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NOSB questions cover ocean biology, chemistry, geology, physics, navigation, geography, and related history, literature, and public policy. Questions are presented in "buzzin'" rounds (rapid-fire multiple-choice or short-answer) and the "team challenge," which gives students an opportunity to apply their critical thinking skills

to questions involving real-time data and cutting edge research and policy issues.

For a sample of the kinds of questions included in the competition, go to the NOSB Web site (www.comsec.edu/nosb/Dev2Go/web/anchor/press/home_page) and click on "Test Your Ocean Knowledge."

NEW METHOD TO EVALUATE CLOUD SEEDING

A new method for the objective evaluation of short-term nonrandomized operational convective cloud seeding projects on a floating target aircraft was used to evaluate seeding effects on the Texas High Plains (THP) and Edwards Air Force Base programs during the 1999-2000 and 2001-2002 seasons. Seeding control units were defined to be a 100-acre wheat plot for each year. A definition of previous randomized seeding experiments at Texas and Thailand. The units were defined and retrieved by a computerized automatic algorithm, which is not subject to human bias.

The computer-based method made use of NEXRAD mosaic radar data to define fields of circular (25 km) radius floating target analysis units with 100 times from first echo to the disappearance of all echoes and then superimposed

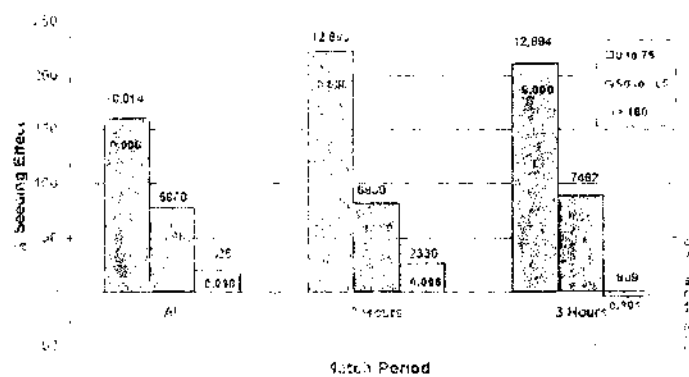
the track and seeding actions of the project seed aircraft onto the unit fields to define seeded and nonseeded analysis units. Objective criteria were used to identify "control" matches for each of the

operational target within 1.5 hours and 2 h of the time on a given day. The seeding of a particular unit took place. These were done to determine whether selection biases and the diurnal convective cycle con-

founded the results.

This analysis effort is consistent with the recommendations from the National Research Council report, "Critical Issues in Weather Modification Research."

Although the results of all analyses were subjected to statistical testing, in the absence of a priori treatment randomization, P-values cannot be used as probabilities for the effects say-



Apparent seeding effect, [(S/Ns)-1]100(%), as a function of pretreatment age at initial treatment and match period (number of hours since first treatment) for matches made outside the operational target for the High Plains Program in 1999 and 2000. The average rain change (acre-ft) per unit is shown above each bar. The corresponding P-values are shown within each bar.

seed units from the archive of nonseeded units. To minimize potential contamination by seeding, no seeding was allowed for any control unit if its perimeter came within 15 km of the perimeter of a seeded unit during its lifetime.

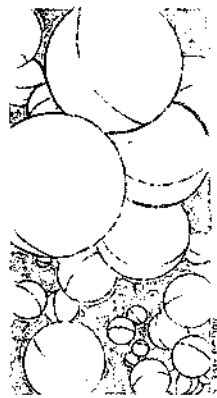
The matches were selected four within and outside each op-

ing occurred by chance, but merely to determine the relative strength of the various findings. The apparent effect of seeding in both programs was large, even after determining the effect of selection biases and the diurnal convective cycle. The most conservative estimates of seeding effects were obtained from

case of matches drawn from outside the operational target within 11% of the time that each unit was initially seeded. Under these circumstances, the percentage increase exceeded 50% and the volumetric increment was greater than 500% acre-ft (3700 kilotons) per unit with strong *P*-value support ($p < 0.0001$) on both the rLP and rLP programs. This is in good agreement with the apparent percentage effects of seeding for the operationalized Texas and Thai cloud-seeding programs, which were 48% and 48% to 92%, respectively. The seeded units in the rLP program appeared on radar with the largest apparent seeding effects in the region. Although these results indicate a strong case for enhanced rainfall by the operational seeding programs, such programs must be viewed as substitutes for operationalized seeding efforts that are conducted in conjunction with detailed physics measurements and realistic cloud modeling. Such activities are not normally the purview of operational programs, and the current funding climate where they should be undertaken by the partnership between the research and operational sectors. —WILLIAM WOODLEY (WOODLEY WEATHER SERVICES) AND DANIEL ROSENBERG, "The Development and Testing of a New Method to Evaluate the Operational Cloud-Seeding Program in Texas," in the February Journal of Applied Meteorology.

PULSED LIDAR FOR AIRCRAFT WAKE CHARACTERIZATION
The range-pulsed Doppler lidar, recently successfully used for wind and turbulence measurements, has been modified for long range characterization of wake vortices from aircraft. This mainly concerns the opto-mechanical ar-

A PING-PONG BALL'S CHANGE



tendencies of this particular type of avalanche, which moves much more erratically than those with heavier snow, and is therefore more dangerous. In the experiment, cameras and air-pressure sensors situated along the slope recorded the movement and speed of individual balls and showed occurrences of turbulent eddies in the "ball-avalanche." The resulting model was surprisingly uncomplicated. However, more research will be required to determine just how accurate the model is in replicating an actual avalanche's movement.

range and the scanning device on the hardware side, and the four-stage data-processing algorithm being developed to achieve precise profiles of tangential velocities from which the vortex parameters like trajectories, core separation, tilt angle, and circulation can be derived. During an extended field trial during summer 2002 at the airfield of Evreux, France, the potential of the pulsed lidar for wake-vortex characterization in the atmospheric environment could be demonstrated.

The main advantage of the pulsed lidar is the long-range capability of several kilometers—allowing the observation over long periods from the moment of wake generation to a progressed state of vortex decay. The flexible scanning device makes it possible to investigate the vortex behavior not only near the ground, but also outside the ground influence, by pointing

the scanning area steeper in an upward direction. The operation onboard an aircraft for characterization of wake vortices generated by a preceding aircraft is under consideration. —FRIEDRICH KOPIEHLER, INSTITUTE OF ATMOSPHERIC PHYSICS, STEPHAN RAHM, and GOJEN STANJKHO, "Characterization of Aircraft Wake Vortices by 2 μ m Pulsed Doppler Lidar," in the February Journal of Atmospheric and Oceanic Technology.

CONVECTIVE SYSTEM EXPANSION AS PREDICTOR

It is possible to estimate the probable lifetime of a convective system, within a certain error bar, considering only its initial area expansion. We analyzed the relationships between the initial area expansion rate of tropical convective systems and their total life duration using an objective tracking of convective systems during their life cycle. We

also investigated the hypothesis that the area expansion, and hence the convective activity, impact the high-level wind divergence.

The WOTAMCOBA experiment over Tropical South America makes possible dynamic and thermodynamic analysis of convective systems and their associated precipitation from the combination of satellite images, meteorological radars and rain gauges, and radiosonde data. We used the full resolution GOES-S satellite images to detect and track the convective systems during their life cycle. This objective tracking was performed for 98 days during the WOTAMCOBA case, a summer covering tropical South America. The high-level wind and divergence have been estimated using objective satellite wind observations.

Initial area expansion not only predicts the life cycle of the con-

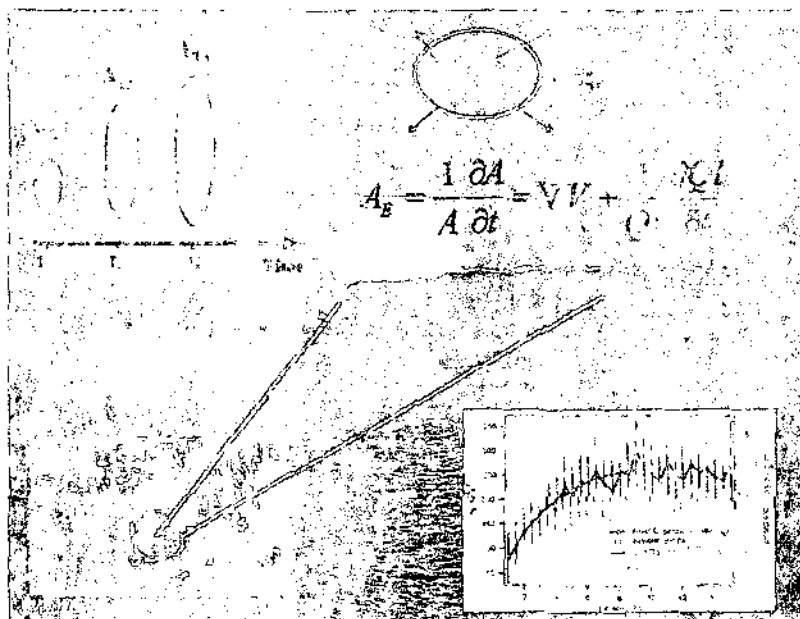
vective systems but also appears to be a good indicator of convective precipitation. The analysis of the area expansion shows that this initial area expansion parameter could be very useful for short-range forecasts, convection diagnostics, and maybe to help improve the precipitation estimation from geostationary meteorological satellites. Also, the area expansion can be used to determine the convective system life stage and to supply information about the condensation processes and the upper level divergence. It is shown that the area increase in the initial stage is mainly due to the condensation process, then, forward in the mature stage, the upper level wind divergence increases. (JULY/AUGUST 2001, M. LAURENT, "Convective System Area Expansion over Amazonia

and Its Relationship with Convective System Life Duration and High Level Wind Divergence," *The March Monthly Weather Review*

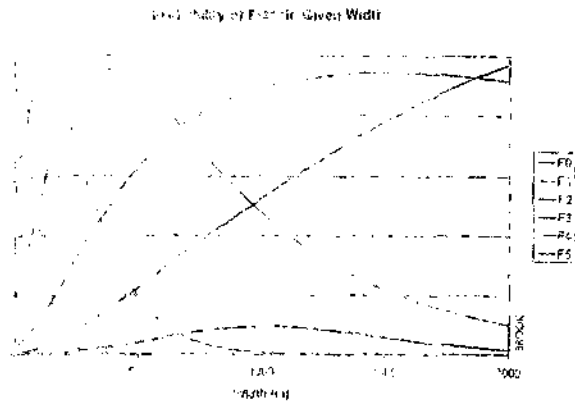
TORNADO STRENGTH AND PATH RELATIONSHIP

Convective path length and width are reported in discrete values. For many purposes, such as developing statistical models of hazards, it is desirable to have continuous relations. This is accomplished by modeling reported path length and widths of tornadoes using Weibull distributions for different values of the Fujita (Damage) scale ("F" scale). Weibull distributions are frequently used to model variations in wind speeds being both continuous, non-negative, and with a curve trailing off toward higher values. The fits are good over a wide range of length and width. Path length and width tend to increase with increasing F-scale, although the changes over time in the data for some aspects are large enough that caution must be exercised in interpretation of short periods of records. For example, the mean reported width of F3 tornadoes shows a slow increase beginning in early 1970s, when it was a little less than 200 m, to the mid-1990s, when the mean reported width was over 500 m, followed by a rapid decrease in the late 1990s and early 2000s. These changes appear independent of changes in NWS policy concerning whether the mean path width or maximum path width should be reported.

The statistical distributions demonstrate that, as the length or width increases, the most likely F-scale value associated with the length or width tends to increase (see figure, next page). Nevertheless, even for long or wide tornadoes, there is a significant probability of a range of possible F-values, so that simple ob-



Schematic diagram of the convective system detection and size evolution. The figure also shows the equation relating A_e , the normalized area time rate of expansion, with the upper-level wind divergence and the condensation/evaporation rate (QI is the liquid water content). On the right side, the figure shows A_e at the initiation stage, as a function of the convective system lifetime.



Probability of the Fujita damage scale rating given the reported width of a tornado. Damage intensity increases from F0 to F5. Thin lines associated with F0-F2 and thick lines with F3-F5. Colors go from green to red to black within each group of three.

width of the length or width is insufficient to make an accurate estimate of the F scale. Tornadoes rated F5 are rare enough, however, that they are never the most likely damage rating for any length or width. —MICHAEL R. BROWN, SOUVENIR OF SEVERE STORMS (2002), *On the Relationship of Tornado Path Length and Width to Intensity in the April Weather and Forecasting*

OUTBREAKS OF TORNADOES IN HURRICANES

Although midlevel dry intrusions have been mentioned as a possible trigger in tornado outbreaks with landfalling tropical cyclones for more than three decades, a systematic analysis of the historical outbreaks has been lacking. Analysis of rawinsonde observations shows that of the 13 Atlantic basin tropical cyclones producing tornado outbreaks (20 or more tornadoes) in mainland North America between 1960 and 1999, 11 were found to have evidence of a midlevel dry intrusion near or over the area of the outbreak

The "positive" outbreak cases occurred when the favored area for tornadogenesis (i.e., the right front or northeast quadrant of the tropical cyclone) coincided with a pronounced midlevel relative humidity gradient as determined from relative humid-

ity reservoir most often located in the eastern semicircle of the storm.

Subsequent research is planned into the origin of the midlevel dry air reservoirs. Surface baroclinic boundaries appear to have been involved in at least two of the cases and additional research is warranted with respect to that issue, as well. —LON CURTIS (KWTX-TV), *Midlevel Dry Intrusions as a Factor in Tornado Outbreaks Associated with Landfalling Tropical Cyclones from the Atlantic and Gulf of Mexico in the April Weather and Forecasting*

ECHOES

"Preventative plans on a larger scale are needed."

—JOHN SCHELLNHUBER, head of a group of climate scientists at the Tyndall Centre for Climate Change Research in the United Kingdom, speaking after a meeting in Britain of leading European and American climatologists in January that produced some imaginative ideas for dealing with climate change. Among the "larger-scale" proposals were various methods to deflect the Sun's rays, including sending billions of tiny balloons into the stratosphere or utilizing gigantic mirrors in space, as well as ideas to use giant reservoirs filled with saline water to offset rising sea levels and algae farms to absorb greenhouse gases.

Critics say the unusual suggestions indicate governments and some scientists are out of touch with ways to sensibly deal with the problem of climate change.

ity at 850, 700, and 500 mb relative humidity data. A review of all tropical cyclone landfall events since 1960 revealed only three cases with clear evidence of similar midlevel dry intrusions that failed to produce an outbreak of 20 tornadoes or more. However, each of those cases did produce a significant number of tornadoes.

The analysis showed no correlation between landfall intensity and outbreak potential in the 13 cases, but did detect a strong diurnal signal. Almost two-thirds of the tornadoes in the 11 positive cases occurred between 1500 and 2400 UTC (daylight hours in the region examined). The horizontal distribution of midlevel dry air varied from case to case, but two basic patterns were identified: in one, a mass of dry air impinged on much of the northern or northwestern semicircle of the storm's water circulation and gradually divided into two separate areas (to the northwest and to the northeast) as the storm advanced poleward; the other involved apparent ingestion of a lobe of dry air from