

Online Trajectory Module in COSMO: status

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1 Overview

Table 6.1: Rules for Implementation of Changes

No.	Description	Status
1	Information of WG coordinators and discussion within the management	Done
2.1	Design, development and documentation	Done
2.2	COSMO Standards followed (monitored by TAG)	Done
3.1	Pass the technical test suite (monitored by TAG/SCA)	Done
3.2	4-eyes assurance (monitored by SCA/TAG)	Done
3.3	Testing of single cases with verifications against observations	Done
3.4	More testing only if significant changes of the results	Not relevant
4	Presentation of the results	Done
5	Provide documentation	Done
6	Nominate a responsible person	Done
7	Approval by STC	Pending
8	Submission of code to SCA for final check and integration	Done

2 Details

Point 1: Information of WG coordinator and discussion within the management

Massimo Milelli (WG 6 coordinator) has been informed about this development by email on November 21, 2013. In the week of November 24, 2013, Massimo Milelli has discussed this idea with the TAG during one of the regular TAG web meetings. Following on the positive outcomes of the discussion, the trajectory module has been presented to the SMC during a teleconference on December 2013 by Massimo Milelli. The SMC approved the integration of this development into an official COSMO version. COSMO version 5.1 is targeted for the integration of the trajectory module.

Status: **DONE**

Point 2.1: Design, development and documentation

The module has been designed and developed by Annette Miltenberger and colleagues in 2012 already. It has been published in GMD in 2013 (Miltenberger et al., 2013). A user guide has been published as supplement of this paper. Following on the positive decision by the SMC, a code review has been performed by Anne Roches and some parts have been re-designed and rewritten. A new user guide has been written.

Status: **DONE**

Point 2.2: COSMO Standards followed (monitored by TAG)

The COSMO Standards were largely followed before the review/rewrite. Full compliance with the standards has been achieved through the review/rewrite. The code is available to the TAG. It has been sent to Massimo Milelli and Ulrich Schättler on April 14, 2014.

Status: **DONE, but TAG should look at it?**

Point 3.1: Pass the technical test suite (monitored by TAG/SCA)

As far as we know, no technical test suite has been approved by COSMO so far. However, this development is a simple diagnostic tool and doesn't affect the prognostic equations of the model. The code passes the MeteoSwiss technical test suite.

Status: **DONE, but TAG/SCA should look at it?**

Point 3.2: 4-eyes assurance (monitored by TAG/SCA)

The code has originally been developed by Annette Miltenberger and colleagues. Anne Roches reviewed the code in details. She also has rewritten some parts to reach full standards compliance and to ensure "COSMO quality level". These parts have been re-examined by Annette Miltenberger and Stephan Pfahl. The 4-eyes principle has thus been thoroughly applied.

Status: **DONE, but SCA/TAG should look at it?**

Point 3.3: Testing of single cases with verifications against observations

The original code by Annette Miltenberger has been extensively tested for several cases. Some are published in Miltenberger et al. (2013). In addition, this module has been applied at several research institutions already, proving its scientific soundness. The re-written version provides slightly different results (typically $O(10E-10)$ for the horizontal trajectory position, $O(10E-7)$ for the vertical position, $O(10E-9)$ for the traced wind components, $O(10E-8)$ for the traced temperature and pressure, $O(10E-13)$ for the traced specific content of humidity variables in most cases). Several cases have been recomputed with the re-written version and compared to the results obtained with the original version. No significant differences in the trajectory behaviors could be observed. The trajectory module has thus been tested intensively and its scientific soundness proven. Unfortunately, it is not possible to directly compare against observations since trajectory observations are not readily available.

Status: DONE

Point 3.4: More testing only if significant changes of the results

The trajectory computations are a pure diagnostic tools. They thus do not change the results. This point is thus not relevant for this development.

Status: not relevant

Point 4: Presentation of the results

Annette Miltenberger presented the trajectory module and the results obtained at the COSMO User Seminar 2013 (ftp://ftp-anon.dwd.de/pub/DWD/Forschung_und_Entwicklung/CUS2013_presentations_PDF/Model_Developments_Dynamics_and_Numerics/COSMOseminar_2013_miltenberger.pdf) as well as at several conferences (e.g. AMS Mountain Meteorology Conference in 2012 or DACA 2013).

Status: DONE

Point 5: Provide documentation

The scientific rationale as well as a test case are presented in Miltenberger et al. (2013). This paper also describes shortly the workflow and implementation choices. A new user guide has been written in order to match perfectly the current implementation. It has been sent to Massimo Milelli and Ulrich Schättler on April 14, 2014.

Status: DONE

Point 6: Nominate a responsible person

Stephan Pfahl, senior scientist at ETH in the Atmospheric Dynamics group of Heini Wernli and co-author of Miltenberger et al. (2013), will be the responsible person for this code (<http://www.iac.ethz.ch/people/pfahls>). He has a long-term position, knows the COSMO model very well, and has accompanied the development of the trajectory module from the beginning.

Status: DONE

Point 7: Approval by STC

The STC will decide (based on the outcomes of the SMC phone conference of April 16, 2014) if the code can be integrated into COSMO 5.1. The SMC approved the integration of the module into an official version during its phone conference of December 2013. If the SMC thus agrees with version 5.1 as target version and if the STC follows the SMC recommendation, the module should be integrated.

Status: PENDING

Point 8: Submission of code to SCA for final check and integration

The code has been sent to Ulrich Schättler on April 14, 2014 for final check and integration.

Status: **DONE**

3 References

A. K. Miltenberger, S. Pfahl and H. Wernli (2013). An online trajectory module (version 1.0) for the nonhydrostatic numerical weather prediction model COSMO. Geosci. Model Dev., 6, 1989-2004, doi:10.5194/gmd-6-1989-2013.