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Committee Directory
Publications
Statements
Certification
Annual Meeting
Awards
Related Sites

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Image Repository
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COMPARISON OF THE HAILSTORM CHARACTERISTICS BETWEEN TWO DIFFERENT AREAS IN GREECE

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Abstract: The Greek National Hail Suppression Program using airborne seeding is applied in Central Macedonia and Thessaly in the period April to September, covering an area of 5,000 square kilometers. In the present study, the storm characteristics of the two protected target areas, during the period April to August 2005, are described and are compared. The analysis utilizes radar data recorded by the TITAN system. The results will contribute to the knowledge of the storms in the area.

SEEDING OPERATIONS IN THE GREEK NATIONAL HAIL SUPPRESSION PROGRAM

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Abstract: The Hellenic Agricultural Insurance Organization (EL.G.A.) is a public organization and the main insurance carrier of the agricultural production in Greece. The Meteorological Applications Centre (KE.M.E.) is the section of EL.G.A. which has conducted, since 1981, the Greek National Hail Suppression Program using airborne seeding, aimed at reducing insurance payments due to hail damage. The Program is being applied in Central Macedonia and Thessaly in the period April to September, covering an area of 5,000 square kilometers. The cloud seeding is performed by three aircraft releasing AgI in developing hail-bearing clouds as indicated by radar. The purpose of this study is the evaluation of the seeding operations that took place during the period April to August 2005. The seeding variables such as location, time and seeding rate are examined. In addition, the comparison of seeding rate between different types of storms is examined.

A CLIMATIC INVESTIGATION OF THE RELATIONSHIP BETWEEN SYNOPTIC FACTORS AND HAIL OCCURRENCE IN NORTHERN GREECE DURING THE DOMINATION OF 500-HPA LOWS

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ABSTRACT An objective detection and analysis of 500-hPa cyclones (lows) is performed during the warm period (15 April-15 October) of the year for the central and east Mediterranean region and especially for northern Greece. The NCEP/NCAR reanalysis gridded data of geopotential height and temperature are employed in the detection of lows and in the calculation of the various dimension, shape and instability parameters. The parame-ters are used in the identification of hail days during a period of 13 operational hail seasons in northern Greece where the National Hail Suppression Program is conducted. The estimated conditional probability (8%) for hail occurrence under low domination indicates that hailfalls are rather rare and lacking severity. When however, the PVA advection centers, which usually accompany the lows are considered, hailfalls are more frequent (20%) and severe. This is attributed to the increased low-level instability at the PVA centers in the absence of extended cloud covers. Hail-related lows are larger and bear a greater resemblance to circles than the ordinary lows. They are usually moderate or negligibly elongated in the northeast to southwest direction and originate at the east coast of Adriatic Sea.

A THREE-DIMENSIONAL MODELING STUDY OF HAILSTORM SEEDING

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Abstract: A three-dimensional cloud model is used to simulate transport and diffusion of an artificial ice nucleation agent in conditions of hypothetical hailstorm seeding. The microphysical parameterization use the bulk a second-moment scheme for all species. According to the beneficial competition criteria silver iodide is directly injected and released into an assumed embryo formation region, between -80C and -120C isotherms and 25-45 dBZ radar reflec-tivity contours on line with length of 1.5 km. The results from the case study simulation have shown that agent

typically has about 2-3 min to spread in the seeding zone after its activation and relatively low vertical extension of spreading from the axis of dispersion, which is less than 160 m. The agent activation leads to earlier ice initiation that causes earlier initiation of precipitation. The implication of the seeding is that cloud seeding with a 6 min time frequency contributes in registration of the maximum hailfall decrease at the ground of about 11.01 %, compared to the unseeded case. The maximum rainfall increase of 25.79 % and hailfall decrease of 10% is found in the experiment with 0.4 g/m initial seeding rate, 5.5 km seeding height and 10 km seeding distance, compared to the base run simulation, respectively.

A SENSITIVITY TEST FOR HAIL PREVENTION ASSESSMENT WITH HAILPAD MEASUREMENTS

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Abstract: The evaluation of the French hail prevention project with silver iodide ground generators is based on daily corre-lations between the running time of the generators and the intensity of point hailfalls as indicated by hailstone number determined with hailpads. A normalization of these two parameters by their daily mean values allows the aggregation of hail days, and the setting-up of larger data samples for a statistical examination in which the ran-dom nature of hail becomes less important. In this paper, the evaluation is made from the 1948 point hailfalls recorded in an area of 16,000 km² of the Midi-Pyrénées region during 17 hail seasons. A cumulative method of correlation between the seeding and hailfall data shows that only the major hail days, with at least 15 point hail-falls measured in a hailpad network of 7 km mesh, may enable the detection of a seeding effect from a ground generator network of 10 km mesh. With this observation, the correlation between the seeding and hailfall data for 438 hailfalls on 18 major hail days indicates a beneficial effect of the seeding on 15 days, with a hail decrease of 40% for the correctly seeded events. This ratio amounts to 50% when the hailfall kinetic energy is considered instead of the hailstone number.

POTENTIAL WATER AUGMENTATION FROM CLOUD SEEDING IN THE COLORADO RIVER BASIN

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Abstract. A spatially-distributed snow energy and mass balance model, updated with all available snowpack obser-vations, is used to assess the potential for water augmentation by winter orographic cloud seeding in the Colorado River Basin. The modeling system outputs snow water equivalent (SWE) on a 1 km grid throughout the continental United States. The April 1 SWE from the last two years are horizontally integrated across existing and potential seeding target areas in the basin and multiplied by approximately 0.1 to calculate water yields from an assumed seeding-induced increase of 10 percent. Major uncertainties in this method, including snowpack ablation and target area selection, are described. Given those uncertainties, it is estimated that in an average precipitation year, about one million acre-feet of additional snowpack water could be produced by seeding. Somewhat more could be pro-duced in a wet year and about 500,000 acre-feet in a dry year. These figures are reasonably close to those from older studies of augmentation potential in the basin.

Simulations of Snowpack Augmentation in the Colorado Rocky Mountains

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Abstract: In this paper we summarize a project designed to evaluate the feasibility of using a mesoscale model to support cloud seeding operations and the physical evaluation of seeding responses. The model used was the Colo-rado State University Regional Atmospheric Modeling System (RAMS). RAMS provided forecasts of precipitation and winds for the 2003-2004 winter season. Detailed evaluation of model forecast orographic precipitation was per-formed for 30 selected operational seeding days. In addition, the model was run to emulate cloud seeding operations performed by Western Water Consultants. It was shown that the model can be a useful forecasting aid in support of the seeding operations. But, the model over-predicted precipitation, particularly on moist southwest flow days. This was likely due to over-simulated convection when little or only relatively shallow convection actually occurred. The model also exhibited virtually no seeding response in terms of precipitation. Possible reasons for that are discussed.

APPLICATION OF A HYDROLOGIC MODEL TO ASSESS THE EFFECTS OF CLOUD SEEDING IN THE WALKER RIVER BASIN OF NEVADA

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Abstract: The focus of this study is to use a physically-based, distributed hydrologic model to estimate the impacts of cloud seeding efforts on the streamflow generated within the areas of the Walker River Basin targeted by the Nevada seeding program. The hydrologic model is calibrated using GIS information, model default values, and

manual calibration to fit observed streamflow at a USGS surface water station within the Walker River Basin. The calibrated model is then used in two case studies that are designed to simulate a non-seeded condition and a seeded condition with a 10% increase in precipitation on the five target areas. The results from the two modeling case studies indicate that the additional precipitation applied in the seeded case results in increases in evaporation and runoff from the target areas but does not significantly impact the storages of moisture in the groundwater and soil zone for all of the five target areas. The fraction of seeding-increased precipitation that resulted in streamflow varied from 49% to 89% among the different target areas. The remainder of the additional precipitation resulted in evapotranspiration from the target areas.

ROLE FOR LIGHTNING IN TORNADOGENESIS AND POSSIBLE MODIFICATION

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Abstract: New consideration is given to the action, under severe storm conditions, of repeated, spatially-localized, intracloud lightning flashes providing enhancement of updraft wind velocities towards initiation of a tornado. The basis for the updraft wind enhancement comes from lightning-generated H+ and OH- ion concentrations that are driven for energy release to opposite lower and upper cloud levels, respectively, by the residual electric field of the thunderstorm. The model consideration is related to recent reports of intracloud flash rate measurements associated with tornadic activity. The required spatial localization of the intracloud-containing flash rate may be a contributing factor to tornadoes being relatively rare occurrences in such storms. Nevertheless, cloud seeding is proposed to alle-viate updraft velocity build-ups by promoting “in-situ” recombination of the lightning-generated concentrations of ions.

A Preliminary Assessment of Inducing Anthropogenic Tropical Cyclones Using Compressible Free Jets and the Potential for Hurricane Mitigation

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Abstract: We have conceptually studied the potential for mitigation of natural hurricanes by inducing anthropogenic perturbations prior to or in front of an advancing hurricane. We propose actual hardware for the task. It consists of multiple jet engines mounted on barges or ships that will be dispatched to strategic locations in the ocean where the sea surface temperature is high and the vertical temperature profile and atmospheric conditions are such that the potential for development of a hurricane or tropical storm is high. The engines will direct compressible high momentum, high-speed free jets skyward causing entrainment of even larger amounts of additional air to form plumes and updrafts. The unstable humid updraft will itself produce conditions for additional entrainment and evolution of tropical cyclones. These anthropogenic perturbations will extract enthalpy from the ocean, cooling the ocean surface and depriving the advancing natural hurricane of its needed thermal energy.

COPING WITH PRECIPITATION VARIABILITY

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Abstract. The precipitation high variability and its intermittency suggest the use of percentiles to obtain a more de-tailed description of this variable. In general, the percentiles produce classes which allow a better comparison be-tween correlated points. In our case the comparison is done using rain gage data from Midland and San Angelo, Texas. Apparent changes in precipitation associated with cloud seeding operations over the San Angelo area are estimated by regression analysis, but conditional probabilities are used to support potential positive increases in some years. This technique seems adequate to be used also in insurance claims. Spectral analysis is also used to detect weather modification signals.

TOWARDS A NEW PARADIGM FOR WEATHER MODIFICATION SCIENCE AND TECHNOLOGY

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ABSTRACT Weather modification science and technology development and implementation program plans have been created since 1946, and have collectively led to modern weather modification technologies. These modern weather modifi-cation technologies have helped the community at large for over 60 years. Recent technological and scientific ad-vances, scientific community recommendations, and

contemporary socioeconomic problems form the basis for con-structing a new plan that facilitates the development and applications of modern weather modification technologies for more effectively benefiting society. Pending Congressional legislation adds urgency to a new approach for de-veloping weather modification science and technology. This paper describes this new approach. The proposed approach encompasses a comprehensive agenda of fundamental and applied research and develop-ment efforts directed toward optimizing existing technologies used to manage “treatable” atmospheric processes and conditions, and to allow the development of select relevant innovative technologies. It will require a permanent, national program that administers its resources and oversees its activities. High-level implementation guidelines are also provided.