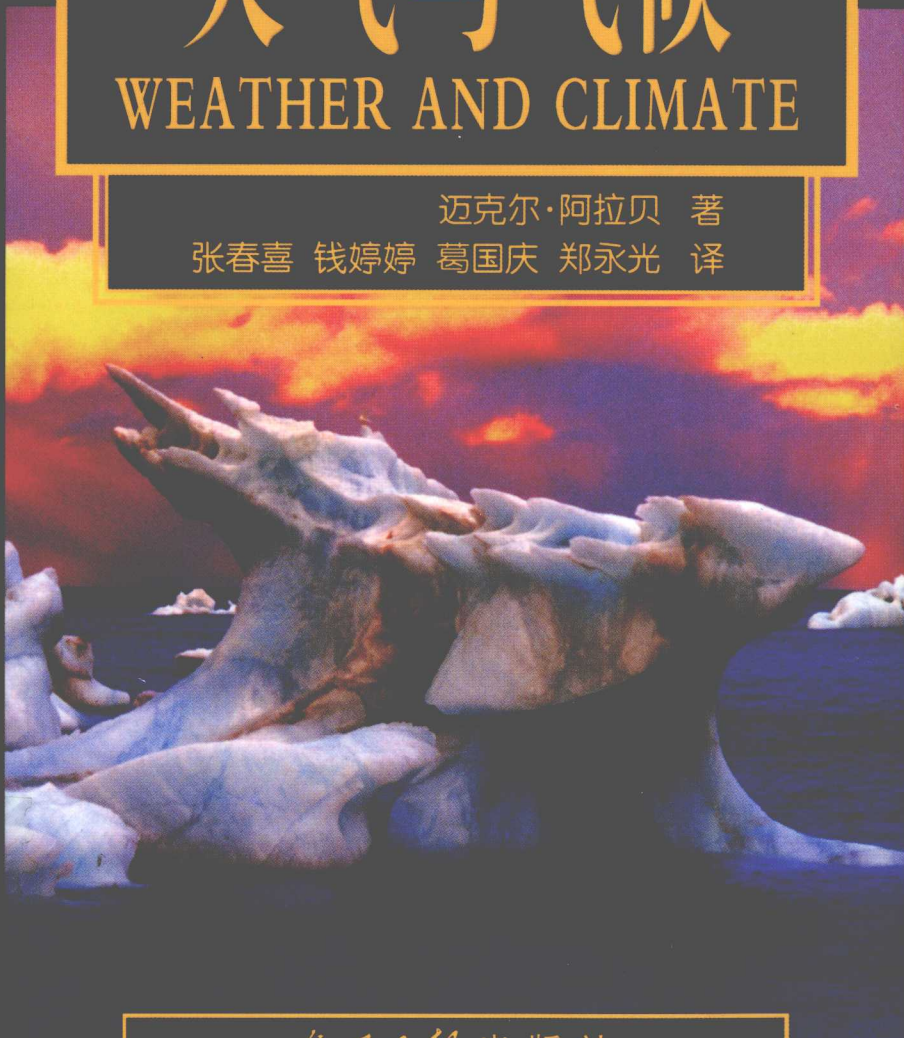


科学分类手册
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天气与气候

WEATHER AND CLIMATE

迈克尔·阿拉贝 著
张春喜 钱婷婷 葛国庆 郑永光 译



光明日报出版社



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(美)迈克尔·阿拉贝 著
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言景計現

THE FACTS ON FILE

WEATHER

AND

CLIMATE

HANDBOOK

MICHAEL ALLABY



Facts On File, Inc.

原书导言

大家都对天气感兴趣：我们想知道出门是否要添加衣服，打算去海滩时是否有一个好天气，或者周六的比赛是否会因为下雨而取消。更为严重的是，我们必须为灾害性天气做准备：如果有飓风正在逼近，如果附近有强风暴，它可能引发龙卷或山洪暴发，或者如果有突发的寒潮可能会带来大风雪或冰雹，这时，我们都需要提前的预报。对于那些在户外工作的人们，可靠的预报可以挽救生命。

现在，我们还有其它的理由来关注大气中发生的现象。很多科学家担心释放出的二氧化碳和其它气体可能会改变大气的化学组成，从而在将来影响全球的气候。

关于气候变化的讨论已开始转变为对大气过程的科学认识。同样，大气的过程也导致了每天的天气变化。天气预报这一晚间电视的主角，是成千上万的地面观测、卫星资料和用世界上最快、最高效的计算机执行数学计算制作出来的。虽然，电视天气预报通常不难理解，有时候，他们使用的词汇听起来也很熟悉，但实际上这些词汇都是具有精确含义的专业术语。如“锋”、“高”、“低”、“风寒”甚至“阵雨”等这些术语都涉及到复杂的概念。理解这些术语的科学含义有助于理解电视播报员所描述的天气形势的预报。同样，科学家在解释气候变化的概念时也会用到很多专业术语。如果不知道这些术语的意思，就不能真正理解科学家的观点。不懂得天气与气候的基本概念，我们就无法判断一个人的意见是否比其他人的更有分量。

大气总是处在不停地运动中和不断地变化中。正是它不停地运动造成了各种各样天气现象的发生，而特定地方年复一年发生的主要天气类型就形成了该地区的气候。关于天气的科学研究称为气象学；针对世界上过去、现在和将来的气候的科学研究称之为气候学。两者紧密相连——气候学家必须学习气象学——但两者又是有区别的。

由美国 Facts On File 出版社出版的《科学分类手册》系列涵盖了如下学科：天气与气候、几何、微积分、代数、化学、物理、生物、地球科学、海洋科学、空间与天文学。《科学分类手册·天气与气候》把大量的信息压缩成精致的内容，

简洁、全面又易于理解。本书包含 4 个主要部分：术语、人物介绍、大事记、图和表，最后附有便捷的索引，方便学生和教师快速查证。

■术语表：术语的作用首先是理解专业词汇的含义。它是十分必要的，也是本书中最重要的部分，本书共包含 2200 多个术语。每个术语的内容凝练而简洁，许多条目还附有简图，以帮助澄清术语的含义。

■人物介绍：像所有的科学家一样，天气与气候的大气科学家是在几个世纪中发展壮大起来的，他们有着伟大的贡献，如亚里士多德、伽利略和本杰明·富兰克林等都是卓有功绩的科学巨匠，但还有许多对科学作出重要贡献的科学家却默默无闻。本书介绍了 100 多位科学家，他们的研究和发现都曾推动世界对天气与气候的理解。

■大事记：大气的研究开始于 2000 多年以前。英文单词“meteorology”（气象学）源自于亚里士多德大约于公元前 340 年所著的《气象学》（Meteorologica）一书。“大事记”包含了有关大气科学的重大发现和最重要事件：从亚里士多德的《气象学》（Meteorologica）一书开始，直至今日。

■图和表：有价值的科学内容通常可以用图和表加以归纳，以支持学生和教师对本书内容的理解，本书包含 20 多个实用资料的表格。其中包括风力等级、飓风等级以及龙卷等级；雪崩和雹暴强度表；不同地球表面的反照率；雪线随纬度的变化等等。此外还包括世界各地飓风的名称以及报告当前天气状况的气象电码。

本书把天气与气候置于科学的大背景之下，突出了所有学科间的紧密联系，更相比较、融会各学科领域中的信息。

SECTION ONE

GLOSSARY

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第一章 术语

absolute humidity The mass of water vapour present in a given volume of air, usually expressed in grams per cubic meter, but taking no account of changes in humidity caused by variations in the volume of air due to changes in temperature and pressure.

absolute instability The condition in which the environmental lapse rate (E.L.R.) is greater than the DALR, but because this is a slower rate of cooling than the E.L.R. always becomes less than the surrounding air. If the air contains vapour, it rises to a height at which this starts to condense, clouds form, and the rate of ascent heat of condensation will warm the air, reducing the lapse rate from the DALR to the saturated adiabatic lapse rate (S.A.L.R.). The difference between the E.L.R. and the S.A.L.R. is greater than that between the E.L.R. and DALR, so the instability of the air will increase.

absolute momentum The sum of the momentum of a particle in relation to the surface of the Earth and its momentum due to the rotation of the Earth.

absolute stability The condition of air when the environmental lapse rate (E.L.R.) is less than the saturated adiabatic lapse rate (S.A.L.R.). In a parcel of air is made to rise, it will cool at the dry-adiabatic lapse rate (DALR). This is higher than the S.A.L.R. and therefore also higher than the E.L.R. The rising air will quickly reach a level at which it is cooler than the surrounding air and so it will sink once more. It is forced to rise high enough for the S.A.L.R. to start to condense, the condensation will release latent heat, warming the air and thereby making it warmer than the E.L.R. The S.A.L.R. is still greater than the E.L.R., so sinking air will always be warmer than the air around it and will sink.

absolute temperature The temperature measured on the Kelvin scale. It is a method with the 0 K, which is negative 273.15 °C, as 0 K, and the temperature at which it boils (273.15 °C) as 273.15 K.

absolute vorticity The vorticity about a vector that is parallel to the direction of motion. It is the sum of the planetary vorticity (ω) and relative vorticity (ζ) and is possessed when a moving is relative to the surface of the Earth. It is

ablation The removal of ice and snow from the ground surface by melting and also by the process of sublimation.

absolute drought In Britain, a period of 15 consecutive days during which no rain falls.

absolute humidity The mass of water vapor present in a given volume of air, usually expressed in grams per cubic meter, but taking no account of changes in humidity caused by variations in the volume of air due to changes in temperature and pressure.

absolute instability The condition of air when the environmental lapse rate (ELR) is greater than the dry adiabatic lapse rate (DALR). As it rises, a parcel of air cools at the DALR, but because this is a slower rate of cooling than the ELR it will always be warmer than the surrounding air. If the air contains water vapor, it may reach a height at which this starts to condense to form clouds. The release of latent heat of condensation will warm the air, reducing the lapse rate from the DALR to the saturated adiabatic lapse rate (SALR). The difference between the ELR and the SALR is greater than that between the ELR and DALR, so the instability of the air will increase.

absolute momentum The sum of the momentum of a particle in relation to the surface of the Earth and its momentum due to the rotation of the Earth.

absolute stability The condition of air when the environmental lapse rate (ELR) is lower than the saturated adiabatic lapse rate (SALR). If a parcel of air is made to rise, it will cool at the dry adiabatic lapse rate (DALR). This is higher than the SALR and therefore also higher than the ELR. The rising air will quickly reach a level at which it is cooler than the surrounding air and so it will sink once more. If it is forced to rise high enough for its water vapor to start to condense, the condensation will release latent heat, warming the air and altering its lapse rate from the DALR to the SALR. The SALR is still greater than the ELR, so the rising air will always be cooler than the air around it and will sink.

absolute temperature The temperature measured on the Kelvin scale. It is reported in kelvins (K), without a degree sign (i.e., as 300K, not 300°K). The absolute temperature at which water freezes (32°F) is 273.16K and the temperature at which it boils (212°F) is 373.16K.

absolute vorticity The vorticity about a vertical axis that a mass of fluid possesses when it moves in relation to the surface of the Earth. It is the sum of the planetary vorticity (f) and relative vorticity (ζ) and in

冰雪消融 通过融化或者升华过程失去地表的冰雪。

绝对干旱 指英国连续超过 15 天没有降水。

绝对湿度 给定体积空气中的水汽质量,通常用克/立方米(g/m^3),它与温度与气压变化导致的湿度改变无关。

绝对不稳定 环境递减率(ELR)大于干绝热递减率(DALR)时大气的状况。当气块上升时,气温度以干绝热递减率下降,但是由于其降温速率较之环境递减率慢,所以它总是比环境大气暖。如果大气含有水汽,则到达一定的高度就会凝结成云。凝结的潜热释放会加热大气,将干绝热递减率降低为湿绝热递减率(SALR)。环境递减率(ELR)和湿绝热递减率(SALR)之间的差值比环境递减率(ELR)和干绝热递减率(DALR)之间的大,因此大气的不稳定性增加。

绝对动量 质点相对于地球的动量及与地球旋转相联系的动量之和。

绝对稳定 环境递减率(ELR)小于湿绝热递减率(SALR)时大气的状况。气块上升时,它以干绝热递减率(DALR)降温。而干绝热递减率(DALR)比湿绝热递减率(SALR)大,因此也比环境递减率(ELR)大。上升的空气块很快比环境大气冷,因此要转为下沉。如果他抬升到足够的高度使得水汽开始凝结,凝结将释放潜热,加热空气块并将递减率由干绝热递减率(DALR)变为湿绝热递减率(SALR)。湿绝热递减率(SALR)仍比环境递减率(ELR)大,所以上升的空气块仍比环境大气冷,因而也将下沉。

绝对温度 使用凯尔文温标的温度。它的单位为凯尔文(K),并不带有度的符号(即,例如 300K 而不应表示为 300°K)。冰点(华氏 32°F)的绝对温度为 273.16K,水的沸点的温度(华氏 212°F)为 373.16K。

绝对涡度 流体相对于地球表面运动时所具有的以垂直方向为轴的涡度。它是行星涡度(f)与相对涡度(ζ)之和,在没有摩擦的情况下,

the absence of friction it remains constant, owing to the conservation of angular momentum.

absolute zero The temperature at which the kinetic energy of atoms and molecules is at a minimum. It is 0 on the Kelvin scale and equal to -459.67°F (-273.15°C). It is the lowest temperature possible (and unattainable according to the third law of thermodynamics).

absorption (1) A process by which one substance (the absorbent) takes up and retains another (the absorbate) to form a liquid or gaseous solution. (2) The transfer of energy from electromagnetic radiation to atoms or molecules that it strikes.

acceleration A rate of change of speed or velocity, measured in units of distance multiplied by the square of a unit time, such as feet per second per second (ft s^{-2}) or meters per second per second (m s^{-2}). If a body is moving in a straight line, and accelerating at a constant rate from a speed u to a speed v , its acceleration (a) is given by: $a = (v - u)/t$, where t is the time taken, and $a = (v^2 - u^2)/2s$, where s is the distance covered.

accessory cloud A small cloud that is seen in association with a much larger cloud belonging to one of the cloud genera. The most common accessory clouds are pileus, tuba, and velum.

acclimatization An adaptive, physiological response that allows an animal to tolerate a change in the climate of the area in which it lives.

accretion The process by which an ice crystal grows as it falls through a cloud containing many small, supercooled water droplets. If the water droplets are very supercooled, they freeze immediately on contact with the ice crystal. New crystals are added one on top of another, with air trapped between them. If the water droplets are only slightly supercooled, they may not freeze instantaneously. Instead they form a layer of liquid water that surrounds the ice crystal before freezing as clear ice.

accumulated temperature The sum of the amount by which the air temperature is above or below a particular datum level over an extended period. If, on a particular day, the mean temperature is m degrees above (or below, in which case it has a negative value) the datum level and it remains so for n hours ($= n/24$ days), the accumulated temperature for that day is $mn/24$ degree days. Adding the accumulated temperatures for each day yields the accumulated temperature for a week, month, season, or year.

accumulation The extent by which the thickness of a layer of snow or ice increases over time. It represents the amount of material added, minus the amount lost during the same period through ablation.

由于角动量守恒,绝对涡度保持常数不变。

绝对零度 原子与分子动能极小时的温度。在凯尔文温标中,它为 0,相当于 -459.67°F (-273.15°C)。它是可能的最低温度(但是根据热力学第三定律,这是一个不可能达到的温度)。

吸收 (1)一种物质(吸收剂)容纳保留另一种物质(被吸收体)从而形成液体或气体溶剂的过程。(2)电磁辐射的能量向被其碰到的原子或分子传输。

加速度 速度的变化率,用单位长度和单位时间的平方来度量,如英尺每秒平方(ft s^{-2})或者米每秒平方(m s^{-2})。设物体沿直线运动,速度由 u 以不变速率加速到 v ,则加速度(a)为: $a=(v-u)/t$,其中 t 是所需时间,又 $a=(v^2-u^2)/2s$,其中 s 为物体移动的距离。

附属云 属于某一云系的大块云所连带的小块云。最常见的附属云有蘑菇云、喇叭云和帆状云。

气候适应性 一种动物随其生活区域气候变化的适应性生理学反应。

结冰 当冰晶下落经过含有很多过冷小水滴云层时的冰晶增长过程。如果小水滴异常过冷,它们一接触到冰晶就迅速冻结。新的晶体就会附加于另一个之上,两者之间有空气被截留在中间。如果小水滴只是轻微过冷,它们也许不会马上冻结。而是形成一液态水层,在冻结成冰之前包围着冰晶。

积温 某一时期内大于或小于某一特定资料标准的气温总和。在某一天如果平均的温度超过资料标准为 m 度(或者低于,这样就是负值),并且持续了 n 个小时(即 $n/24$ 天),那么这一天的积温就是 $mn/24$ 度天。把每天的积温相加就是周、月、季、年积温。

累积雪(冰)厚 某一时段内雪或者冰层增长的厚度程度。它相当于这段时间内增加的冰雪量减去因消融作用损失的量。

acicular ice (fibrous ice, satin ice) Ice in the form of long, pointed crystals and hollow tubes, with air in the tubes and between the crystals.

acid deposition The placing, onto surfaces, of airborne substances that are more acid than naturally occurring, clean rain; usually as a consequence of pollution from industrial or vehicle emissions. This can occur as dry deposition, acid rain, acid mist, acid snow, or acid soot.

acidity A measure of the extent to which a substance releases hydrogen ions when dissolved in water, or the extent to which a substance acts as receptor for a pair of electrons from a base. Acidity is measured on a scale of 0–14 and is equal to $-\log_{10} c$, where c is the concentration of hydrogen ions in moles per liter. The scale measures the “potential of hydrogen,” abbreviated to pH. A neutral (neither acid nor alkaline) solution has a hydrogen-ion concentration of $10^{-7} \text{ mol l}^{-1}$, so it has a pH of 7. A pH lower than 7 indicates an acid solution and one higher than 7 an alkaline solution. The scale is logarithmic, so a difference of one whole number in pH values indicates a tenfold difference in acidity.

acid rain Rain that is more acidic than normal as a result of contamination by pollutants. “Acid rain” is often used as a blanket term to describe all forms of acid deposition. Ordinary, unpolluted rain has a pH of about 5.6. Acid rain has a pH value of less than 5.0.

acid soot (acid smut) Particles of soot bound together by water that has been acidified. Acid soot tends to cling to solid surfaces and is corrosive. It is a by-product of the inefficient burning of oil or coal with a high sulfur content.

actiniform An adjective describing a cloud pattern in which lines of clouds radiate from a central point or branch from one another, like the branches of a tree.

active front A weather front that is associated with appreciable amounts of cloud and precipitation.

active glacier A glacier in which the ice is flowing.

active instrument An instrument that sends out a signal that is then reflected back to it.

active layer The soil above a layer of permafrost that thaws during the summer and freezes again in winter.

actual elevation The vertical distance a weather station lies above sea level.

针状冰(纤维状冰,缎状冰) 长尖角晶体与中空管状样式的冰,在管子与晶体之间存有空气。

酸性沉降 大气中从空中降落到地面的酸性物质,其酸度大于自然发生的干净的雨滴,它通常是由工业或车辆排气造成的污染所产生。其发生形式如干沉降、酸雨、酸雾、酸雪或酸烟等。

酸度 是对溶于水中的物质释放出氢离子多少,或从碱基获得一对电子能力的一种度量。酸度划分为0-14个等级且等于 $-\log_{10}c$,其中 c 为氢离子的每升摩尔浓度。等级划分是对“氢离子活度”的计量,简写为pH。中性(既非酸性也非碱性)溶液具有 10^{-7}mol l^{-1} 氢离子浓度,所以它的pH值为7。pH值小于7为酸性溶液,大于7为碱性溶液。由于等级是对数划分的,因此pH值相差1,酸度相差十倍。

酸雨 由于污染造成的比自然降水的酸性更强的雨。“酸雨”常作为一般术语来描述所有形式的酸性沉积物。通常情况下,未受污染的雨的pH值大约为5.6。酸雨的pH值小于5.0。

酸性烟尘(酸性煤尘) 与酸化的水结合在一起的烟灰粒子。酸性烟尘易附于固体表面并具有腐蚀性。它是含硫量较高的石油或煤不充分燃烧的副产品。

放射状的云 云线由中心点向外辐射或象树枝一样接连出现分支的云型的形象。

活跃锋 有大量云和降水的锋面天气系统。

活冰川 冰具有流动性的冰川。

主动式仪器 具有发射信号和接收返回信号的仪器。

活性层 在永久冻结带之上的一层土壤,它在夏天融化,在冬天冻结。

实际高度 一个气象测站高于海平面的垂直距离。

actual evapotranspiration (AE) The amount of water that is lost from the ground surface each month by the combined effects of evaporation and transpiration.

actual pressure The pressure measured by a barometer after it has been corrected for temperature, latitude, and any instrumental error, but before it has been reduced to the mean sea-level pressure.

adfreezing The sticking together of two objects when a layer of water freezes between them.

adiabat The rate at which a parcel of air cools as it rises and warms as it descends.

adiabatic An adjective describing a change of temperature that involves no addition or subtraction of heat from an external source.

adiabatic atmosphere A theoretical atmosphere in which the temperature decreases at the dry adiabatic lapse rate (DALR) throughout the whole of its vertical extent.

adret Sloping ground that faces in the direction of the equator and therefore is sunny.

adsorption The chemical or physical bonding of molecules of a substance (the adsorbate) to the surface of a solid object or, less commonly, of a liquid (the adsorbent), where the molecules form a layer.

advanced very high resolution radiometer (AVHRR) An instrument carried by weather satellites that senses cloud and surface temperatures. It stores its data on magnetic tape and transmits it on command to surface receiving stations. It also transmits both low- and high-resolution images in real time.

advection The transport of heat due to the movement, usually horizontal, of air or water.

advective inversion A temperature inversion that is produced when cold air moves across a warm surface, undercutting air that had previously been warmed by contact with the surface, so that the warm air then lies above the cold air.

advection fog Fog that forms when warm, moist air is carried horizontally across a cold surface by a wind blowing at about 6–20 mph (10–32 kmh⁻¹).

advective thunderstorm A thunderstorm that is triggered by the advection of warm air across a cold surface, or of cold air above a layer of warmer air at a high level. Warm air is cooled when it crosses a cold surface,