Geophysical Research Abstracts
Vol. 21, EGU2019-16460, 2019
EGU General Assembly 2019

New insights in the scaling regimes of our atmosphere based on satellite radar imagery (InSAR)

Gert Mulder, Freek van Leijen, and Ramon Hanssen
Delft University of Technology, Delft, Netherlands (g.mulder-1@tudelft.nl)

Over the last decades there has been an ongoing debate about the about the turbulence scaling laws of our atmosphere (Pinel, 2014). Especially, the difference and transition between small systems with sizes up to tenths of kilometres and larger climatic systems (Lovejoy, 2009; Frehlich, 2010).

The main sources to analyse these transitions are measurements from aircraft or climate models. However, the aircraft data measurements are often disturbed due to flight paths on larger distances and scales in weather models often reflect the model structure itself instead in contrast to measurements.

In this research we want to show an analysis from an alternative data source to study scaling laws in the atmosphere called interferometric synthetic aperture radar (InSAR), which measures the refractivity of the atmosphere. Although this technique has been around for some decades now and several studies on scaling laws already exist, the spatial and temporal coverage was limited. However, with the arrival of the Sentinel-1 satellites, much larger datasets are available. Current time-series consist of about 500 images, with a coverage of hundreds (range direction) by thousands of kilometres (azimuth direction) and resolution of up to 50 meter.

Earlier studies, like Hanssen (2001), identified clearly the Kolmogorov turbulence scaling regime of -5/3 for distances up to 10 kilometres. This is also clearly visible in our current work. However, for larger distances older estimates where not accurate because of the limited coverage and removal of trends in the data. Using the new Sentinel-1 dataset, we observe scaling close to the -2.4 scaling regime that is seen in other studies, but it can vary a lot or even be absent for individual cases. Also, there is a clear relation between weather type and the magnitude and onset of this second scaling regime. While cases with strong convective rainfall show a more dominant -5/3 regime, the -2.4 regime is more dominant on days with calm weather.

The main focus of this research has been on the Netherlands, including parts of Belgium and Germany, but it is possible to study larger regions. This would enable us to expand the studied spectrum from hundreds to thousands of kilometres.

References:

Pinel, J., et al., The horizontal space–time scaling and cascade structure of the atmosphere and satellite radiances, Atmos. Res. (2014), http://dx.doi.org/10.1016/j.atmosres.2013.11.022

Lovejoy, S., A. F. Tuck, D. Schertzer, and S. J. Hovde (2009a), Reinterpreting aircraft measurements in anisotropic scaling turbulence, Atmos. Chem. Phys., 9, 5007–5025, doi:10.5194/acp-9-5007-2009.

Frehlich, R. G., and R. D. Sharman (2010), Equivalence of velocity statistics at constant pressure or constant altitude, Geophys. Res. Lett., 37, L08801, doi:10.1029/2010GL042912.

Hanssen, R.F. (2001), Radar Interferometry: Data Interpretation and Error Analysis. Dordrecht: Kluwer Academic Publishers