Group 2: Checking/Verification & Time Series

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Group 2: Scientific questions

- Can we nowcast severe storms using non-parametric adaptive methods?
- How can we improve the forecasting of droughts and their impact in the Paraíba do Sul basin?

Group 2: Scientific question I -- **Storms**

- **Forecasting severe storms using non-parametric adaptive methods**
  - The frequency of extreme-precipitation events has increased in the last few decades
  - Climate change models predict worsening conditions in coming years, leading to an increase in natural disasters (landslides and floods)
  - Current methods for nowcasting storms combine parametric non-adaptive techniques
  - Short range weather predictions ~ 6 hours ahead of storm

Group 2: Storm Nowcasting -- **Data**

- Satellites
  - Useful visual information about the cloud top -- their height, temperature, total precipitable water, and so on.
  - Spatial resolution: 1km x 1km and 4km x 4km (further reduced by new tech.). Temporal resolution: 30 minutes (new tech. ~ 15 minutes).

- RADAR
  - 3D data, offering hydrometer classification estimates and severe signature.
  - Spatial resolution: 2km x 2km. Temporal resolution: 10 minutes.

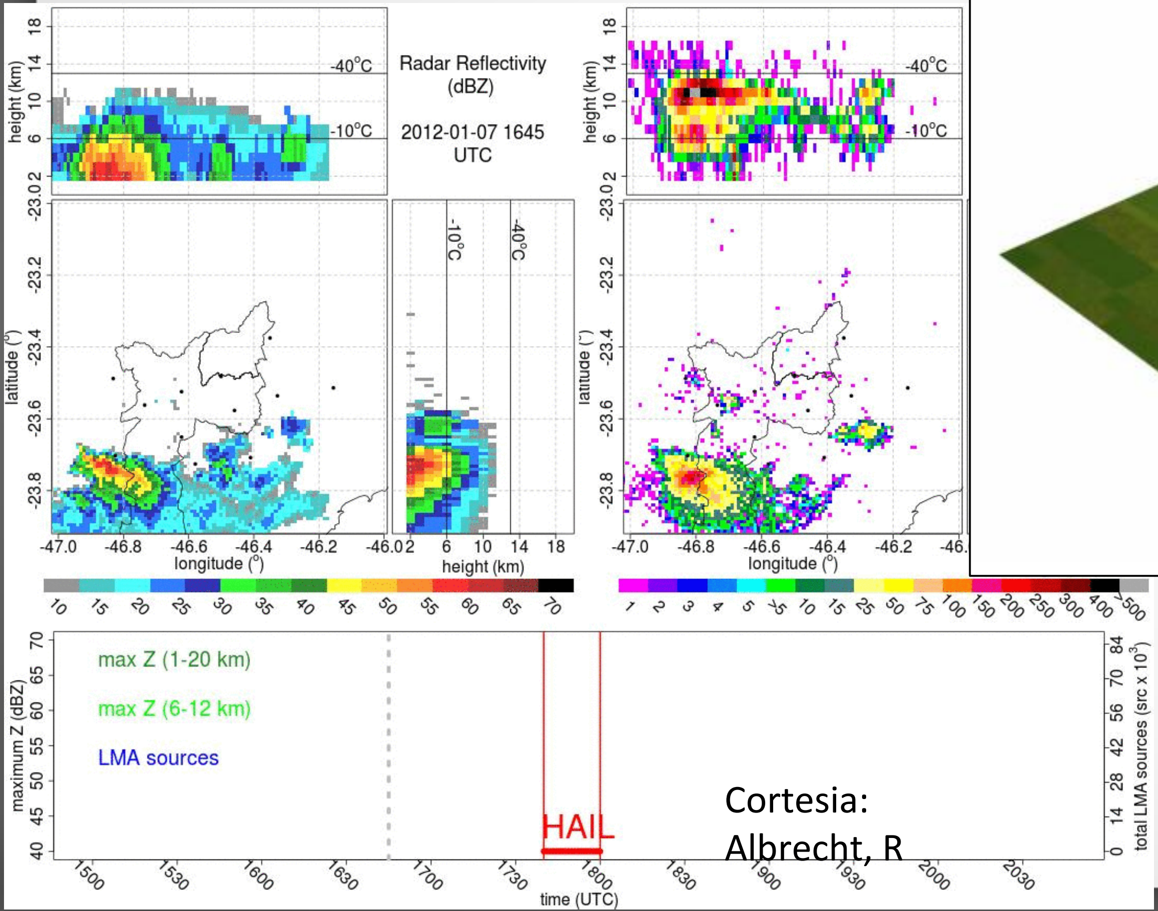
- Numerical Weather Models
  - Offer a wide data range for input into nowcast.
  - Spatial resolution: 5km x 5km. Temporal resolution: 1-6 hour.

DATABASE: Field campaign

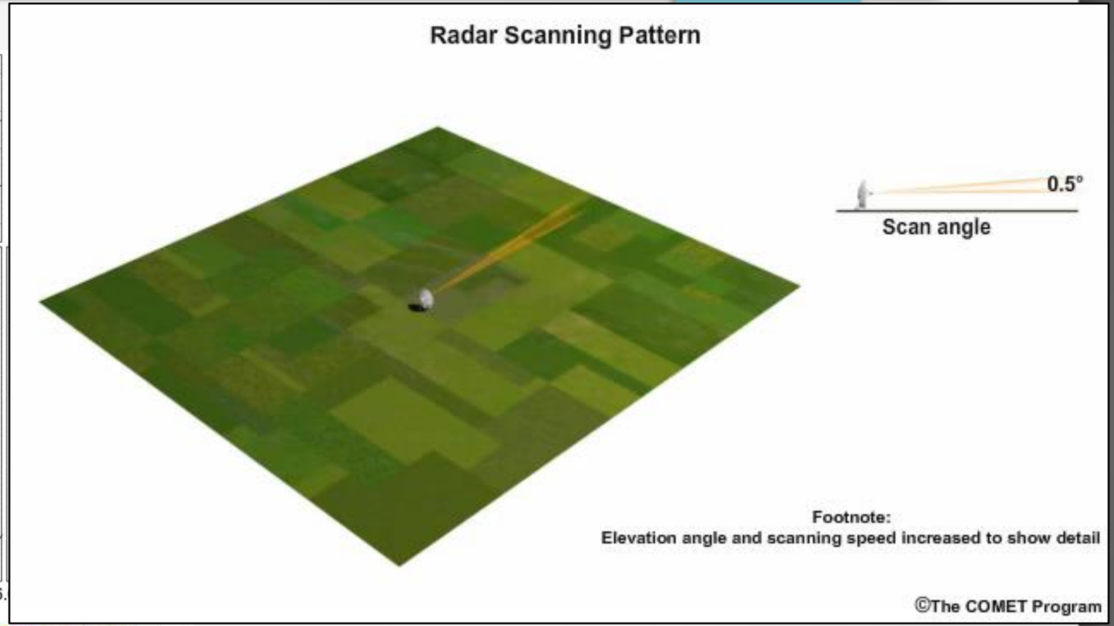
Cloud process of tHe m ... A contribUtion to cloud re

The CHUVA Project – how does convection vary across Brazil? Machado et al., 2014 – Bull. Amer. Met. Soc.

DATABASE: Weather RADAR Data: 3D (lat,lon,level) 2x2km, 10 minutes temporal resolution

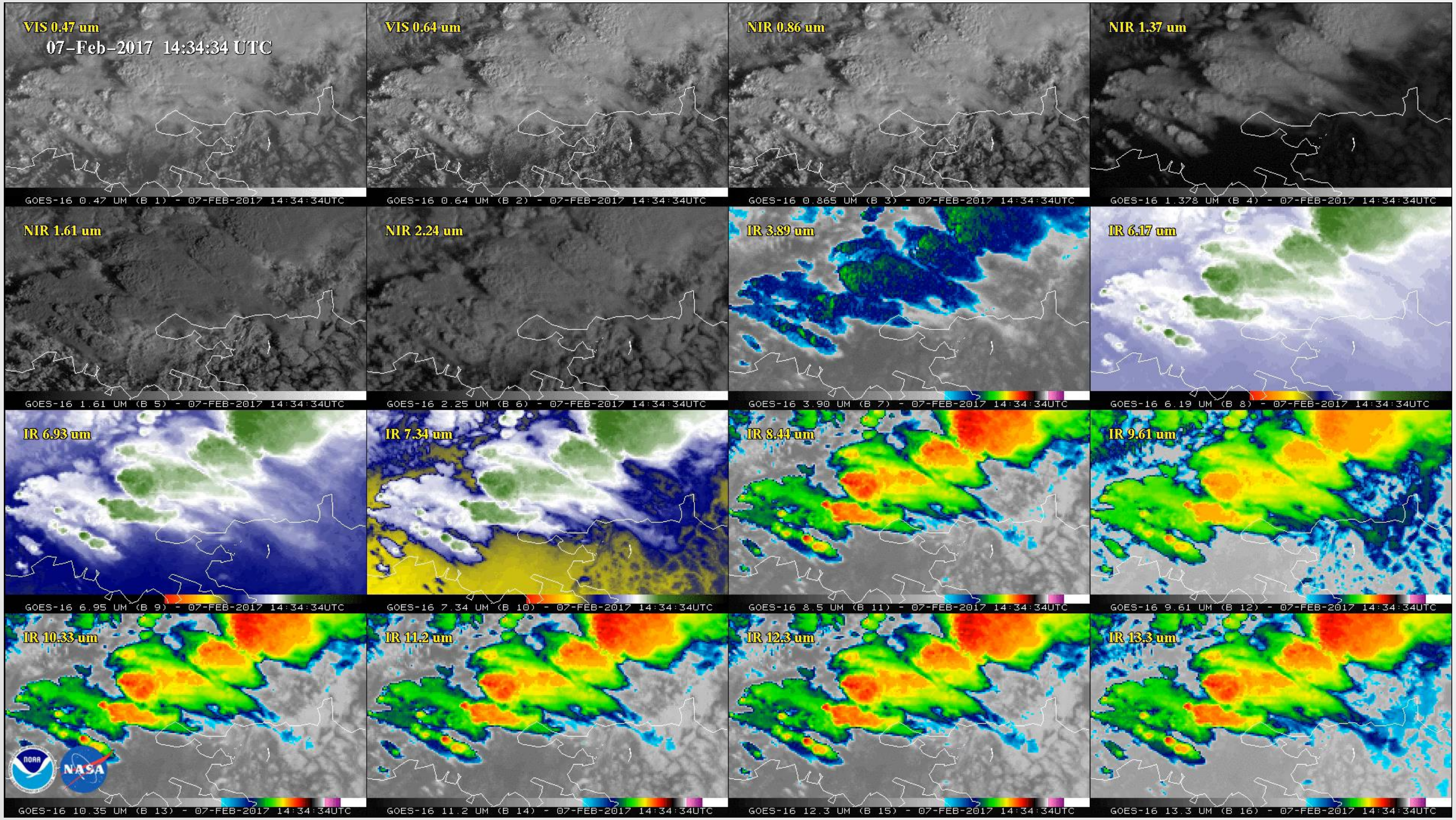


Cortesia: Albrecht, R



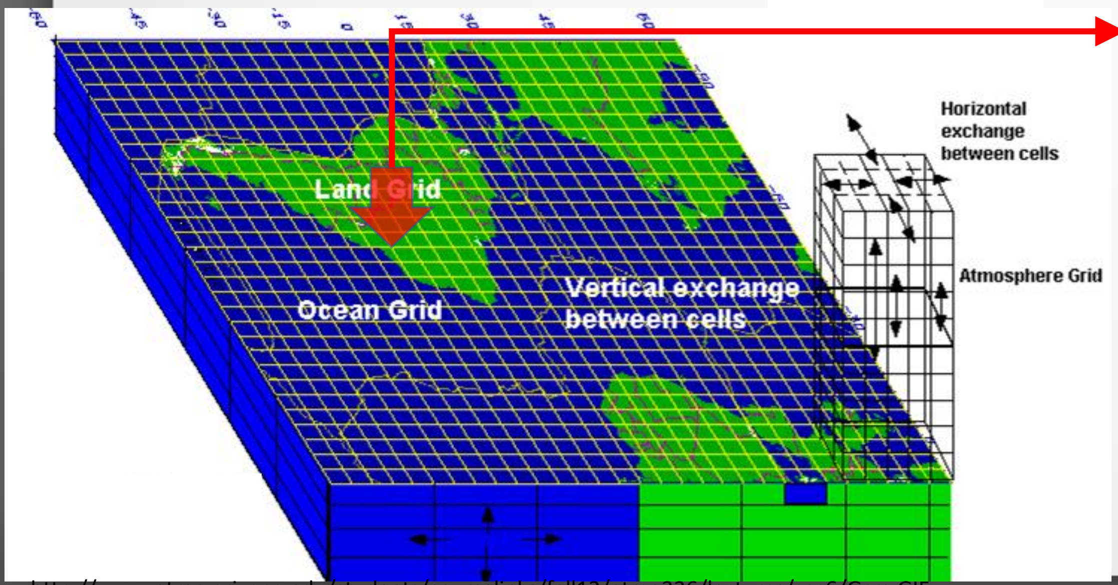
	Z_{HH} (dBZ)	Z_{DR} (dB)	$\rho_{HV}(0)$	K_{DP} (deg km^{-1})	Temperature (°C)
Drizzle	10-25	0.2 to 0.7	>0.97	0 to 0.06	>-10
Rain	25 to 60	0.5 to 4	>0.95	0 to 20	>-10
Snow (dry, low density)	-10 to 35	-0.5 to 0.5	>0.95	-1 to 1	< 0
Snow* (dry, high density)	-10 to 35	0.0 to 1	>0.95	0 to 0.4	<0
Snow (wet, melting)	20 to 45	0.5 to 3	0.5 to 0.9	0 to 1	0 to 5
Graupel, dry	20 to 35	-0.5 to 1	>0.95	0 to 1	<0
Graupel, wet	30 to 50	-0.5 to 2	>0.95	0 to 3	-15 to 5
Hail, small < 2 cm wet	50 to 60	-0.5 to 0.5	0.92 to 0.95	-1 to 1	-15 to 20
Hail, large > 2 cm wet	55 to 65	-1 to 0.5	0.90 to 0.92	-1 to 2	-25 to 20
Rain and hail	45 to 80	-1 to 6	>0.9	0 to 20	-10 to 25

DATABASE: Weather Satellite Data: 2D (lat,lon) 1x1 to 4-4km resolution, every 15 (New GOES and MSG) or 30 minutes

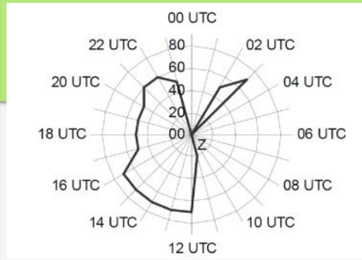


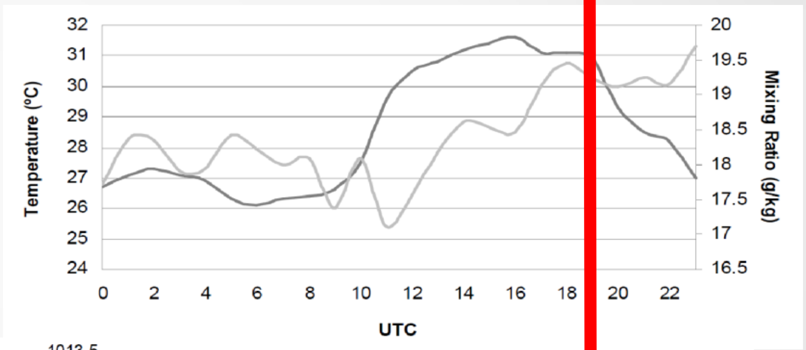
DATABASE:

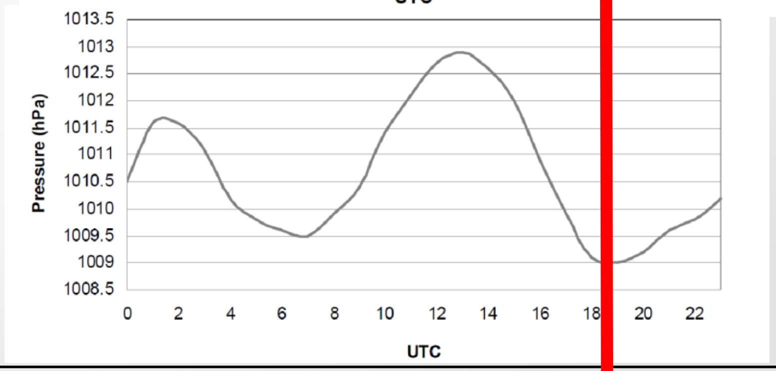
Numerical Weather Models: 3D (lat,lon,level) – 6 hour or 1 hour temporal resolution of analises data and every 1 hour for forecasting
Ground station: up to 1 hour



http://www.atmo.arizona.edu/students/courselinks/fall12/atmo336/lectures/sec6/Gcm.GIF







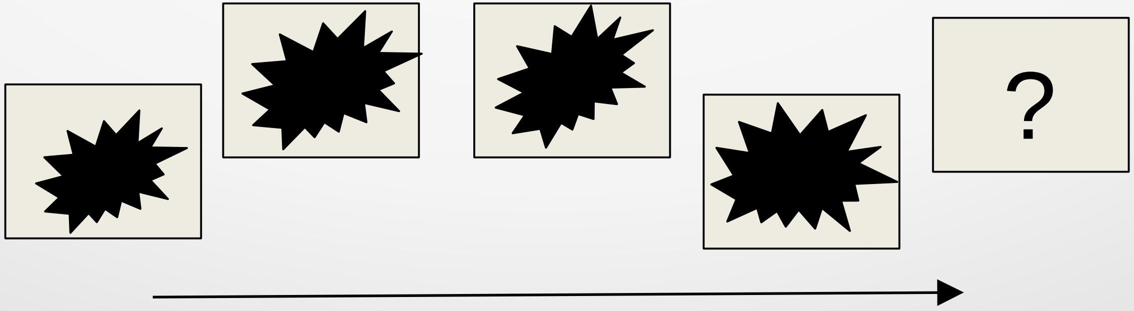
Time

Group 2: Storm Nowcasting -- **Methods**

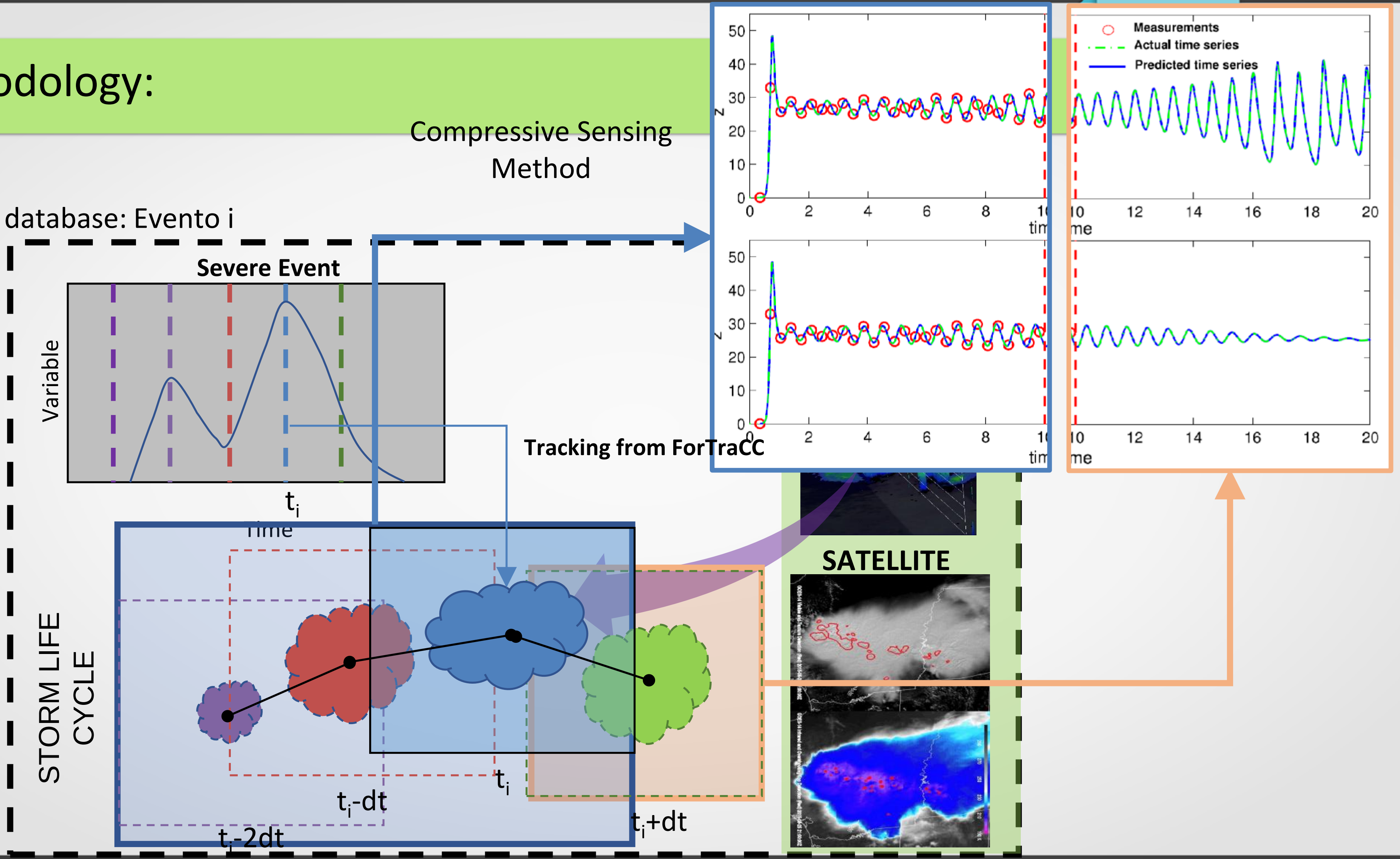
- Which variables are important?
  - Huge amount of data available, but most may be irrelevant for our purposes or have strong interdependencies.
  - Machine learning use allows to isolate the most relevant variables -- nowcasts need to be very computationally efficient to be effective.
- After sufficiently reducing the problem-size (relevant variable identification), we proceed to produce the forecasts.

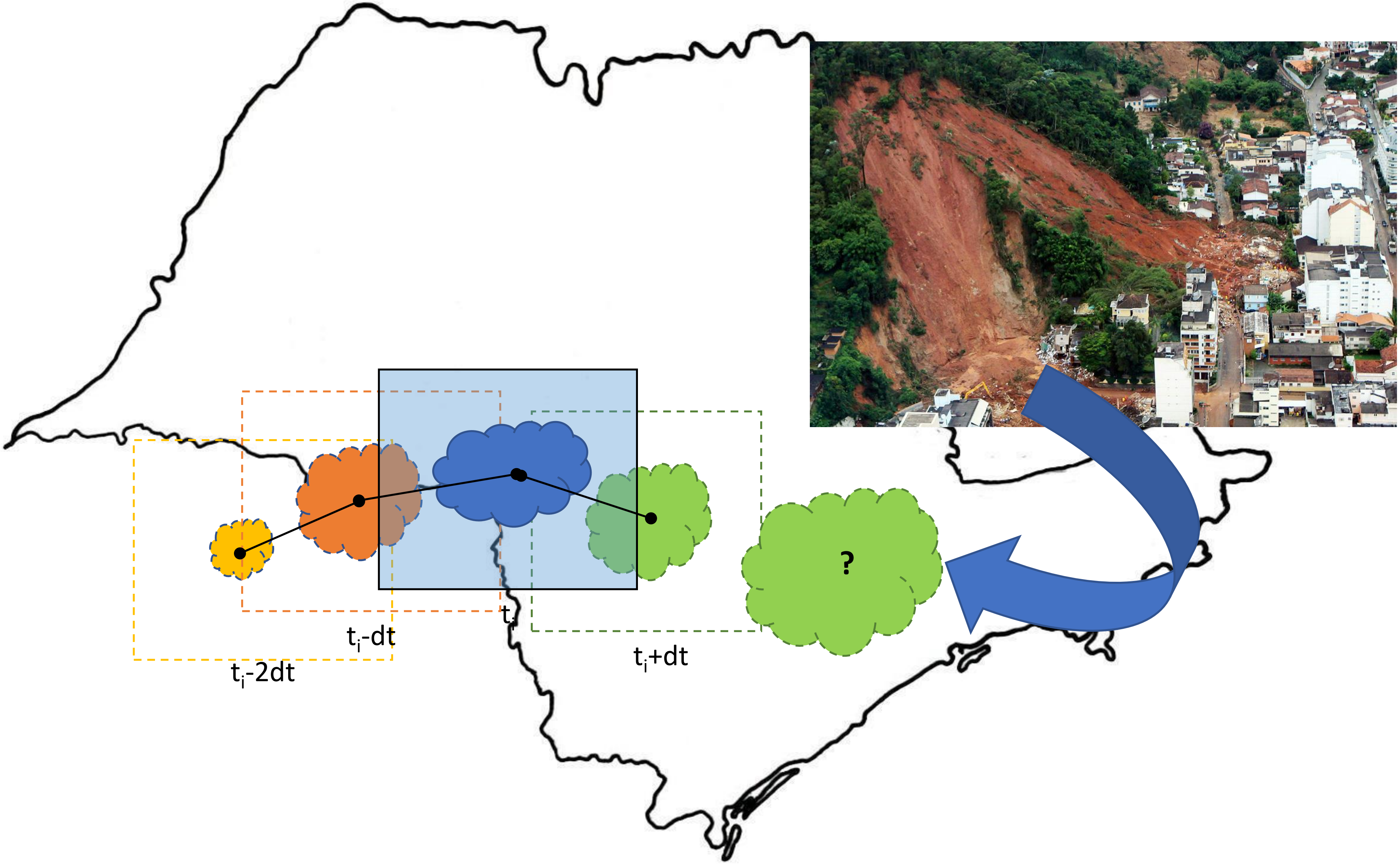
Group 2: Storm Nowcasting -- **Methods**

- "Lagrangian" nowcasting: storm-chasing
  - Follow the developing storm along its trajectory.
  - Derive dynamical model using Compressive Sensing; fitting previous data recordings and extrapolating to the future.
  - Predict system's development and perform parameter changes in the dynamical model to assess possible tipping points.



Methodology:





t_i-2dt
t_i-dt
t_i
t_i+dt
?

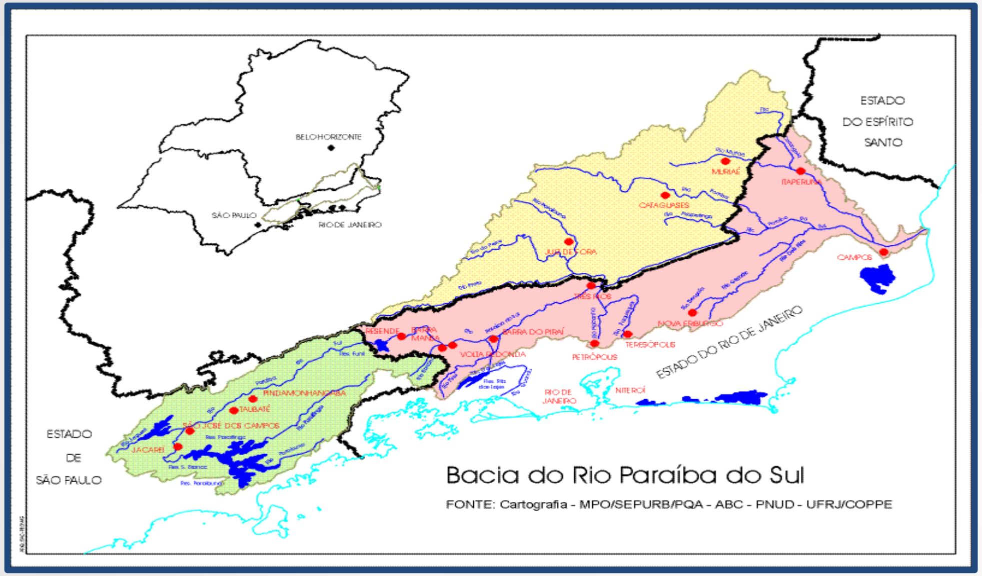
Group 2: Storm Nowcasting -- **Methods**

- "Eulerian" nowcasting: risk areas focus
  - High risk areas ~ landslides or flooding
  - Develop early-warning indicators for these areas
  - Diagnose pre-convective states: apply compressive sensing to weather variable time-series and local information (e.g., rain gauge and soil humidity)
- Overarching Goal:
  - Two parameter-free algorithms -- one for predicting severe storm characteristics and the other for early warning of potentially catastrophic natural hazards

Group 2: Scientific questions II -- **Droughts**

- **Forecasting droughts and their impact in the Paraíba do Sul Basin**
  - The Paraíba do Sul Basin is a water-supply for one of the most populous and wealthy Brazilian cities, Rio de Janeiro
  - Seasonal drought forecasting is still a challenge
  - Areas in need of further work include assessing the impact of droughts on socio-economic sectors, such as energy production and water supply
  - Drought representation in climate system forecasts (CMIP5) on future climate scenarios can support decision makers to reduce the potentially devastating impacts of drought

Group 2: Motivation -- **Droughts**



http://www.brasilpost.com.br/2014/10/15/sistema-cantareira-imagens-de-satelite_n_5992402.html

Group 2: Drought Forecasting -- **Data**

- Observation
  - Variables: precipitation, temperature, evapotranspiration, stream flow
  - GPCP, INMET, ANA, INPE, CEMADEN, ONS

- Numerical climate models
  - North America Multimodel Ensemble
  - CMIP5
  - Regional Climate Models (RegCM, ETA)
  - Streamflow: basin committee (AGEVAP, ANA)

Group 2: Drought Forecasting -- **Methods**

- Index Calculations: SPI, PDSI, SPEI on different time scales (McKee et al., 1993; Palmer, 1965; Vicente-Serrano et al., 2010)
- Quantification of drought: duration, frequency, severity (Spinoni, et al. 2014; Spinoni, et al. 2015)
- Forecast quality assessment using several verification measures, such as Pearson and Spearman correlation coefficient, Brier skill score, continuous ranked probability skill score, and ROC curves (Hersbach, 2000; Stephenson et al., 2008; Wilks, 2006; Jolliffe and Stephenson, 2012)
- Quantify the sampling uncertainty using non-parametric bootstrap method (Mason, 2008; Jolliffe and Stephenson, 2012)
- Assessment of models projections: CMIP5 and Regional Climate Models - drought representation in historical period and quantification of changes for future periods in different RCPs

Group 2: Thanks!

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