Trajectory Calculation as Supporting Tool for Dust Storm Forecasting

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Outline

- ❑Introduction
- ❑Dust forecasting
- ❑Methodology
- ❑Proposed system
- ❑System validation
- ❑Conclusions

Introduction

- **Dust storms affect human**
  - Health
  - Commercial
  - Transport
  - Military operations
- **Dust storm research topics**
  - Dust characteristic
  - Dust sources
  - Transport process
  - Dust forecasting

Dust Forecasting

- Wind plays a major role in the generation and transport of dust storm.
- Drought condition is important factor
- Several dust forecasting models were developed
  - Aerosols models coupled with NWP models

- Proposal: Dust forecasting support tool using forward trajectory calculation is proposed.

Methodology

- Considering dust as a moving object in space and time
- Forward trajectory is used to determine the path it will follow

Trajectory Calculation

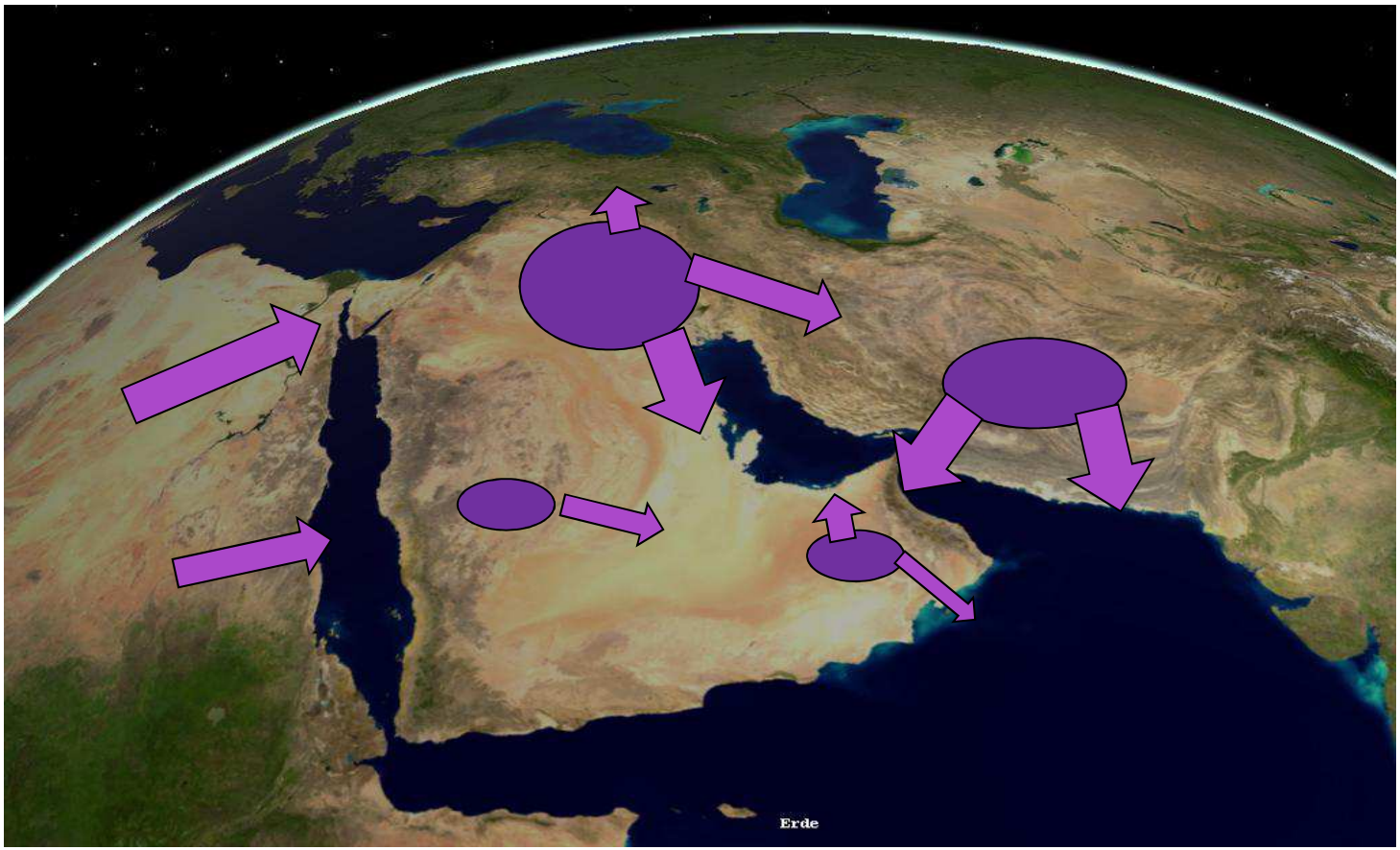
$$x_i(t+\Delta t) = x_i(t) + v_i(t)\,\Delta t \qquad \text{where i=1,2,3}$$

$$x_i^{n+1}(t+\Delta t) \approx x_i(t) + 0.5\Delta t\left\{v_i(x_i(t),t) + v_i(x_i^n(t+\Delta t),t+\Delta t)\right\}$$

Euler-Cauchy -Method with iteration, 2nd order accuracy

- hourly input of wind data
- cubic spatial interpolation
- linear temporal interpolation

Dust sources surrounding the area

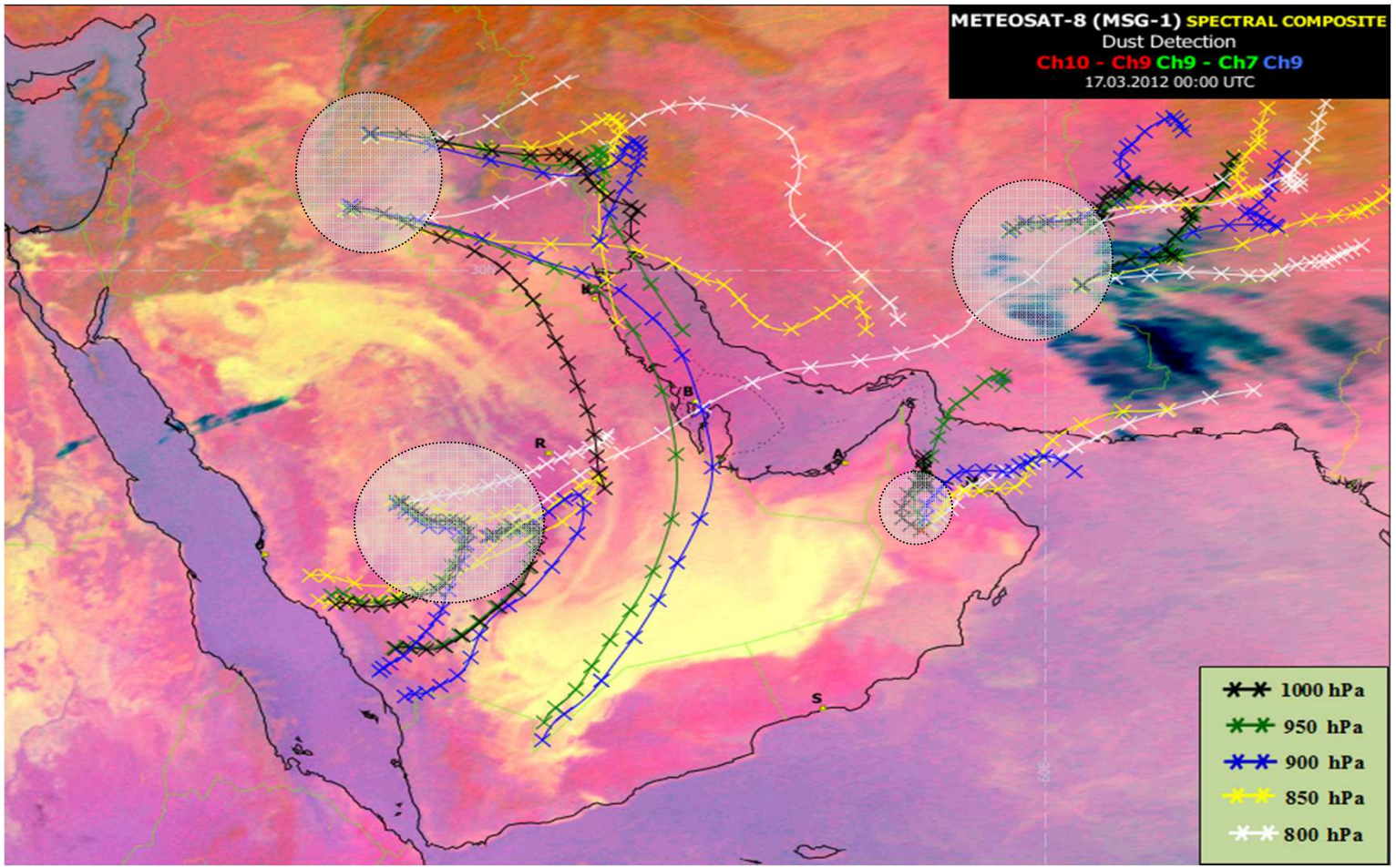


Dust sources surrounding the Arabian Peninsula [Al-Badi, 2006]

Proposed System

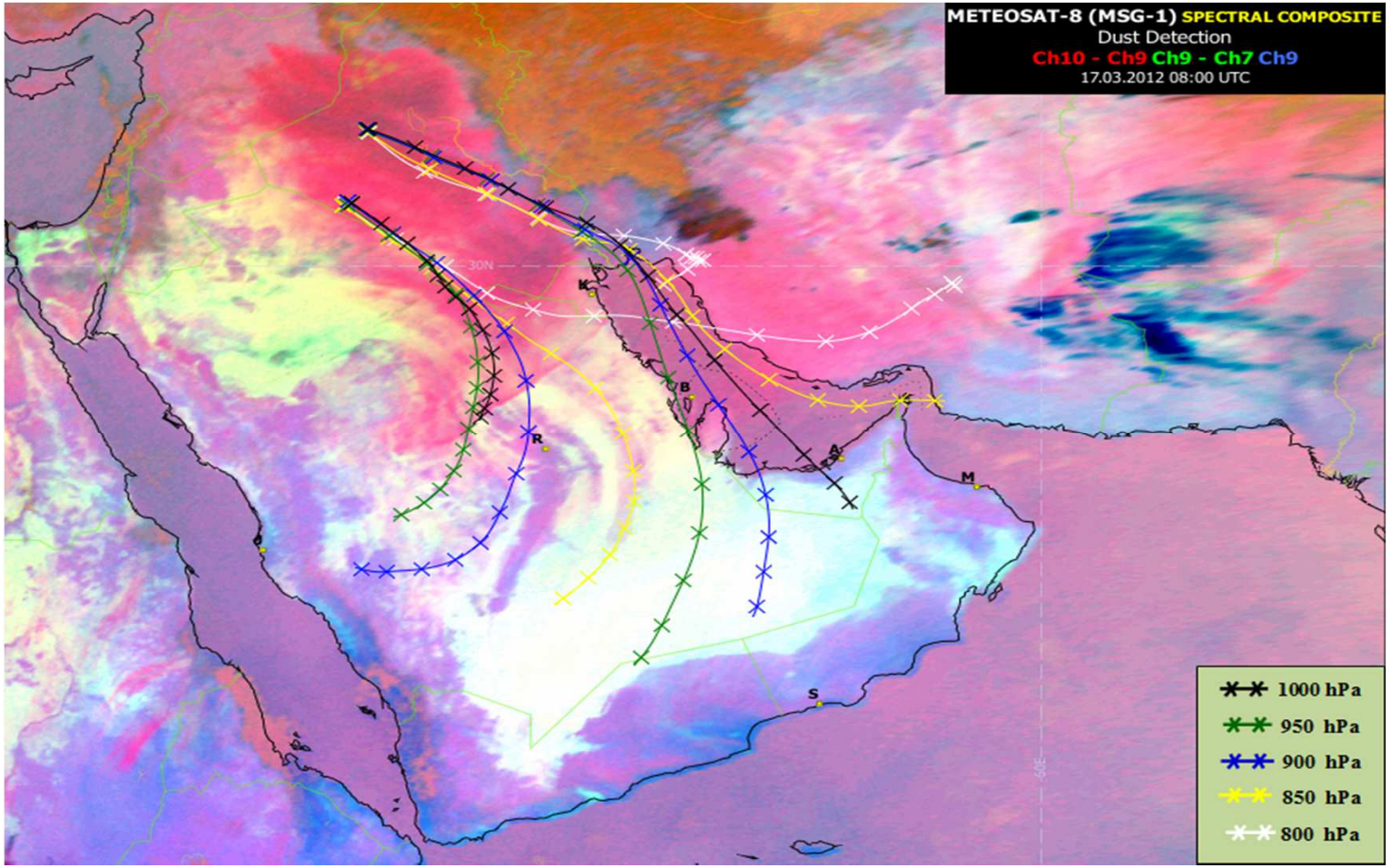
- "if Scenario" mode (during normal condition)
  - Answer the question "what are the possible paths if a dust storm is generated from one of the sources?"
  - Trajectory is calculated for each dust source after each NWP model run and for different time
- "real time" mode (during dust storm condition)
  - Used to adjust the first guise of the "if scenario" mode.
  - Trajectories are recalculated after dust detection with the correct location

48h forecast “if scenario” for 17/3/2012 00 UTC



Dust Storm 17-19 Mar 2012
Tigris and Euphrates rivers basin

Sat: 17/3/2012 08UTC
Trajectory: 48h based on 17/3/2012 00UTC



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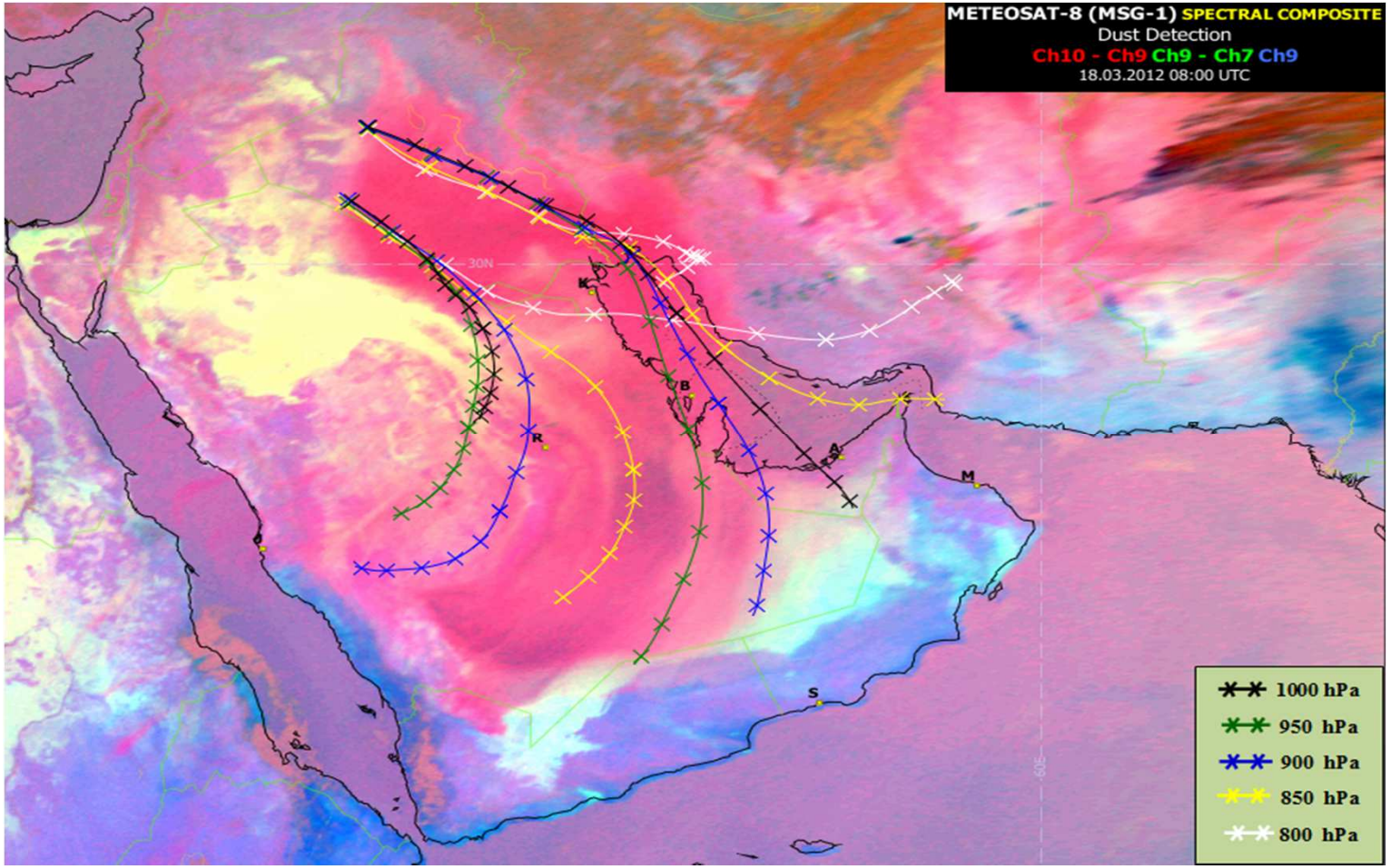

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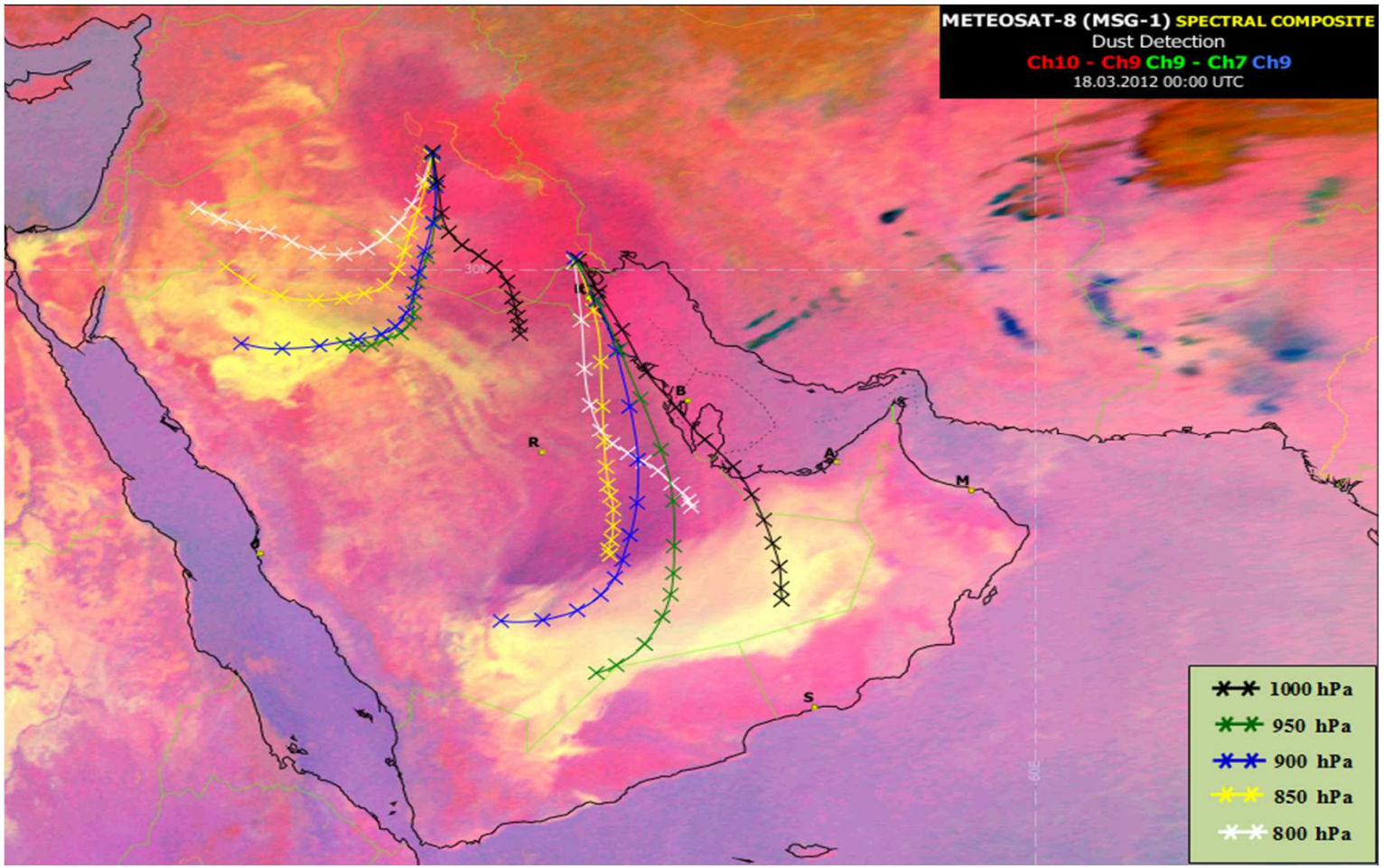

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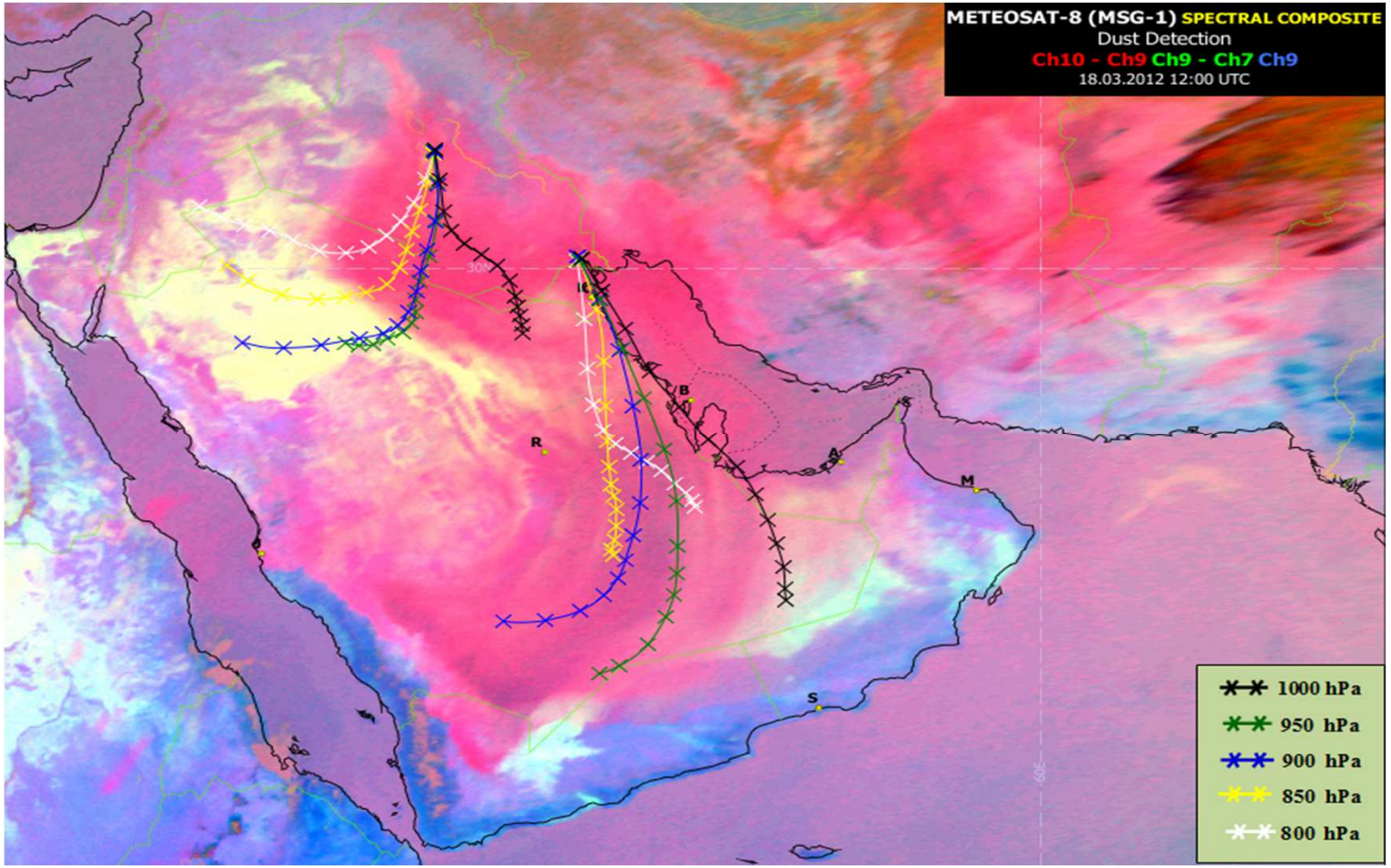

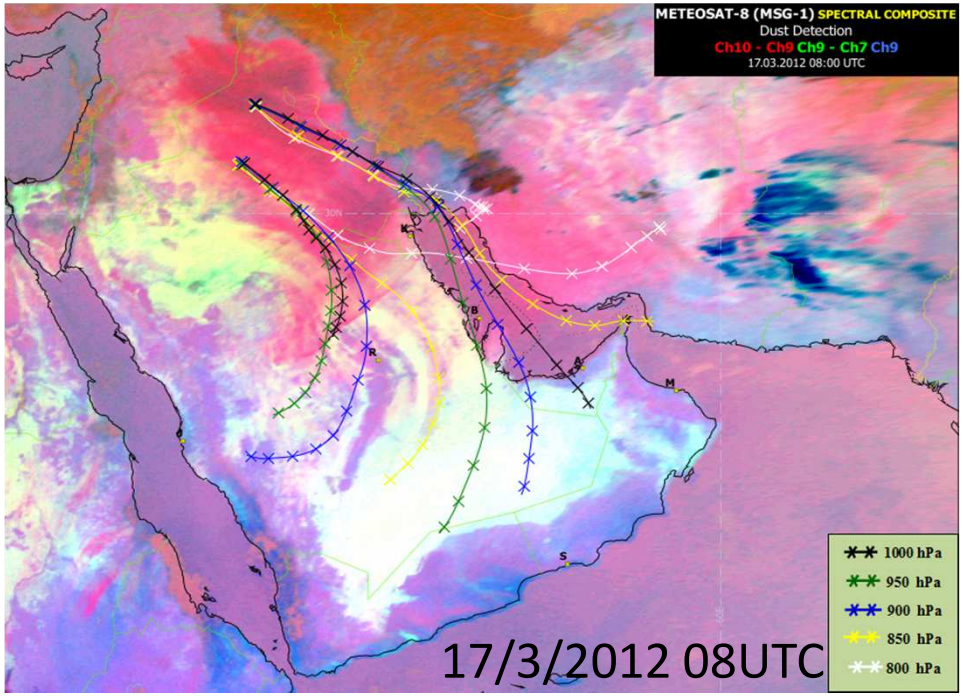
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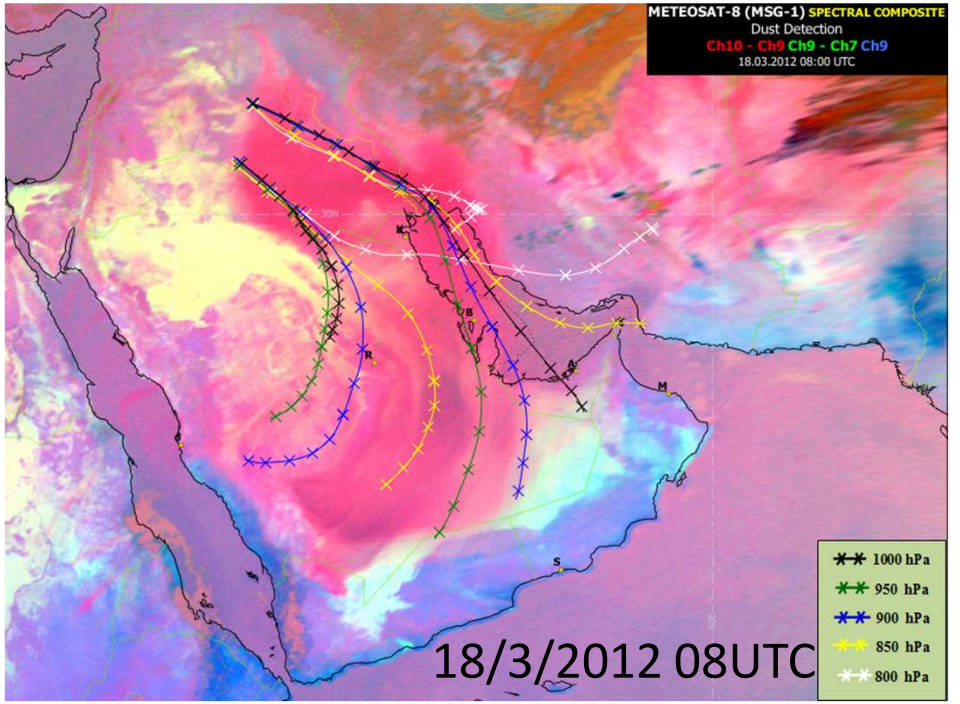
Dust Detection
Ch10 - Ch9 Ch9 - Ch7 Ch9
17.03.2012 08:00 UTC
1000 hPa
950 hPa
900 hPa
850 hPa
800 hPa
17/3/2012 08UTC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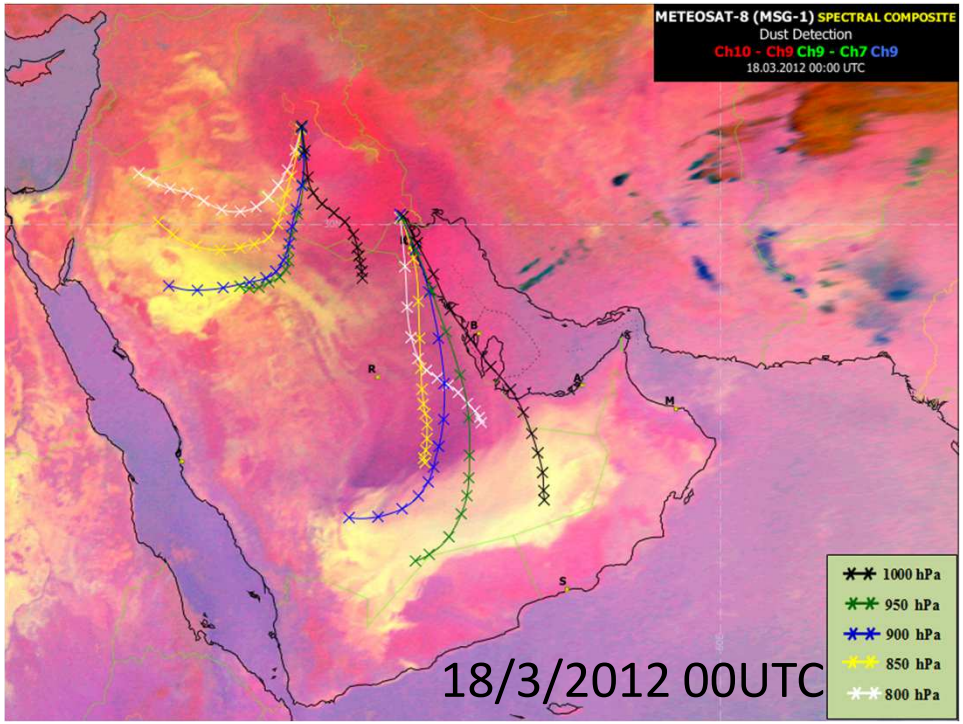
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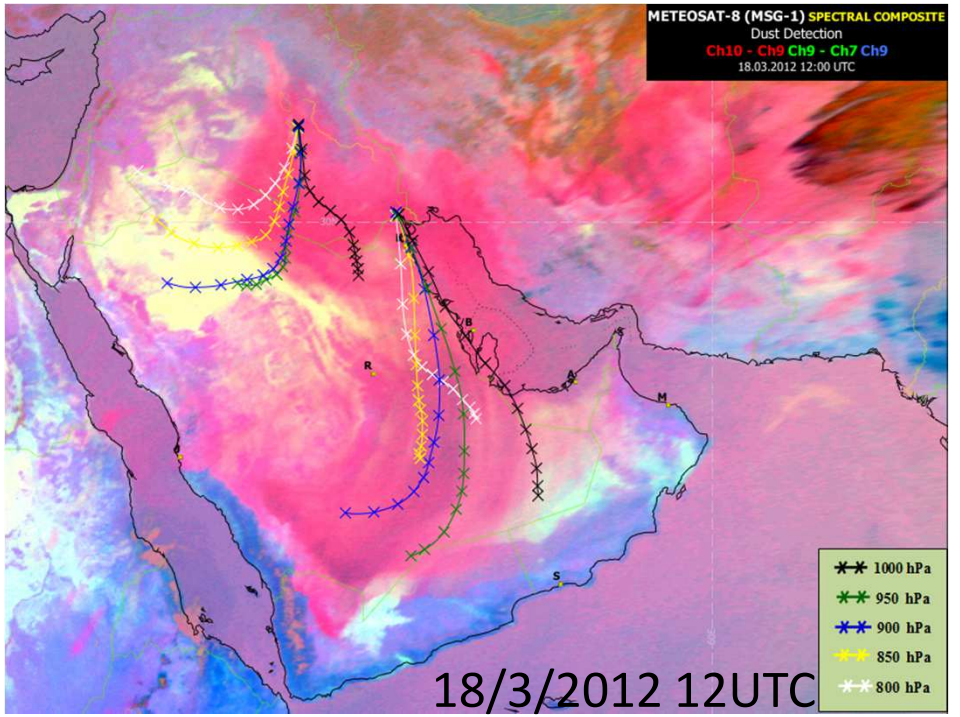
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Dust Storm 18-21 Mar 2012
Sistan and Baloushistan basin

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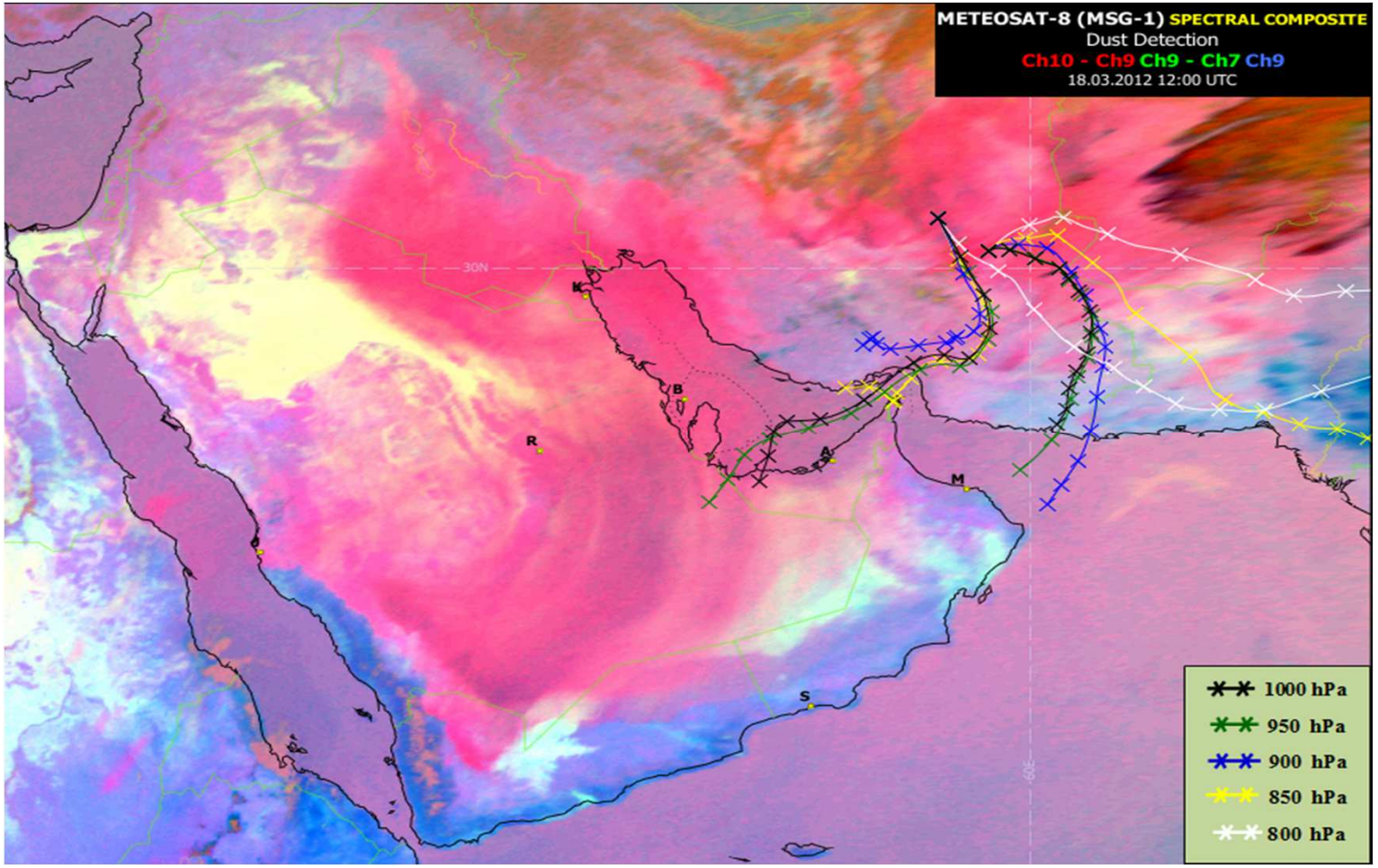
Trajectory: 48h based on 18/3/2012 00UTC



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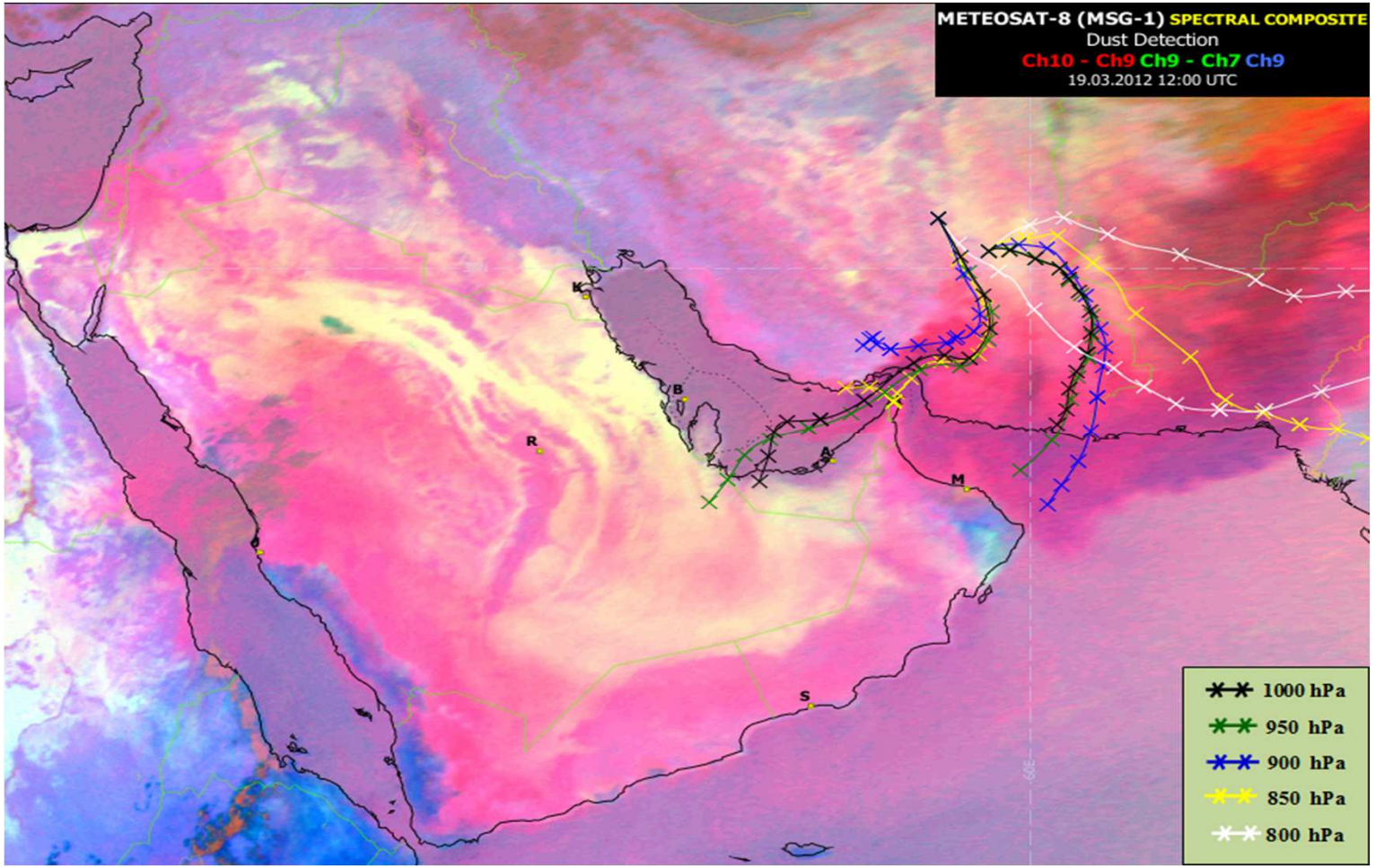

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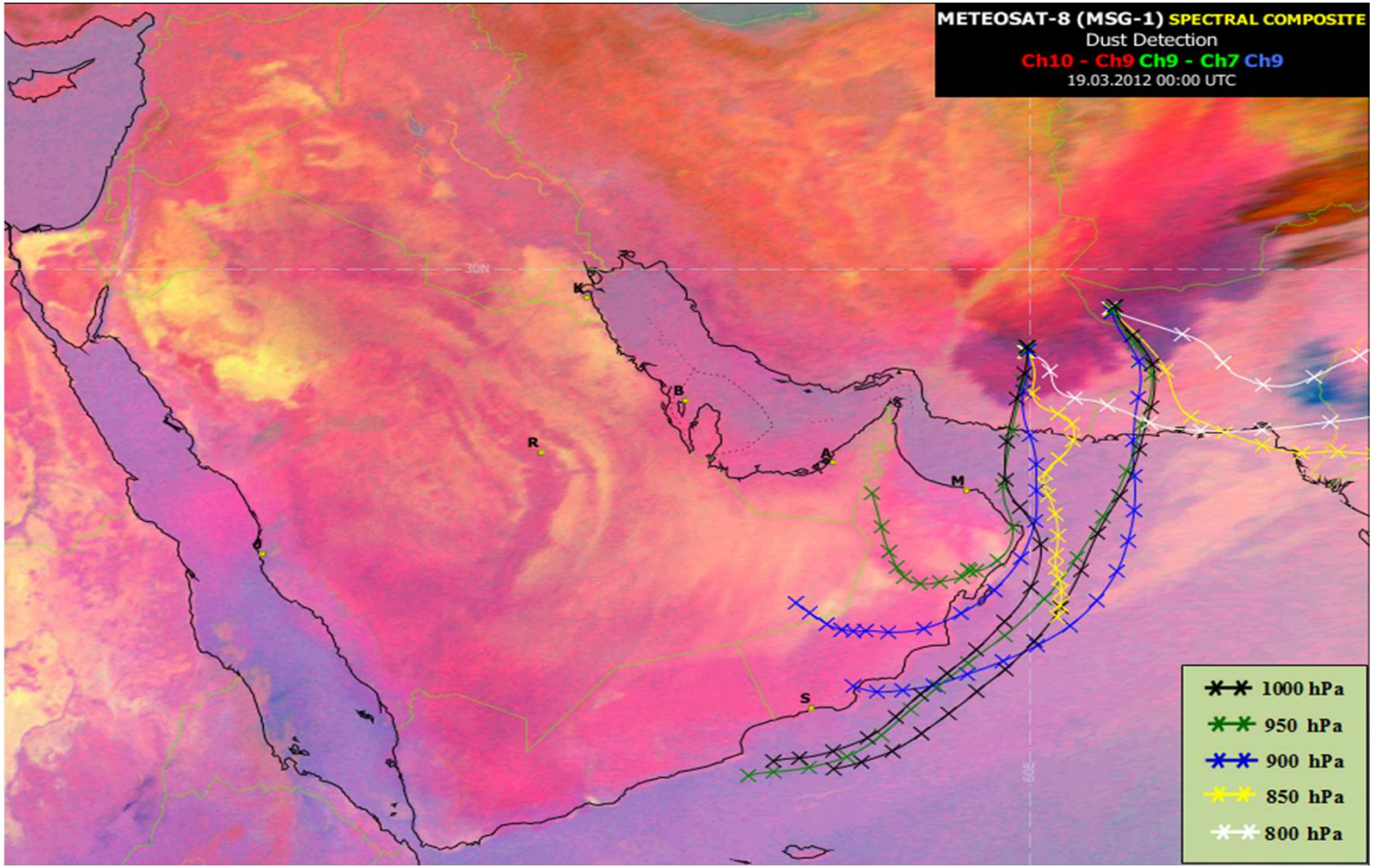
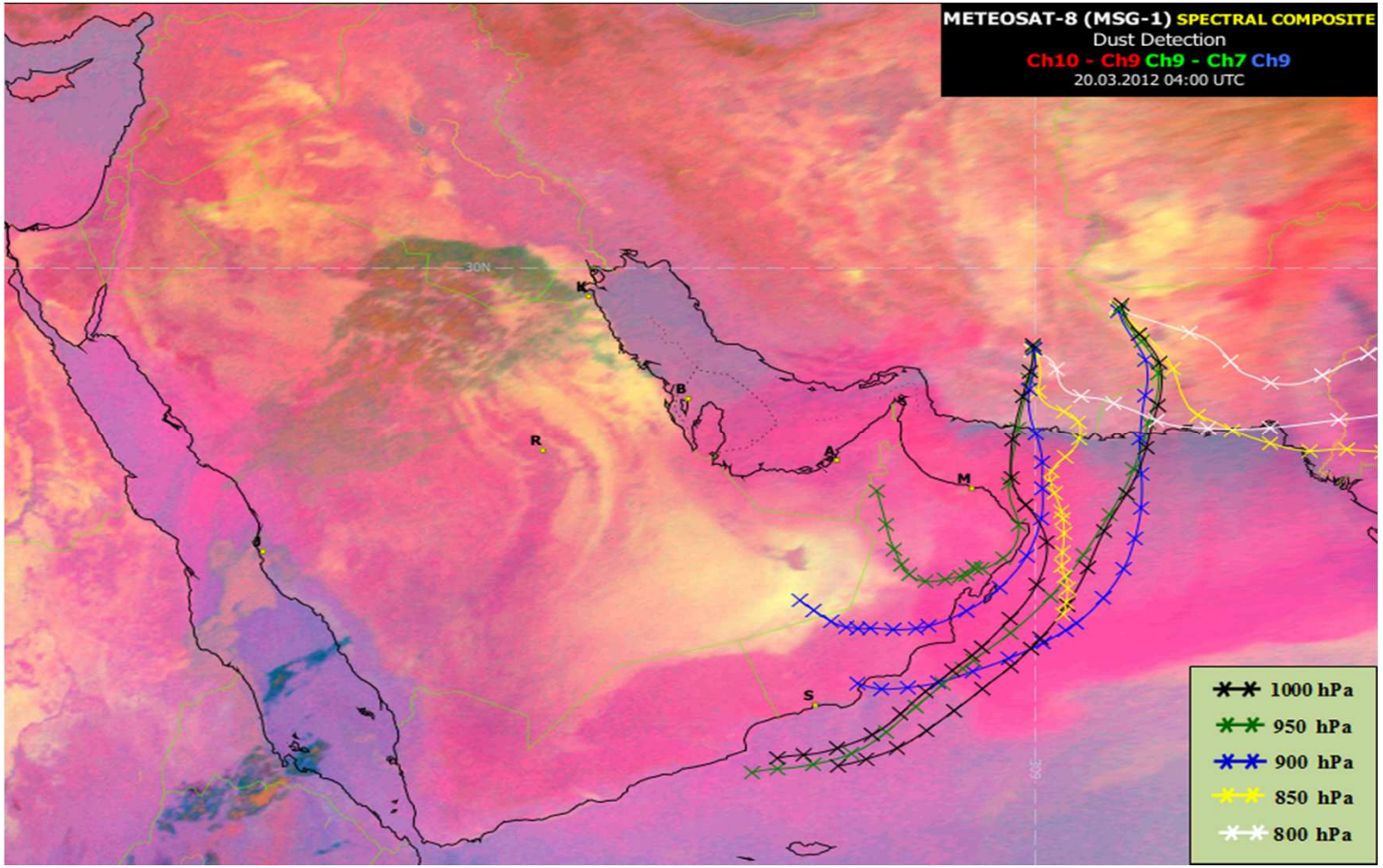
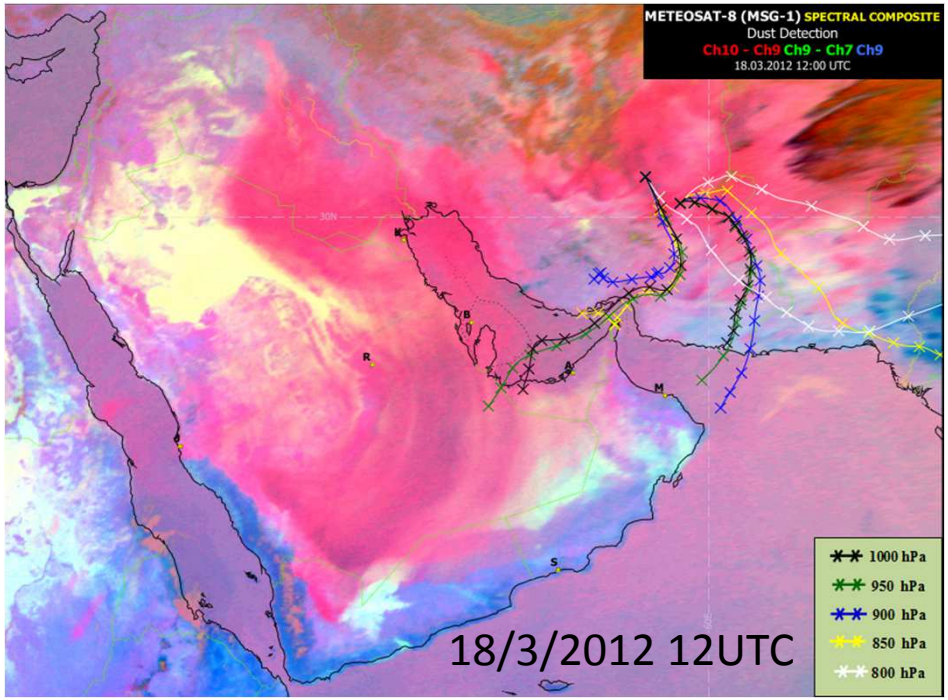


Sat: 20/3/2012 04UTC
Trajectory: 48h based on 19/3/2012 00UTC

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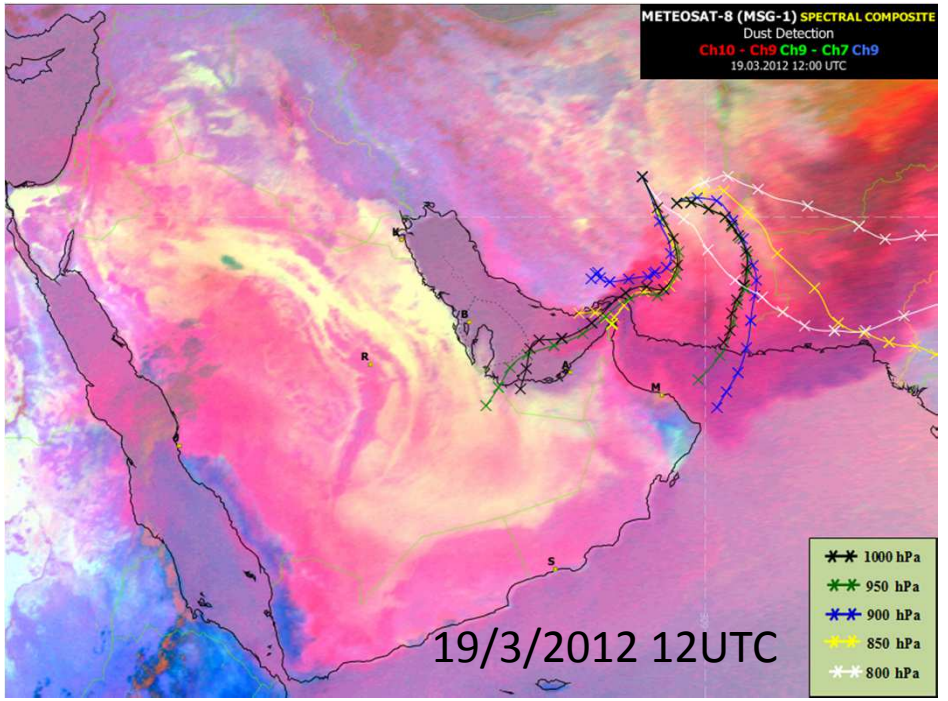
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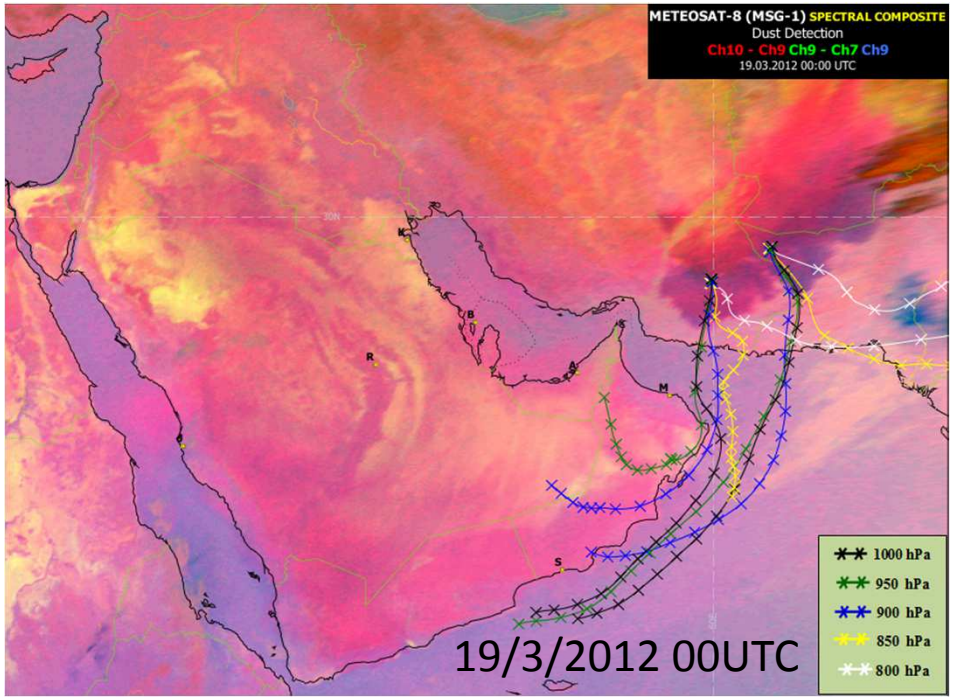
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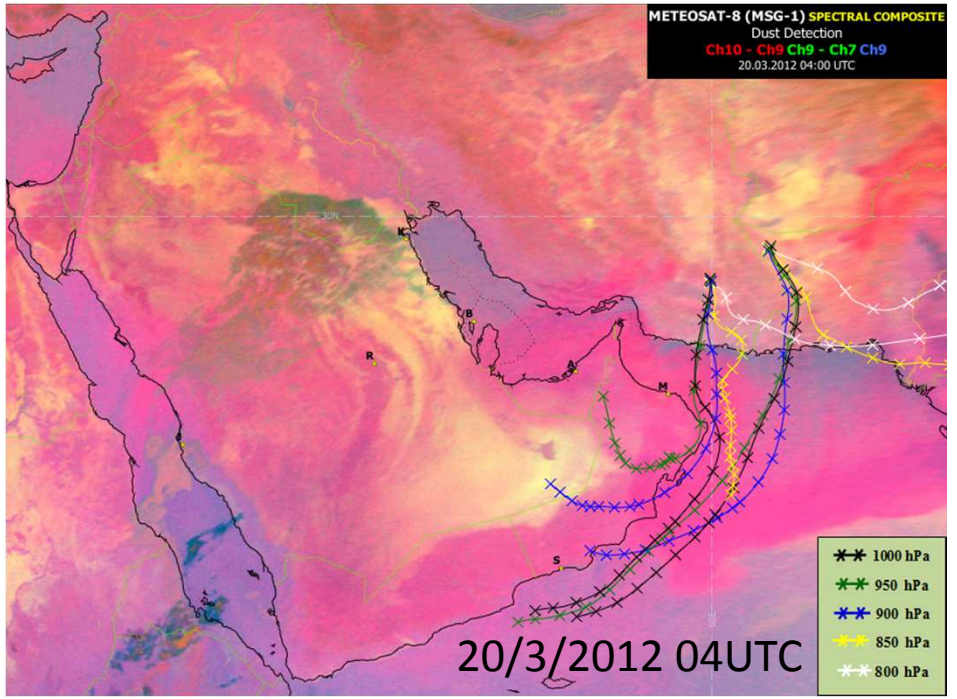
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20/3/2012 04UTC

Conclusions

- Trajectory based forecast supporting system was proposed
- The system give a first guess guidance.
- First guess is improved once the dust storm is detected
- Validation results shows good agreement with observation
- The quality of the system is a function of the quality of the NWP model forecast

Thank you for your attention