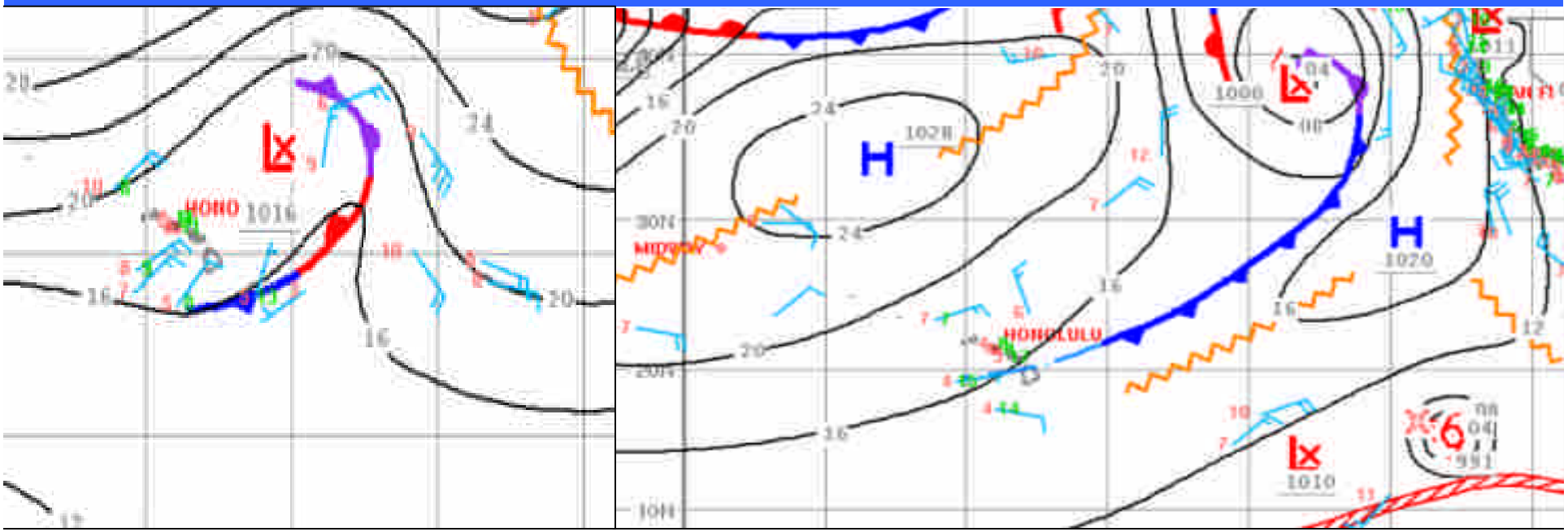
The Application of Satellite-derived Dataset in the Analysis and Numerical Weather Prediction of the Winter Storms in Hawaii



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OUTLINE

- ***Introduction***
- ***Methodology--- Low-pass objective analysis / WRF 3D-Var***
- ***Case study---winter storms***
- ***Summary***

To improve conventional low-level analysis and numerical weather predictions over the open ocean.

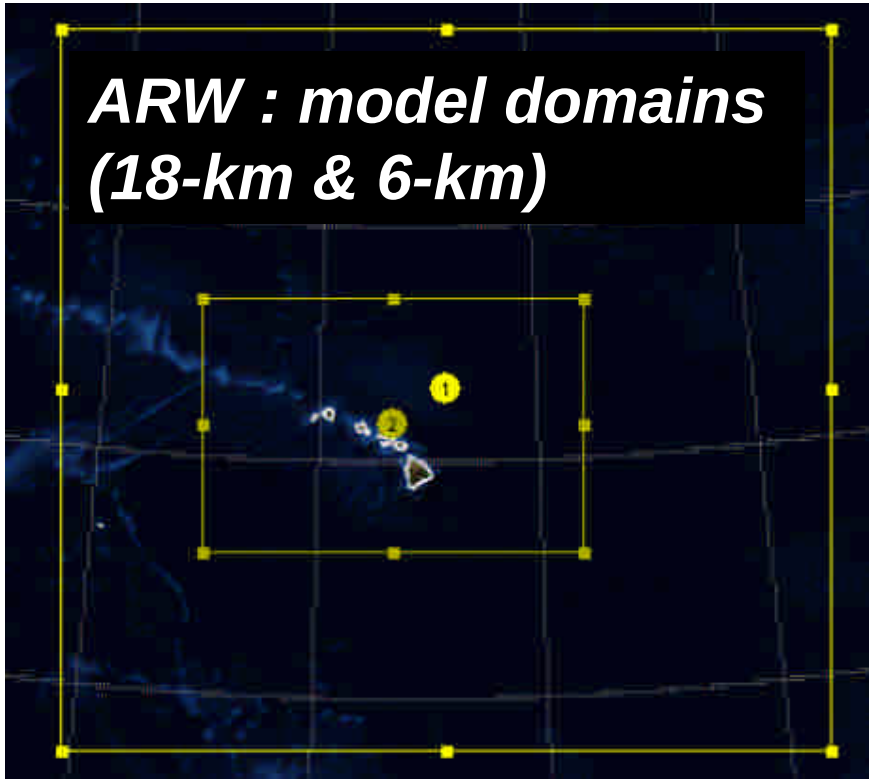
Methodology

- *Low-pass objective analysis (Maddox 1980)*
- *WRF 3D-Var System (Barker et al. 2004)*

- ***To incorporate the unconventional observations.***
- ***To determine the optimal initial conditions for numerical predictions.***

$$J(x) = J^b + J^0$$
$$= \tfrac{1}{2} (x^b - x)^T B^{-1} (x^b - x)$$
$$+ \tfrac{1}{2} (y^0 - y)^T (E+F)^{-1} (y^0 - y)$$

The cost function is a combination of forecast and observation deviations from the analyzed variables, weighted by the inverse of the corresponding forecast-and observation-error covariance matrices.



Model physics

MICROPHYSICS: Ferrier scheme (Ferrier et al. 2002).

CUMULUS PARAMETERIZATION: Betts-Miller-Janjic scheme (Janjic 1994, 2000).

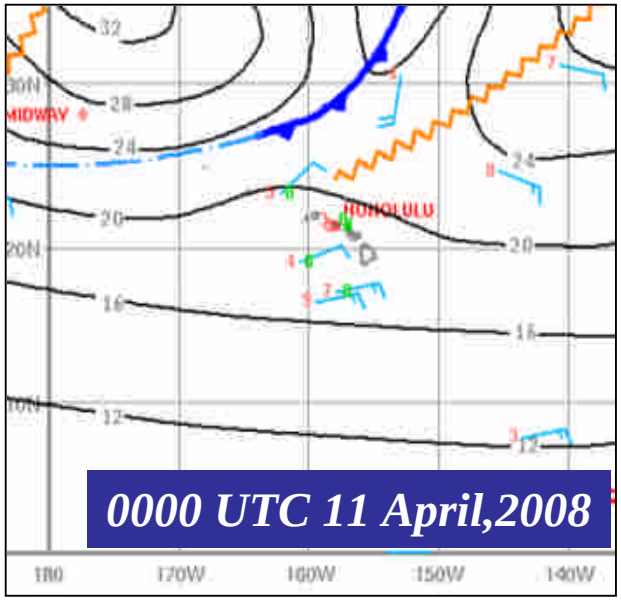
PLANETARY BOUNDARY LAYER PHYSICS: Yonsei University scheme (YSU) (Skamarock et al. 2005).

LAND SURFACE PHYSICS: Noah Land-Surface Model (Chen and Dudhia, 2001).

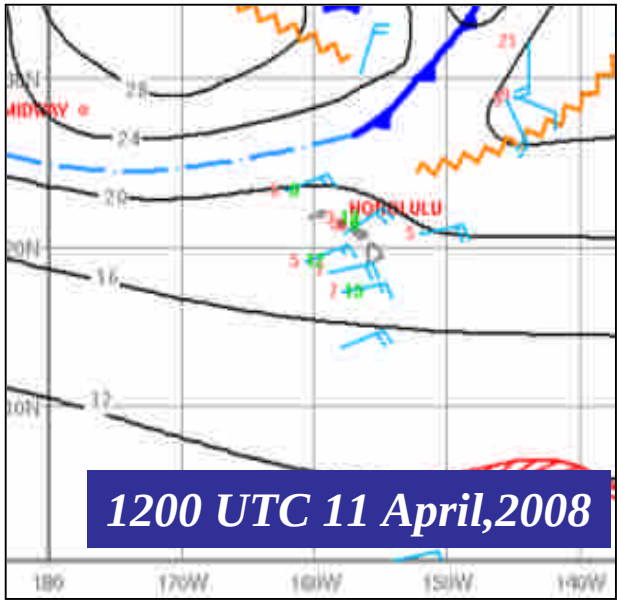
LONGWAVE RADIATION: RRTM scheme: Rapid Radiative Transfer Model (Mlawer et al. 1997).

SHORTWAVE RADIATION: Dudhia scheme (Dudhia 1989).

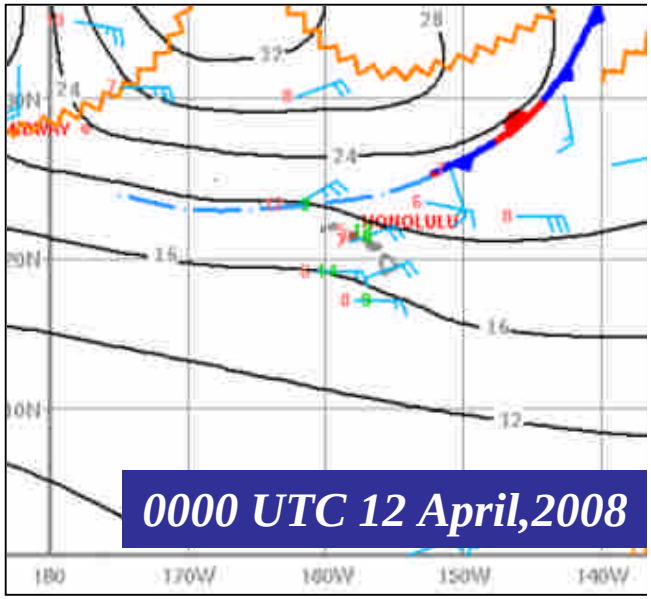
To detect the Propagation of a Surface Front over the Ocean by the Reanalyzed Oceanic Surface Winds



0000 UTC 11 April,2008

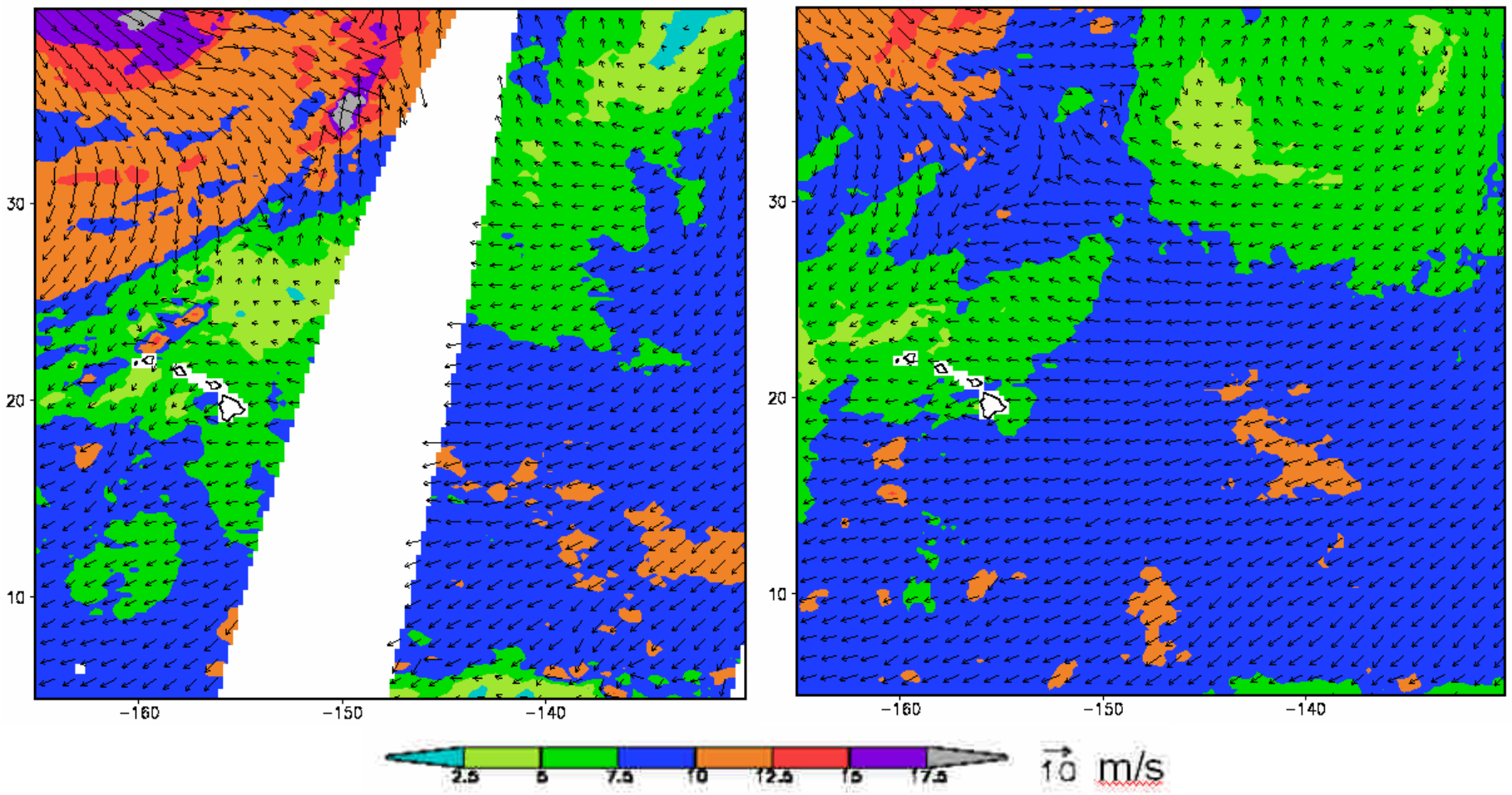


1200 UTC 11 April,2008



0000 UTC 12 April,2008

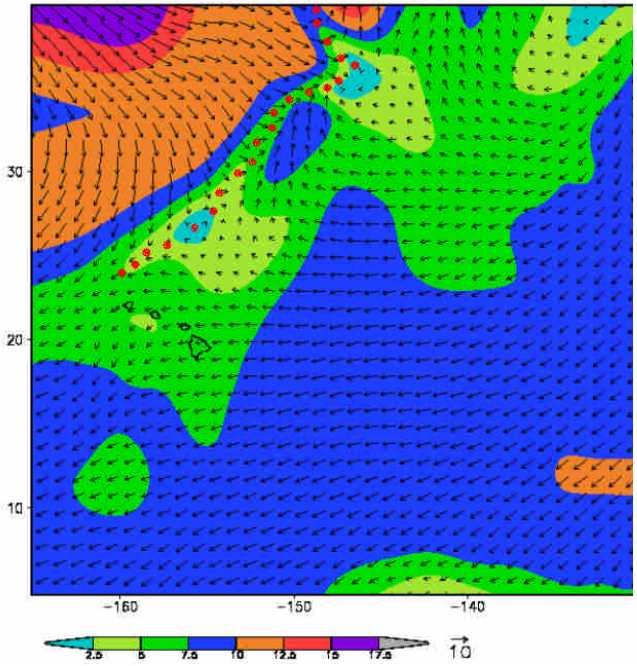
11 April,2008 at descending (02-04 UTC) 11 April,2008 (Daily)



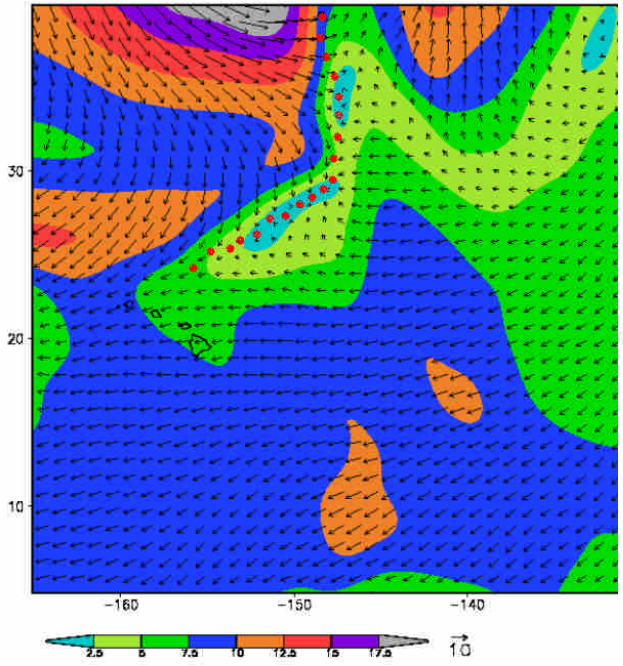
How to fill out the blank swath with daily data ?

Low-pass analysis (Maddox 1980)

0000 UTC 11 April,2008



1200 UTC 11 April,2008



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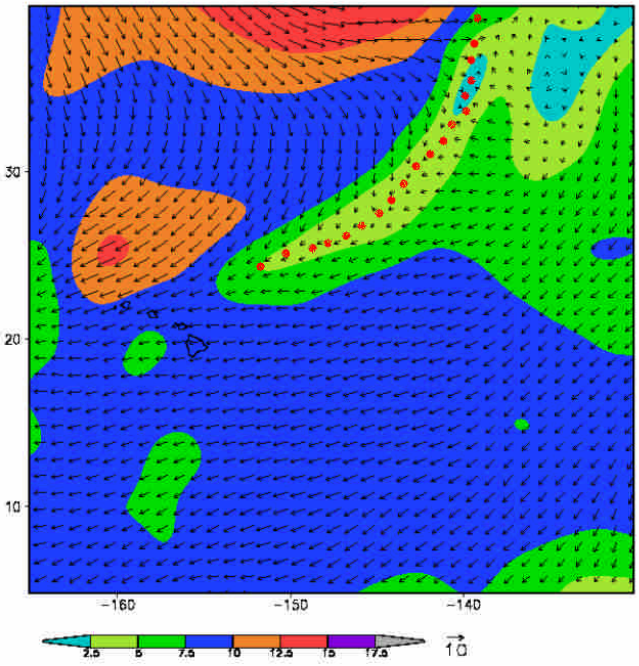
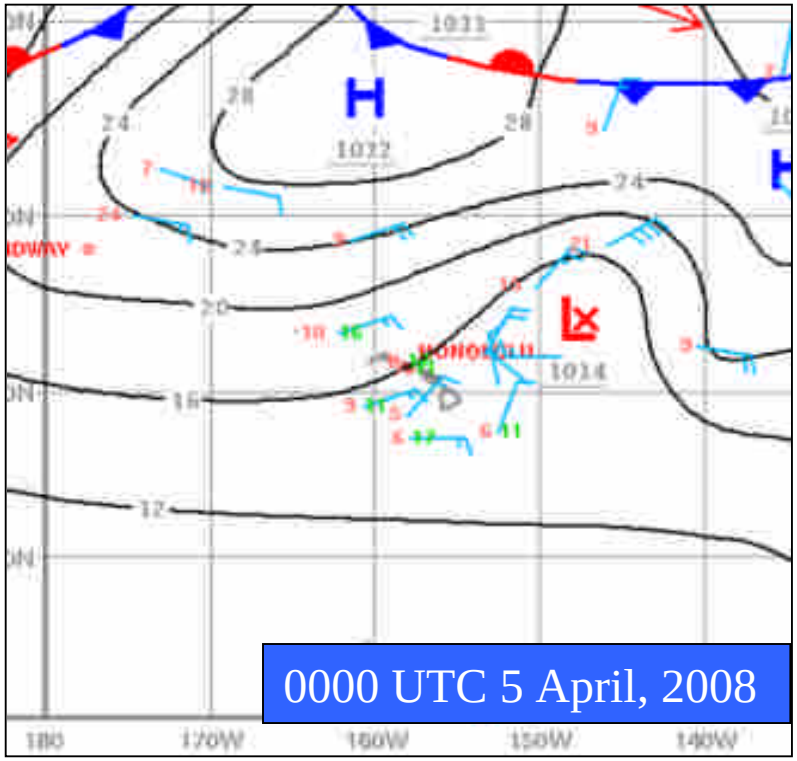


To determine the surface frontal bounday by the wind shift and wind confluence.

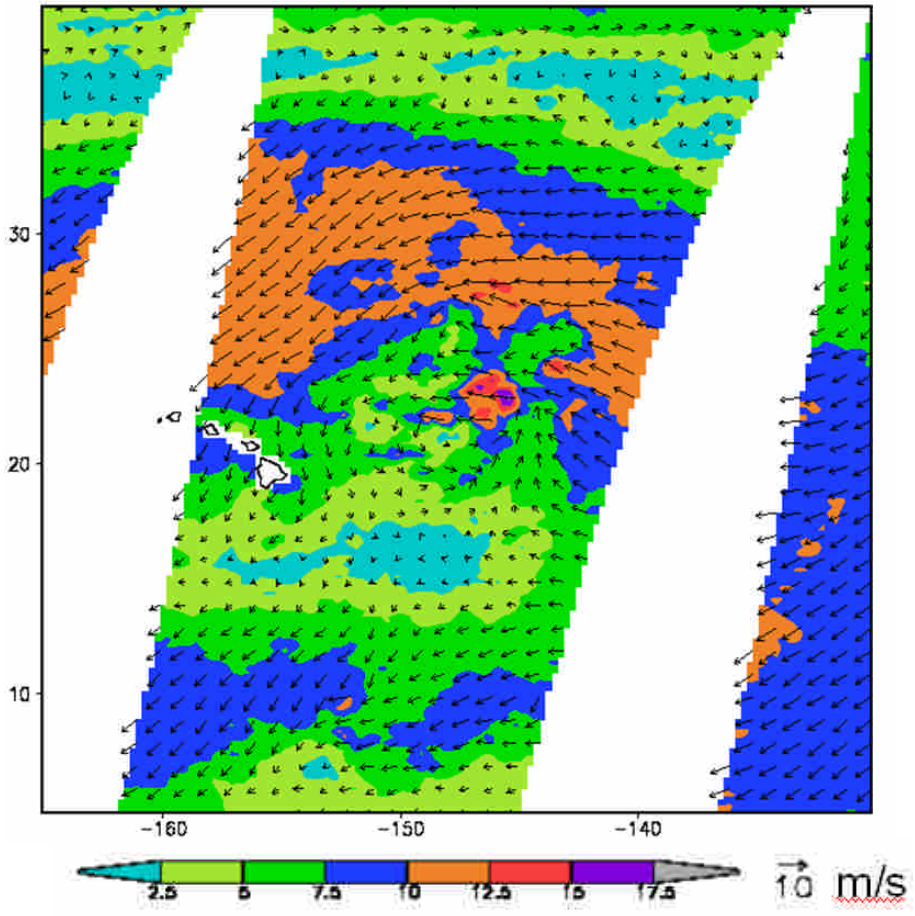
- The wind shift and wind confluence from the reanalyzed ocean surface winds can help to determine the frontal boundary and reveal the propagation of a cold front over the open ocean, north of the Hawaiian Islands during 11-12 April 2008.

- Meanwhile, the strengthening of the northeasterly flow over Hawaii with the eastward-migrating high-pressure system is also revealed during the passage of the surface cold front.

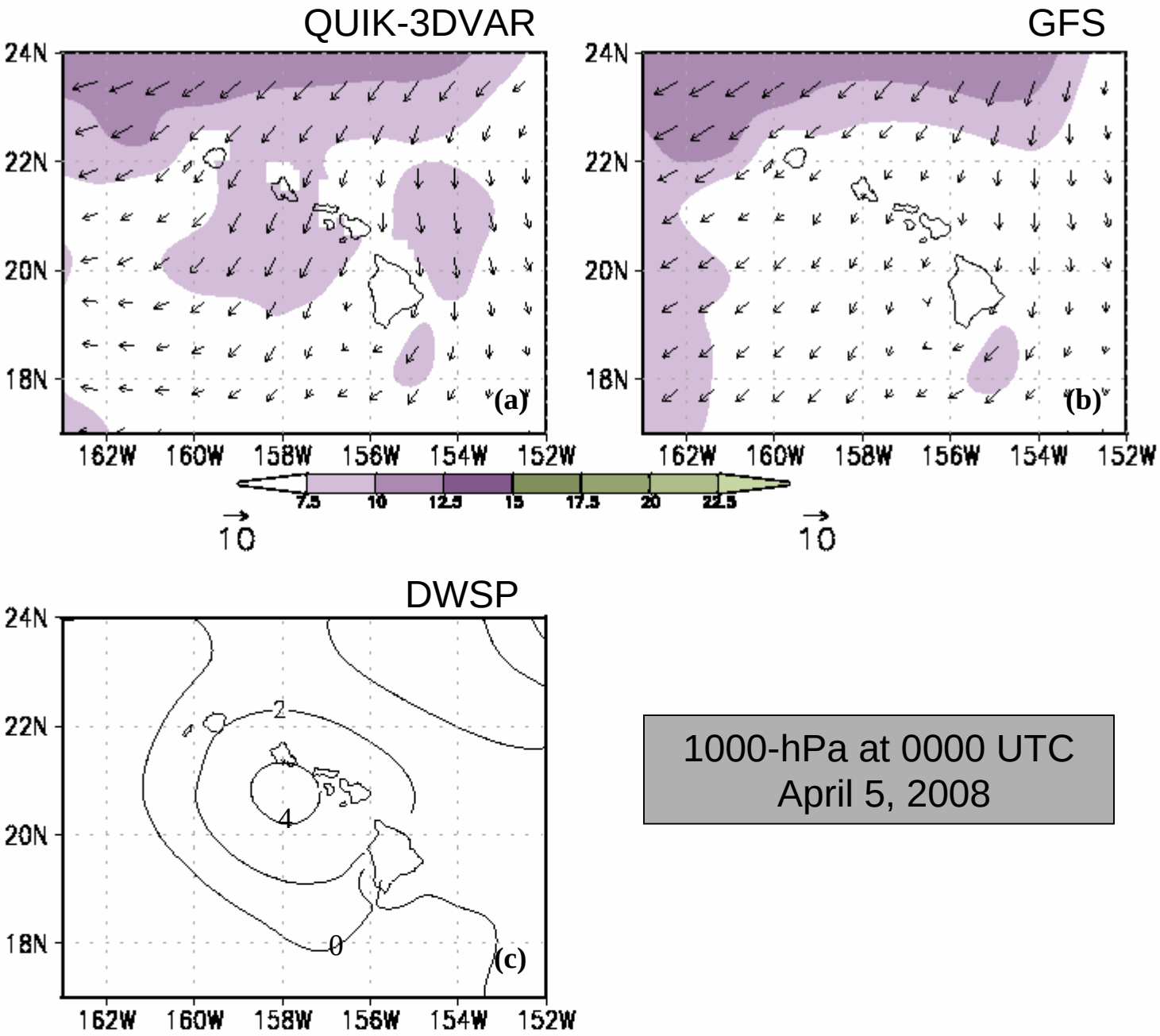
Numerical Prediction ----- a Kona Storm



0000 UTC 5 April, 2008

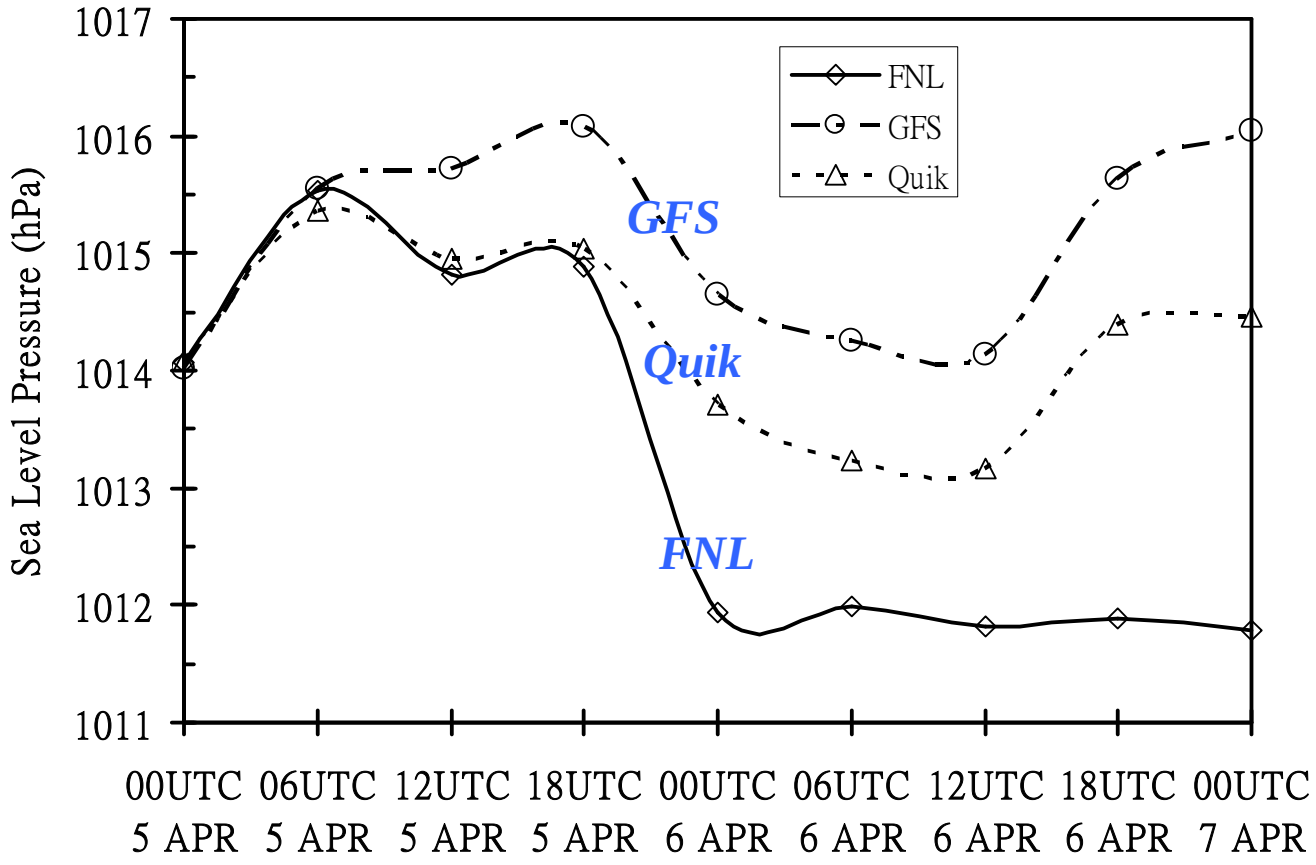


Quik 0200-0400 UTC 5 April



1000-hPa at 0000 UTC
April 5, 2008

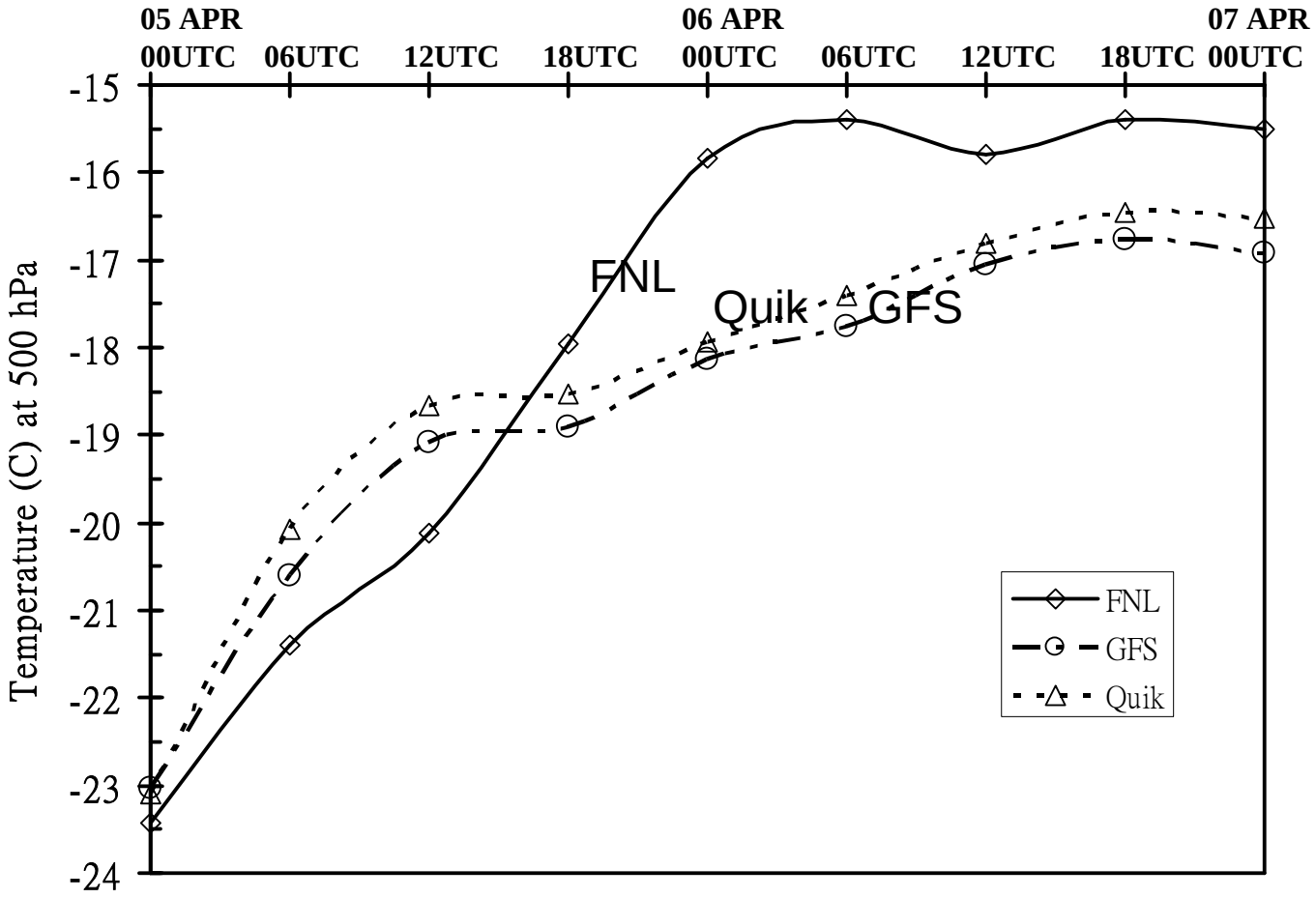
----- Prediction of Sea Level Pressure -----
Quik(3D-Var) and GFS run
vs NCEP reanalysis



Question?

- *Why the Sea level pressure of a kona low deepened significantly (~3 mb/ 6 hrs) during 1800UTC 05 April-0000UTC 06 April, 2008 in the NCEP reanalysis?*

Reanalysis/Simulated 500-hPa cold-core temperature (°C)

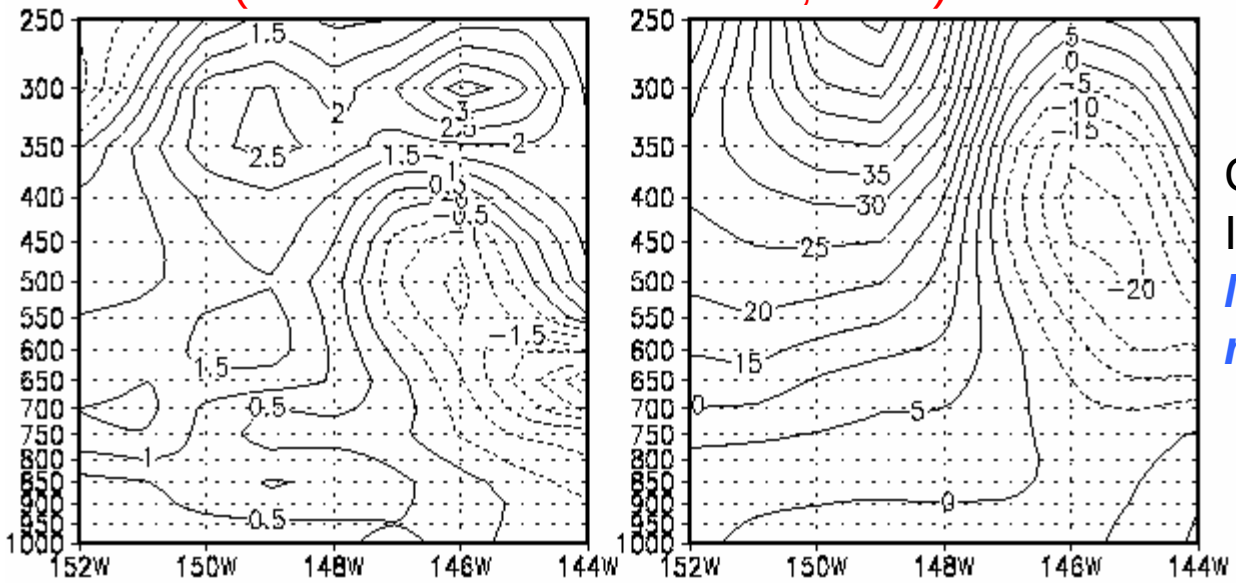


FNL-reanalysis, GFS and Quik (3D-Var)

Vertical cross sections in the difference of Temp (C) and Geopotential Hgt (m)

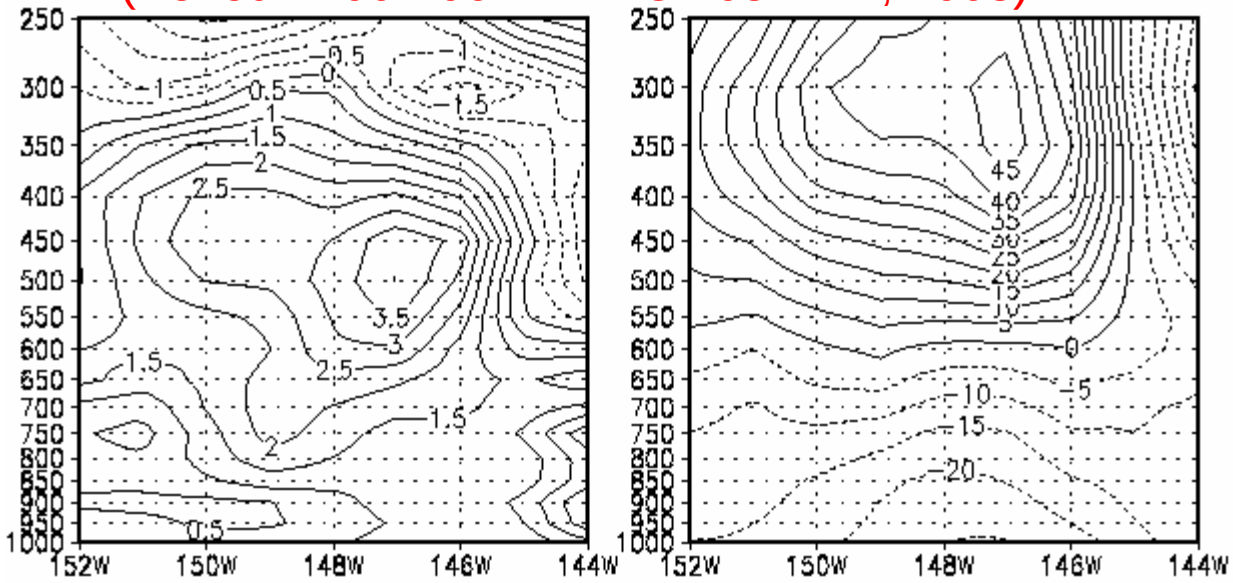
(Period I: 18Z-12Z 05 APR, 2008)

Temp:
Int 0.5 ^{0}C
NCEP reanalysis



GeoP-Hgt
Int 10-m
NCEP reanalysis

(Period II: 00Z 06 APR-18Z 05 APR, 2008)

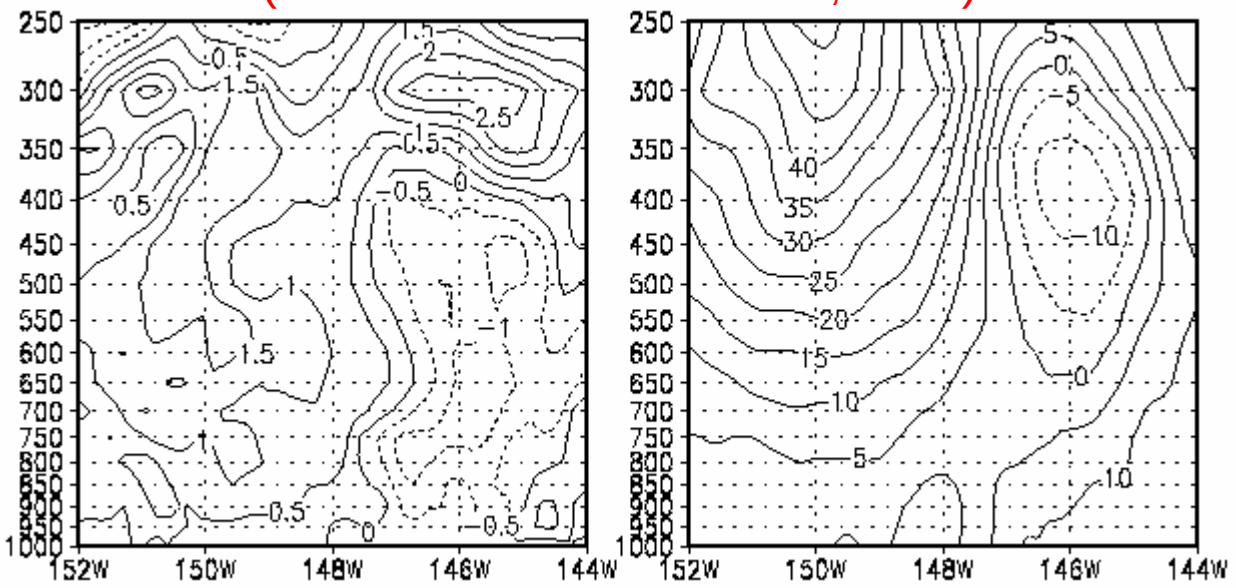


Vertical cross sections in the difference of Temp (C) and Geopotential Hgt (m)

(Period I: 18Z-12Z 05 APR, 2008)

Temp:
Int 0.5 ^{0}C

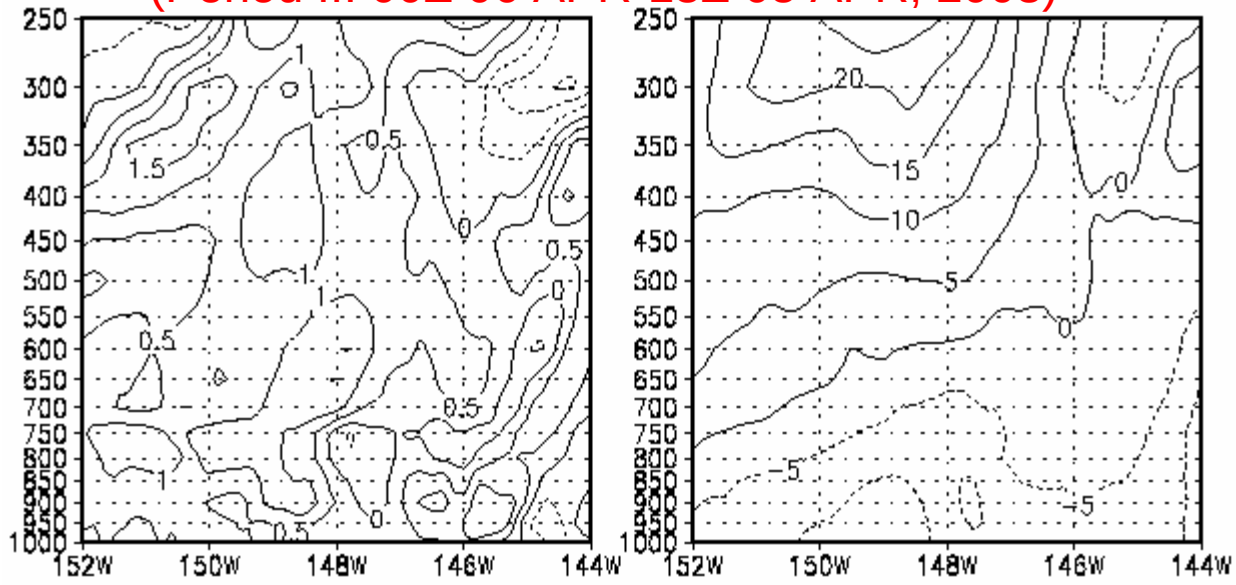
Quik run



GeoP-Hgt
Int 10-m

Quik-run

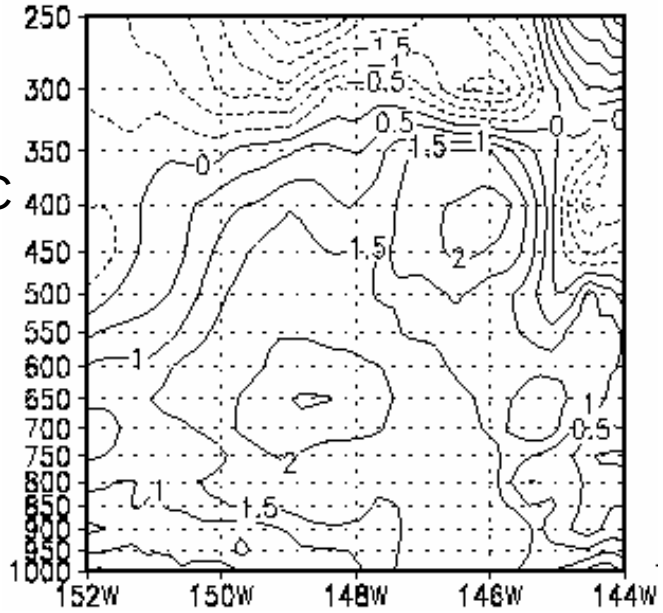
(Period II: 00Z 06 APR-18Z 05 APR, 2008)



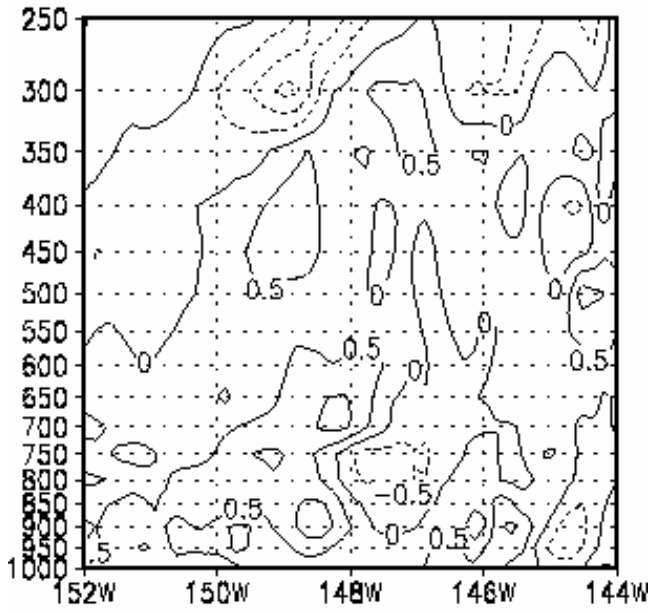
Vertical cross sections in the difference of Temp (C) at 0000UTC 06 APR, 2008

Temp:
Int 0.5 ^{0}C

FNL-GFS



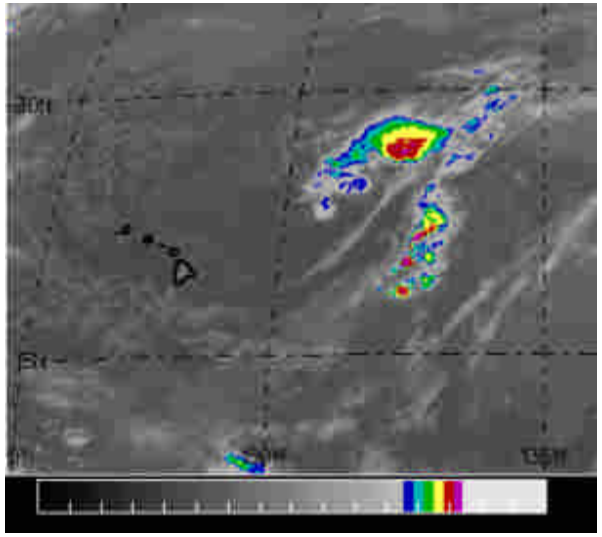
Quik-GFS



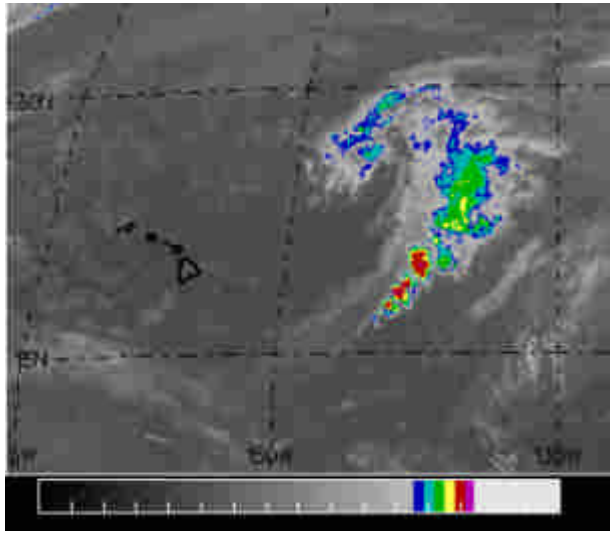
Question?

- *What is the possible mechanism related to the environmental warming before/during the deepening of the Kona low near surface?*

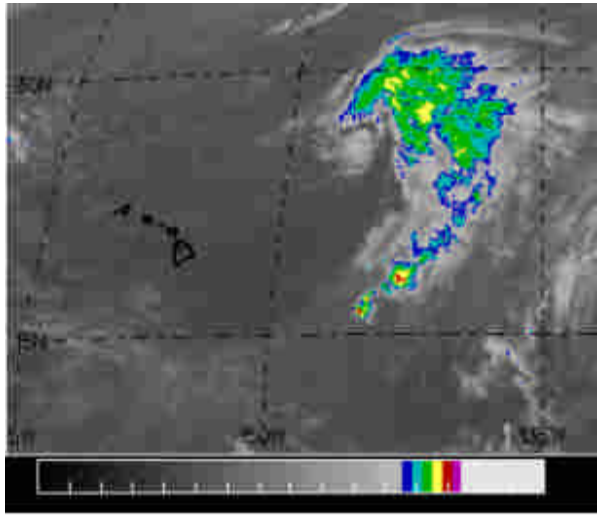
1200UTC 5 APR 2008



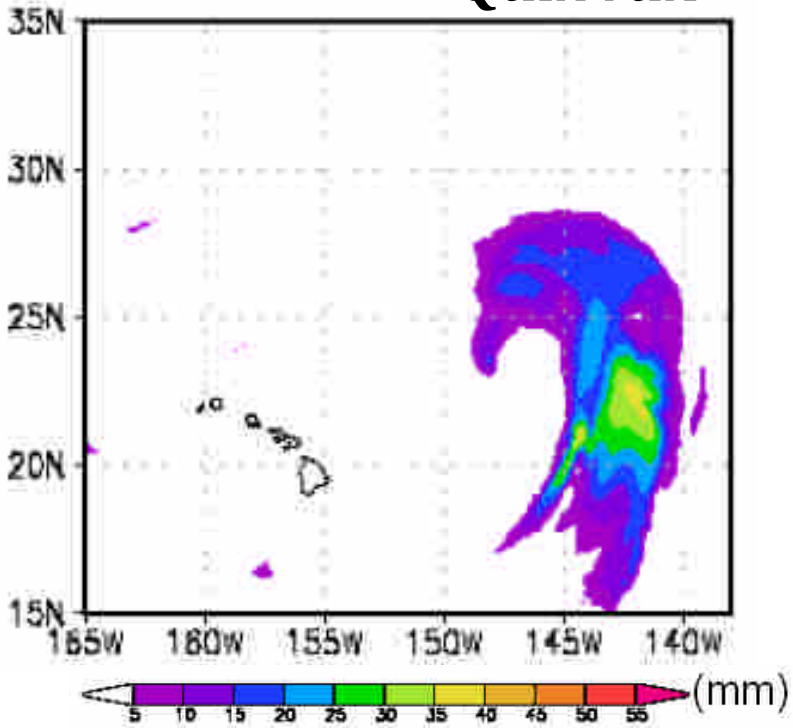
1800UTC 5 APR 2008

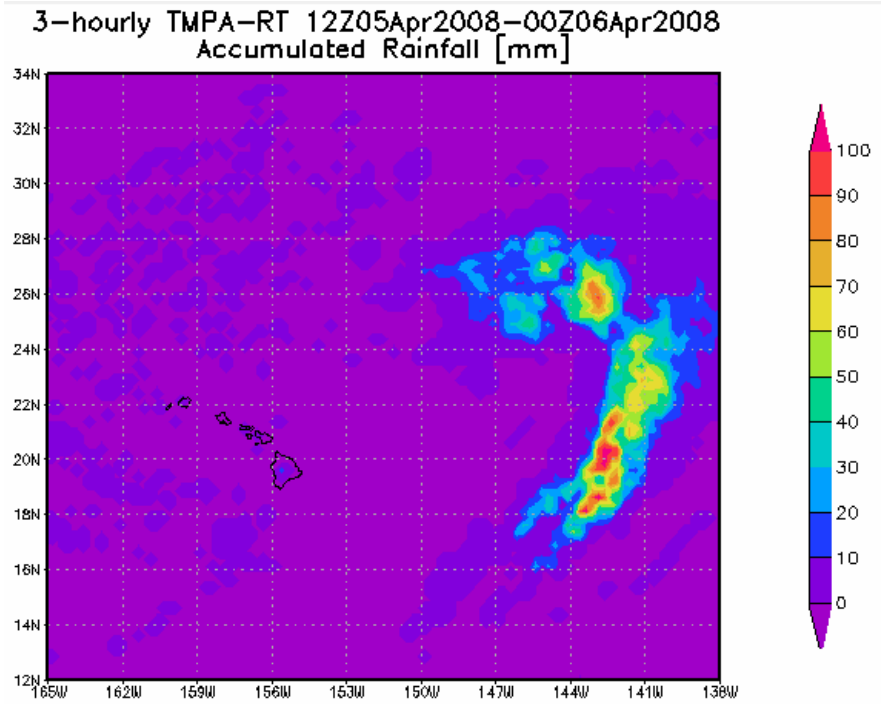


0000UTC 6 APR 2008



Quik run





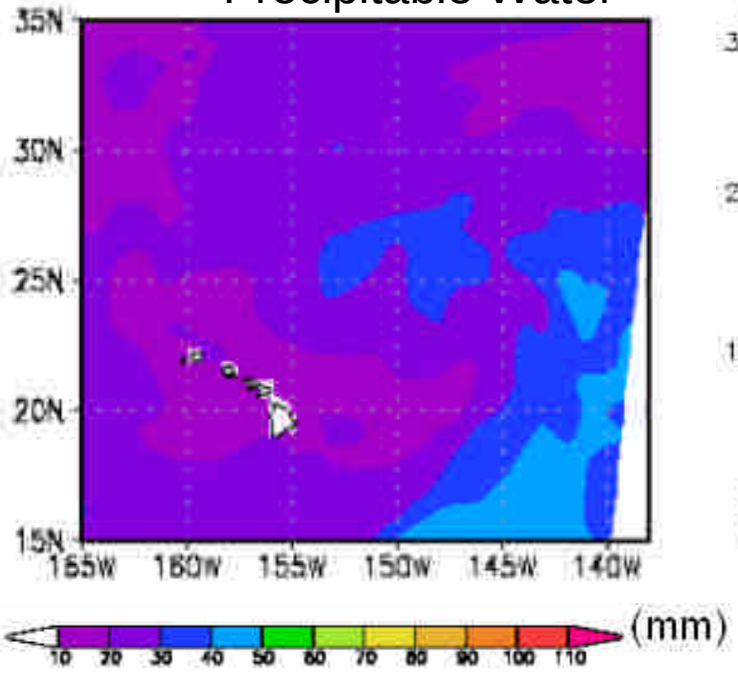
Simulated 12-hr accumulated rainfall by Quik run during 12Z/05 APR -00Z/06 APR

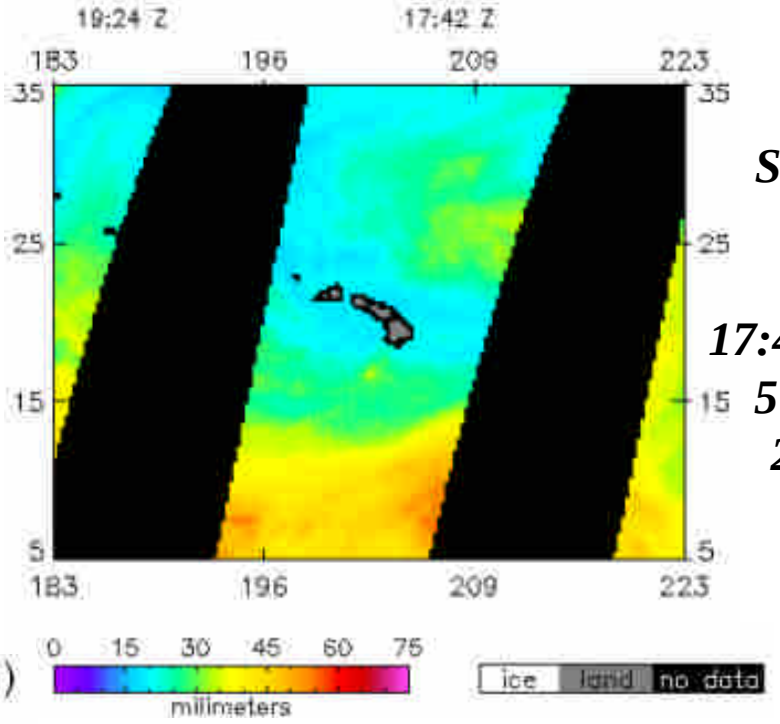
12-hr accumulated rainfall retrieved by TRMM during 12Z/05 APR -00Z/06 APR

Precipitable Water

NCEP-FNL PW

1800 UTC 5 APR 2008

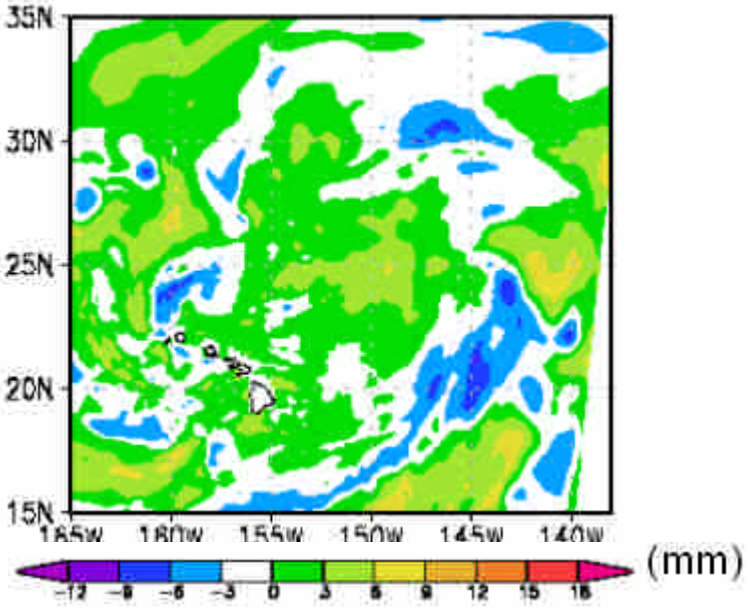




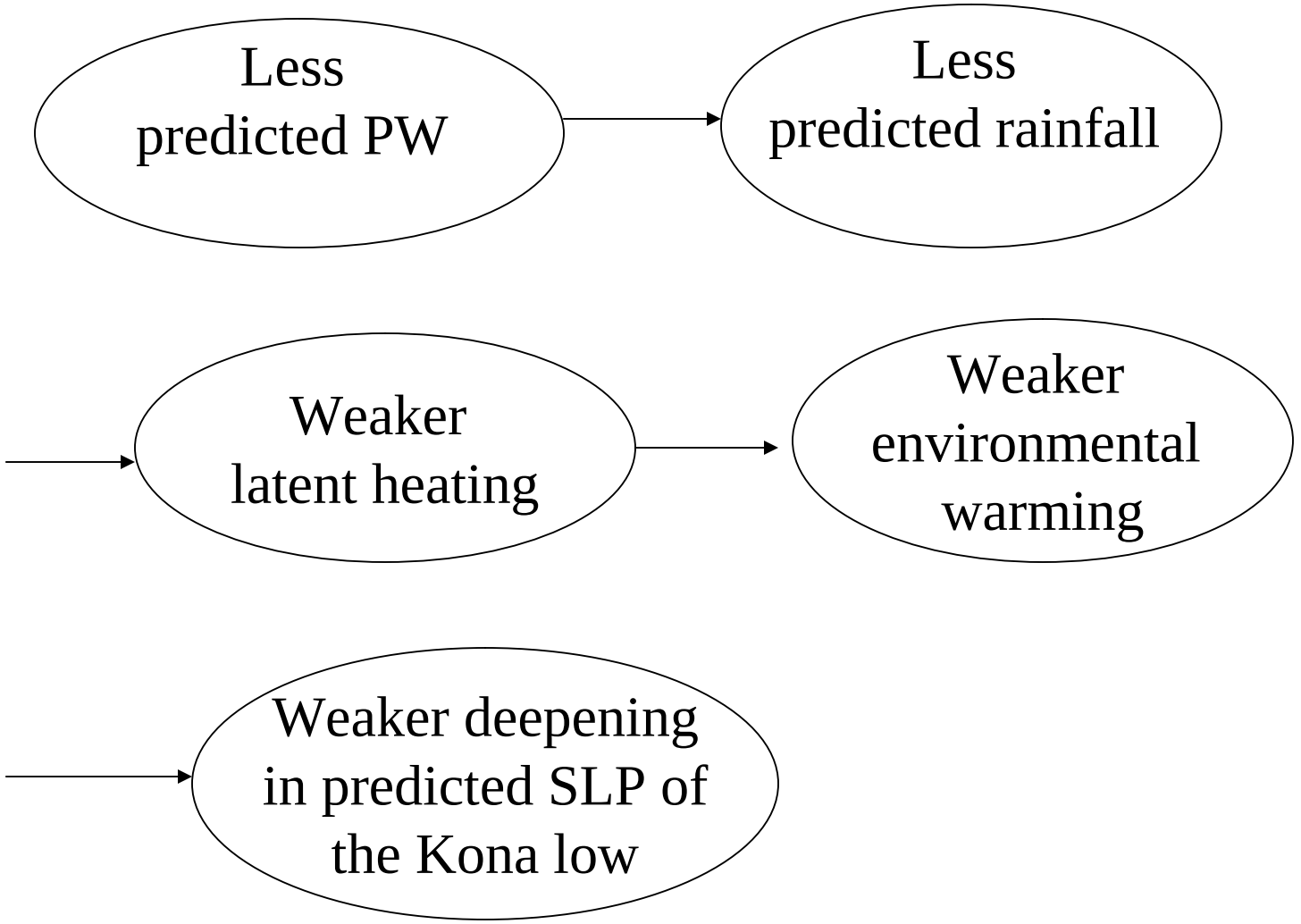
SSM/I PW

17:42 UTC 5 APR 2008

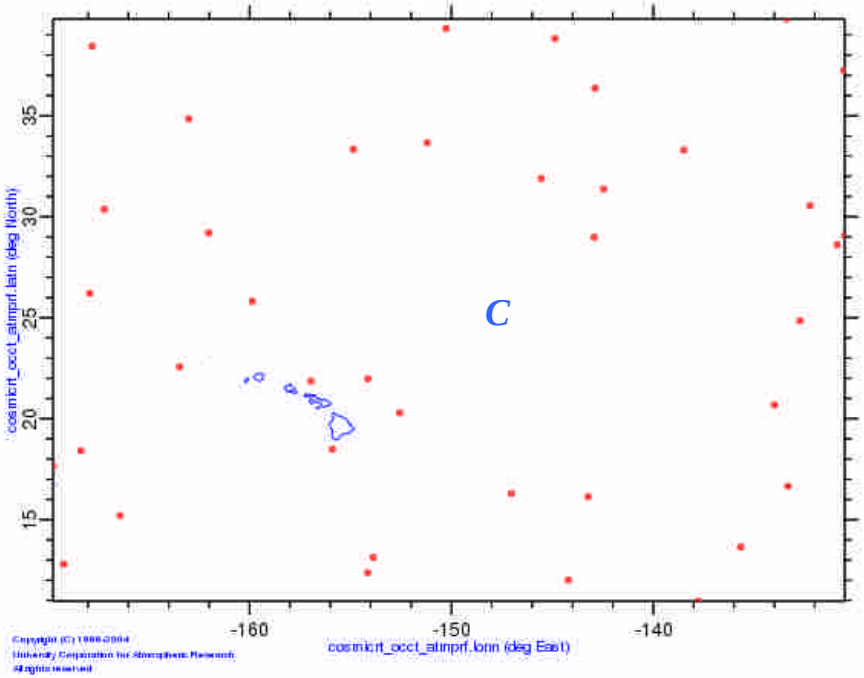
FNL-GFS

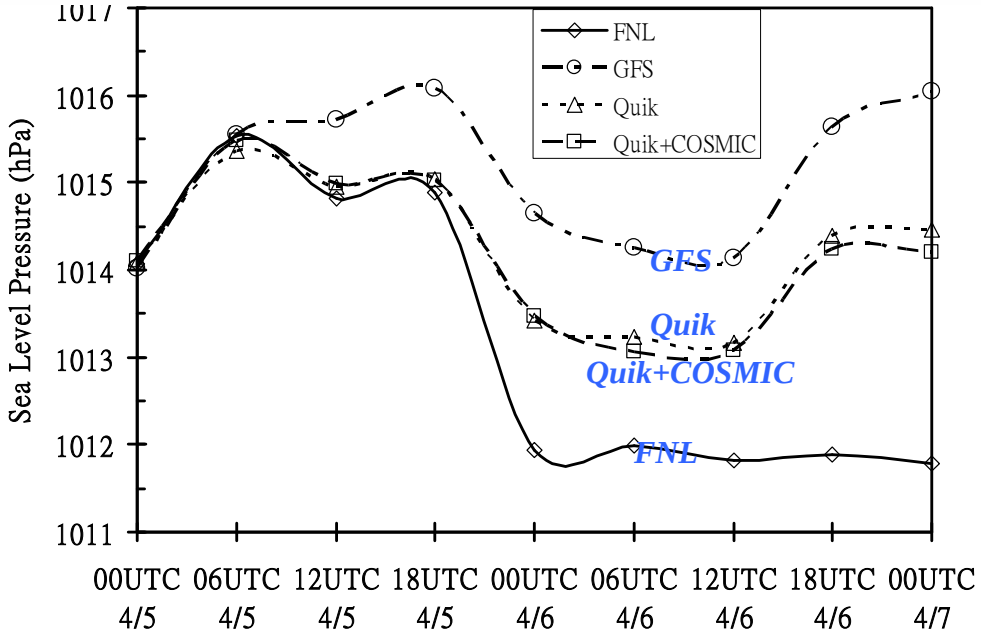


Summary in the numerical prediction of the Kona low



- The assimilated satellite-derived ocean surface winds improve the cyclonic circulation of a Kona storm over the open ocean in the initial condition and also improve the prediction of the SLP of the Kona low.





FORMSAT-3/ COSMIC

April 05, 2008