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It seems the trend in meridional overturning circulation reported by Bryden et al (2005) may be an artifact of not accounting for the annual cycle in Gulf Stream transport.

In calculating the Atlantic volume transport across 24 degrees North, Bryden et al assume annual average values of the Gulf Stream of +35.6 Sv for 1957, 1981, and 1992; and +37.6 Sv for 1998 and 2004. It appears important, however, to take into account an annual cycle in Gulf Stream transport. Sato and Rossby (Deep Sea Research, vol 42, p149−164, 1995) report an annual cycle in the baroclinic component of the Gulf Stream transport having an amplitude of 8Sv, Tanom=−4*cos(w*t)+1*sin(w*t), where w=2*pi/12 and t is the month. Similarly, Kelly et al (JPO, vol 29, no 3, p313−327) report that the Gulf Stream volume transport in the spring exceeds the fall by about 7 Sv.

The first two transects used by Bryden et al (2005) occurred during the fall (Baringer and Molinari, GRL, vol 26, no 3, pp353−356, 1999), while the most recent transect occured during the spring. Thus the earlier sections were made at a time when northward Gulf Stream transport is expected to be small and the most recent transect during maximum transport. Given that the seasonal storage of mass allows for no more than a 1Sv anomaly in the total flux across 24N (Wunsch and Heimbach, JPO, submitted) and variations in the Atlantic Ekman transport at 24N are expected to be small (Trenberth et al, JPO, v20, p1742−1760, 1990), variations in Gulf−Stream transport are probably balanced by changes in mid−ocean barotropic or geostrophic transport.

Bryden et al (2005) calculate the total transport at depths shallower than 1,000 meters as the residual between mid−ocean geostrophic transport and Gulf Stream plus Ekman transport, yielding a trend of −0.16 \pm 0.03 Sv/year. If the geostrophic transports are adjusted for seasonal anomalies using the equation of Sato and Rossby (see above), the inferred trend in the transport at depths shallower than 1,000m is insignificant at −0.05 \pm 0.06 Sv/year. Table~1 provides more details regarding the timing of the cruises and the transport values.

It seems that the trends reported by Bryden et al (2005) owe to an aliasing of the annual cycle in Gulf Stream transport. The nature of seasonal variability in the overturning circulation will become more clear when observations from the moored array become available. In the mean time, whether the estimated trend in overturning is an aliasing of the seasonal variability could be tested by complimenting the 2004 Spring transect with a Fall transect. My prediction is that a Fall transect, analyzed using the methodology of Bryden et al (2005), would show a strong overturning circulation.

Table 1:

Cruises and dates:	1957 Oct	1981 Sep	1992 Aug	1998 Feb	2004 May
Transports shallower than 1,000m depth (Sv):					
Gulf−Stream (from Bryden):	+35.6	+35.6	+35.6	+37.6	+37.6
Gulf−Stream with seasonal anomaly (adjusted):	+32.7	+34.6	+36.7	+36.5	+41.6
Mid−ocean geostrophic (from Bryden)	−12.7	−16.9	−16.2	−21.5	−22.8

Total shallower than 1000m (from Bryden)	+22.9	+18.7	+19.4	+16.1	+14.8
Total shallower than 1000m (adjusted)	+20.0	+17.7	+20.5	+15.0	+18.8