MISMO workshop: Nov.25, 2008

Observed atmospheric heating profile and its relationship to the process toward the convectively active phase

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with

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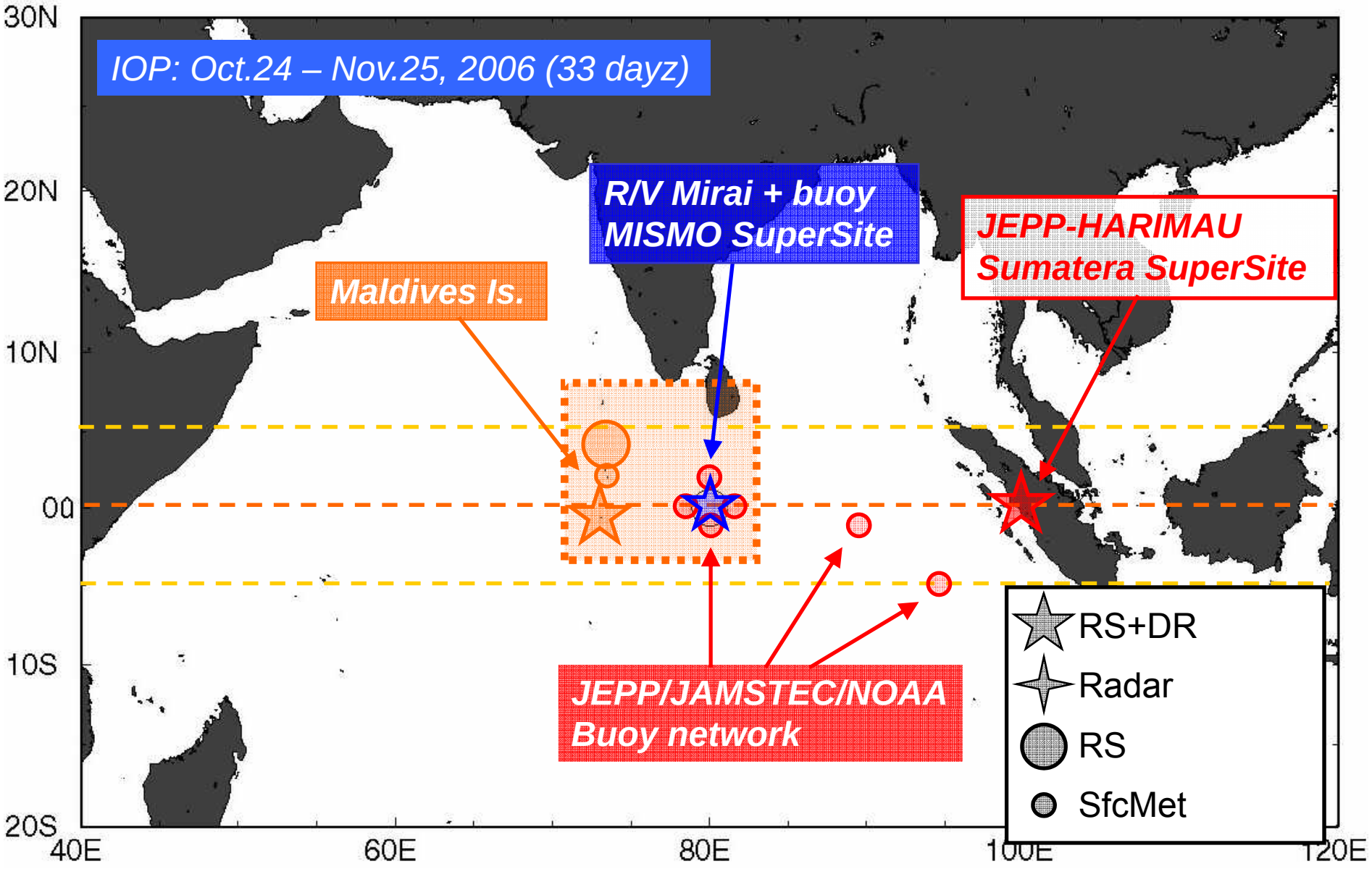
MISMO-IOP Obs. Network

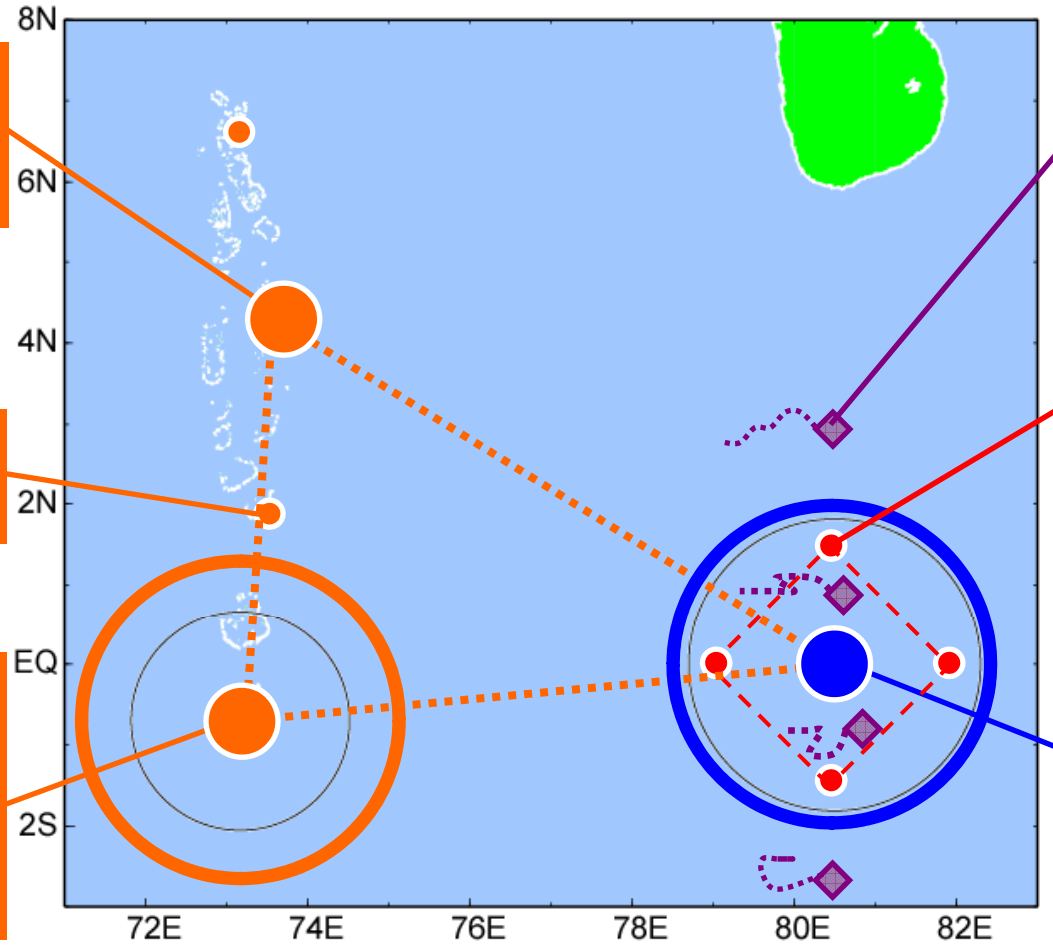


MISMO-IOP Core Obs. Area

Hulhule Is.
Radiosonde
AWS、GPS

Kadhdhoo Is.
AWS、GPS

Gan Is.
Doppler Radar
Radiosonde
AWS、GPS、
Ceilometer, etc.



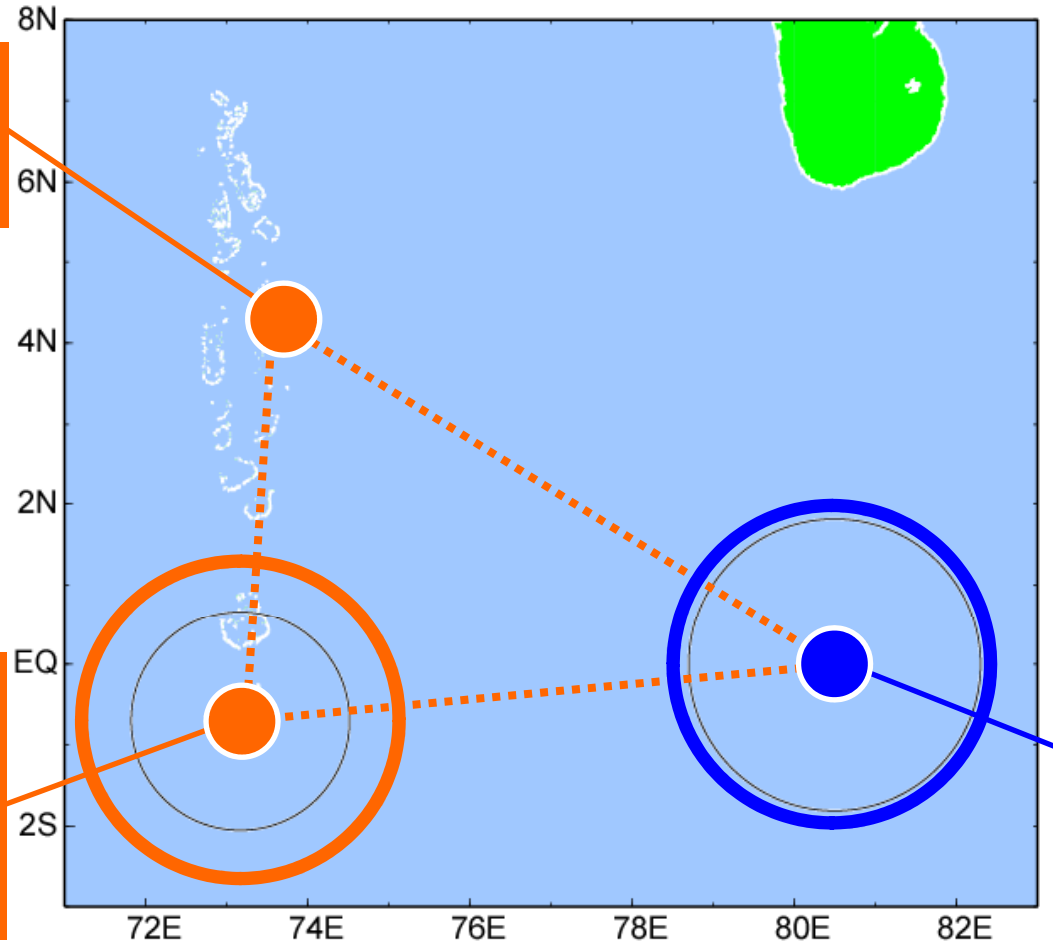
Float
Temp / Salinity

Mooring Buoys
Surface Met.
Temp, Salinity,
Current, etc.

R/V Mirai
Doppler Radar
Radiosonde
Wind Profiler
CTD
etc.

MISMO-IOP Core Obs. Area

Hulhule Is.
Radiosonde
AWS、GPS



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R/V Mirai
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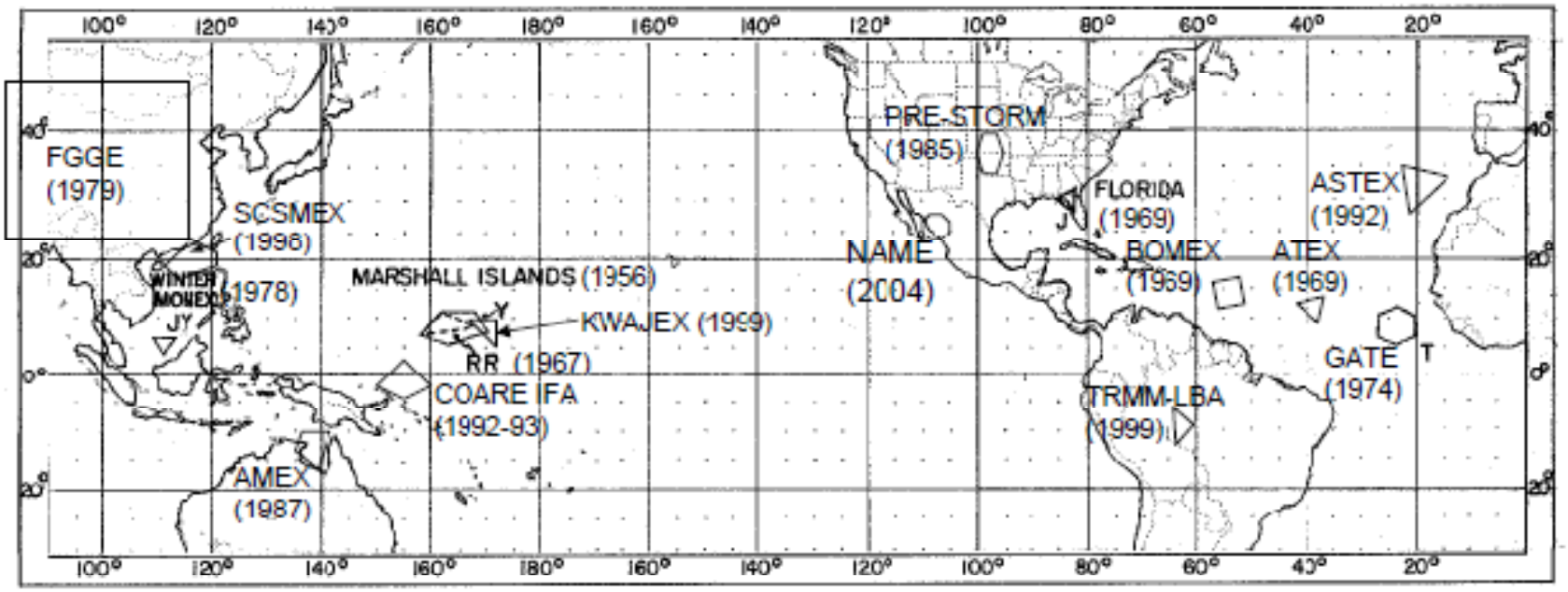
etc.

Budget Analyses to estimate Diabatic Heating

Previous Budget Analyses with Sfc Soundings

Where have budget studies been conducted?



The first budget analyses in the Indian Ocean

Johnson (2003)

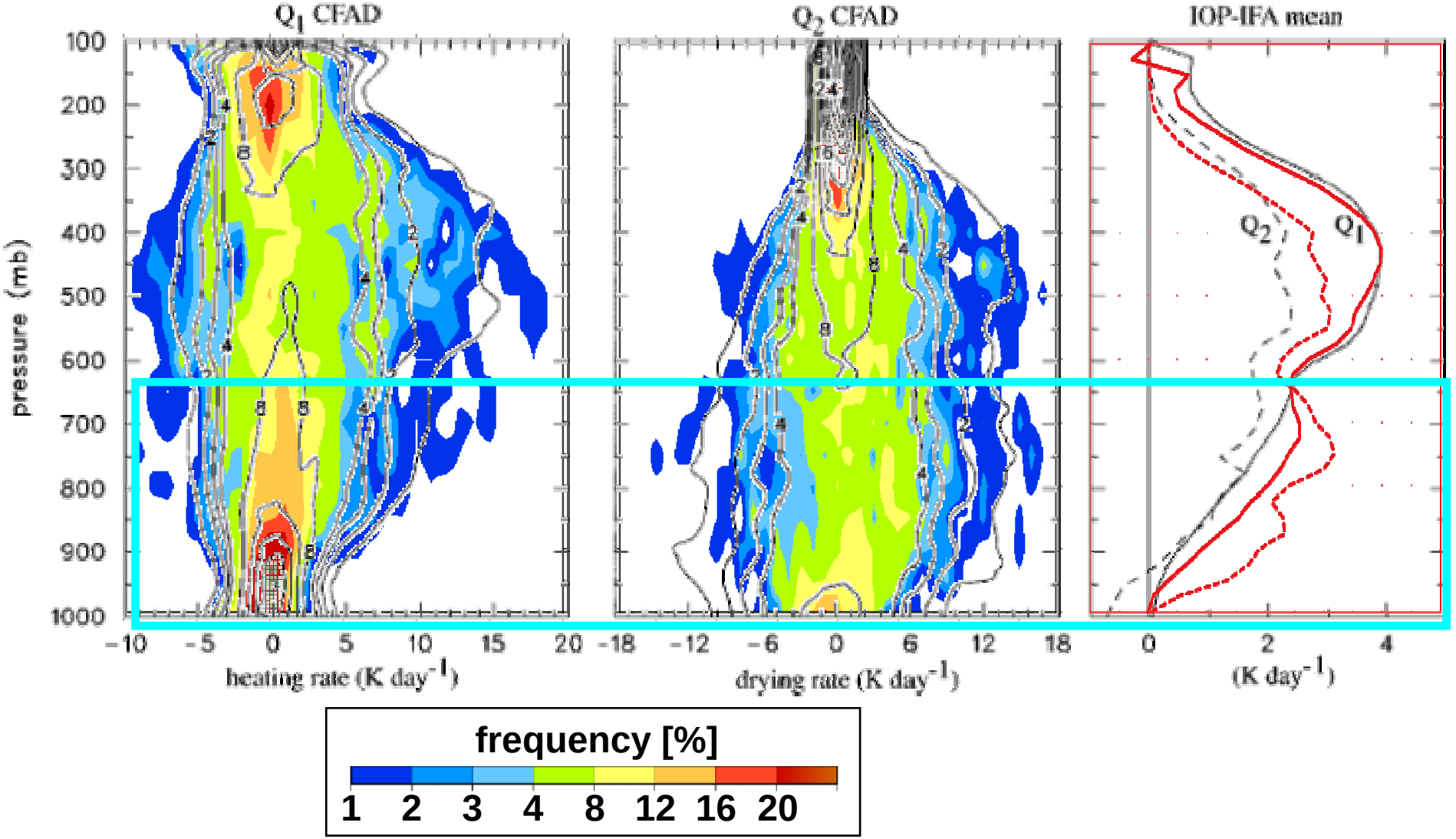
IOP-Averaged Vertical Profile: MISMO vs. TOGA/COARE

color: MISMO

contour: TOGA/COARE

Red: MISMO

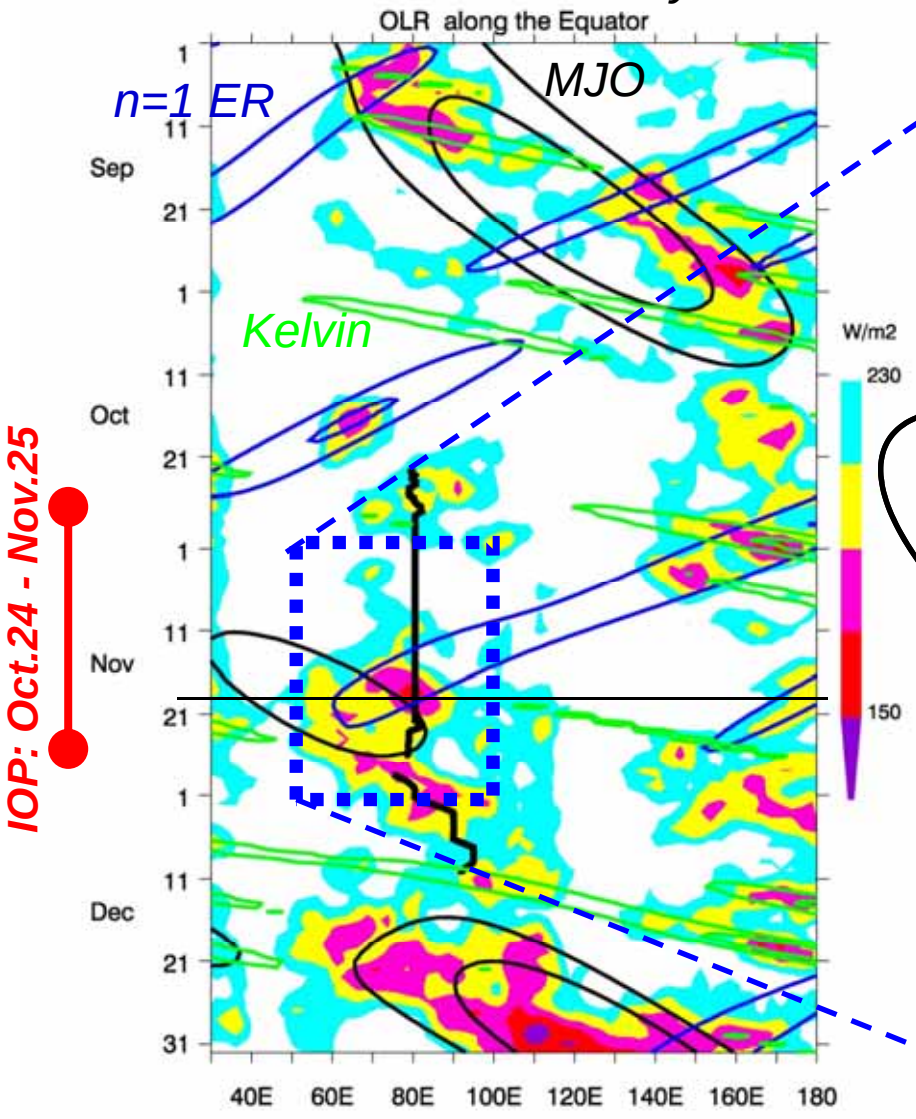
Black: TOGA/COARE



TOGA-COARE result is from Johnson and Ciesielski (2000)

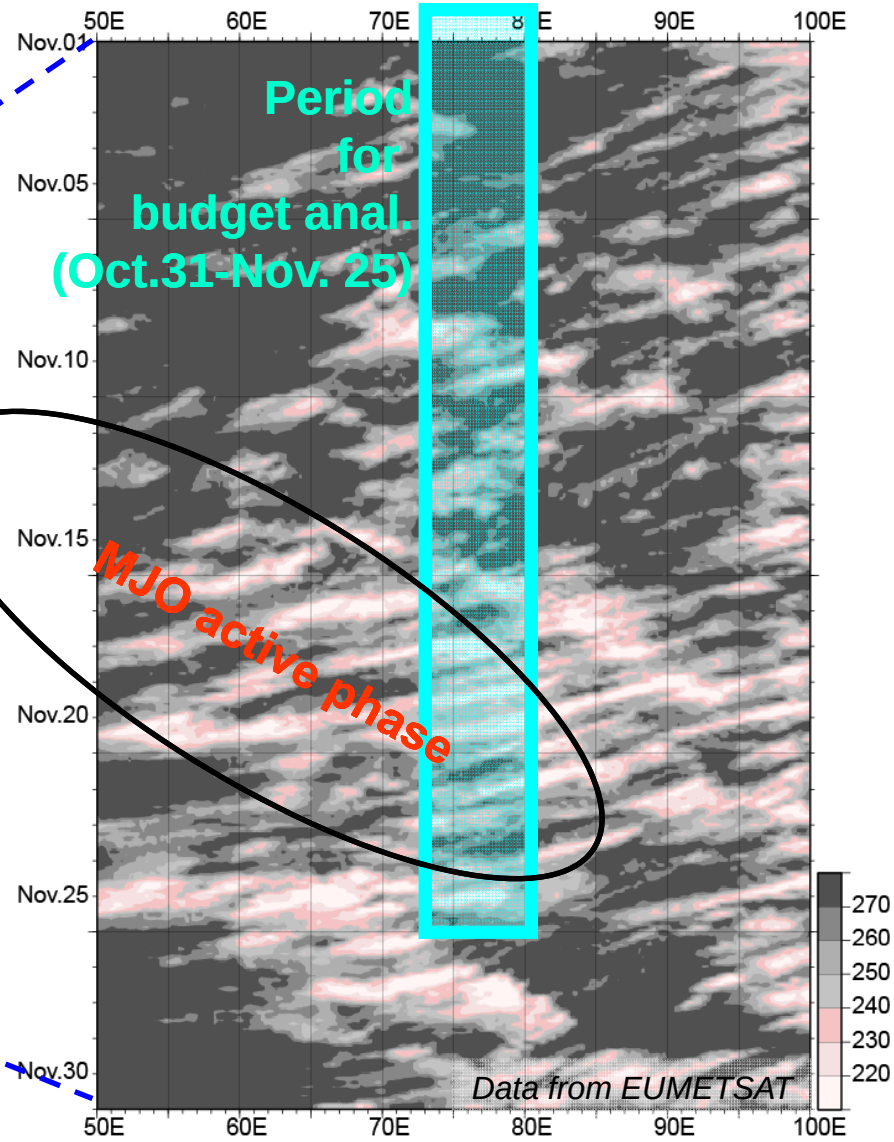
Outline of the IOP

OLR and mode analyses



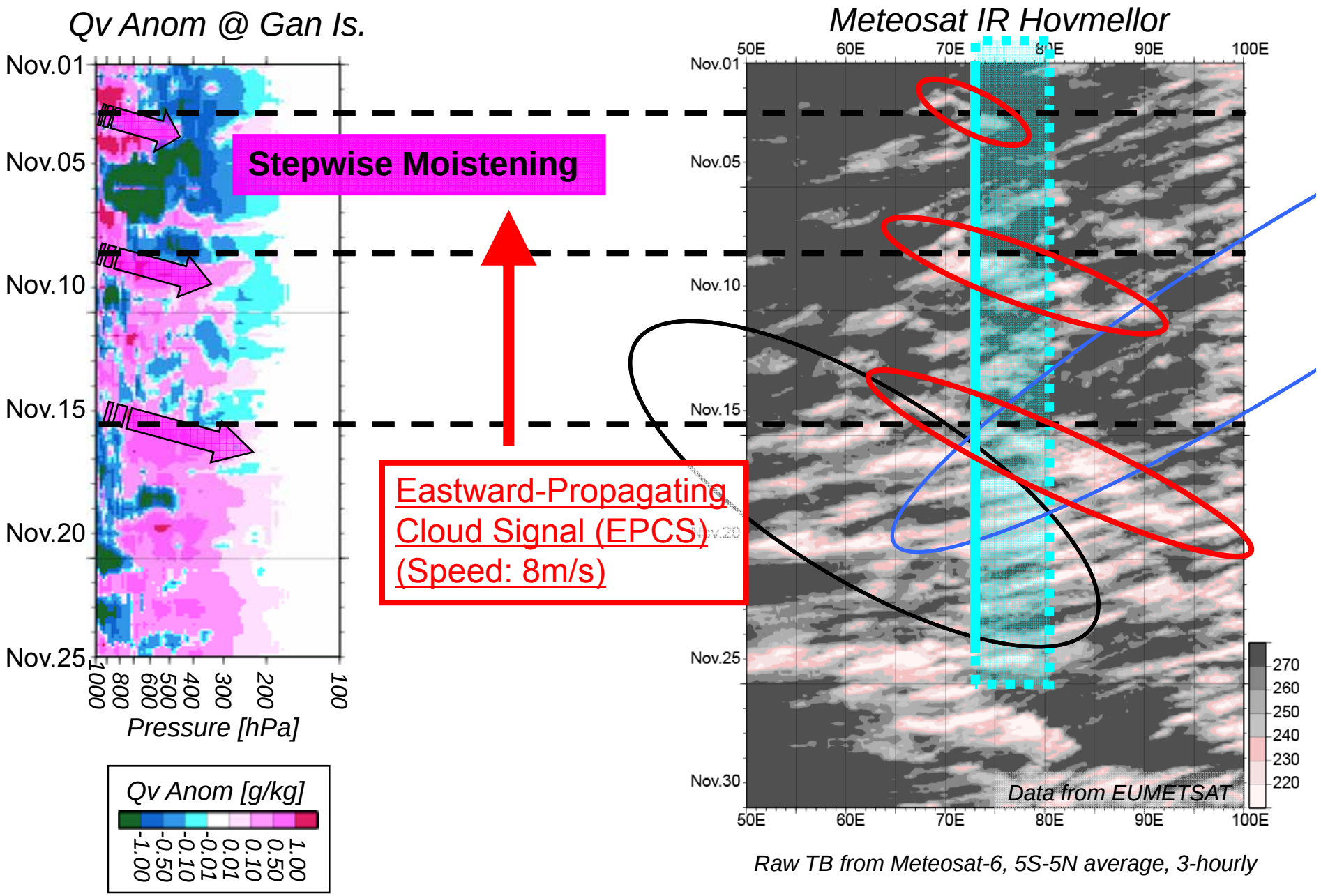
OLR mode analyses after Wheeler and Weickmann (2001)
contour: 7.5W/m^2, negative only

Meteosat IR Hovmellor



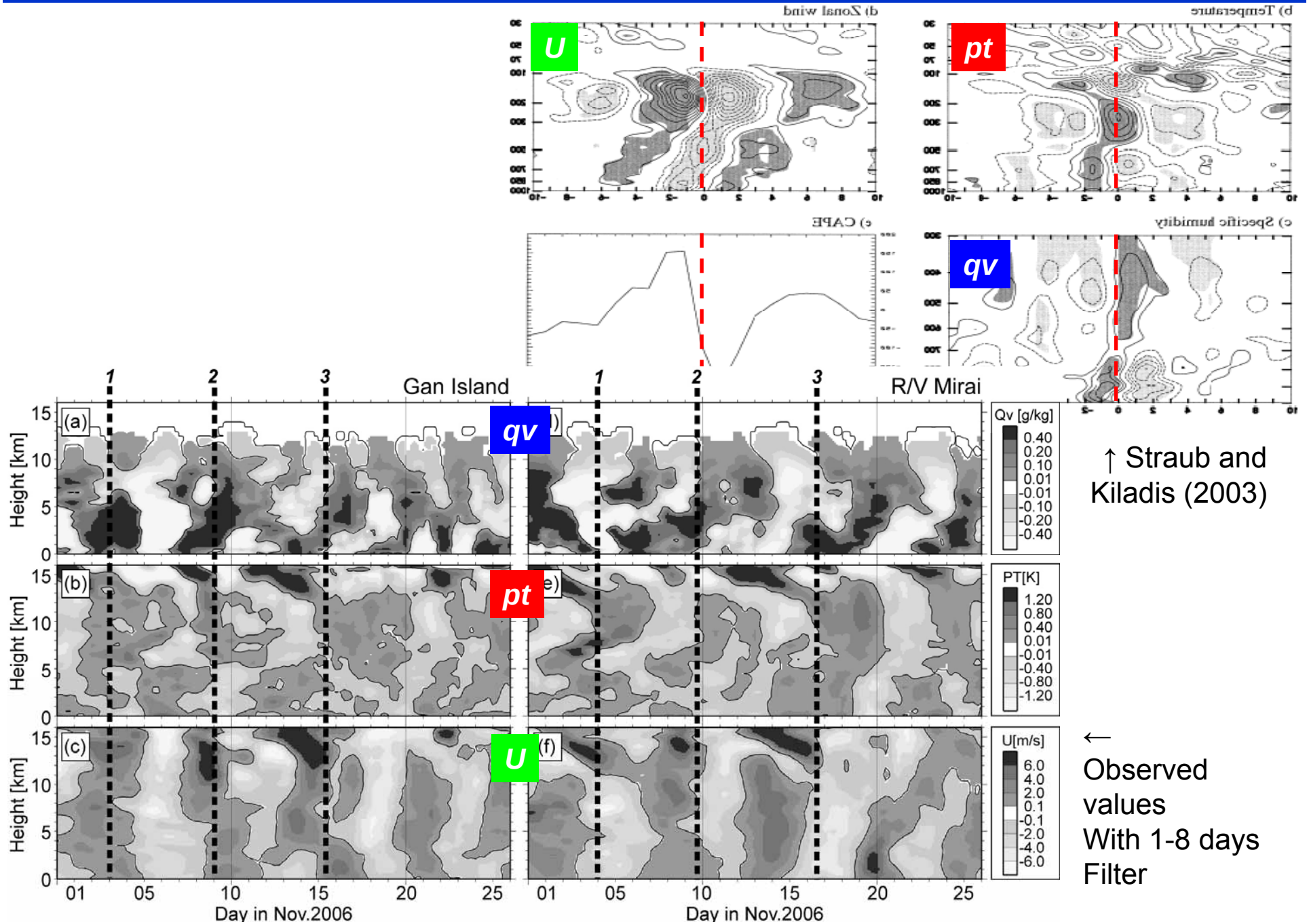
Raw TB from Meteosat-6, 5S-5N average, 3-hourly

Stepwise Moistiening <-> Eastward-Propagating Signal



Raw TB from Meteosat-6, 5S-5N average, 3-hourly

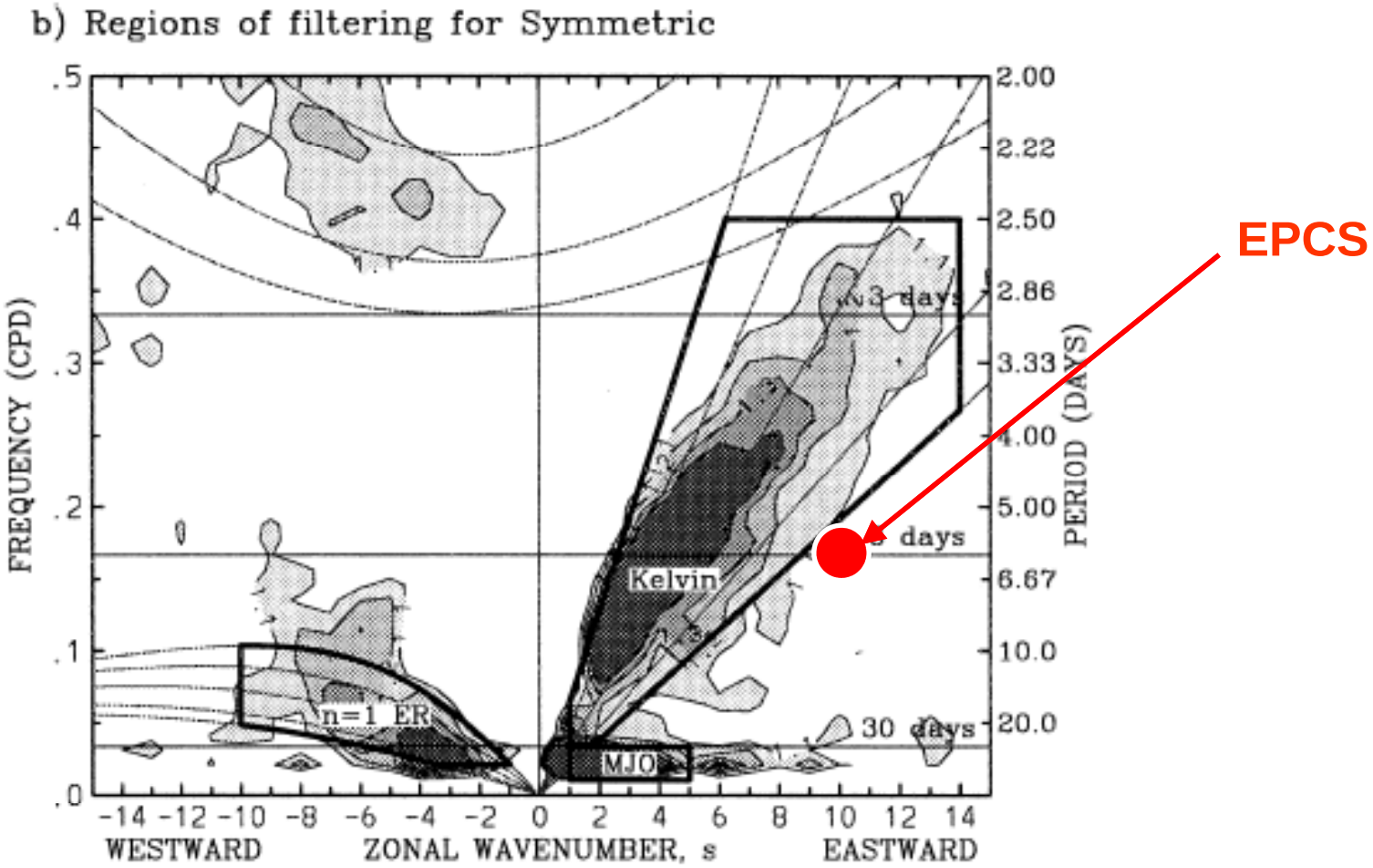
EPCS = Most Kelvin Wave ?



↑ Straub and Kiladis (2003)

← Observed values With 1-8 days Filter

EPCS in Wavenumber-Frequency Domain



Wheeler and Weickmann (2008)

Slow Gravity / Kelvin Wave ←→ Shallow Heating

Tulich and Mapes (2008)

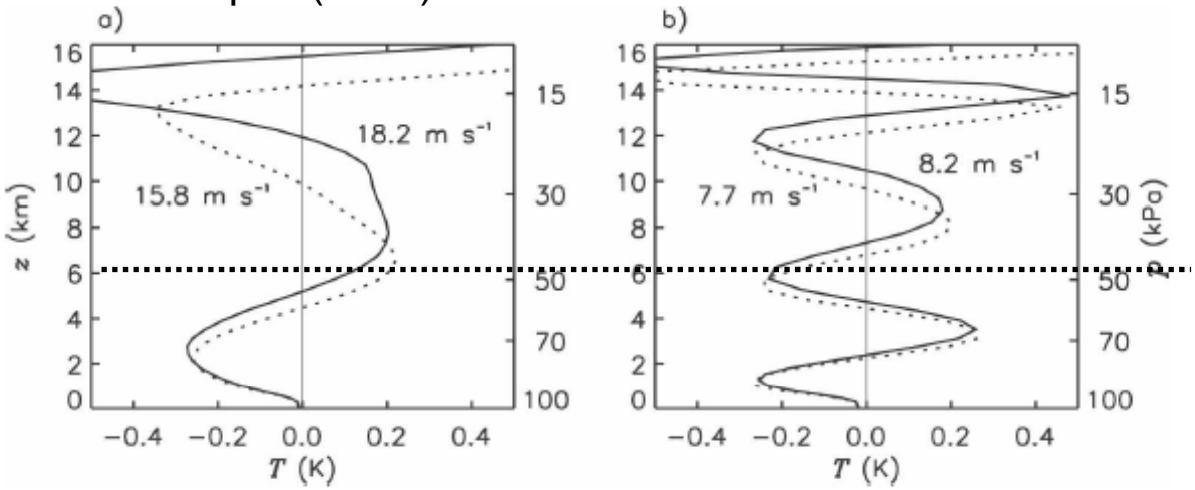
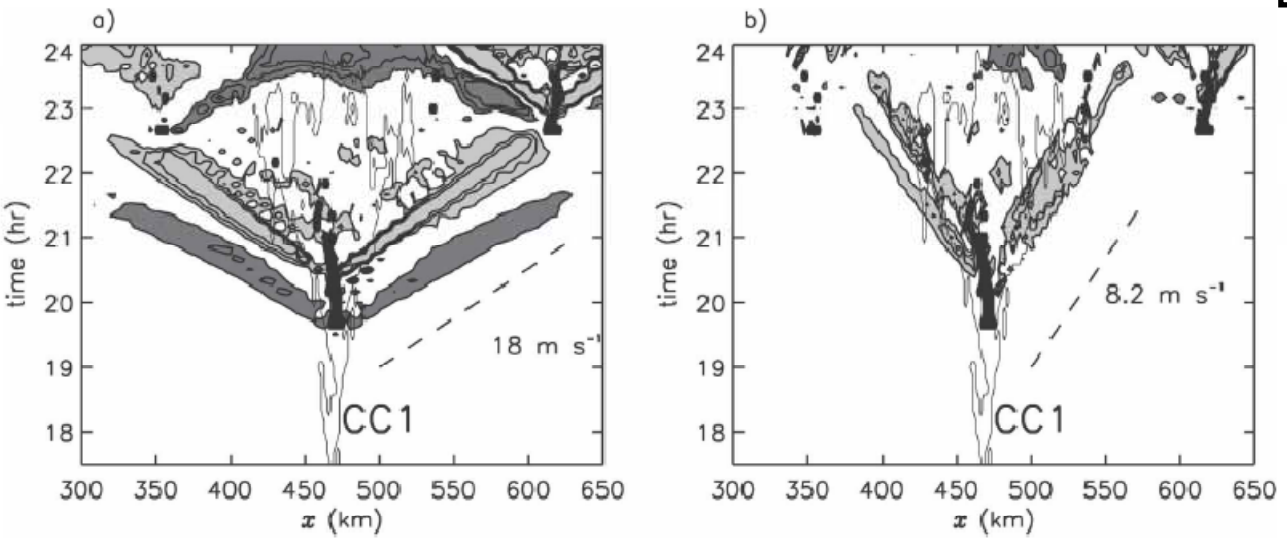


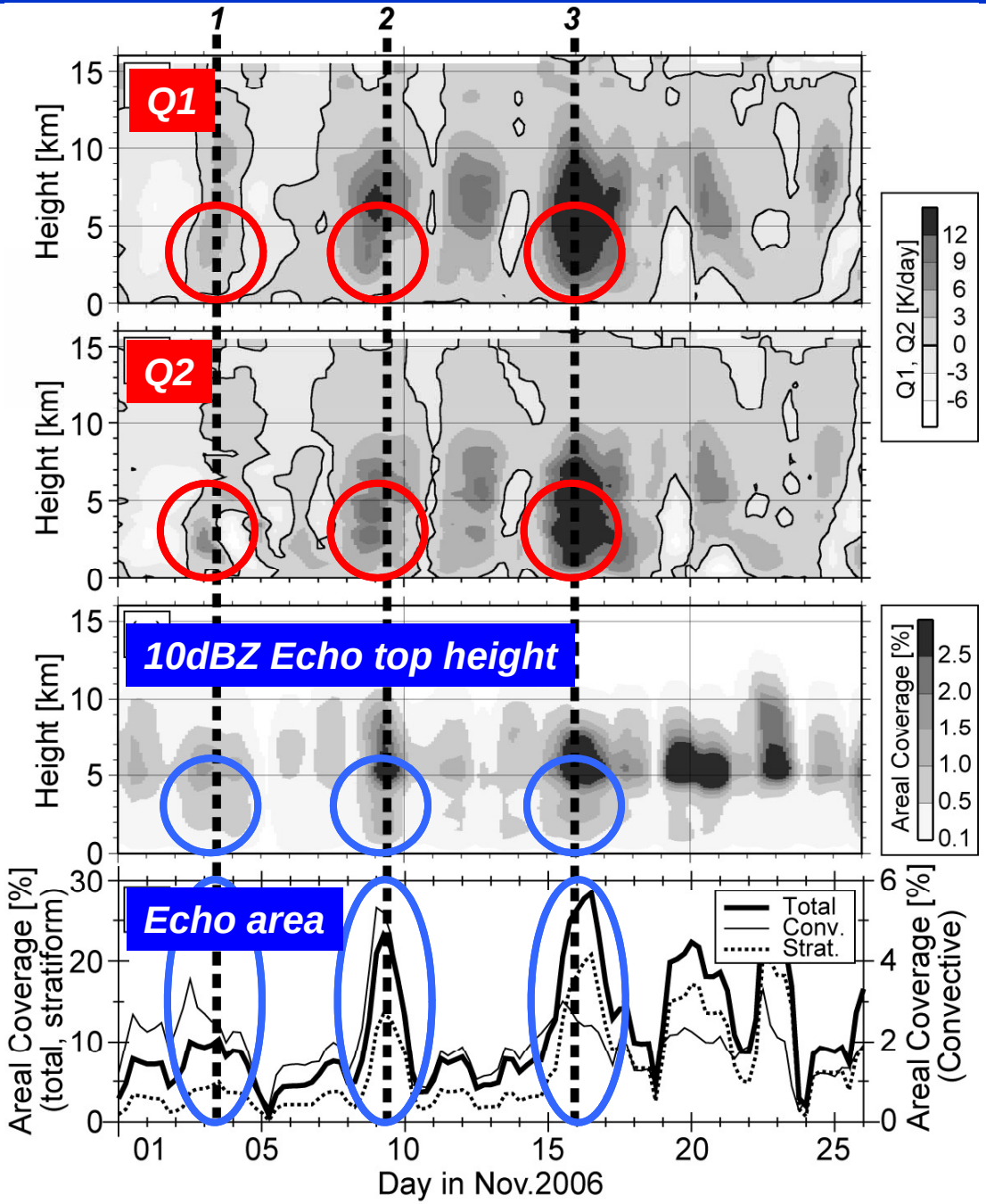
FIG. 3. Temperature structures of the (a) "slow" [$c_n \cong 18$ (solid) and 16 m s^{-1} (dashed)] and (b) gust-front [$c_n \cong 8.2$ (solid) and 7.2 m s^{-1} (dashed)] modes. Each curve is valid for a modal temperature amplitude index T_n of −1 K (see TRM07 for details).



Ohuchi and Yamasaki (1997)

…
the other is destabilized by **moderate heating at lower levels** under the control of surface friction (FK: frictional Kelvin mode)
…
FK is characterized by **smaller phase velocities (10 m/s)**
…

Time Series of Heating Profile



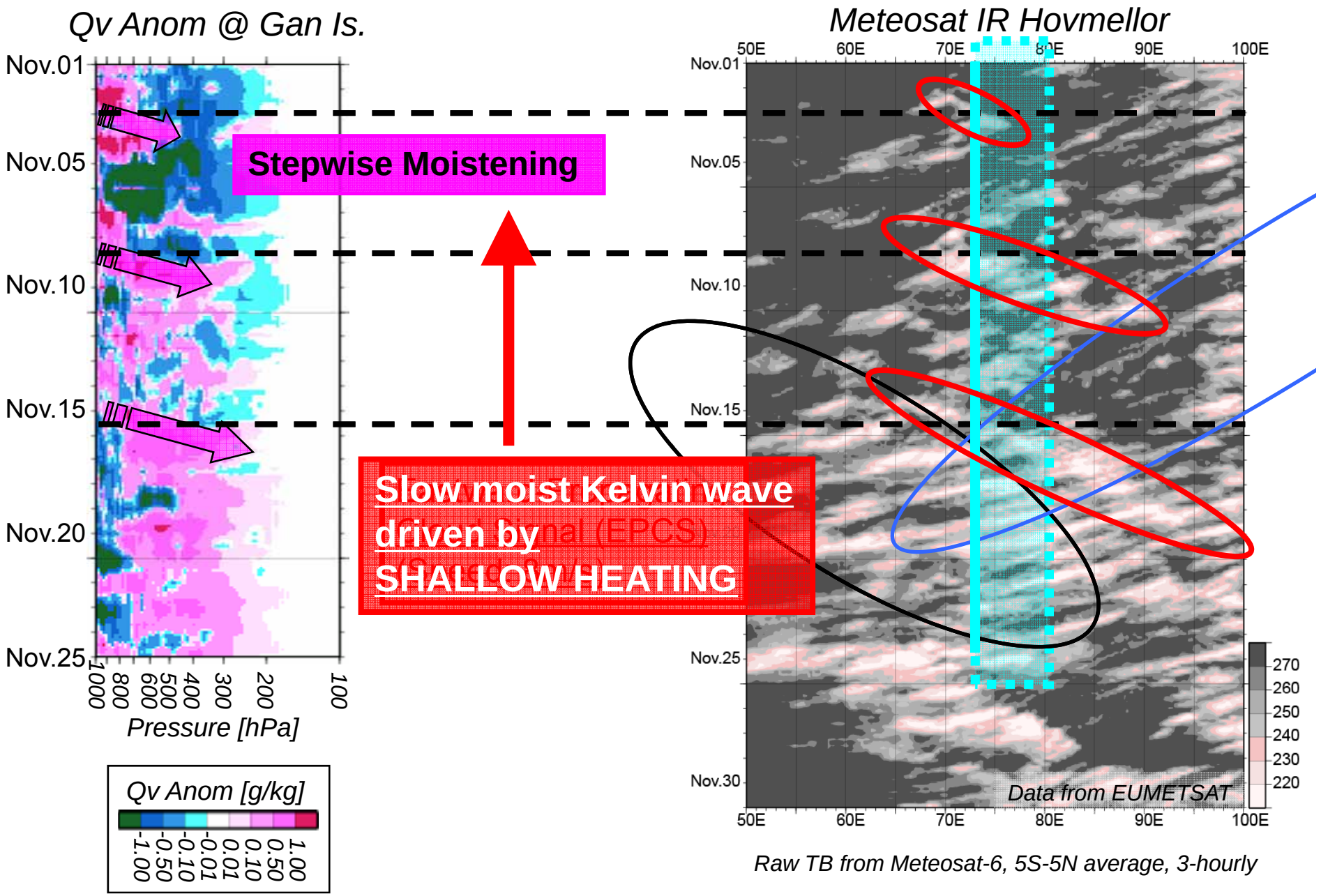
Upright Profiles with Large Q1 and Q2 at Lower Troposphere

Including Shallow Heating in EPCS

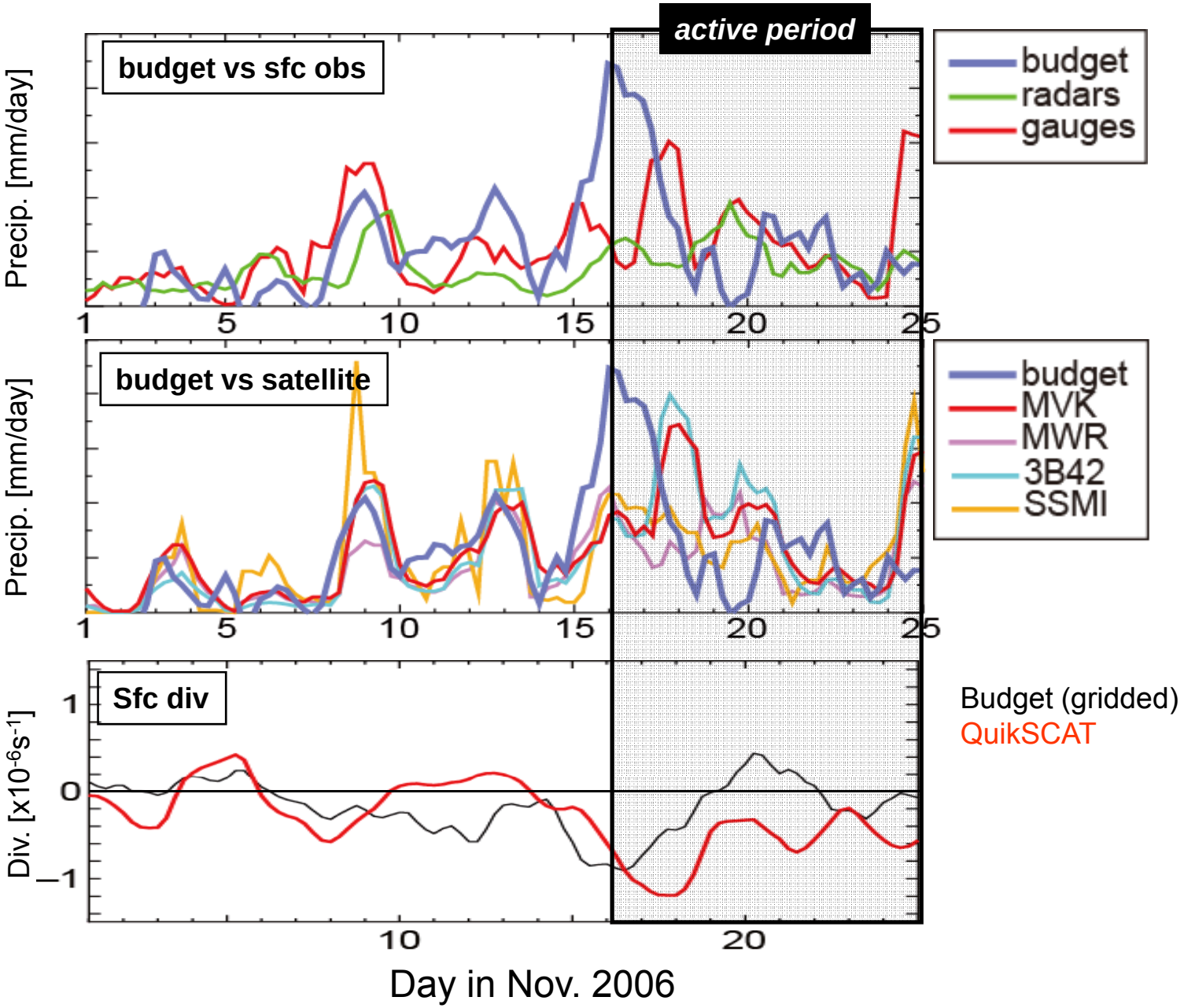
Large amount of Shallow Clouds

Large stratiform portion
→ need to compensate low-level cooling
→ evidence of low-level heating

Stepwise Moistiening <-> Eastward-Propagating Signal



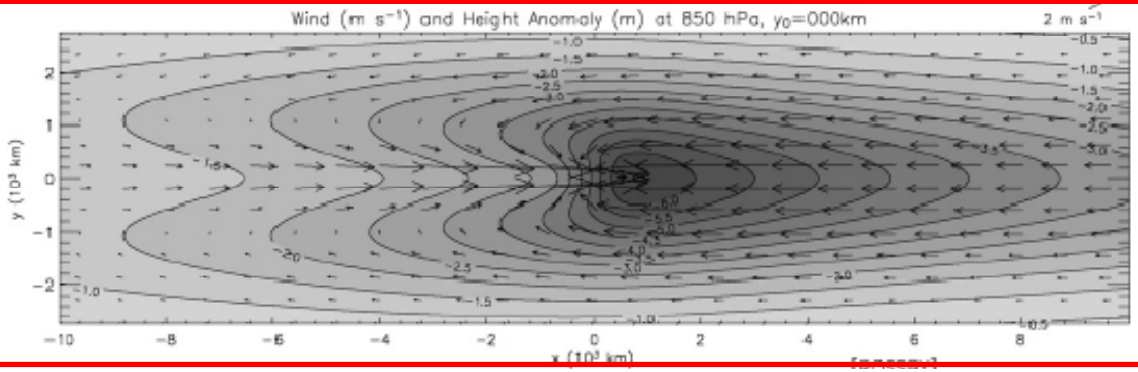
Rainfall: Budget vs. Other Observations

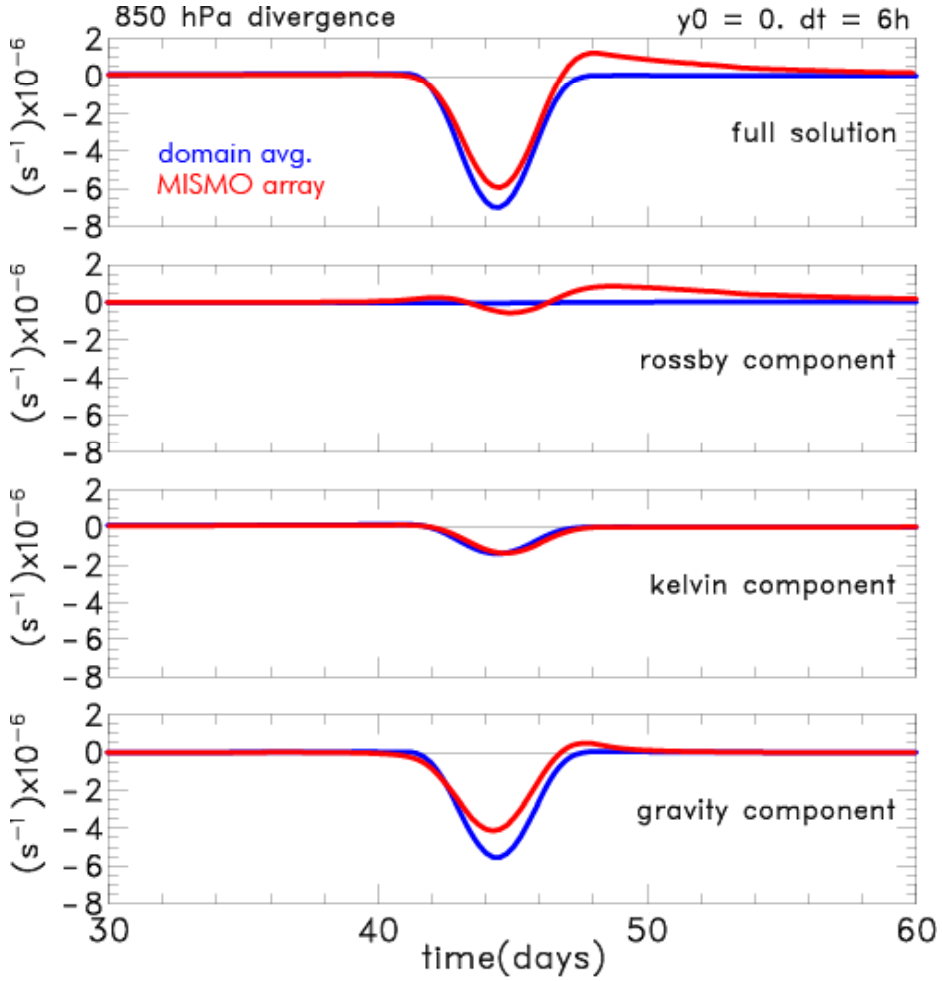


Budget (gridded)
QuikSCAT

Simulating Budget Analyses

Theoretical Wind Field
with TOGA/COARE-like heating
(Schubert and Masarik 2006)





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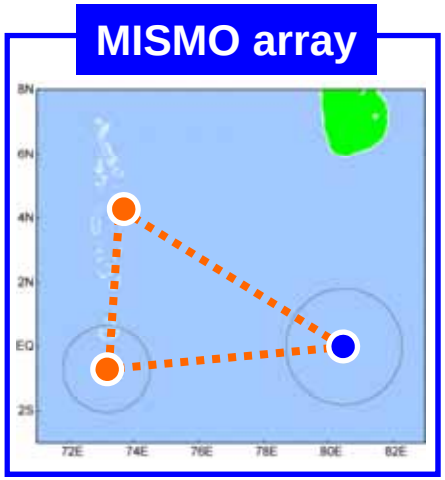
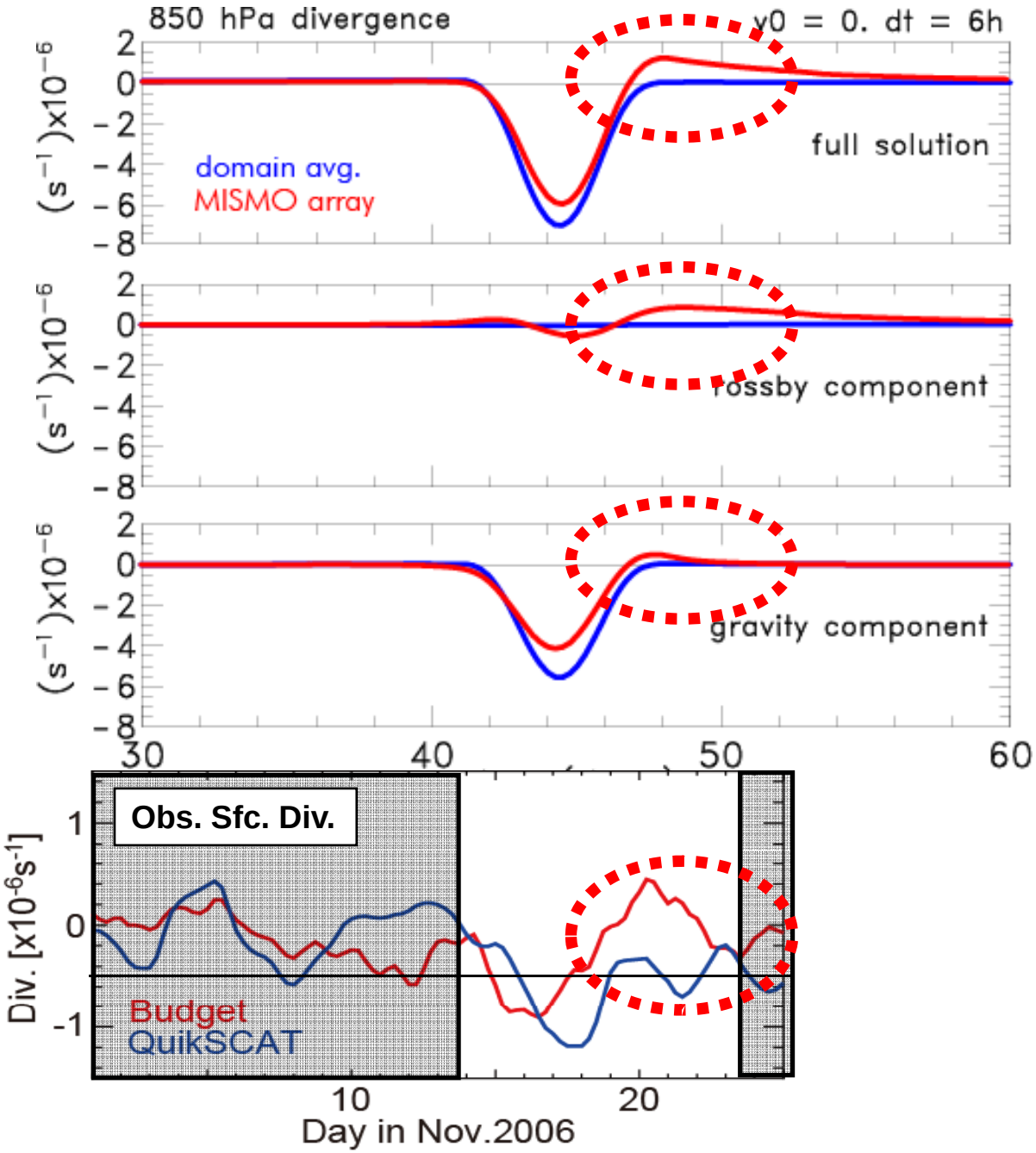
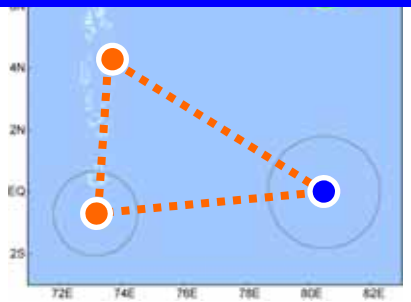


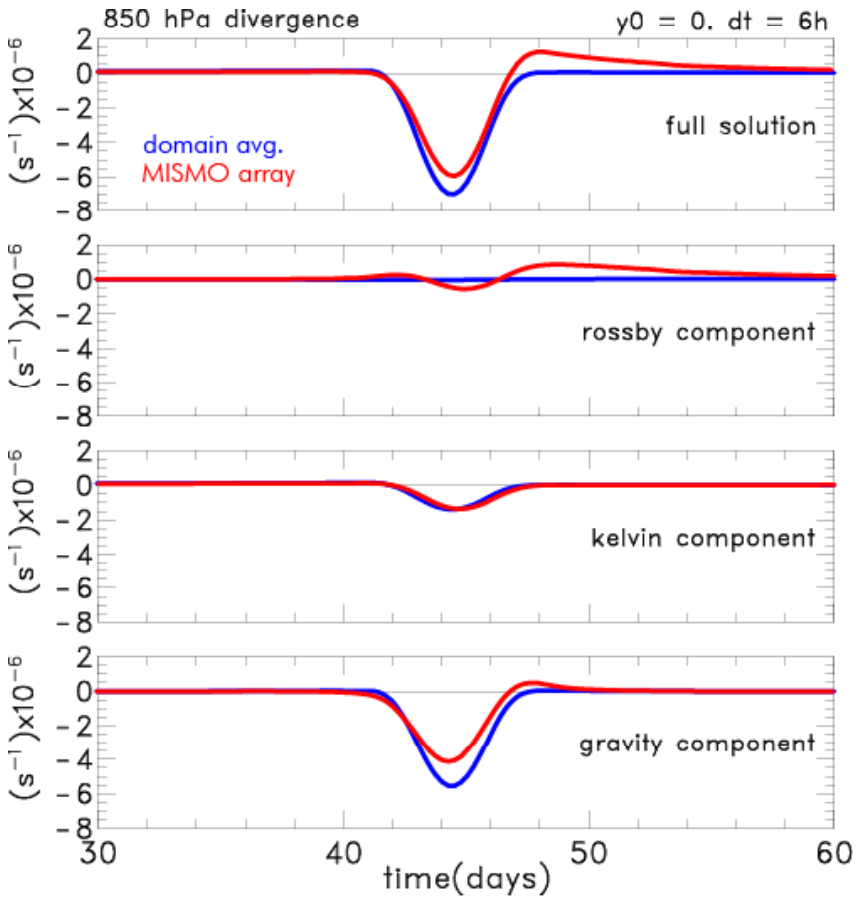
Comparison of Simulation and Observation



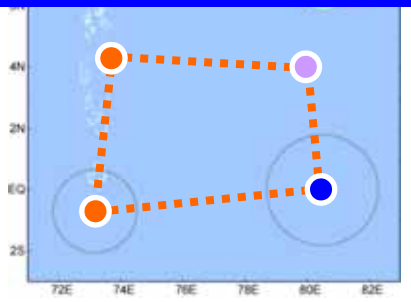
Reducing Errors

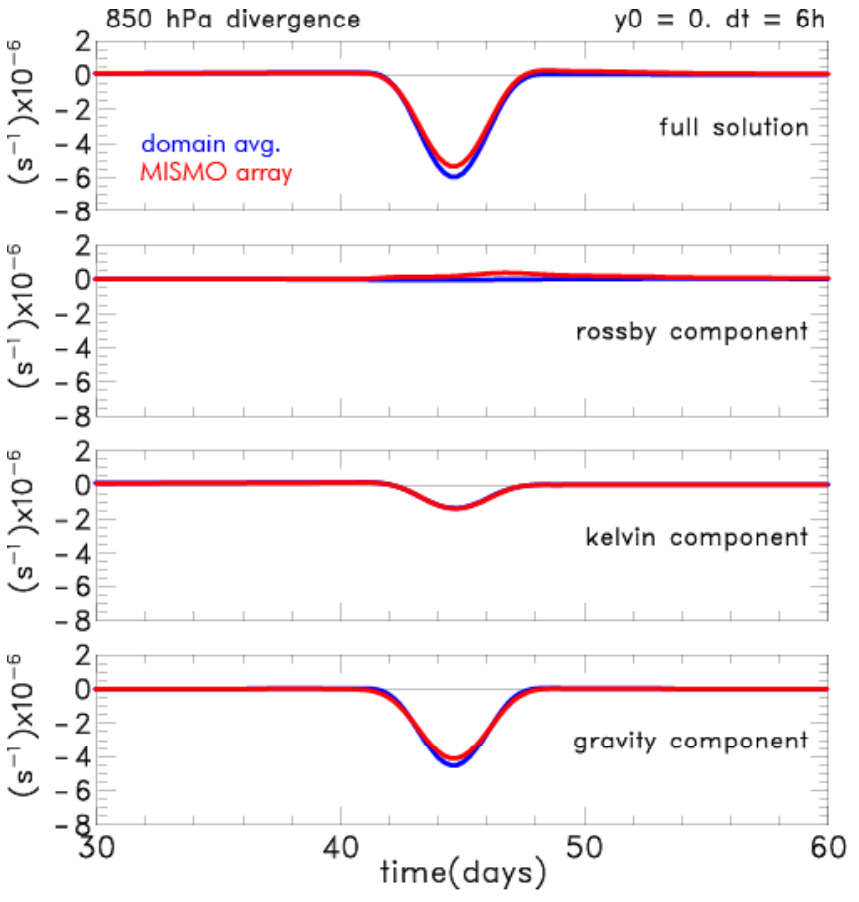
MISMO array (triangle)





MISMO array +1 (Rectangular)





Summary

- The budget analyses were applied to the sounding dataset in MISMO.
- IOP-averaged Q1 and Q2 shows higher value in lower troposphere than in TOGA/COARE.
- The temporal variation of Q1 and Q2 shows high value in the lower troposphere when the eastward-propagating cloud signals (EPCSs) passed over.
- The slow speed of EPCSs could be explained by the shallow heating to make higher vertical mode to promote slow gravity wave.
- The EPCS moistened the atmosphere in stepwise sense before MJO active phase
- The estimated rainfall well matched to the in-situ measurements and satellite-based estimations, before the active phase.
- The theoretical simulation of the budget analyses shows similar error to the observed one in the MJO active phase. The Rossby- and gravity-wave component made these error in the simulation.
- The additional point to make rectangular could reduce the error by synoptic-scale circulation (especially Rossby and gravity wave component).