PROCHAIN ARRÊT

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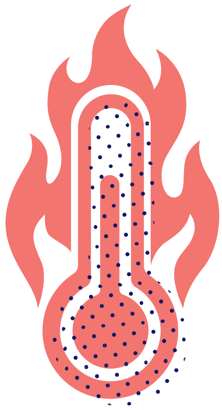


One hundred years of heatwave

Operating at 50°C

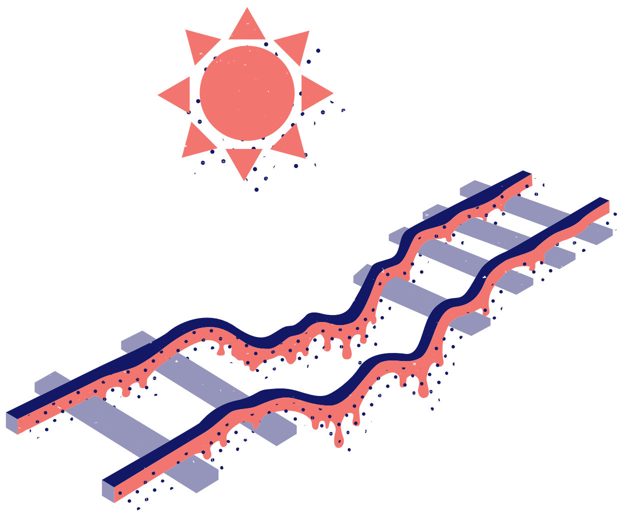
A seemingly inevitable climate trajectory

The reference warming trajectory for climate change adaptation (TRACC in French), adopted by the French government as its planning framework, projects average temperature rises of +2°C by 2030, +2.7°C by 2050, and +4°C by 2100 across mainland France and Corsica, compared with the end of the 19th century. In concrete terms, Paris's mean annual temperature could reach 15°C in 2100 — the same as in Mediterranean city Montpellier today — while the southern half of the country would exceed an average of 18°C, matching current conditions in Andalusia (Météo-France, DRIAS portal, 2024). In 2050, there will be five times more heatwaves, which will extend from early June to mid-September; while some southern cities could experience as many as 120 tropical nights – when temperatures do not dip below 20°C - per year.

For transport operators, these figures are no abstract horizon: they are already a common feature of every summer. SNCF Réseau has established that rails begin to expand as soon as their temperature exceeds 45°C. Yet when the outside air reaches 37°C, the temperature of steel rails regularly climbs to 55°C and can exceed 70°C at the height of a heatwave. Expansion, constrained by attachment to the sleepers, causes buckling of up to several centimetres. The operational response consists of imposing temporary speed restrictions, reinforcing patrols, and in some cases painting rails white — a technique used by Network Rail in the United Kingdom which, by its own measurements, reduces rail temperature by 5 to 10°C.

An unevenly distributed vulnerability

The thermal design thresholds of rail networks vary considerably between countries. British rail networks have historically been designed to operate between -10°C and +35°C; Spanish networks between 0°C and +45°C; the Saudi network between +10°C and +55°C. France, climatically similar to Spain in its south and the United Kingdom in its north, has no single uniform reference standard. The UK Climate Change Risk Assessment 3 (2021) estimates that track buckling incidents could be four to five times more frequent in Great Britain by 2050, and that the annual cost of heat-related disruption could be multiplied eightfold by the 2080s under a high-emissions scenario. The 2003 European heatwave alone caused 137 track buckles across the UK, at an estimated cost of £2.5 million (Network Rail and Adaptation Sub-Committee reports).



Rails are not the only metallic infrastructure exposed. Overhead catenary wires expand and sag in the heat, weakening current collection by the pantograph. Automatic tensioners partially absorb this effect, but their margins are finite. SNCF Réseau deployed the Metigate tool in 2022, which combines Météo-France forecasts with artificial intelligence to anticipate rail temperature beyond atmospheric measurements alone. On the road surface, bitumen begins to deform at 30 to 40°C for the most flexible asphalt mixes, and melts between 50 and 60°C for standard surfacing. Road surface temperature easily exceeds 50°C when air temperatures reach highs of 38°C. Several French département councils now spread lime wash on secondary roads, which can reduce surface temperature by around 10°C according to local technical services departments.

Underground networks: a thermal paradox

Metros present a specific challenge. Older underground networks have not been fully air-conditioned, for a physical reason: air conditioning on trains means that the extracted heat is released into tunnels already warmed by regenerative braking and the repeated opening of doors. New York has documented this experience: its air-conditioned trains frequently render platforms unbearable during summer peak hours, with temperatures running up to ten degrees above those outside (Slate, 2024). By contrast, newer networks built in hot climates — Dubai, Riyadh, Singapore and Madrid's modern extensions — are fully air-conditioned by design, with oversized extraction systems and tunnels. Older European networks must instead work within their inherited constraints: refrigerated ventilation rather than conventional air conditioning, water fountains at high-footfall stations, and reinforced seasonal teams during heatwave episodes. Above ground, the fitting of air conditioning to bus fleets is accelerating everywhere.

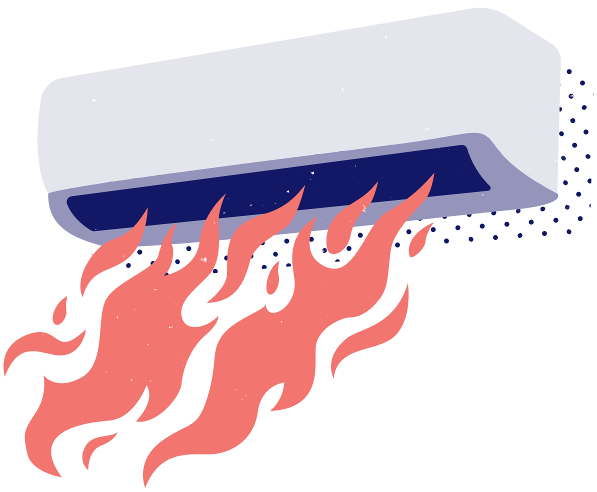
A troubling paradox remains: air conditioning, the simplest solution for passenger comfort, is also an accelerant of the urban heat island effect. Widespread adoption across a major conurbation could raise outdoor temperatures by 2 to 3°C during a heatwave, according to estimates cited by the French Ministry of Ecological Transition in response to parliamentary questions in 2023. By cooling itself, public transport mechanically contributes to making the surrounding city hotter.

Looking ahead to 2044: heatwave as a season

By 2044, on the TRACC trajectory, mainland France will experience average temperatures 2.5 to 3°C above the 1976–2005 baseline. Regional heatwave peaks will regularly exceed 45°C in the southern half of the country and 42°C in the northern half. For transport operators, this translates into a paradigm shift: the heatwave is no longer an exceptional event to be managed, but a season in its own right.

The likely operational consequences compound one another. Maintenance cycles are getting shorter: the increased frequency of thermal expansion mean that inspections will be necessary on an almost daily basis in summer; preventive maintenance costs could double or triple according to British scenario analyses. Replacement programmes are speeding up: wider thermal-range steels, concrete sleepers, systematic reflective painting. Commercial rail speeds are structurally reduced by 5 to 15% between June and September, lengthening journey times. Connections fall out of step.

Operating patterns themselves could be partially reversed. Daytime heatwave peaks make operations during the hottest hours unbearable. Several southern networks are already experimenting with increased nocturnal mobility: reinforced services from 05:00 to 11:00 and from 19:00 to midnight, with a service trough between 13:00 and 17:00. This is a return of the Mediterranean siesta, but on the scale of the network. On the energy side, air conditioning for buses and trams consumes up to 30% more energy at the height of summer; strained electricity grids prioritise hospitals and care homes, and operators must negotiate their supply slots. Finally, underground stations, cooler than the street, become de facto climate refuges: homeless people and those in difficulty settle there at night, and operators are torn between keeping them open continuously (an implicit social mission, albeit with a lower sense of security) and maintaining closures (which exposes the most vulnerable to the elements).



The story

Five days in Macondo

Toulouse, July 2044

Many years later, standing before a thermometer locked at 51°C, Aureliano Buendía would cast his mind back to that distant afternoon when his grandfather had taken him to skate on the frozen La Ramée pond. Ice, in those days, had still existed in winter. It seemed now as improbable as a legend.

His phone vibrated at 05:12. It was Metigate, but he had no need to open the application: he already knew what it would say. The night before at 23:00, platform 3 at Marengo station had still been reading 34°C; at 04:00 that morning it would have been 31. No overnight respite — it was the fourth day of red-class 5 heatwave, the last category before a total shutdown. He got up, drank a litre of lukewarm water, and looked out of the window. The sky was flat, yellow-white, featureless.

Aureliano was forty-seven and worked as the daytime operations manager for the Toulouse network, operated since 2042 by a Keolis subsidiary. Fifteen years in the trade — he had started on Line A just before it went to full automation in 2030. Today he worked from a control centre that the controllers had nicknamed Macondo, ever since a trainee who read García Márquez had observed that it was always either too hot or too cold there, and that the rain, when it came, seemed reluctant to stop. The name had stuck. From Macondo he managed a team of twenty-three controllers and coordinated with seven depots. But the core of his work for the past five summers was no longer incident management: it was heat management.

At 06:30 he arrived at the centre, air-conditioned to 24°C — a strict target set by the city authority. On the main screen, the network map was divided into thermal zones. The eastern section of Line B, running overground between Ramonville and Bayard, was showing light green: a predicted track temperature of 47°C at 14:00. The T1 tram line, in dark orange along boulevard Lascrosses: predicted 51°C at 15:00. Buckling possible, class 2. He began with the routine: a video inspection of at-risk sections, catenary tensioner checks, water level verification in the forty-seven frost-resistant drinking fountains installed between 2032 and 2040. Three were out of service, including one at Jean-Jaurès — the busiest station. He dispatched a team.

At 08:15, the first serious call. It was Úrsula Iguarán, manager of the Saint-Michel bus depot: “Aureliano, I’ve got three vehicles stuck at the depot — their air conditioning has given up. The filter is clogged with Saharan dust. We can put them back on at 14:00 or not at all.” Saharan dust — a persistent sirocco drifting up across the Mediterranean — had been an operational variable since 2039. A modern bus’s air conditioning unit consumed far more energy when the filter was saturated and failed more quickly. Aureliano made the call and removed the vehicles from service. The ratio of available buses on route 16 would fall to 78%.

At 09:50, an unknown number. A calm, young voice: “Good morning, I’m calling from the Belin care home — we have six residents who need to get to Purpan hospital for their dialysis, but the number 76 bus is no longer stopping nearby because the route has apparently been suspended.” Aureliano checked the screen: route 76 was diverting south because of a road surface deformation at Casselardit. The diversion added seventeen minutes. He arranged an air-conditioned minibus with Úrsula. Found. Sent. A slow, costly solution. The network was muddling through.

At 11:00, the outside temperature at Blagnac was reading 44°C. The metropolitan authority sent a video message: at 13:00, the entire network would switch to «red day» mode. This meant tram speeds capped at 30 km/h between 13:00 and 17:00, buses running every twenty minutes rather than eight, the metro running normally but with audio safety announcements every five stations. And schools closing early at 11:30 — meaning that half an hour later, children would flood onto the school buses alongside their parents, against the flow. Aureliano felt his stomach tighten. He called for reinforcements.

At 13:22, the first piece of bad news. Tram T1 stranded between Compans-Caffarelli and Arènes: slack catenary, pantograph snagged. No accident, but two hundred and thirty passengers to evacuate. Temperature beneath the vehicle floor: 38°C. Aureliano activated the heat evacuation plan: immediate opening of the adjacent premises — a café-tabac operating under a municipal agreement, which became a cool-down relay point during crises — water distribution, bus rerouting. By 13:41, everyone was under shelter. No hospital trips needed.

It was at 15:12 that the day’s main event occurred. A flashing light on the screen: class 1 deformation on the Toulouse–Saint-Sulpice railway line, at the Lalande junction. SNCF Réseau had just sent a cross-alert: their sensors were showing expansion of more than eight millimetres. The patrol teams would be on site within twenty minutes — Melquíades, the team leader, a fifty-three-year-old Catalan so named because he predicted deformations before the sensors caught them, as if he could read rails the way others read maps. He confirmed. The line, which ran services to the north of the conurbation, was closed until further notice. Aureliano activated the replacement bus plan. Eighteen additional coaches pulled from the depots, half of them with questionable air conditioning. No other choice.

At 19:30, he looked at the summary screen. The day's tally: two confirmed deformations on the suburban railway, four catenary incidents, eleven buses immobilised by heat, three hundred and twenty minutes of cumulative passenger delay, zero heat-related hospitalisations within the network. The critical KPI — zero fatalities — had held. The comfort KPI: far from glorious. The punctuality KPI: below the contractual threshold.

As he departed at 20:00, he paused in the concourse of Marengo station. On the benches, two people were asleep — homeless individuals whom the metropolitan authority's rules granted access to stations between 22:00 and 05:00 during class 5 red episodes. Other large European networks had made the same choice in preceding years. Úrsula, that morning, had said to him with a wry smile: "Are we running a transport network or a shelter network, Aureliano?"

On the Compans forecourt, the thermometer read 33°C. The night would be the fifth tropical night in a row. In the Macondo of the novel he had read as a teenager, it had rained for four years, eleven months and two days without interruption; that deluge had eventually engulfed the Buendías' certainties. In Toulouse, how many days had it been since it last rained? He dared not check. Tomorrow morning, at 05:12, Metigate would vibrate again, and Macondo would start counting once more.

Three forward-looking scenarios

WHITE SCÉNARIO

Industrial adaptation

In an optimistic scenario, the 2030s are devoted to the industrial transformation of the networks. Rails are progressively replaced by wider thermal-range steels designed to withstand up to 60°C in service. Overhead wires are fitted with intelligent self-regulating tensioners. Buses and trams are 100% air-conditioned, powered by photovoltaic micro-grids installed on depot rooftops. Bus lane road surfaces are laid with light, reflective asphalt, halving surface temperatures. Public transport authorities finance these investments through dedicated environmental taxation. Commercial speeds are maintained in summer. The heatwave becomes a managed season, just as winter has been managed in the Alps. The cost is substantial — involving heavy investment in the climate resilience of public transport — but the passenger experience does not deteriorate, and the social contract of public transport is preserved.

GRAY SCÉNARIO

Constant troubleshooting

In the intermediate trajectory — the most likely given current trends — adaptation happens in fits and starts, without any overarching plan. Rolling stock renewal follows its normal schedule, with no particular acceleration. Track deformations become frequent but are managed on a case-by-case basis, with speed restrictions. By 2044, 80% of buses are air-conditioned, with the remaining 20% kept in service for lack of resources for their replacement. Commercial speeds fall by between 8 and 15% in summer. Wealthier passengers avoid public transport during hot hours, turning instead to air-conditioned autonomous pods. Captive users — those in precarious circumstances, the young, the elderly — endure a degraded service. Ridership becomes distorted: full during cool hours, empty during hot ones. The financial model comes under strain. The network muddles through.

BLACK SCÉNARIO

Seasonal breakdown

In the pessimistic scenario, political and budgetary inaction compounds the acceleration of climate change. Summers become partially unworkable: for three to five weeks per year, services are reduced to 40% of normal levels. Buckling becomes a poorly controlled safety risk; several accidents make headlines and erode public confidence. Private autonomous pods take over durably for the better-off. The public network becomes a winter service, abandoned in summer. Homeless people colonise stations that have become climate refuges, with no accompanying public policy. Social tensions around stations rise. The social contract of public transport — universal, reliable, safe — unravels season by season.

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