The story of early Numerical Weather Prediction or *Hydrodynamical Weather Forecasts* in the US and Sweden

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Summer 1903 was cold, rainy and stormy in northern Europe

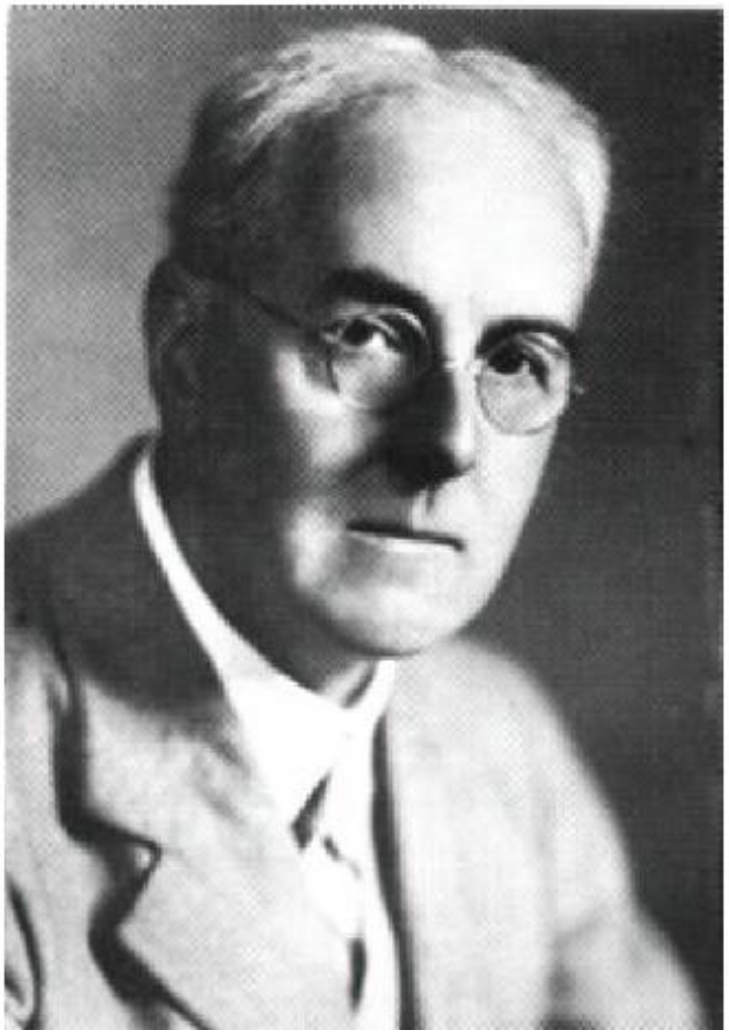
At this time Sweden was the only country in north-western Europe that did not issue gale warnings

One of the families who sat through this awful summer in the archipelago of Stockholm was professor Vilhelm Bjerknes and his family.

Professor Vilhelm Bjerknes

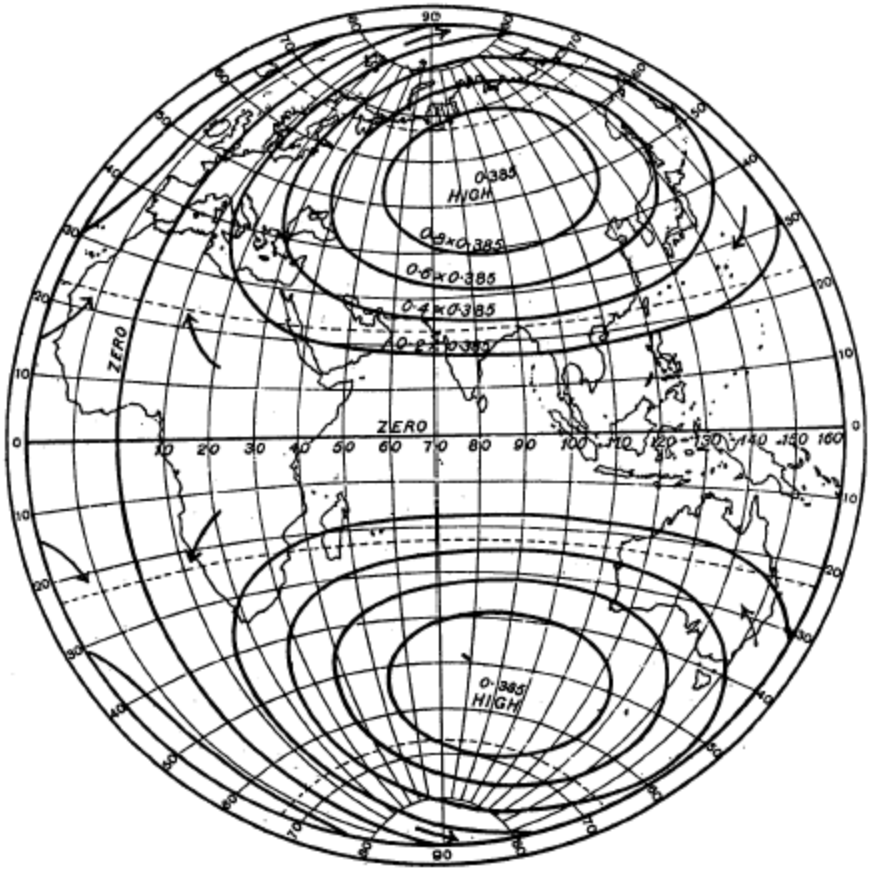
In a speech to the Swedish Physics Society 24 October 1903 Bjerknes suggested that weather forecasting should be seen as a physical-mathematical task and not an empirical-statistical

Lewis F. Richardson took Bjerknes' words ad notam and set out to calculate the weather



But the experiment failed for three reasons

To illustrate the equivalence between analytical and numerical solutions Richardson designed a simplified atmosphere



…but the patterns moved westward!!

But the results was correct: westward motion of barotropic planetary waves!

64 000 mathematicians would be needed!

That would be no problem in 50 years time!

Richardson selected the weather situation 20 May 1910 due to its rich observational coverage, also in the vertical.

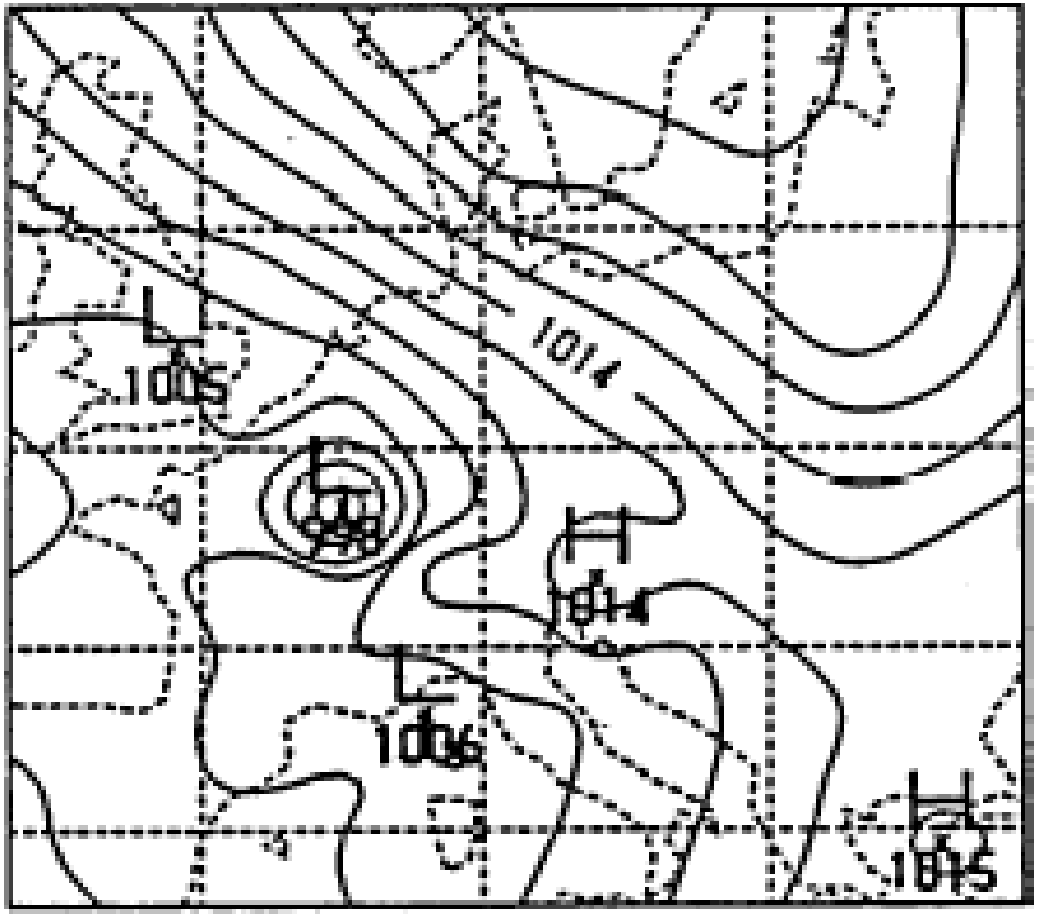


Fig. 3. Sea level Pressure. Original data.

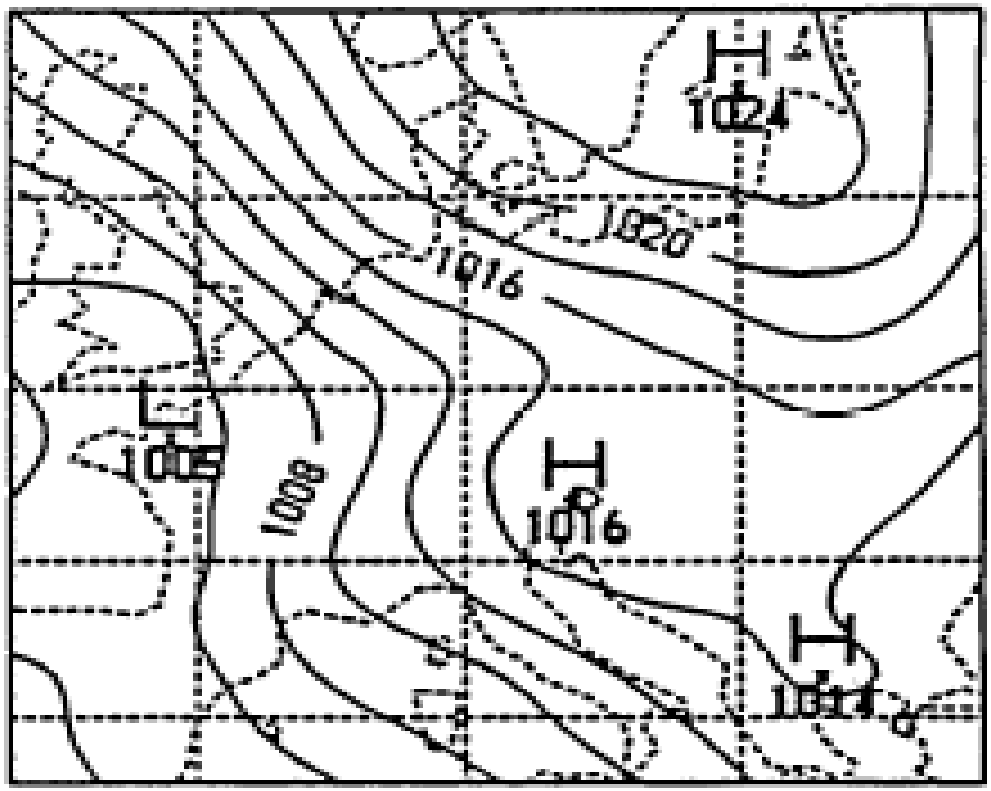


Fig. 4. Sea level Pressure. Filtered data.

-But why 20 May 1910??

The original data contained too much noise and set off gravity waves which disturbed the calculations **(Peter Lynch's analysis and smoothing)**

The 20 May 1910 the earth passed through the tail of Halley's comet (photo is taken one week earlier)

…so the scientific world made numerous aerological soundings to find out if the comet's tail had caused any "global environmental change"

The true fathers of numerical weather prediction?

Vladimir Zworykin demonstrates electronic television, 1929

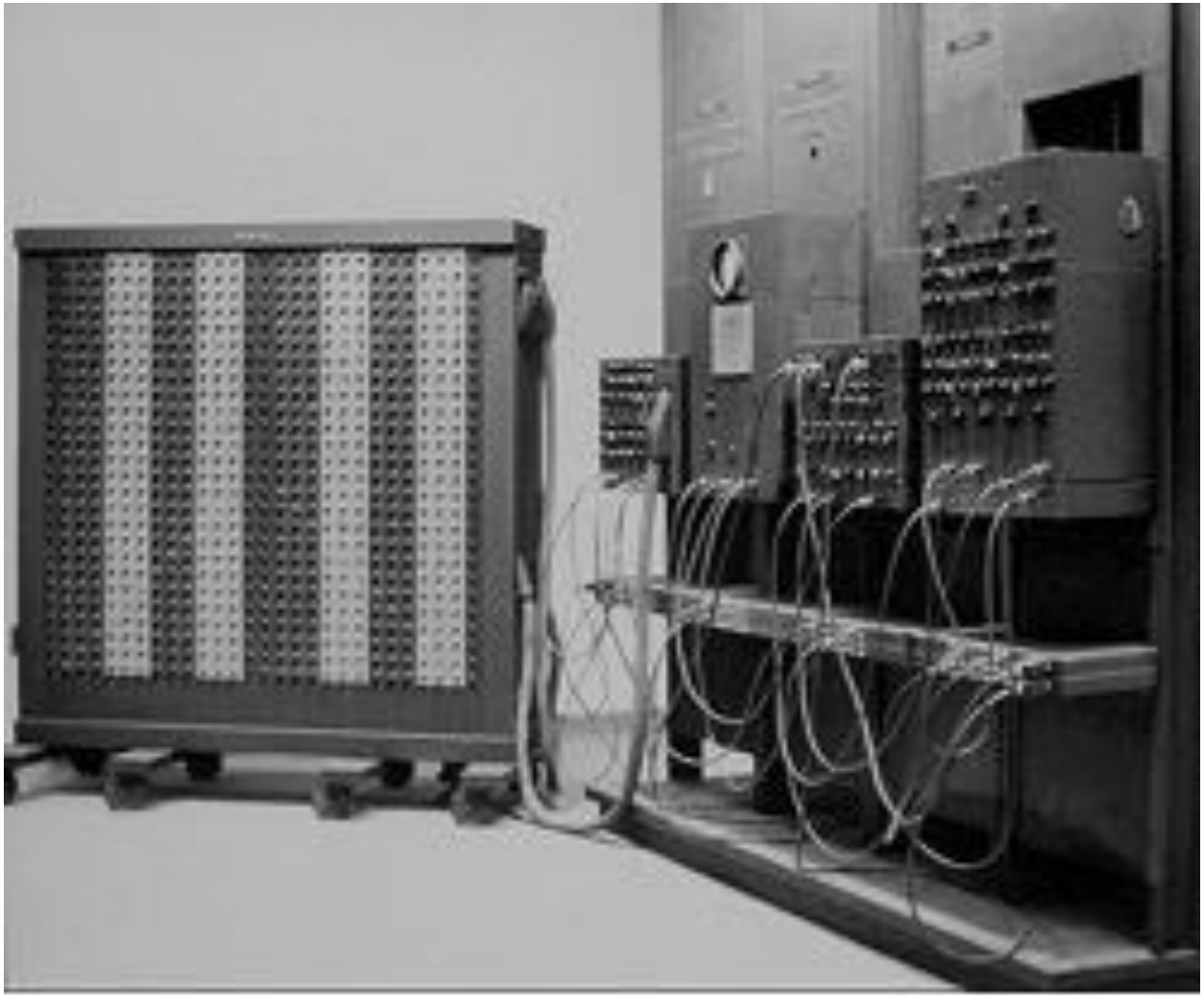
Vladimir Zworykin 1889-1982
Father of the TV

John von Neumann 1903-57
Father of the computer

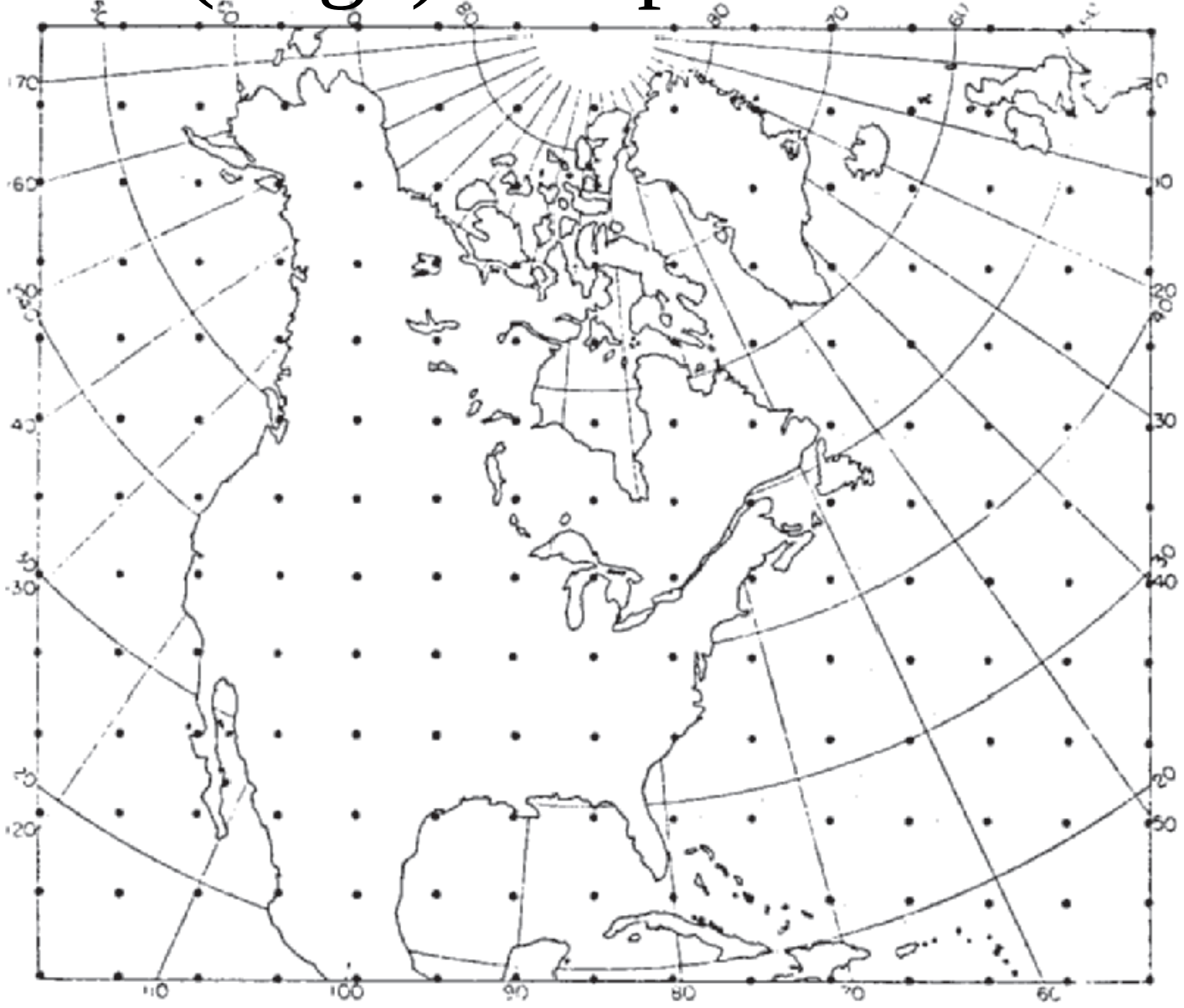
Von Neumann and Zworykin wanted to united the TV and the computer into

+

The first Numerical Weather Prediction experiment was conducted in Maryland in the US in 1950



The (large) computational area



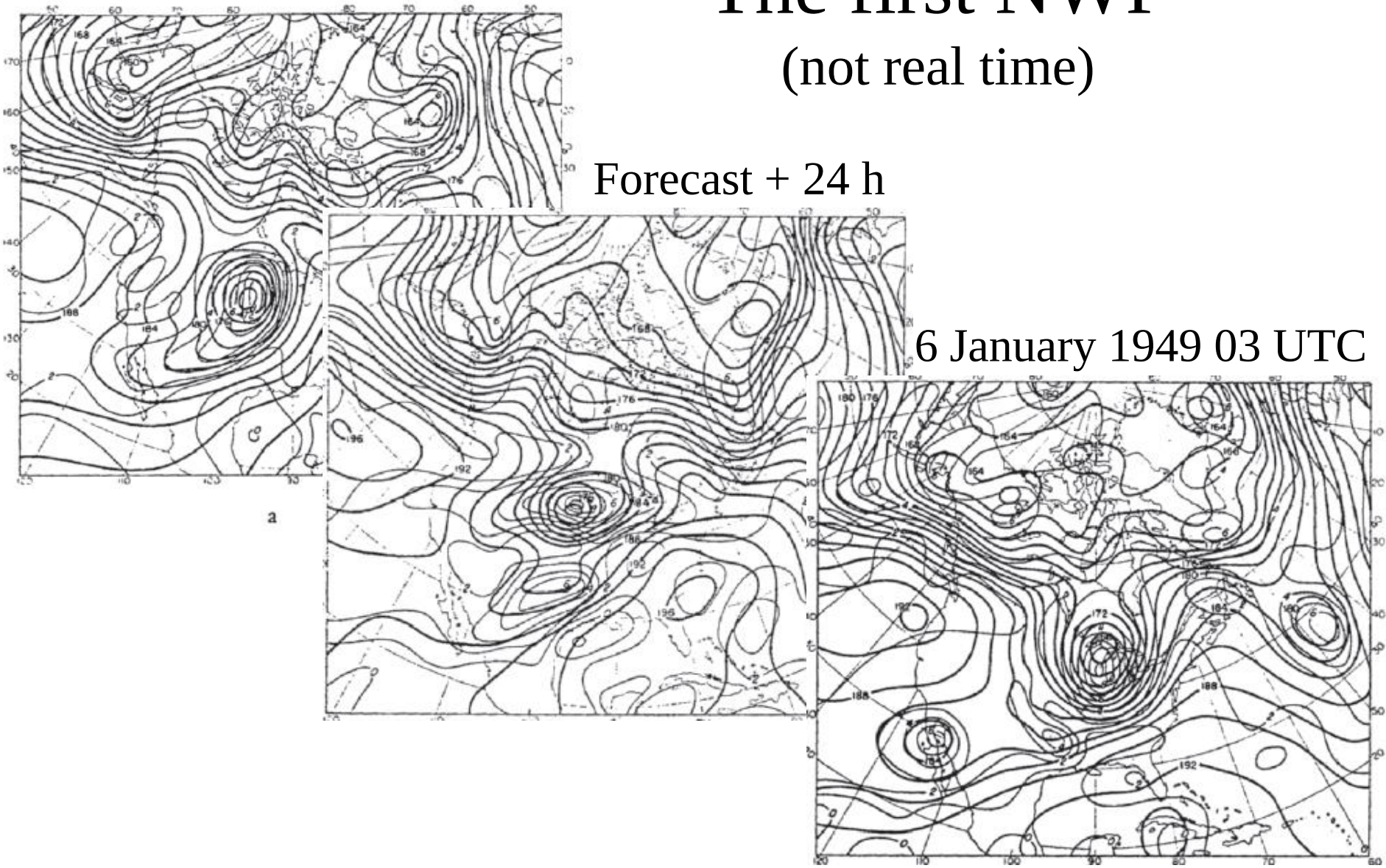
The first NWP

(not real time)

5 January 1949 03 UTC

Forecast + 24 h

6 January 1949 03 UTC



The 1954 start of operational Numerical Weather Prediction in Sweden (but not only by Swedes)

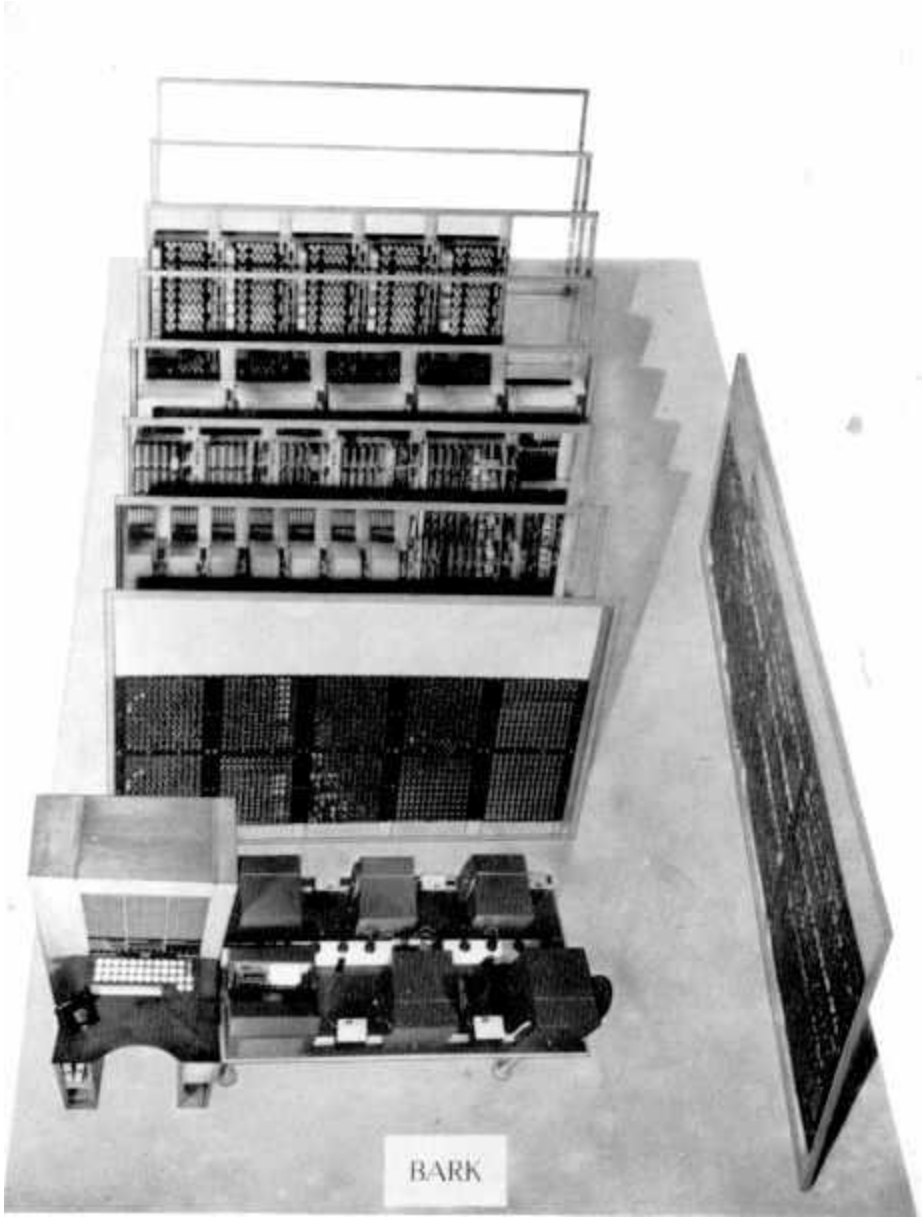
Why in Sweden?

-C. G. Rossby back from the US 1947
(home-longing, management and politics)

-Swedish state-of-art computers
(BARK 1950, BESK 1953)

-International support
(from the US and Belgium)

1950 BARK=
Binary
Automatic
Relay Calculator



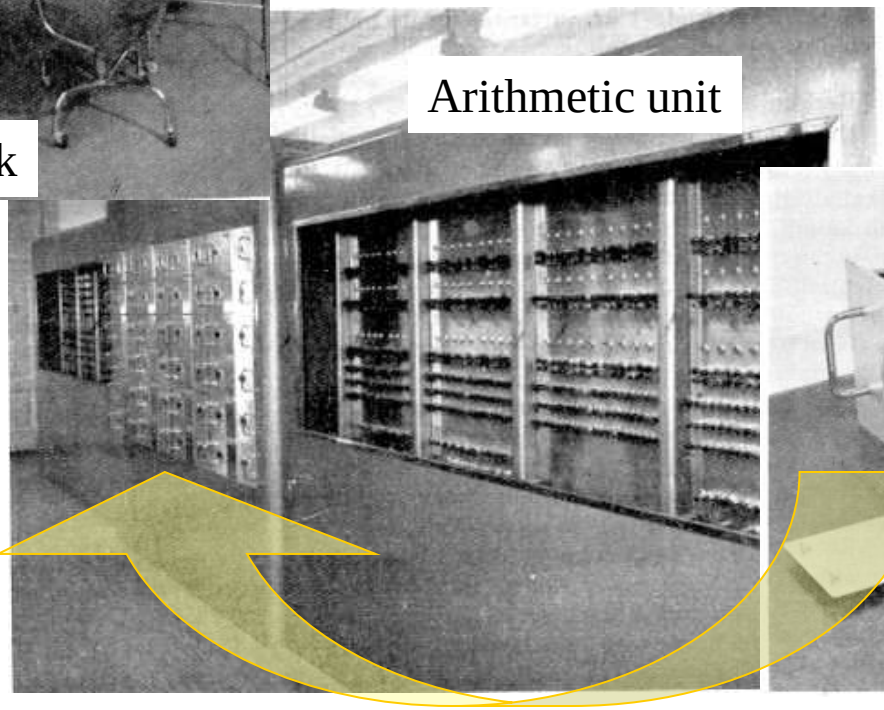
1953

BESK= Binary Electronic Sequence Calculator

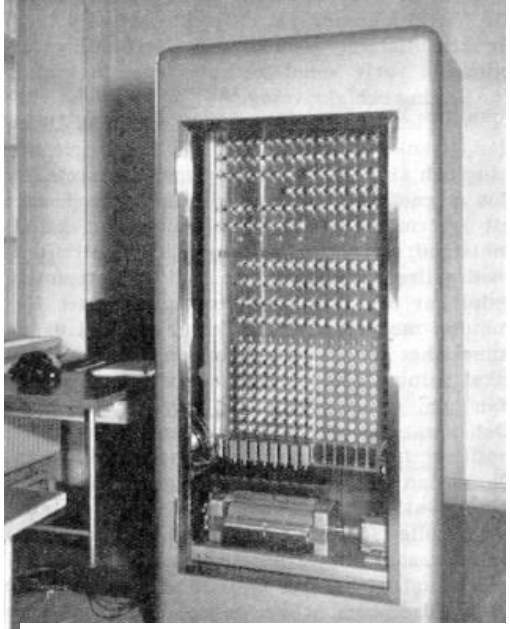
BESK

In 1953 the world's "best" computer

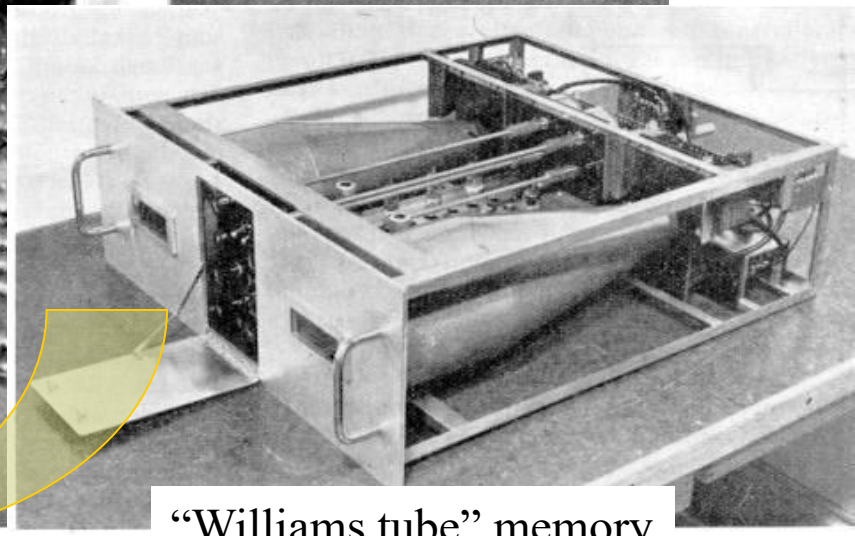
Control desk



Arithmetic unit

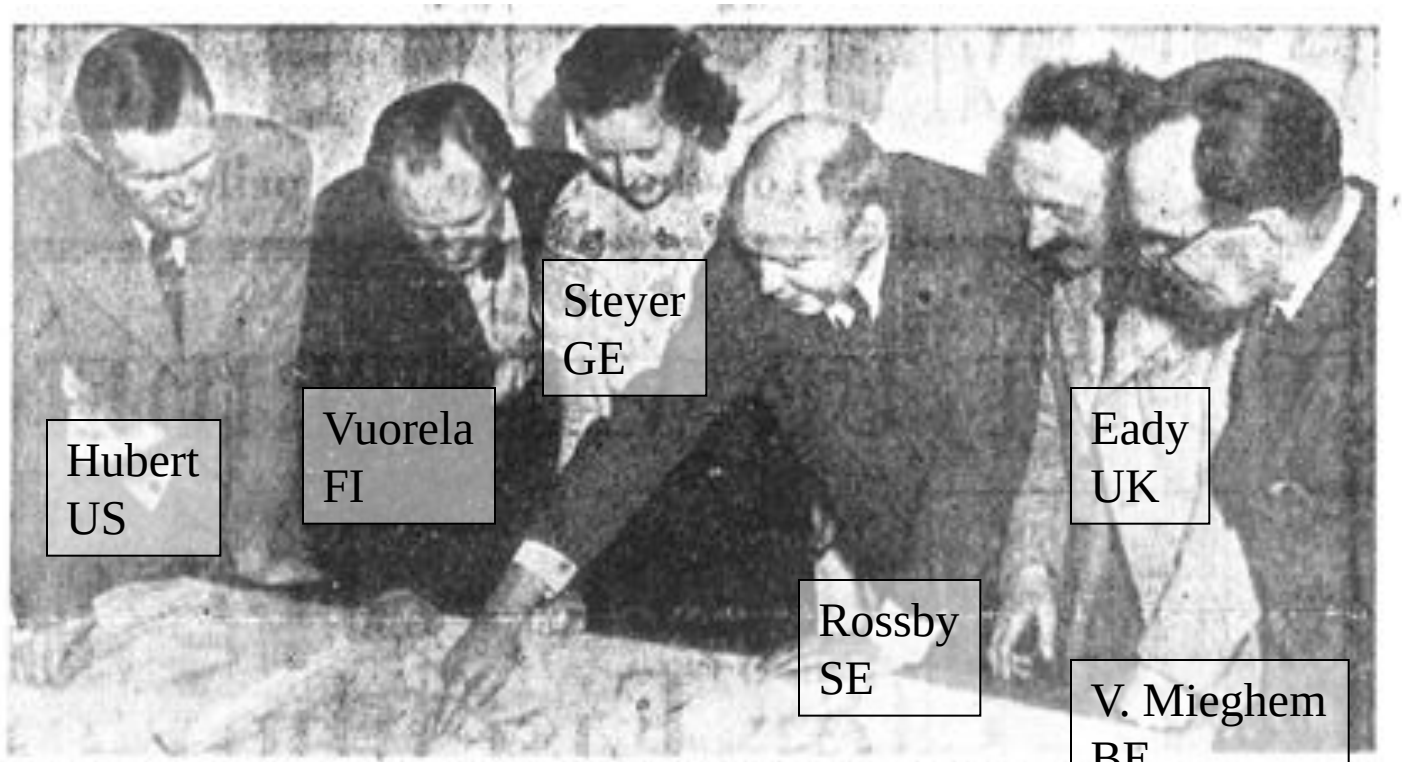


Electrostatic drum memory



"Williams tube" memory

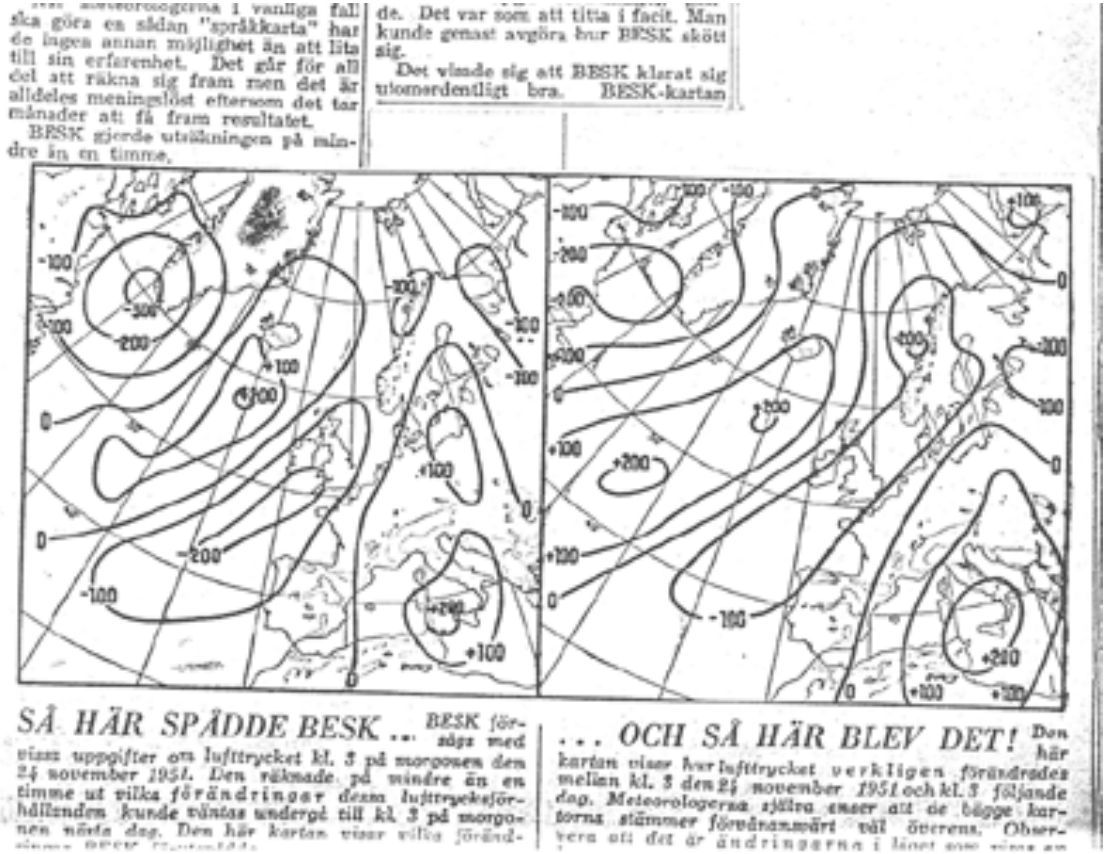
The International Meteorological Institute



En del av det nya meteorologiska institutets forskarstab samlad över en världskarta med en intressant "insnörning", vars framtidsuppgifter tydligen förtjänar diskuteras: fr. v. William Hubert, Washington, dr Lauri Vuorela, Helsingfors, fröken Christa Steyer, Hamburg, institutionschefen professor Rossby, dr Eric Eady, London, och professor Jacques van Mieghem, Brysse[illegible].

Rossby wanted, like V. Bjerknes after WWI, to play an international role in the political reconstruction after WWII

In Stockholm tendency calculations were carried out, first by hand in 1952, later on BESK in 1953



SÅ HÄR SPÅDDE BESK ... BESK försågs med vissa uppgifter om lufttrycket kl. 3 på morgonen den 24 november 1951. Den räknade på mindre än en timme ut vilka förändringar dessa lufttrycksförhållanden kunde väntas undergå till kl. 3 på morgonen nästa dag. Den här kartan visar vilka förändringar meteorologerna i vanliga fall ska göra en sådan "språkkarta" har de ingen annan möjlighet än att lita till sin erfarenhet. Det går för all del att räkna sig fram men det är alldeles meningslöst eftersom det tar månader att få fram resultatet.

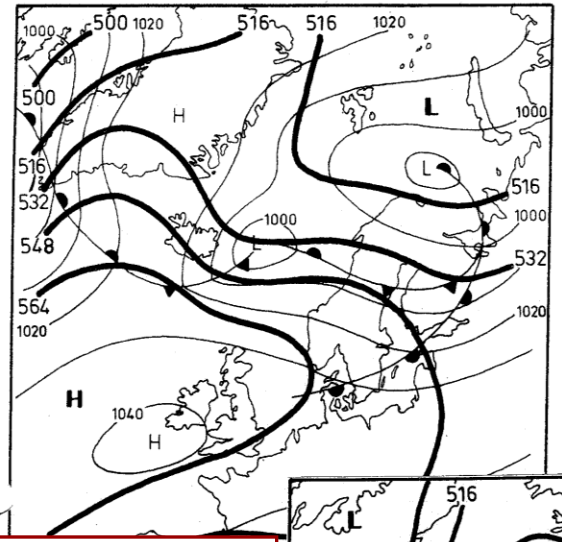
BESK gjorde uträkningen på mindre än en timme.

... OCH SÅ HÄR BLEV DET! Den här kartan visar hur lufttrycket verkligen förändrades mellan kl. 3 den 24 november 1951 och kl. 3 följande dag. Meteorologerna själva anser att de bägge kartorna stämmer förvånansvärt väl överens. Observera att det är ändringarna i läget som vissa av de. Det var som att titta i facit. Man kunde genast avgöra hur BESK skött sig.

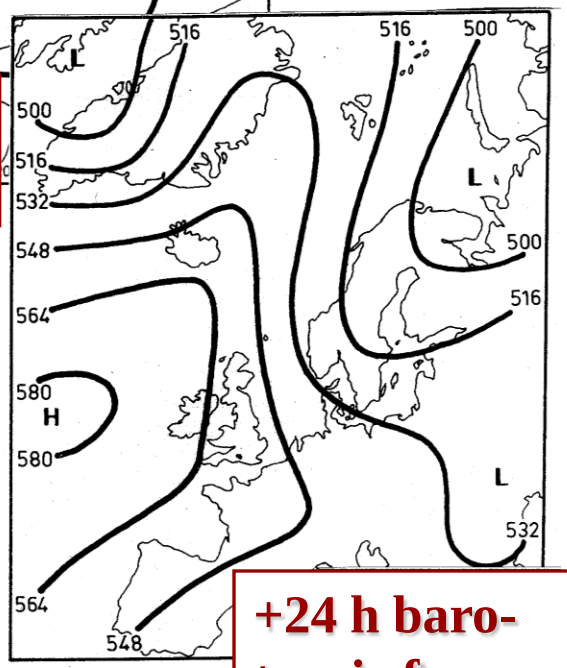
Det visade sig att BESK klarat sig utomordentligt bra. BESK-kartan

The Swedish tabloid *"Expressen"* published the results almost a year before *"Tellus"* (forecast left, analysis right)

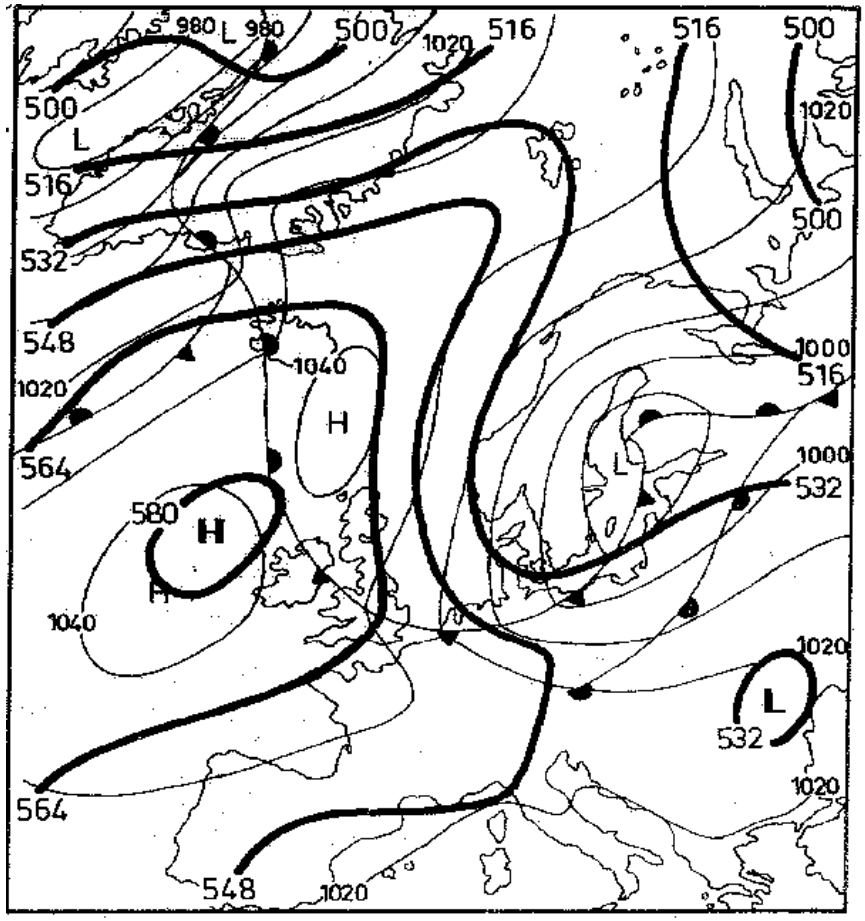
Barotropic re-run of the "tree-feller" storm the 2-3 January 1954



2 January 1954 00 UTC

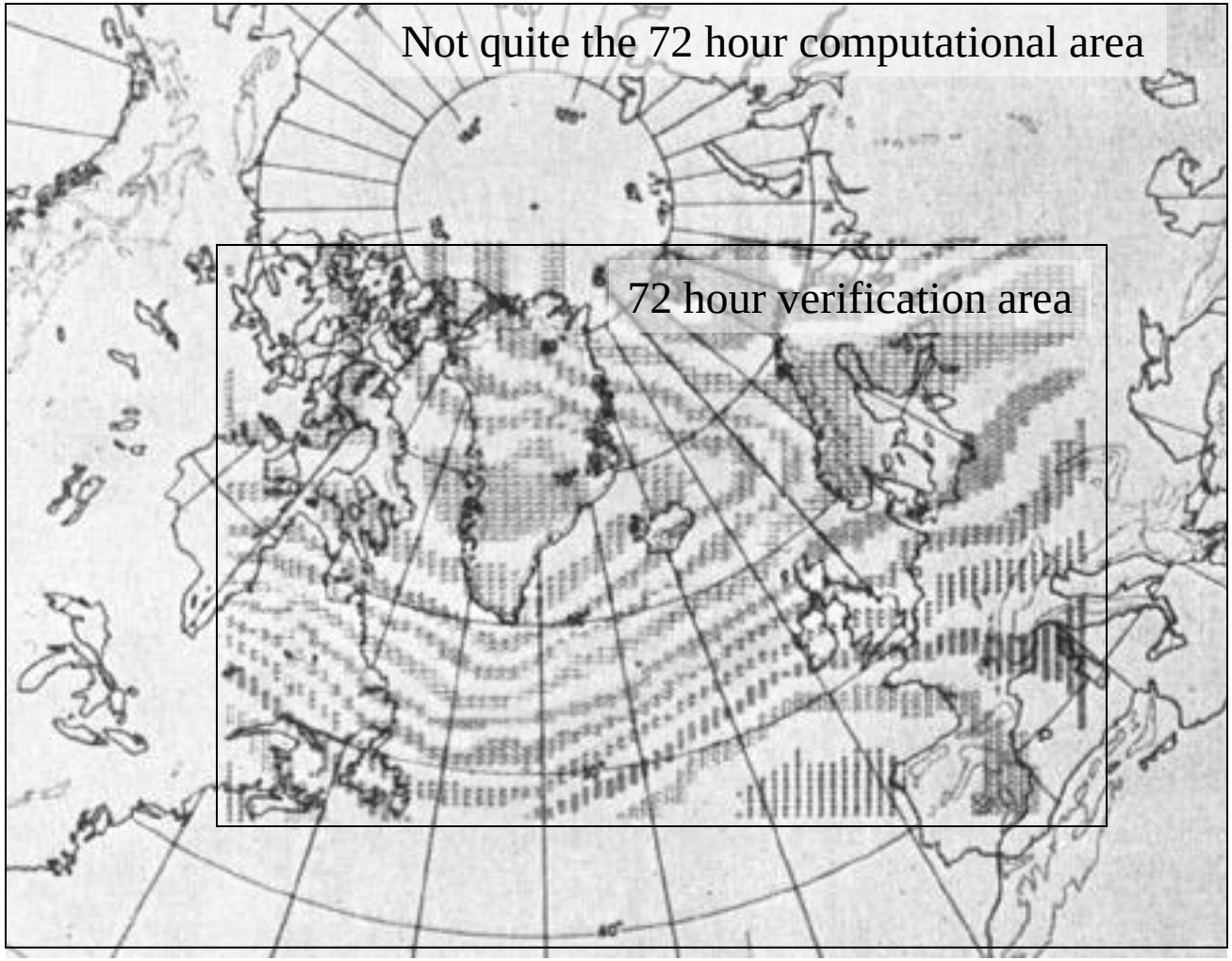


+24 h baro-tropic forecast



3 January 1954 00 UTC

First real time NWP in late September 1954



From the operational period Dec 1954-May 1955

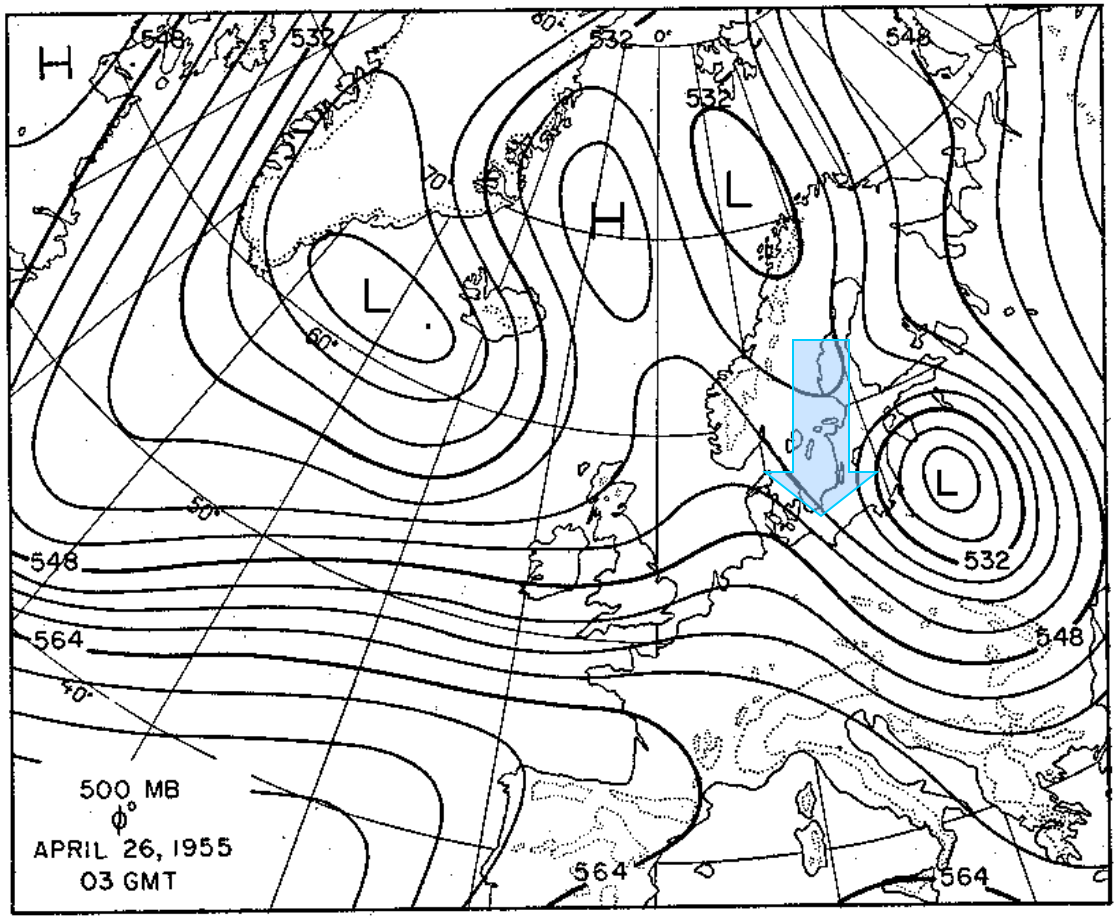
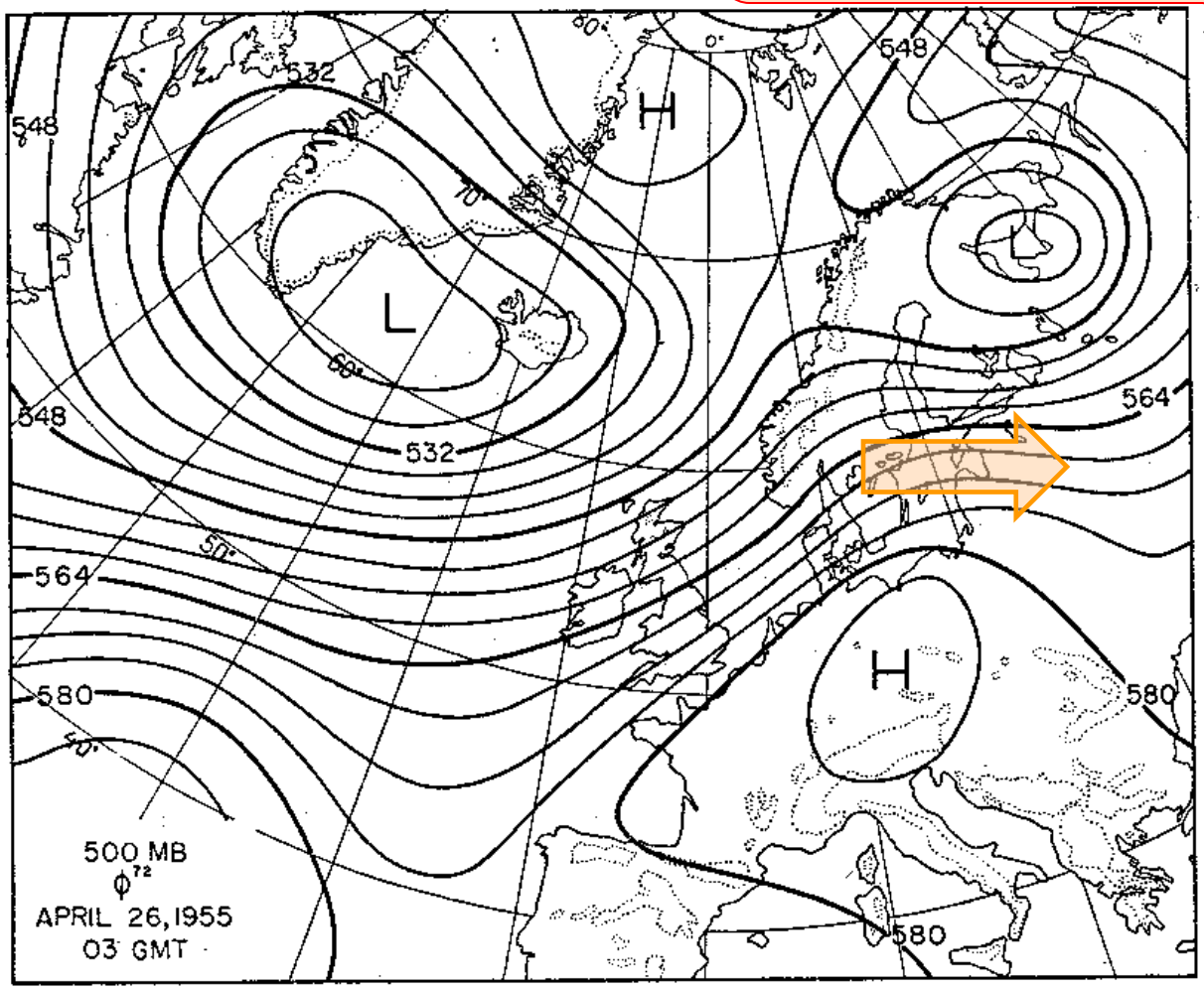


Fig. 3 a. Observed 500 mb contours on April 26, 1955, 0300 GMT. The heights are given in decameter as unit.

-Professor Dahlqvist, when is Spring coming?

-Tomorrow at 2 pm!



+72 hours

Fig. 3 b. 72-hour forecast of 500 mb from map shown in a.

…and Spring came!

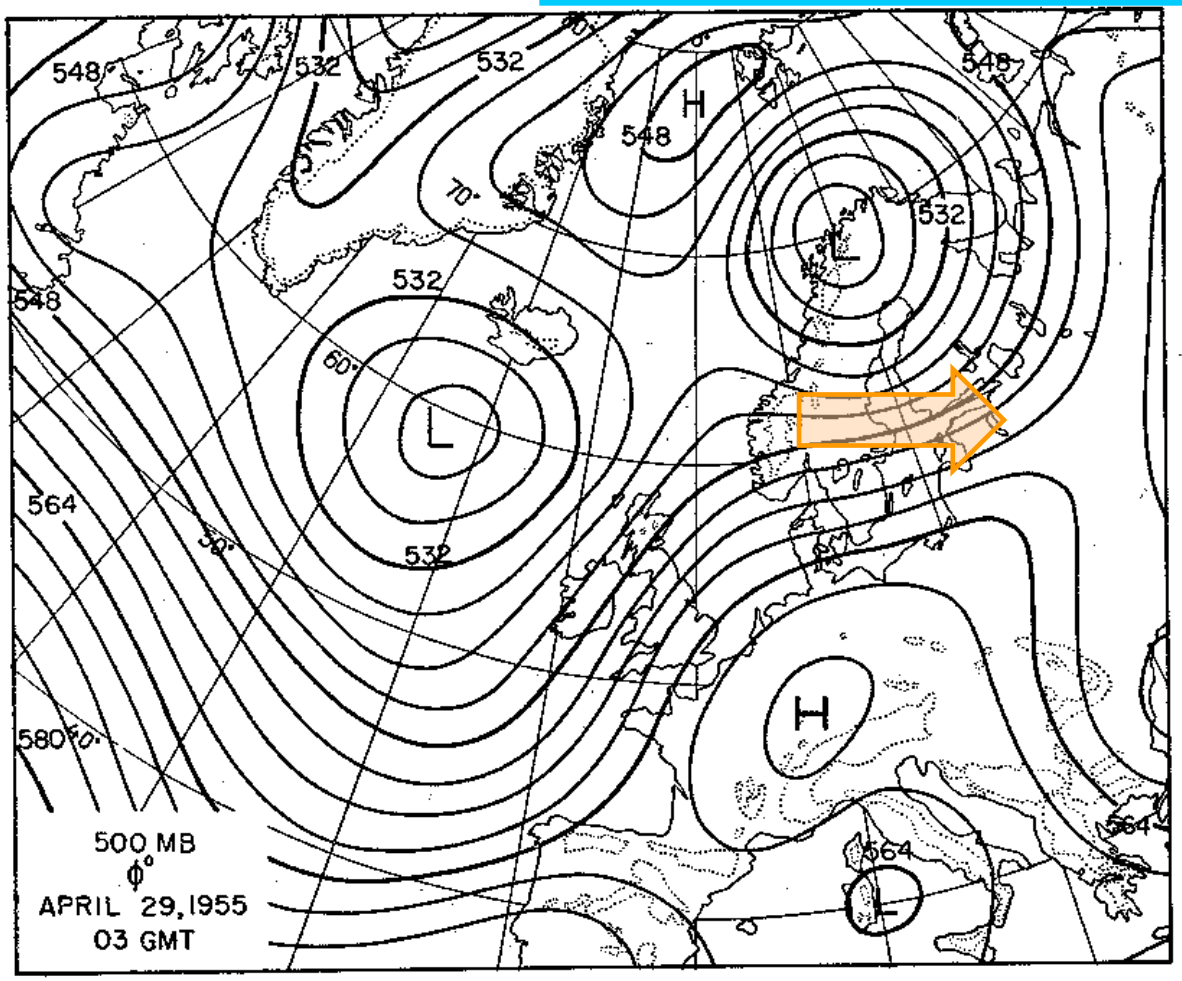


Fig. 3 c. Observed contours on April 29, 1955, 0300 GMT.

From wheat to bread!

Bert Bolin shows automated 500 mb forecasts for Ragnar Fjørtoft (Norway) and George Corby (UK) around 1956

Why Sweden succeeded:

-C. G. Rossby back from the USA 1947
-Swedish state-of-art computers
-International support

-Choice of barotropic model (skilful and providing operational experience)
-Efficient automatic analysis system (Bergthorsson-Döös, 1955)
-Not too small NWP area (but not too big either, avoiding retrogression of the planetary waves!)

END