1.5 Initial Tendency Method

Objective of the evaluation method used in this work is to evaluate the models without the use of additional measurements. This kind of evaluation has to verify intrinsic physical properties or the general behavior of the model.

Under the assumption of a stationary climate one can assume, that statistically all variables have to be constant. This is expectably true for extensive or intensive variables.

The time scales for which different variables in the climate system are quasi constant can become very large. Also variables that vary with the diurnal cycle would cause problems, if the diurnal cycle isn't resolved by the model starting times. If the model is for example only started at the local morning, the tendencies for temperature would always be positive whereas this doesn't point to erroneous behavior of the model. It is important to note that the diurnal cycle might not be resolved by a 6-horal sampling.

Due to this for this evaluation known tendencies of all variables will be subtracted before averaging. To determine the known tendencies the reanalysis from which the model is started are used to calculate the real background tendencies.

For a Variable Φ let Φ_0^R be the reanalysis field from which the model is started and Φ_1^R the next reanalysis field available after a time of ΔT.

The forecast field for t seconds after Φ_0^R is denoted $\Phi^M(t)$. The model time step numbered $0 \leq i \leq n \in \mathbb{N}$ is Δt seconds. Therefore model fields are available for $t = i\Delta t$ and called Φ_i^M.

The Background tendency is $\dot{\Phi}^R = {}^{(\Phi_1^R - \Phi_0^R)}/_{\Delta T}$ if $i < {}^{\Delta T}/_{\Delta t}$, elsewise $\Phi_{2,3,\ldots}^R$ will be used such that the time step i is in between the used reanalyses. The model tendency $\dot{\Phi}_i$ exclusive the background tendency between the time steps i and $i+1$ is then calculated by:

$$\dot{\Phi}_i = \frac{\Phi_{i+1}^M - \Phi_i^M}{\Delta t} - \dot{\Phi}^R \tag{1.3}$$

Occasionally due to practical reasons some model tendencies $\dot{\Phi}_i$ to $\dot{\Phi}_j$ will be examined only averaged:

$$\dot{\Phi}_{ij} = \frac{1}{j-i} \sum_{k=i}^{j-1} \dot{\Phi}_k = \frac{\Phi_j^M - \Phi_i^M}{(j-i)\Delta t} - \dot{\Phi}^R \quad \text{with:} \quad i < j \leq n \tag{1.4}$$

For some variables the model can be configured or adapted to add different tendency terms, that are normally are integrated, directly to the model output. This then allows for another way to compute $\dot{\Phi}_i$:

$$\dot{\Phi}_i + \dot{\Phi}^R = \sum_k \dot{\varphi}_k^M \tag{1.5}$$

Here $\dot{\varphi}_k^M$ are the different model tendencies from the dynamics and physics of the NWP. It is important that all processes are included for this equation to hold.