covariance matrix are plotted on Panels (d) and (e), respectively. In comparison to the a priori or forecast quantities (Fig. 13b–c), the assimilation has logically flatten the error spectrum.

Fig. 19 shows the surface values of the four dominant a posteriori and adapted error eigenvectors. The first three vectors mainly explain temperature driven wave-patterns and AIS meanders along the eastern coast of Sicily (data were not assimilated in this region). The fourth vector is a salinity related pattern on the southern part of the Ionian slope, with a temperature signature at the northeastern open boundary. These dominant vectors differ from the forecast ones (Fig. 14). The assimilation has decreased the error amplitude and reorganized the error structure, in agreement with the data innovations.

3.2.2. September 18–24, 1996

Selected results of the estimation and study subsequent to the assimilation on Sept. 18 are presented. Some aspects of the adaptive evolution of the error covariances are summarized. The features and variabilities of the physical fields are discussed and their estimation is evaluated by intercomparisons with the OI fields, SST images and in situ data.

The assimilations on Sept. 18 and Sept. 22 (Fig. 4b–c) introduce the non-uniform properties of the data (specific variables, resolution in space and time, localized sampling) into the error statistics. The adaptive evolution of the error covariance is now influenced by the statistics of both the observations and dynamics. For example, the similarity coefficient ρ (Section A.4) between the ES forecasts for Sept. 18 and Sept. 22 is,

$$\rho_{18-22} = \frac{\sum_{i=1}^{285} \sigma_i \left(\Pi_{18}^{\frac{1}{2}}(-)\, E_{18}^{T}(-)\, E_{22}(-)\, \Pi_{22}^{\frac{1}{2}}(-) \right)}{\sum_{i=1}^{292} \sigma_i(\Pi_{22})} = 58\%. \tag{2}$$

Even though the two ES forecasts have similar sizes (285 and 292), their amplitude and structure are only 58% alike. Similar comments apply to the Sept. 22 and Sept. 24 ES forecasts. For each of the Sept. 18–22 and Sept. 22–24 periods, the terminal prediction of the dominant error variance (not shown) also indicates that the error growth is tempered downstream of the sampling locations. The scales and patterns of the corresponding error eigenvector forecasts confirm that these data influences are in accord with the features identified in Sections 3.1 and 3.2.1. For the Sept. 18–22 error forecast, the features involved are the ABV, MCC, IBV and Ionian slope fronts. For the

Fig. 18. Adaptive learning of dominant errors. Panels (a–b) show the surface T, S gridded a posteriori data residuals as estimated by ESSE objective analysis on Sept. 18. Panel (c) is the surface S of error vector number 81 after adaptation. This vector explains parts of the residual shown by (b). Panel (d) is the eigenvalue spectrum of the normalized ES covariance after adaptation. Panel (e) is the cumulative (0–1) spectrum associated with (d). Using 50 vectors explains 73% of the variance explained by the 286 vectors; 100 vectors explain 87% of that variance. Comparing with Fig. 13, the assimilation flattens the error spectrum.