Impact of Global Hawk Data from the SHOUT-ENRR 2016 Field Campaign on an Atmospheric River in the Central North Pacific

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Global Observing Systems Analysis (GOSA) Group

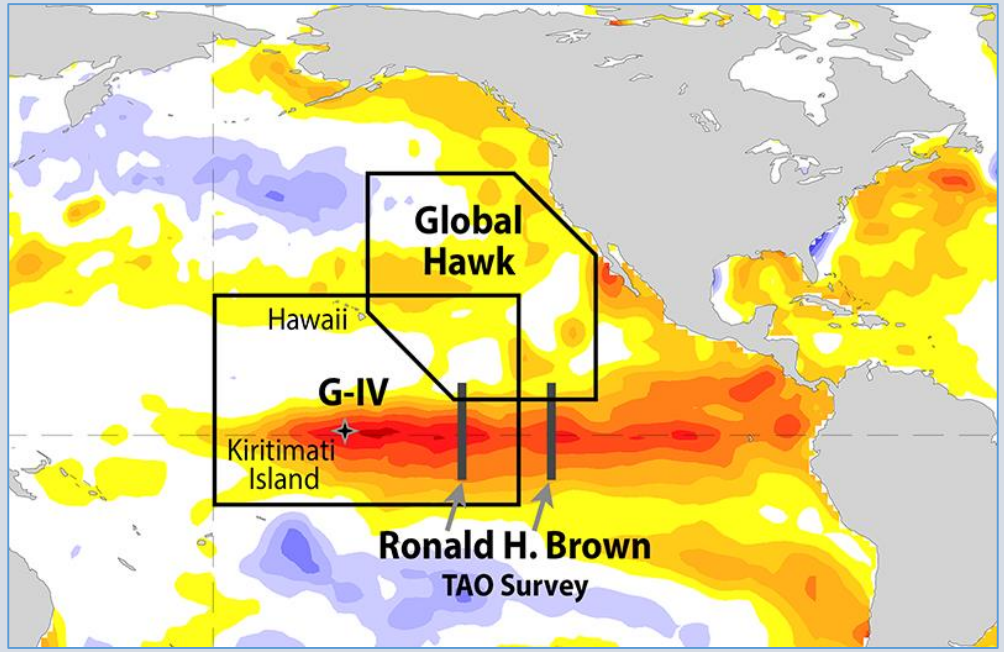
http://www.esrl.noaa.gov/gsd/gosa/

Outline

- Overview of SHOUT and 2016 El Niño Rapid Response (ENRR) mission
- Ensemble Transform Sensitivity (ETS) targeting technique during SHOUT-ENRR
- Evolution of Extratropical storm and Atmospheric River in Feb 2016
- Impact of Global Hawk (GH) dropsonde data on storm forecast and Atmospheric River
- Conclusions

Sensing Hazards with Operational Unmanned Technology (SHOUT) El Niño Rapid Response (ENRR) Field Campaign

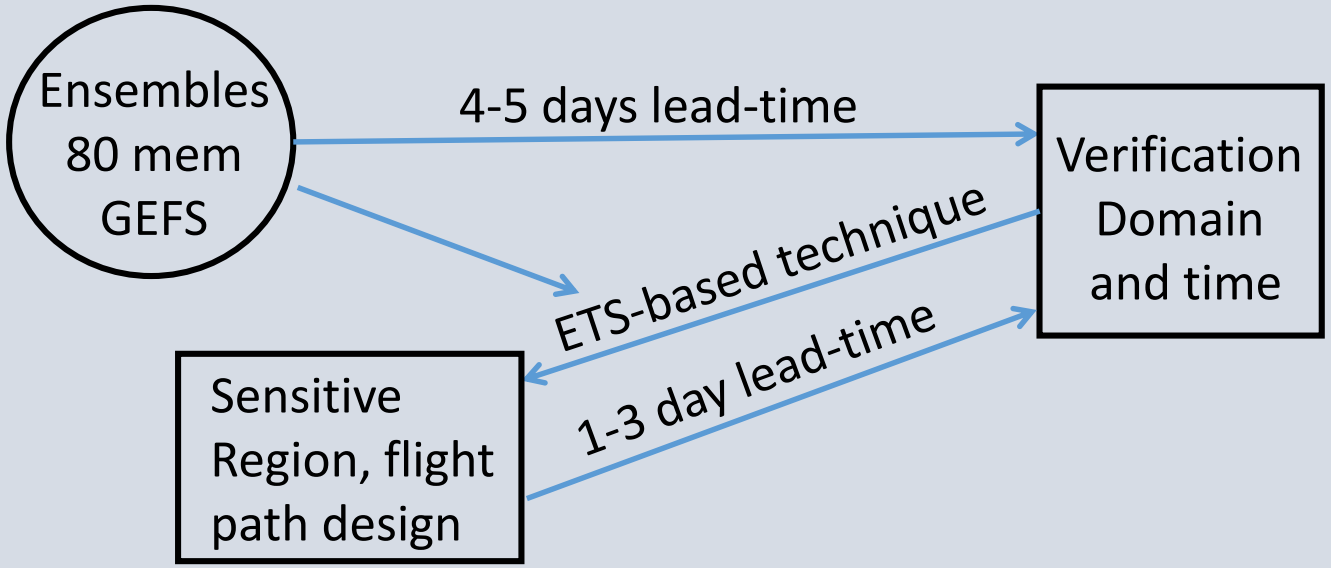
- **What is SHOUT?**
  - Project within NOAA's Unmanned aircraft systems (UAS) program
  - One component tests impact of real UAS data on forecasts using targeted observing strategies, denoted Observing System Experiments (OSEs)
- **SHOUT-ENRR**
  - Joint effort Feb 2016
  - Improve U.S. West Coast forecasts
  - Global Hawk sampled 3 storms
  - 3rd Storm – Feb 21st – strong AR and well sampled
    - 66 total dropsondes released



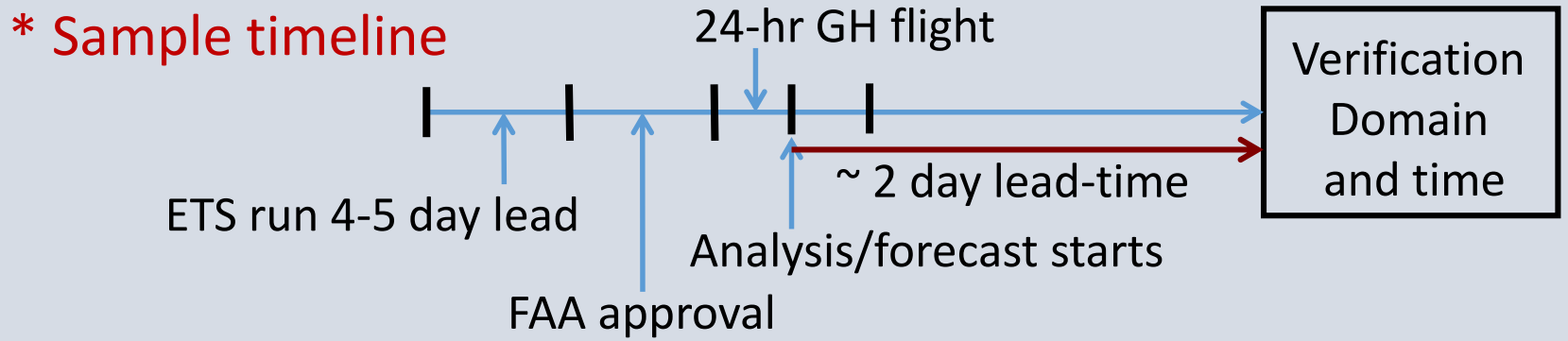
http://www.esrl.noaa.gov/psd/enso/rapid_response/

ETS targeted observing technique during SHOUT-ENRR

- Improve forecasts in verification region at selected *targeting and verification times*
- Calculates *gradient* of total forecast error variance to analysis error variance reduction



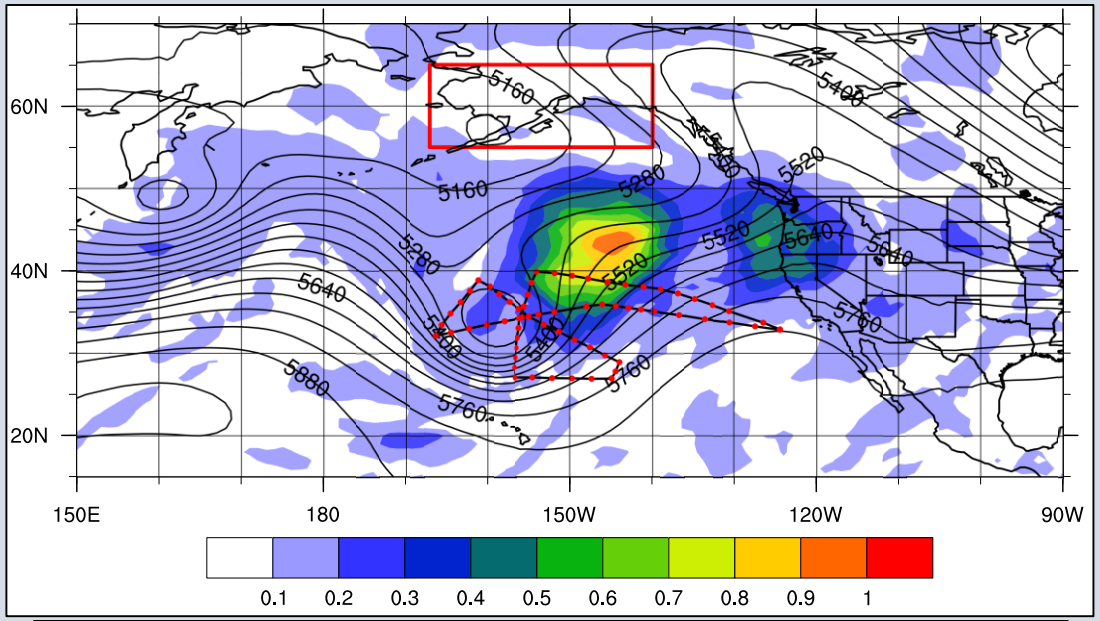
- Daily forecast briefings providing high-impact cases 4-5 days in advance
- ETS to identify areas of large error growth at 1-3 day lead time
- Subsequent flight path design

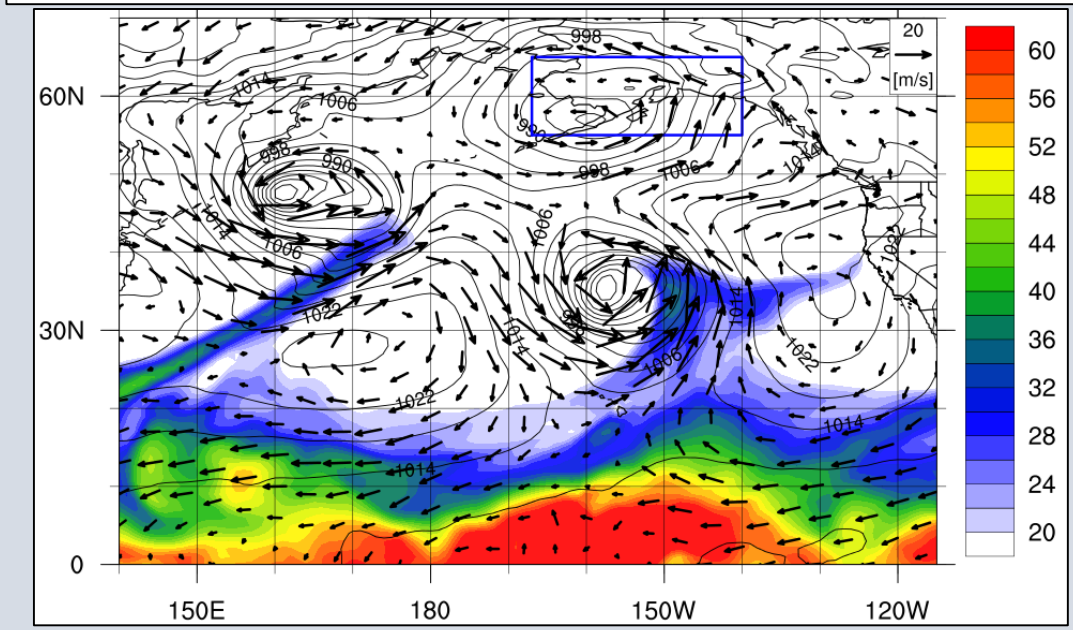


Zhang et al. (2016)

Targeting Feb 21st 2016 Extratropical Storm

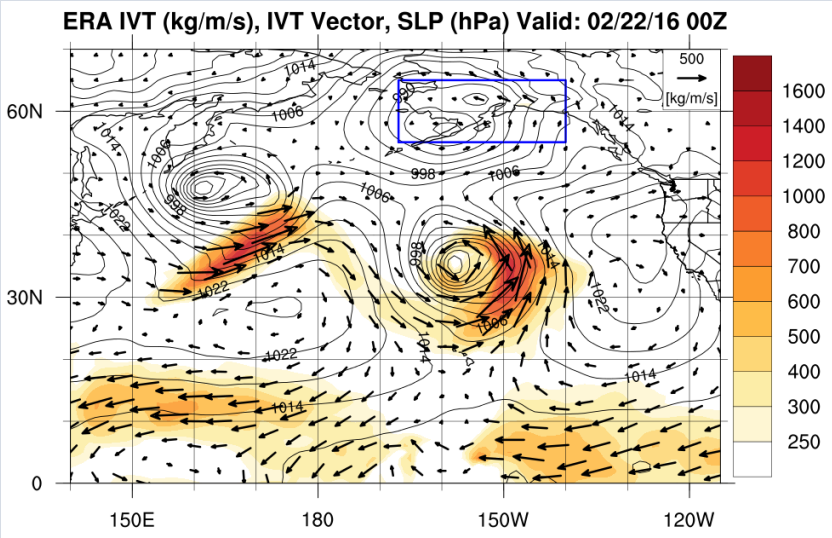
- **Feb 21st 2016 Storm**
  - Extratropical storm with AR
  - ETS sensitivity (top right) at GH flight time (00z Feb 22nd) for verification time (00z Feb 24th) over AK verification domain
  - MSLP and IWV at flight time from ERA-Interim
- **Methodology of GH dropsonde impact**
  - Assimilate GH dropsondes into NCEP GFS over 4 analysis cycles (18z Feb 21 – 12z Feb 22)
  - CTRL: Operational obs. without GH dropsondes
  - DROP: CTRL plus GH dropsondes
  - Results verified against ERA-Interim

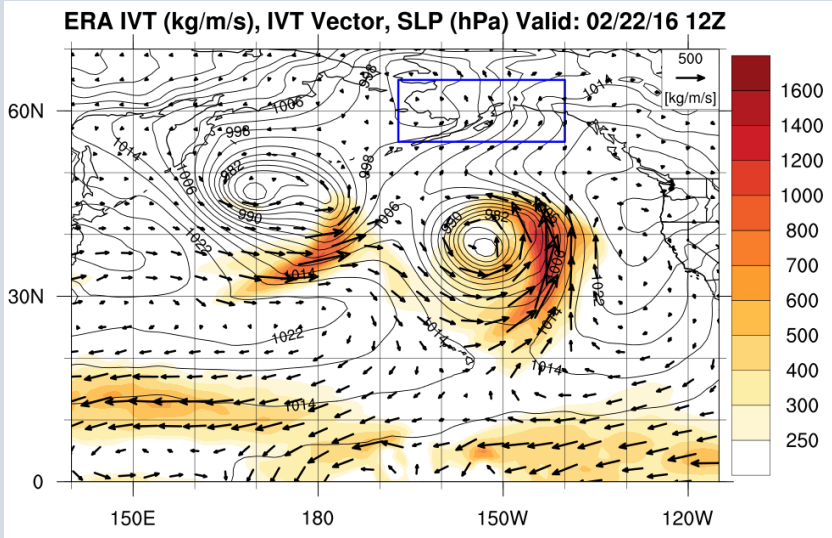


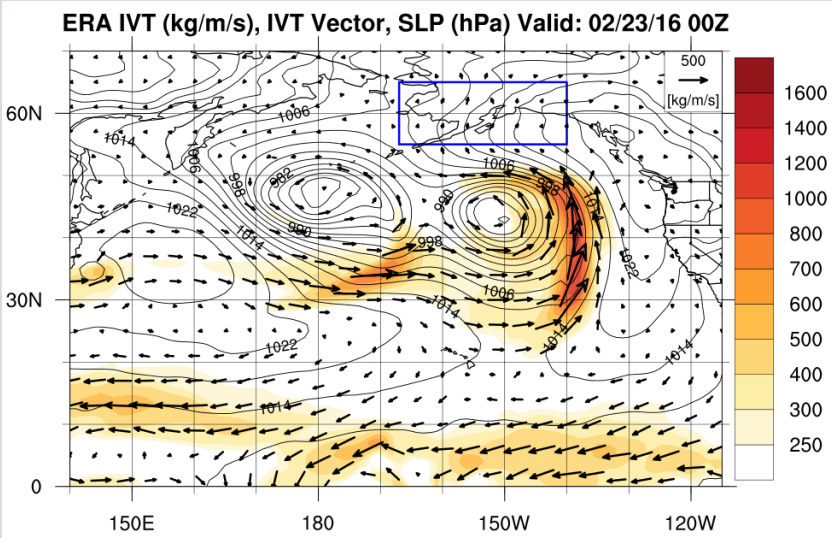


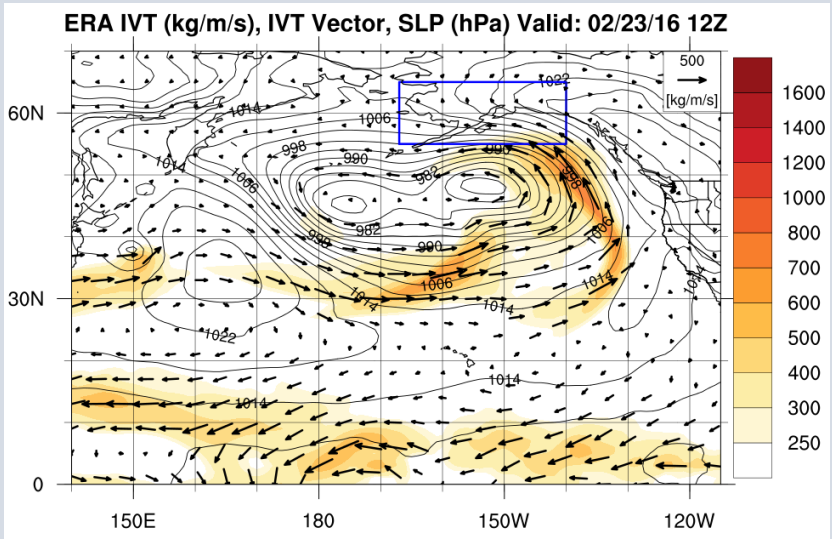
Evolution of Feb 21 Storm system and associated Atmospheric River

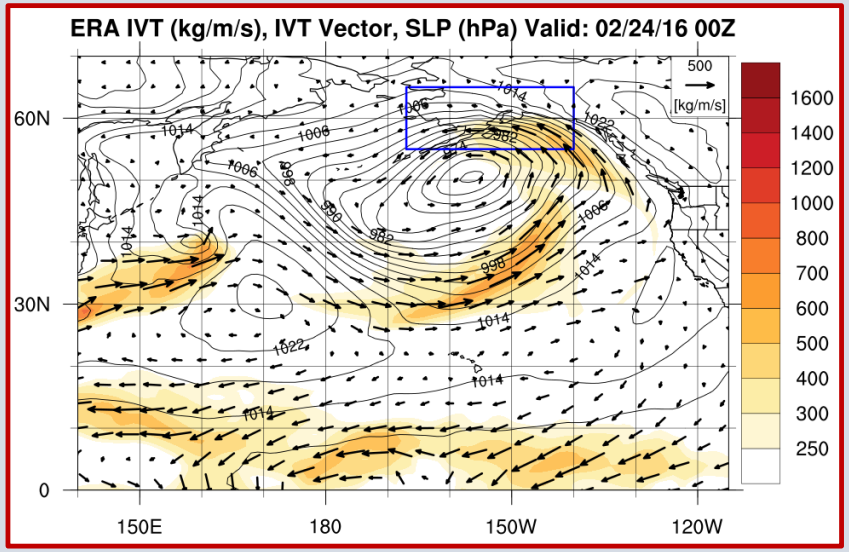
ERA-Interim reanalysis Integrated Vapor Transport (IVT)

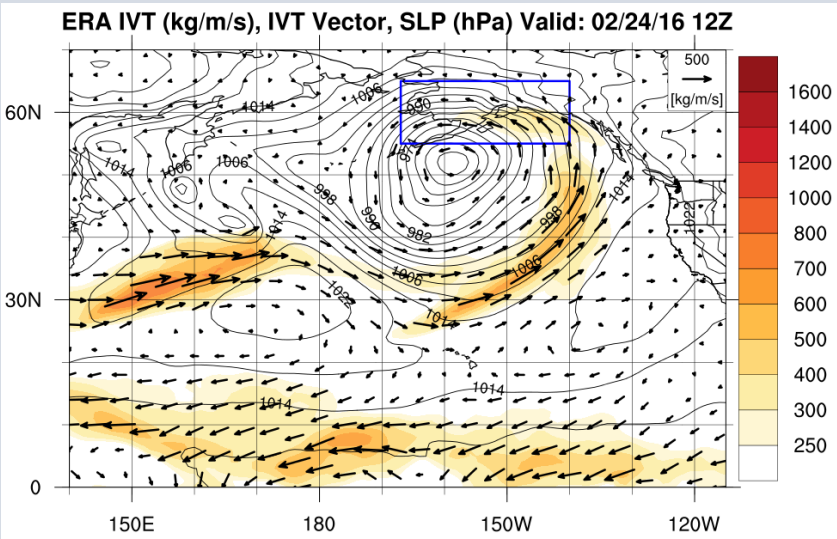








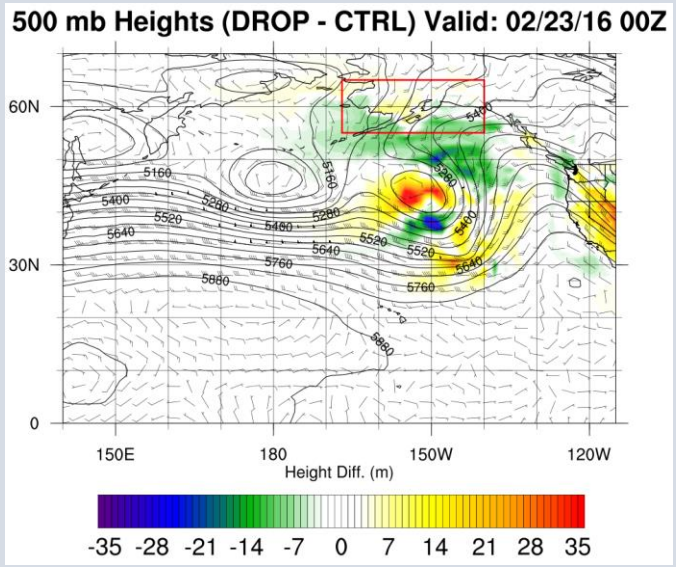


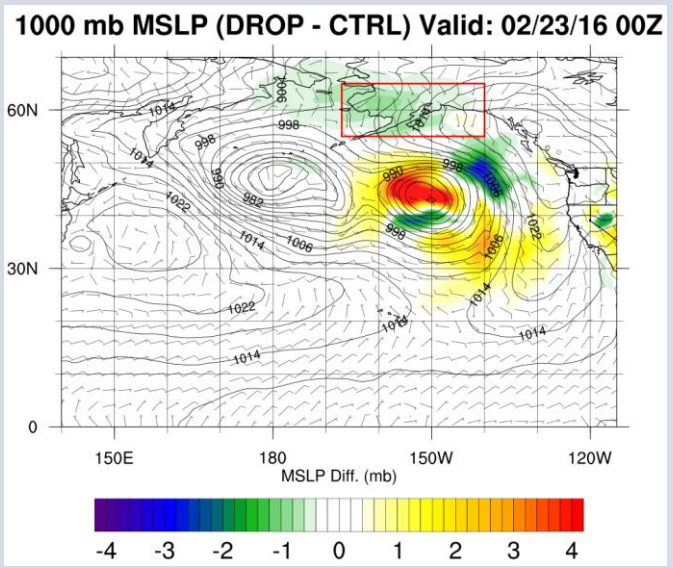


Adding GH dropsondes using ETS technique improves forecast of HGT and MSLP

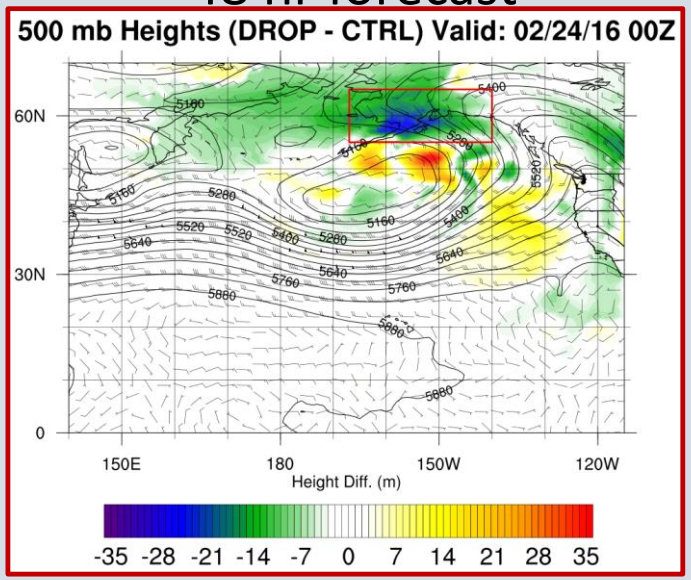
GFS Init: 2/22/00z: Absolute error difference 24-72 forecasts

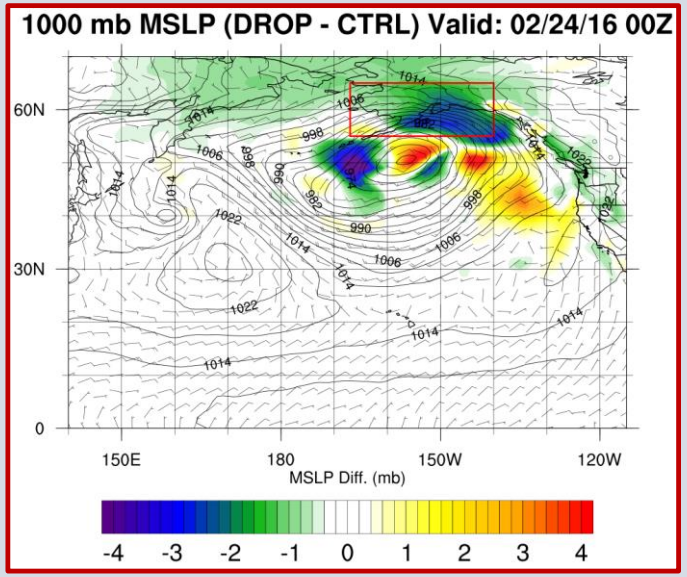
24 hr forecast



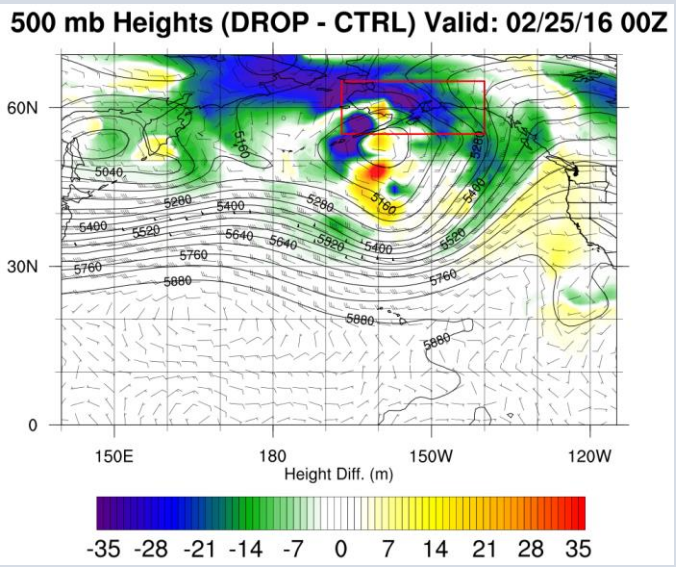


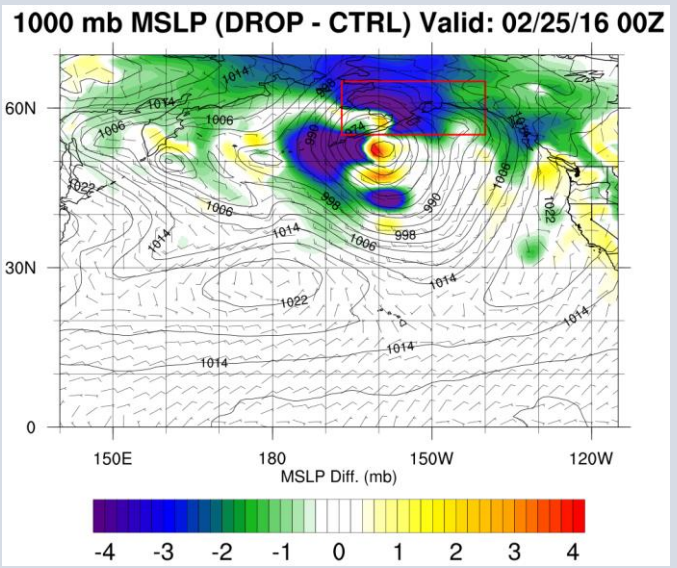
48 hr forecast



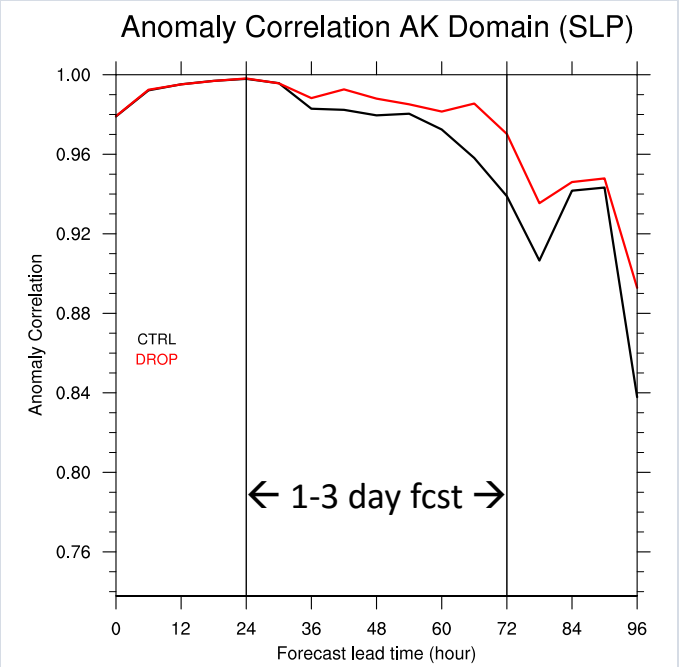


72 hr forecast

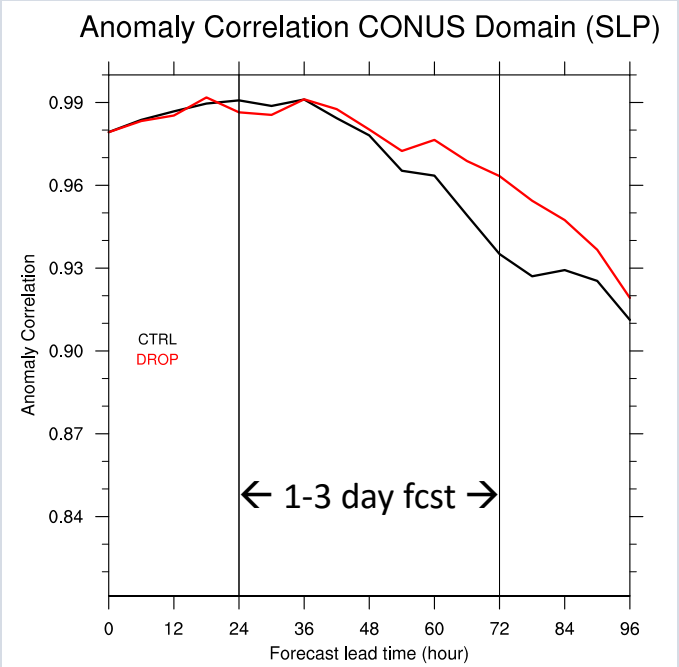




Adding GH dropsondes improves forecast skill of 500 hPa HGT and MSLP



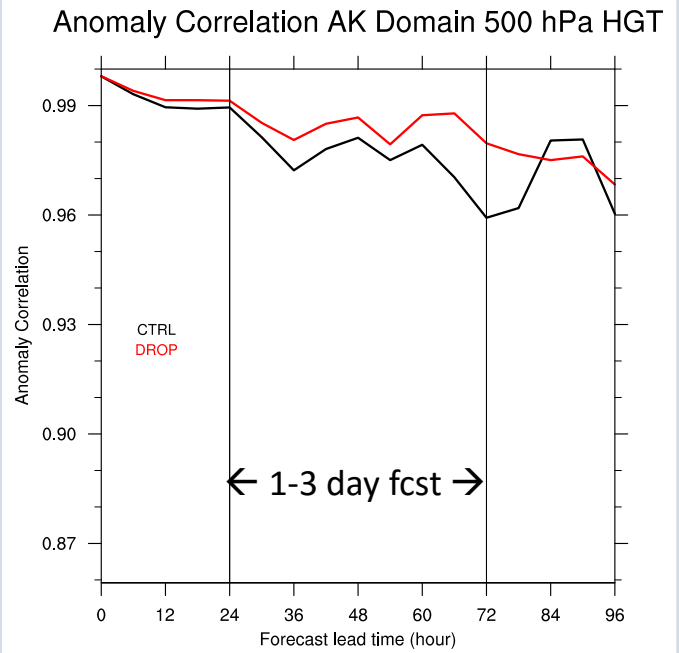
MSLP



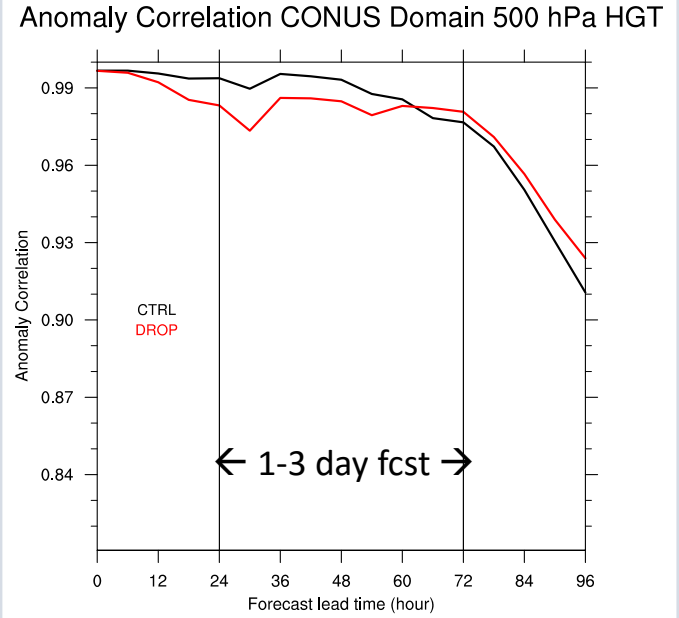
GH dropsondes provide higher anomaly correlations over Alaska and CONUS at 24-96 hrs for MSLP and HGT

CTRL – Black

DROP - Red



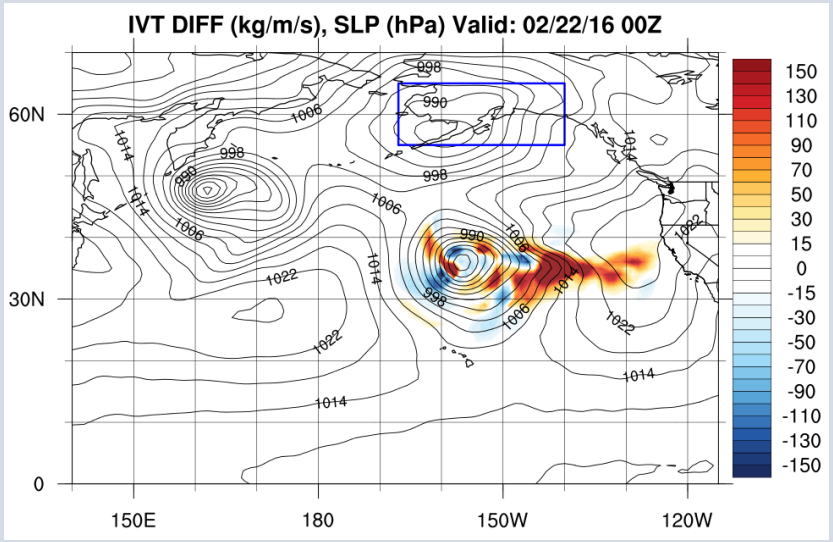
500 hPa Height

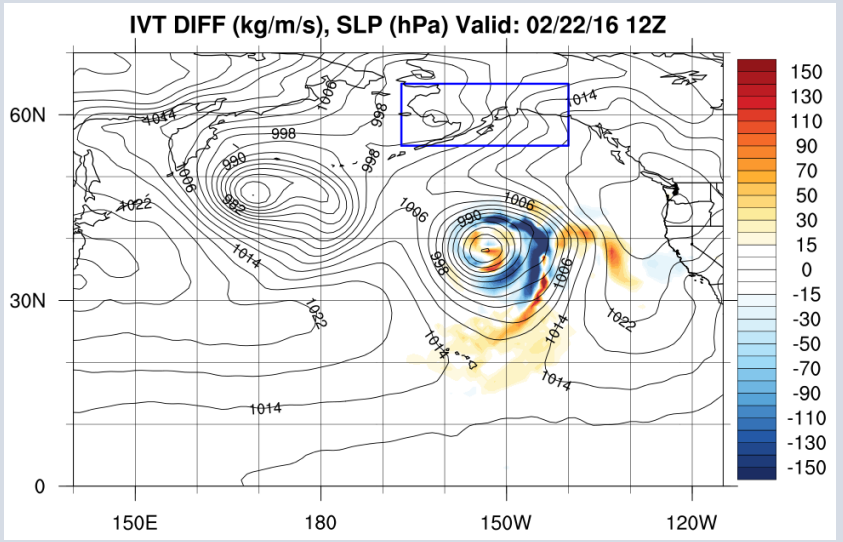


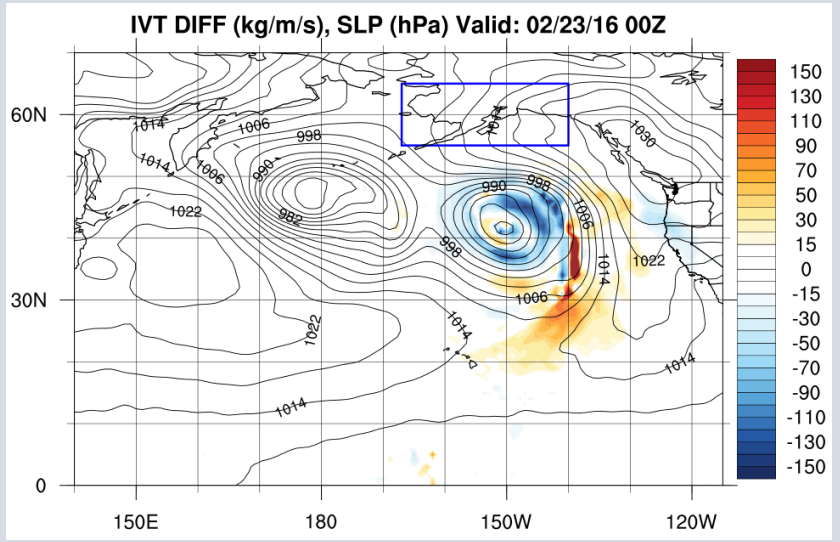
Assimilating dropsondes modifies the Atmospheric River and core of cyclone

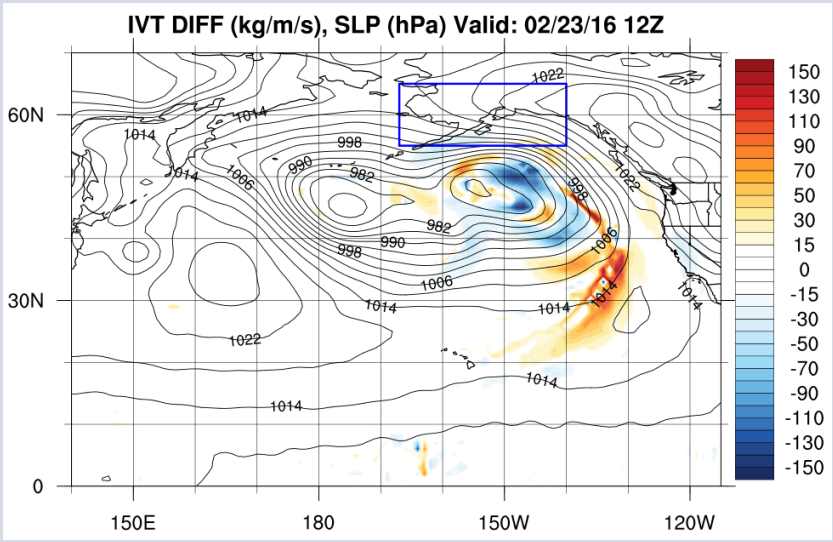
GFS Init: 2/22/00z

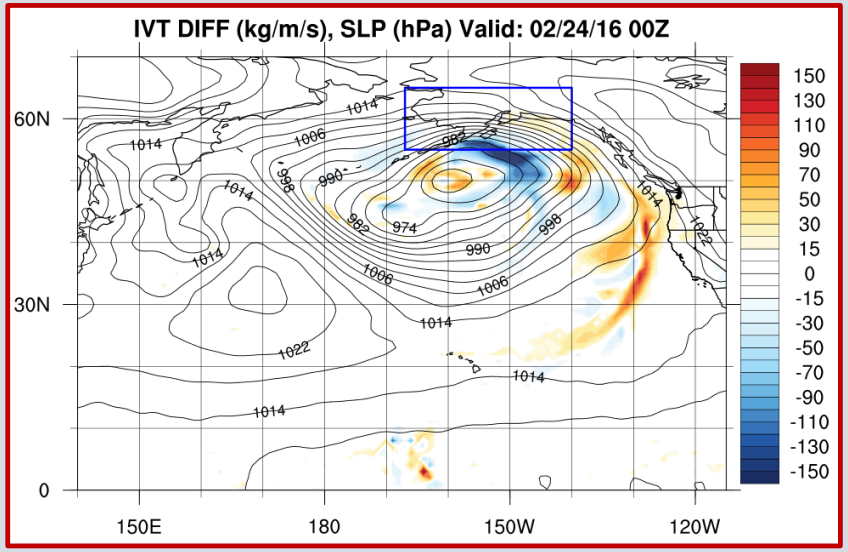
DROP-CTRL differences of IVT

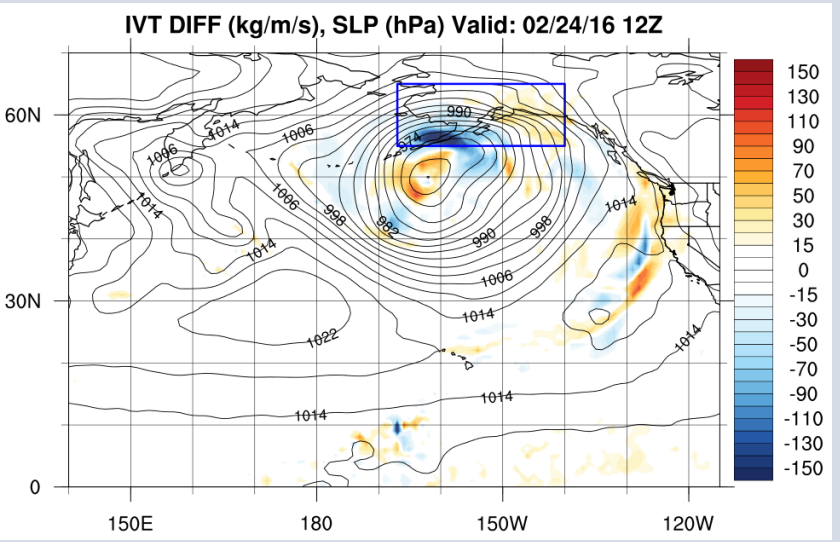




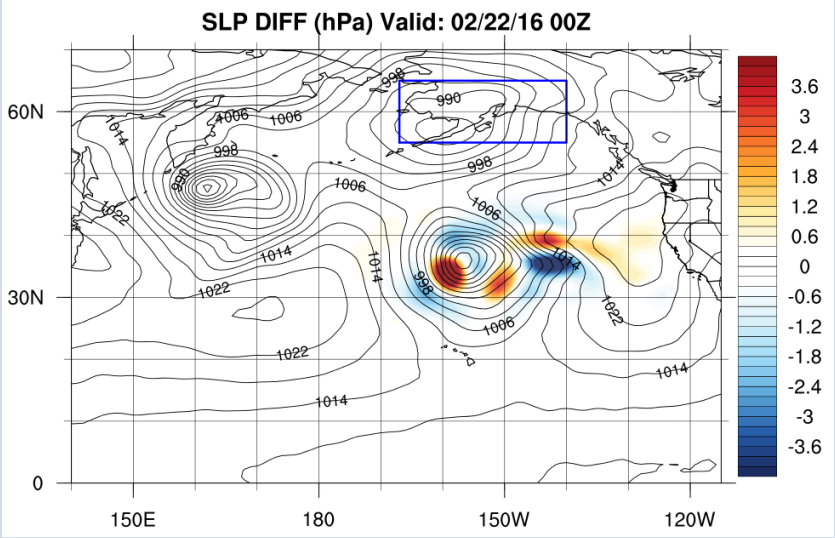


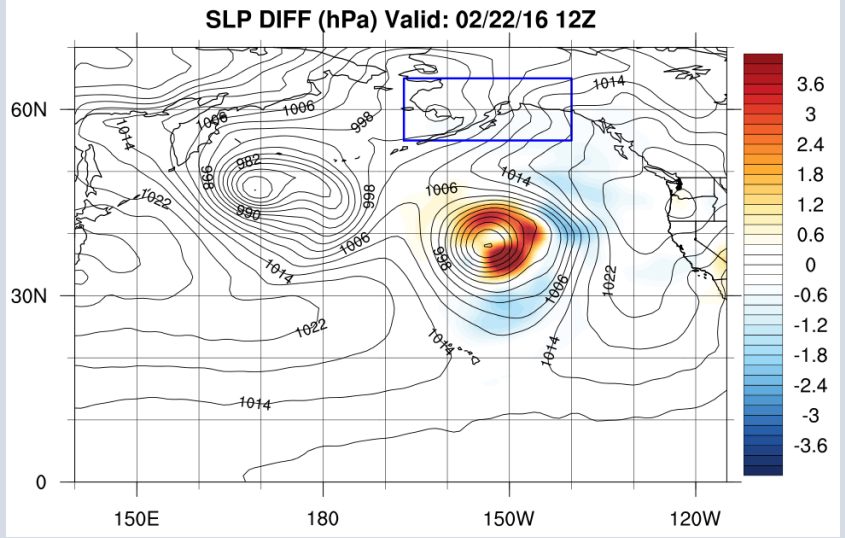


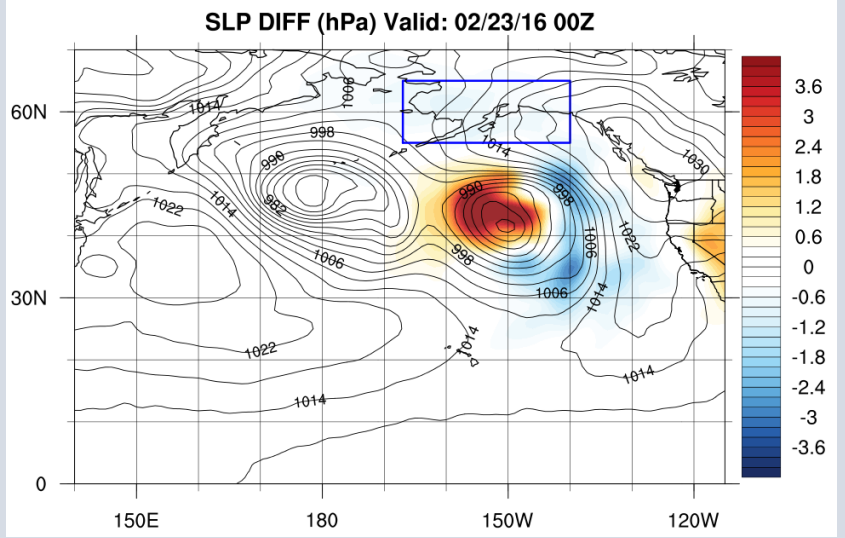


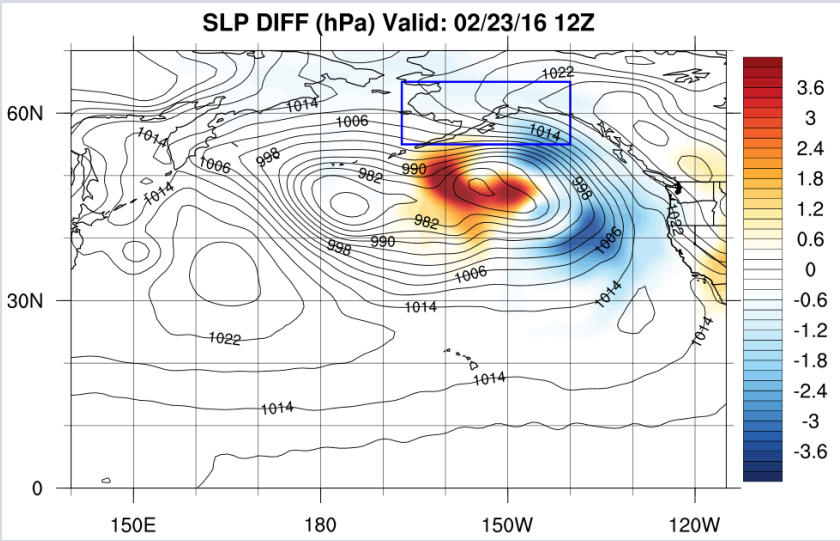


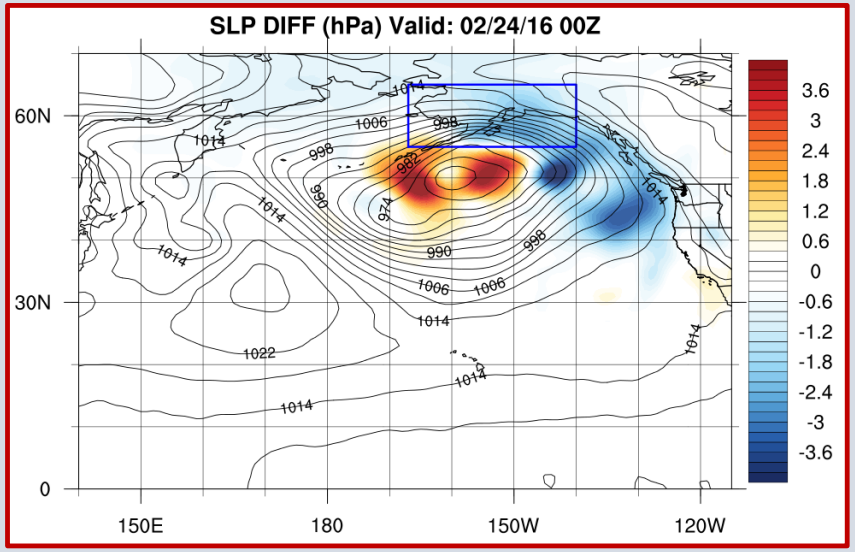
Assimilating dropsondes modifies the MSLP field
GFS Init: 2/22/00z
DROP-CTRL differences of SLP

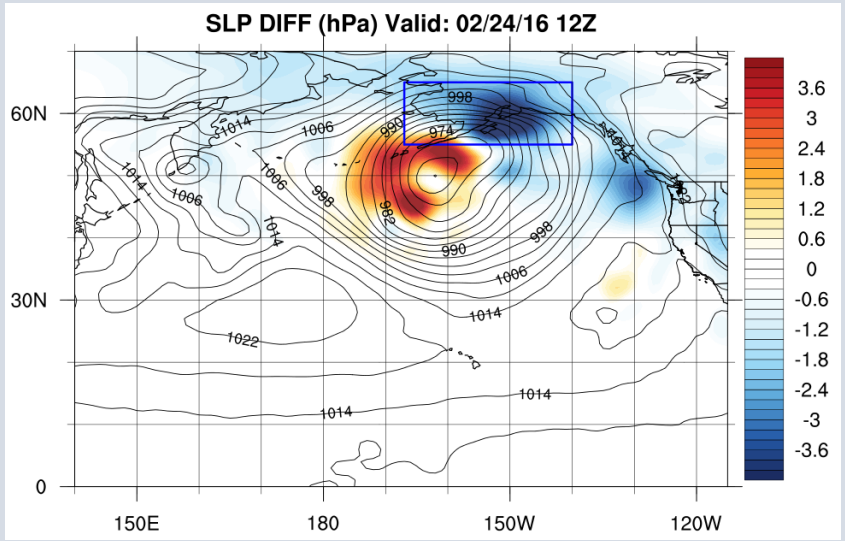




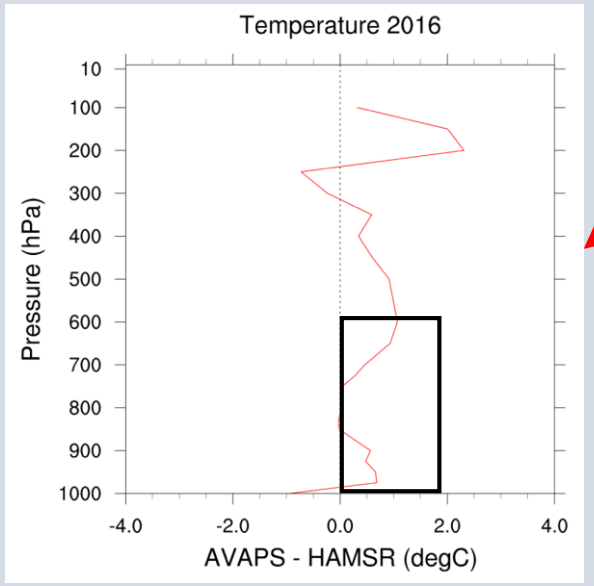


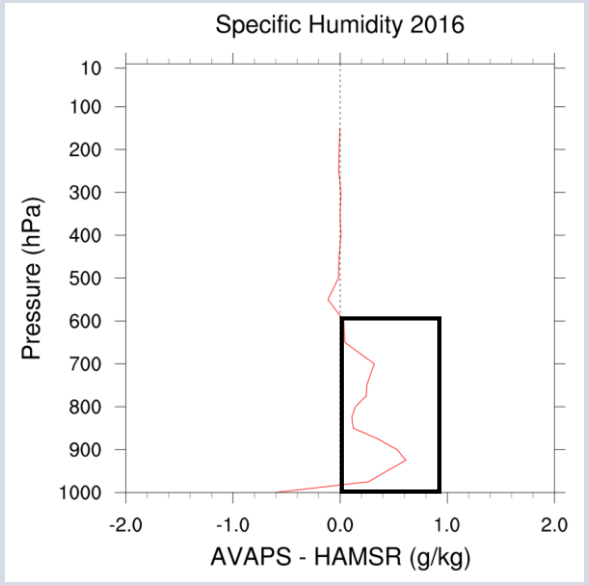






Assimilating High Altitude MMIC Sounding Radiometer (HAMSR) into NCEP's Global Model



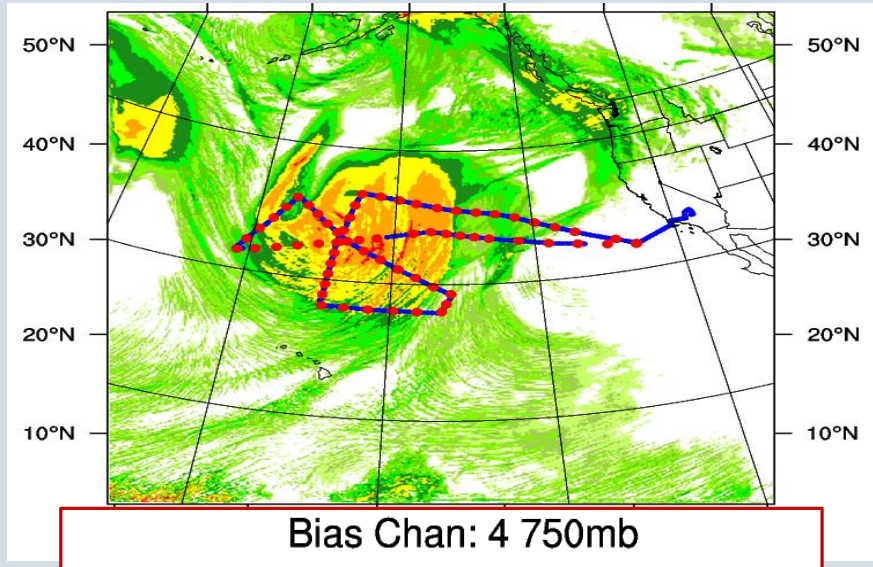


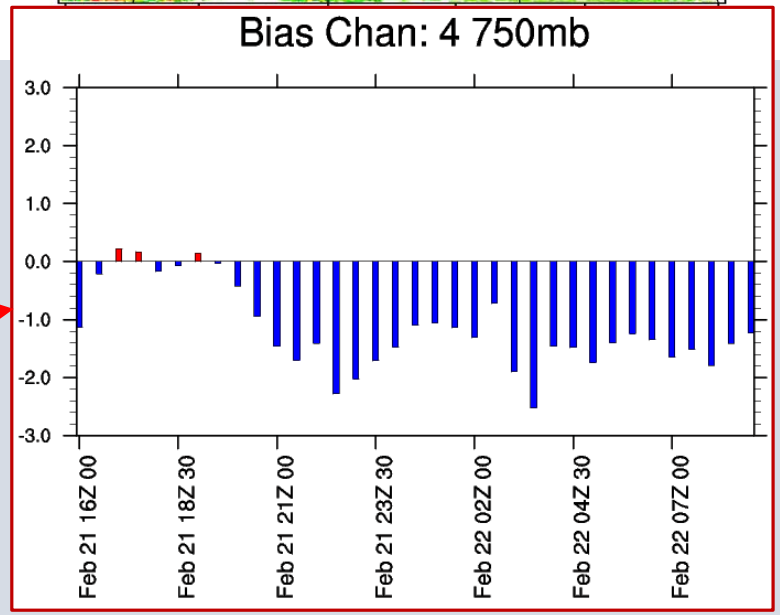
- Cold and dry bias found in HAMSR retrievals compared with dropsondes
- Biases on order of 1 degC and 0.6 g/kg

- Goal: assimilate ***HAMSR radiances*** into NCEP Global model (no capability yet)

- Simulating just forward component of HAMSR using Community Radiative Transfer Model (CRTM) with WRF indicates preliminary biases at low level channels (36-hr forecast)

WRF 24-h precipitation 12Z Sep 21 - 12Z Sep 22 2016



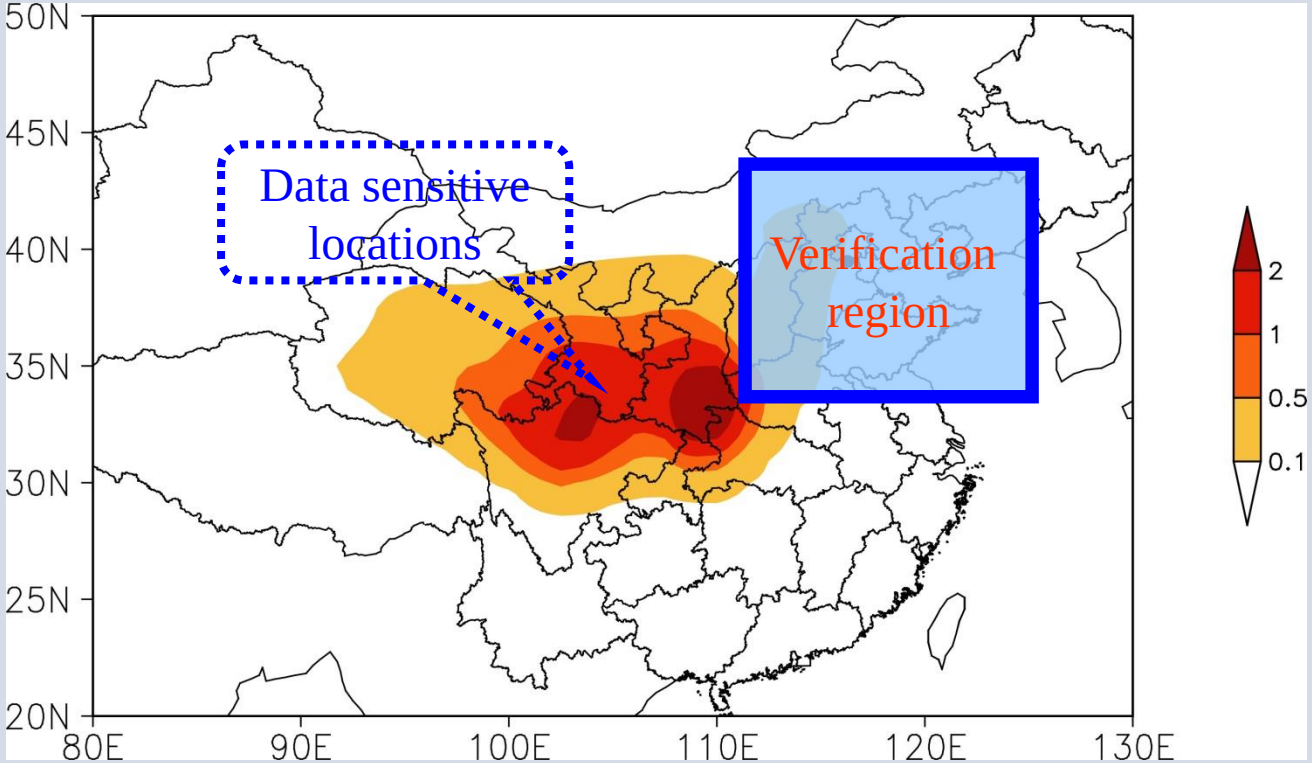


Conclusions

- Joint SHOUT-ENRR 2016 Field mission provided opportunity to investigate historic El Niño
- Strong Atmospheric River during Feb 21st storm system
- Impact of dropsondes improves forecasts across AK and CONUS
- Dropsondes moisten the AR along cold front, create drier conditions in core of cyclone
- Work ongoing to assimilate HAMSR radiance data into NCEP Global model

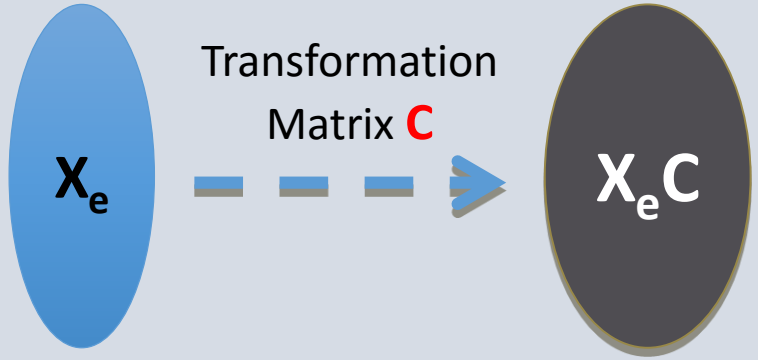
Ensemble Transform Sensitivity technique

(a) Calculate Ensemble transform matrix
(b) Predict forecast error covariance (analysis and forecast error)
(c) Estimate prediction error variance reduction



The locations of sensitive regions is dependent on the area in which a forecast improvement is wanted, the verification area, but also the forecast length and the atmospheric flow between the targeting and verification times.

Zhang et al. (2016)



Ensemble perturbations 80 GEFS members

Perturbations transformed to represent effect of adaptive observations

specify regions for possible adaptive observations

ETS based on Total Energy Norm
Temp, wind at 200, 500, 700 hPa