













Fig. 9. Difference in time-series data of curtailed aggregated PVS power output by data processing method.

curtailed aggregated PVS power output in electric power system service area is smaller than the pre-determined level in the UC scheduling. When the curtailed aggregated PVS power output in electric power system service area is calculated based on the aggregated PVS power output and without using LPF model, however, the curtailed aggregated PVS power output is almost the same as the pre-determined level in UC scheduling.

The difference between two time-series data is large also after 14:00, because the smoothing effect among various areas is large. Besides, the reason for the large smoothing effect is large fluctuation of observed irradiance, the effect of LPF is large. Therefore, the short-term fluctuation is large even with the curtailed power output when it is calculated based on the aggregated PVS power output and without using LPF model. If such a time-series data with large short-term fluctuation is used in the impact assessment of high penetration PVS on the power system frequency, the impact would be over evaluated. In other words, the proposed model to calculate the time-series data of aggregated PVS power output is useful for the impact assessment on the system frequency even in the situation that the aggregated PVS power output must be curtailed due to the surplus power supply.

## 6. Conclusion

This study proposed a modelling method of aggregated PVS power output employing a LPF which takes into account a smoothing effect of power output fluctuation around individual observation point. The result showed that the hourly standard deviation of spatial average fluctuation of 32 min cycle or shorter is estimated almost half of that of simple average irradiance without applying the LPF model. Then, this study applied the proposed model to calculate the curtailed aggregated PVS power output and discussed the usefulness of proposed model. The comparison with the time-series data calculated based on the aggregated PVS power output and without using LPF model showed that the proposed model is useful even for the curtailment situation.

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