A Threefold Classification of Extratropical Cyclogenesis

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(With thanks to T. Hewson, F. Ahmadi-Givi and A. Deveson)

Petterssen and Smebye Classification

Classification schemes come and go and are forgotten and re-invented again, but Petterssen and Smebye's (1971) endures (forever?)

It is a simple, qualitative description that is useful in labelling which theoretical view of cyclone development seems to be most applicable.

Type A:

Strong thermal advection at low levels, with an upper level response.
Somewhat like a baroclinic wave.

Type B:

Upper level feature provokes a reaction in a baroclinic region below.
"Non-modal" growth.

How to identify A or B?

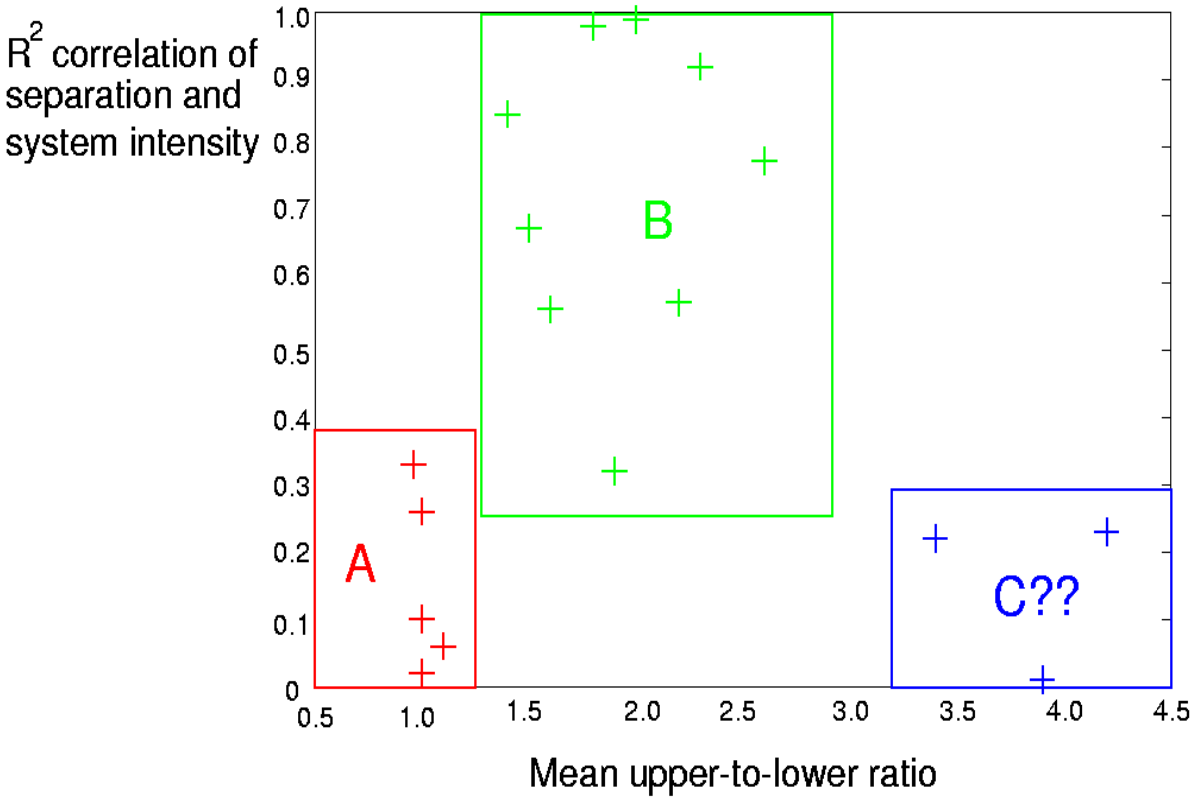
Stare very hard until inspiration strikes.

Or:

Deveson et al (2000) objective method:

Find maxima in mid-level vertical motions that are attributable (via adiabtic QG ω eqn) to upper and lower level forcings.

Construct mean ratio of these motions and look for correlation between their separation and system strength.



Are Type C Events Driven by a Different Dynamical Mechanism?

Maybe so!

Ahmadi-Givi and Craig (2001): case study of FASTEX IOP18 using PV inversions and numerical simulations.

This was a type C event, and was characterized by extremely strong latent heat release.

We postulate that some of the dynamical features of this case might constitute “generic type C behaviour”...

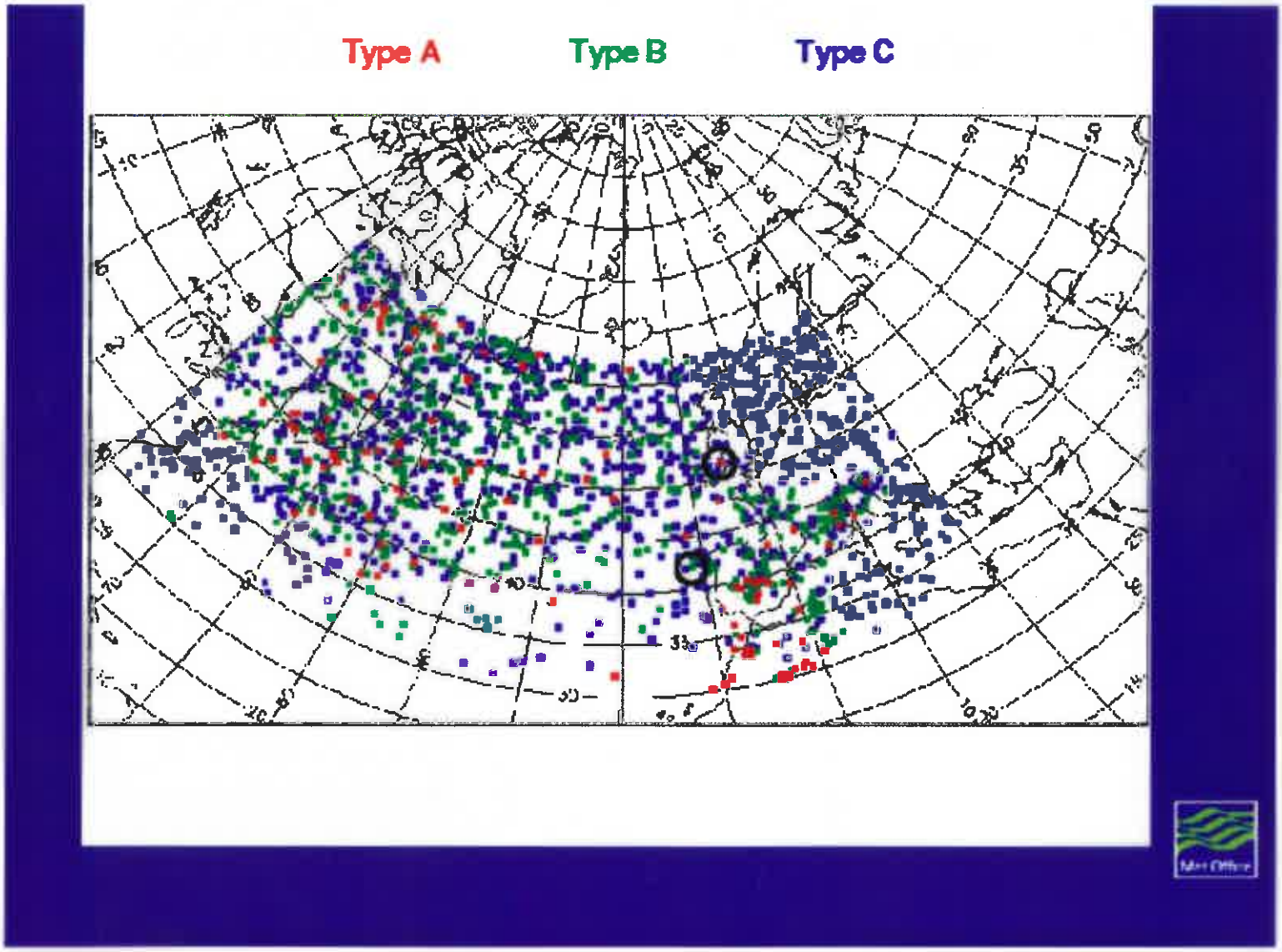
(1) Initial stages dominated by an upper-level precursor, as in type B.

(2) Little co-operative interaction with weak surface baroclinicity: very weak theta anomaly.

(3) Strong latent heat release crucial to intensification.

(4) Interactions of upper-level feature and diabatic PV anomaly are such as to weaken low-level fields attributable to upper level feature.

Classification of Events in a Database of Cyclones Occurring During 2000



Note: Classification uses instantaneous value of ratio only.

(This figure courtesy of T. Hewson)

Another Type C Cyclone

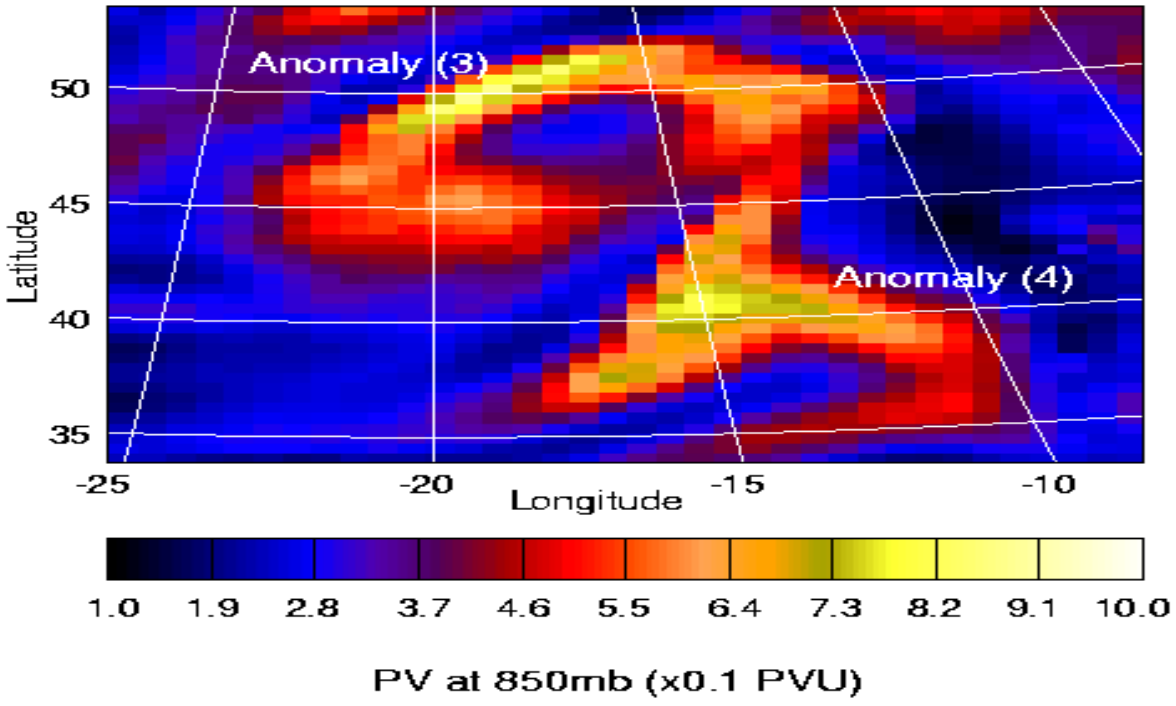
Try a similar analysis for FASTEX IOP4, which has four anomalies of interest:

(1) A surface theta anomaly (feeble throughout!).

(2) A pre-existing upper-level feature.

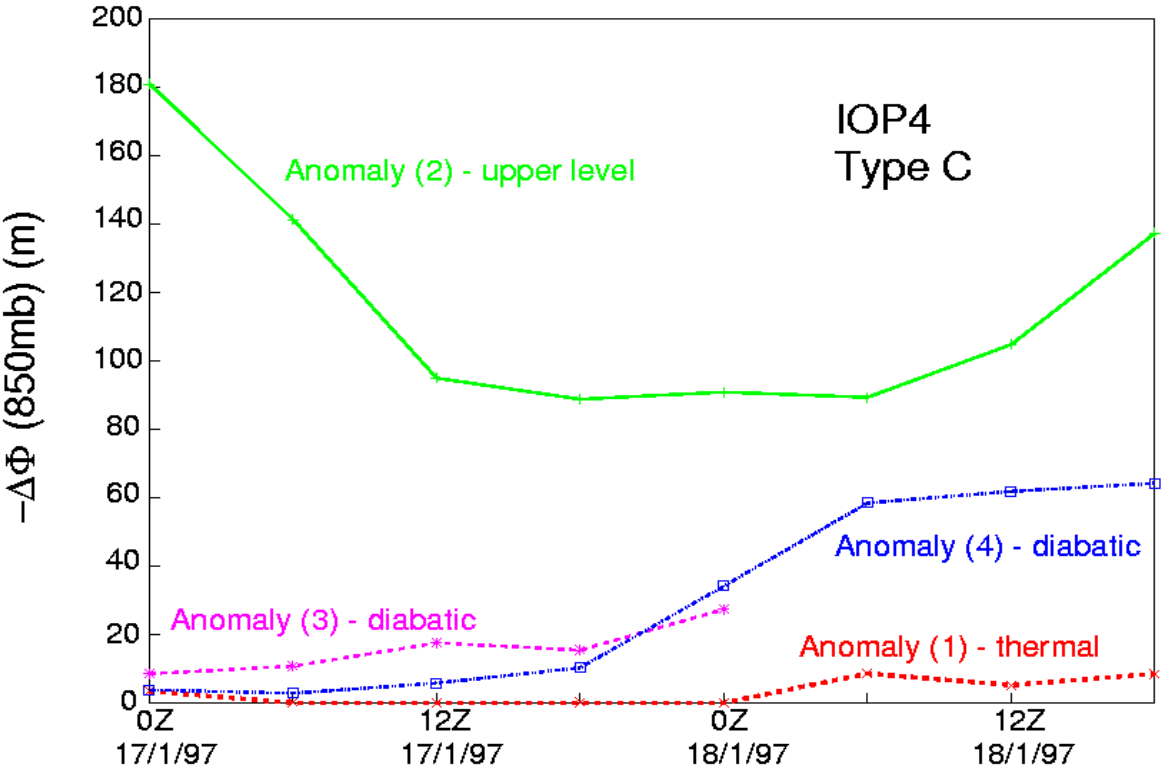
(3) A moderate diabatic PV anomaly, formed as a convective response to (2).

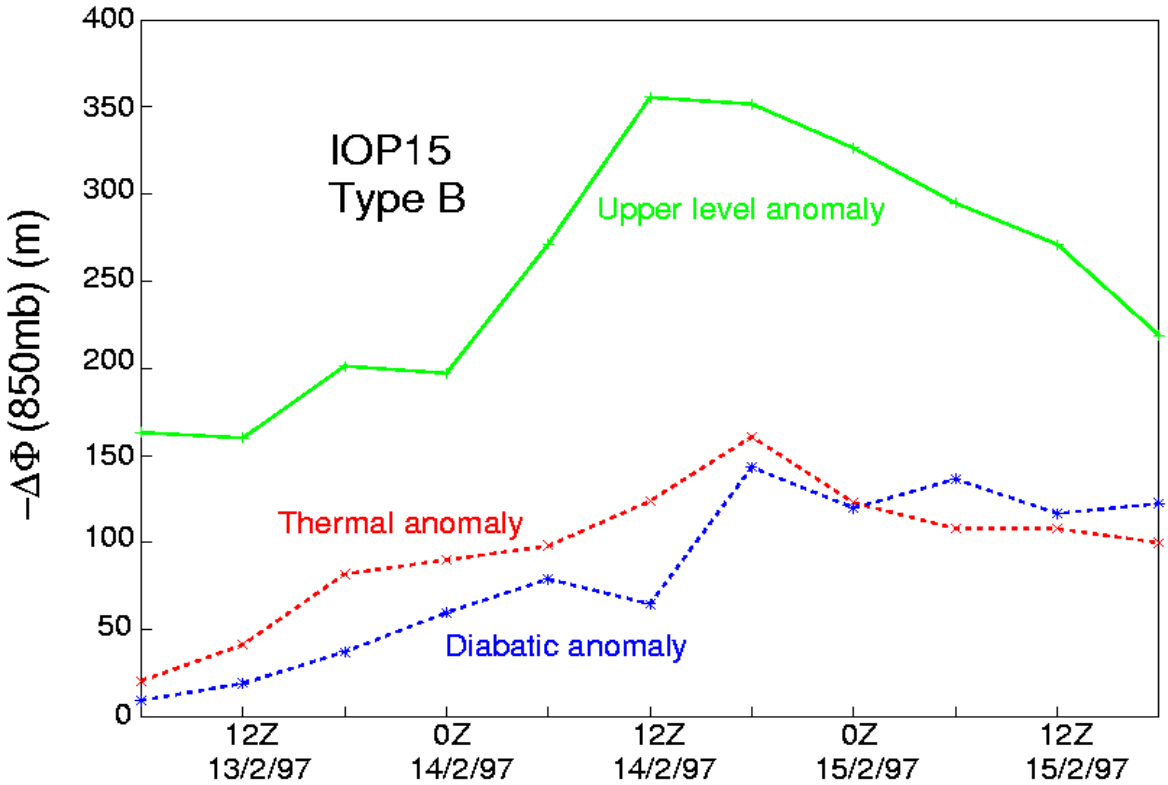
(4) A diabatic anomaly that initially lies well to the south of the system and is weak.



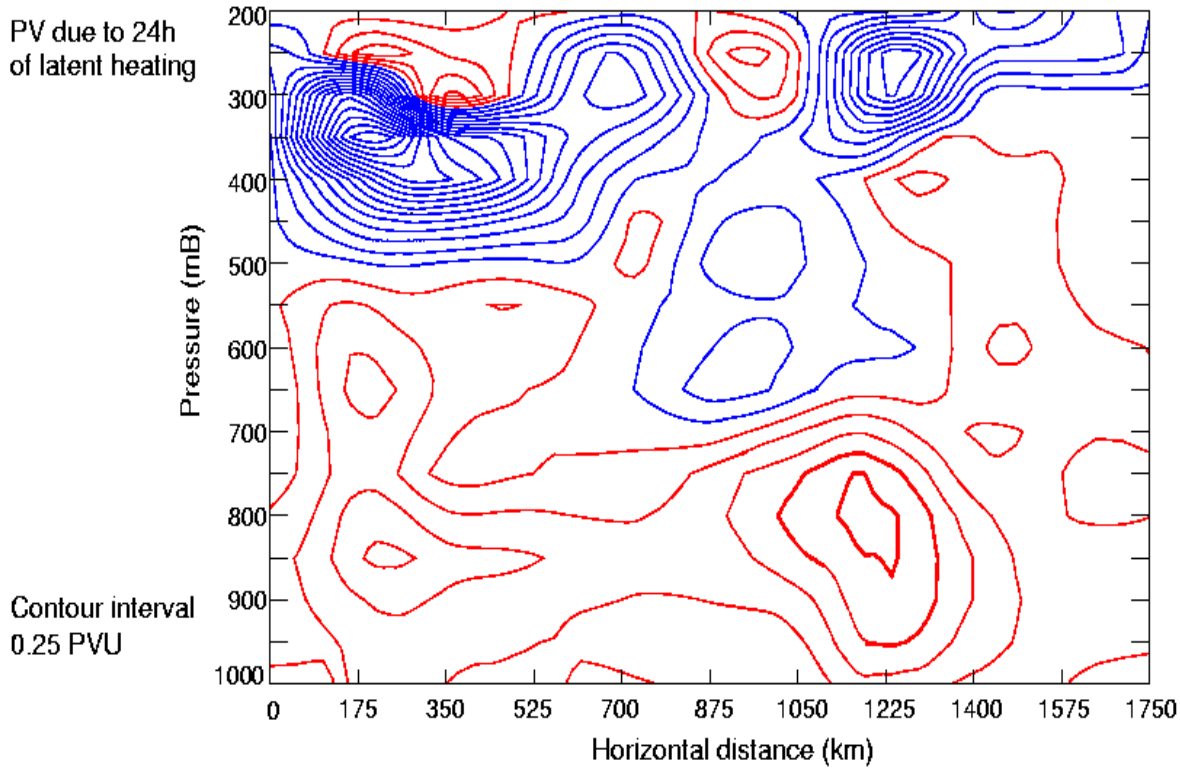
Development driven by motion of (4), which is drawn into the vicinity of the low. It can then develop strongly through convection.

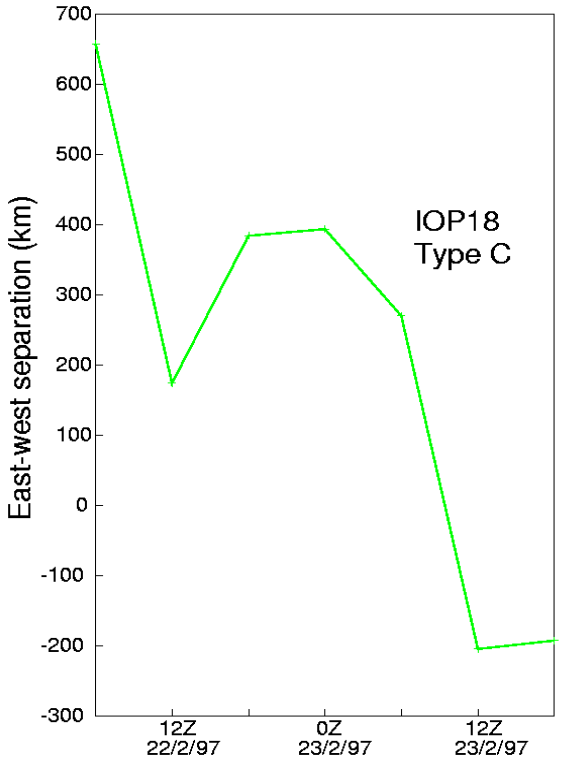
Relative Amplitudes

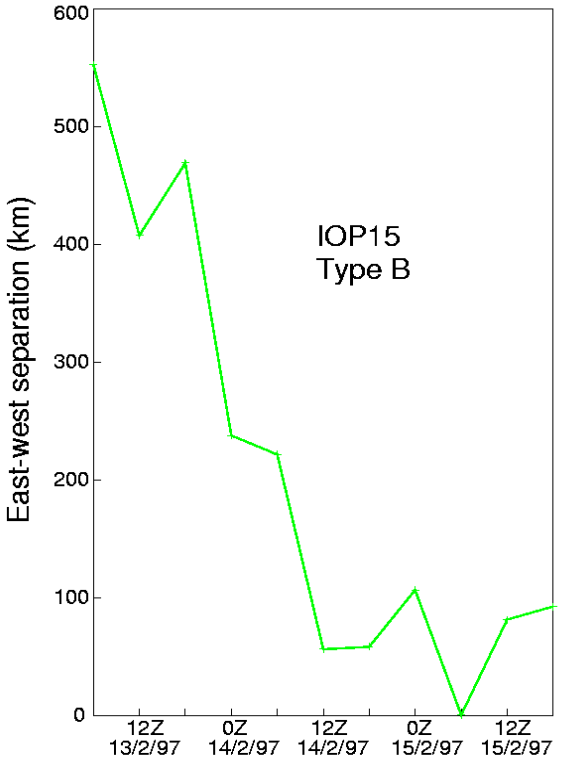




Separation of Anomaly Responses







Should the Petterssen and Smebye A, B classification scheme be extended by introducing an additional type, C?

Very possibly, because:

Significant events occur that do not fit into the traditional A, B scheme (2 such cases identified from QG ω analysis).

There are good indications that similar events may be frequent occurences.

PV inversion analyses of type C candidates show that they have shared dynamical properties.

Intensification in these cases is primarily driven by latent heat realease and thus the events have dynamics distinct from A and B systems.