IFERP
connecting engineers... developing research

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 3, March 2018

# Advance Technology for Carbon Mitigation and Climate Change: A Review

[1] Sudipto Sarkar
[1] Department of Mechanical Engineering, Galgotias University, Yamuna Expressway Greater Noida, Uttar Pradesh
[1] sudipto.sarkar@Galgotiasuniversity.edu.in

**Abstract: Since the carbon budgeting and sequestration process is going on everywhere to avoid so many natural devastations, this is the best time to shed light on the merits of TES. With this in mind, an idea has been developed to determine the functionalities and uses of a contemporary instrument that plays a vital role conceptually in the calculation of carbon concentration in the Earth's atmosphere. Mitigation of climate change consists of measures to reduce long-term global warming extent or rate and its related consequences. Mitigation of climate change generally means reductions in human (anthropogenic) greenhouse gas (GHG) emissions. Mitigation can also be achieved through increasing the carbon sink capacity, e.g., through reforestation. Mitigation strategies will dramatically reduce the risks associated with global warming caused by humans. One of the issues often discussed regarding mitigation of climate change is the stabilization of atmospheric concentrations of the greenhouse gases. There are so many anthropogenic gases which are the main cause of the climate change.**

**Keywords: Carbon Mitigation, Climate Change, Emission, Emission Spectrometer.**

## INTRODUCTION

Propagating the recent development that has taken place in remote sensing is worthy of note. The TES (Tropospheric Emission Spectrometer) is an infrared spectrometer that is one of four instruments on board NASA's Aura satellite for this purpose. TES focuses on the troposphere, the atmospheric layer that ranges from the ground up to the altitude at which aircraft fly. TES can distinguish concentrations of gases found at different altitudes with its very high spectral resolution which is a key factor in understanding their behavior and impact[1].

The defining issue of our time is climate change and we are at a defining moment. The impacts of climate change are global in scope and unprecedented in scale, from shifting weather patterns that threaten food production, to rising sea levels that increase the risk of catastrophic floods. Without drastic action today, it will be more difficult and costly to adapt to those impacts in the future[2].

Greenhouse gasses occur naturally, and are important for the survival of humans and millions of other living things, by preventing some of the warmth of the sun from reflecting back into space and rendering Earth live. But after more than a century and a half of industrialization, deforestation, and large-scale agriculture, atmospheric concentrations of greenhouse gases have risen to record levels that have not been seen in 3 million years. When populations, economies and living standards rise, so does the greenhouse gas (GHG) cumulative amount[3].

The IPCC( Intergovernmental Panel on Climate Change) released a special report in October 2018 on the effects of 1.5 ° C global warming, stating that reducing global warming to 1.5 ° C would require rapid, far-reaching, and unparalleled improvements in all aspects of society. The report found that limiting global warming to 1.5 ° C compared to 2 ° C could go hand in hand with ensuring a more sustainable and equitable society, with clear benefits for humans and natural ecosystems. Although previous estimates centered on predicting the harm if average temperatures were to increase by 2 ° C, this report shows that there will be many of the negative effects of climate change at 1.5 ° C.The study also addresses a variety of effects on climate change that could be avoided by limiting global warming to 1.5oC compared with 2oC or more. Global sea level rise by 2100, for example, would be 10 cm lower, with a global warming of 1.5 ° C compared to 2 ° C. In summer, the likelihood of an Arctic Ocean free of sea ice would be once per cent with a global warming of 1.5 ° C, compared to 2 ° C at least once a decade. Despite global warming of 1.5 ° C, coral reefs will decrease by 70-90 percent, while nearly everything (> 99 percent) would be lost at $2^0$C[4].

## METHODOLOGY

- *Launching And Payload Details:*

The Aura satellite was launched on 15 July 2004 from Vandenberg Air Force Base, California. The satellite travels in an orbit at an altitude of 705 km (438 miles) that brings it close to the north and south poles of Earth. The spacecraft advances 22 ° west with each orbit. It is back at its starting point after 233 orbits (16 days), and the pattern repeats.TES is the first satellite instrument with high spectral resolution to provide simultaneous concentrations of carbon monoxide, ozone, water vapor and methane throughout the lower atmosphere of the Earth.The lower atmosphere (the troposphere) is located between the earth and the height at which the aircraft fly, and is a significant part of the atmosphere that is often influenced by our activity. It demonstrates vital information about global warming and climate change, the water cycle and air pollution. Comprehending the distribution and movement of all of these trace gasses is vital if we are to comprehend and properly represent climate and air quality. TES renders measurements of infrared radiance used to derive the vertical distribution of important pollutants and greenhouse gases[5].

- *Need Of TES:*

Standard routine TES items include vertically resolved oz one profiles, carbon monoxide, water vapor, deuterated w ater vapor, and methane. TES uses a variety of special me asurements that provide denser spatial sampling along orb its and a continuous mode of coverage (transect) to identif y air pollution.

- *Nadir Views And Limb Views:*

TES also observe NADIR VIEW and LIMB VIEW . Limb viewing provides a much longer path through the atmosphere, and looking through a greater mass of air improves the chances of observing sparsely distributed substances that might be missed in the nadir view Limb viewing angle also makes the altitudes of the observed chemicals easier to determine. Yet nadir visibility is less obscured by clouds, is capable of reaching the lowest parts of the troposphere, and helps scientists to study shifts as small as tens of kilometers through distances.

Specific observations could only be planned during the 9 or 10 orbit gaps in the Global Surveys and are carried out in one of three simple modes[6].

- **Stare:**In nadir mode point for up to about 4 minutes at specific locations over testing sites and other scientific interest. Thesemeasurements are made as long as the target is within +/- $45^0$ (up to 210 seconds) of the nadir position.
- **Transect:** In nadir mode, point at a collection of contiguous areas to cover approximately 850 KM or in limb mode forever.
- **Step-&-Stare:** Point for 4 seconds on nadir (5.2 seconds with reset needed) Aura travel 39 KM in Its orbit during that period and its nadir point on the surface of the earth moves 35 KM.emphasis again on nadir for repeating the same again and again.

- *What does TES derives Mean :*

Area profiles, atmospherictemperature, water vapor and deuterated water vapor concentrations, carbon monoxide with methane, nitricacid, effective cloud pressure and optical depth, surface temperature or land emissivity are mostly obtained from TES radiance spectra.

- *Principle*:

The fundamental principle of FTIR (Fourier Transform infrared Spectrometer) is just to split and merge a light beam such that a wavelength dependent interference is generated by the recombined beam.

- *Working Of TES :*

TES is a FTIR that tests the energy (radiance) of infrared light produced by the Earth's surface and by troposphere gasses and particles. At certain wavelengths of signature each substance emits infrared radiation. Earth's atmosphere's emission wavelengths vary with cloud cover and the concentration of the different gasses and particles that absorb and emit infrared energy, and the pressures and temperatures at which they are found. Because the emission wavelengths differ with temperature and pressure, and the temperature and pressure vary with altitude, we can infer the altitude of the chemical species if the emission spectra are determined very accurately.

- How does TES measures?

The TES instrument was equipped with very fine spectral resolution, with a spectral resolution of 0.1 cm-1 or 0.025 cm-1, respectively, allowing one scan every 4 or 16 seconds. This fine spectral resolution helps TES to determine the wavelengths at which main substances in the troposphere emit and to measure their pressure-widened lines of infrared absorption. These lines are used to identify substances within the troposphere, and to determine their altitude.

## CHEMICAL CLUES

In addition to the temperature and associated error estimates, the standard TES products consists of vertical volume mixing ratio (VMR) profiles for troposphere ozone, water vapor ,deuterated water ,carbon monoxide and methane at a range of altitudes derived from pressure level.

*Ozone:*Ozone is an integral part of the troposphere. Ozone protects us high up in the stratosphere from the damaging Ultraviolet rays of the sun. But below that, it acts as a greenhouse gas at the top of the troposphere, and contributes to global warming. This plays a key role in a chemical process, in the middle of the troposphere, which clears the air of certain contaminants. But it does contribute to smog at the bottom of the troposphere, where we live and breathe, and is toxic to plants and animals.TES measurement allow scientist to monitor the accumulation, formation, degradation and movement of this vital chemical across the atmosphere at different altitudes[7].

- In order to measure $O_3$troposphere budget and determine its role in troposphere chemistry and climate forcing, we need to know the origin, distribution and fate troposphere ozone abundance affects.

*Carbon Monoxide:*Carbon monoxide (CO) is an excellent tracer for pollution sources and pollution pathways through the troposphere. Since the lifetime of most CO (situated in the lower troposphere, or boundary layer) is on the order of months, compared to the inter-hemispheric mixing time of 1–2 years, it is not thoroughly mixed throughout the troposphere. This means that the global distribution of CO closely resembles its source distribution, which is greatest near the surface. Conversely, in the free troposphere CO has a relatively long lifetime, which permits the study of long range transport in the upper troposphere and makes it a useful tracer of other pollutants[8].

Biomass burning and the use of fossil fuel (followed by hydrocarbon oxidation and methane oxidation) are the primary sources of man-made CO emissions, and more than half of all CO emissions are considered man-made. Reaction to the hydroxyl radical (OH) is the major global sink for troposphere CO. Carbon monoxide, after carbon dioxide and methane, is the third most common carbon based trace gas in the atmosphere.

## TES CONTRIBUTION IN UNDERSTANDING CARBON MONOXIDE

TES also has the benefit of detecting CO in the winter and in the lower troposphere while most other instruments can detect CO in the summer only. TES provides new information on gross emissions and vertical CO distribution during major biomass burning events occurring in both equatorial and boreal regions, which can be used to better understand changes to the Earth's carbon cycle[9].

- *Potential for CO to indirectly control the oxidative capacity of the troposphere:*

Vertically transported CO outcomes in longer lifetimes of $O_3$ precursors and enhanced convection regions of $O_3$ in the middle and upper troposphere, thus directly affecting the radiation balance on Earth. Carbon monoxide interacts in the atmosphere with radicals of hydroxyl (OH) which reduce their abundance. Because OH is the only important tropospheric sink for many atmospheric trace gases emitted into the atmosphere, CO has the ability to influence indirectly much of the troposphere's oxidative power. Since OH radicals also help to increase the lifespan of powerful greenhouse gases such as methane, CO also indirectly increases the potential for those gasses to warm globally. Troposphere O3 is formed in the presence of NOx and water vapor, by photochemical oxidation of CO. Then, by photolysis, O3 produces hydroxyl radicals (OH) in water vapor regions. TES also uses CO profiles to assess the temperature / pressure profiles and the exit pathways of boundary layers.

## GLOBAL WATER CYCLE

Knowing how water flows between Earth's surface and atmosphere (water cycle) is crucial for forecasting climate and water supply in different parts of the world, and for formulating plans to help people adapt to climate change caused by global warming. By offering an important piece of the puzzle, TES helps deepen our comprehension of the water cycle[9][10].

- *What Do We Learn From TES On The Global Water Cycle?*

TES water isotope measurements help track the origin and movement of water vapor throughout the Earth's atmosphere and explain how the hydrological cycle is at different locations. The water isotopes are a good tracer for the background of an air parcel's formation, condensation, and evaporation. Increased condensation means more depletion of the isotope and reduced evaporation means less depletion of the isotopes. Global distribution of isotopes generally show increased latitude depletion and decreased depletion near convection regions.

- *Under Estimation Of Continental Convection In Tropical Water Cycle*

There is so much ocean water on earth that it may come as a surprise to learn that the role of continental convection in the tropical water cycle has traditionally been underestimated. When condensation model are higher than observation and evaporation models are lower than observations.The TES profiles have included details on the specific isotopic signals for each source, enabling scientists to discern and decide how much water from oceans versus terrestrial sources evaporates into the atmosphere. As TES is capable of distinguishing the water vapor that comes from tropical evapotranspiration, some details are revealed regarding the role of plant transpiration as a source of water vapor.

- *Re-evaporation of Precipitation*

TES models show that precipitation evaporation is an important process in tropics to regulate cloud formation. It points out that evaporation of rain falling from the bottom of clouds is very significant-typically recycling between 20 and 50% during rainfall. The precipitation is re-evaporated into the atmosphere up to 70 per cent. Identifying rainfall evaporation as an important process for rehydration in tropics is helping to recognize and measure some of the water sources previously "hidden."

These findings are exciting; especially regarding the role that water plays in climate. In addition, the beginning and stopping points for arrows on water cycle process diagrams commonly used in undergraduate level courses may need to be updated to take these new findings into account. Cloud-water processes play a direct role in the Earth's radiative equilibrium and are crucial to understanding climate change.

## CONCLUSION

Such results are exciting; especially as regards the role water plays in climate. Additionally, the start and stop points for arrows on water cycle process diagrams widely used in undergraduate-level courses may need to be revised to take into account these new findings. Cloud-water processes play a direct role in the radiative equilibrium of the Earth, and are crucial to understanding climate change.

## REFERENCES

[1] H. Herzog, “Carbon Dioxide Capture and Storage,” in *The Economics and Politics of Climate Change*, 2015.

[2] W. Y. Chen, T. Suzuki, J. Seiner, and M. Lackner, *Handbook of climate change mitigation*. 2012.

[3] E. Kriegler *et al.*, “The role of technology for achieving climate policy objectives: Overview of the EMF 27 study on global technology and climate policy strategies,” *Clim. Change*, 2014.

[4] M. L. O. Baboulet, “Wind energy,” in *Handbook of Climate Change Mitigation*, 2012.

[5] Intergovernmental Panel on Climate Change and Intergovernmental Panel on Climate Change, “International Cooperation: Agreements & Instruments,” in *Climate Change 2014 Mitigation of Climate Change*, 2015.

[6] J. Lehmann and S. Joseph, *Biochar for environmental management: Science and technology*. 2012.

[7] U. Stockmann *et al.*, "The knowns, known unknowns and unknowns of sequestration of soil organic carbon," *Agriculture, Ecosystems and Environment*. 2013.

[8] F. Humpenöder *et al.*, "Investigating afforestation and bioenergy CCS as climate change mitigation strategies," *Environ. Res. Lett.*, 2014.

[9] K. Bäckstrand, J. Meadowcroft, and M. Oppenheimer, "The politics and policy of carbon capture and storage: Framing an emergent technology," *Global Environmental Change*. 2011.

[10] M. Sugiyama, "Climate change mitigation and electrification," *Energy Policy*, 2012.

[11] Prachi Dewal, Gagandeep Singh Narula and Vishal Jain, "Detection and Prevention of Black Hole Attacks in Cluster based Wireless Sensor Networks", 10th INDIACom; INDIACom-2016, 3rd 2016 International Conference on "Computing for Sustainable Global Development", 16th – 18th March, 2016 having ISBN No. 978-9-3805-4421-2, page no. 3399 to 3403.

[12] Prachi Dewal, Gagandeep Singh Narula, Anupam Baliyan and Vishal Jain, "Security Attacks in Wireless Sensor Networks: A Survey", CSI-2015; 50th Golden Jubilee Annual Convention on "Digital Life", held on 02nd to 05th December, 2015 at New Delhi, published by the Springer under ICT Based Innovations, Advances in Intelligent Systems and Computing having ISBN 978-981-10-6602-3.

[13] Ishleen Kaur, Gagandeep Singh Narula and Vishal Jain, "Identification and Analysis of Software Quality Estimators for Prediction of Fault Prone Modules", INDIACom-2017, 4th 2017 International Conference on "Computing for Sustainable Global Development".

[14] RS Venkatesh, PK Reejeesh, S Balamurugan, S Charanyaa, "Further More Investigations on Evolution of Approaches for Cloud Security", International Journal of Innovative Research in Computer and Communication Engineering , Vol. 3, Issue 1, January 2015

[15] K Deepika, N Naveen Prasad, S Balamurugan, S Charanyaa, "Survey on Security on Cloud Computing by Trusted Computer Strategy", International Journal of Innovative Research in Computer and Communication Engineering, 2015

[16] P Durga, S Jeevitha, A Poomalai, M Sowmiya, S Balamurugan, "Aspect Oriented Strategy to model the Examination Management Systems", International Journal of Innovative Research in Science, Engineering and Technology , Vol. 4, Issue 2, February 2015