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Scenarios for Adding Adjustments or QC within IVAD

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attm Configuration Details (with UK NOC)
Annex F: QC Flag Discussion
Annex G:

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attm Configuration Details (with UK NOC)

Annex F: QC Flag Discussion

Annex G:

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Core

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International Comprehensive Ocean-Atmosphere Data Set (ICOADS)

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The International Maritime Meteorological Archive (IMMA) Format

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Mod-qc

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Meta-vos

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Table C8

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Ivad

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Table C96

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Error

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variable

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variable

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Near-surface oceanographic QC (*Nocq*) attm (28 characters)
Table C10:

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Near-surface oceanographic QC (*Nocq*) attm (28 characters)
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Near-surface oceanographic QC (*Nocq*) attm (28 characters)
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Near-surface oceanographic QC (*Nocq*) attm (28 characters)
Table C10:

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are examples of the record types that can be constructed from the Core plus these attachments (where Table numbers are used to indicate the corresponding attm) (NOTE: ~~strikethrough~~ below indicates updates are still needed, or marks material that has been moved elsewhere):

•

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:

C0 (108 characters)

- ICOADS-standard structure (used for Release 2.5, see Supp. E):
  ~~C0 + C1 + C2 + C3 + C4 + C6 (372 characters, before C6)~~
- NCDC-variant structure (used alternatively for Release 2.5, see Supp. E):

~~C0 + C1 + C2 + C3 + C6 (315 characters, before C6)~~

• historical record:

~~C0 + C5 + C6 (~~

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~~)~~

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Inclusion of the attm count (*ATTC*) field in the *Core*, and of the attm ID (*ATTI*) and attm data length (*ATTL*) fields at the beginning of each attm, enables computer parsing of the records.

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Thus additional variations on these basic record types are implemented by inclusion or omission of attms, and new attms can be defined in the future as needed for new data or metadata requirements.

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SMV is actually defined, and more information given about other fields specific to WMO Pub. 47, in Dave Berry's documentation regarding the processing of this attm for R2.5 (http://icoads.noaa.gov/e-doc/imma/WMO47IMMA_1966_2007-R2.5.pdf).

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2. The calibrated minimum value = 0, but to allow for uncalibrated data a small negative minimum value might be required. In WOD the calibration indicator is Code16 of the

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-specific secondary header.
3. The most valued pCO2 is when a seawater temperature and salinity are also available at the same depth. Consider this in the parameter selection logic during data processing.
4

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5. Crosscheck WOD Code 17 of the

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-specific secondary header, if set = 1 (implies the use of nitrate + nitrite as the value) set field to missing.

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C9. Near-surface oceanographic QC (*Nocq*) attm.

No.	*Len.*	*Abbr.*	*Element description*	*Min.*	*Max.*	*Units (Code)*
1	2	*ATTI*	attm ID			Note: set *ATTI*=9
2	2	*ATTL*	attm length	b	b	Note: set *ATTL*=28

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the IMMT-based scheme as listed in Table C96a, thus all flags in this attm would follow that scheme.

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3. As agreed at the April 2013 UK EarthTemp meetings, it appears we need at least 4 configurations: (0) not calibrated, (1) calibrated, (2) bottle calibrated, (3) others.

***Nocq* attm notes**

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QC flags and calibration information paralleling the data value (and accompanying depth) fields in the *Nocn* attm (Table C8).

Table

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archive adjusted Julian

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archive adjusted Julian

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Intended to document insertion of this attm into the ICOADS IMMA archive. Julian day number is the integer part of the Julian date (ref. http://en.wikipedia.org/wiki/Julian_day#Julian_Date), but tentatively *AJDN* will instead start with day zero at 1 October 2012 (thus *AJDN* + 2456201 would equal the official Julian Day number).

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See Annex D for a general discussion of scenarios for adding adjustments or QC within the IVAD project, and see Annex E for a more specific discussion of *Ivad* attm field configuration and record management details (with the UK National Oceanography Centre).

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Subsidiary *Ivad* record-type to

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Subsidiary *Ivad* record-type to

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Main IMMA record type: *Core* + *Icoads* +

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+ *Uid* + *Suppl*
Subsidiary IMMA record type: *Uid* + *Ivad* + *Ivad* + *Ivad* … + *Ivad*
Subsidiary IMMA record type: *Uid* + *Error* + *Error* +

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… + *Error*

Unresolved questions concerning this new multi-record (Main and Subsidiary) linked approach include: whether there can be multiple subsidiary records associated with a given main record *UID* (probably the most flexible approach), and what limit may need to be established on the overall number of *Ivad* and/or *Error* attms associated with a given main record *UID* (for Fortran memory management considerations; 100 is tentatively suggested as the maximum).

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02[2]	Not evaluated, not available or unknown	Noused for data when no QC has beentest performed or the information on this elementquality is not available

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1	QC has been performed; element appears to be correct
2	QC has been performed; element appears to be inconsistent with other elements

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QC has been performed; element appears to be doubtful

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4	QC has been performed; element appears to be erroneous

54	Bad	The value has been changed as a result of QCfailed critical documented QC test(s) or as assigned by the data producer

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The value has been changed as a result of QC

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6	Reserved
7	Reserved
8	Reserved

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1. Adapted partially from the Minimum Quality Control Standard (MQCS) configuration for flags Q_1-Q_{29} as stored in the IMMT format (ref., http://www.bom.gov.au/jcomm/vos/documents/immt4.pdf). However MQCS flags 6 and 7:

> 6 – The flag as received by the GCCs was set to “1” (correct), but the element was judged by their MQCS as either inconsistent, dubious, erroneous, or missing
>
> 7 – The flag as received by the GCCs was set to “5” (amended) but the element was judged by their MQCS as inconsistent, dubious, erroneous, or missing

are specialized to Global Collection Centre (GCC) functions and not widely meaningful outside that environment. Thus they were not used for *VQC*, and are marked as "Reserved" (e.g. for IVAD-related QC).

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If

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(i.e. within the IMMA records, as is not presently the case). The specific

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within IVAD
(Proposed solutions to each scenario are in blue)

Scenario 1

An original air temperature record (20˚C) is adjusted for a ship heating bias (+1.1˚C) and height adjusted to 10 m (-0.2˚C). The user wants to assess the separate impacts of the bias adjustment and the height adjustment. To support the user, three separate IVAD attachments are needed.

1. All factors applied: *VAD*=20.9˚C
2. Bias correction only: *VAD*=21.1˚C
3. Height correction only: *VAD*=19.8˚C

Note: This sequence can be expanded to more than two adjustments to a single value. In many cases, storing the individual adjusted values and the all-factors-applied adjustment may be necessary. This could be complicated by order-of-operation dependent corrections (see scenario 4 below).

The author of the adjustments should submit 3 IVAD corrections (one for each case above) and document them as required. The IVAD central data center will not take responsibility for data processing of corrections in the IVAD portal. Each correction will be stored in a separate IMMA *Ivad* attm.

Scenario 2

The original *Core* air temperature (AT) record was flagged by ICOADS as out of a realistic range. A provider provides either a corrected value for *AT*, e.g. fixing transposed digits, or a bias-corrected replacement. How do we address the quality flag issue?

An error fix will go into the *Core AT* field during the next ICOADS Release and the QC flag will be set appropriately (QC is rerun with each new Release). The bias-corrected *AT* is held in an *Ivad* attm; if a user requests *AT* with all available bias corrections, the core AT—regardless of the QC, is supplied together with the bias-corrected *AT*. Thus we anticipate that the IVAD user interface will always provide the *Core* value along with available bias correction(s) whenever an adjusted value from an *Ivad* attm is requested.

In contrast, current thinking is that this user interface approach would not also apply to errors, i.e. users interested in erroneous values probably would need to get the full IMMA data set and seek out any *Error* attms.

Scenario 3

The original *AT* was in error. Provider 1 sent a corrected value. Provider 2 applies scenario 1 to the corrected value. How do we handle this with the *Ivad* attm? Would the first *Ivad* attm store the corrected value with *VEI* set accordingly, and would subsequent *Ivad* attms 2-4 store the *VAD* based on the error-corrected value of AT?

The corrected value from Provider 1 will go into the *Core* and will have a corresponding *Error* attm. Provider 2 will submit as many *Ivad* attms as necessary. By its very nature, an *Ivad* attm must reference a value in the *Core* from a specific Release (tracked via Release number details available in the *Uida* attm).

A problem would arise if Provider 2 submits an *Ivad* adjustment for an erroneous value detected either simultaneously or later in the process. A suggestion was made to track groups working on adjustments/error corrections for specific parameters, so we can avoid conflicting work. A “timestamp” may be included in the *Ivad* and *Error* attms, which may help sort out such conflicts during the processing of a new Release (see scenario 5 below).

Scenario 4

What if an adjustment actually depends on the magnitude of the value, for example, a nonlinear correction to a wind speed value because of changing ship size? Then the order of application of a bias adjustment (e.g., for ship shape, flow distortion) and subsequent height adjustment is important. Will this be handled with multiple *Ivad* attms showing the possible outcomes? The role of an expert panel (not currently funded) may be crucial to define the necessary *Ivad* attms for these unique cases.

In this case we expect there would be two *Ivad* attms. However, if this is a one-provider scenario, we recommend that the provider make a single final complete adjustment. If there are two providers, and the second uses the first *Ivad* adjusted value e.g. for flow distortion, and adds their height adjustment, the result should be a single value from provider 2. Many of these details need to be included in the provider documentation.

We also discussed establishing the Terms of Reference for an informal IVAD international coordination panel. Helping make decisions in these cases may be one role of the panel.

Scenario 5

Suppose a bias adjustment was made to an *AT* value in R2.5. However for R2.6.0, a duplicate report was received in delayed-mode. How do we deal with the duplicate and the possibility that the new and the old release *ATs* may be either identical or different? If identical, do we carry the R2.5 *VAD* temperature to R2.6.0? If different, do we scrap the *VAD* from R2.5 and notify the original provider? This is just one of many scenarios that will arise between Releases, so we need to discuss how to assign/carry information regarding applicability of each IVAD attachment for future releases.

If the original R2.5 report and the R2.6.0 duplicate contain exactly the same *AT*, it seems that the IVAD adjustment could be copied to R2.6.0 (although the mechanics of this may be challenging). We would need traceability of the *Ivad* attm back to R2.5 (tracked via Release number details available in the *Uida* attm). In addition, a "timestamp" may be included in each *Error* and *Ivad* attm.

If the R2.5 and R2.6.0 duplicate records do not have the same *AT*, it seems we must delete (i.e. no longer offer publicly, unless in the "intermediate" file product) the entire R2.5 record. The set of deleted records will then need to be analyzed. Perhaps we should state this policy in an IVAD policy document. Again, making a decision regarding the IVAD attachment from the earlier Release may be a role for the informal international coordination panel.

Annex E:

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Liz Kent and Dave Berry's comments (16 May 2012 e-mail) on an earlier version of the *Ivad* attm (in black), and responses (in blue; ref. also Shawn Smith's 13 June 2012 e-mail, providing an earlier version of responses):

1) Interplatform uncertainty. Might want to consider a more general name for this. You could have uncertainty that is correlated across e.g. platforms, measurement methods or countries. Or even for just daytime observations, or when it is raining. The flag would then have to explain how the partly correlated uncertainty linked across records.

An alternate approach would be to fix two uncertainty values to well known standards and allow the third uncertainty to be defined by the *VAD* provider, e.g. include random (*VAUR*) and bias (*VAUB*) uncertainty fields for all *VAD*. The question would be whether or not a single method for random uncertainty and bias can be established, or if an indicator field for the *VAUR* and *VAUB* would still be needed. The third "addional" uncertainty field (*VAUA*) would allow the *VAD* developer flexibility to provide any other uncertainty they feel important. A limited controlled vocabulary of uncertainty types/methods could be included in an indicator field. This field could be used for correlated uncertainties (platforms, measurement fields, etc.) or other uncertainty values that we have not considered in previous discussions.

The second alternative would be to make all three of the uncertainty fields definable, but we agreed that this could be very confusing to the users. Having at least 2 uncertainty fields that are widely used and understood (random and bias) should benefit the user community.

In conjunction with the response to question 2, we went with three *VAU* fields (as stated above for the first alternative: *VAUR*, *VAUB*, and *VAUA*), and three corresponding indicator fields (*IVAUR*, *IVAUB*, and *IVAUA*). The specific configurations for the indicator fields will need to be fleshed out during prototyping, but ideally it would be helpful if possible to agree on a limited controlled vocabulary of uncertainty types/methods to include in the indicator fields (extending e.g. to correlated uncertainties—with respect to platforms, measurement fields etc.—or to other uncertainty types that we have not considered in previous discussions).

2) I think you need an indicator for each of *VAUR/B/I* and that it has to allow for more than 0-9. For example you could imagine having different random uncertainties for each different measurement method (bucket, eri, hull, etc) and then also want to indicate how the measurement method was determined (GTS code, delayed mode, Pub. 47, estimated from country etc.) which could easily lead to many more than 10 combinations, which were differently defined for each of *VAUR/B/I*. The codes would need to be individual to each attachment (i.e. not even every SST adjustment attachment might have the same codes—although consistency would be encouraged where possible).

Agreed: to have an indicator field for each uncertainty field with more than 0-9 options. As now shown in

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, this is suggested to remain a 1-character field stored a base36 number.

Clearly of course not all information about the individual uncertainty values is going to be able to be captured in an indicator field. Much of the details on how the uncertainties were created and how best to use them must be captured in the supporting documentation, referenced by the *ARC*.

3) *ARC*—allow for 2 characters rather than 2 digits?
Agreed: We modified the confirmation of *ARC* (author reference code–*Ivad*), as well as that of the similar fields *ARCE* (author reference code–*Error*) and *ARCT* (author reference code–

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), to two (strictly alphanumeric) characters (thus disallowing symbols). As noted in the relevant tables, this also permits interpretation as base36.

This will cover the possibilities of (i) using characters rather than digits to convey meaning to *ARC* (e.g. BK might mean Berry and Kent, 2011), but also using a larger range of 2-character base36 numbers. Guidance decisions will be needed later, but tentatively we suggest ICOADS/IVAD centrally should probably assign this field (or at least its permanent value) rather than the IVAD providers.

4) Do we need a flag to say which (if any) is the recommended attachment—i.e. the default that would be obtained via the NCAR interface? This could give more information e.g. published and current; published and superseded; unpublished etc.

If we understand correctly this idea seems hard to manage and carries a presumption of recommendation that might not ubiquitously apply to all usage situations. Through the GUI, and of course in the supporting IMMA records, we will offer all *Ivad* attms. We also feel what is recommended is important and could change over time. Originally, we had thought not to seed any check box clicks in the NCAR GUI as a default, but maybe this would be helpful—we would take advice from IVAD expert teams on this. If a flag was set in the data record, in some cases it would need to be changed, e.g. if it was superseded, this would be an additional complicating step when adding new *Ivad* records.

We will continue to consider designing the columns of information in the *ARC* master table to ensure we can capture the status of the reference document.

We note that every *Ivad* attm submitted to ICOADS will be assigned a "date stamp" (*AJDN* in Table C96) for insertion into ICOADS that may be useful to support the expert teams' decisions on recommended adjustments. Also however the procedure to "unpublish" an *VAD* correction is not yet clear, i.e. policies as to when and how *VAD* corrections will be removed from an ICOADS Release.

5) iVAU. Rather than being a combined flag for *VAUR/B/I* this should probably be a link to documentation.

Agreed: As discussed under question 2, a separate indicator has been included for each uncertainty value. Again however much of the documentation for the uncertainty calculations and application will probably need to be separate and linked to via *ARC*.

6) The *VQC* is rather different to the concept of trimming—is there any idea that they might relate in any way? Also I know it's based on the MQCS flags but it might be useful to differentiate between values that "appear to be erroneous" and those that are clearly unphysical.

These are good questions. Table C96a outlines the current approach, but other proposals and refinements, as we progress through prototyping process would be welcome. The ICOADS trimming flag configuration is currently as shown in Table E1, with possible mappings to Table C96a—this illustrates your very accurate observation that *VQC* is rather different to the concept of trimming, since the mapping in Table E1 is not always straightforward or even in some cases resolvable. Table E2 shows a possible alternative approach to Table C96a in configuring *VQC*, based approximately on the proposal made to the IODE-JCOMM ODS process, which could include a value as suggested for “clearly unphysical.”

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0: No QC has been performed on this element

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1: QC has been performed; element appears correct

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3: QC has been performed; element appears doubtful

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4: QC has been performed; element appears erroneous

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(N/A; trimming is essentially univariate, except wind *U*/*V* and derived variables)	2: QC has been performed; element appears inconsistent with other elements
(N/A; trimming does not change data values)	5: The value has been changed as a result of QC

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Table E2. Possible reorganization and expansion of the standardized flag scheme

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to IODE-JCOMM Ocean Data Standards (ODS) (see Annex F, Table F2). This could form an alternative approach to configuring *VQC*.

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Earlier response comments (13 June): VQC is designed to be a wide-open QC field. The vision would allow an IVAD developer to create any type of advanced QC and distill the results down to this short list of QC flags. For example, if someone wanted to create a combined flagging scheme that included input from the MQCS, NCDC, and ICOADS flagging schemes, they could establish a procedure and map their combined flagging approach to the simple flag structure in *VQC*. Any methods and flag mapping would be documented via the *ARC*.
Regarding the difference between "appears to be erroneous" and "clearly unphysical", we could add a separate flag, but note that the majority of the users want less flags, not more. Most users would not differentiate between "appears to be erroneous" and "clearly unphysical". Most users would only used data flagged as 0, 1, or 5 in the

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scheme, and some only those data labeled 1. For example, in the SAMOS QC, we conduct a range check for physical limits and flag data as "erroneous" just by visual inspection. We would map both these flags into 4 because the data should not be used. Whether or not we placed the former into a separate "clearly unphysical" flag would no change the "do not use" recommendation. The only reason to include a flag that states the data "are incorrect" vs. "appears to be erroneous" would be if we believe a user would treat these flags differently.

7) Regarding implementation. The 2 methods described (extending the IMMA line or linked attachments) both have their attractions. We discussed this issue and felt that the linked method probably provides the flexibility that we believe is needed. It also has practical attractions - you don't have to download the whole of ICOADS again just to get a new adjustment. It also allows researchers to use the same methodology to exchange information for testing etc. taking advantage of the software IVAD provides or adapting it if something slightly different is needed for a particular application.

Agreed: the IMMA1 design and modifications to the rdimma1 software are progressing in that direction.

8) If the field is linked rather than attached to the record then that might be a reason to provide the adjustment in VAD rather than the value.

At this stage, we propose sticking with the existing plan to include only the final adjusted value in the *Ivad* attm. Resources at this time do not allow us to consider all the ramifications of changing to include just the adjustment value. As one consideration, the adjustment values might be positive or negative, which may not fit with the tightly controlled range of the final adjusted data values, in that the control information for adjusted field characteristics might then no longer be strictly inherited from *ICN* & *FN*.

Annex F: QC Flag Discussion: Oceanographic and Marine Meteorological Quality Control Schemes; and Proposal to Adopt a Common Value-Added QC (*VQC*) Flag

Background

This Annex briefly reviews a variety of quality control (QC) flag schemes currently available from various oceanographic and marine meteorological datasets, building on the previous work of DMPA (2008), which reviewed two QC flag schemes currently used within ICOADS processing: (i) NOAA National Climatic Data Center Quality Control (NCDC-QC) and (ii) "trimming." DMPA (2008) also reviewed three selected flag schemes external to ICOADS: (iii) the JCOMM Minimum Quality Control Standard (MQCS), (iv) Shipboard Automated Meteorological and Oceanographic System (SAMOS), and (v) Global Ocean Surface Underway Data (GOSUD).

This Annex also discusses published work comparing a wide range of existing QC flag schemes, together with a recent IODE-JCOMM Ocean Data Standards (ODS) proposal for a standardized quality flag (QF) scheme. QF schemes managed by the following projects were among those reviewed for this Annex: (a) OceanSITES (2010); (b) MQCS-6 (JCOMM 2009); (c) NOAA National Data Buoy Center (NDBC) buoy and C-MAN (NDBC 2009); (d) SeaDataNet (2009); (e) Global Temperature-Salinity Profile Programme (IOC 2010); and (f) Integrated Science Data Management (ISDM) Drifting Buoys (ref. *TBD*). The Annex concludes with discussion of our recommendation for setting the Value-Added QC (*VQC*) flag in the *Ivad* attm.

Reviewing these and other QF schemes, the following conclusions by Reiner Schlitzer (http://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxnZWJpY2h3aWtpfGd4OjdhMDljMGI5NjdlMjUwNDI&pli=1) are apparent

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Too many QC schemes currently exist
Ranging from simple to very detailed
Many schemes have flags that describe data history rather than data quality
Mapping between schemes is sometimes difficult.

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Mapping Between Ocean Dataset QC Flags

Published work comparing existing QC procedural results and QF schemes includes Cummings (2010) and IODE (2010). The Ocean Data View (ODV) group has provided the most comprehensive list of oceanographic QC flag schemes and their current mappings as they are used in the Ocean Data View IV to display original data points or gridded fields based on the original data from multiple and often very different datasets (ODV 2011).[1]

Standardizing Ocean and Marine Meteorological QC Flags

Following recommendations from the First IODE Workshop on Quality Control of Chemical Oceanographic Data Collections (IODE 2010), a formal proposal (Konovalov

[1] ODV (2011) compared QC flag schemes (and mappings between them as implemented in ODV software) for: ODV, GTSPP, ARGO, SEADATANET, ESEAS, WOD, WODSTATION, WOCEBOTTLE, WOCECTD, WOCESAMPLE, Qartod, BODC, PANGAEA, SMHI and OceanSITES.

et al. 2011) was submitted to the IODE-JCOMM Ocean Data Standards (ODS) group outlining a standardized QF scheme for all oceanographic and marine meteorological data.[2]

The following information was extracted from the proposal, outlining a two-level quality flag scheme:

> The first or primary level is composed of five quality codes and their definitions (Table F1). The second level complements the first level by reporting the results of QC tests performed and data processing history (Table F2). For example, if a data user only wants data flagged "good," then this person will only use the primary level. On the other hand, if the user needs information justifying the primary level flags, then the secondary level provides complete information on the quality test applied and their results. In this way the data user can accept or reject any data based on level 1 or make an informed choice based on level 2.
>
> The first level quality flags are limited in their number and restricted to those listed in Table F1. These flags are of increasing numerical value in line with the decreasing quality of data providing an easy analysis and filtering of data in a database or joining of data from different databases. The reason for a specific quality flag for a data point is justified by the results of applied quality tests, with details proclaimed at the second level. While different tests can be applied and qualified as required, the critical and non-critical tests for data sets of different nature and origin and information on the tests and their results is completely preserved at the second level. The added level of detail enables clear justification of the nature and reason of the primary quality flags.
>
> The second level quality flags are variable in their quantity and quality summarizing information on the applied quality tests (e.g., excessive spike check, regional data range check, etc.) and data processing history (e.g., interpolated values, corrected value, etc.). This scale makes it possible to join the gained experience and information from established programs and projects (e.g., Argo, GTSPP, OceanSites, Qartod, SeaDataNet, IMOS, MMI, WOD, etc.) and provides a possibility for additional currently unforeseen second level quality tests and procedures.

Table F1. Primary-level quality flag codes and definitions. Any quality control tests must be well documented in the metadata that accompany the data.

Code	Primary level flag's short name	Definition
1	Good	passed documented required QC tests
2	Not evaluated, not available or unknown	used for data when no QC test performed or the information on quality is not available
3	Questionable/suspect	failed non-critical documented metric or subjective test(s)
4	Bad	failed critical documented QC test(s) or as assigned by the data producer
9	Missing data	used as placeholder when data are missing

[2] Update note: subsequent to the drafting of this Annex, the proposal to the IODE-JCOMM Ocean Data Standards (ODS) group was accepted and published, see: http://www.iode.org/index.php?option=com_oe&task=viewDocumentRecord&docID=10762

Table F2. Examples of secondary-level codes and descriptions. All objective (i.e., reproducible, numerical metric tests) or subjective (e.g., expert review) tests should be well documented, including peer-reviewed or authoritative reference sources as part of the metadata that accompanies the data.

Code	*Quality control test and data processing history*
01	regional data range check
02	excessive gradient check
03	excessive spike check
04	excessive offset/bias when compared to a reference data set
05	excessive data uncertainty
06	unexpected X/Y ratio (e.g., chemical stoichiometry or property-property X to T, S, density, among others)
07	excessive spatial pattern check ("bullseyes")
...	…
20	below detection limit of method
21	interpolated value (not measured)
22	data offset corrected value relative to a reference data
23	expert review
Etc. ...	…

Assuming the proposal is eventually adopted, how this scheme might be mandated and implemented across various data producers is still under debate and the transition may not be easy and straightforward. However, the following are listed in Konovalov et al. (2010) as advantages for adopting this scheme:

Small and fixed number of unambiguous flags at the primary level;

Primary level code values are numeric and ordered such that increasing quality flag values indicate a decreasing level of quality. This supports the identification of all data that meet a minimum quality level;

The monotonic primary scale facilitates the inheritance of quality flags for derived or calculated variables. For example, when temperature and salinity values are used to calculate density, the density value will inherit the flag of the datum with the lowest quality;

The scheme is universal; it can be applied to all types of data making possible to merge and exchange them;

It enables mapping between quality flags and quality tests;

Existing QF schemes can be mapped to the proposed scheme with no information loss;

Data sets with different QF schemes can be merged into one data set preserving all existing quality flags and making possible to apply new tests and save their result.

Planned QC flag (*VQC*) implementation for IVAD

Within the *Ivad* attm (Table C96), we envision using field *VQC* (Table C96a) as a mechanism for storing externally provided data QC information. Specifically, the provider of QC information would be requested to map their flags to the

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0-9 configuration for *VQC* and describe their method in external documentation as linked via *ARC* (also original QC flags could be stored in the *Suppl* attm together with original data).

For *VQC* the proposed flag scheme (Table C96a) is patterned partly after that used by the Global Collection Centers (GCCs) for the IMMT format, however 6-7 will not coincide with IMMT since those are specific to the GCCs (6-8 may be reserved for future IVAD requirements). The MCQS scheme also essentially matches the current flag scheme being used by the GTSPP group for oceanographic observations, and has some similarities to the aforementioned ODS proposal (see Table F1), as well as to some QC flag configurations defined in the BUFR format (WMO 2011).

While the goals and general advantages as described above for the primary-level QC flag scheme seem very appropriate to pursue, we decided not to use the specifically proposed Table F1 flag scheme. One particular concern we had in Table F1 was with the positioning of value 2 (not evaluated, not available or unknown), between values 1 (good) and 3 (questionable/suspect). Values 1 and 3 (also 4, bad) all imply determination of data quality via a single QC process, and clearly should appear together. In contrast, value 2 indicates that the data were not subject to the QC process, so potentially that value belongs more properly down with 9 (missing data) (see Annex H, Table H2 for a possible alternative). We further note that the IMMA format satisfies through a different approach other general goals of the ODS proposal, including that existing QF schemes can be mapped to the proposed scheme with no information loss—but IMMA does this through the preservation of original input supplementary data (including such flags) rather than a re-mapping of information to new universally defined flags.

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[http://www.oceanobs09.net/proceedings/ac/FCXNL-09A02-1656379-1-AC_4C_cummings.pdf].

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JCOMM, 2009: Minimum Quality Control Standard (MQCS-IV; Version 6). Annex 2 to Recommendation 9 (JCOMM-III) [http://www.wmo.int/pages/prog/amp/mmop/documents/MQCS-VI-JCOMM-III.pdf].

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SeaDataNet, 2009 (?): BODC Vocab Library L201 – SeaDataNet measured qualifier flags.

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[Note: more work is needed in Tables C10a-b to whether original (e.g. N) or edited (e.g. Ne) variables are being referred to; yellow highlighting has been used to flag some changes, or where they may be needed.]

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code the value "-1", rather than "/", was proposed to signify missing information, but blank is the IMMA standard.

ECR *Table C10b*. **Change Codes** for Edited Cloud Reports *{from Table 3 of H99}*

CCe[#]	Case (brief description)	Changes made [need to change to "e" vars?]	Occurrence (%) * Land all obs	Land light obs	Ocean all obs	Ocean light obs
0		none	87.4	87.4	87.2	86.9
1	N=9 with precipitation or fog	N=8; CL=10,11 or CM=10	1.6	1.6	2.6	2.6
2	Nh=0 with CM>0 and CL=0	Nh=N	0.8	0.8	0.5	0.5
3	Nh=N with CH>0 and CL=CM=0	Nh=0	0.1	0.1	0.2	0.2
4	Nh<N where it should be Nh=N	Nh=missing	0.3	0.4	0.6	0.6
5	CL =/ with CM or CH not /	CM,CH=missing	0.1	0.1	0.5	0.5
6	CM or CH miscoded as 0	CM or CH=msg	3.2	3.5	3.7	4.1
7	CM=7,2 for Ns	CM=11,12	3.7	3.5	1.1	1.2
8	CM=/ for Ns	CM=10	2.4	2.2	1.8	1.9
9	CM or CH miscoded as /	CM or CH=0	0.3	0.3	1.8	1.5

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can occur only with CCe=7 or 8).
* Data years 1982-1991.

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Note: Appendix A explains the difference between Subsidiary files and Subsidiary records, and Appendix B discusses the planned assignment to ICOADS of dataset DOIs.

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Table 2. Author Reference Code (*ARC*) Table information, and its relevance to the Main, Subsidiary, and Auxiliary file types.

Author Reference Code (*ARC*) Table (another Dynamic aspect, separately stored?)

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Appendix A: Discussion of Subsidiary files versus Subsidiary records

Excerpt from *Proposed IMMA Revisions* (annotated in yellow):

> *"Switch to multi-record "linked" approach:* Rather than modifying the *Icoads* attm as was originally proposed to include *UID* and associated release-tracking information etc., those fields are placed in a short new *Uida* attm (see Table C98), which appears both in the Main and (any optional) Subsidiary records, linking them all together (see further discussion following Table C8), e.g.:
>
> *Main* IMMA record type: *Core* + *Icoads* + *Immt* + *Mod-qc* + *Meta-vos* + *Uida* + *Suppl*
> *Subsidiary* IMMA record type: *Uida* + *Ivad* + *Ivad* + *Ivad* … + *Ivad*
> *Subsidiary* IMMA record type: *Uida* + *Error* + *Error* + *Error* … + *Error*
>
> Alternatively, information such as ship metadata (*Meta-vos*) attms, or the proposed alternative QC (*Alt-qc*) attms, might be conveyed separately back to ICOADS in a file containing only Subsidiary records [i.e. constituting a Subsidiary file], i.e. to be blended with (or possibly into fields in other attms, in the case of *Alt-qc*) the Main records before provision to users:
>
> *Subsidiary* IMMA record type: *Uida* + *Meta-vos*
> *Subsidiary* IMMA record type: *Uida* + *Alt-qc* + *Alt-qc* + *Alt-qc* … + *Alt-qc*
>
> Such Subsidiary records thus would not be provided directly to users."

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Appendix B: Planned Assignment of Digital Object Identifiers (DOIs)

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In keeping with recent positive standardization developments in this area, NCAR now has the capability to assign dataset DOIs (http://www.doi.org). For ICOADS, we envision that a given Release (e.g. R2.5.1) as offered publicly from NCAR would be assigned a DOI, also including the accompanying (dynamic) NRT preliminary component.

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Thus possibly only the brown data components as indicated in Table 1 would be associated with the DOI (i.e.

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limited to those stored in the IVAD DBMS and also written out periodically from the DBMS to IMMA1 format). DOI assignment carries the responsibility of file-set reproducibility and accurate linkage to citation in publications. Opening access to new IVAD attachments has significant DOI implications, so we plan to handle this in a systematic way. If a DOI change is required, a new file-set will be created from the IVAD.