SOLUTIONS FOR GLOBAL WARMING CONTROL AND EXPERIMENTAL LABORATORY VALIDATION

CIRIAF Centro Interuniversitario di Ricerca sull'Inquinamento da Agenti Fisici - "Mauro Felli"

IUGG XXIV 2007 PERUGIA ITALY

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Overview

Greenhouse gases (primarily carbon dioxide) have rapidly increased over the last century mainly because of massive usage of fossil fuel for energy production; a direct consequence is the increase of average low atmosphere temperature. IPCC (Intergovernmental Panel on Climate Change) 4th assessment report predicts that continued greenhouse gas emissions (current rate) would cause at the end of the 21st century a globally-average surface warming between 1,8 and 4°C.

The only meaningful greenhouse gases reduction attempt is represented by Kyoto Protocol; the emissions reduction fixed by such protocol is however not enough to solve global warming problem. Furthermore, most effective solutions for carbon dioxide capture like chemical absorption processes or physical solvent processes are still too expensive and hard to be realized.

An innovative simple proposal for global warming control is here presented which is based on Earth surface albedo enhancing by means of laying reflecting surfaces.

The proposal includes an original relation (patent n. PG 2006 A 0086) between reflecting surfaces extension and corresponding average temperature decrease; furthermore a ratio between greenhouse gases emission, in terms of equivalent carbon dioxide, and reflecting surfaces extension is also introduced. Many solutions for realizing reflecting white surfaces are also proposed: roof painting, road and low value areas whitening, floating white island and artificial salt lakes, etc... .Furthermore, personal behavior and practices may also help to enhance Earth albedo: usage of white umbrella, white cloths, etc. This paper deals with an theoretical and experimental validation of the proposed method. A mathematical model has been proposed and verified by a lab prototype; model and experimental results validate the proposed patented method.

The proposal

Solar energy is carried by electromagnetic short wave radiation (0.2 - 4 μm); when energy reaches Earth surface it is splitted into the following contributes:

− 26% of it is reflected by clouds and particles in the atmosphere;

−19% of it is absorbed by clouds, gases and particles in the atmosphere;

− 55% reaches Earth surface where is mainly absorbed by the ground and the ocean, warming the planet.

Earth emits (thermal emission) long wave radiation (4-25 μm) towards outer space; such radiation is partially and normally shielded by atmosphere; however, shielding is enhanced by high concentration of greenhouse gases like CO_2 producing Earth surface temperature increase. **In the proposed technology, shortwave energy reflection by Earth surface is improved in order to dim the warming energy.**

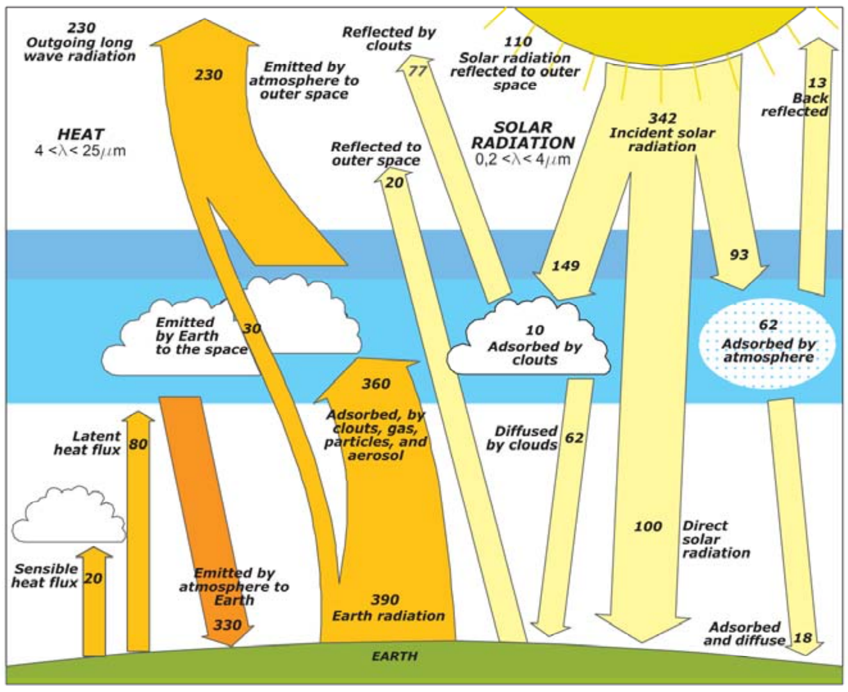

Figure 1: Earth energy flows (W/m²).

The mathematical model

An innovative mathematical model is proposed which evaluates the relation between albedo and global temperature. Figure 2 represents a scheme of radiative exchange among Earth surface, atmosphere and outer space which is based on two energy balances separately carried out on visible and infrared spectrum; an eight equation system is obtained.

Unknown data: w_2, w_3, w_2', q_2, q_3, q_2', T_2, T_3

Known data: w_1, q_1, T_2, t_2, r_2, r_3, τ_2, ρ_2, ρ_3, α_2, α_3

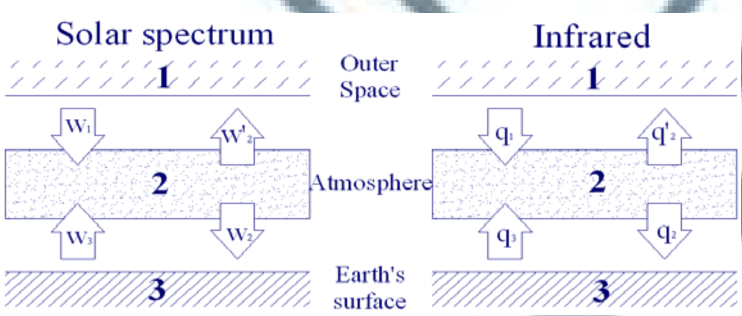

Figure 2: scheme of the irradiation heat exchange.

w Radiance (total energy generated by a body in terms of reflected, emitted and transmitted energy) in the solar spectrum

q Infrared radiance

t, r Average transmission and reflection coefficients in the solar spectrum

τ, ρ, α Average infrared transmission, reflection and absorption coefficients

T_3 Earth surface temperature

T_2 Atmosphere temperature

T_1 Celestial vault temperature

$$\begin{cases} w_2 = w_1 \cdot t_2 + w_3 \cdot r_2 \\ w'_2 = w_1 \cdot r_2 + w_3 \cdot t_2 \\ w_3 = w_2 \cdot r_3 \\ q'_2 = \sigma_0 \cdot \alpha_2 \cdot T_2^4 + q_3 \cdot \tau_2 \\ q_2 = \sigma_0 \cdot \alpha_2 \cdot T_2^4 + q_3 \cdot \rho_2 \\ q_3 = \sigma_0 \cdot \alpha_3 \cdot T_3^4 + q_2 \cdot \rho_3 \\ w_2 + q_2 = w_3 + q_3 \\ w_3 + w_1 + q_3 = w_2 + w'_2 + q'_2 + q_2 \end{cases} \Rightarrow T_3$$

Reflecting surfaces modify the average absorption coefficient of Earth. The following equations give the average absorption coefficient in the visible and infrared spectra of Earth surface when a reflecting surface is introduced:

$$a'_3 = \left[a_3 \cdot (S_T - S_R) + a_R \cdot S_R\right] / S_T \qquad \alpha'_3 = \left[\alpha_3 \cdot (S_T - S_R) + \alpha_R \cdot S_R\right] / S_T$$

a_3, α_3 = Actual Earth average absorption coefficient in the solar and infrared spectrum

a_R, α_R =Average absorption coefficient in the visible and infrared spectrum for the reflecting surface

a'_3, α'_3 = New Earth average absorption coefficient in the visible and infrared spectrum

The following hypothesis are assumed:

−Earth temperature reduction of 0.6±2°C (equal to the last 50 years increase);

−usage of surface with titanium dioxide a_R =0,1;

−CO_2 released in atmosphere in the last 50 years=1100 billions of tons;

−CO_2 adsorbed by oceans and biosphere= 631 billions of tons;

−CO_2 concentration increase in the last 50 years = 469 billions of tons;

−solar average radiation = 342 W/m²;

Under the previous hypothesis, the model allows to evaluate (Table 1): the total surface needed to compensate the temperature increase due to emission of greenhouse gases in the last 50 years, the new average absorption coefficient in the solar spectrum for Earth and the equivalent reflecting surface which compensates the temperature increase produced by 1 ton of CO_2 .

	simbolo	Earth temperature reduction equal to the last 50 years increase	
		0.6°C	0.8°C
Total surface needed to compensate the temperature increase due to emission of greenhouse gases in the last 50 years	S_R	$9.33 \cdot 10^6\ Km^2$	$12.41 \cdot 10^6\ Km^2$
The new average absorption coefficient in the solar spectrum for Earth	a'_3	0.905	0.900
The actual average absorption coefficient in the solar spectrum for Earth	a_3	0.92	0.92
The reflection equivalent surface which allows to compensate the temperature increase producing by emission of 1 ton of CO_2	S_{CO2}	$8.48\ m^2/Ton_{CO2}$	$11.28\ m^2/Ton_{CO2}$

Table 1:Application of mathematical model.

Experimental validation

Mathematical models have been experimentally proved (CIRIAF Congress proceedings march 2007) by means of a lab prototype. It reproduces heat exchange among Sun, Universe and Earth.

Figure 3 shows the prototype: two concentric domes lay on an insulating Teflon plate. Inside the inner dome a spherical cap represents the Earth surface. An array of temperature sensors are installed on the Earth surface. Vacuum is made inside inner dome to allow only radiative heat exchanges. Vacuum inside inner dome is made by a vacuum pump. CO2 fills the space between the two domes to avoid frost formation. Vacuum inside inner dome is made by a vacuum pump. CO_2 fills the space between the two domes to avoid frost formation. An heat exchanger keeps CO_2 temperature at -35°C. High pressure xenon lamp illuminates the Earth-like surface passing through the two domes.

Figure 3: lab prototype.

A measurement campaign allowed to determine the relation between Earth-like surface temperature and albedo for different irradiation conditions. Results show that:

$$\frac{\Delta T}{\Delta \alpha} = \frac{0{,}38\,K}{0{,}01}$$

This result agrees with the one obtained by the mathematical model for the average solar irradiation.

Large scale application

1.Roof Whitening treatment of industrial sheds (40% contribute of the Italian objectives for the Kyoto Protocol);

2. whitening treatment of Italian main highways (enough to reach 50% of the Italian objectives for the Kyoto Protocol;

Examples

Viaduct Langhirano Highway

−Dimension: 5000 m² ;

−applied products: Cycle Ecopittura Mangiasmog Fotosilox painting;

−project: Global Engineering Spa;

−treatment of piers and intrados of the new concrete viaduct built by Coger Spa for the Langhirano road. Within the project a treatment with Ecopittura Fotosilox white painting has been realized. As the surfaces are not horizontal, an in-depth study of the painting performance in terms of global warming reduction is required. It could be preliminary estimated as about 100 CO_2 eq ton.

Figure 4: viaduct Langhirano Highway.

Antenna "De Gasperi" bridge in Langhirano road

−Dimensions: 4000 m² ;

−applied products: Cycle Ecopittura Mangiasmog Fotosilox; painting;

−project: Global Engineering Spa;

−treatment of concrete surfaces of supporting brace in the "De Gasperi" bridge, included in the new road network of Langhirano. Within the project a treatment with white painting Ecopittura Fotosilox has been realized.

Figure 5: antenna "De Gasperi".

3. re-starting up of disused salt-working sites (reaching 10% of Italy's objectives for the Kyoto Protocol);

4. new starting up of salt-working sites in low valuable areas (industrial zones or oil plants along the coast);

5. white reflecting surfaces installed on floating offshore partially flooded areas using marine salt.

Figure 6: salt-working sites.

Small scale application

Not only national and international actions can be envisaged, but each of us can make the difference as well.

−Household energy saving, usage of low energy impact transport systems and renewable sources, energy efficiency, all are personal possible choices;

−besides that, a new chance is available today, selecting white reflecting certified surfaces in the garden furniture, umbrellas, tents, beach towels, car painting, etc.

−different granulometry dust of calcium carbonate used in gardens and flowerbed.

Figure 7: example of flowerbed furnish by calcium carbonate gravel.

Figure 8: example of an everyday usage of the white color.