# METEOROLOGY AS A PART OF THE PHYSICS CURRICULUM IN THE NETHERLANDS

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THE possibility of teaching meteorology as a part of the geography curriculum in secondary schools has been discussed recently in this journal (Fosket and Fosket 1981, Rowe 1982). These articles mentioned difficulties such as the inadequate training of the teachers involved and the lack of interest in the subject among teachers and pupils. In the Netherlands interest in meteorology is increasing, particularly among physics teachers. This article describes how weather is being gradually introduced into the physics curriculum. First of all I shall say something about meteorology in physics lessons for pupils aged 16 to 18 at the 'O' to 'A' level stage. I shall then go on to discuss the reasons why I think meteorology lessons should also be given to younger pupils in secondary schools. Some ideas for classroom activities are given. These ideas are based on the experience we have gained in the Netherlands of introducing weather into physics lessons. Finally I shall discuss some of the problems that arise when weather is introduced into the early years of the physics curriculum.

## METEOROLOGY AS PART OF THE 'A-LEVEL' PHYSICS COURSE

During the past ten years a number of Dutch physics teachers have become interested in the weather because it is something which can be experienced and observed every day and it is a good basis for illustrating the relevance of many physical principles. During this same period the ACLO (Dutch advisory board on Physics curriculum Development) had begun to introduce a number of new topics into the physics curriculum for the top classes in secondary schools. Meteorology was one of the new topics which the ACLO decided to add to their list: every year teachers (or sometimes pupils) choose two of these topics and these are then examined in the leaving examination taken at the end of the secondary course. (Other topics include astrophysics, solid state physics and extensions of optics, kinetic theory of gases and electricity.) Moreover the ACLO considered meteorology to be so extensive that they split it up into two parts, one called 'dynamical meteorology' and the other 'physics of the atmosphere' (physical meteorology). Several pupil-texts with these titles are now available commercially and are in use in schools. More details about the content of these texts are given in Tables 1 and 2.

As soon as meteorology appeared on the examination syllabus teachers who had previously not devoted any lesson time to weather began to show an interest and to consider how they could introduce the subject into their lessons. Teachers were stimulated into widening their knowledge of the subject. This was done through articles that appeared in Dutch journals for physics teachers and by organising extension courses for teachers (run by the Dutch Association of Science Teachers). These courses consisted mainly of dynamical and synoptic meteorology, since physics teachers are normally not familiar with these subjects and do not know how to approach them. Vertical motion and adiabatic processes were the only aspects of 'physics of the atmosphere' which were incorporated into the course. It was assumed that physics teachers needed no extra training in other aspects. During a session of a typical course current weather and recent weather were discussed: theoretical concepts were continuously illustrated with the help of up-to-date weather charts. As part of the course, video-tapes of a Dutch television-course on the weather, and films (available from a film library) on different aspects of the weather were shown. The idea was to stimulate the teachers to use these films and tapes in their lessons. At the end of the course participants went on an excursion to the Royal Netherlands Meteorological Institute. Most teachers appreciated the courses they attended and generally found the subject interesting.

Most of the teachers, however, doubted whether it would be possible to set up sufficient relevant experiments in the classroom.

The factors which stimulated the introduction of meteorology into the 'A-level' syllabus can be summarised thus: the enthusiasm of the teachers, the enhanced status that meteorology acquired when it became an examination subject, the availability of pupil-texts, the special training courses that were organised and the articles that appeared in the teacher's journals.

This year (1982) is the first in which 'dynamical meteorology' has been included in the examination syllabus for all schools. Although first impressions are encouraging it will not be possible to assess definitive results until the subject has been taught for a number of years. No results are available yet for 'physics of the atmosphere' either, because so far the subject has only been taught in a very limited number of schools.

TABLE 1 Dynamical meteorology

1. Basic concepts: isobars, isotherms, gradient, cold front, warm front, stationary front, depression.
2. Radiation balance as a function of latitude.
3. Pressure as a function of height.
4. Pressure at a height of 5 km:
   a. as a function of temperature
   b. as a function of place.
5. Coriolis acceleration: Buys Ballot's law.
6. Equations of motion:
   a. straight isobars (with or without friction)
   b. curved isobars (with friction).
7. 'Stationary waves' in the atmosphere.
8. Divergence and convergence and the consequences of these phenomena on the observed weather.

TABLE 2 Physics of the atmosphere

1. Temperature profile in the atmosphere.
2. Radiation.
3. Vertical motion and adiabatic processes.
4. Water in the atmosphere.
5. Clouds and fog.
6. Condensation and freezing.
7. Precipitation.
8. Cumulus and cumulonimbus clouds.
9. Severe local storms.

## METEOROLOGY IN THE EARLY YEARS OF SCHOOL PHYSICS

In addition to the developments sketched above, increasing numbers of physics teachers are giving attention to weather in lessons for younger pupils. There are various reasons for this. Teachers find it useful to make their pupils familiar with phenomena such as rain, wind, clouds etc which pupils know from everyday life. These introductory lessons help pupils to make proper use of the information they can get

from the weather-forecasts and weather charts that are issued daily on radio, TV and in newspapers. A third reason is that, when pupils are dealing with the many aspects of weather, they are also dealing with aspects of physics in an interesting and attractive setting. A fourth reason is that since meteorology may sometimes be part of the physics curriculum in the later years, the general introduction to physics should contain some meteorology. The things that pupils associate with the word 'weather' initially are very different from the topics that are mentioned in, for instance, Table 1. In my opinion pupils should be allowed to explore the everyday life aspects of weather before they are faced with all the material that properly belongs to dynamical meteorology. Another good reason for starting meteorology in the earlier years is that only very few secondary school pupils in fact go on to follow physics courses to 'A'-level into which meteorology has been incorporated. Therefore, if one wants to show the links between physics and the weather to a greater number of pupils, one has to do this in the first years of the secondary school.

For these reasons the popularity of the topic weather among physics teachers is increasing. We now summarise some of our ideas about what activities can be done in lessons on the weather. These ideas have proved useful in Dutch schools.

### ACTIVITIES IN METEOROLOGY LESSONS (FOR PUPILS AGED 13–15)

Lessons on the weather can be made very attractive and interesting. As mentioned before, films and video-tapes can be used. The current weather can be discussed with the help of a weather chart from the newspaper (photocopy or transparency for overhead projection). One can also use an audio-tape or video-tape with a recent radio – or TV – forecast or even a forecast that is being broadcast at the very moment when the lesson is being given. Weather observations made by pupils can be compared with forecasts for the period in which the pupils made their observations. The results can be evaluated by giving the pupils tasks to perform:

They can be given a newspaper weather chart and five different forecasts and asked to decide which forecast fits the map.

They can be given a number of photographs or drawings and a description of a weather–situation and asked to find out which photographs correspond to the weather described.

- They can be asked to solve a crossword puzzle with meteorological terms.
- They can be asked to write a figure caption for an illustration from a book on the weather.

If the teacher allows the pupils to work in small groups on a variety of tasks, the subject of weather can be explored in a great variety of ways. Pupils are usually highly motivated when the members of the group to which they belong have themselves chosen the aspect of weather they are going to study, and the way they are going to do it. If every group reports its results to the class, one can get a good impression of different aspects of the weather. Some of the many activities which can be done in small groups are:

Gathering information by reading books or articles on the weather or by consulting an encyclopedia.

Conducting a classroom experiment. Some processes that occur in the atmosphere can be simulated in the classroom with simple experiments. Examples have been given by Tricker (1970), Trowbridge (1973) and other authors.

- Constructing simple equipment: making simple versions of meteorological instruments, such as barometers, rain-gauges etc (c.f. Virgo 1976).

Making routine weather-measurements: pupils measure pressure, temperature, humidity, wind speed, wind direction, visibility and cloudiness.

Carrying out small-scale investigations,
for instance: measuring the amount of rainfall inside and outside a built-up area.
measuring wind near tall buildings.
measuring temperature in the town and in the surrounding countryside.

- Collecting articles, weather charts and weather forecasts from newspapers. These items can be displayed on classroom noticeboards.

Making a cloud-atlas: drawings or photographs of clouds are collected and classified with the help of a cloud atlas or an illustrated book on clouds.

Making a text for a poster or a series of slides. It is comparatively easy to obtain posters and slides for educational purposes.

- Gathering proverbs about the weather and weather lore: pupils can try to explain them and make their own comments.

Pupils generally become very enthusiastic about a weather project because it allows them to engage in so many different activities and because there are so many aspects of the weather to be investigated. If interest in the weather is aroused in this way, it becomes easier to introduce and discuss in the classroom in later years topics such as those shown in Tables 1 and 2. In lessons for pupils ages 13–15 it is more difficult to separate the aspects of weather that are linked to physics from other aspects. It is for this reason that some physics teachers do not like introducing the topic of weather into physics lessons. Others ask their geography colleagues to participate with them in the weather project, and to give some of their lesson time to meteorology.

## PROBLEMS

There are two main problems in teaching weather to first and second year physics classes. One is the lack of Dutch pupil-texts on the subject. Teachers usually have to write their own 'book' in the form of stencils, compiled with the help of foreign pupil-texts (e.g. Patterns 1974, ASEP 1974) and sources such as Tricker (1970), Virgo (1976) and Dutch equivalents (listed in Floor and Geuzebroek-Frederik 1981).

Another problem is that so few teachers have had any proper training in meteorology. At this moment most teachers teaching physics up to 'O'-level (or equivalent) have not studied meteorology during their training courses. Nowadays, however, most Dutch teacher training colleges with a physics department do teach meteorology to their students. The course includes most of the topics mentioned in Tables 1 and 2. Furthermore the physics field courses attended by trainee teachers include the measurement of elements of the weather, the observation of weather and other phenomena in the atmosphere and a study of the necessary theory. In the future, therefore, Dutch physics teachers will be better equipped to incorporate meteorology into their physics lessons. It is to be hoped that meteorology will gradually acquire a more important place in the physics curriculum.

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