Advances in Climate Prediction and Climate Model Validation from Space Observations

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Application of the mathematical laws of physics to the prediction of weather, climate and climate change is considered to be one of the major scientific advances of the twentieth century. Space observations have played an important role in advancing each of these areas: improving the initial condition for weather prediction; measuring the boundary conditions at the Earth surface for climate prediction; and validating the climate models for climate change projections.

Advances in dynamical data assimilation and other data-synthesis techniques have lead to improvements in the description of the four dimensional structure of the weather and climate system, and thus to dramatic improvements in weather prediction, so crucially dependent on the accuracy of the initial atmosphere conditions. When it was recognized, nearly 30 years ago, that predictions beyond the deterministic limit of weather forecasting crucially depend upon the global boundary conditions at the Earth's surface, progress in advancing the science of climate prediction became largely dependent on the improvements in space observations of global boundary conditions.

The lecture will show how global observations of the boundary conditions, and sensitivity experiments with climate models, established the scientific basis for dynamical climate prediction beyond day-to-day weather. These sensitivity experiments investigated the effects of changes in the boundary conditions of sea surface temperature, soil moisture, and snow and sea ice. With further advances in our ability to predict the boundary conditions themselves, and further advances in assimilating space observations of the global boundary conditions, operational dynamical seasonal prediction has become a reality.

The lecture will also show the critical importance of space observations in validating climate models. The radiation budget at the top of the atmosphere, and water and energy budget at the Earth surface and in the lower troposphere, are utilized to validate climate models used for century scale projections of climate.