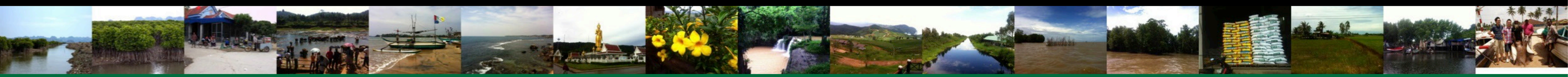

Comparative analysis of CH_4 measured by MODIS and SCIAMACHY from west Siberian lowland

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In this study, our approach was based on MODIS and AMSR-E satellite database, through NDVI and LST (Land Surface Temperature) biophysical inference model to estimate the methane emission in Siberian lowland and to do comparative analysis with SCIAMACHY measurement data. The wetland coverage was represented by 7 types of land cover from MERIS, ENVISAT data. The biophysical inference models have three equations (CH4_lst, CH4_ndvi and CH4_Ndl), which were calculated from regression analysis based on different vegetation and land surface temperature condition. We found that from 2003 to 2010 more that 12% of year growth rate of methane emission measured by SCIAMACHY. The models estimation of the year growth rate of CH4_lst, CH4_ndvi and CH4_Ndl from 2003 to 2012 were 0.24%, 4.74% and 0.36% respectively. Our findings show the CH4 emission increase significantly in time series with seasonal increases in temperature.

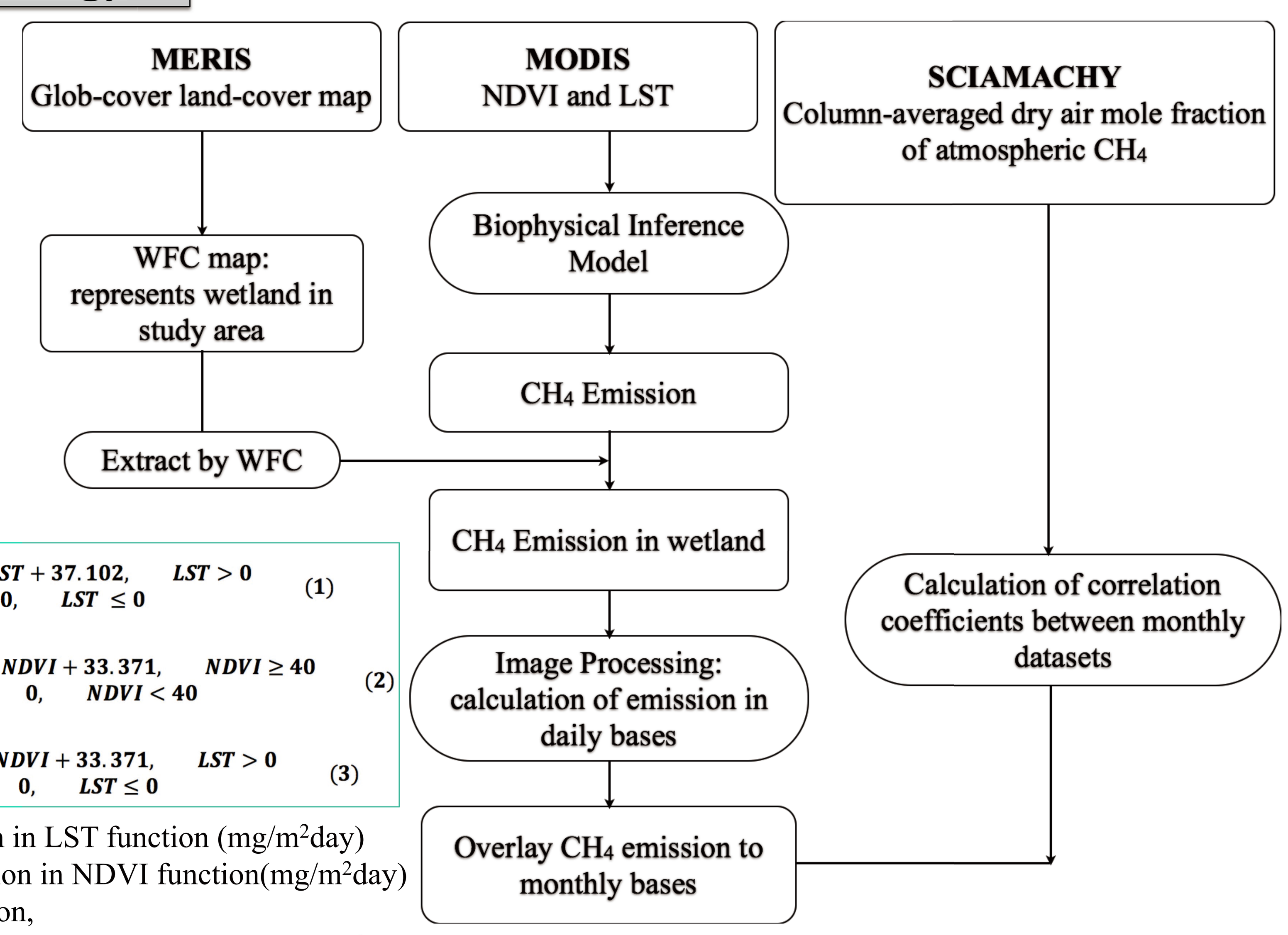
Background

Methane is a particularly effective greenhouse gas and its emission sources comprise anthropogenic activity, fossil fuel combustion, rice agriculture, livestock, landfill and some biomass burning and natural sources such as wetlands, termites and the ocean (IPCC. 2007). The concentration of atmospheric CH4 has more than doubled since pre-industrial times, and its radiative forcing is estimated to be the second largest after CO2 (Forster et al. 2007). Global warming is predicted to be most pronounced at high latitudes (Wagner,2009), and thawing of permafrost could release large quantities of greenhouse gases into the atmosphere, thus further increasing global warming and transforming the Arctic tundra ecosystems from a carbon sink to a carbon source(Oechel et al. 1993).

Objective

- To estimate methane emission through NDVI and Land Surface Temperature (LST) biophysical inference model by MODIS.
- To do comparative analysis with SCIAMACHY measurement data.

Methodology



$$FCH4_{lst} = \begin{cases} 0.4181 * LST + 37.102, & LST > 0 \\ 0, & LST \le 0 \end{cases} \quad (1)$$

$$FCH4_{ndvi} = \begin{cases} 0.1505 * NDVI + 33.371, & NDVI \ge 40 \\ 0, & NDVI < 40 \end{cases} \quad (2)$$

$$FCH4_{Ndl} = \begin{cases} 0.1505 * NDVI + 33.371, & LST > 0 \\ 0, & LST \le 0 \end{cases} \quad (3)$$

Where $FCH4_{lst}$= CH4 emission in LST function (mg/m^2day)
$FCH4_{ndvi}$ = CH4 emission in NDVI function(mg/m^2day)
$FCH4_{Ndl}$ = CH4 emission, combine LST and NDVI function (mg/m^2day)
NDVI = original NDVI * 100

Results and Discussion

CH4 Emission Estimation

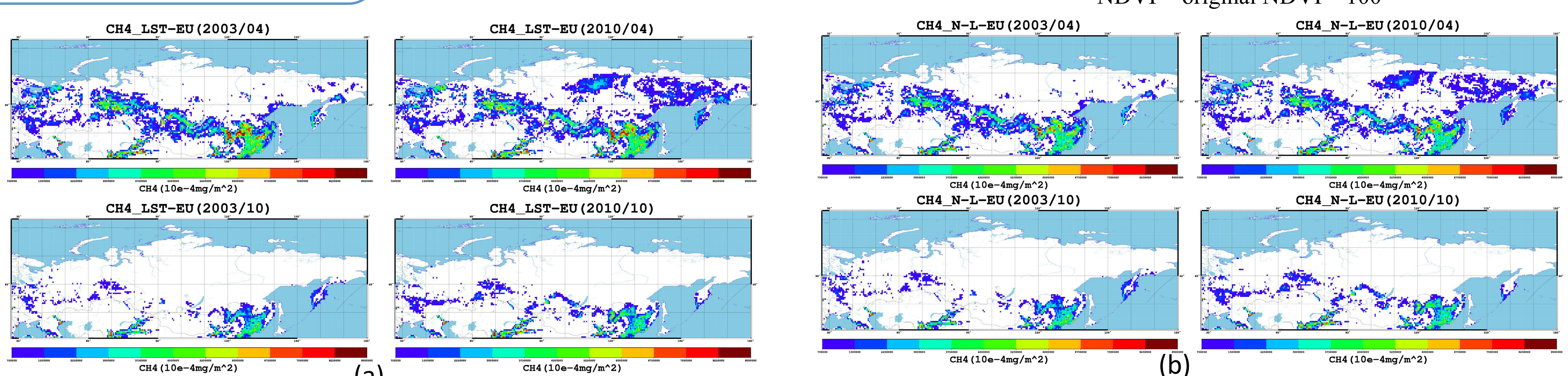


Fig.1 Map of monthly CH4 emission of April and October in 2003 and 2010. Map (a) and (b) are derived from equation (1) and (3) respectively. Left and right rows are the emission maps of April and October in 2003 and 2010 separately.

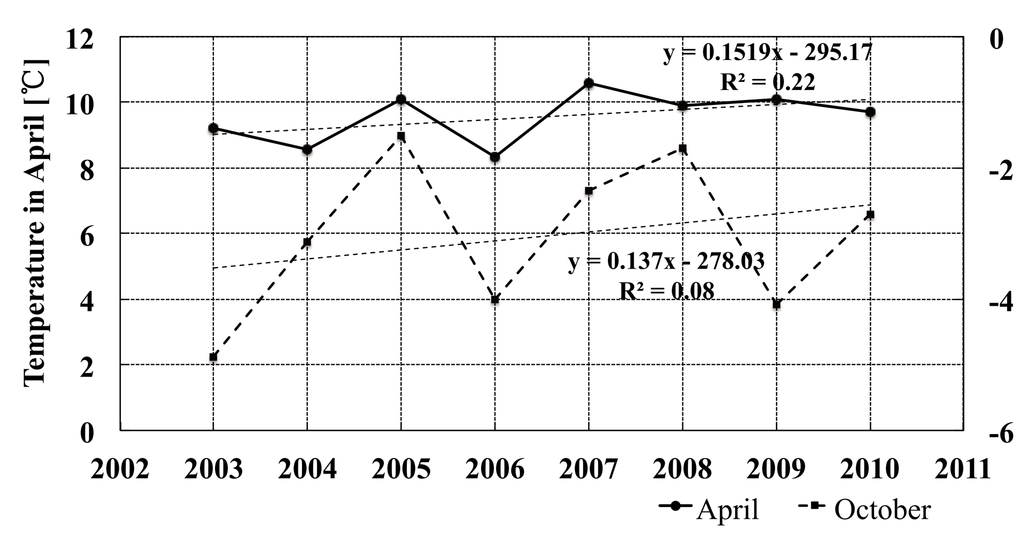
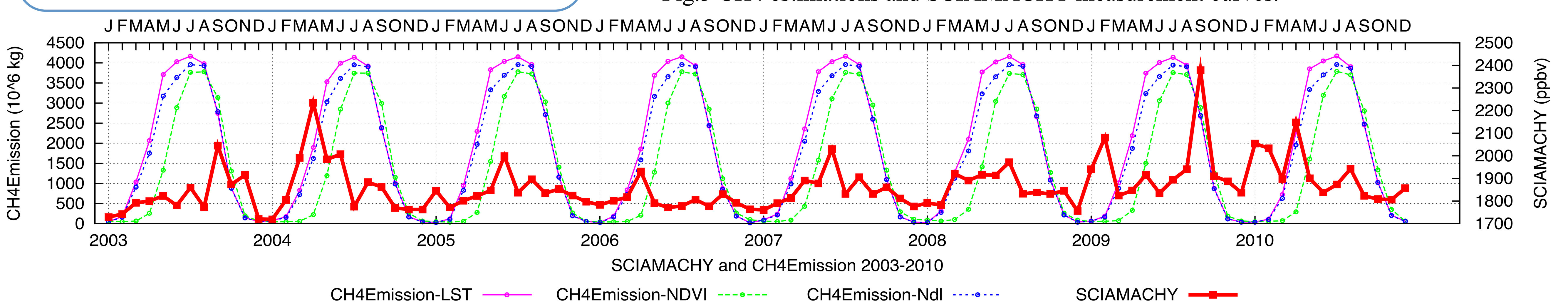


Fig.2 Mean temperature changing dynamics of April and October in 2003 and 2010.

- Fig.1 (a) and (b) clearly indicates the CH4 emitting area in April was larger in 2010 (right row) than in 2003 (left row). During summer growing season continuous CH4 emissions has been extended till temperature goes minus. Whereas, CH4 emission didn't stop immediately when winter comes.
- Fig.2 is a curve of averaged temperature of April and October from 2003 to 2010. There are obvious rising trends, imply the temperature has increased in the same month of year. It is a probably reason that why CH4 emission spring earlier and fallen time was delayed. It is also means LST is an important index, which impact CH4 emission.

Comparison analysis with SCIAMACHY

Fig.3 CH4 estimations and SCIAMACHY measurement curves.



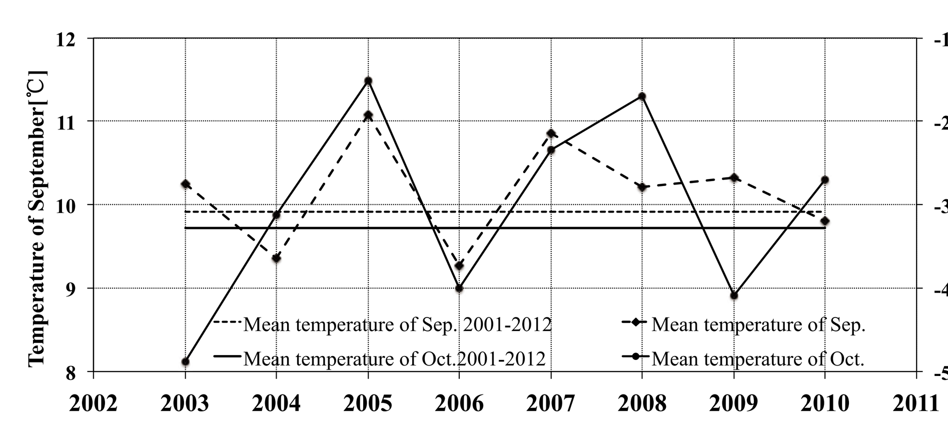


Fig.4 Mean annual temperature of September and October from 2003 to 2010.

- Fig. 3 expresses the seasonal characteristics of CH_4 emission and SCIAMACHY concentration data. From 2003 to 2010 more that 12% of year growth rate of methane emission was measured by SCIAMACHY and the models estimation of the year growth rate of CH4_lst, CH4_ndvi and CH4_Ndl from 2003 to 2012 were 0.24%, 4.74% and 0.36% respectively. There is good agreement among three definitions and SCIAMACHY. The CH4_lst (pink) and CH4_Ndl (blue) have quite similar character, but CH4_ndvi has a delay phenomenon than the others, but the offset time fitted very well. It because vegetation growing usually starts when temperature risen to specified value, but emission will stop when ground frozen up. It means CH_4 emission is also affected by vegetation. For SCIAMACHY data, in 2003 and 2009 the peak value happened in September and at the same time lower temperature will happen in October.
- Fig. 4 represents mean annual temperature September and October from 2003 to 2010 to prove this phenomenon. There is a big difference in 2003 and 2009, indicate higher temperature induce higher emissions.

Conclusion remarks

- The estimation results have good correlation with SCIAMACHY measurement data, although they are not in the same scale measurement, at least show the proximity trends and seasonal changes.
- The wider range of SCIAMACHY than estimation curves probably because of estimation error, land-cover type and human activity source such as fossil fuel and so on.
- The amount of emission is quite depending on temperature. The estimation still under calibration by other referenced publications, these examinations will lead positive effects in near future.

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