SAMPLE

Earth's Dynamic Systems: Glaciers

Rivers of Ice

Aira Astralis

Free sample: Introduction & Chapter 1

putrabooks.github.io

Buy the full book:

Carousell carousell.sg/p/earth-s-dynamic-systems-glaciers-ebook-pdf-1467849059

ElevenReader

Payhip

Contents

Introduction

Chapter 1: What a Glacier Is

Chapter 2: How Ice Becomes a Glacier

Chapter 3: Reading the Landscape

Chapter 4: How Glaciers Move

Chapter 5: The Bed

Chapter 6: The Water Beneath

Chapter 7: Surges and Quakes

Chapter 8: The Carving Machine

Chapter 9: What the Ice Leaves Behind

Chapter 10: The World's Glaciers

Chapter 11: Ice Cores and the Long Record

Chapter 12: Glaciers Beyond Earth

Chapter 13: The Great Retreat

Chapter 14: What the Retreat Costs

Chapter 15: Fun Facts and Trivia, Weighed

Chapter 16: The Hazards of the Melt

Conclusion

This free sample contains the Introduction and Chapter 1. The complete book contains the full contents above.

Introduction

A glacier is a persistent body of natural ice, in mineral terms a form of rock, that is constantly moving under its own weight, and it is the most sculptural force on the planet's surface: every major mountain range carries its signature, whole lowland landscapes are built from its rubble, and the northern half of North America and Europe is blanketed with the debris of the ice that left. The same slow white presence is now the most visible barometer of a warming climate, its fronts retreating on every continent except the highest Antarctic interior, its meltwater feeding rivers that half of Asia drinks from. This book tells the whole story of glaciers, from the physics of how a pile of snow becomes a river of rock, to the landscapes it carves and leaves behind, to the satellite-era accounting of a cryosphere in retreat, in plain language with no equations needed to follow it.

The chapters open with the substance itself: how snow becomes glacier ice, why that ice is blue, how the great ice sheets, shelves, and mountain glaciers are told apart, and how a glacier's health is measured by the balance between what falls on it and what melts off. The middle chapters carry the mechanics and the craft: how the ice moves, what happens at the bed where ice, water, and rock negotiate, the sudden surges and ice quakes, the erosion that turns V-shaped river valleys into U-shaped glacial ones, and the inventory of landforms, moraines, drumlins, erratics, and fjords, that a glacier leaves as its signature. The survey chapters carry the world: the glacier countries from the Alps to the Andes, the ice cores that archive the planet's past atmospheres, and the surprising glaciers of Mars and Pluto. The closing chapters carry the present crisis: the great retreat measured since the 1980s, its costs in water, coasts, and hazard, and the future that the mass-balance arithmetic already implies.

The book's honest through-line is that glaciers are both actors and records. As actors they shaped the surface of a tenth of the world's land; as records they hold the atmosphere's history in bubbles and the climate's verdict in their fronts, and the reader who reaches the last page of this book will be able to read both: the landscape on a mountain drive, and the news photograph of a retreating glacier, each legible as the work of forces explained here.

The mountain glacier's anatomy completes the chapter's foundation, because the later chapters use its parts by name. A glacier begins high in its cirque, the accumulation zone, where the snow gathers and the ice is born; it flows down the valley, the ablation zone, where the melting, the calving, and the wasting subtract from it; and the two zones meet at the equilibrium line, the height contour where the year's books balance, the same line the mass-balance

chapter introduces. The terminus, the front or snout, is the glacier's public face, the part photographed and measured, advancing or retreating with the balance; the icefall is the steep reach where the surface breaks into seracs and crevasses as the flow accelerates; and the ice margins, the edges where the ice meets rock and melt, are where the debris gathers that the deposition chapter follows.

With this anatomy in hand, the reader can follow every later chapter's vocabulary, and the book's picture of a glacier as a single connected machine, from snowfall to meltwater, is complete enough to build on.

The calving deserves its own paragraph, because the tidewater and lake glaciers lose their ice in a way the mountain accountant must book separately. Where a glacier's front floats or stands in deep water, the ice front sheds bergs, entire blocks of the terminus breaking off and floating away, and the calving can remove ice as fast as the flow delivers it, the front's position set by the water depth and the fjord's shape rather than the weather; the tidewater cycle the first chapter introduced follows from this, the front retreating down its fjord's deepening trough until the shallows at the head stabilize it, the slow advance beginning again as the shoal is built. The reader should hold the bookkeeping's distinction, because the crisis chapters depend on it: a calving front's retreat is not always a climate's verdict, and a mountain front's is, the two ledgers kept separately for exactly the reason the retreat chapter's exceptions will show.

A paragraph on the ice shelves, because the floating fringe of the ice sheets is the system's vulnerable edge and the news's recurring item. The ice shelves, the seaward extensions described in the first chapter, hold the land ice back, the grounded ice's flow partly braked by the shelf's buttressing; when a shelf thins or collapses, the glaciers behind accelerate, the mechanism the satellites measured after the Antarctic peninsula collapses. The reader should hold the physics of the vulnerability: the shelves melt from below by the warming seas, the ocean attacking the ice where the air cannot, and the sea's warming is therefore the ice sheets' quiet siege, the shelf line the siege's front, the subject's most-watched boundary on Earth.

Chapter 1: What a Glacier Is

The definition deserves a careful start, because a glacier is not merely ice, and the word's precision matters. A glacier is a body of natural ice, formed from compacted snow, that persists from year to year and moves, flowing under its own weight the way a very slow, very thick fluid would; a frozen lake is not a glacier, a snowfield is not a glacier, and the distinction is the motion, which the movement chapters will show is a property of ice at thickness, not an occasional event. The ice itself is a genuine mineral aggregate, a monomineralic metamorphic rock in the geologist's terms, ordinary water ice kept close to its melting point, and that combination, rock strength at the surface and near-fluidity at depth, is what gives glaciers their strange double character, carving like a chisel while flowing like a syrup.

The world's glacier ice is overwhelmingly stored in the two great ice sheets, the continental glaciers of Antarctica and Greenland, which together hold ninety-nine percent of the planet's glacial ice; the remaining one percent, the mountain glaciers and ice caps scattered through every major range, matters far beyond its volume, as the water chapters will show. The formal threshold between the categories is area: glacial bodies larger than fifty thousand square kilometers are ice sheets; the smaller cousins are ice caps; and the portions of sheets and caps that extend over the sea are ice shelves, floating thin plates fed by the land ice behind them. Tidewater glaciers are those that terminate in the sea, most of Greenland's and Alaska's outlet glaciers among them, and they live a life of their own: their advance-and-retreat cycles run for centuries and respond only weakly to the weather, driven instead by the underwater geometry of their fjords, which is why the sea-level chapters treat their behavior separately from the climate-driven mountain glaciers.

The categories close with the thermal ones, because a glacier's temperature decides much of its behavior. A temperate glacier, the common alpine kind, is at its melting point throughout, wet at the bed and fast; a polar, or cold-based, glacier is frozen to its bed, dry beneath, and slow, the kind that preserves rather than erodes; and the subpolar glaciers carry both temperatures in one body, temperate at depth and polar near the surface, the state that many Arctic and Andean glaciers occupy. This thermal key is worth holding from the start, because the erosion, motion, and hazard chapters all turn on it: the same ice, wet or frozen at its base, is two different geological instruments, and the map of which is where is the first page of any glacier's story.

The firn line's annual march deserves a paragraph, because the glacier keeps its own calendar on its surface. Each winter the snowline, the boundary between old glacier ice and the new seasonal snow, crawls down the glacier;

each summer it climbs back, and the height it reaches at the melt season's peak is the year's signature, visible from the valley and, in the modern era, from every satellite pass. The perched snow that survives a full year has begun the firn transformation, the firn line marking where accumulation is real, and the surveyors read the annual snowline as a proxy for the whole mass balance, a single observable that summarizes the year's climate on one line across the ice. The reader who sees photographs of the same glacier across different summers is watching this book's arithmetic drawn on the mountain, the snowline's rise and fall the glacier's own ledger, kept in a script anyone can learn in an afternoon and read for a lifetime.

The snow-to-ice transformation's time deserves a closing paragraph, because the patience is part of the wonder. In a wet, warm glacier the firn may become ice in a few years of pressure; in the cold high interiors of the ice sheets the transformation takes centuries, the dry snow slowly densifying toward the sealing depth where the bubbles close, and the transformation's pace is the archive's own clock, the ice-core chapter's readings dated by the depth of the firn's end. The reader should file the range, years to centuries for the same chemistry, as one more expression of the thermal key the first chapter introduced: the same snow, in a warm valley or a cold interior, becomes ice on different schedules, and the globe's glaciers are arrayed along that spectrum of patience, from the quick alpine firn to the slow polar deep, all of it the same transformation this chapter has walked.

A closing note on the glacier's color and light, because the subject's beauty is physics and deserves the explanation's completion. The deep blue of the old ice, the bubbles' loss and the depth's selective absorption, is joined by the surface's other optics: the snow's white, the meltwater's turquoise from the rock flour, the blue-grey of the crevasse's shadowed walls lit through its own ice, and the ice caves' glow, the light passing through the arch and arriving blue, the cave a lens of the very absorption this chapter named. The reader standing in an ice cave, or seeing one photographed, is inside the physics, the chapter's explanation surrounding them on every wall, and the glacier's beauty, filed by the trivia chapter as fact, is here filed as understood, the book's habit throughout.

End of free sample. The full book is available at putrabooks.github.io

ABOUT THE AUTHOR

Aira Astralis is a science writer specializing in astronomy and space exploration. Her work spans the full breadth of humanity's relationship with the cosmos -- from the earliest naked-eye observations to the engineering marvels of modern space missions.

Her books are built on a foundation of primary sources: peer-reviewed research, mission archives, and direct engagement with the scientific community. She writes for readers who want to understand not just what we know about the universe, but how we came to know it.

She believes that the most important frontier is not out there but in the gap between what scientists discover and what the public understands. Her books exist to close that gap.