Observing the Shallow Convection Part of the Deep Convective Life Cycle

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Related Poster (shown at this workshop):
https://faculty.nps.edu/scott.powell/presentationfolder/Powell_20210525_TPON.pdf

Scan for related poster

Photo: Shallow postfrontal convection at Pacific Grove, CA, on 25 January 2021, during a test rawinsonde launch for the planned California Investigation of Convection over Ocean (CALICO), planned for early 2022.

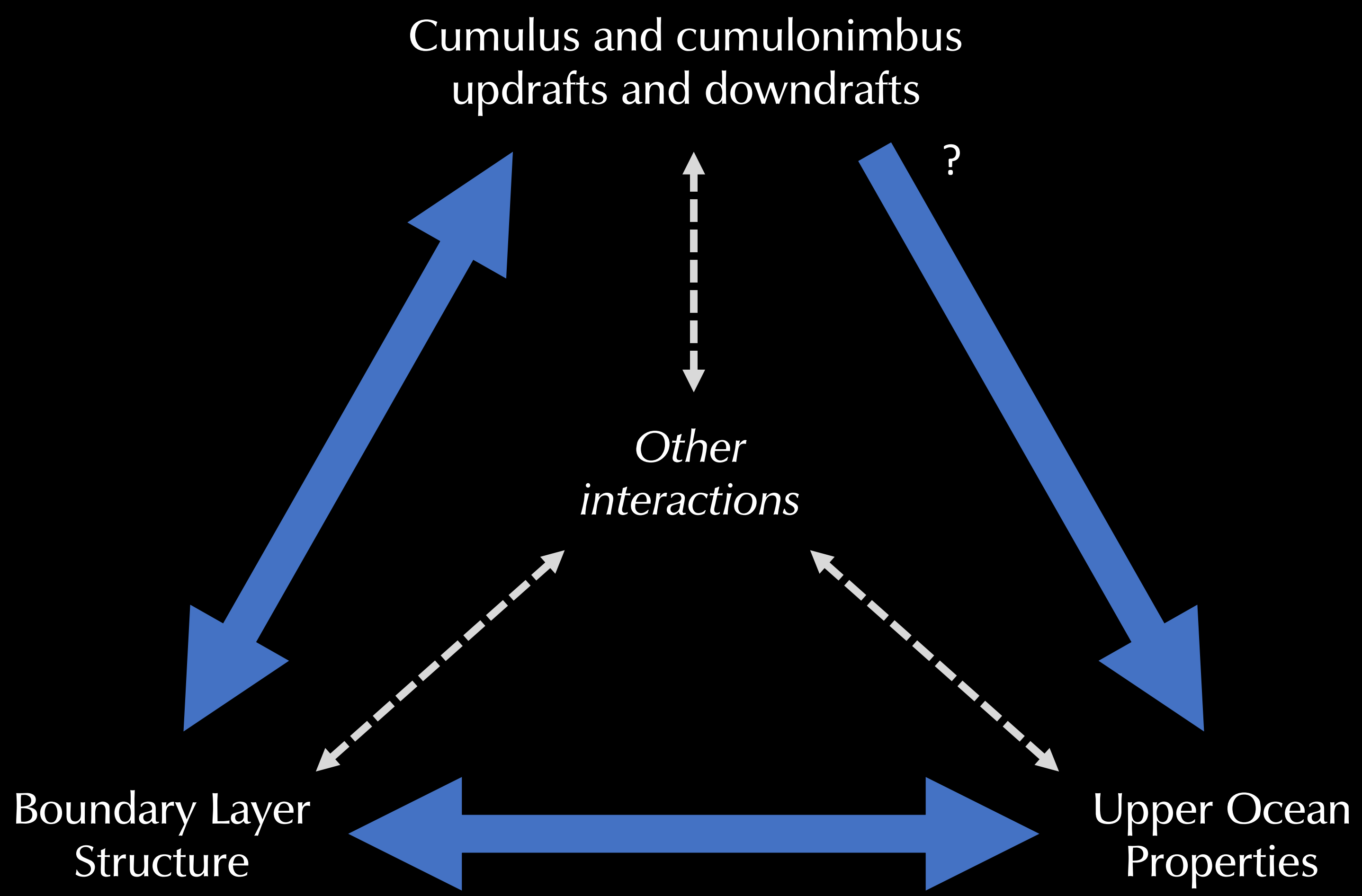
Why do we want to observe shallow-to-deep convective transitions (and therefore shallow, non-precipitating cumuli)?

1) Rapid transitions (i.e., minutes to hours) can proceed "extreme" weather events (e.g., supercells, growth of squall lines).

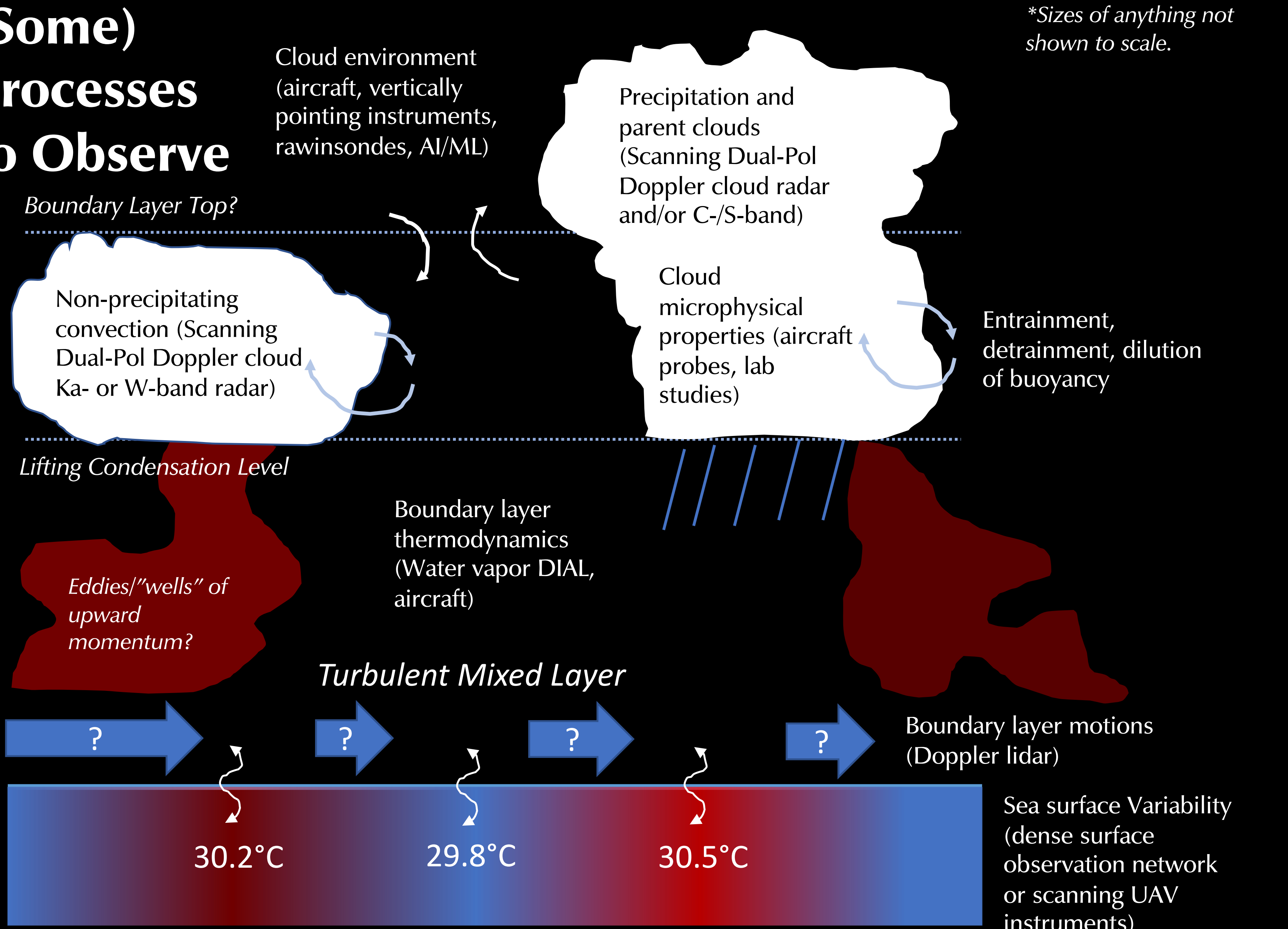
2) Convective transitions occurring on longer time scales (hours to weeks) is a critical process for a variety of phenomena (e.g., diurnal cycle, Matsuno-type waves, MJO).

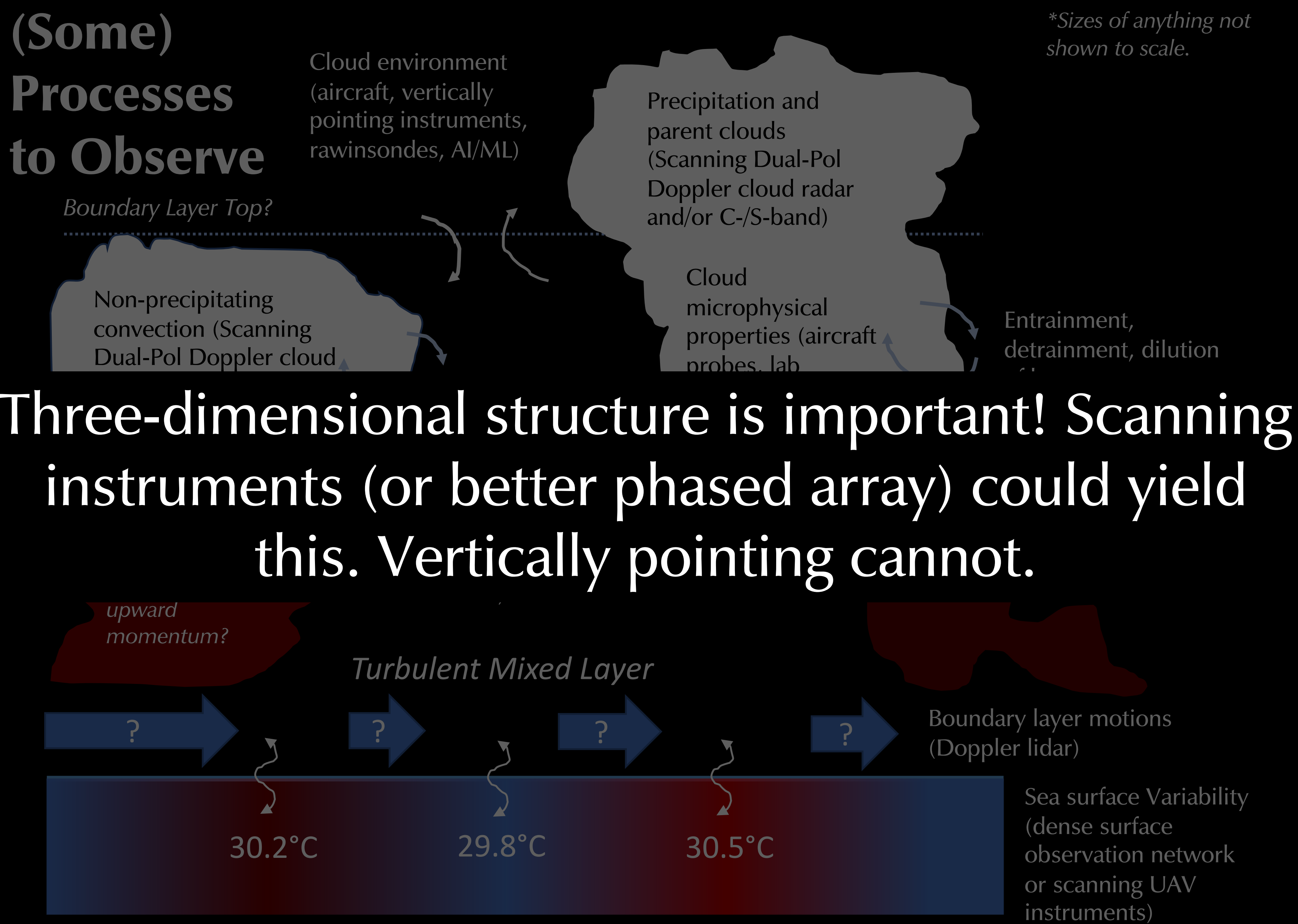
3) Cumulus parameterizations are probably over-dependent on oversimplified relationships between convective evolution and thermodynamic properties of cloud environment.

4) <u>Spatiotemporal variability</u> in atmospheric boundary layer thermodynamic and dynamic structure is probably key to understanding where and when convection develops, but we know little about what this variability looks like.


Cumulus and cumulonimbus
updrafts and downdrafts
?
Other
interactions
Boundary Layer
Structure
Upper Ocean
Properties

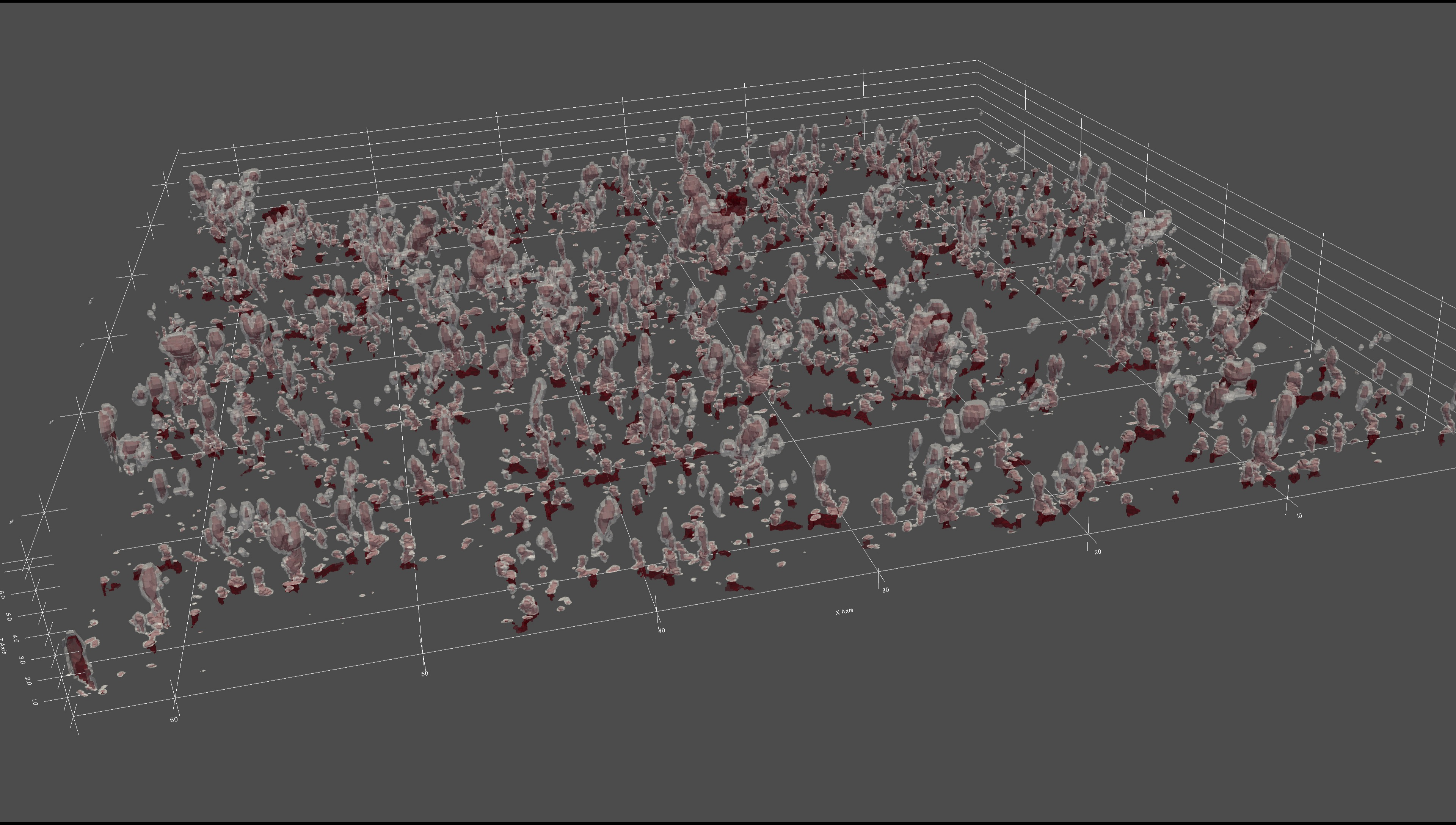
(Some) Processes to Observe





Three-dimensional structure is important! Scanning instruments (or better phased array) could yield this. Vertically pointing cannot.

We can model convective evolution…



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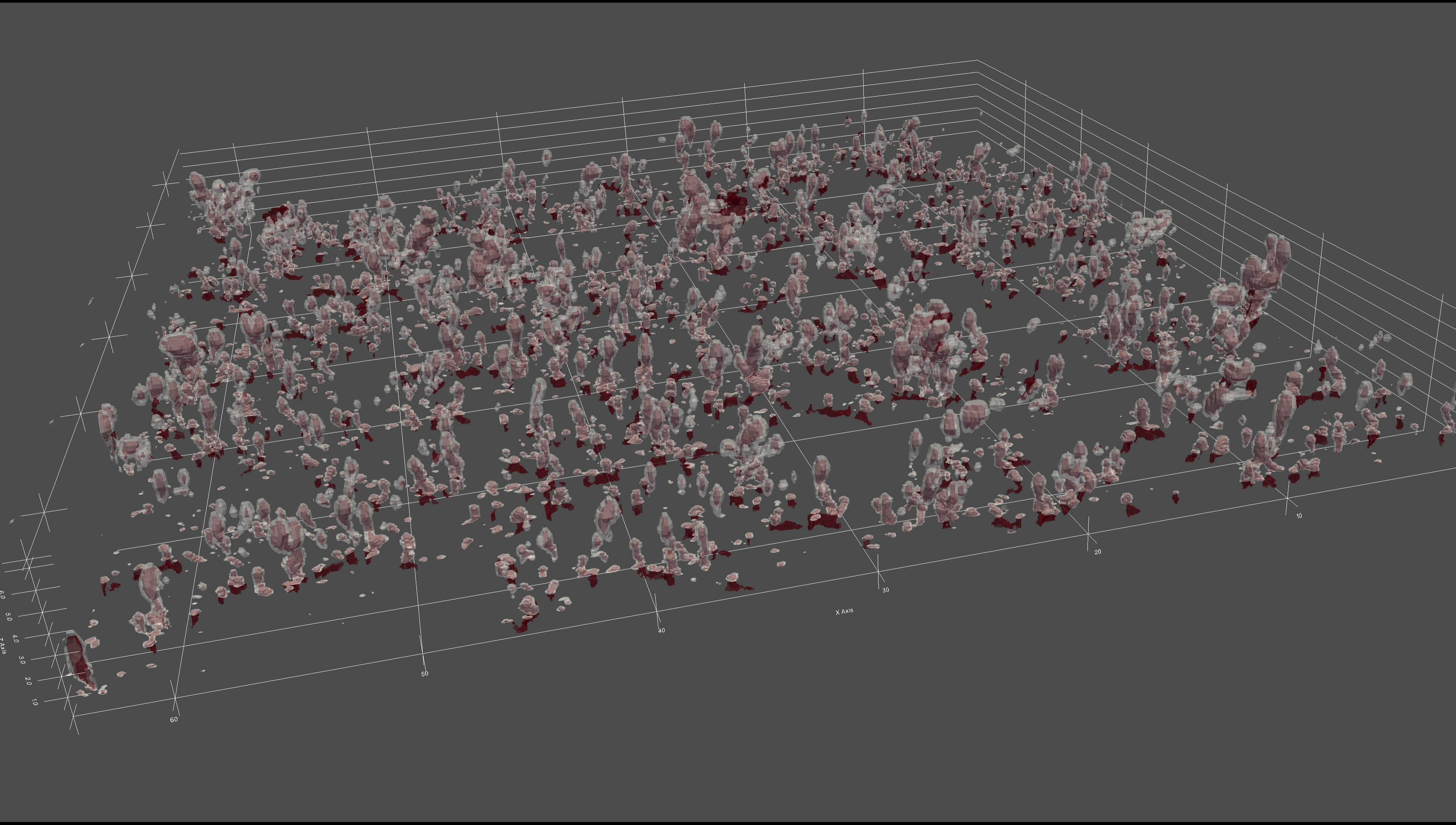
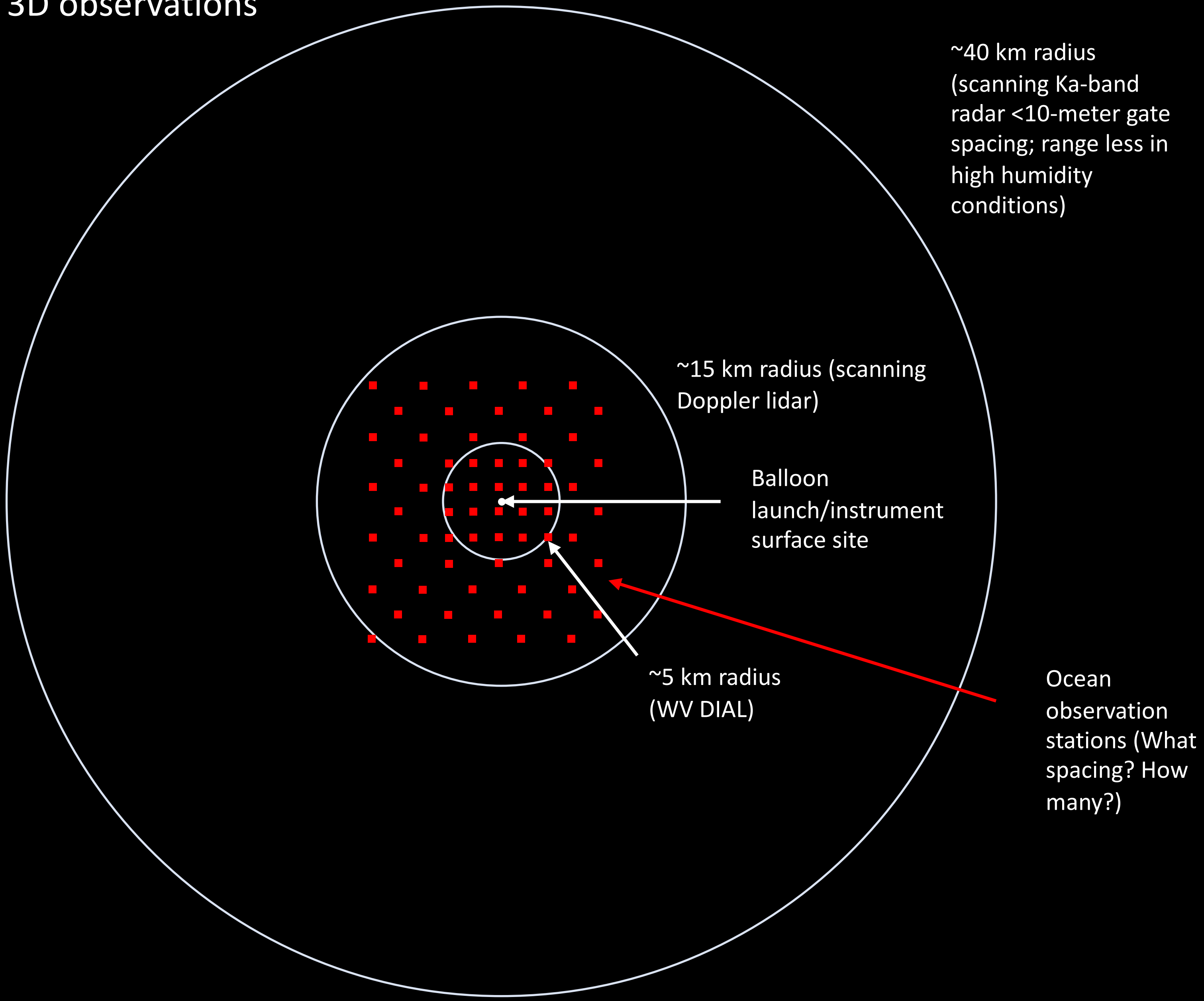
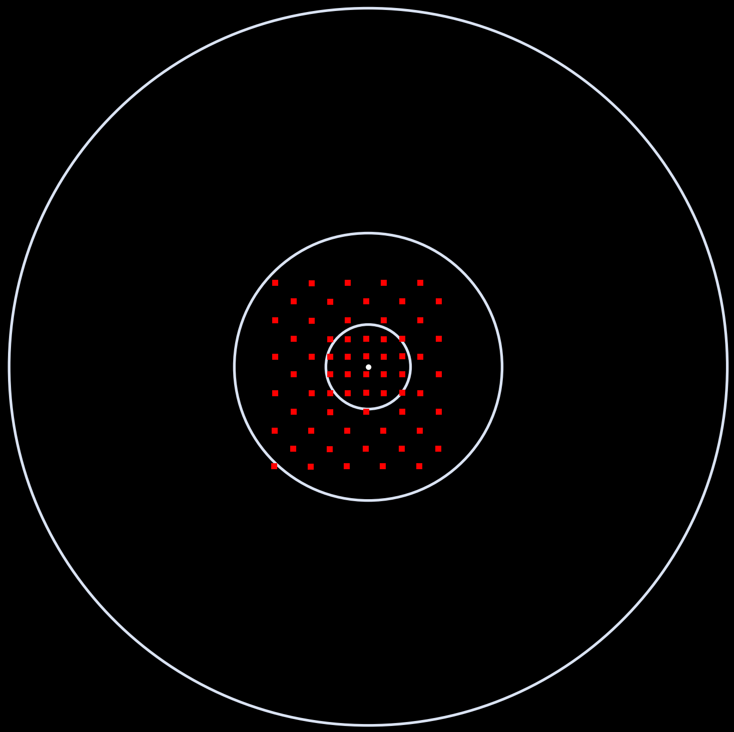


but is the simulated convection realistic?

A hypothetical single site for 3D observations

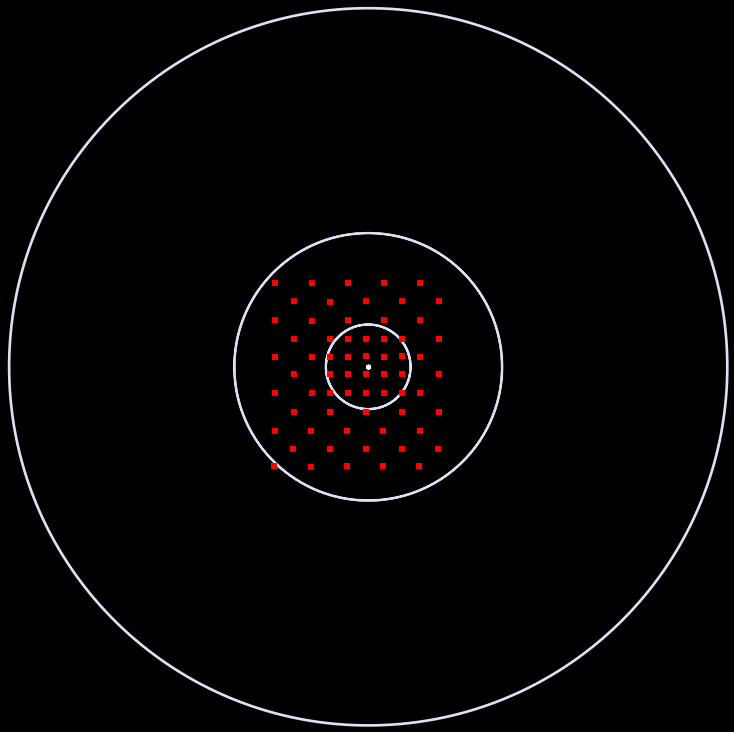




What are the fundamental quantities involved in convective evolution? (Loaded question)

Updraft vertical acceleration?

$$\frac{Dw}{Dt} = -\frac{1}{\rho}\frac{\partial p'}{\partial z} + B + (drag, etc.)$$



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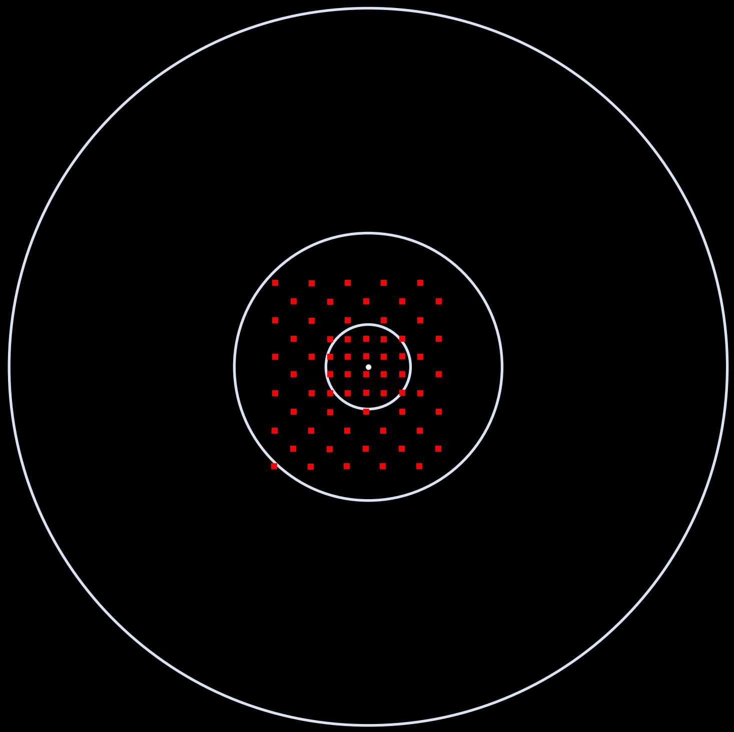
These are related to thermodynamic structure of boundary layer and above LCL, which we can possibly observe.

A hypothetical single site (crude) field plan



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A specific question: Is variability in temperature, humidity, convergence, etc. more important in

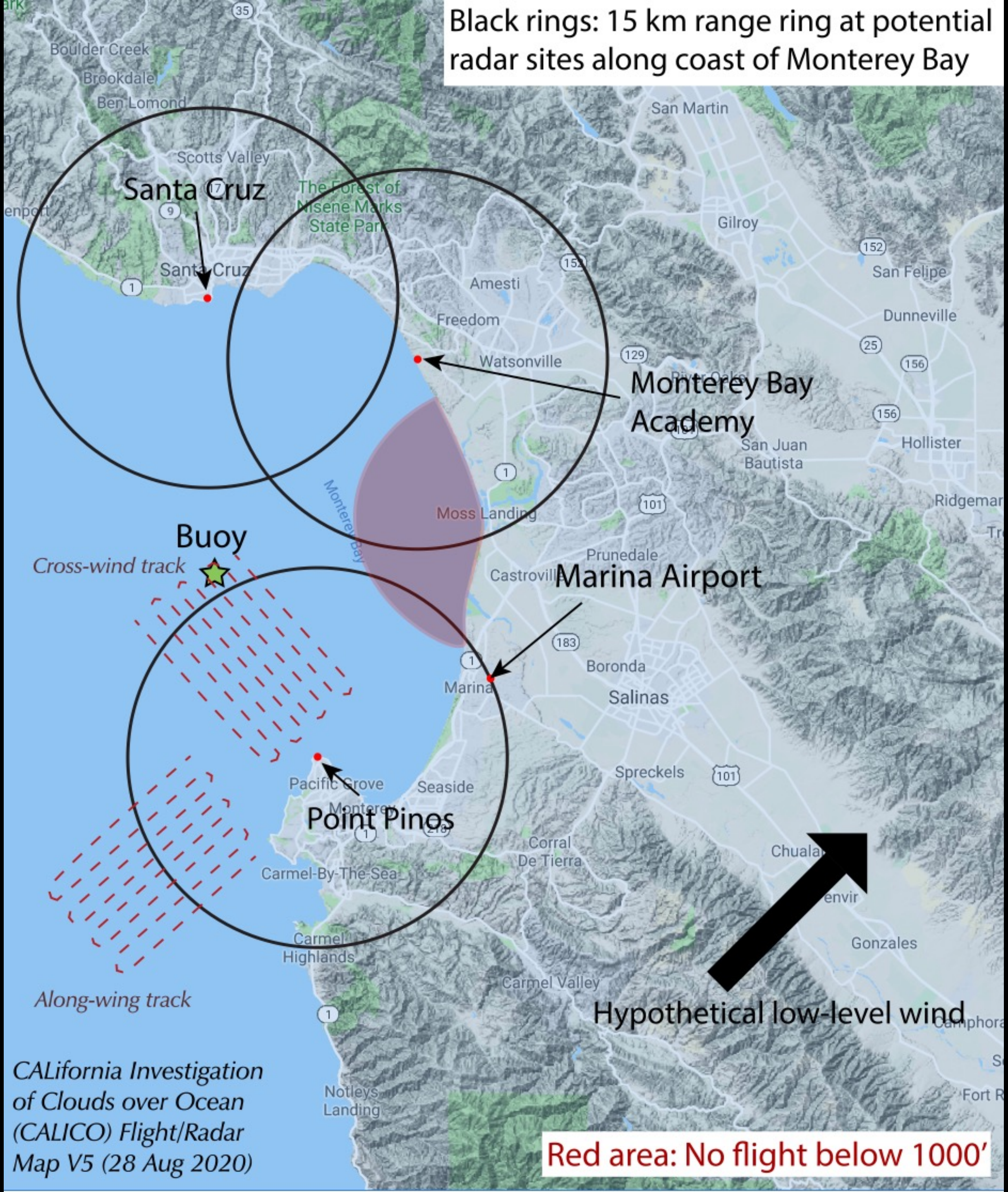
i) the atmospheric boundary layer, or

ii) the lower free troposphere

in determining *when* and *where* convection grows (at the individual cloud scale or maybe larger scales?)

Early 2022

Limited instrumentation and funding availability is a major challenge to executing even a limited field effort!



Conclusion: Three-dimensional observations of boundary layer and shallow cloud structure co-located with ocean surface observations are needed to improve process-level understanding that can influence development of next-generation numerical models. Multi-spectral remote sensing capabilities can help.

At what point are we satisfied that models can appropriately represent processes that are too small or fast in scale to be observed?