Climate System Observations and Analysis

F. Martin Ralph

Summary and Way Forward

Major "Drivers" – PSD

- Water resources issues
  - Anticipating "too little" and "too much"
  - "Water is the next oil"
- Extreme events
  - Do climate models adequately represent extremes?
- Arctic climate change
  - How will ice pack change and why?

Mission

To address these issues **requires state-of-the-art tools**

- To better understand, monitor and predict the underlying physical processes
- To reduce uncertainties in associated climate projections and weather & water forecasts

Core Strategies

- To meet these scientific and technical challenges PSD develops and maintains a suite of modern observation and analysis tools
- Mesoscale and microscale observing networks
- Specialized sensors and sensor combinations for unique applications
- Reanalysis tools
- Diagnostic tools

PSD Water Cycle - Surface Observing Systems

Precipitation gauges

Precipitation disdrometers

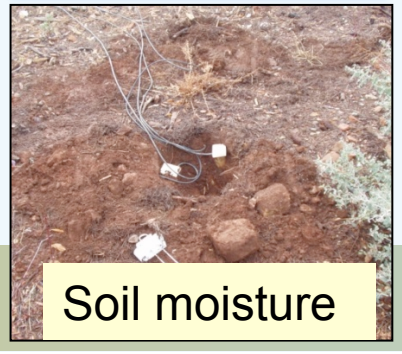
Rain

Snow

Surface-Met

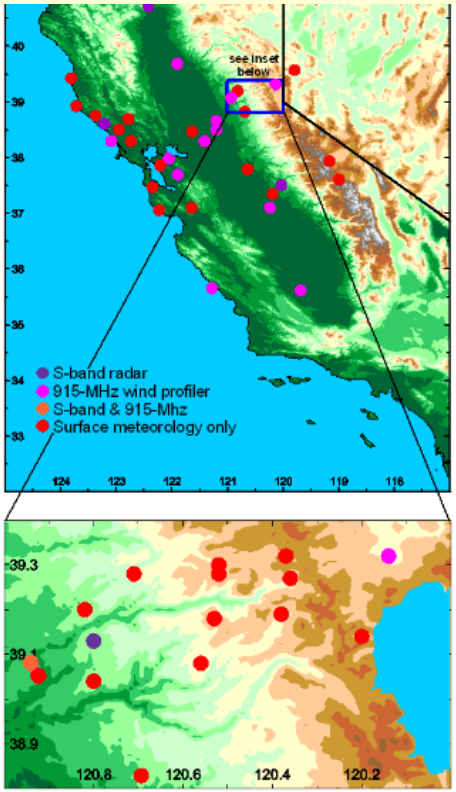
Soil and Stream

Stream level



Soil moisture

Real-time data access



Surface meteorology & snow depth

PSD Remote Sensing Observing Systems*

* Plus Arctic Observatories

915-MHz wind profiler with RASS

Profiling

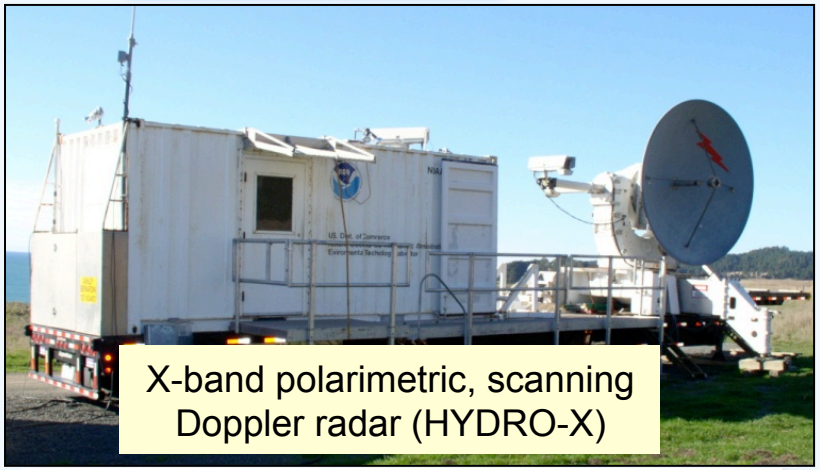
Scanning

Precipitation

Boundary Layer

¼-scale 449-MHz wind profiler with RASS

S-band precipitation profiling radar (S-PROF)



X-band polarimetric, scanning Doppler radar (HYDRO-X)

C-band scanning Doppler radar (SKYWATER)

FM-CW snow-level radar

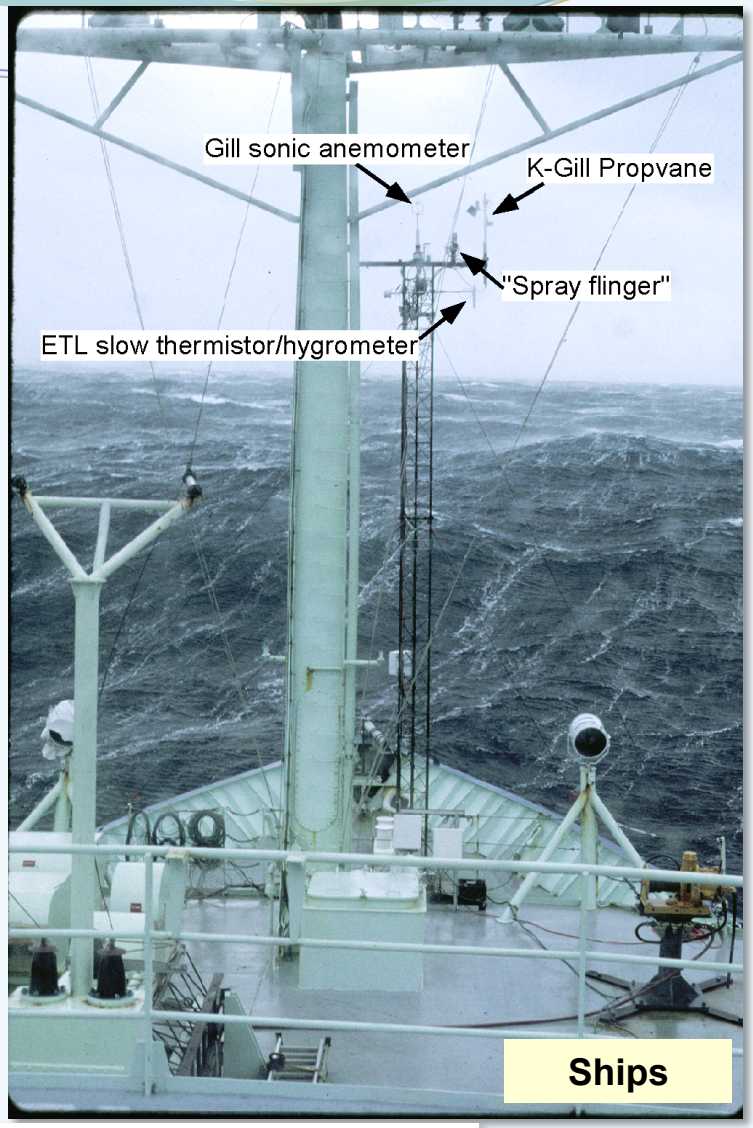
Also see poster by Matrosov et al.

Bistatic sodar

GPS receiver for integrated water vapor

Fluxes


State-of-the-Art Sensors



Ships

'Planes, Trains, and Automobiles' - A Diversity of Experimental Approaches

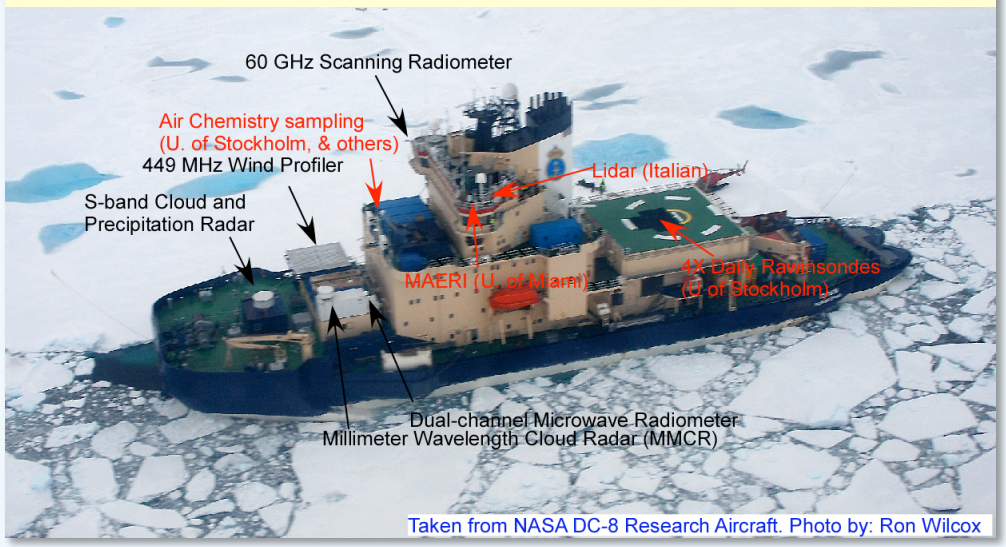
Aircraft

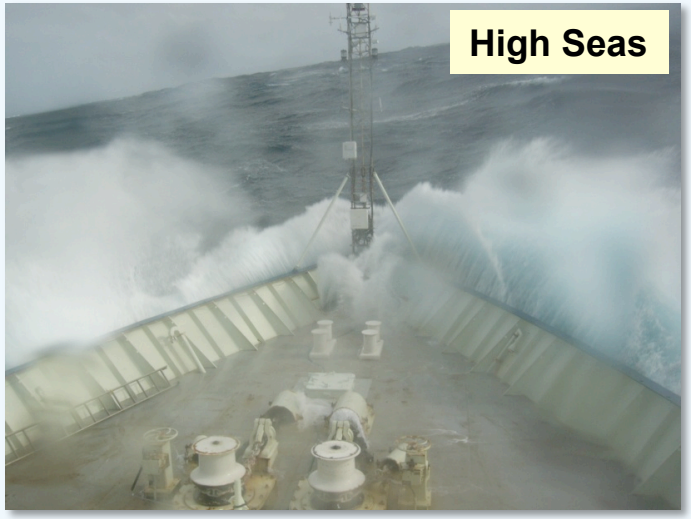

Buoys

See posters by Fairall, Bariteau and Wolf

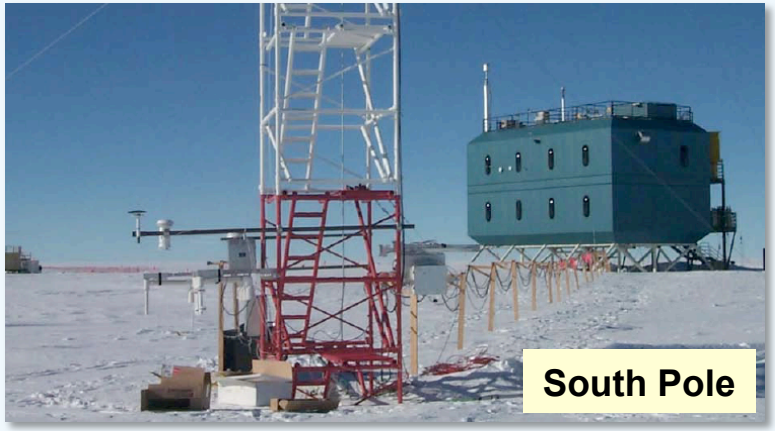
Observations in Extreme Environments

North Pole - 87 N, Aug 2008, Swedish Icebreaker "Oden"

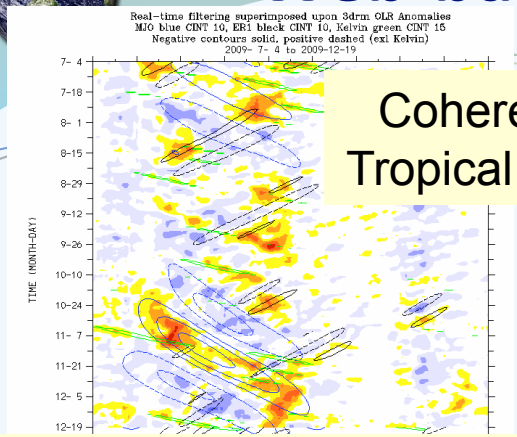




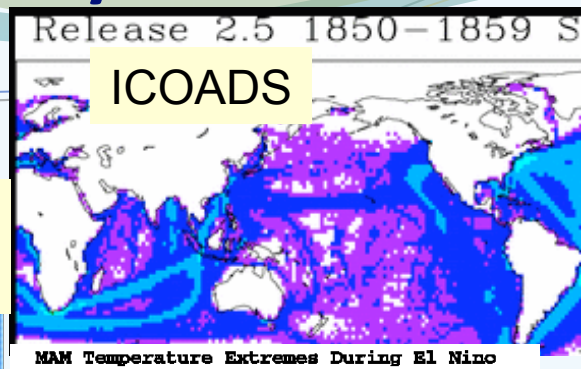
Also see poster by Darby



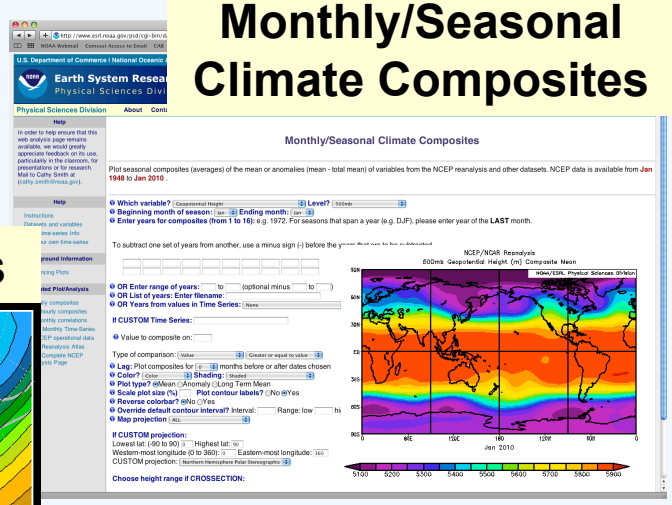
Web-based Visualization and Analysis tools



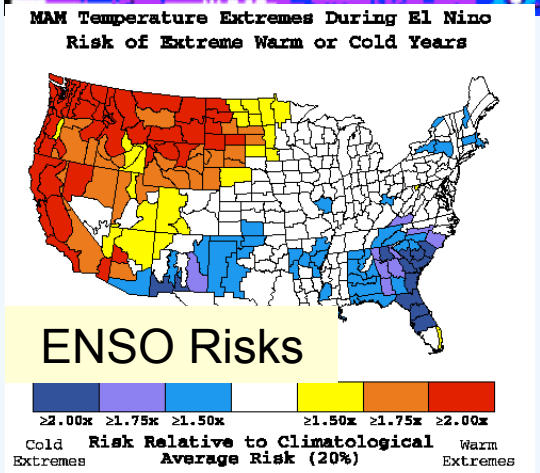
Coherent Modes
Tropical Convective



ICOADS

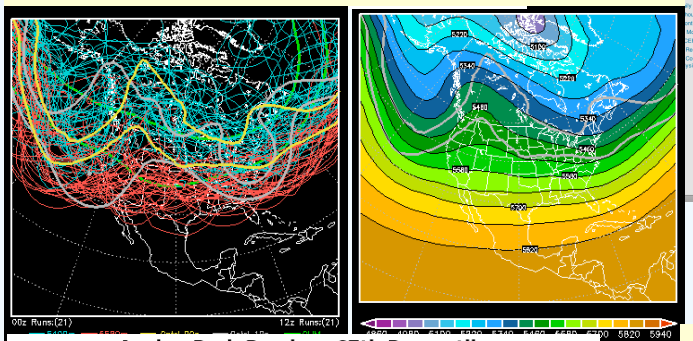


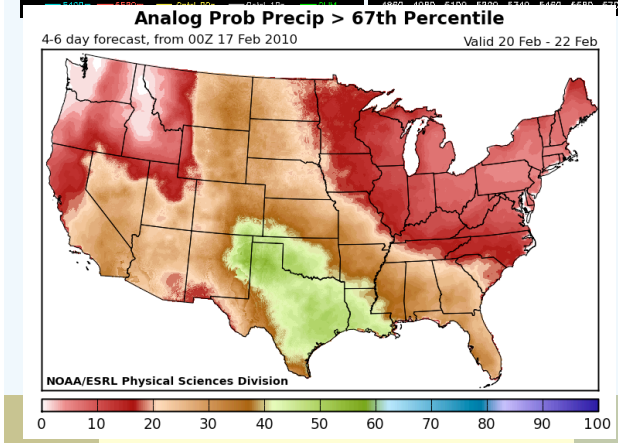
Monthly/Seasonal Climate Composites



ENSO Risks

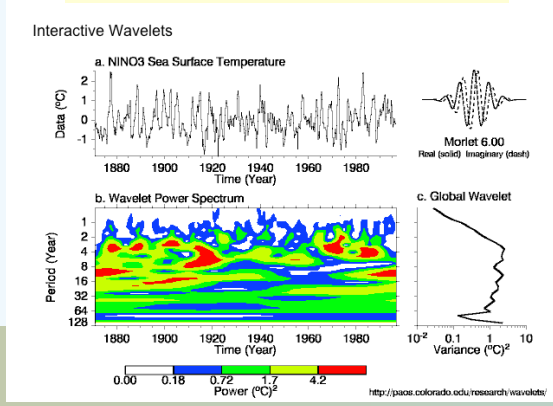
Ensemble Forecast Products



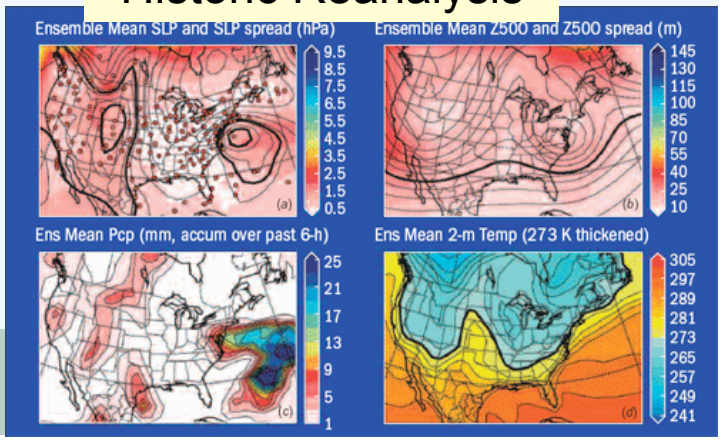


Reforecast Products

Interactive Wavelet



Historic Reanalysis



Core Competencies

- Driven by NOAA-mission-focused science and service gaps, and informed by research and user needs

- Provided by a talented pool of engineering, IT, scientific and support staff (Fed, CI, Contract)
  - Equivalent of ~20 full time staff are dedicated to Observing systems
  - Equivalent of ~10 full time staff are dedicated to Analysis tools

Impact

- Usage of the online reanalysis tools (see Smith poster)
  - Broad user base
  - Large volumes of data downloaded by many users

- Usage of observations (see White & Schneider posters)
  - Frequent access to real-time data
  - Enables many research publications
  - Working with industry through a formal CRADA (Cooperative Research And Development Agreement)

Innovation & Future Directions

- Earth System Analysis Tools (e.g., Historic Reanalysis)
- Traditional field experiments (e.g., MJO, CalWater)
- Long-term monitoring of key physical processes
  - Arctic
  - Fluxes between air-sea-land-ice
  - Precipitation
  - Water vapor transport
- Downscaling

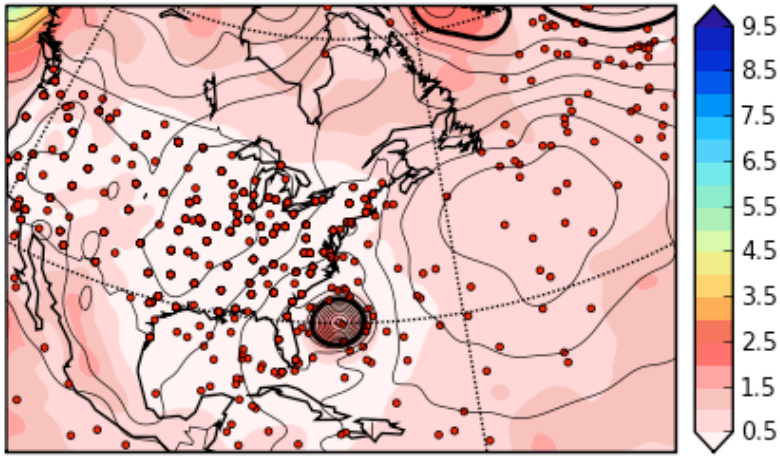
Earth System Analysis

- Looking "back" to the future – using "20th Century Historic Reanalysis" (Compo et al.)

Can analyze conditions during historic weather and climate events of the first half of the last Century, including

- hurricanes
- floods
- droughts
- heat waves
-
-

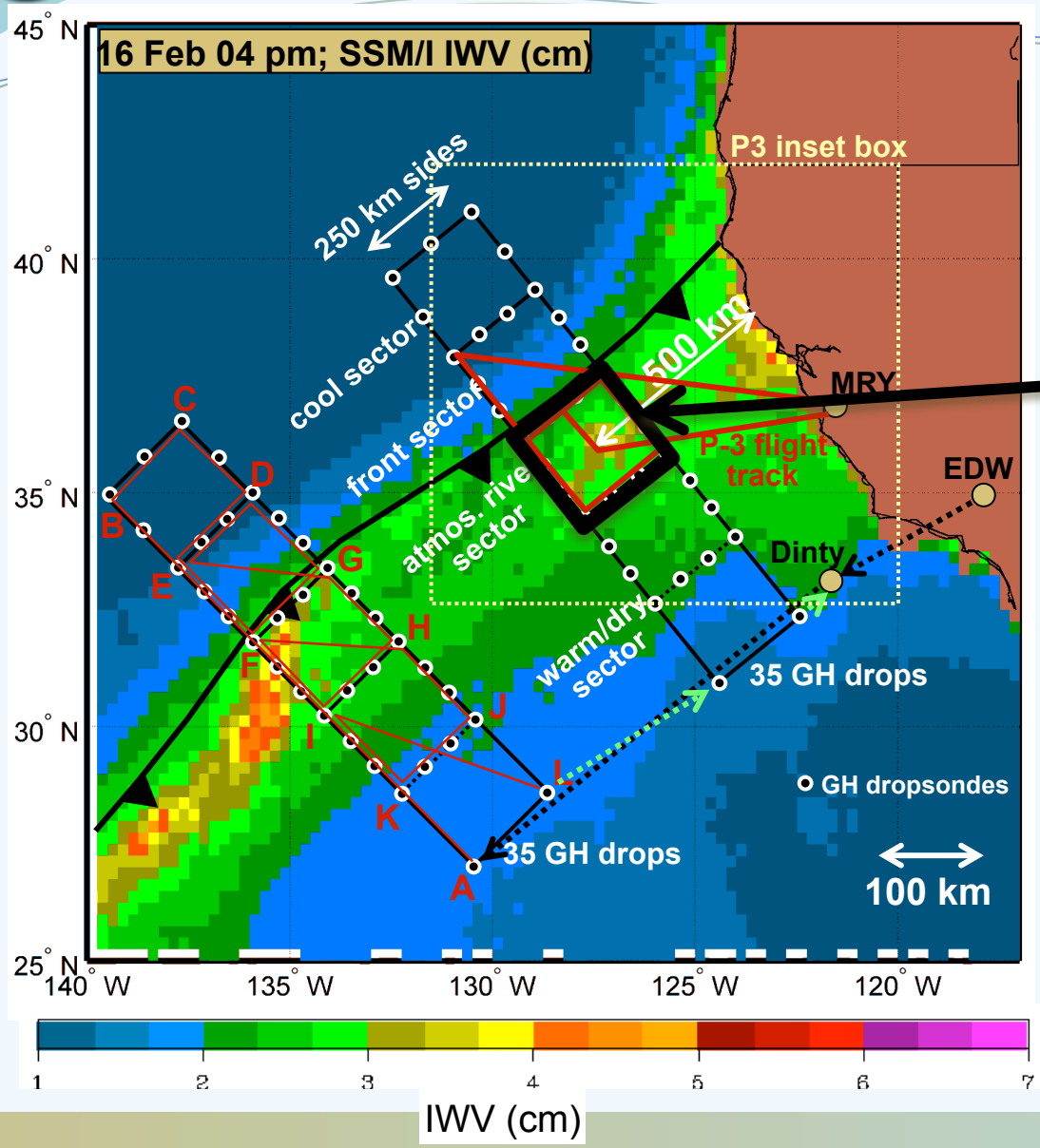
21 September **1938 (!)**



Sea Level Pressure and ensemble spread (color)

Compo, Whitaker, Sardeshmukh 2009

Field experiments: e.g., CalWater Phase II*



"How well do climate models represent water vapor transport, especially atmospheric rivers?"

Scale of a Climate model grid cell

Measure the detailed water budget

- air-sea fluxes
- horizontal transport
- precipitation

Data collection by

- aircraft
- ship
- ground-based systems

*In conceptual phase

Summary

- PSD uses and develops state-of-the-art observation and analysis techniques to evaluate the capabilities and limitations of key climate tools and improve upon them

- These efforts focus on NOAA's Mission and PSD core competencies in
  - **Water cycle**
  - **Extreme events**
  - **Arctic climate change**