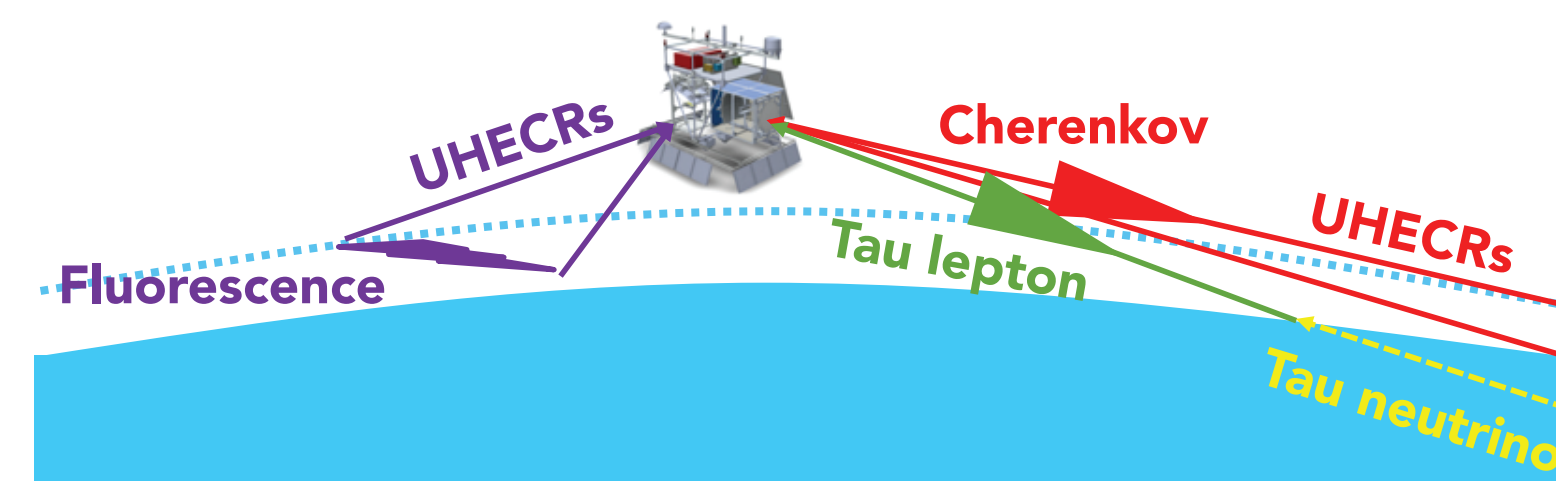


# UCIRC2: EUSO-SPB2's Infrared Cloud Monitor

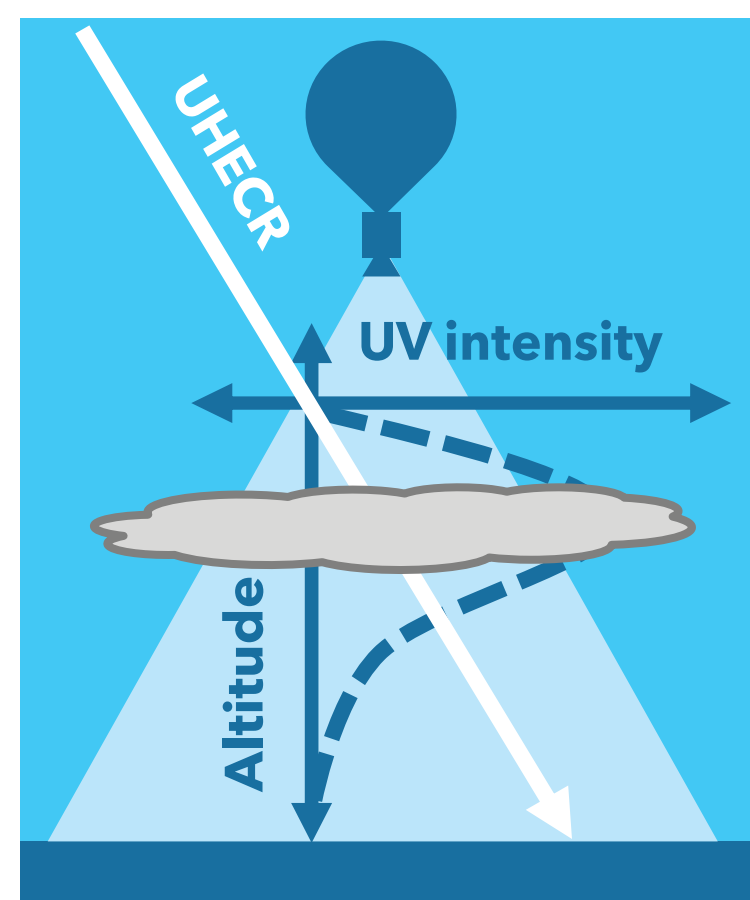
REBECCA DIESING, ALEXA BUKOWSKI, NOAH FRIEDLANDER, ALEX MILLER, STEPHAN MEYER, AND ANGELA V. OLINTO

## MOTIVATION

**EUSO-SPB2** | The second generation Extreme Universe Space Observatory on a Super Pressure Balloon will search for ultra high energy cosmic rays ( $E > 1 \text{ EeV}$ ) and neutrinos with  $E > 10 \text{ PeV}$  from above. It will also serve as a pathfinder for the Probe of Extreme Multi-Messenger Astrophysics (POEMMA).



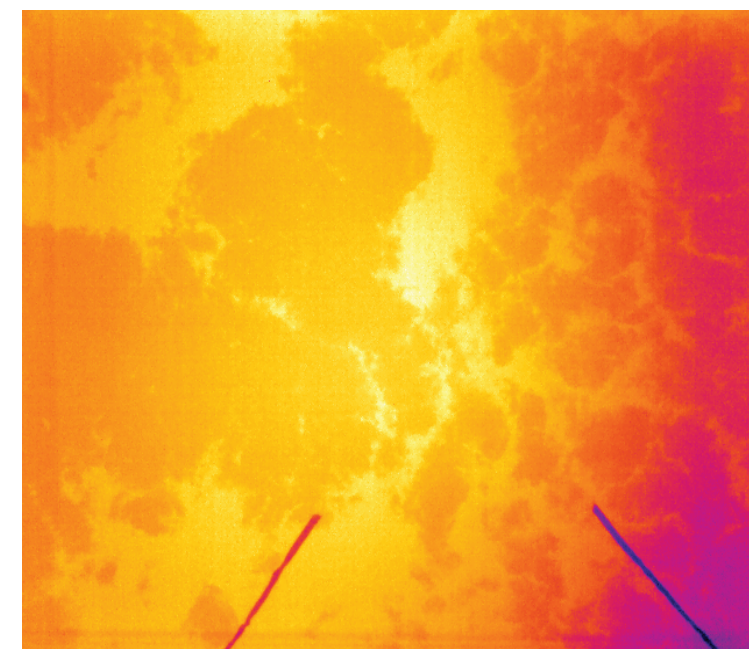
**THE ROLE OF CLOUDS** | Clouds constrain the geometric aperture of the experiment, and extensive air showers may peak below clouds; we need to know their coverage and altitude at all times.



## METHOD

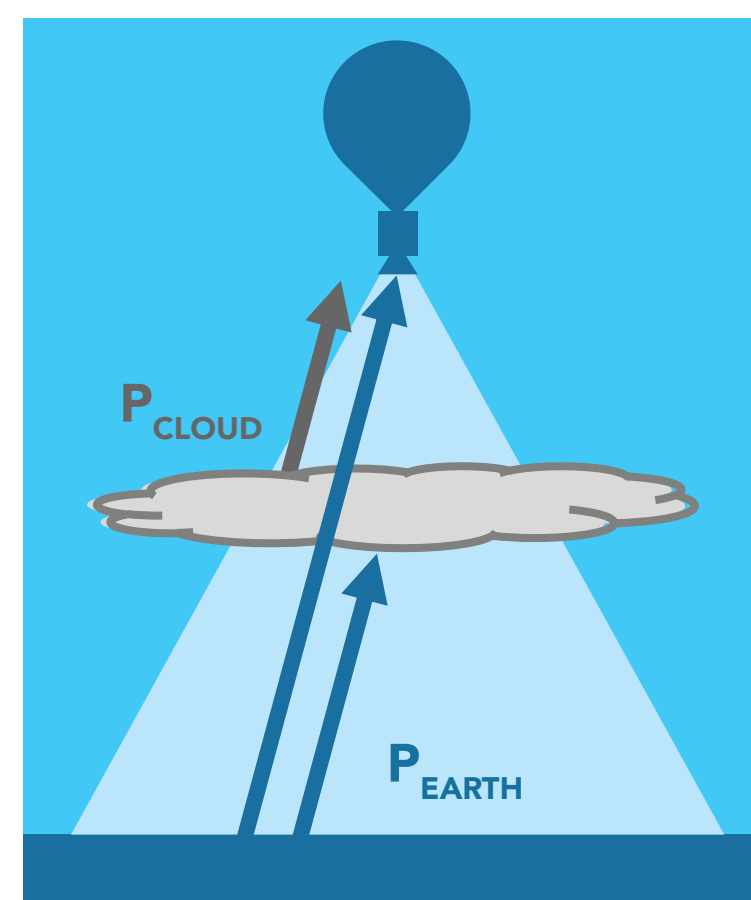
**CLOUD COVERAGE** | Monitoring coverage is straightforward with an IR camera.

**FIGURE 1.** Uncalibrated image captured by UCIRC1, which flew on EUSO-SPB1 in 2017.



**CLOUD ALTITUDE** | A cloud's altitude can be estimated from its temperature. In the simplest case, with one layer of clouds:

$$P_{\text{TOTAL}} = \epsilon_{\text{CLOUD}} P_{\text{CLOUD}} + (1 - \epsilon_{\text{CLOUD}}) P_{\text{EARTH}}$$

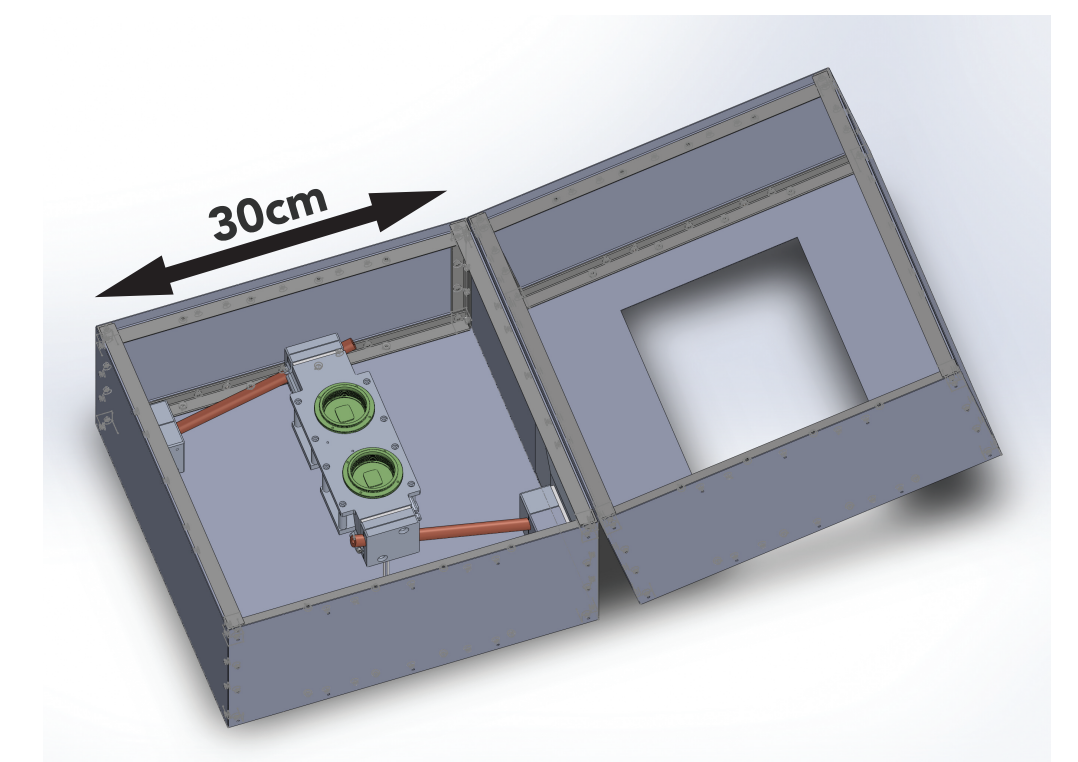


We can disentangle emissivity from power by observing clouds at two frequencies near the cloud's blackbody peak; the power ratio between them is independent of emissivity.

## DESIGN & CALIBRATION

**UCIRC2** (University of Chicago Infrared Camera) will consist of two IR cameras observing at 10 and 12 microns, near cloud blackbody peak.

**FIGURE 2.** Rendering of UCIRC2, with cameras (green circles) pointed toward the viewer. 10 and 12 micron filters will be mounted in front of each camera. A system of peltier coolers (white rectangular prisms), heat pipes (copper-colored tubes), and resistive heaters (not shown) will maintain a steady camera temperature. The entire system will be enclosed in an aluminum box (grey structure) and coated with emissive paint (not shown).



The thermal responses of the cameras are being tested under vacuum over all potential environmental and target temperatures.

