



# Climate Sensitivity to Solar Irradiance and Climate Models

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- **SORCE meeting on Decade Variations in the Sun and the Climate. Oct 28,2004.**
- **by David Douglass**



# Study 1

## Solar Sensitivity

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See: Paper by Douglass, Clader and Knox at  
<http://arxiv.org/physics/papers/0411/0411002>

- Sensitivity  $k$

$$\Delta I = k \Delta T$$

- Radiative equilibrium

$$\frac{\Delta I}{I} = 4 \frac{\Delta T}{T}$$

$$k_0 = \frac{4I}{T} = 0.051$$

# Measurement of sensitivity

## Douglass, Clader, Knox

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- from MSU temperatures and satellite irradiances

$$k = 0.10 \pm 0.02$$

- Gain  $g$

$$g = \frac{k}{k_0} = 2.1$$

- Response time

**3 months**



# Feedback

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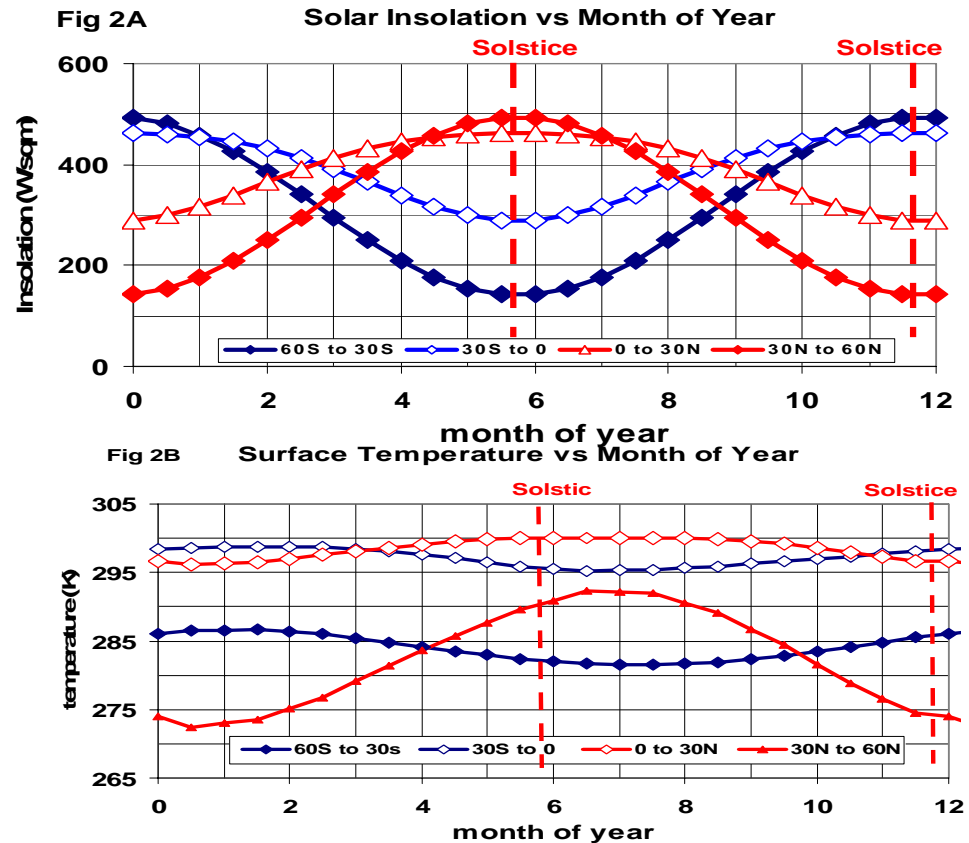
- Gain  $> 1$  means positive feedback
- Coupling to El Nino [White]?

# Study 2. The Seasons

(Douglass, Blackman and Knox. Physics Lett. A 325 p315 2004)

- Irradiance  
~200W/sqm

- Temp  
~6 C



# Study 2

## Sensitivity from seasons

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$$k = \frac{\Delta T}{\Delta I} = \frac{6 \text{ C}}{200 \text{ W / sqm}} = 0.03 \text{ C / W / sqm}$$

*response time  $\approx 2$  months*

# Study 2

## Low sensitivity? Explanation?

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- DBK paper

$$k / k_0 = p \cdot \text{gain}$$

$$p = \text{dynamic factor}$$

- Relaxation time 2 months means that  $p \sim 1$  and not  $\sim 0.2$  as had been assumed.

# Study 2

## Negative feedback is required

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- Thus

$$g \sim 0.5$$

- And Negative feedback is required
- Mechanism? Lindzen Iris?

# Topic 3 General Climate Models

(Douglass, Pearson and Singer. GRL July 2004

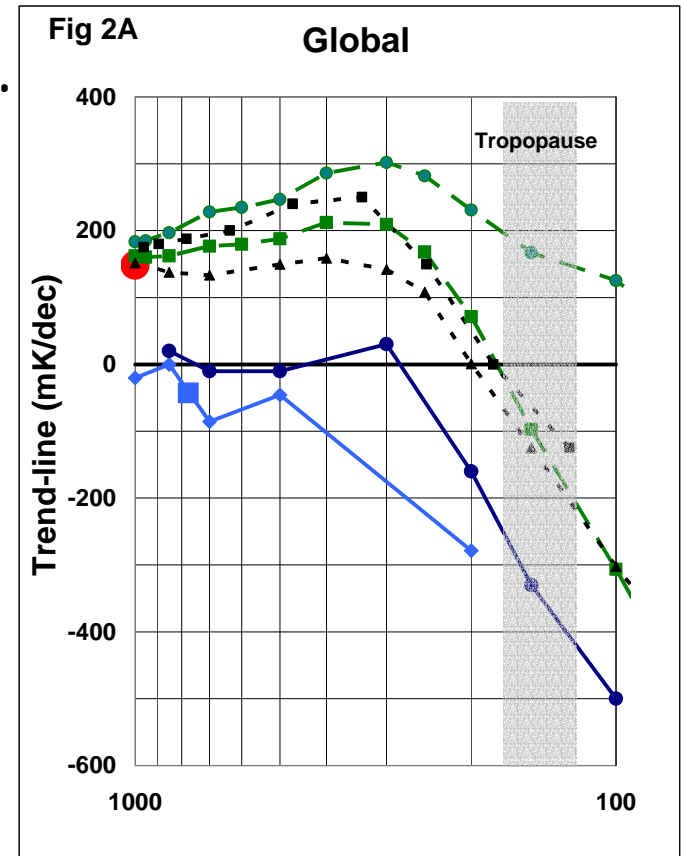
DOI: 10.1024/2004GL020103)

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- Models “ explain “ surface Temp using using many parameters
- Can not explain many other things

# Altitude Dependence

- Douglass, Pearson and Singer (GRL July 2004)
- Observed Trend is negative while models gives positive trends





# Models. What is wrong?

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- Models assume response times  $\sim 10$ s years. Means that dynamic factor  $p < 1$
- To explain amplitudes they need  $\text{gain} > 1$ . This requires positive feedback

# Models. What is wrong?

## Positive feedback?

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- positive feedback (water vapor) is postulated and put into the models
- There is no observational evidence

# Models. What is wrong?

## The response time?

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- Observed times are short
- Dynamic factor  $p \sim 1$
- Gain  $g$  not  $> 1$
- Positive feedback not needed
- Observations in fact give negative feedback



# David Douglass presentation

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- The End
- Thank You