Federal Policy Research

Annual activity report

2024/05 – 2025/04 | PASPARTOUT

[RT/23/PASPARTOUT]

Pathways of particles, VOCs and moisture into East-Antarctica in a changing climate

https://ozone.meteo.be/projects/paspartout

[Alexander MANGOLD]
[Royal Meteorological Institute of Belgium]
[alexander.mangold@meteo.be]
[0032-(0)2-3730-593]

[Nicole VAN LIPZIG] – [Katholieke Universiteit Leuven]
[Christophe WALGRAEVE] – [Universiteit Gent]
[Nadine MATTIELLI] – [Université Libre de Bruxelles]

The Report is drawn up by the Coordinator for the entire network and sent to the address: impuls@belspo.be on the dates set in article 7.6 of annex I to the contract. It presents the state of progress and achievements of the research, as well as forecasts for the following of the project. This information refers explicitly to the tasks and the project schedule defined in articles 2 and 3 of annex I. It also informs of any modification of the data included in the initial and earlier activity reports and gives the list of publications and missions carried out during the past year. This template must be completed in English.

1. EXECUTIVE SUMMARY OF THE REPORT

Pathways of particles, VOCs and moisture into East Antarctica in a changing climate

Current knowledge on the interaction between clouds, atmospheric particles, and VOCs, as well as on the atmospheric transport and transformation pathways of atmospheric compounds in Antarctica is still limited. This is unfortunate, as Antarctica is not only a key region for the evolution of the future global climate, but also very sensitive to a changing climate. The main objective of PASPARTOUT is, (i) establishing an in-depth understanding of the links between atmospheric circulation patterns, weather regimes, particles, VOCs and moisture, (ii) determining the source regions and origin (natural, anthropogenic) of organic and inorganic compounds, and (iii) investigating implications and changes within a changing global climate.

The objectives of PASPARTOUT are:

- PASPARTOUT will establish an in-depth understanding of the links between atmospheric circulation patterns, weather regimes, particles, VOCs and moisture;
- PASPARTOUT will characterise VOCs and partially oxidised VOCs in an unprecedented way and improve the understanding of their degradation pathways and seasonal patterns;
- PASPARTOUT will characterise the seasonal patterns of metals and rare earth elements, and Pb, Sr and Nd isotopes;
- Understanding the seasonal variability in the sources of nitrate in Antarctica through the measurement of nitrate isotopes (δ15N, δ18O, Δ17O);
- PASPARTOUT will determine the source regions and atmospheric transport pathways of organic and inorganic compounds;
- PASPARTOUT will investigate implications and changes to the before-mentioned points within a changing global climate.

PASPARTOUT started in February 2023 and the reporting period is thus for the second project year. The main tasks were to analyse data and to prepare the BELARE 2024-2025 expedition to Princess Elisabeth station. Several meetings of the project partners took place:

- Belare 2023-2024 debriefing meeting at RMI Brussels, 9 April 2024
- Project progress meeting in Ghent, 4 July 2024
- Belare 2024-2025 debriefing meeting at ULB 25 April 2025

Besides these meetings there were several (in-person, online) meetings between project partners and with the International Polar Foundation in order to discuss practical project points and preparation of the Belare expedition.

One member of PASPARTOUT participated in the Belare 2024-2025 expedition: Paula Lamprea of Ghent University. She stayed at Princess Elisabeth station (PES) from mid-January 2025 to mid-February 2025. During her stay she completed the foreseen tasks successfully. The sampling system for year-round passive (6 samples + 4 blanks) and active collection of VOCs (ATS; 50 samples + 5 blanks) on the southern science shelter at PES was checked, and the samples were collected. These samples are now being analysed and interpreted at Ghent University.

Two new VOC sampling systems with a stronger engine, and after some code improvements, were installed last season. One at L0 near the coast (70.53716°S, 24.19750°E), in between IPF's AWS and ULB's sampler. This ATS is powered by 6 batteries, which are recharged by a solar panel and a wind turbine. Next to it, a passive sampler (6 samples + 4 blanks) was also installed. The second ATS was installed at PES as a replacement for the previous ATS located on the southern science shelter.

The automatic (year-round) sampling system for inorganic analysis was visited. However, the sampling system motor did not work in winter 2024 and therefore no good samples could be collected. The system has been prepared for winter 2025 operation. In addition, two large snow pits were done in order to collect snow samples. These samples are on the way back to Belgium via cold chain cargo transport.
Further, the instrumentation of the atmospheric observatory (aerosol instruments, cloud and precipitation instruments, total ozone and uv radiation instrument, and radio soundings by weather balloons) has been successfully maintained.
The project is thus in schedule. Planning for the coming Belare expedition 2025-2026 has already started.
Also, PASPARTOUT related results have been published and presented in peer-reviewed articles, at scientific conferences and have been stored at referenced data repositories (see section 9).

The coordinates of the coastal sample sites are:
Site 1; large snow pit and automatic inorganic sampler = 70°32'11.93"S 24°12'30.25"E;
Site2; second snow pit = 70°32'9.03"S 23°59'15.60"E
Site 3; 70.53716°S, 24.19750°E; automatic VOC sampler

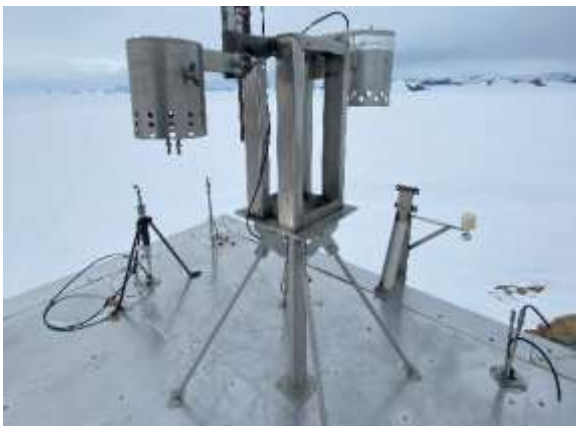

Image left: auto-sampler for organic analyses on the southern science shelter at PEA; image right: new installed auto-sampler for VOC near the coast



Image left: installation of the automatic sampler for inorganics; image right: snow pit and sampling near the coast

2. PROMOTOR(S)

2.1. coordinator (partner 1)

1. Dr. Alexander MANGOLD, Royal Meteorological Institute of Belgium

2.2. Other partners

2. Prof. Dr. Nicole VAN LIPZIG, Katholieke Universiteit Leuven

3. Prof. Dr. Christophe WALGRAEVE, Universiteit Gent

4. Prof. Dr. Nadine MATTIELLI, Université Libre de Bruxelles

3. PROJECT WEBSITE, SOCIAL MEDIA …

[https://ozone.meteo.be/projects/paspartout]
[https///belatmos.blogspot.be]
[https://ozone.meteo.be/projects/paspartout/expedition-belare-2024-2025] / report for the BELARE expedition 2024-2025 of Paspartout Pax
…

4. PROGRESS REPORT

4.1. GENERAL DELAY

If your project has been delayed in general due to a late start, please indicate it on the table here below and do not take this general delay into account on the tables referring to the tasks (point 3.2.)

A. Has the beginning of your project been delayed?	☐ Yes	☒ No
B. How many months has the beginning been delayed from the starting date indicated in the contract?	[number of months]	

REASON FOR THE DELAY

Not applicable

4.2. PROGRESS OF THE PROJECT

WP= Work Package; T =Task; D =Deliverable
List the Work Packages, the Tasks and the Deliverables of your project.
Add as many lines as needed to each work package, and as many work packages are required.
PROGRESS COLUMN:

- *Assess each task by indicating: 25% - 50% - 75% or 100% in accordance to its completion.*
- *Indicate the achievement of deliverables by crossing the box it if has been accomplished.*

DELAY COLUMN:

- *Indicate when a task has been delayed in relation to the Gantt chart of Annex I of the contract, by crossing the box.*

WP 1: **Project coordination, management, reporting**

			Progress	Delay
T.1.1.	**T1.1: Coordination activities**		continuous	☐
	D.1.1.1		☐	
	D.1.1.2		☐	
	D.1.1.3		☐	
T.1.2.	**Interaction between project partners**		Continuous	☐
	D.1.2.1		☐	
	D.1.2.2		☐	
	D.1.2.3		☐	
T.1.3	**Reporting activities**		50%	
	D.1.3.1	Initial report	☒	
	D.1.3.2	Progress meetings	☒	
	D.1.3.3	Annual report 2024	☒	
	D.1.3.4	Annual report 2025	☒	

WP 2: **Organics – Sampling strategy, innovative analytical methods and VOC analysis**

			Progress	Delay
T.2.1.	**Active sampling**		50%;	☐
	D.2.1.1	Operational sequential sampler for (po-)VOCs	☒	
	D.2.1.2		☐	
	D.2.1.3		☐	
T.2.2.	**Development and optimisation of new methods**		75%	☐
	D.2.2.1	Target method for (po-)VOC developed and optimized	☐	
	D.2.2.2	Non-target method based on TD-GCxGC-Orbitrap HRMS for (po-)VOC developed and optimized	☐	
	D.2.2.3	non-Target method based on TD-PTR-Time-of-flight-HRMS for (po-)VOC developed and optimized	☐	
T.2.3	**Understanding** the seasonal variances in atmospheric composition of (po-)VOCs		Planned in year 3	☐
	D.2.3.1	Understanding of degradation pathways, and seasonal patterns are investigated	☐	
	D.2.3.2		☐	
	D.2.3.3		☐	

WP 3: **Dust and inorganic compounds in air and snow**

			Progress	Delay
T.3.1.	**Sampling of airborne particles and particles from snow pit sample**		50% Done for year 1	☐
	D.3.1.1	Operational sampling system for airborne particles and snow pit samples taken	☒	
	D.3.1.2		☐	
	D.3.1.3		☐	
T.3.2.	**Seasonal records of dust deposition rates, morphology and chemical composition**		25 %	☐
	D.3.2.1	from airborne samples (size, shape, number)	☐	
	D.3.2.2	from snow pit samples (crystallography and density throughout the two snow profiles) (size, shape, number, …) / bulk trace element concentration	☐	
	D.3.2.3		☐	
T.3.3	**Metal-bearing nano-particles in snow composition analysis from snow pit**		50 %	☐
	D.3.3.1	nano-particle analysis	☐	
	D.3.3.2		☐	
	D.3.3.3		☐	
T3.4	**Nitrate concentration and isotopes: analysis of reactive nitrogen atmospheric chemistry**		0 %	☐
	D3.4.1	analysis of nitrate and its isotopes from airborne particles and snow pit samples	☐	
			☐	

WP 4: **Physical particle properties and complementary data**

			Progress	Delay
T.4.1.	**Complementary data at coastal site: data from optical particle sizer, disdrometer, meteorology**		50%	☐
	D.4.1.1	data analysed from instrumentation at coastal site	☐	
	D.4.1.2		☐	
	D.4.1.3		☐	
T.4.2.	**Complementary data from atmospheric observatory at PES**		67%	☐
	D.4.2.1	data analysed from cloud and precipitation observatory at PE	☒	
	D.4.2.2	data analysed from aerosol observatory and further complementary data at PES	☒	
	D.4.2.3		☐	

WP 5: **Present-day atmospheric dynamics and air mass origin**

			Progress	Delay
T.5.1.	**Air mass tracing current climate/meteorology: applying Flextra and Flexpart to present-day conditions**		50%	☒
	D.5.1.1	back trajectory analysis and cluster analysis	☐	
	D.5.1.2	dispersion modelling with Flexpart	☐	
	D.5.1.3		☐	
T.5.2.	**Weather patterns and links with observations at PES: model data analysed and linked to observations**		80 %	☒
	D.5.2.1	East Antarctic weather patterns derived and related to observed data	☒	
	D.5.2.2		☐	
	D.5.2.3		☐	
T.5.3	**Climate modelling cloud-aerosol interaction: assessment of aerosol effect per weather type**		50%	☐
	D.5.3.1	Assessment of the aerosols effect per weather type	☒	
	D.5.3.2		☐	
	D.5.3.3		☐	

WP 6:: **Future atmospheric dynamics, air mass origin and impact on particles, VOC, moisture**

WP was planned to start in last year of project

			Progress	Delay
T.6.1.	*Future weather patterns from CMIP6: model data analysed and implications for atmospheric properties;* replaced by: **Explaining recent trends in the atmospheric branch of the hydrological cycle and cloud properties**		Adapted 95%	☐
	D.6.1.1	East Antarctic future weather patterns derived and implications for atmospheric properties	☐	
	D.6.1.2		☐	
	D.6.1.3		☐	
T.6.2.	**Air mass tracing future climate/meteorology: applying Flextra and Flexpart to CMIP6 meteorology**			☐
	D.6.2.1	back trajectory analysis and cluster analysis	☐	
	D.6.2.2	dispersion modelling with Flexpart	☐	
	D.6.2.3		☐	

WP 7: **Data management**

Task 7.2 starts only in second half of 2024

			Progress	Delay
T.7.1.	**Data secured locally with partners: data storage at partner institutes**		Continuous	☐
	D.7.1.1	Data of each partner stored and secured at partner institutes	☐	
	D.7.1.2		☐	
	D.7.1.3		☐	

T.7.2.	**Data stored/secured at national/international data bases: data submitted to referenced data bases**		Continuous	☐
	D.7.2.1	Data of PASPARTOUT submitted to referenced data bases	☐	
	D.7.2.2		☐	
	D.7.2.3		☐	

WP 8: **Valorisation, Dissemination, Exploitation**

See also section 9 of this report

			Progress	Delay
T.8.1.	**Data and results published to scientific community**		Continuous	☐
	D.8.1.1	Data and results published to scientific community	☐	
	D.8.1.2		☐	
	D.8.1.3		☐	
T.8.2.	**Data and results communicated to stakeholders**		Continuous	☐
	D.8.2.1	Data and results communicated to stakeholders	☐	
	D.8.2.2		☐	
	D.8.2.3		☐	
T.8.3	**Results communicated to general public and project website operational**		Continuous	☐
	D.8.3.1	Results communicated to general public and website operational	☐	
	D.8.3.2		☐	
	D.8.3.3		☐	

5. REPORT ON ACHIEVEMENTS

5.1. SPECIFIC OBJECTIVES ACCOMPLISHED

List the Specific Objectives stated in Annex I and signal which of them have been achieved by putting 'X' in the 'Accomplished' column.

PASPARTOUT has the scientific deliverables as mentioned in section 4. There are no further specific objectives, however, the project has several scientific goals:

A) PASPARTOUT will establish an in-depth understanding of the links between atmospheric circulation patterns, weather regimes, particles, VOCs and moisture;
B) PASPARTOUT will characterise VOCs and partially oxidised VOCs in an unprecedented way and improve the understanding of their degradation pathways and seasonal patterns;
C) PASPARTOUT will characterise the seasonal patterns of metals and rare earth elements, and Pb, Sr and Nd isotopes;
D) Understanding the seasonal variability in the sources of nitrate in Antarctica through the measurement of nitrate isotopes (δ15N, δ18O, Δ17O);
E) PASPARTOUT will determine the source regions and atmospheric transport pathways of organic and inorganic compounds;
F) PASPARTOUT will investigate implications and changes to the before-mentioned points within a changing global climate.

None of them is at this phase of the project accomplished, each project task contributes to one or the other objective.

In the following section 5.2 we describe per objective the tasks which contributed to the progress of accomplishing the objective

5.2. CONTRIBUTION OF THE SPECIFIC OBJECTIVES TO THE GOAL OF THE PROJECT

Briefly explain how the accomplished objectives drive the project closer to its goal. Signal which tasks and deliverables have led to their accomplishment. Mention the target groups reached. Duplicate the table as needed.

A) PASPARTOUT will establish an in-depth understanding of the links between atmospheric circulation patterns, weather regimes, particles, VOCs and moisture;

Task 4.1: Complementary data at coastal site: data (meteorology)
The small meteorological data logger has been installed in January 2024 near the coast next to the auto-sampler for inorganic samples. Its data has preliminary been analysed and almost the whole year period (Jan-2024 to Jan-2025) is available.
Task 4.2: Complementary data from atmospheric observatory at PES
The data of the cloud and precipitation observatory (ceilometer, MRR) are continuously retrieved, checked and stored in the KUL database. The datasets are publicly accessible through the KU Leuven RDR (https://doi.org/10.48804/07SS6R and https://doi.org/10.48804/MDDKU0) and are updated there annually. The data of the aethalometer and nephelometer for physical aerosol properties are also continuously retrieved and analysed.
task 5.1: Air mass tracing current climate/meteorology: applying Flextra and Flexpart to present-day conditions; please refer to objective E)
task 5.2: Weather patterns and links with observations at PES: model data analysed and linked to observations
At KUL, the classification of ceilometer cloud observations into different cloud categories has been completed. Based on these classification results, the analysis linking weather observations at PES with large-scale atmospheric dynamics has also been almost finalized. ERA5 geopotential data was clustered into weather patterns using SANDRA (simulated annealing and diversified randomization, https://doi.org/10.1175/JCL4175.1) for the entire period (2010-2025) for which cloud observations are available, which were then correlated to the observed cloud type. Given the results of the paper mentioned in task 5.3 (https://acp.copernicus.org/articles/24/13751/2024/) and of the cloud classification, we restricted the analysis to the summer periods. This is because one of the core findings in the paper was that INP concentrations do not have a significant impact during the winter. This work will be finalized in the coming month.
task 5.3: Climate modelling of the cloud-aerosol interaction
We have studied the effect of different INP concentrations on the representation of clouds including the presence of liquid water in clouds and their radiative impact for an extensive set of cases. For this we used the regional climate model COSMO-CLM^2. Part of this work started in the CLIMB project, but was finalized in PASPARTOUT, and a peer-reviewed publication is currently available in atmospheric chemistry and physics (https://acp.copernicus.org/articles/24/13751/2024/). The model setup used here has been adapted to allow real INP concentration measurement profiles to be used in the aerosol module, as opposed to the parametrization used before. This adapted model will be applied to study the cloud-aerosol interaction for different weather types using the INP filter measurements taken during the CLIMB campaign, which will be scaled up or down to test the weather types' sensitivity.
Target groups reached: scientific community by presentations at conferences and publications in journals (see section 9).

B) PASPARTOUT will characterise VOCs and partially oxidised VOCs in an unprecedented way and improve the understanding of their degradation pathways and seasonal patterns;

Sampling instrumentation has been set up (**task 2.1**).
Task 2.2.1: Target method for (po-)VOC developed and optmised:
Task 2.2.2: Non-target method developed and optimized
Task 2.2.3: Non-target method based on TD-PTR-time of flight HRMS developed and optimized

The development of a target method for VOCs and po-VOCs in TD-GC-HRMS has been conducted in the first two years of the project. A literature review on VOCs and po-VOCs in polar regions, their reactivity, effect on secondary organic aerosol formation and future implications in a changing climate is being done. From this literature study and previous research, a broad range of VOCs and po-VOCs have been selected for which the analytical method has been developed and optimized. The developed method is now fine-tuned for the analysis of the samples that are now being sampled and will be collected next season. The samples that were collected this season were analysed and are now undergoing the data analysis steps and quality control checks. The obtained dataset will be further interpreted in the third year of the project. New weekly air samples are being taken at PES and the coast with the optimized autosampler (with design improvements in terms of air tightness and are equipped with a new engine with gearbox) and will be analyzed and interpreted with the developed method once they are collected during the next research expedition.
Target groups reached: scientific community

C) PASPARTOUT will characterise the seasonal patterns of metals and rare earth elements, and Pb, Sr and Nd isotopes;

The sampling instrumentation was set up during the 23-24 season. However, technical issues prevented automatic sampling from occurring in 2024. These issues have been resolved during this 24-25 season, but possible contamination may have occurred during the replacement of the collectors, which could affect the 2025 results. Samples from the 24-25 season are still on their way back, leaving Cape Town in the next few days. They are expected to arrive at the end of June (**task 3.1**). The present focus is thus on the 23-24 samples.
Both snow trenches have been dated using data on stable water isotopes ($\delta^{18}O$, δD, d-excess). Samples are currently being analyzed for their metal and rare earth element composition at the G-Time Laboratory (ULB). The feasibility of Sr, Nd and Pb isotopic ratios analyses is questionable due to the low trace element concentrations and the problems encountered during the handling of the automatic sampler during the 24-25 season. Characterization of the dust regarding particle size, number, volume and mass concentration, as well as the dust's optical properties, are now being conducted on discrete samples at the EUROCOLD Laboratory of DISAT (Università degli Studi di Milano-Bicocca). The nanoparticles present in the samples will be measured in June at the Institut de Physique du Globe de Paris (IPGP, Paris). Once all the samples have been measured over the next few months, they will be analyzed from a seasonal perspective (**task 3.2**).

D) Understanding the seasonal variability in the sources of nitrate in Antarctica through the measurement of nitrate isotopes (δ15N, δ18O, Δ17O);

Snow samples were taken during both 23-24 and 24-25 seasons. Analyses of oxygen isotopic compositions for the campaign 23-24 have been successfully performed and give precious information about the time scale, the seasonal variability and the snow accumulation per season (**tasks 3.1 and 3.2**).

E) PASPARTOUT will determine the source regions and atmospheric transport pathways of organic and inorganic compounds;

task 5.1: Air mass tracing current climate/meteorology: applying Flextra and Flexpart to present-day conditions.
The Flextra backward trajectory model results have been analysed for the period Jan-2010 to Feb-2021. A cluster analysis has been done. The atmospheric dispersion simulations have been done for 3 austral summer seasons up to now. The relation of air mass origin and atmospheric pathways to aerosol properties have been analysed, in particular for the austral season 2020-2021.
Target groups reached: Scientific community.

F) PASPARTOUT will investigate implications and changes to the before-mentioned points within a changing global climate.

Please see section 6.4

6. REPORT ON INCIDENCES

6.1. OBJECTIVES OF THE PROJECT

Name any of the Specific Objectives stated in Annex I that have been cancelled or subjected to any changes, explain why and provide alternative(s) if any.

Task 4.1 **Complementary data at coastal site: data from optical particle sizer, disdrometer, meteorology**	
Cancelled / Changed?	Changed
Reason:	To install a disdrometer and an optical particle sizer (OPS) at the coastal site appeared too much energy-demanding; In addition, the OPS was not ready for the campaign due to necessary repairs. However, the meteorology sensor has been installed as planned at the coastal site.
Alternative / Change:	For the particle number, results of the observatory at PES can be used as proxy. For the disdrometer, proxy data from the nearby weather station (wind, snow height, radiation) can be used instead.

6.2. COMPLETED TASKS & DELIVERABLES

Tasks completed:
Task 1, Reporting activities: initial report, progress meetings and annual report submitted.

Task 2.1.1 Operational sequential sampler for (po-)VOCs: overall three such sampling systems have been successfully installed at PES during Belare 2023-2024 and Belare 2024-2025: one at the southern science shelter (replaced in 2024-2025), and one near the coast.

Task 3.1.1: Operational sampling system for inorganic airborne particles and snow pit samples taken: During the Belare 2023-2024 campaign, the respective sampling system has been set up successfully at the coastal site and samples from two snow pits have been taken. This has been repeated during Belare 2024-2025, which unfortunately encounters delay (transport back) for this specific campaign.

A. Have the tasks been completed as they were intended to?	☒	Yes	☐	No
B. Do deliverables comply their intended characteristics?	☒	Yes	☐	No
C. Have deliverables been handled as described in the DMP?	☒	Yes	☐	No

If your answer is 'no', explain why they have been modified, and how this impacts the rest of the project using the table here below. Duplicate the table as needed. Do NOT include tasks and deliverables that have been completed as intended, which fulfil their intended characteristics, and which have been handled as described in the DMP.

T.X.X.	
D.X.X.X.	
Comments	

6.3. DELAYED TASKS & DELIVERABLES

A. Have any tasks or deliverables been delayed?	☒	Yes	☐	No

If your answer is 'yes', explain the reasons for the delay, how this impacts the rest of the project, and it the delay puts at risk the outcome of the project, possible solutions. Include information regarding the compliance of delayed deliverables with their intended characteristics and state if they are being handled as described in the DMP. Duplicate the table below as needed.

T.4.2.	**Complementary data from atmospheric observatory at PES**
D.4.2.1 and 4.2.2	Data analysed from cloud-precipitation-aerosol observatory and auxiliary data
Comments	Results will be available by M30 (instead of M26); analyses of most recent data takes additional time; no impact for delay on other deliverables; deliverable still complies with intended characteristics and will be handled as described in DMP.

T.5.1.	**Air mass tracing current climate/meteorology: applying Flextra and Flexpart to present-day conditions**
D.5.1.1 and 5.1.2	Back trajectory and dispersion modelling for present-day climate
Comments	Results will be available by M30 (instead of M15); no impact for delay on other deliverables; deliverable still complies with intended characteristics and will be handled as described in DMP.

T.5.2.	**Weather patterns and links with observations at PES: model data analysed and linked to observations**
D.5.2.1	East Antarctic weather patterns derived and related to observed data
Comments	Results are available by M26 (instead of M22); no impact for delay on other deliverables; deliverable still complies with intended characteristics and will be handled as described in DMP.

6.4. ABANDONED TASKS & DELIVERABLES

A. Have any tasks been abandoned?	☒	Yes	☐	No
B. Have any deliverables been abandoned?	☒	Yes	☐	No

If your answer is 'yes', explain why, how this impacts the rest of the project, if it puts at risk the outcome of the project and what is planned to do instead, if applicable. Duplicate the table below as needed.

Tasks 6.1 .	Future weather patterns from CMIP6: model data analysed and implications for atmospheric properties**;** **NEW title:** **Explaining recent trends in the atmospheric branch of the hydrological cycle and cloud properties**
D.6.1.1,	D.6.2.1East Antarctic future weather patterns derived and implications for atmospheric properties; ; **NEW Deliverable :** **Analysis of Recent Trends in the Atmospheric Hydrological Cycle and Cloud Properties**
Comments	The Task 6.1 that included the task on future weather patterns from CMIP6 was originally intended to take five person-months of a PhD student, Florian Sauerland. However, during the first part of PASPARTOUT, two valuable opportunities arose. Firstly, the work on climate modelling of cloud-aerosol interactions, which had been started within the BELSPO CLIMB project, had not yet been finalized for peer-reviewed publication. We therefore decided to continue and extend that work within the PASPARTOUT framework. We are now pleased to announce that a peer-reviewed publication is available in Atmospheric Chemistry and Physics. Secondly, within the framework of the FWO-funded PARAMOUR project (EOS O0100718F), an analysis had been carried out using the fully coupled ice sheet–ocean–sea ice–atmosphere–land model of the circum-Antarctic region (PARASO). This model was driven by EC-Earth and an ensemble of ERA5-based hindcasts. The initial scope of a paper on this topic focused on the relationship between sea ice, ocean properties, and the surface mass balance. Within PASPARTOUT, we performed an additional analysis on the atmospheric part of the hydrological cycle, from moisture transport to evaporation and precipitation over the Southern Ocean, to moisture transport toward the ice sheets. Moreover, an analysis was conducted on the trends in cloud properties like cloud cover and phase across these simulations, which fit well within the scope of PASPARTOUT. By including this analysis, we were able to elevate the scientific work, and a paper is now ready for submission in the journal Climate Dynamics. Since no tasks are dependent on this work Task 6.1, we decided that the impact of spending the five months on these two works in progress would be greater than what could have been achieved by focusing on future weather patterns from CMIP6. There are no other deliverables dependent on this task. Task 6.2 also requires CMIP6 data, but can be performed independently.

7. REPORT ON DATA MANAGEMENT PLAN

If your DMP has been modified, please submit the new DMP together with this report.

A. Has your DMP been modified?	☐ Yes	☒ No

8. REPORT ON FOLLOW-UP COMMITTEE

8.1. COMPOSITION & ROLE

A. Has the composition and/or role of the Follow-up Committee changed?	☐ Yes	☒ No

If your answer is YES, please fill out following table. Otherwise, delete tables A. COMPOSITION and B. WAY OF WORKING.

8.2. MEETINGS AND DECISIONS TAKEN IN CONCERTATION WITH THE FOLLOW-UP COMMITTEE

PASPARTOUT project members stayed in contact with members of the follow-up committee and discussed also PASPARTOUT related topics. Below we give an overview per member of this committee.

Dr. Somporn Chantara, Chiang Mai University, Thailand, Chemistry Department and Environmental Science Research Center
A meeting is planned in summer to discuss the outcome of the analytical method development and the interpretation of the results.

Prof. Roland Kallenborn, Norwegian University of Life Sciences, As, Norway, Faculty of chemistry, biotechnology and food science
A meeting is planned in summer to discuss the outcome of the analytical method development and the interpretation of the results.

Dr. Heike Wex, Leibniz Institute for tropospheric research, Leipzig, Gemany:
Heike Wex is first author of a paper in final review for Geophysical Research Letters (titel: Antarctica's Unique Atmosphere: Really Low INP concentrations). Alexander Mangold (RMI) and Preben Van Overmeiren (UGent) are co-authors. She is co-author of the PASPARTOUT paper in ACP https://acp.copernicus.org/articles/24/13751/2024/.

Dr. Stefania Gili, Princeton University, USA, Geoscience Department
A call was organized in November 2023 for the planning of new sampling and analyses; a new meeting online is planned in summer 2025 to discuss the development of the publication strategy and analysis strategy.

Prof. Yann Sivry, Université Paris Cité, Institut de Physique du Globe de Paris, UMR-CNRS;
E-mail exchange was performed with Prof. Y. Sivry during fall 2023. A future meeting occurred end of March; the methodology for the preparation and analyses was discussed and finalized; in June 2025, S. Wauthy will spend 1 week for the analyses of the nano-particle analyses by sp-ICP-MS and TOF-ICP-MS at IPGP.

Dr. Ruth Mottram, Danish Meteorological Insitute, Denmark
Dr Ruth Mottram visited KU Leuven on 12 December 2022 and we discussed the project. She also gave a seminar entitled: "Ice sheets in the climate system: becoming comfortable with uncertainty".

9. REPORT ON VALORISATION ACTIVITIES / reporting period 05/2024 to 04/2025

9.1. PUBLICATIONS

Peer-reviewed publications:

Sauerland, F., Souverijns, N., Possner, A., Wex, H., Van Overmeiren, P., Mangold, A., Van Weverberg, K. and van Lipzig, N., 2024. Ice-nucleating particle concentration impacts cloud properties over Dronning Maud Land, East Antarctica, in COSMO-CLM2. Atmospheric Chemistry and Physics, 24(23), pp.13751-13768.

Wex, H. O. Eckermann, Z. Juranyi, R. Weller, A. Mangold, P. Van Overmeiren, S. Zeppenfeld, M. Van Pinxteren, M. Dall'Osto and S. Henning, Antarctica's Unique Atmosphere: Really Low INP concentrations, Geophys. Res. Lett., in review, 2025.

Boxho S., Vanderstraeten, A., Mattielli, N., Laruelle, G.G., Bory, Bonneville, S. Patagonian to African Dust Sources Shift During the Last Glacial-Interglacial Transition: Insights from Rare Earth Element Provenancing in Antarctic ice cores, Geophys. Res. Lett., in prep, 2025.

Other publications than conference proceedings

The ceilometer and micro-rain radar data have been submitted to the KU Leuven research data repository: https://rdr.kuleuven.be/

Sauerland, Florian; Gorodetskaya, Irina; Souverijns, Niels; Gossart, Alexandra; Mangold, Alexander; van Lipzig, Nicole, 2024, "Ceilometer observations taken at Princess Elisabeth Station, Dronning Maud Land, East Antarctica", https://doi.org/10.48804/07SS6R, KU Leuven RDR, V1

Sauerland, Florian; Gorodetskaya, Irina; Souverijns, Niels; Gossart, Alexandra; Mangold, Alexander; van Lipzig, Nicole, 2024, "MRR observations taken at Princess Elisabeth Station, Dronning Maud Land, East Antarctica", https://doi.org/10.48804/MDDKU0, KU Leuven RDR, V1

Nadine Mattielli, Stefania Gili, Sibylle Boxho, Aubry Vanderstraeten, Steeve Bonneville, Christophe Walgraeve, Preben Van Overmeiren, Goulven Laruelle, Aloys Bory, James King, Paola Formenti, Andy Delcloo, Kristof Demeestere, Herman Van Langenhove, Alexander Mangold, Past and Modern Mineral Dust in East Antarctica: faithful tracers of the atmospheric circulation and climate variability through time, ARSOM (Académies Royales de Belgique, Classe des Sciences et Techniques) publication, to be accepted.

Van Tiggelen, Maurice; Smeets, Paul C J P; Tijm-Reijmer, Carleen H; Kuipers Munneke, Peter; van den Broeke, Michiel R; van Lipzig, Nicole P M; Mangold, Alexander: IMAU Antarctic automatic weather station data, including surface radiation balance (AWS16, Princess Elisabeth station), PANGAEA, https://doi.pangaea.de/10.1594/PANGAEA.974126, 2024. **In**: Van Tiggelen, Maurice; Smeets, Paul C J P; Tijm-Reijmer, Carleen H; Kuipers Munneke, Peter; van den Broeke, Michiel R; Oerter, Hans; Eisen, Olaf; Steinhage, Daniel; Kipfstuhl, Sepp; van Lipzig, Nicole P M; Mangold, Alexander; Lhermitte, Stef; Lenaerts, Jan T M: IMAU Antarctic automatic weather station data, including surface radiation balance (1995-2022), PANGAEA, https://doi.pangaea.de/10.1594/PANGAEA.974080, 2024

9.2. PARTICIPATION / ORGANISATION OF (INTER)NATIONAL SEMINARS, CONFERENCES…

Date	1-2 April 2025				
Name of Event	Nordic Ozone Group meeting 2025				
Type of Event	☐	National	☒	International	
Contribution as…	☐	Organizer	☒	Speaker	☐ Attendant
Participant(s)	Alexander Mangold				
Institution	IRM-KMI				
Contribution	Mangold, A., E. Koistinen, N. Pezzetti, Q. Laffineur and A. Delcloo, Time series analysis of uv and total ozone measurements at Princess Elisabeth station, East Antarctica, Nordic Ozone Group meeting, Helsinki, Finland, 1-2 April 2025, https://en.ilmatieteenlaitos.fi/nog2025.				

Date	3-4 October 2024				
Name of Event	International Workshop on Monitoring Chemical Pollution in Antarctica https://scar.org/scar-news/cross/impact-news/impact-workshop-2024				
Type of Event	☐	National	☒	International	
Contribution as…	☐	Organizer	☐	Speaker	☒ Attendant
Participant(s)	Paula Lamprea				
Institution	Ghent University				
Contribution					

Date	11-13th September 2024				
Name of Event	8th International Geologica Belgica Meeting 2024				
Type of Event	☐	National	☒	International	
Contribution as…	☐	Organizer	☒	Speaker	☐ Attendant
Participant(s)	N. Mattielli & S. Boxho				
Institution	ULB				
Contribution	Mattielli, N., Gili, S., Boxho S., Vanderstraeten, A., Mangold, A., Walgraeve, C., Van Overmeiren, P., Delcloo, A., Laruelle, G.G., Bory, A., Bonnevielle, S., *Modern mineral dust depositions in East Antarctica: faithful geochemical tracers of Southern Africa dust contributions and evolution of the climate during the Holocene*, 8th International Geologica Belgica Meeting 2024, Liège, 11-13th September 2024.				

Date	6 January 2025

Name of Event	SEGH Fellow seminar		
Type of Event	☐ National	☒ International	
Contribution as…	☐ Organizer	☒ Speaker	☐ Attendant
Participant(s)	Nadine Mattielli		
Institution	ULB		
Contribution	Mattielli, N., Gili, S., Boxho S., Vanderstraeten, A., Mangold, A., Walgraeve, C., Van Overmeiren, P., Delcloo, A., Laruelle, G.G., Bory, A., Bonnevielle, S., *Past and Modern Mineral Dust in East Antarctica: faithful tracers of the atmospheric circulation and climate variability through time*, SEGH Fellow seminar, 6th January 2025, online		

Date	27 April – 2 May 2025		
Name of Event	EGU General Assembly 2025		
Type of Event	☐ National	☒ International	
Contribution as…	☒ Organizer	☒ Speaker	☐ Attendant
Participant(s)	Florian Sauerland		
Institution	KU Leuven		
Contribution	Co-convenor of Session AS4.4: Clouds, moisture, and precipitation in the Polar Regions: Sources, processes and impacts (https://meetingorganizer.copernicus.org/EGU25/session/53565) Florian Sauerland, Pierre-Vincent Huot, Sylvain Marchi, Hugues Goosse, Nicole van Lipzig: EC-Earth- and ERA5-driven retrospective ensemble hindcasts with the fully coupled ice-sheet–ocean–sea ice–atmosphere–land circum-Antarctic model PARASO (https://meetingorganizer.copernicus.org/EGU25/EGU25-17914.html)		

Other outreach activities (General talks, press releases, etc)

website IRM: https://ozone.meteo.be/projects/paspartout/expedition-belare-2024-2025

Boxho, S., Paspartout project : Pathways of particles, VOCs and moisture into East-Antarctica in a changing climate, BELARE 23-24, focus on ULB part, Archives Antarctiques Belges-Belgische Antarktische Archieven, ULB, 24 March 2024.

KU Leuven Dag van de Wetenschap 2024: Wervelende Weersystemen, experiment, video, and posters for children, 24 November 2024, Leuven, Belgium

Van Lipzig Interview 1/5/2024 VRT NWS CHECK - Ja, klimaatverandering zorgt voor meer turbulentie tijdens een vlucht https://www.vrt.be/vrtnws/nl/2024/04/11/check-klimaatverandering-en-turbulentie/

Mangold, A., Notre l'environnement, le climat et l'Antarctique, Workshop for children of 10-11 years, presentation and experiments, TADA, (http://toekomstatelierdelavenir.com), 14 December 2024, Anderlecht, Belgium

Mattielli, N. L'Antarctique, Le Continent Blanc, Workshop for children of 10-11 years, presentation and experiments, TADA, (http://toekomstatelierdelavenir.com), 14 December 2024, Anderlecht, Belgium

9.3. SUPPORT TO DECISION MAKING (IF APPLICABLE)

The connection between scientific research on Antarctica and policy is largely managed by the Scientific Committee on Antarctic Research (SCAR). Belgium is a Full Member of SCAR, represented by the Belgian National Committee on Arctic and Antarctic Research (BNCA^{2}R, http://www.bncar.be/bncar/). Profs. Nicole van Lipzig, C. Walgraeve and N. Mattielli, and Drs. Alexander Mangold and Andy Delcloo are members of BNCAR and have been following the meetings to ensure that all scientists involved are aware of the on-going research. Alexander Mangold is secretary of BNCA^{2}R. Via the SCAR ImPACT working group on organic persistent pollutants, UGent partners contribute to spread scientific results on VOCs.