Interpretation of Tidal Constituent Sa

A comparison of the Doodson numbers in the IOS (UK) and IOS (Canada) prediction programs revealed a difference in the interpretation of the constituent Sa that has the potential to degrade the accuracy of tidal predictions in Australia. The former program is used by the former National Tidal Facility Australia, the National Tidal Centre, Bureau of Meteorology and the Transport Department of West Australia while the latter program is used by the Hydrographic Office RAN and a significant number of other Australian organisations.

Constituent Sa, which represents the seasonal variation (with period of about one year) in mean sea level is quite significant in Australian waters. It may have an amplitude of up to 0.4 metres but generally is in the order of 0.1 metres.

The Doodson numbers for Sa used in the IOS(UK) program (Reference A Table 4) are 0 0 1 0 0 0. Those used in the IOSD(Canada) (Reference C, Appendix 4) are 0 0 1 0 0 -1. The former set involves only the mean longitude of the sun and its rate of change. The latter set also involves the mean longitude of the solar perigee and its rate of change. The effects of the difference in the last number are calculated in Annex A. While the effect on the speed of the constituent is almost negligible, the effect on our programs calculation of the initial phase of Sa is large giving rise to inaccurate tidal predictions.

Source of Constituent Constant	IOS (UK)	Difference	IOS (Canada)
Constituent name	Sa		Sa
Interpretation Doodson numbers	0 0 1 0 0 0		0 0 1 0 0-1
Speed (degrees/hour)	0.0410686	0.0000019	0.0410667
Period (mean solar days)	365.24254		365.24995
Phase in degrees at time origin	(0000 GMT 1/1/76)		
	278.78841	-77.472360	357.26077
Phase in degrees at	(0000 GMT 4/4/84)		
	9.54387	-77.33048	86.874358

It is not particularly important which Doodson numbers are used for the constituent as long as those used in the prediction program are the same as those used in the tidal analysis.

The effect of the differing Doodson number on the accuracy of past predictions was demonstrated by test predictions for a year using Sa with Doodson Numbers 0 0 1 0 0 0 and 0 0 1 0 0 1. Using a typical amplitude of 0.1 m, the difference in tidal height varied from zero to 0.13 m.

There are two ways to deal with the difference in interpretation

1   Include details of the Doodson number for Sa in the metadata accompanying tidal constituent constants
2   Modify analysis and prediction programs to use the IOS (UK) interpretation i.e. the Doodson number for Sa is 0 0 1 0 0 0

It would be prudent to implement both.

References
A: "The Fine Resolution of Tidal Harmonics" by M. Amin 1975.
B: "The Harmonic Development of the tide generating Potential" by A.T. Doodson 1921.
C: "Manual for Tidal Heights Analysis and Prediction" MGG Foreman. IOS (Canada) 1977.