



meteomatics

Your Experts in Weather Data Processing.

Using MATLAB to Empower Modern Numerical Weather Forecasts

Dr. Martin Fengler

CEO

World Class Talent in Meteorology, Data Science, Drone Development and Service Delivery

We are proud of Meteomatics' fair, hardworking, 'can-do' culture and a highly skilled multi-disciplinary team who rise to the challenge with our customers in a positive fashion. Creativity is a core skill whether it be in thinking, design, architecture or science.



Why Does Weather Matter?

It affects our daily life.



Better understanding of the weather helps reducing business costs.



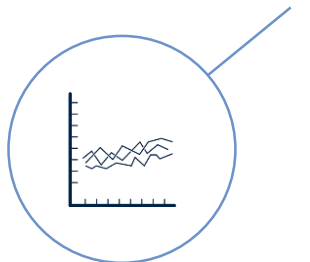
It affects our business.



Better understanding of the weather improves predictive maintenance.



It is highly variable.



Better understanding of the weather reduces the impacts of natural hazards.



Key Takeaways

Weather API & MATLAB

enable us to:

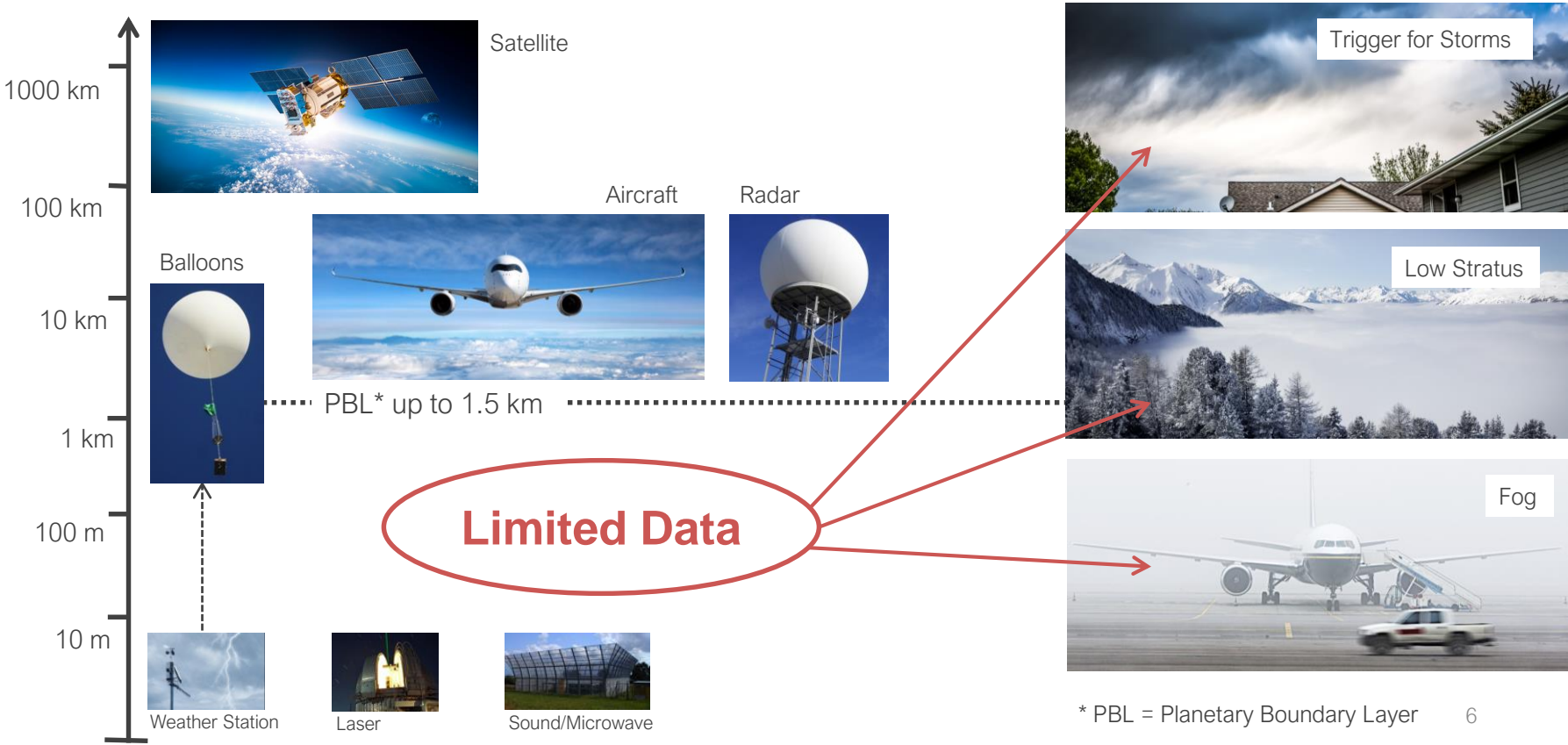
- ... model gathered drone data
- ... simulate new measurement techniques
- ... implement physical parametrizations
- ... visualize meteorological data
- ... carry out statistical analyses
- ... enrich training of machine & AI learning with weather data
- ... give deeper insights into your weather related business

Key Challenges



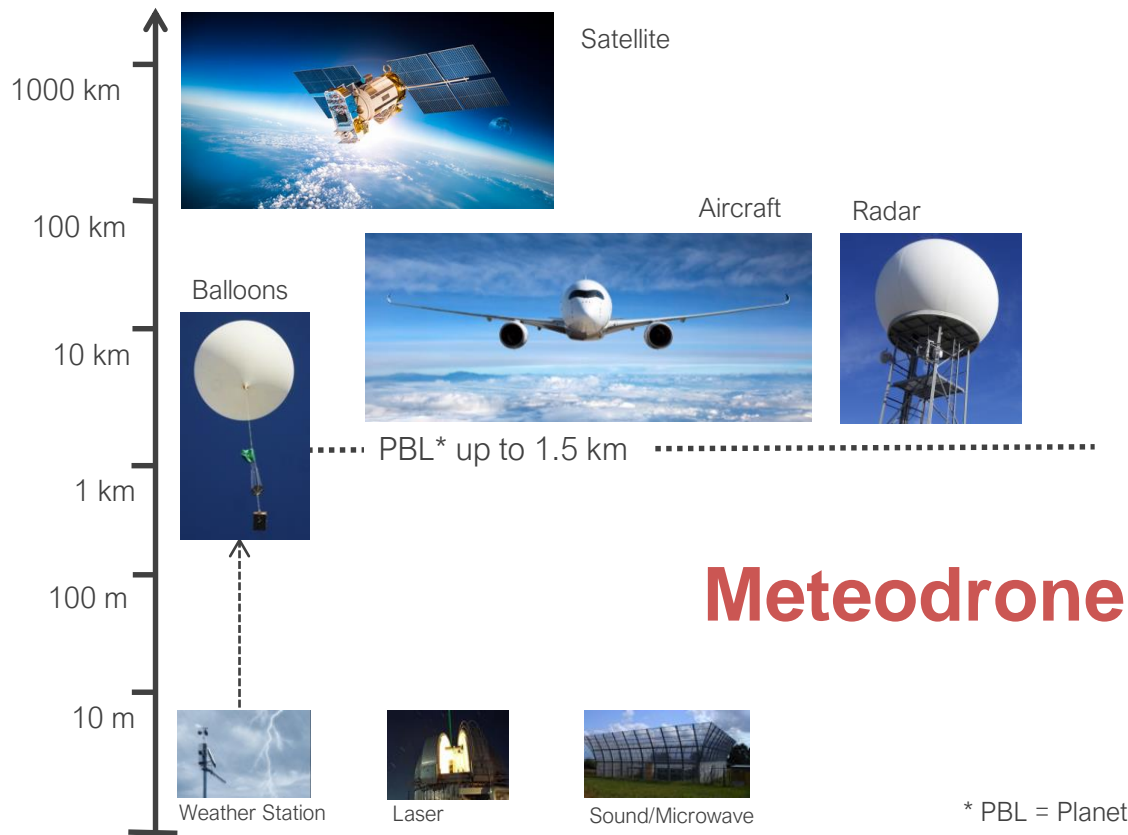
- Inaccuracy of Forecasts
- Access to Historical Data
- Huge Amount of Data
- Inconsistent Data Formats

Current Data Situation



* PBL = Planetary Boundary Layer 6

Improving Data Situation

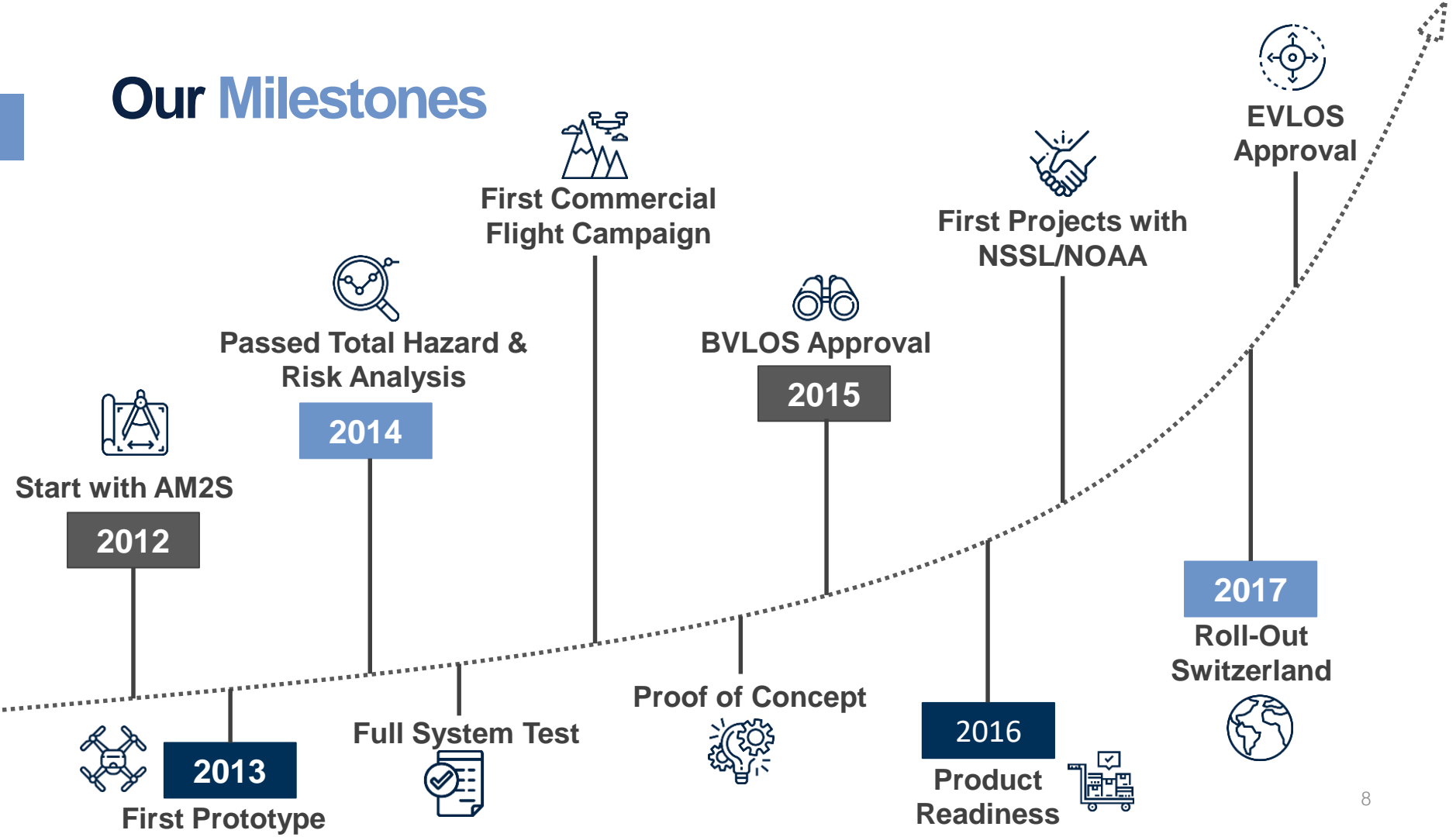


Meteodrone



* PBL = Planetary Boundary Layer

Our Milestones





Our mobile systems allow highly flexible missions.

Meteodrone Sensors & Flight Profile



Pressure

Accuracy: 0.1 hPa
Response Time: 250 ms



Dew Point

Accuracy: 0.2 °C
Response Time: < 4 s



Temperature

Accuracy: 0.1 °C
Response Time: 1 s



Relative Humidity

Accuracy: < 2 %
Response Time: < 4 s

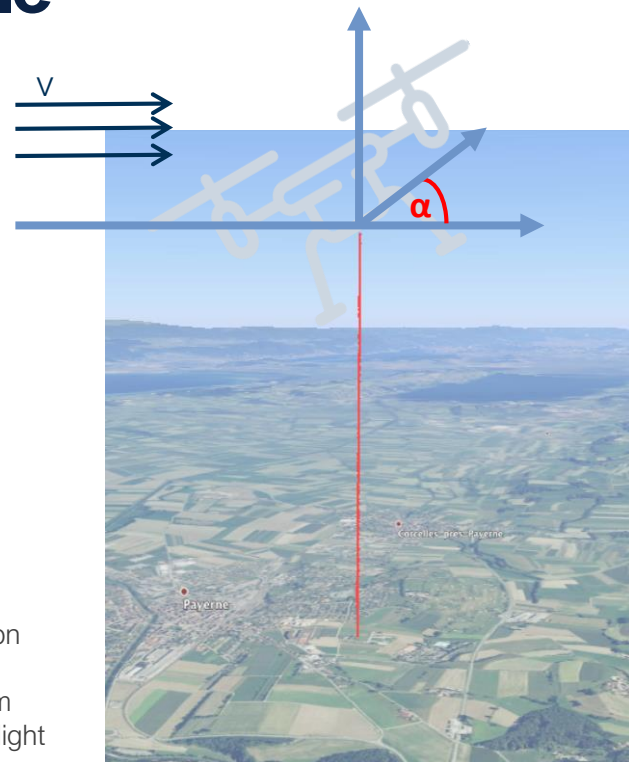


Wind Speed & Direction

Accuracy: < 1 m/s
Response Time: 250 ms

The aircraft automatically compensates wind drag:

- Compute wind speed and direction from roll & nick angle
- Vertical flight profile up to 3'000 m
- Currently working on increasing flight altitude to 6'000 m



Prototyping done in MATLAB
Modelling & Simulation

Sensors are radiation-shielded and mounted in the rotor downwash.

Modelling & Simulation of Meteodrone

Input

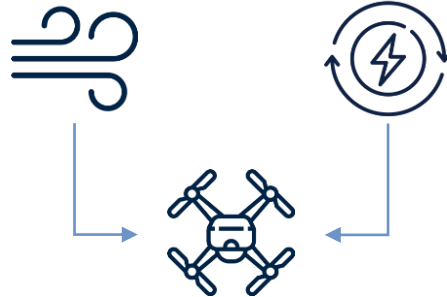
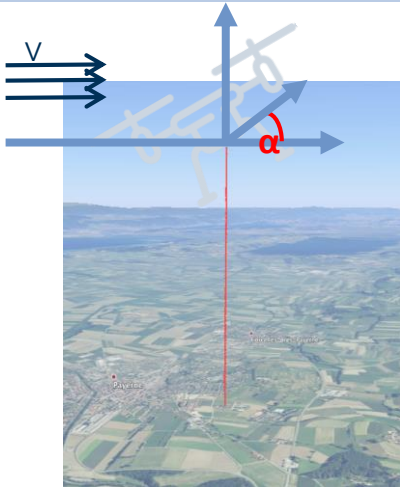
- Roll and Pitch angle
- Power Consumption

Drone Model

- Physics based
- Automatic wind drag compensation
- Comparison to wind tunnel and outside conditions
- Postprocessing and calibration
- MATLAB / C++
- Deployed on ARM Processor

Share Results

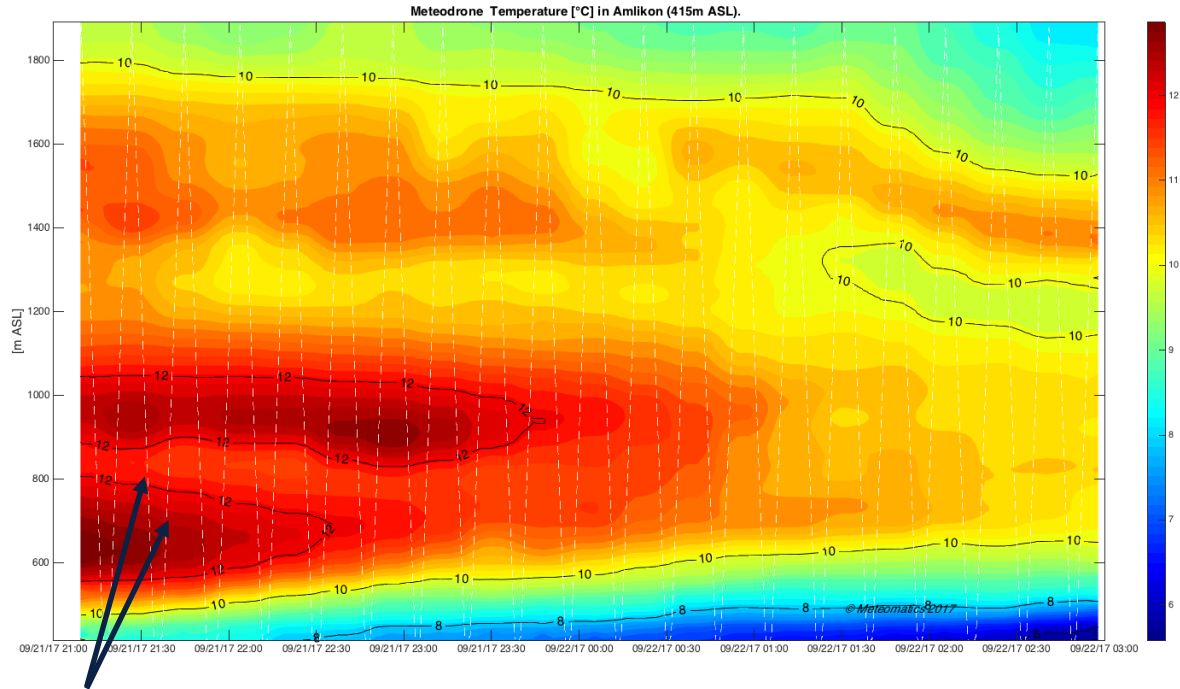
- Send data in real-time to ground station
- Post-processing / WRF model-input
- Weather API



```
Editor - /Users/mfengler/Desktop/Meteo...
EDITOR      PUBLISH      VIEW
New Open Save Find Files Compare Go To Comment Indent Breakpoints Run Run and Advance Run and Time
File Edit Breakpoints Run Run and Advance Run and Time
1 function [dn,data]=query_time_series_from_weather_api(user,password,model,start_date,perio
2
3 % Function to query gridded data from the Meteomatics Weather API.
4
5
6 % Input:
7
8 % start_date: as Matlab datenum
9 % period: string according to ISO date format , e.g. P2DT3H = 2 days, 3 hours
10 % resolution: string according to ISO date format , e.g. PT1H = hourly resolution
11 % lat: latitude in decimal degree
12 % lon: longitude in decimal degree
13
14 % [dn,data]=query_time_series_from_weather_api(user,password,model,start_date,period,reso
15
16
17 % Output:
18
19 % dn: date vector containing Matlab datenums
20 % data: vector/matrix containing the requested parameter values
21
22 % See also the documentation under https://api.meteomatics.com
23
24
25 % This Matlab code is under BSD license. Martin Fengler, St. Gallen, 2017
```

Amlikon 21. – 22.09.17

Temperature

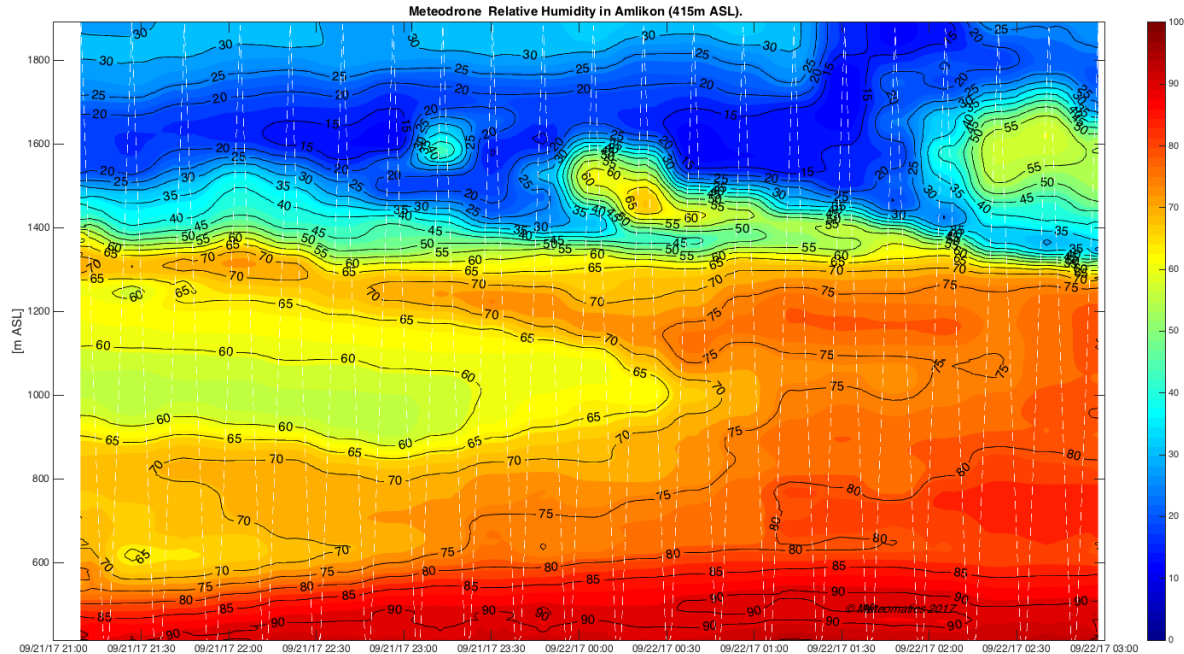


White dots indicate the drone flight track.

Visualization done in MATLAB

Amlikon 21. – 22.09.17

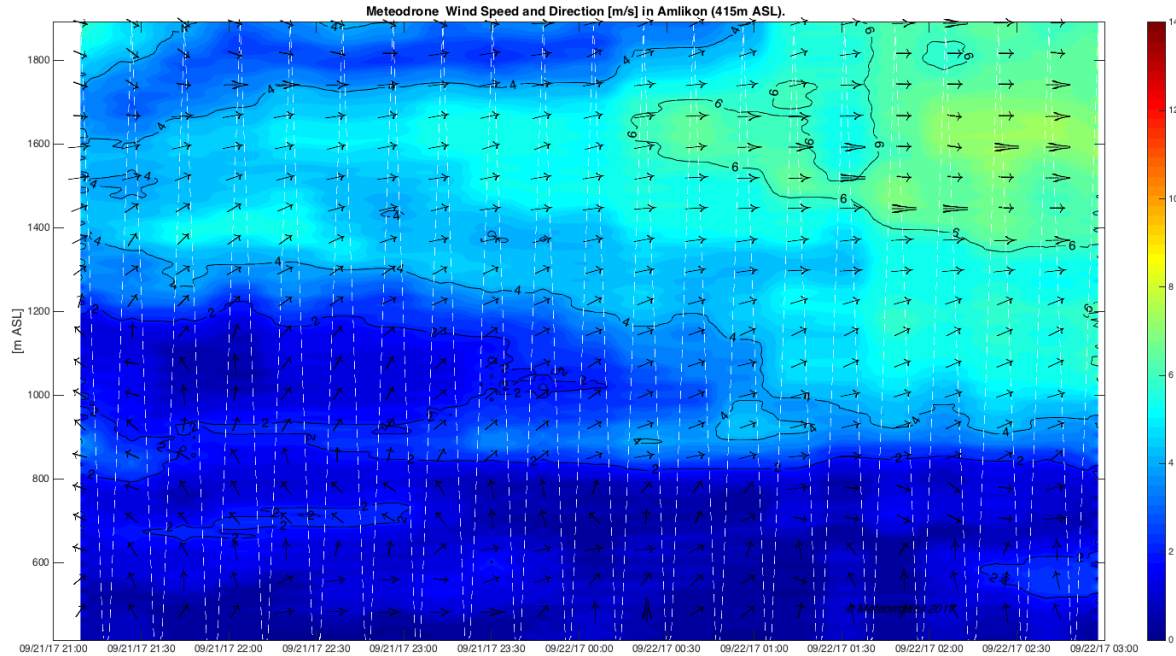
Relative Humidity



Visualization done in MATLAB

Amlikon 21. – 22.09.17

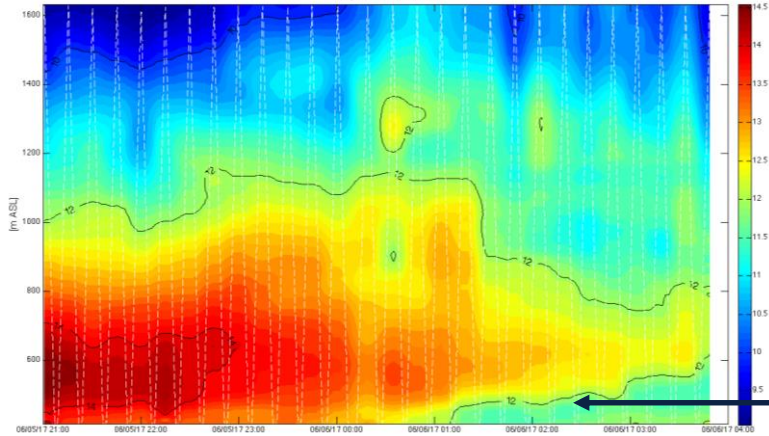
Wind Speed & Direction



Visualization done in MATLAB

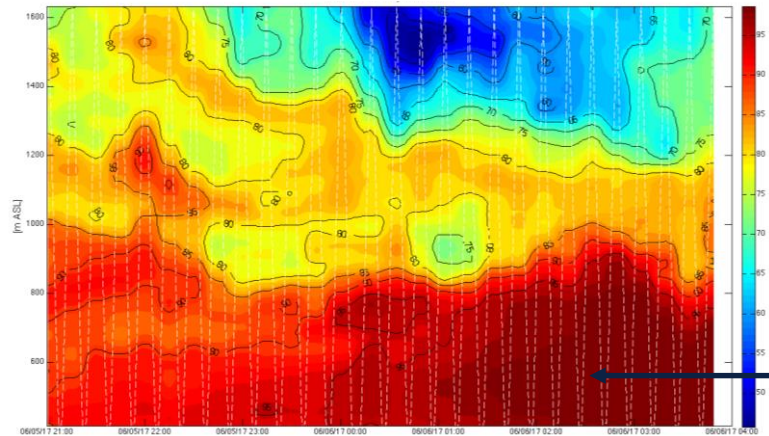
Amlikon 05. – 06.06.17

Temperature in Amlikon.



Temperature

Ground Inversion



Relative Humidity

100% RH



Shallow Fog:
Up to 150 m

**Fully
automated**



**Customized
to your needs**



**New dimension
in precision**

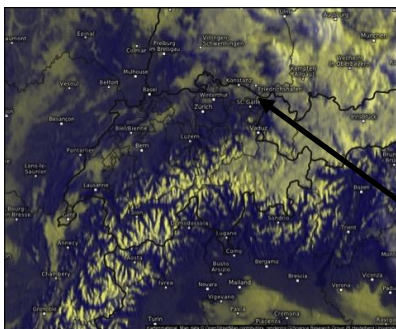
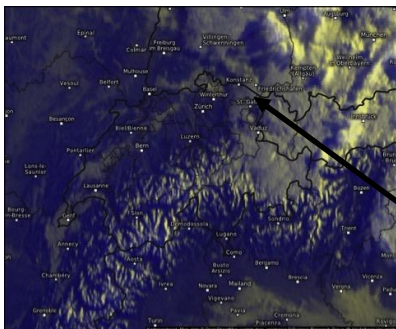


**Maximum
flexibility**

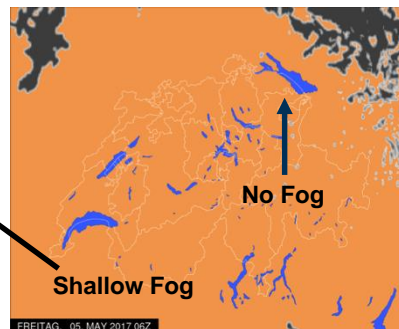
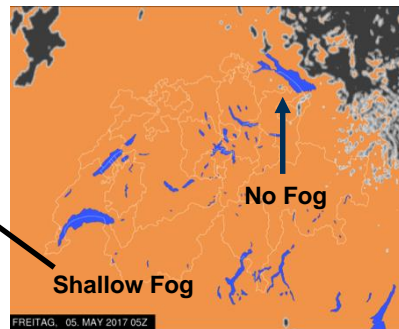


Morning Fog at Lake Constance 05.04.17, 7 am & 8 am

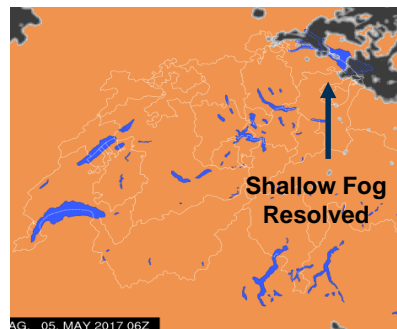
Satellite Cloud Cover



Swiss1k **Without**
Meteodrone Data



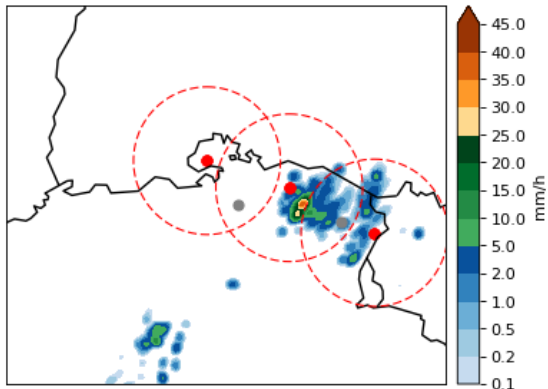
Swiss1k **With**
Meteodrone Data



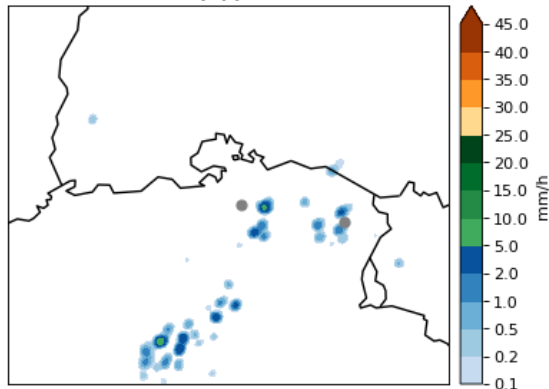
Meteodrones in Schaffhausen, Amlikon and Marbach until 5 am

Thunderstorms in St.Gallen 29. – 30.05.17

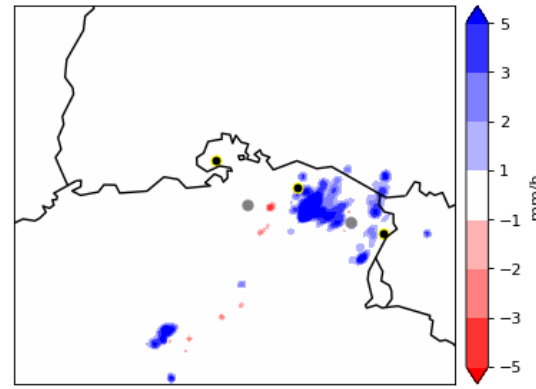
With Meteodrone
29.05.17



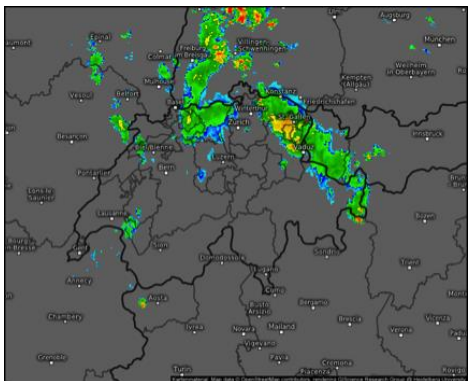
Without Meteodrone
29.05.17



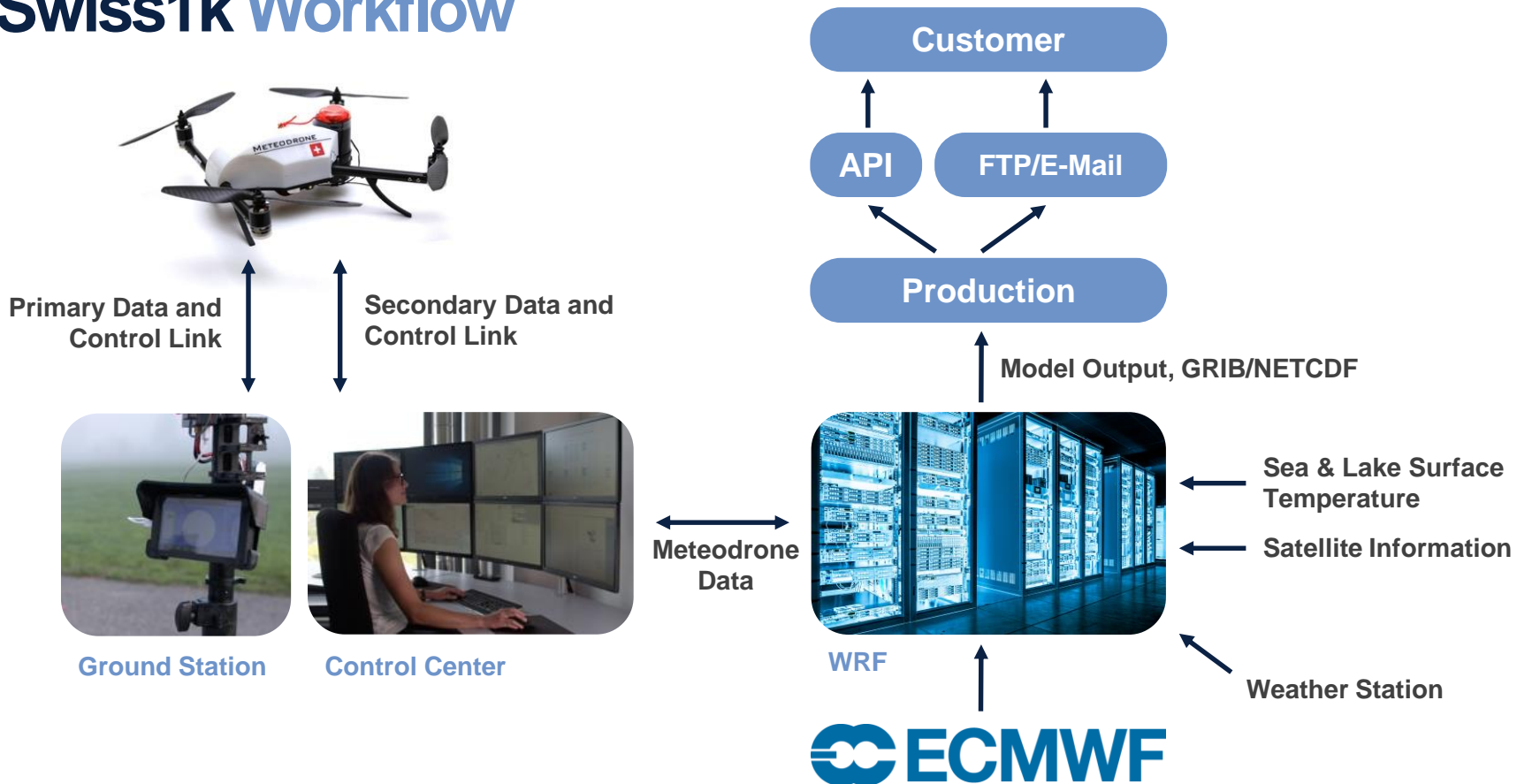
Difference
29.05.17

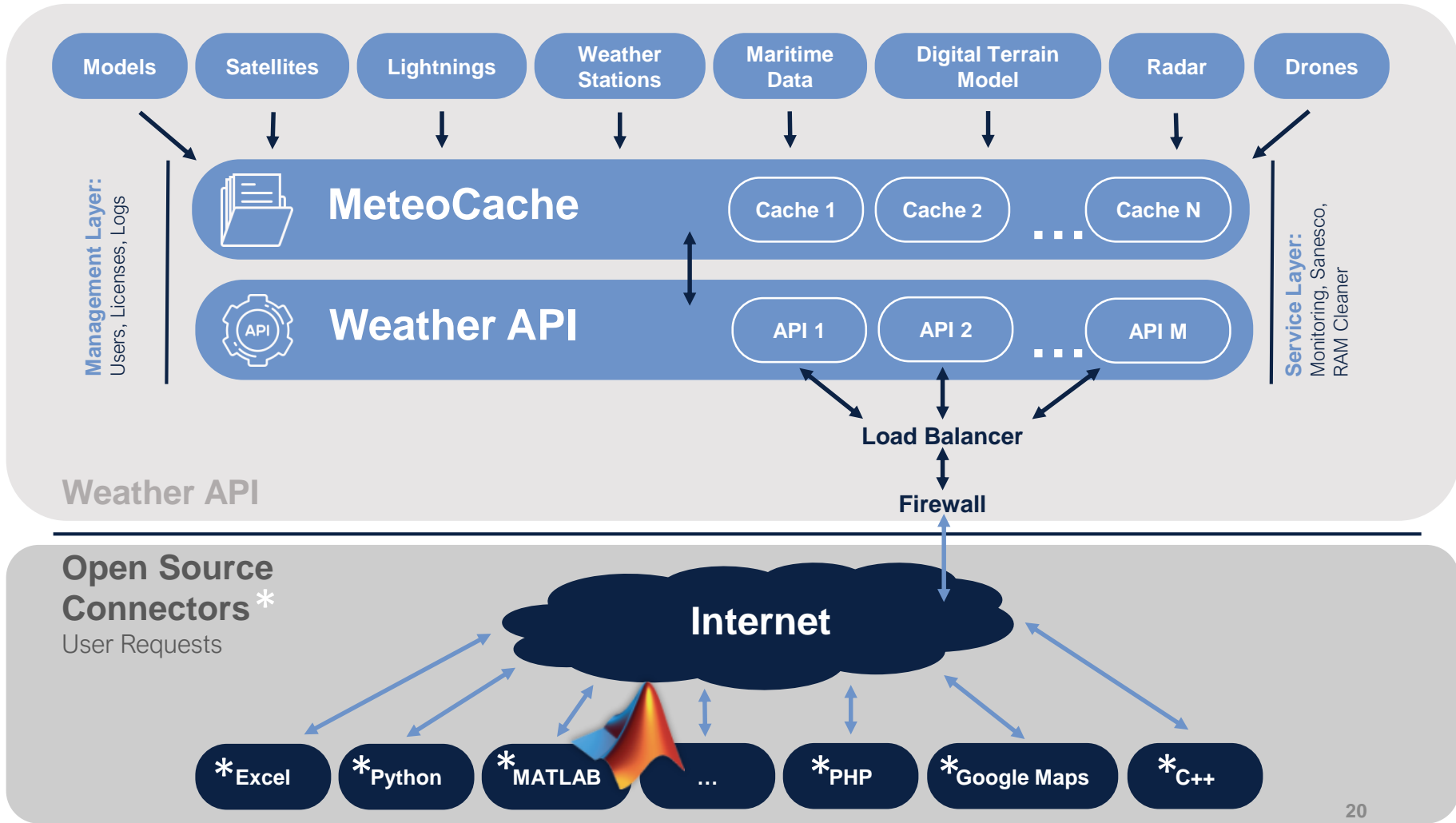


Swiss1k was the only model to capture these storm cells and forecasted them 23 hours ahead!



Swiss1k Workflow





Weather API

USP



Weather data as a single version of truth



On the fly calculation for most up-to-date forecasts



Hyperlocal forecasts delivering enhanced temporal and spatial resolution



Variety of formats and connectors in different programming languages



Detailed and up-to-date documentation

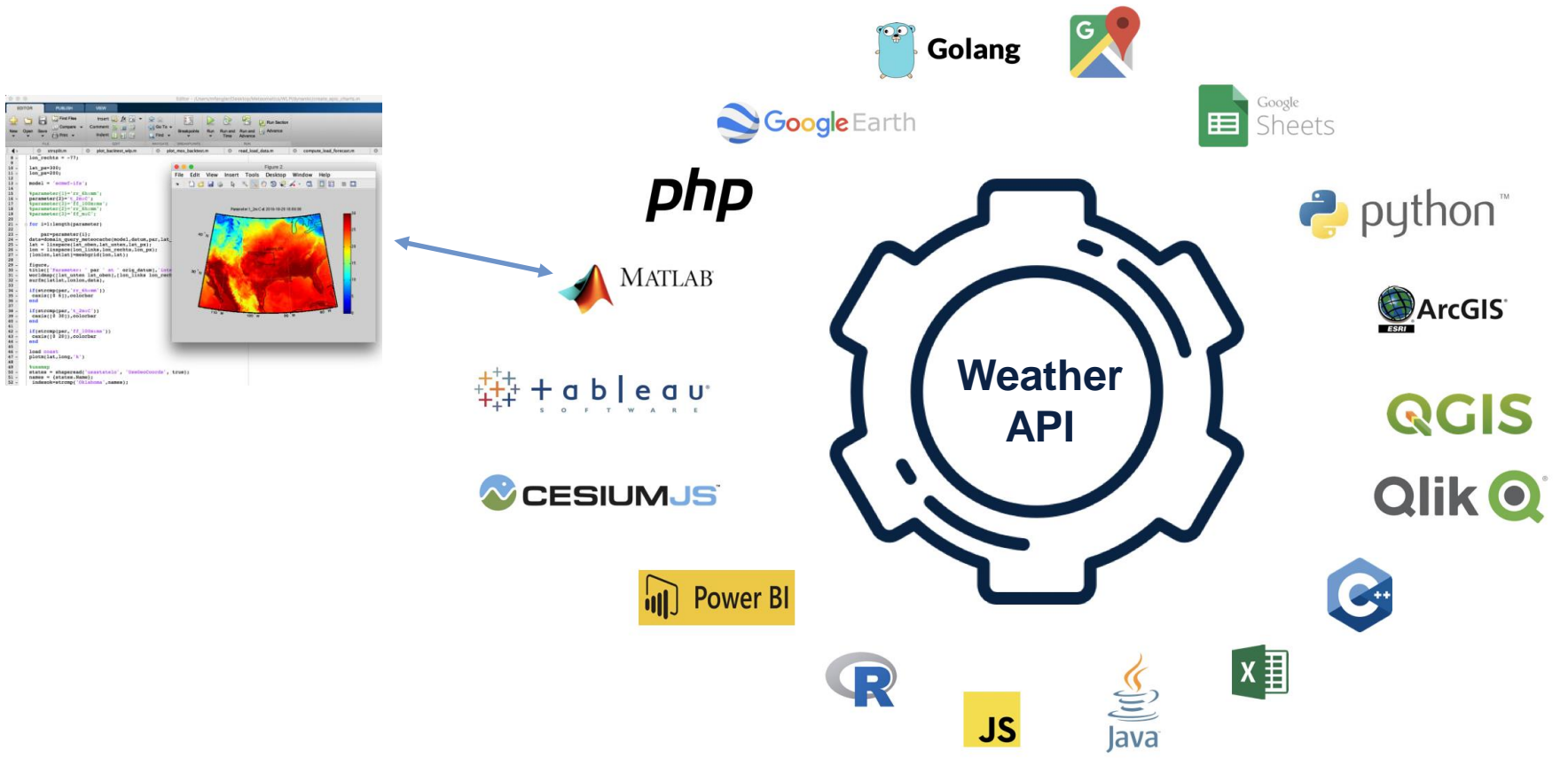


Flexible & fast integration & usage



Simple one-stop access to high quality weather data worldwide

Variety of Possible Integrations



Weather API in MATLAB File Exchange

MathWorks® Products Solutions Academia Support Community Events

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File Exchange

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MATLAB Central Files Authors My File Exchange Contribute About

Meteomatics Weather API Connector

version 2.0.0.0 (371 KB) by Martin Fengler

This packages contain samples to query any meteorological data from the Meteomatics Weather API.
<https://api.meteomatics.com>

★★★★★ 10 Ratings
23 Downloads
Updated 14 Sep 2018
[View License](#)

+ Follow Download

Overview Functions

Accessing any weather, ocean or environmental data should be simple and convenient: Meteomatics provides a REST-full API to global historical, current and forecast data. This includes derived data from different centers (GFS, ECMWF, UK MetOffice, Env. Canada etc...), radar data, satellite, observational, lightning, land usage, digital terrain model data. Moreover, you can get also derived parameters like wind power and solar power data and forecasts for a given geolocation. The API provides time series as well as spatial data. The latter is also offered through a WMS/WFS-compatible interface. This package includes some examples to enable a quick start when dealing with this API. An online documentation is available through <https://api.meteomatics.com>.

Comments and Ratings (12)

- Pham Van Tien** 25 Dec 2018 ★★★★★ demo tres bien!
- Sabrina Burger** 21 Aug 2017 ★★★★★ Nice documentation and great weather data
- Sabrina_Bu** 21 Aug 2017 ★★★★★
- Daniel Kästli** 15 Aug 2017 ★★★★★ easy to use, great results
- Livio Roth** 14 Aug 2017 ★★★★★ Very easy to use, I did not need much time to get the first weather data with the good documented code. Thanks!

MATLAB Release Compatibility

Created with R2015a
Compatible with any release

Platform Compatibility

Windows macOS Linux

Tags

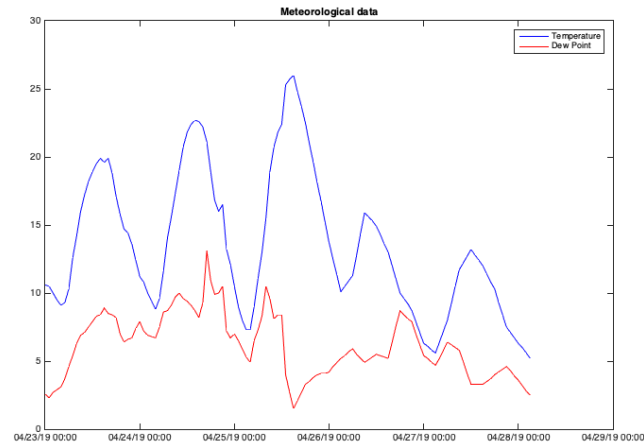
api ecmwf meteorology solar weather wind

Others Also Downloaded

- NetCDF/GRIB reader** 82 Downloads ★★★★★
- zoharby/plot_google_map** 216 Downloads ★★★★★
- TopoToolbox** 66 Downloads ★★★★★

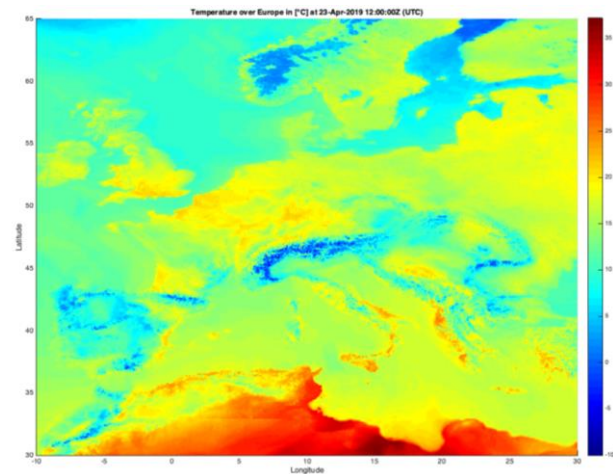
Weather API in MATLAB

```
% -----  
% Sample to query weather data at a certain location time series  
% -----  
  
lat   = 50.123;  
lon   = 10.843;  
  
start_date = floor(now); % Could be anything like a datenum |  
period     = 'P5DT3H15M'; % period of 5 days, 3 hours, 15 min  
resolution = 'PT1H';      % 1h resolution  
  
parameters = 't_2m:C,d_2m:C'; % Temperature and Dew Point at 2m  
  
[dn,data]=time_series_query_meteocache(user,password,'mix',start_date,period,resolution,parameters,lat,lon);
```

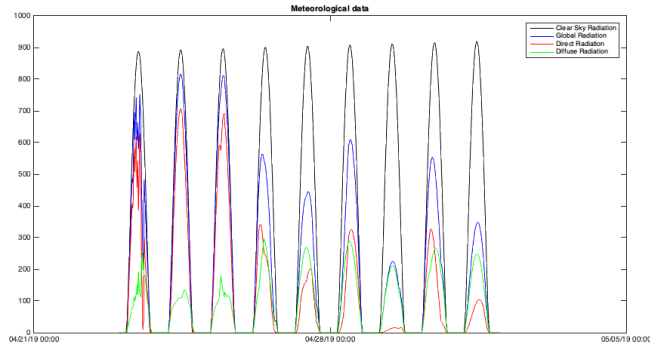


Weather API in MATLAB

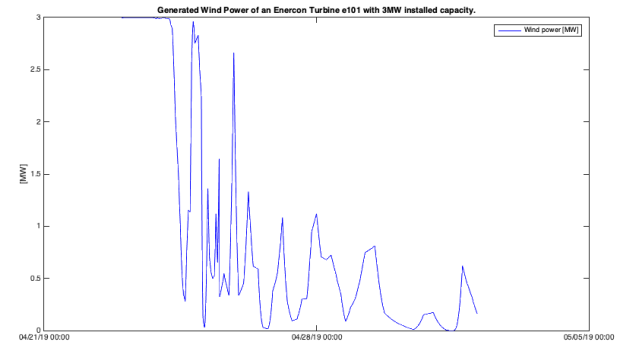
```
% -----  
% Sample to Query a domain for temperature  
% -----  
  
% Define corners of a rectangular domain in decimal degrees  
lat_top = 65;  
lon_left = -10;  
lat_bottom = 30;  
lon_right = 30;  
  
% Define Pixel resolution  
lat_px = 300;  
lon_px = 600;  
  
% Create Lat/Lon grid for visualization  
lat = linspace(lat_bottom,lat_top,lat_px);  
lon = linspace(lon_left,lon_right,lon_px);  
[lons,lats] = meshgrid(lon,lat);  
lats = flipud(lats);  
  
% Set date  
validdate = floor(now)+0.5; % datenum(2016,12,24,15,35,0);  
  
parameter = 't_2m:C';  
  
% Query the grid:  
data=domain_query_meteocache(user,password,'mix',validdate,parameter,lat_top,lon_left,lat_bottom,lon_right,lon_px,lat_px);  
  
figure, surf(lons,lats,data,'EdgeColor','none')
```



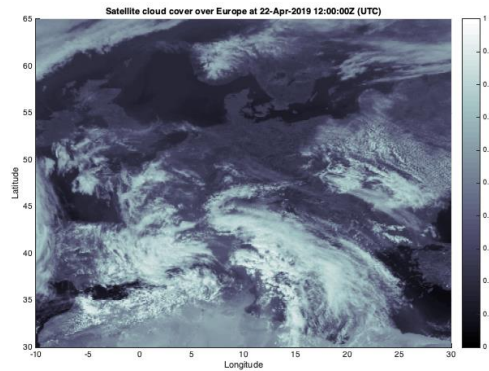
Weather API in MATLAB



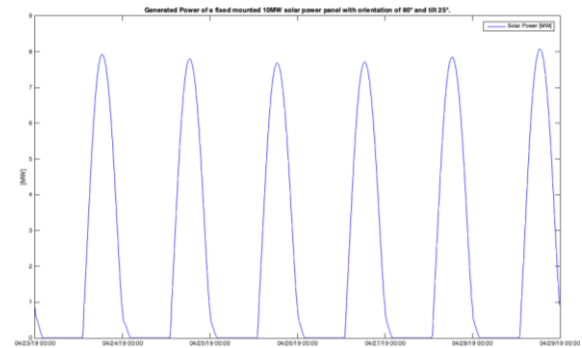
Global, diffuse, direct and clear sky radiation



Wind Power



MSG Satellite Data



Solar Power

Key Takeaways

Weather API & MATLAB

enable us to:

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- ... simulate new measurement techniques
- ... implement physical parametrizations
- ... visualize meteorological data
- ... carry out statistical analyses
- ... enrich training of machine & AI learning with weather data
- ... give deeper insights into your weather related business

Thank You



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