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**Introduction**

The effects of anthropogenic climate change on vegetation dynamics have received increasing attention of the scientific community in the past decades (Schwartz 1999; Richardson et al. 2013), as global and regional changes in land surface phenology (LSP) have been documented (de Jong et al. 2012; Garonna et al. 2014; Jeong et al. 2011; Anwar et al. 2015; Badeck et al. 2004; Julien & Sobrino 2009). To understand the processes underlying these changes in LSP and to be able to make predictions for the future, the feedback loops of phenology and the climate system have to be investigated (Richardson et al. 2012; Richardson et al. 2013). Developing climate based LSP models and comparing them to the effects observed in satellite and field data is seen as an important step to investigate these complex interactions (Schwartz 1999; Jolly et al. 2005).

[…]

*Aims & Research Questions*

The focus of this master thesis lies on the analysis of the impact of global changes in climatic controls on global land surface phenology. To achieve this, three main research goals have been set:

* Comparison and validation of a modelled LAI dataset with a remotely sensed LAI for the years 1982–2011
  + How well do raw LAI values between the two datasets correlate?
  + Where do LSP parameters such as SOS and EOS from the two datasets correlate well, where do they differ?
  + How well and where do trends found in the two datasets compare to each other?
* Analysis of global changes in the three climatic control factors underlying the modelled LAI: temperature, VPD and radiation
  + Are there inter-annual changes in global dominating climatic controls?
  + Are there inter-annual trends for the impact of individual climatic controls
* Analysis of the changes of impact of climatic controls during SOS and EOS
  + Are there inter-annual changes in global dominating climatic controls prior to SOS and EOS?
  + Are there inter-annual trends for the impact of individual climatic prior to SOS and EOS?
  + How do trends observed in climatic controls correlate with trends observed for EOS and SOS?

**Discussion**

Climatic Controls

Trends in Climatic Controls by Quarter

*Moisture*

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| --- | --- |
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| Jan-Mar | Apr-Jun |
| Macintosh HD:Users:davidschenkel:Documents:Uni:Masterarbeit:2_controls:bimonthly_changes:plots:quarter_MOIST_FAC_18.png | Macintosh HD:Users:davidschenkel:Documents:Uni:Masterarbeit:2_controls:bimonthly_changes:plots:quarter_MOIST_FAC_24.png |
| Jul-Sep | Oct-Dec |

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Increasing Control Decreasing Control

Figure x: global 30-year trends in moisture control factor by quarter

Trends in moisture control show more regional variations than the temperature controls, but most regions experience a strong increase in moisture control of up to 10% per decade. As Matsoukas et al. (2011) note, part of the increase in control is due to the ERA Interim data on which the climatic controls are based, showing a faster rise in air temperature T than the rise in dew point temperature Td, leading to increasing estimates for VPD.

While a lot of the areas showing a strong increase in moisture control are semi-arid and arid regions, which are dominated by moisture control anyway, the more interesting cases are the regions that are not yet dominated by moisture control. This is the case in Europe, which shows an increase in moisture control particularly during the second quarter of the year, when plant growth rates are at a peak.

Strong increases in moisture control can also be found in South America over all four periods. This increase is likely amplified by several major drought events between the years 2000 and 2010. The impact of this change in control does not correlate with LAI measurements however (Anderson et al. 2015), suggesting that other biophysical parameters influence phenology more than evaporative stress.

The decrease of moisture control in southern Africa and north-eastern Australia, which are both nonetheless dominated by moisture control over all 30 years, are also worth discussing. The effective decrease of VPD, or increase in moisture, has been analysed in prior research for both regions based on modelled as well as remotely sensed data (Dorigo et al. 2012; Chen et al. 2014). While Dorigo et al. point out that precipitation is the main driver for the increase in southern African soil moisture, there is no clear consensus yet how precipitation and soil moisture influence each other in this region (Dorigo et al. 2012; Cook & Pau 2013) or how and how strongly ocean current anomalies such as the ENSO influence southern African precipitation and soil moisture (Reason & Jagadheesha 2005).