Methods. We employed the longitudinal scans for a group of 8 Alzheimer’s patients from the ADNI dataset. For each subject we measured the deformations to match the follow-up scans to the baseline using the Symmetric Log-Domain Demons Algorithm

- Spatial consistency –
  The degree of expansion/contraction in the whole brain can be assessed at two different levels within the same framework

- Global change at regional level (Shift of the boundaries):
  computing the flux of the deformation across the brain’s surface.

- Local change at voxel level (Infinitesimal volume change):
  point evaluation of the deformation’s Jacobian determinant.

Temporal consistency –
For each subject, the sequence of deformations at each time point was used to define a subject-specific prior longitudinal deformation and the prior was used to re-estimate the deformations as a weighted average between spatial and temporal information.

\[ \mathbf{v} = G_{\sigma} \ast \left( \frac{\sigma_t^2 \mathbf{v}_X + \sigma_x^2 \mathbf{v}_t}{\sigma_t^2 + \sigma_x^2} \right) \]

Results.
The correlation between manual derived brain volume changes and the measure of whole brain changes derived from the deformation field was of \(0.899\). The temporal regularization procedure generally led to more linear trends for the subject-specific changes in time and increased the correlation with manual derived measures reaching the maxima of \(0.922\) when the weight of the temporal information was half of the spatial.

Figure. Flux-derived brain volume change in time for a specific subject without temporal regularisation (black dots) and with different trade-off for the temporal constrain (coloured lines). The amount of the weight on the temporal constrain led to a more linear (regular in time) estimation of the progression.