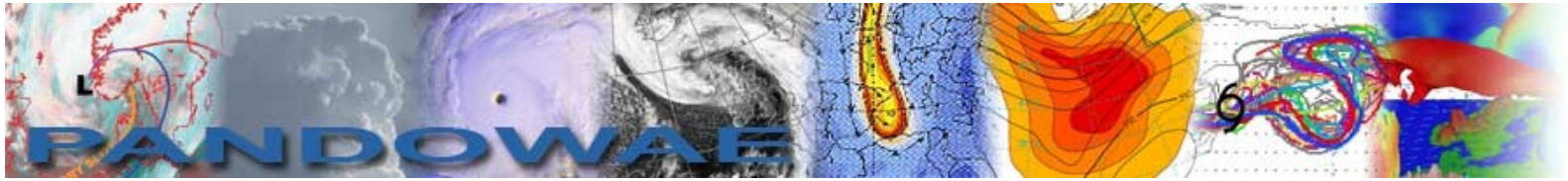
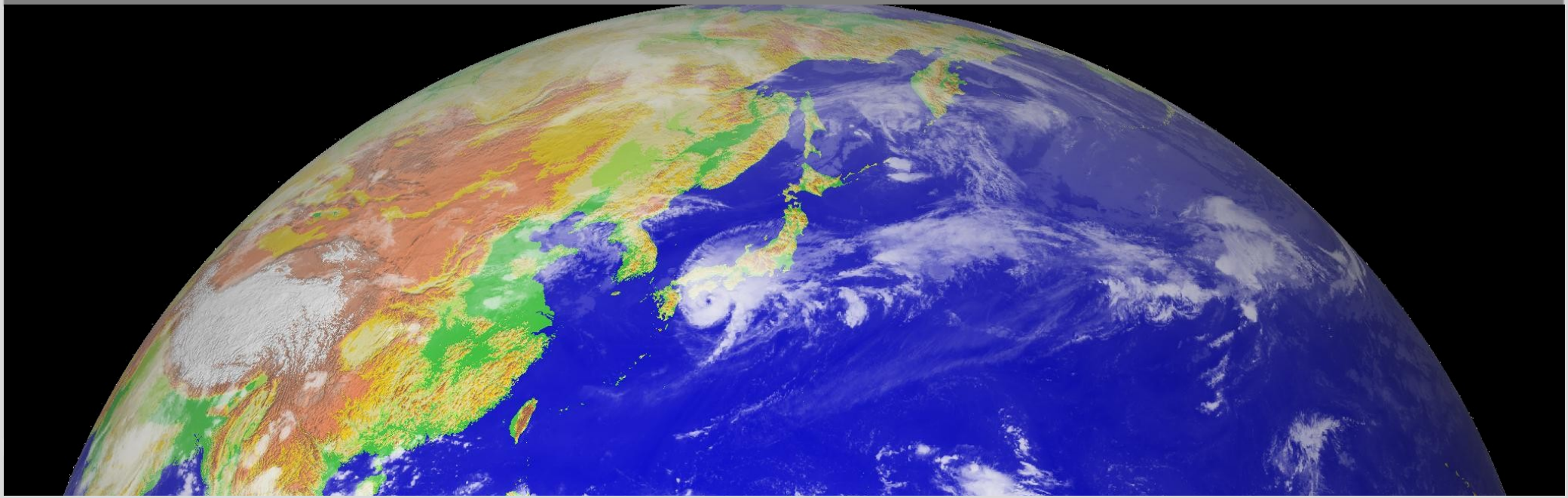


Karlsruhe Institute of Technology

Mechanisms responsible for structural changes during the extratropical transition of Typhoon Sinlaku (2008): a model study

COSMO User Seminar, Monday 17.03.2014



hilke.lentink@kit.edu

Contents

- Introduction
- Methods
- Results
- Methods, continued
- Outlook

Introduction

Goal:

Quantify the mechanisms that determine the structural changes of a tropical cyclone during extratropical transition (ET), based on the observations made during T-PARC along with modeling

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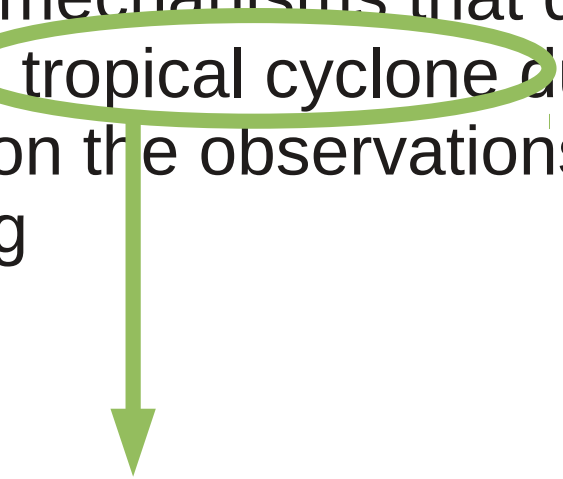
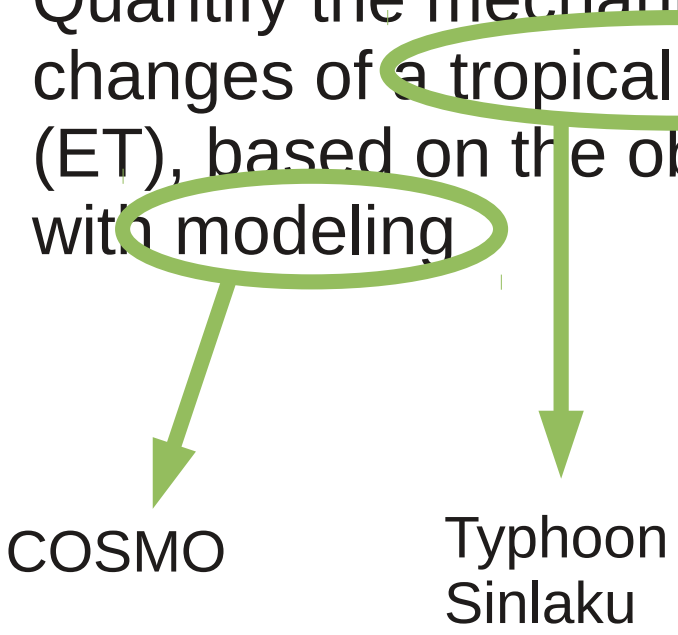


Typhoon
Sinlaku

Introduction

Goal:

Quantify the mechanisms that determine the structural changes of a tropical cyclone during extratropical transition (ET), based on the observations made during T-PARC along with modeling



Introduction

Goal:

Quantify the mechanisms that determine the structural changes of a tropical cyclone during extratropical transition (ET), based on the observations made during T-PARC along with modeling

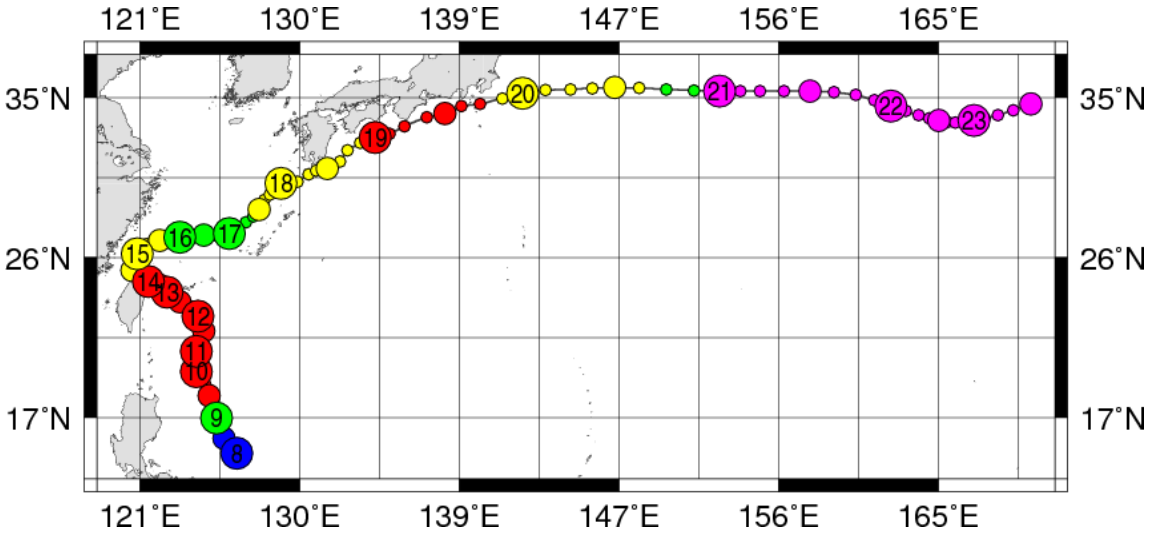
COSMO

Typhoon Sinlaku

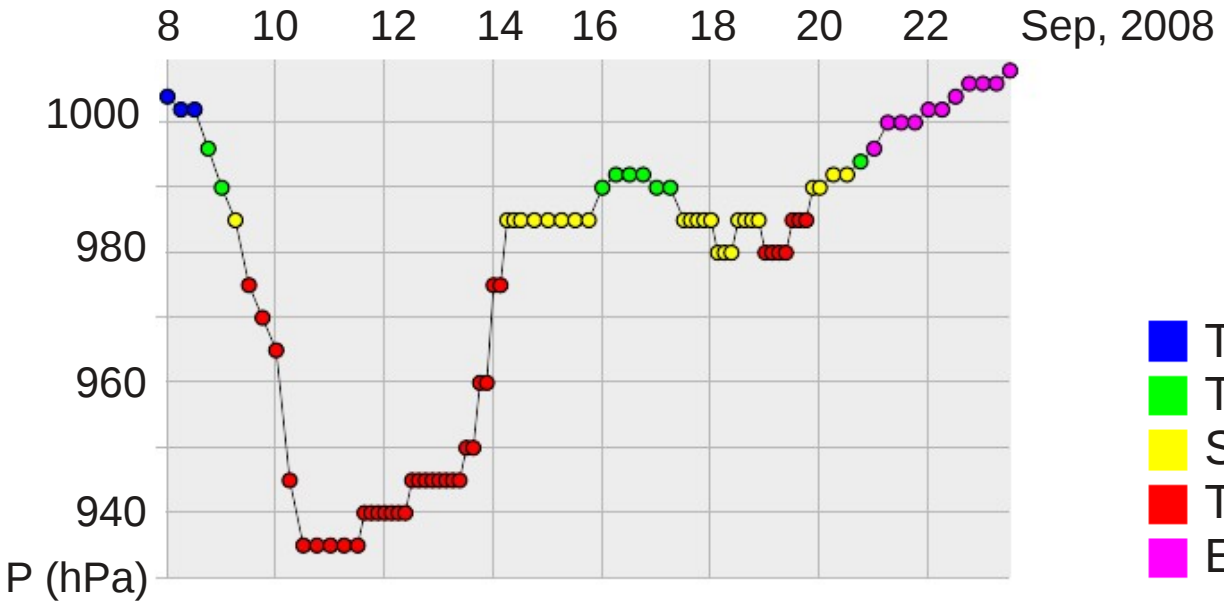
THORPEX Pacific Asian Regional Campaign

- Dropsondes
- ELDORA doppler radar
- Lidar
- (Satellite)

Introduction – Tropical Cyclone



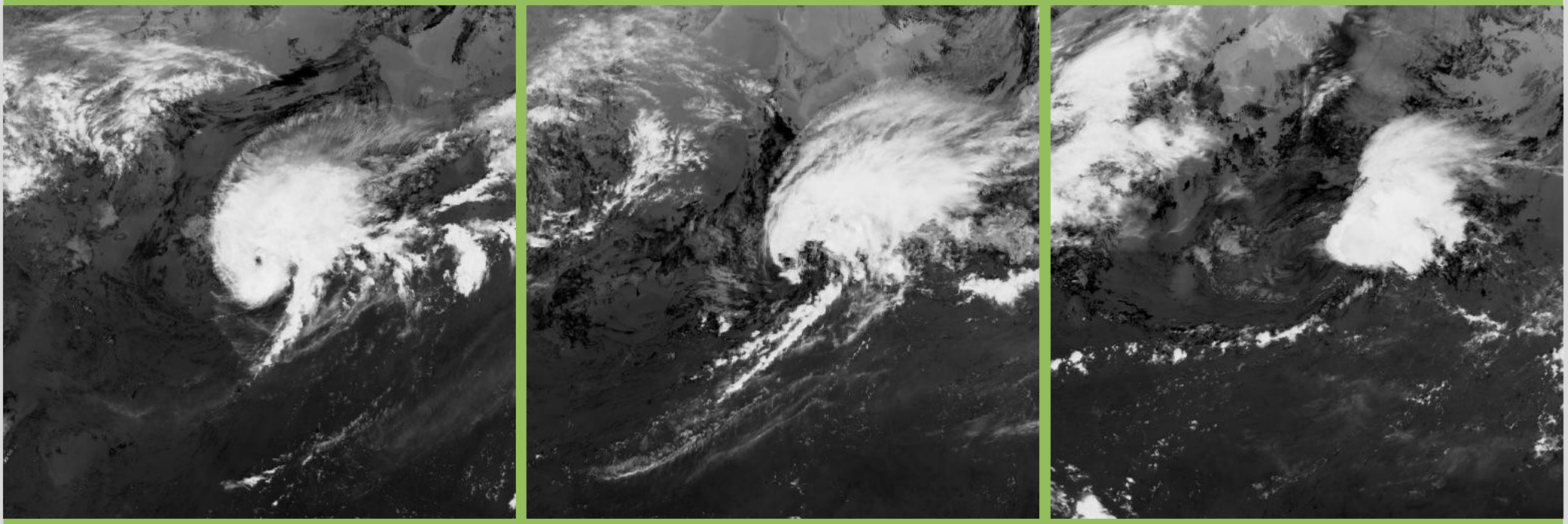
Typhoon Sinlaku
(8-24 Sept. 2008)

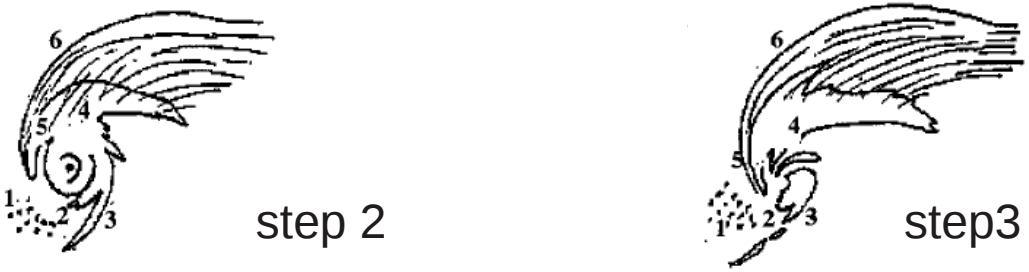


- Tropical depression (<62 km/h)
- Tropical storm (63-88 km/h)
- Severe Trop. Storm (89-118 km/h)
- Typhoon (>119 km/h)
- Extratropical

Introduction – ET of Sinlaku

19 Sept. 2008, 00UTC (Typhoon)	20 Sept. 2008, 00UTC (Severe Trop. Strom)	21 Sept. 2008, 00UTC (Extratropical)



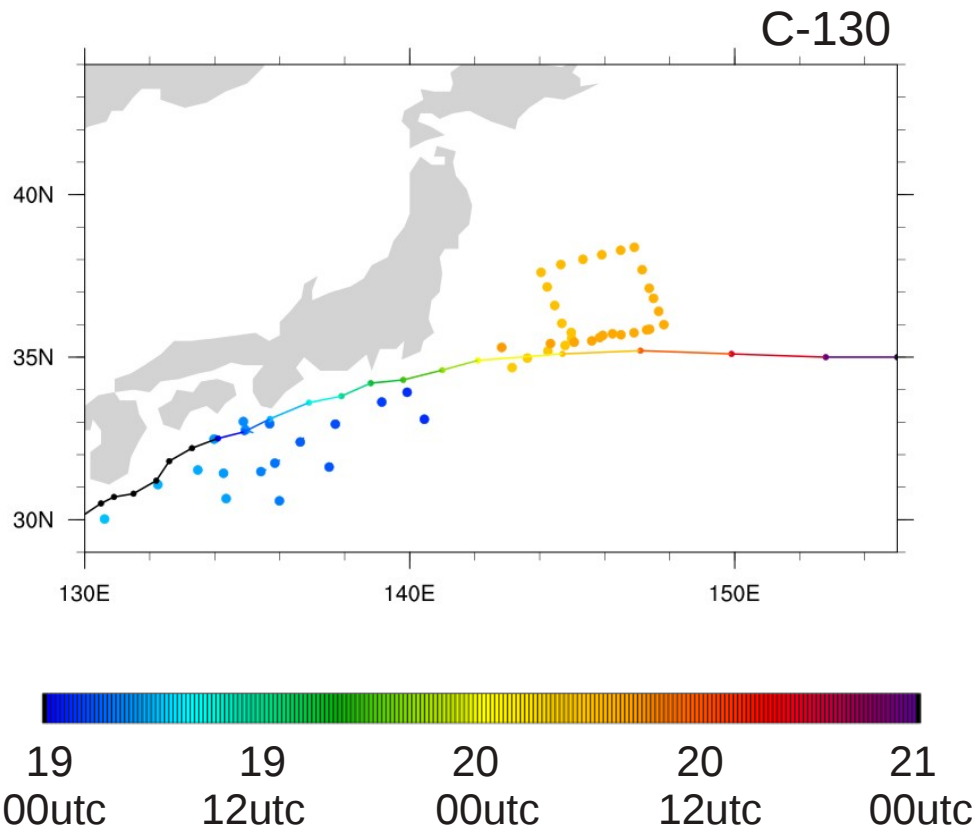


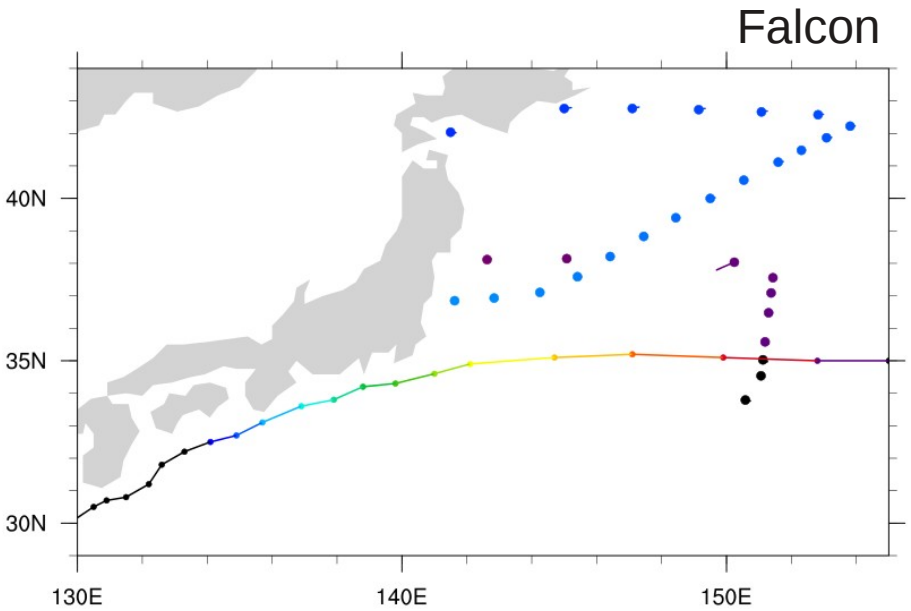
step 2 step3 extratropical

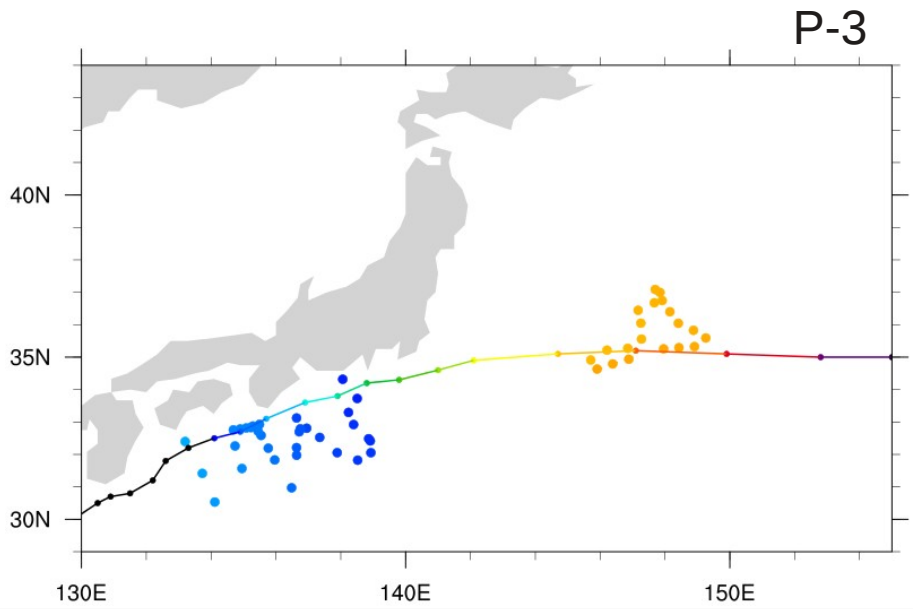
Conceptual model of the transformation stage of ET by: Klein, Harr and Elsberry (2000)

Introduction – observations

Location and drift of dropsondes







Introduction

Motivation:

- ECMWF data only every 6 hrs
- ECMWF data relatively coarse
- Measurement data during two time periods
- Measurement data not continuous

Modelling is used to fill the gap in between,

to analyze high resolution structural changes over time.

Methods

Step 1: Simulate Sinlaku

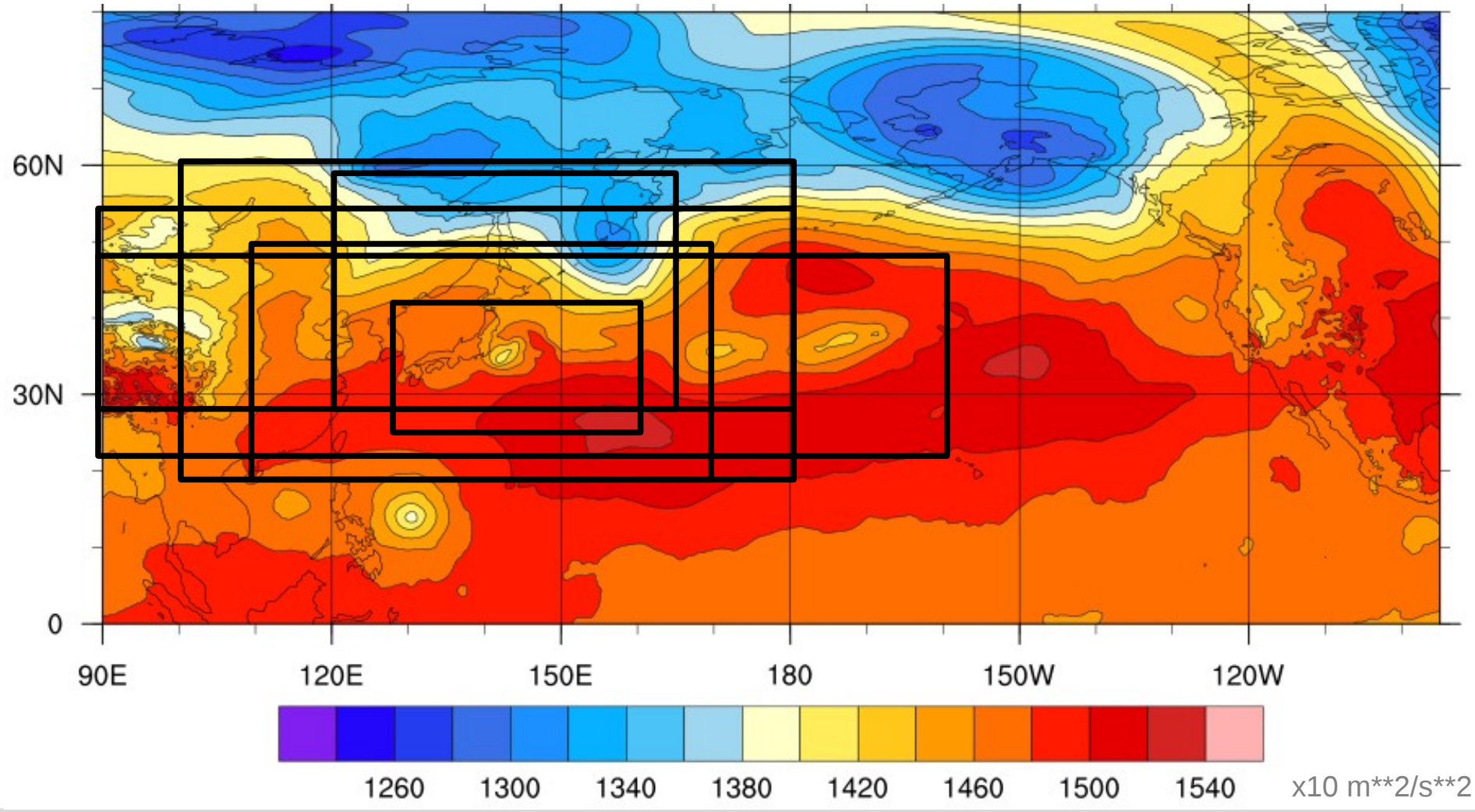
Methods

Step 1: Simulate Sinlaku

- COSMO
  - 7 km & 2.8 km resolution
  - ECMWF Research re-analysis data (incl. dropsonde data), 0.25°
- Different initial times (18/19/20 Sep, 00/06/12/18 UTC)
- Different areas

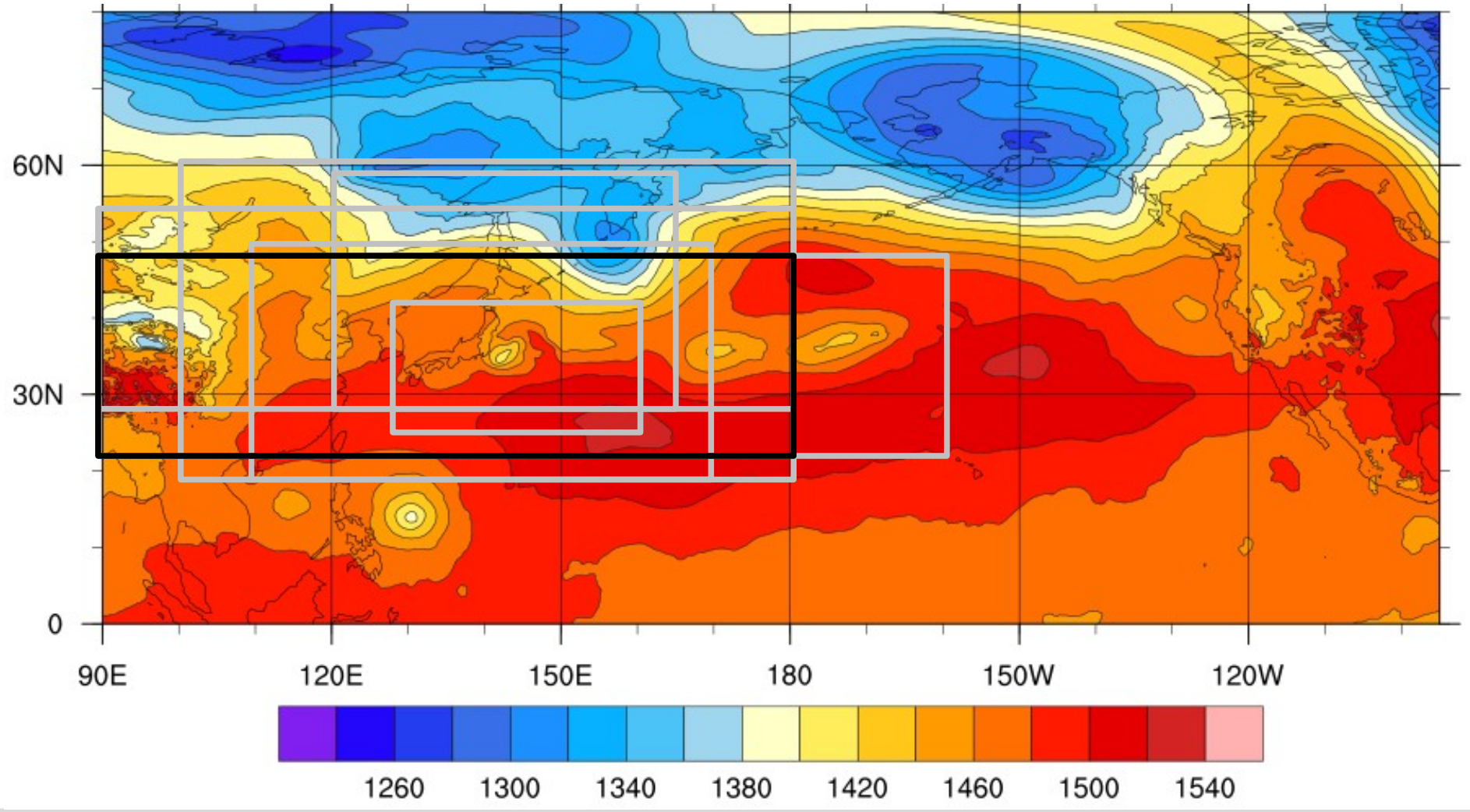
Methods – simulation area

ECMWF Re-analysis data including dropsondes,
Geopotential, 850 hPa, 20 Sep 00UTC

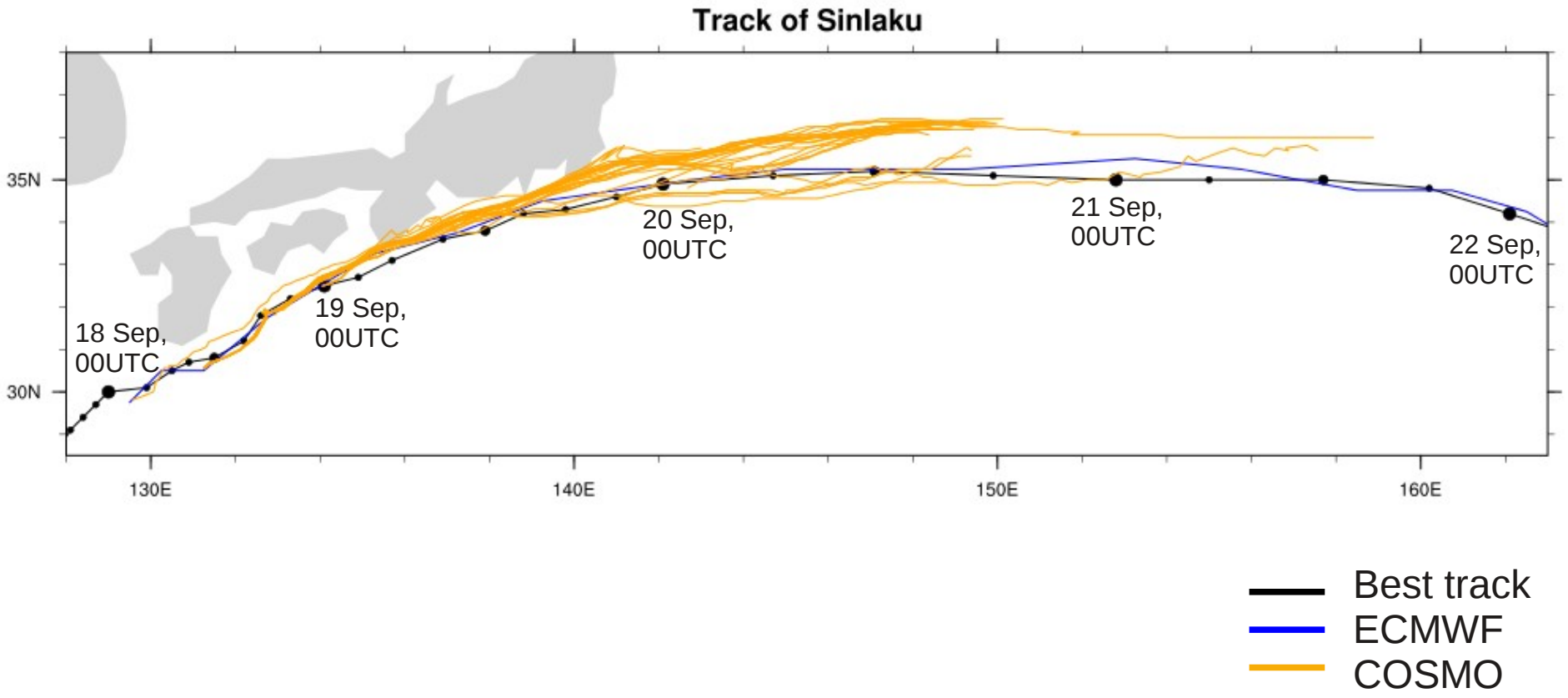


Methods – simulation area

ECMWF Re-analysis data including dropsondes,
Geopotential, 850 hPa, 20 Sep 00UTC



Methods – simulations



Methods

Step 1: Simulate Sinlaku

- COSMO
  - 7 km & 2.8 km resolution
  - ECMWF Research re-analysis data (incl. dropsonde data)
- Different initial times (18/19/20 Sep, 00/06/12/18 UTC)
- Different areas

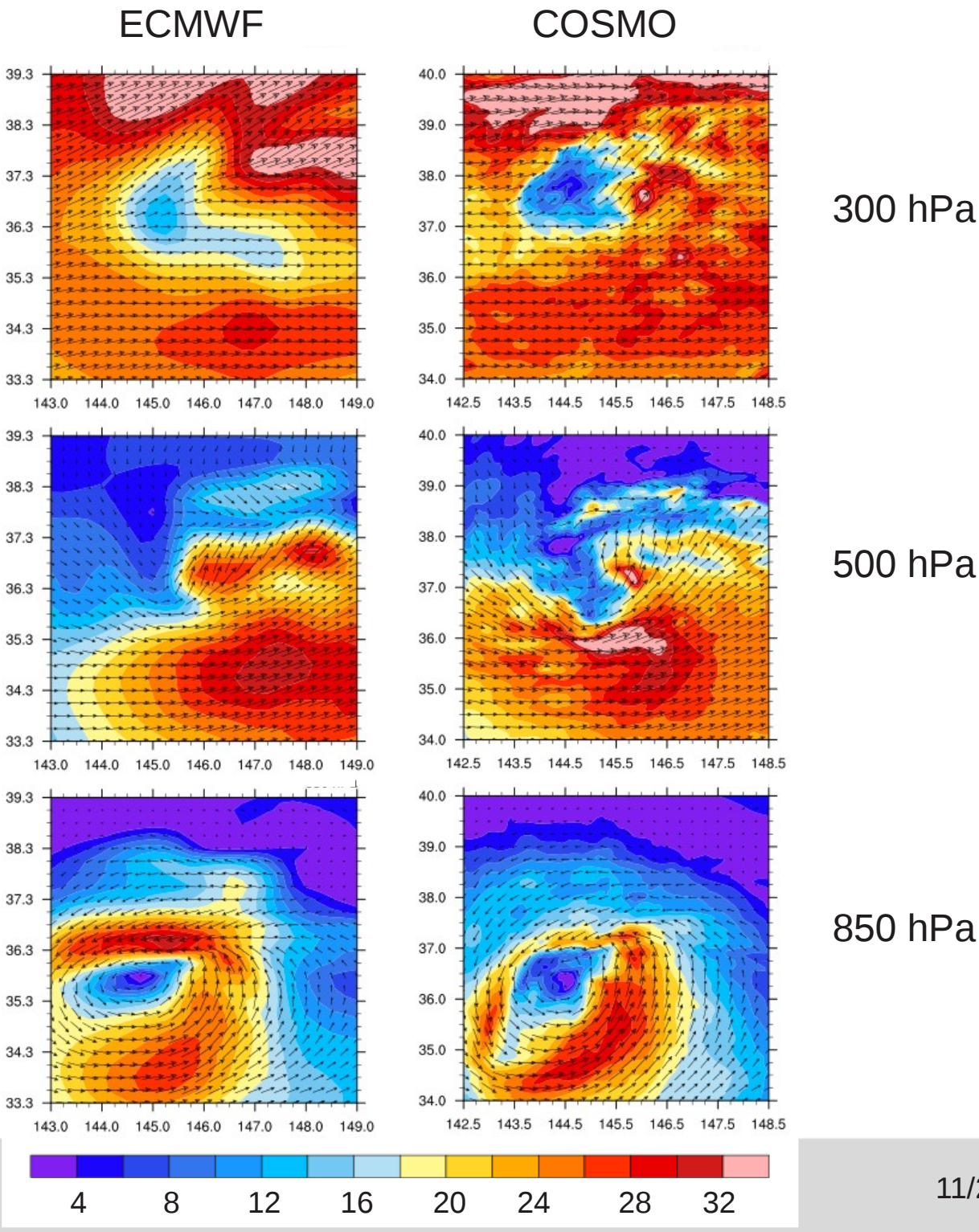
Step 2: Compare the simulation to observations and other data

Results

Comparison to ECMWF data

Here:

- Velocity (m/s)
- 20 Sept, 06UTC (= 36 hrs forecast)

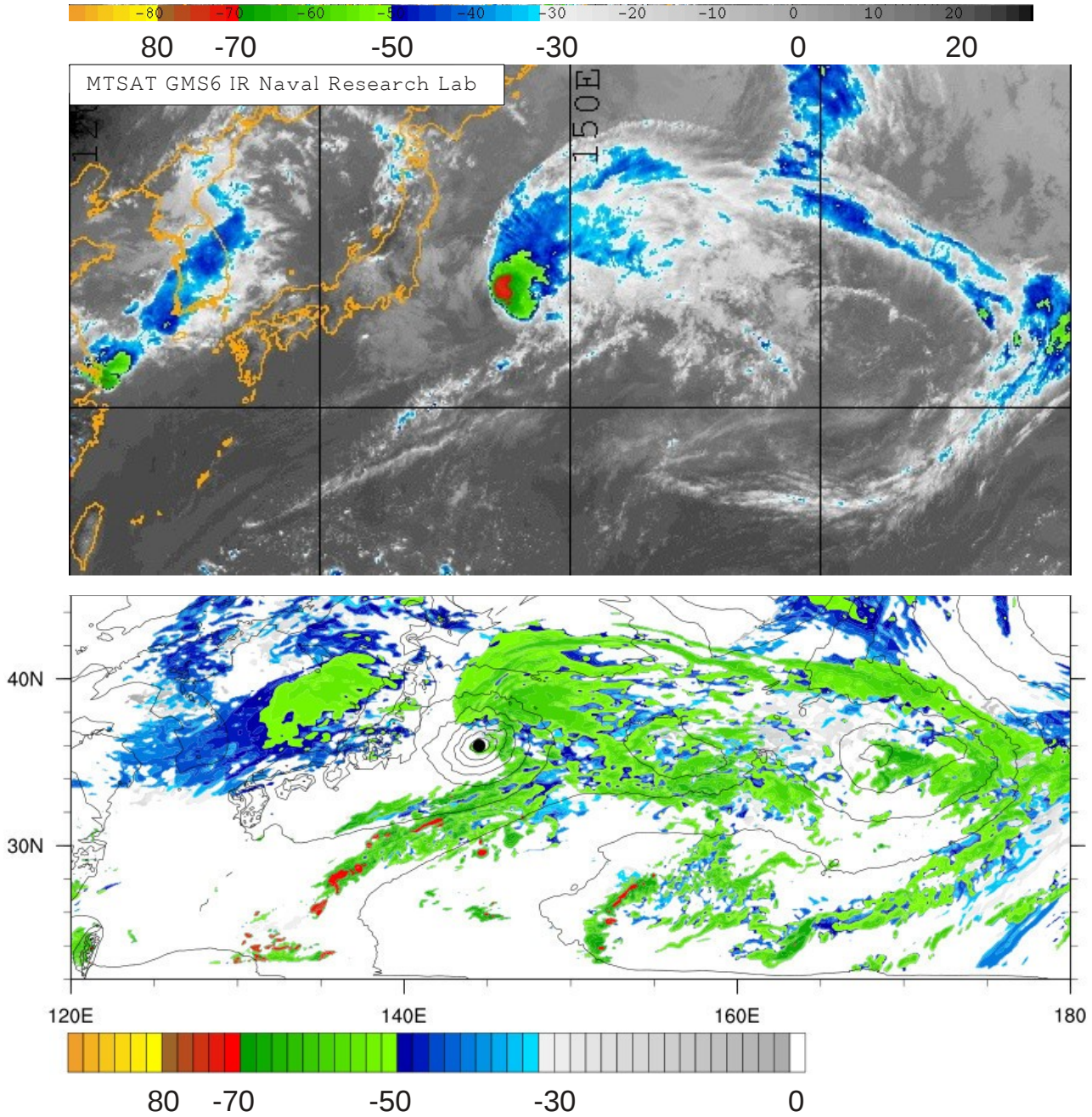


Results

Comparison to satellite data

Here:

- Cloud top temperature (°C)
- 20 Sept, 06UTC (= 36 hrs forecast)

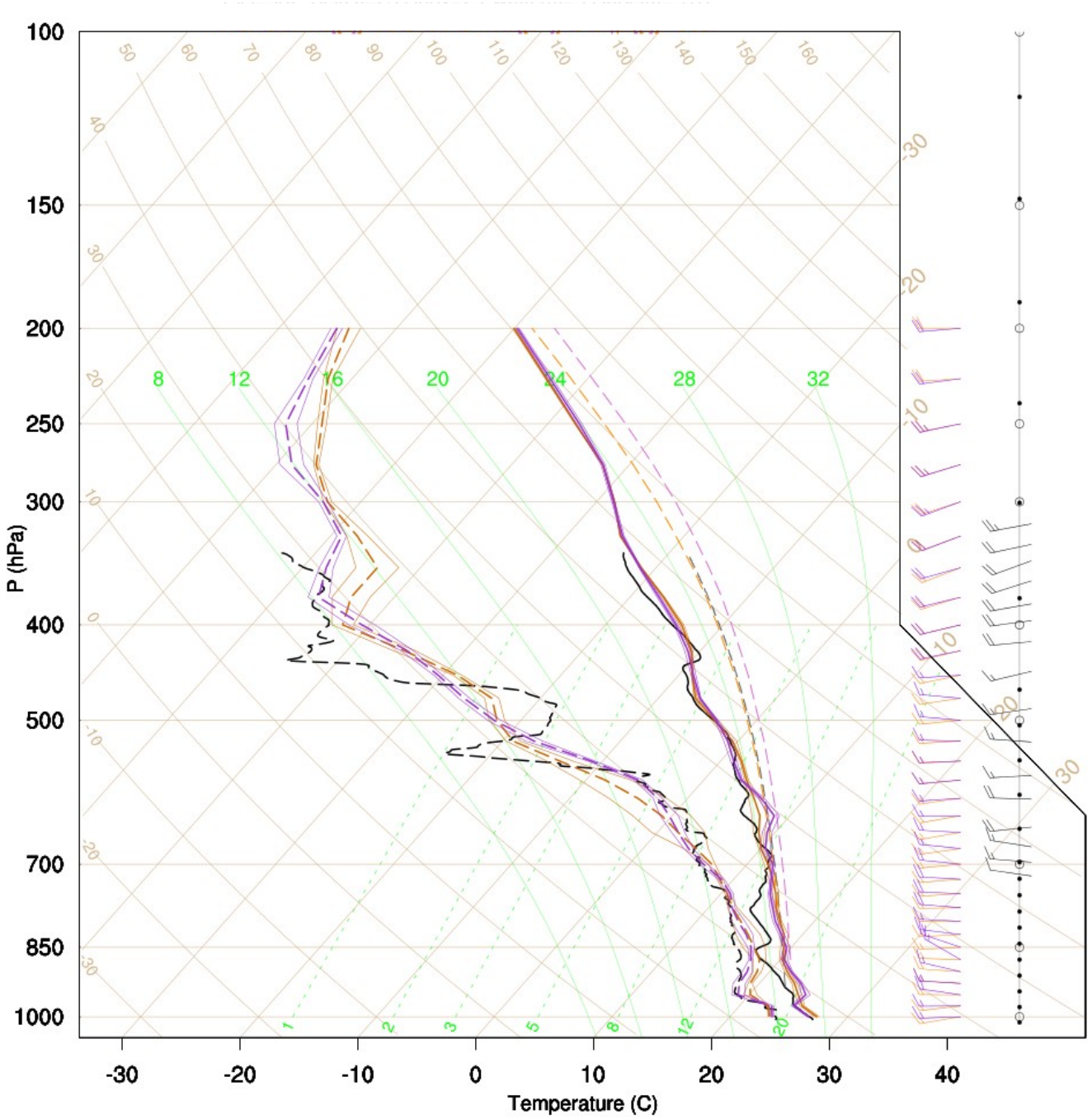


Results

Comparison to dropsonde data

Dropsonde from C130:
19 Sept, 05:02 UTC

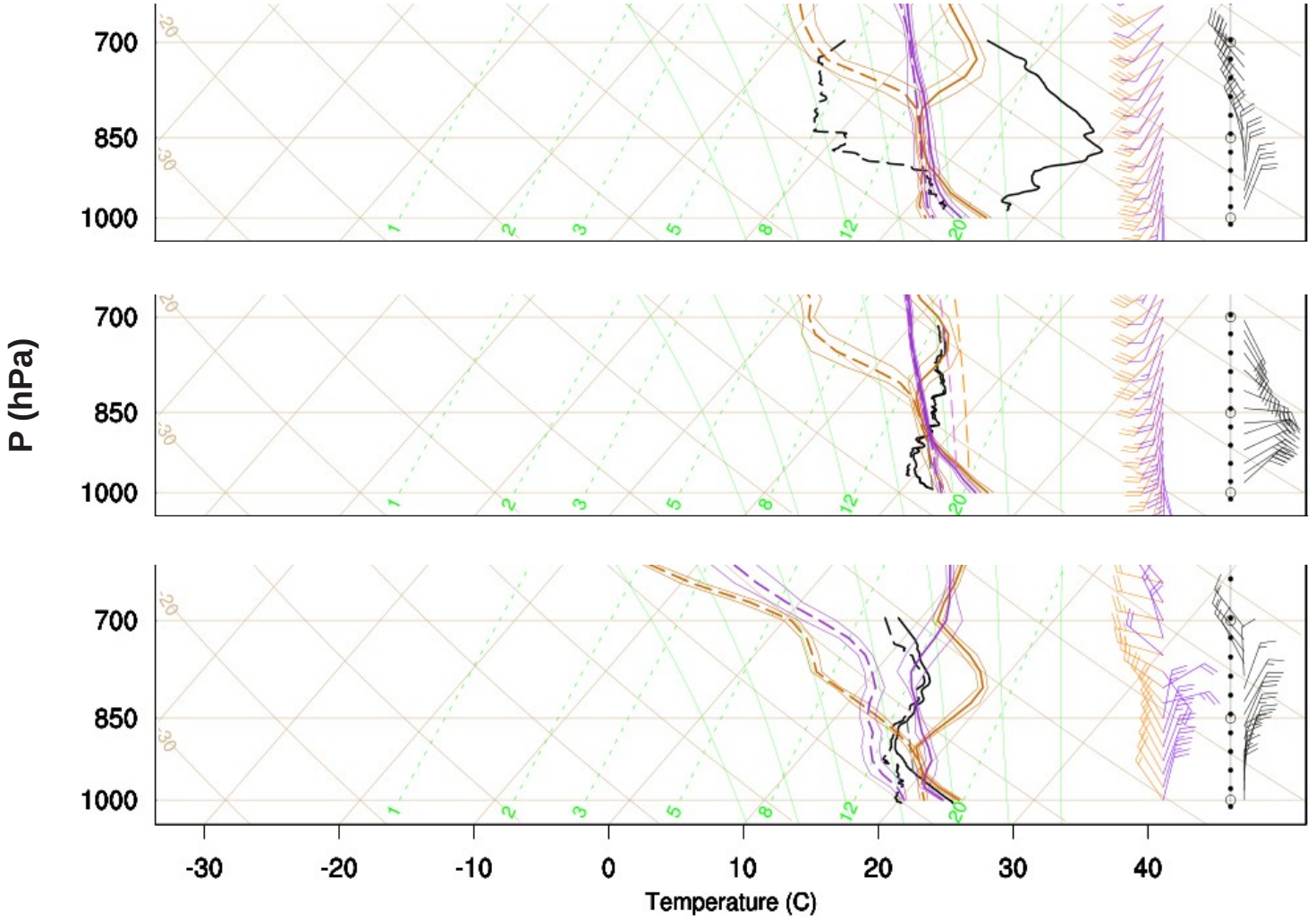
Cosmo:
19 Sept, 05 UTC
(= 11 hrs forecast)



Dropsonde
COSMO (absolute location)
COSMO (relative location)

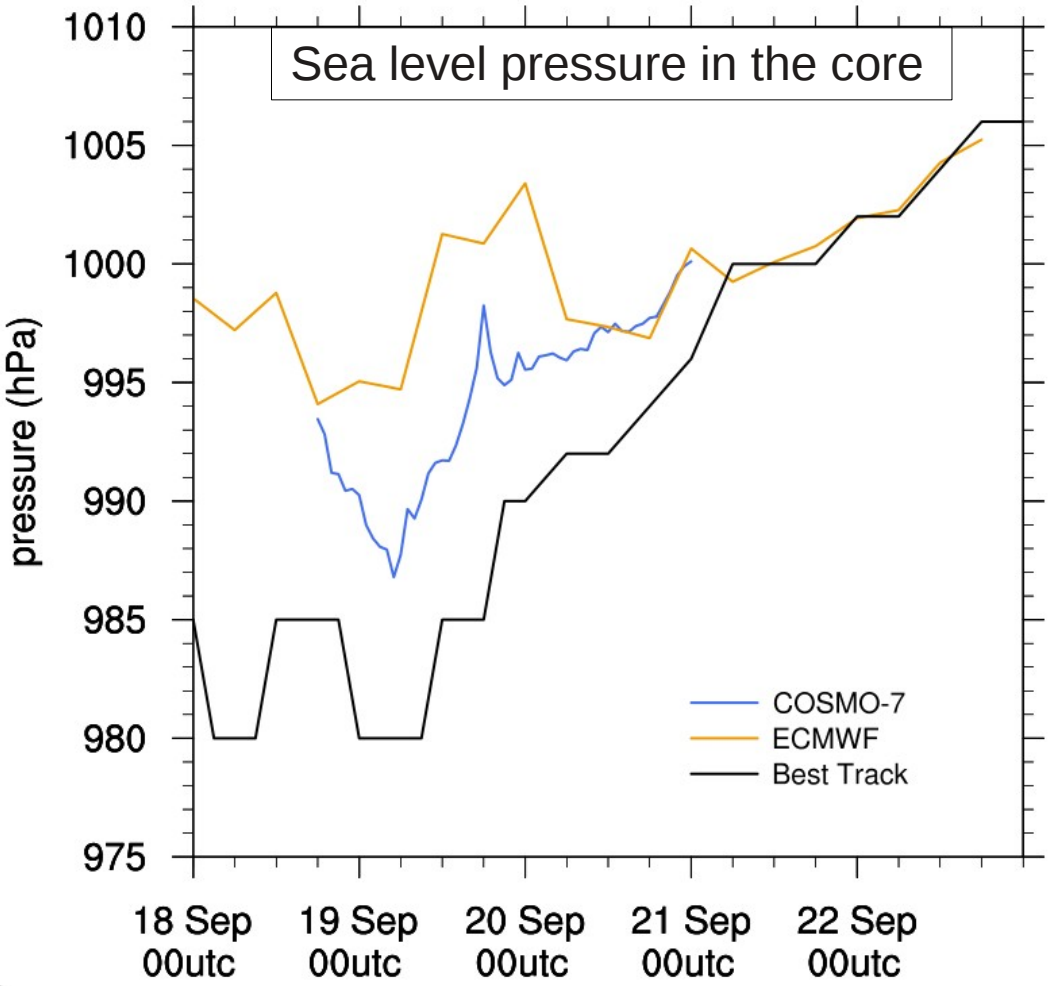
Results

Comparison to dropsonde data



Results

- The storm is too weak in initial data



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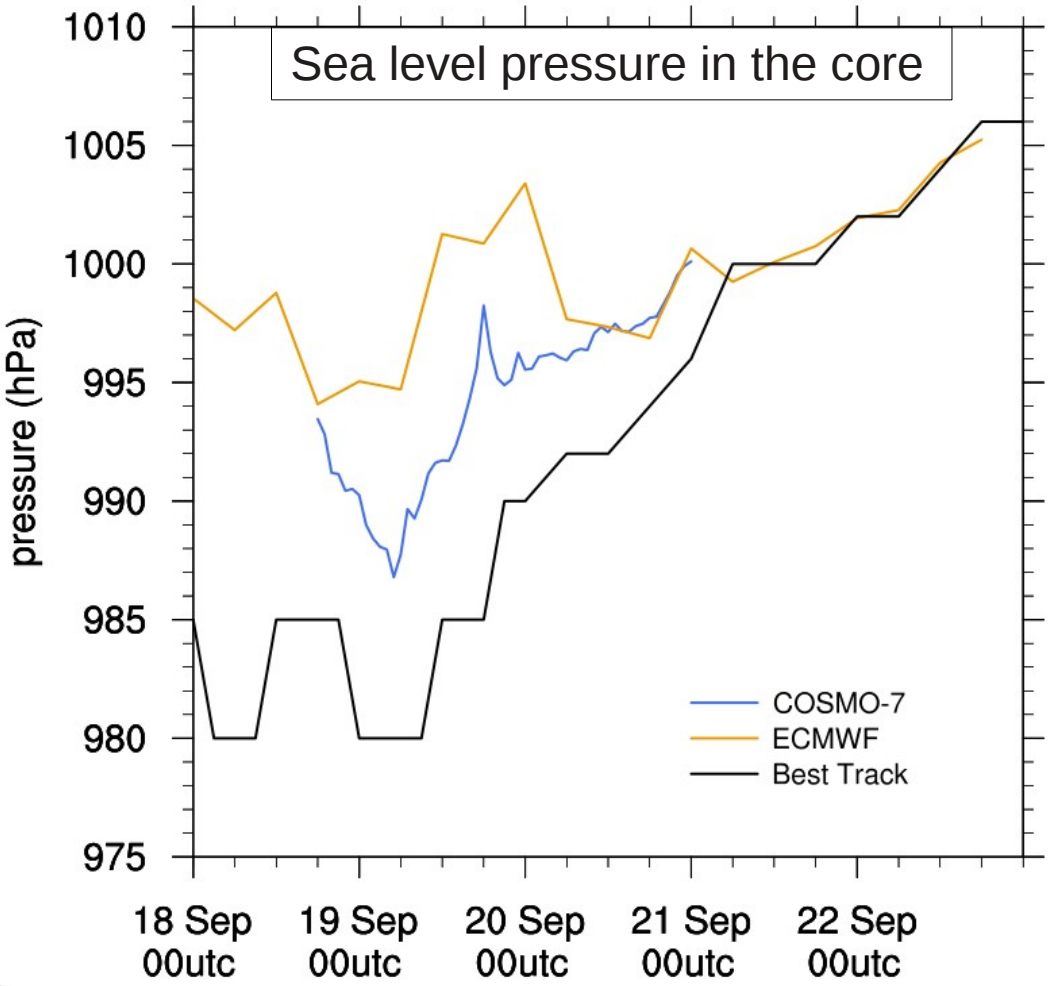
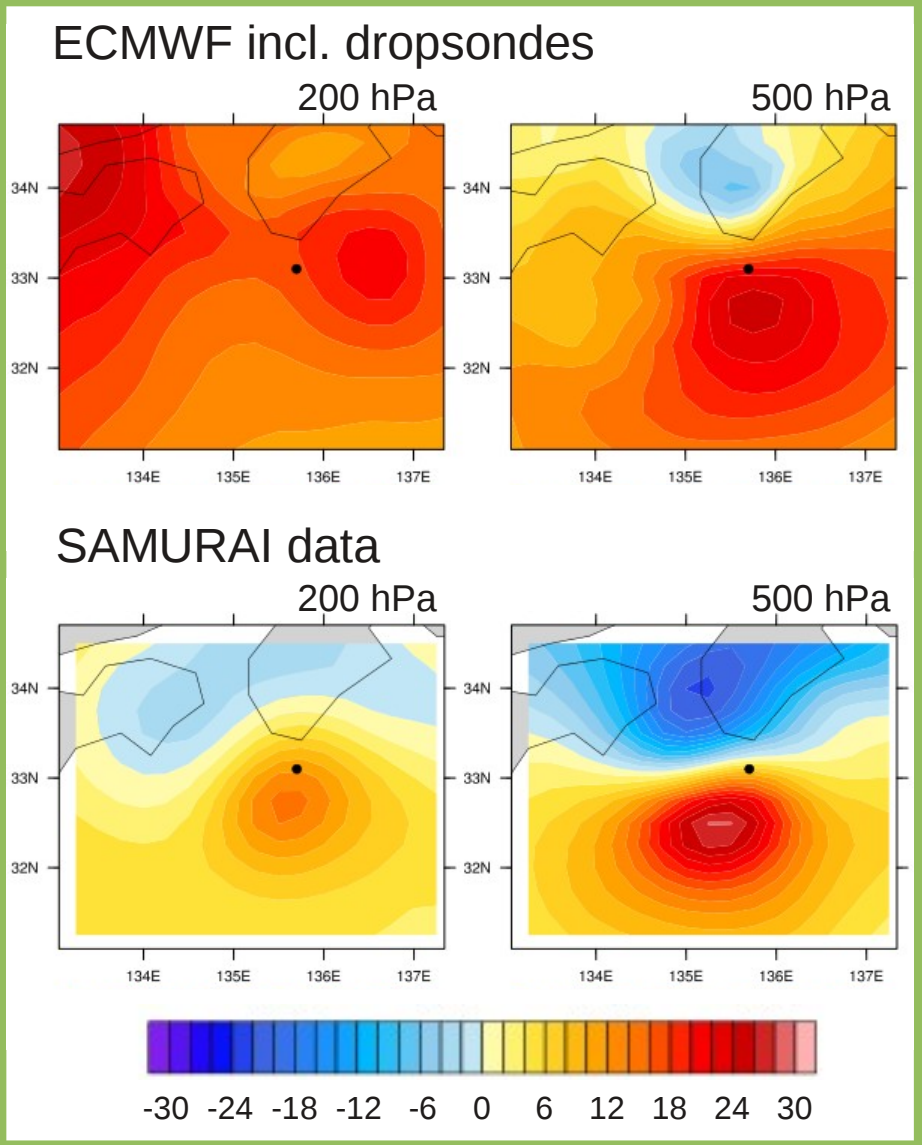
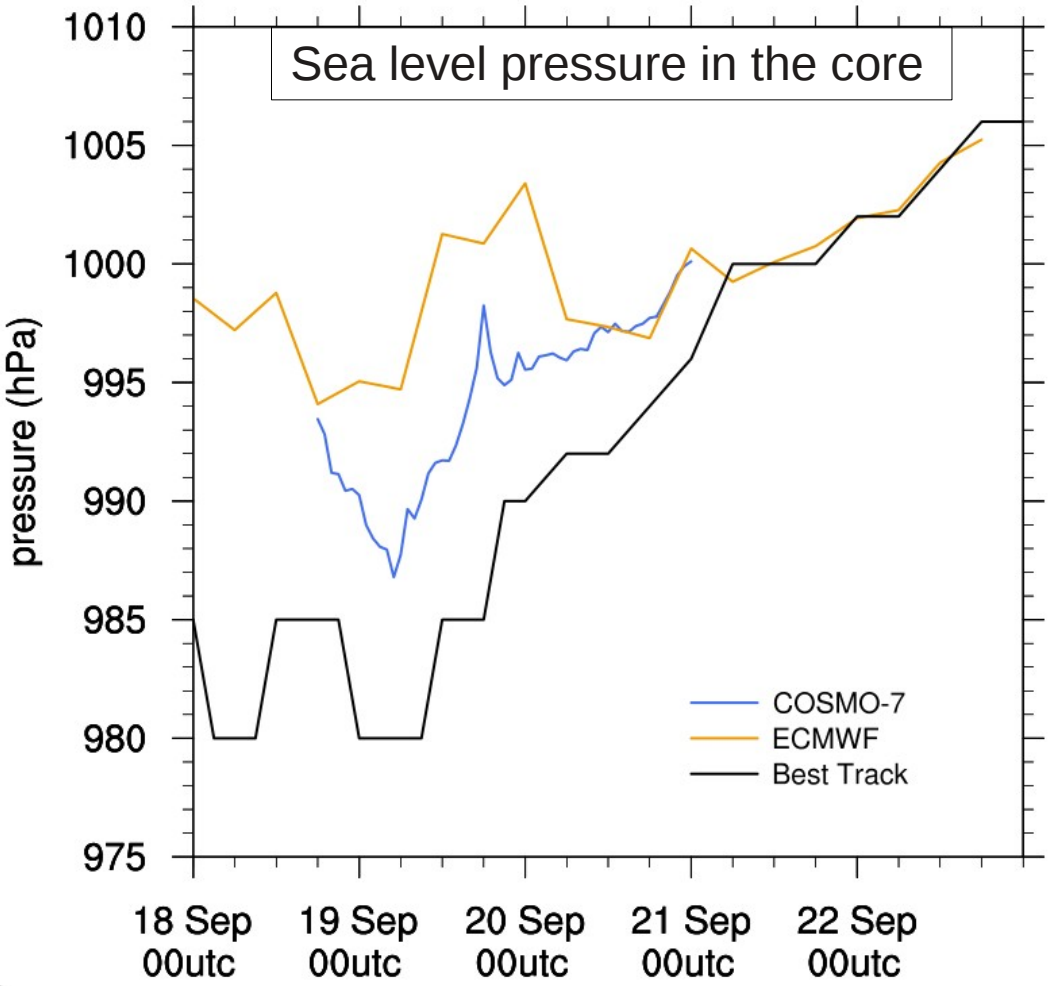


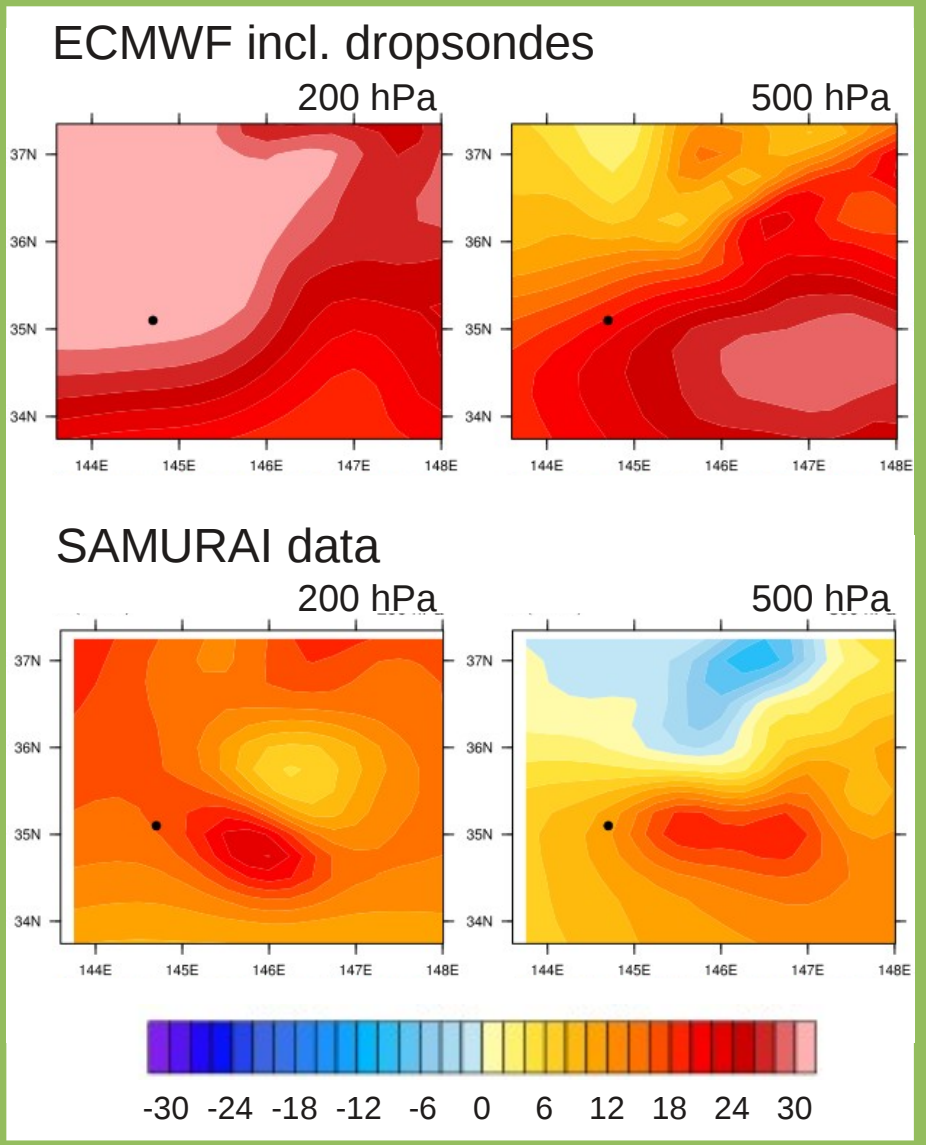


Here:
u (m/s)
19 Sep. 2008, 06UTC

Results

- The storm is too weak in initial data





Here:
u (m/s)
20 Sep. 2008, 06UTC

Methods, continued

Step 1: Simulate Sinlaku

Methods, continued

Step 1: Simulate Sinlaku

- COSMO
  - 7 km & 2.8 km resolution
  - ECMWF Research re-analysis data (incl. dropsonde data)
  - SAMURAI data at the location of the storm

Methods, continued

SAMURAI software

- Assimilates data from various observations to achieve the most likely estimate for the state of the atmosphere

Methods, continued

SAMURAI software

- Assimilates data from various observations to achieve the most likely estimate for the state of the atmosphere
- ECMWF Re-analysis (0.25°) + ELDORA doppler radar (reflectivity and radial velocity) + dropsondes (p, T, RH, u, v, winddir) + satellite imagery (atmospheric motion vectors)

Methods, continued

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➔ Best estimate of the atmospheric state in the core region of Sinlaku

Methods, continued

SAMURAI software

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- ➔ Best estimate of the atmospheric state in the core region of Sinlaku

- Used for Sinlaku two students at the KIT during their Diplomthesis (Annette Förster and Julian Quitinting)

Methods, continued

SAMURAI software

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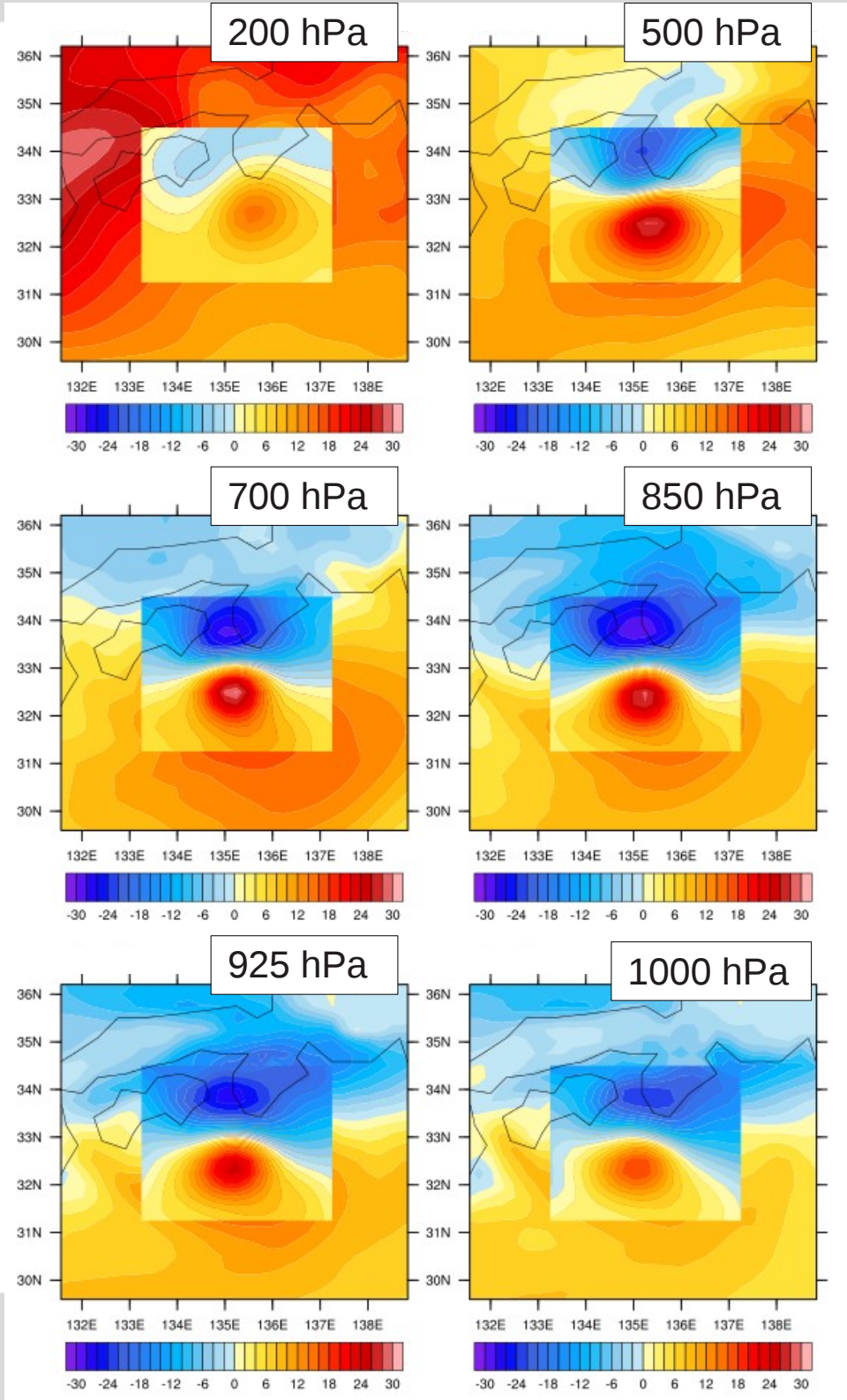
- ECMWF Re-analysis (0.25°) + ELDORA doppler radar (reflectivity and radial velocity) + dropsondes (p, T, RH, u, v, winddir) + satellite imagery (atmospheric motion vectors)
- ➔ Best estimate of the atmospheric state in the core region of Sinlaku

- Used for Sinlaku two students at the KIT during their Diplomthesis (Annette Förster and Julian Quitinting)
- Available at 19 Sep 00/06UTC and 20 Sep 06UTC, on a small domain (~ 400 x 400 km)

Methods, continued

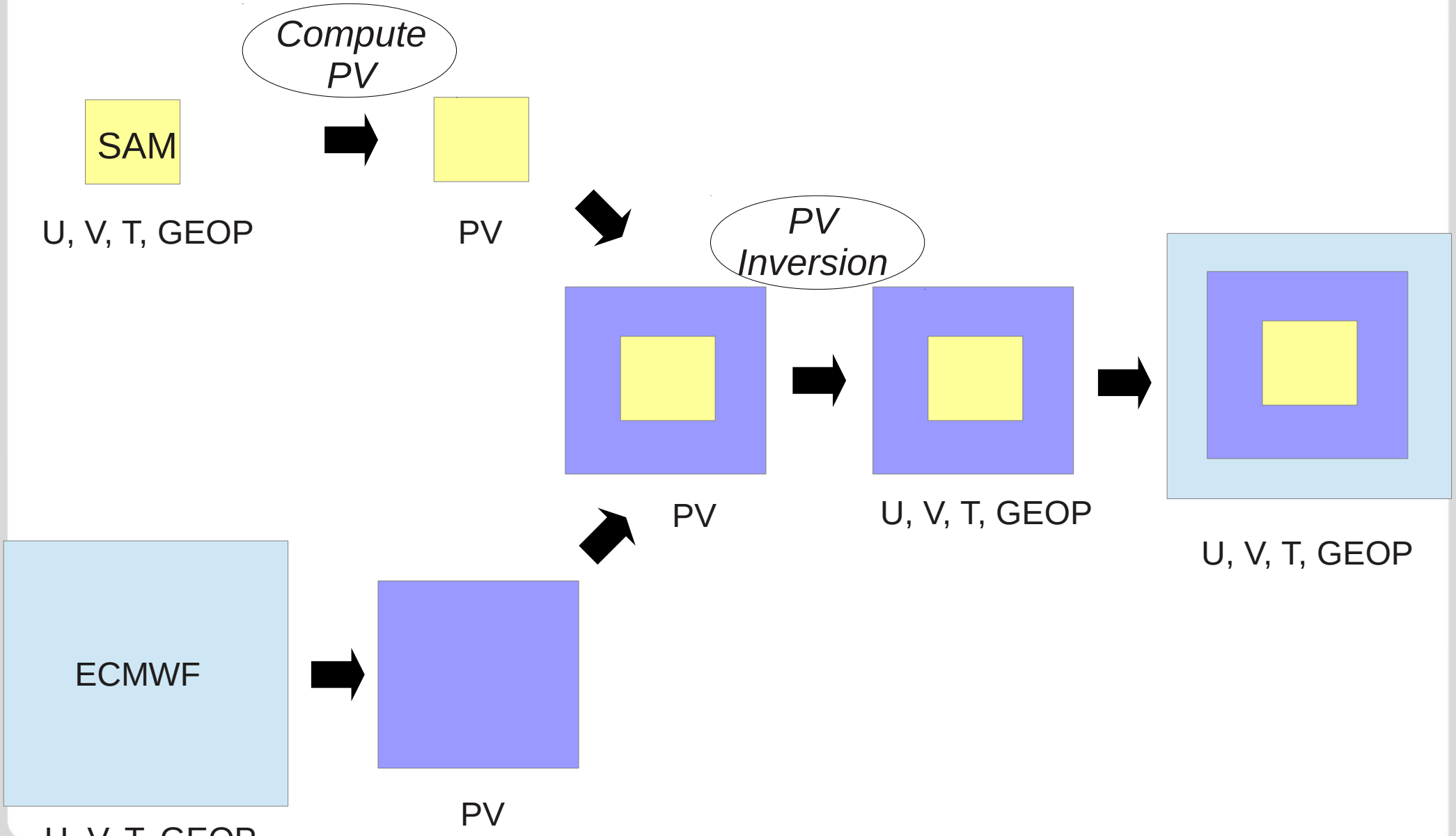
- SAMURAI data is unbalanced and inconsistent
- Sharp borders

Replacing the storm and smooth the borders using PV-inversion technique



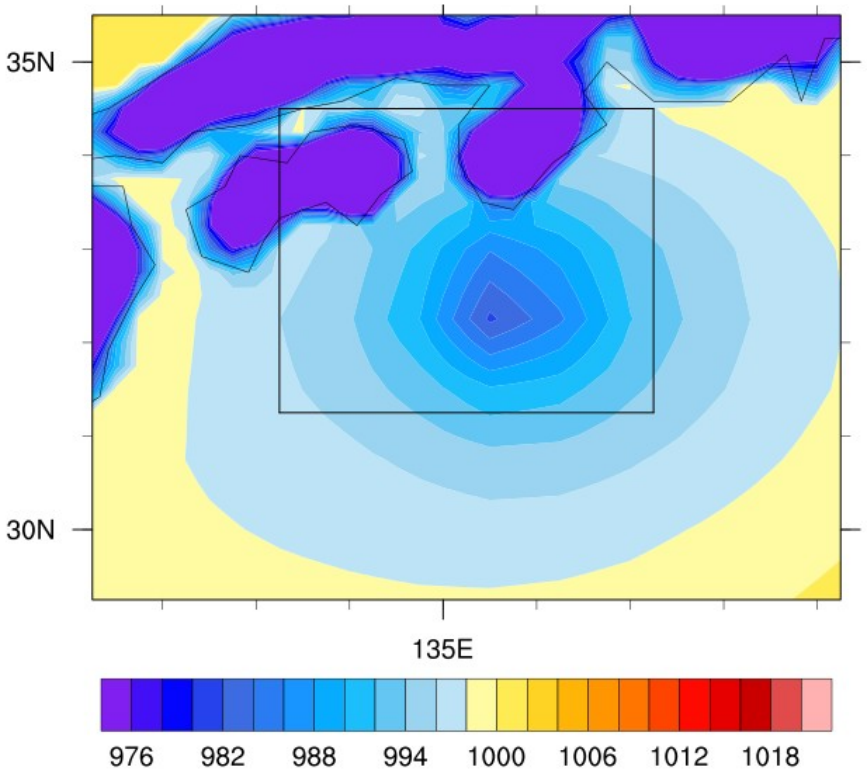
Here: u (m/s), 19 Sep. 2008, 06UTC

Methods, continued



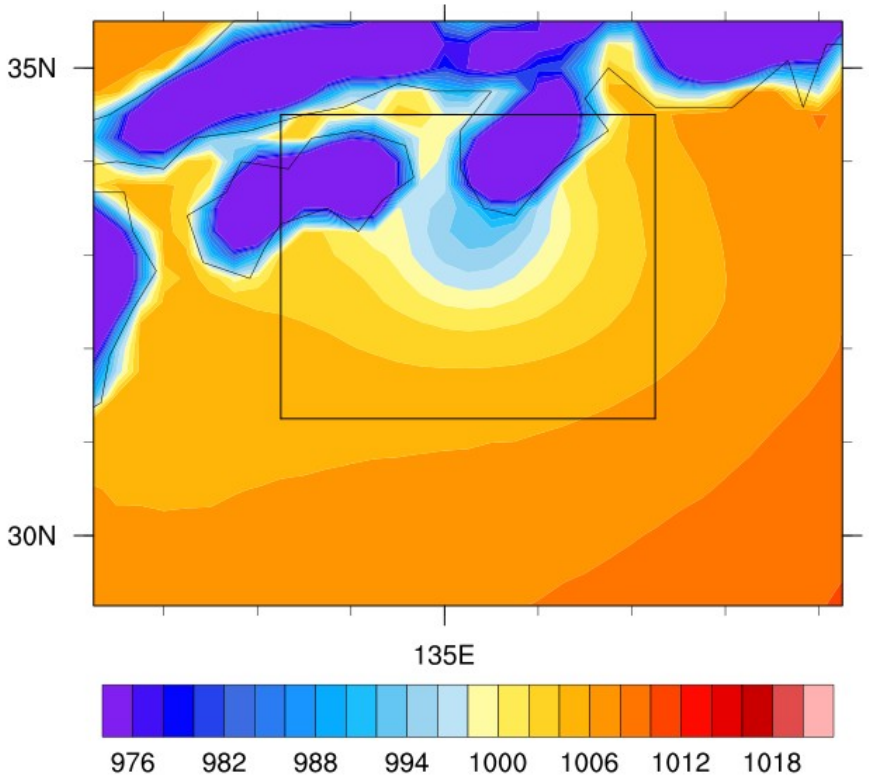
Methods, continued

Including SAMURAI data



Pressure (hPa)

ECMWF re-analysis incl. dropsondes



Pressure (hPa)

Here: model level 40/40, almost surface level

Outlook

Step 1: Simulate Sinlaku

- Simulation including increased storm

Outlook

Step 1: Simulate Sinlaku

- Simulation including increased storm

Step 2: Compare the simulation to observations and other data

Outlook

Step 1: Simulate Sinlaku

- Simulation including increased storm

Step 2: Compare the simulation to observations and other data

Step 3: Quantify the mechanisms that determine structural changes