NATS climate risk and adaptation progress report

Report to DEFRA on the third round of the climate change adaptation reporting power (ARP3)

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Glossary

Acronym	
ADS-B	Automatic Dependent Surveillance–Broadcast
AOA	Airport Operators Association
ANSP	Air Navigation Service Provider
ARP	Adaptation Reporting Power
ATC	Air Traffic Control
ATM	Air Traffic Management
CAA	Civil Aviation Authority
CCC	Climate Change Committee
CDP	Formerly the Carbon Disclosure Project
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
ESG	Environmental, Social and Governance
GHG	Greenhouse gas
GIS	Geographic Information Systems
HVAC	Heating, Ventilation and Air Conditioning
ICAO	International Civil Aviation Organization
LTIP	Long-Term Investment Programme
NACME	National Airspace Crisis Management Executive
NM	Nautical Mile
NERL	NATS (En Route) plc
NSL	NATS (Services) Limited
SBTi	Science Based Target initiative
TCFD	Task force on Climate-related Financial Disclosures
UKCP	United Kingdom Climate Projections

1. Introduction

1.1. Executive summary

Climate change is altering the natural world around us in incremental but measurable ways. We only experience a fraction of these effects in an individual and local way. However, a business like NATS is exposed to significant and growing risks and costs, and the requirement to adapt to the impact of climate change across its estate and within the airspace it manages.

This report sets out the progress NATS has made in identifying and assessing the climate risks it faces, now and into the future, since its original report in 2011. As a result of improvements to climate modelling and risk assessments, as well as a clearer focus on resilience throughout NATS, the report provides a significant update. The report complements similar work on climate change resilience undertaken by NATS' airport customers and EUROCONTROL.

Nine top physical climate risks have been identified:

1. Precipitation (flooding from rivers and surface water) at en-route air traffic control centres;
2. Storms (precipitation and lightning) at remote sites;
3. Wind speed and gusts at remote sites;
4. Sea level rise at airports where NATS provides the ATC service;
5. Precipitation (flooding from rivers and surface water) at airports where NATS provides the ATC service;
6. Summer extreme temperature (heat overload) at an en-route air traffic control centre and ATC tower;
7. Summer extreme temperature (heat overload) on ATM infrastructure, especially at sites in central and southern England;
8. Increased frequency & intensity of thunderstorms and extreme weather events may disrupt operations;
9. Increased frequency & strength of clear-air turbulence may disrupt operations.

A summary of these top risks is presented, with a number of controls and actions identified for implementation.

1.2. Structure of the report

Section 1 provides background information on the drivers of climate change related disclosure, a profile of NATS and its resilience objective, and the scope of this report. Section 2 focuses on climate change physical risks, summarising the priority risks based on a quantitative assessment using two reference scenarios. Section 3 provides a qualitative assessment of NATS' climate change transitional risks and opportunities. Section 4 highlights some case studies of good practice and the outcome of NATS' ARP3 assessment, including key controls and actions which will be undertaken to improve resilience and adapt to a changing climate.

1.3. About NATS

NATS is the primary Air Navigation Service Provider (ANSP) in the UK. It provides Air Traffic Control (ATC), engineering and other services to aircraft flying in UK domestic airspace and the eastern part of the North Atlantic Ocean (Shanwick), at 13 UK airports plus Gibraltar and 6 military airfields.

NATS Holdings Limited consists of two main subsidiaries; NATS (En Route) plc ("NERL") and NATS (Services) Limited ("NATS Services" or "NSL"), in addition to a number of joint ventures which are not within its operational control and are out of scope of its ARP3 assessment.

NERL is the sole provider of ATC services for aircraft flying in UK domestic and Shanwick airspace. It operates under a licence granted under the Transport Act 2000 and is regulated by the CAA and, until January 2021, the European Commission's Single European Sky (SES) legislation.

NSL operates in contestable markets and services UK and international customers, providing ATC, engineering, airport optimisation and consultancy services.

1.4. Policy context

The principal legal, regulatory and voluntary drivers for climate change resilience / adaptation preparation and reporting are set out below.

1.4.1. Legal, regulatory and voluntary drivers

Climate Change Act 2008

DEFRA periodically make requests of owners/operators of critical national infrastructure to report on their resilience to climate change, as per sections 61-63 of the Climate Change Act 2008. This Adaptation Reporting Power (ARP) provides for the Secretary of State to direct certain organisations (for example, owners and operators of critical national infrastructure) to prepare a climate change resilience report.

Following a direction to prepare a report, NATS, together with 10 airports and the CAA, prepared a climate change adaptation report in 2011 for ARP1. This was informed by several information sources, including the UK Climate Projections 2009 (UKCP09) dataset and research commissioned by NATS.

A request to report was received in 2014 for ARP2. However, there having been no material update to the available environmental data, it was determined that there would be limited benefit in updating the previous report.

A request was made by DEFRA in 2018 and accepted by NATS, for ARP3. There was a specific requirement that sectors work collaboratively to update their climate change resilience plans, including the aviation sector. Airport operators with more than 50,000 movements per annum are within the scope of the DEFRA request, in addition to NATS.

An aviation sector risk template was agreed with DEFRA, the AOA and reporting organisations to outline requested information in recognition of the objectives and principles for reporting. It outlines what information will be considered essential in ARP3 reporting, and reporting organisations can supply other additional content depending on their individual needs/ circumstances.

NERL licence requirement

Condition 2 of the NERL licence requires the preparation and submission of a resilience plan to the CAA every two years. The CAA defines resilience as "*the capability of an ANSP's assets, networks, people and procedures to anticipate, prevent, absorb and adapt to a disruptive event with any disruption or degradation of service managed in alignment with pre-agreed performance standards and to safely and rapidly recover to normal services*". While the CAA may not have specifically asked about climate change as a challenge to NATS' resilience, extreme weather events are included in its evaluation for potential causes of disruption, and NATS' infrastructure and proactive barriers are already accounting for high degrees of resilience to physical risks.

However, in preparing this report, NATS has further developed and updated forecasts and risk evaluations that can be used to drive the future sustainment and resilience enhancement to its infrastructure. NATS sees the biennial resilience plan as an appropriate channel for progress and status updates on the impacts of climate change and the mitigation plans being developed.

Task Force for Climate related Financial Disclosures (TCFD)

The Financial Reporting Council will mandate new requirements linked to the Task Force for Climate related Financial Disclosures (TCFD) framework from 2022-2023. This will require NATS to prepare mandatory climate related financial disclosures annually, using the TCFD framework in its Annual Report & Accounts. This ARP3 report is an interim step towards full TCFD compliance.

Companies Act

Sections 172 and 414C of the Companies Act 2006 (the Companies, Partnerships and Groups (Accounts & Non-Financial Reporting) Regulations 2016) requires companies to report on the impact of the environment on their activities, complementing the Climate Change Act and requiring NATS to report on material environmental risks in its Annual Report & Accounts. This so-called 'double materiality' provision is relevant to this report, as it sets out a requirement for companies to report both on their own environmental impacts as well how environment risks impact the company. NATS operates in a high carbon sector and faces risks to its business operations arising from climate change, as set out in this report.

Voluntary disclosure

As at 2021, NATS is the only ANSP to report voluntarily on its environmental performance and management to CDP, scoring an A- grade for its most recent financial year 2020-21[i]. Amongst other criteria, CDP independently assesses robust governance and oversight of climate issues, rigorous risk management processes, verified greenhouse gas emissions reporting and reduction in emissions across the value chain. The A- grade puts NATS in the top 2% of the 13,000 organisations which disclosed to CDP and demonstrates the company's commitment to environmental stewardship and implementing best practice. This result builds on NATS' public commitment to setting a science-based net zero target with Science Based Target initiative (SBTi) in 2021[ii].

1.4.2. Climate Change Committee

The Climate Change Committee (CCC) is an independent public body, formed under the Climate Change Act to advise the United Kingdom and devolved governments and parliaments on tackling and preparing for climate change. The CCC reviews the ARP process and reports submitted by the relevant organisations, which is laid before Parliament, and subsequently informs the UK climate change risk assessments and the national adaptation programme.

ARP reports should detail:

- The current and future projected impacts of climate change on the organisation;
- Proposals for adapting to climate change;
- An assessment of progress towards implementing the policies and proposals set out in previous reports.

The objectives of the ARP3 reporting cycle are to support integration of climate change risk management into the work of organisations and secondly, to understand levels of preparedness at sector and national levels.

Reviews[iii] of previous ARP reports have identified the following common issues:

- Evidence of how interdependency risks between sectors were understood and acted on was not always present;
- Gaps in data describing vulnerabilities of infrastructure to extreme weather were highlighted;
- Gaps in reporting from organisations meant it was difficult to assess changes at the sector level;
- Few opportunities from climate change were presented;
- Few examples of risks identified for buildings or staff; and
- Inconsistency in the maturity and transparency of action planning, prioritisation and monitoring.

It is likely that the review of ARP3 reports will assess these concerns, as well expand on new challenges arising from submitted reports.

1.5. Governance

The NATS Executive Committee is responsible for climate change and other sustainability policy. A Responsible Business policy sets out NATS' environmental ambition and is complemented by an ISO 14001 environmental management system. A sustainability strategy sets out multiple goals, including net zero emissions from its business operations by 2035, and in partnership with the aviation industry, net zero airspace emissions by 2050.

1.6. Disclosure of environmental information

NATS has reported on its environmental performance for over a decade, both in its Annual Report & Accounts and in a standalone Responsible Business report. This reporting has evolved to meet increasing expectations from stakeholders and in response to regulation, including:

- CDP reporting
- Mandatory GHG emissions reporting
- The Adaptation Reporting Power of the Climate Change Act 2008
- The corporate governance code
- The EU emissions trading scheme
- The EU non-financial reporting directive / Companies Act 2006
- The forthcoming task force on climate-related financial disclosures (TCFD)

1.7. Resilience objective

NATS submitted its original adaptation report in 2011[iv], following the DEFRA direction to report as part of ARP1. For ARP 2, there having been no material update to the available environmental data, it was determined that there would be limited benefit in updating the previous report. However, separately the CAA established a new resilience requirement for NATS in 2018 by modifying the NERL licence. This led to the development of a resilience plan which outlines the principles, policies and processes by which NATS assures its resilience, contingency and business continuity as set out in the NERL licence and pursuant to its duties under section 8 of the Transport Act 2000[v].

2. Physical risks

2.1. Introduction

In the past, extreme weather events have caused disruption or damage to NATS' assets including radar facilities, buildings and air traffic control towers at airports. NATS' assets have remained operational throughout most of these events without significant loss of ATC services, primarily due to the inherent resilience of the NATS facilities provided by overlapping coverage of radar and communication sites and back-up systems. The most significant impacts of extreme weather events on NATS' operations historically have been caused by disruption to services and systems that NATS relies upon (roads, energy supply, telecommunication networks, etc.). These extreme weather events have had the biggest impact on business continuity, in particular preventing staff from reaching NATS sites, or affecting power supply. Instances where NATS' assets have suffered significant damage directly include the destruction of the Lowther Hill radar site radome as a result of 140 MPH winds in December 2013, and, more recently, the loss of multiple sites/assets simultaneously as a result of power failure in November 2021 during storm Arwen[vi].

Figure 1 - Accessing NATS' remote sites/assets in winter storm conditions

A transport resilience review published by Government in 2014[vii] highlighted the risks to critical infrastructure in the aviation sector, for example, from wind and flooding. Recommendations for airports included reviewing the location of utility and IT infrastructure, while a number of other recommendations applied to all owners and operators of transport infrastructure.

2.2. Identification and assessment of physical risks

2.2.1. Background

NATS' original climate change risk assessment for ARP1 identified 11 climate risks (see Table 1), with two physical risk prioritised; i) snow, sleet, blizzard, ice and ii) jet stream movement. The physical risks have been reassessed as part of ARP3 (see Table 3), with some noticeable changes in terms of the assessment results and the risk prioritisation.

Priority	Risk variable	Business function	Impact description
1	Snow, sleet, blizzard, ice	Operation of ATM systems & delivery of service	Access by staff to centres. Resilience of systems & remote site equipment to prolonged snow & ice. Access to remote sites for maintenance.
		Financial (revenue)	Financial impact of loss of revenue for extended periods of weeks – months during which traffic volume severely reduced.
2	Jet stream movement	Financial (revenue)	If the movement of the jet stream is enough such that the preferred (most efficient) routing for transatlantic flights is further north, such that routes are moved outside of NATS' controlled airspace. This will impact NATS revenue.
3	Public perception of travel	Financial (revenue)	Customers' behaviours/choices. Choosing to fly less frequently and shorter flights.
4	Restriction on numbers of flights	Financial (revenue)	Financial. NATS revenue would be capped by the restriction.
5	Rainfall / flooding	Operation of ATM systems & delivery of service	Weather avoidance, delays, track mileage increases. Disruption at airports.
6	Environmental protest	Facilities	Direct action against the aviation community, NATS is targeted by environmental protestors.
7	High winds	Operation of ATM systems & delivery of service	Weather avoidance, delays, track mileage increases. Damage to buildings and remote sites.
8	Freezing fog / inflight icing	Operation of ATM systems & delivery of service	Dangerous flying & take-off landing conditions resulting in closure/reduction in capacity of airports. Reduction of capacity of ATC sectors.
9	Thunderstorms & lightning	Operation of ATM systems & delivery of service	Increased delays, track mileage. Traffic avoidance of weather system and temporary closure of airports affected.
10	Summer mean temperature rise	Operation of ATM systems & delivery of service	Impact on transition levels & min holding levels. Degraded aircraft climb performance.
11	Sea level rise	Operation of ATM systems & delivery of service	Flooding of ATC centres. ATC operations cease due to flooding.

Table 1 – ARP1 priority climate risks

Since NATS' ARP1 report, engineering and asset management controls have been relied on to ensure contingency against the risk of extreme weather events. Measures to reduce the likelihood of climate-generated events and to mitigate their impact have also been deployed on a tactical basis.

2.2.2. Recent developments

The European Organisation for the Safety of Air Navigation, known as EUROCONTROL, has published a series of papers on the risks facing the European aviation industry from climate change, to raise awareness of these risks and share good practice. The most recent assessment[viii] provides an update on a previous study[ix] and highlights the following risks:

- Extreme sudden rainfall and rising sea levels are assessed to pose a growing risk to airport infrastructure;
- Major storms, which cause en-route delays, are expected to increase in intensity;
- Future flight operations will be modified by climate change, with jet streams reducing many transatlantic flight durations both eastbound and westbound.

The Eurocontrol findings complement NATS' own assessment of airspace related climate risks, which was commissioned in 2020 as part of ARP3 preparations. The analysis will be published by NATS on its website in parallel with its ARP3 report.

In 2021, NATS commissioned a separate update to its ARP1 assessment to review and prioritise the key risks from climate change, using the most recent UK Climate Projections (UKCP18) - and similar - climate modelling. The ARP3 project, supported by external consultants, included a literature review, interviews with key subject matter experts across NATS, desktop GIS, climate scenario analysis and a risk assessment.

2.3. Methodology for latest assessment of physical climate risks

A bottom-up methodological approach used the latest climate scenarios and projections and the latest asset data from NATS to undertake a mixed quantitative and qualitative assessment of climate risks. This was combined with a literature review and stakeholder engagement (via interviews and a workshop) to produce the assessment of climate risks that met both DEFRA and the aviation sector specific requirements.

The supporting infrastructure required to provide ATC, engineering and other services for civil and military customers was included in the scope of the assessment, comprising 236 individual sites/assets in total, across the United Kingdom and Gibraltar (see Figure 2).

Figure 2 - Map of NATS' UK sites/assets

The assessment steps involved:

- **Scoping** – discussing and agreeing the direction and priorities for the APR3 assessment, location data for all NATS sites/assets, identification of key literature for review, and agreeing the stakeholder engagement approach;
- **Literature review** – a literature review that focused on a series of adaptation reporting questions, set in the context of the aviation sector, NATS and its stakeholders and customers;
- **Interviews** – the literature review was supplemented with interviews with key NATS personnel from across its Technical Services, Operations, Facilities Management and Legal teams;
- **Assessment of climate risks** – a preliminary assessment of climate risks was compiled by combining:
    - The NATS site/asset group location data from the UK and Gibraltar;
    - Overlaying climate data spatially from a larger number of climate variables to summarise the climate trends across the asset groups regionally;

    - Supplementing the assessment with details on the past extreme events (such as Storm Ciara and Storm Dennis), thresholds, controls, planned upgrades or improvements;
    - Summaries of these findings were used to complete the DEFRA ARP3 template (for aviation);
    - A detailed assessment was carried out for each of the 7 asset groups[1] and airspace (for all climate variables and scenarios) to score each risk separately before extracting the main risks in and across the asset groups to create the top 9 priority risks set out in this ARP3 report.
- **Review** – the preliminary assessment of climate risks was reviewed and refined further in a workshop with a wider group of NATS representatives.

For the ARP3 assessment, the following parameters were used:

- Airspace:
    - High emissions scenario (RCP8.5), i.e., a reasonable worst-case proxy;
    - Baseline present day;
    - Time horizon 2100.
- Estate sites/assets:
    - Two future emissions scenarios; medium-high (RCP4.5) and high (RCP8.5), i.e. a scenario aligned with the Paris Agreement 2°C temperature goal and a worst-case scenario respectively;
    - Baseline 1981-2000;
    - Time horizon 2050s (or 2070s alternative if not available).

[1] Radars, navigation aids, civil & military control towers, radio communications sites, en-route air traffic control centres and office facilities.

2.4. Climate change projections

Table 2 below shows a summary of the main findings per variable, datasets and scenarios used, for the UK and Gibraltar, including overall trends.

Risk variable	Overall trends	Scenarios	Main findings by the 2050s (or alternative) for the high emissions scenario	Datasets
Freezing fog / minimum winter temperature	• Increase in winter mean daily minimum temperatures • Fewer frost/days below freezing/days with freezing fog • The frequency of fog is expected to diminish • But we still need to be prepared for cold snaps with freezing fog	RCP8.5	• By the 2050s, for the high emissions scenario (RCP 8.5) all areas across the UK see an even greater increase in winter mean daily minimum temperature. The warmest places in south west England and London are over 2°C warmer compared to the baseline. The coldest parts of north Scotland are projected to be up to nearly 3°C warmer (-2.6°C) but still below freezing in the 2050s. • There is also an increase in winter minimum daily temperatures for Gibraltar, increasing by 1.6°C (compared to a 1971-2000 baseline) to 5.7°C by the 2050s. Although not common, days below freezing and freezing fog can still occur with temperatures reaching as low as -2.6°C currently. By the 2050s for the high emissions scenario, winter minimum extreme temperatures also increase by 1.6°C to -1.1°C.	• UKCP18 land Projections – regional 12km projections. Proxy: Winter mean daily minimum temperature (°C) • Spanish climate change platform AdapteCCa. Winter mean daily minimum temperature (°C)
Humidity	• Increasing humidity in winter in the UK • Minimal change in the number of humid days for Gibraltar	RCP4.5 and RCP8.5	• An increase of between 21-24% in winter specific humidity is projected for the 90th percentile (meaning a 10% chance of being above this) across the UK. The highest projected percentage increase in specific humidity is seen in south east England (24.4%) by the 2050s (under the high scenario RCP 8.5). The lowest increases are seen in the Isle of Man (20.9%) and Northern Ireland (21.4%). • For Gibraltar, the number of consecutive humid days in winter decreases slightly from 5.4 days (in the 1971-2000 baseline) to 4.9 days, showing minimal change by the 2050s under the high scenario.	• UKCP18 land projections – regional 12km projections. Change in specific humidity (%) • Spanish climate change platform AdapteCCa. Number of consecutive humid days

Risk variable	Overall trends	Scenarios	Main findings by the 2050s (or alternative) for the high emissions scenario	Datasets
Precipitation – flooding	• Flooding will become more severe and more frequent as a result of climate change, both river and surface water flooding	Not applicable	• Flood risk to sites is in Northern Ireland, Scotland and Wales. Flooding will become more likely at these sites and events potentially more severe.	Present day flood risk. Where available the 1 in 1,000 year annual chance flood risk data has been used as a proxy for a climate change scenario. • Environment Agency Flood Zone 2, Flood Zone 3 and 1 in 100 surface water flooding • Natural Resources Wales (NRW) rivers (Flood Zone 3) and sea flooding (1km). • Northern Ireland Department for Infrastructure: Present day - floodplain rivers. Present day - floodplain sea. • Scottish Environmental Protection Agency (SEPA) river flooding, surface water flooding and coastal flooding.
Storms – precipitation and lightning	• Daily precipitation rates are expected to increase in winter across the UK • Daily precipitation rates are expected to decrease in summer for the UK • There is a future increase in lightning frequency over the UK domain in summer and to a lesser extent in spring, little change in winter, and a decrease in autumn • Gibraltar is expected to see a slight decline in precipitation	Precipitation RCP4.5 and RCP8.5 Lightning RCP8.5	• By the 2050s (for RCP8.5) winter is projected to get wetter with precipitation expected to increase by 19% to 39% across the UK (with a 10% chance of being more than this). • By the 2050s (for RCP8.5) summers are expected to get drier with rainfall expected to decrease by -21%% to -58% across the UK (with a 90% chance of being less than this). • By the 2070s (for RCP8.5): In winter, future decreases in lightning are seen over the sea to the north and west of the UK, where high flash rates are seen in the present-day. In summer there is a very different pattern of lightning, with a considerable future increase in lightning over the southern part of the domain. In autumn, future decreases in lightning are seen widely across the UK domain. • For Gibraltar, winter precipitation is expected to decline slightly (-0.1mm/day) from 2.4 to 2.3 mm/day by the 2050s under the high emissions scenario. Summer precipitation is projected to also decline slightly from 0.3 to 0.2 mm/day.	• UKCP18 land projections – probabilistic projections. Change in precipitation (%). • Spanish climate change platform AdapteCCa. Precipitation (mm/day) for Andalucía (Gibraltar). • UKCP18 land projections - UKCP18 local 2.2km data. Lightning flash rate (key findings),

Risk variable	Overall trends	Scenarios	Main findings by the 2050s (or alternative) for the high emissions scenario	Datasets
Sea level rise	• Sea level will rise, affecting low-lying areas more • Risk of coastal flooding from storm surges and high tides will increase as sea levels rise • Increased storminess can also increase coastal flood risk	RCP8.5	• Environment Agency sea level rise allowances for England (by river basin region, upper end allowance) ranging from an additional 256.5mm in north west England to 300.6mm in south west England. • SEPA cumulative rise in sea level across Scotland (by river basin, upper end allowance) by 2100 ranging from an additional 0.85m in Clyde and Tay, up to 1.02m in Shetland. • NRW estimated mean sea level rise (by local authority area, upper end) by 2100 ranging from 0.95m for Denbighshire, up to 1.11m for the southern coastal authorities in Wales. • Low-lying coastal areas in Gibraltar are projected to be below flood level in 2050, particularly on the eastern side of the peninsula.	• UK: coastal design sea levels - coastal flood boundary extreme sea levels (2018) with regulator climate change allowances for sea level rise and storm surge (no up to date climate change allowances data for Northern Ireland) • Gibraltar: climate central - land projected to be below 10-year flood level in 2050, with climate change under the high emissions scenario
Snow	• Reduced snow events are expected • Lying snow disappears almost entirely over low-elevation regions	RCP8.5	• By the 2030s, the area with the greatest winter lying snow amount (mm) decreases to an average of 8.3mm in east Scotland (8.3 mm or 50% less compared to the baseline). • The lowest snow lying amount on mainland UK is in London (0.1mm), south east and south west England at 0.2mm respectively, all between 0.1-0.3 mm less than the baseline.	• UKCP18 land projections - UKCP18 local 2.2km data. Lying snow amount (mm)
Summer mean temperature rise	• Greater chance of hotter summers • Southern England warms more than northern regions of the U	RCP8.5	• By the 2050s (for RCP8.5), summer mean daily maximum temperature (90th percentile) increases across the whole of the UK, reaching an average of 14.8°C in north Scotland (an increase of 2.6°C from the baseline) and 25.6°C in London (nearly 4.2°C higher than the baseline). • For Gibraltar, mean daily maximum summer temperature increases by 2.6°C (compared to the 1971-2000 baseline) to 33.4°C by the 2050s under the high emissions scenario.	• UKCP18 land projections – regional 12km projections. Summer mean daily maximum temperature (ºC) (90th percentile) • Spanish climate change platform AdapteCCa. Summer mean daily maximum temperature (ºC) for Andalucía (Gibraltar)

Risk variable	Overall trends	Scenarios	Main findings by the 2050s (or alternative) for the high emissions scenario	Datasets
Summer extreme temperature	• Future extreme summer temperatures are expected to increase in frequency and duration	RCP4.5 RCP8.5	• 100-year return levels of daily extreme summer temperatures (90th percentile) across the UK range from 29°C in the north (a 4.2°C increase from the baseline) to 42.3°C in the south (4.9°C higher compared to baseline) • For Gibraltar, maximum daily extreme summer temperatures increase by 2.1°C (compared to a 1971-2000 baseline) to a high of 40.2°C by the 2050s for the high scenario (the scenario and dataset for Gibraltar does not look at a return level and cannot be directly compared to the UK values)	• UKCP18 land projections – probabilistic Projections of Climate Extremes (PPCE). 100-year return levels of daily maximum temperature in Summer (90th percentile) • Spanish Climate Change Platform AdapteCCa. Maximum daily extreme summer temperatures for Andalucía (Gibraltar)
Wind speed and gusts	• Increasing wind speed and gusts during winter for western parts of the UK	RCP8.5	• Between the 2050s and 2070s there is a future increase in surface winds over western parts of the UK and over the ocean in winter. • Decreasing wind speed is seen over the south and east of the UK. • In summer, there is a widespread decrease in wind speeds over the land.	• UKCP18 Land Projections - UKCP18 Local 2.2km data. Maximum Wind Speed of Gust at 10m (above ground level) (m s-1) and Wind speed at 10m (above ground) (m s-1)
Fog	• Inconclusive	Not applicable	• The frequency of fog is expected to diminish at UK airports. • Predicted increase in the occurrence of fog (due to warm weather and longer winter nights). • Current lack of confidence in the projections for changes in fog.	• No UKCP data available, trends evident in the data • NATS (2010) The impact of climate change on UK traffic patterns

Table 2 – Climate projections key findings

2.5. Summary findings of the main physical climate hazards

General climate change trends projected over UK land for the 21st century in UKCP18 are broadly consistent with earlier climate projections (UKCP09) showing an increased chance of warmer, wetter winters and hotter, drier summers along with an increase in the frequency and intensity of extremes. All areas of the UK are projected to be warmer, more so in summer than in winter. Hot summers are expected to become more common. Rainfall patterns across the UK are not uniform and vary on seasonal and regional scales and will continue to vary in the future. Future climate change is projected to bring about a change in the seasonality of extremes. We can continue to expect increases to extreme coastal water levels driven mainly by increases in mean sea level rise, although we cannot rule out additional changes in storm surges[x].

For Gibraltar, southern Europe is projected to experience strongest warming increases during the summer months. The Iberian Peninsula will suffer a decrease in precipitation exposing it to higher risks of drought. As heat waves increase, southern Europe will experience trends towards more intense and longer periods of drought. Gibraltar is almost completely surrounded by water, so projected sea level rise poses a threat to the peninsula[xi].

The main physical hazards for NATS, and any related thresholds, include:

- **Precipitation – flooding**: Increased risk of flooding risk from rivers and surface water across the UK. Flooding is expected to become more severe and more frequent as a result of climate change. A 1 in 1,000 year annual chance flood risk data has been used as a proxy for a climate change scenario.
- **Storms – precipitation and lightning:** Daily precipitation rates are expected to increase in winter and decrease in summer across the UK. There is a future increase in lightning frequency over the UK in summer and to a lesser extent in spring, little change in winter, and a decrease in autumn. Gibraltar is expected to see a slight decline in precipitation.
- **Wind speed and gusts:** Wind speeds and gusts are projected to increase in winter for western parts of the UK (between the 2050s and 2070s). In summer, there is a widespread decrease in wind speeds over the land.
- **Summer extreme temperatures:** Future extreme summer temperatures are expected to increase in frequency and duration. The south of England could experience extreme heat over 40°C in summer, with hot temperatures between 38-40°C seen across central and southern England. In Gibraltar, extreme summer temperatures are expected to increase by around 2°C.
- **Sea level rise** – will affect low-lying areas with a greater risk of coastal flooding from storm surges and high tides as sea levels rise. Sea level is expected to increase by the 2050s to between 0.26m and 0.30m across England, (with greater increases expected in the south due to movement of the earth's crust after the last ice age). In Scotland, the estimated sea level rise by 2100 ranges from 0.85m up to 1.02m. Wales is expected to see around 1m of sea level rise by the end of the century. Low-lying coastal areas in Gibraltar are projected to be below flood level in 2050, particularly on the eastern side of the peninsula.

2.6. Physical risk assessment findings

The physical risks have been reassessed as part of ARP3 (see Table 3), with some noticeable changes in terms of the assessment results and the risk prioritisation.

Priority	Risk variable	Business function	Impact description	Interdependencies
1	Precipitation (flooding from rivers and surface water) at en-route air traffic control centres	Operation of ATM systems & delivery of service	Fluvial and surface water flood risk have been identified as potential risks at en-route air traffic control centres. Anecdotal evidence has suggested that there is already a risk from these sources and that ad hoc emergency maintenance has been conducted to improve drainage capacity and reduce flood risk to their sites.	Interdependencies include: • Electricity supply and allied distribution networks, and other utilities • Internet and communications networks • National and local transport network • Access routes to NATS sites • Dependency / enabler with adjacent ANSPs providers on airspace network, ATC and data sharing.
2	Storms (precipitation and lightning) at remote sites	Operation of ATM systems & delivery of service	• All remote communications, radar and navigation sites could be highly impacted by lightning strikes or heavy precipitation. • Extreme heavy precipitation, including hail, could cause damage to asset and impede operation. • Rainfall could penetrate asset and cause damage. • Heavy precipitation could also lead to low visibility conditions at airfields. • Simultaneous loss of multiple sites or assets can ultimately lead to reduced operational service and the suspension of services at airfields.	Interdependencies include: • Electricity supply and allied distribution networks, and other utilities • Internet and communications networks • National and local transport network • Access routes to NATS sites • Dependency / enabler with adjacent ANSPs providers on airspace network, ATC and data sharing.
3	Wind speed and gusts at remote sites	Operation of ATM systems & delivery of service	• Damage and loss of radar (and radome) during high winds/storm occurred in 2013, requiring replacement of asset (9 months of disruption) at one radar site and upgrades to all other radars at NATS sites. • Services are already being impacted by high winds and the number of storms in last two years, e.g. radars in high risk areas were switched off and motors disengaged to prevent damage. NATS has operated in reduce redundancy mode at least twice in the last two years. Another example includes the loss of an antenna	Interdependencies include: • Electricity supply and allied distribution networks, and other utilities • Internet and communications networks • National and local transport network • Access routes to NATS sites

Priority	Risk variable	Business function	Impact description	Interdependencies
			even though it was expected to withstand high wind. • Simultaneous loss of multiple sites or assets can ultimately lead to reduced operational service.	
4	Sea level rise at airports where NATS provides the ATC service	Operation of ATM systems & delivery of service	Assets at three airfields, including two control towers, have been identified as within a tidal flood risk area, only one of which has existing tidal defences.	Interdependencies include: • Electricity supply and allied distribution networks, and other utilities • Internet and communications networks • National and local transport network • Access routes to NATS sites
5	Precipitation (flooding from rivers and surface water) at airports where NATS provides the ATC service	Operation of ATM systems & delivery of service	Assets at three airfields, including two control towers, have been identified as having a risk from precipitation or flooding, i.e. from surface water flooding.	Interdependencies include: • Electricity supply and other utilities • Internet and communications networks • National and local transport network • Access routes to NATS sites • Dependency / enabler with adjacent ANSPs providers on airspace network, ATC and data sharing.
6	Summer extreme temperature (heat overload) at an en-route air traffic control centre and ATC tower	Operation of ATM systems & delivery of service	There have been no reported past events of direct asset damage due to extreme summer temperatures. Water cooling is sometimes deployed in summer highs which can disrupt operations.	Interdependencies include: • Electricity supply and allied distribution networks, and other utilities • Internet and communications networks • National and local transport network • Access routes to NATS sites • Dependency / enabler with adjacent ANSPs providers on airspace network, ATC and data sharing.
7	Summer extreme temperature (heat overload) on ATM infrastructure, especially at sites in central and southern England	Operation of ATM systems & delivery of service	Extreme heat events could cause damage to equipment components, either limiting or stopping their operation. As the temperature approaches 40°C, from 38 – 40°C components can start to malfunction.	Interdependencies include: • Electricity supply and allied distribution networks, and other utilities • Internet and communications networks • Dependency / enabler with adjacent ANSPs providers on airspace network, ATC and data sharing.
8	Increased frequency & intensity of thunderstorms and extreme weather	Operation of ATM systems &	A thunderstorm event in in July 2019 led to significant disruption for airlines. Given the scale of the event and its proximity to busy	• Interdependencies include: • Dependency / enabler with adjacent ANSPs on airspace network, ATC and data sharing.

Priority	Risk variable	Business function	Impact description	Interdependencies
	events may disrupt operations	delivery of service	airspace around London, options for rerouting were limited leading to operational restrictions.	
9	Increased frequency & strength of clear-air turbulence may disrupt operations	Operation of ATM systems & delivery of service	Turbulence is reported to account for 65% of weather-related accidents. Aircraft encountering turbulence can experience sudden vertical motions which in severe cases can cause injuries to their crew and passengers, and rarely, structural damage to the aircraft.	

Table 3 – ARP3 priority climate risks (physical)

3. Transition risks & opportunities

3.1. Introduction

As a result of the transition to a low carbon economy, there are policy, legal, market and reputational risks for NATS to manage. Some of these are direct, for example, access to green electricity, while others are indirect, for example, policies and targeted litigation designed to reduce air travel, increased resilience/adaptation costs, and the industry viewed as a significant part of the climate crisis in eyes of the public – potentially leading to a loss of investor confidence and an inability to attract good talent in the future. The scope of this risk includes NATS' corporate functions, as well as relationships and dependencies with key stakeholders.

These risks have a high likelihood; the only question is the severity of their impact and whether the business is adequately prepared. Climate change transition risks will further complicate climate change mitigation and adaptation steps, resulting in increased direct and indirect costs, reporting requirements, audit/assurance, and regulatory oversight, etc. These issues will also challenge our customers and key suppliers, requiring increased coordination.

NATS has to operate within the prevailing climatic and meteorological conditions and deliver services to customers despite what is envisaged to be a more challenging operating environment. Understanding the potential impacts and influences on the business will help inform its future governance, strategy and investment profiles.

There are also opportunities for NATS to consider and pursue, particularly market-based ones which may partially offset some of the increased costs from transition impacts.

3.2. Identification and assessment of transition risks

3.2.1. Background

NATS' original climate change risk assessment for ARP1 identified 11 climate risks (see Table 1), with two transitional risks prioritised; i) public perception of travel, and ii) restrictions on numbers of flights. The transitional risks have been reassessed as part of ARP3 (summarised in Table 4).

3.2.2. Methodology for latest assessment of transition climate risks

A top-down qualitative assessment of transition risks was undertaken. This took account of the earlier ARP1 review and the scope of the requirements set out by the TCFD, including policy & legal, technology, market and reputation risk (and opportunities).

3.3. Transition risk assessment findings

3.3.1. Policy & legal

Policy development and consumer behavioural change may seek to constrain aviation activities that contribute to climate change dampening demand. These could, for example, include introduction of a frequent flier tax, increases in air passenger duty, imposing an aviation fuel tax, strengthening of the CORSIA rules, or increasing the cost of emissions trading. While indirect, these 'upstream' risks still have the potential to affect NATS.

Requirements already exist on disclosure of efforts to identify and assess climate change risks, for example under the UK Climate Change Act, and will soon also apply to TCFD reporting. This activity is likely to increase further.

Separately, there has been an increase in climate related shareholder action and litigation against companies and governments[xii], which influences policymakers and the public. Some of this has been directed towards airlines and airports in the UK, EU and USA, which has the potential to affect NATS' customers directly.

The regulatory requirements for airspace change have also increased significantly in the UK in recent years partly in response to public opinion on aircraft community noise impacts, and even though airspace changes incorporate other environmental benefits. There is increasing risk that NATS' airspace projects could be subject to a Secretary of State review (known as 'called-in application'), or a separate judicial review by other complainants seeking to overturn a CAA decision on a similar basis to successful airport expansion challenges.

However, there are also potential policy opportunities for NATS:

- Influence the development of aviation-specific climate change resilience and adaptation policy at regional and global levels, through increased collaboration with other ANSPs and industry bodies, including UK Sustainable Aviation, CANSO, EUROCONTROL and ICAO's Committee on Aviation Environmental Protection.
- NATS has been pro-active in managing resilience and can demonstrate to policymakers and regulators the steps taken to date and future plans.

3.3.2. Technology

The technological pathway to a zero emissions economy will have a number of direct and indirect challenges for NATS:

- NATS will be increasingly reliant on the electricity grid for power, heating, ventilation and air conditioning and travel. This reliance creates a risk from outages and cascade failures, regardless of fault;
- NATS' critical sites have multiple layers of back-up fossil fuel generation and batteries on site to cover outages. While these legacy systems are only used intermittently, they are not always fully reliable as was demonstrated by storm Arwen. A wholescale replacement back-up solution has not yet been identified, however this challenge is not unique to NATS, so it is expected that a market driven option will develop;
- NATS' non-critical sites or functions are equally at risk from outages and cascade failures, although they may still affect its business, the likely impact is lower[xiii];
- NATS is planning to commission photovoltaic (PV) arrays at its main sites. This will help reduce its scope 2 emissions in the short term and minimise exposure to electricity price fluctuations in the long term. However the capacity of the arrays will be less than the baseload at its main sites;
- New technological solutions deployed to improve climate change resilience will also need to be risk assessed. For example, space-based Automatic Dependent Surveillance–Broadcast (ADS-B) surveillance can be used to complement (and provide back up for) ground-based radar. However, the impact from climate change on atmospherics will have to be monitored to ensure the system meets all requirements.

3.3.3. Market

There is much uncertainly on how sectors will respond to climate change and how demand patterns will evolve for individual commodities, products and services. Disruption is likely, if not inevitable. Specific risks for NATS include:

- Since NATS signed a low-carbon biogas contract (for heating), the price has increased by 230%. The cost of its commitment to procuring low carbon gas may continue to increase as demand from the market for this gas increases;
- NATS' net zero commitment may require it to engage in the CO_2e sequestering / offsetting market. Demand for these solutions is likely to increase, and so too the price, as companies seek solutions for hard-to-treat GHG emission sources in the short term;
- Increased costs of finance and insurance as a result of the financial sector's perspective of NATS' exposure to transition risk;
- Changes to the tourism climatic index in future suggest there may be changes to traffic flows affecting north-western Europe[xiv] which has the potential to affect revenue;
- Disruption to upstream/downstream supply chains and distribution networks arising from lack of preparedness and resilience by NATS' stakeholders in their transition to net zero;
- Aviation fuel price volatility (whether kerosene, sustainable alternate fuels, hydrogen, battery, or hybrid) is likely to affect demand;
- Reduced demand for aviation arising from changes to public / corporate appetite for travel and increasing concerns about climate change, or imposed demand management options by government to contract the sector's impact on climate change

However, there are also related commercial opportunities, some of which already exist and others are potential:

- Intelligent Approach is a suite of tools that NATS has developed to improve resilience to weather events or other disruption, particularly during strong headwind conditions that would otherwise reduce the runway landing rate. Using enhanced time based separation (eTBS) and the latest European Wake Vortex Reclassification (RECAT-EU), controllers can optimise the spacing between aircraft in the landing stream. This sits alongside NATS' cross-border arrival manager (XMAN) which optimises the stream of traffic out to 350 NM and a Demand Capacity Balancer (DCB) application which optimises runway operations, taking into account forecast and current adverse weather conditions. The tools provide better on time performance[xv], and reduce the need for stack holding, saving fuel and CO_2 emissions.
- NATS has partnered with other industry experts to develop the concept of remote digital towers and supported London City airport to become the first UK airport in the world to deploy this technology in 2021. The remote digital tower allows controllers to manage aircraft safely from an off-site location, while providing controllers with valuable new tools that would be difficult and not cost-effective to provide in a traditional control tower. The outcome is improved resilience in adverse weather conditions and avoiding risk from climate change to legacy buildings and infrastructure at airports. There is also built-in resilience for operations to be provided from the host location.
- The growing number of wind farms worldwide shows the importance of this renewable energy resource and as demand for more renewable energy increases there is a transition risk that developers are unable to commission these, in part due to safety challenges and the impact on aircraft surveillance. NATS, in partnership with other industry experts, has developed a range of supports to ensure both industries can operate efficiently without any adverse effects on each other. These include advice on planning, impact analysis and mitigation solutions, for example, changing airspace design, modifications to primary radars and deploying new secondary surveillance radar.
- As airlines and ANSPs pursue net zero commitments, for example, by taking action to achieve their SBTi commitments, there is an opportunity to develop data-led services to

optimise performance of the airspace network and how it supports airspace users in maximising efficiencies.
- Changes to airline cost indices will encourage flight planning which minimises CO_2 emissions and direct trajectories through UK airspace, instead of longer trajectories which avoid UK airspace, with positive impacts on NATS' revenue as a result.
- Innovative solutions such as formation flying (fello'fly[xvi]) and contrail avoidance[xvii] may be called on for deployment in the North Atlantic. NATS is supporting exploratory research on both concepts, and this could be accelerated and have global application.

3.3.4. Reputational risk

Climate change is a potential source of reputational risk tied both to evolving Government policy and priorities, and to changing customer or community perceptions of a company's level of contribution to the transition to a lower-carbon economy. Public concern about aviation's environmental impact[xviii], and measures to address that impact, is allied to other risks such as the potential for increased regulation and reduced demand for air travel.

There has been increased scrutiny of NATS by institutional investors and lenders arising from their assessment of risk exposure in high-carbon sectors. Should NATS not be perceived to be responding appropriately, this could potentially, lead to reduced confidence in NATS' outlook and financial/environmental, social and governance (ESG) ratings which would increase the cost of finance to NATS.

As the regulated supplier of en-route air traffic services within the UK, NATS is required to deliver services that meet minimum performance standards and requirements as set out by the CAA. NATS will need to develop its services, systems and infrastructure to meet these performance requirements in light of more challenging climatic and meteorological conditions. Failure to do so may result in reputational damage and penalties being imposed by the CAA.

Misalignment, or lack of coordination, between NERL, NSL, airport operators and airlines, and NATS' supply chain, on climate change impacts and adaptation has the potential to lead to service disruption and increased costs which could also negatively affect reputation.

Increased environmental conscience may affect future recruitment and retention of staff, especially younger candidates and others for whom ethical considerations feature highly in their career choices, if they cannot see that NATS is actively following a programme of environmental improvement.

Risk variable	Business function	Impact description	Interdependencies
Policy and legal	Finance, Legal, Communications and Operation of ATM systems	Policy, legal and shareholder action, as well as consumer behavioural change may seek to constrain aviation activities that contribute to climate change dampening demand.	Interdependencies include: • Customers, including airports, airlines, military • Other ANSP providers
Technology	Technical Services	The pathway to a zero emissions economy will have a number of challenges: • Alternative to fossil fuel back-up energy generation • Increasing reliance on electricity grid	Interdependencies include: • Renewable energy developers and allied distribution networks, and other utilities • Advances in back-up energy storage

		• New solutions will need to demonstrate their own climate change resilience	
Market	Commercial, Finance and Communications	The costs of transition to a low carbon economy are likely to be significant, but less than the cost of inaction, and include: • Green energy and CO_2e sequestering / offsetting costs are likely to increase significantly with demand. • Changes to the tourism climatic index suggest there may be changes to traffic flows affecting north-western Europe and NATS' revenue • Action by corporate travel bookers to reduce their aviation emissions in service of net zero targets, as well as consumers-led behavioural change may result in reduced demand for air travel.	• Disruption to upstream / downstream supply chains and distribution networks arising from lack of preparedness and resilience by NATS' stakeholders in their transition to net zero.
Reputation	Finance and Communications	• Public perception of NATS and its efforts to transition to the low-carbon economy affects other risks which may result in additional regulation and reduced demand. • Increased scrutiny from investors and the finance community could result in changes to its rating and outlook. • Not responding to stakeholder concern on environment could affect NATS' licence conditions, or even the renewal of its licence. • Future recruitment and retention of staff may become more difficult.	• Public perception of the aviation industry and its efforts to transition to the low-carbon economy may lead to reputational damage and loss of confidence in industry efforts to manage its climate risks effectively.

Table 4 – ARP3 priority climate risks (transition)

4. Adaptation

4.1. Good practice

In gathering evidence to support a revised risks assessment for ARP3, a number of NATS case studies and examples of good practice were also collected.

4.1.1. NATS resilience plan and incident management

In 2018 the CAA added a new licence requirement for the management of the economically regulated part of the business (NERL), requiring the development of a resilience plan explaining how we meet our service obligations. A NATS resilience plan was published and submitted to the CAA in 2019 and updated in 2021, with a further update planned in 2023. NATS' strategy is to achieve resilience by designing, maintaining and continuously improving the proactive and reactive controls within operations and the associated assets, systems and processes across the business. The resilience plan is supplemented by Incident Management processes and procedures that enable incidents which could affect service delivery to be visible, controlled and managed. The processes use the established Gold/Silver/Bronze hierarchy used across the UK by the emergency services, supplemented by communication and control protocols to engage customers and airport operators in the management and resolution of the incident. NATS also has a role in the National Airspace Crisis Management Executive (NACME), the CAA-led organisation for managing incidents that affect UK airspace (for example, volcanic ash).

4.1.2. Plan 39

If an event occurs within the airspace above the south of England (the London Terminal Manoeuvring Area) that would lead to multiple diversions, the initial response would be for Terminal Control to establish availability at airports for receiving diversions. To expedite this process, reduce confusion and minimise the chance of further incidents during an intense period of the operation, a mass diversion procedure has been developed (known as Plan 39) which involves working with airports, airlines, the CAA and the Department for Transport (DfT) to pre-approve landing slots at alternate airports. The plan provides Terminal Control with immediate pre-authorised capacity for diversions for specified airlines and aircraft types at specified airports, enabling controllers to respond quickly to an incident. Some of the likely triggers for Plan 39 include unexpected airport closures, significant thunderstorm activity and adverse weather at airports.

4.1.3. Met Office embedded within NATS' operations

In 2016 the UK Met Office integrated a meteorologist team onsite at NATS Swanwick. This 24/7 service, working with meteorologists at airports and their Exeter head office, aims to interpret emerging weather information to develop reasoned forecasts applicable to air traffic control. This proactive activity has increased the resilience of the NATS operation to adverse weather events, thereby enabling us to maintain safe and efficient services even in the face of unpredictable meteorological conditions. There is a particular focus on thunderstorm (CB) and low visibility forecasting, but meteorologists also advise on Shanwick operations and extreme weather events.

4.2. Next steps

Following the completion of the ARP3 project, the findings and recommendations will be reviewed and adopted. A new climate change strategy has been developed, with a series of controls and actions devised to mitigate the risks identified. The next two relevant milestones will be, complete the update to the NATS resilience plan and align reporting with the requirements of TCFD, each in 2023.

Changes arising from ARP3 will be set out in NATS' future business plans for consultation with the CAA and customers in the normal way. Additional steps to be undertaken by NATS in the meantime are set out below.

4.2.1. Governance

NATS will ensure clear accountability for climate change at Director level. NATS' Risk Governance Board and Business Continuity Steering Group retains oversight of overall risk and resilience matters, while the Environmental Strategy Steering Group is responsible for oversight of its climate change adaptation strategy and plan, underpinned by a ISO14001 Environment Management System. An update will be prepared as part of the NATS Board's annual environmental management review and include indicators and metrics for assessing progress.

4.2.2. Climate change adaptation strategy

The objectives of NATS' climate change adaptation strategy are to manage the risks and impacts of climate change, working closely with its stakeholders, and to report on its progress to regulators. NATS will:

- Embed and update climate change adaptation good practice within management systems and processes;
- Use climate change scenario analysis to inform decision making linked to key infrastructure and investments;
- Assess and report on climate change hazards, including extreme weather events, impacts and resilience as part of TCFD and ARP;
- Engage customers, suppliers and other stakeholders to raise awareness, coordinate on climate change resilience and minimise interdependency risks;
- Develop a climate change adaptation plan which will incorporate appropriate controls and actions to mitigate climate change adaptation risks.

In response to the review of key climate risks (physical and transition), a comprehensive set of actions has been developed. These actions will be prioritised and incorporated into NATS' project and business plan cycles.

4.2.3. Enterprise risk management and controls

A new risk climate change risk has been set out in NATS' enterprise risk management system, focusing on three specific sub-risks, i.e. adaptation (physical and transition) and mitigation, which together may impact its operations, engineering, infrastructure and corporate functions. Work continues to develop and embed these risks and their controls across the business.

Two strategic controls will be implemented in relation to climate adaptation risks:

1) the adoption of a management approach consistent with the international standard on adaptation to climate change; and
2) the formal incorporation of climate change resilience into the NATS resilience plan.

NATS will review current and future industry standards and guidance, e.g. TCFD, ISO 14090 and BS 9631, to identify best practice and areas for further improvement. NATS will undertake this work, where possible, in collaboration with the wider aviation industry to understand, assess and manage industry wide resilience, including airport customers, EUROCONTROL and other key stakeholders.

NATS will incorporate both physical and transition climate risk considerations within its updated resilience plan. The updated plan will consider and manage climate risks in the same manner as other risks. This will ensure appropriate governance and action tracking for all drivers that may affect resilience. Through collaboration, the assessment will also consider interdependencies between NATS and their suppliers and customers, as well as other stakeholders.

4.2.4. Awareness and communication

Through training, awareness and communication, NATS will embed climate risk evaluation and adaptation throughout the organisation, helping employees identify how their roles and projects may be affected by climate change. This will ensure the retention of institutional subject matter expertise and will enable ongoing assessment of adaptive capacity. The scope of existing environmental training will be expanded to include climate change adaptation, risk and why this is important to NATS.

New tools will be developed to support decision making using climate change scenario analysis, e.g. proformas to screen for climate risks, or GIS based systems to provide climate data at project locations. Improved use of data and decision-making support tools will allow for an improved ability to respond to climate risks and opportunities across the whole physical asset base. A GIS-based system would allow asset and spatial data to be integrated, this could include, but not be limited to:

- Climate change projections;
- Flood risk data;
- Weather and flood warning information; and
- Wider environmental constraints.

4.2.5. Actions

A large number of individual risks and actions have been identified linked to each of the variables highlighted in table 3, as well as for others which have a lower priority and are not included here. Some of these steps will entail further scoping and evaluation of impacts, while others will require the implementation of specific actions, potentially with other stakeholders. Actions include, for example:

- The installation of flood detection systems at key high risk sites and a plan to act on flood alerts from relevant organisations;
- Use the issuing of Met Office weather warnings as a trigger for convening NATS' incident management processes;
- Integrate climate projection scenarios into the long-term investment programme (LTIP);
- Influence the national contingency response to weather events to ensure that restoration of critical services and utilities takes place in a controlled and triaged way;
- Ensure key suppliers are aware of NATS' climate change adaptation plan and have reviewed any dependences;
- All projects to consider the potential impact from climate change over the lifetime of the asset or service, as part of the project environmental risk assessment tool.

5. Appendix

5.1. Airspace assessment

The review of climate risk to airspace operations will be published by NATS in parallel with this report on its website[xix].

5.2. Airspace environmental performance indicators

Two sets of environmental performance indicators are enclosed below for additional context. These indicators, although driven by short-term weather conditions, traffic flow and other factors, may be useful to track over time as a proxy for measuring the impact of weather (and potentially climate change) to aviation operations.

Inclement weather can result in problems for air traffic control and delays to flights. The analysis for this report did review weather parameters but their priority was not as high as those described in Table 3. For completeness, the number of weather regulations applied by NATS over time is described in Figure 3 (note change in data/methodology from 2016).

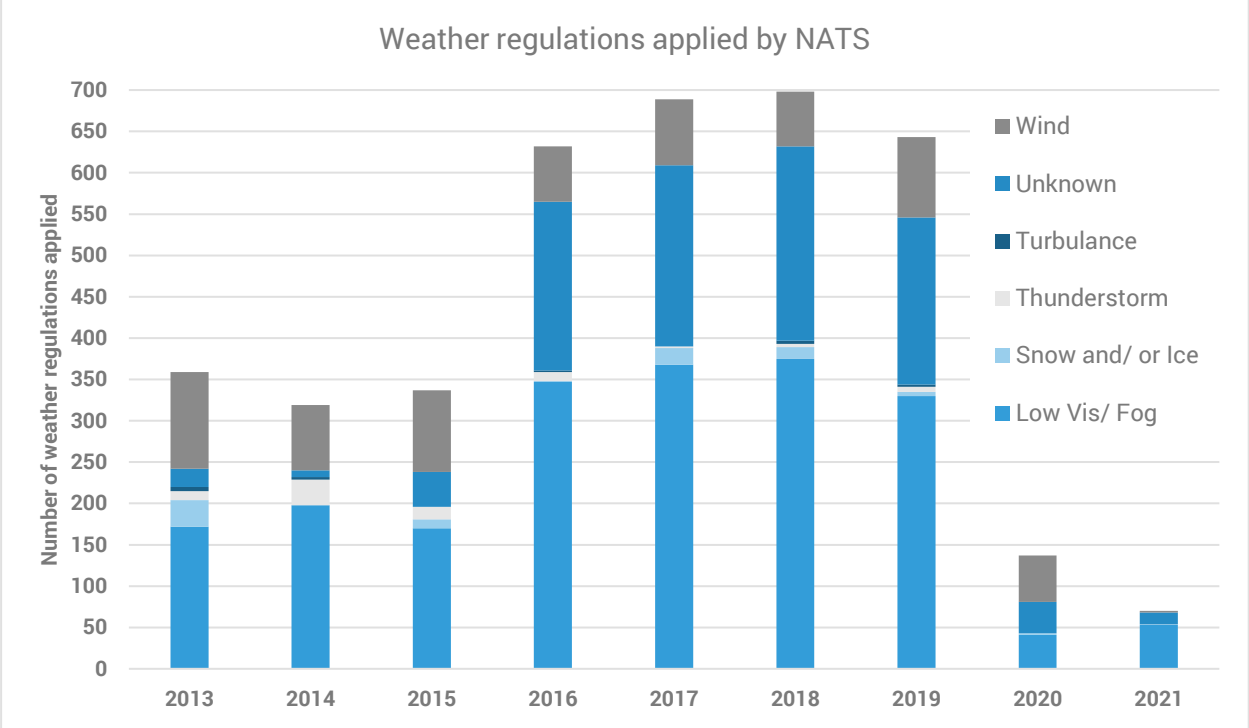

Figure 3 – Airport and domestic en-route weather related regulations by year

The location of the north Atlantic tracks is heavily influenced by the location of the jet stream. The westbound tracks are set daily by NATS in order to avoid the core jet stream flow. Figure 4 describes the variation of the oceanic entry point for the core west-bound track position over time.

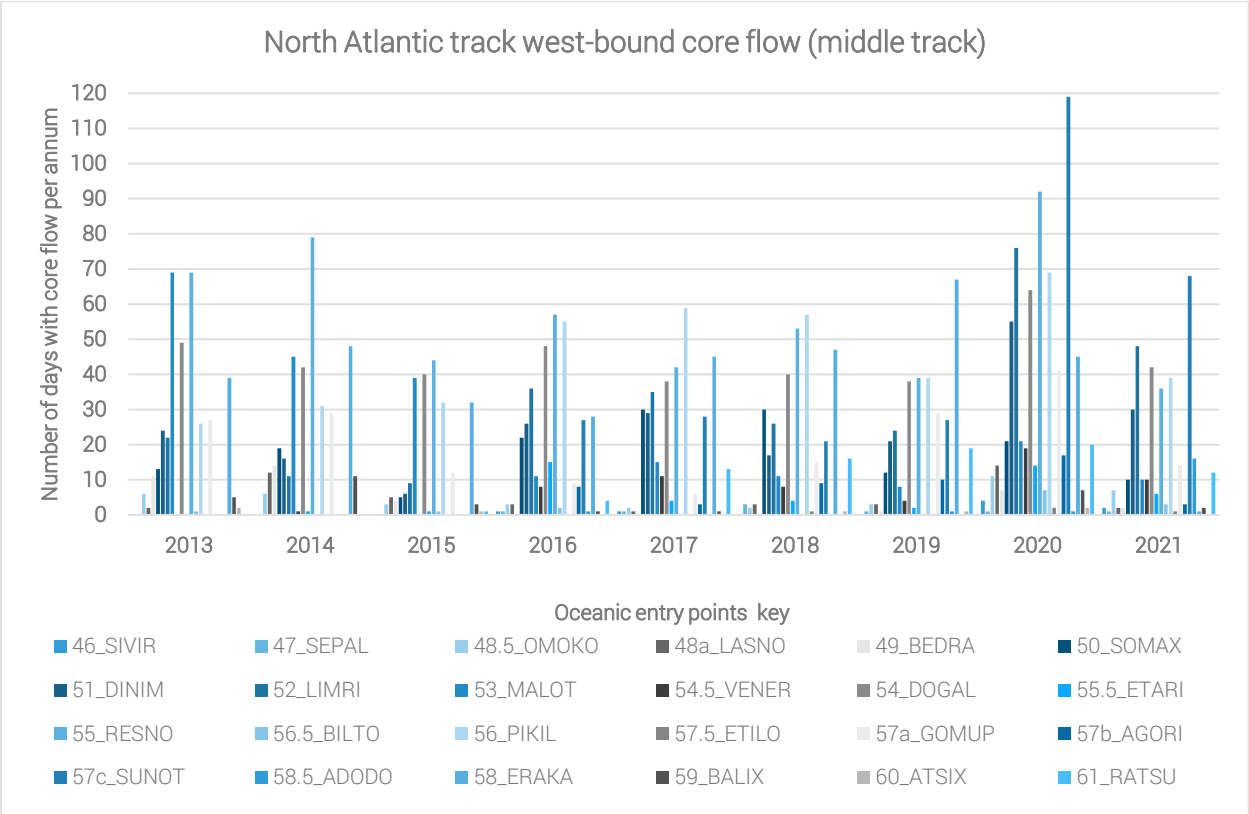

Figure 4 – The distribution of the latitude of the oceanic entry point for the core westbound north Atlantic track for each year

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