Jim Doyle's Comments and Suggestions

Excellent mature program; the presentations were really great. The quality of the science is really impressive and it was great to see the collaborations that have developed.

1. Challenge 1: Integrate multiple components more to address the bigger questions: Observations, LES, COAMPS etc. The observations themselves are quite diverse, can they be analyzed more in totality. Multiple excellent LES efforts

2. Challenge 2: What is the necessary level of complexity to forecast/simulate fog? What are the important physical process parameterizations that need to be treated in a more sophisticated manner (e.g., double moment microphysics etc.).

3. Challenge 3: Multiple processes/mechanisms for fog have been discussed. Is there a way to prioritize these as a function of situation, location etc. Do processes vary for onset and dissipation similar to the persistence of fog in a near steady state? What are the relative importance of external forcing vs. internal processes?

4. Challenge 4: Gaps - The role of longwave radiative forcing and interactions with aerosols/microphysics. Deposition rates. Aerosols, sources, turbulence interactions. Turbulence generation near the surface. Diffusion growth. Also, vertical velocities near the surface can be very important and can we measure these accurately (?).

5. Horizontal cales sandwiched between turbulence/microphysics and meso and synoptic scale beyond the specifics of Sable Island?

A few more notes and general challenges below, a number of which the FATIMA program has successfully addressed.

Understanding and predicting fog involves addressing several complex and interrelated challenges:

1. **Microphysics and Droplet Formation**
    - **Cloud Condensation Nuclei (CCN):** The availability and characteristics of CCN, which vary spatially and temporally, are crucial for fog formation.
    - **Droplet Growth:** Processes such as condensation and coalescence, influenced by local humidity, turbulence, and aerosol properties, determine droplet size and distribution.
2. **Boundary Layer Processes**
    - **Turbulence and Stability:** Fog develops within the planetary boundary layer, where turbulence and atmospheric stability significantly impact its formation and persistence.

- **Vertical Mixing:** Stable boundary layers can suppress vertical mixing, leading to cooling and condensation, while turbulence can either sustain fog by redistributing moisture or dissipate it by introducing drier air.

3. **Radiative Transfer and Energy Balance**
   - **Surface Cooling:** Longwave radiative cooling at the surface is a primary driver for fog formation, especially in radiation fog scenarios.
   - **Solar Radiation:** Daytime solar heating can dissipate fog; however, interactions with aerosols and fog droplets can modulate this effect.
4. **Surface and Land-Atmosphere Interactions**
   - **Surface Fluxes:** Heat and moisture exchanges between the surface and atmosphere influence fog development.
   - **Land Use Changes:** Urbanization and alterations in land use can affect fog formation through mechanisms like the urban heat island effect and pollution.
5. **Synoptic and Mesoscale Forcing**
   - **Weather Systems:** Large-scale atmospheric features such as fronts, cyclones, and pressure systems can create conditions conducive to fog formation.
   - **Local Circulations:** Mesoscale phenomena like sea breezes and topographically induced winds can influence fog by modifying local temperature and humidity profiles.
6. **Numerical Weather Prediction (NWP) Challenges**
   - **Model Resolution:** Accurately predicting fog is challenging due to the complex interplay of myriad processes in its formation and high spatiotemporal variability.
   - **Parameterization Uncertainties:** Simplified representations of cloud microphysics, turbulence, and radiation in models can lead to inaccuracies in fog forecasts.