## Contents

|  | Page |
|--|------|
| Abstract   | v    |
| Acknowledgments  | ix   |
| Contents   | Х    |
| List of Tables   | xii  |
| List of Figures  | xiii |
| Lists of abbreviations   | xvii |
| Chapter  |      |
| Lists of abbreviations<br>Chapter<br>1. Introduction   | 1    |
|  | 1    |
| <ul> <li>1.1 Background and rationale</li> <li>1.2 Objectives for studies</li> <li>1.3 Literature reviews</li> <li>1.4 Concept of study</li> </ul> | 2    |
| 1.3 Literature reviews   | 3    |
| 1.4 Concept of study   | 6    |
| 1.5 Road map of thesis   | 7    |
| 2. Methodology   | 9    |
| 2.1 Data source and data management  | 9    |
| 2.2 Variables  | 11   |
| 2.3 Study diagrams   | 12   |
| 2.4 Graphical methods  | 14   |
| 2.5 Statistical methods  | 15   |
| 3. Analysis of temperature change  | 20   |
| 3.1 Temperature changes in Southeast Asia during 1973-2008   | 20   |

| 3.2 Temperature changes in Southeast Asia during 1909-2008  | 31   |
|---|------|
| 3.3 Conclusions   | 35   |
| 4. Analysis of solar radiation absorption   | 36   |
| 4.1 Preliminary data analysis   | 37   |
| 4.2 Studies completed of solar radiation absorption   | 38   |
| 4.3 Conclusions   | 48   |
| 5. Conclusions and discussions  | 50   |
| 5.1 Overall findings  | 50   |
| 5.2 Discussions   | 52   |
| <ul><li>5.2 Discussions</li><li>5.3 Limitations and suggestions</li><li>5.4 Recommendations</li></ul> | 53   |
| 5.4 Recommendations   | 54   |
| References  | 55   |
| Appendix 1 Article "Temperature Changes in South-East Asia: 1973-2008"                                | 60   |
| Appendix 2 Article "Spatial and Temporal Patterns of Temperature Change in                            | n 72 |
| Southeast Asia and Australia"   |      |
| Appendix 3 Article "Surface air temperature changes from 1909 - 2008 in                               | 78   |
| Southeast Asia assessed by factor analysis"   |      |
| Appendix 4 Article "Spatial and Temporal Patterns of Solar Irradiance in                              | 90   |
| Australia as Revealed by Exploratory Factor Analysis"   |      |
| Vitae   | 130  |

## List of Tables

| Tables |  | Page |
|--------|--|------|
| 3.1    | Results of the factor analysis with factor loadings            | 27   |
| 3.2    | The increase per decade in the first, second and third periods | 35   |



## List of figures

| Fi | gures |  | Page |
|----|-------|--|------|
|    | 1.1   | Concept of study   | 7    |
|    | 2.1   | The study area for climate change                                  | 10   |
|    | 2.2   | The study area for solar radiation energy                          | 11   |
|    | 2.3   | The diagram of climate change in Southeast Asia                    | 12   |
|    | 2.4   | The diagram of solar radiation absorption in Australia             | 13   |
|    | 3.1   | Time series plots with fitted linear models for period 1973-2008   |      |
|    |       | for the 40 grid-boxes  | 21   |
|    | 3.2   | Box plots of residuals from fitted model                           | 21   |
|    | 3.3   | Normal quantile plot   | 22   |
|    | 3.4   | Auto-correlation function plots for the 40 grid-boxes              | 23   |
|    | 3.5   | Auto-correlation function plots for the filtered residuals.        |      |
|    |       | The dotted line represents the 95% confidence interval for         |      |
|    |       | a zero correlation   | 24   |
|    | 3.6   | Filtered temperatures in 1973-2008                                 | 25   |
|    | 3.7   | Spatial correlations of filtered residuals                         | 25   |
|    | 3.8   | Bubble plots of correlations between filtered monthly              |      |
|    |       | temperatures in grid-boxes before (left) and after (right) fitting |      |
|    |       | the factor model   | 27   |
|    | 3.9   | Six regions were combined by factor analysis (left) and the        |      |
|    |       | combined regions after extended the area for all directions        |      |
|    |       | (right), for comparison with the extended area                     | 28   |
|    | 3.10  | Six regions were combined by factor analysis                       | 29   |
|    |       |  |      |

| Figures |   | Page |
|---------|---|------|
| 3.11    | Temperature changes in regions defined by factors                         | 30   |
| 3.12    | Temperature changes, with 95% confidence intervals for the predicted      |      |
|         | temperature change in the next decade                                     | 31   |
| 3.13    | Mean temperature change of each period                                    | 32   |
| 3.14    | The adjoining grid-boxes were combined into six regions in                |      |
|         | the first, second and third period  | 33   |
| 4.1     | Plots of the observed maximum solar radiation and 0.8 times the extra-    |      |
|         | terrestrial solar radiation for eight selected stations                   | 37   |
| 4.2     | Five patterns of solar radiation absorption and their mean estimation     |      |
|         | for 5 stations  | 39   |
| 4.3     | Residual quantile plots for five selected stations, where the response    |      |
|         | of the additive model is five-day average of the daily percentage solar   |      |
|         | radiation absorption  | 40   |
| 4.4     | Residual quantile plots for the same five selected stations, where the    |      |
|         | response is location dependent square root transformed five-day           |      |
|         | average of the daily percentage solar radiation absorption, and then      |      |
|         | filtered with a lag 1 term  | 41   |
| 4.5     | Solar radiation absorption dots and their mean estimation for 5 stations  |      |
|         | with latitudes between 10°S and 30°S based on model (4.2)                 | 42   |
| 4.6     | 4.6 Auto-correlation function plots of residual from raw data and no filt |      |
| 4.7     | Auto-correlation function plots of residual from transformed and          |      |
|         | filtered data   | 44   |

xiv

## Figures

48

| 4.8  | Factor analysis divides the stations into 7 geographical groups | 45 |
|------|---|----|
| 4.9  | The seven dominating factor in the trend estimation based on    | 46 |
|      | model (4.3)   |    |
| 4.10 | Estimated percentage cloud cover (line) with 68% confidence     |    |
|      | interval (shaded) in each month of a year                       | 47 |

Estimated annual average percentage cloud cover (line) with 68% 4.11 Prince of Songkla Unitversity Prince af Songkla Campus Pattani