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CLIMATE RESEARCH FACILITY

Large-Scale Forcing for AMIE-GAN

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Acknowledgments

Chuck Long (PNNL), Chidong Zhang (U. Miami), Steve Williams (NCAR), Bob Rilling (NCAR), Courtney Schumacher (TAMU), Scott Collis (ANL), and all field campaign participants

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Analysis Method – The Constrained Variational Analysis

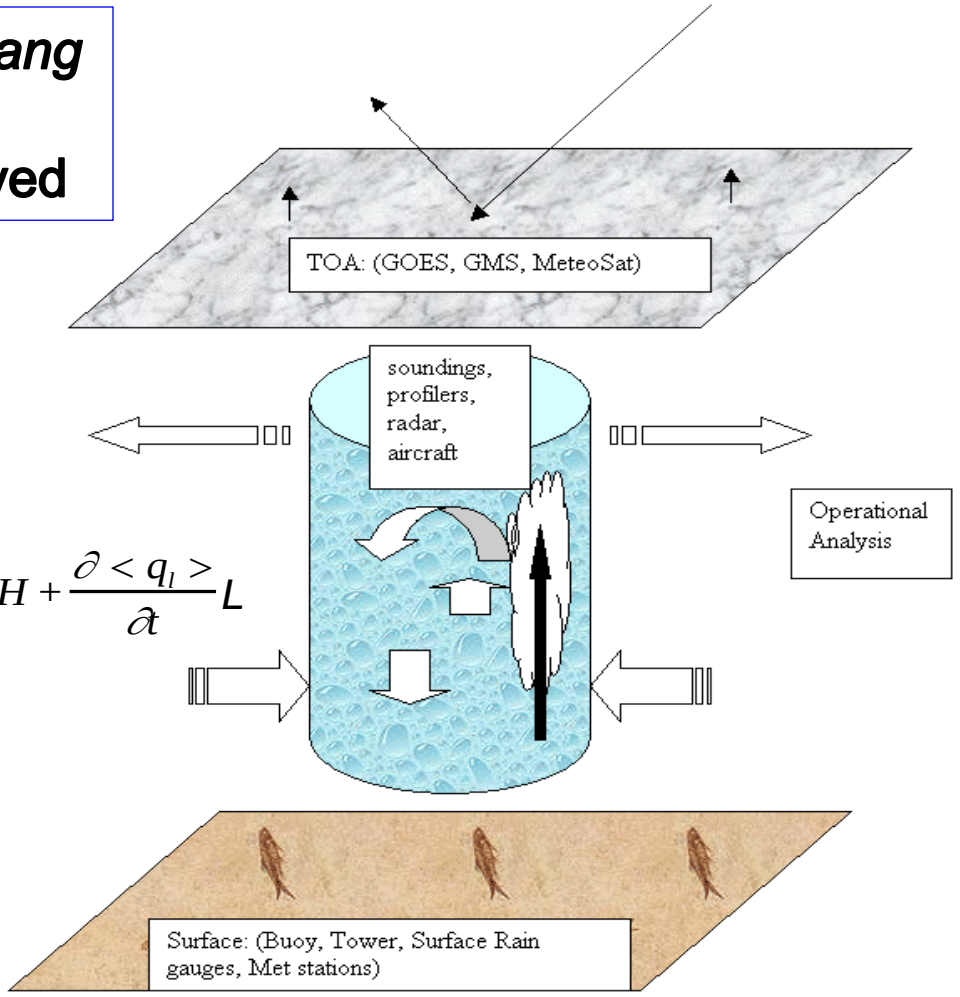
Constrained Variational Analysis (*Zhang and Lin, 1997*) – Mass, Moisture, Energy, and Momentum are conserved

$$\langle \nabla \cdot \vec{V} \rangle = -\frac{1}{g p_s}\frac{dp_s}{dt}$$

$$\frac{\partial \langle q \rangle}{\partial t} + \langle \nabla \cdot \vec{V} q \rangle = E_s - Prec - \frac{\partial \langle q_l \rangle}{\partial t}$$

$$\frac{\partial \langle s \rangle}{\partial t} + \langle \nabla \cdot \vec{V} s \rangle = R_{TOA} - R_{SRF} + LPrec + SH + \frac{\partial \langle q_l \rangle}{\partial t} L$$

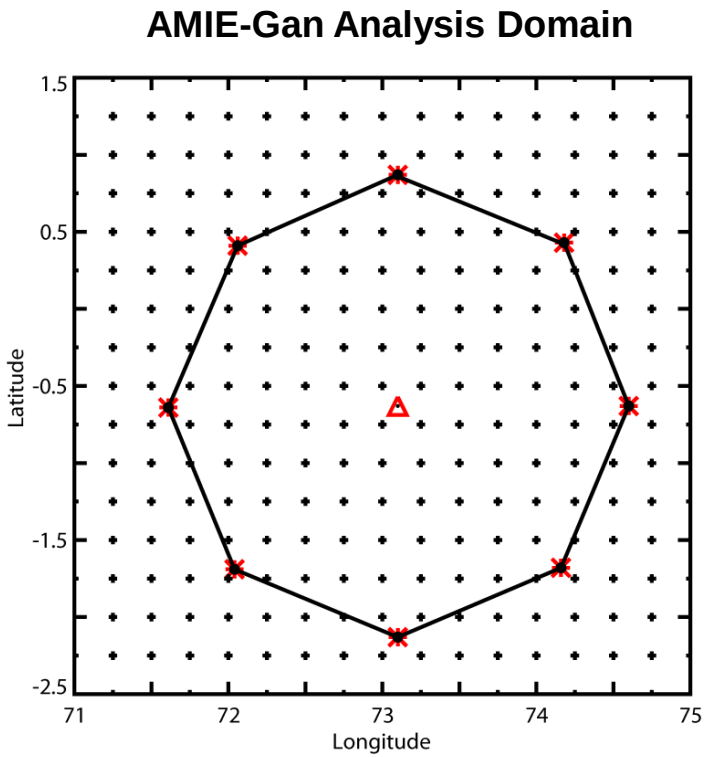
$$\frac{\partial \langle \vec{V} \rangle}{\partial t} + \langle \nabla \cdot \vec{V}\vec{V} \rangle - f\vec{k} \times \langle \vec{V} \rangle - \nabla \langle \phi \rangle = \vec{\tau}_s$$



(Courtesy of Dr. M. Zhang of SBU)

Derived forcing from VA is dynamically and thermodynamically consistent with surface and TOA observations

Analysis Details

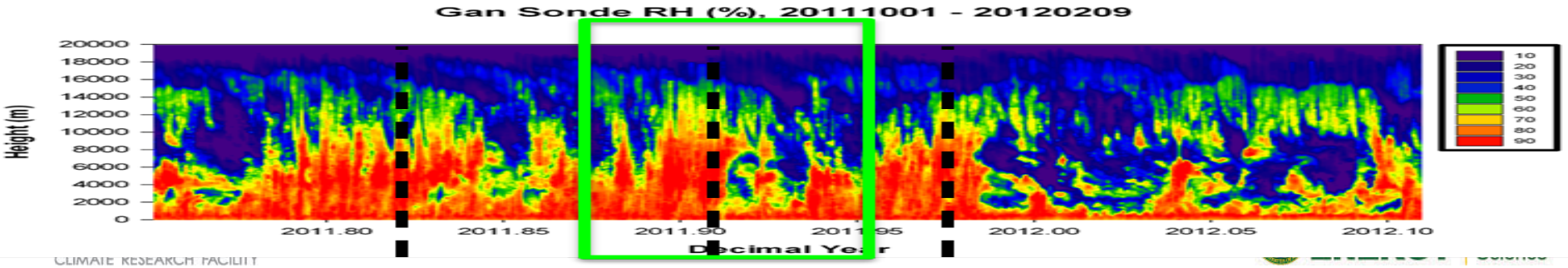


Forcing Data Product Details

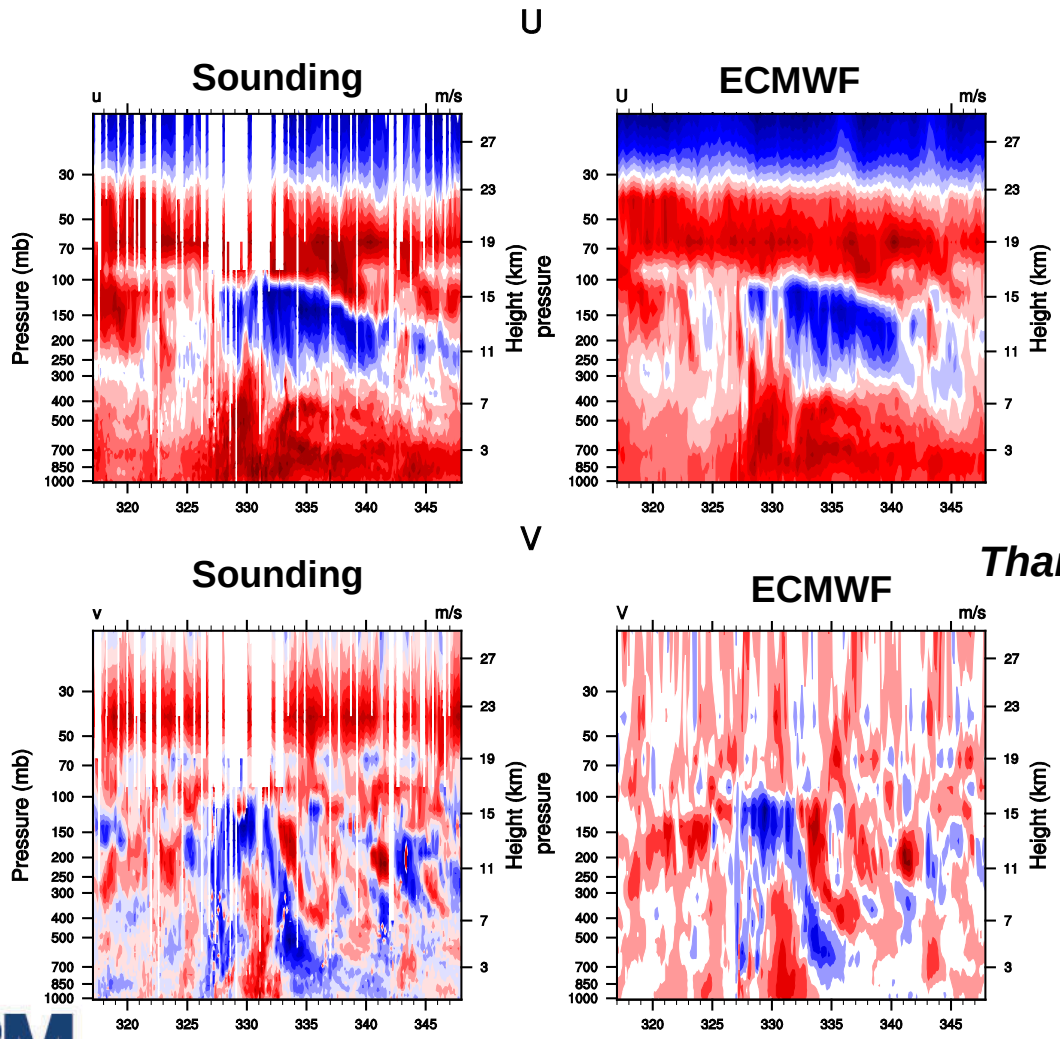
- 11/13/2011 - 12/13/2011 (2nd MJO)
- Analysis done over the area covered by S-POL
- 3 hours, 25mb

Data Used

- ECMWF analysis as first guess
- Precipitation from observations
  - S-POL precip
  - TRMM precip
- Other required surface and TOA fluxes from the ECMWF model



ECMWF analysis is pretty good



Thanks to Steve Williams (NCAR)

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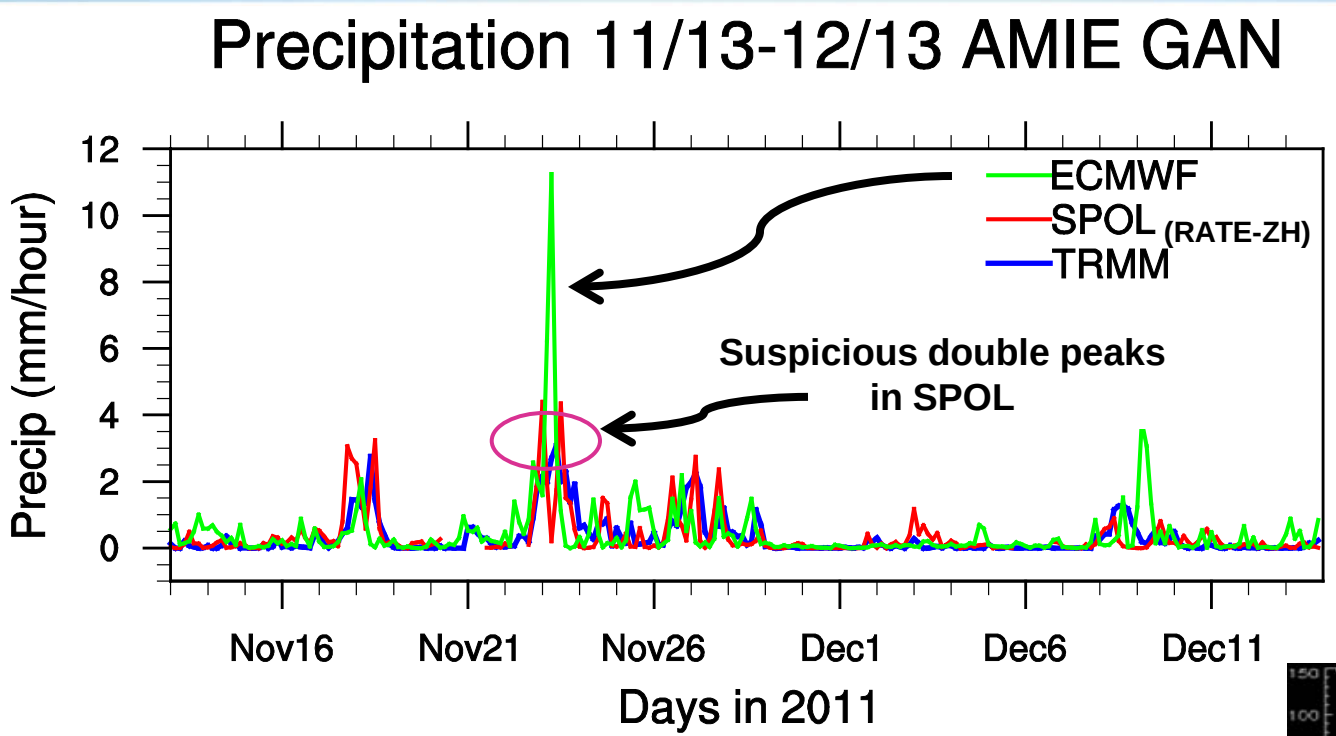
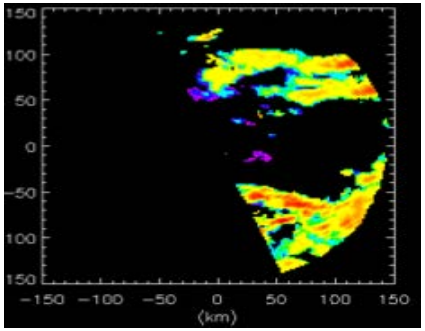
But not for precipitation …



SMART



- ECMWF precip is too strong
- Notice suspicious double spikes of SPOL precip for major rain events, due to the average over only half of the domain? A full 360 degree integration data is needed

Thanks to Bob Rilling (NCAR)
Courtney Schumacher (TAMU)

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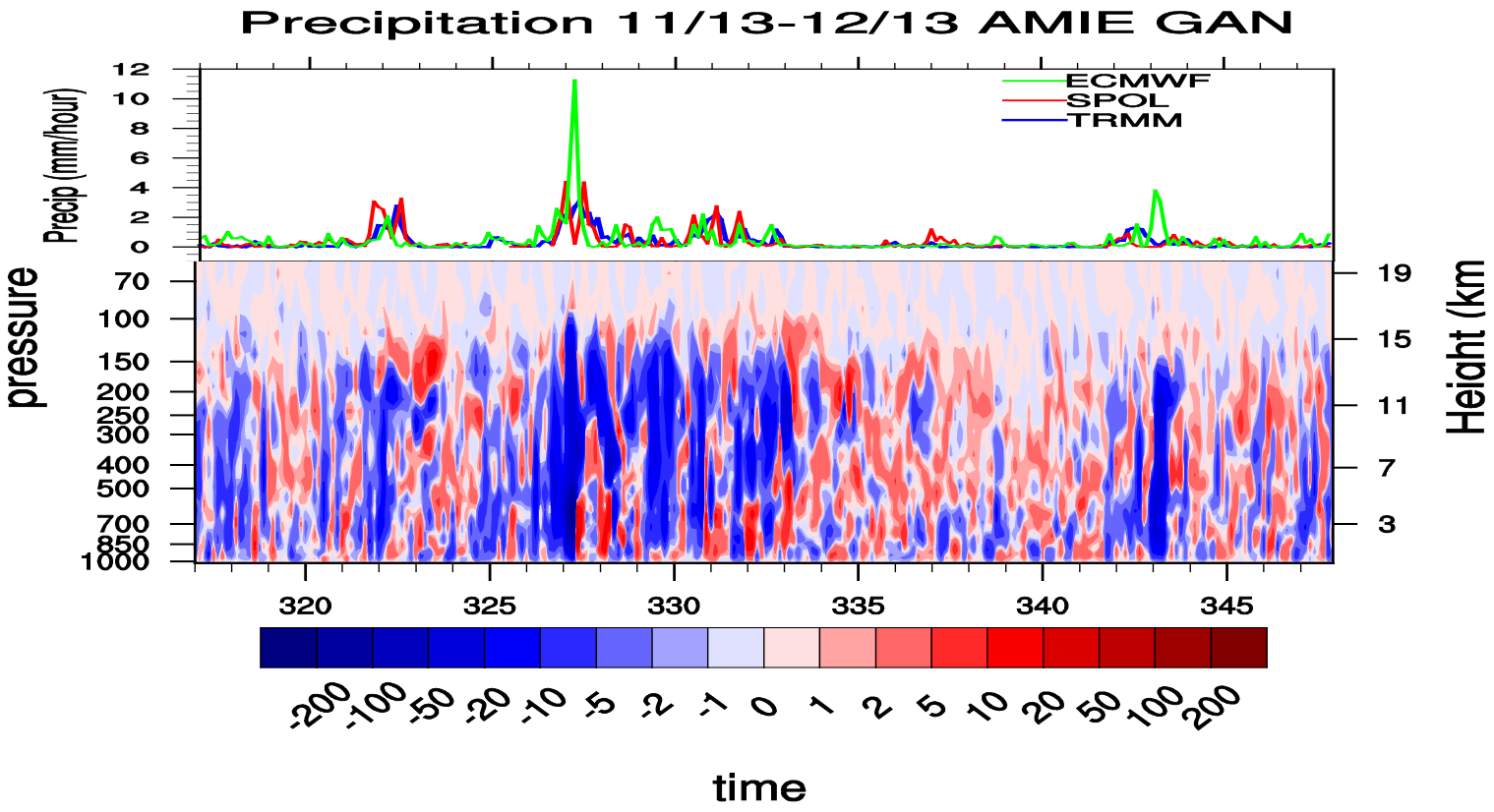
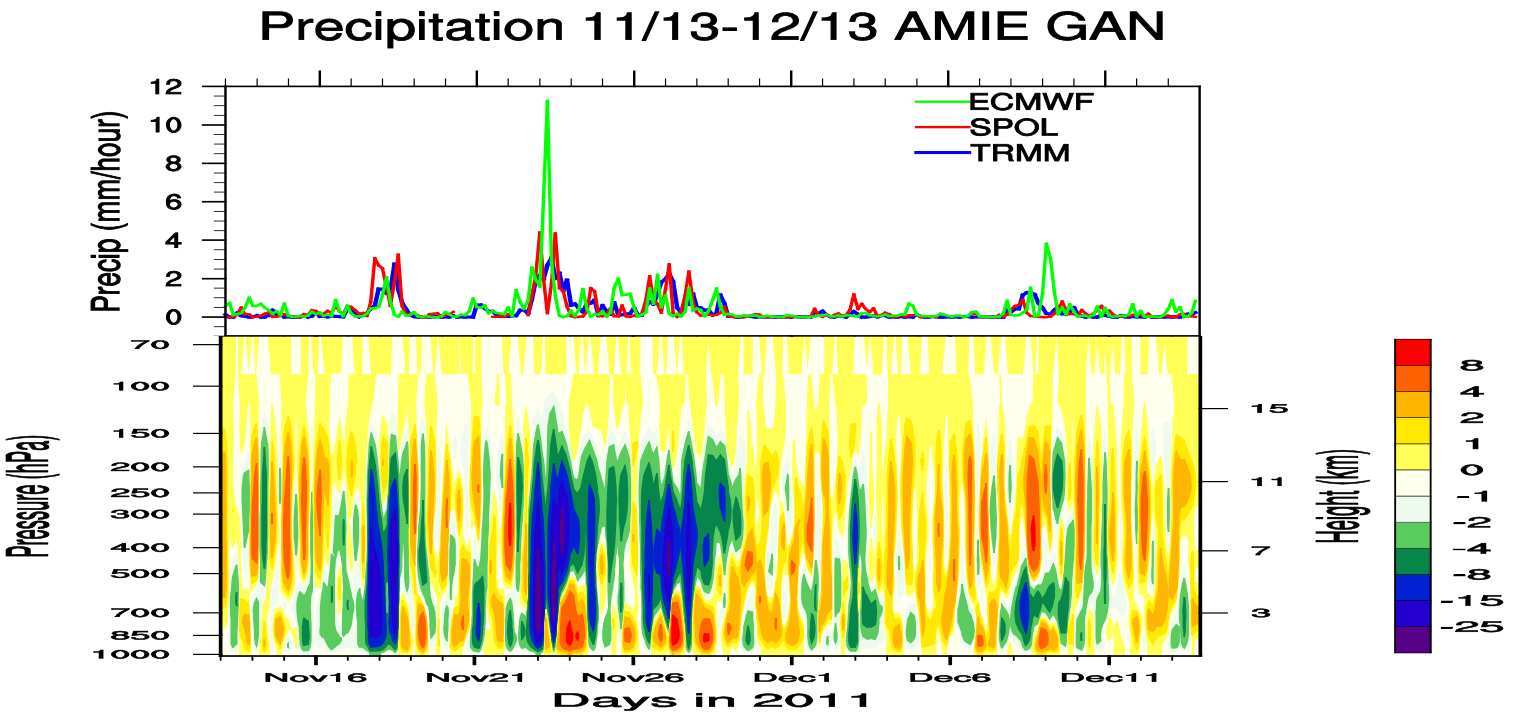
Precip largely influences the forcing fields – ECMWF Omega



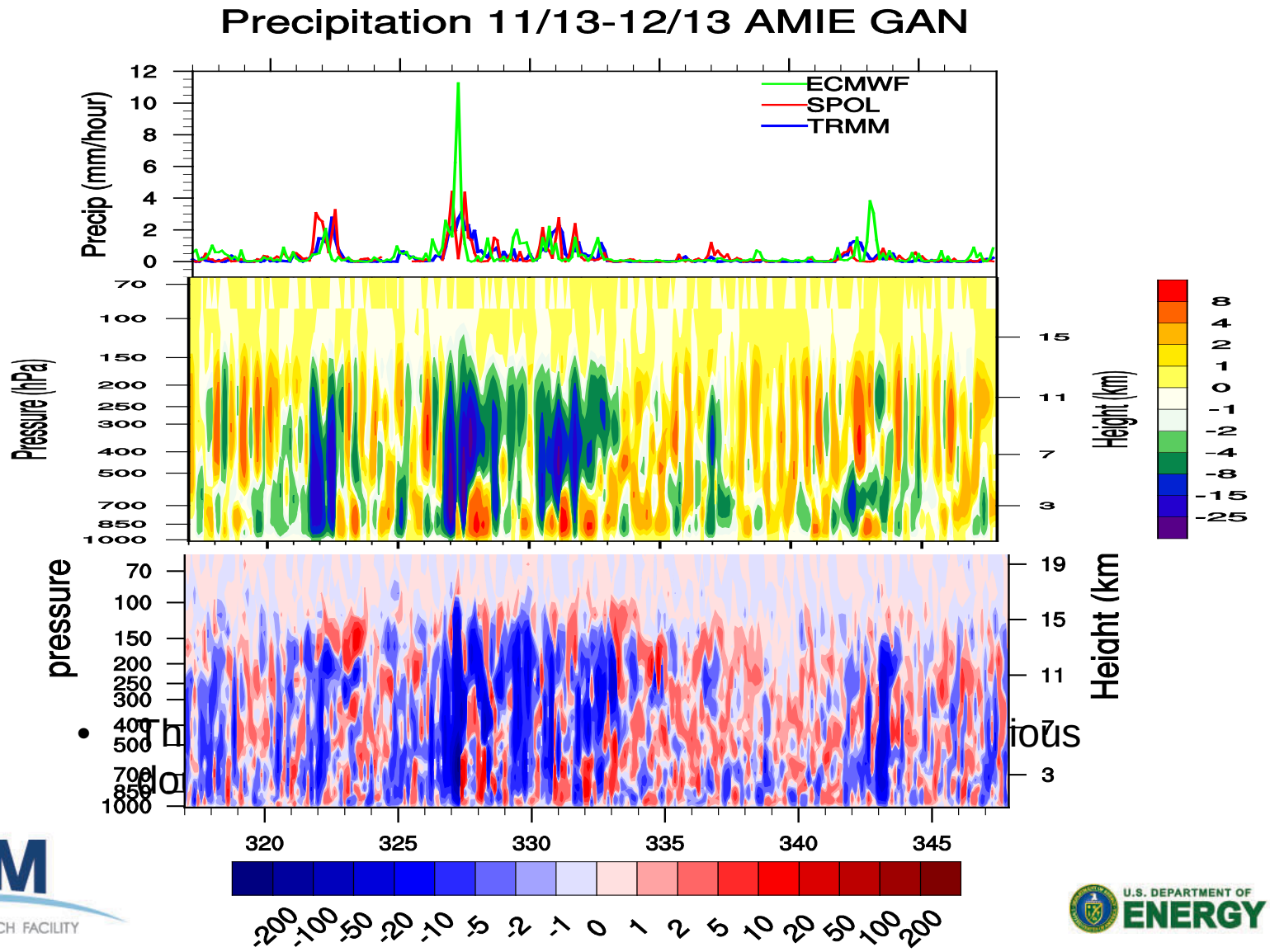
- Upward motion is too strong in ECMWF due to the very large precipitation on Nov. 23rd

Omega: constrained with SPOL rainfall



- The magnitude is significantly reduced, but suspicious double peaks are seen in the derived Omega field

Omega: constrained with SPOL rainfall



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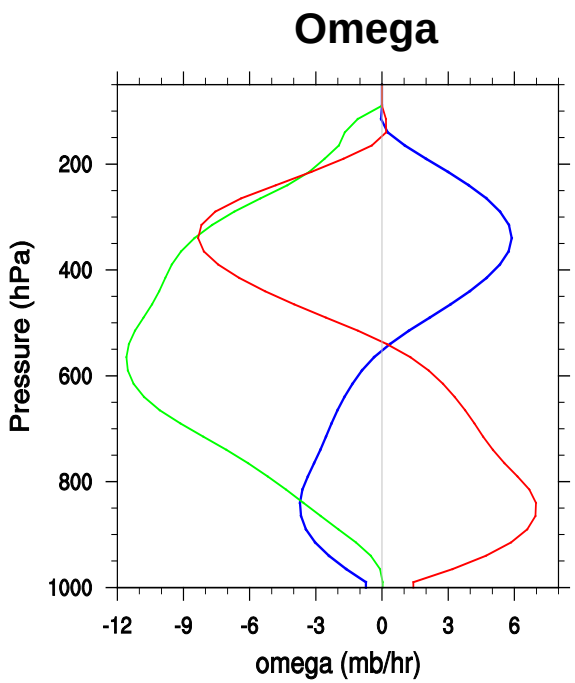
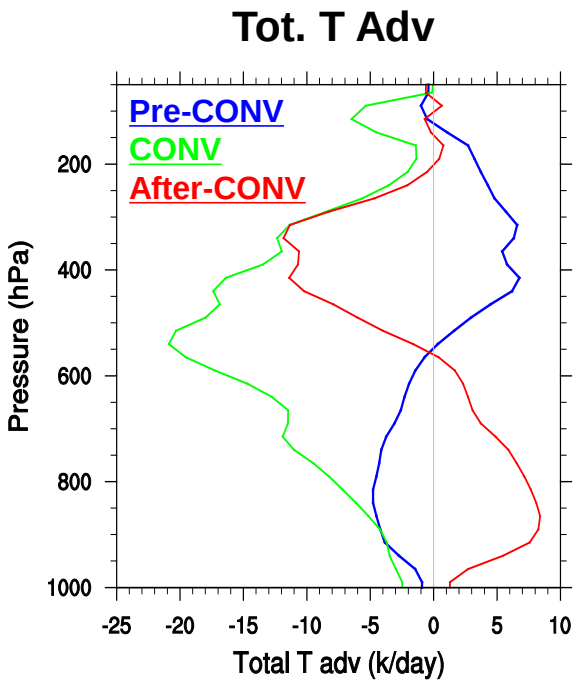
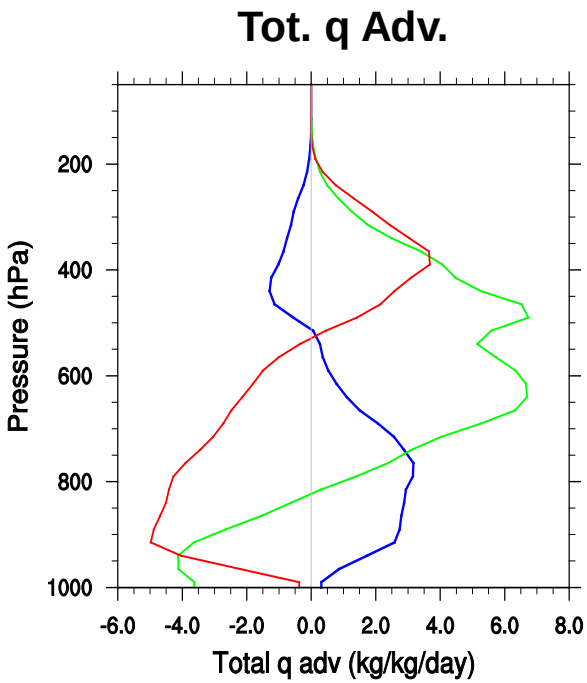
Large-scale forcing

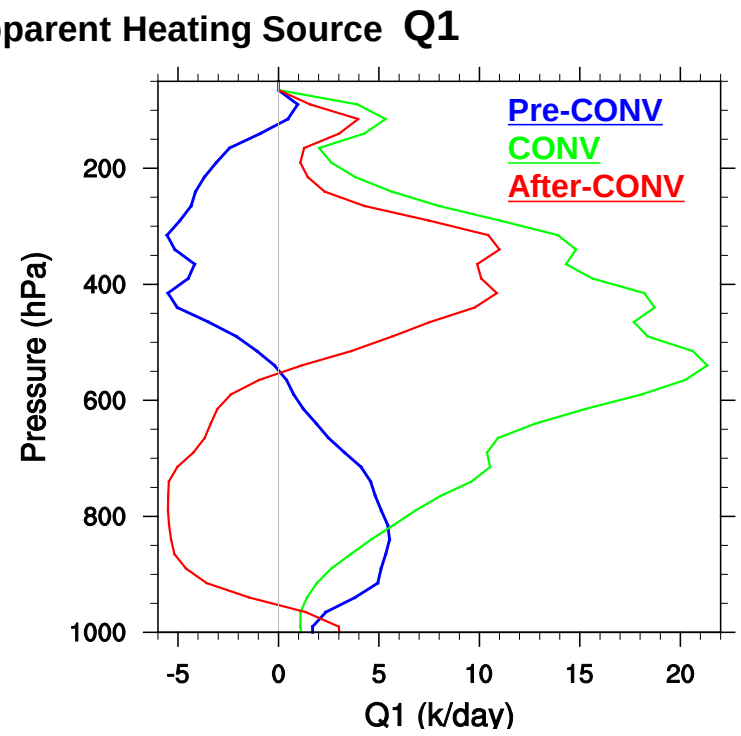


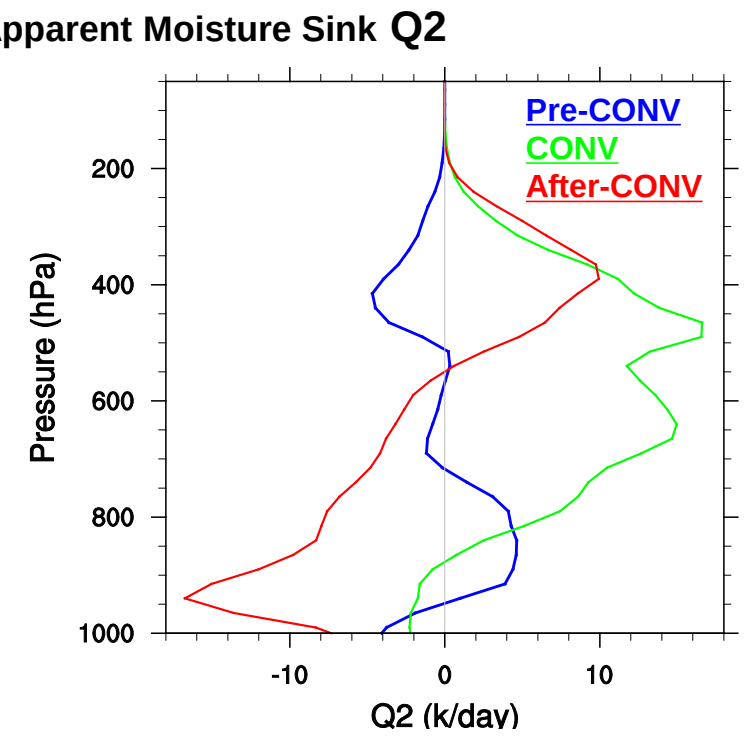




- Pre: lower layer moisture convergence with weak upward motion
- CONV: upward motion in the entire column with maximum near 600 hpa associated strong advective cooling and moistening in the middle troposphere
- After: downward motion in the lower troposphere and warming and drying there.

Q1 & Q2 at different stages





- Pre: low-level condensational heating and drying, high level cooling and moistening
- CONV: column condensation heating and drying
- After: low-level evaporative cooling and moistening, high level heating and drying

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Summary

- A large scale forcing data set for AMIE-GAN is developed based ECMWF analysis
- The analysis data needs to be adjusted to balance the observed precipitation, given the large uncertainty in the model produced precipitation field
- The derived forcing and Q1/Q2 fields allow to study the characteristics of the large-scale structure and diabatic heating/moistening associated with the tropical convective systems observed during the field campaign

Future work

- Address uncertainty in the observed precipitation
  - Double peaks in SPOL
- Incorporated more observations into the analysis:
  - Surface Radiation from C. Long
  - Address uncertainties in observed precipitations and etc
    - Possible correction with surface rain-gauge obs
  - Liquid water path from MWR
  - Incorporate sounding data as background field
  - TOA flux based satellite data?
  - ECOR surface fluxes?
- Compare with radar-derived LH profiles (from Courtney Schumacher)

Thank You

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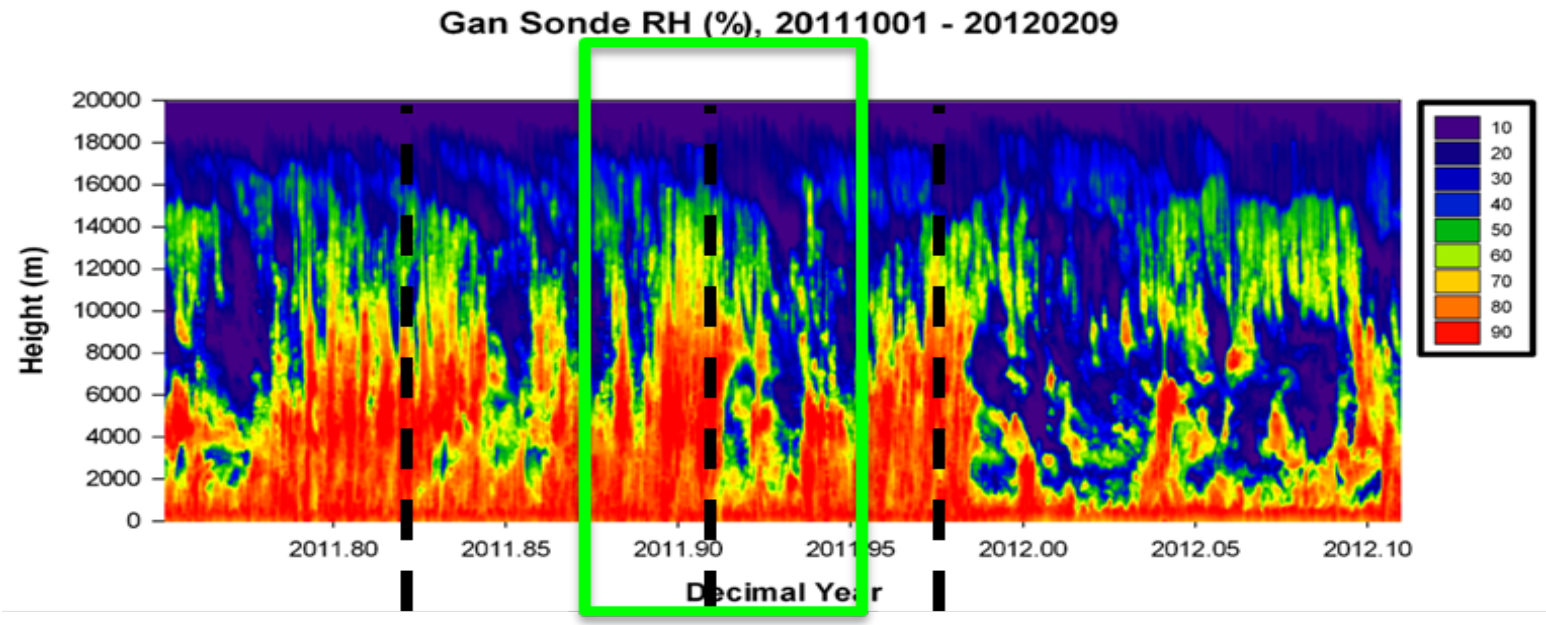
Gan Events



- First 2 Gan events stronger, last weaker
- Significant mid level moistening

C. Long of PNNL

Forcing and Diabatic Heating/Moistening Structures

- Large-scale forcing and diabatic heating/moistening structures at different stages of convection (such as before, during and after the Nov 23rd heavy rain event)