

# Eye2Sky – a network of all-sky imagers enabling high-resolution and very short-term forecasts of solar irradiance

Thomas Schmidt, J. Stührenberg, N. Blum, J. Lezaca, A. Hammer, T. Vogt





# Instrumentation

## Meteorological sensors

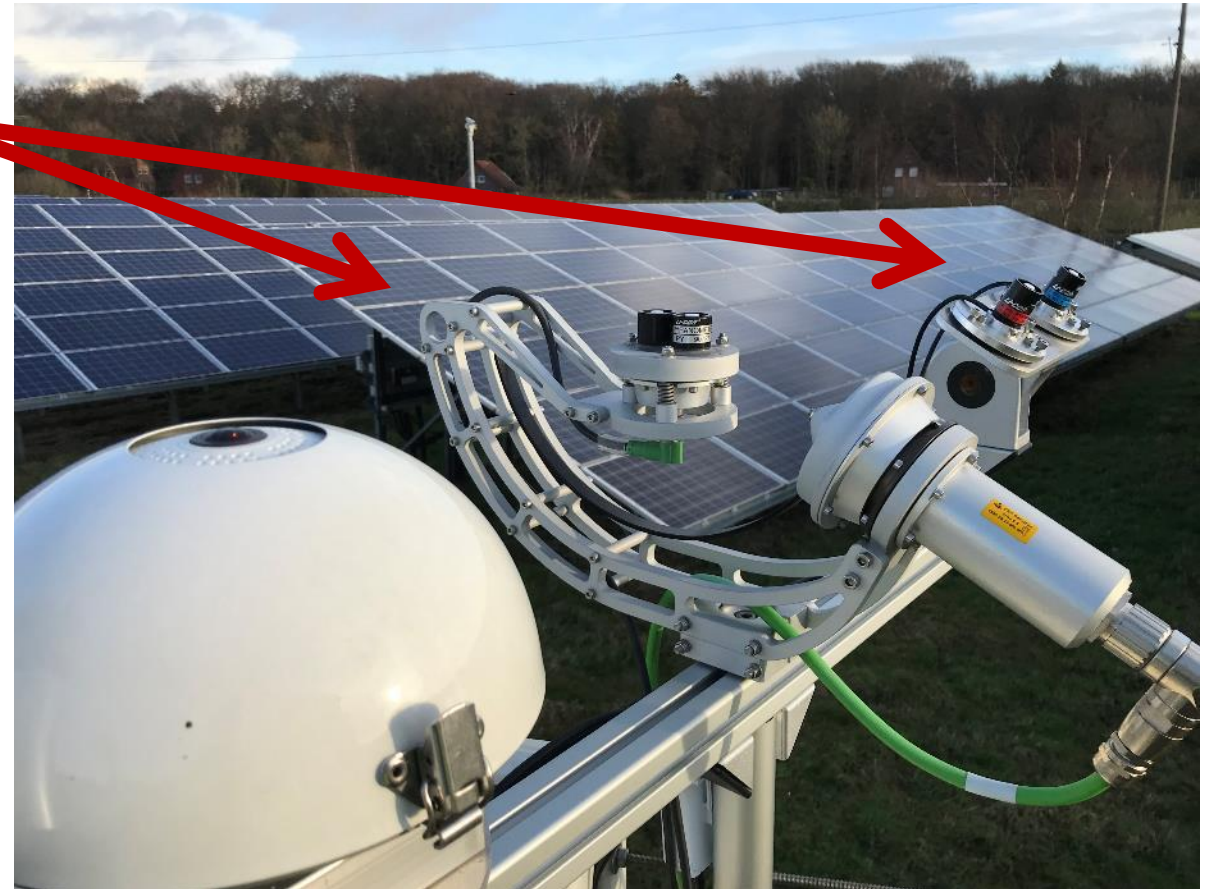
- Solar irradiance sensors (GHI, DHI, DNI, GTI)
- Air temperature and humidity

## All-sky imagers

- Commercial surveillance camera used
- Fish eye lenses with 180° field of view
- Recording images every 30s

## Ceilometers

- 6 atmospheric lidars (ceilometer) measuring cloud height



Photography of Eye2Sky station PVNOR

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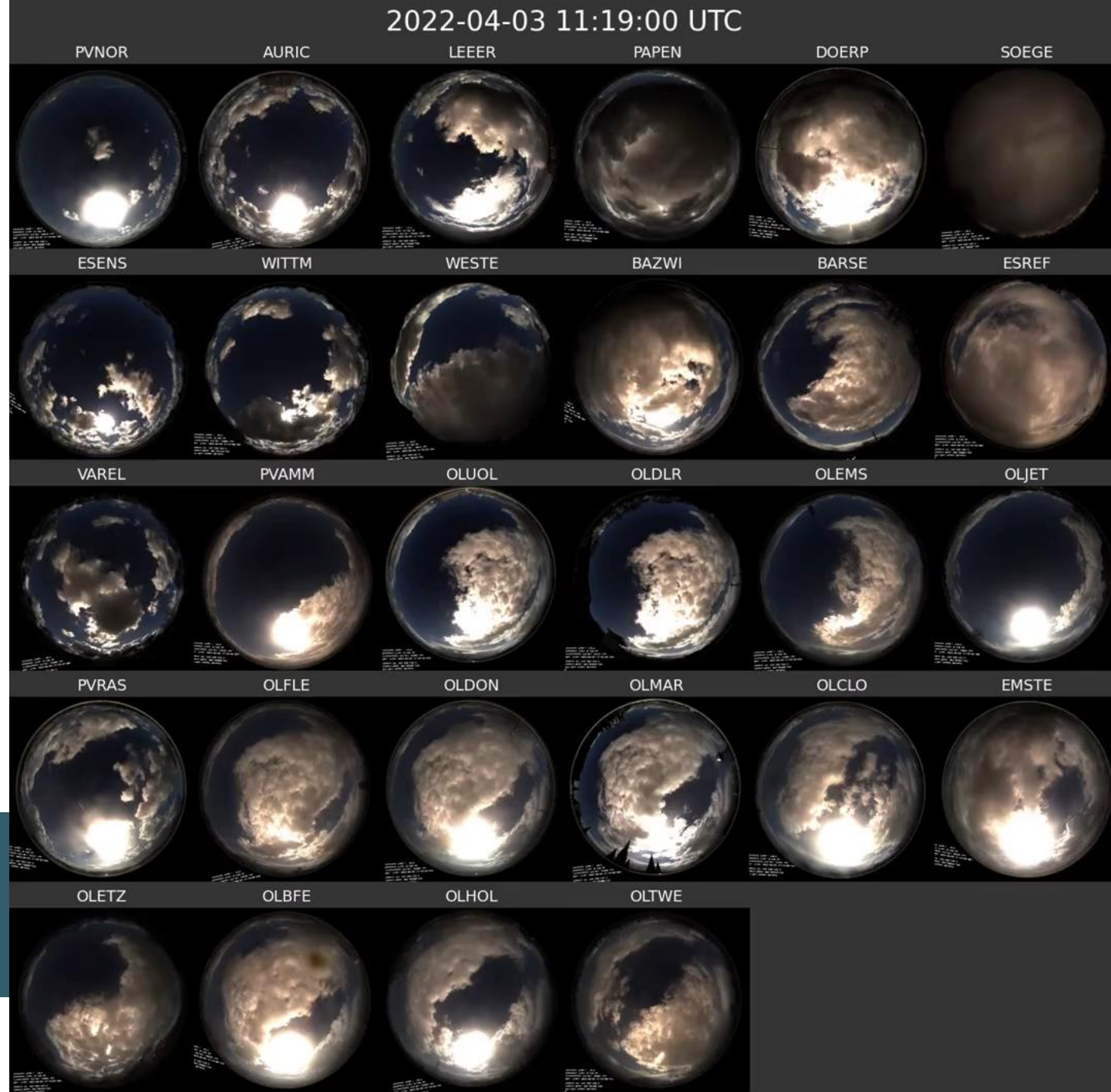
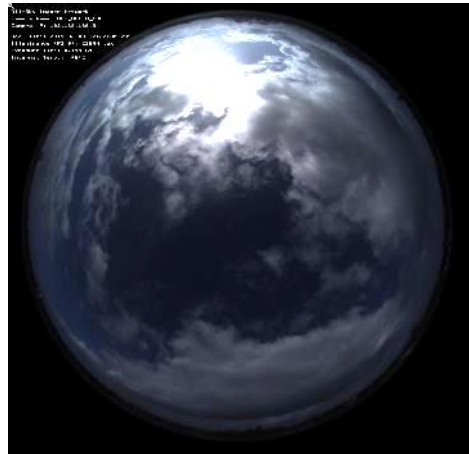
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Photography of Eye2Sky station PVNOR

# 2 hours of weather seen by multiple fish eye cameras



## Why cameras?

# Instrumentation

## Meteorological sensors

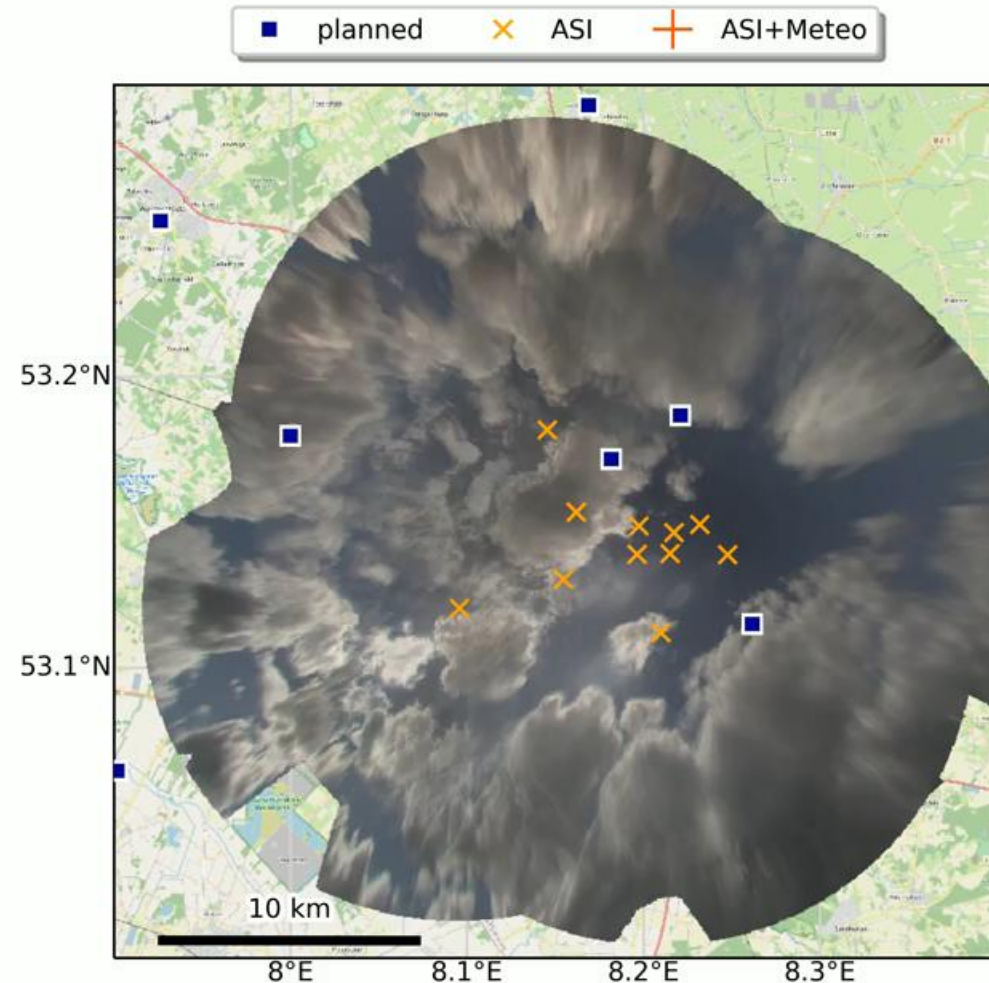
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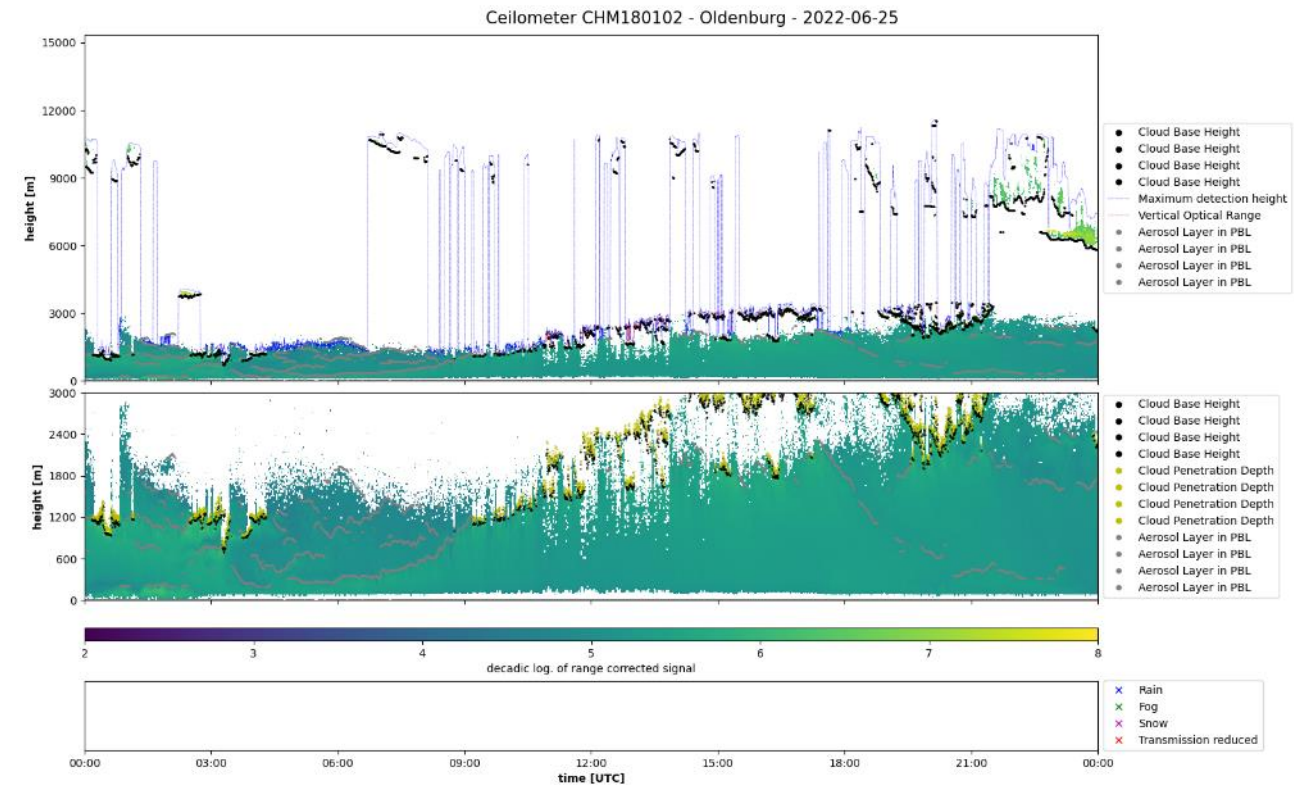
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Data visualization from CHM-15k located in Oldenburg-Wechloy



# Eye2Sky Model



# Objective: High quality short-term forecasts of solar resources for grid operators, plant operators & energy traders



## Stakeholder

- Plant operator
- Grid operator
- Energy trader

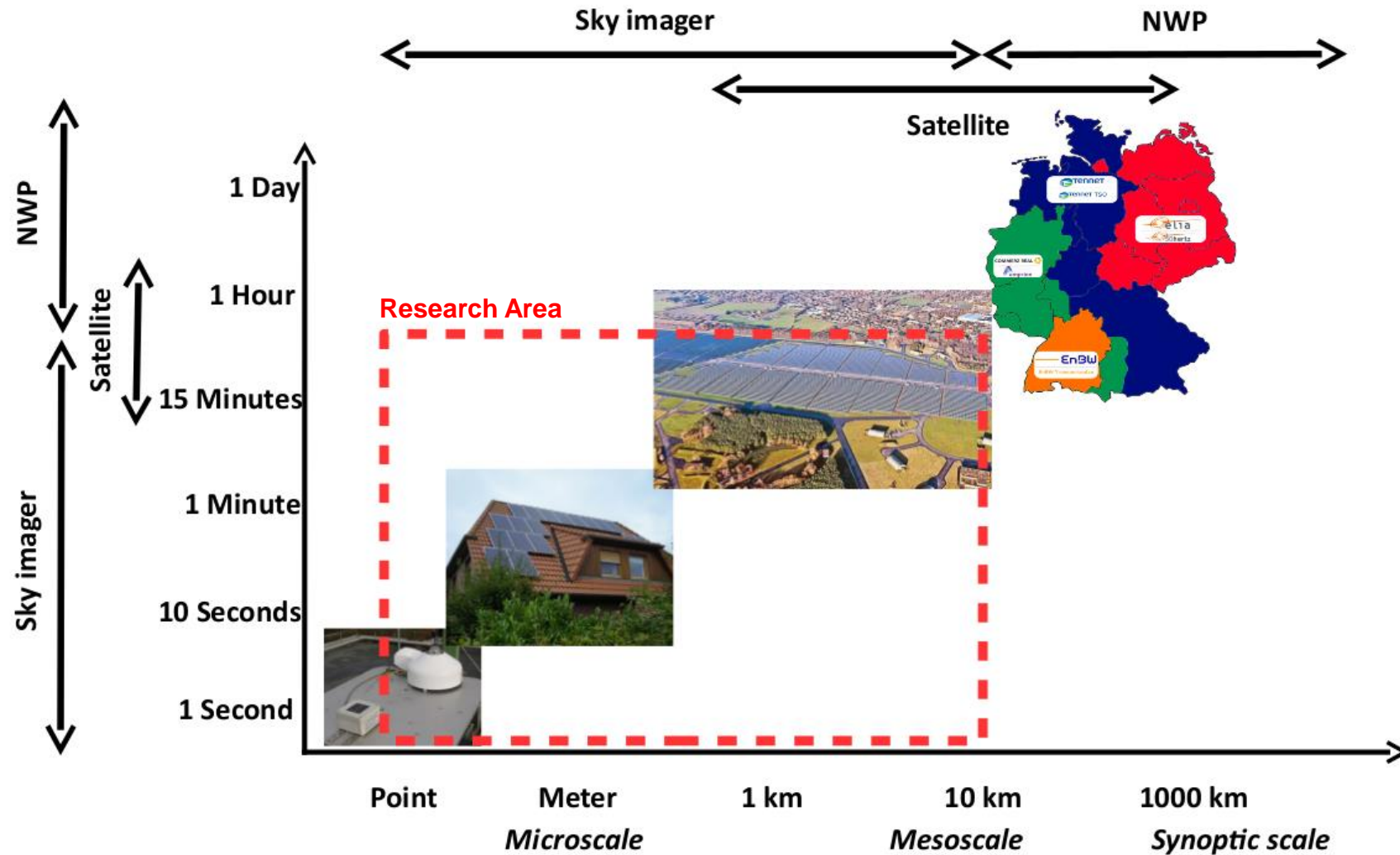
## Applications

- Grid control
- Re(d)ispatch
- Storage Management
- DSM/DRM
- Plant operation
- Energy trading

## Facilities/Systems

- Networked Systems
  - Distribution grids
  - Micro grids
- Single facilities
  - Large-Scale PV
  - CSP
  - PV-Diesel-Hybrid

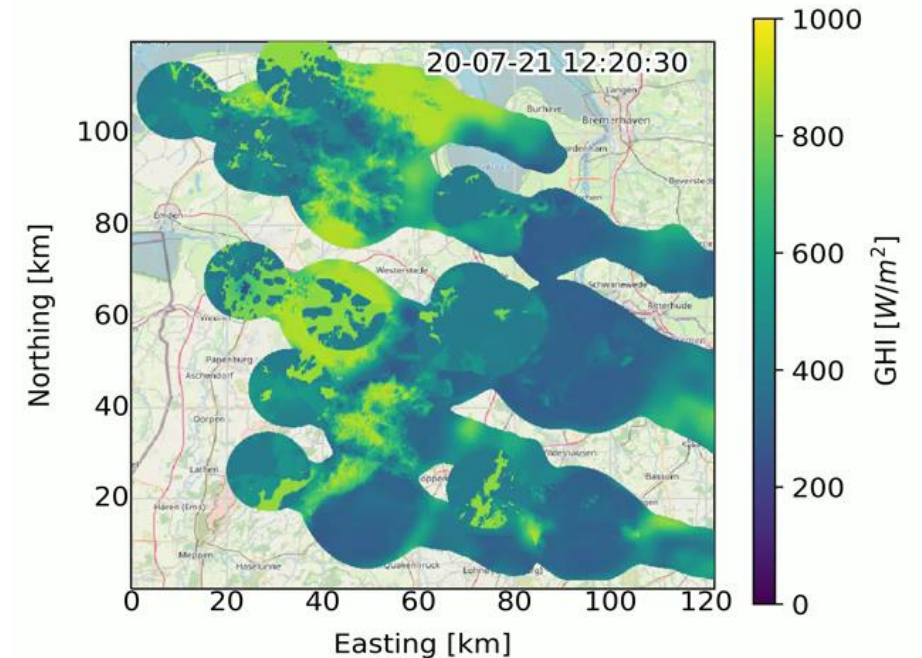
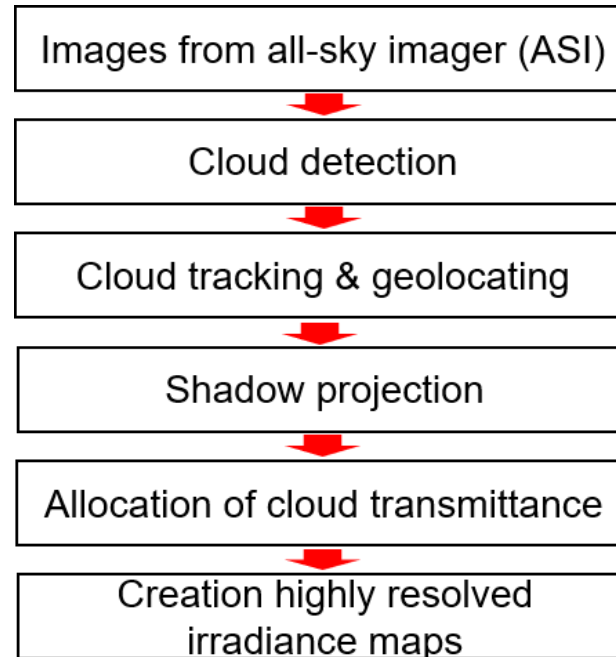
# Challenge: spatial and temporal variability of solar radiation is not fully captured by satellites



# ASI based nowcasts



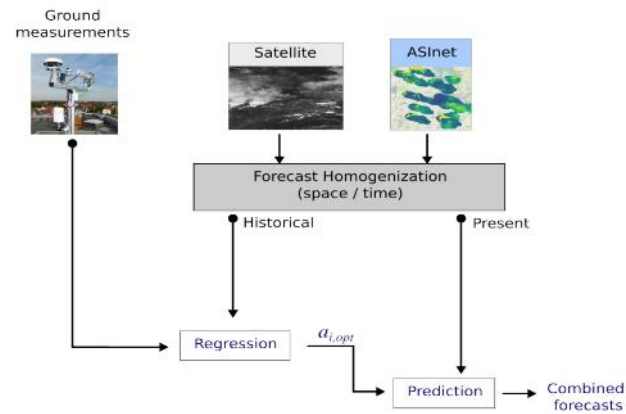
- Coverage and horizon:
  - Depending on cloud conditions
  - ~8 km radius
  - ~15 minute horizon
- High resolution:
  - 1 minute temporal
  - 50 meter spatial
- Accuracy:
  - Fast updates of current conditions allow for accurate nowcasts



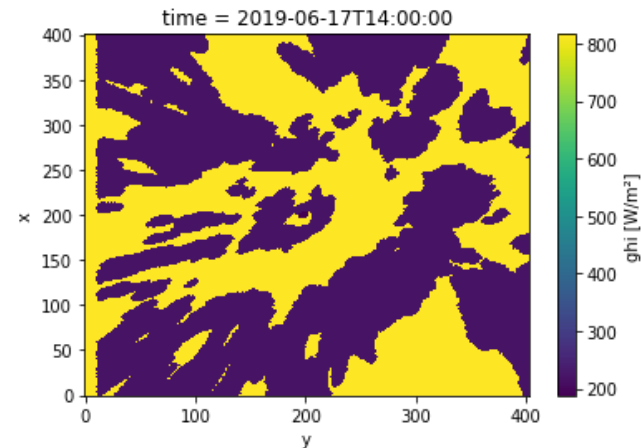
## Literature

- Nouri et al.: 'Nowcasting of DNI maps for the solar field based on voxel carving and individual 3D cloud objects from all sky images', SolarPACES, 2017
- Blum et al.: 'Analysing spatial variations of cloud attenuation by a network of all-sky imagers', Remote Sensing, 2022

## Development of forecasting methods and strategies



## Variability and Uncertainty



## Critical weather events



## Literature

- Nouri et al.: 'Multi-source observations to improve solar forecasting within the Smart4RES project', smart4res.eu, 2021
- Ranalli et al.: 'Cloud advection and spatial variability', EUPVSEC, 2020

# Applications



## Stakeholder

(Smart) Grid operator

Energy traders

Plant operator

House owners

## Task

Grid stability

Dispatching backup capacities

Ramp mitigation

PV + Battery/Storage: Management

Short-term trading

Increase PV hosting capacity

Operation of virtual power plants

Demand response management

Network of ASI

1-2 local ASI

# Conclusions & Outlook

## Conclusion

- ASI systems and networks contribute to novel seamless short-term solar forecasting methods from 1-60 minutes ahead
- High resolution input data along with high update frequencies allow for more detailed and accurate solar resource forecasts

## Outlook

- Hybrid seamless forecast model: We aim to combine multiple data sources to provide best as possible forecast products
- We always look for applications & partners for discussions and projects



# Thank you for listening...



## Contact us:

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## Website:

<https://www.dlr.de/ve/en/eye2sky>

## Video:

[Portrait of Eye2Sky in 5 Min Video](#)

