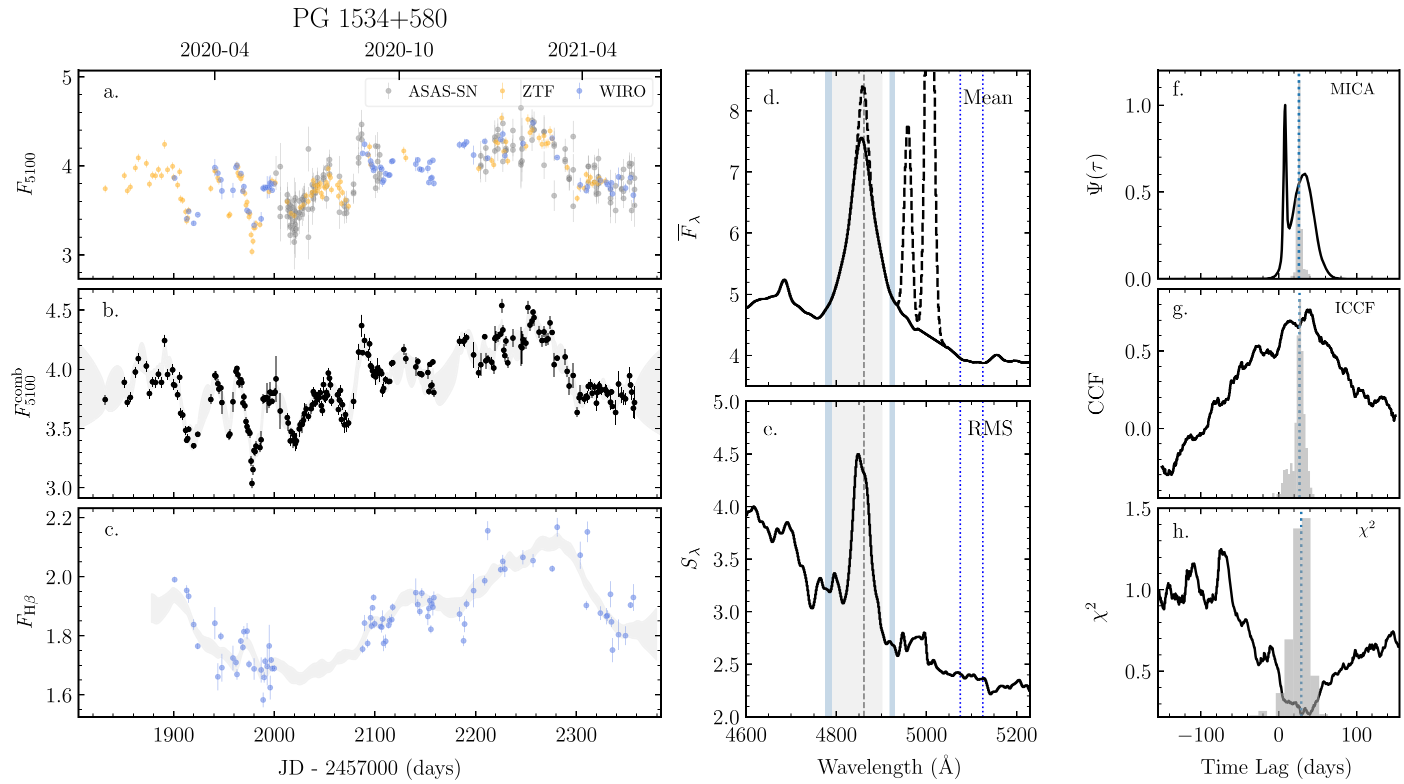

Figure 15. Time-series analysis of PG 1534+580. The meanings of the panels, lines, and histograms are the same as in Figure 2.

3.5. Time-series Analysis

We made use of three different methods to measure the Hβ time lags: the interpolated cross-correlation function (ICCF; Gaskell & Sparke 1986 and Gaskell & Peterson 1987), the χ^2 method (Czerny et al. 2013), and the MICA algorithm, which is a nonparametric approach to constrain the 1d transfer function in RM (Li et al. 2016). Here we briefly introduce the three methods for completeness. More details can be found in the references above.

ICCF: A commonly employed method in RM, we measured the time lags of Hβ using ICCF. In general, the time lags can be measured from the peak of the CCF and the centroid of the CCF above a threshold (80% of the peak), which are marked as $\tau_{\rm peak}$ and $\tau_{\rm cent}$, respectively. The uncertainties of the time lags were estimated using the "flux randomization/random subset sampling (FR/RSS)" method (Peterson et al. 1998, 2004). In the present paper, the median and 1σ limits of the cross-correlation centroid distributions (CCCDs) and the cross-correlation peak distributions generated by the FR/RSS method were adopted as the final lags and their uncertainties.

The χ^2 method: The χ^2 method (Czerny et al. 2013) was also employed to measure the time lags between the continuum and Hβ light curves. Czerny et al. (2013) found that the χ^2 method works better than using ICCF for the AGNs with red-noise variability. The technique takes into account the weights of the points in light curves through their uncertainties. After shifting and interpolating the Hβ light curves, the χ^2 were calculated by

$$\chi^2 = \frac{1}{N}\sum_{i=1}^{n}\frac{(x_i - A_{\chi^2}y_i)^2}{\delta x_i^2 + A_{\chi^2}^2\delta y_i^2}, \tag{6}$$

where x_i and y_i are the continuum and interpolated Hβ fluxes, and δx_i and δy_i are their uncertainties. A_{χ^2} is a normalized factor formulated as

$$A_{\chi^2} = \frac{S_{xy} + (S_{xy}^2 + 4S_{x3y}S_{xy3})^{1/2}}{2S_{xy3}}, \tag{7}$$

where

$$S_{xy} = \sum_{i=1}^{N}(x_i^2\delta y_i^2 - y_i^2\delta x_i^2),$$
$$S_{xy3} = \sum_{i=1}^{N}x_i y_i \delta y_i^2,$$
$$S_{x3y} = \sum_{i=1}^{N}x_i y_i \delta x_i^2. \tag{8}$$

We took the minimum points in the χ^2 functions as the time-lag measurements. Similar to the ICCF method, the uncertainties were generated from FR/RSS as well.

MICA:[28] MICA (Li et al. 2016) is a Bayesian-based nonparameteric approach to infer the 1D transfer function from the continuum and emission-line light curves. It assumes that the transfer function is a sum of relatively displaced Gaussians and employs the diffusive-nested sampling technique to obtain posterior distributions of Gaussian parameters. For each set of parameters, we calculate the corresponding transfer function and obtain the centroid of the transfer function. The mean of the distribution of centroids is taken as the best estimate of the time lag and its uncertainty by the 68.3% confidence interval.

The CCFs and CCCDs, the χ^2 functions and their lag distributions, and the transfer functions and the corresponding

[28] MICA is available at https://github.com/LiyrAstroph/MICA2.