Summary of Prigent et al. (2005) and Prigent et al. (2012) datasets

Prigent et al. (2005) dataset

ERS satellite: microwave scatterometer (5.25 GHz; active)

Frequency: 5.25 GHz (water vapor/cloud absorption are negligible for this band, so no atmospheric correction is needed)

ERS scatterometer performance is summarized in Frison and Mougin (1996)

Swath: 500 km wide

Look angle: ranging from 18° to 59° (backscattering coefficient σ is a function of incidence angle, and all values in the dataset are corresponding to the 45° incidence angle)

Fitting data: surface roughness z0 measurements were obtained from Greeley et al. (1997) (California, Nevada, Namibia), as well as Marticorena et al. (1997) + Callot et al. (2000) (North Africa and Middle East). The fitted empirical formula is then applied to global ERS σ measurements to extrapolate for global z0.

Fitting: z0 = exp(1.88+0.32σ) (1)

Since the in-situ z0 measurements were obtained in arid and semi-arid regions, the relationship is accurate over arid and semiarid areas (where σ is small than –15 dB) but becomes less correct over densely vegetated regions with large σ (> –10 dB). But since Meier is using other z0 parameterizations for other non-arid and snowy regions, it is probably better to extrapolate for yielding z0 the whole globe to avoid numerical errors due to NaNs (especially for my dust emission scheme).

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Time period and temporal resolution: year 1997 monthly (12 monthly data for each grid)

Horizontal resolution: equal-area grid; 0.25° by 0.25° at equator

Data dimension: 660066 \* 6 \* 12 (all data stored as a 1-D vector; 6 variables in total)

Variables: ('cellnum','lon','lat','sig\_ers','roughness','snow')

My data path: /gpfs/fs1/work/dleung/roughness\_Prigent/Pr05\_z0\_monthly

Some quick plots:

A picture containing graphical user interface

Description automatically generated

Fig. 1. Prigent et al. (2005) aeolian roughness length. Top left: Minimum value of 12 months of year 1997. Top right: Maximum value of 12 months of year 1997. Seasonality is due to vegetation (semiarid and nonarid regions).

Prigent et al. (2012) dataset: Combining PARASOL (passive) and ASCAT (active) measurements

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PARASOL satellite: imaging radiometer/polarimeter (passive)

9 channels; 865 nm was used by Prigent.

Data is more sensitive to atmosphere compared with active sensing especially for longer wavelengths.

Heavy contamination and more missing data during the summer because of dust aerosol contamination during the summertime dust season over arid/semiarid regions –> the dataset only represents boreal winter months (2007 November to 2008 February).

PARASOL provides monthly reflectance measurements which gives k0, k1, k2 as coefficients for bidirectional reflectance:

R = k0 + k1\*F1 + k2\*F2 (2)

Roujean et al. (1992) and Marticorena et al. (2004) showed that the protrusion coefficient (k1/k0) characterizes the surface roughness. k1/k0 values are independent of wavelength.

Resolution: 5.3 km by 6.2 km at nadir

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MetOp satellite: ASCAT microwave scatterometer (5.25 GHz; active)

Measurements were not affected by atmosphere at this frequency

Swath: 500 km

Resolution: equal-area grid; 0.25° by 0.25° at the equator

Again, incidence angles changes but all values in the dataset are corresponding to the 45° incidence angle, same as Prigent et al. (2005).

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Fitting data: same as Prigent et al. (2005): Greeley et al. (1997) (California, Nevada, Namibia), as well as Marticorena et al. (1997) + Callot et al. (2000) (North Africa and Middle East). The fitted empirical formula is then applied to global ASCAT and PARASOL measurements to extrapolate global z0.

Bilinear fitting: z0 = exp(2.31+0.32σ+0.65\*k1/k0) (3)

Applying the fitted formula to the global 6 km PARASOL measurements and 0.25° ASCAT measurements gives the global z0 map. Satellite measurements were obtained between Nov 2007 and Feb 2008. When PARASOL observations are not present (due to aerosol/cloud/snow etc), z0 is retrieved from ASCAT observations.

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Time period and temporal resolution: Nov 2007–Feb 2008 seasonal mean (1 data for each grid)

Horizontal resolution: 0.00833° by 0.00833°

Data dimension: 43200 \* 21600 \* 1 (note: I obtained the data from Laurent Menut who works with Prigent; he might have regridded the data from an equal-area grid to a proper lat lon grid for his CHIMERE CTM.)

My data path on Cheyenne: /gpfs/fs1/work/dleung/roughness\_Prigent/ z0\_CHIMERE\_usgs\_ASCAT\_m.nc

Some quick plots:

A picture containing graphical user interface

Description automatically generated

Map

Description automatically generated

Fig. 2. Prigent et al. (2012) (topleft) and Prigent et al. (2005) wintertime (topright) roughness z0. Bottom: ratio of topright / topleft. Blue values over most of the globe indicates that Eq. (3) is inherently bigger than Eq. (1) mostly because of the red term that comes from the PARASOL passive reflectance fitting.

Remark: Prigent’s dataset only characterizes aeolian or small-scale roughness (roughness of rocks/pebbles/vegetation relevant to dust modeling) and thus its z0 is much smaller than roughness of other products (with topography/terrain etc). See below for a quick comparison between CLM, MERRA2, and Prigent’s roughness.

