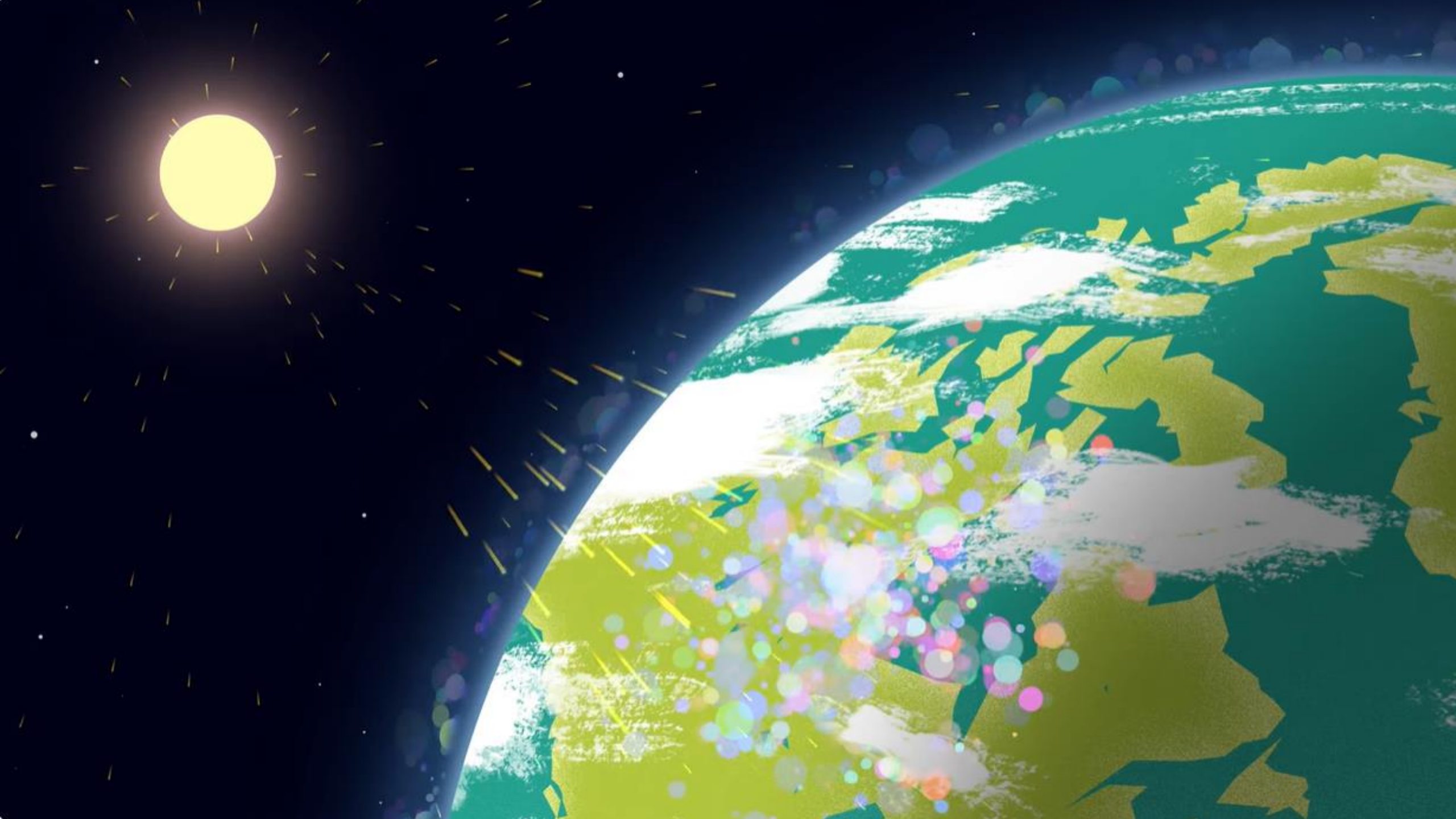
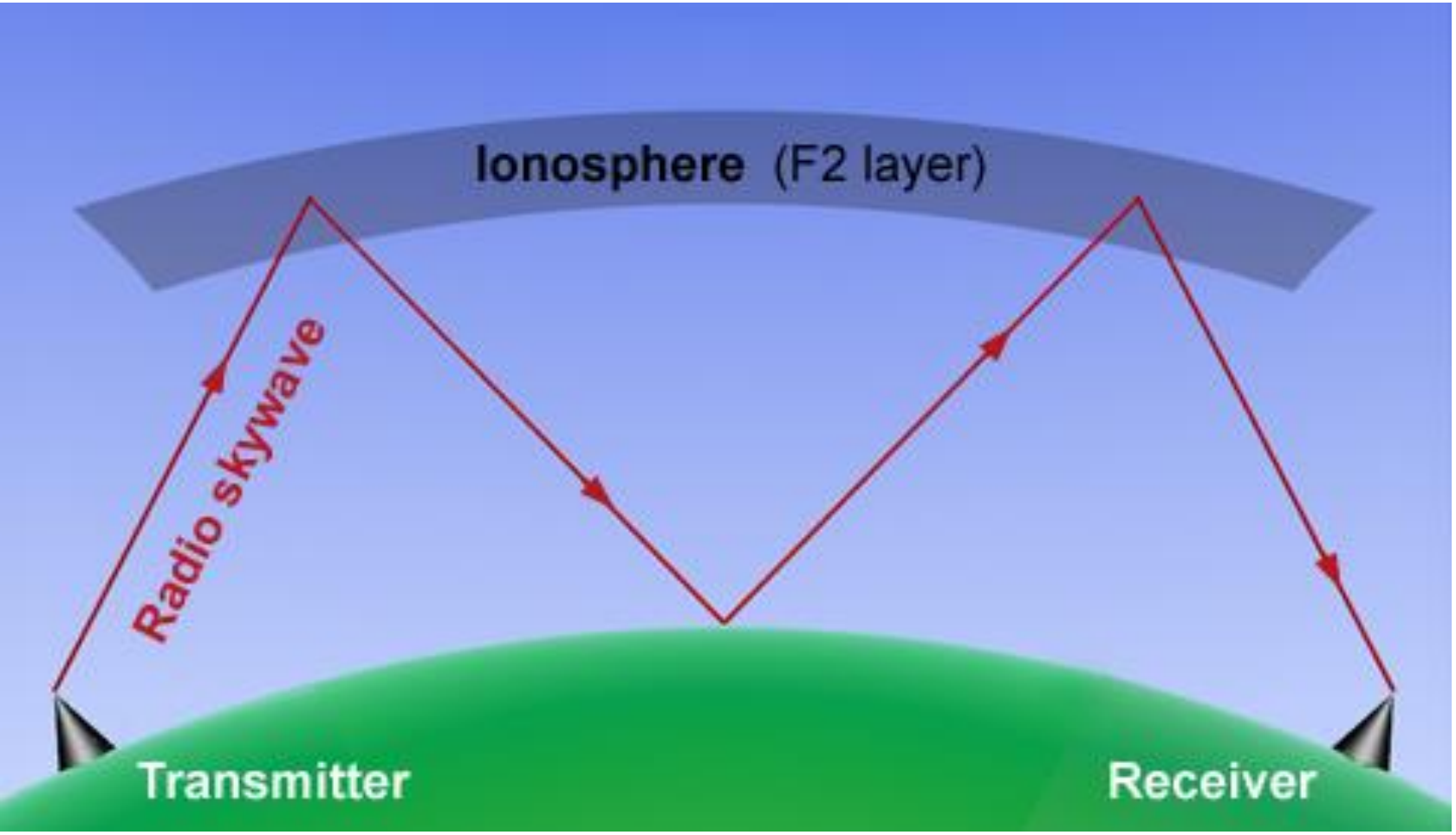
National Technical University
"Kharkiv Polytechnic Institute"

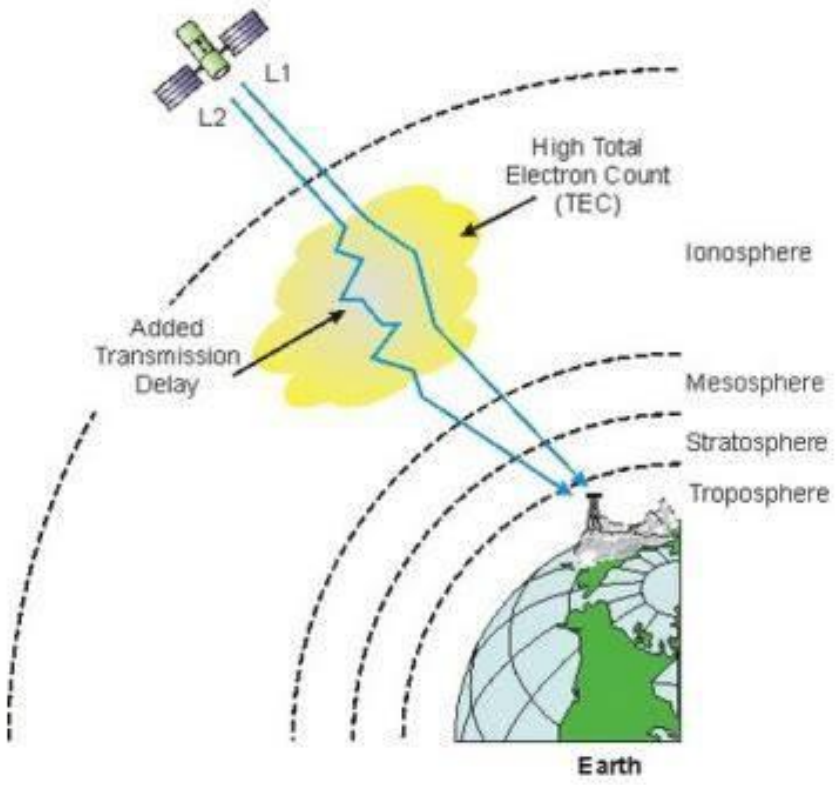
Науково-дослідний інститут Іоносфери: Напрямки наукової роботи та перспективи розвитку

Доповідач: Дмитро Котов, директор

Харків, 23 січня 2026 року







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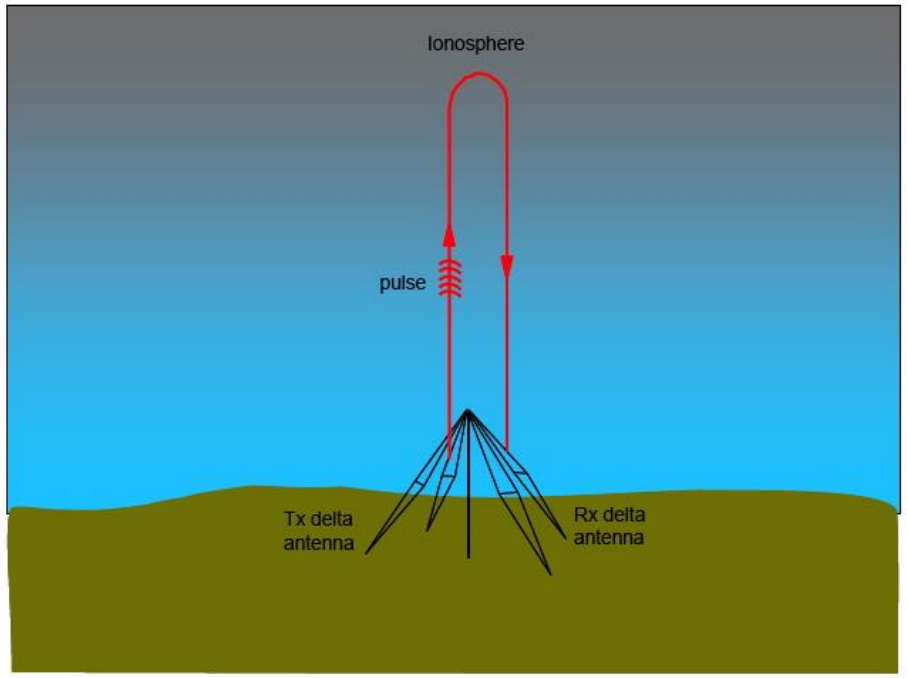
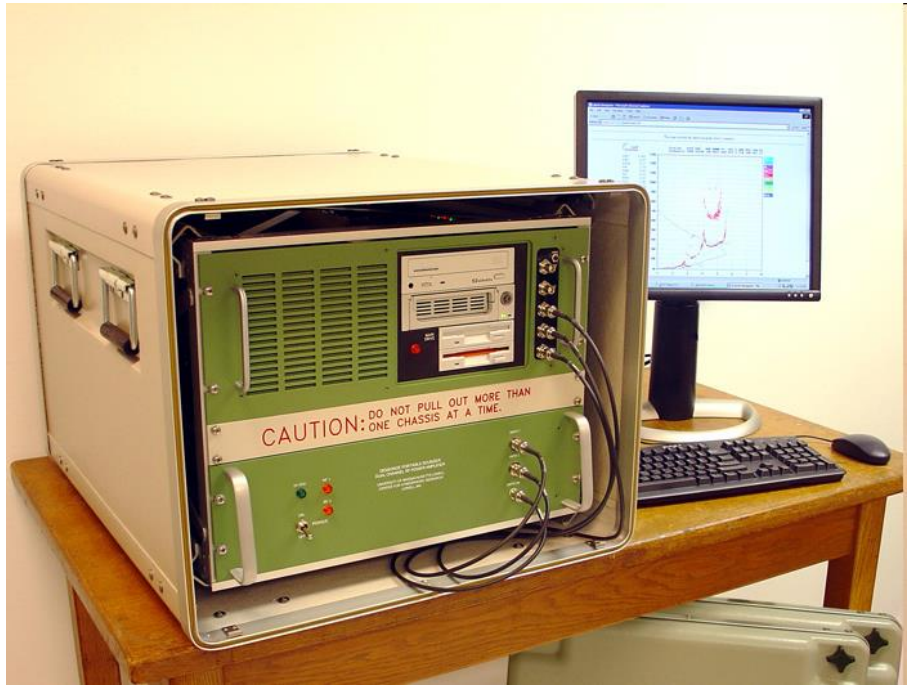
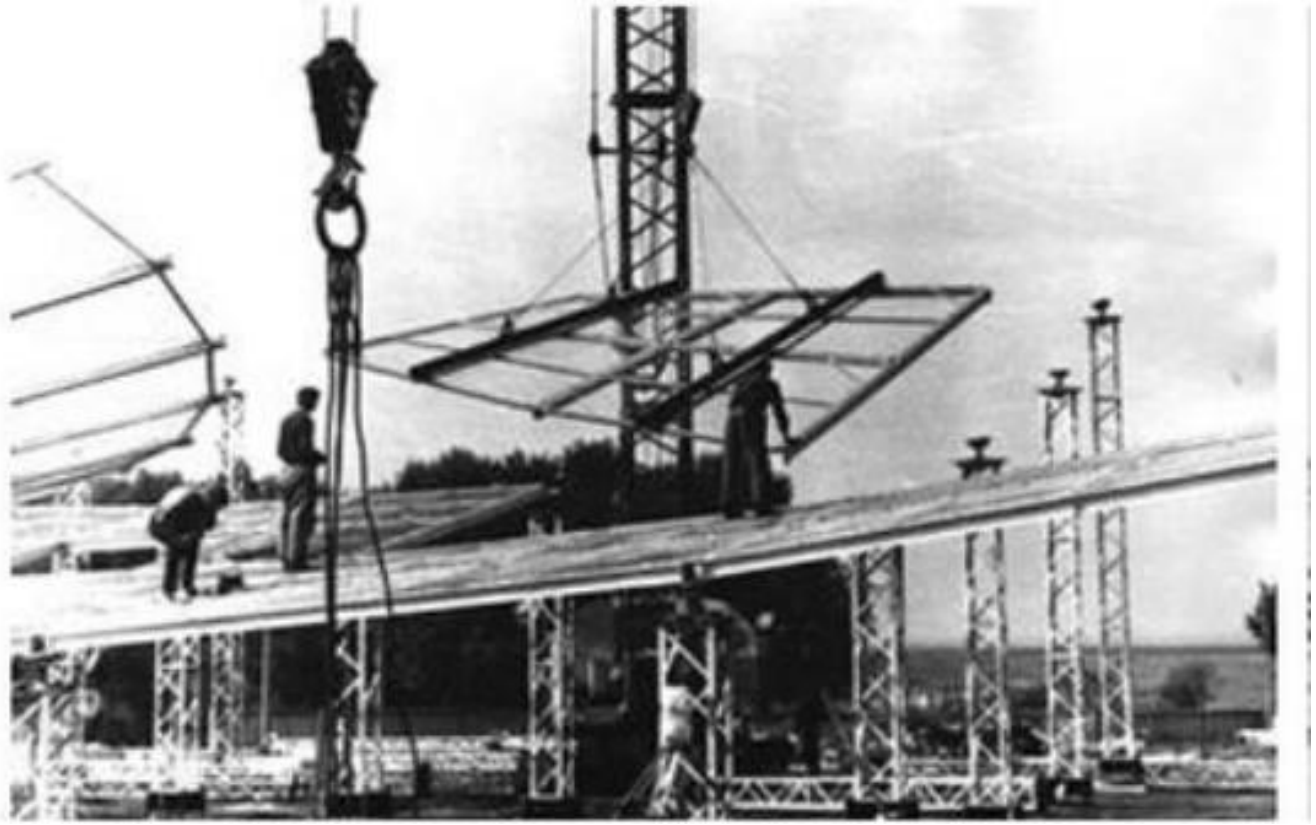


Найпростіший засіб дослідження – іонозонд

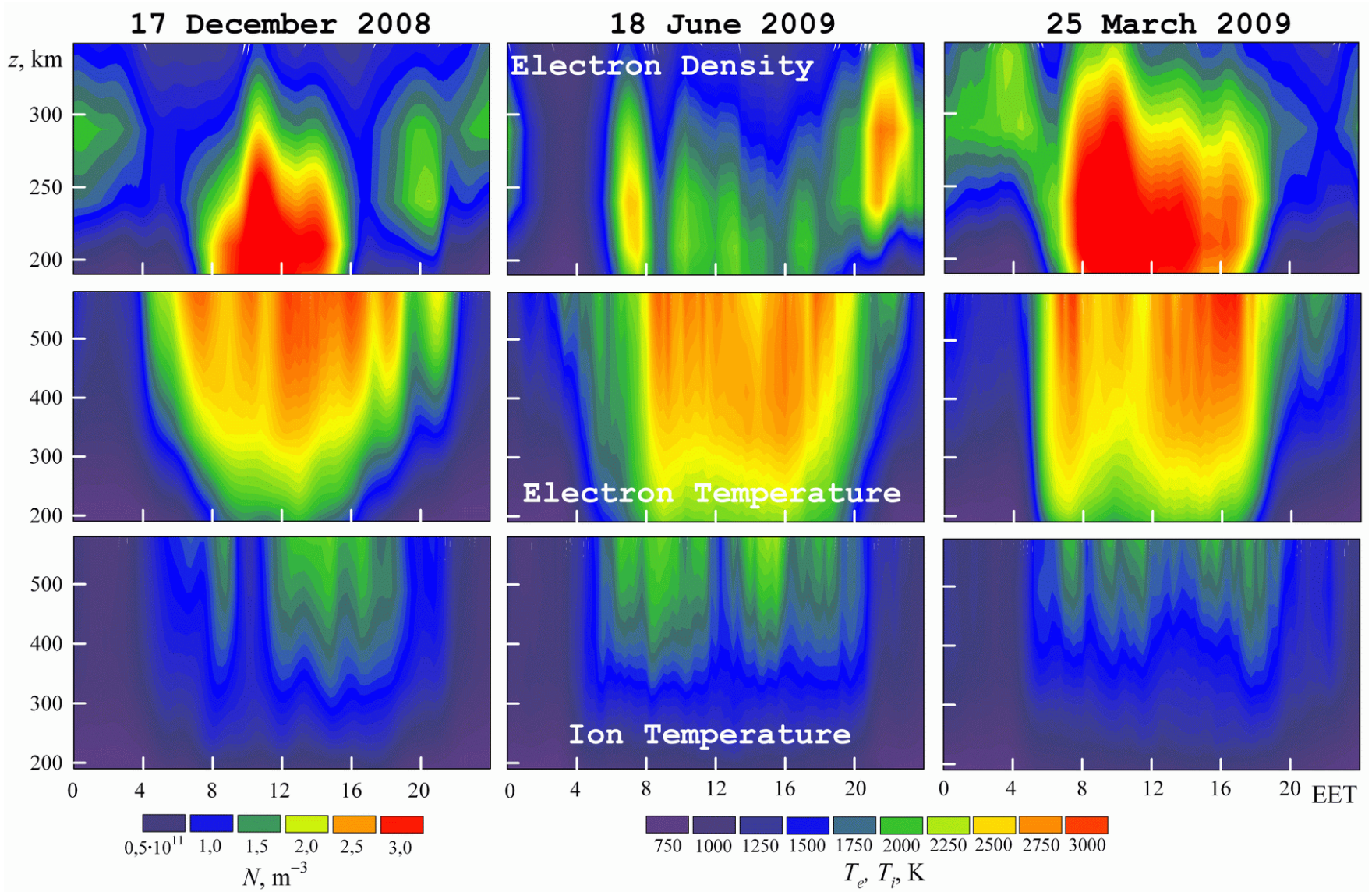


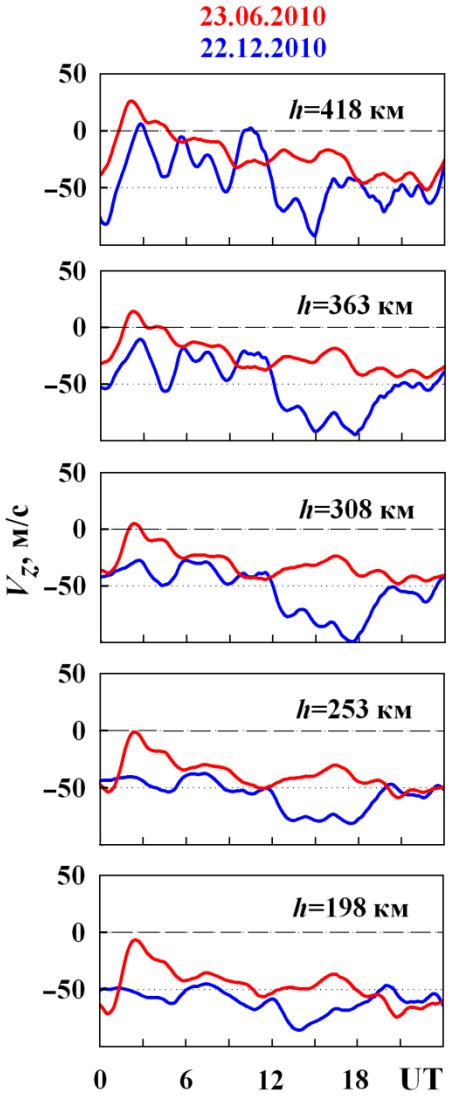
Найкращій – радар некогерентного розсіяння



Зміїв, середина 1970х

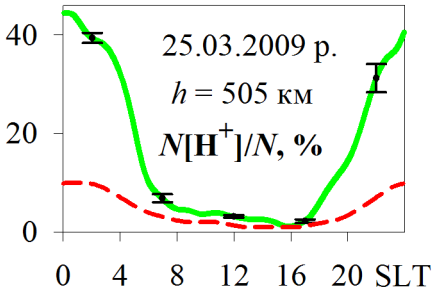
Віталій Таран



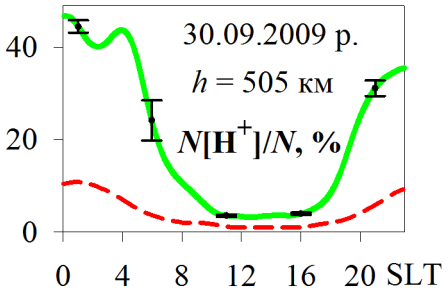


Результати спостережень

Весняне рівнодення



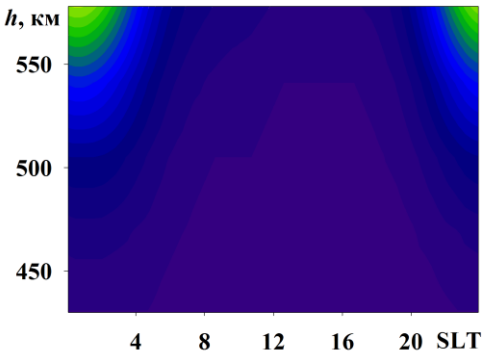
Осіннє рівнодення



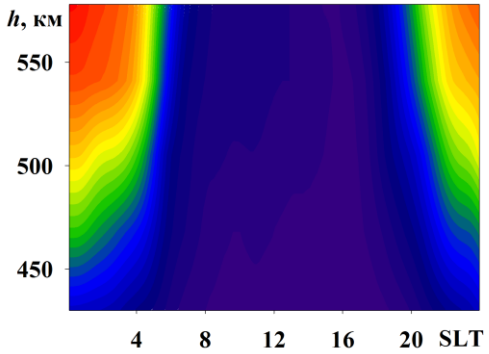
Дані радара НР Інституту іоносфери

Дані моделі IRI-2012

Дані моделі IRI-2012:

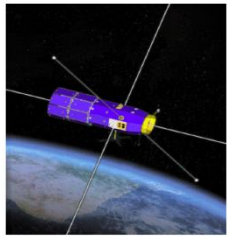


Дані Інституту іоносфери:

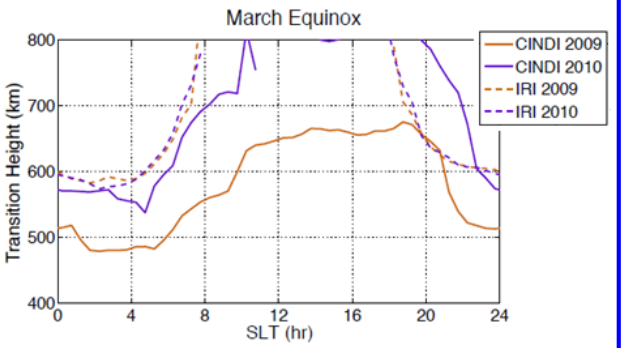


The C/NOFS Satellite

- Communication/Navigation Outage Forecast System
  - Launched in April 2008
  - 13° inclination orbit
  - 400-850 km
- CINDI (Coupled Ion Neutral Dynamics Investigation)
  - Ion Density
  - $[H^+]$, $[O^+]$



O^+/H^+ Transition Height



Результати дуже добре узгоджуються

Перші публікації, про які не мріяли

Contents lists available at ScienceDirect

Journal of Atmospheric and Solar-Terrestrial Physics

journal homepage: www.elsevier.com/locate/jastp

Research Paper

Night-time light ion transition height behaviour over the Kharkiv (50°N, 36°E) IS radar during the equinoxes of 2006–2010

Dmytro V. Kotov [a,*], Vladimír Truhlík [b], Phil G. Richards [c], Stanimir Stankov [d], Oleksandr V. Bogomaz [a], Leonid F. Chernogor [a], Igor F. Domnin [a]

[a] Institute of Ionosphere, Kharkiv, Ukraine
[b] Institute of Atmospheric Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic
[c] George Mason University, School of Physics Astronomy and Computational Science, 4400 University Drive, Fairfax, VA, USA
[d] Royal Meteorological Institute, Belgium

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Transition height
Solar minimum
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IRI

ABSTRACT

This research investigates anomalous nighttime ion density behaviour over the Kharkiv, Ukraine incoherent scatter radar (49.6° N, 36.3° E, 45.3° inv) during the equinoxes of 2006–2010. The observations show that the altitude of the transition from O^+ to lighter ions was much lower than empirical and physical models predict. The standard physical model produces very good agreement for the O^+ densities but underestimates the H^+ densities by a factor of 2 in March 2006 and a factor of 3 in March 2009. The anomalously low transition height is a result of similar lowering of the ionospheric peak height and also of significantly increased H^+ density. The lower ionospheric peak height may be caused by weaker nighttime neutral winds. The calculations indicate that the higher measured topside ionosphere H^+ densities are most likely due to higher neutral hydrogen densities. Both factors could be the result of weaker than usual magnetic activity, which would reduce the energy input to high latitudes. Prolonged low activity periods could cause a global redistribution of hydrogen and also allow more neutral hydrogen to settle down from the exosphere into the mid-latitude ionosphere. The finding of the need for higher H densities agrees well with recent H-alpha airglow measurements and it is important for accurate modelling of plasmasphere refilling rates and night-time N_mF_2 values.

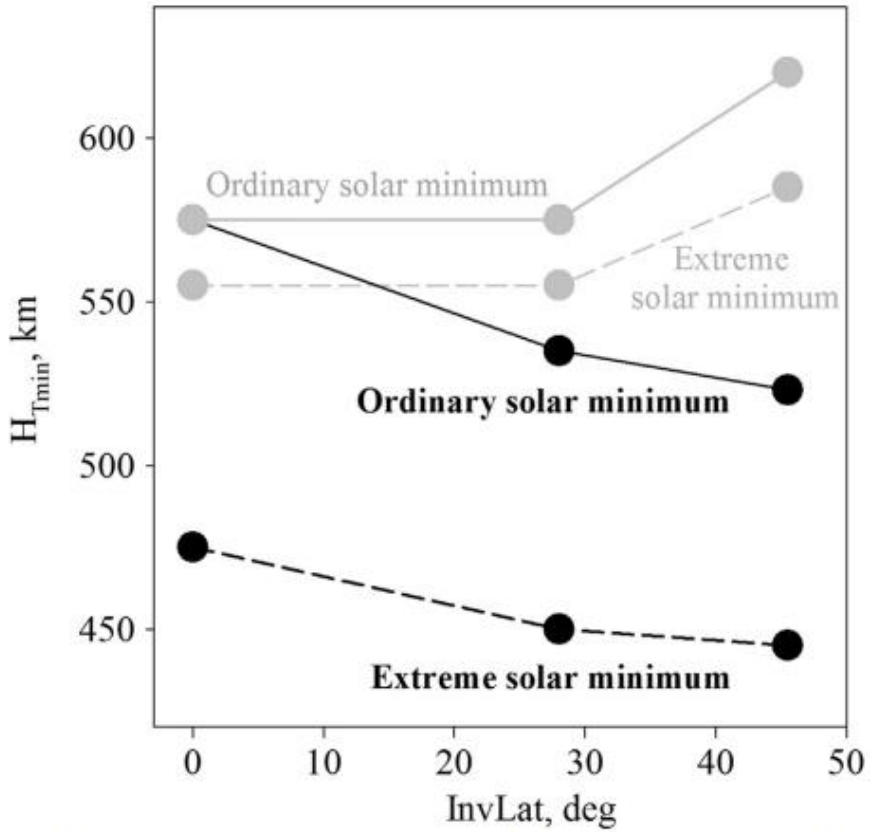


Fig. 3. Latitudinal variations in H_{Tmin}. Black lines show recent equinoctial C/NOFS, Arecibo and Kharkiv IS radars data, grey lines – earlier in situ data (IRI model).

Перші серйозні проєкти

SCOSTEP
Scientific Committee on Solar-Terrestrial Physics

VarSITI
Variability of the Sun and Its Terrestrial Impact
SCOSTEP Program 2014-2018

Project SPeCIMEN

Article 2:

Coordinated investigations of topside H^+ ions: new results for inner magnetosphere

D.V. Kotov[1], V. Truhlik[2], P.G. Richards[3], M.O. Shulha[1], O.V. Bogomaz[1], I.F. Domnin[1]
[1]Institute of Ionosphere, Kharkiv, Ukraine
[2]Institute of Atmospheric Physics, Prague, Czech Republic
[3]George Mason University, Fairfax, VA, USA


Dmytro Kotov


Vladimir Truhlik


Philip Richards


Maryna Shulha


Oleksandr Bogomaz

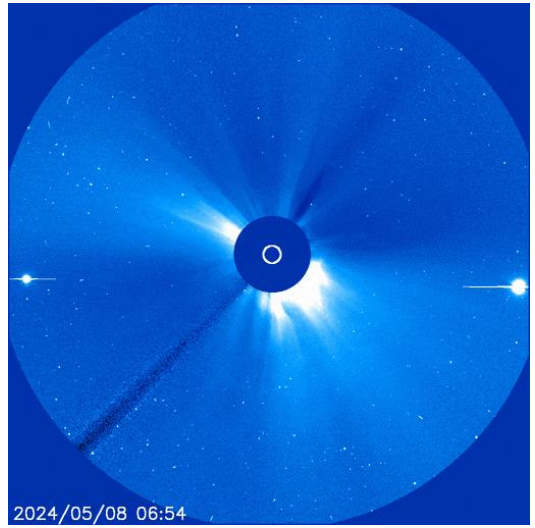

Igor Domnin

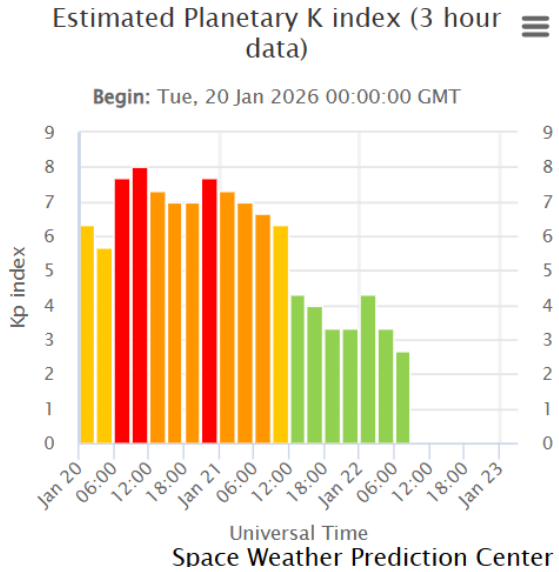
Atomic hydrogen (H) is a crucially important constituent of the Earth's atmosphere. These atoms form the geocorona which directly impacts the dissipation of the ring current during the recovery phase of magnetic storms [*Ilie et al.*, 2013]. The H^+ ions, which are produced by the charge exchange reaction of H with ionospheric O^+, are primarily responsible for existence of the plasmasphere and its refilling after the emptying by severe storms [*Richards and Torr*, 1985].

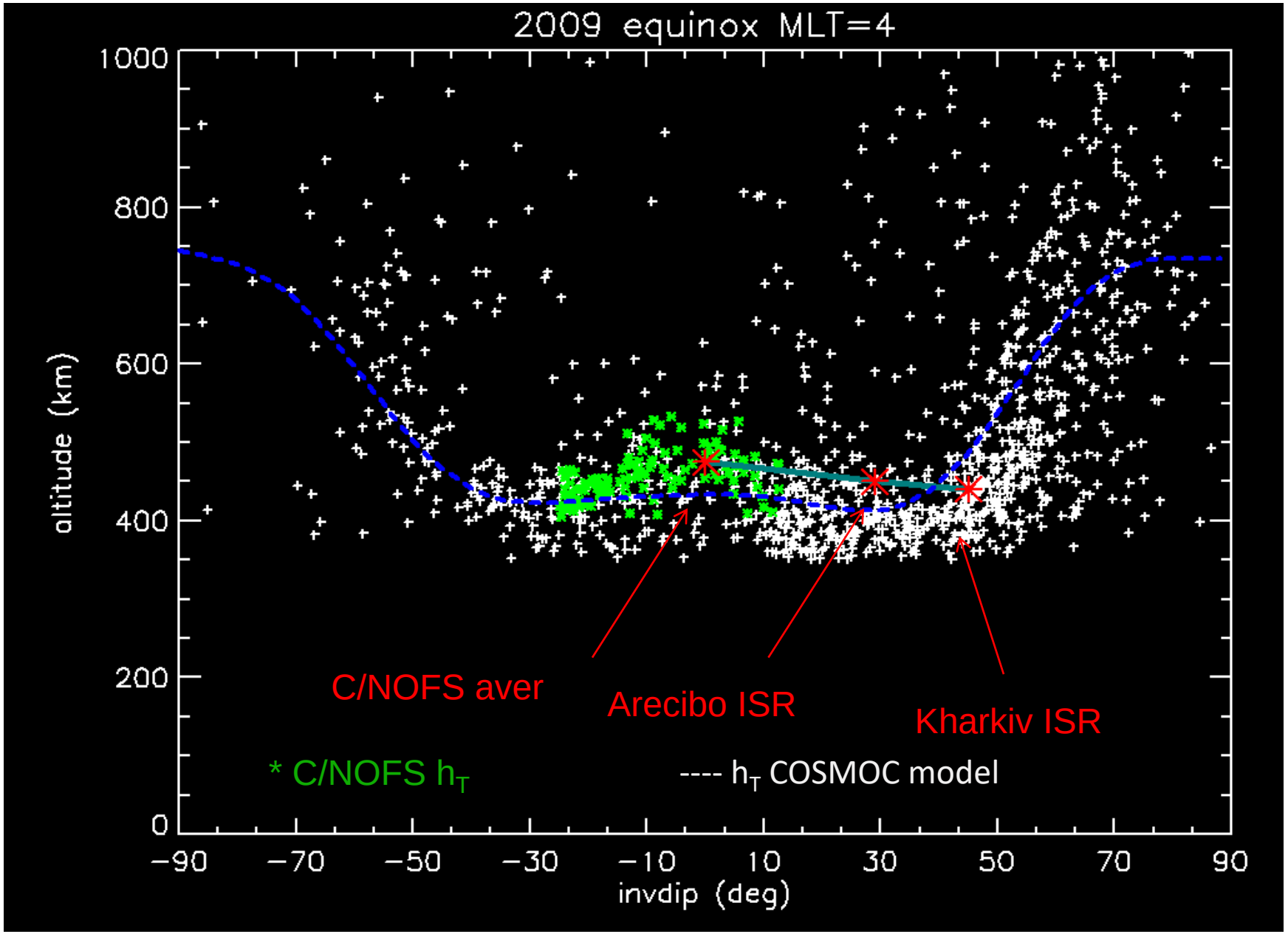
Our previous studies in 2015-2016 revealed that the NRLMSISE-00 neutral atmosphere model underestimated the H density by a factor of 2 to 3 during the period of extremely low solar activity 2006–2010 [*Kotov et al.*, 2015, 2016]. We noted also that this finding was the key to explaining the lower than normal O^+-H^+ transition heights (height where H^+ becomes the dominant ion) as well as significant enhancements of the nighttime peak of the electron density (NmF_2).

Перші серйозні проєкти

SPACE WEATHER PREDICTION CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION







Глобальна крос-валідація даних, інструментів, методів

Створення нових моделей

Article

A Global Empirical Model of the Ion Temperature in the Ionosphere for the International Reference Ionosphere

Vladimír Truhlík [1,*], Dieter Bilitza [2,3], Dmytro Kotov [4], Maryna Shulha [4] and Ludmila Třísková [1]

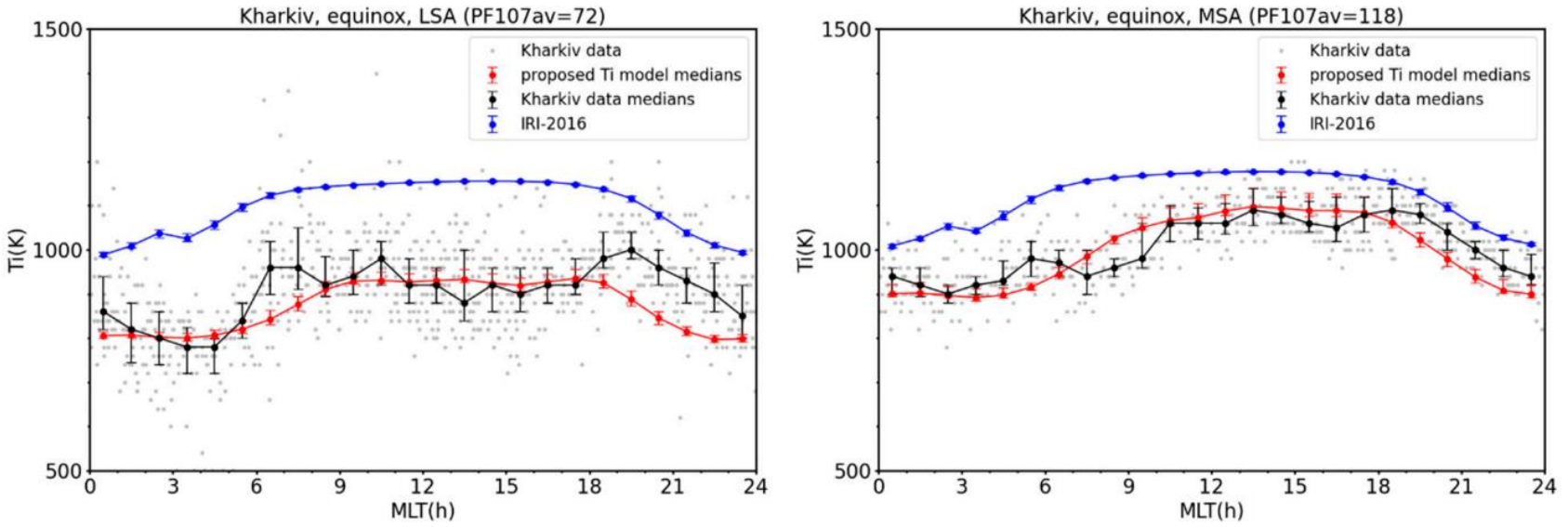
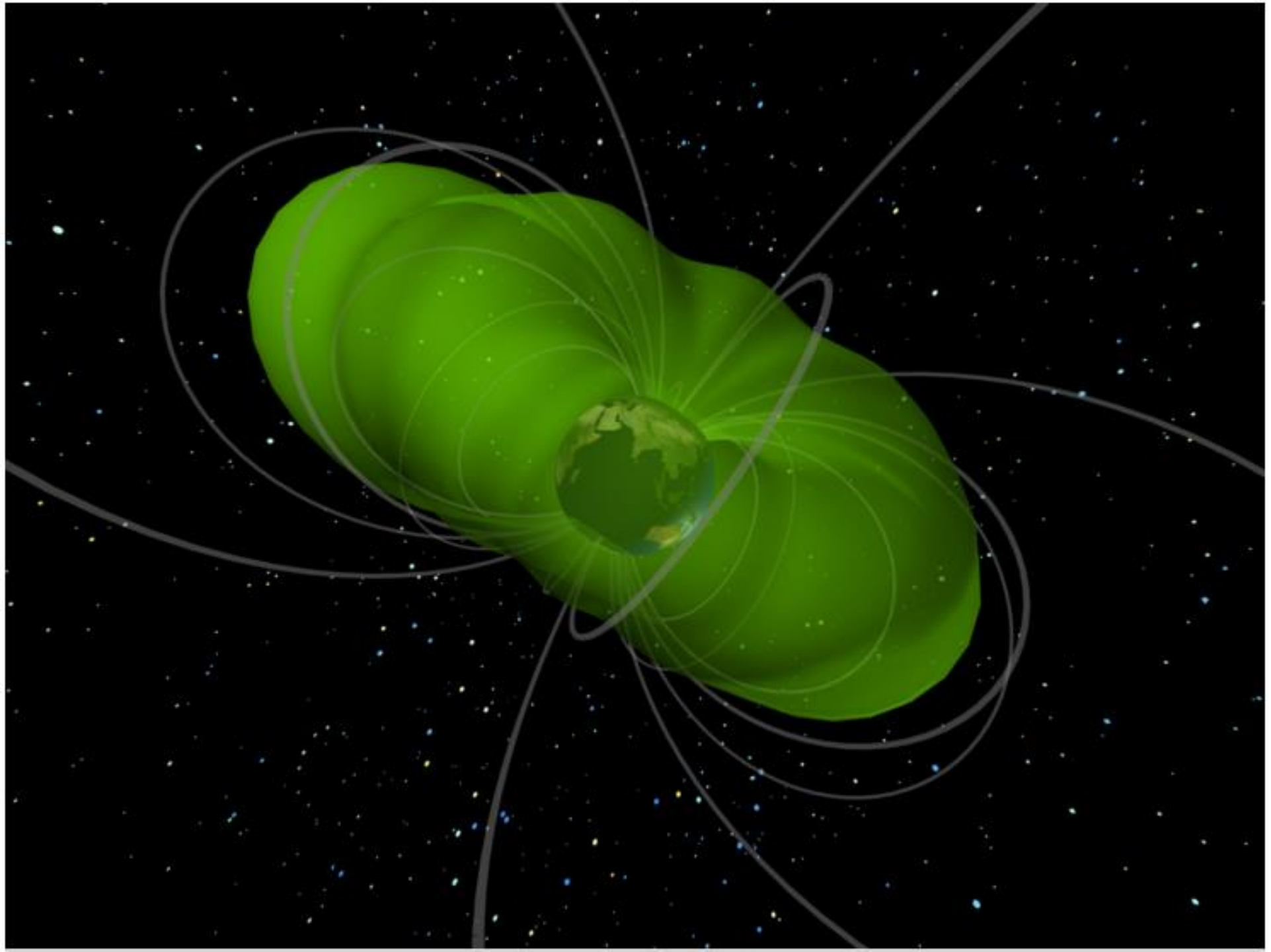
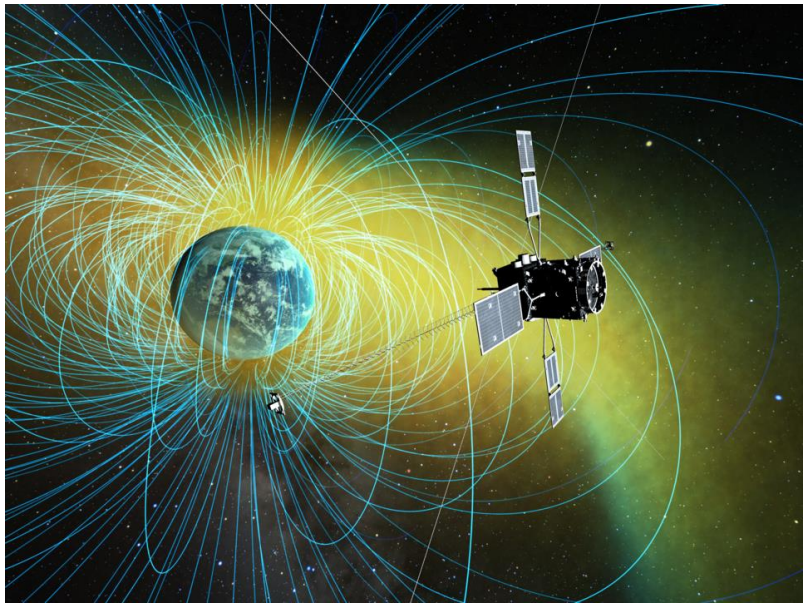


Figure 9. Local time variation of Kharkiv Ti data (grey points—individual measurements; black circles—medians in 1 h wide MLT bins; error bars represent upper and lower quartiles), corresponding medians and lower/upper quartiles from the proposed Ti and IRI-2016 models (red and blue, respectively). The left panel represents low solar activity (LSA) and the right panel represents medium solar activity (MSA).



Іоносфера – лише старт

Перше глобальне дослідження плазмосфери



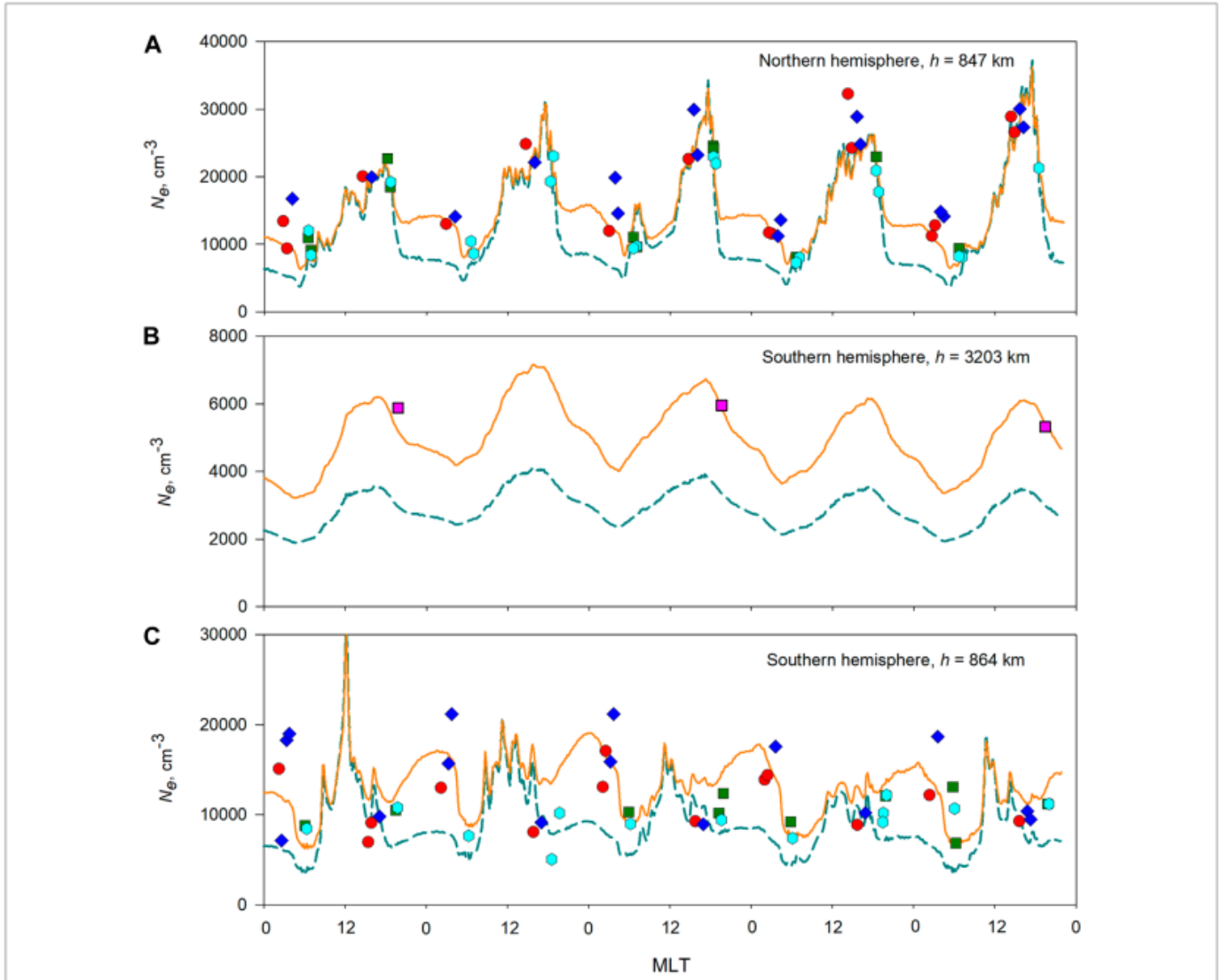
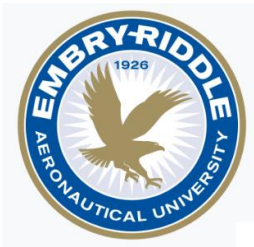


FIGURE 4
Diurnal variations of the plasma density in the topside ionosphere at northern **(A)** and southern **(C)** ends and in the high-altitude plasmaspheric part **(B)** of the L = 1.75 flux tube during 27 April—1 May 2017. The dashed dark blue line shows the simulation using the standard NRLMSIS H density while the solid orange line is for the NRLMSIS H density multiplied by a factor of 2.75. In the top and bottom panels, the symbols show DMSP data: F15 (red circles), F16 (blue diamonds), F17 (dark green squares), and F18 (cyan hexagons). Pink squares on the middle panel denote the Arase satellite data.

frontiers | Frontiers in Astronomy and Space Sciences

TYPE Original Research
PUBLISHED 05 June 2023
DOI 10.3389/fspas.2023.1113706

Несподівані відкриття



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Huixin Liu,
Kyushu University, Japan

REVIEWED BY
Sai Gowtam Valluri,
University of Alaska Fairbanks, United States
Stavros Dimitrakoudis,
National and Kapodistrian University of Athens, Greece

*CORRESPONDENCE
Dmytro Kotov,
dmitrykotoff@gmail.com

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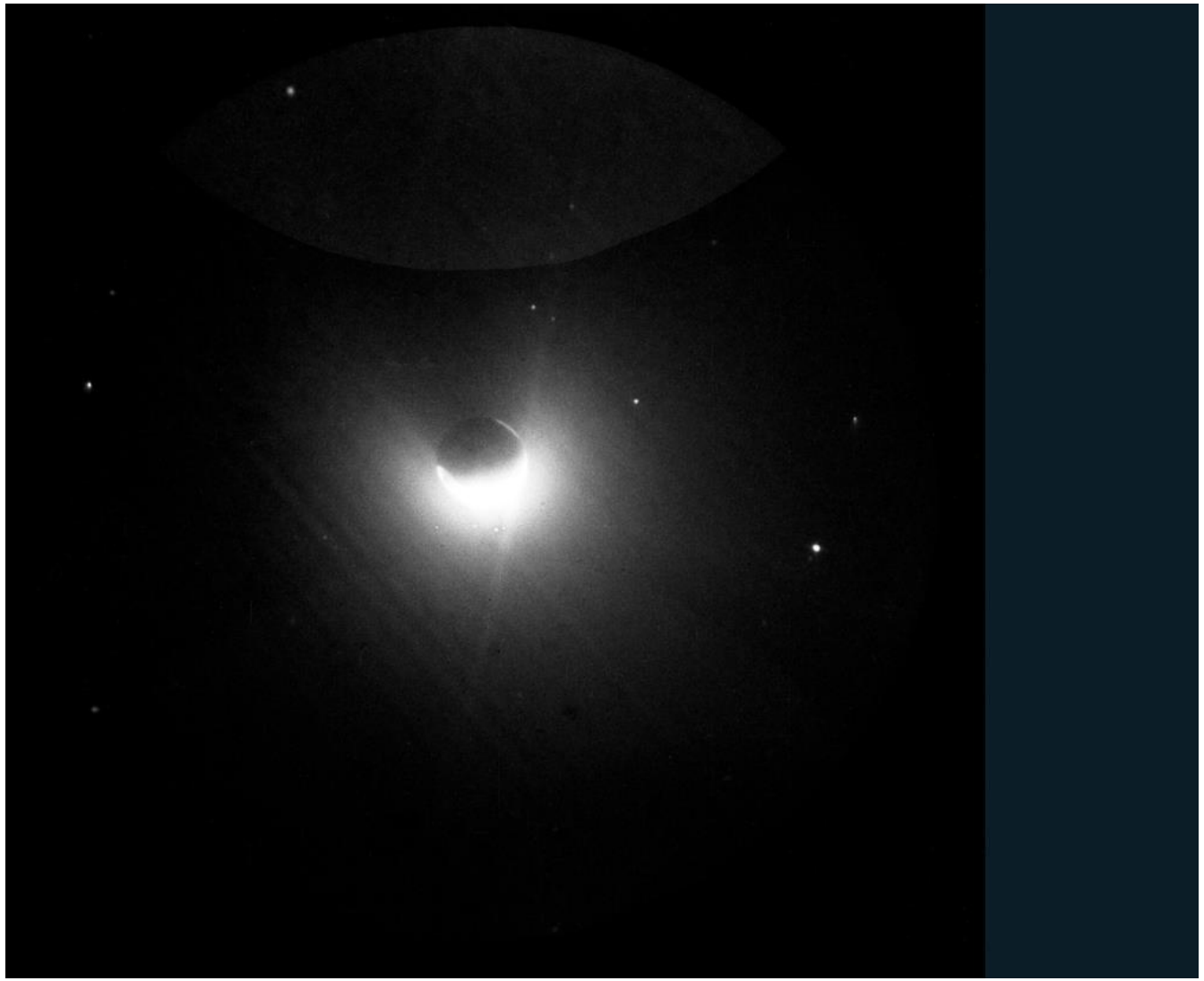
Front. Astron. Space Sci. 10:1113706.
doi: 10.3389/fspas.2023.1113706

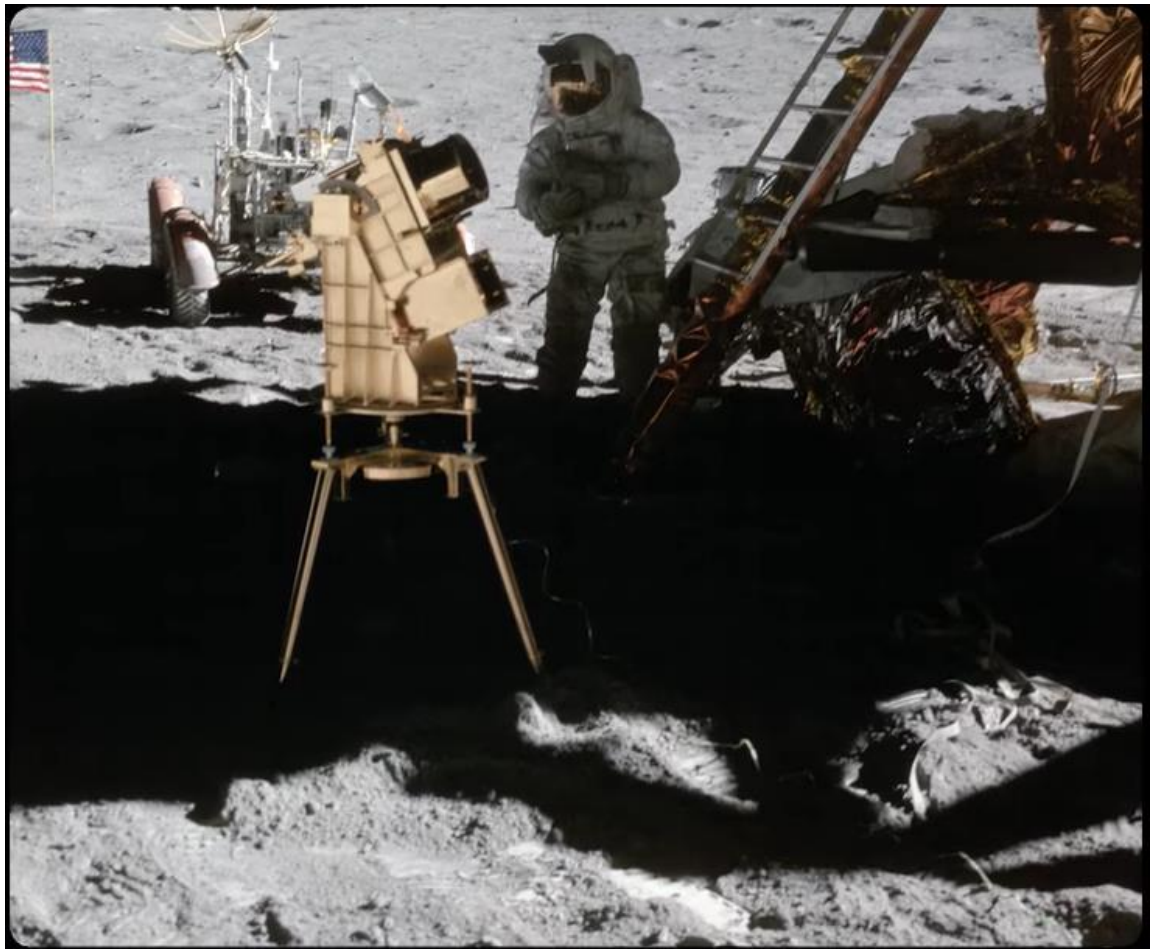
Interhemispheric ionosphere-plasmasphere system shows a high sensitivity to the exospheric neutral hydrogen density: a caution of the global reference atmospheric model hydrogen density

Dmytro Kotov[1]*, Phil G. Richards[2], Maryna Reznychenko[1], Oleksandr Bogomaz[1,3], Vladimír Truhlík[4], Susan Nossal[5], Edwin Mierkiewicz[6], Taras Zhivolup[1], Igor Domnin[1], Yoshizumi Miyoshi[7], Fuminori Tsuchiya[8], Atsushi Kumamoto[8], Yoshiya Kasahara[9], Masahiro Kitahara[8], Satoko Nakamura[10], Ayako Matsuoka[11], Iku Shinohara[12] and Marc Hairston[13]

[1]Institute of Ionosphere, Kharkiv, Ukraine, [2]Department of Computer Science, University of Alabama in Huntsville, Huntsville, AL, United States, [3]State Institution National Antarctic Scientific Center of the Ministry of Education and Science of Ukraine, Kharkiv, Kyiv, Ukraine, [4]Institute of Atmospheric Physics of the Czech Academy of Sciences, Prague, Czechia, [5]Physics Department, University of Wisconsin-Madison, Madison, WI, United States, [6]Department of Physical Sciences, Embry-Riddle Aeronautical University, Daytona Beach, FL, United States, [7]Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Japan, [8]Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, Sendai, Japan, [9]Graduate School of Natural Science and Technology, Kanazawa University, Kanazawa, Japan, [10]Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Japan, [11]Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University, Kyoto, Japan, [12]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Sagamihara, Japan, [13]William B. Hanson Center for Space Sciences, The University of Texas at Dallas, Richardson, TX, United States

Далі, вище, цікавіше – геокорона

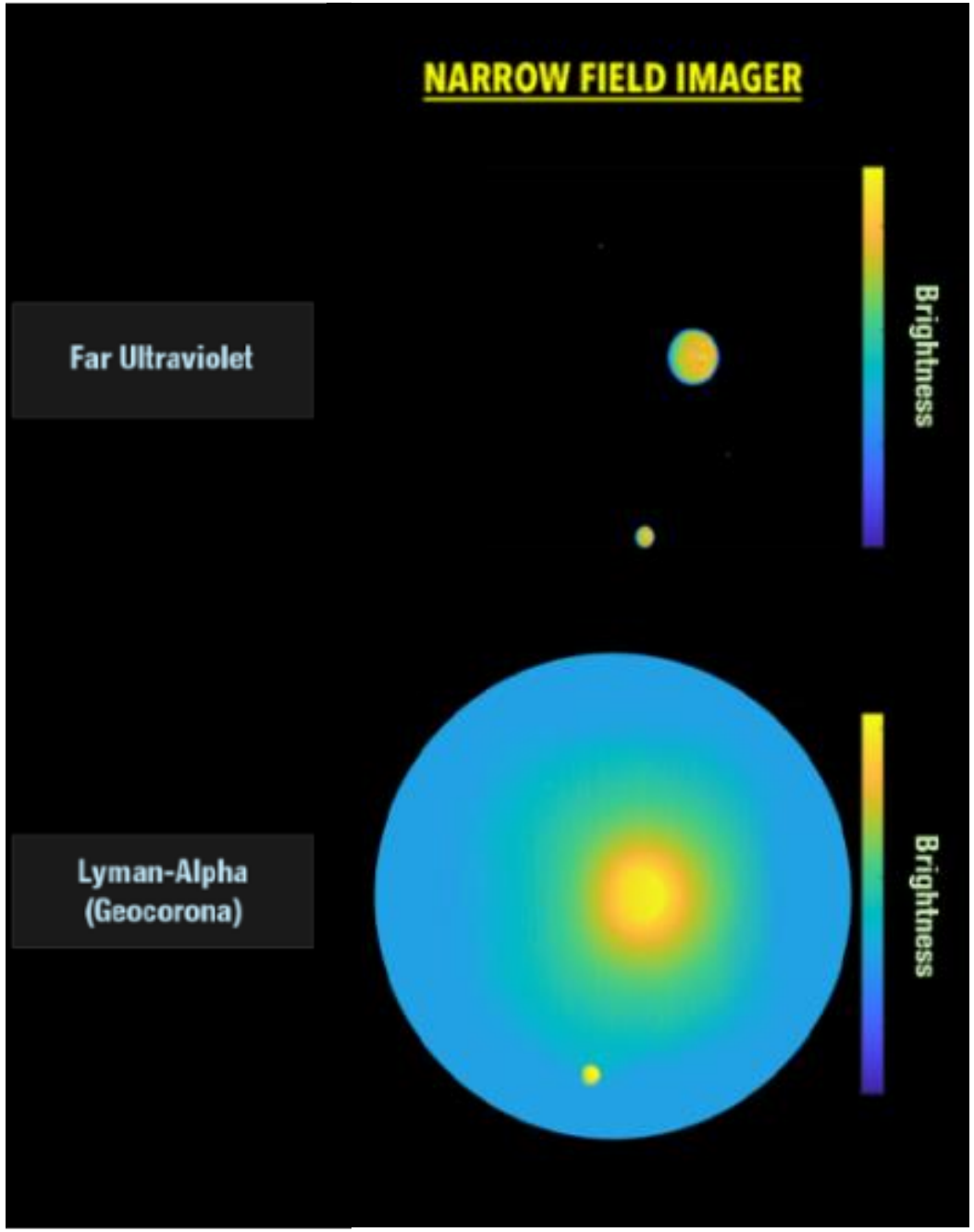




Apollo 16, 1972

Геокорона – півстоліття потому

NASA's Carruthers Geocorona Observatory Reveals 'First Light' Images



Листопад 2025

Експертиза теорій

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

IION

NATURE COMMUNICATIONS | DOI: 10.1038/ncomms13655 ARTICLE

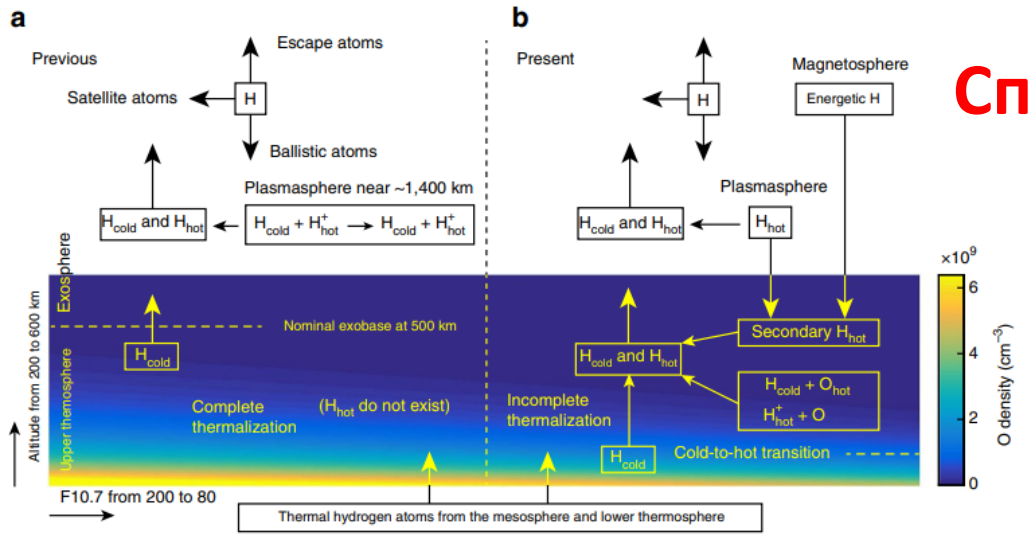


Figure 3 | The previous geocorona theory and the new physics implied in this study. (**a**) Only cold hydrogen atoms, with a Maxwellian kinetic distribution determined by the ambient oxygen temperature, are present in the upper thermosphere, since complete thermalization is assumed. (**b**) Incomplete thermalization, due to low oxygen density especially under solar minimum condition, allows the presence of hot hydrogen atoms in the upper thermosphere. Variation of the atomic oxygen density in the upper thermosphere with solar activity is calculated using the NRLMSISE-00 model[19]. We emphasize that in the present work the cold atoms refer to those atoms that diffuse upward from the lower thermosphere (that is, the thermal atoms), and the hot atoms are the ones that are kinetically energized through processes such as charge exchange and momentum transfer.

*Qin, J., Waldrop, L. Non-thermal hydrogen atoms in the terrestrial upper thermosphere. Nat Commun **7**, 13655 (2016). https://doi.org/10.1038/ncomms13655*

Спростовано

Hydrogen atoms near the exobase are cold: independent observations do not support the hot exosphere concept

Dmytro Kotov[1]* and Oleksandr Bogomaz[1,2]

[1]Institute of Ionosphere, Kharkiv, Ukraine, [2]State Institution National Antarctic Scientific Center of the Ministry of Education and Science of Ukraine, Kyiv, Ukraine

Kotov D and Bogomaz O (2023) Hydrogen atoms near the exobase are cold: independent observations do not support the hot exosphere concept. Front. Astron. Space Sci. 10:1200959. doi: 10.3389/fspas.2023.1200959

Новий рівень експертизи → Нові партнерства → Нові відкриття

manuscript submitted to *JGR: Space Physics*

The role of solar Lyman-alpha in the formation of the telluric hydrogen corona

R. R. Hodges[1], J. D. Huba[2], and D. V. Kotov[3]

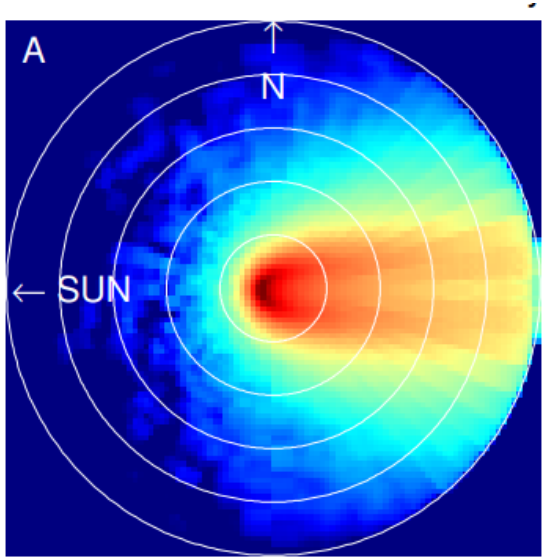
[1]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO

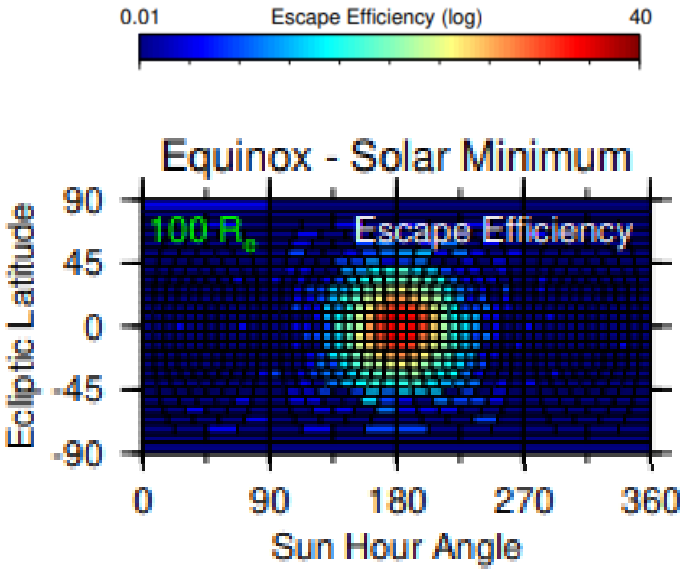
[2]Syntek Technologies, Fairfax, VA

[3]Institute of Ionosphere, National Technical University "Kharkiv Polytechnic Institute"

Key Points:

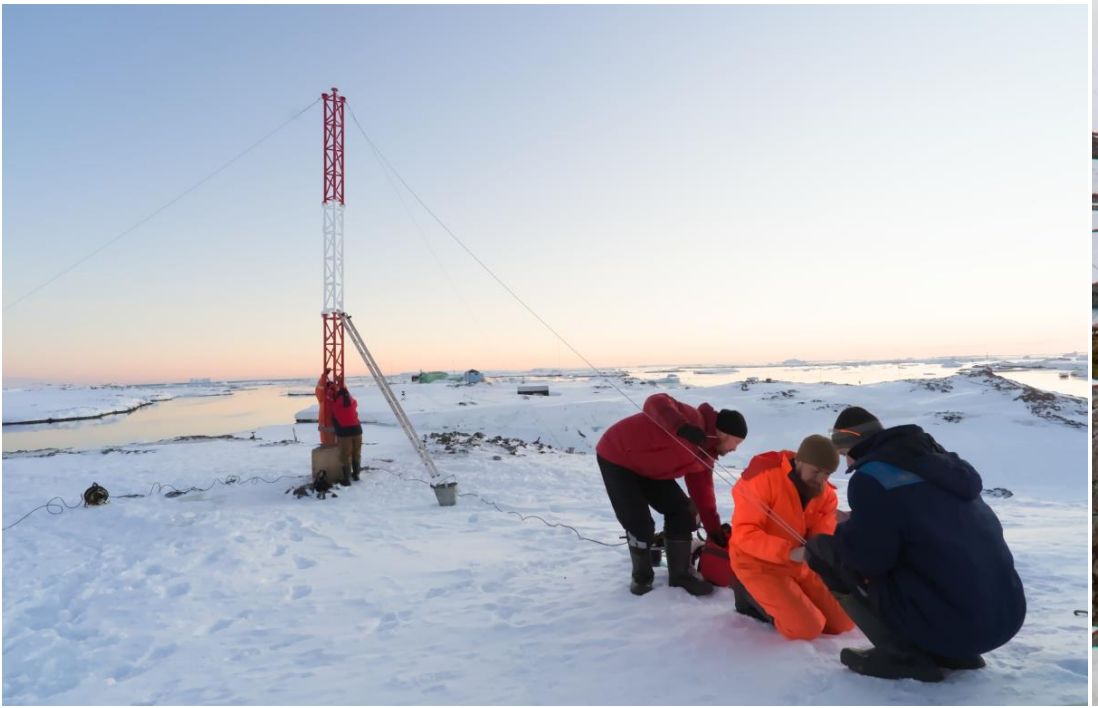
- The telluric corona is not an exosphere. Collisions with particles abound. The rate of hydrogen contact with Lyman alpha is about 1 Hz.
- The telluric corona is a comet-like coma with a collimated tail of escaping hydrogen atoms that extends hundreds of Earth radii.
- The tail of the telluric coma is created by the transfer of anti-sun momentum from solar Lyman-alpha photons to hydrogen atoms.





"Houston, we have a problem"

Іоносфера є скрізь



Олександр Богомаз – теж

Партнерський проєкт з Українським науково-технічним центром

“Діагностика іоносферних збурень над Україною, викликаних природними та техногенними процесами”

On May 25, 2024, Russia released two modified gliding bombs that exploded in the home improvement store ‘Epicentr’ (similar to Home Depot store) in Kharkiv, Ukraine.

The resulting fire started at ~13:02 UT, was partially contained by ~14:45 UT, and covered area of ~10,000 m^2.

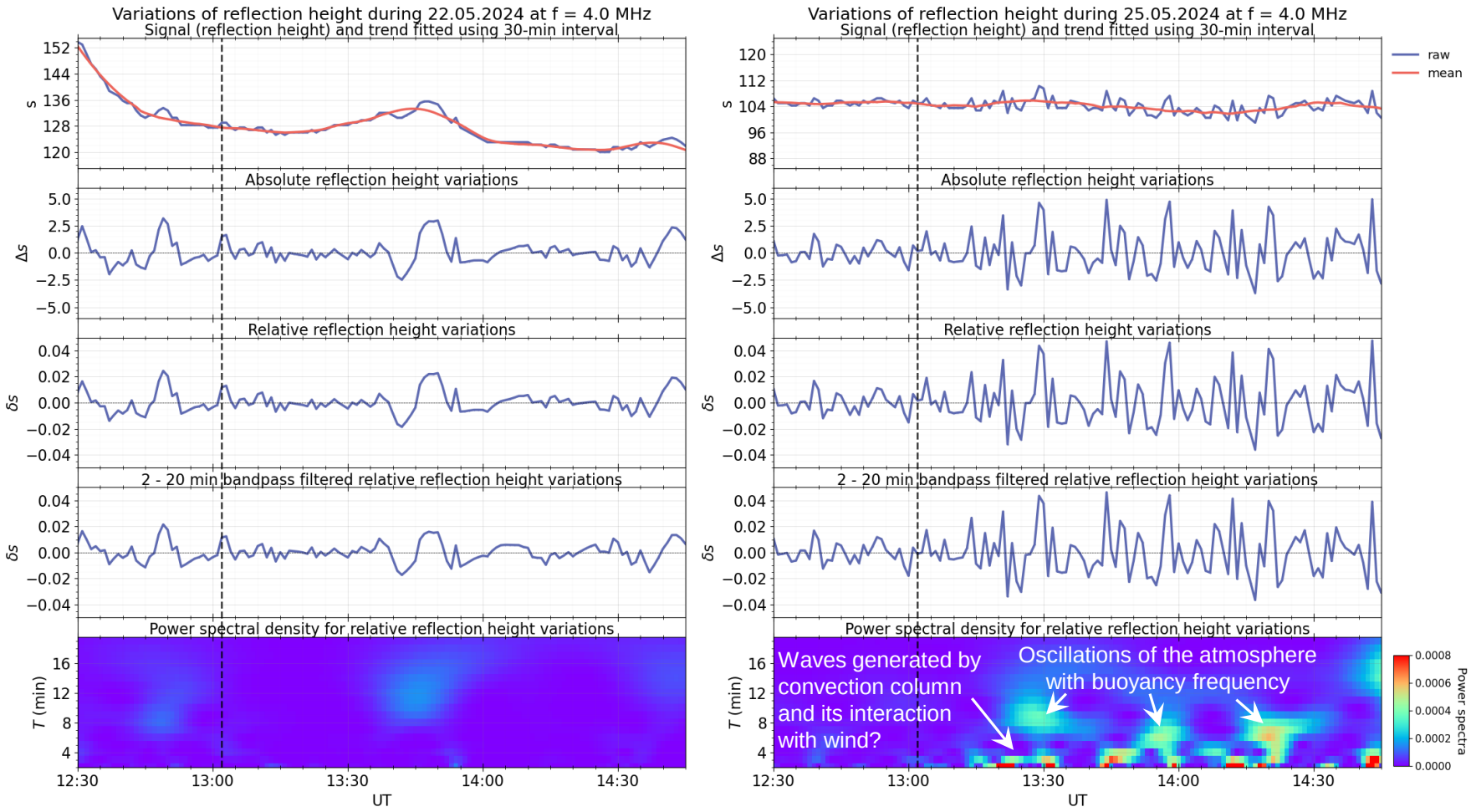
As the store contained large quantities of flammable materials (paint, wood, etc.), estimated total power of fire is ~2 GW.

19 people died, 65 injured.

Video of the fire was filmed from a window of an apartment building:

Reference day May 22

The fire day May 25



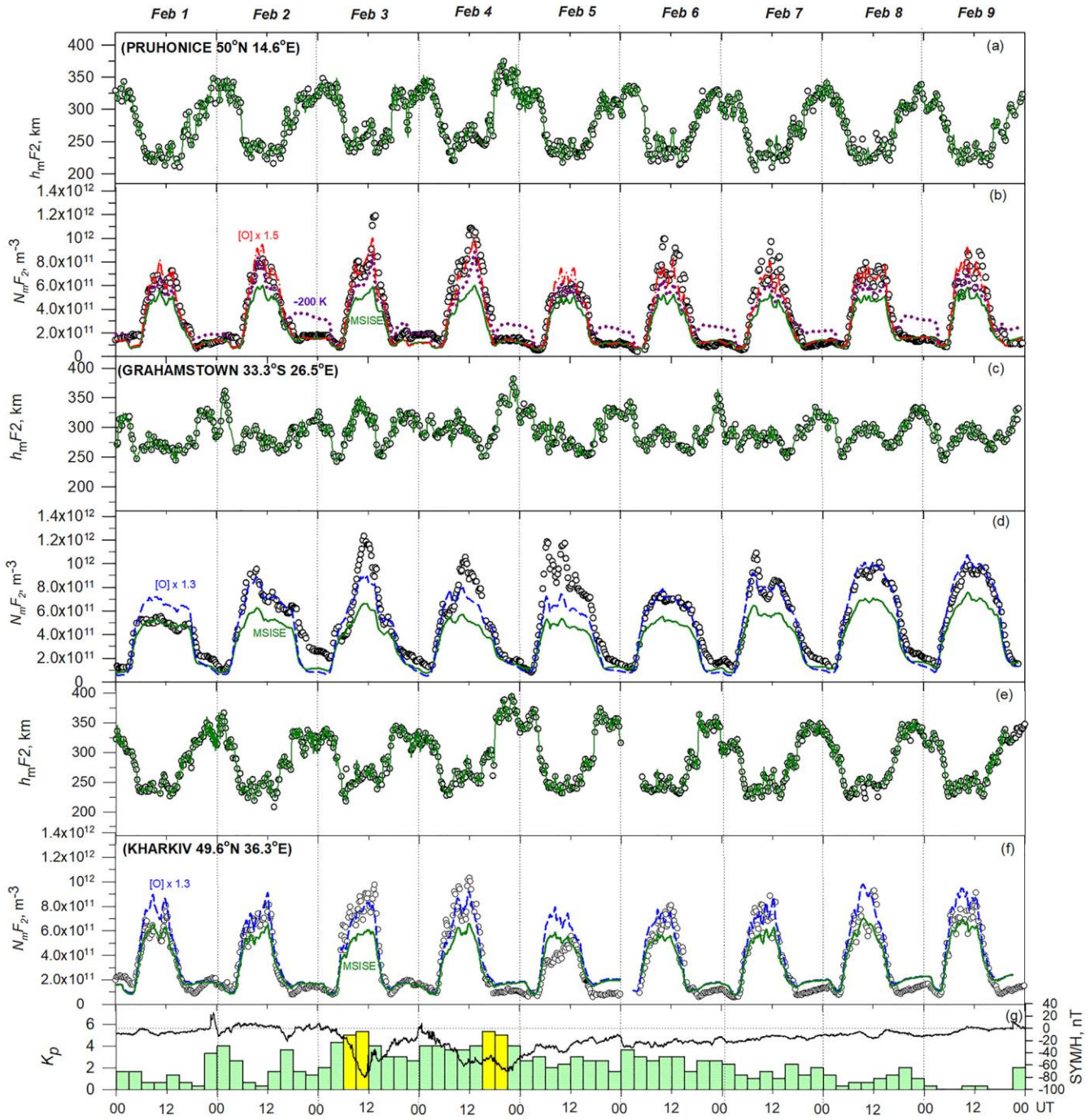
Kotov et al., AtmoSense/AIRWaveS Conference, April 15-17, 2025, Daytona Beach, FL

Велика війна не зупинила розвиток обсерваторії

Один з найважливіших результатів

Той самий випадок, коли науку неможливо ігнорувати

Втрата 38 супутників Starlink. Лютий 2022 року



Головне – це ідея

I результат

Geophysical Research Letters

RESEARCH LETTER
10.1029/2024GL112620

The Thermosphere Was Poorly Predictable Not Only During but Also Before and After the Starlink Storm on 3–4 February 2022

M. O. Reznychenko[1,2], D. V. Kotov[1], P. G. Richards[3], O. V. Bogomaz[1,4], A. I. Reznychenko[2,5], L. P. Goncharenko[6], T. G. Zhivolup[1], and I. F. Domnin[1]

[1]Institute of Ionosphere, National Technical University "Kharkiv Polytechnic Institute", Kharkiv, Ukraine, [2]Space Research Centre of Polish Academy of Sciences, Warsaw, Poland, [3]Department of Computer Science, University of Alabama in Huntsville, Huntsville, AL, USA, [4]State Institution National Antarctic Scientific Center, Ministry of Education and Science of Ukraine, Kyiv, Ukraine, [5]Institute of Radio Astronomy, National Academy of Sciences of Ukraine, Kharkiv, Ukraine, [6]Massachusetts Institute of Technology, Haystack Observatory, Westford, MA, USA

Key Points:

- For magnetically quiet days, the observed daytime N_mF_2 values were ~50% larger than those simulated using the NRLMSISE-00 model
- This implies ~30% larger neutral O density comparing with the NRLMSISE-00 model prediction or the density underestimation by the model
- Similar problem with the O density prediction happens for some periods for different years

Supporting Information:

Supporting Information may be found in the online version of this article.

Correspondence to:

D. V. Kotov and M. O. Reznychenko,
dmitrykotoff@gmail.com;
mrezn.cbk@gmail.com

Abstract Observation-based simulations of the ionosphere were performed with the NRLMSISE-00 model for six locations around the globe during 1–9 February 2022, which includes the so-called Starlink Storm. Unlike other studies, we focused on the magnetically quiet days around the storm. Unexpectedly, the observed values of the F2-layer peak density were ~50% larger than the simulated values. We show that this implies that the daytime O density in the thermosphere was systematically ~30% larger than the NRLMSISE-00 predicts. Further investigation shows that this discrepancy is not an exclusive feature of the period around the Starlink Storm and a similar problem happens for some periods for different years. It is unclear if the reason is an actual increase of the O density or its underestimation by the model. Resolving this problem is critical for providing accurate predictions of the atmosphere to avoid the degradation of normal operation or even loss of space assets.

СУСПІЛЬНЕ ХАРКІВ

Учені з Харкова виявили проблему у прогнозуванні атмосфери, що призвела до "наймасовішої втрати" космічних апаратів

Ганна Цьомик

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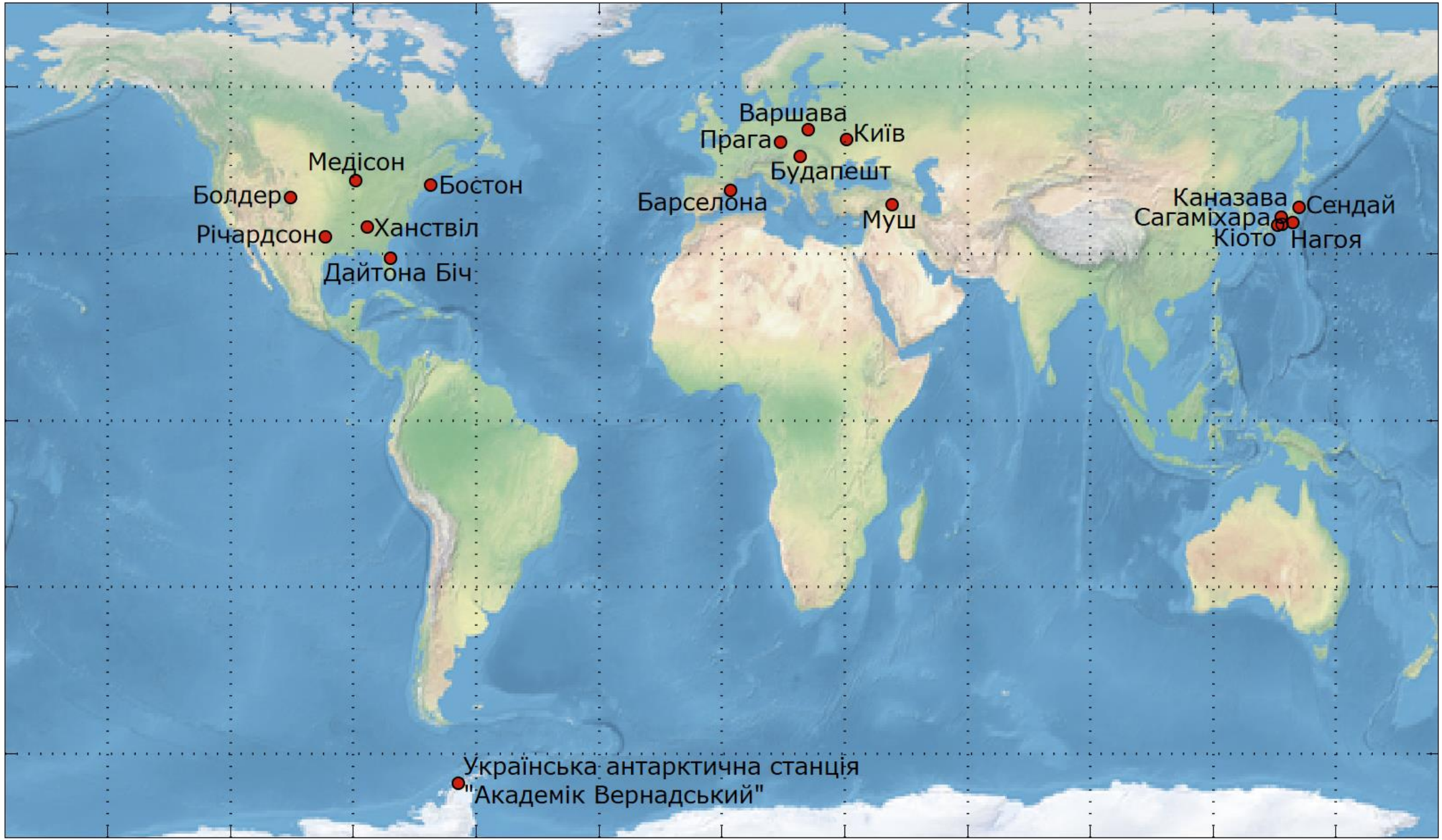
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