REPORT ON
SECOND ARGO TRAJECTORY WORKSHOP
(ATW-2)

Best Western Incheon Airport Hotel

Korea

27 – 28 October 2006

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In this draft, there are a number of points that ATW-2 attendees need to comment on. These are identified in bold italic.

1) Introduction, Purpose and Aims of ATW-2

Following an informal meeting in Venice in March 2006, designated as the First workshop, the Second Argo Trajectory Workshop was scheduled for October 2006.

An initial set of ocean velocity data 'YoMaHa'05' calculated from float surface positions has been released by Hiroshi Yoshinari and colleagues, as mentioned in Argonautics 7 News in Brief.

The overwhelming majority of the present Argo fleet uses Argos satellites for data telemetry and position fixing, which means that several hours can elapse between a float reaching the surface and the first position being calculated. During this time the float can be carried several kilometres by the surface current. A corresponding unmeasured displacement can occur at the end of the float's surface time. YoMaHa'05 uses the earliest and latest positions reported during the surface part of a float cycle to define the submerged ocean velocity, so it does not account for the unmeasured displacements. If the surface arrival and departure times are known, a higher level product could be generated by extrapolating the surface trajectory from the end reported positions to estimated surfacing and diving positions. ATW-2 was concerned with establishing procedures to undertake this extrapolation.

The two main scientific challenges are:

Estimation of times at end of ascent and start of descent
Estimation of position at those times by extrapolation of reported surface positions

In addition, the filling of traj.nc files by DACs does not always conform to the published format, and there are aspects of the published format that are inadequate to enable the extrapolation to be undertaken. Therefore ATW-2 needed to identify ways in which the traj.nc files are unhelpful or inadequate for the preparation of a complete trajectory product.

Although the meeting followed the pattern of the published agenda included as an annex to this report, a number of items, particularly format issues, arose at regular intervals. The structure of the report assembles common themes rather than reflect the order of the discussion.

2) Format issues

Format issues arose regularly throughout the agenda. ATW-2 wishes to request/recommend a number of additions to the format of traj.nc files. ATW-2 also wishes to draw the attention of DMT and DACs/PIs to a number of ways in which submitted traj.nc files are inconsistent with the existing published format.

ATW-2 proposes to compile a list of format checks that all traj.nc files should pass. MS will take the lead in assembling the list of tests described in this report, and will circulate it for review.

When a list is agreed, ATW-2 proposes that one of the GDACs should test traj.nc files and report test failures to DACs. Since some DACs may not be able to fix all the problems immediately, test failures should not cause files to be rejected. We suggest that in order to not swamp DACs with failure listings, the format check should be run, for example, once per month. DACs should receive a listing that summarises how many floats fail each test, so that anomalies and 'unexpected' failure modes are obvious to the DAC.

ATW-2 requests DMT to consider whether AIC could monitor the status and frequency of certain trajectory file problems (as is done for profile files), which would be useful both to DMT and users.

It might be helpful to produce a 'trajectory white list' of floats that have passed format consistency checks, and would indicate the number of cycles in the file with DATA_MODE_TRAJECTORY = D (ie trajectory extrapolation work has been performed). 'Clean files' that have no trajectory extrapolation would be identified in the white list as having zero DATA_MODE_TRAJECTORY = D.

2.1) Monitoring of reports and correction of file inconsistency problems

ATW-2 draws the attention of the DMT to the need for a mechanism by which format and file inconsistencies can be reported, logged and monitored to ensure corrections are made.

JJ, HY, MS had all presented lists of format problems/inconsistencies that they had encountered. In many cases these have already been notified to the responsible DACs. Workshop members will work with the DACs in their own country to help resolve and correct these problems (aoml, bodc, jma, kma). DACs that did not have a country representative at ATW-2 (coriolis, csio, csiro, incois, meds) will be contacted at DMT to establish whether they anticipate a particular difficulty (resource problem, technical problem) in correcting the format of their files.

2.2) Format checks proposed for traj.nc files

The following paragraphs describe properties that ATW-2 recommend that all traj files should fulfil, and which should be tested at GDAC. Some of these are restatements of the agreed format; some of them are clarifications or refinements. In some cases the published format has a 'hole' so that things that strictly conform to the User Manual but are in fact unhelpful, are now made illegal. Paragraphs in italic are proposed as GDAC tests. The plain text provides further clarification, and guidance on how to fill variables.

2.2.1) Missing cycles

All CYCLE_NUMBERs should be present, starting with either 0 or 1. A zero cycle is optional.
so
min(CYCLE_NUMBER) = 0 or 1
and
length(unique(CYCLE_NUMBER)) =
1 + max(CYCLE_NUMBER)-min(CYCLE_NUMBER)

If a cycle was missed because there were not enough transmissions to create a profile (or no transmissions at all), placehoder measurements should be introduced. All variables are _FillValue, except CYCLE_NUMBER, which takes the appropriate value for the missed cycle. The number of placeholder measurements should match the number of drift data normally reported, plus a minimum of two measurements equivalent to the first and last transmission times during a normally-reported cycle.

We also recommend that in all cycles, a minimum of 1 placeholder measurements be inserted for a drift pressure, even if the float does not measure and report drift pressure. Then a PI can insert a nominal value in delayed mode (if able to do so) without changing the variable dimensions. The

inclusion of a drift pressure in either RT or DM is strongly recommended, because meta files do not always enable a user to infer the park pressure of the cycle.

The question was discussed of how

length(JULD_DESCENT_START)

compared with

length(unique(CYCLE_NUMBER)).

TK showed there are systematic differences between DACs as to whether these two lengths are the same. The suggestion at the meeting was that

length(JULD_DESCENT_START) = length(unique(CYCLE_NUMBER)).

Since the meeting, BK has thought about this some more and now proposes a solution different to the one suggested at the meeting. The issue will have to be reviewed and some agreement reached.

The problem is as follows, and is relevant for both 'active' and 'dead' floats.

Suppose there is no cycle number zero (but the logic is identical even if there is a cycle zero). If the latest surface cycle reported in a file is cycle N, then all the transmission times have CYCLE_NUMBER = N. The ascent and descent juld and positions are stored in index N of their arrays, because there are no missing cycles. But one important time for extrapolation calculations is JULD_DESCENT_START for cycle N+1, because this is the dive event that occurs at the end of cycle N. Therefore the N_CYCLE dimension must be N+1 and

length(JULD_DESCENT_START) = length(unique(CYCLE_NUMBER))+1.

JULD_DESCENT_START(N+1) will have a value in either RT or DM, and JULD_ASCENT_START etc will contain FillValue.

Therefore BK now proposes for discussion that DACs should be asked to create files with

N_CYCLE = length(unique(CYCLE_NUMBER))+1

so that there are placeholders for delayed-mode addition of all relevant time and extrapolation information without changing the variable dimensions. The format check on traj files would then flag as inconsistent any file for which

N_CYCLE = length(unique(CYCLE_NUMBER))

2.2.2) Surface transmissions to be bracketed by JULD_ASCENT_END and JULD_DESCENT_START

Apart from algorithm errors, there are many cases where JULD_ASCENT_END and JULD_DESCENT_START do not bracket the reported surface position times. This occurs when the start and end times are estimated from metadata, but the metadata does not describe the float cycle (eg phase of cycle drifting due to buoyancy changes, clock drift, metadata errors).

> *For each unique CYCLE_NUMBER n, the JULD values with non-absent surface positions, identified by POSITION_ACCURACY = G, or an Argos class from Table 5, must lie in the range (JULD_ASCENT_END(cycle_n),JULD_DESCENT_START(cycle_n+1)). If this test fails, JULD_ASCENT_END and JULD_DESCENT_START should be FillValue and _STATUS should be 9. The indexes must take account of possible cycle zero.*

Reviewing the first draft of the report, CS has said that she wishes to retain the bad start and end times filled from metadata, because they contain implicit information about the float performance when the phase of the cycle has altered. To be consistent with other parts of the

Argo data system, there should be a QC variable for JULD_DESCENT_START which is 1 when the data are presumed good, and 4 when they are found to be bad. If such a QC variable is introduced, then the rule might be:

'If the start and end variables have _STATUS = 1, ie filled from metadata, then if the bracket test fails, all of the juld start and end variables filled from metadata have _QC = 4.' It is possible that some of the juld start and end variables will be filled from metadata and some are transmitted by the float.

The introduction of a _QC for these variables may not be fully backwards-compatible for all users programs. Previously the user might have expected these data to be 'good' when present. Now we would be saying 'you must modify your program to read an extra variable and we advise you to discard the values when the QC is 4'.

Question for agreement: Do we want to introduce JULD_DESCENT_START_QC etc as proposed by CS so that we can retain the known bad times calculated from metadata ?

2.2.3) Include earliest and latest transmission times in JULD array

This is a recommendation, and does not require a GDAC test.

If a float transmits data but the satellite pass does not generate a position, the time of earliest/latest transmission during a cycle can be several hours away from the time of the earliest/latest position. Therefore the times of earliest and latest transmission should be in JULD with all the other variables having FillValue. (This is usual practice at aoml for example.) At aoml, if the first satellite pass does produce a position, then the time of earliest transmission, taken from the hex message, will only be a few minutes earlier than the time of the earliest position, but it will still have a distinct JULD value. Including these times could assist envelope methods for determining ASCENT_END and DESCENT_START.

[Question for Claudia/Megan: When I look at the file, how do I know these times are surface transmission times ? There is no flag that says 'These times were on the surface'. They might for example be associated with some submerged event. So I don't see how to identify these cycles to help the envelope. Up until now, I identified JULD corresponding to surface by checking for non-FillValue of position.]

2.2.4) Consistent use of _QC for POSITION and JULD

POSITION_QC and JULD_QC should only take values listed in Table 2.

MS and others reported on quite widespread occurrence of unexpected values in the QC of POSITION and JULD (eg spaces and FillValues).

It was noted that some DACs code the netCDF FillValue in POSITION_QC. This variable should be coded according to Table 2. Although the netCDF FillValue is defined in the manual, it should not be used for this purpose. If POSITION is not known, POSITION_QC = 9.

Since there is a RT speed check, we expect the most common value should be 1. POSITION_QC should be 0 only when there has genuinely been no QC applied

It was noted that some DACs seem to have a similar problem filling JULD_QC with appropriate values. We request BODC, JMA, CORIOLIS to check how they fill these variables. If there is uncertainty, MS has notes of apparent problems.

2.2.5) JULD to be monotonic

JULD should be monotonic (ie non-decreasing).

HY reported that sometimes there are reversals in JULD. The User manual does not explicitly state that JULD must be sorted, but it should be changed to do so. Bad files will be identified by GDAC checks. We suspect that instances of JULD reversals are more likely data errors than the reporting of correct JULD out of sequence.

2.2.6) Increment in JULD consistent with CYCLE_NUMBER

It seems that none of the bulk format checks reported at the meeting tested the consistency of assignment of CYCLE_NUMBERs. Generally, when CYCLE_NUMBER of surface data increases by 1, JULD should advance by approximately CYCLE_TIME. Failure to do so could be because the float cycle time actually changed (clock problem, grounding, etc) or it could be that a cycle was missed but the CYCLE_NUMBER was not counted correctly (eg 20 day advance in JULD but CYCLE_NUMBER increments by 1).

In 2004 BK identified and reported to DACs some files in which surface events had no data but the CYCLE_NUMBER was continuous. APEXs report CYCLE_NUMBER in the message, and the CYCLE_NUMBER in the traj.nc should agree with the cycle number reported by the float. Our earlier proposal requires that unreported cycles should have FillValue placeholders in JULD, which should solve this problem. For float types that do not count and report cycle number, DACs that assign cycle numbers should check elapsed times since previous cycles and correctly allow for missed cycles, taking into account the metadata CYCLE_TIME.

At present, this has not been formulated into a test that could be applied automatically. If such a test can be identified, it could be added to the list of GDAC tests.

2.3 Format deficiency in meta.nc files

There is a long-standing problem with recording APEX mission parameters in meta.nc: There is no consistent way to record APEX UP and DOWN times. This needs to be fixed, either with unambiguous new variable names, or with an agreed way to use the existing variables to record UP and DOWN.

When DMT has agreed the correct way to code APEX UP and DOWN, DACs need to implement it.

2.4 Errors in meta files

TK showed examples of Park and Profile missions where the meta files aren't filled correctly. This makes it impossible to infer the park pressure from meta files, which illustrates the importance of measuring and reporting drift pressure in traj.nc.

TK is asked to draw such cases to the attention of the DACs concerned, and use whatever procedure is developed by DMT for monitoring the correction of such reported problems.

DMT is asked to develop an action to resolve problems in improperly filled meta files.

3) Extrapolation of trajectory

3.1) Extrapolation method

Based on analysis of 377 SIO floats in the Pacific between 20°N and 60°S, BK presented evidence that when the Park et al. method is enhanced so that weights have a time constant of order a few hours, the Park et al. method outperforms other methods (linear extrapolation, Davis et al.) in predicting a withheld Argos fix of POSITION_ACCURACY=3. There did not seem to be strong sensitivity to the choice of time constant (a few hours) but this must be investigated further.

BK reported that he had not removed positions with POSITION_QC = 4 from his analysis of different extrapolation methods, so some analysed trajectories will be erroneous. The analysis needs to be repeated and the results circulated for review.

The file used as input for these tests will be provided to CS so that the Schmid et al. procedure can be compared with the other procedures at low latitude.

Assuming no unexpected problems in BK's reanalysis, the modified Park et al. method is proposed to be adopted to generate a routine product. Replacement of Park et al by a differnet low-latitude product will be considered in the light of further tests by CS.

When the traj.nc files are robustly filled with transmission times, positions and flags, and ascent/descent start and end times, a program can be routinely run to generate ascent/descent positions.

3.2) Storage of extrapolation/interpolation/surface fit results in traj.nc files

New variable names for position variables

The results of the surface trajectory calculations can be stored in the existing traj.nc files if new variables are introduced. This would be backwards-compatible, and would not require any change by users of existing files. A table is included towards the end of the report showing the proposed additional names. The proposal requires approval by DMT.

New variables of dimension N_CYCLE are used to store the positions corresponding to the ascent and descent start and end times. The trajectory method will not provide position for DESCENT_END or ASCENT_START, but we propose to introduce those variables as mandatory placeholders and fill them with FillValue (and _STATUS = 9). Positions come with an _ERROR estimate in km, and a _STATUS (1,2,9). STATUS will be 1 (estimated) for trajectory fits, but could be 2 (transmitted) for GPS/Iridium floats.

[Should we introduce QC as well as status, especially if we introduce QC on the times ?]

[Should we use metres instead of km for the error ?]

New variables of dimension N_MEASUREMENT are used to store the positions along the fitted trajectory corresponding to the times of reported transmissions. They come with an error, which initially would be the distance misfit between the transmitted position and the fitted position. There

will also be a STATUS. Since the _FIT variables are always estimated, the _STATUS takes the char value 'I' if the position is interpolated within other positions. If the JULD was outside the times of reported positions (eg an early or late transmission time that had no position) the STATUS is 'E' for exatrapolated.

If a time weighting is used as part of the fitting procedure, then there will be a different fitted trajectory for extrapolation to ASCENT_END and DESCENT_START. Therefore the FIT variables need to be of dimension (N_MEASURTEMENT,N_FIT) where N_FIT is the number of different extrapolations reported.

DATA_MODE_TRAJECTORY(N_CYCLE)

Since there is DATA_MODE to indicate inspection of JULD, LATITUDE, LONGITUDE, we propose DATA_MODE_TRAJECTORY(N_CYCLE) to indicate whether trajectory analysis has been performed for the cycle in question. DATA_MODE_TRAJECTORY takes the value R,A,D. When the traj file is first generated, DATA_MODE_TRAJECTORY is R (not FillValue) for all cycles.

TRAJECTORY_EXTRAPOLATION_COMMENT(STRING256)

We recommend that HISTORY is not required, but there should be a space to record the method used for extrapolation calculations, analogous to SCIENTIFIC_CALIB_COMMENT in profile files. We suggest TRAJECTORY_EXTRAPOLATION_COMMENT(STRING256)

Assembly of a trajectory product database

The details of the rectilinear and circular velocities generated by the extrapolation method are useful oceanographic diagnostics, and should be included in a product, alongside the submerged velocity for each cycle. Note that since the floats may be subject to wind slippage, the rectilinear part may not be the true ocean velocity, but the circular part should have greater reliability (away from low latitude).

We envisage that when traj.nc files have been generated with ASCENT and DESCENT positions, a trajectory product will be assembled from the individual files. This product would include the rectilinear and circular components from the fitting calculations, so these coefficients do not need to be stored in the traj.nc files.

At present a trajectory product including surface extrapolation cannot be generated because of a lack of complete timing information. We expect that in the long term Delayed Mode processors will be responsible for submitting D mode files that have complete timing information. In the short term, if we wait until all Delayed Mode processors have completed this process, we will introduce a delay that is not acceptable to the Argo. In order to achieve a product in an acceptable time scale, it will be necessary for one individual or group to take responsibility for working with DACs to complete the timing information (especially for APEXs), and then implement an extrapolation procedure across the entire fleet. As a short-term solution, BK may be able to get a Masters student to start the task in the first half of 2007.

> *We further conclude that the only way to achieve and maintain a trajectory product with a reasonable update timescale would be to obtain funding for an individual working in a national Argo group to (i) undertake the Delayed Mode QC of time for those floats that aren't likely to be handled on a reasonable timescale by the DAC/PI responsible for them and (ii)*

perform extrapolation calculations for the complete array. We note that AST has endorsed the importance of trajectories in general terms (refer to last AST report). We suggest that if AST expresses an expilcit requirement for the preparation of a delayed-mode trajectory product, it would increase the likelihood of success of a proposal to a funding agency.

4) QC of position

TK introduced the procedure developed at JAMSTEC for QC of position. This is equivalent to a more sophisticated speed check algorithm. The apparent speed between pairs of positions is compared with an absolute speed threshold (5 knots), and also with the average speed (Vav) along the apparent track.

A surface displacement is suspicious when (i) the speed exceeds 5 knots and (ii) the speed exceeds 2.5*Vav. The procedure is applied iteratively after suspicious positions are identified. At present, positions that are close together in time but which differ by a distance consistent with POSITION_ACCURACY Argos class may be erroneously flagged as suspicious. JAMSTEC are asked to revise the procedure to allow such positions to remain as POSITION_QC = 1. When the procedure has been refined, it could be recommended for use in delayed-mode analysis of position.

JAMSTEC requested to modify their position qc algorithms to take account of Argos classes, and to evaluate the revised algorithm. After they are confident that it can be applied in automatic mode, JAMSTEC is requested to make the algorithm available to DACs. If this is endorsed we propose DACs implemement the new method to replace the present RT speed check.

The amount of misfit between transmitted positions and a fitted trajectory could also be used as a delayed mode (but possibly automated) QC of position. This requires further investigation.

5) DAC filling of times traj.nc files

Many of the workshop participants had compiled experience of DAC defects in the filling of times in traj.nc files, especially JULD_ASCENT_END, JULD_DESCENT_START.

The bulk of the Argo fleet consists of

SIO SOLO
WHOI SOLO
PROVOR
APEX

SOLO, PROVOR

The first three categories can be resolved by working with a small number of PIs. BK has a robust method for resolving times in SIO SOLOs.

Further work with Breck Owens is required to resolve WHOI SOLOs.

We believe Coriolis has plans to work on resolving the problem for PROVORs.

The critical problem concerns APEX floats, which are used by a large number of PIs and DACs, with varying levels of skills, experience and resources.

APEX

For APEX floats, JULD_DESCENT_START can probably be determined routinely from an envelope method, but this requires further investigation. If envelope methods are found to be satisfactory, then this time could be found in delayed mode independent of the DAC.

For APEX Park and Profile floats, which now includes nearly all APEXs, JULD_ASCENT_START occurs at an unpredictable interval after the float descends from park pressure to maximum pressure. Therefore JULD_ASCENT_END is also unpredictable (with variation of several hours).

> *Therefore, the only way to determine JULD_ASCENT_END/ JULD_START_TRANSMISSION is for DACs to calculate it from the time of Argos telemetry messages, which are available to DACs but not to users. This is the single most critical problem for trajectory determination. As a matter of urgency we ask DMT to urge DACs to fill JULD_ASCENT_END correctly in real time. Where this information has not been filled in existing traj.nc files, DACs will need to reprocess all historical data.*
>
> *BK will notify DMT that ATW-2 considers APEX timing questions to be the number one priority to enable progress on trajectory products.*
>
> *MS will ask AST cochairs for their view of what would be an acceptable timescale to make progress on the problem of DACs filling APEX JULD_ASCENT_END.*

Some early APEX floats may not send the required 'message counter'. However, these floats are also unlikely to be Park and Profile, so an envelope method may be useable to estimate JULD_ASCENT_END

At present, the filling of ASCENT_START and DESCENT_END is considered to be a lower priority. Sometimes it is not know, sometimes it may be available from float telemetry.

6) Documentation

> *The text part of the User Manual should be modified. There are places where the manual is complete, but further text would help to clarify how files should be filled. There are places where the format is not sufficiently specific, and ATW-2 recommends tightening the definition of how certain variables should be handled. CS will undertake these clarifications with those responsible for the manual.*
>
> *DMT is requested to agree changes to traj format to include new variables for reporting extrapolation results. If they are approved, the new variable names will need to be included in the User Manual and described.*

In due course, the procedures used for inferring _START and _END times and for extrapolation of position will need to be documented in a trajectory manual comparable to the delayed mode QC manual. This should be drafted when the work has progressed sufficiently to enable an established set of procedures to be identified.

7) Drift during ascent and descent

While several workshop members had considered this problem, there were no presentations on the topic. HY said that he would be formulating and testing some ideas, and would communicate them to interested people in due course.

8) Non_Argos telemetry

There have been a few ORBCOMM floats, but we were not aware of anyone planning to use that technology in the future. There is now a growing number of Iridium floats ***(should parse meta files and get an exact number)*** maintained by aoml and jma.

For short surface times and positions from GPS, we propose: JULD, LATITUDE, LONGITUDE are filled filled with data in the N_MEASUREMENT arrays as usual, even if there is only a single position measurement reported.

> *BK will contact PIs for Iridium/GPS floats (Riser, Owens, Shikama) and ask them to advise on the position accuracy for the GPS fixes and the likely elapsed time between the JULD for position and the actual surface/dive times.*

If PIs can report the time offset between JULD_ASCENT_END and JULD_START_TRANSMISSION, then this could be allowed for when preparing the traj files. If there is a known minimum time at surface, then this should be reflected in the difference between JULD_ASCENT_END and JULD_DESCENT_START.

In the absence of such information, there is no extrapolation of position, so in the N_CYCLE arrays:

<POSITION>_ASCENT_END is position of earliest GPS position reported
<POSITION>_DESCENT_START is position of latest GPS position reported

If only one GPS position is transmitted, the position is used to fill both variables. If there is no other knowledge of float surface and dive times, the earliest and latest JULD (or the single value if there is only one) is copied into JULD_ASCENT_END, JULD_DESCENT_START.

Since there is no trajectory fitting, the _FIT variables take FillValues. POSITION_FIT_STATUS is 9.

9) Communication on trajectory matters

> *It would be useful to start using a trajectory mailing list at AIC (maybe there is one already ?) to communicate with users interested in trajectories.*

10) Future meetings

> *BK will report on the workshop at the upcoming DMT. CS will ask DMT cochairs to adjust the balance of time between discussion of ATW-2 and DMQC-2.*

The workshop was considered to be have been very helpful for identifying problems and resolving plans of action. A further meeting will be required, possibly immediately prior to the next DMT, depending on the location and time of that meeting.

Annex – 1 List of workshop participants

KK: Kuh Kim (27 Oct only),SNU, Korea. kuhkim@ocean.snu.ac.kr
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BK: Brian King, NOC, UK. b.king@noc.soton.ac.uk

Annex – 2 ATW-2 Agenda

1) Purpose and Aims of Workshop

2) Platforms and Timing

2.1) Review of mission cycle by platform type
- APEX
- PROVOR
- WHOI Solo
- SIO Solo

2.2) Summary of success by each DAC in filling timing information (ASCENT_END, DESCENT_START, etc) for the platform types handled by that DAC

2.3) Methods for estimating missing information
- 2.3.1) 'Envelope' methods
- 2.3.2) Recently-deployed floats where 'envelope' methods may not work
- 2.3.3) Specific problems in APEX 'park and profile'
- 2.3.4) Identification of other platforms where envelope method may fail

2.4) Metadata

3) Extrapolation of surface trajectory to ASCENT_END and DESCENT_START

3.1) Review of present activities

3.2) Intercomparison studies
- Which methods perform best ?
- How do we choose between them ?

3.3) Error estimates

3.4) Regional exceptions

4) Other issues

4.1) QC of position in .nc files

4.2) Weighting of position fixes

4.3) Routine generation of products – can this be done at GDACs ?

4.4) Format of results in NetCDF

4.5) Documentation

4.6) Drift during ascent and descent

4.7) Non-Argos telemetry

4.8) Training of DACs to fill times

5) Any other Business

6) Summary

6.1) Identify follow-up activities

6.2) Recommendations to DMT

6.3) Requirement for further meetings

Annex 3 Summary of action items

Action	*Action required by*
ATW-2 proposes to compile a list of format checks that all traj.nc files should pass. MS will take the lead in assembling the list of tests described in this report, and will circulate it for review.	*MS*
When a list is agreed, ATW-2 proposes that one of the GDACs should test traj.nc files and report test failures to DACs. Since some DACs may not be able to fix all the problems immediately, test failures should not cause files to be rejected. We suggest that in order to not swamp DACs with failure listings, the format check should be run, for example, once per month. DACs should receive a listing that summarises how many floats fail each test, so that anomalies and 'unexpected' failure modes are obvious to the DAC.	*GDAC*
ATW-2 requests DMT to consider whether AIC could monitor the status and frequency of certain trajectory file problems (as is done for profile files), which would be useful both to DMT and users.	*DMT, AIC*
ATW-2 draws the attention of the DMT to the need for a mechanism by which format and file inconsistencies can be reported, logged and monitored to ensure corrections are made.	*DMT*
Workshop members will work with the DACs in their own country to help resolve and correct format problems (aoml, bodc, jma, kma). DACs that did not have a country representative at ATW-2 (coriolis, csio, csiro, incois, meds) will be contacted at DMT to establish whether they anticipate a particular difficulty (resource problem, technical problem) in correcting the format of their files.	*ATW-2 attendees*
TK is asked to draw such cases to the attention of the DACs concerned, and use whatever procedure is developed by DMT for monitoring the correction of such reported problems.	*TK*
DMT is asked to develop an action to resolve problems in improperly filled meta files.	*DMT*
When DMT has agreed the correct way to code APEX UP and DOWN, DACs need to implement it.	*DMT, DACs*
BK reported that he had not removed positions with POSITION_QC = 4 from his analysis of different extrapolation methods, so some analysed trajectories will be erroneous. The analysis needs to be repeated and the results circulated for review.	*BK*
The file used as input for extrapolation method tests will be provided to CS so that the Schmid et al. procedure can be compared with the other procedures at low latitude.	*CS*
The results of the surface trajectory calculations can be stored in the existing traj.nc files if new variables are introduced. This would be backwards-compatible, and would not require any change by users of existing files. A table is included towards the end of the report showing the proposed additional names. The proposal requires approval by DMT.	*DMT*
We suggest that if AST expresses an explicit requirement for the preparation of a delayed-mode trajectory product, it would increase the likelihood of success of a proposal to a funding agency.	*AST*
JAMSTEC will be requested by TK to modify their position qc algorithms	*TK, JAMSTEC,*

to take account of Argos classes, and to evaluate the revised algorithm. After they are confident that it can be applied in automatic mode, JAMSTEC is requested to make the algorithm available to DACs. If this is endorsed we propose DACs implemement the new method to replace the present RT speed check.	*DACs*
BK will notify DMT that ATW-2 considers APEX timing questions to be the number one priority to enable progress on trajectory products.	*BK*
Therefore, the only way to determine JULD_ASCENT_END/ JULD_START_TRANSMISSION is for DACs to calculate it from the time of Argos telemetry messages, which are available to DACs but not to users. This is the single most critical problem for trajectory determination. As a matter of urgency we ask DMT to urge DACs to fill JULD_ASCENT_END correctly in real time. Where this information has not been filled in existing traj.nc files, DACs will need to reprocess all historical data.	*DMT, DACs*
MS will ask AST cochairs for their view of what would be an acceptable timescale to make progress on the problem of DACs filling APEX JULD_ASCENT_END.	*MS, Roemmich, Freeland*
The text part of the User Manual should be modified. There are places where the manual is complete, but further text would help to clarify how files should be filled. There are places where the format is not sufficiently specific, and ATW-2 recommends tightening the definition of how certain variables should be handled. CS will undertake these clarifications with those responsible for the manual.	*CS*
DMT is requested to agree changes to traj format to include new variables for reporting extrapolation results. If they are approved, the new variable names will need to be included in the User Manual and described.	*DMT, Carval (?)*
BK will contact PIs for Iridium/GPS floats (Riser, Owens, Shikama) and ask them to advise on the position accuracy for the GPS fixes and the likely elapsed time between the JULD for position and the actual surface/dive times.	*BK, Iridium PIs*
It would be useful to start using a trajectory mailing list at AIC (maybe there is one already ?) to communicate with users interested in trajectories.	*AIC*
BK will report on the workshop at the upcoming DMT. CS will ask DMT cochairs to adjust the balance of time between discussion of ATW-2 and DMQC-2.	*BK, CS*