

# Xweather

Setting and visualizing weather simulations

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Co-advisor: Prof. DSc. Marcio Cataldi

# how to model the atmosphere?



Governing Equations

$$\frac{\partial u}{\partial t} \quad \frac{\partial v}{\partial t} \quad \frac{\partial w}{\partial t}$$

Observed Data



Physics



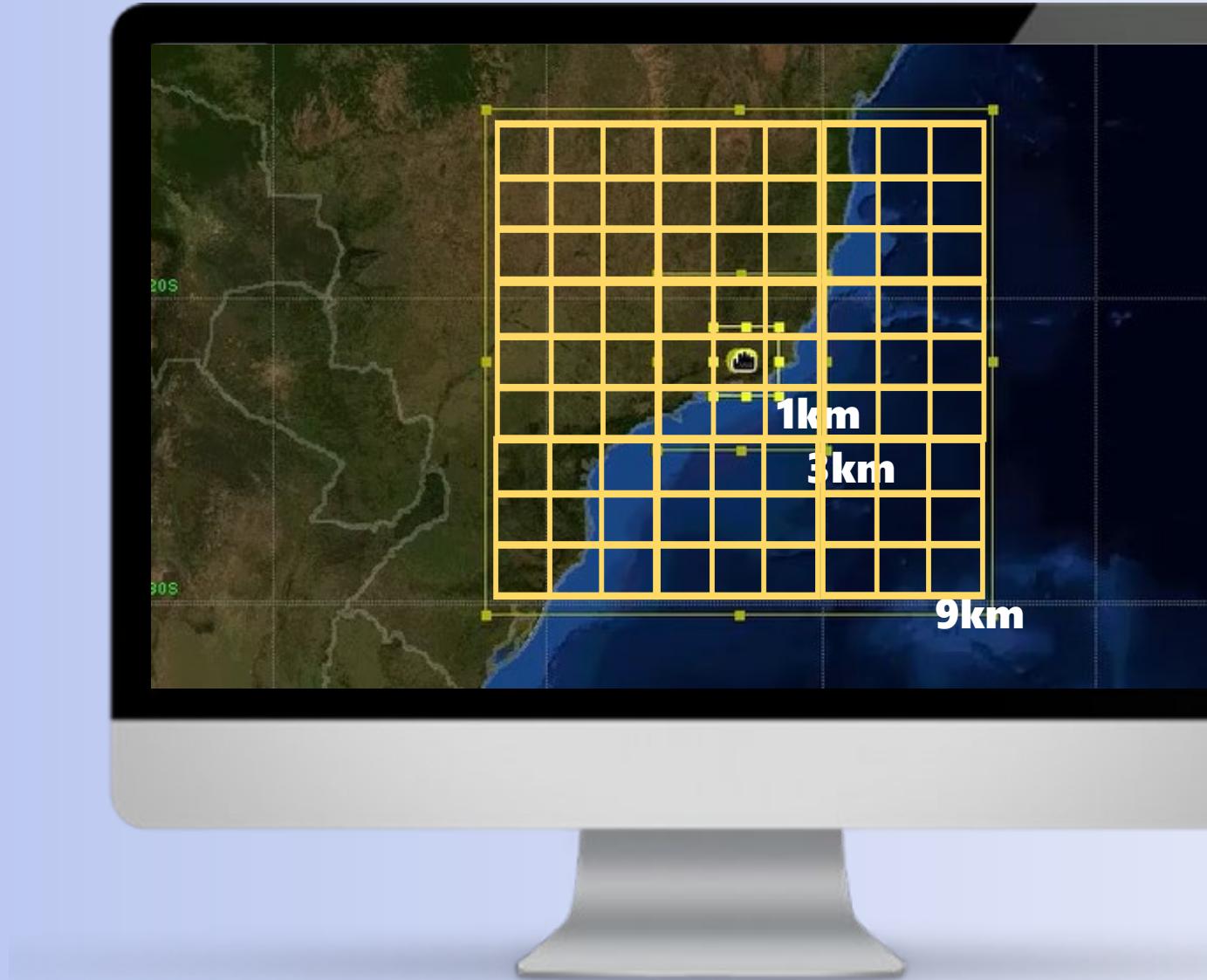
# set up, perform and analyze a forecast

**Weather Research & Forecasting Model  
(WRF)**



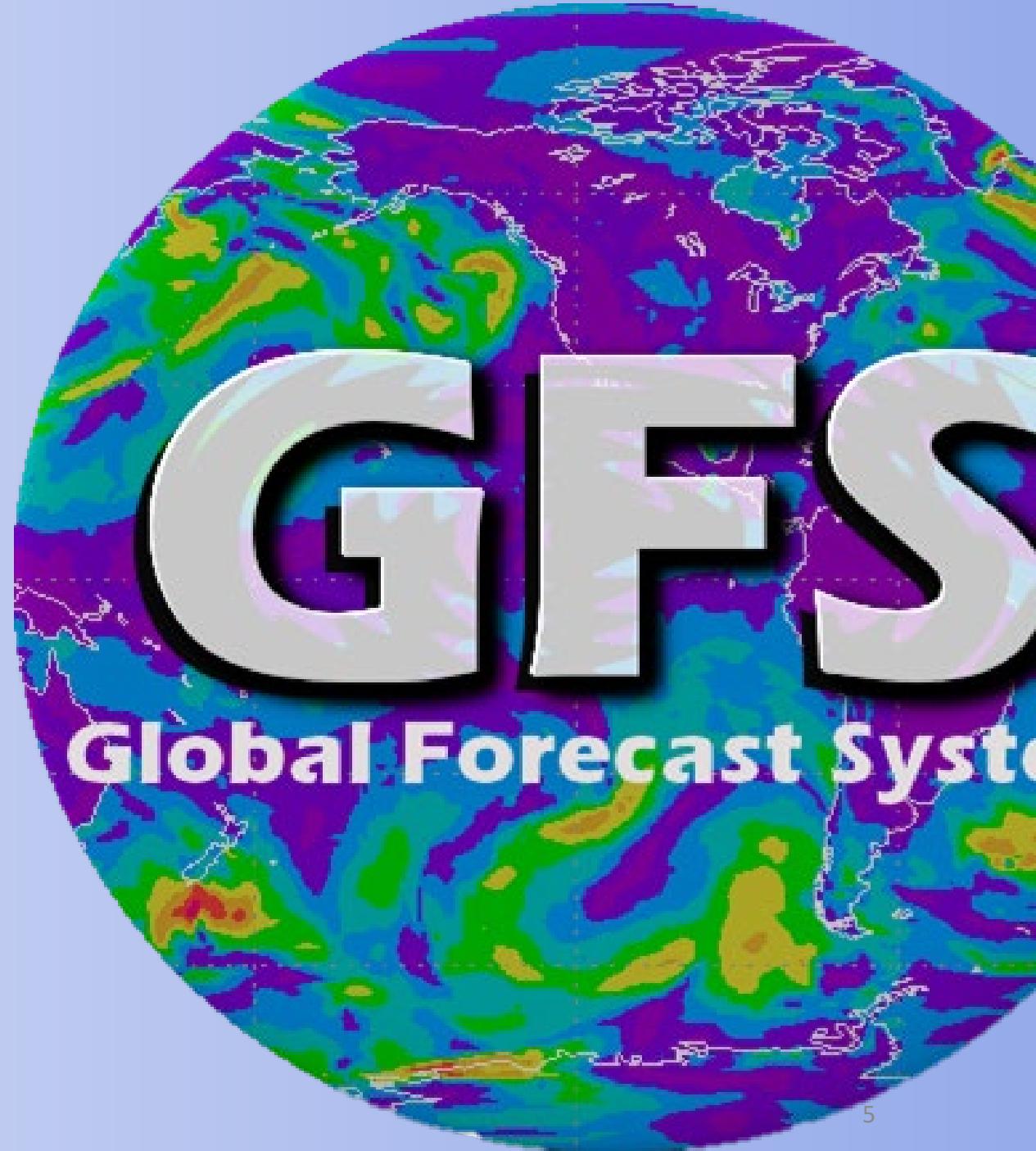
# 1 Domains

Delimit regions of  
interest with  
different resolutions



# 2 ICBC

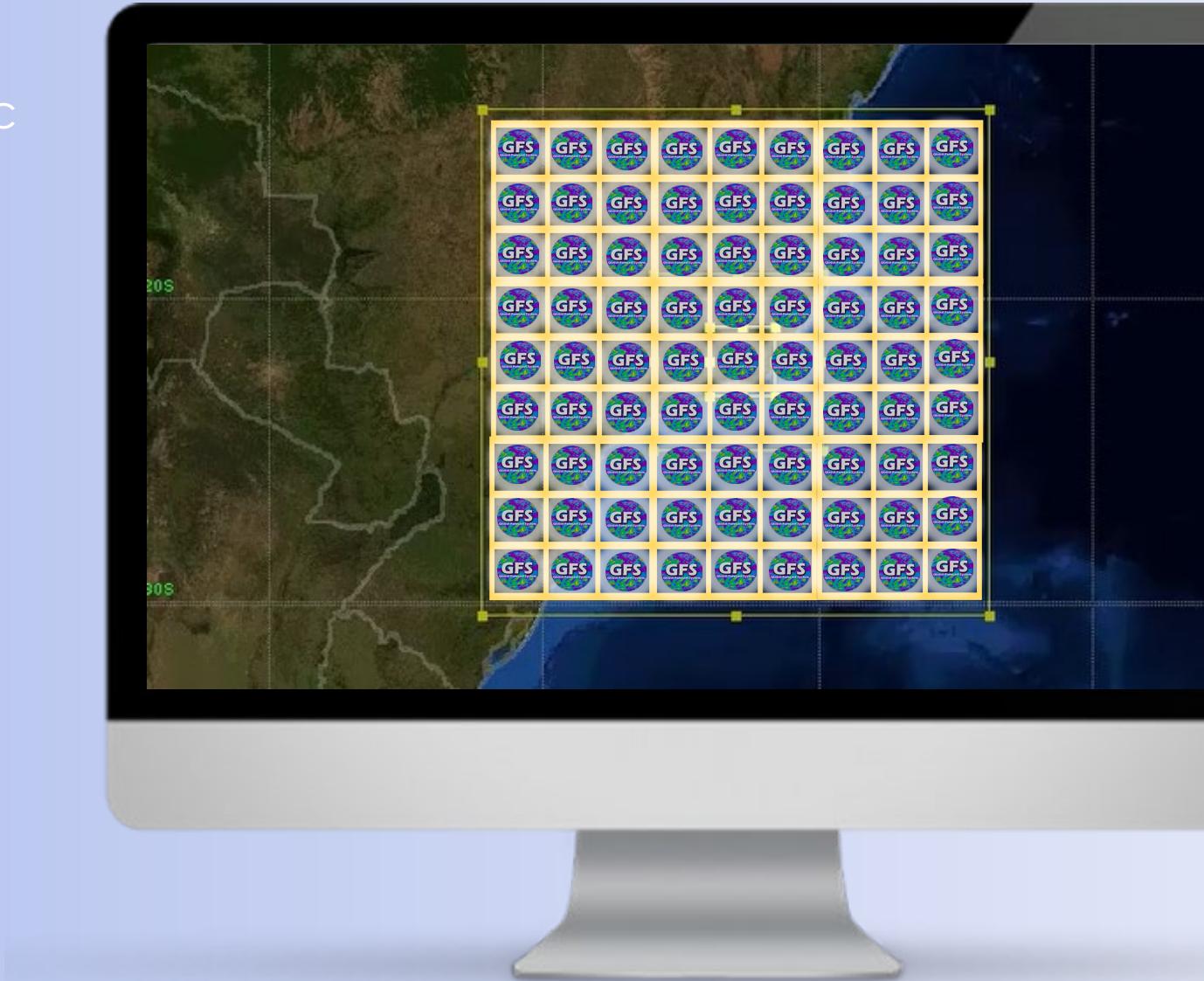
Download icbc  
according to run  
date



# 3

## MERGE

domains and icbc



# 4 RUN

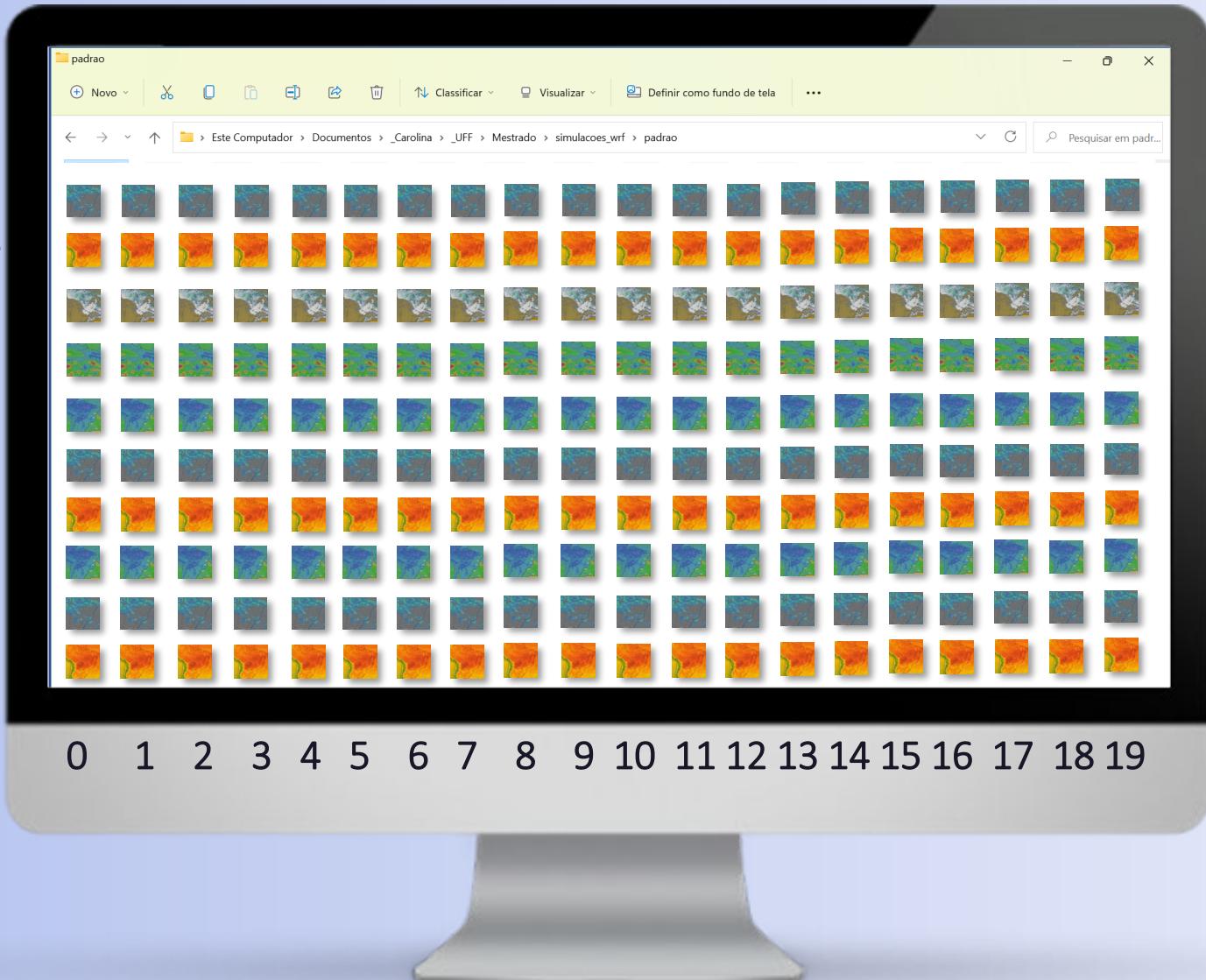
Wait until the run  
is over.

```
EROD (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/erod/')
CLAYFRAC (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/clayfrac_5m/')
SANDFRAC (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/sandfrac_5m/')
IRRIGATION (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/irrigation/fao/')
CONLS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/conls/')
VARLS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/varls/')
OA1LS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/oails/')
OA2LS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/oa2ls/')
OA3LS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/oa3ls/')
OA4LS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/oa4ls/')
OL1LS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/ol1ls/')
OL2LS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/ol2ls/')
OL3LS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/ol3ls/')
OL4LS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/ol4ls/')
CONSS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/conss/')
VARSS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/varss/')
OA1SS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/oa1ss/')
OA2SS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/oa2ss/')
OA3SS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/oa3ss/')
OA4SS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/oa4ss/')
OL1SS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/ol1ss/')
OL2SS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/ol2ss/')
OL3SS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/ol3ss/')
OL4SS (priority=1, resolution='default', path='../../Build_WRF/WPS_GEOG/orogwd3_10m/ol4ss/')
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Successful completion of wrf.      !
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
carolina@localhost WPS]$ █
```

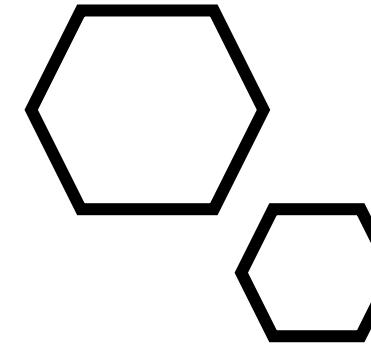
# 5 ANALYSIS

Generate figures

convergence  
temperature  
divergence  
Instab. Idx.  
moisture  
v. motion  
pressure  
clouds  
rainfall  
wind



```
3 require File.expand_path("../..", __FILE__)
4 # Prevent database truncation if the environment is test
5 abort("The Rails environment is running in production mode!
6 require 'spec_helper'
7 require 'rspec/rails'
8
9 require 'capybara/rspec'
10 require 'capybara/rails'
11
12 Capybara.javascript_driver = :webkit
13 Category.delete_all; Category.create!
14 Shoulda::Matchers.configure do |config|
15   config.integrate do |with|
16     with.test_framework :rspec
17     with.library :rails
18   end
19 end
20
21 # Add additional requires below this line if you need them
22
23 # Requires supporting ruby files with custom matchers and
24 # run as spec files and its subresources. This means you're
25 # in _spec.rb will both be required. For explanation of each
26 # require see https://rspec.info/documentation/multi-file-specs.html
27 # end with _spec.rb. You can continue to use test-only
28 # code here, but you won't need it in most cases.
29
30 # option on the command line. It will also be required in
31 # the support file under the same name.
32
33 # mongoid
34
35 # buffer
```



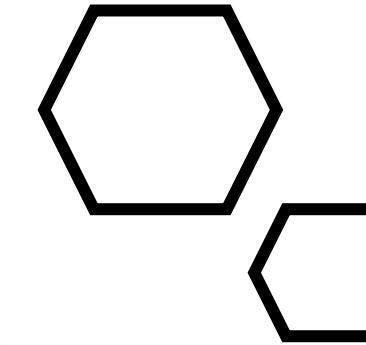
# X-Weather – v1

Data visualization

Statistics and Probability

Ensembles with different parameterizations

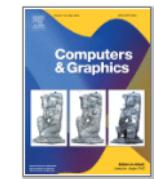
```
3 require File.expand_path("../..", __FILE__)
4 # Prevent database truncation if the environment is test
5 abort("The Rails environment is running in production mode!
6 require 'spec_helper'
7 require 'rspec/rails'
8
9 require 'capybara/rspec'
10 require 'capybara/rails'
11
12 Capybara.javascript_driver = :webkit
13 Category.delete_all; Category.create!
14 Shoulda::Matchers.configure do |config|
15   config.integrate do |with|
16     with.test_framework :rspec
17     with.library :rails
18   end
19 end
20
21 # Add additional requires below this line if you need them
22
23 # Requires supporting ruby files with custom matchers and
24 # run as spec files and its subresources. This means you're
25 # in _spec.rb will both be required. For explanation of
26 # run twice. It is recommended that you do not name
27 # end with _spec.rb. You can configure this one time
28 # option on the command line.
29
30 # option on the command line.
31
32 # No results found for 'mongoid'
```



# X-Weather – v1



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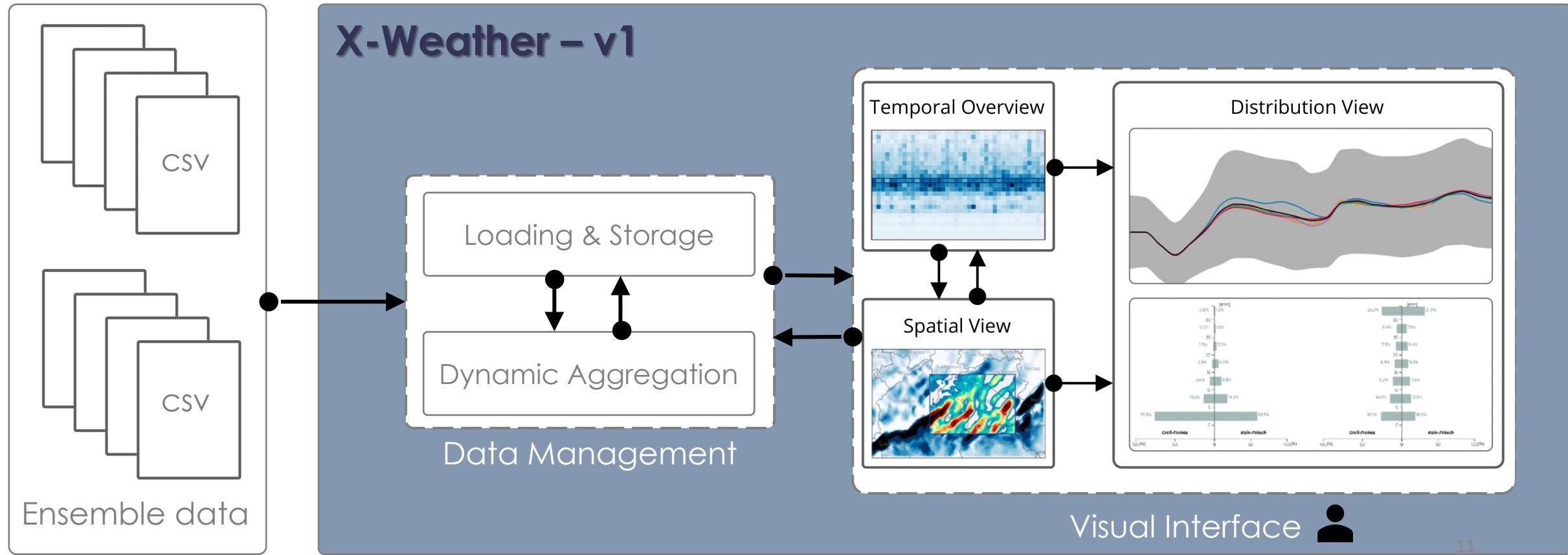


Special Section on EnvirVis

Visualizing simulation ensembles of  
extreme weather events

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Marcio Cataldi <sup>a</sup>✉, Fabio Miranda <sup>b</sup>✉, Marcos Lage <sup>a</sup>✉

# Preprocessing



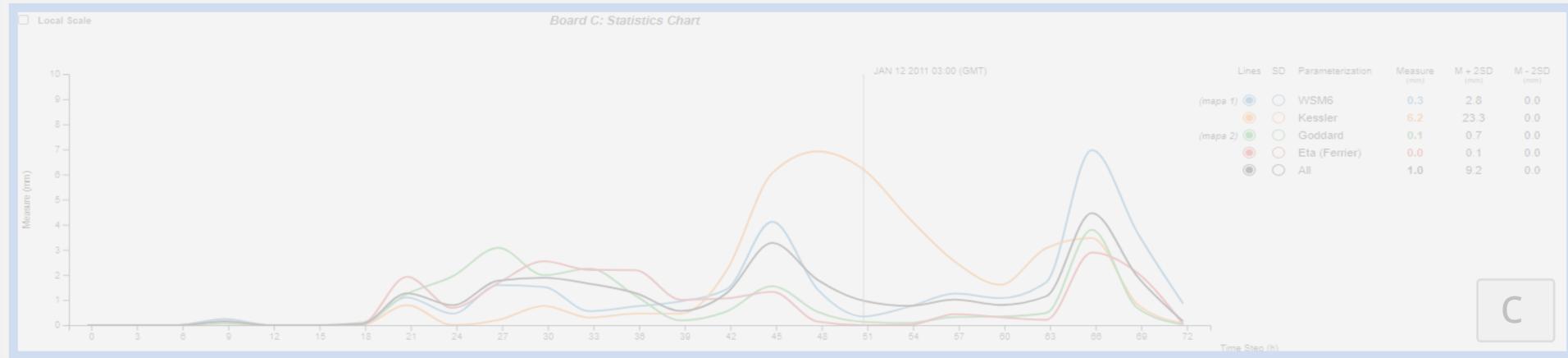
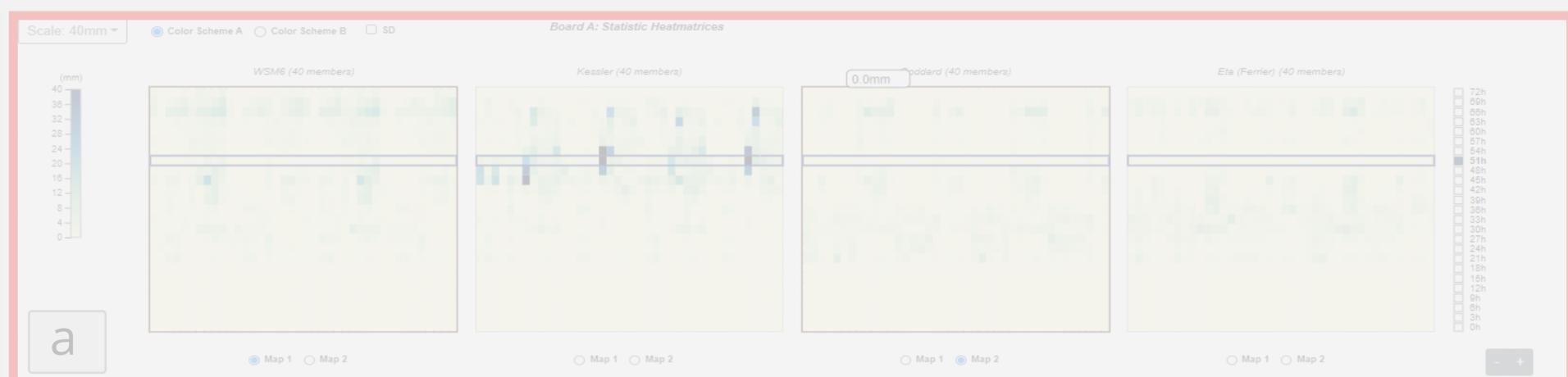
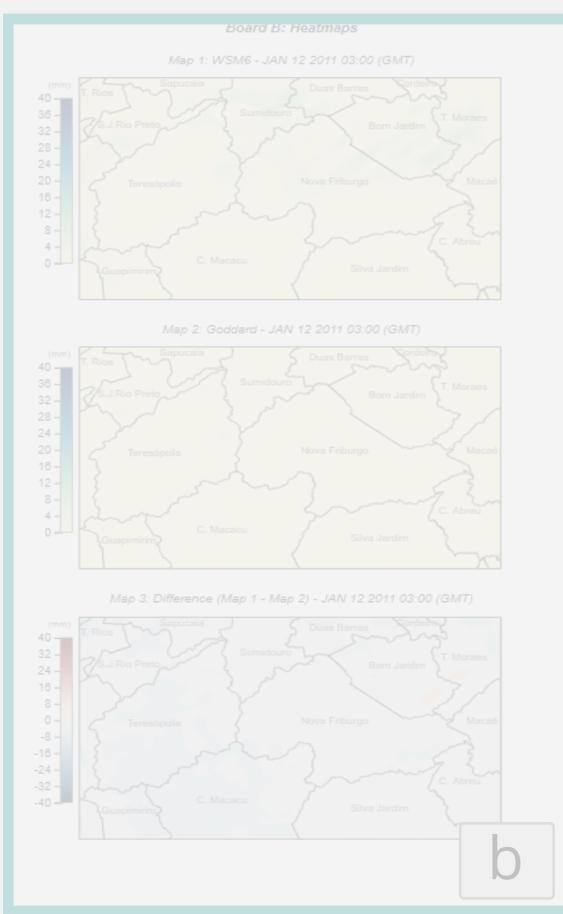
d

Statistics % Probability

Global Variable: Rain ▾ Measure: Quantile 90% ▾

Lens: (disabled) ▾

Cloud Microphysics ▾



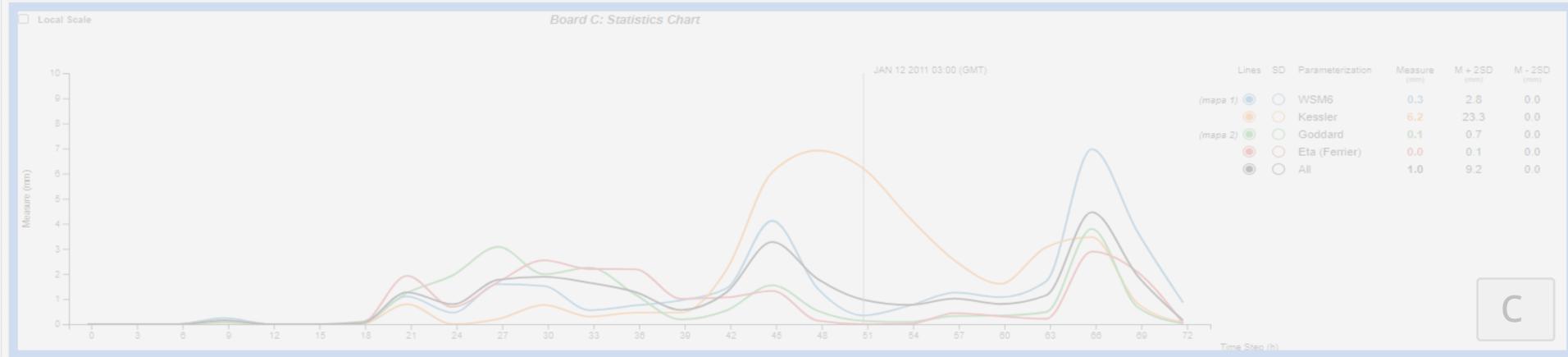
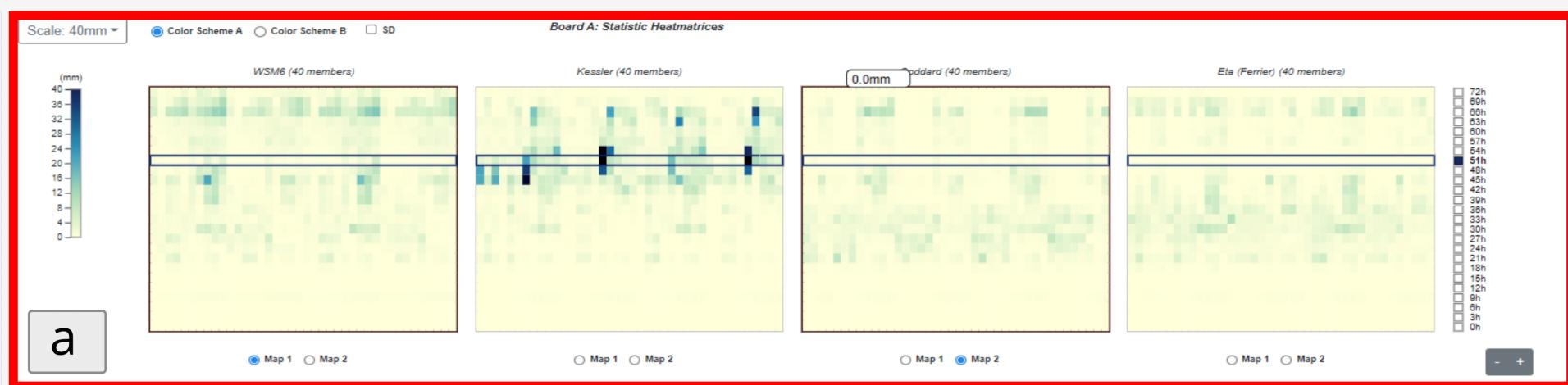
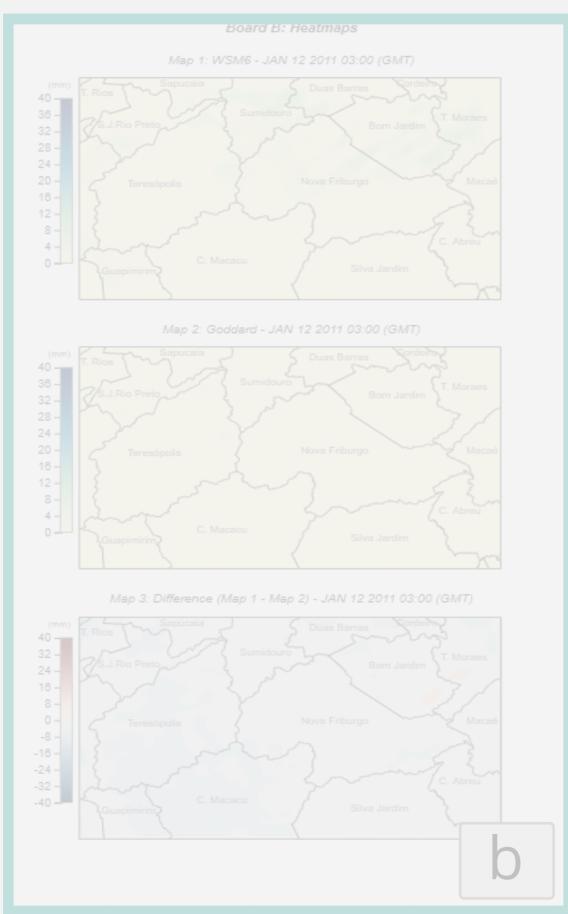
d

Statistics % Probability

Global Variable: Rain - Measure: Quantile 90%

Lens: (disabled)

Cloud Microphysics



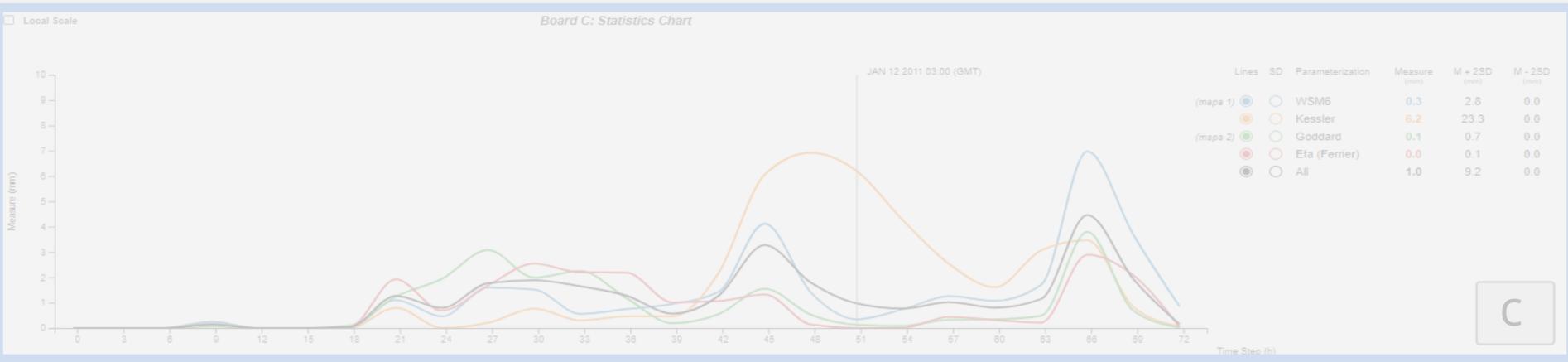
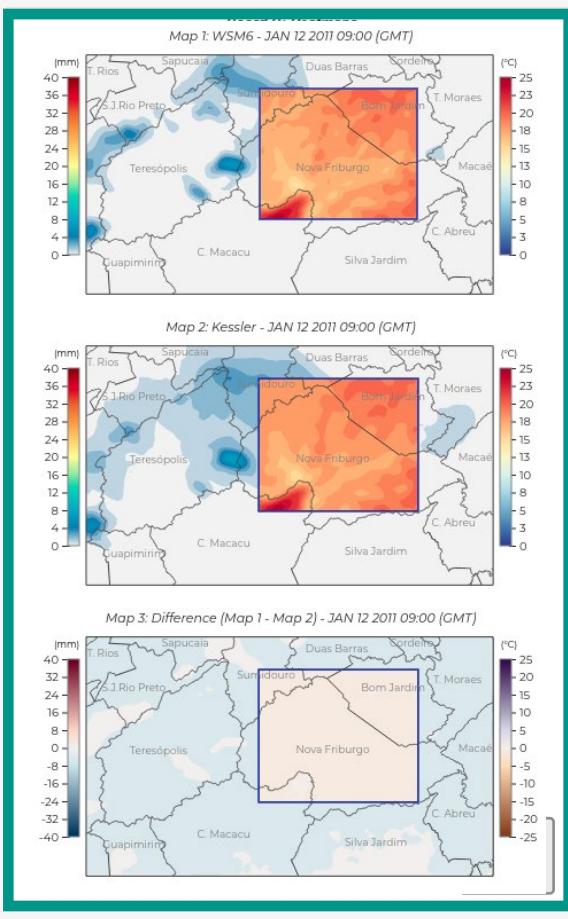
d

Statistics % Probability

Global Variable: Rain - Measure: Quantile 90%

Lens: (disabled)

Cloud Microphysics



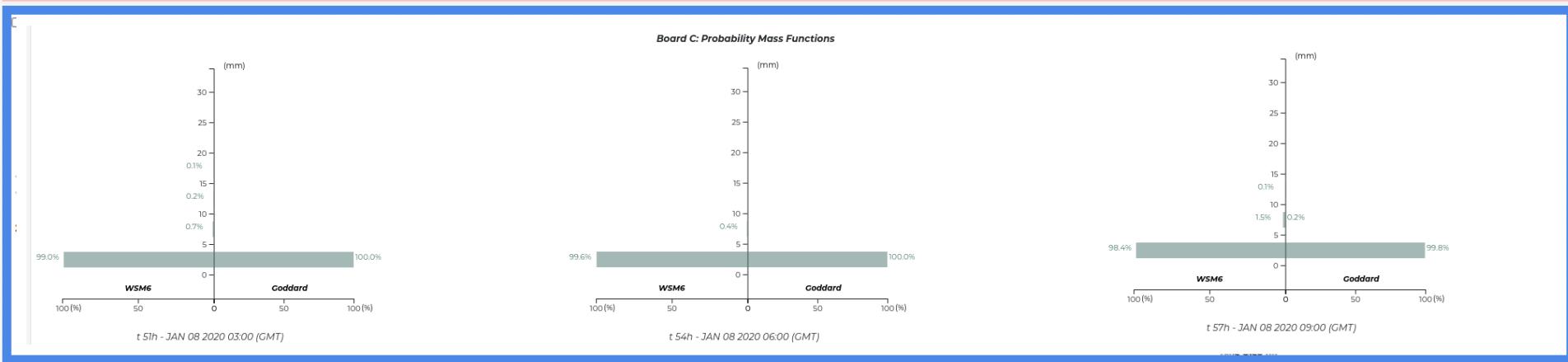
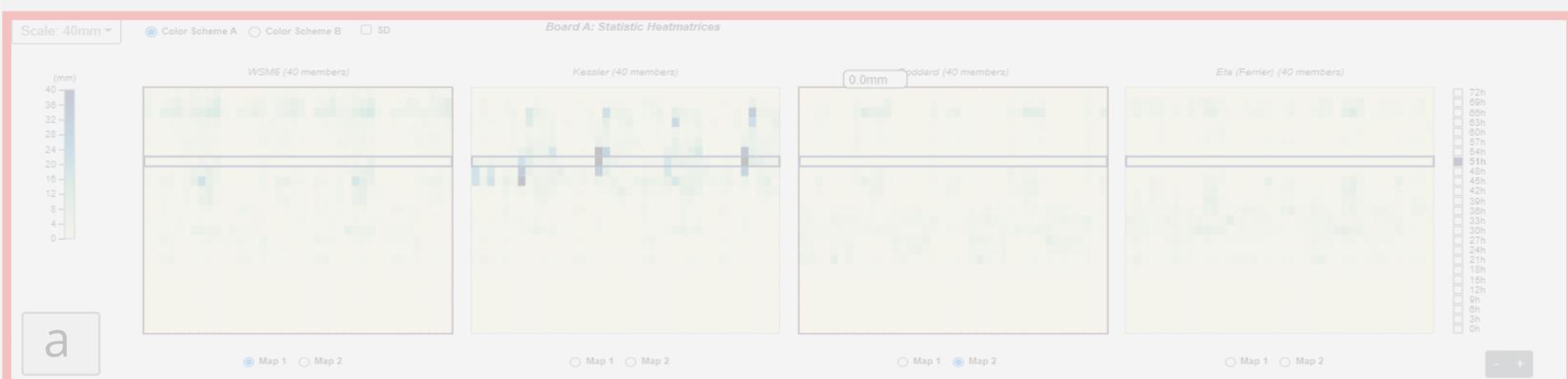
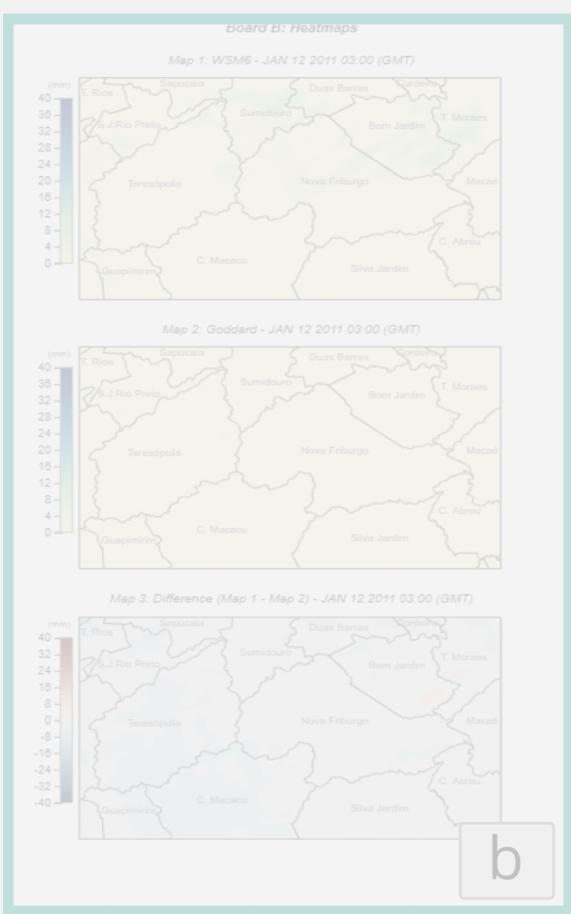
**d**

Statistics % Probability

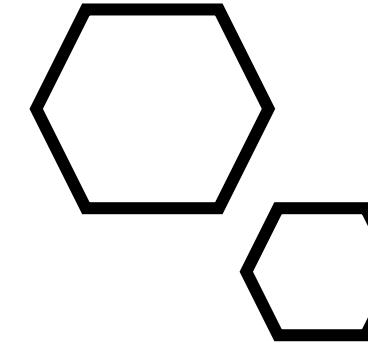
Global Variable: Rain - Measure: Quantile 90%

Lens: (disabled)

Cloud Microphysics



# X-Weather – v2



Set up a run

Follow up a run

Build ensembles

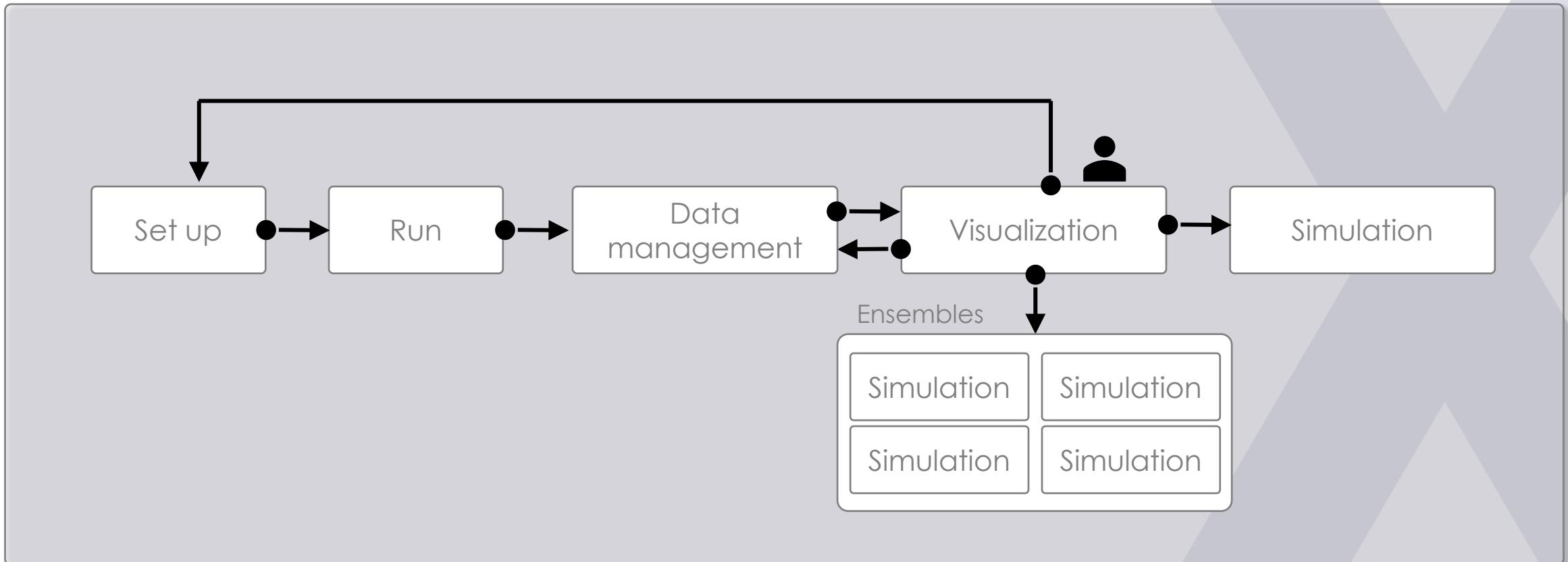
Data visualization

Statistics and Probabilities

Ensembles with different parameterizations

```
3 require File.expand_path('../..', __FILE__)
4 # Prevent database truncation if the environment is test
5 abort("The Rails environment is running in production mode!
6 require 'spec_helper'
7 require 'rspec/rails'
8
9 require 'capybara/rspec'
10 require 'capybara/rails'
11
12 Capybara.javascript_driver = :webkit
13 Category.delete_all; Category.create!
14 Shoulda::Matchers.configure do |config|
15   config.integrate do |with|
16     with.test_framework :rspec
17     with.library :rails
18   end
19 end
20
21 # Add additional requires below this line. See README for more information.
22
23 # Requires supporting ruby files with custom matchers and helpers
24 # in spec/support/ and its subdirectories
25 # in _spec.rb will be required automatically
26 # run twice. It is recommended that you do not
27 # end with _spec.rb. You can configure this
28 # option on the command line.
29
30 # option on the command line.
31
32 # No results found for 'mongoid'
```

# X-Weather – v2



Start





Start: 2011-01-10\_00:00:00

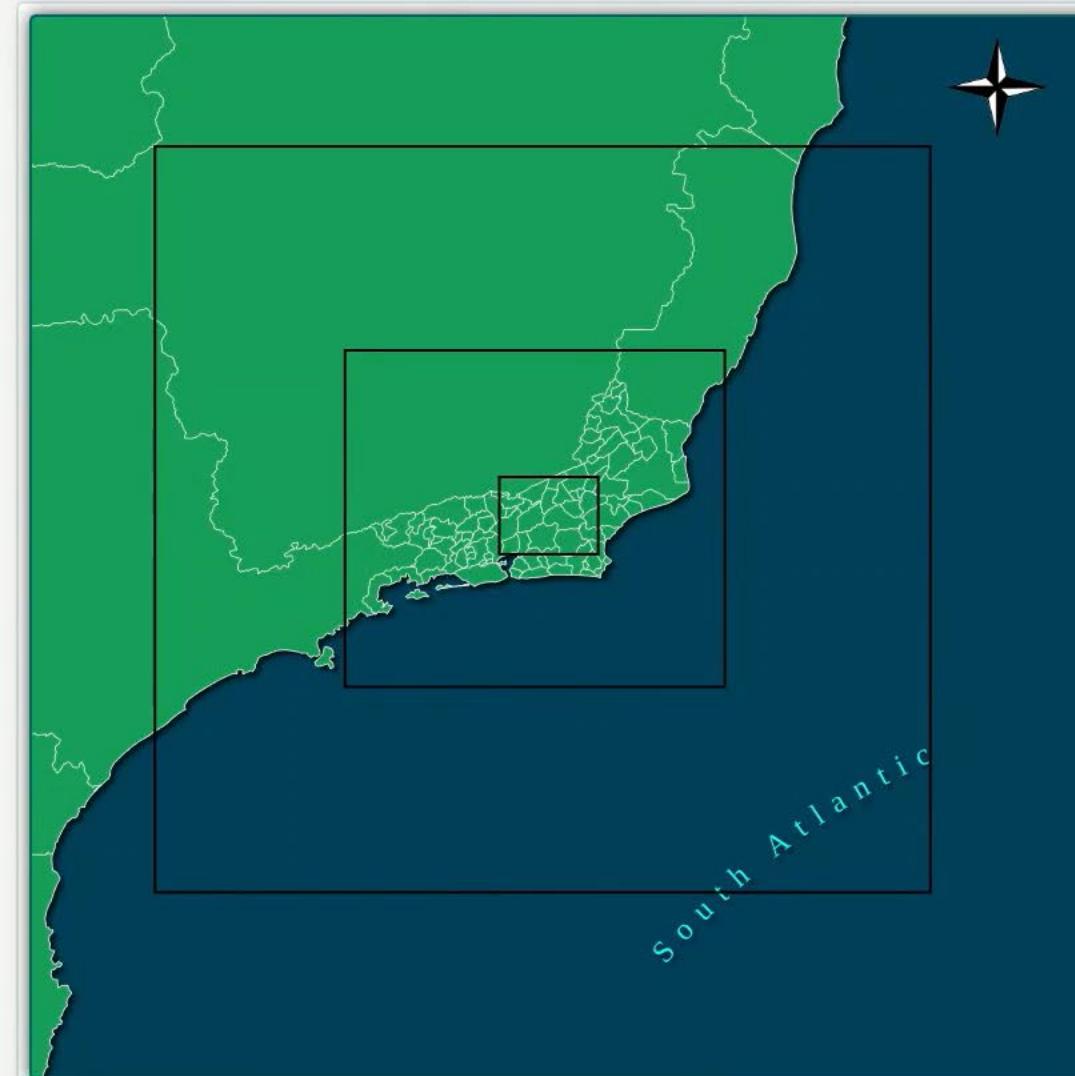
End: 2011-01-13\_00:00:00

Coarse res. (m): 18000

Ref Lon: &lt;-00.000&gt;

Ref Lat: &lt;-00.000&gt;

Update Brush Save Run ►

Domain Summary

Id	Parent Id	Resolution	Ref Lon	Ref Lat	e_we	e_sn	Actions
1	1	18000 m	-42.72°	-22.33°	54	52	
2	1	6000 m	-42.82°	-22.32°	79	70	
3	2	2000 m	-42.65°	-22.29°	61	49	

Physics Set Up

## Micro-physics

Kessler (1) ▾

## Cumulus

Grell-3D (5) ▾

## P. B. L.

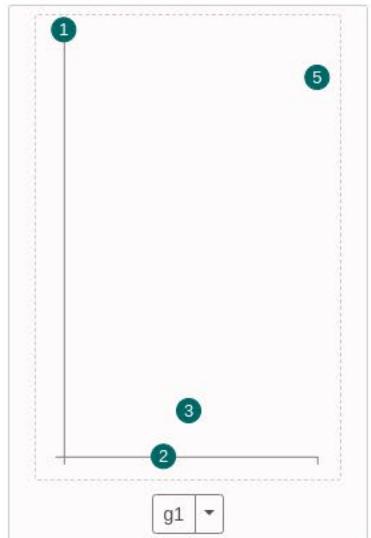
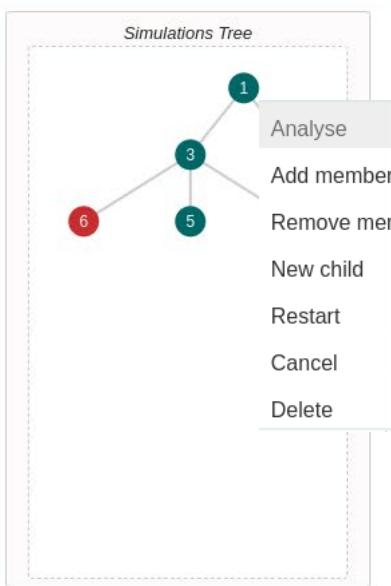
YSU (1) ▾

## Land Surface

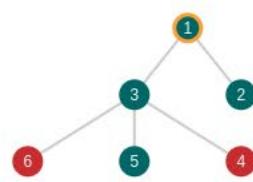
NoahMP (4) ▾

## Surface Layer

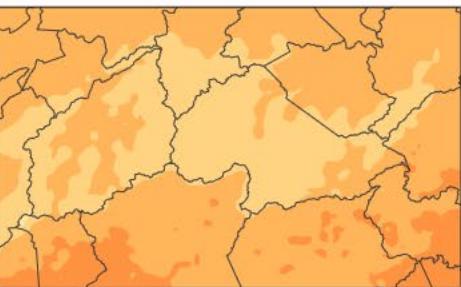
MM5 (1) ▾



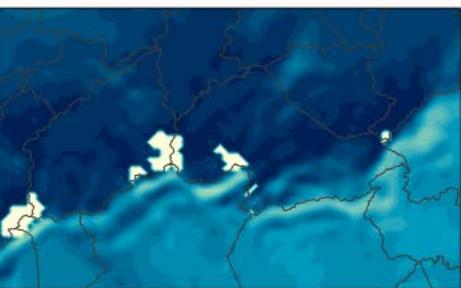
## Simulations Tree



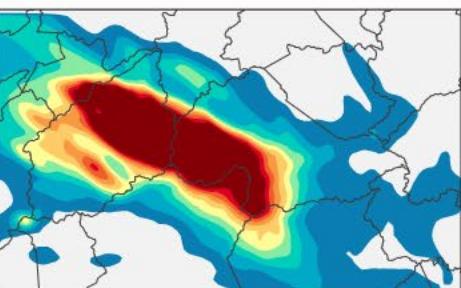
0 10 20 30 40 50 °C  
Grid 3 (1km) - Temp. (°C) - t36h



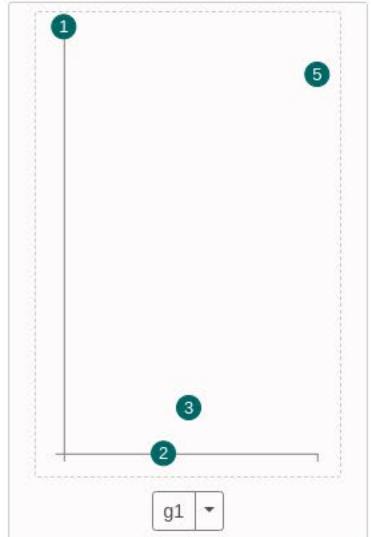
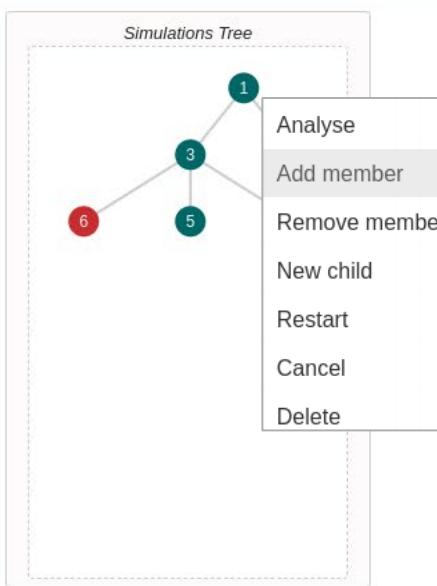
0 20 40 60 80 100 %  
Grid 3 (1km) - Moist. (%) - t36h

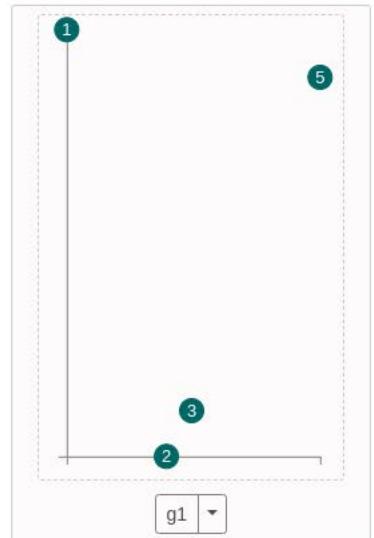
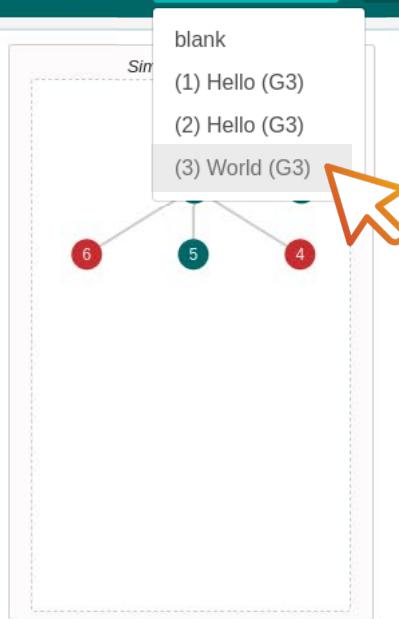


0 20 40 60 80 100 mm  
Grid 3 (1km) - Precip. (mm) - t54h (9h)

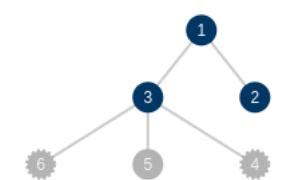








## Simulations Tree



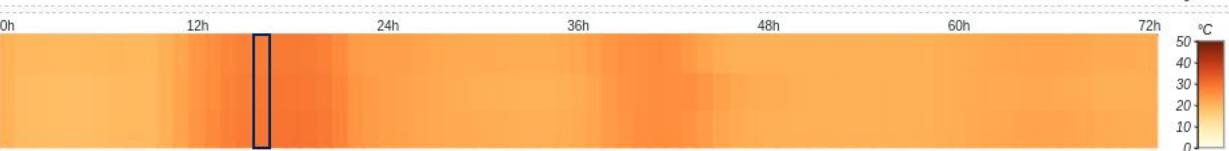
## Precipitation

time: 48h to 66h  
avg: 7.94  
range: 18h  
colors: 1h



## Temperature

time: 16h  
avg: 29.33



## Moisture

time: 16h  
avg: 68.34



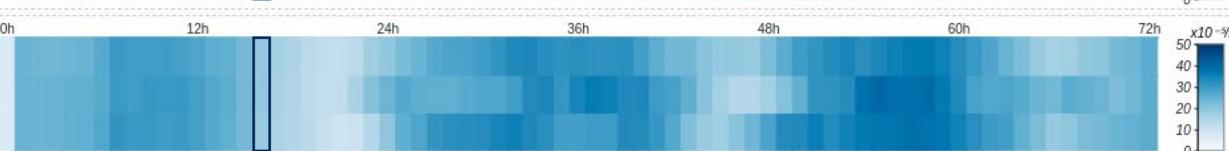
## Div.300hPa

time: 16h  
avg: 2.44



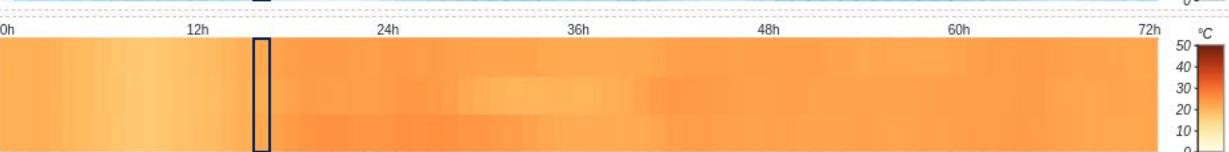
## Conv.850hPa

time: 16h  
avg: 18.44



## K-Index

time: 16h  
avg: 22.01



## Omega

time: 16h  
avg: 0.17



g1

prec

20

1

tmp

25

moist

90

hdiv

2.0

conv

2.0

kidx

25

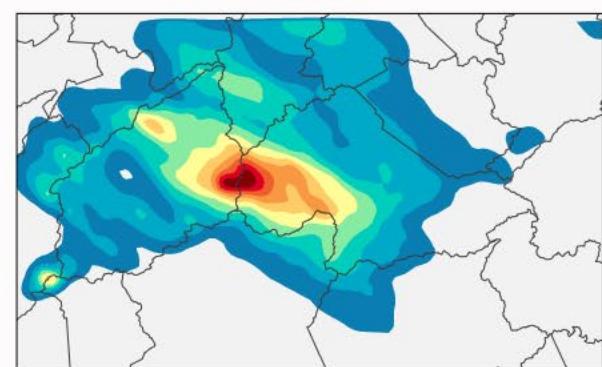
omg

0.5

Update

0 20 40 60 80 100  
mm

Precipitation

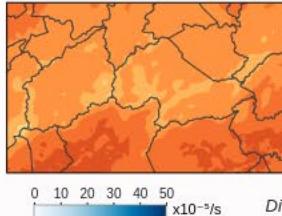


0 10 20 30 40 50 °C

Temp.

0 20 40 60 80 100 %

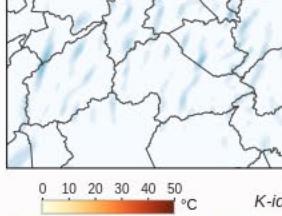
Moist.



Div.

0 10 20 30 40 50 x10^-5/s

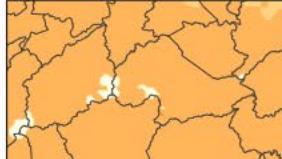
Conv.



W

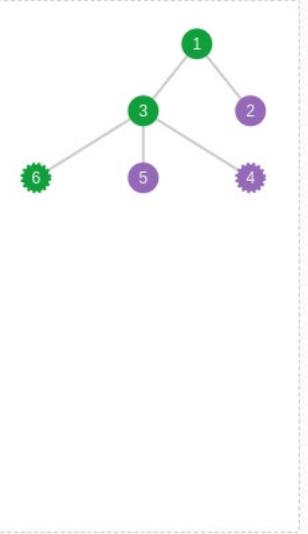
0 0.5 1 1.5 Pa/s

K-idx



W

## Simulations Tree



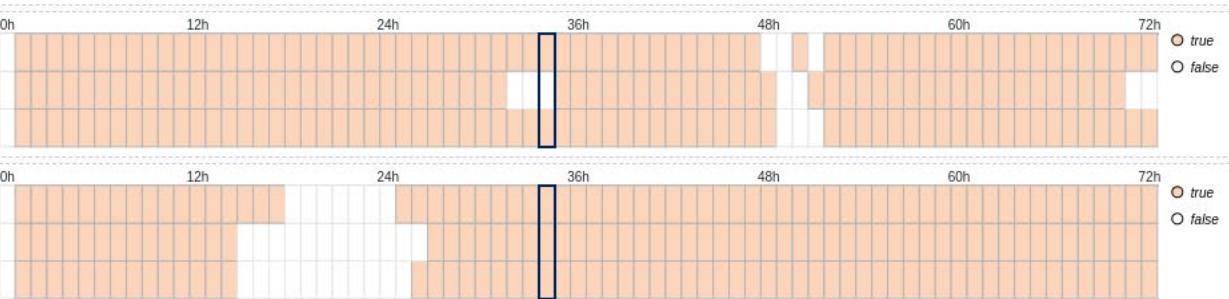
## Precipitation

time: 46h to 66h  
prob: 100.0%  
range: 20h  
colors: 1h



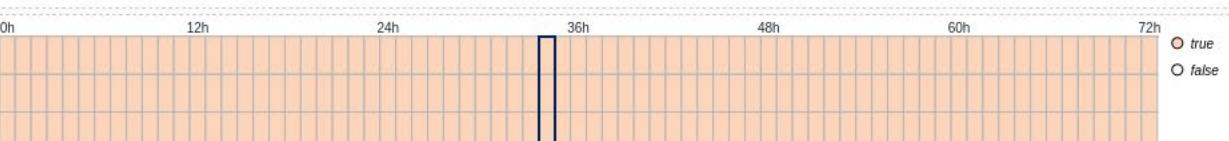
## Temperature

time: 34h  
prob: 66.7%



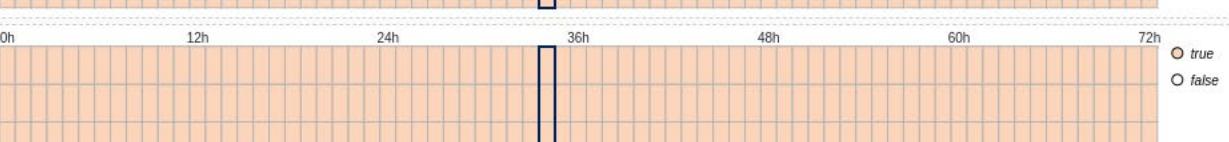
## Moisture

time: 34h  
prob: 100.0%



## Div.300hPa

time: 34h  
prob: 100.0%



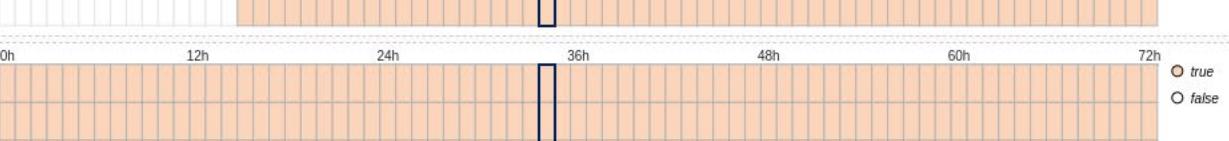
## Conv.850hPa

time: 34h  
prob: 100.0%



## K-Index

time: 34h  
prob: 100.0%



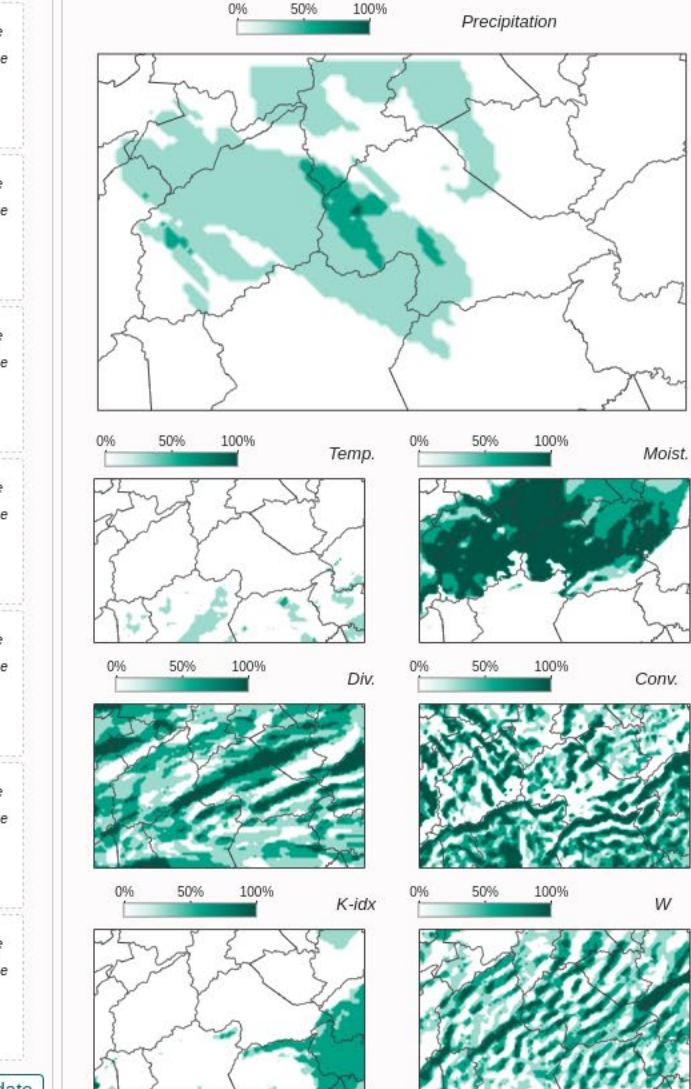
## Omega

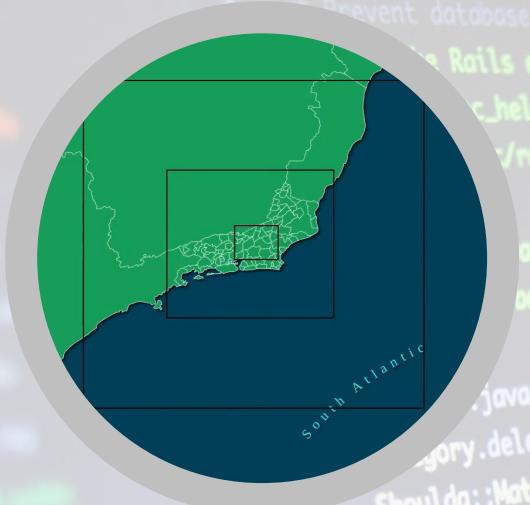
time: 34h  
prob: 100.0%



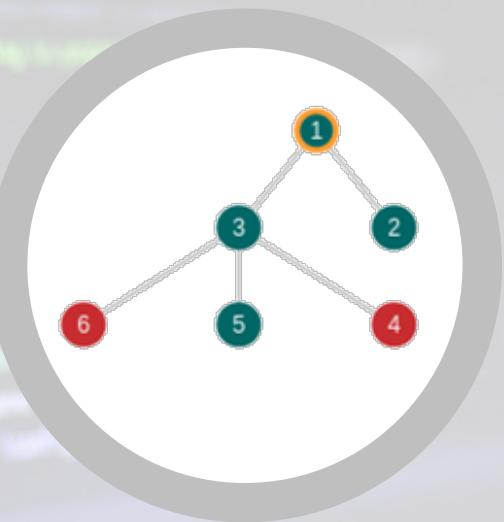
g1 ▾

prec 20 1 tmp 25 moist 90 hdiv 2.0 conv 2.0 kidx 25 omg 0.5

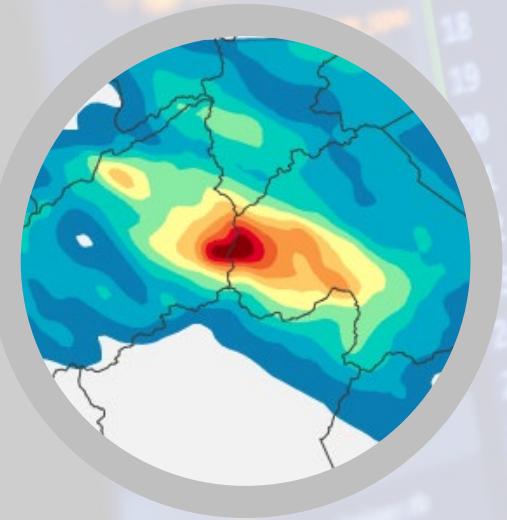




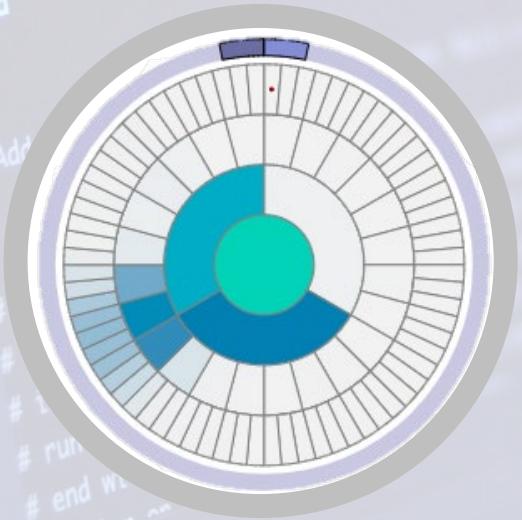
setting



provenance control



Individual analysis



aggregations



ensembles



Carolina Veiga  
carolvfs@gmail.com