

23.08.04 WCDL 팀미팅

고해상도 기후모델(HighResMIP)을 이용한 한반도 태양광 발전량의 근미래 전망

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Data

1) 발전량 관측 자료

- 발전소: 영암F1태양광 / 용량: 13.296 MW (메가와트)
- 지점: 전라남도 영암군 삼호읍 삼포리 1895 (34.74N, 126.41E)
- 기간: 2015.01.01 – 2022.12.31 (총 8년), daily

2) 재분석 자료: ERA5

- 기간: 2015.01.01 – 2022.12.31 (총 8년), daily, 해상도: $0.25^{\circ} \times 0.25^{\circ}$

3) 모델 자료

- 모델: HadGEM3-GC31-HM
- 시나리오 2개: highres-future, highresSST-future
- 기간: 2015.01.01 – 2050.12.30 (총 36년), daily, 해상도: N512; 1024 x 768 longitude/latitude (~50km)

Method

Calculation of solar PV

Solar PV power yield depends on PV power generation potential (PV_{POT}) and installed capacity. PV_{POT} is a dimensionless value, which describes the performance of PV cells relative to the nominal power capacity under actual environmental conditions. Therefore, PV_{POT} multiplied by the nominal installed watts of PV power capacity is the actual PV power generation. Following previous studies^{15,43,62}, we used daily T , I and W to calculate PV_{POT} :

$$PV_{POT} = P_R \frac{I}{I_{STC}} \quad (4)$$

where I represents surface downwelling shortwave radiation and I_{STC} represents shortwave flux on the PV panel under standard test conditions, defined as a constant of $1,000 \text{ W m}^{-2}$. P_R is the performance ratio, representing temperature influence on PV efficiency:

$$P_R = 1 + \gamma(T_{cell} - T_{STC}) \quad (5)$$

where γ is defined as $-0.005 \text{ }^{\circ}\text{C}^{-1}$ in monocrystalline silicon solar panels, representing the negative impact on conversion efficiency, and T_{STC} is the cell temperature under standard test conditions ($25 \text{ }^{\circ}\text{C}$). T_{cell} is the actual cell temperature, which is approximated by T , I and W :

$$T_{cell} = a1 + a2 \times T + a3 \times I + a4 \times W \quad (6)$$

where $a1$, $a2$, $a3$ and $a4$ are taken as $4.3 \text{ }^{\circ}\text{C}$, 0.943 (unitless), $0.028 \text{ }^{\circ}\text{C (W m}^{-2})^{-1}$ and $-1.528 \text{ }^{\circ}\text{C (m s}^{-1})^{-1}$, respectively. These coefficients represent the influence of meteorological conditions on the cell temperature. The ambient T determines the base temperature of the cell,

<- (Lei et al. 2023 NCC) PVpot 계산에 이용한 수식 (eq.4 ~ eq.6)

* The actual PV power generation
= PVpot x PV power capacity

* 자료의 T(온도), I(surface downwelling shortwave radiation), W(풍속) 이용

[Method]

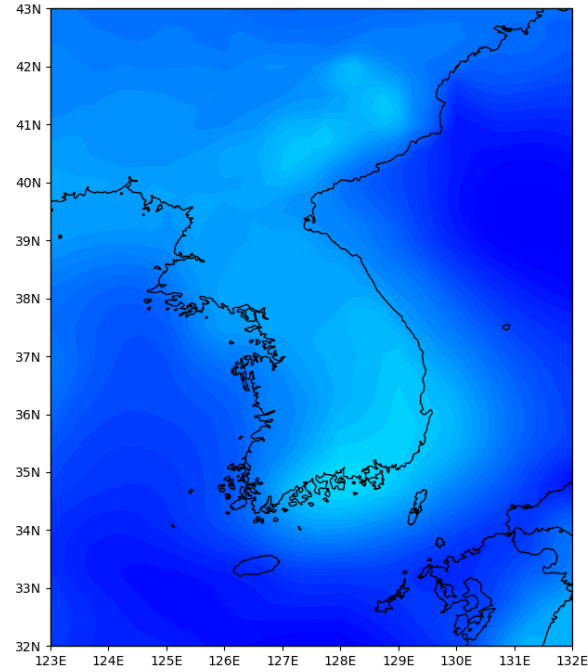
(1) 다음 수식들을 이용해 PV pot 계산

-> 한반도 주변 값 only (위도:32~43N, 경도:123~132E)

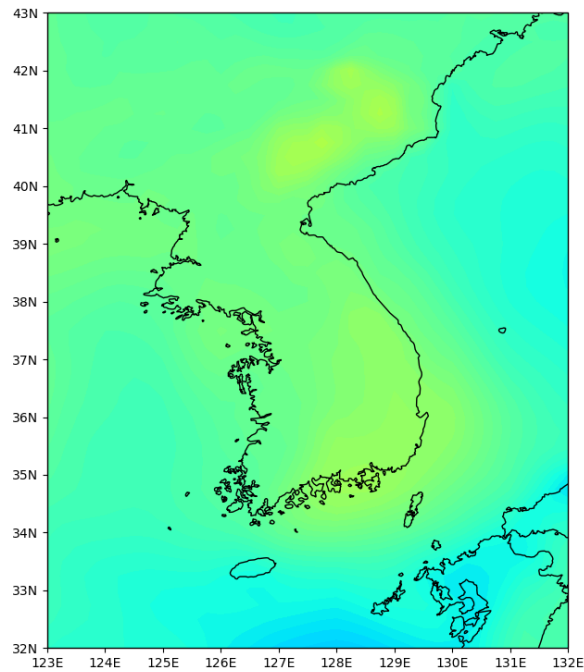
(2) Daily 자료를 월평균 (monthly mean)

한반도 주변 PV pot 월별 map (ERA5, 2015-2022 mean)

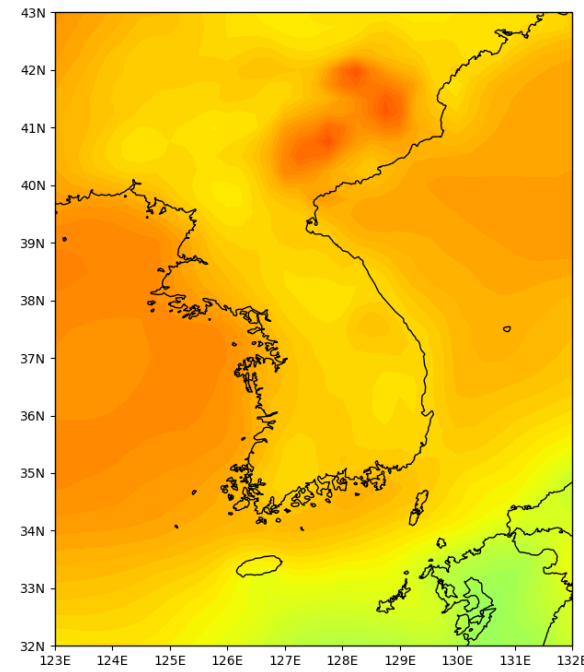
1월



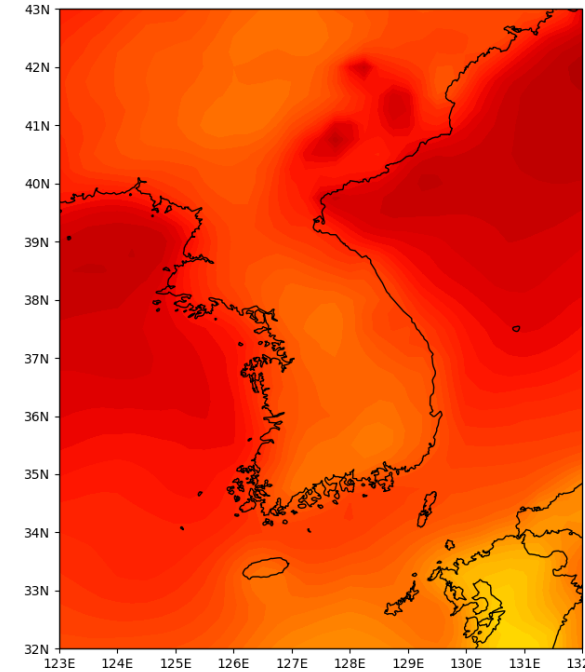
2월



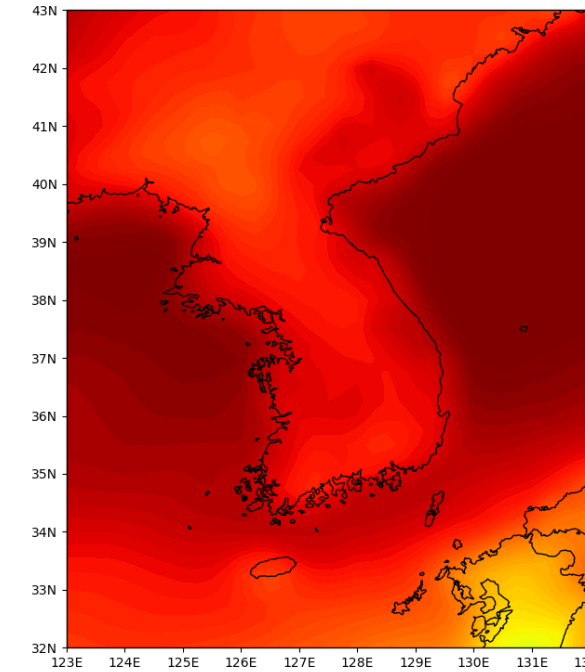
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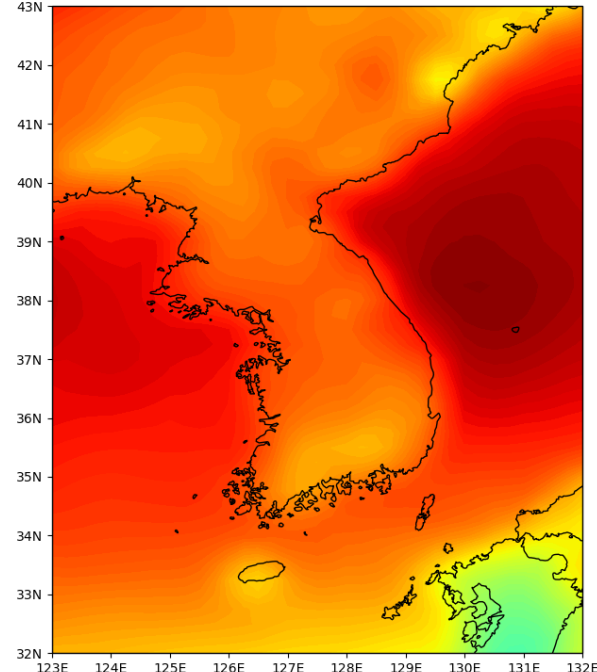
4월



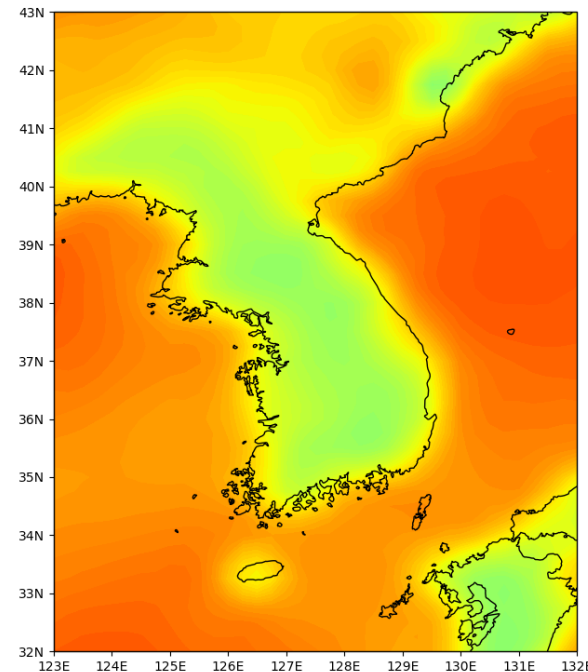
5월



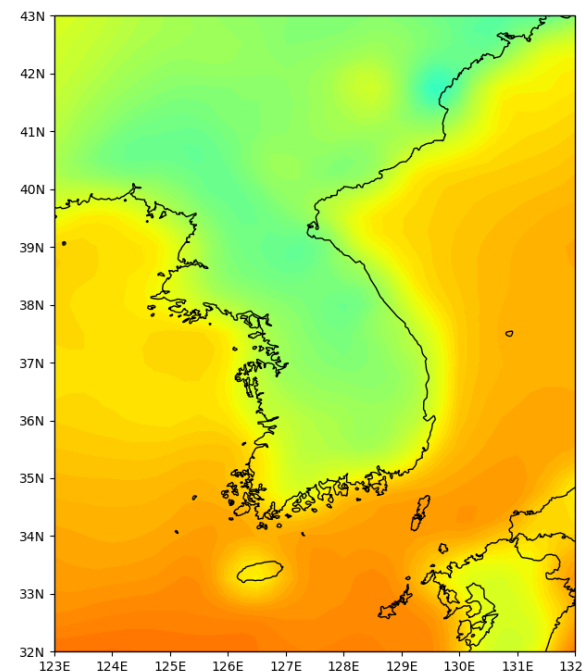
6월



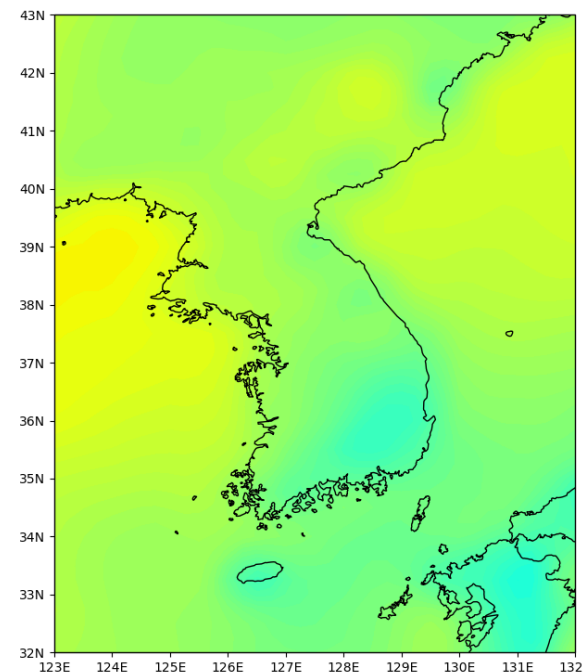
7월



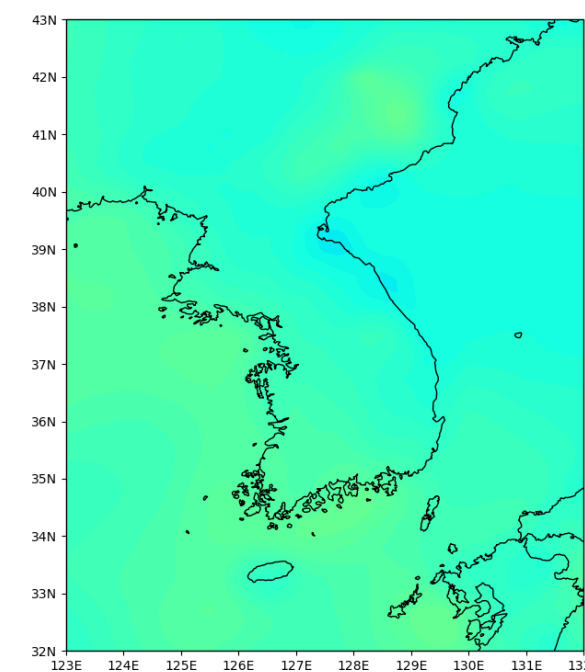
8월



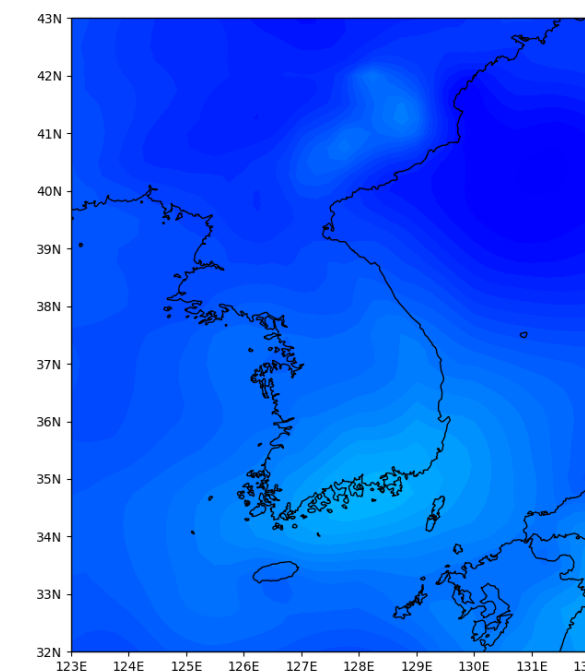
9월



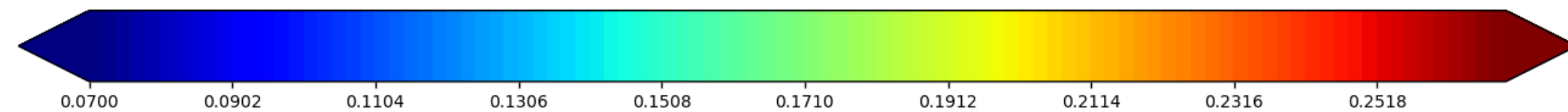
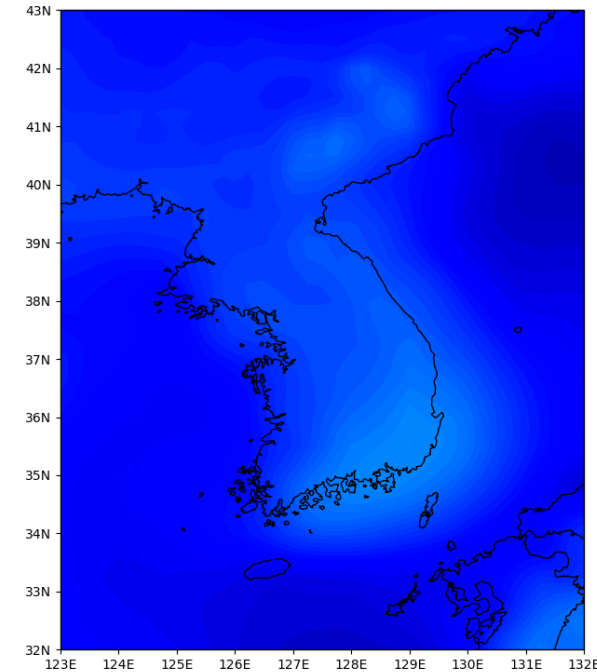
10월



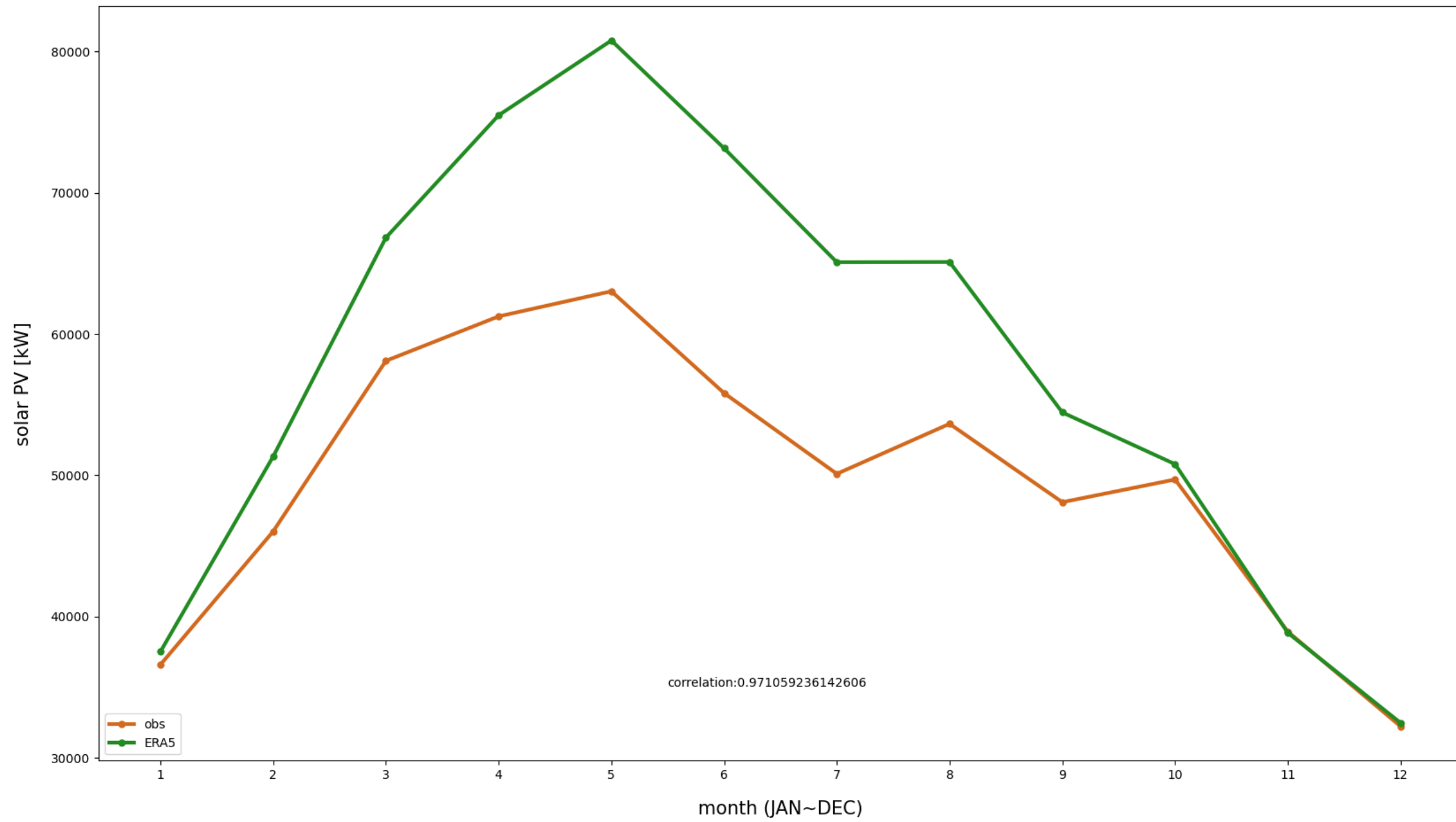
11월



12월



발전량 비교 – 2015~2022 월평균 시계열



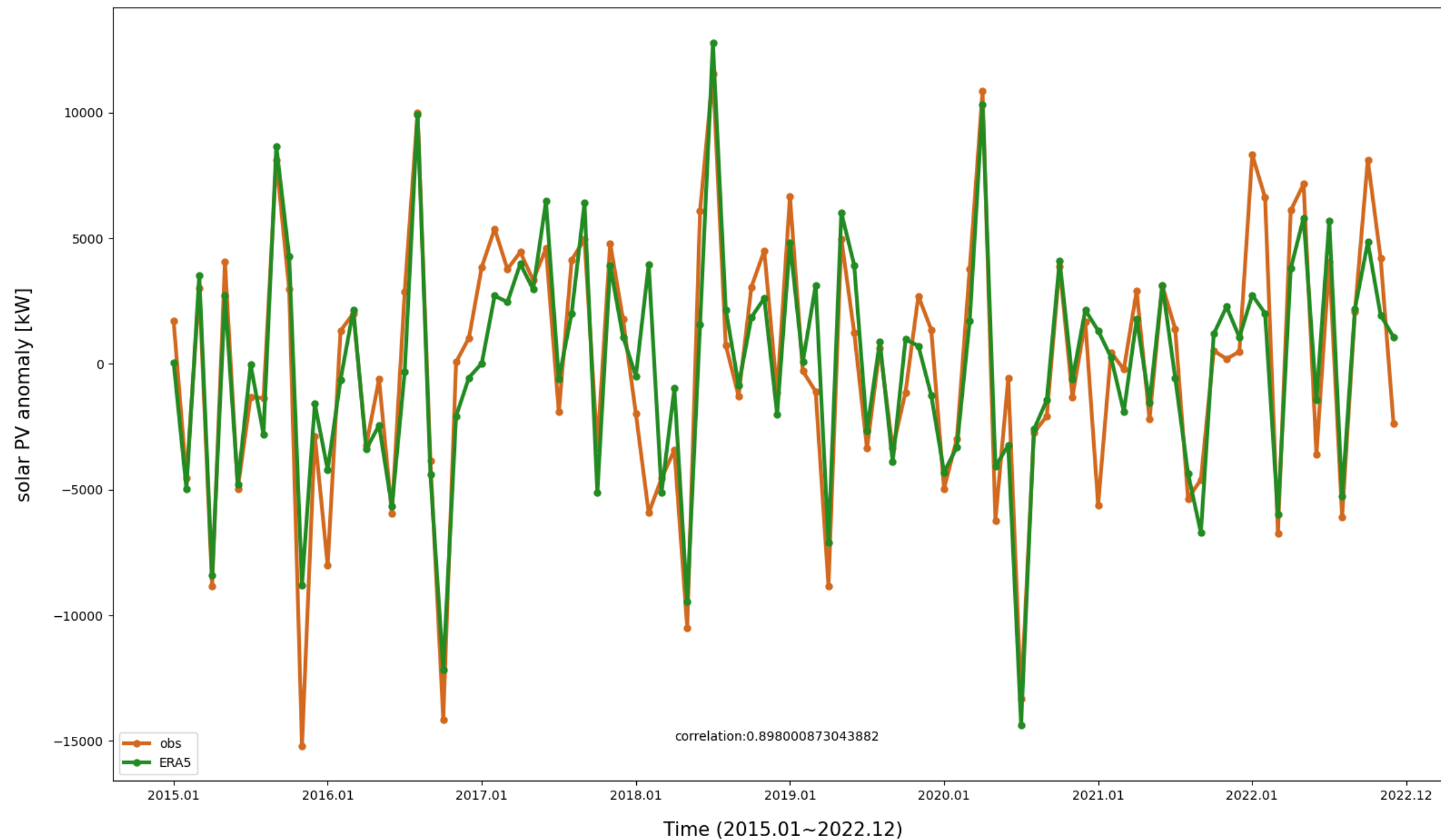
Result

: 재분석 자료를 활용하여 계산한 solar PV의 월평균 시계열이 관측값의 시계열과 높은 상관관계를 가짐

=> 사용한 수식 및 재분석자료가 비교적 관측량을 잘 모의함

* correlation: 약 0.971059

발전량 비교 – 2015~2022 anomaly 시계열

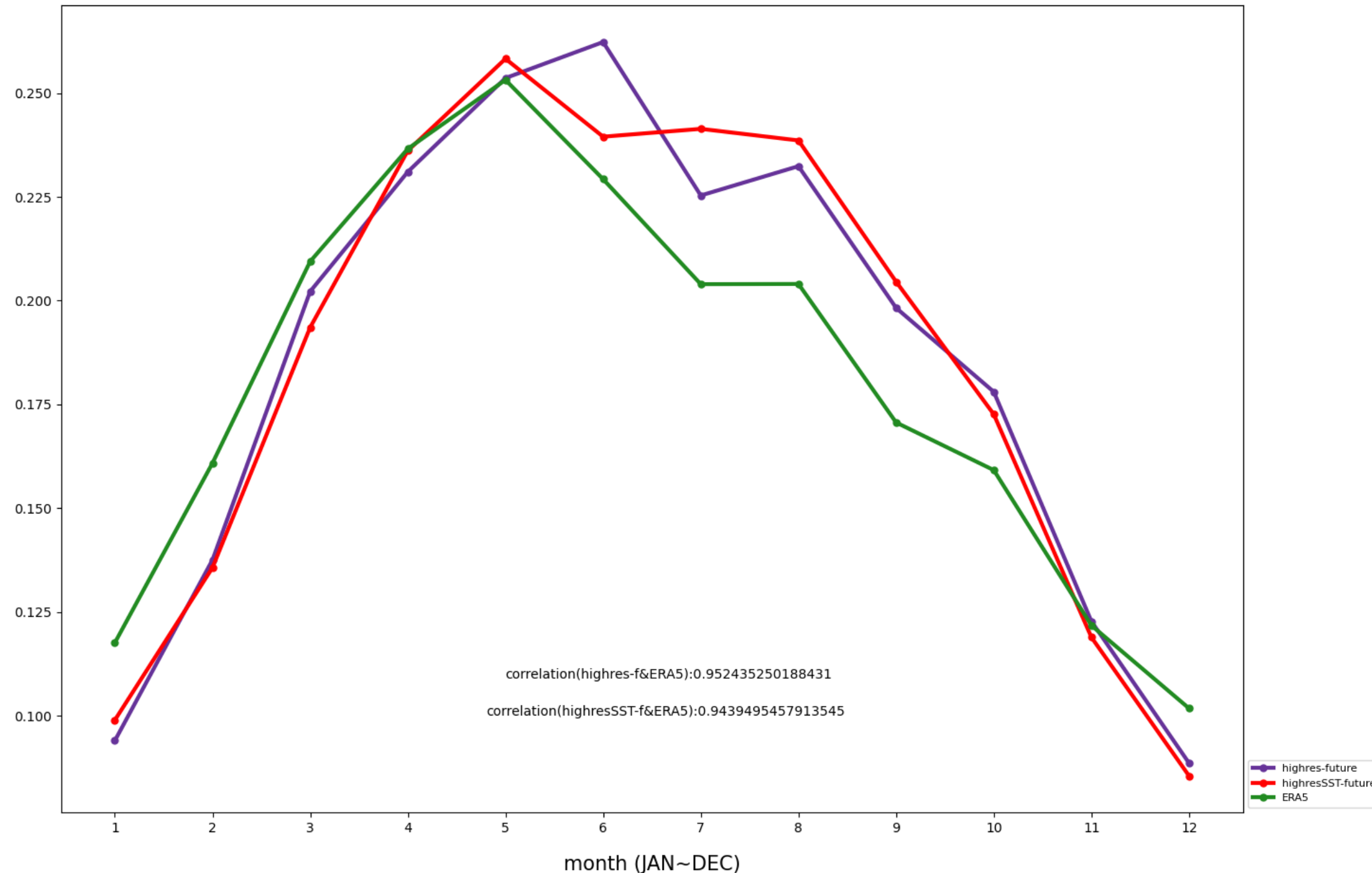


Result

: 재분석 자료를 활용하여 계산한 solar PV의 anomaly 시계열이 관측 값의 시계열과 높은 상관관계를 가짐
=> 사용한 수식 및 재분석 자료가 변동성 또한 잘 모의함

* correlation: 약 0.898001

기후모델 미래 전망 – 2015~2022 월평균 시계열



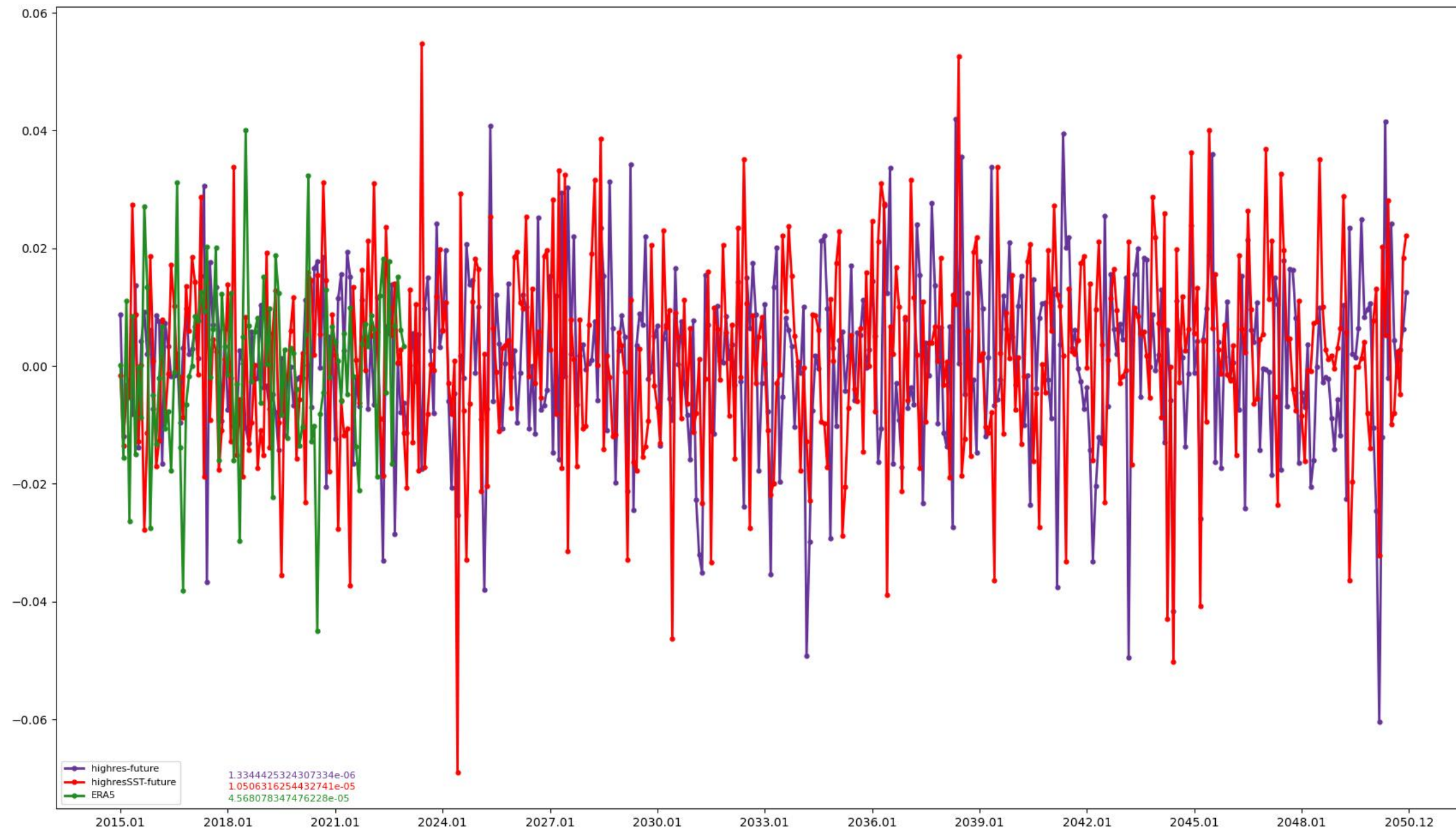
Result

: 모델 실험 자료들을 활용하여
계산한 PV pot이 재분석 자료를
활용하여 계산한 PV pot 값과
각각 높은 상관관계를 가짐
=> 모델 자료도 관측량을 비교적
잘 모의할 수 있을 것으로 보임

* correlation(highres-f&ERA5): 약 0.952435

* correlation(highresSST-f&ERA5): 약 0.943950

기후모델 미래 전망 – 2015~2050 anomaly 시계열



Result

(1) anomaly 또한 모델 실험
자료들과 ERA5 자료에서 비슷한
값을 얻음

(2) 미래 태양광 발전량 증가
(긍정적 signal)

* 기울기 단위: [PVpot anomaly/month]
highres-f) 약 0.133444×10^{-6}
highresSST-f) 약 1.05063×10^{-5}
ERA5) 약 4.56808×10^{-5}