WOD

Operational and On Demand Weather Forecasts

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Outline of this talk

* Why?
* Design philosophy
* WOD overview – deployment and updates
* Examples of applications
* Summary

Why?

* There is a need for the potential of running high resolution operational forecasts in many developing countries
* Lack of necessary infrastructure is delaying progress
* The WOD system solves some of these problems
  * "Infrastructure in a box"
  * Shares many features with the SARWeather system
* Partially funded by DfID and the EU via the ClimDev work programme
* Done in collaboration with UNECA
* Initial focus on Small Island States (SIDs) in Africa
  * Runs operationally in Cabo Verde and Seychelles

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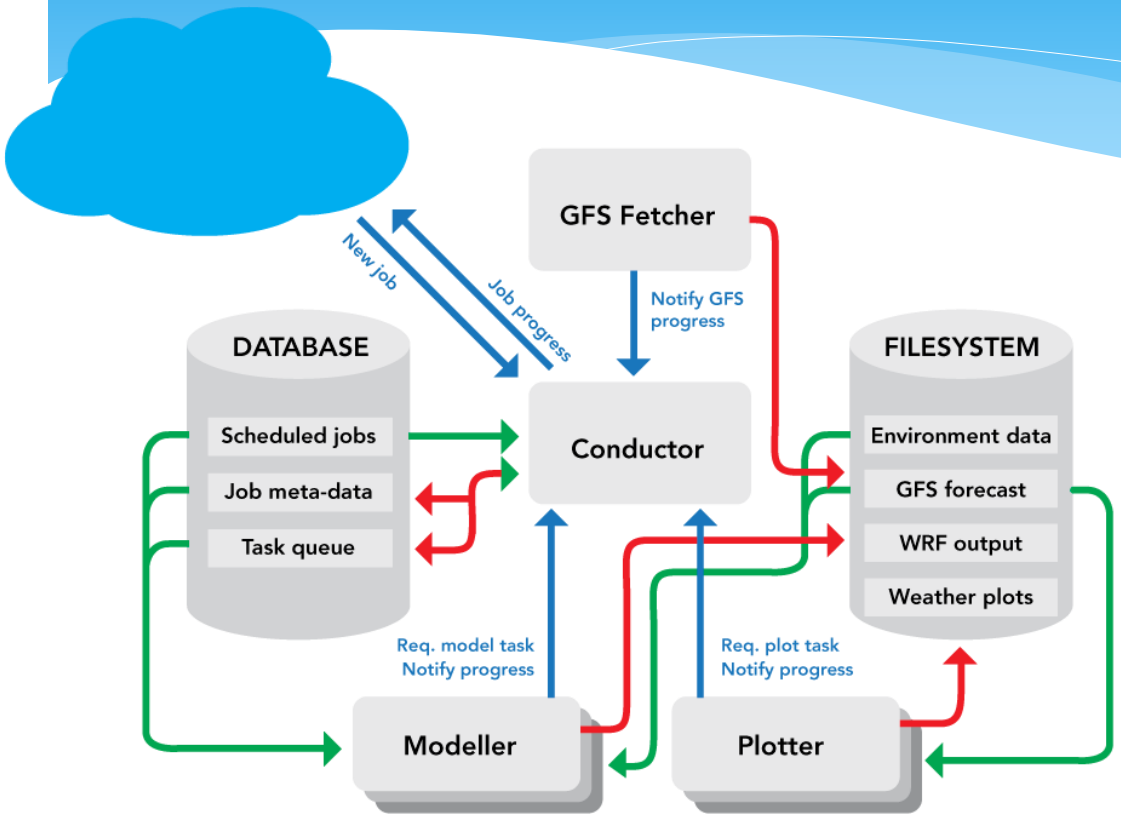
UKaid
from the British people

UNECA

Design philosophy

* Based on **Open Source** components
  * **WRF/WPS** weather model and accompanying software
  * **Python** language and libraries
  * **Linux, PostgreSQL,** and **nginx** webservices
* **Event Driven**
  * Processing starts as soon as possible
  * Computing resources don't stand idle out of fear
* **Scalable** and **Resilient**
  * Just add computing nodes for increased throughput
  * Other nodes step in if one is removed

WOD Overview



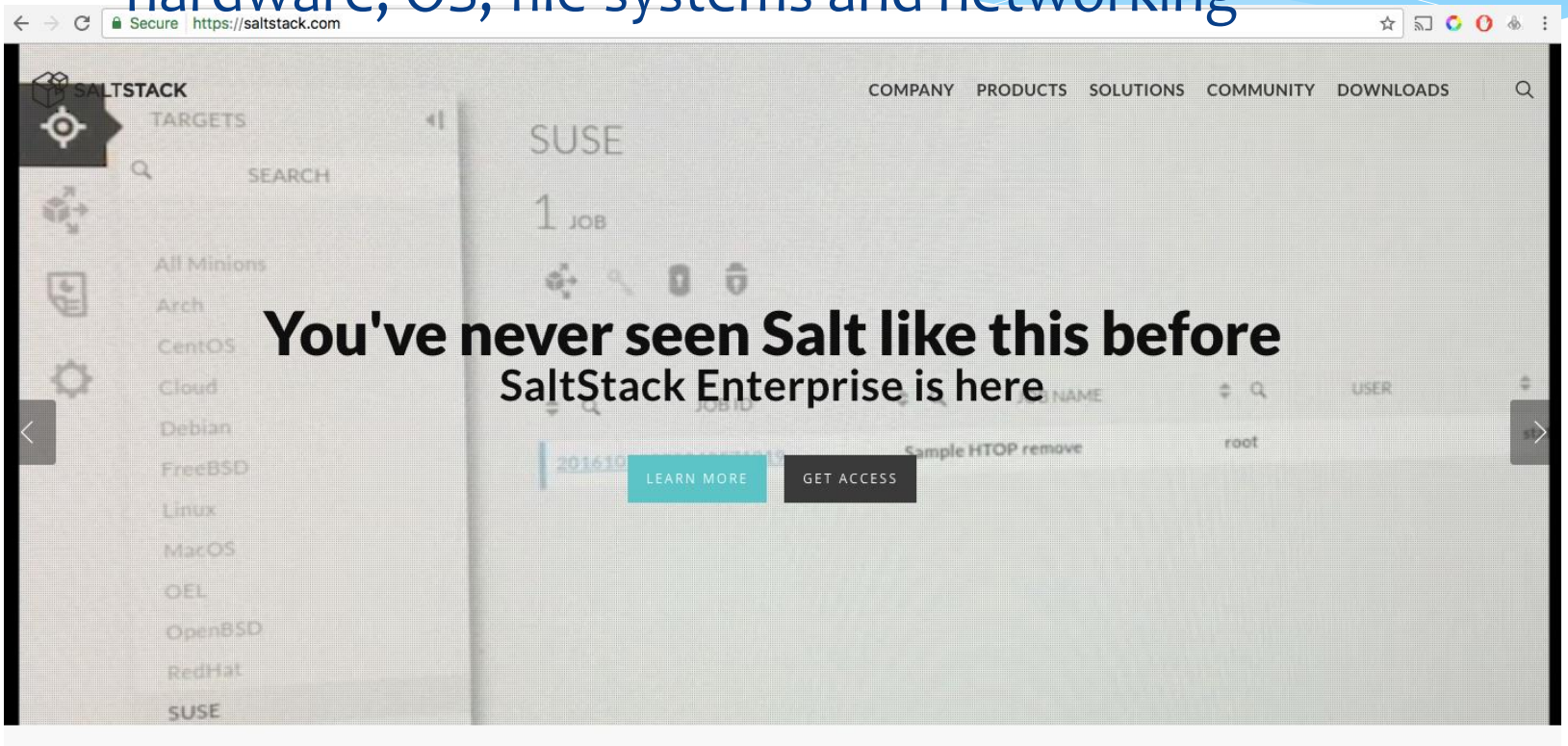
- Red lines: data being written
- Green lines: data being read
- Blue lines: messages being sent
- Blue boxes: individual tasks within the WOD system.
- Cylinders: data stores, both relational database and networked file-system
- Grey boxes: WOD system services that perform specific tasks, such are running the weather model (i.e. Modeller) or create weather charts (i.e. Plotter)

System description

* Built around the WRF-Chem modelling system
* Initial and boundary data taken from the global GFS model as well as the GEFS and CFS systems
* System installation is fast and highly automated
* Can be used to create conventional short- to medium-range weather forecasts for any location on the globe as well as ensemble and S2S forecasts
  * Input can be GFS, GEFS, and/or CFS
* Can be used as a tool to provide input to other modelling systems, such as hydrological and agro-models
* A wide variety of post-processing options are also available

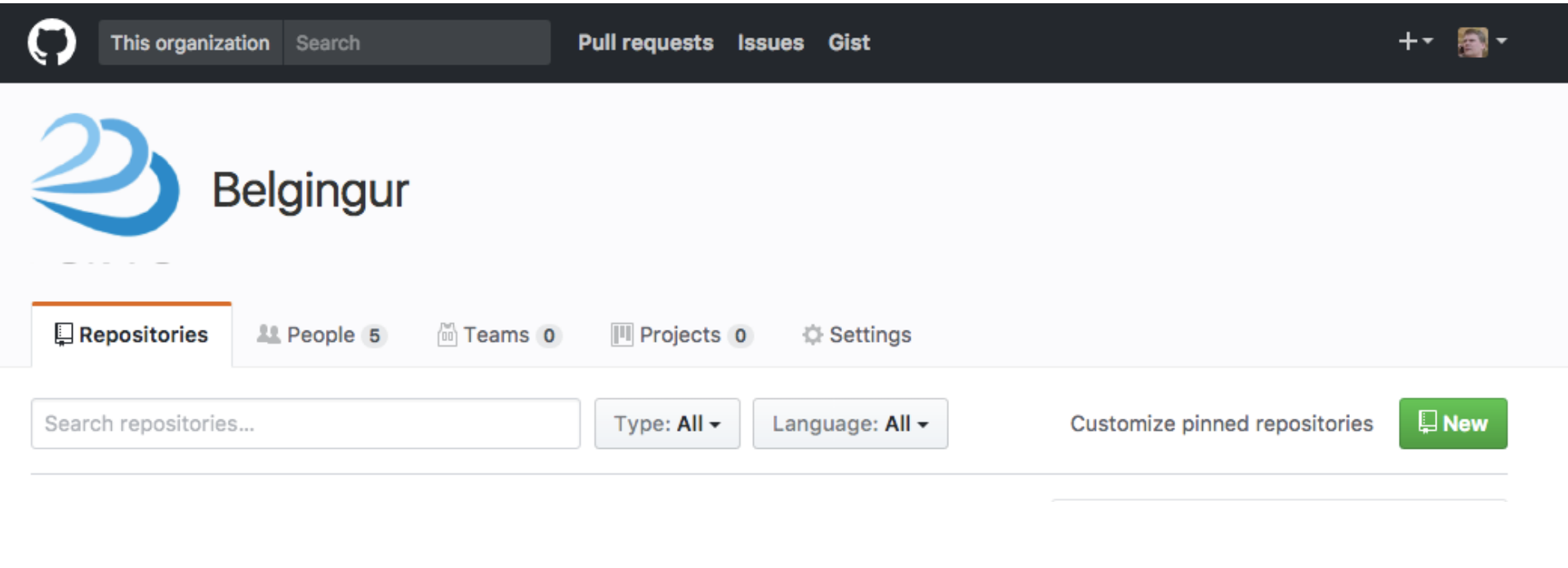
Deployment and updates

* Deployment and updates of WOD systems is automated with **salt** scripts after deploying hardware, OS, file-systems and networking



Deployment and updates

- Code is retrieved from GitHub, while WRF, WPS and associated binaries are retrieved from Belgingur's servers.



Deployment and updates

* The deployment scripts are under source control along with WOD source code and is exercised and tested on Belgingur's Continuous Integration Servers with each change to the code
* This ensures that deployments and updates will run smoothly

The basic configuration is in the form of a deployment descriptor such as this one for Cabo Verde

```
# Mask for the internal network.
network.ip4.mask: 10.10.0.0/24

# DNS Name of web server as known to external clients
web_server.name: wod.inmg-wod.org

# Mapping from host-names to modeller definitions
troupe.modellers:
  node01:
    cores: 15  # Usually one less than the cores per machine
    machines:
    - ibnode01
    - ibnode02
    - ibnode03
    - ibnode04

# Mapping from host-names to the number of plotters to run on that host
troupe.plotters:
  cpv: 10

# Number of hours of GFS data to fetch
troupe.gfs_fetcher.forecast_duration: 240

# Specify reduced GFS region to speed up downloads.
troupe.gfs_fetcher.subregion:
  # Beware that the sub-region files are (2017.01.17) uncompressed,
  # so for regions over ~40% of the globe, the full download is smaller!
  toplat: 30
  leftlon: -36
  bottomlat: 2
  rightlon: -8

# Set to your own caching HTTP server if available
# troupe.gfs_fetcher.proxy: proxy.belgingur.is:3128
```

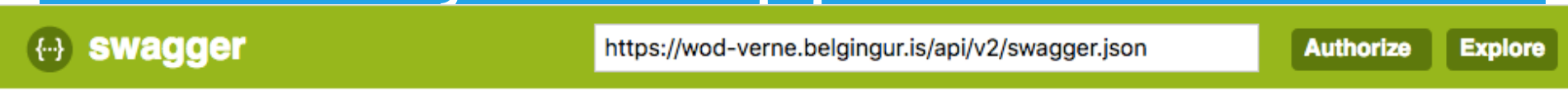
Development

* More flexible API's
* Will be possible to access upstream data via the same API's
  * Don't need to run a WOD forecast to access forecast charts and/or point forecasts from the GFS system
* Add the potential for 3D-VAR data assimilation
* Being integrated to
  * the JRC/Delft3D storm surge modelling system
  * SiteWatch, a fleet management software used by e.g. IceSAR

System applications

* The WOD post-processing provides charts, meteograms and forecast verification and is split into modules
  * By default, observations are taken from the MADIS website - https://madis.ncep.noaa.gov
  * Possible to integrate other data sources
* Each module has a dedicated web interface and API
* Possible to control the dissemination of results
* The WOD system comes with a simple website that combines all three widgets

System applications



Belgingur Weather On Demand

Proprietary

data-grid	Show/Hide | List Operations | Expand Operations
data-meta	Show/Hide | List Operations | Expand Operations
data-point	Show/Hide | List Operations | Expand Operations
meta-job	Show/Hide | List Operations | Expand Operations
meta-schedule	Show/Hide | List Operations | Expand Operations
widget-meteo	Show/Hide | List Operations | Expand Operations
plot	Show/Hide | List Operations | Expand Operations
widget-trellis	Show/Hide | List Operations | Expand Operations

[BASE URL: /api/v2 , API VERSION: 2.0.0]

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System applications

POST /meta/job — Create a job

Response Class (Status 201)

Meta-data about the newly created job

Model | Example Value

```
{
  "analysis": "string",
  "client": "string",
  "domains": [
    {
      "center": {
        "latitude": 0,
        "longitude": 0
      },
      "dimensions": {
```

Response Content Type: application/json

Parameters

Parameter	Value	Description	Parameter Type	Data Type
user		Name of user on the client system if aplicable	formData	string
title	(required)	**Human-readable name of the new job**	formData	string
type	(required)	**The name of a registered job type**	formData	string
cen_lat	(required)	**Latitude of forecast centre point**	formData	double
cen_lon	(required)	**Longitude of forecast centre point**	formData	double
start		Start of new job as ISO timestamp	formData	string
length		Length of job in hours	formData	integer
upstream_name		Name of configured upstream forecast to use data from	formData	string
upstream_member		Ensemble member of configured upstream forecast to use data from	formData	integer

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POST /meta/job/{job}/schedule — Create a schedule from a job

Implementation Notes

Creates a new schedule with the given job as the prototype. The job will be associated with the new schedule, replacing the previous schedule if any.

Response Class (Status 201)

Meta-data about the newly created schedule

Model | Example Value

```
{
  "created": "string",
  "expires": "string",
  "pri_base": 0,
  "prototype": "string",
  "ref": "string",
  "scrub_limit": "initial",
  "triggers": {}
}
```

Response Content Type: application/json

Parameters

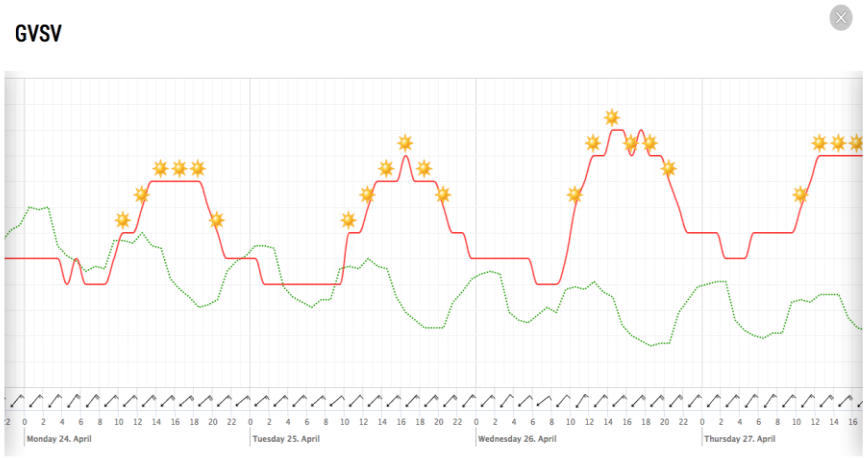
Parameter	Value	Description	Parameter Type	Data Type
job	(required)	**Reference to the requested job such as 20161004-150319-cfa2e7b577de**	path	string
ref	(required)	**Reference string for the new schedule**	formData	string
period_length	12	Length in hours of forecast period for scheduled jobs	formData	integer
period_offset	3	Start of forecast period in hours from the analysis date of the upstream data which triggers the schedule.	formData	integer

System applications

FORECAST METEOGRAMS VERIFICATION ABOUT

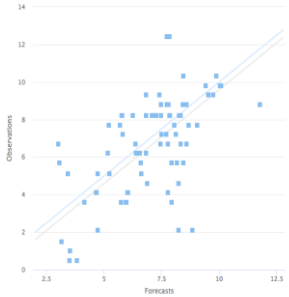
Meteograms

Área Ampliada (9km) GVSV

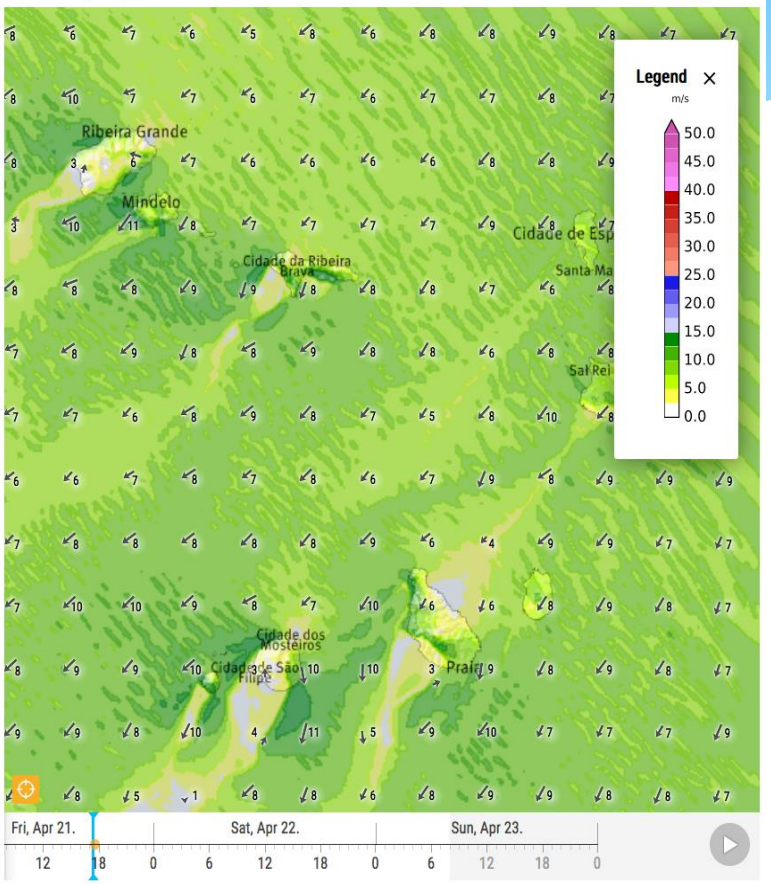


Forecast Verifiation

cpv-5-1.1 GVNP Wind Speed 24 hrs.



Islands (1km) Wind Friday 21. April at 5:30 pm CVT



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Produtividade

Cropview

T01 (Santa Helena/PR)

Lat:-24.8570958, Long:-54.3364532

Talhão: 100 ha - Solo Argiloso (Teor Argila 36 - 60)

Plantio: 15/02/2018 - Safrinha 130 Dias - Prod. 110 Sacas/ha

Alta — Baixa

Decêndio			Temp. Média	Chuva decêndio	Chuva acumulada	Excedente	Déficit	Fenologia	Produtividade	Sacas/ha	Total Sacas
1	15/02/18	24/02/18	24°C	79 mm	79 mm	50 mm	0	Estabelecimento	100%	110	11.000
2	25/02/18	06/03/18	26°C	93 mm	172 mm	70 mm	0	Estabelecimento	100%	110	11.000
3	07/03/18	16/03/18	27°C	85 mm	257 mm	40 mm	0	Desenv. Vegetativo	100%	110	11.000
4	17/03/18	26/03/18	23°C	50 mm	307 mm	21 mm	0	Desenv. Vegetativo	100%	110	11.000
5	27/03/18	05/04/18	23°C	22 mm	329 mm	0	1 mm	Desenv. Vegetativo	99%	109	10.920
6	06/04/18	15/04/18	24°C	0 mm	329 mm	0	14 mm	Desenv. Vegetativo	91%	100	10.006
7	14/04/18	23/04/18	24°C	0 mm	329 mm	0	23 mm	Desenv. Vegetativo	74%	82	8.157
8	**26/04/18**	**05/05/18**	**24°C**	**0 mm**	**329 mm**	**0**	28 mm	**Florescimento**	**61%**	**67**	**6.676**
9	**06/05/18**	**15/05/18**	**22°C**	**11 mm**	**340 mm**	**0**	12 mm	**Frutificação**	**56%**	**62**	**6.211**
10	16/05/18	25/05/18	17°C	49 mm	389 mm	0	0	Frutificação	56%	62	6.211
11	26/05/18	04/06/18	17°C	47 mm	436 mm	0	0	Frutificação	56%	62	6.211
12	05/06/18	14/06/18	16°C	45 mm	481 mm	36 mm	0	Maturação	56%	62	6.211
13	15/06/18	24/06/18	16°C	45 mm	526 mm	39 mm	0	Maturação	56%	62	6.211

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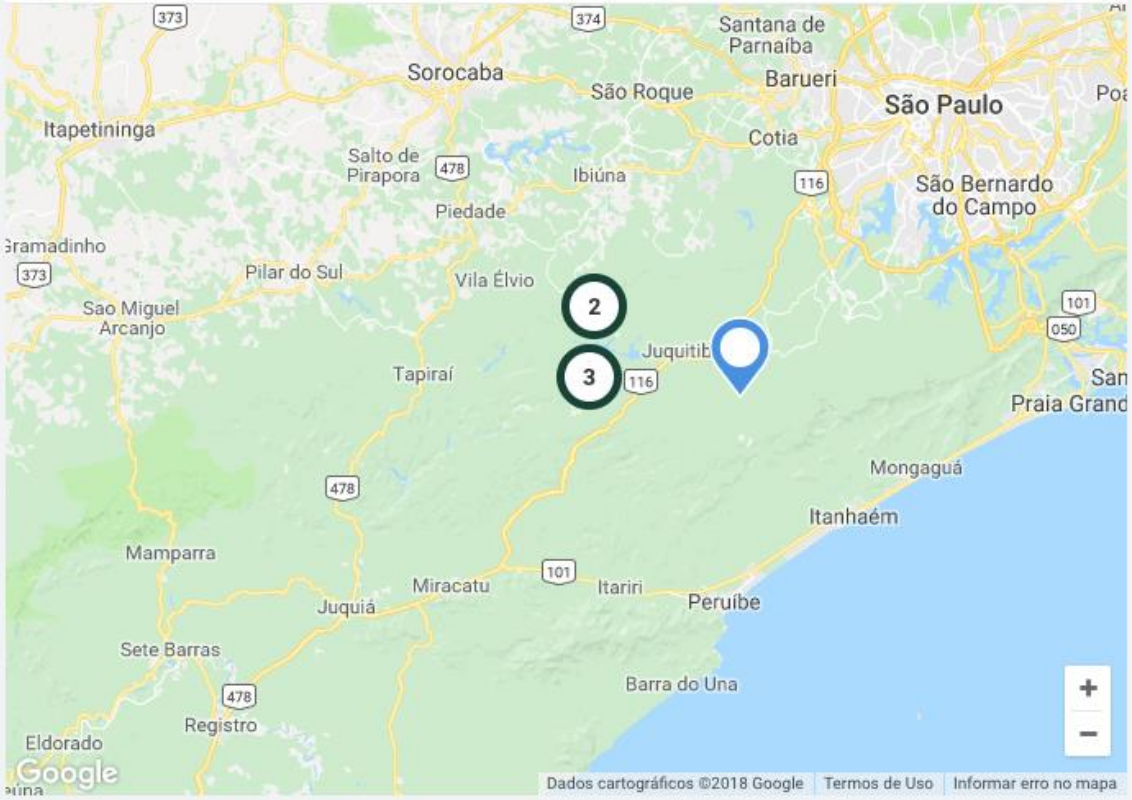
Mapa detalhado



Estações

Votorantim 1

23.2 °C
0 mm/s

98.6 %
---

9 dias atrás

Votorantim 2

19.7 °C
0 mm/s

95.2 %
---

17 horas atrás

Votorantim 4

18.6 °C
0 mm/s

99.9 %
---

10 horas atrás

Votorantim 5

16.9 °C

99.9 %
---

12 horas atrás

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Previsão do tempo (Próximos 10 dias) - Votorantim 1

04/05	05/05	06/05	07/05	08/05	09/05
19 °C ▼ 28 °C ▲	17 °C ▼ 25 °C ▲	14 °C ▼ 21 °C ▲	17 °C ▼ 22 °C ▲	16 °C ▼ 21 °C ▲	12 °(
0.4 mm	0.6 mm	1.6 mm	0.9 mm	8 mm	0 mr
6 kWh/m².dia	5 kWh/m².dia	2 kWh/m².dia	3 kWh/m².dia	4 kWh/m².dia	5 kW
44 % ▼ 95 % ▲	64 % ▼ 99 % ▲	84 % ▼ 100 % ▲	74 % ▼ 100 % ▲	72 % ▼ 99 % ▲	57 %
0.9 m/s ▼ 3.5 m/s ▲	0.5 m/s ▼ 3.5 m/s ▲	0.9 m/s ▼ 3.2 m/s ▲	1.7 m/s ▼ 4.1 m/s ▲	1.5 m/s ▼ 4.3 m/s ▲	1.6 r

Hora (Horário de Brasília)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
Temperatura °C	27	28	28	27	25	23	19	19	19	19	19	19	19	19	19	19	18	17	17	19	21	23
Volume de chuva mm	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Radiação W/m²	800	761	603	480	315	92	0	0	0	0	0	0	0	0	0	0	0	0	0	58	282	463
Umidade %	47	44	44	51	67	84	94	95	91	86	81	78	77	76	77	78	80	81	81	82	71	67
Velocidade do vento m/s	0.9	1.3	1.8	2.1	2.5	2.4	2	2.4	3	3.2	3.4	3.5	3.4	3.5	3.5	3.4	2.9	2.4	1.9	1.3	0.5	0.9
Direção do vento	←	←	↙	↙	↓	↘	→	↗	↗	↗	↗	↗	↗	↑	↑	↑	↑	↑	↑	↑	↗	↘

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System applications

* WOD is run operationally in Cabo Verde and Seychelles
  * http://syn.meteo.gov.sc
  * http://www.inmg-wod.org

Summary

* The WOD system can be used to create conventional short- to medium-range weather forecasts for any location on the globe as well as ensemble and S2S forecasts
* Designed to meet the needs of NMHs that have limited resources and little experience in running operational forecast systems
* It is based on **Open Source** components
* It is **Event Driven**
* It is **Scalable** and **Resilient**
* Output can be used as input into other decision support software

Thank you

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