Summary of CRYSTAL-FACE project goals and modeling plans

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Our research focuses on two aspects. First, to obtain measurements and perform data analyses and simulations that can test the hypothesis that cumulonimbus (Cbs) clouds transport large quantities of gases and aerosols that once detrained from their anvils transform into haze/cloud condensation nuclei particles upon which homogeneous freezing can occur or possibly ice nuclei that can promote heterogeneous freezing of cirrus crystals. Thus we anticipate large variations in cirrus crystal concentrations, and, hence, cloud optical properties (albedo) depending on whether the airmass vented by the Cbs is clean or polluted. Second, we wish to measure and model the moisture budget of Cbs, with an emphasis on the efficiency of moistening of anvils and of the lower stratosphere.

Our modeling plans are as follows:

- Perform realtime mesoscale forecasts of cirrus over South Florida.

We plan on providing realtime mesoscale numerical weather prediction support to CRYSTAL-FACE to aid in decision-making regarding aircraft operations, defining suitable tasks for a given day, and deployment of other field resources and personnel. Grid 1 with 48km grid spacing in the current RAMS forecast model covers most of the 48 contiguous states including south and east of Florida. Grid 2 with 12km grid spacing will be moved to cover all of south Florida where it can support aircraft operations out of Key West as well as in the experimental regions over and south of south Florida. Grid 3 with 2.5-3km grid spacing will have a roughly 200kmX200km that is moveable within grid 2 so that it can accommodate potential movement of the focused experimental area. This grid spacing is sufficient to explicitly resolve, albeit crudely, individual Cbs. In the case of south Florida, the sea-breeze circulation has strong local forcing on convection as shown by Pielke (1974a,b), so that we anticipate that the model will have good skill for convective cells over the peninsula. Cbs forming offshore and upstream of Florida will most likely be harder to predict unless they are forced by local islands such as Andros or the Florida Keys, or are embedded in larger-scale disturbances captured in the large-scale data fields.

- Begin mesoscale and cirrus resolving model (CiRM) simulations of cirrus events observed during FACE.

The planned mesoscale/storm-scale simulations of specific events during CRYSTAL-FACE will be done similar to the forecast model setup except that observed rather than

forecast data will be used for initialization and lateral boundary nudging and grid 3 will have finer grid spacing, perhaps 1km. Using model output data as well as data obtained from NPOL and ELDORA radars, moisture budget analysis will be performed to calculate anvil moistening efficiencies and cross tropopause moisture transport efficiencies. In addition, model output data from those simulations will be used to drive CiRM simulations. The model output data will be shared with the CRYSTAL FACE modeling community for providing large-scale forcing to other cirrus modeling groups.The CiRM will be initialized from the mesoscale model output data at locations where cirrus formation is likely, or observed, and it will have large-scale forcing from the mesoscale model simulated data.

- Begin analysis and model sensitivity experiments to examine possible influence of varying CN/CCN/IFN fluxes into bases of Cb's, air detrained from cirrus anvils and affects on cirrus properties.

During the second year of the project, following the completion of the field campaign, it is planned to select cases for sensitivity studies and begin prototype simulations of clean and relatively polluted cases to examine the possible influence of enhanced SO2/CN/CCN/IFN air ingested into the base of Cbs, detrained from anvils, and participating in the formation of cirrus clouds. The particular combination of mesoscale simulations and CiRM simulations will have to be experimented with to determine the most appropriate model combination to examine the hypothesis that cirrus radiative properties are regulated by the nature of the airmass ingested into Cbs.