Carbon Footprint and Offset
Antarctic Quest 21 Expedition

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Introduction and Methodology

The Antarctic Quest 21 expedition has been undertaken in the name of climate and pollution science. It is therefore befitting that the carbon footprint generated during the planning, execution and aftermath of the expedition should be minimised as far as possible and what cannot be avoided should be mitigated by appropriate means. The team, and particular the expedition leader Paul Hart, have taken care to reduce the impact of the expedition through utilising existing equipment wherever possible, rather than purchasing new, as well as transporting equipment by sea and communicating electronically, thus avoiding unnecessary and air travel.

This report provides an overview of the carbon footprint calculations and compensation undertaken on behalf of the expedition. As there are no readily available carbon footprint calculators that provide a perfect fit for an Antarctic expedition, and therefore a variety of calculators and methods have been used to estimate the carbon footprint of the Antarctic Quest 21 expedition.

IT, Website and Communication

Several organisations provide information on the impact of IT and Internet data on carbon footprint. Climate Care states that the carbon footprint of gadgets, the internet and the systems supporting them accounts for 3.7% of global greenhouse emissions, similar to the global aviation industry. In essence, the energy consumption of manufacturing and shipping of the hardware and the powering and cooling of servers and hardware are the main cause of the carbon footprint, as the energy mix of most countries is still predominantly fossil-fuel based. So, every time we use a search engine, send or receive an email, look at social media content or stream music and video, greenhouse gases are emitted. For example, a simple email without attachments causes the emission of 4 g CO_2 and one view of a typical website produces around 1.8 g CO_2.

Some statistics on energy consumption in this sector (Climate Care):

- around a third of energy is used by our devices
- approximately one fifth is consumed by the networks
- just under one third drives the data centres and servers
- around one sixth of the energy goes into manufacturing of hardware (gadgets and servers)

On the other hand, meeting virtually online has a smaller footprint than travelling across a country or internationally for a face-to-face meeting and some service providers, including Google, Facebook, WordPress, Etsy and Adobe, have committed to move to 100% renewable energy.

In this context, the actual impact of the expedition's IT and communication is difficult to establish and a conservative approach has been taken to estimate this element of the carbon footprint. At this time (August 2022), much of the reported data that allows calculations to be made, appears to be referring to a limited range of original sources. For this reason, and the large uncertainty in the estimates and extrapolations of online

activities, a few, relatively convenient sources (Down to Earth, Energuide and Websitecarbon) were used for the expedition footprint calculations. The following elements were taken accounted for:

- 53000 emails @ 4 g carbon dioxide equivalents (CO_2e) per email for text only, with 10% including attachments (50 g CO_2e per email), amounting to 456 kg CO_2e
- 1680 hours on zoom meetings – there are several ways to look at this, (1) with 1 h @ 2.5 GB data, and each GB data being equivalent to 1.8 kWh electricity, then assuming 475 g CO_2e per kWh as a worst-case non-renewable energy (3590 kg CO_2e) and (2) using zoom emission calculator (385 kg $_{CO2e}$). Having no way of deciding who is correct, the middle ground (1900 CO_2e) seems a reasonable approximation.
- 42400 WhatsApp messages @ a similar carbon intensity as emails, with around 12% including gifs or photographs (400 kg CO_2e)
- 1400 hours on internet searches, building and maintaining the expedition website (90 kg CO2e)
- Expedition website operative for 2 years (660 kg CO2e)
- 15 GB shared cloud data storage (13 kg CO2e)

This amounted to 3.4 t CO2e for the pre-expedition phase. Having no way of estimating the post-expedition online traffic, especially related to outreach activities, a rough estimate would be doubling this footprint for the purpose of compensation to arrive at **7.8 t CO_2e**.

Expedition Equipment and Specialist Clothing

Much of the expedition equipment was either pre-owned (e.g. tools, safety equipment, rucksacks, cooking utensils) or loaned (e.g. helmets, harnesses, skis, sleeping bags, crampons). The only items purchased were tents, sleds, rescue beacons and two sets of ski boots. The new purchase amounted to around £19000 in monetary value. Given that this is non-standard and no specific carbon accountancy is available, the carbonfootprint.com calculator for 'manufactured stuff' was used to calculate that **newly purchased expedition equipment amounted to about 6 t CO_2e**.

Specialist expedition clothing was donated by Klaettermusen, and consisted of water-proof outer layers, warm mid- and base-layers of varying materials. The total value of this clothing was around £16000 and taking a similar approach as the one for equipment for clothing, the carbonfootprint.com calculator was used to estimate the footprint, which amounted to around **6.4 t CO_2e**.

Air Travel

Air transport has been calculated using the calculator offered on the web by ICAO, which has the advantage that it has access to realistic data on distances between airports, aircraft type and average fuel consumption, and average aircraft occupancy on all routes. All air travel undertaken and anticipated for training events and the expedition itself has been calculated for the entire team in this way.
The estimated carbon footprint for air travel using ICAO for the team was 10.8 t CO_2. However, this does not take into account radiative forcing (RF). RF takes into account both, the present-day impacts from today's emissions and also longer term impacts from long-lived greenhouse gases emitted by aviation at high altitude. Different calculators apply different multiplication factors to take account of radiative forcing, ranging from 1.0 to 3.0, some apply it only once the flight has reached a certain altitude (typically 25000 ft) and there is no consensus as yet (Atmosfair, Carbon Offset Guide, Climate Care, Climate Neutral Group, DEFRA, IATA). Given this diversity, the

UK (DEFRA) approach was taken and a factor of 1.9 was applied to take into account of radiative forcing. Therefore, **the overall aviation footprint amounted to 19.8 t CO_2e**.

Road Travel for the Team

Road travel is the most important land-based travel and has been estimated by asking team members to provide records and planned travel. The overall road travel with cars or vans is unlikely to have exceeded 20000 miles. Car Carbon Footprint Calculator was used to estimate emissions, assuming a medium-sized estate car with a fuel efficiency of 280 g/km.

The estimated carbon footprint for road travel amounted to 5.8 t CO_2e.

Equipment Transport

The carbon footprint of long-distance transport of cargo varies considerably between modes of transport. For example, the carbon dioxide equivalent (CO_2e) of 1 tonne cargo transported between London and Glasgow by rail is 11 kg, by road is 78 kg and by cargo aeroplane is 298 kg (calculated with CarbonCare).

The expedition minimised the carbon footprint of transporting the expedition equipment and food to Antarctica with the support of the company Polar Latitude, who stored the expedition equipment barrels on the deck of their vessel MS SeaVenture. SeaVenture made her way from Bremerhaven, Germany to Ushuaia, Argentina and then to the Antarctic Peninsula as part of her annual cruise plan. In terms of footprint calculations, this transport was treated this in the same way as cargo shipped by a commercial container ship. To meet the ship, the equipment was driven by two team members from the Southwest England to Germany, a distance of around 1400 km. The return of the equipment was undertaken by different vessels and slightly different routes, but with an equivalent carbon footprint.

The carbon footprint for one tonne of equipment transported was estimated using the CarbonCare CO2 calculator, which is based on the EU EN16258 standard and reported here as 'Well-to-Wheel' CO_2e values, meaning that the total energy required and greenhouse gas (GHG) emissions from the oil well to burning of the fuel in the vehicle or vessel are accounted for. Calculations, which include an element of extrapolation for routes not listed in the CarbonCare calculator resulted in a **total of 560 kg CO_2e** for the return voyage of our expedition equipment. This may be a slight over-estimation, as we won't be returning much of the food. The following elements were included:

- Road Travel from Southwest England to Bremerhaven by small van: around 1400 km and 195 kg CO_2e
- Ferry from Dover to Calais: around 100 km and 1 kg CO_2e
- Sea Cargo from Bremerhaven, Germany to Ushuaia, Argentina and on to the Antarctic Peninsula: around 17000 km and 84 kg CO_2e.
- Sea Cargo returned to Portugal: 84 kg CO_2e
- Ferry from Portsmouth to Northern Spain: 5 kg CO_2e
- Road Travel from Northern Spain to Portugal: 190 kg CO_2e

To put our footprint of 560 kg CO_2e for equipment transport into perspective, it amounts to around 5% of the footprint of the average British citizen (around 8000-12000 kg CO_2e) and to 3.8% of that of the air freight from London Gatwick to Ushuaia, Argentina (27000 km return, 15000 kg CO_2e).

Diet

The team will be on around 6000 kcal per day (or 1.2 kg food) and this exceeds the 'normal' daily calorific intake by around 3800 to 4000 kcal. With food items ranging from dehydrated expedition rations, olive oil, plant-based biltong bars, soups, flapjacks and chocolate bars, a typical expedition diet mix made up from fruit, nuts and seeds, grains and pulses, vegetables and meats was selected to estimate the carbon footprint of the food intake during the expedition using My Emissions.

The calculated daily additional (beyond normal 2200 kcal/day) footprint per person per day for the expedition diet was ca. 6 kg CO_2 equivalent per day, which for 8 expedition team members and 36 days of expedition **amounted to a dietary total of 1.7 t CO_2**.

Summary Results

The total carbon footprint for the elements of the expedition considered here was 48 tonnes carbon dioxide equivalent, as shown in the summary table below:

Footprint Source	**tonnes CO_2e**
Aviation	19.80
Road travel	5.80
Equipment transport by ship	0.17
Equipment transport by road	0.39
Excess dietary intake	1.70
IT and communication	7.80
Expedition equipment	6.00
Expedtion clothing	6.40
Total	**48.06**

Mitigation

For the purpose of mitigation, the carbon footprint of the expedition was rounded up to 50 t. Earthly was chosen as an established organisation that invests in the environment to counter industrial impacts with natural solutions, while underpinning each of their projects with solid science. Many of their projects are REDD+ (Reduce Emissions from Deforestation and Degradation) and address several of the United Nations Sustainable Development Goals (UN SDG). The expedition's carbon mitigation was undertaken in two stages:

1) December 2021: Early estimations of carbon footprint was undertaken for travel, transport of cargo and diet (20 t CO_2) were compensated through the Mai Ndombe REDD+ Project in the Congo basin. This project helps to protect the world's second largest intact rainforest as well as helping local communities through education and medical care.
2) August 2022: Final estimations for the footprint included all new and updated estimates in this report, a total of 50 t CO_2, leaving an additional 30 t CO_2 to compensate. This was done by supporting the Rimba Raya Peatland Protection, which is working on all 17 UN SDG in Borneo.