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CUET · GEOGRAPHY · CLASS XI · CODE 313

World Climate and Climate Change

CUET unit: World Climate and Climate Change

By **UniDrill** · NCERT-grounded study material

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📌 Snapshot

- There are three approaches to climate classification — empirical, genetic, and applied — with **V. Koeppen's empirical scheme (1918)** as the most widely used framework, built on observed temperature and precipitation data.
- The **five major climatic groups (A–E)** and their letter-coded subdivisions each link to specific temperature/precipitation thresholds — a favourite area for NTA direct-recall and match-type questions.
- Climate change has geological, historical and recent evidence of variability — the bridge between physical geography and contemporary environmental concerns.
- Greenhouse gases, the greenhouse effect, global warming, the ozone hole and the **Kyoto Protocol (1997 / in force 2005 / 35 industrialised countries)** are high-frequency CUET pegs.
- CUET tests both definitional accuracy (letter codes, °C thresholds) and cause-effect reasoning (sunspots, Millankovitch cycles, GHGs → global warming).

📖 Detailed Notes

2.1 Core concepts

- **Three approaches to climate classification: Empirical** (based on observed data, particularly temperature and precipitation), **Genetic** (organises climates according to their causes), and **Applied** (for a specific purpose). Koeppen's scheme is empirical (NCERT §Koeppen's Scheme, p. 91).
- **Koeppen's scheme** is "the most widely used classification of climate" — V. Koeppen identified a close relationship between vegetation distribution and climate, selected certain values of temperature and precipitation, and used these to delineate groups; he introduced the use of **capital letters** (for groups/major sub-divisions) and **small letters** (for type-level seasonality and temperature severity). Developed in **1918** and modified since (NCERT p. 91).
- **Koeppen's five climatic groups (Table 11.1, p. 91):**
- **A — Tropical:** Average temperature of the **coldest month is 18° C or higher**.
- **B — Dry Climates:** Potential evaporation exceeds precipitation.

- **C — Warm Temperate (Mid-latitude):** Average temperature of the coldest month is **higher than −3° C but below 18° C**.
- **D — Cold Snow Forest Climates:** Average temperature of the coldest month is **−3° C or below**.
- **E — Cold (Polar) Climates:** Average temperature for **all months is below 10° C**.
- Capital letters **A, C, D and E delineate humid climates**; **B is dry**.
- **Small-letter subdivisions** (for seasonality of precipitation): **f** = no dry season; **m** = monsoon (short dry season); **w** = winter dry season; **s** = summer dry season. The small letters **a, b, c, d** refer to the degree of severity of temperature. For **B climates**, capital **S** = steppe/semi-arid; **W** = desert/arid (NCERT p. 92).
- **Climatic types (Table 11.2, p. 92):** Af (Tropical wet — no dry season), Am (Tropical monsoon — short dry season), Aw (Tropical wet and dry — winter dry), BSh (Subtropical steppe — low-latitude semi-arid), BWh (Subtropical desert — low-latitude arid), BSk (Mid-latitude steppe — semi-arid), BWk (Mid-latitude desert — arid), Cfa (Humid subtropical — no dry season, warm summer), Cs (Mediterranean — dry hot summer), Cfb (Marine west coast — no dry season, warm and cool summer), Df (Humid continental — no dry season, severe winter), Dw (Subarctic — winter dry and very severe), ET (Tundra — no true summer), EF (Polar ice cap — perennial ice).
- **Group A — Tropical Humid Climates:** Exist between the Tropic of Cancer and the Tropic of Capricorn; sun overhead throughout the year; presence of the **ITCZ** keeps them hot and humid; annual range of temperature is very low and annual rainfall high. Three types:
- **Af — Tropical Wet:** Near the equator — Amazon Basin, western equatorial Africa, East Indies islands; significant rainfall every month as thunder showers in the afternoon; uniformly high temperature; daily max ~30°C, min ~20°C; **tropical evergreen forests** with dense canopy and large biodiversity (NCERT p. 92).
- **Am — Tropical Monsoon:** Indian subcontinent, NE South America, Northern Australia; heavy rainfall in summer; dry winter.
- **Aw — Tropical Wet and Dry:** North and south of the Amazon forest in Brazil and parts of Bolivia/Paraguay, Sudan and central Africa; annual rainfall less than Af/Am and variable; wet season shorter, dry season longer; **deciduous forest and tree-shredded grasslands** (NCERT p. 93).
- **Group B — Dry Climates:** Very low rainfall not adequate for plant growth; cover a very large area extending from **15° -60° N and S of the equator**. At low latitudes (15°–30°) they occur under subtropical highs where subsidence and inversion prevent rainfall; on the western margins of continents (adjoining cold currents) they extend equatorwards (e.g., west coast of South America); in mid-latitudes (35°–60°) they sit in continental interiors beyond the reach of maritime-humid winds, often ringed by mountains. Divided into **steppe (BS)** and **desert (BW)** types and further into **subtropical (BSh, BWh) 15° -35°** and **mid-latitude (BSk, BWk) 35° -60°** (NCERT p. 93).

- **Subtropical Steppe (BSh) and Subtropical Desert (BWh):** Located in the transition zone between humid and dry climates; steppe receives slightly more rainfall (enough for sparse grassland); both have highly variable rainfall — variability hits the steppe harder and causes famine; rain in deserts falls as short intense thundershowers and is ineffective for soil moisture; **fog is common in coastal deserts bordering cold currents**; the highest shade temperature ever recorded — **58° C at Al Aziziyah, Libya on 13 September 1922** — comes from this group.
- **Group C — Warm Temperate (Mid-Latitude) Climates:** Extend from **30° -50°** of latitude mainly on the eastern and western margins of continents; warm summers with mild winters; four types:
- **Cwa — Humid Subtropical (winter dry, hot summer):** poleward of Tropics of Cancer/Capricorn, **mainly in N Indian plains and S China interior plains**; similar to Aw but warm winter.
- **Cs — Mediterranean:** west coast in subtropical latitudes 30°–40° — Central California, Central Chile, SE and SW Australia; under subtropical high in summer and westerlies in winter; **hot dry summer and mild rainy winter**; summer monthly average ~25°C, winter <10°C; annual precipitation **35–90 cm**.
- **Cfa — Humid Subtropical (no dry season):** eastern parts of continents in subtropical latitudes — eastern USA, S and E China, southern Japan, NE Argentina, coastal S Africa, eastern Australia; thunderstorms in summer and frontal precipitation in winter; summer mean ~27°C, winter 5°–12°C; annual precipitation **75–150 cm**.
- **Cfb — Marine West Coast:** poleward of the Mediterranean climate — NW Europe, west coast N America (north of California), southern Chile, SE Australia, NZ; marine influence makes temperatures moderate; summer 15°–20°C, winter 4°–10°C; precipitation throughout the year, varying greatly **50–250 cm** (NCERT pp. 93–94).
- **Group D — Cold Snow Forest Climates:** Large continental areas of the northern hemisphere between **40° -70° N latitude** in Europe, Asia and North America; severity of winter rises with latitude.
- **Df — Cold humid winter:** poleward of marine west coast and mid-latitude steppe; winters cold and snowy; frost-free season short; large annual range; abrupt weather changes.
- **Dw — Cold dry winter (Subarctic):** mainly **NE Asia**; pronounced winter anticyclone whose summer weakening produces a monsoon-like reversal of wind; winter temperatures extremely low — many locations below freezing for **up to seven months**; precipitation in summer; annual precipitation **12–15 cm** (NCERT p. 94).
- **Group E — Polar Climates:** Exist **poleward beyond 70° latitude**; two types:
- **ET — Tundra:** named after the low-growing **mosses, lichens and flowering plants**; region of **permafrost** (permanently frozen sub-soil); short growing season and water-logging support only low-growing plants; very long summer daylight.

- **EF — Ice Cap:** interior **Greenland and Antarctica**; temperature below freezing even in summer; very little precipitation; accumulated ice deforms and breaks under mounting pressure, forming **icebergs** that float in Arctic/Antarctic waters; **Plateau Station, Antarctica, 79° S** portrays this climate.
- **Climate Change — long-run perspective:** The current climate has prevailed for the last **~10,000 years** (the present inter-glacial); geological records show alternation of glacial and inter-glacial periods; geomorphological features at high altitudes/latitudes show glacier advances and retreats; **sediment deposits in glacial lakes** reveal warm/cold periods; **tree rings** provide clues about wet/dry periods; historical records describe vagaries in climate; change in climate is a "natural and continuous process" (NCERT §Climate Change, p. 95).
- **India in the geological past:** Rajasthan desert experienced wet and cool climate around **8,000 BC**; the period **3,000–1,700 BC** had higher rainfall and **2,000–1,700 BC was the centre of the Harappan civilisation**; dry conditions accentuated since (NCERT p. 95).
- **Geological deep time:** the earth was warm 500–300 million years ago through the Cambrian, Ordovician and Silurian periods; during the Pleistocene epoch glacial and inter-glacial periods occurred; the **last major peak glacial period was about 18,000 years ago**; the present inter-glacial began **10,000 years ago**.
- **Climate in the recent past:** The 1990s recorded the warmest temperatures of the century and some of the worst floods; the **1967–77 Sahel drought** south of the Sahara; the **1930s "dust bowl"** in the southwestern Great Plains of the USA. Europe witnessed warm/wet/cold/dry episodes — warm-dry conditions in the 10th–11th centuries when Vikings settled in Greenland; **"Little Ice Age" in Europe from 1550 to about 1850**. From **1885–1940** world temperature showed an upward trend; after 1940 the rate slowed (NCERT pp. 95, 97).
- **Causes of Climate Change — Astronomical:** (i) **Sunspots** — dark, cooler patches on the sun that increase/decrease in a cyclical manner; some meteorologists hold that more sunspots produce **cooler and wetter weather with greater storminess**, while fewer sunspots produce warm and drier conditions — though these findings are "not statistically significant". (ii) **Millankovitch oscillations** — cycles in variations in Earth's orbital characteristics around the sun, the wobbling of the earth, and changes in Earth's axial tilt; all alter the amount of insolation received (NCERT pp. 95–96).
- **Causes of Climate Change — Terrestrial:** (i) **Volcanism** — eruptions throw aerosols into the atmosphere; aerosols remain for a long period and reduce solar radiation reaching the surface; **Pinatoba and El Cion** eruptions caused average temperature to fall for some years. (ii) **Anthropogenic** — the most important effect is the increasing concentration of greenhouse gases (NCERT p. 96).
- **Greenhouse Effect:** The atmosphere transmits incoming short-wave solar radiation but absorbs most of the long-wave radiation emitted upwards by the Earth's surface; gases that absorb long-wave radiation are called GHGs; the warming

processes are collectively the **greenhouse effect**. Analogy: a greenhouse made of glass is transparent to incoming short-wave but opaque to outgoing long-wave radiation; everyday examples are a closed car in summer or a closed vehicle in winter (NCERT box, p. 96).

- **Greenhouse Gases (GHGs):** The primary GHGs of concern today are **CO_2, CFCs, CH_4, N_2O and O_3**; other gases — **NO and CO** — react with GHGs and affect their concentration. Effectiveness depends on concentration, atmospheric life-time and the wavelength absorbed; **CFCs are highly effective**; **ozone absorbs UV in the stratosphere but absorbs terrestrial radiation in the lower troposphere**. **CO_2** has the largest concentration; from fossil fuel combustion (oil, gas, coal); forests and oceans are CO_2 sinks; deforestation also raises concentration; CO_2 adjusts to source-sink changes over 20–50 years and is rising at **~0.5% annually**; doubling of CO_2 over pre-industrial level is used as an index for estimating climate change in climatic models (NCERT pp. 96).
- **Ozone Hole:** Ozone occurs in the stratosphere where UV rays convert oxygen into ozone; CFCs (products of human activity) drift into the stratosphere and destroy ozone; **large depletion occurs over Antarctica** — the **ozone hole** — allowing UV rays to pass through the troposphere (NCERT p. 96).
- **Kyoto Protocol: Proclaimed in 1997**; went into effect in **2005**; ratified by **141 nations**; binds **35 industrialised countries** to reduce GHG emissions by **2012 to 5% less than 1990 levels** (NCERT p. 96).
- **Global Warming consequences:** Rise in sea level due to melting glaciers, ice caps and thermal expansion of the sea may inundate large parts of coastal areas and islands; **annual average near-surface air temperature of the world is ~14° C**; the **greatest warming of the 20th century was during 1901–44 and 1977–99**, with global temperatures rising by ~0.4°C in each period and a slight cooling in between (more marked in the Northern Hemisphere); globally averaged annual mean temperature at the end of the 20th century was **~0.6° C above that recorded at the end of the 19th century**; the **seven warmest years during 1856–2000** were recorded in the last decade of that period; **1998 was the warmest year — probably not only for the 20th century but for the whole millennium**; the **Gangotri glacier is receding at ~23 m per year** on average (NCERT p. 97 and news clipping).

2.2 Definitions to memorise

Term	Definition	Page
Empirical classification	Climate classification based on observed data, particularly temperature and precipitation	91
Genetic classification	Classification of climates according to their causes/origins	91
	Classification of climate for a specific purpose	91

Term	Definition	Page
Applied classification		
Koeppen's scheme	Most widely used empirical classification (1918) using mean annual/monthly temperature and precipitation	91
ITCZ	Inter Tropical Convergence Zone — belt where trade winds converge; keeps tropical climates hot and humid	92
Group A — Tropical	Coldest month ⩾18°C	91
Group B — Dry	Potential evaporation > precipitation	91
Group C — Warm Temperate	Coldest month >–3°C but <18°C	91
Group D — Cold Snow Forest	Coldest month ⩽–3°C	91
Group E — Cold (Polar)	All months <10°C	91
Permafrost	Permanently frozen sub-soil characteristic of Tundra (ET) climate	94
Iceberg	Floating mass of ice broken from EF ice-sheets due to mounting pressure	94
Sunspots	Dark and cooler patches on the sun that increase/decrease cyclically	95
Millankovitch oscillations	Cycles in Earth's orbital eccentricity, wobble (precession) and axial tilt (obliquity) altering insolation	95
Aerosols	Particles from volcanic eruptions that reduce solar radiation reaching Earth	96
Greenhouse effect	Atmospheric absorption of long-wave radiation emitted by Earth, warming the atmosphere	96
Greenhouse gases (GHGs)	Gases that absorb long-wave radiation — primary: CO_2, CFCs, CH_4, N_2O, O_3	96
Ozone hole	Depletion of stratospheric ozone (mainly over Antarctica) caused by CFCs	96
Kyoto Protocol	1997 international agreement (in effect 2005) binding 35 industrialised countries to cut GHG emissions to 5% below 1990 levels by 2012	96
Dust bowl	Severe 1930s drought in the south-western Great Plains of the United States	95
Little Ice Age	Period in Europe ~1550 to ~1850 of cooler temperatures	95
Pleistocene epoch	Geological epoch of alternating glacial and inter-glacial periods	95

2.3 Diagrams / processes to remember

- **Table 11.1 — Climatic Groups According to Koeppen (p. 91):** Five rows A-B-C-D-E with their temperature/precipitation thresholds — the single most testable summary.
- **Table 11.2 — Climatic Types According to Koeppen (p. 92):** Full code list Af / Am / Aw / BSh / BWh / BSk / BWk / Cfa / Cs / Cfb / Df / Dw / ET / EF with one-line characteristic per code.
- **World distribution map (implicit in Table 11.1):** A in equatorial belt; B in subtropical highs and continental interiors 15–60°; C in warm-temperate margins 30–50°; D in northern continental interiors 40–70°N; E poleward of 70°.
- **Greenhouse Effect process (p. 96):** Short-wave solar radiation passes through atmosphere → absorbed by Earth's surface → Earth emits long-wave radiation upward → GHGs absorb this long-wave radiation → atmosphere warms. Analogy: glass of a greenhouse / closed car or bus.
- **Millankovitch cycle concept (pp. 95–96):** Three orbital variables — **eccentricity** of orbit around sun, **axial tilt (obliquity)**, and **wobble (precession)** — each operating on different time scales, collectively altering insolation.
- **News clippings (p. 97):** "Greenhouse gases rising alarmingly" (Antarctic ice cores), "Gangotri is shrinking 23 m every year", "Ice Age cometh" and "Warming Arctic could affect global weather" — used as visual evidence of recent climate change.

2.5 Key data table (chapter facts at a glance)

#	Fact / figure	NCERT source
1	Year Koeppen's scheme was developed	1918, p. 91
2	Number of major Koeppen groups	5 (A, B, C, D, E), Table 11.1 p. 91
3	Group A threshold	Coldest month ⩾18°C, Table 11.1 p. 91
4	Group C threshold	Coldest month > –3°C and < 18°C, Table 11.1 p. 91
5	Group D threshold	Coldest month ⩽ –3°C, Table 11.1 p. 91
6	Group E threshold	All months < 10°C, Table 11.1 p. 91
7	Dry-climate latitudinal range	15°–60° N and S, p. 93
8	Mediterranean (Cs) precipitation range	35–90 cm, p. 93
9	Cfa precipitation range	75–150 cm, p. 94
10	Cfb precipitation range	50–250 cm, p. 94
11	Dw annual precipitation	12–15 cm, p. 94
12	Highest shade temperature on Earth	58°C at Al Aziziyah, Libya, 13 Sept 1922, p. 93
13	Polar climates latitude	Poleward beyond 70°, p. 94

#	Fact / figure	NCERT source
14	Present inter-glacial began	~10,000 years ago, p. 95
15	Last major peak glacial period	~18,000 years ago, p. 95
16	Little Ice Age in Europe	1550–1850, p. 95
17	Sahel drought	1967–1977, p. 95
18	US Dust Bowl decade	1930s, p. 95
19	Kyoto Protocol — proclaimed / in force / countries	1997 / 2005 / 141 ratified, 35 industrialised bound, p. 96
20	Kyoto Protocol target	5% below 1990 by 2012, p. 96
21	CO_2 growth rate	~0.5% per year, p. 96
22	CO_2 adjustment time	20–50 years, p. 96
23	Global mean temperature, end-20C vs end-19C	~0.6°C warmer, p. 97
24	Periods of greatest 20C warming	1901–44 and 1977–99 (~0.4°C each), p. 97
25	Warmest year of the millennium	1998, p. 97
26	Gangotri glacier retreat	~23 m/year, p. 97 news clipping
27	Annual mean near-surface temperature of world	~14°C, p. 97

2.4 Common confusions / NTA trap points

- **A vs. E threshold trap:** Group A needs the coldest month **⩾18° C**; Group E has **ALL months below 10° C**. NTA often swaps 18°C with 10°C or inserts "hottest month" as a distractor.
- **B-climate sub-types confusion: S = steppe (semi-arid), W = desert (arid); lowercase h = subtropical (hot), k = mid-latitude (cool)**. Students mix up capital S/W with lowercase s/w (which indicate dry season in other groups).
- **Sunspot relationship reversal: More sunspots → cooler and wetter** (not warmer). Counter-intuitive and a favourite trap.
- **Kyoto Protocol dates:** Proclaimed **1997**, came into effect **2005**, ratified by **141 nations**, but binds only **35 industrialised countries** to emission cuts. NTA frequently conflates these numbers.
- **Ozone vs. Greenhouse distinction:** Ozone layer depletion (UV problem, caused by CFCs in the stratosphere) is separate from the greenhouse effect (long-wave radiation trapping, caused by CO_2, CH_4 etc.).
- **Indian Peninsula is "Am" (Tropical Monsoon)** — Exercise 1(iii) answer; not Af, BSh or Cfb.

- **Highest temperature on Earth** — Al Aziziyah, Libya, 58°C, 13 Sept 1922; located in a **B-climate (subtropical desert)**, not A.
- **The C and A type vegetations** are commonly mixed — A has tropical evergreen/ deciduous; Cs has Mediterranean evergreen scrub; Cfa has mixed broadleaf.
- **Plateau Station (Antarctica, 79° S)** is the EF (Ice Cap) example — not ET.
- **The list of "humid" climate groups is A-C-D-E** (Exercise 1(v)); B is dry — so any "humid" foursome that includes B is wrong.
- **1998 = warmest year of the 20th century AND the millennium** (Exercise 1(iv)), not 1990, 1885 or 1950.

🎯 Practice MCQs

📊 PYQ Alignment

This chapter appears consistently in CUET Geography papers, typically contributing questions on Koeppen's classification codes and temperature thresholds (direct recall and match-type) as well as the causes and consequences of global warming (statement-based and assertion–reason type). The greenhouse effect, Kyoto Protocol details, and the distinction between ozone depletion and climate change are particularly favoured by NTA. For year-wise CUET stems see /pyq/geography.