Radiative-dynamical Feedbacks and Aerosol Indirect Effects in Marine Stratocumulus

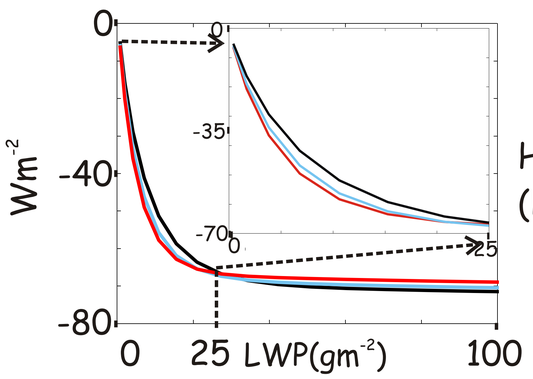
Jonathan L. Petters[1], Jerry Y. Harrington[2], Jason N.S. Cole[3], Howard W. Barker[3], Eugene E. Clothiaux[2]

1 - University of California - Santa Cruz 2 - The Pennsylvania State University 3 - The Meteorological Service of Canada

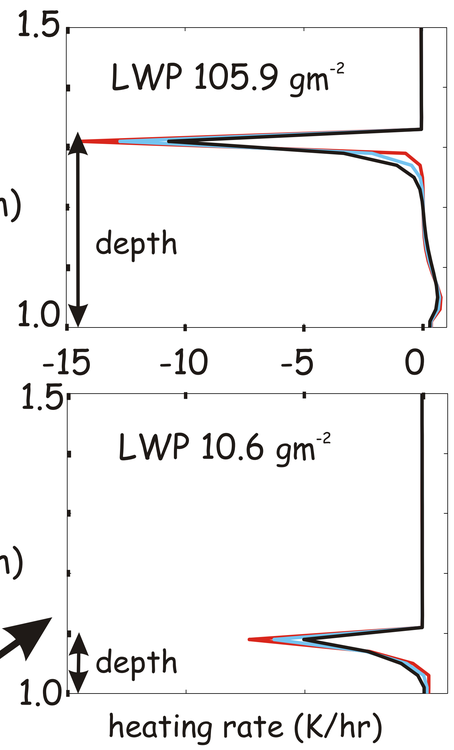
In many large-eddy simulations (LES), longwave (LW) radiative heating is computed as a function of liquid water path (LWP) only, not droplet concentration. How valid is this assumption?

Integrated longwave flux divergence changes with droplet concentration, especially for thin clouds (LWP < 25 g/m^2)

Integrated cloud LW cooling



Longwave heating profile



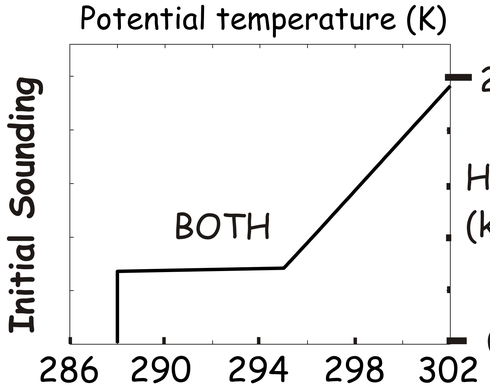
50/cc
200/cc
1000/cc

Profiles of longwave heating also change with droplet concentration

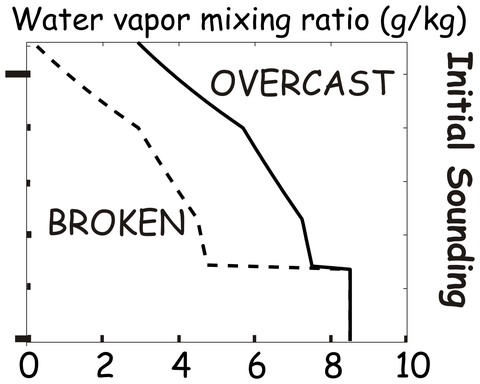
Investigate LW radiative-dynamical feedbacks within model nocturnal stratocumulus clouds using RAMS in LES mode for these droplet concentrations
50 m horizontal res., 30 m vertical res., 6 hour simutations

OVERCAST CASE - photo Alexei Korolev
BROKEN CASE - photo Bart Geerts

Potential temperature (K)

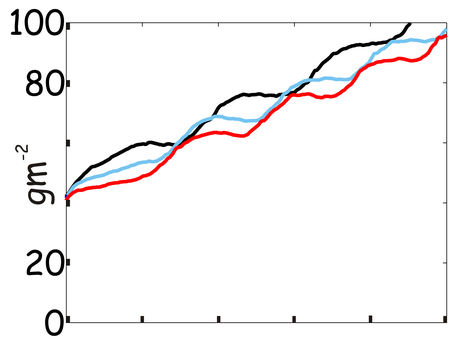


Water vapor mixing ratio (g/kg)

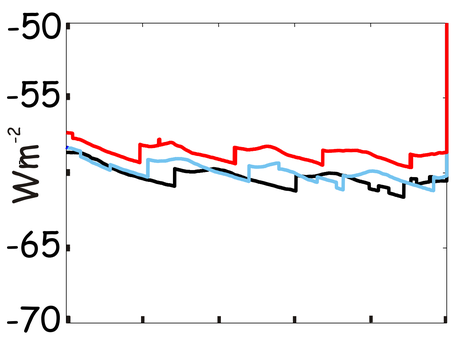


Thick OVERCAST Case

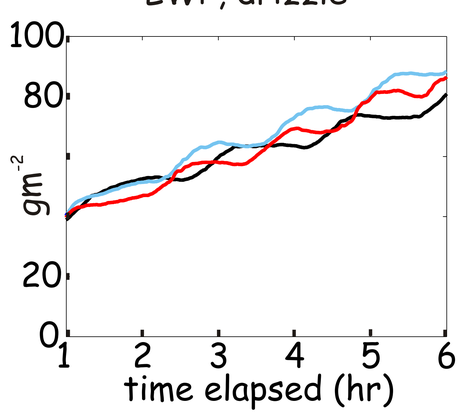
LWP, no drizzle



Integrated cloud LW cooling



LWP, drizzle

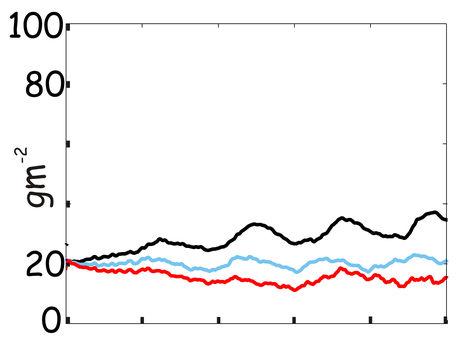


Differences in cloud evolution exist because of differences in LW cooling, but the drizzle process obscures this effect. Suggests that LW can be paramaterized as LWP-only for thicker cloud layers.

Thin BROKEN Case

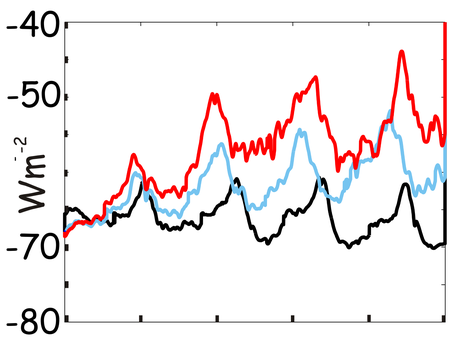
50/cc
200/cc
1000/cc

LWP, drizzle

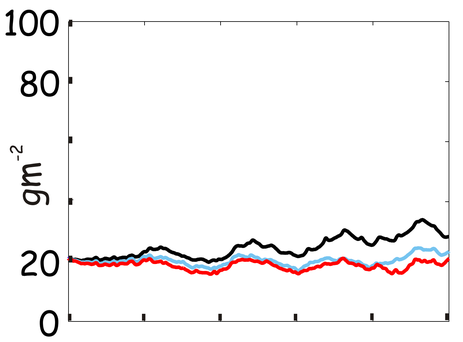


LWP dependent on droplet concentration. Use same one (200/cc) for radiative computations only to see if this dependence is related to LW cooling

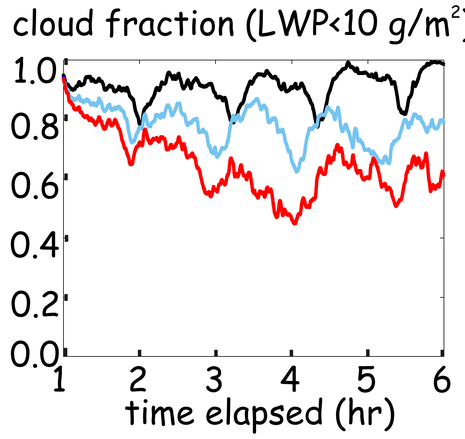
Integrated cloud LW cooling



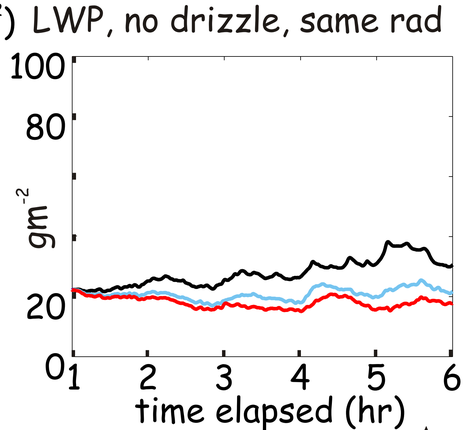
LWP, drizzle, same rad



cloud fraction (LWP<10 g/m^2)



LWP, no drizzle, same rad



Evolution of LWP more similar here; precipitation not a prime player for these simulations

HYPOTHESIS - initially entrainment and LW cooling work together to create different cloud fractions dependent on drop concentration; cloud fraction and associated integrated LW cooling drive LWP evolution from then on.

This work funded by the Department of Energy's Atmospheric Radiation Measurement Program and the Pennsylvania Space Grant Consortium.