On the Relation Between Mesoscale Convective System Life Cycles and TRMM Observations over Southeastern South America (SESA)

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Motivation

The big thing missing in analysis of the TRMM database is a temporal context for individual storms: ***Where are they in their lifecycles?***

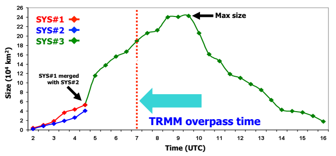


Figure 1. *0.5 h evolution of 210-K area between 0200 UTC and 1600 UTC of 24 Dec 2006.*

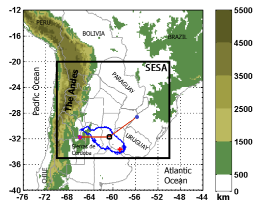


Figure 2. *Example of MCS tracking (24 Dec 2006). MCS initiation (red point), max extent (black open square), MCS dissipation (blue point), RPF location (red cross), and 210-K contour (blue line) at TRMM overpass time.*

Objectives

- *Build a database of TRMM Radar Precipitation Features (RPF) and determine where they fit in the life cycle of each Mesoscale Convective System over SESA. Use the database to:*
  - *Differentiate between very rainy RPFs and very convectively intense RPFs.*
  - *What is the diurnal cycle of each type of RPF?*
  - *Where does each type of RPF tend to originate? Reach maturity? Dissipate?*
  - *Explain the reasons for the double maximum in time of initiation; why do so many MCSs initiate over the slopes of the Andes Mountains after sunset?*

Datasets

TRMM RPF UofU Database

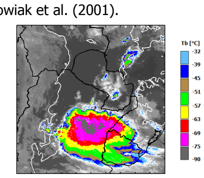
Database of **R**adar **P**recipitation **F**eatures (RPFs) derived from the TRMM satellite is used to identify different types of extreme MCSs using different proxies of precipitation and intensity.

Thresholds for each category of extremes from 13 year TRMM observations (1998-2010)

Parameter	5%	1%	0.1%	0.01%
Volumetric Rainfall *[mm h⁻¹ km²]*	17,695	174,830	574,950	1,035,900
Min 37-GHz PCT *[K]*	254.3	216.3	161.5	127.2
Min 85-GHz PCT *[K]*	180	115.7	74.2	56.5
Flash Rate *[#/min]*	5.5	51	254.5	578.4

GOES infrared (IR) channel 4

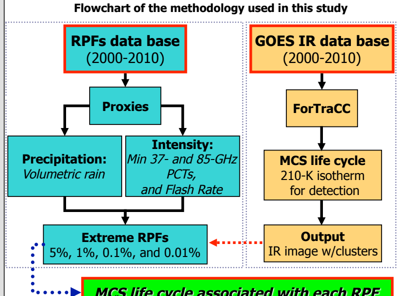
This dataset isused as input of ***Forecast and Tracking the Evolution of Cloud Clusters (ForTraCC).*** More information about the data can be obtained from Janowiak et al. (2001).



Example of IR image over SESA. The thick white contour outlines the 0.5-km topography

Methodology

Flowchart of the methodology used in this study

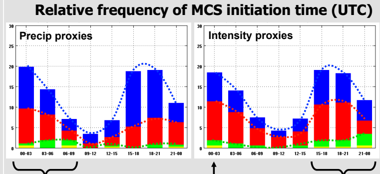


Forecasting Tracking of Active Cloud Clusters (ForTraCC)

- The life cycle of the MCSs is determined using ForTraCC (Vila et al. 2008).
- This is an objective and automated method to describe structural properties of the cloud shields derived from the IR imagery. A convective system is defined as an area of at least 150 pixels (2400 km²) enclosed by a temperature threshold.
- In order to identify areas representative of deep convection within the convective systems, areas with infrared brightness temperature values below 210 K are identified.
- The location and evolution of each cluster for each time are determined by means of a tracking algorithm included in the ForTraCC technique, which assumes continuity of the systems based on their greatest areal overlap.

Characterization of the MCS sample

Relative frequency of MCS initiation time (UTC)

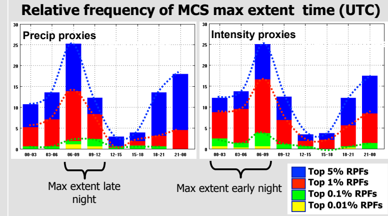


Max frequency during the night → extreme RPFs

Very interesting!

Max frequency in the afternoon → extreme RPFs

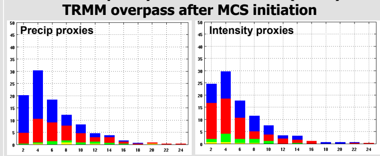
Relative frequency of MCS max extent time (UTC)



Max extent late night

Max extent early night

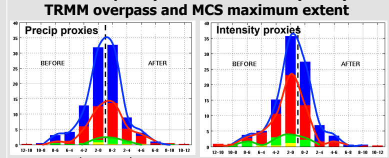
Relative frequency of time difference (hours) of TRMM overpass after MCS initiation



Extremely rainy RPFs tend to occur several hours after initiation, close to the mature phase.

Extremely intense RPFs tend to occur close to initiation of the system, before maturity.

Relative frequency of time difference (hours) of TRMM overpass and MCS maximum extent



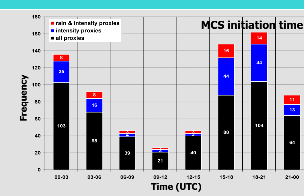
Extremely rainy RPFs tend to occur ***during maturity***

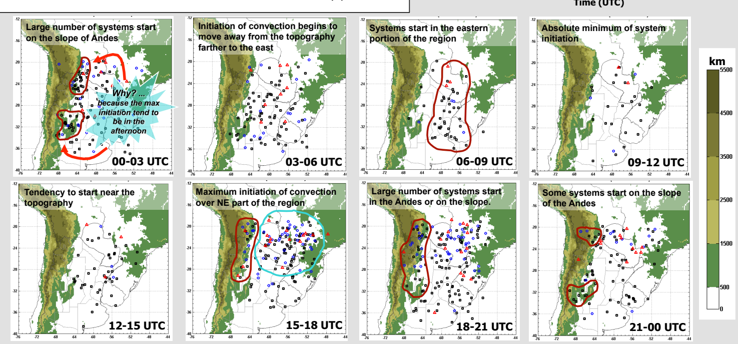
Extremely intense RPFs tend to occur ***before maturity***

Diurnal cycle of the MCS onset

Three categories of systems are defined:

- **Intensity proxy cases:** the system analyzed with Fortracc is associated with an extreme 5% RPF in some of the intensity proxies (min37pct, min85pct or flash rate) but not in volumetric rain
- **Rain proxy cases:** the system analyzed with Fortracc is associated with an extreme 5% RPF in volumetric rain and at least 1 intensity proxy.
- **All proxies:** the system analyzed with Fortracc is associated with an extreme 5% RPF in volumetric rain *and also in all* intensity proxies





Conclusions

- ***Double maximum in initiation time***
- ***Strong preference for early night initiation over Andes slopes***
- ***Very intense RPFs occur soon after MCS initiation***
- ***Very rainy RPFs occur close to the time of MCS maximum extent***

Future work

Based on the spatial maps of the daily cycle of the position where the systems are started, the following questions arise:

Systems that start near the mountain show a maximum frequency in the afternoon (18-21UTC), near time of maximum temperature.

1. ***What are the differences from those systems that have an early night initiation?***
2. ***What is the synoptic environment / meso alpha circulation associated with them?***

To answer this question, the operational fields of the **NCEP Climate Forecast System Reanalysis** (NCEP-CFSR) will be used to make composites of different environments and combine these with the vertical profile of reflectivity in different stages of the MCS life cycle.

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