

#### The climate debate: basic science and possible actions

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### Outline

**1. Earth System** 2. Weather Observations 3. Models of the climate **4. Weather vs Climate** 5. Climate forcings 6. Climate response 7. Possible actions

Sunlight passes through the atmosphere and warms the Earth's surface. This heat is radiated back toward space.

> Most of the outgoing heat is absorbed by greenhouse gas molecules and re-emitted in all directions, warming the surface of the Earth and the lower atmosphere.



Mars Thin atmosphere (Almost all CO<sub>2</sub> in ground) Average temperature : - 50°C



Venus Thick atmosphere containing 96% of CO<sub>2</sub> Average temperature : + 420°C



Sources: Calvin J. Hamilton, Views of the solar system, www.planetscapes.com; Bill Arnett , The nine planets, a multimedia tour of the solar system, www.seds.org/billa/tnp/hineplanets.html

#### Planets and atmospheres



Venus

Earth

Mars

NASA

	- + + +		+-+
Surface pressure relative to Earth (bars)	90	1	0.007
Major greenhouse gases (GHG)	CO2	H <sub>2</sub> O, CO <sub>2</sub>	CO2
Temperature if no GHG (°C)	-46	-18	-57
Actual temperature (°C)	477	15	-47
Temperature change due to GHG	+523	+33	+10



#### **Energy Budget**



#### Physics becomes very complex pretty soon



#### Atmosphere

#### Anthropo - sphere

The second

#### Hydrosphere

#### Lithosphere and Pedosphere

Biosphere



#### Human Activity & interaction with Climate



#### Monitoring the weather from space







### Monitoring the weather from the ground



#### Monitoring the oceans





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# Computer Models to Simulate Climate

Research Aeteorology



### Weather what is happening outside right now











## **Climate vs Weather**

Climate is the **average** of local weather conditions over a period long enough (>30 years) to provide a reliable average that includes the inevitable peaks and troughs of natural variability.

So climate integrates all weather and its variability



#### Temperature change









#### Temperature and CO<sub>2</sub> concentration in the atmosphere over the past 400 000 years (from the Vostok ice core)



50 years of CO2 observations show an increase of 2.2 parts per million per year This rate of increase is extremely fast geologically



## CO<sub>2</sub> evolution









#### Projected surface temperature changes

#### **Geographical pattern of surface warming**



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#### Sea level changes





#### Sea level changes



#### Sea level changes





## Carbon Penalty



## Carbon Penalty



## **Possible Actions**



## ANYTHING WE DO REQUIRES ENERGY







AGV Automotrice Grande Vitesse



A Deserver

# Annual greenhouse gas emissions from 'standby' power

















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#### Hydro Power



### Wind Power



# Solar thermal (Hot Water)





Solar hot water evacuated tube collector.



Solar hot water panel with roof-top tank.

#### Solar Power (photovoltaic)











#### Geothermal Power

# Power extracted from heat stored in the earth

Surface plant

Cold water (25°C) circulated down to hot rock resevoir

> Directionally drilled wells to intercept fracture zone

Hydraulic fracture zone (10,000 square feet)



Hot water (200°C) produced from second well

10,000 feet

Reservoir, 225 to 300°C (depends on depth and location)





#### How the Proposed Renewable Energy Network Might Look



С

Wind

Hydro

 $\bigcirc$ 

Solar PV

Biomass

Geothermal





#### Final thought

Even if your action won't make a huge difference .... think of what happened if 7 billion people did the same thing. **So, why not start making** 







Doesn't it make you feel insignificant?

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## Thank you



#### Monitoring the weather from the ground



