The curlometer technique

- The curlometer technique allows to estimate the current density vector from the Ampere's law, assuming stationnarity:

  $$\mu_0 \boldsymbol{J} = \boldsymbol{curl\, B}$$

  Using the individual location and the B-field measurement of each spacecraft, this equation can be written as:

  $$\mu_0 \boldsymbol{J}_{ijk}.(\Delta \boldsymbol{r}_{ik} \times \Delta \boldsymbol{r}_{jk}) = \Delta \boldsymbol{B}_{ik}.\Delta \boldsymbol{r}_{jk} - \Delta \boldsymbol{B}_{jk}.\Delta \boldsymbol{r}_{ik}$$

  This gives the current density $\boldsymbol{J}_{ijk}$ perpendicular to the plane surface generated by the satellites *i, j* and *k*.
  $\Delta \boldsymbol{r}_{ij} = \boldsymbol{r}_i - \boldsymbol{r}_j$ is the separation vector between the spacecraft *i* and *j*.
  $\Delta \boldsymbol{B}_{ij} = \boldsymbol{B}_i - \boldsymbol{B}_j$ is the diffrerence between the magnetic field measurement by the satellites *i* and *j*.

- *div T*, divergence of the magnetic field estimated from the 4 satellites measurement is an indicator of the error of the estimate of ***J***

- *r curv* is an estimate of the curvature radius of the field lines assumed to be locally a portion of a circle
  $\mathbf{r}_{curv} = |\mathbf{B}|/\nabla_{\perp}\mathbf{B}$

References:

Dunlop, W. M., Southwood, D. J., Glassmeier, K.-H., andNeubauer, F. M.: Analysis of multipoint magnetometer data,Adv. Space Res., 8, 9–10, 1988

Dunlop, M. W., Balogh, A., Glassmeier, K.-H., and Robert, P.:Four-point Cluster application of magnetic field analysis tools:the curlometer, J. Geophys. Res., 107, 1384–1398, 2002.

Robert, P., Dunlop, M. W., Roux, A., and Chanteur, G.: Accuracyof current density determination, in Analysis Methods for Multi-Spacecraft data, ISSI Sci. Rep. SR-001, 395–418, 1998