Early investigations of an aquaplanet

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The Académie Royale des Sciences et Belles Lettres de Prusse began in 1744 to announce open competitions. A problem was posed every year and ideas for a solution were submitted from all over Europe. Themes were chosen from natural sciences, mathematics and the humanities. The topic of the second competition in 1746 was "Détermine l'ordre et la loi que le vent devrait suivre si la terre était environée de toutes côtés par l'Océan, de sorte qu'on pût en tout temps trouver la direction et la vitesse du vent pour chaque endroit" (Determine the rules the wind would have to follow if the earth would be completely covered by the ocean such that one could find direction and speed of the wind at any time and any location). D'Alembert won the prize and his contribution was published in 1747 together with two more solutions to this problem, one by Daniel Bernoulli titled "Recherches physiques et mathématiques sur la théorie des vents réglés, sujet proposé par L'Académie Royale des Sciences pour 1746" and another one by an unknown author titled "Versuch einer Bestimmung der Gesetze der Winde, wenn die Erde überall mit einem tiefen Meer bedeckt wäre." The latter two obviously made it to win the status "accessit".

D'Alembert was a member of the Academy but was allowed to submit a solution because he was a foreign member. His text consists of an introduction written in French where he points out that the gravitational forces of the moon and the sun which cause tidal motion in the ocean, must act on the atmosphere as well. He proposes that these forces form one of the general causes of the winds. He admits that solar heating may also stir up the winds but turns away from this mechanism for the moment because exact solutions are impossible in this case. He expects that several hundred years of research are needed to solve the complete problem. Instead he attacks the less difficult problem of tidal oscillations in the atmosphere. The technical part of D'Alembert's treatise is written in Latin. There is again a short introduction where he describes the contents of the various parts of his work. This abstract is followed by an impressive chain of problems and solutions where he proceeds from static problems to the oscillations and the related wind velocities. In addition he deals with the air motion between mountain chains. There is, however, no clear conclusion with respect to the flow fields to be expected.

Bernoulli speculates that the 'elastic' atmosphere of the Earth needs to be compressed and kept in its place by an atmosphere around it. This task is performed by the solar atmosphere in which all the planets float. The frictional interaction of the solar atmosphere with that of the earth prevents the latter from following the earth during its rotation. Using this hypothesis Bernoulli performs explicit calculations of the wind velocity. In addition, Bernoulli evaluates those winds which are caused by the solar heating.

The third author argues that it must be the heating by the sun which causes the winds to blow. A resting sun would cause the air to flow to that point under the sun. The rotation of the earth

modifies this pattern and induces the trade winds. The idea of gravitationally generated winds is refuted on the basis of incorrect reasoning.

The contributions are impressive through the freshness of various approaches. On the other hand, the basic equations of fluid mechanics were not yet available in 1744 which limits the rigor of argumentation. The relation of all this work to the earlier publications by Halley and Hadley is discussed.