Supplementary Data

Article

Mangrove Phenology and Environmental Drivers derived from Remote Sensing in Southern Thailand

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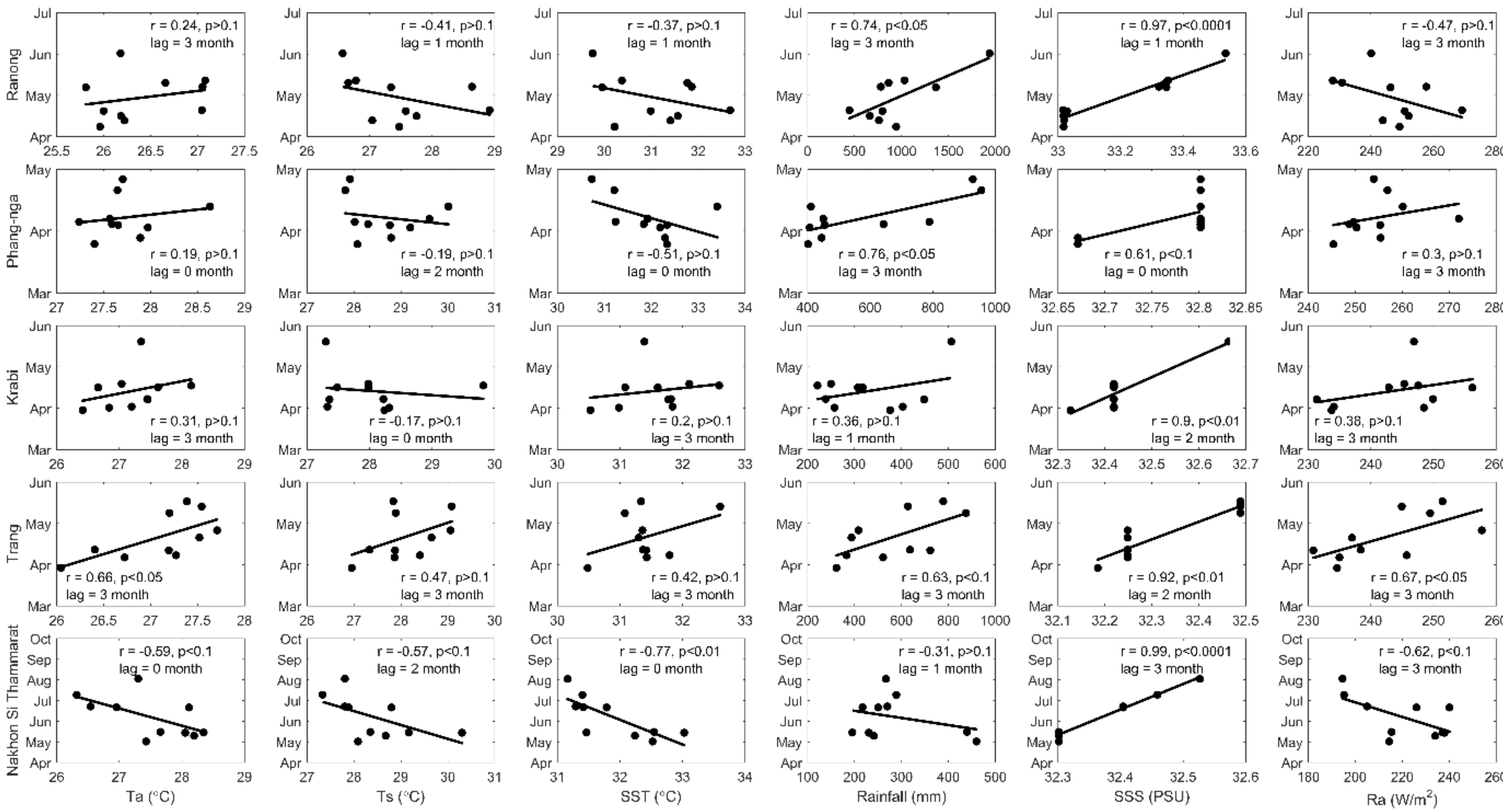
Figure S1 shows the relationship in site by site of SOS (Figure S1 a), POS (Figure S1 b) and EOS (Figure S1 c) with the six drivers including air temperature (Ta), surface temperature (Ts), sea surface temperature (SST), rainfall, sea surface salinity (SSS) and radiation (Ra). The best correlation coefficient and the lag month from lag analysis are reported for each graph in the figure. The result indicates that the cumulative rainfall is likely the main factors driving green-up date (SOS) later date, for all the Andaman Sea sites but not for the Nakhon Si Thammarat site. Increasing rainfall about three months before the SOS induced later SOS of the Anadaman sea mangroves but not at the Gulf of Thailand site (Nakhon Si Thammarat). However, high rainfall lead to earlier POS of mangrove at the Andaman Sea sites in contrast to the responses of the mangroves at the Gulf of Thailand site. In contrast, increasing rainfall produced later EOS at all sites.

Temperature is another important driver of SOS and POS. Increasing averaged Ta over the previous 0 to 3 months beforehand results in a later SOS and POS on the Andaman Sea sites but results in an earlier SOS and POS in the Gulf of Thailand sites. Increasing averaged Ta delayed EOS at both the Andaman Sea and Gulf of Thailand sites. Increasing Ts and SST resulted in earlier SOS and POS but later EOS at Nakhon Si Thammarat site.The result shown in Figure S1 show that SSS induced later SOS for all sites and earlier POS for all sites except for the mangroves at Phang-nga site. There was later EOS at all sites except Trang site. There was no significant between EOS and SSS at Krabi site. However, the relationship between SSS and mangrove phenology is not very clear-cut because of the lack of sufficient SSS points, due to the coarse pixel sizes of the SSS data.

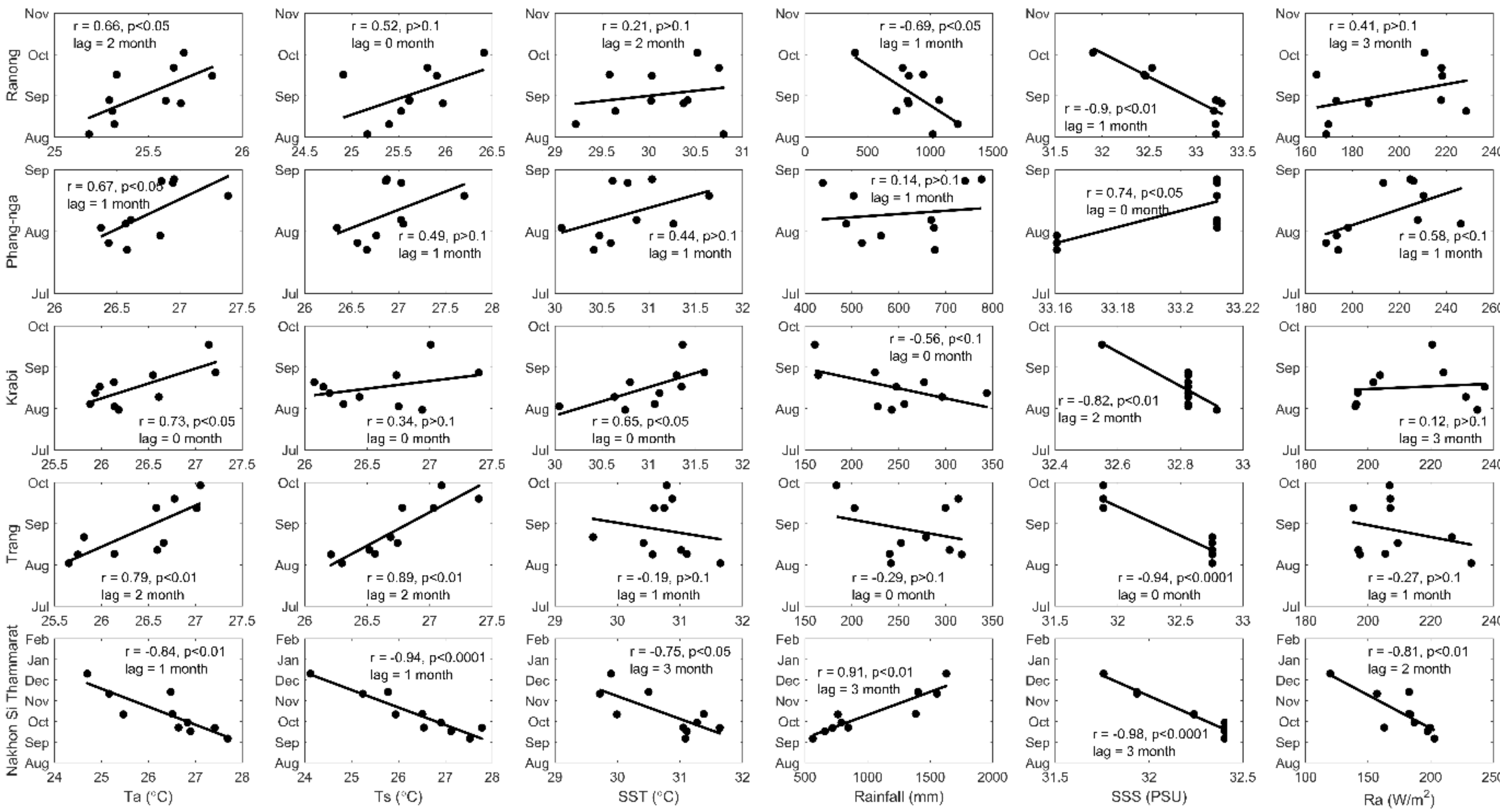
The Ra is also a driver that has significant differential effects at each site and on each of the phenology parameters. The increasing averaged Ra about 2 - 3 months beforehand induces later SOS at Trang province site, earlier POS at Nakhon Si

Thammarat province site, and later EOS at Ranong and Nakhon Si Thammarat province sites. Therefore, there is no clear-cut effect of Ra that applies to all sites.

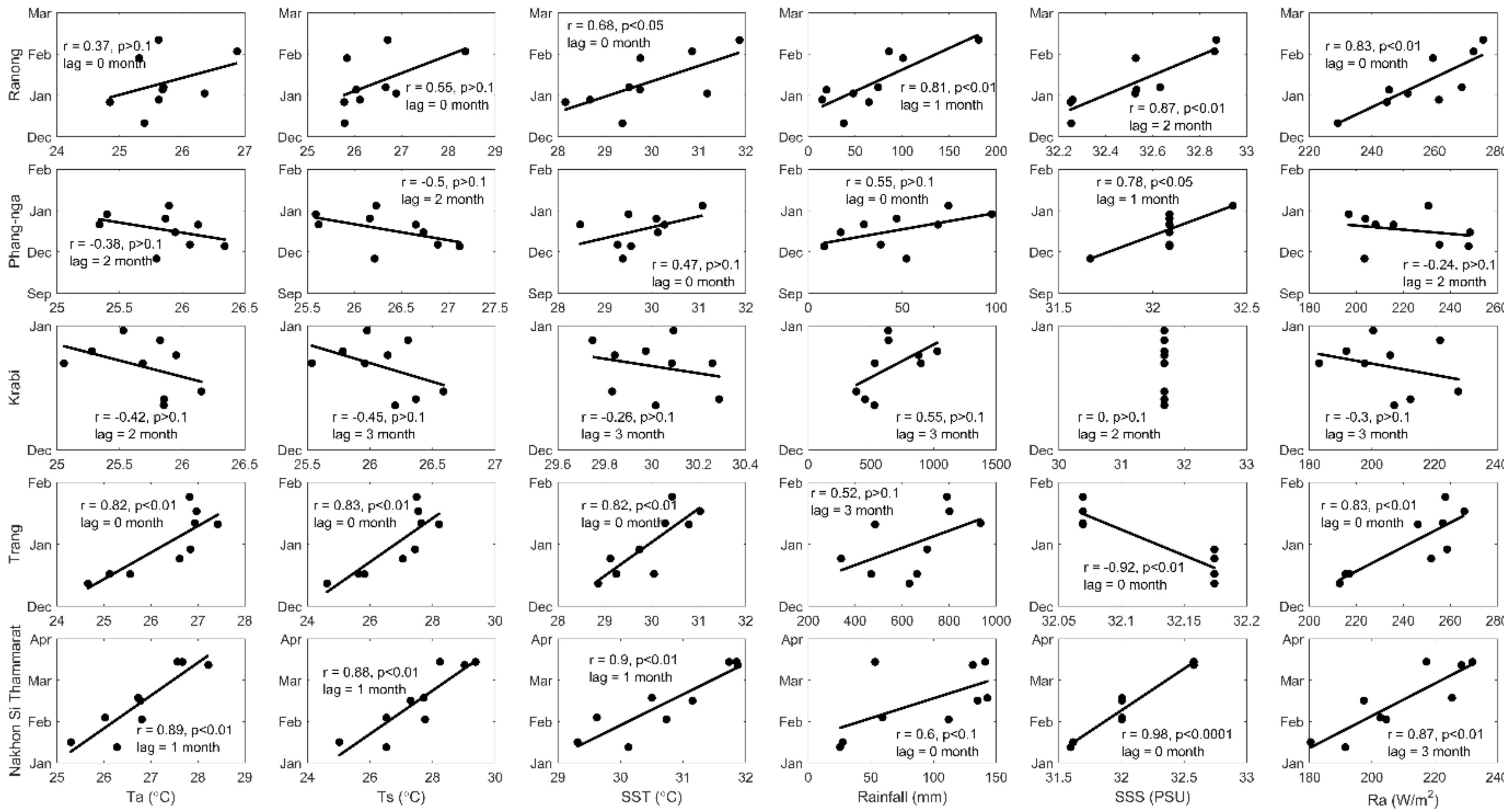


Ranong
r = 0.24, p>0.1
lag = 3 month
r = -0.41, p>0.1
lag = 1 month
r = -0.37, p>0.1
lag = 1 month
r = 0.74, p<0.05
lag = 3 month
r = 0.97, p<0.0001
lag = 1 month
r = -0.47, p>0.1
lag = 3 month
Phang-nga
r = 0.19, p>0.1
lag = 0 month
r = -0.19, p>0.1
lag = 2 month
r = -0.51, p>0.1
lag = 0 month
r = 0.76, p<0.05
lag = 3 month
r = 0.61, p<0.1
lag = 0 month
r = 0.3, p>0.1
lag = 3 month
Krabi
r = 0.31, p>0.1
lag = 3 month
r = -0.17, p>0.1
lag = 0 month
r = 0.2, p>0.1
lag = 3 month
r = 0.36, p>0.1
lag = 1 month
r = 0.9, p<0.01
lag = 2 month
r = 0.38, p>0.1
lag = 3 month
Trang
r = 0.66, p<0.05
lag = 3 month
r = 0.47, p>0.1
lag = 3 month
r = 0.42, p>0.1
lag = 3 month
r = 0.63, p<0.1
lag = 3 month
r = 0.92, p<0.01
lag = 2 month
r = 0.67, p<0.05
lag = 3 month
Nakhon Si Thammarat
r = -0.59, p<0.1
lag = 0 month
r = -0.57, p<0.1
lag = 2 month
r = -0.77, p<0.01
lag = 0 month
r = -0.31, p>0.1
lag = 1 month
r = 0.99, p<0.0001
lag = 3 month
r = -0.62, p<0.1
lag = 3 month
Ta (°C)
Ts (°C)
SST (°C)
Rainfall (mm)
SSS (PSU)
Ra (W/m2)

(a) SOS


Ranong
r = 0.66, p<0.05
lag = 2 month
r = 0.52, p>0.1
lag = 0 month
r = 0.21, p>0.1
lag = 2 month
r = -0.69, p<0.05
lag = 1 month
r = -0.9, p<0.01
lag = 1 month
r = 0.41, p>0.1
lag = 3 month
Phang-nga
r = 0.67, p<0.05
lag = 1 month
r = 0.49, p>0.1
lag = 1 month
r = 0.44, p>0.1
lag = 1 month
r = 0.14, p>0.1
lag = 1 month
r = 0.74, p<0.05
lag = 0 month
r = 0.58, p<0.1
lag = 1 month
Krabi
r = 0.73, p<0.05
lag = 0 month
r = 0.34, p>0.1
lag = 0 month
r = 0.65, p<0.05
lag = 0 month
r = -0.56, p<0.1
lag = 0 month
r = -0.82, p<0.01
lag = 2 month
r = 0.12, p>0.1
lag = 3 month
Trang
r = 0.79, p<0.01
lag = 2 month
r = 0.89, p<0.01
lag = 2 month
r = -0.19, p>0.1
lag = 1 month
r = -0.29, p>0.1
lag = 0 month
r = -0.94, p<0.0001
lag = 0 month
r = -0.27, p>0.1
lag = 1 month
Nakhon Si Thammarat
r = -0.84, p<0.01
lag = 1 month
r = -0.94, p<0.0001
lag = 1 month
r = -0.75, p<0.05
lag = 3 month
r = 0.91, p<0.01
lag = 3 month
r = -0.98, p<0.0001
lag = 3 month
r = -0.81, p<0.01
lag = 2 month
Ta (°C)
Ts (°C)
SST (°C)
Rainfall (mm)
SSS (PSU)
Ra (W/m2)

(b) POS



(c) EOS

Figure S1. Scatterplots of the relationship between phenology parameters and drivers at five study sites: The Andaman Sea sites (Ranong, Phang-nga, Krabi and Trang) and the Gulf of Thailand site (Nakhon Si Thammarat). The lag month in the figure shows the lag-time in months (0, 1, 2 or 3) that gave the best correlation coefficient in the lag-time analyses. Lag-times were calculated using average monthly Ta, Ts, SST, SSS and Ra: for example, if a parameter measured in May is a manifestation of a driver with a 3-months lag-time then the driver was the prevailing conditions 3 months before (in February). In the case of rainfall, the sum of the cumulative rainfall was used (0, 0+1, 0+1+2, and 0+1+2+3 months). For rainfall a lag time of 3 months reflects cumulative rainfall over the previous 3 months) not just the rainfall 3 months previously. Thus, a 3-months lag for the rainfall driver for the month of May reflects cumulative rainfall from Feb to May.