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Review Article

Greenhouse Gas-Related Climate Changes and Some Expected Skin Alterations

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Abstract

The stratum corneum (SC) materializes the interface between the body and its environment. Such a structure is influenced by the climate, and thus appears to be reactive to seasons. A series of physicochemical parameters are involved in such a relationship. Among them, the environmental relative humidity and dew point are concerned, as well as the insensible loss of water from the skin, and the mechanism of water-as-ice and the higgledy-piggledy-water in the SC. Global climate changes (GCC) refer to sustained alterations in regional climates over relatively long periods. In recent years, GCC were identified as the expression of a global atmosphere warming showing a continuous trend in the increase in average and peak temperatures. Presently, the increasing temperature has already altered the distributions of some living organisms, including infectious agents and their vectors. Extreme weather conditions (wind, rain, storm, flood,…) are progressively noted. Direct effects on the skin physiology are particularly present on the SC structure and functions. Any direct influence on dermatoses depends on extreme weather events. Indirect effects concern longer term changes in the patterns of skin cancers, infections and infestations worldwide. A fairly obvious recommendation based on the science would be that climatic influences will exert in the life to come some effects on the prevalence of a series of dermatoses.

Keywords: Skin; Climate; Dew point; Greenhouse gas; Ecosystem; Stratum corneum

Abbreviations

GCC: Global Climate Change; UVL: Ultraviolet Light; SC: Stratum Corneum; TEWL: Transepidermal Water Loss; ULEV: Ultraviolet Light-Enhanced Visualization; RH: Relative Humidity

Background

Global climate changes (GCC) have apparently developed in the world at an increasing rate over the recent past decades. They are perceived as progressive increases both in average and peak temperatures in many geographic regions. In addition, the same areas are gripped by unusual modifications in air moisture, atmospheric pressure and dew point [1,2]. They influence rain and wind activity, glacier melting, as well as salinity, pH and level of the seawater [3]. There is a limited literature on the impact of long-term GCC on human skin. Publications are mainly focused on direct and indirect effects of climate changes on skin physiology and on patterns of specific dermatoses. The current GCC manifestations are associated with an increase in average and peak temperatures on the earth surface. It is acknowledged that the average air surface temperature has increased by 0.6°C over the past century, and it is expected to increase by a further 2°C in about a hundred years or so.

The evolving GCC is mainly attributed to an accumulation of the anthropogenic sources of greenhouse gases (carbon dioxide, methane, chlorofluorocarbons, and nitrous oxide) in the atmosphere [4]. GCC related to greenhouse gas production exhibit some expected effects on the skin condition [5-9]. At present, changes are already observed in climate effects on arthropod-borne diseases [10], and on accentuation of typical seasonal changes in the skin presentation [11-15].

GCC occur so gradually that it is difficult to identify any close association between climate changes and specific skin conditions. Population-based studies of the incidences and prevalences of dermatoses are expected to be helpful when they are reported in regions where definitive GCC are taking place. Presently, it seems foolhardy to guess and predict the possible changes in prevalence and clinical manifestations of most dermatoses. The same is true for the adaptations of future treatment strategies. It is possible that some diseases will become underdiagnosed and undertreated in some parts of the world. Whatever risk exists is extremely small that the incidence of many dermatoses will be rapidly changing.

GCC are thought to increase the frequency and severity of extreme weather events, including tropical cyclones, hurricanes, typhoons, droughts, and heat waves. These occurrences lead to rising sea levels and floods, and to a shift in the distribution and behavior of a series of living organisms. Presently, ocean acidification has altered its carbonate system. By a matter of fact, some past massive organism extinction events have been attributed to ocean acidification, and the current rate of changes in seawater chemistry is unprecedented. Evidence suggests some major consequences for marine organisms building shells, skeletons, and tests of biogenic calcium carbonate. Such aquatic organisms include tropical reef-building and cold-water corals, crustose, coralline algae, *Halimeda*, benthic molluscs,

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echinoderms, coccolithophores, foraminifera, pteropods, seagrasses, jellyfishes, and fishes. Potential changes in the distributions and abundances of various species could propagate through multiple trophic levels of marine food webs.

GCC effects on skin physiology

Human skin acts as a biosensor and responds to changes in the environment for maintaining internal homeostasis. Low ambient temperatures and decreased environmental humidity enhance skin roughness (xerosis) [15-18]. Ultraviolet light (UVL) exposures alter the intrinsic skin biology and its ecosystem. They are responsible for photoaging [19].

For the next decades, the greenhouse effect will probably affect the skin, particularly the stratum corneum (SC). This superficial structure represents the major boundary between the organism and the environment including xenobiotics. Any GCC will possibly produce changes in the human skin integrity and functioning. Predictive information is tentatively inferred from data characterizing skin under controlled climate conditions using noninvasive bioengineering techniques [17,20]. At present, it appears that in vivo reflectance confocal microscopy [18,21,22], skin capacitance mapping [23,24] and UVL-enhanced visualization (ULEV) [23,24] represent sensitive informative tools probably showing early GCC effects on the SC.

The relationship between the SC and water is much more complex than a simple model of moisturized sponge. The concepts of water-as-ice and the higgledy-piggledy-water should be taken into consideration when considering GCC impact [25,26]. These features largely condition the epidermal barrier function that is indeed under the influence of the environment [27]. The corneocyte desquamation process is further dependent on these physical features [28].

Exposure to dry environmental conditions leads to increased SC roughness, decreased electric capacitance and Transepidermal water loss (TEWL). Studies examining the role of temperature and relative humidity (RH) in human subjects have found that average skin temperature is more influenced by the ambient temperatures than by RH [17,29,30]. Furthermore, TEWL decreases rapidly with the lowering of the environmental temperature [29,31].

Direct GCC effects on dermatoses

A series of observations points to some climate-related natural disasters that have recently affected human skin [32]. The most common skin diseases occurring after extreme weather events are various bacterial infections, particularly those due to Gram-negative microorganisms. Fungi and viruses are other less frequent causes of skin infections due to climate changes. Ozone depletion increases UVL exposure, which leads to photoaging [19]. There is some evidence that the effects of the higher temperatures resulting from global warming increase the incidence of skin cancers [33].

Indirect GCC effects on dermatoses

Short-term climate variability related to recurrent events such as El Niño, is associated with warmer ambient temperatures, frequent storms, rains, floods and conversely droughts. These events have clearly contributed to higher incidences of vector-borne infectious diseases including malaria, leishmaniasis and dengue.

Indirect effects of GCC on skin disorders remain subtle or unknown. Temperature, precipitation, humidity, cloudiness, UVL radiation, and global weather conditions possibly influence in an indirect way some patterns of dermatoses. In the past, changing climates have modified some characteristics in animals and vegetations. These species evolved, flourished or disappeared [34,35]. Of note, current GCC are associated with higher abundances of specific infestation vectors [36]. Warming and changes in ambient humidity and precipitations affect the geographic distribution of a series of vectors including ticks [37,38], mosquitoes [39], sandflies [38], and snails [40,41]. The incidences of some dermatoses have changed over time, but the putative influence of climate change remains unsettled. Seasonal variations presently occur in a variety of skin diseases including acne, seborrheic dermatitis, miliaria, psoriasis, scabies, bacterial infection patterns, and fungal dermatoses. However, the precise relationships between these conditions and GCC remain unclear.

Conclusion

The environment, particularly the combination of the ambient temperature and RH likely influence the SC texture and its functional potential. Therefore, the skin physiology is susceptible to be altered by any event in GCC. A series of bioengineering methods are precise and reproducible to ascertain the changes in skin barrier functions, and to detect subtle changes in the skin in response to shifting environmental conditions.

References

1. Paquet F, Piérard-Franchimont C, Fumal I, Goffin V, Paye M, Piérard GE, et al. Sensitive skin at menopause; dew point and electrometric properties of the stratum corneum. Maturitas. 1998; 28: 221-227.
2. Devillers C, Piérard GE, Quatresooz P, Piérard S. Environmental dew point and skin and lip weathering. J Eur Acad Dermatol Venereol. 2010; 24: 513-517.
3. Rahmstorf S. A new view on sea level rise. Nature Reports Climate Change. 2010; 4: 44-45.
4. Meinshausen M, Meinshausen N, Hare W, Raper SC, Frieler K, Knutti R, et al. Greenhouse-gas emission targets for limiting global warming to 2 degrees C. Nature. 2009; 458: 1158-1162.
5. Piérard-Franchimont C, Piérard S, Piérard GE. Geoclimatic stress impact on the skin. Dermat Actual. 2006; 100: 22-24.
6. Andersen LK. Global climate change and its dermatological diseases. Int J Dermatol. 2011; 50: 601-603.
7. Andersen LK, Hercogová J, Wollina U, Davis MD. Climate change and skin disease: a review of the English-language literature. Int J Dermatol. 2012; 51: 656-661.
8. Balato N, Ayala F, Megna M, Balato A, Patruno C. Climate change and skin. G Ital Dermatol Venereol. 2013; 148: 135-146.
9. Singh B, Maibach H. Climate and skin function: an overview. Skin Res Technol. 2013; 19: 207-212.
10. Rogers DJ, Randolph SE. Climate change and vector-borne diseases. Adv Parasitol. 2006; 62: 345-381.
11. Kikuchi K, Kobayashi H, Le Fur I, Tschachler E, Tagami H. The winter season affects more severely the facial skin than the forearm skin: comparative biophysical studies conducted in the same Japanese females in later summer and winter. Exogenous Dermatol. 2002; 1: 32-38.
12. Piérard-Franchimont C, Piérard GE. Beyond a glimpse at seasonal dry skin. A review. Exogenous Dermatol. 2002; 1: 3-6.
13. Andersen F, Andersen KH, Kligman AM. Xerotic skin of the elderly: a summer

versus winter comparison based on biophysical measurements. Exogenous Dermatol. 2003; 2: 190-194.

14. Rawlings AV. Dry skin: environmental aspects. Exogenous Dermatol. 2004; 3: 72-80.

15. Piérard-Franchimont C, Piérard GE. [Between factoids and facts, between dry skin and rough skin]. Rev Med Liege. 2000; 55: 945-949.

16. Tagami H, Kobayashi H, Zhen XS, Kikuchi K. Environmental effects on the functions of the stratum corneum. J Investig Dermatol Symp Proc. 2001; 6: 87-94.

17. Delvenne M, Piérard-Franchimont C, Seidel L, Albert A, Piérard GE. The weather-beaten dorsal hand clinical rating, shadow casting optical profilometry, and skin capacitance mapping. Biomed Res Int. 2013; 2013: 913646.

18. Manfredini M, Mazzaglia G, Ciardo S, Simonazzi S, Farnetani F, Longo C, et al. Does skin hydration influence keratinocyte biology? In vivo evaluation of microscopic skin changes induced by moisturizers by means of reflectance confocal microscopy. Skin Res Technol. 2013; 19: 299-307.

19. Rittié L, Fisher GJ. UV-light-induced signal cascades and skin aging. Ageing Res Rev. 2002; 1: 705-720.

20. Xhauflaire-Uhoda E, Loussouarn G, Haubrechts C, Léger DS, Piérard GE. Skin capacitance imaging and corneosurfametry. A comparative assessment of the impact of surfactants on stratum corneum. Contact Dermatitis. 2006; 54: 249-253.

21. Piérard GE. In vivo confocal microscopy: a new paradigm in dermatology. Dermatology. 1993; 186: 4-5.

22. Corcuff P, Gonnord G, Piérard GE, Lévéque JL. In vivo confocal microscopy of human skin: a new design for cosmetology and dermatology. Scanning. 1996; 18: 351-355.

23. Xhauflaire-Uhoda E, Piérard-Franchimont C, Piérard GE, Quatresooz P. Weathering of the hairless scalp: a study using skin capacitance imaging and ultraviolet light-enhanced visualization. Clin Exp Dermatol. 2010; 35: 83-85.

24. Piérard GE, Piérard-Franchimont C, Delvenne P. [Environmental effects on the stratum corneum]. Rev Med Liege. 2014; 69: 68-71.

25. Forestier JP. Peau sèche-rêche et “Hydratation”. Concept de la capture de l’eau organisée comme de la glace. Int J Cosmet Sci. 2004; 26: 183-195.

26. Piérard-Franchimont C, Hermanns-Lê T, Piérard SL, Piérard GE. Climatic changes and the antinomy of dehydrating water. Rev Med Liège. [in press].

27. Denda M, Sato J, Masuda Y, Tsuchiya T, Koyama J, Kuramoto M, et al. Exposure to a dry environment enhances epidermal permeability barrier function. J Invest Dermatol. 1998; 111: 858-863.

28. Pierard GE, Goffin V, Hermanns-Le T, Pierard-Franchimont C. Corneocyte desquamation. Int J Mol Med. 2000; 6: 217-221.

29. Cravello B, Ferri A. Relationships between skin properties and environmental parameters. Skin Res Technol. 2008; 14: 180-186.

30. Berger X, Grivel F. Mean skin temperature in warm humid climates. Eur J Appl Physiol Occup Physiol. 1989; 59: 284-289.

31. Chen CP, Hwang RL, Chang SY, Lu YT. Effects of temperature steps on human skin physiology and thermal sensation response. Building Environ. 2011; 46: 2387-2397.

32. Noe R, Cohen AL, Lederman E, Gould LH, Alsdurf H, Vranken P, et al. Skin disorders among construction workers following Hurricane Katrina and Hurricane Rita: an outbreak investigation in New Orleans, Louisiana. Arch Dermatol. 2007; 143: 1393-1398.

33. van der Leun JC, Piacentini RD, de Gruijl FR. Climate change and human skin cancer. Photochem Photobiol Sci. 2008; 7: 730-733.

34. Bradley M, Kutz SJ, Jenkins E, O’Hara TM. The potential impact of climate change on infectious diseases of Arctic fauna. Int J Circumpolar Health. 2005; 64: 468-477.

35. Pounds JA, Bustamante MR, Coloma LA, Consuegra JA, Fogden MP, Foster PN, et al. Widespread amphibian extinctions from epidemic disease driven by global warming. Nature. 2006; 439: 161-167.

36. Gilbert L. Altitudinal patterns of tick and host abundance: a potential role for climate change in regulating tick-borne diseases? Oecologia. 2010; 162: 217-225.

37. Lindgren E, Tälleklint L, Polfeldt T. Impact of climatic change on the northern latitude limit and population density of the disease-transmitting European tick Ixodes ricinus. Environ Health Perspect. 2000; 108: 119-123.

38. Brownstein JS, Holford TR, Fish D. Effect of Climate Change on Lyme Disease Risk in North America. Ecohealth. 2005; 2: 38-46.

39. Tanser FC, Sharp B, le Sueur D. Potential effect of climate change on malaria transmission in Africa. Lancet. 2003; 362: 1792-1798.

40. Peterson AT, Shaw J. Lutzomyia vectors for cutaneous leishmaniasis in Southern Brazil: ecological niche models, predicted geographic distributions, and climate change effects. Int J Parasitol. 2003; 33: 919-931.

41. Zhou XN, Yang GJ, Yang K, Wang XH, Hong QB, Sun LP, et al. Potential impact of climate change on schistosomiasis transmission in China. Am J Trop Med Hyg. 2008; 78: 188-194.

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