READING THE ANTHROPOCENE

A STUDY GUIDE FOR CLIMATE CHANGE, POETRY AND MONT BLANC

There's more than one way to read a poem.

Literature lovers often refer to **"close reading,"** the process of getting deep under the skin of a text, analyzing its content, and appreciating the form.

In *Graphs, Maps, Trees: Abstract Models for Literary Theory*, scholar Franco Moretti argues for **"distance reading."** He sees a need to pull out from the detail, and place a text alongside others in the broad trends of time and genre.

A third method, **intertextual reading**, gets close to a text by pulling in its literary context, comparing and contrasting a work with other words that are in its same "neighborhood" of theme, background, or the impact it has made on our culture.

There's also more than one way to study climate change.

We might look at one slice, **a snapshot**, of the issue. This could be a focus on one short period of time, or impacts made on one specific region, or the way a specific phenomena in the system—say albedo, or ocean acidification—works.

Another approach is to look at **the Big Picture**. This involves the challenging but necessary effort to learn how all the many temporal, spatial, and functional pieces interact together.

Increasingly, people are also taking an **interdisciplinary approach** to climate change. Climate change is not just a collection of scientific data. Social scientists, cognition researchers, and communications experts are interested in how science abstractions are converted into understanding and action. As both an urgent environmental and social issues, climate change also becomes a subject of the arts: literature, visual art, and music.

"Reading the Anthropocene" aims to encourage all of the above approaches, using a diverse collection of tools and platforms. The organizing principle behind the Guide is one location—Mont Blanc, in the Swiss Alps—and Percy Bysshe Shelley's famous poem of the same name.

Each unit covers a climate change topic that can be explored through short readings, video, and a visual arc of related information. A corresponding literature-based section includes an annotated copy of the poem, supplemental readings, and ideas for sparking discussion.

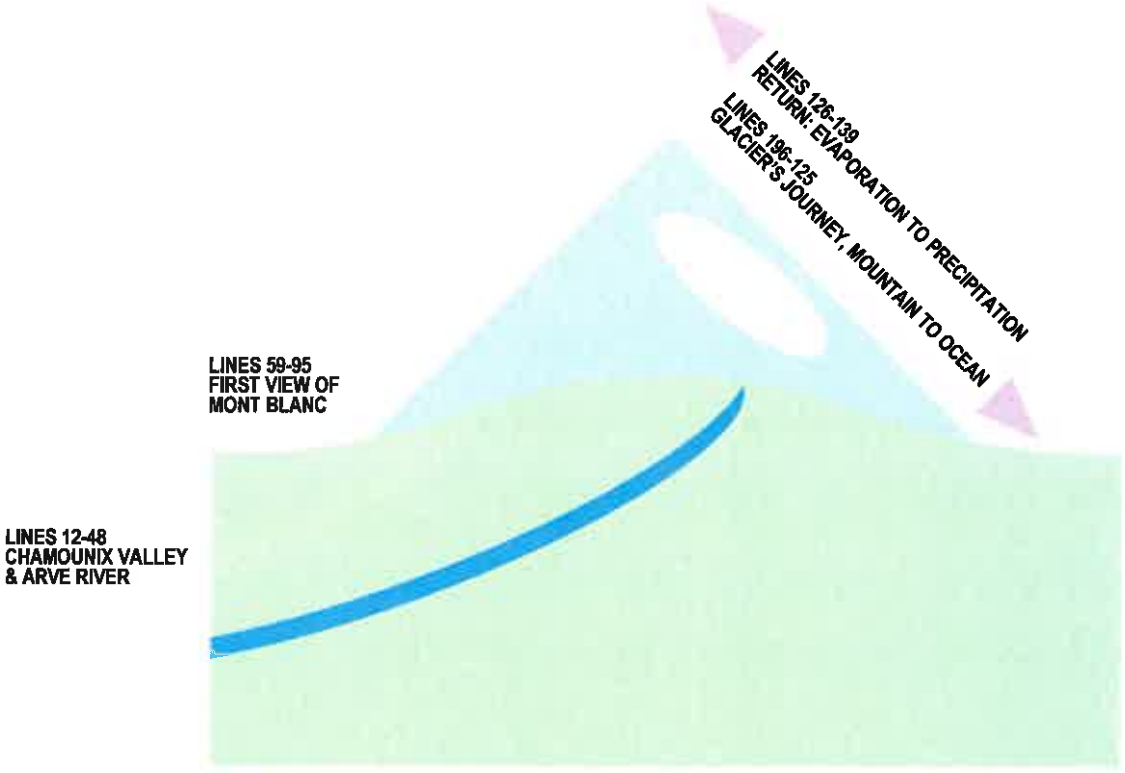
The following key resources will enhance the use of the Study Guide:

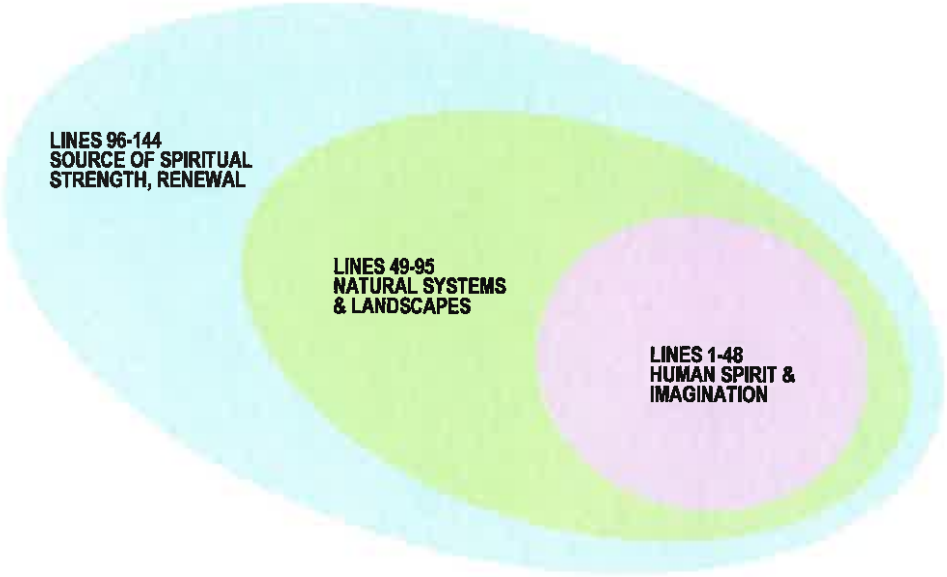
The Mont-Blanc Scientific Atlas features interactive information and 3D images
http://www.atlasmontblanc.org/en/home/

IPCC's 2013 chapter on "Cryosphere" is the most up to date, global state-of-the-ice report
https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter04_FINAL.pdf

The Norton Anthology's overview of the Romantic Period
http://www.wwnorton.com/college/english/nael/romantic/welcome.htm

Mapping Shelley's "Mont Blanc"





Writing Weather, Reading Ice

A SNAPSHOT OF MONT BLANC

KEY CONCEPTS
poet-scientist
literary bio
paleoclimate
data proxy
sulfates

In May of 1816 Percy Shelley, along with his wife, Mary, and her sister, left a chilled and dreary England for the summer warmth and outdoor adventures of the Continent. They rented a villa on the shores of Lake Geneva, Switzerland, and quickly discovered that their holiday resort was subject to extreme weather events, winter-like temperatures, and an unusual lack of direct sunlight. In fact, the Alps, like many other regions, was under the thumb of powerful climatic forces interacting together to dramatically alter the seasons. In Indonesia, one year before, the island volcano Tambora had erupted, spewing 400 million tons of sulfuric gas into the atmosphere. Subtropical jet streams spread the plume like an umbrella over the northern hemisphere, dropping global temperatures between 0.7 and 1.3 °F. Tambora's sulfate injection was only the recent in a series of smaller eruptions around the world that, when compounded together, produced amplified effects that were slow to dissipate and refrigerated the earth for several years.

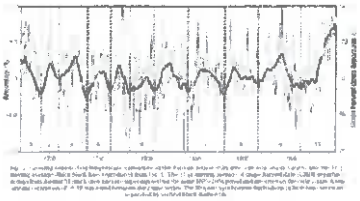
This moment in history has come to be known as "the year without summer": the coldest year, in the coldest decade, at the tail end of the coldest long-term interval in modern history we call the Little Ice Age (1300-1870). Another tag for 1816 is "the year of the beggar," which refers to the domino effect of crop failures, famines, social unrest and economic crashes that swept across Europe and North America. Mary Shelley was surprised to meet a young woman in the shadow of the Jura mountains who, "although she had lived all her life among vineyards, could not inform me during which month the vintage took place." Mary speculated in a letter that the Swiss woman appeared so "utterly ignorant" of the seasonal cycle as to accept the notion of "frosts in July." People in the early nineteenth century had not worked out that a volcano far away in the exotic South Seas could be the cause, many months later, of chilled Alpine villagers needing to bundle up in extra outerwear. Study of the planetary feedback loop of climate forcers and impacts was still in its infancy. And as we know, even two hundred years later, many people still have difficulty understanding the role of the climate in daily life.

The climate disruption of 1816 is suspected of having influenced and altered social, political and cultural life in a variety of ways. Unreliable weather has been blamed as a factor in Napolean's downfall at Waterloo. When agricultural catastrophe reduced the ability to feed horses, an enterprising German invented a new "grain-free" form of transportation: a wooden prototype of the bicycle. JMW Turner's paintings are famously noted for capturing the saturated sunsets that came in the wake of Tambora's pyroclastic discharge. Some believe this gloomy climate, which pervaded Charles Dickens' impressionable childhood, can be detected in his later fiction. And, of course, extraordinarily stormy weather often kept the Shelleys' and company indoors, and inspired them to amuse each other with gothic tales. Given that instrumental measurements of climate were not perfected until the 1880s, literary works produced circa 1816 can vividly (if not precisely) substantiate meteorological events and other natural phenomena.

Unit I focuses primarily on a slice of climate history, and specific—mostly invisible—elements at work to create observable conditions in the region of the Mont Blanc massif. We then narrow our focus to a single time capsule in nature's archives: an ice core sample from Greenland.

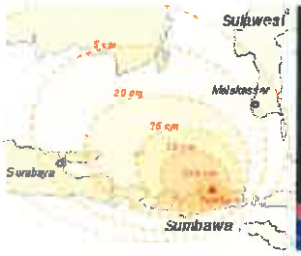
We also look at Shelley's poem alongside other 1816 literary sources which, when compiled together, provide a chapter of the environment's biography that complements other forms of historical and scientific data.

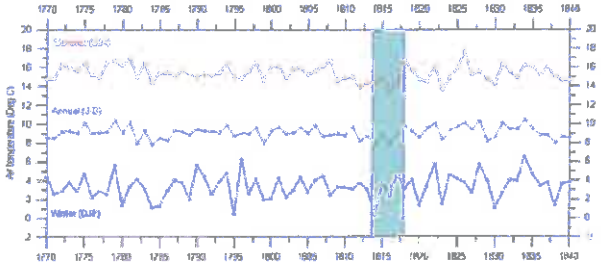
explore and inquire: records

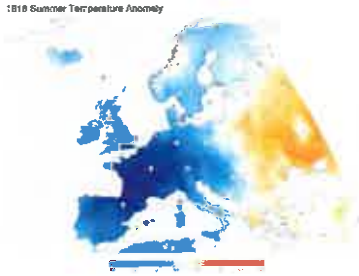


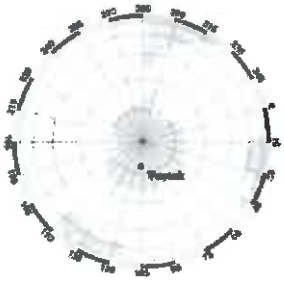
READ "Percy Bysshe Shelley 1792-1822"
http://www.poetryfoundation.org/bio/percy-bysshe-shelley#poet

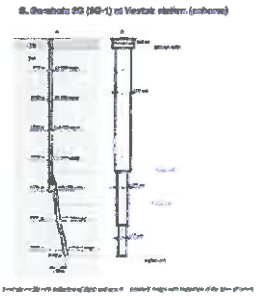
WATCH "Climate Change: Understanding the Facts"
https://www.youtube.com/watch?v=8BgD9xul16g

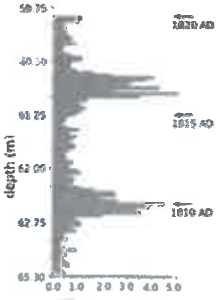


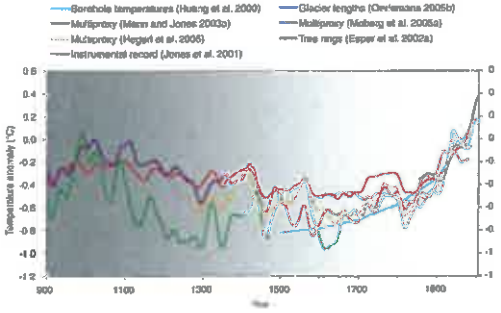












CLIMATEXCHANGE Simply by comparing two ice core samples—one from Greenland and the other from Antarctica—Jihon Cole-Dai and his fellow chemists discovered in 2009 that a previously unknown volcano had erupted 200 years earlier. In 2014, Caroline Williams, a Latin American history scholar, found South American astronomical records from the early 1800s that note changes in the earth's atmosphere around 1810 that corroborate the ice record. However, the location of the mystery volcano, has yet to be pinpointed.
http://ucsdnews.ucsd.edu/archive/newsrel/science/10-09Volcano.asp
http://www.eurekalert.org/pub_releases/2014-09/uob-fea091814.php

text and context

In the Part I preamble of "Mont Blanc," Shelley briefly sketches out his themes and geography. The first line of the poem gives Nature top billing as "the everlasting universe of things," and as the "Now dark—now glittering" source of the Poet's inspiration. Brooks lead to a "vast river," and we get a quick glimpse of a lonely mountain rising above "wild woods." Part II returns to the beginning of the journey, when author comes upon the Arve river, bursting into the valley.

Thus thou, Ravine of Arve—dark, deep Ravine—
Thou many-colour'd, many-voiced vale,
Over whose pines, and crags, and caverns sail
Fast cloud-shadows and sunbeams: awful scene,
Where Power in likeness of the Arve comes down
From the ice-gulfs that gird his secret throne,
Bursting through these dark mountains like the flame
Of lightning through the tempest;—thou dost lie,
Thy giant brood of pines around thee clinging,
Children of elder time, in whose devotion
The chainless winds still come and ever came
To drink their odours, and their mighty swinging
To hear—an old and solemn harmony;
Thine earthly rainbows stretch'd across the sweep
Of the aethereal waterfall, whose veil
Robes some unsculptur'd image; the strange sleep
Which when the voices of the desert fail
Wraps all in its own deep eternity;
Thy caverns echoing to the Arve's commotion,
A loud, lone sound no other sound can tame;
Thou art pervaded with that ceaseless motion,
Thou art the path of that unresting sound—
Dizzy Ravine! and when I gaze on thee
I seem as in a trance sublime and strange
To muse on my own separate fantasy,
My own, my human mind, which passively
Now renders and receives fast influencings,
Holding an unremitting interchange
With the clear universe of things around;
One legion of wild thoughts, whose wandering wings
Now float above thy darkness, and now rest
Where that or thou art no unbidden guest,
In the still cave of the witch Poesy,
Seeking among the shadows that pass by
Ghosts of all things that are, some shade of thee,
Some phantom, some faint image; till the breast
From which they fled recalls them, thou art there!

A hypothesis begins to form, of phenomena produced by a powerful, though first unseen, force. Observation #1: the sound of rushing water which, we will discover, is glacial melt.

METAPHOR River as embodiment of another Power, which in turn is described as a monarch.

METAPHOR Pine trees as history's "giant brood" of "children."

INTERTEXT Compare "Mont Blanc" to Lord Byron's poem "Darkness" — also written in 1816, the Year Without Summer — while Byron was visiting the Shelley's in Switzerland. See Unit I Research)

THEME "Man is an instrument over which a series of external and internal impressions are driven, like the alternations of an ever-changing wind over an Aeolian lyre, which move it by their motion to ever-changing melody. [But the human being] produces not melody alone, but harmony, by an internal adjustment of the sounds or motions thus excited to the impressions which excite them."

FROM SHELLEY'S "A DEFENSE OF POETRY"

Lines 34-48 outline the role of the poet-scientist, who gathers and processes data, and continues to revise his theories via "unremitting exchange." Poesy is imagination, a useful tool for exploring the natural world.

ICE CORE BASICS by Bethany Davies, AntarcticGlaciers.org

The large Greenland and Antarctic ice sheets have huge, high plateaux where snow accumulates in an ordered fashion. Slow ice flow at the centre of these ice sheets (near the ice divide) means that the stratigraphy of the snow and ice is preserved. Drilling a vertical hole through this ice involves a serious effort involving many scientists and technicians, and usually involves a static field camp for a prolonged period of time. Shallow ice cores (100-200 m long) are easier to collect and can cover up to a few hundred years of accumulation, depending on accumulation rates. Deeper cores require more equipment, and the borehole must be filled with drill fluid to keep it open. The drill fluid used is normally a petroleum-derived liquid like kerosene. It must have a suitable freezing point and viscosity. Collecting the deepest ice cores (up to 3000 m) requires a (semi)permanent scientific camp and a long, multi-year campaign[6]. // **LAYERS IN THE ICE.** If we want to reconstruct past air temperatures, one of the most critical parameters is the age of the ice being analysed. Fortunately, ice cores preserve annual layers, making it simple to date the ice. Seasonal differences in the snow properties create layers – just like rings in trees. Unfortunately, annual layers become harder to see deeper in the ice core. Other ways of dating ice cores include geochemisty, layers of ash (tephra), electrical conductivity, and using numerical flow models to understand age-depth relationships. Although radiometric dating of ice cores has been difficult, Uranium has been used to date the Dome C ice core from Antarctica. Dust is present in ice cores, and it contains Uranium. The decay of 238U to 234U from dust in the ice matrix can be used to provide an additional core chronology[7].
// **INFORMATION FROM CORES: ACCUMULATION RATE.** The thickness of the annual layers in ice cores can be used to derive a precipitation rate (after correcting for thinning by glacier flow). Past precipitation rates are an important palaeoenvironmental indicator, often correlated to climate change, and it's an essential parameter for many past climate studies or numerical glacier simulations. // **MELT LAYERS.** Ice cores provide us with lots of information beyond bubbles of gas in the ice. For example, melt layers are related to summer temperatures. More melt layers indicate warmer summer air temperatures. Melt layers are formed when the surface snow melts, releasing water to percolate down through the snow pack. They form bubble-free ice layers, visible in the ice core. The distribution of melt layers through time is a function of the past climate, and has been used, for example, to show increased melting in the Twentieth Century around the NE Antarctic Peninsula[8]. // **PAST AIR TEMPERATURES.** It is possible to discern past air temperatures from ice cores. This can be related directly to concentrations of carbon dioxide, methane and other greenhouse gasses preserved in the ice. Snow precipitation over Antarctica is made mostly of H216O molecules (99.7%). There are also rarer stable isotopes: H218O (0.2%) and HD16O (0.03%) (D is Deuterium, or 2H)[9]. Isotopic concentrations are expressed in per mil δ units (δD and δ18O) with respect to Vienna Standard Mean Ocean Water (V-SMOW). Past precipitation can be used to reconstruct past palaeoclimatic temperatures. δD and δ18O is related to surface temperature at middle and high latitudes. The relationship is consistent and linear over Antarctica[9]. Snow falls over Antarctica and is slowly converted to ice. Stable isotopes of oxygen (Oxygen [16O, 18O] and hydrogen [D/H]) are trapped in the ice in ice cores. The stable isotopes are measured in ice through a mass spectrometer. Measuring changing concentrations of δD and δ18O through time in layers through an ice core provides a detailed record of temperature change, going back hundreds of thousands of years. An example of using stable isotopes to reconstruct past air temperatures is a shallow ice core drilled in East Antarctica[10]. The presence of a "Little Ice Age", a cooler period ending ~100 to 150 years ago, is contested in Antarctica. Disparate records often provide conflicting evidence. This ice core attempted to investigate the evidence for cooler temperatures during this period. A 180 m deep ice core from the Ross Sea, Antarctica, was drilled by a team led by Nancy Bertler in 2001/2002[10]. The top 50 m of the ice core was analysed at 2.5 cm resolution using a continuous melting system. Ice core samples were analysed for stable isotope ratios, major ions and trace elements. An age model was extrapolated to the ice core using a firm decompaction model[10]. Deuterium data (δD) were used to reconstruct changes in summer temperature in the McMurdo Dry Valleys over the last 900 years. The study showed that there were three distinct periods: the Medieval Warm Period (1140 to 1287 AD), the Little Ice Age (1288 to 1807 AD) and the Modern Era (1808 to 2000 AD). These data indicate that surface temperatures were around 2°C cooler during the Little Ice Age[10], with colder sea surface temperatures and possibly increased sea ice extent, stronger katabatic winds and decreased snow accumulation. The area was cooler and stormier. // **PAST GREENHOUSE GASSES.** The most important property of ice cores is that they are a direct archive of past atmospheric gasses. Air is trapped at the base of the firn layer, and when the compacted snow turns to ice, the air is trapped in bubbles. This transition normally occurs 50-100 m below the surface[6]. The offset between the age of the air and the age of the ice is accounted for with well-understood models of firn densification and gas trapping. The air bubbles are extracted by melting, crushing or grating the ice in a vacuum. This method provides detailed records of carbon dioxide, methane and nitrous oxide going back over 650,000 years[6]. Ice core records globally agree on these levels, and they match instrumented measurements from the 1950s onwards, confirming their reliability. Carbon dioxide measurements from older ice in Greenland is less reliable, as meltwater layers have elevated carbon dioxide (CO_2 is highly soluble in water). Older records of carbon dioxide are therefore best taken from Antarctic ice cores. // **THERMAL DIFFUSION.** Other complexities in ice core science include thermal diffusion. Prior to becoming trapped in ice, air diffuses to the surface and back. There are two important fractionation processes: thermal diffusion and gravitational settling[11]. Thermal diffusion occurs if the surface is warmer or colder than the bottom boundary (the close-off depth). This temperature gradient occurs from climate change, which affects the surface first. The heavier components of the air (like stable isotopes) also tend to settle down (gravitational settling). Thermal diffusion and gravitational settling can be measured and analysed because the fractionation of air follows well understood principles and relationships between different stable isotopes (namely, nitrogen and argon).

Changing Landscapes, Crossing Divides

MONT BLANC AND THE BIG PICTURE

KEY CONCEPTS
eco-criticism
metaphor
climate forcer
carbon cycle
feedback loop

In *Poetics* Aristotle describes metaphor as the transfer of "a strange term ... from one species to another." Every metaphor has two parts. The thing we want to describe is sometimes called the *tenor*, or *signified*, while the image we use to describe it is the *vehicle*, or *signifier*. The essence of metaphor can be found in its etymology. *Meta* is Greek for "across" or "over," while *phor*, from *pherein*, means "to carry." To use metaphor is to engage in the act of transferring meaning between two objects—between a signifier and a signified—that are otherwise unrelated. Consider these lines from Frank O'Hara's poem "In Memory of My Feelings": "My quietness has a man in it, he is transparent /and he carries me quietly, like a gondola, through the streets." O'Hara's first metaphor is the invisible *man* (the vehicle) he uses to give shape to his *quietness* (the tenor). He then adds a second type of metaphor, a simile, when he depicts the quietness/man as a *gondola*.

Aristotle considered the poetic use of metaphor a sign of genius. But all humans are wired to juxtapose intangible, complex and unfamiliar phenomena with the everyday world they see around them. Metaphors are used in many types of communication, and we've been using them for as long as can be remembered. Glaciers, for example, are often compared to rivers in order to explain that they are moving and shaping the landscape. A glacier isn't a river of course (although, to add another metaphor, it often"feeds" one), but the comparison to an active force that the human eye captures clearly helps people conceptualize a much slower, barely perceptible movement that occurs over centuries. In *The Roadless Yaak*, nature writer Rick Bass takes a different and fresh metaphorical approach when, from the perspective of deep time and outer space, he depicts a glacier as "a sinuous galloping thing, sliding across the landscape with an elegant gait, leaving behind tracks etched in stone and spoor the size of small villages."

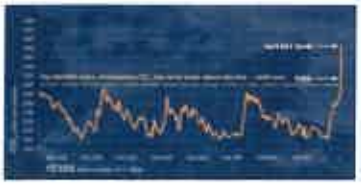
Metaphors are often used to describe systems in nature, or convey scientific information. Due to its broad geographic variability, a decades-long lag time, and the mostly invisible chain of cause and effect, climate change is a prime candidate for the metaphorical treatment. By calling the cumulative impact of fossil fuel consumption and emissions a "carbon footprint," for example, we establish a mental guide for the less tangible link between human activity and environmental sensitivity. Some experts find that the familiarity of medical metaphors help people understand climate concepts. Society's high confidence in medical professionals has been used to instill a similar trust level in climate science. And the benefits of mitigating climate risks are often equated with disease prevention measures. In fact, as Diane Ackerman asserts in *An Alchemy of the Mind,* metaphor is not simply handy in science communications: it is a form of the scientific method itself, allowing us to visually and linguistically "dissect and organize experience."

In Unit II we'll explore the various ways Percy Bysshe Shelley puts metaphor to work in his poetry, and how he makes creative connections between the "macro" of a breathtaking and enigmatic landscape, and the "micro" of human experience.

We'll also look at the complicated relationships between some of the planet's largest systems—the carbon cycle, the cryosphere, and climate.

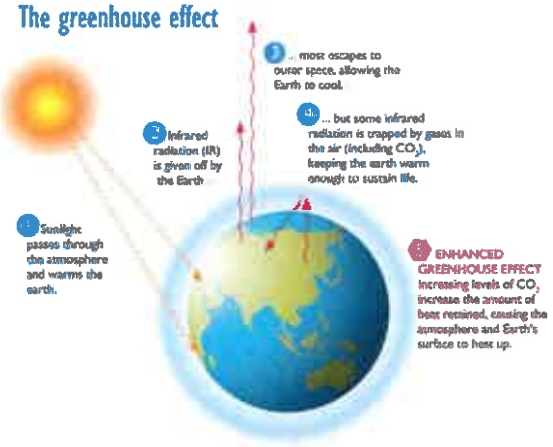
Even when we have a good grasp of scientific principles, the overarching concept of climate change can retain some opacity. This section features a variety of tools that transform the abstractions into models of meaning.

explore and inquire: causes

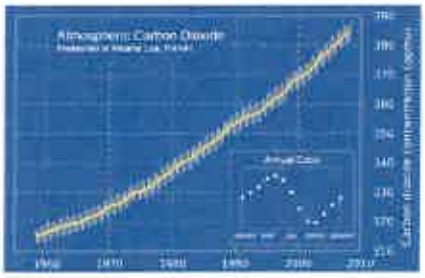


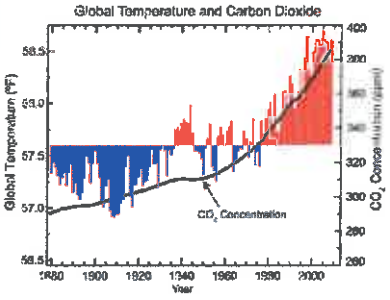
READ "IPCC Summary for Policymakers (2013)"
http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf

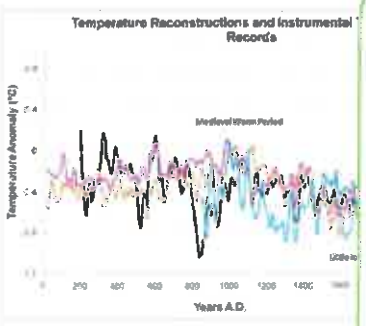
WATCH "The Carbon Cycle"
https://www.youtube.com/watch?v=c40jebr9jbg

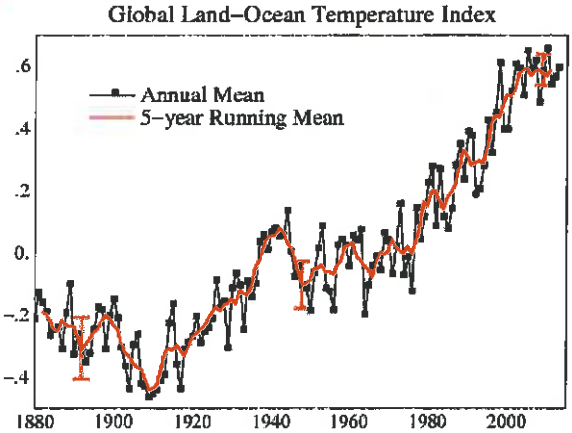


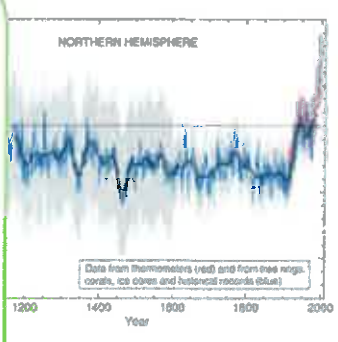
CLIMATEXCHANGE The Albedo Effect (from the Latin for "whiteness") describes the way the earth's surfaces bounce the sun's rays (shortwave radiation) back into the atmosphere. Higher Albedo means the earth's surface is more reflective. Glaciers, icebergs, and snow fields have high albedo. But water absorbs much more radiation. A balanced ratio of sea ice to ocean water is a key concern in the effort to slow and reverse climate change. https://www.youtube.com/watch?v=cW4JTHz1aRg











text and context

As the poet and reader continue their ascent, the source of the crashing river's mystery is suddenly exposed in Part III: Mont Blanc, "snowy, and serene." In a preceding short meditation (lines 49-59), Shelley notes that while some people believe in "remoter world" after death, he "look[s] on high." The Alps are Shelley's spiritual home, even as they lead him "like a homeless cloud from steep."

Far, far above, piercing the infinite sky,
Mont Blanc appears—still, snowy, and serene;
Its subject mountains their unearthly forms
Pile around it, ice and rock; broad vales between
Of frozen floods, unfathomable deeps,
Blue as the overhanging heaven, that spread
And wind among the accumulated steeps;
A desert peopled by the storms alone,
Save when the eagle brings some hunter's bone,
And the wolf tracks her there—how hideously
Its shapes are heap'd around! rude, bare, and high,
Ghastly, and scarr'd, and riven.—Is this the scene
Where the old Earthquake-daemon taught her young
Ruin? Were these their toys? or did a sea
Of fire envelop once this silent snow?
None can reply—all seems eternal now.
The wilderness has a mysterious tongue
Which teaches awful doubt, or faith so mild,
So solemn, so serene, that man may be,
But for such faith, with Nature reconcil'd;
Thou hast a voice, great Mountain, to repeal
Large codes of fraud and woe; not understood
By all, but which the wise, and great, and good
Interpret, or make felt, or deeply feel.

The fields, the lakes, the forests, and the streams,
Ocean, and all the living things that dwell
Within the daedal earth; lightning, and rain,
Earthquake, and fiery flood, and hurricane,
The torpor of the year when feeble dreams
Visit the hidden buds, or dreamless sleep
Holds every future leaf and flower; the bound
With which from that detested trance they leap;
The works and ways of man, their death and birth,
And that of him and all that his may be;
All things that move and breathe with toil and sound
Are born and die; revolve, subside, and swell.

THEME "That very day,
From a bare ridge we also first beheld
Unveiled the summit of Mont Blanc, and grieved
To have a soulless image on the eye
That had usurped upon a living thought
That never more could be. ...

... Winter like a well-tamed lion walks,
Descending from the mountain to make sport
Among the cottages by beds of flowers.

With such a book
Before our eyes, we could not choose but read
Lessons of genuine brotherhood, the plain
And universal reason of mankind,
The truths of young and old."

FROM WILLIAM WORDSWORTH'S "THE PRELUDE"

In Part II Shelley explored the human mind's response to Nature. Here, he steps outside the poet-scientist role to consider Nature as a personified force, with capacity to communicate, instruct, and model authenticity.

Daedalus was the hero of Greek myth who constructed a Labyrinth, and then wings by which to escape it. Nature's design is clever and intricate as well.

In lines 84-95 the view of the mountain's grandeur leads the Poet to consider several natural cycles: climate, the seasons, geology, human culture, life and death.

INTERTEXT Check out "Vertigo" by Alice Oswald, from *The Guardian*'s series of climate change poems. (See Unit II Research)

"Vertigo"

A Climate Change Poem
by Alice Oswald

May I shuffle forward and tell you the two minute life of rain
Starting right now lips open and lidless-cold all-seeing gaze
When something not yet anything changes its mind like me
And begins to fall
In the small hours
And the light is still a flying carpet
Only a little white between worlds like an eye opening after an operation
No turning back
each drop is a snap decision
A suicide from the tower-block of heaven
And for the next ten seconds
The rain stares at the ground
Sees me stirring here
As if sculpted in porridge
Sees the garden in the green of its mind already drinking
And the grass lengthening
Stalls ...
Maybe a thousand feet above me
A kind of yellowness or levity
Like those tiny alterations that brush the legs of swimmers
Lifts the rain a little to the left
No more than a flash of free-will
Until the clouds close their options and the whole melancholy air surrenders to
pure fear and ... falls
And I who live in the basement
one level down from the world
with my eyes to the insects with my ears to the roots listening
I feel them in my bones these dead straight lines
Coming closer and closer to my core
This is the sound this is the very floor
Where Grief and his Wife are living looking up

(Printed in *The Guardian*, May 11, 2015)

KEY CONCEPTS
reader response
the sublime
climate impacts
glaciation
geoengineering

Imagining What's Next

MONT BLANC: SYNTHESIS

The chemistry of climate change is simple. As we saw in Unit II, the more carbon burned, the more carbon dioxide is emitted. The fewer forests saved, the less capacity the planet has for absorbing CO2. More CO2 trapped in the atmosphere leads to hotter temperatures, which accelerates the melting of critical fresh, frozen water reserves, which leads to higher sea levels … longer droughts … flourishing of disease … extreme weather patterns … seasons gone haywire ... and refugee influx. Under the business as usual scenario our oceans could become one hundred and fifty times more acidic than they were before the Industrial Revolution —a pH level that hasn't existed for more than twenty million years. Substantial portions of the world's mountain glacier inventory is expected to disappear by 2030. Ecologists working in Glacier National Park peg their total liquidation date at around 2020.

The real story of climate change is a story of uncertainty, a "choose your ending" exercise with no historical precedent to use as a guideline. What are the planet's thresholds for climate disruption? How exponential is the amplification of various climate forcers? At what point will social systems fail, as climate change impacts cascade through our communities? Just how adaptable are humans and other species? And what is the tipping point for motivating aggressive, global and long-term policies? Where will the technology come from?

This unit addresses climate change impacts—the other end, opposite forcers, of the climate "stick." Our particular focus will be on vulnerable mountain glacier systems like Mont Blanc's. Glacier recession is a dramatic and observable sign of the unscrupulous speed of climate change. In conjunction, we'll study the final third of Shelley's poem for its moving—and presciently ecological—rendition of the glaciation process.

We then move to human responses to, and solutions for, the effects of climate change. Geoengineering was once treated as untouchable in climate mitigation conversation, a risky proposition reserved for a last-ditch, worst-case scenario. Of interest to this discussion is the strategy (as yet untested, but gaining traction) for infusing our atmosphere with sulfates, thereby imitating the global cooling qualities of volcano.

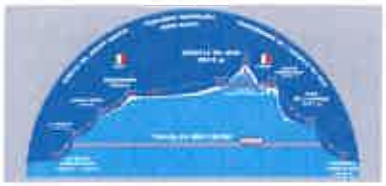
Many organizations and movements are invested in the goal of climate sustainability: 2000 Watt Society, 350.org, Yale Environment 360, the degrowth economic school, and coal divestment groups, to name just a few. This section highlights just one, the Breakthrough Institute, which has become well known for its support of technological innovation, urbanization, and nuclear energy.

READER RESPONSE

The intent for the end of Unit III is for students to respond, either creatively or critically (or both), to the culmination of this Study Guide's topics and inquiries. Students are asked to produce one of the following:

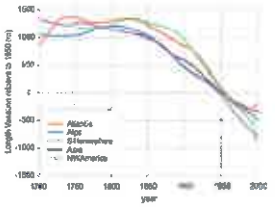
- Compose a poem addressing climate change as an environmental, social, and/or persona issue
- Create a piece of speculative "flash fiction" set in the future, when global warming is "old history"
- Write a nonfiction essay that is: (a) informed by at least one significant aspect of climate change science; and (b) cites at least one substantial passage from a published writer from the fields of poetry or fiction.

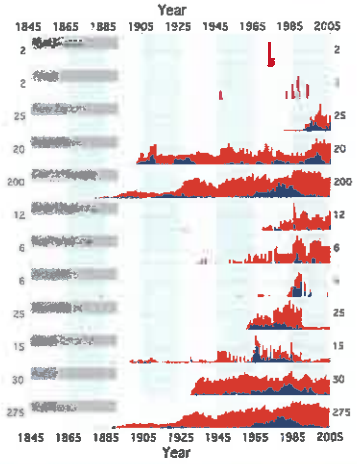
explore and inquire: impacts



READ "The Ecomodernist Manifesto"
http://www.ecomodernism.org/manifesto/

WATCH "David Keith: A Critical Look at Geoengineering"
https://www.ted.com/talks/david_keith_s_surprising_ideas_on_climate_change?language=en





GEOENGINEERING THE POEM The implications of intentionally manipulating the environment bring the Shelleys to mind. Mary's novel *Frankenstein* fictionalizes the unintended consequences of bioscience hubris. Percy's poetry does not share these apprehensions, but cautions readers to not underestimate the Nature's systems. Even so, "Mont Blanc," like a geo-engineer's plan to mimic volcanic aerosols, perform its own ecological mimesis. The last third of the poem (facing page) re-enacts glaciation and the hydrological cycle — from mountain runoff to seaside estuary; from ocean evaporation and back into Alpine precipitation. Perhaps the human race has always, and always will be, "wired" for recreating the world around it.

COMPARE PERCY'S "GLACIER LIT" WITH MARY'S *FRANKENSTEIN* DESCRIPTION OF THE SAME GEOGRAPHY

"Immense glaciers approached the road; we heard the rumbling thunder of the falling avalanche, and marked the smoke of its passage. Mont Blanc, the supreme and magnificent Mont Blanc, raised itself from the surrounding aiguilles, and its tremendous dome overlooked the valley. … [V]ast mists were rising from the rivers which ran through it, and curling in thick wreaths around the opposite mountains, whose summits were hid in the uniform clouds, while rain poured from the dark sky, and added to the melancholy impression I received from the objects around me. … Presently a breeze dissipated the cloud, and I descended the glacier. The surfaces is very uneven, rising like the waves of a troubled sea, descending low, and interspersed with rifts that sink deep. The field of ice is almost a league in width, but I spent nearly two hours in crossing it. …
I suddenly beheld the figure of a man, at some distance, advancing towards me with superhuman speed. He bounded over the crevices in the ice, among which I had walked with caution; his stature also, as he approached, seemed to exceed that of man." —from *Frankenstein*(62-65)

text and context

Power dwells apart in its tranquillity,
Remote, serene, and inaccessible:
And *this*, the naked countenance of earth,
On which I gaze, even these primeval mountains
Teach the adverting mind. The glaciers creep
Like snakes that watch their prey, from their far fountains,
Slow rolling on; there, many a precipice
Frost and the Sun in scorn of mortal power
Have pil'd: dome, pyramid, and pinnacle,
A city of death, distinct with many a tower
And wall impregnable of beaming ice.
Yet not a city, but a flood of ruin
Is there, that from the boundaries of the sky
Rolls its perpetual stream; vast pines are strewing
Its destin'd path, or in the mangled soil
Branchless and shatter'd stand; the rocks, drawn down
From yon remotest waste, have overthrown
The limits of the dead and living world,
Never to be reclaim'd. The dwelling-place
Of insects, beasts, and birds, becomes its spoil;
Their food and their retreat for ever gone,
So much of life and joy is lost. The race
Of man flies far in dread; his work and dwelling
Vanish, like smoke before the tempest's stream,
And their place is not known. Below, vast caves
Shine in the rushing torrents' restless gleam,
Which from those secret chasms in tumult welling
Meet in the vale, and one majestic River,
The breath and blood of distant lands, for ever
Rolls its loud waters to the ocean-waves,
Breathes its swift vapours to the circling air.

Mont Blanc yet gleams on high:—the power is there,
The still and solemn power of many sights,
And many sounds, and much of life and death.
In the calm darkness of the moonless nights,
In the lone glare of day, the snows descend
Upon that Mountain; none beholds them there,
Nor when the flakes burn in the sinking sun,
Or the star-beams dart through them. Winds contend
Silently there, and heap the snow with breath
Rapid and strong, but silently! Its home
The voiceless lightning in these solitudes
Keeps innocently, and like vapour broods
Over the snow. ...

INTERTEXT In Mary Shelley's *Frankenstein*, Doctor F. travels to Mont Blanc to escape his troubles and enjoy his honeymoon, only to be hunted down by his monster on the same Glacier Percy describes. (See Appendix)

To: Thomas Peacock
From: Percy Bysshe Shelley
Date: July 24, 1816:

On the other side rises the immense glacier of Montanvert, fifty miles in extent, occupying a chasm among mountains of inconceivable height, and of forms so pointed and abrupt, that they seem to pierce the sky. [W]e saw ... masses of ice detach themselves from on high, and crash with loud dull noise into the vale. The violence of their fall turned them into powder, which flowed over the rocks in imitation of waterfalls, whose ravines they usurped and filled. ... These glaciers flow perpetually into the valley, ravaging in their slow but irresistible progress the pastures and the forests which surround them, performing a work of desolation in ages, which a river of lava might accomplish in an hour, but far more irretrievably... The glaciers move perpetually forward onward, at the rate of a foot a day [and] drag with them from the regions when they derive their origin, all the ruins of the mountain... Within this last year, these glaciers have advanced three hundred feet into the valley. Saussure, the naturalist, says that they have their periods of increase and decay: the people of the country hold an opinion entirely different; but as I judge more probable. Its agreed by all, that the snow on the summit of Mont Blanc ... and that ice, in the form of glaciers, subsists without melting in the valley of Chamouni during its transient and variable summer.

Additional Research materials to be determined