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Pan-European Study of Pesticides long-range Atmospheric Transport (PESPAT)

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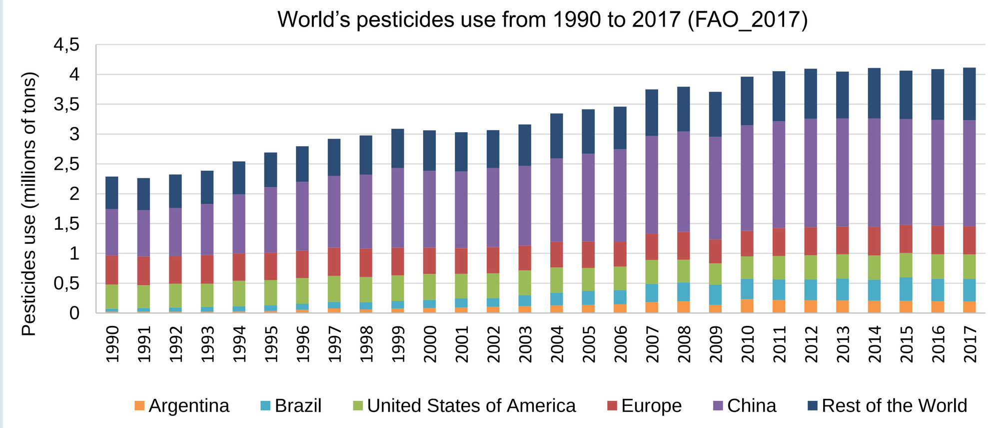
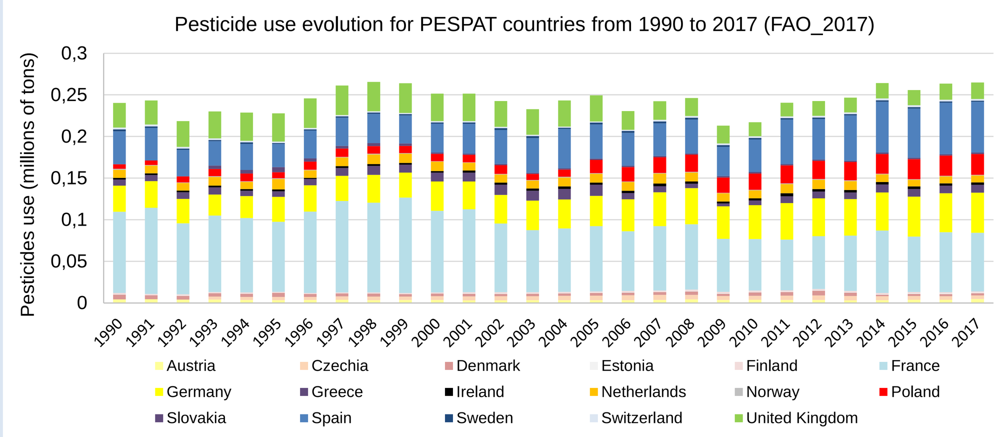
Introduction

Modern day pesticides were introduced to the world of agricultural production in the 1940's and consisted mainly of organochlorine pesticides (OCPs) which were intensely used around the world. Since the 1960's, concerns regarding OCPs' persistence, bioaccumulation potential and toxicity arose. Therefore, these compounds have been banned within the Stockholm Convention on persistent organic pollutants.
They were then replaced by current-use pesticides (CUPs) that were thought to be more environmentally friendly due to their lower persistence and non-target toxicity than OCPs. However, serious concerns rose in the last decade regarding their environmental fate and impact on human health (Xia et al., 2020). Despite that, their use has never stopped and has even increased over the years. The global use of pesticides was amounting in 2017 to 4.1 x 10^6 tons worldwide (FAO, 2017).

CUPs can enter the atmosphere upon application (spraying) and volatilisation from soil and plant surfaces (Van den Berg et al., 1999). Once they do, CUPs partition between the gaseous and particulate phase based on their physico-chemical properties as well as meteorological parameters (Schumer et al., 2010).

Information on the distribution of CUPs in air is only available for few European countries (e.g. France, Spain, Czech Republic), usually limited to only few sites. Moreover, most of previous studies addressed the rural (near-source) environments, while almost no data are available for remote sites, such as high mountains or polar sites, crucial for assessing long–range atmospheric transport. Therefore, there is a real need to fill this gap by providing a snapshot of the CUPs occurrence in air over Europe during the main pesticide application period.





Objectives of the study

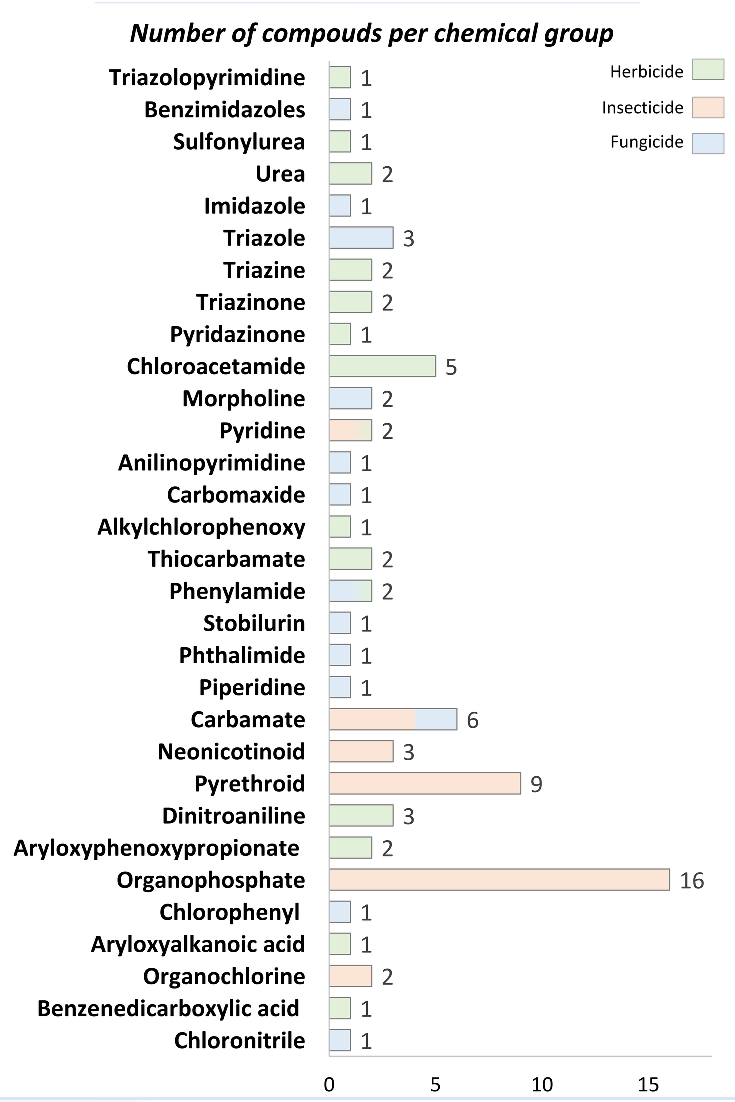
The main aims of the PESPAT study are to:

- identify the CUPs prone to long–range atmospheric transport (based on results from the high mountain/polar sites)
- report on CUPs atmospheric levels at sub-alpine and lowland rural/ remote sites in Europe in spring 2020
- identify the spatial variations in CUPs occurrence at the European level
- improve the current knowledge on gas-particle partitioning of CUPs under different atmospheric conditions

Methodology

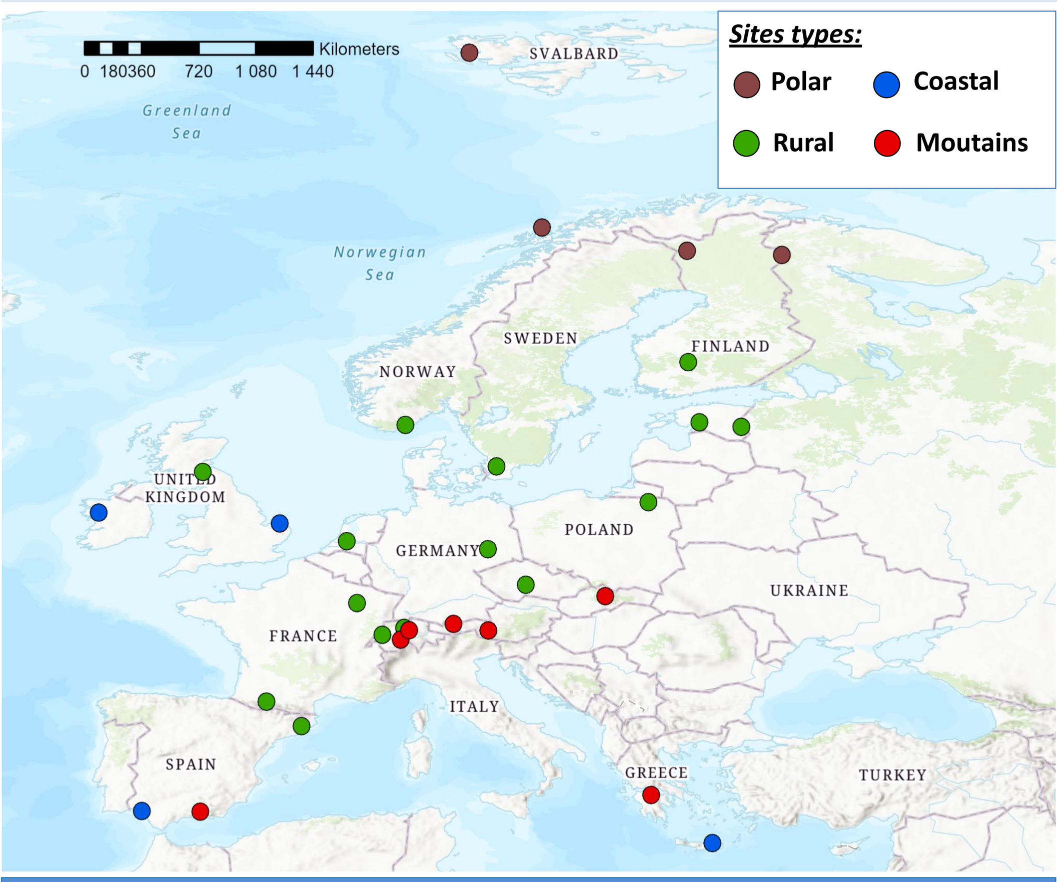
CUPs selection

The CUPs studied were chosen based on their potential for long–range atmospheric transport, their chemical classes or to their previous occurrence in air.
The selected 78 CUPs are distributed over 31 chemical groups.



Sampling sites

A total of 30 sites across 17 countries participated to this sampling campaign.
Based on their characteristics, these sites were then classified into four categories



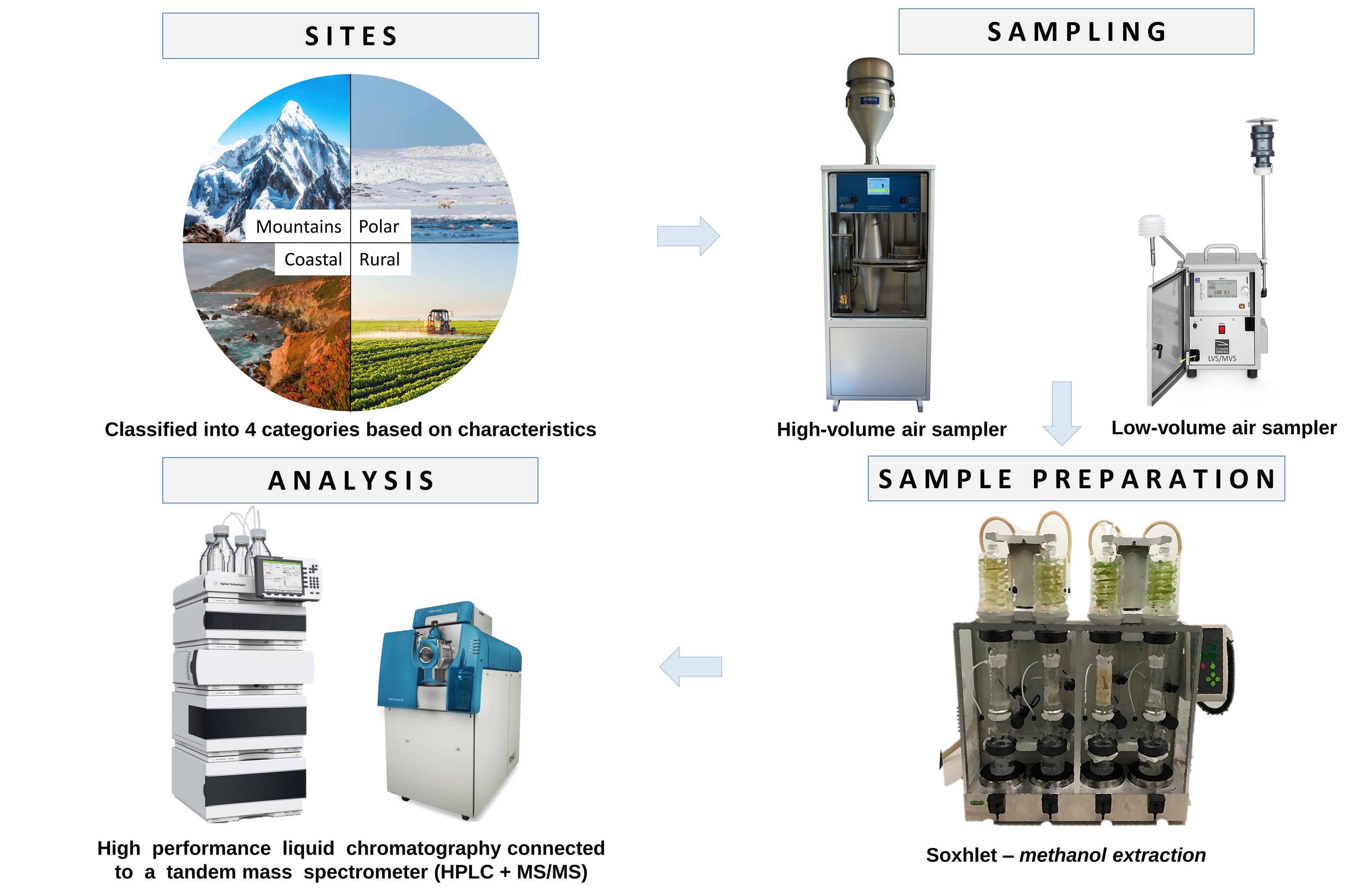
Sampling period

The sampling campaign took place over a month period with sampling occurring every second week from the 28th of April to the 28th of May.
During each of the sampled week, one 48 hours sample was collected.

Sampling + sample processing

The usage of low and high-volume air samplers was done at sites collecting:
- the particulate phase using quartz fiber filter
- the gaseous phase using sandwich configuration (PUF/XAD2/PUF)

Depending on sites limitations, only the particulate phase was sampled.
Each participating site was requested to collect at least one field blank during the sampling campaign.

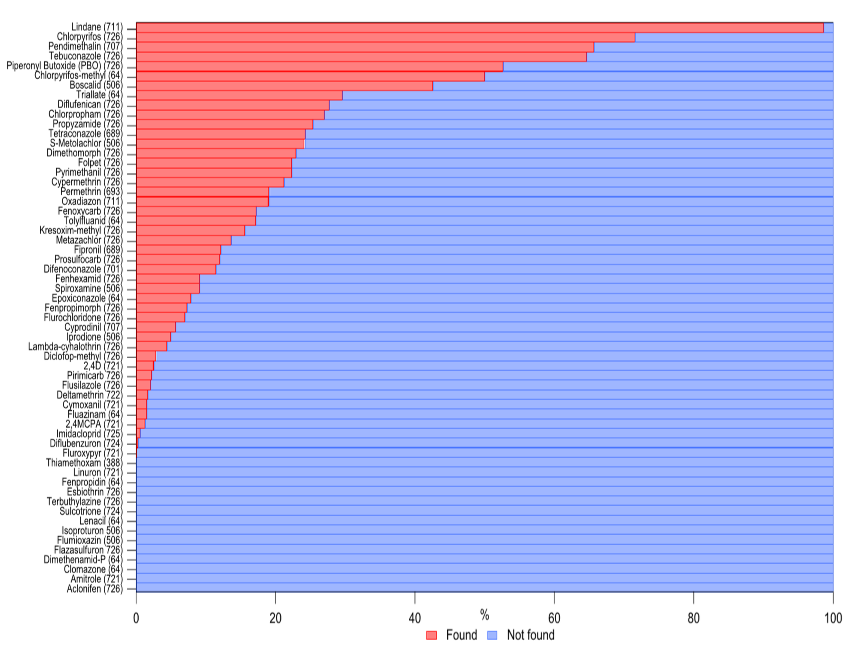


Expected results

(as the campaign is still ongoing, this section will be used to showcase the types of results that will be expected)

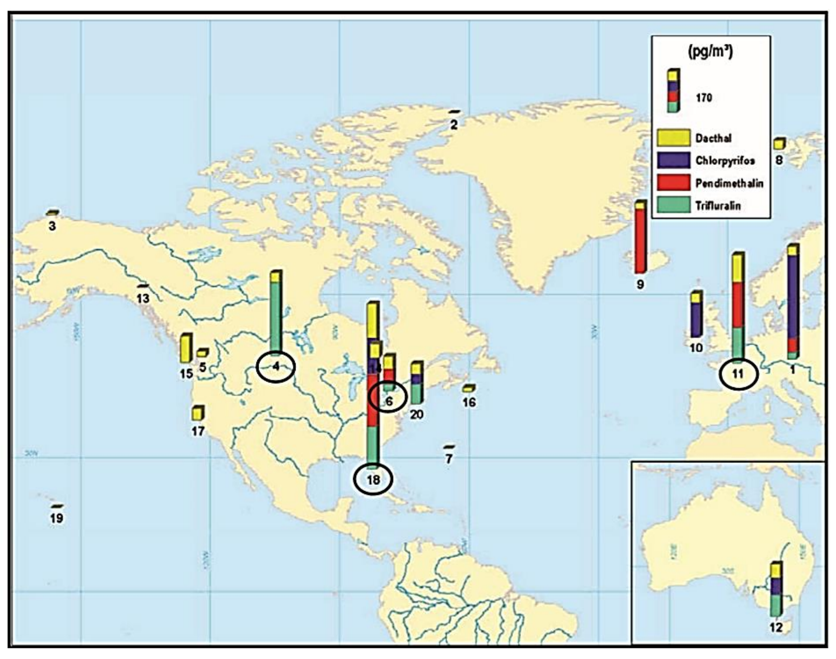
Detection frequency (Désert et al., 2018)

Presence/absence of CUPs will be assessed across all sites, and on a characteristics basis



Comparison of particulate CUPs concentrations (Kobližková et al., 2012)

CUPs concentrations found in the gaseous and particulate phases will be compared at the European Scale



Gas-particle partitioning (Qiao et al., 2019)

Concentrations gathered from gaseous and particulate will be used to validate gas-particle partitioning models.

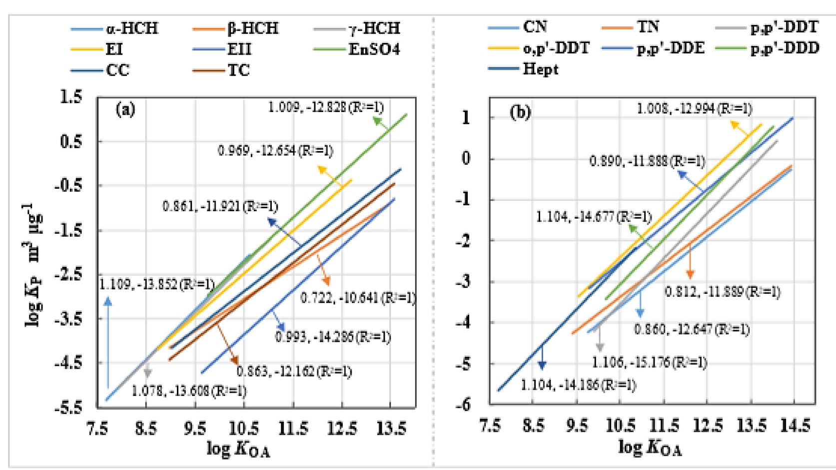
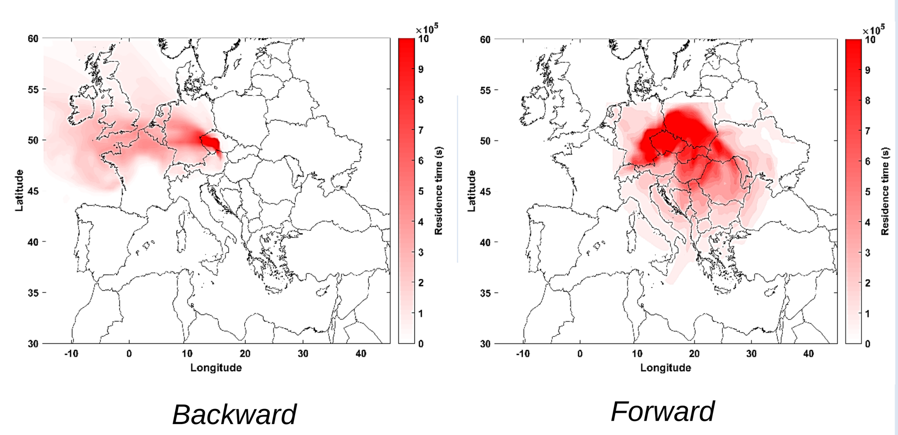


Fig. S4 Predicted log K_P versus log K_{OA} for 15 OCPs by pp-LFER model (-40°C~+23 °C). The numbers with the arrows are the slope and intercept for each line.

Long-Range Atmospheric Transport (Degrendele et al., 2018)

Based on meteorological data, backward as well as forward advected air parcels' residence time distribution will be assessed for each sample collected.



Scientific impact

Absence of potential for long-range atmospheric is prerequisite for CUPs registration into the European market. However, evidence that some CUPs have been reaching the Arctic via long-range atmospheric transport from Europe exists (Balmer et al. 2019). Considering the regulative context, this project will be able to verify the presence of CUPs in remote areas, such as high mountains and polar adjacent station, as well as their capability of long-range atmospheric transport.

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