continental scale. These profiles are most accurately obtainable on scales sampled by Doppler radars and research aircraft. The distribution of cloud properties in the grid volume, including the radiative flux profile and microphysical properties associated with the clouds, is also a GCSS requirement, a need which can perhaps best be met by coordinating with the ARM and GVaP measurement programs. Finally, GCSS requires information on the distribution of internal cloud properties (e.g., updrafts and downdrafts, mass fluxes, and microphysics), for which very detailed measurements will be needed. Thus, for the planned GCSS study of the MCS type of cloud system, it is essential that a multiscale experiment be performed. The plan is to have the GCSS working groups finalize the Implementation Plan, which is in draft form, by early 1994. A summary of the GCSS strategy is published in the Science Team Report (Betts et al. 1993).

2.4 GEWEX Water Vapor Project (GVaP)

David Starr

The goal of the GEWEX Water Vapor Project (GVaP) is to improve the understanding of water vapor in meteorological, hydrological, and climatological processes through improving knowledge of water vapor and its variability on all scales. This goal clearly requires a multiscale observing strategy. A pilot project was deemed the most appropriate first step toward achieving this goal. An implementation plan has been developed for this pilot phase, which has four research components:

- The assessment of current capabilities to determine the global distribution of water vapor content using various spaceborne remote sensing instruments and algorithms through a rigorous comparison focused on the period July 1987-June 1989.
- Operation of a state-of-the-art, research quality, multisensor Water Vapor Reference Station at the ARM/CART site near Lamont, Oklahoma for a continuous period of 3 months in late spring of 1995 (which coordinates perfectly with the CME plans).
- Performance of a systematic, intensive intercomparison of as many of the available in situ and remote sensing water vapor sensors as possible during a 4-week episode within the 3 month operation period of the Water Vapor Reference Station.
- Initiation of research and development to define and fully characterize an optimum water vapor sensor and data processing system for use with operational radiosondes and to work toward international standardization with the World Meteorological Organization.

The GVaP Strategic Research Plan and the Pilot Phase Implementation Plan have both been published (Starr and Melfi 1991, 1992). The plans for the Water Vapor Reference Station instrumentation consist of adding a Raman lidar and three-hourly radiosonde

observations to the suite of ARM systems described below during the three-month deployment at Lamont, Oklahoma, and to operate these systems in a semi-continuous fashion (3-5 days on, 2-3 days off). The systematic instrument intercomparison project would involve balloon-borne instruments (e.g., carbon hygristor, humicap, and other sensors), surface and/or aircraft remote sensing systems (Raman lidar, microwave radiometer, FT interferometer, DIAL, and infrared spectrometer), and in situ aircraft observations (Lyman-α absorption hygrometer, chilled mirror dew point hygrometer, cryogenic collection, etc.).

GVaP requires high temporal resolution water vapor and wind profile measurements to obtain information concerning the spatial mean and sub-grid scale variability within satellite footprints and global climate model grid boxes (roughly 100 km on a side). Furthermore, the Water Vapor Reference Station would be partly concerned with understanding the causes and effects of this variability, particularly in relation to cloud processes. There is obviously considerable benefit to be gained by having GVaP coordinate its observing systems at this site with the ARM, GCSS, USWRP, and GCIP programs, particularly during the intensive intercomparison episode.

2.5 Atmospheric Radiation Measurement (ARM)/CART site

Bill Pennell

The Department of Energy's Atmospheric Radiation Measurement (ARM) goals are: (1) to provide an experimental test bed for improving the treatment of radiative transfer in global climate models (GCMs) under all kinds of cloud cover, and (2) to improve the parameterization and modeling of cloud formation, maintenance, dissipation, and related processes in GCMs. The following scientific requirements are most critical to the ARM objectives:

- Quantitatively describe the spectral radiative energy balance profile under a wide range of meteorological conditions.
- Identify the processes controlling the radiation balance by direct and comprehensive comparison of field observations with detailed calculations of radiative fluxes and associated cloud and aerosol contributions.
- Develop a knowledge base necessary to improve parameterizations of radiative properties of the atmosphere for use in GCMs. This requires intensive measurements on a variety of temporal and physical scales such as in the proposed multiscale experiment. A major thrust is placed on the role of clouds, including their distribution and microphysical properties.