SAMPLE

Earth's Dynamic Systems: Weather

How the Sky Works

Aira Astralis

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

Introduction

Weather is the planet's conversation with the Sun, and everyone has overheard it. The Sun heats the tropics more than the poles, the ocean more slowly than the land, the day side more than the night; the atmosphere, restlessly trying to even out the difference, moves, and the moving is the weather. Every breeze, every cloud, every storm front, every snowfall is part of one global business, the transport of heat from where the Sun gives it to where the darkness takes it away, conducted by air and water in a thousand local dialects, and the dialect you live under, humid or dry, windy or calm, stormy or settled, is your weather, the single most discussed natural phenomenon on Earth and the oldest subject of human conversation after food and each other.

This book is a field guide to that conversation, written for the general reader with no mathematics in it. The first chapters set the stage: what the atmosphere is made of and how it is layered, how the Sun's uneven heating builds the pressure differences that drive the winds, and how the rotation of the planet bends every current into the swirling patterns that make weather interesting rather than simple. The middle chapters follow the water: humidity, clouds, fog, rain, snow, and the great convective engines of thunderstorms and hail. Later chapters take up the storms of the tropics, the craft of forecasting from the first weather maps to the modern computer models, the extremes of heat, drought, flood, and whirlwind, and the question every reader now brings to the subject, how a changing climate is changing the weather's habits.

One distinction should be planted now, because the whole book depends on it: weather is not climate. Climate is the long average, the statistics of a place over decades; weather is today's draw from that deck, an individual event the climate conditions but never fully determines. The two are separate subjects, they obey different questions, and the failure to keep them apart, in casual talk as in headlines, is the source of most public confusion about both; the chapters that follow will keep the distinction honest, and use it, in the end, to say precisely what a warming world does and does not do to the weather outside the reader's window.

How the account unfolds. The opening chapters build the machine: the ocean of air, the sun's uneven heating, the great circulations, the fronts and traveling lows of the middle latitudes. The middle chapters follow the water through its whole career, vapor to cloud to rain, and then the storms, thunder and whirlwind and the tropical cyclone, the machine's concentrated masterpieces. The craft of forecasting receives its own chapter, from telegraph wires to

ensemble probability, the extremes get theirs, and the account closes with the question of the century, what a changing climate does to the weather's odds.

Each chapter stands alone well enough for the reader who dips, but the whole is one argument, and the chapters are ordered so the argument accumulates: sun, spin, water, storm, and at last the forecast, the species' reply. The subject rewards the whole reading twice, once for the machine and once for the craft, because the two are the weather's twin identities, a piece of physics the age has learned to compute and a daily companion the reader will keep consulting long after the last page.

Chapter 1: The Ocean of Air

The atmosphere is thin, and the fact deserves the opening page. The planet is nearly thirteen thousand kilometers across; the weather, nearly all of it, lives in the bottom dozen kilometers, a gossamer wrapping that would be thinner, on a classroom globe, than a coat of varnish, and half of the atmosphere's entire mass lies below the summit of the highest mountain. There is weather above that, storms of the high stratosphere and weather of the ion's domain, but the weather of experience, cloud and rain and wind, belongs to the lowest layer, the troposphere, a shallow ocean of gas hugging the ground, heated from below by a sun-warmed surface, cooled from above by the radiation of space, and therefore, permanently and by design, restless.

The gas itself is a recipe worth memorizing, because everything in the book follows from it. Dry air is four-fifths nitrogen and one-fifth oxygen, a rounding of argon, and a small, crucial fraction of carbon dioxide; the variable ingredient, the one that does the interesting work, is water vapor, present in amounts from almost nothing in polar winter to a few percent of the air in a steamy equatorial afternoon. Water is the atmosphere's working fluid: it carries heat invisibly as vapor, releases that heat when it condenses, becomes the droplets and crystals of every cloud, and falls as every rain, and the whole difference between a desert and a rainforest, meteorologically, is how much of this one ingredient the local air is licensed to hold. The carbon dioxide and water vapor together also make the air a blanket, transparent to incoming sunlight but partial to outgoing heat, the greenhouse whose arithmetic sets the planet's baseline temperature, the stage on which all weather plays.

The atmosphere is layered, and the layering explains the weather's ceiling. In the troposphere, warmed from below, air rises easily, and the layer mixes and churns; above it, at the tropopause, the air grows warmer with height again, and the warmer-over- colder arrangement is a lid, quiet, stable, the stratosphere, where nothing convects and aircraft ride smooth above the storms below. The lid's height varies with latitude, lower at the poles and nearly twice as high over the tropics, and the storms of the tropics know it: the giant thunderstorms of the equatorial belt flatten against it like smoke against a ceiling, spreading into the anvil shapes the whole world recognizes, and the jet streams, the fastest winds on the planet, form along its slopes, the subject of a later chapter.

And the ocean of air is pressurized, in a way the reader has felt without naming. The bottom of the atmosphere bears the weight of all the air above it, a pressure of about a kilogram per square centimeter at sea level, declining with altitude to nothing at the top; weather, in its purest definition, is the

pattern of that pressure's ups and downs, because air flows from high pressure to low, and the pressure differences that drive it come from the temperatures that made them. The barometer, the instrument that measures this weight, is thus the weather's fundamental sensor: a falling barometer means air is leaving, usually for a storm's approach; a rising one means air is arriving, usually with clearing skies; and the weather map, the great invention of the nineteenth century, is at bottom a drawing of where the pressure is high and where it is low, the book's whole subject reduced to contour lines on a page.

The sky's own color and light deserve a closing paragraph, because they are weather's daily gift and its physics is gentle. The blue of a clean sky is scattered sunlight, the air's molecules throwing the short wavelengths in all directions while the long pass straight through, which is why the sky is bluest where the view is darkest and why the whole dome pales toward the horizon, where the light crosses more air to reach the eye; the red of sunrise and sunset is the same arithmetic with the sun low and the path long, the blue spent en route and the survivors crimson; and the halo round the moon, the corona of glory round the mountain shadow, the green flash of the rare clean sunset, and the crepuscular rays that column the broken cloud are all the same business, light and air negotiating.

The reader who knows the sky's colors as physics carries a weather instrument in every glance, and the oldest forecasters' signs, the red sky of a dry west at morning, are signposts the atmosphere has always been willing to give.

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.