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The History of Weather Prediction

The article "*The origins of computer weather prediction and climate modeling"* by Peter Lynch is about all of the different people who made possible the current understanding of the world weather and the ability to predict it by making giant leaps in both mathematics, hydrodynamics, and computer technology. No one man could have made this possible; it took the life's work of many different men to make weather prediction and understanding a reality.

It all started with the development of thermodynamics and hydrodynamics. Then came three men who might be considered the founding fathers of weather prediction, these men were Cleveland Abbe, Vilhelm Bjerknes, and Lewis Fry Richardson. In 1901 Cleveland Abbe wrote a paper titled "*The physical basis of long-range weather forecasting"* which proposed using mathematics to predict weather. Not long after, Vilhelm Bjerknes, a Norwegian scientist introduced a plan to predict weather which included two steps: To observe the atmosphere, then calculate movement using the laws of motion. In 1922, while working at the Meteorological Office in, Lewis Fry Richardson wrote a book titled "*Weather Prediction by Numerical Process"* where he criticized the then current practice of using an "*Index of Weather Maps"* to predict weather by finding a previous map that resembled your current map and deducing that the weather will act in a similar manner. This method was of course highly inaccurate as Richardson points out. He then laid out a forecasting scheme which was based on Bjerknes' program and involved an unimaginable volume of numerical computation which he realized would be practically impossible without computers. Richardson was not dissuaded by this and continued to

make advances in the field. Soon, he developed a method in which atmospheric properties were tabulated as accurately as possible at different latitudes, longitudes, and heights. Then, these numbers are processed mathematically to yield a current state of the atmosphere. The process is then repeated to yield the state of the atmosphere at a time 2...3 and so on. Richardson's work was very important to the field, but unfortunately was not fully appreciated for years to come. With the invention of the radiosonde in 1927 the ability to actually take accurate measurements of the atmosphere very quickly and repeatedly over time became a reality which made the accumulation of precise atmospheric data much easier. Then there was John von Neumann who is often considered the father of computer science developed cutting edge mathematical concepts and masterminded the construction of "*The Electronic Computer Project"*. With the completion of the electronic computer the very first merger of mind and machine came together to make meteorological prediction. In 1946 the "*Meteorological Research Project"* was created and with this came access to more funding and official acknowledgement. Soon after Jule Charney joined Von Neuman and began work on equations known as the *quasi-geostrophic* system to predict atmospheric flow. Charney eventually developed the barotropic vorticity equation and designed an algorithm for solving the equation. Soon after, the algorithm was put into use on the ENIAC producing astounding results. The problem was that each run took 24 hours so the process was only keeping up with the weather, not predicting it. Nevertheless, using a computer to do numeric calculations was a massive leap in modern meteorology, and is the event horizon of meteorological advancement. N.A. Phillips implemented the first long-range simulation of atmospheric circulation, and in the years following the science of meteorology advanced at an astonishing rate. As computers get more powerful and mathematical algorithms get more complex we see the birth of modern meteorology.

The development of modern meteorology took the work of many individuals from many different fields mastering their disciplines and developing working solutions to the insurmountable complexity of the atmosphere. The most important fields were physics, mathematics, chemistry, computer engineering, software engineering, and instrumentation development. Without the groundbreaking discoveries and advancements made in not only these fields, but a multitude of others, weather prediction would still be a visionaries' dream.

One point that is clear in this article is that scientific progress is only made through dedicated work and experimentation. In a sense you can look at it as trial and error because by conducting experiments and learning from what works and what doesn't you learn more about what you are trying to understand. The scientific progress is made by piecing all of this knowledge together to create a big picture of understanding which can only be done by building on the discoveries of previous scientists and making new discoveries, adding to the knowledge of the science being studied. The reason for this is: if scientists did not build on previous discoveries science would be at a standstill because every scientist would have to start from scratch. As with the case of meteorology, thermodynamics and hydrodynamics were discovered long before modern meteorologists even started attempting to master the atmosphere. Thermodynamics has a long history that began with Otto von Guericke who was a scientist who built a vacuum pump in order to attempt to disprove some of Aristotle's theories and eventually led to Sadi Carnot who was the "*father of thermodynamics*". Carnot wrote a paper entitled "*Reflections on the Motive Power of Fire*" leading to the first textbook of thermodynamics in 1859 by James Joule. Hydrodynamics also has a long history which in itself is a sub discipline of fluid dynamics. The history of who developed fluid dynamics is extremely vast as there are a multitude of disciplines included in fluid dynamics, and many different individuals who made

contributions to the science. Fluid dynamics is a very good example of scientific advancement because no one man developed this science. It took many scientists many years to develop the science, and if any of them had given up, the field might not be anywhere near as advanced as it is now. Science is a true testament to the human condition for without the determination and curiosity that is present in everybody there would be no science.