**Results**

***Dataset validation: comparing LAIre to LAI3g***

*Comparing raw LAI data*

Correlating mean bimonthly LAI values resulted in an average r of 0.78 with a standard deviation of 0.02. There is a clear break starting from January 1984 (see fig X), the average correlation coefficient from 1982 to 1983 is at 0.82 whereas the period from 1984 to 2011 is at the total average of 0.78. The correlations show a periodical minimum in the first half of September visible in all years, deviating up to 0.08 from the average.

Yearly maxima show an average correlation coefficient of 0.86 and an average covariance of 1.82. Yearly minima show an average correlation of 0.83 and an average covariance of 0.74 and yearly means show an average correlation of 0.90 and an average covariance of 1.23. Scatterplots of yearly mean and minimum LAI values show a distinct outlier group where LAIre pixels have a higher value than the corresponding LAI3g pixels (see fig X). These areas on the scatterplot correspond to pixels in the tropics (Central Africa and central America).

*Comparing LSP parameters*

The LSP parameter extraction for the LAI3g was successful for about 14’220 pixels on average per year and excluded 6’740 pixels on average every year for reasons other than water bodies or deserts. For the LAIre, 18’850 pixels were successfully processed and 1’840 pixels were excluded for reasons other than water bodies or deserts. There were no significant differences in number of pixels extracted between the two extraction methods.

When correlating the LSP parameters from the two datasets, the correlation coefficients achieved with the Midpoint method were on average around 0.15 for the GSL and EOS, and below 0.05 for SOS. Correlation coefficients from the Midpoint method were around 0.3 for GLS And EOS and around 0.09 for SOS.

*Differences in SOS*

The lowest differences in SOS between LAIre and LAI3g can be found for the high northern latitudes with differences below 15 days for both extraction methods. South of the tropics, the differences are more pronounced than in the northern hemisphere with differences in SOS of up to 60 days. In the tropics the differences go above 180 days.

*Differences in EOS*

Parts of eastern Europe and central Asia show a difference in EOS of over 60 days for the LAIre. The same can be seen for parts south of the Sahara in Africa and eastern Asia, albeit less pronounced.

*Differences in GSL*

The differences in GSL show growing seasons up to 60 days longer for the LAIre in the northern hemisphere, particularly in eastern Europe where the difference can go up to 120 days longer in the LAIre. The northernmost parts of Eurasia and America however show slightly longer growing in the LAI3g. The southern hemisphere shows more variation with no clear over or underestimations.

*Trend analysis 1982 – 2011*

*Decadal change SOS*

Both datasets show a slightly earlier onset of the growing season for northern Europe and a later onset in southern America. The LAIre also shows a later onset south of the Sahara where the LAI3g lacks data. The LAI3g shows an earlier onset of SOS for China which are much less pronounced in the LAIre.

*Decadal change GSL*

Both datasets show a shortening of GSL in south America as well as in the east of southern Africa. They also both show a lengthening of GSL in northern Europe and China and in the west of southern Africa. Different results are seen south of the Sahara with the LAI3g indicating a slight GSL lengthening and the LAIre showing a shortening.

*Decadal change EOS*

Both datasets show a trend of a later EOS for southern Africa as well as in southern America. The LAI3g shows a later EOS for northern Europe, which is not visible in the LAIre dataset. The LAIre however shows a trend towards an earlier EOS for central Asia which is not visible in the LAI3g dataset due to lack of data.

***Climatic Controls***

*Yearly Dominating Control*

For the northern latitudes, temperature is the dominating control factor annualy, with radiation being the main control factor for the eastern USA, Europe and east Asia. Moisture is the dominating control for the Middle East and most of Africa as well as most of Australia. The Tropics are controlled by radiation, as is most of south America.

Changes in the dominating annual control factor over 30 years can mainly be found along the borders of areas of different dominating controls. An exception to that is northern Europe where the areas of radiation controlled and temperature controlled regions varies quite dramatically over the years. (see fig X)

*Quarterly Trends for Climatic Controls*

*Moisture*

The analysis of the bimonthly change of moisture control per decade showed almost no significant increase in moisture control for any period. However, in the first quarter of the year, a strong decrease of moisture control can be observed for the Middle East and central Asia with decadal change of over 20% in some parts.

The second quarter shows a decrease of moisture control in the northern latitudes, particularly Greenland and north-eastern Siberia with changes rates of around 15 to 20%. For the third quarter, the same can be observed for the high latitudes of northern America. The fourth quarter shows a decrease in moisture control factor of around 10% in eastern Europe.

*Temperature*

The temperature control shows a decrease of about 10% per decade for southern Africa in the first quarter of the year. Starting around March until May, the Middle East and south of the Sahara shows an increase in temperature control of around 10% per decade. The second quarter also shows an increase in temperature control for the Gobi desert of over 10%. The third and fourth quarter shows an increase in control for south America, mainly around Brazil of over 10% per decade. Also in the fourth quarter is an increase in control of over 10% for the south-eastern edge of the Sahara.

***Influence of Climatic Controls (CC) on Phenology***

*Dominating Climatic Control during SOS and EOS*

*Dominating controls at Start of Season*

Dominating controls during SOS in the northern hemisphere are mainly temperature for higher latitudes and radiation for lower latitudes. The SOS in the subtropics are dominated by moisture and the tropics by radiation. The southern hemisphere is also mainly dominated by moisture in the subtropics and radiation in the south of Africa, south of Australia and some parts of southern America. Only small parts of the southwest America and south-eastern Australia are affected by temperature controls.

Analysing the time-series of dominating controls during the SOS shows that the areas unaffected by dominating controls, apart from desert and high mountainous areas, are in Siberia and wide parts of Canada where the dominating control is temperature over all 30 years. A lot of change can be observed in Europe and central Asia where the dominant control varies between temperature and moisture control. The southern hemisphere mainly shows small variations in the extent of moisture-controlled and radiation-controlled areas.

*Dominating Controls at End of Season*

The End of Season in the northern Hemisphere is dominated by the radiation control factor for many parts such as central and eastern Europe, east and south Asia and the east of north America. Central Asia, the middle East and the north of Africa are dominated by the moisture control during EOS, as is the western part of the USA. The temperature control only dominates very high latitudes. The southern hemisphere is also mostly radiation controlled during EOS with the exception of Australia and southern Africa which are mainly moisture controlled.

The time-series over the last 30 years showed annual changes between all 3 controls for most of the higher northern latitudes. The rest of the world only shows small variations around the border regions of dominating controls, mainly between moisture and radiation controlled areas.

*Shift in Climatic Controls during SOS and EOS*

*Moisture*

For SOS, both datasets show a strong increase in influence of the moisture control in southern America, getting about 5% to 10%, and in some areas up to 14% more controlling per decade. A strong increase in control can also be observed south of the Sahara with an increase of about 10%. A slight decrease in control can be observed in western Africa, along the eastern Indian coast as well as north east Asia, particularly in the LAIre dataset. The two datasets show almost no change in the influence of moisture control during the growing season for the northern hemisphere.

For EOS, the two datasets agree with each other in showing an slight increase in influence moisture control for the northern hemisphere of around 1% – 5% and some areas in central and eastern Asia where the change of influence has a rate of over 13% per decade. A slight increase in moisture control can also be seen in southern America with a rate of about 3-9% per decade. In southern Africa, both datasets show a decrease in moisture control of around 10%.

*Temperature*

For impact of the temperature control the two datasets yield differing results. The LAIre showas a slight decrease of the temperature control of around 1-6% while the LAI3g shows a slight increase of the temperature control of about 1-6%. Around the Gobi desert, the LAI3g shows a decrease of influence while the LAIre shows a strong increase in influence of the temperature control of over 13%. For north east America, both datasets show a slight decrease in the influence of the temperature control factor of 5-10% with some high outliers around 15% change per decade for the LAI3g.

For the EOS, no significant changes in temperature control can be observed.

*Light*

For SOS, the two datasets show a good agreement on the light control. In the northern hemisphere, light becomes a stronger control with a rate of up to 10% per decade, except for parts of northern America where the effect is not as strong with only about 1-5% increase in control. Southern Africa shows a strong decrease in light control of about 10% as well as in southern America where the rate is up to 8% per decade.

Change rates during the EOS show less agreement between the two datasets. The LAI3g shows an increase in light control of about 7% where the LAIre does not show any change. The LAIre however shows a decrease of importance of the the radiative control of around 7% in central Asia and an increase of around 7% in southern Africa.

*Correlation of changes in LSP to changes in Climatic Controls*

Correlation coefficients for the comparison of changes in LSP parameters and changes in climatic controls over the last 30 years can be seen in table X. The moisture control shows a strong negative correlation for SOS at -0.61 for LAIre and a slight negative correlation of -0.23 for the LAI3g. LAIre also shows a small positive correlation for EOS and Moisture of 0.22. The temperature control shows no correlation for either dataset. The light control shows a small correlation for SOS of r = 0.35 for LAIre and 0.28 for LAI3g.