Daniel Rosenfeld: **Uncertainties in aerosol cloud-mediated radiative forcing: two large and highly uncertain opposite effects from shallow and deep clouds**

Cloud albedo (Twomey) effect has been recognized until now as the main mechanism for aerosol cloud mediated radiative forcing. However, changing the cloud drop size in clouds has profound impacts on their precipitation forming processes. The dynamic response of clouds to changes in precipitation in them can lead to modifications of the cloud cover and cloud depth that often incur much greater radiative forcing than the albedo effect alone. In marine stratocumulus that occur in atmospheric stable conditions, aerosols have been recently recognized as responsible in to the transition between open and closed cell regimes. A change from the regime of partial cloud cover of open cells to the fully cloudy regime of closed cells incurs a negative radiative forcing that can exceed 100 w m-2. When considering this effect alone, the climate system should have been cooling due to anthropogenic aerosols.

The recent reports that the net aerosol cloud-mediated radiative forcing is rather small implies that there should be a similarly large positive radiative forcing that balances this cooling effect. This warming is likely to be caused by the response of mainly deep tropical convective clouds to aerosols delaying precipitation forming processes and hence invigorating the clouds, causing their tops to be colder and to form larger anvils, which eventually decay to greater areas of semi-transparent ice clouds. The added CCN and ice nuclei produce smaller ice crystals in the anvils and this also causes them to expand and live longer and detrain greater amount of vapor to the upper troposphere and lower stratosphere. Substantial positive radiative forcing can be incurred by the added cirrus and upper tropospheric vapor.

The net radiative forcing is the balance of at least two very large and opposite terms due to the opposite effects of aerosols on radiative forcing from shallow and deep clouds, which are poorly quantified. Therefore the net effect is highly uncertain, even with respect to its sign.

Even if the net effect is very small on a global average, the cooling occurs mainly over the subtropical highs and migratory anticyclones over ocean, whereas the warming occurs mainly at the areas of deep tropical convection. The spatial separation can propel atmospheric circulation systems that would modify the weather patterns.

Furthermore, the magnitudes of these effects on shallow and deep clouds will not necessarily change the same way in future climates. In order to understand the climate system and being able to predict more accurately future climates it is essential to recognize these effects and incorporate them in the climate models.

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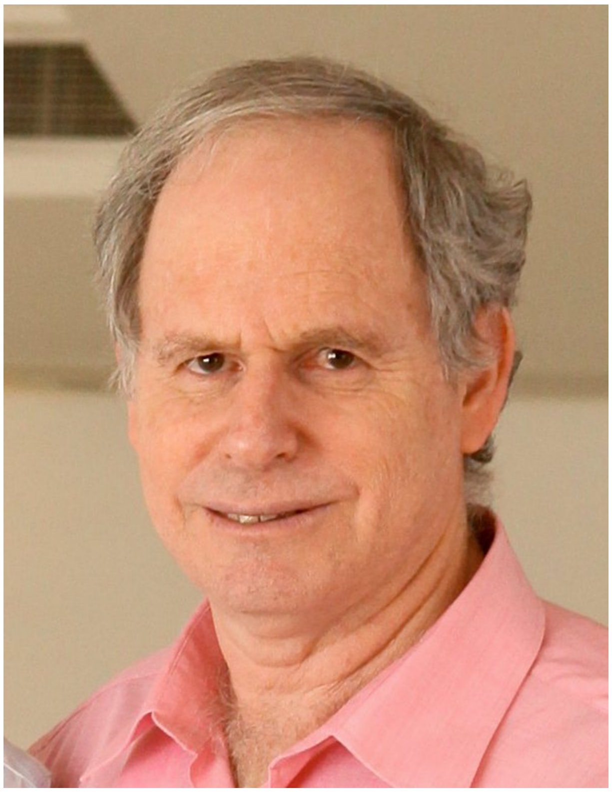
Dr Daniel Rosenfeld earned a PhD at the Hebrew University of Jerusalem in 1986. His interest in the impacts of cloud-aerosol interactions on precipitation arose from his involvement, as a graduate student, in Israel's need to obtain additional water from unconventional sources, which included cloud seeding. Currently he is chair of the Committee on Planned and Inadvertent Weather Modification of the American Meteorological Society. He regards cloud seeding mainly as a means to engage in cloud physics research.



Dr Rosenfeld has received numerous international awards in recognition of his scientific contributions, including the Verner Suomi Medal of the American Meteorological Society, the Schaefer Award of the Weather Modification Association, and the Friendship Award of the People's Republic of China. Dr Rosenfeld has authored more than 130 peer-reviewed scientific articles, which are widely quoted (H-Factor of 34).