Comparing Ronny Meier's aeolian roughness length data against Danny Leung's data

Ronny Meier's data:
path: /glade/p/cesmdata/cseg/inputdata/lnd/clm2/surfdata_map/release-clm5.0.18/surfdata_0.9x1.25_hist_Z0MG_16pfts_Irrig_CMIP6_simyr2000_c210624.nc

I saw that oceans and other areas of higher roughness z_0 were replaced by a (fill?)-value of 0.0004257025 m. I removed all grids with this value and plotted the remaining z_0 (in cm; the surfdata stores z_0 in m).

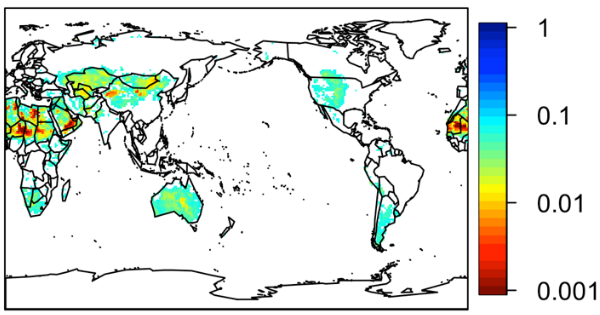


Fig. 1: Ronny Meier's roughness length data (from Prigent et al., 2005) in cm (data is in m).

My data:
I used an empirical fitting formula from Prigent (see info at the end of this document) to extrapolate roughness length for the whole globe. The formula relates in-situ roughness length z_0 measurements to the satellite measurements of backscattering coefficient σ:
$z_0 = \exp(1.65+0.30\sigma)$
(note: this formula was suggested by Prigent in a recent communication and it seems different from the empirical formula stated in Prigent et al., 2005, which is $z_0 = \exp(1.88+0.32\sigma)$.)
applying the formula to the global measurements of σ gives a global map of z_0 below. Therefore, my data is covering all continents. Prigent et al. (2005) noted that since the in-situ z_0 measurements are only in arid and semi-arid regions, it will be not as accurate to apply the formula in nonarid regions. However, my drag partition scheme will be used for anywhere with LAI smaller than a threshold value (e.g., 1), so I need to extrapolate values a bit and avoid my dust emission scheme to misbehave with NaNs.

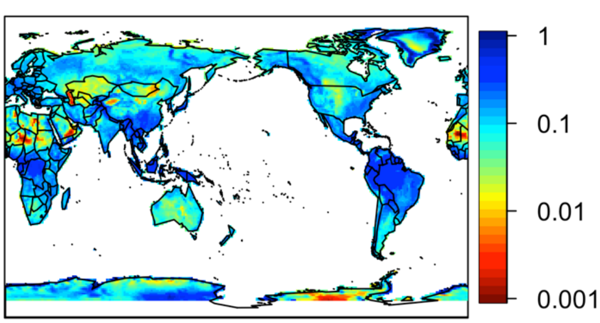
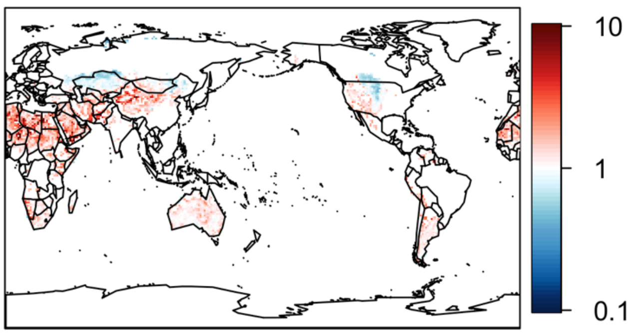


Fig. 2: My roughness length data (from Prigent et al., 2005) in cm. The end of this document stores info about this data.

Comparing two datasets:
The ratio of Ronny Meier's dataset to my dataset:



My z_0 data is generally 1–5 times larger than Ronny Meier's. For now I do not know why, assuming Meier is using the same 1997 data as I do. I think this difference is not very important to my drag partition and dust emission schemes.

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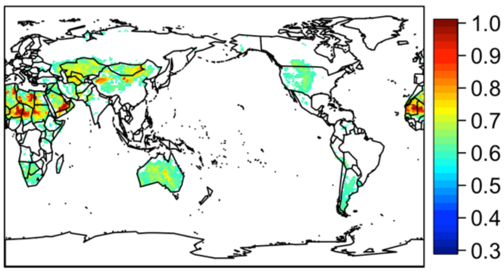
(If anyone is interested) I used both datasets with my drag partition scheme to calculate the drag partition effect of wind friction velocity.
The plots below show the drag partition factor F_{eff}, which is the fraction of ustar retained for soil erosion/dust emission.

The drag partition effect F_{eff} is given by (Marticorena and Bergametti, 1995; Darmenova et al., 2009):

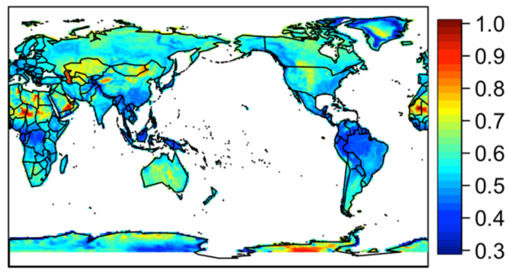
$F_{eff} = 1 - (\log(z_0/z_{0s}) / \log(0.7*(X/z_{0s})^{0.8}))$
(z_0 in m in this equation; log is natural log.)

Our parameter choice:
$z_{0s} = 30 * D_p / 2$
$D_p = 130$ e-6 m
X = 10 m (the least constrained parameter; globally varying but taken as globally constant for all previous studies. Ranged from 0.1 m to 120 m in previous studies.)

a) F_{eff} using Ronny Meier's data:



b) F_{eff} using my data:



b) – a)

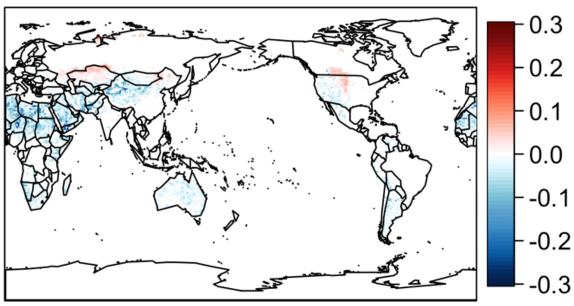


Fig. 3: Drag partition factors F_{eff} calculated using a) Ronny Meier's z_0 data, b) my z_0 data, and c) the difference between the two.

Using my data and Ronny Meier's data differs by generally less than 0.1 of the drag partition effect. Since my data has slightly higher roughness (Fig. 2), a smaller F_{eff} is resulted, meaning my data dissipates ustar a little more. The difference of ~0.1 or less is consistent across arid and semiarid regions globally.

I generally do not worry too much about the difference. It will change the modeled dust emissions a bit but the change is quite consistent across most arid regions. Therefore, it will be relatively easy to tune with certain global tuning factors in the dust emission scheme. I can tune the dust emissions if we use Ronny Meier's data. But regardless of which data to use, the drag partition scheme will need z_0 data on all grids of continents (grids with landmask != NA in CLM) with LAI+SAI < 1 at any timestep.

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A little info on Prigent et al. (2005) dataset

You can find one year of data (1997) at:

https://share.obspm.fr/s/it2KfkgBp4zjtsz

Password: Can be obtained from Catherine Prigent, Ronny Meier, or Danny Leung.

The file name is roughness.tar. The individual file names inside this tar file are of the form ERS1_mm_1997_MTM_ascii.gz. Here is a short description of the file:

```
ccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c ERS scatterometer and roughness data for YYYY
c (backscattering coefficient at 5.25GHz, interpolated to 45deg incidence angle)
c There is a file per month. Files are in ascii.
c Data are on a 0.25deg equal area grid: all grid pixels
c are reported, but only data over land are relevant for the
c backscattering coefficient (other pixels flagged -99.)
c and only data over arid and semi arid snow free regions
c are valid for the roughness length (other pixels should be flagged -9)
c To read the file in fortran, for January 1997
real lon,lat,sig_ers,roughness,snow
integer cellnum
open(1,file='ERS1_01_1997_MTM_ascii', status='old')
read(1,11) cellnum,lon,lat,sig_ers,roughness,snow
11 format(i6,1x,f7.2,1x,f7.2,1x,f6.2,1x,f6.3,1x,f5.2)
c * cellnum = cellnum in the grid (internal use)
c * lon = longitude between -180 and 180
c * lat = latitude between -90 and 90
c * sig_ers = ERS scatterometer backscattering coefficient in dB
c * missing values or pixels over ocean are set to -99.
c * roughness = aerodynamic roughness length in cm estimated from
c * ERS in arid and semi-arid snow free areas. Roughness lengths
c * are not estimated for the other environnements (filter directly related
c * to the scatterometer data themselves). Missing values
c * are set to -9. There are erroneous values sometimes
c * reported in coastal areas or above inundated surfaces
c * that have not been properly filtered.
c * If estimate of roughness length in other areas are
c * required, one could try using:
c * roughness=exp(0.30*sig_ers+1.65)
c * which is the expression used for arid and semi arid areas.
c * snow = snow cover (in time percentage) for the pixel as given
c * by the NSIDC flag. Indicative only.
```