

# WAsP CFD | Accurate AEP's Anywhere

A. Bechmann, D. Cavar, H.E. Jørgensen,  
D. Heathfield, M.C. Kelly, O. Rathmann,  
P-E Rethore, N.N. Sørensen, I. Troen



# WASPECFD

## Accurate AEP's Anywhere

### Background

### Breakthroughs

### Conclusions

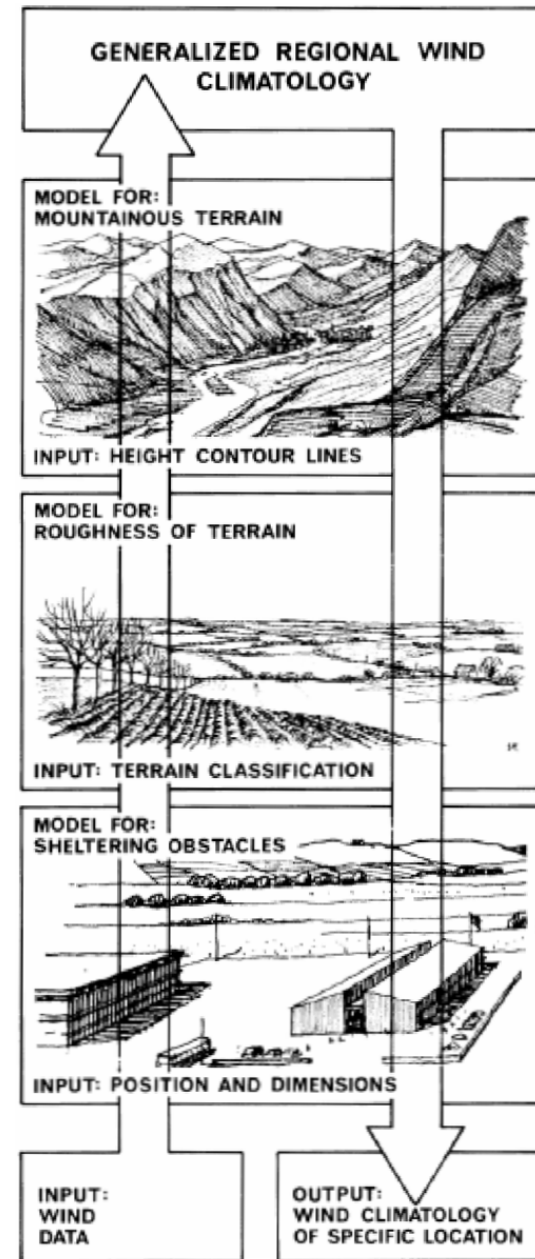
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# WAsP

25-year old icon

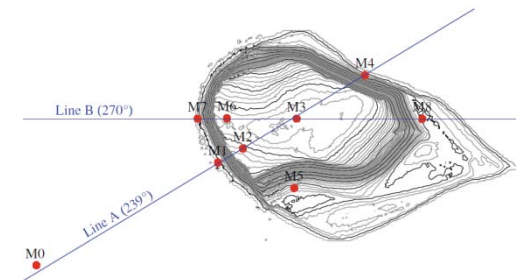
1. Predicts AEP
2. Wind Atlas Method
3. Measurement Driven
4. Linear Flow Models



## Bolund Blind Comparison:

**Table 1** Mean absolute speed-up Error (%) for different model types

RANS 2 eq.	(11.4)
Experiment	(13.3)
RANS 1 eq.	(13.8)
LES	(14.1)
Linearized	(20.6)



## CFD

### 20 years of CFD with EllipSys3D

1. CFD solves nonlinear NS-equations
2. CFD improvements for complex terrain
3. CFD + WAsP?

# SWOT

## WAsP

### Weakness

- Accuracy (linearized)
- Fixed method "inadaptable"
- Estimates AEP only
- WAsP is developed by a relative small group

### Threats

- It has reached its potential?

# SWOT

## CFD

### Strength

- Accuracy (non-linear)
- Highly adaptable
- Estimates everything
- Large CFD community, online forums and open source

### Opportunities

- Improve AEP
- Future research possibilities

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## CFD

### Weakness

- Only a flow solver
- Expensive (whole volume)
- Complicated, need specialists
- "Random" results (Numeric's)
- Closed siting community

### Threats

- Only accessible for a few big companies

# SWOT

## WAsP

### Strength

- WAsP method (the standard)
- Inexpensive (single position)
- Intuitive / Easy to use
- Repeatable results
- Many users and developed by university researchers

### Opportunities

- Influence the development of wind energy world-wide

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## SWOT - Conclusion

“The weakness of one program  
is the strength of another”

## Goal

“to combine CFD and WAsP  
exploiting the strengths of both”

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# 1. Made CFD Statistical

- A. WAsP can import CFD results
- B. New “statistical” BC’s for CFD
- C. CFD calc. sector-averaged results
- D. CFD does AEP!

## CFD

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## 2. Made CFD Fast

- A. CFD simulations made on high speed clusters
- B. WAsP has built-in internet connect
- C. Pay per calc. = low CFD license + no hardware cost

## CFD

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### 3. Made CFD Automatic

- A. Setting up a WAsP project also sets up a CFD project
- B. The gridding, simulation, post-processing is auto
- C. High resolution & low user interact = consistent results

## CFD

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- ~~- Only a flow solver~~
- ~~- Expensive (whole volume)~~
- ~~- Complicated, need specialists~~
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## Conclusions

1. Combined CFD and WAsP in a way that exploits the strengths of both
2. Made it possible to do AEP's with CFD
3. More validation needed ...

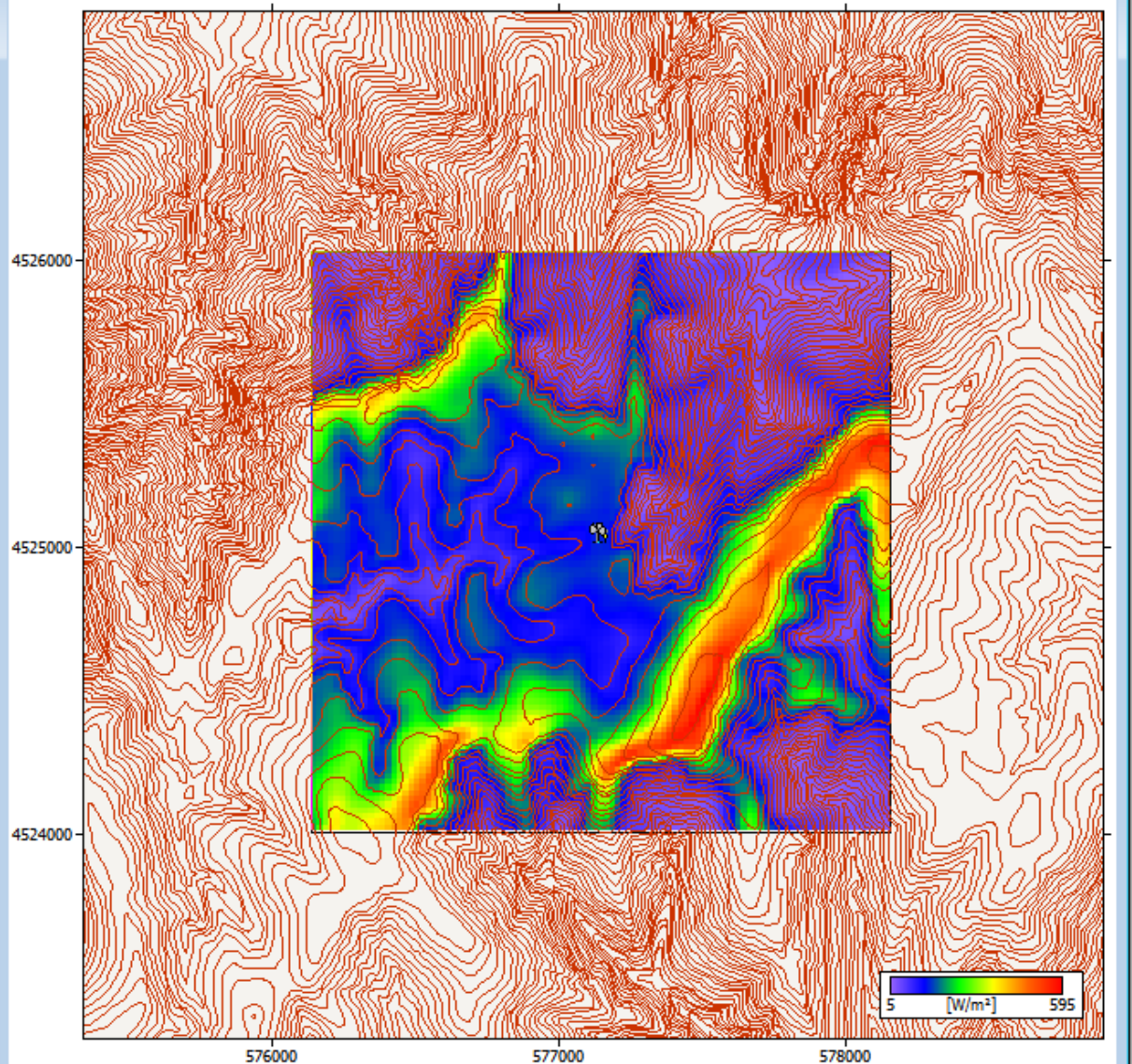
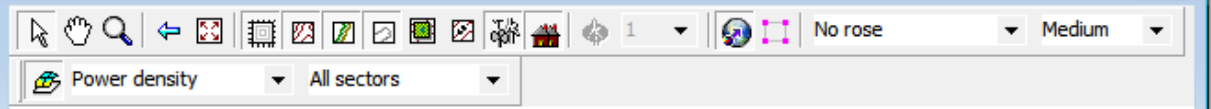


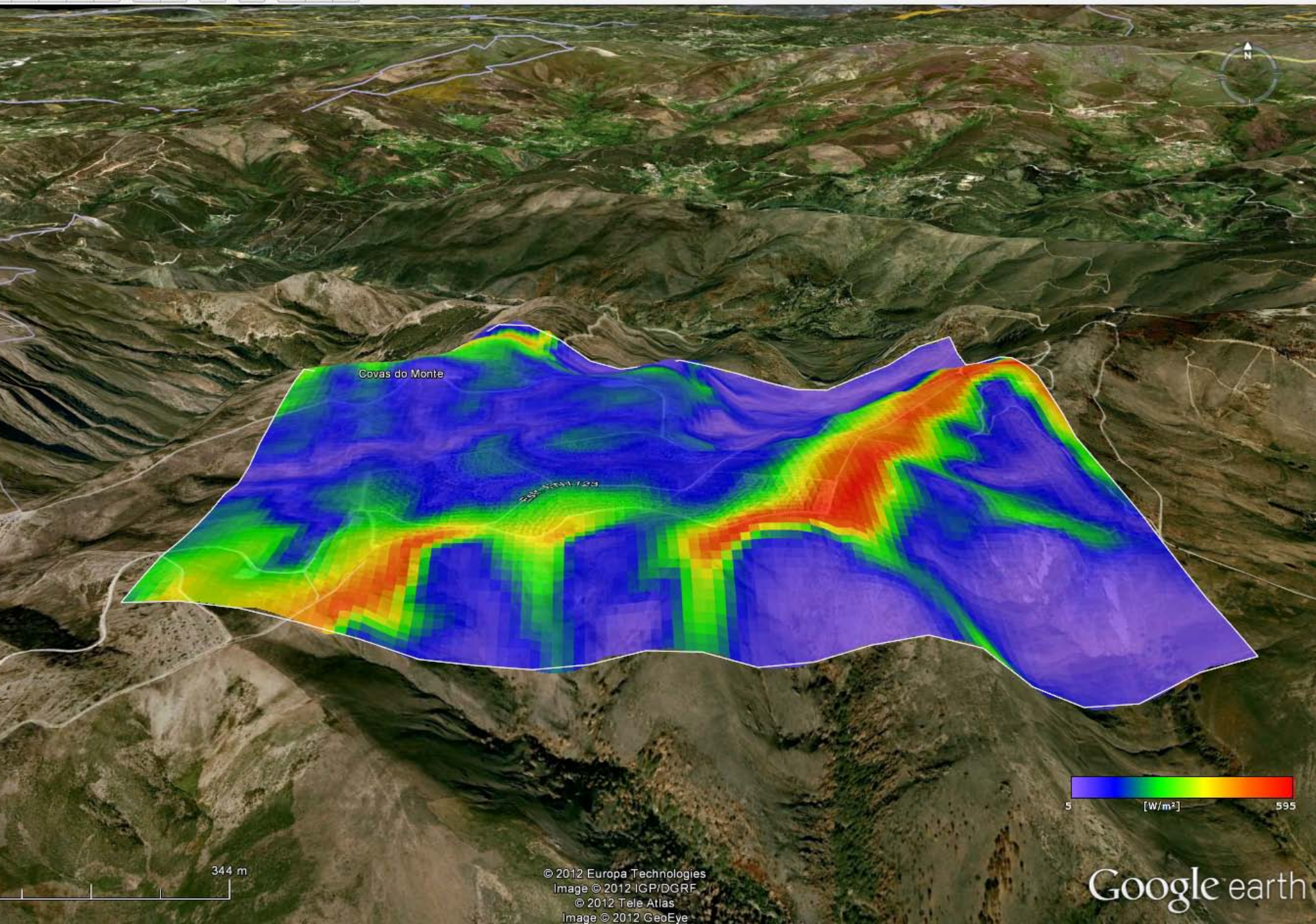


Workspace hierarchy

- Aveiro-Viseu\_full' WAsP workspace
  - CFD project 6' WAsP CFD project
    - 'Aveiro-Viseu' Vector map
    - '06' Reference site
    - 'Wind atlas 2' Wind atlas
      - 'Station 06, 1991-95' Met. station
        - 'Port06' Observed wind dimate
    - 'CFD interest area' Resource grid
  - Project 7 WAsP CFD project
  - Project 8' WAsP CFD project
  - Project 9' WAsP CFD project
  - Project 10' WAsP CFD project

Spatial View: UTM Zone 29 (European-Mean 1950)





Covas do Monte

234 3341 / 23

344 m



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Google earth

~~The End~~  
The Beginning  
new