150 years of observation, research and education of students in the field of agricultural meteorology at Aas in Norway

”FLUXES AND STRUCTURES IN FLUIDS”

Kaliningrad June 2015

Tor Håkon Sivertsen

(Invited speaker)

Independent scientist

Risør Norway,

Vidar Thue-Hansen

Norwegian University of Life Sciences

and

Arne Auen Grimenes

Norwegian University of Life Sciences

The background of ’meteorology’ as a ’science’

- About 350 years before Christ the Greek philosopher Aristotle did write a treatise on the subject of meteorology. What seems to remain today of this treatise is
- a compendium written in Arabic language in the 9th century based on the treatise of Aristotle, as well as translations of this compendium into the Hebrew language and into Latin during the medieval period (Schoonheim, 2000)
- Beginning in the renaissance in Italy the empirical science of physics was developed in Europe.
- Concepts and theories of physics were created, and methods of measuring values of parameters like temperature, pressure, energy, volume, mass, length ‘et ceterea’ of physical objects were developed.

Start of meteorological measurements in Europe on a daily base

- At a few institutions in Europe routine measurements of the temperature of the air, the pressure of the air or the amount of precipitation were established on a daily base in the 18th century.
- The temperature of the air and the sea level pressure have been measured in Stockholm from the year 1754 and in Uppsala from the year 1722.
- Precipitation has been measured at Uppsala since 1722 and at Stockholm since 1785.

Some of the first institutions in Europe dealing with meteorology to make prognoses of the weather (especially the weather on the sea was focused on by several of the institutions)

Austria(1851):Zentralanstalt für Meteorologie und Geodynamik'(in Vienna)

Great Britain(1854):United Kingdom's national weather service(London)

Denmark (1872): The Danish Meteorological Institute

Begium(1876): A meteorological bulletin was published, dependent on a synoptic map made by an institution established in the year 1976

Sweden(1874): Statens Meteorologiska Central Anstalt

France (1854): The meteorological service in France did start in Paris after a catastrophe in the Black Sea due to a violent storm

Norway(1866): Det norske meteorologiske institutt (in Christiania/ Oslo)

Establishment of some national institutions in Norway

In 1814 close to the end of the Napoleonic wars in Europe the very poor society of Norway managed to initiate democracy and some institutions of a democracy.

A constitution was established that did contain: Elements from the constitution of United States of America, from ideas developed in in Europe before the revolution in France as well as the heritage of enlightened absolutism of the administration of the Danish/ Norwegian kingdom, and also from laws given by the Norwegian kingdom in the middle ages.

The first educational institution in Norway on the national level was founded in Christiania (Oslo) in 1811 as 'Det Kongelige Frederiks Universitet'(The royal Fredric University) when Norway and Denmark still were united and the capital was the city of Copenhagen.

The second educational institution in Norway on the national level was established in 1859 and called 'Den høiere Landbruksskole paa Aas'. 'The higher agricultural school at Aas'

Start of observation of weather in Norway connected to agricultural crop production

From the start in 1859 of the ‘The higher agricultural school at Aasit was established a department for chemistry at this institution, and the leader of this department did administrate physics as well as doing measurements and teach meteorology as a part of physics.

For the year 1863 there exists a table showing the amount of precipitation for each month this year. And in the bottom of the table the amount of yearly precipitation at Aas in 1860, 1861 and 1862 also are given .

The Norwegian University of Life Science

‘Den høiere Landbruksskole paa Aas’ was established in 1859.

In 1897 this institution was named ’Norges landbrukshøgskole’ (Norwegian College of Agriculture);

It was debated if it was right and nescessary to make this institution into a scientific institution. Influential groups among the delegates to the parliament and among the farmers considered this too costly and unnescessary in 1897,(Tveite, 1997, Berge, 1997).

In 1919 a new law did pass the Norwegian Parliament, and the teachers at Aas were now called ’professors’. The length of the education was two years in 1897. During the 50 years to come the length of he education was extended to 3 years and later to 4 years. 1990 the length of the education was 5 years.

In 2005 the institution did receive the new name ’Norwegian University of Life Sciences’.

Global change of climate

On Campus Ås several institutes have been involved in research on global change of climate, both in Europe and in developing countries.

On the European level Norway did participate in the COST ACTION 734 ’Impacts of climate change and variability on European agriculture’ 2006 – 2011.

The representatives from Norway in the management committee did come from Norwegian Institute of Agricultural and Environmental Research and Norwegian Unviversity of Life Sciences.

Teaching of meteorology

In the period from the year 1859 to 1898 teaching meteorology was taught as a topic in physics by the lecturer in chemistry and physics.

The teaching volume in meteorology was very modest, with a total of from 5 to 10 hours.

During the transition to Agricultural College in 1898, physics separated from chemistry as a department of its own. Meteorology was lectured as part of physics, but now with a fixed and considerably larger number of study hours (20 hours).

Climatology was a part of the meteorology. The number of courses offered to the students increased from two introductory courses in the beginning of the1960tis to four courses in the 1970-1980tis, including a course in agricultural meteorology at the PhD level.

The two last mentioned courses are now closed down, and the teaching commitments transferred to non- permanent faculty members

Publications connected to a workshop on agro meteorology

- In june 2006 the University at Aas together with The Agrometeorological Service of Norway, did arrange a workshop called 'Workshop on Environmental Fluid Mechanics as Elements in Agrometeorological Modeling'.
- According to the book of abstracts 20 oral contributions were presented at this workshop. After the workshop 12 papers were printed as proceedings in a special issue of Idojaras, 'Quarterly Journal of the Hungarian Meteorological Service', (Sivertsen and Tyvand, 2007).
- This workshop was an an attempt to bring together scientists usually making presentations in different 'cheese dooms' of science (agronomy and fluid mechanics.)

The site of the university at Aas

- The landscape is dominated by open fields, small forests and low glacial moraine hills. Around the university campus, a residential area of one- and two-stored houses has developed during the last 50 years, but open fields still surround a major part of the campus.

The agrometeorological experimental field station

- The agrometeorological experimental field station, 12,000 m^2, is surrounded by 50 ha flat farmland and is very little disturbed by local urbanization.
- The municipality 'Ås kommune' has experienced residential development, but the landscape surrounding the experimental field station is not very disturbed by industry, traffic, and tall buildings.
- The level of the area surrounding the station is nearly flat, and it has a shallow basin open towards southwest, with a slope of 1%.


he present site of the
grometeorological
xperimental field
tation

The soil texture

The soil texture of the soil layers at the site are described using a Norwegian system for soil texture, (Sveistrup, 1984).

Tables containing many soil physical parameters for the soil profile at the site exists, and it is therefore possible to run sophisticated SVAT- (Soil-Vegetation-Atmosphere-Transfer) models at this site.

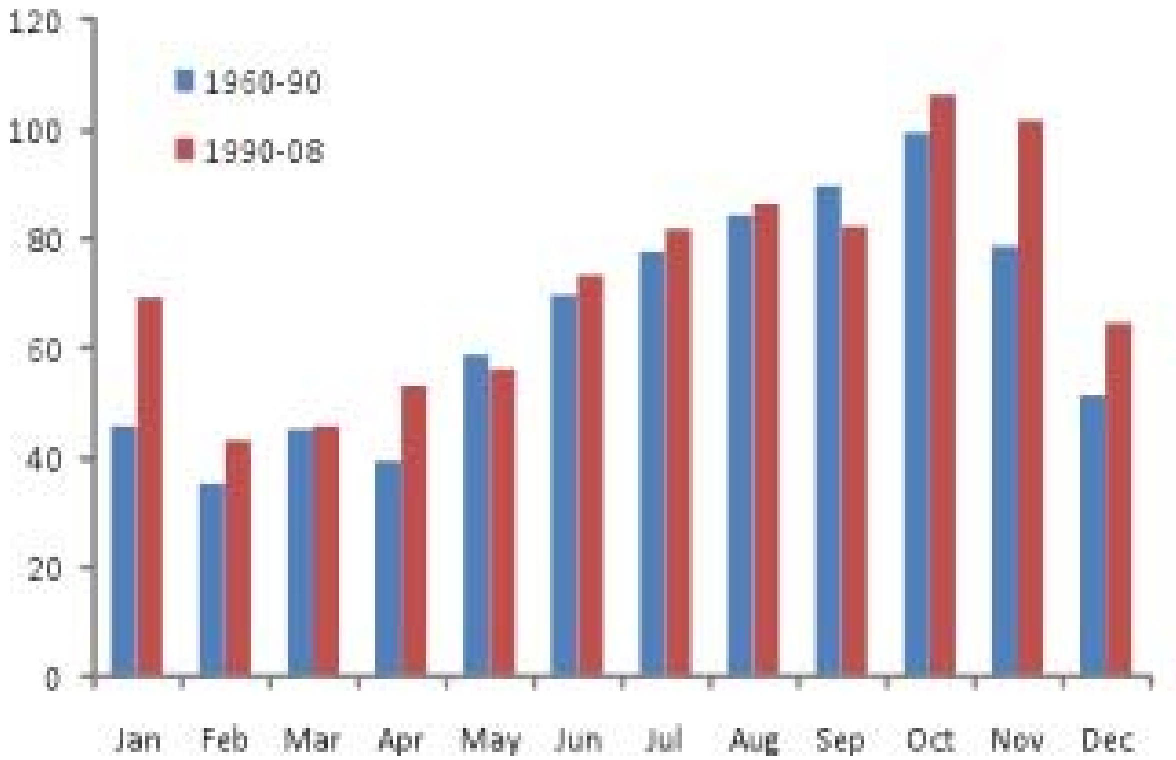
The following soil physical parameters are provided for 4 or 5 layers: Average of 5 measurements by penetrometer, porosity of the soil, density of the mineral material of the soil, density of dry soil sample, hydraulic conductivity, and 5 points on the water retention curve.

In addition chemical properties (pH, total C, total N, interchangeable cations) and distribution curves of the size of the mineral particles of the soil are provided.

The climate at the agrometeorological field station

- The site of the experimental field station is situated 40 km south of the city of Oslo and 8 km east of ‘Oslo fiord’. The climate is not very different from the climate of Oslo and the surrounding eastern regions of Southern Norway.
- The yearly mean temperature 1961-1990 (meteorological normal) was 5,3 ° C,
- and the average yearly amount of precipitation 1961-1990 was 776 mm (meteorological normal).

The climate at the agrometeorological field station



Normal amount of monthly precipitation (1961-1990), and average monthly precipitation (1991-2008)

The equipment at the agrometeorological field station

- The agrometeorological experimental field contain a small low building with an office and a garage, and a bunker like structure with some equipment, but unfortunately flooding due to precipitation almost every year disturbs the use of the bunker.
- Most of the area is covered by short cut grass meadow.
- At the site there also are several minor fields used for growing crops like cereals, potatoes, vegetables etc. connected to different projects in different periods.
- The main sensors for radiation measurements are mounted on a large boom.
- Instruments for measuring meteorological parameters describing temperature of the air, temperature of the soil, wind, precipitation, etc. are placed in different parts of the area,

The equipment at the agrometeorological field station

The equipment at the agrometeorological field station

Parameter values recorded by the institute

	Parameter value recorded	Current instrument	Start of series
1	Temperature of the air * 2m	PT100	1874
2	Minimum air temperature *2m	Derived from 1	1874
3	Maximum air temperature * 2m	Derived from 1	1874
4	Minimum air temperature at grass level * 10 cm	PT100 **	1969
5	Soil temperature, 2 cm	PT100	1983
6	Soil temperature, 5 cm	PT100	1960
7	Soil temperature, 10 cm [1]	PT100	1896
8	Soil temperature, 20 cm [1]	PT100	1896
9	Soil temperature, 50 cm [1]	PT100	1896
10	Soil temperature, 100 cm [1]	PT100	1896
11	Relative humidity of the air	Hair hygrometer	1874
12	Evaporation in mm	Built at dept. (vibrating wire gauge)	1996
13	Amount of precipitation *	Built at dept. (gauge cell)	1874
14	Snow depth * in cm	Built at dept. (ultra sound echo)	1874
15	Air pressure *	Vaisala/Digital Barometers PTA200	1885
16	Horizontal wind velocity, 10 m	Windmaster Ultrasonic Anemometer	1874
17	Maximum wind speed	Derived from 16	
18	Wind direction 10m	Windmaster Ultrasonic Anemometer	1874

Parameter values recorded by the institute

	Parameter value recorded	Current instrument	Start of series
19	Global irradiation, 295-2800 nm [2]	Eppley Precision Pyranometer	1949
20	Reflected global irradiation	Eppley Precision Pyranometer	1966
21	Albedo	Derived from 19 and 20	1983
22	Diffuse irradiation, 295-2800 nm	Eppley Precision Pyranometer	1966
23	Radiation energy balance 285-60 000 nm	Radiation Energy Balance System/Pyranometer	1960
24	PAR photosyntetic active radiation	LI-COR Quantum sensor	1977
25	Irradiation 295-385 nm (UV)	Eppley Ultra-Violet Pyranometer	1977
26	Irradiation 495-2800 nm	Eppley Precision Pyranometer + cut of filter	1977
27	Irradiation 630-2800 nm	Eppley Precision Pyranometer + cut of filter	1977
28	Irradiation 695-2800nm (IR)	Eppley Precision Pyranometer + cut of filter	1977
29	Red band irradiation (630-695 nm)	Derived from 27 and 28	1977
30	Green band irradiation (495-630 nm)	Derived from 26 and 27	1977
31	Blue band irradiation (385-495 nm)	Derived from 19, 25 and 26	1977
32	Soil heat flux	EKO/CN-81H	1983

Parameter values recorded manually by the institute

*	Quantities with parallell manual observations from separate instruments		
1M	Temperature of the air, 2m	Mercury thermometer	
2M	Minimum air temperature , 2m	Minimum thermometer	
3M	Maximum air temperature air,2m	Maximum thermometer	
4M	Minimum temperature at grass level	Minimum thermometer	
13M	Amount of precipitation	Standard precipitation bucket	
14M	Snow depth	Measuring stick	
16M	Air pressure	Mercury barometer	

Parameter values recorded by the Agrometeorological Service of Norway

	Parameter value recorded	Current instrument	Start of series
1	Temperature of the air , 2m average (60 min), min and max last hour,and instantan temperature	Väisäla HMP44	1993
2	Relative humidity of the air, 2m average(60min), last min, and max last hour	Väisäla HMP44	1993
3	Global irradiation 295-2800nm	Kipp&Zonen CM11	1993
4	Horizontal wind velocity 2m average (60 min, 10min) and max (10sec and 10min)	Vector A 100R	1993
5	Amount of precipitation mm (near the ground)	ARG 100 Tipping bucket	1993
6	Soil temperature 1 cm	Campbell 107 TemperatureProbe	1993
7	Soil temperature 10 cm	Campbell 107 TemperatureProbe	1993
8	Soil temperature 20 cm	Campbell 107 TemperatureProbe	1993

Parameter values recorded by the Agrometeorological Service of Norway

9	Leaf wetness duration 2m	Campbell 237 sensor	1993
10	Snow depth in cm	Campbell SR50	1999
11	Net shortwave radiation	Kipp& Zonen pyranometer CNR1	1999
12	Albedo	Kipp& Zonen pyranometer CNR1	1999
13	Reflected short wave radiation	Kipp& Zonen pyranometer CNR1	1999
14	Long wave radiation from the sky	Kipp& Zonen pyranometer CNR1	1999
15	Long wave radiation from the ground	Kipp& Zonen pyranometer CNR1	1999
16	Global radiation	Kipp& Zonen pyranometer CNR1	1999
17	Net radiation	Kipp& Zonen pyranometer CNR1	1999
18	Volumetric water content 10cm (not in use)	Delta-T type ML1 TDR-sensor	1999
19	Volumetric water content 40 cm (not in use)	Delta-T type ML1 TDR-sensor	1999
20	Volumetric water content 80cm (not in use)	Delta-T type ML1 TDR-sensor	1999

Parameter values recorded by the Norwegian Meteorological Institute

This institute presently have a GEONOR-instrument to record precipitation parameter values and a Väisäla HMP45A- combination instrument to measure temperature of the air and relative humidity of the air 2m above the ground.

This station has got the WMO-number 01463.

Long series of meteorological observations at Aas

- (Gjelten, 2013) is presenting an overview of the different series of meteorological recordings at Aas from the year 1874 to the year 1988.
- Each year since 1980 tables containing recordings at the experimental field station have been published, and this publication is called 'Meteorologiske data for Ås' (by Hansen, V.H., and Grimenes, A.A.)
- 'The agrometeorological service of Norway (Landbruksmeteorologisk Tjeneste), did put up an automated meteorological station at this site in 1988. On the Internet the series of these meteorological recordings may be found.

Research in agro meteorology

- With the exception of an analysis of the soil temperature at the beginning of the 20th century, the department itself did not perform any systematic agricultural meteorological research.
- Local climate mapping, see (Grimenes and Hansen, 2004)
- Evapotranspiration and energy balance, see (Hansen, 1980A ,1980B, 1981, 1982, and 1985)
- Solar radiation and its spectral distribution, see (Olseth and Hegg, 1982), (Hegg, 1983), (Kvifte, Hegg and Hansen, 1983), (Hansen, 1984), (Berre and Lala, 1989), (Johnsen et. al., 1997), (Futsæter and Grimenes, 1998), (Sivertsen, 2006),
- Experimental technology and instrumentation. see (Hansen and Hegg, 1979), (Hansen, 1982A , 1982B, 1982C,and 1982D), (Bjørkan, 2001), (Grimenes et. al, 2002), (Antonsen, 2006), and (Gjelten, 2012).
- Estimation of leaf wetness duration (SVAT-modelling)

SVAT-modelling

- Reasearch also have been made on crop modelling and SVAT-modelling using data from the experimental field (Kvifte, 1987) and (Sivertsen, 1991, 1993, and 1995)

- A SVAT-model (Soil-Vegetation-Atmosphere-Transfer-Model) is a model containing the physics of the atmosheric boundary layer (Prantl-layer) , the vegetation, and the soil connected to energy balance and water balance.

- Crop grow models often contain SVAT-models.

What is the place of agricultural meteorology in the future society?

Internationally is developed indicators connected to 'sustainable agricultural crop production', especially 'use of energy' and 'use of water'.

In agricultural meteorology methods is developed to contribute to calculation of the indicators mentioned. The numerical models in agricultural meteorology mainly are physical models of conservation of 'energy' and 'water' in the systems.

Monitoring meteorological parameters and weather phenomena has always been important elements of agricultural meteorology. And from the campus of the University at Aas monitoring of meteorological parameters in agricultural districts all over the country of Norway has been organised for more than 20 years.

Research in agrometeorology as an element in supporting crop research

We claim that it is of importance to have crop research in Norway connected to ideas of ‘sustainable crop production’.

An interesting step could be initializing conceptual discussions on the national level in Norway connected to ‘sustainable crop production’.

Crop production in agriculture is much dependent on the weather conditions in the agricultural fields and the gardens of horticultural production during the year, especially during the growing season.

Therefore problems connected to the weather phenomena and global change of climate is important to consider when discussing ‘sustainability’. The site considered is fit for such research in agronomy.

Photograph: Bernhard Muehr
www.wolkenatlas.de, institute for Meteorology and Climate
Research, University of Karlsruhe, Germany