TO: IGC Delegates 05Jan11
SUBJ: Jan11 IGC Meeting ANDS report
FROM: IGC ANDS Committee
Angel Casado, Bruno Ramseyer, members
Bernald S. Smith, Chairman
FAI & SSA RTCA representative
SSF/SSA EGU co-representative
NAA FAI Commission on Airspace and Navigation Systems delegate
OSTIV TSP member
UNOOSA's ICG ad hoc observer
SUBJ: Jan11 EnvCom report
FROM: Bernald S. Smith
IGC and NAA FAI EnvCom delegate, FAI EnvCom VP

Acronyms in Appendix I

ACTION ITEM - Current GFAC members and the expiry dates of their 3-year terms of office are Ian Strachan (UK-IGC meeting of 2011), Angel Casado (Spain-IGC meeting of 2011), Tim Shirley (Australia-IGC meeting of 2012) and Marc Ramsey (USA-IGC meeting of 2013). Nominations by ANDS will be presented at your meeting for your consideration for election to fill the expiring terms and filling an open term.

ACTION ITEM - Proposed SC3 Rule (see separate agenda item): Documentation/verification for glider flight altitude height achieved and gain made for claims of flight made above 50,000'msl must utilize a GNSS-derived altitude from an IGC GFAC-approved FR. See Appendix II for details.

Personal discussions of varying length by Smith on this matter have ensued with Ian Strachan, Bruno Ramseyer, JCWeber (CIA President), a CIA official from Sweden, who is deeply conversant with high altitude balloon flight verification, an NAA (USA NAC) official expert advisor of superior intellect on such matters, and IGC President Bob Henderson. After all of the above and development of what you read in Appendix II, a very recent in depth discussion was held with the pilot responsible for the current glider altitude record as part of the Perlan project. Subsequently, some discussion has taken place with SC expert Ross MacIntyre.

RTCA - Smith's involvement continues with SC-186 (ADS-B), SC159 (GPS) and to a much lesser extent with other SCs. RTCA meetings conducted with WebEx/telcon relieve much travel time/personal expense. It should be noted that many RTCA meetings, especially 186 & 159, include intensive EUROCAE participation. ION and CGSIC meetings also are on his list of things to do because of their pertinence to GNSS.

The current GPS constellation consists of 32 Block II/IIA/IIR/IIR-M satellites. Work continues on SVN49's problem with interference from its L5 frequency system. Other GNSS constellations are in varying degrees of progress towards full operational capability, with GLONASS being the most advanced.

FLIGHT RECORDERS - Ian Strachan, IGC's GFAC Chairman, will report on this subject. A complete updated rewrite/reorganization of the SC3 Annex has been accomplished. Recent extensive discussion re ENL/MOP matters continues.

FAA/SSA MOU - Mitre work on the FAA/SSA MOU (VFR ADS-B) continues but was slowed by difficulties obtaining proper equipment. The SSA committee of Steve Northcraft (Chairman), Hal Becker and Smith, along with SSA Chairman Umphres and occasionally an AOPA person, continue to have monthly telcons with Mitre's Rob Strain who is managing the program for FAA; a very short oral report re the latest may be given at your meeting if such is deemed appropriate.

As a reminder, the MOU establishes a collaborative effort to develop a phased plan to provide the soaring community with low-cost, lightweight, portable Automatic Dependent Surveillance - Broadcast (ADS-B) avionics equipment that may be used by the soaring community and others to reduce collision risk in visual meteorological conditions.

OSTIV at Philadelphia - Strain is one of the OSTIV track speakers at PHL11, the 26-29Jan11 SSA Conference in Philadelphia, PA at the Sheraton Society Hill Hotel (not Convention because no displays/booths) reporting on MOU flight testing to date. One of the MOU test pilots is SSF Chairman Rich Carlson. Other SSA Conference OSTIV track speakers include the FAA's Don Walker, reporting on ADS-B Equipment for Non-Rule Airspace, Loek Boermans reporting on Design of a Sailplane Wing Airfoil for Boundary Layer Suction, Helmut Fendt reporting on Safety Pays which I believe you will hear at your upcoming meeting, Helge Hald reporting on Basic Training and Evaluation Methods, Michael Kristensen reporting on FAST TRACK-Simulators and Dedicated Instructors, and Ian Oldaker reporting on Improve Your Instructing with Basic Laws and presenting a paper from Alfred Ultsch on FLYTOP Club Safety Training. Altogether the OSTIV track will hear from 20 speakers.

OSTIV nite at PHL, a reception, dinner and presentation, will hear from Danny Howell talking about The Development and Flights of the LightHawk in which he will discuss the status and performance of the LightHawk sailplane. He will talk about the difficult design challenges and manufacturing advances required to produce a glider which has a one ft/sec sink rate, capable of exploiting microlift, a very weak atmospheric lift condition, mostly unusable for conventional sailplanes. (The category of Microlift Glider was adopted for inclusion in the FAI Gliding Sporting Code in October 2004.)

UNOOSA - Smith continues to attend the UNOOSA's ICG meetings, the one last Fall being five days in Turin, Italy. Recall he attends as a US State Department invitee observer connected with CGSIC. Issues deal with the proliferating number of satellite positioning systems. As a result of such attendance, he determined that FAI should be encouraged (SSA does not, and and IGC may not, qualify) to become an official affiliate/observer. He presented a proposal to IGC's President Bob Henderson (an FAI ExBd member), who supported it, and presented it to the FAI ExBd. They approved it, recommending that Smith be the FAI representative thereto, and directed the FAI office to proceed with an application. Pending approvals up the line of bureaucracy, a final decision cannot be made until the ICG meeting next Fall in Japan. What's the importance of ICG? Smith has considered presenting a paper titled: GPS: DOOMED. ICG's purpose is to assure that doesn't happen. But he hastens to assure you, the US has taken steps on its own to protect GPS frequency broadcasts from other systems' same-frequency potential interference.

EGU - Representing SSF/SSA's Associate membership therein, Smith plans to attend the next EGU meeting near Madrid, Spain 26/27Feb11, coming from there directly to Lausanne for the IGC meeting 02-05Mar11. The earlier dates than plenary are to make a short presentation* to your Bureau, for which permission was granted by President Henderson.

*Among other things, it will cover the proposal in the Sporting Code for glider flight records above 50,000ft.

The next FAI CANS meeting is 28/29Mar10, currently planned in Lausanne, which Smith plans to attend as the NAA (USA's NAC) delegate thereto.

FAI Environmental Commission - As previously reported, its President Michael Goth died in a glider accident last year, so Smith and the other VP (Norway's Kare Liasjo) have been acting in his stead, including being included on the FAI Commission Presidents email list (so they know all the background secrets!). Smith represented the EnvCom at the FAI's Dublin General Conference and also prepared the agenda for the forthcoming EnvCom meeting, 22Jan11 in Lausanne. At your meeting, he will circulate, or give orally, a very short report to you on that.

Thank you very much for the opportunity to serve where I can meet so many interesting people, and enjoy it as much as I do.

s/Bernald

- end of report -

Appendix I
ACRONYMS & DEFINITIONS

(a short list)

ADS-B - Automatic Dependent Surveillance - Broadcast
ANDS - Air Traffic, Navigation and Display Systems
AOPA - Aircraft Owners and Pilots Association
CANS - Commission on Airspace and Navigation Systems
CIA - FAI's Ballooning Commission
CGSIC - Civil GNSS Service Interface Committee
EGU - European Gliding Union
ENL - Engine Noise Level
EnvCom - FAI's Environmental Commission
FAI - Federation Aeronautique Internationale
GFAC - GNSS Flight Recorder Approval Committee
GNSS - Global Navigation Satellite System
GPS - Global Positioning System (USA)
ICG - International Committee on GNSS (United Nations)
IGC - International Gliding Commission
ION - Institute of Navigation
MOP - Means of Propulsion
MOU - Memorandum of Understanding
NAA - National Aeronautic Association
NAC - National Airsport Control
OSTIV - Organization Scientifique et Technique Internationale du Val a Voile
PHL - Philadelphia
RTCA - no separate meaning, a private non-profit corporation addressing aviation requirements and technical concepts to advance the art and science of aviation and aviation electronic systems for the benefit of the public, with nearly 300 volunteer organizations, more than 25% of which are non-US, from the entire worldwide aviation community, functioning as a Federal Advisory Committee, to develop consensus-based recommendations on contemporary aviation issues, whose documents are most often used as the basis of government-issued TSOs
SC - Special Committee or Sporting Code
SSF - Soaring Safety Foundation
TSP - OSTIV's Training & Safety Panel
UNOOSA - United Nations Office for Outer Space Affairs

Appendix II (taken from a report submitted by Smith to ANDS, GFAC and others)
Here's another long one - about 7 pages including the background communications to which I refer.

Concurrence is sought with a proposal for an FAI SC change to require GPS for glider altitude measurement above 50,000ft. What follows is the gist of discussions.

A - I recognize that SBAS reduces GPS tropospheric delay error, and that such error varies over time, but I aver we know reasonably well what that max error is, disregarding periods of intense sunspot activity.
B - SBAS is not now available worldwide; granted it may well be sometime in the future, but flights are being prepared now for areas of non-SBAS coverage. Granted, a ground FR in the hands of the OO at takeoff could establish corrections for iono error, but the flight could well proceed beyond the range of that ground unit's corrections' acceptability.
C - I accept statements of other error sources, but I aver they are manageably capable of being accounted for.
D - There is a need to address the issue of flight verification instrument calibration.

Trying to put my simple mind to this issue of IGC's potential interest in revising the altitude claim issue for the, at present one glider pilot attempting a glider record altitude flight above 50K feet, and to keep it an honest recognition of achievement, I come up with something like the following, for which I further apologize for it being in feet; that will be changed to metric, as discussed later below:

Proposed Rule for IGC Glider Flight Altitude Height Achieved and Gain Made for Claims of Flight Made Above 50,000'msl:
1 - claims must utilize a GPS IGC GFAC-approved FR containing a baro transducer for documentation (That will be modified in the future whenever any other GNSS becomes fully operational worldwide, e.g. GLONASS which is closest to such achievement. For now, I'm sorry, but we must limit it to GPS.)
2 - the claim shall be GPS-derived geodetic altitude, not baro msl, utilizing a geodetic datum within x ft of ITRF.
3 - The claim shall be reduced from the documentation evidence by y ft.
4 - The resulting reduced claim difference from an existing record shall exceed the existing record by z%.
5 - The first claim utilizing GPS must exceed the existing baro claim by w ft.
6 - No other documentation, e.g. baro-derived, is acceptable.
7 - Claims are not acceptable for flights made within v hours of periods of intense sunspot solar flux radiation. Documentation must include suitable evidence that there was no such activity within that time period.
8 - The FR must be calibrated within the existing FAI SC rule requirements for:
~ GPS altitude up to 95000ft msl*
~ baro altitude up to 50000ft msl
~ GPS/baro altitude comparison up to t ft*

* are there calibration requirements for GPS besides GFAC?

So, if the above is acceptable, what are the values of tuvwxyz and the meaning of intense?

A - with a proper defining of intense, v may not be necessary, otherwise, it shall be 96.
B - intense shall mean solar flux exceeding the high of the previous u hours.
C - u shall be 24.
D - v see A
E - w shall be 3%
F - x shall be 10ft (no problem for GPS and GALILEO)
G - y shall be 1000ft
H - z shall be 2% (or maybe just 1%)
I - t gives me trouble; maybe it's best to say calibration for both GPS and baro up to, say, 40000'. I'm thinking of calibration lab accessibility. GPS calibration is by simulator, in my experience with RTCA. So, how to compare. Dare I suggest the baro is included only to prolong the old ways?

Some of those may seem/be excessive, especially:
- the y value, based on discussions with others, could be 500ft.
- the need for any u or v value, based on FR experience since implementation of use during solar flare activity (the cycle being 11 years and of small impact during daylight hours in the latitudes flown by most gliders), but attempting world altitude records may enter areas of solar flux GPS signal deterioration and see further discussion of flight hours.

Is this whole thing too bureaucratic? Where did my numbers come from? A conservative look at documentation, experience and wide-eyed gut feelings.

Not being fully conversant with the 1yr/2yr IGC SC rule change cycle, if we've run out of time (my fault) for getting all the detail of this completed in time to meet the deadline, I would like to ask for a vote at the forthcoming IGC meeting, proposing acceptance of this GPS requirement for flight above 50K'. The ensuing subsequent year until the 2012 IGC meeting would be used for metrification while 'fine-tuning' of numbers, etc. It would then be proposed to the 2012 plenary to fully accept the final draft of all the above, with implementation being immediate, not waiting until Oct12. I had originally thought to seek final approval at the forthcoming meeting, with Bureau oversight approval for necessary changes for sooner implementation, but we have time.

Issues that need to be addressed within the proposal include the following, coupled with my recommendation:
- active 3-axis flight control dampers vs passive: active permitted

- aerodynamic flight controls vs thrust reactors: FC reactors disallowed
- auto pilot: permitted
- human occupied and controlled: required
- state acceptance: we have no control without a change; as I understand it, the issue is a requirement for national record before acceptance as an international record such that a state could refuse to acknowledge a state record, thus precluding a world record
- records: per above; national vs international
- all this just for one pilot: yes, among other things, the worldwide publicity would be very nice, but of course that works both ways if there's an accident. I wondered about requiring anybody else trying it to have the same training the current pilot does, a NASA and USAF test pilot as well as a longtime glider pilot, with both an F104 time to climb to 84K' record of just over 3 minutes, who also holds a glider altitude record made some 40+ years later for a flight above 50K ft.
- nite flt: permitted
- MOP: permitted? (none in current aircraft under construction)
- pressurization: required
- GPS engine specs: altitude/temperature range certified; temp log req'd?

FR - Flight Recorder
GFAC - GPS Flight Recorder Approval Committee
GNSS - Global Navigation Satellite System
ITRF - International Terrain Reference Frame
MOP - Means of Propulsion
NASA - National Aeronautics and Space Administration
SBAS - Space Based Augmentation System
SC - Sporting Code
USAF - United States Air Force

Bernald
Bernald S. Smith
FAI IGC ANDS Committee Chairman

Below is a summary of discussion as noted previously:
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Gents, This is to bring us three together.

Brian Utley is a former Director and President of SSA, a retired (I think) industry executive who probably knows more about computers than anybody really should, a versatile person when it comes to getting things done and NAA consultant for, among other things, hi-alt including use of GPS.

Hans Akerstedt is a retired SAS Captain, experienced and excellent balloon pilot and expert for CIA on flight verification, especially hi-alt.

Among other things, Bernald Smith is the one who started FAI, via IGC, down the path of utilizing GPS instead of baros and cameras for flight verification.

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From Brian Utley:
We at the NAA have been concerned about the problem of determining geometric altitude accurately at all altitudes including the stratosphere. Additionally I am involved with the Stratos project on the topic of geometric altitude verification at 120,000 ft and more. I can share with you the direction I am taking on this topic which may have some value for the Perlan project.

To this point in time the IGC has depended upon barometric altitude corrected for altimeter setting and instrument calibration. In my article in Soaring Magazine of February this year I discussed the significant deviation from geometric altitude that occurs. This analysis used radiosonde data from various locations and at different times of the year corrected for altimeter setting. Deviations of hundreds of feet are not uncommon and can be below and above the actual geometric altitude depending upon atmospheric temperature distribution. I have also evaluated many flight logs against radiosonde data and GPS derived altitude data. The common view has been that GPS altitude data is unreliable because of the inherent error factor which I will discus later in this message. However my findings are that the error caused by using barometric pressure is invisible but larger than the GPS error. The larger the barometric error the better the GPS rendition of altitude looks. One of the problems with GPS altitude is that the measurement has a low repeatability factor. By this I mean that in a given flight log there will be differences in result from sample to sample. Some very small, some larger. I will discuss this later. Notwithstanding this, undulation in the altitude rendered is less and even substantially less than the barometric measurement.

I recently evaluated the flight logs from a High Altitude, Long Endurance UAV. The flight lasted 14 days and the maximum altitude was over 77,000'. The primary measurement was by GPS with an OAT log. The flight data was evaluated against radiosonde data from weather sounding stations within 300 miles. The GPS engine was WAAS enabled and the nearest WAAS reporting station was also within 300 miles. Reviewing all sources allowed one to conclude that the claimed GPS reported altitude could be supported.

Regarding the usage of GPS altitude measurement above 60,000 ft., the DOD rule is that the device must not be capable of BOTH altitude measurement above 60,000 ft AND speed in excess of 1,000 km/hr. The device being used for the Stratos project is the Garmin 15X-W and is expected to perform up to the desired altitudes. I have the first prototype and will be testing it shortly.
(The DOD requirement does not apply to some non-USA manufactured GPS engines;

there are at least some such available, but this poses no problem because flight at speeds above 1000kph in a glider for the near future are highly unlikely! - Bernald)

Now to GPS usage for altitude measurement. The NAA has used two Novatel DL-4 precision receivers for several years for measuring high performance World Record General Aviation attempts. (Developed for NAA in Canada with a grant from ION under the leadership of one of my ION colleagues for use in supersonic flight - Bernald). The most challenging of these is the 3 km speed record due to the need to establish start and finish times to extremely close tolerances. These devices sample at up to 20Hz and by using one as a ground reference station it is possible to achieve centimeter level accuracy using post flight processing.

Now a word about sources of error in GPS measurements. Note the following:

1. Orbital variation (ephemeris variation)
2. Clock synchronization between satellites and ground receiver
3. Satellite constellation configuration
4. Ionospheric distortion
5. Stratospheric distortion
6. Multi-path distortion

WAAS ground stations can resolve some of these errors and reduce vertical errors to less than 7 meters thereby qualifying GPS approaches for basic instrument conditions. The key is that the ground station, having absolute position knowledge can provide correction factors for users within the neighborhood of the ground station. The quality of the correction factor is reduced as the radius from the WAAS station is increased due to differences in the visible satellite constellation and the change in signal path through the atmosphere.

For local (up to 50 km) enhancement I have used one GPS receiver on the ground as a base station and a second station removed from the base by some distance. The base station record for several hours and the data log is processed to create a virtual position by averaging all the records. A correction table is created by time and then applied to the output of the second receiver. Results of this process yield 3 sigma results that are comparable or even better than WAAS results.

I have tried to encapsulate some of my experiences here, I trust it doesn't come across as too pedantic but I wanted to create a basis for discussion.

Regards,
Brian Utley
NAA Contest and Records Board

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From Hans Åkerstedt

Altitude measurements is a an interesting subject and I could write a long essay about how we have treated it in the CIA. With me it all started when I wrote my examination thesis at the Royal Technological University in Stockholm 1968. I happened to stumble over a Chinese report from 1955 about converting barometric to geometrical altitude.

For us one problem has been that altitude records have always been based on geometrical altitude. Pressure altitude would probably have been more appropriate as the balloon performance is probably more related to pressure altitude or density altitude than geometrical altitude.

It is sometimes a problem for pilots (and NACs) but we have a good tool if we have a good radiosonde table. In fact just compensating for deviations from ISA at low altitude gives a good result.

Our rules state that the geometrical altitude has to be calculated with an accuracy of 1% and a new record has to be 3% better than the old one. Up to about 10 000 m a barometrical altitude can be converted to geometrical within these limits but then we need altimeter/barograph calibration and radiosonde data. GPS altitude is already geometrical but has to be corrected for difference WGS84 - MSL. This can easily be calculated on line:

<http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/intpt.html>http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/intpt.html
or
<http://sps.unavco.org/geoid/>http://sps.unavco.org/geoid/

In very general terms the correction is about -50m on the northern hemisphere and +50m south of the equator. But with a curious anomaly in the Indian Ocean of about 200m.

A few years ago I had a case with an Indian altitude attempt about 20 000 m. It was recorded with 4 different instruments.

1: A Volkslogger barograph. According to manufacturer not usable over 18 000m
2: An Indian barograph. Not calibrated
3. An indian GPS. No information received.
4: A Garmin 276. This info was used but gave the lowest result of all four.

GPS altitude is said to be accurate to about 3 time the horizontal accuracy. Many believe that the horizontal accuracy is 5-10 meters but that varies from

manufacturer to manufacturer. For Garmin The EPE shown in the display is 50% probable error. For other manufacturer it may be 33%. For records we want the 95% probability and that is about 2.3 times the 50% error.

So the Garmin EPE suddenly converts to about 25 m error horizontally.

The altitude accuracy is said to be about 3 times the horizontal error. One reason is that for a good horizontal fix there are satellites all around the horizon but for altitude fixes there are very few satellites below the balloon altitude. Makes sense.

Barometrical altitude accuracy is dependent and proportional to the altitude and has to be converted to geometrical altitude taking into account the actual atmospherical data. GPS altitude accuracy is about +/- 75 m regardless of altitude and has only to be corrected for the local difference between GPS altitude (WGS84) and MSL.
Hans Akerstedt Retired Captain SAS
CIA delegate Sweden 1974-
FAI Astronautical Record alt Delegate 2010-
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Hans, I write you as the ballooning expert on high altitude flight verification on the advice of Mr. Weber, responding to me querying him about what you folks were doing about using GPS rather than baro for higher altitudes. I have thus found that we in gliding are not the only ones so interested and that indeed the USA's NAA is also looking into it. I would be most interested in what you have done so far and will of course share with you where we're going as well as what goes with NAA, whose man on the task to determine how GPS can be used at high altitude is a longtime friend of mine.
Bernald
Bernald S. Smith
IGC Airspace, Navigation & Display Systems (ANDS) Committee Chairman,
USA Delegate to FAI's Commission on Airspace and Navigation Systems (CANS),
Captain, UAL (retired),
Commander USN (retired)