Thunderstorm Life Cycle Observation from Radar and Satellites

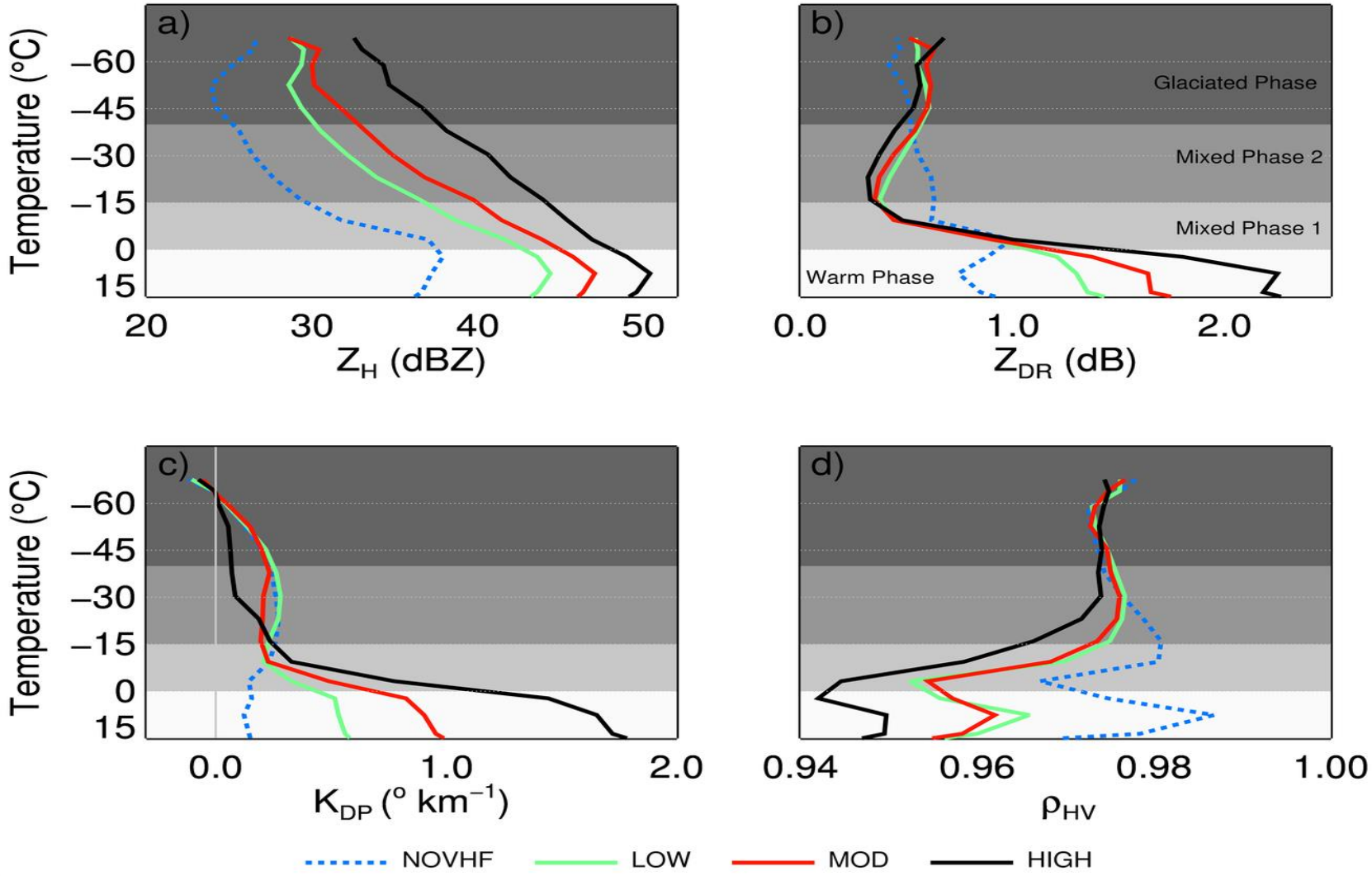
Luiz.Machado@inpe.br

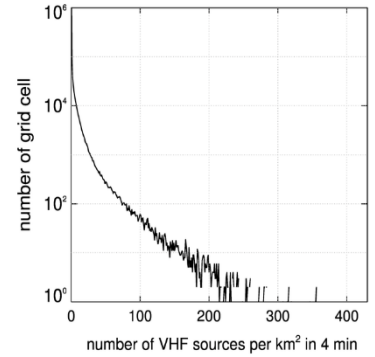
and

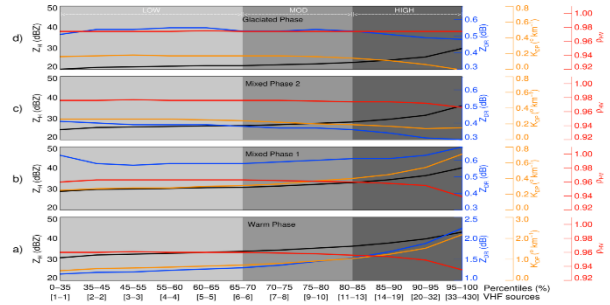
Wagner Flauber, Enrique Mattos and Bruno Medina

Outline

- Lightning and X Pol Radar: Lighting Frequency
- Thunderstorm Life Cycle – Observed by LMA and X Pol Radar
- Thunderstorm Life Cycle – Nowcasting Parameters
- Thunderstorm Life Cycle – Observed by MSG.





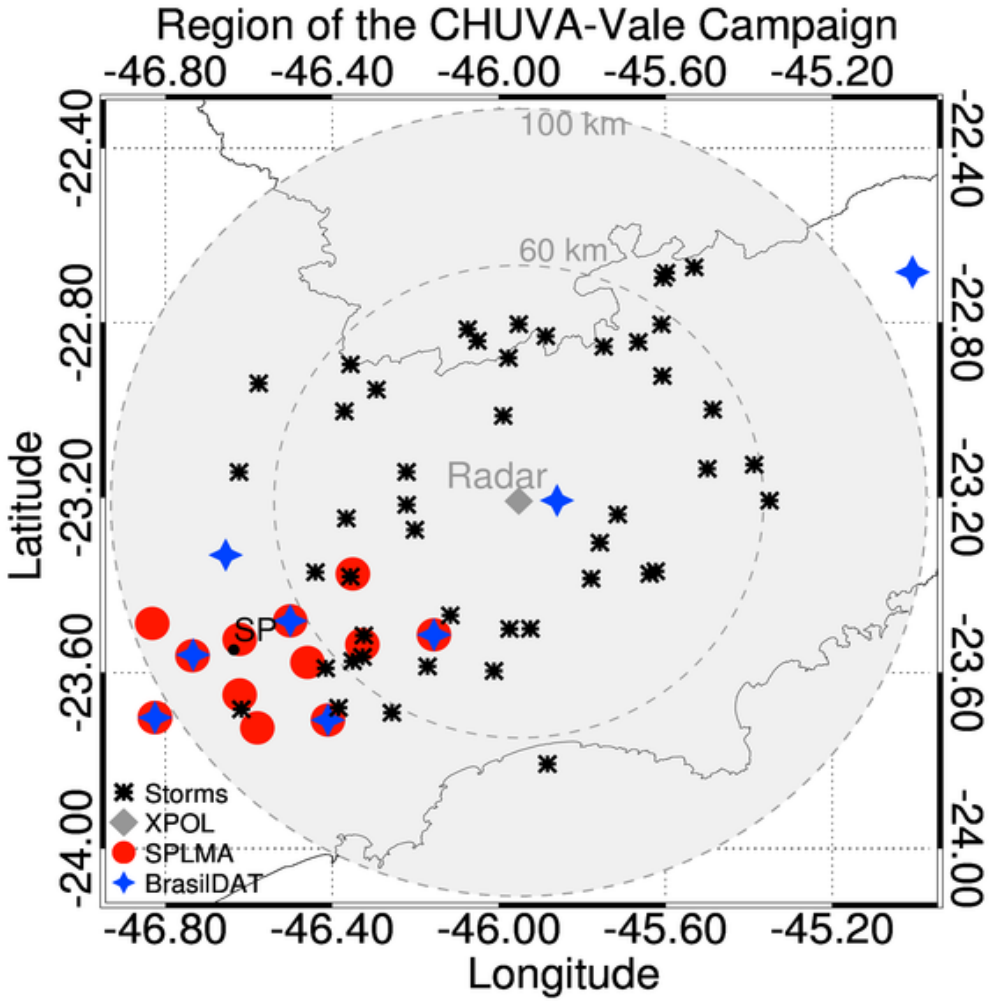


Important for MTG and GOES-R
Lig. frequency α Hydrometeor
→ Profile for Assimilation

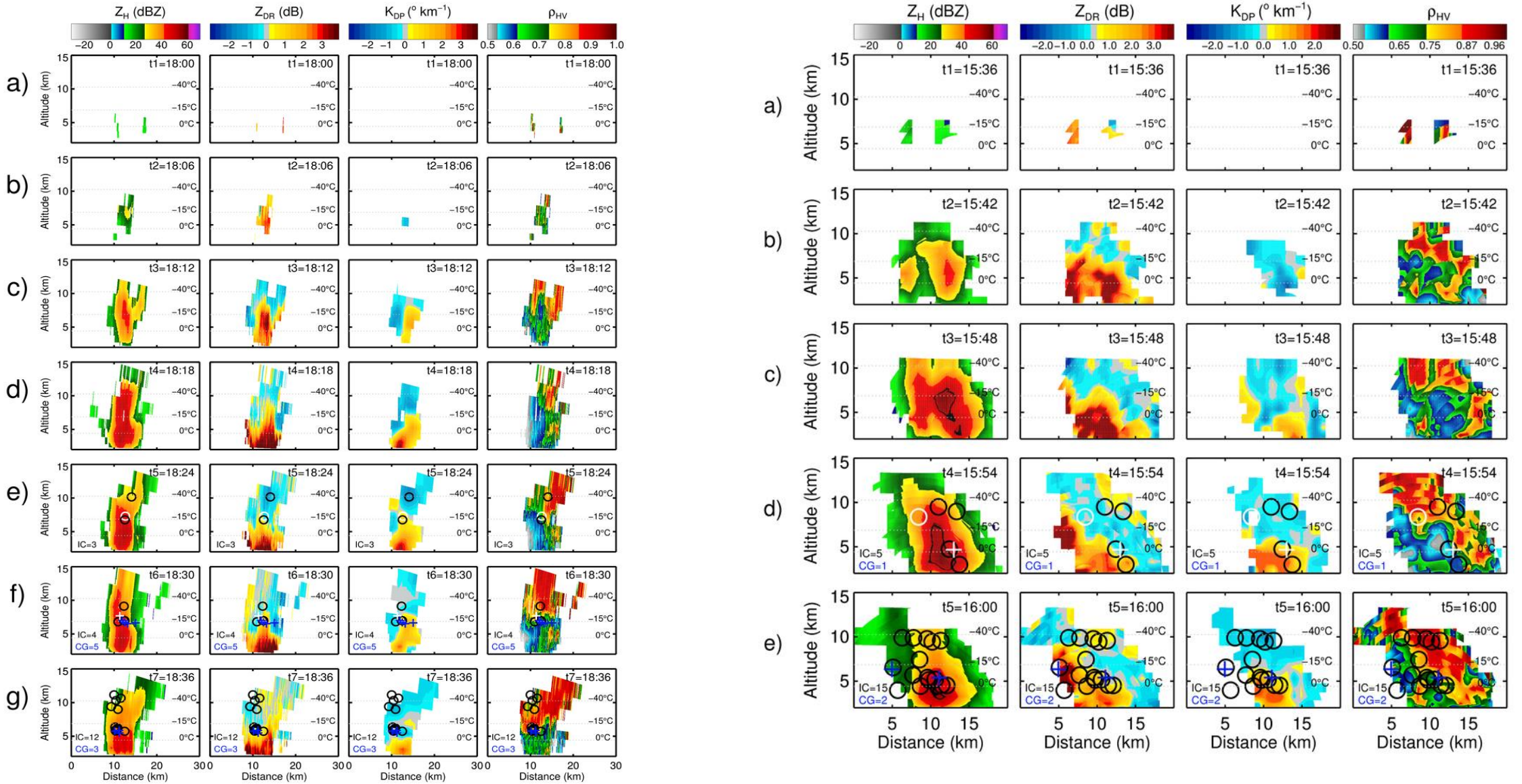
Mean profiles of (a) Z_H (dBZ), (b) Z_{DR} (dB), (c) K_{DP} (° km^{-1}) and (d) ρ_{HV} for the NOVHF (blue dashed line), LOW (green solid line), MOD (red solid line) and HIGH (black solid line) categories of VHF sources per km^2 in 4-minute time interval. The gray vertical line in (c) represents 0 ° km^{-1} for K_{DP}. The regions highlighted in gray colors indicate the layers of vertical profiles (warm, mixed 1, mixed 2 and glaciated phase layers).

Thunderstorm Electrification and X-Band Polarimetric Radar: Lightning Frequency by Enrique V. Mattos, Luiz. A. T. Machado, Earle R. Williams and Rachel Albrecht Submitted to Journal Geophysical Research.

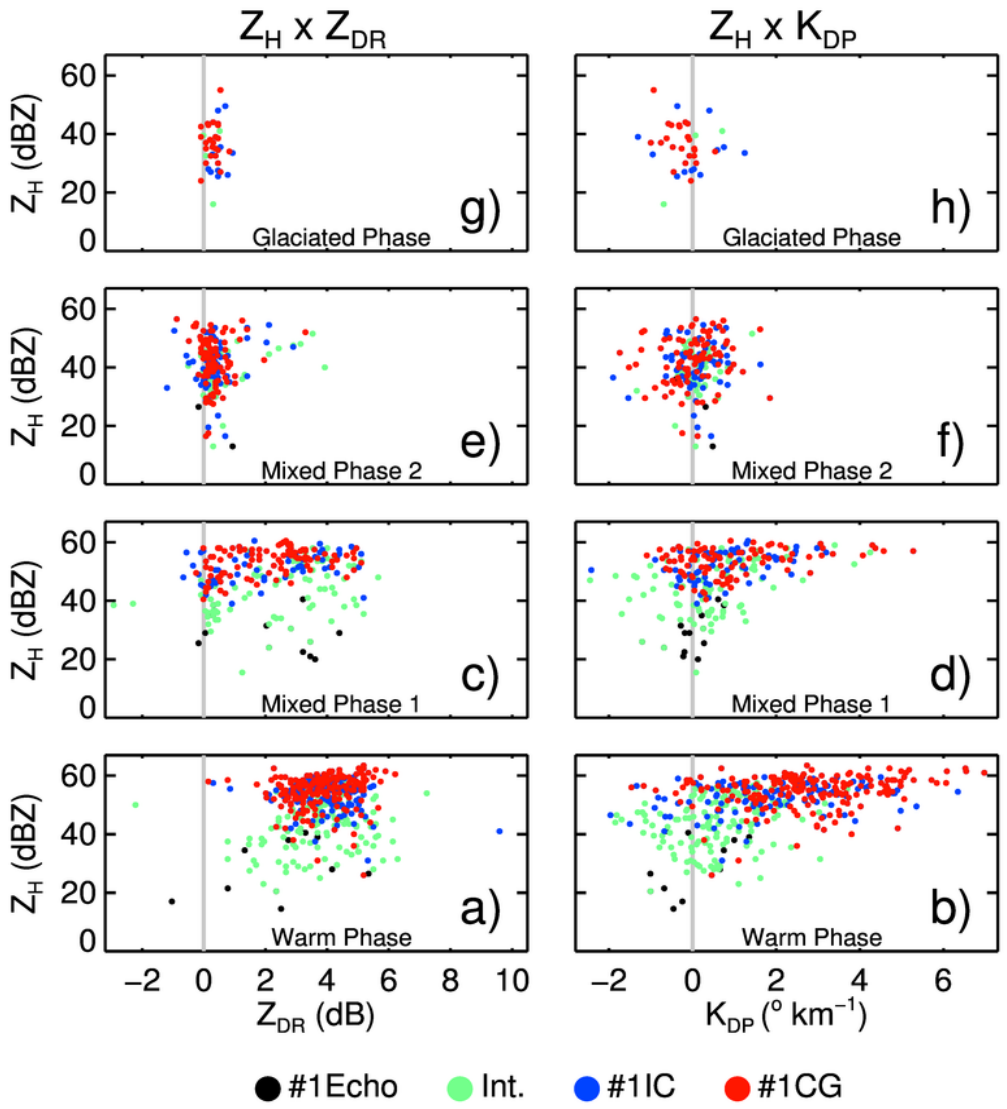
46 Life Cycle cases available
For combination with MSG



Region of the CHUVA-Vale campaign with the localization of the X-band radar (gray shaded region), and the SPLMA (red circles) and BrasilDAT (blue stars) lightning sensors. Asterisks represent the locations of the 46



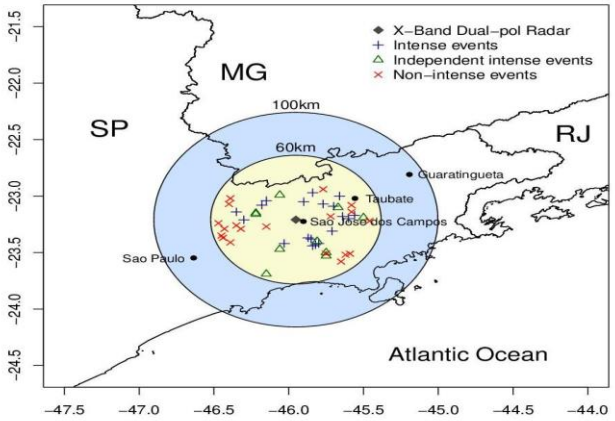
Vertical cross sections of the polarimetric variables (Z_H, Z_{DR}, K_{DP} and ρ_{HV}) of the thunderstorm evolution.
The locations of the initiation point for the intracloud flashes are indicated with black circles and for the cloud-to-ground by blue crosses white color indicate the first intracloud and cloud-to-ground flashes



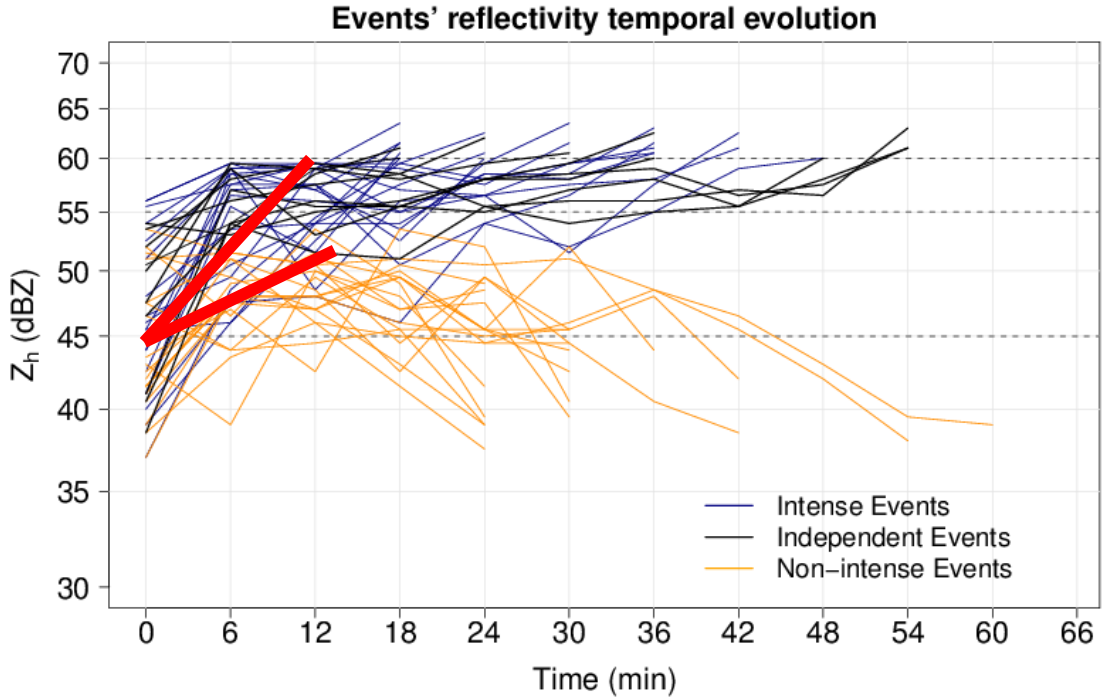
Scatter plots between Z_H (dBZ) and Z_{DR} (dB) (left panels) and between Z_H (dBZ) and K_{DP} (° km^{-1}) (right panels for the four life cycle stages of thunderstorms

Intense Events – reach 60 dBZ

Non Intense Events – Do not reach 60 dBZ, but reach more than more than 45 dBZ



19 intense events maximum reflectivity location (blue crosses), 10 independent intense events maximum reflectivity location (green triangles) and 19 non-intense events maximum reflectivity location (red X's).



$$\frac{Specific\ Volume}{Volume\ Total}$$

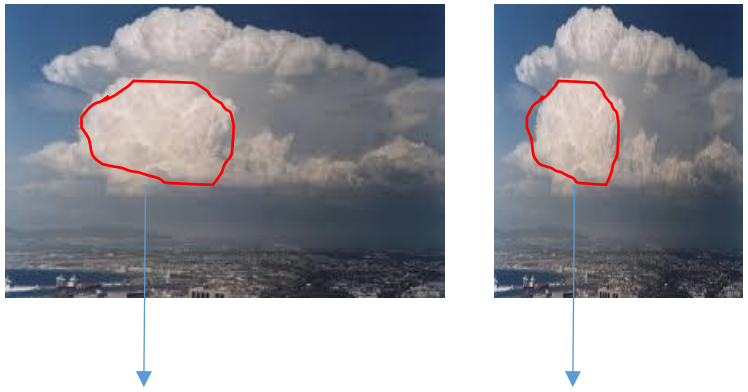
$$\frac{\partial(\ Specific\ Var.)}{\partial T}$$

$$\frac{\partial(\ Specific\ Volume\ Var.)}{\partial T}$$

Maximum reflectivity temporal evolution for intense events (blue), independent intense events (black) and the non-intense events (yellow).

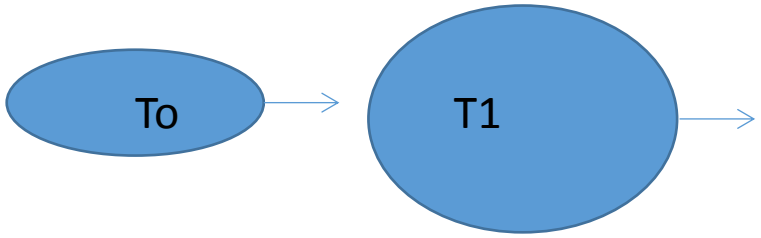
Time is correspondent to the first time 35 dBZ rain cell was detected at 3 km CAPPI.

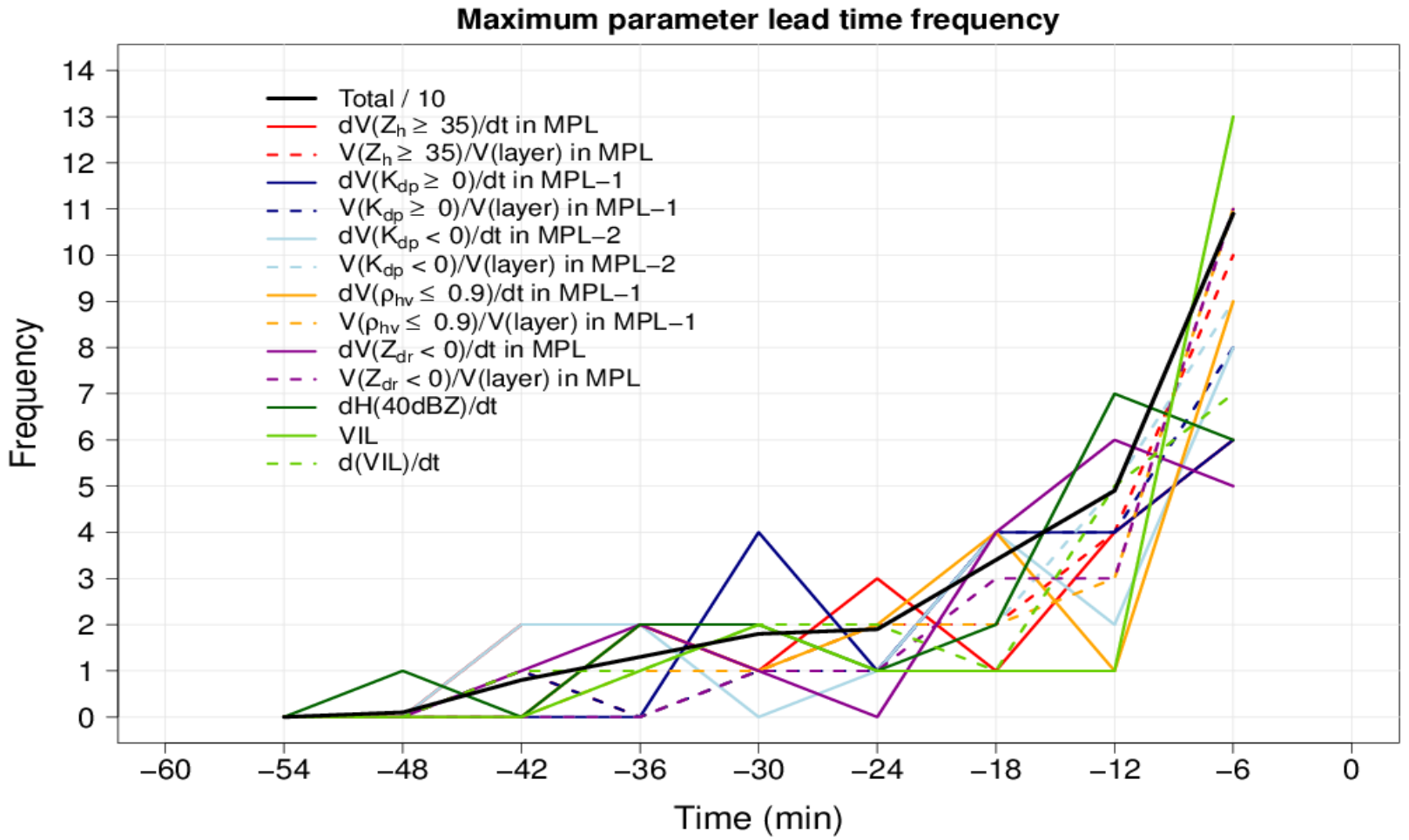
29 life cycle of intense rainfall and 19 cases of non-intense to be combined with MSG.



%Volume_t_0 %Volume_t_1

(Volume_t_0 - Volumet$_1$)/ΔT

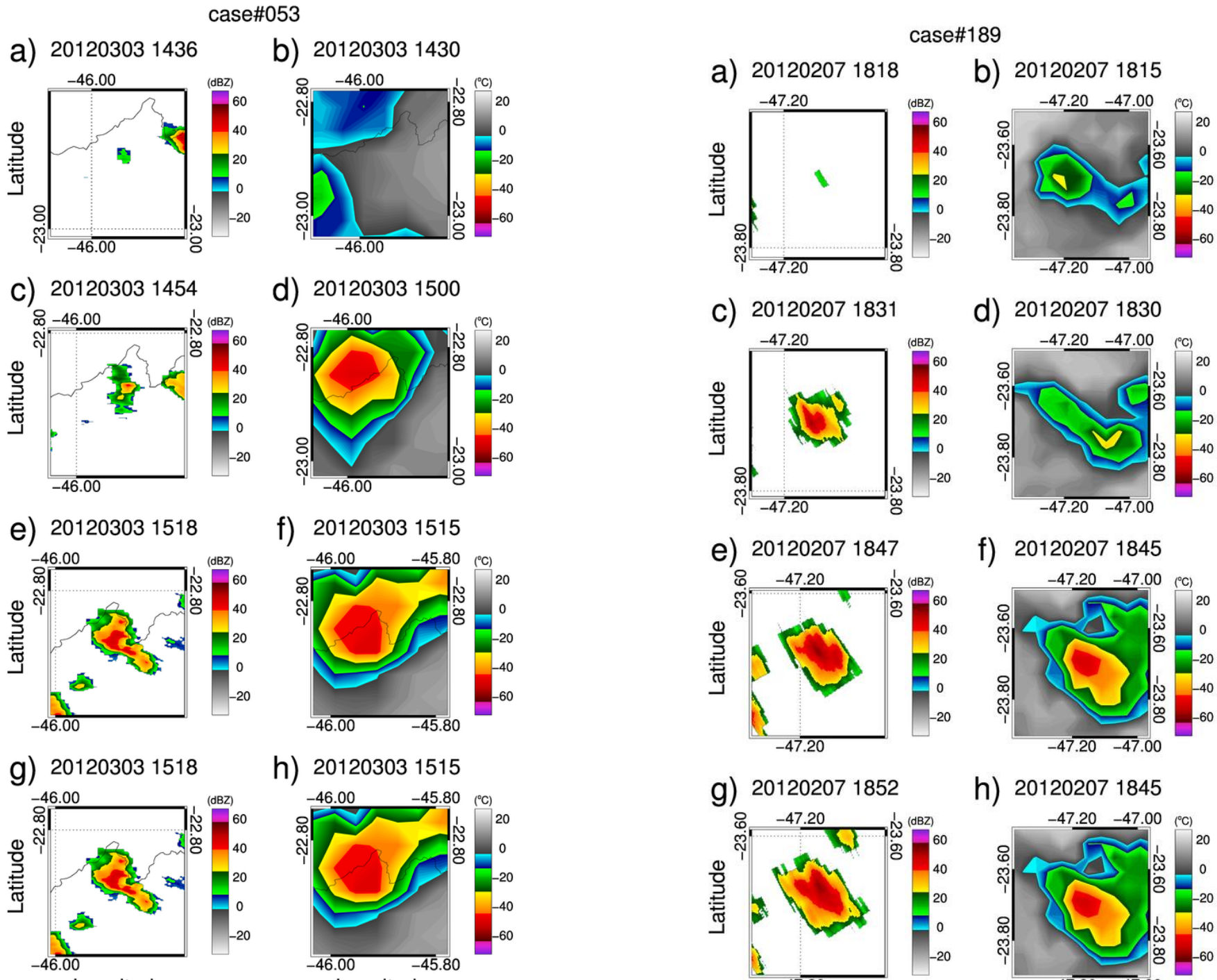




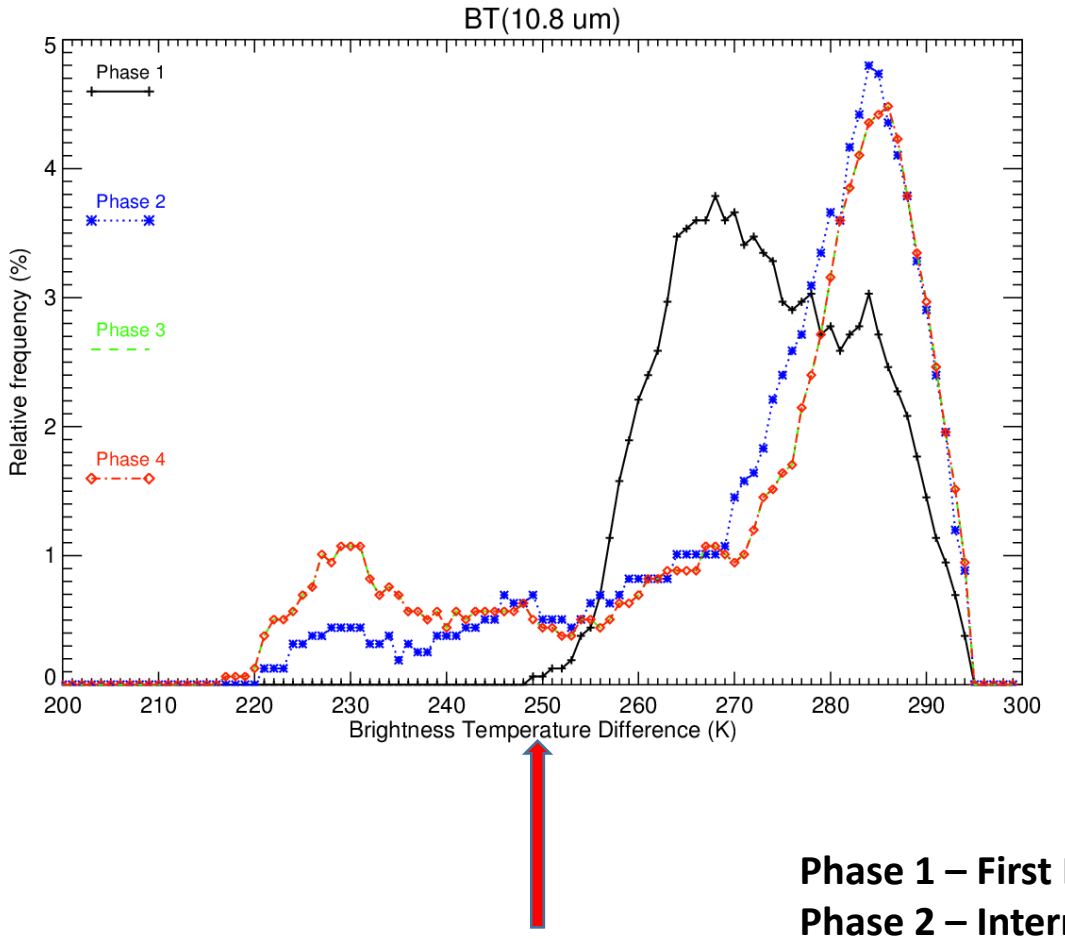
Frequency of volume fraction and trend parameters values in terms of lead time. Black line presents the total for all parameters, divided by 10.

Is MSG Able to See this Evolution?

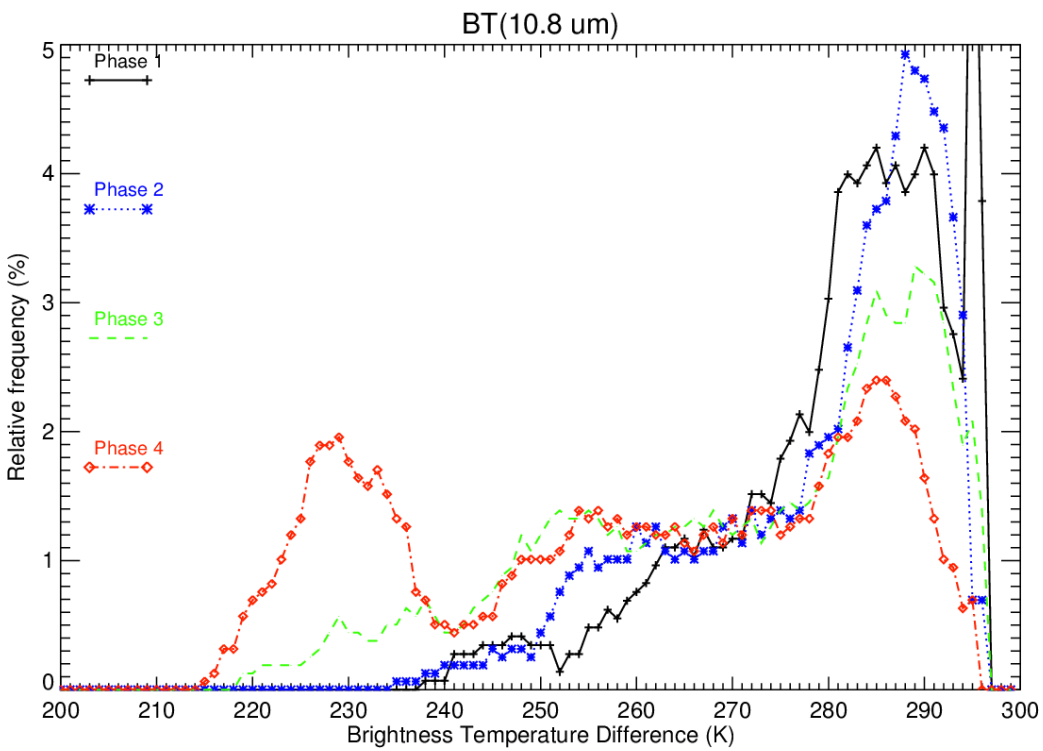
High Inclination (23S,46W) – Compact Rain Cells


case#053
a) 20120303 1436
b) 20120303 1430
c) 20120303 1454
d) 20120303 1500
e) 20120303 1518
f) 20120303 1515
g) 20120303 1518
h) 20120303 1515
case#189
a) 20120207 1818
b) 20120207 1815
c) 20120207 1831
d) 20120207 1830
e) 20120207 1847
f) 20120207 1845
g) 20120207 1852
h) 20120207 1845
Latitude
(dBZ)
(℃)
60
40
20
0
−20
−40
−60
−46.00
−45.80
−23.00
−22.80
−47.20
−47.00
−23.80
−23.60

Case #53

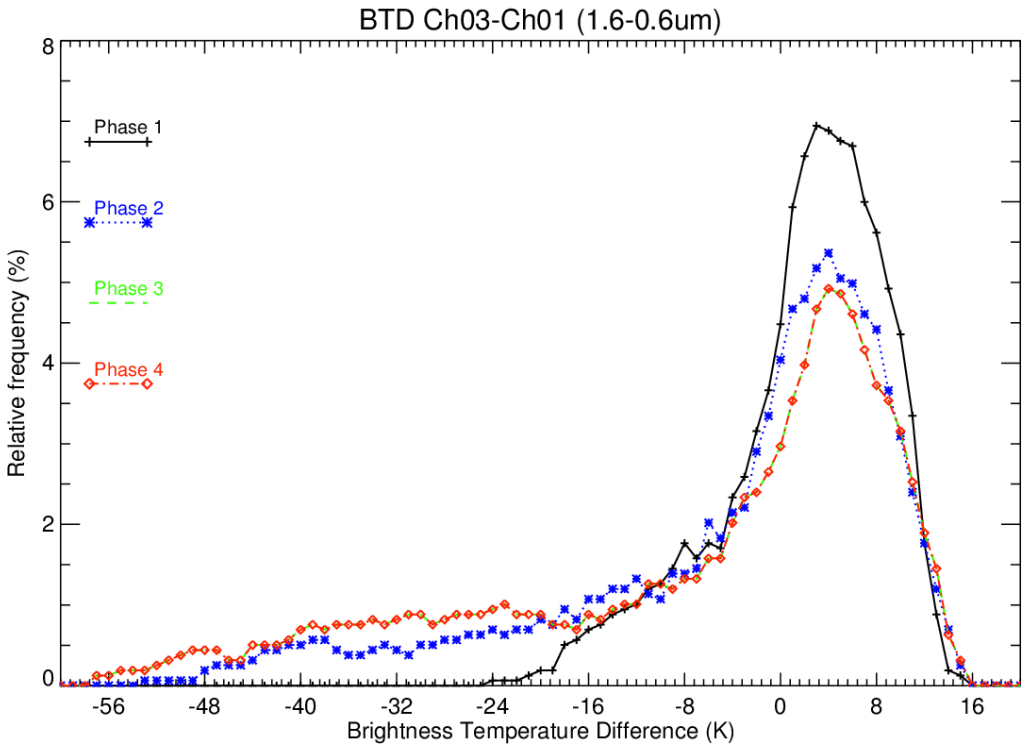


Case #189



Phase 1 – First Reflectivity above Melting layer
Phase 2 – Intermediary
Phase 3 – First Intra cloud
Phase 4 – First Cloud Ground

Case #53



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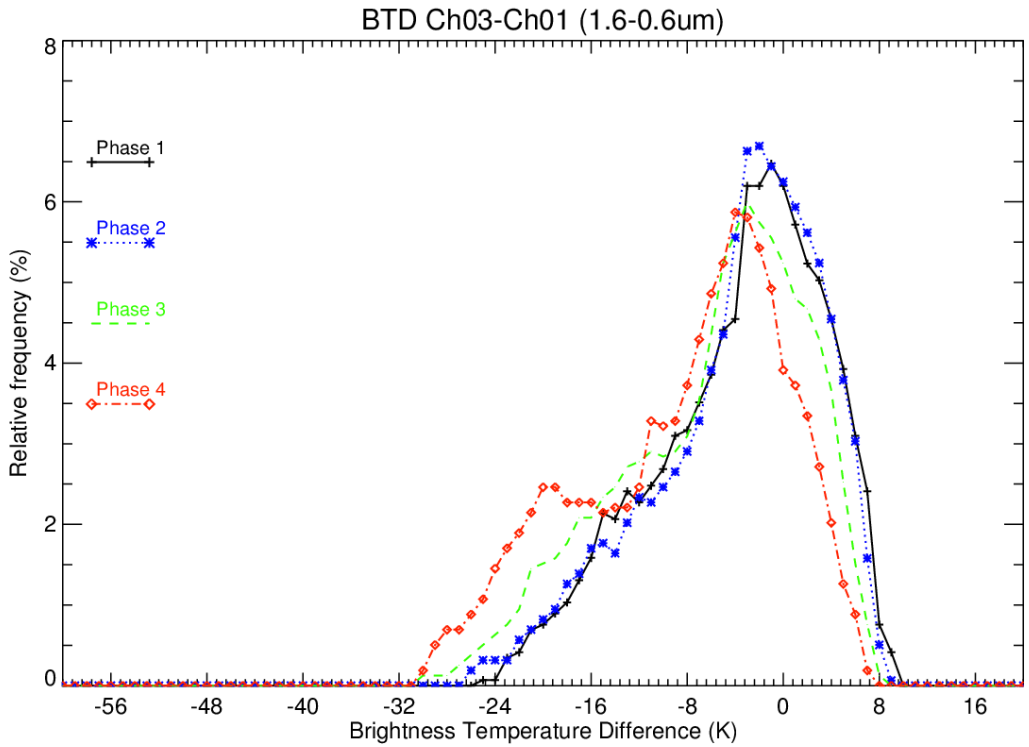

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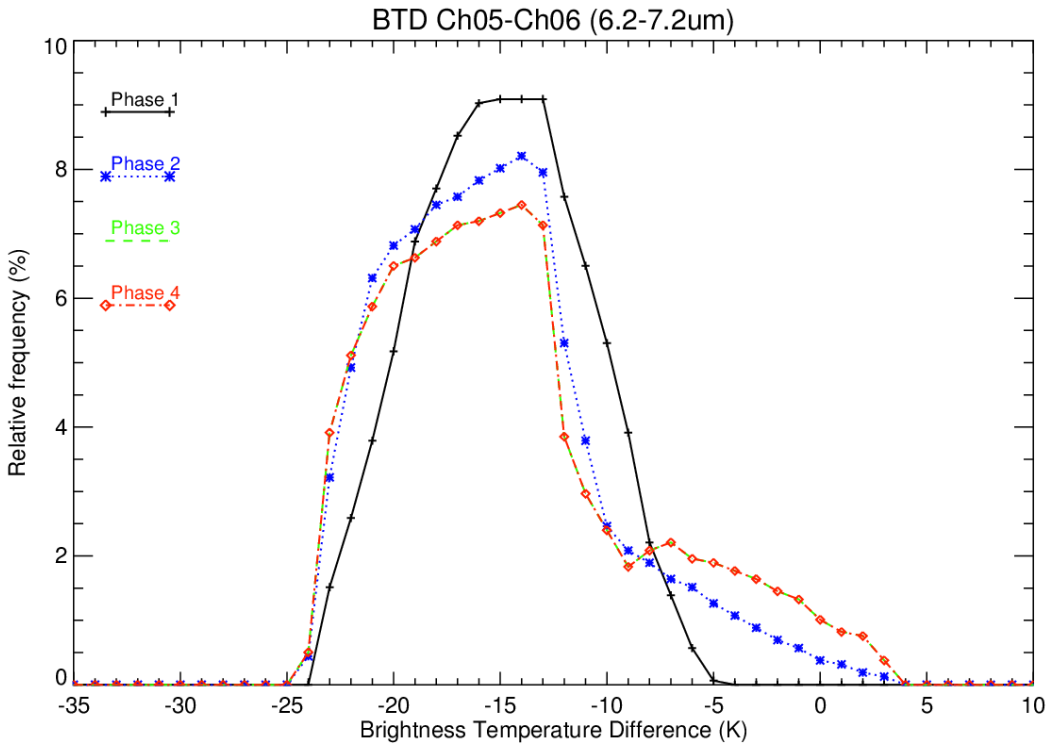

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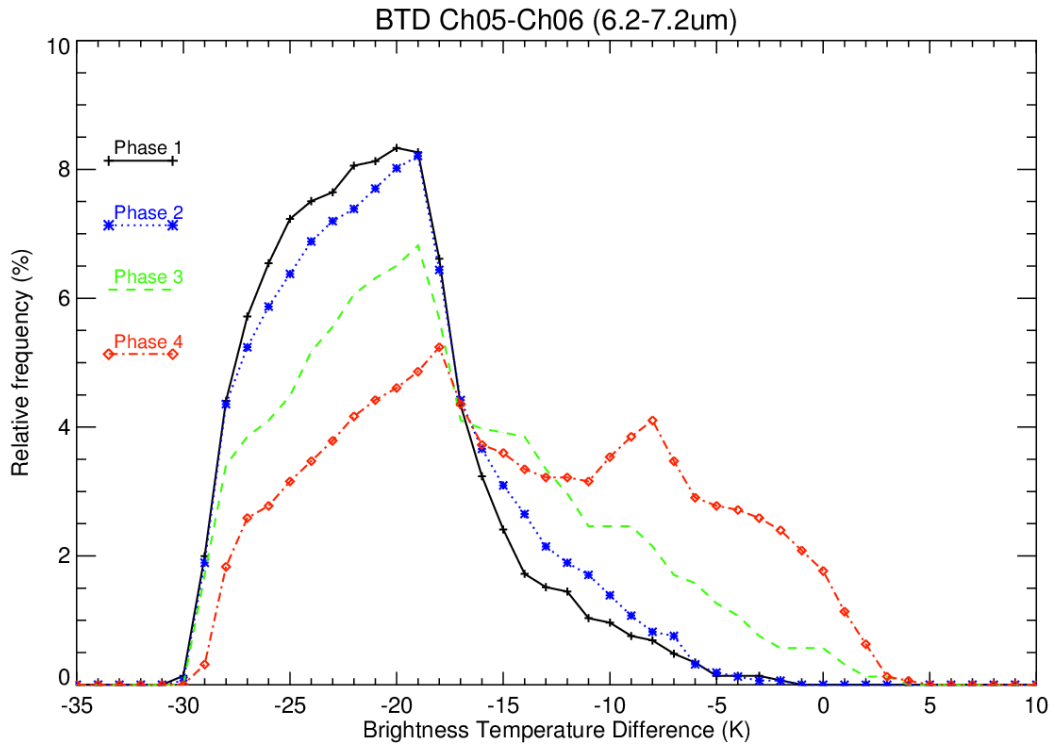

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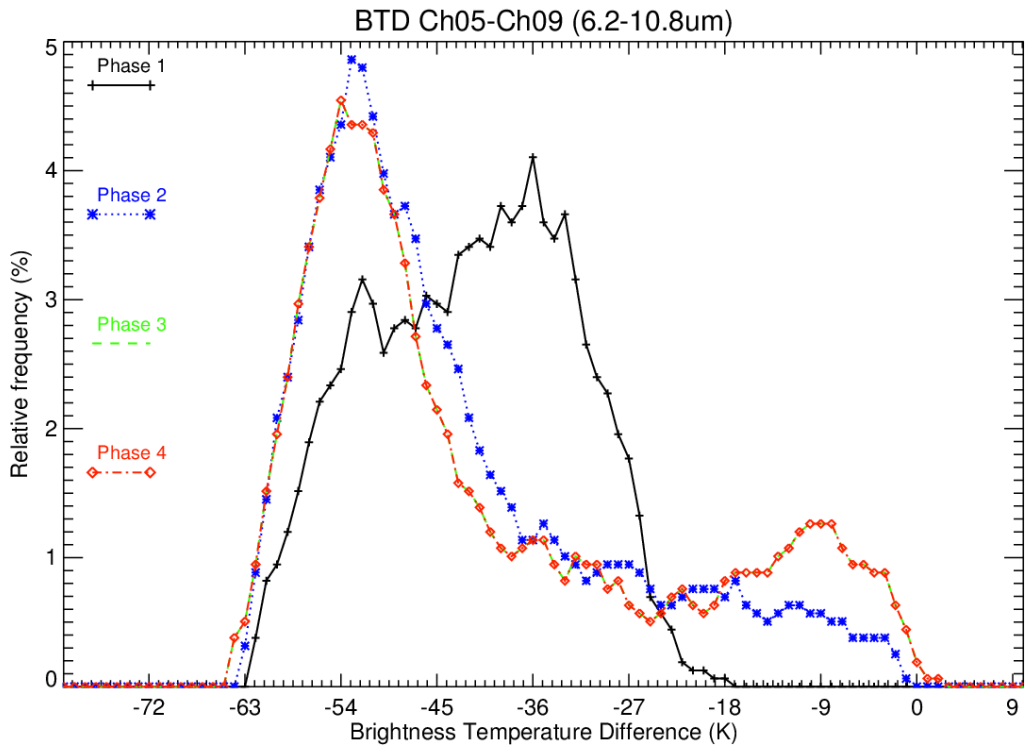

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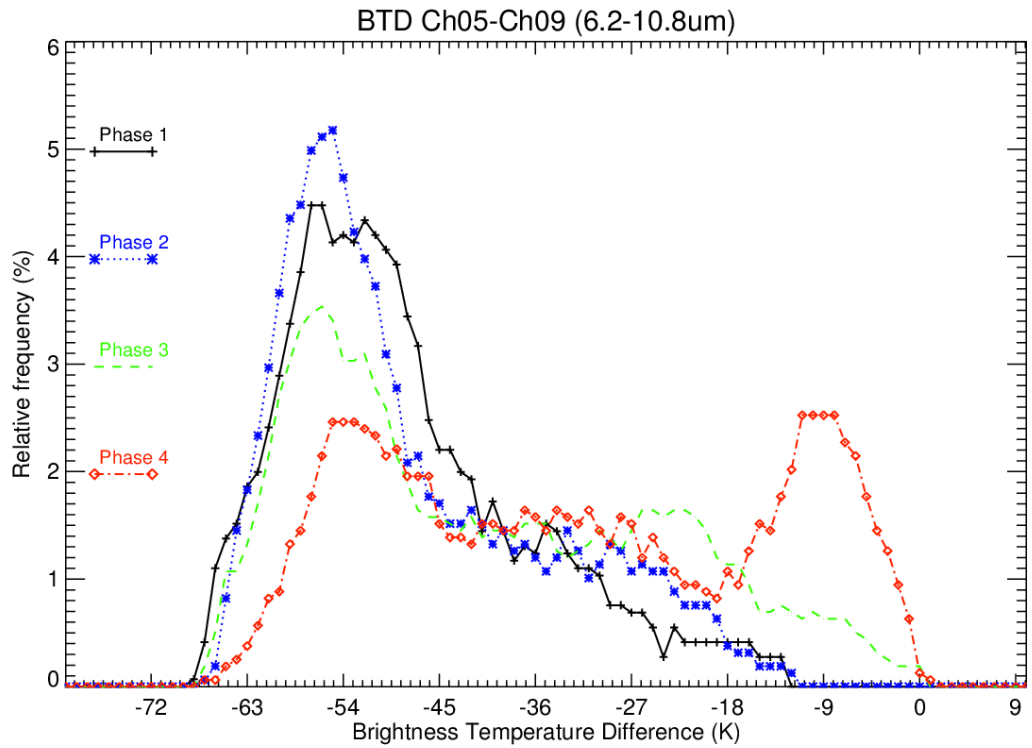

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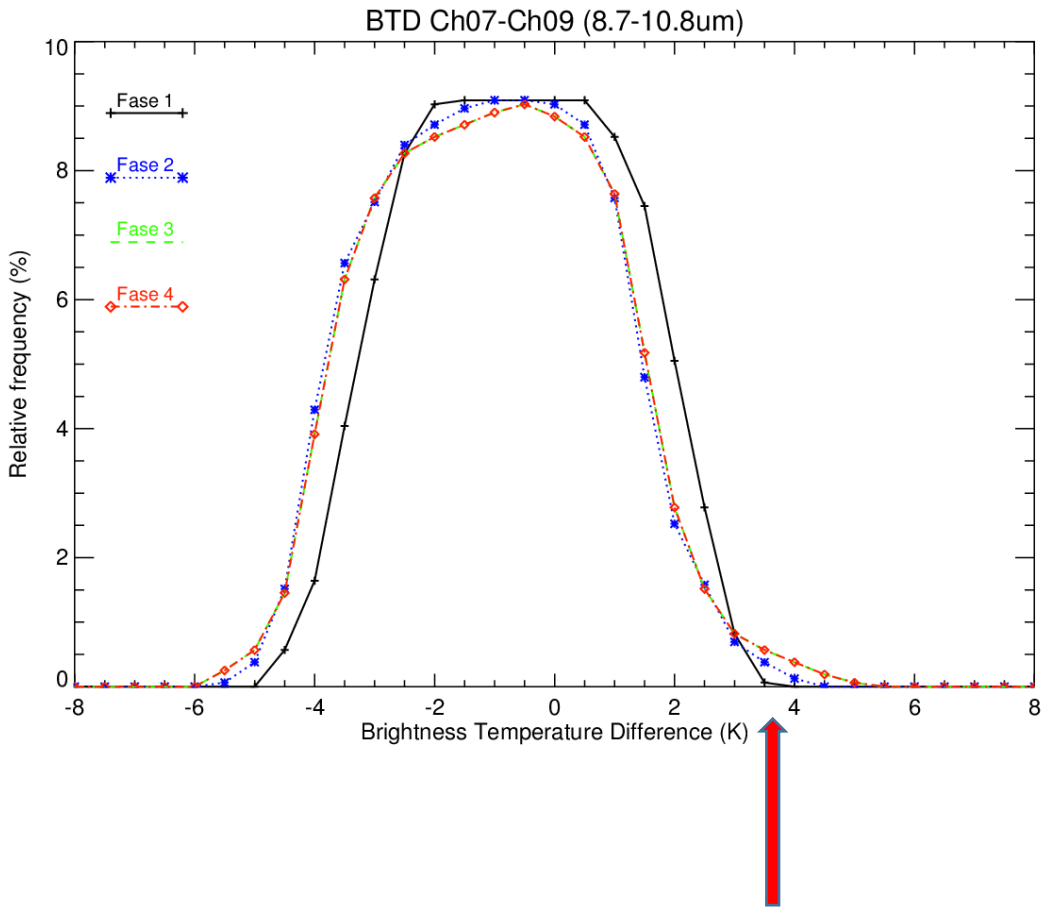

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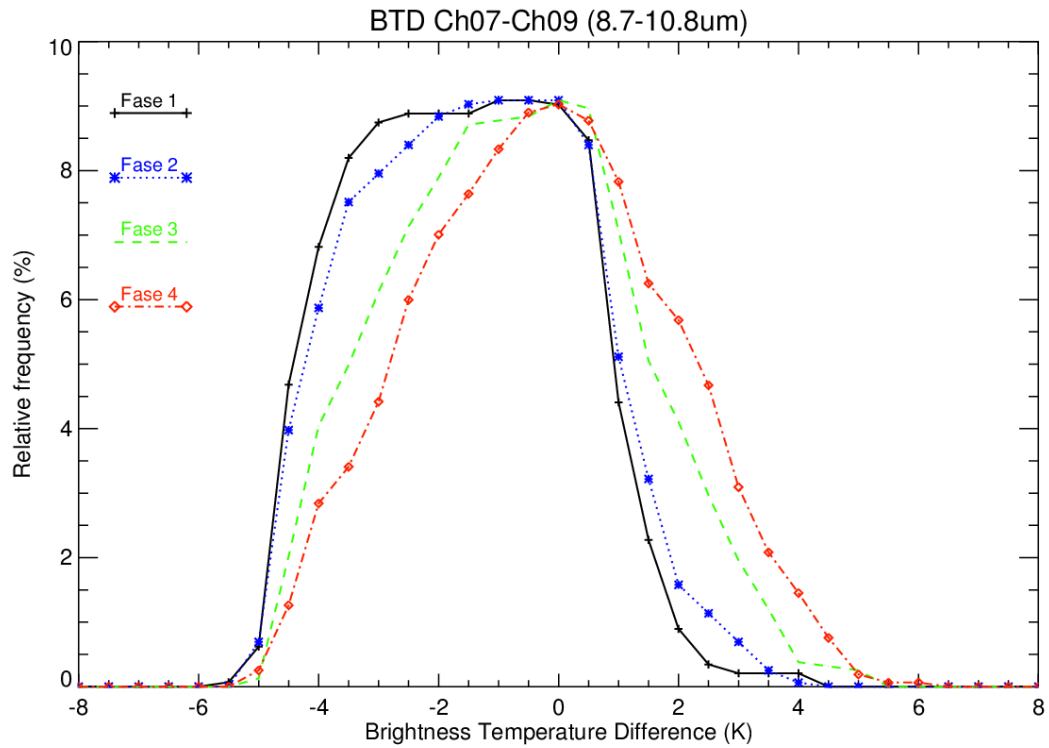
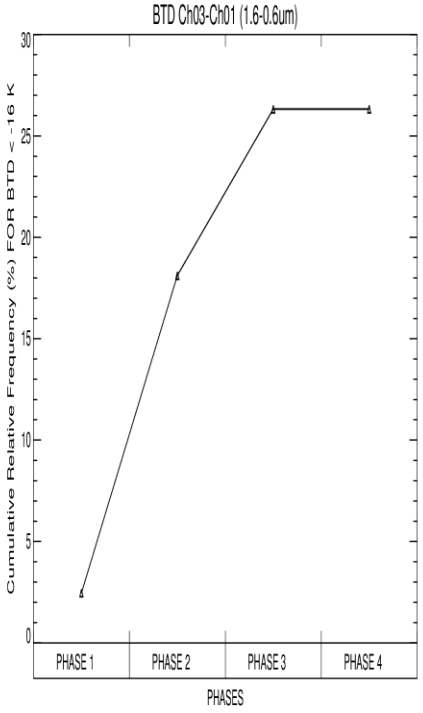


Time Evolution of the Area Fraction Threshold



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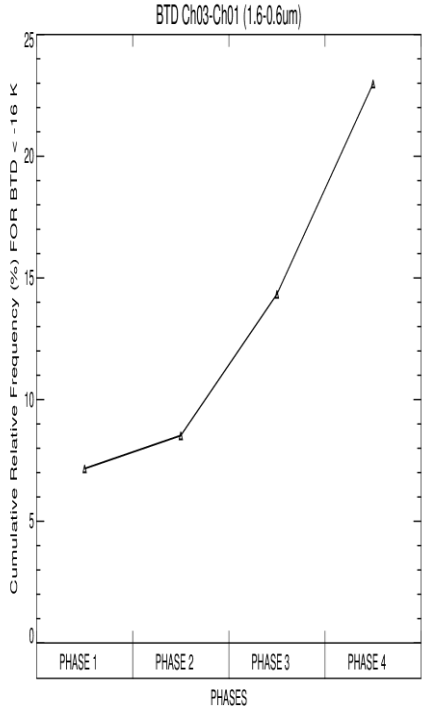

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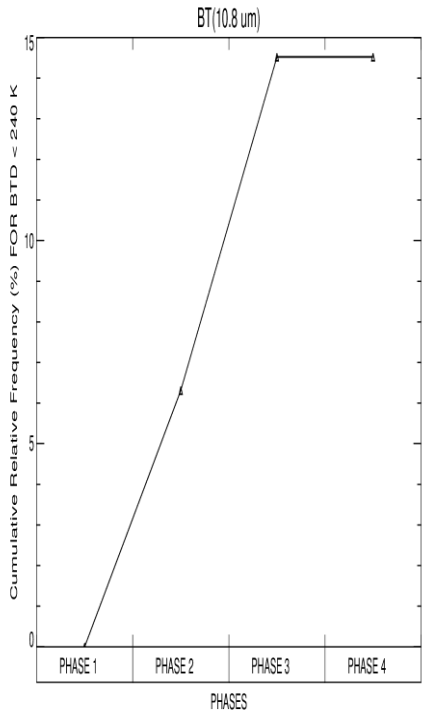

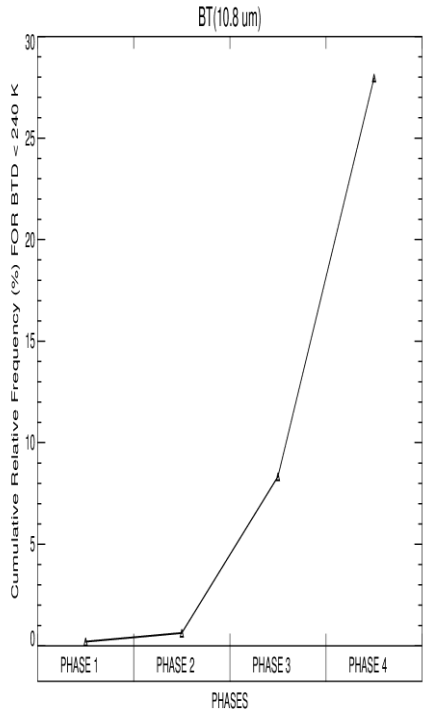

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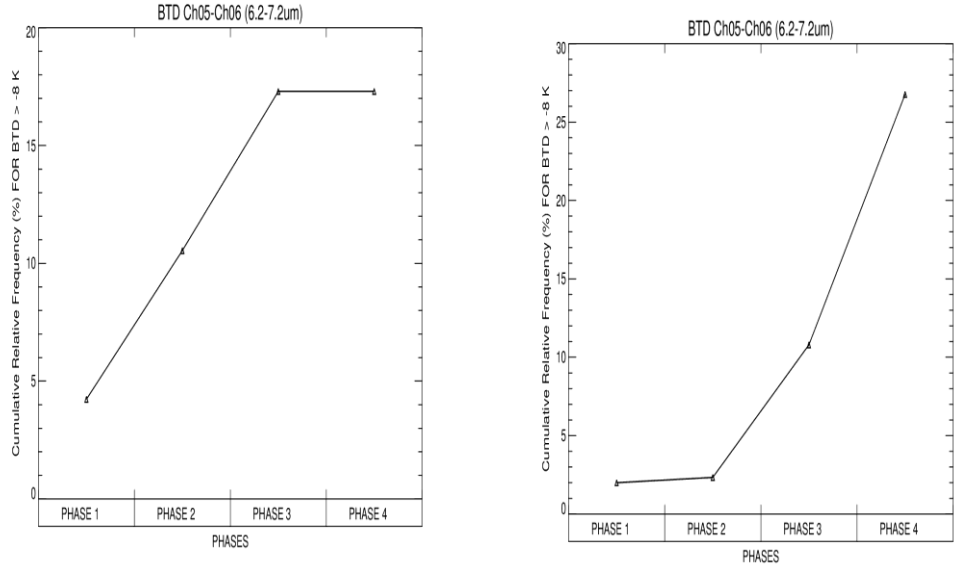

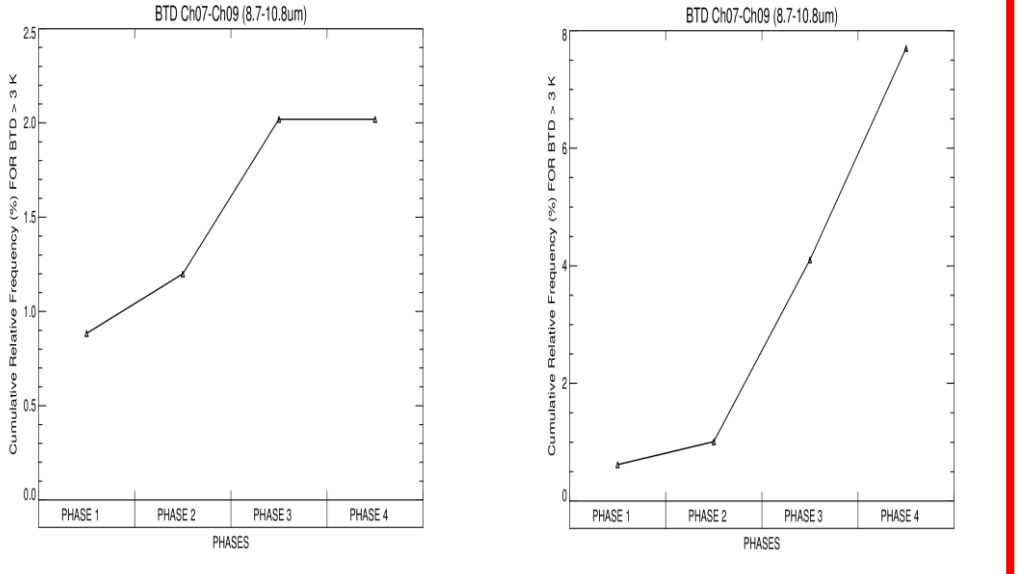

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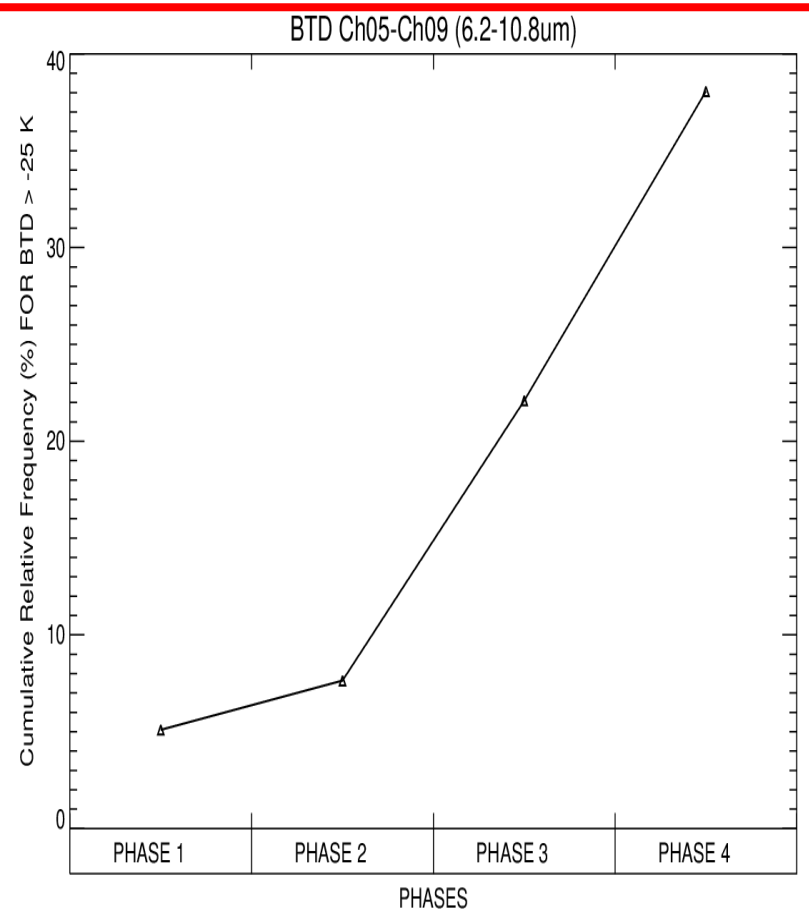

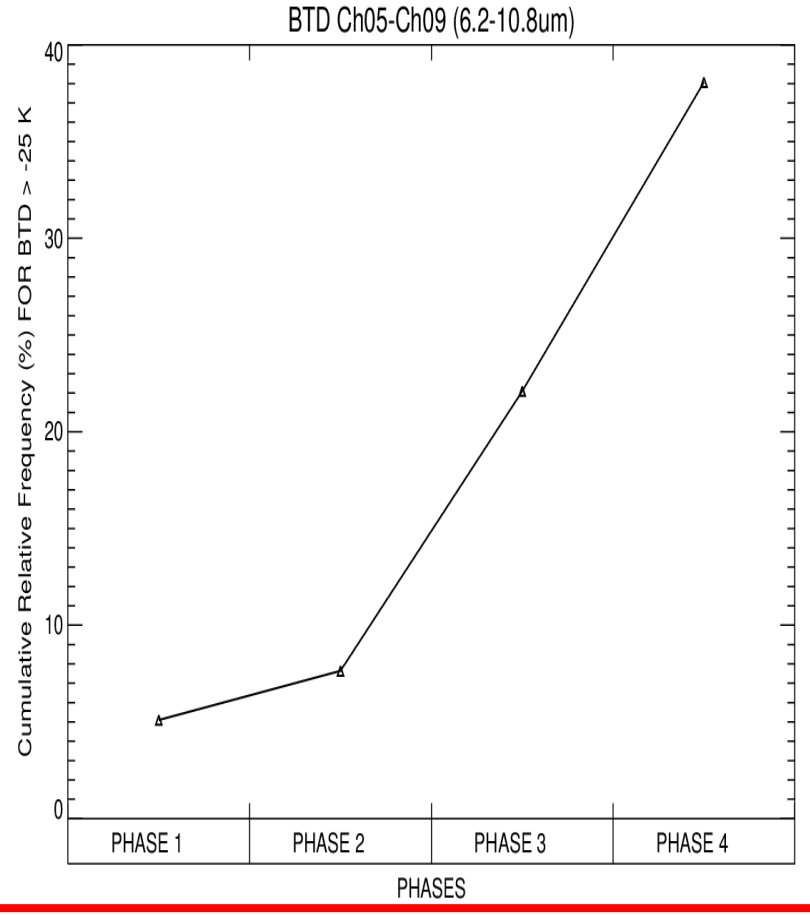

Conclusion

- Convective Systems have a typical behavior when move from Storm to Thunderstorm or from regular Storm to Intense Rainfall.
- Zdr and KDP column is clearly observed when convection is moving to have the first IC
- MSG, even with a large view angle inclination, describes the storm evolution to thunderstorm.
- Water vapor channels as well 1.6, 0.6 and 10.8 are the best channels to describe this evolution
- Results encourage the development of an algorithm to nowcasting convective clouds to develop electrification or “severity”.