

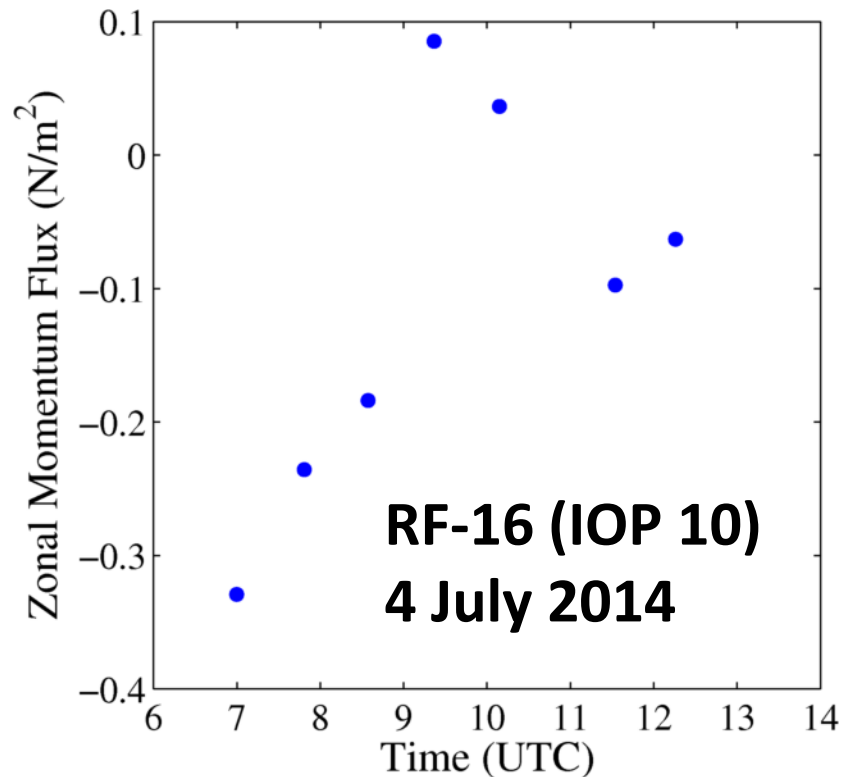
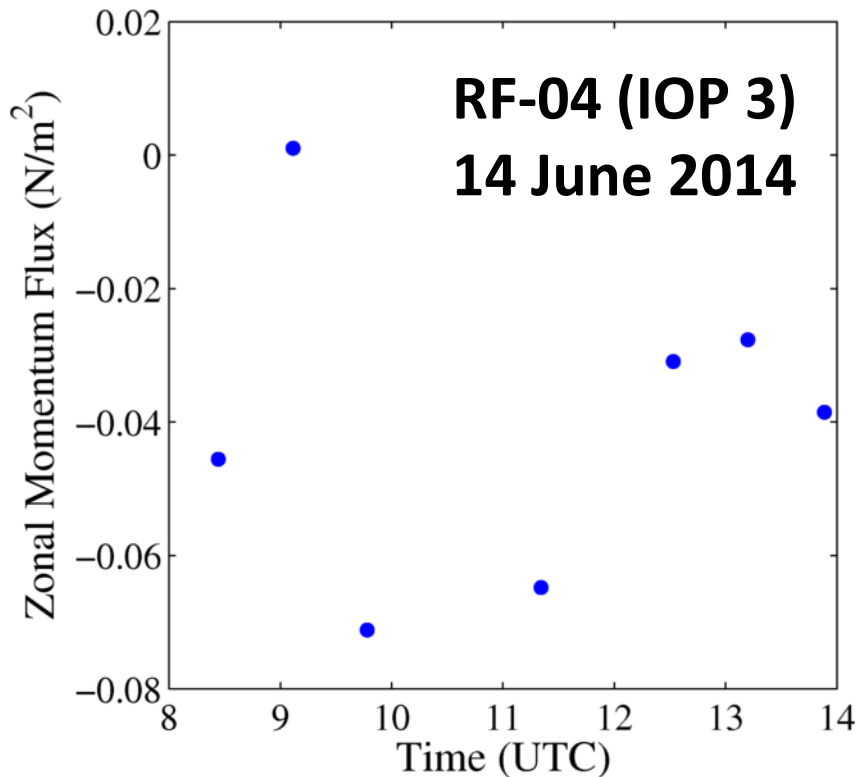


Gravity Wave Predictability During Deepwave

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Deepwave Science Meeting
10-11 December 2015
Monterey, CA

NCAR-GV Zonal Momentum Flux



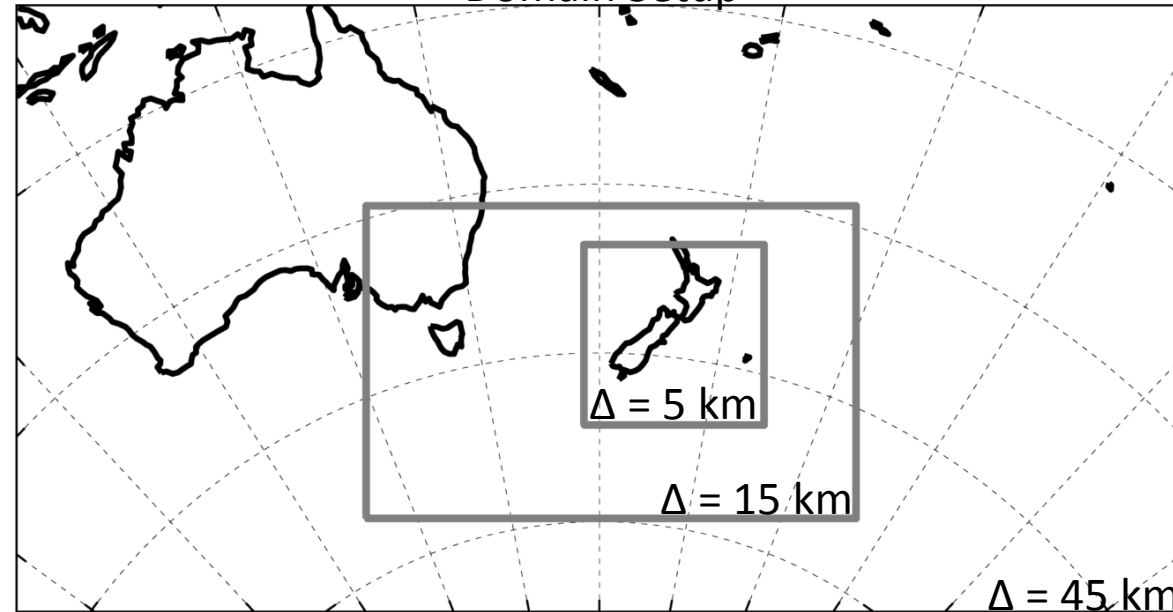
- RF-04 – Weak to moderate FL zonal momentum flux
- RF-16 – Moderate to Strong FL zonal momentum flux
- Relatively large temporal variability during both flights
- How sensitive is momentum flux to forcing flow?

Motivation

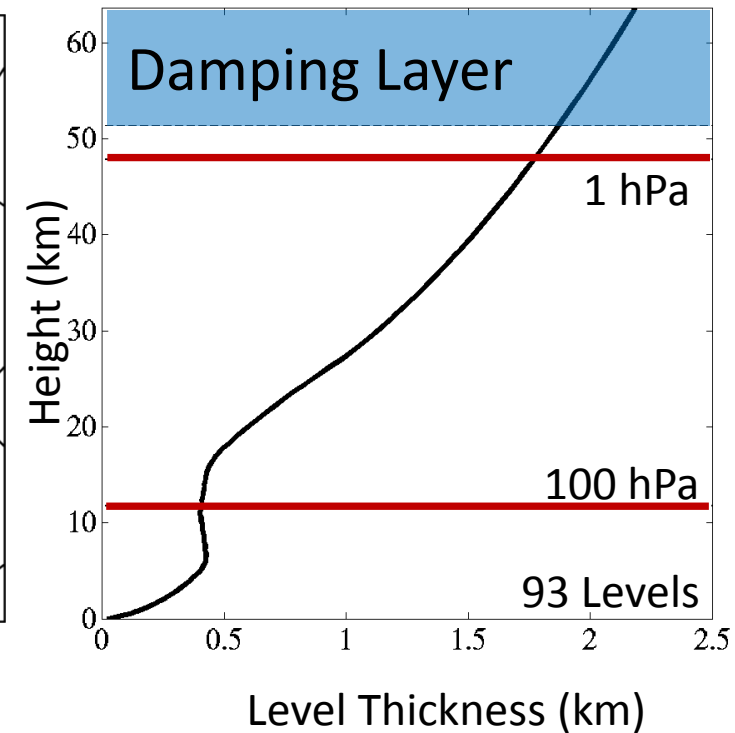
- Validating deterministic model predictions with wave measurements is difficult:
 - Waves are evolving in time
 - Sensitive dependence of model predictions on ICs
- Deep propagating waves have a strong impact on upper atmosphere circulation:
 - Typically parameterized in GCMs
 - How does resolved drag vary with IC uncertainty?
- Use an ensemble to evaluate the predictability of mountain waves propagating in the stratosphere for two DEEPWAVE events:
 - IOP 3/RF04 -- 14 June 2014
 - IOP 10/RF16 -- 4 July 2014

COAMPS Ensemble Configuration

Domain Setup



Vertical Grid

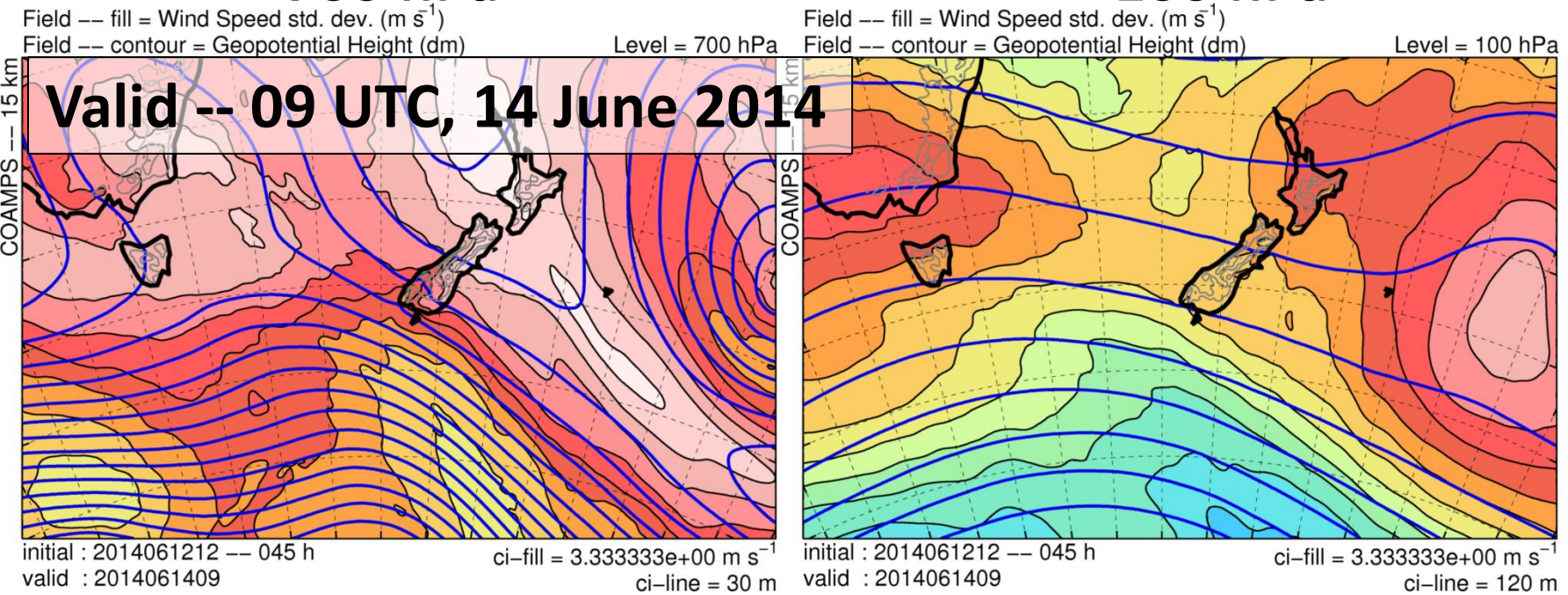


- Two-way nested domains of 45-, 15, and 5-km horizontal resolution
- 93 vertical levels: 38 levels below 10 km, 61 levels below 20 km
- Ensemble mean IC/BC interpolated from a NAVGEM analysis
- 20 members: IC/BC's perturbations from global Ensemble Transform

Synoptic Flow – RF04

700 hPa

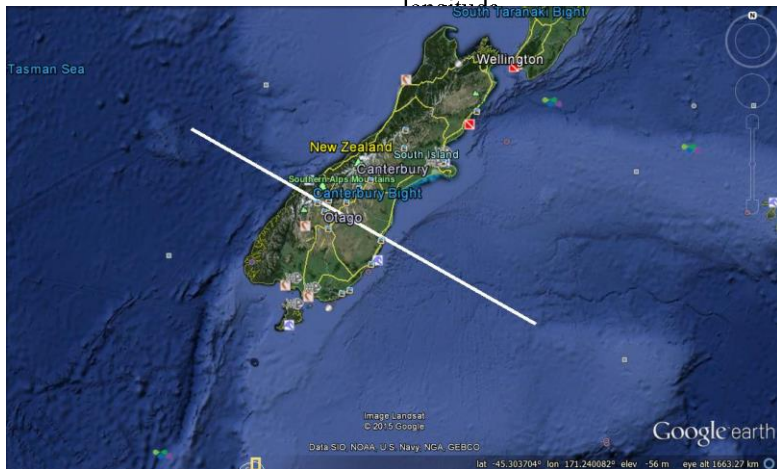
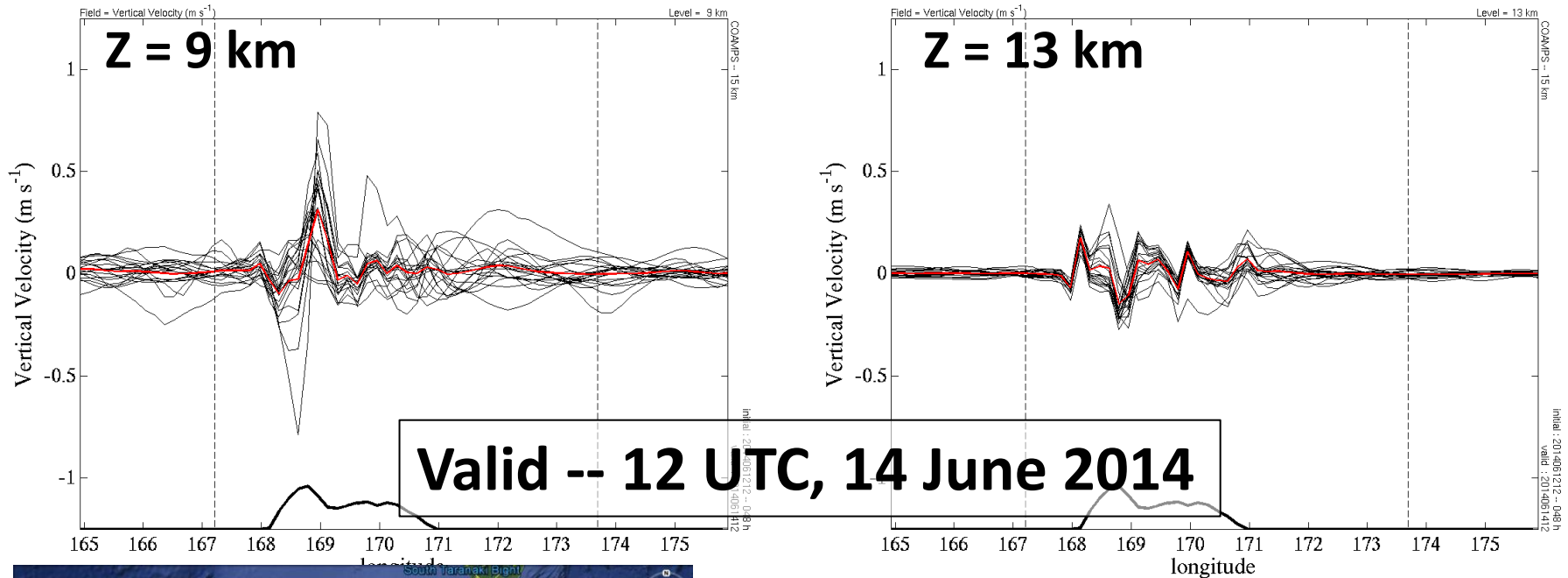
100 hPa



- Weak cross-barrier flow at crest level.
- Small amplitude tropospheric waves associated with weak crest level flow.

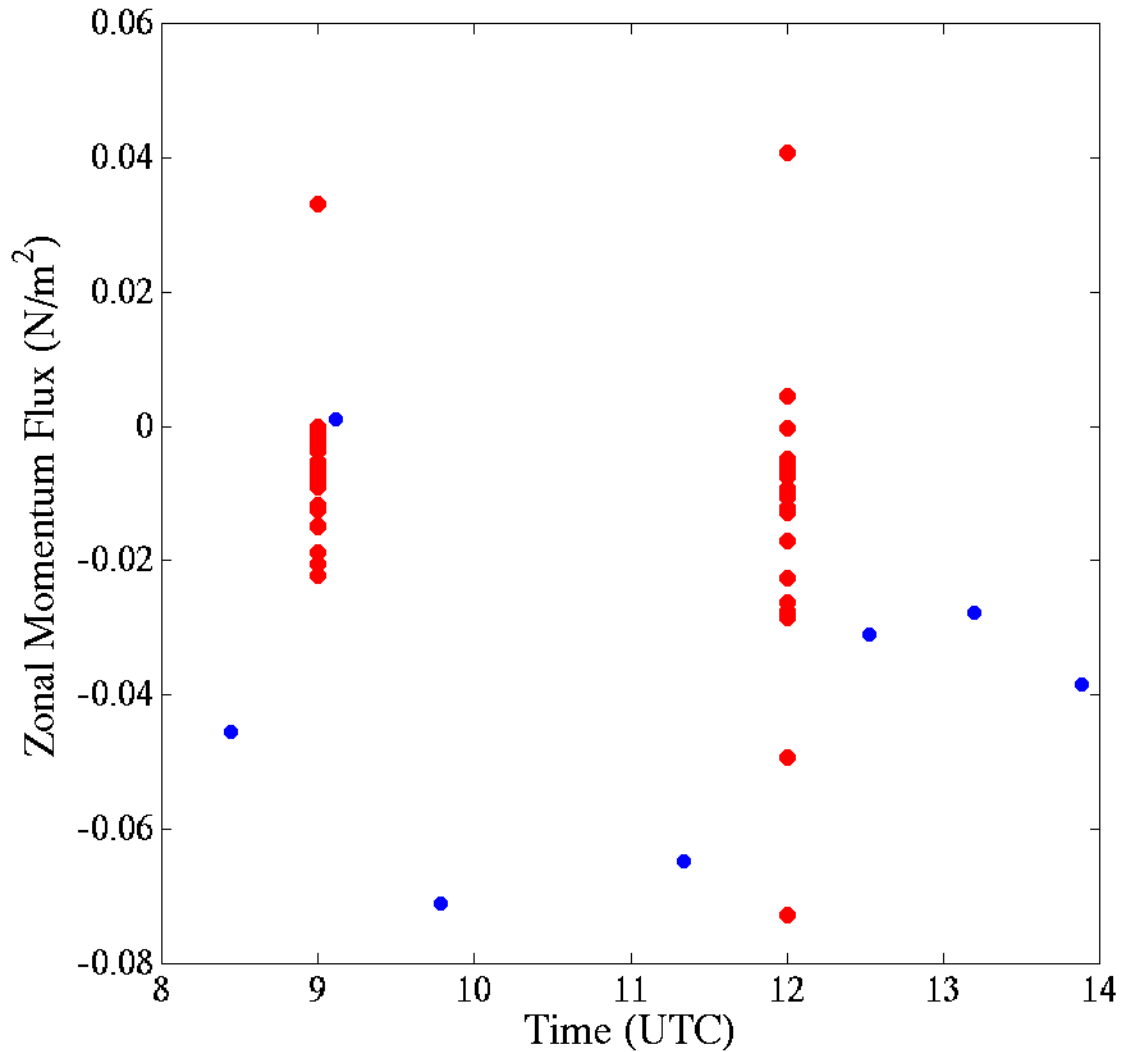
Ensemble Vertical Velocity

48 h Forecast



- Ensemble spread and wave amplitude decrease with height.
- May be resolution related, investigating this now

Zonal Momentum Flux vs. NCAR-GV RF-04 Observations



RF04: 14 July 2014
Take off: 0700 UTC
Landing: 1445 UTC
7 cross-barrier legs

Blue -- Observation

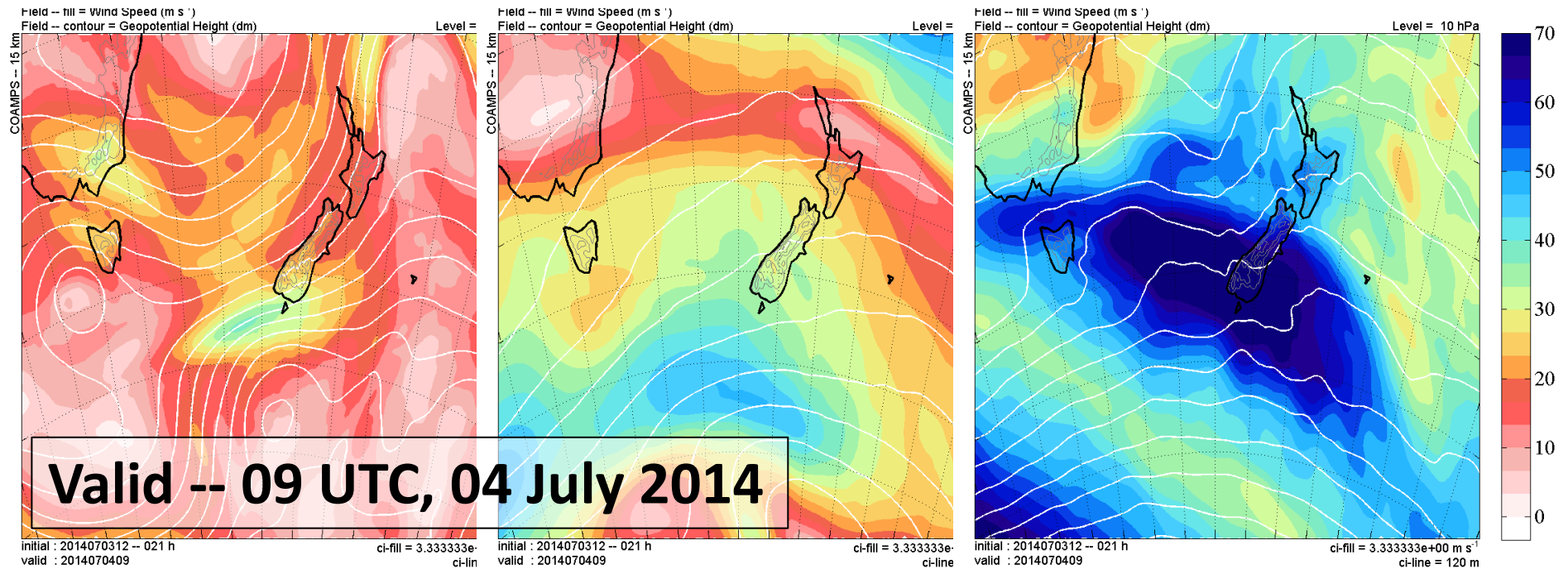
Red -- Ensemble Forecast

Synoptic Flow – RF 16

700 hPa

100 hPa

10 hPa



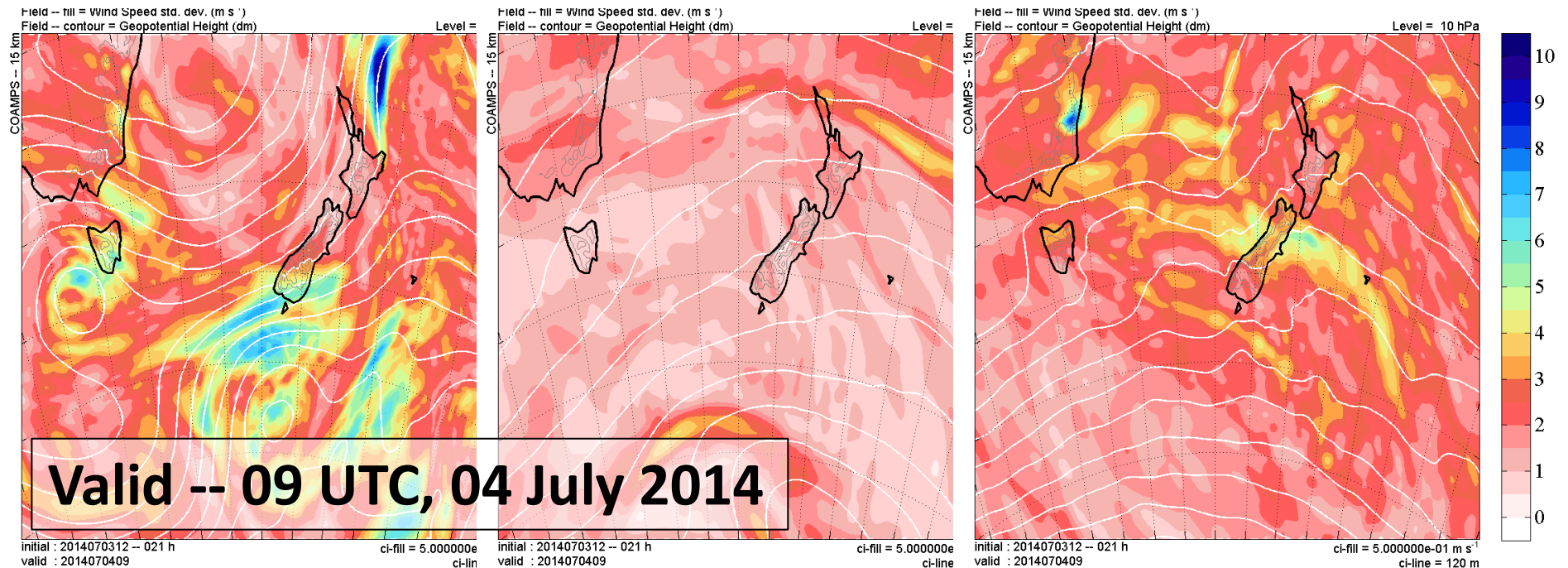
- Short-wave trough; 40 m/s jet interacting with southern portion of south island; 70 m/s stratospheric jet.
- RF16: 06 UTC – 13 UTC 4 July 2014

Synoptic Scale Ensemble Spread

700 hPa

100 hPa

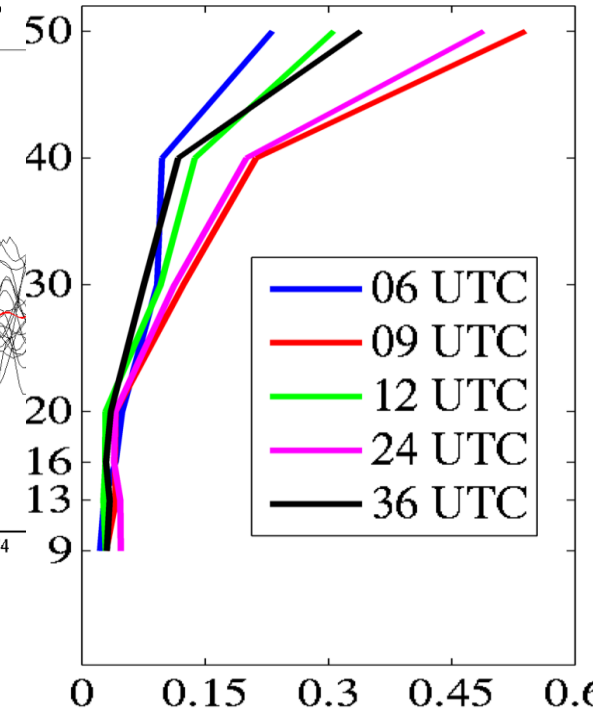
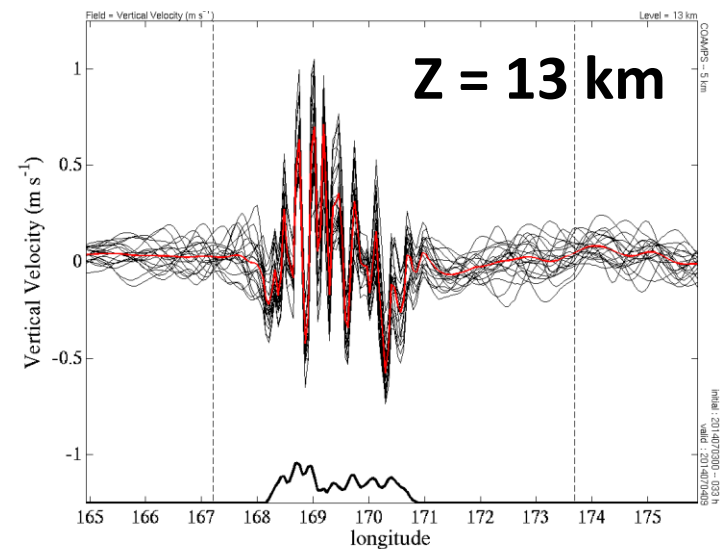
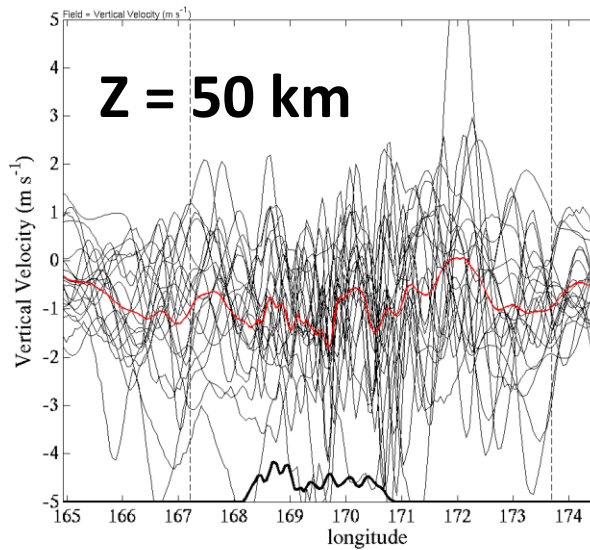
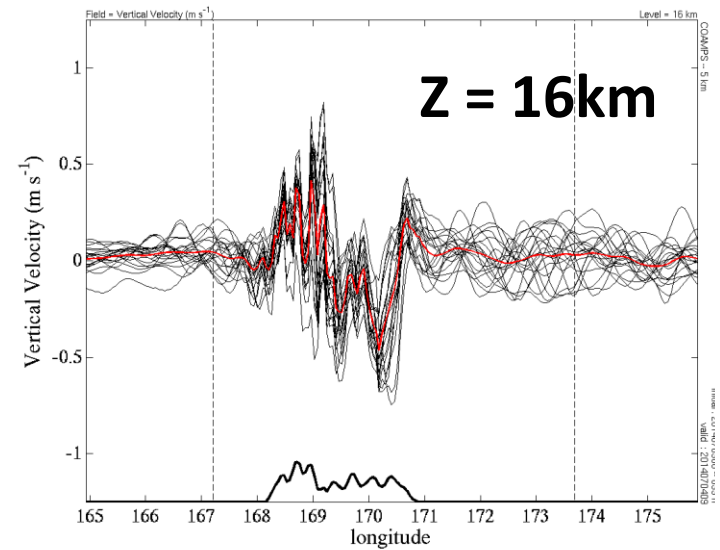
10 hPa



- Ensemble spread associated with 700 hPa jet
- Wind perturbations relatively small near the tropopause and in the middle stratosphere.

Ensemble Vertical Velocity

Vertical velocity at 09 UTC --- 33 h forecast

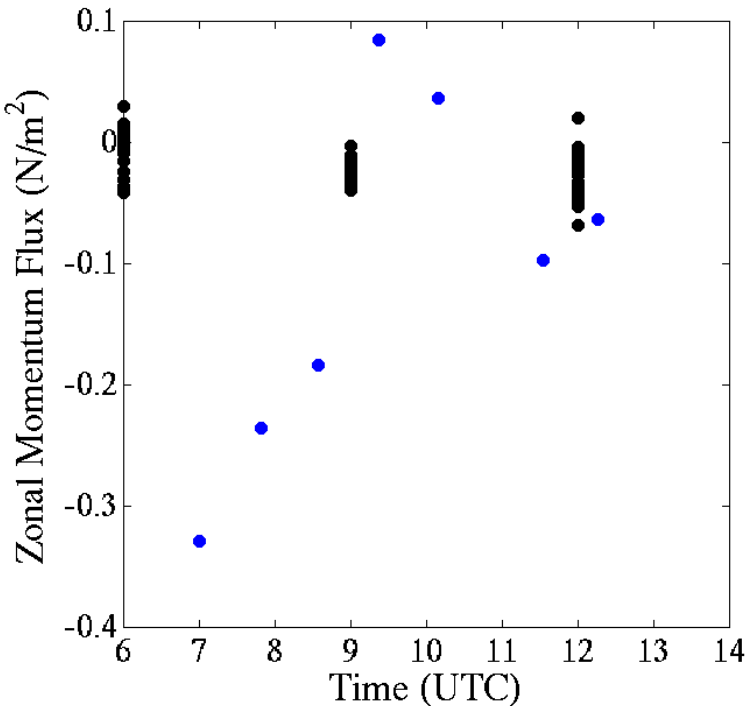


- Wave amplitude grow with height
- Apparent breaking near 16 km
- Ensemble spread grows with height

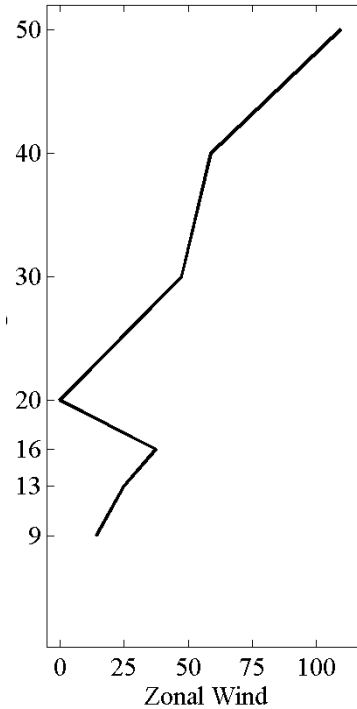
Zonal Momentum Flux

33-h Forecast

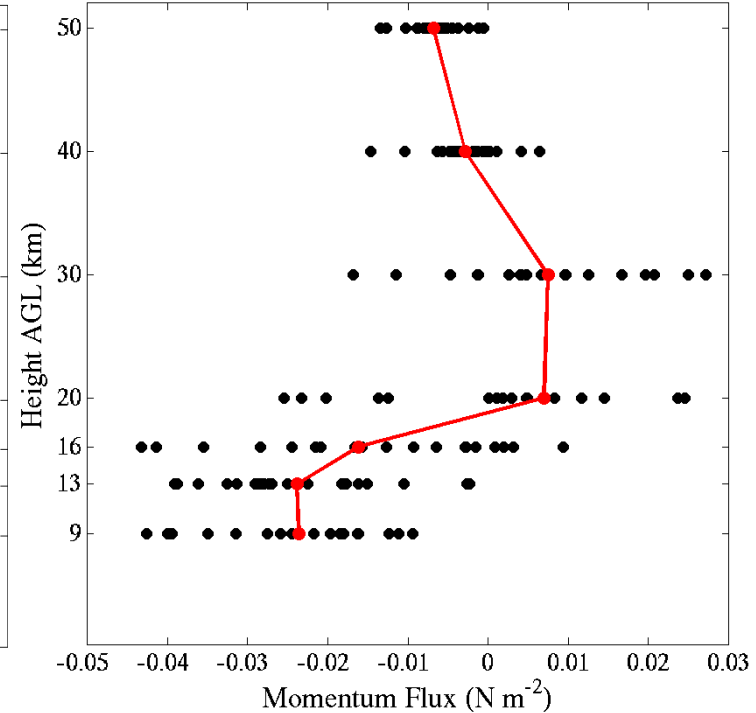
Obs. and Model



U



Mfx at 09 UTC (Mid Flight)



- Increase of zonal momentum flux with height above 13 km (~flight level), apparent breaking region.
- Very large spread relative to zonal momentum flux
- Under prediction of momentum flux's. Resolution issue?

Conclusions

- Disagreement between mountain wave predictions and observations may be fully accounted for by initial-condition uncertainty.
- Model simulations of gravity waves must be interpreted from a probabilistic perspective when compared to observations.