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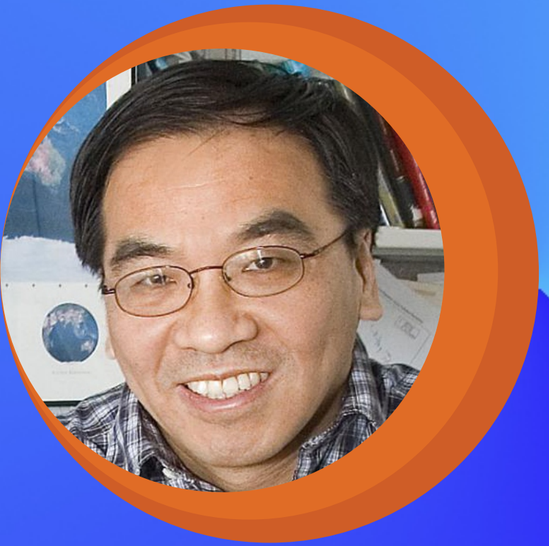
#AzadiKaAmritMahotsav

Lecture Series on

Cloud and Precipitation Physics and Dynamics

MINISTRY OF EARTH SCIENCES

Using knowledge on cloud microphysics and cloud-radiation interactions to improve solar irradiance forecast



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Abstract:

Solar energy has become an increasingly important source of renewable energy, calling for accurate forecast of solar irradiances over multiple time horizons (e.g., from minutes to days). The highly variable nature of clouds and their interactions with radiation poses daunting challenges to solar forecast that is based either on observations or numerical weather prediction (NWP) models. This talk covers two parts. The first part focuses on observation-based models, which are often limited largely to forecasting global horizontal irradiance (GHI) or direct normal irradiance (DNI) over relatively short time horizons (e.g., <1 hour), and lack clear physics and clarity of interpretability. I will show how to address these shortcomings by incorporating physics underlying cloud-radiation interactions into observation-based models to improve forecast accuracy, extend forecast time horizons, and develop clear interpretation of the forecast improvements. I will present a theoretical framework that links GHI and DNI with cloud properties, a hierarchy of four physics-informed persistence models based on the theoretical framework that can be used to simultaneously forecast GHI, DNI and diffuse horizontal irradiance (DHI), and machine learning models that gradually introduce model predictors based on the theoretical framework. The results demonstrate the value and feasibility of incorporating physics into observation-based models, and recommend the combined use of GHI and DNI, which significantly improves the forecast accuracy compared to using individual irradiances alone because the pair contains more information on cloud-radiation interactions. Long-term measurements collected at the U.S. Department of Energy Atmospheric Radiation Measurement (ARM)'s Southern Great Plains (SGP) site are used to train and evaluate the models. The second part is introducing our research on improving the physics-based Weather Research and Forecast specifically tailored for solar forecasting (WRF-Solar). In particular, I will discuss parameterizations of turbulent entrainment-mixing processes and DNI, their implementations into WRF-Solar, and influences on solar forecast.

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