

~~NAME~~ of Climatic Change & History | NO.

~~Virginia Papers~~ ~~Herbert M. M. M.~~

Notes on Huntington. ~~Papers on~~
~~peace, & on Russia.~~

Huntington, Climatic Changes

p. 1

I) Uniformity of Climate

Every species demands uniform conditions within narrow limits. Complex climate aids organic evolution. Since Miocene, complexity the rule. Remarkable uniformity of earth's climate in geol. history, deduced from presence of similar organisms since Proterozoic, perhaps Archeozoic. 60°C . max. possible range in geologic time. This range includes

2 most critical temps. possible, freezing
pt. of water & pt. where it can dissolve
= vol. of CO_2 . Water's extraordinarily
high latent heats. It's peculiar vol. change
with heat, affecting ocean circulation. It's
unequalled power to dissolve, & remain water.
Ionizing power, causing electro-chemical
reactions so important to life. Also, after
 H_2O , most capillary powerful liquid.

Important relations with CO_2 : H_2O .
absorbs widely varying vols. of different substances,

Henning

p. 2

but $\approx$ vol. of CO_2 , varying with temp. Exactly = at $15^\circ \text{C} = 59^\circ \text{F}$, optimum for man, & also mean of earth's surface. CO_2 freely leaves & enters H_2O . Change with heat & destruction - fundamental chemical characteristic of life. Thus earth's temp is only one at which life's chemical reactions may occur.

Huntington,
Climatic Changes

Chap. II The Variability of Climate

Contraction of earth increases rotation speed. But tidal drag decreases it. Stress & change from there. Increasing salinity of oceans, by making hot equator water tend to sink, slows ocean circulation, increases climatic contrasts.

CO_2 & H_2O vapor are blankets.* During periods of equable climate, these are locked into limestone & coal by land & marine organisms. The blanket gone, diverse climate results. (If true, man's release of this CO_2 & H_2O by industry will affect climate.) Schuchert says that revolutions, high lands, are contemporaneous with diverse climate, as present. Erosion & vulcanism return CO_2 to air.

14th century, last great crisis of historic pulsations. Storms move north, increase. Ice moves north. Yucatan drier. Glacial advances have wiped out 1000's of species in biogeology. They may do the same to peoples & civilizations.

20,000 year precession. Not important. (Webster says 26,000 "s, called Platonian year)

Bruckner periods, 33 years. A part of the 11-12 year sunspot cycle, - historic pulsations - glacial - geological pulsation chain.

Sunspots. More storms, lower temperatures.

Pleionism migrations. 27 day cycle, corresponding to

* Sun's heat, short λ , can get in, but earth's radiations, long λ , cannot get out.

sun's rotation. Also 3 mo. & $2\frac{1}{2}$ year cycles. Irregularity,
excesses, in one or more climatic factors. Traveling. Long range
forecast possibilities.

Cyclonic vacillations.

Storminess increases with sunspots.

Chap. III

Hypotheses of Climatic Change

Criteria for good hypothesis:

- 1) Solar & terrestrial causes must both be considered
- 2) Is glaciation due to redistribution of earth's heat, or change in total?
- 3) Why are climatic & orogenic revolution synchronous?
- 4) Repetition of conditions without regular period.
- 5) All existing agencies of change must be considered.

1) Croll's eccentricity theory.

21,000 yr. precession cycle. About once in 100,000 years, planets are grouped to make greatest ellipticity in earth's orbit.

But this demands alternate glaciation in n. & s., while they were probably simultaneous. Demands regular period, which ain't. Does not explain "sub epochs."

2) Carbon Dioxide Theory.

Tyndall & T. C. Chamberlin. Arrhenius, Langley.
 CO_2 may by itself change earth's mean 2°C . 5° to 8° probable for glaciers. But CO_2 's heat will a) affect water vapor in air, b) reverse the circulation of ocean currents, by increasing low lat. evaporation & salinity, causing warm poles.

At critical point when reverse circulation changes to way it is now (due to cooling thru loss of CO_2) whole earth is chilled by cool surface waters (I should think they'd be warmer) which also absorb more CO_2 & diminish moisture in air. Glaciation.

When cold polar water gets to equator, it gives up CO_2 , warmer interglacial period. Eventually absorption at poles & emission at equator must =. Then original

factors again cool us off more. Many glacial cycles of decreasing amplitude thus caused. Erosion finally restores CO_2 , old circulation restored, coral in Greenland.

- 1) No evidence for or against oceanic reversals.
- 2) More than low temp needed to explain glaciers. Prec. & atm. circ. involved.
- 3) Proterozoic oceans must have been as saline as today's; dubious
- 4) Historic pulsations unexplained.

3) The Form of the Land

Influencing currents. Obviously a factor, but geohistorically not always connected with climate. (consistent?) Too ponderous a factor to explain small pulsations.

4) Volcanic

Hemphrys, W.), Abbot, Fowle. Dust in air lowers temp., observed fact. But we are now in ~~an~~ near glacial climate, & there is no dust in air. Also, pits & cones of necessary eruptions not to be found.

5) Polar wandering.

Dismissed by astrophysicists

6) Thermal solar hypothesis.

Absolute changes in sun's heat denied. ^{because, tho they do happen.} Also, such a change would decrease interzonal temp. gradients (I don't merit) decrease storminess, reverse of glacial facts. Predistribution of earth's atmospheric pressure more likely.

9/2
06
5/3

Chap. IV

The Solar Cyclonic Hypothesis

Köppen & Newcomb have shown earth's temp. varies with sunspots. Surface of earth coolest when sun radiates most energy, time of many spots. Storms. Contrasts increased. Storms carry heat to stratosphere, it is lost in space. Increase of pressure, rather than heat, the initial factor in these storms. Pressure unknown, perhaps electro-magnetic.

Regions now made more or less stormy by sunspots were similarly affected by greater historic pulsations.

Probably external sources govern sunspot cycle of 11.2 years. Planetary rotation probably. Jupiter's 11.86 yr. cycle dominating. Sunspots are cyclonic disturbances on sun.

Approach of star to sun should explain great commotion of glaciation.

(over)

Chap. IV

The Climate of History

3 hypotheses:

a) Uniformity; b) progressive desiccation (because 30° - 40° lat. was moister 2-3000 years ago than now) c) pulsations.

Palmyra & desert Syria, e.g., once as densely pop. as England. - H.C. Butler. This partly in Christian times. Olives & vines there once. Soil gone, water gone, $\therefore$ people gone. Great forests once in north Syria, gone. S. Syria shows no such change, due to local orography. Caspian Sea & Tiam Sham Mts. were once drier than now.

Mediterranean moist: 5-400 B.C., 0 A.D., 1000 A.D.

" dry: 1200 B.C., 700 A.D., 1300 A.D.

Calif. tree record agrees with Medit. historical record. Correlation coefficients. Naples is not so well correlated, & has no summer drought like Jerusalem & Cal. But Hunt. connects agric.-social hist. of Rome with Sequoia curve, in Worldpower & evolution.

Droughts have occurred in supposedly moist periods, but this due to short fluctuations. There have always been deserts, their boundaries move. 325 B.C., Alex.'s march.

Gregory's date palm objections. However, they allow for $2-3^{\circ}$ temp. change, & only rain fall change. (besides, they seem poorly founded) 30-40% rain fall change often observed at same temp.

Yucatan was drier at critical times. Thus it is today at time of many sunspots.

Climatic Changes

Chap. VI

Climatic Stress of 14th Century

Ice & Floods in Europe. Unusual drought, some other years. Oceanic floods, too. Freezing of entire Baltic. Norway's wheat failed, had to be imported by Hansa, latter gaining political influence. Turbulent politics result. England's worst famines, "incessant rain, cold stormy summers." Wheat price up 5 times. Wages up 10%, permanently. Later drought. Peculiarly "continental" climate for Eur. Caspian sea unusually wet, same time. Lap Nor rose. Drought in India, because Central Asia did not warm up. Greenland, present ice front established, formerly it had been farther north. Aboriginal eskimos kill Norse settlers, forced south by cold. All these things agree with fate of climates at times of many sunspots. Chinese sunspot record shows 14th cent. max

Chapter VII

Glaciation according to solar cyclonic hypothesis.

Continents higher than now, which by itself causes coolth & extremism. Superimpose sunspots on this, get glaciation. Storminess carries away heat. Storm track shifted north to mid-Canada, (from n. U. S.), & to Scandin. Greater evap. from oceans & precip. As condensation occurs up high, this heat lost in space. Total precip. increases. More snow falling, snow reflects sun, temp. still lower. Snow field is high pressure, pushes storms south, so precip. is at margins, it grows. Frozen fogs reflect sun, emit earth's heat. Storm track nears trade winds, esp. in summer, gets moisture from them, thus making this region more arid.

Geologic evidence that storm track was pushed south. Sea lowered, warm currents bothered. Faster erosion, less CO_2 . Colder ocean absorbed more CO_2 . Increased salinity, slows circulation, increases contrasts.

Mts., dry plains, oceans, stop ice sheet. Sheet nearly level, not a dome. Great Basin had lakes, more water. Slow moving lens more effective than fast in bringing water from Gulf of Mex. to Chicago, because of long spiral route.

When sun spots left, glaciers warmed, (& dried, esp. Keweenaw)

Chap. VIII

Some problems of glacial periods

I) Localization

Low temp not controlling factor. Precipitation, even without temp. change, would do much. Hobbs' anti-cyclonic hypothesis, that moisture is brought by winds from above, disproved. Distribution satisfactorily explained by s.c.h.

II Sudden advent

CO₂ theory not satis. here.

III Variations in snowline & glacial height.

4000' lower in Alps, only 1500' in Venezuela.
∴ it was more than general temp decrease, but also involved decrease of precip. near equator, such as happens today during sunspot times.

High glaciers not augmented, because it was colder & precip. occurred further down hill.

IV Lakes, etc., in englaciated regions.

All old streams found where streams most numerous with many spots.

V Permian & Proterozoic low lat. & sea level glaciation.

Great land masses of those times covered by highs, storms forced south.

Storms ~~on~~ tracks concentric about magnetic poles, which wander. Possibly this happened then, but no evidence.

Simul., red beds in north, indicating deserts. Not due to heat but lack of moisture. Red beds accumulate today in Tarim Basin & Transcaspian. Local orography

determined glaciers, as at Boston, Alaska, Falklands.
Warm northern Permian seas not simul with glaciers.

Other conditions, such as CO_2 , must always be favorable, but solar condition must always be considered as one important factor.

Chap. IX

The Origin of Loess

(Loess formed today in lee of Gobi desert)

Before, during, or after glaciation? We say immediately after. Geologic evidence for time between retreat of glacier & formation of loess. Loess of same material as glacial drift, & is thickest at ice margins. Loess vegetation fossils not boreal.

Retreat of ice exposed zone of drift to outflowing glacial winds. Desert pavements between loess & underlying till form wind erosion.

Most loess connected with just one (Iowan, or 7th) glaciation, some with others. Sandpots tend to make Montoma - Ill. - Mahe crescent more and, favoring loess. Sandpot tendencies will overbalance ice-sheet high push when ice is retreating. Iowan loess more extensive than others because it retreated faster, leaving more bare land to be blown.

Chap. IX

Causes of Mild Geological climates.

Warm arctic of most time. But not as warm as often thought. Tropical plants found there probably adapted selves somewhat. Knowlton asserts non-zonal arrangement, due to red-beds. But these may be formed under moderate conditions. But zoning was less extreme in past.

Sea now disturbed. Quiet it, stop storms which carry heat aloft, & clouds which block it, raise temp. $5-10^{\circ}\text{C}$. Westerlies become steadier. Arl. Drift & Japan current turned more north, because reverse winds of cyclones hold them up. Fogs over land would hold in heat from ocean, protect delicate plants from rapid temp. changes. Ocean circulation speeded, equator colder, contrasts lessened.

Ocean gradually heated, a great conservative body.

Would require great cold to alter its effects.

Cordier's gyroscopal oscillation hypothesis. Length of day ^{independent of temperature} important to reproduction of many plants. Geologic evidence of seasons, in various times. If times of no seasons alternate with those of seasons, Cordier may be right. So warmer temps alone would not allow tropical plants to move north - length of day must be changed.

Terrestrial Causes of Climatic Changes

Contraction of earth. Speeds rotation, & equatorial bulge grows, lands affected. But tidal friction slows rotation. Contraction comes in spasms. Water more affected than land in bulging, so alternately equatorial lands would be submerged & ~~lowered~~ emerged. Lands slowly bulges out too, causing e-w. mts. Contraction due to chemical reorganization of rocks - metamorphism, e.g. - & escape of gases.

Climatic results from change in:

I) amount of land

- a) increased contrasts, lower spec. heat., less fog.
- b) " barom. gradients, winds.
- c) Connection.
- d) water vapor lessened, oceans smaller. Connection takes vapor from air. then & lost on land does some.
- f) This, increases contrasts, favorable for glaciers. Each glaciation followed emergence of land.

II distribution of land

- a) n. to s. continuity
Gulf stream due to land deflection, often broken. epeiric Cretaceous sea probly got it once, took heat more directly to Arctic that way.
- b) low lat. lands

They increase eq. low pressure, as Africa now augments trade winds, & increases pressure of sub trop. high. Deserts increased. ∴ Pressure strengthens westerlies, more heat carried north.

- c) Midlat. land area.
Colder winters. Contrasts. Oceanic circulation
impaired, poles colder.

III) Height of land
Contrasts increased. Mts. cutoff moisture in lee.

IV) Volcanism
Low pressure areas. When cooled, still differ in black-
ness from environment. Heat added probly negligible.

V) Internal heat
Dubious. But, if true, would explain ancient
uniformity.

Climatic Changes

Chap. XII

Post-glacial crustal movements & climatic changes

Last great glaciation: 30,000 - 18,000 B.C.

Glacier retreat 18,000 - 6,000 B.C.

Severe continental climate

And continued changes up to 300 A.D.

Magdalenian pd. of human history, reindeer in Europe, end of Paleolithic. This ice was still farther south than at present during Babylon-Egyptian days, & that could mean a lot.

Shifts of land height, climatic significance, locally.

Chap. XIII

Changing composition of oceans & atmosphere.

Affect secular progression especially. Salinity:

- 1) influence ^{slow} evaporation rate
- 2) Boiling pt
- 3) CO₂ absorption
- 4) circulation.

- 1) film of salt on water
- 2) New Eng. harbors ice band.

Ice increases "land" area, contrasts. Continental highs strengthened, outblowing winds, snow cannot get to land, less glaciation. 3) Slight change in temp. causes ocean to give up highly significant amounts of CO₂. 4) Sinking of saline tropical water slows circulation, increases contrasts.

Increase of oxygen due to plant life since earth's formation, perhaps. St. John says Venus

has no oxygen in atmosphere. Perhaps it is too active to be free unless continually freed by plants.

Chap. XIV Effect of other bodies on sun

Nile floods, Calif. tree-rings, Chinese earthquakes, & sunspots all show 260-80 year cycle. Planetary, meteoric effects on sun. Novae, near nebulae, due to running thru nebular material. Sun has probably been affected ~~very~~ to a greatly lesser degree than conspicuous novae, which are brightened 1000 fold by nebulae. Possible electromagnetic effect of passing stars. Invisible stars probably more numerous than visible, it might have been one of them. But chances for their producing so many glaciations are poor. It would have dragged orbits to great ellipticity, & they are not so. Possible electro effects in 5-70,000 year periods, tidal in 12,000,000,000. Radiation (electro, as well as others) $\propto (15^\circ)^4$. But electromagnetism increases with agitation, & double stars ($\frac{1}{3}$ stars are such) are always agitated. Alpha Centauri, the nearest star, 4.3 light years away.

Climatic Changes

Chap. XV

The Sun's journey thru space

- 1) Irregular timing of glaciation
Because stellar influences are irregular. Geologic evidence perhaps indicates greater glaciation in ~~Archean~~ Proterozoic than later. Leons says present chances of star approach less than past. Internal heat may have prevented Archean glaciation.
- 2) Division of glacial periods into epochs.
Because stars come, often, in clusters. Hyades, e.g.
- 3) Length of epochs
Later intergl. epochs shorter than earlier, 16-8-4-2-1 ratio. Intergl. 5 times as long as glacial. Historic pulsations & smaller are what one would expect from ~~periodic~~ kaleidoscopic influence of many stars.
- 4) Great mildness, even in some interglacial epochs.
- 5) Great mildness, even in some interglacial epochs.

Table of nearest stars, by Schlesinger & Shapley.
Sirius, Altair, Alpha Centauri, & Procyon, in that order, are major controls. 81.2 year period of max. disturbance on Alpha Centauri, pd. of rev. of double star. This shows up in climatic history.

Open-minded conclusion. Astronomy does not prove his theory, but at least, as far as is known, does not disprove it.

Chap. XVI Earth's crust & sun.

climatic & crustal changes usually together, not always.
Wolf's sunspot & Milne's earthquake records for 19th century show a relationship.

Thermal & electrical causes for crustal change dismissed.

20% more winter than summer quakes. No variation at equator. Conditions reversed in Japan & China.

Hyp: Air heavier in winter, & storms, which vary air weight violently, more frequent. More sunspots, more storms, more earth movement. Japan & China, summer storms more numerous (typhoons) Few storms, few quakes, in low lat.s.

Eulerian movement, 430 day earth wobbling

Pole wandering, ascribed by Jeffreys to meteorology. This is most irregular at times of most quakes & storms.

Storm shocks analogous to tap which makes strained glass break rather than bend. Atmospheric effect is slight compared to what crust can stand.

Plains may alter isostasy by burying erosion.

Times of great climatic stress ~~also those of~~
give greatest stimulus to organic evolution.