

Hailstorms in the southern Brazil

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Outlines

1. Objective
2. Motivation
3. Background studies
4. Initiatives in progress

First (of all)

A little bit of our Geography



(1) Amazon rain forest

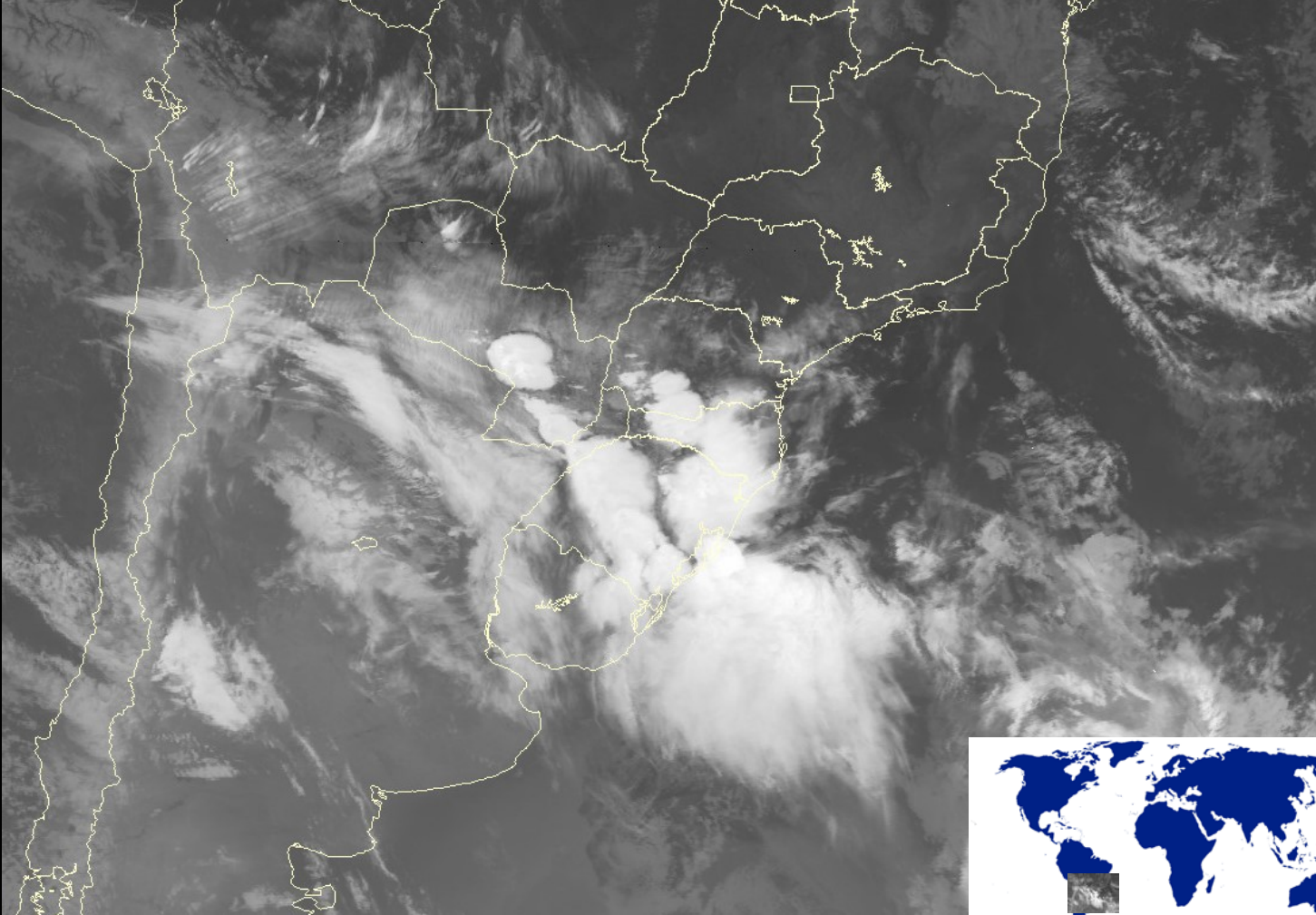
(2) Savanna

(3) Subtropical rain forest

1. Objective

The main goal of this presentation is to show the importance of studying hailfall in the southern Brazil, the current status of understanding about hail in that region and the initiatives we have tried to put into practice, including the difficulties found.

2. Motivation



- During warm months a great number of MCCs (combined with LLJ/CF) can form in the west over northern Argentina and southern Paraguay and move eastward reaching the southern Brazil.
- Although we see a great number of studies devoted to hail, it practically was not yet studied in the southern Brazil and it is a big challenge for our weather forecasting systems.

2. Motivation

Every year hailstorms have destroyed homes and caused millions of dollars in damage in plants, crops, cars, buildings and animals in southern Brazil.



TAM 3307- 08/02/2015

Southwest of Paraná



3. Background studies of hail in Brazil

Only a few studies:

Berlato, M.A. Melo, R.W., Fontana, D.C., 2000. Risco de ocorrência de granizo no Estado do Rio Grande do Sul. Revista Brasileira de Agrometeorologia, 8, 121-132.

Iliine, V.M., Minuzzi, R.B., Rolim, J.L.W., 2010. Climatologia da precipitação de granizo na região central do estado de Santa Catarina. 16° Congresso Brasileiro de Meteorologia, Belem-PA, 5 pages.

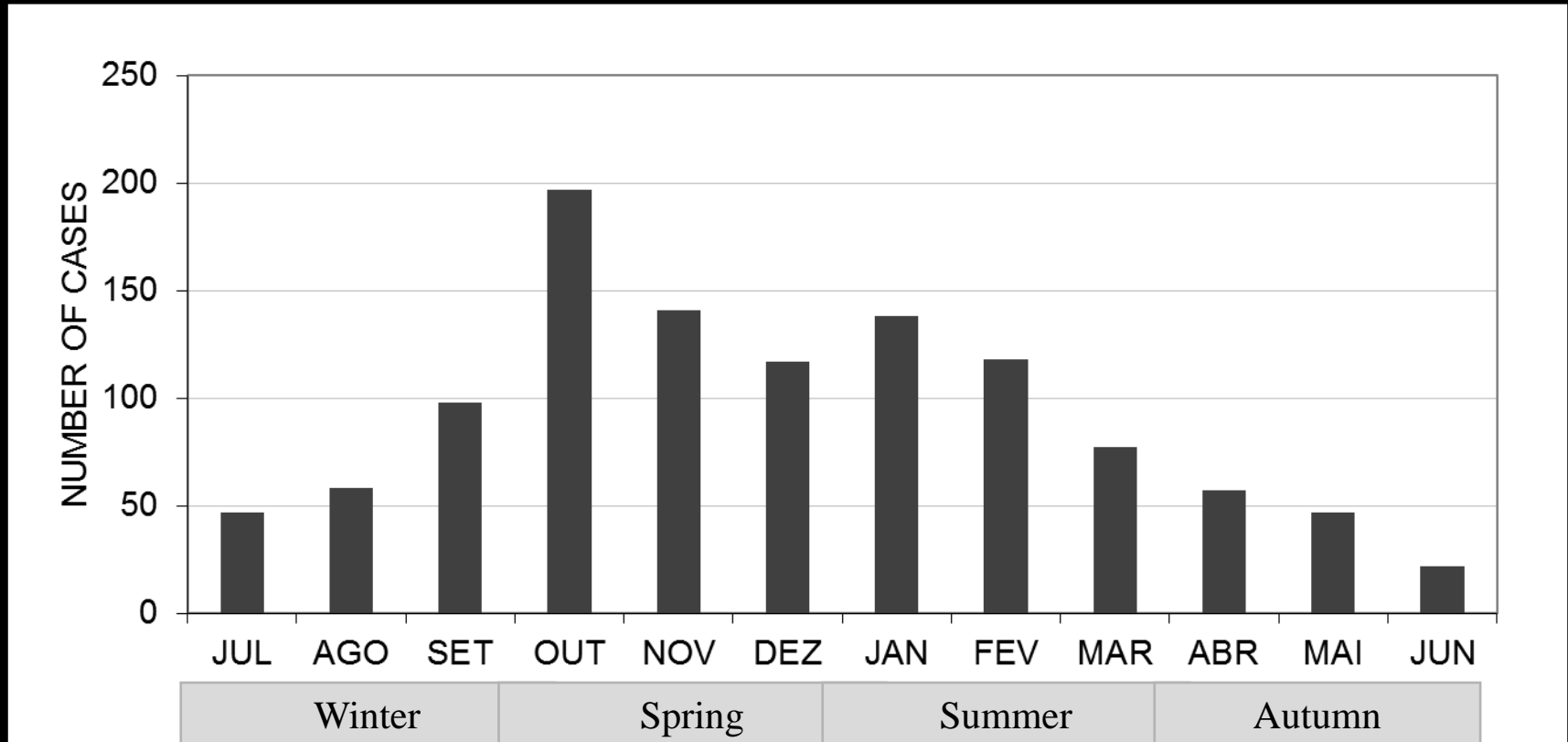
Marcelino, I.P.V.O, Mendonça, M., Rudorff, F.M., 2004. Ocorrências de granizo no estado de Santa Catarina. Simpósio Brasileiro de Desastres Naturais, 1, Florianópolis: GEDN/UFSC, 2004. p.795-805 (CD-Rom).

- Limitation of the language (written in Portuguese);
- Very local approaches

(difficult to be recognized by the current literature on the subject)

3. Background studies of hail in Brazil

Frisby, E. M., Sansom, H. W., 1967. Hail incidence in the tropics. *J. Appl. Meteor.*, 6, 339–354. (Table 1 N. 11)

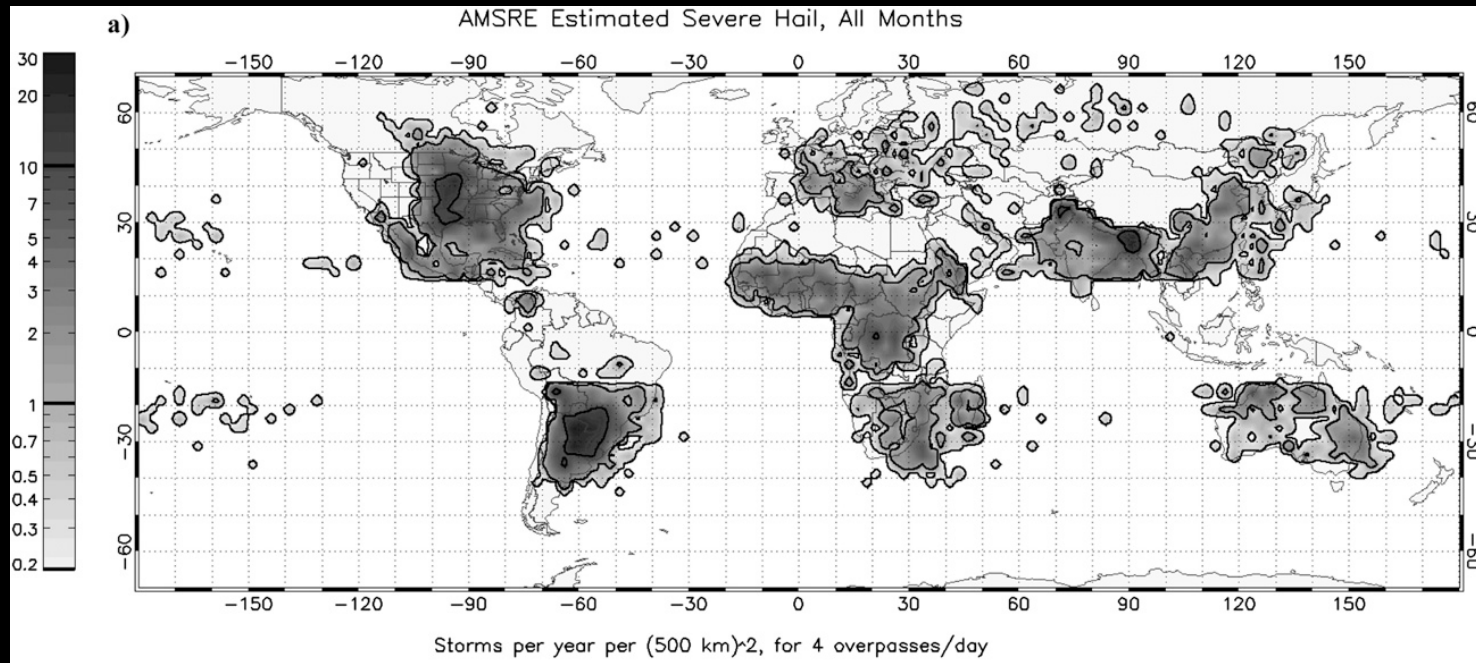


Total number of ground-based reports: 1117

Period: 1943-1960

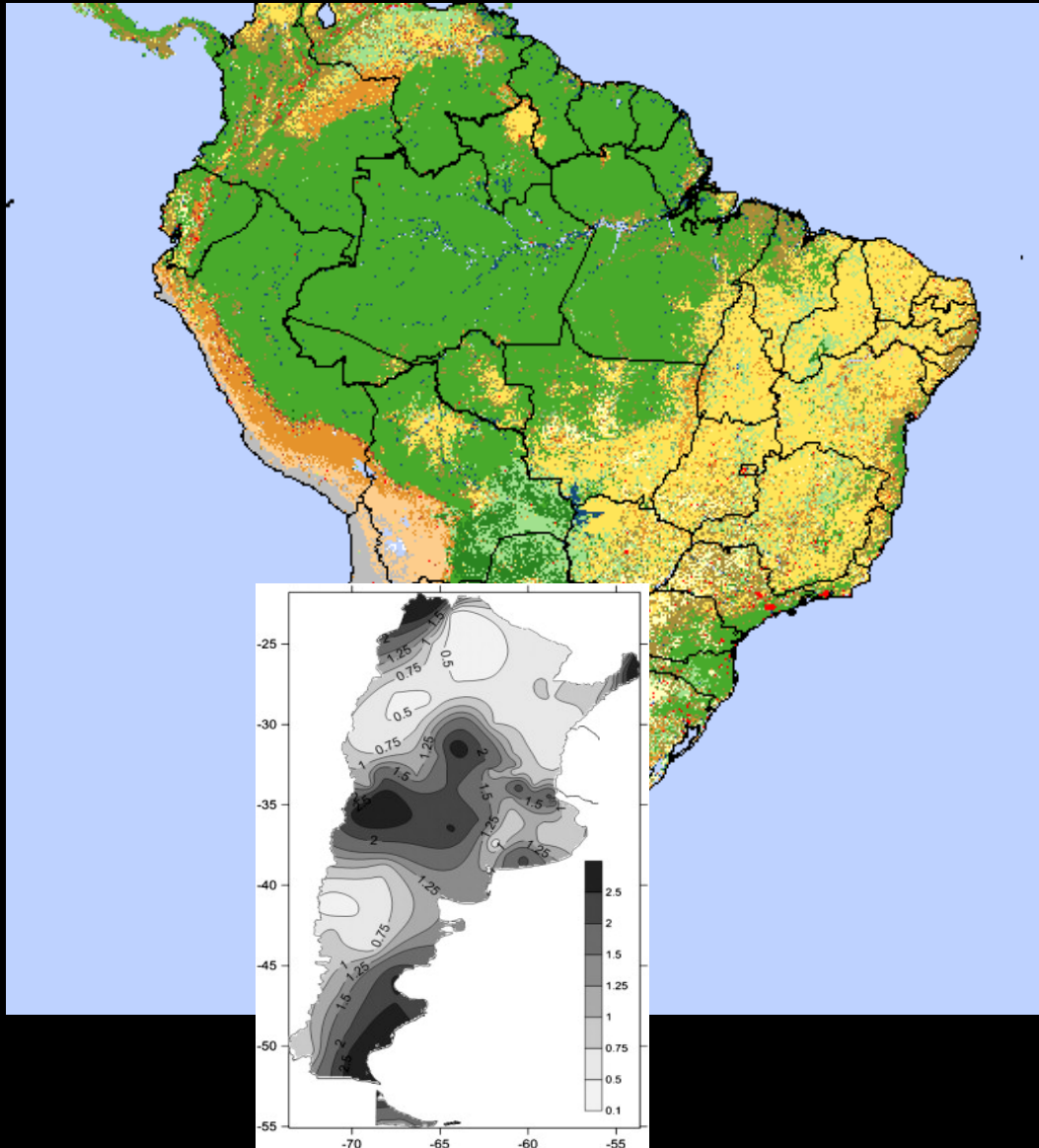
Southernmost location: Itapeva – SP (Lat: 23°59')

3. Background studies



- Satellite-based hail detection: only a few studies can be found (e.g., Cecil, 2009; Bedka, 2011; Cecil and Blankenship, 2012; Ferraro et al., 2015).
- Western border of southern Brazilian states, northern Argentina and southern Paraguay form an area of greatest extent and intensity of occurrence of hailstorms (Cecil and Blankenship; 2012)
- However, the authors used surface-based reports from USA, which reinforces the need of local ground truth to promote the advance in remote sensing products.

3. Background studies



Mezher et al. (2012) reported that Bernardo de Irigoyen, the farthest northeastern Argentina station, located just a few kilometers from the border with the Brazilian States of PR and SC, shows the highest annual mean hail frequencies of Argentina.

4. Initiatives in progress

Hailstorms in the southern Brazil

The project aims to study hailstorms in the Southern Brazil, including the identification of potential data sources, the development of a hailpad network, the collection and analysis (chemical and microbiological) of hailstones, the identification of the local, synoptic and large-scale atmospheric conditions favoring hailstorms and the use of the information to improve remote sensing techniques and the microphysics parameterization in weather forecast models.

Jorge A. Martins^{1*}

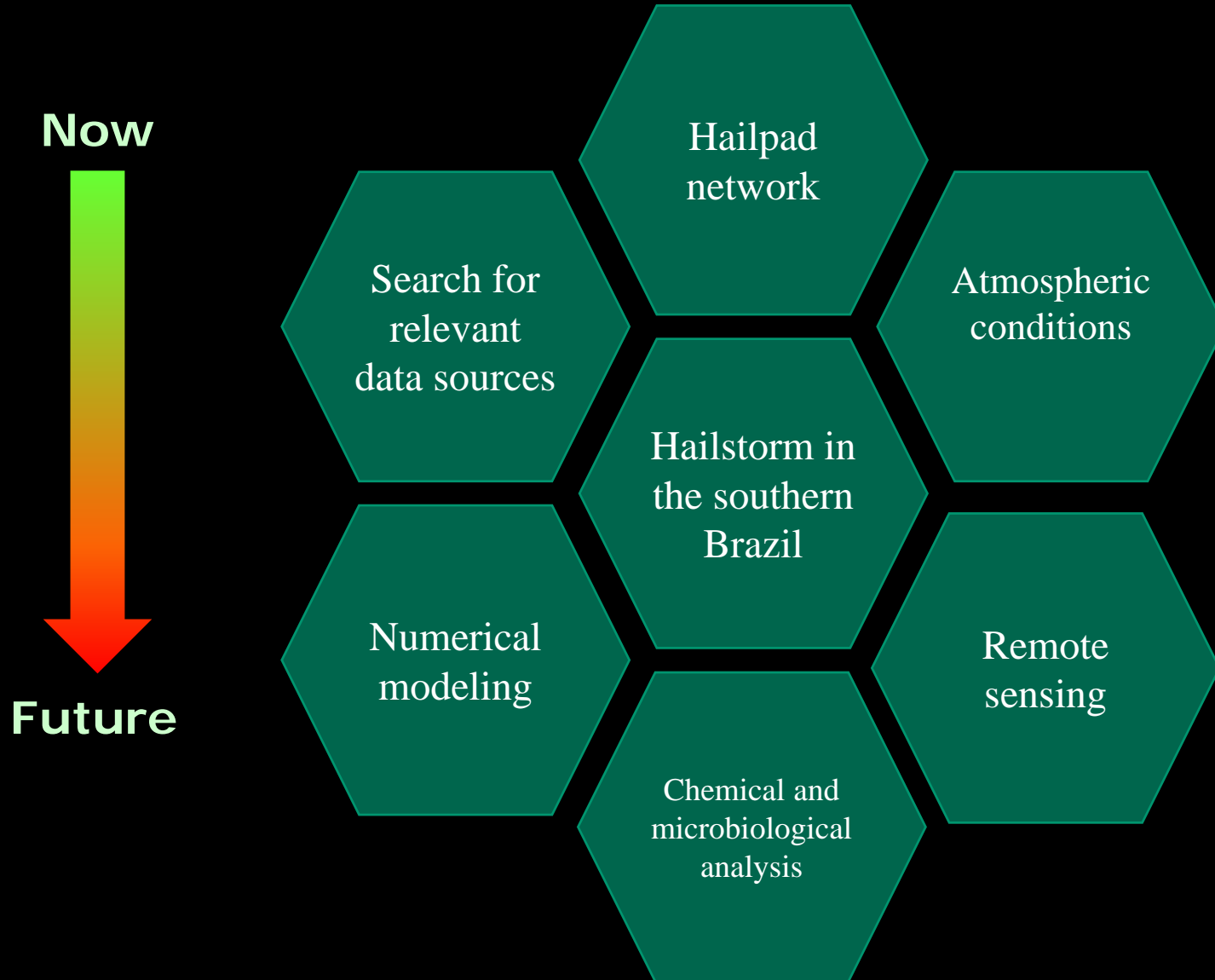
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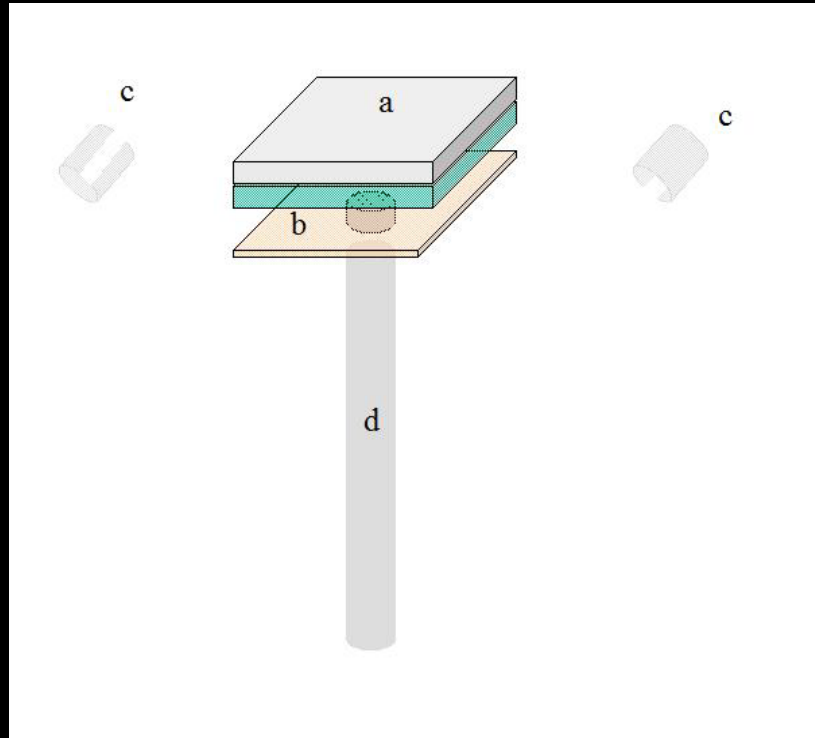
4. Initiatives in progress

Main components of the project



4. Initiatives in progress

Hailpad network



Schematic diagram of the hailpad structured: (a) Styrofoam sandwich plate partially enfolded with heavy density aluminum foil; (b) ceramic plate attached to a 100 mm diameter pvc cap – it serves as the basis for the detection Styrofoam plate; (c) connectors made of 40 mm PVC pipe; (d) support made of 100 mm pvc tubes where the cap fixed at the ceramic plate is attached. A hailpad installed in the field (right picture).

4. Initiatives in progress

Hailpad network

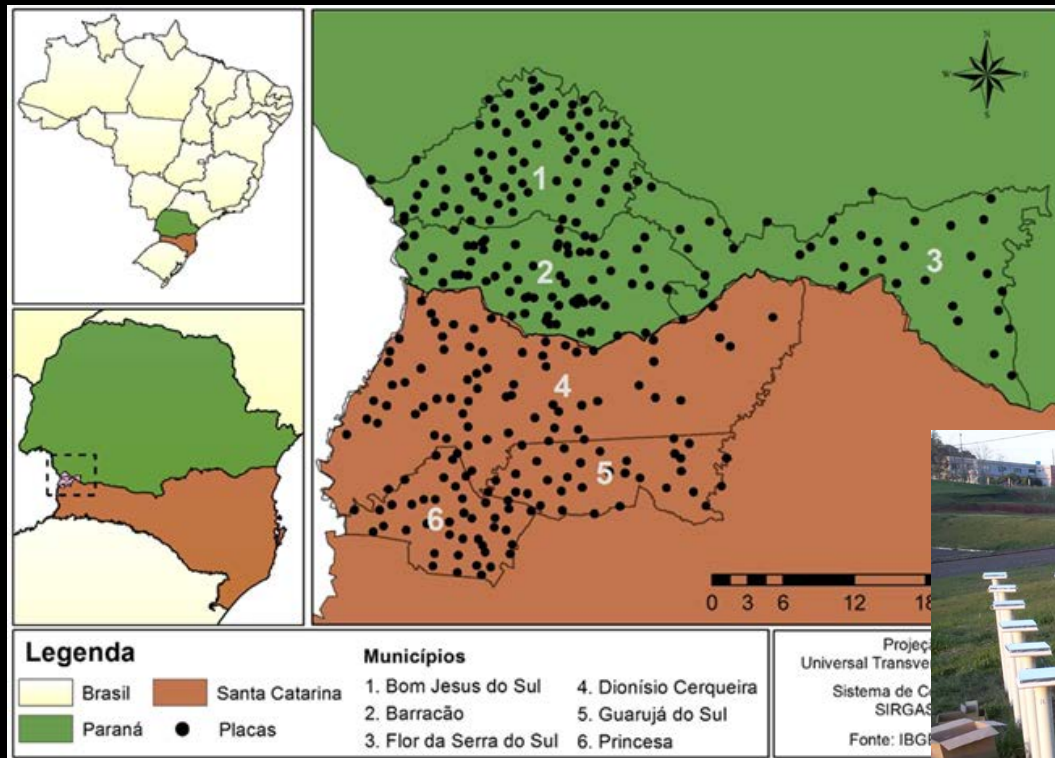
Hailpad network: Hailpads are produced by students and maintenance by students and Secretaries of Agriculture of the municipalities involved.



4. Initiatives in progress

Hailpad network

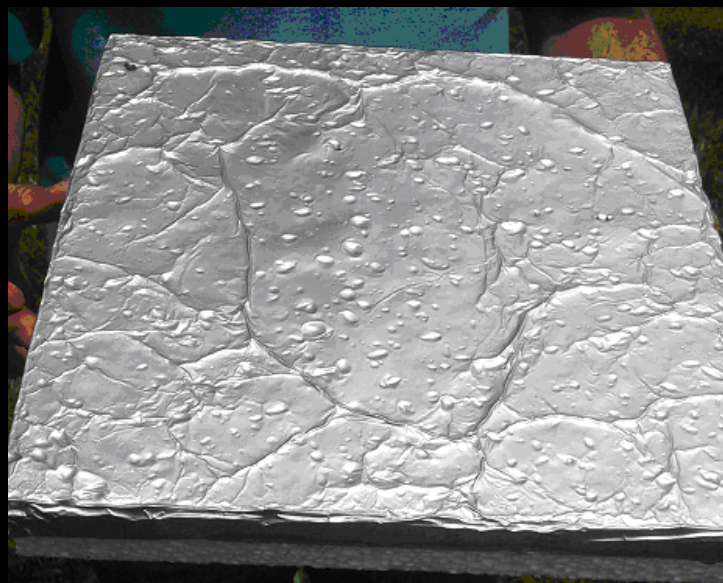
Hailpad network: July 2014 up to now - 300 hailpads in 6 municipalities + 36 hailpads for validation; only annual control, but waiting funds for a storm-by-storm control



4. Initiatives in progress

Hailpad network

Hailpad network: Now - dents mark counting; Next - hailpad calibration (relates the dents mark to the hailstone diameter)



	A	B	C	D	E	F	G	H	I	J
Diametro	DC-006	BJ-041	DC-002	BJ-009	DC-024	DC-001	DC-050	DC-030		
1										
2		3	1	2	2			1	2	
3		14	25	6	23	2	3	1	49	
4		32	32	11	51	6	6	2	55	
5		24	26	6	64	7	5	2	38	
6		17	21	4	46	2	3	6	34	
7		10	13		20	1	1	4	14	
8		4	7	2	11	2		2	4	
9		1	4		8	2			3	
10		2	2		2	2		2		
11		1	1		1					
12		1				1		1		
13										
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15										
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18										
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21										



4. Initiatives in progress

Building a database

Mining and organizing alternative database to achieve an understating of the atmospheric conditions favoring hailfall in the region: Brazilian National Civil Protection; conventional weather station networks (INMET, Airports, local networks); farm hail insurance; legal actions involving hail; a hailpad network operated around Fraiburgo – SC.



National Institute of Meteorology - INMET



Meteorological Network of Aviation Command (REDEMET)

4. Initiatives in progress

Building a database

1) Reports released by the Brazilian National Civil Protection: reports based on emergency assistance - hail is the cause of the disaster (nationwide); 22 year period from 1991 to 2012; NR=1630

2) Reports released by the Brazilian National Civil Protection: reports based on emergency assistance - hail could not be the cause of the disaster, but it was reported (PR); 36 year period from 1981 to 2016; NR=889

3) WSN Agronomic Institute of Paraná (IAPAR): hail is reported (PR); 30 year period from 1986 to 2015; NR=2833)

4) WSN Information Center on Environmental and Hydrometeorological Resources (CIRAM): hail is reported (SC); 69 year period from 1948 to 2016; NR=2253

5) WSN National Institute of Meteorology (INMET): hail is reported (nationwide); 41 year period from 1972 to 2012; NR=935

4. Initiatives in progress

Building a database

6) WSN Aviation Command (REDEMETS): hail is reported (nationwide); 14 year period from 2003 to 2016; NR=335

7) AGF Anti-Granizo Fraiburgo Ltda - hail prevention system using silver iodide ground generators: Hailpad network operated around Fraiburgo (SC); 19 year period from 1998 to 2016; NR=

8) Association of Brazilian Tobacco Growers (Afubra): farm hail insurance (southern states); +50 year period from 1956/1963 to 2016; NR=

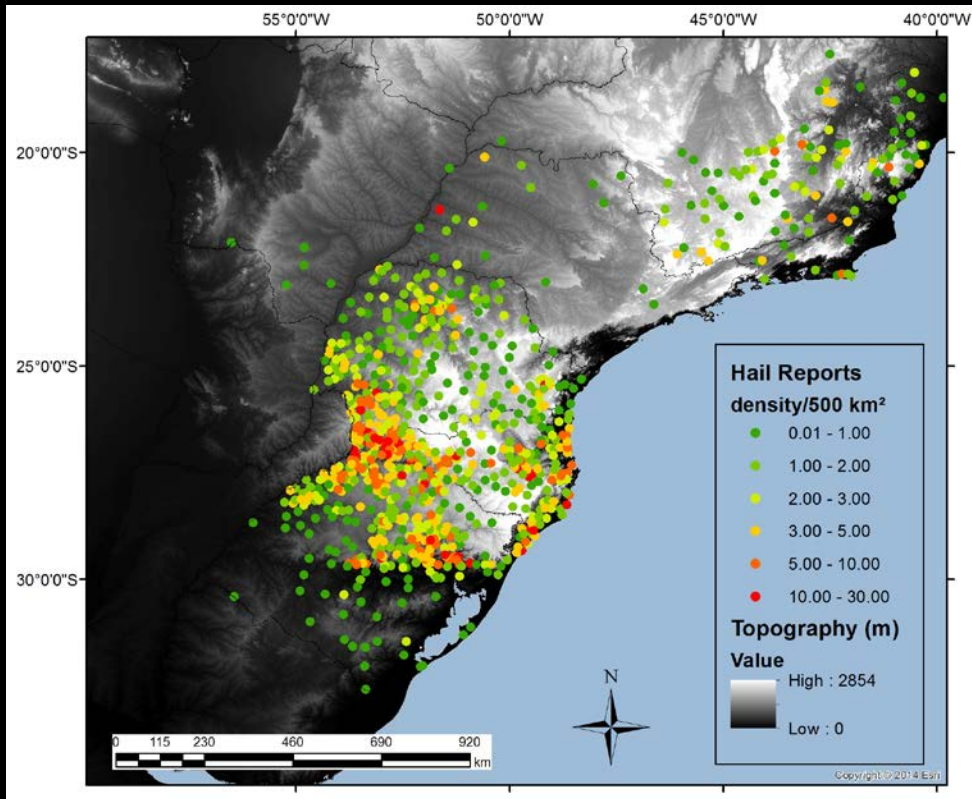
9) Brazilian Justice System: hail is mentioned in legal actions involving hail (nationwide); 25 year period from 1991 to 2015; NR= 829

4. Initiatives in progress

Building a database

Reports released by the Brazilian National Civil Protection – based on reports of emergency assistance given to the population affected by the disaster - assumed to be destructive hailstorms.

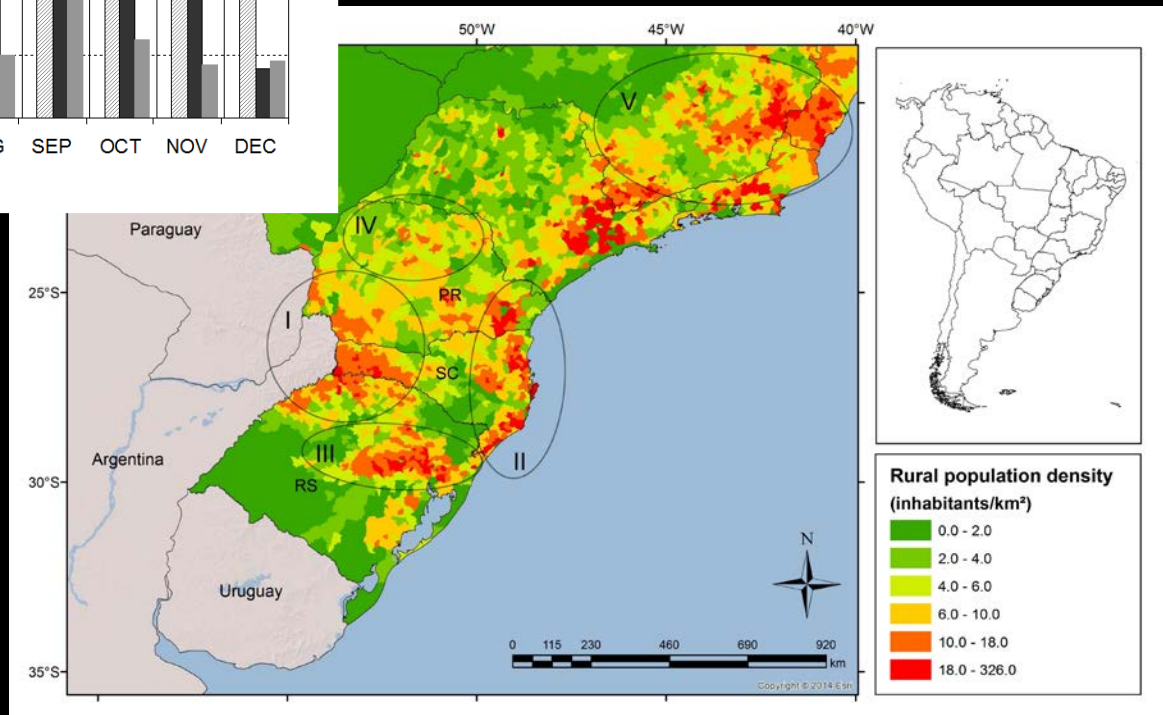
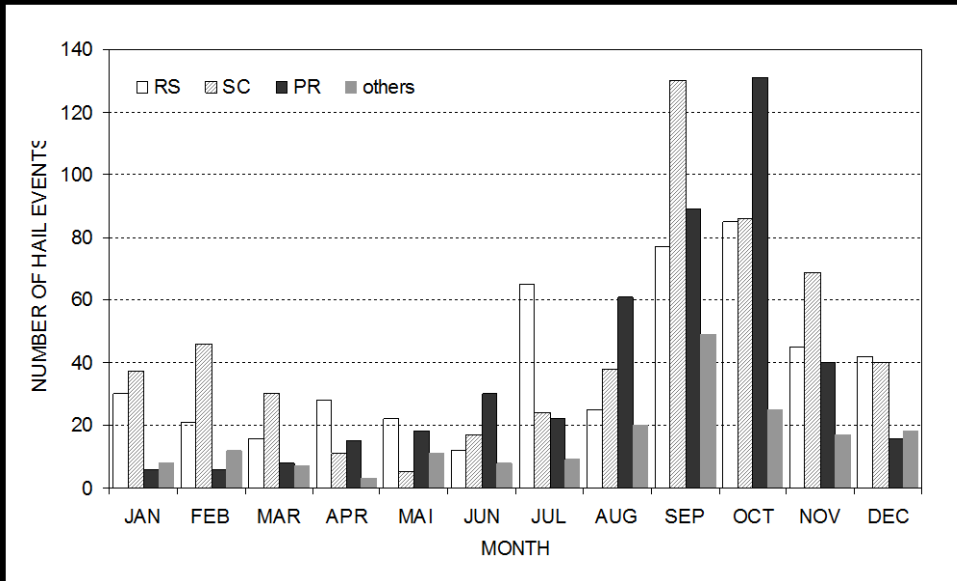
- large spatial variability, with the majority of hailstorm in the three southernmost states;
- Most hailstorms in the late afternoon and evening of the winter/spring transition, in agreement with a few other studies in the subtropics;
- discrepancies compared to satellite signatures, but confirm that the region is prone to the development of destructive hail storms.



4. Initiatives in progress

Building a database

- number of hail reports correlated with population in rural areas;
- different from the majority of studies for temperate zones, which suggest spring/summer as the hail season;



4. Initiatives in progress

Atmospheric conditions favoring hailfall

The southern Brazil is affected by several weather systems, often acting in combination, making it difficult to interpret which one is the most responsible by causing hail at the ground.

The main atmospheric systems crossing the southern Brazil are:

- Cold frontal systems (CFSs), which are more frequent during the winter and spring;
- Local convective systems (LCSs), common during warm months and may also be associated to the passage of CFSs
- Intensification of the low level jet (LLJ).



- How such atmospheric systems combine to produce hailstorms is an open question

- Mesoscale convective complexes (MCCs), which can form in the west over northern Argentina and southern Paraguay and move eastward reaching the southern region
- Large-scale forcing associated with the middle and upper-level circulation such as the upper-level jet (ULJ); open question.

To conclude:

We have to keep working hard!!

Thank you for your attention!

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