

Period of the year	Category of work by the level of energy consumption, W	Air temperature, °C	Surface temperature, °C	Relative humidity, %	Air speed, m / s
Cold	Ia (up to 139)	22-24	21-25	60-40	no more than 0,1
Warm	Ia (up to 139)	23-25	22-26	60-40	no more than 0,1

Measures to improve the air environment in the production area include: proper organization of ventilation and air conditioning, space heating. Ventilation can be carried out naturally and mechanically. The following volumes of outdoor air must be supplied to the room: with a room volume of up to 20 m^3 per person - at least 30 m^3 per hour per person; if the volume of the room is more than 40 m^3 per person and there is no emission of harmful substances, natural ventilation is allowed [11].

The area of the room where the work was carried out is 33 m^2, the volume is 99 m^3, the air exchange rate is 3 1/h. Consequently, the air exchange in the room is 297 m^3/h. For this value of air exchange, a single-stage blower SB-0310 D0 with a power of 2.2 kW is suitable [15].

The heating system must provide sufficient, constant and uniform heating of the air. In rooms with increased requirements for air purity, water heating should be used. The microclimate parameters in the laboratory used are regulated by the central heating system.

The room is naturally ventilated. Air enters and exits through cracks, windows, doors. The main disadvantage of such ventilation is that the supply air enters the room without preliminary cleaning and heating. [11].

5.2.2 Noise and vibration

Noise and vibration worsen working conditions, have a harmful effect on

the human body, namely, on the hearing organs and on the whole body through the central nervous system. As a result, attention is weakened, memory deteriorates, reaction decreases, and the number of errors during work increases. Noise can be generated by operating equipment, air conditioning units, daylight fixtures, and can also be emitted from outside. The standard equivalent sound level at workplaces is 80 dBA [11].

5.2.3 Lighting

Insufficient lighting increases the number of errors in work, increases fatigue, reduces labor productivity, and causes diseases of the organs of vision. Adequate, but inadequate lighting of parts or work surfaces is also unfavorable for human well-being and labor productivity.

The main way to protect against insufficient lighting is to comply with lighting standards [11]. In a room with the III category of visual work with high accuracy, the illumination should be 200 lux, and the ripple coefficient should be 15%. Illumination pulsations are due to the low inertia of the radiation of gas-discharge lamps, the luminous flux from which pulsates at an alternating current of industrial frequency.

The number of luminaires for the room is calculated:

$$n = \frac{E * S * Z * K}{F * U * m},$$

where E – normalized illumination, E = 300 lux;

S – room area, S = 297 m^2;

Z – luminaire correction factor, Z=1,2;

K – safety factor taking into account the decrease in illumination during operation, K=1,2;

F – luminous flux of one lamp, ЛД 40, F=2130 lux;

U – utilization rate, U=0,55;

m – number of lamps in the luminaire, m=2,

$$n = \frac{300 * 297 * 1.2 * 1.2}{2130 * 0.55 * 2} = 54{,}4 \text{ units}$$

Rounding up we get 55 lamps.

Organization of the workplace can protect against insufficient lighting. Illumination of the workplace should be uniform. The desktop should be located in a well-lit place, preferably by the window. The person at the table should be facing or left side to the window (right-handed). Artificial light fixtures should be positioned in the same way relative to the human body [11].

5.2.4 Electromagnetic field

Display, processor, keyboard emit electromagnetic radiation. According to [11], the strength of the electromagnetic field at a distance of 50 cm around the screen in terms of the electrical component should be no more than:

- in the frequency range 5 Hz ÷ 2 kHz - 25 V/m;
- in the frequency range 2 kHz ÷ 400 kHz - 2.5 V/m.

The magnetic flux density should be no more than:

- in the frequency range 5 Hz ÷ 2 kHz - 250 nT;
- in the frequency range 2 kHz ÷ 400 kHz - 25 nT.

To protect against EMI, you can increase the distance from the source (the screen must be at least 50 cm away from the user), as well as use filters and other personal protective equipment. Various filters are used to protect against EMI:

- glass filters of full protection, providing attenuation of the power of electromagnetic radiation, for example, filters of the Russian production "SINKO";
- spectral computer glasses;
- special headband for partial screening of negative energy-informational interaction of computer radiation in the frequency range 5 Hz - 400 kHz [11].

5.2.5 Ionizing radiation

When working with a computer, the display is a source of ionizing radiation. Under the influence of ionizing radiation in the body, a violation of normal blood clotting, an increase in the fragility of blood vessels, a decrease in immunity, etc. The radiation dose at a distance of 20 cm to the display is 50 μR/h.

The design of the computer should ensure the exposure dose rate of X-ray radiation at any point at a distance of 0.05 m from the screen no more than 100 μR/h [12].

5.2.6 Psychophysiological factors

Psychophysiological hazardous and harmful production factors by the nature of the action are subdivided into physical overload and neuropsychic overload.

Physical activity can be associated with the movement of materials, semi-finished products, finished products, etc. to the required distances and cause dynamic overload.

Static load is due to the need for the worker to exert efforts without moving the whole body or individual parts of the body. It is determined by the weight of the load being held (the amount of force applied) and the holding time.

When performing labor functions, you should not be in a forced position (inclined body positions, forced bends, doing work only while standing, on your knees, squatting, etc.). Labor activity associated with pronounced motor activity, with loads exceeding physiologically grounded optimal and permissible values, has an adverse effect on the health of the worker.

When designing a workplace, it should be borne in mind that a fixed working posture is not physiologically justified, since it causes impaired blood circulation in the lower extremities and organs of the pelvic region, leading to occupational diseases (varicose veins, hemorrhoids, etc.).

When designing workplaces, it is necessary to strive to ensure that the working posture is as close as possible to the natural posture of a person. Therefore, it is advisable to provide for the possibility of working both standing and sitting. Particularly noteworthy is the design of armchairs for people who constantly work while sitting at the control panels. The design of the chair should be such as to distribute body pressure as evenly as possible on the area of support. This is possible when the chair most closely matches the anatomical structure of a person.

Physical inactivity is negatively reflected in the state of health - a violation of the functions of the body (musculoskeletal system, blood circulation, respiration, digestion, etc.) with limited motor activity, a decrease in muscle resistance forces.

Prevention of hypodynamia provides for the elimination of static work, changing the working posture during work, conducting industrial gymnastics with a rational complex of physical exercises, etc.

The intensity of attention is characterized by the duration of the concentration of observation, the number of objects of simultaneous observation, the density of signals (light, healthy) and messages.

The degree of intensity of the analytic functions for the visual analyzer depends on the size of the object of discrimination and the distance of the object from the eyes, the difference in the contrast between the object of discrimination and the background, for the auditory analyzer - on the ratio between the levels of speech and noise.

Emotional stresses cause changes in the functional state of the central nervous system.

To prevent the harmful effects of drowsiness, it should be borne in mind that labor activity is associated not only with the activity of the muscular apparatus and sensory organs (analyzers), subject to the conscious control of a person, but also with the cardiovascular, digestive, excretory, endocrine and other systems that are not under human control and maintain the daily rhythm of activity.

Prevention of drowsiness when working on night shifts is reduced to the following main activities:

- it is necessary for those working at night to maintain a daily sleep rate of eight hours;
- the beginning of shifts must be set at 8, 16 and 24 hours with a three-shift operating mode and at 8, 14, 20, 2 hours with a four-shift operating mode;
- the transition from shift to shift should be made in a week or two

weeks, and the alternation of shifts should be as follows: morning - evening - night;

- workers on night shifts should not engage in heavy physical labor or work that requires tension of the central nervous system in their free time. Free time should be active time [11].

5.2.7 Electrical safety

Safe for humans is the value of alternating current - 10 mA, direct current - 50 mA, safe voltage 12 V [13].

When electric current passes through the human body, damage to the body may occur. The effect of current on the human body can be local and general. General (reflex) damage - electric shock, poses the greatest danger to a person: the work of the central nervous and cardiovascular systems is disrupted, which leads to fibrillation and paralysis of the heart, as well as to respiratory arrest.

During the research, equipment was used, the power of which is carried out from a network with a voltage of 220 V. According to the presence of signs of electrical hazards - the room is classified as a low-risk room. To avoid injury, the following rules were followed:

- study the operating instructions for the equipment;
- inspect the workplace before each switch on of equipment;
- pay special attention to the sequence of switching on and off the power of individual nodes.

To ensure safety, before starting work, it is necessary to remove hair, prepare the necessary tools and devices for work, prepare a work table. It is also necessary to inspect the device and check the absence of external damage to electrical equipment, the presence and serviceability of control, measuring and signaling devices, a computer, toggle switches, switches, etc.

If faults are found, it is not allowed to carry out repairs on your own, you must report to the person in charge. It is forbidden to start work if malfunctions of any equipment used are identified, if the personnel have not passed the training and testing of labor safety knowledge in the prescribed manner.

The safety of working with electrical equipment increases if the room is clean, free from dust, vapors, acids and alkalis, corrosive gases and other harmful impurities that cause corrosion. After finishing work with the installation, you must:

- exit the program, turn off the power of the computer;
- disconnect the unit from the mains;
- lower the power switch.

According to the rules for electrical installations, live parts should not be accessible for accidental contact, and parts accessible to touch should not be energized, posing a risk of electric shock in normal operation of an electrical installation, as well as in case of damage to the insulation [13].

There are electrical protective equipment to protect people working with electrical equipment from electric shock, from the effects of an electric arc and an electromagnetic field. They are divided into basic and additional. The main ones include protective equipment, the insulation of which can withstand the operating voltage of the electrical installation for a long time, and which allow you to touch live parts that are energized. Additional protective equipment is equipment which in themselves may not be at a given voltage to provide protection. When working with electrical equipment, if necessary, use such personal protective equipment, helmets, gas masks, gloves, etc.

It should be remembered that the nature and consequences of damage depend on the magnitude, frequency and path of the current, the duration of exposure. Timely assistance in case of electric shock allows you to save the life of the victim. Therefore, help must be provided immediately. When providing first aid, the victim must be disconnected from the live part, while protecting yourself from the danger of contact with current leads.

If an employee is struck by an electric current, it is first of all necessary to release the victim from the effects of the electric current as soon as possible: turn off the switch, switch; unscrew the plugs; remove fuses and so on.

Next, check the condition of the victim. Do not touch metal objects and the

victim's body. You can only touch his clothes. Wear dielectric gloves or wrap a dry cloth, scarf or sleeve around your hand. Stand on dry boards, logs, rolled dry clothing, rubber mat, or wear dielectric overshoes.

In case of minor lesions, the victim should be taken out to fresh air. If breathing is very sharp and convulsive, artificial respiration should be given. If breathing stops and there is no pulse, artificial respiration and chest compressions are performed. Call an ambulance if necessary or, if necessary, arrange for the delivery of the victim to the nearest medical institution. Notify the head of the structural unit about the accident [13].

Classification of premises for electrical safety, according to [13]:

- Safe;
- With increased danger;
- Especially dangerous.

Auditorium 122 of the TPU building belongs to the first class premises, as: humidity does not exceed 60%; there is ventilation and heating; the floor covering is made of dielectric material; air temperature up to 30.0 degrees; there is no release of technical dust and chemically active substances.

5.3 Emergency Safety

An emergency situation is a situation in a certain territory resulting from an accident, a dangerous natural phenomenon, a catastrophe, the spread of a disease that poses a danger to others, a natural or other disaster that may or have resulted in loss of life, damage to human health or the environment, significant material losses and violation of the living conditions of people. There are two types of emergencies:

- technogenic;
- natural.

Technogenic emergencies include fires, explosions, sabotage, emissions of toxic substances. Natural emergencies include natural disasters. The most likely technogenic emergencies are fires.

Accident hazards include a sudden and uncontrollable source of energy: a

moving object, uncontrollable movement or energy [14].

Let's consider possible emergencies in TPU building No. 10 in room 122, namely:

- falling from the height of one's own growth;
- electric shock;
- fire breakout.

Measures to prevent and eliminate the above emergencies are presented in Table 5.2.

Table 5.2 - Emergency situations

Emergency situation	Prevention measures	Emergency response measures
Falling from the height of one's own growth	1. Maintenance of the premises in proper order. 2. Work space limitation. 3. Timely briefing.	1. Examine or interview the victim; 2. If necessary, call an ambulance (112,103); 3. Stop bleeding, if any; 4. If there is a suspicion that the victim has a broken spine (sharp pain in the spine with the slightest movement), it is necessary to provide the victim with complete rest in the supine position until qualified medical care is provided.
Electric shock	1. Grounding of all electrical installations. 2. Work space limitation 3. Ensuring the inaccessibility of live parts of the equipment. 4. Timely briefing.	1. Quickly release the victim from the electric shock; 2. Call an ambulance (112,103); 3. If the victim has lost consciousness, but breathing has been preserved, he should be comfortably laid down, unfastened clothing, create an influx of fresh air and ensure complete rest; 4. Victim should be allowed to smell ammonia, sprinkle water on his face, rub and warm the body.
Fire	1. Timely briefing. 2. Installation of	1. De-energize the room, cut off the air supply;

	automatic fire extinguishing equipment in premises. 3. Installing smoke and fire detectors. 4. Providing escape routes and maintaining them in proper condition. 4. Monitoring the operation of electrical appliances.	2. Immediately report the fire to the duty officer or to the security post; 3. If possible, take measures to evacuate people, extinguish a fire and save material assets.

5.4 Fire and explosive safety

According to the explosion and fire hazard, the premises are divided into categories А, Б, В1-В4, Г and Д, and buildings - by category А, Б, В, Г и Д [13]. Categories of premises and buildings are determined based on the type of combustible substances and materials in the premises, their quantity and fire hazard properties, as well as on the basis of the space-planning solutions of the premises and the characteristics of the technological processes carried out in them.

The room in which this work is performed, according to the degree of explosion and fire, belongs to the category B.

Possible causes of fire:

– short circuits in the power supply;

– work with open electrical equipment;

– malfunction of current-carrying parts of installations;

– non-observance of fire safety rules;

– presence of combustible components: doors, tables, cable insulation, etc.

Fire prevention measures are divided into: technical, operational, organizational, and regime.

Technical measures include: compliance with fire safety rules, norms in the design of buildings, in the installation of electrical wires and equipment, heating, ventilation, lighting, proper placement of equipment, etc.

Operational activities include timely preventive inspections, repair and testing of technological equipment, etc.

Organizational measures provide for the correct operation of equipment, the correct maintenance of buildings and territories, fire-prevention instructions for workers and employees, training of production personnel in fire safety rules, the publication of instructions, posters, an evacuation plan, etc.

Regime measures include the establishment of rules for organizing work and compliance with fire safety measures.

In the event of an emergency, you must:

1. Inform the management (duty officer).

2. Call the appropriate emergency service or the Ministry of Emergency Situations - tel. 112.

3. Take measures to eliminate the accident according to the instructions.

5.5 Chapter Conclusion

In this chapter, we identified harmful and dangerous factors generated when analyzing the measurement data of gamma background on the PC, among which are:

- noise [11];
- microclimate [11];
- EMF [11];
- ionizing radiation [12].

It was found that auditorium 122 of 10 building of TPU:

- belongs to the class "safe" for electrical safety (up to 1000 V) [13];
- belongs to the class "moderately fire hazardous" for fire and explosion safety [14].

Methods of reducing the impact of harmful and dangerous factors on the researcher are described. The last subsection analyzes possible emergencies. Also described are measures to prevent them and measures to eliminate the consequences of emergencies. The most likely emergency is the occurrence of a fire in the workplace due to equipment fire.

Conclusion

It was determined that the largest amount of liquid precipitation fell in 2017 (346.2 mm) and 2020 (372.4 mm). The least amount of precipitation fell in 2016 (245.6 mm) and 2019 (203 mm).

During the analysis, it was found that the removal of all precipitation during the warm period of 2019 did not affect the result - the regression coefficients and correlations remained insignificant, and when considering a short period of time (on a synaptic scale), there is a significant correlation between the gamma background and pressure (-0.41), temperature (0.65), wind speed (0.57).

References

1. Вариации естественного гамма-фона во время выпадения атмосферных осадков / Б.Б. Гвоздевский, Ю.В. Балабин, А.В. Германенко, Э.В. Вашенюк, Л.И. Щур // Вестник Кольского научного центра РАН, 2010. – №2. – 82 С. 104 – 109. Беспалов В.И. Взаимодействие ионизирующих излучений с веществом – Томск: Изд-во ТПУ, 2007. – 369 с
2. 35. Каратаев В.Д., Яковлева В.С., Эргашев Д.Э. Исследование радиоактивности объектов окружающей среды на территории Томской области // Изв. вузов. Физика. – 2000. – Т. 43. – № 4.– С. 105-109.
3. Вариации радиационного фона и климатических параметров в северной части Азовского моря [Электронный ресурс] / И.Н. Бекман, М.А. Хасков, В.И. Пасека, Л.Е. Панаркина, Г.Б. Рязанцев. – Режим доступа: https://docviewer.yandex.ru/?url=http%3A%2F%2Fprofbeckman.narod.ru %2FER4.pdf&name=ER4.pdf&lang=ru&c=56c1e011c6f0&page=8, свободный.
4. Рябкина К.-, Кондратьева А.Г. Развитие технологии радиационного мониторинга в городской среде // Иностранный язык в контексте проблем профессиональной коммуникации: материалы II Международной научной конференции, Томск, 27-29 Апреля 2015. - Томск: ТПУ, 2015 - С. 64-65, Диплом 1 степени
5. Степаненко А.А., Рябкина К.- Влияние дождевых осадков на радиационный фон окружающей среды // Иностранный язык в контексте проблем профессиональной коммуникации: материалы II Международной научной конференции, Томск, 27-29 Апреля 2015. - Томск: ТПУ, 2015 - С. 69-70
6. Трудовой кодекс Российской Федерации от 30.12.2001 № 197-ФЗ (ред. от 30.04.2021). – URL: https://docs.cntd.ru/document/901807664 (дата обращения 20.05.2021). – Текст : электронный.
7. Кукин П.П. Безопасность технологических процессов и производств: учеб. Пособие / П.П. Кукин, В.Л. Лапин – М., Высшая

школа, 1999 – С.318.;

8. Об основах охраны труда в Российской Федерации: Федеральный закон от 17 июля 1999 № 181 – ФЗ // Российская газ. – 1999 – 24.07.– С.4.

9. ГОСТ 12.2.032-78. ССБТ. Рабочее место при выполнении работ сидя [Текст]. – Введ. 1978-04- 26. – М.: Издательство стандартов, 1978 – С.5.

10. ГОСТ Р 50923-96. Дисплеи. Рабочее место оператора [Текст]. – Введ. 1996-07- 10. – М.: Стандартинформ, 2008 – С.4.

11. СанПиН 1.2.3685-21. Санитарно-эпидемиологические правила и нормативы «Гигиенические нормативы и требования к обеспечению безопасности и (или) безвредности для человека факторов среды обитания» [Текст]. – введ. 2021-01-28.

12. СанПиН 2.6.1.2523-09 Нормы радиационной безопасности (НРБ-99/2009). − М.: Минздрав России, 2009.

13. ГОСТ 12.1.038-82. ССБТ. Электробезопасность [Текст]. – Введ. 1983-01- 07. – М.: Издательство стандартов, 1988 – С.2.

14. ГОСТ 12.1.004-91. Система стандартов безопасности труда (ССБТ). Пожарная безопасность. Общие требования [Текст]. – введ. 1991-01-01. – М.: Госстрой России, ГУП ЦПП, 1999 – С.6.

15. Воздуходувки.про. – URL: https://vozduhoduvki.pro/ (дата обращения 20.05.2021). – Текст : электронный.