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Modelling the *Braer* Oil Spill—A Comment on Proctor *et al.* (1994)*

I read with interest the recent paper by Proctor *et al.* (1994) replying, in part, to what they perceived as criticism by Turrell (1994) of their modelling efforts in attempting, at the time of the event, to predict the movement and dispersion of the oil spill released from the grounded tanker *Braer* in January 1993.

However, Turrell (1994) was first drafted in March 1993, at the start of the reassessment period of *Braer* scientific work, and was written for three distinct, and different, reasons:

1. **To describe factually the progress of the modelling work during the period, and explain why the models were in error.** This was not a trivial point at the time. Many administrators and managers involved in the incident and its aftermath working within several agencies had been exposed to the modelling work from a very early stage in the incident, both through 'official' channels, such as faxes from the modelling groups, but also publicly through articles in daily newspapers and journals such as *New Scientist*. The 'consumers' of these products soon became acutely aware that the predictions were in disagreement with the observations of actual oil distributions presented to them by SOAFD, not just quantitatively but also qualitatively, i.e. simplistically the oil went southeast when the models predicted it to go northeast.

Many of the people made aware of model product during the incident had little oceanographic knowledge, and had no concept of the difficulties and limitations of numerical models, but they could see that the models had got this event 'wrong'. It was important that the difficulties involved in, for example, parameterizing the extreme physical conditions which were experienced at the time of the *Braer*, were clearly explained. This was especially important as the 'consumers' of model product included agencies who presently do, and in the future may, fund numerical modelling projects in diverse areas such as the assessment of the ecological impact of the fish farming industry and modelling applied to coastal zone management. It was obviously in the interest of the modelling community to very clearly describe the faults of the models at the time, how they arose and how they might be corrected, in order to maintain credibility for numerical modelling in general.

2. **To explain how oil got to the areas where it was ultimately observed.** No hindcasts of the *Braer* oil spill were available when Turrell (1994) was written. The observations of oiled sediment south-east of Fair Isle were being explained by several unrealistic theories. One involved the large scale movement of bed load between Shetland and Fair Isle. The simple models in Turrell (1994) were, therefore, presented in order to demonstrate that the basic physical processes of vertical diffusion and wind-driven transport could account for the observed distributions. No recourse to exotic transport processes were required.

3. **To suggest improvements that could be made for future oil spill modelling.** The improvements suggested in Turrell (1994) arose from the many discussions that were held during the first few months of 1993. They were stated so that they might be submitted in a coherent form to the Donaldson Inquiry, the Ecological Steering Group on the Oil Spill in Shetland (ESGOSS) and the Inter-Agency Committee on Marine Science and Technology (IACMST). Several of the recommendations were reiterated by Proctor *et al.* (1994).

Indeed, the implementation of the first of the recommendations may have been of critical importance at the time of the *Braer* grounding. It is now clear from the description of the events immediately before the *Braer* ran aground (for example *Mar. Engng Rev. (MER)* February 1994, 12–14) that if an accurate forecast of the ship's drift had been available at the time, it may have influenced the decision to evacuate the vessel.

Just after the decision was made at 0810 on 5 January 1993, to evacuate the last remaining personnel because of the fear of imminent grounding, the vessel's northerly drift halted, and she began to drift towards the west away from Horse Island under the influence of the changing tidal currents (*MER*, 1994). Two further hours elapsed before she eventually struck rocks on the western side of Garths Ness. The fine resolution tidal model of the area presented in Proctor *et al.* (1994; Fig. 9) shows the change of tide quite clearly between 0900 and 1000 to the south of the island. An operational numerical model supplying accurate forecasts to the agencies involved during an emergency operation would be of great benefit.

Proctor *et al.* (1994) incorrectly cite that Turrell (1994) accounted for 15% of the spilled oil. In fact, the modelling described by Turrell (1994) is purely descriptive, and at no point are amounts of oil referred to. This was not the object of the study. As explained above, it was merely to address the observed oil distribution qualitatively.

However, the remark does raise an interesting question. What was the final fate of all of the *Braer* oil? An approximate budget performed by the Marine Laboratory Aberdeen accounts for some 56% of the oil (Table 1), with the fate of 44% still unaccounted for. It is to be regretted that the 'hindcast' performed by Proctor *et al.* (1994) was rather a justification of their models, rather than a comprehensive assessment of the ultimate fate of the oil. The only way that this will be

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TABLE 1

Approximate budget prepared by the Marine Laboratory Aberdeen of the oil spilled from the tanker *Braer.**

	Tonnes	Percent (%)
In water column	5000	6
In sediment: SE Fair Isle	17 000	20
In sediment: W Shetland	12 000	14
Deposited on land	800	1
Lost to atmosphere	12 000	14
Unaccounted for	37 200	44
Total	84 000	

*Results taken from the final report of the Ecological Steering Group of the Oil Spill in Shetland ESGOSS (in press). The figures refer to water and sediment surveys performed around Shetland between 13 and 19 January 1993. The figure for the amount lost to the atmosphere is a mean one. Estimates range from 10 to 20% of the total amount.

examined is by numerical modelling as insufficient data exist to describe a complete inventory of all of the spill.

It is quite likely that the missing 44% remained in the water column, possibly occupying large volumes of the North Sea, but at low concentration levels. But where did this contaminated water eventually go? What may have been the likely concentrations in this water mass? Numerical models may be able to provide an assessment of the likely transport paths the oil underwent and provide estimates of exposure levels experienced by marine life, but the study of Proctor *et al.* (1994) disappointingly stops once roughly similar modelled and observed patterns have been generated. Surely one of the great advantages of models is to extrapolate from known results to gain some knowledge of possible unknown conditions?

There is no doubt that numerical models are now capable of producing quantitative results. Although oceanographic modelling greatly lags behind atmospheric modelling in the quantitative application of numerical models, there are many examples available when models are used in an engineering sense, with testable quantified outputs, with stated accuracies. Examples in use at present would be tidal and storm surge predictions.

Oil spill modelling must be moved into this category. We require predictive capabilities to deal with incidents such as the *Braer* at a national level. The basic models are available, but require some development in order that small-area operational models are available for the UK. The dissemination of interpreted model output must be improved. It is to be hoped that the valuable experiences gained during the modelling of the *Braer* oil spill, and the recommendations arising from these experiences as summarized in Turrell (1994) stimulate future work accompanied by the necessary funding.

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Turrell, W. R. (1994). Modelling the *Braer* oil spill—a retrospective view. *Mar. Pollut. Bull.* **28**, 211–218.