

SCOR WORKING GROUP 27 (WITH IAPSO & UNESCO)

TIDES OF THE OPEN SEA

Report of Final Meeting, Grenoble, 29 August 1975

Members present: D. E. Cartwright (UK) Chairman; C.G. Dohler (Canada); W.H. Munk (USA); F. Schott (FRG); T. Teramoto (Japan); S. Voyt (USSR); B.D. Zetler (USA). (J. Hyacinthe and R. Radok were unable to attend).

National Reports

The following summaries of work done in the last year or projected for the future were given.

Hyacinthe (France, written report) had tested the CNEXO instrument alongside the standard tide-gauge in Brest harbour for 6 months, with excellent comparative results. He had then laid the instrument in the 2200m site B of the 1973 Intercalibration Exercise, and recovered it successfully after 5 months. Unfortunately, this record was spoiled by a fault in the a/c supply to the vibrating wire, probably incurred at the time of launching, and never encountered before. He intended to re-lay the capsule at site B, and the results of both tests will be circulated to those concerned when complete, for comparison with the 1973 results. Hyacinthe hoped for an eventual campaign to occupy some 20 tidal stations in the North Atlantic, using a yacht-sized vessel for maximum economy, but no definite plans had yet been made.

Cartwright (UK) reported on shallow water and oceanic programmes at IOS-Bidston, combining pelagic measurements with numerical tidal models of various scales. Results from the last few years' measurements round the shelf edge surrounding Britain had been used to model the entire shelf seas, with estimates of dissipation in distinct zones such as the Irish and North Seas. A more southern set of boundary data for the North Sea was planned as part of the JONSDAP exercise in early 1976. An oceanic programme was underway, to define the tides along boundaries defined by latitudes $37\frac{1}{2}^{\circ}\text{N}$ and $53\frac{1}{2}^{\circ}\text{N}$, longitude 30°W (Mid-Atlantic Ridge) and the West European shelf. About three-quarters of the circuit were due to be completed in October 1975, and the whole will be used in conjunction with an ocean-cum-shelf model to study shelf-edge conditions and the effects of dissipation. The zone under study will also be useful for marine tide loading in Europe and as "sea-truth" for geodetic studies by satellite altimeter. Some 30 sets of pelagic tidal constants, obtained by IOS over the past seven years, had been sent to I.H.O.

Dohler (Canada) presented a written report. Aanderaa pressure meters had been deployed in Arctic waters and on seven seamounts in the northeast Pacific, but only a few meters had so far been recovered. Work is in hand to improve the reliability of acoustic releases. Records had been obtained from several sites in Hudson Bay, James Bay, St Lawrence River, Cabot Strait and on the Scotian Shelf. The Central and Atlantic records are to be used in conjunction with the GEOS-3 Altimeter studies. Future projects include a string of tidal stations off the Bay of Fundy/Gulf of Maine complex. The keypunching of the IHO library of tidal constants is well underway, and should be completed by the next IHO Conference in April 1977.

Zetler (USA) reported on work at IGPP (La Jolla) and by Wimbush at Nova University (Florida). The MODE tides study had been published, (J. Phys. Oceanog. 5, 430-441, 1975), and the results will be used with calculations of meteorological effects on sea level to provide sea-truth for the GEOS-3 Altimeter in its primary test area of good orbital tracking. Hendershott and Parke had made progress with the difficult problem of solving the ocean tidal equations with crustal yielding and shelf-attraction, and their model will also be used in the GEOS-3 work. Wimbush and Mofjeld are continuing the Caribbean tide study originated by Zetler. Wimbush is adding pressure capsules of his own design to current meter strings in the Gulf of Mexico and in the Florida Straits, and plans a shelf-edge study on the Blake escarpment. Munk and Zetler are investigating a tidal modulation in acoustic signals from Eleuthera Island to Bermuda. The ray path passes through the MODE area, but encounters only the minor axis of the M_2 ellipse, which is insufficient to account for the amplitude of modulation. Zetler also reported that NOAA (National Ocean Survey) are installing gauges in the Gulf of Alaska.

Schott (FRG) has continued his work on baroclinic tides, using experiments off the NW African shelf, in the Iberian Basin, and in the MODE area, and has examined their role as a

possible sink for barotropic tidal energy, using Baines-type calculations of shelf edge interactions. Baroclinic and barotropic energy levels have been found to be roughly equal in places. Calculations of world-wide energy conversion rates from shelves and bottom-scattering suggest that baroclinic tides are unlikely to balance the known energy budgets. Zehel has nearly completed his 1 degree world tidal model including shallow seas down to 20m depth. He finds 3.6×10^{19} ergs/sec total M_2 dissipation, of which only 0.7×10^{19} is due to bottom friction, the rest being due to lateral eddy viscosity, according to his model.

Teramoto (Japan) reported little progress in oceanic tides, but plans were being prepared for an experiment involving bottom pressure measurements across the area of the Kuroshio Current.

Voyt (USSR) reported a new tide modelling venture by Marchuk, involving stratification, bottom friction and homogeneous boundary conditions. Voyt himself has completed a paper on the influence of stratification and bottom topography on long wave propagation. He was unable to supply information on Arctic tidal constants which had been requested by Canadian researchers.

Review of past achievements and future possibilities

As agreed at the 1974 meeting, the Chairman had written a 10-page survey of the Working Group's activities, entitled "The future of oceanic tidal research", with a 22-page appendix by R. Radok, summarising the detailed accounts from the first ten volumes of the SCOR Proceedings. Copies had been circulated to all members and others interested. In brief, WG 27 had stimulated a great deal of research into instrument development and analysis techniques during its ten years of existence, culminating in the Intercalibration Exercise report, which had been published by Unesco a few weeks before the Grenoble Assembly. However, the early realisation of reliable oceanic tidal maps, hoped for when the Group was formed, had proved over-optimistic. The numerical modellers who were most likely to produce such maps had made little use of the new pelagic measurements, and field-workers were unable to get ships to oceanic test-points specified by the modellers. Other techniques for tackling the problem, such as inversion of the Earth Tide marine loading equations, or analysis of satellite orbit perturbations, are becoming relevant. Further progress will need a wider inter-disciplinary approach than was possible within the original framework of Working Group 27.

Field deployments of bottom pressure recorders will continue to be necessary for a long time, but it is now obvious that only very few countries are willing to support such programmes. Active participants are too few, and their tasks too diffuse to justify an international working group. The Chairman's survey did however conclude with advocations for new Working Groups in related areas of research, and these were discussed at the meeting.

One possible research area was "Baroclinic Tides". The subject had frequently been suggested as an extension to the work of WG 27, but had been considered too distracting from its main purpose. After discussion, the Group decided not to recommend a new Working Group in this field because : (a) too few people are really interested, (b) it would be difficult to frame a succinct objective, (c) the subject is inseparable from the wider issues of internal wave dynamics, of which the tidal motions form only a minor component, (d) the "energy sink" question now seems less important than was once thought.

The other research area considered was "satellite altimetry of the sea surface", since this appears in principle to be the most promising means of obtaining world-wide tidal definition, provided the required accuracy (a few decimeters) is reached. The suggestion of a new Working Group was also rejected because : (a) the SCOR Officers felt that technological advance of measurement systems was the first requirement and this was not a function for SCOR, (b) it was not yet known whether the accuracy was sufficient for independent tidal analysis, as distinct from providing tidal estimates as "sea truth" corrections for geoid determination, (c) there is at present a restriction on the release of altimeter data to oceanographers. Nevertheless, WG 27 agreed that the matter of a Working Group on satellite altimetry of the sea surface should be re-considered at a later date. To that end, they authorised the Chairman to pass a Resolution to IAPSO, urging early release of altimeter data for oceanographic research, and that IAPSO should ask SCOR to form a Working Group on this subject as soon as the first investigators had shown the data to be accurate enough to serve for tidal determination.

Finally, Working Group 27 endorsed a Resolution framed by the IAPSO Committee on Tides and Mean Sea Level, welcoming the recent move by the International Hydrographic Organisation to computerize their lists of tidal constants, and to include constants from the open sea,

and urging all oceanographers who obtain tidal data to send their harmonic constants to I H B as a central data bank.

Dr Dale Krause, a visitor representing Unesco, offered to disseminate a statement similar to the above through the publication IMS Newsletter.

After a brief exchange of polite commendations, the Chairman declared the Working Group on tides of the open sea to be disbanded.