A Climatology of Precipitating Open-cell Convection over the Northeast Gulf of Alaska

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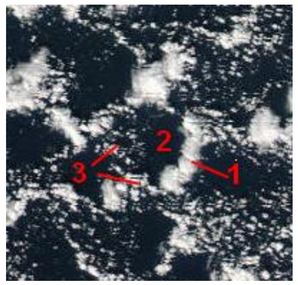
Introduction

- Open-cell convection is a form of shallow (i.e., up to a few kilometers deep) moist (cloudy) mesoscale maritime convection

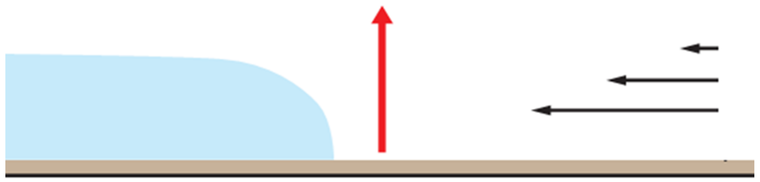


MODIS true color image of open-cell convection from the Aqua satellite from 2310 UTC on 7 November 2006. The pixel size is 500 m by 500 m. The image is 100 km by 100 km. Arc clouds are found along the downwind edge (1) of the nearly cloud-free center (2) while ring clouds are found along the cell's sides and rear (3).

  - Justification for its study is the role it plays in the general circulation and climate
    - Via associated heat, moisture, momentum, and cloud radiative fluxes
  - Generally attributed to thermodynamic instability
    - Surface-based convection
    - Climatologically favored in regions of cold-air outbreaks at middle to high latitudes

Motivation and Purpose

- Sikora et. al (2011) present an eight-year (1999-2006) northeast Pacific Ocean climatology of:
  - Frequency of open-cell convection
  - Thermodynamic and kinematic environment of its formation
    - Sikora, T. D., G. S. Young, M. D. Stepp, and C. M. Fisher, 2011: A synthetic aperture radar-based climatology of open-cell convection over the northeast Pacific Ocean. *J. Appl. Meteor. Climatol.*, 50, 594-603.
  - Suggest similarity between organization of middle- to high-latitude open-cell convection and tropical deep moist convection



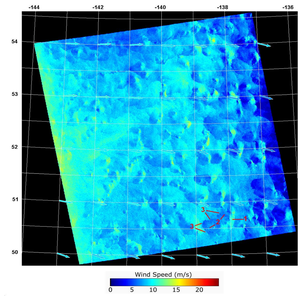
Updraft (red arrow) and therefore cloud formation can be enhanced in the presence of vertical wind shear and precipitation-driven cold pool (blue shading). Referred to as cold-pool dynamics

  - Sikora et al. (2011) document appropriate vertical wind shear but lack precipitation data

- The purpose of this research is to address whether or not open-cell convection from the Sikora et al. (2011) study is associated with precipitation

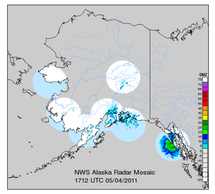
Data

- Sikora et al. (2011) document 616 fields of open-cell convection in satellite synthetic aperture radar-derived wind speed (SDWS) images



SDWS image from 0301 UTC on 8 November 2006. Pixel size is 600 m by 600 m. Pale blue arrows indicate NOGAPS near-surface wind vectors. The squall appears as an area of stronger wind (1), with a sharp gradient along its leading edge. The trailing lull appears as an area of weaker wind upwind of the squall (2), with the cell's sides and upwind edge also marked by a sharp gradient of wind speed (3).

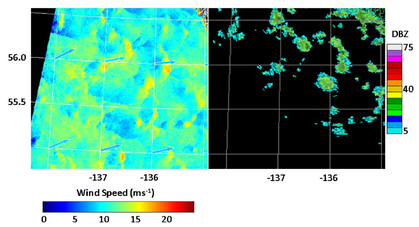
- Corresponding precipitation data are from WSR-88D Level-III 0.5° elevation angle short-range base reflectivity images from coastal Alaska
  - Right-to-left: Sitka/Biorka Island (PACG), Middleton Island (PAIH), Kenai (PAHG, not employed), King Salmon (PAKC, not employed)



Sample National Weather Service Alaska weather radar mosaic.

Methods

- 154 of the Sikora et al. (2011) SDWS images contain open-cell convection signatures that overlap in space with coverage in contemporary WSR-88D images from either PACG or PAIH
  - Time difference between any two images of a single pair is typically a few minutes or less
    - Allows for direct comparison of individual cells in the overlap region



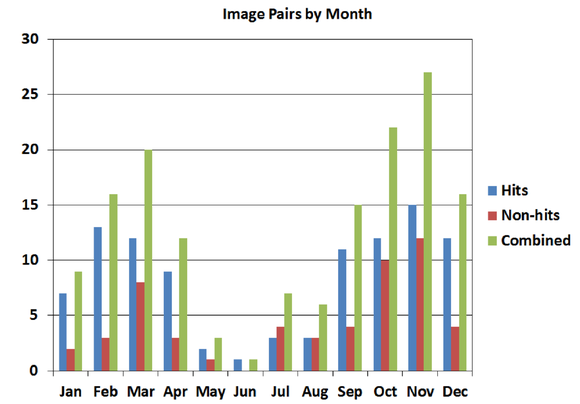
Left: Portion of SDWS image from 15:16 UTC 09 March 2004. Right: Portion of PACG 0.5° elevation angle short-range base reflectivity image from 15:16 UTC 09 March 2004.

Methods Continued…

- *Hit* – At least one SDWS open-cell convection signature in the overlap region is associated with precipitation
- *Non-hit* - No SDWS open-cell convection signatures in the overlap region are associated with precipitation

Results and Discussion

- Hits: 100, Non-hits: 54



- Short-range base reflectivity data range to near 230 km
  - At that range, the 0.5° beam center height is close to 5400 m above the elevation of the WSR-88D for standard refractive conditions
  - Thus, it is possible that the beams overshot certain open-cell convection precipitation, with the chance of overshooting increasing with distance from the WSR-88Ds

	Hit Signatures	Non-hit Signatures
First Quartile (km)	97	99
Median (km)	141	163
Third Quartile (km)	173	195
Skewness	-0.3	-0.7
Kurtosis	-0.8	-0.7

Statistics for distance-to-WSR-88D distributions for hit signatures and non-hit signatures

  - Resulting *P* value from a Mood's median test is 0.04, indicating the medians of the two distance distributions are different at the 95% confidence level, supporting the overshoot suggestion

Summary

- For nearly 65% of the image pairs, at least one SDWS open-cell convection signature in the overlap region is associated with precipitation
  - The percentage of image pair hits may be conservative
  - The results support the concept that open-cell convection can be organized by cold-pool dynamics

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For details, see Sikora, T. D., E. B. Wendoloski, and R. E. Marter, 2014: A climatology of precipitating open-cell convection over the northeast Gulf of Alaska. *J. Appl. Meteor. Climatol.*, 53, 2843-2847