Kvk Projectendag – 7 April 2011

WindVisions

Photo courtesy of airliners.net

WAGENINGEN UR
METEOROLOGY AND AIR QUALITY

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D. van Dinther

Contents

- Project Information:

  Problem-definition – Objective – People – Hardware – Project-organization – Deliverables

- Current work (the science):

  New algorithms to determine cross-wind with scintillometers

The Problem

- The operations at Mainport Schiphol are highly sensitive to a number of critical weather parameters, most notably precipitation, the *local wind field* and *visibility*.

- For save and efficient airport operation now and in the future, under the condition of a changing climate, *routinely monitoring* and prediction of these critical weather parameters is essential.

Objective

Develop a Wind and Visibility Monitoring System (WindVisions) at Mainport Schiphol:

- WindVisions will consist of:
  - a cross-wind scintillometer:
    → *horizontal* long range wind and visibility sensor
  - a SODAR (Sound Detecting And Ranging):
    → *vertical* scanning wind sensor

- The area of interest to monitor is the landing and take-off course of air-planes ranging from the surface to about 300m height along a runway.

People

Prof. Dr. AAM Holtslag – Chair of WUR-MAQ

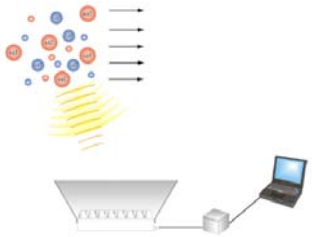
Dr. Ir. OK Hartogensis – Daily Supervisor and Project Leader

Ir. D Van Dinther – Project PhD student

Drs. P. van den Brink; Ing. J.O. Haanstra; Ing. R. ten Hove (Schiphol Group)

Ir. L.E.M. Smit (LVNL)

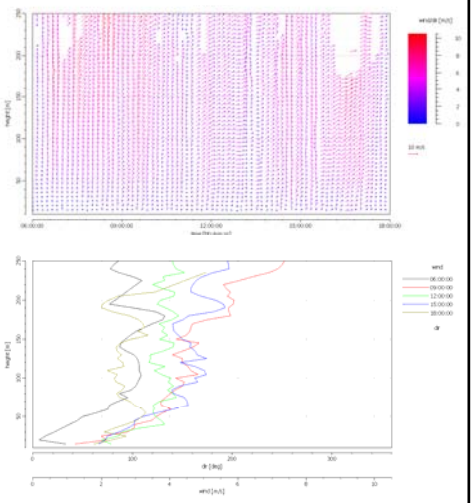
Hardware - SODAR



- A SODAR emits short acoustic pulses into the atmosphere.
- A SODAR receives reflected (backscattered) acoustic pulses from temperature inhomogeneities (turbulent eddies) in the air

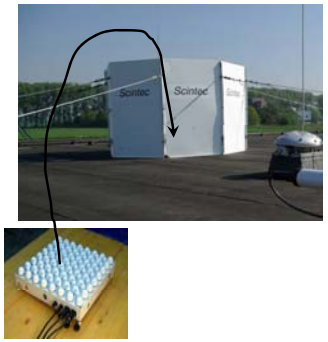
- Doppler frequency shift → wind speed and direction @ many heights
- Amplitude → turbulence intensity @ many heights

Hardware - SODAR



Hardware - SODAR

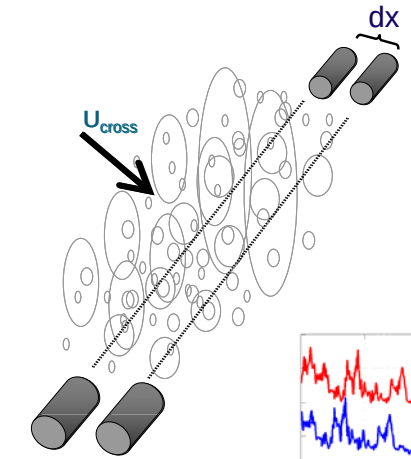
Now:



Working on:

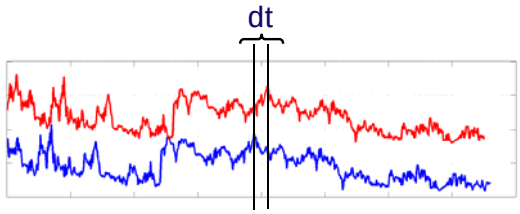
Hardware - Scintillometer

Hardware - Scintillometer

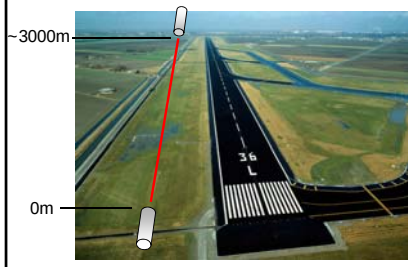


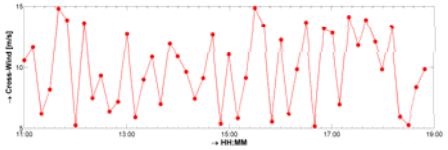
Scintec BLS-series

$U_{cross}=dx/dt$



Hardware - Scintillometer





- Intensity fluctuations → line-averaged cross wind speed @ one height
- Intensity mean → line-averaged visibility @ one height

Hardware - Scintillometer

Transmitter

Processing Unit

Receiver

Organization of the Project

- **Phase 1:** Hotspot MainPort Schiphol – HSMS01
  - Technology Development
  - Location: Mainly Wageningen + Cabauw
  - Time: Feb 2010 – Feb 2012
- **Phase 2:** Theme 6 - Climate Projections – WP1.3
  - Deployment WindVisions
  - Location: Mainly Schiphol
  - Time: Feb 2012 – Feb 2014

Deliverables Phase 1

- Development WindVisions
- Testing and development at Haarweg and Cabauw

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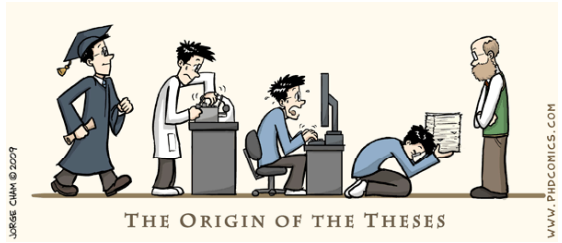
- Development WindVisions
- Testing and development at Haarweg and Cabauw
- Novel instrument development on cross-wind scintillometry:
  - Improved algorithm for the double-receiver cross-wind scintillometer.
  - New algorithms for single aperture cross-wind scintillometer.
  - Horizontal as well as vertical wind measurements (down-drafts)
  - Scintillometers fitted with adjustable diaphragms.
  - Visibility algorithm for the scintillometer

Deliverables Phase 2

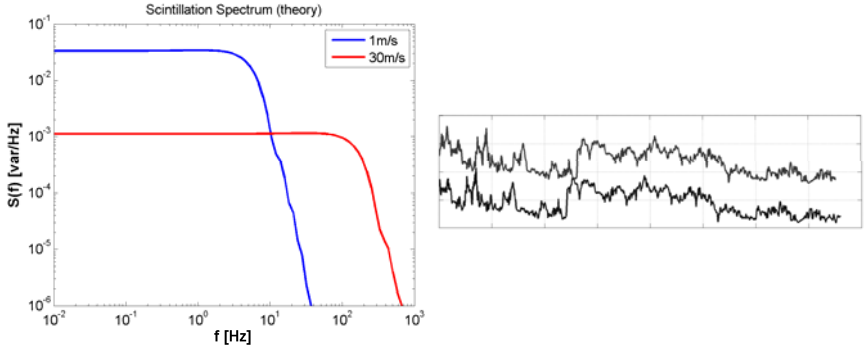
- Towards Operational WindVisions at Schiphol airport
- Synergy/Embedment with Modeling approaches:
  - Harmonie (IMPACT)
  - WRF
- PhD thesis!



Single Aperture cross-wind techniques

Scintillometer Spectrum: $S(f) = 4\pi^2 K^2 \int_0^L \int_{2\pi f/v}^{\infty} k\phi_n \sin^2\left(\frac{k^2 x(L-x)}{2KL}\right)\left[(kv)^2 - (2\pi f)^2\right]^{-1/2} dk dx$

Clifford (1971)



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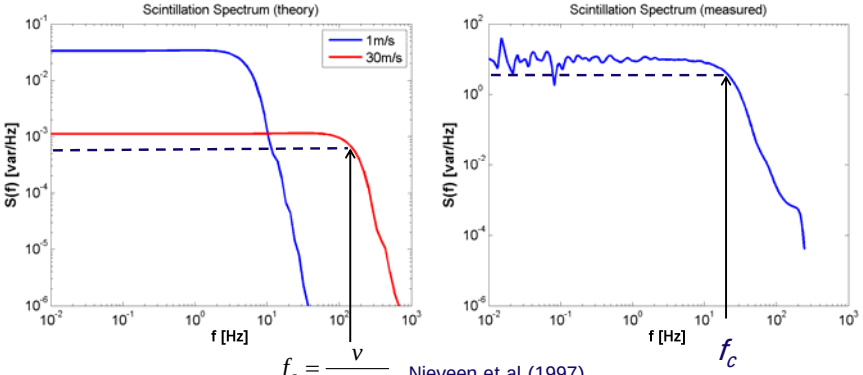
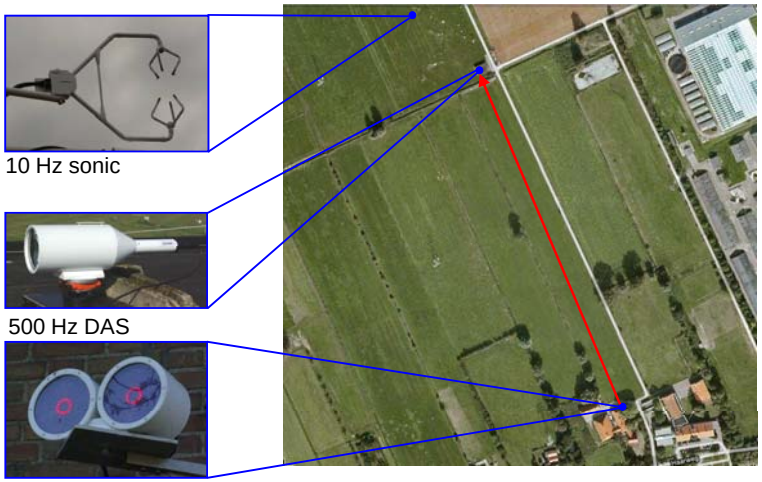


$$f_c = \frac{v}{1.25D}$$ Nieveen et al (1997)

Single Aperture cross-wind techniques



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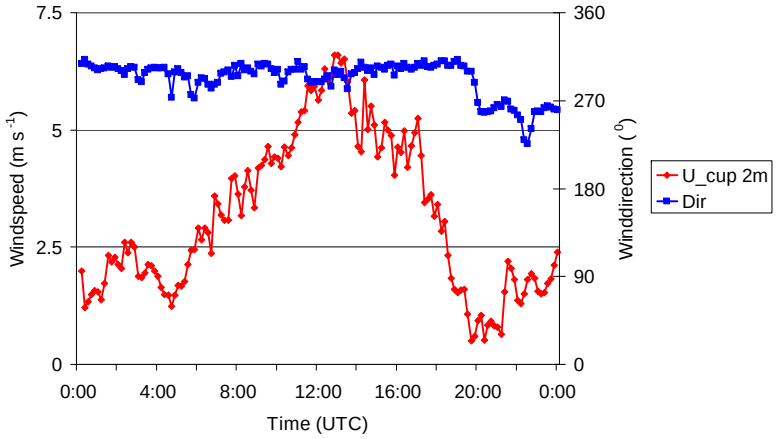
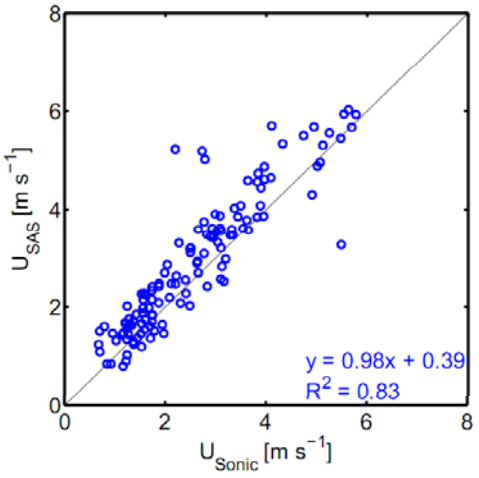
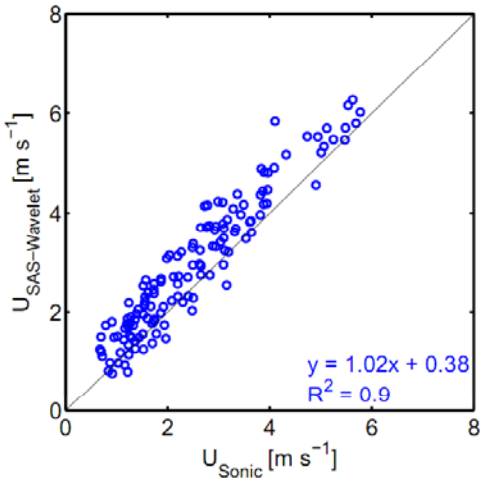




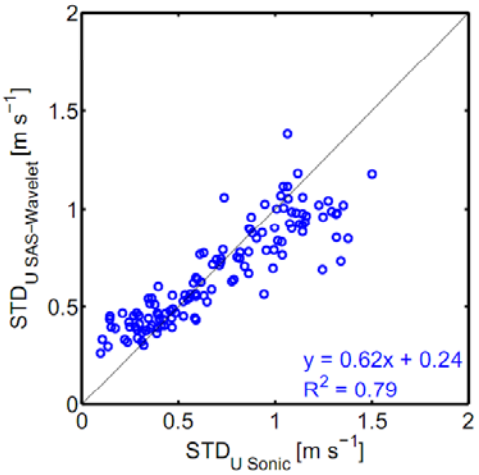
MAIN RESULT

10-minute variables plotted:
• **U_{Sonic}:** Crosswind of scintillometer path derived from Sonic Anemometer
• **U_{SAS}:** BLS operated as a SAS – Crosswind based on ***10min FFTs***



Special Case:
spectra based on wavelets

10-minute variables plotted:
• **U_{Sonic}:** Crosswind of scintillometer path derived from Sonic Anemometer
• **$U_{SAS-wavelet}$:** BLS operated as a SAS – Crosswind based on ***1 s wavelet***



Special Case:
Fluctuations in cross-wind

10-minute variables plotted:
• **$STD_{U\ Sonic}$:** Standard deviation of crosswind of scintillometer path derived from Sonic Anemometer
•**$STD_{U\ SAS\text{-}Wavelet}$:** BLS operated as a SAS – Standard deviation of crosswind based on ***1 s wavelets***

Conclusions:

- Method works!
- Wavelet approach able to obtain crosswind for 'short' averaging times (1 s.)
- Less std(U_{cross}) SAS due to path averaging
- SAS better results than DAS

The END