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Research Article

Advancing climate action: Lower atmospheric thermodynamics, financial mechanisms, and the Phase-out of fossil fuels

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Abstract

In this present study, the increased lower atmospheric thermodynamics, which, over the decades, culminated in global warming, proposed and contemporary climate financing, and termination of fossil fuel usage: the way forward, were looked into. The methodology adopted was mainly observations of the atmospheric (weather) activities, which formed parts of the primary data, from which information was obtained at different stages, and some parts of secondary materials, which were parts of existing literature. The study shows that, although atmospheric thermodynamics, ideal dry gaseous components; hydrostatic stability, heat conduction, temperature, convection, radiation, adiabatic processes, latent heating, lapse rate and Earth's stability which together kept the Earth in constant equilibrium are battled by the global warming and its effects are devastatingly bringing the ecology, ecosystems and economies of African nations to nearly alarming points. The results showed that two options are only feasible: seeking alternatives to fossil fuel usages and Climate Financing and Climate Justice to mitigate the situation. The results also went further to show that African nations, which are poorer than the developed nations, are more susceptible and have the direct impacts of Climate Change, and are to benefit more from Climate Financing. It was recommended that the United Nations' schema for 2023, which outlined six (6) critical activities for governments and financial institutions for ICF (International Climate Finance) promises, must be kept towards ensuring Climate-free nations by 2027 for sustainable ecosystems and clean energies in Africa.

1.0 Introduction

The 18th-century Industrial Revolution of Northwest Europe has shown a tremendous increase in fossil fuel consumption. However, in the 21st century, the supply reached 78.8% of all the energy consumed by the industrialised nations. Despite the discoveries of new major fossil deposits yet the reserves of the Earth's deposits remain limited. Fossil fuels are dirty hydrocarbons that contribute to global warming and pollute the Biosphere and the Troposphere (Kankara, 2024b). Yet, Climate Change (CC) grew to be a vast area that encompasses the fossil fuels, which are classes of hydrocarbon-containing materials used as sources of energy of organic origin found within the crust of the Earth. These are petroleum (natural gas, aviation fuel, and kerosene), oil-bearing shale, bitumen, tar sands, coal, and heavy oils (oils with complex hydrocarbon materials) (Steeve, 2020). They contain carbon and were formed due to geological processes that acted on the remnants of organic matter formed by photosynthetic action. This process began in the Archean Eon of the Precambrian Era (4,000-2,500) by (Steeve, 2020).

Laura (2020) reported that most carbonaceous materials before the Devonian period (419.2- 358.9 my) were derived from algae and bacteria. Those happening during and after that interval resulted from the plant's matter. One of the main by-products of fossil fuel combustion is Carbon IV Oxide (UNFCCC, 2006). A significant amount of CO_2 was continuously added to the Earth's atmosphere by the growing demand for fossil fuels in manufacturing, transportation, and construction (IPCC, 2007). The carbon emission concentration in the atmosphere oscillates between 275 parts per million by volume (ppmv) and 290 ppmv of dry air from 1000 CE up to the late 18th century. However, in 1959, it rose to 316 ppmv, and reached 421 ppmv in 2023. As part of greenhouse gases resulting from anthropogenic activities, CO_2 absorbs and reradiates infrared light back to the Earth's surface. In it is Methane (CH_4), a chief constituent of natural gas, and another potent greenhouse gas. Its concentrations in Earth's atmosphere have witnessed a rise from 722 parts per billion (ppb) before 1750 to 1,859 ppb by 2018, with a terrific rise to 1,919 ppb by 2023 (IPCC, 2007).

The Keeling curve monitors the variations of CO_2 in the atmosphere, and in (Steeve, 2020), it is realised to be rising despite minor seasonal variations, due to an increase in energy demand. During the first half of the 21st century, fossil fuels contributed about 80% of the world's energy demands (Liegeois et al, 2003). At the COP28 in 2023 in Dubai, attended by 200 member countries, it was agreed to begin the transition of the world's economies from fossil fuels to renewable energy (Laura, 2020). This is to reduce the risks associated with escalating greenhouse gas concentrations in the atmosphere, contributing to climate change. Therefore, to achieve the net-zero carbon emissions goal by 2050, which will limit the global temperature to about 1.5°C, the delegates encouraged the acceleration of renewable energy projects such as wind, solar, and other sources by 2030 (Ladan, 2011).

Many countries use lignite for energy (such as electricity generation), even though most of the lignite (Liegeois et al, 2003) is geologically young, formed during the Mesozoic and Cenozoic eras (251 my), and its thick beds lie close to the surface (most of the time greater than 30m). This makes its production cost low (Kankara, 2024a). However, its utilisation of lignite is perplexing due to its high-water content, usually more than 75% in some varieties. In many countries, such as Australia, New Zealand, Canada, the United States, and elsewhere, there is increased use of lignite by local utilities, industries, and local consumers close to the mine locations (Haido, 2023).

This study aims to analyse the synergy between lower atmospheric thermodynamic changes, climate financing mechanisms, and strategies in phasing out fossil fuels as climate mitigation goals. By integrating atmospheric science, economic policy, and an energy transition framework, the paper seeks to provide actionable insights for policymakers, scientists, and financial stakeholders. In addition, the objectives are: to assess the impact of lower atmospheric thermodynamics; analyse the effectiveness of the current financial instruments (e.g., green bond, carbon pricing, international climate funding) especially the ration between mitigation and adaptation; identify barriers to fossil fuel phase-out paths; propose integrated policy frameworks that aligns atmospheric science insight with equitable financing strategies for just and rapid energy transition; and highlight case studies and success models where coordinated climate action has successfully reduced fossil independence.

2.0 Materials and Methods

2.1 Review of Related Literature

UNEP (2005) reported that in the Tropospheric structures, the equilibrium state of the system can be determined by a small number of properties such as temperature, pressure, and volume. Therefore, in atmospheric thermodynamics dissertations, these elementary phases are considered. All weather occurs in the troposphere, which is about 75% of the total composition of the whole atmosphere, or the lower atmosphere. The troposphere begins at the Earth's surface with a varying height between 11 and 12 miles at the equator. It is five and a half miles at 50°N and 50°S, and just under four miles at the poles. However, the troposphere temperature decreases with height, also the gas density decreases with height, prompting a thinner air (Kankara, 2024a) as shown in Figure 1. The higher it is, the more the temperature drops from the usual of 17°C to -51°C at the tropopause (Kankara, 2024a). In the last 40 years, due to climate change, the boundary between the troposphere and the neighbouring stratosphere (pink) has grown, as also the rise in global temperatures (UNFCCC, 2006).

The portion of sky nearest to the Earth has been continuously moving upward at a rate of 50 to 60 meters per decade, from weather balloon data gathered in the northern hemisphere over the past 40 years (UNEP, 2005). Because air inflates during the hotter season and contracts in the cold, the upper border of the troposphere, also known as the tropopause, naturally rises and falls with the seasons throughout the year. However, the troposphere is growing higher into the atmosphere, caused by more greenhouse gases and heat trapped in the atmosphere (UNFCCC, 2006). Although scientists do not envisage that this alteration will have a big impact on the weather, this study serves as a glaring reminder of how climate change affects the entire planet.

Fig. 1: Presence of Troposphere in Nigeria: The Mabilla Highlands

2.2 Concept and Context of Atmospheric Thermodynamics

The Hadley circulation, characterised by the rise of warm, tropical air in the equatorial area and the fall of colder air in the subtropics, results in a net production of kinetic energy. As a heat engine, the Hadley system's thermodynamic efficiency has been fundamentally consistent between 1979 and 2010, averaging 2.6%. The Hadley regime's power generation has increased at an average annual rate of roughly 0.54 throughout the same period. This suggests a surge in the system's energy input that corresponds with the tropical sea surface temperature trend (Hazo et al, 2019). Then, when the air travels in the direction of the convective system, it becomes wet. In a deep convective core, ascending motion causes condensation, cooling, and air expansion. As an anvil cloud eventually descends, an upper-level outflow is seen, preserving mass.

A hurricane's thermodynamic behaviour can be compared to a heat engine that transforms heat energy into wind energy by moving heat from the sea's heat reservoir, which is at around 3000K (27 °C), to the tropopause's heat sink, which is at around 2000K (-72 °C).

Heat and water vapour are absorbed by air parcels moving near the sea surface; the heated air rises and expands, resulting in condensation and precipitation. The Coriolis force drives the circulatory winds created by the rising air and condensation, which create waves and boost the volume of warm, humid air that fuels the cyclone. The maximum winds seen in hurricanes will rise in response to both a drop in temperature in the upper troposphere and an increase in temperature near the surface. It predicts the maximum hurricane intensity and outlines a Carnot heat engine cycle when applied to hurricane dynamics.

For every rise of temperature, the atmosphere's capacity to store water increases by roughly 9%. (It is not directly influenced by other factors such as density or pressure.) Using the August-Roche-Magnus formula, one can estimate this equilibrium vapour pressure, or water-holding capacity. This demonstrates that, under the assumption of a constant relative humidity, the absolute humidity must likewise rise exponentially as the temperature of the atmosphere rises (for example, as a result of greenhouse gases). The efficacy of rainfall may be affected by the intensity of convection, cloud creation is correlated with comparative humidity, and convective processes may result in wide-ranging drying due to augmented areas of subsidence, so this purely thermodynamic argument is controversial.

Haddeland et al. (2014) state that atmospheric thermodynamics uses the laws of classical thermodynamics to enlighten procedures such as cloud development, atmospheric convection, boundary layer meteorology, vertical inconsistencies in the atmosphere, and the properties of moist air. Atmospheric thermodynamic graphs help forecast storm development. Atmospheric thermodynamics underpins many climate considerations, including convective-equilibrium climate models, as well as cloud microphysics and convection parameterisations used in numerical weather models (Maiwada, 2017).

Advanced studies on water phase transitions, homogeneous and inhomogeneous nucleation, show that the impact of a dissolved material on cloud condensation, and the function of super-saturation in the development of cloud droplets and ice crystals. Different temperatures, including virtual, wet-bulb, and equivalent potential temperatures, are frequently taken into account while discussing moist air and cloud theories. The dynamics of tropical cyclones, the turmoil interaction between air particles in clouds, the large-scale dynamics of the atmosphere, and energy, momentum, and mass allocation are all related. The adiabatic and diabatic forces acting on air parcels are included in the elementary equations of air motion, either as grid-resolved or sub-grid parameterizations, and are used to explain the main function of atmospheric thermodynamics. Numerical weather and climate forecasts are based on these equations.

Heinrich Hertz created the first atmospheric thermodynamic diagram in 1884. Then, in 1888, Von Bezold wrote a lengthy study titled "On the thermodynamics of the atmosphere," in which he defined the pseudo-adiabatic process, which describes the lifting, expanding, cooling, and eventual precipitation of water vapour in air.

The action of buoyant forces that allow warmer air to rise, more dense air to descend, and water to change from liquid to vapour and then condense is explained by atmospheric thermodynamics. It is a fascinating area of physical chemistry that has had a significant impact on the advancement of contemporary science. Energy changes within a system and between the system and its surroundings are the subject of thermodynamics. Therefore, it plays a role in all atmospheric processes, including the microphysical processes that yield clouds and aerosols, the significant universal motion, and the local allocation of radiative and latent heat in the atmosphere (Maiwada, 2017).

The hydrostatic equation, temperature lapse rate, scale height, and the idea of hydrostatic stability, the model gas law are presented. In addition, the potential temperature notion that is linked to the Brunt-Vaisala occurrence and the static stability of the atmosphere, the idea of an air parcel and its enthalpy and free energy are shown (Maiwada, 2017).

The Clausius-Clapeyron equation, and the concepts of neutral buoyancy and free convection are presented and examined using an illustrative and aerological diagrams of standard meteorological practice, atmospheric sounding, and adiabatic conversion for the unsaturated and saturated. Convective obtainable potential energy and convective inhibition will be presented and discussed there.

2.3 Study Area and Scope

Africa is the second largest continent, with a latitude of 9.10210N and a longitudinal position of 18.28120E (Figure 2). Its distinctive and varied geography includes the Sahel, the Sahara desert, the semi-arid zones, the Ethiopian highlands, the Swahili Coasts, the rainforest, freshwater zones, the African great lakes, and the South African highlands. The Atlantic, Red, Mediterranean, and Indian oceans enclose it. It is 30.5 million square kilometres in size, with a relief of mountains, plateaus, and rift valleys, the most notable of which is the East African Rift Valley system. According to Kankara (2024b), Mount Kilimanjaro is the highest point.

Fig. 2: Africa, Showing Regions

3.0 Results and Interpretations

3.1 Dry Air Thermodynamics and Stability

The model that relates the physical variables of any homogeneous substance is presented in equation (1). This representation for all gases over varied conditions is referred to as the *perfect gas approximation*, and is given in the form:

$$PV = mRT \quad (1)$$

where p is the pressure in Pascal (Pa), V is the volume in cubic metre (m^3), m is the mass in kilogram (Kg), T is the temperature in Kelvin (K), and R is the *specific gas constant*, whose value is determined by the gas and expressed as the amount of substance in terms of number of moles is defined by:

$$n=m/M \quad (2)$$

where M is the molecular weight of the gas.

The expression in equation (1) can be rewritten as:

$$PV = nRT \quad (3)$$

where R is the universal gas constant, usually at a value of 8.3143 $Jmol^{-1}K^{-1}$. The kinetic theory of gases posits a perfect gas model that is the assemblage of rigid spheres randomly hitting the wall of the containing vessel or medium, and moving and bouncing with each other. Because of this lack of mutual interaction, the core energy of the gas, which is related to its temperature and the total of all the kinetic energies of the rigid spheres, is determined. The second implication is that, for a mixture of gases, one can define a partial pressure P_i for each component i as the pressure it would have at the same temperature and volume if it were alone (Maiwada, 2017). By applying Dalton's law to a combination of gases, the fractional volume, $V_{i,}$ as that occupied by the same mass at the same temperature and pressure, can be expressed as.

$$P = \sum_i P_i \quad (4)$$

where, for each gas, it holds that (Akpaneno & Kankara, 2023):

$$P_i V = n_i RT \quad (5)$$

Equation (1) can be used to model the gas mixture of a specific gas constant R as:

$$R = a_{mi} R_{mi} T \quad (6)$$

The mix of gases, water in any form, its 3 physical properties, and suspended solid/liquid particles (aerosol) makes up the atmosphere. Nitrogen gas, which has a specific gas constant of 296.80, a mass fraction of 0.7552, and a molar fraction of 0.7809, is the primary component of dry atmospheric air. Oxygen gas, which has a specific gas constant of 259.83, a mass fraction of 0.2315, and a molar fraction of 0.2095, comes next. The molar and mass fractions of argon are 0.0093 and 0.0128, respectively, and its specific gas constant is 208.13. The specific gas constant for carbon dioxide is 188.92, its mass fraction is 0.0005, and its molar fraction is 0.0003. Up to roughly 100 kilometres above the ground, the composition of the air remains stable, but farther up, molecular diffusion predominates over turbulent mixing.

3.2 The Atmospheric Radiation

The atmospheric radiation is predisposed by the quantity of electromagnetic energy intermediate the Earth's surface and the Sun, the super planet. It is also affected by the atmospheric factors such as clouds, aerosols, and gases. Atmospheric radiation encompasses both long-wave (thermal) and solar radiation, or sunshine. The amount of solar energy reaching and reflected by the Earth's atmosphere is dependent on several parameters such as temperature, humidity, cloud droplets, aerosol particles, atmospheric gases, and even the characteristics of the land and ocean surfaces, as shown in Figure 3. It is therefore pertinent to note that this atmospheric radiation is the most crucial in weather variations. For instance, the convective clouds are a result of sunlight heating the land surface; long-term reflection and absorption of radiation by aerosols, gases, or clouds affect the temperature changes and rainfall patterns; and so on.

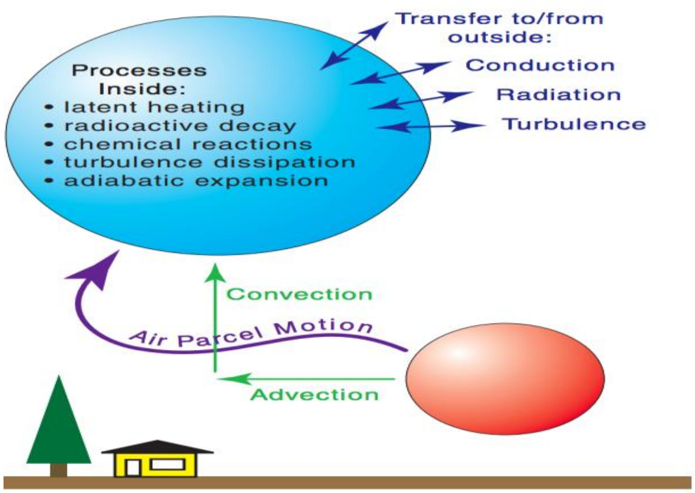

Fig. 3: Dimension of Heat Transfer to Attain an Equilibrium

The Atmospheric Radiation Measurement (ARM) is a user facility operating in six observational sites globally to investigate the intermittent atmospheric energy. These locations have special equipment such as radars, lidars, and so on, used to record more than 100 atmospheric characteristics variables, including radiation, temperature, and humidity profile, ozone, soil moisture, aerosol, precipitation, and so on. ARM also uses airplanes and tethered balloons. To properly sample regular and yearly cycles of air characteristics and radiation, the ground-based equipment is in operation around the clock (Figure 4).

The first large-scale facility to continuously quantify the cloud and aerosol properties and their impact on Earth's energy balance using a wide range of instruments was ARM, which was established in 1989. The research produced by ARM data analysis has changed the game. Today, it serves as a template for programs all across the world. Since ARM is now the most advanced facility for advancing scientific knowledge of the physical characteristics of the atmosphere, researchers worldwide use ARM data to improve numerical models of weather and climate to advance people's safety and standard of living everywhere (Figure 5).

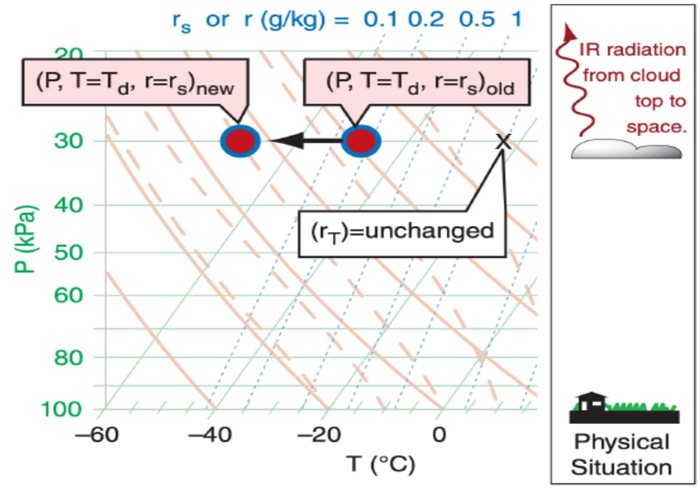

Fig. 4: Radiation from Clouds

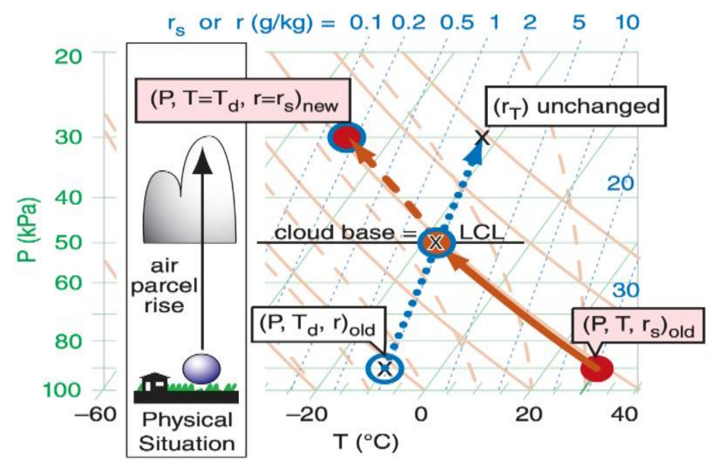

Fig. 5: Air Rise from Cloud's Base

Radiation facts include the fact that the evolution of stratocumulus clouds depends on intricate relationships between radiation, turbulence, and precipitation. Additionally, the effects of aerosol particles and cloud droplets on atmospheric radiation are substantial and rely on the specifics of the particle sizes, shapes, and chemical properties.

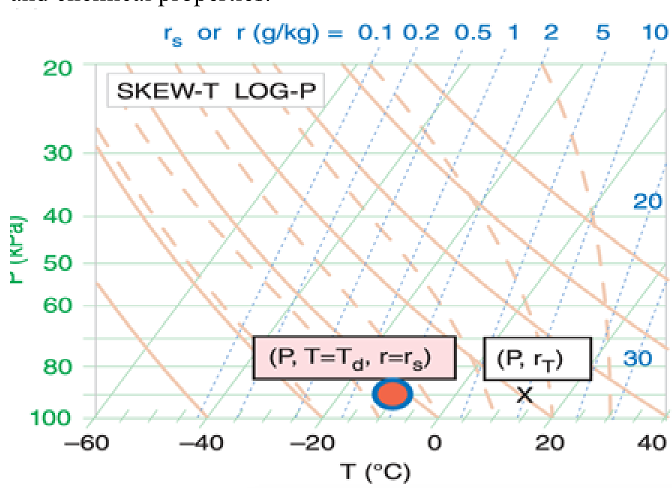

Fig. 6: Saturation of Air at a Certain Level

The Sun is the source of atmospheric radiation, where thermal infrared radiation at wavelengths matching the spectral lines of infrared-active classes is free when the atmosphere warms as a result of solar radiation being absorbed by the Earth's surface and by water vapour and ozone in the atmosphere. In addition to being reflected from the Earth, solar radiation is also dispersed throughout the atmosphere by particulate matter (known as Mie scattering) and molecules (known as Rayleigh scattering). As a result, the atmosphere is made up of both heat emission from the atmosphere and radiation, that is, sunlight that has been scattered and reflected.

Furthermore, UV radiation with a broad variety of wavelengths is present in the solar spectrum. Because of the ionisation of atmospheric species, extreme ultraviolet (EUV) light is absorbed high in the atmosphere, above roughly 130 km. The resultant excited species either recombine with thermal electrons or move on to ion-molecule interactions, which release the stored energy as photons, mostly in the visible spectrum. Similarly, at a distance of around 120 km, molecular oxygen is broken down into atomic form by far ultraviolet (FUV) radiation in the Schumann–Runge continuum. After undergoing the $O+O+M \rightarrow O2^{*}+M$ process, the long-lived atomic oxygen does not recombine until it has diffused or been mixed in some other way downward into the deeper atmosphere, which is around 100 km away. O(1S) metastable oxygen, which is produced when oxygen and atomic oxygen exchange energy, emits the atomic oxygen green line at 557.7 nm. This radiation and the photons released by associated reactions combine to form the airglow, another kind of high atmospheric radiation (Figure 6).

These radiations possess data on the atmosphere as it is a function of temperature and concentrations entailed in the blackbody radiation model. With the knowledge of species' mixing ratio in the case of CO_2, the anticipated temperature can be modelled. On the other hand, the concentrations of variable minor constituents can be ascertained if the temperature is known. Similar airglow lines, like the oxygen green line, use their Doppler shifts and widths to indicate wind and ambient temperature, respectively. Thus, a lot of basic information about the atmosphere can be obtained by remote sensing. The conceptual description of atmospheric remote sensing instruments and the considerations that go into selecting the most appropriate instrument for a given application are the main topics of this article.

Determining the source function requires an understanding of the scattering phase function as well as the scattering and absorption coefficients. The Planck model, for temperature and frequency, is related to the source function linked to an emission procedure in local thermodynamic equilibrium. The radiative transfer calculation is converted into an integro-differential equation by the scattering source function, which involves an integral across all directions of incidence. The difficulty of radiation calculations is significantly increased by this aspect of the scattering process. The plane-parallel cloud assumption, which assumes that clouds are homogeneous and infinite in the horizontal, has led to the development of numerous effective and precise techniques for solving the radiative transfer equation for numerical models and remote sensing applications (Liliana, 2022).

Solar energy is reflected and absorbed by clouds. Under the plane-parallel assumption, the radiative characteristics of clouds can be ascertained by solving the radiative transfer equation. The cloud water path and solar zenith angle determine the cloud albedo and absorption of solar radiation if the vertical distribution of humidity and the cloud particle size distribution are known. The total mass of cloud water in a vertical atmospheric column per unit of surface area is known as the cloud water path.

The cloud albedo surges as a result of the solar zenith position and the cloud water path. For very large cloud water paths, it approaches a limit, while for lesser values, it rises with cloud water path the fastest. Plane-parallel clouds absorb less solar radiation as the solar zenith angle increases, but this absorption increases when the cloud water path increases. A typical water droplet size distribution and a sun zenith angle of 60°, the cloud albedo and absorption can range from around 25% to over 80% as the cloud water content grows from 10 to 1000 g m^{-2}. The size of cloud particles also affects the cloud's albedo and solar radiation absorption. Because smaller droplets present a higher surface area for the same mass, the albedo is larger for smaller droplets when the cloud water path remains stable.

Terrestrial radiation is efficiently absorbed and emitted by clouds. Water clouds become opaque to terrestrial radiation when their water pathways exceed roughly $20gm^{-2}$. Assuming that cloud surfaces absorb and emit terrestrial radiation like black substances is a reasonable approximation for the majority of aqueous clouds. Because cirrus clouds have smaller cloud water pathways and greater cloud particle sizes than water clouds, they are typically only partially transparent to terrestrial radiation. Additionally, recent research indicates that predicting the outgoing long-wave radiation with overcast atmospheres results in considerable errors due to the neglect of infrared scattering processes.

In contrast to the plane-parallel cloud assumption, Liliana (2022) anticipated that real clouds are inhomogeneous and horizontally finite. Increased transmission and absorption of solar radiation throughout the atmosphere result from solar energy leaking from cloud sides when the Sun is overhead. Because cloud are more likely to intercept and reflect solar energy, there is an increase in both reflected and absorbed solar radiation at large sun zenith angles. Additionally, the transmission of long-wave radiation is significantly impacted by finite clouds.

The mass of water vapour per the mass of dry air in a specific volume is the water vapour mixing ratio. It is a good indicator of the measure of air parcels in the atmosphere since it is preserved in atmospheric methods that do not include condensation or evaporation (Haido, 2023).

3.3 Atmospheric Oscillations and Geostrophic Winds

Group theoretical techniques are used to establish general formulations for the matrix elements. These eigenfunctions and eigenvalues are determined in detail for the lunular 24-hourly and semi-diurnal fluctuations. The orthogonality property is deduced from a matrix representation of the Hough functions and related eigenvalues that is created following a thorough analysis of the separable case.

Disparity heating on the Earth's surface causes variations in air temperature at different places. Warmer air expands and produces lower air density and pressure than the surrounding cooler air. The difference in air pressure between two places is known as the

pressure gradient. The pressure differential is what propels the formation of winds. Haido (2023).
The pushing force will be stronger and the winds will be stronger if the pressure gradient is tighter, as wind often moves from higher pressure to lower pressure regions. The wind direction is also influenced by ground friction and the Earth's rotation in addition to air pressure. The rotation of the Earth causes a deflection of a moving air mass to the right of the northern hemisphere.
The Northern hemisphere air travels from West to East with the Earth's surface as it spins. For instance, at Point A, the air mass will shift to position A due to the Earth's rotation, and will move to location C rather than B. This is because, at higher latitudes, point A moves eastwards more quickly than point B. As a result, the air mass will be redirected to the right of an observer at point A.
The Coriolis Effect is the apparent deflection of a moving air mass brought on by the rotation of the Earth. The Coriolis force, which deflects air masses to the left in the southern hemisphere and to the right in the northern hemisphere, is a meteorological representation of the influence of the Earth's rotation. The air movement direction and the Coriolis force's direction are perpendicular. The Coriolis force decreases close to the equator and increases at higher latitudes.
The Coriolis force deflects the air mass to the right as it begins to move. Until the pressure gradient force balances the Coriolis force, the deflection rises. The wind will be blowing parallel to the isobars at this time. The wind is known as the geostrophic wind when this occurs. It functions best when there is geostrophic wind. The impact of air-ground friction must be taken into account in practice. The wind will be pointing slightly in the direction of the low-pressure side when the Coriolis, frictional, and pressure gradient forces are all balanced.

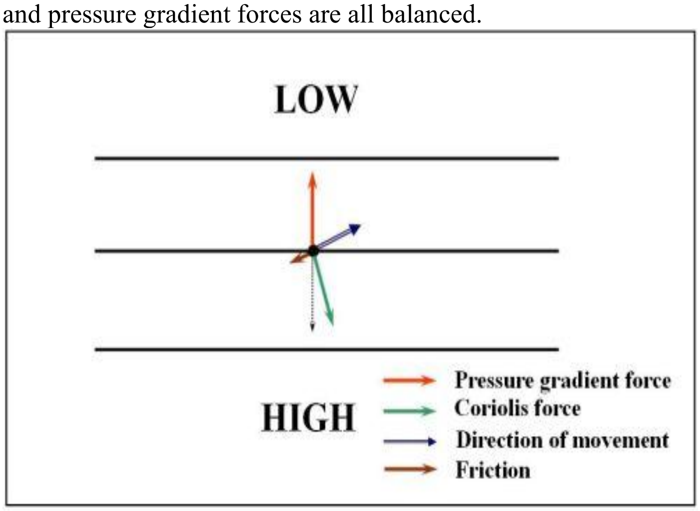

Fig. 7: Balance between Pressure Gradient Force and the Resultant (dotted line) Coriolis Force and Frictional Force

In general, geostrophic winds are more in line with the actual winds over the ocean because the friction acting on an air parcel is less over the sea than it is on land.
By looking at how the actual air temperature and humidity vary with altitude, atmospheric stability may be ascertained. Traditionally, a sounding balloon is used to record variations in vertical temperature and humidity (Fergus, 2020; Figure 7).

4.0 Way Forward

4.1 Ending Fossil Fuels' Usage Globally

The G4 (USA, UK, Germany, and France) and the majority of developed countries (Russia, China, Canada, Japan, Singapore, Korea, Brazil, etc.) are now looking into how to construct gadgets that would reduce the use of fossil fuels both within and outside of their member countries. To diversify their energy mix and ease concerns about rising greenhouse gas concentrations, many countries have developed renewable energy sources (wind, solar, hydroelectric, tidal, geothermal, and biofuels) while also increasing the mechanical efficiency of engines and other fossil fuel-dependent technologies.
Earth is nearing the conclusion of the fossil fuel era. People get more excited and hungrier for what lies beyond by exchanging fresh ideas and letting them see beyond the (fossil age) horizon. They also gain a better awareness of the strategic questions that will arise along the route. The stranded liabilities disaster of coal mining, or how CEOs of coal companies devastate the environment, defraud workers, and take millions of dollars (Fergus, 2020).

4.2 Finding the Alternatives

a. *Transformation of public transportation:* This is the use of Electric Cars and Trams. This was already embraced and begun by most developed and some developing countries. Already, many nations have begun transforming their transportation systems and the CC menace by creating new technologies of modern car designs that do not use fuel but solar energy. Recently, the UAE has begun producing flying cars that consume less petrol. Similarly, there are innovations in modern aircraft with less fuel consumption. African governments must start making preparations too (Stay, 2021).
   Trams are more or less like trains, both in size and otherwise. It does not use coal, it uses electricity. It is currently a means of public transport in Turkey, used in major cities like Istanbul and Iskesahir.
b. *Reduction of Petroleum Usages*: More petrol consumptions facilitate more global warming. Many vehicles can be kept. Many far East Asian nations, such as Korea, have started cutting down the use of locomotives and vehicles that use (Stay, 2021)
c. *Use of CNG*: This is the Compressed Natural Gas, which is about to kick-start in most emerging African nations, particularly Nigeria. In 2024, President Bola Tinubu made moves to start the process by instructing NNPC to begin making necessary preparations on how to effectively break and compress large molecules of hydrocarbons to desired need (Hazo et al, 2019)
d. *Use of Renewable Energy Sources:* They are solar energy, biomass energy, wind energy, and hydroelectric power. Harnessing of solar energy to produce light for industries and other households in Nigeria has since

begun, but that of Wind and HEP is receiving slow attention.

e. *Building storm-resistance*: These are housing, drought-tolerant crops, and reliable water supply installations (Fergus, 2020)

f. *Investment on social safety nets*: In order to provide safety nets in times of crisis, additional components may include insurance and social protection programs. These are being developed in many nations, but more assistance is available, such as through the global accelerator on jobs and social protection. The 4 billion people who do not now have social protection are to be given it.

4.3 Climate Financing

Half of the world's population now lives in the climate danger zones, with a 15 times higher probability of people dying due to climate impacts, the UN has called for doubling the finance for its adaptation. Climate financing is an umbrella term for financial research, such as loans, grants, or domestic budget allocation for CC mitigation, adaptation, or resilience. It can come from public or private sources and can be channeled by various multilateral development Banks and other development agencies such as the World Bank, Islamic Development Banks, Asian Development Bank, African Development Bank, etc.

Climate justice was made possible by the 1992 United Nations Framework Convention on Climate Change, which adopted the historic idea of "common but differentiated responsibilities." However, justice requires that those who have contributed more to the issue take on a larger share of the burden for finding a solution. For instance, heavy emitters must take immediate action to reduce emissions. For countries with fewer resources to keep up with the massive financial obligations brought on by the acceleration of climate change, justice also relies on wealthier nations lending money to those with fewer resources. In many ways, climate justice can be achieved through climate finance when it is adequate and invested properly.

Six crucial steps are listed in the UN's 2023 agenda for governments and financial institutions to fulfil their commitments to international climate funding. The climate shifts, and hotter days turn into unexpected floods as global warming increases. To stop areas from falling beneath the increasing waters, it might be as difficult as building an intricate system of canals and dams. To address fundamental steps to lower greenhouse gas emissions and prepare for climate change, a significant amount of funding is needed. The majority of countries contributing little to climate change are poorer ones with few factories and minimal resources. The majority of greenhouse gas emissions originate from wealthy nations. These were noted under the current effort to fund the catastrophe caused by climate change.

a. Annual Donations of $100 Billion to Developing Nations

The global agreement on climate change has agreed to inject $100 billion per year into developing countries from 2009, to combat climate change challenges through adaptation and carbon emissions reduction. The funds are meant to be aggregated from wealthier nations through bilateral and multilateral channels. In addition, private funds are to be generated through public interventions and donations. Funds can also flow via grants, loans, and insurance. So far, the amount has not been reached, and the utilisation of the collected amount was unevenly disbursed between adaptation and mitigation. In 2020, the OECD data showed that developed nations provided only $83.3 billion, with only about 8% distributed among low-income countries (Hazo et al, 2019).

Instead, the major funding source was loans, which primarily went to middle-income nations. Investment costs rise as a result. However, the high levels of public debt in many developing nations make it challenging to use the money for that purpose. The fact that the money is being dispersed fairly and appropriately shows that the world community is dedicated to justice.

b. Adherence to Extra Budget If Need Be

Every government aspires to achieve net-zero emissions, but nations and communities must first adjust to climate change before mobilisation money can be provided. With fewer emissions and greater susceptibility to the effects of climate change, adaptation is the top goal in both countries, as it is in many least developed nations. (Hazo and others, 2019). Fair distribution of funds must be achieved without imposing further limitations. Nearly all adaptation money comes from the public sector, and over 60% of it comes from loans rather than grants. Foreign finance sources are crucial for many developing countries. As the effects of climate change become more obvious, the cost of adaptation continues to increase. According to the United Nations Environment Program (UNDP), governments could have to employ up to $300 billion a year by 2030 and possibly $500 billion by 2050. However, these anticipated costs are five to 10 times larger than current financial flows. The Climate Policy Initiative found that adaptation now only receives $50 billion a year, meaning that at least 10% of climate efforts go towards this goal. This disparity is still apparent in the $100 billion commitment, however, it is less obvious. Around $29 billion and $49 billion, respectively, were allotted for adaptation and GHG emission mitigation in 2020, according to the OECD (Kankara, 2017).

c. Financing Development Banks

The present lending scheme to nations for sustainable development and climate change is flimsy, weak, and shortsighted; it does not take into account the state of the economy today. Injustices in the global financial system were also discovered to have significant effects. Many nations lack the financial means to invest in global climate action, despite their desire to do so. Half of the 52 developing countries that are currently experiencing serious debt issues are among the most climate-vulnerable in the world, with 40% of communities living below the poverty line.

Unsustainable national debt loads are mostly caused by high finance expenses. Before the current spike in interest rates, the least developed nations that borrowed from global financial markets had to pay interest rates as high as 8%, while many wealthier nations only had to pay 1%.

This can result in significant expenses for climate funding that go beyond what is already necessary for climate action. More than

60% of climate finance in 2019–2020 involved borrowing money, approximately $384 billion. Just $47 billion had concessional or low-cost interest rates. The total amount of grant funding was just $36 billion. To tackle the magnitude of the crisis, the UN has urged for change in the global fiscal system to make climate and development finance more accessible, sufficient, and cheap. A yearly SDG Stimulus that would increase funding for sustainable development by at least $500 billion a year was also recommended by the UN. The Bridgetown Initiative, spearheaded by the UN Secretary-General and the Prime Minister of Barbados, calls for allocating billions of dollars from the SDG Stimulus, international development banks, and the International Monetary Fund (Hazo et al, 2019).

There are already plans to raise more than $1.5 trillion in green investments from the private sector per year. Current inequities are not only immoral, but they also pose a significant barrier to progress that will shape the planet's future, especially considering the magnitude of climate finance that is needed. Between 2011 and 2020, public and private climate funding nearly doubled, and in 2021, it may reach $940 billion, of which three-quarters will come from domestic sources. The majority is found in Western Europe, North America, Eastern Asia, and the Pacific. By 2030, avoiding the worst effects of climate change would cost $4.3 trillion a year; as the planet warms further, the costs will only increase. Climate finance for renewable energy should increase as funding for fossil fuels decreases.

d. Making the Green Climate Fund Realizable

The Paris Agreement established the major global climate fund, termed the Green Climate Fund (GCF), to direct funding towards developing nations in the battle against climate change (Kankara, 2017). Its resources are split between adaptation and climate mitigation. By lowering the rate of adaptation finance, which must be supplied through grants or the equivalent, the fund helps to promote climate justice. Furthermore, the nation’s most at risk from climate change, such as the African states, should get half of the adaptation resources. The GCF gathered $12.8 billion in its first phase of resource mobilisation, which took place between 2020 and 2023, to help 128 nations and a billion people become more resilient. A second round of funding for the GCF is currently in progress for the years 2024–2027, which are critical for addressing climate change and achieving the Sustainable Development Goals (UNEP, 2005).

e. Loss and Damage Funds Establishment

The establishment of a loss and damage fund was decided upon in the 2022 climate discussions on global perspectives. The UN Secretary-General called to action on loss and harm a matter of international solidarity and climate justice, and he has called for the fund to be established immediately, even though the specifics, such as where and how the funds should be allocated, are still being worked out. Adaptation funds aid in reducing and preparing for the effects of climate change. However, loss and destruction are unavoidable, and vulnerable developing nations bear an unfair and disproportionate share of these costs (Akpaneno & Kankara, 2023). In particular, the funding will assist in covering climate-related costs that occur even when nations prepare and adapt well in advance. It can also use a variety of financial tools. One alternative put out by the UN was to impose taxes on windfall profits from fossil fuels. Another option is debt swaps, in which current debt is cancelled to free up funding for climate actions (Kankara, 2024a).

f. Ensuring Climate Disaster-Free Nations by 2027

When disasters are on the horizon, employing early cautionary systems saves lives. However, only half of the countries have access to preventive products. As extreme weather and climate events become more common, the UN has launched a campaign to have protective covers for homes that are at risk within the next 5 years. This is more feasible now than it was previously because 95% of communities have access to cell phones and 95% can use the Internet (Kankara, 2024a). There have been five times as many disasters in the last 50 years, with an average of 115 fatalities and $202 million in losses per day. In addition to safeguarding people's rights to life and safety, early warning systems are incredibly cost-effective.

According to the Global Commission on Adaptation, damage can be decreased by 30% with a 24-hour warning of an approaching disaster. By spending $800 million on these systems in underdeveloped nations, losses of $3 to $16 billion a year could be avoided. To get universal coverage, the Early Warnings for All project recommends investing $3.1 billion between 2023 and 2027 (Kankara, 2017). Moreover, that will only amount to 50 cents per year per person. The UN is working with the Red Cross, corporations, donor countries, development banks, civil society organisations, and the insurance industry to make it a reality and hasten swift action.

5. Conclusion

The environment faces existential dangers from fossil fuels. The absence of agriculture, poor land performance, drought, slow economic growth, drying up of streams and river beds, persistent warming of the biosphere and troposphere, excessive rains that cause violent flooding, desertification, lack of and slow ecosystem development, and the removal of nutrients and moisture from the land are all consequences of their initiation or triggering of global warming. The land turns arid and unusable for cultivation.

Long-lasting heat waves, desertification, ocean acidification, and catastrophic events like crop failures and bushfires are already beginning to occur and will only get worse over time, draining fragile economies and wrecking infrastructure. Sea level rise will cause several nations to lose significant land.

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Declaration of Conflict of Interest

The authors have collectively contributed to the conceptualization, design, and execution of this journal. They have worked on drafting and critically revising the article to include significant intellectual content. This manuscript has not been previously submitted or reviewed by any other journal or publishing platform. Additionally, the authors do not have any affiliation with any organization that has a direct or indirect financial stake in the subject matter discussed in this manuscript.

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