procedures, and data archiving. A project management committee, to consist of one or more representatives from each of the cooperative programs and agencies, will be formed to provide direct interfaces with the cooperative programs and national and international agencies. A field project support office will provide logistical suport in carrying out the various recommendations provided by the working committees, including processing of documents, interfacing with program and agency representatives, organizing meetings, providing data management, and guidance and participation in field program implementation. Finally, a science team will consist essentially of all participating scientists in the cooperative field program.

3. Colloquium presentations

N94-24382

3.1 Grand challenge scientific questions in coupled modeling

Steven Koch

The "kickoff presentation" by the colloquium organizer was designed to set the background for the colloquium. Differences between past convective field experiments and the present opportunity for a truly multiscale field experiment were highlighted. This opportunity has arisen in part from the modernization of the nation's weather observing capabilities and also from the recent or planned establishment of special observing systems over the central U.S. by several new programs (ARM, GVaP, etc.). Most convective field experiments in the past (e.g., SESAME, CCOPE, CINDE) have attempted to resolve only the immediate scales of moist convection using network arrays that spanned two or three atmospheric scales at most. Furthermore, these scales have been defined more on practical considerations (cost, manpower, etc.) than on a clear understanding of their theoretical significance. Unfortunately, this has precluded a description of the entire life cycle of MCSs and their interaction with larger scale systems, the land surface, and trace species. Fortunately, the following factors now make it possible to attempt to simulate scale contraction processes from the synoptic scale down to the cloud scale, as well as interactions between complex meteorological, land surface, precipitation, chemical, and hydrologic processes with coupled, multiscale models:

- The availability of new technology to sample meteorological fields at high temporal and spatial resolution over a *broad* region made possible by the weather observing modernization program
- Increased computer power and improved numerical approaches to run limited area models with nonhydrostatic precipitation physics so as to explicitly resolve MCS processes
- Four dimensional assimilation of non-conventional data to provide dynamically consistent datasets for diagnostic analysis of nonlinear scale-interactive dynamics

Several examples of scale-interactive processes which present grand challenges for coupled, multiscale modeling were presented. For example, the comparative roles of dry dynamical processes relative to diabatic processes in causing the transition from strong symmetric stability to vanishing symmetric stability needs to be understood in order to assess the possible role of this process in organizing deep convection into bands, particularly in the presence of frontogenetical forcing. Another mesoscale instability process important to the MCS scale-interaction issue is associated with mesoscale gravity-inertia waves. A particularly well-documented example from CCOPE (the Cooperative Convective Precipitation Experiement) indicated that ageostrophic circulations associated with an unbalanced jet streak excited gravity waves that were instrumental in forcing the development of a strong summertime MCC in the Dakotas, and that the MCC subsequently appeared to produce local feedback effects upon the wave structure and energetics (Koch et al. 1988; Koch and Dorian 1988). However, the single-array sampling concept in CCOPE prohibited detailed study of the larger-scale behavior of the waves, their precise interaction with convection beyond the network, and the possible effects of the convection on the larger-scale flow. Another example of strongly scale-interactive processes includes cold fronts whose leading edge sometimes appears as a density current or internal bore capable of initiating frontal squall lines. These structures originate in some instances from cross-frontal radiative inhomogeneities caused by the cloud distribution across the front (Koch 1984; Dorian et al. 1988), in other cases from microphysical effects related to melting and evaporation (Parsons et al. 1987), and in still others to the interaction of mountains with tropopause folds (Koch and Kocin 1991). Clearly, a carefully designed multiscale experiment is required to fully understand and be able to correctly model these processes. Equally important and complex issues concern the interactions between boundary layer, surface, and topographic effects. Included in this list are interactions between sub-grid scale heterogeneity of land surface/vegetation and sub-resolvable fields of cumulus clouds, and the importance of interactions between boundary layer circulations and internal gravity waves in the overlying statically stable layer in organizing convective cloud systems. Finally, the possible influence of MCS momentum and heat transports and sources/sinks on larger scales of motion is poorly understood in terms of the following questions: (a) Are the feedback effects transitory or long-lasting and how deep of a layer is affected with what kind of dynamic balance? (b) How do these influences depend upon the character of the convective system, its life cycle, its interaction with the wind shear, etc.?

This keynote talk concluded with examples of important issues in each of the topic areas addressed in this colloquium: data assimilation, the measurement and modeling of moist processes, the parameterization of sub-grid scale convection, coupled land surface/hydrology/mesoscale models, coupled chemistry/atmospheric models, boundary layer and radiative transfer processes, the validation of coupled multiscale models, and techniques and resources for storm-scale numerical weather prediction. Since many of these ideas appear as recommendations from the workshop (see section 4), they are not recorded here.

N94-24383

3.2 Next generation initialization techniques

Tom Warner: Overview of the Mesoscale Data-Assimilation Problem

John Derber:	*An overview of variational data assimilation techniques, and practical approximations for operational implementation*
Milija Zupanski:	*Current status and plans for regional four-dimensional variational data assimilation research at NMC*
Steve Cohn:	*Some fundamental problems in data assimilation*
Hans Verlinde:	*Overview of the state of the art for initialization of cloud models*

Four-dimensional data assimilation strategies can generally be classified as either current or next generation, depending upon whether they are used operationally or not. *Current-generation* data-assimilation techniques are those that are presently used routinely in operational-forecasting or research applications. They can be classified into the following categories: intermittent assimilation, Newtonian relaxation, and physical initialization. It should be noted that these techniques are the subject of continued research, and their improvement will parallel the development of next generation techniques described by the other speakers in this session. *Next generation* assimilation techniques are those that are under development but are not yet used operationally. Most of these procedures are derived from control theory or variational methods and primarily represent continuous assimilation approaches, in which the data and model dynamics are "fitted" to each other in an optimal way. Another "next generation" category is the initialization of convective-scale models, a topic which was reviewed by Hans Verlinde.

Intermittent assimilation systems use an objective analysis to combine all observations within a time window that is centered on the analysis time. The background or first-guess field is obtained from a model forecast that is valid at the analysis time. The model is then integrated forward for a short period of time, and the analysis step is repeated. Through this sequence of analyses and short forecasts, a four-dimensional data set is produced. *Continuous first-generation assimilation systems* are usually based on the Newtonian-relaxation or "nudging" techniques. Here the observations are inserted at each time step