THE EFFECT OF PROBABILISTIC INFORMATION ON THRESHOLD FORECASTS

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WEATHER AND FORECASTING

PURPOSE

"The study reported here asks whether the use of probabilistic information indicating forecast uncertainty improves the quality of deterministic weather decisions" (805).

PARTICIPANTS

Ten atmospheric science students at University of Washington

- All had basic training in forecasting

TASK

Four forecasts made over two sessions

- Each forecast was for a different date: 2/14/03, 2/20/03, 3/11/03, 3/26/03

Forecast was for four different locations in Puget Sound region

Forecasts consisted of:

- Wind speed and wind direction reports every six hours for a 48-hour period beginning at 5pm on the stated date
- A decision of whether to post a high wind advisory (for wind speeds over 20 knots) for the area, and if so, for which hours

MATERIALS

Historic weather information about region

- Satellite Imagery
- Radar Imagery
- Buoy observations
- Regional terminal airdrome forecasts (TAFs)
- Products from weather models
  - Pennsylvania State University–National Center for Atmospheric Research Mesoscale Model
  - Nested Grid Model
  - Aviation Model

All information above was *deterministic*, i.e. gave a numeric forecast with no associated uncertainty

PROBABILITY PRODUCT

- Given to participants on half the forecast tasks
- Color-coded map represent probability of winds over 20 knots
- Generated using centroid mirroring ensemble (ACME)

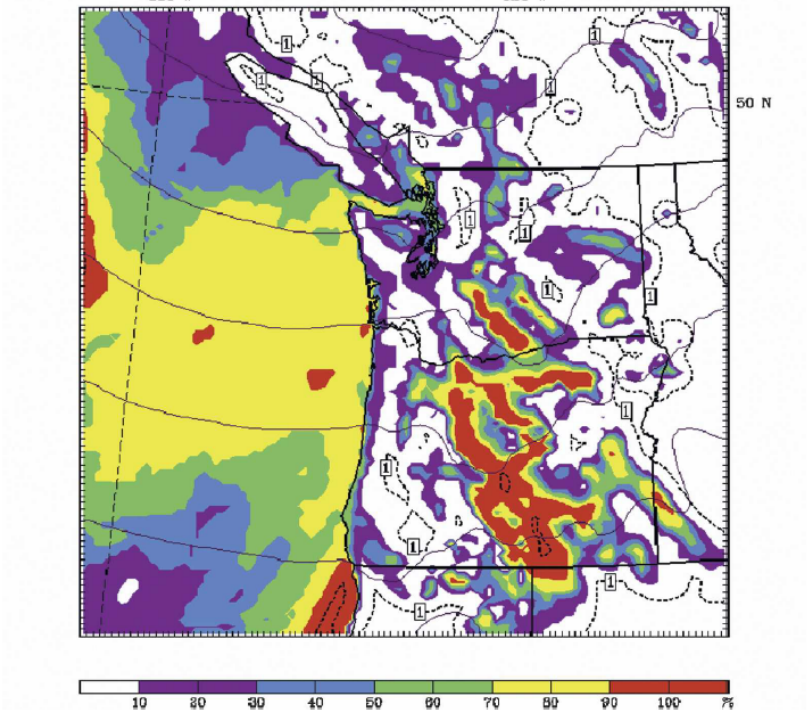


FIG. 1. ACME ensemble winds greater than 20 kt. This chart was color-coded for probability. Warmer colors indicate higher probabilities.

PROCEDURE

Forecast locations posted above participants' workstation

- Also showed location of TAF forecasts

Forecast materials and probability product presented on computer

Two answer sheets provided:

- Wind speed and direction
- Wind advisory decision
- Separated in order to reduce effect of wind speed judgment on wind advisory

PROCEDURE, CONT'D

Experimenter introduced task, forecast materials, and probability product to participant

Participants were required to report high wind probability for all four locations at all available forecast times

- Ensured that participants used the probability product

Participant performed two forecasts in first session, returned a week later for last two

- One forecast/session contained probability product

RESULTS

Wind speed and direction data not analyzed

- Collected in order to make task seem realistic

Each date contained eight forecast periods with probability product

Four locations x four dates x eight forecast periods = 128 forecast cases

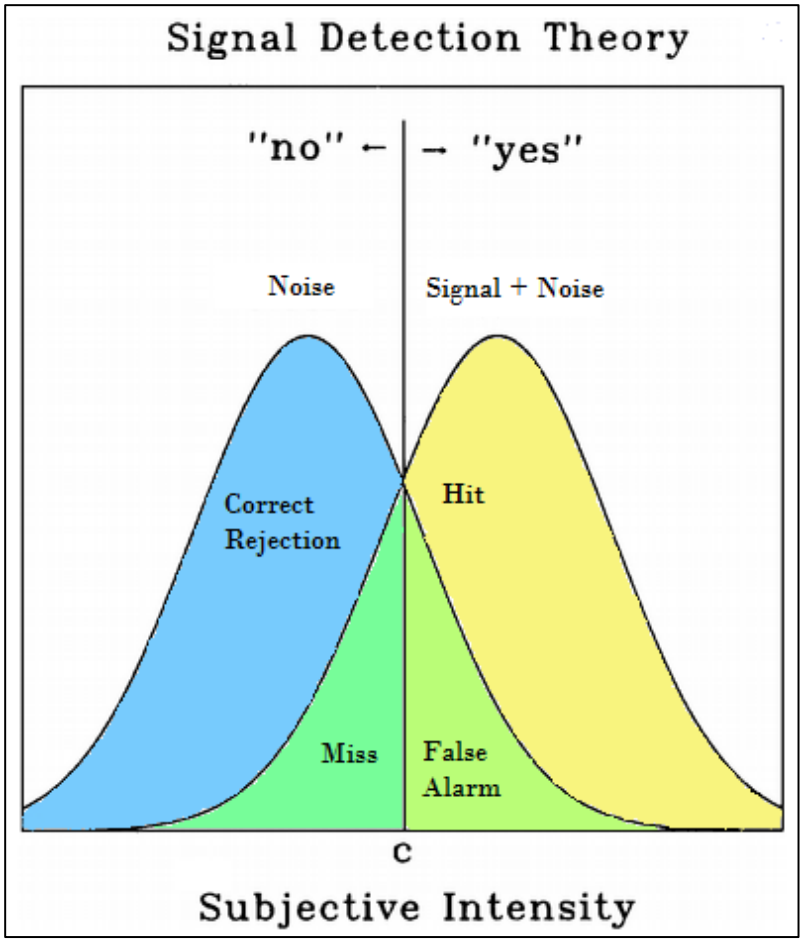
- In 26 cases, probability of high wind was unclear
- These cases thrown out
- 128 – 26 = 102 forecast cases included in analysis

RESULTS, CONT'D

Wind advisory posting accuracy measured in terms of signal detection theory sensitivity

d' = sensitivity

C = response bias



RESULTS, CONT'D

d' was greater for forecasts with the probability condition than for forecasts without it, (d_{with} =1.25, $d_{without}$ =0.92)

Response bias was more conservative with probability product (*C*=0.11) than without it (*C*=0.19).

- the participants posted *fewer* advisories with the probability product (38% of the time) than without it (45% of the time)
- Forecasting more accurate with probability product

HUMAN RESPONSE BIAS

In all forecasts, people tended to post too many forecasts when high wind probability was low(0-30%), and too few when probability was high(90-100%)

- Liberal bias in low-probability conditions, conservative bias in high-probability conditions

ATTENUATION OF HUMAN RESPONSE BIAS

When there was no probability product, participants posted a wind advisory 23% of the time on 10%-probability-or-less cases, and 81% of the time in 90%-probability-or-more cases

With the probability product, participants posted a wind advisory 12% of the time in low-probability cases, and 88% of the time in high-probability cases

- The probability product attenuated the human response bias, and improved forecasting

Danger of conservative bias:

Dangerous weather conditions will be overlooked by forecasters, leaving the general public susceptible to severe weather accidents and injury

Danger of liberal bias:

The general public will learn to ignore forecast warnings, and ignore them in the presence of an actual dangerous weather event (leading to accidents and injury)

RESERVATIONS

This study was done on participants with forecasting experience

- Cannot generalize to naïve users

This study was done on a threshold forecast

- i.e. a forecast which was made when weather conditions exceeded a certain limit
- Cannot generalize to all weather forecasting decisions

SIMILAR STUDIES

Baars et al., 2004: probability estimates improve forecasts of extended periods of time

Keith, 2003: probability estimates improve forecasts when safety is an issue

- Probability information may improve forecast accuracy across a variety of threshold decision-making and for various populations of users

REFERENCES

Baars, J. A., C. Mass, & Albright, M. (2004). Performance of National Weather Service forecasts versus model output statistics. Preprints, *20th Conf. on Weather Analysis and Forecasting and 16th Conf. on Numerical Weather Prediction.*

Keith, R. (2003). Optimization of value of aerodrome forecasts. *Weather and Forecasting 18*, 808–824.

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