Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 10, Issue, 01, pp.63876-63878, January, 2018

INTERNATIONAL JOURNAL
OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

REVIEW OF RESEARCHES ON ARTIFICIAL INFLUENCE ON IONOSPHERE

*Xueqing Zhang

Montana Tech of the University of Montana, 59701, USA

ARTICLE INFO

Article History:
Received 28th October, 2017
Received in revised form
23rd November, 2017
Accepted 17th December, 2017
Published online 19th January, 2018

Key words:

Artificial influence,
Ionosphere research,
Review.

ABSTRACT

Two artificial methods, which affect the ionosphere, including physical and chemical, are studied in this paper. In this paper, we summarize the physical methods and the chemical methods of chemical ionization, such as the influence of different nuclear explosion types on the ionosphere, the ionospheric thermal effect of rocket launching, the influence of high-power radio heating on the ionosphere. World scholars' researches on the human impact ionosphere research process and progress is systematically summarized too.

Citation: Xueqing Zhang. 2018. "Review of researches on artificial influence on ionosphere", *International Journal of Current Research*, 10, (01), 63876-63878.

INTRODUCTION

In general, the earth atmosphere above 60km is partially or completely ionized due to solar radiation and is called the ionosphere. The ionosphere contains a large amount of free electrons and ions, which can change the propagation speed, refraction, reflection and scattering of radio waves and generate polarization plane rotation, Human use these characteristics of the ionosphere in varying degrees and that different human activities affect ionosphere with different mechanism and scope of their roles. In this paper, the perspectives of nuclear physics, thermophysics and chemistry on this area are reviewed respectively.

Nuclear physics methods affect the ionosphere

Nuclear explorations produce a variety of radiation, including electromagnetic radiation such as infrared, visible light, ultraviolet, gamma rays, and particle radiation, including secondary electrons and neutron flux, and produce powerful electromagnetic impulse and shockwave airflow. The ionosphere is full of electrons, ions and so on. All kinds of radiation from the nuclear explosion may change the properties of the ionosphere. In the middle of the last century, researchers successively observed that the nuclear explosion affected the ionosphere while nuclear test of large equivalent (50 tons of TNT) at high altitude over the island of Novoya Zemlya.

****Corresponding author:*** **Xueqing Zhang**
Montana Tech of the University of Montana, 59701, USA

W.Dieminger et al (Dieminger, 1962) from German pointed out that on that day of nuclear explosion from 10am to 10:30am, the critical frequency of the ionospheric F2 layer increased with 100% in electron density considerably; the critical frequency oscillations with an interval of one and a half hours were amplified quadrupled; the ionosphere showed obvious irregularities from 11:30am to 12:03pm, which could not be explained. G.G.Bowman (Bowman, 1962) pointed out in 1962, that changes in the ionospheric F2 layer were observed during August 1958 of the two Johnston island nuclear test within 100km height. After that, S.N.Mitra (1964), P.R.Sengupta (Sengupta, 1964) observed that the nuclear explosion had an impact on the ionosphere too. PeinanJiao[5] conducted a study on the ionospheric effects of low-level nuclear explosion in 1979 by high-frequency backscattering detection and obtained the parameters of additional ionization and ionosphere disturbances caused by nuclear explosions. The results were compared with those gotten by other means in the vicinity of the explosion area, and they were matched with each other. X. Zhang (Zhang, 2015) conducted a study on North Korea's underground nuclear explosion in May 2009, and believed that acoustic gravity waves generated by underground nuclear explosions could trigger and impact on ionospheric disturbances. The variations of ionospheric parameters were also observed by GPS, including high-frequency disturbance of 2-5 minutes and lowfrequency disturbance of 2-5 minutes. In recent years, researchers have used numerical simulation methods to further quantify the impact of airborne nuclear explosions on the ionosphere. Zhengyu Zhao *et al.* (Zhengyu, 2007) obtained the space-time distribution of ionization effects in space nuclear explosion by numerical simulation according to the energy deposition equation of ionospheric equilibrium equations and rays in the atmosphere. Yinglong Tao (Yinglong, 2010) analyzed the generation mechanism of ionospheric effects in highaltitude nuclear explosions for high-altitude nuclear explosion scenarios over 100km. Numerical simulation equations for additional ionization effects were established. In the form of difference equations, Cheng *et al.* (Yinhui Cheng, 2011) setup a method of additional current densities and conductivities based on the ionospheric parameters and the applied electric field. The space-time distribution of ionized electron density in a nuclear explosion scenario was calculated and the influence on shortwave communications was analyzed too. In general, nuclear explosions have different degrees of impact on ionospheric parameters Since the purpose of the nuclear explosion is not intended to act the ionosphere, the influence of the ionosphere is passive. At present, the research on artificial influencing the ionosphere focuses on how to avoid the influence of the ionospheric anomaly on human beings. But nuclear explosions do have influences on ionosphere, which should be paid more attention by researchers.

Thermal physics methods affect the ionosphere

Impact of rockets on the ionosphere

Satellite launch vehicle and its high temperature flame, can cause local disturbance and properties changing of ionosphere. M.Mendillo (Mendillo, 1975) published an article on Science in 1975, and said that the rocket Saturn V launched by NASA greatly affected the ionosphere spatial properties and caused a substantial reduction in density of total electron within 1000km of the propeller's combustion; after that (Mendillo, 1981), more researchers began to focus onto this field. V.A.Pilipenko (Pilipenko, 2008) from Russia analyzed the ionospheric effects caused by the Aureol-3, and discussed the mechanism of ionospheric disturbance during rocket propulsion. BRT.Cotts*et al.*[13] studied the ionospheric whistle wave effect caused by rocket-triggered lightning and set up a series of numeric models. A large amount of data was observed and helpful for the prediction of the electron profile of the earth's radiation band. In October 2015, the website of phys.org (Https://phys.org/news/2015-10-nrl-rocket-effects-dusty-plasma.html,October 6 2015) reported that more than 30 small rocket fired simultaneously, released 90kg aluminum oxide to stain the ionosphere, and the data of the ionospheric electron density affected by a large number of rocket propeller were obtained effectively. The impacts on ionospheric properties by rocket launching have an adverse effect on communication and navigation positioning. Strengthening the research in this area is helpful in avoiding these negative impacts and explaining the ionospheric mechanism.

The effect of radio heating on the ionosphere

Directive ionospheric radiation on the ground with high-power (0.1MW) or ultra-high power(1MW-100MW) transmitters the ohmic heating after ionizing the medium by electromagnetic waves can also change the electrokinetic properties of the medium, as well as ionospheric electrons density distribution and plasma temperature, this method is called as ionospheric high-power radio heating. A.P.Willmore (Wallmore, 1964). conducted a study of ionospheric heating in F layer in 1964, and analyzed the need of ionospheric heating energy input to maintain the ionization temperature. After that, G.Meltz *et al.* carried out a series of studies in 1974, and considered that it could influence the ionosphere by radiating high power with electromagnetic wave of HF, analyzed changes and distributions of electron temperature and density in E and F layer by nonlinear dissipative heating on various conditions. Then, microwave heating to the bottom ionosphere has been studied too. In 2003, WengengHuang (Wengeng Huang, 2003) established a theoretical model of high-ion radio wave heating high layer ionosphere on the premise of assuming dipole diffusion, based on the momentum equation, energy equation and electronic continuity equation. According to this model, for certain parameters of transmitter and absorption model, obvious changes of ionospheric electron temperature and density would happen. In 2008, Bin Xu (Bin Xu, 2008) discussed the problem of ionospheric heating in low-altitude regions, and argued that the temperatures of electron and ionization were not so consistent. In 2009, Feng Deng *et al.* (Feng Deng, 2009) established a two-dimensional model of ionizing radiation heated by microwave radiation in middle and low latitudes, and showed the results of simulation heating at two different times in the morning and evening respectively. It was considered the heating results showed that obviously difference while the ionospheric conditions varying. In 2013, Shuji Hao (Shuji, 2013) set up a directional radiation model for generating ELF/EHF waves with dual beam amplitude modulation (DAM) and circular geometry modulation (CGM), based on the modulation heating theory and the idea of phased array antenna. The correctness of this model is verified by comparison with experimental data. In 2015, Pedersen. Todd (2015) introduced the largest power ionospheric heater in Alaska and made a number of interesting discoveries. In 2016, B.L. Beaudoin (2016) conducted a study on a mobile high-power radioactive ionospheric modulation. The research and activities of high-power radio heating make it possible for mankind to make better use of ionosphere for some purpose, and have great theoretical and practical significance undoubtedly. There is clear and potential value for military too.

Chemical methods affect the ionosphere

Releasing chemical materials with strong affinity in the ionosphere can affect ionospheric electron density, and even form ionospheric holes, which is an effective means for artificial ionospheric disturbance. In 1979, D.G.TORR[24] analyzed the data obtained from NASA project of atmospheric exploration in the United States, and considered the photochemical effects of nitrogen in the ionosphere could not be ignored and discussed the chemical reactions of NO^+、O_2^+、N_2^+ from plasma, atoms and molecules. In 2005, Wengeng Huang *et al.* (Wengeng Huang, 2005), studied the influence of releasing H2O and SF6 on the ionosphere by the means of chemical s26pecies, considered the ionospheric chemical-processing and diffusion of neutral gas in the layer and formation of ionospheric holes. In 2010, Yaogai Hu (Yaogai Hu, 2010) established a three-dimensional kinetic model for the ionospheric releasing of chemicals that diffuse neutral gases, ionized chemical reagents, and simulated ionospheric release of typical chemical species such as H_2O、CO_2、H_2 and SF_6, and pointed out the space-time variation of the ionosphere in the certain area. After that, Yaogai Hu (Yaogai Hu, 2013) also analyzed ionization effects of chemical releasing, considered that the release of neutral gases such as H_2O、CO_2、H_2 and SF_6 in the ionosphere could lead to electron loss in the release region and the formation of obvious artificial ionospheric cavities explored the effect of release height on ionospheric distribution of ionization, ionospheric cavity morphology and dynamic characteristics, and analyzed its genesis too. In 2011,Yong Huang et al (Yong Huang, 2011 and Yong Huang, 2012). Analyzed the diffusion of H_2O and SF_6 and chemical reaction process in ionosphere, and calculated the temporal and spatial evolution of ionospheric electron density after the release of two gases over Beijing in China. Later, the release of different chemical substances to influence the ionosphere was studied, the feasibility of researching chemical species to release ionospheric cavities voluntarily in laboratory environment was verified (Yu Liu, 2015), electrostatic fluctuation and electromagnetic fluctuation and whistling mode was studied, and that the growth of electron ion mixing instability in the boundary layer and vortex was considered. The formation of coherent structures plays an important role in the nonlinear evolution of ionospheric cavities. The study of the chemical release affecting the ionospheric properties is a basic plasma-physics frontier topic, which has very important academic value.

Conclusion

With the continuous expansion of human activities, human beings are more and more aware of and dependent on the ionosphere. Artificial influences on the properties of ionosphere are also paid more and more attention. Different human behaviors have different influence on the ionosphere. Researchers should conduct a more in-depth study on how they will affect, how they affect and impact on human activities of nuclear physics, thermophysical and chemical methods, which are of great academic values and applications value for understanding ionospheric mechanisms.

REFERENCES

Beaudoin. B. L. 2016. Novel high-power radio-frequency sources for mobile ionospheric heating. 2016 IEEE International Conference on Plasma Science, 2016.

Bin Xu. Temperature enhancement induced by ionosphere heating in low altitude region. Progress in Natural Science, 2008, Vol 18: 1339-1343.

Bowman. G.G. 1962. Some Effects of Nuclear Explosions on the Ionosphere. *Australian Journal of Physics,* 1962, vol15:405-419.

BRT.Cotts, etc. Ionospheric effects of whistler waves from rocket-triggered lightning. Atmospheric Science, 2011, 10: 1029-1034.

Dieminger, W. etc. 1962. Effects of Nuclear Explosions on the Ionosphere. Nature, vol193: 963-964.

Feng Deng. Two-dimensional numerical simulation of large-scale inhomogeneous field heating by ionospheric heating in middle and low latitude. *Acta PhysicaSinica,* 58

Meltz. G. 1974. Ionospheric heating by powerful radio waves. Radio Science, Vol 9: 1049-1063.

Meltzz. G. 1980. Microwave heating of the lower ionosphere In NASA, Washington. The Final Proc. Of the Solar Power Satellite Program Rev. 403-406.

Mendillo. M. 1981. The effect of rocket launches on the ionosphere. *Advances in Space Research*, vol 1: 275-290.

Mendillo. M., 1975. A large-scale hole in the ionosphere caused by the launch of skylab. *Science,* 187 (4174): 343-346.

Mitra. S.N. 1964. Effect of Nuclear Explosions Upon the Ionosphere. *Journal IETE Journal of Research,* vol10:323-340.

NRL rocket experiment tests effects of dusty plasma on the ionosphere [OL]. Https://phys.org /news/2015-10-nrl-rocket-effects-dusty-plasma.html,October 6 2015.

Pedersen Todd. HAARP, the most powerful ionosphere heater on Earth. Physics Today 2015, vol 68: 72-73.

Peinan Jiao. Detection of ionospheric effects from far-field nuclear explosions using high-frequency backscattering. Acta GeophysicaSinica, 1986, vol29 (05): 425-431.

Pilipenko. V. A. 2008. Electromagnetic and plasma effects in the ionosphere induced by Rocket Launches. *Russian Academy of Science,* P109-112.

Sengupta. P.R. 1964. Ionospheric effects of high-altitude nuclear explosions. *Journal of Atmospheric and Terrestrial Physics,* Vol26: 919-923.

Shuji Hao. Theoretical analysis of very low frequency / very low frequency directional radiation induced by ionospheric modulation. Acta PhysicaSinica, 2013, 62: 452-459

TORR. D. G. 1979. Chemistry of the thermosphere and ionosphere. *Journal of Atmospheric and Terrestrial Physics,* vol 41: 797-839.

Wallmore. A. P. 1964. Ionospheric Heating in the F-Region. Proceedings of the Royal Society of London, Vol. 281: 140-149.

Wengeng Huang, *et al.* Release of Chemical Substances by Ionospheric Artificial Space Science, 2005, 25: 254-258.

Wengeng Huang. High-power radio waves on the high ionosphere heating. *Journal of Space Science,* 2003, Volume 23: 343-351.

Yaogai Hu. Ionospheric disturbances of chemicals with different release levels. Acta PhysicaSinica, 2013, vol. 62, 29401.

Yaogai Hu. 2010. Ionospheric release of several typical chemical species, *Acta PhysicaSinica*, 59: 8293-9309.

Yinglong Tao. Numerical simulation of the effects of high altitude nuclear explosion on ionosphere [D] .Beijing: Tsinghua University, 2010.

Yinhui Cheng *et al.* 2011. High altitude nuclear electromagnetic pulse penetration ionospheric numerical simulation. Strong laser and ion beam, 23: 441-444.

Yong Huang *et al.* 2012. Comparison of ionospheric disturbances with different chemical substances released. *Chinese Journal of Space Science,* 32: 33-39.

Yong Huang *et al.* Studies on the deionization ionization electron density of chemicals released. *Chinese Journal of Geophysics,* 2011,54: 1-5.

Yu Liu. Laboratory research on the evolution of ionospheric cavity hollow layer formed by active release of chemical substances [D]. University of Science and Technology of China, 2015.

Zhang X. Traveling ionospheric disturbances triggered by the 2009 North Korean underground nuclear explosion. Ann. Geophys, 2015, vol 33: 137-142.

Zhengyu Zhao *et al.* Numerical simulation of ionization effect of air nuclear explosion. *Acta PhysicaSinica,* 2007,56: 4297-4304.

****