

CHAPTER 11

CLIMATE: HOW DOES GLOBAL CLIMATE CHANGE?

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- HOW DO WE KNOW IT IS HAPPENING?
- HOW DO WE FIX IT?
- HOW DO WE LIVE WITH IT?



CLIMATE CHANGE

- WHAT ARE THE SIMILARITIES AND DIFFERENCES BETWEEN WEATHER AND CLIMATE ?
- WHAT ARE THE MAJOR COMPONENTS OF THE EARTH'S CLIMATE SYSTEM?
- WHAT FACTORS FORCE A PLANET'S CLIMATE TO CHANGE?
- HOW IS CLIMATE CHANGE STUDIED?
- WHY SHOULD OUR CLIMATE BE STUDIED, WHY IS IT IMPORTANT?

Current conditions at Waterloo, Waterloo Municipal Airport (KALO) Lat: 42.55°N Lon: 92.4°W Elev: 873ft.

WEATHER

Humidity 52% Fair More Information: Wind Speed SE 14 mph Local Forecast Office 53°F Barometer 30.22 in (1023.5 mb) VS. More Local Wx Dewpoint 36°F (2°C) 3 Day History 2°C Visibility 10.00 mi Hourly Weather Forecast Wind Chill 49°F (9°C) Last update 27 Apr 8:54 am CDT CLIMATE Extended Forecast for Cedar Falls IA Today Tonight Monday Monday Night **Tuesday Night** Wednesday Wednesday Thursday Tuesday Night 30 % 30 % 30 % 40 % 30 % 60% 50% 50% High: 65 °F Low: 55 °F High: 79 °F Low: 49 °F High: 64 °F Low: 44 °F High: 66 °F Low: 50 °F High: 68 °F Mostly Sunny Mostly Cloudy Windy, Chance Mostly Sunny Partly Cloudy Severe Chance Chance Chance then Partly and Breezy then Chance Showers then Thunderstorms Showers then T-storms Showers then Mostly Sunny and T-storms and Severe and Windy Chance Thunderstorms Sunny T-storms Breezy Breezy Basemap Options **Detailed Forecast** Topographic V Click map to change the forecast location Partly sunny, with a high near 65. Breezy, with a southeast wind 14 to 16 mph, with gusts as high as 23 mph. Today A 30 percent chance of showers and thunderstorms after 1am. Mostly cloudy, with a low around 55. Breezy, with a Tonight south southeast wind 15 to 17 mph, with gusts as high as 23 mph. New rainfall amounts of less than a tenth of an Denver



AT A GLANCE

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Indicators of a Warming World

Different types of climate data recorded by many different research groups around the world all show the world is warming. The following data were assembled by NOAA's National Centers for Environmental Information and include data from researchers around the world. The graphs show measurements of (1) anomaly (changes above and below an expected level indicated as 0); (2) change in size; or (3) change in area. Up and down arrows signal the overall trend in data.



-1

Glacier Mass

Most mountain glaciers are retreating. Mass balance is the difference between loss and gain of ice in a glacier. Negative measurements mean shrinking glaciers.









This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.

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CHANGES IN THE ENERGY RECEIVED FROM OUR SUN



The nuts and bolts of our climate system

Incoming energy 1368 W/m²



Incoming solar radiation

 1368 W/m^2



 $1368 \text{ W/m}^2 \div 4 = 342 \text{ W/m}^2$

Non-rotating disk surface area = πr^2

average radiation at surface: 1368 W/m^2



Rotating sphere surface area = $4\pi r^2$

average radiation at surface: 342 W/m^2



CALCULATING THE AVERAGE TEMPERATURE OF EARTH

DATA FROM SATELLITES AND THE SPACE STATION

-16°C (257K OR 3°F)

TEMPERATURE DATA FROM THE EARTH'S SURFACE (AVERAGED OVER THE PAST 80 YEARS)

• 15°C (288K OR 59°F)

GREENHOUSE EFFECT

- WATER VAPOR (H_2O_V)
- CARBON DIOXIDE
 (CO₂)
- METHANE (CH₄)



MILANKOVITCH CYCLES

THREE CYCLES;

1.ORBITAL ECCENTRICITY2.AXIAL TILT / OBLIQUITY

3.PRECESSION

100,000 YEARS 41,000 YEARS 26,000 YEARS



Precession

26,000 Year Precession Period



OBLIQUITY (TILT)

- EFFECT OF TILT: CHANGE IN TEMPERATURE RANGE
- AT MINIMUM TILT = HIGHER ANGLES = DECREASING THE GLOBAL TEMPERATURE VARIATION.





WHY IS IT HOT AT THE EQUATOR?

WHY ARE THE POLES COOL?

Sea surface

temperatures



GLOBAL AIR PRESSURES













OCEAN CURRENTS







CIRCULATION CHANGES? COLLAPSE?

0



ORIVING FORCES BEHIND CLIMATE CHANGE

- CHANGES IN THE STRENGTH OF THE SUN
- HUMANS
- TECTONIC PROCESSES
- ENERGY AND CARBON TRANSFERS IN OUR OCEANS

PREPARING FOR THE FUTURE

CLIMATE CHANGE PRODUCTS









INVASIVE SPECIES





Approx. Half a Billion Animals Perished.







Bréf til framtíðarinnar

A COLOR AND A COLOR AND

Ok er fyrvet mafnkunnal jöknilinn ett að minna titt sinn. A mæsta 200 krunn er tallið að allir jöklas lændnins farl söma leið. Detta minninmerka er til vitnis som að við vitnum hvað er að gerant og hvað þærf að gera. Aðeins þá veint hvort við gerðam sinterað.

A letter to the future

Ok is the first loclandic glacies to lose its status as a glacies. In the next 200 years all our glaciers are expected to follow the same poin. This monument is to acknowledge that we know what is happening and what needs to be done. Only you know if we did is.

> Agan 2019 415ppm CO1

GLOBA CLIMATI CRIS

OKJOKULL GLACIER

A letter to the future

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> Agin 2019 415990 CO1



Environmental Racism Is Nothing New

Race is the most significant predictor of a person living near contaminated air, water, or soil.

56%

of the population near **toxic waste** sites are people of color.

Are • • more likely to Have ... live without 38% potable water and higher modern nitrogensanitation. dioxide exposure. People of color:

Nation.



95% of their claims against polluters **denied by the EPA**.

Environmenta

Areas exposed to:

: hurricanes
: desertification or drought

: small islands &

deltas subjected to extreme weather / greater surf (some islands will be completely submerged)

OF THE COMMONS' 'TRAGEDY

