



Rüzgâr Ölçümünde Yeni Bir Teknoloji: LIDAR

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Makine Mühendisliği Bölümü, İzmir Yüksek Teknoloji Enstitüsü

Urla / İZMİR

8 Ekim 2015

3ncü İzmir Rüzgar Sempozyumu ve Sergisi

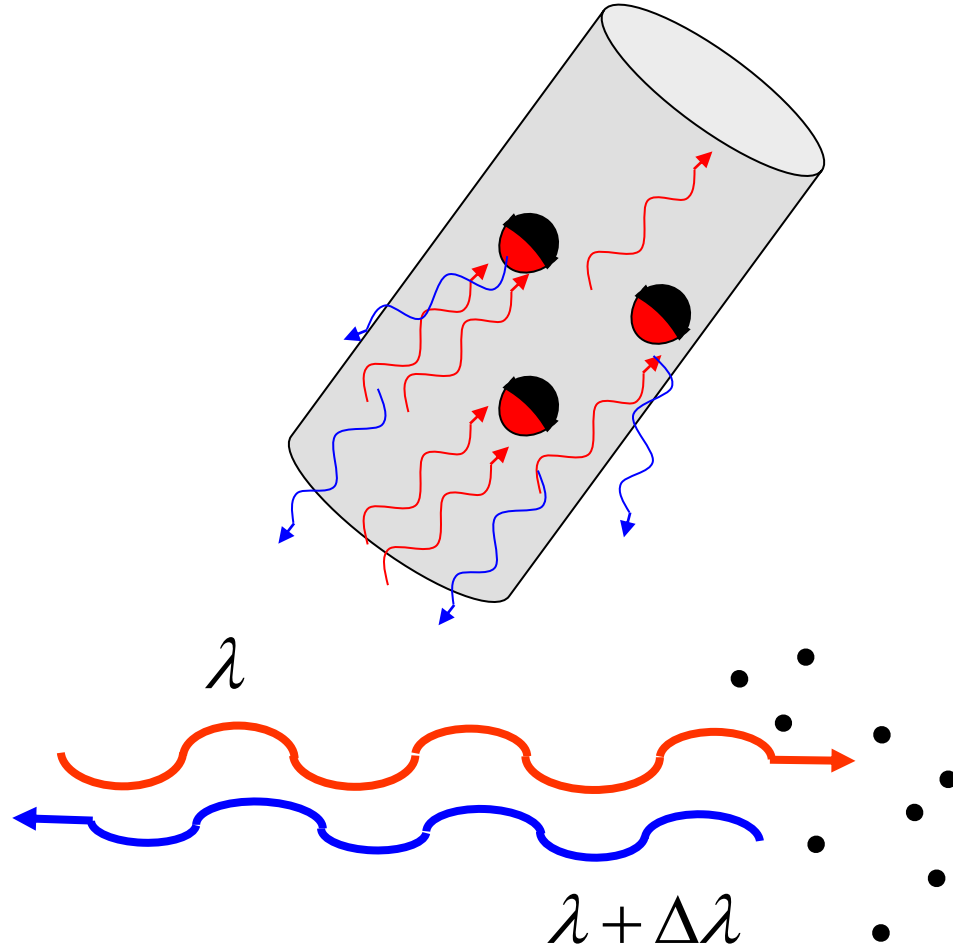
Sunum içeriđi

- Özgeçmiş (1 dakika)
- LIDAR Nedir? (3 dakika)
- Seçilmiş Örnek Deneyler
 - Wake (Rüzgar çıkması) Ölçümü (4 dakika)
 - Ormanlarda LIDAR kullanımı (4 dakika)
 - LIDAR'lar hata yapar mı? (4 dakika)
- LIDAR Teknolojisinin Geleceđi
 - WindScanner teknolojisi (2 dakika)
 - NEWA Projesi (2 dakika)
 - IEC Standartları (1 dakika)
- Soru/Cevap (tüm gün)

Özgeçmiş

- **1975:** Antalya
 - **1998:** İstanbul Teknik Üniversitesi, Uçak Mühendisliği, Lisans
 - **2002-2005:** Danimarka Teknik Üniversitesi, Rüzgar Enerjileri Bölümü, Y.Lisans
 - **2006-2010:** Danimarka Teknik Üniversitesi, Rüzgar Enerjileri Bölümü, Doktora
 - **2002-2010:** Danimarka Teknik Üniversitesi, Rüzgar Enerjileri Bölümü, Araştırma Görevlisi
 - **2010-2014:** Danimarka Teknik Üniversitesi, Rüzgar Enerjileri Bölümü, Bilim Adamı, WAsP Ekibi
 - **2014-halen:** İzmir Yüksek Teknoloji Enstitüsü, Makine Müh. Bölümü, Yrd.Doç.Dr.
 - **2015-halen:** ÜSTÜN Enerji Mühendislik, WindDecision, AR-GE Müdürü
-
- TÜREB, Yunan Rüzgar Enerjileri Birliği (ELETAEN), Danimarka Mühendisler Sendikası (IDA) ve MMO İzmir Şubesi üyesiyim
 - Evli, 2 kız babası

Light Detection and Ranging (LIDAR) Nedir?



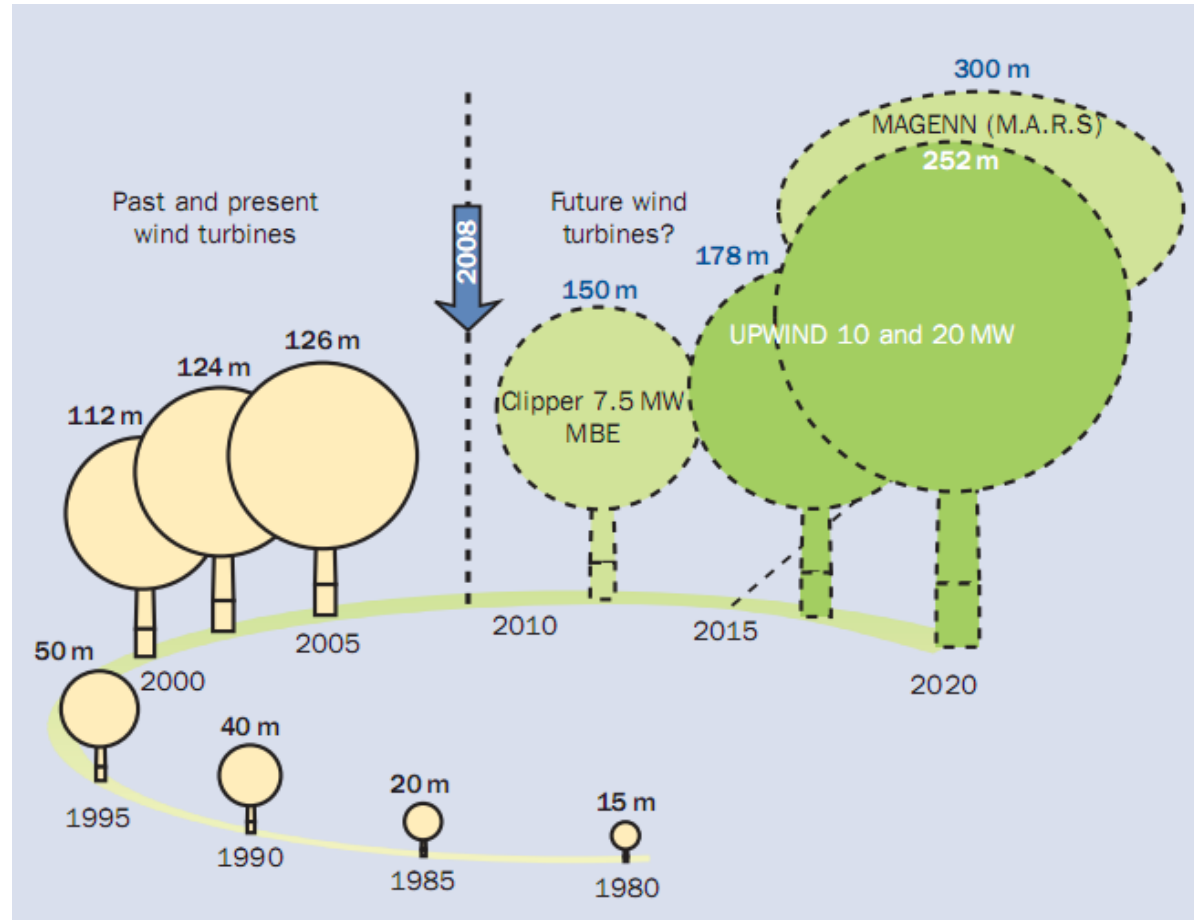
$$\Delta\lambda = \frac{2V_r\lambda}{c}$$

V_r :Hız

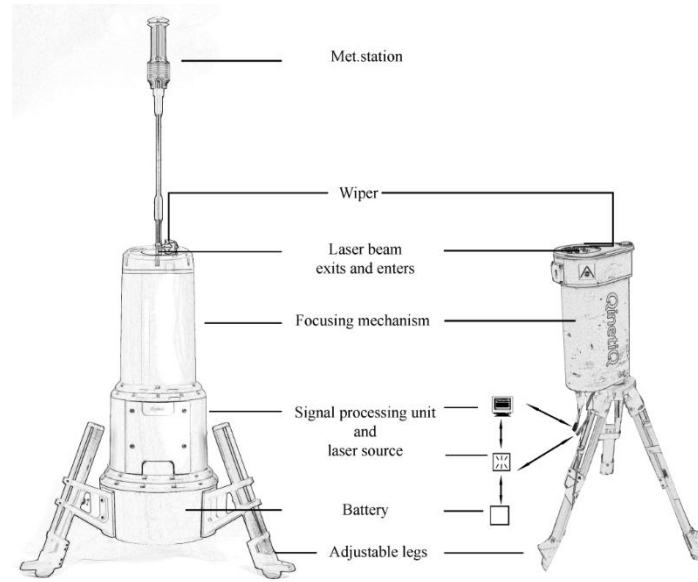
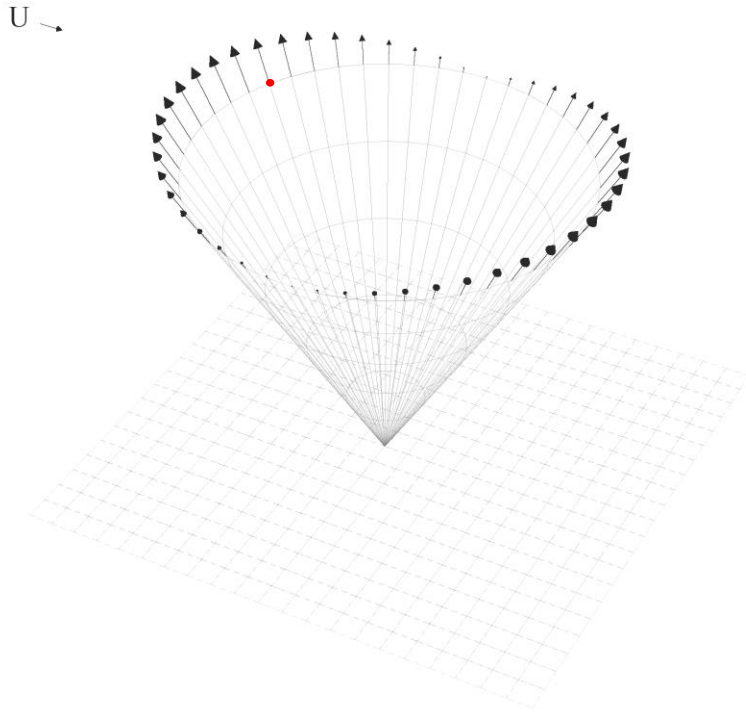
c : $3 \cdot 10^8$ m/s (ışık hızı)

λ : $1.55 \mu\text{m}$. (dalga boyu)

Neden LIDAR teknolojisi?



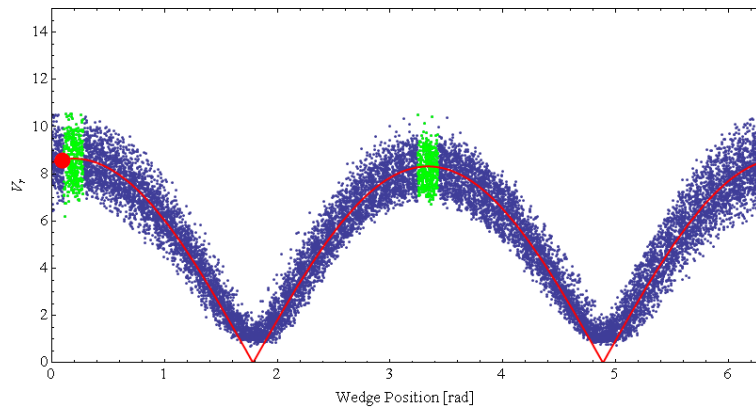
Kaynak: EWEA, Wind Energy – The Facts (March 2009), GarradHassan.



ZephIR

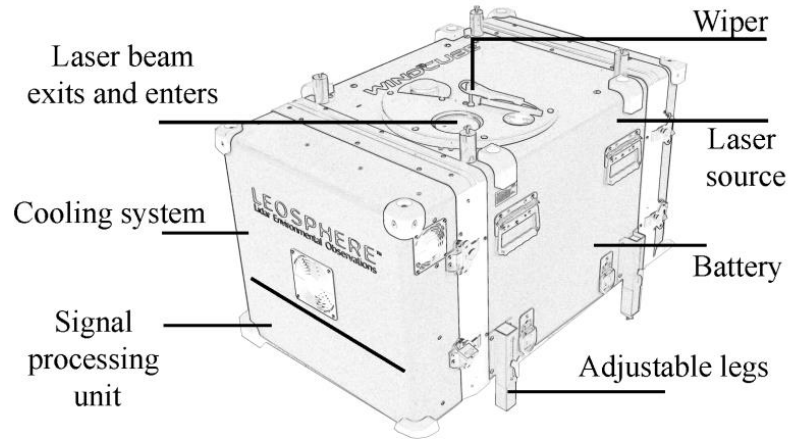
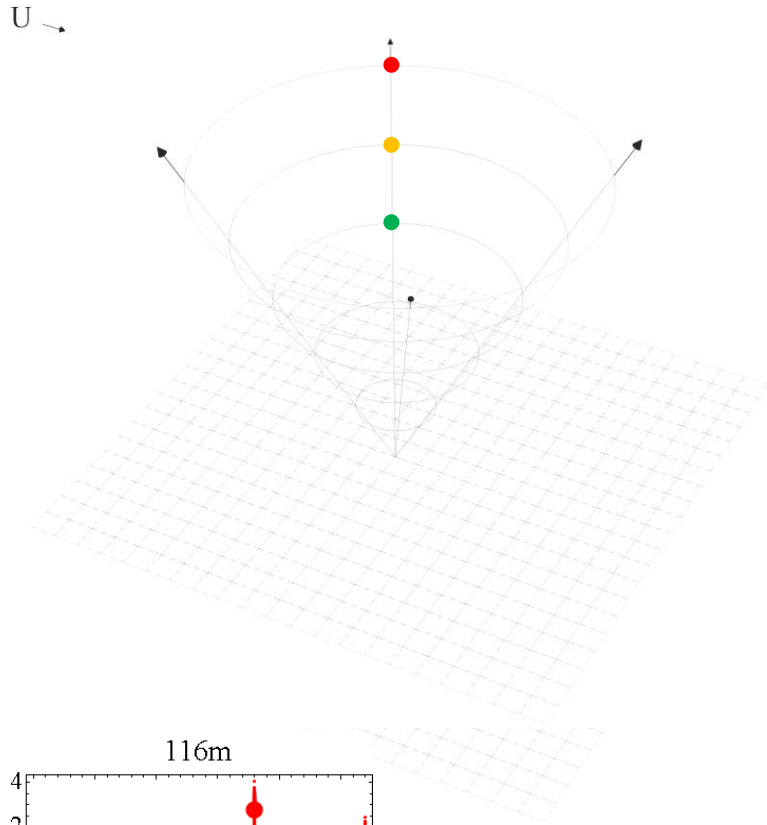


www.zephirlidar.com/



$$v_r(\theta) = |A \cos(\Theta - \theta) + B|$$

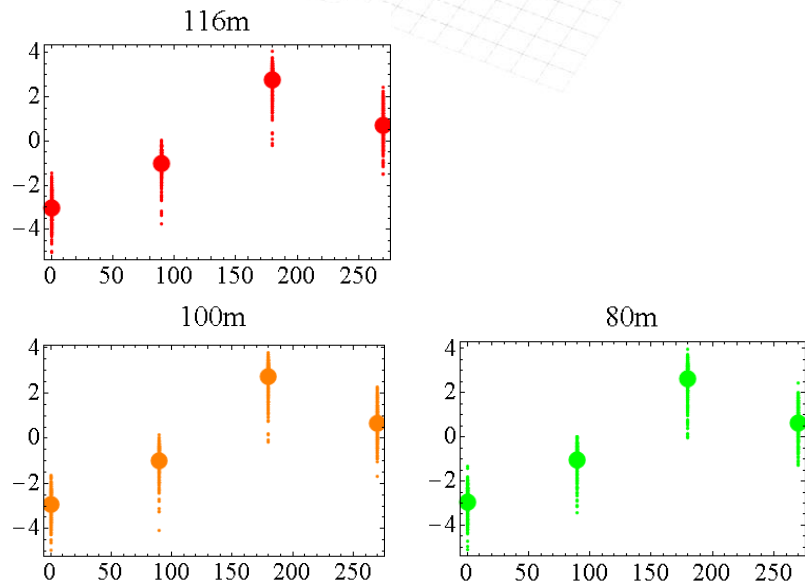
$$U = \frac{A}{\sin \phi} \quad w = \frac{B}{\cos \phi}$$



WindCube



www.leosphere.com



$$u = \sqrt{u_1^2 + u_2^2}$$

$$u_1 = v_r(0) - v_r(\pi) \quad u_2 = v_r\left(\frac{\pi}{2}\right) - v_r\left(\frac{3\pi}{2}\right)$$

$$w = \frac{v_r(0) + v_r(\pi)}{2 \cos \phi} = \frac{v_r\left(\frac{\pi}{2}\right) + v_r\left(\frac{3\pi}{2}\right)}{2 \cos \phi}$$

$$\Theta = \arctan(u_1, u_2)$$

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Energy
Systems,
Athens GREECE



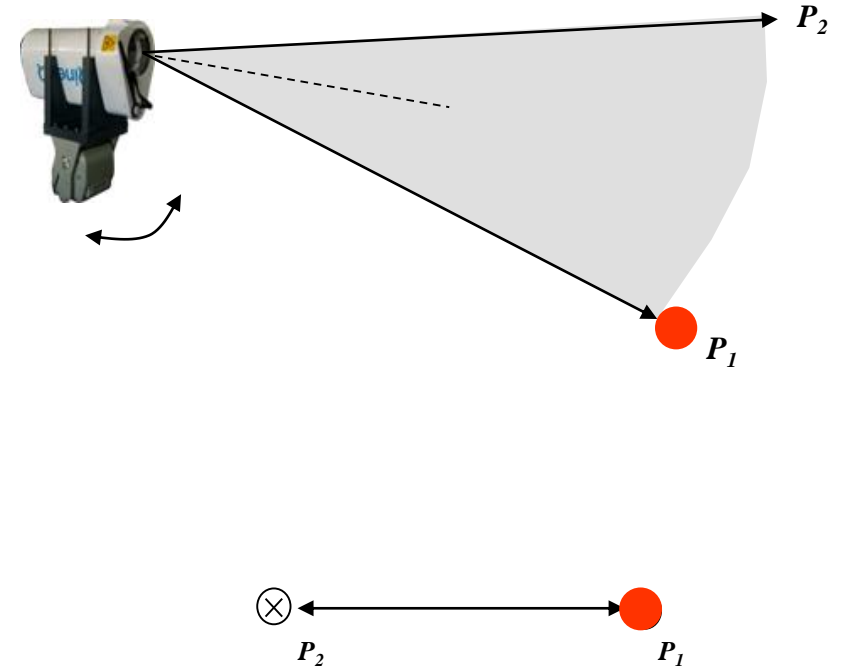
Seçilmiş Örnek Deneyleler

Araştırma Ekibi:

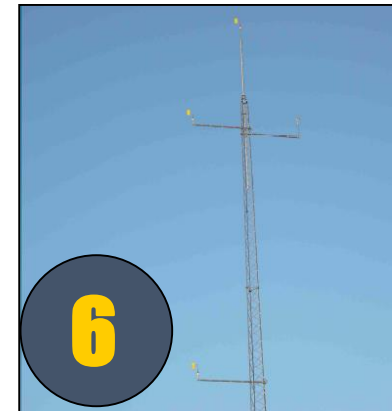
Ferhat Bingöl,¹⁺²⁺³ Jakob Mann,¹⁺²⁺³ Gunner C. Larsen,¹ Ebba Dellwik,² Dimitris Foussekis³

Deney1: Wake (Rüzgar çıkması) Ölçümü

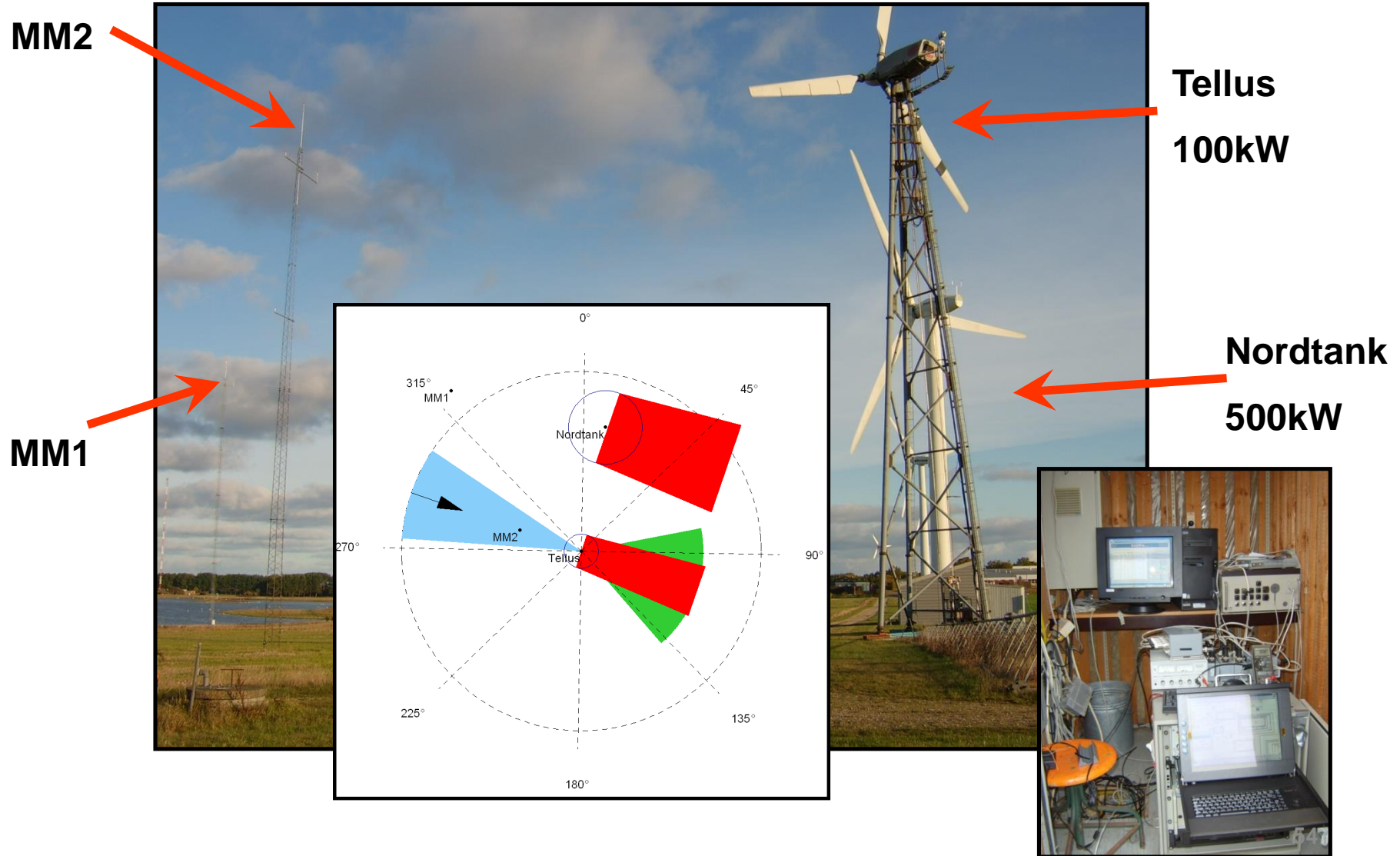
Hedef: Rüzgar çıkmasının 2D and 3D görüntüsünü anlık olarak elde etmek ve modellemeleri güncellemek



Deney1: Hazırlık



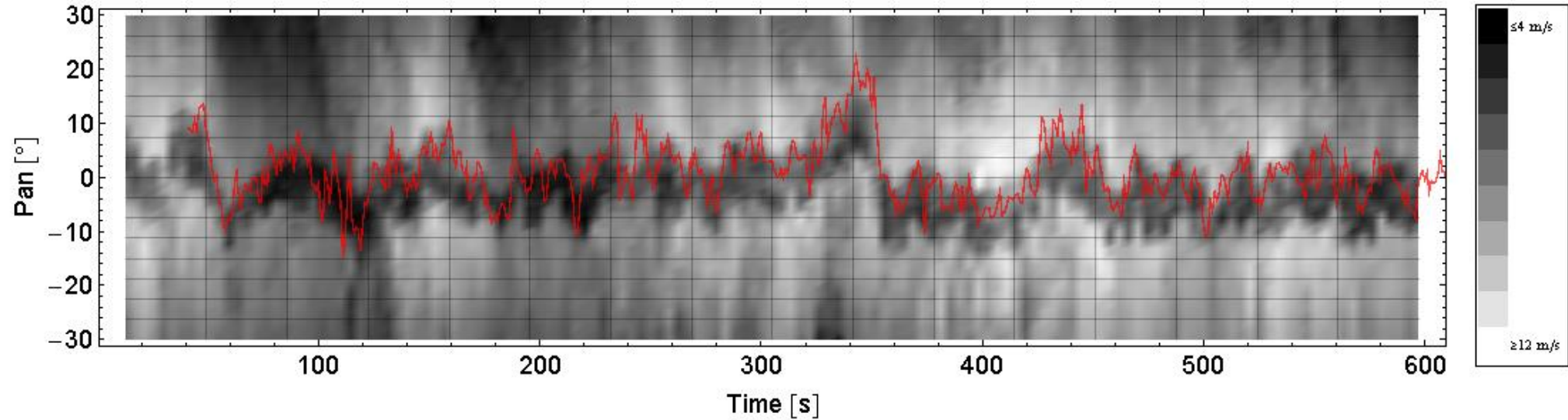
Deney1: Veri toplama



Deney1: Sonuçlar

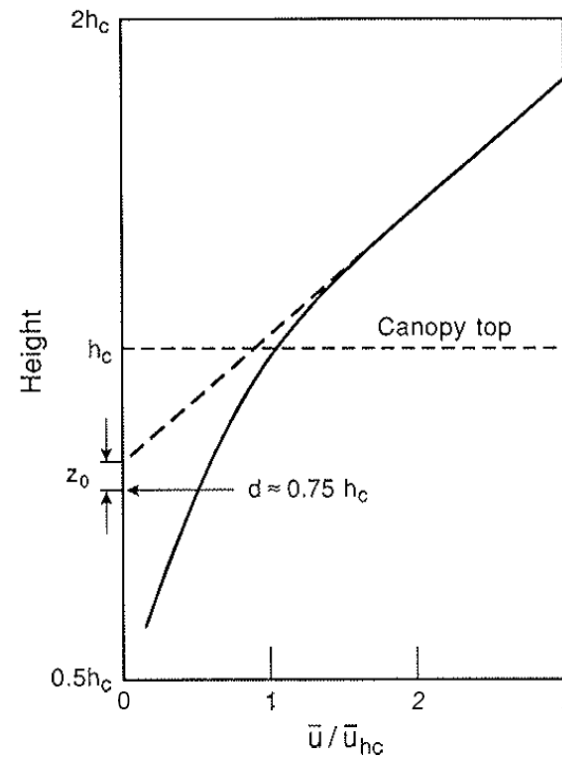
Date 2005-11-15 Time 19:10 Number of Scans 82092

LiDAR				Turbine				Met.Mast							
WS [m/s]				Yaw [°]				WS [m/s]				WD [°]			
Mean	Min	Max	StdDev	Mean	Min	Max	StdDev	Mean	Min	Max	StdDev	Mean	Min	Max	StdDev
8.15	3.29	13.80	1.58	290.0	272.0	309.0	5.3	9.45	6.30	13.10	1.37	289.0	286.0	292.0	2.5

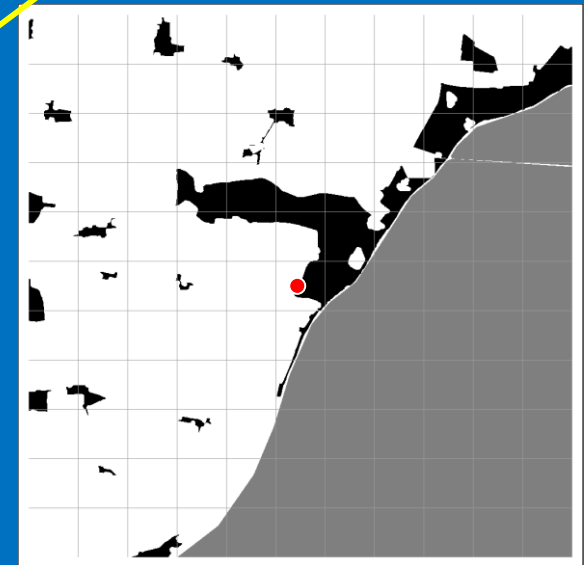
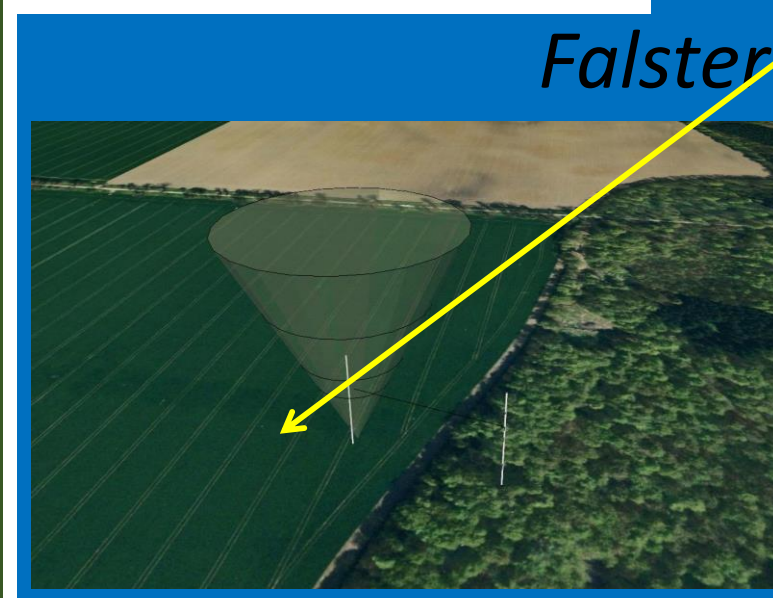
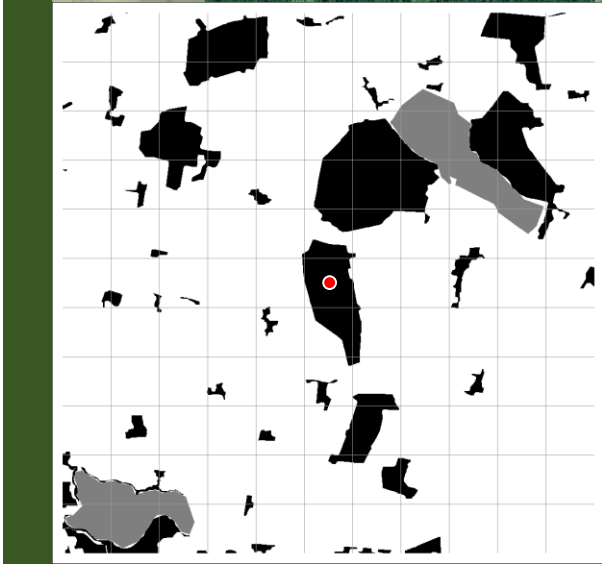
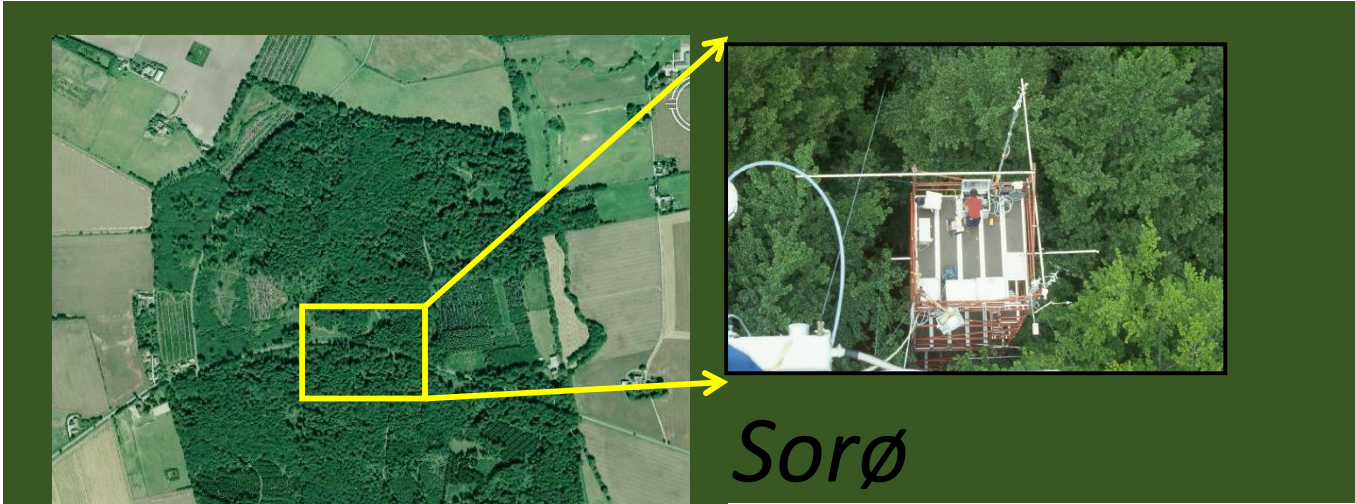


Deney2: Ormanlarda LIDAR Kullanımı

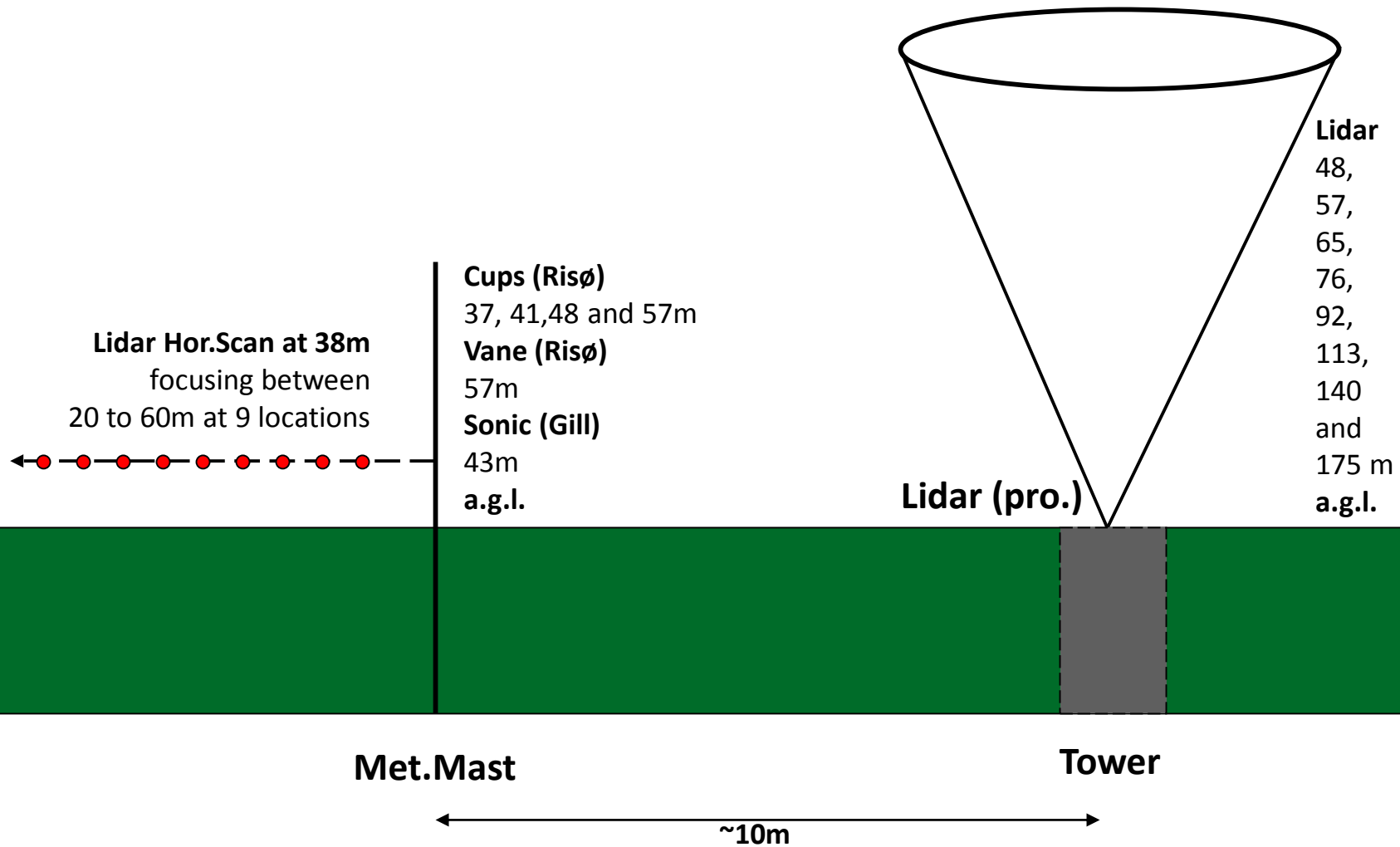
Hedef: Ormanların üzerinde türbin yüksekliğine kadar ölçüm yapabilme ve modelleri güncellemede kullanmam



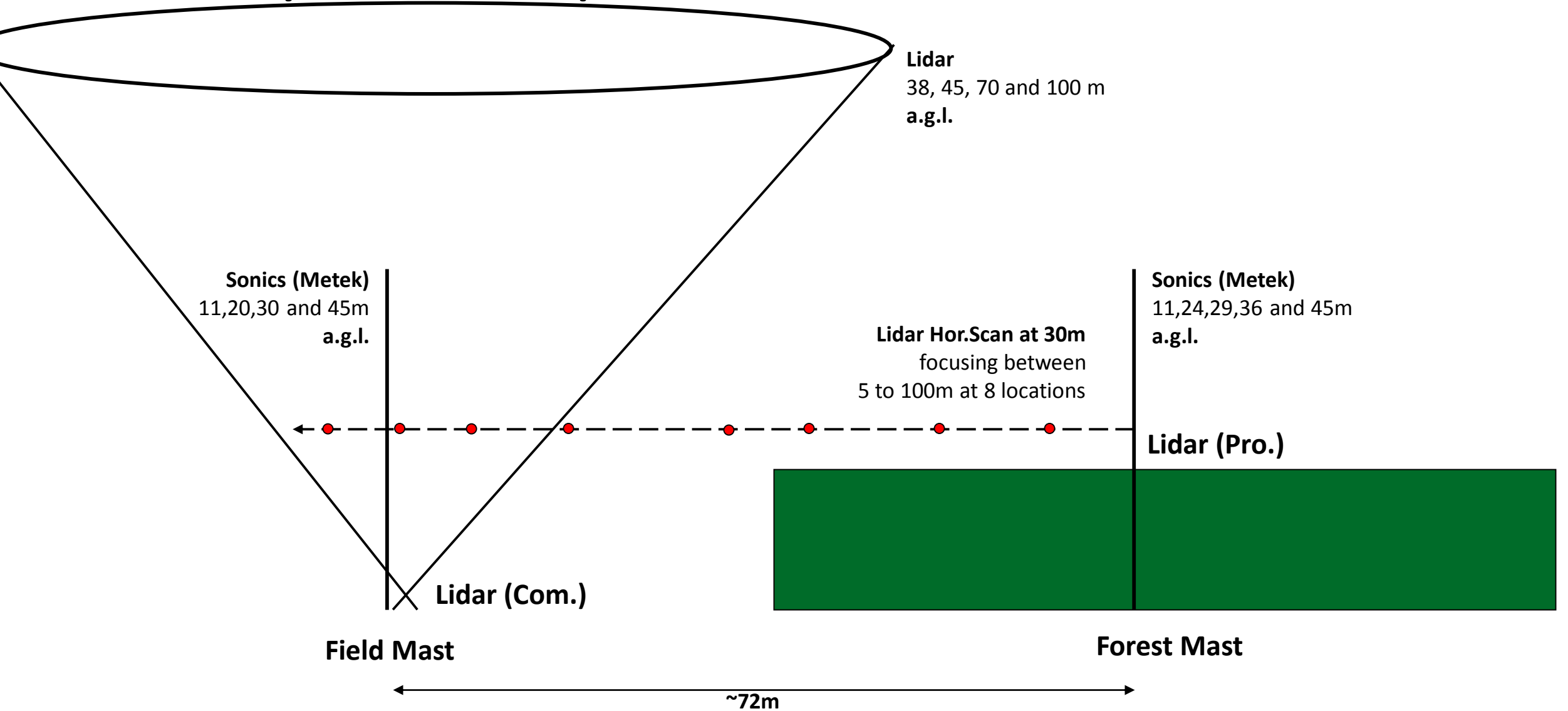
Deney2: Hazirlık



Deney2: Veri Toplama - Sorø

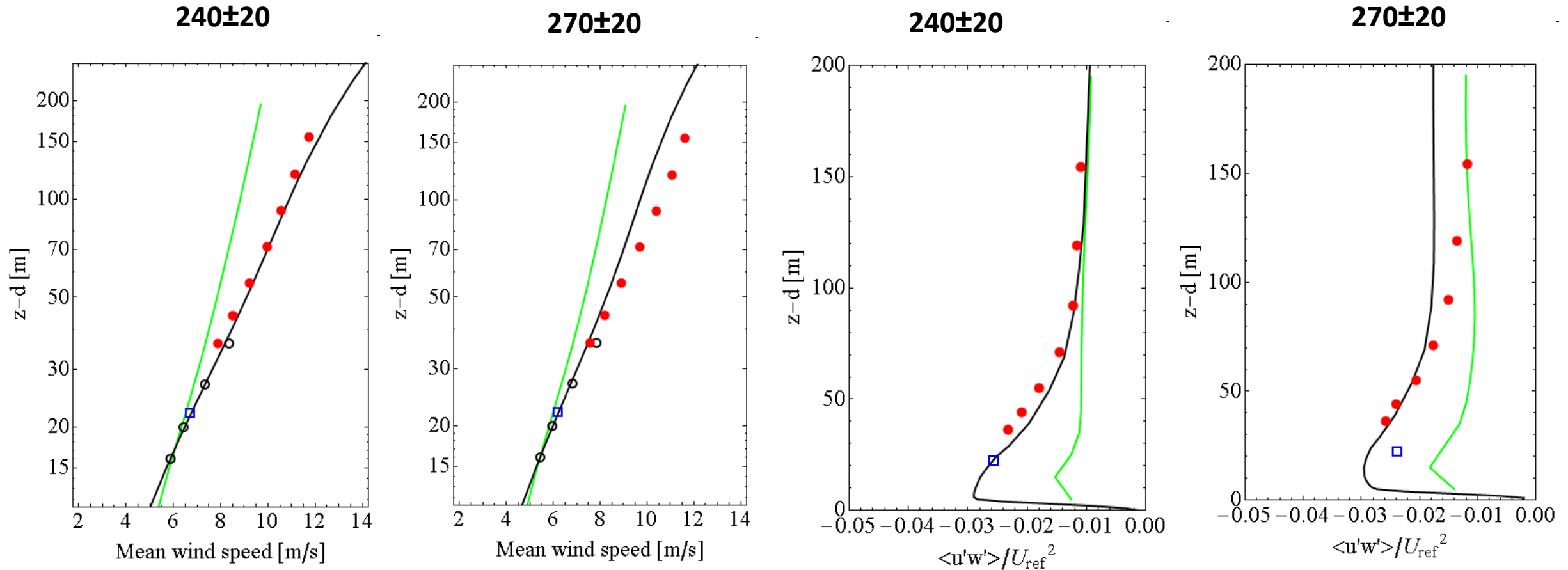


Deney2: Veri Toplama - Falster



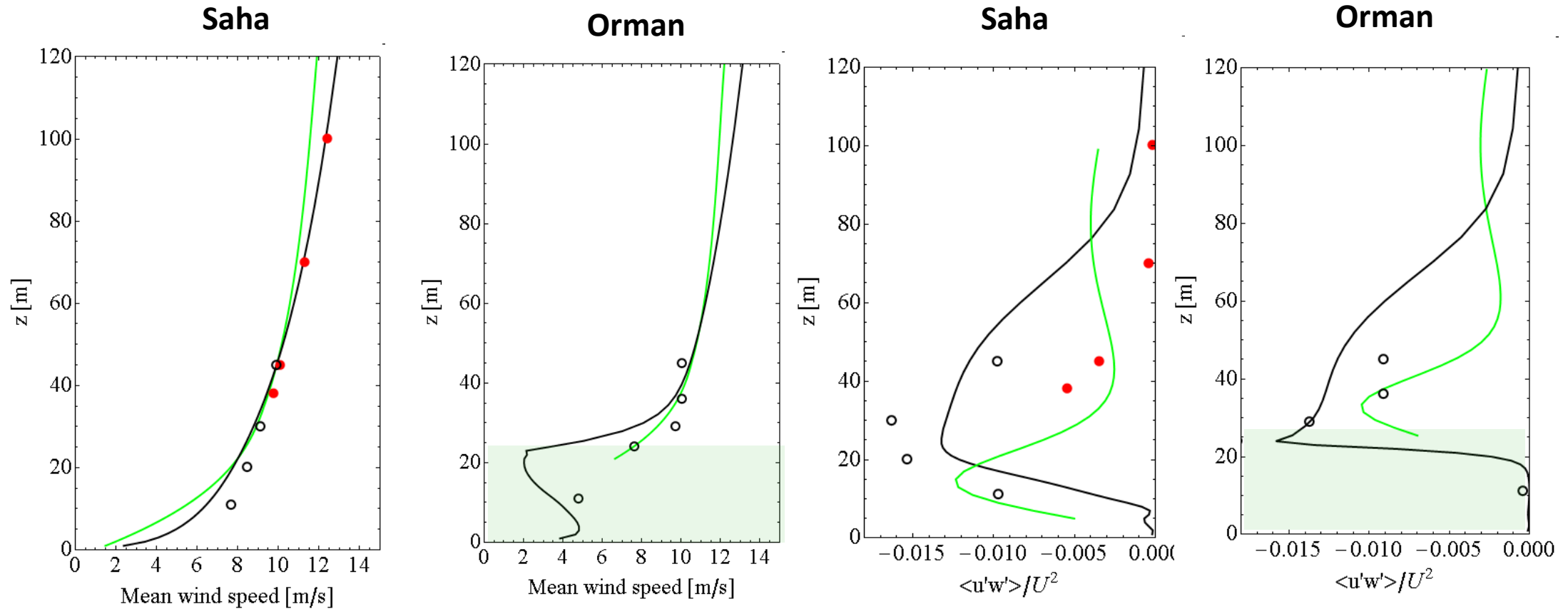
Deneý2: Sonular- Sorø

- Sonic
- Cups
- Lidar
- WEng
- SCADIS



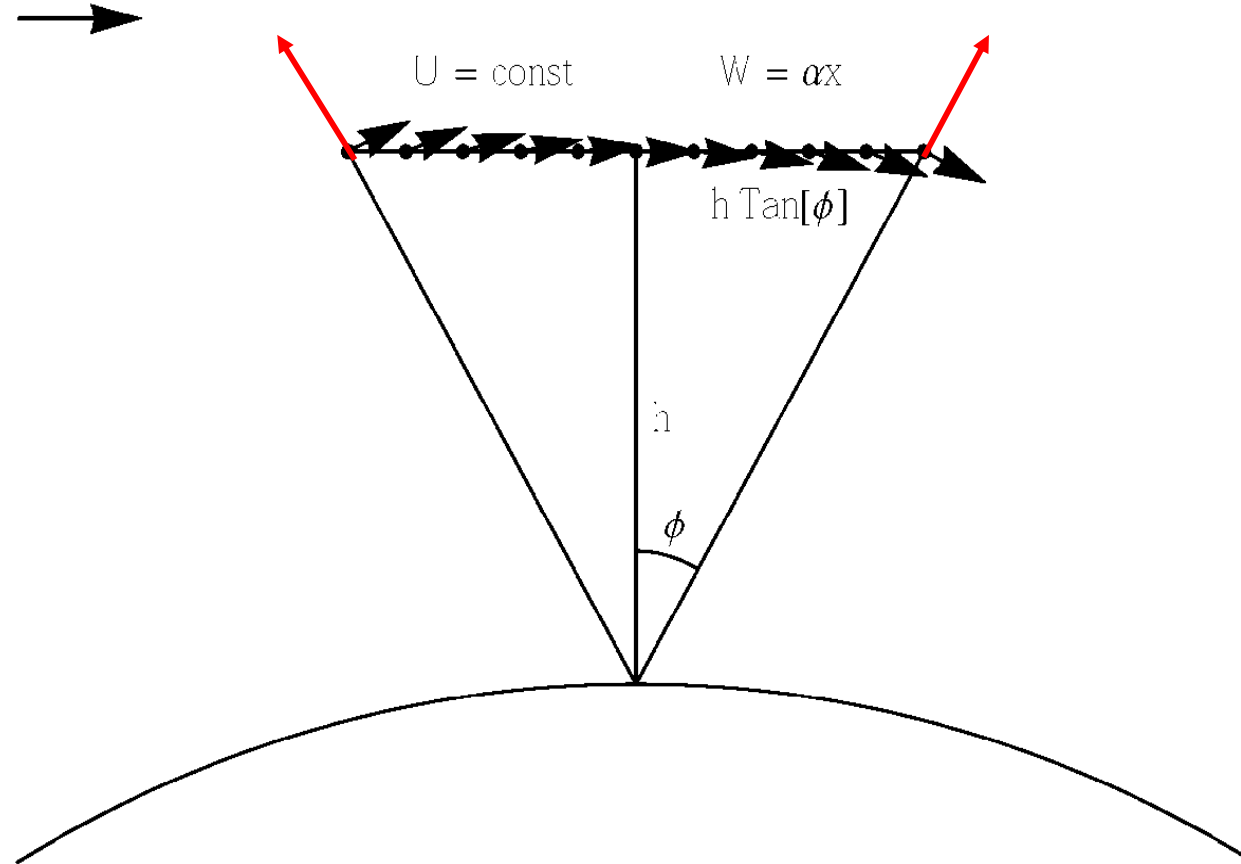
Deney2: Sonuçlar- *Falster*

- Sonics
- Lidar
- WEng
- SCADIS
- Forest

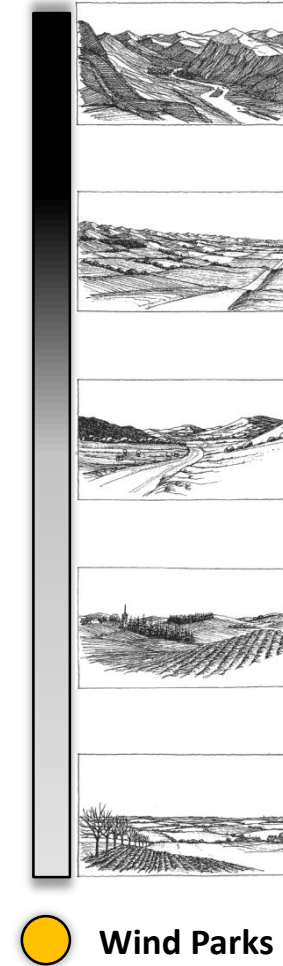
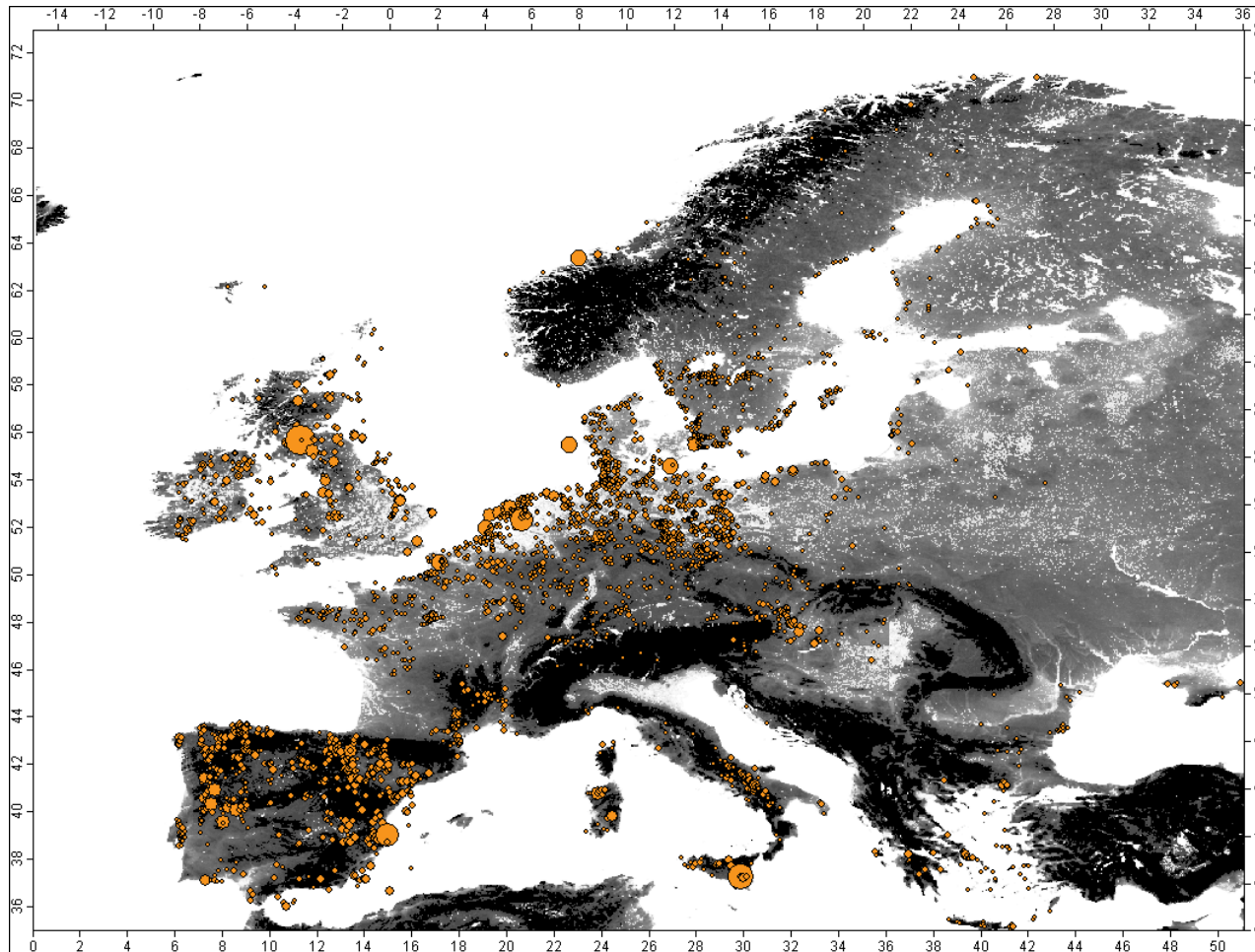


Deney3:LIDAR'lar hata yapar mı?

Hedef: Kompleks bir arazide bir LIDAR ne kadar hata yapar anlamak ve bu hatayı tahmin edebilen bir yazılım geliştirmek.



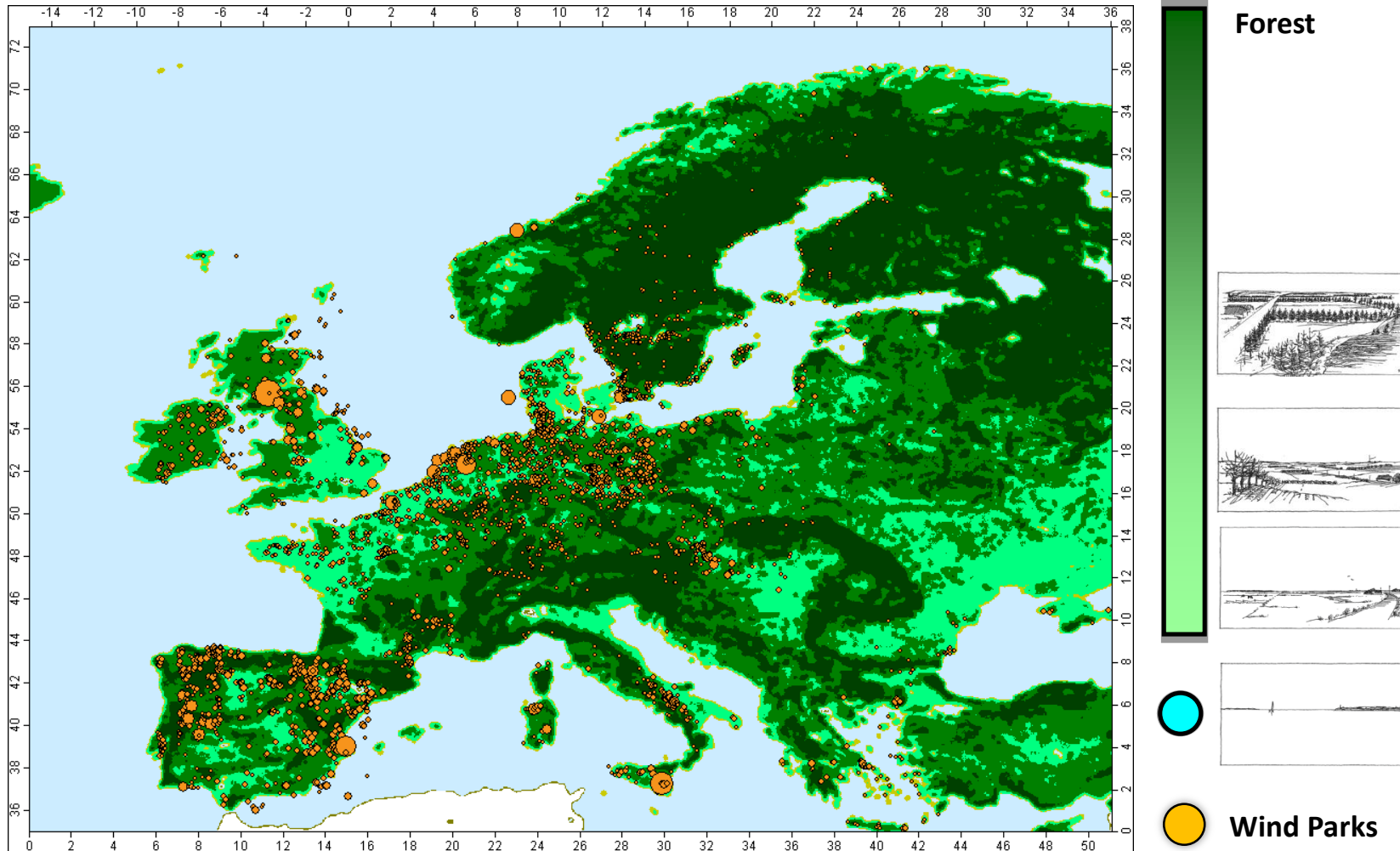
Deney3: LIDAR hatası neden önemli?



 **Wind Parks**

Data source: D. A. Hastings et al., The global land 1km base elevation (globe) digital elevation model. National Oceanic and Atmospheric Administration, National Geophysical Data Center, U.S.A., 1999.

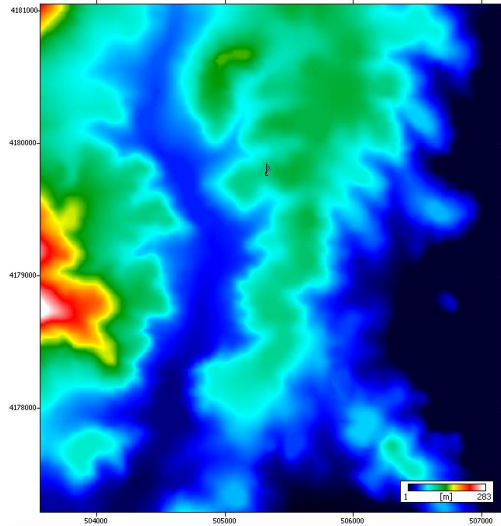
Deney3: LIDAR hatası neden önemli?



*Data source: T. J. R. C. JRC.
Global land cover 2000 -
Europe.
Technical report,
European Environmental
Agency, Nov 2006.*

Deney3: Hazırlık

Lavrio (Λαύριο)

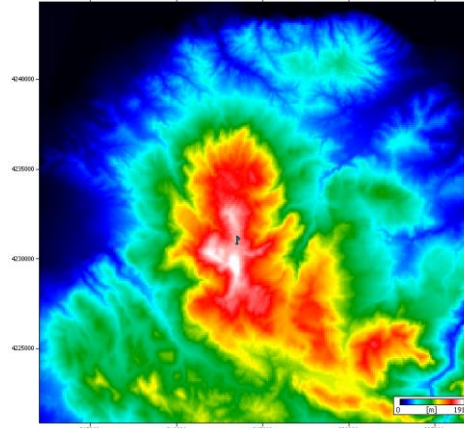


Veri:

- 2007-Aralık 2008-Ocak
- **Direk: 10, 32, 54, 76,100**
- **LIDAR: 32, 78**



Panahaiko (Παναχαϊκό)

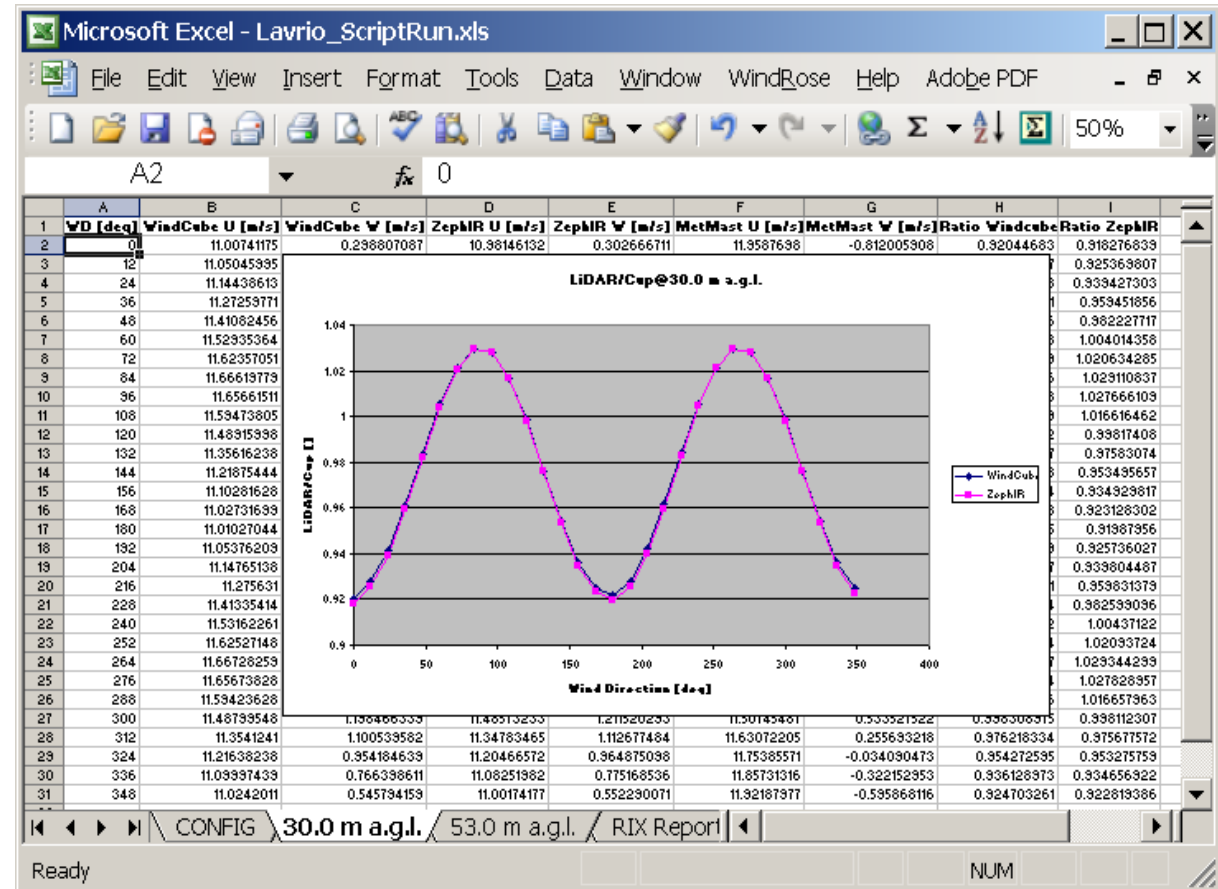
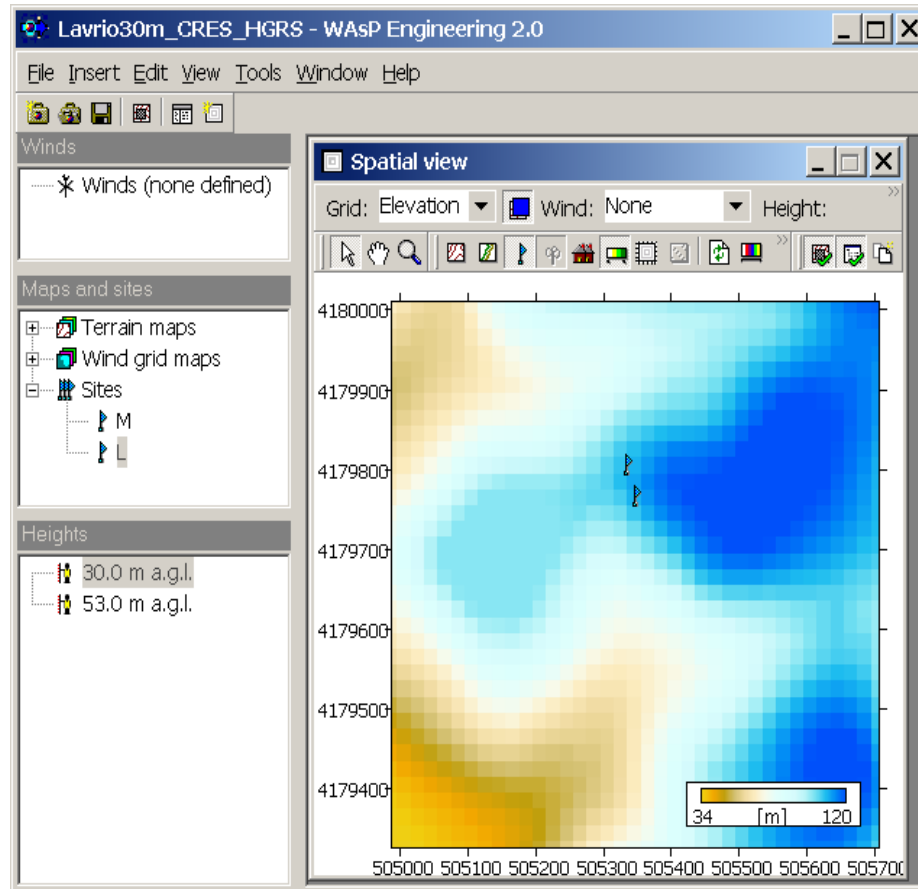


Veri:

- 2007-Eylül 2008-Ekim
- **Direk 10,20, 30, 40, 54**
- **LIDAR: 30, 55**



Deney3: Geliştirilen Yazılım



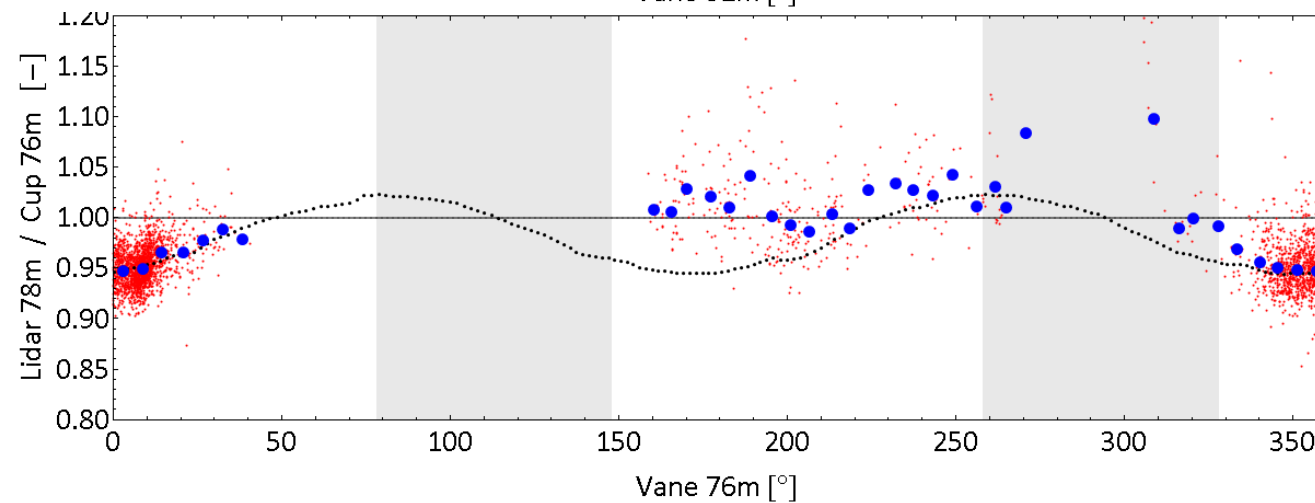
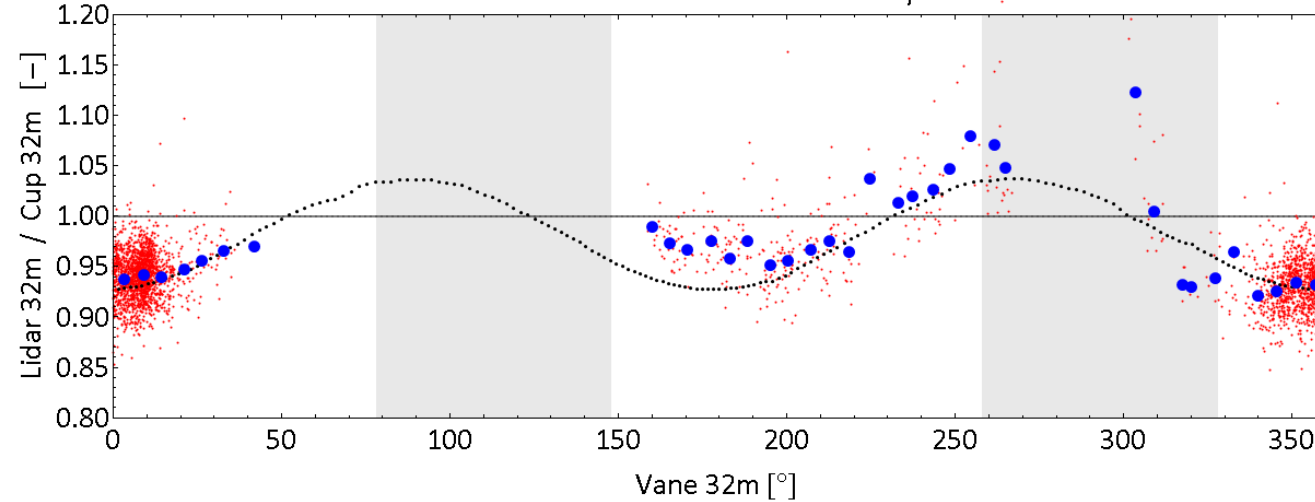
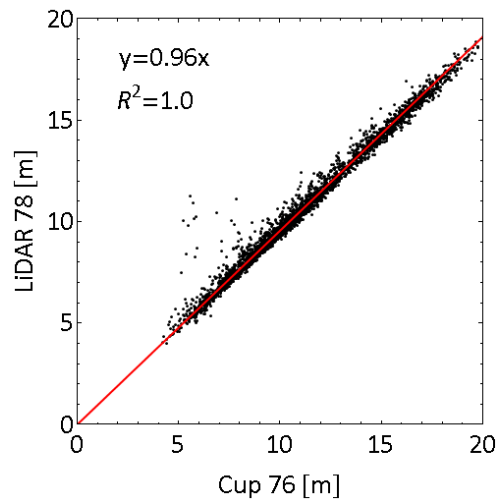
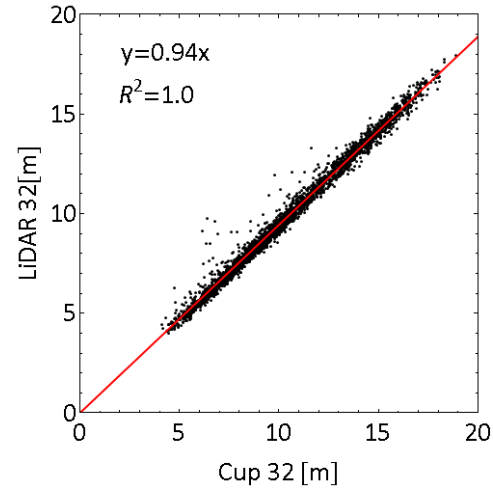
Deney3: Sonuçlar - *Lavrio*

Map Resolution=4m

Map Size=2400m x 2400m

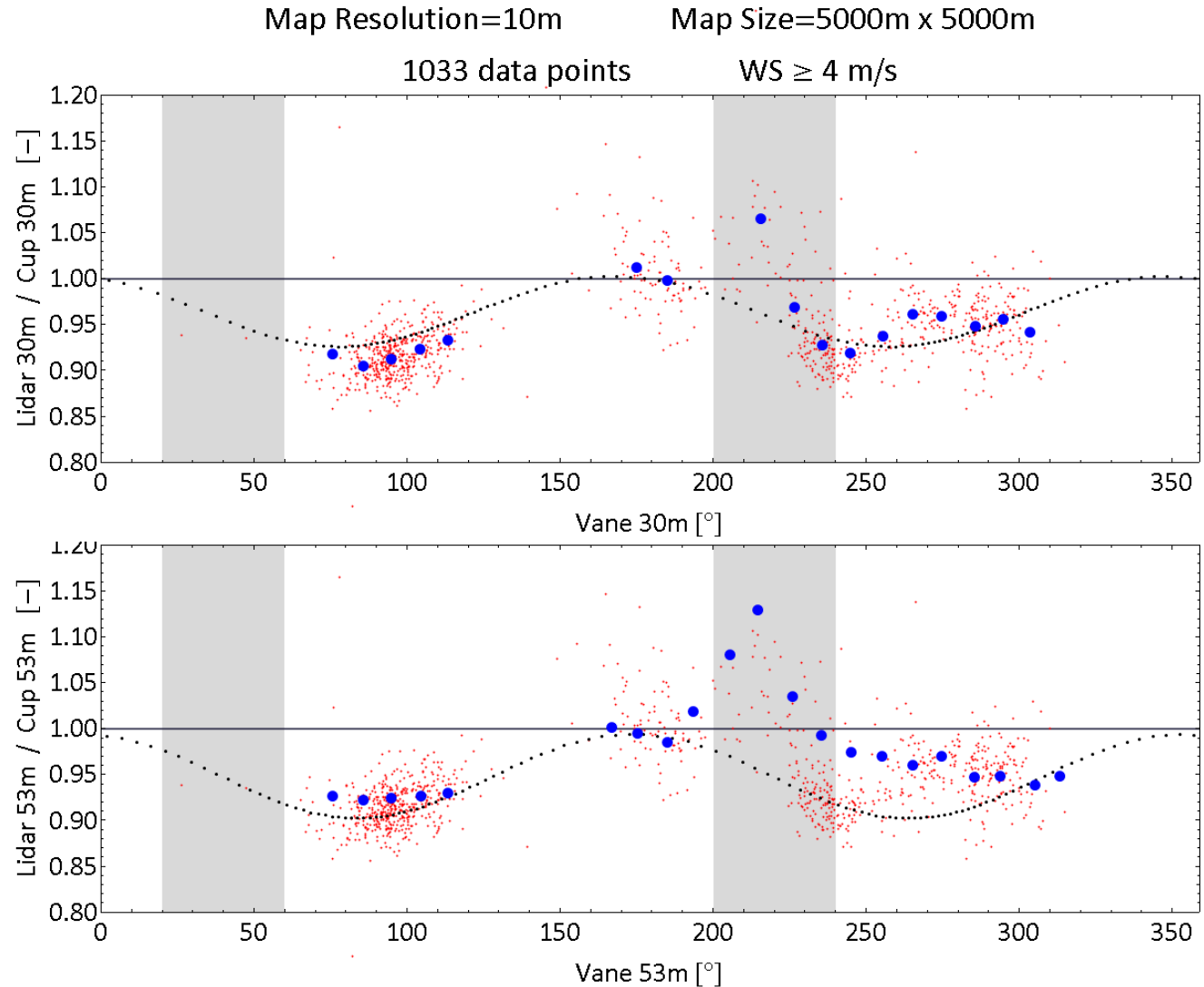
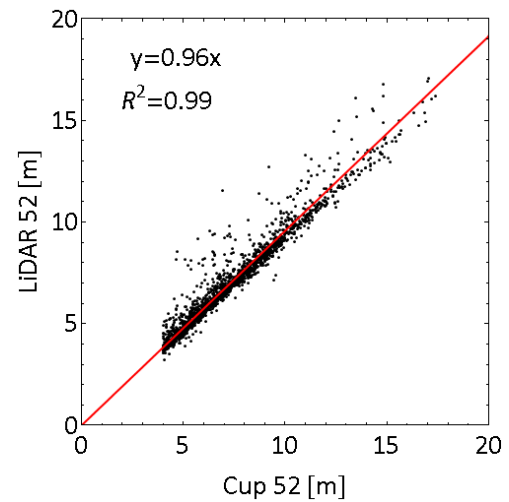
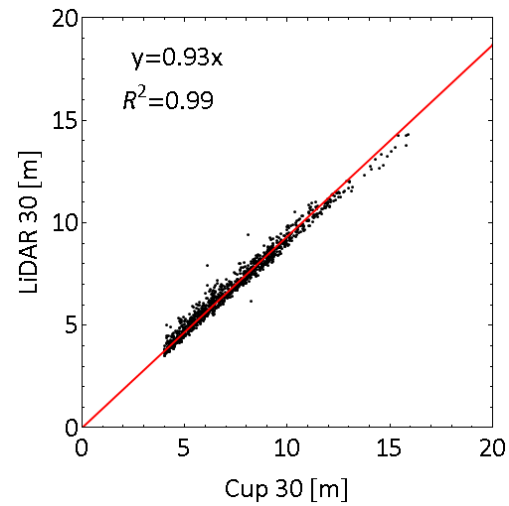
3110 files

$U \geq 4$ m/s



- 10min. runs
- 6° bins of 10min. runs
- Mast Shadow
- Model results

Deney3: Sonuçlar - *Panahaiko*



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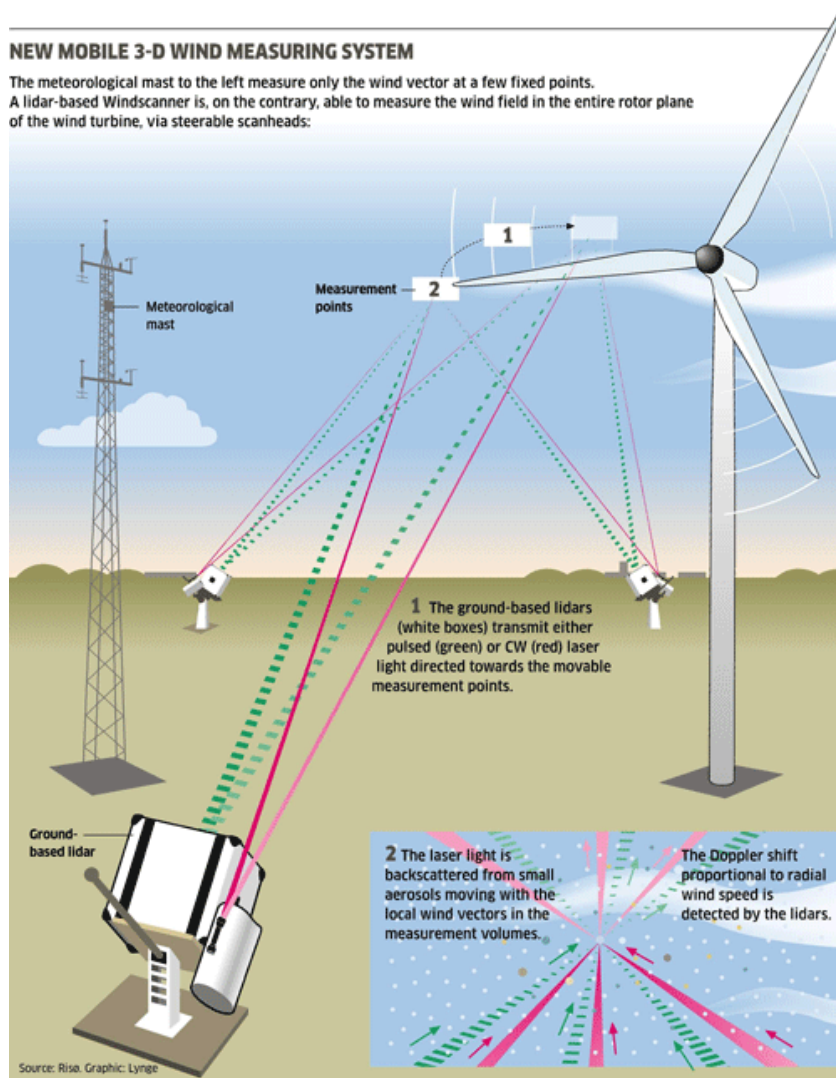


LIDAR Teknolojisinin Geleceđi

Arařtırma Liderleri:

Jakob Mann, Torben Mikkelsen

WindScanner



Torben Krogh Mikkelsen

Professor in Remote Sensing for Wind Energy

Department of Wind Energy
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ORCID: 0000-0002-5428-856X

??emails???: tomi@dtu.dk

Phone: 46775009

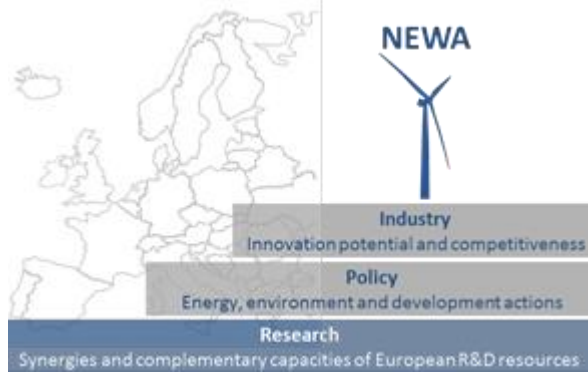
Mobile: 4131 5709



<http://www.windscanner.dk/>

<http://www.windscanner.eu/>

NEWA - New European Wind Atlas ERA-NET PLUS



Belçika
Danimarka
Almanya
Latviya
Portekiz
İspanya
İsveç
Türkiye



Fonlayıcı



Katılımcılar



Jakob Mann
Professor
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Meteorology



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DK-4000 Roskilde
Denmark

??emails???: jmsq@dtu.dk
Phone: 46775019
Mobile: 21362962

<http://euwindatlas.eu/>

Standartlar



**International
Electrotechnical
Commission**

www.iec.ch/

Güncel Haberler

- Teknik Komite 88 (TC-88), 61400-12 sürümünü güncellemek üzeredir
- TSE Ayna Komite, gelişmeleri takip etmektedir.

Teşekkürler!

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