Impacts of Dropsonde Observations on the Predictability of Two Landfalling Atmospheric River Events in February 2016

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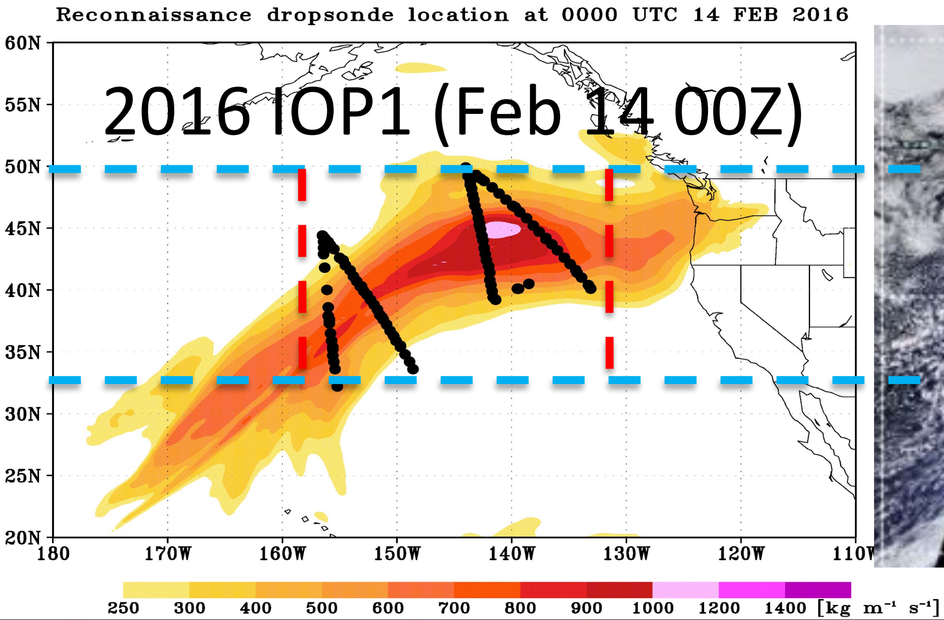
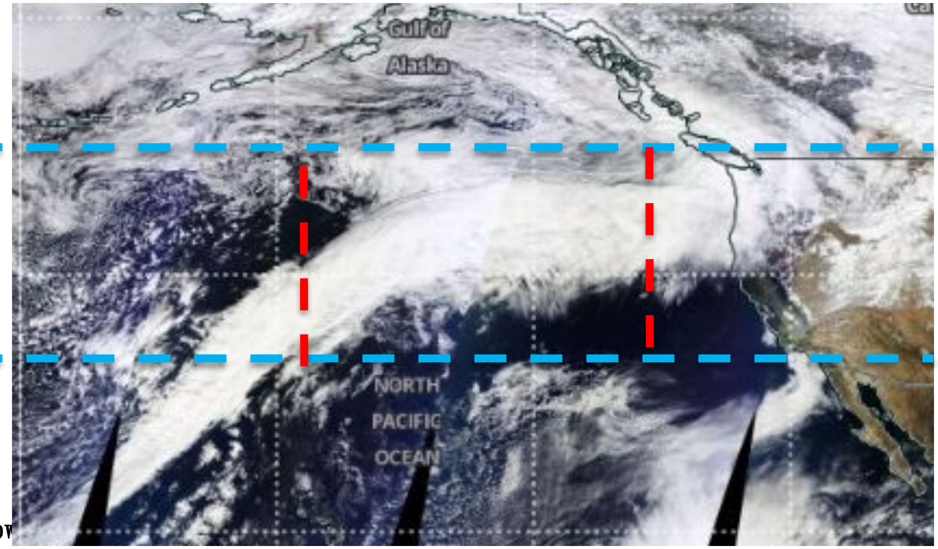
Acknowledgements: Jennifer Haase, Andy Martin, Rachel Weihs, Michael Murphy

Kate Howard, Vijay Tallapragada (NOAA/NCEP/EMC)





Aqua/MODIS from NASA/world view

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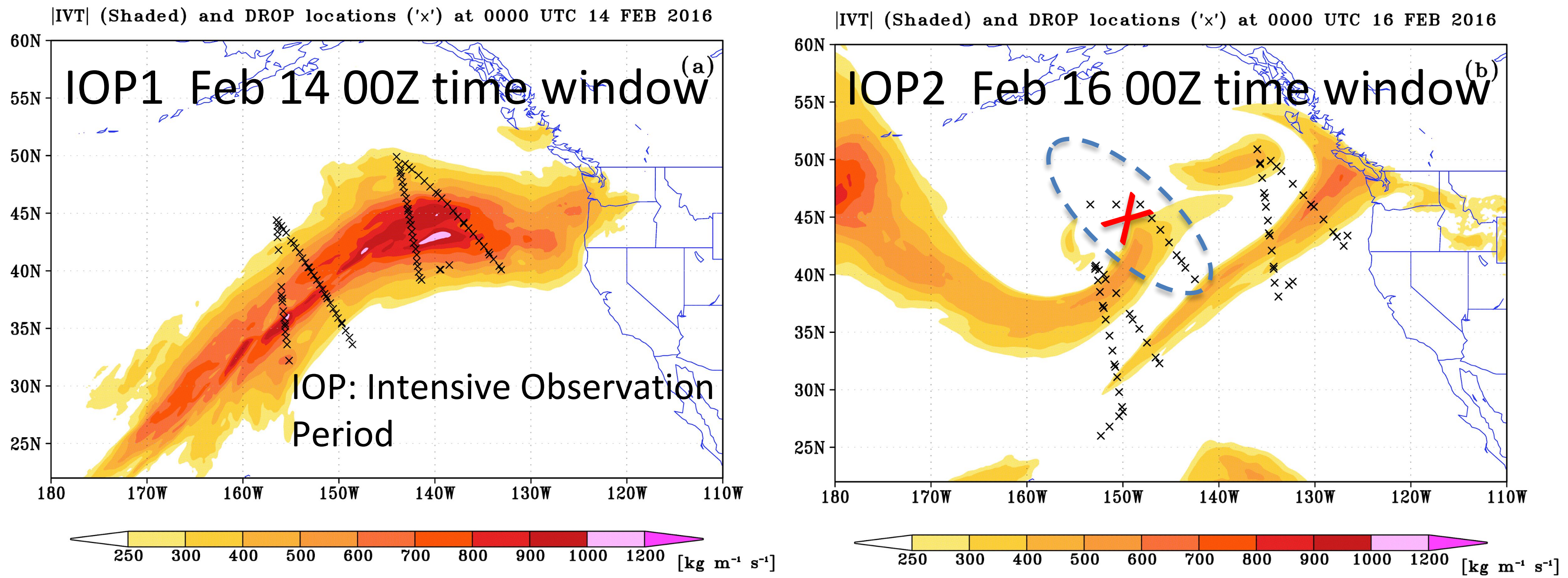
Motivation

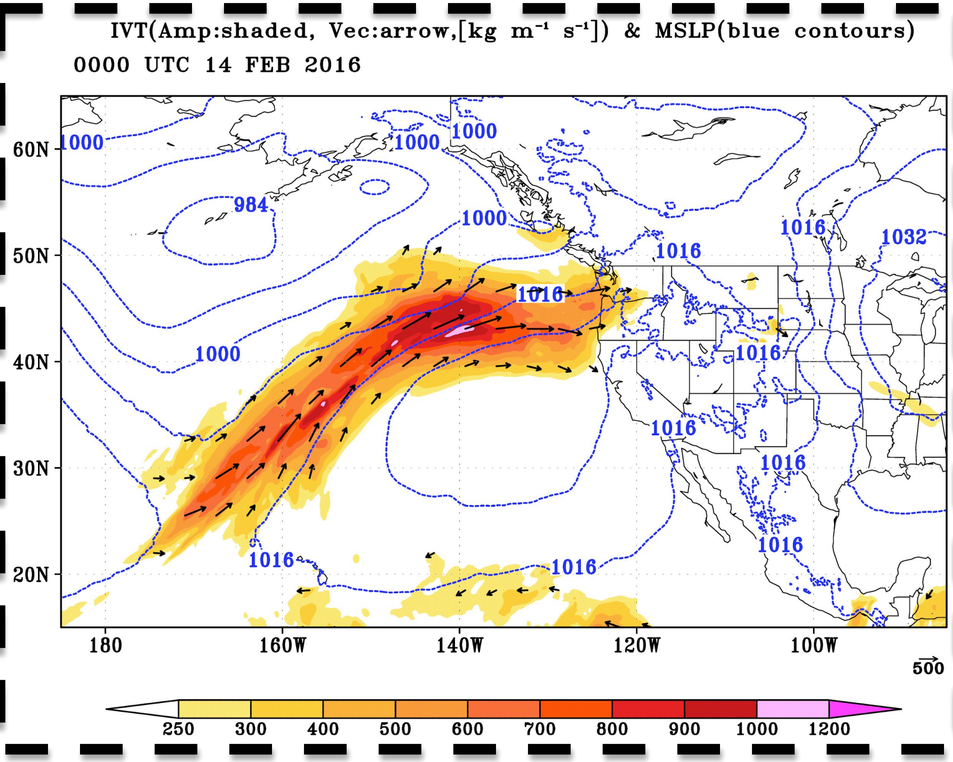


Sciences questions:

1. How to better assimilate the available observations for an AR event in a regional model?
2. How do the AR Recon observations impact the initial condition and forecast skills for of the model for these two ARs?
3. What are the added value of AR Recon observations?

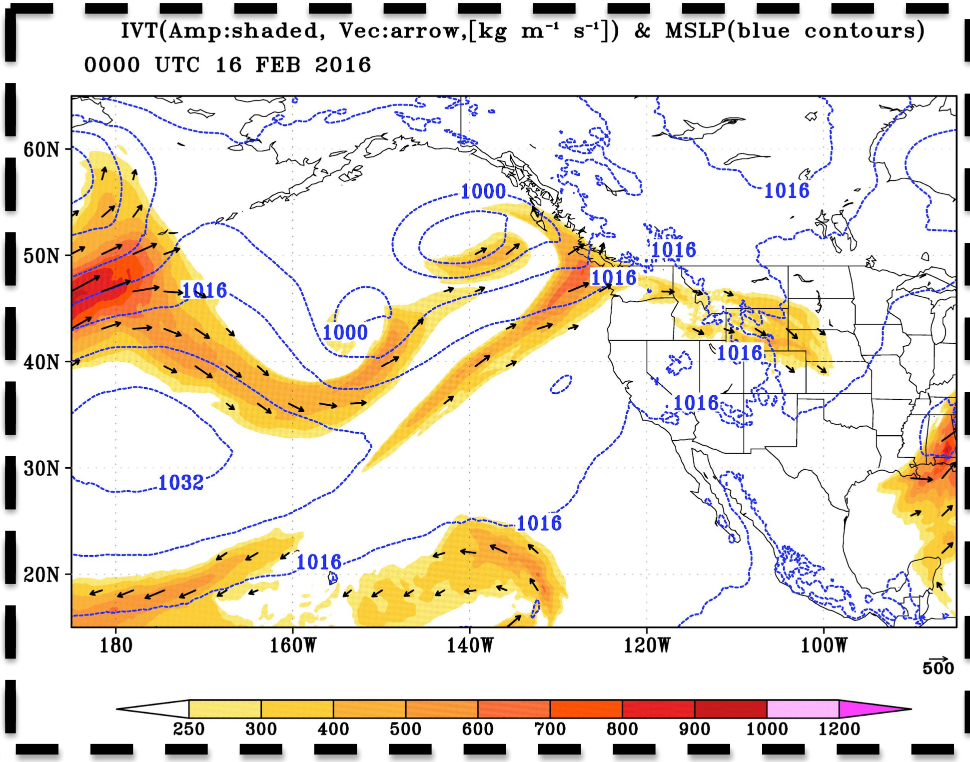
Synoptic Overview: MSLP and IVT

Feb 14 00Z



IOP1

Feb 16 00Z

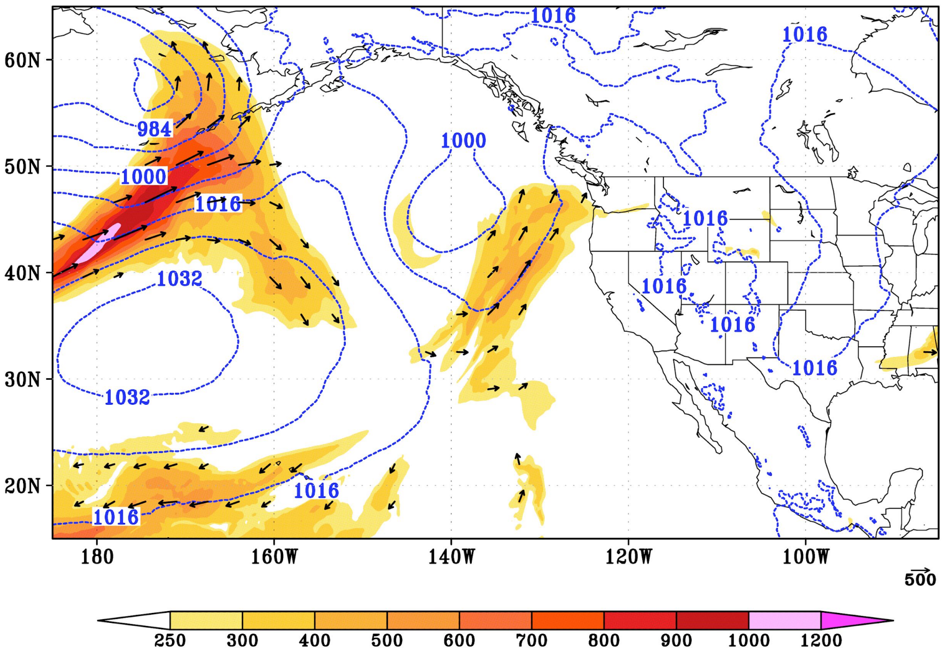


IOP2

Synoptic Overview: MSLP and IVT

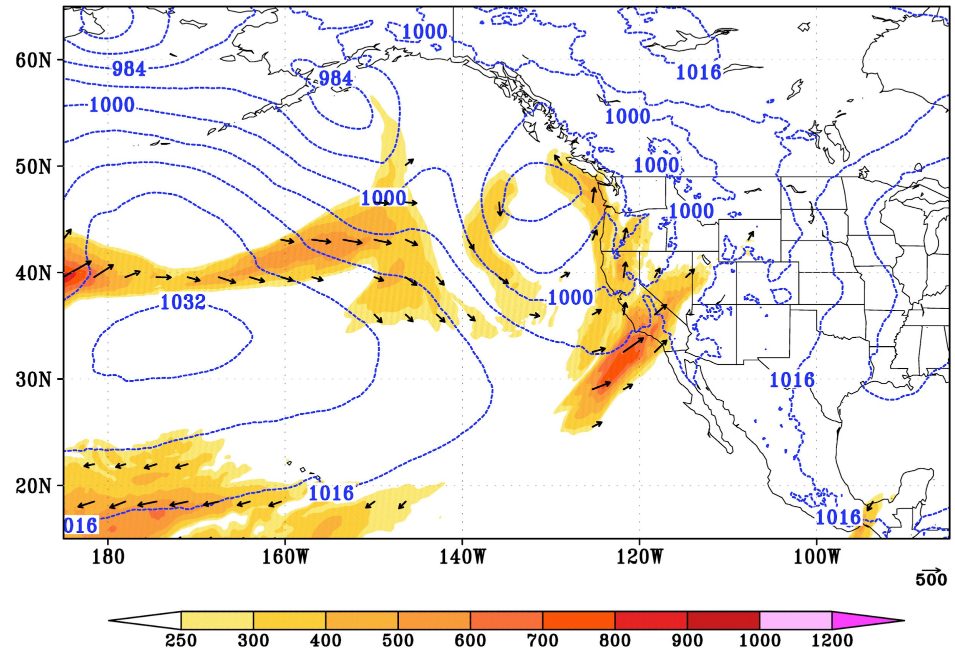
Feb 17 00Z

IVT(Amp:shaded, Vec:arrow,[kg m⁻¹ s⁻¹]) & MSLP(blue contours)
0000 UTC 17 FEB 2016

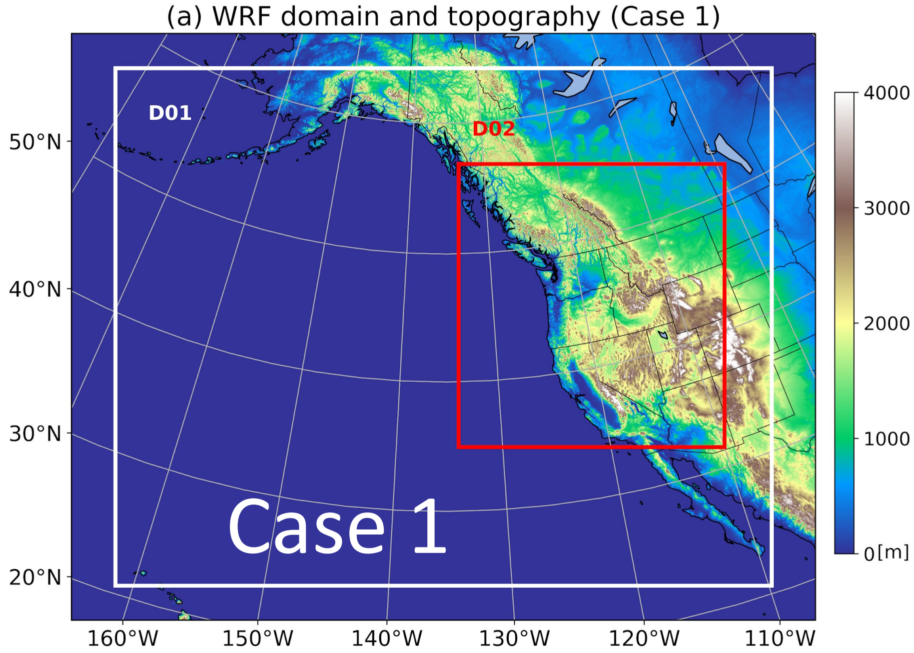


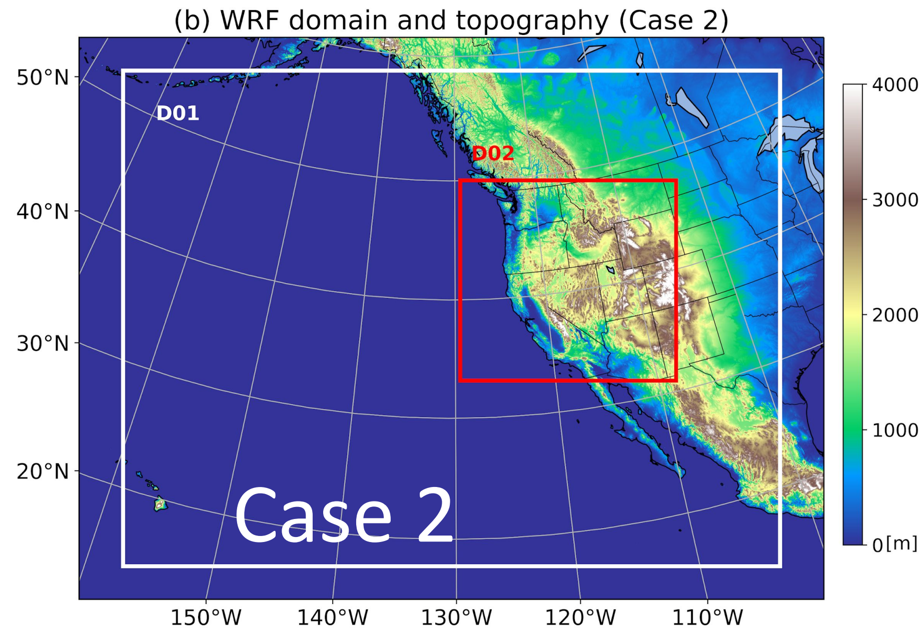
Feb 18 00Z

IVT(Amp:shaded, Vec:arrow,[kg m⁻¹ s⁻¹]) & MSLP(blue contours)
0000 UTC 18 FEB 2016



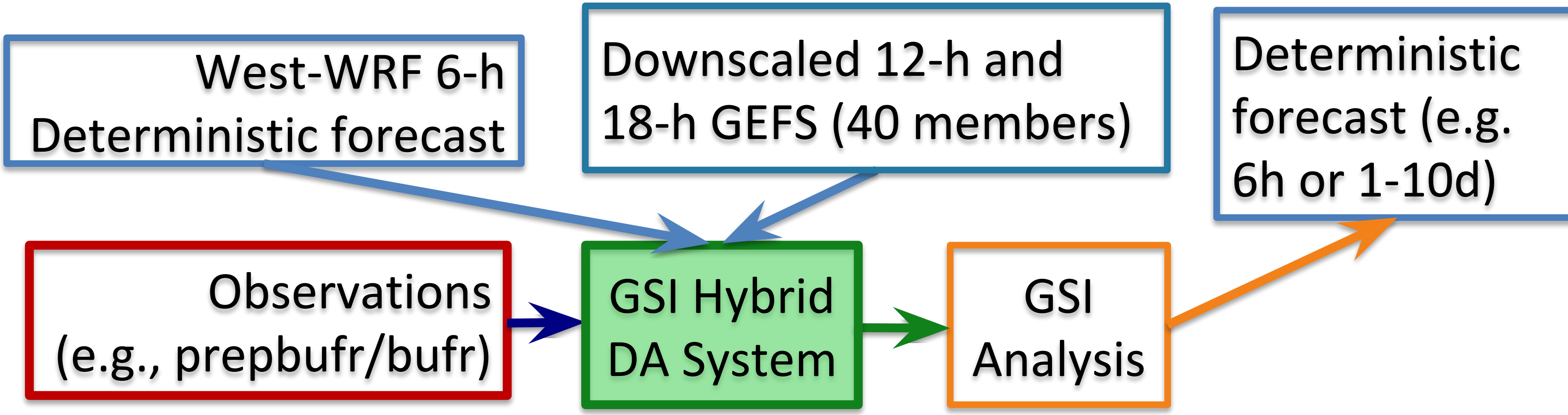
West-WRF@cw3e configuration





- West-WRF (v3.9.1.1): 9(3) km, New Thompson scheme, the Yosei University PBL, the Grell 3D cumulus, the Noah land surface, 6-h cycling
- Community Gridpoint Statistical Interpolation (GSI, v3.6) system hybrid 3DEnVAR (h3d) and 4DEnVar (h4d)

Experiment design

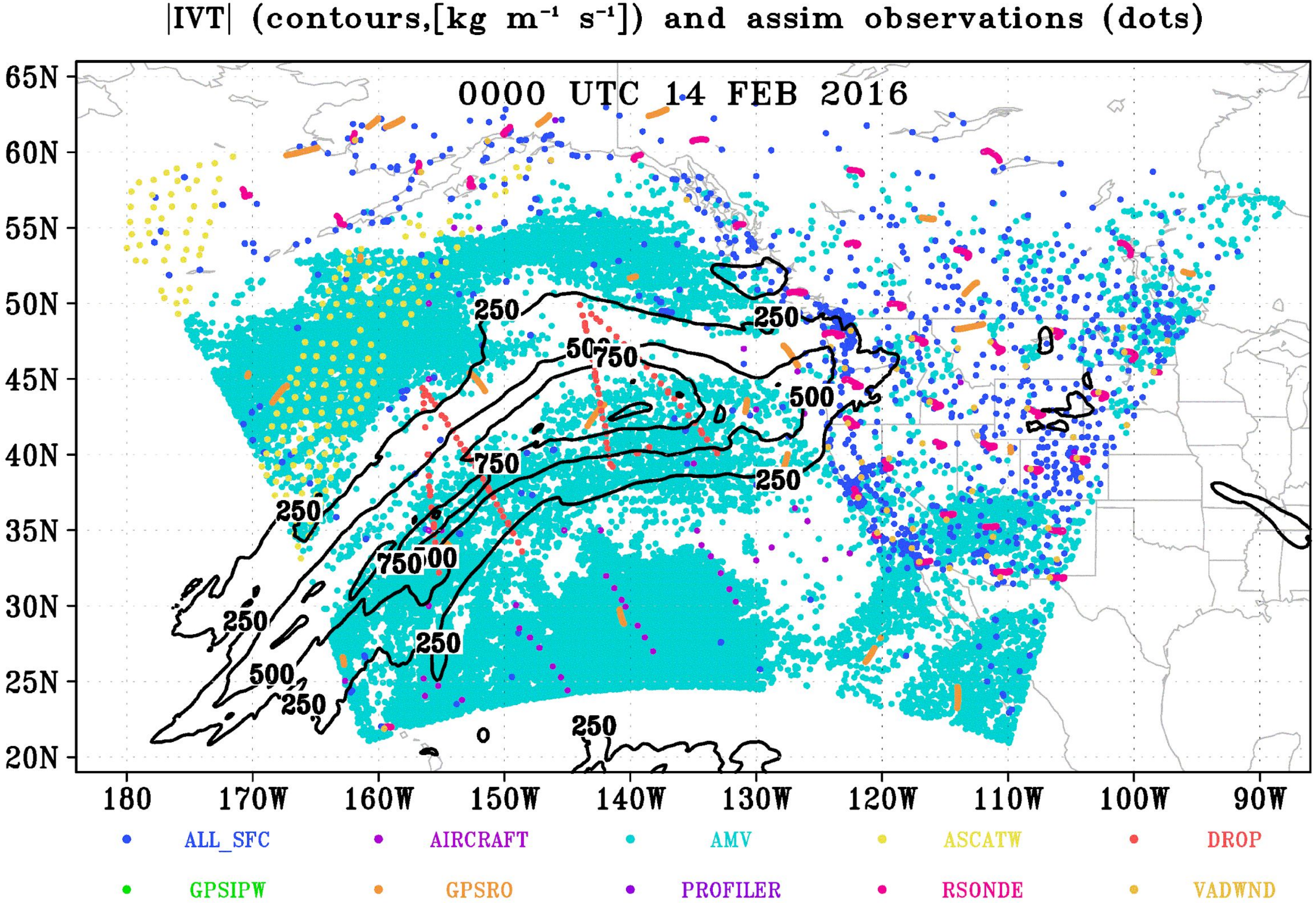


I. *Conventional run (CONV run)*: assimilate conventional data (include GPSRO and AMV) using h3d and h4d; ➔to compare two methods; to evaluate dropsonde impact.

II. *Conventional + Satellite run (SAT run)*: assimilate all data in I. and satellite data from AMSUA, ATMS, MHS, HIRS4,GOESFV.

III. *Denial run*: remove a particular data type, e.g., NoDROP means the denial of dropsondes in CONV run or SAT run.

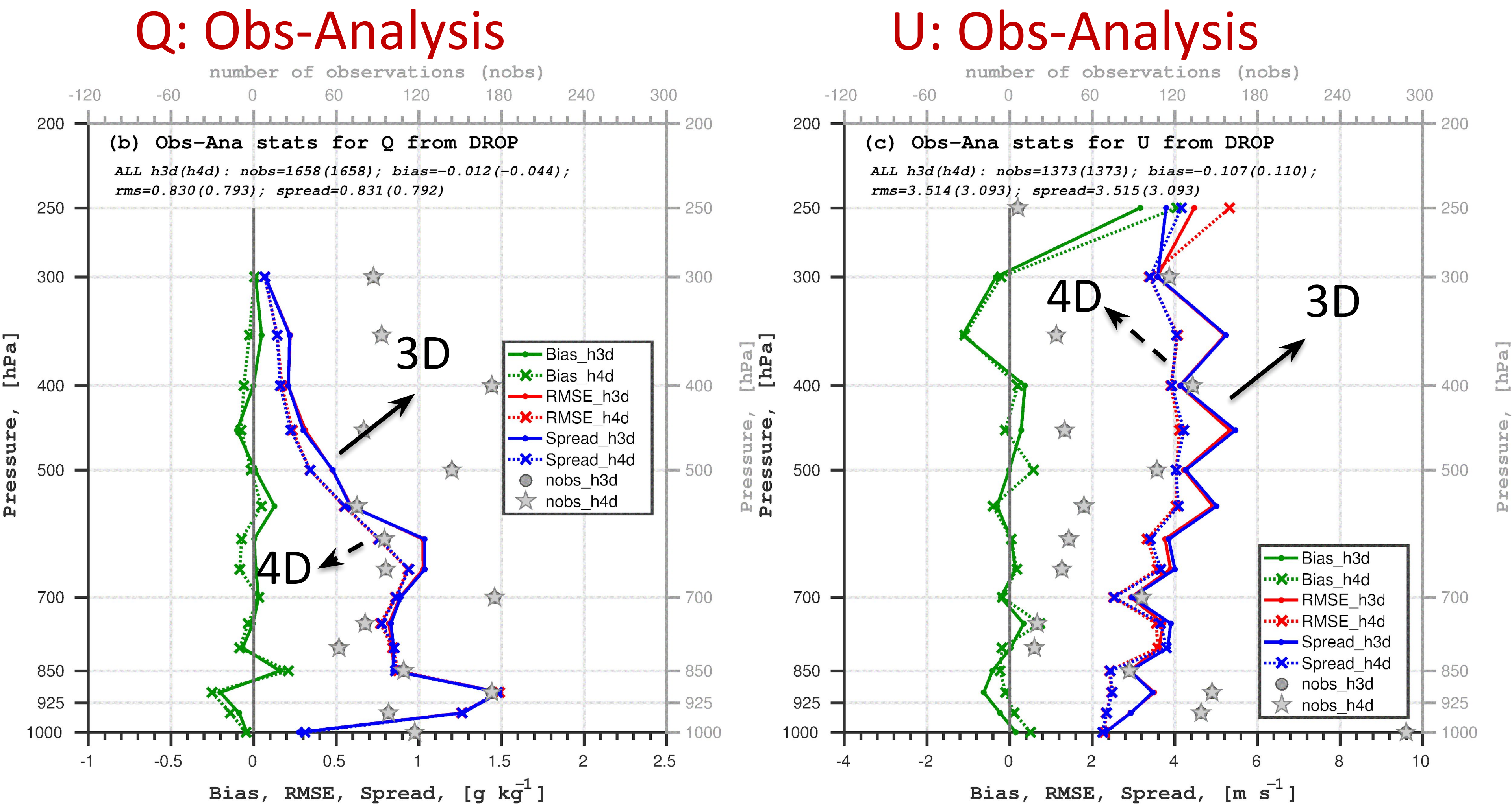
A snapshot of assimilated conventional data



DROP: Recon Dropsondes

H3D vs. H4D (observation space):

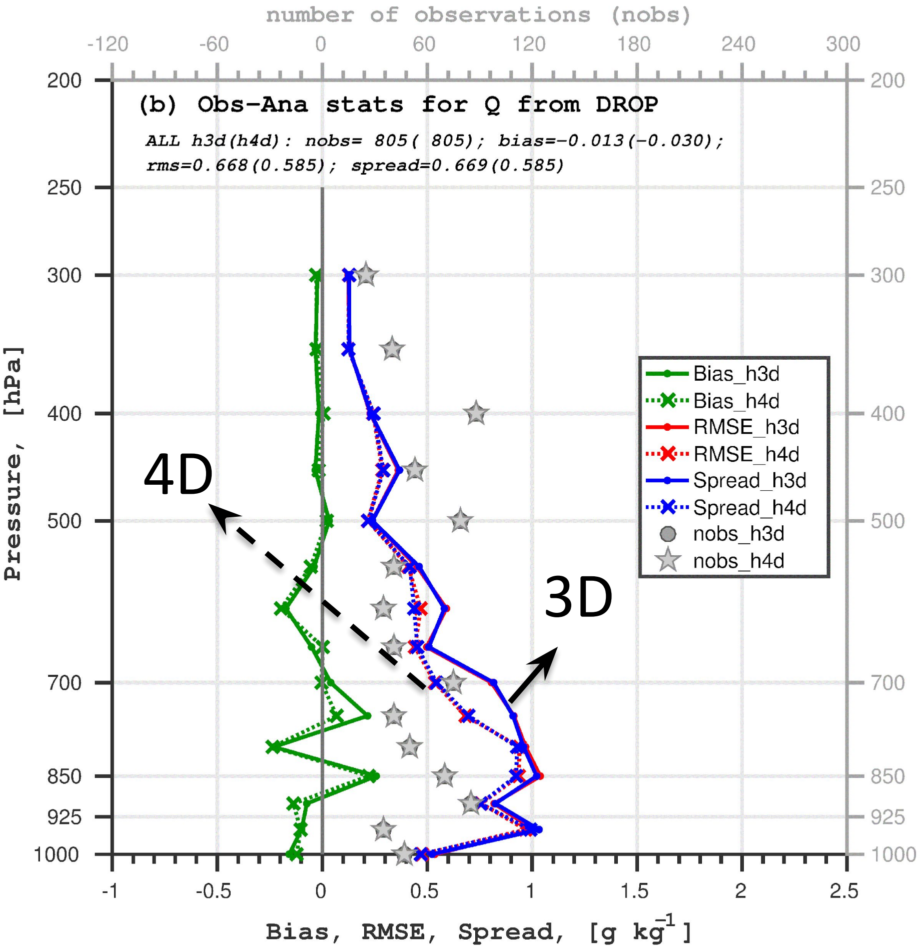
Fit of observations to model analysis (Case 1)



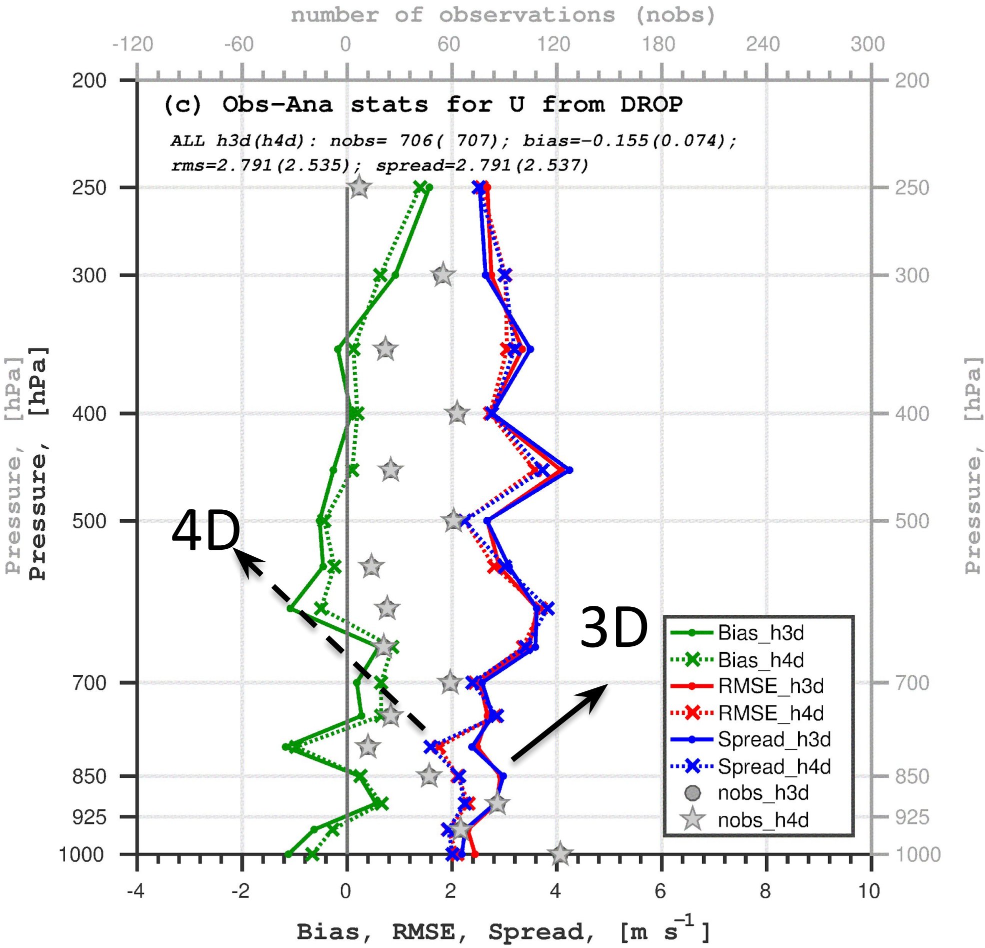
Zheng et al. 2018 in prepare

H3D vs. H4D (observation space):
Fit of observations to model analysis (Case 2)

Q: Obs-Analysis

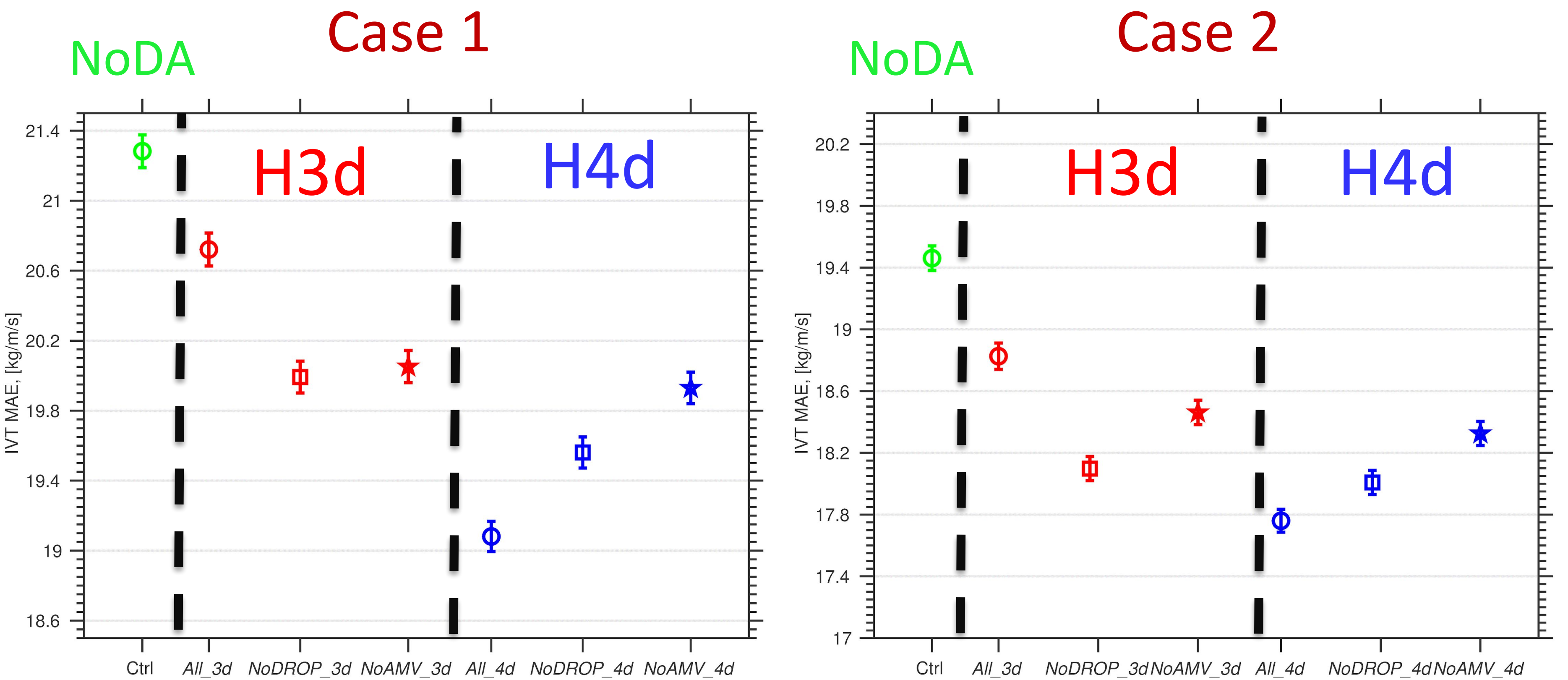


U: Obs-Analysis



Zheng et al. 2018 in prepare

Model space: IVT analysis (updated) errors



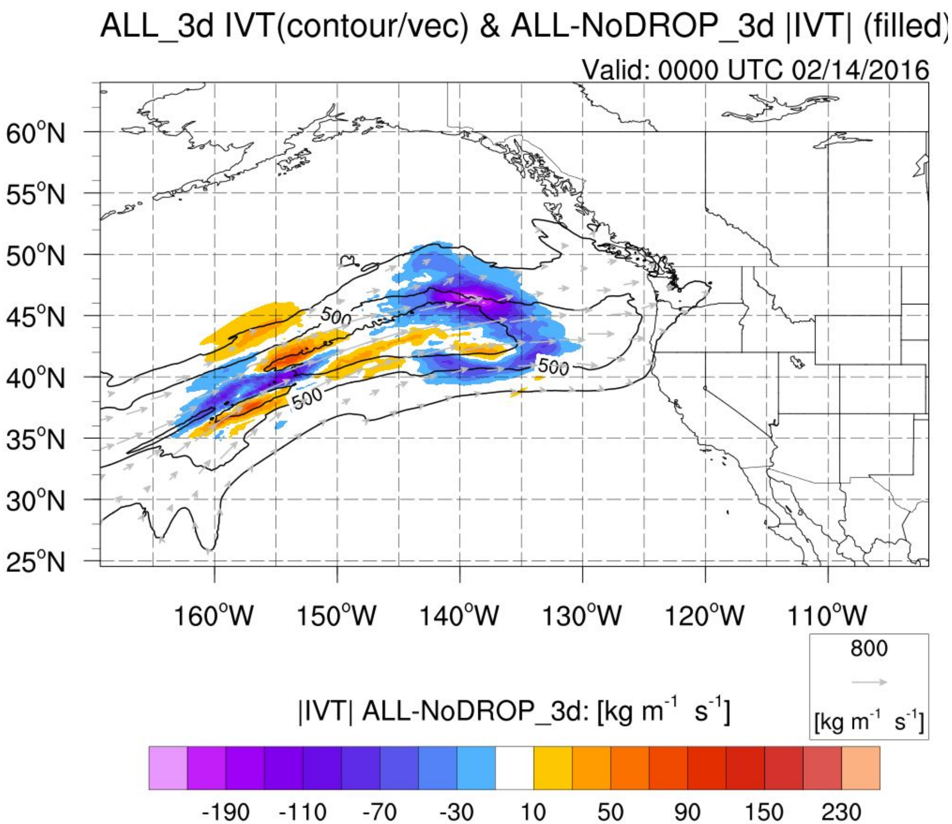
Assimilation of conv data reduces analysis (IC) errors.

Wrong methods of handling AMV and DROPs could bring more analysis errors .

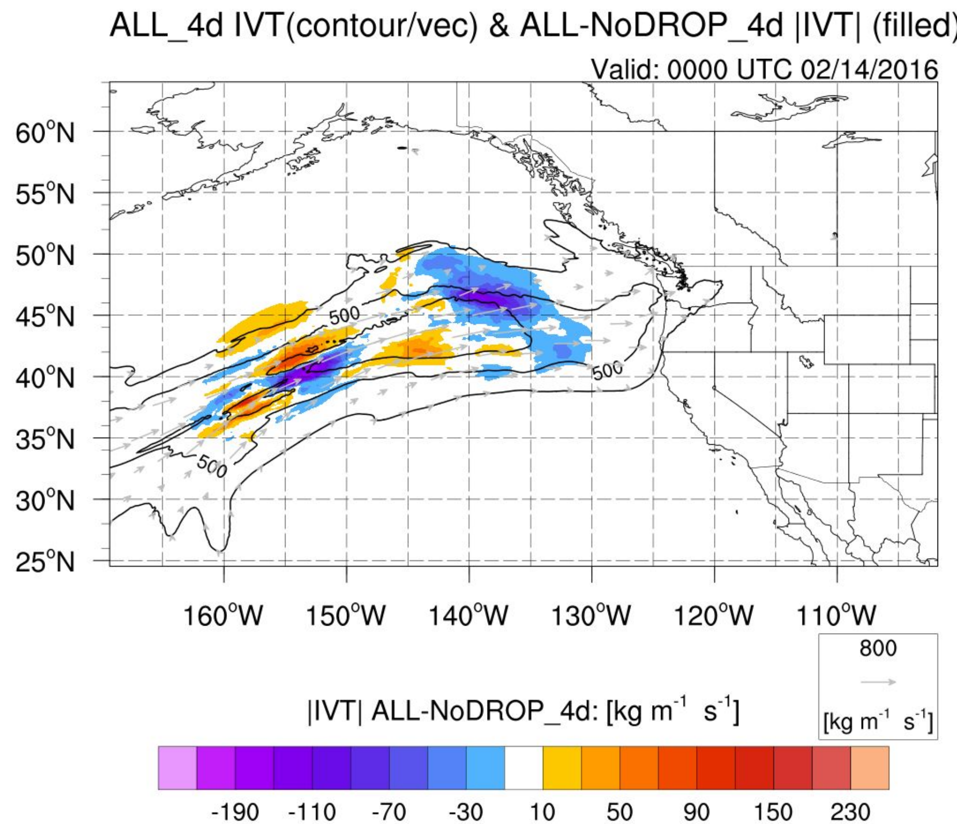
Removal of DROPs or AMV using 4D-EnVAR increases IC errors.

DROP impact in H3D and H4D (SAT run)

H3d: With–Without DROP (filled)

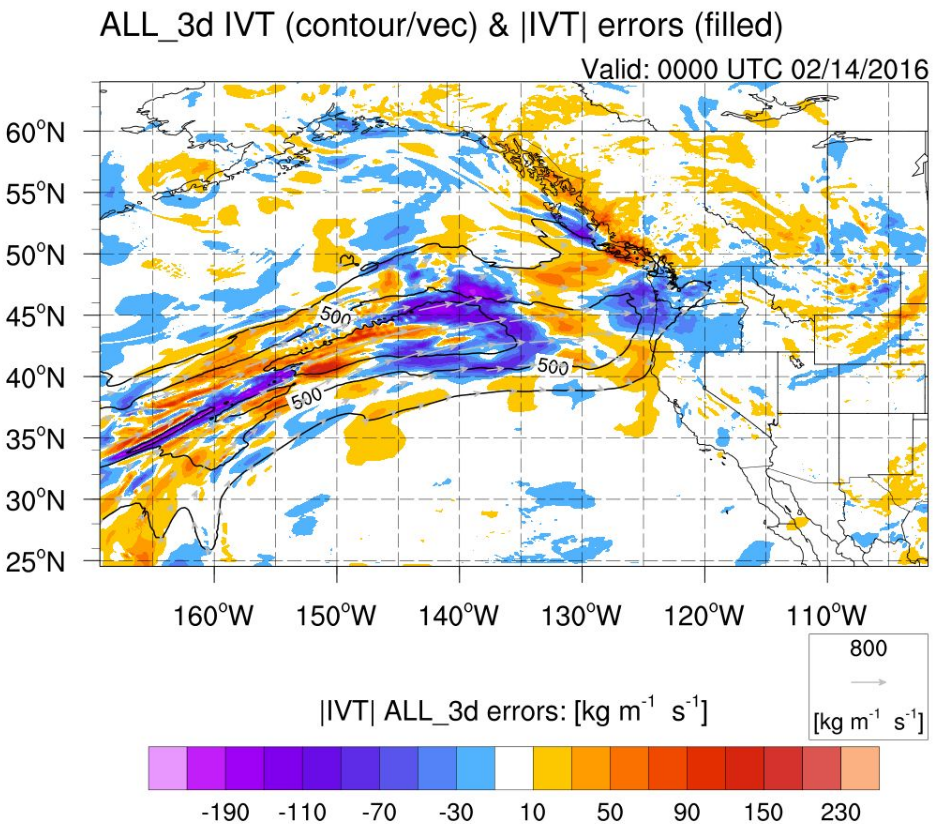


H4d: With–Without DROP (filled)

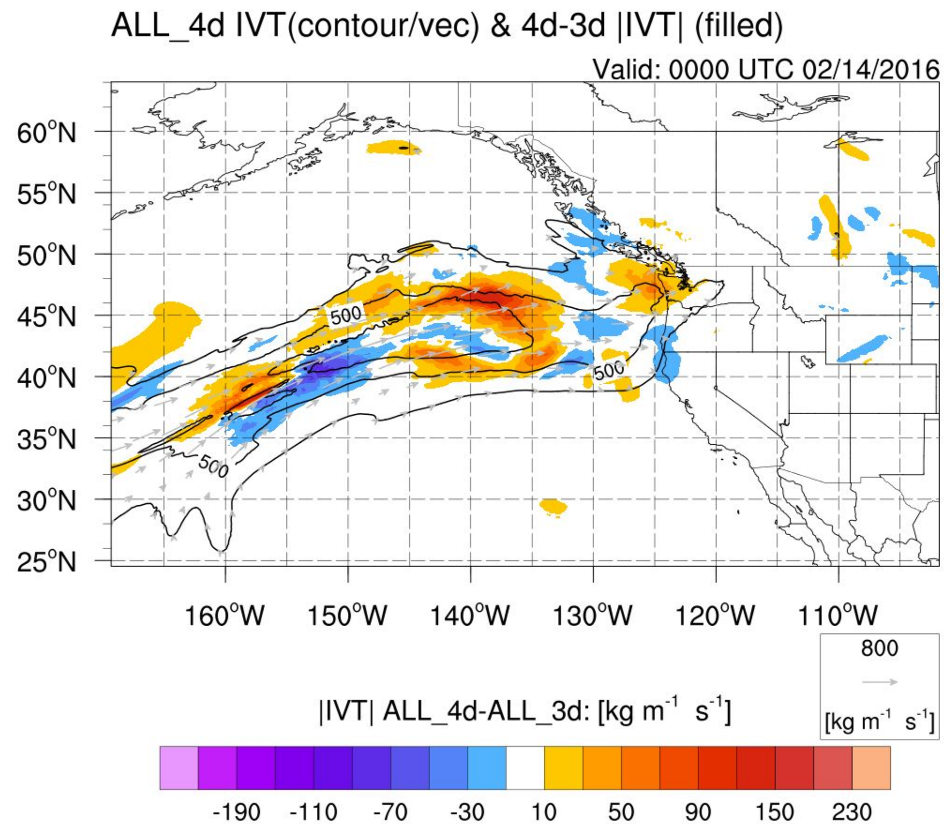


Analysis error in H3D (ALL data) and H4D-H3D

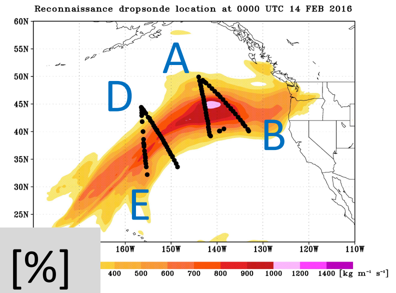
ALL_3D |IVT| errors (shaded)



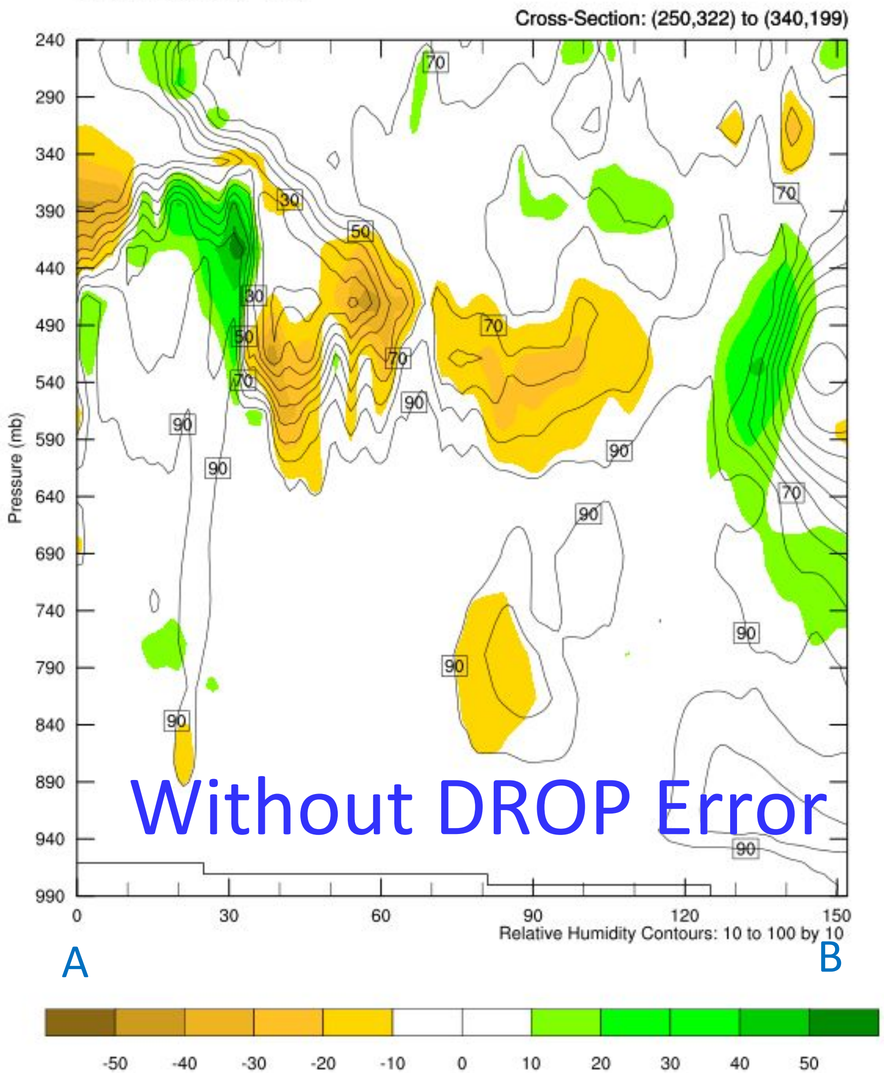
H4D-H3D IVT difference (shaded)



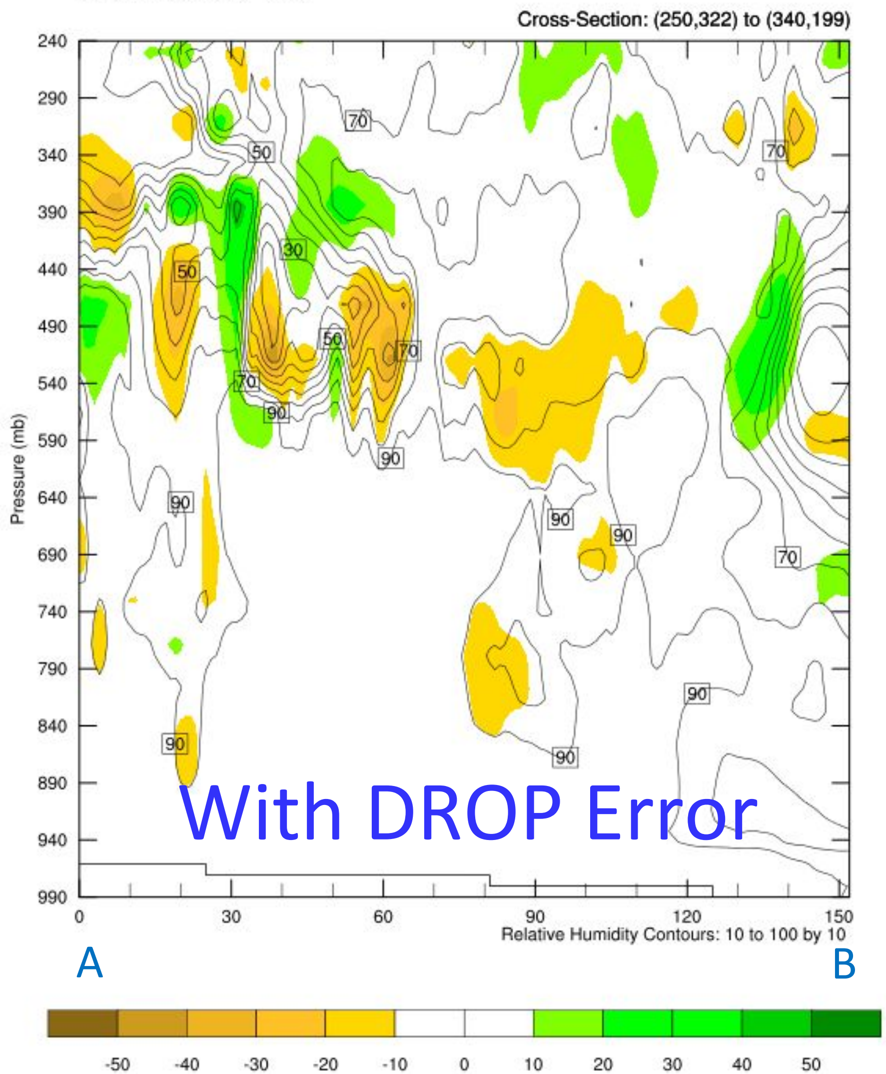
Dropsonde impact on initial conditions: cross section of relative humidity



Shaded: RH errors in NoDROP run, [%]

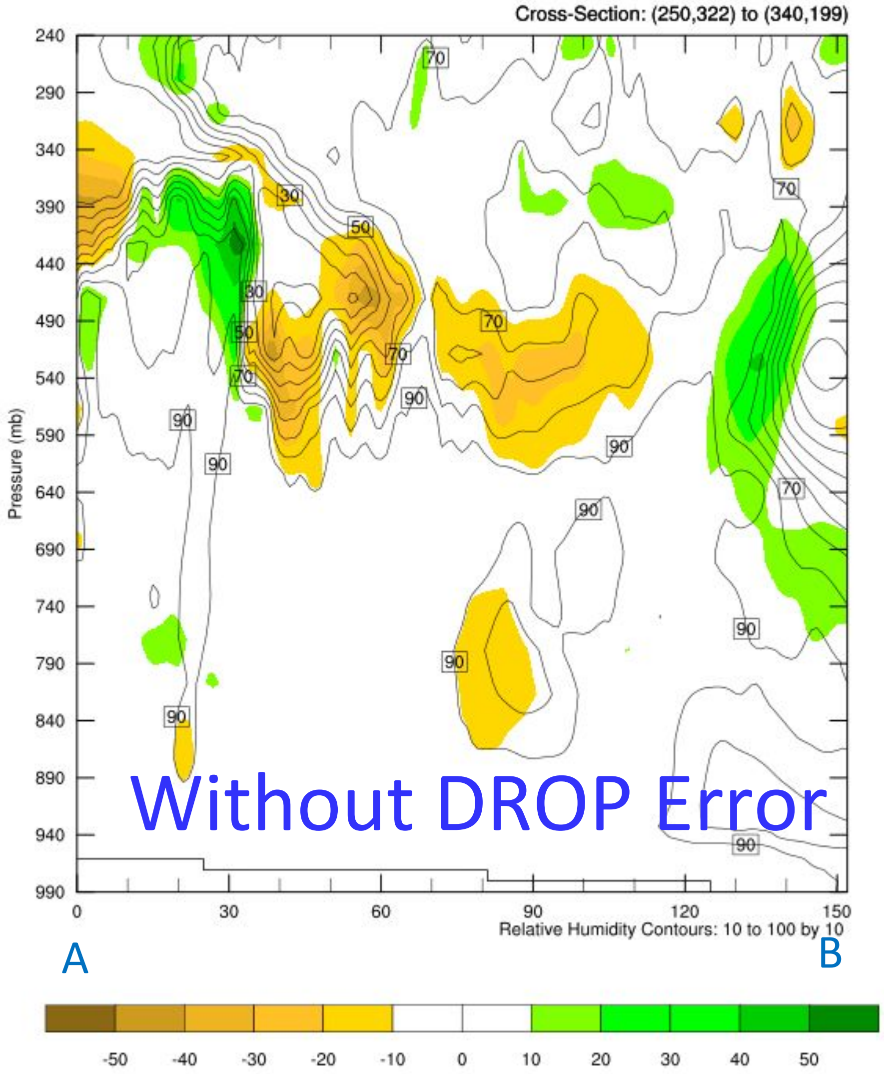


Shaded: RH errors in ALL run, [%]

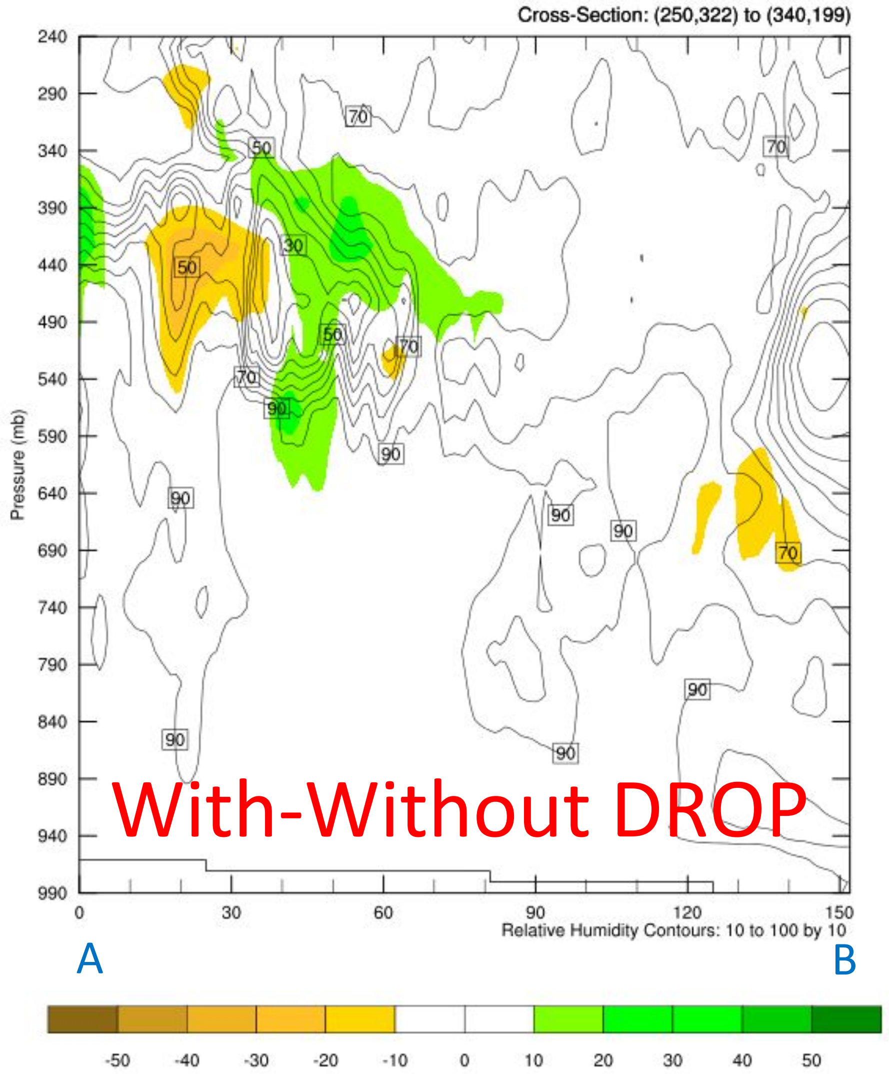


Dropsonde impact on ICs: cross section of RH

Shaded: RH errors in NoDROP run, [%]

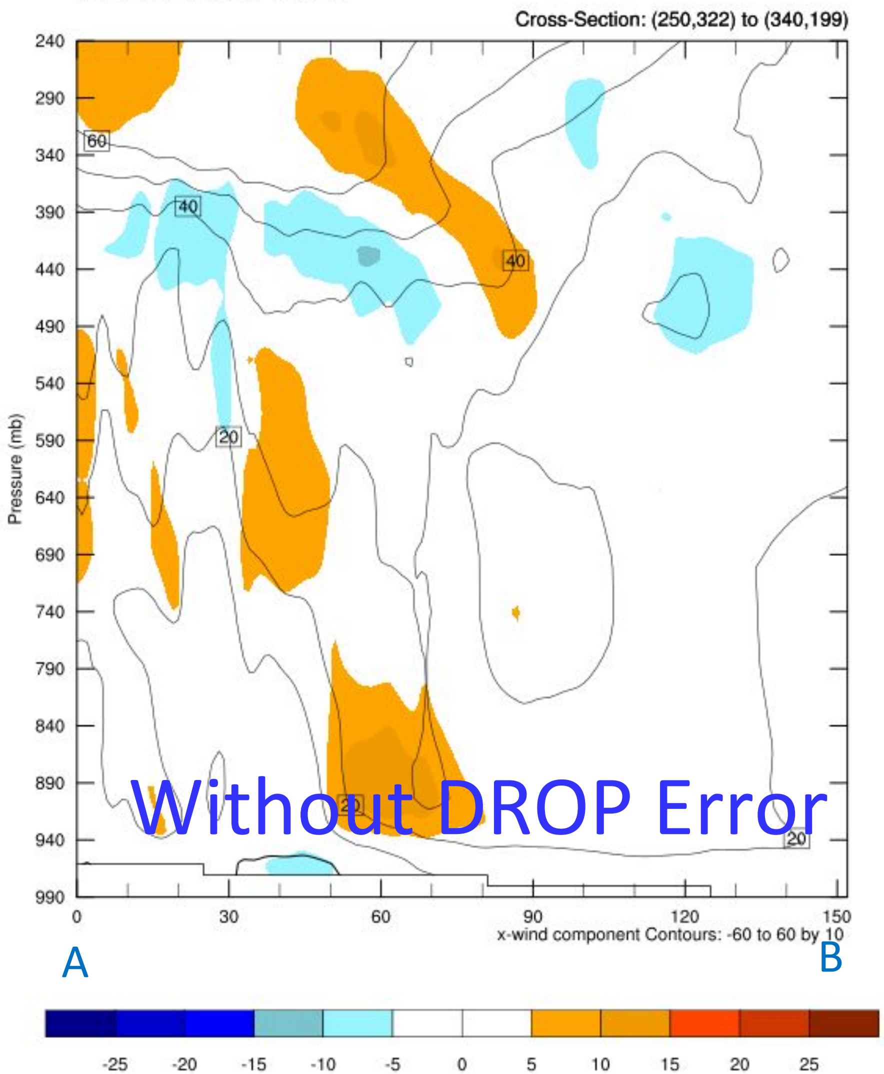


Shaded: ALL-NoDROP RH diff run, [%]

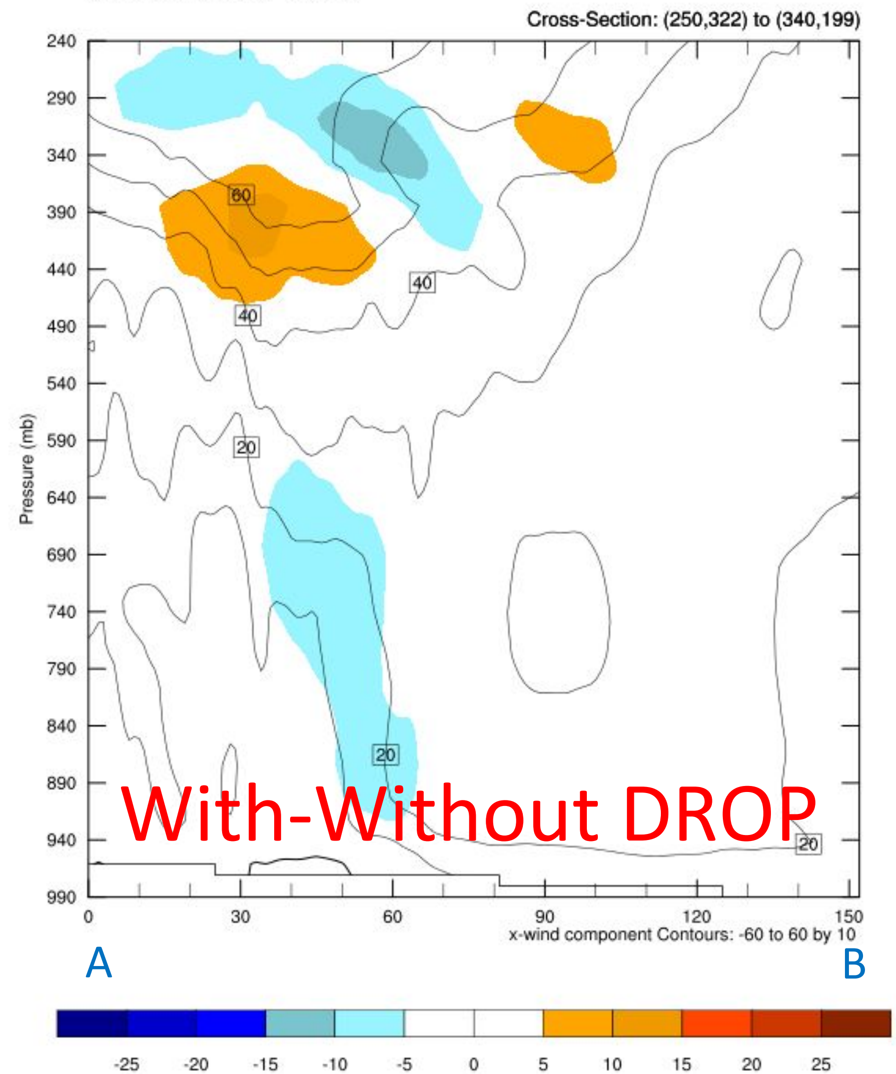


Drops impact on ICs: cross section of Uwind

Shaded: U errors in NoDROP run, [%]

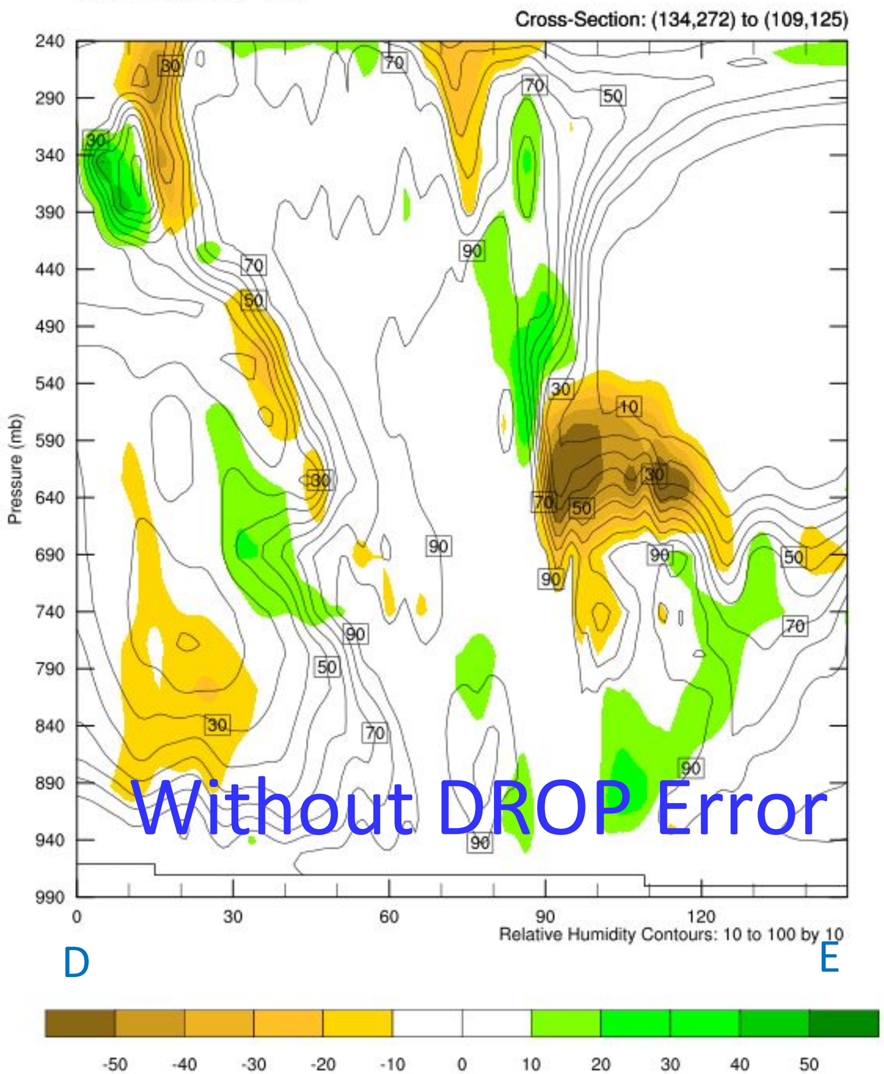


Shaded: ALL-NoDROP U diff run, [%]

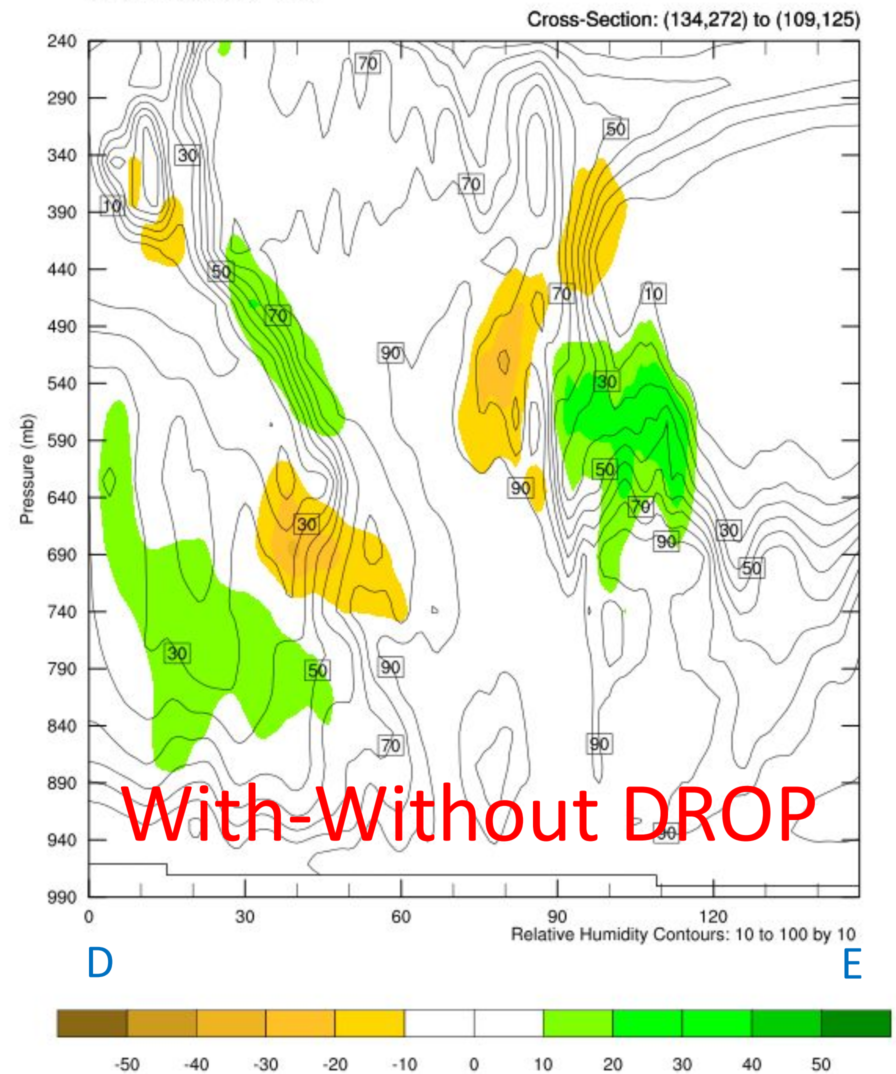


Dropsonde impact on ICs : RH for path DE

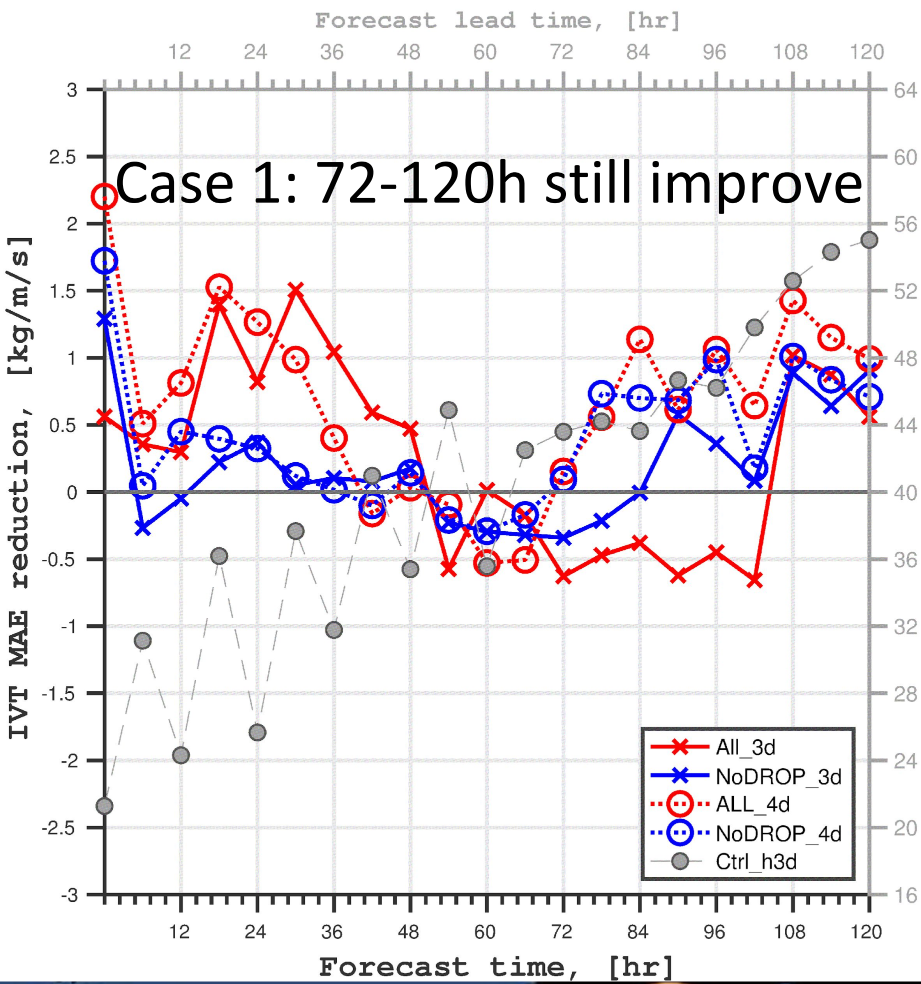
Shaded: RH errors in NoDROP run, [%]

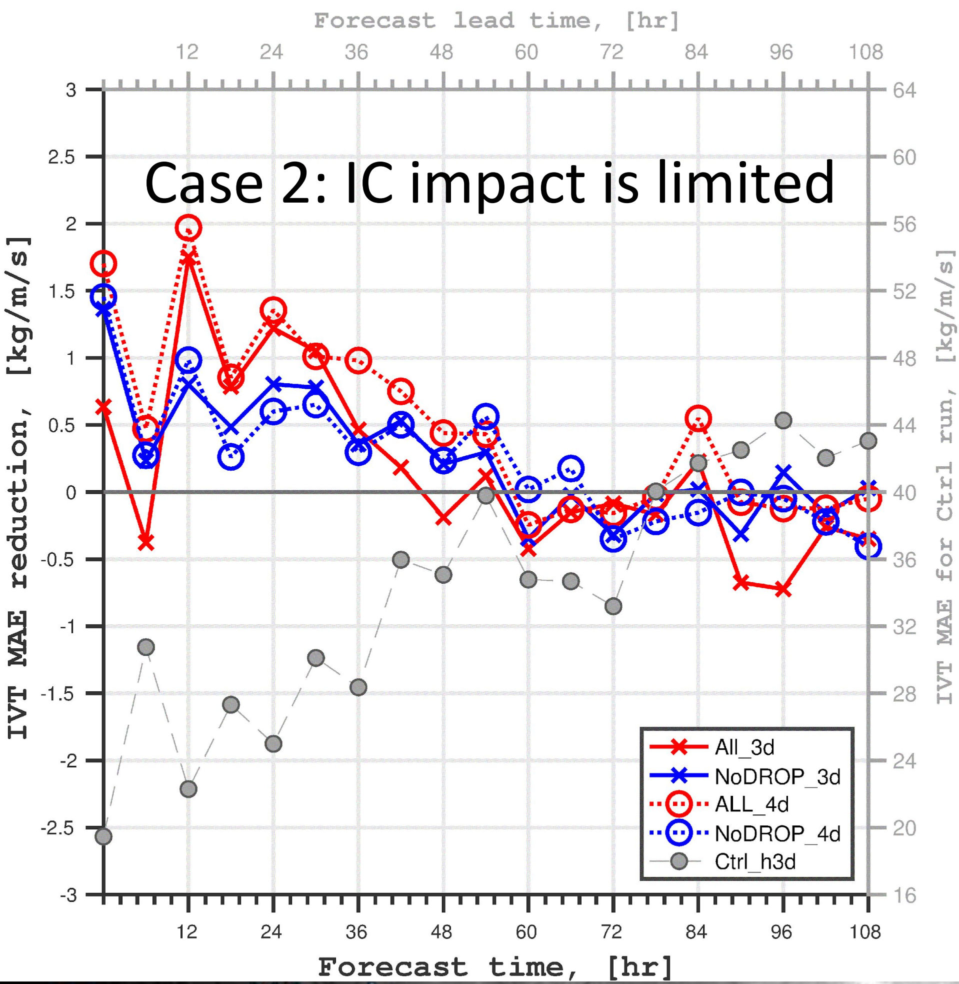


Shaded: ALL-NoDROP RH diff run, [%]



CONV run forecast validation

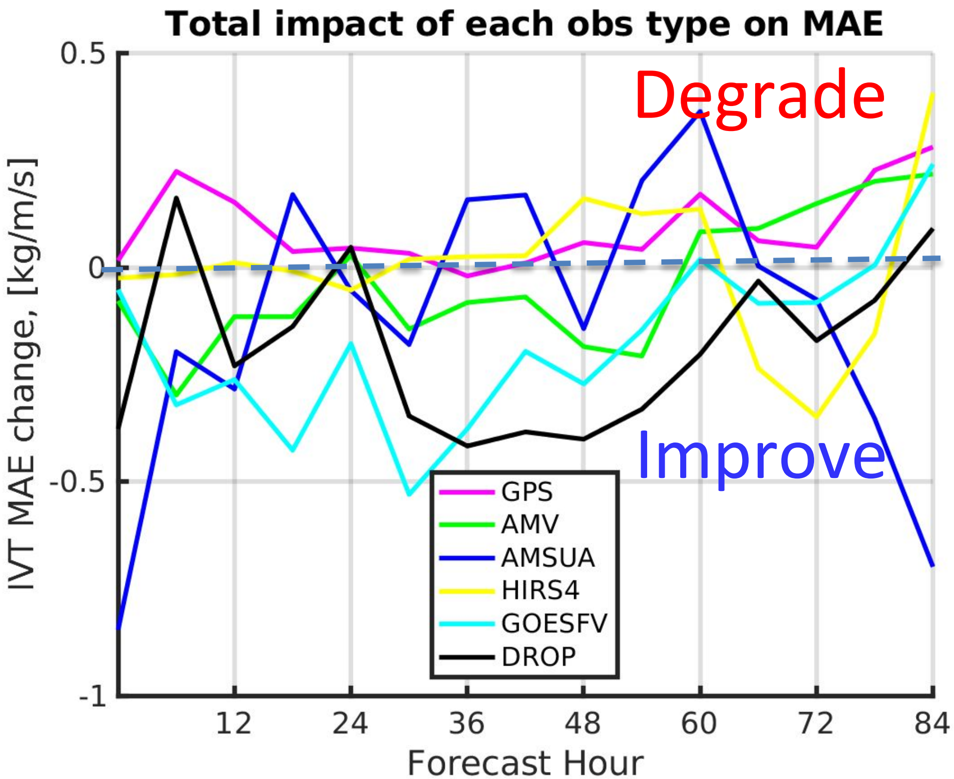


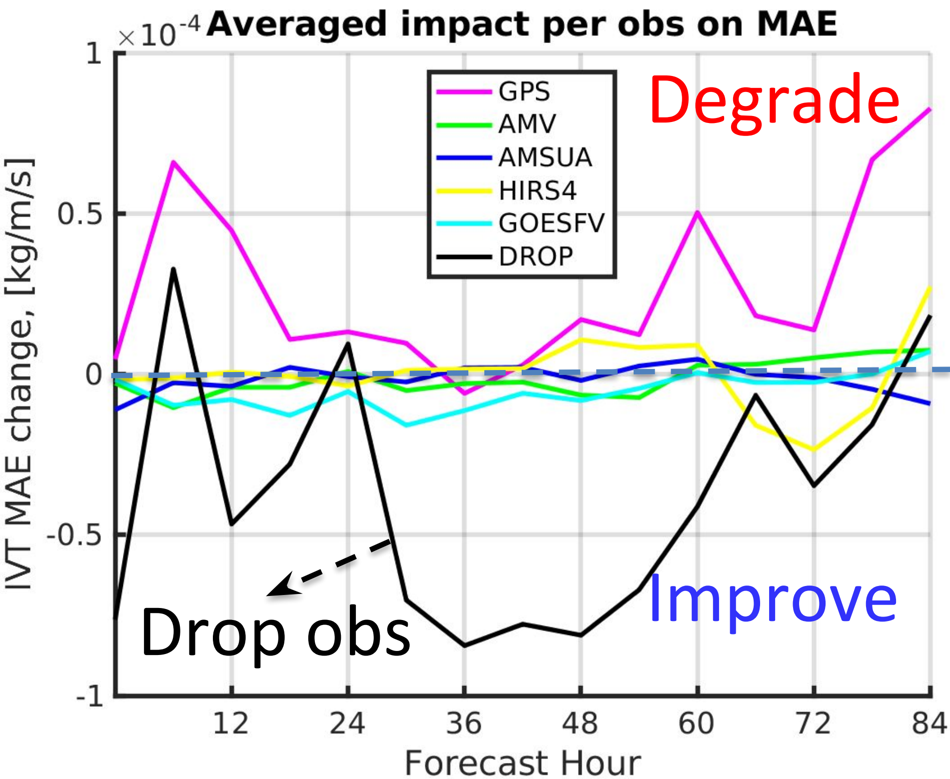


SAT run and its denial run forecast validation: impact of different observation types

Impact=MAE(ALL)-MAE(Denial_Run), Denial_RUN: GPS, AMV, AMSUA, HIRS4,GOESFV, DROP

>0 Increase error→Degrade; <0 Reduce error→Improve





Conclusions and ongoing work

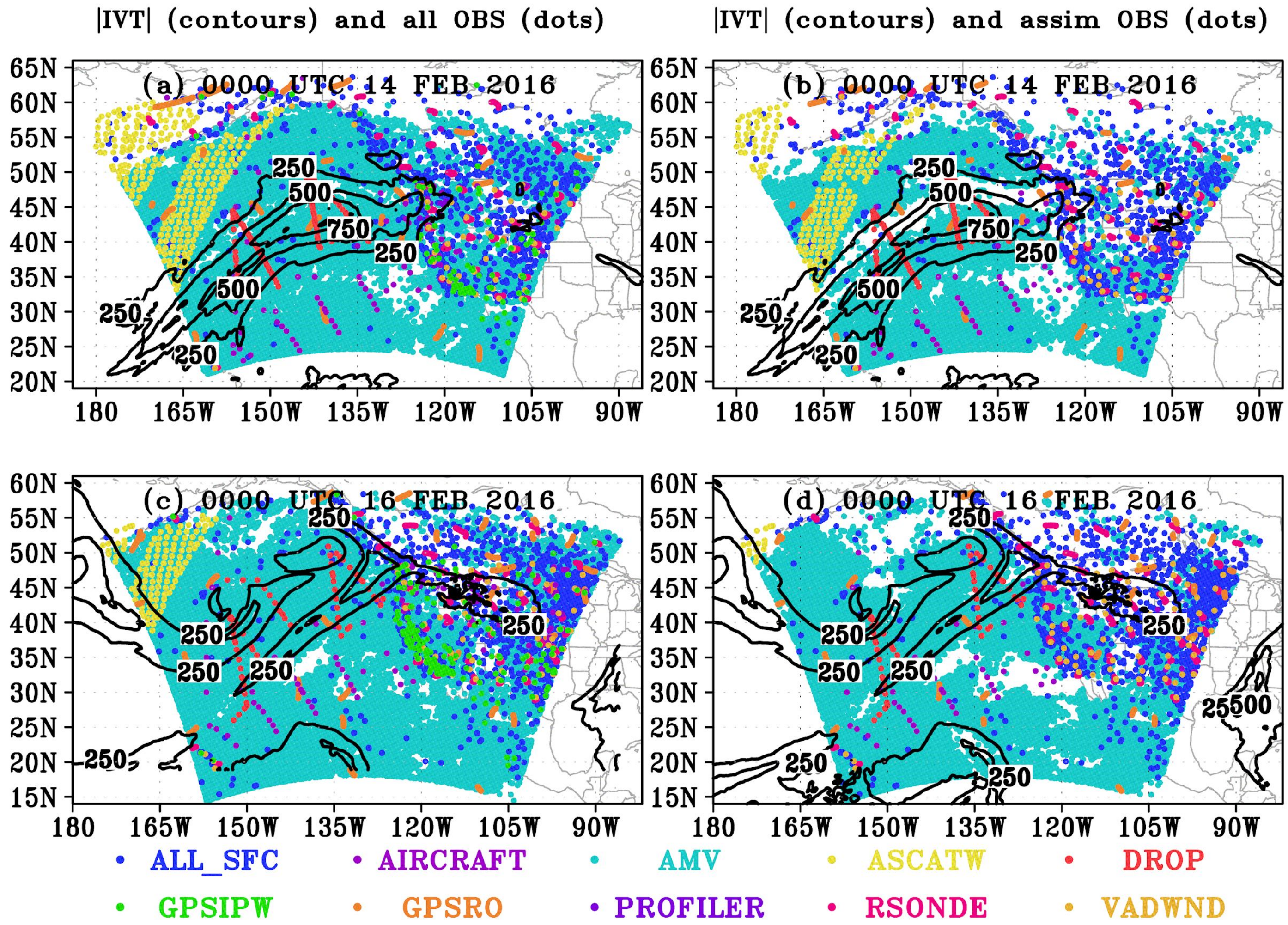
- *4D-EnVAR is superior over 3D-EnVAR in assimilating humidity and wind fields for both AR cases.*
- *Dropsonde data improved both the initial conditions and forecasts in the two 2016 AR cases out to medium range.*
- *When compared with satellite and GPSRO data, dropsonde observations are improving the forecasting skills most if taking # of observations into account.*

Ongoing work:

- Comparing the impacts of different DA methods on AR ICs and forecast (*Zheng et al. in prepare*).
- Evaluating the impacts of satellite data from different platforms and channels on the landfall AR forecasts (*Zheng et al. in prepare*)\

- Extras

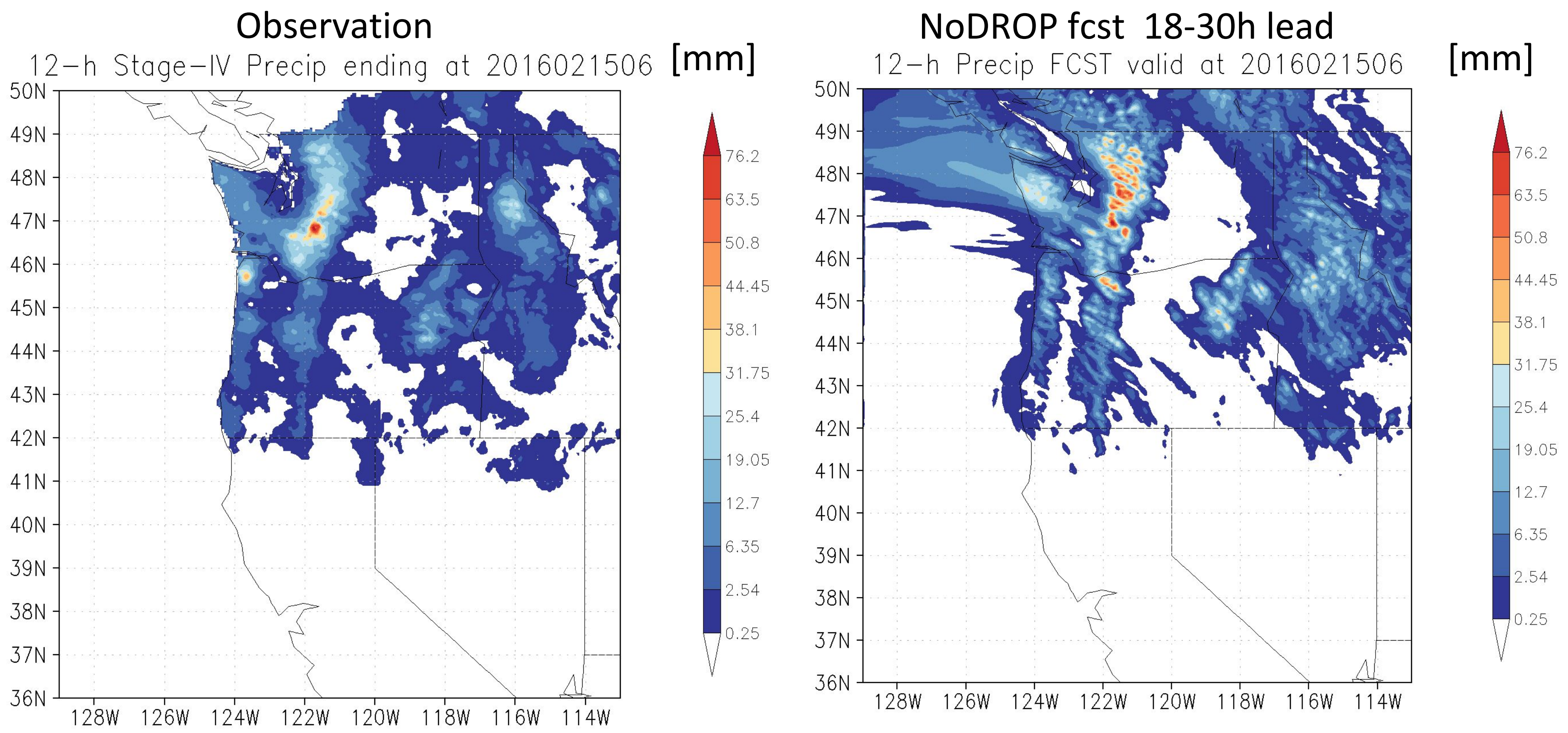
Conventional observation available and assimilated



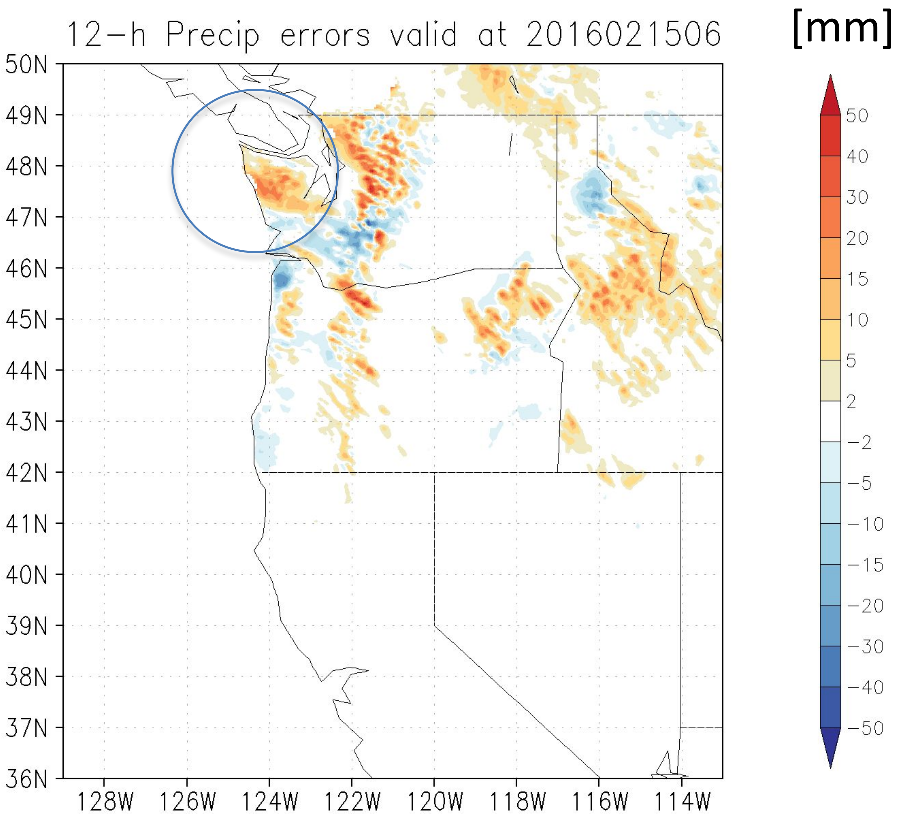
Initial efforts on developing data assimilation system in West-WRF

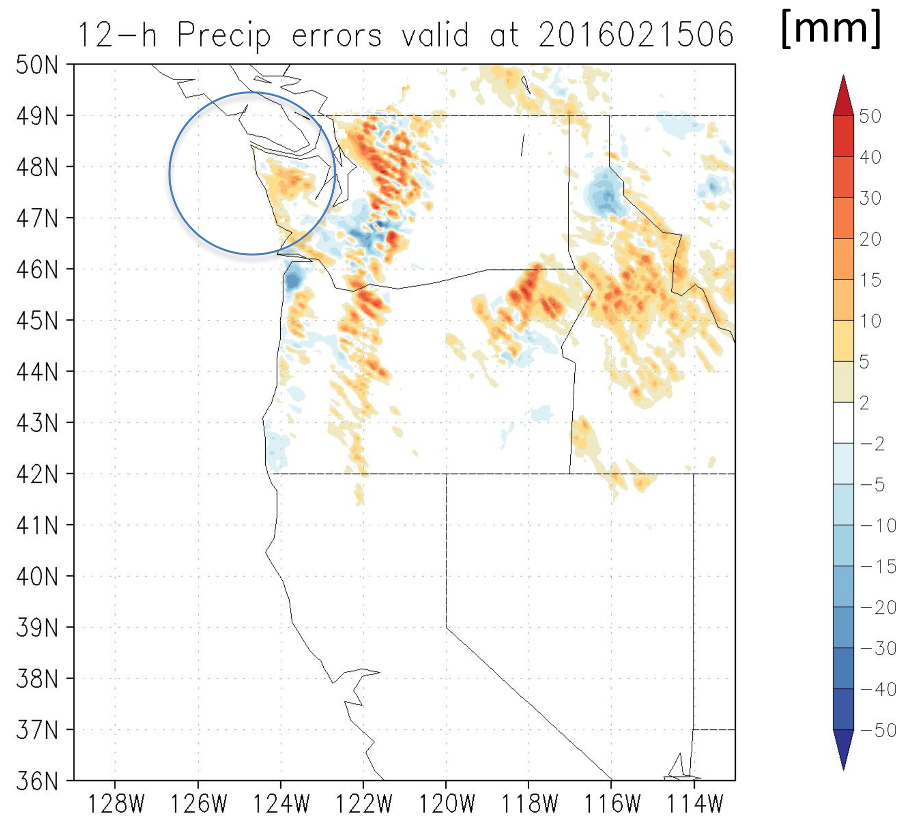
- Goals:
  i. Assess data impact in West-WRF, including AR Reconnaissance dropsonde data, in-situ observations (e.g., CW3E radar, radiosondes), satellite, and GPSRO data.
  ii. Develop near-real time DA system for West-WRF
- Tested systems and methods
  i. Data Assimilation Research Testbed (DART)/West-WRF system (Ensemble Adjustment Kalman Filter or EAKF, *Anderson et al. 2009*)
  ii. Gridpoint Statistical Interpolation (GSI)/West-WRF (hybrid 3(4)D-EnVar, *Wang 2008*)
  iii. Different ensemble methods: Fixed Covariance Perturbation method, Downscaled GEFS/CMCE ensemble

IOP1: 12h accumulated precipitation



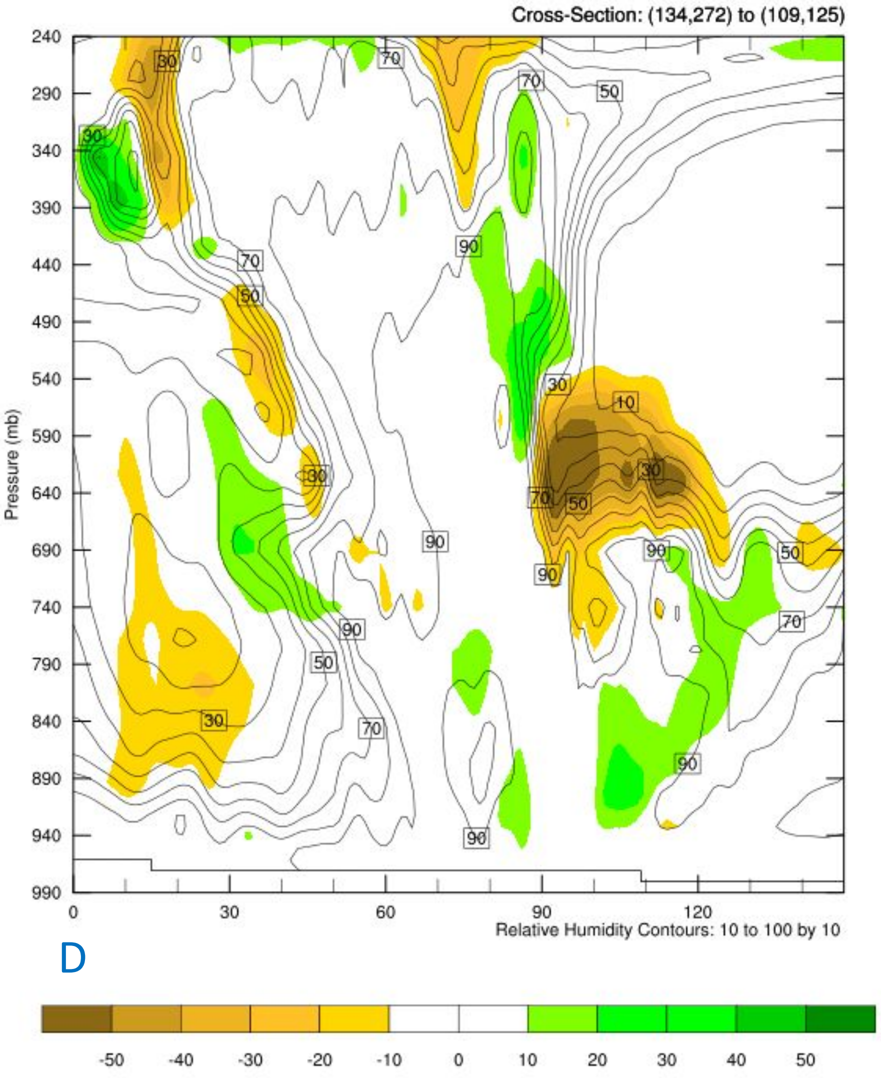
Precip errors: NoDROP vs. ALL



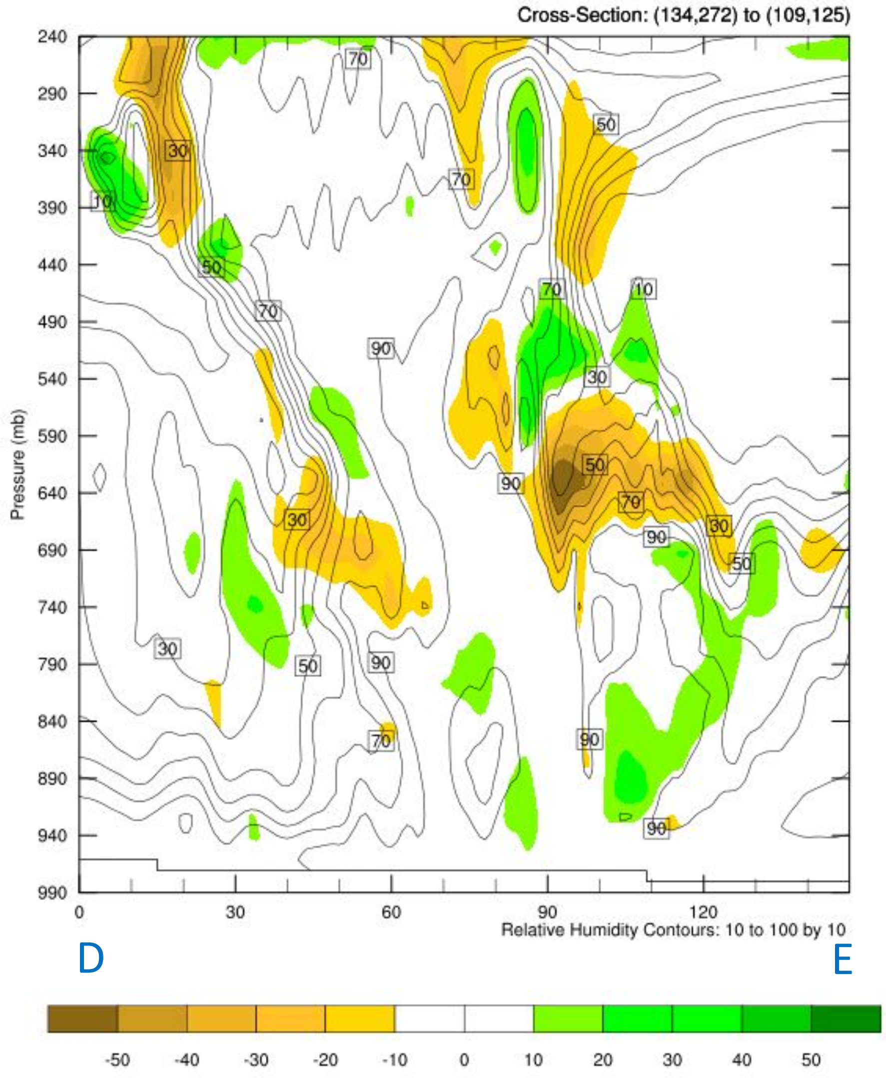


RH errors for path DE

Shaded: RH errors in NoDROP run, [%]

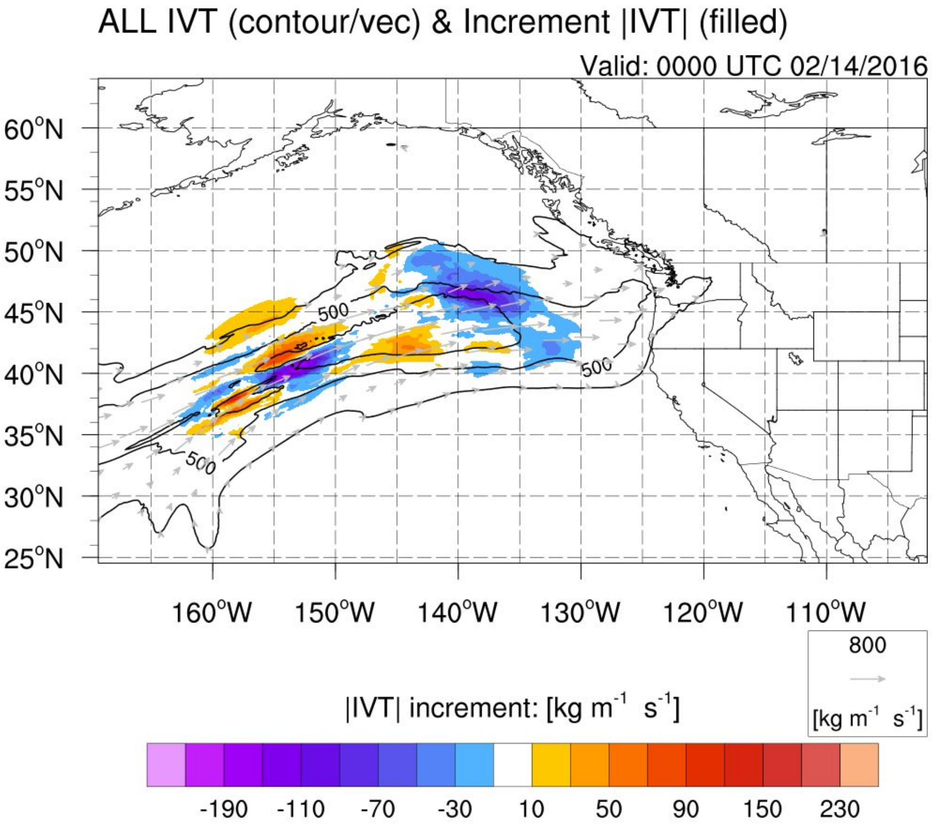


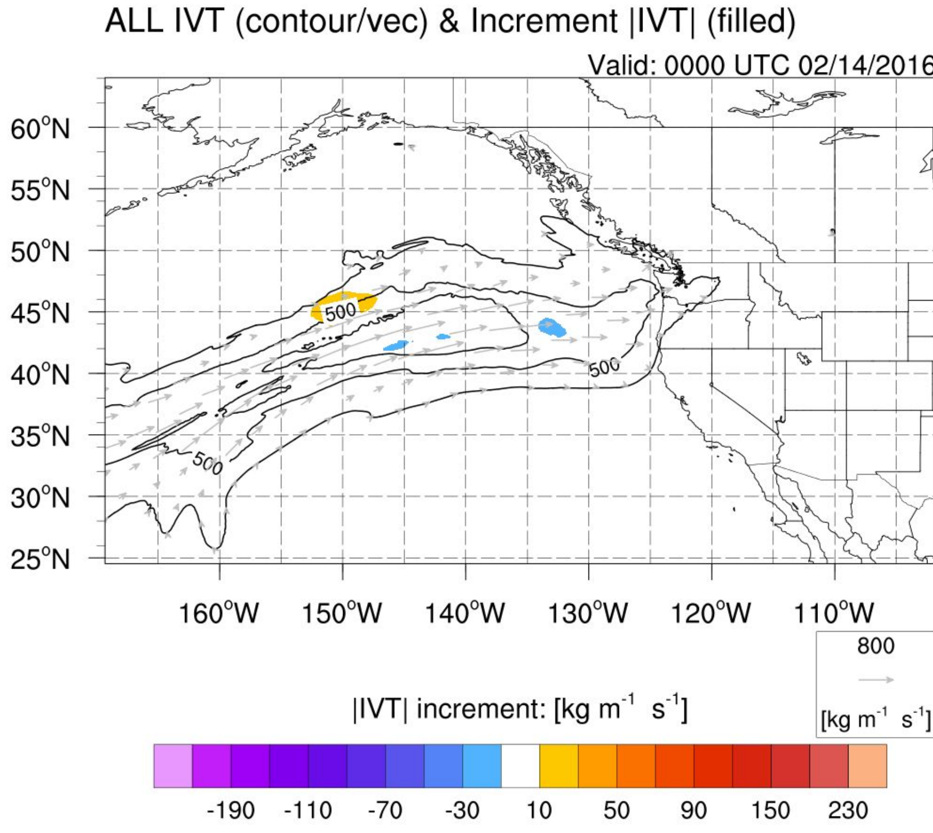
Shaded: RH errors in ALL run, [%]



The impact of different observation types: DROP sonde vs. GPSRO+AIRCRAFT

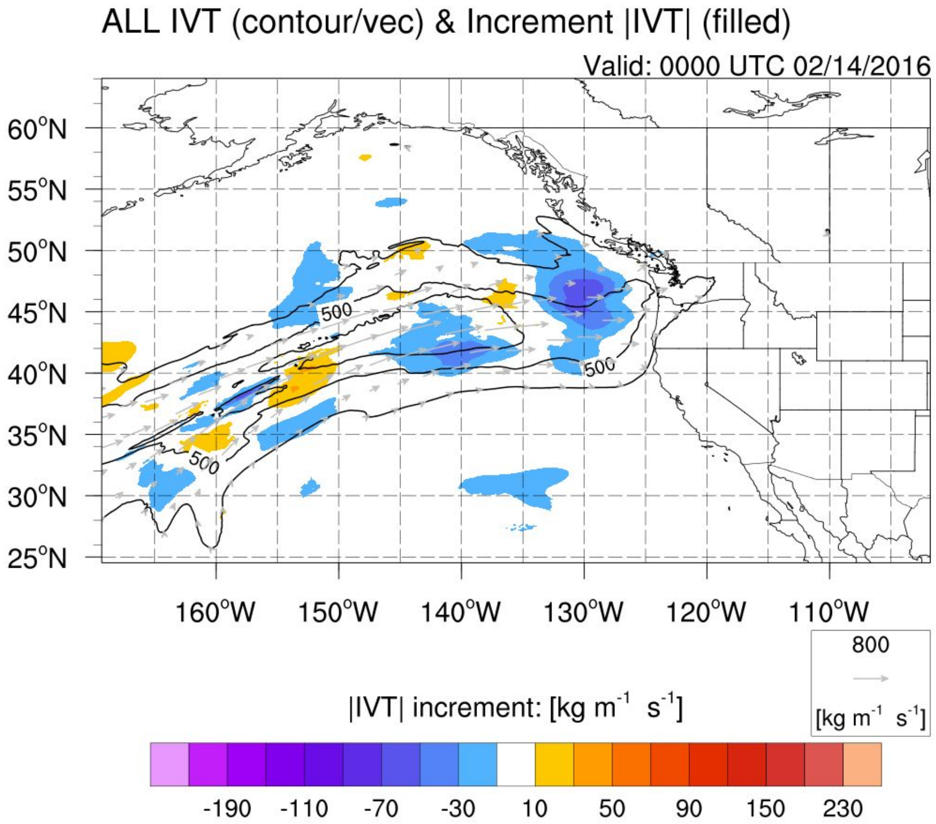
Shaded: ALL-Denial run IVT

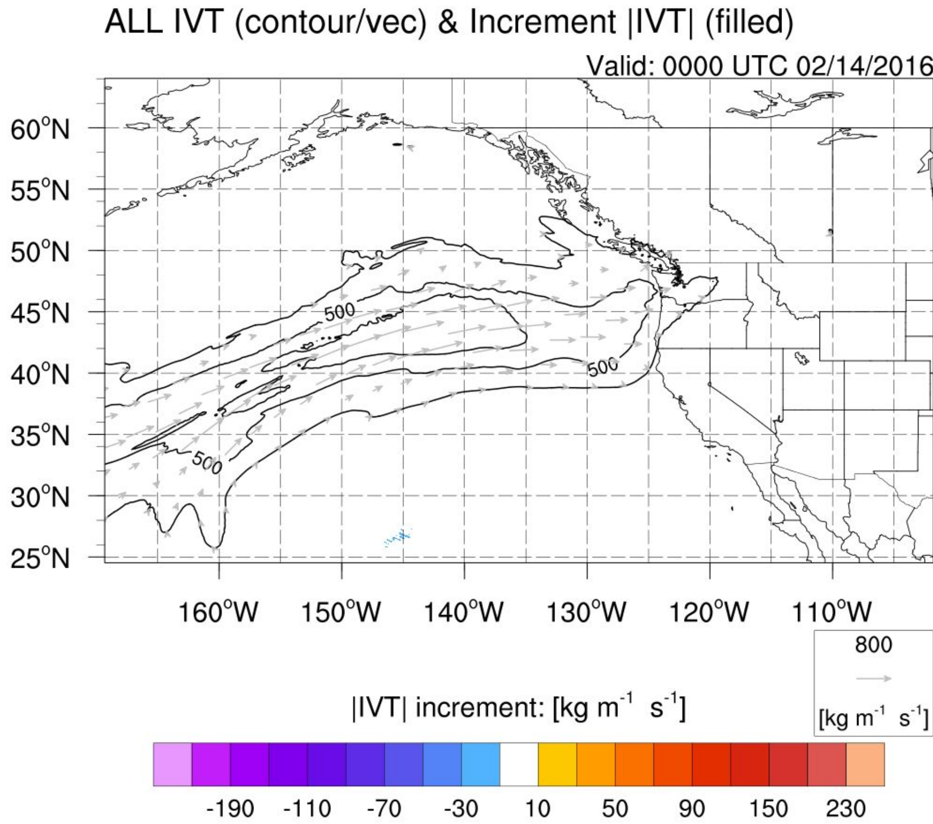




The impact of different observation types: AMSUA vs. AMV wind

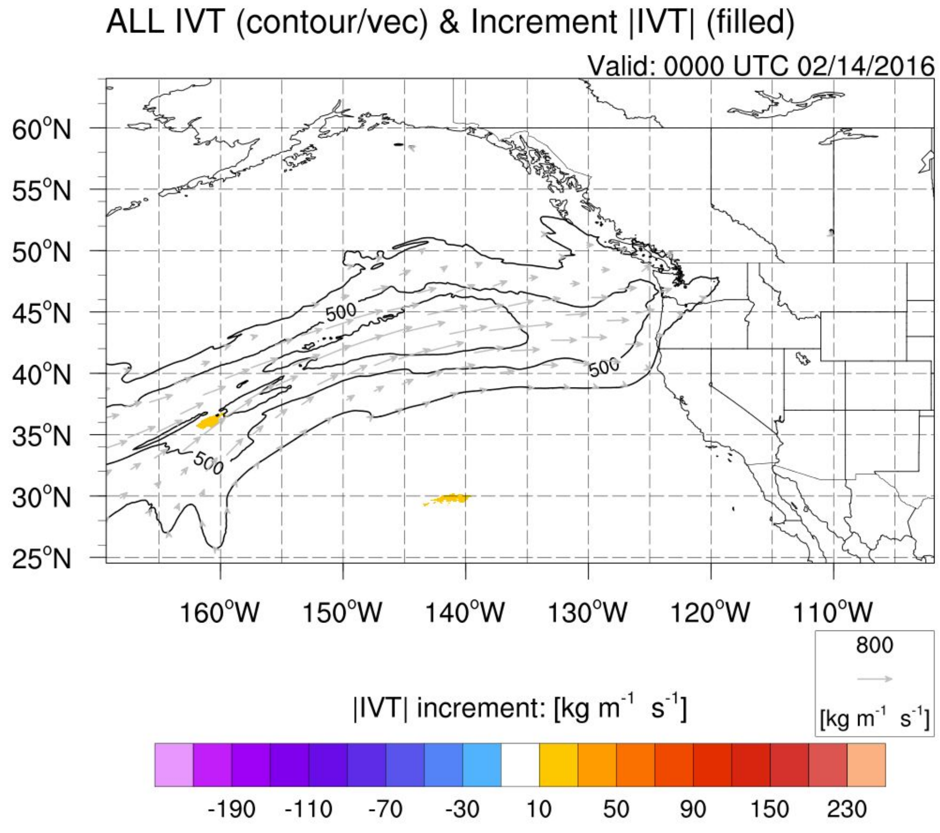
Shaded: ALL-Denial run IVT

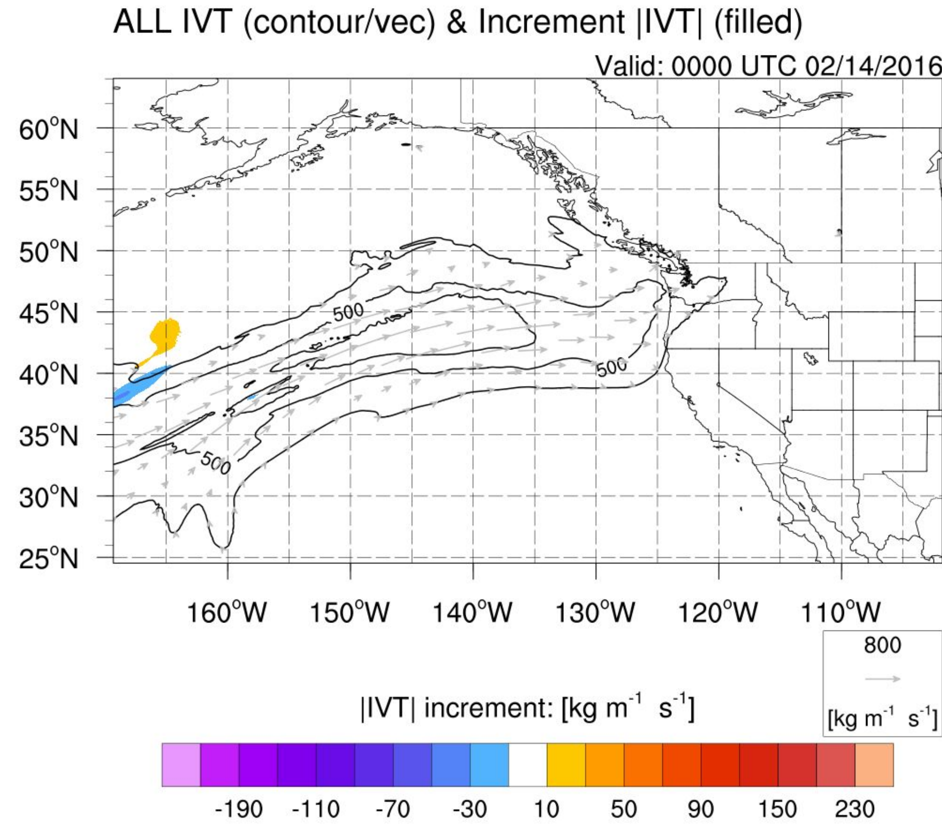




The impact of different observation types: GOESFV and HIRS4 radiance

Shaded: ALL-Denial run IVT





Initial analysis error in 4DEnVAR and differences

ALL_4d run |IVT| errors (shaded)

ALL_4d-ALL_3d differences (shaded)