THE ANTICLOCKWISE CHECKED VOWEL CHAIN SHIFT IN MODERN RP IN THE TWENTIETH CENTURY: INCREMENTATIONS AND DIAGONAL SHIFTS

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ABSTRACT

This paper presents evidence for a chain shift in the checked vowel sub-system of modern RP over one hundred years, based on LMER analysis of over 10000 vowels from 108 speakers with birthdates from 1883 to 1990. The data confirms previously identified gender-differentiated change in F1 and F2 of TRAP, as well as date-of-birth driven incremental change in F1 of KIT, F1 of STRUT, F2 of FOOT, and, for DRESS, an (F2-(2xF1)) diagonal shift by date of birth that follows TRAP's path. We also present evidence for an active female-driven change in the LOT vowel, an (F2-(2xF1)) diagonal shift towards the close central area of the vowel space. The paper demonstrates differing statistical patterns in these shifts over time, and suggests a possible origin in changes to TRAP early in the 20th century. All data and additional figures for this study are available via OSF.io. on application to the author.

Keywords: modern RP, incrementation, peripherality, checked vowels, chain shift.

1. INTRODUCTION

Internal and external motivations' role in linguistic change remains a much-debated topic in historical linguistics [30, 24, 25, 27]. It is common to find speech patterns indicative of systematic vowel chain shifts in diachronic and apparent time studies in many varieties of English, notably those on the North American continent [28, 26, 5, 7, 14].

While the Great Vowel Shift took place on English soil, and there are many reports of individual vowel shifts in the UK in recent times [e.g.16, 9, 3, 39, 15], reports of present-day ongoing systematic chain shifts are rarer. One example is [37]'s findings of an anti-clockwise chain shift of the checked vowels in speakers born and bred in Ashford, Kent. The authors claim these vowel changes have diffused from London, along with population movements after WWII. The Ashford chain shift's endpoints were mirrored in results from Reading, Berks. (west of London), albeit by different historical paths.

The present paper provides new collective evidence of a similar, but not identical, coordinated anticlockwise short vowel shift over the course of the 20th century for KIT, FOOT, DRESS, TRAP, STRUT, LOT, and FOOT in modern RP, an elite sociolect of the British Isles. The paper presents a set of linear mixed-effects regression models, using formant data from 108 speakers with birthdates spanning from 1883 to 1990. This is a combination of previously published formant sets and automatically extracted forced-aligned data. All speakers were attendees of independent and public schools during adolescence. This social criterion, independent of phonological or phonetic criteria, is important for establishing a consistent sample [11].

In section 6, we speculate that this anti-clockwise chain shift may have been instigated by a change in the *peripherality* of TRAP which took place in RP early in the 20th century, where the previously identified lowering and backing of that vowel [42] now fits into a more systematic chain shift. Changing peripherality in the lower vowel space is already familiar from sociolinguistic studies of N. Am. English [24].

2. PREVIOUS RESEARCH

Daniel Jones in succeeding editions of his descriptive works [21] speculated on vowel change in modern RP. Wells [41] includes remarks on younger and older, or more conservative forms of RP TRAP and other vowels. [3, 19] were early acoustic studies investigating variation and change across RP vowel systems; see also [16, 17, 9, 10, 43].

[9, 10] identified diachronic changes in the configuration of TRAP-STRUT and LOT-FOOT in modern RP, although the data did not enable conclusive determination of the independent movements that contributed to the *TRAP-STRUT rotation*, or the pattern of FOOT and LOT, whether by FOOT-fronting alone or in combination with LOT-raising. Changes in KIT and DRESS in modern RP have not been reported previously, although [37] reports changes in (non-RP) Kent data (fronting of KIT, diagonal lowering of DRESS).

[17] reports on apparent and incipient changes ('break groups') in DRESS, FOOT, and TRAP, and tentatively STRUT, although, as they admit, the evidence is less clear in their male-only corpus. [43] finds evidence of LOT raising in comparisons between

[17]'s speakers born in or before 1951, and younger speakers born since 1976. [43] thus claims that LOT, alongside shifts in TRAP and FOOT "can be seen as taking part in a systematic anticlockwise shift of RP vowels" (2013:45).

3. THE DATA CORPUS

The present corpus comprises previously published and newly collected F1 and F2 measurement data from 108 individual speakers of modern RP, 52 females and 56 males, born between 1883 and 1990. Recordings come from interviews, reading passages, public speeches and laboratory data (citation forms /hVd/ syllables). This represents a range of speech settings, but even the most 'informal' data consists of one-on-one interviews with relative strangers, and is more representative of careful rather than truly casual speech between intimates. These data provide a historical time span that can reveal large overall statistical trends. We treat the data here as sufficiently comparable: the affordances as well as the limitations of an approach on this scale must be borne in mind in looking at the results. Details of the data are as follows:

1. BBC Broadcast speech; 2 male speakers (born 1909 and 1927) from [34], see also [4];
2. Citation forms; 1 dataset, averages from 25 male speakers born before 1945 [40];
3. Citation forms; 20 male speakers, four age groups (1930s to 1980s) [17]
4. BBC Broadcast speech; HM Queen Elizabeth II's Christmas broadcasts over 3 decades, counted here as three speakers [16]
5. Citation forms; 16 female speakers, two age groups (1930s and 1980s)[i]
6. Reading passage data (approx. 5-6 minutes per speaker) from 24 male, 24 female speakers (1960s to 1990).This data comes from sociolinguistic interviews recorded in Cambridge University's sound-treated room in the Phonetics Laboratory in 1997, 1998 and 2008. Recordings were force-aligned using FAVE with a modified BEEP dictionary.[ii] Formants were extracted using online FAVE-extract [35] with the Mahalanobis distance method (May/June 2015). Output was manually transformed to [41] keywords.
7. Interviews (n=16) and speeches (n=2) from online recordings: 9 male and 9 female speakers, located through alumni lists from independent schools in the UK. Born between 1883 and 1960. Good sound quality segments of 6-10 minutes were extracted from publicly available recordings and recorded to .wav using *Audacity*, sampled at 44 kHz. Recordings were analysed semi-automatically (April-May 2018) using FAVE-Extract [35] and MFA [32] via the DARLA web interface [33] and the Vowels R package [22]. Output was manually transformed to [41] keywords.

In all, the corpus encompasses 24690 vowel tokens from as wide a range of the vowel space as was possible in each case; in some published sources only a subset of all possible vowel categories was available.

4. METHODS OF DATA ANALYSIS

4.1. Forced alignment and formant extraction

Forced aligned and automatic vowel formant extraction are becoming more widely used in sociolinguistic studies of phonetic data, a movement which brings sociolinguistics and the natural sciences in closer alignment with the adoption of 'hands-off' methods of data-gathering. The pros and cons of forced aligned data can be expressed as a balancing act between scale and precision [13], since while forced alignment algorithms are efficient, they are not perfect. The present study approaches this issue from a pragmatic perspective, that the combination of forced aligned data and hand-extracted data across the time span provides a corpus-internal quality check, and while some tokens may be 'off' because of alignment errors, against a background of over 10 000 tokens, such errors are not of crucial importance. In addition, internal consistency is promoted by use of the Mahalanobis-distance metric in the extraction algorithm [8].

The analysis of the checked vowel subsystem is based on 10375 checked vowel tokens within the larger set of 24690 tokens. Table 1 shows the Ns of the six vowel categories.

Keyword	N	No. of speakers	Word types
KIT	2861	108	344
DRESS	2520	108	375
TRAP	1722	108	238
STRUT	1845	108	165
LOT	974	108	171
FOOT	453	106*	46
TOTAL	**10375**		

Table 1: Data set for the present study. 56 male and 52 female speakers. * = One male (b. 1910) and one female (b. 1986) speaker lacked FOOT tokens.

4.2. Normalisation

The complete corpus of 24690 vowel tokens was used to normalise the data in a speaker-intrinsic, vowel-extrinsic and formant-intrinsic manner [38], using the

Lobanov z-score normalisation algorithm [31] in the NORM suite [36]. This algorithm currently has best practice status in sociolinguistic variationist research [1, 12, 6], and represents a logical choice given the increasing use of automatic formant extraction.

4.3. Linear mixed effects regression using R

Input data sets of vowel formants (F1, F2) were classified according the factors *speaker, date of birth (DOB), sex* and *word*. *Speaker* and *word* were included in all models as random effects [20]. *Lmer* modelling was performed in the R studio environment using the packages *lme4* [2] and *lmerTest* [23]; the latter with ANOVAs and Satterthwaite's *t*-tests. Each vowel category's two formants were processed in individual runs. Combinations of *gender* and *date of birth* were tested as fixed effects and as possible interactions. Optimum models of the data were determined using ANOVA comparisons. All significant models fulfilled the assumption of homoscedasticity, checked by visual inspection of residual plots, Q-Q plots and histograms of residuals [44].

Following identification of significant effects for F1 and F2 changes for the vowels DRESS, TRAP and LOT, we employed a metric reported in [29]: (F2-(2xF1)) to generate a diagonal measure. For these three vowels, the diagonal measure was then subjected to the same modelling as the independent formants. As the diagonal models proved significant, the results below report findings on DRESS, TRAP and LOT for the diagonal (F2-(2xF1)).

5. RESULTS

5.1. Statistical evidence for the chain shift

Table 2 summarises the statistical details of fixed effects from the regression models described in section 4. Table 3 provides details of ANOVA comparisons to determine an optimal model. Finally, Figure 1 presents a diagram of the significant shifts within the vowel space.

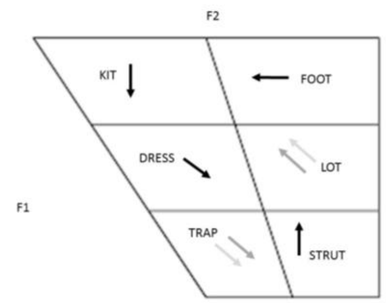
Vowel parameter	Fixed effects	Estimate	Std Error	df	*t*
KIT F1 increase	dob	2.40E-03	6.44E-04	1.48E+02	3.727
DRESS diagonal decrease	dob	-0.017994	0.001982	129.8451	-9.077
TRAP diagonal decrease	gender M	0.288157	0.132687	56.75188	2.172
	dob	-0.015958	0.003317	147.3295	-4.811
STRUT F1 decrease	dob	-0.00717	0.001054	127.8672	-6.802
LOT diagonal increase	genderM	16.312569	7.051025	85.35584	2.314
	dob	0.022323	0.003001	113.1619	7.439
	genderM:dob	-0.008378	0.003592	85.24701	-2.333
FOOT F2 increase	dob	0.005947	0.001486	173.6811	4.001
* all models with speaker and word as random effects					

Table 2: Details of LMER modelling of significant shifts.

ANOVA Comparison to (simpler model*)	df	AIC	BIC	LogLik	Deviance	Chi sq	df	*p*	
KIT F1 (random effects only)	5	2915.4	2945.2	-1452.7	2905.4	12.884	1	0.000331	***
DRESS diagonal (random effects only)	5	7768.4	7797.6	-3879.2	7758.4	63.824	1	1.36E-15	***
TRAP diagonal (dob, random effects)	6	6638.8	6671.5	-3313.4	6626.8	4.5722	1	0.03249	*
STRUT F1 (random effects only)	5	3920.5	3948.1	-1955.3	3910.5	41.367	1	1.26E-10	***
LOT diagonal (gender + dob, random effects)	7	2673.2	2707.3	-1329.6	2659.2	5.1856	1	0.02278	*
FOOT F2 (random effects only)	5	420.36	440.94	-205.18	410.36	14.755	1	0.000122	***
* all models with speaker and word as random effects									

Table 3: Details of LMER modelling

Figure 1: The Anticlockwise Checked Vowel Shift. Black arrows=date of birth (DOB); greyscale arrows =gender +/* DOB. Vertical = F1 only; horizontal = F2 only; diagonal = F2-(2xF1).



5.2. DRESS TRAP LOT diagonal (F2-(2xF1)) shifts

Figures 2, 3 and 4 show diagonal shifts in DRESS, TRAP and LOT as scatterplots by date of birth, and gender where relevant, with linear regression lines added using Excel. Similar plots for KIT, STRUT, FOOT are available via osf.io by application to the author.

Figure 2: Diagonal shift, DRESS by date of birth

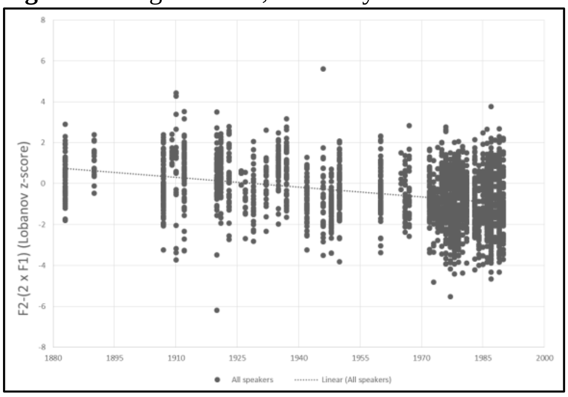


Figure 3: Diagonal shift, TRAP by gender + date of birth

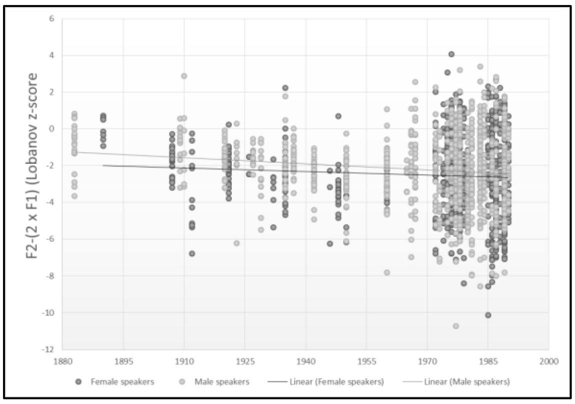
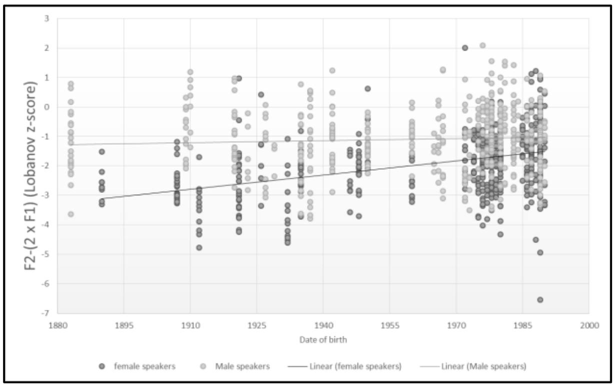


Figure 4: Diagonal shift, LOT by gender * date of birth



6. DISCUSSION

We can see three different types of historical sociolinguistic change here, matching three different significance patterns in the regression models.

6.1. Incrementation (KIT, DRESS, STRUT, FOOT)

The first type of result, encompassing four of the vowels in the sub-system, we call *incrementation*, referring to the gradual increase in KIT F1, FOOT F2, and the gradual decrease in STRUT F1 and the DRESS F2-(2xF1) diagonal. This accords with [26]'s description of the process by which "successive cohorts and generations of children advance the change beyond the level of their caretakers and role models, and *in the same direction over many generations*" (2007: 346, emphasis added). Incrementation is seen most clearly in changes modelled by date of birth only, whether on a single formant parameter (F1 of KIT and STRUT, F2 of FOOT) or on a diagonal (F2-(2xF1) for DRESS).

6.2. Gender + date of birth (TRAP)

In the second type of result, the movements of trap shown here match up well with previous reports of lowering and backing in this vowel [42],[9]. Gender as a fixed effect is also present in this data, and Figure 3 suggests different slopes of change for male and female speakers are indeed present. The diagonal measure gives revealing results here, as we can see a lowering and backing path that is sustained over time, differentiated by gender, but converging towards the youngest birth cohorts, possibly indicating a no-longer dynamic change.

6.3. Gender/date of birth interaction (LOT)

The third pattern is the case of LOT, which is the most innovative result here. Contrary to previous findings in [43], change is found here in *both* F1 and F2, and in the diagonal, conditioned by gender *in interaction* with date of birth. As Figure 4 shows, female speakers show a strong upwards trajectory, while the linear regression line for male speakers is more or less flat. [43]'s data lacks multiple generations of female speakers, which may explain why this effect is not found in that study. The result suggests a third possible sociolinguistic status: an active, gender-driven sociolinguistic change-in-progress of LOT fronting and raising.

6.4. From peripheral to non-peripheral TRAP

It is interesting to speculate on system-internal motivations for this chain shift over 100 years. We put forward the hypothesis here that this change could have been provoked by the shift of TRAP from the peripheral to the non-peripheral system of the vowel space in modern RP. More work on this is needed.

7. CONCLUDING REMARKS

As [29] demonstrates, a time frame of a century allows a better view of these types of long-term changes, in a span of more than three or so living generations. With recent advancements in recording and analysis techniques and the increased availability of heritage recordings, it is now possible to cover longer time-spans with concrete data [18].

8. REFERENCES

[1]Adank, P., Smits, R., van Hout, R. 2004. A comparison of vowel normalization procedures for language variation research. *JASA*. 116(5), 3099–3107.

[2]Bates, D., Maechler, M., Bolker, B., Walker, S. 2015. Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, 67(1), 1–48.

[3]Bauer, L. (1985). Tracing phonetic change in the received pronunciation of British English. *Journal of Phonetics*. 13, 61–81.

[4]Deterding, D. (1997). The formants of monophthong vowels in Standard Southern British English pronunciation. *JIPA*, 27, 47–55.

[5]Dinkin, A. J. 2009. *Dialect Boundaries and Phonological Change in Upstate New York*. PhD dissertation, U. Penn. https://repository.upenn.edu/edissertations/79/

[6]Dinkin, A. J. 2018. Revisiting the Inland North Fringe. Paper presented at *NWAV 47*, New York.

[7]Durian, D. 2012. *A New Perspective on Vowel Variation across the 19th and 20th Centuries in Columbus, OH*. (Electronic Thesis/Dissertation). Retrieved from https://etd.ohiolink.edu/

[8]Evanini, K. 2009. *The permeability of dialect boundaries: a case study of the region surrounding Erie, Pennsylvania*. Publicly Accessible Penn Dissertations 86. https://repository.upenn.edu/edissertations/86

[9]Fabricius, A. H. 2007. Variation and Change in the Trap and Strut Vowels of RP: A Real Time Comparison of Five Acoustic Data Sets. *JIPA*, 37(03), 293–320.

[10]Fabricius, A. H. 2008. Using Angle calculations to demonstrate vowel shifts: A diachronic investigation of the short vowel system in 20th Century RP (UK). *Acta Ling. Hafn.* 40, 1: 7–21.

[11]Fabricius, A. H. 2018. Social Change, Linguistic Change and Sociolinguistic Change in Received Pronunciation. In Braber, N., Jansen, S. (eds), *Sociolinguistics in England*. 35–66. London: Palgrave Macmillan.

[12]Fabricius, A. H., Watt, D., Johnson, D. E. 2009. A Comparison of Three Speaker-Intrinsic Vowel Formant Frequency Normalization Algorithms for Sociophonetics. *Lg. Var. & Change*, 21(03), 413–435.

[13]Fromont R., Watson K. (2016) Factors influencing automatic segmental alignment of sociophonetic corpora. *Corpora* 11(3): 401–431.

[14]Fruehwald, J. 2013. *The Phonological Influence on Phonetic Change*. PhD dissertation, U.Penn. https://jofrhwld.github.io/papers/master2.pdf (Accessed 23.11.18)

[15]Haddican, B., Foulkes, P., Hughes, V., Richards, H. (2013). Interaction of social and linguistic constraints on two vowel changes in northern England. *Lg.Var. & Change*, 25(03), 371–403.

[16]Harrington, J., Palethorpe, S., Watson, C. (2000). Monophthongal vowel changes in Received Pronunciation: An acoustic analysis of the Queen's Christmas broadcasts. *JIPA* 30(1-2), 63–78.

[17]Hawkins, S., Midgley, J. 2005. Formant frequencies of RP monophthongs in four age groups of speakers. *JIPA* 35, 2: 183–199.

[18]Hickey, R. (ed). 2017. *Listening to the Past: Audio records of Accents of English*. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781107279865

[19]Henton, C. G.1982. Changes in the vowels of Received Pronunciation. *Journal of Phonetics*, 11, 353– 71.

[20]Johnson, D. E. 2009. Getting off the GoldVarb Standard: Introducing Rbrul for Mixed-Effects Variable Rule Analysis. *Lg and Ling. Compass*, 3(1), 359–383.

[21]Jones, D. 1932. *An Outline of English Phonetics, 3rd edition*. Leipzig: Teubner.

[22]Kendall, T., Thomas, E.R. 2010. *Vowels: vowel manipulation, normalization, and plotting in R.* cran.r-project.org/web/packages/vowels/index.html.

[23]Kuznetsova A., Brockhoff P.B., Christensen R.H.B. 2017. "lmerTest Package: Tests in Linear Mixed Effects Models." *Jnl of Statistical Software* 82(13), 1–26.URL: http://doi.org/10.18637/jss.v082.i13

[24]Labov, W. 1994. *Principles of Linguistic Change, volume 1: Internal factors*. Oxford: Blackwell.

[25]Labov, W. 2001. *Principles of Linguistic Change, volume 2: Social factors*. Oxford: Blackwell.

[26]Labov, W. 2007. Transmission and diffusion. *Lg* 83: 344–387.

[27]Labov, W. 2010. *Principles of Linguistic Change, volume 3: Cognitive and Cultural factors*. Oxford: Wiley-Blackwell.

[28]Labov, W., Ash, S., Boberg, C. 2006. *Atlas of North American English: Phonology and Phonetics*. Berlin: Mouton/de Gruyter.

[29]Labov, W., Rosenfelder, I., Fruehwald, J. 2013. One hundred years of sound change in Philadelphia: Linear incrementation, reversal, and reanalysis. *Lg* 89(1):30–65. doi:10.1353/lan.2013.0015.

[30]Lass, R. 1997. *Historical Linguistics and Language Change.* Cambridge UK: Cambridge University Press.

[31]Lobanov, B. M. 1971. Classification of Russian vowels spoken by different listeners. *JASA* 49:606–08.

[32]McAuliffe, M. Socolof, M., Mihuc, S., Wagner, M., Sonderegger, M. 2017. Montreal Forced Aligner: trainable text-speech alignment using Kaldi. In *Proc. 18th Conf. of the International Speech Comm. Assoc*.

[33]Reddy, S., Stanford, J. 2015. A Web Application for Automated Dialect Analysis. In *Proceedings of NAACL-HLT 2015*.

[34]Roach, P., Knowles, G., Varadi, T., Arnfield, S. 1993. MARSEC: a machine readable spoken English corpus. *JIPA*. 23: 47–55.

[35]Rosenfelder, I., Fruehwald, J., Evanini, K., Seyfarth, S., Gorman, K., Prichard, H., Yuan, J. 2015. FAVE (Forced Alignment and Vowel Extraction) 1.2.2. Zenodo. Available at: http://doi.org/10.5281/zenodo.9846.

[36]Thomas, E. R., Kendall, T. 2007. NORM: The vowel normalization and plotting suite. Online Resource. lvc.uoregon.edu/norm/index.php

[37]Torgersen, E., Kerswill, P. (2004). Internal and external motivation in phonetic change: Dialect levelling outcomes for an English vowel shift. *Journal of Sociolinguistics*, 8(1), 23–53.

[38]Watt, D., Fabricius, A.H., Kendall, T. 2011. More on vowels: Plotting and normalization. In di Paolo, M., Yaeger-Dror, M. (eds.), *Sociophonetics: A Student's Guide*. London: Routledge, 107–118.

[39]Watt, D., Tillotson, J. 2001. A spectrographic analysis of vowel fronting in Bradford English. *English World Wide*, 22, 2: 269–303.

[40]Wells, J. C. 1962. *A Study of the Formants of the Pure Vowels of British English*. MA thesis, Univ. of London.

[41]Wells, J. C. 1982. *Accents of English. Vol. 2*. Cambridge: Cambridge University Press.

[42]Wells, J. C. 2002. *Whatever happened to Received Pronunciation?* https://www.phon.ucl.ac.uk/home/wells/rphappened.htm (Accessed 23.11.18)

[43]Wikström, J. (2013). An acoustic study of the RP English LOT and THOUGHT vowels. *JIPA* 43,1: 37–47.

[44]Winter, B. (2013). *Linear models and linear mixed effects models in R with linguistic applications*. arXiv:1308.5499. [http://arxiv.org/pdf/1308.5499.pdf]

[i] Kindly provided by C. Moreiras and B. Evans.

[ii] Kindly provided by L. Mackenzie.