Air pollution, water scarcity, and climate change are among the greatest challenges of our time. Many of the tiny particles floating in the air—called aerosols—originate from chemical reactions between polluted air and volatile organic compounds emitted by vegetation. For example, when pine trees release scents and essential oils into the air, they can change in the atmosphere and form solid or liquid particles. Aerosols affect the air we breathe and the way clouds form; they can even change how much sunlight reaches the Earth's surface and influence cloud formation and participation.

This project will study how aerosols form and change following chemical reactions in atmospheric water particles and clouds. Atmospheric scientists know that these changes are important, but we still don't understand them very well. For this reason, our research team will combine laboratory experiments with computer models that simulate how aerosols are formed and transformed in the presence of water-containing particles.

One of the main goals of this project is to analyze how the aerosols formed from natural gases emitted by trees interact with clouds. Such data will help improve tools that can predict how other, similar compounds behave, including organic pollutants emitted by forest fires or vehicular traffic. Our team will also use advanced computer programs supported by artificial intelligence to make these predictions faster and more accurately. We will test these new models using carefully designed experiments, including measurements performed in a special environmental chamber that mimics aerosol formation in the atmosphere. These reactors use advanced instruments to analyze chemical changes occurring in the aerosol particles; these results will verify if the computer predictions match the experimental data.

The improved model will be used to study air quality and climate across larger areas, using regional-scale models will be developed at the final stage of the project. Similar models, but without the detailed chemistry embedded into them, are used in weather forecasts. The results will help us to better understand how natural organic compounds and human activity affect air pollution and the climate. This project brings together chemistry, environmental, and computer sciences to improve our understanding of air pollution and support better policies and regulations that protect health and the environment.