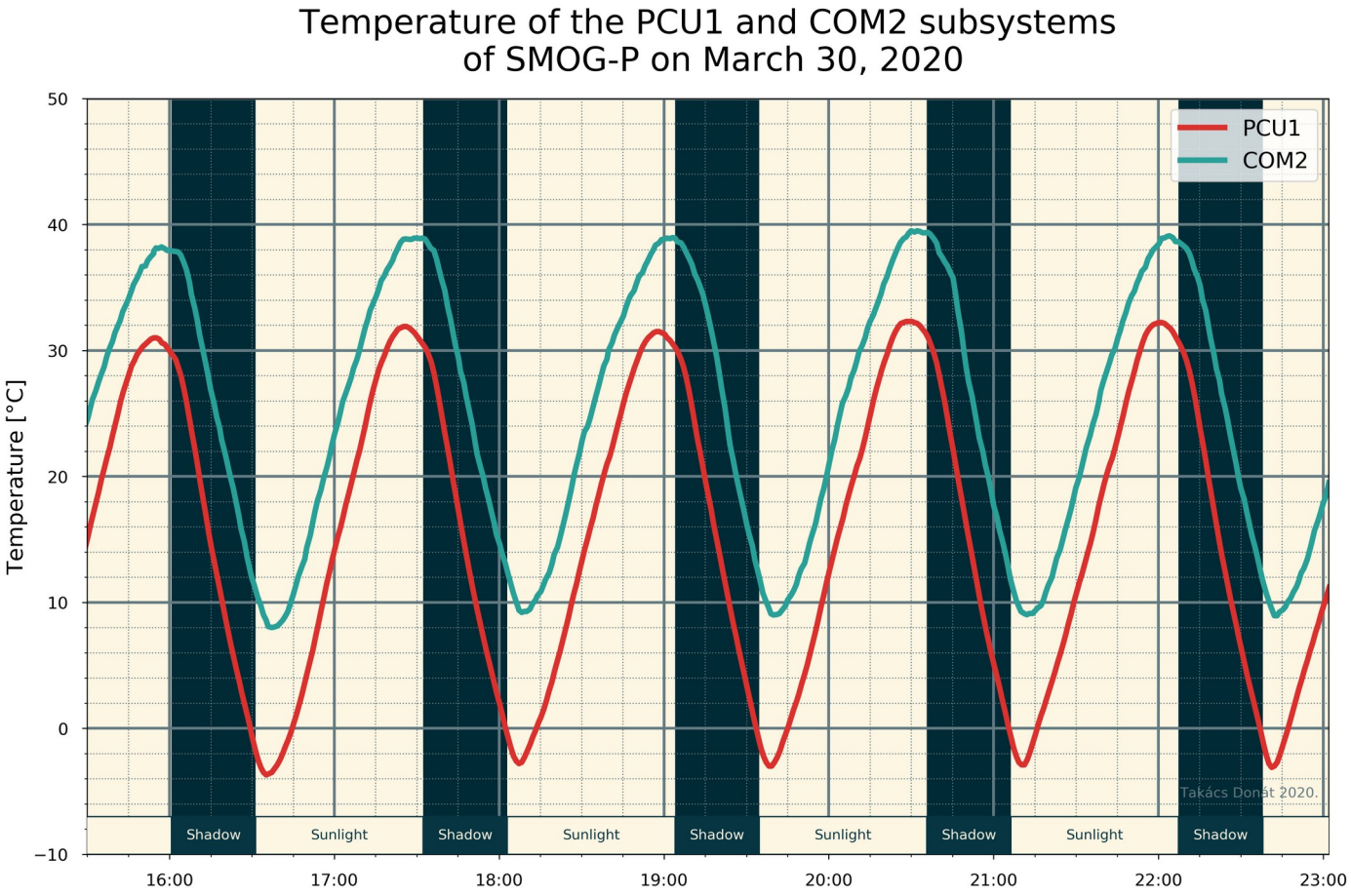
SMOG-P: A Successful Space Project

SMOG-P, the world's tiniest satellite manufactured at the Budapest University of Technology, has just passed its first half year of flawless operation in space. It has two purposes:

- ensure appropriate operating conditions for its on-board equipment
- continuously execute its measurement tasks as instructed from the Earth, and relay back the results.

Due to its starting orbit altitude and the fact that this altitude decreases by 4-5 km per week, it is expected to reach the denser layers of the atmosphere and burn up by the end of September.

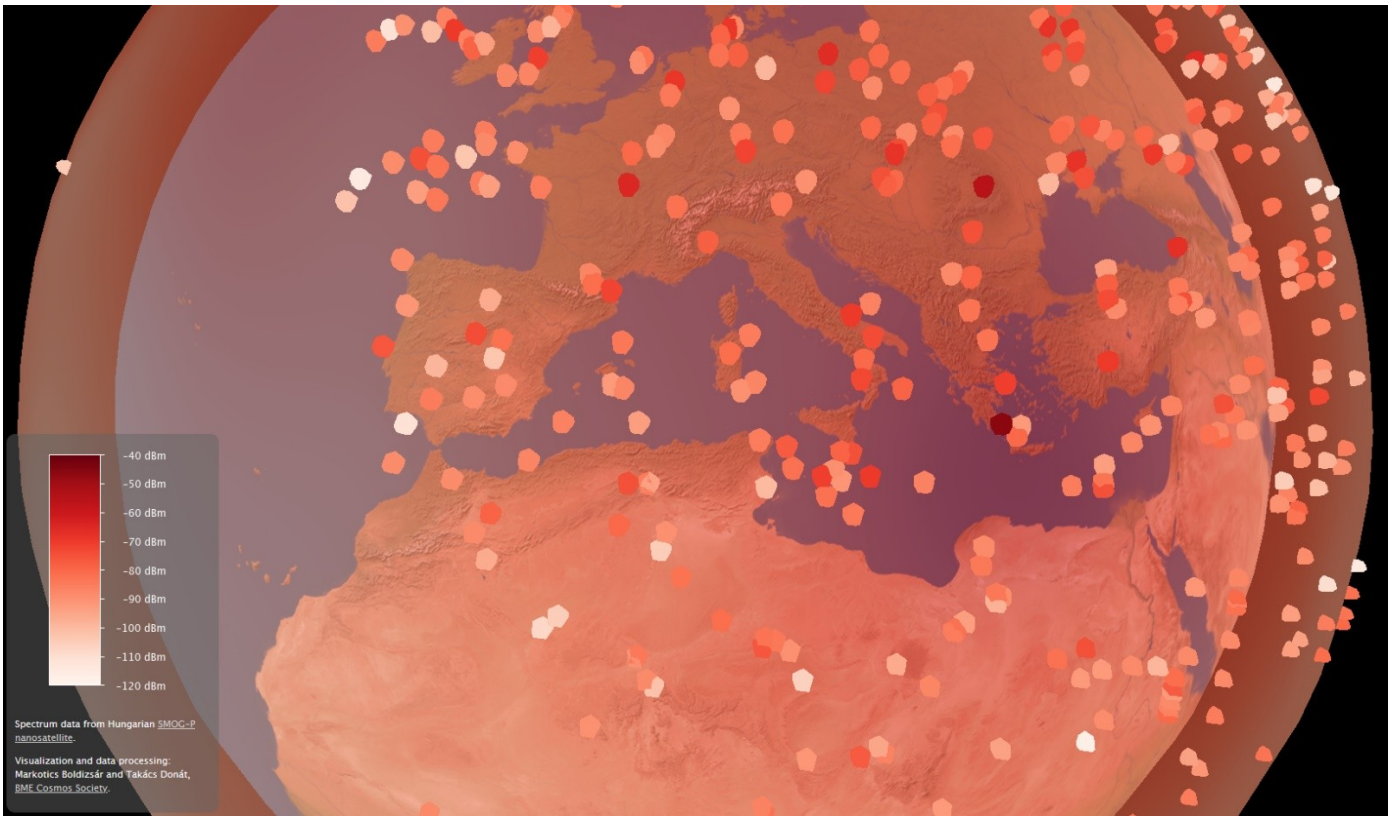
The greatest design challenge was to ensure the ambient temperature and energy supply/storage needed for its on-board equipment to operate. The figure below shows the two subsystems most affected by fluctuations: the primary energy supply unit (pcu1) on the satellite's the internal surface, and the communications system inside, responsible for terrestrial radio communications. The processing and visualization of the received data was performed by our student *TAKÁCS Donát*. The picture shows the orbit segments when the satellite is exposed to sunlight and when it is in the shadow of the Earth.



A control station on the top of Building "E" of the University, operated by Senior Engineer Dr. *DUDÁS Levente* and Station Operator *HÖDL Emil*, is used for receiving the data and

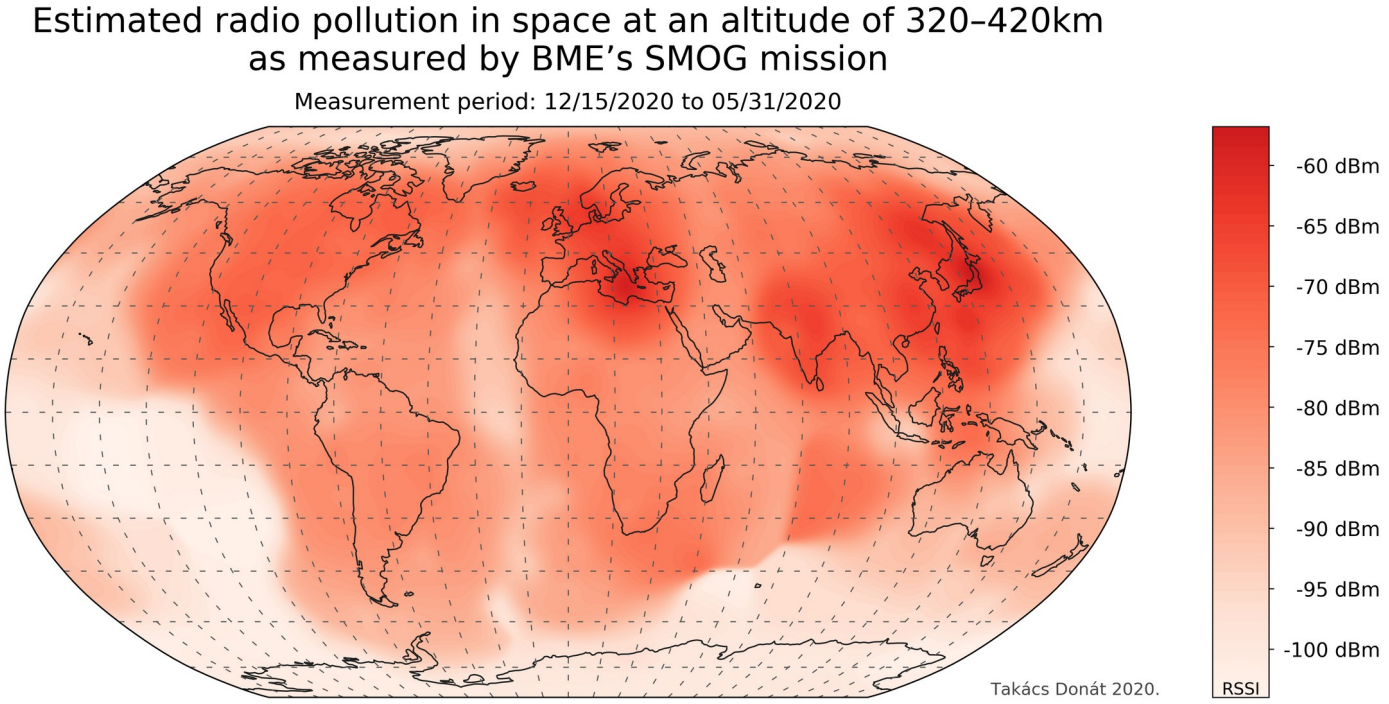
keeping contact with the satellite. The pandemic didn't cause any disruption because the satellite was operated fully remotely from home. The data are not encrypted and can be received in the ham radio frequency band. The data decoding software can be downloaded from the SMOG-1 website: http://gnd.bme.hu/smog. The software can be used to display the received data on any private computer and visualize the reception location along with the electrosmog. Many enthusiastic and helpful persons interested in satellite technology have helped to improve the software. Data arrive from ten countries over the Internet to our central server at https://gnd.bme.hu/gndupload/stationsdata.php. To date, *HEGEDÜS Tamás* (HA6NAB) in Hungary and *ILLÉS József* (OM3BC) in Slovakia have received the most data packets. The satellite's continuously and automatically updated key operation parameters can be viewed on a dashboard supervised by *HERMAN Tibor*: http://gnd.bme.hu/grafana/d/jyKiTk_Wz/smog-p-status?orgId=1&kiosk .

The mission of SMOG-P is to confirm and map the presence of human-induced electrosmog surrounding the Earth. From its 350-km-high orbit, it covers a circular surface area with a diameter if 4,000 km beneath it. This is the area from which its antenna receives signals. Due to its slow spin and non-isotropic antenna pattern, measurements have to be taken at small time differences, recording the signal with the largest amplitude. Up till now it has performed about 2,000 measurements. A still of the 3D video showing the simplified distribution of the measurement points can be seen in the picture below. The software was written by our students *MARKOTICS Boldizsár* and *TAKÁCS Donát*. The online interactive 3D map can be viewed at https://gnd.bme.hu/mb/site/.

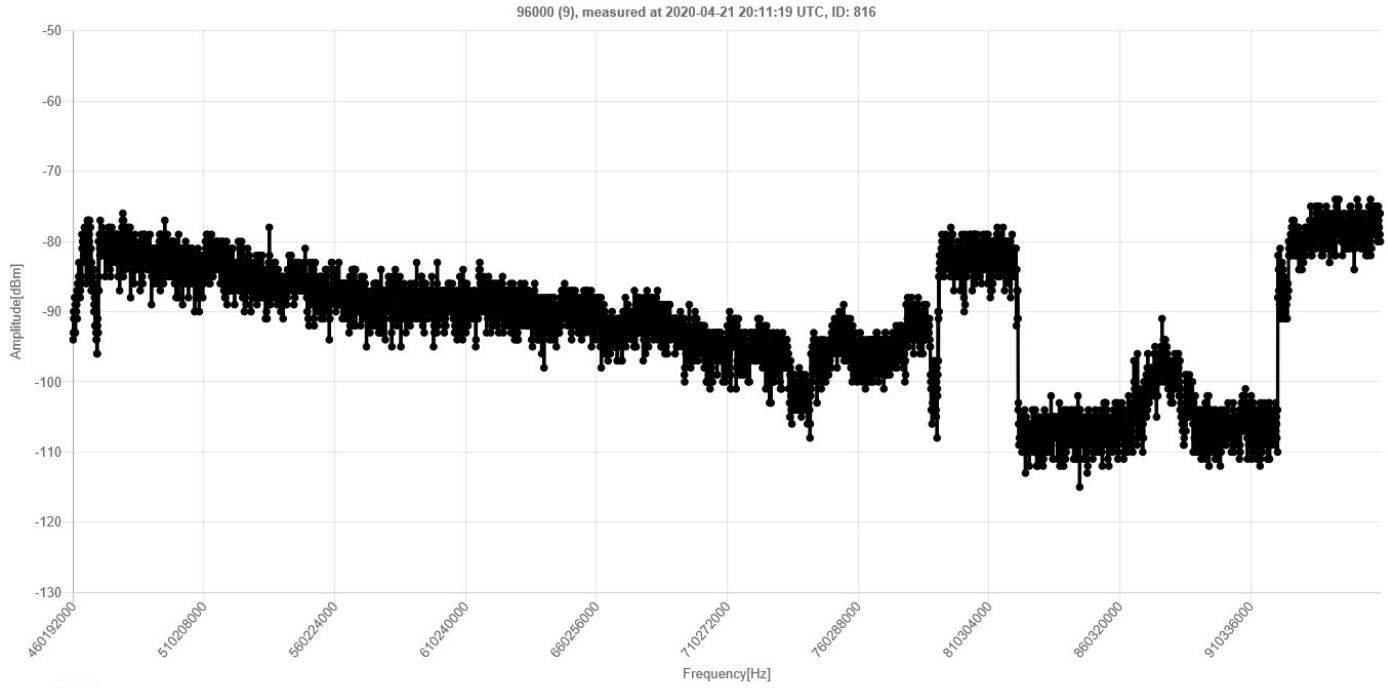


The picture below shows the electrosmog covering the Earth in a cylindrical projection. The satellite receives no signals above the oceans as there are no signal sources there. We note

here that due to the university environment, more and more enthusiastic students get involved in our work, in line with our goal. This is also facilitated by the BME Cosmos Society (a local chapter of SEDS), a student association at our university focused on space activities. We hope that as our space engineer program starts, this activity can be further intensified.



During the operation of the satellite and the preliminary evaluation of its measurements, we have been in close contact with experts of the National Media and Infocommunications Authority (NMHH). Based on our measurement results, we intend to convince the Earth Observation working group of the European Space Agency (ESA) to add electrosmog, a novel kind of pollutant, to the list of environmental pollutants. The International Telecommunication Union (ITU) is also awaiting our results, mainly due to the possible use of our space measurements in designing terrestrial telecommunications systems. The following image shows our most surprising result based on measurements above Europe. The spectrum image clearly shows that the levels of signals from mobile systems (810–950MHz) are almost identical to those emitted by large TV transmitters operating at around 500 to 600 MHz. At the start of our project, we unfortunately were unable to convince the service providers of the necessity to examine these signals. Accordingly, we could not enjoy their support during our work.



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timestamp: 2020-04-21 20:11:19
rbw: 9
step_size: 96000
Chart ampitude min value -130
Chart ampitude max value -50

Once our small satellite SMOG-1 is put into orbit in fall this year, we will be able to also observe components of 5G mobile systems below 960MHz.

Meanwhile we will need to modernize our terrestrial antenna systems and add redundant units.

In our work conducted so far using BME's environment and background, we have enjoyed crucially important contributions from our sponsors. We hope for their continued support.

Dr. GSCHWINDT András
SMOG Project Manager