NASA DC-8 for PECAN

Richard Ferrare[1], Amin Nehrir[1], John Hair[1], Allen Larar[1], Tim Moes[2]

[1]NASA/LaRC, [2]NASA/AFRC

PECAN Planning Meeting

March 2-3, 2015

Instruments

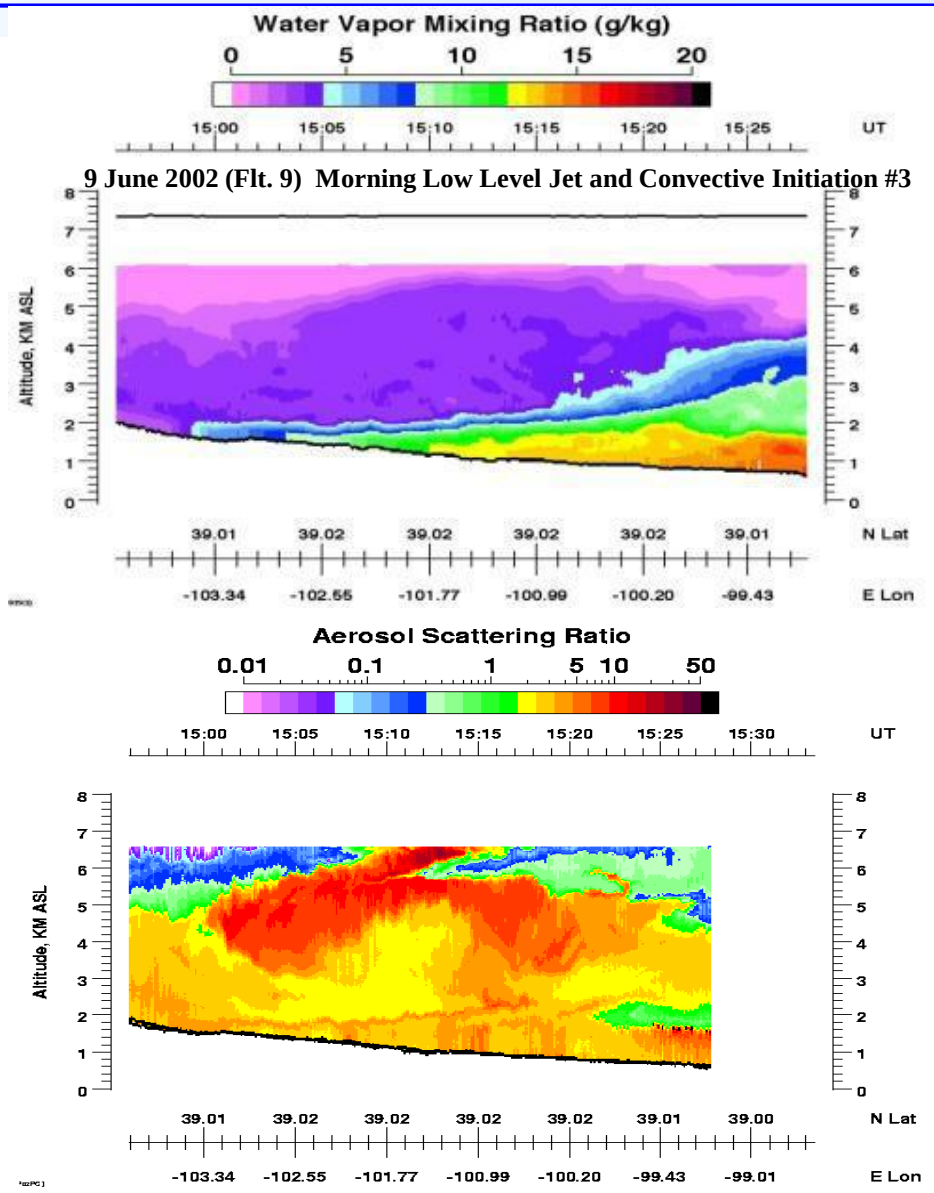
Lidar Atmospheric Sensing Experiment (LASE)

- Airborne Water Vapor DIAL
- Laser
  - 5 Hz doubled-pulsed Ti:sapphire
  - 100 mj at λ_{on} and λ_{off}
- Wavelengths
  - 815 nm (λ_{on}- λ_{off} = 40-70 pm)
  - Two separate line pairs
- NASA DC-8 aircraft
- Simultaneous nadir, zenith operations
- Real-time data analysis and display

LASE Water Vapor, Aerosol, & Cloud Profiling on NASA DC-8

- Water vapor profiles
  - daytime and nighttime
  - surface to upper trop.
  - 0.01 to 25 g/kg
  - accuracy: 6% or 0.01 g/kg
  - resolution (variable)
    - vertical: 330 m
    - horizontal: 14 km (1 min)

- Aerosol/cloud profiles
  - daytime and nighttime
  - 0.03 to 25 km
  - -resolution (variable)
    - vertical: 30 m
    - horizontal: 200 m



NASA / NOAA Airborne Sounder Testbed - Interferometer (NAST-I) Overview

NAST has flown ~ 175 mission sorties accumulating ~ 950 hours of flight data in 19 field experiments
[e.g., CAMEX, C-IOP, WV-IOP, TRACE-P, IHOP, CRYSTAL-FACE, INTEX, EAQUATE, JAIVEx, SNPP]

- ✓Validation tool
- ✓AQUA/SNPP/JPSS risk mitigation
- ✓Airborne science
- ✓Engineering testbed

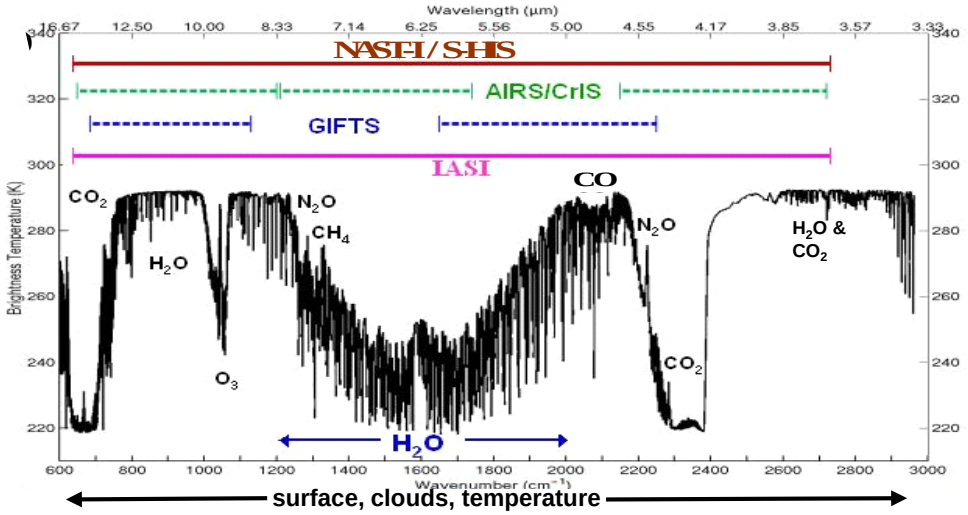
IR Michelson Interferometer

Spectral range: 3.5 - 16 μm (630 – 2700 cm^{-1})
Spectral res.: 0.25 cm-1 ($\nu/\nu\delta$ > 2000)
Spatial res.: 130m/km flight alt. (1.3 km @ 10 km)
A/C platforms: ER-2, Proteus, WB-57, DC-8

Radiometric Measurement Capability

Radiances <0.5 K absolute accuracy, ~ 0.1 K precision

"Upwelling" IR Radiance Spectrum: Earth + Atmosphere



NAST-I Field Campaign Contributions

NAST-I DATA PRODUCT	CAMPAIGN RELEVANCE
Radiance • Infrared spectrum (3.5 – 16 μm) with 0.25 cm^{-1} spectral resolution. • Infrared spectral radiative heating/cooling information during aircraft ascents and descents.	**Science** • Temperature and trace species information helpful to characterize the boundary layer and free troposphere; contributes to weather, climate, air quality and biogeochemistry studies • Information on water vapor, ozone, cirrus clouds, and vertical profiles of infrared spectral radiance in the upper troposphere and lower stratosphere region beneficial for better understanding the radiative forcing of this region on climate system • Information on local meteorology, infrared heat budget, and trace gas evolution
Atmospheric Thermodynamics • 3-d characterization of atmospheric state (temperature & moisture). • Profiles with vertical resolution of ~1-2 km for clear air or above clouds, vertical region dependent; horizontal resolution of < 130 m per km flight altitude	**Validation** • Contributes toward radiance and geophysical product validation, e.g., AIRS, IASI, CrIS • Inter-comparisons by spectral and spatial convolution to common resolution and coverage • High spatial resolution enables the effects of scene variability to be assessed
Atmospheric Composition • Profiles in clear air or above clouds with vertical resolution of 2 – 10 km, depending on altitude and atmospheric constituent • Tropospheric CO and O_3 (PBL and free troposphere) from nominal flight altitude; other trace species (e.g., CO_2, CH_4, N_2O, and SO_2) also possible during platform ascents / descents.	**Future sensor studies** • Direct and derived NAST-I products contribute toward instrument specification and retrieval studies for future sensors, e.g., missions defined within the National Research Council Earth Science Decadal Survey (NRC DS)
Cloud Microphysical & Radiative Properties • Effective top height, temperature, & spatial extent • Effective particle size & optical depth • Spectral emissivity	
Surface Properties • Temperature and spectral emissivity	

Instrument Status/Schedule

- LASE
  - Successfully conducted ground test at LaRC in Jaunary-February
  - Ship to AFRC in May
  - Integration and test flights on DC-8 in June
- NAST-I
  - Integrated on ER-2 in February
  - Conduct NPP flights from Iceland in March
  - Check fit for DC-8 in April
  - Integration and test flights on DC-8 in June

Objectives

PECAN Objectives

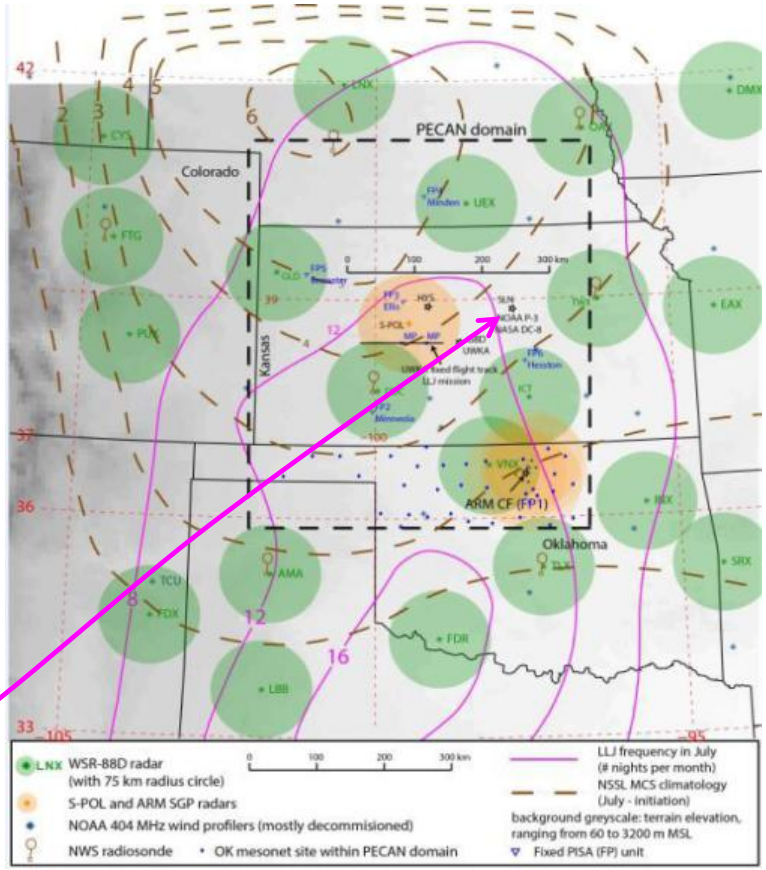
Combined LASE and NAST-I measurements would characterize 3-D fields of water vapor, temperature, RH, aerosol, and cloud distributions

Provide profiles of temperature, water vapor, clouds, and aerosols for:

- Identifying elevated layers of Convective Available Potential Energy (CAPE) associated with nocturnal CI
- Determining how the distribution of water vapor impacts the development and maintenance of nocturnal convection
- Conducting data assimilation experiments for improving predictions of convective initiation
- Providing cal/val data for SNPP and JPSS CrIMSS (CrIS, ATMS) sensors

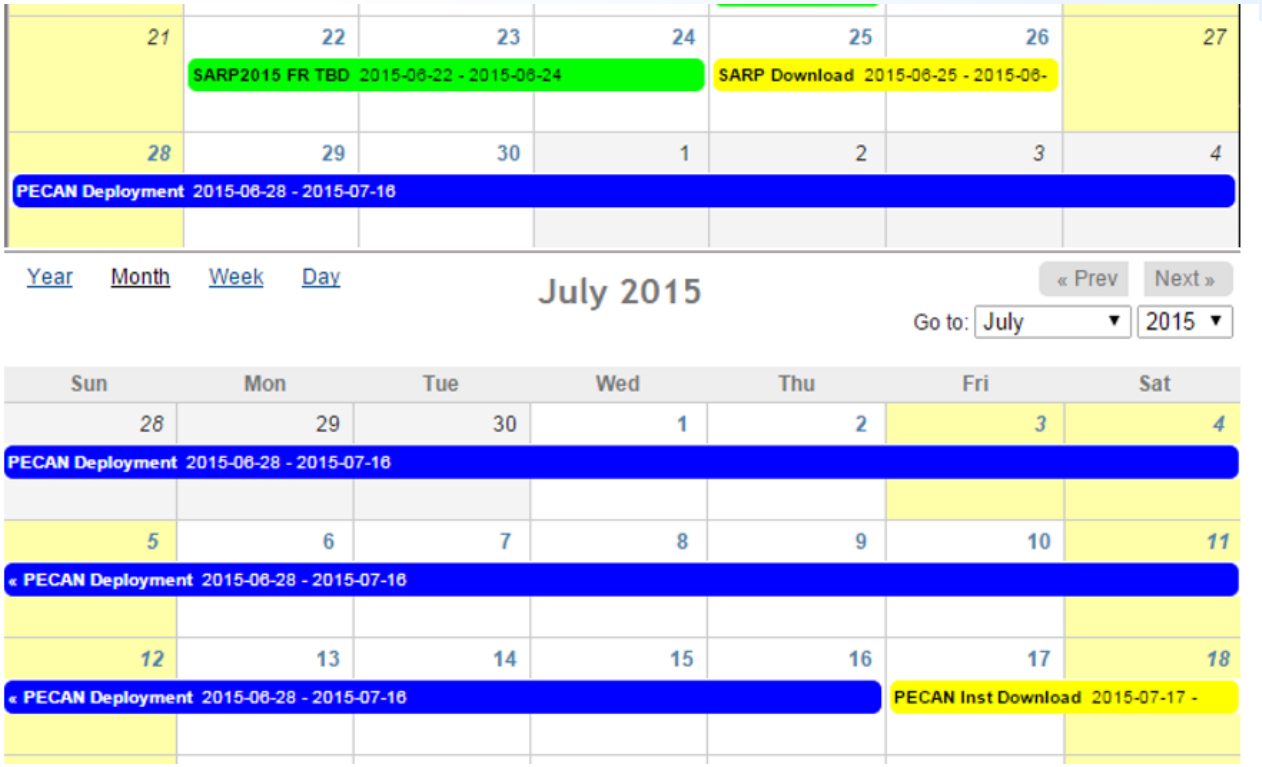
DC-8 Base, Schedule, Timeline, etc.

DC-8



- DC-8 integration and testing at NASA Armstrong Flight Research Facility (Palmdale, CA)
- Aircraft ID (NASA 817)
- Speed ~ 447 knots
- Typical flight duration expected for PECAN = 5-7 hours
- Flight time available for PECAN ~ 45 hours
- PECAN base = Salina, KS
- Mission Scientist = Tim Moes (AFRC)
- DC-8 crew and scientists in first floor of Hangar 600 at Salina Municipal Airport
- One DC-8 scientist (Ferrare or Nehrir) will be at Hays

DC-8 Schedule

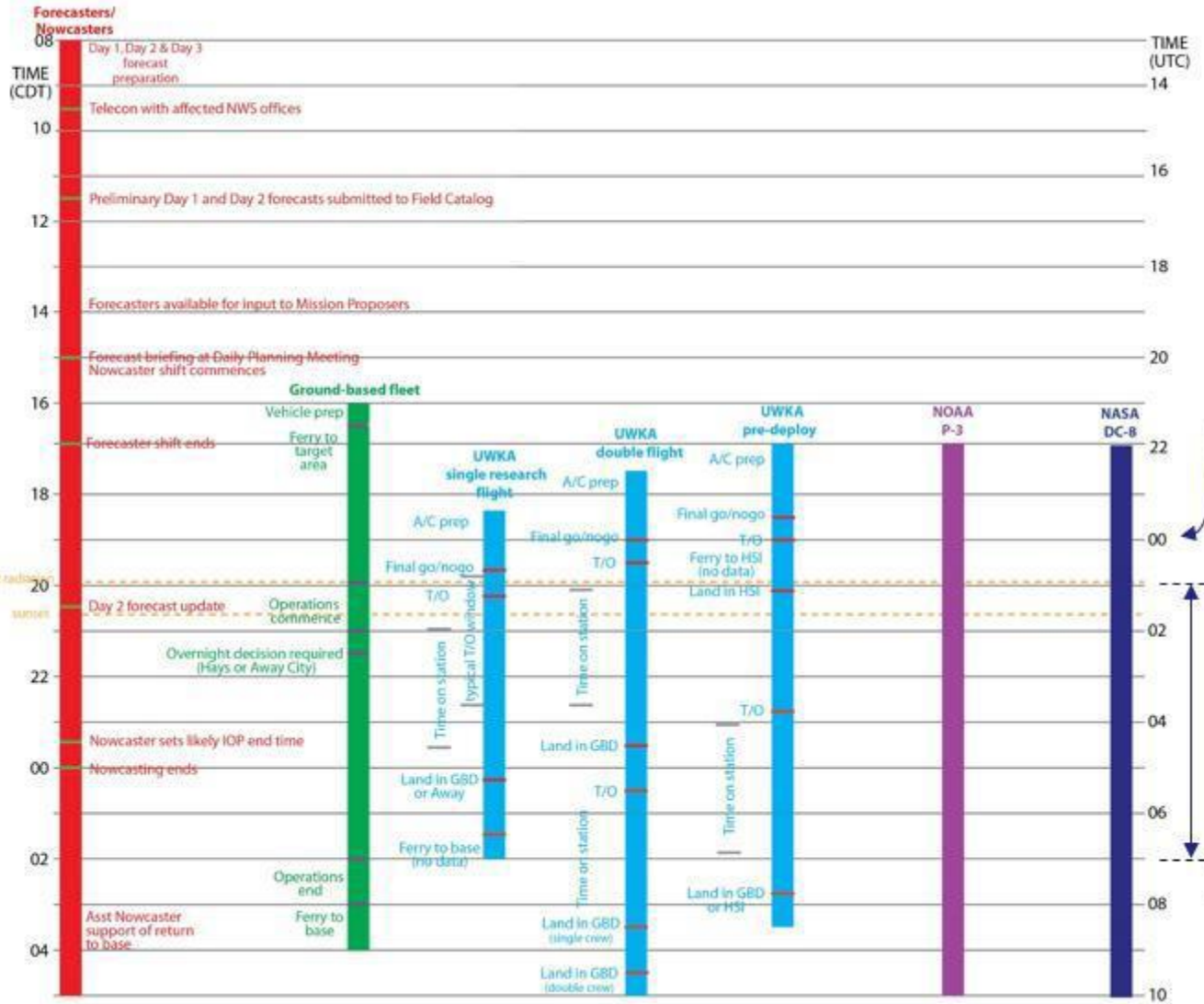


- PECAN instruments to be integrated and tested during NASA Student Airborne Research Program (SARP) ~ June 3-26
- Instrument Integration ~June 3-19
- Instrument flight tests ~ June 22-24
- Transit to Salina ~ Sunday June 28
- PECAN operations ~ June 28-July 15
- Transit back to Palmdale ~ Thursday July 16

<u>Need to schedule a media day at Salina Airport</u>

- DC-8 (and P-3?)
- Late afternoon before flight
- Which day?

Typical Schedule for DC-8 Flight Day



DC-8 Timeline

Final go/no-go

A/C and instrument prep (~3 hour)

T/O (Salina)

Science flight (~6 hour)

Landing (Salina)

Instrument post-flight (~1 hour)

Questions?