

```
(
  "version": "1",
  "dateGenerated": "2015-01-29T10:10:10",
  "status": "OK",
  "units": {
    "air_temperature": "K",
    "surface_downwelling_shortwave_flux_in_air": "W/m2",
    "wind_from_direction": "",
    "wind_speed": "m/s"
  },
  "forecast": [
    {
      "location": {
        "name": "47.01,9.1",
        "latitude": 47.01,
        "longitude": 9.1
      },
      "initDate": "2014-12-24T12:00:00.000Z",
      "validDate": "2014-12-24T13:00:00.000Z",
      "values": {
        "wind_speed": 8.989384463238128,
        "air_temperature": 272.46184021374273,
        "wind_from_direction": 191.00104716874304,
        "surface_downwelling_shortwave_flux_in_air": 225.64158229465014
      }
    }
  ]
}
```



meteo *matics*

Your Experts in Weather Data Processing.

Weather API

Dr. Martin Fengler

Meteomatics Company Profile



- Weather service provider
- Specialized on industrial weather forecasts, high-resolution local weather models and data distribution
- Located in Berlin & St. Gallen
- 20-25 employees with strong backgrounds in physics, mathematics and computer sciences
- Over 10 years of experience, customers in various sectors

Meteomatics

Weather API

Industrial Services

Meteodrone
SWISS1k

Company backbone:

- Model mix
- Model data
- Station data
- Satellite data
- Ocean data
- Soil data
- Derived parameters
- Astronomical parameters
- ...

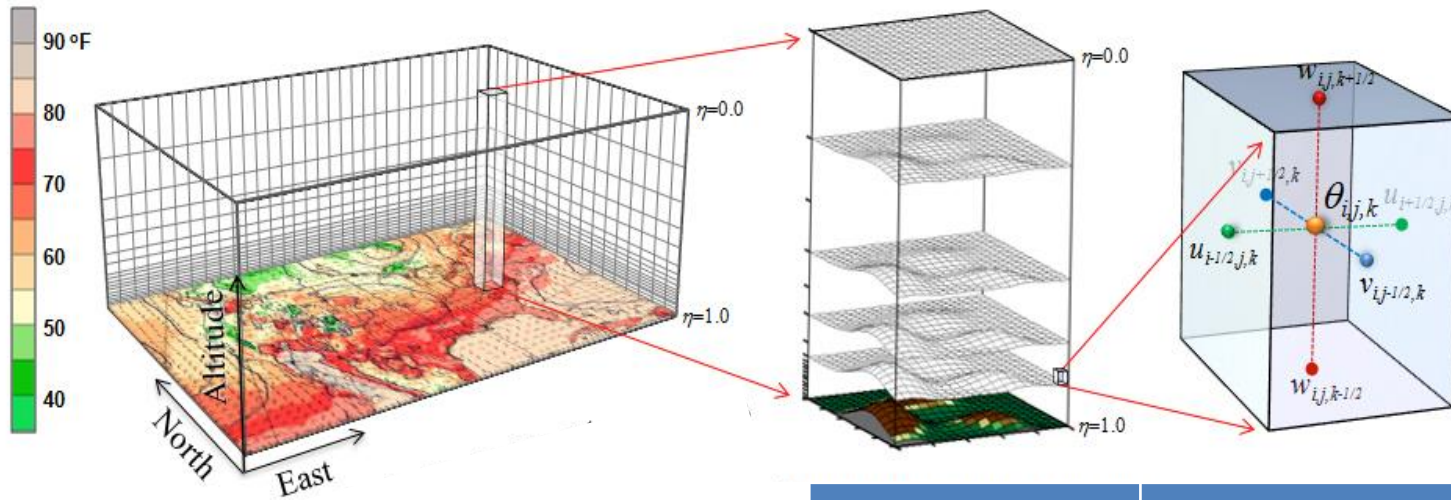
Bespoke solutions:

- Wind power
- Solar power
- Hydro power
- Snow drift
- ...

High-resolution weather modeling:

- Better PBL data
- Improve fog & storm forecasts
- Customized solutions

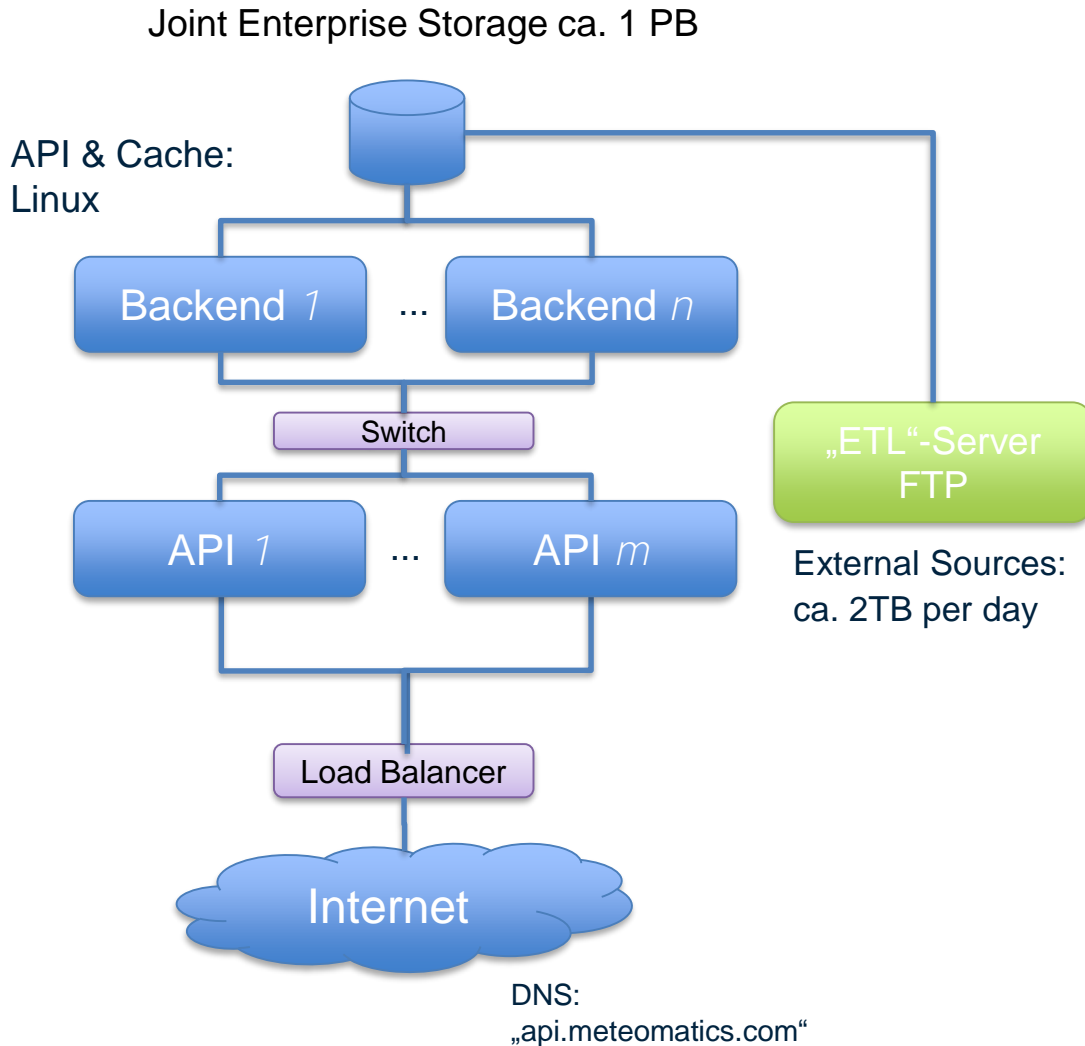
Numerical Weather Prediction = Big Data!



With 4d-grids we end up immediately in the Big Data universe!

Center	Model	Volume p.d.
ECMWF	IFS, IFS-ENS, Seasonal	150 GB
NCEP	GFS, NAM, Ens.	90 GB
Env. Canada	GEM	100 GB
UK MetOffice	UKMO, EURO4	40 GB
WRF	SWISS1k	150 GB
Satellite, Radar
...

Meteo Cache Framework



Weather API

Data format:

XML, JSON, CSV, NetCDF,...

Temporal resolution:

5min-60min.

Performance:

> 10.000 queries per second*

Coverage:

“Global weather data”

**) depending on query type*

Industrial, scalable APIs

Weather forecast data through an API:

HTTPS request:

https://api.meteomatics.com/2018-06-04T00:00:00ZP2D:PT3H/t_2m:C/47.41,9.34/xml

JSON-Response:

```
{
  "version": "3.0",
  "user": "meteomatics-mapserver",
  "dateGenerated": "2018-06-04T20:00:42Z",
  "status": "OK",
  "data": [
    {
      "parameter": "t_2m:C",
      "coordinates": [
        {
          "lat": 47.4122,
          "lon": 9.34065,
          "dates": [
            {
              "date": "2018-06-04T00:00:00Z",
              "value": 16.9
            },
            {
              "date": "2018-06-04T03:00:00Z",
              "value": 15.4
            },
            {
              "date": "2018-06-04T06:00:00Z",
              "value": 17.3
            },
            {
              "date": "2018-06-04T09:00:00Z",
              "value": 21.4
            },
            {
              "date": "2018-06-04T12:00:00Z",
              "value": 23.8
            },
            {
              "date": "2018-06-04T15:00:00Z",
              "value": 25.2
            },
            {
              "date": "2018-06-04T18:00:00Z",
              "value": 20.8
            },
            {
              "date": "2018-06-04T21:00:00Z",
              "value": 17.6
            },
            {
              "date": "2018-06-05T00:00:00Z",
              "value": 17.3
            },
            {
              "date": "2018-06-05T03:00:00Z",
              "value": 17.1
            },
            {
              "date": "2018-06-05T06:00:00Z",
              "value": 17.6
            },
            {
              "date": "2018-06-05T09:00:00Z",
              "value": 21.9
            },
            {
              "date": "2018-06-05T12:00:00Z",
              "value": 24.7
            },
            {
              "date": "2018-06-05T15:00:00Z",
              "value": 25.3
            },
            {
              "date": "2018-06-05T18:00:00Z",
              "value": 23.4
            },
            {
              "date": "2018-06-05T21:00:00Z",
              "value": 19.7
            },
            {
              "date": "2018-06-06T00:00:00Z",
              "value": 18.5
            }
          ]
        }
      ]
    }
  ]
}
```

XML-Response:

```
<meteomatics-api-response version="3.0">
  <user>meteomatics-mapserver</user>
  <dateGenerated>2018-06-04T20:00:03Z</dateGenerated>
  <status>OK</status>
  <data>
    <parameter name="t_2m:C">
      <location lat="47.4122" lon="9.34065">
        <value date="2018-06-04T00:00:00Z">16.9</value>
        <value date="2018-06-04T03:00:00Z">15.4</value>
        <value date="2018-06-04T06:00:00Z">17.3</value>
        <value date="2018-06-04T09:00:00Z">21.4</value>
        <value date="2018-06-04T12:00:00Z">23.8</value>
        <value date="2018-06-04T15:00:00Z">25.2</value>
        <value date="2018-06-04T18:00:00Z">20.8</value>
        <value date="2018-06-04T21:00:00Z">17.6</value>
        <value date="2018-06-05T00:00:00Z">17.3</value>
        <value date="2018-06-05T03:00:00Z">17.1</value>
        <value date="2018-06-05T06:00:00Z">17.6</value>
        <value date="2018-06-05T09:00:00Z">21.9</value>
        <value date="2018-06-05T12:00:00Z">24.7</value>
        <value date="2018-06-05T15:00:00Z">25.3</value>
        <value date="2018-06-05T18:00:00Z">23.4</value>
        <value date="2018-06-05T21:00:00Z">19.7</value>
        <value date="2018-06-06T00:00:00Z">18.5</value>
      </location>
    </parameter>
  </data>
</meteomatics-api-response>
```

Weather API: Connectors

Data Connectors

- Python, Excel, Java, C++, C#
- Flexible & fast integration
- Historical, current & forecast data
- Radar, satellite, model data...

	A	B	C	D
1	Start_date	20.03.2016 11:00		
2	Interval(mins)	25,00		
3				
4	Variable	Temperatur [°C]	Globalstrahlung [J/m²]	PARAMETER
5				
6	Lat	50,40	50,40	50,40
7	Lon	10,00	10,70	10,70
8				wind_speed
9	validdate			
10	20.03.2016 11:00	3,90	5978068,50	16,3
11	20.03.2016 11:25	4,20	6373172,10	16,8
12	20.03.2016 11:50	4,40	6676474,00	17,2
13	20.03.2016 12:15	4,50	6883042,60	17,3
14	20.03.2016 12:40	4,50	6989616,40	17,2
15	20.03.2016 13:05	4,60	6994516,20	17,1

```
import meteomatics_weather_api as api
import datetime as dt

username = 'max'
password = 'mustermann'
lat = 47.11
lon = 11.47
startdate = dt.datetime.utcnow().replace(hour=0, minute=0, second=0, microsecond=0)
enddate = startdate + dt.timedelta(days=1)
interval = dt.timedelta(hours=1)
parameters = ['air_temperature', 'relative_humidity', 'precipitation_amount_3h', 'wind_speed', 'wind_from_direction']

df = api.query_time_series(lat, lon, startdate, enddate, interval, parameters, username, password)
```

Applications: Wind power analysis

Analysis of new/potential portfolios. Deal or no deal?

The screenshot shows a Microsoft Excel spreadsheet titled "meteomatics_energy_connector". The interface includes the standard Excel ribbon with tabs for "Datei", "Start", "Einfügen", "Seitenlayout", "Formeln", "Daten", "Überprüfen", "Ansicht", and "Entwicklertools". The active cell is B9, containing the formula "ge_energy_1_5sl".

The spreadsheet data is as follows:

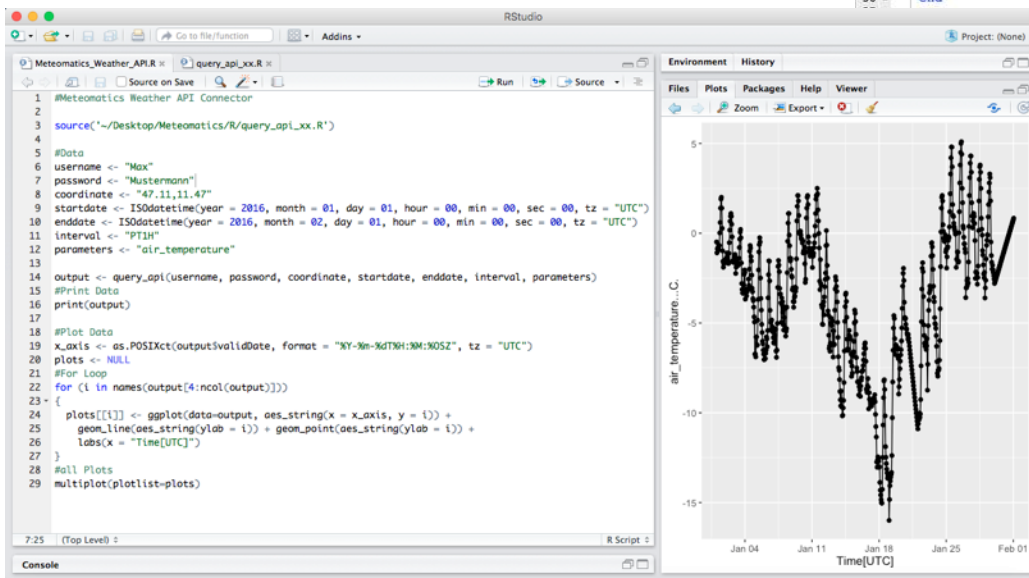
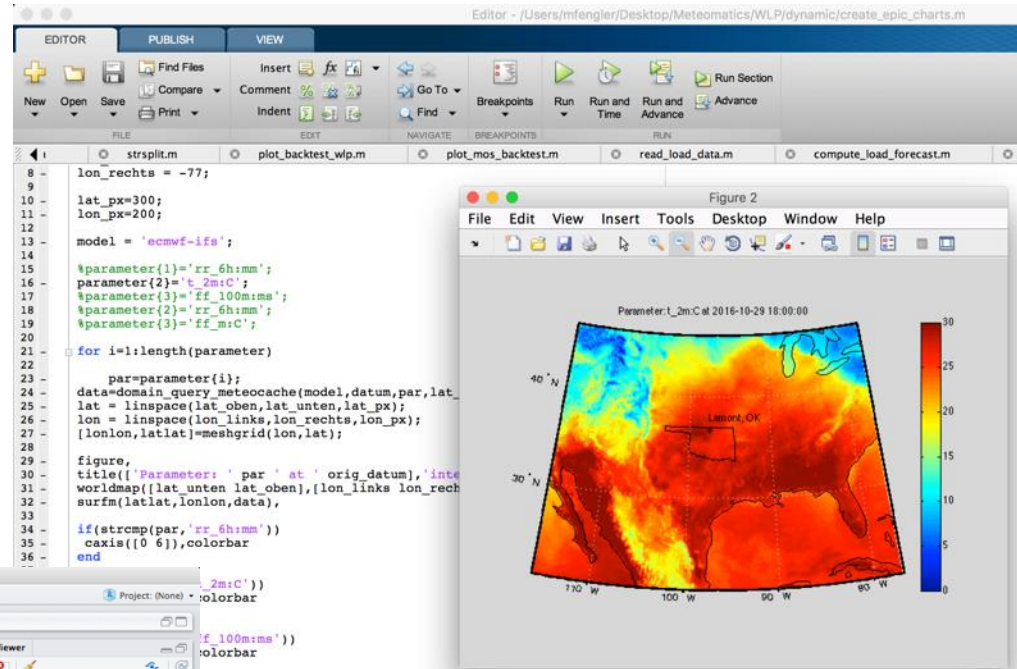
	A	B	C	D	E	F	G	H	I	J
1	Feste Werte:	50,923/10,456/-bonus_b2000	50,923	10,456	bonus_b2000_2000	100	Turbine model:	ge		
2	Start Datum:	01.09.2016 00:00	Daten beziehen							
3	End Datum:	29.09.2016 02:00	Intervall (min):	15						
4	Standort	1	2							
5	Lat	48,2569	50,797725							
6	Lon	7,800	8,9219942							
7		<input checked="" type="checkbox"/> aktiv	<input checked="" type="checkbox"/> aktiv							
8	Name Standort:	Standort #1	Standort #2							
9	Turbine model:	ge_energy_1_5sl	stas_v117_3300							
10	Hub Height [m]:	ge_energy_1_5sl								
11		ge_energy_1_5sle								
12	#####	ge_energy_1_5sle								
13		ge_energy_1_6_100_1600								
14	16.09.2016 13:30:00	ge_energy_1_6_82_5								
15	16.09.2016 13:45:00	ge_energy_1_7_100_1700								
16	16.09.2016 14:00:00	ge_energy_1_85_82_5								
17	16.09.2016 14:15:00	ge_energy_1_85_87								
18	16.09.2016 14:30:00		7,000							
19	16.09.2016 14:45:00		78,000							
20	16.09.2016 15:00:00		85,000							
21	16.09.2016 15:15:00		93,000							
22	16.09.2016 15:30:00		1,000							
23	16.09.2016 15:45:00		106,000							
24	16.09.2016 16:00:00		112,000							
25	16.09.2016 16:15:00		118,000							
26	16.09.2016 16:30:00		129,000							
27	16.09.2016 16:45:00		143,000							
28	16.09.2016 17:00:00		157,000							
29	16.09.2016 17:15:00		185,000							
30	16.09.2016 17:30:00		199,000							
31	16.09.2016 17:45:00		213,000							
32			227,000							

A dropdown menu is open for the "Turbine model:" cell, showing a list of turbine models including "stas_v117_3300" and "IND POWER [MW]". A blue arrow points from a callout box containing the text "> 700 power curves" to the dropdown list.

Weather API: Connectors

Data Connectors

- Matlab, R,...
- Flexible & fast integration
- Radar, satellite, model data...



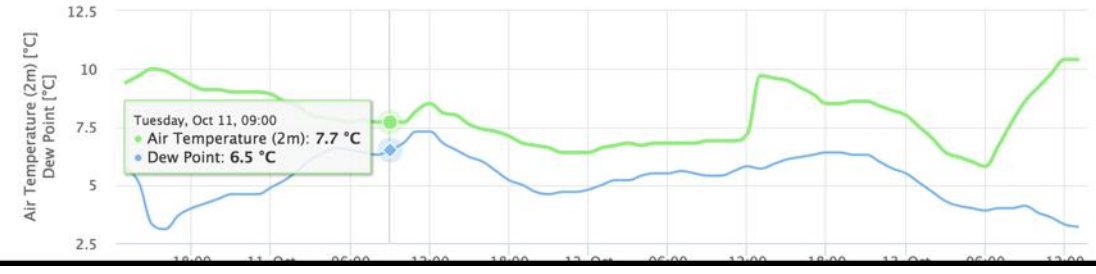
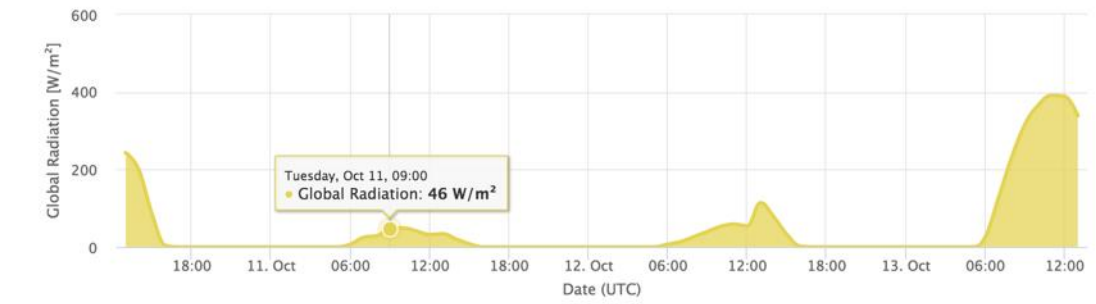
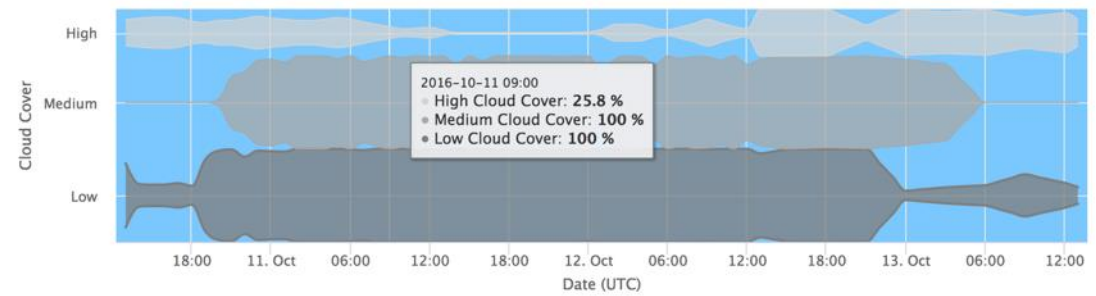
Weather API: data for arbitrary locations

Global Forecasts | pst time - Google-Suche | Martin

demo.meteomatics.com/global-forecasts/

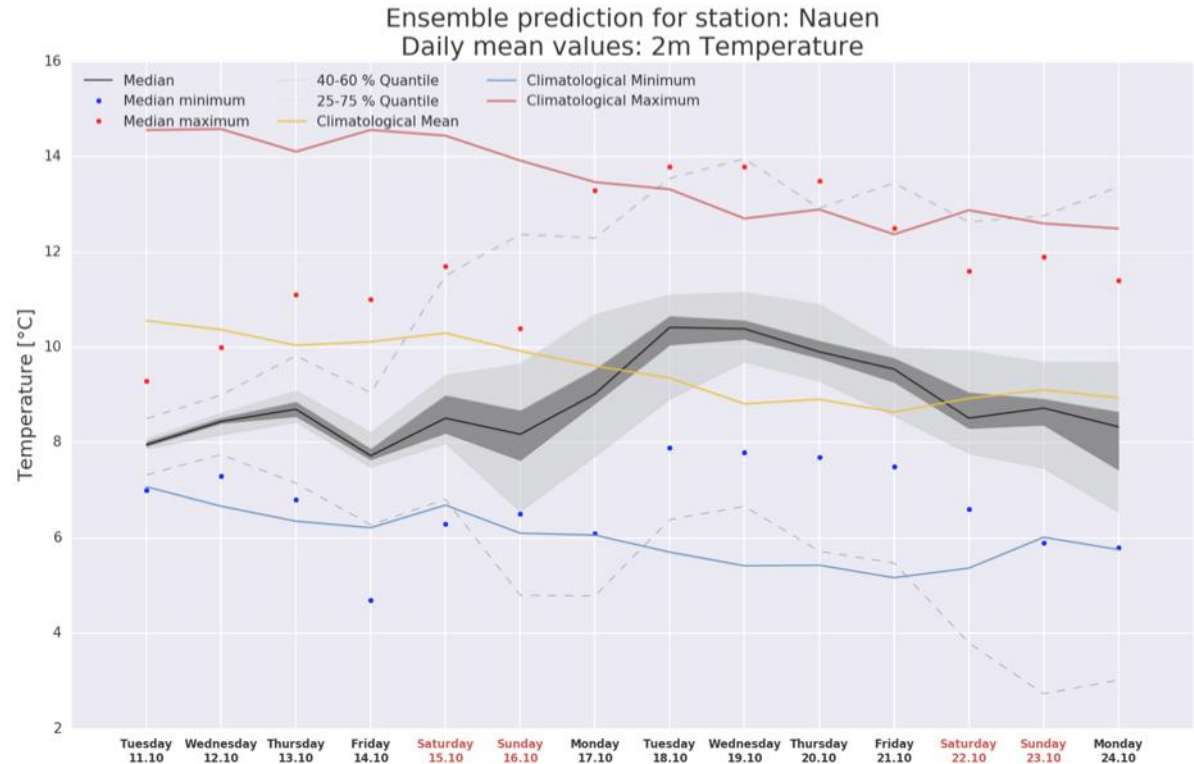
meteo**matics**
Your Experts in Weather Data Processing.

Coordinates: 52.51 / 13.491 | Date: (UTC) 2016-10-10, 13:00 | -3 days | +3 days | Weather Overview | Weather Charts



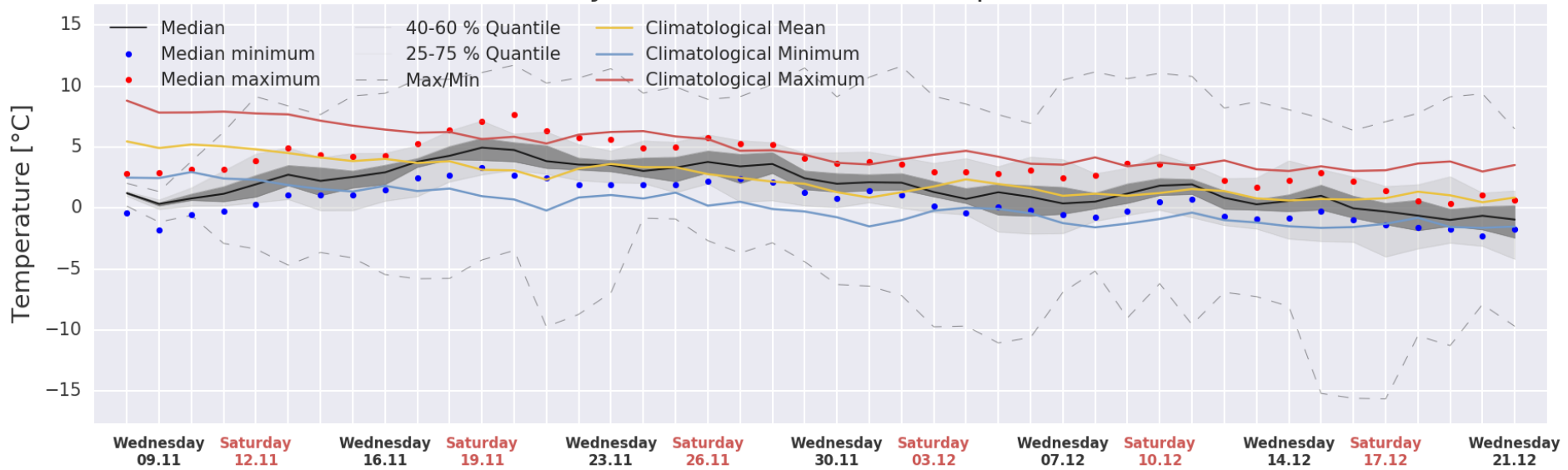
Weather API: 15 days ensemble data

ECMWF Ensemble forecast to analyze upcoming trends: 15days

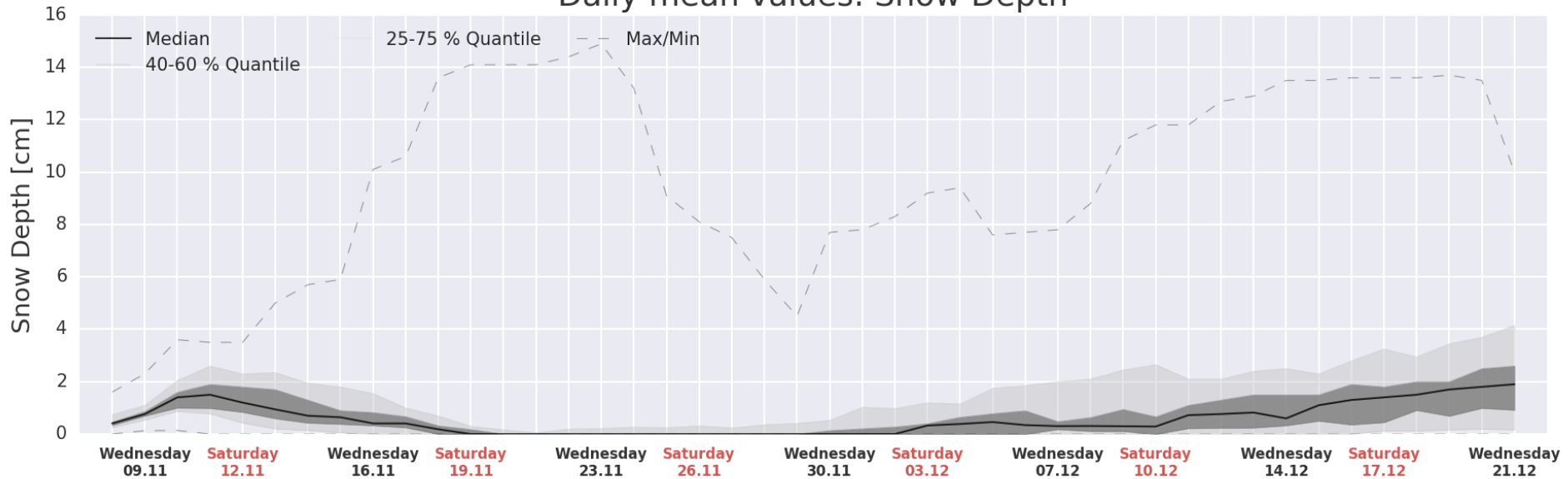


Weather API: ECMWF 46 days ensemble data

Daily mean values: 2m Temperature

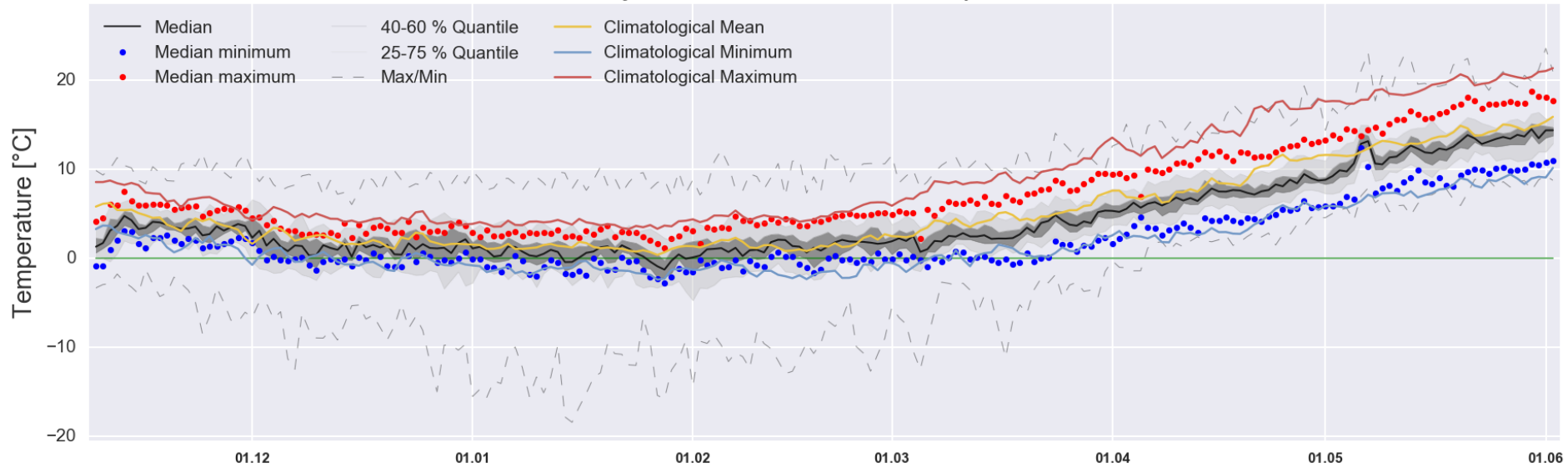


Daily mean values: Snow Depth

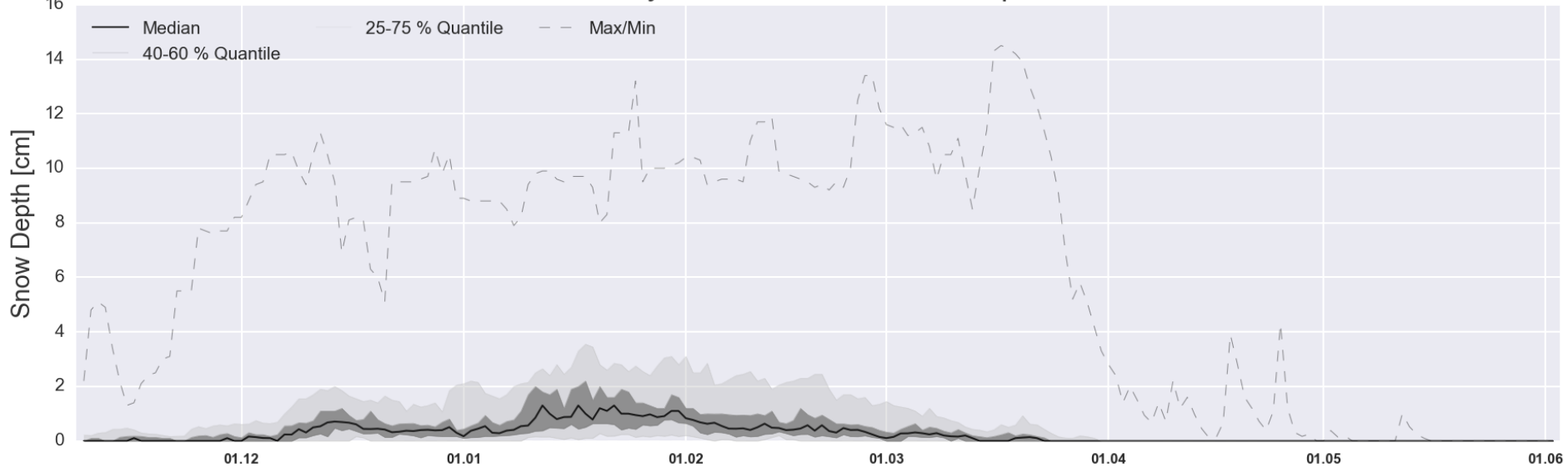


Weather API: Seasonal Forecasts for 7-months

Ensemble prediction 7 months: Hamburg
Daily mean values: 2m Temperature

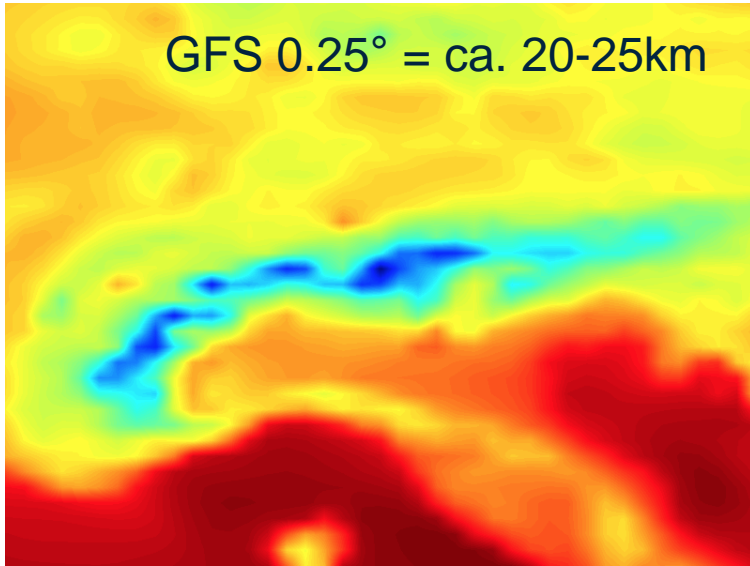


Ensemble prediction 7 months: Hamburg
Daily mean values: Snow Depth

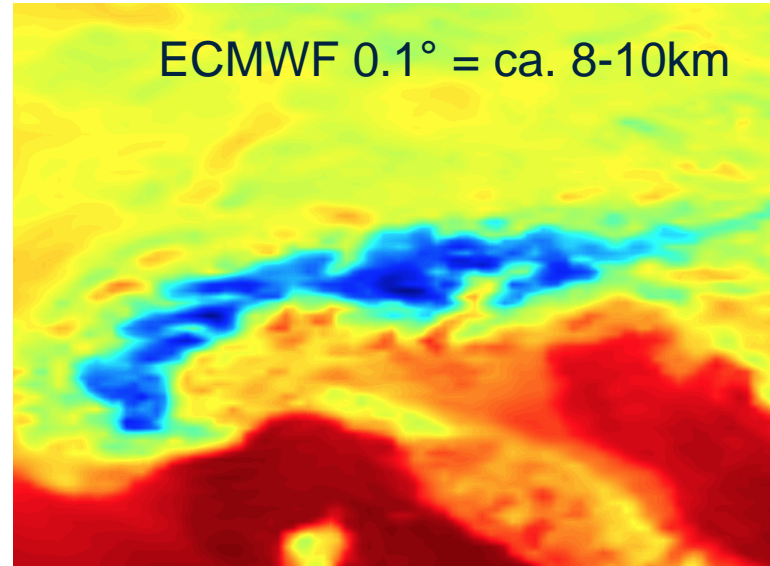


On the fly down-scaling: improving data insights!

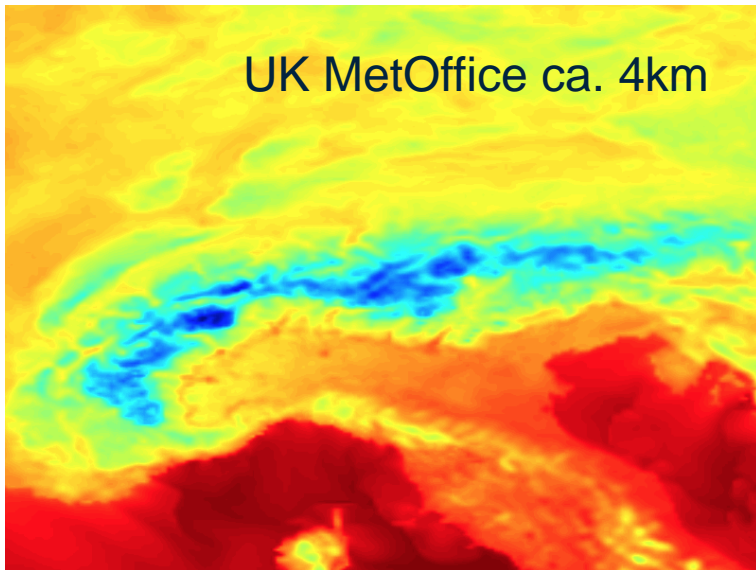
GFS 0.25° = ca. 20-25km



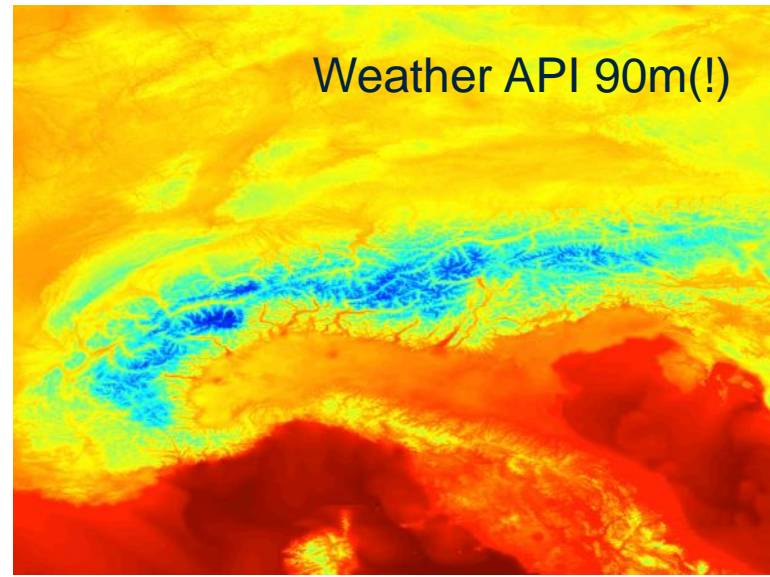
ECMWF 0.1° = ca. 8-10km



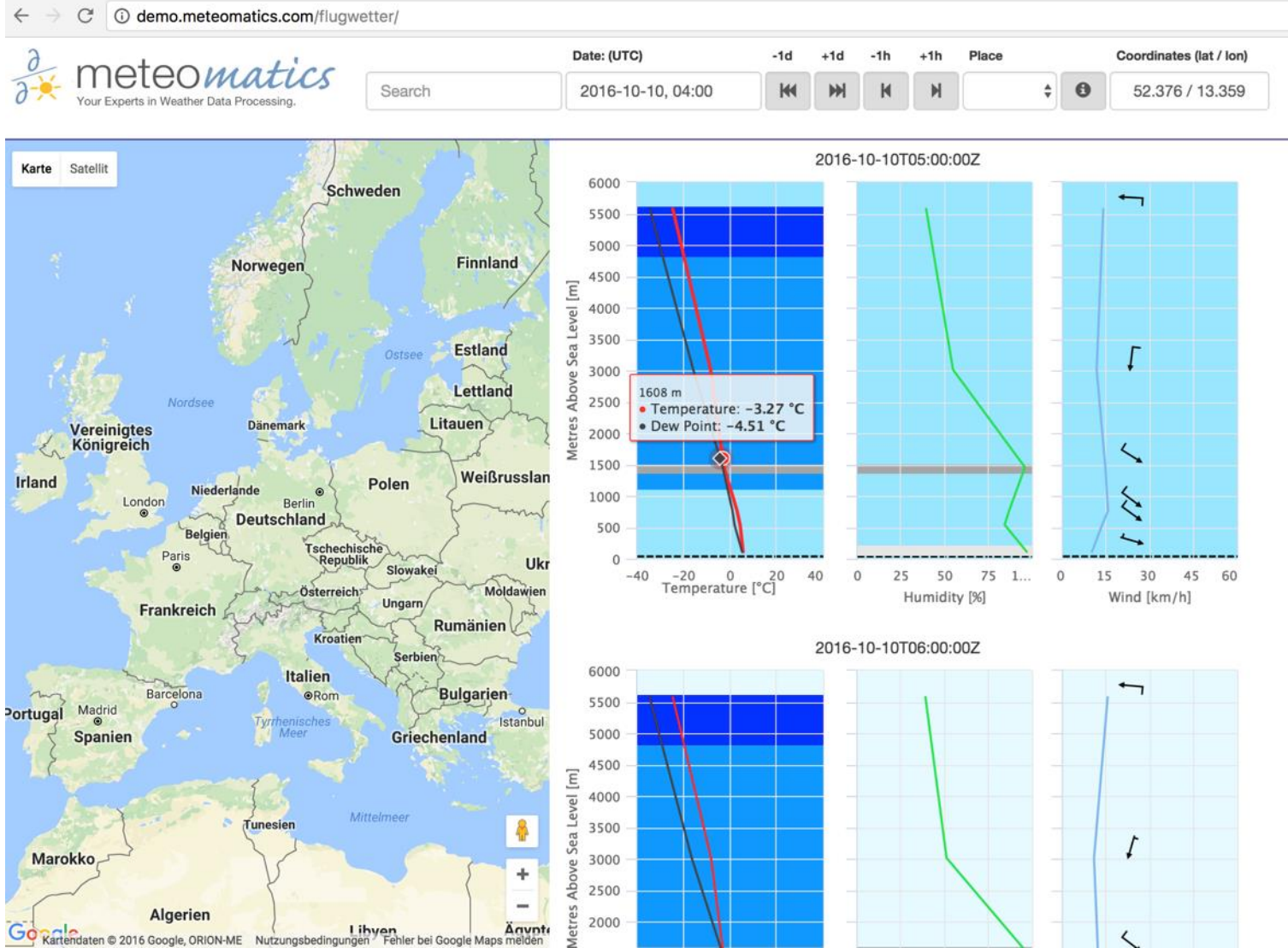
UK MetOffice ca. 4km



Weather API 90m(!)



Upper air level data for arbitrary locations

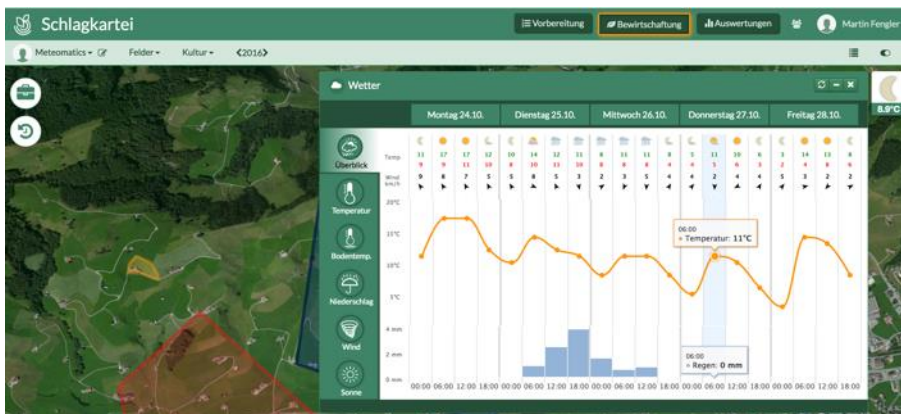
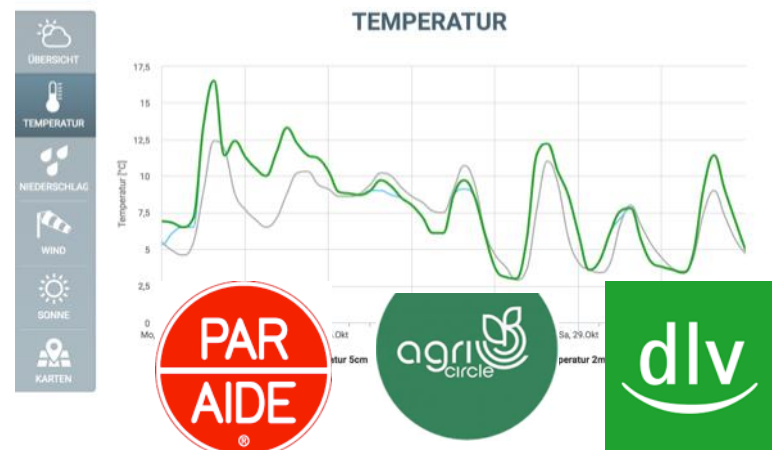


Our experience in AgriCulture

Agriculture parameters:

- Dew-Index, Rime-Index
- Leaf wetness, Guttation
- Growing Degree Days (Basis 10°C)
- Phytophthora Negativ Forecast
- Soil temperature 5/15/50/150 cm
- Evaporation, Evapotranspiration
- Frost, soil temperature, Frost warning
- Grassland fire index
- Palmer Drought Index
- Moisture Stress index
- Moon light index

The screenshot shows the 'agrarheute' website interface. At the top, there are navigation tabs for 'Pflanze', 'Tier', 'Technik', 'Betriebsführung', 'Markt', 'Panorama', 'agraro-Jobbörse', and 'Smart Farming'. Below these, market prices are listed for various products like 'Jungbullen', 'Kühe', 'Ferkel', and 'Schweine'. A search bar is present on the right. The main section is titled 'WETTER FÜR ROMOOS (6113)' and includes a location selector and buttons for 'heute', '7 Tage', and '14 Tage'.



Maritime Data available today from our API



Maritime Parameters

- wave height (mean/max)
- wave direction
- wave period
- direction of total swell
- direction of wind waves
- wave period 1st moment
- wave period 2nd moment
- period of total swell
- period of wind waves
- direction of first swell
- direction of second swell
- direction of third swell
- drift (speed & direction)

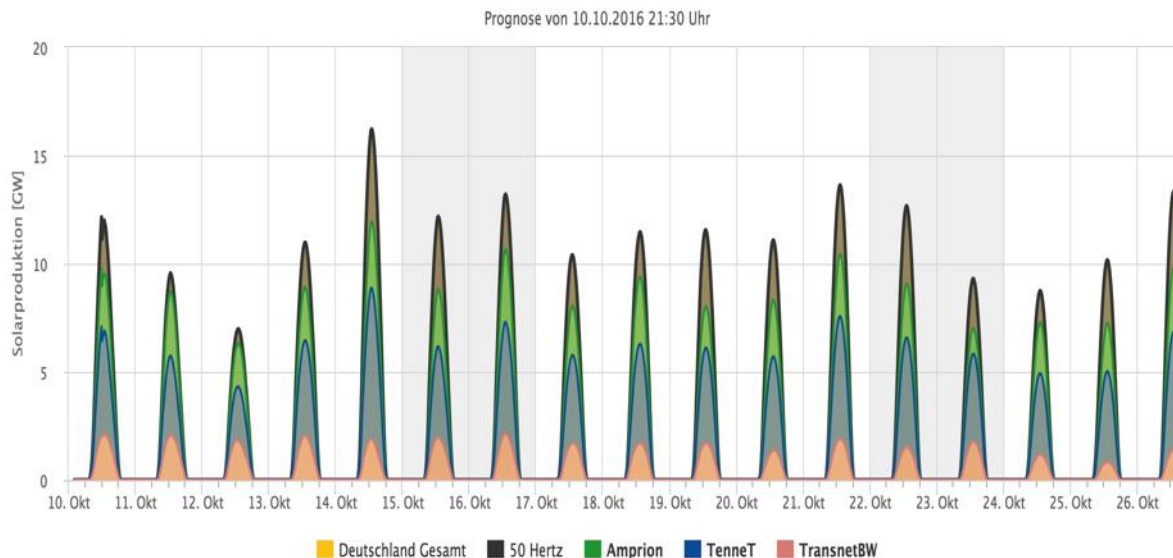


Applications: Solar Power Forecasts

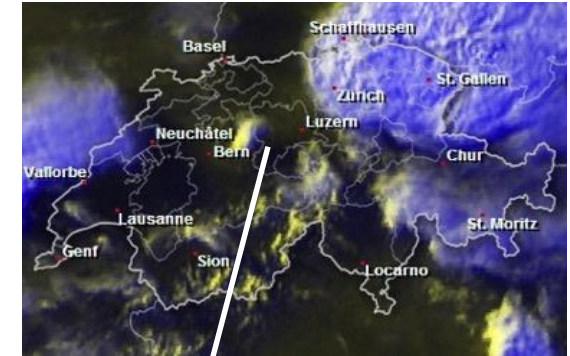
- (i) Take historical data from your sites
- (ii) Calibrate/train your model with historical model and panel data

=> for a model of your choice from API

- (iii) Apply your regression coefficients to any future model run

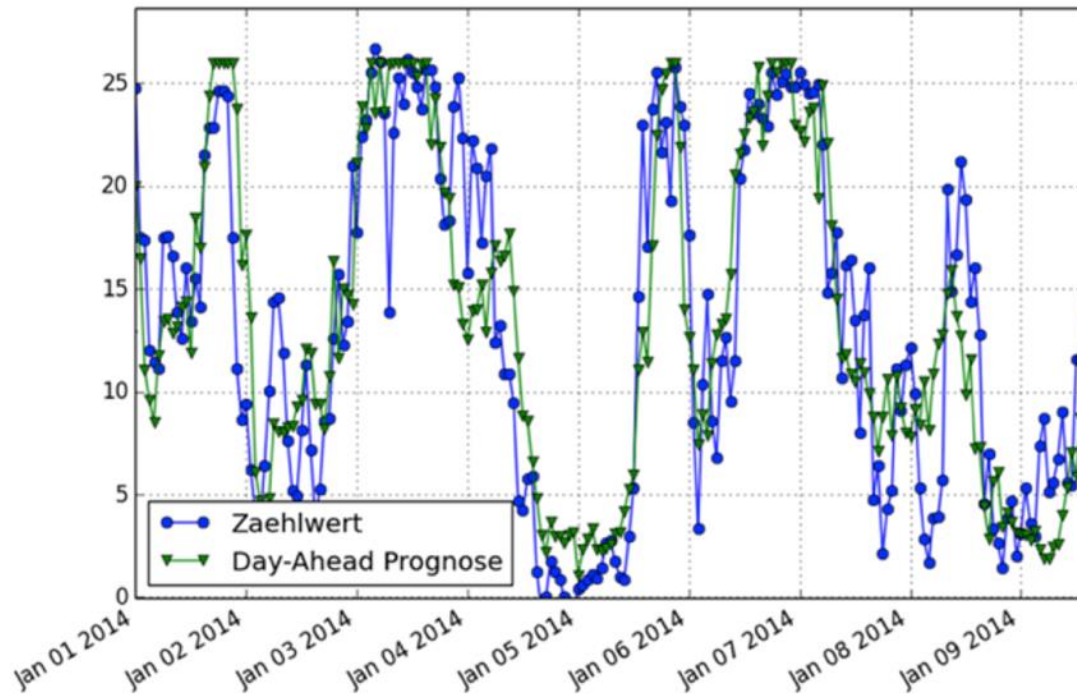


Solar Power Forecast by Meteomatics



Applications: Wind Power Forecasts

Mix the forecast of the different models!

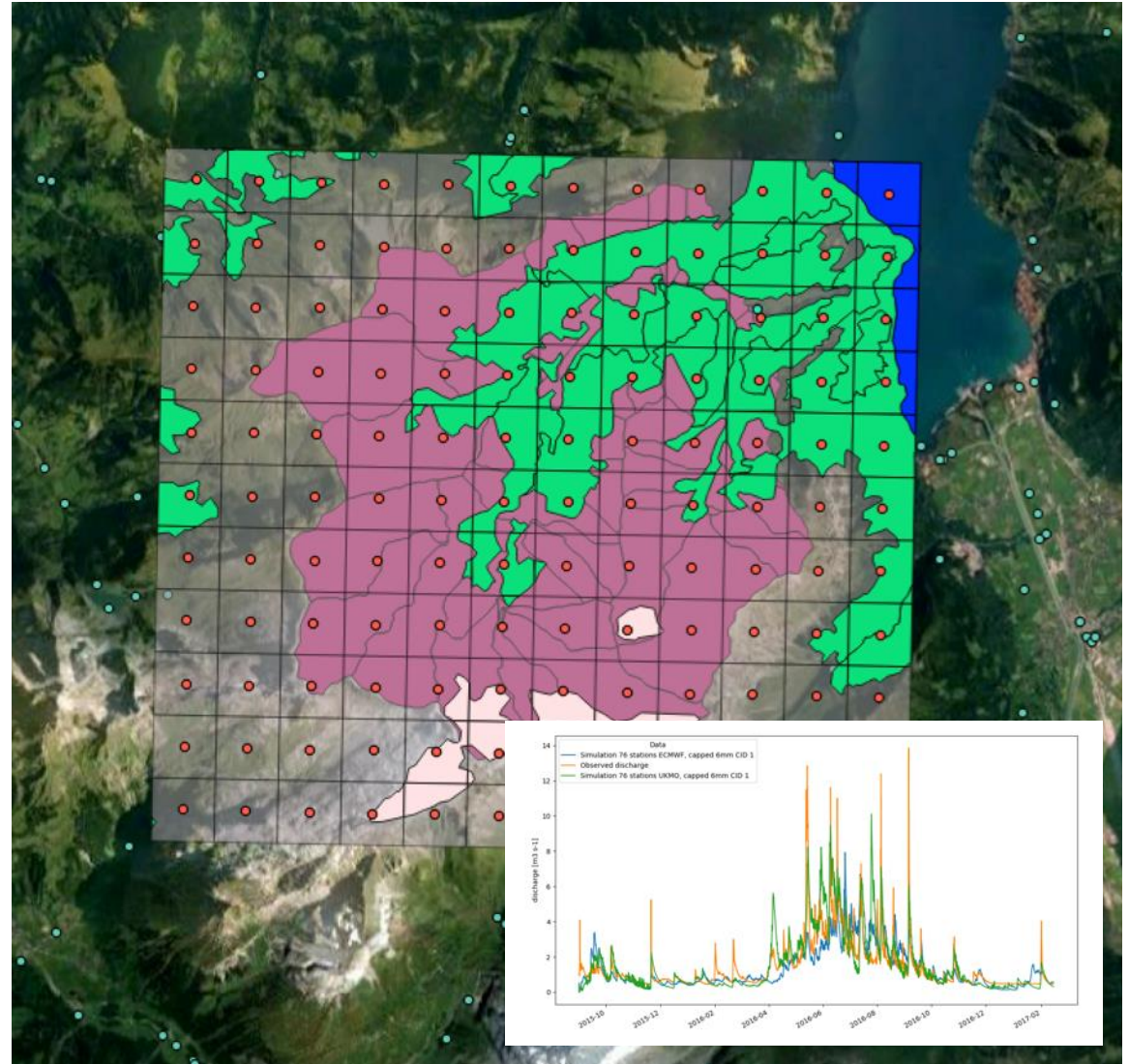


Wind farm (nRMSE):
Intraday < 8%
Day Ahead < 10%

Applications: Hydro Power Forecasts

Feeding API data into hydro power codes.

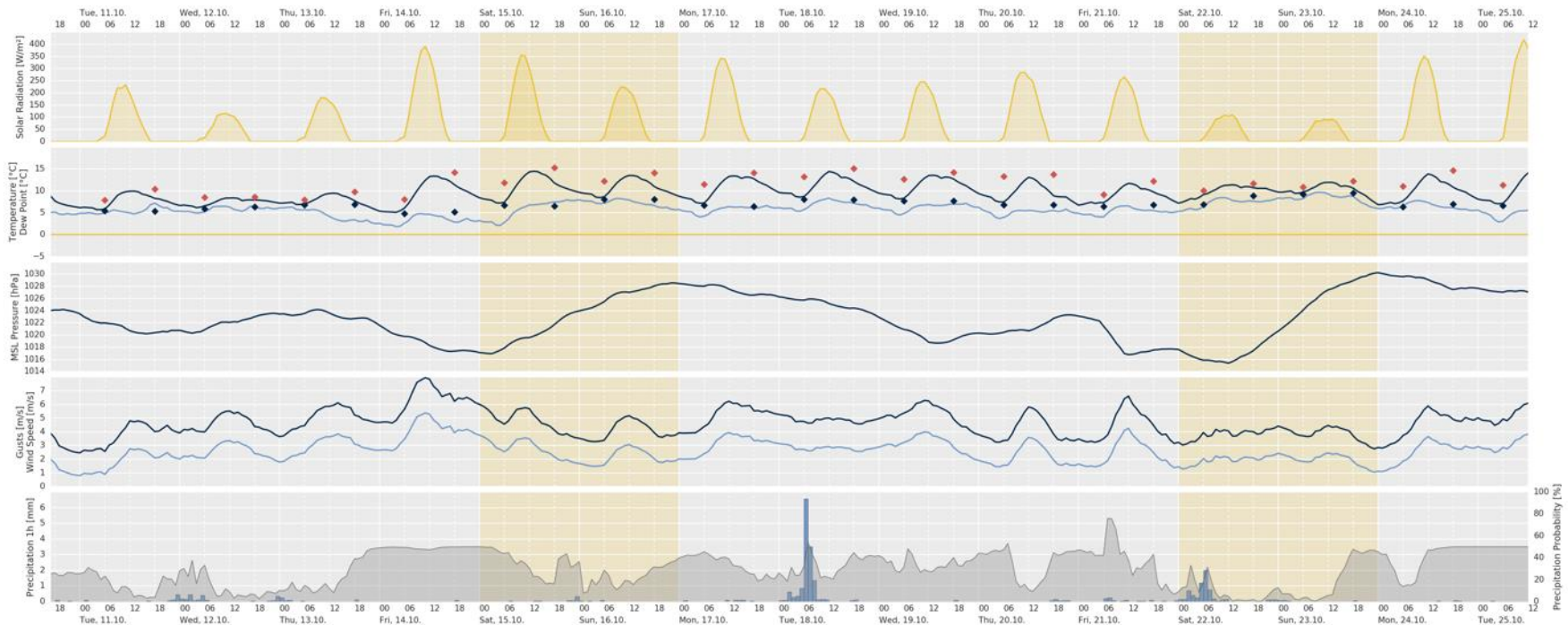
- radar & precip data
- radiation
- evaporation
- temperature



Applications: Forecasts for your own station data

Build your own „MOS“/model:

dresden-nossener-bruecke
(generated at 2016-10-11 05Z)



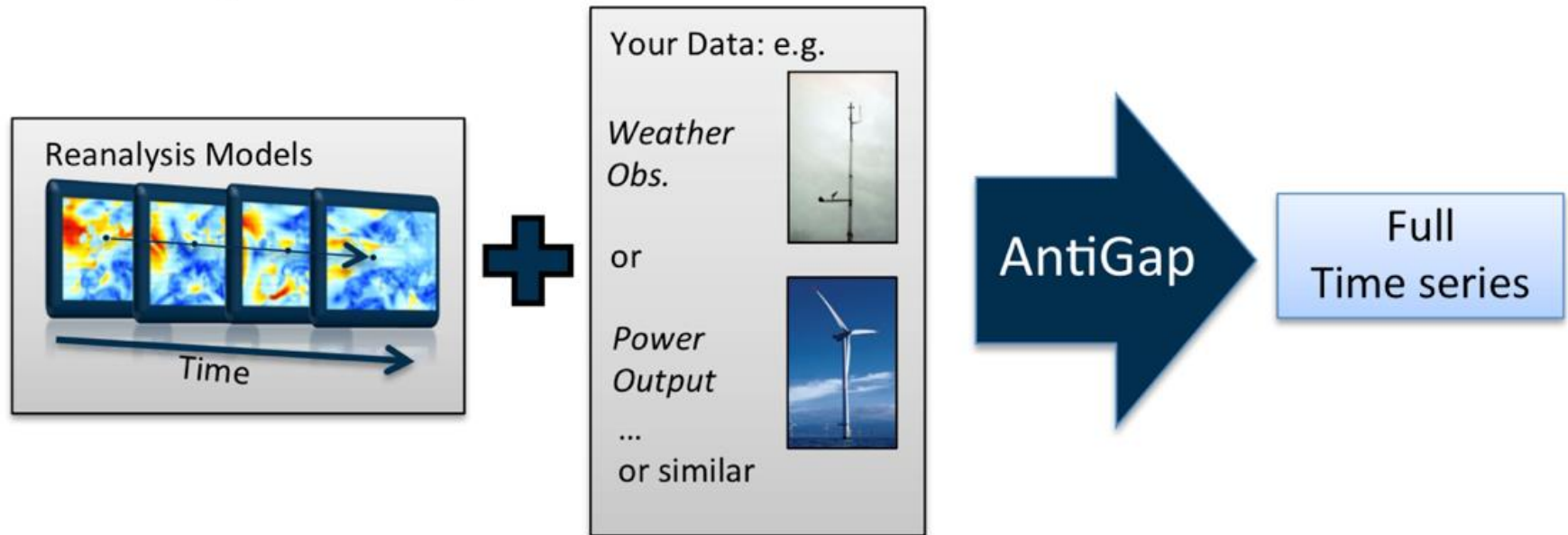
Temperature Error MAE Intraday/Day Ahead: 0.8°C-1.0°C.

Applications: Filling gaps in time series

HindCast & fill missing data:

- ECMWF ERA Interim model data reach back till 1979.
- ECMWF IFS data reach back till 2014*
- GFS, UK MetOffice....

Functionality of AntiGap

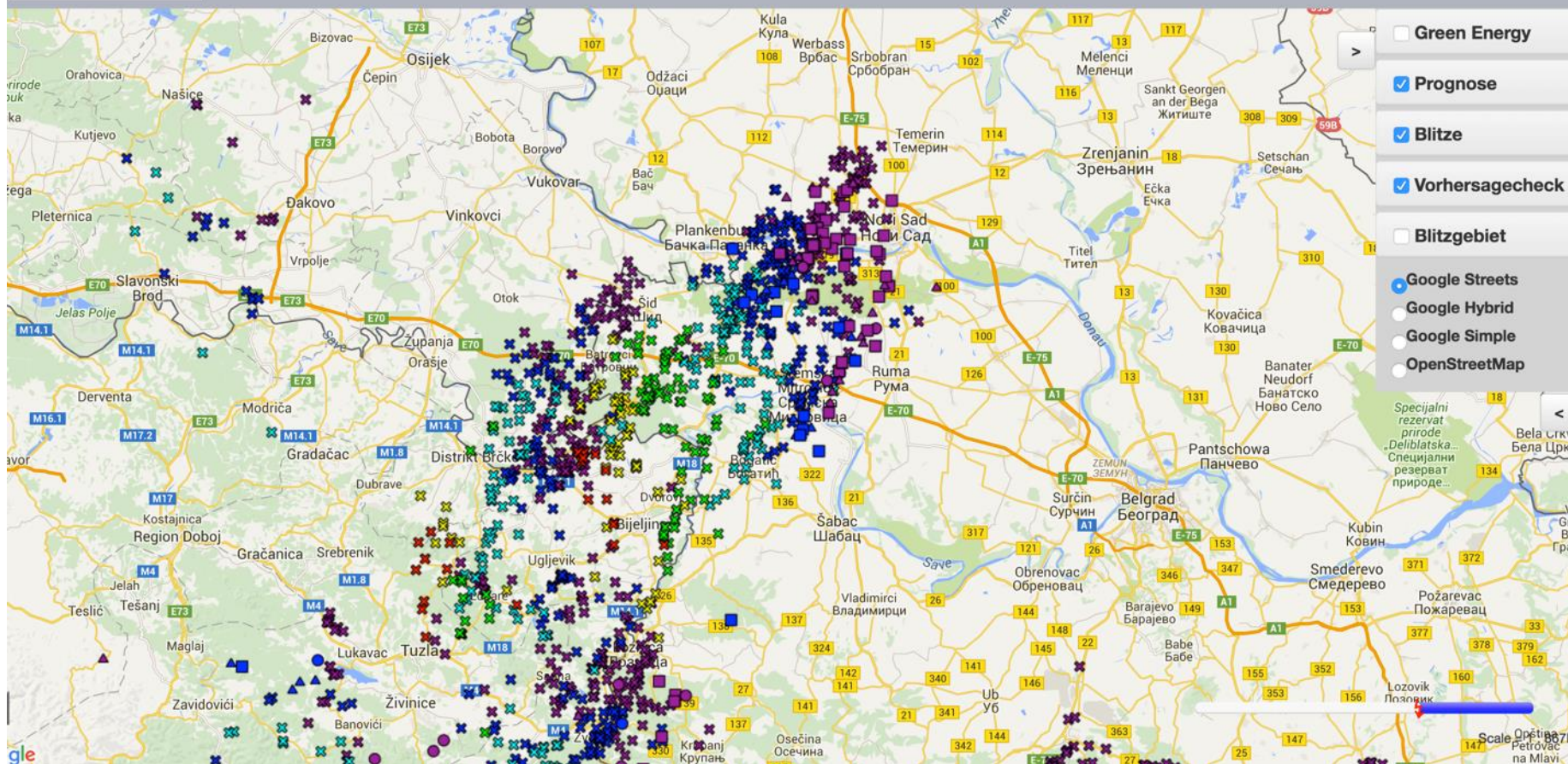


*) can be extended

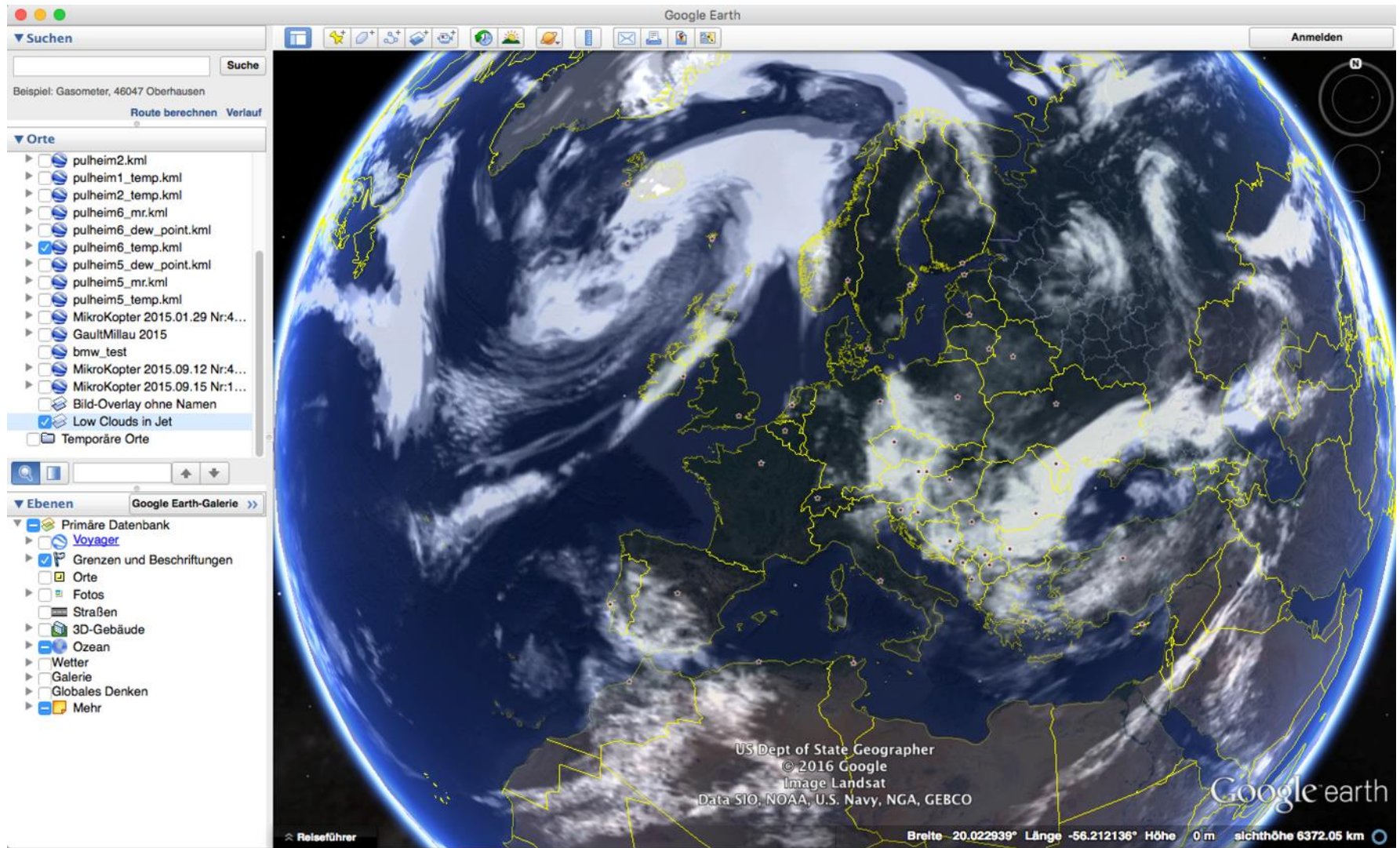
Applications: Real-time Lightning Forecasts

SIEMENS

BLIDS Aktuell



Our Weather-API supports also WMS: Google Earth

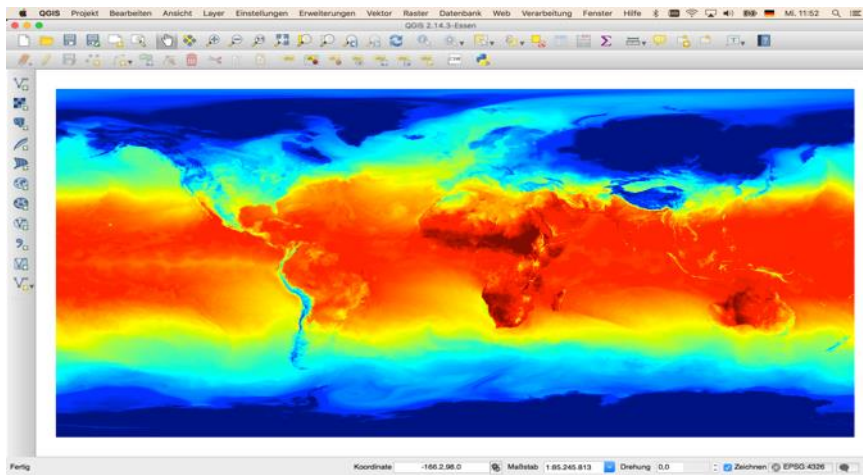


Integration into GoogleMaps

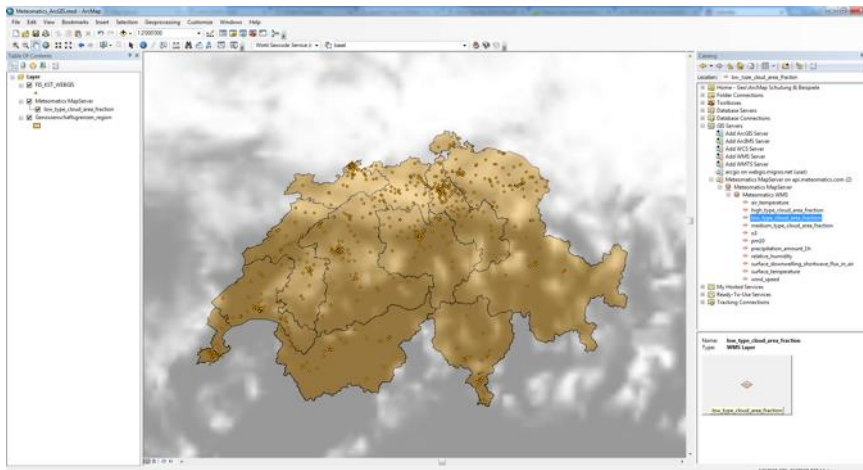
The screenshot displays a web browser window with the following elements:

- Browser Header:** Chrome browser, tabs for 'Map Server' and 'pst time - Google-Suche', address bar showing 'demo.meteomatics.com/wms/'.
- meteo-matics Logo:** 'Your Experts in Weather Data Processing.'
- Control Panel:**
 - Parameter:** Low Cloud Cover
 - Style:** GRAY
 - Date:** (UTC) 2016-10-10, 12:00
 - Resolution:** high
 - Base Map:** ROADMAP
- Map View:** A satellite-style map showing cloud cover data over Europe and Africa. A legend on the right indicates cloud cover percentages from 0,0% to 100,0%.
- Sidebar:** A list of data sources including 'cmc-gem', 'dwd-radar-pg', 'ecmwf-cams', 'ecmwf-ens', 'ecmwf-era-interim', 'ecmwf-ifs', 'ecmwf-seasonal', 'fmi-silam', 'mch-radar', 'meteomatics-climate-mix', 'meteomatics-german10k', 'meteomatics-heliosat', 'meteomatics-mix' (highlighted), 'meteomatics-swiss1k', 'ncep-gfs', and 'ukmo-euro4'.

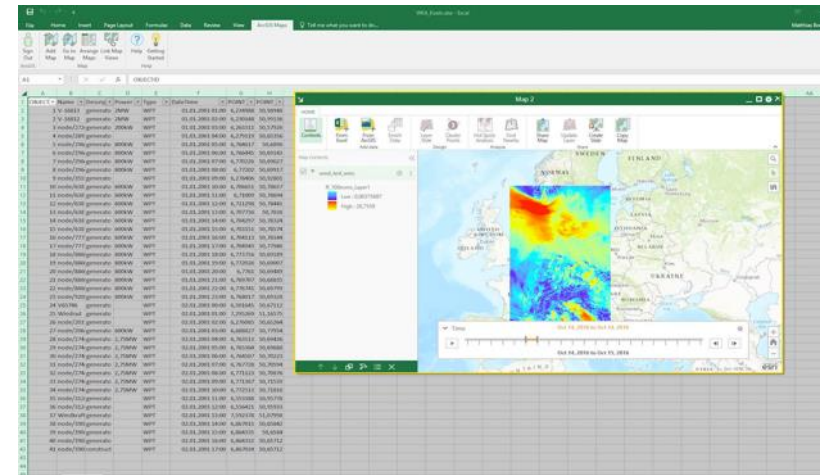
Integration into ESRI and QGIS



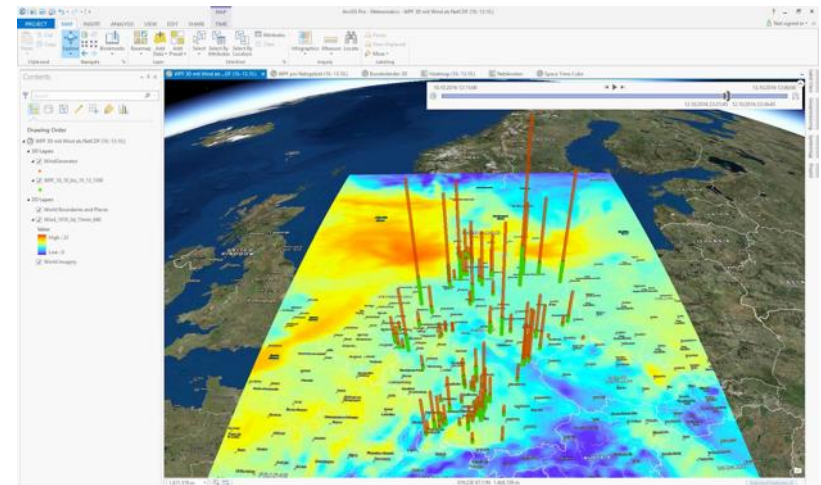
QGIS



ArcGIS



ArcGIS for office

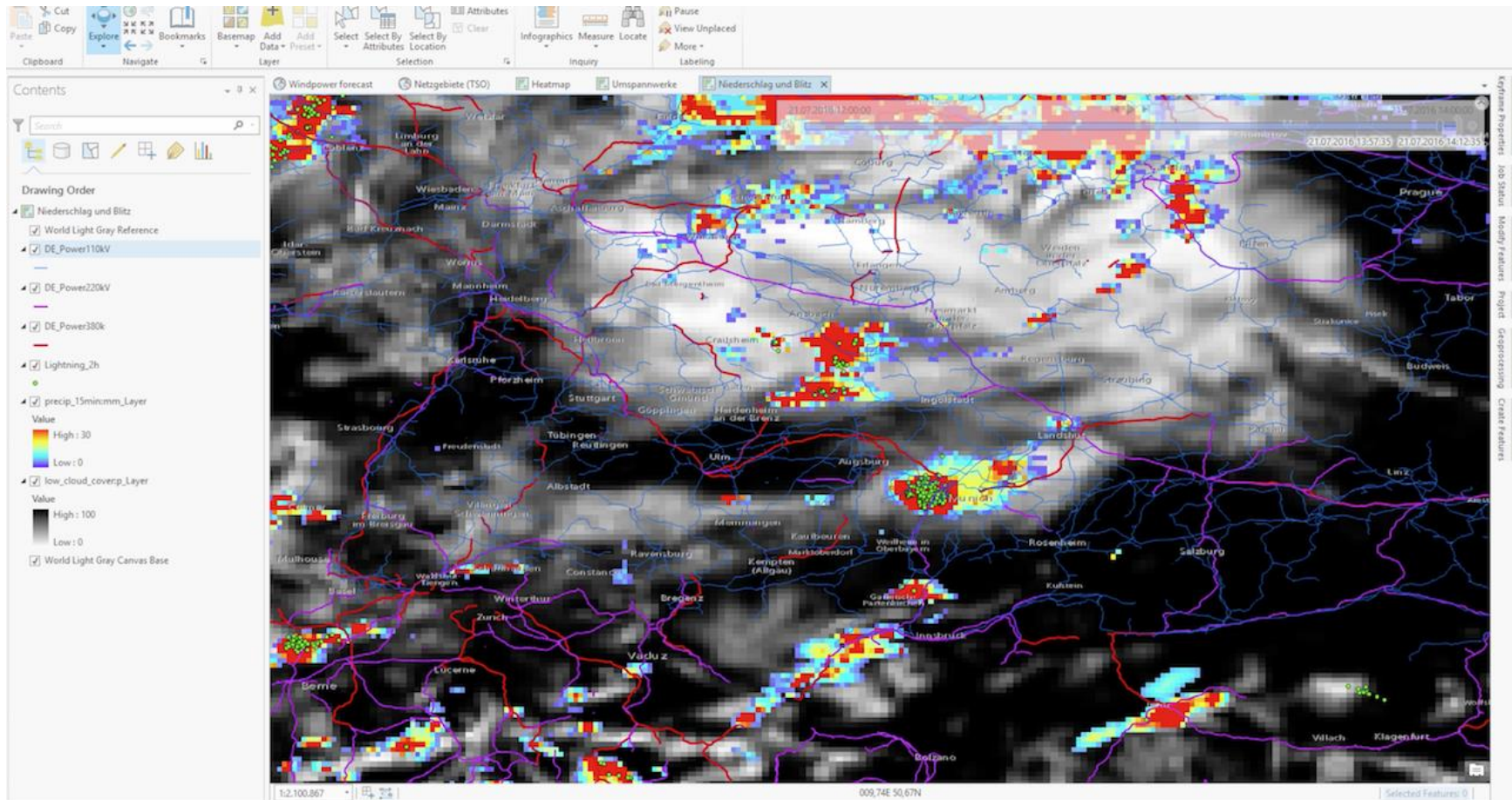


ArcGIS Pro

Integration into ESRI (ArcGIS)

Multi-Layer representation for a transmission system operator (TSO):

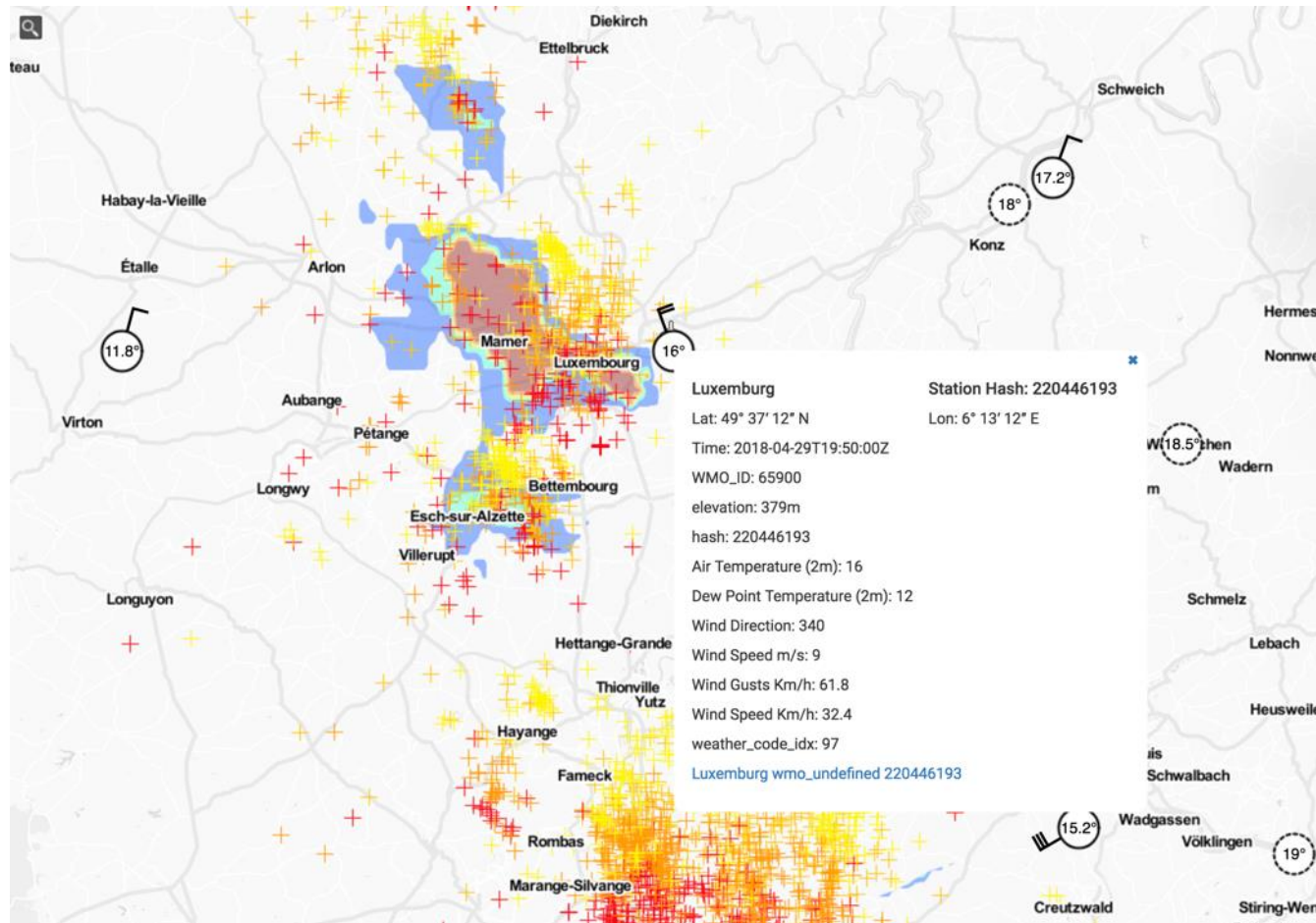
- Cloud layer (satellite images), radar images, lightning data
- Historical & actual data and nowcasting 2hours ahead, weather model data even up to 10 days
- Overlay with power line network



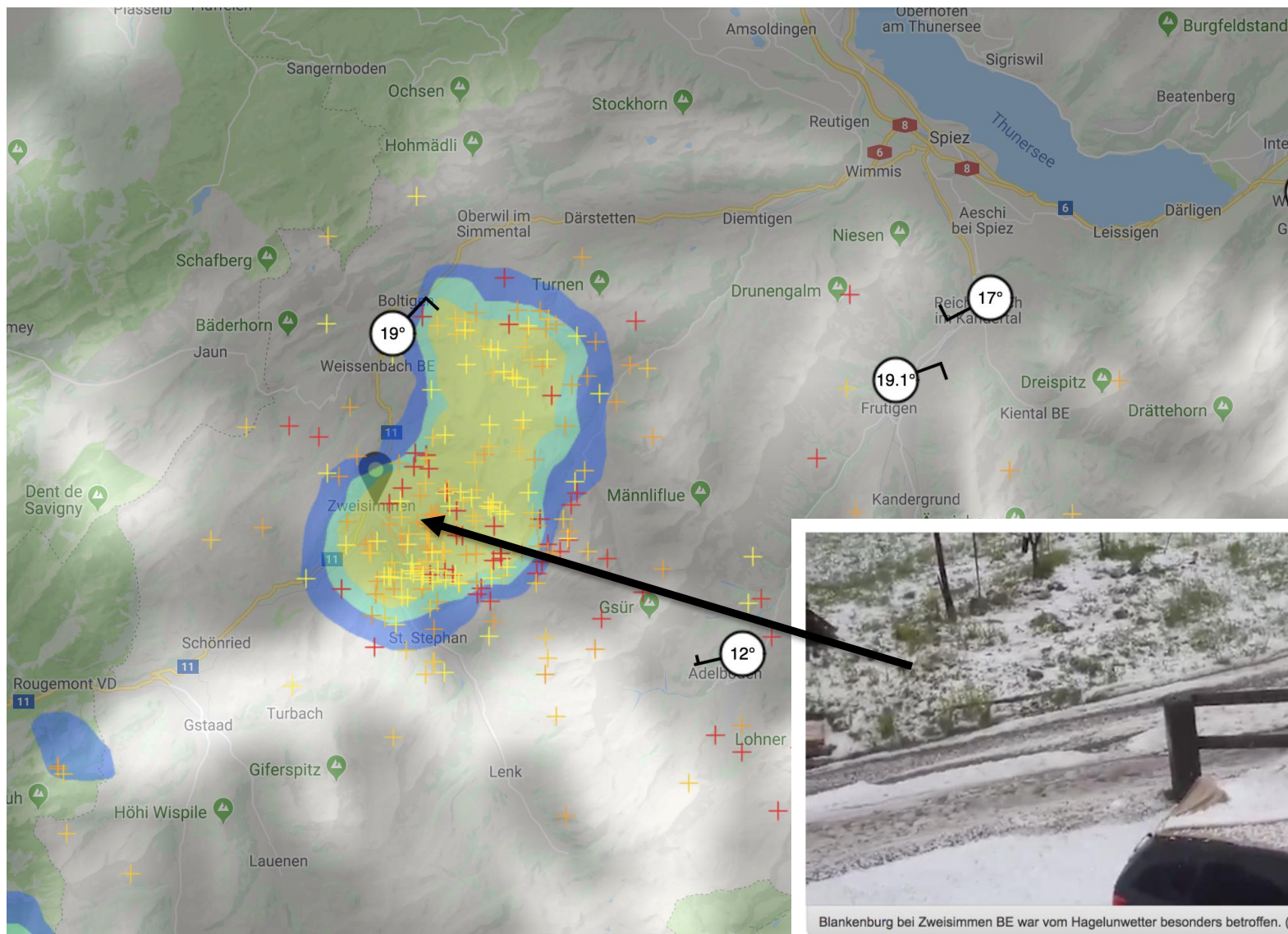
Radar, hail & lightning data (WMS/WFS layer)

For insurances it is highly important to get precise data on

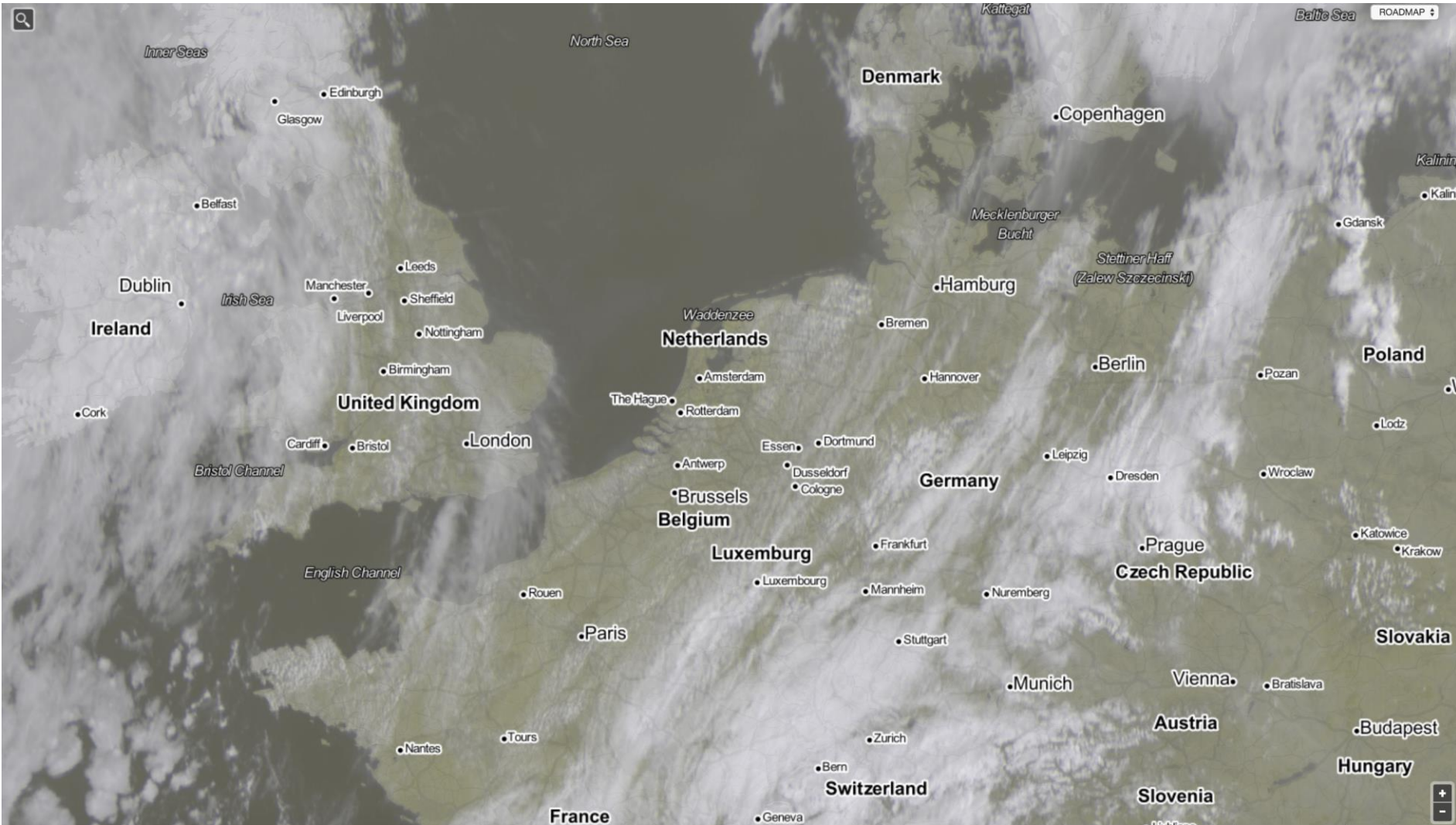
- Historical lightning & hail events
- Storm data
- Rain & flood data



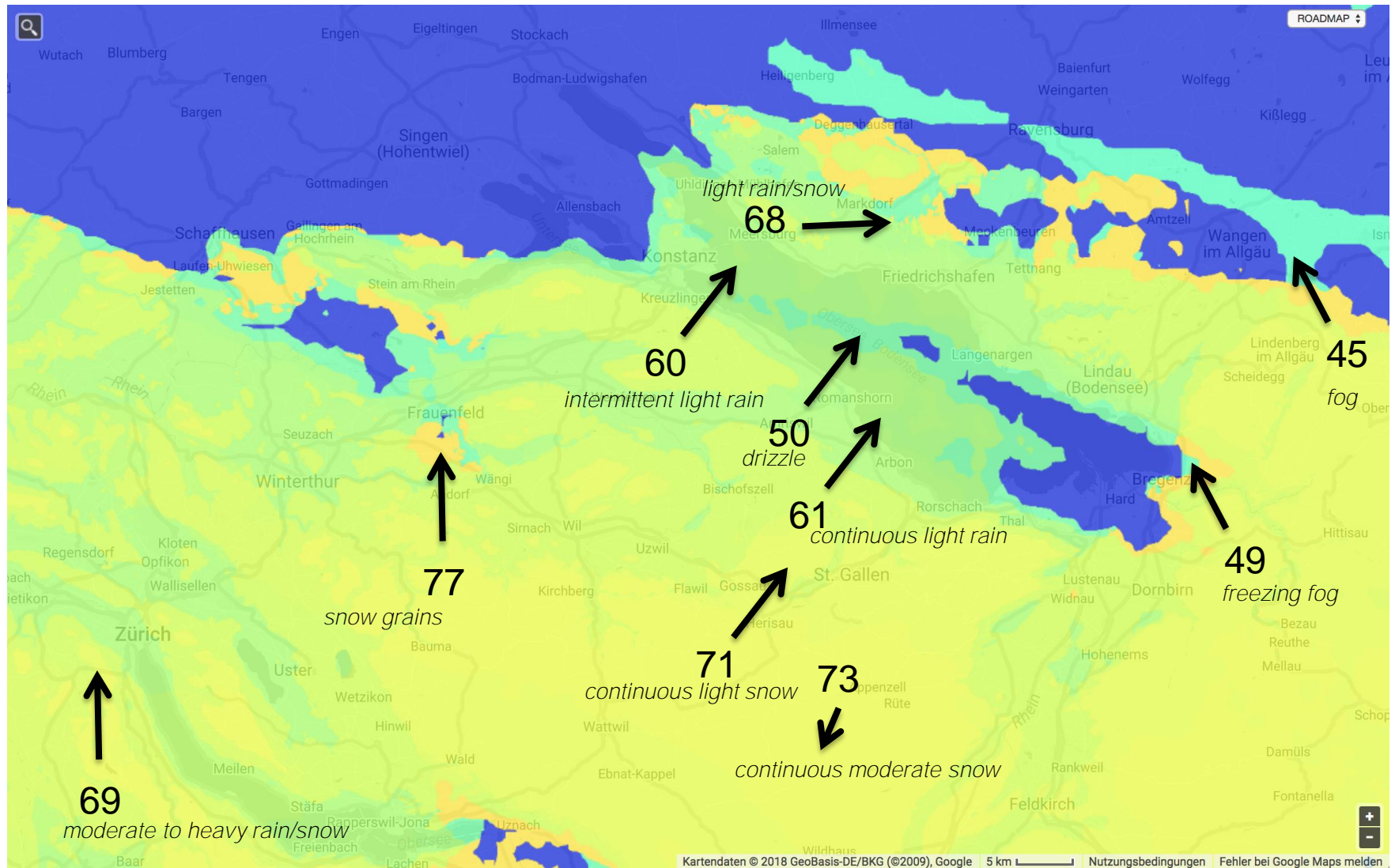
Radar, hail & lightning data (WMS/WFS layer)



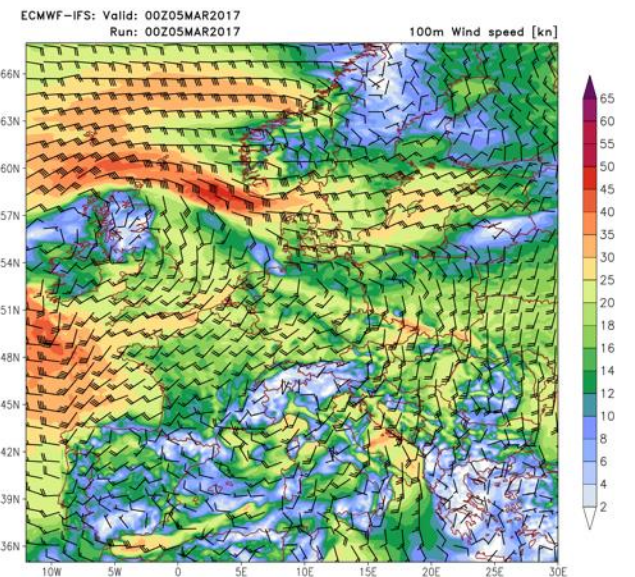
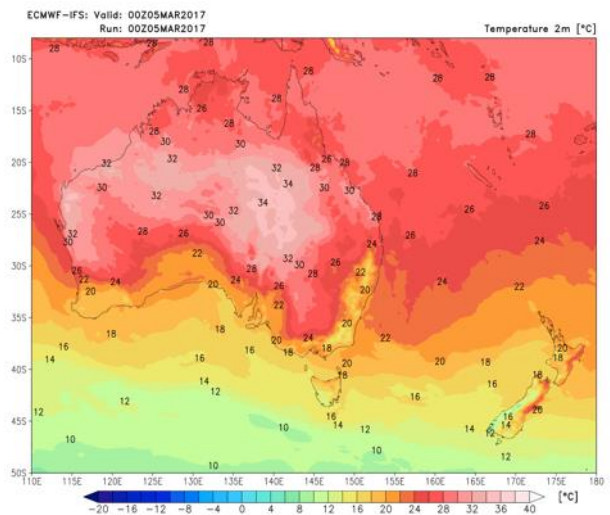
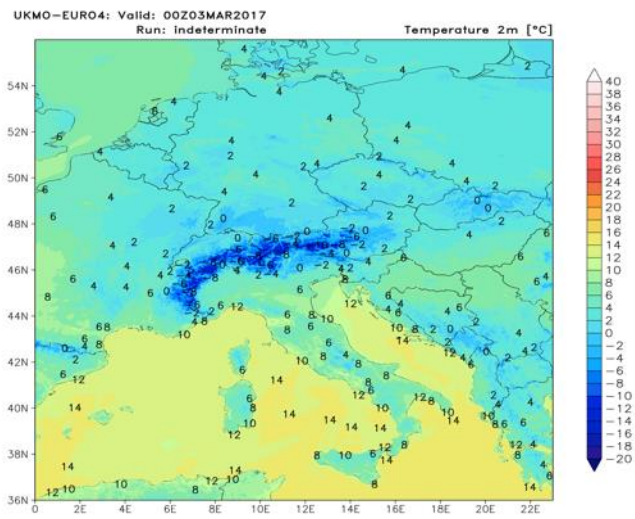
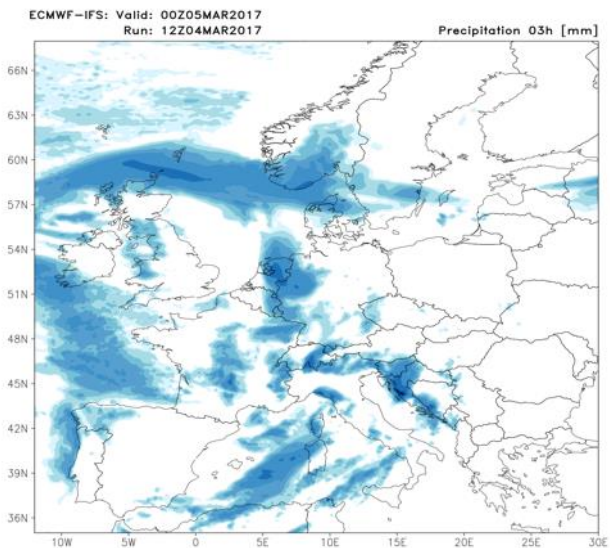
Real-time satellite images



Computing the weather code (ww) on-the-fly from radar data



Meteorological Maps on Arbitrary Models & Domains



Integration into Customized Products

Homepage weather

The screenshot shows the homepage weather widget for meteo.matics. The logo features a stylized sun and the text "meteo.matics Your Experts in Weather Data Processing." The location is "St. Gallen". The weather forecast for Monday, Tuesday, and Wednesday is displayed with icons and temperatures. Below the forecast is a navigation bar with links: Branchen, Wetter API, Produkte, Referenzen, Meteodrones, and Unternehmen. The background of the widget is a satellite image of the Earth.

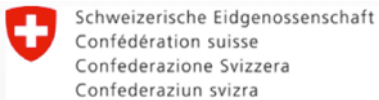
St. Gallen		
Monday	Tuesday	Wednesday
0°C 12°C	0°C 6°C	-1°C 5°C

Branchen | Wetter API | Produkte | Referenzen | Meteodrones | Unternehmen

Calendar integration into ical & iphone:

9	27	28	1. März	2	3	4	5
-0°C - 12°C	-0°C - 6°C	-1°C - 5°C	3°C - 8°C	-1°C - 13°C	4°C - 14°C	1°C - 6°C	
10	6	7	8	9	10	11	12
-1°C - 5°C	-2°C - 8°C	2°C - 6°C					
11	13	14	15	16	17	18	19

References



Bundesamt für Zivilluftfahrt BAZL

Eidgenössisches Departement des Innern EDI

Bundesamt für Meteorologie und Klimatologie MeteoSchweiz

Workshop

- User: ecmwf-workshop , PW: ecmwf2018
- API online documentation:
<https://api.meteomatics.com>
- Demo-Tool:
<https://wms.meteomatics.com>

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