Title: Thermometer screens and the geographies of uniformity in nineteenth-century meteorology

Short title: Thermometer screens and the geographies of uniformity

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Summary

By the 1860s a number of thermometer stands, screens and boxes were being used at public observatories and in private settings. The ultimate object of these humble pieces of scientific infrastructure was to protect the thermometers from precipitation and radiation. In response to concerns over the quality of designs and the comparability of results a trial of the various apparatuses was staged at Strathfield Turgiss, Hampshire, in 1868 and subsequent discussions were organised by Britain's Meteorological Society (from 1883, Royal Meteorological Society). In an attempt to guarantee uniformity of exposure, the Society recommended the adoption of the Stevenson screen, a double-louvred box designed by Thomas Stevenson in 1866. It was promoted as an essential part of the Society's network of second-order and climatological stations across England. Despite the Meteorological Society's aim of overcoming the idiosyncracies of geography through recourse to a uniform pattern

screen, their chosen design ended up embodying a particular geography: the aesthetic and moral codes of the suburban domestic garden.

Key words: meteorology, uniformity, scientific personae, thermometer screen, garden

Introduction

In *Reading the Skies*, Jankovic argues that the science of meteorology in Britain and its empire was remodeled in the early nineteenth century. Increased emphasis was placed on the quality of instruments, standardization, and on the discipline of measurement. The practice of recording local weather in isolated spots was dismissed as useless if rendered in a form that prevented comparison with other records. The observer was to 'give no credence to place, time, nor any other aspect within the system of atmospheric processes, pursuing a disciplined and even mechanical measurement of everything which occurred in the atmosphere and which could be recorded in a quantitative way.'[1] Fleming *et al* argue that meteorology laid claim to universality through its infrastructure. Anderson notes that – despite significant and public failures to achieve these ends – people trusted that meteorology, like other kinds of physical knowledge, 'would become mathematical and certain'.[2] The puzzle of the weather could be solved with sufficient observations over an extensive area, with coordination and centralization of efforts, the modern telegraph and more traditional forms of communication, volunteer subscribers and public funding.

For many leading commentators in Britain, observation both defined and impelled meteorology. Meteorology was, according to John Herschel, a science of detail, especially when pursued with precision instruments, aided by elite observatories and interpreted by statistical techniques.[3] Efforts to coordinate weather

observations across large-scale continental, imperial and international terrestrial and ocean spaces revealed the extent of atmospheric phenomena and seemed to promise similarly large-scale theory development and public utility. Victorian meteorology, viewed from the perspective of the new synoptic weather maps, was therefore an exemplary survey science, simultaneously freed from the trammels of locality while offering grand geographical vistas.[4]

Yet the weather maps in circulation in the 1850s and 1860s across Europe and America were more statements of intent than reliable records of atmospheric conditions. Beyond the boundaries of a few elite observatories, meteorology had no choice but to rely on a diverse body of observers, the vast majority of whom collected weather observations as a leisure activity. As a globally-oriented survey science, meteorology exemplified a spatially distributed form of scientific production that relied on what Kohler calls the 'strength of weak ties'.[5] It continued to be made up of quite different groups of actors, from metropolitan observatory directors to provincial volunteer observers, using a variety of instruments to take different kinds of observations. The exchanges between these different groups 'made visible the processes of fashioning facts into science', where 'the standards and values of these processes became part of the debates.'[6] As Schaffer has noted of the same period, the development of universal standards 'was supposed to produce consensual uniformity but was just as likely to breed bitter dispute', with such disputes raising 'fundamental issues of best practice in the enterprise of precision measurement, which was, after all, supposed to allow science more effortlessly to escape the trammels of interest and judgment'.[7]

With its reliance on large networks of volunteer observers, Victorian meteorology had no choice but to operate as a domesticated science; a pursuit

conducted within the spatial and temporal confines of daily life and domestic routine.[8] Prior to the movement for the professionalization of science in the latter half of the nineteenth century, a variety of sites were used to carry out scientific investigation, from the pub to the country house.[9] Rooms were added or adapted to function as greenhouses, observatories, museums or laboratories; gardens were similarly repurposed.[10] Women often had no choice but to use domestic dwellings as a venue for scientific work, while 'men's identities as knowledge producers were just as profoundly shaped by the rhetoric and practices of the domestic sphere'.[11] Other family members could also be put to work, alongside servants and gardeners. With the dramatic shift towards public institutional venues of science in the later nineteenth century, the ability of the domestic sphere to function as a credible location for the conduct of precision science was increasingly brought into question, as De Chadarevian shows in her analysis of the controversy between Julius Sachs and Charles Darwin.[12] However, the domestic sphere persisted as an important site for the conduct of science, literally and figuratively, even if 'the roles, meanings, and occupied spaces' of the household were reshaped and repositioned in relation to the spaces of public, institutional science.[13] Work on the history of public research stations and field labs, for instance, shows that many such sites configured themselves along domestic principles. Eigen demonstrates that the coastal research stations in France adopted domestic arrangements as a means of instilling a research discipline on its visitors; socialised as members of the 'household'.[14]

This paper explores the fashioning of facts into science within the domesticated spaces of Victorian meteorology. In doing so it attends to the 'historical significance of domestic matters for the production of scientific knowledge.'[15] It pays close attention to the trials and debates over the adoption of a pattern thermometer

screen in Britain in the second half of the nineteenth century. These screens, stands or boxes, were designed to protect thermometers from the idiosyncrasies of location, such that temperature observations could be compared from site to site. Although the intention was to guarantee uniformity of exposure locally and across an extensive observational network, the meaning of uniformity was anything but uniform and ended up embodying the aesthetic and moral codes of the suburban domestic garden.

Early thermometer stands

The observation of air temperature was a common feature of the nineteenth century, but even by the 1840s there was no agreement as to the manner in which static thermometers should be placed. A wide variety of boxes, screens and stands were in use.[16] Perhaps the most popular in the first half of the nineteenth century was the Glaisher stand, where the thermometers were exposed to the air and the stand could be revolved on its post to keep the instruments in the shade. It had been adopted at the Greenwich Observatory since 1841, unsurprisingly given that James Glaisher moved to the Royal Observatory in Greenwich in 1835 to serve as Superintendent of Department of Meteorology and Magnetism.[17] Another was that designed by Henry Lawson, the astronomer and founding member of the Meteorological Society, at his observatory in Bath. Lawson claimed that: 'On Conversing with my Meteorological friends as to the indications of their Thermometers, and the situations they respectively occupied with respect to shade &c., I found that the variations or differences between my Thermometers and theirs were often much greater than the circumstances of the day or weather seemed to warrant'.[18] Lawson proposed a fixed box where the thermometers were freely exposed to the air.[19] A third design was that of naturalist George A. Martin, a physician at Ventnor on the Isle of Wight. Martin

placed several thermometers in ‘a little observatory, built expressly in a most exposed, and, for such a purpose, unobjectionable situation. It consists of a thatched roof, supported on wooden uprights, partly resting against a wall; the whole being between eight and nine feet in height.’ Martin conceded that those who visited note the spot ‘is too much exposed, and likely rather to underrate the temperature than to over-rate it; my object, however, has been to elicit truth, and I would rather understate facts than subject myself to the imputation of exaggerating them’.[20]

In 1866 in the Scottish Meteorological Society’s *Journal*, engineer Thomas Stevenson published his own design for a ‘meteorological box’ to house minimum and maximum thermometers and dry and wet bulb thermometers.[21] Stevenson, an Edinburgh civil engineer and for 16 years Honorary Secretary of the Scottish Meteorological Society (and father to author Robert Louis Stevenson), came from a family famous for their work on improving lighthouses. Stevenson’s box was designed to isolate and protect thermometers from ‘merely local influence’, particularly direct and reflected exposure to solar radiation. It featured a double-louvred design to allow the free flow of air, protection from the sun and from rain or snow. The box sat exactly four feet above the ground (figure 1).[22]

Figure 1 around here.

Several years earlier, in 1860, George Symons, an employee of the Meteorological Office under Robert Fitzroy, enlisted the help of observers to test various meteorological apparatus, including rain gauges and thermometer screens. Symons had formed the British Rainfall Organisation (BRO) in 1860. Symons eventually gave up his post at the Meteorological Office to devote himself to the task

of running the BRO. A number of observers helped Symons test various rain gauges through the late 1860s: Col Michael Foster Ward at Calne in Wiltshire and the Rev. T. E. Crallan at Framfield, Sussex. When Calne moved to Switzerland, the gauges from Calne and Framfield were transferred to the rectory at Strathfield Turgiss in Hampshire, which sat on the estate of the Duke of Wellington. The Rev. Charles Higman Griffiths, a keen naturalist and microscopist, took over the trials (figure 2).

Figure 2 around here.

Like the rain gauges, Symons was unhappy at the use of different thermometer stands by meteorological observers. He organised a lengthy trial of various stands in the grounds of Strathfield Turgiss, added by a grant of £45 from the Royal Society, with instruments supplied by Louis Casella, the London instrument maker, and calibration by the Kew Observatory. The Rev. Griffith agreed to read the dry and wet thermometers three times daily (at 9am, 3pm and 9pm), and the maximum and minimum thermometers once each day at 9am, from November 1868 to April 1870.[23] As well as the Martin, Lawson, Glaisher and Stevenson screens, five others were tested, designed respectively by Henry James, the Rev. Fenwick Stow, Pastorelli, Henry Lefroy and Griffiths himself. Observations were also made with a suspended and an aspirated thermometer. The effects of shrubbery and trees were also tested, given that many observers believed they produced ‘true shade’. The diminutive Pastorelli stand was buried in shrubbery for a time (figure 3).

Figure 3 around here.

In his work on the Victorian physics laboratories, Schaffer argues that these new sites were based in part on a 'tranquil fantasy and strenuously engineered reality of a place in the country'.[24] He also shows that the later nineteenth century was witness to a boom in country house construction on the landed estates, with large areas often set aside 'for an increasingly specialized male domain: laboratories, conservatories and billiard rooms' where country house physics could be pursued.[25] The rectory at Strathfield Turgiss did not represent the 'apparently effortless privilege' of nearby Stratfield Staye House, home of the Dukes of Wellington and before them the Pitts, but it did share the more generic characteristics of the country house and its grounds, with its elite, 'secluded and improvised geography'.[26] Griffiths' observational regimen and the environmental arrangements were part of a strategy to insulate the site from outside influence and to 'make its measures count everywhere'.[27] The Strathfield Turgiss rectory and the country house also shared a 'highly deliberate regard to their natural setting'. Eigen points out that the country house was meant to respond in an intimate way to its site and to nature, principally through its exposures, from which the changing scene could be appreciated. The same thing applied to the rectory and indeed other meteorological stations, where the observer was also obliged to 'make best use of the exposures the station carefully arranged.'[28]

Debating uniformity

The experiments at Strathfield Turgiss were motivated by two questions: 'What is the object of a thermometer screen?' and 'What conditions must a stand or screen fulfill before it can be considered worth using at all?'[29] Symons, along with Griffith, Stow, and Frederick Gaster – a long-standing Meteorological Office employee – reframed

these as a series of 12 conditions. These were circulated amongst interested gentlemen and discussed at a meeting of the Fellows of the Meteorological Society on 19 November 1873, spurred not only by the work at Strathfield Turgiss but also by a paper by John Plummer at the Society's June 1873 meeting. Plummer was the Observer at Durham University from 1867 and his paper discussed the history of the observations and the screens used to house the thermometers.[30]

The conditions that were presented for discussion at the Society's meeting were: 1. that the stand be protected from direct rays of sun; 2. the temperature of the stand should not affect the thermometers; 3. There should be no reflected heat from the ground or other objects; 4. no radiation to the sky should be allowed; 5. the stand must be independent of all other objects; 6. There should be free circulation of air; 7. and 8. the thermometers should not be touched by rain or snow; 9. there should be no need for attention between readings; 10. ample room for duplicate instruments is preferred; 11. the screen should not be costly; and 12. the stand should be easily moved. There were also the stipulations that the screen be made of yellow pine, painted white; the box four feet above the ground and sat in the middle of a turfed area, 15 feet square. Each point was debated and amendments to the wording of the conditions were made in some cases. Central to these debates was the notion of uniformity. Although never acknowledged explicitly, the implication was that consensus on the twelve points would engender a model observational space for the recording of the temperature of the air, such that observations in different localities could be compared one to another.

Uniformity was discussed in relation to the fifth condition, where it was emphasized that one pattern of stand had to be used in all localities. This was supported by Mr Prince's paper on shade temperatures, delivered at the same meeting.

Prince argued that 'the infinite variety of thermometer stands, hitherto employed, had been the greatest obstacle to obtaining such an amount of uniformity as would render the observations of any six meteorologists in the kingdom fairly comparable.'[31] In response to the desirability of one pattern, Colonel Alexander Strange – retired member of the Great Trigonometrical Survey of India and superintendent of the Government of India's scientific instruments – asked: 'Uniformity, then, is the point for consideration?'[32] Robert Scott, Director of the Meteorological Office, stated that it was 'perfectly certain' that uniformity was impossible across different climates, such as those experienced across the British empire. In the case of Canada and India for instance, the Stevenson screen was considered too small and too close to the ground, either overheating or getting clogged up with snow. William Marriott noted some years later that in India the Stevenson screen 'would not do at all', and that it would struggle in the sort of winter conditions found in Canada or the Alps.[33] It was judged that uniformity could only be translated across the relatively minor differences found in 'localities', defined specifically as those 'between one man's back garden, and another man's garden'. Strange's reference to a 'universality of pattern' was therefore founded on the geographical imaginary of a place in the English garden.[34]

Point 11 also raised questions about uniformity and locality. For Strange excellence in construction was to be prioritised over cost, saying that 'efficiency should not be sacrificed to economy'. Although he conceded that if two stands were equally good, the cheapest should be used, he argued that 'if you talk of cost, you lead people's thoughts rather towards economy than efficiency, and I think, in scientific questions, cost should have nothing to do with the matter'. George Whipple, Chief Assistant (and, from 1876, Superintendent), also argued that cost was 'trivial' when compared to the value of observations over many years: 'it is a false economy to

begin a series of observations with inferior applications'. Symons and others argued against this and worried that an expensive stand would compromise the desire for wide coverage, Mr Wilson saying 'the one thing we want is uniformity, but if you decide on a Stand which is expensive, you will exclude a great number of observers'. The President, Robert James Mann, suggested that the clause should be understood 'in the sense that it means as cheap as is consistent with efficiency' and in the subsequent vote, 10 Fellows supported, while 6 rejected it.[35] Talk of false economies and scientific efficiency spoke eloquently if obliquely to the required financial capacities and personal virtues of the Society's observers.

The report on the Strathfield Turgiss experiments was eventually published as an appendix to the *Quarterly Weather Report* of the Meteorological Office, authored by Frederic Gaster. The report concluded that open stands – including Glaisher's – were exposed to rain, fog, dew and to direct radiation from sun and ground, with the effect that they recorded too great a range of temperatures, as opposed to closed, louvred screens, which recorded too small a range. The latter was determined to be a preferable fallibility: 'Stevenson's and the Kew stands appear to have fewer defects than the others, and the Stevenson (though small) is on the whole the most handy and generally available'. [36] That said, noted Gaster, 'It is not pretended for one moment that even this screen is all that can be desired'. It was suggested that when compared to the Glaisher stand, the Stevenson failed to record the maxima during cloudy weather, while in clear weather the air experienced 'heating up' in the screen.[37] It was also suggested, again compared to the Glaisher stand, that the lack of circulation in the Stevenson screen meant higher minimum temperatures. In conclusion, Gaster reminded the reader that 'We do not know even now how far from *truth* the readings

recorded are on any stand, but only how far they differ from a certain standard, and that standard is believed to be somewhat faulty.'[38]

The Stevenson screen began to be promoted and adopted widely during the mid-1870s, several years before Gaster's report was published. The Meteorological Office recommended its use at Telegraphic Stations and the Meteorological Society at its climatological stations, both low order stations where cost would have been a key consideration. Robert Scott promoted its use in his widely circulated and well-received *Instructions in the Use of Meteorological Instruments,* where he noted that the 'exposure of thermometers is confessedly one of the most difficult questions in Meteorology'. Although he acknowledged a range of opinions on the best form of screen, the Stevenson was to be 'as good as any hitherto proposed, although it too is capable of improvement'.[39] Alexander Buchan, Secretary of the Scottish Meteorological Society, supported Stevenson's pattern in his *Handy Book of Meteorology*.[40]

Networks of weather observation

One of the main objects of the Meteorological Society (from 1883, the Royal Meteorological Society) was the administration from 1874 of a series of 'second order stations' run by volunteers, with twice-daily observations (at 9 am and 9 pm). From 1880 the Society administered a series of climatological stations, with a single set of observations taken at 9 am. Managing the volunteers and their stations fell to William Marriott, which he did mainly through correspondence and annual site visits, aided occasionally by George Symons and other trusted meteorologists. By 1911 the Society administered 131 stations across the British Isles. To qualify as a second order station a site had to be of interest to the Society, such that it provided coverage of an

area where no other data were available. Observers had to submit to a number of regulations in terms of the configuration of the site, the types of observations made, the timing of those observations and the form in which the data were reported back to the Society.[41]

Marriott's correspondence as Assistant Secretary of the Society was voluminous, much of it relating to the Society's network of weather stations. He responded quickly to all enquiries from potential and actual observers, striking a didactic tone as he advised, praised, coaxed and admonished. Where he provided direct advice to observers he did so by repeating standardized advice and instructions. He also referred observers to a small set of key meteorological texts, which were themselves aimed at a general audience. Writing to one observer in 1874 for instance he said: 'I am sorry you cannot understand Buchan [Alexander Buchan's *Introductory Textbook of Meteorology*, 1871], but it is almost too abstruse for any one to learn meteorology from, if he does not know anything about it. I send by book post from the Library [Albert] Morris's "Treatise on Meteorology" which I think you will find more elementary.'[42] He also routinely recommended Henry Scott's *Instructions in the Use of Meteorological Instruments*[43] and, after its first publication in 1881, his own *Hints to Meteorological Observers*, which he had prepared under the direction of the Council of the Society.[44]

In his correspondence, Marriott presented the Society's observers with a series of questions and stipulations to help them establish and manage their stations. In a letter to Frederick Green in October 1874, shortly after the network had been established, Marriott noted that 'regulations as to exposure of instruments &c.' were not yet published but that 'The conditions to be fulfilled are:– that none but standard and verified instruments should be used, and that every observer should possess a

barometer, dry, wet, max, and min thermometers and a rain-gauge; that a Stevenson screen be provided and that it be not placed within 10 feet of any wall; that the rain-gauge, when placed with its orifice 1 foot above the ground should have 60° of zenith distance clear in all azimuths… It is also desirable that there should be a dark [bulb thermometer] in sun, and min[imum thermometer] on grass.'[45] After receiving observations for the month of November from Green, which appeared to Marriott 'to be very good', he nonetheless asked: 'Is the Thermometer over grass? Is it free from the influence of surrounding objects? What is its distance from buildings, walls and trees? Is the ground flat or does it slope and if so how much, and in what direction?'[46]

The siting of the thermometer screen and the type of stand was of constant concern to Marriott and preoccupied much of his correspondence. In his letters in the mid-1870s he noted that he did not wish to press the Fellows to use any particular stand – even though he had actually done so with Green and others – but he did call on observers to use a closed, louvred stand, which had to be raised 4 feet above the ground in a well exposed position, over 15 square feet of grass, and away from the influence of buildings.[47] He was dismissive of open stands like Glaisher's. In a letter to the Rev. D. Hugh Quelch in 1875 he argued that 'you do not get very good results' with exposed screens like Glaisher's: 'An open stand is always objectionable on account of radiation and besides that the sun shines on the instrument in the afternoon.' Later that year he recommended Stevenson's stand as it was the 'least objectionable', was 'generally used' and the results were comparable with other stations.[48] Marriott's recommendation gradually turned into insistence. He noted in 1882 that the Stevenson screen 'is that recommended by the Society and is required to be used at all our stations. The chief gist is to secure uniformity.'[49]

Marriott was quick to admonish any observer who threatened his desire for uniformity. Misdemeanors included the use of the wrong-coloured paint on the screen's woodwork; the use of metal rather than wood in the screen's construction; the incorrect placement of the screen; and the deployment of idiosyncratic, home-made screens. Correspondence such as that with C.J. Ward was common: 'With respect to your present stand I am afraid it is hardly suitable, as it has a solid bottom and appears to be supported on the stump of a tree. Stevenson's stand is open at the bottom and only protected by wire netting.'[50] Of the 45 stations inspected during 1880, 14 were documented to have some features that deviated from Stevenson's pattern, to be of a different pattern, or to be 'homemade'. Requests for changes were published and made public in the Society's *Quarterly Journal*.[51]

Despite the detailed instructions given in correspondence, in *Hints* and in inspection reports, Marriott was often forced to concede that volunteers had to work within their means and their situation, especially with regard to the space available to them to place their screen and other instruments. Balancing the desire for wide coverage and for uniform exposure was a vexing issue for the British meteorologists. A comprehensive survey of the nation's weather demanded numerous stations spread evenly across space. The use of volunteer observers compromised this, both in terms of coverage and location. In some regions, such as the south of England, Marriott had to decline offers of assistance, while in others – the northwest of England for instance – the distance between stations could be very large.[52] The sorts of places in which weather stations were established ranged widely, from the lawns of stately homes, public parks, seaside promenades, allotments, to private back gardens. The latter was by far the most common. Reconciling the effects of the specifics of locality upon the instruments preoccupied Marriott. He noted that one observer's situation was not

‘thoroughly open and exposed but perhaps it is about as good a one as can generally be had in towns.’[53] This sensibility was echoed in Gaster’s report on the Strathfield Turgiss experiments, where he asked meteorologists to consider to what extent ‘the readings taken in the small back gardens common in towns can be compared to those taken in large open spaces in the country’?[54] The urban back garden was understood as a compromised site of scientific survey. The open lawns of the rural country house and its more general sensitivity to its natural exposures constituted the ideal space of inquiry and underwrote the Society’s wider conceptualization of uniformity. The suburban garden functioned as the pragmatic compromise locality.

Work on the Victorian middle-class home has shown that the domestic garden provided ‘seclusion, refuge and repose in as rural an ambience as possible’, while communicating a relatively high level of social and financial status. It was an ambiguous domestic space, reserved for relaxation, exercise and gardening. It was also a space for the fulfillment of responsible and useful work – including scientific activities – unaffected by ‘the taint of money-grubbing and sharp practice’.[55] Lustig notes that while the open parks of the gentry estates were beyond the reach of the majority of the Victorian middle classes, they chose to mimic those landscapes in miniature around their new suburban villas using ‘lawns, grouped trees and what elements of the picturesque could be crammed in’. The garden aesthetics found in these spaces expressed a ‘connoisseurship of plants and science that was the essence of a new horticulture.’ The suburban middle classes looked to works of garden design and horticulture ‘for guidance in how to establish themselves appropriately in their new environments.’[56] Preston notes that photographs of gardens increased in the last decades of the nineteenth century, which often mirrored those found in gardening manuals. The images also acted ‘as individual records of family advancement and

personal celebrations of the space and privacy of the new homes' being built in the suburbs. The images demonstrated social progress in the form of increased leisure time and showed off the self-contained space in which to explore it productively at home.[57]

From 1884 the Society's inspectors began to use photography to document its stations, which were included as part of the annual Inspection Report to the Council: 'These photographs now form a valuable and interesting series of pictures, showing the exposures and surroundings at the various stations.'[58] The thermometer stand – usually a Stevenson – typically sat in the centre of the composition. The photographs were also inhabited by the observer and their assistants, employees, families or charges, who were usually grouped around the screen. Many of the observers had dressed themselves and their families in the manner of a formal family portrait (figure 4). Others posed as if taking observations (figure 5). The images demonstrated the value placed on the domestic garden as a space of useful work and familial respectability. They conveyed meteorological study as an appropriately domesticated leisure pursuit, one which sat comfortably within the prevalent garden aesthetic, and that helped anchor its owners there. Results at these stations were published in abstract in the Society's *Quarterly Journal*, which functioned as the Society's explicit contribution to the gift economy that existed between it and the volunteers, but the photographs make clear that the enhancement of a person's cultural and moral capital was, probably, far more valued.[59]

Figures 4 and 5 around here.

Uniformity applied as much to these observers as to their station: 'The Meteorological Society insists on uniformity', Marriot noted in *Hints*, 'and only accepts the observations of those persons who comply with its requirements'.[60] Observers were required to embody virtues of self-denying passivity, self-restraint and automatism, as well as attentiveness and dexterity.[61] Punctuality and regularity were particularly crucial, to ensure an unbroken record of weather data. Albert Morris encapsulated this expectation in his popular *Treatise on Meteorology*, where he claimed that 'The observer should be very punctual to the hour of 9 A.M., and not indifferently half an-hour earlier or later. This hour (may we call it breakfast?) is the one least likely to be interfered with by the avocation of the day or absence from home; it is the hour by which, at the latest, every well-behaved member of society, of every rank, will be (health permitting) awake and visible.'[62] The observers captured in the station photographs sought to communicate their virtues through the public display of their private living habits – well-behaved, awake and visible.[63] The Rev. Griffiths embodied the scientific personae of the ideal meteorological observer most completely. Commenting on the Strathfield Turgiss thermometer screen experiments, George Symons claimed that 'The confinement, regularity, punctuality, and self-denial involved in undertaking these observations single-handed, is only equaled by the accuracy with which Mr. Griffiths takes and enters observations.'[64]

A new pattern screen

In November 1882 the Council of the Meteorological Society decided to investigate whether the Stevenson screen they had adopted at their stations could be improved. A Thermometer Screen Committee was established to advise on the new pattern's precise design and the position of the instruments within.[65] Marriott wrote to the

instrument maker Louis Casella asking for a screen for the Committee to consider at their meeting and to exhibit in their rooms.[66] In May 1883 Marriott reported to Robert Scott that Edward Mawley was to compare a new, larger, pattern with an 'ordinary' Stevenson screen and asked the Meteorological Office for the loan of instruments. Mawley arranged to have the new screen made up by a local carpenter in Croydon and installed at his home.

Mawley was a distinguished meteorologist – he served on the Meteorological Society's Council from 1881 to 1908 and acted as President in 1896 and 1897. He was also well known as a horticulturalist. He was a founding member, Secretary and later President of the National Rose Society, and recipient of the Royal Horticultural Society's Victoria Medal of Honour in recognition of his work in horticulture.[67] Mawley combined his two interests in his studies of the seasons, observations of which he published in both meteorological and horticultural journals.[68] He was also author, with Gertrude Jekyll, of *Roses for English Gardens*. Jekyll was an important proponent of the Arts and Crafts Movement, especially in the way its tenets related to garden design. Her work promoted the values of traditional craftsmanship, vernacular design and the rural English aesthetic of the cottage and its garden.[69] Jekyll and Mawley's book supported a similar style, with its advice on how 'to deck our garden pictorially'.[70]

Mawley's thermometer screen trials were carried out over a five-month period, from June to November 1883, at his family home in Addiscombe, Surrey. Mawley had moved his family there in 1872 upon the death of his father, where he bought one of the new suburban villas built on the former Royal India Military College estate. The plot was undeveloped, allowing him to lay out the garden 'to the best advantage for meteorological observations, and also for growing roses.'[71] He had

operated a second order station there since 1877, when he installed a Stevenson screen alongside his older Glaisher stand. In his obituary of Mawley, Marriott noted that 'It was my pleasure to inspect his stations at Addiscombe and Berkhamstead [where Mawley moved in 1885] on twelve separate occasions, and I always was able to report that everything was in good order.'[72] For the 1883 trials the new pattern Stevenson screen was placed on a large lawn on the other side of a path from the old pattern screen and the Glaisher stand, with flower borders and rose bushes surrounding them (figure 6). Observations were made of the movement of the air through the screens with a miniature Robinson's anemometer, while the amount of light admitted into the screen was tested using light-sensitive paper.

Figure 6 around here.

Mawley reported on his trials at a meeting of the Society in November 1883, the proceedings being published in the Society's *Quarterly Journal* in 1884.[73] It was reported that the new screen allowed air to circulate more effectively than in the old pattern; that it let in slightly more light; and that it was cooler during the hottest part of the day. The new screen was recommended due to its better ventilation, it being stronger, more roomy, better suited for extreme climates and less liable to hold the heat of the sun for such a long period of time. At the meeting, Symons responded positively to the report's recommendations, while Gaster struck a more balanced note. Gaster went on to discuss his own recent experiments with two old-pattern Stevensons, where he had hung an umbrella over one, claiming that the unshaded screen produced higher temperature readings: 'This seemed to show that although by

adopting the Stevenson screen we got uniformity in exposure, but we did not get accuracy.' Others were more critical of the new screen and called for further tests.

Concluding the debate, John Knox Laughton, the Society's President, reminded the audience that the Committee had been instructed simply to 'recommend the exact pattern of Stevenson screen, with the view of obtaining something like uniformity at the Society's stations. Whether Stevenson screens give the best possible exposure was quite another question, on which meteorologists might perhaps be agreed some day; but till then, it is most desirable that they should all be of the same size and pattern.'[74] Obituaries in *Symon's Meteorological Magazine* and in the *Quarterly Journal of the Royal Meteorological Society* asserted that the trials Mawley conducted in his back garden at Addiscombe were instrumental in persuading the Royal Meteorological Society to adopt the new enlarged Stevenson pattern.[75] The official report of the Thermometer Screen Committee laid out the precise dimensions of the new pattern, and the second edition of *Hints to Meteorological Observers* insisted that stations must use it.[76]

Conclusion

The history of the adoption of the Stevenson pattern thermometer screen serves as a reminder to students of the survey sciences that it is instructive to pay attention not just to people or to instruments, but to more humble infrastructures that supported both, sometimes literally. There could be as much at stake in the design and adoption of an instrument stand or frame as in the instruments it held. Through the efforts of various prominent meteorologists and societies, by the end of the nineteenth century the Stevenson screen was generally established as *the* pattern thermometer screen across the British Isles. Yet, even the most forthright supporters of the screen

recognized its limitations. As Gaster noted, ‘we got uniformity in exposure, but we did not get accuracy’. The example of overheating Indian or snowbound Canadian thermometer screens demonstrated that uniformity was or could be made to be a geographical achievement. The extension of large-scale physical surveys across space compromised to the principles of the physical sciences, but such compromises were often accepted as a necessary part of any project with significant geographical ambition.

Debates about the means and ends of uniformity often resulted in dispute rather than consensus. The thermometer screen trials at Strathfield Turgiss and Addiscombe, the subsequent debates, and the implementation of their recommendations, made visible the challenges of fashioning a survey science that relied on a network of volunteer labour. The rural estate park constituted the model environment against which uniformity was defined, but this was challenged by the need for more observers recording from a greater number of sites across an extended area. The incorporation of this picturesque, elite aesthetic within the confines of the suburban garden provided one solution to this problem. Meteorology’s infrastructure was domesticated such that it could be practiced within the rhythms of daily life, while the garden was reshaped as a physical milieu within which the middle classes could practice science and shape their own scientific personae. This process was demonstrated most clearly at Mawley’s station at Addiscombe, where he laid out his lawns, shrubberies and borders in ways that spoke both to a rural aesthetic and to scientific principles.

Urbanisation constrained and challenged this aesthetic and scientific space. It is telling that in 1885 Mawley chose to continue his ‘life of quiet usefulness’ by moving from rapidly-urbanising Addiscombe to rural Berkhamsted in Hertfordshire,

where it was said ‘he soon created one of the finest meteorological stations in the country’.[77] Mawley, like the Rev. Griffiths, was considered to embody the scientific virtues of the ideal meteorological observer. The hundreds of photographs of the Royal Meteorological Society’s stations reveal them to be exemplars but by no means exceptional observers. Across Britain, Victorian observers dressed themselves, their families and their gardens, arranged themselves around a Stevenson screen and faced Marriott’s camera. In doing so they helped to justify meteorology’s epistemological authority as a domesticated science, precisely by anchoring its practice in virtuous bodies and geographies.

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Figures

Figure 1 – Diagram of Stevenson’s design for a thermometer screen (in Thomas Stevenson, ‘New Description of Box for Holding Thermometers’, *Journal of the Scottish Meteorological Society* **1** 122 (1866) on p. 122).

Figure 2 – Strathfield Turgiss Rectory, Hampshire (frontispiece to G.J. Symons’ *British Rainfall, 1868* (London, Edward Stanford, 1869)).

Figure 3 – Thermometrical enclosure, Strathfield Turgiss (in F. Gaster, 'Report on experiments made at Strathfield Turgiss in 1869', A*ppendix II* to the *Quarterly Weather Report of the Meteorological Office for 1879*, London, HMSO, 1889, pp. 1–27, on p. 12.)

Figure 4 – Photograph of meteorological station at Wallington, Northumberland, 1893 (National Meteorological Archive, Exeter, Z28.L4; reproduced with permission of the Royal Meteorological Society)

Figure 5 – Photograph of meteorological station at Cheltenham, 1889 (National Meteorological Archive, Exeter, Z28.L4; reproduced with permission of the Royal Meteorological Society)

Figure 6 – Plan of Mawley's thermometer screen trials (in E. Mawley, 'Report on Temperatures in Two Different Patterns of Stevenson Screens', *Quarterly Journal of the RMetS* **10**, 1–7 (1884), on p. 2).

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