Legend : reviewer
comment of the authors

Review of manuscript 2023-418 *Internal tides off the Amazon shelf Part I: importance for the structuring of ocean temperature during two contrasted seasons*, by F. Assene et al.

Manuscript reviewed by Clément Vic on 25th August 2023.

This is my second review of the manuscript. The authors brought significant changes to the manuscript as compared to the initial version. They addressed most of my comments favorably. The manuscript has improved, and the science is more clearly presented, although the manuscript contains unnecessarily long (and sometimes not relevant) paragraphs. I think the length of the manuscript (770 lines) could be reduced to ~500 lines while gaining in clarity. Importantly, I still have one major comment regarding how the heat budget is derived – I am confused with some terms. Also, the manuscript would strongly benefit from an in-depth proofreading by someone knowledgeable in English writing. I tried to give some advice on writing, but could not do it thoroughly throughout the whole manuscript.

Major comments

- **Major comment #1**: Regarding section II.3.2, I do not understand how the term ADV is broken down into the terms called ADV* and Non-Linear terms. I would like the authors to clarify the following points:
- The Reynolds decomposition is not explained. I am not sure how the averaging operator is defined. If the decomposition is something like low-frequency signal + tidal signal, how is it computed online?
  The terms were not computed, we were trying to explain the implicit process in advection. That was rewritten (L207)
- In the classic Reynolds decomposition, the terms <U'.grad(T)> and <U.grad(T')> should vanish and one is le_ with the turbulent term <U'.grad(T')>.
- How is the term Numdiff_ADV computed? Is it what is called "residual" (line 238)? Then, I guess it is computed as the residual of equation (6)? Is it a diapycnal or isopycnal term? Then, does it belong to ADV or to ZDF? Lines 594- 597, it is written that the numerical dissipation of the diffusive part of the advective scheme belongs to z-ADV.
  Numdiff_ADV refers to numerical dissipation of the FCT advection scheme (Zalesak, 1979). This part was rewritten for better understanding (L207).

Also, at the end of the manuscript, I did not have a very clear idea of the different contributions from the diffusive and advective terms. I think it would be good to compute the overall contribution of each term, averaged in a box or two boxes, inshore and offshore of the shelf break.
We add at the end of the result a section about heat budget terms contribution (L515).

- **Major comment #2**: Section III.2. There is a strong temperature bias to the northwest, where the NOTIDE simulation performs better than the TIDE simulation – see Figure 1 in the

present document. It should be discussed. Also, Figure 3f, NOTIDE performs better than TIDE for 7 months (March-July and Sept-Oct), which is more than half of the year. Overall, this is not clear that including Ides improves the quality of the simulation.

We agree with the reviewer that the strong bias in tidal simulation is unexpected, but in the former manuscript (FM) and in the present revised manuscript (RM, L279) we added references to other studies in the same region that includes the same bias. In fact, this bias is not unusual.

- Major comment #3: The manuscript would strongly benefit from lightening. Make sure that all statements are backed up either by a Figure or a reference, and avoid speculative and confusing statements. I think some of the discussion could be moved to the result section. For example, the discussion on mode-1 wavelength related to dissipation hotspots (L. 517).

We agree with the reviewer. Many part of the manuscript has been rewritten, including discussion sections. But we kept discussion about mode-1 as is, since we don't find how to merge with result sections, and we think it is better for readability to discuss it in a separate section.

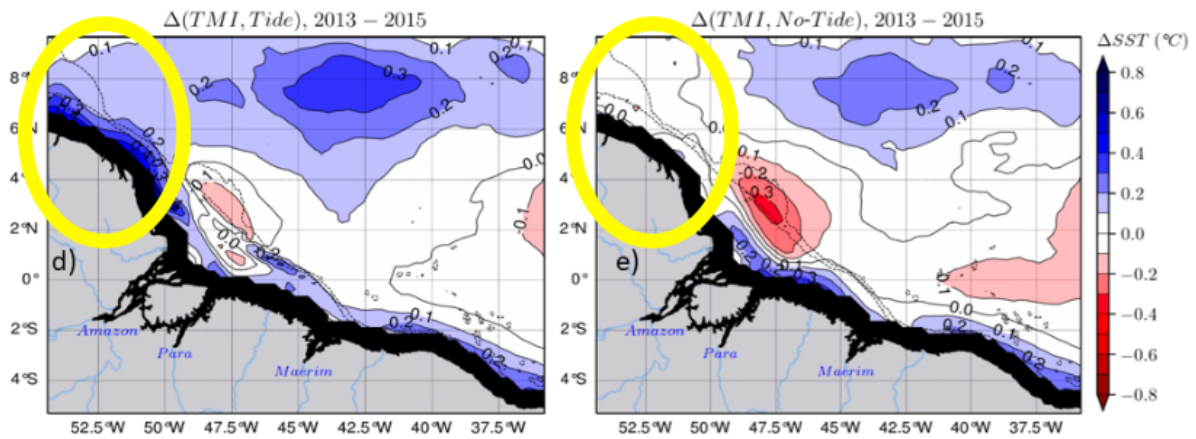



Figure 1: Partial screenshot of Figure 2 in the manuscript. Within the area circled in yellow, the NOTIDE simulation has a smaller bias than the TIDE simulation.

Minor comments

- L. 15: Use "baroclinic and barotropic" or "internal and external" but try not to mix
them together. This has been fixed L15 and 26
- L. 16: contrasting → contrasted corrected L16
- L. 17: Twinned → Twin corrected L18
- L. 19: thaw ? You mean warm ? corrected L20
- L. 20: avoid using "could" or "may" etc. when the conclusion is clear-cut. corrected L21 and elsewhere
- L. 27: remove "horizontal propagation" removed L27
- L. 29: we found THAT corrected L29
- L. 32: what are the first and second seasons? corrected L16 and 31
- L. 38: The sentence reads bizarrely. Temperature (per se) is not a mechanism, so I am not sure one can say that it plays a role in ocean dynamics. corrected L38
- L. 55: remove "also called internal tidal/gravity waves" and "may" corrected L52
- L. 57: remove "The precise location of this dissipation is a big unknown" as I do not think this is true anymore. Many efforts have been carried out in recent years to narrow down

uncertainties and map tidal energy dissipation (Kunze 2017, MacKinnon et al. 2017, de Lavergne et al. 2019, 2020, etc.) the sentence has been removed

- L. 62: "encounter others" you refer to wave-wave interactions? corrected L60

- L. 64-71: The links between ISW, linear and non-linear waves are unclear. Also, I do not think that all the information is relevant to the paragraph. For example, the phase locking of ISW with IT troughs brings confusion. Also, that ITs advect water masses along their propagation is very surprising to me. Do you have a reference to back this up? If so, it needs to be developed as this is quite an unusual mechanism (most of the Time, as far as I know, internal waves are close to linear and do not perform any Advection). If not, please remove. We agree with the reviewer, the sentence has been removed and the paragraph rewritten L52

- I would move the paragraph from L. 103 to L. 112 to L.72 as it describes some mechanisms regulating temperature variability and would be logically articulated towards the beginning of the introduction. We agree with the reviewer L62

- L. 83: typo retroflection corrected L81

- L. 87: "possesses"? Features? corrected L87

- L. 93: Sentence lacks a verb. corrected L92

- L. 96: I do not see why incoherent / non-stationary ITs are brought in here. The rest of the paragraph (L. 97-102) is not related to the present study, it should be deleted. We agree with the reviewer, this part haw been rewritten L95

- L. 114: enters. Runs? We agree with the reviewer L98

- L. 125: the previous questions are not explicitly written. It would be good to repeat them explicitly in this paragraph. We agree with the reviewer, the questions have been rewritten for readability L102

- L. 135: remove "used" removed L119

- L. 136: IS derived? Added L119

- L. 140: I do not think acronym RSS is used later; it should be removed. Removed L122

- L. 152: remove "can" removed L135

- L. 153: remove sentence starting with "Unlike…" removed L136

- L. 164: "the vertical diffusion coefficient" → vertical diffusion (it parameterizes the Vertical diffusion through a coefficient) corrected L146

- L. 170 and 174: move hip to references? We agree with the reviewer, we moved to data availability statements L668

- L. 177: (i) and (ii) are confusing. You mean that SSH and U, V are prescribed? Corrected L157

- L. 182: "derived"? Through thermal wind balance? The baroclinic currents are derived from barotropic using thermal wind balance

- L. 184: "3-years" → three-year (no s as this is an adjective) corrected L163

- L. 185: remove "of run" removed L164

- L. 186: remove "the" before Ides removed L165

- L. 188: remove "used in this study" The sentence has been removed

- L. 188: what is the "current's circulation"? we wanted to refers "circulation". The sentence has been removed

- L. 193 and 194: what are "vertical propagation modes"? I think you refer simply to vertical modes. removed L170

- L. 194: "harmonic" → tidal frequency? corrected L171

- L. 196: remove sentence starting with "Even…" removed L172

- L. 200: remove "as a first order approximation" removed L176

- L. 210: I do not understand "the energy loss of other tidal harmonics". This was a mistake, the sentence has been rewritten L186

- Eq. (3)-(5): what are the asterisks referring to? This has been rewritten

- L. 221: remove "and emphasizes the pathway of the respective Ides (external or internal)" This has been rewritten L195

- L. 230: "velocities component" → velocity components corrected L203

- L. 252: "advection diffusion"? Please clarify This was a mistake, the paragraph has been rewritten L203

- L. 252: typo expect corrected L211

- L. 258: Why is FOR_z not shown? Is it negligible? FOR_z is not negligible, but in this study we focus only on ocean processes (advection and discussion)

- L. 262: remove "model's" removed L219

- L. 265: remove "for the period" removed L222

- L. 267: remove "at" removed L224

- L. 268: amplitude and phase are not shown in Fig. 2. Please make sure that the figures are adequately referred to. The amplitude (color shading) and phase (solid contours) are hown in figure 2a and 2b, and this is explained in the figure caption, and now in RM L225

- L. 270-272: show maps with relative differences? This bias is close to Ruault et al. (2020) bias, then is 'usual' for this region. Moreover, we don't think that adding that figure will be useful for the manuscript, since we are trying to go straight to the main goal of the study.

- L. 278: Is it really the Mid-AtlanIc Ridge? To me, this is still the Brazil Basin… Maybe show deep (4000 m? 5000 m?) contours of bathymetry. In fact, this is the mid-Atlantic ridge, as we verified from Google Earth. But the sentence has been rewritten L236

- L. 279: "It is worth noting…" this is not investigated in the study and should be removed. Also, L. 282, I am not sure that comparing NEMO and FES only through their resolution is relevant as they are very different models, resolving different sets of equations. This has heen rewritten L 237

- L. 284: "later"? removed L241

- L. 288: "flows" → propagates corrected L245

- L. 296: remove "once generated". Also, importantly, I am not sure if there is a straightforward link between slope criticality and the direction of propagation. If you do not have a reference for this statement, please remove. This has heen removed L247

- L. 302: "for the" → over corrected L251

- L. 302: remove "can" removed L252

- L. 304: is q shown anywhere? Does it bring any piece of information relevant to the study? The sentence has been removed

- L. 309: "extensive" → important? corrected L256

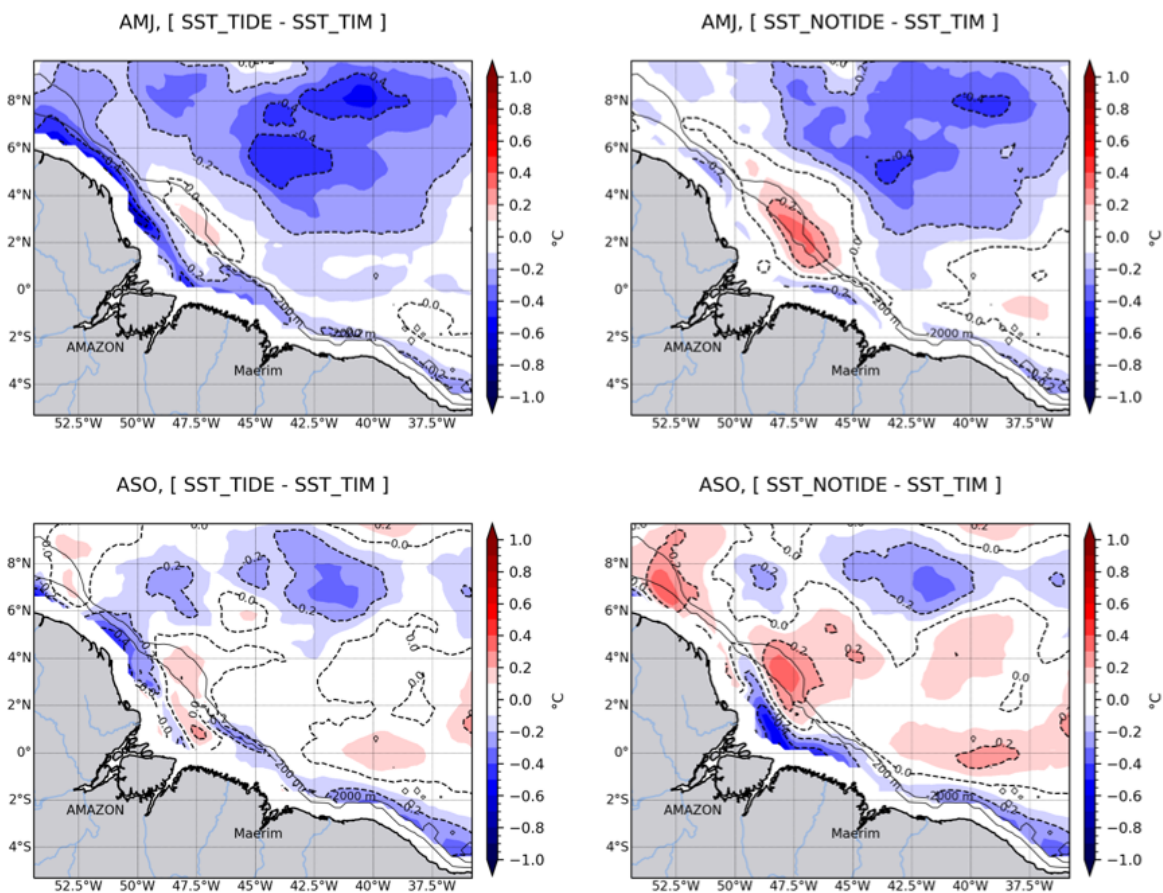
- L. 311: "extensive" → pronounced? corrected L258

- Fig 2g: there are horizontal stripes on the shelf. I guess they come from the graphic treatment of the data that are likely missing shoreward of a given distance. This area should be masked. corrected in RM

- L. 322: As far as I understand, the Reynolds decomposition gives you the coherent part of the M2 tide? If so, it should be explicitly written. The harmonic analysis we performed only give the coherent part. The incoherent is unknown. The paragraph has been removed L 267

- L. 324: "neglectable" → negligible. The paragraph has been removed L 267

- L. 325: I do not see any logical link ("which means") between seasonality and the Cumulative effect of coherent and incoherent tidal harmonics. The paragraph has been removed L 267

- L. 329: remove "it should be noted" removed L269
- L. 330: "into" → onto corrected L271
- L. 339: TIM → TMI corrected L278
- L. 342: remove "corresponding" removed L282
- L. 355: remove "hereabove and elsewhere" removed L295
- L. 357 and elsewhere: remove "(black line)" (etc.) as this belongs to the figure caption. removed
- L. 362: "eroded"? corrected L298
- L. 362: "petty" → small corrected L299
- L. 367: "heat" → heat exchange? corrected L304
- Figure 4: could you show the difference between seasonal TMI data and model data? This has been done. We do not find it to be relevant for the manuscript.
I find difficult to follow the discussion in section IV.1. The paragraph has been rewritten L318

- L. 381: I do not understand the link between ldes and a speculative upwelling. The paragraph has been rewritten L318
- L. 403: I am not expert in air-sea interactions, but is it really unexpected that a negative SST anomaly induces a positive Qt anomaly? In fact, they are inversely correlated, and this is what we obtained.
- L. 406: remove sentence starting with "As it…" removed L341
- Figure 5e: "corr coef" is R? Is it worth showing R^2 then? R^2 is the significance of the correlation coefficient.
- L. 442: remove sentence starting with "Note that…" removed L377

- Section IV.3. is quite descriptive and lacks some kind of dynamical interpretation. We do not add dynamical interpretation, since we try to do so in the next section with heat budget terms.

- L. 460: remove "therefore" removed L394

- L. 475: remove "Stratification" removed L407

- L. 476: "isodensities" -> isopycnal layers? corrected L408

- L. 478: remove "the isodensities are thicker…" and "As a result of this" corrected L411

- L. 482: "ITs and likely the barotropic Ides" should be referred to jointly as "Ides" as the analysis does not allow separating them. corrected L415

- Figure 8 and associated discussion. Why showing only the 2-20m contribution? I think that internal Ides do not formally exist in homogeneous mixed layers and will break preferentially where N2 is large (see references in de Lavergne et al. 2020). It would be more relevant to show the variables integrated over larger depths, maybe down to the thermocline. In fact, IT break down of MLD, but the induced-mixing expands in the mixed-layer, as we see along IT pathways for 2-20 mean.

- L. 505: remove "Whatever" removed L438

- L. 509: "inverted"? corrected L441

- L. 512: "extension" → extent? corrected L444

- L. 534: remove "waves" removed L464

- L. 561-562: this is not obvious, and the overall view on the temperature budget would benefit from showing integrated values in boxes (see Major Comment #1). We added this L514

- L. 572: I do not see a clear link between a tidal residual mean transport and a cooling/warming effect. The sentence has been rewritten L497

- L. 590: I do not understand the last sentence of the paragraph. removed L511

- L. 595: "nonlinear effect between the temperature and the currents" are you referring to IT breaking? Yes, among others. But the sentence has been rewritten L485

- L. 600: "velocity of the (mode-1) internal tidal waves is maximum in the thermocline"? I do not think so, the vertical group speed is maximum where the stratification is weak. We agree with the reviewer, this was a bad mistake. We rewrite the sentence L485

- L. 601: "working harder"? Idem

- L. 629: ISW and mixing. This is a bit speculative and not properly addressed in the study. Please remove. The paragraph has been rewritten L551

- L. 704: remove sentence "This hits the …" This paragraph has been removed.

References

de Lavergne, C., Falahat, S., Madec, G., Roquet, F., Nycander, J., & Vic, C. (2019). Toward global maps of internal Ide energy sinks. Ocean Modelling, 137, 52-75.

de Lavergne, C., Vic, C., Madec, G., Roquet, F., Waterhouse, A. F., Whalen, C. B., ... & Hibiya, T. (2020). A parameterizaLon of local and remote Idal mixing. Journal of Advances in Modeling Earth Systems, 12(5), e2020MS002065.

Kunze, E. (2017). Internal-wave-driven mixing: Global geography and budgets. Journal of Physical Oceanography, 47(6), 1325-1345.

MacKinnon, J. A., Zhao, Z., Whalen, C. B., Waterhouse, A. F., Trossman, D. S., Sun, O. M., ... & Alford, M. H. (2017). Climate process team on internal wave–driven ocean mixing. Bulletin of the American Meteorological Society, 98(11), 2429-2454.

Ruault, V., Jouanno, J., Durand, F., Chanut, J., Benshila, R., 2020. Role of the Tide on the Structure of the Amazon Plume: A Numerical Modeling Approach. J. Geophys. Res. Oceans 125, e2019JC015495. https://doi.org/10.1029/2019JC015495

Answers to Reviewer 2 [Nicolas Grisouard]

RC Lx : reviewer comment line x
RM Lx: revised manuscript line x

RC L16 ⇒ corrected in the RM L16
RC L19 ⇒ corrected in the RM L20
RC L23 ⇒ corrected in the RM L24
RC L24 ⇒ corrected in the RM L25
RC L25 ⇒ The sentence has been removed in the RM
RC L30 ⇒ corrected in the RM L29
RC L33 ⇒ corrected in the RM L32
RC L37 ⇒ corrected in the RM L37
RC L44 ⇒ corrected in the RM L42
RC L50 ⇒ corrected in the RM L49
RC L53-55 ⇒ corrected in the RM L52-54
RC L62 ⇒ corrected in the RM L60
RC L64-70 ⇒ This part of the paragraph has been removed in the RM
RC L78 ⇒ corrected in the RM L78
RC L87-88 ⇒ corrected in the RM L87-88
RC L91 ⇒ corrected in the RM L90
RC L94 ⇒ corrected in the RM L94
RC L99 ⇒ This part of the paragraph has been removed in the RM
RC L103 ⇒ corrected in the RM L62
RC L107 ⇒ corrected in the RM L66
RC L108 ⇒ corrected in the RM L67
RC L123 ⇒ This part of the paragraph has been removed in the RM
RC L125 ⇒ corrected in the RM L108
RC L151 ⇒ corrected in the RM L134
RC L170 ⇒ This part of the paragraph has been moved to Data availability Statements section RM L669
RC L192 ⇒ corrected in the RM L169
RC L196 ⇒ This part of the paragraph has been removed in the RM
RC L215 ⇒ RM L190 The authors choose to keep as is because it doesn't prevent the reader from understanding, and this is in line with several previous studies cited in section II.3.1 of the RM
RC L228 ⇒ corrected in the RM L202
RC L235 ⇒ This part of the paragraph has been removed in the RM
RC L250 ⇒ corrected in the RM L209
RC L252 ⇒ corrected in the RM L211
RC L253 ⇒ corrected in the RM L212
RC L259 ⇒ corrected in the RM L214
RC L279 ⇒ corrected in the RM L236

RC L291-294 ⇒ This part of the paragraph has been removed in the RM
RC L302-303 ⇒ corrected in the RM L251-252
RC L315 ⇒ corrected in the RM L261
RC L317 ⇒ corrected in the RM L263
RC L318 ⇒ corrected in the RM L264
RC L324 ⇒ This paragraph has been removed in the RM
RC L339 ⇒ corrected in the RM L278
RC L335 ⇒ This part of the paragraph has been moved to Data availability Statements section RM L669
RC L362-363 ⇒ corrected in the RM L299-300
RC L317-372 ⇒ corrected in the RM L308-309
RC L373-374 ⇒ corrected in the RM L309-310
RC L381 ⇒ corrected in the RM L318
RC L401 ⇒ corrected in the RM L337
RC L406 ⇒ corrected in the RM L342
RC L416 ⇒ corrected in the RM L351
RC L421 ⇒ corrected in the RM L356
RC L430 ⇒ corrected in the RM L361
RC L433 ⇒ corrected in the RM L368
RC L441 ⇒ corrected in the RM L376
RC L460 ⇒ corrected in the RM L394
RC L470 ⇒ corrected in the RM L403
RC L472 ⇒ corrected in the RM L405
RC L476 ⇒ corrected in the RM L408
RC L481 ⇒ corrected in the RM L414
RC L492 ⇒ corrected in the RM L425
RC L504-505 ⇒ corrected in the RM L437-438
RC 521 ⇒ corrected in the RM L453
RC L532 ⇒ corrected in the RM L462
RC L537 ⇒ corrected in the RM L467
RC L539-540 ⇒ This paragraph has been removed in the RM
RC L546 ⇒ The authors felt that this sentence should remain in place in the RM (L473), but in the end, we'll take this suggestion into account in the next revision.
RC L545 ⇒ Unfortunately, the authors mess this relevant suggestion of the reviewer. It should be $3°N–6°N$ instead of $3°N–3°N$. This will be taken into account in the next revision
RC L551 ⇒ corrected in the RM L477
RC L555-556 ⇒ corrected in the RM L481
RC L557 ⇒ corrected in the RM L483
RC L564 ⇒ Unfortunately, the authors mess this relevant suggestion of the reviewer. It should be $3°N–7°N$ instead of $3°N–3°N$. This will be taken into account in the next revision
RC L584 ⇒ corrected in the RM L509
RC L599 ⇒ This paragraph has been removed in the RM
RC L610-611 ⇒ RM L534-535
RC L624 ⇒ corrected in the RM L545
RC L629 ⇒ corrected in the RM L551
RC L632 ⇒ corrected in the RM L556
RC L641 ⇒ corrected in the RM L560

RC L646 ⇒ corrected in the RM L564
RC L651-652 ⇒ corrected in the RM L569-570
RC L656 ⇒ corrected in the RM L574
RC L668 ⇒ corrected in the RM L584
RC L683 ⇒ This sentence has been removed in the RM
RC L685 ⇒ corrected in the RM L598
RC L690 ⇒ corrected in the RM L602
RC L694 ⇒ This sentence has been removed in the RM
RC L715 ⇒ Unfortunately, the authors mess this suggestion, this will be taken into account in the next revision
RC L722 ⇒ corrected in the RM L620
RC L732 ⇒ corrected in the RM L630
RC L750 ⇒ corrected in the RM L647
RC L752 ⇒ corrected in the RM L648
RC L756 ⇒ corrected in the RM L652
RC L760 ⇒ corrected in the RM L656
RC L766 ⇒ corrected in the RM L662
RC L787 ⇒ corrected in the RM L684