New York City College of Technology
Department of Architectural Technology

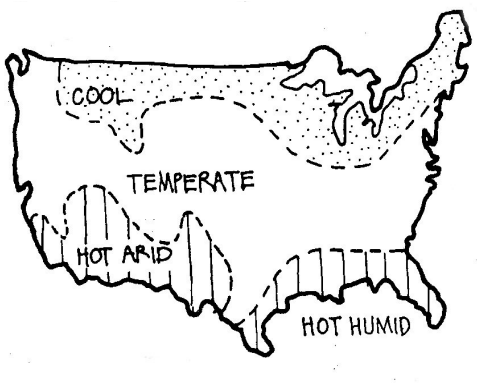
AR 1250- SITE PLANNING - 3 credits

MACROCLIMATE

The Central Purpose of Planning

The central purpose of planning is to create for any person or group of people an environment suited to their needs, and climate must be a first consideration. It is fundamental first, in the selection of an appropriate region for the proposed activities and then, within that region, in the selection of the most appropriate property. Once a site has been chosen, two new considerations suggest themselves. How do we best respond to the climate givens in terms of the site and structural design, and by what means can we modify the effects of climate to improve the situation.

Climate and Site



We must look at the following characteristics of the main climate types:

- ,macro vs. microclimates
- climatological data
- humidity
- wind
- sun path diagrams
- typical vegetation.

With this knowledge you will be prepared to design for different types of climates

Climate

Climate is generally the prevailing weather conditions of a region throughout the year, averaged over a series of years.

Weather

Weather is the state of the atmosphere a a particular time

Climate and Weather

The most obvious facts of climate are the annual, seasonal, and daily changes in temperature. These will vary with changing conditions of altitude, longitude, exposure, vegetation, and proximity to local weather modifiers as the gulf stream, water bodies, ice masses, or desert.

Global Warming

Global warming is a trend toward higher temperatures over time. Global warning is still a subject of debate. Scientists have not yet agreed that Global Warming is a real factor.

Scientists know for certain that human activities are changing the composition of Earth's atmosphere. Increasing levels of greenhouse gases. There is no doubt this atmospheric buildup of carbon dioxide and other greenhouse gases is largely the result of human activities.

By increasing the levels of greenhouse gases in the atmosphere, human activities are strengthening Earth's natural greenhouse effect. The key greenhouse gases emitted by human activities remain in the atmosphere for periods ranging from decades to centuries.

A warming trend of about 1 ºF has been recorded since the late 19th century. Warming has occurred in both the northern and southern hemispheres, and over the oceans. Confirmation of 20th-century global warming is further substantiated by melting glaciers, decreased snow cover in the northern hemisphere and even warming below ground.

Today, efforts are being made to reduce, avoid, and to better understand the risks associated with climate change. Many cities and states across the country have prepared greenhouse gas inventories; and many are actively pursuing programs and policies that will result in greenhouse gas emission reductions.

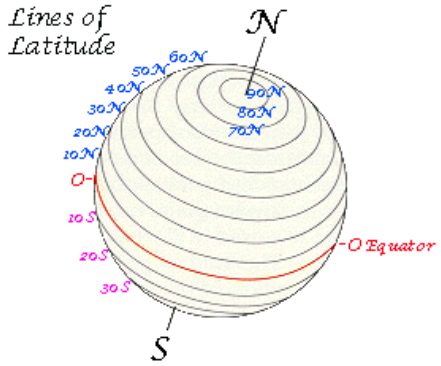
Types of Climate
This addresses what size area is affected by the climate conditions

- Macroclimate The weather for an area over a long period of time – usually 30 years.
- Mesoclimate Local Variant of Macroclimate caused by Topography, Vegetation or Human Action
- Microclimate Climate of a particular site caused by features unique to a site

Macroclimate
Macroclimate refers to the general climatic conditions of a region which is in turn determined by the following 4 factors

Latitude
Elevation
Bodies of Water
Mountain Slopes

Macroclimate - Latitude



Latitude is measured as the distance from the equator, either north or south of zero. More Northerly latitudes or those further from the equator receive less sun.

New York City is located at 40 degrees North Latitude

Macroclimate - Elevation
Elevation (height above sea level). As elevation increases, the temperature decreases 3 degrees for every 1000 feet; thinner air is not able to hold heat.

Macroclimate – Bodies of Water
Lakes and oceans. Water moderates the climate by reducing the temperature extremes (water heats up and cools down more slowly than land due to its higher specific heat).
Day- Cooler breezes from sea move inland
Night- warmer air from land moves to water

Macroclimate – Mountain Slopes
Wind drives air up a slope, the air cools and drops moisture.
Windward slope (Of or on the side exposed to the wind or to prevailing winds) tends to be cool, humid and vegetated.
Leeward slope (on the side away from the wind) is warm and dry.

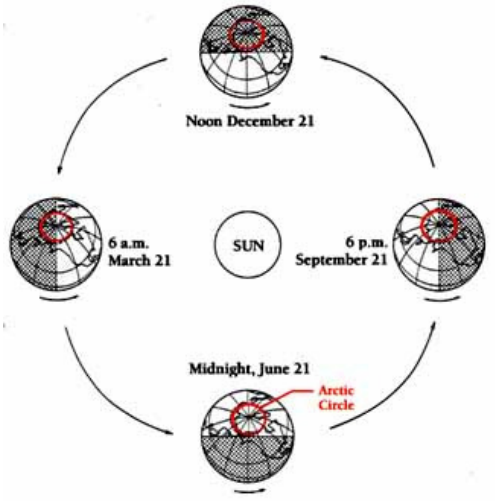
Mesoclimate
Mesoclimate refers to the climate of a particular area or city

Microclimate
Microclimate is the local climate of a particular site caused by features unique to the site. This climate is influenced by naturally occurring conditions and manmade modifications to the environment.

Universal Nature of Climate and Weather
To better understand climate one must understand the universal framework that governs climate and weather. World climate cycles are influenced by many factors, chief among them is the sun.

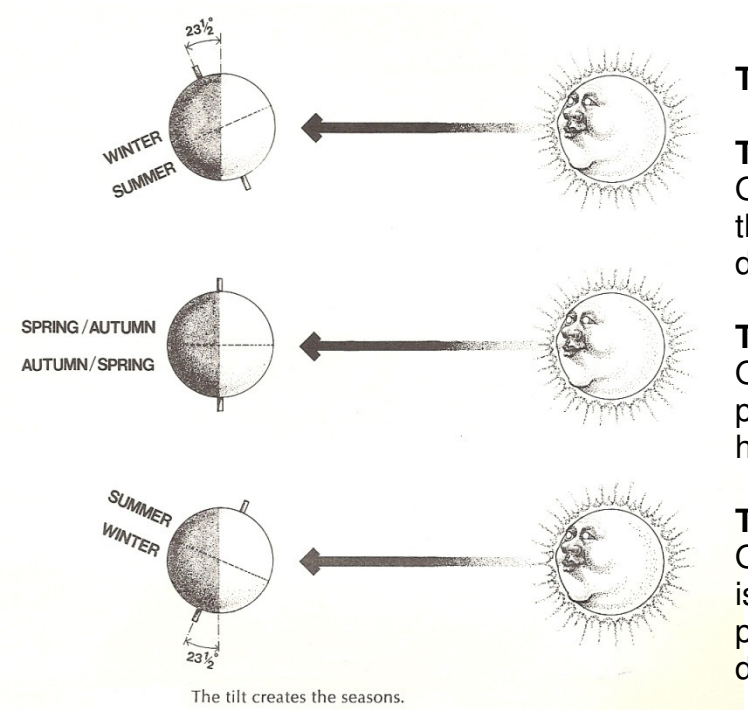
The Sun
The sun is the source of all terrestrial energy. It sets into motion and controls the thermal currents of the oceans. It activates and controls the currents in the air. It sets the rhythm of glacial advances and retreats. We cannot alter these patterns that are determined by the sun.

Earth Rotates about Sun



The Earth's tilt creates the seasons.
The planet earth, with tilted axis, moves in a yearly loop around the sun. The incidence of the sun's radiation is a function both of our sphere's elliptical orbit and of its oscillating axial tilt. This variance in radiation accounts for climactic differentials and seasonal temperature change.

The Sun is the most important element to consider in site and building design.



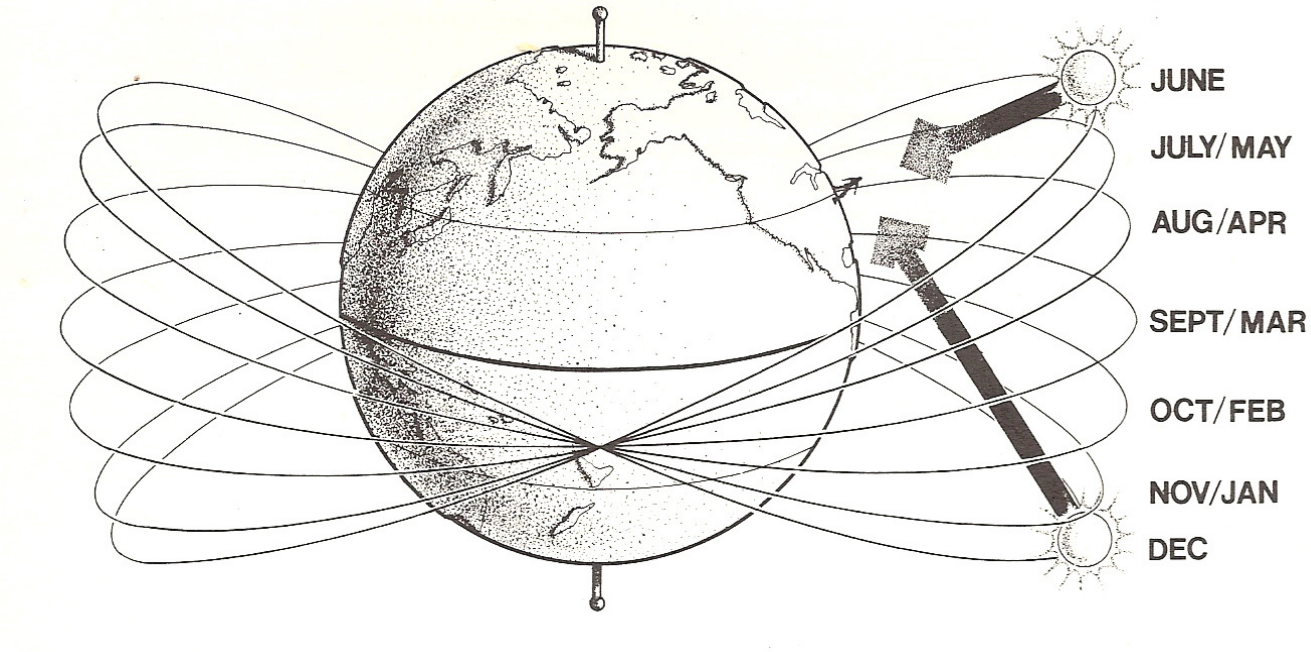
The tilt creates the seasons.

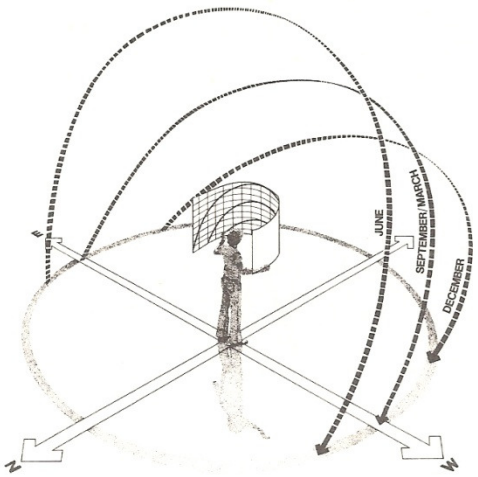
The Earth's tilt creates the seasons.

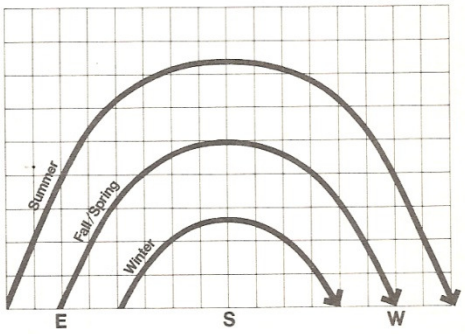
The Summer Solstice
On June 21st the sun is at its highest point in the sky and we receive the greatest hours of daylight.

The Winter Solstice
On December 21st the sun is at its lowest point in the sky and we receive the fewest hours of daylight.

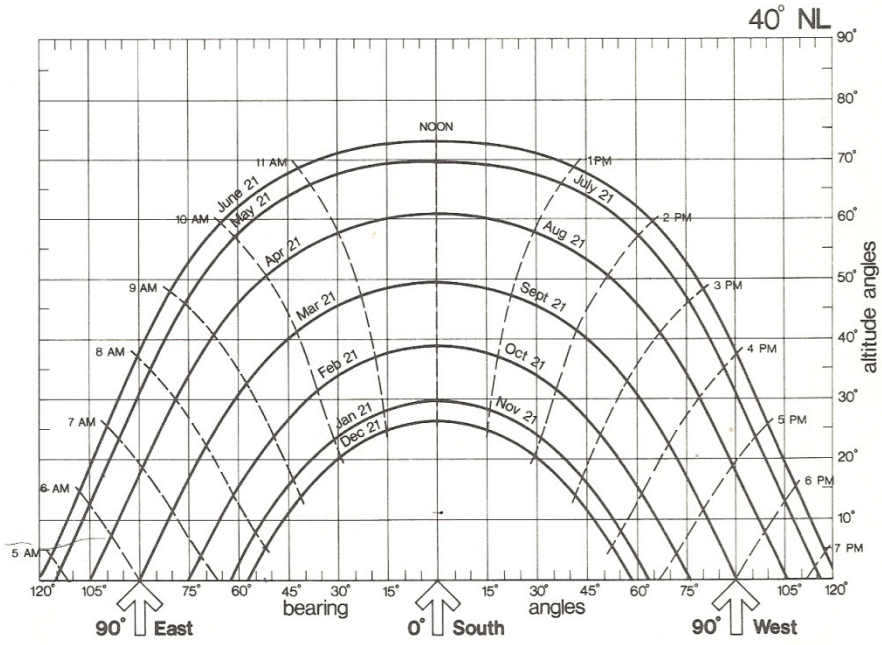
The Equinox
On September 21st and March 21st the sun is halfway between its highest and lowest points and we receive equal amounts of daylight and nighttime hours.







Monthly paths.



Charting the Path of the Sun

Standing in a single location we project the path of the sun on to a graph marking its location for every hour from sunrise to sunset

This chart includes the following:

The Altitude of the Sun
The angle of the sun above the horizon

Azimuth or Bearing of the Sun
The position or angle of the sun relative to true south

Time of the day
The chart shows the position of the sun for every hour it is above the horizon. (Sunrise to Sunset)

Month of the year
The chart includes an indication of the suns position for each month of the year

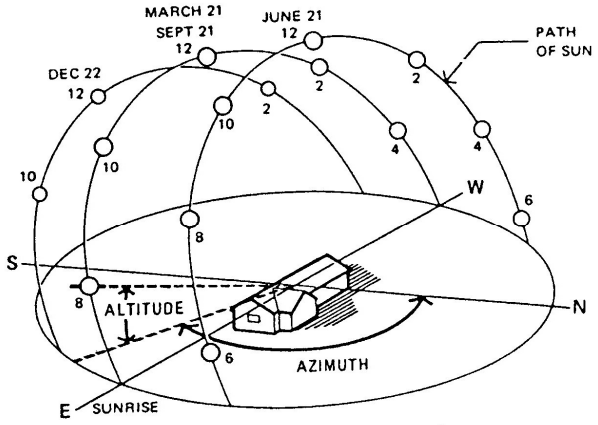
The following months have identical sun paths as they are equidistant from the Solstices

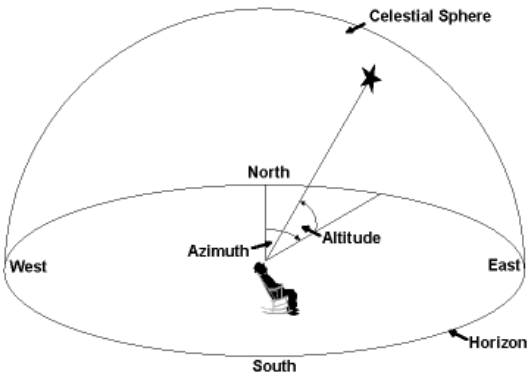
January 21st & November 21st

February 21st & October 21st

March 21st & September 21st

May 21st & July 21st





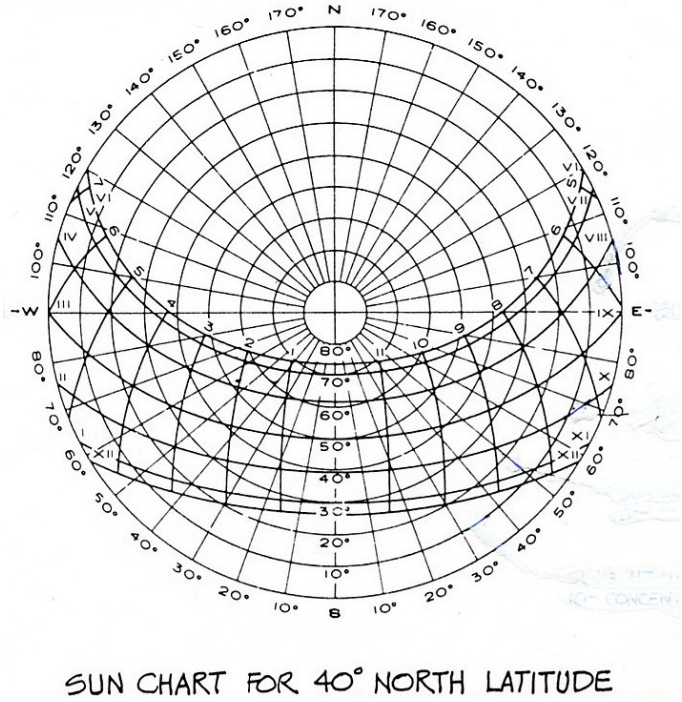
The sun's path rises in the east, moves across the southern sky and sets in the west. We need two coordinates to locate any point in space e.g. X & Y. At any given time the position of the sun can be described by its azimuth and its altitude

The Sun- Azimuth
The Azimuth or bearing angle measures the horizontal position of the sun relative to true south. It is the angle, along the horizon, of the position of the sun measured east to west from south.

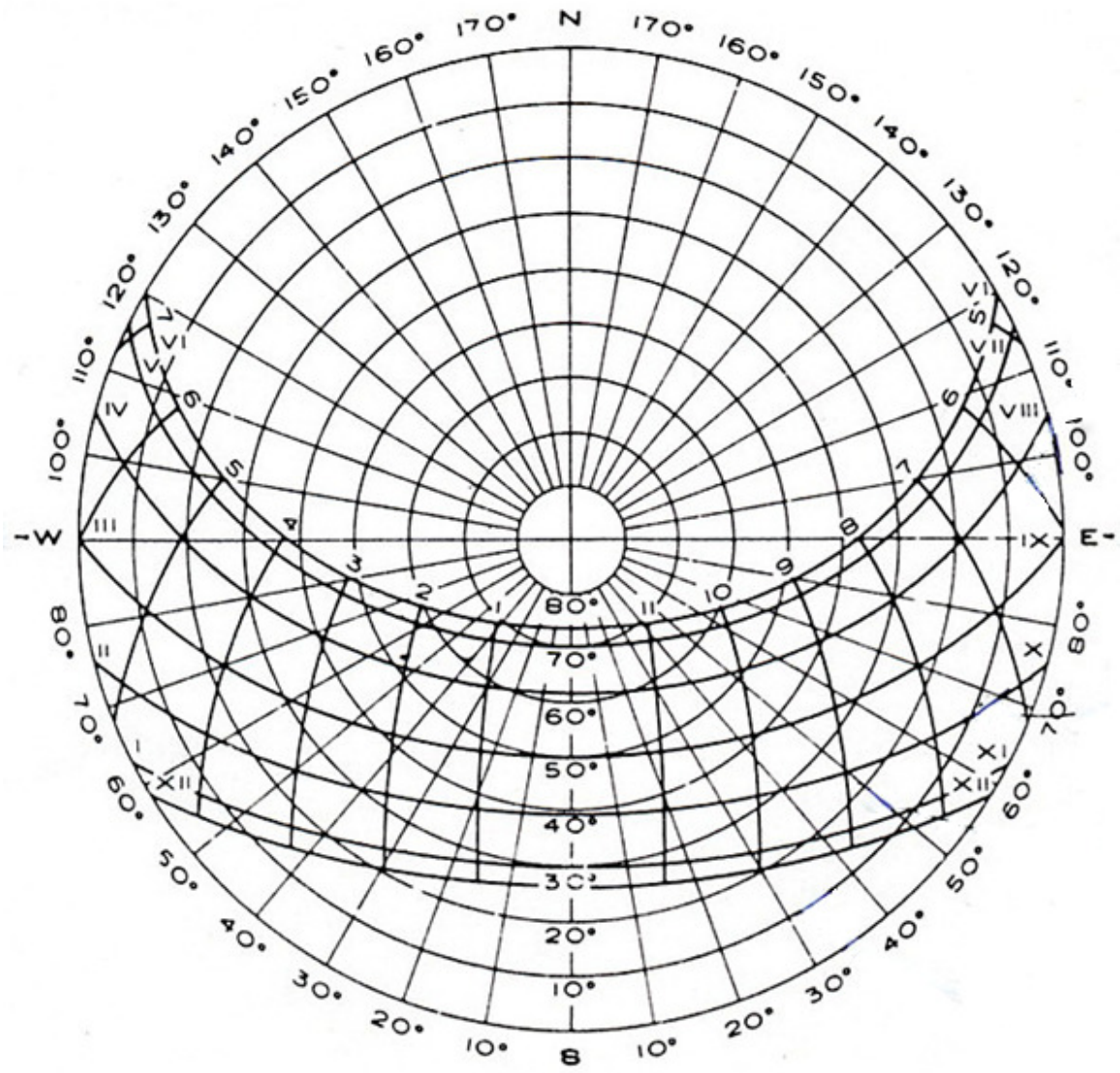
The Sun- Altitude
The altitude measures the vertical position of the sun. It is the angle above the horizon of the position of the sun measured from the horizon. It is 0 degrees at sunrise and sunset, since the sun is at the horizon. If the sun is directly overhead the altitude is 90 degrees.

The Sun- Path
The path of the sun varies with the seasons. In the northern hemisphere, in the summers, the sun is high in the sky; it also has a longer path (longer days) East and west elevations receive more sun, so does the roof. In the winter the sun is lower and has a shorter path (shorter days). The south receives the most sun exposure

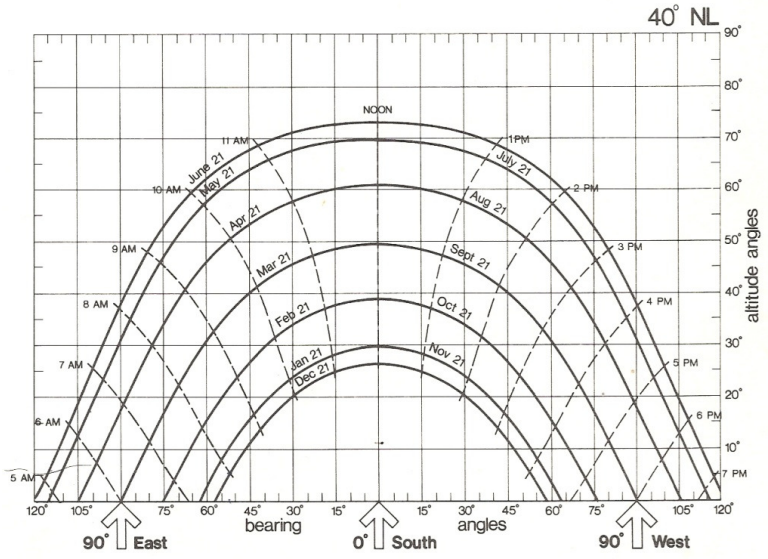
Sun Chart



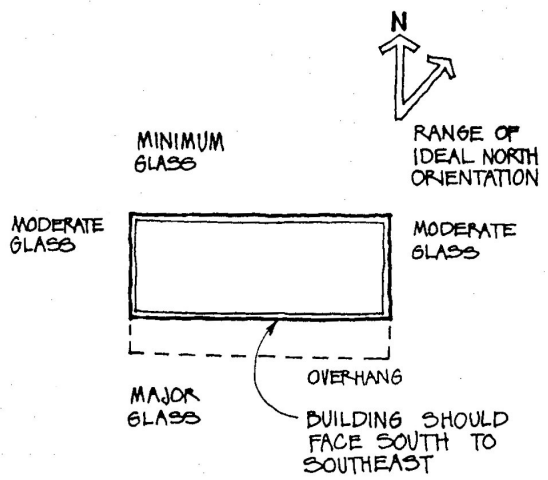
A Sun chart is a map of the sky showing the path of the sun on the same day of each month over the year. It is specific to latitude



SUN CHART FOR 40° NORTH LATITUDE

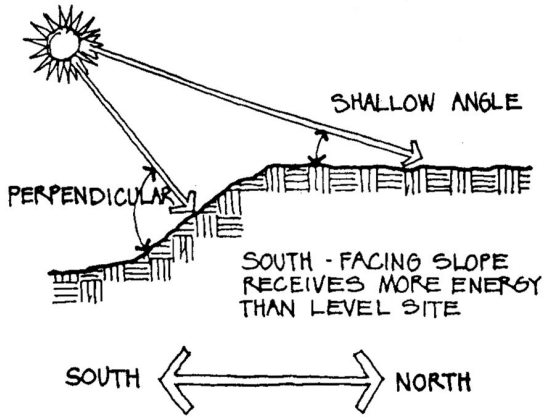


Solar Orientation



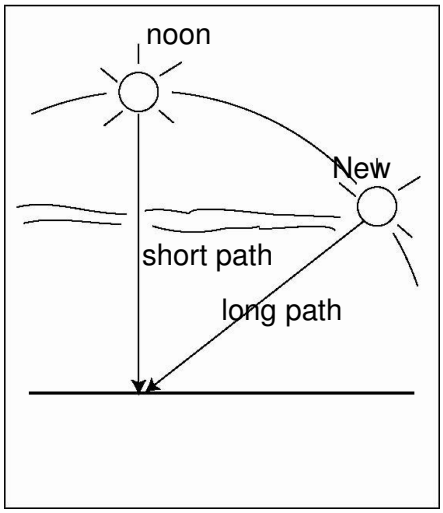
For Cool and Temperate Zones!
Major glass areas should receive winter sun but not summer sun, therefore facing south or southeast with large overhangs or trees to protect from summer sun.

The Sun- Angle



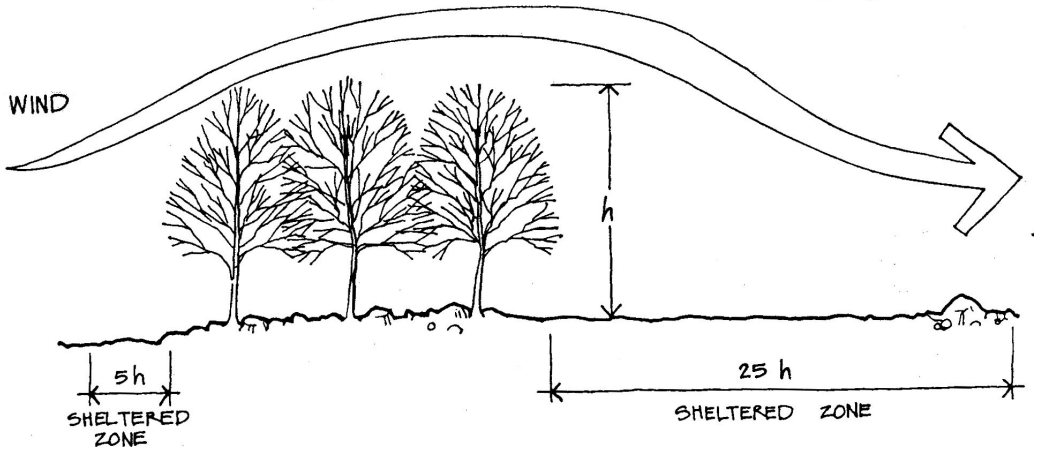
Solar energy is determined by the angle of the surface. The sun is hottest when it is perpendicular to a surface

Solar Radiation

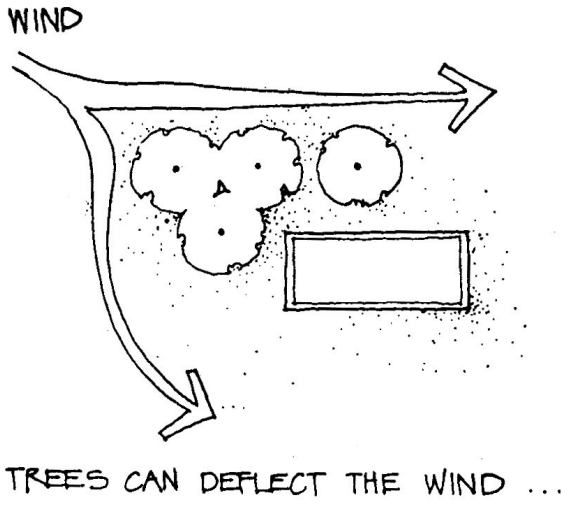


The amount of solar radiation received by a surface is determined by the angle that the sun's rays make with the surface. A surface perpendicular to the sun with receive the most, a flat site gets less

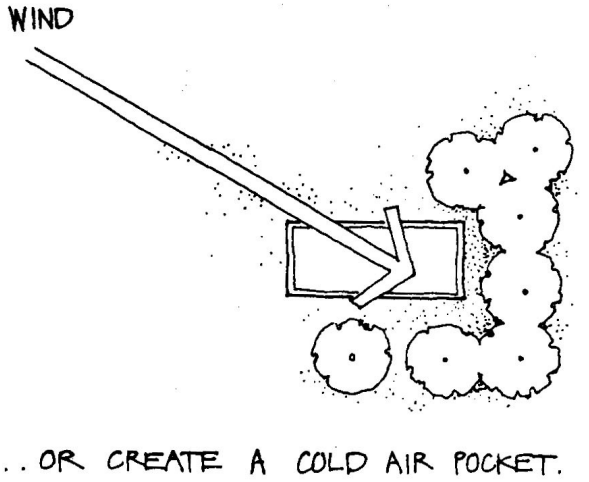
Wind
The direction and velocity of winds and the dates of violent storms need to be charted.
Landscape and building designs, and siting of buildings should be optimized to account for wind loads



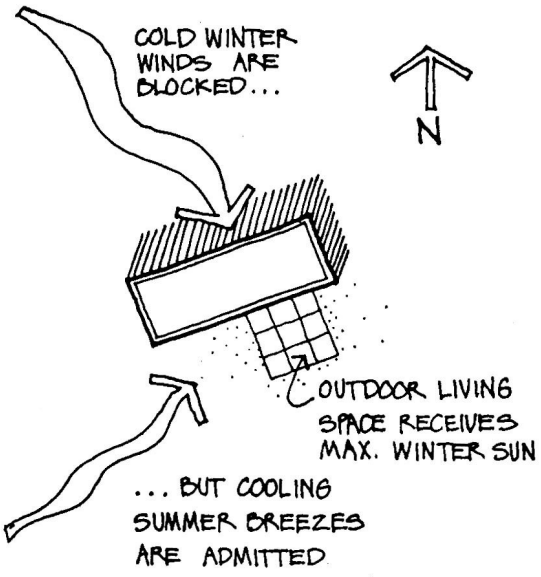
Trees Provide Protection from the wind



Winds are affected by Tree locations, Trees can deflect the wind

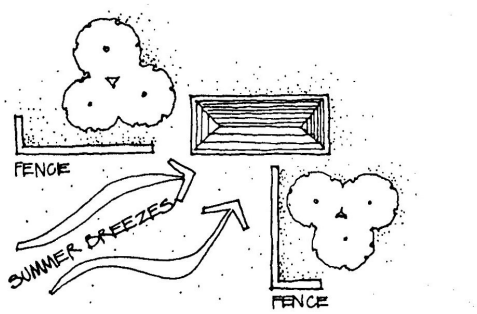


Winds are affected by Tree locations, Trees can create a cold air pocket



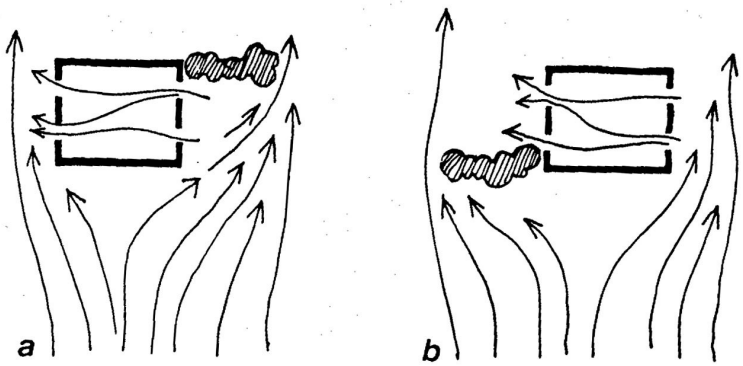
Outdoor space Southeast of a building

Architecture can channel breezes



CHANNELED SUMMER BREEZES

Diversion of airflow through building



tem·per·a·ture (t m p r- -ch r , -ch r, t m pr -) *n. Abbr.* **T, t, temp.**

- The degree of hotness or coldness of a body or an environment.
- A specific degree of hotness or coldness as indicated on or referred to a standard scale.
- The degree of heat in the body of a living organism, usually about 37.0°C (98.6°F) in humans.
- An abnormally high condition of body heat caused by illness; a fever.

Temperature – Degree Days

Degree Days is defined as the number of degrees that the average temperature for the day is below 65F. A day with a mean temperature of 50F has 15 heating degree days, while one who's temperature is above 65F has zero degree days. The total number of degree days in a year is a good indication of energy required to maintain a constant indoor temperature.

The higher the number of degree days the colder the climate

Climate - Humidity

Humidity is the amount of water vapor in the air and can be described in different ways.

The term that you'll hear most often to describe the humidity is "relative humidity." Another common measurement of humidity is the "dew point,"

Absolute humidity: The mass of water vapor in a given volume of air

(i.e., density of water vapor in a given parcel, usually expressed in grams per cubic meter

Relative humidity:

The ratio of the amount of water vapor in the air at a specific temperature to the maximum amount that the air could hold at that temperature, expressed as a percentage.

Dewpoint:

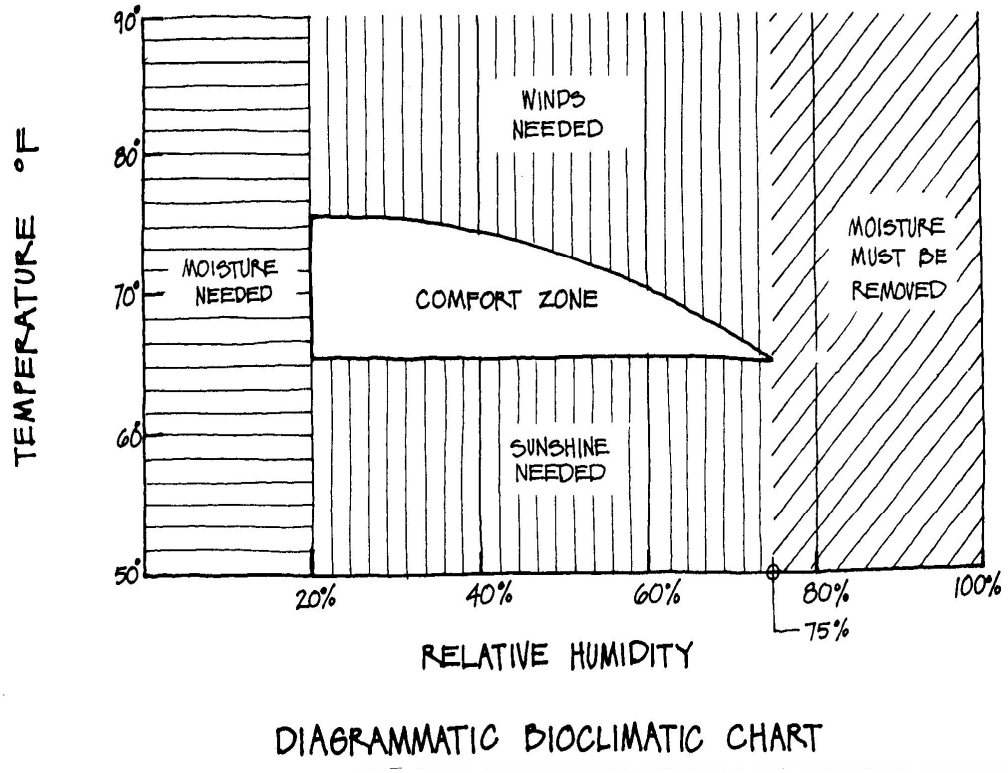
If we cool air without changing its moisture content, eventually we'll reach a temperature at which the air can no longer hold the moisture it contains. Then water will have to condense out of the air, forming dew or fog. The dewpoint is this critical temperature at which condensation occurs.

The dewpoint is a measure of how moist the air mass itself is.

So it's not wrong to say, "It's not the heat, it's the humidity," but it's a lot more precise to say "**It's not the heat, it's the dewpoint**". If you want to know how humid it is on a hot August day, listen for the dewpoint!

Precipitation
The amounts of precipitation in the form of dew, rainfall, frost, or snow are important factors to consider in site planning. When cloud particles become too heavy to remain suspended in the air, they fall to the earth as precipitation. Precipitation occurs in a variety of forms; hail, rain, freezing rain, sleet or snow.

Human Comfort



DIAGRAMMATIC BIOCLIMATIC CHART

Human comfort is effected by temperature, humidity, radiation and air movement. The comfort zone is that combination of temperature and humidity in which the average person feels comfortable. In the U.S. roughly between 65F to 75F and between 20% and 75% relative humidity

There are Four Climate Regions

The Cold Region
The Cool-Temperate Region
The Warm Humid Region
The Hot-Dry Region

The Cold Region
The Cold Region is categorized by areas with an extremely cold winter, and an extremely long winter, with short winter days
Extreme winter cold
Deep snow
Strong winds
High windchill factor
Deep frost
Scrub forest cover
Short winter days
Long winters
Alternating freeze and thaw
Rapid spring melt

Cold Region Community

1. Orientation to sun
2. Provision for plowing and snow storage
3. Utilization of all protective ground covers as windscreens and soil stabilizers
4. Crosswind alignment of traffic-ways and linear site use areas
5. Reduction in size of plan areas to minimize costly excavation and frost-proof construction
6. Preservation of all possible vegetation, with strong wind resistant edges left intact
7. Grouping of activity areas to reduce travel time
8. Provision of community recreation and cultural centers within or near concentration of dwellings
9. Alignment of traffic-ways to fall within the shadow bands to preclude ice buildup
10. Avoidance of low ground, natural drain-ways, and floodplanes

Cold Region Community Site

1. Creation of enclosed courts and sun traps:
2. Use of Short access-ways, grouped entries, raised platforms and covered walks
3. Preservation or planting of windscreens; installation of snow fencing; use of low strong vertical enclosure
4. Provision of intermediate points of shelter on a long traverse; placement of structures to block wind
5. Use of Post, beam and platform construction to avoid the need for extensive excavation and foundations, move with the ground surface by use of stepped horizontal planes
6. Clearing of small clustered use areas.
7. Maximum utilization of daylight: orientation toward sunlit spaces with views
8. Utilization of a clustered-compound plan, which tends to engender community life and close social ties
9. Use of decks, raised walkways, and flexible ground surfacing to preclude frost heave and keep people out of slush and mud
10. Positive surface drainage to the natural lines of storm water flow, with natural covers preserved to prevent soil erosion

Cold Region Building

1. Massive low-profile, well-insulated structures, with maximum exposure of walls and roof areas to the sun and minimum exposure to wind; heat loss to be limited in all ways including limitation of window area
2. Protection of approaches from snow drift, raising of entrance platforms
3. Placement of windows away from prevailing winds; orientation of long building axis into wind, utilization of topography, trees and wind-screens
4. Orientation of entrances in lee (side of building away from wind)
5. Reduction of building perimeter and ground contact to reduce foundation problems and heat loss
6. Forest cover preserved and buildings nestled against the protective slopes and tree masses
7. Design of windows and living areas to exact the full contribution of the sun
8. Attention to comfortable home environment
9. Elimination of vulnerable joints
10. Steep roof pitch deep overhangs exaggerated storm drainage gradients to facilitate rapid runoff

The Cool-Temperate Region

Categorized by Variable temperatures, ranging from warm to hot in the summer, cold in the winter, and moderate in the spring and fall.

Cool-Temperate Region - Condition

1. Variable temperatures ranging from warm to hot in the summer; cold in the winter, and moderate in the spring and fall
2. Marked seasonal change
3. Changing wind directions and velocities
4. Violent storms occur frequently
5. Periods of drought, light to heavy rain and frost and snow may be expected
6. Soils are generally well drained and fertile

Cool-Temperate - Community

1. Definition of land use and traffic patterns to reflect local temperature ranges and other climatic conditions
2. Community plans must function in all seasons
3. Alignment of streets and open spaces to block cold winter winds and block warm summer breezes
4. Design of streets and utility lines to withstand extreme conditions

5. Consideration of high winds, flooding and snowstorms
6. Provision of extensive park and open spaces
7. Incorporation of natural waterways
8. Use of private and public gardens
9. Preservation of indigenous vegetation within the open space framework
10. Planning of each community as a unique expression of its setting

Cool-Temperate Site

1. Wide variety in the type and size of outdoor activity areas
2. Dramatization of the seasonal variations; consideration of spaces for winter, spring, summer, and fall activities
3. Design recognition of the prevailing wind and breeze patterns
4. Construction to withstand the worst of the storms
5. Provision for all-weather durability and maintenance
6. Protection of prime regional forest and agricultural lands
7. Sensitive planning and zoning of all water-related lands
8. Use of pools and fountains to enhance community spaces
9. Community plan to integrate with nature
10. Full utilization of scenic possibilities

Cool-Temperate Building

1. Elimination, by design of extremes of demands for cooling, heating and ventilating
2. Consideration of design requirements of each season
3. Plan organization in response to effects of winds
4. Structural design to meet most sever conditions
5. Consideration of shrinkage, swelling, condensation, freezing, and snow loading
6. Expansion and extension of plan forms when desirable, since excavation and foundation construction are not generally a problem
7. Utilization of recreation values of site
8. Water catchment and storage is not a prime consideration
9. Design of building areas and form in response to topography
10. Treatment of each building site to realize full landscape potential

The Warm-Humid Region

Categorized by consistently high temperatures and high humidity

1. Temperatures high and relatively constant
2. High Humidity
3. Torrential Rainfall
4. Storm winds of typhoon and hurricane force
5. Breeze almost constant in the daylight hours
6. Vegetative covers from sparse to luxuriant and sometimes jungle-like
7. The sun’s heat is enervating
8. Sky glare and sea glare can be distressing
9. Climactic conditions breed insects
10. Fungi are a persistent problem

Warm-Humid Community

1. Spacing of habitation in a dispersed manner
2. Situated in channels or areas of movement
3. Avoidance of floodplains and drainage-ways. Disturbed areas are subject to erosion
4. Settlements located in thee of protective land masses, above level of storm-driven tides
5. Channel favorable effects of the breeze
6. Use of foliage in views
7. Heat-of-day gathering places should be roofed or shaded
8. Reduction or elimination of glare by plan location and well placed tree planting
9. Elevation of use areas and walkways by deck and platform construction to open to breeze and reduce insects
10. Use of stone, concrete, metals and treated wood in contact with ground

Warm-Humid Building

1. Cooling by all feasible means; open building plans. High ceilings, broad overhangs, louvered openings, and air conditioning of local areas
2. Air circulation, periodic exposure to sunlight
3. Use of colonnade, arcade, pavilion, covered walkway. Orientation of entrance and windows away from storm track
4. Wind-resistant structures
5. Rooms, Corridors, balconies and patios as interconnected breezeways
6. Utilization, indoors and out, of indigenous plant materials for the cooling effect of their foliage
7. Provision if SHADE
8. Positioning of viewpoints away from the glare and provision screening
9. Elevate structures above the ground, facing into the breeze, and insect-proofing of critical areas
10. Open well-ventilated storage. Fungus resistant materials and drying devices as needed

Hot-Dry Region Condition

1. Intense heat in the daytime
2. Often intense cold at night
3. Expanses are vast
4. Sunlight and glare are penetrating
5. Drying winds are prevalent and raise devastating dust storms
6. Annual rainfall is minimal
7. Spring rains come as cloudburst
8. Water supply is extremely limited
9. Limited agricultural productivity necessitates the importation of food and other goods
10. Irrigation is necessary

Hot-Dry Region Community

1. Creation of cool areas of use
2. Provision for group activities
3. Ranch plan patterns
4. Within dispersed compounds provision for compact spaces with narrow passageways to provide relief from sun
6. Protection of all natural growth surrounding the development
7. Avoid flood prone areas
8. Minimization of irrigation needs by compact planning and multiple use of seeded areas
9. Locate settlements and community areas close to transportation
10. Coordination of land use and traffic patterns with irrigation routes and reservoir locations

Hot-Dry Region Building

1. Thick walls, high ceilings, wide overhangs, limited fenestration, light colors, response to angles and arcs of sun
2. Exclusion of chill night air by insulation, reduction of heat loss and use of localized radiant heat
3. Low ranch type spreads
4. Cool compact and dim interior spaces
5. Seal against dust and wind
6. Group rooms around planted irrigated courts and patios
7. Catchment of spring rainfall. Water from roofs, courts and paved areas.
8. Recycle wastewater. Type of use will determine treatment
9. Provision for food and fodder storage
10. Irrigation in interiors courts, evaporation of moisture provides cooling.