

**Name: Dr. Mustafa Asfur**

**Date: April 3, 2023**

## CURRICULUM VITAE

### **1. Personal Details**

Home Address: Kabul, Zip Code 24963

Home Telephone Number: 04-8104474

Office Telephone Number: 09-8304106

Cellular Phone: 0505-778750

Electronic Address: [mustafaa@ruppin.ac.il](mailto:mustafaa@ruppin.ac.il)

### **2. Higher Education**

#### **A. Undergraduate and Graduate Studies**

<b>Period of Study</b>	<b>Name of Institution and Department</b>	<b>Degree</b>	<b>Year of Approval of Degree</b>
2013-2017	Bar Ilan University, Biology. "The effect of testosterone on reproductive success and survival in free- living Balochistan gerbils (Gerbillus nanus)"	M.Sc	2018
2001-2005	Tel Aviv University, Geophysics and planetary sciences. "The Connection Between the Schuman Resonance from Lightning and Climatic Parameters"	Ph.D	2005
1998-2000	Tel Aviv University, Geophysics and planetary sciences	M.Sc	2001
1995-1997	University of Haifa, Geography and environmental studies	M.A	1997
1992-1995	University of Haifa, Geography and environmental studies	B.A	1996

#### **B. Post-Doctoral Studies**

<b>Period of Study</b>	<b>Name of Institution, Department and Host</b>	<b>Degree</b>	<b>Year of Completion</b>
2005-2009	Open University, Life Science, Host: Prof. Yoav Yair	Post-Doc	2009

### **3. Academic Ranks and Tenure in Institutes of Higher Education**

<b>Dates</b>	<b>Name of Institution and Department</b>	<b>Rank/Position</b>
2022 - present	Ruppin Academic Center, Marine Sciences	Senior Lecturer
2017- 2021	Ruppin Academic Center, Marine Sciences	Lecturer
2015- 2018	Bar Ilan University, Biology	External lecturer
2013- 2020	University of Haifa, Geography and Environmental Studies	External lecturer
2005 - 2010	Oranim Collage, Geography department	Lecturer

### **4. Offices in Academic Administration**

<b>Dates</b>	<b>Offices in Academic Administration</b>
2022- present	Head of the Department of Marine Sciences, Ruppin Academic Center (RAC)
2022-present	Chairman of the Teaching Committee of the Faculty of Marine Sciences, RAC
2022-present	Member of the Academic Appointments Committee - RAC
2021- 2022	Member of the Disciplinary Committee, Ruppin Academic Center (RAC)

### **5. Scholarly Position and Activities outside the Institution**

#### **Reviewing of scientific journals**

<b>Name of journal</b>	<b>Role</b>
Journal of Atmospheric and Solar-Terrestrial Physics	Reviewer
Environmental Research Letters	Reviewer

### **6. Participation in Scholarly Conferences**

#### **a. Active Participation**

##### **International Conferences**

<b>Date</b>	<b>Name of Conference</b>	<b>Place of Conference</b>	<b>Subject of Lecture/Discussion</b>	<b>Role</b>
June 6-7, 2023	The Ocean and Seas in Geographical Thought IGU Thematic conference	Milan, Italy	Climate mediated changes in seawater chemistry and their potential effects on marine lightning intensity in Mediterranean Sea	Session Chair and Presenter

April 23-28, 2023	European Geosciences Union- EGU	Vienna/ Austria	Climate mediated changes in seawater chemistry and their potential effects on marine lightning intensity	Presenter
April 23-28, 2023	European Geosciences Union- EGU	Vienna/ Austria	Effects of cloud-to-water lightning strokes on open sea fish cages during eastern Mediterranean winter thunderstorms	Poster
March 13-15, 2023	Connect2Innovate conference	Manama, Bahrain	Climate Change and lightning flash	Presenter
July 18-22, 2022	International Geographical Union	Paris, France	Global Change and Nile Damming Processes May Affect Lightning Flash Intensity Over the Mediterranean Sea	Presenter
June 23, 2022	19th EWRS Symposium 2022	Athens / Greece	Weeds' pollen rupture due to thunderstorms electric fields can increase allergy risk	Poster
June 20, 2022	17th International Conference on Atmospheric Electricity	Tel Aviv/ Israel	The Dependence of Lightning Generated Underwater Acoustic Noise On Lightning Intensity	Session Chair
June 19, 2022	CLIMATE   OCEAN   CHANGE	Haifa/ Israel	Climate Change & Nile Damming Affect Med Sea Lightning Flash Intensity	Poster
April 19-30, 2021	European Geosciences Union	Vienna/ Austria	The effect of varying alkalinity in Mediterranean seawater on lightning flash intensity – An experimental approach	Presenter
August 17-21, 2020	International Geographical Union	Istanbul/ Turkey	Ocean Acidification Increases the Lightning Intensity Over the Ocean	Presenter
May 3-8, 2020	European Geosciences Union	Vienna/ Austria	Ocean Acidification Increases the Lightning Intensity Over the Ocean	Presenter
October 12-16, 2009	5th European conference on severe storms	Landshut, Germany	Lightning Activity in Hurricanes	Presenter
February 16-20, 2019	10th International Meeting Steroids and Nervous System	Turin/ Italy	Sex Differences	Presenter
April 19-24, 2009	European Geosciences Union	Vienna/ Austria	Lightning-Wind Intensity Relationship in Hurricanes	Presenter
June 25 – July 1, 2006	European Summer School	Venice/ Italy	Global warming	Presenter
April 19-30, 2004	Climate Variability in the Twentieth Century (C20C)	Abdus Salam ICTP – Trieste/ Italy	Using Global Lightning Observation to Study Global Climate Change	Presenter

December 8-12, 2003	American Geophysical Union (AGU)	San Francisco, USA	African Lightning-Climate Variability	Presenter
November 16-20, 2003	International Young Scientists Global Change Conference	Trieste/ Italy	Lightning and Climate: The Water Vapor Connection	Presenter
June 6-9, 2003	Proceeding of 12th International conference on Atmospheric Electricity	California, USA	Global lightning and climate variability	Presenter

### **Local Conferences**

<b>Date</b>	<b>Name of Conference</b>	<b>Place of Conference</b>	<b>Subject of Lecture/Discussion</b>	<b>Role</b>
June 1, 2023	The Deep Ocean	Haifa University	Submarine discharge in Mediterranean Sea	Presenter
February 21, 2023	Israel Geological Society	En Gedi, Dead Sea	Long-term changes in Frutarom beach groundwater table total dissolved mercury levels	Presenter
December 22, 2022	Conference of the Israeli Geographical Society	Hebrew University of Jerusalem	The effect of the construction of the Aswan Dam on the intensity of lightning over the Mediterranean Sea	Session Chair and Presenter
July 6-7, 2022	50th Annual Conference on Science and the Environment	Expo Tel Aviv	Effect of marine lightning on stress response in open-sea fish cages	Poster
December 5, 2021	Conference of the Israeli Geographical Society	Tal Hai	Why is lightning more intense over the oceans?	Session Chair and Presenter
March 24, 2020	Israel Geological Society	Jerusalem	Ocean Acidification Increases the Lightning Intensity Over the Ocean	Presenter
December 30, 2019	Conference of the Israeli Geographical Society	Haifa	Ocean Acidification Increases the Lightning Intensity Over the Ocean	Session Chair and Presenter
March, 25-29, 2018	Israel Geological Society	Med. Sea	Ocean acidification	Co-Presenter
May 4-6, 2004	Merging remotely sensed and in-situ observations of aerosols and atmospheric processes	Tel Aviv	Using Global Lightning Observation to Study Global Climate Change	Co-Presenter

**b. Organization of Conferences or Sessions**

<b>Date</b>	<b>Name of Conference</b>	<b>Place of Conference</b>	<b>Subject of Lecture/ Role at Conference/ Comments</b>	<b>Role</b>
August 24-30, 2024	IGU Thematic Conference	Dublin, Ireland	Challenges and prospects in the evolving Mediterranean coastal and marine scenery	Session Chair
June 5-8, 2023	IGU Thematic Conference	Milano, Italy	Planning issues – Land/Sea interaction	Session Chair
December 22, 2022	Conference of the Israeli Geographical Society	Hebrew University of Jerusalem	The effect of the construction of the Aswan Dam on the intensity of lightning over the Mediterranean Sea	Session Chair
June 19-24, 2022	International Conference on Atmospheric Electricity (ICAE 2022)	Tel Aviv University	The effect of seawater total alkalinity on lightning flash intensity – An experimental approach	Local Organizing Committee ICAE 2022
December 5, 2021	Conference of the Israeli Geographical Society	Haifa University	The potential effect of anthropogenic salinization and acidification on lightning flash intensity over the Mediterranean Sea	Session Chair
December 30, 2019	Conference of the Israeli Geographical Society	Haifa University	Ocean Acidification Increases the Lightning Intensity Over the Ocean	Session Chair

**7. Invite Lectures\Colloquium Talks**

None

**8. Research Grants**

**a. Grants Awarded**

<b>Role in Research</b>	<b>Co-Researchers</b>	<b>Topic</b>	<b>Founded by/Amount</b>	<b>Year</b>
PI	Dr. Jacob Silverman	Lightning and mariculture	Ministry of Energy, Israel. 500,000 NIS	2021
Co-PI	Prof. Abidelfatah Nasser	Pathogens in Aquatic Ecosystem	Ministry of Health, Israel. 100,000 NIS	2021
Co-PI	Dr. Jacob Silverman	Lightning climatology in the Israeli Mediterranean EEZ	Ministry of Energy, Israel. 50,000 NIS	2022

**b. Submission of Research Proposals – Pending**

Role in Research	Co-Researchers	Topic	Founded by/Amount	Year
PI	Dr. Zohar Barnett-Itzhaki	Building and analyzing a database of lightning activity to understand climate change processes in Israel	KKAL / 2004/22 /קק	2023

**c. Submission of Research Proposals – Not Funded**

Role in Research	Co-Researchers	Topic	Founded by	Year	Score
PI	Dr. Zohar Barnett-Itzhaki	Artificial intelligence and laboratory approaches to investigate the spatial variability of lightning intensity over the Mediterranean Sea	ISF / 250,000 NIS	2022	Not available
PI	Prof. Ursula Siebert	Lightning and on sea turtle behavior	German Israeli Foundation (GIF) / 1,000,000 NIS	2021	Not available
Researcher	Prof. Baruch Rubin	Lightning and pollen rupture	ISF / 800,000 NIS	2021	Not available
Researcher	Dr. Jacob Silverman And Yaniv Levy	Behavioral Responses of Loggerhead Sea Turtles to Underwater 1 Lightning Generated Acoustic Noise in the Eastern Mediterranean Basin	Ministry of Science	2021	Not available
Researcher	Dr. Jacob Silverman	The effect of seawater temperature, pH and mineral composition on lightning flash intensity over the	ISF	2020	Not available

		modern and Archaean oceans – An experimental approach			
Researcher	Dr. Jacob Silverman	The effect of seawater temperature, pH and mineral composition on lightning flash intensity over the modern and Archaean oceans – An experimental approach	ISF	2019	Not available
Researcher	Dr. Jacob Silverman and Prof. Abidelfatah Nasser	Impact of flooding events in the Alexander stream on the microbial water and sediment quality in the nearby Beit-Yanai bathing beach	Ministry of Science	2019	Not available

## 9. Scholarships, Awards and prizes

Year	Name of award	Awarded By	Sum
2005 -2009	Scholarships for a Post-doctoral student	The Higher Education Council	300000NIS
2007	Discovery Magazine Top Science Stories of 2007 (ranked 25th in top 100 stories), 2007	Discovery Magazine (One of 25 science stories for 2007)	-

## 10. Teaching

### a. Courses Taught in Recent Years

Year	Name of Course	Type of Course Lecture/Seminar/Workshop/High Learn Course/Introduction Course (Mandatory)	Degree	Number of Students
2023 - present	Physical Oceanography	Introduction Course (Mandatory) - Ruppin Academic Center	B.Sc	120
2020 - present	Introduction to Atmosphere and Climate	Introduction Course (Mandatory) - Ruppin Academic Center	B.Sc	120

2020 – present	Biostatistics	Introduction Course (Mandatory) - Ruppin Academic Center	B.Sc	120
2018-present	Advanced data processing methods	Introduction Course (Mandatory) -Ruppin Academic Center	B.Sc	120
2017 - present	Biostatistics (parametric and non-parametric methods)	Introduction Course (Mandatory) -Ruppin Academic Center	M.Sc	13
2017 - 2019	Biogeochemical Cycles in oceanic systems	Introduction Course (Mandatory) - Ruppin Academic Center	M.Sc	13
2014-2019	Biostatistics	Introduction Course (Mandatory)- Bar Ilan University	B.Sc	170
2014-2016	Geo-signal Analysis	Lecture – Haifa University	M.A	25
2013-2020	Earth and space science	Lecture – Haifa University	M.A	20
2013-2020	Sphere Interactions	Lecture – Haifa University	M.A	20

**b. Supervision of Graduate Students**

<b>Name of Student</b>	<b>Title of Thesis</b>	<b>Degree</b>	<b>Date of Completion / in Progress</b>	<b>Students' Achievements</b>
Shmuel Hilo	The effect of changes in the chemical and physical properties of sea water as a result of climate change on lightning activity in the sea	M.Sc	in Progress	



Hila Bar	The effect of electromagnetic radiation on the photosynthesis, <i>(Co-instructor- Dr. Yacob Silverman, IOLR)</i>	M.Sc	in Progress	
Yoav Michel	Surveillance of Emerging Pathogens and Antibiotic Resistance in Aquatic Ecosystem.	M.Sc	in Progress	
Roy lavie	Measurement of the stress hormone in fish in response to marine lightning in fish cages. <i>(Co-instructor- Dr. Yossi Ayzin, Ruppin Academic Center)</i>	M.Sc	in Progress	One poster Presented in a scientific conference.
Omer Krispil	Bacterial contribution of sewage treatment plants <i>(Co-instructor- Dr. Yacob Silverman, Israel Oceanographic and Limnological Research - IOLR)</i>	M.Sc	in Progress	One poster Presented in a scientific conference.
Idel Abramovitch	The effect of electromagnetic radiation on the photosynthesis, respiration and calcification of <i>Stylophora pistillata</i> corals. <i>(Co-instructor- Dr. Yacob Silverman, IOLR)</i>	M.Sc	Complete his thesis November 2021	
Michal Shamir	Examination of the abiotic mechanism for the movement of mercury from the coastal strip of Haifa bay to the sea. <i>(Co-instructor- Dr. Yacob Silverman, IOLR)</i>	M.Sc	Complete her thesis in October 2022	One scientific paper in preparation
Strauch Sheran	The effect of sea state on the rate of Fresh Groundwater Discharge in the Hanikra sea cave.	M.Sc	Complete his thesis	One scientific paper in preparation.

	(Co-instructor- Dr. Yacob Silverman, IOLR)		November 2022	One poster Presented in a scientific conference.
--	--	--	---------------	--

### **11. Miscellaneous**

From 2009 to 2012 I was the principal of a science school, so I did not engage in scientific research, and in 2013 I started studying for a doctorate in life sciences at Bar Ilan University. In 2018 I returned to scientific research in the Faculty of Marine Sciences at the Ruppin Academic Center.

### **12. Professional Experience**

I was the director of the Observatory in Nazareth between the years 2000 - 2008. In the years 2008-2012 I was the director of a school of science.

## **PUBLICATIONS**

### **A. Ph.D. Dissertation**

1. "The Connection Between the Schuman Resonance from Lightning and Climatic Parameters and Sprites", 2004, Hebrew, Tel Aviv University, Prof. Colin Price.
2. "The effect of testosterone on reproductive success and survival in free-living Balochistan gerbils (*Gerbillus nanus*)", 2017, Hebrew, Bar Ilan University, Prof. Lee Koren.

### **B. Scientific Books (Refereed)**

None

### **C. Other Scientific Publication:**

None

### **D. Articles in Refereed Journals**

#### **D.1. Published**

1. **Asfur, M.**, and Price, C., 2001: Observations of lightning and sprites in the United States from Mitzpe Ramon, Israel, *Bulletin of Israel Meteorological Society*, Vol. 6, 1. (In Hebrew).
  - *MA Writing and processing the data and editing the graphs.*
2. Price, C., **Asfur, M.**, Lyons, W., and Nelson, T., 2002: An improved ELF/VLF method for globally geolocating sprite-producing lightning, *Geophysical Research Letters*, Vol. 29, No' 3. <https://doi.org/10.1029/2001GL013519> (IF=4.72; SJR=2.01; JR=Earth and planetary science; Q=1; Number of citations=31)
  - *MA Field measurements and data processing and graph editing*
3. Yoav, Y., Price, C., Zev, L., Joachim, J., Peter, I., Adam, D., Meir, M., Baruch, Z., and **Asfur, M.**, 2003: Sprites observation from the space shuttle during the Mediterranean Israeli dust experiment (MEIDEX), *Journal of Atmospheric and Solar Terrestrial Physics*, Vol 65, 635-642. [https://doi.org/10.1016/S1364-6826\(02\)00332-2](https://doi.org/10.1016/S1364-6826(02)00332-2). (IF=1.735; SJR=0.52 ; JR= Geophysics; Q=2; Number of citations=46)
  - *MA Field measurements and graph editing.*
4. Hsu, R., Su, H., Alfred, C., Lee, L., **Asfur, M.**, Price, C., Yair, Y., 2003: Transient Luminous events in the Vicinity of Taiwan, *Journal of Atmospheric and Solar Terrestrial Physics*, Vol 65, 561-566. [https://doi.org/10.1016/S1364-6826\(02\)00320-6](https://doi.org/10.1016/S1364-6826(02)00320-6). (IF=1.735; SJR=0.52 ; JR= Geophysics; Q=2; Number of citations=32)
  - *MA Measurement and analysis of data.*
5. Price, C., **Asfur, M.**, 2006: Can Lightning Observations be Used as an Indicator of Upper-Tropospheric Water Vapor Variability? *Bulletin of the American Meteorological Society*, Vol. 87, No. 3, pp. 291–298. <https://doi.org/10.1175/BAMS-87-3-291> (IF=8.766; SJR=3.37 ; JR=Atmospheric Science; Q=1; Number of citations=72)
  - *MA Measurement and analysis of data and article writing.*
6. Price, C., **Asfur, M.**, 2006: Long Term Trends in Lightning Activity over Africa, *Earth Planets Space (EPS)*, 58,1197- 1201. <https://doi.org/10.1186/BF03352010> (IF=2.73; SJR=0.84 ; JR=Geology; Q=1; Number of citations=17)
  - *MA Measurement and analysis of data and article writing.*
7. Price, C., Yair, Y., and **Asfur, M.**, 2007: East African Lightning as a Precursor of Atlantic

Hurricane Activity, *Geophysical Research Letters*, Vol. 34 L09805.  
<https://doi.org/10.1029/2006GL028884> (IF=4.72; SJR=2.01; JR=Earth and planetary science; Q=1; Number of citations=57)

- *MA data processing and graph editing*

8. Price, C., **Asfur, M.**, & Yair, Y., 2009: Maximum hurricane intensity preceded by increase in lightning frequency, *Nature Geoscience*, 2, 5, 329-332. <https://doi.org/10.1038/ngeo477> (IF=13.57; SJR=5.44; JR=Earth and planetary science; Q=1; Number of citations=142)

- *MA Writing, processing, and analyzing data. As part of the Post-doctorate.*

9. Warburton, E., Kam, M., Bar- Shira, E., Friedman, A., Khokhlova, I., Koren, L., **Asfur, M.**, Geffen, E., Kiefer, D., Krasnov, B., Degen, A., 2016: Effects of parasite pressure on parasite mortality and reproductive output in a rodent-flea system: inferring host defense trade- offs, *Parasitology Research* ;115(9):3337-44.<https://doi.org/10.1007/s00436-016-5093->(IF=2.28;SJR=0.72;JR=Veterinary; Q=1; Number of citations=2).

- *MA analyzing data.*

10. Matas, D., Doniger, T., Sarid, S., **Asfur, M.**, Yadid, G., Khokhlova, I. S., ... & Koren, L., 2020: Sex differences in testosterone reactivity and sensitivity in a non-model gerbil. *General and Comparative Endocrinology*, 291, 113418..  
<https://doi.org/10.1016/j.ygcen.2020.113418>(IF=2.82;SJR=0.82;JR=Animal Science and zoology; Q=1; Number of citations=0)

- *MA analyzing data.*

11. **Asfur, M.**, Price, C., Silverman, J., & Wishkerman, A., 2020a: Why is lightning more intense over the oceans?, *Journal of Atmospheric and Solar-Terrestrial Physics*, Volume 202, 105259. <https://doi.org/10.1016/j.jastp.2020.105259> (IF=1.735; SJR=0.52 ; JR=Geophysics; Q=2; Number of citations=17)

- *MA Writing, processing, and analyzing data.*

12. **Asfur M.** Silverman J., & Price C., 2020b: Ocean acidification may be increasing the intensity of lightning over the oceans. *Scientific Reports*, 10, 21847.  
<https://doi.org/10.1038/s41598-020-79066-8>.  
(IF=5.133; SJR=1.24; JR=Multidisciplinary; Q=1; Number of citations=6)

- *MA Writing, processing, and analyzing data.*

13. Silverman, J., Price, C., & **Asfur, M.**, 2021. The possible effect of seawater total alkalinity

on lightning flash intensity – An experimental approach. *Geophysical Research Letters*, 48, e2021GL093654. <https://doi.org/10.1029/2021GL093654>  
(IF=4.72; SJR=2.01; JR=Earth and planetary science; Q=1; Number of citations=1)

- *MA Conducting a laboratory experiment and analyzing the results.*

\*14. **Asfur, M.**, Price, C., Yair, Y. Silverman J., 2023. Spatial variability of lightning intensity over the Mediterranean sea correlates with seawater properties. *Scientific Reports*, 13, 5834. <https://doi.org/10.1038/s41598-023-33115-0>  
(IF=4.9; SJR=2.01; Behavior and Systematics ; Q=1; Number of citations=0)

- *MA Conducting a laboratory experiment and analyzing the results and writing the article.*

\*15. Sarid, S., Naor, H., **Asfur, M.**, Khokhlova, I. S., Krasnov, B. R., Kotler, B. P., ... & Koren, L. (2023). Free-living gerbils with higher testosterone take fewer risks. *Physiology & Behavior*, 114277. (IF=3.75; SJR=0.75; Multidisciplinary; Q=2; Number of citations=0)

- *MA Conducting a laboratory experiment and analyzing the results*

\*16. Silverman J., Shtroych S., and **Asfur, M** 2023. Seasonal variations in the biogeochemical properties of groundwater and seawater in the Rosh-Hanikra sea-cave, northern Israel. *Journal of Geophysical Research: Biogeosciences*. **submitted**  
(IF=4.43; SJR=1.34; Aquatic Science ; Q=1; Number of citations=0)

- *MA Conducting a laboratory experiment and analyzing the results and writing the article.*

\*17. **Asfur, M.**, Price, C., Barnett-Itzhaki, Z., Gerber, T., Tabibi, S. and Silverman J., 2023. How long a time series of lightning intensity is required to determine the effect of climate change?. *Scientific Reports*, **Submitted**  
(IF=4.9; SJR=2.01; Behavior and Systematics ; Q=1; Number of citations=0)

- *MA Conducting a laboratory experiment and analyzing the results and writing the article.*

## **D.2. Miscellaneous Publication**

### **Article Reviewed**

1. Price C. and **Asfur M.**, 2001: Lightning and Climate: The Water Vapor Connection, *American Geophysical Union (AGU)*.
2. Price C., and **Asfur M.**, 2003: Global lightning and climate variability, *International Commission on Atmospheric Electricity, (ICAE)*.
3. Yair Y., Price C., Israelevich P., Devir A., Moalem M., Ziv B., Levin Z., Joseph J., Koren I., and **Asfur M.**, 2003: (invited) Sprites, Elves and other transient luminous events (TLEs) observed from the space shuttle Columbia during the Mediterranean Israeli Dust Experiment. In: *Proceedings of the IUGG meeting*, June 30th-July 11th, Sapporo, Japan, vol. B, p. 195 .
4. Yair Y., Aviv R., Price C., **Asfur M.**, and Ravid G., 2007: Can Spontaneous Synchronization of Lightning Flashes Occur in a Network of Distant Thunderstorms? *Geophys. Res. Abs.*, vol 9, 03235, EGU General Assembly, Vienna, 15-20 April, SRef-ID: 1607-7962/gra/EGU2007-A-03235.
5. Price C., Yair Y., and **Asfur M.**, 2007: Lightning as a precursor of Atlantic Hurricane activity. In: *Proceedings of the 13<sup>th</sup> International Conference on Atmospheric Electricity*, August 13-17, Beijing, China, p. 577-580.
6. Yair Y., Aviv R., Ravid G., **Asfur M.**, and Price C., 2007: Transient synchronization and coupling of lightning activity in severe Mediterranean winter thunderstorms. In: *Proceedings, 9<sup>th</sup> Plinius conference on Mediterranean storms*, 10-13 September, Varenna, Italy, p.36.
7. Price C., **Asfur M.**, and Y. Yair, 2008: Lightning activity in Atlantic hurricanes. *Geophysical Research Abstracts*, Vol. 10, EGU2008- 02495, SRef-ID: 1607-7962/gra/EGU2008-A-02495, EGU General Assembly, Vienna, 2008.

8. Price C., Asfur M., and Yair Y., 2008: Lightning activity in Atlantic hurricanes. 3rd International Symposium on Lightning Physics and its Effects, *COST* Action P-18, 14-15 April, Vienna, p.44.
9. Price, C., Asfur, M., and Yair, Y., 2009: Lightning-Wind Intensity Relationship in Hurricanes. *Geophysical Research Abstracts*, Vol. 11, EGU2009-11853, EGU General Assembly, Vienna, 19-24 April, 2009.
10. Asfur, M., Silverman, J., Price, C. (2020, May). Ocean acidification may be increasing the intensity of lightning over the oceans, In EGU General Assembly Conference Abstracts (pp. EGU2020-5363).
11. Silverman, J., **Asfur, M.**, & Price, C. (2021, April). The effect of varying alkalinity in Mediterranean seawater on lightning flash intensity-An experimental approach. In EGU General Assembly Conference Abstracts (pp. EGU21-5582).

**E. Articles or chapter in Scientific Books**

None

**F. Articles in Conference Proceeding**

None

**G. Entries in Encyclopedia**

None

**H. Other Scientific Publications**

None

**J. Other Works Connected with my Scholarly Field**

None

**K. Submitted Publications**



### **L. Summary of my Activities and Future Plans**

Lightning discharges occur very frequently on Earth, averaging about 50 strikes per second. Most lightning activity occurs over land, but it has been previously demonstrated that extremely powerful lightning discharges (<1%) that are 100-1000 times more energetic than regular lightning, known as superbolts, occur predominantly over the oceans (>90%). It is interesting to note that an inordinately high proportion of superbolts that occur over the oceans annually, occur over the Mediterranean Sea (ca. 30%), including the Levantine basin. Over the last two years I have been investigating this phenomenon using a laboratory experimental system that I built, which generates electrical sparks and simulates in principal atmospheric electrical discharges. Together with a fiber-optic spectrophotometer that measures the spectral intensity of the sparks, which is equivalent to their current, I have been studying the effect of seawater chemical properties on the intensity of the generated sparks.

So far, I have shown that cloud to ground lightning discharges are strongly dependent on the conductivity of the ground/water, providing an additional mechanism explaining the occurrence of superbolts predominantly over the oceans. Furthermore, I have shown that the pH of seawater also influences the intensity of the experimental sparks. The results of these experimental studies have already been published in scientific research papers (#20-23 in list of publications). Understanding the interaction between lightning and the ocean is very important, on the one hand, as I have shown, the seawater chemistry of the oceans may have an important effect on the intensity of lightning discharges, and on the other hand the lightning itself may have an effect on the seawater (see below). Until now, it has been generally accepted that the primary mechanisms responsible for charge buildup and distribution in clouds resulting in electrical discharges in the atmosphere, are convective processes and physical properties of ice particles and water droplets in clouds (size, density and collision rate), with no regard to the conductivity of the ground/water or the chemical properties of the water in the clouds or the ground below. It is my intention to study these relations in depth using my laboratory setup, identify natural analogs that can be used to support my experimental results and conduct field observations accordingly.

Lightning activity in the atmosphere, has also been shown to be an important source of nitrate (NO<sub>3</sub>) and ozone (O<sub>3</sub>), which are both important for the evolution and development and maintenance of the terrestrial and marine biospheres. Considering that the chemistry of the oceans and the atmosphere have changed dramatically over geological time scales, it is interesting to consider and study their effect on lightning intensity under primordial conditions and shed light on their contribution to the development of cellular life on Earth.

Finally, the impact of Cloud to Water Lightning Strikes (CWLS) on the sea surface has been shown to generate very strong acoustic noise in seawater, which is equivalent to ~1% of their energy. Such energetic noise is considered to be equivalent to the noise generated by powerful explosions at the water surface or the operation of air-guns used for seismic surveys of the sea bottom. Numerous studies have shown that acoustic noise generated during seismic surveys usually causes



a flight/stress response in marine biota, such as dolphins, whales and sea turtles as well as fish in fish cages. In extreme cases, where the animals were near the noise source, some of them sustained injuries at varying degrees (in some cases fatal) by the generated shock waves. Similarly, I expect that lightning generated underwater acoustic noise will cause similar flight and stress responses in marine biota.

In the following I detail research topics related to the different aspects of lightning, briefly described above, which I intend to investigate over the coming years:

1. The effect of climate change on lightning intensity. The main goal is to understand the effect of anthropogenic global change processes such as global warming, acid rain, ocean acidification, etc. on lightning intensity through their effect on the physical and chemical properties of seawater and cloud water. In this context, I would also like to study the effect of these changes on the production of tropospheric O<sub>3</sub> and NO<sub>3</sub>.
2. Examine the combined effects of temperature, salinity, pH and mineral composition of seawater, atmospheric pressure, temperature and gas composition during the Archean on lightning flash intensity with my experimental setup.
3. Studies have suggested that the atmospheric oxygenation event that occurred during the Archean period, 3.8 billion years ago, was generated by appearance of blue-green algae (cyanobacteria) through photosynthesis. I would like to explore the possibility that oxygen production by hydrolysis of water by lightning and/or its interaction with CO<sub>2</sub> could have generated the atmospheric oxygen, O<sub>3</sub> and NO<sub>3</sub> long before the appearance of cyanobacteria. To this end, I will build a system that simulates the atmospheric and seawater conditions that prevailed during the Hadean period to investigate the rate of oxygen production by lightning.
3. Study the generation of acoustic noise by lightning, especially superbolts, and determine the relations between the peak current energy of lightning strikes at the surface of the Eastern Mediterranean Sea and their acoustic signature.
4. Analyze existing Loggerhead sea turtle trajectories from 2008 until present, available from the Israel Nature and Parks Authority, Sea Turtle Rescue Center. These data will be analyzed in the context of Cloud to Water (CW) lightning discharge locations and intensities in the Mediterranean Sea available from the World Wide Lightning Location Network (WWLLN) data center.
5. I would also like to study the diving behavior of the sea turtles in response to lightning generated acoustic noise, as this could provide an explanation for internal tissue tears in stranded sea turtles, usually found along the Israeli Mediterranean shoreline after winter storms. Where, lightning generated noise could induce a diving response beyond physiological limits (depth and time), possibly leading to internal injuries and mortality of sea turtles. This could be achieved by tagging rehabilitated sea turtles and correlating their diving behavior with lightning activity in their vicinity.

6. Building a model that examines the global energy balance of lightning. The aim of this study is to calculate the overall energy of all lightning in the world by using measurements of the global frequency and intensity of lightning from freely accessible data archives.

7. The effect of the chemical composition of rainwater on the intensity of lightning in Israel. The goal is to examine the chemistry of rainwater from south to north, and from west to east in Israel, and to examine the distribution of lightning from south to north in Israel. The basic premise of this study is that rain water is more acidic in the northern part of Israel than in the south, so it is possible that electrical activity will be stronger in the north than in the south.