Israel Air Force Colonel Ilan Ramon

In memory of the crew members of the Columbia space shuttle who gave their lives in the advancement of science

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Continuing the Legacy:
Space Shuttle Explores the Outer Frontiers of Science

"We are deeply saddened and devastated by the loss of our colleagues in science, the crew members of the NASA space shuttle Columbia on the STS107 mission, with whom we worked hand in hand to explore the outer bounds of science and their implications for the health and well-being of our planet, the preservation of our environment and the understanding of our atmosphere on Earth," says project coordinator of the Israeli space research program on the shuttle, Dr. Yoav Yair, atmospheric scientist at the Open University of Israel. "It is our goal to continue the legacy of these astronauts, who bravely touched the forefront of advancement, seeking to learn the secrets of nature in a way that man on Earth cannot. We who worked with them will continue their legacy and disseminate, analyze and evaluate what we have learned from their work in space."

The data collected on space shuttle Columbia relating to the MEIDEX – Mediterranean Israeli Dust Experiment, a joint project of Tel Aviv University and the Open University, together with the Israeli Air Force, the Ministry of Science, the Israeli Space Agency and NASA, was transmitted almost in its entirety to Earth during the course of the mission. The following are the preliminary observations and the objectives of the experiment.

400-500 million tons of dust emanate annually from the Sahara Desert and spread over the Mediterranean Sea and the Atlantic Ocean all the way to Florida, Mexico, the Caribbean, Ireland and Switzerland in enormous dust plumes. This scope of dust is steadily on the increase and atmospheric scientists would have to wonder what the long term and short term impact of all that dust will be on our planet's climate.

How does this dust migration work and what are its effects? The overall area of the Sahara Desert has become increasingly dry. Over-irrigation in Chad and Mauritania and the excessive utilization of water in Africa have resulted in the drying up of natural bodies of water, which causes a decrease in rain, drought conditions, and increasingly large areas of desert, so dry that nothing holds the sand down against the winds which whip it up and carry it huge distances, further aggravating the amounts of dust released into the atmosphere. Almost 60% of the dust carried in Earth's atmosphere comes from the Sahara Desert.

How do dust storms affect the atmosphere? The immediate effect of large concentrations of dust directly inside clouds is the curtailment of rain by suppressing precipitation. Research by Prof. Daniel Rosenfeld of the Hebrew University demonstrates that dust interferes with the natural rain-making function of clouds and reduces rain, which can cause drought, decrease natural green growth and result in further drought.

How does dust affect health? Dust clouds induce breathing difficulties, especially in children. Large accumulations of dust usually result in a sharp rise in the number of patients in hospitals suffering from breathing disorders. Trapped with these desert

View from the shuttle of the Middle East region – Israel to the Red Sea.

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particles is an influx of pathogens and bacteria carried from the Sahara Desert over the Atlantic Ocean, perhaps the cause of migration of diseases from one locale to a totally different area.

How do dust clouds affect radiation, global warming, and the greenhouse effect? Here there may be a "silver lining to this cloud," although opinions are divided on the dynamic. The dust plumes appear to offset some of the damage of excessive heat threatening Earth through the greenhouse effect. Dust particles alter the properties of clouds, making them opaque to solar radiation. This may help to cool the ground below by deflecting more solar radiation back into space.

"Actually many of the effects of dust on the rest of the globe are conjecture, particularly considering large scale impacts or attempting to develop a model of the implications of this massive movement over time," says Dr. Yair. "It is extremely important to quantify and map the developments from every possible vantage point and obtain a reliable global picture that can clarify so much of the unknown in equations that describe our atmosphere in global climate computer models."

A sophisticated array of cameras, radiometric and video, transmitted data that was recorded on three digital video records.

Dr. Yoav Yair, project coordinator, coordinated between the various partners in this experiment which was also designed to compare the information collected from the space shuttle to information collected closer to Earth. A research aircraft flew about the lower atmosphere collecting parallel information as instructed, sampling and measuring dust particles and data directly below the route of the space shuttle. The information was also coordinated with data from two satellites already orbiting.

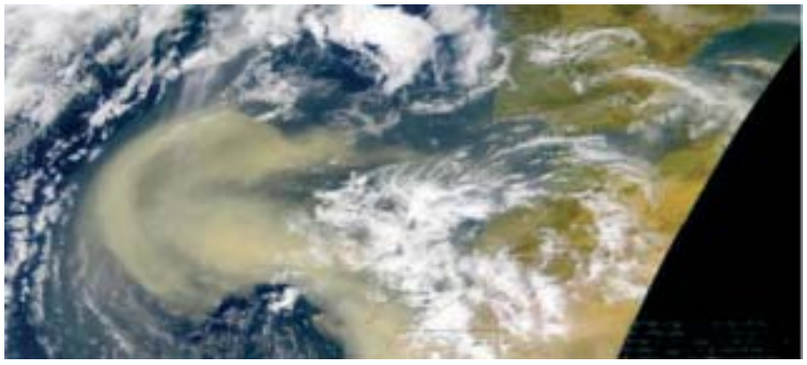
Dr. Yoav Yair coordinated the communications and implementation of the project from the NASA Goddard Space Flight Center in Maryland during the space flight.

"While I spent three years preparing for this space flight and for 16 glorious days it was the most unforgettable experience of my life," says Dr. Yoav Yair, "I can speak for myself and my colleagues that it is unquestionably one of the saddest events in our lives. In memory and in honor of our colleagues, the astronauts, some of the finest people we have had the honor of meeting and working with, and whose work was excellent and flawless, we wish to express our gratitude by continuing our research and scientific endeavor and dedicating it to their memory. May their families, friends and caring people all over the world find consolation in the realization of their objectives."

Dr. Baruch Ziv, meteorologist from the Open University of Israel, provided the researchers and astronauts with ongoing weather forecasts directing their attention to locations of dust cloud development, as well as lightning and storms. The cameras could thus be tilted by the astronauts to suitable angles to catch some critical shots.

An additional research project focused on the impact of lightning and electricity in the upper atmosphere. Strong bolts of lightning emit electromagnetic waves which travel thousands of kilometers reaching all around the globe. But a less frequent quirk is the occurence of pulses of electricity emitted into the atmosphere causing ionization and excitation of nitrogen that emits a red glow, lasts for several milliseconds and takes on peculiar shapes. These are known as elves, when they take on ring-like, donut shapes spreading outward, and sprites, when they take on jellyfish-like shapes. "We got some great shots of these unique shapes because we were using excellent cameras and equipment. The astronauts were able to take pictures at precisely the right moment. These phenomena are extremely brief. These photos will enable us to explore the link between

Dust storm over the Sahara desert.



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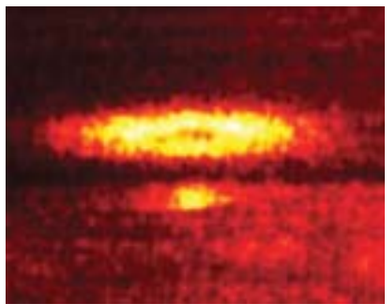
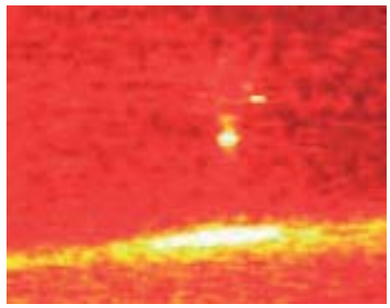
upper atmosphere transient luminous events and lower atmosphere electrical lightning with which we are all familiar. It is also important for further space travel to be familiar with the dynamic of electrically charged areas."

The shuttle utilized the light hours of the day to observe dust storms and especially the area of the Middle East above which they flew 3-4 times a day and the dark hours to photograph lightning flashes and thunderstorms in Southeast Asia, Australia, South America and the United States. "The outstanding thing about this experiment was the excellent international cooperation. We had input and interaction with stations in Hungary, Japan, Crete, Stanford in California, Duke University, MIT, Rhode Island, two stations in Israel and as far afield as the South Pole. This enabled us to collect data simultaneously from all these locations and to compare them to obtain a global picture of the atmospheric conditions during critical natural phenomena."

Participating in this extensive project were Tel Aviv University researchers from the Department of Geophysics and Planetary Science, Prof. Zev Levin and Prof Joachim Joseph, who initiated the project several years ago. Dr. Yoav Yair's partner on the lightning research was Dr. Colin Price. Prof. Levin oversaw the aircraft flights based in Crete.





Clockwise:
Work station in the shuttle; Rare photos of an "elf" and a "sprite" – pulses of electricity emitted into the upper atmosphere for several milliseconds during a lightning storm photographed from the space shuttle; Dust clouds over the Middle East; At the NASA Goddard Space Flight Center in Maryland (l to r) Dr. Yoav Yair, Open University, Project Coordinator; Major Meir Moalem, Israel Air Force; Prof. Joachim Joseph, Tel Aviv University; and Tom Dixon Freestar Mission Manager (Photo by Chris Gunn).