**Proposal**

**1. Introduction**

Clouds are important for regulating the weather and climate, locally and globally {Tiedtke, 1993 #72}. Locally the clouds are responsible for precipitation and thunderstorm events, and through their high reflectivity they influence the global energy balance substantially {Hartmann, 1992 #73}. The low altitude clouds inside the boundary layer, e.g. cumulus clouds, are a crucial part in the hydrologic cycle as they control the upward transport of moisture {de Arellano, 2012 #66}. Studies show that changes in this hydrologic cycle do affect the climate {Pielke, 1998 #64}, and vice versa, the ongoing climate change has a large effect on cloud cover {de Arellano, 2012 #66}. Understanding the mechanisms behind cloud formation is therefore crucial to create reliable weather and climate models.

Many studies have investigated relations between atmospheric variables and cloud formation (BRONNEN), and the impact of climate change on clouds (BRONNEN). However, as forests are known to behave hydrologically differently than other land uses, e.g. Forests respond different to heatwaves than grassland {Teuling, 2010 #74}, it is essential to also study the effects of forests on cloud formation. This is needed to correctly implement forests into the weather models. Furthermore, the ongoing global intensification of agriculture is causing a vast decrease of natural ecosystems, including forests. On the other hand, active forest management is improving forest conditions, protecting ecosystems and creating new forests, increasing the standing biomass of European forests by about 40% {Foley, 2005 #63}. To simulate and study the effect of future forest adaptations on regional and global it is necessary to further understand the dynamics between forests and cloud formation.

Studies show that deforested areas in rainforests affects the type and density of the cloud cover. Shallow clouds formed over the deforested areas, while there were only deep clouds over the dense forest {Chagnon, 2004 #68}. Even though the high moisture content above dense forest provides enough convective available potential energy (CAPE), no new convective shallow clouds form due to a lack of a lifting mechanism {Wang, 2009 #67}. However, the difference in length scales {Irvine, 1997 #75} and temperature between the deforested and forested areas cause convective mesoscale circulations {Souza, 2000 #76}, which act as a lifting mechanism for the shallow clouds above at the transition zones. From these findings it can be hypothesized that the opposite also occurs, that a transition from homogeneous arable farmland or pastures into forest trigger mesoscale circulations. But that in this case, the high CAPE above the forest results in deep convective clouds instead of shallow clouds.

**FIG1-**

**FIG1-**

From a preliminary study it is evident that under certain circumstances there is more cloud formation above forests than above neighbouring grasslands (Fig 1). To get a further understanding of this phenomenon, we will process and study satellite images to find out under which conditions the clouds form and what they contribute to the total cloud budget. Most studies so far that relate to this topic have been conducted in the Amazon, and while this area suffers from almost no human influences, it is not very practical for weather forecasting. Areas that would benefit most from improvements in the models are areas that have a dense population, therefore we choose to study the effect of Western European forests. As the Amazonian climate differs from the temperate climate in Western Europe, the data and results of the previous studies can therefore not be used directly and we will mainly work with European data.

**RQ1** Research was already done on the impact of mesoscale circulations on convection and cloud formation. But these studies disagree on the conditions under which the flows develop and how they can possibly result in the formation of clouds. The initial consensus was that the synoptic weather conditions should be weak before the circulations occur at all {Avissar, 1998 #79}. However, more recent studies conclude that synoptic weather effects do alter the circulations’ shape and orientation, but do not affect their strength{Weaver, 2004 #80}{Baidya Roy, 2002 #81}{Raasch, 2001 #82}{Prabha, 2007 #83}. This claim is supported by modelling studies that found that under certain favourable synoptic conditions the surface heterogeneity induced mesoscale circulations with significant heat and moisture fluxes {Frye, 2010 #84}{Roy, 2009 #85}. But again, other studies disagree with the conclusion that the mesoscale circulation are significant compared to the turbulent flows {Kang, 2008 #86}. To correctly implement the dynamics of forests into weather and climate models, it is necessary to look into the role of synoptic weather on possible cloud formation above forests. The aforementioned research was done using observations from the Amazonian rainforests, or were model studies. These studies hint that there are complex dynamics involved, but as this research aims to understand the dynamics in European forests with a different climate and air composition, research with local data is required.

**RQ2** Another aspect of this study will be the spatial scale – amount of CAPE, length scales

**RQ3** Is it significant?

* What are the determining factors for cloud formation over forests
* Is the size of the forest of importance for the formation of clouds
* What is the contribution of the additional cloud formation on the total cloud budget

**2. Material and methods**

**2.1 Data**

**2.2 Study area**

**2.3 Approach**

Papers zjin maar over korte tijden

**3 Planning**

**4 feasability**

* Is there significantly more cumulus formation above forests than the surroundings areas.
* Which weather variables are the most influential for forming deep cumulus clouds.
* What is the effect of the size of a forest on the formation of deep cumulus clouds.