19. COMMISSION DE LA VARIATION DES LATITUDES

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A. REPORT OF THE DIRECTOR OF THE CENTRAL BUREAU FROM 1938 TO THE END OF 1947

When, in May 1922 after the First World War, the I.A.U. and the I.G.G.U. met for the first time it was decided that the systematic study of the motion of the pole should be continued. This study had been commenced over 23 years earlier by the International Geodetical Association and had been continued without interruption during the war, thanks to the keenness of the observers and the work of the Swiss and Dutch geodesists and astronomers, who had undertaken to maintain the necessary contacts between the observing stations and the Potsdam Central Office. The Second World War, which broke out barely two decades later, had more serious consequences for this study. The generous and worthy offer of our Swiss colleagues to be intermediaries between the belligerent countries and to help in the exchange of data between the observing stations and the Central Bureau passed unheeded. The Italian Foreign Minister at the time refused to allow the observing books to be transmitted. We had hoped that, when hostilities were over and communications had been re-established, we should be able to obtain, although late, the complete series of observations. But, unfortunately, the war proved to have had serious consequences for our work. The station of Carloforte, after having had its observing activity increasingly hampered, was compelled, in the face of increasing danger, to dismantle the instruments and suspend all activity in the spring of 1943. From Batavia came the even more sad news of the complete destruction of the station. During 1940 the Adelaide Observatory had to suspend its activities. So, of the eight stations on which the latitude service was based in 1940, and which were giving yearly about 11,000 values for the latitude, three were missing, two of which were amongst the most active, while for other reasons the work of some of the other stations was more or less seriously hampered at various times. We also lament the loss of some of our best supporters who, directly or indirectly, had greatly helped our work and whose loss leaves a gap which cannot be filled. It will suffice to recall the names of Kimura, Schlesinger, Aguilar, Schumann, Bianchi, Yamasaki, Kawasaki, to realize what a gap has been caused in these recent years in the small circle of students of this problem; this gap will be particularly felt by the writer, who was fortunate in having, from his early years, the above-mentioned astronomers as colleagues. I should like to pay tribute to their memory.

It would not be right if, at this point, after having recalled the sad part, I did not mention the valuable help received from the Allied Military Government, which made it possible to re-establish relations with the President of the Commission, Sir H. Spencer Jones and the Vice-President of the I.G.G.U., Dr W. Lambert, and to obtain not only the observation books from the stations but also financial help to enable us to continue our work and to fill the gap in our knowledge of the motion of the pole caused by the delay in the receipt of the observations since 1940. We are also very grateful to the American, Colonel Washburn, who, as a head of the liaison office between M.A.G. in Rome and the Ministry of Education, managed to arrange that the work at our station of Carloforte should be started again.

To all those who helped us and co-operated with us, and especially to the three above-mentioned, I express my warm and heart-felt thanks.

I. *Observational Work at the Stations of the International Latitude Service*

Since January 1938, the date which ended my last report presented to the I.A.U. at Stockholm in August 1938, the following observers have taken duties in the international latitude stations:

At Mizusawa:

M. Yamasaki and S. Kawasaki until the end of 1942.
Tadahiko Hattori, from January 1943 to May 1944 and then from October 1944 to date.
Shigetsugu Takagi, from January 1943 to September 1944.
Tetsuro Ikeda, from June 1944 to date, acting director of the station.
Susumu Goto in August and September 1944.

At Kitab:

L. Schtschirgezky from the beginning to end of 1941.
W. Obraszow from the beginning of 1940 to the end of 1941.
E. Schaposhnikowa from the beginning of 1942 to the period of the last observation book received (March 1946).
M. Korotaeva from May 1942 to March 1946.
G. Lange intermittently from the beginning of 1944.

At Carloforte:

G. Righini from the beginning of the period until December 1939.
M. Mattana from the beginning of the period until June 1941.
T. Nicolini from July to October 1941 and June to October 1946.
A. Colacevich from January to the end of April 1940.
N. Missana-Rudari from July 1941 to April 1943.
M. Castellano from October 1941 to December 1941 and from June 1946 to date.

At Gaithersburg:

E. L. Williams for the whole period.

At Ukiah:

H. G. Wrocklage from the beginning until the end of August 1946.
L. F. Canvette from December 1946 to date.

At Adelaide:

R. V. Burton from the beginning until August 1940 when observations ceased.

At La Plata:

V. Manganiello from the beginning until October 1942.
T. Agabios, from September 1942 until the end of June 1943.
R. Lassalle from July 1944 until the end.

At Batavia:

E. A. Scharpff from beginning to March 1940, the last month for which we received observations.
Schulte in the first months of 1938.
Poldervaart from December 1938 to the first month of 1939.
Ch. M. Kalkmann from February to December 1939.
K. Gsoellpointner from March to December 1939.
Poels the first three months of 1940.

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All the stations, unfortunately, were subject during these years to more or less prolonged interruptions for different reasons, with the exception of Mizusawa and perhaps also Kitab. From this last station we have not received any observation books since April 1946. It is to be hoped that the work of observation has continued and that soon, with the support of the authorities and bodies which are trying to re-establish cultural exchanges with the U.S.S.R. we may be able to receive the observations since March 1946. Russian Science has made an important contribution to the work of the International Latitude Service since 1899, first with the station of Tschardjui and then later of Kitab. The Kitab observations would be particularly valuable for the months in 1946 during which we have not at our disposal either the observations of Carloforte or those of Ukiah.* But the station that was particularly missed during these years was Carloforte; the lack of suitable and willing staff, which already was much felt during 1939 when three months of valuable observations were lost by incapacity or apathy in installing and adjusting the zenith telescope after the overhaul and repair done by the Officine Galileo of Florence, was fully manifest in the following year 1940, when during August, without any reason, the observations were completely stopped, and it was not possible to start them again until the beginning of July 1941.

In June 1938 the large zenith telescope which had been in use for 39 years and was in need of complete overhaul in every part, had to be exchanged with another one of the same make of a somewhat smaller dimension, which was obtained on loan from the Astronomical Observatory of the Palermo University. This instrument was in use from June 1938 until the end of March 1939. The recommencement of regular observations, entrusted in the second half of 1941 to conscientious staff, was soon hampered by the war, which in the spring of 1943 had assumed such violence as to necessitate the closing down of the Observatory. Later on, at the end of hostilities, every effort was made for an early resumption of work, but the assurances and promises of the ministries in Rome, and even the intervention of Colonel Washburn, met with so many obstacles that not until the spring of 1946 was it possible to begin the repairs at the station and the reinstallation of the instruments, enabling the observations to be recommenced. Even now, at the time of writing, the staff necessary for the regular functioning of the station has not been allocated.

For the station of Gaithersburg we deplore an instrumental fault in the micrometer which at the beginning was unnoticed (movement of the micrometer head with respect to the screw itself). This fault developed later to such an extent as to render suspect the observations of the last three months of 1941, compelling us to reject completely the results obtained in December 1941. Once the fault was repaired it was noticed that the displacement of the position of the movable wire with respect to the readings had necessarily affected the determinations of the progressive errors of the screw and it was necessary to reduce the observations without taking these errors into account.

In the second half of 1946 Mr H. G. Wrocklage, observer at Ukiah, who had spent many years at the station and had attained an exceptional standard of observing, had a sudden illness which interrupted the observations for three months (September to November 1946). From December 1946 the regular work was taken up in a commendable manner by Mr Canvette. We have already referred to the destruction of the Batavia Observatory. We deplore what has happened, which has deprived our research of such an important contribution. It is hoped that the archives of the station have not been lost and that the details of the observations since March 1940 (the date of the latest observations to reach us) will be available, and that in the near future we shall see the station reopened.

From Adelaide we received, at the end of the war, the observation books which extend up to August 1940, when observations were stopped, the telescope being then returned to Mizusawa, the period of loan having expired. The renewal of the loan and the resumption of observations is under consideration. It is hoped that this will prove possible, because

* [The Kitab observation books from March **1946** to September **1947** have been received since the report was written. H. S. J.]

the combination of the observations at Adelaide with those at La Plata adds greatly to the weight with which the polar motion is determined. The station of La Plata, thanks to the great interest of their observers and particularly of Ing. V. Manganiello, and of the directors Aguilar, Manganiello and Wallbrecher, has continued observations for the whole period except for a few months in 1947, when it was necessary to interrupt them for a complete overhaul of the instrument. Now Director Wallbrecher is considering the installation of a photographic instrument.

As far as Mizusawa is concerned we have nothing to say except to mention the loss of the founder of the station, Prof. Kimura, who directed the observatory with great ability until his death, and of his collaborators S. Kawasaki (from April 1922) and M. Yamasaki (from April 1924).

The actual work of observation achieved by the different stations during the nine years is summarized in the following Table in which we give the total number of pairs of stars observed in each year at the individual stations:

TABLE I

	1938	1939	1940	1941	1942	1943	1944	1945	1946	Total
Mizusawa	1,166	1,464	1,510	1,205	1,373	1,220	1,208	1,178	1,339	11,663
Kitab	1,298	1,325	1,677	1,315	1,310	1,909	2,077	1,549	315**	12,775
Carloforte	1,699	872*	597†	875‖	1,322	197¶	—	—	910††	6,472
Gaithersburg	1,313	1,307	1,253	1,433	1,232	1,440	1,370	1,053	1,558	11,959
Ukiah	1,336	1,468	1,205	1,188	1,145	1,221	1,454	1,541	1,221	11,779
Adelaide	1,280	1,501	530‡	—	—	—	—	—	—	3,311
La Plata	1,582	1,125	890	1,058	841	521	1,045	253‡‡	—‡‡	7,315
Batavia	1,937	1,962	267§	—	—	—	—	—	—	4,166
	11,611	11,024	7,929	7,074	7,223	6,508	7,154	5,574	5,343	69,440

* Of low weight because the three months April, May and June are completely missing and the remaining months are of poor quality.

† Only the first eight months and exceptionally poor even during months of the most favourable weather.

‡ Only the first eight months of the year.

‖ Only the second half of the year.

§ Only the first three months of the year.

¶ Only the first three months of the year.

** Only the first three months: presumably the work has been carried on but the observations have not been received.

†† Only from June to December.

‡‡ Only the months of January and February. The note-books of observations for other months up to March 1947 have reached us in the form of microfilms, but they have not been computed on account of difficulties in utilizing these copies. Thanks to the kind interest shown by the Director of the Military Geographical Institute of Florence we shall shortly have copies sufficiently clear and we shall proceed with the computation of these observations.

The values of the monthly mean latitudes obtained from the two groups of observations at the different stations are to be found in the following Tables where the number of pairs used for the mean are stated. Tables II and III contain the results of the northern stations and Tables IV and V those of the southern stations; for both groups we have separated the evening observations from the morning. The latitudes were calculated in the usual manner, keeping unchanged for the whole of 1940 the values already adopted for the levels, for the scale of the micrometer screws and for the progressive and periodical errors. After 1940, while keeping the same values for the levels and the errors of the micrometer screws, we adopted slightly different values for the screw-values based on the results of the definitive reductions of the observations in the years 1935–40. The mean positions and proper motions of the stars used up to the end of 1940 were based on a communication by Prof. Kimura, before the Albany *General Catalogue* had been received. When I started the definitive calculations the data received from Kimura were compared with the *General Catalogue*; while there was on the whole very good agreement,

TABLE II

Evening

Epoch	Group	Mizusawa φ	Mizusawa Obs.	Kitab φ	Kitab Obs.	Carloforte φ	Carloforte Obs.	Gaithersburg φ	Gaithersburg Obs.	Ukiah φ	Ukiah Obs.
		″		″		″		″		″	
1938·06	IV	3·775	27	1·825	38	8·817	99	13·334	34	12·240	28
·14	V	·444	58	·615	22	·733	76	·247	45	·135	36
·23	VI	·508	57	·764	47	·876	91	·354	67	·386	25
·31	VII	·410	46	·599	68	·779	78	·350	71	·298	52
·39	VIII	·266	62	·593	82	·756	99	·253	38	·217	76
·47	IX	·165	9	·400	65	·670	95	·159	64	·044	72
·55	X	·180	49	·603	81	9·026	124	·225	52	·134	84
·64	XI	·328	38	·794	93	·235	81	·431	111	·172	84
·72	XII	·438	69	·861	100	·156	68	·478	46	·170	75
·80	I	·550	73	·823	59	·120	43	·433	80	·152	54
·88	II	·438	59	·733	29	8·863	52	·107	55	11·959	48
·97	III	·762	43	·687	20	9·017	20	·395	45	12·203	46
1939·06	IV	3·638	57	1·711	12	8·885	22	13·408	24	12·230	50
·14	V	·472	54	·659	53	·696	44	·102	47	·076	41
·22	VI	·574	85	·739	65	·852	22	·364	68	·342	52
·31	VII	·421	108	·615	50	—	—	·280	65	·261	60
·39	VIII	·307	62	·621	73	—	—	·223	83	·153	60
·47	IX	·190	55	·404	78	—	—	·224	51	·021	72
·56	X	·200	69	·622	62	·907	109	·298	66	·161	83
·64	XI	·334	46	·725	84	9·145	69	·428	42	·179	78
·73	XII	·377	49	·838	57	·178	38	·434	63	·161	71
·80	I	·475	64	·760	68	·316	70	·482	82	·141	78
·89	II	·284	65	·667	46	8·952	70	·167	68	11·977	72
·97	III	·638	65	·866	53	9·182	37	·395	50	12·152	23
1940·06	IV	3·630	76	1·788	29	9·018	31	13·336	45	12·113	35
·14	V	·564	52	·710	47	8·708	71	·067	31	·075	34
·22	VI	·619	52	·834	79	·870	59	·297	55	·274	42
·31	VII	·488	77	·744	68	·718	46	·319	57	·275	48
·39	VIII	·344	99	·639	99	·608	35	·274	51	·180	54
·47	IX	·161	85	·409	94	·655	36	·231	50	·060	72
·56	X	·145	41	·760	74	·825	38	·276	61	·135	70
·64	XI	·540	45	·864	100	9·057	34	·471	49	·201	59
·73	XII	·411	85	·779	92	—	—	·479	90	·187	66
·80	I	·453	98	·747	86	—	—	·418	65	·183	45
·89	II	·463	38	·740	52	—	—	·179	42	11·963	62
·97	III	·625	52	·812	47	—	—	·488	49	12·243	30
1941·07	IV	3·557	50	1·793	28	—	—	13·220	38	12·147	41
·14	V	·399	35	·727	83	—	—	·148	58	·006	41
·22	VI	·614	50	·811	46	—	—	·367	53	·245	48
·30	VII	·468	72	·727	46	—	—	·237	80	·224	40
·39	VIII	·358	69	·699	55	—	—	·173	72	·142	48
·47	IX	·265	46	·577	61	—	—	·220	85	·132	60
·56	X	·308	13	·623	108	8·774	78	·221	60	·100	72
·64	XI	·304	34	·756	104	·948	110	·423	62	·244	72
·71	XII	·351	39	·827	90	·976	92	·430	102	·225	59
·79	I	·380	82	·784	26	9·087	62	·378	58	·231	53
·88	II	·272	62	·785	18	8·924	86	·240	70	·015	42
·96	III	·531	57	·892	9	·933	41	(·627)	26	·264	36
1942·07	IV	3·406	41	2·078	11	8·905	28	13·364	26	12·141	24
·14	V	·368	39	1·607	25	·788	33	·215	44	11·995	48
·22	VI	·504	65	·961	18	9·034	53	·332	49	12·153	36
·30	VII	·411	78	·708	51	8·916	55	·217	68	·161	36
·39	VIII	·419	91	·706	87	·861	51	·149	63	·035	41
·47	IX	·313	83	·632	34	·839	63	·123	83	·037	48

TABLE II (*continued*)

Evening

Epoch	Group	Mizusawa		Kitab		Carloforte		Gaithersburg		Ukiah	
		ϕ	Obs.	ϕ	Obs.	ϕ	Obs.	ϕ	Obs.	ϕ	Obs.
		″		″		″		″		″	
1942·56	X	3·375	50	2·582	66	8·825	122	13·140	58	12·022	78
·64	XI	·521	78	·792	98	·935	45	·280	60	·160	72
·71	XII	·504	50	·785	92	·960	89	·387	59	·220	60
·79	I	·533	60	·666	76	·995	61	·343	66	·247	60
·88	II	·403	42	·458	86	·846	45	·202	37	·080	47
·96	III	·510	49	·848	44	9·071	53	·571	28	·345	36
1943·06	IV	3·389	63	1·773	80	8·940	37	13·439	41	12·274	48
·14	V	·282	31	·526	41	·843	34	·301	51	·084	40
·23	VI	·424	71	·790	44	9·051	40	·473	89	·255	54
·31	VII	·400	72	·733	70	—	—	·303	70	·129	36
·39	VIII	·288	61	·640	88	—	—	·234	58	11·976	60
·47	IX	·225	54	·684	135	—	—	·158	58	·903	66
·56	X	·343	58	·711	106	—	—	·103	56	·929	64
·64	XI	·466	53	·852	124	—	—	·226	75	12·028	72
·72	XII	·521	22	·892	110	—	—	·275	74	·099	71
·80	I	·592	92	·818	89	—	—	·159	70	·171	48
·90	II	·247	27	·713	80	—	—	·070	64	·071	37
·98	III	·515	35	·872	38	—	—	·309	38	·469	24
1944·06	IV	3·522	42	1·731	53	—	—	13·287	66	12·327	42
·14	V	·347	34	·499	101	—	—	·247	54	·144	36
·23	VI	·505	43	·706	76	—	—	·440	59	·329	71
·31	VII	·326	46	·670	95	—	—	·338	56	·184	48
·39	VIII	·243	71	·721	99	—	—	·281	69	·065	54
·48	IX	·076	48	·692	112	—	—	·263	81	·003	60
·56	X	·222	50	·795	138	—	—	·190	45	11·873	84
·64	XI	·380	65	2·005	110	—	—	·234	90	·926	96
·72	XII	·609	64	·082	107	—	—	·144	39	·963	84
·81	I	·637	97	1·948	98	—	—	·025	80	12·026	60
·89	II	·442	61	·684	68	—	—	12·984	41	11·845	60
·98	III	·711	33	·928	30	—	—	13·292	32	12·331	50
1945·06	IV	3·587	65	1·772	51	—	—	13·148	36	12·382	53
·14	V	·540	39	·556	54	—	—	·144	42	·200	54
·22	VI	·573	51	·683	60	—	—	·388	48	·446	48
·31	VII	·307	89	·553	69	—	—	·381	71	·360	72
·39	VIII	·231	72	·486	80	—	—	·396	65	·206	56
·47	IX	·046	46	·491	107	—	—	·291	46	·121	84
·55	X	·046	48	·680	77	—	—	·264	37	·030	102
·64	XI	·167	53	·868	106	—	—	·257	58	·064	89
·72	XII	·325	22	2·041	80	—	—	·299	23	·013	81
·80	I	·470	47	·158	60	—	—	·185	66	11·948	80
·90	II	·442	65	1·692	20	—	—	12·945	33	·695	30
·97	III	·661	27	2·090	44	—	—	13·028	28	12·032	45
1946·06	IV	3·777	47	2·054	48	—	—	13·170	65	12·231	69
·14	V	·626	55	1·737	64	—	—	12·984	70	·077	70
·22	VI	·719	59	·830	58	—	—	13·246	68	·268	51
·30	VII	·497	92	—	—	—	—	·303	42	·357	84
·39	VIII	·312	53	—	—	—	—	·255	49	·217	72
·48	IX	·159	69	—	—	8·685	54	·287	35	·248	84
·56	X	·015	50	—	—	·869	120	·312	57	·174	88
·64	IX	·160	64	—	—	9·038	57	·423	76	·231	48
·72	XII	·242	53	—	—	·246	84	·503	95	—	—
·81	I	·297	72	—	—	·251	63	·426	72	—	—
·89	II	·255	51	—	—	·116	41	·125	70	—	—
·97	III	·486	38	—	—	·340	48	·359	28	·161	65

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TABLE III

Morning

Epoch	Group	Mizusawa φ	Mizusawa Obs.	Kitab φ	Kitab Obs.	Carloforte φ	Carloforte Obs.	Gaithersburg φ	Gaithersburg Obs.	Ukiah φ	Ukiah Obs.
		″		″		″		″		″	
1938·07	V	3·568	25	1·612	34	8·687	78	13·193	20	12·155	26
·14	VI	·635	54	·807	18	·901	63	·394	32	·359	35
·23	VII	·497	65	·718	46	·740	83	·360	65	·363	24
·31	VIII	·392	44	·586	65	·847	61	·314	70	·245	48
·39	IX	·182	49	·370	49	·678	90	·174	43	·126	77
·47	X	·222	15	·508	64	·753	80	·289	64	·149	72
·56	XI	·355	39	·685	77	9·157	114	·447	37	·228	84
·64	XII	·362	51	·726	81	·265	71	·519	98	·238	78
·73	I	·420	61	·735	71	·271	49	·392	38	·154	77
·80	II	·402	89	·708	48	8·879	40	·156	81	11·958	53
·88	III	·631	49	·925	23	9·046	38	·460	26	12·182	47
·98	IV	·698	35	·858	18	8·736	6	·223	31	·158	35
1939·06	V	3·485	52	1·766	12	8·740	9	13·054	12	12·034	46
·14	VI	·657	56	·901	47	·870	29	·349	41	·328	42
·22	VII	·507	81	·669	62	·844	26	·352	62	·332	47
·31	VIII	·388	83	·658	45	—	—	·307	59	·210	60
·40	IX	·194	46	·283	73	—	—	·275	62	·041	60
·47	X	·294	43	·554	71	—	—	·305	28	·140	72
·56	XI	·360	56	·670	55	9·037	102	·461	56	·252	86
·64	XII	·382	43	·723	73	·202	57	·485	44	·190	78
·73	I	·502	50	·737	54	·267	31	·506	48	·143	72
·80	II	·339	59	·722	46	8·979	62	·216	75	11·942	77
·89	III	·533	67	·814	34	9·343	53	·453	64	12·215	71
·97	IV	·550	49	·844	52	·111	22	·335	47	·120	19
1940·06	V	3·459	73	1·700	19	8·757	19	13·071	41	12·013	30
·14	VI	·688	47	·902	32	·988	42	·311	28	·261	32
·22	VII	·584	50	·800	71	·787	43	·291	58	·252	42
·31	VIII	·470	56	·689	73	·677	42	·285	55	·256	48
·39	IX	·264	82	·407	88	·619	20	·072	51	·127	54
·47	X	·268	72	·611	93	·846	22	·349	44	·199	70
·56	XI	·349	21	·736	74	·953	89	·450	60	·293	66
·64	XII	·591	34	·755	97	9·095	20	·557	44	·234	60
·73	I	·394	80	·626	82	—	—	·510	81	·187	66
·80	II	·260	92	·700	86	—	—	·185	64	11·967	39
·89	III	·534	40	·799	48	—	—	·550	41	12·219	51
·97	IV	·541	63	·847	47	—	—	·480	41	·149	30
1941·07	V	3·411	45	1·815	23	—	—	13·246	31	11·954	38
·14	VI	·685	33	·900	80	—	—	·293	47	12·277	32
·22	VII	·501	57	·790	45	—	—	·273	57	·077	41
·30	VIII	·518	66	·762	39	—	—	·214	89	·195	37
·39	IX	·369	59	·636	56	—	—	·154	73	·211	48
·47	X	·381	60	·631	67	—	—	·195	66	·354	59
·56	XI	·314	11	·692	102	8·907	72	·376	61	·333	72
·64	XII	·418	25	·802	94	·957	101	·486	65	·234	67
·71	I	·419	42	·721	83	9·059	68	·457	91	·203	60
·79	II	·286	83	·683	23	8·882	63	·201	61	·000	52
·88	III	·379	71	·811	18	9·014	76	·434	54	·370	40
·96	IV	·437	54	·902	11	8·980	26	(·186)	30	·064	30
1942·07	V	3·395	44	1·545	10	8·811	18	13·141	38	12·068	23
·14	VI	·600	38	·989	21	·974	16	·436	44	·246	42
·22	VII	·499	56	·744	18	·928	35	·147	32	·101	36
·30	VIII	·462	82	·639	36	·884	40	·192	72	·090	30
·39	IX	·318	64	·607	78	·851	49	·163	68	·068	42
·47	X	·407	68	·588	25	·917	57	·176	71	·073	48

TABLE III (*continued*)

Morning

Epoch	Group	Mizusawa φ	Mizusawa Obs.	Kitab φ	Kitab Obs.	Carloforte φ	Carloforte Obs.	Gaithersburg φ	Gaithersburg Obs.	Ukiah φ	Ukiah Obs.
		″		″		″		″		″	
1942·56	XI	3·482	36	1·731	72	8·963	115	13·273	56	12·129	78
·64	XII	·542	57	·744	97	·944	105	·345	47	·218	72
·71	I	·535	51	·610	90	·988	83	·440	55	·226	60
·79	II	·377	51	·434	61	·820	62	·273	54	·076	60
·88	III	·547	53	·798	71	9·117	39	·472	39	·341	35
·96	IV	·430	47	·776	43	8·922	25	·465	15	·321	33
1943·06	V	3·348	49	1·567	72	8·933	23	13·356	40	12·113	48
·14	VI	·459	29	2·154	29	·953	26	·501	43	·273	42
·23	VII	·406	65	1·759	27	9·002	37	·381	35	·147	54
·31	VIII	·344	80	·704	60	—	—	·248	65	·038	35
·39	IX	·274	62	·640	80	—	—	·300	37	11·958	60
·47	X	·382	42	·669	126	—	—	·204	55	·964	66
·56	XI	·487	38	·804	101	—	—	·258	50	·988	60
·64	XII	·448	62	·830	121	—	—	·292	73	12·058	71
·72	I	·586	20	·841	95	—	—	·195	85	·130	66
·80	II	·363	74	·627	89	—	—	·111	56	11·981	39
·90	III	·636	31	·816	74	—	—	·320	61	12·313	36
·98	IV	·517	29	·829	30	—	—	·188	45	·289	24
1944·06	V	3·271	45	1·538	54	—	—	13·220	57	12·176	36
·14	VI	·350	32	·711	83	—	—	·347	40	·394	36
·23	VII	·367	30	·641	70	—	—	·371	54	·276	63
·32	VIII	·289	41	·580	82	—	—	·341	43	·196	48
·39	IX	·130	64	·552	92	—	—	·317	45	·038	53
·48	X	·167	37	·727	106	—	—	·279	80	·001	60
·56	XI	·338	40	·890	125	—	—	·314	43	11·967	81
·64	XII	·388	57	2·010	113	—	—	·261	111	12·024	96
·72	I	·465	52	2·004	86	—	—	·149	33	·029	84
·81	II	·464	69	1·748	92	—	—	12·918	78	11·848	53
·89	III	·801	54	·986	59	—	—	13·184	42	12·206	58
·98	IV	·647	34	·810	28	—	—	·059	32	·258	41
1945·06	V	3·488	59	1·621	52	—	—	13·123	30	12·206	47
·14	VI	·631	34	·797	48	—	—	·301	32	·478	53
·22	VII	·467	62	·600	59	—	—	·295	46	·438	48
·31	VIII	·393	78	·449	65	—	—	·346	54	·331	72
·40	IX	·142	65	·491	60	—	—	·368	57	·182	53
·48	X	·122	37	·453	102	—	—	·438	39	·098	84
·55	XI	·355	30	·726	70	—	—	·464	17	·107	102
·64	XII	·245	42	·883	107	—	—	·265	52	·133	80
·72	I	·400	18	2·013	68	—	—	·280	23	·029	75
·81	II	·351	33	1·832	60	—	—	12·989	84	11·711	62
·89	III	·700	65	2·233	15	—	—	13·172	38	12·005	27
·97	IV	·596	31	2·035	35	—	—	·212	28	·091	44
1946·06	V	3·658	45	1·772	38	—	—	12·984	65	12·044	63
·14	VI	·719	37	·818	53	—	—	13·186	45	·297	60
·22	VII	·681	61	·670	54	—	—	·216	71	·358	41
·31	VIII	·500	73	—	—	—	—	·255	51	·295	82
·39	IX	·269	52	—	—	—	—	·286	68	·270	66
·48	X	·220	65	—	—	8·745	54	·334	54	·215	85
·56	XI	·142	35	—	—	·954	113	·422	79	·306	88
·64	XII	·210	56	—	—	9·107	59	·562	92	·296	48
·72	I	·105	56	—	—	·107	82	·377	106	—	—
·81	II	·106	65	—	—	·085	60	·212	79	—	—
·89	III	·526	50	—	—	·395	37	·484	86	—	—
·97	IV	·488	41	—	—	·246	38	·267	35	·129	57

Table IV

Evening

		Adelaide		La Plata		Batavia	
Epoch	Group	φ	Obs.	φ	Obs.	φ	Obs.
		″		″		″	
1938·06	IV	36·547	40	31·781	74	38·167	64
·14	V	·692	59	·887	75	·434	29
·23	VI	·776	76	·848	54	·535	68
·30	VII	37·091	43	32·127	48	·830	87
·39	VIII	·026	67	31·825	91	·951	59
·47	IX	36·984	36	·795	65	·747	73
·55	X	·767	28	·629	86	·236	119
·64	XI	·724	32	·539	78	·387	108
·72	XII	·895	90	·838	94	·690	111
·81	I	·657	70	·675	80	·166	91
·88	II	·344	67	·592	64	·070	63
·97	III	·677	73	·985	64	·367	71
1939·06	IV	36·539	104	31·870	57	38·103	49
·14	V	·682	76	·967	69	·324	73
·22	VI	·626	80	·884	71	·458	85
·30	VII	37·124	60	32·240	90	·599	62
·39	VIII	36·997	69	31·920	41	·815	86
·47	IX	·988	75	·810	47	·750	82
·55	X	·943	66	·606	40	·250	78
·64	XI	·760	27	·495	34	·444	57
·73	XII	·953	88	·773	33	·754	91
·81	I	·735	69	·463	54	·252	101
·88	II	·473	35	·579	44	·262	91
·97	III	·673	37	·924	61	·593	66
1940·05	IV	36·579	55	31·826	36	37·966	37
·15	V	·719	41	·918	82	38·033	49
·22	VI	·591	28	·897	52	·095	39
·30	VII	·958	26	32·226	51	—	—
·40	VIII	·982	37	31·882	32	—	—
·47	IX	·929	35	·729	31	—	—
·56	X	·763	15	·620	44	—	—
·62	XI	·793	10	·520	47	—	—
·72	XII	—	—	·801	31	—	—
·82	I	—	—	·587	39	—	—
·88	II	—	—	·431	34	—	—
·97	III	—	—	·842	54	—	—
1941·05	IV	—	—	31·773	70	—	—
·15	V	—	—	·857	44	—	—
·23	VI	—	—	·912	43	—	—
·32	VII	—	—	32·167	42	—	—
·39	VIII	—	—	·953	38	—	—
·47	IX	—	—	·783	52	—	—
·56	X	—	—	·771	31	—	—
·65	XI	—	—	·509	50	—	—
·72	XII	—	—	·816	61	—	—
·81	I	—	—	·575	76	—	—
·89	II	—	—	·421	62	—	—
·98	III	—	—	·801	68	—	—

		La Plata	
Epoch	Group	φ	Obs.
		″	
1942·05	IV	31·708	53
·15	V	·913	49
·21	VI	·849	43
·31	VII	32·228	50
·39	VIII	·033	32
·47	IX	31·967	28
·56	X	·960	29
·64	XI	·667	29
·72	XII	32·010	48
·80	I	31·717	52
·89	II	·451	67
·97	III	·739	34
1943·07	IV	31·608	28
·15	V	·791	58
·22	VI	·661	37
·31	VII	32·033	29
·39	VIII	31·890	29
·45	IX	·750	6
·55	X	·829	32
·64	XI	·780	21
·73	XII	·919	27
·80	I	32·104	32
·91	II	31·588	23
·95	III	32·010	1
1944·06	IV	31·696	28
·14	V	·623	12
·22	VI	·708	98
·31	VII	32·026	73
·38	VIII	31·793	48
·50	IX	·774	27
·55	X	·615	18
·66	XI	·635	42
·71	XII	·928	65
·81	I	·909	33
·89	II	·685	77
·99	III	32·039	53
1945·07	IV	31·853	60
·14	V	·944	81

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TABLE V

Morning

Epoch	Group	Adelaide φ	Adelaide Obs.	La Plata φ	La Plata Obs.	Batavia φ	Batavia Obs.
		″		″		″	
1938·06	V	36·612	38	31·935	50	38·421	59
·14	VI	·633	63	·871	61	·491	42
·23	VII	37·126	72	32·256	39	·731	77
·30	VIII	36·921	33	31·970	36	·934	94
·39	IX	·904	48	·788	76	·839	71
·47	X	·908	32	·667	60	·268	77
·55	XI	·703	27	·523	71	·456	97
·64	XII	·929	34	·719	55	·774	124
·72	I	·741	75	·645	83	·246	129
·81	II	·452	59	·533	64	·213	103
·88	III	·709	52	·925	54	·543	47
·97	IV	·544	66	·950	60	·103	82
1939·06	V	36·640	100	31·994	51	38·380	45
·14	VI	·616	78	·928	46	·333	72
·22	VII	37·005	99	32·249	61	·615	95
·30	VIII	36·930	59	31·990	66	·757	86
·37	IX	·926	47	·877	29	·649	94
·47	X	·846	64	·721	30	·219	111
·55	XI	·724	45	·442	23	·525	73
·64	XII	·975	32	·734	21	·754	77
·73	I	·729	75	·569	25	·364	107
·81	II	·522	59	·252	35	·289	104
·88	III	·756	32	·888	48	·636	101
·97	IV	·575	25	·932	39	·210	75
1940·05	V	36·571	53	31·888	33	38·023	23
·15	VI	·676	40	·892	47	37·833	58
·22	VII	·880	27	32·266	40	38·430	61
·30	VIII	·772	24	32·016	35	—	—
·40	IX	·805	46	31·948	15	—	—
·47	X	·845	40	·646	22	—	—
·56	XI	·969	9	·617	39	—	—
·62	XII	37·002	18	·683	28	—	—
·72	I	—	—	·533	16	—	—
·82	II	—	—	·400	13	—	—
·88	III	—	—	·842	15	—	—
·97	IV	—	—	·831	54	—	—
1941·05	V	—	—	31·835	48	—	—
·15	VI	—	—	·685	32	—	—
·24	VII	—	—	32·231	24	—	—
·32	VIII	—	—	31·983	29	—	—
·39	IX	—	—	·951	30	—	—
·47	X	—	—	·770	27	—	—
·56	XI	—	—	·578	24	—	—
·65	XII	—	—	·737	35	—	—
·73	I	—	—	·509	46	—	—
·81	II	—	—	·379	54	—	—
·89	III	—	—	·864	34	—	—
·97	IV	—	—	·723	38	—	—

Epoch	Group	La Plata φ	La Plata Obs.
		″	
1942·05	V	31·788	36
·15	VI	·837	40
·21	VII	32·205	21
·32	VIII	·009	22
·39	IX	·109	15
·47	X	31·816	17
·55	XI	·860	13
·64	XII	·978	15
·72	I	·791	28
·80	II	·541	33
·89	III	·780	68
·97	IV	·623	17
1943·07	V	31·721	26
·15	VI	·642	36
·21	VII	·941	18
·31	VIII	·851	14
·40	IX	·857	18
—	X	—	—
·58	XI	·753	15
·63	XII	·970	12
·74	I	·855	14
·79	II	·511	31
·93	III	32·075	14
—	IV	—	—
1944·07	V	31·726	9
·15	VI	·624	9
·23	VII	32·085	94
·32	VIII	31·794	57
·38	IX	·783	42
·49	X	·587	24
·54	XI	·563	10
·65	XII	·887	41
·70	I	·785	43
·81	II	·684	29
·89	III	32·079	65
·99	IV	31·958	48
1945·06	V	31·966	39
·15	VI	·765	73

Table VI

North—Evening

Epoch	Group	Mizusawa φ	Obs.	Kitab φ	Obs.	Carloforte φ	Obs.	Gaithersburg φ	Obs.	Ukiah φ	Obs.
		″		″		″		″		″	
1935·06	IV	3·657	42	1·897	5	8·915	42	13·494	54	12·236	56
·14	V	·345	59	·709	47	·890	40	·159	61	·034	26
·23	VI	·547	63	·812	31	·977	80	·340	61	·272	59
·30	VII	·373	79	·782	50	·912	90	·231	50	·138	70
·39	VIII	·292	78	·673	74	·834	75	·199	94	·083	67
·47	IX	·163	42	·487	70	·645	133	·044	68	11·957	55
·56	X	·284	53	·759	52	·808	156	·159	64	12·019	94
·64	XI	·499	59	·839	89	·940	149	·355	36	·232	96
·72	XII	·503	42	·831	63	·945	74	·474	68	·240	78
·80	I	·567	87	·788	62	·941	31	·573	69	·232	72
·89	II	·567	73	·653	48	·850	29	·224	53	·120	60
·97	III	·734	39	·896	49	9·032	26	·596	42	·338	39
		Totals	716		640		925		720		772

North—Morning

Epoch	Group	Mizusawa φ	Obs.	Kitab φ	Obs.	Carloforte φ	Obs.	Gaithersburg φ	Obs.	Ukiah φ	Obs.
		″		″		″		″		″	
1936·06	V	3·380	43	1·646	5	8·831	31	13·246	34	12·081	48
·14	VI	·645	48	·934	45	9·018	42	·257	44	·306	21
·23	VII	·451	78	·803	28	8·928	76	·285	46	·171	55
·30	VIII	·390	77	·721	48	·858	69	·150	53	·122	70
·39	IX	·244	69	·572	60	·677	53	·167	82	11·998	59
·47	X	·275	32	·669	63	·827	126	·206	71	12·094	54
·56	XI	·434	28	·917	59	·964	124	·373	40	·229	96
·64	XII	·539	40	·812	96	·951	136	·539	23	·235	96
·72	I	·511	34	·765	59	·976	66	·576	60	·278	77
·81	II	·423	69	·733	54	·794	19	·215	53	·057	71
·90	III	·616	76	·826	44	9·028	13	·526	42	·365	56
·97	IV	·634	47	·929	40	8·945	19	·526	30	·267	36
		Totals	641		601		774		578		739

South—Evening

Epoch	Group	Adelaide φ	Obs.	La Plata φ	Obs.
		″		″	
1935·06	IV	36·647	84	31·722	122
·14	V	·785	92	·816	114
·23	VI	·726	63	·717	132
·30	VII	37·053	32	32·069	111
·39	VIII	36·895	56	31·925	86
·47	IX	·914	28	·863	95
·56	X	·894	40	·785	99
·64	XI	·710	85	·633	78
·73	XII	·868	44	·920	81
·81	I	·664	75	·745	76
·89	II	·461	69	·558	88
·97	III	·699	55	·831	78
	Totals		723		1160

South—Morning

Epoch	Group	Adelaide φ	Obs.	La Plata φ	Obs.
		″		″	
1935·06	V	36·743	82	31·804	111
·14	VI	·661	95	·773	94
·23	VII	37·052	70	32·104	117
·30	VIII	36·859	23	31·887	98
·39	IX	·860	47	·847	62
·48	X	·843	18	·754	68
·56	XI	·731	38	·709	85
·64	XII	·886	76	·878	45
·73	I	·713	42	·800	64
·81	II	·420	72	·626	60
·89	III	·713	61	·909	70
·97	IV	·653	57	·745	68
			709		928

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in two instances I found a sensible difference; in the declination and proper motions of star 1 of the pair 51 (group IX) and of star 1 of the pair 65 (group XI). The first leads to a difference of $+0''\cdot48$ in the mean declination of the pair and a change of this amount in the latitudes derived from it; and in consequence a difference of about $+0''\cdot08$ to the mean latitude obtained from that group, from the epoch 1940 when we adopted the data of the *General Catalogue* in the calculation of the ephemerides. The second discrepancy results in a decrease in the value for the latitude obtained with the pair of about $0''\cdot085$ also from 1940, and in a decrease of $0''\cdot014$ for the mean latitude of the group. The values which we give for 1940 are referred to the declinations of the previous years, but not the values for the years 1941–46; this gives rise to the difference between the values of z obtained for the groups IX and XI in the first years and the last years.

It may be recalled that following a decision taken at Stockholm by our Commission the Central Bureau was entrusted with the final calculation of the observations made during 1935 at the International stations, because from the beginning of that year the present programme of observation, slightly different from that of the previous years, was adopted. In order that the results for that year should be on a uniform basis with those of the following years, all the observations taken in 1935 have been recomputed. The results are summarized in Table VI in a similar manner to those for the years 1938–46.

Using the values of the mean latitude adopted in the previous years for each of the different stations, the instantaneous co-ordinates x and y of the North Pole of rotation and the z term were calculated for the mean epoch of the observation of each group, for the morning and evening observations separately. This separation is necessary, because the z term depends on effects of a diverse nature and, in particular, on the corrections to the adopted declinations of the stars. This effect has a magnitude greater than all the others and a value which is characteristic of each group, as is seen by comparing, in Table VII, the value of z derived from the morning observations in any month with the value derived from the evening observations in the following month, the same group of stars being observed. In Table VII are given the values found for the co-ordinates x and y of the pole from morning and evening observations, together with the mean values; also the values of z from morning and evening observations, together with the mean values for the same group but in consecutive months.

It may be remembered that when it was possible to use the results from Adelaide and La Plata to supplement those of the northern stations, the instantaneous co-ordinates of the pole were derived not only in the customary manner but also by taking into account the southern observations, so obtaining results which have greater weight. The advantage of including the results of the southern observations becomes more apparent the smaller the polar motion, as the magnitude of the residual errors of observation then approximates more nearly to the amplitude of displacements of the instantaneous pole from the mean pole. It would be very advantageous if the co-operation of the two southern stations were permanent. But, as we have already stated, the observations at Adelaide were discontinued in 1940 and the inclusion of the observations from La Plata only would be of little, if any, value. However, as the calculations were made for 1935 and subsequently for the years 1938 and 1939 in this manner, i.e. taking into account all the seven stations, we give in Table VIII the values for 1935, obtained from the northern stations only, and in Table IX those for the same years 1935, 1938 and 1939, obtained from all the seven stations.

The agreement between the two values of the co-ordinates X and Y, obtained from the evening and morning groups is generally satisfactory, but it is apparent how noticeably the agreement is affected by lack of or extreme poorness in observations at times at some stations, which by their geographical position affect noticeably the determination of one or other of the co-ordinates.

Thus it is clear that the X values become less accordant when there is a noticeable decrease in the number of observations at Carloforte, as is usually the case in the winter months, or, worse still, when the observations are missing altogether, while the lack of

Table VII
Northern Stations

Epoch	Group	X E.	X M.	X Mean	Y E.	Y M.	Y Mean	Z E.	Z M.	Z Mean
		″	″	″	″	″	″	″	″	″
1937·97	III–IV	—	—	—	—	—	—	—	+·029	—
1938·06	IV–V	−·215	−·206	−·210	−·044	+·014	−·015	+·097	−·063	+·063
·14	V–VI	−·114	−·145	−·129	+·057	+·048	+·052	−·081	+·107	−·072
·23	VI–VII	−·116	−·170	−·143	+·092	+·106	+·099	+·061	−·021	+·084
·31	VII–VIII	−·114	−·067	−·090	+·148	+·128	+·138	−·032	−·044	−·026
·39	VIII–IX	−·055	−·065	−·060	+·134	+·178	+·156	−·105	−·219	−·074
·47	IX–X	−·039	−·024	−·031	+·145	+·168	+·156	−·235	−·142	−·227
·56	X–XI	+·129	+·120	+·124	+·119	+·142	+·130	−·098	+·046	−·120
·64	XI–XII	+·195	+·180	+·187	+·095	+·154	+·129	+·058	+·087	+·052
·72	XII–I	+·126	+·149	+·137	+·062	+·062	+·062	+·094	+·064	+·090
·80	I–II	+·054	+·013	+·033	+·025	−·037	−·006	+·092	−·095	+·078
·88	II–III	−·016	−·004	−·010	−·071	−·012	−·041	−·094	+·133	−·094
·97	III–IV	−·116	−·206	−·161	+·014	−·090	−·038	+·101	+·034	+·117
1939·06	IV–V	−·101	−·086	−·094	+·062	−·082	−·010	+·054	−·096	+·044
·14	V–VI	−·118	−·125	−·122	−·017	+·003	−·007	−·114	+·106	−·105
·22	VI–VII	−·120	−·101	−·111	+·085	+·118	+·102	+·054	+·018	+·080
·31	VII–VIII	−·052	+·023	−·015	+·115	+·104	+·110	−·034	−·024	−·008
·39	VIII–IX	+·038	−·019	+·010	+·096	+·222	+·159	−·086	−·231	−·055
·47	IX–X	+·037	+·040	+·039	+·163	+·144	+·154	−·206	−·089	−·218
·56	X–XI	+·093	+·084	+·089	+·151	+·170	+·161	−·099	+·020	−·094
·64	XI–XII	+·160	+·180	+·170	+·128	+·137	+·133	+·021	+·054	+·020
·73	XII–I	+·181	+·167	+·174	+·078	+·094	+·086	+·061	+·094	+·057
·80	I–II	+·202	+·123	+·163	+·084	−·003	+·041	+·097	−·090	+·095
·89	II–III	+·114	+·172	+·143	+·022	+·061	+·042	−·121	+·136	−·105
·97	III–IV	+·069	+·075	+·072	−·016	−·012	−·014	+·121	+·066	+·128
1940·06	IV–V	−·007	−·067	−·037	−·016	−·054	−·035	+·056	−·118	+·061
·14	V–VI	−·150	−·113	−·132	−·070	−·036	−·053	−·088	+·098	−·103
·22	VI–VII	−·109	−·131	−·120	+·003	+·017	+·010	+·063	+·028	+·081
·31	VII–VIII	−·129	−·146	−·138	+·076	+·082	+·079	−·008	−·042	+·010
·39	VIII–IX	−·109	−·107	−·108	+·109	+·120	+·114	−·111	−·225	−·077
·47	IX–X	−·011	+·031	+·010	+·183	+·164	+·174	−·226	−·075	−·225
·56	X–XI	+·101	+·048	+·074	+·109	+·161	+·135	−·102	+·028	−·089
·64	XI–XII	+·053	+·039	+·046	+·051	+·109	+·080	+·101	+·119	+·064
·73	XII–I	+·158	+·096	+·127	+·109	+·174	+·142	+·073	+·024	+·096
·80	I–II	+·089	+·161	+·125	+·088	+·021	+·055	+·049	−·106	+·037
·89	II–III	+·055	+·111	+·083	−·048	+·102	+·027	−·062	+·127	−·084
·97	III–IV	+·026	+·128	+·077	+·061	+·044	+·053	+·131	+·113	+·129
1941·07	IV–V	−·023	+·134	+·055	−·031	−·019	−·025	+·015	−·011	+·064
·14	V–VI	+·059	−·030	+·015	+·044	−·059	−·008	−·079	+·106	−·045
·22	VI–VII	−·021	+·027	+·003	−·029	+·009	−·010	+·092	+·025	+·099
·30	VII–VIII	−·024	−·037	−·031	−·001	+·004	+·002	−·004	+·005	+·010
·39	VIII–IX	+·031	−·017	+·007	+·037	+·048	+·042	−·065	−·094	−·030
·47	IX–X	+·046	−·013	+·016	+·119	+·062	+·090	−·112	−·080	−·103
·56	X–XI	−·007	+·046	+·019	+·082	+·141	+·112	−·118	−·026	−·099
·64	XI–XII	+·077	+·037	+·057	+·144	+·128	+·136	+·005	+·060	−·010
·71	XII–I	+·067	+·068	+·067	+·106	+·142	+·124	+·032	+·057	+·046
·79	I–II	+·096	+·061	+·079	+·081	+·055	+·068	+·034	−·101	+·046
·88	II–III	+·114	+·073	+·093	+·023	+·118	+·071	−·082	+·054	−·091
·96	III–IV	−·002	+·047	+·023	+·015	+·003	+·009	+·080	+·035	+·067
1942·07	IV–V	+·072	−·040	+·016	−·029	+·048	+·009	+·053	−·129	+·044
·14	V–VI	−·003	−·011	−·007	+·042	−·002	+·020	−·128	+·128	−·129
·22	VI–VII	+·017	−·016	+·001	−·025	−·033	−·029	+·073	−·037	+·100
·30	VII–VIII	+·006	−·024	−·009	+·040	+·022	+·031	−·041	−·068	−·039
·39	VIII–XI	+·002	+·022	+·012	−·015	+·056	+·020	−·088	−·123	−·078

TABLE VII (*continued*)

Northern Stations

Epoch	Group	*X*			*Y*			*Z*		
		E.	M.	Mean	E.	M.	Mean	E.	M.	Mean
		″	″	″	″	″	″	″	″	″
1942·47	IX–X	+·025	+·011	+·018	+·028	+·043	+·035	−·135	−·092	−·129
·56	X–XI	−·008	+·014	+·003	+·029	+·024	+·027	−·134	−·008	−·113
·64	XI–XII	−·015	−·033	−·024	+·006	+·052	+·029	+·016	+·037	+·004
·71	XII–I	−·006	−·017	−·012	+·064	+·129	+·096	+·047	+·035	+·042
·79	I–II	−·001	+·027	+·013	+·085	+·134	+·109	+·034	−·128	+·035
·88	II–III	−·034	+·033	·000	+·096	+·105	+·102	−·125	+·128	−·126
·96	III–IV	+·045	−·002	+·022	+·135	+·139	+·137	+·141	+·057	+·135
1943·06	IV–V	+·033	+·053	+·043	+·132	+·136	+·134	+·037	−·065	+·047
·14	V–VI	+·082	+·062	+·072	+·140	+·012	+·076	−·103	+·142	−·084
·23	VI–VII	+·137	+·077	+·107	+·061	+·076	+·068	+·022	+·011	+·082
·31	VII–VIII	+·084	+·113	+·098	+·054	+·037	+·045	−·009	−·060	+·001
·39	VIII–IX	+·122	+·172	+·147	+·049	+·072	+·060	−·106	−·093	−·083
·47	IX–X	+·186	+·077	+·132	+·010	+·005	+·007	−·136	−·094	−·114
·56	X–XI	+·094	+·101	+·098	−·041	−·043	−·042	−·121	−·007	−·107
·65	XI–XII	+·112	+·129	+·120	−·053	−·012	−·032	+·005	+·026	−·001
·72	XII–I	+·096	−·020	+·038	−·046	−·063	−·054	+·055	+·027	+·040
·81	I–II	−·066	+·019	−·023	−·059	−·002	−·030	+·016	−·137	+·021
·90	II–III	+·090	−·076	+·007	+·009	+·020	+·014	−·121	+·095	−·129
·98	III–IV	−·091	−·042	−·067	+·106	−·003	+·051	+·079	+·037	+·087
1944·06	IV–V	−·071	+·004	−·033	+·070	+·137	+·103	+·038	−·119	+·037
·14	V–VI	−·042	+·027	−·007	+·131	+·158	+·144	−·118	+·034	−·118
·23	VI–VII	−·010	+·030	+·010	+·153	+·154	+·153	+·073	−·004	+·053
·31	VII–VIII	+·091	+·061	+·076	+·120	+·163	+·141	−·024	−·060	−·014
·39	VIII–IX	+·190	+·192	+·191	+·075	+·164	+·119	−·055	−·094	−·057
·48	IX–X	+·293	+·263	+·278	+·105	+·075	+·090	−·108	−·076	−·101
·56	X–XI	+·274	+·274	+·274	−·024	−·020	−·022	−·091	+·016	−·083
·64	XI–XII	+·292	+·266	+·279	−·105	−·075	−·090	+·034	+·062	+·025
·72	XII–I	+·139	+·164	+·151	−·209	−·128	−·168	+·076	+·038	+·069
·81	I–II	−·027	−·012	−·019	−·195	−·166	−·180	+·006	−·158	+·022
·89	II–III	−·004	−·105	−·055	−·118	−·151	−·134	−·166	+·102	−·162
·98	III–IV	−·126	−·179	−·152	−·076	−·080	−·078	+·110	+·106	+·106
1945·06	IV–V	−·169	−·138	−·153	+·009	+·030	+·019	+·030	−·079	+·068
·14	V–VI	−·196	−·152	−·174	+·043	+·064	+·053	−·089	+·109	−·084
·22	VI–VII	−·129	−·146	−·137	+·137	+·159	+·148	+·079	+·002	+·094
·31	VII–VIII	−·007	−·124	−·066	+·223	+·216	+·219	−·027	−·068	−·012
·40	VIII–IX	+·065	+·120	+·092	+·230	+·235	+·232	−·085	−·110	−·076
·48	IX–X	+·170	+·172	+·171	+·219	+·254	+·236	−·158	−·120	−·134
·55	X–XI	+·283	+·186	+·234	+·124	+·115	+·119	−·112	+·027	−·116
·64	XI–XII	+·310	+·248	+·279	+·038	+·033	+·036	−·020	+·012	+·003
·72	XII–I	+·343	+·267	+·305	−·059	−·071	−·065	+·073	+·071	+·042
·81	I–II	+·292	+·187	+·239	−·189	−·177	−·183	+·093	−·146	+·082
·89	II–III	+·037	+·163	+·100	−·172	−·262	−·217	−·210	+·162	−·173
·97	III–IV	+·045	+·104	+·074	−·239	−·135	−·187	+·070	+·100	+·116
1946·06	IV–V	−·067	−·162	−·114	−·165	−·151	−·158	+·145	−·066	+·122
·14	V–VI	−·174	−·179	−·176	−·122	−·050	−·086	−·078	+·065	−·072
·22	VI–VII	−·136	−·247	−·192	−·042	+·034	−·004	+·083	+·024	+·074
·31	VII–VIII	−·231	−·204	−·217	+·191	+·142	+·166	−·070	−·076	−·023
·39	VIII–IX	−·113	−·155	−·134	+·203	+·275	+·239	−·156	−·186	−·116
·48	IX–X	−·055	−·047	−·051	+·289	+·231	+·260	−·196	−·134	−·191
·56	X–XI	+·140	+·095	+·117	+·273	+·302	+·287	−·204	−·083	−·169
·64	XI–XII	+·156	+·171	+·163	+·229	+·281	+·255	−·059	+·013	−·071
·72	XII–I	+·263	+·263	+·263	+·163	+·163	+·163	+·044	−·088	+·029
·81	I–II	+·263	+·278	+·270	+·084	+·060	+·077	+·048	−·146	−·020
·89	II–III	+·246	+·234	+·240	−·067	−·042	−·054	−·102	+·198	−·124
·97	III–IV	+·290	+·167	+·228	+·047	−·059	−·006	+·067	+·090	+·132

TABLE VIII

Northern Stations

Epoch	Group	X E.	X M.	X Mean	Y E.	Y M.	Y Mean	Z E.	Z M.	Z Mean
		"	"	"	"	"	"	"	"	"
1935·06	IV–V	−·064	−·007	−·036	+·029	+·059	+·044	+·122	−·089	+·106
·14	V–VI	+·049	−·055	−·003	+·006	−·043	−·019	−·098	+·116	−·094
·23	VI–VII	−·027	+·011	−·008	+·041	+·026	+·034	+·068	+·005	+·092
·30	VII–VIII	+·037	−·008	+·015	+·026	+·010	+·018	−·038	−·074	−·016
·39	VIII–IX	+·035	−·009	+·013	+·058	+·073	+·066	−·110	−·194	−·092
·47	IX–X	−·003	+·036	+·017	+·069	+·069	+·069	−·267	−·113	−·230
·56	X–XI	+·049	+·045	+·047	+·004	+·038	+·021	−·119	+·059	−·116
·64	XI–XII	−·007	−·001	−·004	+·041	+·101	+·071	+·051	+·091	+·055
·72	XII–I	+·005	+·010	+·008	+·084	+·147	+·116	+·075	+·095	+·083
·80	I–II	−·023	−·025	−·024	+·092	+·004	+·048	+·085	−·079	+·090
·89	II–III	−·053	−·034	−·044	+·030	+·104	+·067	−·054	+·150	−·066
·97	III–IV	−·059	−·041	−·050	+·068	+·043	+·056	+·200	+·141	+·175

observations at Kitab brings a greater uncertainty to the determination of Y. From this it is clear that it is desirable that the work should proceed everywhere with the greatest regularity and without interruption. The interruptions, apart from upsetting the homogeneity and continuity of the results, also cause doubts and uncertainties. I wonder whether, in view of all the difficulties experienced in Italy in maintaining the service at Carloforte, it would not be advisable to revert to the original system prior to 1914 when all the stations were directly controlled by the old International Geodetic Association.

It has been already pointed out that the values of Z derived from the observations in each group represent to a great extent the effect of the errors in the adopted declinations and consequently they give, with a change of sign, the corrections to the mean of the declinations of each group. It follows that the values of Z obtained in successive years should agree; the agreement is, in fact, satisfactory when it is remembered that the individual values are subject to errors of observation and that in Z are included also the effects of real or apparent latitude variations, which can be separated only with difficulty.

In Table X are summarized the values obtained in each year from 1935 to 1946, after applying the corrections to the values for the years previous to 1940 to the groups IX and XII, as already mentioned, in order to reduce all the results to the positions of the *General Catalogue*. In the last line the mean value for each group is given. The mean error of a single value, derived from the scatter about the mean values, is $\pm 0''\cdot 028$; that of the mean group corrections is $\pm 0''\cdot 008$.

The values of X and Y from Tables VII, VIII and IX were plotted and smooth curves drawn to pass as nearly as possible through the plotted points. From these curves the co-ordinates X and Y of the instantaneous pole were read off at every tenth of a year and are given in Table XI. With these values the curves showing the polar motion are to be found in the diagrams.

II. *Final Reductions of the Observations for the Period* 1935–40

The end of 1940 completed the first period of 6 years, which includes five Chandlerian periods and six yearly periods, from the time when the reduction of the observations taken at the International Latitude Stations was entrusted to us. The reduction in the work of the Office caused by the war enabled me to investigate the observational data so far collected in order to determine improved values of the polar motion to supersede the provisional values which are published year by year.

Table IX

Northern and Southern Stations

Epoch	Group	X E.	X M.	X Mean	Y E.	Y M.	Y Mean	Z_b E.	Z_b M.	Z_b Mean	Z_a E.	Z_a M.	Z_a Mean
		″	″	″	″	″	″	″	″	″	″	″	″
1935·06	IV–V	−·063	−·025	−·044	+·030	+·043	+·037	+·120	−·087	+·120	+·106	+·020	+·106
·14	V–VI	+·037	−·044	−·004	−·004	−·033	−·019	−·097	+·113	−·092	+·004	+·081	+·012
·23	VI–VII	−·023	−·001	−·012	+·045	+·015	+·030	+·068	+·005	+·091	+·072	−·280	+·077
·30	VII–VIII	+·026	−·007	+·010	+·016	+·011	+·014	−·037	−·074	−·016	−·260	−·075	−·270
·39	VIII–IX	+·012	−·018	−·003	+·039	+·066	+·053	−·108	−·191	−·091	−·112	−·062	−·094
·47	IX–X	−·005	+·032	+·014	+·068	+·066	+·067	−·264	−·111	−·228	−·095	−·001	−·079
·56	X–XI	+·063	+·035	+·049	+·016	+·030	+·024	−·120	+·059	−·116	−·034	+·081	−·018
·64	XI–XII	−·004	−·020	−·012	+·043	+·085	+·064	+·050	+·092	+·055	+·099	−·092	+·090
·72	XII–I	−·022	−·042	−·032	+·062	+·103	+·083	+·076	+·099	+·084	−·102	+·029	−·097
·80	I–II	−·050	−·050	−·050	+·069	−·017	+·026	+·087	−·075	+·093	+·083	+·273	+·056
·89	II–III	−·060	−·083	−·071	+·026	+·062	+·044	−·052	+·153	−·064	+·282	−·026	+·278
·97	III–IV	−·081	−·053	−·067	+·050	+·034	+·042	+·200	+·140	+·177	+·021	+·092	−·003
1937·96	—	—	—	—	—	—	—	—	+·033	—	—	+·109	—
1938·06	IV–V	−·187	−·215	−·201	−·021	+·007	−·007	+·093	−·062	+·063	+·116	·000	+·112
·14	V–VI	−·133	−·161	−·147	+·042	+·034	+·038	−·078	+·110	−·070	+·009	+·029	+·004
·23	VI–VII	−·119	−·176	−·147	+·089	+·101	+·095	+·065	+·026	+·087	−·036	−·423	−·003
·31	VII–VIII	−·128	−·088	−·108	+·135	+·110	+·122	−·026	−·038	·000	−·326	−·165	−·374
·39	VIII–IX	−·034	−·071	−·052	+·150	+·172	+·161	−·102	−·212	−·070	−·148	−·069	−·156
·47	IX–X	−·030	−·013	−·021	+·152	+·177	+·164	−·232	−·137	−·222	−·107	−·007	−·088
·56	X–XI	+·098	+·093	+·095	+·094	+·119	+·106	−·091	+·052	−·114	+·102	+·189	+·047
·64	XI–XII	+·163	+·141	+·152	+·069	+·121	+·095	+·063	+·095	+·057	+·182	−·020	+·185
·72	XII–I	+·093	+·129	+·111	+·035	+·040	+·037	+·098	+·068	+·097	−·053	+·115	−·036
·80	I–II	+·040	+·013	+·026	+·013	−·037	−·012	+·094	−·096	+·081	+·138	+·314	+·126
·88	II–III	−·039	−·032	−·035	−·083	−·036	−·059	−·094	+·135	−·095	+·339	−·021	+·326
·97	III–IV	−·142	−·201	−·171	+·022	−·085	−·032	+·103	+·031	+·119	−·053	+·041	−·037
1939·06	IV–V	−·148	−·101	−·125	+·023	−·094	−·036	+·059	−·098	+·045	+·078	−·019	+·060
·14	V–VI	−·130	−·147	−·139	−·028	−·015	−·022	−·113	+·107	−·106	−·035	+·013	−·027
·22	VI–VII	−·154	−·147	−·151	+·055	+·079	+·067	+·059	+·025	+·083	+·023	−·350	+·018
·31	VII–VIII	−·106	−·038	−·072	+·093	+·079	+·086	−·042	−·032	−·009	−·403	−·175	−·377
·39	VIII–IX	+·015	−·084	−·035	+·086	+·196	+·141	−·089	−·241	−·061	−·165	−·133	−·170
·47	IX–X	−·042	−·052	−·047	+·131	+·104	+·118	−·209	−·095	−·225	−·111	+·007	−·122
·56	X–XI	+·036	+·012	+·024	+·127	+·135	+·131	−·094	+·026	−·094	+·023	+·221	+·015
·64	XI–XII	+·147	+·147	+·147	+·112	+·114	+·113	+·026	+·060	+·026	+·179	−·049	+·200
·73	XII–I	+·157	+·138	+·148	+·058	+·070	+·064	+·066	+·100	+·063	−·074	+·135	−·062
·80	I–II	+·188	+·152	+·170	+·074	+·022	+·048	+·103	−·089	+·102	+·126	+·342	+·131
·89	II–III	+·068	+·098	+·083	−·016	−·001	−·009	−·117	+·144	−·103	+·282	−·011	+·312
·97	III–IV	+·019	+·002	+·011	−·059	−·073	−·066	+·124	+·072	+·134	+·009	+·054	−·001

TABLE X

Group...	IV	V	VI	VII	VIII	IX	X	IX	XII	I	II	III
Year	″	″	″	″	″	″	″	″	″	″	″	″
1935	+·106*	−·094	+·092	−·016	−·092	−·150†	−·116	+·041†	+·083	+·090	−·066	+·175
1936	+·122	−·096	+·090	+·032	−·050	−·103	−·093	+·042	+·079	+·127	−·201	+·154
1937	+·092	−·075	+·058	−·014	−·103	−·161	−·142	−·005	+·051	+·084	−·106	+·152
1938	+·063	−·072	+·084	−·026	−·074	−·147	−·120	+·038	+·090	+·078	−·094	+·117
1939	+·044	−·105	+·080	−·008	−·055	−·138	−·094	+·006	+·057	+·095	−·105	+·128
1940	+·061	−·103	+·081	+·010	−·077	−·145	−·089	+·050	+·096	+·037	−·084	+·129
1941	+·064	−·045	+·099	+·010	−·030	−·103	−·099	−·010	+·046	+·046	−·091	+·067
1942	+·044	−·129	+·100	−·039	−·078	−·129	−·113	+·004	+·042	+·035	−·126	+·135
1943	+·047	−·084	+·082	+·001	−·083	−·114	−·107	−·001	+·040	+·021	−·129	+·087
1944	+·037	−·118	+·053	−·014	−·057	−·101	−·083	+·011	+·069	+·022	−·162	+·106
1945	+·068	−·084	+·094	−·012	−·076	−·134	−·116	−·013	+·042	+·082	−·173	+·116
1946†	+·122*	−·072	+·074	−·023	−·116	−·191	−·169	−·085	+·029	−·020	−·124	+·132
1946*	+·090	—	—	—	—	—	—	—	—	—	—	—
Mean	+·071	−·090	+·081	−·008	−·074	−·135	−·112	+·007	+·060	+·058	−·122	+·125

* Half-weights should be given to the two values for 1935 and 1946, as the first is obtained from the observations for the month of January only and the second for December only.

† The corresponding values for the years 1935–40 have been corrected in order to bring the proper motions to the values given by the G.C.

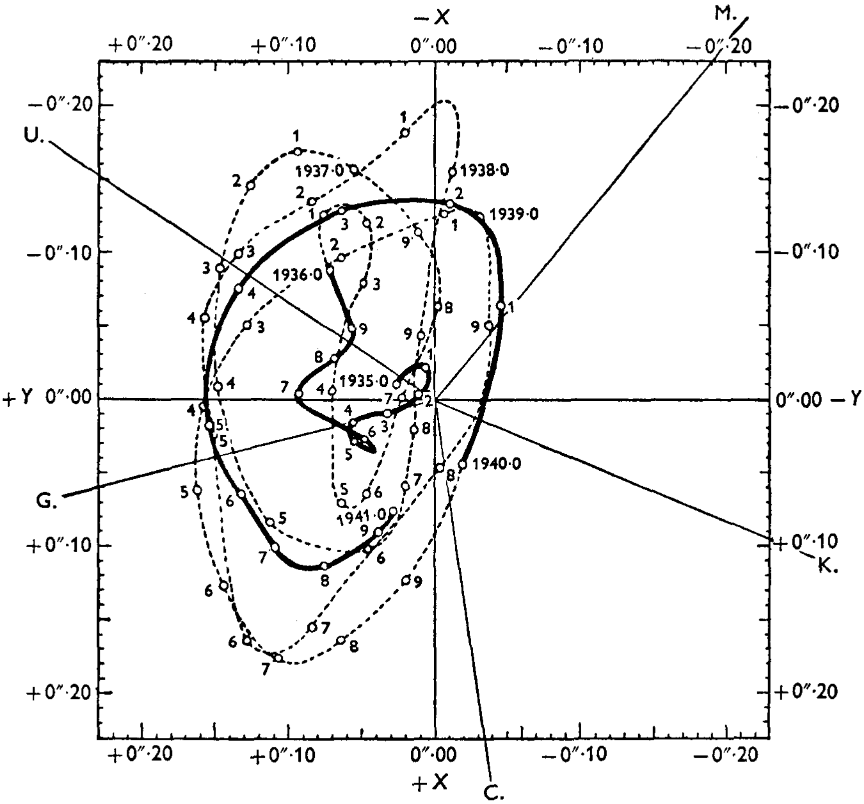

Fig. 1.

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Table XI

Epoch	X	Y
	″	″
1938·0	−·156	−·012
·1	−·183	+·020
·2	−·135	+·084
·3	−·100	+·136
·4	−·056	+·158
·5	+·024	+·153
·6	+·162	+·128
·7	+·154	+·084
·8	+·046	−·002
·9	−·048	−·038
1939·0	−·120	−·031
·1	−·126	−·006
·2	−·097	+·063
·3	−·051	+·127
·4	+·004	+·156
·5	+·062	+·162
·6	+·127	+·143
·7	+·176	+·107
·8	+·165	+·065
·9	+·123	+·019
1940·0	+·044	−·020
·1	−·064	−·046
·2	−·134	−·012
·3	−·129	+·063
·4	−·076	+·132
·5	+·018	+·153
·6	+·064	+·131
·7	+·100	+·108
·8	+·114	+·075
·9	+·091	+·038
1941·0	+·070	+·016
·1	+·038	−·013
·2	+·003	−·012
·3	−·013	+·006
·4	−·004	+·069
·5	+·021	+·093
·6	+·040	+·124
·7	+·066	+·121
·8	+·082	+·081
·9	+·074	+·047
1942·0	+·023	+·018
·1	+·007	+·006
·2	−·004	+·001
·3	+·001	+·016
·4	+·009	+·027
·5	+·009	+·028
·6	−·007	+·034
·7	−·008	+·076
·8	+·002	+·103
·9	+·014	+·120

Epoch	X	Y
	″	″
1943·0	+·030	+·146
·1	+·056	+·112
·2	+·087	+·070
·3	+·118	+·055
·4	+·145	+·036
·5	+·129	−·005
·6	+·104	−·037
·7	+·063	−·056
·8	+·007	−·033
·9	−·049	+·012
1944·0	−·066	+·058
·1	−·026	+·125
·2	+·004	+·156
·3	+·060	+·144
·4	+·210	+·116
·5	+·268	+·084
·6	+·272	−·060
·7	+·182	−·150
·8	−·010	−·180
·9	−·084	−·130
1945·0	−·144	−·062
·1	−·173	+·012
·2	−·152	+·135
·3	−·060	+·211
·4	+·092	+·237
·5	+·191	+·228
·6	+·280	+·065
·7	+·305	−·038
·8	+·252	−·178
·9	+·115	−·215
1946·0	+·012	−·176
·1	−·144	−·105
·2	−·191	−·004
·3	−·217	+·166
·4	−·140	+·234
·5	−·020	+·288
·6	+·134	+·278
·7	+·265	+·195
·8	+·292	+·092
·9	+·246	−·040
1947·0	(+·214)	(−·078)

Northern Stations

Epoch	X	Y
	″	″
1935·0	−·012	+·025
·1	−·023	+·007
·2	−·004	+·010
·3	+·009	+·032
·4	+·017	+·056
·5	+·028	+·053
·6	+·030	+·049
·7	−·003	+·092
·8	−·028	+·068
·9	−·049	+·057
6·0	−·088	+·071

Northern and Southern Stations

Epoch	X	Y
	″	″
1935·0	−·036	+·026
·1	−·043	+·005
·2	−·021	+·008
·3	−·001	+·030
·4	+·008	+·050
·5	+·028	+·050
·6	+·021	+·042
·7	−·028	+·064
·8	−·054	+·041
·9	−·067	+·037
1936·0	−·105	+·060
1938·0	−·188	−·019
·1	−·185	+·013
·2	−·142	+·072
·3	−·109	+·125
·4	−·052	+·163
·5	+·021	+·150
·6	+·132	+·099
·7	+·126	+·056
·8	+·033	−·013
·9	−·068	−·061
1939·0	−·150	−·034
·1	−·152	−·017
·2	−·134	+·032
·3	−·086	+·100
·4	−·023	+·135
·5	+·045	+·146
·6	+·118	+·132
·7	+·148	+·080
·8	+·133	+·020
·9	+·074	−·030
1940·0	(−·025)	(−·087)

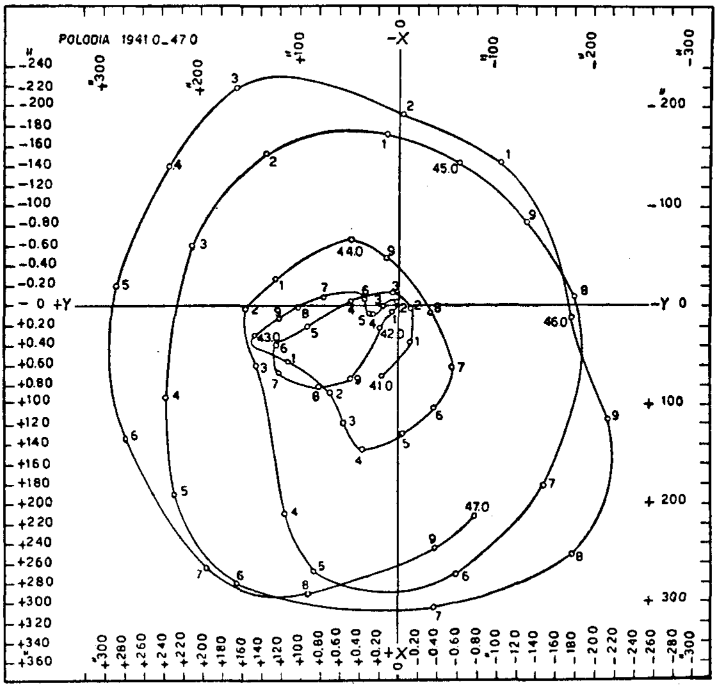

Fig. 2.

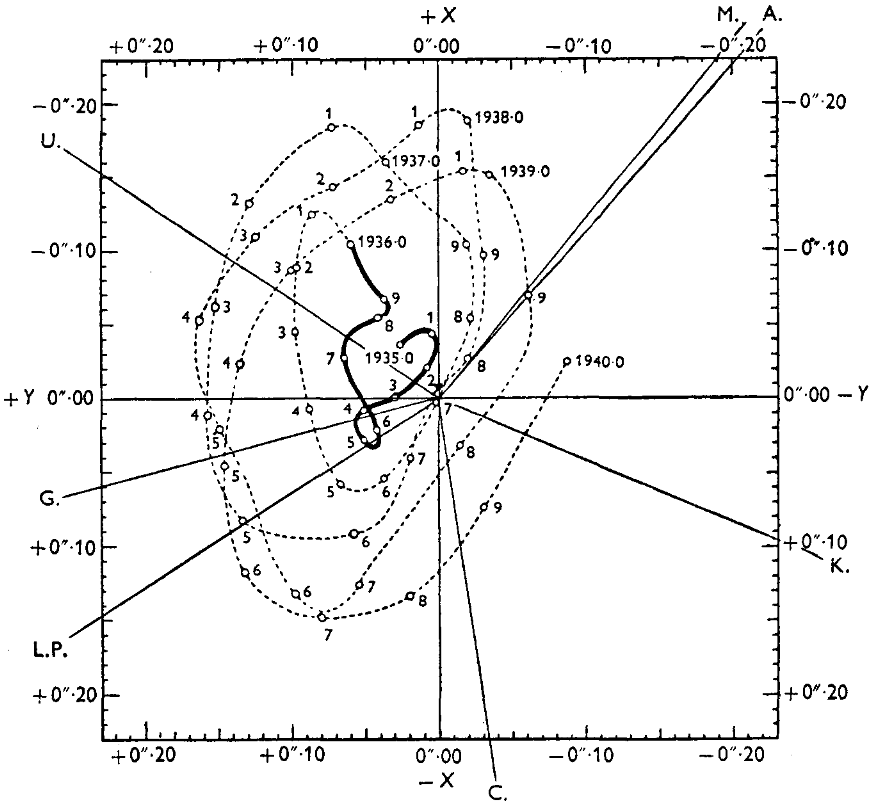

Fig. 3.

First of all we had to investigate the instrumental constants in order to ensure that the values of the latitude variation were free from systematic errors of an instrumental nature. The large mass of observations obtained at the several stations had to be analysed in order to determine the value of one revolution of the micrometer screw of each instrument and its variations with temperature and time. The conclusions have been published in the *Memorie dell' Accademia Nazionale dei Lincei di Roma.** At almost all the stations special observations were made for this purpose, limited in the earlier period to the observations of certain polar stars at their maximum elongation, and then later supplemented by the observation of a pair of stars, as suggested by Prof. Kimura.

The first of these methods offers a means of obtaining simultaneously the screw-value as well as material for the investigation of periodic and progressive errors of the screws, but has many inconveniences for the determination of the screw value. The second is really efficient only when the declinations of the stars are very accurately known and when the observations are continued systematically throughout the whole period, to co-ordinate the results obtained in the different epochs. A long time (about half an hour) is required for the observation of a circumpolar star across the whole field of view of the telescope near its elongation; to observe at intervals of two-tenths of a revolution throughout this time is a considerable strain on the observer; in addition, the position in which the telescope is set will introduce flexure effects. The uncertainties which are thus introduced could perhaps be eliminated if the observations of each star were equally distributed not only between the two instrumental positions but also between the two elongations; this would necessitate repeating the work at intervals of several months and giving preference to observations which are taken when the temperatures are almost identical; but we cannot be certain that nothing will have intervened in the meantime to alter the scale-value of the micrometer. Sufficient attention has not been paid to these factors and the inconsistent results obtained make one suspect the existence of systematic differences due to flexure and personal errors, though no reliable conclusions can be drawn. I believe that if one cannot afford a period long enough for observing, with all possible precautions, a fundamental star very near to the pole, this method of determining the screw-value should not be recommended, as the accuracy of the results obtainable is not proportionate to the work entailed.

The results show, without any doubt, that the method of observing pairs of stars is much more efficient, but for this it is essential: (1) that the declinations and proper motions of the stars should be known with a great accuracy; (2) that the difference in the declinations should be sufficiently large, so that the effects of accidental errors of observation as well as of errors on the adopted declinations are minimized; (3) that the observations of the same pair of stars should be repeated on many evenings in different instrumental positions so as to eliminate personal and instrumental errors and to obtain material for estimating the order of magnitude of the accidental error of measurement, and later for judging whether the differences between the results from individual pairs are to be attributed to errors in the declinations or to accidental errors of measurement; (4) that observations should be made of many pairs in the hope of balancing out the effects of errors of the adopted declinations; (5) that a number of pairs should be observed at different periods of the year when the temperatures will be different (for instance in the northern hemisphere with observations taken in the morning in the month of April after the latitude observations, and in July in the evening before the latitude observations) in order to determine the effect of temperature on the screw-value. I shall not give details of the results obtained at individual stations but merely mention that the proposal made at the meeting in Paris in 1935 by Prof. Kimura that the stations should observe a large number of star pairs has been followed in practice only at the stations of Batavia, Adelaide, La Plata, Mizusawa and Kitab (perhaps because with a larger staff they could more easily attend to this extra work).

* *Memorie Classe Scienze fisische, matematiche e naturali dell' Accademia Nazionale dei Lincei*, vol. 1, fasc. 4, Sezione 1. Roma, 1947.

Unfortunately, the method of making the observations has been interpreted differently at different stations. The stars given by Kimura present a serious difficulty, as the pairs do not follow each other in such a way that they can be observed in succession; if one particular pair is observed, it is necessary to miss the next pair and sometimes two or three others; moreover, at certain times as many as 14 pairs occur in a period of two hours, but there are other periods during which only three or four are to be found. At Batavia it was thought that all the 92 pairs should be observed, and that it would have been sufficient to do this once or twice every year. At other stations, a selection was made of certain pairs, and the measures of these pairs were repeated many times during each year. The choice of the pairs having been made according to different criteria, the pairs observed at the different stations were not the same. This gave rise to some difficulty when it was desired to intercompare the results obtained. Since it can be assumed that the effect of errors in the declinations will be less the larger the number of different pairs observed, the number of pairs should not be too small; on the other hand, each pair should be observed for a sufficient number of times to enable corrections to the declinations to be derived. At the same time, it is important not to overload the observers. Experience gained in recent years at the different stations shows that 40 pairs will be sufficient. It is desirable that all the stations should concentrate on these pairs and preferably on those which have already been observed sufficiently to derive reliable corrections to the declinations, so that the results can be reduced to the mean of all the pairs. These corrections are found in the Table on pp. 280–1 of my above-mentioned work. I must also mention another trouble which came to light in the course of this investigation. From time to time there occur sudden and apparently inexplicable changes in the micrometer screw-value, without any note in the observing book of any adjustment of focus having been made. While, for instance, for Batavia every small fact which might possibly affect the observations is noted, for Kitab there is no note to account for a change of screw-value of over 0″·055 corresponding to a displacement of the plane of the wire system of the order of about 2 mm. We must also add that these variations are exactly confirmed by the results of the subsequent investigations.

TABLE XII

Year	Adelaide	Mean error	La Plata	Mean error
	″	″	″	″
1935	+·00468	±·00204	−·00628	±·00114
1936	+·01230	±·00293	−·00676	±·00130
1937	+·00982	±·00261	−·00891	±·00140
1938	+·00814	±·00201	−·00444	±·00141*
			+·00419	±·00053†
1939	+·01013	±·09215	+·00052	±·00136
Mean	+·01009	±·00120	−·00686	±·00068‡
			+·00177	±·00111§

* Value obtained from the first eight months of the year 1938.
† Values obtained from the four last months of this year.
‡ Mean obtained from the period for the years 1935–37 and the eight months of the year 1938.
§ Mean of the last months of 1938 and the year 1939.

Having completed this first study and having determined the micrometer screw-values and their variations, both with temperature and through the six-year period, all the latitude variations were re-computed. It is clear that if there had not been any errors in the declinations adopted for the latitude pairs and if the adopted screw-values at the different stations were correct, the mean of the monthly latitudes (and particularly those derived only from the nights when all the six pairs of each group were observed) should give identical results. If this does not happen, differences must arise from errors of the adopted declinations or screw-values. If we consider the results obtained in a particular month for a particular group, observed by the five northern stations, we have six unknowns for the six corrections of declinations and five for the corrections of the five micrometer screw-values; i.e. a total of 11 unknowns, with 30 equations of condition; it is clear that it is possible to determine these 11 unknowns. A rigorous solution would have involved very heavy computations, made more difficult by the small differences between the coefficients for the correction of the micrometer screw-values at the various stations for any given pair. A method of successive approximations was therefore adopted. Particulars need not be given; but as an illustration of the results, those obtained for the two stations of the southern parallel at Adelaide and La Plata are quoted. Taking the micrometer screw-values found on p. 215 (for Adelaide) and on p. 231 (for La Plata) of my quoted work, I found, after three successive approximations, that for the years 1935–39 the value of the screw-values required the corrections given in Table XII on p. 200.

A glance at these corrections and at their mean errors shows that the differences between the yearly means are not necessarily real differences; we must subdivide the whole interval into limited periods within which the corrections oscillate within the limits of the expected errors. For Adelaide two periods are enough: the one consisting of the year 1935 and the other of the years 1936–39. For La Plata, the following five periods are used: (1) 1935–36; (2) 1937; (3) 1938, January to end of August; (4) 1938, September to December; (5) 1939–40. The following values of the screw-values were used:

Adelaide	1935	$R = 39''{\cdot}9481 - 0''{\cdot}00120\,(t^\circ - 15^\circ{\cdot}0)$
	1936–39	$R = 39{\cdot}9535 - 0{\cdot}00120\,(t^\circ - 15^\circ{\cdot}0)$
La Plata	1935–36	$R = 39{\cdot}7644 - 0{\cdot}00117\,(t^\circ - 15^\circ{\cdot}0)$
	1937	$R = 39{\cdot}7620 - 0{\cdot}00117\,(t^\circ - 15^\circ{\cdot}0)$
	1938 to end of August	$R = 39{\cdot}7665 - 0{\cdot}00117\,(t^\circ - 15^\circ{\cdot}0)$
	1938 Sept.–Dec.	$R = 39{\cdot}7751 - 0{\cdot}00117\,(t^\circ - 15^\circ{\cdot}0)$
	1939–40	$R = 39{\cdot}7710 - 0{\cdot}00117\,(t^\circ - 15^\circ{\cdot}0)$

Along with the determination of the corrections to the screw-values we have determined the declination correction for each star pair, required to reduce the latitude derived from that pair to the mean value for the whole group. It must be remembered that these corrections are not the whole corrections, as each group needs a declination correction to reduce the groups to the same basis. This error of the mean declinations of each group, however, affects the correction for the screw-values. It may happen, therefore, that for two groups of stars, observed on the same night, two different corrections for the screw-value may be required, and that such systematic differences will recur from year to year, because they have their origin in a residual error of the declinations of the two groups.

It is unnecessary in this report to give particulars of these investigations, which require detailed description, supported by all the numerical results, and which will have to be published separately. It is sufficient to mention that these computations have been completed and that, using the derived values, the definitive reduction of all the observations obtained from the beginning of 1935 to the end of 1940 has been undertaken and completed.

For the eight stations we have derived for each pair and for each group the values of the mean monthly latitudes and for each group also the mean latitudes for each night. The computation of the instantaneous co-ordinates of the pole and the detailed study of the residual term, due to phenomena of local or general character, is still to be done. It may be of interest to mention a result already obtained. Because of the uniformity of distribution through the year of the observations at La Plata and because the observations during six years, which include six yearly cycles and five Chandlerian cycles, were all made by one observer, I have analysed the mean latitudes according to the hour angle $\theta_{☾}$ of the Moon at the mean time of observation, giving to the individual values a weight proportional to the number of pairs used. The values ϕ of the latitude for the different lunar hour-angles are given in Table XIII, where the number of pairs and the relative weight is also given for each value. In the fifth column are given the residuals of each value from the mean. In the sixth are given the values computed from the following formula omitting the terms in $3\theta_☾$ for the reason given below and in the seventh are the corresponding residuals v'.

$$f = 31''\cdot814 + 0''\cdot0016 \cos\theta_☾ - 0''\cdot0059 \sin\theta_☾ + 0''\cdot0156 \cos 2\theta_☾ - 0''\cdot0047 \sin 2\theta_☾ + [+0''\cdot0010 \cos 3\theta_☾ + 0''\cdot0033 \sin 3\theta_☾ + \ldots].$$

Inspection of the residuals v shows how the latitude values vary periodically, and that the main term must be half the lunar day. By analysing them, the formula given above was derived. The sum of the squares of the residuals v is 6783, and of the residuals v' is only 3120, i.e. less than half. When the calculation is repeated with the inclusion of the terms in $3\theta_☾$, the sum of the squares of the residuals is 3037. This reduction is far too small to enable us to attribute any reality to those terms. This result, while confirming the results obtained years ago by Stetson, proves that in the latitude determinations we must take into account a short-period variation, of a maximum amplitude of three to four hundredths of a second, which might be caused by the sum of the effects of different phenomena due to the Moon, such as the deviation of the vertical produced by solid tides and refraction phenomena related to atmospheric tides. Even this brief description is sufficient to show how much interest this type of research can have not only for astronomy but also for geodesy and geophysics, and how necessary it is that, as soon as possible, the service should be intensified in order to secure a wider collection of observations, which should be of the highest accuracy.

TABLE XIII

Moon's hour angle	Seconds of lat.	No. of pairs	P	v	f	v'
0^h	31″·808	350	1·2	−6	31″·831	−23
1	833	372	1·2	+19	825	+8
2	833	469	1·6	+19	816	+17
3	811	385	1·3	−3	806	+5
4	794	442	1·5	−20	798	−4
5	781	399	1·3	−33	793	−12
6	794	469	1·6	−20	793	+1
7	789	407	1·4	−25	797	−8
8	821	452	1·5	+7	805	+16
9	802	345	1·1	−12	813	−11
10	834	406	1·3	+20	822	+12
11	834	379	1·3	+20	827	+7
12	819	353	1·2	+5	828	−9
13	812	323	1·1	−2	825	−13
14	825	370	1·2	+11	819	+6
15	821	335	1·1	+7	812	+9
16	799	374	1·2	−15	806	−7
17	814	416	1·4	0	803	+11
18	804	350	1·2	−10	804	0
19	792	435	1·4	−22	809	−17
20	830	395	1·3	+16	816	+14
21	834	390	1·3	+20	824	+10
22	816	301	1·0	+2	830	−14
23	843	347	1·2	+29	833	+10

The attempt to correlate the latitudes with lunar declinations did not give any conclusive results. Probably there are many effects which are so small that they are masked by other larger effects. I hope to revert to this particular research when all the computations have been completed. It will then be possible to eliminate the effect of the motion of the pole from the derived latitudes and therefore it should be easier to identify the lunar effects; it will then be possible to obtain the corresponding values also for the other stations.

I hope that I have given a clear idea of the actual state of the work of the definitive reductions of the observations for the six years, 1935–40. The delay in completing this work has been due in part to the necessity for overtaking the arrears of computation of the observations obtained during the war years and in part to the fact that insufficient staff has been available to permit the work to be hastened.

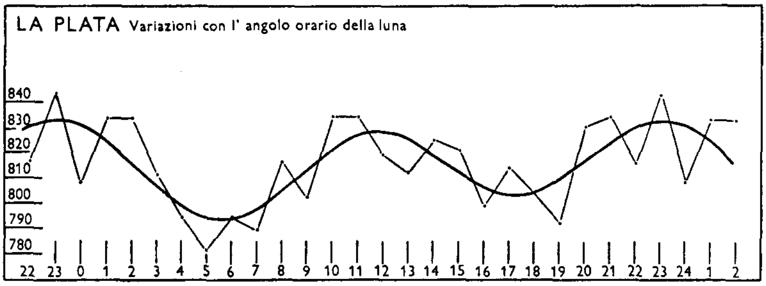

Fig. 4.

III. *Research carried out in Italy for the Study of the Problems of Latitude Variation*

I feel that it is my duty, before concluding this report, to draw the attention of the Commission to some researches which have been carried out in Italy, although they do not come under the Central Bureau.

When in 1943 war operations compelled observations at Carloforte to be suspended, it was decided, in agreement with the President of the Italian Geodetic Commission, and with the approval of the Ministry, to take advantage of a programme of work already in hand by Prof. Cecchini, Director of the Observatory of Pino Torinese, to undertake latitude determinations at the Observatory, using the same methods as at the International Stations, and to continue them until such time as work could be resumed at Carloforte. While Dr Missana, the observer from Carloforte, using a zenith telescope put at his disposal by the Observatory of Capodimonte, observed the two latitude groups, each of six pairs of stars, Prof. Cecchini, assisted by Dr A. Fresa and Dr Tedeschini, observed the same stars with a Bamberg transit instrument as well as the preceding and following groups of the general programme. In this way not only was a mutual check of the results obtained, but the uninterrupted period of night observations lasting eight hours provides data for complementary researches of great interest. This work was continued until the end of 1946 so that there are available seven months of simultaneous observations. These observations can also be used for the study of the movement of the pole during the period in which the collaboration of Carloforte was lacking.

The results of these two long series of observations are only partly available at present, but the full results should be ready within a few months.

In connection with series of latitude observations, intended for investigation of local phenomena, I must also mention those recently started by Prof. Peisino at Teramo. The observations are made with a small zenith telescope and the programme is similar to that adopted at the International stations.

A research of great interest is in progress at Naples by Dr Nicolini, who, after having made a great contribution as an observer at the station of Carloforte, has now devoted himself to the study of latitude variation phenomena, analysing from different viewpoints the large number of observations which have been so far gathered, with the purpose of separating, as far as possible, the two principal movements of the pole, the yearly movement and the Chandler movement. He has already published two papers, one in the *Rendiconti* and one in the *Memorie dell' Accademia Nazionale dei Lincei*; he has prepared a summary of his conclusions which is included in this Report. Apart from the variable amplitudes and periods shown both by the annual cycle and the Chandlerian cycle, there is also shown a displacement of the path of the pole with respect to the mean pole. This displacement, while showing at times a relative regularity of motion, has at other times sudden variations which coincide with changes of programme. It seems reasonable to believe that, while the regular displacements are to be attributed to the imperfect knowledge of the proper motions in declination of the observed stars, the sudden displacements are due to the lack of a proper connection between the different programmes of observation. This draws attention to an inconvenience which has not been sufficiently emphasized. Although we have nearly a half century of accurate observations for the determination of the motion of the pole, we still lack a homogeneous system of declinations.

In the case of the stars included in the first programme of observation at the northern stations (from 1899 to the beginning of 1906) we have, in addition to the investigation of Prof. Fr. Cohn (*Ableitung der Declinationen und Eigenbewegungen der Sterne für den Internationalen Breitendienst*), the direct determinations made with the meridian circle of the Bonn Observatory by Dr Mönnichmeyer (*Beobachtungen der Internationalen Polhöhensterne*, Bonn, 1904). But there is no direct link with the following programmes. It is true that an effort was made always to keep in a new programme a number of pairs belonging to the old programme, but a liaison between the mean systems of declinations was missing. A determination of the declinations of the stars used at the latitude stations would be of great value and might help to enlighten some parts of the problem, though it is difficult to say whether the consequences of these missing links could entirely be overcome; it might then be necessary to recompute all the observational material. In my view the declinations ought to be observed not only with meridian circles but also with vertical circles, such as those of Pulkova, Odessa, Munich, Babelsberg, Belgrade, etc. and possibly making use also of instruments in the prime vertical. The Observatory of Capodimonte intends, as soon as it obtains permission from the Ministry to reorganize its staff, to start these determinations with the Repsold Meridian Circle and eventually to use also a transit instrument in the prime vertical, for which an application has already been made; but it is hoped that the Capodimonte Observatory will not be the only one and that other observatories which possess suitable instruments will collaborate, so that reliable declinations can be determined. If only four observatories would collaborate with a degree of accuracy similar to that of Mönnichmeyer's work we should secure proper motions of greater reliability and obtain better agreement between the latitudes deduced from the different pairs than is possible using the positions of the Boss *General Catalogue* which, though good, are not good enough for the purpose.

From this research by Nicolini it seems to me that the interpretation to be given to the Chandlerian period of the polar motion is still an open question, particularly if we think of the variability of the amplitude as well as of the duration of the period. It appears necessary, rather than desirable, to continue the observations without interruption; while studying means of making them more reliable and numerous, the present liaison system between the stations must be continued, so as to limit as much as possible the sources of uncertainty, among which we must give full weight to the insufficient knowledge of declinations.

IV. *Future Work*

From what has been said, it is clear that if the war has noticeably hampered the normal prosecution of research, these years have not, however, been entirely fruitless. I would dare to say that it is clearer to-day how the study of the movement of the pole of terrestrial rotation is to be considered as a problem of great interest to astronomers, geodesists and geophysicists. In order to clarify many still obscure points, a full and complete collaboration from all sides is indispensable. The astronomical observations ought to be perfected to such an extent as to obtain a much higher degree of accuracy. This to me seems unattainable unless we could increase the focal lengths, eliminate the use of levels, and increase the stability of the instruments. All this seems to have been achieved with the photographic instrument in use at the Naval Observatory at Washington, but with a noticeable increase of work, as to the night observing has been added the measurement of the plates. The proposal to equip a number of stations with similar instruments would certainly, if achieved, give a noticeable advantage, as residual errors due to refraction and personal errors in setting would be eliminated. But if we want to obtain from these new instruments the fullest advantages, we should never depart from the condition presented by the present latitude stations that they should be placed on the same parallel, so as to be able always to observe the same stars. A decision which would enable us to create in the northern hemisphere a group of at least three stations equipped with similar instruments, with at least two stations in the southern hemisphere, would be indeed welcome. For instance, if we wanted to keep the present station of the Naval Observatory, I believe it would not be difficult to find in Europe suitable localities (in Italy for instance, Catanzaro in Calabria, a town of over 40,000 inhabitants) and probably even in the western regions of the United States, north of San Francisco. Personally, I consider it indispensable to retain the stations where they are at present, and as they are at present.

There is no doubt, though, that to eliminate the inconvenience of the discontinuity presented by the station of Carloforte where, for climatic reasons, there are several months of great activity, with other months (in the late autumn and early spring) with very few possibilities of observations, it would be desirable to obtain the co-operation of another observatory placed not far from the Greenwich meridian, in a favourable climatic position, as for instance at Lisbon, prepared to make an efficient contribution by means of regular and systematic observations. Perhaps a recommendation from the I.A.U. to this effect, proposed by our Commission, might result in an understanding with that Observatory and obtain its co-operation.

But our researches do not concern only astronomy, which might well be contented with a less exhaustive study of the problem, but also other fields from which it would be desirable to receive some co-operation. For instance, there is no doubt that it would be very useful to have experiments and observations with the aim of verifying at different places on the Earth the effects produced by the actions of the Moon upon the direction of the local vertical and upon the atmospheric tides, to see to what extent they can cause systematic variations in the refraction; in general, it would be important to know with accuracy every event of meteorological, seismic, hydrological and volcanic nature which might show noticeable perturbations in the state of disposition of masses of the Earth. It is not appropriate for me to draw a programme of such wide co-operation, particularly in view of the difficult conditions under which scientific research is working in almost all countries of the world. It will be enough for the present to have remarked upon it and to leave to the future the task of providing for it.

V. *Financing of the Central Office*

Up to the beginning of the war it had been possible to provide for the needs of the Central Bureau with the remittances sent regularly every year by the I.A.U., the International Union for Geodesy and Geophysics together with the grant from the Consiglio Nazionale delle Ricerche and from the Ministry of Public Instruction. When, later on, difficulties first arose in transferring money from one country to another, they were overcome by a method of compensation. The Consiglio Nazionale delle Ricerche in Rome was credited with the money due to Italy by the I.A.U. and the I.U.G.G. The Consiglio Nazionale delle Ricerche paid to us the amounts due. So the useless double transfer of funds was avoided; this system was carried on also during the war. To be precise I should say that the I.A.U. should have paid the sum of 1350 francs (gold) to the Observatory of Arcetri for the publication of the *Immagini spettroscopiche del bordo solare*, and 2250 francs (gold) to our Central Bureau; since the total sum was in excess of the Italian subscription, the amounts of money given to Arcetri and to Naples were proportionally reduced. When in 1943 and 1944 our office at Naples was cut off and could not receive any financial grant either from the Ministry or from the Consiglio Nazionale delle Ricerche, we had to turn to the generous and keen interest of the President of our Commission, Sir Harold Spencer Jones, and to the Vice-President of the International Union of Geodesy and Geophysics, Dr Walter D. Lambert. We received from the first a sum of £200 sterling granted to us by the Royal Society of London, and from the second an amount of 245.06 dollars, on behalf of the International Association of Geodesy. Similarly thanks to the interest of the President, Sir Harold Spencer Jones, we received during the year 1946 the sum of £200 sterling from each of the two international unions. It was thanks to these grants that we were able to carry on our work; because while the devaluations of the lira reduced it to one-fortieth of its pre-war value, the grant from the Consiglio Nazionale delle Ricerche was still the same and the grant of the Ministry was only double the original. We therefore had to meet practically all the expenses with the grants which reached us from the Unions. I had hoped that the situation would improve during 1947 but instead it deteriorated. It is true that the Unions fixed an annual grant of 2500 francs (gold) each and that the International Astronomical Union at the beginning of 1947 gave instructions to the Consiglio Nazionale delle Ricerche to pay me the amount of 2250 francs (gold) corresponding to the contribution due from Italy to the Union. But so far we have not yet received payment of the residue and nothing has reached us from the International Association of Geodesy, so that, for the whole of the year 1947, the Central Bureau, apart from the partial grant of the International Astronomical Union, has received only the 25,000 lire from the Consiglio Nazionale delle Ricerche (the same sum was granted to us before the war) and 40,000 lire from the Ministry (which is double what had been granted to us in 1942–43) and therefore a total of 210,386.80 lire, which covers only a small part of our real expenses.

It is to be hoped that we shall succeed in obtaining in the very near future the payment of the grant fixed by the Unions for the year 1947–48, payments which are facilitated by the Consiglio Nazionale delle Ricerche of Rome which is disposed to follow the system which proved so practicable in the past, that is to say in paying to us on behalf of the Union the grants and being credited with the subscriptions. But apart from this it is also absolutely necessary that the Consiglio Nazionale delle Ricerche adjust their contribution to the present value of the lira. If this is not done so as to secure our financial position for 1948, it will be impossible for us to continue our work. We have already made an application for this. So far we have met with no success. If it is wished that the Central Bureau should remain entrusted to Italy, which has contributed so powerfully to the study of the problems of the variation of latitude since the time of the researches of Fergola and of A. Nobile, it is necessary that the representatives of Astronomy and Geodesy in the Consiglio Nazionale delle Ricerche and the Italian Geodetical Commission at the Ministry manage to persuade and remind those who still, to-day, contribute practically the same sums as before the war, that the actual value of the lira is only one-fortieth of the pre-war value.

LUIGI CARNERA
Director

APPENDIX. *Observed Characteristics of the Polar Movement.* By T. NICOLINI

As 45 years of definitive results of the International Latitude Service and 12 years of provisional results reduced by Prof. L. Carnera are now available, it is possible to examine in a relatively simple way the fundamental characteristics of the observed polar movement. The summary here sketched presents some features of interest which are not fully in accord with what is generally accepted.

The present analysis is based on analogy with beating wave-forms. The two ascertained components of the polar motion have periods of 1·00 and nearly 1·20 years, so that the

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oscillations in X and Y, as well as the resultant total motion, have variations in amplitude with 'beat period' of about 6 years.

The period of a single revolution of the pole will be subject to an oscillation, as is clear from the first diagram in the figures. It follows from theory that when the crests of that oscillation are contained in the interval 1·00–1·20 years, the annual component is predominant; when this interval contains the troughs of the oscillation, Chandler's component is predominant.

The straightforward application is evident from the diagram, based on the times of transits of the polar path through $+X$. The wave-form shows, about 1923 and 1939, discontinuities in which the amplitude ratio of the two components is reversed: the predominant term is the annual within this time interval, the Chandlerian out of it. These clear indications, like the 'beat period' (which is the simple period of the figured wave-form), must be kept in mind when analysing the data of the International Latitude Service, in order to get a proper disentanglement and determination of the two components of the motion.

A detailed discussion is given in 'Contributi Astronomici' (*Capodimonte*, ser. II, vol. III, No. 8). This paper gives sixteen successive determinations of the annual term. When these have been subtracted from the total polar motion, the residual component is Chandler's motion. The regularity of this component in X and Y is so striking that it must be concluded that only the annual and Chandler's periodicities have physical reality. In contrast to the annual terms, Chandler's term shows striking variations in amplitude; there are five intervals within each of which the amplitude may be considered fairly constant. In Table I are given the mean annual terms in the five intervals of determination which are closest to those now mentioned for that of Chandler.

Table I

Annual terms in five intervals, by tenths of year (unit 0″·01)

Fractions of year ...		·0	·1	·2	·3	·4	·5	·6	·7	·8	·9	Bary-centres
1890·7–907·6	X	−1·5	−5·9	−8·1	−7·2	− 3·3	+ 2·5	+ 7·3	+ 9·0	+ 7·4	+3·6	+0·4
	Y	−4·1	−1·3	+2·3	+5·5	+ 7·6	+ 7·3	+ 5·2	+ 0·9	− 2·2	−4·9	+1·6
1907·7–16·6	X	−1·1	−5·4	−6·3	−3·4	+ 2·2	+ 7·6	+11·8	+11·3	+ 8·2	+4·0	+2·9
	Y	−5·8	−2·8	+2·5	+7·8	+10·8	+11·3	+ 7·4	+ 2·6	− 2·9	−6·1	+2·5
16·7–22·6	X	+2·2	−2·3	−3·2	+0·2	+ 5·5	+10·4	+14·2	+14·3	+11·4	+7·1	+6·0
	Y	−5·9	−2·5	+3·0	+7·2	+ 9·4	+ 8·9	+ 5·3	− 0·5	− 5·3	−6·9	+1·3
22·7–39·6	X	−4·8	−8·7	−9·4	−7·3	− 3·6	+ 0·8	+ 6·8	+ 8·9	+ 5·5	+1·3	−1·0
	Y	−6·2	−4·1	+1·7	+7·2	+10·7	+11·2	+ 8·8	+ 2·8	− 3·0	−5·9	+2·3
39·7–46·6	X	−1·0	−4·1	−5·4	−3·4	− 3·4	+ 8·9	+12·4	+12·2	+ 8·1	+3·1	+3·4
	Y	−0·6	+1·3	+4·9	+9·4	+12·0	+12·3	+ 7·6	+ 2·0	− 0·4	−2·1	+4·6

Table II

Chandler's term in five intervals, by tenths of cycle, commencing with the troughs of the X oscillation (units 0″·01)

Fractions of cycle...			·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
(I)	1890·0–907·8	X	−14·9	−10·9	− 4·3	+ 5·5	+11·5	+12·9	+10·7	+ 3·7	− 5·7	−12·2
		Y	− 0·8	+ 8·8	+13·7	+12·6	+ 6·7	− 1·3	− 7·8	−13·3	−13·4	− 7·7
(II)	1907·8–17·3	X	−19·6	−16·0	− 7·4	+ 8·0	+16·6	+20·0	+16·7	+ 5·0	− 6·1	−16·2
		Y	− 0·5	+12·6	+19·9	+19·8	+10·8	− 2·0	−13·6	−20·1	−20·6	−13·6
(III)	17·3–23·2	X	−13·8	− 9·2	− 4·4	+ 4·0	+ 9·4	+11·6	+ 9·2	+ 3·4	− 3·8	− 9·2
		Y	+ 1·0	+ 8·6	+12·2	+11·0	+ 6·0	− 0·6	− 8·6	−11·0	−10·2	− 3·8
(IV)	23·2–42·7	X	− 7·3	− 5·3	− 2·7	+ 0·5	+ 3·8	+ 6·8	+ 6·6	+ 3·2	− 0·7	− 4·9
		Y	+ 0·4	+ 3·5	+ 5·7	+ 6·2	+ 4·7	+ 1·4	− 3·2	− 6·0	− 5·8	− 3·8
(V)	42·7–46·3	X	−11·3	− 7·3	− 1·3	+ 6·7	+13·3	+16·7	+14·7	+ 4·3	− 4·7	−10·7
		Y	+ 3·0	+ 8·3	+12·3	+11·7	+ 3·7	− 4·7	−12·3	−16·3	−14·0	− 6·7

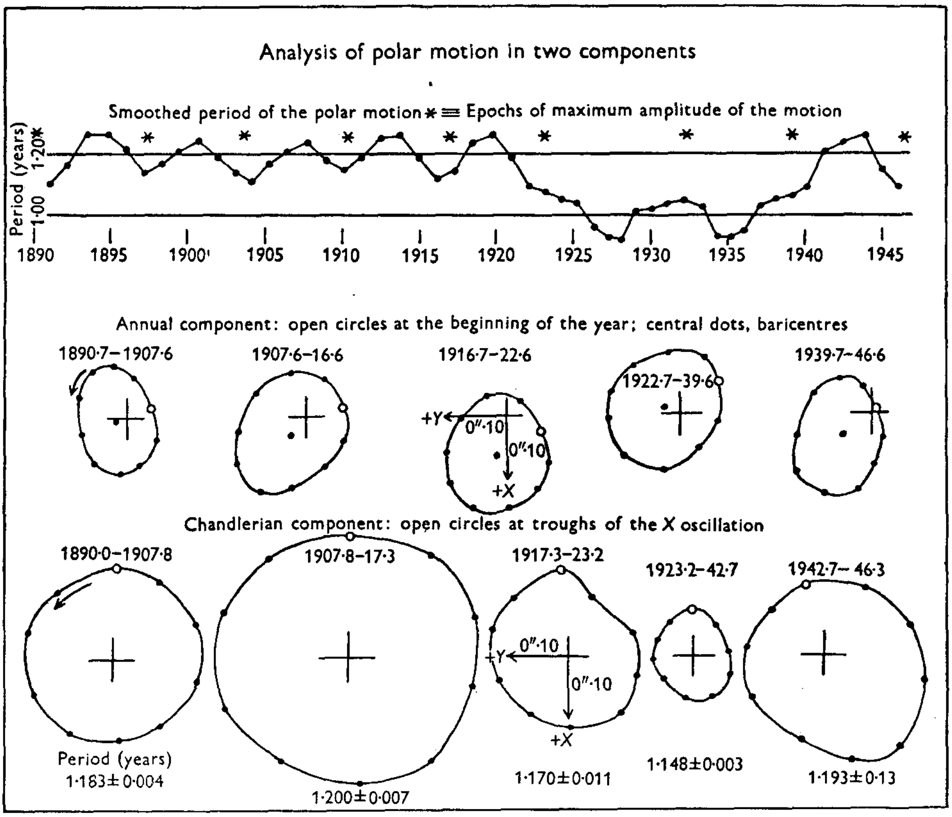

Fig. 5.

The shifting of the barycentres in reference to the 'mean pole' (assumed origin of X and Y) is an apparent motion, a 'programme shifting' due to errors in proper motions and changes in the observing programme. For instance, since 1940 the declinations from the Albany *General Catalogue* have been used; the previous values were modified by as much as $+0''{\cdot}96$ and $-0''{\cdot}16$; in addition the observations at the Carloforte Station (nearly on the X axis) have had a long period of interruption. Consequently, the shifting of the barycentre in the last interval is not surprising. The results referring to Chandler's term are synthesized in Table II and are shown, under the annual ones, in the figure. It is of interest to note that the period is variable in correspondence with the amplitude variation.

The transits of Chandler's motion through the points of maximum co-ordinates $+X$ and $-X$, give a time series whose dates are all determined with about the same precision. As our series begins at 1890·0, and this epoch coincides with a well-established transit through $-X$, i.e. with a trough of the X oscillation, we will consider here the whole series of these troughs. This series has been accurately smoothed by considering the epochs corresponding to all the crests and troughs of Chandler's oscillations in X and Y. The best results are so obtained, and they are given in Table III, with the first differences P, which correspond to the successive single values of Chandler's period. Some more details are given in the published paper, particularly in Table VII.

These results may be used to get both mean periods and their precision. In regard to the M.S.E. of a value P, it appears possible without serious difficulty to make a general estimate (from differences, considered as accidental, between tabulated P and mean values in the five large intervals), which gives 0·054 years. On account of the presumably equal precision of all the epochs, each of the five intervals is to be considered as affected by the same M.S.E., and then we get the M.S.E. of the mean periods. The final results are synthesized in Table IV.

TABLE III

Transits of Chandler's component pole through points of maximum co-ordinate $-X$, and successive periods

Epochs	P	Epochs	P	Epochs	P	Epochs	P	Epochs	P
1890·00	1·09	1901·88	1·19	1913·78	1·17	1925·64	0·93	1936·91	1·10
91·09	1·21	3·07	1·15	14·95	1·23	26·57	1·17	38·01	1·18
92·30	1·24	4·22	1·21	16·18	1·16	27·74	1·12	39·19	1·22
93·54	1·16	5·43	1·12	17·34	1·18	28·86	1·09	40·41	1·16
94·70	1·13	6·55	1·19	18·52	1·26	29·95	1·15	41·57	1·13
95·83	1·25	7·74	1·18	19·78	1·21	31·10	1·11	42·70	1·16
97·08	1·24	8·92	1·26	20·99	1·09	32·21	1·19	43·86	1·22
98·32	1·20	10·18	1·12	22·08	1·11	33·40	1·14	45·08	1·20
99·52	1·19	11·30	1·21	23·19	1·18	34·54	1·23	46·28	1·19
1900·71	1·17	12·51	1·27	24·37	1·27	35·77	1·14	(47·47)	—

TABLE IV

Amplitude and mean periods of Chandler's component motion in five intervals

Intervals:		I 1890·7–1907·8	II 1907·8–17·3	III 1917·3–23·2	IV 1923·2–42·7	V 1942·7–46·3
Nos. of periods:		15	8	5	17	3
Amplitude:	$A=$	0″·282	0″·420	0″·242	0″·132	0″·292
Periods (years):	$P=$	1·183	1·200	1·170	1·148	1·193
M.S.E.		±·004	±·007	±·011	±·003	±·013

The variations of period appear to be significant; moreover, they appear nearly proportional to the corresponding amplitude variations, according to the relation

$$P=0{\cdot}185A+1{\cdot}128$$

(P in years, A in 0″·01 units). It might be thought that the variations of period are apparent, and due to some unforeseen effect of the changes of programme on Chandler's term. But the reliability of the results can hardly be challenged, for though a change of programme may shift the annual term it should not modify that of Chandler. In the effective motion, the 'beat period' is clearly seen; it is the time interval between successive epochs of maximum amplitude of the total polar movement (or between crests, or troughs, in the first diagram), and it gives immediately Chandler's period. So, after the maximum amplitude at about 1917, come those of 1923, of 1931, and of 1939; the 'beat period' is clearly lengthened, and this interference effect shows in the simplest way that Chandler's period has decreased. This same fact is also evident in the diagram given by Sir H. Spencer Jones in 'Observations made with the Cookson floating Zenith Telescope, 1927–36' (*Royal Observatory, Greenwich*), which are independent of the international programme. The reality of variations in the period is checked also by the analysis of the second differences; reference may be made to the respective diagram in the paper in 'Contributi' (*Capodimonte*).

The variation of the mean period, particularly the small value during the fourth interval, shows that the analogy (proposed by G. U. Yule) of the 'bombarded pendulum', in which there is a natural period of oscillation, while the periodicity is disturbed by changes of phase, is not appropriate. It would seem preferable here to make the analogy with an uncompensated pendulum, or with one of variable length.

Another conclusion from the above may be mentioned, which provides a warning with regard to changes in the plan of the I.L.S. Up to the present the continuity of programme of the stations on the same parallel has kept the wandering of the 'mean pole' sufficiently under check. Every change of programme should be carefully studied in advance, otherwise this check could become rather confused, and a valuable series of data could get impaired.

B 1. Abstracts of Papers by Members of the Staff of the U.S. Naval Observatory

1. 'Lunar effects on clock corrections.' By Paul Sollenberger and G. M. Clemence. *A.J.* **48**, 78, 1939. The analysis of five years of clock corrections determined by the PZT shows the normal tidal effect in longitude.

2. 'Effect of the Moon on the determination of latitude at Washington.' By Wm. Markowitz and S. M. Bestul. *A.J.* **49**, 81, 1941. The analysis of 24 years of latitude observations with the PZT shows the normal tidal effect in latitude.

3. 'The free polar motion, 1916·0–1940·0.' By Wm. Markowitz. *A.J.* **50**, 17, 1942. The motion was determined from the PZT and the Cookson telescope observations of Greenwich. The motion was regular up to 1923 but not thereafter. The average amplitude and period were $0''\cdot104$ and 422 days. Increase in period is correlated with increase in amplitude. The pole of figure did not show a secular change.

4. 'Redeterminations of latitude and longitude.' By Wm. Markowitz. *Trans. Amer. Geophys. Union*, **26**, 197, 1945. Apparent continental shifts are traced to systematic errors. The indicated westward shifts of Greenland found by Jelstrup are ascribed to a systematic correction of about 4^s that the earlier lunar methods of longitude determinations require. An indicated change of 1^s in the longitude of South America is ascribed to errors in the early cable determinations. An indicated change of $-0''\cdot7$ in the latitude of three U.S. Coast and Geodetic Survey stations is eliminated when modern proper motions are used.

5. 'Declinations and proper motions of 64 stars observed with the photographic zenith tube.' By Paul Sollenberger. *A.J.* **51**, 145, 1945. The relative declinations and proper motions were derived from the PZT observations. The tabulated values are on the FK3 system.

6. 'Magnitude effects in proper motions.' By Wm. Markowitz. *A.J.* **51**, 153, 1945. A comparison of the PZT and transit circle proper motions in declination shows a magnitude effect in the latter. Additional data, which confirm this, show that the effect varies with different declination zones.

7. 'Variation of latitude at the U.S. Naval Observatory, 1938 to 1945.' By Paul Sollenberger. The annual results have been published as a continuation of the results of preceding years in the *A.J.* numbers: 1110, 1130, 1141, 1144, 1147, 1150, 1154 and 1159. The 1946 results are in the Press.

B 2. Report on the U.S. Naval Observatory Photographic Zenith Tube No. 2

Photographic zenith tube No. 2, being constructed by the Material Department of the Observatory, is to be located at the U.S. Naval Base, Guantanamo Bay, Cuba. The objective has been accepted from the makers, the Perkin-Elmer Corporation.

Drawings of the instrument are being prepared and will be available soon. Those desiring copies may write to the Observatory. The Observatory has been designated by the I.A.U. as an information centre on matters concerning the PZT.

The new station is in nearly the same longitude as Washington while its latitude is $+20°$. By operating the two stations additional information regarding the variation of latitude and longitude will be obtained. The weather conditions at the two stations being independent, the accuracy of the time service will be increased.

The general principles of the design of F. E. Ross are followed except that the automatic reversal and the synchronous motor-plate drive, which have been incorporated in PZT No. 1, are now part of the instrument. The instrument rests on rails set in a hollow concrete foundation instead of having massive iron castings for the lower part of the tube. The various parts of the instrument may readily be disassembled and set up again at another site where a foundation has been cast. A brief comparison of the two instruments follows:

	PZT No. 1	PZT No. 2
Aperture	8 in.	8 in.
Focal length	203 in.	149 in.
Half-field in arc	10′	17′
Height, main part	140 in.	54 in.
Weight, largest section	700 lb.	250 lb.
Exposure, each image	20 sec.	20 sec.

A study of the Washington observations indicates that the accuracy of the PZT is limited largely by variations in refraction through the night; it is not operated like the usual photographic instrument in which all the stars on the plate are taken simultaneously. It appears, therefore, that a reduced focal length will not materially reduce the accuracy, whereas important advantages will accrue because of the larger field and increased speed. The operation of the new PZT will serve as a test.

B 3. Photographic Zenith Tube for the Royal Observatory, Greenwich

Observations with the Cookson floating zenith telescope were terminated in 1940 and will not be resumed. A photographic zenith telescope is under construction and will be placed at the new site of the Observatory at Herstmonceux, Sussex. The design differs in many respects from the Washington design. The principal differences are as follows:

(i) The aperture is 10 in., focal length 135 in.

(ii) A plain ball-bearing is used for constraint of the rotary, in place of the conical bearing, in order to reduce friction and to facilitate construction.

(iii) An autocollimation method is used as a criterion of the angle of reversal of the rotary.

(iv) As a fixed axis of rotation is not required for (iii), a definite constraint in the horizontal plane is not needed. The two working orientations are each defined by a pair of stops instead of by a single stop.

(v) Adjustments to the objective are provided for squaring-on and for coincidence of the nodal plane and photographic plate.

(vi) Automatic reversal is accomplished by means of a system of wires which exert a pure torque on the rotary and therefore no tilting torque on the tube. The system is such that unidirectional rotation of the driving shaft is converted into reciprocating rotation of the rotary.

(vii) The plate carriage is annular and the plate-holder mount is circular so that symmetry of diffraction pattern is secured. The carriage constraints are external to the aperture.

(viii) Relative motion of the carriage and rotary is made to approximate to pure translation by means of a compensating system of flexed rods which constrain the carriage in the horizontal plane to which the motion is restricted by means of three balls that roll between horizontal planes.

(ix) Uniformity of rate in the relative translation of carriage and rotary is obtained by a specially designed system comprising a differential roller and metallic tapes.

(x) The time-scale is produced photographically by means of a clock-controlled lamp, giving flashes of very short duration. An independent chronograph is not required.

(xi) The height of the mercury surface is accurately adjustable and, as criterion of adjustment for constancy of scale-value, an optical null method has been introduced for use in conjunction with a suspended silica rod.

C. General

Vol. VIII of the *Results of the International Latitude Service*, containing the definite discussion of the observations at the International Latitude Stations from 1922·7 to 1935·0 by Dr H. Kimura was published in 1940. As the volume was printed in Japan, copies were not available until after the conclusion of the war; with the assistance of the U.S. Coast and Geodetic Survey, the stock of copies was brought to America and distributed from there.

Arrangements have been made, through the International Council of Scientific Unions, for grants in aid of the work of the Central Bureau of the International Latitude Service to be paid by U.N.E.S.C.O. through the International Astronomical Union and the International Union for Geodesy and Geophysics. These grants are paid with arrangements by which U.N.E.S.C.O. accepts financial responsibility for certain permanent scientific services of international character, the scientific direction of the work remaining with the Unions themselves. A separate grant has also been made towards the cost of publication of vol. IX of the *Results of the International Latitude Service.*

H. Spencer Jones
President of the Commission

Report of meetings

President: Sir Harold Spencer Jones.

Secretary: Paul Sollenberger.

Sessions: August 20, at 10.30 a.m.; August 21, at 11.30 a.m.

The President opened the meeting with a brief review of the conduct of the latitude work during the war. Mizusawa and Kitab continued work without interruption throughout the war, but observations at Carloforte were stopped. The President arranged for the collection of observing books from the American and Russian stations, and sent them to Prof. Carnera. The books from Japan were received after the end of the war through the U.S. Coast and Geodetic Survey. U.N.E.S.C.O. has accepted the latitude work as a project which it will support through the International Astronomical and Geodetic Unions. The report of Carnera appears in the Report of the Commission.

In view of the fact that Prof. Carnera is about to retire the President recommended that the work of the Central Bureau be continued in Italy under the direction of Prof. Cecchini at Turin. A resolution to this effect was approved, as was also a resolution thanking Prof. Carnera for carrying on the work during the difficult period of the war.

It was stated that arrangements have been made to resume work at Carloforte in spite of some difficulties. Prof. Cassinis had been very helpful in making the necessary arrangements through the National Research Council in Italy.

The President pointed out the importance of continuing latitude observations at the two stations on the same parallel in the southern hemisphere, particularly in the northern winter when northern observations are less complete. Observations were made at Adelaide, with a zenith telescope loaned by Mizusawa, for 7 years till the end of 1940, when the telescope was returned to Japan. La Plata is now the only remaining southern station. It is considered important that observations be resumed at Adelaide. That observatory has been closed, and the site of the new University Observatory is not suitable for latitude variation observations. A suitable site has been found near the old observatory, however, but a telescope and funds are required. An experienced observer is available.

The President has requested the Minister of the Interior of the Commonwealth Government to provide the necessary funds to enable observations to be resumed for a period of 7 years. A favourable response is looked for, but it was believed that a resolution by the Union, stressing the importance of the project, would be helpful. Such a resolution was adopted. At the end of the 7-year period it is expected that the development of the photographic zenith tube will require a review of the international latitude variation programme.

The President stated that in 1944 the Batavia station had been destroyed, and that the observing books have disappeared. The zenith tube is intact at the Bosscha Observatory.

Prof. Carnera is undertaking the reduction of the latitude results from 1935·0 to the end of the present year. The questions as to money grant and form of publication were discussed. In particular, there was a question as to the possibility of abridging the publication. The President favoured publication in the same form as before, as also did Dr Lambert and Prof. Cecchini. The President thought that the nations which were carrying on the latitude work should have the greatest voice in the manner of publication. M. Tardi said that the Association of Geodesy had not contributed to the recent volume. He thought that only 30 to 100 persons were interested in all the details, and thought that, instead of printing 1000 copies, a smaller number should be produced by some other process. It was pointed out that part of the cost of publication of the results computed in Japan had been borne by that government, but that Italy would probably be unable to do likewise. The President believed that unforeseen uses for the complete work might arise, and advocated full publication. He hoped that the Association of Geodesy would contribute. Dr Lambert hoped that U.N.E.S.C.O. would help, but had no definite information.

The President proposed a grant of 8000 gold francs towards the cost of publication of the results from 1935·0 to the end of the present year. This was to be in addition to the 4000 gold francs voted at Copenhagen, but not yet spent. The Commission approved the proposed grant. It was also agreed that the annual grant of 3000 gold francs for carrying on the work of the Central Bureau would be continued.

The President asked for a special grant of 1000 gold francs for moving the archives, records, calculating machines and other equipment of the Central Bureau from Capodimonte to Turin. This was approved.

A letter from Prof. Hagihara was read, urging that the latitude results should be published promptly. The President thought that the delays in recent years had not been due to the Central Bureau, but were caused by delays in forwarding the observing books to that agency. A resolution was adopted urging that the observing stations should forward the observing books to the Central Bureau promptly.

The President summarized a communication from Prof. Hagihara. At Mizusawa two entirely different types of telescope, one photographic and one visual, were used. The latitudes determined by these two instruments during a four-year period were closely similar. The following data were given:

Systematic difference (photo-visual)		$-0''.035$
Mean closing errors:	Photo	$-0''.251$
	Visual	$-0''.221$

It was further noted that the variation of closing errors from year to year, as obtained with the two instruments, was closely similar. This indicated that the variations were not due to the instruments themselves, a result contrary to the conclusion of F. E. Ross. The variation in atmospheric conditions from evening to morning are therefore considered a more probable cause of the variation in closing error. Prof. Cecchini said that fifteen years ago he had noted a close correlation between closing errors and atmospheric conditions. The results communicated by Prof. Hagihara showed that the annual component of the latitude variation was relatively uniform in amplitude, while the amplitude of the Chandlerian component varied widely. Similar results have been found by Nicolini (*vide* pp. 206–10). It was also noted that the length of period and amplitude of the Chandlerian component increased and decreased together.

Prof. Orlov proposed that the effect of the variation in the position of the mean pole should be removed from the published latitudes. He proposed that corrections for this

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purpose should be derived for application to the published latitudes for 1900–35, and that the effect of variation in the position of the mean pole should be excluded from the results in the future. The President asked how the polar movement was to be computed, and Prof. Orlov replied that it was to be by the method of successive approximations. He said he had already done this for his own work, and furnished a paper to illustrate. The President pointed out that the application of such corrections would cause delay in the work of the Central Bureau, and therefore suggested that it should be left to that Bureau to decide whether corrections should be made. Prof. Orlov also proposed that the latitude of 39° 8′ should be kept for the location of latitude instruments, but that the existing instruments should be replaced with larger telescopes, such as the Pulkova instrument of 135 mm. aperture.

The President said that there had been no proposal to change the latitude from 39° 8′. He expressed the opinion that any decision about a change in the instruments should be delayed pending more experience in the use of photographic zenith tubes. He thanked Prof. Orlov for drawing attention to these matters.

In further discussion of the matter the President said that the fluctuations of the mean pole shown by the Greenwich observations and by the results derived from the international observations showed some fluctuating differences. He believed that the question required research. Further, he stated that Greenwich results showed that the fluctuation of the mean pole depended on the amplitude of the polar motion. Prof. Orlov did not agree with this conclusion. He advocated the application of corrections for the mean polar motion, even for periods of only one year.

Prof. Cecchini presented a resolution expressing the great interest of the International Astronomical Union in the observations for the variation of latitude, made with the large zenith telescope of l'Instituto Geografico e Cadastral de Lisbonne. The resolution was adopted.

Dr Lambert presented a proposal to refer all latitude values to the same pole. The matter was discussed very briefly. It was felt to be a matter requiring careful study, and it was therefore postponed for consideration at the next meeting of the Union. In the meantime the Central Bureau will be able to study the matter.

Mr Sollenberger said that Dr Beals was planning to install a photographic zenith tube at Ottawa. He had expressed a desire that the Union should adopt a resolution supporting such projects, as an assistance to him in obtaining the necessary funds. A suitable resolution was approved by the Commission.