Introduction

- Monin-Obukhov similarity theory (MOST)
  Valid in principle for Horizontally Homogeneous and Flat surfaces (HHF)
- Similarity
  - Can solve the closure problem in conservation equations
  - Also necessary in complex terrain
  - Applied in numerical models
  - Useful in hydrology, air-quality applications etc.
- Research question: MOST or local scaling in complex terrain?

Table 1: Main characteristics of the i-Box measurement sites.

<table>
<thead>
<tr>
<th>Sites</th>
<th>Name</th>
<th>Slope (°)</th>
<th>Levels</th>
<th>Tower Height (m)</th>
<th>Elevation (m)</th>
<th>Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koslass</td>
<td>CS-VF0</td>
<td>0</td>
<td>3</td>
<td>16.93</td>
<td>545</td>
<td>Valley floor</td>
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<tr>
<td>Terfens</td>
<td>CS-SF8</td>
<td>2</td>
<td>12</td>
<td>575</td>
<td></td>
<td>South-facing</td>
</tr>
<tr>
<td>Eggen</td>
<td>CS-SFI</td>
<td>1</td>
<td>1</td>
<td>829</td>
<td></td>
<td>South-facing</td>
</tr>
<tr>
<td>Weerberg</td>
<td>CS-NF10</td>
<td>10</td>
<td>1</td>
<td>930</td>
<td></td>
<td>North-facing</td>
</tr>
<tr>
<td>Hochhauser</td>
<td>CS-MT27</td>
<td>27</td>
<td>1</td>
<td>1009</td>
<td></td>
<td>North-facing</td>
</tr>
<tr>
<td>(*), Arhbus</td>
<td>CS-MT21</td>
<td>21</td>
<td>1</td>
<td>2020</td>
<td></td>
<td>Mountain-top</td>
</tr>
</tbody>
</table>

Results of temperature variance

- Local scaling can be applied: similarity functions (Table 2)
- The -1/3 exponent is successful: small root-mean-square errors (RMS)
- No neutral limit (Fig. 3) (Tampieri et al. 2009)
- No general complex terrain formulation is found (yet?)

 stable

- Larger scatter than unstable (Fig. 3)
- Again in near-neutral limit the similarity functions diverge (Tampieri et al. 2009)
- The -1 exponent is not successful at all stations
  - The flat sites (Koslass and Eggen) present very small exponent
  - Slope dependence of the exponent?

Results of humidity variance

- Large scatter (Fig. 3)
- The -1/3 exponent seems to be successful
- Near-neutral: finite value approached
- No general complex terrain formulation

stable

- Large scatter for all i-Box sites (Fig. 5) in accordance to previous literature (e.g. Moraes et al. 2005)
- Local scaling does not seem to apply: no regularities

Table 2: Coefficients of best-fit similarity functions for temperature variance and RMS, with respect to best fit curve and from literature curve (Nadeau et al. 2013), for the 5 i-Box sites, for ζ<0 and ζ>0.

<table>
<thead>
<tr>
<th>i-Box sites</th>
<th>ζ&lt;0 (unstable)</th>
<th>ζ&gt;0 (stable)</th>
<th>ζ&lt;0 (unstable)</th>
<th>ζ&gt;0 (stable)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>b</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Koslass</td>
<td>2.66</td>
<td>3.34</td>
<td>0.4</td>
<td>1.79</td>
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<td>Terfens</td>
<td>3.03</td>
<td>-8.45</td>
<td>0.58</td>
<td>3.22</td>
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<td>Eggen</td>
<td>5.81</td>
<td>-99.75</td>
<td>0.1</td>
<td>0.15</td>
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<tr>
<td>Weerberg</td>
<td>5.74</td>
<td>-100.73</td>
<td>0.01</td>
<td>0.12</td>
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<tr>
<td>Hochhauser</td>
<td>4.39</td>
<td>-32.12</td>
<td>0.35</td>
<td>0.25</td>
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<tr>
<td>Nadeau et al 2013</td>
<td>2.67</td>
<td>-16.29</td>
<td>0.33</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Conclusions

- Local similarity can be applied at i-Box sites, for temperature (stable and unstable) and for humidity variance (unstable)
- No universality of the results (different functions than literature)
- The best-fit curve is in most of the cases higher than literature)
- Site-to-site dependence for temperature variance
- Temperature variance (stable): the -1 exponent is not valid in the flat i-Box sites
- Slope dependence?
- Similar curves for i-Box sites in the case of humidity variance (unstable)
- Can one local similarity function be applied in complex terrain?

References