clusion. Besides its 14 papers the book contains a list of those who attended the symposium; an account of a modeling problem sprung on the participants for discussion without their having prior knowledge of its nature; four assessments of the proceedings by as many judges; and satisfyingly complete author and subject indexes.

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Air and Sea

Atmosphere-Ocean Interaction. E. B. KRAUS. Oxford University Press, New York, 1972. viii, 276 pp., illus. $18.75. Oxford Monographs on Meteorology.

The sea surface is a restless creature. It both responds to the atmosphere and modifies its condition. Exchanges of matter, momentum, and energy are basic to the global climate balances at one end of the scale and to the physical and chemical environment enjoyed by phytoplankton at the other. A tantalizing variety of physical processes are involved, and their interplay continues to challenge both oceanographers and meteorologists. For example, as Kraus points out, the chemical composition of droplets in spindrift, swept from the crest of a wave in a high wind, is variable and different from the bulk composition of seawater because of the existence of a surface film of largely biological origin. The evaporation of these droplets provides salt nuclei for subsequent precipitation in moderate and low latitudes.

This book is concerned with the physics of the processes involved in the interactions between the ocean and the atmosphere. Its scope is a good deal wider than Kitaigorodsky's "Physics of Air-Sea Interaction" (at present available only in Russian), which concentrates on the local exchange processes for momentum, heat, and matter. There is rather less emphasis here on the overall parametrization needed by numerical atmospheric modelers, perhaps for good reason—where the physics is lacking, attempts at parametrization are likely to be misleading. The states of matter near the interface, ranging from mushy ice to bubbles and spray, illustrate the complexities involved. Surface waves, turbulent transfers near the interface, both above and below, the structure of the planetary boundary layer and large-scale, low-frequency planetary waves all receive some attention. More detailed accounts of each of these are available elsewhere but not placed so firmly in this context.

Not always easy to read, the book suffers at times from an unevenness in level. On the one hand, ideas about surface tension are described in detail, even though these should be common knowledge to juniors in a good physics course. On the other hand, the mathematical approaches given for the specification of atmospheric and oceanic turbulence are likely to be tough going for all but well-trained physical oceanographers and meteorologists. The latter problem is, I suppose, intrinsic to the subject matter, but the professional or the advanced graduate student, to whom the book is addressed, may find some parts of it either prolix or, when results are given without the supporting arguments, frustratingly brief. Nevertheless, it complements well the existing books on this subject and with its breadth of coverage and fine bibliography will surely find its place on the bookshelves of both meteorologists and physical oceanographers.

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Climate and Human History

Times of Feast, Times of Famine. A History of Climate since the Year 1000. EMMANUEL LE ROY LADURIE. Translated from the French by Barbara Bray. Doubleday, Garden City, N.Y., 1971. xxiv, 426 pp. + plates. $10.

Ladurie has given us a wealth of carefully considered data on the geologically recent history of climate in *Times of Feast, Times of Famine*. This synthesis is derived from a mass of contemporary documentary evidence of crop yields, dates of grape harvests, and reports on wine quality and on advances of glaciers, mostly from the long series of records from France and the Alpine region.

As a student of past climate as deduced from palynology I find it exciting but almost daunting to encounter the precision with which the professional economic historian can pinpoint the years of abnormal climate, when the radiocarbon-dated pollen diagrams cannot yet indicate which decades were affected by climatic alterations. Ladurie has proceeded cautiously in evaluating the phenological data, avoiding the trap of trying to derive paleoclimatic inferences from historical events which were not direct climatic indices; he set himself the task of compiling data to which he could apply "a qualitative method comparable in rigor if not in accuracy and variety to the methods of modern meteorology." A potential pitfall is the change in areas of crop growth due to economic and cultivation changes; for example, the northward movement of olive growing from 1550 to 1600 occurred not because of climatic warming but because the growers were trying to exploit an expanding market, actually at a time of colder climate. Ladurie also maintains that late medieval reductions in French grape cultivation resulted not from climatic change but from high labor costs due to the plague and disruptions of war. He is opposed to the climatic-determinist approach to history, exemplified by Huntington, and criticizes C. E. P. Brooks, for using circular reasoning in his studies of paleoclimate, for using secondary rather than available primary sources, and for introducing a fictional glacial retreat in the middle of the "Little Ice Age." Historians draw criticism for lack of interest in climatic history, and Ladurie castigates those students of climate he calls "cycle mad."

The long series of French and German wine harvest dates and quality reports have been examined for their phenological interest: early harvests resulted from warm springs and summers characterized by anticyclonic conditions, and late ones from cool springs and summers with cool and cloudy cyclonic conditions. The correspondence of German records with those from France is reassuring, and indicates regional climatic control. Reliable German records assembled by K. Müller cover the years 1453 to 1950, with some data back to A.D. 1000. The French data (many of them gathered by Angot) are ample back to the 17th century, with fewer series covering the 16th century, and with some data back to the 14th century. The validity of the phenological data is confirmed by comparisons of vintage dates and wine quality reports with meteorological records in the last two centuries. Germany experienced generally warm summers from 1453 to 1552, but from then until about 1600 the summers were over-

whelmingly unfavorable for wine production, and the French phenological data are similar. Ladurie notes this correspondence with the expansion of Alpine glaciers from 1554 to 1592, and then the especially cool episode 1593–1602 saw quicker glacier advance and the crushing and burying of alpine hamlets. The extracts from contemporary accounts make vivid and alarming reading, as masses of ice larger than houses crashed down on houses and fields overhung by the snouts of advancing glaciers. These accounts and the increasingly accurate sketches and paintings which were made from the 17th century onward allow the accurate measurement of ice advance relative to the present. The work of the local clergy to halt the ice led in one case to the planting of a cross at the advancing snout (in 1818) which existed until the early 20th century and provided an accurate marker for early studies of glacial history. The prayers and religious processions to protest the glacier advances seem to have often coincided with the start of glacier stillstands or retreats, interestingly enough.

Ladurie describes 1596 to 1867 as the period of glacier imperialism throughout the European Alps, and his scrutiny of the contemporary texts and illustrations has led him to explore the Alps on foot to learn from field observations the exact location of past glacier positions from historical accounts. The retreat of the alpine glaciers beginning in the warm decade 1860–70 started shortly after the first glacier photographs began to be taken, so that there are some excellent illustrations in this book of the changed positions of the ice fronts. Series of early thermometric observations seem to bear a strong relationship to the glacier movements, with lag response times of less than a decade. This widespread retreat has lasted until the 1950's, but the return to cooler climate in the Northern Hemisphere since then has not been sufficiently marked until very recently to be treated at any length in this book, which was first printed in France in 1967.

To conclude, Ladurie has succeeded in presenting a wealth of primary climatic data to form a sound basis for subsequent studies of, for instance, the relationship of human history to climate, and in giving us in his own words "a climatic history with a human face."

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A Circle of Virtuosi

The Experimenters. A Study of the Accademia del Cimento. W. E. KNOWLES MIDDLETON. Johns Hopkins Press, Baltimore, 1971. xvi, 416 pp., illus. $22.50.

Middleton's book on the Cimento is something of a disappointment for the reader who has been led to believe in the key significance of 17th-century Italian scientific societies. The standard account of the role of this Florentine association is as a stepping-stone between the Roman Accademia dei Lincei (1603–1629) and the Royal Society of London (1660), each of which gradually channeled individual scientific curiosity into communal and systematic inquiry carried on in learned societies. Middleton's carefully documented account (the only one since Targioni Tozzetti's in 1780) concludes that the association of "experimenters" at the Medici court was more disorganized and less influential than has generally been supposed. With evidence aplenty, he demolishes the inflated claims about its uniqueness, power, reputation, and accomplishments that have so easily found their way into Italian accounts and unravels the complex chronology of this association's meetings and experiments. Only the specialist will want to follow Middleton into the thickets of details, but he can do so with great assurance of the reliability of the presentation. Middleton knows his primary sources extremely well, and more often than not lets them speak for themselves, in a faithful but readable English translation.

The gist of the story is that the Grand Duke of Tuscany, Ferdinand II, and his brother Prince Leopold each independently, when affairs of state permitted, performed experiments generally designed to refute Aristotelian physics. Records suggest that some experiments were begun as early as 1641, but the Academy cannot be said to have existed prior to 1657. The circle of virtuosi included Galileo's last pupil, Vincenzo Viviani, employed at court as an engineer; Giovanni Alfonso Borelli, the polymath professor of mathematics at Pisa; Ferdinand's physician Francesco Redi; and several other Pisan academics, Rinaldini, Marsili, and Uliva. Leopold's secretary, Segni, kept notes until 1660 and was succeeded by the young Magalotti, upon whom fell the burden of preparing the Academy's sole publication, the *Saggi di Naturali Esperienze* (1667). This small but active group met sporadically, principally in the summer when professorial duties were light, and occasionally in the dead of winter when it was possible to make use of the extreme cold for experimentation. Thermometers and barometers were their favorite instruments, though they also toyed with pendulums, magnetism, electricity, chemical reactions, and snakebites. According to the author, their work was extremely competent for the epoch, and in some cases quite original, though we know this only in retrospect. Failure to publish their findings or to communicate regularly with other circles of experimenters in London and Paris reduced their potential impact on the body of scientific information. Even when the *Saggi* finally appeared, some five years after the experiments, it made little impact upon the small but growing international scientific community. By that time, the Academy had split up following a serious falling-out between its two most intelligent and active members, Viviani and Borelli. The latter subsequently quit his post at Pisa, and two other associates also left Tuscany. Nine months after the last recorded meeting Leopold also left Florence to become a cardinal.

For all his contributions in setting straight many points of detail, Middleton has avoided very significant questions that did not occur to him because of the meticulous and focused character of his book. He makes no concerted attempt to assess the place of science in the Medici court, or to explain the lack of continuing interest in natural philosophy outside the tiny ring of experimenters. Middleton could throw a great deal of light on the relative popularity of literary and antiquarian pursuits so well described by Eric Cochrane, but he ignores the question completely. He has also shied away from dealing in depth with the impact of the Counter-Reformation on scientific pursuits in Florence, though this is an obvious component of the Cimento's peculiar character and demise. It would have been much more profitable to explore these realms than to devote one-half of the text to an—admittedly good—annotated new translation of the *Saggi*, which is nevertheless currently available in English in a decent 17th-century version. *The Experimenters* might thereby have been more balanced, and would have given the reader more for his money.

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