

**Review
of the scientific advisor
on the dissertation work of Madina Orazgazievna Tursumbayeva
“Effect of meteorological parameters on air quality in large cities of Kazakhstan”,
presented for the defense of Ph.D. degree on educational program “8D050204-
Meteorology”**

The work of Madina Tursumbayeva addresses the critical issue of $PM_{2.5}$ pollution and the meteorological parameters affecting the concentrations of $PM_{2.5}$ in major cities of Kazakhstan and Central Asia. In 2021, Astana and Almaty experienced high annual $PM_{2.5}$ concentrations, exceeding WHO annual limits by 4.5 and 7.1 times, respectively with the maximum in winter due to higher coal consumptions for heating and unfavorable weather conditions. Using sounding data, Madina conducted an analysis of temporal variation of planetary boundary layer height (PBLH) and its effect on $PM_{2.5}$ concentrations in one of the most polluted cities in Kazakhstan, Almaty. She found that the highest 20% $PM_{2.5}$ concentrations corresponded to lower PBLH (less than 500 m AGL), and calm wind conditions (lower average wind speeds within the PBL and a lower ventilation coefficient) as well as lower air temperature and higher relative humidity. Clear negative correlation between PBLH and $PM_{2.5}$ concentrations were also obtained for major cities of Kazakhstan and Central Asia (Almaty, Astana, Ashgabat, Bishkek, Dushanbe, and Tashkent) using ERA5 reanalysis data.

Using the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPPLIT) model developed by the National Oceanic and Atmospheric Administration (NOAA), it was found that in Almaty, Bishkek, Dushanbe, and Tashkent high $PM_{2.5}$ episodes slow-moving air masses were typical (67%, 77%, 50% and 70% from the total trajectories in Almaty, Bishkek, Dushanbe, and Tashkent, respectively). However, in Ashgabat and Astana no prevailing back trajectories were found. Thus, these cities may be susceptible to regional transport of air pollutants, for example, from intensive industrial cities such as Karaganda and Pavlodar .

The dissertation work includes the issue related to official inventory estimations of pollutant emissions based on which the transportation is the main source of emissions. The work suggests that instead of summing up all the pollutants (PM, SO_2 , NO_2 , CO, and others) together, each pollutant should be characterized by its distinct sources separately. Moreover, the dissertation explores the impact of the COVID-19 lockdown on pollutant levels, particularly $PM_{2.5}$. The results showed that the concentrations during this period with the reduced transportation on the roads did not exhibit a noticeable decrease. This observation prompts a critical reassessment of existing assumptions and underscores the need for a comprehensive understanding of the factors influencing pollutant concentrations, beyond conventional expectations. The findings obtained during the dissertation work provide valuable information on air quality sensitivity to meteorological

parameters, that can be useful for the implementation of national and regional strategies for air pollution control and mitigation.

During her PhD she contributed to the following research papers which were published in the high-ranking journals:

1. Tursumbayeva, M., Muratuly, A., Baimatova, N., Karaca, F., Kerimray, A. (2023). Cities of Central Asia: New hotspots of air pollution in the world. *Atmospheric Environment*, 309, 119901. <https://doi.org/10.1016/j.atmosenv.2023.119901> (Q1, IF - 5)
2. Mukhtarov, R., Ibragimova, O.P., Omarova, A., Tursumbayeva, M., Tursun, K., Muratuly, A., Karaca, F., Baimatova, N. (2023). An episode-based assessment for the adverse effects of air mass trajectories on PM_{2.5} levels in Astana and Almaty, Kazakhstan, *Urban Climate*, 49, <https://doi.org/10.1016/j.uclim.2023.101541> (Q1, IF - 6.4)
3. Baimatova, N., Omarova, A., Muratuly, A., Tursumbayeva, M., Ibragimova, O.P., Bukenov, B., Kerimray, A. (2022). Seasonal Variations and Effect of COVID - 19 Lockdown Restrictions on the Air Quality in the Cities of Kazakhstan. *Environmental Processes*. <https://doi.org/10.1007/s40710-022-00603-w> (Q3, IF - 4.4)
4. Tursumbayeva, M., Kerimray, A., Karaca, F., Permadi, D. A. (2022). Planetary Boundary Layer and its Relationship with PM_{2.5} Concentrations in Almaty, Kazakhstan. *Aerosol and Air Quality Research*, 22(8), 210294. <https://doi.org/10.4209/aaqr.210294> (Q2, IF - 4.0)

From November 2022 to January 2023, she successfully completed a research internship at the Institute of Atmospheric and Earth System Research (INAR) at the University of Helsinki in Finland in Helsinki (Finland). During her research internship, she played an active role in a project focused on evaluating the performance of the WRF-CHIMERE modeling system in simulating meteorological parameters and PM_{2.5} levels for both Beijing (China) and Almaty (Kazakhstan). She successfully accomplished all the planned tasks and continues to collaborate with INAR to finalize the research findings for publication in a research article.

Madina presented the results of her research studies at the several conferences of national and international levels:

1. Tursumbayeva, M. (2021). Air particulate pollution in Almaty, Kazakhstan. *Farabi Alemi*, Almaty, Kazakhstan
2. Tursumbayeva, M., Kerimray, A. (2022). Temporal variations in PM_{2.5} pollution in the major cities of Central Asia. *Asian Aerosol Conference 2022*, Taipei, Taiwan

3. Tursumbayeva, M. (2023). Impact of meteorological factors on PM_{2.5} concentrations in Almaty. *Second Central Asian Air Quality Conference*, Astana Kazakhstan.

4. Tursumbayeva, M., Baimatova N. (2023). Cities of Central Asia: New Hotspots of Air Pollution in the World. *5th International Environmental Chemistry Congress*, Antalya, Turkey.

Madina Tursumbayeva actively participated in the execution of the following research projects: AP09260359 "Comprehensive assessment of air pollution in Almaty: source-apportionment, spatiotemporal assessment" (2021-2023) and BR10965258 "Development of a research program to improve air quality in Nur-Sultan and Almaty using state-of-the-art analytic methods and modeling tools" (2021-2023) funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan.

During the study, Madina Tursumbayeva showed herself as qualified, hardworking, and motivated scientist, able to independently conduct her own research.

In general, I am pleased with Madina's achievements during her PhD program. The research work that has been done during her PhD program is a valuable contribution to understanding the interaction between meteorology and air pollution in the cities of Kazakhstan and Central Asia region. Madina Tursumbayeva has succeeded to publish several research papers in high impact factor journals (Q1-Q3). The results presented in the dissertation work "Effect of meteorological parameters on air quality in large cities of Kazakhstan" by Madina Tursumbayeva meet the criteria for Ph.D. dissertations in specialty Meteorology and I recommend it for public presentation.

Scientific supervisor, Ph.D.



Aiymgul Kerimray