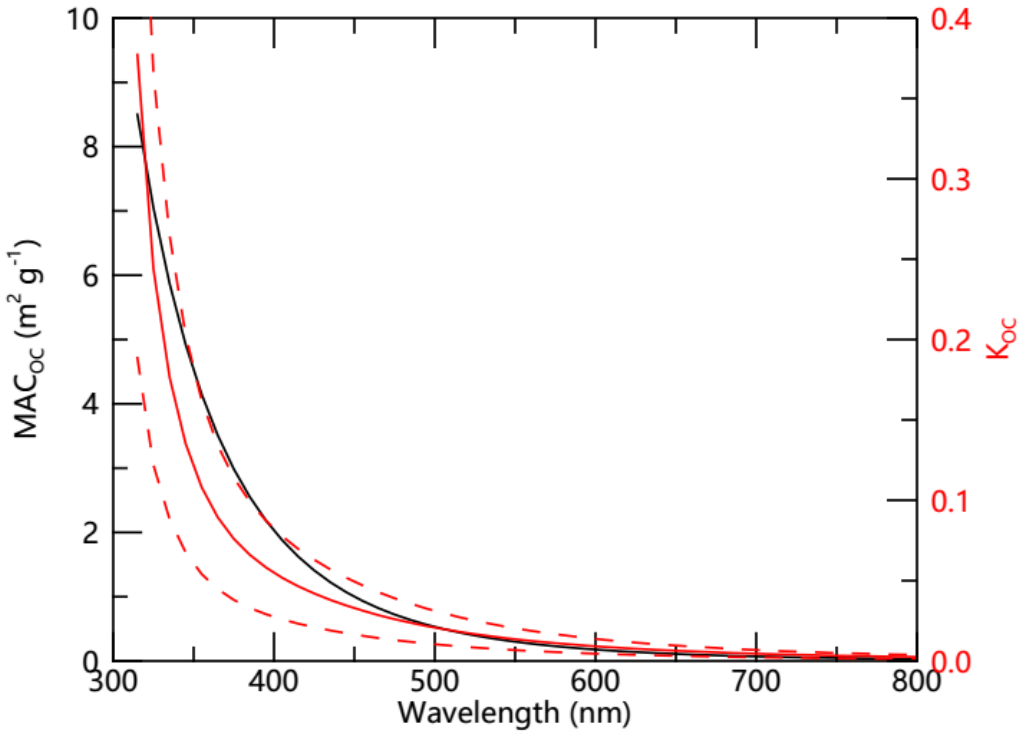

Figure S1. Mie theory calculated mass absorption coefficient (MAC) (solid black line) and imaginary refractive index (RI) (solid red line) of OC, assuming an MAC of 0.3 m^2 g^{-1} at 550 nm, a real RI of 1.55, an absorption angstrom exponent (AAE) of −6, and a particle diameter of 200 nm for OC. The dashed red lines represent a 50% increase and a 50% decrease in imaginary RI.

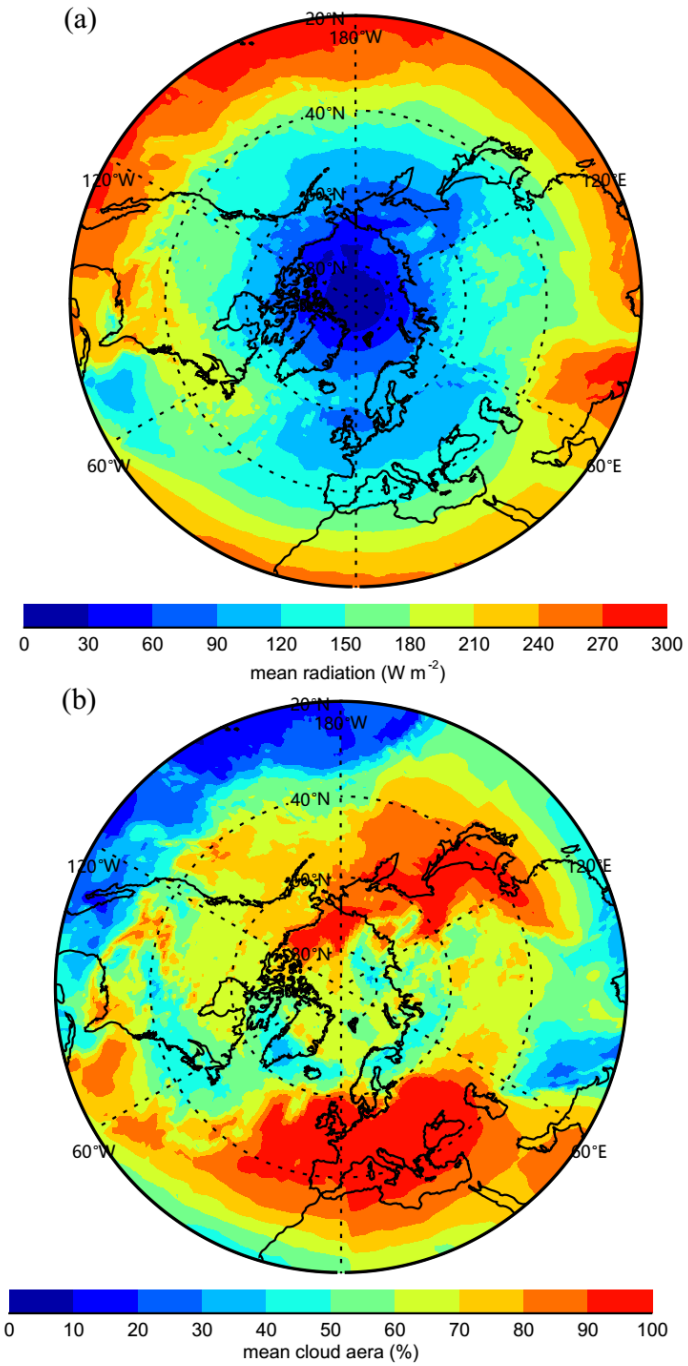

Figure S2. The 2003–2018 spatial distributions of (a) average solar flux, and (b) cloud fraction, both of which are obtained from the Clouds and the Earth's Radiant Energy System (CERES) (https://ceres.larc.nasa.gov/products.php?product=SYN1deg).

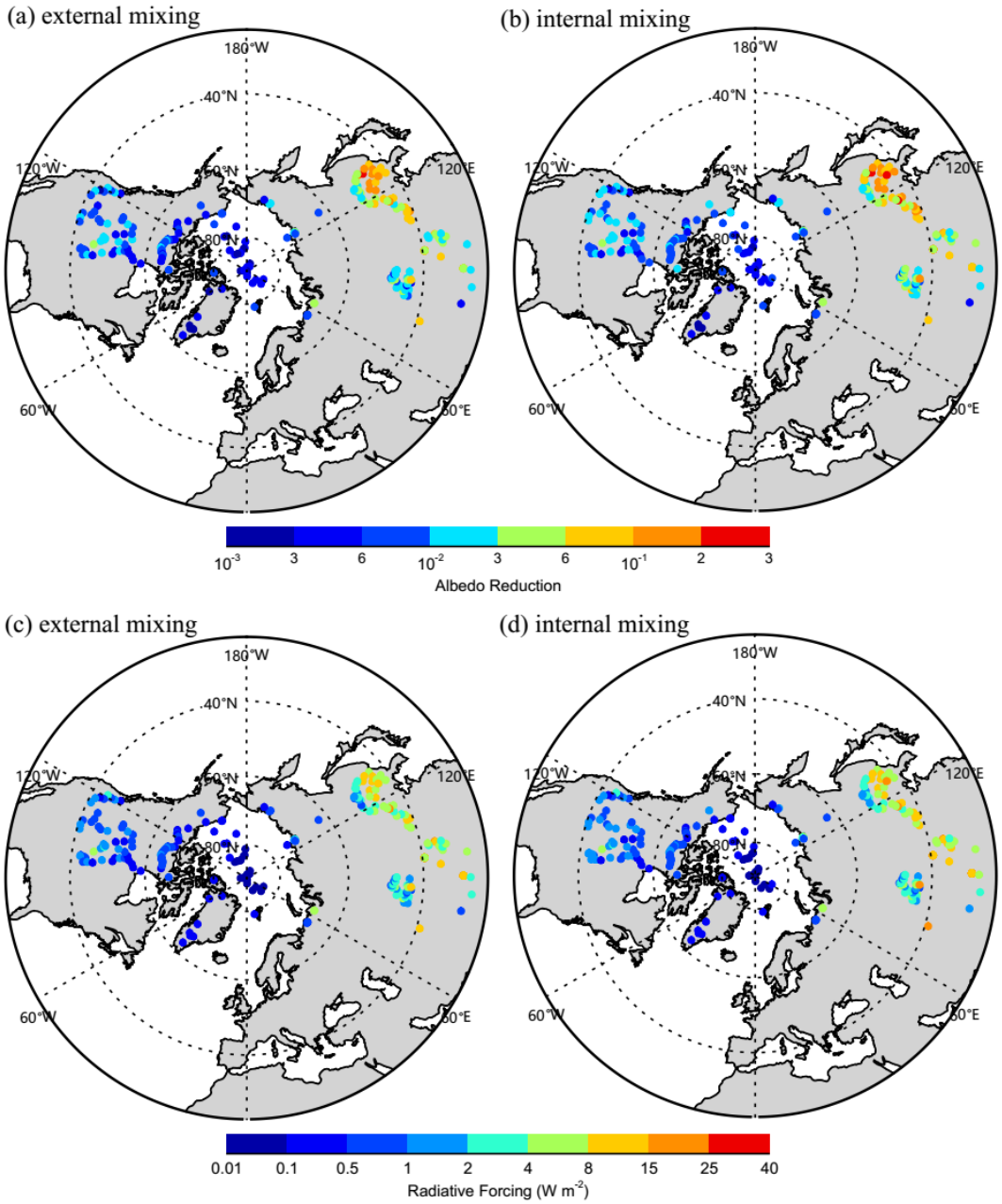

Figure S3. The spatial distributions of calculated snow albedo reductions from (a) an external mixed particle, and (b) an internal mixed particle, based on in situ measurements of fresh snow. (c) and (d) Same as (a) and (b), but for radiative forcing.

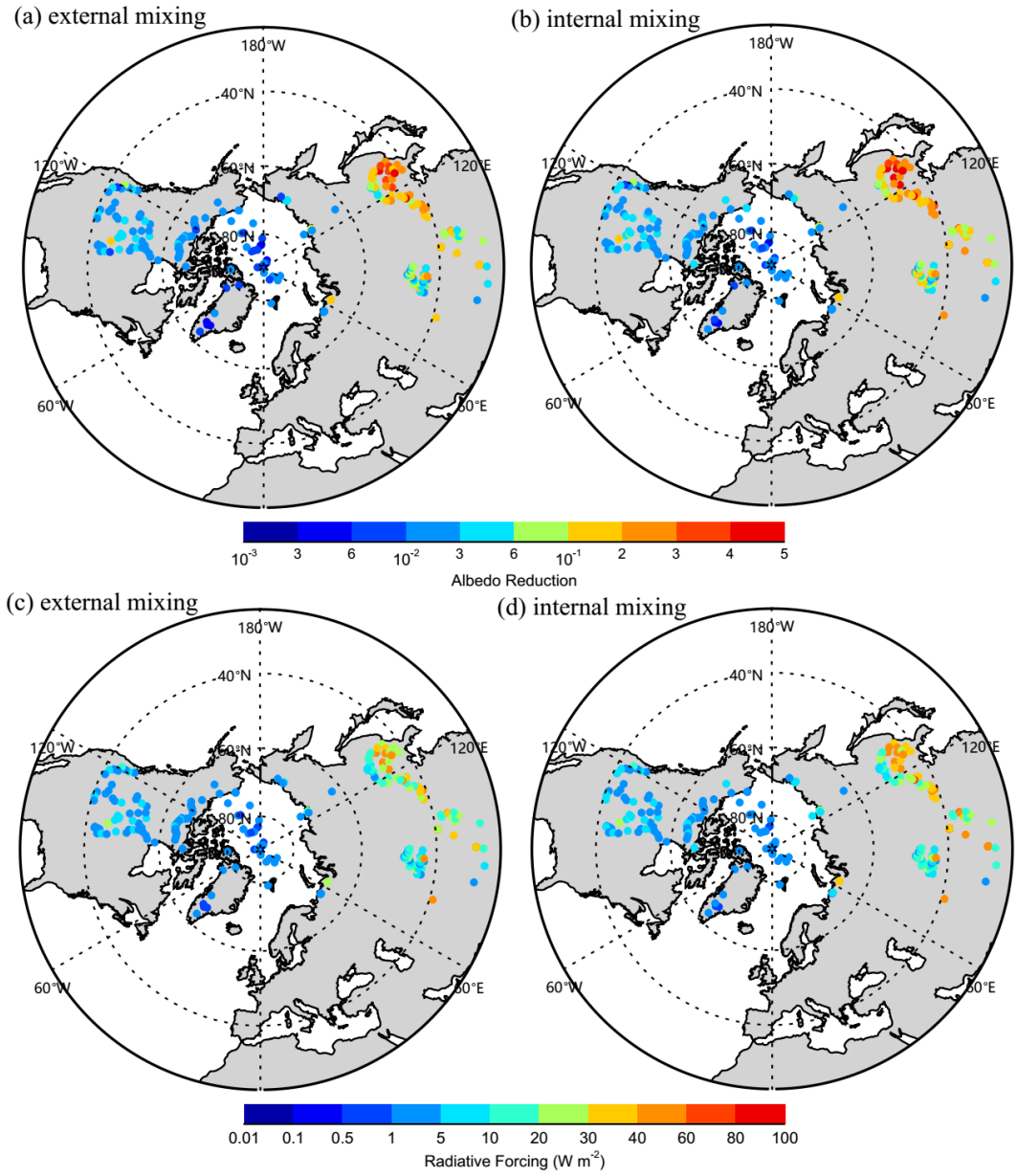

Figure S4. Same as Figure S3, but for old snow.

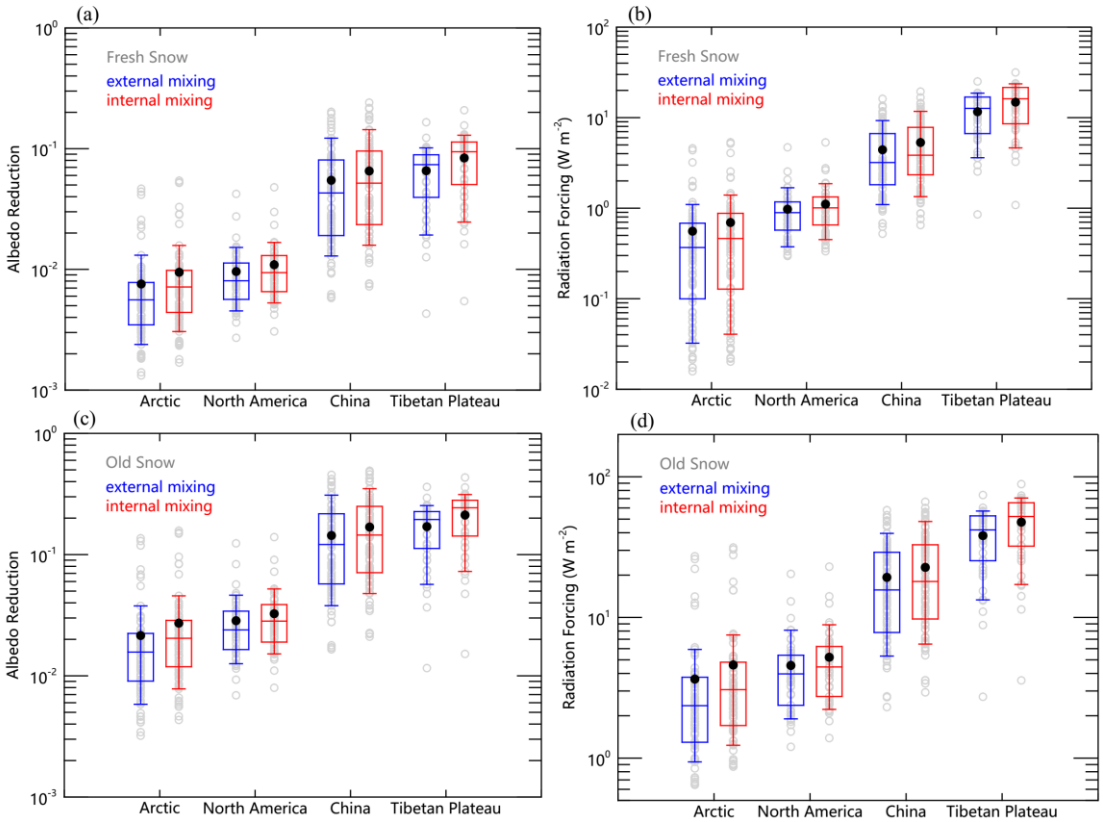

Figure S5. Statistical plots of (a) albedo reduction, and (b) radiative forcing, in different regions for fresh snow. (c) and (d) Same as (a) and (b), but for old snow. The boxes denote the 25th and 75th quantiles, horizontal lines denote the 50th quantiles (medians), solid dots denote averages, and whiskers denote the 10th and 90th quantiles. In situ data is shown as gray circles.

Table S1. Parameterization coefficients for the ratio of broadband snow albedo of an internal mixed particle versus an external mixed particle ($E_{\alpha,\ integrated,\ para}$), for non-absorbing particles.

BC (ng g^{-1})	Core/shell	a_0	b_0	b_1	a_2
0-200	1.1	-1.4999E-04	6.3289E-01	4.4739E-01	9.9952E-01
	1.2	-2.8857E-04	6.2817E-01	4.4969E-01	9.9909E-01
	1.3	-4.1933E-04	6.2416E-01	4.5152E-01	9.9871E-01
	1.4	-5.4464E-04	6.2072E-01	4.5296E-01	9.9836E-01
	1.5	-6.6606E-04	6.1772E-01	4.5407E-01	9.9802E-01
	1.6	-7.8452E-04	6.1507E-01	4.5490E-01	9.9771E-01
	1.7	-9.0040E-04	6.1270E-01	4.5548E-01	9.9740E-01
	1.8	-1.0134E-03	6.1059E-01	4.5584E-01	9.9711E-01
	1.9	-1.1224E-03	6.0875E-01	4.5596E-01	9.9683E-01
	2.0	-1.3234E-03	6.0588E-01	4.5542E-01	9.9633E-01
	2.1	-1.3234E-03	6.0588E-01	4.5542E-01	9.9633E-01
	2.2	-1.4131E-03	6.0486E-01	4.5475E-01	9.9610E-01
	2.3	-1.4953E-03	6.0404E-01	4.5386E-01	9.9589E-01
	2.4	-1.5704E-03	6.0334E-01	4.5278E-01	9.9570E-01
	2.5	-1.6389E-03	6.0269E-01	4.5155E-01	9.9553E-01
	2.6	-1.7016E-03	6.0204E-01	4.5019E-01	9.9538E-01
	2.7	-1.7590E-03	6.0135E-01	4.4873E-01	9.9524E-01
	2.8	-1.8117E-03	6.0059E-01	4.4718E-01	9.9512E-01
	2.9	-1.8607E-03	5.9973E-01	4.4558E-01	9.9502E-01
	3.0	-1.9072E-03	5.9872E-01	4.4397E-01	9.9493E-01
200-1000	1.1	-3.6229E-05	7.7791E-01	3.6928E-01	9.9674E-01
	1.2	-7.0295E-05	7.7151E-01	3.7105E-01	9.9390E-01
	1.3	-1.0333E-04	7.6540E-01	3.7252E-01	9.9133E-01
	1.4	-1.3537E-04	7.6020E-01	3.7370E-01	9.8895E-01
	1.5	-1.6701E-04	7.5540E-01	3.7464E-01	9.8670E-01
	1.6	-1.9838E-04	7.5095E-01	3.7535E-01	9.8455E-01
	1.7	-2.2976E-04	7.4668E-01	3.7587E-01	9.8249E-01
	1.8	-2.6099E-04	7.4261E-01	3.7619E-01	9.8050E-01
	1.9	-2.9188E-04	7.3871E-01	3.7631E-01	9.7860E-01
	2.0	-3.5250E-04	7.3097E-01	3.7592E-01	9.7512E-01
	2.1	-3.5250E-04	7.3097E-01	3.7592E-01	9.7512E-01
	2.2	-3.8097E-04	7.2738E-01	3.7543E-01	9.7355E-01
	2.3	-4.0841E-04	7.2379E-01	3.7475E-01	9.7210E-01
	2.4	-4.3490E-04	7.2013E-01	3.7391E-01	9.7077E-01
	2.5	-4.6065E-04	7.1630E-01	3.7293E-01	9.6955E-01
	2.6	-4.8583E-04	7.1226E-01	3.7182E-01	9.6844E-01
	2.7	-5.1060E-04	7.0796E-01	3.7058E-01	9.6743E-01
	2.8	-5.3439E-04	7.0355E-01	3.6925E-01	9.6651E-01
	2.9	-5.5837E-04	6.9880E-01	3.6782E-01	9.6568E-01
	3.0	-5.8229E-04	6.9383E-01	3.6633E-01	9.6492E-01

Table S2. Same as Table S1, but for absorbing particles.

BC (ng g^{-1})	Core/shell	a_0	b_0	b_1	a_2
0-200	1.1	-1.2238E-04	6.4835E-01	4.3599E-01	9.9957E-01
	1.2	-2.2834E-04	6.4582E-01	4.3668E-01	9.9921E-01
	1.3	-3.2187E-04	6.4400E-01	4.3696E-01	9.9890E-01
	1.4	-4.0591E-04	6.4269E-01	4.3691E-01	9.9862E-01
	1.5	-4.8262E-04	6.4173E-01	4.3663E-01	9.9837E-01
	1.6	-5.5361E-04	6.4101E-01	4.3619E-01	9.9814E-01
	1.7	-6.2006E-04	6.4042E-01	4.3565E-01	9.9793E-01
	1.8	-6.8275E-04	6.3992E-01	4.3504E-01	9.9772E-01
	1.9	-7.4215E-04	6.3946E-01	4.3439E-01	9.9753E-01
	2.0	-8.5156E-04	6.3865E-01	4.3294E-01	9.9718E-01
	2.1	-8.5156E-04	6.3865E-01	4.3294E-01	9.9718E-01
	2.2	-9.0137E-04	6.3832E-01	4.3213E-01	9.9702E-01
	2.3	-9.4761E-04	6.3804E-01	4.3122E-01	9.9687E-01
	2.4	-9.8999E-04	6.3784E-01	4.3019E-01	9.9674E-01
	2.5	-1.0282E-03	6.3772E-01	4.2902E-01	9.9661E-01
	2.6	-1.0619E-03	6.3770E-01	4.2769E-01	9.9650E-01
	2.7	-1.0912E-03	6.3779E-01	4.2619E-01	9.9641E-01
	2.8	-1.1161E-03	6.3796E-01	4.2453E-01	9.9633E-01
	2.9	-1.1374E-03	6.3818E-01	4.2274E-01	9.9626E-01
	3.0	-1.1561E-03	6.3836E-01	4.2087E-01	9.9620E-01
200-1000	1.1	-3.0421E-05	7.8815E-01	3.6300E-01	9.9711E-01
	1.2	-5.6630E-05	7.8522E-01	3.6372E-01	9.9467E-01
	1.3	-8.0749E-05	7.8117E-01	3.6428E-01	9.9256E-01
	1.4	-1.0290E-04	7.7776E-01	3.6460E-01	9.9068E-01
	1.5	-1.2363E-04	7.7470E-01	3.6471E-01	9.8897E-01
	1.6	-1.4371E-04	7.7149E-01	3.6463E-01	9.8740E-01
	1.7	-1.6265E-04	7.6880E-01	3.6442E-01	9.8593E-01
	1.8	-1.8054E-04	7.6650E-01	3.6408E-01	9.8453E-01
	1.9	-1.9828E-04	7.6396E-01	3.6363E-01	9.8322E-01
	2.0	-2.3248E-04	7.5879E-01	3.6238E-01	9.8080E-01
	2.1	-2.3248E-04	7.5879E-01	3.6238E-01	9.8080E-01
	2.2	-2.4901E-04	7.5609E-01	3.6159E-01	9.7969E-01
	2.3	-2.6518E-04	7.5324E-01	3.6066E-01	9.7866E-01
	2.4	-2.8098E-04	7.5021E-01	3.5960E-01	9.7771E-01
	2.5	-2.9728E-04	7.4659E-01	3.5837E-01	9.7685E-01
	2.6	-3.1250E-04	7.4307E-01	3.5700E-01	9.7606E-01
	2.7	-3.2742E-04	7.3928E-01	3.5546E-01	9.7536E-01
	2.8	-3.4211E-04	7.3520E-01	3.5376E-01	9.7473E-01
	2.9	-3.5605E-04	7.3105E-01	3.5193E-01	9.7417E-01
	3.0	-3.7076E-04	7.2632E-01	3.4998E-01	9.7367E-01