Climate change could change the air that we breathe: NTU study

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Each gulp of air humans take contains more than just oxygen. PHOTO: ST FILE

PUBLISHED 7 HOURS AGO

SINGAPORE - When it comes to the impact of climate change, nations are on guard for the major ones: Rising sea levels. Droughts or floods. Extreme weather events.

But a warming world may have more insidious repercussions, with a new study led by researchers at the Nanyang Technological University (NTU) showing that climate change could also affect the very air we breathe.

Each gulp of air humans take contains more than just life-giving oxygen. It is also populated with micro-organisms such as bacteria and fungi, each too small to be seen with the naked eye.

By studying air samples taken at different heights from ground level and up to 3,500m, researchers at NTU's Singapore Centre for Environmental Life Sciences Engineering have shown that as the world warms, the composition of micro-organisms in the air could change.

Their paper was published on Tuesday (Feb 8) in the scientific journal Proceedings Of The National Academy Of Sciences Of The United States of America.

There are already indicators showing that airborne micro-organisms can impact human health and agriculture, said NTU's Professor Stephan Schuster, who supervised the latest work. So a changing composition of the air microbiome - micro-organisms in the air - could have implications for human societies, he added.

For example, Prof Schuster's team had found earlier that while healthy people did not suffer ill effects from breathing in micro-organisms from the air, people with respiratory diseases showed an increased immune response, worsening their respiratory symptoms.

"Any change in the dynamics of airborne microbial communities could impact respiratory health in an as-yet unknown - and therefore potentially concerning - way," Prof Schuster told The Straits Times.

As global temperatures warm, heat-tolerant micro-organisms that thrive in tropical climates could spread to higher latitudes, affecting biodiversity and agriculture there.

"This could change disease dynamics for various crop species, and potentially also livestock, which are not adapted to tropical airborne microbial communities," Prof Schuster added.

Life in the air

Atmospheric micro-organisms such as fungi and bacteria usually remain suspended in the air once they are blown off the planet's surface.

Only a fraction of these find their way back down to the surface, together with larger particles such as sand grains or dust, or when washed down by rain droplets.

For the latest research, which involved more than 30 scientists from NTU as well as their collaborators from institutions in Germany and Brazil, the team took 480 air samples in Germany.

The samples were collected by researchers scaling a 200m meteorological tower, and using a research aircraft that circled at different heights from ground level up to 3,500m.

From the samples, the researchers could identify about 10,000 airborne microbial organisms, and map out where in the air column they were found.

They found that the part of the air column from the ground up to about 1,000m - where the boundary layer is - is rather evenly mixed during the day.

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The link between micro-organisms and air circulation

The boundary layer is the part of the atmosphere closest to the ground and is the part of the air column that is most intimately affected by the ground, through interactions with solid earth or water surfaces.

For instance, when the sun beats down on Earth, the ground warms up faster than the air.

But the ground re-radiates heat, causing the air parcel closest to it - and the micro-organisms it contains - to warm and rise up the air column.

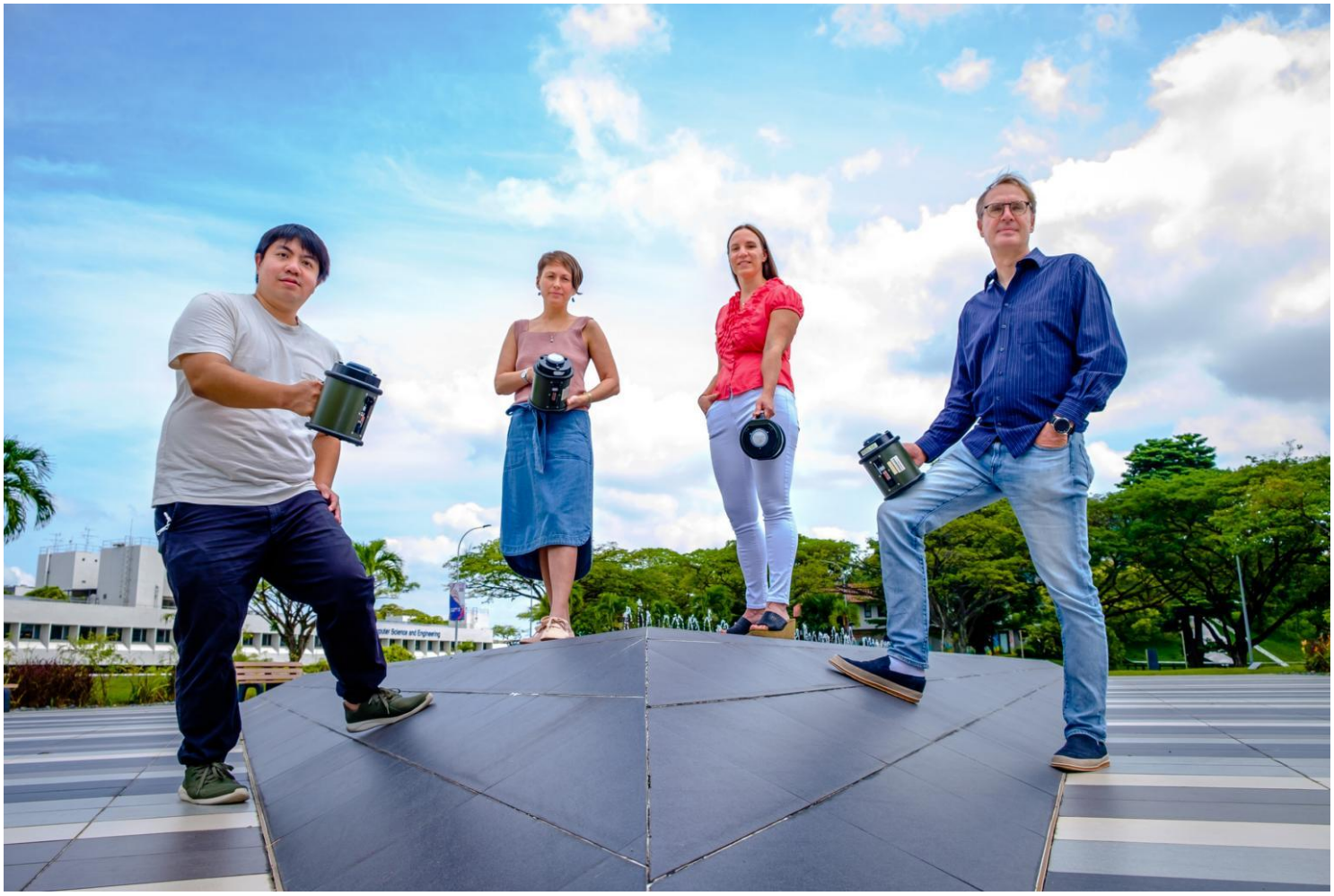
This continues throughout the daylight hours, with air parcels closest to the ground constantly being moved up within the boundary layer in turbulent fashion.

At night, however, without the heating effect of the sun, the air in the boundary layer becomes more stratified, or layered, with the warmer, less dense air parcel sitting atop cooler air parcels closer to the ground.

Said Prof Schuster: "This means that airborne microbial organisms remain suspended in the air during night time as their return to the ground is impeded by the denser air masses."

This effect is also the reason hazy mornings tend to clear up after the sun rises fully, when the ground starts to heat up , causing air closest to it - and the suspended particles they contain - to rise.

The research team found there is a varying air microbiome composition within the boundary layer over the course of a day. Daytime hours were characterised by larger amounts of bacteria and certain types of fungi, while wood-rotting fungi thrive at night.



Above the boundary layer, however, the composition of micro-organisms did not change, regardless of day or night.

These stable upper air layers are not affected by daytime circulation patterns in the boundary layer, as the day and night temperatures above the boundary layer are the same.

The researchers think the lack of temperature changes over the course of a day prevents bacteria in the higher layers from returning to the ground.

At the stable upper levels above the boundary layer, the researchers also found the presence of bacteria that can tolerate higher amounts of solar radiation.

This means these organisms can survive the sun's shortwave radiation, unlike more sensitive micro-organisms living on the ground.

How climate change could change the air we breathe

These findings, say the researchers, indicate that temperature would be a key factor in changing the composition of the air microbiome.

The reason for this lies in the changing height of the boundary layer.

In a warmer world, higher surface temperatures can raise the height of this layer.

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"As air near the surface heats up, it ascends through the atmosphere, pushing the upper boundary higher," said Prof Schuster.

A higher boundary layer would mean that the part of the air column affected by day-night circulation patterns overlaps with the previously stable parts of the atmosphere, where a greater abundance of bacteria thrive.

This could mean that all airborne bacteria and fungi, including those that can act as plant pathogens or cause respiratory illnesses in humans and animals, could reach densely populated areas of human societies that are currently unaffected.

How exactly the changing composition of micro-organisms in the air could affect human health and ecosystems warrants further research, Prof Schuster said.

He added that the team hopes to conduct similar studies in other global settings, in indoor and outdoor environments, to investigate the composition of the air microbiome elsewhere.

(From left) team leader NTU Prof Stephan Schuster, Research Director (Meta-'omics & Microbiomes); Dr Daniela Moses Deputy Research Director (Meta-'omics & Microbiomes); Dr Elena Gusareva, Research Fellow, and Dr Irvan Luhung, Senior Research Fellow, who are holding air samplers used in their air microbiome research. PHOTO: NTU

Prof Schuster's key message?

"Look up - there are microbes in the sky," he said, in reference to the popular Netflix satirical film Don't Look Up.

The movie had, through the prism of global reaction towards a fictional comet hurtling towards Earth, highlighted political and media indifference to climate change.

"Changes to the planet's airborne micro-organisms driven by climate change could impact agricultural crops and our yields in food production," said Prof Schuster.