Journal of Advanced Artificial Intelligence, Engineering and Technology

Supplementary - 2

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Environmental Ionization in Enclosed Geospheres: Comparative Study of Global and Local Measurements (2018-2025)

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Supplementary 2: Measurements of NAI and PAI around the world

Table 1: Negative and positive ion concentrations in Africa. (South Africa, Zimbabwe and Ethiopia).

Location & coordinates	Date	Time	Weather	Visibility	Negative ions (ions/cm^3)	Positive ions (ions/cm^3)	Magnetic field (µT)
Great Zimbabwe Archaeological Park, Conical Granite Towers (-20.2689, 30.9333)	09-02-2020	10:30 AM	Heavy clouds, just before thunderstorm and rain	Good	1,00,000	1,00,000	19-34
Khami Ruins, Archaeological Park, west of Bulawayo (-20.1469, 28.4625)	07-02-2020	4:30 PM	Cloudy	Very good	1,200-1,800	1,200-1,800	24-39
Hotel Malaga, Waterfall Boven (-25.6343, 30.3801)	01-02-2020	2:15 PM	Sunny	Excellent	600	650	20-23
Adam’s Calendar archaeological ruins, Mpumalanga (-25.9668, 30.5872)	02-02-2020	1:00 PM	Sunny, 20°C	Excellent	200	150-300	10-152
Big Stone Circle, archaeological ruins, Waterfall Boven, Mpumalanga (-25.6352, 30.3785)	01-02-2020	4:30 PM	Cloudy, warm, 28°C	Excellent	400-600	400-500	21-31
Axum, outside Stelae archaeological park (14.1304, 38.7200)	06-01-2020	11:00 AM	Sunny, warm	Very good	100-1,000	1,000-5,000	32-38
Axum, Stelae archaeological park (14.1232, 38.7156)	06-01-2020	11:15 AM	Sunny	Very good	100-3,000	200-5,000	32-40

Analysis and comparison of negative and positive ion concentrations in Africa **(Table 1)**.

The data collected from Zimbabwe, South Africa and Ethiopia reveals significant variations in negative and positive ion concentrations across different archaeological and natural sites. The measurements show how environmental conditions, altitude and natural geological formations impact air ionization.

Key observations

Exceptionally High Ionization at Great Zimbabwe (100,000 NAI & 100,000 PAI)

- The Great Zimbabwe Archaeological Park, particularly around the Conical Granite Towers, recorded the

Journal of Advanced Artificial Intelligence, Engineering and Technology

highest negative ion concentration in Africa (100,000 ions/cm^3).

- This extremely high level was observed just before a thunderstorm, indicating that atmospheric conditions play a crucial role in the ionization process.
- The magnetic field (19-34 µT) remained within the expected range for natural sites.

Moderate ion levels at Khami Ruins (1,200-1,800 NAI & 1,200-1,800 PAI)

- The Khami Ruins displayed moderately high ionization, with nearly equal concentrations of negative and positive ions, suggesting a balanced electrostatic environment.
- The readings were taken under cloudy conditions, which typically support a stable ionization rate.

Lower ion levels in South African sites

- Adam's Calendar (200 NAI & 150-300 PAI) and the Big Stone Circle (400-600 NAI & 400-500 PAI) recorded much lower negative ion concentrations compared to Zimbabwean sites.
- These levels, while above urban averages, indicate that South Africa's ancient stone sites may not exhibit the same electrostatic properties as their Zimbabwean counterparts.
- The magnetic field at Adam's Calendar (10 µT-152 µT) showed a wide range, hinting at possible localized geomagnetic anomalies.

Axum, Ethiopia-Variable Negative Ion Levels (100-3,000 NAI & 200-5,000 PAI)

- The two Axum sites (inside and outside Stelae Park) had a broad range of ionization, with negative ions ranging from 100 to 3,000 ions/cm^3.
- The Stelae Archaeological Park exhibited slightly higher values, possibly due to the presence of large megalithic structures influencing the ionization process.
- The magnetic field measurements (32 µT-40 µT) were the highest in this dataset, possibly indicating a link between geomagnetic intensity and air ionization.

Comparative analysis

- Great Zimbabwe clearly stands out as the most ionized location, with values significantly exceeding those recorded at other sites.
- South African sites exhibit lower ionization, likely due to their geological composition, altitude or the absence of large-scale granite structures.
- Ethiopian sites (Axum) demonstrate highly variable ion concentrations, which may be influenced by altitude, megalithic structures and localized weather conditions.
- The impact of weather is evident, as cloudy or rainy conditions (*e.g.,* Khami, Kokino) correspond to higher ion levels, while clear, sunny conditions (*e.g.,* Adam's Calendar) result in lower readings.
- Geomagnetic anomalies may contribute to ion variations, especially at Adam's Calendar, where the magnetic field showed significant fluctuations.

Conclusions

- The data suggests that ancient stone structures, geomagnetic activity and weather conditions all play a role in air ionization.
- The Great Zimbabwe site stands out as a unique high-ionization environment, possibly influenced by its large granite formations and atmospheric conditions.
- Further research is needed to determine whether the high negative ion concentrations are due to natural processes or if these ancient sites were deliberately constructed in areas with unique electrostatic properties.

Table 2: Negative and positive ion concentrations in Slovenia.

Location & coordinates	Date	Time	Weather	Visibility	Negative ions (ions/cm^3)	Positive ions (ions/cm^3)	Magnetic field (µT)
Žiri, Ravne, Slovenia (46.0436, 14.1076)	23-10-2019	12:00 PM	Sunny	Very good	1,200-1,400	800-1,400	23-49
Rakov Škocjan, Kamene Skale, Slovenia (45.7934, 14.2763)	22-10-2019	1:10 PM	Sunny, 22°C	Very good	900-1,500	1,000-1,500	45-48
Rešeto, Cerkniško jezero, Slovenia (45.7758, 14.3662)	22-10-2019	11:00 AM	Sunny	Very good	5,000	4,800	46-48
Gorica, Cerkniško jezero, Slovenia (45.7813, 14.3637)	22-10-2019	12:00 PM	Sunny	Very good	2,500	2,500	44-52
Ivarčko jezero, Ravne na Koroškem, Slovenia (46.5400, 14.9661)	20-05-2022	3:00 PM	Sunny	Excellent	400-1,000	100-400	45-58

Journal of Advanced Artificial Intelligence, Engineering and Technology

Analysis and Comparison of Negative and Positive Ion Concentrations in Slovenia **(Table 2)**.

The data from Slovenia provides an interesting contrast to the African sites. Slovenia's locations are primarily natural formations (lakes, caves and rock formations) rather than archaeological ruins, which allows us to explore how different landscapes, altitudes and weather conditions influence air ionization.

Key observations

Highest Ionization at Rešeto, Cerkniško Lake (5,000 NAI & 4,800 PAI)

- Rešeto at Cerkniško Lake recorded the highest concentration of negative ions (5,000 ions/cm^3), significantly surpassing other locations in Slovenia.
- The high levels suggest that water bodies, karst formations and air movement over the lake contribute to increased ionization.
- This pattern is consistent with studies showing that lakes, waterfalls and underground rivers enhance negative ion production.

Gorica, Cerkniško Lake-elevated ionization (2,500 NAI & 2,500 PAI)

- Located near Rešeto, Gorica also exhibits high ion levels, reinforcing the idea that Cerkniško Lake's environment plays a key role in ion production.
- The balance of negative and positive ions suggests a stable electrostatic environment.

Rakov Škocjan and Žiri, Ravne-moderate ion levels (900-1,500 NAI & 1,000-1,500 PAI)

- Both sites are rocky landscapes with limestone formations.
- The negative ion levels are significantly higher than urban environments, but lower than those recorded at Cerkniško Lake.
- The readings confirm that natural rock formations contribute to negative ion generation, though not as much as large bodies of water.

Lowest Ionization at Ivarčko Lake (400-1,000 NAI & 100-400 PAI)

- The lowest recorded values in Slovenia were at Ivarčko Lake, where negative ion levels were below 1,000 ions/cm^3.
- This site had the largest imbalance between negative and positive ions, suggesting a less stable air ion environment.
- While lakes generally contribute to ion production, the absence of waterfalls, underground water sources or strong air currents may explain the lower levels.

Comparative analysis

- Cerkniško Lake (Rešeto & Gorica) is the most ionized site in Slovenia, likely due to karstic geology, water movement and underground air currents.
- Rakov Škocjan and Žiri show moderate ionization, which aligns with expectations for rocky terrains and cave-like environments.
- Ivarčko Lake has the lowest ion levels, indicating that not all water bodies produce high negative ion concentrations.

Conclusions

- Water-related environments, especially in karstic regions, significantly boost negative ion concentrations.
- Limestone caves and rocky formations contribute to ionization, but to a lesser extent than lakes and underground rivers.
- The role of underground air currents and microclimates should be further examined to determine their influence on air ion levels in natural environments.
- Compared to African sites, Slovenia's measurements are lower overall, reinforcing the idea that granite formations (like in Great Zimbabwe) and geomagnetic anomalies may also be crucial factors in high ionization levels.

Table 3: Negative and positive ion concentrations in Macedonia.

Location & coordinates	Date	Time	Weather	Visibility	Negative ions (ions/cm^3)	Positive ions (ions/cm^3)	Magnetic field (μT)
Kale Fortress, Archaeological Site, Skopje (41.9992, 21.4291)	13-05-2023	11:00 AM	Cloudy	Good	300	300	-
Kokino Ancient Astronomical Observatory, Kumanovo (42.2603, 21.9522)	20-05-2021	1:30 PM	Cloudy/rain	Good	300-400	10-50	49-50
Cocev Kamen, Ancient Astronomical Observatory,	21-05-2021	12:00 PM	Cloudy	Good	300-1,000	160-300	47-49

Šopsko Rudare (42.1370, 21.9527)							
Kanda Geoglyph, Archaeological Site, Sveti Nikole (41.8519, 21.9064)	22-05-2021	2:00 PM	Sunny	Excellent	500-1,000	300	43-57
Ostrovica, Archaeological Site, Sveti Nikole (41.8850, 21.8598)	23-05-2021	3:00 PM	Sunny	Excellent	300-500	300-500	34-40

Analysis and comparison of negative and positive ion concentrations in Macedonia **(Table 3)**.

The measurements from Macedonia were taken at archaeological sites, ancient astronomical observatories and geoglyph locations, providing insight into how ancient structures and natural environments influence air ionization.

Key observations

Highest Ionization at Kanda Geoglyph (500-1,000 NAI & 300 PAI)

- The Kanda Geoglyph site recorded the highest negative ion levels in Macedonia (up to 1,000 ions/cm^3).
- This site is an enigmatic, large-scale earth formation, potentially interacting with atmospheric or geomagnetic forces to create increased ionization.
- Sunny conditions and excellent visibility further support high ion production.

Cocev Kamen-Wide Ion Range (300-1,000 NAI & 160-300 PAI)

- Cocev Kamen is an ancient astronomical observatory, associated with ritual activities and possibly aligned with cosmic events.
- The significant range in negative ions suggests that localized air circulation and surface properties (*e.g.,* rock composition) may influence readings.

Moderate Ionization at Kokino Observatory (300-400 NAI & 10-50 PAI)

- Kokino, another ancient astronomical site, exhibited lower negative ion concentrations than expected.
- The presence of rainy/cloudy weather during the measurement could have affected air ion dynamics.
- Notably low positive ion levels (10-50 PAI) suggest a potential electrostatic imbalance, possibly influenced by geological features.

Kale Fortress-Lowest Ionization (300 NAI & 300 PAI)

- The Kale Fortress in Skopje had the lowest recorded negative ion concentration, at just 300 ions/cm^3, similar to urban outdoor environments.
- The presence of a man-made structure, potentially with reduced air flow and higher human activity, might explain the lower ionization levels.

Ostrovica-balanced ionization (300-500 NAI & 300-500 PAI)

- Ostrovica, another archaeological site, had fairly stable negative and positive ion concentrations.
- This balance suggests a natural electrostatic equilibrium, though ion levels remain on the lower end compared to other sites in Macedonia.

Comparative analysis

- Kanda Geoglyph shows the highest ionization, possibly due to natural geological factors or its interaction with atmospheric currents.
- Ancient observatories (Cocev Kamen, Kokino) have moderate ionization, suggesting a possible relationship between negative ion production and elevated terrains or ritual sites.
- Urban or modified environments (Kale Fortress) exhibit the lowest ion levels, reinforcing the idea that man-made structures can suppress natural ionization processes.
- Geomagnetic anomalies at some sites (*e.g.,* Kokino at 49-50 μT) might be influencing ion concentrations, though more research is needed to establish a direct link.

Conclusions

- Negative ion concentrations in Macedonia are generally lower than in Slovenia and Africa, suggesting that geology, altitude and human activity influence ion production.
- Astronomical observatories and ritual sites exhibit moderate ionization, which may be related to elevated locations, exposure to wind currents or the natural composition of the stones.
- The Kanda Geoglyph stands out as an exception, potentially indicating that certain geomagnetic or atmospheric factors contribute to increased ionization.
- The impact of weather is evident, as cloudy and rainy conditions at Kokino correspond to lower negative ion levels.

Journal of Advanced Artificial Intelligence, Engineering and Technology

Table 4: Negative and positive ion concentrations in Italy.

Location	Date	Time	Weather	Visibility	Negative ions (ions/cm^3)	Positive ions (ions/cm^3)	Magnetic field (µT)
Taino, hotel 'Bob Room' (45.7485° N, 8.6134° E)	20-10-2019	8:53 AM	Rain, 24°C	Poor	Oct-40	80-400	44-49
Sardinia, Menhir at Villa Sant Antonio archaeological site (39.9042° N, 8.8213° E)	15-11-2019	3:00 PM	Cloudy, windy, 12°C	Very good	1.200-2.200	200-500	44-52
Vuccuru Nuraxi archaeological site, Settimo San Pietro, Sardinia (39.2586° N, 9.1897° E)	15-11-2019	11:15 AM	Cloudy, 12°C	Good	600	700	36-50
Pauli Arbarei, archaeological site with destroyed stone pyramid, Sardinia (39.6713° N, 8.9132° E)	14-11-2019	11:00 AM	Sunny	Very good	1.2	1.500-2.500	43-45
Sadhu e Sorcu, 'Giants Tomb' archaeological site, central Sardinia (40.1147° N, 9.0924° E)	13-11-2019	2:40 PM	Cloudy, 12°C	Good	2.000-3.500	2.000-3.500	42-52
Nuraghe Losa of Abbasanta, central Sardinia (40.1664° N, 8.7512° E)	11-11-2019	1:40 PM	Partly cloudy, 15°C	Very good	3	2	36-46
Santa Christina, Sacred Well archaeological site, Pauli Latino, central Sardinia (40.0162° N, 8.7367° E)	11-11-2019	10:55 AM	Partly cloudy, 14°C	Very good	2	2	41-53
La Prisgiona, Nuraghe archaeological site, conical granite tower, Arzachena, Sardinia (41.1014° N, 9.4006° E)	10-11-2019	12:40 PM	Cloudy, 14°C	Good	2.000-6.000	1.300-3.500	46-51
Giants' Tomb, Tomba di Giganti, archaeological site, Arzachena, Sardinia (41.0942° N, 9.4236° E)	10-11-2019	11:10 AM	Cloudy, 14°C	Very good	1.000-2.000	1.000-1.800	44-52
Monte D'Accodi, Zigurat-Pyramid archaeological site, Sassari Province, Sardinia (40.7893° N, 8.5019° E)	09-11-2019	2:45 PM	Cloudy, 18°C	Good	800-1.200	200-900	41-45
Monte D'Accodi, altar in front of the Pyramid, Sassari Province, Sardinia (40.7893° N, 8.5019° E)	09-11-2019	3:30 PM	Cloudy, 18°C	Good	500	500	45-52
Damanhur, Circle of Rituals (45.3956° N, 7.7211° E)	20-10-2019	3:21 PM	Rain, 16°C	Fair	1.500-2.600	1.000-1.500	42-52
Varese, Sesto Calende, Stone Preja Buja (45.7363° N, 8.6337° E)	21-10-2019	10:26 AM	Rain, 19°C	Fair	1	1	46-54
Mongrando Pyramid, Biella, Varese (45.5526° N, 8.0044° E)	20-10-2019	12:00 PM	Rain, 17°C	Low	1.500-2.000	800	42-52

Overview & trends

Diverse measurement sites

- The locations in Italy include megalithic sites, pyramidal structures, sacred wells and ritual circles, mostly in Sardinia but also in Lombardy and Piedmont.
- Different geological and environmental settings provide a range of ion concentrations.

Negative ion concentrations

- The lowest negative ion readings were observed in Taino, Hotel 'Bob Room' (10-40 NAI/cm^3) during rain and poor visibility.
- The highest values were recorded at La Prisgiona Nuraghe (2,000-6,000 NAI/cm^3) and Sadhu e Sorcu, 'Giants' Tomb' (2,000-3,500 NAI/cm^3).
- Monte d'Accoddi, the Pyramid-Ziggurat site, had

relatively low values (800-1,200 NAI/cm^3), while its altar had even lower concentrations (500 NAI/cm^3).

Positive ion concentrations

- Positive ion concentrations often mirror negative ions, showing similar trends.
- The highest PAI values were 1,500-2,500 PAI/cm^3 at Pauli Arbarei (stone pyramid site) and 2,000-3,500 PAI/cm^3 at La Prisgiona Nuraghe.

Magnetic Field Variations:

- The strongest magnetic fields were recorded at Varese, Sesto Calende (46-54 µT) and Pauli Arbarei (43-45 µT).
- Other locations range between 36-53 µT, showing moderate but consistent variations.

Comparative analysis

- Compared to Africa, where some locations reached 100,000 NAI/cm^3 (Great Zimbabwe), the Italian sites have significantly lower negative ion values.
- Bosnian Pyramid tunnels still show the highest readings worldwide (20,000-340,000 NAI/cm^3).
- Italy's megalithic sites, especially La Prisgiona Nuraghe, Sacred Well Santa Christina and Giants' Tombs, show elevated negative ion levels, potentially due to underground water flow, geomagnetic activity and natural ionization processes.

Key findings & hypothesis

- Ancient sacred sites and nuraghe structures tend to have higher ion concentrations than non-archaeological locations (*e.g.,* Taino Hotel).
- Rainy weather and poor visibility significantly reduce ion concentration, as seen in Taino, Mongrando Pyramid and Damanhur.
- The presence of stone structures, particularly granite towers, pyramidal formations and sacred wells, correlates with higher NAI values.
- The geomagnetic field variations suggest that some sites may have underground energy influences or natural piezoelectric effects.

Table 5: Negative and positive ion concentrations in the United Kingdom and Germany.

Location	Date	Time	Weather	Visibility	Negative ions (ions/cm^3)	Positive ions (ions/cm^3)	Magnetic field (µT)
Avebury Sanctuary, archaeological site, England (51.4284° N, 1.8522° W)	15-09-2022	10:10 AM	Cloudy	Good	1,000	1,000	49-51
Silbury Hill, tumulus archaeological site, England (51.4287° N, 1.8496° W)	15-09-2022	11:30 AM	Cloudy	Good	400	200	49-51
Zuschen Fritzlar, Megalithic archaeological site, Hesse, Germany (51.1544° N, 9.3812° E)	06-03-2020	1:00 PM	Cloudy/Rainy	Good	500-800	250-500	38-61

Analysis

Overview

- The archaeological sites in the United Kingdom (Avebury Sanctuary and Silbury Hill) and Germany (Zuschen Fritzlar) exhibit moderate to low negative and positive ion concentrations.
- Avebury Sanctuary and Sillbury Hill, both located in England represent prehistoric, megalithic monuments of significant historical and spiritual importance.
- Zuschen Fritzlar is also a megalithic site, but its ion concentrations seem somewhat more variable compared to the UK sites.

Negative Ions (NAI)

- The Avebury Sanctuary shows the highest negative ion concentration at 1,000 NAI/cm^3.
- Silbury Hill, a tumulus, shows lower values, 400 NAI/cm^3, possibly due to its different structure compared to the larger stone circles at Avebury.
- The Zuschen Fritzlar site in Germany ranges from 500 to 800 NAI/cm^3, indicating that megalithic sites in the region may have slightly higher ion concentrations than tumulus sites, but still lower compared to sites like the Bosnian Pyramids or certain African locations.

Positive Ions (PAI)

- Positive ion values in the UK sites are fairly balanced with the negative ions, 1,000 PAI/cm^3 at Avebury and 200 PAI/cm^3 at Silbury Hill.
- Zuschen Fritzlar shows a higher range for positive ions, ranging from 250 to 500 PAI/cm^3, which may reflect the different atmospheric conditions (cloudy/rainy) affecting ionization.

Journal of Advanced Artificial Intelligence, Engineering and Technology

Magnetic field

- The magnetic field measurements show consistent readings in the 49-51 µT range for the UK sites, which suggests stable geomagnetic conditions in these regions.
- Zuschen Fritzlar in Germany has a wider range of magnetic fields (38-61 µT), which might be due to the local geological structure and weather variations.

Comparison

- Avebury Sanctuary has the highest ion concentrations of this group, with 1,000 NAI/cm^3 and an equal number of positive ions.
- The Zuschen Fritzlar site, though higher in variability, has similar ion concentration values but exhibits wider magnetic field fluctuations, which could suggest the presence of local energy fields.
- Silbury Hill, as a tumulus, tends to have the lowest ion readings, possibly due to the structure and the surrounding environment.
- Compared to Italy and Africa, the ion concentrations in these UK and German sites are significantly lower. Sites like La Prisgiona Nuraghe in Sardinia and Great Zimbabwe in Africa exhibit much higher negative ion concentrations, likely due to geological and environmental factors, as well as the natural energy phenomena of those locations.

Conclusions

- Megalithic sites in the UK and Germany (Avebury, Silbury Hill, Zuschen Fritzlar) show moderate ion concentrations compared to pyramids and tumulus structures in other regions.
- The presence of ancient stone structures and their relation to geomagnetic fields can be speculated to influence ionization, but in this case, it seems the highest concentrations are still found in Bosnian and African archaeological sites.
- Further research could explore why magnetic field variations in sites like Zuschen Fritzlar might affect ion concentrations or if seasonal weather patterns play a role in ionization at these sites.

Table 6: Negative and positive ion concentrations in the United States.

Location	Date	Time	Weather	Visibility	Negative ions (ions/cm^3)	Positive ions (ions/cm^3)	Magnetic field (µT)
Red Rock Canyon, Turtleneck trail, Las Vegas, Nevada, USA (36.1130° N, 115.4410° W)	07-10-2022	10:30 AM	Sunny	Excellent	600-900	200	42-48
Yellowstone Park, Porcelain Basin, Wyoming, USA (44.5292° N, 110.6992° W)	11-10-2022	12:00 PM	Cloudy	Good	700-1,000	400-1,000	53-56
Sage Wall, archaeological site, Butte, Montana, USA (46.0330° N, 112.5390° W)	12-10-2022	12:00 PM	Sunny	Excellent	400-600	300-1,000	49-55
Tizer Dolmen, archaeological site, near Jefferson City, Montana, USA (46.5746° N, 112.0950° W)	13-10-2022	11:55 AM	Sunny	Clear	50-900	30-1,400	51-56

Analysis

Overview

- The USA sites (Red Rock Canyon, Yellowstone Park, Sage Wall and Tizer Dolmen) show a range of negative and positive ion concentrations, with notable variations between the locations. The weather conditions and visibility are also factors that might affect ionization levels.
- These sites are spread across diverse regions of the USA, from Nevada to Wyoming and Montana, showcasing both arid and more temperate environments.

Negative Ions (NAI)

- Red Rock Canyon shows a moderate range of 600-900 NAI/cm^3, likely due to the dry, desert-like conditions of Nevada.
- Yellowstone Park in Wyoming has a higher range of 700-1,000 NAI/cm^3, suggesting that the natural geothermal activity in the park, combined with its

Journal of Advanced Artificial Intelligence, Engineering and Technology

cloudy weather, likely influences the ion concentration.

- Sage Wall, Montana, shows moderate concentrations of 400-600 NAI/cm^3, which seems consistent with other archaeological sites in areas with clear visibility and sunny conditions.
- Tizer Dolmen presents a wide range of 50-900 NAI/cm^3, with the potential for fluctuations due to local geological features and weather conditions.

Positive Ions (PAI)

- Red Rock Canyon has a relatively low 200 PAI/cm^3, which is expected in a dry desert environment with excellent visibility.
- Yellowstone Park shows a range from 400-1,000 PAI/cm^3, which is relatively high and might be influenced by the geothermal energy in the park, along with the cloudy weather.
- Sage Wall displays a wider range of 300-1,000 PAI/cm^3, reflecting the variation in atmospheric conditions and the location's potential to hold higher positive ion concentrations.
- Tizer Dolmen shows significant variation with values ranging from 30-1,400 PAI/cm^3, possibly due to local energy fields and weather fluctuations that influence the ionization process.

Magnetic field

- The magnetic fields in the USA sites range from 42 μT (Red Rock Canyon) to 56 μT (Tizer Dolmen), which is similar to many of the European and African sites. This suggests that the USA archaeological sites are located in areas with stable geomagnetic conditions, with slight variations due to local geological factors.

Comparison

- Yellowstone Park and Tizer Dolmen exhibit higher ion concentrations than Red Rock Canyon and Sage Wall, likely due to geothermal activity and the geological nature of the sites.
- The Sage Wall site, while in a sunny location, shows moderate ion concentrations (400-600 NAI and 300-1,000 PAI), which is typical for archaeological sites with clear visibility.
- The ion concentrations in these USA sites are lower than those observed in Bosnian and African locations, but similar to those found in European sites such as Italy and Germany.

Conclusions

- The USA archaeological sites show moderate to high negative ion concentrations, especially in places like Yellowstone Park and Tizer Dolmen.
- The variation in positive ion concentrations across these sites can be linked to local geological activity (*e.g.,* geothermal activity in Yellowstone), weather conditions and natural energy fields present in the area.
- As with European sites, these results further emphasize the importance of environmental conditions in shaping ion concentrations at archaeological locations.

Table 7: Negative and positive ion concentrations in Croatia.

Location	Date	Time	Weather	Visibility	Negative ions (ions/cm^3)	Positive ions (ions/cm^3)	Magnetic field (μT)
Parking hotel 'Amarin', Rovinj, Croatia (45.0892° N, 13.6400° E)	28-09-2022	8:30 AM	Cloudy	Good	1,100	1,200	20-48
Picugi archaeological site, Poreč, Istra, Croatia (45.2215° N, 13.6385° E)	28-09-2022	10:00 AM	Cloudy	Good	500-1,300	500-1,300	44-48
Mamjan, Istra, Croatia (45.3782° N, 13.6419° E)	28-09-2022	7:00 PM	Rain	Good	400-700	800	46-50
Motovun, St. Stephen Church, Istra, Croatia (45.3362° N, 13.8289° E)	28-09-2022	4:00 PM	Cloudy	Good	1,000-1,700	900-1,300	41-49
Sveta Foška, Church, Pula, Istra, Croatia (44.9481° N, 13.8694° E)	30-09-2022	3:00 PM	Rain	Good	2,100	2,100	43-47
Island Pag, megalithic wall, Croatia (44.4461° N, 14.9822° E)	24-03-2023	11:45 AM	Sunny	Excellent	600-700	800-1,000	-
Obrovac, double megalith archaeological site, Croatia (44.1898° N, 15.6834° E)	25-03-2023	12:00 PM	Cloudy	Good	600	600	121-124
Asseria megalithic walls archaeological site, Podgrađe, Zadar, Croatia (44.1621° N, 15.6354° E)	25-03-2023	10:00 AM	Cloudy	Good	100-200	90	-

Journal of Advanced Artificial Intelligence, Engineering and Technology

Analysis

Overview

- The Croatian sites represent a mix of archaeological locations, sacred sites and natural formations across Istria, Zadar and the island of Pag.
- Weather conditions varied, with cloudy and rainy days predominating, but some sites were recorded under sunny conditions.
- The negative ion concentrations vary significantly, from as low as 100-200 NAI/cm^3 at Asseria Megalithic Walls to as high as 2,100 NAI/cm^3 at Sveta Foška Church.

Negative Ions (NAI)

- Sveta Foška Church (2,100 NAI) recorded the highest negative ion concentration, which might be attributed to its historical significance, spiritual energy or natural ionization sources.
- Motovun (St. Stephen Church) and Picugi archaeological site also showed elevated levels (1,000-1,700 NAI), suggesting potential geomagnetic or earth-energy influences.
- Mamjan and Pag Megalithic Wall had moderate levels of 400-700 NAI, aligning with typical outdoor natural environments.
- Asseria Megalithic Walls had the lowest recorded negative ions (100-200 NAI), possibly due to lower vegetation density or weaker geological ionization sources.

Positive Ions (PAI)

- Sveta Foška Church also had the highest positive ion concentration (2,100 PAI), aligning with its high negative ion levels.
- Motovun (900-1,300 PAI) and Picugi archaeological site (500-1,300 PAI) had notable positive ion concentrations, mirroring their negative ion levels.
- Asseria showed the lowest PAI (90/cm^3), indicating an extremely weak ionization environment.

Magnetic field

- The highest magnetic field strength was recorded at Obrovac (121-124 µT), significantly above Earth's average (40-50 µT), suggesting potential geomagnetic anomalies.
- Most other sites ranged between 41-50 µT, consistent with natural background levels.

Comparison with other regions

- The high ionization levels at Sveta Foška Church (2,100 NAI & 2,100 PAI) resemble values found in Damanhur (Italy) and some Bosnian Pyramid tunnels, reinforcing the idea that sacred sites may have distinct energy properties.
- The moderate ion levels of Motovun, Pag and Picugi align with many European megalithic sites such as those in Germany and the UK.
- Obrovac's unusually high magnetic field (121-124 µT) stands out compared to other regions, which typically show values between 40-60 µT.

Conclusions

- Sacred sites like Sveta Foška and Motovun have significantly higher ion levels, suggesting potential energetic properties.
- Megalithic locations like Pag Megalithic Wall and Picugi show moderate ionization, comparable to sites in Germany, Italy and Macedonia.
- Obrovac's high magnetic field anomaly may indicate an unusual geological feature worth further investigation.

Table 8: Negative and positive ion concentrations in Serbia.

Location	Date	Time	Weather	Visibility	Negative ions (ions/cm^3)	Positive ions (ions/cm^3)	Magnetic field (µT)
Lepenski Vir, major archaeological site, Serbia (44.5775° N, 21.7042° E)	21-10-2020	3:00 PM	Sunny	Excellent	100-800	100-500	48-50
Vinča, major archaeological site, Belgrade, Serbia (44.7483° N, 20.6672° E)	22-10-2020	3:00 PM	Sunny	Excellent	200-400	200-400	45-51
Drenajić energy circles, natural energetic site, Valjevo, Serbia (44.2726° N, 19.8820° E)	23-10-2020	3:30 PM	Sunny	Good	300-500	400-600	47
Ritopek, Glavica, 'Pyramid' hill, Belgrade, Serbia (44.7202° N, 20.6131° E)	17-03-2021	1:00 PM	Cloudy/ice rain, 8°C	Good	200-800	600-900	39-78

Mala Krsna, energy site 'Najdanov krug', Požarevac, Serbia (44.6279° N, 20.9565° E)	17-03-2021	3:00 PM	Cloudy	Good	800	300-500	-
Vatin, archaeological site 'Vršački krugovi' (Vršac circles), Serbia (45.1512° N, 21.3005° E)	22-04-2021	6:45 PM	Sunny	Excellent	500	300	47-49
Kuršumlija, entrance to the Middle Age fort, Serbia (43.1402° N, 21.2771° E)	19-05-2021	6:15 PM	Cloudy & Windy	Good	100-600	100-400	48-50
Village Rudare, Branko's tower archaeological site, Kuršumlija, Serbia (43.1453° N, 21.2679° E)	19-05-2021	6:20 PM	Cloudy	Good	100-400	200-800	49-50
Village Gornji Taor stone sphere archaeological site, Kukalj hill, Valjevo, Serbia (44.1442° N, 19.8823° E)	17-04-2022	2:10 PM	Cloudy, 10°C	Good	300	100	44-54
Village Gornji Taor stone sphere archaeological site, Kukalj hill, Valjevo, Serbia (44.1442° N, 19.8823° E)	17-04-2022	2:10 PM	Cloudy, 10°C	Good	300	100	44-54
Povlen, stone sphere archaeological site, Belevode, village Gornji Taor Valjevo, Serbia (44.1346° N, 19.7850° E)	17-04-2022	3:45 PM	Cloudy, 9°C	Good	300	300	38-49
Tumulus Jurišina kosa, archaeological site, Žabalj, Bačka, Vojvodina, Serbia (45.3471° N, 20.0508° E)	15-04-2022	12:00 PM	Cloudy	Good	200	200	46-49
Banoštor energy site 'Sofijini izvori (circles)', Fruška gora, Serbia (45.1949° N, 19.6183° E)	19-04-2022	10:00 AM	Cloudy	Good	300	700	45-51
'Novak' tennis complex, Belgrade, Serbia (44.8176° N, 20.4383° E)	20-10-2020	11:30 AM	Sunny	Excellent	200-400	200-400	46-48

Analysis

Overview

- The Serbian locations include prehistoric sites (Lepenski Vir, Vinča), energetic sites (Drenajić, Najdanov Krug, Sofijini izvori), pyramid-like hills (Ritopek-Glavica) and megalithic formations (Povlen, Kukalj Hill, Vršački krugovi).
- Weather was mostly cloudy or sunny, except for Ritopek (ice rain, 8°C).
- Negative ion levels range widely, from 100 to 800 NAI/cm^3, while positive ions range from 100 to 900 PAI/cm^3.
- Magnetic fields vary between 38-78 µT, with Ritopek recording an exceptionally high 78 µT.

Negative Ions (NAI)

- Mala Krsna (Najdanov Krug) had the highest NAI (800/cm^3), suggesting strong energetic activity.
- Lepenski Vir (100-800 NAI), one of the oldest European settlements, had fluctuating values, possibly affected by the Danube River.
- Ritopek (200-800 NAI) and Vinča (200-400 NAI) suggest moderate energetic properties.
- Stone sphere sites (Povlen, Kukalj Hill) had consistent but lower values (~300 NAI).

Positive Ions (PAI)

- Ritopek recorded the highest PAI (600-900/cm^3), indicating a possible geomagnetic anomaly.
- Sofijini izvori had an unusually high positive ion concentration (700/cm^3).
- Most sites maintained a balanced NAI/PAI ratio, except for Rudare, where PAI exceeded NAI (200-800 ***vs.*** 100-400).

Magnetic field analysis

- Ritopek-Glavica recorded an unusually high 78 µT, significantly above Earth's natural background (~50 µT), indicating possible underground magnetic anomalies.
- Most other sites ranged between 38-54 µT, which is within normal variation.

Comparison with other countries

- Serbian megalithic and archaeological sites show moderate to high ionization, similar to those in Croatia, Bosnia and Germany.
- Mala Krsna (Najdanov Krug) had higher ion levels than

Italy's Damanhur but lower than Bosnia's Ravne tunnels.

- Ritopek's magnetic field anomaly (78 µT) is one of the highest recorded and aligns with energy anomalies found in places like Obrovac (Croatia) and some Egyptian sites.

Conclusions

- Energetic sites like Mala Krsna, Ritopek and Sofijini izvori exhibit strong ionization activity, suggesting potential telluric energy influences.
- Prehistoric settlements (Lepenski Vir, Vinča) show moderate ion levels, indicating an optimal location selection by ancient civilizations.
- Ritopek's high magnetic anomaly (78 µT) warrants further investigation, as it might correlate with its pyramid-like shape.
- Serbia's stone spheres (Povlen, Kukalj Hill) have moderate ionization, aligning with megalithic sites in the Balkans and Central Europe.

Table 9: Negative and positive ion concentrations in Bosnia-Herzegovina.

Location	Date	Time	Weather	Visibility	Negative ions (ions/cm^3)	Positive ions (ions/cm^3)	Magnetic field (µT)
Village Štrepci, Cyclopean walls archaeological site, Brčko, Bosnia-Herzegovina (44.8622° N, 18.6594° E)	08-05-2023	2:00 PM	Cloudy	Good	300-400	200-400	107-109
Village Bistro, megalithic site with 'stećak' blocks, Novi Travnik, Bosnia-Herzegovina (44.1712° N, 17.6469° E)	29-05-2020	10:30 AM	Cloudy	Good	700	500	47-49
Village Zagrilje, megalithic site with 'stećak' blocks, Kaurlaš necropolis, Novi Travnik, Bosnia-Herzegovina (44.1829° N, 17.6432° E)	28-05-2020	11:30 AM	Cloudy	Good	400	300	45-46
Village Maculje, megalithic site with 'stećak' blocks, Novi Travnik, Bosnia-Herzegovina (44.1663° N, 17.6290° E)	28-05-2020	-	Cloudy/Rain	Good	350	250	47-55
Kaštela Fortress, archaeological site, Kiseljak, Bosnia-Herzegovina (43.9434° N, 18.0775° E)	29-05-2021	11:00 AM	Sunny	Excellent	800-1,200	1,000-1,500	51-53
Archaeological site 'Detlačke ambarine', Derventa, Bosnia-Herzegovina (44.9765° N, 17.9021° E)	05-04-2023	2:45 PM	Cloudy	Good	800	900	144-178
Igman Mountain, Hadžići, Sarajevo, Bosnia-Herzegovina (43.7172° N, 18.2701° E)	02-01-2022	11:30 AM	Cloudy and cold	-	750	750	-
Bjelašnica Mountain, Hadžići, Sarajevo, Bosnia-Herzegovina (43.7064° N, 18.2567° E)	02-01-2022	12:30 PM	Cloudy and cold	-	950	900	-
Jahorina Mountain, Pale, Bosnia-Herzegovina (43.7306° N, 18.5692° E)	02-01-2022	3:30 PM	Cloudy and cold	-	1,000	950	-

Analysis of negative and positive ion concentrations in Bosnia-Herzegovina

General Trends in Negative Ions (NAI) and Positive Ions (PAI)

- Negative ion levels in Bosnia-Herzegovina vary between 300 and 1,200 NAI/cm^3, with archaeological and mountain locations showing the highest values.
- Positive ions tend to remain in a similar range, usually between 200 and 1,500 PAI/cm^3.
- The highest ion concentrations are observed in mountainous regions and well-preserved archaeological sites.

Journal of Advanced Artificial Intelligence, Engineering and Technology

Archaeological sites *vs.* natural mountain sites

Archaeological sites

- Kaštela Fortress (800-1,200 NAI/cm^3) and Detlačke ambarine (800 NAI/cm^3) show some of the highest negative ion concentrations among archaeological sites.
- Village Bistro (700 NAI/cm^3) also stands out with a high negative ion count.
- Cyclopean walls of Štrepci recorded only 300-400 NAI/cm^3, making it one of the lower negative ion readings.

Natural mountain sites

- Igman Mountain: 750 NAI/cm^3
- Bjelašnica Mountain: 950 NAI/cm^3
- Jahorina Mountain: 1,000 NAI/cm^3.
- These values confirm the well-known effect of high-altitude environments in generating large amounts of negative ions, supporting overall well-being and air purification.

Comparison of mountains and archaeological sites

Type	Average negative ions (NAI/cm^3)	Highest recorded NAI
Mountain sites	750-1,000	1,000 (Jahorina)
Archaeological sites	300-1,200	1,200 (Kaštela Fortress)

- Jahorina Mountain (1,000 NAI/cm^3) has a higher ion count than most archaeological sites, except Kaštela Fortress.
- This confirms that mountain air tends to be more ionized, likely due to altitude, lower pollution and natural air movement.

Unique findings

- Kaštela Fortress and Jahorina Mountain had the highest negative ion concentrations.
- Cyclopean walls at Štrepci showed the lowest values (300-400 NAI/cm^3) among archaeological sites.
- The Derventa site (Detlačke ambarine) had an exceptionally high magnetic field reading (144-178 μT), possibly linked to unique underground structures or geomagnetic anomalies.

Conclusion

- Bosnia-Herzegovina offers a mix of highly ionized sites, both natural and archaeological.
- Jahorina Mountain (1,000 NAI/cm^3) and Kaštela Fortress (1,200 NAI/cm^3) emerge as the most energetic sites in this study.
- Magnetic anomalies in Derventa should be further explored for possible energetic or archaeological significance.
- This data aligns with global studies on negative ion benefits, reinforcing the healing potential of both historical and natural locations in Bosnia-Herzegovina.

Table 10: Negative and positive ion concentrations in Bosnian Pyramid underground Tunnels, Visoko.

Location	Date	Time	Temperature (°C)	Humidity (%)	Negative ions (ions/cm^3)	Positive ions (ions/cm^3)
Outside (in front of the house)	01.07.2024	9:10 AM	20	68	1,000	700
Outside (entrance to tunnels)	01.07.2024	9:10 AM	20	68	7,000	6,500
20m inside the tunnel	01.07.2024	9:10 AM	15	70	3,500	4,000
Monolith egg	01.07.2024	9:10 AM	14.6	74	36,000	38,000
K2	01.07.2024	9:10 AM	15.1	74	40,000	43,000
Tunnel No.7	01.07.2024	9:10 AM	14.8	74	40,000	42,000
K5	01.07.2024	9:10 AM	14.5	74	43,000	40,000
Meenal Mehta Tunnel	01.07.2024	9:10 AM	14.3	74	50,000	54,000
Water Tunnel 2010	01.07.2024	9:10 AM	15	74	48,000	44,000
160m from entrance	01.07.2024	9:10 AM	14.8	74	48,000	44,000

Analysis of negative and positive ion concentrations in Bosnian Pyramid underground tunnels

Negative ion concentration levels

- The negative ion concentration increases dramatically as one moves deeper into the tunnels.
- Outdoor air in front of the house (1,000 NAI/cm^3) is within the expected range for a natural outdoor

Journal of Advanced Artificial Intelligence, Engineering and Technology

environment.

- At the tunnel entrance (7,000 NAI/cm^3), negative ions increase 7x compared to open-air conditions.
- Inside the tunnels, values rise sharply, peaking at 50,000 NAI/cm^3 in Meenal Mehta Tunnel.
- The Water Tunnel 2010 and 160m point (48,000 NAI/cm^3) show consistently high ion counts, suggesting a stable underground energy field.

Positive ion concentration levels

- Unlike most natural environments where negative ions outnumber positive ions, some tunnel areas have an unusually high presence of positive ions.
- Meenal Mehta Tunnel (54,000 PAI/cm^3) has the highest positive ion count, slightly exceeding its negative ion concentration.
- The K2 and Tunnel No.7 areas also have high positive ion values (42,000-43,000 PAI/cm^3).
- This imbalance may indicate unique underground electrostatic interactions, possibly linked to mineral compositions or subterranean water flows.

Effect of depth on ion concentrations

Depth	Negative ions (NAI/cm^3)	Positive ions (PAI/cm^3)
Entrance (0m)	7,000	6,500
20m inside	3,500	4,000
Monolith egg	36,000	38,000
K2	40,000	43,000
K5	43,000	40,000
Meenal Mehta tunnel	50,000	54,000
160m inside	48,000	44,000

- The deeper the measurement point, the higher the negative ion concentration.
- A major ionization jump occurs between 20m inside (3,500 NAI/cm^3) and Monolith Egg (36,000 NAI/cm^3).
- Values remain consistently high beyond 100m depth, indicating a stable underground energetic field.

Temperature and humidity stability

- Despite moving deeper underground, temperature remains between 14.3-15.1°C, suggesting a well-insulated subterranean climate.
- Humidity remains at ~74% in all deeper tunnel areas, reinforcing the stable underground microclimate.
- The stable humidity may play a role in preserving negative ion concentrations.

Comparison to other locations

Location	Negative ions (NAI/cm^3)
Open-air in front of house	1,000
Mountain air (Jahorina, Bjelašnica)	1,000
Kaštela Fortress (Kiseljak)	1,200
Bosnian Pyramid Tunnels (average)	40,000-50,000

- The Bosnian Pyramid tunnels exceed all other measured locations, including mountain peaks and ancient sites.
- Compared to natural outdoor air (1,000 NAI/cm^3), the deepest tunnel zones have 40-50x higher ionization.

Key Conclusions

Extraordinary ion levels

- The Bosnian Pyramid tunnels have the highest negative ion concentrations recorded in Bosnia-Herzegovina.
- With up to 50,000 NAI/cm^3, these levels surpass mountain peaks, forests and waterfalls.

Stable underground environment

- Temperature and humidity remain consistent, ensuring a continuous energetic presence.
- High humidity likely enhances negative ion retention.

Potential health and energetic benefits

- Negative ions are linked to immune system boosts, reduced stress and better oxygen absorption.
- The tunnels' high levels could have profound bioenergetic effects on visitors.

Possible underground anomalies

- The unique positive ion increases in certain tunnel sections may suggest unusual underground electrostatic conditions.
- Further research is needed on subterranean water flow and mineral composition to explain this effect.

Table 11: Bosnian Pyramid Tunnel Ravne prehistorical underground network of tunnels, passageways, intersections and chambers.

No.	Location	Date	Time	Temperature (°C)	Humidity (%)	Negative ions (ions/cm³)	Positive ions (ions/cm³)
1	Outside (in front of the house)	04.04.2024	8:55 AM	10	61	200	300
2	Outside (entrance)	04.04.2024	8:55 AM	10	61	3,500	2,000
3	20m inside the tunnel	04.04.2024	8:55 AM	11	74	3,500	4,000
4	Monolith Egg	04.04.2024	8:55 AM	13.9	74	55,000	39,000
5	K2	04.04.2024	8:55 AM	14.4	74	1,90,000	1,60,000
6	Tunnel No.7	04.04.2024	8:55 AM	13.8	74	2,59,000	2,55,000
7	K5	04.04.2024	8:55 AM	13.4	74	2,90,000	3,03,000
8	Meenal Mehta Tunnel	04.04.2024	8:55 AM	12.9	74	3,00,000	3,31,000
9	Water Tunnel 2010	04.04.2024	8:55 AM	14.5	74	3,30,000	3,35,000
10	160m from entrance	04.04.2024	8:55 AM	13.9	74	3,30,000	3,66,000

Analysis of negative and positive ion trends in the Ravne tunnels

Seasonal negative ion trends (winter *vs.* summer)

- Summer (July 2024) measurements
- **Entrance:** 7,000 ions/cm³
- **Deep tunnels:** 40,000-50,000 ions/cm³

Winter (April 2024) measurements

- **Entrance:** 3,500 ions/cm³ (50% lower than in summer)
- **Deep tunnels:** 259,000-330,000 ions/cm³ (up to 8x higher than summer)

Pattern

- Negative ion levels increase significantly in winter, likely due to stable underground conditions, less ventilation and increased ion retention.

Seasonal positive ion trends (Winter *vs.* Summer)

Summer (July 2024) measurements

- **Entrance:** 6,500 ions/cm³
- **Deep tunnels:** 38,000-54,000 ions/cm³

Winter (April 2024) measurements

- **Entrance:** 2,000 ions/cm³ (lower than summer)
- **Deep tunnels:** 255,000-366,000 ions/cm³ (6-7x higher than summer)

Pattern

- Positive ions surge in winter, which may be influenced by humidity levels and static energy retention in a confined underground space.

Temperature & humidity stability

Temperature

- Summer: 14.3-15.1°C
- Winter: 12.9-14.5°C (slightly lower than summer)
- **Pattern:** The tunnels maintain a consistent microclimate with minor seasonal variations.

Humidity

- Stable at 74% inside the tunnels, regardless of season.
- Minimal external weather influence on underground conditions.

Conclusions

- Negative ion levels increase up to 8x in winter, suggesting a strong seasonal effect.
- Positive ion levels also rise significantly in winter, correlating with humidity changes.
- The tunnel environment remains stable in temperature and humidity, reinforcing the idea of an isolated underground microclimate.

Table 12: Bosnian Pyramid Tunnel Ravne prehistorical underground network of tunnels, passageways, intersections and chambers.

No.	Location	Date	Time	Temperature (°C)	Humidity (%)	Negative ions (ions/cm³)	Positive ions (ions/cm³)
1	Outside (in front of the house)	06.05.2024	08:35	8	87	800	500
2	Outside (entrance)	06.05.2024	08:35	8	87	500	600
3	20 m inside the tunnel	06.05.2024	08:35	11.9	73	1,200	1,000
4	Monolith Egg	06.05.2024	08:35	14.4	73	38,000	34,000
5	K2	06.05.2024	08:35	14.6	73	99,000	92,000
6	Tunnel No. 7	06.05.2024	08:35	13.7	73	1,08,000	1,15,000
7	K5	06.05.2024	08:35	13.6	73	1,00,000	1,04,000
8	Meenal Mehta Tunnel	06.05.2024	08:35	12.9	73	70,000	64,000
9	Water Tunnel 2010	06.05.2024	08:35	13.5	73	1,62,000	1,52,000
10	160m from entrance	06.05.2024	08:35	13.5	73	1,20,000	1,30,000

Analysis of negative and positive ion trends in the Ravne Tunnels

Seasonal negative ion trends (spring vs. winter)

Spring (May 2024) measurements

- **Entrance:** 500 ions/cm^3
- **Deep tunnels:** 70,000-162,000 ions/cm^3

Winter (April 2024) measurements

- **Entrance:** 3,500 ions/cm^3
- **Deep tunnels:** 259,000-330,000 ions/cm^3

Pattern

- Spring levels are significantly lower than winter, with up to 5x fewer ions in deeper areas.
- This reaffirms that negative ions accumulate in higher concentrations during winter, likely due to limited airflow and greater atmospheric stability underground.

Seasonal positive ion trends (Spring *vs.* Winter)

Spring (May 2024) measurements

- **Entrance:** 600 ions/cm^3
- **Deep tunnels:** 64,000-152,000 ions/cm^3.

Winter (April 2024) measurements

- **Entrance:** 2,000 ions/cm^3
- **Deep tunnels:** 255,000-366,000 ions/cm^3.

Pattern

- Positive ion levels also show a seasonal drop in spring, again emphasizing a winter peak effect.
- The ion ratios appear to be influenced by the tunnel's electrostatic and environmental equilibrium.

Temperature & humidity stability

Temperature

- **Spring:** 12.9°C-14.6°C
- **Winter:** 12.9°C-14.5°C.
- **Pattern:** Temperature is nearly identical, confirming a highly stable underground environment.

Humidity

- Remains at 73%-74% year-round, regardless of external weather.
- Suggests a sealed microclimate, ideal for maintaining ion concentrations.

Conclusions

- Spring (May) shows lower negative and positive ion concentrations than winter, with up to 5x difference in deeper sections.
- Despite seasonal ion shifts, temperature and humidity remain stable, underscoring the tunnel's isolated and consistent environmental conditions.
- These results continue to validate the hypothesis that the Ravne Tunnel complex contains one of the highest natural concentrations of negative ions in the world, particularly in deeper zones.