KEY

CHEM 304
Fall 2012
HW #8: Climate Change II: non-Chemical Factors, T Histories, Feedbacks, and the *AR4*.

1. a) Define the term "albedo":

b) How can/have humans affected the surface albedo of Earth?

c) Define the term "aerosol", and name the two main classes of them.

d) "Inorganic" aerosols have had the most significant anthropogenic cooling effect (negative forcing): i) what compounds comprise them? ii) what source gases are emitted that result in them? iii) What human activities are responsible for such emissions?

2. The amount of water vapor in the atmosphere has significant effects on climate. Explain how an increase in water vapor may raise temperature, and alternatively how in increase in water vapor may lead to net cooling. Which is a case of *positive feedback*, which is *negative*?

3. Fill in the blanks with "what happens next", and indicate which are cases of positive feedback, and which are *negative*?

a) Initial cause: Increasing T. Result: Sea Ice melts and _____.
b) Initial cause: Increased CO_2 Result: Plant fertilization _____.
c) Initial cause: Increasing T. Result: Permafrost melts and _____.
d) Initial cause: Increasing T. Result: Extended growing season in cold areas _____.

4. Data from the Vostock ice core shows that concentrations of two gasses closely parallel global temperature.
a) Which ones? How do today's concentrations compare to the long-term values?
b) What is the indicator of temperature in these data?
c) How do they "date" the data in the cores (at least in part)? How far back does the Vostock data go?

5. Temperature Histories. See the handout with 4 graphs on it from class.

a) According to temperature records, the planet has warmed by about 0.6°C in the last 100 hundred years. There are two identifiable "jumps" in temperature, during what time periods?

b) How does this 0.6°C increase compare to the range of temps over the past 1500 years or so ("range" = high – low value). What *may* be responsible for the coolest portion of this data?

c) What is the range of temperatures observed on the 10,000 & 100,000 years timescales? What has caused these marked variations (probably with help form feedbacks…)?

6. The IPCC "AR4" report – Part 1: "Drivers of Climate Change"

a) By about what % (relative to "pre-industrial times") have the concentrations of CO_2, CH_4, N_2O, and Halocarbons increased? (See Fig SPM 1)

b) Which of these effects are estimated to have had the greatest overall impact on climate: solar fluctuations, land use changes, or greenhouse gasses? (See Fig SPM 2)

c) Of the 4 "long lived" greenhouse gases noted in Fig SPM 2,
i) Which has/have the highest GWP's? Which have the lowest?
ii) Which has/have largest % change on concentrations relative to pre-industrial times?
iii) Which have had the most total emissions (i.e. largest quantity)? Which have the least?
iv) Rank these 4, from least radiative forcing, to greatest.

d) Which has had the most significant effect on global climate: i) Increases in tropospheric ozone due to smog, or ii) Depletion of stratospheric ozone. What is they net result – cooling or warming?

e) Which "driver" has had the greatest cooling effect, and what is the anthropogenic cause of this driver (i.e. what to we do?)? What substance is emitted? What substance does it turn in to, and how dos this affect climate?

7. The IPCC "AR4" report – Part 2: "Observations": Aside form Temperature itself, name as many other observations that indicate that the planet is getting warmer (I can count ten listed in the report).

8. The IPCC "AR4" report – Part 3: "Assessing Climate Change"

a) Briefly describe the performance of the models (both with and without anthropogenic forcing agents), in terms of their ability to reproduce the warming periods you noted in #4 a) above.

b) What does this suggest about the causes that underlie each of these warming periods (ie. what is the causes, and how well do we understand them?).

9. The IPCC "AR4" report – Part 4: "The Future of Climate Change".

a) Do any of the IPCC "Scenarios" lead to a situation in which warming ceases entirely?

b) The "A1F1" Scenario (see p. 18) results in the most future warming. How does it differ from the "A1B" and "A1T" scenarios?

c) The "B" Scenarios, as a whole, lad to less working then the "A" scenarios, what is the key difference between them?

d) Regional variability/distribution: Which region(s) of the planet are predicted to experience the most significant warming?

304 HW #8

KEY P1

1. A ALBEDO IS THE FRACTION OR % OF INCIDENT SOLAR RADIATION REFLECTED BY EARTH'S SURFACE AND ATMOSPHERE (CLOUDS MAINLY)

B LAND USE CHANGES, FOREST → AGRICULTURE → DEVELOPMENT ETC...

→ THIS HAS HAD A NET COOLING EFFECT

C) AEROSOLS ARE SUSPENDED SOLID PARTICLES OR LIQUID DROPLETS - THE CLASSES ARE: ORGANIC - CARBON-BASED INORGANIC - NOT ↑

D) i) $(NH_4)_2SO_4$ AND NH_4NO_3

ii) SO_2 ↑

iii) COAL ↑

NO ↑ (WITH NH_3 → SEE TROP CHEM)

↑ ALL FORMS OF COMBUSTION

2. CAUSE: INCREASED T → MORE H_2O VAPOR (A GHG...)

EFFECT #1 → MORE H_2O → MORE HEAT TRAPPING → WARMER → MORE $H_2O_{(g)}$ (+)

EFFECT #2 → MORE H_2O → CLOUDS → INCREASE ALBEDO → COOLING → LESS H_2O (OR AT LEAST AT COUNTERACTS 1ST INCREASE) (−)

3. A SEA ICE MELTS → DECREASED ALBEDO → WARMING → MORE MELTING (+)

B INC CO_2 → PLANT FERTILIZATION → COUNTERACTS CO_2 INC (−)

C INC T → MELTS PERMAFROST → MORE CO_2 / CH_4 → WARMING (+)

D INC T → LONGER GROWING SEASON → MORE CO_2 CONSUMED → LOWER G.H.G. → COOLING (−)

4. A) CO_2 / CH_4 → TODAYS CONCENTRATIONS ARE HIGHER THAN PAST 420,000 YEARS → BY FAR!

CO_2 → OLD MAX 280-300 ppm → NOW - 380/390

CH_4 → ~ 900 ppb → NO 2-2.5 ppm

B) ^{18}O CONTENT OF ICE.

C) THEY DATE UPPER LAYERS BY COUNTING → DATA IN CLASS WENT BACK 420,000 YEARS (GOES BACK 680,000 NOW).

5. A) #1 → 1915 - 1945, #2 → 1975 TO PRESENT

B) IT IS ABOUT 1/3 TO 1/2 OF THE 1500 YEAR RANGE (±1.5°C)

→ THE LITTLE ICE AGE SEEMS TO CORRELATE W/ A LAPSE IN SUNSPOT ACTIVITY.

C) ± 6°C → THE MAJOR CHANGES ARE THE RESULT OF VARIATIONS IN EARTH'S ORBIT → BUT ICE-ALBEDO AND PERMAFROST / GHG FEEDBACKS ARE KEY

6. A) CO_2 → ~ 30% CH_4 → 2.5x (250%), N_2O ~ 20%

HALO CARBONS - ∞ → NO NATURAL BACKGROUND.

B) GREEN HOUSE GASES

C) i) HIGHEST - HALO CARBONS : LOWEST CO_2

ii) HALO CARBONS iii) CO_2 = HIGHEST / HALO CARBONS = LOWEST

iv) CO_2 > CH_4 > HALO CARBONS > N_2O

D) STRAT OZONE DEPLETION → COOLING

TROP OZONE POLLUTION → WARMING

↳ THIS HAS BEEN MORE SIGNIFICANT → NET RESULT IS WARMING.

E) AEROSOLS → INDIRECT EFFECT IS "CLOUD SEEDING"

DIRECT EFFECT IS ALBEDO ($(NH_4)_2SO_4$ IS WHITE!)

7. ICE IS MELTING - SNOW COVER RECEDING, SEA LEVEL IS RISING, SHIFTS IN PRECIP PATTERNS, WINDS INCREASING, LONGER DROUGHTS, TEMP EXTREMES, EXTREME PRECIP.

8 A

MODELS WITHOUT ANTHRO FORCING DO NOT REPRODUCE RECENT WARMING TREND. (1995-PRES)

MODELS WITH ANTHRO FORCING DO REPRODUCE RECENT WARMING TREND.

NEITHER MODEL RUN DOES A GREAT JOB REPRODUCING THE EARLIER 20TH CENTURY WARMING TREND (1915-45)

THOUGH THE ANTHRO-CONTAINING VERSION IS A BIT MORE CONSISTENT (VERY SLIGHTLY).

9) A) NO. B) "FI" REFERS TO FOSSIL FUEL INTENSIVE.

C) B SCENARIOS PLACE VALUE ON ISSUES BESIDES GROWTH AND DEVELOPMENT.

D) THE ARCTIC ROASTS!