# Climate Change and Society: a Scientist's Perspective

- Alan K. Betts
- Atmospheric Research
- Pittsford, VT 05763

• akbetts@aol.com

### Climate Research: a scientist's view of the past 35 years

- Born 9/10/1945, Southend-on-Sea, England
- Nottingham High School [grades 5-13]
- Peterhouse, Cambridge [Lord Kelvin scholar; Natural Science Tripos, Theoretical Physics]
- Imperial College, London [PhD, Meteorology, 1970, "Cumulus Convection]
- Colorado State University [1970-78]
- Atmospheric Research [1978-present, Vermont]

# Nottingham High School

- Founded 1513 by Dame Agnes Mellors
- Grades 5-13
- Superb education in science, classics & languages



## Peterhouse, Cambridge

- Peterhouse is the oldest college in Cambridge: it was founded in 1284 by Hugo de Balsham, Bishop of Ely.
- Peterhouse has approximately 250 undergraduates, 90 graduate students, and 45 fellows.
- My advisors were Drs. Kendrew (myoglobin); Klug (viruses); Scheuer (astro-physics)



### **Cumulus Convection**

#### **Physics of shallow cumulus**

Cloud water, no rain Condensation, upward transport, evaporation Reflect/absorb sunlight, 'black" to LW radiation

Huge climate impact



Anaco, Venezuela, 1969

### Field Experiments

- Anaco, Venezuela [VIMHEX-1969]
- Carrizal, Venezuela [VIMHEX-1972] [Organized by Prof. Riehl of CSU]

• GATE 1974 [Convection Subprogram Scientist] Many nations, ships, aircraft

## Global Atmospheric Research Program Atlantic Tropical Experiment



### Global Atmospheric Research Program Atlantic Tropical Experiment



#### 15 + research ships

Vanguard [NASA], Quadra [Canada], Dallas [US Coastguard] 7 research aircraft NCAR Electra

### Vermont : 1978-present

- 1978 Built solar home in Vermont with photovoltaic electricity, passive solar heating and wood-stove
- Now 'Atmospheric Research' in Pittsford, VT
- Funded by National Science Foundation, NASA [and NOAA]: on 3-5 year grants
- Plan and analyze field programs and improve models at ECMWF, NASA and NOAA

### Field Experiments-2

- Kansas grassland prairie: 1987-89: FIFE
- Boreal forest, Canada, 1994-96: BOREAS
- Amazonia, 1999- : LBA

- Land-surface-atmosphere studies over different ecosystems
- Represent *processes* in global models



### **Research Interests**

- 1970's Moist thermodynamics; shallow Cu Tropical convection over land /ocean
- 1980's Moist thermodynamics: "Saturation level" Cumulus parameterization Climate equilibrium in tropics
- 1990's Global model diagnostics/field data Land-surface processes: grassland/forests/snow Soil water-evaporation-precipitation River basin budgets
- 2000's Climate equilibrium over land Carbon/water/cloud/BL coupling

### Moist Thermodynamics

- Enthalpy and total water conserved
- Phase change gives downward energy transport ['refrigerator']
- Saturation level and relative humidity
- From leaf resistance to free atmosphere



### Climate equilibrium in the Tropics-1



Shallow Trade-wind cumulus flowing into deep precipitating tropical convergence zone Trade cumulus balance between ocean evaporation and sinking of dry air

### Climate equilibrium in the Tropics-2



Water vapor in upper atmosphere traps infrared and warms ocean equilibrium

Double CO<sub>2</sub> warms ocean by 2 to 3K in tropics [more at poles]

## **Climate Change**

- One of the great challenges for this century
- Very broad; very complex: biosphere

- What is known? What might we face?
- What does the public know?

• [Actions: Mitigation vs. adaptation]

# Scientific issues - social and political conflicts

- Where does the science stand?
- Can science gives us answers?
- Do we need more science to act?
- What are the political pressures acting in the US and around the world?
- How do these impact on atmospheric science and on us as scientists.
- What are our responsibilities to the science, to society and to the earth?

## Primary driver of climate change

- Greenhouse gases from fossil fuel burning and other industrial sources
- 'blanket earth' by trapping of infrared radiation; driving up equilibrium temperature
- Water vapor and snow/ice amplify effects
- Clouds add complex 'fast' feedbacks: oceans react more slowly
- Biosphere controls our long-term fate

## Slow warming or 'surprises'

- Climate system not very stable
- Last 420K years, Milankovic cycles
- CO<sub>2</sub> Oscillation: 280 and 180 ppm: biosphere coupled
- Slow temperature fall, fast rise: 10°C at pole
- Slow ice growth; rapid collapse:
- Sea level rise: 110m



### What are we now in 2004?

- CO<sub>2</sub> up from 280 to 380ppm; 600ppm 'inevitable', given attitude of USA.
- Far beyond range of 'recent' climate record
- [34MYago at 1000ppm, earth had no Antarctic ice-sheet]
- Mean temperature risen about 1°C; predicted rise 2-5°C this century
- Decade of 1990's warmest on record
- Permafrost melting; tundra greening; ice shelves melting; frost-free season longer

# Climate, energy, water and carbon dioxide linked

- CO<sub>2</sub> is low in atmosphere because of *Photosynthesis by plants*
- $CO_2 + H_2O + sunlight (1\%) Y Carbohydrates + O_2$
- Respiration/metabolism
- Carbohydrates  $+ O_2 Y CO_2 + H_2O + energy$
- almost in balance over millions of years, small conversion to fossil fuels: *Coal, oil, gas*:
- Stored sunlight, concentrated energy

## Diurnal cycle of CO<sub>2</sub>

- October flat: Northern hemisphere mean
- Daytime photosynthesis
- Night-time respiration
- Hemispheric drawdown in August



### Humanity needed concentrated energy.

- Discovered coal, oil and gas Y industrial revolution Burning fossil fuels is putting stored CO<sub>2</sub> back into atmosphere *in a hurry*
- Trees, plants and oceans are taking up about half, but rest is accumulating, and CO<sub>2</sub> is rising faster than biosphere can adapt
- Centuries to burn all stored carbon, millenia for earth [oceans/ice] to equilibrate

## Political response [in USA]

• Here is money to do more research to study climate change, improve climate prediction

• You scientists must reduce the 'uncertainties', so we 'leaders' can make a plan that is 'economically viable'

### Sounds reasonable but it isn't....

- Natural world is very complex and alive *we can't predict very well: many surprises*
- Unlike the world of machines & computers, which are man-made and predictable
- Current problem arises because our technology is having a global impact on the natural world
- Climate change is not fully predictable

### Disinformation in US media

- You would think from the talk shows that climate change was in doubt
- Yes, it is complex; yes, 'predictions' are uncertain..

### but the direction and its cause is clear

• 'Truth' may seem elusive in the face of uncertainty and complexity

but honesty is not

### Letter to Editor

**Global warming not by humans** [JOHN McCLAUGHRY]

• On Feb. 21[2003, Rutland Herald] Professor Richard Wolfson of Middlebury College published a commentary on this page claiming that the earth is getting warmer, human action (fossil fuel combustion) is to blame, and it is a "myth" that scientists still debate the issue. Professor Wolfson, who passes himself off as a scientist, offers zero evidence for these propositions. He merely cites the news releases of an international body (the IPCC) whose public relations office spews out politically doctored and demonstrably false computer projections of the supposed warming to come. .....

## Is it a question of science?

- Our knowledge has expanded 10-fold in two decades, but uncertainty remains same
- Suppose we knew 'global sensitivity' of  $\Delta T$  to doubling CO<sub>2</sub>?
- Does our government listen to scientific advice? What does it hear?
- In US: Academy reports and NOAA say: We need more research .. the 'safe, selfserving' and 'true' response



### Government attitude?

- Union of Concerned Scientists: February 2004
- I want to tell you about an important emerging issue we will be working on in 2004: the blatant abuse, manipulation, and <u>politicization of science by the</u> Bush administration. At the highest levels of government, the Administration has injected politics into the traditionally nonpartisan process through which the government gathers, analyzes, and disseminates science-based information.
- The Bush administration appears interested in scientific research only to the extent that it conforms to policies that the Administration has already chosen. To this end, officials have misrepresented scientific information to the American public, censored and distorted scientific research and analysis, muzzled researchers, stacked (or disbanded) scientific advisory panels, and otherwise manipulated the scientific process.

http://www.ucsusa.org/documents/RSI\_final\_fullreport.pdf

### Contrast a decade ago!

• Science, like any field of endeavor, relies on freedom of inquiry; and one of the hallmarks of that freedom is objectivity. Now more than ever, on issues ranging from climate change to AIDS research to genetic engineering to food additives, government relies on the impartial perspective of science for guidance.

#### — PRESIDENT GEORGE H. W. BUSH, 1990

[Remarks to the National Academy of Sciences, April 23, 1990. Online at bushlibrary.tamu.edu/papers/1990/90042301.html]

### Why does it matter to scientists?

- Weather and climate global
- Weather forecasting 'protected' by shortterm reality: its credibility is seen tomorrow
- Climate science isn't protected. And its predictions are a threat to the 'military industrial complex', so it is under attack [remember Eisenhower?]

## We live in USA

- US trying to impose its will on the world, and protect citizens from "threats"
- Outright deceptions over Iraq war
- WTO and the rich nation agenda
- Pharmaceuticals and their agenda
- GM crops and their agenda
- Climate change and energy industry agenda
- *Policy* is written by each industry
- Façade for public consumption that is, publicly sponsored misinformation
- It is easy for science to get corrupted

### It is an election year!

- US 'democracy' depends on ill-informed, fearful and docile electorate
- Scientists are encouraged to be part of it
- Media present limited world view, and for the most part cannot criticize the administration or the assumptions of US society/ advertisers

# What would be an alternative for government?

- Admit 'deep uncertainty'
- Admit fossil fuel economy is responsible nonetheless
- Start nation and world on renewable path
- It would take courage in the face of vested interests and financial backers
- And chorus: it might be bad for the economy; it might reduce growth by 0.x %

### Who speaks for the earth?

- Those 'foolish environmentalists' who want this great nation to 'freeze in the dark'?
- We 'objective scientists', asking for more funds for research?
- Answering just the questions we are paid to answer, and believing the rationalizations we are told

## There is a price to pay ...

- For human ignorance, greed and arrogance
- Objective science will not save the earth: *it can only document the collapse*
- We as environmental scientists must honestly spell out some of the details
- And help the global society to search deeply for a path forward

