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6. AUTHORS

Gabor Vali

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

University of Wyoming
Research Office
1000 E. University Ave. Dept. 3355
Laramie, WY 82071

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13. ABSTRACT (*Maximum 200 words*)

The principal activity under this grant was the DYCOMS-II field experiment, and the data analyses and reporting that followed. The field experiment yielded unique data. Results have been reported in a number of publications and student theses and dissertations. Additional journal articles are pending publication and/or submission.

The main finding from the field observations is the ubiquity of drizzle in marine stratocumulus even when cloud thickness is as little as 250 m. Diagnosis of this drizzle became possible through the use of the Wyoming Cloud Radar on the NSF/NCAR C-130 research aircraft. In addition, the drizzle provided a suitable target for velocity measurements, so that we were able to obtain the first ever two-dimensional depictions of circulations within the marine boundary layer.



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# Final Technical Report for DODONR4810
## 04/01/2001 - 03/31/2004

**Award No: N00014-01-1-0662**

To: Office of Naval Research, Attention: Ronald J. Ferek
Ballston Center Tower One
800 North Quincy Street
Arlington, VA 22217-5660

Project Title: **Aircraft and Radar Measurements of Marine Stratus.**

P.I.: G. Vali, University of Wyoming

The principal activity under this grant was the the DYCOMS-II field experiment, and the data analyses and reporting that followed. This work substantially extended the research done in coastal stratus under previous ONR grants.

DYCOMS-II was a collaborative effort with many investigators, mostly funded by the National Science Foundation. Our participation was focussed on mounting the Wyoming Cloud Radar (WCR) on the NCAR C-130 research aircraft and participating in all of the DYCOMS flights. Other investigators were granted 7 flights; we have requested two additional flights of 9 hour duration each. The seven main flights consisted of flights at different altitudes along 100-km diameter circles. The two additional flights focussed on repeated sampling of approximately 20-km regions.

The field experiment was successful. Suitable weather conditions existed throughout the project period and the WCR operated well 90+ percent of the time. Notably, this was a new configuration of the radar, using two antennas to provide vertical-plane dual-Doppler capabilities.

From our point of view, perhaps the most important finding from the DYCOMS project is that drizzle is more prevalent in nocturnal marine stratus than expected. Only one of the 9 cases studied had no appreciable drizzle flux at cloud base. All clouds were detectable by the radar from flight levels <1km above the cloud. Another finding is the highly structured character of the radar reflectivity fields. This has been seen before in our earlier studies of coastal clouds but expected clouds further off shore to be more homogeneous. In contrast, the non-homogeneities are just as pronounced, with many different scales evident.

Journal publications arising from the WCR data collected in DYCOMS-II are the following:


Stevens, B., D. H. Lenschow, G. Vali, 29 others, 2003: Dynamics and Chemistry of Marine Stratocumulus -- DYCOMS-II. *Bull. Amer. Meteorol. Soc.* **84,** 579-593.

Stevens, B., D. H. Lenschow, G. Vali, 29 others, 2003: Dynamics and Chemistry of Marine Stratocumulus -- DYCOMS-II. Electronic Supplement to *Bull. Amer. Meteorol. Soc.* **84,** 593-593.

VanZanten M. C., B. Stevens, G. Vali and D. H. Lenschow, 2004: Observations of drizzle in nocturnal stratocumulus. Accepted for publication in *J. Atmos. Sci.*

Lothon, M., D.H. Lenschow, D. Leon, and G. Vali, 2003: Estimating the variance of the reflectivity-weighted fall velocity from in situ drop count statistics in stratocumulus. Submitted.

Stevens, B., G. Vali, K. Comstock, R. Wood, M. C. van Zanten, P. H. Austin, C. S. Bretherton and D. H. Lemschow, 2004: Pockets of open cells (POCs) and drizzle in marine stratocumlus. Accepted for publication in the *Bull. Amer. Meteor. Soc.*

Wang, J.Y. and B. Geerts, 2003: Indentifying drizzle within marine stratus with W-band radar reflectivity profiles. *Atmos. Res.*, **69**, 1-27.

Petters, M.D., J.R. Snider, B. Stevens, G. Vali, I. Faloona and L. Russell, 2004: Accumulation mode aerosol, pockets of open cells, and particle nucleation in the remote subtropical Pacific marine boundary layer. To be submitted to *J. Geophys. Res.*

In addition a number of conference presentation have been made, and there are short reports at the URL <www-das.uwyo.edu/~vali/dycoms/dy_rept.html>.

Data from the project and from earlier coastal stratus work formed the basis of an M.S. thesis by Qing Yang. Material from that thesis will be incorporated in forthcoming publications. In this work, Z-R relationships are compiled for a large number of cases, establishing both an overall average and the range of variation.

The doctoral thesis by D. Leon that is near completion deals with the 2D wind fields retrieved using the vertical-plane dual-Doppler analysis methodology he developed. Prelminary analyses have shown, at least in some cases, patterns of organization of the horizontal winds on the scales of a few kilometers. The horizontal velocity field retrieved using the dual-beam configuration of the WCR during DYCOMS-II shows a strong anti-correlation in the along-track velocity component between the cloud and subcloud layers on a scale several (4-6) times the depth of the boundary layer. Our results, the first direct observations of mesoscale circulations in the shallow, stratocumulus-topped boundary layer, are consistent with previously reported observations (cloud-top heights, saturation point structure, breaks in the cloud layer, etc.) from which the presence of mesoscale circulations has been inferred. These circulations appear to keep the cloud and subcloud layers strongly coupled despite the stabilizing effect of drizzle on the thrmodynamic structure of the boundary layer.