Convection Tracking: Activities, Datasets, and Scientific Insights

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Jet Propulsion Laboratory
California Institute of Technology

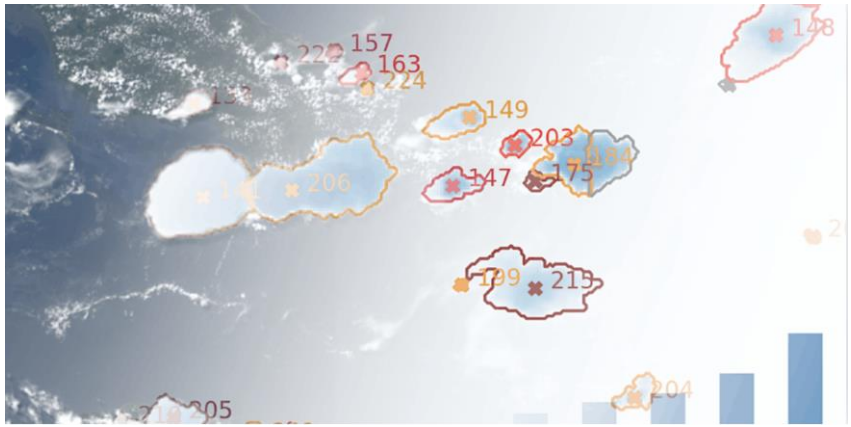
Motivation for Convection Tracking:

1. To form a convection tracking community with the aim of unifying EarthCARE, AOS, INCUS, & GEWEX.
2. Develop a platform for a convection tracking community.

➔ What kind of data products do science communities need?

Activities of Convection Tracking:

1. **Oxford Workshop (April 17-21, 2023)**
   - Various convection tracking tools
   - Multi-variate tracking
   - Definition of “Life Stage”
   - Multi-channel GEO (e.g., ISCCP-NG)



2. **GISS Workshop (April 23-25, 2024), 40+ Presentations**
   - Tracking Algorithms, Methodologies, and Datasets I & II
   - Convective System Oriented Analyses and Evaluations for GSRM/KM-Scale Simulation
   - Cloud Lifecycles and Convective Processes
   - Climate and Radiation
   - Environmental Influences on Convective Systems Across Scales I & II
   - Regional and Field Campaign Perspectives

3. **Convection Tracking Session at the AMS (January 15-16, 2025)**

   Convective Evolution: Processes, Dynamics, Environment, and Links to Weather and Climate
   - 3 Oral Sessions
   - I: Characteristics and Environment; II: Precipitation, III: New methods and Ideas

4. **Convection Tracking Website**

   https://sites.google.com/view/convection-tracking-workshop/home

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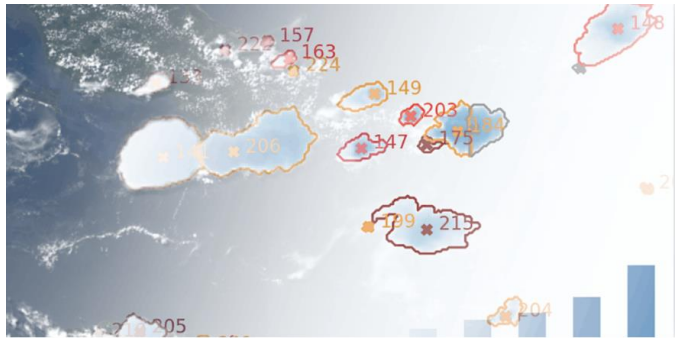

- **Many cloud tracking tools and datasets exist for studying science across different scales**

Tb-based:

- ISCCP-CT (Machado et al., 1998)
- ForTraCC (Vila et al., 2007)
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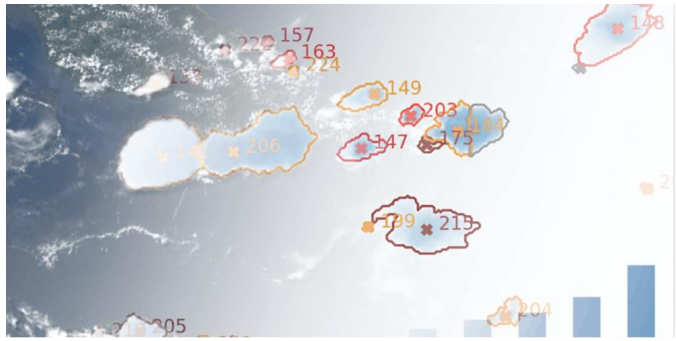

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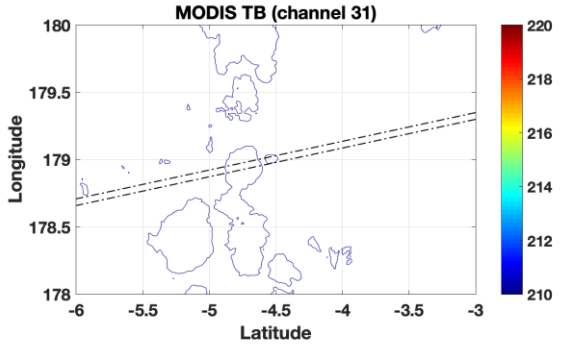
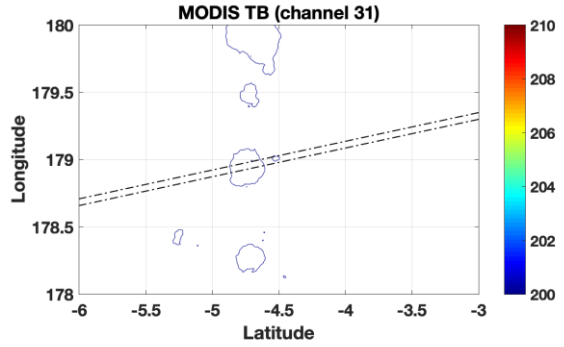
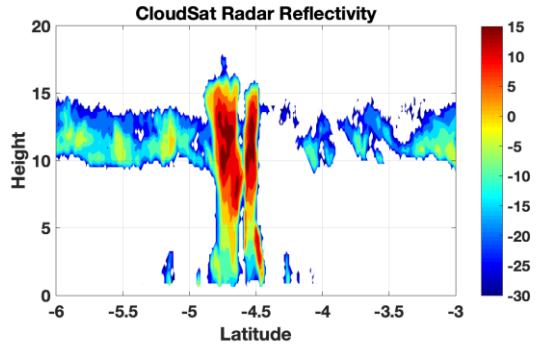
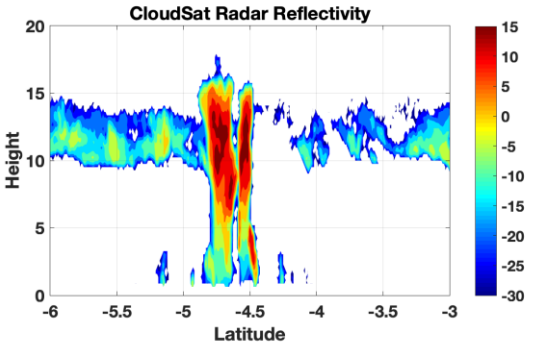
➔ Need to have **intercomparison studies** among different tools focusing on comparing observation-based thresholds for identifying and tracking cloud features.









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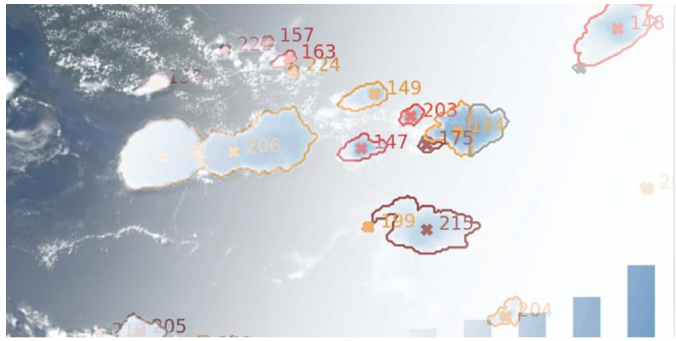

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➔ Need to have **intercomparison studies** among different tools focusing on comparing observation-based thresholds for identifying and tracking cloud features.

❖ A formal review paper on all the different tracking tools is useful.

❖ Zhe Feng and Thomas Fiolleau have been working on a **inter-model and inter-algorithm** study.

❖ Johnny Luo and Yuliya Selevich have been working on a **inter-scale** study.

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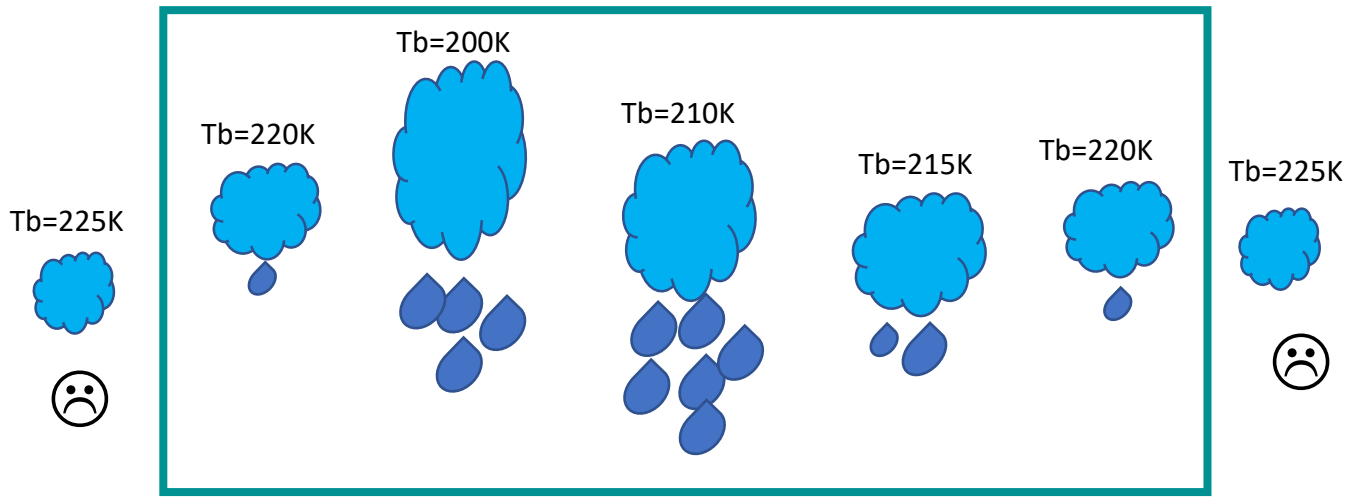
We can track ☺



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(Sean Freeman at UAH & INCUS Team)

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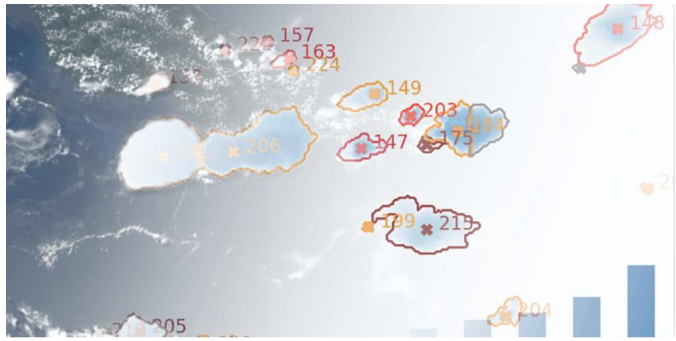

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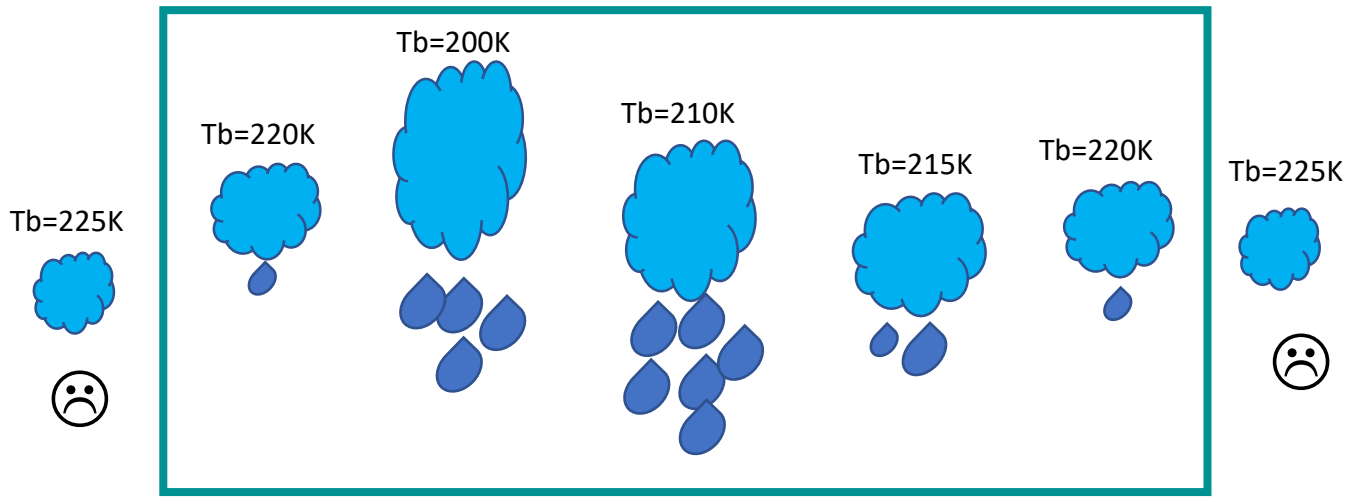
- Sean Freeman at UAH include multi-variate tracking tools in latest TOBAC.
- IR + lightning/IWP/Rain

We can track ☺



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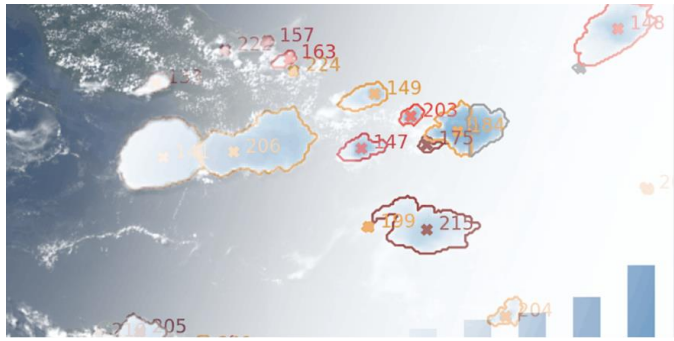

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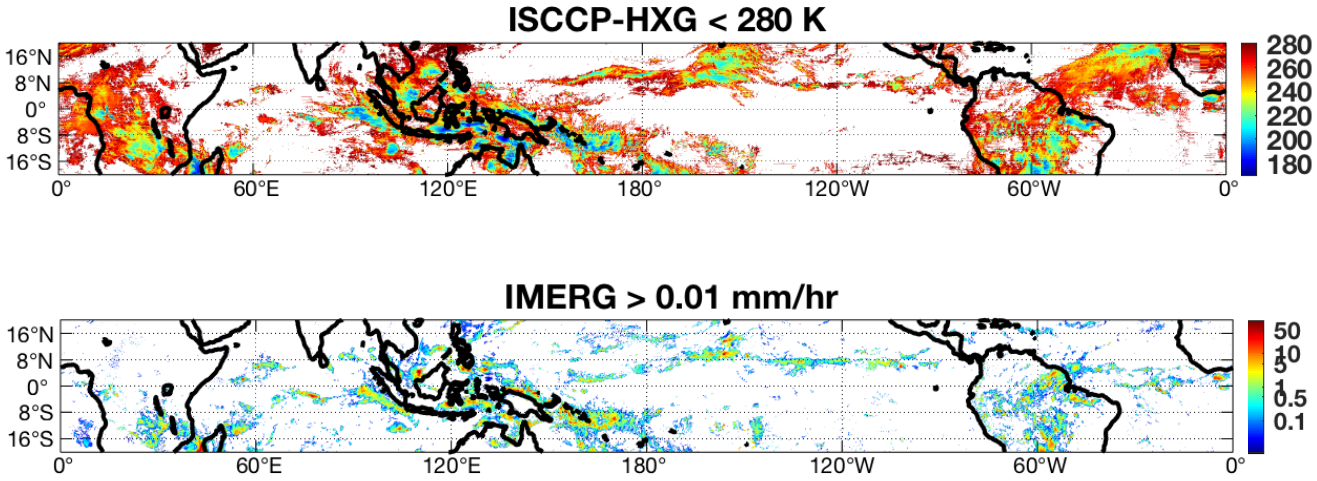

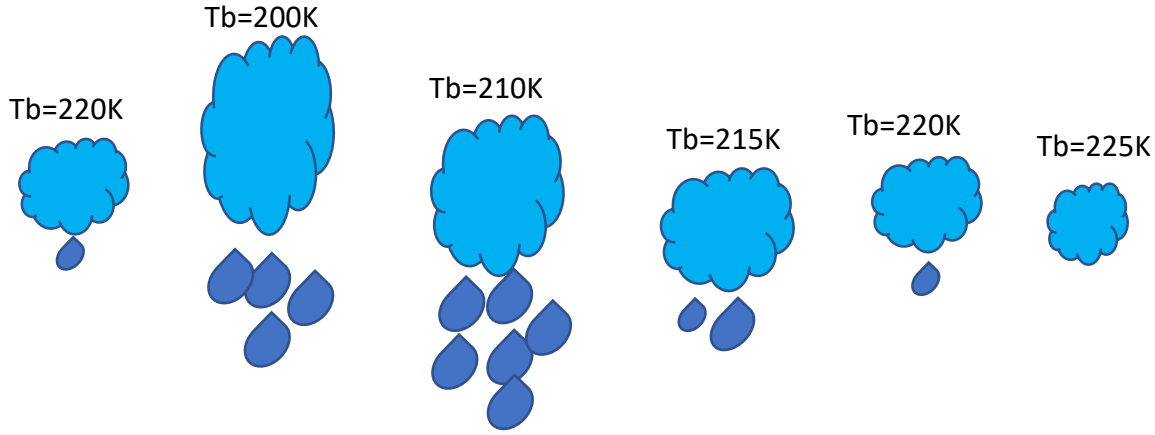

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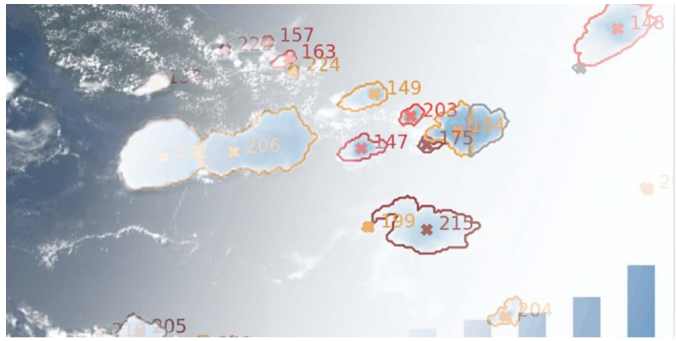

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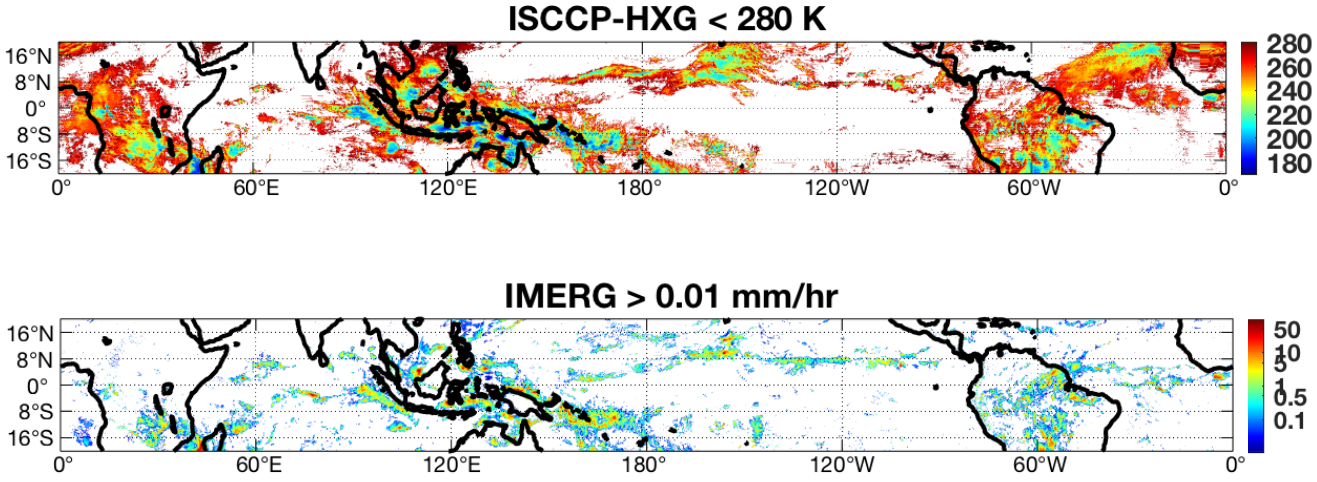

January 1, 2007 at midnight

	PR>0.01 [mm/hr]	PR>0.5 [mm/hr]	PR>5 [mm/hr]
Tb < 280K	−0.27	−0.23	−0.16
Tb < 260K	−0.27	−0.22	−0.16
Tb < 245K	−0.26	−0.21	−0.16
Tb < 220K	−0.26	−0.23	−0.20

❖ IR imagery alone has difficulties in monitoring precipitation.

❖ The evolution of rainfall intensity does not always follow that of cloud top development.

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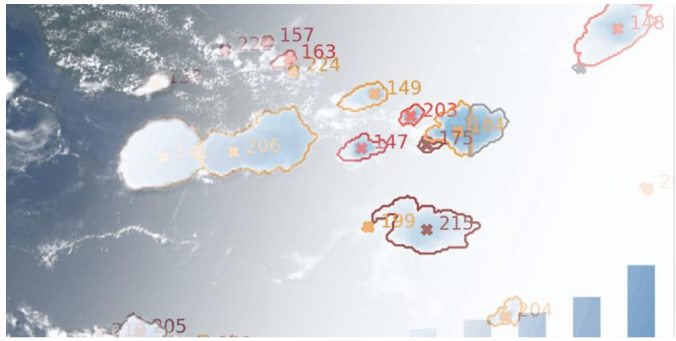

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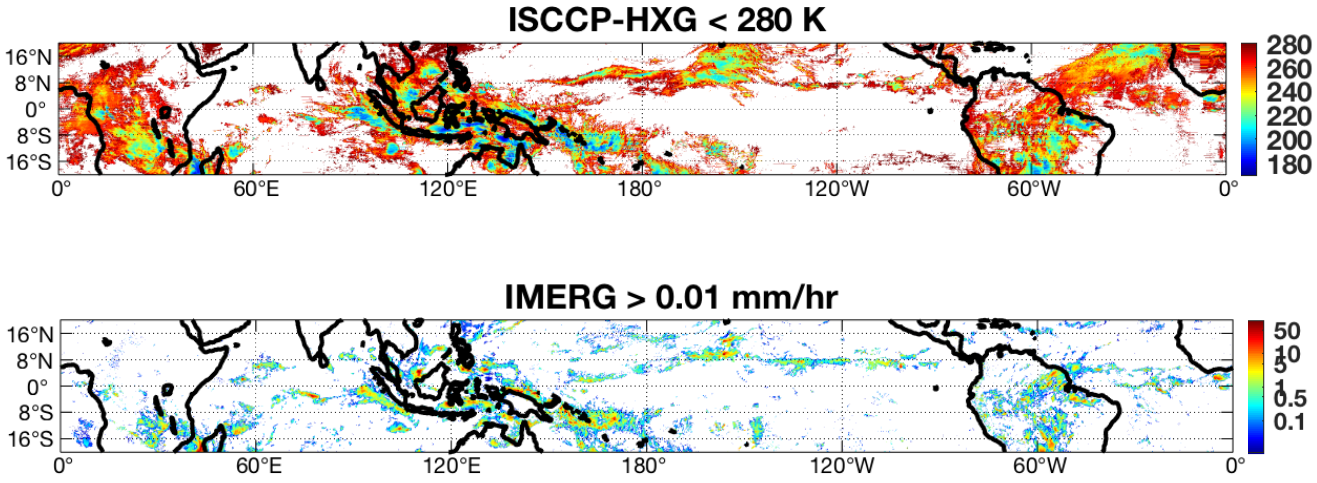
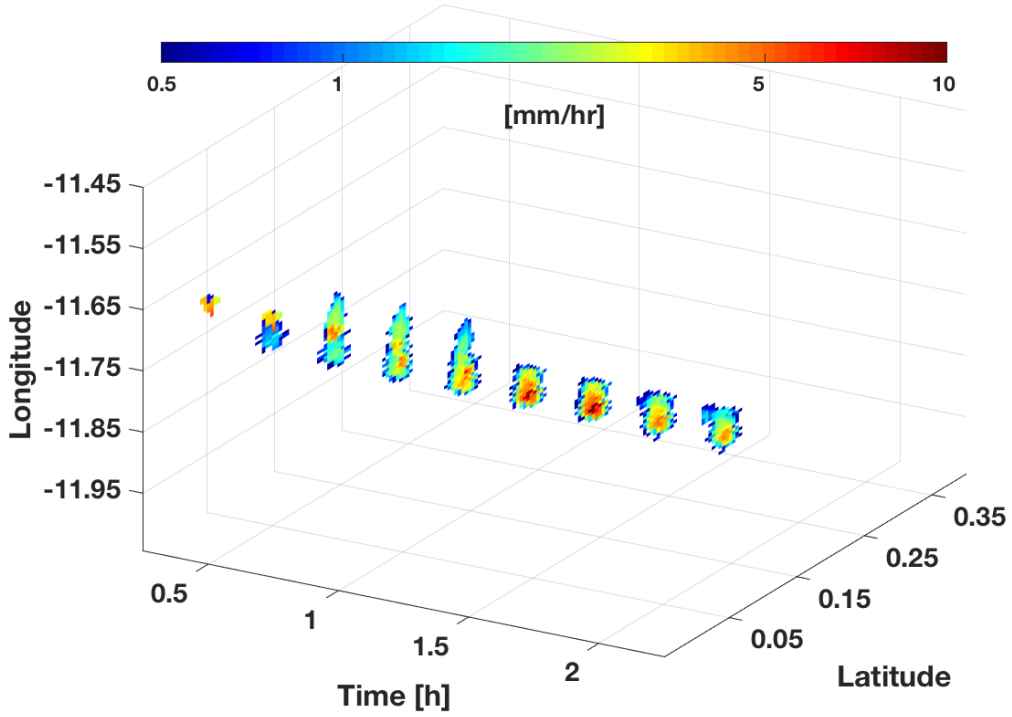
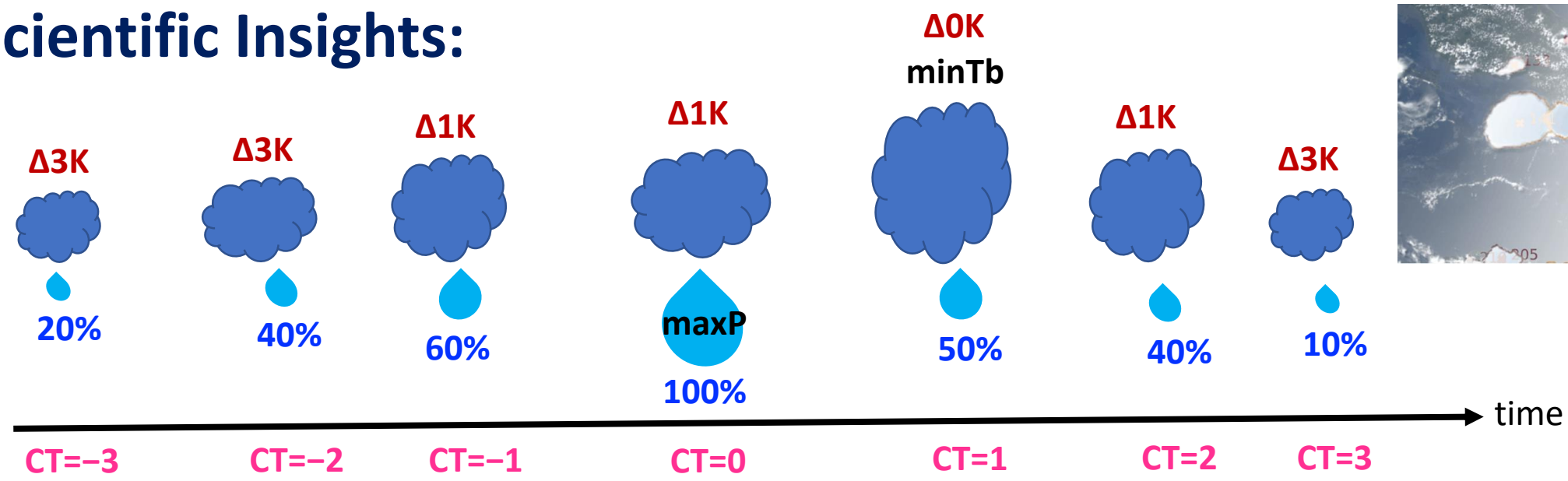
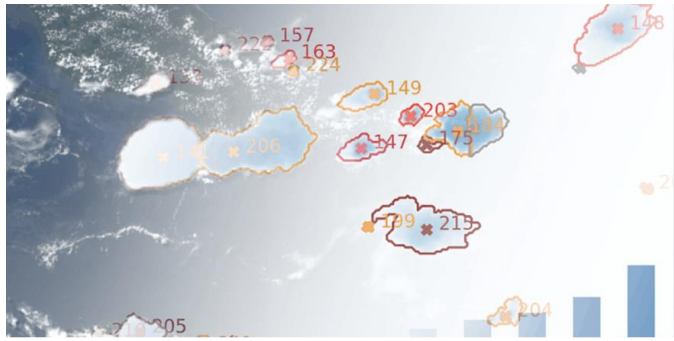
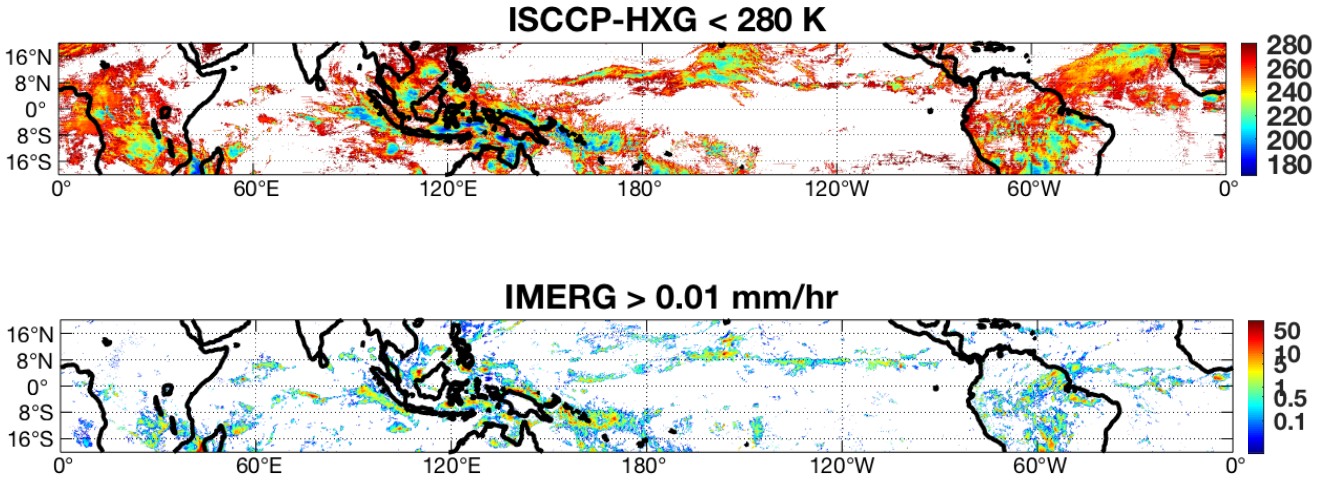


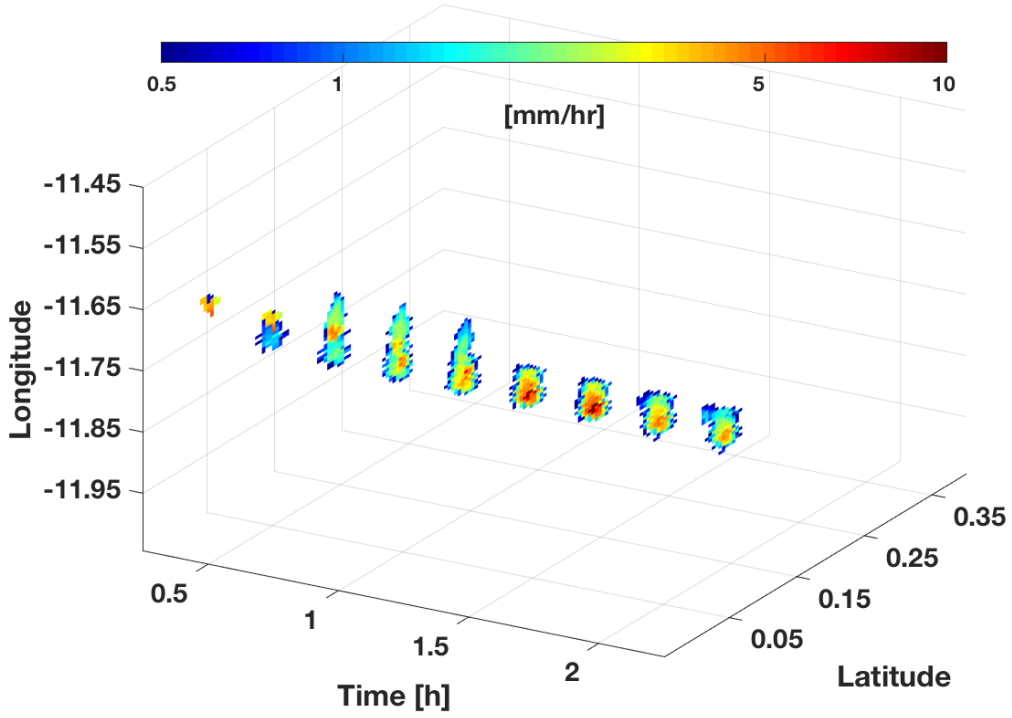


Scientific Insights:









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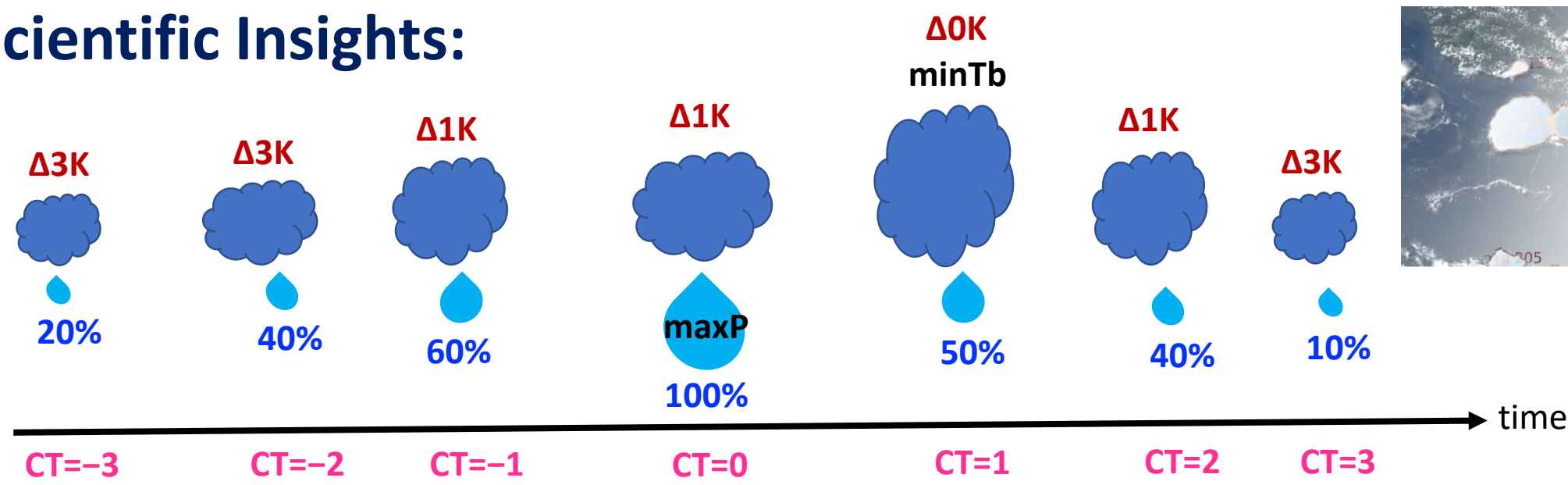
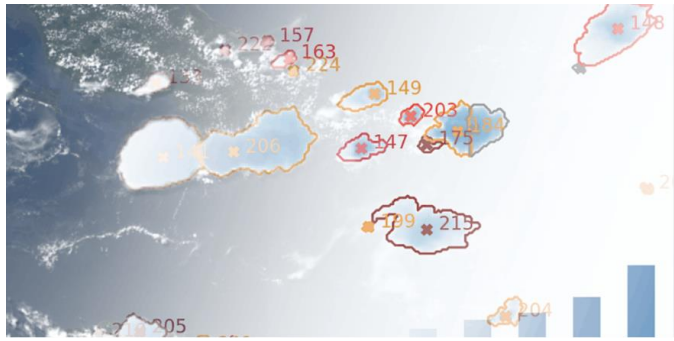
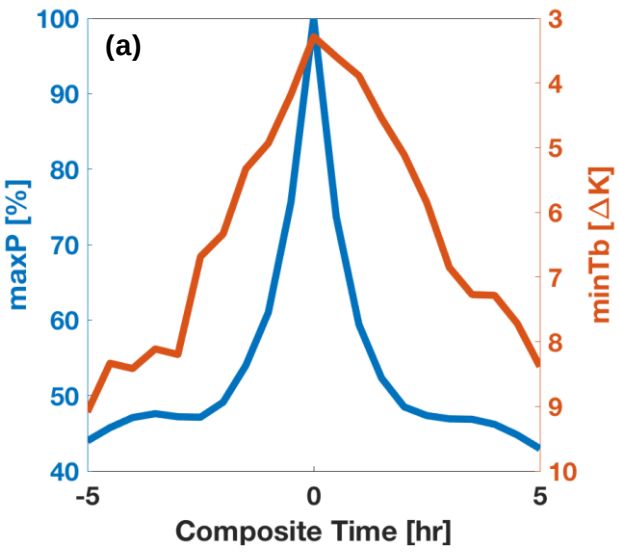
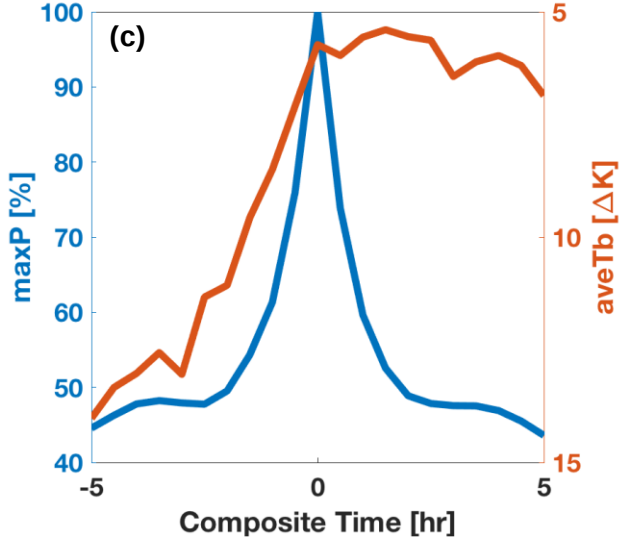








- minTb links to the cloud top of convective core, while aveTb characterizes mainly stratiform rain and cirrus anvils.
- It suggests that convective precipitation has a much shorter duration than stratiform precipitation.

Scientific Insights:

ΔOK

ΔK

20%

CT=−3

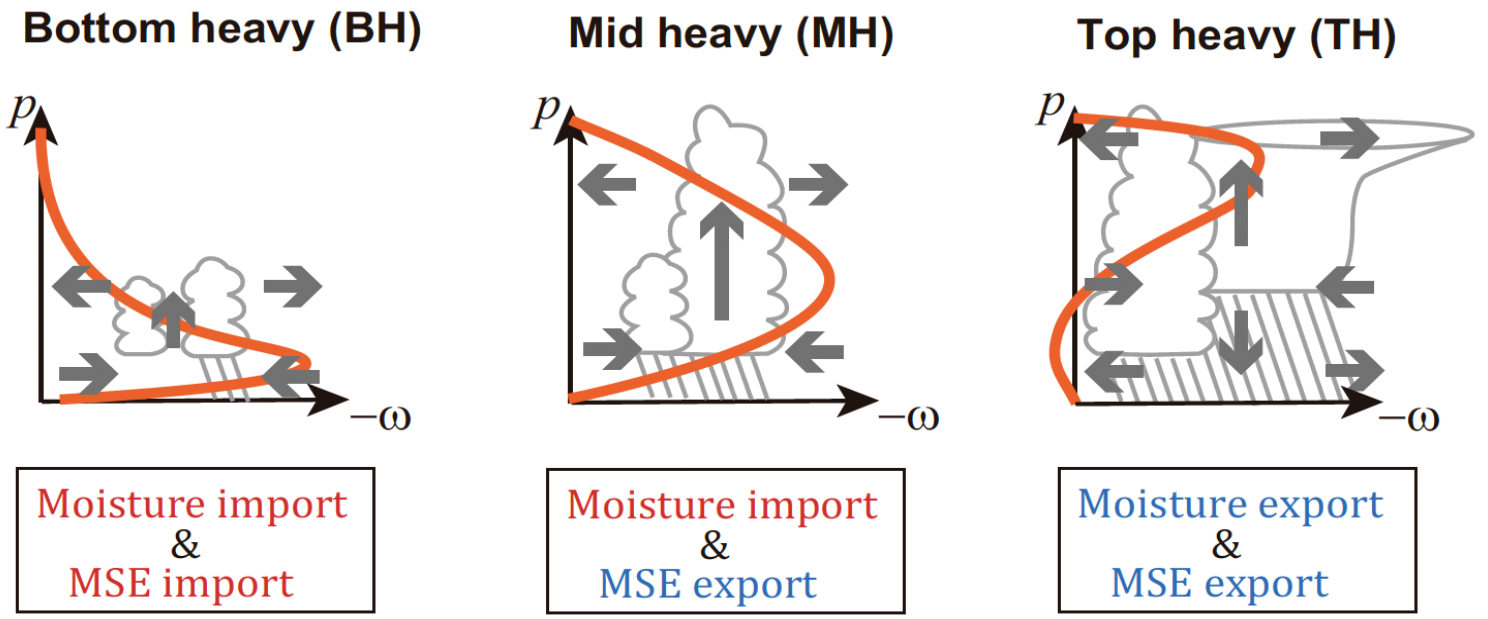
Added column import or export of moisture and moist static energy (MSE)

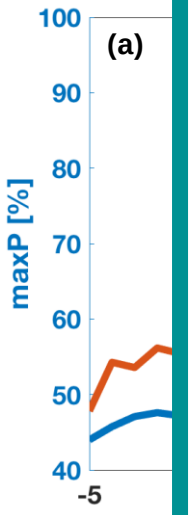
The Energetics of the Lagrangian Evolution of Tropical Convective Systems

HIROHIKO MASUNAGA[a] AND HANII TAKAHASHI[b]

[a] *Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Japan*
[b] *Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California*

(Manuscript received 22 August 2023, in final form 17 January 2024, accepted 26 February 2024)





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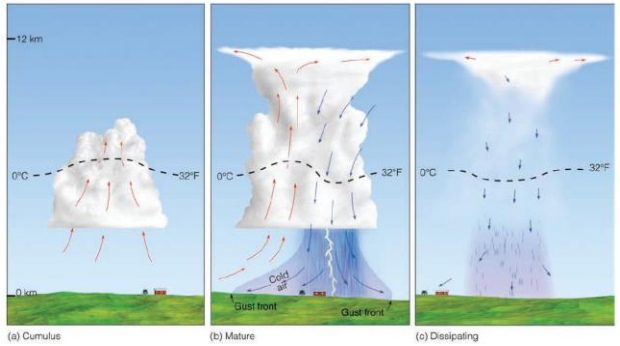
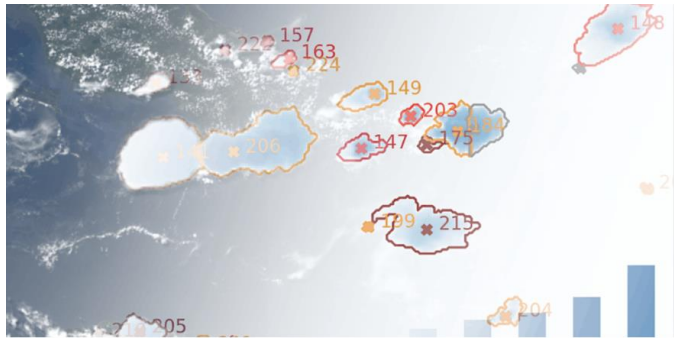
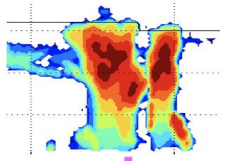


Growing: Before reaching the min TB
Mature: Between growing and dissipating
Dissipating: After reaching the max radius

Futyan and Del Genio (2007)





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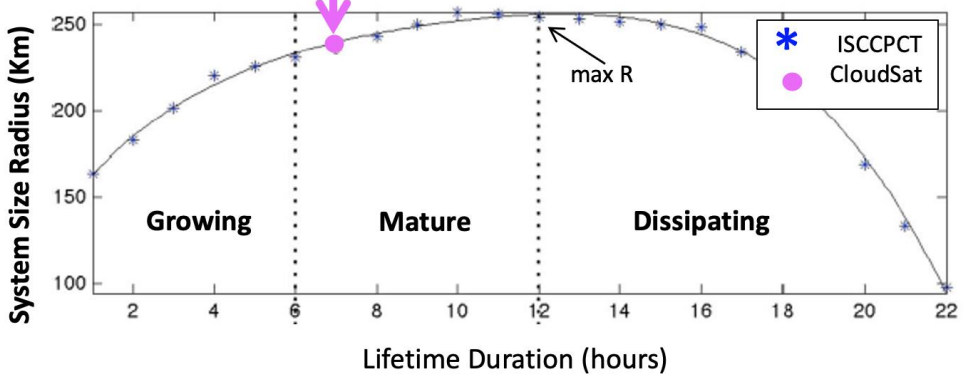

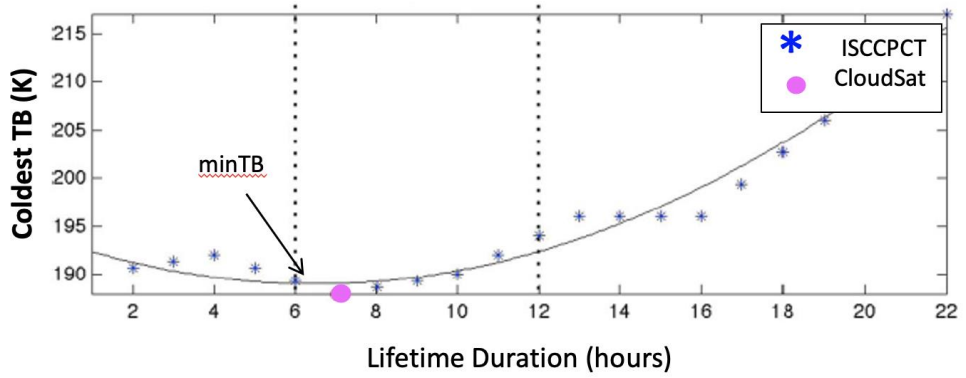

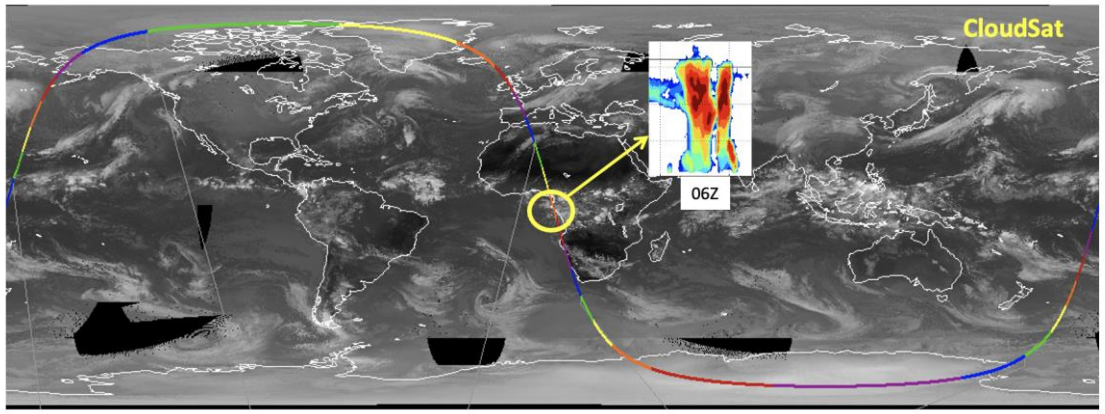

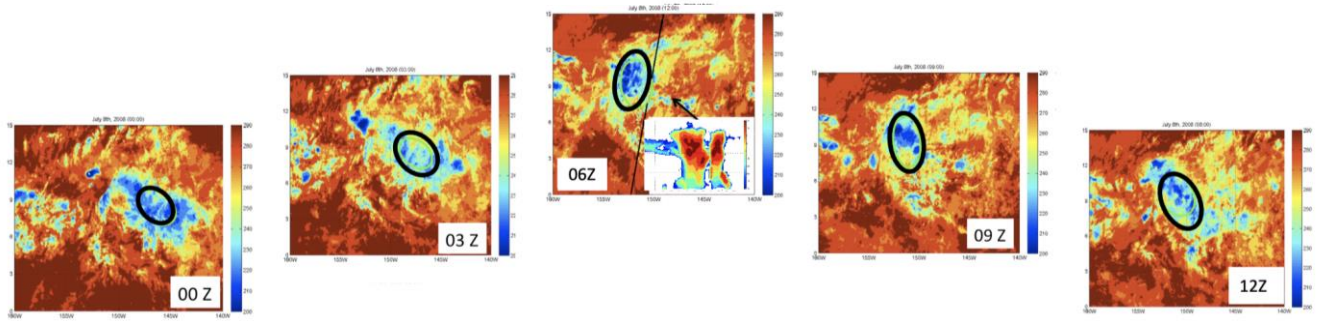

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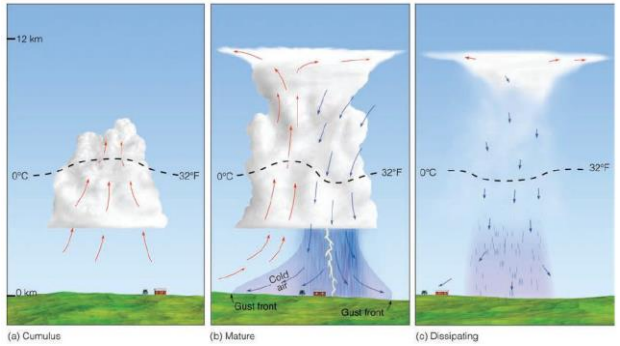

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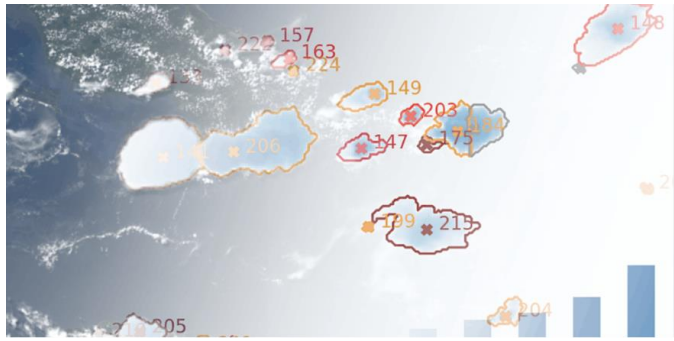

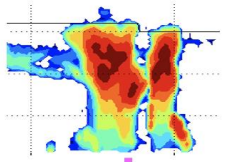

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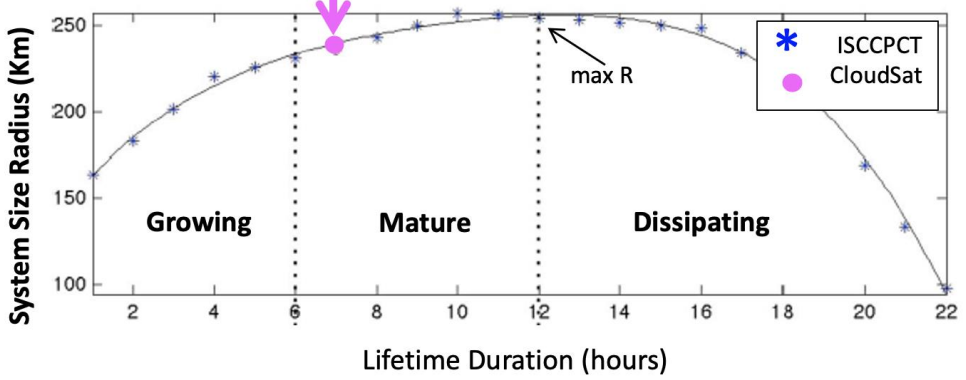
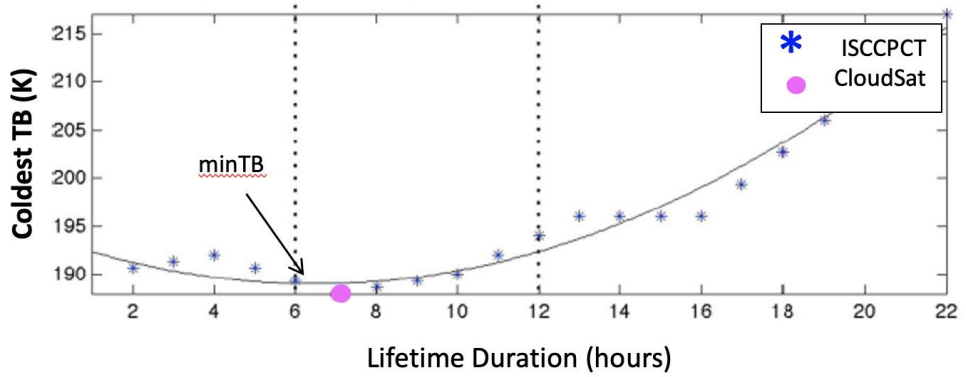


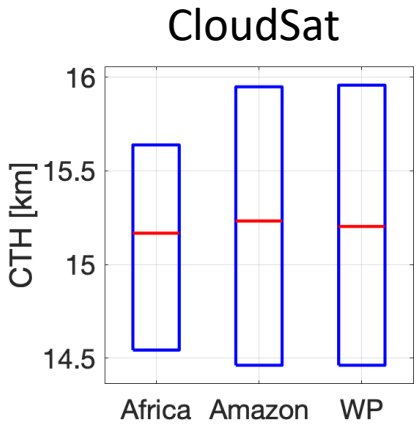


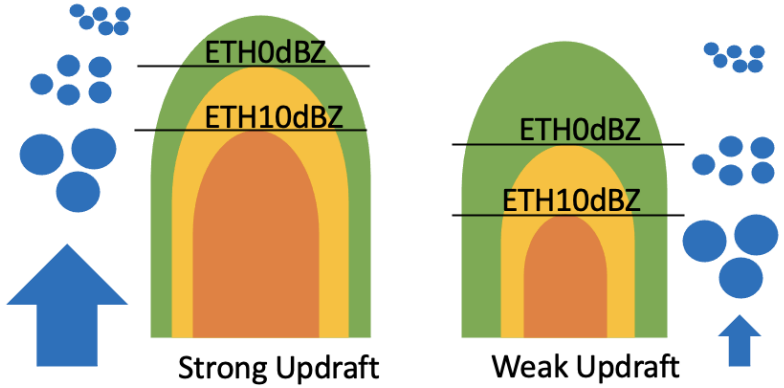
➔ 2/3 of overshootings occur at the growing, 1/3 at mature, and virtually none at dissipating.

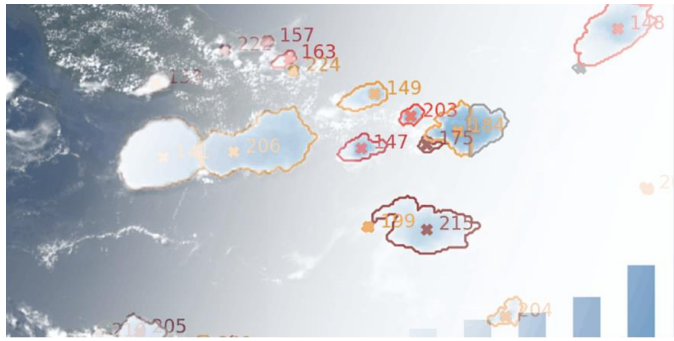
➔ This CloudSat + GEO is a close analogy to AOS/INCUS/EarthCARE + GEO.

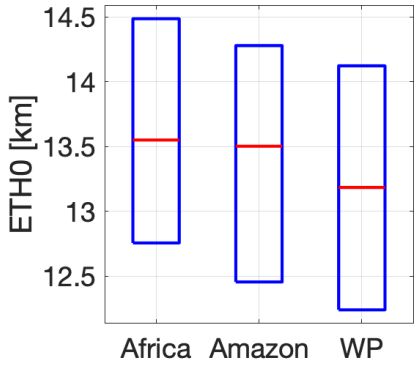
➔ If we have multiple channels from GEO then we can distinguish convective overshoot from thin cirrus.

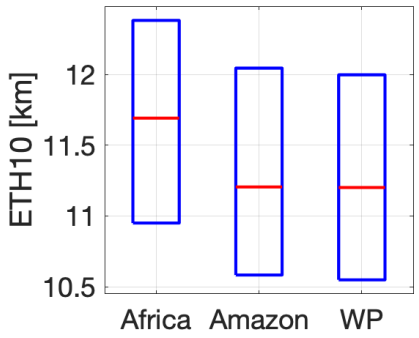
Scientific Insights:

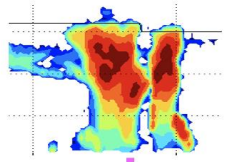




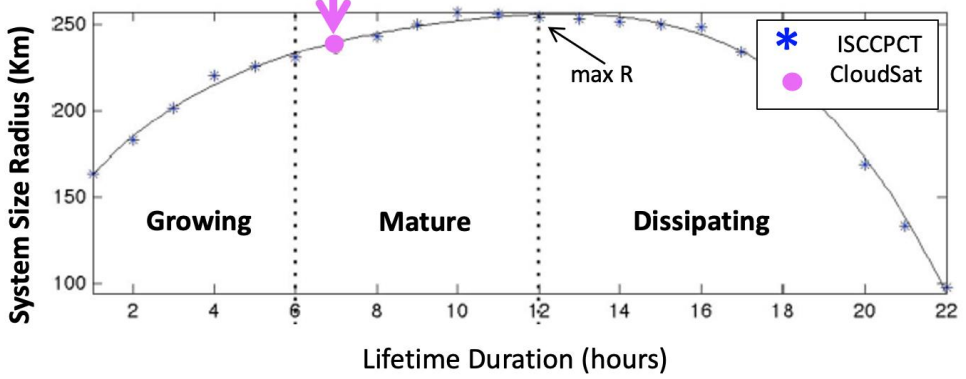


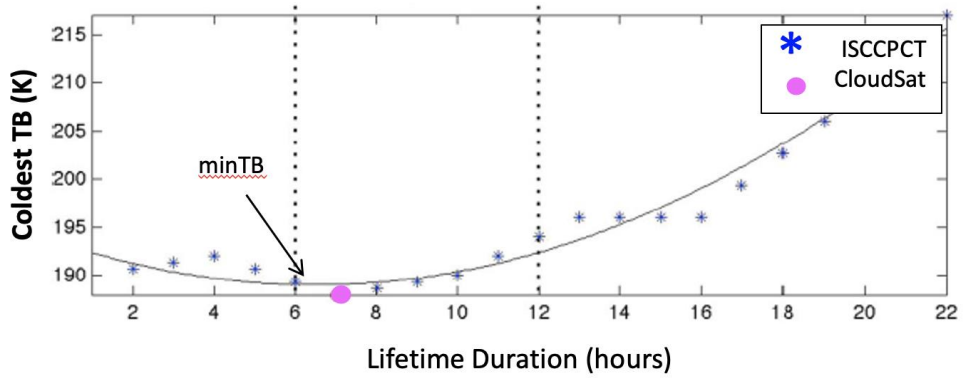






Takahashi and Luo (JGR 2014)





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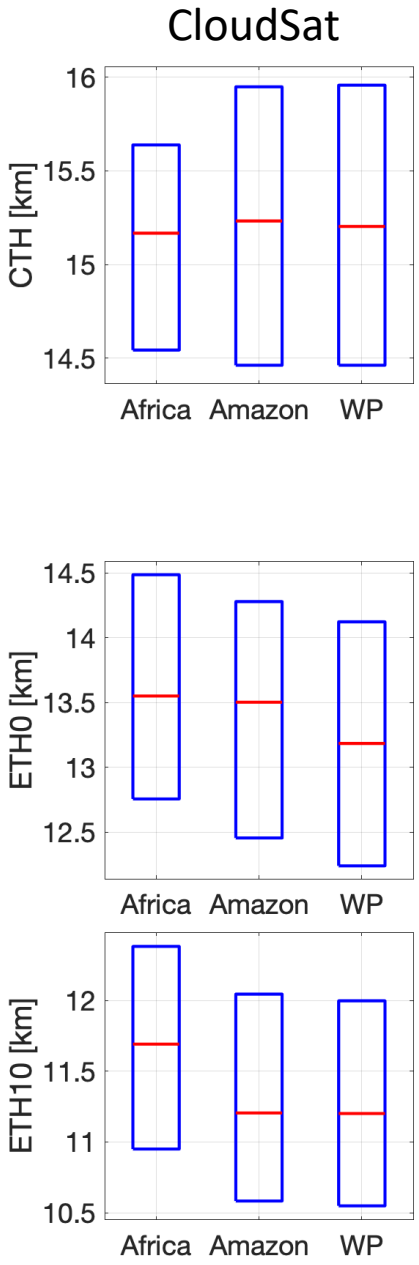

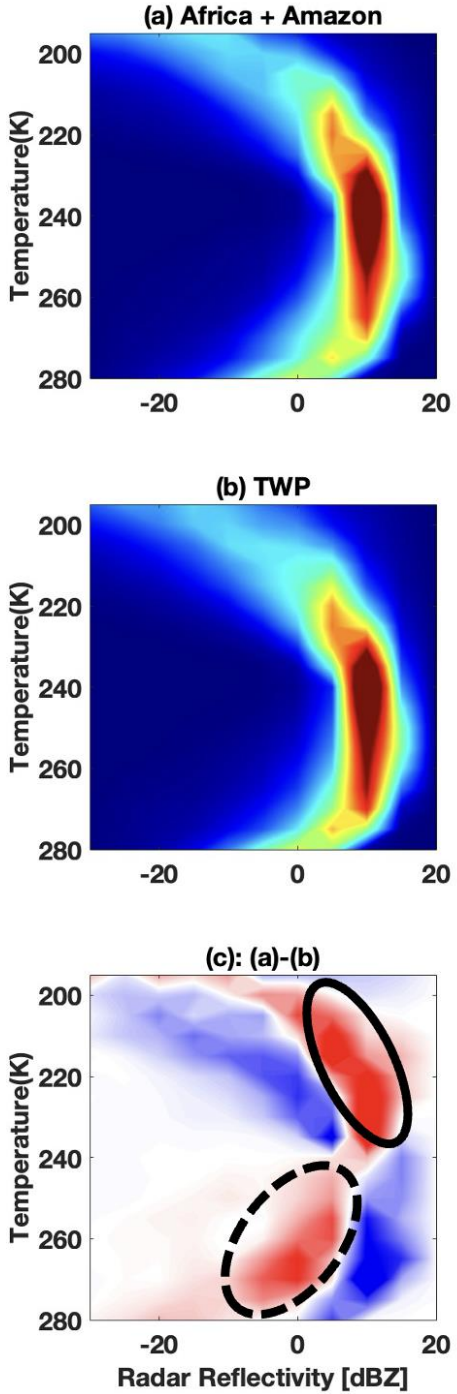

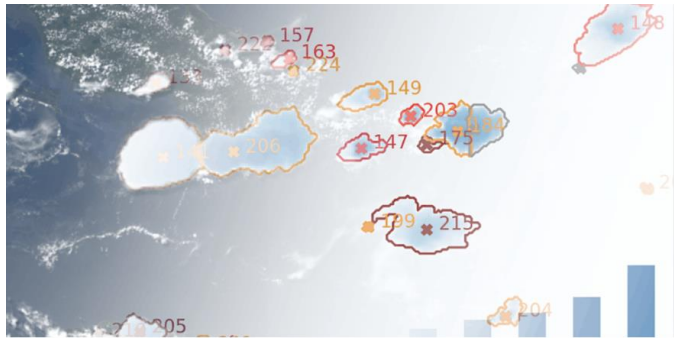

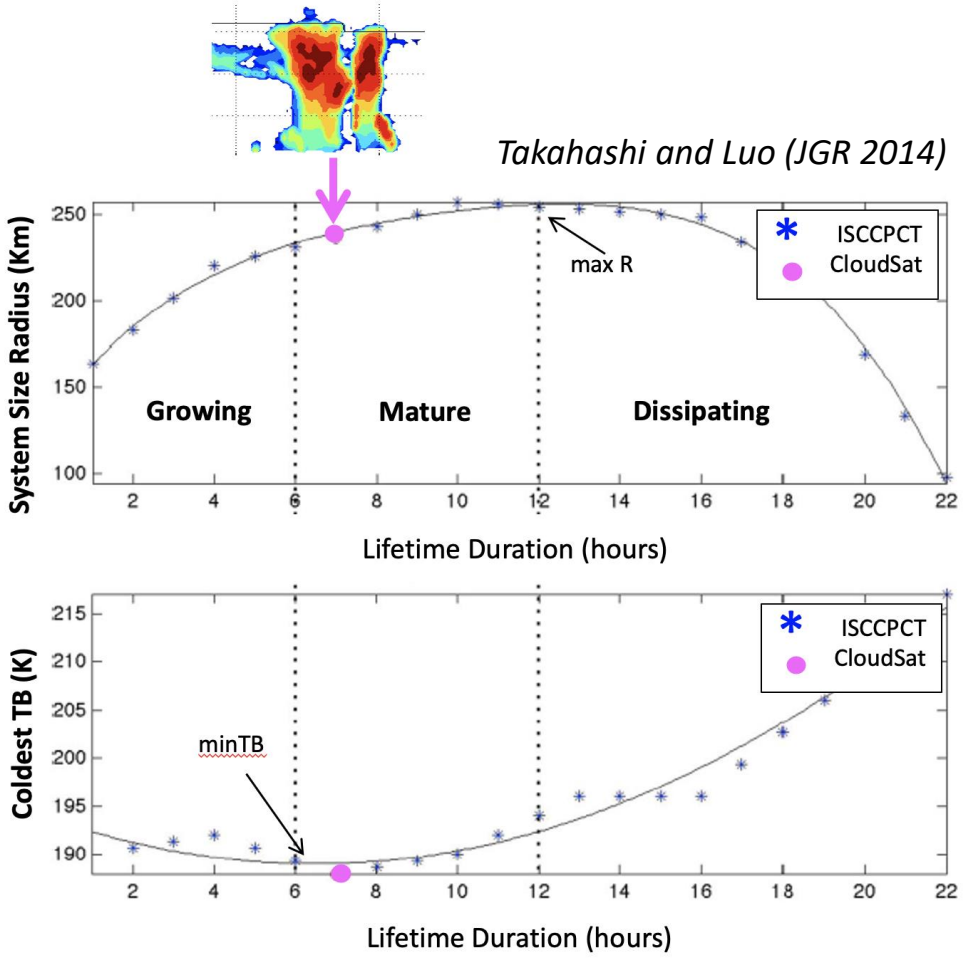

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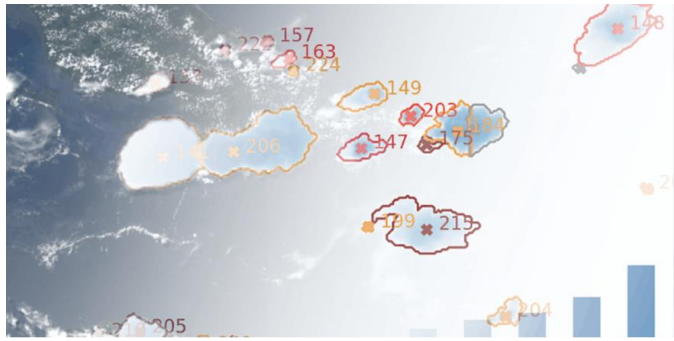
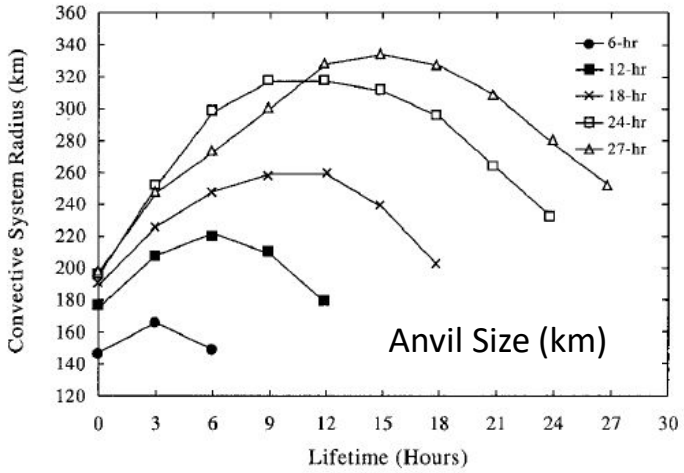


- **Multi-channel GEO datasets are highly valuable for achieving scientific goals.**

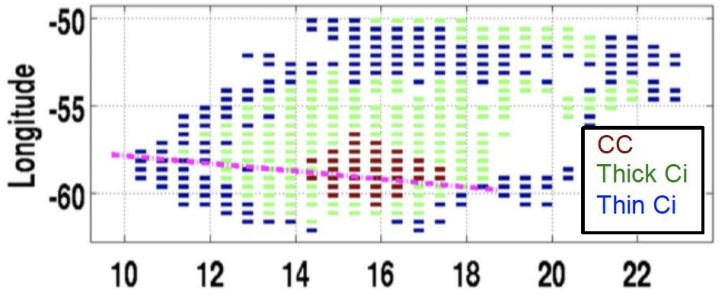


- Relationships between the anvil development and intensity.
- It plays a critical role in radiative-convective feedbacks

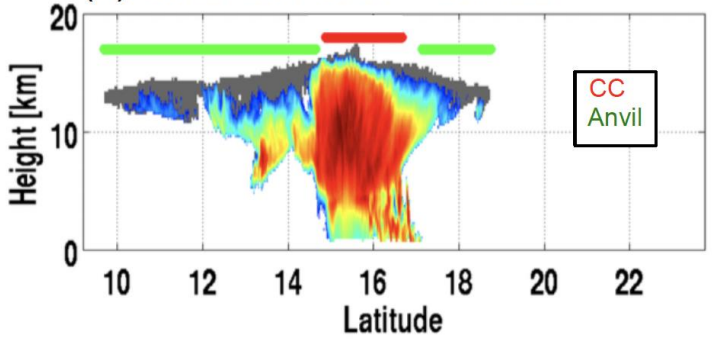
Thin vs. **Thick** cirrus increases ➔ More vs. Less LW effect?

Multi-channel GEO is very helpful to distinguish thin vs. thick anvils.

(a) Cloud Type based on AIRS Emissivity



(b) CloudSat CPR + CALIOP



Long-term Goals:

- To form a solid convection tracking community.
- Develop a community tool that can provide cloud tracking tools for the community
- Review/perspective papers
- Organize more cloud tracking seminars/workshops

Short-term Goals:

- Convection Tracking Workshop at USA/France/Germany
- For tracking tool developers, make the code accessible - GitHub
- Develop a website – I did ☺ https://sites.google.com/view/convection-tracking-workshop/home
- Connect to GDAP/GEWEX activities – Can we add our activities under GEWEX web?
- Appoint sub-leaders to guide work on several key topics that are vital to our community. So far, we proposed six priority areas:

    1. **Multivariable Tracking:**
    2. **Shallow Convection:**
    3. **Environmental Influence:**
    4. **Interscale Comparison:**
    5. **Intermodal Comparison:**
    6. **Inter-algorithms Comparison:**

Thank you!