Geosci. Instrum. Method. Data Syst. Discuss., 2, C369–C373, 2013
www.geosci-instrum-method-data-syst-discuss.net/2/C369/2013/

Geoscientific Instrumentation Methods and Data Systems
Discussions

Interactive comment on "Development and comparisons of wind retrieval algorithms for small unmanned aerial systems" *by* T. A. Bonin et al.

Anonymous Referee #3

Received and published: 1 February 2013

*** general comments

This manuscripts compares three methods that deliver the mean horizontal wind speed and direction from GPS data measured aboard small unmanned aerial systems (UAS). The focus is on UAS that are not equipped with an inertia measurement unit (IMU) or a flow probe (such as a five-hole probe or wind vane) in order to keep the entire UAS simple and cheap. While there are already UAS available that are equipped with flow probes and IMU and that are able to measure turbulence and thus 3d wind fluctuations, these are not topic of the manuscript. This limitation is justifiable since not always turbulence has to be resolved and of course since such simple UAS are about a factor of ten cheaper than UAS equipped with IMU and flow probe.

The three wind-calculation methods, presented in this article and that are only based

on GPS data, have been published before or are implemented in the open-source Paparazzi autopilot system, respectively. Intention of the manuscript is the comparison and evaluation of these methods. However, in order to value this comparison and its results it is necessary to understand at least the basic ideas behind these three methods which are given in section 2. For reference, radio soundings, ground-based measurements and sodar data are used.

The manuscript can be of large value and interest for the atmospheric-boundary layer (ABL) community for purposes that do not require turbulence data but e.g. only the mean horizontal wind vector averaged over several hundreds or thousands of metres. But precondition for this benefit is that some issues in the manuscript are discussed in more detail:

1) Mainly, the comparison of the wind-estimation methods among each other and against the reference systems (radio soundings, ground-based measurements and sodar) has to be performed more quantitatively.

2) The data quality of the reference systems (radio soundings, ground-based measurements and sodar) should be discussed quantitatively.

3) The mathematical and physical origin of the three methods has to be disclosed, as well as he applied simplifications and assumptions that lead to the three methods (currently eq. 1 and 2).

*** specific comments (numbers indicate lines in the manuscript)

a) It should be made clear from the beginning of the manuscript (and not only in half a sentence in section 2) that the discussed methods do not deliver vertical wind and turbulence.

b) around line 75: More details on the SMART sonde would be helpful: size, weight, endurance, propulsion, ...

c) 79: Briefly: what sensors are used for temperature, humidity, pressure and trace gases? What is their individual sensor inertia? At least temperature and humidity become important for fig. 7, and pressure for the altitude in all diagrams.

d) What is the origin of eq.1 and 2, where do they come from? Of course the answer should be 'The atmospheric wind vector is the sum of the ground speed vector and the airspeed vector, the first defined in the earth's coordinate system, the latter in the coordinate system of the aircraft. Its calculation requires a transformation tensor from the aerodynamic to the earth's coordinate system. See e.g. < Wind Measurements on a Maneuvering Twin-Engine Turboprop Aircraft Accounting for Flow Distortion by ALASTAIR WILLIAMS AND DAVE MARCOTTE, JOURNAL OF ATMOSPHERIC AND OCEANIC TECHNOLOGY, 2000 >'

dd) Then it should be explained what assumptions and simplifications were applied in order to obtain eq. 1 and 2.

However, a less elegant and less comprehensive way can be to explain how eq. 1 and 2 consider the difference between heading and track angle.

ddd) How did you obtain the aircraft heading (phi in eq. 1) without IMU?

e) 126/7: The airspeed can only be treated constant at constant throttle and pitch if the angle of attack remains constant. This is not true in turbulent flow where the angle of attack changes dynamically. However, averaged over a certain time or distance (how long?) there should be a mean angle of attack.

f) Line 175ff. It is somewhat dissatisfactory to discuss an algorithm that is a complete secret. Can you please give an outline on the method that is used by Paparazzi to calculate the mean horizontal wind? Any literature?

g) line 203: The mesonet data can show only whether the *surface* wind changes.

h) How do you explain the (sometimes quite enormous) data differences in fig. 6d and all eight fig. 5 ? In general I do not agree with the authors, that the curves shown in fig. 5 and 6 agree well or even very well. Thus, the differences and agreements between

the three methods and the comparison with the reference data should be quantified!

hh) Also, some statements in the text about the quality of agreement that should be (statistically) quantified: line 118, 229, 254, etc.

i) Also, both eq. 1 and 2 offer easy opportunities to calculate standard deviations / a measure for the statistical significance of the methods. So, error bars should be included in fig. 4 to 7.

j) 264: Please cite literature that quantifies the critical gradient Richardson number.

k) 270: Please quantify 'small': centimetres, metres, ...?

l) The sodar delivered data between 30 and 400 m altitude above ground (agl). Why does fig. 6 show a case where this range was reduced to a few metres? There should be days or hours with better sodar data sets for comparison, shouldn't it?

m) 311, 329, 333: Please quantify 'high-resolution'.

n) 317: Please quantify 'accurately'

o) 316: Conclusions: In the sections before it was not shown / discussed that the first two methods 'performed similarly'.

p) fig. 7 top left: Please explain why the remaining temperature inversion experienced a cooling in time as shown in the successive flights.

q) fig. 7 top right: Please explain why the flight at 7:50 shows a dryer profile than the flight at 7:18 local time.

r) fig. 7: Can you please attach error bars to the calculated Ri?

*** technical corrections (numbers indicate lines in the manuscript)

73 and others: Consequent use of the hyphen between two words that become an adjective in front of a noun, such as 'boundary-layer research'

93 and others: To avoid confusions, I'd prefer 'aircraft' or 'aeroplane' instead of 'plane'

116: 'input' instead of 'inputs' ?

118: In order to simplify the reading, please invent an acronym for 'best-curve fitting', e.g. 'BCF'

eq.1: insert space between v and cos, and v and sin

eq.1 and 2: please use a consistent variable for the ground-relative speed (not both Y and S, or is there a difference?). By the way, 'ground speed' should be sufficient.

194 'do' should be 'did'

258 ff: 'Ri' should not be italic

333: typo: 'high-resolution'

fig. 5: Due to the small size of the diagrams it is pretty difficult to identify the individual curves and lines (dotted, dashed etc)

Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., 2, 953, 2012.