Cosmic Rays and The Climate

T. Sloan[1]

Abstract— **A number of papers and posters were presented at the ECRS on the subject of the relationship between cosmic rays (CR) and both the climate and the weather. I was asked by the organisers to attempt to summarise them.**

I. INTRODUCTION

The climatologists calculate that the increase in greenhouse gases in the atmosphere since industrialisation increases the absorption of the albedo infra red radiation so as to absorb extra solar energy at the level of 2 W/m^2. It is likely that this radiative forcing has caused the increase of the global average temperature observed over the last 150 years [1]. Many question this, mostly on the grounds that there have been warm and cold periods in the past. Jasper Kirkby nicely reviewed the palaeontolgical records over the last several hundred thousand years in his talk. However, note that during this time the CO_2 level in the atmosphere has never risen above 300 ppm compared to a pre-industrialisation figure of 280 ppm and a figure of 380 ppm today and which is on a rising curve.

To challenge the IPCC conclusion that the present global warming is probably anthropogenic, one has to assume that their modelling of the effects of greenhouse gases are wrong, which is a possibility and that there exists a so far unknown phenomenon which will explain the observed global warming. Such a phenomenon has to be unknown otherwise it would be included in the climatologists' models.

Assuming that the climatologists' models are inaccurate candidates for such unknown effects are variable solar acivity e.g. through its effect on cosmic rays or variations of the solar irradiance. These were discussed during the meeting.

II. EFFECTS ON THE WEATHER

The weather means the short term variation in atmospheric conditions whereas climate means the long term variations as measured by long term averaging of various parameters eg temperature.

Several reports were made on attempts to correlate the weather with variations in cosmic parameters. S. Kavlakov showed a possible correlation between the Kp index and hurricane frequency but no obvious correlation between the CR neutron monitor (NM) rates [2]. Two reports of attempts to correlate precipitation at Moussala were presented in posters [3]. In the past there have been other reports of correlations between cosmic ray events and precipitation.

[1]Dept of Physics, University of Lancaster, t.sloan@lancaster.ac.uk

III. EFFECTS ON THE CLIMATE

A number of papers and posters were presented which discussed the connection between cosmic rays and the climate with a very good review of the subject by E. Flückiger. The current lack of knowledge of the subject was described in this talk and the need for much more research was emphasised.

I attempt to summarise the talks and posters by asking the following question. What fraction of the 2.0 W m^{-2} calculated by the IPCC could be coming from the effects of variable solar activity on CR or on irradiance changes. I include in this summary estimates from other published work as well as the presentations at the conference. These are the following.

1. Rusov's Energy balance model [4] predicts that eventually we shall see global cooling and the anthropogenic effect is small.

2. H. Svensmark [5] believes that CR affect the low cloud cover and that almost all the radiative forcing is from CR.

3. Y. Stozhkov [6] believes that the Earth is going through one of its cycles and the temperature will come down eventually so that the antropogenic effect is small. This is based on a Fourier analysis of the past global temperature records. He used the observed Fourier coefficients in an analysis of the global mean temperature from the past to predict the future. In the more remote past he used the ^{10}Be records to obtain the mean global temperature. To justify this he demonstrated a correlation between the ^{10}Be concentration in ice cores since 1880 and the observed global mean temperature. The assumption is then made that ^{10}Be can be used as a proxy for this temperature.

Such a Fourier analysis assumes that the global temperature is cylic and so the future behaves like the past. This is clearly not the case if the greenhouse gas concentration continues the rise which we see today. The future will definitely be different from the past. This could be correct if the effects of radiative forcing by greenhouse gases are small, contrary to the predictions of the climatolgists.

4. Voiculescu et al [7] have published an elegant analysis, using correlations of the ISCCP cloud cover data and with ultra violet irradiance and with cosmic rays. They showed that low clouds are mostly affected by ultra violet irradiance over oceans and dry continental areas but respond to cosmic ray induced ionization over moist continental areas with possibly high condensable vapour and aerosol concentration. High clouds respond more strongly to CR variations, especially over oceanic and moist continental areas. One can conclude from this work that there is some contribution to the radiative forcing from solar activity either through the UV irradiance, CR or both.

5. Lockwood and Fröhlich [8] showed that the mean CR rate has been increasing during the past 20 years or so whereas global warming has continued. Hence they conclude that the effect of CR on cloud formation must be small.

6. Sloan and Wolfendale [9] showed that less than 23% of the dip in global average low cloud amount during solar cycle 22 comes from variations in CR. Svensmark et al used this correlation to hypothesise that the effects of ionization cause clouds so that the decreasing cosmic ray rate over the last 100 years is the main contributer to the radiative forcing in this period. The low cloud anomalies as a function of time are shown in figure 1. The dip is clearly seen in solar cycle 22 (1985-1995) but is not so evident in solar cycle 23 (1995-2005).

7. The ISCCP IR data shown in figure 1 were questioned in [10] since they are incompatible with the daytime visible-IR shown in figure 2.

8. Wolfendale, in his talk, described an analysis of the correlations observed by Voiculescu et al [7] between the cloud cover and either cosmic rays or the UV irradiance from the sun. He went on to show that the effects of CR on low clouds was much weaker than the effects of UV irradiance. Hence he felt that the effects of CR on the climate were "utterly negligible".

From the above we can see that the estimates of the effects of solar forcing, by either CR or changes in irradiance, on the climate vary from almost all of global warming to zero effect.

IV. Conclusion

It is clear from the above that there is complete confusion over the amount of radiative forcing coming from variations in solar activity. The climatologists currently believe that all the radiative forcing is coming from anthropogenic greenhouse gases. There is a wide spectrum of views among other scientists (mostly non-climatologists) on how much of this radiative forcing comes from solar activity e.g. through its effect on cosmic rays. As described above, some hold the view that all of the radiative forcing comes from solar activity, in contradiction to the climatologists. Others believe that a part of it may come from such a sources. Yet others believe that none of the radiative forcing comes from such sources.

An ideal aim would be to research this field more completely and derive a value of the radiative forcing from variations of solar activity which could then be used in the climate models. This would improve the precision on the anthropogenic effects.

Acknowledgment

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References

[1] IPPC see the fourth assessment report (avaialble at http://www.ipcc.ch/)
[2] S. Kavlakov talk and poster 1.05 presented at this conference.
[3] E. Eroshenko Poster 1.20 and A. Mishev Poster 1.21 presented at this conference.
[4] V. Rusov posters 1.33 and 1.34 presented at this conference.
[5] Svensmark, H., "Cosmoclimatology:a new theory emerges", News and Reviews in Astronomy and Geophysics, **48**, (2007) 18, and "The Chilling Stars: A New Theory of Climate Change" by Svensmark, H and Calder, N (published by Icon Books/Totem Books, 2007).
[6] Y. Stozhkov poster P1.11 presented at this conference
[7] M. Voiculescu, I.G. Usoskin and K. Mursala Geo. Phys. Res. Letts. **33** (2006) L21802.
[8] M. Lockwood and C. Fröhlich, "Recent oppositely directed trends in solar climate forcings and the global mean surface air temperature", Proc. Roy. Soc. **A464**(2094) (2008) 1367.
[9] T. Sloan and A.W. Wolfendale Envirnomental Research Letters **3** (2008) 024001.
[10] Kristjánsson,J.E. Staple,A. Kristiansen,J and Kaas,E. "A new look at possible connections between solar activity, clouds and climate", Geophysical Research Letters **29** (2002) 2107.
[11] The ISCCP plots can be found on http://isccp.giss.nasa.gov/climanal7.html.

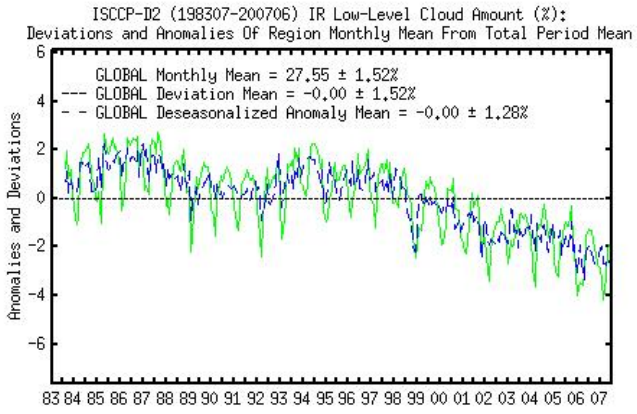

Fig. 1. The low cloud anomalies shown in the ISCCP IR data. The green curve is before seasonal correction and the blue curve is after such correction. The plot is taken from the ISCCP web site [11]

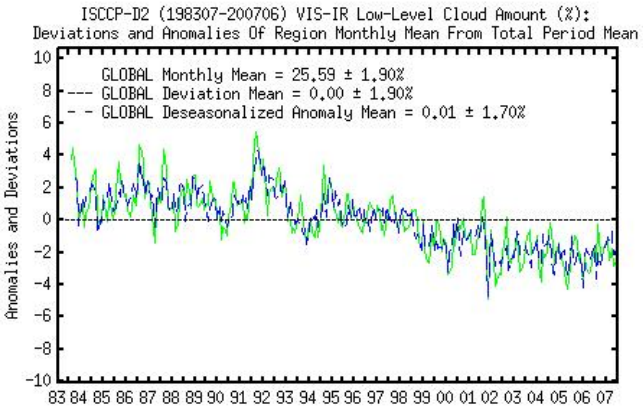

Fig. 2. The low cloud anomalies shown in the ISCCP daytime visible-IR data. The green curve is before seasonal correction and the blue curve is after such correction. The plot is taken from the ISCCP web site [11]