Guidelines for the Layout of Protocols, Bachelor, and Master Theses

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1. Summary

A scientific bachelor or master thesis typically demonstrates new and self-gained findings[1]. It should represent why it is important to gain this knowledge, why it is new, and how it was obtained.

The following text explains the most important design characteristics that a scientific work should include as a study of Geophysics and Meteorology. Consider this a guideline – because of the complexity of various topics, not all design features must be taken exactly as written in this text. When in doubt, contact your supervisor. Features which are described in Chapter 2 include appearance, such as page layout, integration of figures and tables, and correct citation. Chapter 3 shows how to correctly formulate individual parts of your thesis (abstract, introduction, main body, summary and outlook, bibliography, appendices and acknowledgement). If you create a lab report, sections 2.1.-2.3., 2.5., 3.1.-3.2. and 3.8 are especially relevant.

[1] An example of an exceptions would be a bachelor thesis written as a literature study

2. Appearance

All written work must be created using a word processing program on a computer. It is important that formal rules be consistently applied. Just as a thesis should be consistent in content, its arrangement should be uniform in a formal sense. Once a particular design rule has been decided upon, this rule should be maintained consistently throughout the thesis.

In this chapter we will deal first with questions about the appearance of the manuscript. Section 2.1 discusses page layout, Section 2.2 the structure of sections and subsections, Section 2.3 the correct integration of figures and tables, and Section 2.4 citations.

2.1. Page Layout

Be sure to choose the font style, text size, and line spacing so that the text is legible. Margins of 2.5 to 3 cm are sufficient. You can use a similar layout as in this document. A header with a brief label of the thesis on each page is useful, but not absolutely necessary. Page numbers can be placed on each page either in the upper right-hand corner in the header, or the bottom right, as in this document. An exception is the title page, which has no header, and no page number. Page counting still starts with the title page however. The text size in the header should be slightly smaller than the text.

2.2. Sections and Subsections

The following examples illustrate how headlines of a subsection look, what spacing you can use, and how you can customize the font size.

1 Introduction (16-point font, bold)

Here, the corresponding paragraph starts in normal font size (12-point font). A heading can never be followed directly by another heading of a lower degree, it must be followed by a paragraph with text, where a paragraph always consists of several sentences.

1.1 The State of Research (14-point font, bold)

Here, the corresponding paragraph starts in normal font size (12-point font). In this text, nothing is underlined, and nothing is bolded. Emphasis is only done by setting *italics*.

1.1.1 Research at the University of Cologne (12-point font, bold)

Here, the corresponding paragraph starts in normal font size (12-point font). Modern word processing programs typically offer guidelines for hyphenation, which you should make good use of. This is especially useful if you are using a justified alignment, otherwise differing and sometimes very large spaces between words may arise.

2.3. Tables and Figures

Tables and figures allow clear presentation of complex content. Therefore, you should make use of them, provided the tables or figures actually provide good information. It is preferable that they also be understood without the accompanying text. *Please note*: without exception, all tables and figures must be discussed in the main text (with reference).

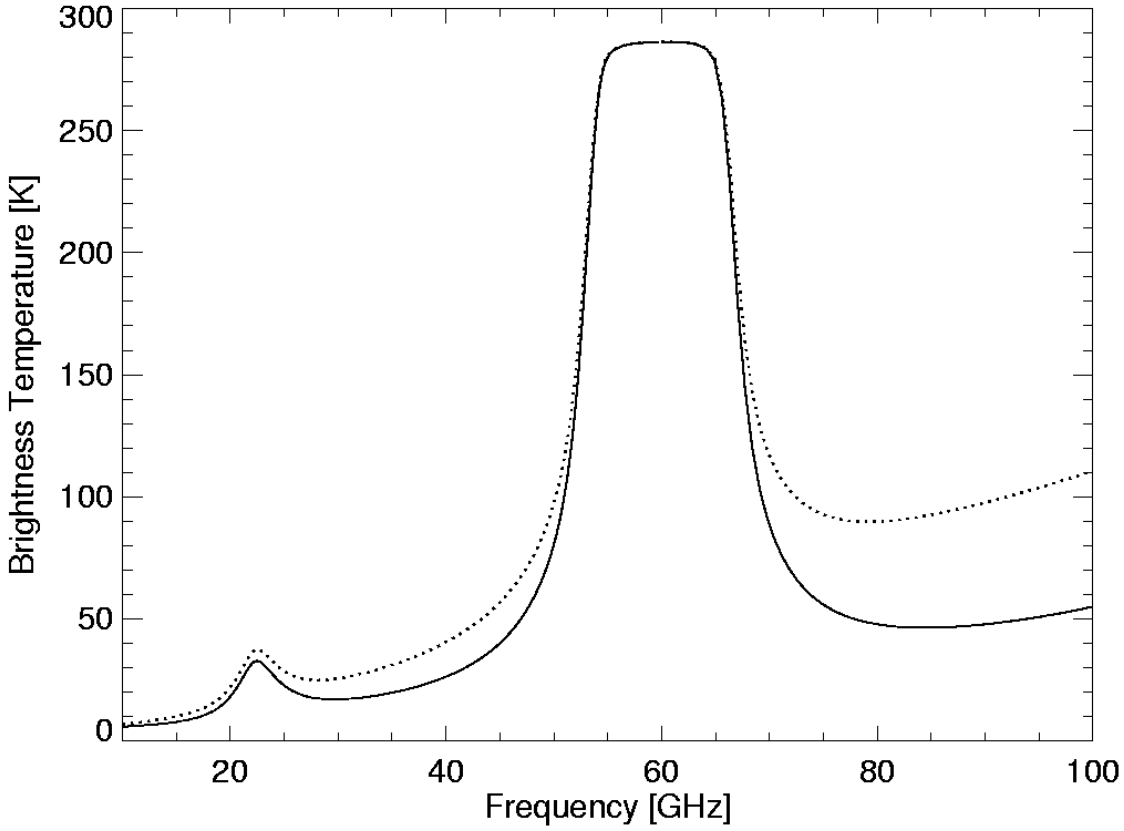

Figure 1: Brightness temperature as a function of frequency in the microwave range. Solid line: cloudless case, dotted line: additional cloud with 250 gm^{-2} total liquid water.

Be especially careful that figure legends (captions) go *below the figure*, and table legends go *above the body of the table*. Make sure these are uniform throughout. The text size may be slightly smaller than the normal text, but never bigger.

For an example of a configuration of a figure, refer to Figure 1. Note that all of the curves are explained in the legend, however no interpretation is done. For this, all axes must be labeled in the pictures and provided with units. From Table 1, it is clear how a table design might look.

Table 1: Accuracy of SRS400 radiosonde sensors.

Parameter	Sensor Type	Accuracy
Temperature	Thermocouple (copper/constantan)	+- 0,2 K
Pressure	Hypsometer	+- 2 hPa
Humidity	Carbon hygristor to April 2009	+- 10 to 20%
	Capacitive polymer from Mai 2009	+- 5 to 10%

2.4. Citations

All sources for all information, statements and arguments in a thesis must be specified. Everything which is not self-researched, self-conceived or self-measured must be quoted as long as it is not common knowledge, i.e. textbook knowledge (for example: $F=m \cdot a$). It is preferred that direct quotes be avoided in scientific publications. Typically, only the ideas,

results and/or data of other works are used or compared to your own results. When citing a source, it is important to not only mention the work and the method used, but also significant results.
You should have read the cited works and checked the statements that you use. Avoid secondary citations. If you specify a source, you must include the corresponding citation in the bibliography. A citation can look like this: Further reading on quoting, see Müller (1999). If published by two authors, cite Müller and Schmidt (2001). If there are more than two authors involved in the publication, quote Müller et al. (2003). If citing using parentheses instead of within the sentence, do it like this (Müller et al., 2003).
Quotations are also allowed from contributions from peer-reviewed journals. Conferences can also generally be used, if the subject was not published anywhere else. The use of websites as references for scientific sources should be avoided (especially Wikipedia and similar websites). Exceptions here are scientific publications, which generally appear only on the internet. Scripts or PDF files which have not been published in a scientific journal should also not be quoted.

2.5. Miscellaneous

- The length of a thesis is no criteria for the quality of a thesis (often the opposite). If uncertain, check the examination regulations, which provide information on the appropriate number of pages.
- Each mathematical symbol and abbreviation should be defined in the text once. After that, you can then use the symbol or abbreviation continuously without having to explain or further describe it. In the case of many mathematical symbols or abbreviations, you can insert a directory of symbols or acronyms at the beginning (immediately after the table of contents) or at the end of the work (as an appendix, before the dedication).
- If you relate something with an already mentioned topic, stay concrete: don't just write *see above, as already shown*, etc., instead always specify explicitly to that which you are referring, for example, *in Chapter 6.3.1 it was shown,* or *in formula (7.32)* ...
- Quantify and substantiate your results. The reader, who is seeing your results for the first time, needs to get an idea of the magnitude/characteristic scale of your work. For examples, refer to Table 2 below.
- Use SI units throughout.
- Units should not be represented in math mode/ math font, i.e., write "km" and not "*km*". The same applies to chemical formulas, i.e. "H_2O" and not "H_2O".

Table 2: Example of imprecise wording and recommendations

Imprecise wording	Recommendation
The magnetic field in the tail is significantly increased.	Better: The magnetic field in the tail is an order of magnitude stronger than the surrounding plasma.
There are slight differences between simulation results and measurement data.	Better: The discrepancy between simulations and measurements is approximately 10%.
The magnetic field shows a small increase.	Quantify the increase!
Mars has only a very weak intrinsic magnetic field.	... compared to what?
The simulation results show relatively good agreement with the data.	Relative to what? "Relative" in this context should not be used.

3. Structure of Content

The following subsections show how you should organize the content of your work. With master and bachelor theses, it is important to establish an outline of your work at an early stage. Talk about this with your supervisor early on.

3.1. Title page

The title page of this document can serve as an example. The title of the work, author, and institution where it was written must be clear. For protocols it is also important to include which semester, for which course, and for which lecturer it was written. For bachelor and master theses, the format of the title page is usually specified. The title must be understandable to anyone with a similar education as the author without any further explanation, and which reflects the contents of the thesis accurately.

3.2. Abstract

The main topics and results of the work must be summarized here as briefly as possible so that the reader can quickly get an overview of what is described in the work. You should also briefly describe your topic, the questions asked, and the methods used that led to the result of the thesis. The summary should be kept as short as possible. Typically, the summary should be kept to ½ to 1 DINA4 page.

3.3. Table of Contents

A table of contents is very useful for the reader of a thesis. All sections of the thesis (with the exception of the table of contents itself) must be listed here along with section numbers and page numbers, including the abstract, which usually comes before the table of contents. Page 2 of this guide provides an example.

3.4. Introduction

The introduction (Chapter 1) should clarify the topic of work. Make sure it is written as a generally understandable discussion. The introduction should consist of the following sections:

- General introduction to the topic: you should also excite non-experts to your topic. This point can also be supported by a concise figure or a newspaper article. Which physical phenomenon is dealt with in the work and what is new/ fascinating/ interesting/ exciting?
- Goal of the thesis: what will be done, what physical effects will be studied and what is new and important?
- Methods used to reach your goal: which method or model is used and what is used for? What is new about the method used here?
- Outline of the work: the common thread of the thesis is established. Each section of the thesis is briefly (about a sentence) explained. Here it is especially important to connect the different sections.

3.5. Main Body

The body is the heart of the thesis. Ideally, it should include 3-4 chapters. Due to the variety of topics in the field of Geophysics/Meteorology, there is no “recipe” for this section. Instead you should consider how you can describe exactly the essential strategies, measurements, data modelling, analysis, etc., while maintaining a clearly recognizable common thread

throughout. At the beginning of each chapter, section, subsection etc., a brief description is written about what will be done and why. At the end, results should be tied together, and preparations made for the next section. Please note: quantify and substantiate all statements! Make sure to clearly separate the contributions of earlier theses from your own research. When possible, separate them by different chapters.

The following shows just one example of how the main body could be structured.

Chapter 2: **State of Research**

- Detailed description of the examined object or phenomenon
- Presentation of the current state of research: list and discuss all preliminary work which is relevant to your work.
- What should my own performance/ contribution be?

Basically, this section can also be integrated with the introduction.

Chapter 3: **Basis & Methods**

- Theoretical background with derivation of relevant formulas (which should also be numbered). Don't digress here, the thesis should not be a textbook.
- Solutions used (for example models that were used or self-developed)
- Explanations of used measurements or measuring instruments
- Physical/ statistical evaluation
- Description of the data origin or data model which was analyzed

Chapter 4: **Results**

- Description of the results, especially through your figures
- Analysis and physical interpretation of the material
- Classification within previous research results
- Critical analysis of open questions and problems which occurred

3.6. Summary and Outlook

Present the condensed results of your work. In summary, you should explain whether the objective of the thesis was accomplished. In the outlook, you have the opportunity to suggest solutions for the elaboration of any unresolved issues. It is also possible that new questions have also arisen that you believe should be further researched.

3.7. Bibliography

All publications mentioned in the text (and only those) should be included in the bibliography. The main function of the bibliography is to make it as easy as possible for the reader to review all of the data. Therefore, a bibliography must be complete, and should be created according to the standards which are also used in relevant journals. Suggestion: use the format of the *Journal of Geophysical Research*.

Dey, S., L. Di Girolamo, and G. Zhao (2008), Scale effect on statistics of the macrophysical properties of trade wind cumuli over the tropical western Atlantic during RICO, *J. Geophys. Res.*, 113, D24214, doi:10.1029/2008JD010295.

Pay attention that the entries are in alphabetical order, and are complete including:

- Author
- Title of the thesis or book
- Journal or publisher
- Edition
- Page numbers
- Year published
- DOI (*Digital Object Identifier*) if available

Insufficient, incomplete, or even missing bibliographies are a serious deficiency. The primary purpose of a scientific work is to make arguments open to criticism (especially your own). Those who do not specify their sources clearly and definitively deprive themselves of possible criticism, and thus is not operating scientifically. Therefore, there can be no scientific work without a bibliography. Less accessible literature, for example an institute report, a thesis or a dissertation, is incorporated into the bibliography so that it is clear where to look in order to obtain a copy of the work.

3.8. Appendices

In experimental work, one or more appendices are often necessary in which the experimental materials, raw data, etc., but also prolonged mathematical derivations are included. Important material that is needed in order to verify all claims of the thesis or repeat the experiment should be included, unless the relevant details are already clear from the text.

Similar to the references in the bibliography, only appendices which are mentioned in the text should be included. If there are two or more appendices, they are numbered as Appendix A, Appendix B, and so forth. Each appendix must also be presented in a way that is understandable. Pure columns of numbers without any description are a waste of paper, because they don’t provide an opportunity for a non-expert to find out the meaning of the numbers.

3.9. Acknowledgement

If you would like to write an acknowledgement, customize a list of people you would like to thank.