Stratospheric envelopes:

Notes for a speculative mode of atmospheric address

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Abstract

As a contribution to ongoing research into the affective experiences of atmospheres, this paper speculates about the modes of atmospheric address emerging from experiments within the stratosphere. In order to do so it draws upon archival material associated with Commander Malcolm D. Ross who, during the 1950s and early 1960s, spent more time than any other person in the stratosphere. Coupling accounts of Ross's experimental ascents with his interest in creative writing and communication, this paper uses three unopened letters carried by Ross into the stratosphere as a point of departure for layering together three strands of thinking. The first is a consideration of the stratosphere as a zone of exchange, experiment and experience. The second is a reflection on the envelope as a spatiotemporal form, a limit, and a lure for thinking. And the third is a discussion of the modes of atmospheric sensing made possible by stratospheric flights. These three strands are worked together in order to develop a distinctive speculative mode of atmospheric address. Such modes of address can contribute to wider efforts across the Geohumanities to account for the differentiated materiality and movement of the earth's atmosphere.

Keywords: atmosphere, envelope, sensing, stratosphere, writing

> "Like its analogues geography and hydrography, aërography, taken literally, means a description of the air. In the past four or five years the term aerology has been used in connection with the exploration of the upper so called free air but it would seem more appropriate to let this term embrace the whole domain of atmospherics, while the world aërography might well be restricted to a description of the atmosphere at various levels" (McAdie, 1916: 266).

> "What we know about the stratosphere is the same as what Plato knows about Atlantis: we've heard tell of it" (Luhmann, 2000: 1).

1. Unopened

Immediately after the Second World War, the stratosphere became the focus of a "program of upper atmosphere research" initiated by the US Office of Naval Research. Named Skyhook, the program was driven initially by "interest in reaction propelled missiles and extreme altitude flight", but was extended to investigate cosmic rays, aeromedicine, insect life, in addition to the basic properties and dynamics of the stratosphere itself (ONR, 1946: 1). During the 1950s Skyhook balloons were used to facilitate the Strato-Lab program, the aim of which was to carry humans into the stratosphere in gondolas that began to approximate early space capsules. A key figure in the Skyhook and Strato-Lab operations was Commander Malcolm D. Ross. During the 1950s and 1960s, Ross spent more time in the stratosphere than any other human being and, during his last flight in 1961 with Victor Prather, reached 113,740 feet.[1]

Ross's papers are housed in the archives of the Smithsonian National Air and Space Museum at the Steven F. Udvar-Hazy Center, near Dulles Airport, Washington DC. Many of the papers remain relatively unsorted, unfiled. Manila envelopes filled with loosely associated images, reports, assorted clippings. As part of a wider project on atmospheric experiments, I sift through this material in April 2016. Among technical reports, newspaper stories celebrating Ross's achievements, and accounts of different flights, I find three sealed

envelopes; one addressed to Ross himself, at his Arlington, Virginia, home; another to his daughter, Jane, at the same address; a third to his son, John. Written on each envelope is the following:

> "Carried aloft on U.S. Navy-Winzen research balloon flight Strato-Lab High 3, from Crosby, Minnesota to near Jamestown, No. Dakota, Launched 0441Am-26 July 1958, landed 3:21pm – 27 July 1958. Altitude 82,000 feet. D. Ross and Lee Lewis".

There are no indications as to where or when the envelopes were sealed: before departure? At 82,000 feet? During the descent or after landing? No indication if whatever the envelopes contain was scribbled hastily in flight, prepared or composed in advance, or written after the fact. No instructions for opening, or for when or where this opening might take place.

I draw the attention of the archivist to these envelopes, and to the fact that they remain sealed. Can they be opened here, now? After examining them, she defers to a supervisor. The rules forbid the opening of such material, I am told. So the envelopes remain sealed, waiting for a reader. I continue to examine the rest of the material in the archive.

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Settled then. But no: I find it difficult to let things rest, to set these envelopes aside, to forget them in favor of continuing to tell a comparatively straight story about a particular period of stratospheric experiment. Long after I have left the archives the envelopes continue to provoke as a nagging question, a perplexing eddy in thought, a proposition of sorts: how to think about and with whatever remains unopened, sealed, fully enveloped? This is not simply a question of the difference between archival materials that are open or transparent, on the one hand, and those that are closed on the other: even the open archive is always hazy, semi-opaque, difficult to decipher, haunted, unsettled (Lorimer, 2009). There is something distinctive, however, about the sealed, unopened, addressed envelope. The unopened envelope is neither a problem to be deciphered nor a puzzle to be solved. As something already closed, withdrawn, unavailable, it invites a relation that can only ever be purely speculative. And on one level it is necessarily speculative for ethical reasons: to open an envelope sealed by someone else and addressed to another is an act of intrusion, a violation, a

form of violence, a criminal act. Indeed, perhaps even to think about what the unopened envelope contains is a form of metaphysical violence, an attempt to fill in whatever is beyond relation (Harrison, 2007).

Defined by a distinctive mode of withdrawal, the sealed object – in this case the envelope – remains alluring, however (Harman, 2005). And this is not simply because, like any object, there is something of the envelope that always remains withdrawn. The allure of an object is not only a vague metaphysical dimension of that object: its allure is also a quality of the form it takes, the affects it catalyzes, and the surfaces it presents (Shaviro, 2014; Thrift, 2010).

The sealed envelope, no less than the sealed book, is therefore alluring because it marks a closure: yet in being sealed it also remains open as a lure for a speculative mode of thinking (Nancy, 2009). Open to possibility, open to multiple writings and readings, open to trajectories of thinking. As I think more about it, my efforts to write about Ross's material continue to be haunted by these unopened letters. In a way, then, the inaccessibility of these envelopes becomes a strange attractor around which the other archival materials in the Ross come to pivot: they begin to exert a kind of gravitational pull that loosely re-organizes how these materials are read. I begin to wonder if the form of their closure might provide an opening of sorts for a narrative about the distinctive layer of the atmosphere into which these envelopes were carried. Might the possibility that these envelopes are unopened, withdrawn, and unavailable, suggest a way of inflecting a story of the stratosphere as a space of experience and experiment? Might the form of the unopened envelope provide an opening of sorts for a narrative mode that would amplify both the dynamics of the stratosphere as a layer of horizontal movement and circulation and its existence as a milieu that can only be explored through particular forms of envelopment and encapsulation? Might they facilitate a mode of address that arcs back to earlier concerns with aërography as the science of the structure of the atmosphere (McAdie, 1916) while drawing from more recent, speculative deployments of such a discipline as part of an encounter with the elemental and atmospheric? (Jackson and Fannin, 2011; Olwig, 2011).

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Using these unopened envelopes as points of departure, in what follows I develop a speculative mode of atmospheric address as a contribution to wider efforts across a range of disciplines to account for the differentiated materiality and movement of the earth's atmosphere (Adey, 2014: Ingold, 2015). Developing this mode of address requires crafting a narrative that in some way allows something of the qualities of empirical experiences with and within the atmosphere to give shape, speed, or style to an account of whatever it is – percept, affect, concept, device, body – this encounter implicates without necessarily indulging in mere mimicry or imitation. I take some orientation here from important if necessarily modest experiments within the orbit of the geohumanities concerned with modes of address and storying in which the linearity of narrative is displaced in favor of the fragmentary, the evocative, the atmospheric (Cameron, 2012; Lorimer and Parr, 2014). Experiments, for instance, in thinking, seeing, feeling, and writing *with* landscape (Wylie, 2005; 2010). Experiments with writing biographies that avoid reproducing the model of the coherent subject through attending to its errant, multiform trajectories and constitutive entanglements (Lorimer, 2015). Experiments with thinking through archival materials that generate sometimes barely sensed affective afterlives (McCormack, 2010). Experiments with worlds as compositional gatherings glimpsed through the arrangement and tenor of scenes of life and the points of contact through which these worlds become palpable (Stewart, 2007). Experiments with stories as creative spacetimes in the making that alternately gather and scatter, stories as more-than-authorial "events that give us a voice" that is never our own (Rose, 2016: 144).

These disciplinary orientations are obviously important: part of how an argument begins to find its ways, how it begins to move through becoming pre-positional, how it begins to craft a germinal mode of address. Orientation emerges from other, minor trajectories that may be clouded/crowded out by more obvious stories of Skyhook and Strato-Lab as sociotechnical and geopolitical experiments and assemblages. Like other earlier and parallel programs, Skyhook and Strato-Lab made the stratosphere explicit as a zone of experiment at

the edge of space. A zone of technical and scientific experimentation, to be sure: for testing temperature, pressure, for measuring wind speed, for explaining what it is that makes the stars twinkle, for making sense of cosmic rays. But no less than earlier ascents, the Strato-Lab flights also made the stratosphere a zone of corporeal, affective, and aesthetic experience: a zone of seeing-with, moving-with, sensing-with the atmospheric.

Importantly, Ross was not only an engineer or technical operative. He had pre-stratospheric interests: interests that emerged and were cultivated during his undergraduate days at Purdue University, a strong center of engineering through which passed key figures in space-travel including Gus Grissom, and both the first and last people to stand on the moon, Neil Armstrong and Eugene Cernan. Ross began an undergraduate major in engineering at Purdue. But at some point he switched major to creative writing, communication, and radio broadcasting. He became a college radio sports commentator and worked as a radio broadcaster in a number of cities after graduation. After obtaining a graduate degree in aerological engineering during World War II, he opened an advertising agency after the war ended. In 1951 he became involved in experiments with high altitude balloon flights undertaken by the Navy: first as an administrator and then as a pilot (Norberg, 2007).

Here I take Ross's affinity for creative writing and for radio commentary as an invitation of sorts to craft a speculative narrative that works with the form and limits of his stratospheric envelopes. This narrative uses the opening afforded by the sealed nature of these envelopes in order to hold together some of the key details of flights into the stratosphere by Ross and others. In the process, the constraint of the envelope provides a lure for thinking and writing about the stratosphere. The envelope can obviously mean different things. As a technical object, the envelope is a spatial-temporal form that provides a degree of partial enclosure in an atmospheric milieu. It is also a way of thinking about a spacetime of affective intensity whose variations can be sensed in bodies(see also Ash, 2015). And it is also a limit that can be stretched and probed technically and aesthetically in order to experiment with the capacities of bodies to affect and be affected. In what follows each of these versions of the envelope provide a way of thinking through and with the force of the atmospheric.

More specifically, the allure of the envelope provide a way of holding onto the broader question of how elements of the meteorological atmosphere becomes explicit and palpable as a medium of experiment and experience through a range of devices (McCormack, 2008; Choy, 2012; Adey, 2014; Engelmann, 2015b). Here this involves cultivating an attunement to the stratosphere as a distinct layer of the atmosphere: a layer with its own qualities and behavior; a layer of energetic exchange defined for the most part by horizontal rather than vertical movement (Morton, 2015). It also involves consideration of how attempts to be and become stratospheric unfold as journeys through which different modes of sensing take place. By sensing I mean not only how being in the stratosphere becomes an occasion for sensing the dynamics of this part of the atmosphere, but how the stratosphere provides a medium via which, through different devices, sensing is disclosed as a process operating transversal to scale or form: a process through which the envelope of the body is opened up at the same time as the body becomes a surface for sensing the operation of processes whose origin is cosmic rather than terrestrial (Engelmann, 2015b).

These lines of thinking are held together here in an episodic narrative that pursues the promise of a speculative mode of address in which both points of origin and intended audiences remain drifting, un-positioned, untethered (see also McCormack, 2014). A mode of address in which there is an intention to send, to move towards in the form of a note or letter, but in which the question of what is sent always remains open by virtue of the fact of being sealed, and because it never quite arrives. Stylistically, this mode of address takes the form of a series of brief notes that draw upon material from the Ross collection and material associated with the Skyhook and Strato-Lab expeditions. These notes mingle together accounts of different ascents. In some cases they draw directly upon Ross's own writing, but they also draw upon accounts of ascents by others and from material drawn from Ross's papers, including for instance, publications by the US agencies operating the Strato-Lab project and newspaper reports of the project and its flights. The aim here is not to try to use this additional material to imagine what the sealed envelopes may have contained: nor to fill in a blank space. Rather, just as the caesura, that which is withdrawn, or the non-relational,

calls forth a relation of sorts, then the sealed envelopes, in remaining sealed, provide an opening of sorts: an opening for a creative gesture of speculation about the experimental sensing of being and becoming stratospheric. In the process, the aim is to stretch the modes of expression through which the movement and materiality of the atmosphere might become palpable and present in forms of thinking and writing across the geohumanities.

2. Stratosphere

You'd have loved the sensation, but it's sometimes too much for me. It began with the launch, "as a thousand thoughts raced through our minds", began with "a sense of tugging at the gondola by an external force, a slight jar, then unrestrained motion" (Ross, 1958: 2). Higher up it was "a horizontal rotation and a pendulum action". Below, "Lake Mille Lacs spread and disappeared so rapidly that I realized air-sickness was imminent. The feeling passed immediately when I returned my attention to the instrument panel" (Ibid., 2).

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The earth's atmosphere is layered, and each layer has its own characteristics and qualities. We spend our lives in the lowest layer, the troposphere, that turbulent zone of vertical and horizontal mixing generating all kinds of localized 'weather-worlds' of differential duration (Ingold, 2010). This is the zone in which the more-than-human affects of variations in temperature, pressure, and humidity precipitate as the felt palpability of meteorological phenomena. The zone in which most of the air in the atmosphere is found, the zone in which the weight of this air is felt most intensely (Adey, 2014).

But familiar as it is, the troposphere has a ceiling and a threshold: physical, affective, imaginative. Above a boundary layer called the tropopause, another layer, the stratosphere, extends upwards from about 15km to 50km (Hare, 1962), varying according to altitude. Unlike the troposphere below, the stratosphere is characterized by a gradual increase in temperature with altitude, caused by the absorption by ozone of ultraviolet radiation from the sun, which ends at about 50km. Because of this temperature inversion, to be in the stratosphere is to be above most of what passes for weather, to be above most of the air. It is

to be in a "windy but oddly weatherless stack of atmospheric layers sliding around from equator to pole without storms or clouds" (Morton, 2015: 36). But it is also to be in a zone with its own trajectories, circulations, stabilities. A zone defined by horizontal rather than vertical movement. A zone in which "never is there even a mist" (Kaempffert, 1934: 185), but where there are nacreous, "tenuous clouds" (Wood, 1951: 273).

Closed – but not hermetically – at both the top and bottom, the stratosphere is a continuous, unbroken layer surrounding the planet. The stratosphere is an envelope of sorts, one that seals weather-worlds in, although not perfectly. The boundary between stratosphere and troposphere is neither flat nor uniform: it is more like a surface of continuous if often gradual variation, of rises and falls, different gradients and curves, inclines and declines, becoming lower over tropospheric depressions and higher over anti-cyclones (Goody, 1958). And sometimes there are sudden extrusions, localized puncturings of the stratosphere by the more violent turbulence below, and sometimes the "tropopause bends back on itself, and overfolds, sometimes even dissipates completely, so that stratospheric air mixes downwards with tropospheric air" (Wood, 1951: 272).

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You'd love the clouds: "cumulus clouds, fleecy and white, dott[ing] the landscape below". You'd love how they appear "as always, to be puffs of cotton oriented in rows as if Mother Nature tended the clouds like a shepherd tends his flock." Love how they appear in "geometrical pattern…in rows extending for miles" (Ross, 1958: 5). Love the "huge mountain like cumulus turbulent structures punched up into the stratosphere" (Ibid., : 8).

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Sounding made the stratosphere explicit. In the late 19th and early 20th the French meteorologist Léon Teisserenc de Bort, an "unofficial aërographer" (McAdie, 1916: 266) launched almost 600 sounding balloons equipped with instruments for recording temperature, pressure, and humidity. About 140 made it to the stratosphere (Goody, 1958). Against the backdrop of a "comfortable feeling among meteorologists that there was nothing more to be discovered" (Goody, 1958: 1), these flights generated data that led de Bort to identify the

existence of an "isothermal layer", above which temperature no longer decreased with altitude. The existence of this zone was also claimed by the German meteorologist Richard Assmann (Hare, 1962), but it was de Bort who, in 1909, coined the term by which it is now known: and he did so on the basis that the stratosphere was a zone of stratified layers rather than of vertical, 'turning', or mixing like the troposphere (Goody, 1958). And it was De Bort who realized that "we cannot theorize on atmospheric phenomenon as if they were continuous in time and space" (cited in Watt, 1910: 49). De Bort who realized that the atmosphere is not one thing, not an object, but a series of layers defined in turn by process and event, and differentiated along surfaces of discontinuity (Simpson, 1926: 138).

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We carry with us instruments for measuring things. These "instruments are artificial senses. They write down all that they feel – temperature, pressure, and other facts of interest to scientists" (Kaempffert, 1934: 185).

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During the mid-19th century, aeronauts such as James Glaisher may have reached the lower reaches of the stratosphere by accident, and with near fatal results. As he found out, as a metaphor for taking flight, being-in-the-air becomes less and less appropriate the higher you get. But the stratosphere only really came to public attention, only really became the focus of media coverage during the 1930s. On May 27, 1931, Auguste Piccard and Paul Kipfer made the first successful ascent into the stratosphere, reaching an altitude of 51,775 feet after launching from a site in Germany. Piccard subsequently made a number of additional ascents, one of which in 1932 was attended by 40,000 spectators. Piccard captivated the "popular imagination by his adventures in the stratosphere" (*Washington Post*, 1932: 6). He made the stratosphere imaginable as a realm of exploration, and a destination for future and more frequent forms of travel. During this period, Auguste's brother Jean and his wife Jeanette Piccard also experimented with stratospheric balloon flights, with Jeanette becoming the first woman in the stratosphere (Hill, 2009). Most of those who ascended, however, were men.

Indeed, paralleling the Navy's Skyhook program, the US army balloon program during the 1950s was called Project 'ManHigh'.

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You'd love the view. You'd love how you can see for almost "300 miles in all directions". And the colour. You'd love how, above the "band of white at the tropopause", "the blue really" begins. How first there is "a light delicate blue, then a sky blue above, and an ever darkening hue, the blue colour changed through many shades of ethereal beauty" (Ross, 1958: 6).

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To different degrees, stratospheric experiments mixed scientific ambition with the technical articulation of relations between geopolitics, aerial politics, and new, emerging senses of 'astro-politik' (MacDonald, 2007). Indeed, during the 1930s, something of a near-space race took shape around stratospheric launches. In the Soviet Union, balloons (the *USSR* and *Osoaviakhim*) reached the stratosphere in 1933, 1934, and 1935. In the US, the US Army and *National Geographic Magazine* sponsored two balloons, *Explorers I* and *II*, the latter of which reached an altitude of 72,395 (DoD, 1958: 1). This was a period, then, during which E.M. Forster was given to remark that the "conquest of the stratosphere" is at hand (2008: 105).

These political resonances continued after the Second World War and into the early space missions of the Cold War. They were also part of complex and geographically distributed assemblages of devices, practices, bodies, and elemental forces. About 1500 Skyhook balloons were launched from the late 1940s into the 1960s, organized around a series of 'phases' or expeditions that took place at locations throughout the US, near the North Geomagnetic pole in Northern Greenland, Canada, the Caribbean, Guam, and in the vicinity of the Galapagos Islands.

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Do you miss me when I am here, when I am so high? We have a "certain awareness of our isolation." An awareness of that "strange sensation of detachment from the earth, a sense of remoteness, a feeling of isolation […] ever present […]". It's "nothing unpleasant" and "if

anything it is […] exhilarating. Radio contact with our colleagues many miles below" does "nothing to destroy this feeling". We feel "physically detached" (Ross, 1958: 6).

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In George Orwell's novel *1984*, O'Brien tries to scare Winston by reminding him of his complete erasure in the future: "You must stop imagining that posterity will vindicate you…. You will be lifted clean out of the stream of history. We shall turn you into gas and pour you into the stratosphere. Nothing will remain of you: not a name in a register, not a memory in the living brain" (cited in Cucu, 2013: 33-34). But O'Brien was wrong: the stratosphere has a memory, even if it is not the memory of an individual, a biography, a person (Baldwin et. al, 2003). The memory of the stratosphere differs from that of the troposphere: where tropospheric memory is turbulent, short-term, episodic, stratospheric memory is slower, gentler, but no less significant. It consists in patterns that persist over a longer period of time, "hemispheric-scale changes in airflow on time scales of a week to several months" (Baldwin et al, 2003: 1). These changes can originate via waves that propagate upward from the troposphere below, such that the "stratosphere organizes this chaotic wave forcing from below to create long-lived changes in the stratospheric circulation" (Ibid.). These changes retain the capacity to fold back into and shape weather-worlds below, in a process that remains under investigation.

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"In a balloon flight I lose my sense of the earth; you become part of the wind—part of eternity, but the minute you land some newspaper reporter is going to ask what did you have to eat?" (Jeannette Piccard, cited in Hill, 2009: 91).

3. Envelope

The envelope is manifold. It is a spatiotemporal surround, a surface that can be stretched, a traveling object. It suggests a degree of immersion, of nearing a limit, of being conveyed. A theory of the envelope and of being enveloped is an account of how different senses of spacetime emerge through the technical and aesthetic process of folding (Ash, 2015). It is an

account of how envelopment involves a differentiated relation between bodies in which bodies are always more than envelopes (Irigaray, 2005). And it is an account of a process that generates a sensed interval of difference between inside and outside: difference sensed across and through the affective capacities of skin, membrane, fabric. This is by no means limited to envelopment in relation to the phenomenology of human embodiment. But the technical process of envelopment certainly shapes the relation between bodies and their atmospheric surround in distinctive ways. Indeed, this technical process is a necessary precondition for being and becoming stratospheric. Gas, whether air, helium, or hydrogen needs to be enveloped in order to generate buoyancy. And the human body needs to be progressively more enveloped in order to become stratospheric.

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If I told you it was "thinner than this page", would you believe me (Ross and Lewis, 1958: 273)? If I told that it's made from polyethylene, one of the most "wondrous of the 'wonder plastics'", a kind of monstrous "first cousin to the plastic familiar to housewives as a wrapping for dozens of supermarket and department store items"? (Visking, 1960: 1). Would you believe me when I say that "if a bullet were fired through the lower half of the […] balloon in flight even it were fully inflated, nothing would happen"? (Undated report, np). Believe me when I say that it is "manufactured from 10 miles" of polyethylene, has a "surface area of 7 acres", is the size of a football field, and is "40-stories high", with a volume of 10 million cubic feet (Winzen, 1960: 2).

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The sealed envelope is a life-world of sorts (Sloterdijk, 2011). And the capsule is a paradigmatic example of such an envelope. The capsule can take many forms: medically, it is an envelope for the delivery of a substance to a destination in the body that would be ordinarily beyond reach without some kind of invasive procedure. Culturally, archeologically, it is a sealed, post-dated container to be opened at a designated future date. And technically, it is that part of a spacecraft in which astronauts travel, usually detachable from the larger

propulsion system. The capsule is the envelope of life support taken to its limits in an environment where the conditions for life fall away.

As they edged towards near space, stratospheric gondolas became progressively more encapsulated. Indeed, already, during the US and Soviet flights into the stratosphere during the 1930s, the balloon gondola had become a sealed space capsule. Versions of these US capsules formed the models for the Strato-Lab program in the 1950s. The most basic of the Strato-lab systems involved open gondolas with occupants equipped with cold weather clothing and oxygen. However, the most sophisticated version consisted of a high altitude pressurized gondola with an entirely artificial environment.

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Do you think me a space traveler? Encapsulated in what is supposed to be a true 'space' cabin, equipped for a "trip to the moon"? (ONR, 1956: 1). I know, "deep within", that we are "probably setting a pattern for a general procedure to be followed at some distant date by the true space pioneers who might make trips on satellites or in space ships to the moon or nearby planets" (Ross, 1958: 4). We are the first to bring our atmosphere with us: to "take our natural sea level environment with us to high altitude" (Ibid., 6).

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Becoming stratospheric was about becoming a new kind of breather (Choy, 2011; Englemann, 2015a), one facilitated by technologies of envelopment, in the shape of early space suits. The space suit presented itself "as an effective prophylactic, not only against death in space but against the death of the dream of space", it equally represented "a confrontation with the body, in all its messiness and vulnerability" (Shaw 2004: 142). The space suit was always more than a cultural icon: a "complicated anthropomorphic balloon containing a portable atmosphere" (Lantry, 1995: 204). Something to be negotiated, worn, in which "learning to live and move within … nylon and rubber garments … was like trying to adapt to life within a pneumatic tire" (quoted in Hersch, 2009: 346). Indeed, the design and engineering of spacesuits mirrored that of the corset: both were "among the most complex garments of their day" (Hersch, 2009: 347). The suits worn by Ross were early space-suits,

versions of the Mercury-type Navy Mark IV suit that would be used by early astronauts (Anderson, 1961). These suits had tubes that could be inflated, thus restricting the movement of blood. When inflated, the suits also, of course, restricted movement.

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You'll want to know what we wear. We wear "suits of new experimental underwear of fabric woven from peanut shells" (ONR, 1961a: 11). We wear pressure suits, designed to "provide a habitable atmosphere" (ONR, 1961a: 11), and covered by a metalized rubber outer garment (ONR, 1959: 1). Our "actual mobility […] is restricted with this outer garment but it's sure nice to have. We're not dancing any jigs up here, but we're getting along fine" (Ross, cited in Anderson, 1961: 24).

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The flight envelope is a diagram of the limits of the capacities of a technical object. As a term it emerged after the Second World War during a period of extensive experimental flight-testing. Test pilots, when taking aircraft to the edge of controllability and performance reliability, were tracing out the limits of this envelope, as part of experiments with emerging forms of aerial life (Adey, 2010). This envelope is abstract, but its limits are palpable, whether or not through stresses on metal, through difficulty in breathing, or through loss of consciousness. The envelope is the limit of what can be sensed or prehended as such, in a body of whatever kind, human or non-human. The envelope is a diagram that holds together the question of how far something can be sensed, what the thresholds of such sensing might be, and what it is that can be sensed.

4. Sensing

Stretching the envelope of stratospheric flight is not simply about seeing how high bodies or balloons can travel. Nor is it only about designing capsules or suits that can take bodies beyond the limits of their atmospheric surrounds. It is also about sensing. On one level, it is about new forms of phenomenological experience of motion and stillness, and of new forms of seeing with and within the reduced air at these heights (McCormack, 2008). But the effort to become stratospheric also involved a systematic attempt to sense the dynamics of those

bodies in response to their becoming stratospheric: sensing how bodies respond to pressure and temperature through different forms of stress. At the same time, the stratosphere became a platform for sensing cosmic processes filtered out by the atmosphere.

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We are being broadcast. We have "flat electrode discs, a little larger than a shirt button, […] glued directly on the skin" and "held securely in place by adhesive tape". Our body temperature is being measured, along with our thigh, hand, foot, rectum. We wear "small amplifiers about the size of a cigarette box and short-range, light-weight radio transmitters" (ONR, 1958a: 7). The electrical impulses in our bodies are "transmitted over radio or telephone circuits to Bethesda, MD", where they are "portrayed on oscilloscopes, direct writers, and audio systems" (DoD, 1958: 1).

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As bodies became stratospheric they also became telemetric. They became part of an ever more elaborate process of the automated transmission of data at a distance. During the 1950s and 1960s telemetry became an important research agenda in aviation, in the monitoring of animal life, and in medicine, to the extent that one observer wrote that "it appears that almost any signal for which there is a sensor can be transmitted from almost any species" (Mackay, 1965). Telemetry was part of the process by which objects sent higher and higher could be monitored as part of new spaces of sensing (Gabrys, 2016). It provided a way of sensing the signal of envelopes being stretched. It became a critical technology of remote-sensing: of the remote-sensing of the rhythms, variations, gradients of bodies becoming stratospheric.

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We are not alone. The reporters asked if we had heard voices up there, but no. But we had other companion species, to help us collect "data on the effects of high altitude on living organisms" (Minneapolis Morning Tribune, 1958: np). Houseflies, fleas, honey bees, eastern tent caterpillars, wax moths, fruit flies, and yellow fever mosquitos (BMS, 1958: 1).

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Under the name of Project RAM (Research Astronautical Medicine), directed by Norman Lee Barr, the US navy championed a "new achievement" in which "heartbeat, breath sound, spoken words and other measurements of the physical condition of humans or animals", can "be transmitted from isolated areas" (ONR, 1958: 7). This achievement was accomplished by "utilizing the electrical impulses generated in the body and by converting other measurements such as body temperature and respiratory volume into electrical equivalents" (DoD, 1958: 1). By no means specific to balloon flights, but extending to aviation more generally, this method was expected to aid the monitoring of future human and animal occupants of space vehicles, in addition to allowing for a new and effective system of distributed diagnosis and monitoring. As with other forms of aerial life the emphasis here was on the capacity to monitor stress: to monitor "the stressful conditions themselves; the emotional reaction of the person to these conditions; and the effects of his reactions on his performance" (Barr and Voas, 1960, 56).

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We are being broadcast. At 64,000 feet, we turned on our "television system" and the first "television pictures were transmitted from the stratosphere to ground and air-borne receivers". After lunch we "went on the air" with a television program at 1300. "For approximately 15 minutes we simply rambled with Lee serving as camera man while I narrated, when we reversed the procedure. The 'program', we were told, was carried 'live' by KSTP-TV in Minneapolis and" …. "was probably one of the strangest programs that a television audience had ever seen and it is probably the only time that amateurs have handled the duties of producers, directors, camera men, announcers and, admittedly, 'actors" (Ross, 1958: 3).

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The telemetric bodies of Strato-Lab operated on the cusp of what appeared to be the possibility of a more general becoming cyborg: of bodies, technologies and environments. While the cyborg now seems an increasingly quaint technoscientific figure – a relic – it was the figure towards which stratospheric and near space exploration seemed to be travelling. As

Clynes and Kline wrote in 1960, as far as space travel goes, the "cyborg deliberately incorporates exogenous components extending the self-regulatory control function of the organism in order to adapt it to new environments" (1960: 31). However, the telemetric bodies of Strato-Lab and of early space capsules were only proto-cyborg: they were merely supported by "artificial atmospheres encapsulated in some sort of environment". They were proto-cyborg because they constituted a form of "temporizing", merely putting the astronaut in the position of a fish travelling in a small bubble of water (ibid., 30).

***

I wonder if you are listening to me now. Are you listening to me in the same way that Mikesell's wife did, "listening to the echo of her husband's heartbeat, pulsating from space high above Minnesota". She said later that "the heartbeat came through quite well… it was a thundering 'thumpker-thump', she said", and it "echoed all over the room" (The Evening Star, 1958: np). Is this how you will hear me?

***

We are being exposed. To cosmic rays. Rays that are actually particles. We wear "body emulsions to investigate specific direct 'hits' […] by […] heavy high-energy particles" (ONR, 1961: 3). "Mu mesons, kappa mesons, tau mesons, and the new and, as yet, not very well understood 'v-particles' (DoD, 1952a: 9). Things "originating in some unknown region beyond the earth's atmosphere," and absorbed by the "denser part of the atmospheric blanket below" (Ibid., 9-10).

***

The process of becoming stratospheric was also a process of sensing the cosmic, in which entities originating beyond the atmosphere became more proximate. Supported by the Atomic Energy Commission, Skyhook Balloons provided platforms for research into the properties of cosmic rays, the existence of which had been confirmed in the mid-1920s. Balloons had long been used for cosmic ray research because they could get above and stay above much of the "denser part of the atmospheric blanket" (DoD: 1952, 10), which absorbs much of the primary particles of cosmic rays before they get to the surface of the earth.

Skyhook and Strato-Lab balloons carried sheets of emulsion sensitive to cosmic ray activity. When cosmic ray particles collided with this emulsion, secondary particles were produced, and these "events" formed the basis for further analysis (DoD, 1960b: 2). The emulsion sheets were arranged in stacks and gridded so that these "nuclear events" could "be traced in three dimensions rather than just two. And the depth of the emulsion block allowe[d] detection of many complete events" in the form of the chain of "secondary interactions started by each primary particle" (NSF, 1959: 1). Sometimes those who ascended in the balloons wore sheets of emulsion on their suits. Some balloons carried up to 800 pounds of emulsion, and upon recovery the "huge stack of processed emulsion" was divided "among scientists in 14 countries for analysis" (1960a, 1), including the USA, Canada, South Africa, Brazil, Denmark, England, France, German, Italy, Poland, and Switzerland, India and Japan (NSF, 1960). Some of these experiments were undertaken at or near the geomagnetic pole because the stratosphere above this location represented the "closest approach to the condition of the primary cosmic radiation as it exists in the solar system that can be measured from any place on the earth" (DoD, 1952: 1).

***

One day I'll tell you about things I've seen. Things you wouldn't believe. I'll tell you about "the centre of the Andromeda galaxy", the "gaseous nebula of Orion", the "aurorae on Venus" (ONR, 1958b: 14). I'll tell you about "water vapor in the atmosphere of Venus" and how it raised the "possibility that some kind of life existed" there (Chicago Tribune 1959: np).

And you'll ask me about the stars, about why it is they twinkle, why they are so scintillating. And I'll say that "there are several possibilities", that maybe "the wind blows turbulent eddies across the line of sight", that maybe "the shadow pattern that these eddies produce is like a shadow pattern on the bottom of a pool of water as the sun shines through its surface" (Mikesell, ONR, 1958: 9).

5. Address

The stratospheric flight was never simply point-to-point. It involved a trajectory that drew in a complex operational assemblage comprising relations between air, sea, and land. One Strato-Lab flight in 1960 involved a seven ship navy task force in the Caribbean Sea, including the aircraft carrier *Valley Forge*, from the deck of which the Skyhook balloons were launched. The carrier could sail in the direction and the speed of the wind, therefore generating the 'no-wind' conditions necessary to launch the balloon. Tracking the balloon was also a complex organizational effort, entailing "teamwork of an anti-submarine warfare task group", the aircraft of "Airborne Early Warning Squadron[s]", an aircraft carrier, and six destroyers, all operating over the two days during which the balloon drifted (DoD, 1960a: 2).

***

May 4th 1961, 113,000ft. They'd have released the press statement by now: "the balloon now floating over the gulf of Mexico is heading southeast and is expected to land aboard the aircraft carrier which is following the flight, at approximately 5:00pm (EDT)" (DoD, 1961: 1).

***

An address is many things. It is a way of "directing or approaching a person or thing"; a form of guidance, or advice; it is an "act of addressing someone or something" in search of aid or in praise; a speech "directed at or appealing to a particular audience", a dedication of a speech or text, the style of that speech or text. But it also refers to the details of a location, physical or digital, at which an individual, household, organization, or landmark of some kind can be found. Historically, it has also been used to indicate a "state or quality of being prepared", and "clothing, equipment" designed for a "particular occasion or purpose".[1]

Derrida, perhaps more than any other thinker, addresses the question of the address, of the "interplay of skillful execution or delivery, and delivery of a letter to its destination" (Bass, 1987: xiv). Derrida, famously, wrote a series of notes lacking a specific addressee. Notes that invite us to think about a form of address that "interrupts the continuous

[1] Oxford English Dictionary, online version, last accessed 15th July 2016.

development of the sequence, abruptly turns towards someone, that is, something, [which] addresses himself to you" (1980: 4).

***

Three envelopes, to which I return. That return to me, revisit me. I wonder what you wrote to yourself. Why you addressed yourself. I wonder how it was you addressed yourself in that letter, if at all. Was that envelope simply a souvenir, material evidence of having been at that altitude? A statement of mere presence, a memory of the ascent, of being there? Perhaps the envelope was always meant to be empty. Perhaps you thought:I address myself "not in order to say this or that, a message or whatever, not even a message that I address to myself", but to "try to stretch myself a bit, I address myself in the way one arches oneself" (Derrida, 1980: 58). The envelope as a stretch in expression: one felt in modification of the capacities of bodies to act, to be affected, to be moved by the conditions in which they move.

***

One day there will be more to tell. About how it all happened. About how, despite the plans, we did not land on the carrier deck. About how after travelling so high, you, Victor Prather, fell such a short distance from the helicopter hoist. About how the suit designed to keep you alive dragged you down and killed you "when the water entered through [the] open face plate" (ONR: 1961b 1). About how you were dead by the time they reached you.[2] *About how I never flew again.*

6. Opening

Three envelopes to which I return. The envelopes are post-marked. Jamestown, North Dakota. And the inscription on the outside gestures to another origin that is pre-positional, that cannot be post-marked, but which is a statement of potential presence nonetheless: *carried to an altitude of 82,000 feet*. An altitude in the stratosphere, it must be said, which is less a point than a virtual spherical surface. An altitude at which there can be no flags planted, huts constructed, machines left behind to rust and become remains.

To tell of something carried to an altitude existing only as a virtual, floating point is to invoke an address that is already scattered, unreachable, that cannot be marked in any quasi-permanent way. That cannot be marked by a monument of any shape or form. A point at which nothing material remains after the event of a stratospheric excursion. A point of arrival at nowhere in particular, an arrival at somewhere that cannot be and is not enveloped, that remains lightly airy, that cannot be forgotten, nor sealed, because it is no place at all (Irigaray, 2005).

What then can be drawn from these envelopes? No content, of course. But an encounter with these envelopes can provide an opportunity to write the atmospheric in its multiple manifestations. Writing the atmospheric in an affective sense is an increasingly well-rehearsed mode of producing accounts of the world. But if atmospheres are differentiated, then writing with them requires the cultivation of different modes of address that take into account the properties and qualities of those atmospheres. What I have been trying to do here is to write in ways that take into account the distinctive and differentiated properties of the meteorological atmosphere that envelops the earth. The promise of the stratospheric envelope provides one way of doing this: it holds in form the force of something excessive of form. And it does so through a series of episodic fragments which, while closed in on themselves, remain open to the conditioning affects of the milieu in which they are immersed. If we are to tell stories, in the orbit of the geohumanities, of atmospheric processes that mix the materiality of the world then we need forms that give us some shape, however briefly, to these stories. Here the envelope does this work: it gives shape to being and becoming stratospheric. In that sense, the stratospheric envelope is a layer of horizontal, atmospheric movement: relatively cloudless, relatively weather-less, relatively self-contained. A layer defined by a surface of discontinuity with the more turbulent troposphere below, with which it sometimes enters a relation of generative mixing.

The stratospheric envelope is a technology of enclosure and encapsulation that affords a way of moving into the relative stability of the upper atmosphere, a technology that

generates a difference between gaseous bodies that allows them to travel beyond certain limits.

And the stratospheric envelope is an alluring spatiotemporal shape that acts and affects at a distance: that folds "inside into outside, public into private" through an "affective point of contact" (Neumark, 2005: 6).

Sometimes this point of contact never arrives. Sometimes the undelivered envelope brings no "unity of sender and receiver" and remains suspended in the tensed time of "waiting" (Ibid., 8). To write with the form and force of a stratospheric envelope is to remain suspended: suspended in a speculative mode of address that blurs, deliberately, sites of sending, possible destinations, multiple addressees: a speculative mode of atmospheric address that in this case considers the unopened envelope as a means to experiment with the process of being and becoming stratospheric through a narrative written along the lines of drift, dispersal, and movement afforded by the stratosphere.

You might ask: "Under these conditions how to be sure that one arrives at whatever or whoever at all?" (Derrida, 1980: 58). Where is the destination, the conclusion? You might answer that whatever it is, being sure in this context is not a matter of giving form or shape to that which the envelope might contain. You might answer that whatever it is, "it is not a matter of pulling meaning out of its envelope—for then it would immediately become good only for discarding—but rather of developing the envelope as such; spreading it out, but by ceaselessly refolding whatever is deployed" (Nancy, 2009: 21). Whatever it is, you might answer that the stratospheric envelope, in whatever shape or form – paper, capsule, balloon, suit – is manifold, and can only ever be addressed in an open-ended way.

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Notes

[1] Officially, the altitude reached by Ross is still recognised as the highest attained by a balloonist. The World Air Sports Federation only recognises flights in which pilots make a successful descent in the craft with which they ascended. For instance, in October 2012, Felix Baumgartner reached 127,851 feet in the Red Bull Stratos balloon Baumgartner, but his record is not recognised because he jumped from his capsule. See http://www.fai.org/. Last accessed 18 January 2017.

[2] The balloonist who died during the recovery stage of the flight was Lieutenant Commander Victor Prather.

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